A55 Knock Road

Appendix D - SATURN Modelling Report

NI004/CO00400445

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Service is our passion. People, our strength

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1. Introduction

1.1. Background

1.1.1. Road Service has commissioned Amey to fully evaluate the impact associated with the proposed upgrade of the A55 Knock Road.

1.1.2. The Belfast Metropolitan Transport Plan (BMTP 2015) has identified the A55 Outer Ring Road as part of the strategic highway network with an increasingly more important role in the future and proposes widening 'to a four lane single carriageway'.

1.1.3. The section under consideration is the 1km stretch of the A55 Outer Ring Road between the service station near the Glen Road traffic lights and the Upper Newtownards Road junction (Figure D1). This will include intersections at Kings Road, Cherryvalley, Kensington Road, Knockcastle Park, Knockwood Park, Knockmount Park, Ascot Park, Shandon Road, and Knockvale Park.

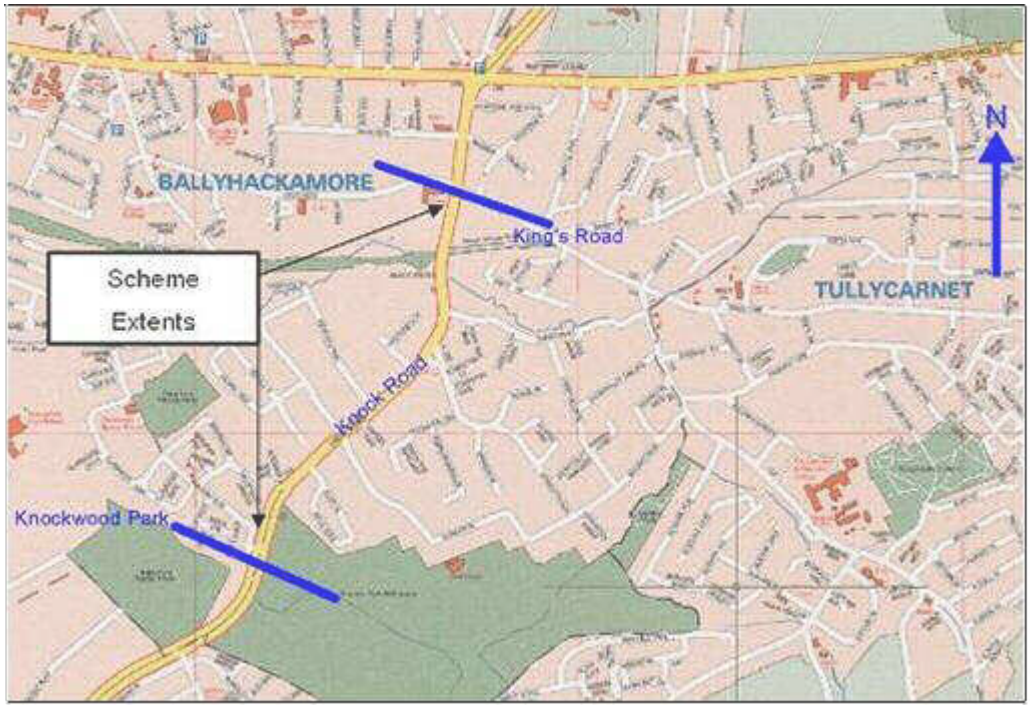

Figure 1: Scheme Location

1.1.4. Since the publication of the Belfast Metropolitan Transport Plan in 2004, three options have been assessed in accordance with the TAG requirements for Stage 2 Preferred Option Appraisal. Following Public Consultation (7th and 8th June 2006), Option B was developed to take account of feedback, and subsequently identified as the preferred option and titled Option D.

1.1.5. This preferred option was approved by the Roads Service Board to take through to detailed design in March 2007. The statutory orders were published in November 2009 and a public exhibition held at the same time to explain the preferred option and seek formal comments from the public. An official consultation period ran between the publication date and the end of December 2009.

1.1.6. A total of 128 submissions were received prior to the Inquiry.

1.1.7. The main grounds for the objections received were:

- The consultation process;
- The risk of increased traffic flows in the adjoining residential area;
- The need for the scheme;
- Inadequate traffic modelling and appraisal;
- Road safety;
- Environmental issues; and
- Effect on property.

1.1.8. Given the nature of these proposals and the likelihood that a number of the objections could not be resolved, the Regional Development Minister announced that a Public Inquiry would be convened in order to give Roads Service, objectors and other interested parties a fair opportunity to be heard and to question the cases both for and against the A55 Knock Road Widening Scheme.

1.1.9. Having reviewed the evidence presented by Roads Service, supporters, objectors and others the Inspectors issued their report into the Public Inquiry, in March 2011.

1.1.10. Whilst the Inspectors recognised the importance of the A55 as a strategic outer orbital road and accepted the need to improve this section and reduce congestion, they made a number of recommendations.

1.1.11. The Inspectors considered the Environmental Statement to be based on flawed traffic data, and as such recommended that this be reviewed following revised traffic assessment.

1.1.12. The argument that the Environmental Statement is flawed is based on the lack of evidence in response to objections from the Residents Association of Cherryvalley Kensington and Shandon (RACKS) that there would be an adverse effect on the environment within this residential area.

1.1.13. Amey had previously determined traffic re-assignment manually based on a number of engineering assumptions. This was considered to be a cost effective method of providing a robust assessment. The Inspectors did not consider these assumptions robust however, particularly in the evening peak period, and recommended further assessment of the effects of the scheme on adjoining streets.

1.1.14. The Inspectors recommended that the Environmental Statement be reviewed based on the new traffic assignment predictions. At a meeting with Amey and Roads Service in April 2011 it was agreed that the recommendations in the Inspectors' Report be embraced. To this end it was agreed that a traffic model be developed to ascertain how best to satisfy the Inspectors' concerns over the traffic assumptions made during the scheme assessment.

1.1.15. This document provides a summary of the processes used in the construction, calibration and validation of base models, the forecasting to future years and the extraction of outputs from the model.

1.2. Traffic Model Format

1.2.1. In order to address the concerns raised at the Inquiry in relation to the underestimation of traffic impacts on the RACKS area, it was agreed that Amey should produce a local assignment model. For the purposes of this study a SATURN model was deemed to be the appropriate tool. Figure 2 shows the local model study area.

1.2.2. SATURN is a dynamic, congested assignment and simulation model. It operates by loading a trip matrix of zone-to-zone origin-destination (O/D) trip movements on to a link and junction (node) network. The O/D trips are assigned to network routes taking into account the travel time, distance and congestion delay costs of using each route. SATURN functions by performing a number of iterations, whereby zone-to-zone routings are adjusted and traffic between each origin and destination may be loaded onto several different routes. Version 10.9.24 of the SATURN program has been used for the A55 Knock Road model.

1.2.3. The end-state of each model run is an 'equilibrium assignment', in which, taken together, all trips in the network are assigned on to the lowest cost routes. This end-state is a reasonable reflection of how traffic distributes through a network in reality.

