Aberdeenshire Council
Kintore Capacity Study
Additional Testing

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1 INTRODUCTION

1.1 Introduction

1.1.1 Following the recently completed Kintore Traffic Capacity Study, Aberdeenshire Council has requested that SIAS Limited (SIAS) undertake additional testing to refine conceptual network improvements to aid the performance of the road network.

1.1.2 The Kintore Traffic Capacity Study involved an assessment of the traffic impact of proposed development sites in Kintore, using the Kintore S-Paramics traffic model originally developed in 2008.

1.1.3 The principal objective of the study is to evaluate the operational impact of the potential infrastructure interventions.

1.2 Kintore Model Background

1.2.1 The Base Kintore S-Paramics model was completed in 2008 using observed data from 2007 and is representative of 2007 conditions.

1.2.2 The Kintore models represent the following AM and PM peak periods:

- AM Peak Period 07:00 – 10:00
- PM Peak Period 16:00 – 19:00

1.2.3 The peak hours for the Kintore model were calculated from the original 2007 survey data as:

- AM Peak Hour 07:15 – 08:15
- PM Peak Hour 16:45 – 17:45

1.2.4 Figure 1.1 shows the Kintore study area.

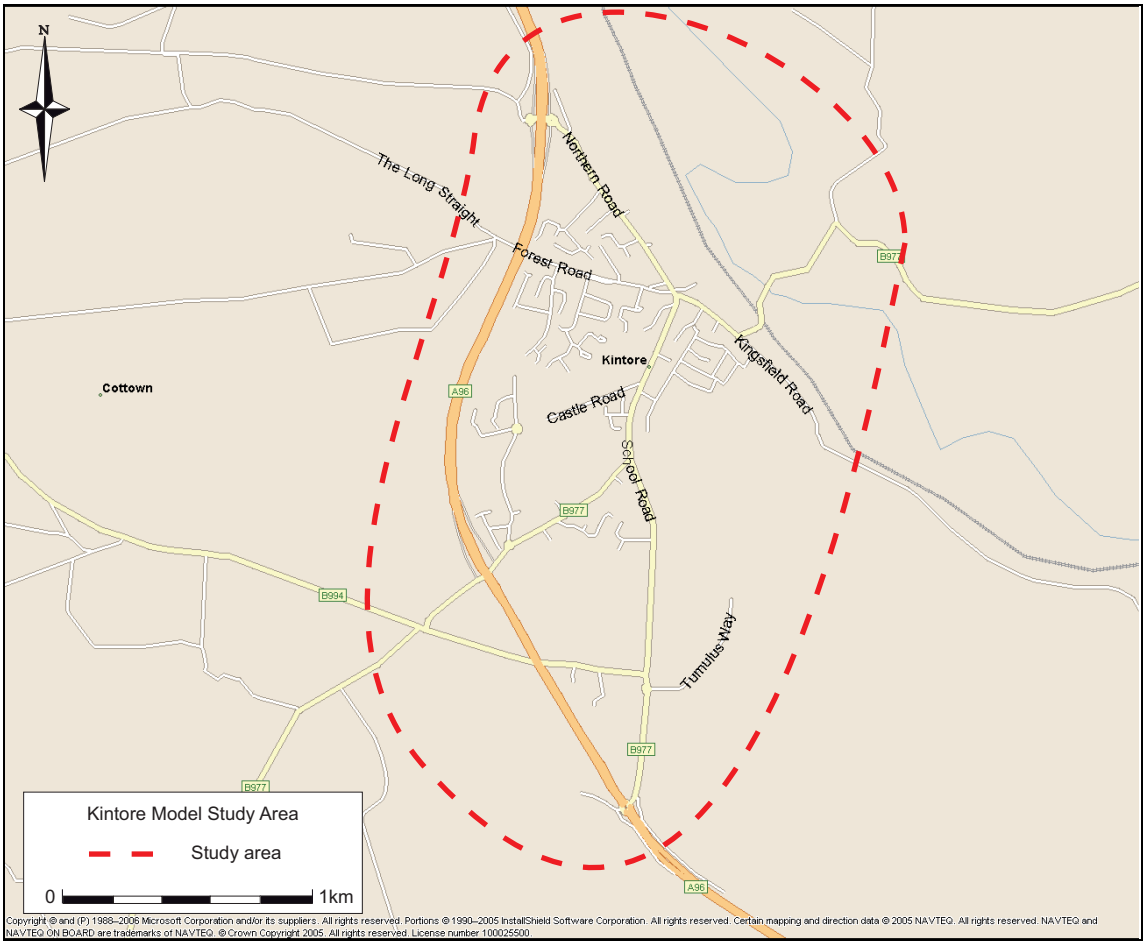

Figure 1.1 : Study Area

1.3 2012 Do-Minimum

1.3.1 The Kintore 2012 Do-Minimum model has been agreed with Aberdeenshire Council and was developed from the 2007 Kintore Base model. NRTF central growth has been applied to traffic travelling on the A96, B977 and B994. The NRTF central growth factors applied, from 2007 to 2012 were:

- Lights 1.077
- Heavies 1.075

1.4 2012 Committed Developments

1.4.1 The 2012 committed development content was agreed with Aberdeenshire Council and is detailed in Table 1.1.

Table 1.1 : 2012 Committed Developments

Development	Type	Area
Braefarm	Employment	Midmill Call Centre
	Housing	50 Houses and 36 housing association flats
Woodside Croft	Housing	Approx 200 houses
Midmill South	Office	GFA 866 m2
	Workshop	GFA 3,322 m2
	Warehousing	GFA 10,113 m2
Retail Development	Retail	GFA 1,696 m2
	Petrol Filling Station	8 Pump
Midmill South East	Office	GFA 3,614 m2
	Light Industry	GFA 5,421 m2
	Warehousing (storage)	GFA 20,267 m2
	Warehousing (commercial)	GFA 4,045 m2
Midmill East	Office	GFA 2,550 m2
	Light Industry	GFA 515 m2
Gauchhill	Housing	30 Houses

1.4.2 The 2012 committed development locations are shown in Figure 1.2.

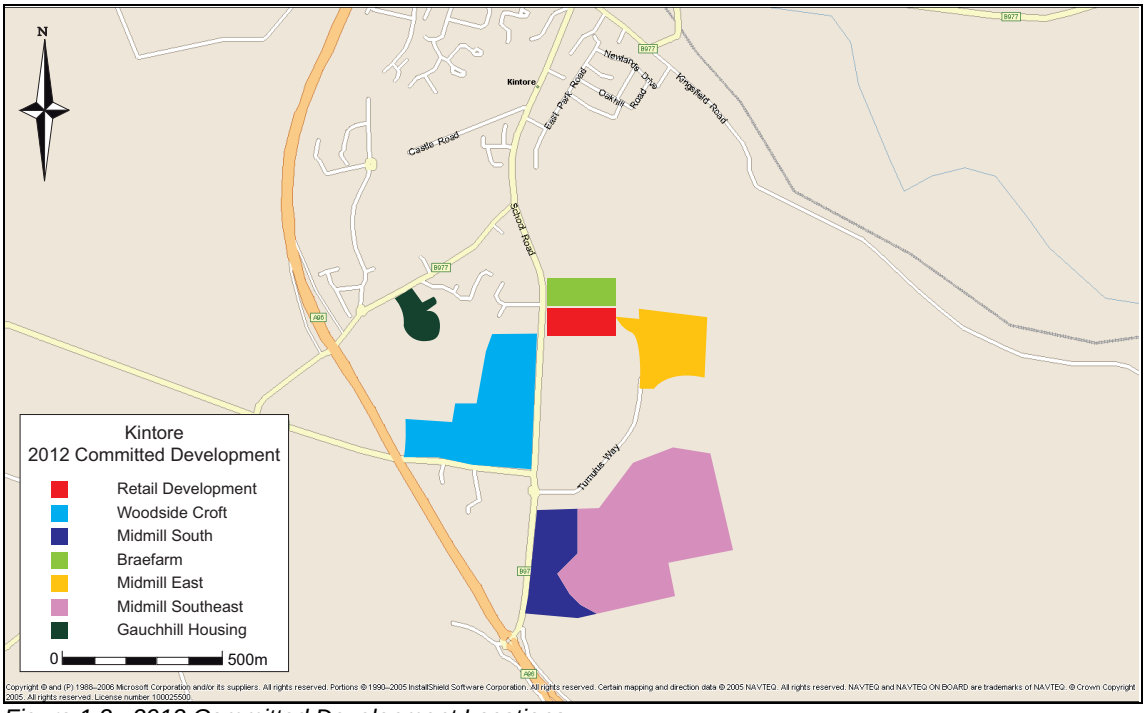

Figure 1.2 : 2012 Committed Development Locations

1.4.3 The total numbers of trips generated by the 2012 committed developments have been agreed with Aberdeenshire Council and are shown in Table 1.2.

Table 1.2 : Peak Period Trip Totals

Development	AM	PM
Braefarm	303	314
Woodside Croft	261	432
Midmill South	117	122
Retail Development	614	914
Midmill East	120	105
Midmill South East	340	281
Gauchhill	40	63

2 TEST SCENARIOS

2.1 Introduction

2.1.1 As requested by Aberdeenshire Council, four scenarios have been tested in the 2012 Kintore Do-Minimum model. The four scenarios comprise combinations of the following design elements:

- New four arm signal controlled junction at B994/B977/Tumulus Way junction
- New Roundabout at B994/B977/Tumulus Way junction
- Revision to Broomhill Roundabout
- New Slip from the A96 to B994
- New slip from the B977 to A96

2.1.2 Table 2.1 details the content of the four scenarios tested.

Table 2.1 : Test Scenario Summary

Infrastructure	Test 1	Test 2	Test 3	Test 4
Signals at B994/ B977/ Tumulus Way	√		√	
Roundabout at B994/ B977/ Tumulus Way		√		√
Broomhill Roundabout Revision	√	√	√	√
A96 to B994 Slip	√	√	√	√
B977 to A96 Slip			√	√

2.1.3 Figures 2.1 to 2.5 show the infrastructure interventions. Figure 2.1 shows the new signal controlled junction at the B994/B977/Tumulus Way junction. This replaces the priority junction at the B994 and B977, and also the existing roundabout at the B977 and Tumulus Way.

