LDPAP

Barnton Junction Linsig Modelling

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The City of Edinburgh Council

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Executive Summary

This Technical Note describes the Linsig modelling undertaken for the revised layout options of the Queensferry Road / Maybury Road / Whitehouse Road, Barnton junction, as discussed in the Stage 1 Report. The options intend to provide improvements for pedestrians and cyclists without detrimentally impacting traffic throughput.

Base Linsig models were provided by the City of Edinburgh Council (CEC) and reviewed for consistency against the existing layout of the junction and the current on-street operation. The Linsig analysis demonstrates the junction currently has problems with capacity and progression through the network which correlates with the observations on-street during the peak periods.

The observed traffic flows found that on average the total number of vehicles, when converted to pcus, that progress through the junction is approximately 5350 pcus in the AM peak and 5100 pcus in the PM peak. The committed development traffic increases these flows by approximately 340 pcus in both peaks. This demonstrates that the existing junction is currently managing a significantly high volume of traffic. With committed development flows in place, the operation is expected to get worse and as a minimum fixed time plan updates are likely to be required to better manage traffic throughput prior to any future dynamic control strategy being implemented (if applicable).

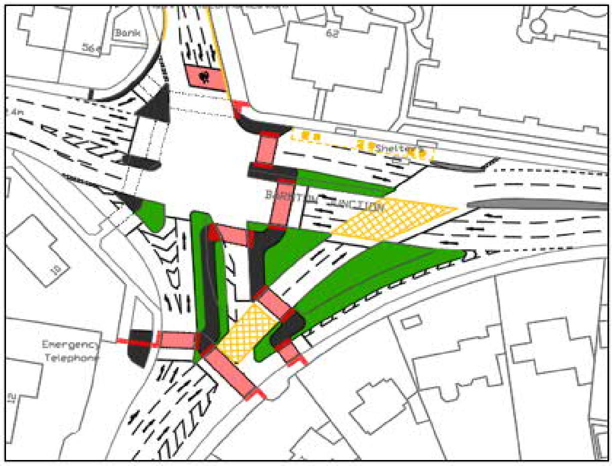
With revised timings and coordination, Linsig suggests that PRC improvements and overall delay reductions could be made under the base layout. However, some on-street validation would be required to ensure any changes to timings do not have any significant impact on queuing and associated throughput, particularly for the westbound Queensferry Road movements. On-street validation will be critical for all options should they be constructed.

With offline cycle facilities proposed to connect between the southwest side of the junction on Maybury Road and the northeast side of the junction on Whitehouse Road, there is a need to link up the facilities. The existing layout may be able to accommodate the required minimum crossing widths for Toucan facilities but the size of the existing traffic islands are expected to cause problems for accommodating cyclists, potentially putting them in compromised waiting positions. This risk becomes worse if pedestrian and cyclist numbers and interactions increase. Therefore, the existing layout as it stands will require improvements to accommodate cyclists.

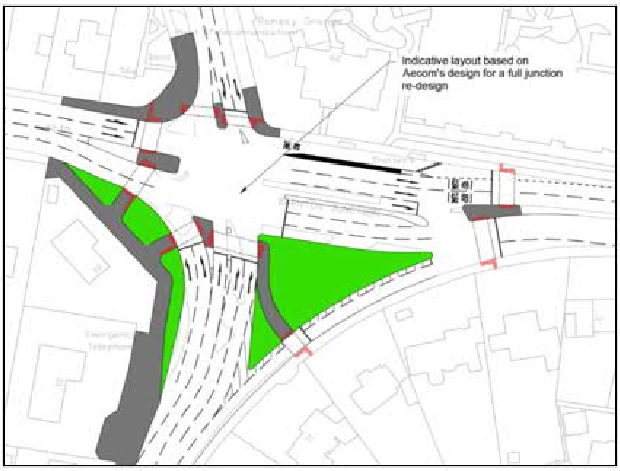
Four options have been put forward to improve pedestrian and cyclist throughput at the junction. Two options were previously covered in the Stage 1 reporting and two further options have been put forward as part of the Linsig analysis.

The four options vary significantly in complexity and associated cost, but none are expected to provide operational improvements to manage the increase in traffic referred to above. They are, however, expected to improve provision for NMUs primarily by accommodating the proposed cycle connections, but also by creating more route choice for all NMUs and under some scenarios shorter journey times and reduced delay.

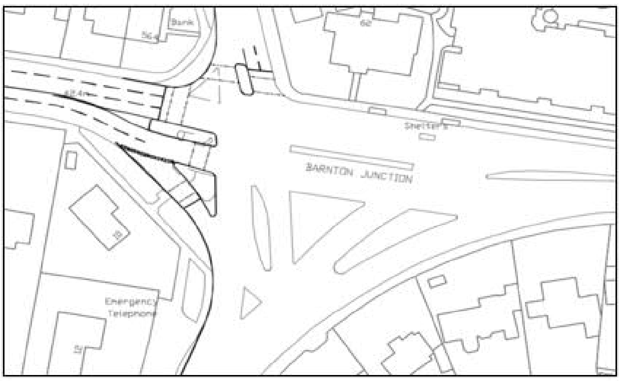
Option 7.1.A



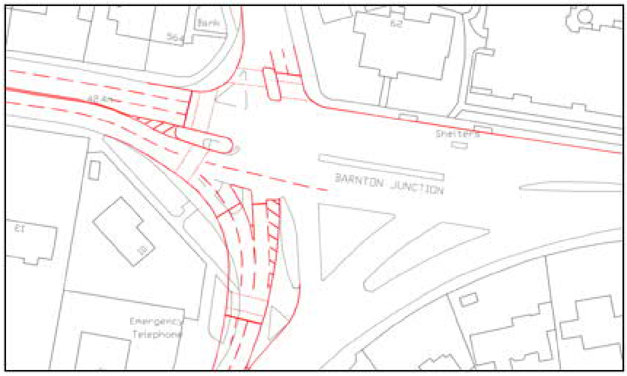
Option 7.1.B



Option 7.1.C



Option 7.1.D



Of the options, option 7.1.A provided the best Practical Reserve Capacity (PRC) for the junction and also provides the best route choice for pedestrians, making navigation of the junction more direct, albeit via a number of controlled crossings. The main concern is that the additional crossings through the centre of the junction reduce the already limited stacking which could create more difficulties during on-street signal timing validation.

Option 7.1.B tightens up the junction layout which in turn reduces NMU journey time, but there are concerns over how this layout could be implemented safely, particularly with respect to the wide five-lane approach on Maybury Road which already has problems with "last second" weaving vehicles as identified by the Cramond and Barnton Community Council. This option is not recommended and can be discounted.

Options 7.1.C and 7.1.D are intended to be relatively lower cost solutions by only amending the western side of the junction to incorporate the required space for Toucan crossing facilities. These options made the PRC broadly worse but did provide some potential journey time reductions for NMUs. Note, option 7.1.C ultimately requires a five-stage crossing to navigate between the cycle facilities in the southwest and northeast of the junction, this may therefore generate some poor user perception, even if journey time is not adversely affected. On this basis, option 7.1.C may be a better solution if the cycle path continues north on the west side of Whitehouse Road.

A summary of the PRC and total delay for each option compared against the base is detailed in the table below.

Barnton Junction Summary Table

	AM		PM	
Option	**PRC (%)**	**Total Delay (pcu/hr)**	**PRC (%)**	**Total Delay (pcu/hr)**
Base	-4.40%	136	-3.6%	117.8
Option 7.1.A	-11.3%	139.1	-6.8%	98.1
Option 7.1.B V2	-31.1%	411.9	-13.7%	167.1
Option 7.1.c	-19.2%	259.1	-9.9%	150.9
Option 7.1.D	-19.2%	266.1	-22.4%	285.6

It should be noted that PRC values for these options have been generated by running Linsig's CYOP and offset coordination functions, however, although this can give an indication of how much PRC can be achieved under each option it may be that a reduced level of PRC is required to manage the short central sections, with queues relocated to the external approaches. This approach appears to have been taken for the current operation whereby PRC values of -25% to -30% are found when the base layout and on-street timings are tested with the base traffic flows. This is necessary to reduce the risk of locking up and very little traffic proceeding. On-street validation will be critical for whatever option is taken forward, so it is suggested that no option is completely ruled out based on the PRC values alone.

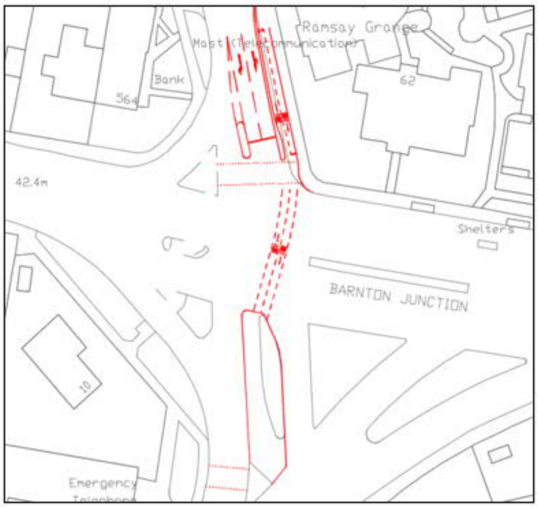
Yellow box markings may be required to help manage the junction operation. In all option tests including the addition of committed development traffic to the base layout, the junction is heavily reliant on yellow box markings to have their desired effect in stopping vehicles from exit blocking other movements. Without this intervention then there is a high risk of the junction locking up or at least severely reducing traffic throughput.

Sensitivity testing was undertaken to review the NMU operation and understand whether more direct routes for these users could be achieved. This review considered the implementation of a diagonal crossing through the centre of the junction to link the southwest and northeast corners of the junction where offline cycle facilities are proposed. It also considered the pedestrian journey time and associated delay between these two points under the options considered above.

Jacobs would not recommend a diagonal crossing through the centre of the junction. Although this would create a more direct route and reduce NMU delay, it is considered that the length of the crossing required, at over 20 metres, would create safety and operational implications. A cycle only diagonal facility would also not be considered a viable solution as although the crossing times would be reduced, it is still considered that this would generate a risk as pedestrians may try to use the facility (as the shortest possible route) with potentially insufficient timings applied.

Dedicated cycle facilities could be provided from Whitehouse Road to the southern central island and possibly vice versa, subject to re-integration into shared space at both ends. This would be expected to have lower risk of misinterpretation for pedestrian use. Note, the northeastern footway would need to be reduced to 2.0 metres to accommodate a segregated two-way cycle facility.

The sensitivity test options are detailed below.



A final sensitivity test was undertaken to determine whether an offset midblock crossing could be provided on Whitehouse Road approximately 50 metres north of the junction, without detrimentally impacting the junction operation. This would potentially provide an alternative offline route for cyclists rather than the need to cross from west-east and vice versa at the Barnton junction. The analysis suggested this could be implemented without impacting the junction operation but queues from the junction would be expected to block back through the midblock crossing point.

General Conclusions

- The existing junction layout currently has problems with capacity and progression through the network during the peak periods and a level of intervention is likely to be required when the committed developments are in place.
- The sizes of some existing traffic islands are unlikely to be appropriate for Toucan crossing provision.
- The Option 7.1.B layout has the worst practical reserve capacity and is considered to have significant safety risks, therefore, it is not recommended to be taken forward.
- All other design options are expected to have an impact on how the junction will operate, but the on-street reduction in capacity is not expected to be significantly worse than the existing layout and operation. It is expected that the existing junction and all options put forward would have to accept a reasonable level of queuing on entry approaches. This is to manage the short interconnecting lanes within the junction to ensure blocking back and associated locking up does not occur.
- Option 7.1.A provided the best practical reserve capacity of all the options. It also provides the best route choice for pedestrians, making navigation of the junction more direct. This is, therefore, recommended as the preferred option to pursue to improve NMU connectivity between the southwest and northeast corners of the junction.
- Options 7.1.C or 7.1.D could still be taken forward as potentially lower cost solutions to option 7.1.A. However, if the cycle path continues north on the west side of Whitehouse Road, then both options could be better solutions than option 7.1.A.

- Yellow box markings are likely to be required to help manage the junction operation.
- A diagonal crossing through the centre of the junction is not recommended due to the excessive length of the crossing.
- A dedicated cycle facility could be provided from Whitehouse Road to the southern central island and possibly vice versa, subject to re-integration into shared space at both ends. This would reduce journey times for cyclists at the expense of traffic progression, primarily from Whitehouse Road.
- An offset midblock crossing on Whitehouse Road is not expected to impact the junction operation.

1. Introduction

This technical note describes the Linsig modelling undertaken for the proposed layout options of the Queensferry Road / Maybury Road / Whitehouse Road, Barnton junction, as discussed in the Stage 1 Report. The options intend to provide improvements for pedestrians and cyclists without detrimentally impacting traffic throughput.

Base Linsig models were provided by the City of Edinburgh Council (CEC) and reviewed for consistency against the existing layout of the junction and the current on-street operation.

Committed development flows for the AM and PM peak periods were included within the base modelling received and compared against previous Microsimulation analysis undertaken by Jacobs. No inconsistencies were noted, and therefore, the flows were taken forward in all option tests within the Linsig analysis. An initial review of the 2020 Aecom Transport Assessment (TA) suggested the current traffic conditions and development demands were suitable to be used for this project. However, a more in-depth review indicated that development assumptions may not take account of all proposed housing in the Maybury/West Craigs area.

The 2020 Aecom Transport Assessment contained observed traffic flows comparable to Jacobs' observed traffic flows and were considerate acceptable. The TA also included localised observed trip rates providing a more robust trip generation assumption than would normally be used. However, the more in-depth review highlighted the number of housing units forecast in the Aecom TA were not the same as those forecast in the Arup 2016 TA. Therefore, a more up to date review of the Maybury/West Craigs development area was undertaken based on the most recent information contained in Edinburgh's City Plan. A revised set of flows for the committed developments have been developed based on this review and taken forward in both the network wide Vissim analysis and the Linsig modelling.

The observed traffic flows found that on average the total number of vehicles, when converted to pcus, that progress through the junction is approximately 5350 pcus in the AM peak and 5100 pcus in the PM peak. The committed development traffic increases these flows by approximately 340 pcus in both peaks.

The base layout of the junction is detailed in Figure 1 below.

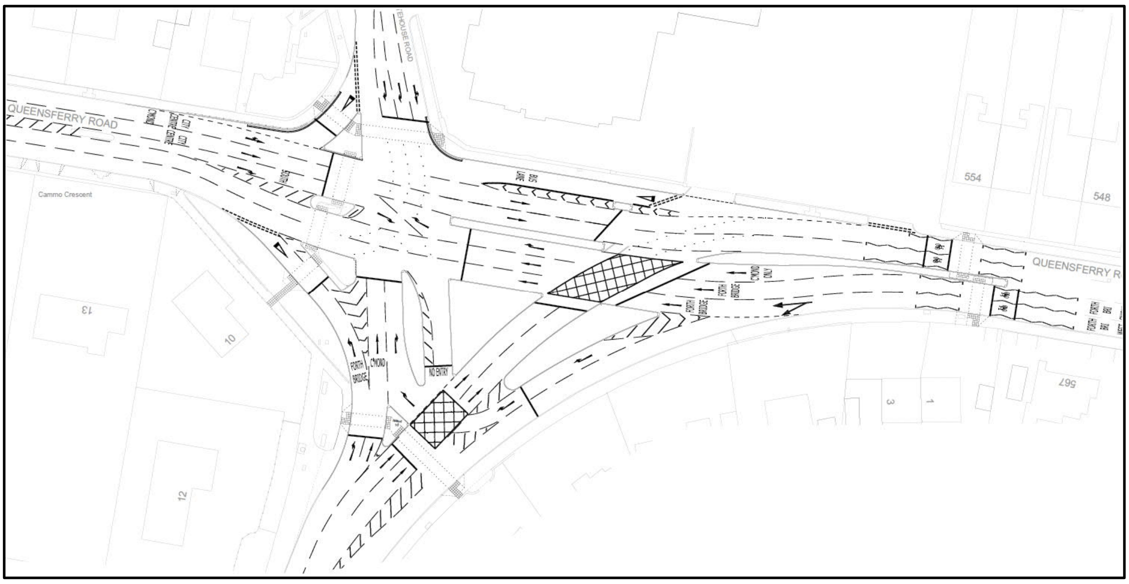


Figure 1: Existing junction layout

Two potential revised layouts were proposed in the Stage 1 Report; one was put forward by Jacobs (option 7.1.A), and the other was put forward as part of Aecom's "Maybury Road – Transport Feasibility Study" report, dated 08/05/2020 (option 7.1.B).

<u>Layout Option 7.1.A</u>

This option contained focused improvements based on the existing Barnton junction arrangement. A pedestrian/ cycle route through the centre of the junction is provided by the provision of 4m wide Toucan crossings connecting both sides of Maybury Road to the footway in the Northeast corner between Whitehouse Road and Queensferry Road, significantly improving accessibility and space for pedestrians and cyclists. From the proposed shared use path on the western footway this would require a four-stage crossing, the same as the existing arrangement. The U- turn movement has been removed due to reallocation of carriageway space. Pedestrian crossings would be retained on the western side of the junction as the space within existing traffic islands is considered too small to safely accommodate cyclist provision.

The general arrangement for this proposal is detailed in Figure 2 below.

Figure 2: Option 7.1.A Jacobs proposed junction layout from Stage 1 Report

Layout Option 7.1.B

A full junction re-design to improve pedestrian and cyclist crossings through the junction. Introduction of 4m wide Toucan crossings on all approach arms, widening of islands to accommodate waiting and tightening of junction radii where possible to reduce crossing distances.

The general arrangement for this layout is detailed in Figure 3 below.

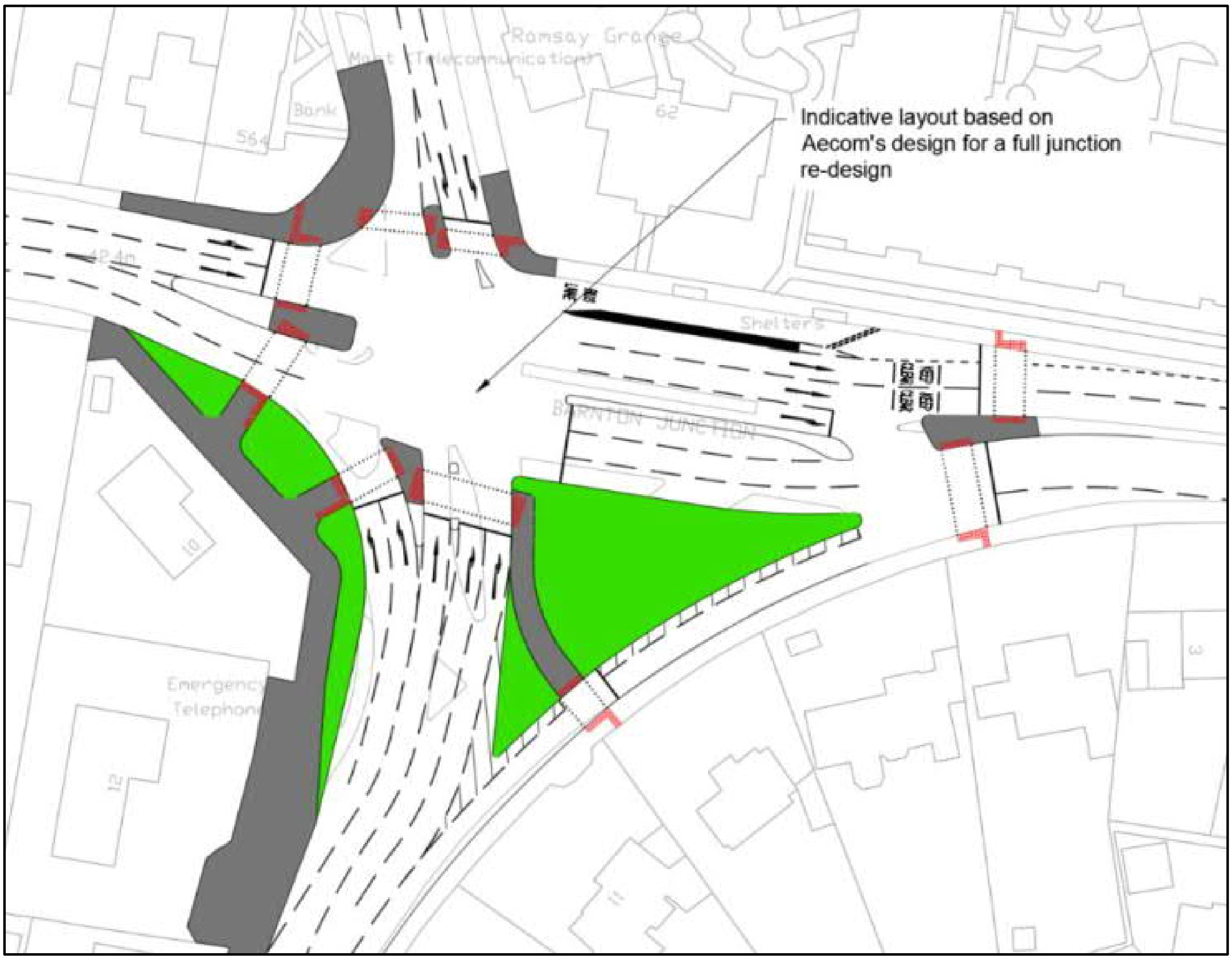


Figure 3: Option 7.1.B Proposed junction layout based on the preferred design within the Maybury Road Transport Feasibility Study, 08/05/2020

2. Base Linsig Model Review

The base Linsig model provided by CEC has been reviewed for consistency against the existing layout of the junction and the current on-street operation. The Linsig Network layout is detailed in Figure 4 below:

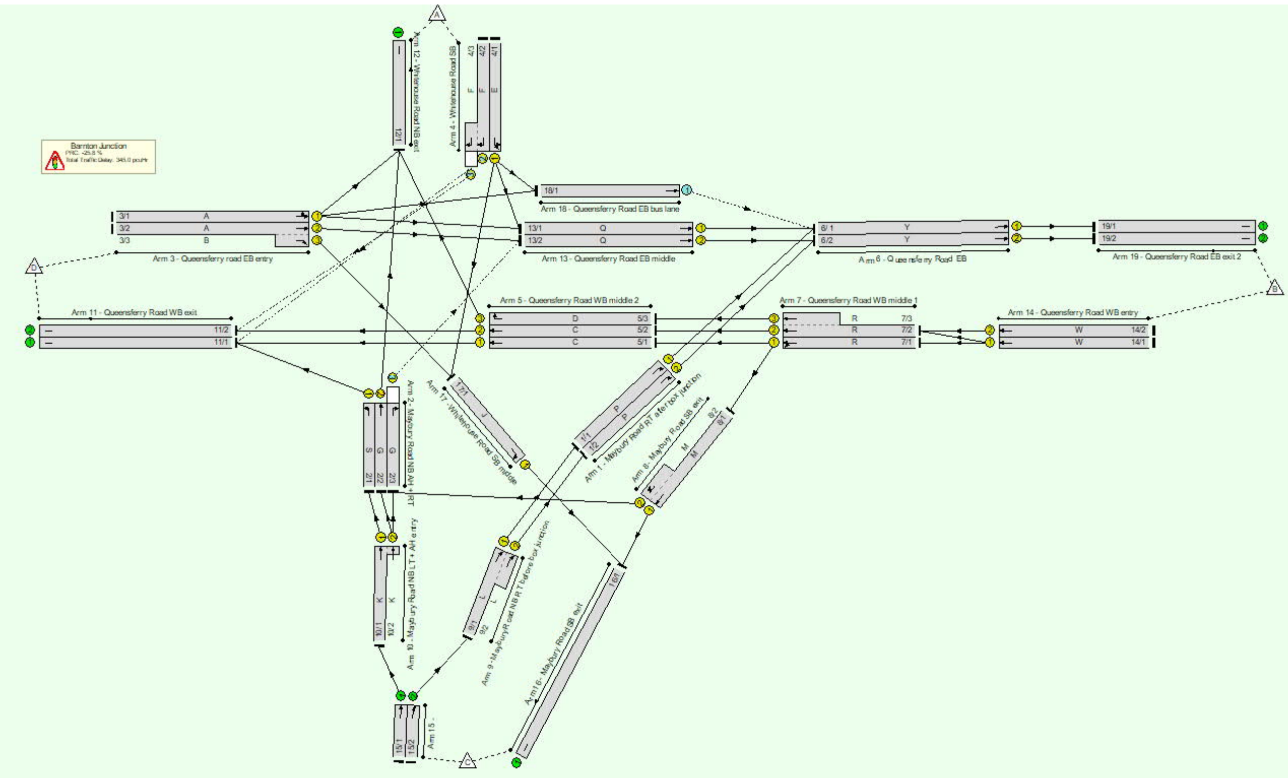


Figure 4: Base model layout as provided by CEC

Note, the separate midblock staggered crossing facility to the east of the junction has been included within the model due to proximity and potential for impact on traffic throughput.

The setup of the model has been reviewed with the following observations made:

- The majority of lane widths have been set to 3.25m, therefore, saturation flows may not be as accurate as possible under the standard Linsig RR67 measurement method. Some saturation flows have also been "directly entered", it is assumed this has been done to validate against queue lengths.
- Lane 8/1 modelled with a lane length of 29m, however, storage appears closer to 40m.
- Arm 18 (bus lane) has not been specified to give way to Lane 1/1.
- All cruise speeds set at 30kmh, which appears low for a 40mph speed limit, this may affect coordination/ queuing outputs.
- Many cruise speed link lengths are incorrect which will affect coordination of signals and queuing outputs.
- Phasing does not match current operation as no left turn slip lane eastbound into Whitehouse Road has been provided (Phase C and associated give way missing).
- Phase G is an RTIGA on-street but has been set up as a full green arrow phase.
- Not all intergreens between phase conflicts had been specified (e.g. Phase H and G).

- Give way parameters have not been set up for a typical right turn at a signalised junction (i.e. following industry standard guidance), it is therefore assumed these have been calculated using a more appropriate software package.
- Phase T left turn from Maybury Road is not set up with a priority exit onto Queensferry Road.
- Phase N right turn not set up with a signallised give way to opposing Phase M.
- Some Minimum Green periods have been specified incorrectly.
- No buses have been allocated to the bus gate.
- UTC base cycle times have been allocated for the signal timings but the fixed time operation for stage change points has not been replicated, this includes only one pedestrian crossing window for the midblock staggered crossing on Queensferry Road to the east of the junction.

The results for this model are contained within summary tables 1 and 2 but should be treated with caution given the errors noted with phase set-up and intergreens. Jacobs have generated an alternative version with the observations noted above rectified. This model has been validated against the queue surveys contained within Aecom's "Maybury Road – Transport Feasibility Study" report and found to be broadly aligned.

Given additional option testing is to be undertaken with committed development flows in place, it was considered necessary to run Linsig's CYOP (Cycle Time Optimisation) function to determine optimised timings and SCOOT based cycle times for the base model, this will allow a better comparison between the options to be made. Note, SCOOT based cycle times will be used for CYOPs as it is understood the junction is being future proofed for SCOOT operation.

The results for the base layouts (AM and PM peak periods) are detailed in Tables 1 and 2 below:

Barnton Junction (AM Peak)		Base Layout / Base Flows 100 secs			Base Layout / Base Flows (Jacobs) UTC 100 secs			Base Layout / Base Flows (Jacobs) CYOP 104 secs			Base Layout / Committed Development Flows (Jacobs) - UTC 100 secs			Base Layout / Committed Development Flows (Jacobs) - CYOP 104 secs		
Item	Lane Description	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	44.40%	27.7	3.2	71.80%	42.4	10.6	90.80%	61.4	12.9	89.80%	60.6	15.5	89.80%	55.2	14.4
1/2	Maybury Road RT after box junction Ahead	51.40%	28.3	3.9	75.40%	44.2	11.7	91.60%	61.6	13.8	91.50%	64.3	16.9	91.50%	57.7	16
2/1	Maybury Road NB AH + RT Left	6.40%	2.9	0.8	13.80%	5.7	0.5	16.00%	5.5	0.5	20.60%	6.0	0.8	21.90%	5.4	0.8
2/2	Maybury Road NB AH + RT Ahead	95.30%	116.2	12.8	88.50%	89.6	10.6	92.00%	100.2	11.7	88.50%	89.6	10.6	80.50%	68.0	9.3
2/3	Maybury Road NB AH + RT Right	0.00%	0.0	0	2.80%	68.1	0.1	2.90%	66.8	0.1	2.80%	66.7	0.1	2.90%	65.5	0.1
3/1	Queensferry road EB entry Left Ahead Ahead2	108.60%	198.9	84.6	112.2 : 112.2%	250.1	112.5	91.6 : 91.6%	35.2	29.2	119.8 : 119.8%	358.6	157.7	93.0 : 93.0%	38.3	31
3/2+3/3	Queensferry road EB entry Ahead Right	104.3 : 104.3%	138.4	37.7	113.9 : 113.9%	269.4	58.1	91.9 : 91.9%	41.1	22.1	122.8 : 122.8%	388.3	74.7	94.0 : 94.0%	45.4	23.5
4/1	Whitehouse Road SB Left Ahead Left2	86.80%	67.7	12.4	95.50%	101.6	15.8	90.30%	79.1	13.8	95.50%	101.6	15.8	90.30%	79.1	13.8
4/2+4/3	Whitehouse Road SB Right	100.0 : 100.0%	158.1	11.9	96.2 : 99.3%	144.8	10.9	91.6 : 91.6%	106.0	8.3	96.2 : 99.3%	144.8	10.9	85.3 : 85.3%	85.4	6.9
5/1	Queensferry Road WB middle 2 Ahead	33.30%	3.3	0.4	41.90%	6.7	5.5	78.30%	60.9	15.1	36.10%	5.9	4.1	88.00%	77.4	18.1
5/2	Queensferry Road WB middle 2 Ahead	81.00%	10.4	8.4	75.50%	18.2	20.9	87.00%	64.6	17.7	80.90%	20.6	23.7	93.00%	91.4	21.7
5/3	Queensferry Road WB middle 2 Right	61.20%	58.4	2.9	68.00%	80.4	3.3	70.70%	94.8	3.3	68.00%	79.3	3.3	70.70%	105.2	3
6/1	Queensferry Road EB Ahead	70.90%	10.0	22.9	73.80%	6.8	13.4	67.40%	4.7	8.1	81.10%	9.0	17.2	73.10%	6.0	10.7
6/2	Queensferry Road EB Ahead	54.70%	9.1	16.4	56.60%	5.6	9.4	67.90%	5.4	13.1	54.50%	4.4	6.5	72.60%	7.0	13
7/1	Queensferry Road WB middle 1 Ahead Left	113.30%	278.0	85.1	89.10%	32.2	28	76.80%	12.2	22.8	92.50%	37.9	31.4	89.10%	22.3	32.7
7/2+7/3	Queensferry Road WB middle 1 Ahead	110.9 : 110.9%	243.7	76.1	75.9 : 75.9%	21.7	18.3	49.1 : 49.1%	6.9	8.5	80.9 : 80.9%	24.2	21	50.9 : 50.9%	9.0	9.3
8/1+8/2	Maybury Road SB exit U-Turn Ahead	99.0 : 0.0%	120.3	24.6	73.7 : 73.7%	13.7	13.3	67.8 : 67.8%	49.7	17.1	85.0 : 85.0%	20.4	18.7	78.1 : 78.1%	55.9	21.5
9/1+9/2	Maybury Road NB RT before box junction Ahead	112.9 : 112.9%	279.4	63.1	79.6 : 79.6%	34.6	14.6	74.6 : 74.6%	30.4	13.4	97.8 : 97.8%	71.8	29.9	91.8 : 91.8%	46.5	24.1
10/1+10/2	Maybury Road NB LT + AH entry Ahead	23.7 : 23.7%	3.0	1.7	24.0 : 24.0%	3.2	1.8	23.5 : 23.5%	2.9	1.7	27.2 : 27.2%	3.3	1.9	26.7 : 26.7%	3.0	1.8
13/1	Queensferry Road EB middle Ahead	75.20%	9.7	8.1	58.50%	5.6	2.1	46.90%	13.5	9.3	61.00%	5.9	2.5	51.30%	16.6	9.9
13/2	Queensferry Road EB middle Ahead	46.80%	3.5	0.6	39.80%	4.6	2.8	50.90%	10.7	7.9	31.10%	3.4	2	53.50%	12.9	7.9
14/1	Queensferry Road WB entry Ahead	54.90%	5.7	9.2	59.50%	6.5	11	66.70%	7.4	14.2	61.70%	6.8	11.8	73.00%	8.7	17.4
14/2	Queensferry Road WB entry Ahead	51.90%	5.3	8.4	48.90%	5.4	7.8	40.90%	4.7	5.9	52.10%	5.7	8.8	40.00%	4.6	5.8
15/1	*Maybury Road Ahead (free flow)*	*19.00%*	*1.1*	*0.1*	*19.00%*	*1.1*	*0.1*	*19.00%*	*1.1*	*0.1*	*21.80%*	*1.2*	*0.1*	*21.80%*	*1.2*	*0.1*
15/2	*Maybury Road Ahead (free flow)*	*36.30%*	*1.5*	*0.3*	*36.30%*	*1.5*	*0.3*	*36.30%*	*1.5*	*0.3*	*44.70%*	*1.7*	*0.4*	*44.70%*	*1.7*	*0.4*
17/1	Whitehouse Road SB middle Right	42.70%	32.3	12.3	75.70%	16.6	9.4	86.10%	37.2	16.1	77.40%	17.4	9.6	91.40%	49.9	18.8
18/1	Queensferry Road EB bus lane Ahead	-	-	-	12.70%	4.3	0.1	13.30%	4.2	0.1	12.70%	4.6	0.1	13.80%	4.4	0.1
	PRC (%)	**-25.8%**			**-26.5%**			**-2.2%**			**-36.4%**			**-4.4%**		
	Total Delay (pcu/hr)	**343.9**			**209.6**			**112.0**			**294.0**			**136.0**		

Table 1: Base model results (AM Peak)

Barnton Junction (PM Peak)		Base Layout / Base Flows 110 secs			Base Layout / Base Flows (Jacobs) UTC 110 secs			Base Layout / Base Flows (Jacobs) CYOP 104 secs			Base Layout / Committed Development Flows (Jacobs) - UTC 110 secs			Base Layout / Committed Development Flows (Jacobs) - CYOP 104 secs		
Item	Lane Description	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	39.70%	29.2	3.6	84.40%	83.4	9.9	66.40%	44.1	7.8	97.20%	131.8	15.2	82.00%	45.1	10.2
1/2	Maybury Road RT after box junction Ahead	42.60%	28.7	4	89.90%	95.5	11.9	73.60%	47.6	9.3	112.00%	299.7	33.5	86.30%	51.0	11.9
2/1	Maybury Road NB AH + RT Left	26.20%	4.3	3.8	59.10%	15.3	5.1	59.80%	15.0	4.8	62.60%	15.4	5.5	59.40%	15.6	5.3
2/2	Maybury Road NB AH + RT Ahead	68.00%	65.6	5.8	80.40%	87.4	7.1	55.70%	52.8	5.2	80.40%	87.4	7.1	49.20%	52.0	5.2
2/3	Maybury Road NB AH + RT Right	0.00%	0.0	0	1.50%	75.4	0	1.40%	59.7	0	1.50%	74.5	0	1.20%	60.3	0
3/1	Queensferry road EB entry Left Ahead Ahead2	73.90%	25.6	19.1	87.9 : 87.9%	29.0	29.2	87.0 : 87.0%	33.5	24.6	103.0 : 103.0%	111.8	70.7	86.4 : 86.4%	30.0	25.1
3/2+3/3	Queensferry road EB entry Ahead Right	93.1 : 93.1%	55.8	18.9	91.6 : 91.6%	58.8	8.8	86.6 : 86.6%	43.9	12.6	113.8 : 113.8%	305.1	30.4	93.2 : 93.2%	54.8	13.1
4/1	Whitehouse Road SB Left Ahead Left2	45.90%	41.7	5.9	64.30%	56.6	6.9	45.00%	39.1	5.6	64.30%	56.6	6.9	52.90%	45.1	6
4/2+4/3	Whitehouse Road SB Right	92.0 : 92.0%	88.9	12.5	117.6 : 117.7%	372.2	41.2	88.5 : 88.5%	73.6	10.1	116.8 : 116.8%	361.1	39.9	92.8 : 92.8%	91.5	12.6
5/1	Queensferry Road WB middle 2 Ahead	65.90%	5.9	1.1	63.00%	11.9	14.5	80.00%	24.0	19.9	57.70%	10.1	9.9	81.60%	57.1	21.9
5/2	Queensferry Road WB middle 2 Ahead	85.90%	12.4	3.1	71.70%	15.3	21.1	85.50%	31.7	25.7	76.60%	17.0	23.8	91.10%	71.5	28.3
5/3	Queensferry Road WB middle 2 Right	73.00%	81.1	3.7	73.00%	98.2	3.7	69.10%	88.0	3.4	73.00%	97.7	3.7	69.10%	121.0	3.4
6/1	Queensferry Road EB Ahead	58.10%	5.2	20.2	92.20%	22.8	16.3	82.50%	13.2	14.6	107.10%	163.6	77.3	90.90%	23.3	26.6
6/2	Queensferry Road EB Ahead	51.80%	4.7	15.7	50.80%	8.2	8.3	65.30%	6.5	9	38.80%	8.3	5.2	65.70%	7.4	11.5
7/1	Queensferry Road WB middle 1 Ahead Left	93.90%	46.7	34.1	66.70%	8.0	13	71.60%	9.9	14.2	72.80%	8.6	13.9	79.70%	21.2	31.6
7/2+7/3	Queensferry Road WB middle 1 Ahead	94.2 : 94.2%	47.7	33.4	60.9 : 60.9%	7.3	17	62.2 : 62.2%	8.4	17.6	64.7 : 64.7%	7.7	18.2	62.5 : 62.5%	13.2	16.9
8/1+8/2	Maybury Road SB exit U-Turn Ahead	32.4 : 0.0%	26.8	5.7	34.3 : 34.3%	11.4	4.9	33.7 : 33.7%	12.1	4.5	49.3 : 49.3%	12.5	7.2	55.1 : 55.1%	40.0	14.8
9/1+9/2	Maybury Road NB RT before box junction Ahead	47.0 : 47.0%	19.0	5.8	49.3 : 49.3%	21.1	6.4	48.4 : 48.4%	19.5	5.8	59.7 : 59.7%	23.1	9.9	64.4 : 64.4%	26.4	10.1
10/1+10/2	Maybury Road NB LT + AH entry Ahead	39.2 : 39.2%	4.7	4.8	37.5 : 37.5%	3.6	3.9	37.5 : 37.5%	3.5	3.6	39.6 : 39.6%	3.7	4.2	39.6 : 39.6%	3.6	4.1
13/1	Queensferry Road EB middle Ahead	60.10%	7.6	11	56.40%	2.8	0.7	49.20%	3.2	1.2	66.40%	3.6	1	52.30%	11.4	7.9
13/2	Queensferry Road EB middle Ahead	48.80%	3.1	5.4	24.00%	3.0	1.9	36.00%	3.1	2.5	11.90%	4.2	1.9	32.80%	5.9	3.1
14/1	Queensferry Road WB entry Ahead	62.00%	6.2	12.2	78.30%	13.5	12.8	82.80%	18.9	18.4	85.40%	17.7	17.2	93.40%	27.8	21.5
14/2	Queensferry Road WB entry Ahead	50.50%	4.9	8.3	68.00%	10.6	9.9	68.60%	11.8	10.5	72.30%	11.6	11.2	69.80%	11.3	9.9
15/1	*Maybury Road Ahead (free flow)*	*31.20%*	*1.3*	*0.2*	*31.20%*	*1.3*	*0.2*	*31.20%*	*1.3*	*0.2*	*33.00%*	*1.4*	*0.2*	*33.00%*	*1.4*	*0.2*
15/2	*Maybury Road Ahead (free flow)*	*26.60%*	*1.3*	*0.2*	*26.60%*	*1.3*	*0.2*	*26.60%*	*1.3*	*0.2*	*32.00%*	*1.4*	*0.2*	*32.00%*	*1.4*	*0.2*
17/1	Whitehouse Road SB middle Right	44.80%	36.2	5.2	63.70%	15.8	5.2	65.20%	20.8	5.1	69.70%	17.8	5.5	61.30%	14.1	5
18/1	Queensferry Road EB bus lane Ahead	-	-	-	12.20%	4.3	0.1	11.30%	4.0	0.1	13.00%	4.7	0.1	11.90%	4.2	0.1
	PRC (%)		-4.7%			-30.8%			1.7%			-29.7%			-3.6%	
	Total Delay (pcu/hr)		83.5			110.1			75.9			240.5			117.8	

Table 2: Base model results (PM Peak)

All base model set-ups demonstrate problems with progression through the network which correlates with the observations on-street for the existing layout during the peak periods.

The base UTC timings for the AM peak have been set up to provide good coordination along Queensferry Road for both the eastbound and westbound directions. However, when running the CYOP function within Linsig, the coordination still appears reasonable for the eastbound direction but favours the Maybury Road right turn over the westbound Queensferry Road movement. This may work well as suggested by the results but would need some on-street validation to ensure significant queuing problems do not occur. The CYOP proposed coordination is quite similar under the AM peak committed development flow test, but with even less time given to the West - East movement coordination, which may lead to further problems. However, it should be noted that with the committed development flows added, the high PRC and overall delay values suggest some timing amendments would be required.

The base UTC timings for the PM peak are very similar to the AM peak but with more green time allocated to the eastbound and westbound through movements along Queensferry Road. Running the CYOP function in Linsig is much more aligned with this in terms of coordination, just with more green time allocated to the Maybury Road and Whitehouse Road approaches. With the committed development flows added, the CYOP function again favours more coordination for the Maybury Road right turn.

The revised coordination with committed development flows in place suggest PRC improvements and overall delay reductions could be made under the base layout. However, as noted above, some on-street validation would be required to ensure any changes to timings does not have any significant impact on queuing and associated throughput, particularly for the westbound Queensferry Road movements.

3. Proposed Option Tests

Two options were put forward in the Stage 1 report; option 7.1.A and option 7.1.B. An additional two options have been considered as part of this Linsig analysis report, whereby the existing layout has been updated on the western side to allow for Toucan provision to link the offline cycle facilities to the southwest with the offline cycle facilities in the northeast. These improvements for cyclists have been considered as the existing layout has relatively small islands that may struggle to accommodate both pedestrians and cyclists safely, so these options aim to improve NMU waiting areas. The third and fourth options will be referred to as option 7.1.C and 7.1.D.

To allow ease of comparison of the three options, the results for degree of saturation (DoS), delay, queuing and PRC are all contained in the summary tables in section 3.5.

3.1 Option 7.1.A

The Linsig network layout developed by Jacobs is detailed in Figure 5 below.

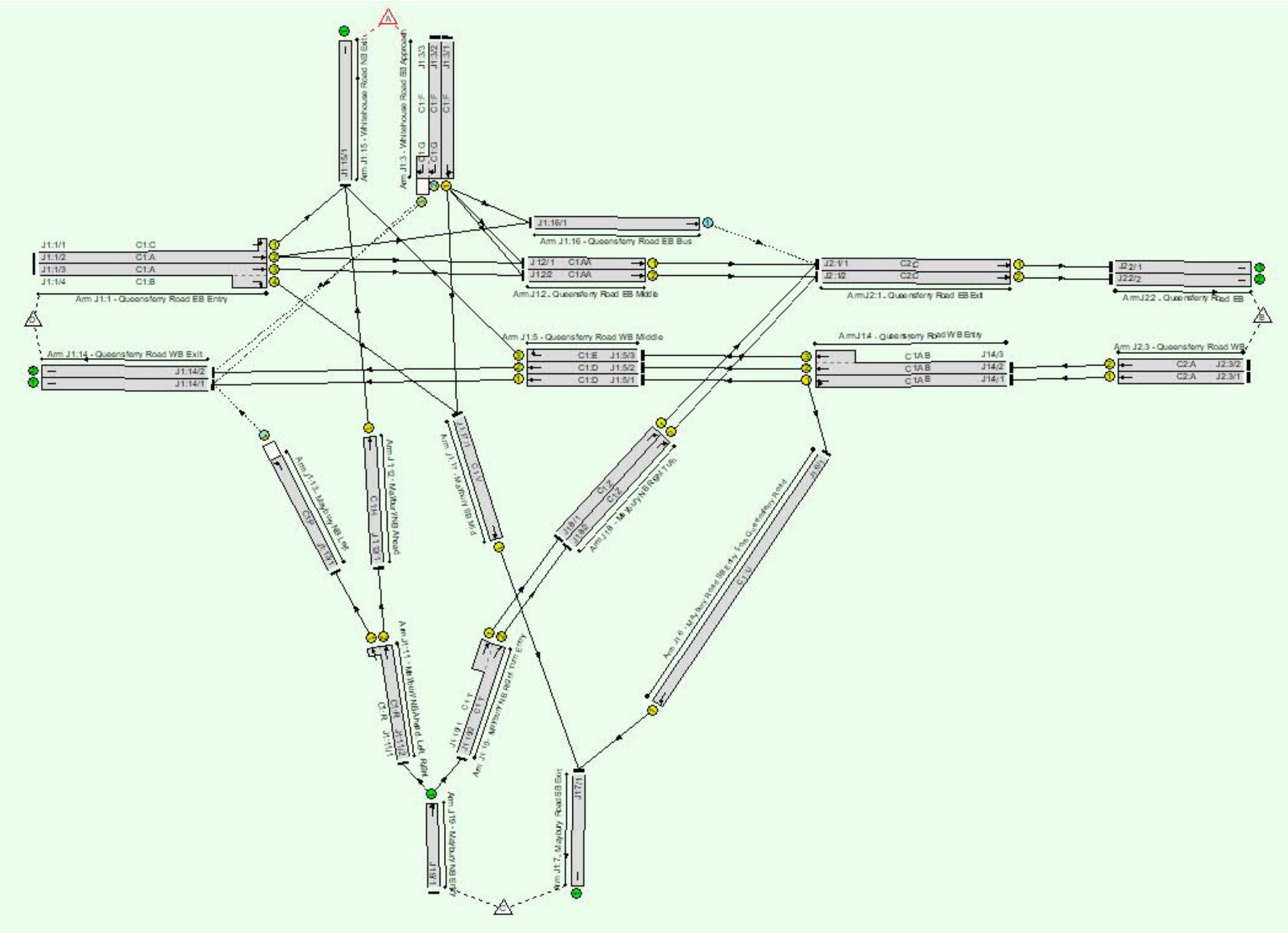


Figure 5: Option 7.1.A model layout

The junction is proposed to operate in four control streams, similar to the existing operation. The Whitehouse Road right turn movements are proposed to operate under a RTIGA.