1.2.4. Outputs from the assignment model include link flows and junction turning movements, least cost zone-to-zone paths and journey times along particular network routes (with delays and distance travelled). This information can be readily compared against observed data in order to calibrate/validate the model.

1.2.5. The SATURN package can also be used for 'matrix estimation', essentially improving the fit between modelled and observed flows by selectively factoring individual cells of the input trip matrix on the basis of traffic counts.

1.2.6. The congested assignment facility in SATURN means that links and junctions constituting the network have capacity (saturation flow) thresholds attached to them. When the assigned traffic flow in the model exceeds the capacity of a link or junction, queuing delay increases and traffic will tend to re-assign, in subsequent model iterations, to find a lower cost route. As assigned flows change in each iteration, so flow/capacity ratios and hence queuing delays across the network also change. This iterative feedback process continues until a stable, minimum cost, equilibrium assignment is reached, whereby no trip O-D movement could change route without overall aggregate travel cost increasing.

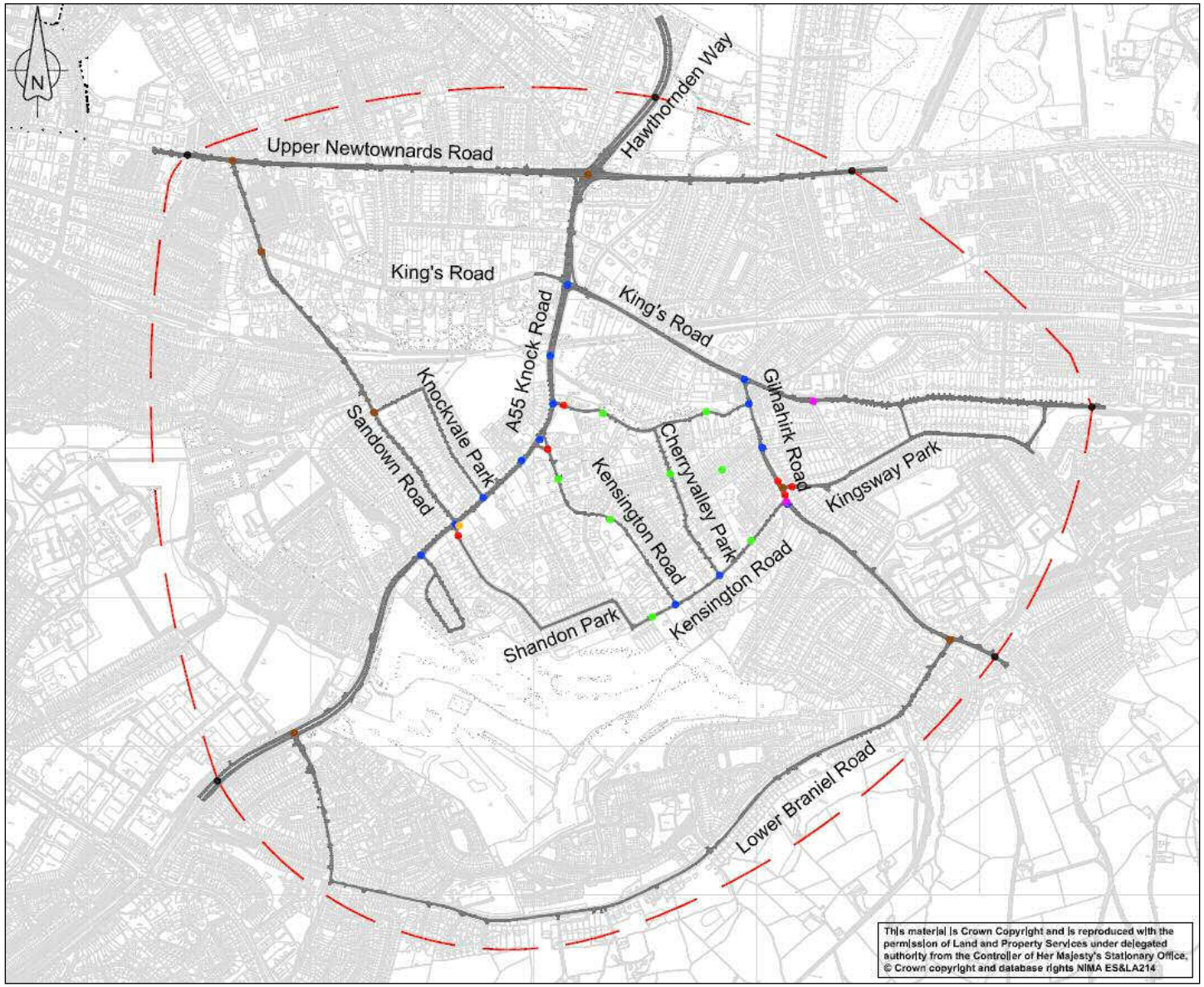

Figure 2: SATURN Model Area

2. Base Models

2.1. Introduction

2.1.1. When undertaking any traffic modelling it is important that a base model is established in the first instance to ensure that a robust assessment of the forecast scenarios is achieved. Two base year (2011) SATURN models were developed for the A55 scheme, representing the AM peak (08:00 – 09:00) and PM peak (17:00 – 18:00) hours. The following sections provide a brief summary of the development, calibration and validation of the base models – further details are provided in the *Local Model Validation Report*[1].

2.2. Model Construction

Model Network

2.2.1. The model network includes the A55 Knock Road between Hawthornden Way and Glen Road, the A20 Upper Newtownards Road between Sandown Road and Castlehill Road, Sandown Road, Kings Road (as far as Melfort Drive), Gilnahirk Road and the residential areas of Cherryvalley, Kensington Road and Shandon Park.

2.2.2. The whole network within the study area has been defined in 'simulation network' format, with detailed modelling of links and junctions (or nodes). The extent of the network area is shown in Figure 3.

2.2.3. Checks have been made on the network to ensure realistic link and junction capacities, speeds, an accurate reflection of turning movements and sensible route choice between origins and destinations.

2.2.4. The types of check that have been made comprise the following:

- Scanning network plots with link distances and speeds attached, to identify erroneous coding;
- Plotting zone origin to destination route choice 'trees' to ensure that the majority of trips between key zones travel on the most likely routes;
- Cross-referencing against link distances and speeds, if a tree shows a strange route choice; and
- Plotting network volume/capacity ratios and queue lengths to confirm that delays occur in correct locations.

