

## Aberdeenshire Council Kintore Capacity Testing – Area D S-Paramics Modelling Testing

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## 1 INTRODUCTION

### 1.1 Background

- 1.1.1 Aberdeenshire Council (AC) requested that SIAS Limited (SIAS) undertake an assessment of the traffic impact of proposed development sites in Kintore, using the Kintore S-Paramics traffic model originally developed in 2008.
- 1.1.2 Three possible sites for the new developments, known as Areas A, B and C, were tested with S-Paramics in 2009. This analysis was covered in SIAS Report *Kintore Traffic Capacity Study (Ref. 71802)*.
- 1.1.3 This Report considers a revised masterplan of Area A, which for the purpose of reporting will be referred to as Area D. This Report should be read in conjunction with the previous Report (*Ref. 71802*).

### 1.2 Objectives

- 1.2.1 As in the previous report, the primary purpose of this assessment is to aid and inform AC on the potential impact on the road network of the Area D development site.
- 1.2.2 The principal objectives of this study were to:
- Evaluate the road network impact of the potential development areas
  - Evaluate the conceptual supporting infrastructure options proposed by Aberdeenshire Council

### 1.3 Kintore Model Background

- 1.3.1 The Base Kintore S-Paramics model was completed in 2008 using observed data from 2007 and is representative of 2007 conditions.
- 1.3.2 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



1.3.3 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

1.3.4 Figure 1.1 shows the Kintore study area.

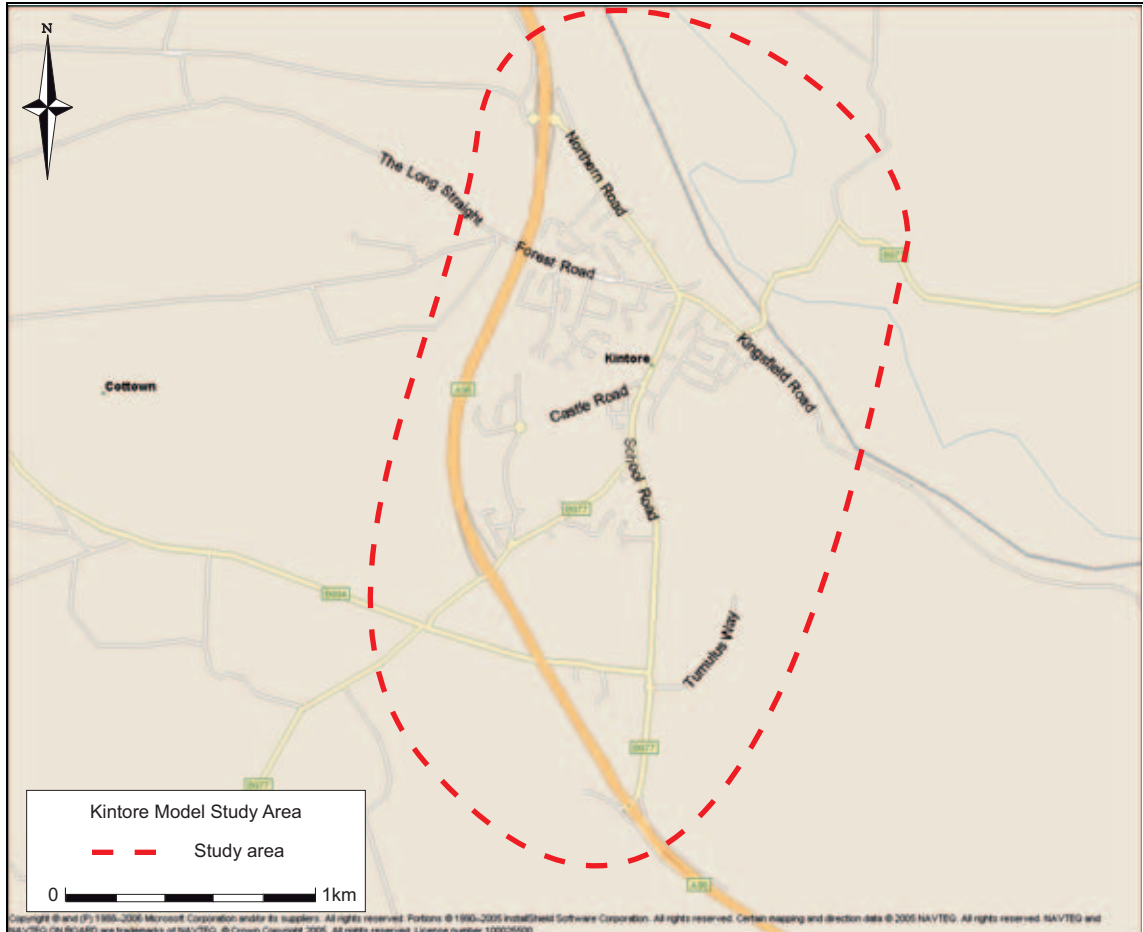


Figure 1.1 : Study Area

## 1.4 Test Scenarios

1.4.1 For this study, a Do-Minimum plus two different tests were required, as shown in Table 1.1.

Table 1.1 : Test Scenarios

Test	Model Content
2016 Do-Minimum	2016 Development
2016 Area D Test 1	Re-alignment of roundabout at Tumbula Way 2016 Development Re-alignment of roundabout at Tumbula Way <i>Broomhill Roundabout:</i> Left turn only from B977 arm No left turn from A96 north No right turn from A96 south Minor arm of Broomhill Roundabout connecting through to B994
2016 Area D Test 2	All Test 1 content A96 on slip from B977 Gaughill Road