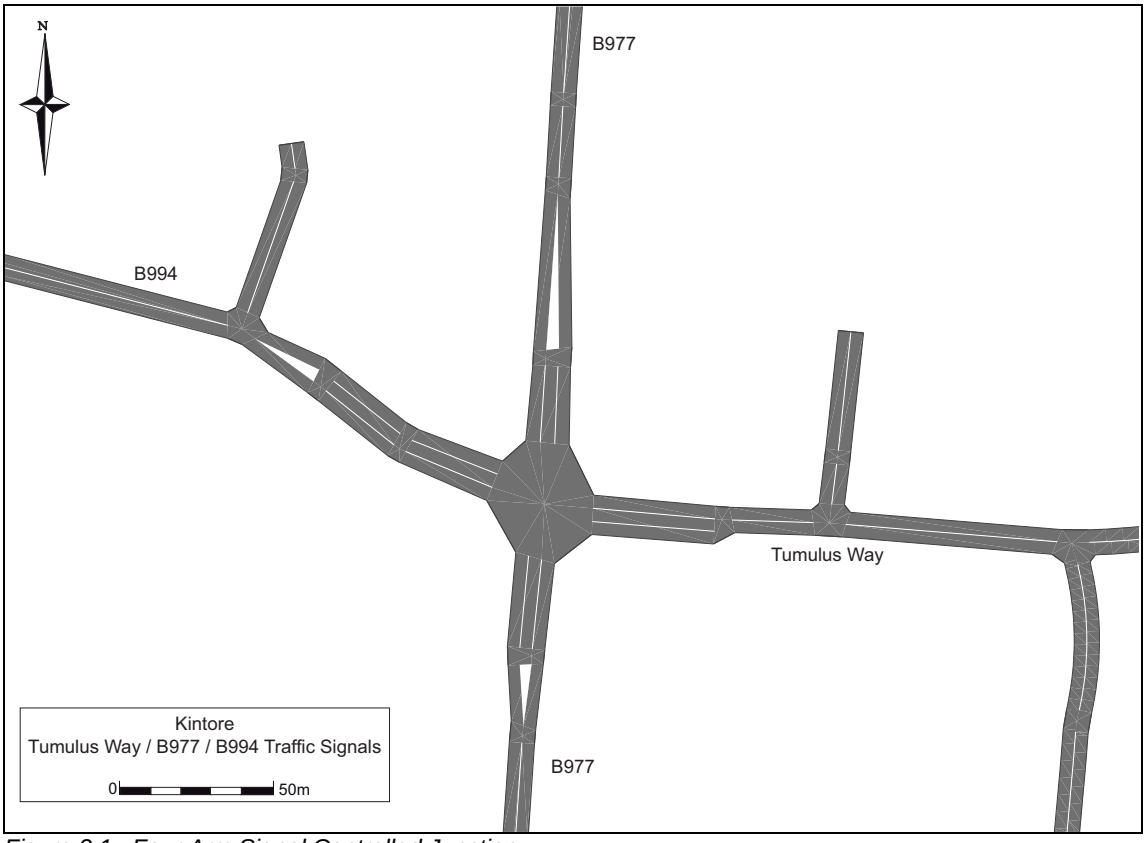

Figure 2.1 : Four Arm Signal Controlled Junction

2.1.4 The signal stages and timings used are shown in Figure 2.2. A pedestrian stage is called every second cycle.

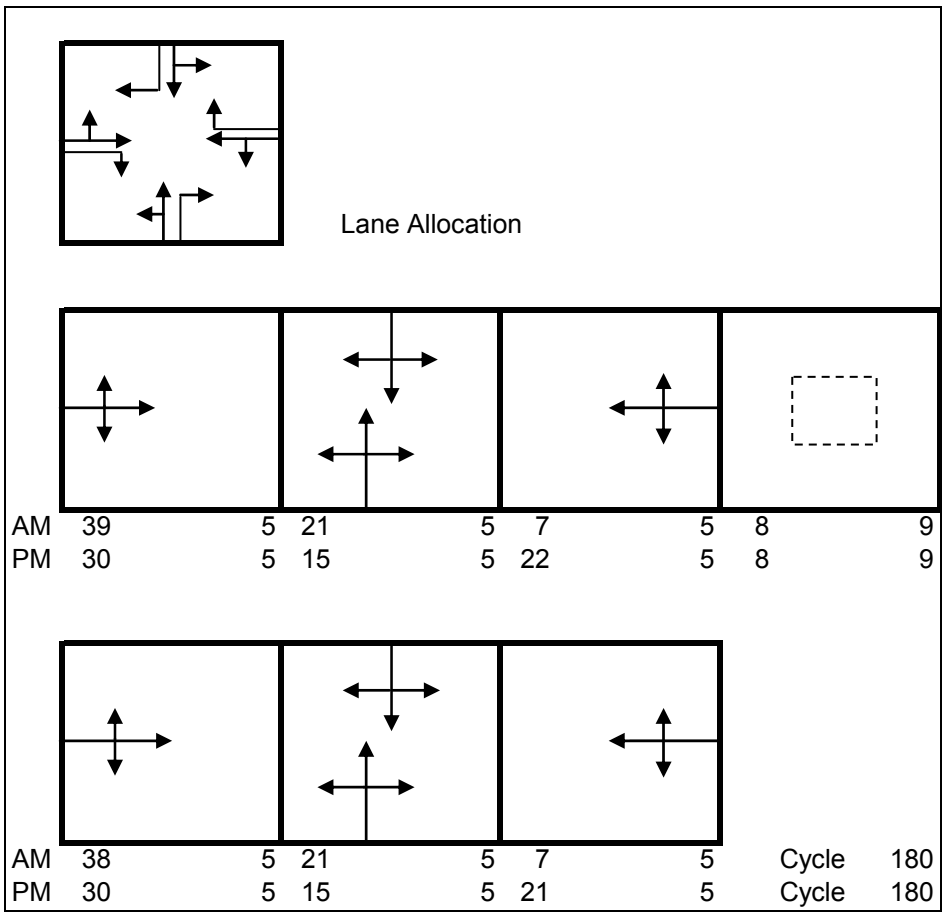

Figure 2.2 : Test 1 and 3 Signal Stages and Timings

2.1.5 Figure 2.3 shows the new roundabout at the B994/B977/Tumulus Way junction. This replaces both the priority junction at the B994 and B977, and also the existing roundabout at the B977 and Tumulus Way.

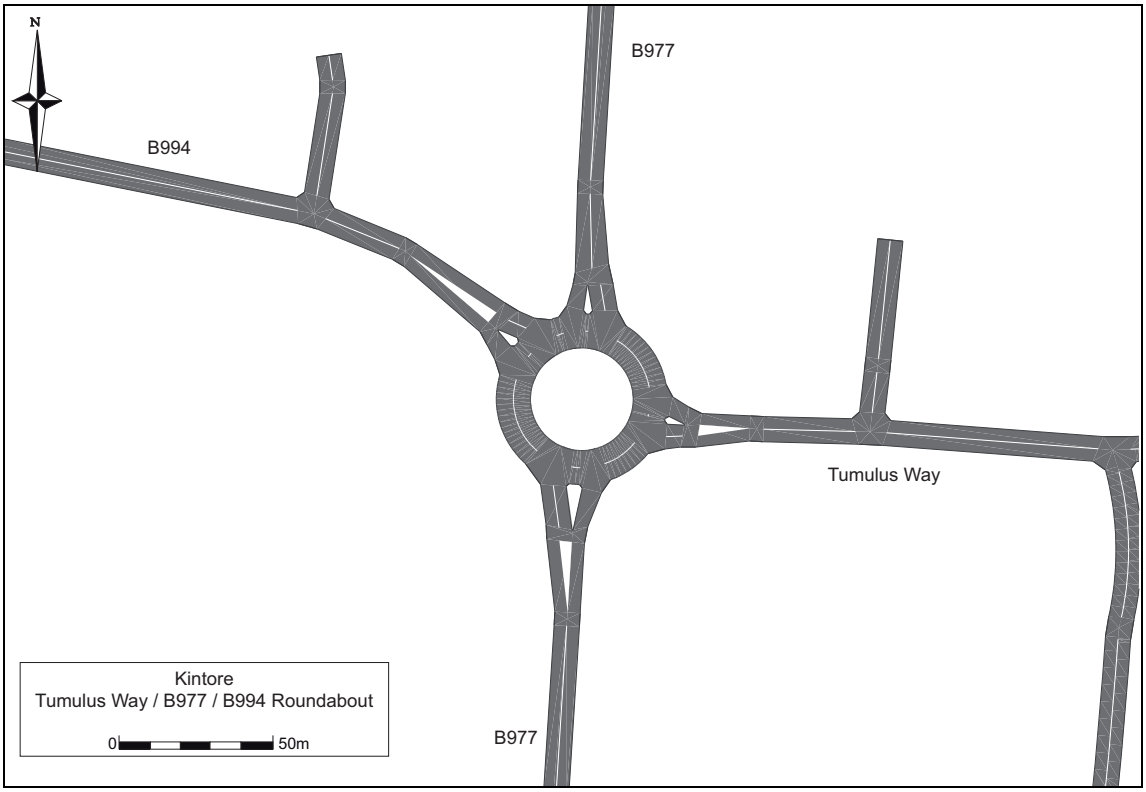

Figure 2.3 : New Roundabout

2.1.6 No pedestrian facilities are provided in the scenarios with this roundabout.

2.1.7 Figure 2.4 shows the proposed revision to Broomhill Roundabout. The improvements include segregated left turn lanes from the A96 southbound to the B977 and from the B977 southbound to the A96. The right turn from the A96 northbound to the B977 is banned.