[1] *A55 Knock Road – Local Model Validation Report, May 2012*

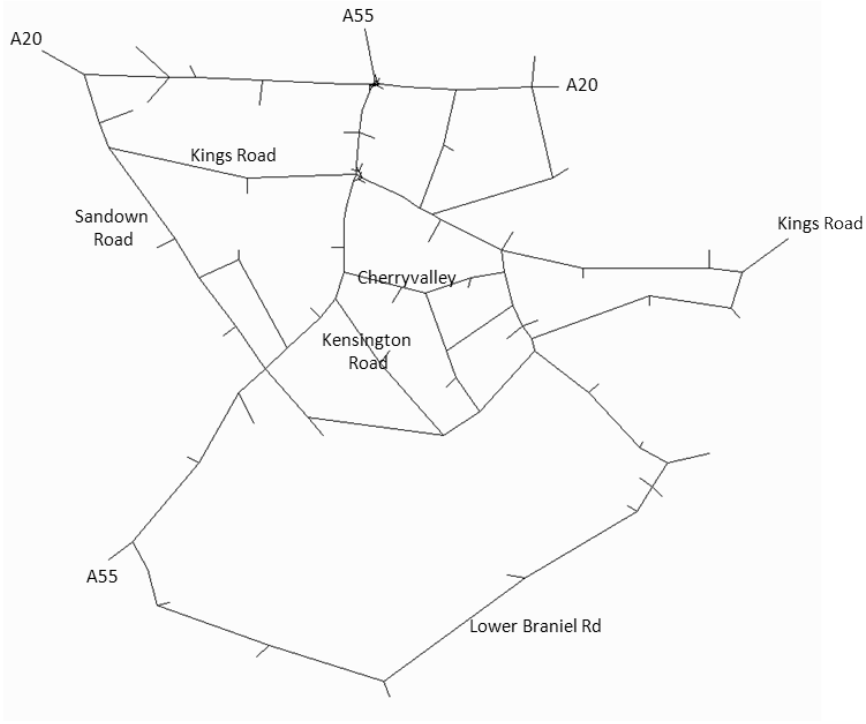

Figure 3: SATURN Network

Zone System

2.2.5. The zone system applied in the model comprises a total of 49 zones, with 43 zones internal to the study area and a further 6 zones external to the study area (see Figure 4). Movements between these zones make up the SATURN trip matrix.

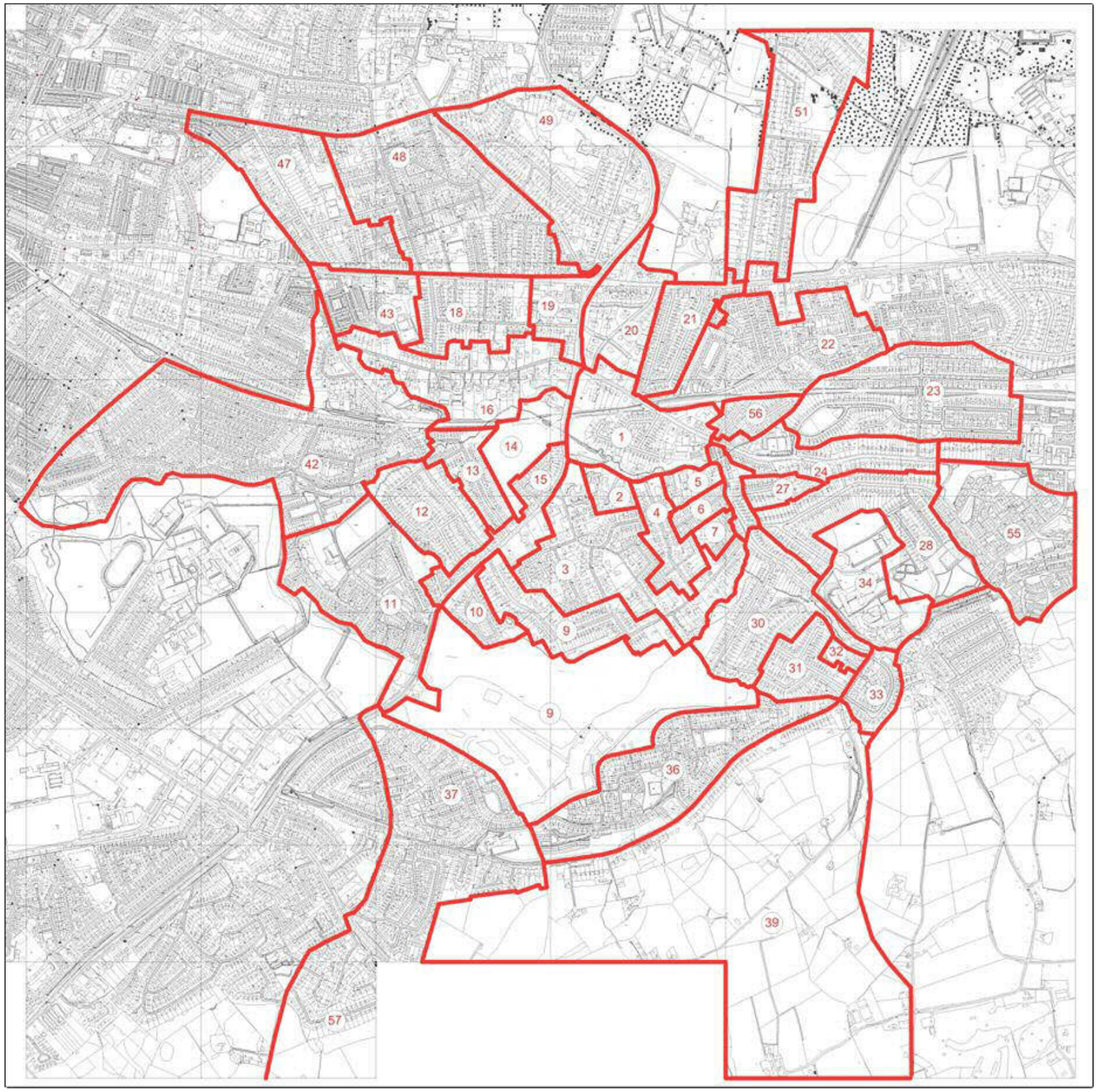

Figure 4: SATURN Model Zones

Demand Matrices

2.2.6. Origin-destination surveys were undertaken (using Bluetooth monitoring) to provide information on key traffic movements in the study area and this was supplemented by a number of classified junction turning counts. A number of internal movements were established using matrix estimation.

2.2.7. Development of the base matrices includes the following stages:

- Furnessing the initial Bluetooth matrix to match monitoring site counts;
- Bluetooth matrix conversion to a coarse zoning system of 10 zones;
- Matrix expansion to detailed model zoning system (49 zones), using expansion factors determined from housing densities and estimates of job numbers by model zone;
- Division and factoring of total vehicle matrix into individual vehicle types (i.e. car/LGV and HGV) as PCUs; and
- Matrix estimation.

2.2.8. Accuracy of the estimated matrix O/D movements was assessed by comparing trip volumes against target counted flows and good level of accuracy was achieved (at least 90% of O/D movements with GEH ≤ 5.0 in all scenarios).

2.3. Model Calibration and Validation

2.3.1. A key indicator of the dependability of the model is how modelled flows compare against observed counts. Calibration and validation of the A55 SATURN model has been undertaken in accordance with DMRB Volume 12 (Section 2, Part 1, Chapter 4, Table 4.2).