1.4.2 Figure 1.2 shows the approximate location of the Area D development.

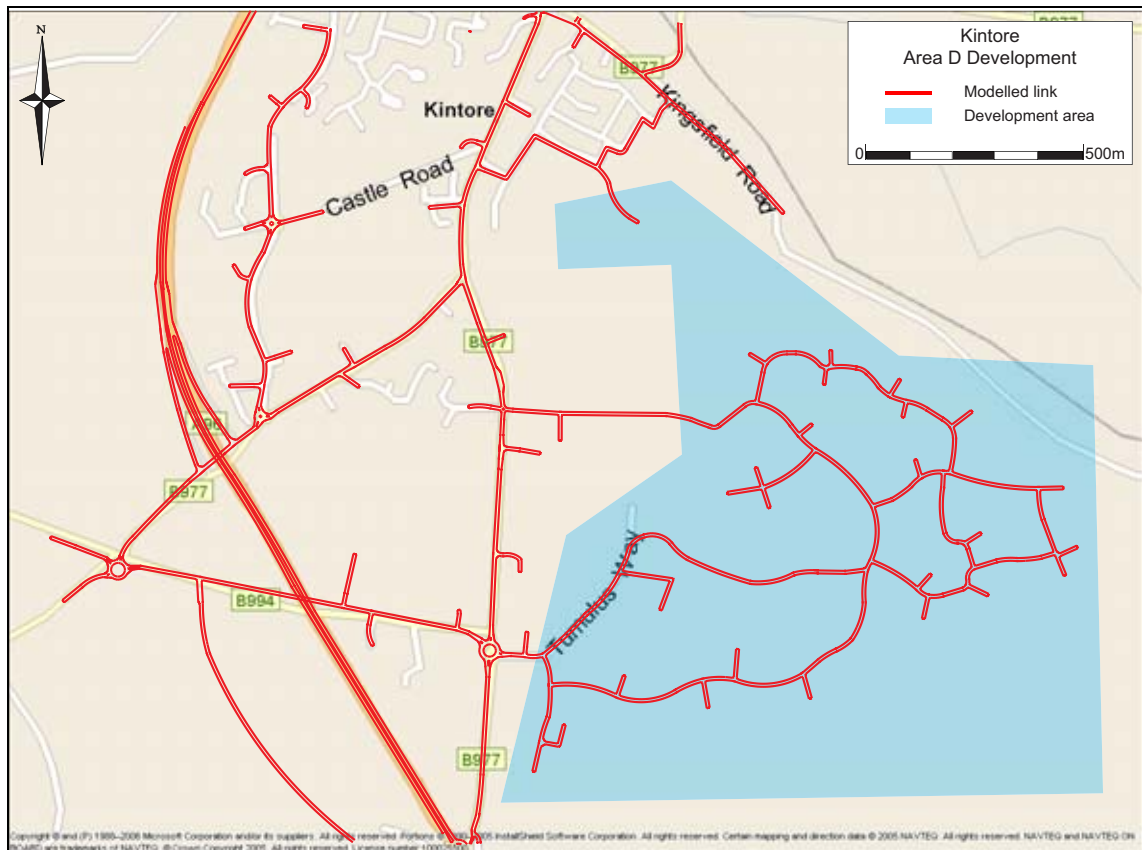


Figure 1.2 : Area D Development Proposal

### 1.5 Sensitivity Test

1.5.1 As a sensitivity test, both of the options have been run with increased flow on the A96. The increased flow is generated from proposed developments north of Kintore, in Inverurie, which have already been tested with S-Paramics in other work. All of the increases are assumed to come from, or go to, Aberdeen to the south.

1.5.2 The increased flow was found by subtracting the flow northbound (southbound) on the A96 in the Kintore model from the flow northbound (southbound) on the A96 in the Inverurie model. The resulting value was then added to the Kintore model.

1.5.3 Table 1.2 shows the increase in trips.

Table 1.2 : Increase in Flow in Sensitivity Test (3hr Period)

Period	Direction	Light Vehicle Flow			Heavy Vehicle Flow		
		Inverurie	Kintore	Difference	Inverurie	Kintore	Difference
AM	Northbound	3,430	2,630	<b>800</b>	363	302	<b>61</b>
	Southbound	5,299	4,863	<b>436</b>	282	201	<b>81</b>
PM	Northbound	6,942	5,778	<b>1,164</b>	191	174	<b>17</b>
	Southbound	4,054	3,227	<b>827</b>	206	142	<b>64</b>



## 2 TRIP ASSIGNMENT AND DISTRIBUTION

### 2.1 Introduction

- 2.1.1 All of the test models were based on the 2012 Do-Minimum model, which is described in previous work. They contain all committed developments in the study area.
- 2.1.2 Flows on the A96, B977 and B994 in the 2012 Do-Minimum model were increased to 2016 levels using NRTF growth factors of 1.059 for light vehicles and 1.064 for heavy vehicles.

### 2.2 2016 Development Content

- 2.2.1 Table 2.1 shows the proposed development content.

