Technical Advice – Modelling of the proposed new indoor basketball stadium, 62&62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough

Date	17/11/2020
To	Transport for NSW (TfNSW)
From	Arcadis Australia Pacific Pty Ltd (Arcadis)
Project Name	Proposed Basketball Stadium – Traffic modelling
Subject	**Modelling of the proposed new indoor basketball stadium, 62&62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough**

1 Introduction

Transport for New South Wales (TfNSW) commissioned Arcadis Australia Pacific Pty Limited (Arcadis) to undertake an operational traffic modelling study in relation to a proposed new indoor basketball stadium, 62 and 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough (the proposal).

1.1 Background

We understand the proposal to be for an indoor basketball stadium incorporating 10 full size courts, car parking and associated works. It is understood that Basketball Association of Newcastle Ltd is in the process of finalizing a lease for the site to accommodate the proposed development.

A key planning issue for TfNSW relates to the potential operational impacts of the proposal on the Hillsborough Road and associated two intersections including:

- H23 Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and
- Hillsborough Road/Waratah Avenue (traffic signals).

1.2 Report purpose

This Technical Advice report has been prepared to document traffic modelling and assessment undertaken in relation to the new indoor basketball stadium proposal. Operational traffic modelling was undertaken for the study area road network using VISSIM software.

The following three access options were modelled with and without the proposal including:

- Option 1 proposes one access point via the Waratah Avenue (left in and right out movements permitted) with no access from the H23 on ramp
- Option 2 proposes two access points via left in/left out access intersection on the H23 on ramp and via left out only at the Waratah Avenue
- Option 3 proposes two access points via left in/left out access intersection on the H23 on ramp and via the Waratah Avenue (left in and right out movements permitted).

A consultation process involving TfNSW and key stakeholders constituted an important element of this modelling study. The stakeholder group was made up of representatives from TfNSW, Lake Macquarie City Council, proponent's Consultant including Catalyst Project Consulting Pty Ltd and SECA solution.

In October 2020, an assumption paper was prepared by Arcadis on traffic generation and distribution modelling assumptions. It was estimated that the proposal would generate about 335 vehicle movements in one hour during the afternoon peak period.

The traffic generation and distribution assumptions were agreed with the stakeholders and formed the basis of the operational traffic modelling for the proposal.

1.3 Modelling study area

Figure 1-1 shows the location of the proposed indoor basketball stadium (shown as red dotted line) and surrounding road network. The site is predominantly surrounding by residential areas to the south and east with the Hillsborough Public School to the north and the Newcastle Inner City Bypass to the west. The proposal is expected to impact traffic operations to both Newcastle Inner City Bypass/Hillsborough Road interchange (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue intersection (traffic signals). Figure 1-1 shows location of two analysed intersections.

Figure 1-1 Location of proposed site

1.4 Traffic modelling approach

A traffic assessment of the impacts associated with the proposed indoor basketball stadium was undertaken in two parts, namely:

- Modelling assumptions – trip generation and distribution of the proposal for business as usual condition. The business as usual condition represents the typical weekday afternoon peak period between 4 pm and 6pm
- VISSIM assessment – modelling three access options on the previous model developed for weekday afternoon peak period between 4 pm and 6pm

Arcadis previously developed a VISSIM network model as part of the Hillsborough Road corridor study for TfNSW. The traffic demand in the VISSIM model was based on counts undertaken during November 2017. The VISSIM model was updated for the following changes including:

- Improvements to the H23/Hillsborough Road (bow-tie) intersection by introducing signalised movements
- Growing background traffic volumes on Hillsborough Road and H23 ramps by 4.5 per cent for three years between 2017 and 2020. The background traffic growth rate of 1.5 per cent per annum is consistent with the future growth rate assumption used for the Hillsborough Road corridor study
- The current VISSIM model boundary extends up to 235 metres on Hillsborough Road from Waratah Avenue signals. In consultation with TfNSW, VISSIM model boundary has been extended to 420 metres until Charlestown Road signalised intersection.

Figure 1-2 shows that VISSIM model network study area.

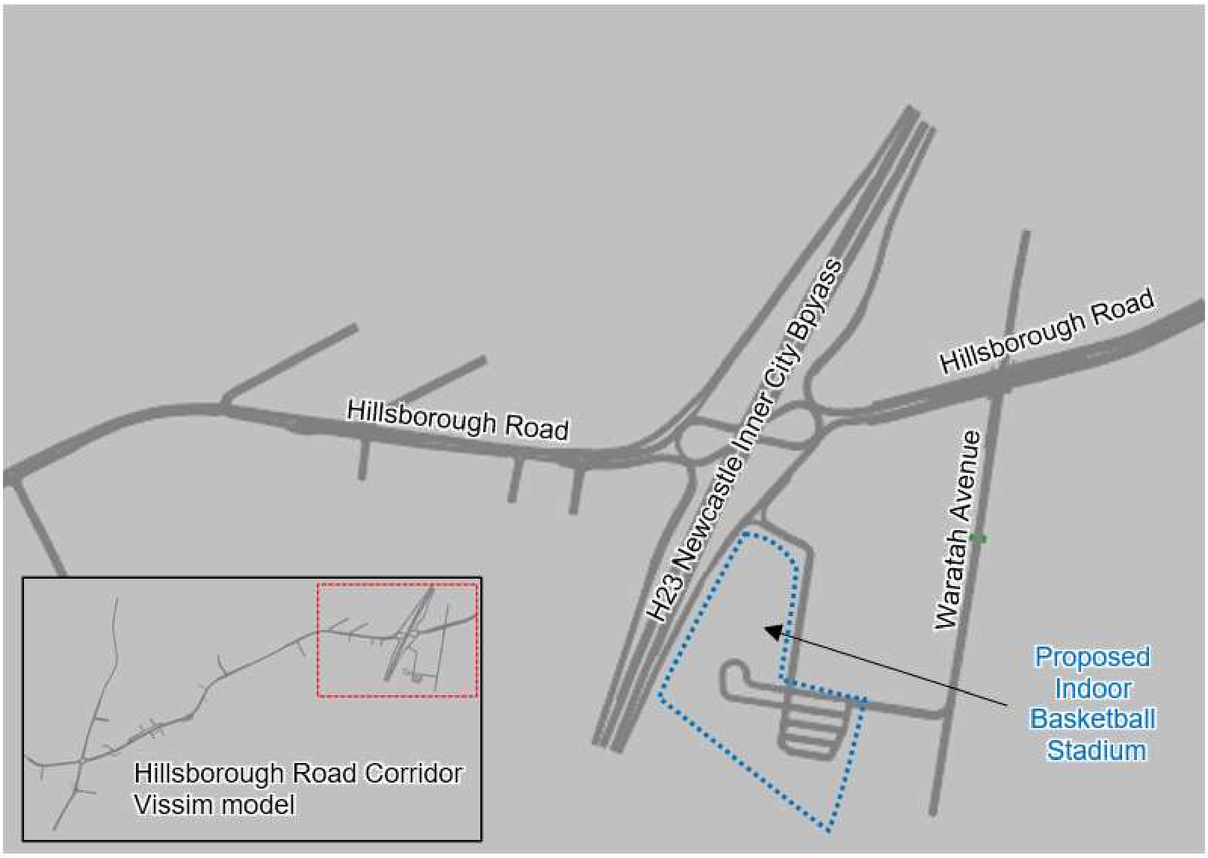

Figure 1-2 VISSIM model network

The relevant data from the following reports / Guides are used where relevant:

- *Architectural Plans - 62 and 62A Hillsborough Rd, Hillsborough and 109 Waratah Avenue, Charlestown*, prepared by BKA Architecture, 18 June 2020

- *P1680 Hillsborough Indoor Stadium Traffic Impact Assessment*, prepared by SECA solution, 19 June 2020
- *Guide to Traffic Generating Developments*, Issue 2.2, October 2002
- *Guide to Traffic Generating Developments Updated Traffic Surveys*, Version TDT 2013/04a, August 2013
- *TfNSW Traffic Modelling Guideline, version 1*, February 2013
- *TfNSW Technical Direction (TTD 2018/002) Traffic Signals in Microsimulation Modelling,* November 2018.

2 Traffic generation and distribution assumptions

The traffic generation and distribution assumptions documented in Section 2 were agreed with the stakeholders and formed the basis of the operational traffic modelling for the proposal.

2.1 Development parameters

The development parameters for the proposed indoor basketball stadium is sourced from *Architectural Plans - 62 and 62A Hillsborough Rd, Hillsborough and 109 Waratah Avenue, Charlestown, June 2020* provided by TfNSW.

The proposal would include provision for 10 indoor basketball courts, offices, car parking and café spaces.

The key development parameters include:

- Ten indoor basketball courts
- Car parking spaces up to 307 parking spaces
- Shutter bus layover, shutter but drop off zone and bus parking zone
- Motorbike and bicycle parking.

2.2 Trip generation

2.2.1 Empirical data

The Guide to Traffic Generating Developments does not provide any specific advice for this type of development. Given the current Covid-19 restrictions it is not possible to survey the existing site to determine the current traffic demands.

Arcadis reviewed empirical data collected for a similar Basketball Stadium elsewhere in Victoria. The actual survey data was collected for the Waverley Basketball Stadium, Chadstone, Victoria[1]. The data was collected in 2009 during a Friday junior representative basketball competition. The Friday data from the Waverley Basketball Stadium represents the normal weekday afternoon condition. The data shows relationship between number of courts and peak hour traffic movements as follows:

- During the weekday afternoon, 5 of 6 courts were used which is equivalent to 83 per cent usages
- The average vehicle movement during the afternoon period was about 42 vehicle movements per hour per court.

The empirical data from the Waverley Basketball provides some guidance on the predicted trip generation from the proposed Indoor Basketball Stadium.

2.2.2 Trip generation during normal weekday use

The normal weekday use of the development will allow for local teams and clubs to use the facilities for training from Monday to Friday and the potential for evening competitions.

The development proposes 10 indoor basketball courts. Assuming 80 per cent usages (eight courts) during weekday afternoon, the development is likely to generate about 335 vehicles movements in a one-hour period. Assuming some overlap between arriving and departing traffic, traffic model adopted traffic split equally in and out of the site.

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[1] *Mullum Mullum Reserve Traffic and Parking Study,* prepared by Ratio for Manning City Council, October 2013.

Table 2-1 summarises trip generation estimated for the Newcastle Indoor Basketball Stadium.

Table 2-1 Trip generation for Indoor Basketball Stadium

Total number of courts	10 courts
Assumed usages during weekday PM peak	80%
Number of courts in use	8 courts
Trip generation rate	PM peak trip rate - 42 vehicle movements per hour per court
PM peak hour trip generation	335 vehicle movements per hour

Table 2-2 shows arriving and departing distribution assumed for the development.

Table 2-2 Arrival and departure distribution

Arrival and departure distribution		PM peak traffic generation (vehicles per hour)		
Arrival	**Departure**	**Arrival**	**Departure**	**Two-way**
50%	50%	167.5	167.5	335

Figure 2-1 shows the 15-minute arrival and departure distribution profiles between 4pm and 6pm proposed to be used for the VISSIM model. Table 2-3 show estimated 15-minute arrival and departure traffic volumes between 4pm and 6pm for the development traffic.