2.3.2. The five main tests outlined in DMRB have been applied to the model and a summary of the results is shown below.

Test 1

2.3.3. For movements between 700 pcu/hr and 2700 pcu/hr, the proportions of flows modelled within 15% of observed are as follows (target = 85%):

- AM peak - 90%; and
- PM peak - 93%.

Test 2

2.3.4. For movements less than 700 pcu/hr, the proportions of flows modelled within 100pcu/hr of observed are as follows (target = 85%):

- AM peak - 94%; and
- PM peak - 95%.

Test 3

2.3.5. For movements greater than 2700 pcu/hr, the proportions of flows modelled within 400 pcu/hr of observed are as follows (target = 85%):

- AM peak - N/A; and
- PM peak - N/A.

Test 4

2.3.6. The total percentages of assigned flows in each model that have a 'GEH' value of 5.0 or less, when compared to observed counts, are as follows (target = 85%):

- AM peak - 87%; and
- PM peak - 87%.

Test 5

2.3.7. The proportions of all journey time routes that have a modelled time within 15% of observed are as follows (target = 85%):

- AM peak - (8 out of 9 routes) = 89%;
- PM peak - (7 out of 8 routes) = 88%.

2.3.8. These summary results show that each of the base models performs very well when compared to the DMRB criteria in each case and is therefore considered to be fit for purpose.

3. Traffic Forecasting

3.1. Forecast Scenarios

3.1.1. Following the development of the validated 2011 base models, the models have been amended to assess the likely impacts of the A55 scheme. Scenarios have been created for 'Do Minimum', i.e. without the scheme and 'Do Something', i.e. with the scheme. The scheme that has been modelled is that which was presented at the Public Inquiry.

3.1.2. At the time of modelling it was anticipated that the scheme could be completed by 2016 and therefore this was chosen as the year of opening. Two further forecast years, 2026 and 2031, were also modelled.

3.2. Forecasting Methodology

3.2.1. The TEMPRO model was developed by the Department for Transport as a computer tool for predicting the growth in travel demand in Great Britain. TEMPRO uses information on demographics, largely from the 2001 Census, with forecast of housing, jobs and population then uses this information to ultimately predict trip end (i.e. origins and destinations) growth.

3.2.2. Until fairly recently, this model did not include Northern Ireland; as part of a planned road scheme, Roads Service commissioned a version of TEMPRO that covers Northern Ireland, referred to as TEMPRO-NI.

3.2.3. For the purposes of this study it was agreed with Roads Service that TEMPRO-NI growth factors would be the most appropriate. Following discussions with Roads Service Consultancy DaTA Section, information on trip ends was provided for both 'Car Driver Only' and 'All Modes' although the information on 'All Modes' was not used in this study.

3.2.4. The zone system applied in TEMPRO-NI is based on electoral Wards; those wards within the study area were identified as follows:

- Cherryvalley;
- Gilnahirk;
- Ballyhanwood (2%);
- Tullycarnet;
- Upper Braniel;
- Lower Braniel;
- Hillfoot;
- Lisnasharragh;
- Orangefield;

- Knock;
- Ballyhackmore;
- Sydenham (5%);
- Island (10%);
- Bloomfield;
- Belmont (33%); and
- Stormont (90%).

3.2.5. Factors were derived for each ward from the TEMPRO-NI data for each year, by comparing the sum of origins and destinations between years. For trips between external zones factors were calculated based on the sum of all wards. The resulting factors are shown in Appendix D1.

3.2.6. As the SATURN trip matrix is separated into two user classes, light vehicles and heavy vehicles, it was also necessary to derive factors that could be applied to LGVs and HGVs. This calculation was based on factors extracted from the National Transport Model (NTM) and applying an adjustment using a comparison between trip productions generated for England and trip productions generated by TEMPRO-NI for Northern Ireland. Factors derived are as below:

- 2011 – 2016: LGV = 1.1631; HGV = 1.0157
- 2011 – 2026: LGV = 1.5741; HGV = 1.0795
- 2011 – 2031: LGV = 1.6586; HGV = 1.1589

4. Model Outputs

4.1. Introduction

4.1.1. As outlined previously, the Inspectors' Report on the Public Inquiry indicated that the previous manual reassignment of traffic in the RACKS area was not considered robust, particularly in the evening peak period. Therefore, the key objective of the SATURN modelling was to provide a more detailed assessment of the impact of the scheme on traffic in the RACKS area. The following sections provide a summary of the outputs from the SATURN model, firstly in terms of overall network performance, and secondly to address the specific issue of traffic in this area.

4.2. Summary Outputs

4.2.1. The SATURN model can be used to provide information on a range of statistics for each option. Tables 1 and 2 below provide summary statistics for the network as a whole.

4.2.2. Table 1 shows that in 2016 during the AM peak the introduction of the scheme is predicted to result in an increase in average network speed, along with a corresponding reduction in travel time on the network. A similar increase in average speed and reduction in travel time is also shown in 2026, although the forecast year 2031 shows negligible changes.

4.2.3. Table 2 shows that in 2016 during the PM peak the scheme is predicted to result in a significant increase in average network speed, with a corresponding reduction in network travel time. The same changes are not obvious in the forecast years during the PM peak, with no change in average speed experienced in either 2026 or 2031.

Table 1: Summary Statistics – AM Peak									
Criteria	2016			2026			2031		
	DM	DS	% change	DM	DS	% change	DM	DS	% change
Link Cruise Time (PCU-Hrs)	423.0	425.1	0.5	472.4	474.0	0.3	489.0	490.9	0.4
Travel Time (PCU-Hrs)	1238.5	1211.1	-2.2	1732.9	1697.0	-2.1	1963.1	1971.4	0.4
Travel Distance (PCU-Kms)	19514.8	19526.0	0.1	21725.3	21767.5	0.2	22462.9	22504.0	0.2
Average Speed (km/h)	15.8	16.1	1.9	12.5	12.8	2.4	11.4	11.4	0.0

Table 2: Summary Statistics – PM Peak									
Criteria	2016			2026			2031		
	DM	DS	% change	DM	DS	% change	DM	DS	% change
Link Cruise Time (PCU-Hrs)	459.5	457.8	-0.4	503.0	506.3	0.7	520.1	522.3	0.4
Travel Time (PCU-Hrs)	1562.2	1424.3	-8.8	2029.7	2054.2	1.2	2195.1	2192.9	-0.1
Travel Distance (PCU-Kms)	19473.1	19401.3	-0.4	21198.1	21267.7	0.3	21907.5	21974.1	0.3
Average Speed (km/h)	12.5	13.6	8.8	10.4	10.4	0.0	10.0	10.0	0.0

4.3. Key Link Flow Changes

4.3.1. As outlined previously, one of the key objectives of the SATURN modelling is to assess the potential impact of the scheme on traffic flows in the RACKS area. AM and PM peak hour flow information has been extracted from the SATURN models for both the 'Do Minimum' and 'Do Something' scenarios for each of the forecast years. Traffic flow diagrams showing the turning movements at the key junctions along the A55 as predicted by the SATURN are included in Appendix D2, with a summary of the changes in flow on key links in the RACKS area outlined in Tables 3 and 4.