*Table 2.1 : 2016 Area D Development Content*

Development Type	Size
<i>Residential</i>	
Housing	1,200 units
<i>Industrial</i>	
Class 4 Business	7,500 m <sup>2</sup> GFA
Class 5 Business	7,500 m <sup>2</sup> GFA
Class 6 Warehouse	32,500 m <sup>2</sup> GFA
<i>Educational</i>	
Primary School	450 pupils
Secondary School	1,000 pupils
<i>Community Facilities</i>	
Nursery	765 m <sup>2</sup> GFA
Nursing Home	40 residents
Dentist/MC	582 m <sup>2</sup> GFA
Shop Units	902 m <sup>2</sup> GFA
Housing	95 units

- 2.2.2 Trip rates for the development content above have come from a variety of locations. Rates for the Residential and Industrial units came from TRICS 2008(b) and were used in previous Kintore work; rates for the Educational and Community Facilities also came from the TRICS database and were provided by Aberdeenshire Council. The trip rates are shown in Table 2.2.



Table 2.2 : Trip Rates for Area D Content

Development Type	AM Peak (07:00 - 10:00)		PM Peak (16:00 - 19:00)	
	In	Out	In	Out
<i>Residential</i>				
Housing	492	1,171	1,304	874
<i>Industrial</i>				
Class 4 Business	244	55	55	210
Class 5 Business	244	55	55	210
Class 6 Warehouse	315	151	131	275
<i>Educational</i>				
Primary School	142	108	28	46
Secondary School	253	162	76	121
<i>Community Facilities</i>				
Nursery	65	56	37	45
Nursing Home	10	6	8	10
Dentist/MC	38	13	14	42
Shop Units	123	114	151	152
Housing	39	93	103	69
<i>Total</i>	1,965	1,984	1,962	2,054

2.2.3 As is shown in the table, the nursery and the shop units of the community facilities have linked or pass by trips associated with them, effectively reducing the trip generation by 10% and 30% respectively.



2.2.4 Finally, the total new trips were calculated, and are shown in Table 2.3.

Table 2.3 : Total Area D Development Trips

Development Type	AM Peak (07:00 - 10:00)		PM Peak (16:00 - 19:00)	
	In	Out	In	Out
<i>Residential</i>				
Housing	492	1,171	1,304	874
<i>Industrial</i>				
Class 4 Business	244	55	55	210
Class 5 Business	244	55	55	210
Class 6 Warehouse	315	151	131	275
<i>Educational</i>				
Primary School	142	108	28	46
Secondary School	253	162	76	121
<i>Community Facilities</i>				
Nursery	65	56	37	45
Nursing Home	10	6	8	10
Dentist/MC	38	13	14	42
Shop Units	123	114	151	152
Housing	39	93	103	69
<b>Total</b>	<b>1,965</b>	<b>1,984</b>	<b>1,962</b>	<b>2,054</b>

## 2.3 Trip Distribution

2.3.1 The trip distribution for the new development trips has been calculated as in the previous work. The distribution of trips from a gravity model provided by AC was applied to external trips of the Area D development.

- 36.2% A96 South
- 44.3% A96 North
- 19.5% B994 West

2.3.2 The average proportion of commuter traffic was calculated for existing housing and employment zones in the model and this proportion was applied to the proposed 2016 development. The commuter trips were distributed as per the gravity model.

2.3.3 As in previous work, the trip matrix was adjusted to allow for trips which start at the development and end elsewhere in Kintore, or vice versa.

2.3.4 A new zone was placed in the model for the employment area, each school and the community facilities. In addition, each new area of housing was represented by a new zone.



### **3 NEW ROAD TRAFFIC IMPROVEMENTS**

#### **3.1 Introduction**

- 3.1.1 In order to accommodate the new developments, new road facilities have been designed by AC and have been tested in this analysis. They were compared against a Do-Minimum model, which contains the new development and the re-alignment of the Tumulus Way roundabout but otherwise contains no road improvements.
- 3.1.2 Two separate options, Test 1 and Test 2, were developed, which are identical except for a new A96 On Slip from the B977.
- 3.1.3 The new junction at the Community Centre is currently coded as a priority junction which works adequately, but can be built as a signalised junction in the future, particularly to improve pedestrian and cycle facilities.

#### **3.2 Test 1**

- 3.2.1 This scenario features the new roundabout on Tumulus Way/B977, which now directly links with the B994.
- 3.2.2 The Broomhill roundabout further south is now extensively altered. Southbound vehicles on the B977 now access the A96 by means of a segregated left turn and slip lane; moreover, vehicles from the B977 cannot now access the roundabout meaning they cannot access the A96 northbound. The northbound arm of the B977 has now been closed off entirely. Initial analysis identified the flow of southbound traffic on the A96 that turned left to the B977 amounted to approximately 300 vehicles in the whole of the AM period. This closure will result in more traffic passing through Kintore to reach the new development sites.
- 3.2.3 Northbound traffic wishing to leave the A96 use a new link road built off the minor arm of the roundabout. This arm now links with the B994, forming a signalised junction. Traffic from the B994 may not turn into the new link road. No pedestrian facilities have been coded into the signalised junction at the new link road, however, walk with facilities could be provided.
- 3.2.4 Figure 3.1 shows the new link road and the new Tumulus Way roundabout. Figure 3.2 shows a more detailed diagram of the Broomhill roundabout.