Running the CYOP function in Linsig under the committed development flows suggests the junction would need to operate under a cycle time of 120 secs during the AM peak to achieve the best possible PRC of -7%. If the junction was to operate at the same cycle time as proposed for the base layout (104 secs), a PRC of -11.3% is expected. Note, a reasonable queue is expected on the mid-link Maybury Road southbound Phase V, this may therefore require an additional stage to allow this to run twice to keep the queue low for both the Queensferry Road eastbound right turn traffic source and the Whitehouse Road southbound ahead traffic source. Testing this operation provides a PRC of -12.4% PRC during the AM Peak. Given the improvement in PRC between a 120 secs cycle and a 104 secs cycle is not too significant, the 104 secs cycle would be expected to offer greater throughput potential for pedestrians and cyclists due to the increased frequency of the Toucan crossings being called.

Running the CYOP function in Linsig for the PM peak would require a 120 secs cycle to achieve the best possible PRC of -3.5%. If the junction was to operate at the same cycle time as proposed for the base layout (104 secs), a PRC of -6.8% is expected. As with the AM peak, given the improvement in PRC between a 120 secs cycle and a 104 secs cycle is only marginal, the 104 secs cycle would be expected to offer greater throughput potential for pedestrians and cyclists due to the increased frequency of the Toucan crossings being called.

3.2 Option 7.1.B

The Linsig network layout provided by CEC and developed for the Maybury Road – Transport Feasibility Study, 08/05/2020 is detailed in Figure 6 below.

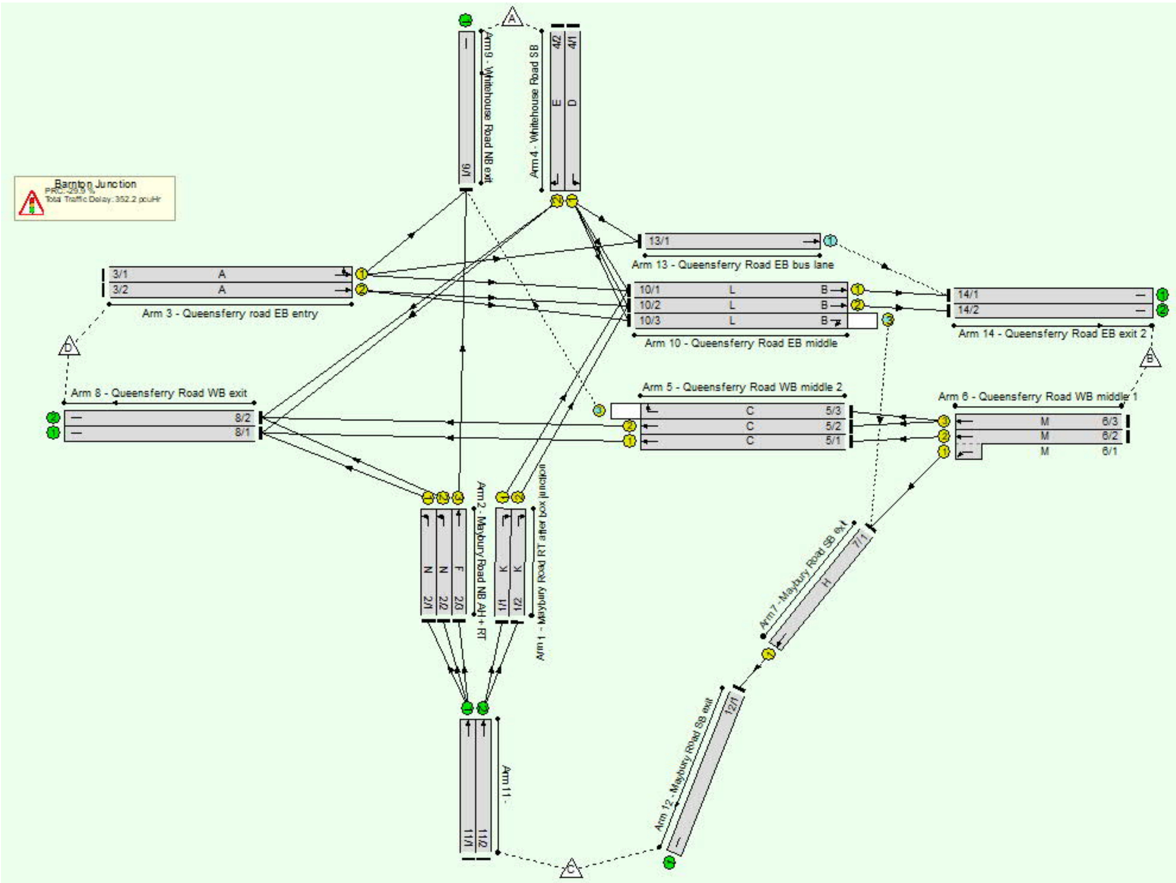


Figure 6: Option 7.1.B model layout

The model was reviewed against the design drawing for consistency and the proposed operation was checked for acceptability, the following observations were made:

- Many cruise speeds set at 30kmh, which appears low for a 40mph speed limit, this may affect coordination/ queuing outputs.
- Many cruise speed link lengths are incorrect which will affect coordination of signals and queuing outputs.
- Right turn into Maybury Road is extremely tight, particularly for larger vehicles. Swept path analysis has been checked and a much bigger turning radii is required. This effectively reduces the right turn stacking space from 41m to 34m which also has an impact on the westbound right turn stacking space from the previously specified unrestricted 40m length to a flare lane of 24m.
- The Maybury Road set up of two lanes leading to five lanes for approx. 50m on the immediate approach to the junction, is considered a complex arrangement that may lead to driver confusion on the immediate approach to the junction. A supplementary paper to the Cramond and Barnton Community Council's discussion paper, dated 19th July 2018, highlighted this being a safety issue under the existing layout and this option would appear to make the potential for last second lane changes more prevalent.
    - It is also noted that the lane setup in Linsig on the Maybury Road approach is likely to be creating more throughput than is realistically achievable under the space constraints.
- The right turn angle for the double right turn from Maybury Drive to Queensferry Road East may create problems if one of the two turning vehicles is an articulated HGV. This may impact westbound storage if additional carriageway space is required following swept path analysis.
- The Queensferry Road eastbound middle section Phase B is set up as an RTIGA giving way to opposing traffic under main Phase L. The opposing traffic consists of two lanes at potentially high speeds given the 40mph speed limit. This may pose a safety issue and would need further consideration before possible implementation.
- The Queensferry Road eastbound middle section ahead movements have also been allocated RTIGA Phase B as well as its associated main Phase L, this is an incorrect set up but would not alter the proposed timings.
- The Queensferry Road westbound middle section right turn under Phase C is set up as giving way to opposing traffic. The opposing traffic consists of two lanes at potentially high speeds given the 40mph speed limit. This may pose a safety issue and would need further consideration before possible implementation. It has also been set up to terminate before the eastbound movement to allow pedestrian crossing Phase P to the west to run. This potentially leaves vehicles in a stranded position in the carriageway without knowing when to proceed and could lead to confusion/ exit blocking.
- Phase E is set up as a fully signallised right turn but has not been allocated intergreens to reflect this.
- Many intergreens are missing or are not long enough to manage a conflict based on current national standards (e.g. ped phase J is 12m to 13m long but only has an intergreen of 7 secs allocated.)
- Pedestrian crossing over left turn Maybury Road Phase N is missing.

The results for this option are contained in Tables 3 and 4, however, given some of the observations are potentially critical for operation, Jacobs have created an additional model with amendments that are considered necessary to establish a minimum level of adequacy for this option to be considered further. It should be noted that this model has only been prepared to allow a more realistic comparison between options to be made, Jacobs still have concerns with some fundamental principles in this design, as raised above. The new option will be referred to as option 7.1.B V2.

The results for option 7.1.B suggest an AM Peak under base flows would provide a PRC of -29.9% and PM peak PRC of -7.2%. Option 7.1.B V2 containing Jacobs' updates suggests an AM Peak PRC of -31.1% and PM peak PRC of -13.7%. Both sets of results suggest the proposal will provide worse overall operation than option 7.1.A.

3.3 Option 7.1.C

A revised proposal to allow the existing layout to be modified for 4m wide Toucan crossings on the western side is detailed in Figure 7 below. The basic layout of the Linsig Network diagram is broadly aligned with Figure 1 but with the Queensferry Road eastbound left turn slip removed. Five "walk with traffic" crossings are required between the Northeast and Southwest corners of the junction.

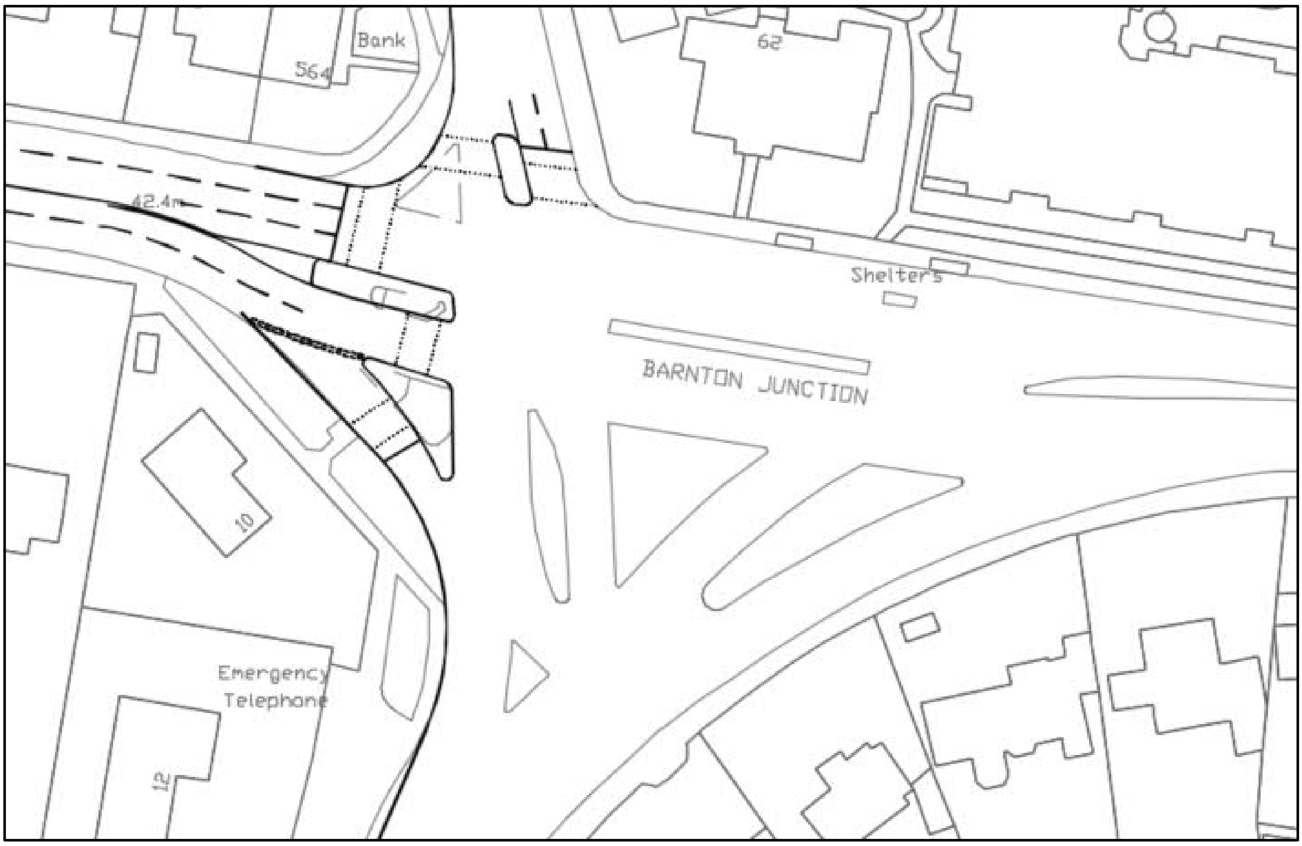


Figure 7: Option 7.1.C Design alterations from existing layout

This layout is expected to operate worse than option 7.1.A, with an AM peak PRC of -19.2% and a PM peak PRC of -9.9%, however, the provision for pedestrian and cyclist shared space would be much improved at the western crossings.

Note, as with option 7.1.A, a reasonable queue is expected on the mid-link Maybury Road southbound Phase, this may therefore require an additional stage to allow this to run twice to keep the queue low for both the Queensferry Road eastbound right turn traffic source and the Whitehouse Road southbound ahead traffic source.

3.4 Option 7.1.D

An additional option to allow the existing layout to be modified for 4m wide Toucan crossings on the west side of the junction. This option maintains the number of crossings required to navigate between the northeast and southwest corners of the junction, as per the existing arrangement. The proposed layout is detailed in Figure 8 below. The basic layout of the Linsig Network diagram is broadly aligned with Figure 1 but with the Queensferry Road eastbound left turn slip removed and the Maybury Road left turn provided with a second lane. The Queensferry Road westbound u-turn has also been removed.

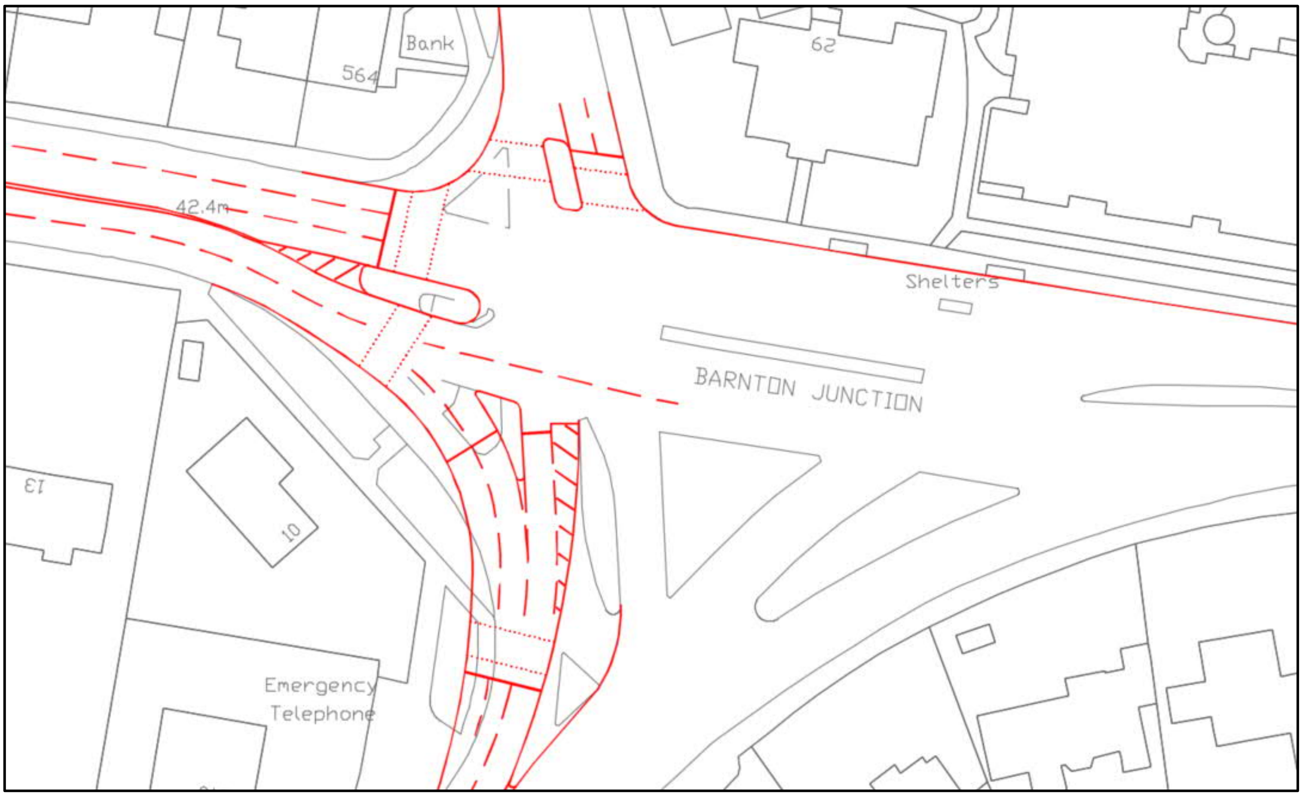


Figure 8: Option 7.1.D Design alterations from existing layout

This layout is expected to operate worse than option 7.1.A, with an AM peak PRC of -19.2% and a PM peak PRC of -22.4, however, the provision for pedestrian and cyclist shared space would be much improved at the western crossings.

Note, as with option 7.1.A and 7.1.C, a reasonable queue is expected on the mid-link Maybury Road southbound Phase, this may therefore require an additional stage to allow this to run twice to keep the queue low for both the Queensferry Road eastbound right turn traffic source and the Whitehouse Road southbound ahead traffic source.

3.5 Results

For ease of comparison, the results for DoS, delay, queuing, and PRC for each option are contained in Tables 3 and 4 for the AM and PM peaks respectively:

Barnton Junction Options (AM Peak)		Option 7.1.A 104 secs			Option 7.1.B 100 secs			Option 7.1.B V2 104 secs			Option 7.1.C 104 secs			Option 7.1.D 104 secs		
Item	Lane Description	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
	J1: Barnton Junction	**100.20%**	-	-	**116.90%**	-	-	**118.00%**	-	-	**107.30%**	-	-	**107.30%**	-	-
1/2+1/1	Queensferry Road EB Entry Ahead Left Ahead2	99.3 : 99.3%	78.5	40.1	115.50%	314.6	94.7	117.40%	338.0	98.9	105.50%	156.3	60.2	106.10%	165.7	61.6
1/3+1/4	Queensferry Road EB Entry Ahead Right	99.2 : 99.2%	83.0	39.7	115.20%	308.6	104.6	116.80%	328.7	108.3	105.6 : 105.6%	157.0	61.7	106.4 : 106.4%	168.4	65.9
2/1	Queensferry Road EB Middle Ahead	44.80%	4.0	2.3	63.00%	13.4	21.4	59.10%	15.4	20.1	43.40%	15.6	15.5	43.10%	16.5	15
2/2	Queensferry Road EB Middle Ahead	55.50%	3.9	1.8	71.90%	17.5	30.8	73.50%	19.0	31.7	53.30%	22.9	21.2	52.50%	23.9	20.7
2/3	Queensferry Road EB Middle Right	-	-	-	73.00%	20.2	5.8	75.20%	21.7	6.2	-	-	-	-	-	-
3/1	Whitehouse Road SB Approach Left Left2 Ahead	73.60%	49.0	10.7	111.50%	284.4	34.6	116.00%	342.2	41	64.10%	40.6	9.8	66.20%	42.4	9.9
3/2+3/3	Whitehouse Road SB Approach Right	76.1 : 76.1%	66.2	5.9	56.80%	43.6	6.7	67.90%	54.2	7.6	80.70%	69.5	8.8	104.40%	210.2	18.3
4/1	Queensferry Road WB Entry Ahead Left	91.20%	27.0	20.2	87.8 : 87.8%	25.3	27.1	91.9 : 91.9%	31.6	32.7	73.60%	8.8	18	85.90%	17.2	30
4/2+4/3	Queensferry Road WB Entry Ahead	50.2 : 50.2%	12.5	8.4	53.50%	14.3	11.5	49.90%	14.4	10.7	39.40%	4.6	5.7	48.0 : 48.0%	7.3	9.2
5/1	Queensferry Road WB Middle Ahead	89.90%	44.5	17.8	94.00%	62.7	19.1	107.40%	193.7	42.7	102.60%	144.5	31.4	102.60%	147.9	31.8
5/2	Queensferry Road WB Middle Ahead	95.00%	63.1	23.4	102.30%	124.0	33.3	109.0 : 109.0%	219.6	50.9	104.30%	156.1	37.1	104.30%	159.5	37.7
5/3	Queensferry Road WB Middle Right	52.20%	56.7	2.8	77.80%	121.4	3	-	-	-	49.50%	58.9	2.8	45.00%	54.5	2.7
6/1	Maybury Road SB Entry from Queensferry Road Ahead	87.60%	50.4	23	77.70%	13.0	18.1	78.80%	16.8	21	76.3 : 76.3%	50.7	19.6	74.60%	49.1	19.3
8/1	Maybury NB Right Turn Right	81.80%	29.1	13.7	116.90%	347.0	50.1	118.0 : 118.0%	345.6	94.1	107.10%	207.8	32.6	102.50%	145.3	25.7
8/2	Maybury NB Right Turn Right	81.60%	28.4	14	116.70%	344.3	51.8	-	-	-	107.20%	206.2	34	102.50%	143.3	26.8
9/1	*Maybury NB Entry Ahead (free flow)*	*22.10%*	*1.2*	*0.1*	*24.50%*	*1.2*	*0.2*	*24.50%*	*1.2*	*0.2*	*21.80%*	*1.2*	*0.1*	*21.80%*	*1.2*	*0.1*
9/2	*Maybury NB Entry Ahead (free flow)*	*45.30%*	*1.7*	*0.4*	*43.80%*	*1.5*	*0.4*	*43.80%*	*1.5*	*0.4*	*44.70%*	*1.7*	*0.4*	*44.70%*	*1.7*	*0.4*
10/2+10/1	Maybury NB Right Turn Entry Ahead	90.3 : 90.3%	43.3	23.5	-	-	-	-	-	-	86.8 : 86.8%	36.2	20.7	88.4 : 88.4%	39.0	21.7
11/2+11/1	Maybury NB Ahead, Left, Right Ahead Ahead2	33.3 : 33.3%	6.2	2.4	-	-	-	-	-	-	27.3 : 27.3%	3.4	2.1	25.7 : 25.7%	3.7	1.9
12/1	Maybury NB Ahead Ahead	100.20%	153.3	15.9	71.50%	48.3	10.1	74.30%	52.5	10.6	107.30%	260.1	22.5	107.30%	258.4	22.3
12/2	Maybury NB Ahead Right	-	-	-	-	-	-	-	-	-	2.90%	85.7	0.1	-	-	-
13/1	Maybury NB Left Left	15.60%	5.1	0.2	13.80%	35.6	1.4	18.0 : 18.0%	34.8	1.7	18.90%	7.8	0.9	79.30%	96.8	6.3
13/2	Maybury NB Left Left	-	-	-	17.10%	35.6	1.8	-	-	-	-	-	-	0.00%	0.0	0
16/1	Queensferry Road EB Bus Ahead	13.30%	5.6	0.4	0.00%	0.0	0	10.70%	3.8	0.1	12.70%	4.1	0.1	12.70%	4.1	0.1
17/1	Maybury SB Mid Ahead	94.40%	62.5	20.6	-	-	-	-	-	-	89.00%	59.8	17.7	91.70%	67.2	18.8
	J2: Midblock East of Junction	**76.90%**	-	-	-	-	-	-	-	-	**69.20%**	-	-	**73.50%**	-	-
1/1	*Queensferry Road EB Exit Ahead*	69.10%	4.0	7.8	-	-	-	-	-	-	67.00%	7.1	29.2	67.30%	7.2	29.3
1/2	*Queensferry Road EB Exit Ahead*	74.60%	4.7	9.8	-	-	-	-	-	-	72.80%	6.9	33.8	72.60%	6.9	33.8
3/1	Queensferry Road WB Ahead	76.90%	10.0	19.1	-	-	-	-	-	-	73.60%	8.8	18	73.50%	8.8	17.9
3/2	Queensferry Road WB Ahead	43.40%	5.0	6	-	-	-	-	-	-	39.40%	4.6	5.7	39.40%	4.6	5.7
	PRC (%)	**-11.3%**			**-29.9%**			**-31.1%**			**-19.2%**			**-19.2%**		
	Total Delay (pcu/hr)	**139.1**			**352.2**			**411.9**			**259.1**			**266.1**		

Table 3: Model results (AM Peak)

Barnton Junction Options (PM Peak)		Option 7.1.A 104 secs			Option 7.1.B 110 secs			Option 7.1.B V2 120 secs			Option 7.1.C 112 secs			Option 7.1.D 120 secs		
Item	Lane Description	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
	J1: Barnton Junction	**93.30%**	-	-	**96.50%**	-	-	**102.40%**	-	-	**98.90%**	-	-	**110.20%**	-	-
1/2+1/1	Queensferry Road EB Entry Ahead Left Ahead2	90.0 : 90.0%	40.5	26.8	74.10%	28.3	18.8	76.50%	32.1	21.5	98.50%	74.5	40.8	107.00%	185.8	68.4
1/3+1/4	Queensferry Road EB Entry Ahead Right	93.2 : 93.2%	56.6	16.6	74.10%	27.7	20.5	74.50%	30.5	22.3	96.7 : 96.7%	75.7	18.7	108.2 : 108.2%	205.6	44
2/1	Queensferry Road EB Middle Ahead	47.70%	2.4	0.5	58.80%	15.8	24.3	74.80%	37.8	28.5	53.50%	14.1	9.5	49.70%	2.8	0.7
2/2	Queensferry Road EB Middle Ahead	35.90%	3.8	2	61.70%	17.2	25.7	76.70%	41.3	30.5	32.40%	5.9	2.6	34.50%	4.4	1.9
2/3	Queensferry Road EB Middle Right	-	-	-	71.30%	27.6	5.7	65.70%	24.0	7.6	-	-	-	-	-	-
3/1	Whitehouse Road SB Approach Left Left2 Ahead	48.50%	41.8	5.8	96.10%	122.8	14.3	86.60%	84.2	11.7	39.70%	37.1	5.6	32.60%	32.0	5.4
3/2+3/3	Whitehouse Road SB Approach Right	91.0 : 91.0%	84.3	12.6	96.50%	110.8	17.9	100.70%	150.4	22.5	98.80%	129.1	19.7	106.80%	228.0	29.9
4/1	Queensferry Road WB Entry Ahead Left	81.70%	9.2	7	86.8 : 86.8%	23.4	29.9	96.1 : 96.1%	47.5	46	82.40%	9.0	6.9	84.40%	28.4	38.8
4/2+4/3	Queensferry Road WB Entry Ahead	65.2 : 65.2%	6.3	5.3	63.70%	15.4	16.8	66.00%	20.1	19.2	60.9 : 60.9%	6.4	20.2	61.7 : 61.7%	15.4	19.2
5/1	Queensferry Road WB Middle Ahead	77.40%	16.6	14.4	93.90%	48.8	27	100.10%	84.9	39.1	96.00%	89.1	30.1	108.90%	215.6	61.1
5/2	Queensferry Road WB Middle Ahead	93.30%	38.6	29	95.30%	54.4	30.4	102.3 : 102.3%	115.3	47.7	98.90%	110.5	36.7	110.20%	240.4	69.5
5/3	Queensferry Road WB Middle Right	51.00%	54.2	2.8	83.50%	148.6	3	-	-	-	52.10%	92.3	3.1	62.00%	90.2	3.5
6/1	Maybury Road SB Entry from Queensferry Road Ahead	61.80%	29.0	15	63.90%	9.5	11.9	83.50%	28.3	20.3	44.3 : 44.3%	26.0	9	45.20%	37.2	15.2
8/1	Maybury NB Right Turn Right	63.40%	26.5	8.2	93.70%	110.4	12.9	102.2 : 102.4%	153.7	24.8	66.60%	52.1	5.2	69.10%	39.1	10
8/2	Maybury NB Right Turn Right	73.50%	30.8	10.3	93.80%	108.9	13.4	-	-	-	90.50%	76.8	9.8	74.70%	42.0	11.6
9/1	*Maybury NB Entry Ahead (free flow)*	*33.50%*	*1.4*	*0.3*	*32.80%*	*1.4*	*0.2*	*32.80%*	*1.4*	*0.2*	*33.00%*	*1.4*	*0.2*	*33.00%*	*1.4*	*0.2*
9/2	*Maybury NB Entry Ahead (free flow)*	*32.40%*	*1.4*	*0.2*	*26.10%*	*1.2*	*0.2*	*26.10%*	*1.2*	*0.2*	*32.00%*	*1.4*	*0.2*	*32.00%*	*1.4*	*0.2*
10/2+10/1	Maybury NB Right Turn Entry Ahead	64.3 : 64.3%	26.5	11.1	-	-	-	-	-	-	53.5 : 53.5%	17.6	8.7	55.4 : 55.4%	20.7	9.4
11/2+11/1	Maybury NB Ahead, Left, Right Ahead Ahead2	51.7 : 51.7%	7.9	5	-	-	-	-	-	-	39.9 : 39.9%	3.9	4.6	38.7 : 38.7%	3.9	3.7
12/1	Maybury NB Ahead Ahead	75.90%	71.7	6.1	50.30%	51.1	5.5	58.00%	60.9	6.3	64.30%	63.1	5.9	64.30%	66.6	6.3
12/2	Maybury NB Ahead Right	-	-	-	-	-	-	-	-	-	1.60%	75.8	0	-	-	-
13/1	Maybury NB Left Left	63.80%	18.6	6.3	69.00%	60.8	7.3	80.4 : 80.4%	63.6	9.6	71.70%	28.6	8.3	105.10%	232.0	19
13/2	Maybury NB Left Left	-	-	-	71.10%	60.7	8.2	-	-	-	-	-	-	101.10%	180.1	16.4
16/1	Queensferry Road EB Bus Ahead	10.40%	20.7	1.4	0.00%	0.0	0	11.00%	3.8	0.1	11.70%	4.1	0.1	10.90%	4.0	0.1
17/1	Maybury SB Mid Ahead	63.40%	18.8	5.5	-	-	-	-	-	-	82.60%	59.2	12.7	70.10%	55.5	11.8
	J2: Midblock East of Junction	**96.10%**	-	-	-	-	-	-	-	-	**91.70%**	-	-	**88.80%**	-	-
1/1	*Queensferry Road EB Exit Ahead*	84.40%	13.2	10.8	-	-	-	-	-	-	84.70%	17.6	23.7	78.90%	15.4	19.8
1/2	*Queensferry Road EB Exit Ahead*	70.10%	9.9	13.3	-	-	-	-	-	-	65.20%	8.6	7.6	61.70%	9.2	8.4
3/1	Queensferry Road WB Ahead	96.10%	44.1	35.5	-	-	-	-	-	-	91.70%	30.0	33	88.80%	19.4	20.3
3/2	Queensferry Road WB Ahead	78.10%	18.4	17.1	-	-	-	-	-	-	64.60%	12.5	12.7	61.80%	9.0	9
	PRC (%)	**-6.8%**			**-7.2%**			**-13.7%**			**-9.9%**			**-22.4%**		
	Total Delay (pcu/hr)	**98.1**			**112.4**			**167.1**			**150.9**			**285.6**		

Table 4: Model results (PM Peak)

Note, the cycle times vary between the options as the CYOP function in Linsig has been used to determine the best possible throughput. Because of the need for coordination, a higher cycle time may not necessarily lead to a better PRC, and therefore, a consistent cycle time across all options may be biased towards a specific design solution.

In both the AM Peak and PM peak, option 7.1.A is expected to offer the best overall PRC for the junction, albeit still over capacity. This option is also the mostly closely aligned to the existing base operation. The main concern is that the additional crossings through the centre of the junction reduce the already limited stacking which could create more difficulties during on-street signal timing validation. It does, however, promote good route choice for NMUs, particularly pedestrians.

As stated before, option 7.1.B is not considered a viable option as there are concerns with the proposed layout from a safety perspective, particularly the five-lane approach to the junction. Notwithstanding, the results also do not suggest an improvement over the base layout or other options put forward.

Option 7.1.C has been generated as a relatively low cost solution but would require NMUs to navigate through five controlled crossings to get between the southwest and northeast corners of the junction. From a operational results perspective, it is not expected to operate as well as the base or option 7.1.A but may be a possible solution to keep costs down. Option 7.1.D was a further development on option 7.1.C to reduce the number of crossings, however, the results suggest that the operation would be worse, particularly in the PM Peak. This is mainly due to the incorporation of the Maybury Road left turn into the main junction operation.

4. NMU Sensitivity Tests

The key objective is to provide the most practical and direct route for NMUs through the junction. This is particularly important between the southwest corner and northeast corner of the junction whereby the proposed offline cycle facilities are to be linked together. Therefore, further consideration has been given to these movements. The first is to review whether more direct facilities for NMUs could be achieved in both directions or possibly just in one direction. The second will be to understand which of the previous options provides the shortest route for NMUs in terms of time to navigate the junction under the optimised signal timings. This is intended to aid the decision process so that not only the impact on traffic is considered. A further test has been undertaken to determine whether an offset midblock crossing located north of the junction on Whitehouse Road, would impact the overall junction operation. This would potentially provide an alternative offline route for cyclist rather than the need to cross from west-east and vice versa at the Barnton junction.

4.1 Review 1 – Direct NMU Route

The most direct route between the southwest corner and northeast corner would be to provide a diagonal crossing through the centre of the junction. This would reduce the number of individual crossings required but would lead to crossing points in excess of 20m, which can be quite daunting for users as they are expected to spend significant time within a live carriageway (albeit under an all red pedestrian movement only). It would also require significant lost time with expected proceeding intergreens in excess of 19 secs to meet national standards. The lost time would inevitably lead to further capacity problems with the junction operation.

Figure 9 below details the possible diagonal NMU routes through the junction and their associated crossing lengths under option 7.1.A. Note, the buildout in the northeast corner in option 7.1.A may not be feasible for bus movements, and may need to be reduced in size, this could further increase crossing lengths up to 30m.

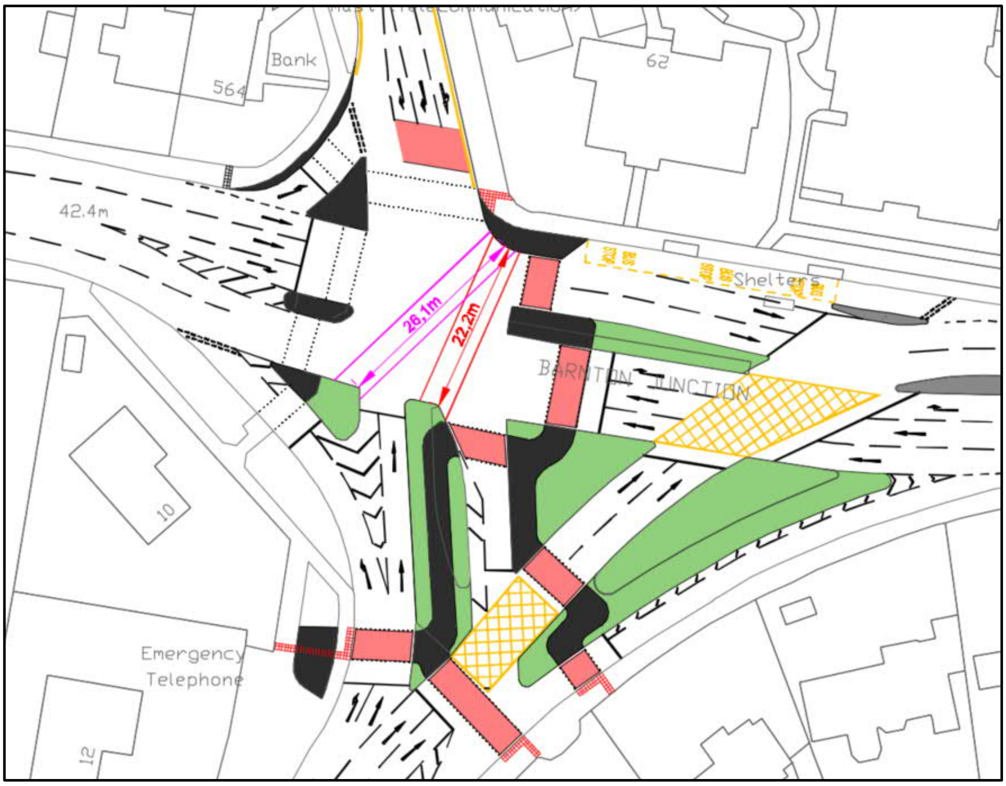


Figure 9: Possible diagonal crossings for NMUs

Jacobs would not consider crossings of this length to be a viable solution for pedestrians at this location due to both the safety and operational implications. It may be possible to generate a cycle only facility, as cyclists would take less time to clear the junction, however, it is still considered that this would generate a risk as pedestrians may try to use the facility as the shortest route with potentially insufficient timings applied. It is therefore, not recommended by Jacobs as an option to take forward.

Dedicated cycle facilities could be provided from Whitehouse Road to the southern central island and possibly vice versa, subject to re-integration into shared space at both ends. This would be expected to have lower risk of misinterpretation for pedestrian use. Note, the northeastern footway would need to be reduced to 2.0 metres to accommodate a segregated two-way cycle facility. Figure 10 below details the indicative arrangement. This would require the RTIGA on Whitehouse Road to be removed.

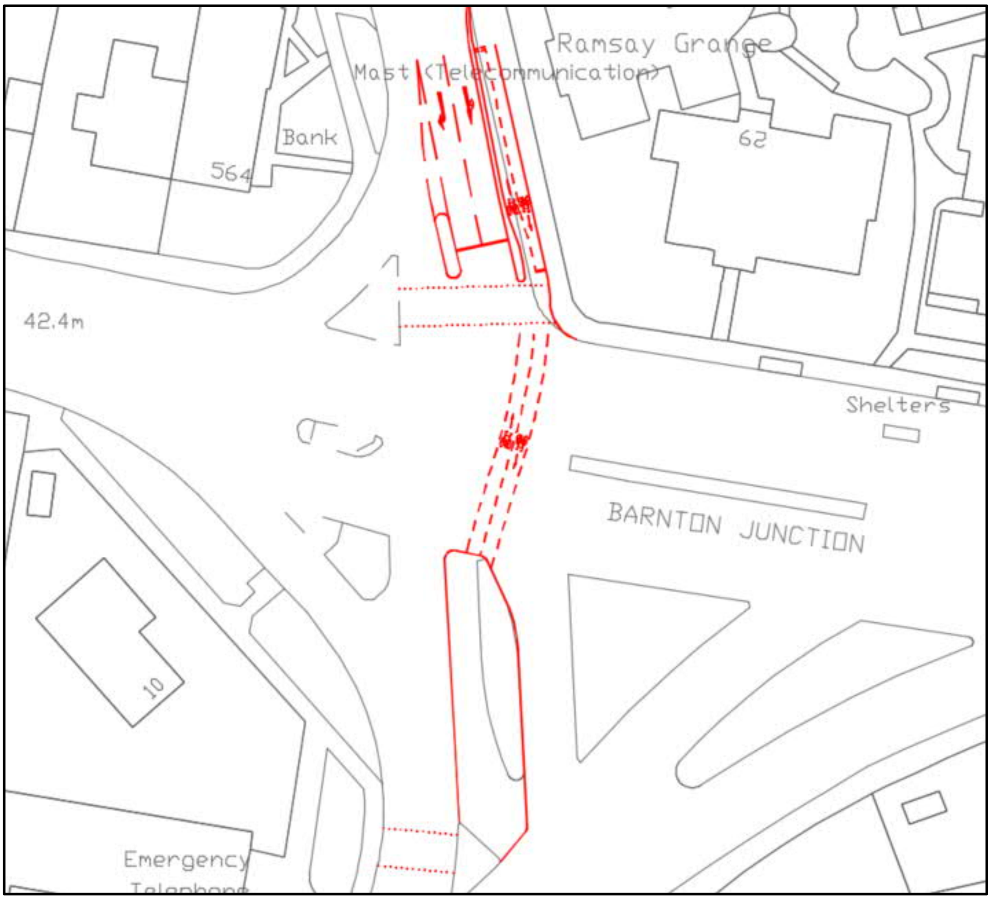


Figure 10: Possible segregated cycle facility

A sensitivity test of the option 7.1.A layout with the segregated cycle facility added, staging amended to remove the southbound RTIGA and a cycle time of 120 seconds provides an AM peak PRC of -21.2% and a PM peak PRC of -17.0% under the committed development flows.

4.2 Review 2 – Crossing Times

This review provides an indication of which of the previous options provides the shortest route for NMUs in terms of time to navigate between the southwest and northeast corners of the junction under the optimised signal timings. If pedestrians and cyclists have alternative routes, then both are reported on. The predicted average journey time and associated delay to pedestrians is detailed in table 5 below.

Barnton Junction NMU Movements		Base		Option 7.1.A		Option 7.1.B V2		Option 7.1.C		Option 7.1.D	
Route / Cycle Time		AM 104 secs		AM 104 secs		AM 120 secs		AM 104 secs		AM 104 secs	
Zone	Description	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)
A - B	Southwest to Northeast Toucans	-	-	232	171	125	86	169	117	137	98
B - A	Northeast to Southwest Toucans	-	-	189	128	125	86	249	197	213	174
C - D	Southwest to Northeast Pedestrian Only	145	99	180	139	-	-	-	-	-	-
D - C	Northeast to Southwest Pedestrian Only	125	79	158	117	-	-	-	-	-	-
Route / Cycle Time		PM 104 secs		PM 104 secs		PM 104 secs		PM 112 secs		PM 120 secs	
Zone	Description	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)
A - B	Southwest to Northeast Toucans	-	-	235	174	154	115	178	126	171	132
B - A	Northeast to Southwest Toucans	-	-	189	128	131	92	251	199	130	91
C - D	Southwest to Northeast Pedestrian Only	178	132	182	141	-	-	-	-	-	-
D - C	Northeast to Southwest Pedestrian Only	128	82	177	135	-	-	-	-	-	-

Table 5: NMU Journey Times (Secs)

Only option 7.1.B would be expected to provide less delay to NMUs than the existing arrangement, but it should be noted that Jacobs believe it would be difficult to achieve a safe operation and layout under this option. Option 7.1.A does not provide reduced journey times between the southwest and northeast corner but does provide greater route choice for pedestrians. Options 7.1.C and 7.1.D provide some improvements but not for all scenarios.

A further test of the cycle provision discussed in sensitivity review 1, suggests a journey time and associated delay for cyclists as follows:

- AM – Southwest to Northeast: Journey Time = 82 secs, Delay = 55 secs
- PM – Southwest to Northeast: Journey Time = 96 secs, Delay = 69 secs
- AM – Northeast to Southwest: Journey Time = 81 secs, Delay = 54 secs
- PM – Northeast to Southwest: Journey Time = 89 secs, Delay = 62 secs

This suggests a reasonable reduction in delay to cyclists could be achieved by the addition of the cycle facilities through the centre of the junction.

4.3 Review 3 – Offset Midblock Crossing on Whitehouse Road

This review considers the impact on the junction operation if a signallised crossing is incorporated on Whitehouse Road approximately 50m from the junction. Option 7.1.A was again used for the testing purposes as this offered the best PRC of the options. The crossing has been given two windows of opportunity to run during a single cycle of the junction operation to ensure NMU waiting times are kept low.

The results suggest there would be minimal impact on the junction operation with an AM peak PRC of -11.3% and PM peak of -6.8%, both are almost identical to the previous modelled results for option 7.1.A. A maximum queue heading northbound of 3.1 PCUs in the AM and 1 PCU in the PM are expected, which is well within the storage capacity to suggest very low risk of exit blocking. In the southbound direction, the queue back to the crossing from the junction is expected to be in the region of 11 PCUs in the AM and 13 PCUs in the PM suggesting blocking back through the crossing is likely to occur, however, timings can be coordinated so that this would not hinder traffic progression. Therefore, the main risk is vehicles sitting across the pedestrian studs at pedestrian green and blocking the path of users.