Table 3: Key Link Changes in Flow – AM Peak

Link	Direction	2016		2026		2031	
		DM	DS	DM	DS	DM	DS
Cherryvalley	To A55	134	226	133	205	131	129
	From A55	105	126	86	44	111	252
	2-way	239	352	219	249	242	381
Kensington Road	To A55	146	151	140	169	140	79
	From A55	57	54	80	61	93	150
	2-way	203	205	220	230	233	229
Shandon Park	To A55	503	446	779	702	816	427
	From A55	29	30	12	101	19	278
	2-way	532	476	791	803	835	705
TOTAL RACKS TRAFFIC	**2-way**	**974**	**1033**	**1230**	**1282**	**1310**	**1315**

4.3.2. Table 3 shows that during the AM peak it is predicted that there will be relatively small changes in traffic in the RACKS area, with an increase of 59 PCUs 2-way (6.1%) predicted in 2016, an increase of 52 PCUs (4.2%) predicted in 2026 and a minor increase of 5 PCUs (0.4%) predicted in 2031. It is not considered that these increases in flow would have a significant impact during the AM peak hour.

4.3.3. Table 4 also shows that during the PM peak it is predicted that there will be relatively small changes in traffic in the RACKS area, with an increase of 60 PCUs 2-way (6.2%) predicted in 2016, an increase of 88 PCUs (7.5%) predicted in 2026 and a minor increase of 95 PCUs (7.8%) predicted in 2031. Again it is not considered that these increases in flow would have a significant impact during the PM peak hour.

Table 4: Key Link Changes in Flow – PM Peak							
Link	Direction	2016		2026		2031	
		DM	DS	DM	DS	DM	DS
Cherryvalley	To A55	54	121	45	114	46	129
	From A55	252	288	270	272	293	252
	2-way	306	409	318	386	339	381
Kensington Road	To A55	66	69	70	76	72	79
	From A55	192	132	260	149	242	150
	2-way	258	201	330	225	314	229
Shandon Park	To A55	228	201	391	381	428	427
	From A55	175	216	142	274	139	278
	2-way	403	417	533	655	567	705
TOTAL RACKS TRAFFIC	**2-way**	**967**	**1027**	**1178**	**1266**	**1220**	**1315**

4.3.4. It is worth noting that following our previous assessment, it was indicated at the Inquiry that increases in traffic flow in the RACKS area during the peak hour were anticipated to be up to 15%. The results of the SATURN modelling as shown in Tables 3 and 4 and outlined in paragraphs 4.3.2 and 4.3.4 clearly show that **this was extremely robust, with the computer modelling predicting a maximum increase in traffic of 7.8%.**

4.4. Analysis of 'Rat-running' Traffic

4.4.1. One of the key concerns of residents within RACKS is that the scheme will lead to an increase in traffic 'rat-running' through the area. In order to address this issue, we have undertaken a select link analysis of the three key links, i.e. Shandon Park, Kensington Road and Cherryvalley, to determine the origins and destinations of traffic on for both the AM and PM peak periods for the year 2016. Outputs from the SATURN model are included in Appendix D3, with the results are summarised in Table 5.

Table 5: Analysis of Origins and Destinations of traffic in RACKS								
	O/D RACKS		O/D GILNAHIRK		O/D KINGS ROAD		O/D KINGSWAY	
	DM	DS	DM	DS	DM	DS	DM	DS
AM Peak	38%	44%	41%	35%	3%	10%	17%	12%
PM Peak	44%	40%	25%	25%	15%	24%	17%	11%

4.4.2. The figures in Table 5 suggest that there is a reasonable proportion of traffic within the RACKS area that would be considered to be 'rat-running'. However, it is noted that in the AM peak implementation of the scheme is predicted to result in an increase in the proportion of traffic with an origin or destination within RACKS, while in the PM peak there is only a small reduction in the proportion of traffic with an origin or destination within RACKS. **This emphasises further Amey's original opinion that the scheme would not have a significant impact on the RACKS area.**

4.5. Comparison with Previous Assessments

Manual Reassignment

4.5.1. As stated earlier in this report, Amey had previously undertaken a manual reassignment of traffic as a result of the scheme in order to provide a cost effective means of robust assessment. Traffic flows were previously factored to 2013 and 2028 levels using NRTF medium growth factors; for the purpose of this study the base year for the SATURN modelling was taken to be 2011 and so the forecast years used in the assessment were also raised accordingly to represent 2016 and 2031.

4.5.2. We have undertaken a comparison of the traffic flows predicted using the manual reassignment against those output from the SATURN model, as shown in Figures 5 to 8. To ensure a reasonable comparison, the manually generated figures were also factored to 2016 and 2031 using NRTF medium growth factors. It should also be noted that only those junctions where changes in flow were predicted by the manual reassignment are included.

4.5.3. Examination of these figures shows that, during the AM peak period the traffic flows along the A55 are significantly lower in the SATURN assessment. When considering the flows on other side roads, it is noted that some of the modelled flows are higher than predicted using the manual predictions (eg Cherryvalley), although correspondingly some modelled flows are also lower than predicted using the manual reassignment (eg Shandon Park).

4.5.4. During the PM peak period, the traffic flows on the A55 are generally higher in the SATURN assessment than predicted previously. Again in this peak period a number of modelled flows are higher than predicted using the manual predictions (eg Cherryvalley), although correspondingly some modelled flows are also lower than predicted using the manual reassignment (eg Kensington Road).

4.5.5. At the Public Inquiry it was suggested that the number of vehicles making the right turn into Shandon Park would be restricted to 90 per hour; this was to be achieved through limiting the green time allocated to this stage to a maximum of seven seconds. It should be noted that the calculation of 90 vehicles per hour was based on an assumed 120 second cycle time, resulting in 30 cycles per hour. It was assumed that three vehicles would be able to make the turn in each cycle, equating to 90 vehicles per hour.

4.5.6. The outputs from the SATURN model show that the predicted volumes are, in some cases, higher than the predicted 90 vehicles per hour (e.g. 2031 PM Peak predicted flow is 213). The model only allows a maximum of seven seconds green time, as presented at the Public Inquiry, however it is important to note that the cycle time in the model is 81 seconds as opposed to 120 seconds as used previously, resulting in a greater number of cycles per hour (44) and thus the number of vehicles making the turn would be higher. In addition, the figure of 90 vehicles is calculated on the basis of the number of vehicles actually making the turn, while the SATURN outputs are the 'demand' flow, i.e. traffic assigned to a particular route between an origin and a destination. **It is important to note, however, that overall the increase in traffic in the RACKS area is less than previously predicted** (worst case increase of 7.8% compared with 15% suggested at the Public Inquiry).