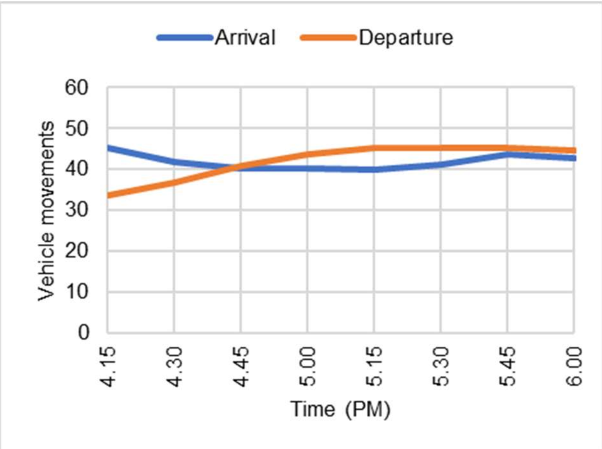


Figure 2-1 Traffic profile for arrival and departure distribution scenarios

Table 2-3 Estimated 15-minute arrival and departure traffic volumes between 4pm and 6pm

Time	Arrival	Departure
4.00-4.15	45	34
4.15-4.30	42	37
4.30-4.45	40	41
4.45-5.00	40	44
5.00-5.15	40	45
5.15-5.30	41	45
5.30-5.45	44	45
5.45-6.00	43	44
Total PM peak two hours (4pm to 6pm)	335	335

2.3 Access options

Three site access options were identified by TfNSW for the proposal, including

- Option 1 proposes one access point via the Waratah Avenue (left out and right in movements permitted) with no access from the H23 on ramp
- Option 2 proposes two access points via left in/left out access intersection on the H23 on ramp and via left out only at the Waratah Avenue
- Option 3 proposes two access points via left in/left out access intersection on the H23 on ramp and via the Waratah Avenue (left out and right in movements permitted).

Figure 2-2 shows schematic diagram of three access options 1 to 3.

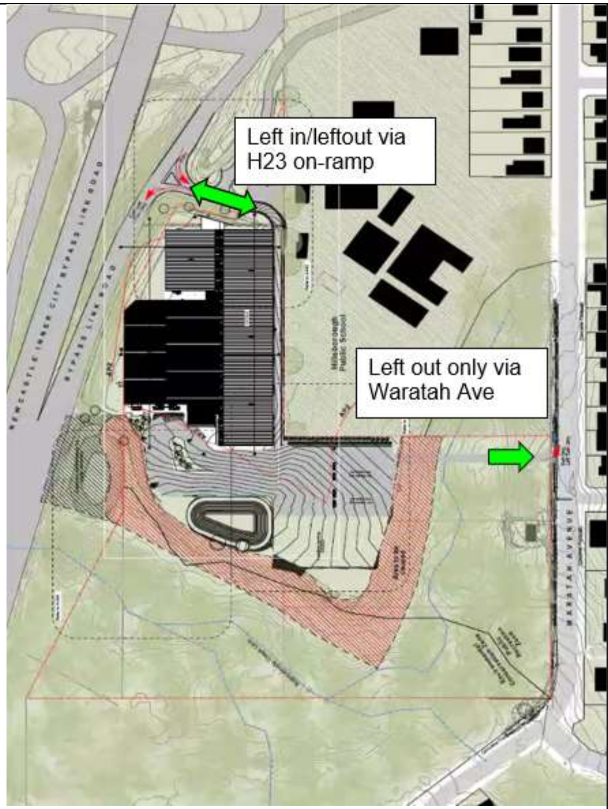
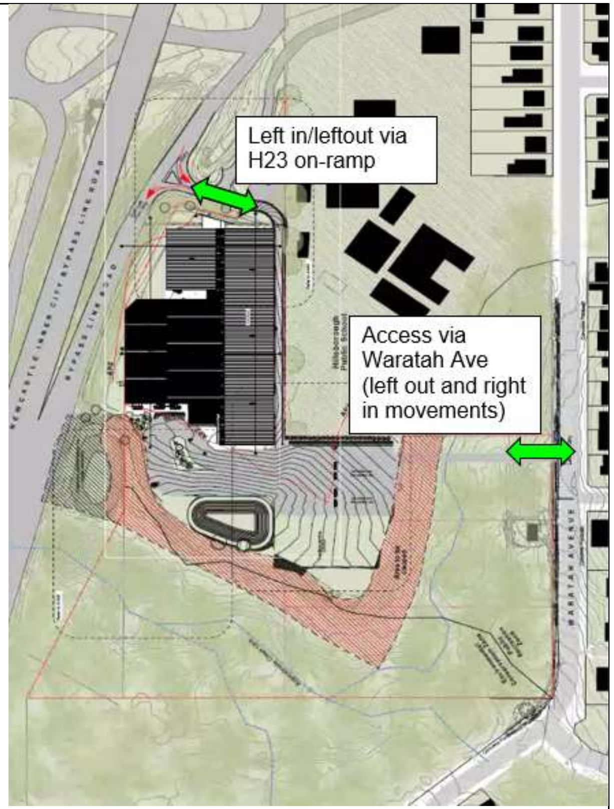
		
Option 1 access via Waratah Avenue (left out and right in movements)	Option 2 access via H23 (left in/left out) and Waratah Avenue (left out only)	Option 3 via H23 (left in/left out) and Waratah Avenue (left out and right in movements)

Figure 2-2 Proposed access arrangement three options

2.4 Traffic distribution

The trip distribution to and from site varies depending on site access options.

2.4.1 Option 1

Figure 2-3 shows traffic distribution for Option 1. Traffic distribution is shown by inbound and outbound direction.

In Option 1, 100 per cent of inbound traffic would access the site via Waratah Avenue. Of these,

- 20 per cent travel from the north via the Newcastle Inner City Bypass
- 10 per cent travel from the south via the Newcastle Inner City Bypass
- 27 per cent travel from the east via Hillsborough Road
- 43 per cent travel from the west via Hillsborough Road.

Similar trip distribution is assumed for the outbound traffic.

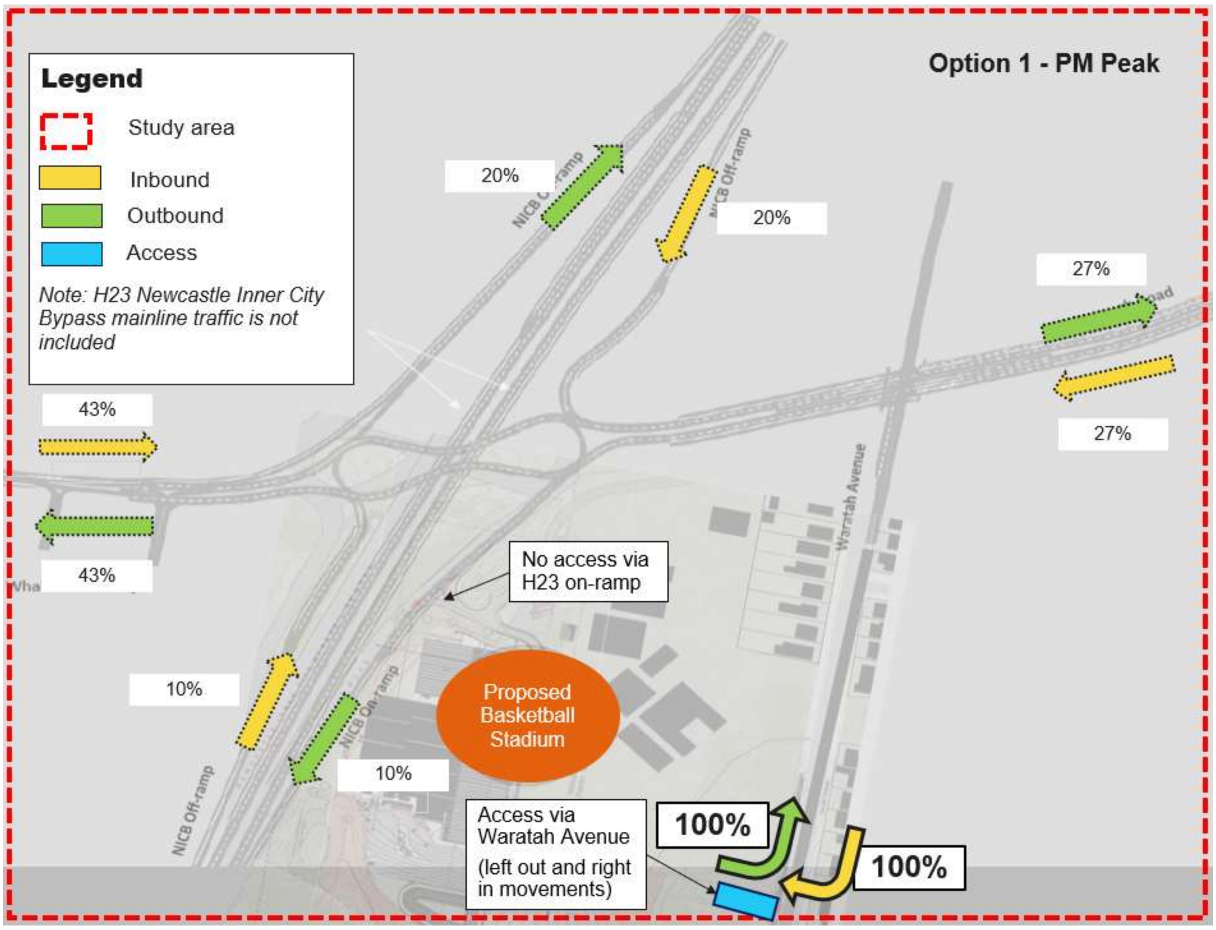


Figure 2-3 Estimated PM peak trip distribution for Option 1

2.4.2 Option 2

Figure 2-4 shows traffic distribution for Option 2. Traffic distribution is shown by inbound and outbound direction.

In Option 2, 100 per cent of inbound traffic would access the site via the H23 on ramp. Of these,

- 20 per cent travel from the north via the Newcastle Inner City Bypass
- 10 per cent travel from the south via the Newcastle Inner City Bypass
- 27 per cent travel from the east via Hillsborough Road
- 43 per cent travel from the west via Hillsborough Road.

In the outbound direction, about 10 per cent of traffic leave the site via the H23 on ramp and 90 per cent of traffic leave the site via the Waratah Avenue.