5. Conclusions and Recommendations

The existing layout of the junction when analysed in Linsig demonstrates the junction currently has problems with capacity and progression through the network which correlates with the observations on-street during the peak periods. With committed development flows in place, the operation is expected to get worse and as a minimum fixed time plan updates are likely to be required to better manage traffic throughput prior to SCOOT control being applied (if applicable).

With revised timings and coordination, Linsig suggests that PRC improvements and overall delay reductions could be made under the base layout. However, some on-street validation would be required to ensure any changes to timings does not have any significant impact on queuing and associated throughput, particularly for the westbound Queensferry Road movements.

With offline cycle facilities proposed to connect between the southwest side of the junction on Maybury Road and the northeast side of the junction on Whitehouse Road, there is a need to link up the facilities. The existing layout may be able to accommodate the required minimum crossing widths for Toucan facilities but the sizes of the existing traffic islands are expected to cause problems for accommodating cyclists, potentially putting them in compromised waiting positions. This risk becomes worse if pedestrian and cyclist numbers and interactions increase. Therefore, the existing layout as it stands will require improvements to accommodate cyclists.

The four options that have been put forward vary significantly in complexity and associated cost, but none are expected to provide operational improvements to manage the increase in traffic. They are, however, expected to improve provision for NMUs primarily by accommodating the proposed cycle connections, but also by creating more route choice for all NMUs and under some scenarios shorter journey times and reduced delay.

Option 7.1.A provided the best PRC for the junction and also provides the best route choice for pedestrians, making navigation of the junction more direct, albeit via a number of controlled crossings. The main concern is that the additional crossings through the centre of the junction reduce the already limited stacking which could create more difficulties during on-street signal timing validation. Option 7.1.B tightens up the junction layout which in turn reduces NMU journey time, but there are concerns over how this layout could be implemented safely, particularly with respect to the wide five-lane approach on Maybury Road which already has problems with “last second” weaving vehicles, as identified by the Cramond and Barnton Community Council. Options 7.1.C and 7.1.D are intended to be relatively lower cost solutions by only amending the western side of the junction to incorporate the required space for Toucan crossing facilities. These options ultimately made the PRC broadly worse but did provide some potential journey time reductions for NMUs. Note, option 7.1.C ultimately requires a five-stage crossing to navigate between the cycle facilities in the southwest and northeast of the junction, this may therefore generate some poor user perception, even if journey time is not adversely affected. On this basis, option 7.1.C may be a better solution if the cycle path continues north on the west side of Whitehouse Road.

It should be noted that PRC values for these options have been generated by running Linsig’s CYOP and offset coordination functions, however, although this can give an indication of how much PRC can be achieved under each option it may be that a reduced level of PRC is required to manage the short central sections, with queues relocated to the external approaches. This approach appears to have been taken for the current operation whereby PRC values of -25% to -30% are found when the base layout and on-street timings are tested with the base flows. This is necessary to reduce the risk of locking up and very little traffic proceeding. On-street validation will be critical for whatever option is taken forward, so it is suggested that no option is completely ruled out based on the PRC values alone.

Additional yellow box markings may be required to help manage the junction operation. In all option tests including the addition of committed development traffic to the base layout, the junction is heavily reliant on yellow box markings to have their desired effect in stopping vehicles from exit blocking other movements.

Without this intervention then there is a high risk of the junction locking up or at least severely reducing traffic throughput.

Jacobs would not recommend a diagonal crossing through the centre of the junction. Although this would create a more direct route and reduce NMU delay, it is considered that the length of the crossing required would create safety and operational implications. Even a cycle only diagonal facility would not be considered a viable solution as although the crossing times would be reduced, it is still considered that this would generate a risk as pedestrians may try to use the facility (as the shortest route) with potentially insufficient timings applied.

Dedicated cycle facilities could be provided from Whitehouse Road to the southern central island and possibly vice versa, subject to re-integration into shared space at both ends. This would be expected to have lower risk of misinterpretation for pedestrian use. Note, the northeastern footway would need to be reduced to 2.0 metres to accommodate a segregated two-way cycle facility.

An additional signal controlled crossing could be provided approximately 50m north of the Barnton Junction on Whitehouse Road, this would allow an alternative offline route for cyclists rather than the need to cross from west-east and vice versa at the Barnton junction. The analysis suggested this could be implemented without impacting the junction operation but queues from the junction would be expected to block back through the midblock crossing point.

Summary

- The existing junction layout currently has problems with capacity and progression through the network during the peak periods and a level of intervention is likely to be required when the committed developments are in place.
- The sizes of some existing traffic islands are unlikely to be appropriate for Toucan crossing provision.
- The Option 7.1.B layout has the worst practical reserve capacity and is considered to have significant safety risks, therefore, it is not recommended to be taken forward.
- All other design options are expected to have an impact on how the junction will operate, but the on-street reduction in capacity is not expected to be significantly worse than the existing layout and operation. It is expected that the existing junction and all options put forward would have to accept a reasonable level of queuing on entry approaches. This is to manage the short interconnecting lanes within the junction to ensure blocking back and associated locking up does not occur.
- Option 7.1.A provided the best practical reserve capacity of all the options. It also provides the best route choice for pedestrians, making navigation of the junction more direct. This is, therefore, recommended as the preferred option to pursue to improve NMU connectivity between the Southwest and Northeast corners of the junction.
- Options 7.1.C or 7.1.D could still be taken forward as potentially lower cost solutions to option 7.1.A. However, if the cycle path continues north on the west side of Whitehouse Road then both options could be better solutions than option 7.1.A.
- Yellow box markings are likely to be required to help manage the junction operation.
- A diagonal crossing through the centre of the junction is not recommended due to the excessive length of the crossing.

- A dedicated cycle facility could be provided from Whitehouse Road to the southern central island and possibly vice versa, subject to re-integration into shared space at both ends. This would reduce journey times for cyclists at the expense of traffic progression, primarily from Whitehouse Road.

- An offset mid-block crossing on Whitehouse Road is not expected to impact the junction operation.

LDPAP

Barnton Junction Linsig Modelling - Addendum

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September 2024

The City of Edinburgh Council

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Contents

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1. Introduction and Background

In 2022, Jacobs reviewed the layout and operation of the existing signalised Queensferry Road / Maybury Road / Whitehouse Road (Barnton) junction, to determine how the junction could be altered to facilitate better walking, wheeling and cycling facilities whilst maintaining optimal levels of throughput for motorised users. This previous review is covered within document B2420330-TN-LS-0003, which forms part of the Stage 2 reporting for the project.

The review included an initial assessment of various design options using the JCT software package Linsig. This helped identify a preferred solution to be taken forward for further analysis within Microsimulation software.

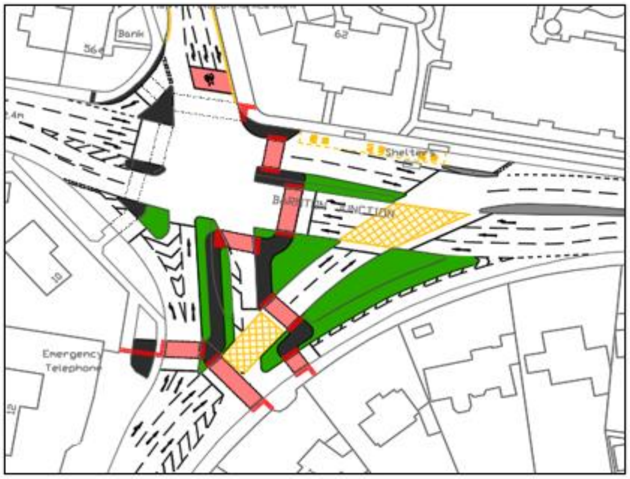
The original task required a base model of the junction to be developed with the signal operation and timings replicated to understand how the junction was performing. This would allow direct comparisons to be made with the options under development. The Linsig analysis demonstrated that the junction has problems with capacity and progression through the network which correlated with the observations on-street during the peak periods.

The base layout of the junction is detailed below.

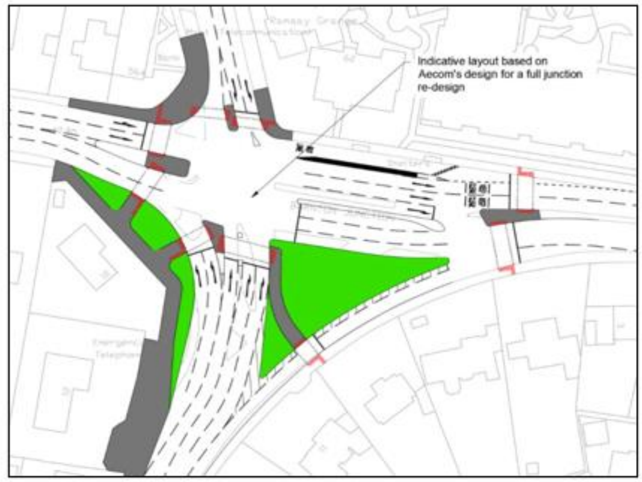
The Stage 2 reporting concluded that offline cycle facilities would be better accommodated on the southwest side of the junction on Maybury Road and the northeast side of the junction on Whitehouse Road and, therefore, in addition to improving pedestrian routes through the junction, there would be a need to provide connectivity for cyclists between these two points. The existing layout may be able to accommodate the required minimum crossing widths for Toucan facilities but the size of the existing traffic islands were expected to cause problems when accommodating cyclists, potentially putting them in compromised waiting positions. This risk would become worse if pedestrian and cyclist numbers and interactions were to increase. Therefore, the existing layout as it stood, would require improvements to accommodate cyclists.

Four options were put forward for further review as part of the original analysis as detailed below.

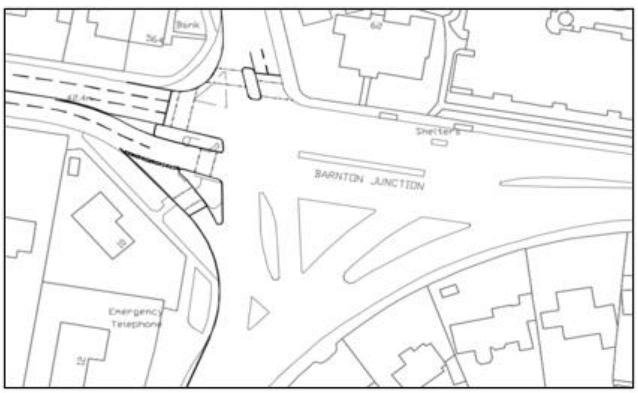
Option 7.1.A



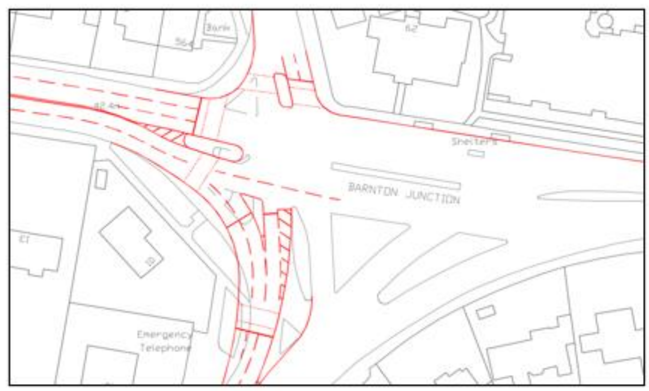
Option 7.1.B



Option 7.1.C



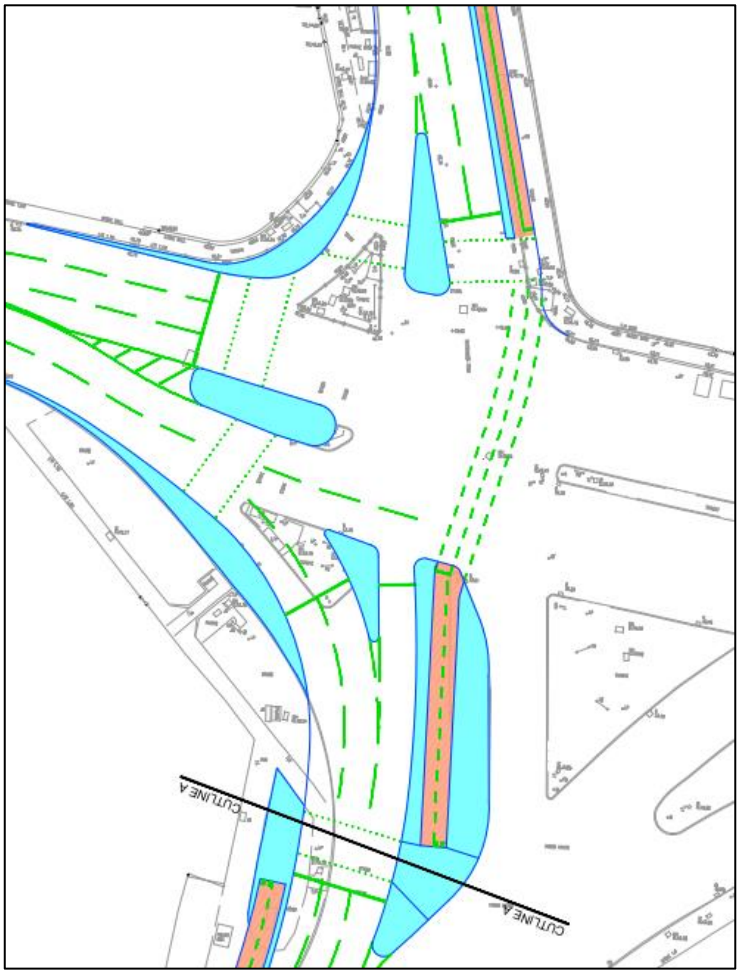
Option 7.1.D



The four options varied significantly in complexity and associated cost, but none were expected to provide operational improvements to manage the expected traffic flows. They were, however, expected to improve provision for walkers, wheelers and cyclists primarily by accommodating the proposed cycle connections, but also by creating more route choice for these users and under some scenarios shorter journey times and reduced delay.

Option 7.1.D was found to be the preferred solution in the analysis but there were still aspirations to provide a more dedicated route for cyclists that would provide a greater level of separation from walkers and wheelers. This led to a possible solution that provided a cycle facility through the centre of the junction that would reduce the need for shared Toucan crossing facilities by operating some of the cycle movements via dedicated signals for cycles. This solution was combined with option 7.1.D to become the preferred solution within the Stage 2 reporting and was taken forward for further analysis within Microsimulation software.

The preferred layout at the end of Stage 2 is detailed below, noting the eastern side of the junction would remain as per the existing arrangement.



However, following discussions with stakeholders it was considered that further analysis was required to determine whether the cycling provision could be accommodated without passing through the centre of the junction. As part of this process, the offline routes for cyclists through the network were further reviewed with the possibility of cyclists being served on the western side of Whitehouse Road. It was also considered that traffic flow profiles have changed since the 2022 analysis which used observed Junction Turning Count (JTC) data from 2019 and, therefore, current JTCs for 2024 were used to ensure the analysis is representative of current conditions.

The following layout options were generated for further review:

1. Relocate cycle crossing to west side of junction – leading to a bidirectional cycle track on the west side of Whitehouse Road
2. Relocate cycle crossing to west side of junction – leading to a bidirectional cycle track on the east side of Whitehouse Road requiring a straight across crossing over Whitehouse Road
3. Relocate cycle crossing to west side of junction with a three stage staggered crossing – leading to a bidirectional cycle track on the west side of Whitehouse Road

This Technical Note reports on the findings of the Linsig modelling undertaken for these revised layout options. To allow direct comparisons to be made with the Stage 2 reporting, the base model and preferred solution from Stage 2 will also be considered further under the revised 2024 traffic flows.

2. Traffic Flows

Updated JTCs for 2024 were undertaken for the analysis. These traffic flows were supplemented with updated committed development flows to determine the overall level of traffic to be used within the modelling for both the AM and PM peak periods.

Edinburgh's Local Development Plan indicates there are several sites in west Edinburgh currently under construction (housing and commercial). The original assessment at Barnton junction accounted for future traffic flows from four development sites: Cammo Meadows and West Craigs (central, north and east).

Since 2019, some of this development has been built and occupied, meaning a proportion of previously modelled future trips will now be accounted for in the 2024 traffic counts. Exact occupancy rates cannot be determined. However, a high-level review of the associated transport assessments and a recent site visit suggests occupancy rates of approximately 2/3 at Cammo Meadows and 1/3 at West Craigs. These proportions have been used to forecast future traffic flows for the remaining development trips that are not currently occupied to determine the number of vehicles that pass through the Barnton junction.

The traffic flows when converted to Passenger Car Units (PCUs) for the analysis are detailed below.

Barnton 0800-0900	A	B	C	D	Total
A – Whitehouse Road	0	63	249	217	529
B – Queensferry Road (E)	100	0	655	907	1,662
C – Maybury Road	262	748	0	123	1,133
D – Queensferry Road (W)	241	1091	114	0	1,446
Total	603	1,902	1,018	1,247	4,771

Barnton 1700-1800	A	B	C	D	Total
A – Whitehouse Road	0	67	199	274	540
B – Queensferry Road (E)	67	0	500	1241	1,808
C – Maybury Road	199	568	0	226	993
D – Queensferry Road (W)	135	1052	165	0	1,352
Total	401	1,687	865	1,741	4,693

There has been an overall reduction in traffic flows between the 2022 analysis and 2024. The observed traffic flows from 2019 used in 2022 analysis, when converted to PCUs, was approximately 5350 PCUs in the AM peak and 5100 PCUs in the PM peak with committed development increasing these flows by approximately 340 PCUs in both peaks. Therefore, there is an approximate reduction of 920 PCUs in the AM peak and 750 PCUs in the PM peak.

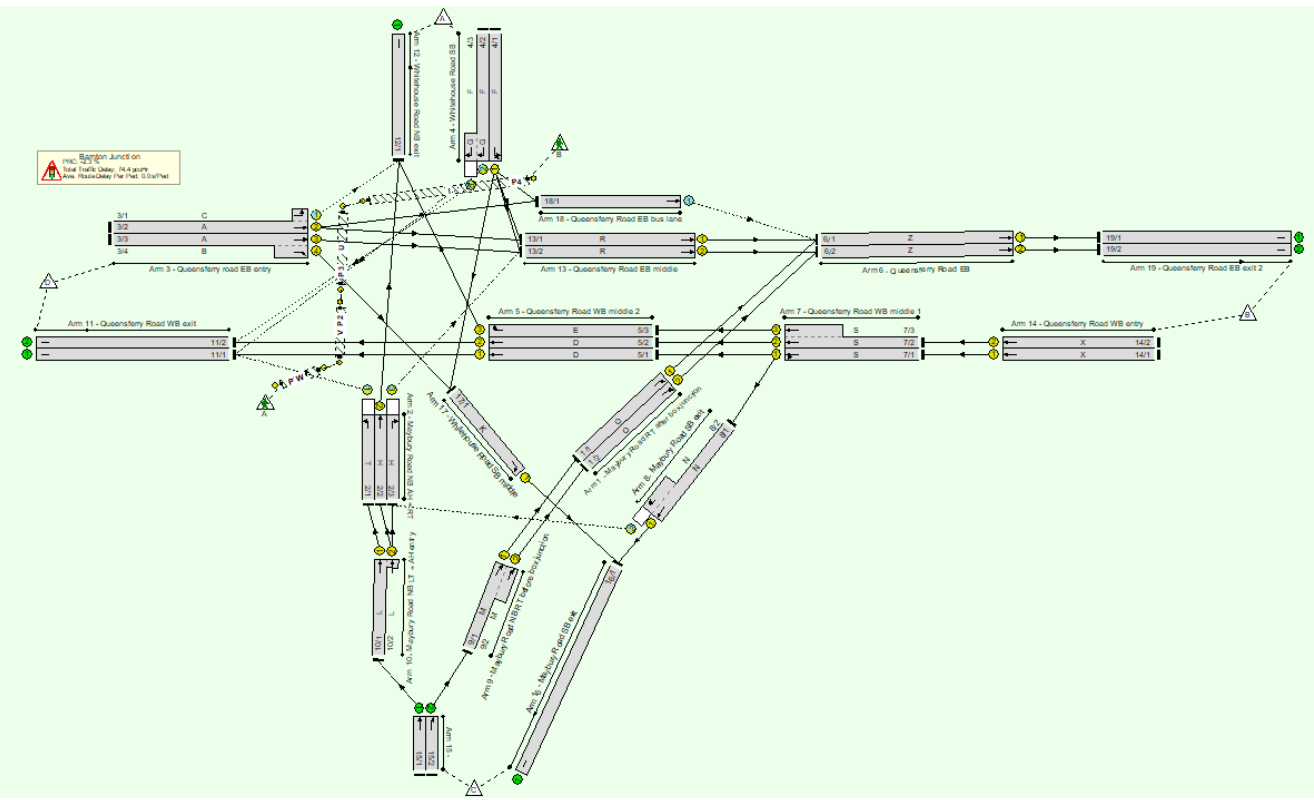
3. Linsig Model Review

As with the previous analysis, SCOOT based cycle times have been used to compare each option as a like for like output, noting SCOOT based cycle times are proposed as the junction is being future proofed for SCOOT operation. Other than for the Base Model existing timings which have a cycle time of 100 secs during the AM peak and 110 secs during the PM peak, all other options have been tested with a consistent cycle time of 104 secs.

3.1 Base Model

The base Linsig model has been updated for the revised flows discussed in section 2 with the UTC timings retained. Note, the separate midblock staggered crossing facility to the east of the junction has been included within the model due to proximity and potential for impact on traffic throughput.

The Linsig Network layout is detailed in the Figure below:



This model was previously validated using the existing UTC signal timings against the queue surveys contained within Aecom's "Maybury Road – Transport Feasibility Study" report and found to be broadly aligned, therefore, it is considered a valid base set-up for the option testing.

The base UTC timings for the AM peak have been set up to provide good coordination along Queensferry Road for both the eastbound and westbound directions. The base UTC timings for the PM peak are very similar to the AM peak but with more green time allocated to the eastbound and westbound through movements along Queensferry Road.

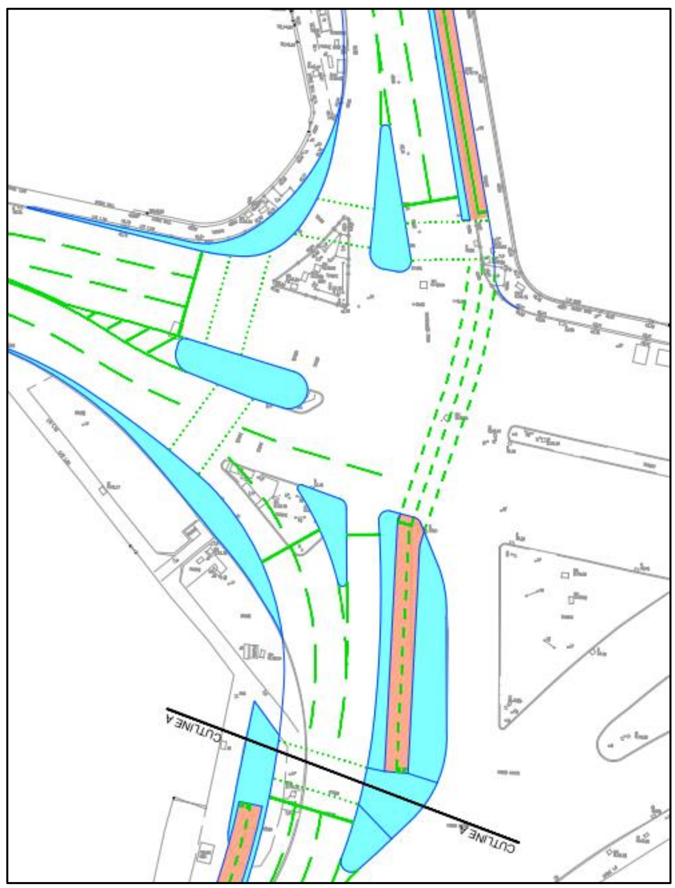
Under the 2022 flow sets with development traffic in place and no change to signal timings, the junction was expected to operate with a PRC of **-26.5%** during the AM peak and **-29.7%** during the PM peak. With the updated 2024 flow sets and development traffic updates, the AM peak PRC is expected to improve to approximately **-2.3%** whilst the PM peak is expected to perform at around **-12%** PRC under the same UTC timings.

Note, the base model set-up still expects problems with progression through the network which correlates with the observations on-street for the existing layout during the peak periods. Coordination in the westbound direction is still the main challenge with a considerable level of queuing expected.

As per the previous option assessment, linsig optimisation can be used in an attempt to improve overall traffic throughput and the revised coordination with the 2024 flows in place does suggest PRC improvements and overall delay reductions could be made under the base layout (AM of **19.7%,** PM of **1.7%**). However, it is expected that some on-street validation would be required to ensure any changes to timings do not have any significant impact on queuing and associated throughput, particularly for the westbound Queensferry Road movements, and so it is unlikely that the level of improvement, particularly in the AM peak would be realised.

3.2 Stage 2 (2022) Recommended Layout

This option was the recommended option from the Stage 2 reporting (2022) and includes a cycle crossing from the southwestern to the northeastern corner of the junction, along with a separate two-stage pedestrian crossing on the western side.



Although this route was convenient for cyclists, there were concerns that pedestrians may attempt to use the central cycleway as a more direct desire line. As the signal timings and more importantly the proceeding safety clearance timings would be configured for cyclists, there is a risk that pedestrians would not have sufficient time to cross safely. Additionally, placing the crossing in the middle of the junction may deter cyclists from using it, particularly those who are less confident, as they might be discouraged by having to navigate multiple vehicle lanes in a single movement.

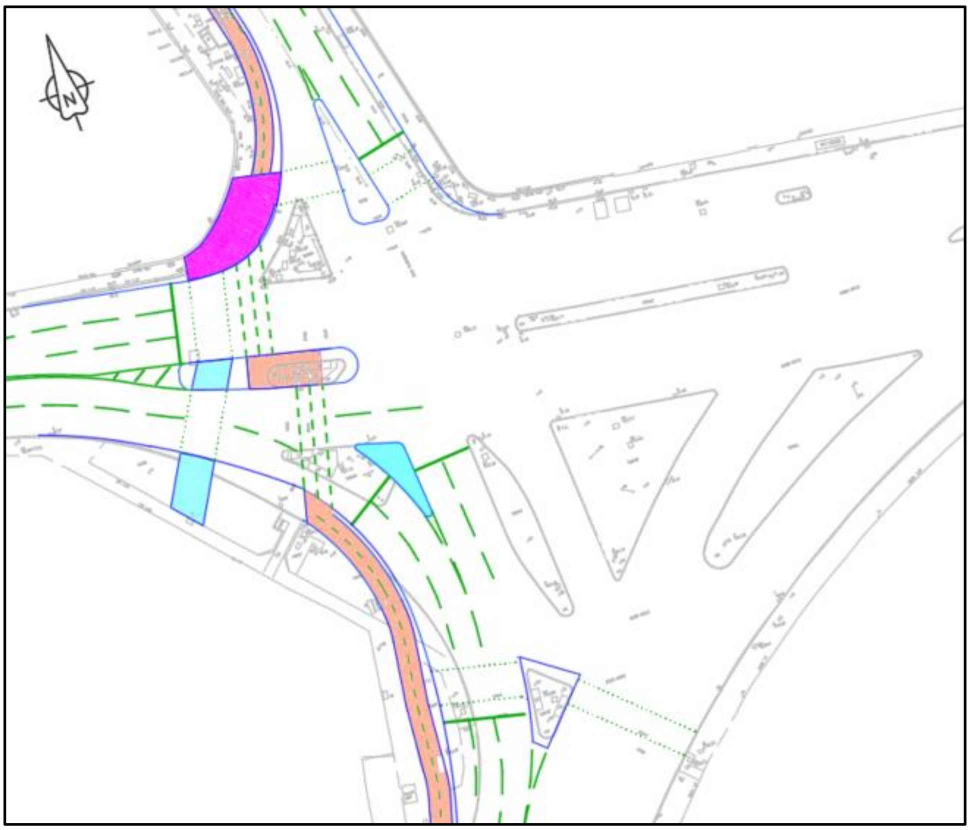
Of the options considered during the previous Stage 2 analysis, this layout was expected to provide the best possible throughput for traffic whilst providing significant improvements for active travel through the junction. Testing this model with the updated 2024 traffic flows and optimising the model for PRC provided an AM peak PRC of **3.2%** and PM peak PRC of **-0.3%.**

3.3 New Option 1 (Cycle crossing on west side of junction and cycle track on west side of Whitehouse Road)

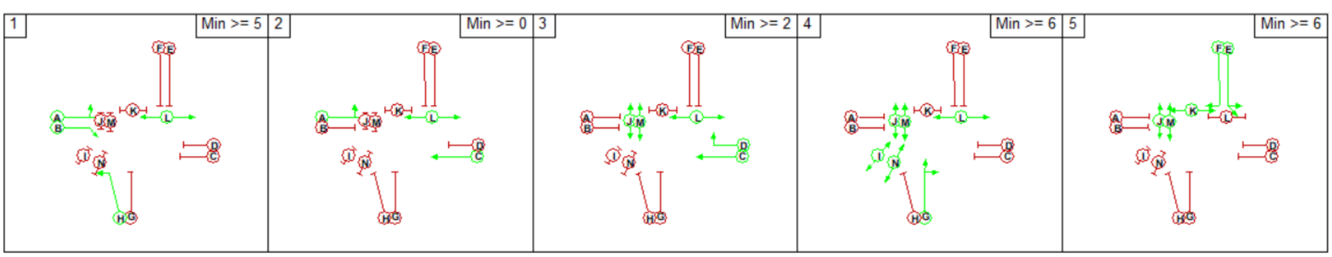
Two sub-options were considered for this proposal:

- Option 1A – Split phased crossings over the west side of the junction for both pedestrians and cyclists (as detailed in the Figure below).
- Option 1B – Straight through crossing over the west side for both pedestrians and cyclists.

These options consider re-routing the cycle track around the west side of the junction and avoids cyclists having to navigate through the middle of the junction.

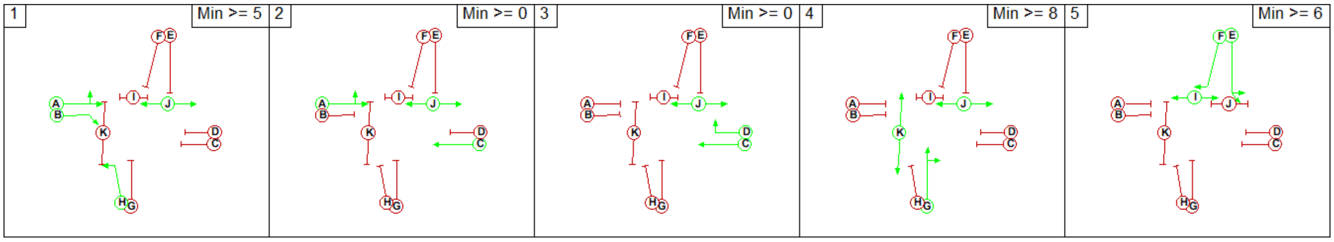


In option 1A, the southern pedestrian crossing is angled to provide separation between the two crossing movements, reducing the potential for see through issues, and the cycle crossing is staggered to allow for sufficient stacking space between crossings. It should be noted that the intention would be to ensure signal timings allow cyclists to typically clear in a single movement, notwithstanding the staggered nature of the crossing. The proposed staging is detailed below.



Option 1A requires no major changes to traffic signalling and, therefore, provides comparable performance to the preferred option from the Stage 2 reporting with an optimised AM peak PRC of **3.0%** and PM peak PRC of **-1.5%.**

In Option 1B, the crossings for pedestrians and cyclists over the west side of the A90 would be made in a single movement. The proposed staging is detailed below.

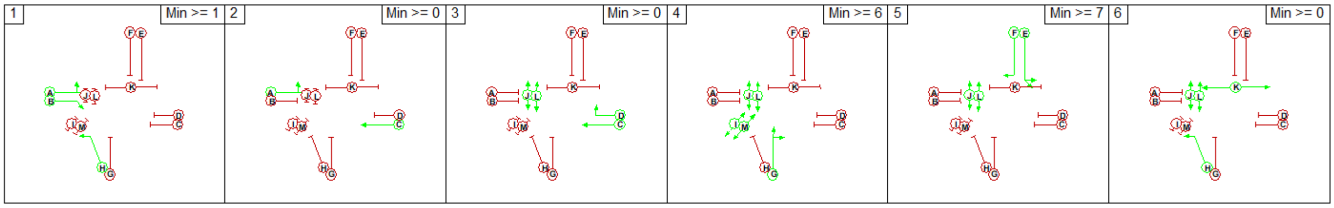


This option would be expected to operate with a PRC of **-15.0%** in the AM peak and **-12.7%** in the PM peak. This suggests the junction would operate worse than Option 1A with more significant issues with queuing expected all around the junction. There are also concerns that the layout would not provide the appropriate level of safety for more vulnerable users. The long crossing over the A90 at approx. 18m would require walkers and wheelers to be in the carriageway space for a reasonable period of time which could be a daunting experience. The need for a traffic island to house the signal head for the eastbound A90 traffic movements may also encourage those crossing to wait in the centre of the junction in an exposed position. Therefore, as this option does not provide significant operational improvements it is recommended that it is not considered further at this stage.

3.4 New Option 2 (Cycle crossing on west side of junction and cycle track on east side of Whitehouse Road – straight across crossing over Whitehouse Road)

For Option 2, the cycleway crossing of Whitehouse Road is located at the junction instead of via a mid-block crossing facility further North. This crossings over Whitehouse Road would be amended to straight through crossings. The Western cycle and pedestrian crossings over the A90 remain the same as in option 1.

It was determined that a two-stage crossing over Whitehouse Road would be unsuitable as there would not be sufficient width to accommodate cyclists waiting to cross without removing one of the two southbound lanes. A direct crossing requires a new dedicated stage to be added to the control strategy. For reference, the proposed staging is detailed below.



This arrangement would significantly impact capacity with an expected AM peak PRC of **-51.8%** and PM peak PRC of **-48.4%**. Therefore, this is not considered a viable option due to the impact it is expected to have on traffic progression and overall queuing.

3.5 New Option 3 (Cycle crossing on west side of junction via triangular island on Maybury Road, cycle track on west side of Whitehouse Road)

This option matches the routing for pedestrians and cyclists in Option 1 but utilises the triangular island on Maybury Road to navigate across the western side of the junction, either by two or three controlled crossings.

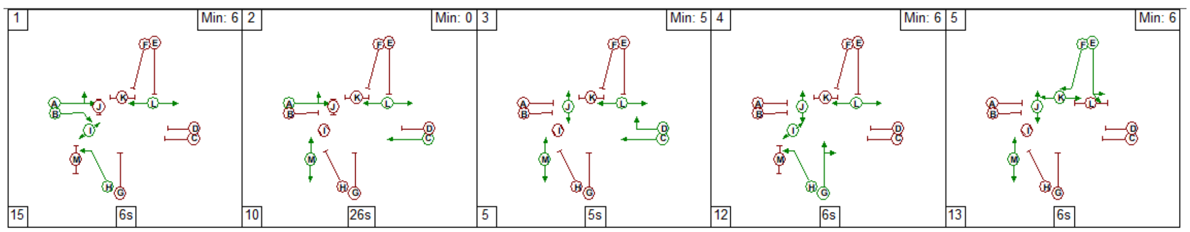
The main purpose of this option was to consider the impact of increasing the size of the island on the western side of the junction to provide more stacking capacity for walkers, wheelers and cyclists. The direct impact of this is the removal of the short flare lane on the A90 eastbound approach. This may be considered a minor reduction to the traffic lane set-up but the implications on the signal operation are more significant. As the flare lane allows a dedicated right turn signal to be provided, without the flare lane in place the offside lane (lane 2) would be subject to the right turn signal with all traffic from this lane legally required to turn right. Therefore, all ahead traffic would be forced into the nearside lane, also noting that this lane has a dedicated bus lane upstream.

The right turn signal could be removed to allow ahead movements to be made from the offside lane, but this would require the two A90 movements to be separated to remove the conflict with the eastbound right turning traffic. It has not been considered appropriate to provide a give way to oncoming traffic solution given the 40mph speed limit and two lanes of opposing traffic.

Two sub-options have been undertaken on this layout to understand what the best signal strategy would be:

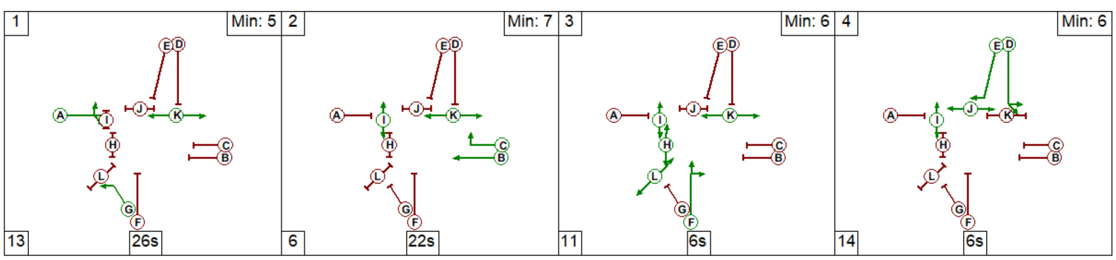
- **Option 3A - The eastbound offside lane is for right turn movements only.**

  The signalling remains the same as option 1 with the first stage having a dedicated right turn phase before running the both the eastbound and westbound ahead movements in stage 2. In this arrangement there is only one lane available for vehicles heading eastbound and, therefore, as expected there is a significant impact on capacity with an AM peak PRC of **-69.4%** and PM peak PRC of **-49.6%.**



- **Option 3B - The eastbound offside lane is for ahead and right turn movements**.

  This arrangement means it is no longer possible to have a dedicated eastbound right turn phase. As vehicles turning right would have to give way to two lanes of 40mph traffic it was decided that the eastbound and westbound movements for Queensferry Road should run in separate stages. This impacts capacity, although to a lesser extent with an AM peak PRC of **-24.6%** and PM peak PRC of **-38.0%.**

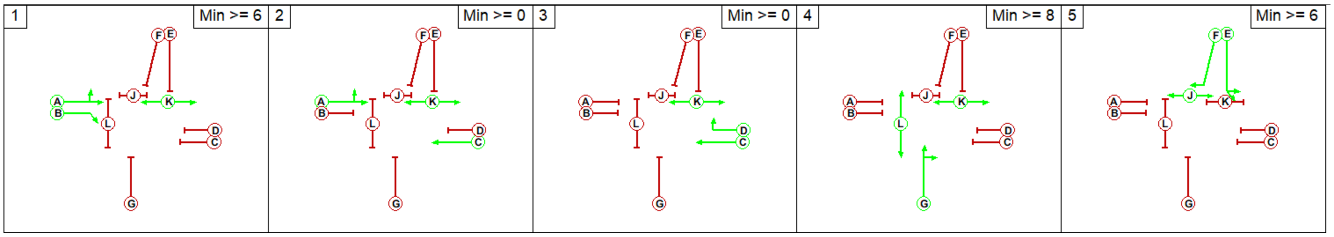


Both arrangements are, therefore, expected to generate significant traffic impacts.

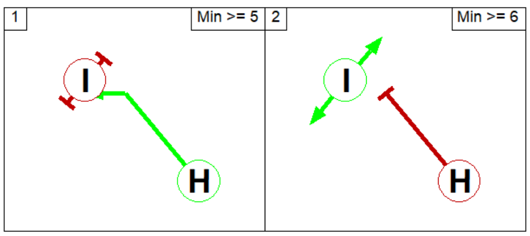
- **Option 3C – Straight through crossing over A90 west side**

Alternatively, a third option was considered that provided a straight through crossing over the A90 linking with the triangular island on Maybury Road. This option would be closer aligned with Option 1 as it allows the flare lane and traffic signal set-up on the A90 eastbound approach to be retained as well as the give-way slip lane operation for the left turn slip from Maybury Road. The proposed staging is detailed below.

Stream 1 – Main Junction



Stream 2 – Maybury Left Turn Slip



As with Option 1B, the crossing over the west side of the A90 would be made in a single movement, however, it would connect with the triangular island on Maybury Road with and additional crossing over the left slip required. This option would be expected to operate with a PRC of **-12.0%** in the AM peak and **-7.2%** in the PM peak. As with Option 1B, although this option is expected to work slightly better, there are concerns that the layout would not provide the appropriate level of safety for more vulnerable users. The long crossing over the A90 at approx. 18m would require walkers and wheelers to be in the carriageway space for a reasonable period of time which could be a daunting experience, particularly given that the crossing would not be perpendicular to the footway space. The need for a traffic island to house the signal head for the eastbound A90 traffic movements may also encourage those crossing to wait in the centre of the junction in an exposed position.

Therefore, it is considered that Option 3 and its variations are not considered as viable options to consider further.

3.6 Sensitivity Testing

The options tested in this section 3 may also be subject to possible design implications at two locations:

1. Reduced flare length on Whitehouse Road to accommodate an uncontrolled crossing immediately north of Barnton Grove.

2. The southwest corner of the junction – A single lane left turn slip on Maybury Road to maximise space for pedestrians and cyclists.

However, these design considerations will be applicable under all option tests and, therefore, to determine their impacts a sensitivity test has been applied to Option 1A only, as this is the best performing option of the new options.

For **location 1**, if the flare length on Whitefield Road is reduced from approx. 10 vehicles to 5 vehicles a significant impact is expected on Whitefield Road. If the same signal timings are retained for Option 1A to allow good progression on the A90 Queensferry Road, then the Whitehouse Road approach would be expected to operate with the following Degree of Saturation (DoS) and Mean Maximum Queue (MMQ):

- AM Peak: DoS = 109.4%, MMQ = 41.3 PCUs *(previous analysis: DoS = 84.7%, MMQ = 11.1 PCUs)*
- PM Peak: DoS = 113.6%, MMQ = 49.7 PCUs *(previous analysis: DoS = 91.4%, MMQ = 12.3 PCUs)*

This demonstrates that the length of the flare will have a significant impact on the operation of the junction. Some redistribution of the green time would allow for minor improvements but at the expense of the other approaches. The reduced flare length is a direct implication of the bi-directional cycle lane on the west side of Whitehouse Road running adjacent to the carriageway, generating a wide uncontrolled crossing area that will need to be reduced to meet local design standards. It may be possible to design this out by creating space for pedestrian storage between the cycle way and the carriageway so that the flare length can be maximised. Therefore, it is recommended that this is investigated further as the design progresses.

For **location 2**, if a single lane is required on the Maybury Road left turn slip to maximise space for pedestrians and cyclists within the central traffic island, under the signal timings generated for the preferred operation, the following DoS and MMQ would be expected on the left turn slip approach:

- AM Peak: DoS = 62.1%, MMQ = 3.4 PCUs *(previous analysis: DoS = 62.1%, MMQ = 3.4 PCUs)*
- PM Peak: DoS = 118.7%, MMQ = 27.4 PCUs *(previous analysis: DoS = 86.7%, MMQ = 7.2 PCUs)*

The results suggest little to no impact will occur during the AM peak but the PM peak would have a significant impact with queuing also expected to impact the adjacent ahead lane leading to Whitehouse Road. If the junction is optimised for PRC, the operation can be improved on this approach but the westbound A90 approach would then be expected to operate over capacity at a DoS of 94.2% in comparison to 87.1% previously. The overall PRC under optimisation would be -4.7% compared to -1.5% previously. Although this does not appear a significant difference there is a greater risk that a queue from the left turn slip lane would impact the adjacent ahead lane on Maybury Road leading to much more significant overall queuing that could ultimately impact the right turn lanes. If this is to be considered further it is recommended the impacts are fully understood within the Microsimulation modelling before design updates are made.

It should be noted that the central island on the A90 is currently proposed to have a 3m width at the western end where pedestrians crossing facilities are provided, increasing to 4m at the eastern end where cycle crossing facilities are placed.