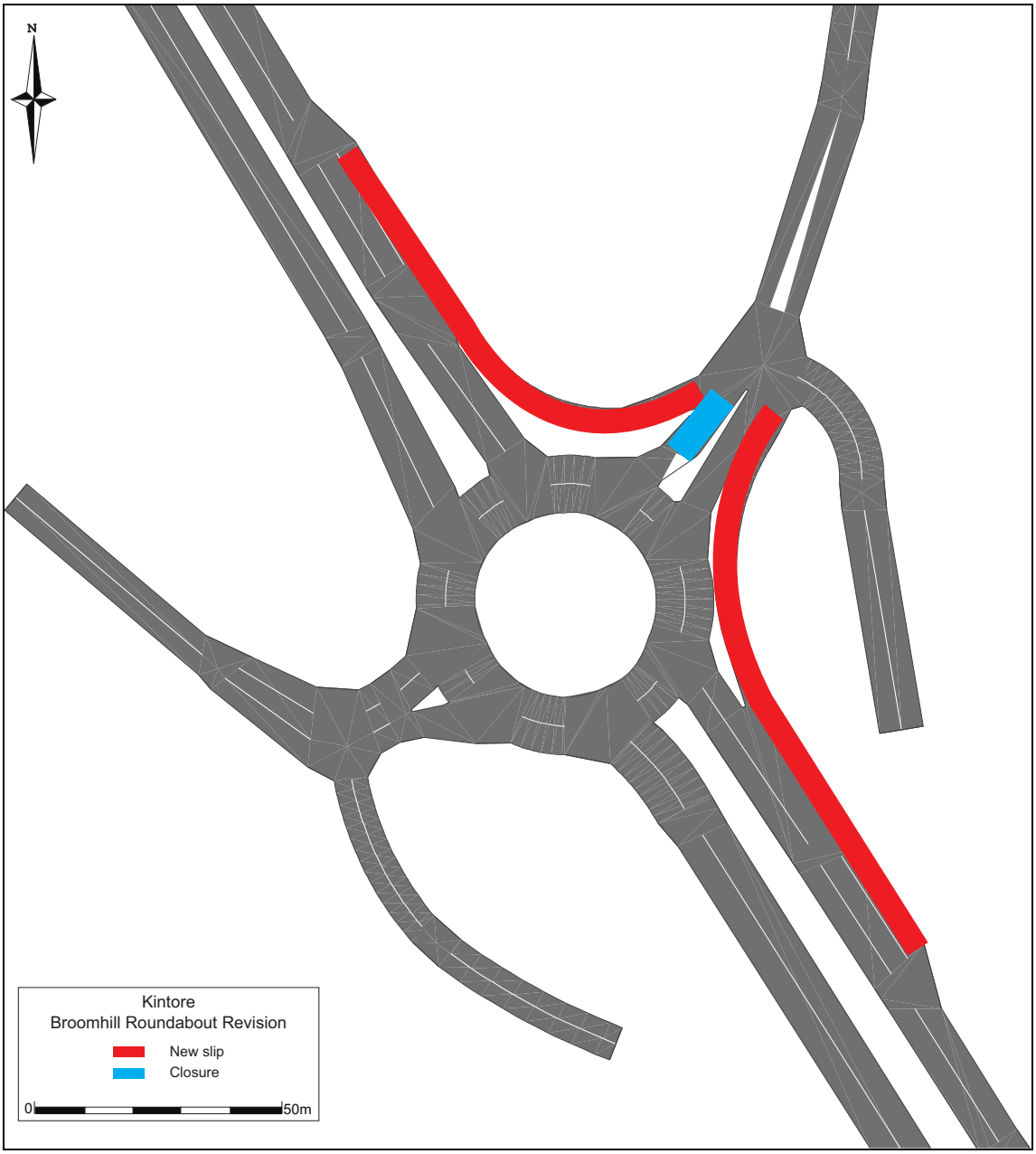

Figure 2.4 : Broomhill Roundabout Proposed Revisions

2.1.8 Figure 2.5 shows the proposed northbound slip from the A96 to the B994.

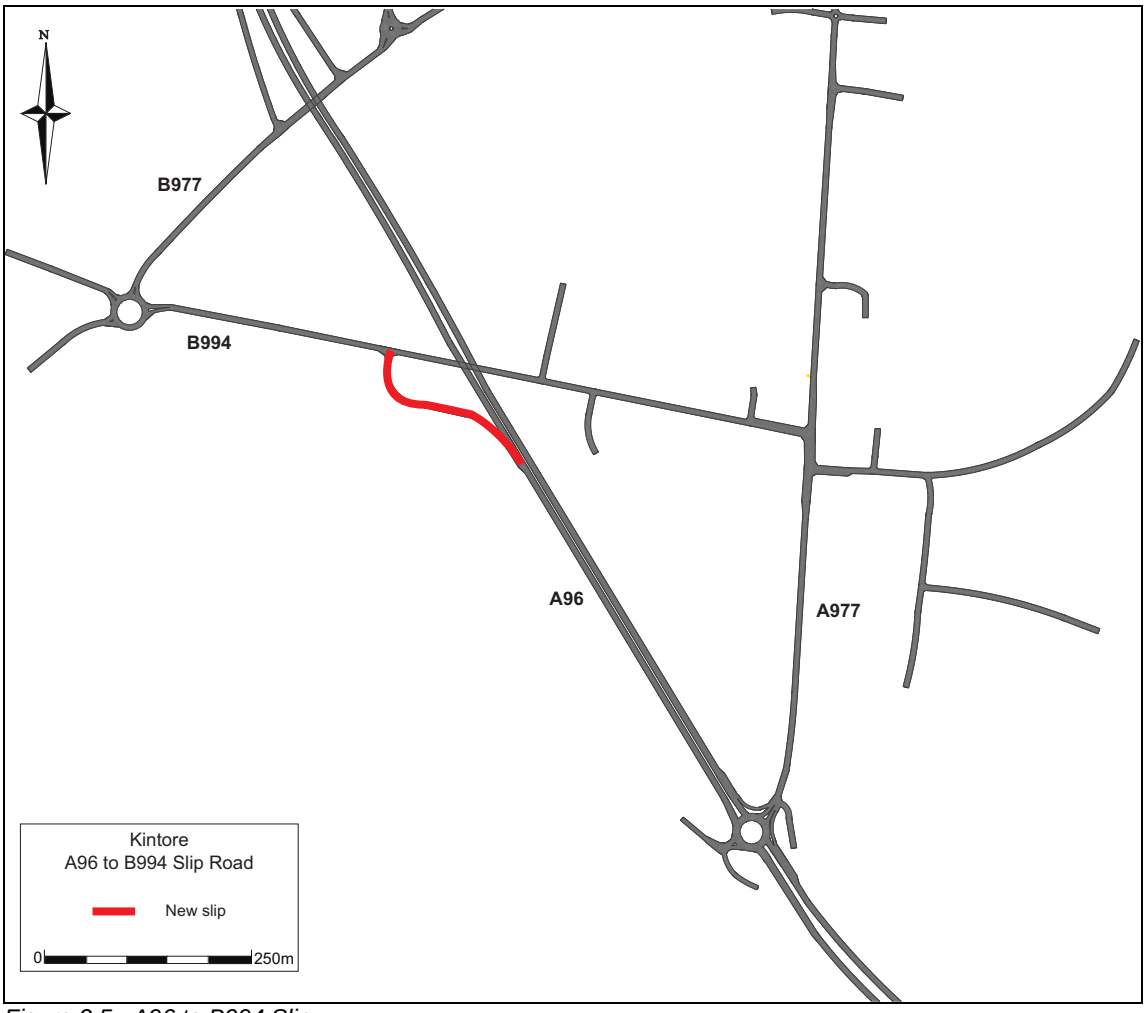

Figure 2.5 : A96 to B994 Slip

2.1.9 The junction of the slip road with the B994 is a priority junction with left and right turn egress allowed from the slip road.

2.1.10 Figure 2.6 shows the proposed southbound B977 to A96 slip. This includes a roundabout linking the slip road to the B977 and the southbound slip from the A96 to the B977.

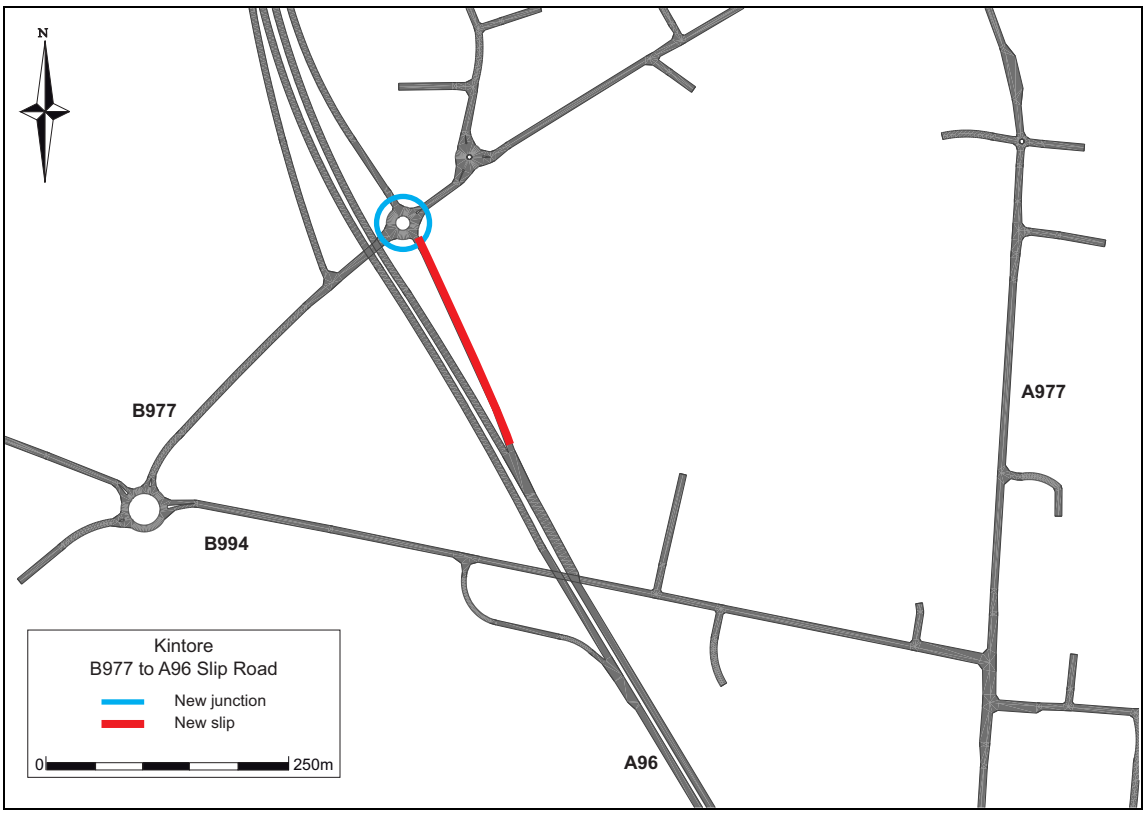

Figure 2.6 : B977 to A96 Slip

2.2 2012 Do-Minimum Model Observations

2.2.1 In the AM peak, queueing was observed on the B977 southbound from Broomhill Roundabout, with the queue extending onto the B994 eastbound for approximately 350m at 08:15. Queueing was also observed on the A96 southbound from Broomhill Roundabout, reaching approximately 400m at 08:00.

2.2.2 No significant queueing was observed in the PM peak.

2.3 Test 1 Model Observations

2.3.1 In both the AM and PM peaks, queueing from Broomhill Roundabout was significantly reduced. The only queueing of note was observed on all arms of the junction of the B994/B977 and Tumulus Way. This could be applicable to the introduction of traffic signals at this location. Queues did not exceed 100m and cleared every cycle.

2.4 Test 2 Model Observations

2.4.1 No significant queueing was observed in the AM or PM peak.

2.5 Test 3 Model Observations

2.5.1 In the both the AM and PM peaks, lower congestion was observed at the B994/B977/Tumulus Way junction compared to Test 1. The introduction of the new slip road from the B977 to the A96 southbound resulted in a reduction in traffic flow on the B994 eastbound and B977 southbound.

2.6 Test 4 Model Observations

2.6.1 No significant queueing was observed in the AM or PM peak.

2.7 Traffic Flow Comparison at Key Junctions

2.7.1 Traffic flows (link counts) have been compared at six key locations in the model network:

- A96 South of Broomhill
- A96 North of Broomhill
- B977 North of Broomhill
- Tumulus Way
- B994
- B977 North of B994

2.7.2 Values are calculated as an average of five S-Paramics model runs and are shown as a difference to the 2012 Do-Minimum. The link count locations are shown in Figure 2.7.

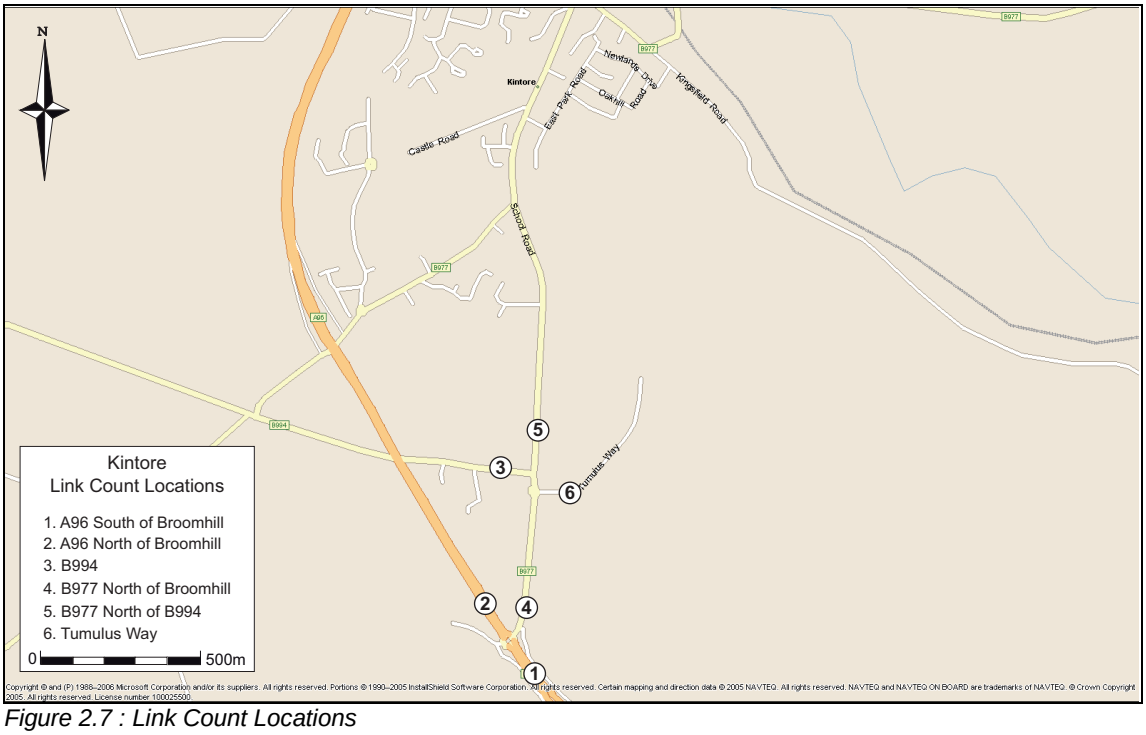

Figure 2.7 : Link Count Locations

2.7.3 Table 2.2 shows the link count comparison for the AM peak hour.

Table 2.2 : AM Peak Hour Link Count Comparison (07:15 – 08:15)