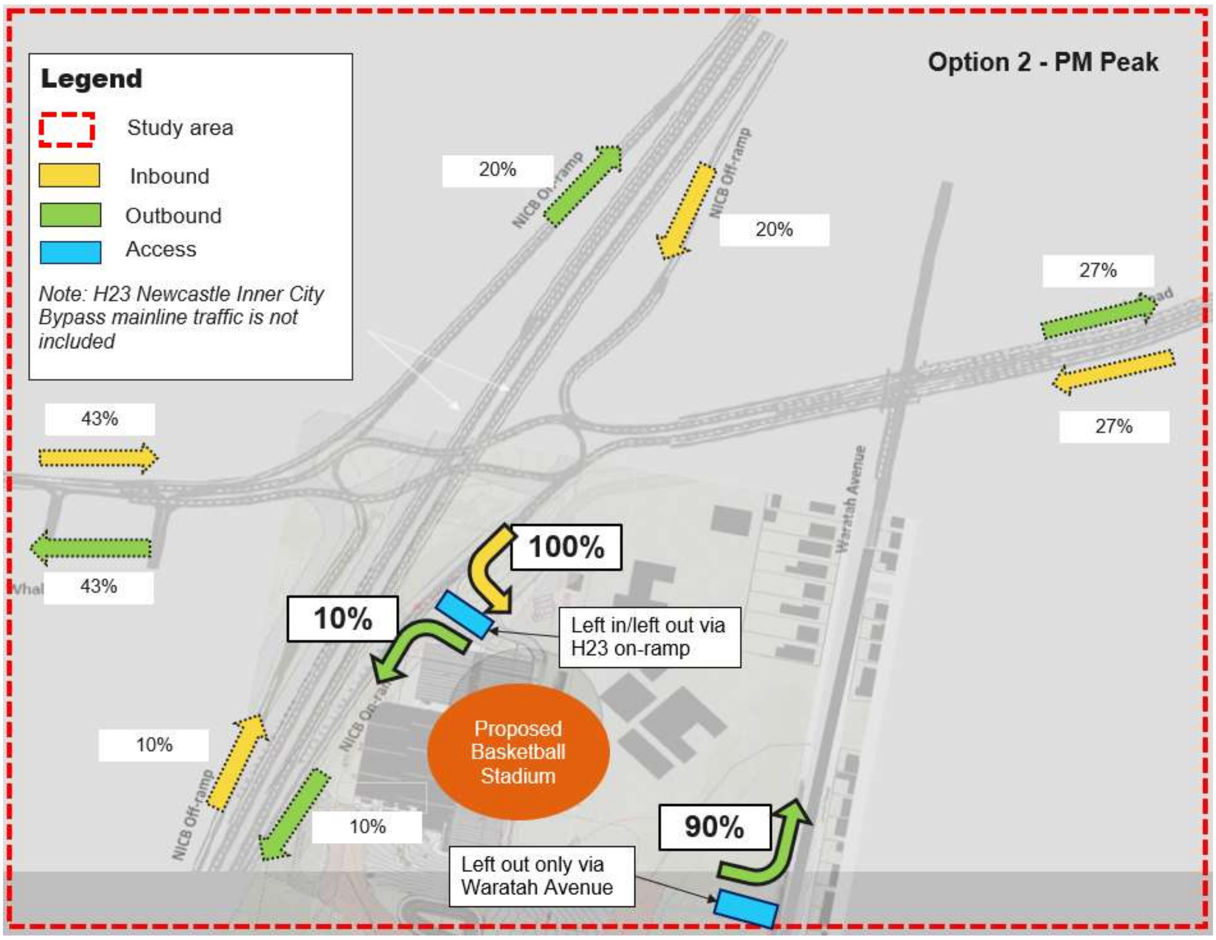


Figure 2-4 Estimated PM peak trip distribution for Option 2

2.4.3 Option 3

Figure 2-5 shows traffic distribution for Option 3. Traffic distribution is shown by inbound and outbound direction.

In Option 3, about 73 per cent of inbound traffic would access the site via the H23 on ramp and 27 per cent of traffic access the site via the Waratah Avenue. Of these,

- 20 per cent travel from the north via the Newcastle Inner City Bypass
- 10 per cent travel from the south via the Newcastle Inner City Bypass
- 27 per cent travel from the east via Hillsborough Road
- 43 per cent travel from the west via Hillsborough Road.

In the outbound direction, about 10 per cent of traffic leave the site via the H23 on ramp and 90 per cent of traffic leave the site via the Waratah Avenue.

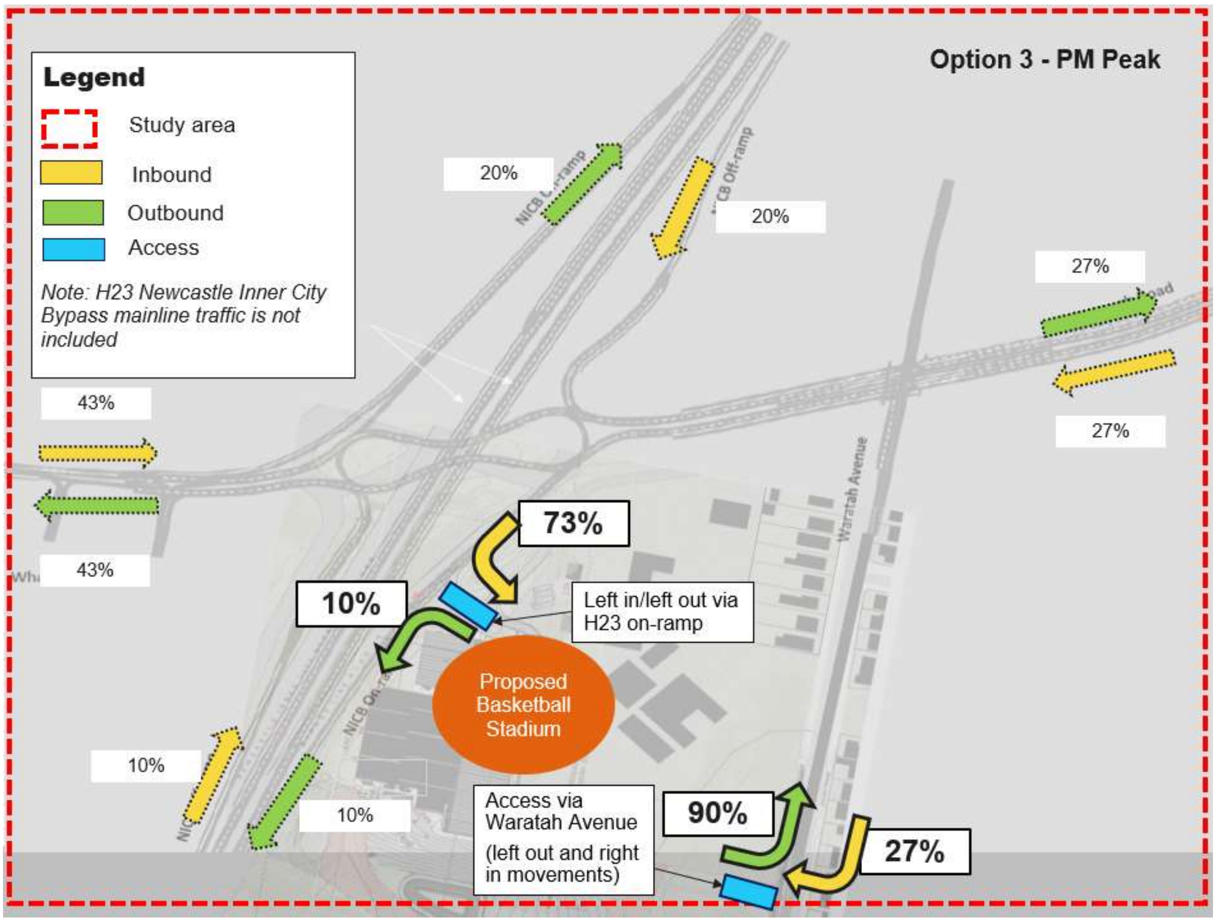


Figure 2-5 Estimated PM peak trip distribution for Option 3

3 Modelling assessment and results

The proposal is expected to impact traffic operations to both Newcastle Inner City Bypass/Hillsborough Road interchange (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue intersection (traffic signals). For modelling purpose, it was assumed that indoor basketball stadium proposal would be operational by 2021. The level of service (LoS), average delays and queue length are reported for both intersections for 2021 afternoon peak hour between 5pm and 6pm.

3.1 Level of service

The intersection level of service (LoS) is reported in accordance with the TfNSW traffic modelling guidelines. These recommend that, for priority intersections such as a roundabout and sign-controlled intersections, the level of service value is determined by the critical movement with the highest delay. With these type of intersection controls (roundabout, Stop and Give Way sign controls), some movements may experience high levels of delay while other movements may experience minimal delay.

For a signalised intersection, the level of service criteria is related to the average intersection delay measured in seconds per vehicle.

Table 3-1 below shows the level of service criteria for intersection assessment.

Table 3-1 Level of service criteria for intersections

Average delay per vehicle (seconds per vehicle)	Level of service (LoS)	Traffic signals, roundabouts	Stop and Give Way sign controls (sign controlled)
Less than 14	A	Good operation	Good operation
More than 14 to 28	B	Good with acceptable delays & spare capacity	Acceptable delays & spare capacity
More than 28 to 42	C	Satisfactory	Satisfactory, but incident study required
More than 42 to 56	D	Operating near capacity	Near capacity & accident study required
More than 56 to 70	E	At capacity; at signals, incident will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
More than 70	F	Unsatisfactory with excessive queuing	Unsatisfactory with excessive queuing

Source: TfNSW Traffic Modelling Guidelines, Version 1.0, February 2013

3.2 Queue length

The queue length (95th percentile) is reported for afternoon peak hour between 5pm and 6pm for Newcastle Inner City Bypass/Hillsborough Road interchange (bow-tie roundabout) and Hillsborough Road/Waratah Avenue intersection (traffic signals). The VISSIM predicted queues lengths are shown graphically in four colours:

	Queue length of less than 100 metres
	Queue length of between 100 and 200 metres
	Queue length of between 200 and 300 metres
	Queue length of greater than 300 meters

3.3 Traffic volumes

The afternoon peak hour traffic volumes are reported for base case (without proposal) and three access options 1 to 3 (with proposal). For modelling purpose, it was assumed that indoor basketball stadium proposal would be operational by 2021.

Figure 3-1 shows predicted turning movements at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue (traffic signals) for base case (without proposal) for PM peak hour (5pm to 6pm).

In the PM peak, Hillsborough Road carried substantially higher traffic volumes in the westbound direction compared to the eastbound direction.

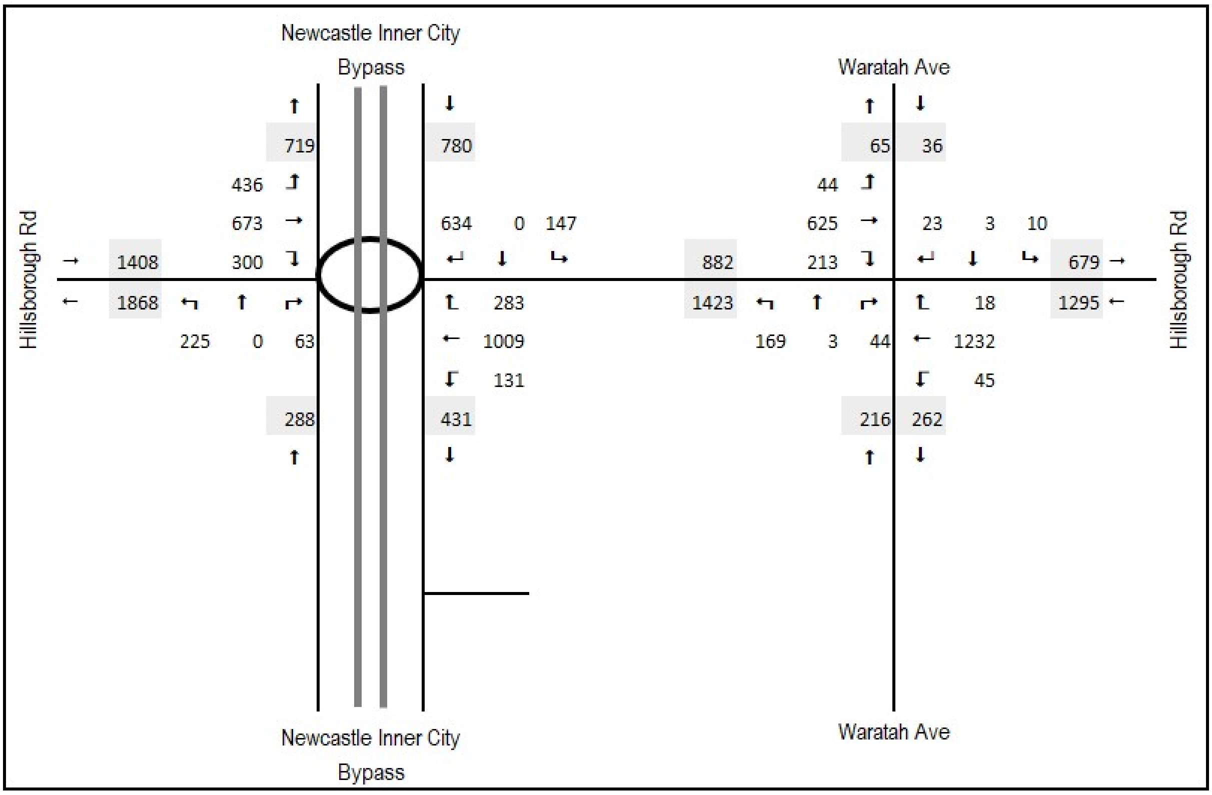


Figure 3-1 Predicted PM peak hour – 2021 without proposal

Figure 3-2 overleaf show predicted turning movements at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue (traffic signals) for access Option 1 (with proposal) for 2021 PM peak hour (5pm to 6pm).