If both design amendments were to be undertaken, then Linsig suggests the following implications:

- Option 1A preferred signal timings: AM Peak PRC = -21.6%, PM Peak PRC = -31.9%
- Option 1A optimised signal timings: AM Peak PRC = -6.5%, PM Peak PRC = -9.9%

4. Summary

A summary table of the results for all options is detailed below:

Option	Practical Reserve Capacity (%)	
	AM	PM
Base UTC Timings	-2.3	-12.0
Base UTC Optimised	19.7	1.7
Stage 2 Preferred	3.2	-0.3
Option 1A	3.0	-1.5
Option 1B	-15.0	-12.7
Option 2	-51.8	-48.4
Option 3A	-69.4	-49.6
Option 3B	-24.6	-38.0
Option 3C	-12.0	-7.2

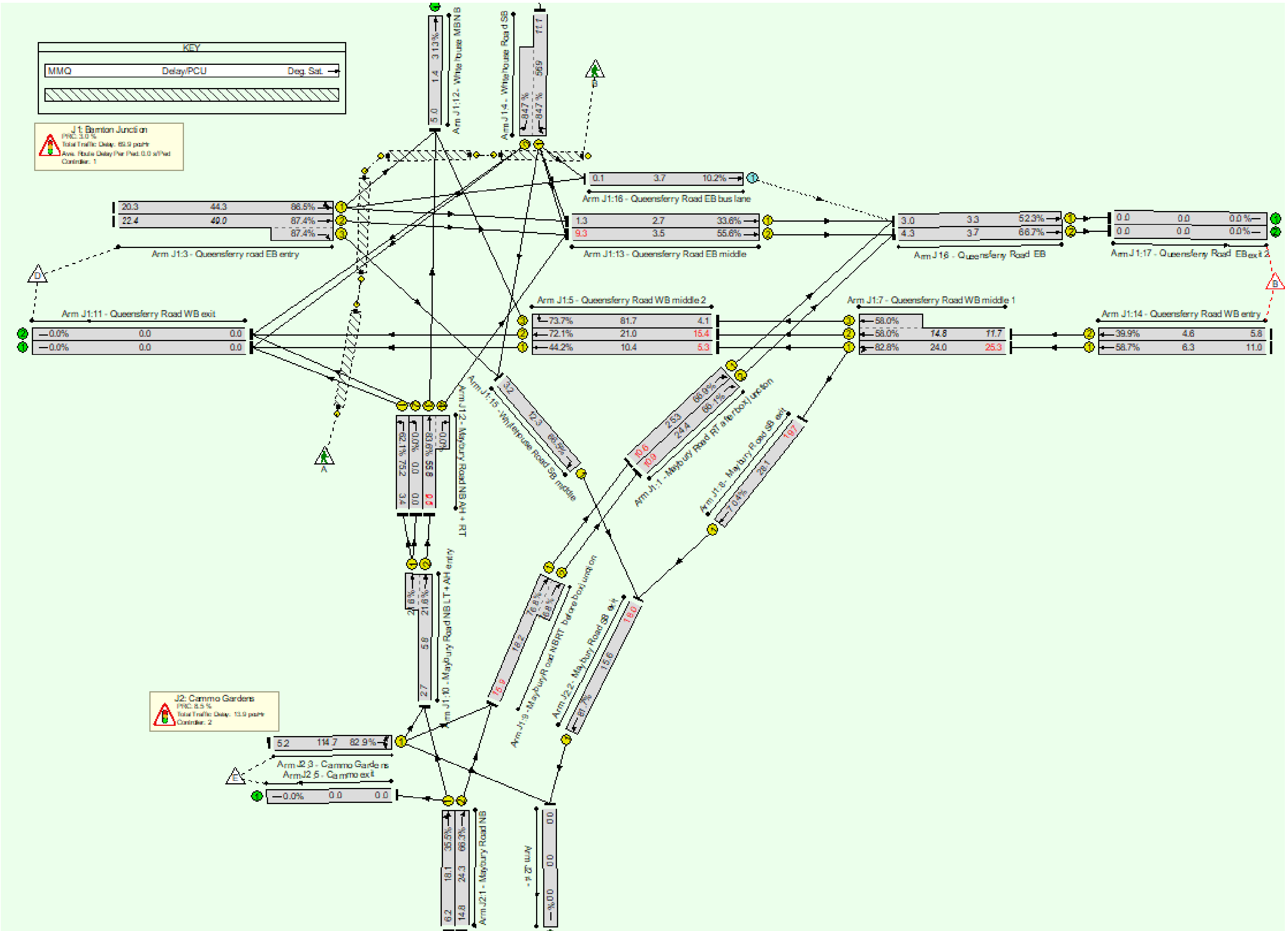
Whichever option is ultimately taken forward, it is expected that further review is required to ensure that the proposed signal timings are appropriate for on-street implementation. This would require up to date traffic counts to be sourced close to implementation. This further analysis is to ensure that the junction operates without blocking within the central sections. As noted in the Stage 2 reporting, it may be that a reduced level of PRC is required to manage the short central sections, with queues relocated to the external approaches. This approach appeared to have been taken for the existing operation whereby PRC values of **-25%** to **-30%** were found in the base layout Linsig analysis when replicating the on-street timings in 2022.

The length of the flare on Whitehouse Road can have a significant impact on how much queuing is expected on this approach and may have wider implications on how the overall junction will operate. Similarly, whether one or two lanes are provided on the Maybury Road left turn slip road may have an implication on how the adjacent ahead and right turn lanes operate if the queue extends back significantly. Therefore, having a shorter flare on Whitehouse Road and a single lane on the left turn will increase the risk of traffic problems occurring.

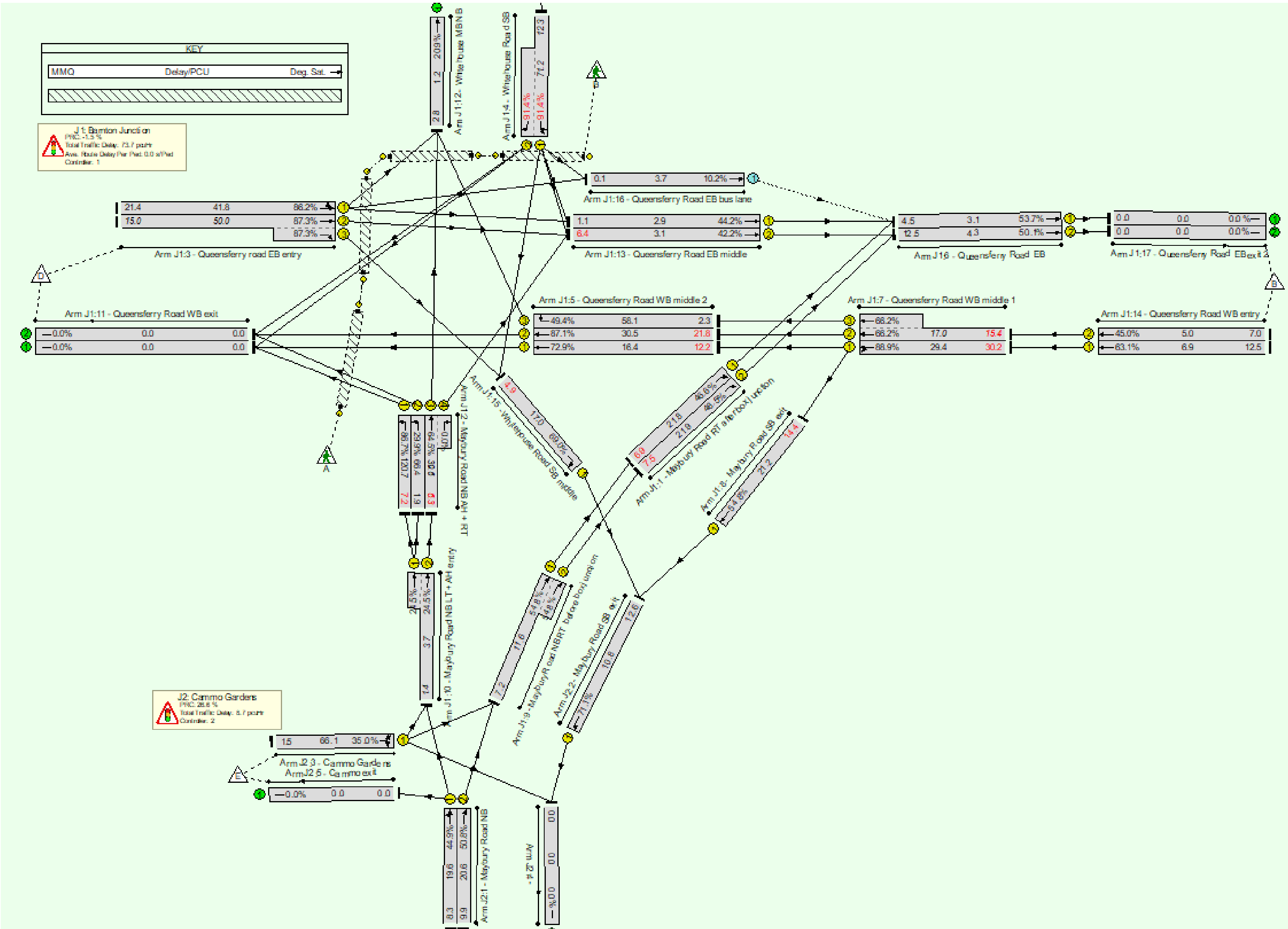
Also, as noted in the stage 2 reporting, additional yellow box markings may be required to help manage the junction operation. The junction will be heavily reliant on yellow box markings to have their desired effect in stopping vehicles from exit blocking other movements. Without this intervention then there is a high risk of the junction locking up or at least severely reducing traffic throughput.

The signal timings for Linsig Model Option 1A have been reviewed to reflect the notes above and ensure appropriate coordination is being provided prior to any further analysis. The final outputs for the AM and PM peak periods are detailed in the Figures below.

Option 1A – AM Peak Output



<u>**Option 1A – PM Peak Output**</u>



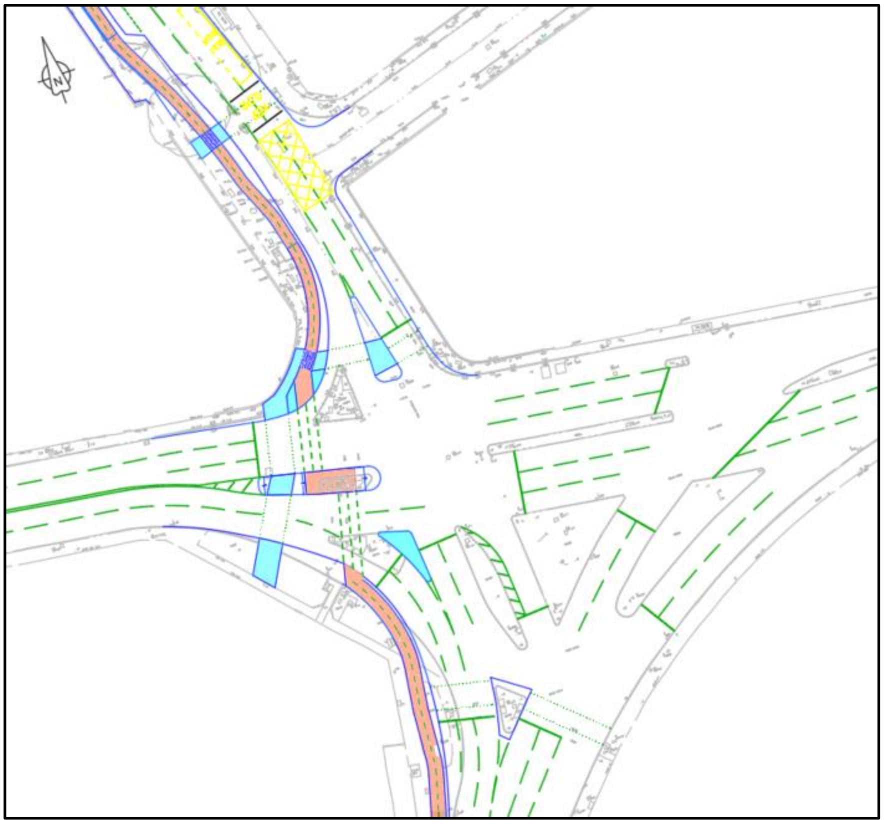
5. Recommendations

Only Option 1A provided results suggesting it would benefit from further investigation as a viable solution, therefore, it is recommended that Option 1A is taken forward for further analysis in Microsimulation software.

There are additional design considerations for the recommended option (1A in image below) to maintain an informal crossing of Whitehouse Road just north of Barnton Grove. All options explored in this report and their performance will be similarly impacted by any change or reduction to the flare length to the on Whitehouse Road to the junction. In the case of a design that impacts the flare length it would therefore be recommended that the impacts of reducing the flare length on Whitehouse Road are tested within Microsimulation software to understand their impact on queuing.

In addition, further tests in Microsimulation software would also be needed if the design explored removal of a left turn lane from Maybury Road, in the event space was needed to create a wider central island (for option 1A). This is unlikely however as the current island width proposed in this option is greater than 3m throughout, with between 3.5 and 4m widths available across the island space which is dedicated to cycles. Further the island is separated for pedestrians and cycles which limits the complexity in the space, and the widths are proportionate to the adjoining parts of the crossing and cycle infrastructure.

A wider view of the proposed amendments under Option 1A are detailed below.



Option 1A has subsequently been taken forward for analysis within the Microsimulation software package VISSIM, the findings of this modelling are discussed within the document “Addendum Maybury and Barnton Modelling Report”.

6. Appendix A - Full Linsig Result Outputs

Barnton Junction (2024 AM Peak)

Item	Lane Description	Base Layout / UTC Timings 100 secs			Base Layout / Optimised Timings 104 secs			Stage 2 Preferred Layout 104 secs			Option 1A 104 secs		
		Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	77.80%	45.9	11.8	72.10%	44.0	11.8	66.90%	23.8	10	66.90%	25.3	10.6
1/2	Maybury Road RT after box junction Ahead	78.40%	46.0	12.4	73.00%	44.3	12.5	66.10%	22.8	10.3	66.10%	24.4	10.9
2/1	Maybury Road NB AH + RT Left	15.90%	5.6	0.6	18.30%	5.7	0.6	35.50%	45.5	2.7	62.10%	75.2	3.4
2/2	Maybury Road NB AH + RT Ahead	87.40%	87.0	10.3	74.90%	60.4	8.7	0.00%	0.0	0	0.00%	0.0	0
2/3+2/4	Maybury Road NB AH + RT Right	0.00%	0.0	0	0.00%	0.0	0	83.60%	60.0	9.6	83.6 : 0.0%	55.8	9.6
3/1	Queensferry road EB entry Left Ahead Ahead2	70.1 : 70.1%	18.1	14.9	74.8 : 74.8%	21.9	17.4	86.80%	44.7	20.6	86.50%	44.3	20.3
3/2+3/3	Queensferry road EB entry Ahead Right	65.6 : 65.6%	23.7	11.6	73.6 : 73.6%	30.5	12.6	87.2 : 87.2%	48.4	22.3	87.4 : 87.4%	49.0	22.4
4/1	Whitehouse Road SB Left Ahead Left2	83.10%	64.9	10.5	75.20%	54.8	9.9	87.0 : 87.0%	61.3	11.7	84.7 : 84.7%	56.9	11.1
4/2+4/3	Whitehouse Road SB Right	92.1 : 92.1%	113.3	7.9	70.7 : 70.7%	65.4	5						
5/1	Queensferry Road WB middle 2 Ahead	29.50%	5.8	3.5	33.00%	8.2	5.7	59.10%	20.3	9.9	44.20%	10.4	5.3
5/2	Queensferry Road WB middle 2 Ahead	65.30%	15.4	16.6	56.40%	15.7	13.6	74.40%	30.1	14.7	72.10%	21.0	15.4
5/3	Queensferry Road WB middle 2 Right	81.00%	105.4	4.6	73.70%	91.1	4.2	65.50%	69.6	3.7	73.70%	81.7	4.1
6/1	Queensferry Road EB Ahead	60.10%	5.5	11.1	60.50%	4.7	9.6	52.40%	3.7	3.9	52.30%	3.3	3
6/2	Queensferry Road EB Ahead	62.40%	6.4	12.9	60.90%	5.6	12.6	66.60%	4.2	16.1	66.70%	3.7	4.3
7/1	Queensferry Road WB middle 1 Ahead Left	84.40%	27.5	24.6	74.10%	15.5	21.3	79.40%	17.8	24.2	82.80%	24.0	25.3
7/2+7/3	Queensferry Road WB middle 1 Ahead	67.6 : 67.6%	18.7	14.5	52.8 : 52.8%	10.1	9.8	48.3 : 48.3%	10.2	11.3	58.0 : 58.0%	14.8	11.7
8/1+8/2	Maybury Road SB exit U-Turn Ahead	81.7 : 0.0%	19.1	18.6	68.7 : 0.0%	18.7	17.2	64.60%	35.5	19.5	70.40%	28.1	19.7
9/1+9/2	Maybury Road NB RT before box junction Ahead	84.3 : 84.3%	37.9	16.6	73.4 : 73.4%	27.0	13.7	67.4 : 67.4%	10.5	12.2	76.8 : 76.8%	18.2	15.9
10/1+10/2	Maybury Road NB LT + AH entry Ahead	24.9 : 24.9%	3.2	1.8	24.5 : 24.5%	2.9	1.7	21.6 : 21.6%	1.4	0.1	21.6 : 21.6%	5.8	2.7
12/1	Whitehouse MB NB Ahead	-	-	-	-	-	-	31.30%	1.4	5	31.30%	1.4	5
13/1	Queensferry Road EB middle Ahead	39.30%	4.0	1.7	41.50%	3.3	1.2	33.90%	2.7	1.2	33.60%	2.7	1.3
13/2	Queensferry Road EB middle Ahead	45.70%	4.1	3.1	45.50%	3.3	3.1	55.40%	3.5	9.3	55.60%	3.5	9.3
14/1	Queensferry Road WB entry Ahead	56.30%	6.2	9.9	58.90%	6.3	11	62.10%	6.7	12.2	58.70%	6.3	11
14/2	Queensferry Road WB entry Ahead	43.90%	5.0	6.5	40.50%	4.6	5.9	36.60%	4.4	5.1	39.90%	4.6	5.8
17/1	Whitehouse Road SB middle Right	59.90%	13.5	7.7	73.90%	26.4	11.8	74.20%	38.9	11.5	66.50%	12.3	3.2
18/1	Queensferry Road EB bus lane Ahead	12.60%	3.9	0.1	12.70%	4.0	0.1	10.10%	3.7	0.1	10.20%	3.7	0.1
	PRC (%)	-2.3%			19.7%			3.2%			3.0%		
	Total Delay (pcu/hr)	74.4			63.6			83.2			83.8		

Item	Lane Description	Option 1B 104 secs			Option 2 104 secs			Option 3A 104 secs			Option 3B 104 secs			Option 3C 104 secs		
		Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	67.30%	18.3	7.9	66.30%	23.7	9.9	59.60%	18.5	9.2	66.70%	21.8	10	64.80%	21.5	9.9
1/2	Maybury Road RT after box junction Ahead	65.80%	17.5	7.7	66.70%	23.3	10.4	60.90%	18.5	9.9	66.30%	21.0	10.3	63.70%	20.5	10
2/1	Maybury Road NB AH + RT Left	62.10%	66.1	3.4	16.00%	28.6	2	16.70%	17.1	1.6	14.10%	40.7	2.6	8.70%	1.9	0.1
2/2	Maybury Road NB AH + RT Ahead	0.00%	0.0	0	0.00%	0.0	0	83.6 : 0.0%	59.4	9.6	89.6 : 0.0%	76.4	10.8	54.5 : 0.0%	28.3	7.2
2/3+2/4	Maybury Road NB AH + RT Right	52.2 : 0.0%	21.8	4.8	83.6 : 0.0%	59.4	9.6									
3/1	Queensferry road EB entry Left Ahead Ahead2	103.20%	142.3	38.5	136.20%	572.1	112.5	152.50%	708.2	282.3	109.60%	233.7	56.4	100.50%	109.4	33
3/2+3/3	Queensferry road EB entry Ahead Right	103.5 : 103.5%	147.8	45	136.6 : 136.6%	578.7	135.5	40.40%	52.1	3.1	109.80%	233.7	62.2	100.8 : 100.8%	112.5	36.9
4/1	Whitehouse Road SB Left Ahead Left2	101.1 : 101.1%	132.9	22	132.2 : 132.2%	524.4	80.5	114.6 : 100.4%	232.6	36.5	107.4 : 101.9%	184.9	29.1	95.5 : 95.5%	88.5	15.7
4/2+4/3	Whitehouse Road SB Right															
5/1	Queensferry Road WB middle 2 Ahead	61.60%	21.8	10	93.50%	66.9	17.6	47.70%	12.9	8	111.30%	268.7	41.4	56.70%	18.3	8.5
5/2	Queensferry Road WB middle 2 Ahead	75.90%	31.8	14.9	94.20%	73.1	19.1	68.90%	22.9	14.6	112.10%	284.5	46	73.10%	28.0	14.6
5/3	Queensferry Road WB middle 2 Right	65.50%	69.6	3.7	73.70%	84.6	4.1	65.50%	69.8	3.7	28.10%	34.0	2.7	65.50%	69.3	3.7
6/1	Queensferry Road EB Ahead	51.50%	3.8	4.4	44.30%	3.1	1.6	46.80%	3.1	2.7	50.40%	3.3	3.3	52.40%	3.7	4.4
6/2	Queensferry Road EB Ahead	65.20%	4.5	18.8	55.00%	3.0	3.3	47.60%	3.1	3.2	62.10%	3.7	5.7	66.00%	4.1	15.6
7/1	Queensferry Road WB middle 1 Ahead Left	79.70%	18.0	24.3	83.20%	19.8	26.7	80.80%	20.6	24.5	83.20%	19.8	26.7	80.20%	18.9	24.4
7/2+7/3	Queensferry Road WB middle 1 Ahead	47.9 : 47.9%	10.1	11.2	44.3 : 44.3%	9.8	10.3	53.1 : 53.1%	12.3	11	44.3 : 44.3%	9.8	10.3	49.5 : 49.5%	10.8	11.1
8/1+8/2	Maybury Road SB exit U-Turn Ahead	62.10%	34.9	19.4	62.10%	34.2	19.4	63.30%	33.3	19.4	64.60%	34.8	19.5	66.00%	35.1	19.5
9/1+9/2	Maybury Road NB RT before box junction Ahead	65.2 : 65.2%	10.0	14.8	65.0 : 65.0%	9.1	12.7	66.1 : 66.1%	9.6	12.2	67.3 : 67.3%	11.4	12.8	68.6 : 68.6%	11.4	12.8
10/1+10/2	Maybury Road NB LT + AH entry Ahead	21.6 : 21.6%	1.4	0.1	21.6 : 21.6%	1.4	0.1	21.6 : 21.6%	1.4	0.1	21.6 : 21.6%	1.4	0.1	21.6 : 21.6%	1.4	0.1
12/1	Whitehouse MB NB Ahead	30.90%	1.4	2.4	27.90%	1.4	5	26.90%	1.4	5	30.20%	1.4	5	31.20%	1.4	4.1
13/1	Queensferry Road EB middle Ahead	32.50%	2.4	0.9	21.70%	2.0	0.2	27.40%	2.1	0.2	31.80%	2.3	0.7	34.30%	2.7	1.2
13/2	Queensferry Road EB middle Ahead	53.80%	3.3	9.2	40.50%	2.7	9	32.30%	2.4	0.6	49.60%	3.0	0.7	55.70%	3.5	9.3
14/1	Queensferry Road WB entry Ahead	62.40%	6.8	12.3	65.10%	7.2	13.5	60.30%	6.5	11.3	65.10%	7.2	13.5	61.80%	6.7	11.9
14/2	Queensferry Road WB entry Ahead	36.30%	4.4	5.1	33.70%	4.2	4.5	38.40%	4.5	5.4	33.70%	4.2	4.5	36.90%	4.4	5.2
17/1	Whitehouse Road SB middle Right	78.90%	43.3	11.8	60.20%	42.4	8.3	70.20%	34.5	10.4	68.60%	32.2	9.7	71.30%	34.7	11.3
18/1	Queensferry Road EB bus lane Ahead	10.10%	3.6	0.1	14.10%	3.6	0.1	12.10%	3.6	0.1	9.30%	3.6	0.1	10.20%	3.7	0.1
	PRC (%)	-15.0%			-51.8%			-69.4%			-24.6%			-12.0%		
	Total Delay (pcu/hr)	89.5			370.6			347.9			238.1			108.6		

Barnton Junction (2024 PM Peak)

Item	Lane Description	Base Layout / UTC Timings 110 secs			Base Layout / Optimised Timings 104 secs			Stage 2 Preferred Layout 104 secs			Option 1A 104 secs		
		Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	91.00%	100.6	11.9	50.70%	49.0	7.4	58.80%	23.2	7.7	46.60%	21.8	6.9
1/2	Maybury Road RT after box junction Ahead	100.80%	159.9	18.7	67.60%	54.3	10.6	56.20%	21.8	7.6	48.50%	21.9	7.5
2/1	Maybury Road NB AH + RT Left	29.40%	7.0	1.2	31.30%	6.9	1.2	86.90%	79.6	8.1	86.70%	120.7	7.2
2/2	Maybury Road NB AH + RT Ahead	93.00%	125.7	10.3	60.40%	55.9	6.3	11.20%	28.6	0.7	29.90%	66.4	1.9
2/3+2/4	Maybury Road NB AH + RT Right	0.00%	0.0	0	0.00%	0.0	0	74.40%	45.2	6.9	64.5 : 0.0%	39.6	6.3
3/1	Queensferry road EB entry Left Ahead Ahead2	93.7 : 93.7%	39.2	36.4	85.8 : 85.8%	28.9	25.1	75.10%	33.5	16.3	86.20%	41.8	21.4
3/2+3/3	Queensferry road EB entry Ahead Right	97.4 : 97.4%	128.0	11.8	84.1 : 84.1%	45.0	7.4	78.0 : 78.0%	42.0	17.4	87.3 : 87.3%	50.0	15
4/1	Whitehouse Road SB Left Ahead Left2	78.60%	66.6	9.5	67.50%	51.6	8	86.8 : 86.8%	60.6	10.7	91.4 : 91.4%	71.2	12.3
4/2+4/3	Whitehouse Road SB Right	99.2 : 99.2%	152.2	13.2	77.7 : 77.7%	66.9	6.4						
5/1	Queensferry Road WB middle 2 Ahead	46.10%	9.2	6.7	53.90%	8.7	5.5	83.00%	33.4	18.3	72.90%	16.4	12.2
5/2	Queensferry Road WB middle 2 Ahead	64.60%	13.6	17.7	76.30%	15.9	19.3	90.30%	47.0	23.4	87.10%	30.5	21.8
5/3	Queensferry Road WB middle 2 Right	59.70%	82.2	2.7	56.40%	67.9	2.5	43.90%	57.9	2.3	49.40%	58.1	2.3
6/1	Queensferry Road EB Ahead	100.40%	65.2	39.2	88.50%	15.0	10.2	65.50%	6.2	4.8	53.70%	3.1	4.5
6/2	Queensferry Road EB Ahead	36.00%	8.6	5.4	52.90%	9.1	8.7	70.80%	6.7	9.3	50.10%	4.3	12.5
7/1	Queensferry Road WB middle 1 Ahead Left	65.10%	7.8	12.6	73.20%	10.6	9.3	76.80%	8.1	6.2	88.90%	29.4	30.2
7/2+7/3	Queensferry Road WB middle 1 Ahead	54.4 : 54.4%	6.7	15.1	61.4 : 61.4%	9.2	18.2	53.8 : 53.8%	6.8	15.7	66.2 : 66.2%	17.0	15.4
8/1+8/2	Maybury Road SB exit U-Turn Ahead	50.2 : 0.0%	13.2	7.7	50.3 : 0.0%	9.4	5.3	51.40%	20.1	13.5	54.80%	21.2	14.4
9/1+9/2	Maybury Road NB RT before box junction Ahead	54.4 : 54.4%	22.0	8.1	55.2 : 55.2%	21.4	8.3	65.8 : 65.8%	11.4	10.6	54.8 : 54.8%	11.6	7.2
10/1+10/2	Maybury Road NB LT + AH entry Ahead	26.4 : 26.4%	3.0	1.5	27.3 : 27.3%	3.6	1.9	24.5 : 24.5%	1.4	0.2	24.5 : 24.5%	3.7	1.4
12/1	Whitehouse Road MB NB Ahead	-	-	-	-	-	-	20.90%	1.2	2.8	20.90%	1.2	2.8
13/1	Queensferry Road EB middle Ahead	62.00%	3.2	0.8	59.10%	3.5	0.8	36.20%	2.2	0.6	44.20%	2.9	1.1
13/2	Queensferry Road EB middle Ahead	9.60%	4.1	1.7	23.30%	5.0	1.7	44.60%	2.6	6.9	42.20%	3.1	6.4
14/1	Queensferry Road WB entry Ahead	76.30%	12.8	12.1	78.70%	18.4	18.5	85.10%	22.5	22.9	63.10%	6.9	12.5
14/2	Queensferry Road WB entry Ahead	60.80%	9.4	8	63.10%	12.4	10.9	56.90%	10.7	8.4	45.00%	5.0	7
17/1	Whitehouse Road SB middle Right	81.40%	26.1	8.2	80.00%	26.7	7.8	74.10%	19.2	7.8	69.00%	17.0	4.9
18/1	Queensferry Road EB bus lane Ahead	12.70%	4.5	0.1	11.70%	4.1	0.1	8.80%	3.6	0	10.20%	3.7	0.1
	PRC (%)	-12.0%			1.7%			-0.3%			-1.5%		
	Total Delay (pcu/hr)	113.9			67.3			81.9			82.4		

Item	Lane Description	Option 1B 104 secs			Option 2 104 secs			Option 3A 104 secs			Option 3B 104 secs			Option 3C 104 secs		
		Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	Deg Sat (%)	Ave. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
1/1	Maybury Road RT after box junction Ahead	70.50%	21.0	1.7	74.70%	42.9	7.9	55.80%	22.9	7.3	66.10%	25.6	6.2	70.20%	20.7	1.7
1/2	Maybury Road RT after box junction Ahead	71.30%	20.0	2.3	75.00%	42.4	8.2	59.10%	23.6	8.1	68.50%	26.1	7.2	71.00%	19.8	2.3
2/1	Maybury Road NB AH + RT Left	95.70%	145.4	9.2	38.30%	22.0	2.6	39.80%	33.7	6	39.60%	24.9	5.5	21.70%	5.1	0.1
2/2	Maybury Road NB AH + RT Ahead	33.80%	46.0	1.8	0.00%	0.0	0	64.5 : 0.0%	43.2	5.4	69.1 : 69.1%	90.4	7.2	43.6 : 43.6%	41.9	3.4
2/3+2/4	Maybury Road NB AH + RT Right	41.5 : 41.5%	43.5	3.6	64.7 : 64.7%	63.2	7									
3/1	Queensferry road EB entry Left Ahead Ahead2	97.30%	85.8	26.4	124.20%	437.9	82.5	134.70%	550.2	203.6	120.30%	387.3	80.3	92.60%	62.4	22.3
3/2+3/3	Queensferry road EB entry Ahead Right	97.2 : 96.0%	87.1	27.7	124.0 : 124.0%	439.6	99.4	64.00%	61.0	5.4	120.30%	385.6	85.1	91.9 : 96.0%	68.0	23.3
4/1	Whitehouse Road SB Left Ahead Left2	91.9 : 96.5%	81.7	13.8	114.3 : 133.6%	427.7	65.8	102.9 : 115.8%	238.8	36.3	92.9 : 108.5%	197.5	30.4	91.9 : 96.5%	81.7	13.8
4/2+4/3	Whitehouse Road SB Right															
5/1	Queensferry Road WB middle 2 Ahead	99.20%	100.7	27.8	127.60%	478.0	87.5	74.60%	27.9	16.8	122.70%	407.1	77.9	92.20%	60.2	19.6
5/2	Queensferry Road WB middle 2 Ahead	101.40%	111.1	34.2	129.20%	490.5	98	85.50%	39.6	22.5	124.20%	421.1	87.8	96.50%	68.6	27.1
5/3	Queensferry Road WB middle 2 Right	43.90%	55.7	2.1	49.40%	67.9	2.4	43.90%	60.6	2.3	15.20%	25.7	1.2	43.90%	56.3	2.2
6/1	Queensferry Road EB Ahead	66.20%	4.9	12.6	55.50%	4.3	8.9	57.20%	7.9	11	61.70%	4.2	11.1	66.00%	4.9	12.9
6/2	Queensferry Road EB Ahead	70.10%	6.0	10.3	63.00%	4.4	5.7	56.40%	7.6	11.3	59.80%	4.0	3.4	70.30%	6.0	10.3
7/1	Queensferry Road WB middle 1 Ahead Left	72.90%	14.3	19.8	72.10%	12.7	17.1	75.70%	7.9	6.1	74.10%	7.5	6.2	72.40%	14.4	20.1
7/2+7/3	Queensferry Road WB middle 1 Ahead	48.9 : 48.9%	10.1	13.7	48.1 : 48.1%	9.4	13.7	55.0 : 55.0%	6.8	16.2	49.4 : 49.4%	6.9	15	49.4 : 49.4%	10.1	13.8
8/1+8/2	Maybury Road SB exit U-Turn Ahead	51.40%	31.2	14.9	48.30%	29.6	10.7	52.50%	20.5	13.5	50.30%	39.7	14.9	51.40%	31.3	14.9
9/1+9/2	Maybury Road NB RT before box junction Ahead	80.7 : 80.7%	37.4	11.8	47.0 : 47.0%	5.6	7.4	66.9 : 66.9%	19.8	9	65.2 : 65.2%	17.9	8.1	80.4 : 80.4%	37.1	11.7
10/1+10/2	Maybury Road NB LT + AH entry Ahead	25.1 : 25.1%	1.4	0.2	25.1 : 25.1%	1.4	0.2	24.5 : 24.5%	3.5	1.4	25.1 : 25.1%	1.4	0.2	25.2 : 25.2%	1.4	0.2
12/1	Whitehouse Road MB NB Ahead	20.90%	1.2	0.1	19.60%	1.2	2.9	19.10%	1.2	1.2	19.70%	1.2	2.9	20.90%	1.2	0.1
13/1	Queensferry Road EB middle Ahead	30.60%	11.4	12.7	26.60%	5.0	8.9	30.70%	2.0	0.3	28.10%	13.3	11.5	31.40%	11.5	12.9
13/2	Queensferry Road EB middle Ahead	41.10%	16.3	16.8	34.70%	9.4	13.8	30.70%	2.0	0.3	32.50%	14.4	13	41.30%	16.3	16.8
14/1	Queensferry Road WB entry Ahead	86.60%	18.5	15.8	86.80%	18.7	15.9	83.80%	21.5	22	86.80%	24.0	24.5	86.00%	18.2	15.8
14/2	Queensferry Road WB entry Ahead	55.40%	9.0	6.6	55.20%	8.9	6.6	58.10%	11.0	9	55.20%	10.2	7.8	55.90%	9.0	6.7
17/1	Whitehouse Road SB middle Right	74.10%	66.8	11.9	70.30%	38.4	5.1	71.40%	14.3	6.8	71.00%	68.6	10.9	74.10%	66.8	11.9
18/1	Queensferry Road EB bus lane Ahead	20.30%	4.0	0.4	6.70%	3.3	0	6.20%	3.4	0	18.20%	4.1	0.8	18.30%	3.9	0.2
	PRC (%)	-12.7%			-48.4%			-49.6%			-38.0%			-7.2%		
	Total Delay (pcu/hr)	92.0			441.7			271.7			368.6			110.2		

LDPAP

Maybury and Barnton Modelling Report

1 | Final

18 April 2025

The City of Edinburgh Council

LDPAP

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Contents

1. Introduction

1.1 Background

As part of the Local Development Plan Action Programme (LDPAP), improved cycle facilities have been proposed on Maybury Road and Whitehouse Road between Glasgow Road and the National Cycle Network Route 1. The upgraded cycle infrastructure includes a protected cycle track in each direction and new at grade cycle crossing over the Barnton junction. To facilitate these cycle improvements, general traffic lanes will be reallocated to cycle only on two sections of Maybury Road, parking removed on Whitehouse Road and a new layout and traffic signal plan at Barnton junction are proposed.

Jacobs has been commissioned by The City of Edinburgh Council (CEC) to design the cycle infrastructure improvements including LinSig modelling of the Barnton junction and VISSIM microsimulation of the whole scheme. The purpose of this report is to detail the VISSIM modelling undertaken and assess the impact the proposed cycle improvement options have on the surrounding road network.

The Maybury study area is shown in Figure 1.1.

Figure 1.1: Study Area

1.2 This Report

This report details the development of the VISSIM Base and Reference Case models used in this assessment including future traffic demand assumptions. The different elements of the proposed cycle improvements are outlined before VISSIM modelling results are discussed. A summary and recommendations are then provided.

The structure of this report is as follows:

- Chapter 2 – Model Development
- Chapter 3 – Scenario Descriptions
- Chapter 4 – Modelling Results
- Chapter 5 – Summary and Recommendations

2. Model Development

A fully calibrated Base model was developed to represent the existing road network and traffic conditions. From this a Reference Case model was created that includes the proposed new layout of Maybury junction, a new signalised junction at Maybury Road/Craigs Road and a bus gate on Turnhouse Road. New future year traffic demands were also derived to take into consideration the anticipated additional traffic volumes associated with the West Craigs (central, north and east) and Cammo Meadows developments located immediately west of Maybury Road.

The Maybury LDPAP cycle improvement scheme was tested in the Reference Case model with additional development demands and compared against the Reference Case with and without the additional development demands. This was to gauge whether it is the proposed scheme or the additional traffic volumes that are impacting the road network most significantly.

The traffic demands for the various models represent the AM peak (08:00-09:00) and PM peak (17:00-18:00) hours.

2.1 Maybury Base Model

A new VISSIM microsimulation model of West Edinburgh area was developed with Maybury Road at the centre of the model. The model ranges from Glasgow Road in the south to Queensferry Road in the north and includes key connections from the Edinburgh City Bypass and Gyle Retail Centre. The links adjoining Maybury Road: Craigs Road, Maybury Drive and Cammo Gardens are also included. The VISSIM model extents are shown in Figure 2.1.

Figure 2.1: Maybury VISSIM Model Extents

2.1.1 Vehicle Types

Car, LGV and HGV vehicle types have been modelled using a matrix based assignment. All corridor bus services are also included, based on fixed routes and stopping patterns.

2.1.2 Model Time Periods

Model time periods are:

- AM peak: 08:00-09:00
- PM peak: 17:00-18:00

For both peak hours, a 15-minute warm up period was included to represent traffic conditions at the start of the peak hour.

2.2 Base Model Calibration/Validation

The morning and evening peak VISSIM models have been calibrated against 2019 observed turning count data. It is important to note the traffic demands in this assessment are based on those prior to the COVID-19 pandemic. The pandemic has impacted traffic volumes and traffic patterns throughout the UK including West Edinburgh and Maybury Road. This assessment assumes that post COVID-19 traffic volumes and patterns will return to a similar level as pre pandemic.

The Maybury model was also validated against 2022 observed count data collected at Maybury Road/Maybury Drive, Maybury Road/Cammo Gardens and Queensferry Road/Cammo Road.

2.2.1 Scot-TAG Calibration Criteria

The Scottish Transport Analysis Guide (Scot-TAG) provides calibration guidance criteria for macroscopic models and these have been applied to the development of the Maybury VISSIM model.

The guidelines state that a minimum of 85% of modelled hourly flows should meet any of the following criteria:

- within 15% of surveyed counts (for flows 700-2700vph)
- within 100vph of surveyed counts (for flows <700vph)
- within 400vph of surveyed counts (for flows >2700vph)

Or

- at least 85% of the modelled hourly flows achieved GEH values of 5 or less when compared to the survey data

The GEH Statistic is a formula used in traffic engineering, traffic forecasting, and traffic modelling to compare two sets of traffic volumes. The equation for the GEH statistic is shown below.

$GEH = \sqrt{ [(Modelled-Observed)^2 / \{ (Observed+Modelled)/2 \}] }$

GEH values of 5 or less can be considered as a good match; values between 5 and 10 may require further investigation and those more than 10 may not be considered as a good match.

2.2.2 Calibration Results

AM and PM modelled traffic flow calibration results are summarised by junction in Table 2.1 and

Table 2.2 for the observed turning count information available in the Maybury area.

Table 2.1: AM Calibration Results

Junction	Number of Observed Counts	Car		All Vehicle Types	
		GEH < 5	GEH < 7.5	GEH < 5	GEH < 7.5
Maybury Rd/ Glasgow Rd	6	6	6	6	6
Whitehouse Rd/ Queensferry Rd/ Maybury Rd	12	12	12	12	12
Drum Brae South/ Drum Brae Drive	2	2	2	2	2
Queensferry Rd/ Clermiston Rd North	5	5	5	4	5
Drum Brae South/ Saint Johns Rd/ Meadow Pl Rd/ Glasgow Rd	2	1	2	2	2
Total	**27**	**26 (96%)**	**27 (100%)**	**26 (96%)**	**27 (100%)**

Table 2.2: PM Calibration Results

Junction	Number of Observed Counts	Car		All Vehicle Types	
		GEH < 5	GEH < 7.5	GEH < 5	GEH < 7.5
Maybury Rd/ Glasgow Rd	6	6	6	6	6
Whitehouse Rd/ Queensferry Rd/ Maybury Rd	12	12	12	12	12
Drum Brae South/ Drum Brae Drive	2	1	2	1	2
Queensferry Rd/ Clermiston Rd North	5	5	5	5	5
Drum Brae South/ Saint Johns Rd/ Meadow Pl Rd/ Glasgow Rd	2	2	2	2	2
Total	**27**	**26 (96%)**	**27 (100%)**	**26 (96%)**	**27 (100%)**

Both peaks meet the Scot-TAG minimum criteria of 85% of counts having a GEH less than 5: 96% in the AM and PM for all vehicle types and also for car only. The maximum GEH across all sites and both peaks is 6.3. Therefore, the comparison of the model and observed data suggests this is a well calibrated model.

2.2.3 Validation Results

Additional traffic counts were commissioned in 2022 to inform design and better understand traffic movements in the Cammo Gardens, Cammo Road and Maybury Drive areas. These observed counts were also used to validate the Maybury VISSIM model.

AM and PM modelled traffic flow validation results are summarised by junction in Table 2.3.

Table 2.3: Validation Results

Junction	Number of Observed Counts	AM Peak Hour		PM Peak Hour	
		Car	All Vehicle Types	Car	All Vehicle Types
Maybury Rd/ Pinegrove Gardens/ Cammo Gardens	12	10	10	12	12
Maybury Rd/ Maybury Drive	6	5	6	5	5
Queensferry Rd/ Cammo Rd	6	4	4	4	4
Total	**24**	**19 (79%)**	**20 (83%)**	**21 (88%)**	**21 (88%)**

In the AM peak 79% of car counts meet the Scot-TAG criteria and 83% for all vehicle types, which is slightly below the suggested minimum criteria. However, the low traffic volumes on the minor roads means this is not considered to be a significant issue. Both car and all vehicles in the PM meet the Scot-TAG minimum of 85% of counts either passing the minimum GEH or percentage difference criteria. Given the small number of counts available, the comparison of the model and observed data suggests this is a well validated model.

2.3 Reference Case Model

There are three planned road network changes in the area surrounding Maybury Road that need to be taken into consideration to meaningfully assess the impact of the LDPAP cycle improvements:

- A bus gate is proposed on Turnhouse Road northwest of the access to West Craigs Crescent (exact location is yet to be determined);
- Revised layout of Maybury junction (as shown in Figure 2.2); and,
- A new signalised junction at Maybury Road/Craigs Road (as shown in Figure 2.3).

All three of these schemes are included as part of the Reference Case model and the modelling assessment.