Ref	Location	2007 Base	2012 Do-Min	Change from 2012 Do-Min Test 1	Test 2	Test 3	Test 4
1	A96 NB south of Broomhill	522	642	1	3	-1	-1
1	A96 SB south of Broomhill	1,922	2,012	134	134	125	135
2	A96 NB north of Broomhill	408	441	236	245	232	244
2	A96 SB north of Broomhill	1,446	1,561	-70	-57	317	417
4	B977 NB north of Broomhill	163	296	-209	-187	-190	-136
4	B977 SB north of Broomhill	543	551	231	242	-146	-175
6	Tumulus Way EB	178	316	28	49	21	50
6	Tumulus Way WB	42	88	-3	-2	-3	-1
3	B994 EB	464	557	310	307	-24	-109
3	B994 WB	76	134	-93	-96	-90	-94
5	B977 NB north of B994	76	144	4	11	15	13
5	B977 SB north of B994	209	240	36	55	-16	3

2.7.4 Table 2.2 shows that in the AM peak hour, all four tests show an increase in traffic on the A96 southbound; this is due to the improvements at Broomhill Roundabout reducing delay.

2.7.5 Traffic flows on the A96 northbound, north of Broomhill Roundabout were higher in all four tests compared to the 2012 Do-Minimum; this is due to the restricted entrance to the B977 from the A96. Flows on the B977 northbound and B994 westbound were lower in all four tests for this reason.

2.7.6 The traffic flows indicate that when the slip from the B977 to the A96 is introduced in Tests 3 and 4, flows on the B994 eastbound and B977 southbound are reduced and flows on the A96 southbound are increased, due to traffic using the new route.

2.7.7 Table 2.3 shows the link count comparison for the PM peak hour.

Table 2.3 : PM Peak Hour Link Count Comparison (16:45 – 17:45)

Ref	Location	2007 Base	2012 Do-Min	Change from 2012 Do-Min Test 1	Test 2	Test 3	Test 4
1	A96 NB south of Broomhill	2,111	2,369	4	1	5	0
1	A96 SB south of Broomhill	744	930	0	0	2	4
2	A96 NB north of Broomhill	1,493	1,667	815	823	811	826
2	A96 SB north of Broomhill	565	611	17	17	127	124
4	B977 NB north of Broomhill	665	820	-798	-790	-792	-785
4	B977 SB north of Broomhill	223	439	-4	12	-106	-79
6	Tumulus Way EB	48	98	0	0	-1	1
6	Tumulus Way WB	93	269	2	0	-2	-6
3	B994 EB	96	203	219	256	148	163
3	B994 WB	431	625	-475	-473	-470	-477
5	B977 NB north of B994	294	365	-117	-81	-112	-83
5	B977 SB north of B994	144	236	-21	-7	-44	-12

2.7.8 Table 2.3 shows a reduction in traffic flow on the B977 northbound and B994 westbound, and an increase on the A96 northbound due to the restriction to the B977.

2.7.9 The traffic flows indicate that when the slip from the B977 to the A96 is introduced in Tests 3 and 4, flows on the B994 eastbound and B977 southbound are reduced and flows on the A96 southbound are increased, due to traffic using the new route.

2.8 Queue Length Comparison

2.8.1 Queue lengths were compared at key junctions in the network as shown in Figure 2.8.

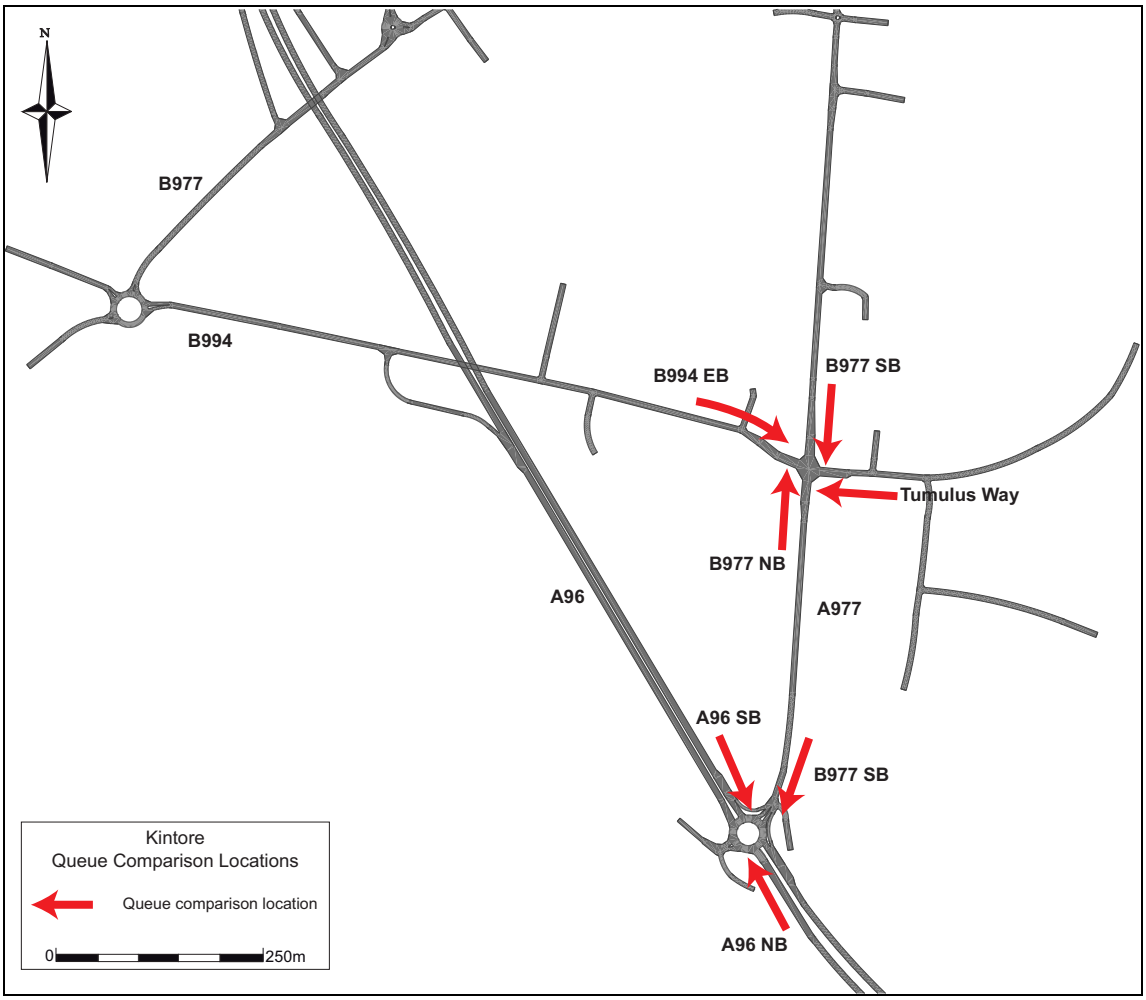

Figure 2.8 : Queue Comparison Locations

2.8.2 Queue statistics have been provided as an average maximum queue length, which is the average of the maximum queue length recorded in each 15min period. A queue is recorded in the model when speed drops below 5mph and the gap in front of a vehicle drops below 10m.

2.8.3 All queue length statistics are calculated from an average of five S-Paramics model runs. Figures 2.9 – 2.14 show the AM peak queue results. No queueing was observed on the A96 northbound at Broomhill Roundabout in the AM peak and this location has been omitted from the comparisons at this stage.

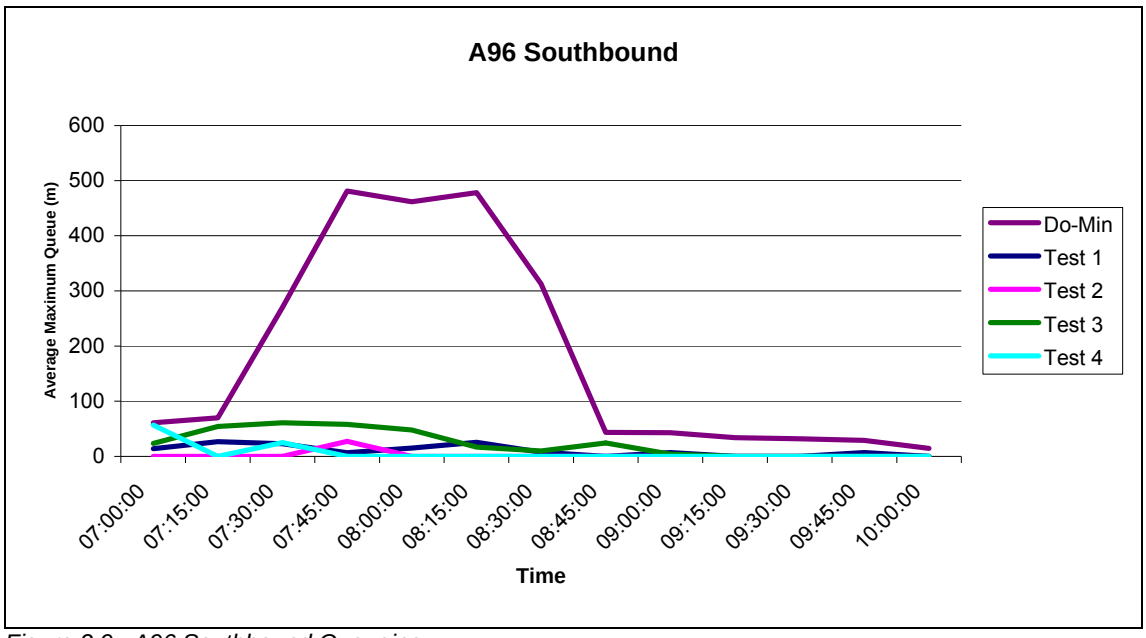

Figure 2.9 : A96 Southbound Queueing

2.8.4 Figure 2.9 shows that in the 2012 Do-Minimum scenario, the average maximum queue reaches approximately 490m on the A96 southbound at Broomhill Roundabout. In the four test scenarios the queue is reduced to less than 80m.