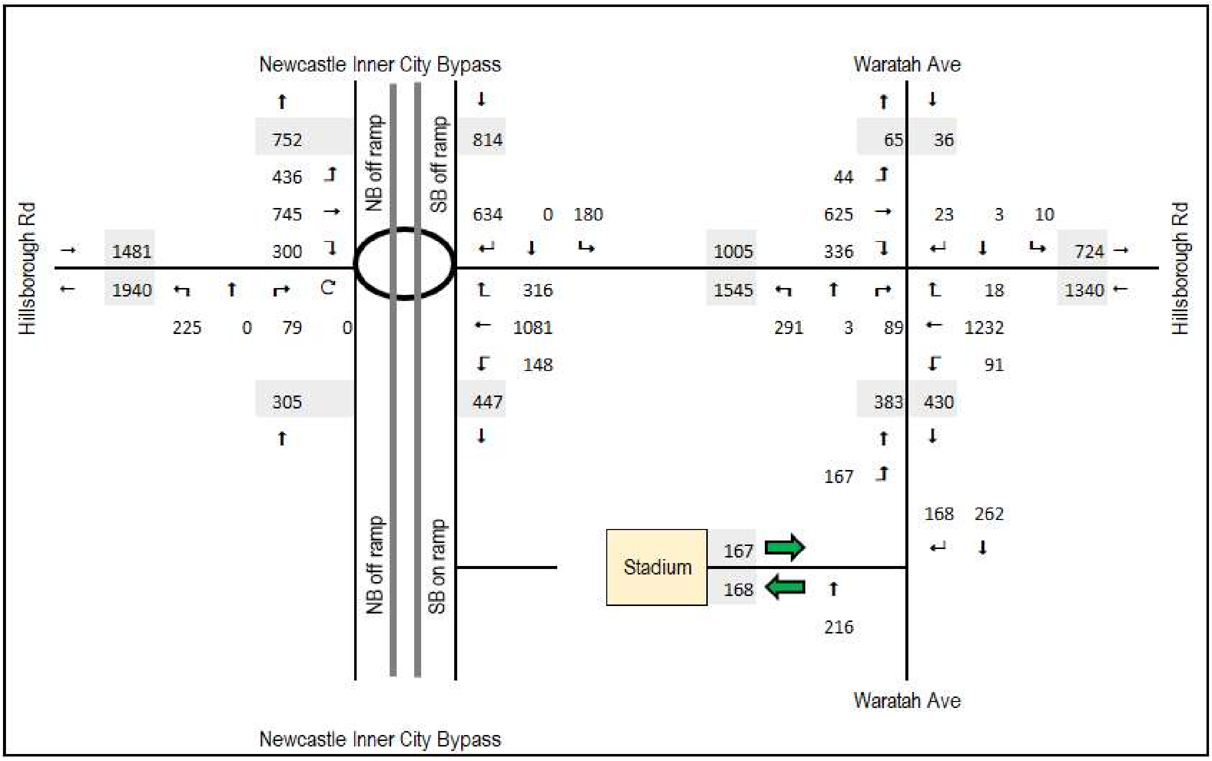


Figure 3-2 Predicted PM peak hour – 2021 Option 1

Figure 3-3 and Figure 3-4 show predicted turning movements at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue (traffic signals) for access Options 2 and 3 (with proposal) respectively for 2021 PM peak hour (5pm to 6pm).

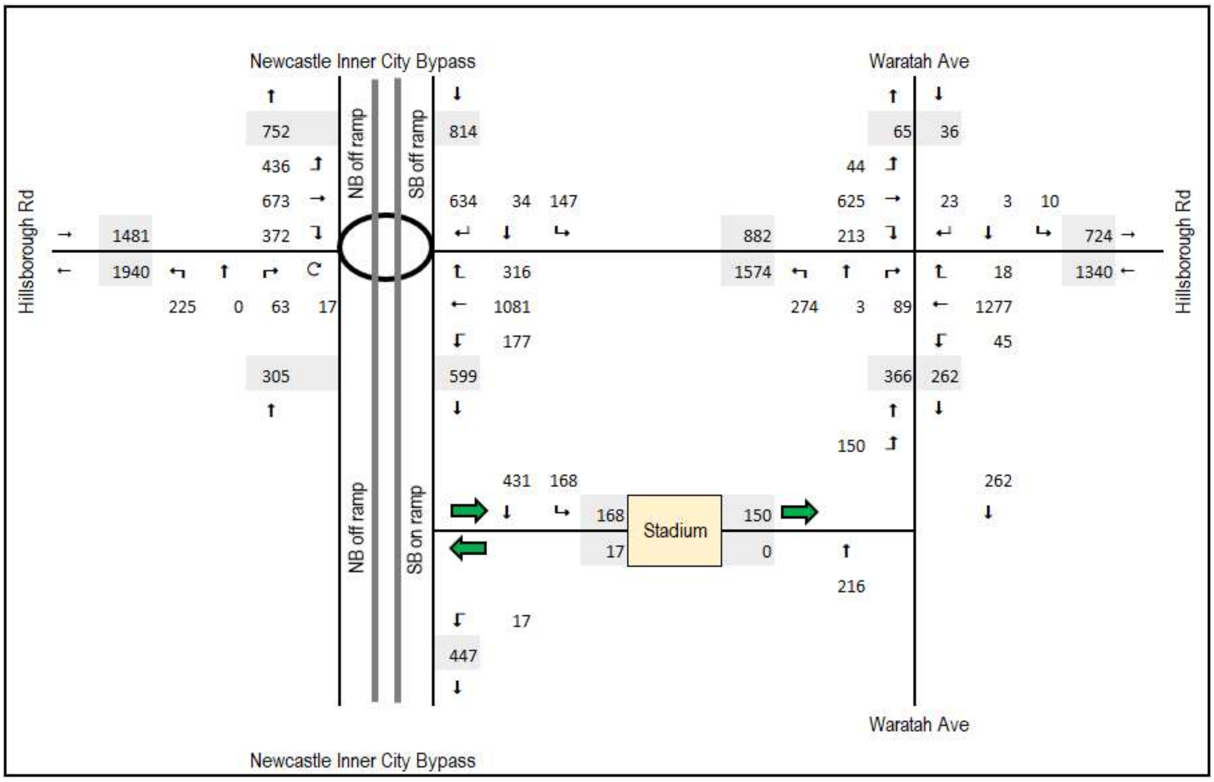


Figure 3-3 Predicted PM peak hour – 2021 Option 2

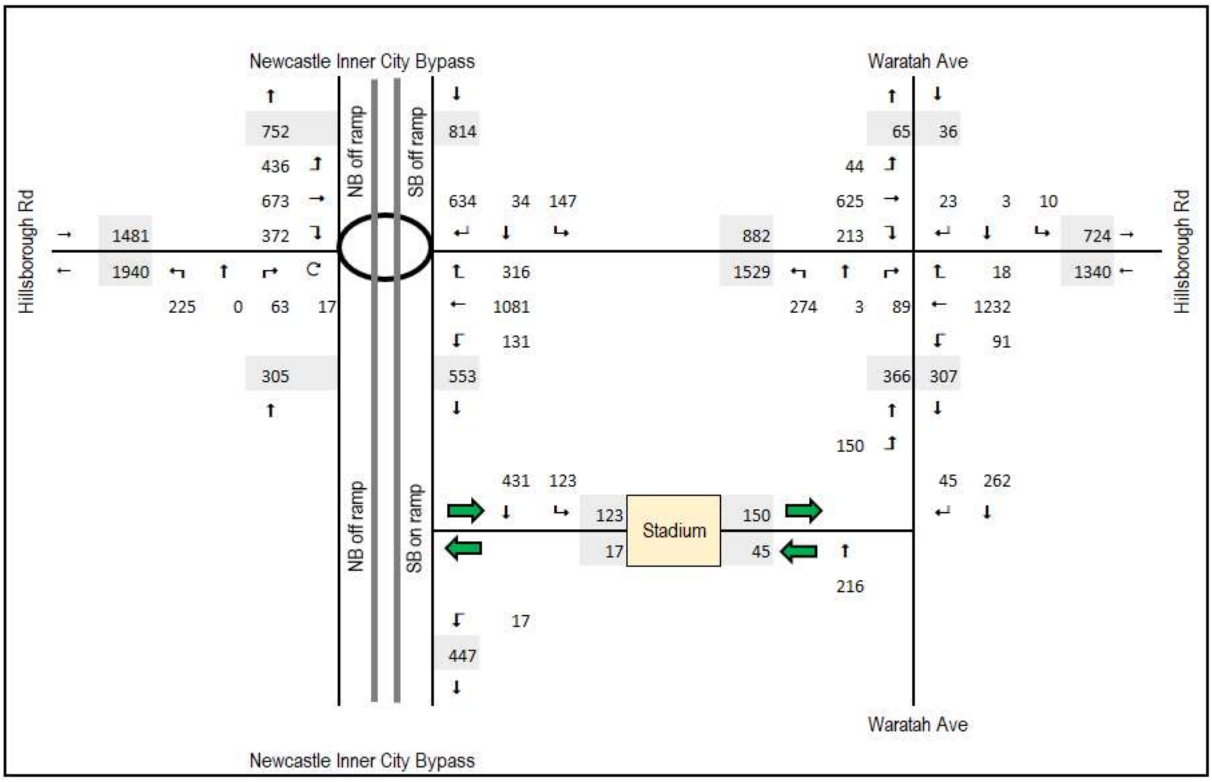
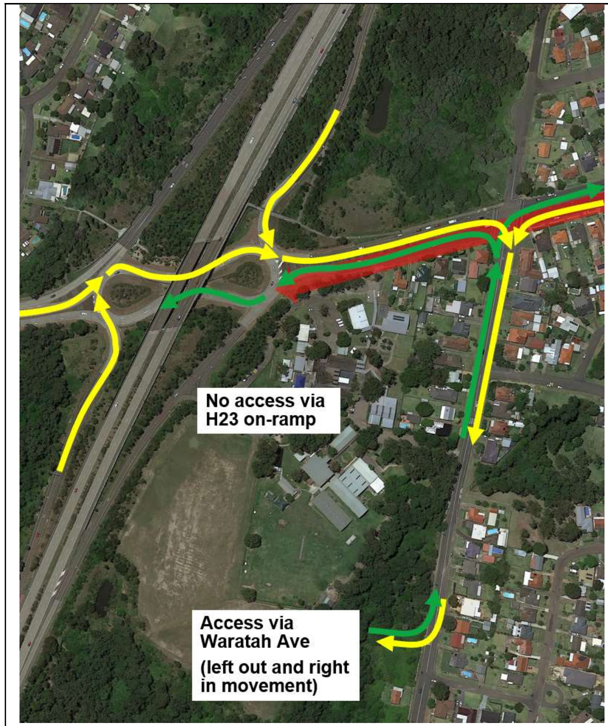