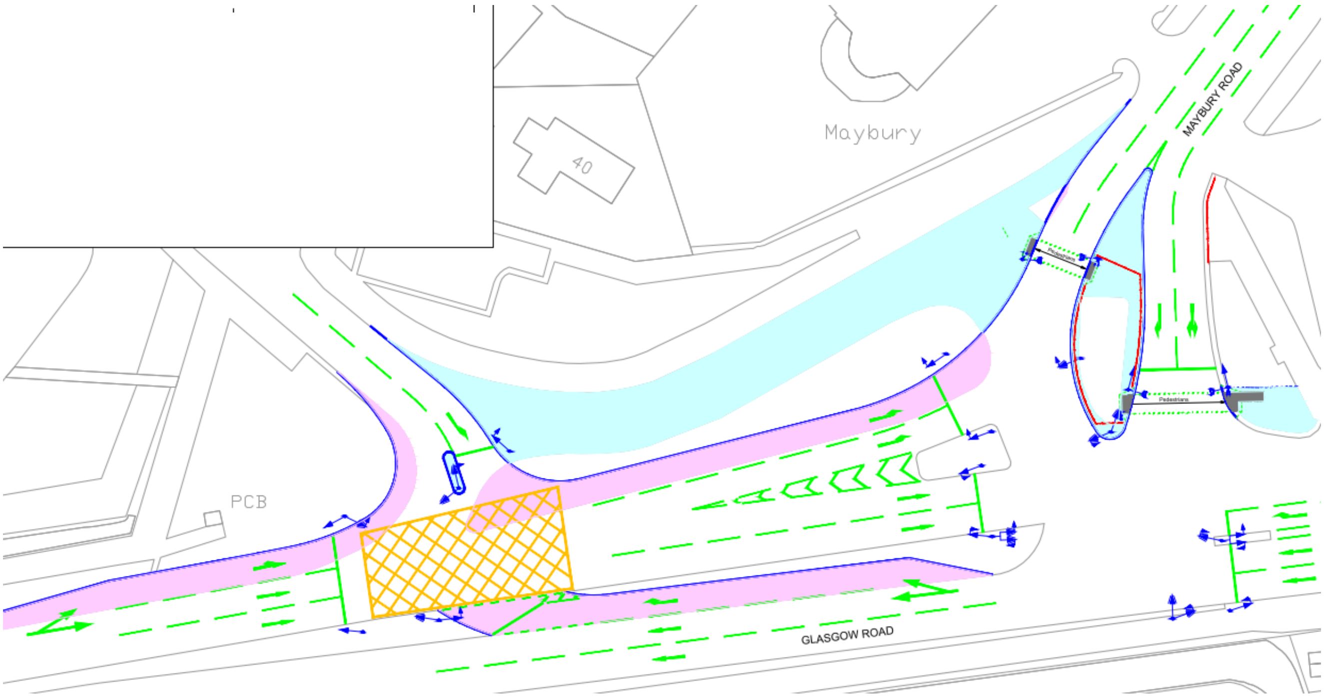

Figure 2.2: New Layout at Maybury Junction

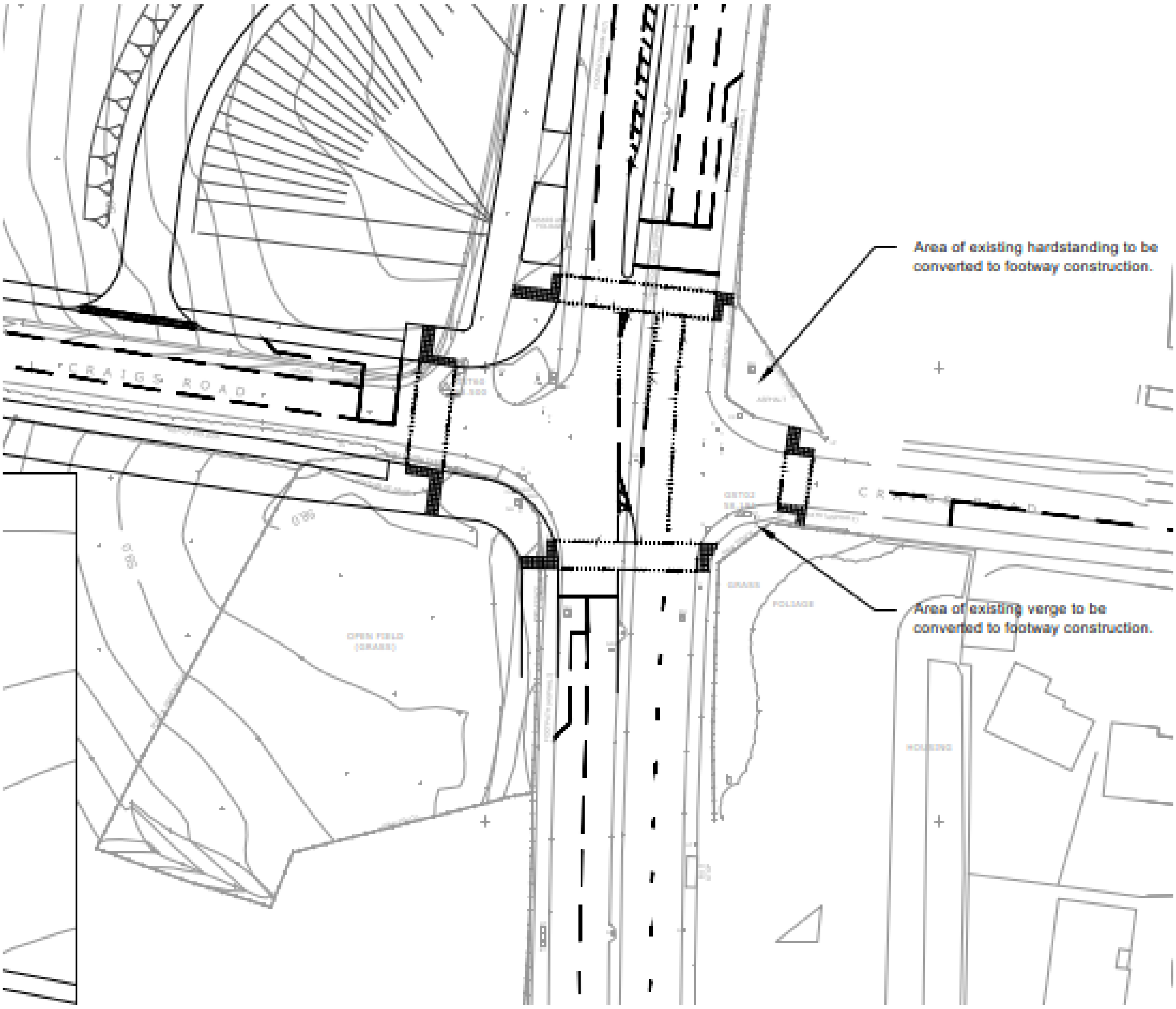

Figure 2.3: New Signalised Junction at Maybury/Craigs Road

2.4 Future Development Demand

There are a number of sites in the West Edinburgh area with approved planning permission for future development (housing and commercial). Of which, four sites adjoin either directly onto Maybury Road or onto Maybury Road via Craigs Road. The additional traffic demand associated with these developments must be taken into consideration for assessing the LDPAP cycle improvement scheme.

Extracted from the supporting Transport Assessments submitted to CEC during the application process, Table 2.4 outlines the forecast additional AM and PM peak hour car trips to and from the developments.

Table 2.4: New Development Car Trips

Development	AM (08:00-09:00)		PM (17:00-18:00)	
	To Development	From Development	To Development	From Development
Cammo Meadows	93	246	268	124
West Craigs (central, north and east sites)	214	754	491	282
Total New Car Trips	**307**	**1,000**	**759**	**406**

For the purposes of this modelling assessment, it has been assumed all these additional car trips will travel on Maybury Road and either pass through the Barnton or Maybury junctions depending on their assumed origin/destination. A gravity model was used to determine the vehicles origin/destination on the model network.

Although not considered as part of this modelling exercise, Table 2.5 below shows the additional forecast car trips from other approved development sites in the West Edinburgh area. These developments could also impact the performance of Maybury Road, Barnton junction and Maybury junction. Additionally, they provided a sense of the scale of development in this area and the potential future increases in traffic flows. Although it is recognised not all 100% of the trips will pass through the study area.

Table 2.5 shows the combined total forecast AM and PM peak hour car trips to and from the listed developments. The number of additional trips from the SAICA site is unknown but the size of the development is known. There are also other sites in the West Edinburgh locale that are likely to become available for development.

Table 2.5: New Development Car Trips

Development	AM (08:00-09:00)		PM (17:00-18:00)	
	To Development	From Development	To Development	From Development
Edinburgh Park RBS East of Mill Tower IBG1 IBG2 IBG3 Elements RHS Airport Hotels	2,755	2,943	2,564	2,548
SAICA	1,000 Dwellings			

3. Scenario Descriptions

Although only one scheme is proposed, the LDPAP Maybury Road design was appraised in VISSIM in three different sections to determine the specific impacts of each of the elements independently. These are described below.

3.1 Scenario 1 – Reallocation of a General Traffic Lane Through Maybury Drive Roundabout

Scenario 1 assesses the proposed reduction from two general traffic lanes to one northbound on Maybury Road through the Maybury Drive roundabout. This is to provide bidirectional segregated cycle lanes on Maybury Road and would be in place from the Craigs Road junction to slightly north of the Meadowsweet Drive junction, as show in Figure 3.1 overleaf.

3.2 Scenario 2 – Reallocation of a General Traffic Lane North of Maybury Junction

Scenario 2 assesses the proposed reduction from two general traffic lanes to one northbound on Maybury Road, north of the Maybury junction to approximate in line with the pedestrian access to East Craig Rigg. As with Scenario 1, this is to provide bidirectional segregated cycle lanes on Maybury Road and is also shown in Figure 3.1 overleaf.

A sensitivity test for Scenario 2 was also undertaken. The test examined the possibility of purchasing land from the Grosvenor Casino carpark immediately north of the Maybury junction. The benefit of this option is an extended merge lane from Maybury junction, allowing two lanes through the junction that merge into one on Maybury Road.

3.3 Scenario 3 – Revised Layout at Barnton Junction

The bidirectional cycle lanes on Maybury Road continue through the Cammo Gardens junction, across Barnton junction and along Whitehouse Road. To facilitate this, the Cammo Gardens junction will become signalised and a revision to the layout and traffic signal plan for Barnton junction is required. A new north-south crossing over Barnton junction is provided for cycles and improvements to pedestrian crossings are also made. The space required for bidirectional cycle lanes on Whitehouse Road are delivered through the removal of parking spaces.

The changes described above form Scenario 3 and are shown diagrammatically in Figure 3.2 overleaf.

In addition to the primary traffic signal plan modelled for Barnton junction, minor adjustments to these plans were also tested to balance impacts on throughput across all arms and determine if junction capacity could be increased. The slight changes to the traffic signal plans are listed below.

- **Do-Something Sensitivity Test 1 (DS1)**
  - Minor variation on stage order to test impact on coordination for movements to Maybury Road
  - Frequency of pedestrian crossing reduced with green time re-allocated to traffic (modelled pedestrian call frequency higher than current observations)

- **Do-Something Sensitivity Test 2 (DS2)**
  - As DS1 but with traffic signal cycle time increased from 104 seconds (DS1) to 112 seconds (DS2)

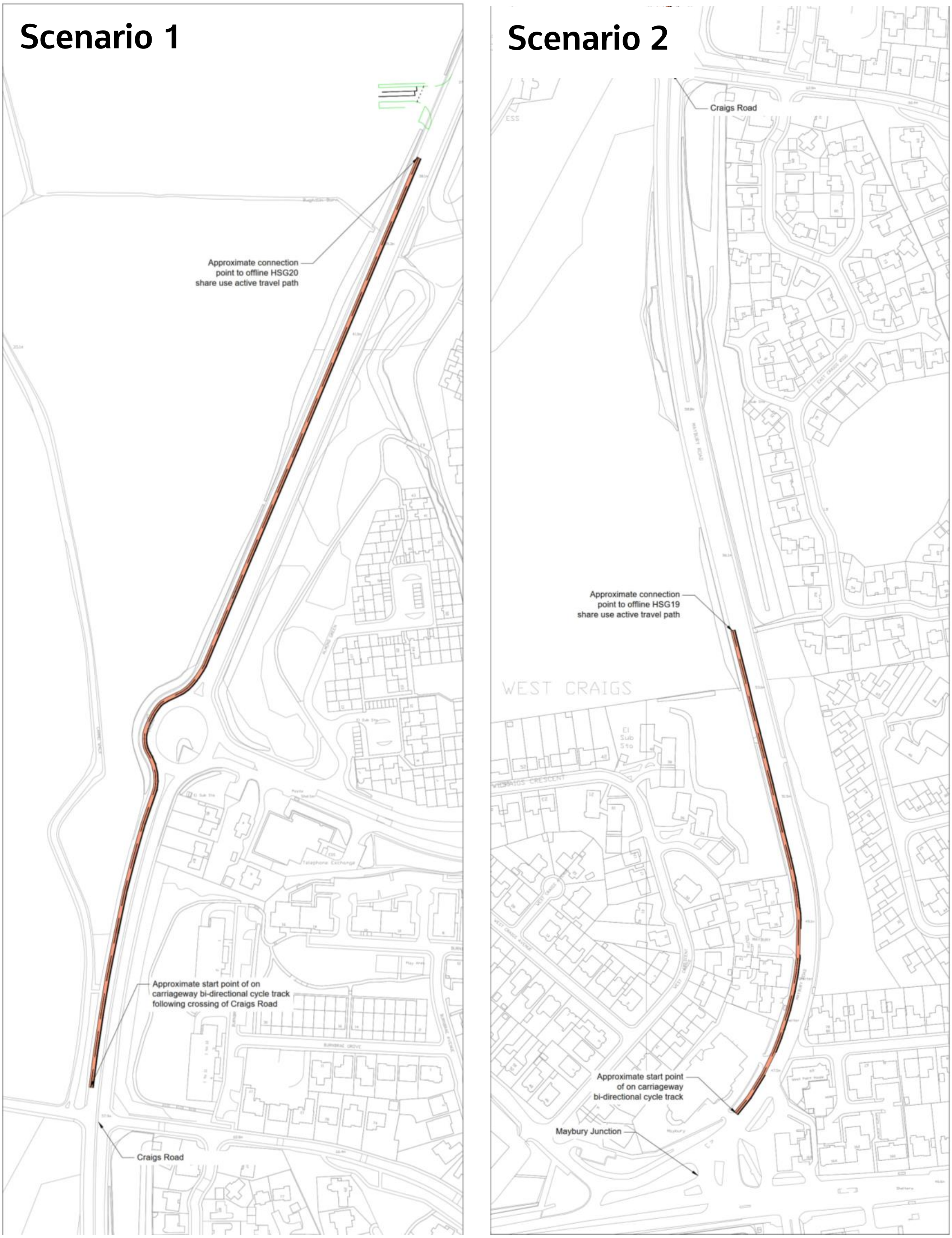

Figure 3.1: Overview of LDPAP Cycle Improvements on Maybury Road – Scenarios 1 and 2

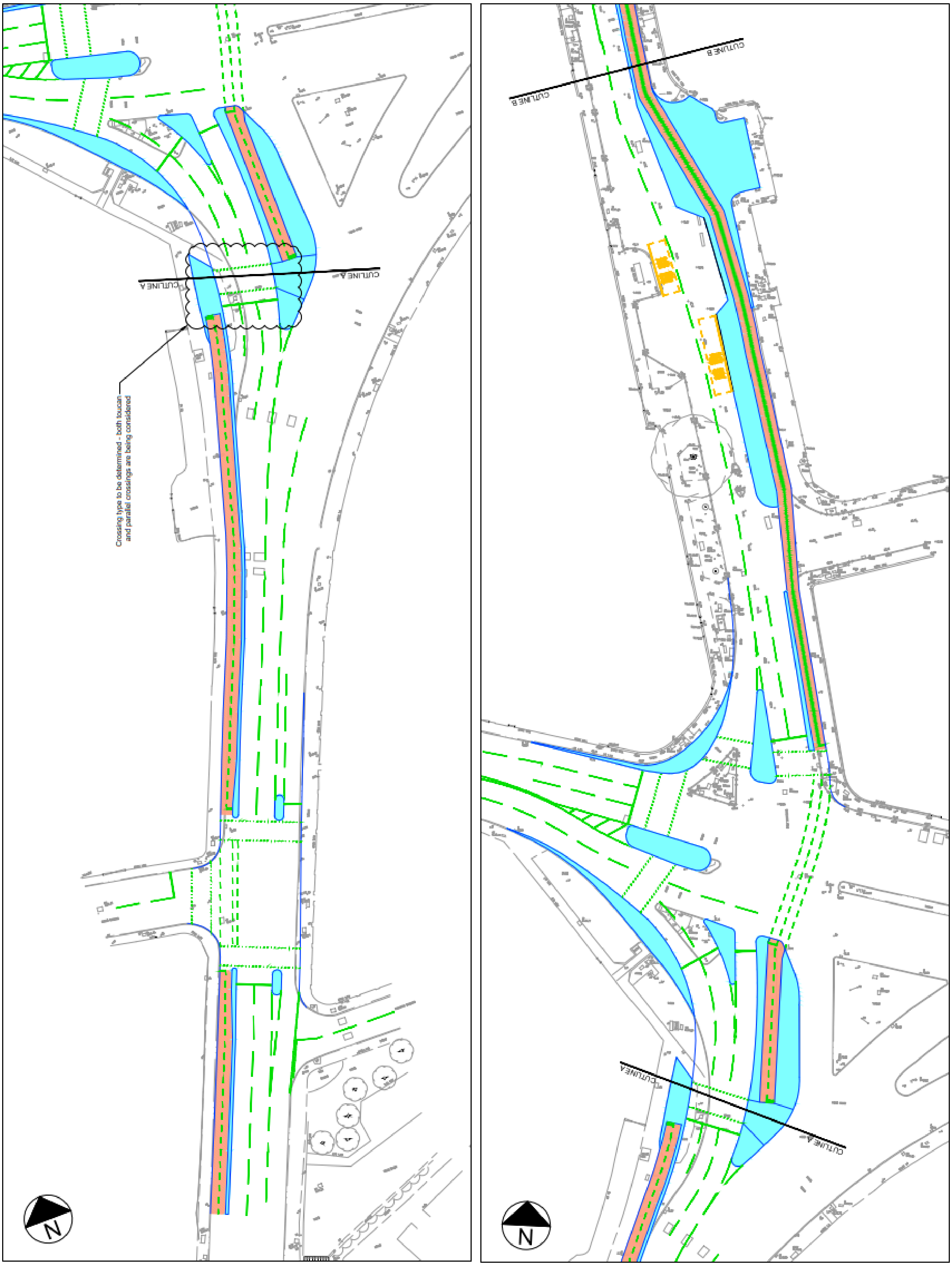

Figure 3.2: Overview of LDPAP Cycle Improvements Through Barnton Junction – Scenario 3

4. Modelling Results

The three scenarios were assessed independently in VISSIM in order to understand their impact on the surrounding road network. The scenarios were tested in the Reference Case model with current traffic demands plus forecast traffic growth from the West Craigs and Cammo Meadows developments, for the AM and PM peaks. Scenarios 2 and 3 are compared against the Reference Case with and without the additional development traffic demands to establish if the impacts on the road network derive from the increase in traffic volumes or the schemes themselves.

The analysis of the scenarios focus on changes in queue lengths, journey times and where appropriate, junction throughput.

4.1 Scenario 1

Scenario 1 reallocates a general traffic lane to cycle only northbound on Maybury Road through the Maybury Drive roundabout.

4.1.1 Model Queue Length Analysis

Modelled queue lengths were extracted from the Reference Case and Scenario 1 models for the AM and PM peaks. The change in queue lengths in the AM peak hour is shown in Figure 4.1. For this analysis, the additional forecast traffic flows associated with the new developments were not included.

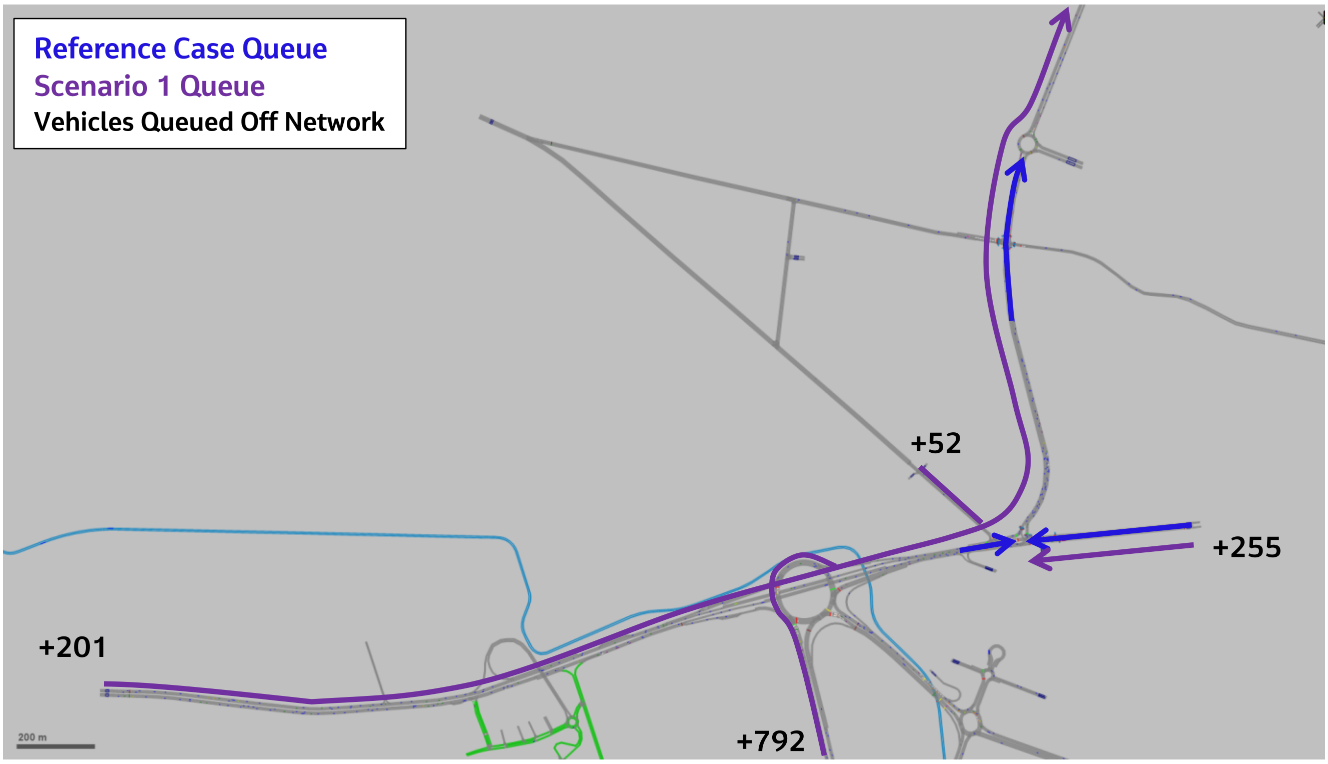

Figure 4.1: Scenario 1 AM Queues

Modelling of Scenario 1 resulted in significant queues forming throughout the model network. At the start of the model period, queues begin to propagate back from the Maybury Road/Meadowsweet Drive junction and tailback through Maybury and Gogar junctions before queuing off the model network at the Edinburgh City Bypass and Glasgow Road (west). There are also extended queues for vehicles travelling from Glasgow Road (east) and Turnhouse Road due to the congestion at Maybury junction.

The queues are so severe under Scenario 1 that a significant proportion of model traffic cannot enter the model network, as shown by the number in Figure 4.1. Furthermore, the queues modelled under Scenario 1 do not take into account the additional traffic demand anticipated to be generated by the new developments west of Maybury Road.

4.2 Scenario 2

Scenario 2 reallocates a general traffic lane to cycle only on Maybury Road northbound from Maybury junction.

4.2.1 Model Queue Length Analysis

Modelled queue lengths were extracted from the Reference Case model with and without the additional West Craigs and Cammo Meadows development traffic demand. For the AM and PM peaks, these queues were compared against the Scenario 2 (with development demand) queues. The change in queue lengths in the AM peak hour is shown in Figure 4.2.

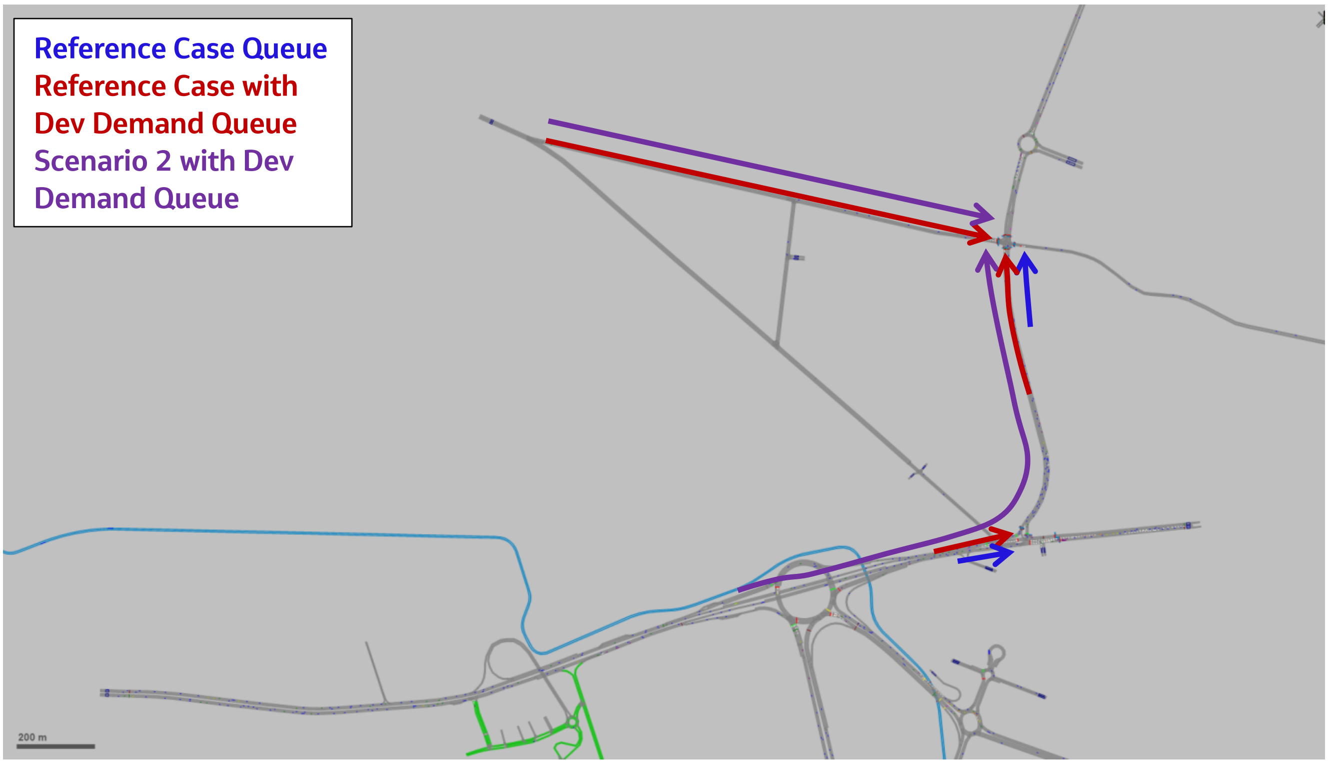

Figure 4.2: Scenario 2 AM Queues

Adding the forecast development demand to the Reference Case model results in increased queues eastbound on Glasgow Road and northbound on Maybury Road. Implementing Scenario 2 extends the northbound Maybury Road queue farther, propagating back through Maybury junction and along Glasgow Road.

In addition to the extended queues on Maybury Road and Glasgow Road, significant queues are anticipated on Craigs Road for vehicles exiting the new West Craigs development sites. Any attempts to reduce this queue, by increasing the traffic signal green time from this arm of the junction, resulted in longer queues on Maybury Road and Glasgow Road.

4.2.2 Model Journey Time Analysis

The extended queues under Scenario 2 predominantly impact eastbound travel on Glasgow Road and the northbound approaches to Gogar roundabout from the Edinburgh City Bypass and the Gyle. AM and PM journey times were extracted from the Reference Case with and without development demand models and the Scenario 2 models. The approximate start and end points of the journey time routes are shown in Figure 4.3.

Figure 4.3: Journey Time Routes

A comparison of average journey times from the three models are shown in Table 4.1 for the AM and PM peak hour. The journey times are displayed in minutes:seconds and the change in journey time from the Reference Case model is shown in brackets.

Table 4.1: Scenario 2 Average Journey Time Results

Route	AM Peak Hour			PM Peak Hour		
	Reference Case	Reference Case with Dev Demand	Scenario 2 with Dev Demand	Reference Case	Reference Case with Dev Demand	Scenario 2 with Dev Demand
Glasgow Road	2:48	3:08 (+0:20)	4:24 (+1:36)	7:08	7:52 (+0:42)	8:06 (+0:58)
Bypass	1:07	1:12 (+0:05)	2:13 (+1:06)	2:37	4:59 (+2:22)	8:04 (+5:27)
Gyle	0:16	0:16 (+0:00)	0:16 (+0:00)	3:12	3:31 (+0:19)	3:49 (+0:38)

Adding the forecast traffic growth from West Craigs and Cammo Meadows developments results in longer journey times on all three routes in both peaks. The increase in journey times is more significant in the PM peak as this is generally the busier peak in terms of overall traffic volumes.

Modelling of Scenario 2 indicates journey times will increase by almost 60% on Glasgow Road and approximately double on the Edinburgh City Bypass in the AM peak with more substantial increases in the PM peak. An already busy route in the PM peak, journey times on Glasgow Road would increase by around one minute impacting buses, airport access and possibly delays to the M9 motorway. The short approach from the Edinburgh City Bypass included in the model would see journey times increase from around two and a half minutes in the PM to over eight minutes. This level of delay would most likely be considered unacceptable and would impact the Hermiston Gait junction and the M8 motorway.

4.2.3 Scenario 2 Sensitivity Test

Acquiring land from the Grosvenor Casino would allow two lanes through Maybury junction to Maybury Road. This would improve junction throughput before vehicles would need to merge into one lane slightly farther north than under the primary Scenario 2 layout.

PM queue lengths for the Scenario 2 sensitivity test are shown in Figure 4.4. The queue lengths for the Reference Case with development demand and the primary Scenario 2 are displayed for comparison.

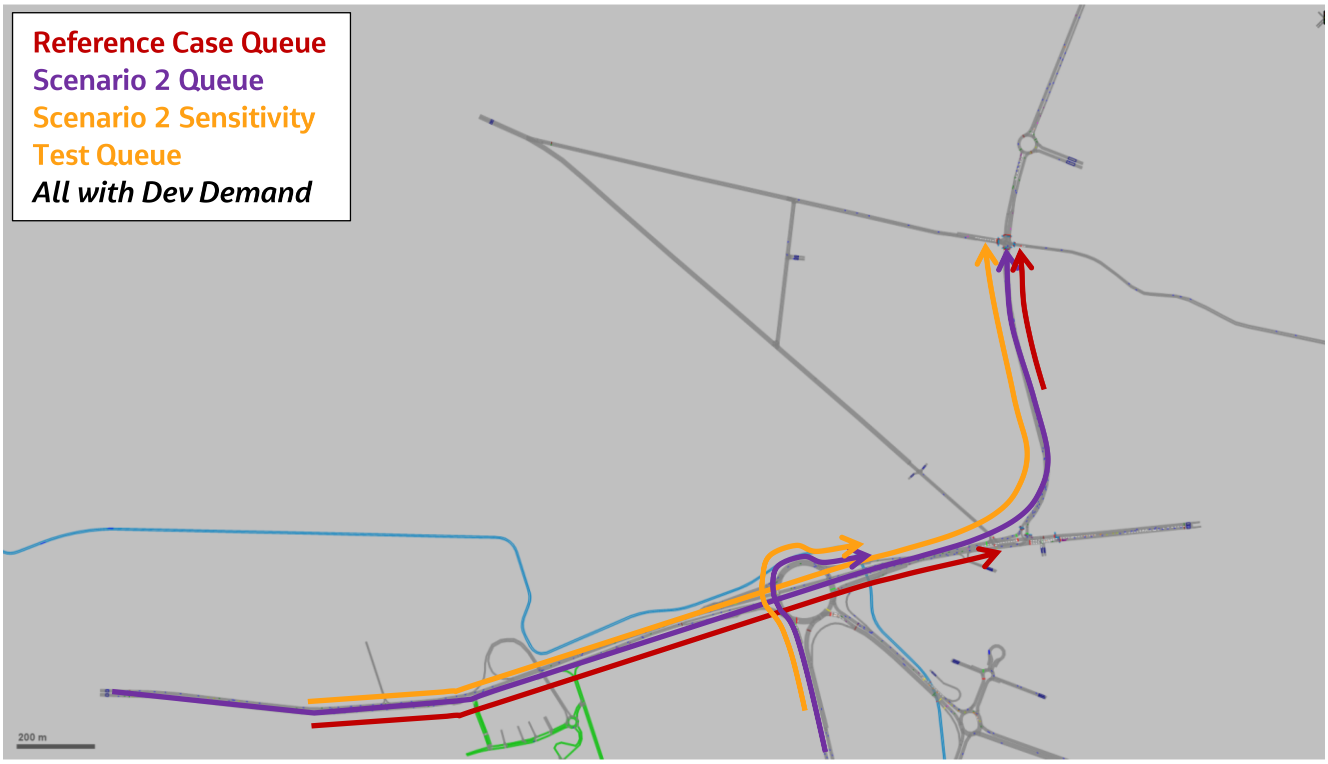

Figure 4.4: PM Scenario 2 Sensitivity Test Queues

In the PM peak under the primary Scenario 2, traffic queues extend along the length of Glasgow Road and to the Edinburgh City Bypass. Providing two lanes through Maybury junction reduces these queue lengths but they are still longer than the Reference Case. The root cause of this is the reduced stacking space on Maybury Road that leads to queues tailing back through Maybury junction.

It is unknown if land could be acquired from the Grosvenor Casino to facilitate the short merge lane north of Maybury junction. Although if it is available, it is unlikely that the limited benefits associated with the merge lane would warrant the additional cost.

4.3 Scenario 3

Scenario 3 delivers a segregated bidirectional cycle lane between Cammo Gardens and Whitehouse Road. The key network change under Scenario 3 is the proposed new layout and traffic signal plan for Barnton junction to cater for a new cycle crossing.

4.3.1 Model Queue Length Analysis

Modelled queue lengths were extracted from the Reference Case model with and without the additional West Craigs and Cammo Meadows development traffic demand. For the AM and PM peaks, these queues were compared against the Scenario 3 (with development demand) queues. The change in queue lengths in the AM peak hour is shown in Figure 4.5.

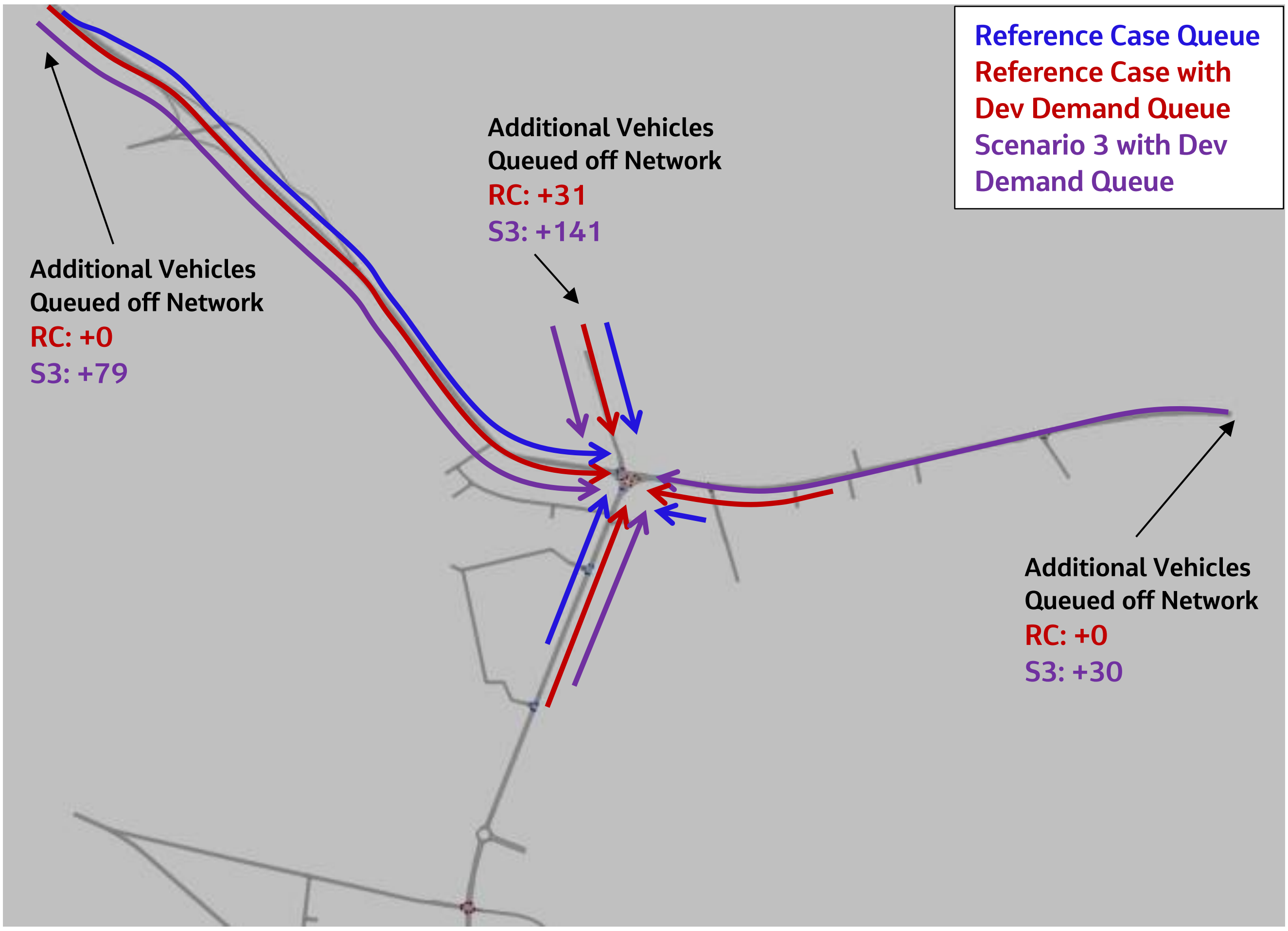

Figure 4.5: Scenario 3 AM Queues

In the AM peak hour, there are long queues eastbound on Queensferry Road with the existing Barnton junction arrangement and traffic demands. Adding the additional development traffic demand and redesigning Barnton junction increases this queue beyond the model extents and results in vehicles being unable to join the model network.

The Barnton redesign also leads to significantly extended queues on Whitehouse Road and Queensferry Road westbound. Modelling indicates over 100 additional vehicles will now be queued on Whitehouse Road, which would equate to an extra 500m+ of queue assuming an average vehicle length of 5m. The westbound queue on Queensferry Road more than trebles in length with the new Barnton layout and signal plan.

4.3.2 Model Journey Time Analysis

There are extended queues on three of the four approaches to Barnton junction under Scenario 2. AM and PM journey times were extracted from the Reference Case with and without development demand models and the Scenario 3 models. The approximate start and end points of the journey time routes are shown in Figure 4.6.

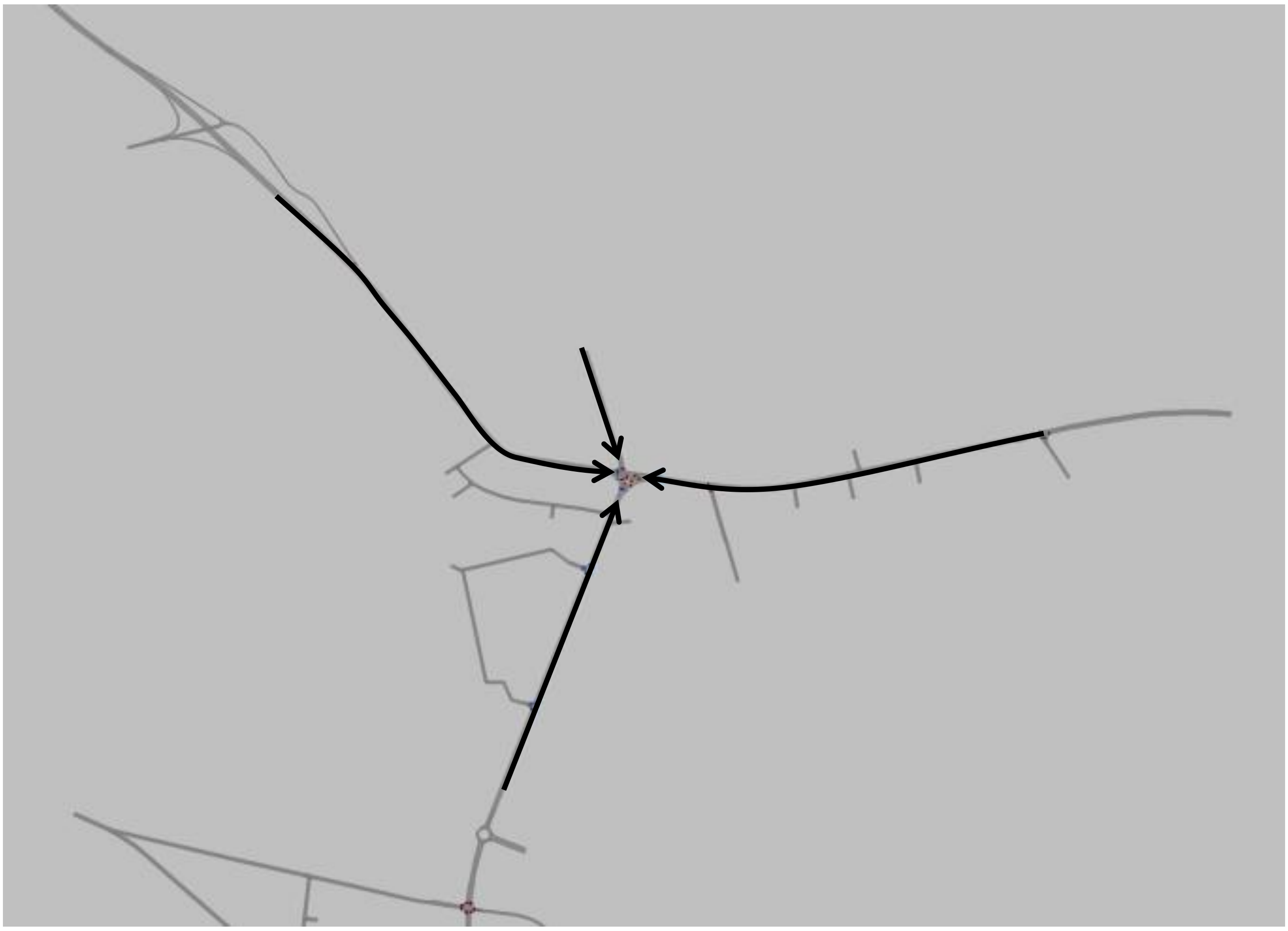

Figure 4.6: Scenario 3 Journey Time Routes

A comparison of average journey times from the three models are shown in Table 4.2 for the AM and PM peak hour. The journey times are displayed in minutes:seconds and the change in journey time from the Reference Case model is shown in brackets.

Table 4.2: Scenario 3 Average Journey Time Results

Approach	AM Peak Hour			PM Peak Hour		
	Reference Case	Reference Case with Dev Demand	Scenario 3 with Dev Demand	Reference Case	Reference Case with Dev Demand	Scenario 3 with Dev Demand
Queensferry Road EB	5:12	6:28 (+1:16)	7:52 (+2:40)	1:35	3:58 (+2:23)	5:48 (+4:13)
Maybury Road	8:21	10:08 (+1:47)	8:16 (-0:05)	10:26	7:33 (-2:53)	5:29 (-4:57)
Queensferry Road WB	2:01	2:53 (+0:52)	7:47 (+5:46)	2:03	4:01 (+1:58)	7:32 (+5:30)
Whitehouse Road	5:07	5:45 (+0:38)	8:23 (+3:16)	4:50	4:47 (-0:02)	5:52 (+1:02)

In the AM and PM peaks, Scenario 3 increases the approach times to Barnton junction on both Queensferry Road arms and the Whitehouse Road approach. Travel times increase between 50% to almost 300% in the AM and 21%-268% in the PM. These delays would likely lead to wider network disruption rather than constrained to the Barnton area.

Queensferry Road is also a key public transport corridor connecting Edinburgh's northwest and Fife with Edinburgh City Centre. Delays to buses of over two and a half minutes to almost six minutes would unlikely be supported.

However, Scenario 3 does improve the approach times from Maybury Road, suggesting there is spare junction capacity available to distribute the impacts more evenly across all arms.

4.3.3 Scenario 3 Sensitivity Tests

Sensitivity tests were undertaken for Scenario 3 to try to balance impacts on throughput across all arms and if possible, improve junction capacity. These tests are outlined below.

- **Do-Something Sensitivity Test 1 (DS1)**
  - Minor variation on stage order to test impact on coordination for movements to Maybury Road
  - Frequency of pedestrian crossing reduced with green time re-allocated to traffic (modelled pedestrian call frequency higher than current observations)

- **Do-Something Sensitivity Test 2 (DS2)**
  - As DS1 but with traffic signal cycle time increased from 104 seconds (DS1) to 112 seconds (DS2)

Although the Scenario 3 sensitivity testing was undertaken to balance impacts across the junction arms, in practice it may be beneficial to prioritise specific approaches over others to maximise throughput from a given approach. E.g. key bus corridors such as Queensferry Road.

AM and PM average journey times were extracted from the VISSIM models and displayed in Table 4.3. The journey times are displayed in minutes:seconds and the change in journey time from the original Scenario 3 models are shown in brackets.

Table 4.3: Scenario 3 Sensitivity Testing Average Journey Time Results

Approach	AM Peak Hour			PM Peak Hour		
	Scenario 3 with Dev Demand	DS1 with Dev Demand	DS2 with Dev Demand	Scenario 3 with Dev Demand	DS1 with Dev Demand	DS2 with Dev Demand
Queensferry Road EB	7:52	7:14 (-0:37)	7:39 (-0:13)	5:48	6:45 (+0:57)	7:06 (+1:17)
Maybury Road	8:16	10:07 (+1:51)	6:52 (-1:23)	5:29	5:21 (-0:07)	5:55 (+0:26)
Queensferry Road WB	7:47	5:41 (-2:06)	2:45 (-5:02)	7:32	8:10 (+0:38)	6:30 (-1:02)
Whitehouse Road	8:23	6:59 (-1:25)	7:40 (-0:44)	5:52	4:50 (-1:01)	4:58 (-0:54)

Modelling of DS1 showed varying results. Overall, the AM improved with increased delays on Maybury Road compared to the original Scenario 3 but reduced delays on the other three approaches. However, this option performed slightly worse in the PM peak.