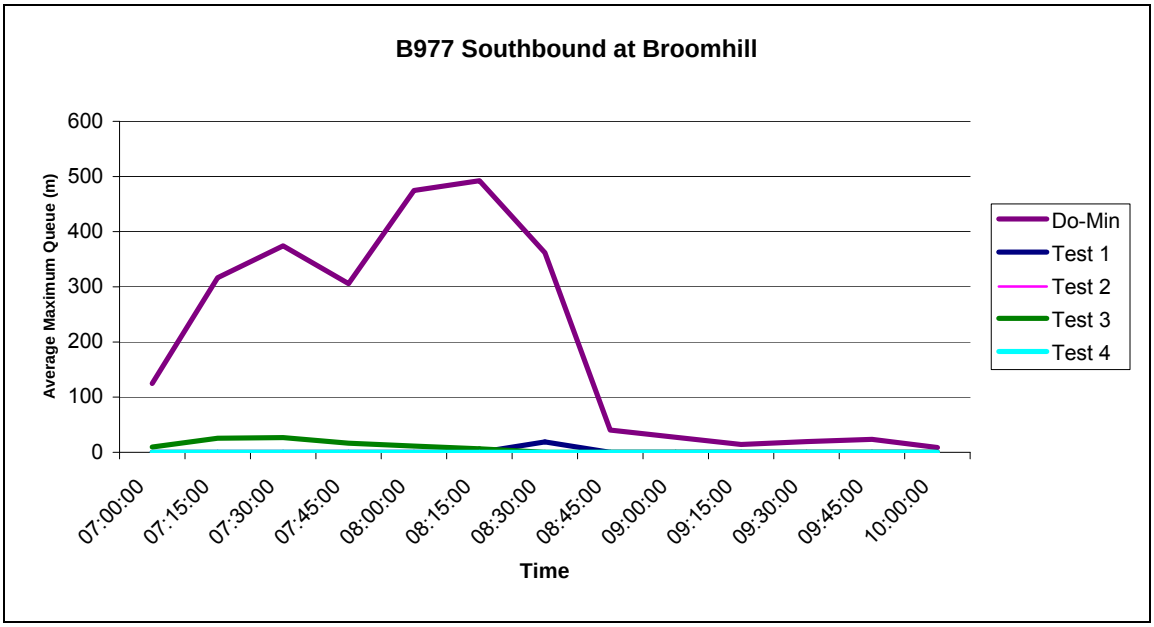

Figure 2.10 : B977 Southbound Queueing

2.8.5 Figure 2.10 shows that in the 2012 Do-Minimum scenario, the average maximum queue reaches approximately 500m on the B977 southbound at Broomhill Roundabout. No significant queueing was observed at this location in any of the test scenarios due to the introduction of segregated left turn lanes from the B977 southbound to the A96 southbound.

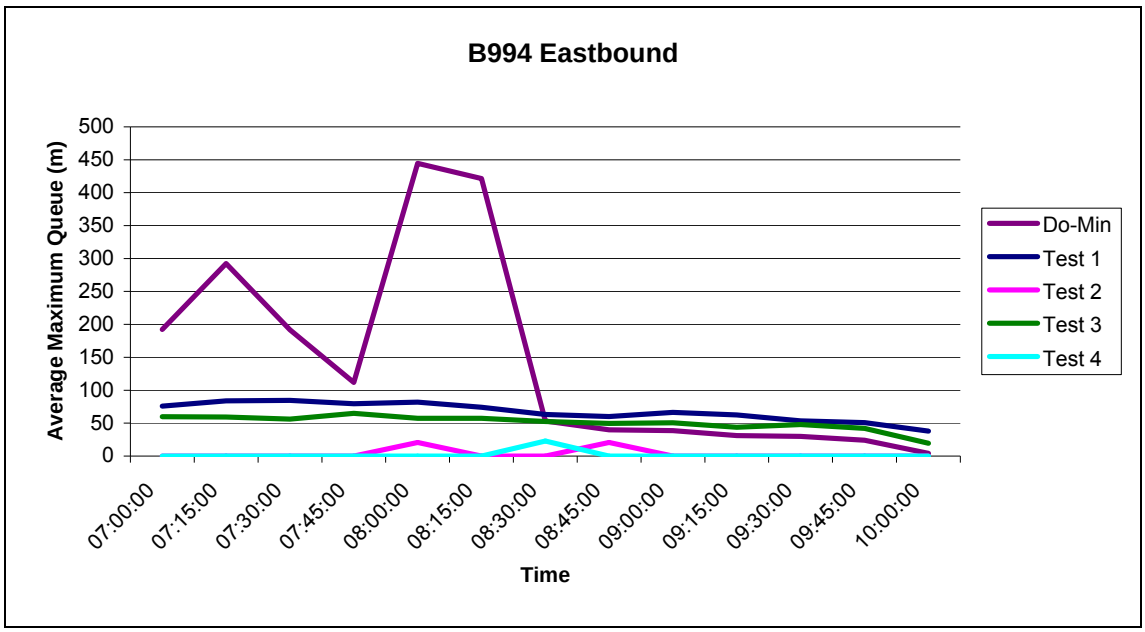

Figure 2.11 : B994 Eastbound Queueing

2.8.6 Figure 2.11 shows that in the 2012 Do-Minimum scenario, the average maximum queue reaches approximately 450m on the B994 Eastbound. This reduced to between 50m and 100m in the two scenarios with traffic signals at the B994/ B977 junction (Test 1 and Test 3). The two scenarios with a roundabout at the B977/ B994 junction were observed to have no significant queueing.

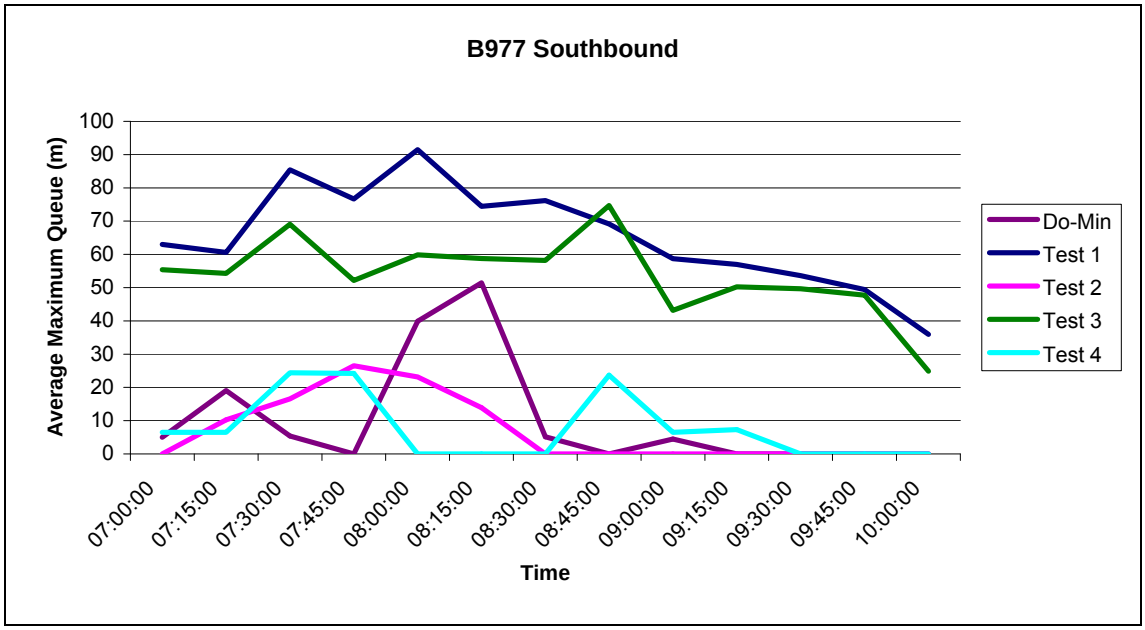

Figure 2.12 : B977 Southbound Queueing

2.8.7 Figure 2.12 shows that in Test 1, with traffic signals at the B977/ B994 junction, queueing was observed to be the highest at this location with queue lengths reaching 90m. When the B977 to A96 slip is introduced in Test 3 queue lengths on the B977 southbound are reduced due to the reduction in traffic using this route. Queue lengths in the two roundabout scenarios were observed to be less than 30m throughout the AM period.

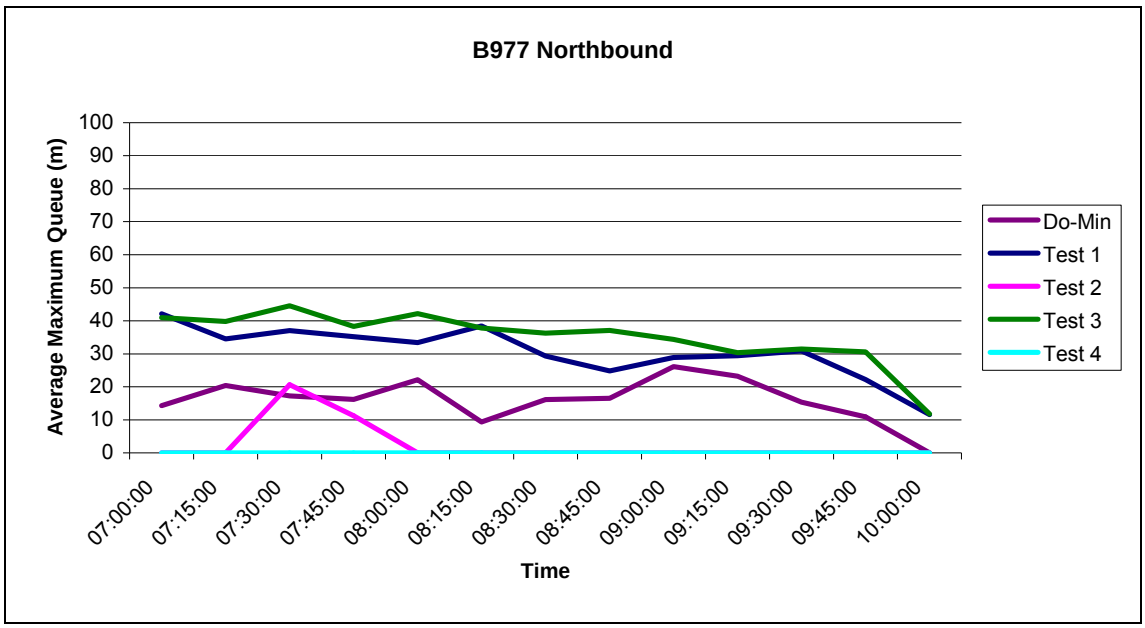

Figure 2.13 : B977 Northbound Queueing

2.8.8 Figure 2.13 shows that the two traffic signal scenarios (Test 1 and 3) were observed to have an average maximum queue length of approximately 40m, while no significant queueing was observed in the roundabout scenarios (Tests 2 and 4).