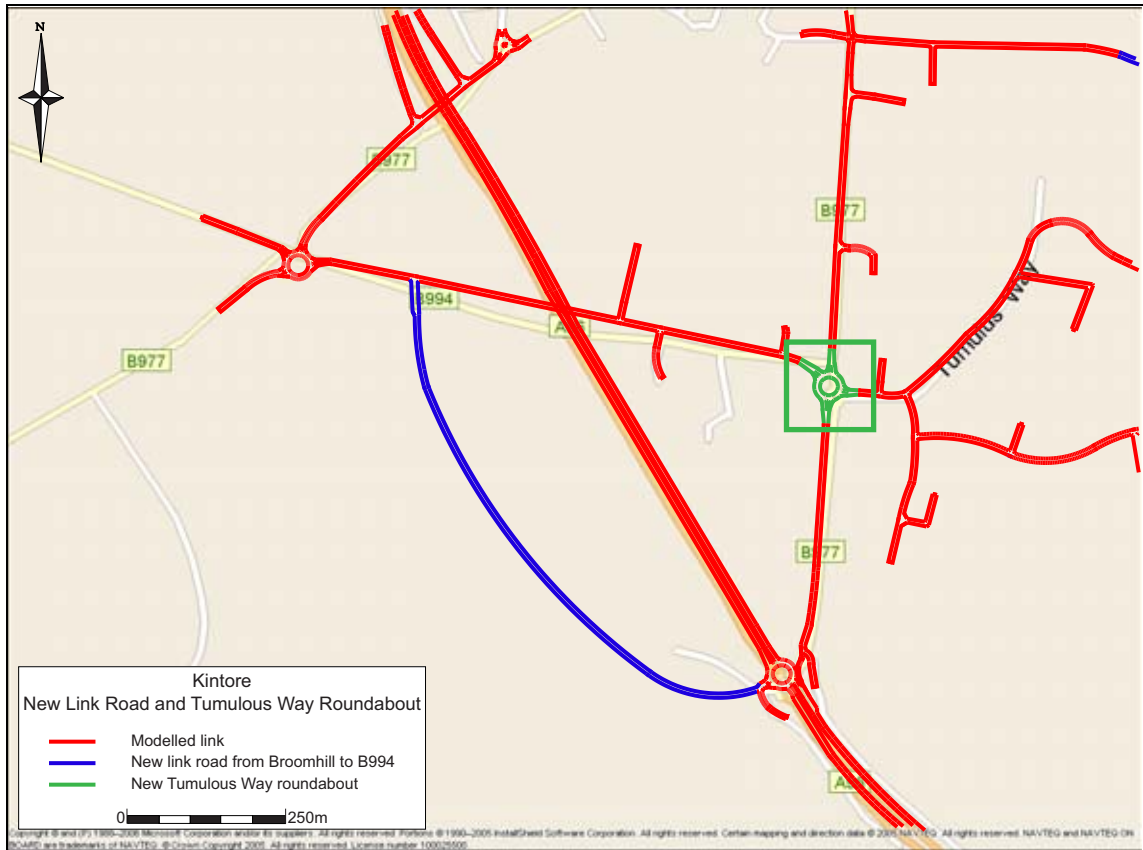


Figure 3.1 : New Link Road and Tumulus Way Roundabout

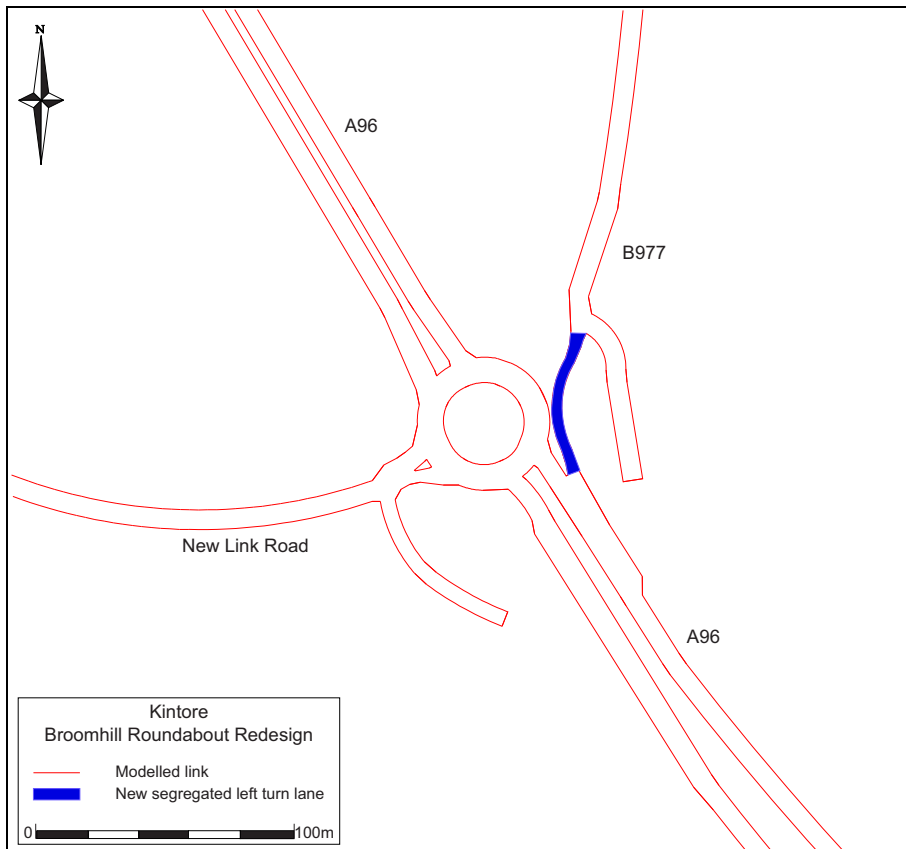


Figure 3.2 : Broomhill Roundabout Redesign





3.2.5 The measures at Broomhill are designed to prevent traffic from the A96 northbound turning right at the roundabout and so causing excessive queueing on the A96 southbound arm. Moreover, the segregated left turn with slip on the B977 prevents queueing on this arm.