DS2 performed slightly better in the PM peak with improvements on Queensferry Road westbound and Whitehouse Road but there were additional delays on Queensferry Road eastbound and Maybury Road. In the AM peak hour, DS2 has reduced approach times compared to the original Scenario 3 on all arms. The most significant of which is Queensferry Road westbound, approximately five minutes, which is in line with the Reference Case models.

The Scenario 3 sensitivity tests indicate there are limited options available to maintain junction capacity if a cycle crossing is required at Barnton. A grade separated crossing or banning certain movements through the junction would be needed to maintain capacity.

Table 4.4 below shows the overall junction throughput under the different Scenario 3 tests. It highlights that no matter what traffic signal plan is in place, capacity at Barnton is going to reduce due to the additional cycle crossing stage. The only way to improve capacity is to reduce the frequency of pedestrians crossing phases. The numbers shown are in vehicles per hour with the change from the Reference Case model displayed in brackets.

Table 4.4: Scenario 3 Sensitivity Testing Junction Throughput

Peak Hour	Reference Case with Dev Demand	Scenario 3 with Dev Demand	DS1 with Dev Demand	DS2 with Dev Demand
AM	4,539	3,990 (-12%)	4,328 (-5%)	4,368 (-4%)
PM	4,874	4,406 (-10%)	4,345 (-11%)	4,462 (-8%)

5. Summary and Recommendations

5.1 Summary

CEC commissioned Jacobs to design and model cycle improvements on Maybury Road in West Edinburgh. VISSIM Base and Reference Case models were developed to assess the impact on the surrounding road network of the cycle improvement proposal, which was separated into three sections in order for the different elements of the design to be tested independently.

- Scenario 1 reallocated a general traffic lane to bidirectional cycle lanes on Maybury Road northbound through the Maybury Drive roundabout. From Craigs Road junction to slightly north of the Meadowsweet Drive junction.
- Scenario 2 reallocated a general traffic lane to bidirectional cycle lanes on Maybury Road northbound from Maybury junction to in line with the pedestrian access to East Craig Rigg.
  - A sensitivity test was undertaken to examine the potential benefits of acquiring additional space from the Grosvenor Casino carpark to facilitate two merge lanes through the Maybury junction.
- Scenario 3 provided segregated bidirectional lanes between the Cammo Gardens junction and Whitehouse Road. It includes the signalisation of the Cammo Gardens junction, removal of parking spaces on Whitehouse Road plus a redesign and new traffic signal plan for Barnton junction to cater for a new cycle crossing.
  - Sensitivity tests were undertaken for Scenario 3 that made minor adjustments to traffic signal timings and phasing. The aim of which was to balance the impacts on throughput across all junction arms and determine if overall junction capacity could be increased.

All three scenarios were modelled in the AM and PM peak hours with two different sets of traffic demands: one using existing traffic volumes and a second that took account of planned new developments. The West Craigs (central, north and east) and Cammo Meadows sites will either join directly onto Maybury Road or onto Maybury Road via Craigs Road. Due to the close proximity of these development sites, the forecast increase in traffic volumes extracted from the associated Transport Assessments needed to be included in the modelling assessment. This modelling exercise did not consider other approved developments in the wider West Edinburgh area.

Modelling of Scenario 1 resulted in significant queues forming throughout the model network in both the AM and PM peaks. The reduced stacking space and capacity northbound on Maybury Road causes queues to propagate back from the Meadowsweet Drive junction and through the Maybury junction and Gogar roundabout. This leads to unacceptable levels of queuing and delay on Glasgow Road, the Edinburgh City Bypass and farther beyond the model extents.

Implementation of Scenario 2 in the AM and PM peak resulted in increased queues and delays on Maybury Road, Glasgow Road and approaches to Gogar roundabout. In the AM period there is also anticipated to be delays to vehicles on Craigs Road exiting the new West Craigs development sites. The most substantial delays were modelled in the PM peak on the Edinburgh City Bypass approach to Gogar where modelled journey times increased from approximately two and a half minutes in the Reference Case model to over eight minutes under Scenario 2. Travel times on the already congested Glasgow Road also increased. The additional queues on the Edinburgh City Bypass and Glasgow Road risk wider network disruption with impacts likely to affect Hermiston Gait and M8 motorway plus the M9 motorway and airport access.

The Scenario 2 sensitivity test that takes additional space from the Grosvenor Casino carpark to facilitate two merge lanes through the Maybury junction, slightly improves the levels of queuing and delays compared to the primary Scenario 2. However, these are still likely to be greater than those modelled in the Reference Case.

Under Scenario 3, the only key change to the road network that impacts traffic flow operation is the redesigned Barnton junction layout to accommodate a new cycle crossing and revised traffic signal plan. Modelling of this scenario indicated increased queue lengths and journey times on all the approaches to Barnton junction in both peaks. Overall, there is a 10% or greater reduction in junction throughput. The sensitivity testing demonstrated that minor adjustments to traffic signals can change where this is most or least severely impacted.

5.2 Recommendations

Modelling of Scenario 1 indicates that removing a general traffic lane at this location is not a viable option. Unacceptable queue lengths extended past the model extents with current traffic volumes. Including the additional traffic associated with all the approved development sites in the West Edinburgh area will only exacerbate these problems further.

Although not as severe as Scenario 1, Scenario 2 increases queues and journey times on Glasgow Road, the Edinburgh City Bypass and approaches to Gogar roundabout. These will impact airport access and key intercity and local bus services on Glasgow Road, as well as potential wider network affects on the M8 and M9 motorways. Acquiring land from the Grosvenor Casino would slightly reduce the negative impacts on traffic flow but this is unlikely to be sufficient to bring queues and delays down to an acceptable level.

Including a cycle only crossing over Barnton junction reduces throughput by over 10%, with the only method of improving capacity to reduce the number of pedestrians crossing phases called per traffic signal cycle. Barnton junction is already over capacity and will likely encounter increased traffic volumes in the near future as a result of new developments in the West Edinburgh area. It is also located on a key bus route connecting the northwest and Fife to Edinburgh City Centre. Therefore, capacity should be maintained if possible. Conversely, the sensitivity testing has highlighted that the junction’s traffic signal plan can be adjusted to prioritise specific approaches. If the key bus routes were prioritised, decision makers may choose to delay general traffic on the other approach arms in order to deliver the active travel benefits of redesigning Barnton junction.

In general, the sheer scale of new development in the West Edinburgh area, and the associated new car trips these developments will generate, will make any attempts to reduce general traffic capacity in this locale extremely challenging. Especially, as the area contains several key strategic routes for general traffic and public transport.

LDPAP

Addendum Maybury and Barnton Modelling Report

1 | Final

18 April 2025

The City of Edinburgh Council

LDPAP

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Contents

1. Addendum

1.1 Introduction

The VISSIM assessment of the LDPAP active travel improvements at Barnton junction was completed in June 2022. Since then, a new design for the junction has been developed. This addendum to the original Maybury and Barnton Modelling Report analyses the performance of the new proposal at Barnton and on the surrounding network using the microsimulation software VISSIM.

The original VISSIM assessment of the Barnton junction was based on 2019 traffic count data and forecast future demands from development sites in west Edinburgh. A new traffic count was commissioned in 2024 and a significant proportion of assumed development has since been constructed. This addendum evaluates the changes in traffic demands and updates the flows for the Base and Reference Case models.

1.2 New Design Proposal

An assessment of multiple different options for Barnton junction was modelled using Linsig and recommended a new design proposal to be tested in VISSIM. A summary of this Linsig assessment can be found in the following document: "*B2420300-TN-LS-0008 P01 (Barnton Addendum)*".

The revised design option for Barnton junction retains the bidirectional cycle track on the west side of Maybury Road and connects to a bidirectional cycle track on the west side of Whitehouse Road, which then transitions from west to east approximately 120m north of Barnton junction to once again align with the previous design. The primary difference between the two designs is the repositioning of the cycle crossing over Barnton junction to connect the cycle tracks. The original option provides a crossing for cycles in the centre of the junction diagonally from southwest to the northeast corner, whereas the new proposal delivers the crossing over Queensferry Road (southwest to northwest corner).

The new design layout at Barnton junction is shown in Figure 1.1 and includes a centre island for cycles to safely wait while crossing Queensferry Road. For reference, the original 2022 design is also provided in Figure 1.2.

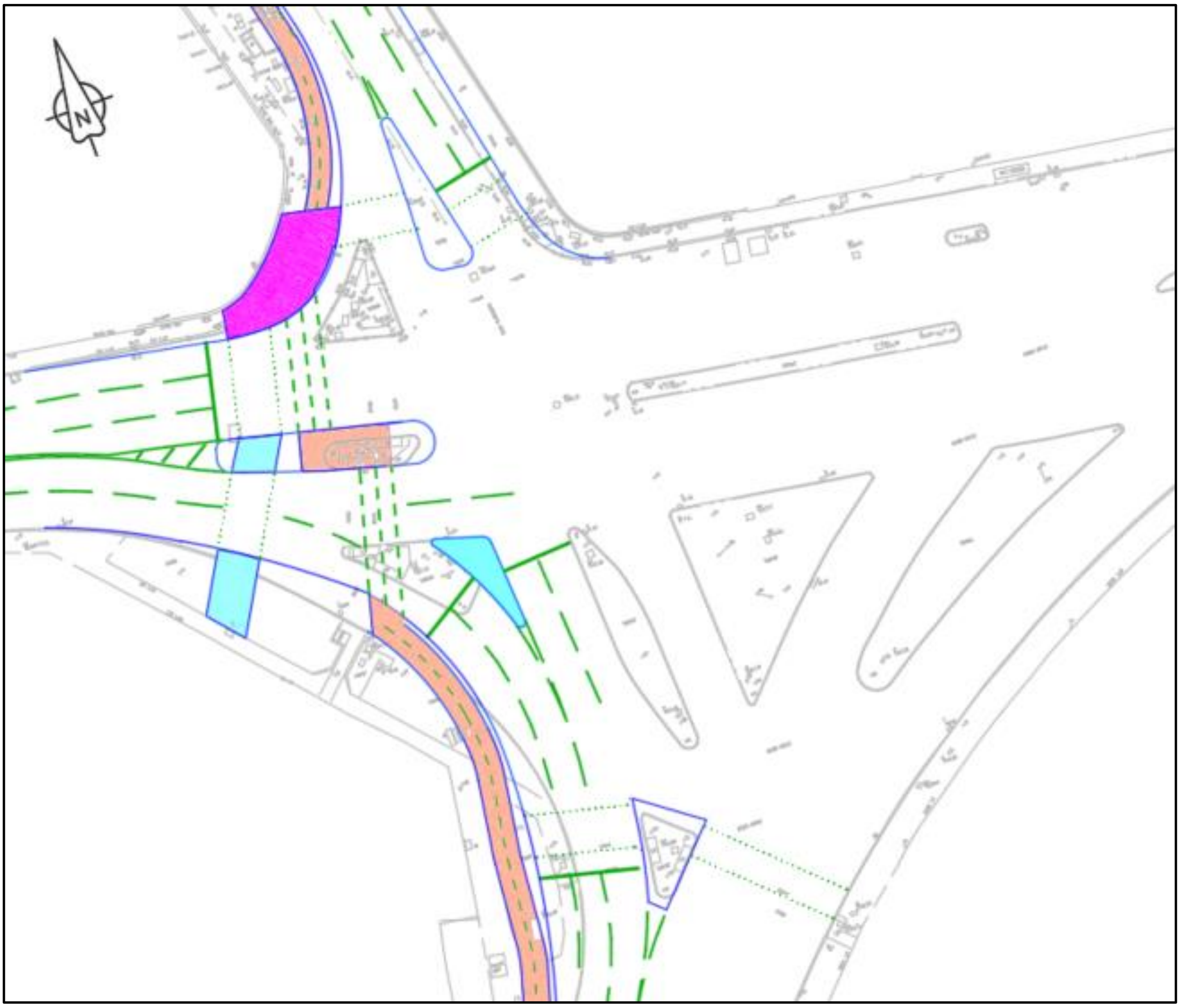

Figure 1.1: Barnton Junction New Design Proposal

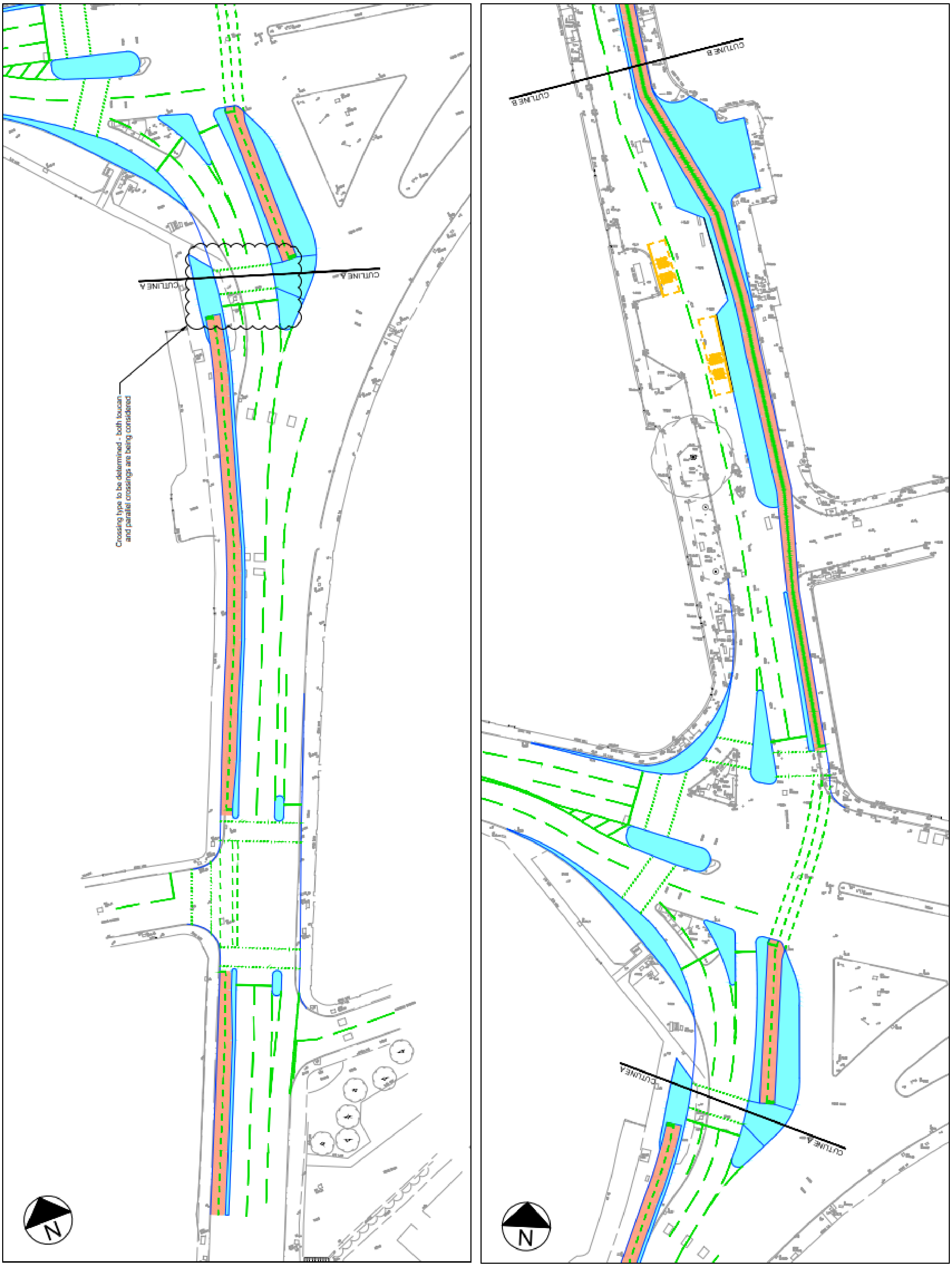

Figure 1.2: Barnton Junction Original 2022 Design Proposal

2. 2019 and 2024 Traffic Flow Comparison

Observed Junction Turning Counts (JTCs) were undertaken at Barnton junction in June 2019 and March 2024, both of which are considered neutral months. A comparison between the two surveys is shown in Table 2.1 for all vehicle types for each movement through the junction.

Over the past five years, total vehicle throughput has reduced by 14% in the morning peak hour and 12% in the evening peak hour. This can most likely be attributed to the change in working patterns post COVID-19. In general, the biggest reduction in traffic flows between the two surveys is to and from Queensferry Road (west).

Table 2.1: Barnton Junction Turning Count Comparison (Total Vehicles)

From Arm	To Arm	AM (08:00-09:00)			PM (17:00-18:00)		
		2019	2024	% Change	2019	2024	% Change
Whitehouse Road	Queensferry Road (E)	63	62	-2%	66	67	2%
Whitehouse Road	Maybury Road	259	240	-7%	164	189	15%
Whitehouse Road	Queensferry Road (W)	227	211	-7%	343	273	-20%
Queensferry Road (E)	Maybury Road	574	598	4%	326	429	32%
Queensferry Road (E)	Queensferry Road (W)	1057	861	-19%	1433	1218	-15%
Queensferry Road (E)	Whitehouse Road	86	100	16%	71	67	-6%
Maybury Road	Queensferry Road (W)	122	41	-66%	362	188	-48%
Maybury Road	Whitehouse Road	241	246	2%	175	191	9%
Maybury Road	Queensferry Road (E)	609	625	3%	487	524	8%
Queensferry Road (W)	Whitehouse Road	352	236	-33%	197	134	-32%
Queensferry Road (W)	Queensferry Road (E)	1233	1039	-16%	1226	1018	-17%
Queensferry Road (W)	Maybury Road	252	87	-65%	162	100	-38%
TOTAL JUNCTION THROUGHPUT		**5075**	**4346**	**-14%**	**5012**	**4398**	**-12%**

Changes in traffic volumes were input into the previous VISSIM model of Barnton junction to re-calibrate to a 2024 baseline. A calibration summary for the 2024 model, using the GEH statistic (previously described in Section 2.2 of the main report), is given in Table 2.2.

Table 2.2: 2024 Barnton Junction Calibration (GEH – Total Vehicles)

From Arm	To Arm	AM (08:00-09:00)		PM (17:00-18:00)	
		2019	2024	2019	2024
Whitehouse Road	Queensferry Road (E)	0.9	2.3	0.4	3.8
Whitehouse Road	Maybury Road	2.7	1.7	2.0	3.2
Whitehouse Road	Queensferry Road (W)	1.0	3.7	0.0	0.8
Queensferry Road (E)	Maybury Road	2.8	2.1	2.8	3.4
Queensferry Road (E)	Queensferry Road (W)	2.1	3.4	0.2	3.9
Queensferry Road (E)	Whitehouse Road	0.1	0.7	2.4	3.1
Maybury Road	Queensferry Road (W)	4.2	2.0	3.0	0.9
Maybury Road	Whitehouse Road	2.3	3.5	3.4	5.4
Maybury Road	Queensferry Road (E)	0.2	5.2	1.4	4.1
Queensferry Road (W)	Whitehouse Road	3.2	1.8	2.3	2.6
Queensferry Road (W)	Queensferry Road (E)	5.5	0.3	1.8	0.8
Queensferry Road (W)	Maybury Road	0.8	4.8	0.8	1.9
OVERALL JUNCTION CALIBRATION (GEH <5)		**11 / 12**	**11 /12**	**12 / 12**	**11 / 12**

A GEH of less than 5 is considered a good match and a GEH greater than 10 a poor match. Only one turning movement in the AM and PM peak periods have a GEH marginally greater than 5 and therefore the 2024 model is considered well calibrated at Barnton junction.

Compared to the 2019 models, only one additional turning movement has a GEH greater than 5 in the PM peak hour, increasing from 3.4 to 5.4. In the AM, there is one turning movement in each of the 2019 and 2024 models with a GEH slight above 5. Overall, the two models can be considered calibrated to a similar standard.

2.1 Development Demand

Edinburgh's Local Development Plan indicates there are several sites in west Edinburgh currently under construction (housing and commercial). The original assessment at Barnton junction accounted for future traffic flows from four development sites: Cammo Meadows and West Craigs (central, north and east).

Since 2019, some of this development has been built and occupied, meaning a proportion of previously modelled future trips will now be accounted for in the 2024 traffic counts. Exact occupancy rates cannot be determined. However, a high-level review of the associated transport assessments and a recent site visit suggests occupancy rates of approximately 2/3 at Cammo Meadows and 1/3 at West Craigs.

Table 2.3 outlines the original 2019 forecast future AM and PM peak hour car trips to and from the developments. The table also provides forecast future traffic flows for the remaining development trips that are not currently occupied. As with the 2022 assessment, a gravity model was used to determine the number of vehicles that pass through Barnton junction.

Table 2.3: Revised Development Car Trips

Development	AM (08:00-09:00)				PM (17:00-18:00)			
	To Development		From Development		To Development		From Development	
	2019	2024	2019	2024	2019	2024	2019	2024
Cammo Meadows	93	31	246	81	268	88	124	41
West Craigs (central, north and east sites)	214	143	754	505	491	329	282	189
Total New Car Trips	**307**	**174**	**1,000**	**586**	**759**	**417**	**406**	**230**

It is worth reiterating, Section 2.4 of the original Maybury and Barnton Modelling Report highlights the significant level of development planned in the vicinity of Barnton junction and future traffic volumes through the junction are anticipated to be greater than forecast in this assessment.

3. Modelling Results

The new design proposal was assessed in VISSIM to understand performance at Barnton junction and if there is significant impact on the surrounding road network. The new option was tested in the 2024 Reference Case model with current traffic demands plus forecast traffic growth from the West Craigs and Cammo Meadows developments, for the AM and PM peaks.

In addition to the new design proposal (crossing in the west), the original design for Barnton junction (crossing in the centre) was re-modelled in the 2024 model to provide a consistent comparison for the two options.

3.1 Traffic Flow Analysis

A key metric for determining the performance of a design solution is a comparison of vehicle throughput. Table 3.1 summarises the total vehicle throughput from each approach arm for the 2024 Reference Case model with forecast development demand for the AM and PM peak hours. Pivoting from the same models, the table also summarises the total (and percentage change) in throughput from the original and new Barnton proposals.

Table 3.1: Total Vehicle Throughput

Approach	AM (08:00-09:00)			PM (17:00-18:00)		
	Ref Case + Dev Demand	Original Design	New Design	Ref Case + Dev Demand	Original Design	New Design
Whitehouse Road	425	301 (-29%)	377 (-11%)	496	394 (-21%)	381 (-23%)
Queensferry Road (E)	1,602	1,006 (-37%)	1,601 (0%)	1,845	1,733 (-6%)	1,853 (0%)
Maybury Road	763	832 (+9%)	798 (+5%)	767	976 (+27%)	1,076 (+40%)
Queensferry Road (W)	1,440	1,460 (+1%)	1,287 (-11%)	1,260	1,394 (+11%)	1,153 (-8%)
Total	**4,230**	**3,599 (-15%)**	**4,063 (-4%)**	**4,368**	**4,497 (+3%)**	**4,463 (+2%)**

The previous results for the original 2022 design indicated a reduction in total junction throughput of around 10%. Re-running the original proposal with updated 2024 traffic flows and revised forecast development demand shows an improvement in the PM peak but performance is slightly worse in the AM peak hour. This is likely attributed to the different mix of traffic movements through the junction between the 2019 and 2024 datasets.

The new design proposal significantly outperforms the original in the AM peak by around 500 vehicles per hour through the junction and operates at a similar level to the original in the PM peak hour (-34 vehicles).

The most notable increase in junction throughput is from Maybury Road. New demand generated from the development sites increases traffic flows on Maybury Road and the proposed new design caters for this by providing improved throughput. Traffic signal green time is increased by around 10% for right turning and straight ahead movements from Maybury Road, while an additional left turning lane is also provided.

Both design proposals remove the southbound right turn flare lane on Whitehouse Road and explains why throughput from this arm is less than in the Reference Case model.

3.2 Journey Time Analysis

Previously, in Section 4.3.2 of the main report, journey time analysis was undertaken. Over the same modelled routes (approximate start and end points of approach times to the junction are shown in Figure 4.6), journey times were extracted from the following models:

- 2024 Reference Case model with forecast development demand
- Original 2022 design (crossing in the centre)
- New 2024 design (crossing in the west)

A comparison of average approach times from the three models are shown in Table 3.2 for the AM and PM peak hour. The approach times are displayed in minutes:seconds and the change in journey time from the Reference Case model is shown in brackets.

Table 3.2: Average Journey Times

Approach	AM (08:00-09:00)			PM (17:00-18:00)		
	Ref Case + Dev Demand	Original Design	New Design	Ref Case + Dev Demand	Original Design	New Design
Whitehouse Road	1:08	7:45 (+6:37)	4:55 (+3:47)	3:42	5:43 (+2:01)	7:10 (+3:28)
Queensferry Road (E)	2:04	14:09 (+12:05)	2:43 (+0:39)	2:00	5:44 (+3:44)	2:46 (+0:46)
Maybury Road	10:22	9:09 (-1:12)	10:05 (-0:17)	11:00	4:18 (-6:42)	2:12 (-8:48)
Queensferry Road (W)	3:14	2:50 (-0:24)	5:01 (+1:47)	3:14	2:00 (-1:14)	5:32 (+2:18)

In the AM peak, approach times on three of the four arms are longer under the new design than in the Reference Case model. However, these are significantly improved when compared to the original proposal for Whitehouse Road and Queensferry Road east, saving around 3 and 12 minutes respectively.

Similarly, in the PM three of the four arms have increased approach times compared to the Reference Case. However, approach times from Maybury Road are significantly improved and outweighs delays on the other approaches. In line with the traffic flow analysis, journey times for the original and new design proposals perform to a similar level with minor differences between the individual approach arms.

3.3 Queue Analysis

Traffic flow and journey time analysis highlighted reduced throughput and increased approach times from Whitehouse Road and Queensferry Road (east) for the original 2022 proposal. Figure 3.1 displays an AM model screenshot of the queue in this model and annotates the comparative queue extents for the Reference Case and new design models.

AM modelling of the original design proposal suggests queues will extend beyond the model network on Whitehouse Road and on Queensferry Road (east). These queues are unlikely to be acceptable on the A90 which is an important strategic public transport corridor for buses travelling to and from the north of Scotland.

There are minimal benefits on the other approach arms with queues on Queensferry Road (west) approximately the same under all three models and only a slight queue reduction on Maybury Road.

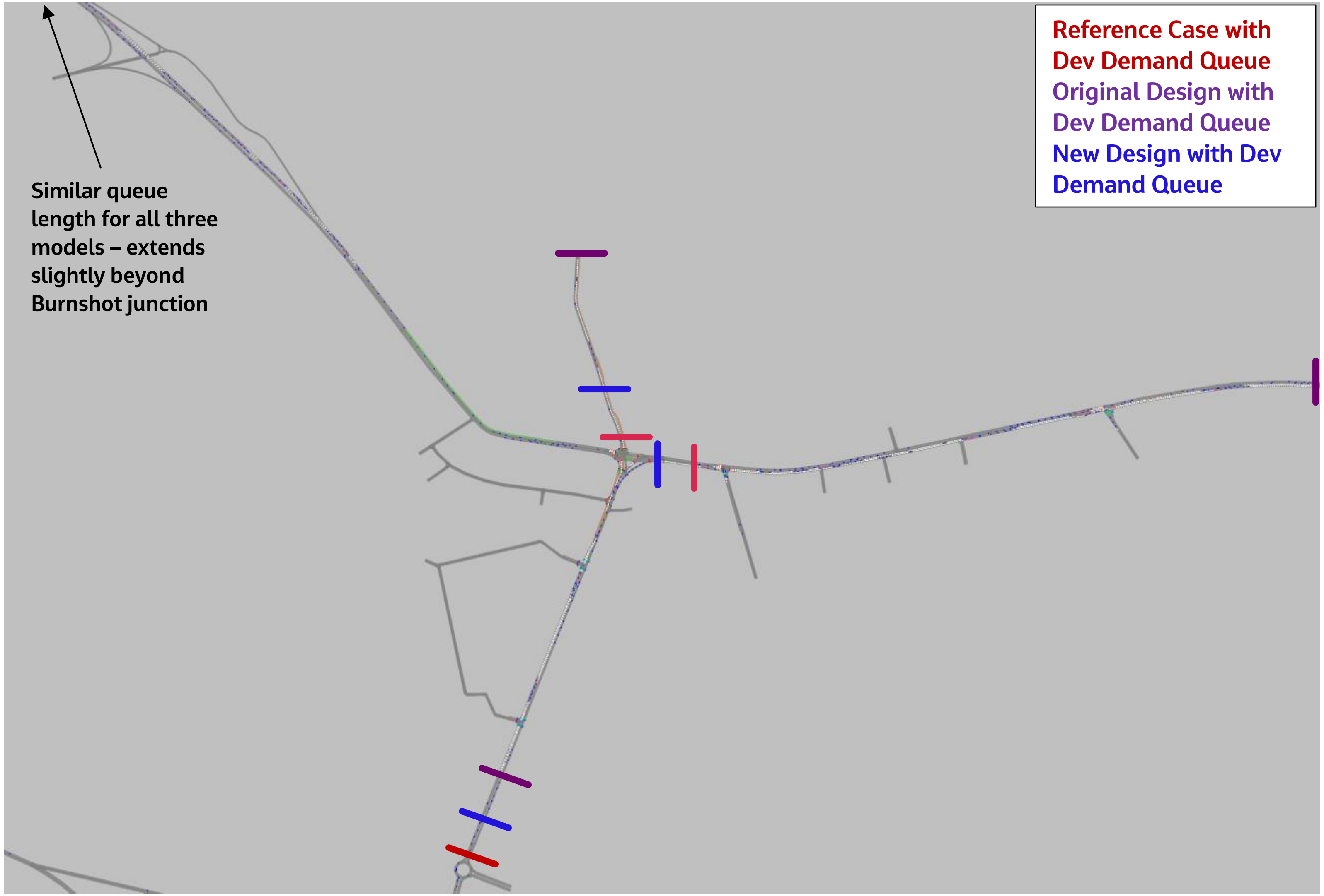

Figure 3.1: Barnton Junction Queue Extents

4. Summary and Recommendations

4.1 Summary

A new LDPAP active travel design for Barnton junction has been developed since the original proposal in 2022. The new option moves the proposed cycle crossing from the centre of the junction to the west over the Queensferry Road (west) approach arm. A central island provides safe stacking space to allow pedestrians and cycles to cross Queensferry Road (west) in two stages.

The original assessment of the 2022 proposal used observed traffic data from 2019 and forecast development traffic flows. New traffic information was collected in 2024 and it was considered prudent to update the Base and Reference Case models to reflect the new data. A proportion of the committed development has also been built and is now occupied, with a review undertaken to ensure forecast traffic demands were not double counted.

Assessed using VISSIM microsimulation software, model analysis indicates the original and new design proposals perform to a similar level in the PM peak hour. Both slightly improving overall junction throughput compared to the Reference Case model, primarily due to increased capacity from Maybury Road, which is reflected in improved approach times on this arm.

In the AM peak hour, the new design outperforms the original 2022 design in terms of overall junction throughput and journey time analysis. Specific improvement was modelled on Whitehouse Road and Queensferry Road (east) where approach times were significantly reduced.

4.2 Recommendation

It is recommended that the new design with the two stage staggered cycle crossing on the western arm of Barnton junction is promoted over the original 2022 design that allowed cycles to cross in the centre of the junction.

The two options provide a similar level of provision for pedestrians and cycles but the new design maintains higher vehicle throughput and minimises delays. This is critical on the A90 which is an important public transport corridor.

Local Development Plan Action Programme Lot 1

HSG 19 Maybury / Barnton & HSG 20 Cammo - Whitehouse Road, Barnton and Cammo Gardens Technical Note

Rev 1

21/04/2022

City of Edinburgh Council

Local Development Plan Action Programme Lot 1

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Contents

1. Introduction

This technical note details the further development undertaken at Cammo Gardens, Barnton Junction and Whitehouse Road, presenting the findings in order to allow City of Edinburgh Council (CEC) to decide upon a preferred concept for implementing an active travel link from HSG 20 Cammo Development through to National Cycle Network Route 1 (NCN1).

The note is split into three sections, listed below, and is followed by a conclusion drawing these together to identify a recommendation for CEC to consider.

- Whitehouse Road spatial review;
- Cycle journey times through Barnton Junction; and,
- Modelling of a junction at Cammo Gardens.

2. Whitehouse Road Spatial Review

2.1 Introduction

To establish the optimal active travel solution for Whitehouse Road, connecting Barnton Junction to NCN1, a spatial review was undertaken. Five locations, identified as either pinch points or key interaction points between cycles, pedestrians and public transport, were reviewed. Both uni-directional and bi-directional cycle track solutions were considered within the context of the existing road corridor cross-section.

By completing this exercise, it was possible to determine which solutions could be accommodated in the existing cross-section or whether additional land may be required, and if any potential relaxations in traffic lane, cycle track or footway widths below desirable may be necessary.

2.2 Spatial Review

For the spatial review, five locations were selected along Whitehouse Road, named Cross-section A to E, based on them being particularly constrained or their potential for high numbers of conflicts between users.

- Cross-section A – Approximately 20m north of Barnton Junction through the existing utility mast and cabinets located in the western verge.
- Cross-section B – Through the southbound bus stop and shelter, and footway outside the shopping area (Scotmid Co-op, Post Office, etc.) on the eastern side of Whitehouse Road.
- Cross-section C – Through the northbound bus stop and shelter on the western side and parking bays on the eastern side of Whitehouse Road.
- Cross-section D – Through the southbound bus stop and shelter opposite Breahead Grove.
- Cross-section E – Through the horizontal curve in Whitehouse Road approximately 150m south of NCN1.

At each of the locations, the cross-section for the existing road corridor was produced using information taken from the topographical surveys providing an understanding of the current allocation of space. Subsequently, proposed cross-sections were drafted implementing uni-directional and bi-directional cycle tracks alongside footways, traffic lanes and bus stops with widths based on the guidance from the Edinburgh Street Design Guide (ESDG). Desirable widths were used where possible; however, due to some pinch points it was necessary to relax these back to absolute minimum widths. Table 1.1 below outlines cycle track widths from the ESDG C4.

Table 1.1 – Minimum Cycle Track Widths

Width	Uni-directional	Bi-directional
Absolute minimum	1.5m	2.0m
Desirable	1.75m	2.5m
High Flows	2.0m+	3.0m+

Discussed below are the key findings from each location for the various cross-sectional layouts considered. A plan showing the cross-section locations, and the cross-sections themselves are contained within Appendix A.

Cross-section A

The costs associated with re-locating a utility mast and associated apparatus are anticipated to be very high, potentially making it unfeasible for the project to finance. While this cannot be accurately confirmed until later stages in the project, the mast creates a pinch point and it is necessary to understand during concept design how a potential cycle track solution could be accommodated if it is to be retained.

Three sub-options have been developed in addition to an existing cross-section:

- A.1 – Existing cross-section through phone mast;
- A.2 – Through phone mast with uni-directional cycle track;
- A.3 – Through phone mast with bi-directional cycle track on eastern side; and,
- A.4 – Through phone mast with bi-directional cycle track on western side.

Assuming the western kerb line remains in the current location to retain an offset from the mast of 0.9m, and that traffic lanes and footways are reduced it was found that:

- For absolute minimum uni-directional cycle tracks with 0.25m minimum buffer an additional 1.76m land beyond the current boundary walls is required; and
- For absolute minimum bi-directional cycle lane (either on the northbound or southbound side) with a 0.25m minimum buffer an additional 0.51m land beyond the boundary wall is required.

With an aim of removing the need for buying additional land, three possibilities to win more space have been identified and based in the order of preference.

Firstly, to potentially reduce the offset from kerb to mast to 0.45m, similar to other street furniture such as signal poles or sign posts, by moving the kerb line, creating an additional 0.45m space; however, this is subject to agreement with the Statutory Undertaker.

Secondly, the traffic lanes could be reduced slightly through further discussions and agreement with CEC. The concern is that the route is used for buses which require greater lane widths, typically 3.25m to pass one another.

Thirdly, it would be possible to narrow the eastern footway slightly to provide the required additional space; however, this would take it below the absolute minimum of 2m over a short length and should be a last resort.

Through a combination of the first and second option, it should be possible to fit a bi-directional cycle track of 2.0m with a 0.25m buffer in existing road corridor, either northbound or southbound, without moving the mast or purchasing additional land. However, it is unlikely that uni-directional cycle tracks could be accommodated without moving the mast due to the extent of additional space required. At a best estimate, it may be possible to gain 0.95m through reduction of the mast offset and reducing on traffic lanes to 3m, but this still leaves a further 0.81m and would need to be taken from the footway, significantly reducing it to approximately 1.2m wide.

Cross-section B

The area around Cross-section B is likely to experience high interactions for pedestrians commuting northbound – southbound, accessing the local amenities (shops or golf club) or public transport. Therefore, it is necessary to understand how a potential cycle track solution would interact with these movements and effect the available space allocated to each of the modes.

Three cross-sections have been developed in addition to an existing cross-section:

- B.1 – Existing cross-section through southbound bus shelter outside shopping area;
- B.2 – Through southbound bus shelter outside shopping area with uni-directional cycle track;
- B.3 – Through southbound bus shelter outside shopping area with bi-directional cycle track on the eastern side; and,
- B.4 – Through southbound bus shelter outside shopping area with bi-directional cycle track on the western side.

Due to the overall width of the road corridor and the existing allocation of space to carriageway, both uni-directional or bi-directional cycle track on the eastern side can be positioned at desirable widths while accommodating footways greater than desirable, a 2m island in front of the bus shelter and two 3.5m traffic lanes. In both instances a potential conflict is introduced through the pedestrian crossing of the cycle track to reach the bus stop.

It has also been assumed that the bus will now stop in-lane likely resulting in vehicles backing up behind. In the existing layout, the southbound lane is wider with further space provided by the hatching, allowing the majority of vehicles to comfortably pass a bus which is stopped.

It should be noted that if a bi-directional cycle track is positioned on the western side, then there is essentially no change to the existing carriageway or layout on the eastern side.

The notable differences between the options are:

- Due to it not being possible to accommodate a uni-directional cycle tracks at Cross-section A and it likely being a bi-directional cycle track taken forward, should a uni-directional cycle track be taken forward for Cross-section B, it would be necessary to incorporate a suitable controlled crossing facility over Whitehouse Road to allow tie in between the two links. It may also be necessary to include a controlled crossing if a bi-directional cycle track is taken forward on the western side to allow cyclists to reach the shops and bus stop.
- The uni-directional or a bi-directional cycle track on the western side will require the felling of the existing mature tree and may also result in the loss of the existing parking bays.
- A bi-directional cycle track on the eastern side does result in a reduction of the available footway space adjacent to the shops from an existing 4.4m to 3.65m; however, this is still much greater than desirable widths.
- A bi-directional cycle track on the western side does not introduce a new conflict for pedestrians looking to access the bus stop.

Cross-section C

Again, this is a key interaction area for pedestrians commuting northbound – southbound and accessing public transport on the western side of Whitehouse Road, while existing parking bays and informal loading for the various shops is located on the opposite side. Therefore, it is necessary to understand how a potential cycle track solution would interact with these movements and whether parking and loading could be accommodated.

Three cross-sections have been developed in addition to an existing cross-section:

- C.1 – Existing cross-section through northbound bus shelter and southbound parking bays outside shopping area;
- C.2 – Through northbound bus shelter and southbound parking bays outside shopping area with uni-directional cycle track;

- C.3 – Through northbound bus shelter and southbound parking bays outside shopping area with bi-directional cycle track on the eastern side; and,

- C.4 – Through northbound bus shelter and southbound parking bays outside shopping area with bi-directional cycle track on the western side.

Similar to Cross-Section B, the overall width allows of the road corridor and existing space allocated to both lanes and existing perpendicular parking bays give significant opportunity to implement either uni-directional cycle tracks or a bi-directional cycle track at desirable widths. For both uni-directional or bi-directional on the eastern side it will be necessary to remove the perpendicular parking bays and consider parallel parking/loading bays. As a result, there is an improvement to the eastern footway where there is an anticipated increase in width of about 1.2m for uni-directional cycle tracks and bi-directional cycle track on the eastern side.

For the bi-directional on the western side, much of the eastern side can be retained as is, including the perpendicular bays, with only the traffic lanes being reduced. However, it does require the western kerb line to be relocated approximately 1.8m east which may have impacts on the carriageway and kerb lines up and down stream of this location as there is already an existing taper in the carriageway alignment.

The notable differences between the options are:

- To accommodate a uni-directional cycle track or bi-directional cycle track on the western side, its necessary to reduce the existing footway from 3.2m to 2.0m. Furthermore, a potential conflict is introduced through the pedestrian crossing of the cycle track to reach the bus stop.

- A bi-directional cycle track on the eastern side does not impact the existing western kerb line, while a bi-directional cycle track on the western side does not impact the existing eastern kerb line.

- For both a uni-directional or bi-directional on the eastern side, the buffer/landing area between the proposed parallel parking bays and the cycle track is around 1m which may be on the narrow side. If there was interest to increase the buffer, then it is anticipated that this may be easier for the bi-directional cycle track due to its lateral position in Cross-Section B, approx. 3.65m from the building line where it would remain straight, rather than tapering west as is currently assumed in Cross-Section C. While the uni-directional cycle track is located approx. 4.40m from the building line in Cross-Section B, similar to Cross-Section C which assumes it runs straight, thus the cycle track would need to taper east between cross-sections and reduce the available footway.

Cross-section D

The width of the road corridor at Cross-section D is somewhat narrow and is further constrained by the existing bus shelter and stop, creating a pinch point which could have high pedestrian interactions. Therefore, it is necessary to understand during concept design how a potential cycle track solution could be accommodated in at this constrained point while managing pedestrian interactions.

Three cross-sections have been developed in addition to an existing cross-section:

- D.1 – Existing cross-section through southbound bus shelter;

- D.2 – Through southbound bus shelter with uni-directional cycle track/bus boarder;

- D.3 – Through southbound bus shelter with uni-directional cycle track and 'island' style footway; and,

- D.4 - Through southbound bus shelter with bi-directional cycle track and 'island' style footway.

Despite the existing western footway being just below minimum width, approximately 1.95m, it has been assumed that this kerbline will be retained in its current location due to the narrow road corridor and to keep costs down. For all options, the cycle tracks and buffers have been reduced to absolute minimum while traffic lanes have been reduced to 3.25m, minimum for a bus route.

From the review, uni-directional cycle tracks will only fit in the existing road corridor if a bus boarder is adopted. This will be approximately 3.4m in width; however, it is understood from previous discussions with CEC that this type of facility is undesirable and generally not acceptable.

Using an 'island' style footway, located between the carriageway and cycle track, requires an additional 1m beyond the existing boundary wall. Achieving the additional space without purchasing land is challenging, and would likely require compromising the proposed footway adjacent to the bus stop, offsets to the wall and possibly narrowing the traffic lanes.

Furthermore, while no cross-section has been produced, it is likely that a bus boarder would also need to be adopted for the bus stop on opposite side of the carriageway 10m north should uni-directional cycle tracks be taken forward due to the constrained space.

Using a bi-directional cycle track on the eastern side with an 'island' style footway fits within the existing road corridor with approximate 0.25m spare. This has been assigned to the footway in the cross-section, but could easily be shared with the cycle track to provide greater than absolute minimum widths. While it can be accommodated, it will be necessary to taper the bi-directional cycle track across the footway in order to transition to the outside of the corridor, and vice versa to move back out to the carriageway edge. As a result, this will introduce two potential conflict points between pedestrians and cyclists which will need to be managed.

No cross-section has been drafted for a bi-directional cycle track on the western side as it there would be no change to either kerb line. As a result of its introduction, the traffic lanes would reduce to approximately 3.76m assuming a 2m wide cycle track and 0.5m buffer. However, on the western side there will be an interaction with the northbound bus stop. Given spatial constraints, the Breahead Grove Junction and driveways, it is unlikely that transitioning to the back of the footway would be as straightforward as the eastern side, therefore a bus boarder may need to be considered instead.

Cross-section E

The geometric alignment at Cross-section E is on both a horizontal and vertical curve where the carriageway transitions from standard two lane with centre line to a wider two lane separated by central hatching. Therefore, it is necessary to understand how a potential cycle track solution could be accommodated while ensuring that suitable space is afforded to all modes of transport to navigate the alignment.