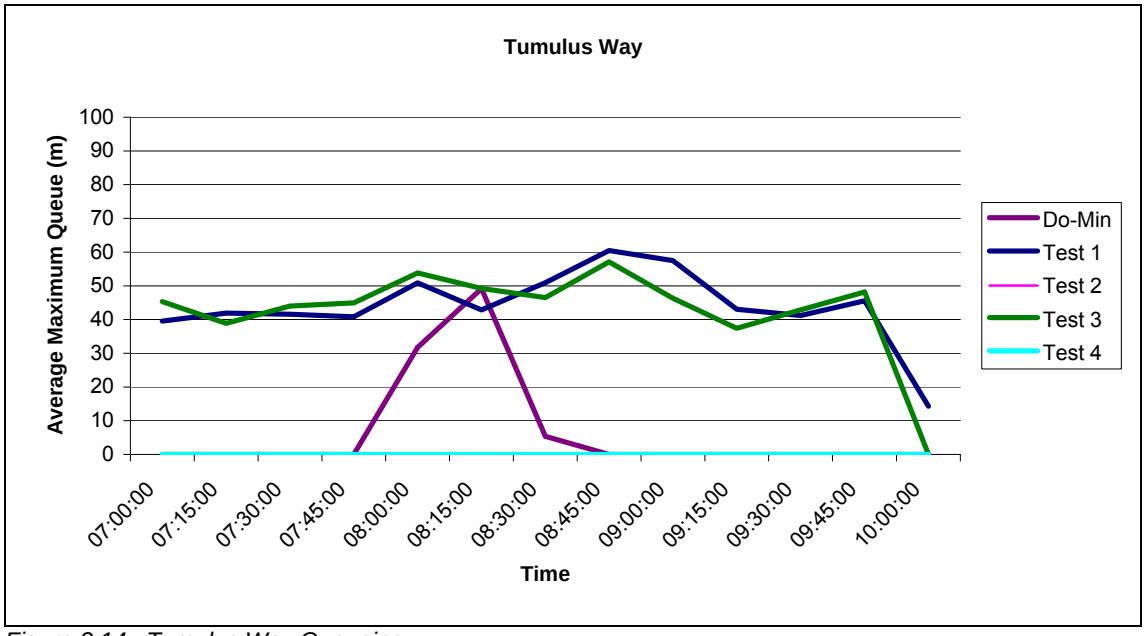

Figure 2.14 : Tumulus Way Queueing

2.8.9 Figure 2.14 shows that an average maximum queue length of approximately 60m was observed on Tumulus Way in the scenarios with traffic signals (Tests 1 and 3). In the roundabout scenarios (Tests 2 and 4) no queueing was observed.

AM Peak Queue Summary

2.8.10 In the AM peak, there were no significant differences in queue lengths between the scenarios at Broomhill Roundabout, however, all scenarios showed a significant reduction in queue length compared to the 2012 Do-Minimum. This was due to the improvements provided at Broomhill Roundabout in all four scenarios. At the B994/ B977/ Tumulus Way junction, queue lengths

were observed to be greater in Tests 1 and 3 due to the delay associated with the traffic signals. These queue lengths did not exceed 100m on any arm of the junction. Queue lengths on the B994 eastbound and B977 southbound were reduced in Test 3 compared to Test 1 due to the reduction in traffic on these routes. This is due to the B977 to A96 slip provided in Tests 3 and 4 which provides an alternative route onto the A96.

2.8.11 Figures 2.15 to 2.20 show the PM queue results. No queueing was observed on the B977 southbound at Broomhill Roundabout in the PM peak, so this location has been omitted from the comparisons at this stage.

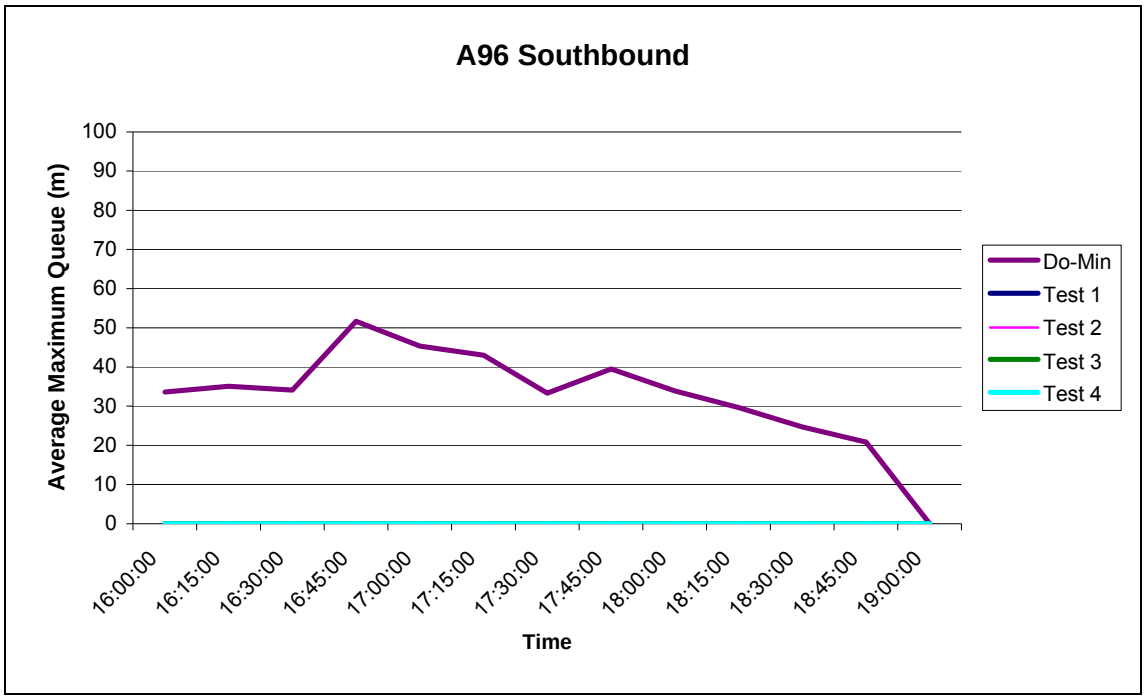

Figure 2.15 : A96 Southbound Queueing

2.8.12 Figure 2.15 shows that on the A96 southbound in the PM peak no queueing was observed in any of the four test scenarios, primarily due to the removal of the right turn from the A96 northbound to the B977.

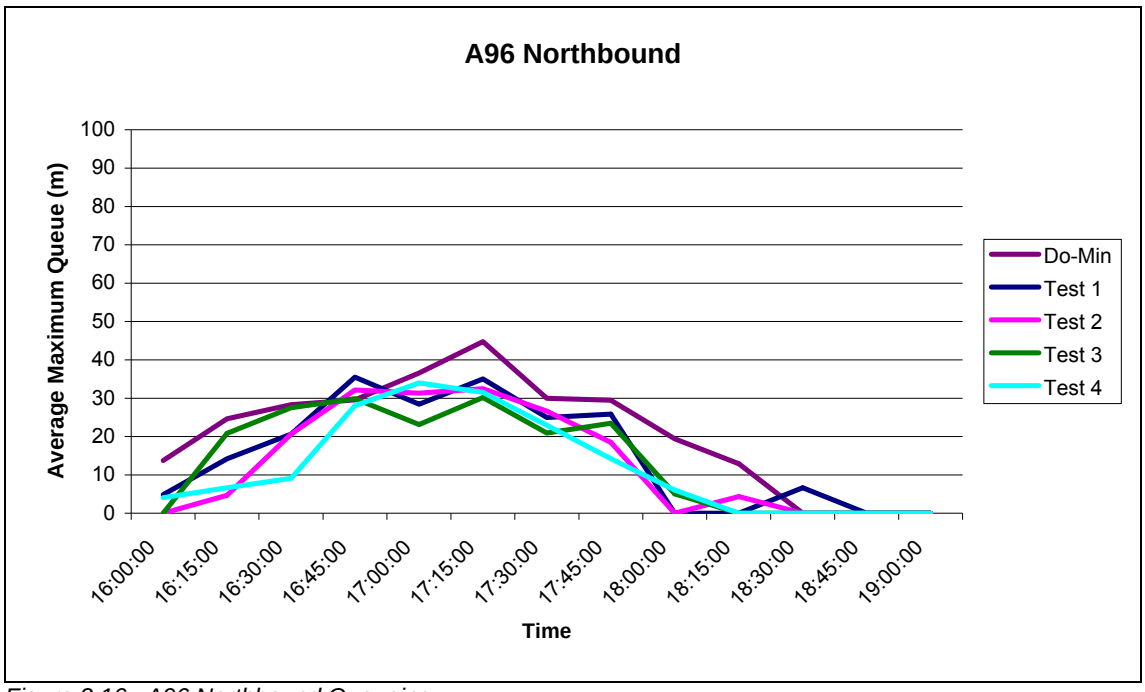

Figure 2.16 : A96 Northbound Queueing

2.8.13 Figure 2.16 shows that similar levels of queueing were observed on the A96 southbound in all four test scenarios and the 2012 Do-Minimum. Queueing was minimal in all scenarios with no queue observed to exceed 50m throughout the PM peak.

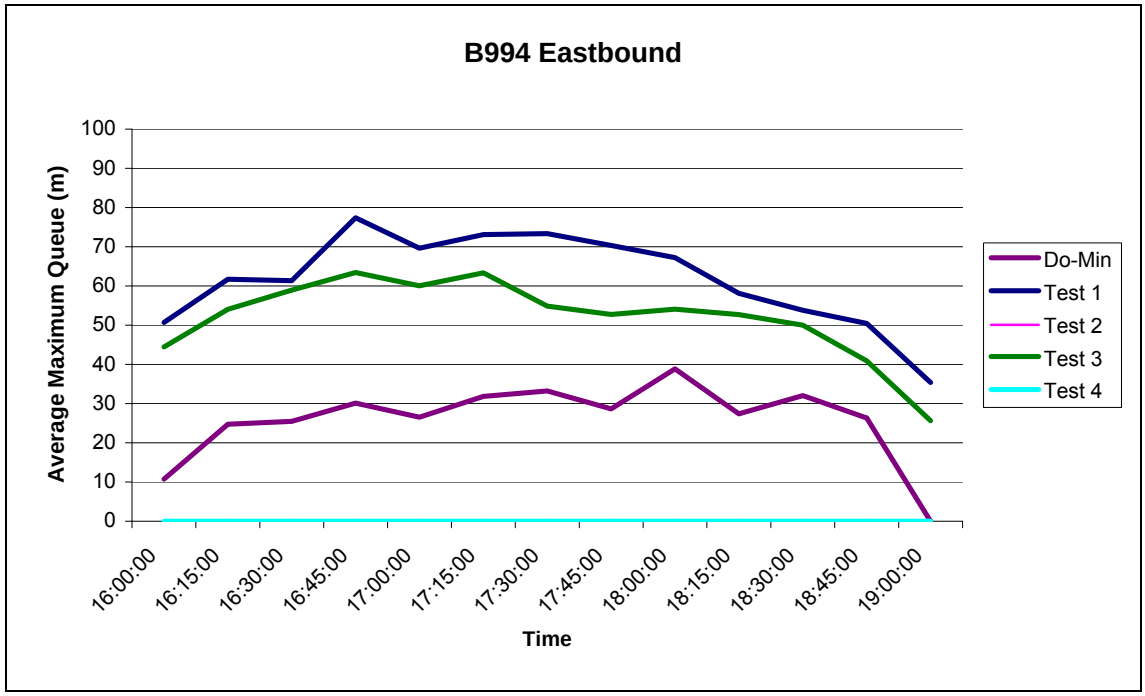

Figure 2.17 : B994 Eastbound Queueing

2.8.14 Figure 2.17 shows that on the B994 eastbound, queue lengths were observed to reach approximately 80m in Test 1 with traffic signals. The average maximum queue length was reduced in Test 3 due to the B977 to A96 slip road reducing routeing on the B994 eastbound. No queueing was observed in the two roundabout scenarios (Test 2 and 4).