Figure 3-4 Predicted PM peak hour – 2021 Option 3

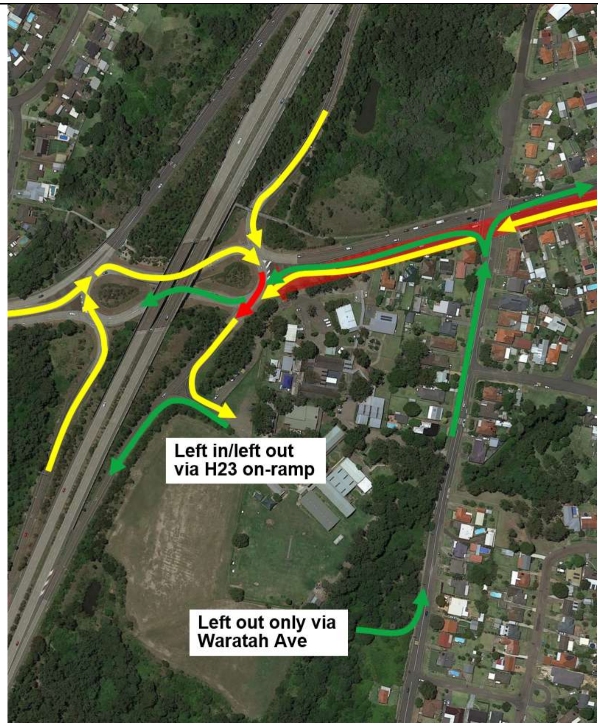
3.4 Conflicting movements

There are significant capacity constraints during the peak hours on the Hillsborough Road particularly at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout). The westbound traffic flows on the Hillsborough Road are critical and would be impacted by the proposal depending on access options. Figure 3-5 shows conflicting movements at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and the Hillsborough Road/Waratah Avenue (traffic signals) for three access options.

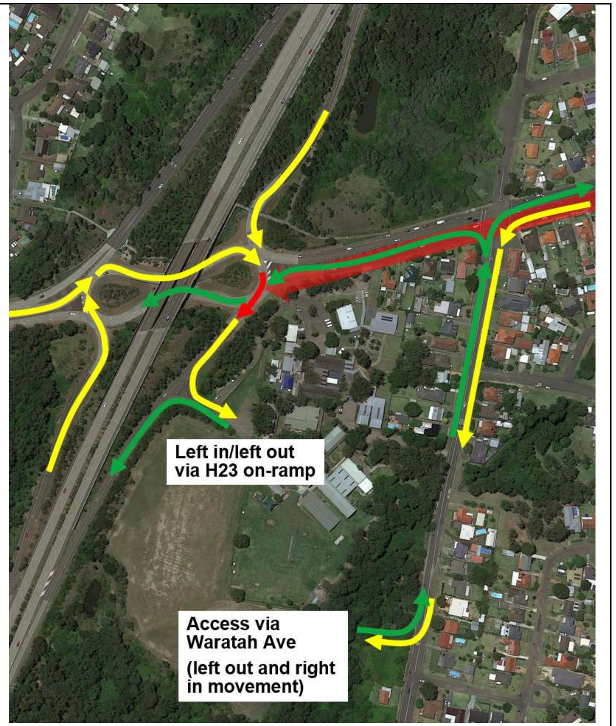
Figure 3-5 shows that Option 1 (one access point via Waratah Avenue allowing for left out and right in movements) would create less traffic conflicting points at the Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) compared to Option 2 and Option 3.



Option 1 access via Waratah Avenue (left out and right in movements)



Option 2 access via H23 (left in/left out) and Waratah Avenue (left out only)



Option 3 via H23 (left in/left out) and Waratah Avenue (left out and right in movements)

Figure 3-5 Schematic diagram showing conflicting movements for three options

3.5 Queue length analysis

The critical queue associated with the proposal is the westbound queue on Hillsborough Road. It has the greatest potential to “spill back” and adversely impact the performance and operation of both Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and Hillsborough Road/Waratah Avenue (traffic signals).

Figure 3-6 below shows the predicted queues (95th percentile) on Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and Hillsborough Road/Waratah Avenue (traffic signals) for afternoon peak hour under three access Options (1, 2 and 3). The predicted queues for the base case (without proposal) is shown in Figure 3-6 for comparison purpose.

The westbound queue length from Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) is predicted to be between 315 metres and 420 metres depending on the proposal access points tested under Options 1 to 3. Due to VISSIM model boundary, westbound queue length on Hillsborough Road is capped to 420 metres.

Under Option 1 (one access point via Waratah Avenue allowing for left out and right in movements), about 315 metres westbound queue length is predicted on the Hillsborough Road in the afternoon peak

Option 2 (two access points, left in/left out at H23 on ramp and left out only at Waratah Avenue), about 420 metres westbound queue length is predicted on the Hillsborough Road in the afternoon peak. Option 2 shows potential queue spill-over on Hillsborough Road and likely to impact Charlestown Road traffic signals

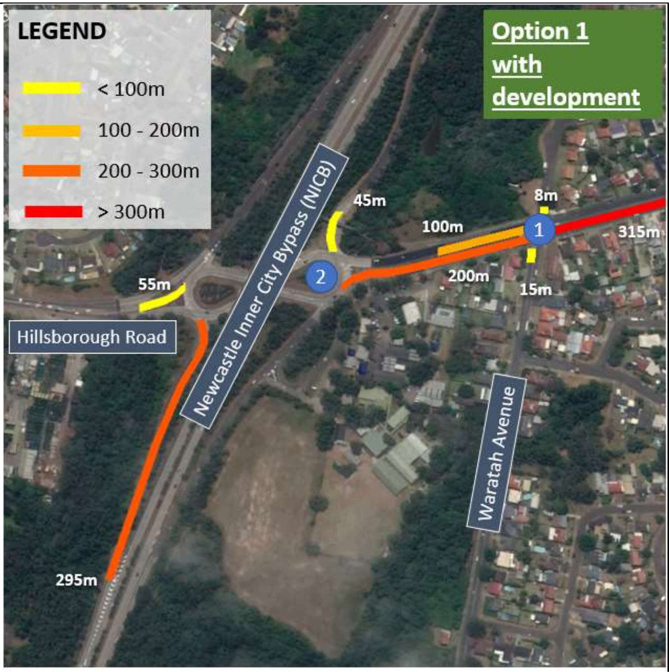
Option 3 (two access points, left in/left out at H23 on ramp and Waratah Avenue allowing for left out and right in movements), about 420 metres westbound queue length is predicted on the Hillsborough Road in the afternoon peak. Similar to Option 2, Option 3 shows potential queue spill-over on Hillsborough Road and likely to impact Charlestown Road traffic signals.

The VISSIM analysis suggested that the proposal would increase the probability of westbound queues overflowing on Hillsborough Road from Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and would extend beyond Hillsborough Road/Waratah Avenue (traffic signals).

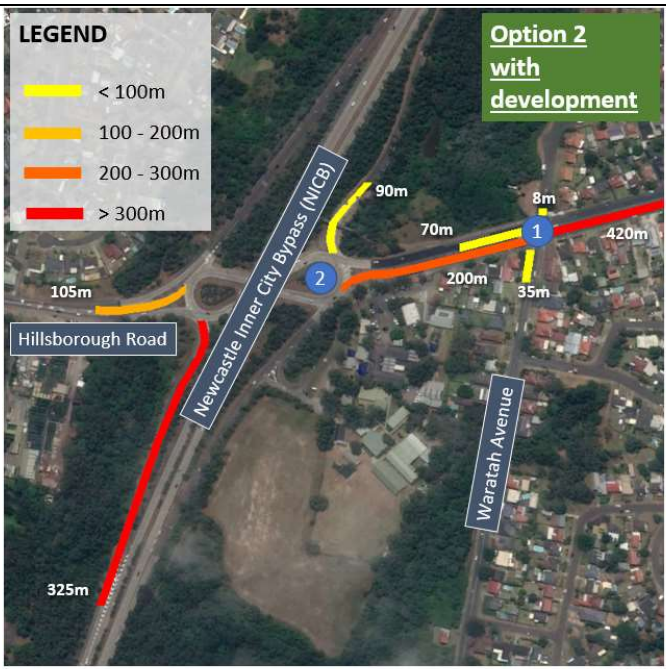
The queue length modelling data highlights that there are significant capacity constraints during the afternoon peak hours on Hillsborough Road.

From queue length perspective, Option 1 (one access point via Waratah Avenue allowing for left out and right in movements) shows relatively better performing option than Option 2 and Option 3.

Base case without development



Option 1 access via Waratah Avenue (left out and right in movements)



Option 2 access via H23 (left in/left out) and Waratah Avenue (left out only)

Note: Queue length for H23 northbound exit ramp is capped at 325 metres based on model boundary

Option 3 via H23 (left in/left out) and Waratah Avenue (left out and right in movements)

Note: Queue length for H23 northbound exit ramp is capped at 325 metres based on model boundary

Figure 3-6 Predicted queues for 2021 PM peak hour

3.6 Delays and level of service analysis

Table 3-2 shows the summary of delays and level of service for the base case (without proposal) and three access options 1 to 3 (with proposal) at Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and Hillsborough Road/Waratah Avenue (traffic signals). Delays and level of service (LoS) is reported for the PM peak hour (5pm to 6pm).

Table 3-2 Delays and level of service of options during afternoon peak hour in 2021

Intersections	Delay Measurement	Base case without proposal	With proposal		
			Option 1	Option 2	Option 3
Hillsborough Road/Waratah Avenue intersection (traffic signals)	Average intersection delay	37 (C)	53 (D)	79 (F)	57 (E)
Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)	Average intersection delay	50 (D)	67 (E)	92 (F)	76 (F)
	Worst movement delay	198 (F)	314 (F)	371 (F)	328 (F)

The delays and level of service data highlights that there are significant capacity constraints during the afternoon peak hours on Hillsborough Road particularly at Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout).

From delays and level of service perspective, Option 1 (one access point via Waratah Avenue allowing for left out and right in movements) shows relatively better performing option than Option 2 and Option 3.

Appendix A includes delays and level of service for 2021 by approaches for base case (without proposal) and three access options 1 to 3 (with proposal) at Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections.

3.7 Impact from 10 years traffic growth

A 10-year traffic growth scenario modelling was undertaken assuming background traffic growth rate of 1.5 per cent per annum between 2021 and 2030.

Appendix A includes predicted turning movements for forecast year 2030 at Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections for base case (without proposal) and three access options 1 to 3 (with proposal) for PM peak hour (5pm to 6pm).

Table 3-3 shows the summary of delays and level of service for 2030 for base case and three access options 1 to 3 at Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections.

Table 3-3 Delays and level of service of options during afternoon peak hour in 2030

Intersections	Delay Measurement	Base case without proposal	With proposal		
			Option 1	Option 2	Option 3
Hillsborough Road/Waratah Avenue intersection (traffic signals)	Average intersection delay	90 (F)	105 (F)	121 (F)	112 (F)
Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)	Average intersection delay	125 (F)	139 (F)	171 (F)	144 (F)
	Worst movement delay	600* (F)	600* (F)	600* (F)	600* (F)

* Note: Delay has been capped due to extent of model boundary

The future year delays and level of service data in 2030 highlight that there are significant capacity constraints during the afternoon peak hours on Hillsborough Road with both Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and Waratah Avenue traffic signals.