**3.3 Test 2**

3.3.1 Test 2 features all of the improvements in Test 1, plus a new On Slip from the B977 to the A96. Figure 3.3 shows the new On Slip.

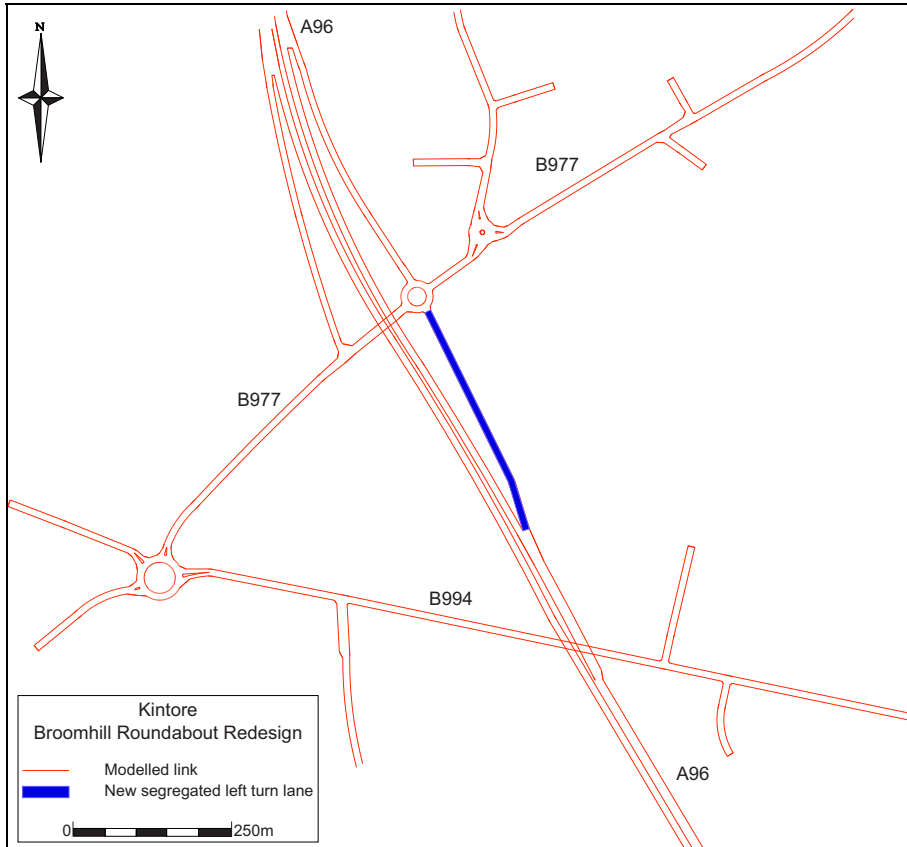


Figure 3.3 : B977/A96 On Slip

3.3.2 The new slip road is designed to reduce flow southbound on the B977 and eastbound on the B994.



## 4 MODEL ANALYSIS

### 4.1 Introduction

4.1.1 As in previous work, the test scenarios in Table 1.1 have been evaluated using

- Model observations
- Traffic flow comparison at key location
- Average queue length comparisons
- Average journey time comparisons

4.1.2 The sensitivity tests have been analysed, and the model observations and journey times are presented as follows.

### 4.2 Model Observations

#### 4.2.1 2016 Do-Minimum

In the AM, severe congestion rapidly builds up on the A96 north and B977 arms of the Broomhill roundabout. Congestion on the B977 in turn leads to queueing on Tumulus Way and the B994, reaching to the model extents. In the PM, there is markedly less congestion with some operational queueing on the A96 north and A96 south arms of the Broomhill roundabout.

#### 4.2.2 Test 1

In contrast to the Do-Minimum, there is no evidence of any significant congestion anywhere in the model in both the AM and the PM models. There is occasional operational queueing at the New Link Road/B994 junction. Removing the right turn from the A96 south to the B977 has the effect of greatly increasing the capacity on the A96 north arm of the roundabout. In addition, the segregated left turn from the B977 increases the capacity from this arm.

#### 4.2.3 Test 2

This option operates rather similar to Test 1, with the exception that there is a slightly longer operational queue on the A96 north arm of the Broomhill roundabout. This is due to the greater flows on this arm from the On Slip at the B977 Gauchhill Road.

#### 4.2.4 Test 1 Sensitivity Analysis

In the AM, this option operates in much the same manner as Test 1. In the PM, there is a degree of queueing and slow speeds on the A96 northbound, but otherwise performs in the same fashion as Test 1.

#### 4.2.5 Test 2 Sensitivity Analysis

There is rather more congestion in this test. In the AM, a long queue develops southbound on the A96 from the Broomhill roundabout. Although much shorter than the queue that develops in the Do-Minimum, it sometimes results in traffic travelling southbound on the A96 leaving the A96 and travelling along the B977, and then re-entering the A96 on the northern arm of the Broomhill roundabout. In the PM, this test performs much as the Test 1 sensitivity analysis, with some delay on the A96 northbound



### 4.3 Traffic Flow Comparisons at Key Junctions

4.3.1 As in previous work, peak hour traffic flows 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

4.3.2 Previous work identified 07:15 – 08:15 as the AM peak hour and 16:45 – 17:45 as the PM peak hour.

4.3.3 The traffic flows were calculated as an average of five runs, and are shown as a difference to the Do-Minimum model. The count locations are shown in Figure 4.1.