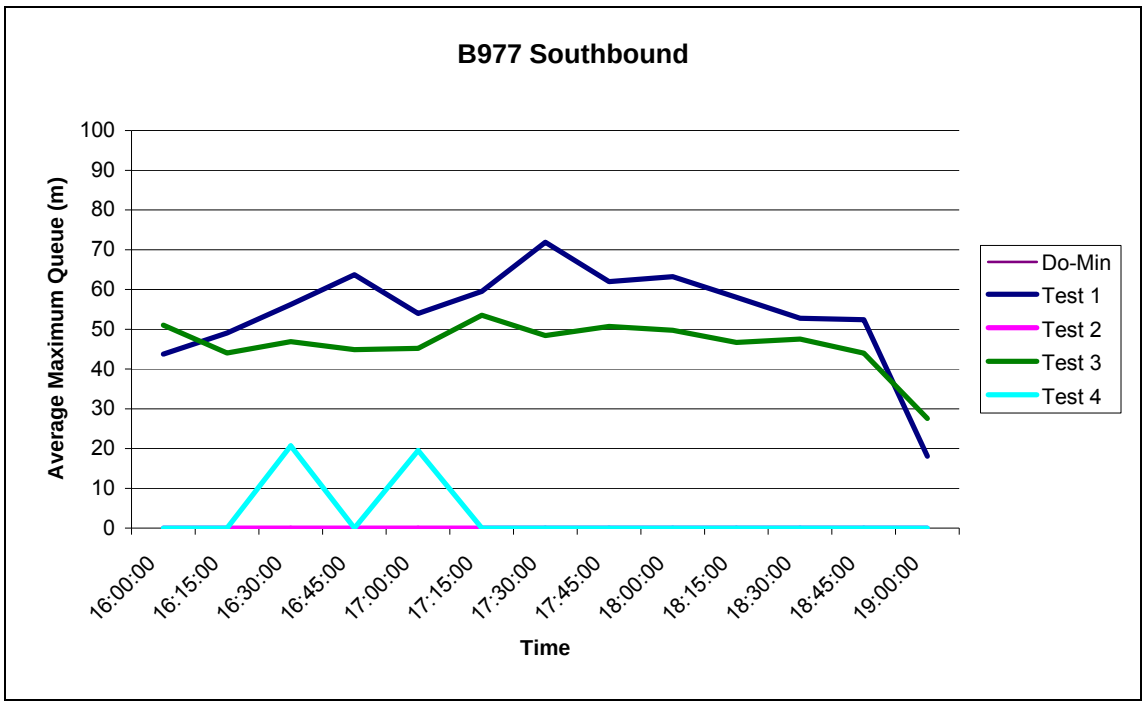

Figure 2.18 : B977 Southbound Queueing

2.8.15 Figure 2.18 shows that queueing on the B977 associated with the traffic signals reached approximately 70m in Test 1 and reduces to 50m in Test 3. No significant queueing was observed in the roundabout scenarios (Tests 2 and 4).

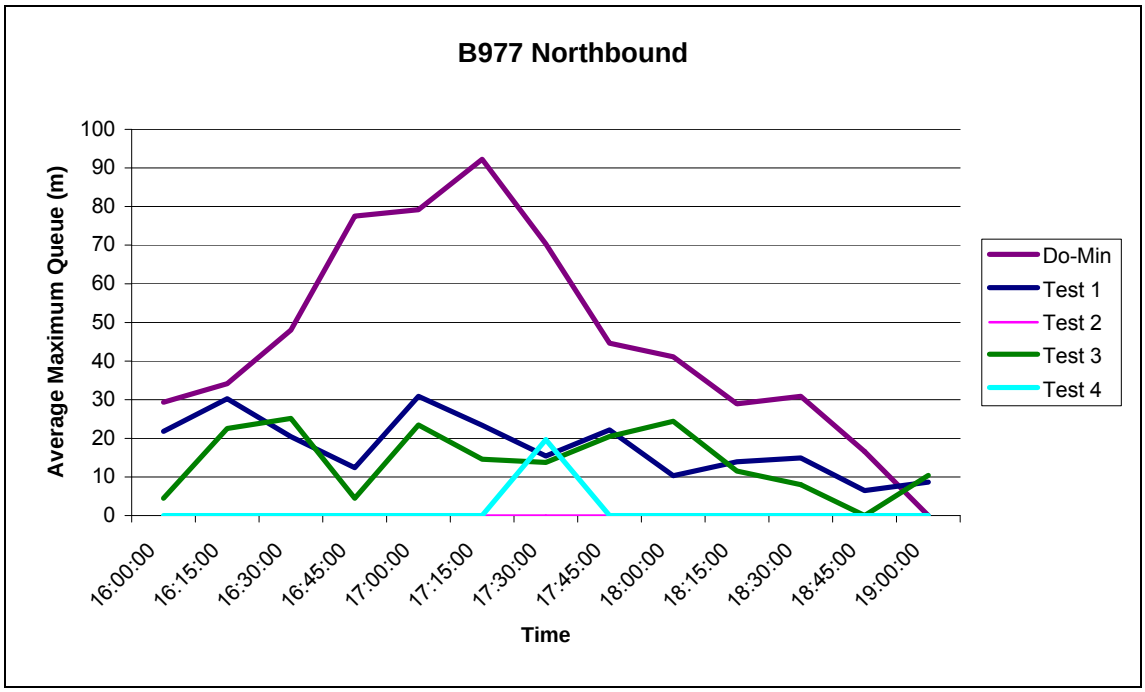

Figure 2.19 : B977 Northbound Queueing

2.8.16 Figure 2.19 shows that queue lengths in the 2012 Do-Minimum extended to approximately 90m on the B977 northbound. In Test 1 the average maximum queue was approximately 30m, reducing to approximately 25m in Test 3. No significant queueing was observed in the roundabout scenarios (Tests 2 and 4).

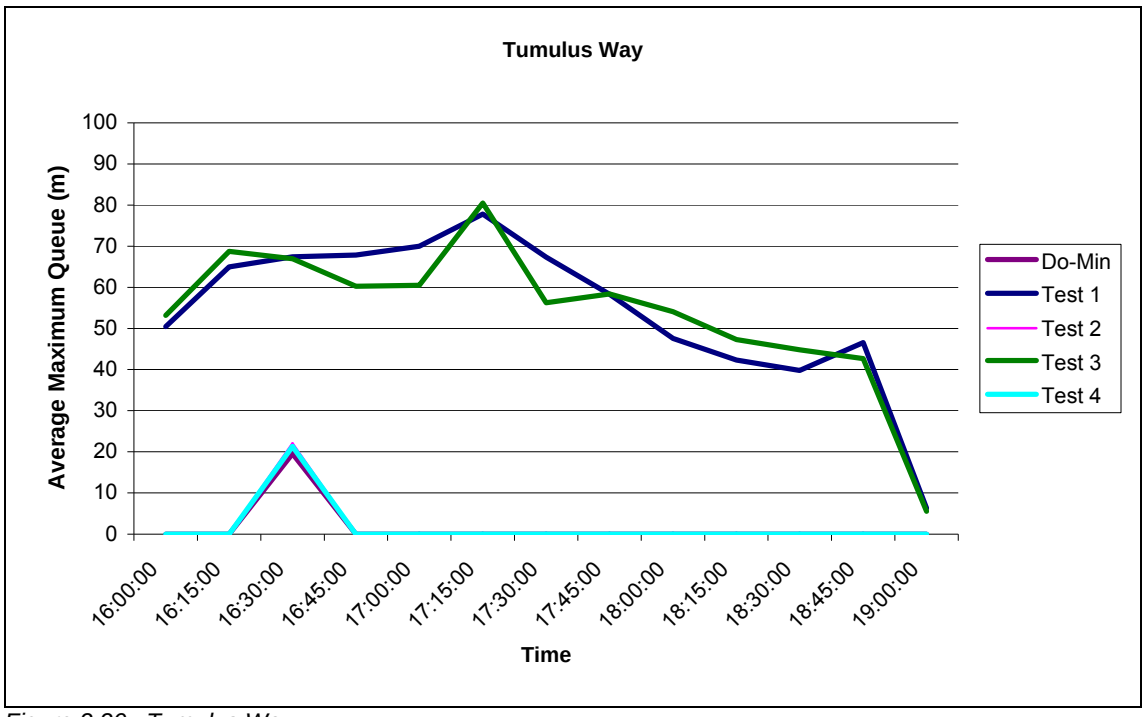

Figure 2.20 : Tumulus Way

2.8.17 Figure 2.20 shows that queue lengths on Tumulus Way extended to approximately 80m in Tests 1 and 3. No significant queueing was observed in the roundabout scenarios (Tests 2 and 4).

PM Peak Queue Summary

2.8.18 In the PM peak, there were no significant differences in queue lengths between the four scenarios at Broomhill Roundabout. At the B994/B977/Tumulus Way junction, queue lengths were observed to be greater in Tests 1 and 3 due to the delay associated with the traffic signals, although queue lengths did not exceed 100m on any arm of the junction. Queue lengths on the B994 eastbound and B977 southbound were reduced in Test 3 compared to Test 1, due to the reduction in traffic on these routes. The B977 to A96 slip included in Tests 3 and 4 provides an alternative route onto the A96.

2.9 Journey Time Comparison

2.9.1 Average journey times were compared on three routes in both directions, as shown in Figure 2.21. The routes compared were:

- A96 northbound and southbound – the length of the A96 in the model network
- B994 eastbound and westbound – from Gauchill roundabout to B994/B977 junction
- B977 northbound and southbound – from School Road/Kingsfield Road junction to Broomfield Roundabout

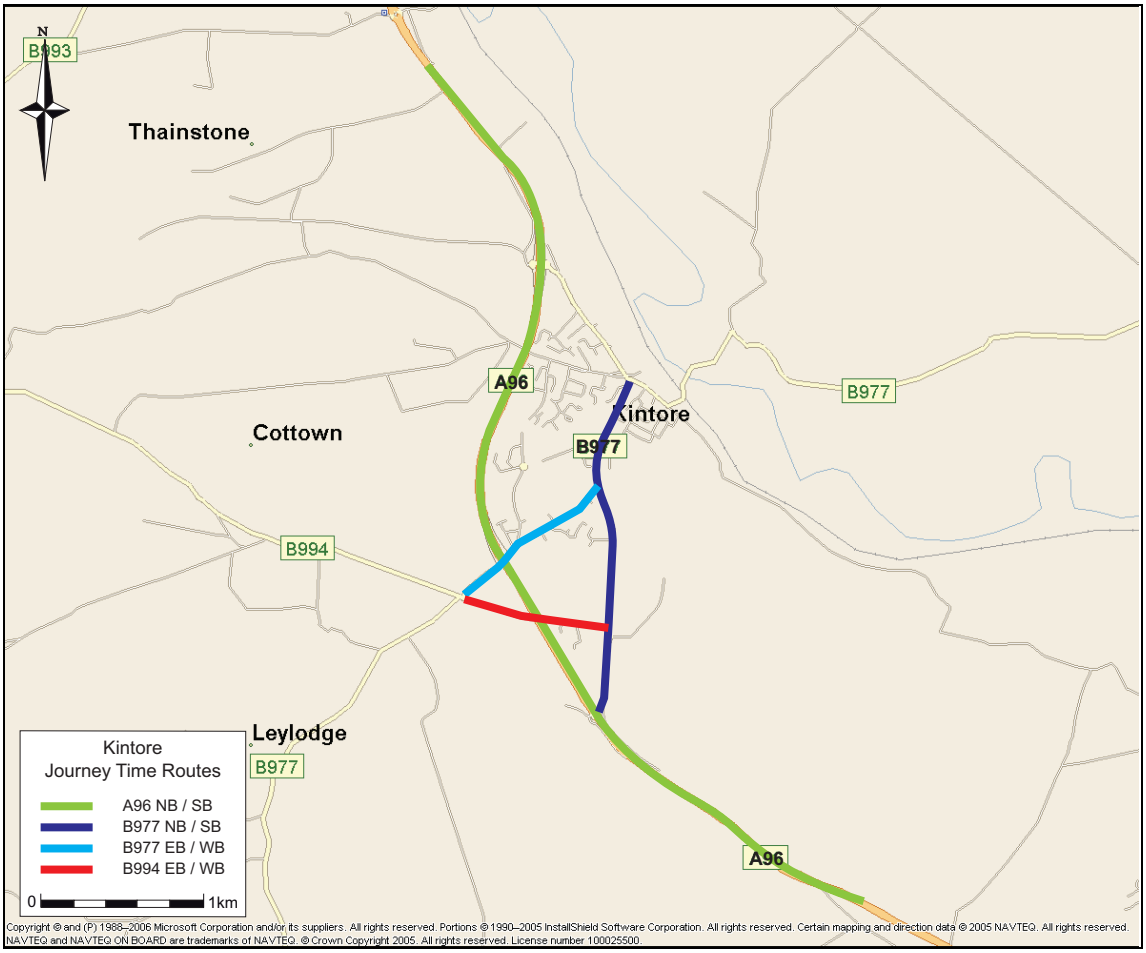

Figure 2.21 : Journey Time Routes

2.9.2 All journey time statistics are calculated from an average of five S-Paramics model runs. In both the AM and PM peaks, no significant changes were observed to journey times on the A96 northbound, B994 westbound, B977 eastbound and B977 northbound, so these routes have been omitted from the comparisons at this stage. Figure 2.22 shows the AM peak hour average journey times.