Appendix A includes delays and level of service for 2030 by approaches for base case (without proposal) and three access options 1 to 3 (with proposal) at Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections.

The modelling scenarios undertaken for 2021 and 2030 suggests the following outcomes including:

- Option 1 (one access point via Waratah Avenue allowing for left out and right in movements) shows potential merit over Option 2 and Option 3
- Option 3 (two access points via left in/left out access intersection on the H23 on ramp and via Waratah Avenue (left out and right in movements permitted) performed better than Option 2

Option 1 and Option 3 are two recommended access options.

4 Potential mitigation measures

Option 1 and Option 3 have been carried forward and tested further with potential mitigation measures.

The following mitigation measures are identified:

- Increase traffic capacity for the eastbound right turning lane on Hillsborough Road western approach. Currently, the single right turning lane is about 70 metres. Two potential scenarios are identified as modification to Waratah Avenue / Hillsborough Road intersection:
  - Scenario 1: Provision of extending the right turning lane on the Hillsborough Road western approach. The right turn bay is proposed to be extended up to 100 metres (refer to Figure 4-1)
  - Scenario 2: Double right turning lanes on the Hillsborough Road western approach. The second right turning lane is proposed to be about 70 meters. Additional exit lane to the Waratah Avenue approach (refer to Figure 4-2)
- Provision of two separating traffic lanes (left only and shared through/right) on the Waratah Avenue southern approach
- Provision of extending the left turning lane on the Hillsborough Road eastern approach. The left turn bay is proposed to be extended up to 200 metres.

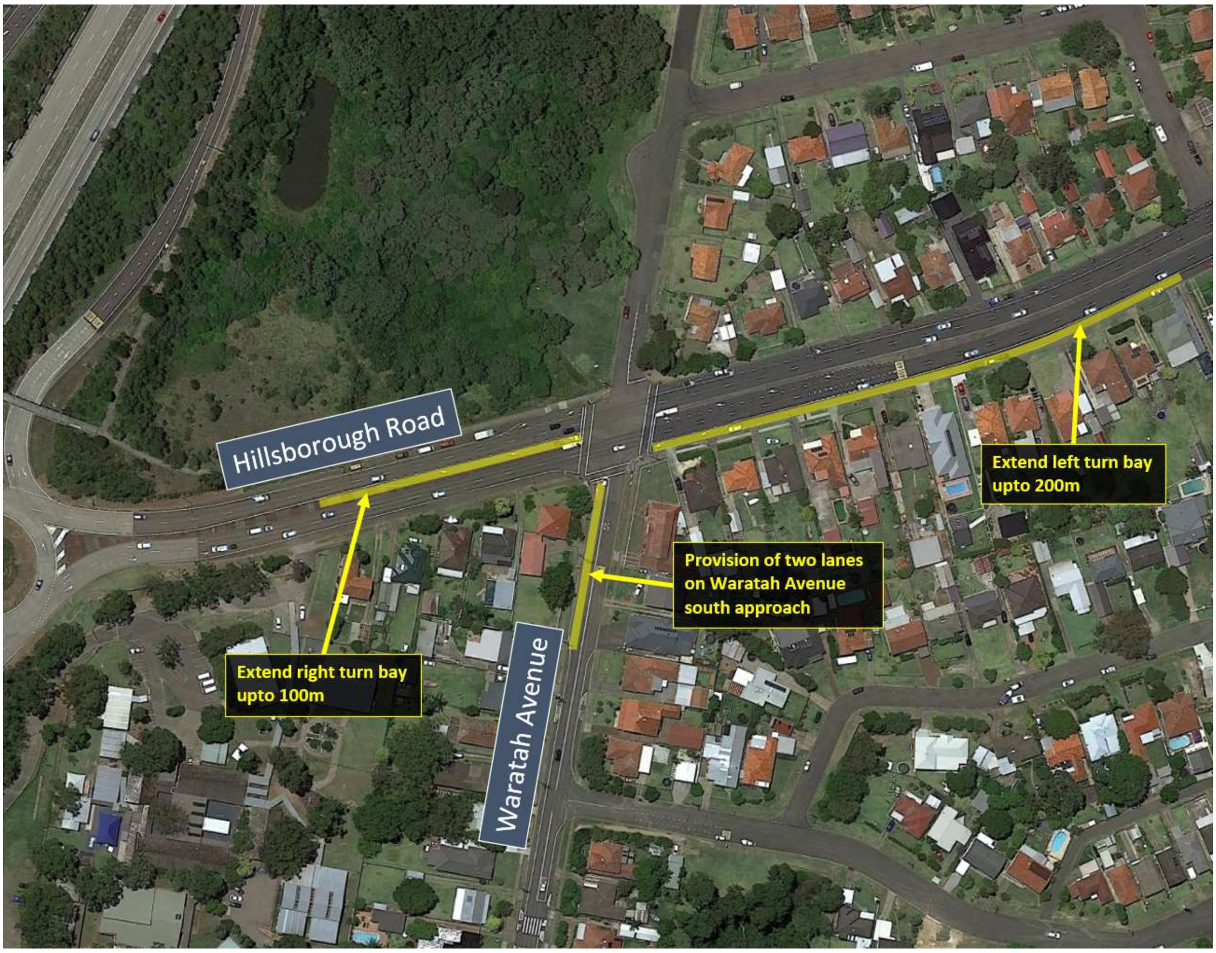


Figure 4-1 Potential modification to Waratah Avenue / Hillsborough Road intersection (Scenario 1)

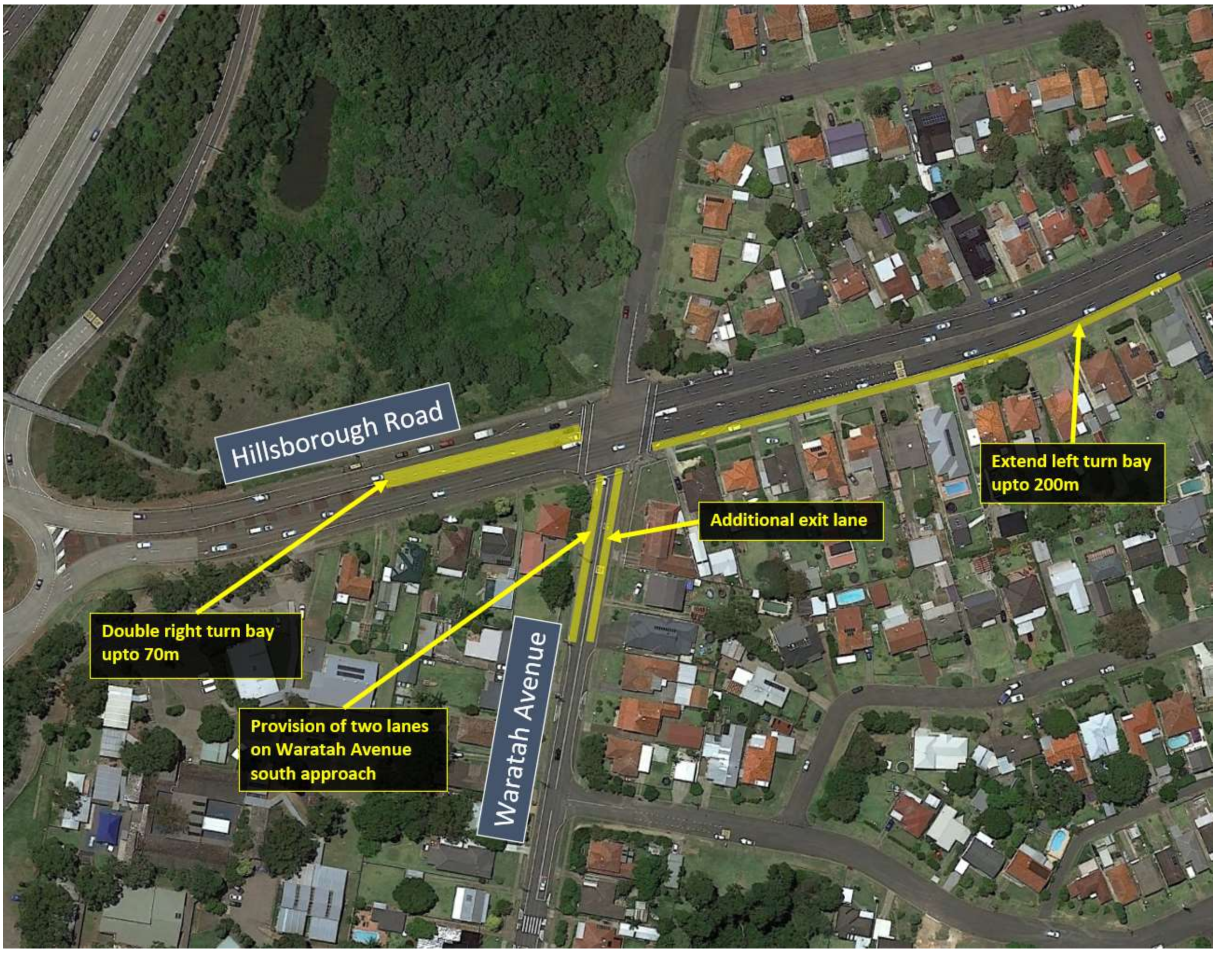


Figure 4-2 Potential modification to Waratah Avenue / Hillsborough Road intersection (Scenario 2)

4.1 Traffic performance of mitigation measures

In consultation with TfNSW, Scenario 1 mitigation measures were modelled for 2021 for two best performing options Option 1 and Option 3.

The extension of right turn bay to 100 metres is assumed for Option 1 only. The left turn bay extension to 200 metres (up to Fairview Avenue) and separate left and right turn lanes on Waratah Avenue are assumed for both Option 1 and Option 3.

Table 4-1 and **Error! Reference source not found.** show summary of delays and level of service for Option 1 and Option 3 with and without mitigation measures.