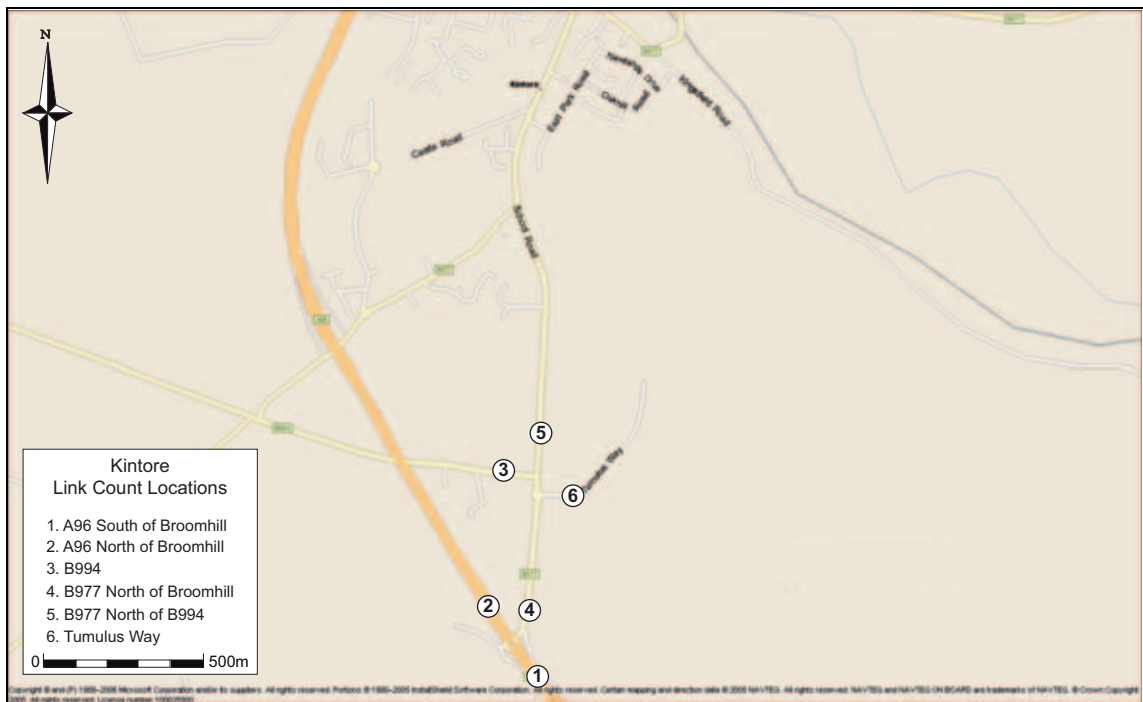


Figure 4.1 : Link Count Locations

4.3.4 Table 4.1 shows the AM peak hour flows.



Table 4.1 : AM Peak Hour Link Count Comparisons

Ref	Location	2016 Do-Minimum	Changes from Do-Minimum	
			Test 1	Test 2
1	A96 NB south of Broomhill	828	3	8
1	A96 SB south of Broomhill	1,968	451	439
2	A96 NB north of Broomhill	471	4	7
2	A96 SB north of Broomhill	1,429	51	511
3	B994 EB	843	484	79
3	B994 WB	106	148	180
4	B977 NB north of Broomhill	461	N/A	N/A
4	B977 SB north of Broomhill	640	302	-162
5	B977 NB north of B994	183	0	3
5	B977 SB north of B994	218	183	119
6	Tumulus Way EB	617	99	86
6	Tumulus Way WB	34	337	365

4.3.5 The results show that there has been an increase in flow on the A96 southbound, south of the Broomhill roundabout in both test models. The main reason for this is due to the severe congestion in the Do-Minimum model causing large queues and so reducing flow. Traffic flow southbound on the A96 north of the roundabout is only marginally higher in the Test 1 scenario, but is far greater in the Test 2 scenario. This is due to the new slip road from the B977. Traffic flows on the B977 north of Broomhill are consequently greater in Test 1 and are lower in Test 2. Flows on other roads tend to be greater in Test scenarios, reflecting the much reduced congestion in these models.

4.3.6 Table 4.2 shows the PM peak hour flows.

Table 4.2 : PM Peak Hour Link Count Comparisons

Ref	Location	2016 Do-Minimum	Changes from Do-Minimum	
			Test 1	Test 2
1	A96 NB south of Broomhill	2,628	9	6
1	A96 SB south of Broomhill	1,145	-3	-3
2	A96 NB north of Broomhill	1,945	-166	-165
2	A96 SB north of Broomhill	677	-43	65
3	B994 EB	351	317	234
3	B994 WB	706	-314	-297
4	B977 NB north of Broomhill	1,014	N/A	N/A
4	B977 SB north of Broomhill	804	-296	-404
5	B977 NB north of B994	444	-125	-118
5	B977 SB north of B994	303	-34	-62
6	Tumulus Way EB	381	-39	-59
6	Tumulus Way WB	668	-44	-37

4.3.7 The results show a broad drop in flows from the Do-Minimum to the test models in contrast to the AM which showed a broad increase. This is due to there being far lower congestion in the PM Do-Minimum, which allows all demand through in the peak hour; at the same time, the new link road in the test models takes a lot traffic from the study locations. The only link that shows a significant increase in flow in the test models is on the B994 eastbound. This will now carry flow from the A96 south to the new developments that would previously have directly used the Broomhill roundabout.