4.5.7. It is Amey's opinion that the SATURN modelled flows are likely to represent a more realistic reflection of the forecast traffic flows as the models are derived from a validated base model that has been developed from 2011 traffic surveys, as opposed to 2006 turning counts that have been factored using NRTF growth factors. In addition, the forecasting applied in the SATURN modelling uses TEMPRO-NI forecasts, which are considered to be more accurate than NRTF. Table 6 shows a comparison between the TEMPRO-NI forecasts and the equivalent NRTF medium growth factors; this shows that the TEMPRO-NI factors are lower.

Table 6: Comparison of NRTF Medium Growth vs TEMPRO-NI		
Year from/to	**TEMPRO-NI***	**NRTF High**
2011 – 2016	1.0466	1.0922
2011 – 2026	1.1158	1.2490
2011 – 2031	1.1463	1.3251

**TEMPRO-NI provides factors for trips between specific origins and destinations. For the purposes of this comparison an average of all zones has been calculated.*

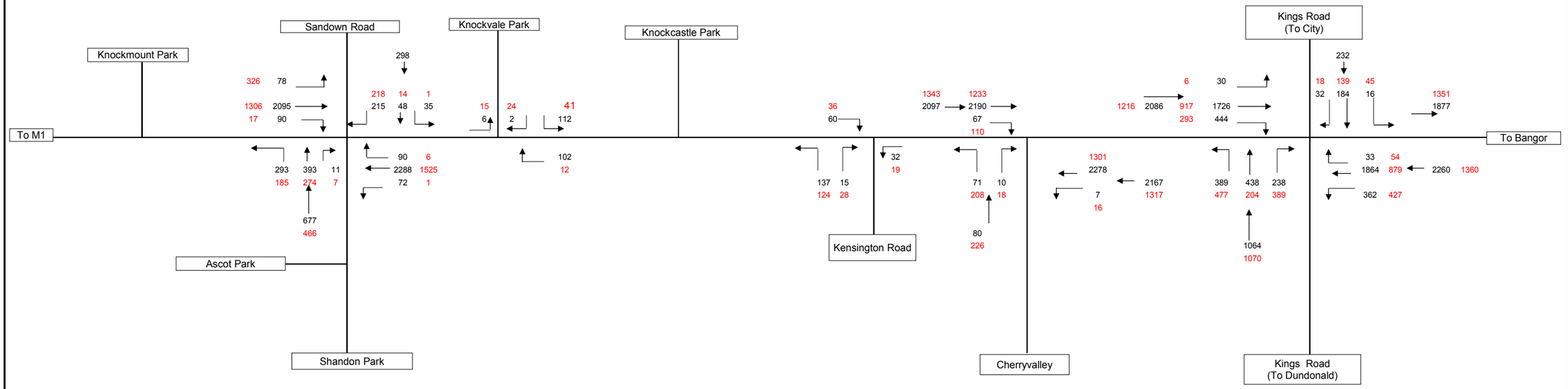

Figure 5: Manual Re-Assignment vs SATURN Modelled Flows (2016 AM Peak)

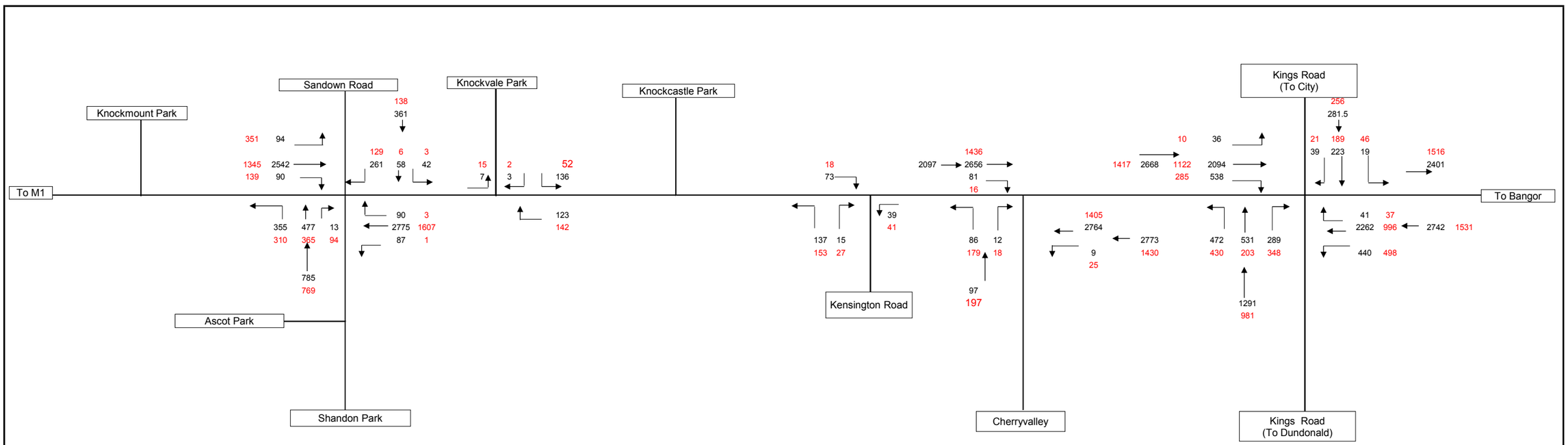

Figure 6: Manual Re-Assignment vs SATURN Modelled Flows (2031 AM Peak)

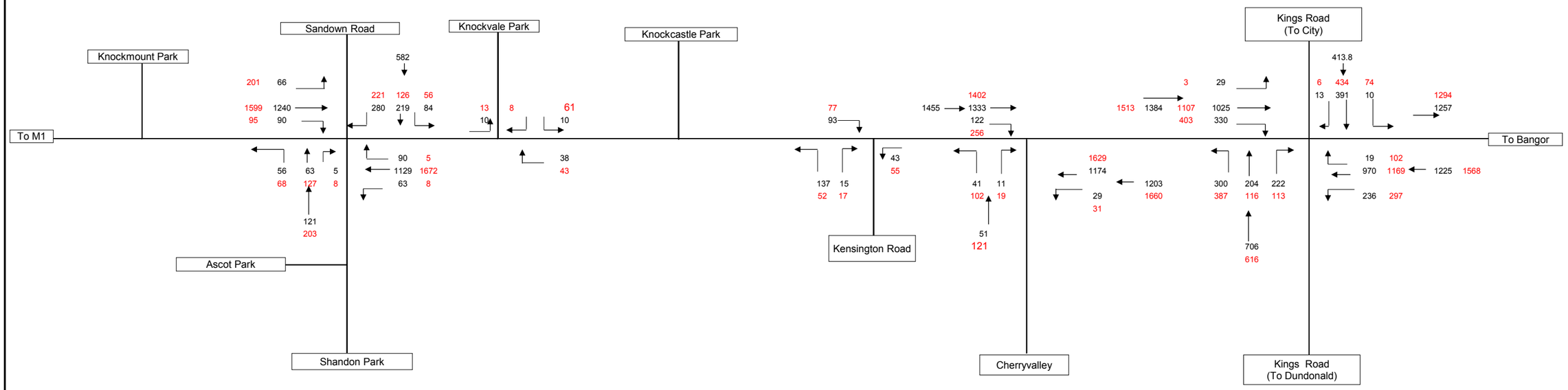

Figure 7: Manual Re-Assignment vs SATURN Modelled Flows (2016 PM Peak)