Table 4-1 Delays and level of service of Option 1 with and without mitigation in 2021

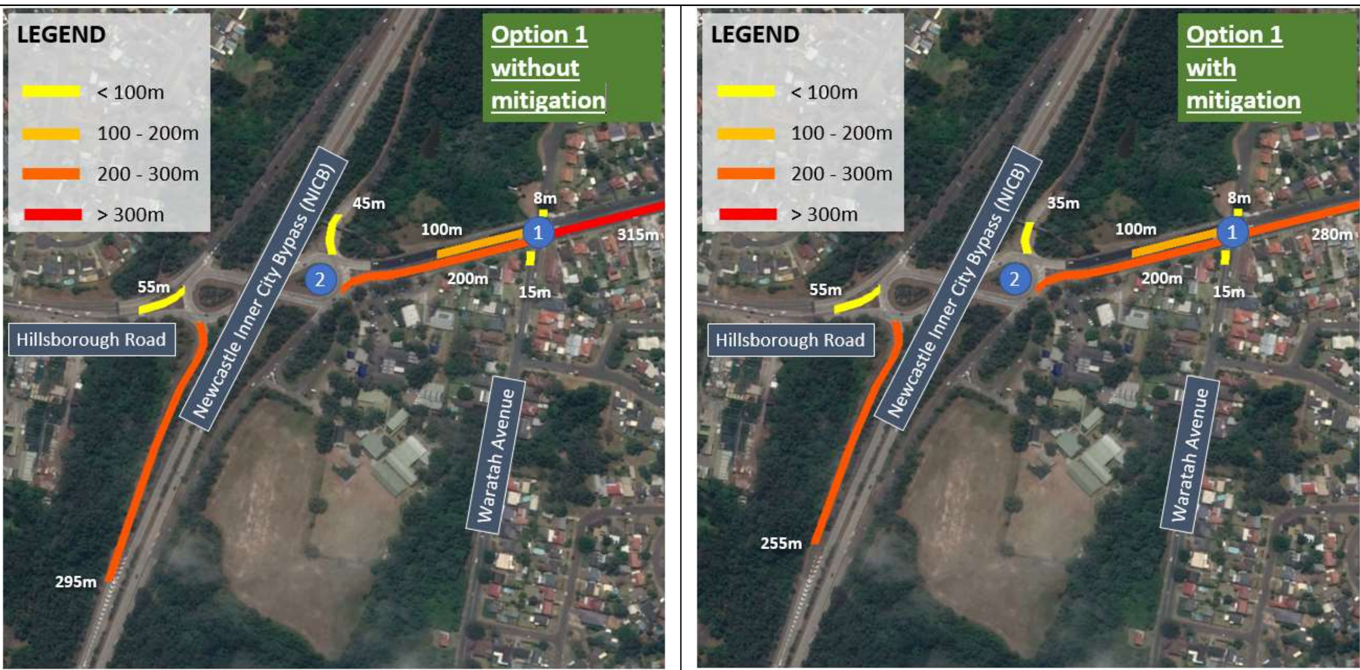
Intersections	Delay Measurement	Option 1 without mitigation	Option 1 with mitigation
Hillsborough Road/Waratah Avenue intersection (traffic signals)	Average intersection delay	53 (D)	50 (D)
Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)	Average intersection delay	67 (E)	60 (E)

Table 4-2 Delays and level of service of Option 3 with and without mitigation in 2021

Intersections	Delay Measurement	Option 3 without mitigation	Option 3 with mitigation
Hillsborough Road/Waratah Avenue intersection (traffic signals)	Average intersection delay	57 (E)	55 (D)
Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)	Average intersection delay	76 (F)	67 (E)

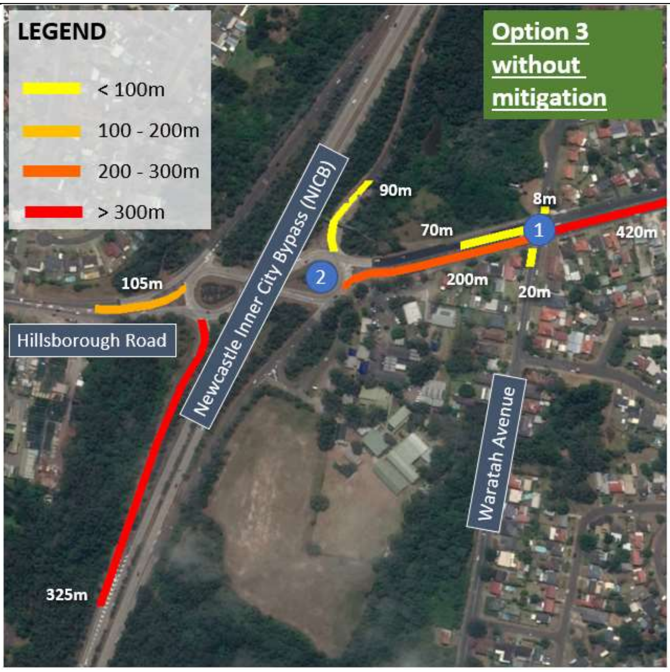
The modelling scenarios with mitigation measures highlights delay and level of service improvements to both Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections. For Option 1, the westbound queue length on Hillsborough Road is predicted to be reduced from 315 metres (without mitigation) to 280 metres with mitigation in place (see Figure 4-3).

For Option 3, westbound queue length would not improve on Hillsborough Road with mitigation measure in place (see Figure 4-4). The westbound queue length is predicted to be 420 metres with mitigation measure in place. The analysis suggests potential need to upgrade the Charlestown Road traffic signals.

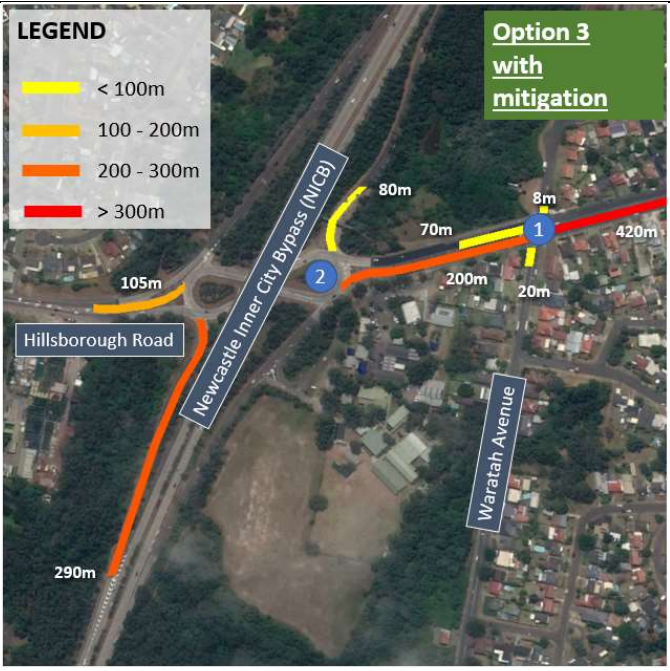


Option 1 without mitigation measures | Option 1 with mitigation measures

Figure 4-3 Queue length comparison for Option 1 with and without mitigation measures



Option 3 without mitigation measures
Note: Queue length for H23 northbound exit ramp is capped at 325 metres based on model boundary



Option 3 with mitigation measures

Figure 4-4 Queue length comparison for Option 3 with and without mitigation measures

5 Conclusions

This Technical Advice report documents the traffic modelling and assessment of a proposed new indoor basketball stadium, 62 and 62A Hillsborough Road and 109-117 Waratah Avenue, Hillsborough (the proposal). The following three access options were modelled including:

- Option 1 proposes one access point via the Waratah Avenue (left put and right in movements permitted) with no access from the H23 on ramp
- Option 2 proposes two access points via left in/left out access intersection on the H23 on ramp and via left out only at the Waratah Avenue
- Option 3 proposes two access points via left in/left out access intersection on the H23 on ramp and via the Waratah Avenue (left out and right in movements permitted).

A consultation process involving TfNSW and key stakeholders constituted an important element of this modelling study. The stakeholder group was made up of representatives from TfNSW, Lake Macquarie City Council, proponent's Consultant including Catalyst Project Consulting Pty Ltd and SECA solution.

It was estimated that the proposal would generate about 335 vehicle movements in one hour during the afternoon peak periods. For modelling purpose, it was assumed that indoor basketball stadium proposal would be operational by 2021.

The traffic generation and distribution assumptions were agreed with the stakeholders and formed the basis of the operational traffic modelling for the proposal.

The afternoon peak period was selected for the proposal as the critical peak for the purpose of this assessment as it has the strongest likelihood or potential to impact traffic operation along Hillsborough Road, coinciding with the dominant westbound traffic movement.

The analysis identified the following key findings:

- There are significant capacity constraints during the peak hours on Hillsborough Road particularly at Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)
- The VISSIM analysis suggested that the proposal would increase the probability of westbound queues overflowing on Hillsborough Road from Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout) and would extend beyond Hillsborough Road/Waratah Avenue (traffic signals)
- The queue length, delay and level of service modelling data highlight that there are significant capacity constraints during the afternoon peak hours on Hillsborough Road particularly at Newcastle Inner City Bypass/Hillsborough Road (bow-tie roundabout)
- Option 1 (one access point via Waratah Avenue allowing for left out and right in movements) shows potential merit over Option 2 and Option 3
- Option 3 (two access points via left in/left out access intersection on the H23 on ramp and via Waratah Avenue (left out and right in movements permitted) performed better than Option 2
- Scenario 1 mitigation measures suggested delay and level of service improvement to both Newcastle Inner City Bypass/Hillsborough Road and Hillsborough Road/Waratah Avenue intersections
- Option 1 and Option 3 are two recommended access options from modelling perspective.

APPENDIX A DETAILED MODELLING DATA

Table A-1 shows delays and level of service by approach for base case (without proposal) and Options 1 to 3 for 2021.

Table A-1 Predicted level of service for PM peak in 2021 by approaches

Intersection	Approach roads	Base case without proposal		With proposal					
				Option 1		Option 2		Option 3	
		Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Hillsborough Road / Waratah Avenue (traffic signals)	North: Waratah Avenue	35	C	48	D	54	D	52	D
	East: Hillsborough Road	49	D	78	F	128	F	87	F
	South: Waratah Avenue	21	B	28	C	45	D	36	C
	West: Hillsborough Road	22	B	30	C	20	B	20	B
	Overall intersection	**37**	**C**	**53**	**D**	**79**	**F**	**57**	**E**
H23 Newcastle Inner City Bypass / Hillsborough Road (bow-tie roundabout)	North: H23 SB off ramp	52	D	61	E	91	F	91	F
	East: Hillsborough Road	59	E	73	F	103	F	83	F
	South: H23 NB off ramp	198	F	314	F	371	F	328	F
	West: Hillsborough Road	41	C	53	D	40	C	35	C
	Overall intersection	**50**	**D**	**67**	**E**	**92**	**F**	**76**	**F**
	Worst movement	**198**	**F**	**314**	**F**	**371**	**F**	**328**	**F**