#### 4.4 Queue Length Comparisons

4.4.1 Queue lengths were compared at a number of locations where queueing was observed in the Do-Minimum model. These locations are:

- B977 southbound
- B994 eastbound
- A96 southbound
- A96 northbound
- New Link Road northbound

4.4.2 Table 4.3 shows the maximum queue lengths for the AM period.

*Table 4.3 : AM Peak Hour Maximum Queue Lengths (metres)*

Route	2016		
	Do-Minimum	Test 1	Test 2
B977 SB	487	0	0
A96 SB	1,065	27	55
A96 NB	0	0	0
B994 EB	223	29	26
New Link Road	N/A	68	70

4.4.3 The results show severe queueing in the Do-Minimum on the B977 southbound, A96 southbound and the B994 eastbound routes. In the test models, there is insignificant queueing on all of the routes, with the exception of the A96 southbound in the Test 2 scenario, which is still almost ten times shorter than the respective Do-Minimum queue.

4.4.4 Table 4.4 shows the maximum queue lengths for the PM period.

*Table 4.4 : PM Peak Hour Maximum Queue Lengths (metres)*

Route	2016		
	Do-Minimum	Test 1	Test 2
B977 SB	56	0	0
A96 SB	132	0	0
A96 NB	62	36	31
B994 EB	25	23	16
New Link Road	N/A	73	84

4.4.5 In the PM, there is markedly lower queueing in the Do-Minimum period. Queues in the test models are also low. Queues on the new link road are slightly higher in the PM period than in the AM period.

#### 4.5 Journey Time Comparison

4.5.1 Average journey times were compared on four routes in both directions. The routes are:

- B977 between Tumulus Way and Northern Road
- B994 between the branches of the B977
- A96 between the model extents



- B977 eastbound and westbound running north of the B994 route

4.5.2 The routes are shown in Figure 4.2.

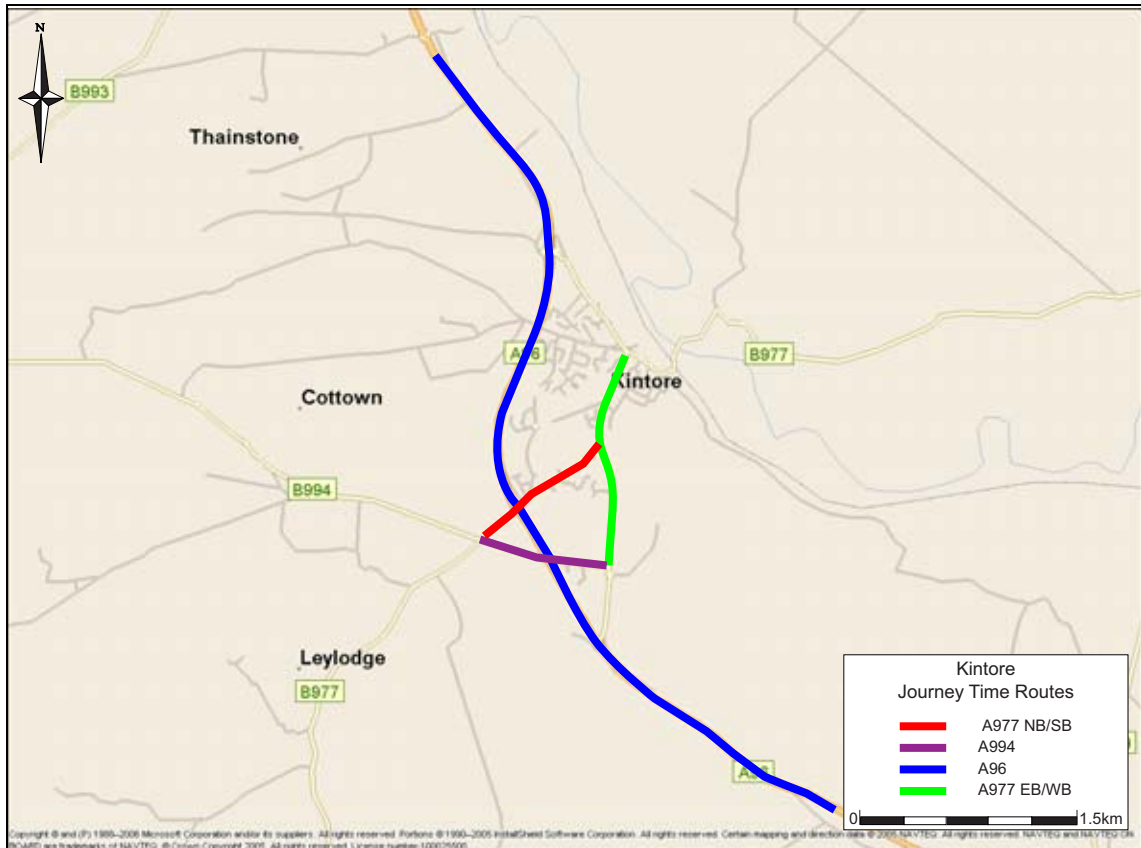


Figure 4.2 : Journey Time Routes

4.5.3 The AM average journey times are shown in Table 4.5 below.

Table 4.5 : AM Peak Hour Average Journey Times (seconds)