Three cross-sections have been developed in addition to an existing cross-section:

- E.1 – Existing cross-section through curve in alignment 150m south of NCN1;
- E.2 – Existing cross-section through curve in alignment 150m south of NCN1 with uni-directional cycle tracks and balanced footways;
- E.3 – Existing cross-section through curve in alignment 150m south of NCN1 with bi-directional cycle track on eastern side and reducing southbound footway; and,
- E.4 - Existing cross-section through curve in alignment 150m south of NCN1 with bi-directional cycle track on western side and reducing northbound footway.

All three options can be accommodated within the overall width of the road corridor; however, the level of service provided varies between the uni-directional and bi-directional solutions.

For all options, 3.25m traffic lanes have been assumed, the minimum for a bus route. Early swept path analysis indicates that this should be suitable for this horizontal curve; however, this will need to be checked as the scheme moves forward to establish whether wider lanes, perhaps 3.5m, may be required.

In the cross-section developed for uni-directional layout, desirable cycle track and minimum buffer widths were adopted. To avoid a footway below 2m on either side of the carriageway, both existing kerb lines would need to be re-located further back, resulting in a reduction of the existing footways to approximately 2.2m northbound and 2.27m southbound when a balanced approach is taken.

If widening of the traffic lanes required to accommodate vehicle movements, some width may need to be taken from the cycle tracks.

For the bi-directional cycle track options, one of the existing kerb lines can be retained. Using the 3.25m traffic lanes, it is possible to accommodate a cycle track to desirable widths with a 0.5m buffer while only reducing the northbound or southbound footways by approximately 0.52m to 2.55m and 2.4m, respectively.

Should it be necessary to increase the traffic lanes to accommodate vehicle movements, this additional space could be taken from a combination of the buffer, cycle track and footway without compromising the level of service significantly.

2.3 Conclusion

Summarised below are the conclusions drawn at each of the cross-sections.

Cross-section A

At the southern end of Whitehouse Road, it will be necessary to take a bi-directional solution forward between Barnton Junction and the shopping area, unless it is feasible to re-locate the existing utility mast, as uni-directional cycle tracks cannot be accommodated without the purchase of land as per Cross-Section A. Whether this is located on the eastern or western side will be dictated by the findings from the Barnton Junction modelling.

Cross-section B and C

Through the shopping area it would be possible to implement uni-directional following a bi-directional further south. While this does have the benefit of creating more civic space as a result of the works on the eastern side, it would require a controlled crossing to be constructed, increasing costs and causing greater disruption to cycle movements. Furthermore, it would require work to both sides of the carriageway, again increasing cost, and requires two island style bus stops which will introduce additional conflict points for pedestrians.

A bi-directional cycle track through the shopping area can be a continuation of the link further south. While a cycle track on the western side will result in less change to the existing layout, the indirect benefit of improved civic space on the eastern side is lost unless further works to improve the footway/area outside the shops is taken forward. Furthermore, a controlled crossing will likely be required to ensure safe passage of cyclists over Whitehouse Road to access the shops.

If located on the east, works are limited to one side and there is no obvious need for a controlled crossing due to the existing ones just north and south at Barnton Junction and Braehead Grove. Due to the proposed layout, there is an increase in the available space afforded to pedestrians outside the shopping area. This is at the loss of parking bays, although two disabled bays would still be provided.

For either an east or west bi-directional cycle track, an additional conflict would be introduced for pedestrians as a result of the island style bus stops.

Cross-section D

As shown in the cross-sections, if uni-directional cycle tracks were to be taken forward, it would need to be with a bus boarder at the bus stop as the island style cannot be accommodated without purchasing additional land. This introduces a significant conflict for pedestrians and cyclists which CEC have indicated in the past they are not in favour of. Furthermore, this would need to be replicated for the northbound bus stop on the opposite side of the road, introducing further conflicts.

A bi-directional cycle track on the western side, will not impact the existing bus stop opposite Braehead Grove; however, for the northbound bus stop, it is likely that a bus boarder will need to be considered to allow continuation of the track due to the constraints limiting the opportunity to transition it to the rear of the footway. Similar to above, this is an undesirable solution.

A bi-directional cycle track on the eastern side can be accommodated at the rear of the footway with space to spare. While this does introduce two new conflict points where pedestrians need to cross the cycle track, this is more preferable to bus boarders which would be required for the other two options.

Cross-section E

Uni-directional or Bi-directional cycle tracks can be accommodated towards NCN1 and the preference will likely be dictated by the findings from the cross-sections further south. While the options provide suitable desirable cycle track widths, a point to consider is that minimum width buffers will likely be required for uni-directional, offering less comfort to cyclists. Furthermore, should traffic lane widths need to be increased for swept paths, more flexibility for re-allocating space is offered by the bi-directional options.

Overall

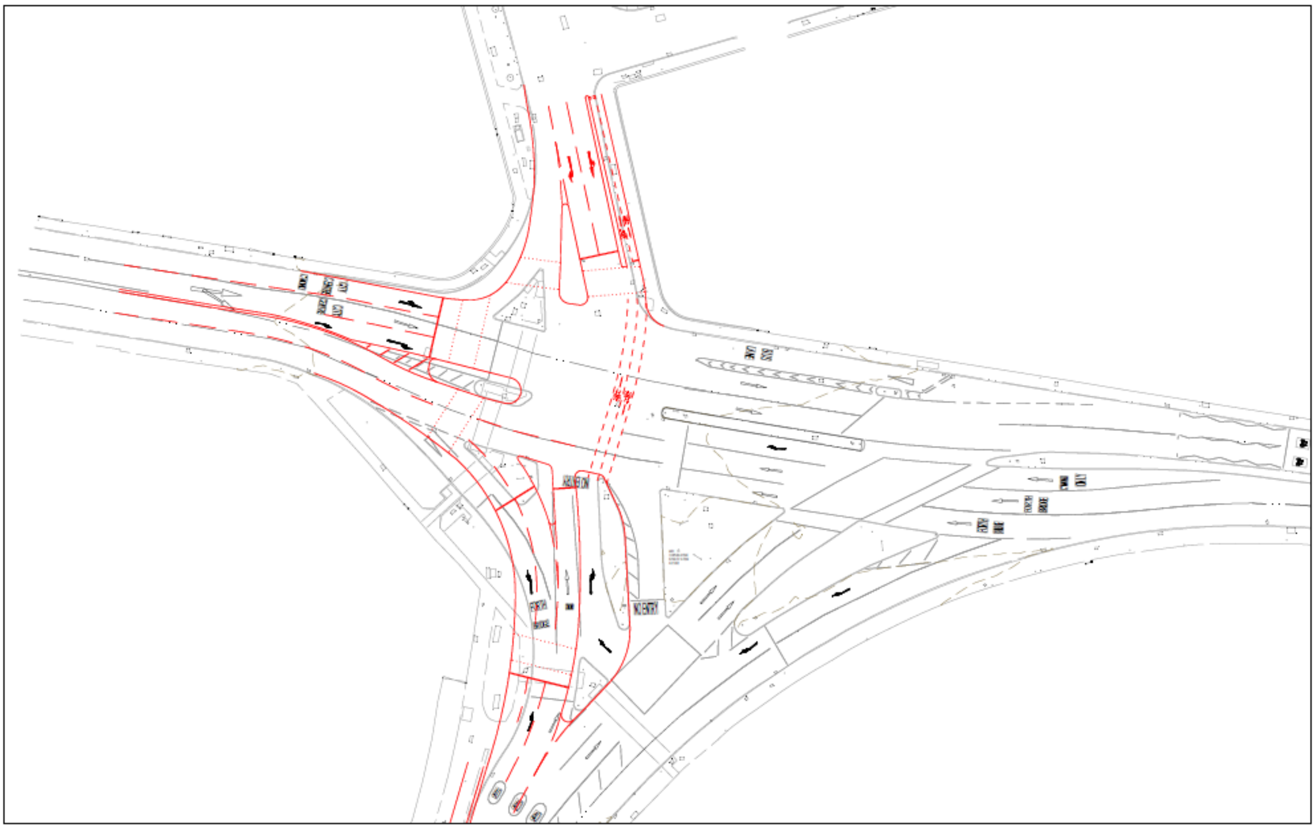
Based on the above, a bi-directional cycle track on the eastern side of Whitehouse Road is the emerging preferred option.

3. Barnton Junction Journey Times

3.1 Background

A review of potential layout options to improve pedestrian and cyclist facilities at the Barnton junction is covered under Jacobs' technical note B2420300-TN-LS-0003 "Barnton Junction Linsig Modelling". This note considered the practical application of Toucan crossings and dedicated cycle signalling to link a proposed cycle route between the HSG 20 Cammo Development to the southwest of the junction on Maybury Road with national cycle network NCN1 to the north along Whitehouse Road. The note put forward three viable layout options that could potentially be implemented with Linsig analysis suggesting similar operation could be achieved as per the current on-street operation. It should be noted that no layout options were found to improve the overall operation of the Barnton junction, particularly considering the additional committed development traffic the junction will need to accommodate.

Following discussions with CEC's active travel team it was considered that option 7.1.d provided the best connectivity for cyclists as it provided a relatively direct route between the south and north of the Barnton junction with options to connect to both western and eastern side of Whitehouse Road. The link to the northwest would be made via two controlled crossings whilst to the northeast it would require four controlled crossings. Navigation of the four controlled crossings would likely increase cyclist journey time and associated delay so consideration in the technical note was given to providing a dedicated cycle facility on the eastern side of Whitehouse Road that would provide a more direct link between the southwest and northeast side of the junction. The proposed alterations to the Barnton junction to accommodate these facilities is detailed in the figure below.



This proposed layout, combined with the addition of a midblock crossing facility immediately north of Barnton Grove, would allow cycle facilities to connect with either the east or west side of Whitehouse Road either via shared space footways, uni-directional cycle lanes or bi-directional cycle tracks.

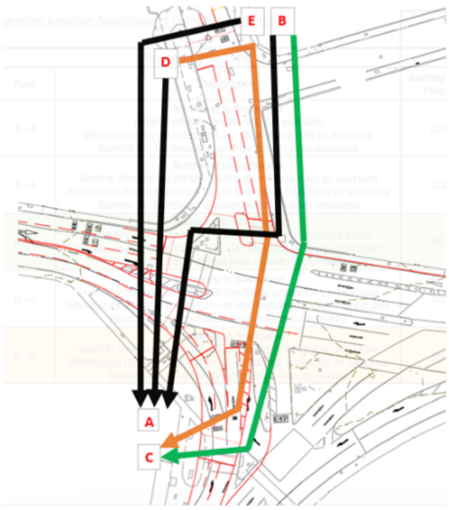
3.1.1 Cycle Journey Times

In addition to the cross-section review of Whitehouse Road covered in section 2, to determine the preferred solution for cycle provision, an analysis of cycle journey times has been undertaken to understand how much typical delay would be expected for cyclists navigating through the Barnton junction. The extents of this review consider the start and end points to be the southwest of the Barnton junction in the vicinity of the southernmost crossing point and either the west or east side of the midblock crossing north of Barnton Grove. A common travel time for cyclists of 3m/s has been used to account for the stop/start nature of the various controlled crossings. The results for average journey times and associated delay to cyclists are contained in the tables below together with a journey key to detail the possible routes for cyclists. The lowest journey time and associated delay has been identified in green with the second lowest in orange.

Barnton Junction Southbound Cycle Movements

Route / Signal Cycle Time		Option 7.1.D AM 104 secs		Option 7.1.D PM 104 secs	
Zone	Description	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)
B - A	**Northeast to Southwest** North to Whitehouse Rd MB - On east side Whitehouse Rd MB to Barnton Jn - Shared use path on east side Barnton Jn - Northeast to Southwest via Toucan crossings	227	168	127	68
E - A	**Northeast to Southwest** North to Whitehouse Rd MB - Bi-directional cycle track on east side Whitehouse Rd MB to Barnton Jn - Bi-directional cycle track on west side Barnton Jn - Northwest to Southwest via Toucan crossings	122	74	141	93
B - C	**Northeast to Southwest** North to Whitehouse Rd MB - On east side (bi or uni cycle track) Whitehouse Rd MB to Barnton Jn - On east side (bi or uni cycle track) Barnton Jn - Via dedicated cycle route through middle	90	47	89	46
D - A	**Northwest to Southwest** North to Whitehouse Rd MB - Bi-directional cycle track on west side Whitehouse Rd MB to Barnton Jn - Bi-directional cycle track on west side Barnton Jn - Via dedicated cycle route through middle	102	59	103	60
D - C	**Northwest to Southwest** North to Whitehouse Rd MB - Bi-directional cycle track on west side Whitehouse Rd MB to Barnton Jn - Bi-directional cycle track on east side Barnton Jn - Via dedicated cycle route through middle	96	49	103	56

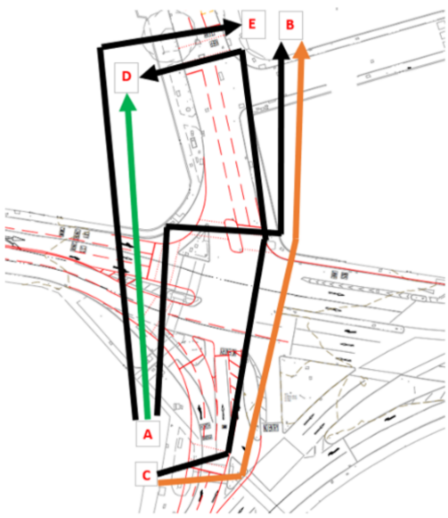
Option 7.1.D



Barnton Junction Northbound Cycle Movements

Route / Signal Cycle Time		Option 7.1.D AM 104 secs		Option 7.1.D PM 104 secs	
Zone	Description	Journey Time (Secs)	Pedestrian Delay (Secs)	Journey Time (Secs)	Pedestrian Delay (Secs)
A - B	**Southwest to Northeast** Barnton Jn - Southwest to Northeast via Toucan crossings Barnton Jn to Whitehouse Rd MB - Shared use path on east side Whitehouse Rd MB to North - On east side	167	108	181	122
A - E	**Southwest to Northeast** Barnton Jn - Southwest to Northwest via Toucan crossings Barnton Jn to Whitehouse Rd MB - Bi-directional cycle track on west side Whitehouse Rd MB to North - Bi-directional cycle track on east side	144	96	152	104
C - B	**Southwest to Northeast** Barnton Jn - Via dedicated cycle route through middle Barnton Jn to Whitehouse Rd MB - Bi-directional cycle track on east side Whitehouse Rd MB to North - Bi-directional cycle track on east side	128	85	134	91
A - D	**Southwest to Northwest** Barnton Jn - Via Toucan crossings on west side Barnton Jn to Whitehouse Rd MB - On west side (bi or uni cycle track) Whitehouse Rd MB to North - On west side (bi or uni cycle track)	116	73	126	83
C - D	**Southwest to Northwest** Barnton Jn - Via dedicated cycle route through middle Barnton Jn to Whitehouse Rd MB - Bi-directional cycle track on east side Whitehouse Rd MB to North - On west side (bi or uni cycle track)	137	90	141	94

Option 7.1.D



The analysis suggests that the typical quickest route and route that has the overall lowest delay would be between the southwest and northeast of the junction and utilising a dedicated bi-directional cycle-track on the east side of Whitehouse Road (route B-C and vice versa). The shortest route in terms of journey length would be for the cycle route to follow the western side through the junction and along Whitehouse Road (route A-D and vice versa), but this route is expected to slightly increase overall journey time and associated delay to cyclists.

If the southwest-northeast connectivity through the Barnton junction with a dedicated bi-directional cycle track on the east side of Whitehouse Road is to be taken forward as the preferred solution under junction layout option

7.1.d, then the crossings on the western side of the junction could be re-allocated as pedestrian only crossing points. This would reduce the amount of shared space through and around the junction, improving the provision for vulnerable users, and encourages cyclists to use the dedicated facilities provided.

4. Cammo Gardens Junction

4.1 Severance (Barrier to Travel)

4.1.1 Introduction

This section considers the severance (barrier to travel) effects that Cammo residents presently experience and what options there are to mitigate against these barriers within the context of the LDPAP lot 1 proposals.

4.1.2 Background

Cammo Walk has been identified as an active travel route under the Local Development Plan and the 2021 Local Development Plan Action Programme.

At the time of writing Cammo Walk is closed to traffic between the car park access to the Cammo estate and Craigs Road, except for cyclists and pedestrians. The closure was introduced as an emergency measure under a TTRO during the Covid 19 pandemic emergency and it is proposed that the closure will be made permanent under an ETRO.

Further, Cammo Walk has recently being the subject of Planning Permission in Principal (application Number 21/02306/PPP) to provide an' active travel route along Cammo Walk corridor'. The application proposes two options for Cammo Walk:

- Option 1 would widen the existing Cammo Walk alignment to 5m and be redetermined for non-vehicular users only. A new 5.5 metre-wide road section along the whole of Cammo Walk's western edge would be introduced to accommodate traffic movements, linking Cammo with Craigs Road.

- Option 2 would redetermine Cammo Walk for non-vehicular users only. Under this option Cammo Walk is retained along its existing alignment and widened to 5m.

The application received approval on 30th March 2022. The options put forward for Cammo Walk would need to be considered further as part of future planning applications.

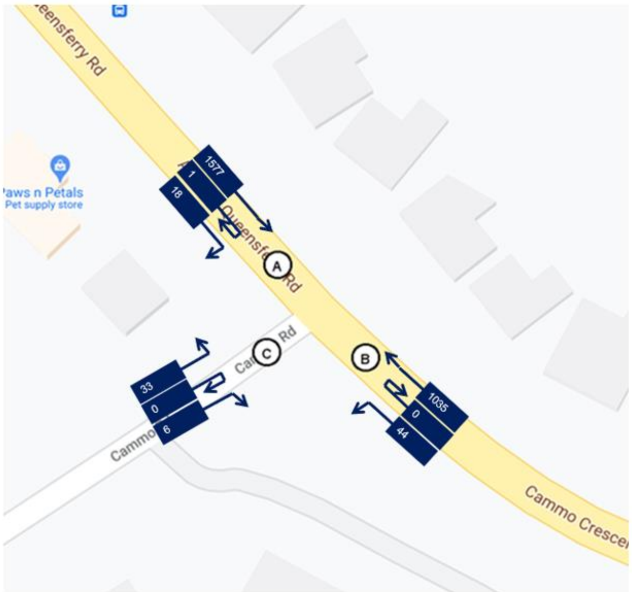
4.1.3 Traffic Movements

Before the current closure, Cammo residents would use Cammo Walk to exit the area going south, as an alternative to turning right from Cammo Gardens onto Maybury Road.

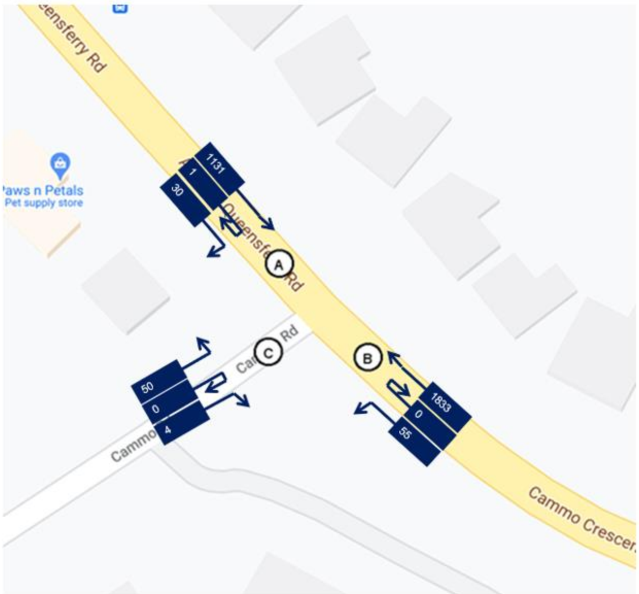
There is a longer route south that uses Cammo Road to access the Maybury Junction and Maybury Road using Turnhouse Road or Craigs Road, respectively. It is, however, uncertain how many residents use this route. Presently, there is a proposal by CEC to promote a ETRO to close Cammo Road before it's junction with Turnhouse Farm Road, which would remove this route option. There is also a proposal to promote a bus gate on Turnhouse Road on the approach to Maybury Junction, although the hours of operation are still uncertain. Should the bus gate proceed without the closure of Cammo Road, Cammo residents using Cammo road to travel south would be required to use Craigs Road to access Maybury Road. Notwithstanding these potential restrictions, a route south using Cammo Road is convoluted and very narrow in places and does not provide an attractive route to the south from Cammo.

A further option for residents to exit Cammo is by turning right out of Cammo Road at Queensferry Road. Queensferry Road is a busy four lane road with a 40 mph speed limit. The traffic survey results from 14/12/21 are shown below and the low numbers turning right would indicate that the right turn from Cammo Road is unattractive. This would be influenced by the heavy volume of traffic on Queensferry Road.

AM Peak

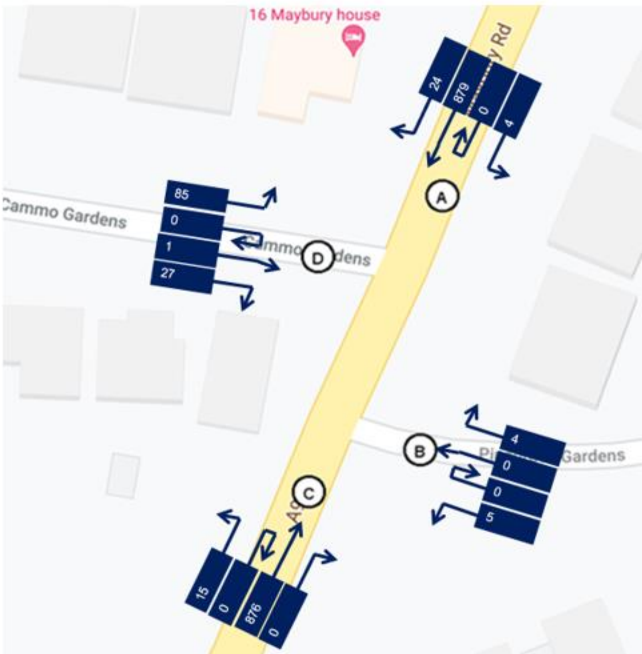


PM Peak

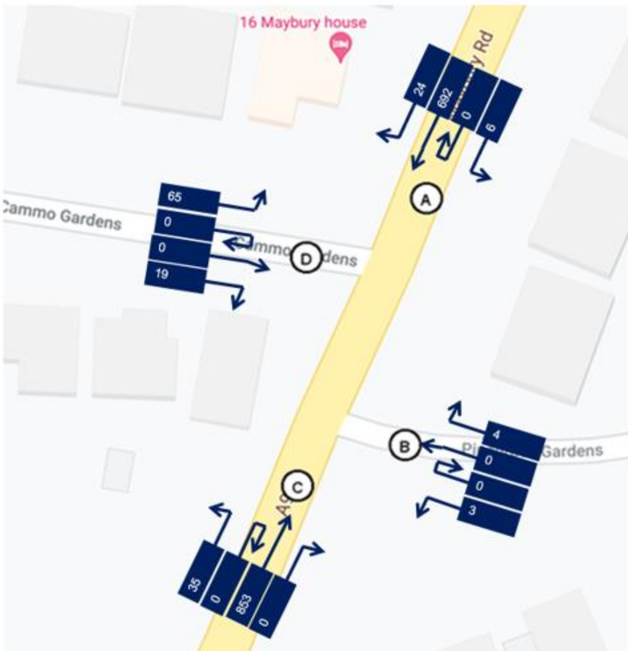


The closure of Cammo Walk (and Cammo Road at Turnhouse Farm Road) would require traffic exiting Cammo to turn right at Cammo Gardens to travel south (assuming very little traffic continues to exit at Cammo Road). This right turn manoeuvre is perceived as being dangerous by residents and, as such, constitutes a barrier to travel. Survey results from 14/12/21 are shown below. This shows that the number of vehicles turning right are small.

AM Peak



PM Peak



Cammo residents have also expressed concerns that the right turn into Cammo Gardens from Maybury Road is unsafe due to the speed of traffic on the inside northbound lane, which is obscured to right turning traffic into Cammo Gardens by queueing northbound traffic in the outside lane. Similarly, northbound queuing traffic on Maybury Road creates poor visibility to southbound traffic on Maybury Road for right turning traffic from Cammo Gardens. Again, the survey results indicate that small volumes of vehicles undertake this turn.

A further concern from residents is that traffic queuing on the approach to Barnton can sit on the yellow box junction, preventing egress from Cammo Gardens.

Concern has also been expressed about the safety of right turning traffic from Pinegrove Gardens due to the speed of traffic on Maybury Road.

To mitigate against the perceived barrier to travel created, primarily, by the closure of Cammo Walk and, potentially, by the closure of Cammo Road, Cammo residents have expressed a wish for the signalisation of Cammo Gardens (and Pinegrove Gardens) at Maybury Road. Although traffic volumes are small, as detailed above, traffic signals are considered to provide a junction that is safer than existing.

The sections below consider the options for the Cammo Gardens and Pinegrove Gardens junctions with Maybury Road, in the context of the closure of Cammo Walk to general traffic at Craigs Road and the LDPAP lot 1 proposal detailed in this report.

4.1.4 Options

Three options have been considered when incorporating Cammo Gardens (and Pinegrove Gardens) into the LDPAP design:

1. Do minimum;
2. Closure of Cammo Gardens; and
3. Introduce traffic signals at Cammo Gardens.

Do Minimum

This option retains the existing Give Way layout. If there is a bi-directional cycle lane on the west side of Maybury Road, the right turn lane into Cammo Gardens would have to be banned to remove any potential hazards associated with the removal of the right run lane in to Cammo Gardens. Any traffic wishing to turn right into Cammo Gardens could turn left at Cammo Road. As shown above, this right turn movement is very low. Cammo residents have expressed concerns that the right turn into Cammo Gardens from Maybury Road is unsafe.

This option does not offer any improvements to the existing situation for traffic entering or leaving the Cammo area from Maybury Road. It also offers no segregation for cyclists using the bi-directional lane proposed under LDPAP.

Closure of Cammo Gardens

The closure of Cammo Gardens would remove all traffic conflicts at the junction. An alternative access junction would be Cammo Road at Queensferry Road. As stated below in section 4.2.2, it is not recommended that this option is taken forward and is not considered further.

Another option would be the use of Cammo Road southbound towards Turnhouse Road. As stated above, there are proposals to close Cammo Road before Turnhouse Farm Road and introduce a bus gate on Turnhouse Road on the approach to Maybury Junction. Notwithstanding, these potential restrictions, this route is convoluted and very narrow in places and cannot be considered as a viable option to mitigate against the closure of Cammo Gardens at Maybury Road.

Signalisation of Cammo Gardens

Section 4.2.1 demonstrates that the Cammo Gardens junction at Maybury Road can be signalised. To accommodate the signals and a bi-directional cycle lane under LDPAP, the right turn into Cammo Gardens requires to be banned with existing right turning traffic having to use the Cammo Road junction with the A90. Whilst this may add more inconvenient to some residents, the signalling of Cammo Gardens would assist with the perceived severance issues. It would facilitate safe exit from the area for traffic and also provide added value for pedestrians with the addition of pedestrian stages at the junction. Further, this right turn has been identified as being potentially dangerous by residents.

As stated in section 4.2.1, that effective signalisation of both Cammo Gardens and Pinegrove Gardens cannot be provided (noting that the traffic movements into and out of Pinegrove Gardens are very small as shown in section 4.1.3). However, the stopping of southbound traffic at the new signalised Cammo Gardens junction could provide additional gaps for right turning traffic from Pinegrove Gardens.

The signalisation of Cammo Gardens is likely to reduce the occurrence of northbound traffic on Maybury Road heading west on the A90 cutting through the Cammo residential area instead of staying on Maybury Road and turning left at Barnton Junction. When the northbound signal on Maybury Road at Cammo Gardens is on green it is anticipated that traffic would progress to the Barnton Junction, a short distance to the north. This is likely to remove any incentive to cut through the Cammo residential area. Outwith this period, northbound traffic will be held on red and will not be able to proceed.

A further benefit is that it provides the best solution for the cycle lanes at the junction with the cycle movements largely segregated from general traffic.

4.1.5 Summary of Options

The benefits and disbenefits of each option for Cammo Walk is presented below, in relation to the barrier to travel for Cammo residents and within the context of the LDPAP proposals.

Option	Proposal	Benefits	Disbenefits
Do minimum	Existing Give way control at Maybury Road Right turn into Cammo Gardens banned	Neutral with regard to existing situation Right turn into Cammo Gardens banned (safety)	Right turn into Cammo Gardens banned (inconvenience) No protection for cycle lane
Closure of Cammo Gardens	Traffic required to use Cammo Road to enter or access area	Removes conflict at Maybury Road Removes conflicts for cyclists using bi-directional cycle lane	Cammo Road at Queensferry Road not recommended as detailed in section 4.2.2 Alternative route using Cammo Road southwards has uncertain status going forward. Notwithstanding this uncertainty, it is not considered a viable alternative route to mitigate against the closure of Cammo Gardens at Maybury Road
Signalisation of Cammo Gardens	Right turn into Cammo Gardens banned. This traffic is required to use Cammo Road to enter area Effective signalisation of Pinegrove Gardens cannot be provided	Right turn into Cammo Gardens banned (safety) Effective linking with Barnton Junction required Right turn from Pinegrove Gardens not controlled	Provides safe exit from the area for traffic Provide additional pedestrian crossing points at Cammo Gardens Reduces likelihood of traffic 'rat-running' through the Cammo residential area

			Provides segregation of cycle movements from general traffic Right turn into Cammo Gardens banned (inconvenience) Provides gaps for right turning traffic from Pinegrove Gardens

4.1.1 Conclusions

Traffic Signals can be accommodated at the junction of Cammo Gardens with Maybury Road. This would provide the best solution in terms of removing any barrier to travel for Cammo residents and incorporating any mitigations into the LDPAP design proposals. It also provides the best solution for the cycle lanes at the junction with the cycle movement largely segregated from general traffic. This proposal requires a right turn ban into Cammo Gardens. This could be perceived as an inconvenience but there is a viable alternative access at Cammo Road. However, the right turn into Cammo Gardens has been identified as a hazardous manoeuvre by Cammo residents.

Retention of the existing layout give way layout also requires a right turn ban into Cammo Gardens. It retains the existing perceived hazardous right turn out of Cammo Gardens and is effectively neutral when considering barriers to travel for Cammo residents. It provides no segregation for cycle movements.

The closure of Cammo Gardens is not considered viable because of the lack of alternative roue options.

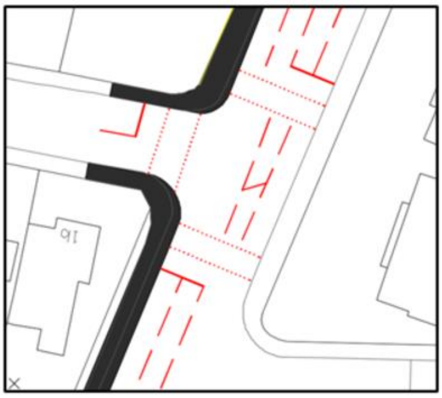
4.2 Modelling Outputs

A review of potential layout options to improve pedestrian and cyclist facilities at the Maybury Road/ Cammo Gardens junction is covered under Jacobs' technical note B2420300-TN-LS-0007 "Cammo Gardens Access Review". This note also covers the implications of closing Cammo Gardens and the re-routing of traffic via the Queensferry Road/ Cammo Road junction.

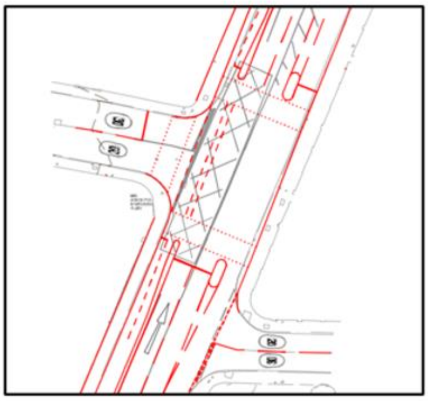
The analysis found that the Maybury Road/ Cammo Gardens junction could be signalised to aid pedestrian and cyclist movements through the junction without detrimentally impacting traffic throughput.

4.2.1 Signalisation of Cammo Gardens

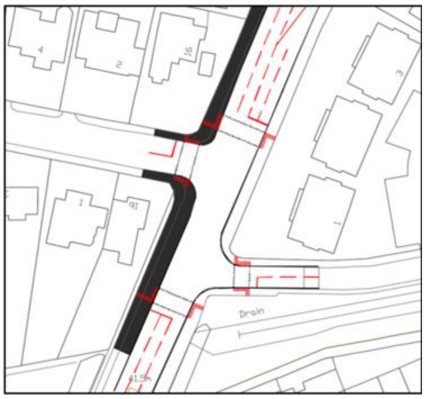
Three option tests were undertaken for the signalisation of the Maybury Road/ Cammo Gardens junction as detailed below



Option 1a



Option 1b



Option 2

Option 1b was found to offer the most significant benefits:

- It would provide separation between pedestrians and cyclists which is much more desirable for vulnerable users, particularly those with visual impairments.
- It would provide greater opportunities for cyclists to progress as there is more scope to allocate green time to the cycle movements within the staging arrangement in comparison to the Toucan crossing in option 1a.
- Banning of the Maybury Road southbound right turn could improve safety as discussed in section 4.1.1 (noting that a give way to opposing traffic situation would still be required under signal operation to maintain acceptable junction capacity).

Extending the footprint of the signalised junction to also include Pinegrove Gardens within the operation was found to have a significant impact on junction capacity. Southbound traffic on Maybury Road was severely affected which could impact the operation of the Barnton junction. It was, therefore, not recommended to take this option forward.

4.2.2 Closure of Cammo Gardens

Closing Cammo Gardens to traffic at the mouth to Maybury Road would yield significant improvements for pedestrians and cyclists, however, to accommodate this closure it is expected that the Queensferry Road/ Cammo Road junction would need to be signalised to aid right turn traffic movements and pedestrian movements. Three further options were considered for the signalisation of the Queensferry Road/ Cammo Road junction.

Option 3a

Option 3b

Option 3c

The analysis suggests this mitigation would generate additional problems for bus progression on Queensferry Road and traffic both on Queensferry Road and those wishing to access and egress the residential area. Therefore, it was not recommended to implement a closure to Cammo Gardens at Maybury Road.

5. Conclusion

From the three respective reviews, it is recommended that a bi-directional cycle track be taken forward to concept design.

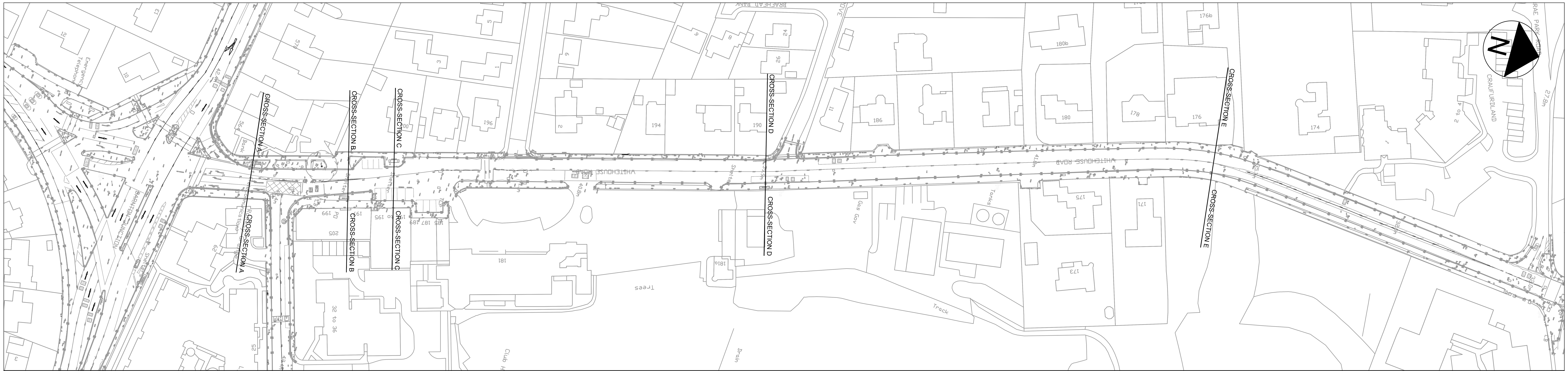
It is proposed that a bi-directional cycle track will connect into the HSG20 Cammo Development shared use active travel path and run north on the western side of Maybury Road. Cammo Walk /Maybury Road could be signalised, as per layout Option 1b in section 4.2.1, banning the right turn in for southbound traffic who will access the existing Cammo estate via Cammo Road, west of Barnton Junction. By doing this, pedestrians and cycles will be separated and afforded their own signal phase allowing them to safely traverse the junction.

North of Cammo Gardens the bi-directional cycle track would continue on the western side, merging into a shared use toucan crossing close to the existing police phone box. Cyclists would cross to the central island, and join a bi-directional cycle track running north-south. Again, this would have its own phase allowing cyclists a safe direct crossing, separate from pedestrians, over Barnton Junction from the central island to the north-eastern corner/southern end of Whitehouse Road. For pedestrians to reach Whitehouse Road, it is proposed to retain the crossing locations in a similar position to where they are currently on the western side of Barnton Junction; however, the islands will be increased in size and reduce the number of crossings to the western side of Whitehouse Road improving the experience.

On Whitehouse Road, the bi-directional cycle track will continue north on the eastern side to NCN1. This will allow for easier access to the shopping area for cyclists as well as allowing for a continuous route rather, than having to cross to the western side of Whitehouse Road.

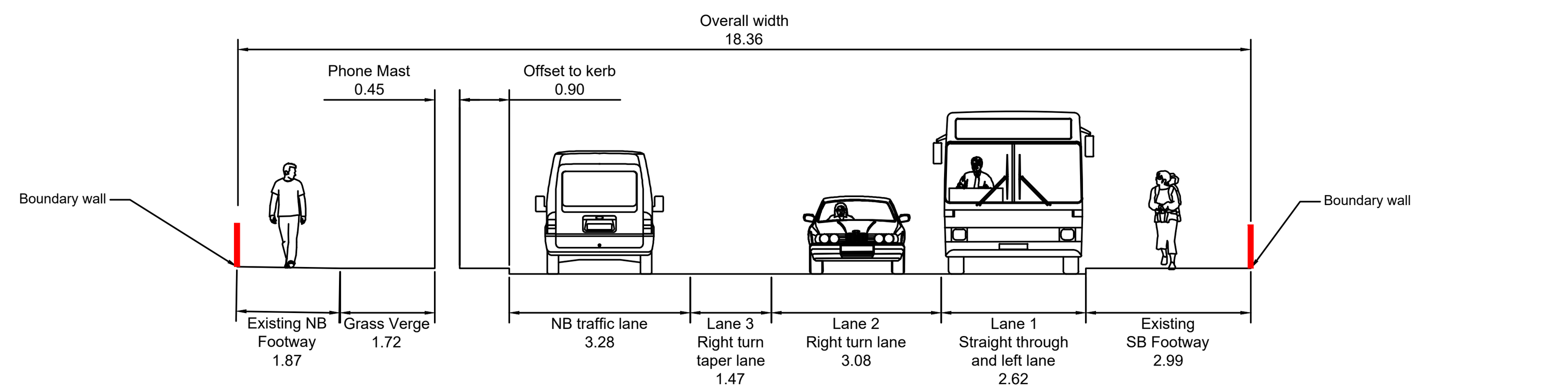
A sketch of the indicative layout of the recommended bi-directional cycle track and junction improvements is contained in Appendix B.