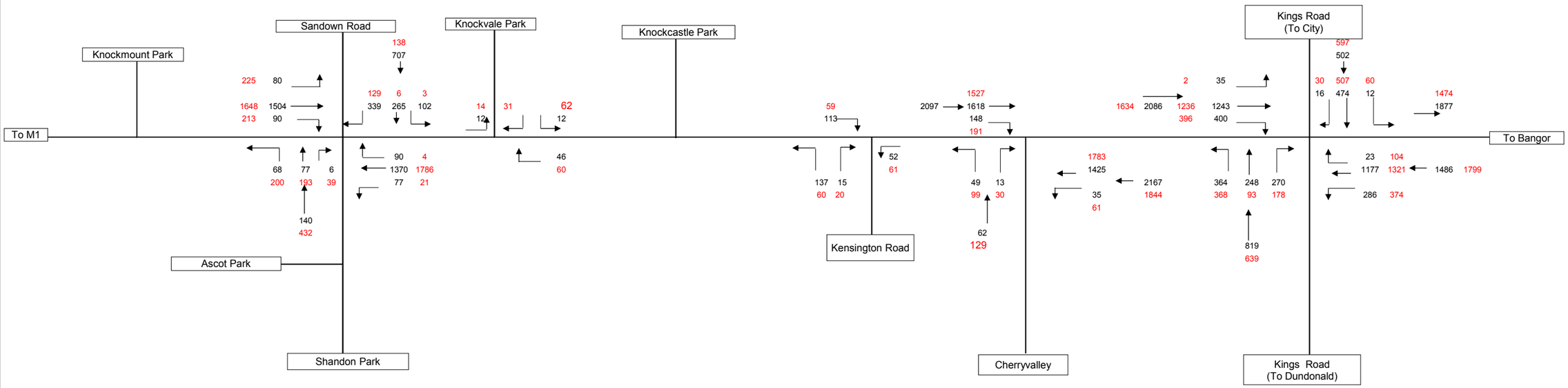

Figure 8: Manual Re-Assignment vs SATURN Modelled Flows (2031 PM Peak)

4.6. Additional Assessments

4.6.1. It was argued at the Public Inquiry that the real cause of the congestion experienced on the A55 was not the single lane section, but rather the junctions with Kings Road and Upper Newtownards Road and the Inspectors' Report recommended that Roads Service consider potential junction improvements at these junctions. As a result, Roads Service has commissioned Amey to complete an assessment of additional junction options using the SATURN model as outlined below. These tests were undertaken to determine if the junction improvements would reduce delay to traffic on the A55 and also reduce the volume of traffic travelling through the RACKS area. Three options relating to junction improvements were considered:

- Option 1 – analysis of additional right turn lane from A55 into Kings Road with a '2 lane merge into 1' as shown on drawing No 400445-SK-044-01 (issue 3 of Residents Association Options report);
- Option 2 – analysis of additional right turn lane from A55 into Kings Road with 2 lanes along Kings Road past Gilnahirk Road Junction as shown on drawing No 400445-SK-044-03 (issue 3 of Residents Association Options report); and
- Option 3 – analysis of additional right turn lane from Upper Newtownards Road into Hawthornden Way, to be achieved through the removal of the left slip to Knock Road and combining ahead and left movements.

Option 1

4.6.2. This option requires additional land take of approximately 5m on the western boundary of Towell House and of approximately 2m on the northern side of Kings Road. As shown in drawing no 400445-SK-044-01, two right turn lanes are provided into Kings Road along with an additional left turn lane from Kings Road. Table 7 provides a summary of the changes in two-way flow within RACKS (i.e. total two-way traffic on Cherryvalley, Kensington Road and Shandon Park) predicted by the SATURN model with this option coded into the network. Further details are provided in Appendix D4.

Table 7: Comparison of RACKS Traffic (two-way) – Option 1

Year	Do Min	Do Something		Option 1	
		Flow (PCU)	% Change	Flow (PCU)	% Change
2016 AM	974	1033	6.1	829	-14.9
2026 AM	1230	1282	4.2	971	-21.1
2031 AM	1310	1315	0.4	1157	-11.7
2016 PM	967	1027	6.2	970	0.3
2026 PM	1178	1266	7.5	1123	-4.7
2031 PM	1220	1315	7.8	1150	-5.7

4.6.3. The figures in Table 6 show that, with the additional widening, traffic flows in the RACKS area are reduced, particularly in the AM peak. The provision of an additional left turn lane helps to reduce congestion on Kings Road, and combined with the provision of two lanes on the full length of the A55, this makes this route more attractive than the traffic calmed route through Shandon Park. Difference plots produced by the SATURN model included in Appendix D4 clearly show a reduction in traffic on Shandon Park travelling towards the A55 (blue line) with an increase on Kings Road (green line).

4.6.4. In the PM peak there is a smaller reduction in traffic in the RACKS area. While there is a slight increase in traffic on Shandon Park travelling away from the A55, overall there is a reduction in terms of 2-way flow. Eastbound traffic on Cherryvalley and Kensington Road is also reduced, although given that the difference plots show a reduction in traffic approaching the Kings Road junction it is likely that this traffic is transferred to Shandon Park.

4.6.5. To determine the potential benefits for the junction we have extracted information as summarised in Table 8. This demonstrates that although traffic throughput is increased, there is little or no benefit in terms of delay or average queues – junction delay is shown to be reduced marginally in both peak periods, although the average queue is shown to be increased slightly in both peak periods. In addition the volume/capacity (or degree of saturation) is shown to increase slightly in both peak periods.

Table 8: Node Statistics – Kings Road/Knock Road junction (Option 1 2016)

	Delay (s)		Average Q (PCU)		Total Flow (PCU)		Volume / Capacity (%)	
	AM	PM	AM	PM	AM	PM	AM	PM
Do Minimum	63.51	57.07	35.26	36.55	2985	3586	71.72	71.00
Do Something	67.83	55.85	36.06	35.58	2945	3527	72.34	70.36
Option 1	61.59	55.27	37.77	39.89	3083	3728	71.89	71.36

Note: 'Delay' is the overall delay for the junction, recorded in seconds.