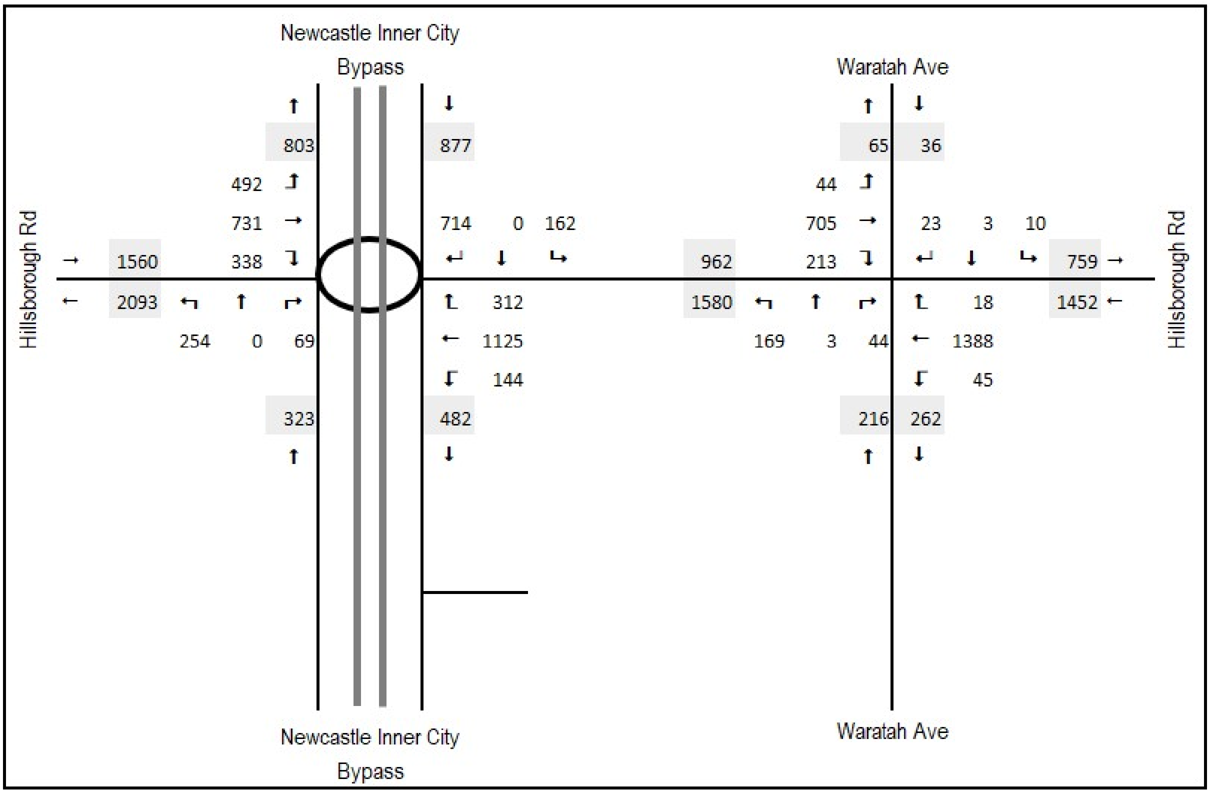


Figure A-1 Predicted PM peak hour – 2030 without proposal

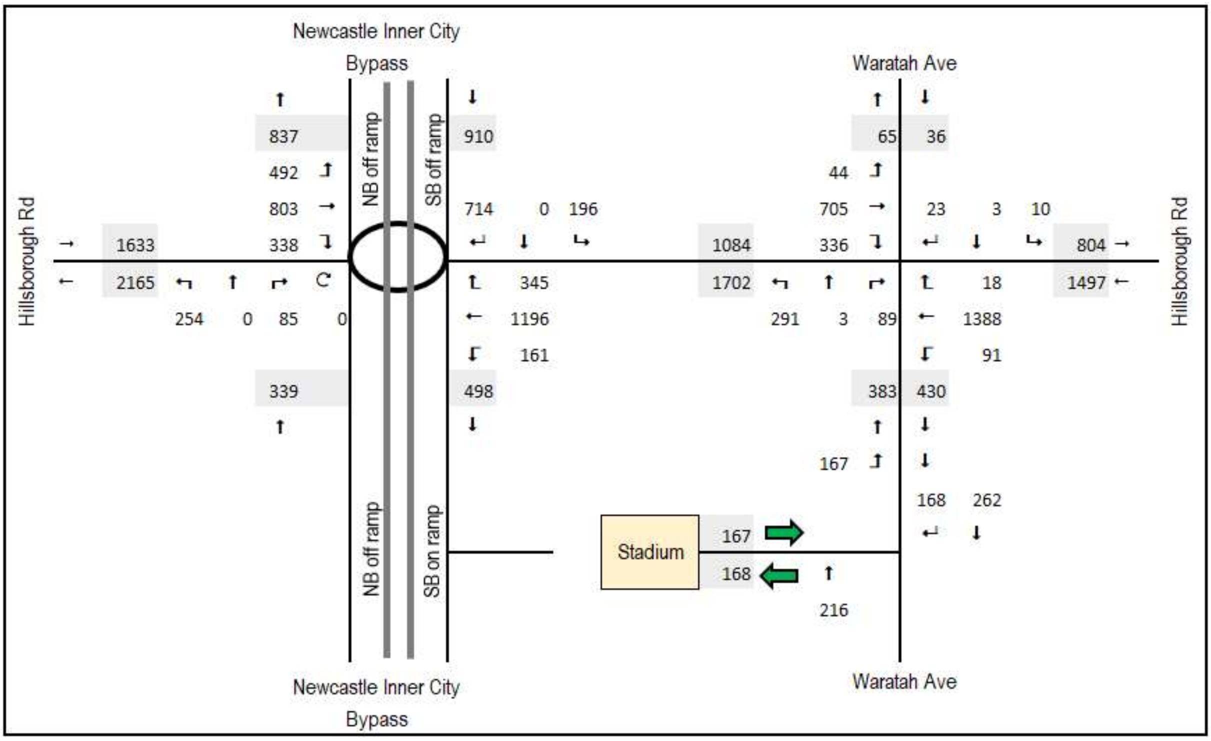


Figure A-2 Predicted PM peak hour – 2030 Option 1

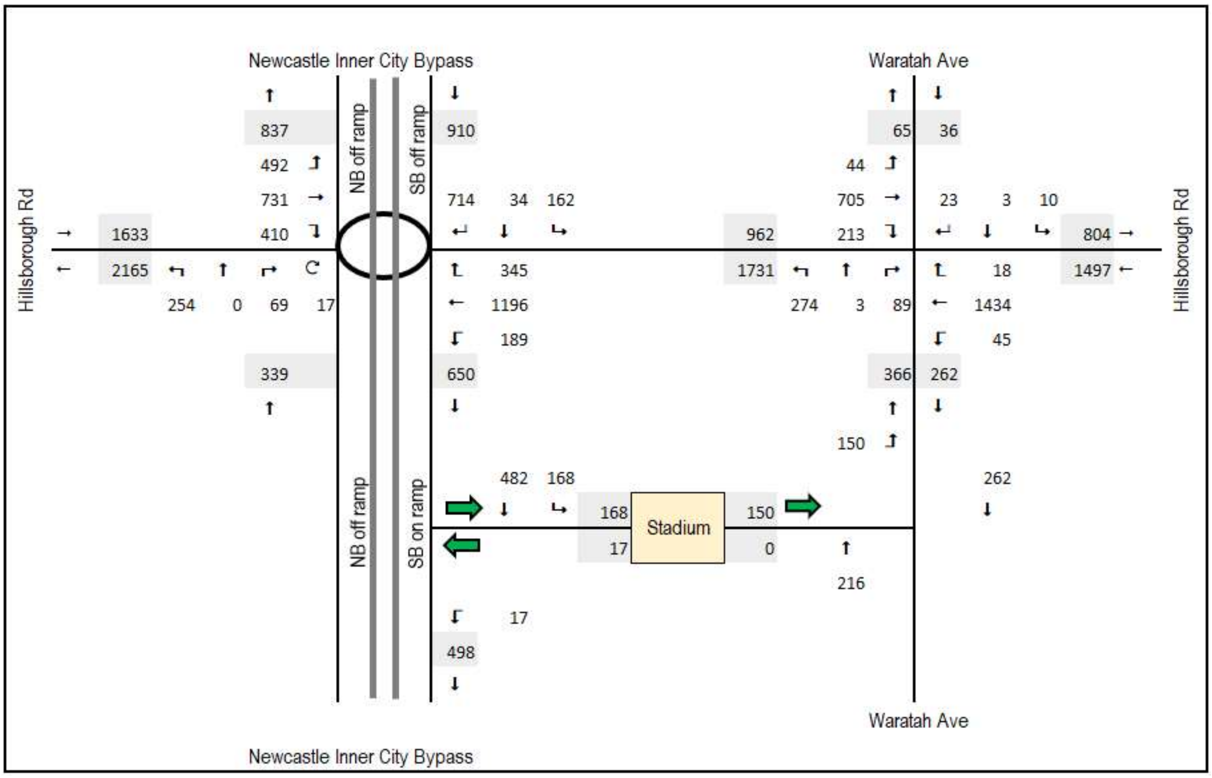


Figure A-3 Predicted PM peak hour – 2030 Option 2

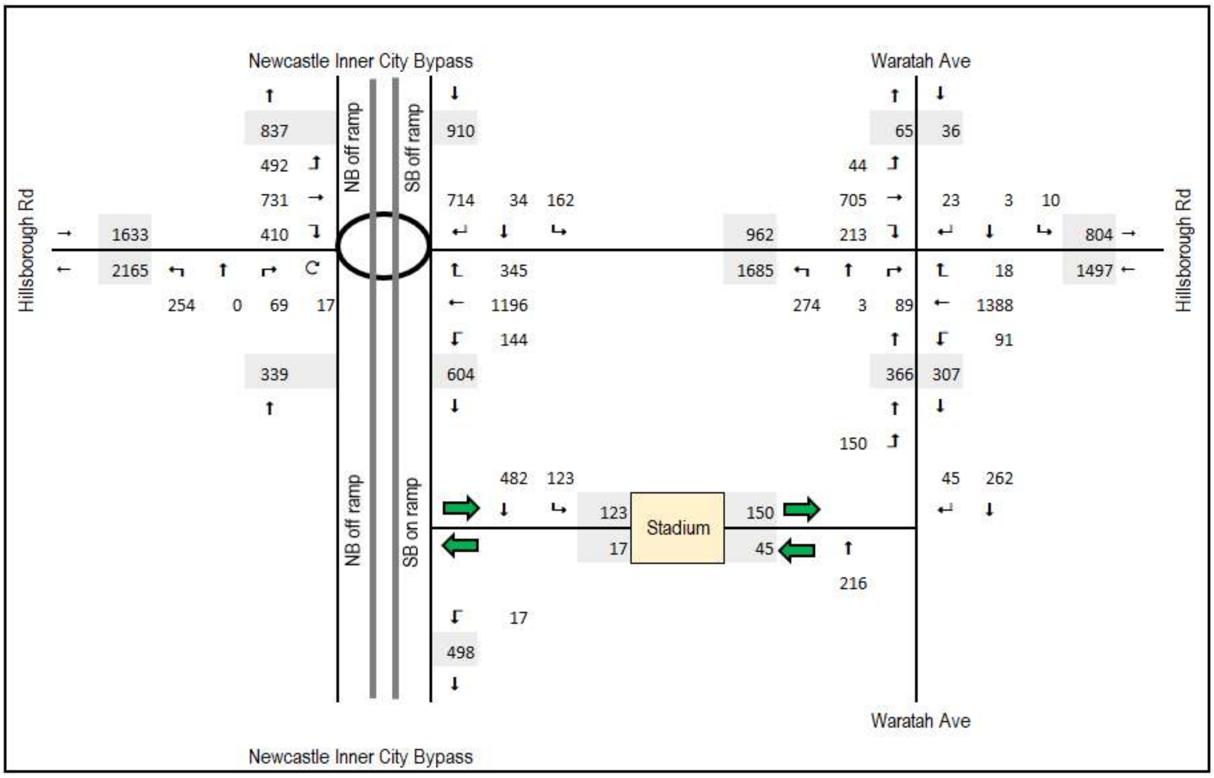


Figure A-4 Predicted *PM peak hour – 2030 Option 3*

Table A-2 shows delays and level of service by approach for base case (without proposal) and Options 1 to 3 for 2030.

Table A-2 Predicted level of service for PM peak in 2030 by approaches

Intersection	Approach roads	Base case without proposal		With proposal					
				Option 1		Option 2		Option 3	
		Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS	Delay (sec)	LoS
Hillsborough Road / Waratah Avenue (traffic signals)	North: Waratah Avenue	73	F	81	F	90	F	87	E
	East: Hillsborough Road	140	F	168	F	185	F	175	F
	South: Waratah Avenue	50	D	68	E	122	F	99	F
	West: Hillsborough Road	23	B	32	C	21	B	21	B
	Overall intersection	**90**	**F**	**105**	**F**	**121**	**F**	**112**	**F**
H23 Newcastle Inner City Bypass / Hillsborough Road (bow-tie roundabout)	North: H23 SB off ramp	151	F	166	F	193	F	170	F
	East: Hillsborough Road	129	F	145	F	149	F	147	F
	South: H23 NB off ramp	600*	F	600*	F	600*	F	600*	F
	West: Hillsborough Road	46	B	68	B	76	B	73	B
	Overall intersection	**125**	**F**	**139**	**F**	**171**	**F**	**144**	**F**
	Worst movement	**600***	**F**	**600***	**F**	**600***	**F**	**600***	**F**

* Note: Delay has been capped based on model boundary