Appendix A. **Spatial Review Cross-Sections**

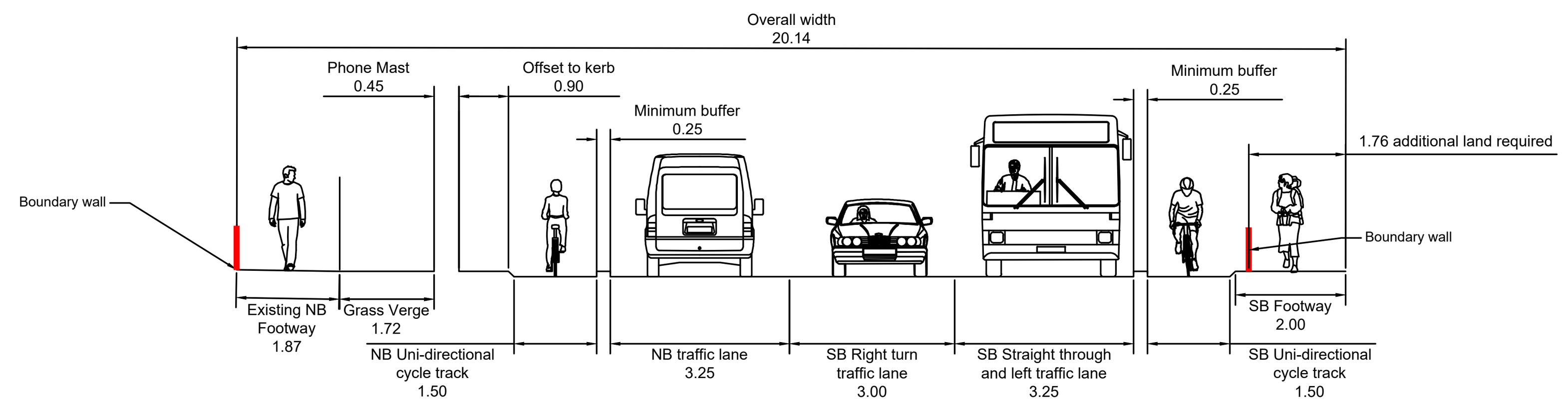


Cross-section A

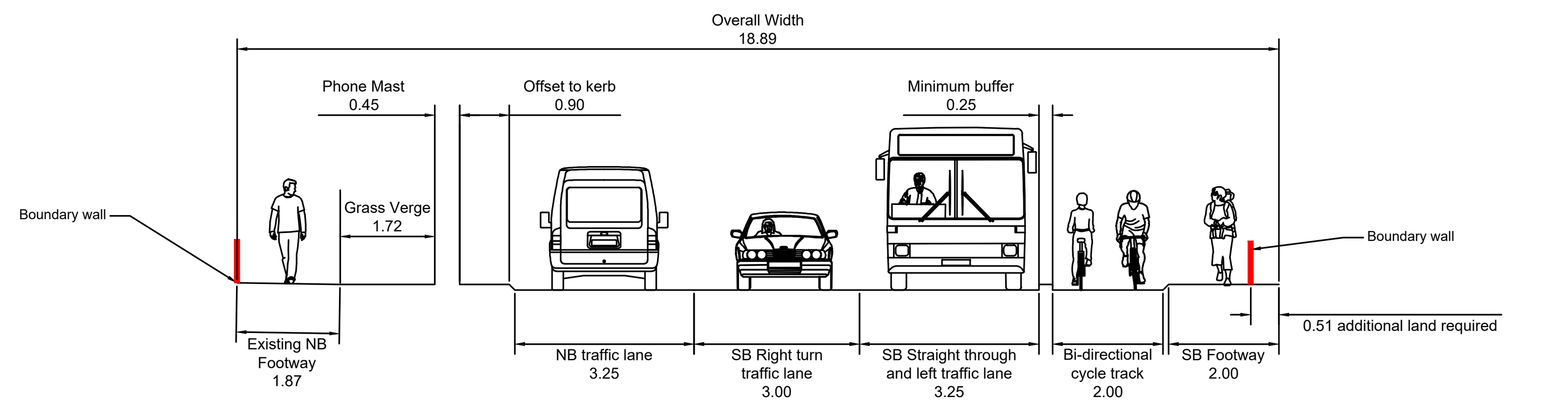
Through phone mast area just north of Barnton Junction



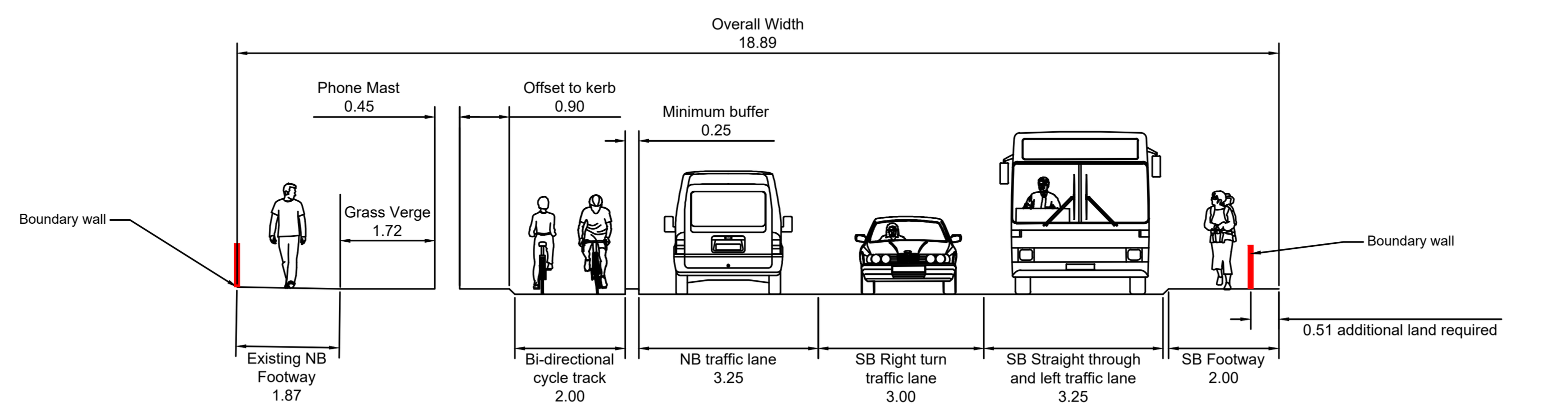
Section A.1 - Existing Cross-section through phone mast



Section A.2 - Through phone mast with uni-directional cycle track



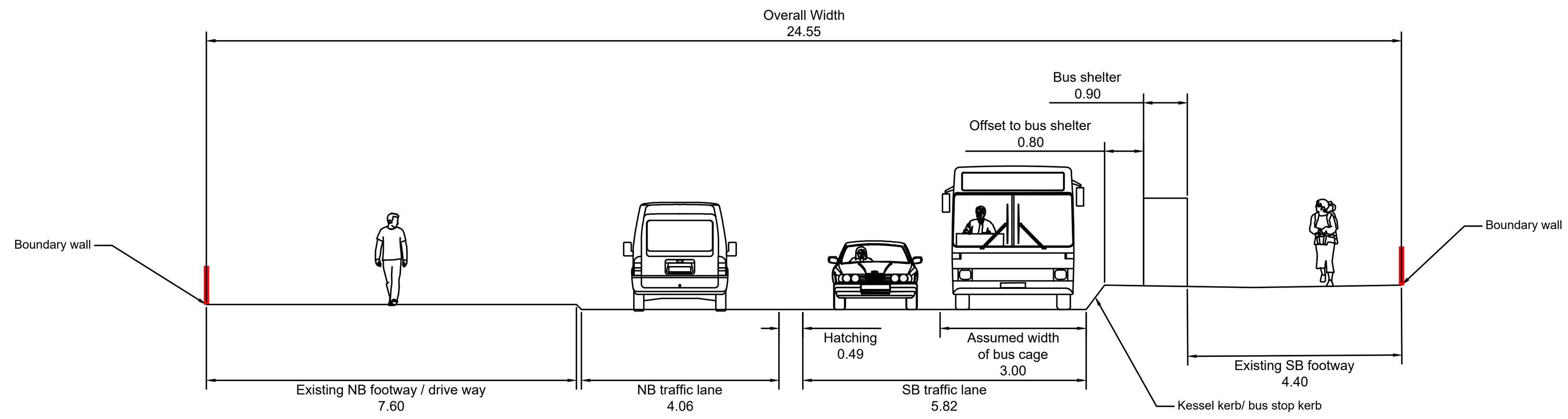
Section A.3 - Through phone mast with bi-directional cycle track on eastern side



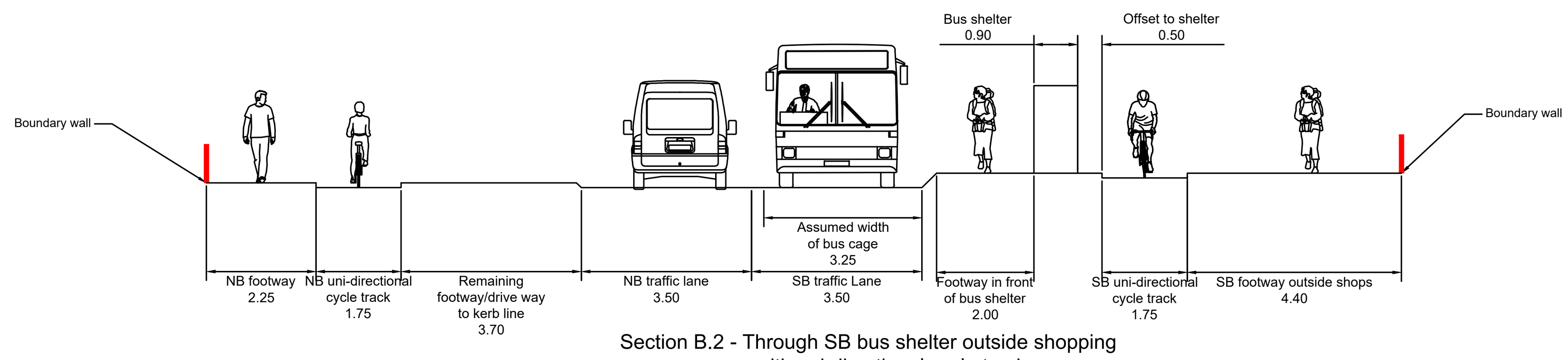
Section A.4 - Through phone mast with bi-directional cycle track on western side

Cross-section B

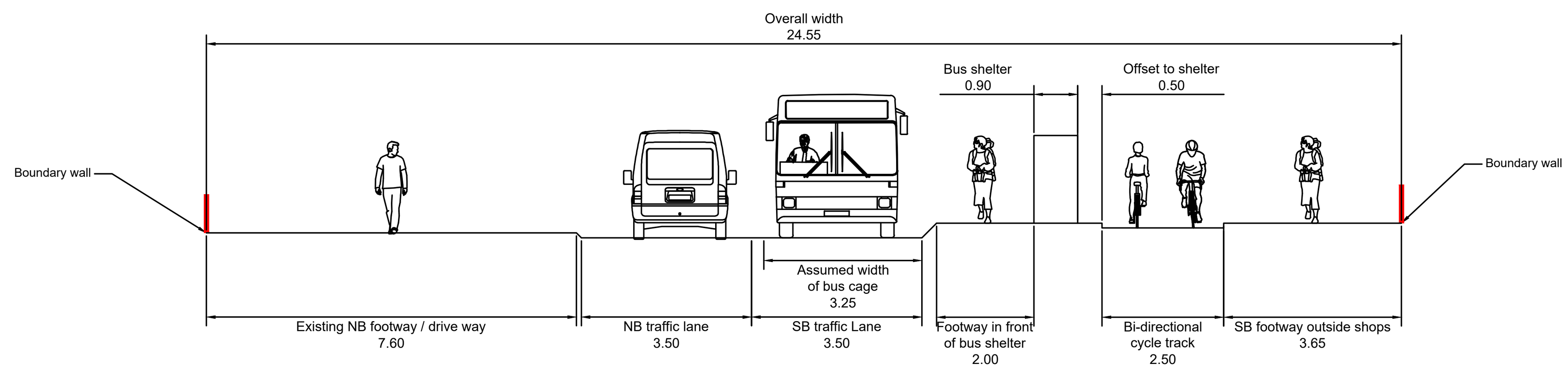
Through southbound bus stop outside shopping area



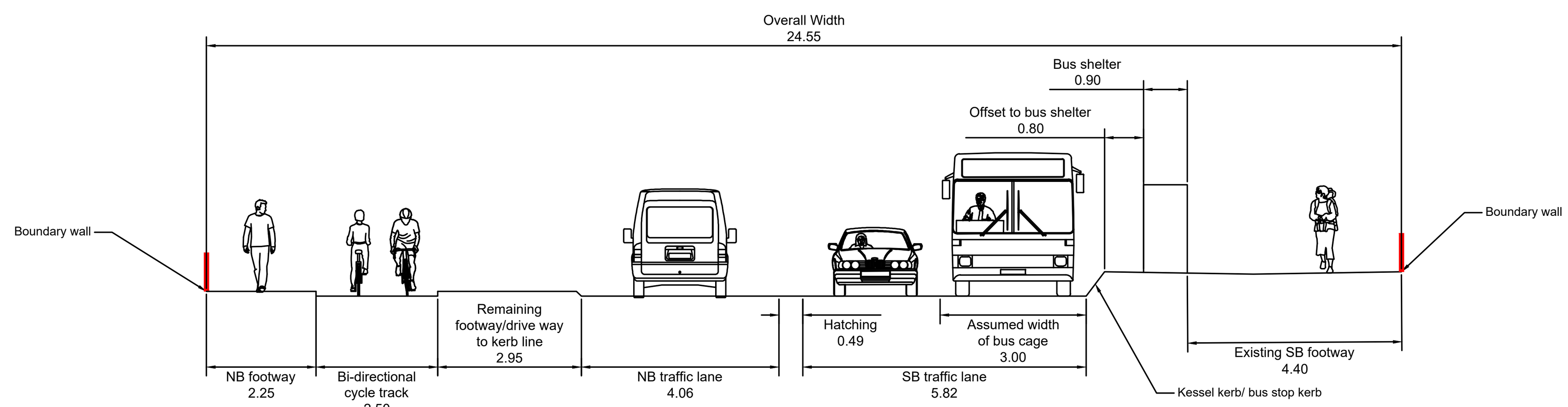
Section B.1 - Existing Cross-section through SB bus shelter outside shopping area



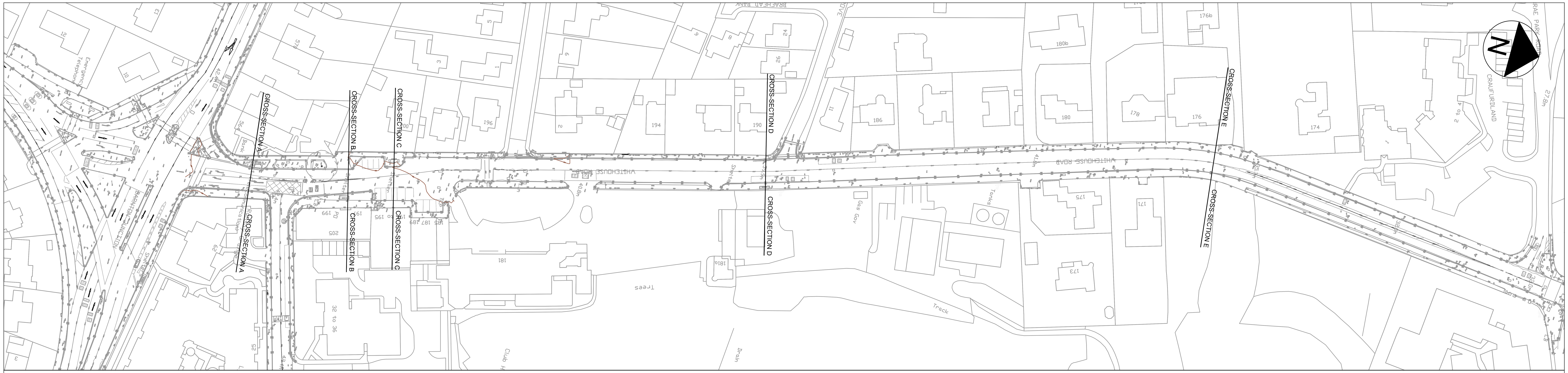
Section B.2 - Through SB bus shelter outside shopping area with uni-directional cycle track



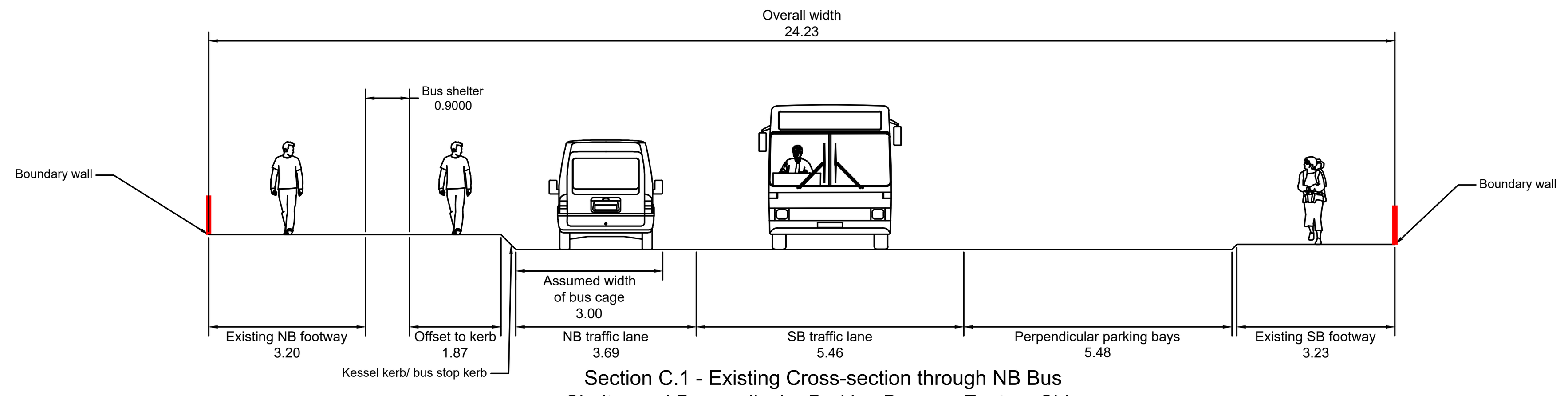
Section B.3 - Through SB bus shelter outside shopping area with bi-directional cycle track on the eastern side



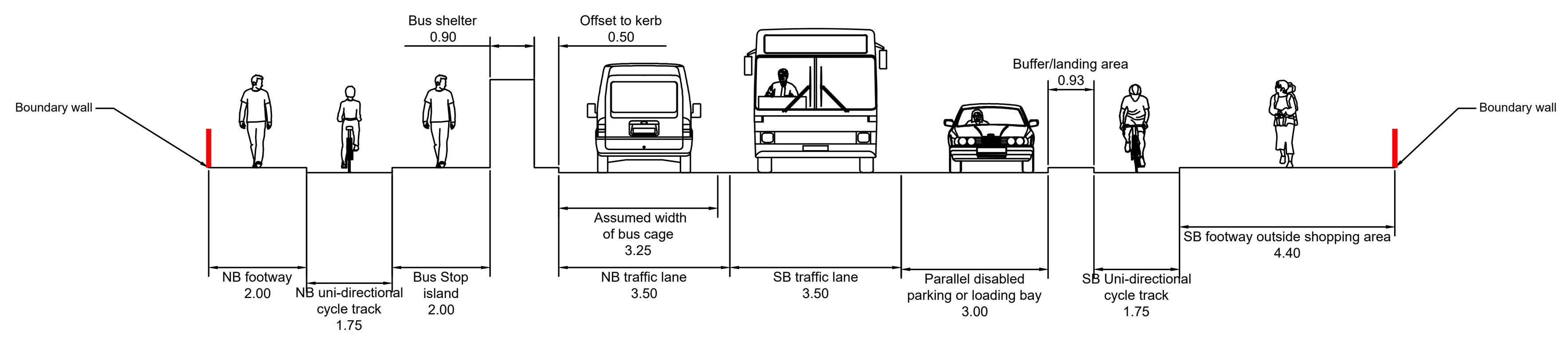
Section B.4 - Through SB bus shelter outside shopping area with bi-directional cycle track on western side



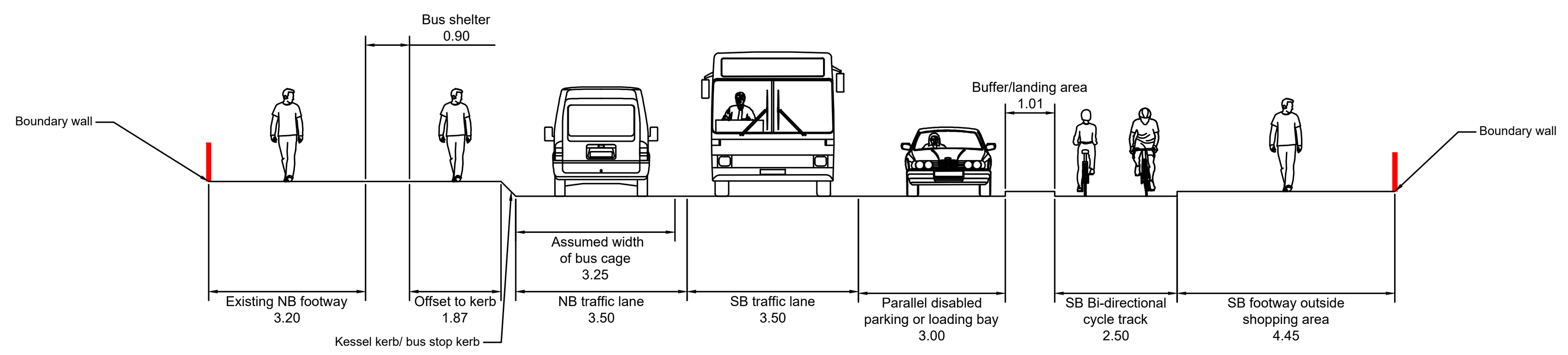
Cross-section C
Through northbound bus stop & southbound parking bays outside shopping area



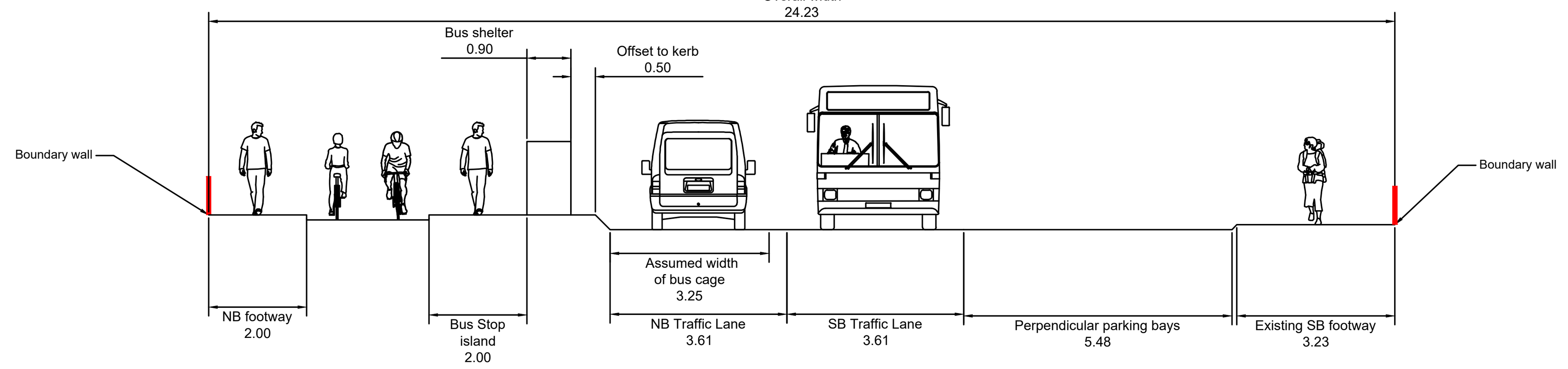
Section C.1 - Existing Cross-section through NB Bus Shelter and Perpendicular Parking Bays on Eastern Side



Section C.2 - Existing Cross-section through NB Bus Shelter and Perpendicular Parking Bays on Eastern Side with Uni-Directional Cycle Tracks

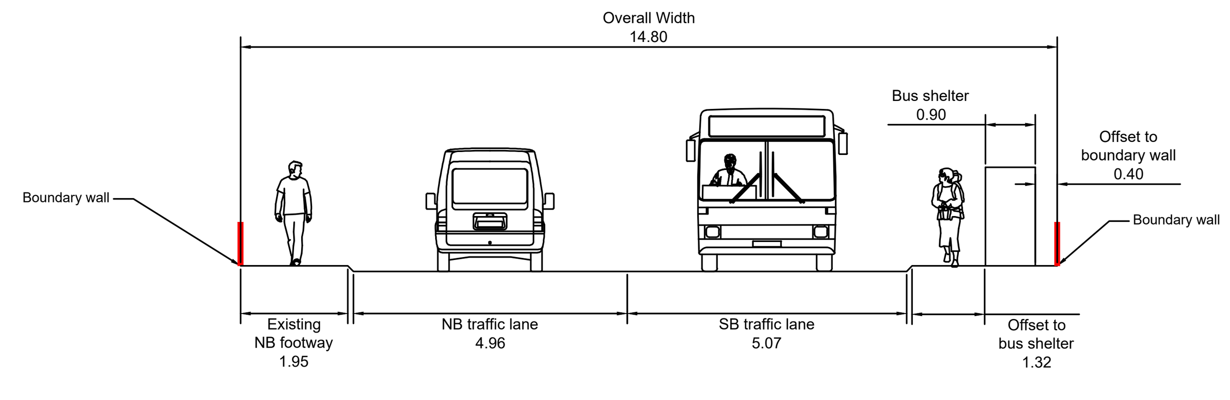


Section C.3 - Existing Cross-section through NB Bus Shelter and Perpendicular Parking Bays on Eastern Side with Bi-Directional Cycle Track on eastern side

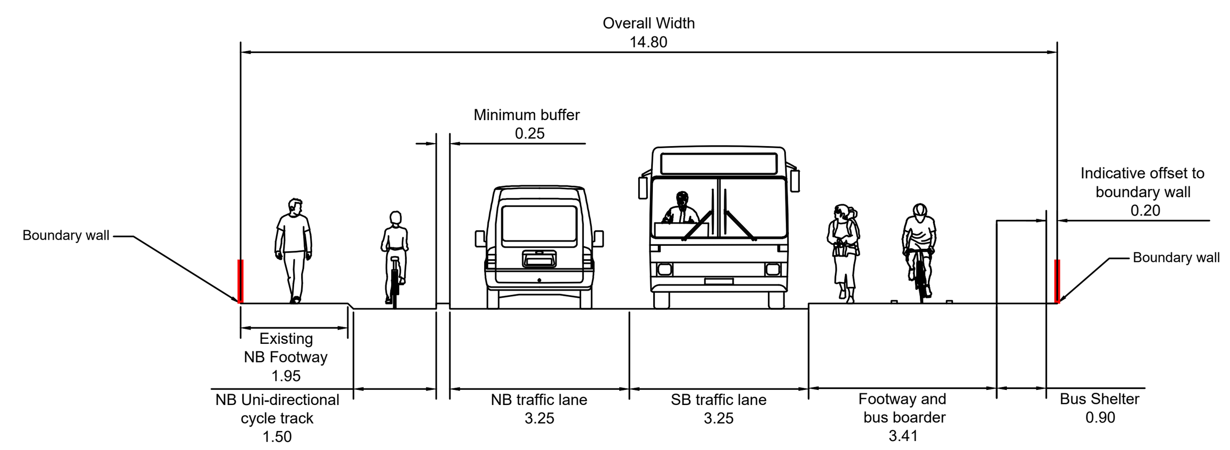


Section C.4 - Existing Cross-section through NB Bus Shelter and Perpendicular Parking Bays on Eastern Side with Bi-Directional Cycle Track on western side

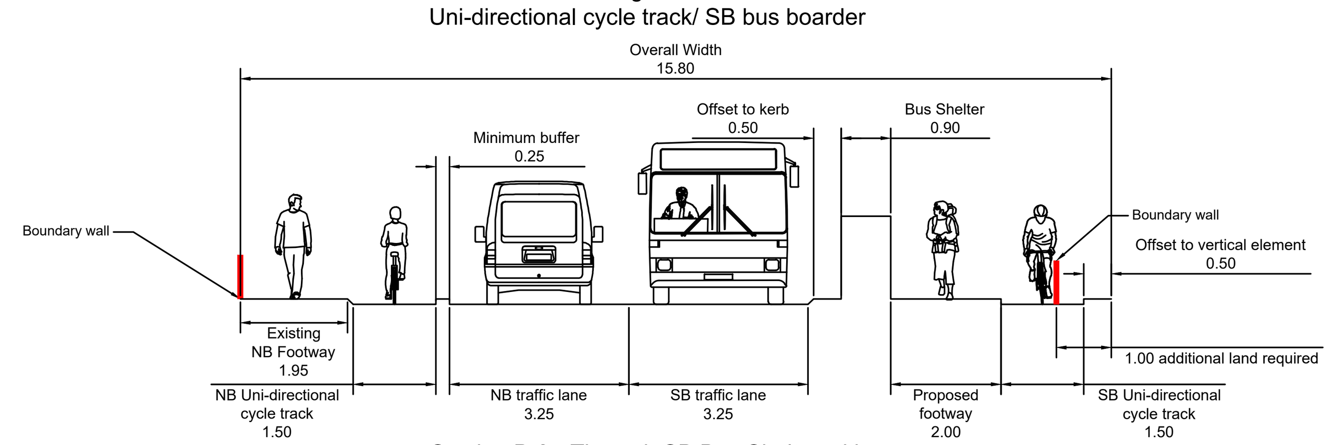
Cross-section D
Through southbound bus shelter adjacent to Breahead Grove



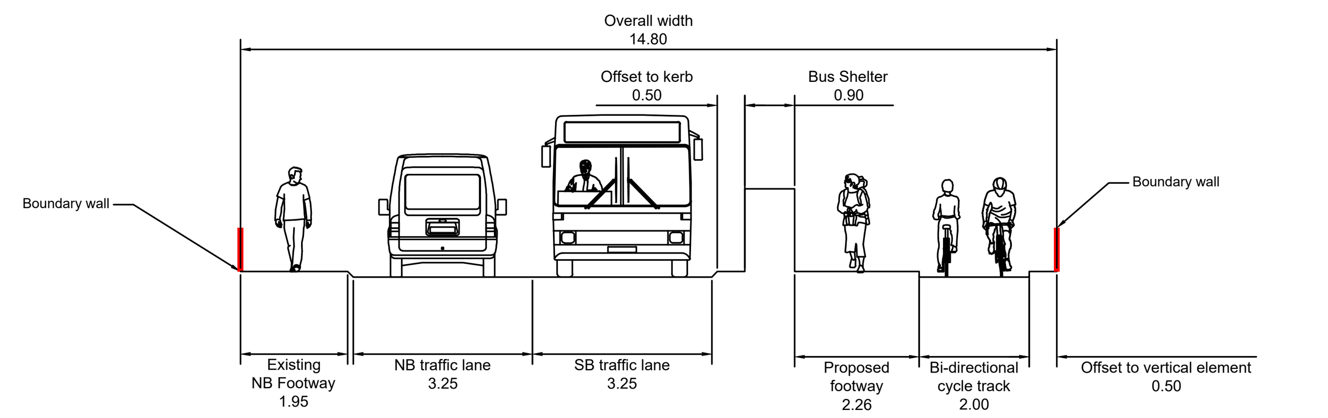
Section D.1 - Existing Cross-section through SB Bus Shelter



Section D.2 - Through SB Bus Shelter with Uni-directional cycle track/ SB bus boarder

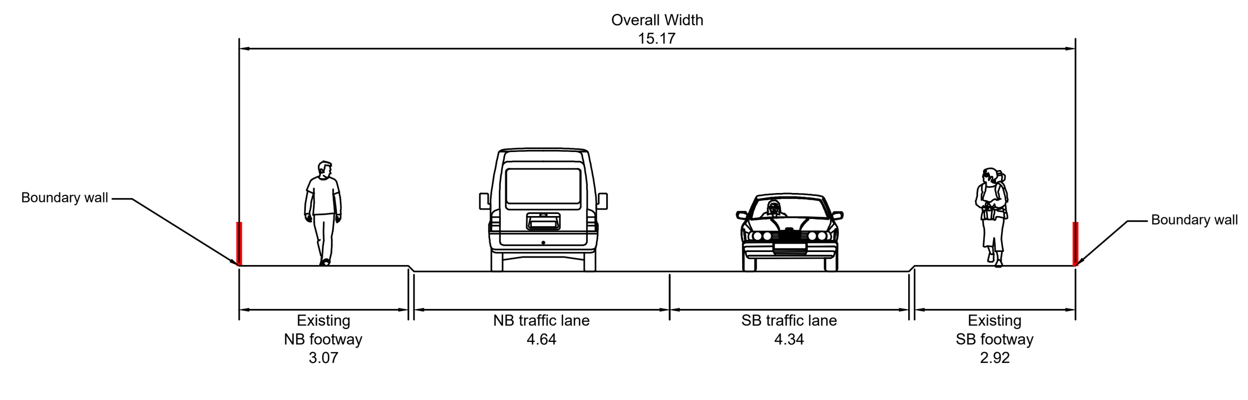


Section D.3 - Through SB Bus Shelter with uni-directional cycle track and 'island' style footway

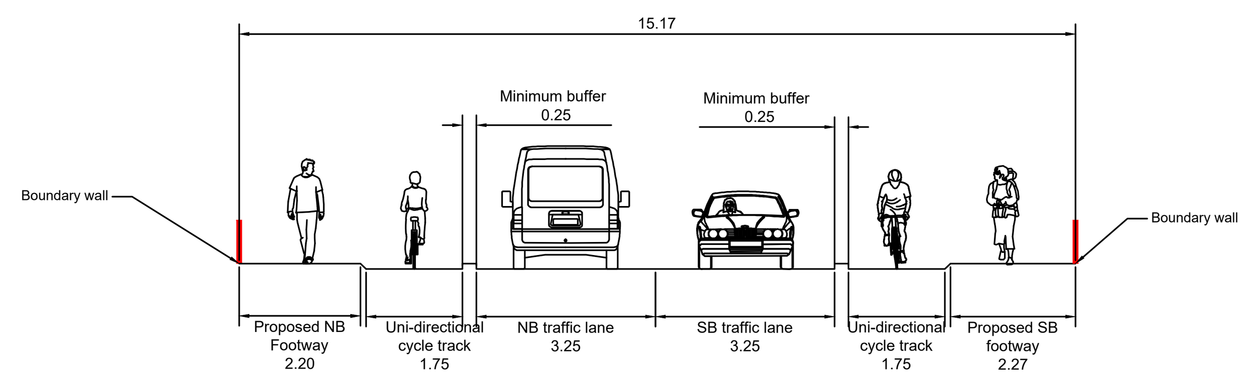


Section D.4 - Through SB Bus Shelter with bi-directional cycle track and 'island' style footway

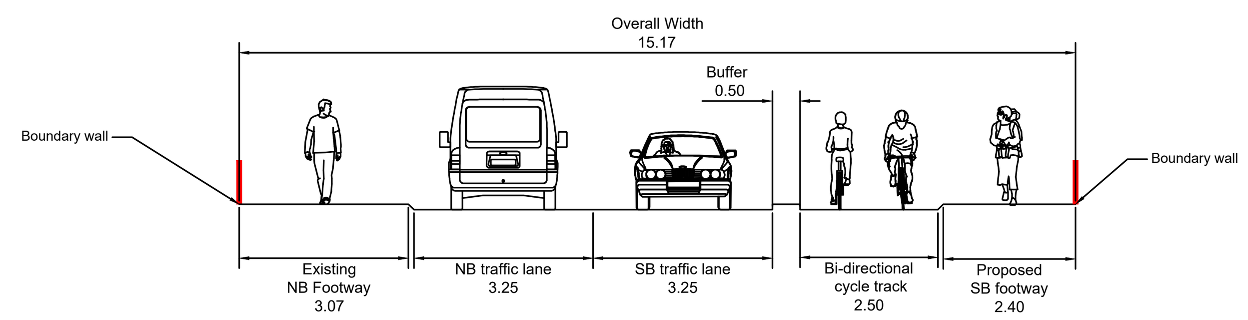
Cross-section E
Through southbound curve in alignment 150m south of NCN1



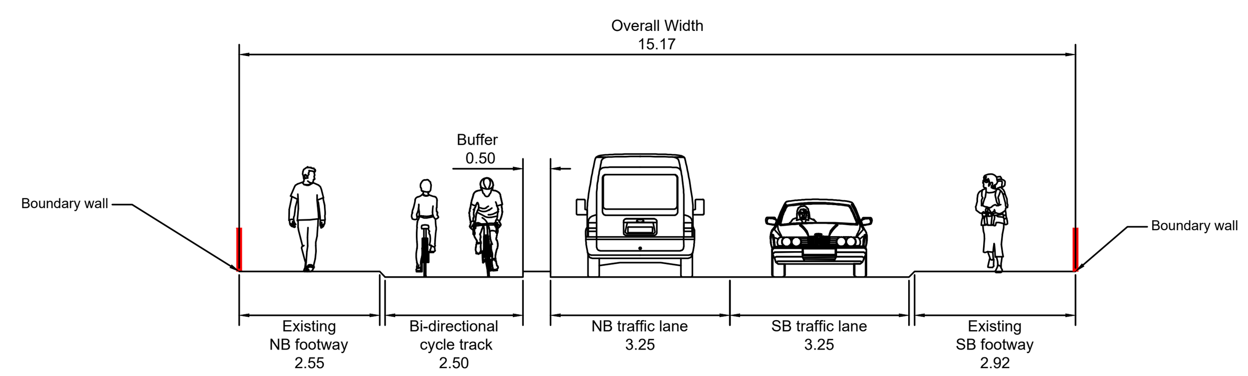
Section E.1 - Existing cross-section through curve in alignment 150m south of NCN1



Section E.2 - through curve in alignment 150m south of NCN1 with uni-directional cycle track and balanced footways

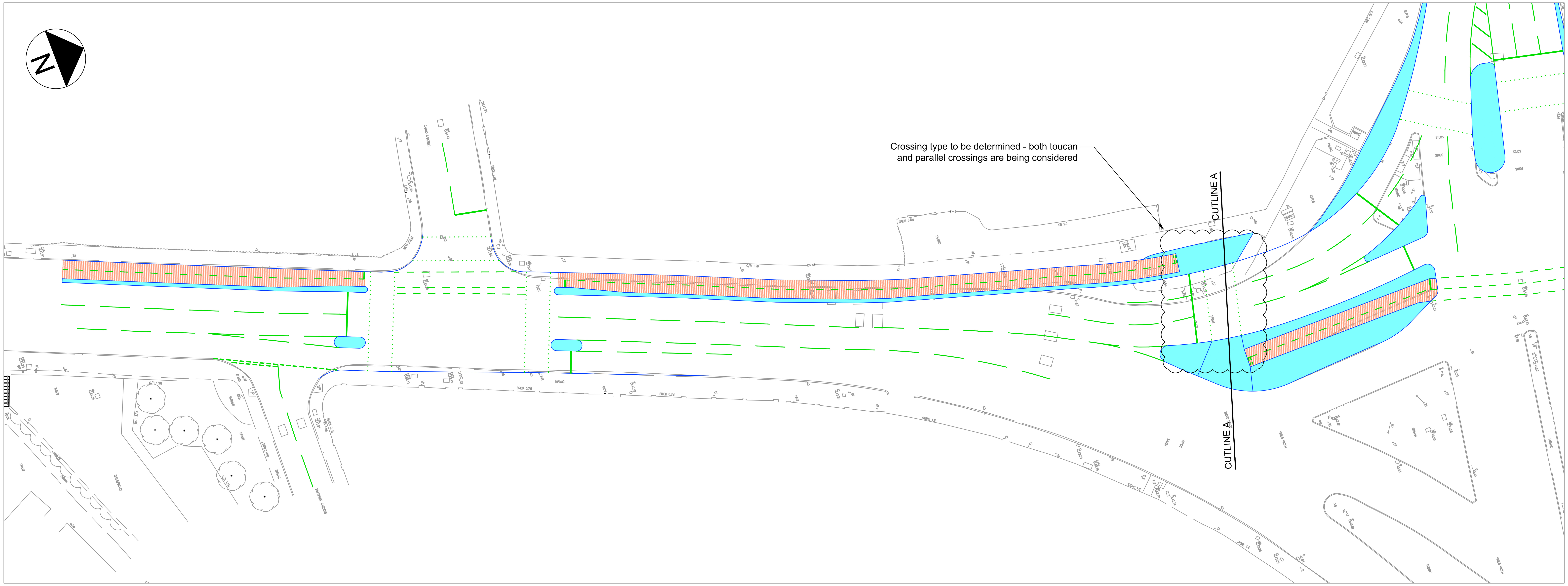


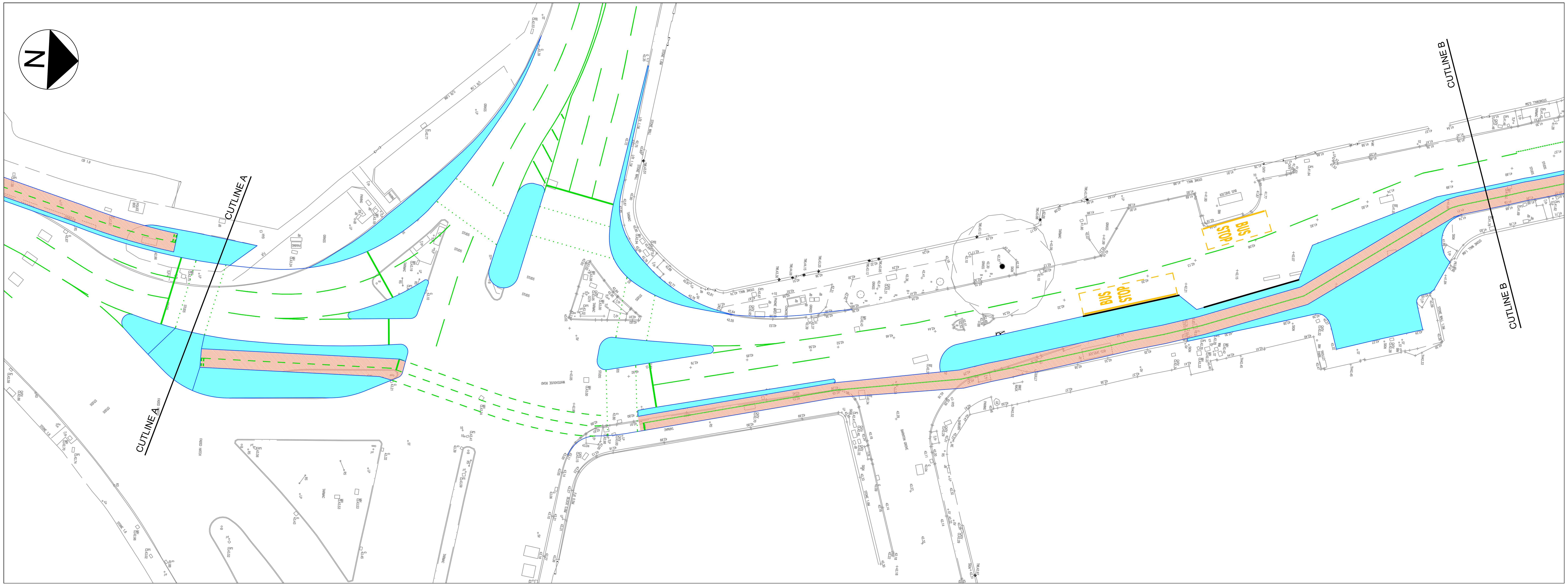
Section E.3 - Through curve in alignment 150m south of NCN1 with bi-directional cycle track retaining existing NB footway width and reducing SB footway width

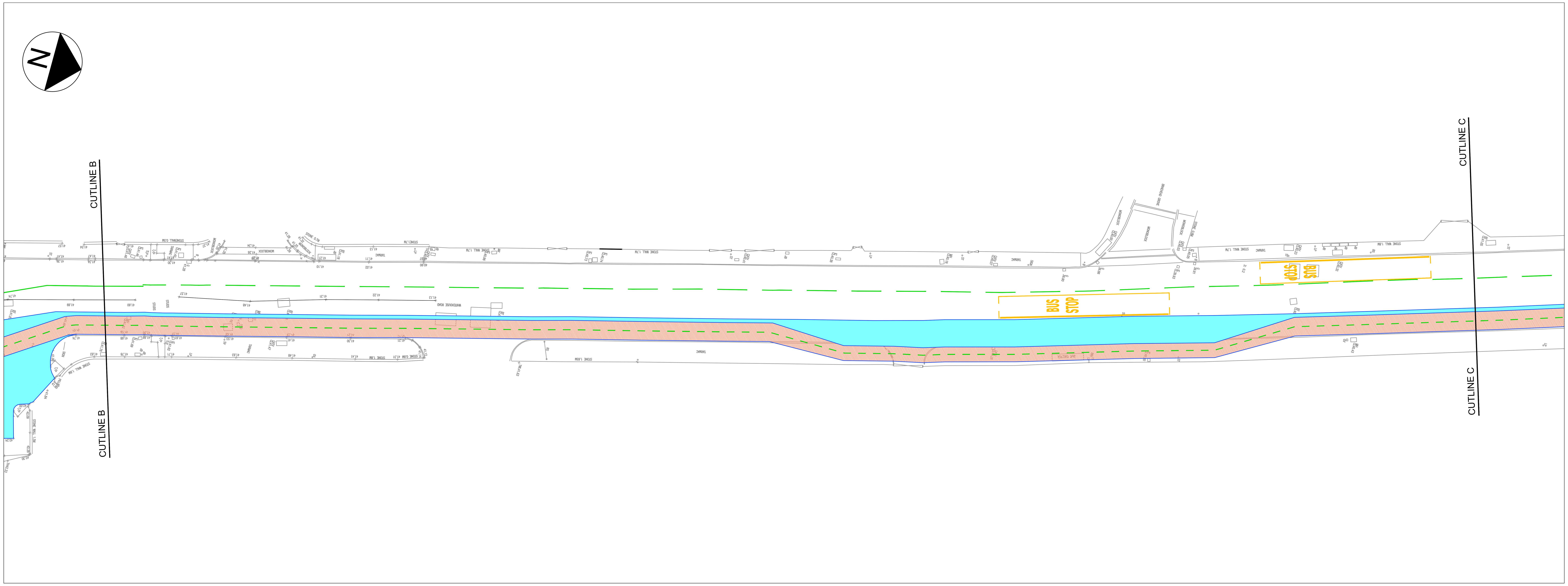


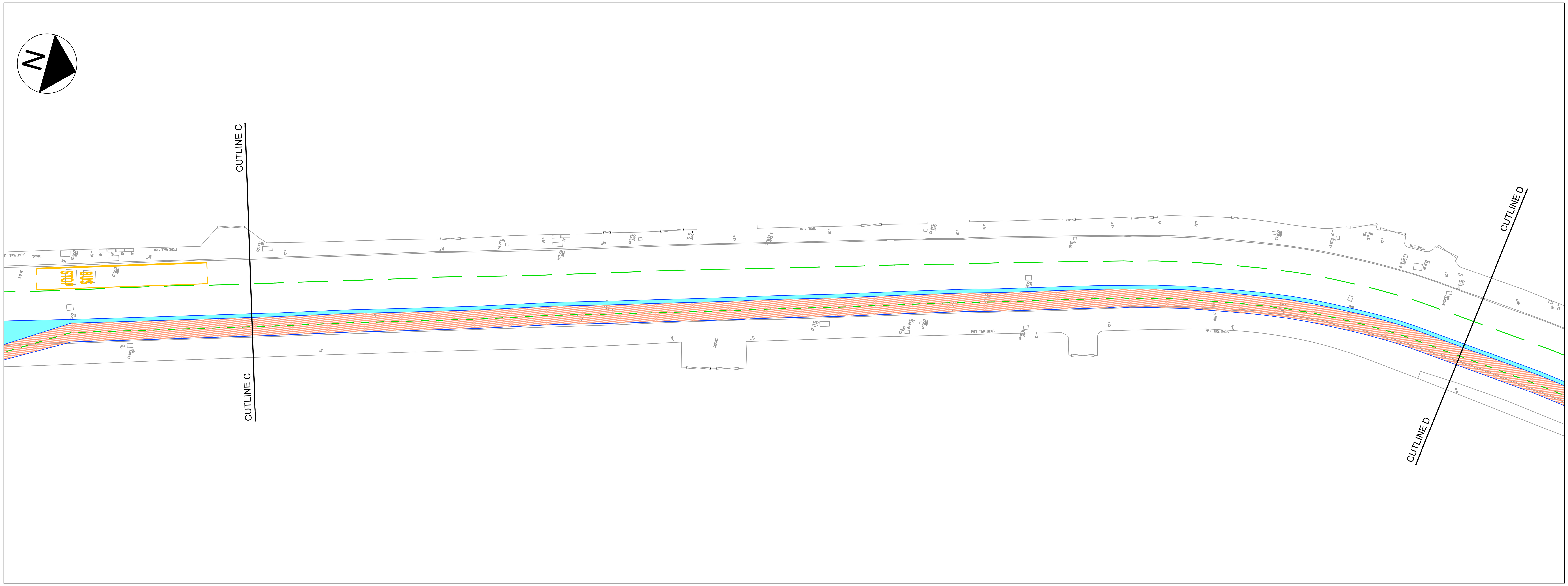
Section E.4 - Through curve in alignment 150m south of NCN1 with bi-directional cycle track retaining existing SB footway width and reducing NB footway width

Appendix B. **Sketch of indicative bi-directional cycle track and junction layout**


Crossing type to be determined - both toucan and parallel crossings are being considered
CUTLINE A
CUTLINE A


CUTLINE A
CUTLINE A
CUTLINE B
CUTLINE B
BUS STOP
BUS STOP


N
CUTLINE B
CUTLINE B
CUTLINE C
CUTLINE C
BUS STOP
BUS STOP


N
CUTLINE C
CUTLINE C
BUS STOP
CUTLINE D
CUTLINE D


N
CUTLINE D
CUTLINE D
KEEP
CLEAR