Option 2

4.6.6. As with Option 1, this option requires additional land take of approximately 5m on the western boundary of Towell House and of approximately 2m on the northern side of Kings Road; however, this option also includes widening on Kings Road as far as the junction with Gilnahirk Road and widening on Gilnahirk Road as shown in drawing no 400445-SK-044-03. Table 9 provides a summary of the changes in two-way flow within RACKS predicted by the SATURN model with this option coded into the network. Further details are provided in Appendix D4.

Table 9: Comparison of RACKS Traffic (two-way) – Option 2					
Year	Do Min	Do Something		Option 2	
		Flow (PCU)	% Change	Flow (PCU)	% Change
2016 AM	974	1033	6.1	901	-7.5
2026 AM	1230	1282	4.2	1073	-12.8
2031 AM	1310	1315	0.4	1185	-9.5
2016 PM	967	1027	6.2	856	-11.5
2026 PM	1178	1266	7.5	1024	-13.1
2031 PM	1220	1315	7.8	1075	-11.9

4.6.7. The figures in Table 9 show that, with the additional widening providing two lanes along Kings Road, traffic flows in the RACKS area are again reduced when compared with both the Do Minimum and Do Something scenarios, although in this option the change is more noticeable in the PM peak. The provision of an additional left turn lane helps to reduce congestion on Kings Road, and combined with the provision of two lanes on the full length of the A55, this makes this route more attractive than the traffic calmed route through Shandon Park in both the AM and PM peak. Difference plots produced by the SATURN model included in Appendix D4 clearly show a reduction in traffic on Shandon Park travelling towards the A55 (blue line) with an increase on Kings Road (green line).

4.6.8. Again to determine the potential benefits for the junction we have extracted information as summarised in Table 10. This demonstrates that, similar to Option 1 although traffic throughput is increased, there is little or no benefit in terms of delay or average queues – junction delay is shown to be reduced marginally in the AM peak periods and increased slightly in the PM peak period, while the average queue is shown to be increased slightly in both peak periods. In addition the volume/capacity (or degree of saturation) is shown to increase slightly in the PM peak period.

Table 10: Node Statistics – Kings Road/Knock Road junction (Option 2 2016)								
	Delay (s)		Average Q (PCU)		Total Flow (PCU)		Volume / Capacity (%)	
	AM	PM	AM	PM	AM	PM	AM	PM
Do Minimum	63.51	57.07	35.26	36.55	2985	3586	71.72	71.00
Do Something	67.83	55.85	36.06	35.58	2945	3527	72.34	70.36
Option 2	63.16	58.13	37.00	40.41	3052	3759	71.12	72.03

4.6.9. The outputs from testing of both Option 1 and Option 2 would suggest that there is potential to reduce the volume of traffic travelling through the RACKS area, but the benefits to strategic traffic on the A55 are limited. The costs associated with these options were estimated to be in the region of £2.2m (costed in 2007) and as such it is considered that this would outweigh the benefits at this stage and therefore neither of these options will be included in the A55 scheme.

Option 3

4.6.10. Option 3 relates to potential improvements at the junction with the Upper Newtownards Road, with a view to reducing congestion for traffic on the A55. It should be noted that the operation of the traffic signals was optimised in 2009 through the use of a linked MOVA system and it is considered that further increases in traffic capacity would not be achieved without significant infrastructure improvements, including the need for land and buildings.

4.6.11. Notwithstanding, we have tested an option that provides an additional right turn lane into Hawthornden Way, by removing the left slip to Knock Road and combining ahead and left movements into one lane. The results are summarised in Table 11 (for the forecast year 2016 only), with figures for the proposed scheme included for comparison.

Table 11: Node Statistics – Knock Road / Upper N'Ards Road junction (2016)

	Delay (s)		Average Q (PCU)		Total Flow (PCU)		Volume / Capacity (%)	
	AM	PM	AM	PM	AM	PM	AM	PM
Do Something	88.06	74.20	70.67	56.75	4901	4517	90.31	87.98
Option 2	92.69	115.46	78.50	98.92	4904	4745	82.68	86.19

4.6.12. The results in Table 11 indicate that this option would in fact result in increases in delay and average queues at this junction and therefore should not be considered further.

5. Summary and Conclusions

5.1. Summary

5.1.1. Road Service Eastern Division has commissioned Roads Service Consultancy and its partner Amey to undertake further detailed traffic modelling in order to address issues raised in the Inspectors' Report on the Public Inquiry into the proposed A55 Knock Road widening scheme.

5.1.2. One of the key objectives of this commission was to address the potential impact of the scheme on traffic in the RACKS area and therefore traffic modelling was undertaken using the SATURN software package in order to estimate potential traffic reassignment. In the first instance, base year (2011) models were produced for the AM (08:00 – 09:00) and PM (17:00 – 18:00) peak hours. These models were calibrated and validated in line with DMRB requirements and were shown to provide a good fit therefore were deemed to be fit for purpose for the scheme.

5.1.3. Base year trip matrices were forecasted to the future years 2016, 2026 and 2031 using information extracted from TEMPRO-NI and loaded onto the SATURN model network to create the Do Minimum scenarios for both AM and PM peak hours. The network was then modified to represent the proposed scheme and create the Do Something scenarios. Further tests were also undertaken on revised junction arrangements at Knock Road/Kings Road and Knock Road/Upper Newtownards Road.

5.2. Conclusions

5.2.1. Comparison of the overall summary results for the Do Minimum and Do Something scenarios indicates that, in the year of opening 2016 the scheme would result in reduced travel times on the network as a whole in both the AM and PM peak, with increased average network speeds. However, the same benefits do not appear to be achieved in the forecast years 2026 and 2031, with minimal differences apparent in 2031 in both peak hours.

5.2.2. With respect to the impact on traffic flow in the RACKS area, it is noted that it was indicated at the Public Inquiry that increases in traffic flow in this area could be in the region of 15% at peak times. **The results provided by the SATURN modelling indicate that, in the worst case scenario (PM Peak 2031) the difference in traffic volumes in the Do Something scenario compared with the Do Minimum in the RACKS area is only 7.8%, proving the initial assessment robust.**

5.2.3. In addition, a comparison of SATURN modelled flows against predicted flows derived previously through manual reassignment shows that flows on the A55 are significantly lower during the AM peak, with relatively small differences on side roads (some modelled flows are higher while others are lower). During the PM peak, flows on the A55 are generally slightly higher, while the differences on side roads are relatively small – again some modelled flows are higher and some are lower. All differences in flow would be considered to be within acceptable thresholds.

5.2.1. The results from the assessment of the first two additional options (Kings Road) showed that although there would be a reduction in traffic flow within the RACKS area, there would be limited benefits to strategic traffic on the A55 in terms of delay and queuing at the Kings Road junction. Given that the costs associated with this option are in the region of £2.2M (costed in 2007) it would be considered that this would outweigh the potential benefits at this stage.

5.2.2. Option 3 considered potential amendments at the junction with Upper Newtownards Road; the results showed that these amendments would result in an increase in delay and queues therefore this scheme should not be taken forward for any further consideration.

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