Ref	Route	2016 Do-Minimum	Test 1	Test 2	Test 1 Sensitivity	Test 2 Sensitivity
1	B977 NB	124	124	124	122	127
1	B977 SB	635	127	128	129	139
2	B994 EB	159	62	59	63	60
2	B994 WB	52	62	60	61	61
3	A96 NB	211	211	211	211	211
3	A96 SB	635	209	212	211	285
4	B977 EB	94	89	97	89	97
4	B977 WB	232	84	106	86	117

4.5.4 The results show that there is little difference between the two tests. The only notable differences between the tests are slightly higher journey times in Test 2. These were at the A96 southbound, caused by increased flow in this direction, and the B977 in both directions, caused by a new roundabout on to the new On Slip.

4.5.5 The modelling results suggest that both of the Tests offer vastly better performance than the Do-Minimum, which suffers from large delay particularly at the B977 southbound, the B994



eastbound, the A96 southbound and the B977 westbound. In all occasions, the delay is caused by queues blocking back from the Broomhill roundabout.

4.5.6 Of the sensitivity tests, only the A96 southbound in Test 2 is noticeably different. Vehicles in this scenario are somewhat slower than those in the main Test 2, without the extra Inverurie traffic. However, the times are still quicker than in the Do-Minimum.

4.5.7 The PM average journey times are shown in Table 4.6.

Table 4.6 : PM Peak Hour Average Journey Times (seconds)

Ref	Route	2016		Test 1		Test 2	
		Do-Minimum	Test 1	Test 2	Sensitivity	Sensitivity	
1	B977 NB	118	126	125	125	123	
1	B977 SB	128	127	129	127	129	
2	B994 EB	49	78	77	79	76	
2	B994 WB	56	116	122	107	116	
3	A96 NB	225	221	221	379	383	
3	A96 SB	264	204	204	205	206	
4	B977 EB	90	89	97	89	97	
4	B977 WB	80	81	96	81	95	

4.5.8 The results for the new options show there are slightly higher journey times in Test 2 on the B994 westbound and the B977 in both directions, but the difference is not significant.

4.5.9 The difference between the options and the Do-Minimum is far less pronounced in the PM peak hour. Only the A96 southbound is noticeably higher in the Do-Minimum; however, the time is quicker than in the AM. On the B994 in both directions, the Do-Minimum is actually faster than the options. This is caused by the new traffic signals on this road slowing traffic down.

4.5.10 The A96 northbound is much slower in both of the sensitivity tests compared with the Do-Minimum scenario and both of the Tests. All of this delay is incurred south of the Broomhill roundabout.



## 5 SUMMARY AND CONCLUSIONS

- 5.1.1 Aberdeenshire Council commissioned SIAS to test a new development proposal, named Area D. The analysis is an extension of other work, described in SIAS Report *Kintore Traffic Capacity Study (Ref. 71802)*, which tested Areas A, B and C, which were similarly sized developments around Kintore.
- 5.1.2 Two different options were developed in order to accommodate the new development. Test 1 features a new roundabout at Tumulus Way, a new link road from the Broomhill roundabout to the B994 (traffic from the B994 is barred from entering the new link road), and the closure of the B977 northbound and southbound arms at the Broomhill roundabout except for a new segregated left turn slip lane southbound to the A96. Test 2 has all of the Test 1 improvements, plus a new on slip from the B977 to the A96.
- 5.1.3 In the AM both of the new options were shown to perform far better than a Do-Minimum option. All of the benefit was derived from reduced delay at the Broomhill roundabout. The lack of a right turn movement from the A96 northbound arm eased flow southbound, while the closure of the B977 southbound prevents delay to traffic on this arm.
- 5.1.4 There is little difference between the two options, but where there is a difference, Test 1, without the new On Slip from the B977, performs slightly better. This is because queues on the A96 southbound in Test 2 tend to be slightly longer, without a complementary reduction in delay southbound on the B977. It should be noted that the new On Slip does remove a large volume of traffic from the roads around Tumulus Way in Test 2 which may provide future benefits.
- 5.1.5 In the PM, there is little difference between the new options and the Do-Minimum.
- 5.1.6 The new link road is necessary to take traffic from the A96 northbound arm that wishes to enter Kintore. Traffic on this road would previously have entered Kintore by turning right at the Broomhill roundabout. The road must be signalised at the junction with the B994 to prevent excessive delay.
- 5.1.7 The junction with the Community Centre is currently coded as a priority junction but can be coded as a signalised junction to improve pedestrian and cycle accessibility.
- 5.1.8 A sensitivity test was also run in both of the Tests, in which additional traffic from proposed developments in Inverurie is placed on the A96 northbound and southbound. The result of this analysis suggests additional queueing on the A96 southbound in Test 2 in the AM. This can also result in southbound traffic leaving the A96 via the B977 and re-entering the A96 from the north. In the PM, the sensitivity test suggests slower journey times and queueing northbound on the A96 in both of the new Tests.
- 5.1.9 Both of the test options have featured a segregated left turn and slip lane from the B977 to the A96 at the Broomhill roundabout. It may be the case that a design without this feature may be acceptable provided the On Slip on the B977 is built to cater for traffic from Broomhill.