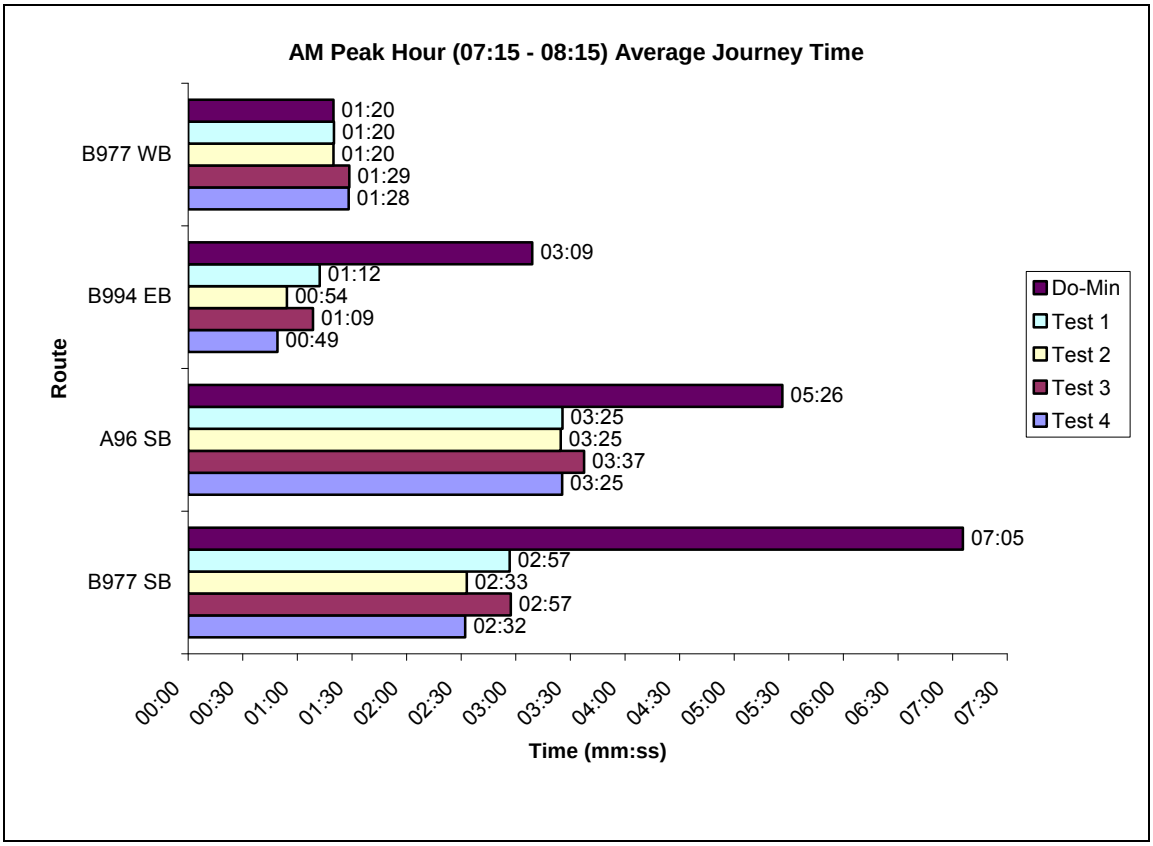

Figure 2.22 : AM Peak Hour Average Journey Times

2.9.3 Figure 2.22 shows that in the AM peak on the B977 southbound, A96 southbound and B994 eastbound, all four test scenarios show a benefit compared to the 2012 Do-Minimum.

2.9.4 Average journey times on the B977 westbound were observed to increase slightly in Tests 3 and 4 due to the addition of the B977 to A96 slip and associated junction in these tests.

2.9.5 On the B994 eastbound and B977 southbound journey times were longer in Tests 1 and 3, due to the delay associated with the traffic signals.

2.9.6 Figure 2.23 shows the PM peak hour average journey times.

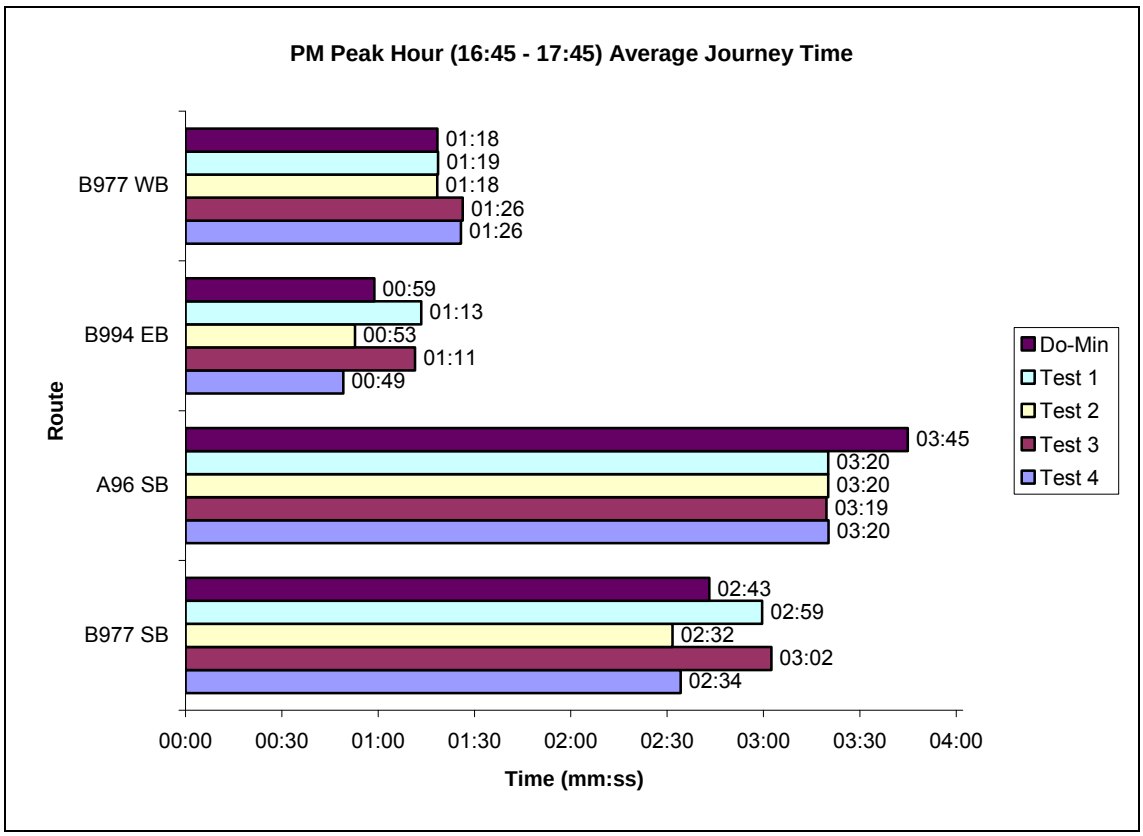

Figure 2.23 : PM Peak Hour Average Journey Times

2.9.7 Figure 2.23 shows that in the PM peak average journey times in the peak hour on the B977 westbound were observed to increase slightly in Tests 3 and 4, due to the addition of the B977 to A96 slip and associated junction in these tests.

2.9.8 On the B994 eastbound and B977 southbound, journey times were longer in Tests 1 and 3, due to the delay associated with the traffic signals. No significant differences in journey times were observed on the A96 southbound.

Journey Time Summary

2.9.9 The journey time results show significant benefits on the A96 southbound and B977 southbound in the AM peak in all four scenarios, compared to the 2012 Do-Minimum. This is due to the segregated left turn lanes at Broomhill Roundabout included in all four tests. In both the AM and PM peaks, journey times on the B977 southbound and B994 eastbound were longer in the signal scenarios (Tests 1 and 3) compared to the roundabout scenarios (Tests 2 and 4) due to the delay associated with the traffic signals.

3 SUMMARY

3.1.1 Four scenarios have been tested in the 2012 Kintore Do-Minimum model. All four tests include improvements to Broomhill Roundabout including segregated left turn slips from the A96 southbound to the B977 northbound and from the B977 southbound to the A96 southbound. A northbound slip from the A96 to the B994 is also included in each test scenario. Tests 1 and 3 are signal controlled at the junction of the B994/ B977/ Tumulus Way, and Tests 2 and 4 have a roundabout at this location encompassing all arms of the staggered junction. Test 3 and 4 have an additional slip from the B977 to the A96 southbound.

3.1.2 The introduction of improvements to Broomhill Roundabout were observed to significantly reduce queue lengths on the A96 southbound and B977 southbound in the AM peak and the A96 southbound in the PM peak. The Broomhill Roundabout improvements also provided journey time benefits on the A96 southbound and B977 southbound in all four tests in the AM peak compared to the 2012 Do-Minimum.

3.1.3 A northbound slip from the A96 to the B994 was included in all tests. Traffic which previously routed via the B977 northbound from Broomhill Roundabout must now use the new slip from the A96 to the B994 as the right turn from the A96 to the B977 at Broomhill Roundabout is not allowed in any of the test scenarios.

3.1.4 A southbound slip from the B977 to the A96 was included in Tests 3 and 4. The slip was observed to reduce traffic on the B994 eastbound and B977 southbound by providing a more direct route to the A96 southbound, however, the results showed no significant benefits in terms of journey time or queue length reductions.

3.1.5 The two designs tested for the junction of the B994/B977 and Tumulus Way were a signalised cross road junction and a roundabout option. The signal controlled junction provides benefits for pedestrians with a full pedestrian stage called every second cycle. The tests which include the signal controlled junction (Test 1 and 3) were observed to have intermittent queueing, due to the delay associated with the traffic signals. These queues cleared every cycle. No queueing was observed in the tests with the roundabout (Tests 2 and 4). There were no pedestrian facilities associated with these scenarios.

3.1.6 A possible recommendation for future work would be to test the scenarios with the roundabout at the junction of the B994/B977 and Tumulus Way with remote pedestrian crossing facilities.

3.1.7 No Kintore testing to date has included the influence of the Aberdeen Western Peripheral Route (AWPR), so no analysis has been undertaken in this study to determine what impact the AWPR could have on the local Kintore network.