6. Traffic and Economic Assessment

6.1 Introduction

6.1.1 The purpose of this chapter is to document the development of a micro-simulation traffic model of Maybole and to present the results from the economic assessment of the proposed bypass scheme.

6.1.2 To determine the viability of any scheme, an economic assessment needs to be undertaken. This is required to determine if the proposed scheme offers 'value for money', through an objective comparison of the quantifiable costs of the 'Do Minimum' situation and the proposed 'Do Something' situations.

6.1.3 This Economic Assessment was undertaken in accordance with the Highway Agency's 'Design Manual for Roads and Bridges (DMRB), Volume 15: Economic Assessment of Road Schemes in Scotland'.

6.1.4 A Paramics micro-simulation model was developed to model the traffic impact of all twelve scheme options. The results from the Paramics model were input into the Transport Users Benefit Appraisal (TUBA) model to calculate user time and vehicle operating costs.

6.1.5 For each of the twelve scheme options, traffic management costs were calculated using a Queues and Delays at Roadworks (QUADRO) model, and accident costs were calculated using a NESA model.

6.1.6 The results from the TUBA, QUADRO and NESA models were then combined to produce a full economic analysis of each option to determine which option would provide the best economic return.

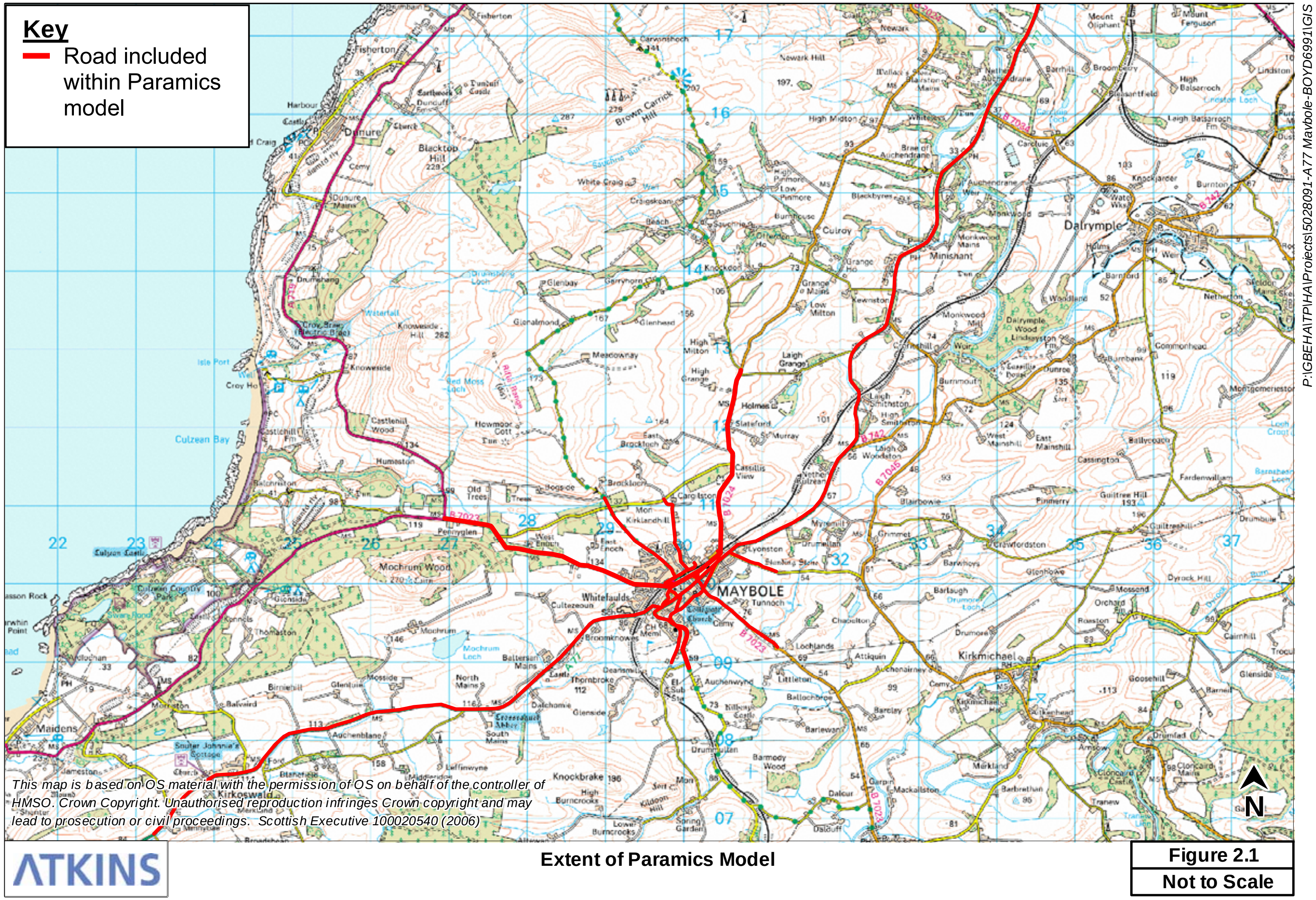
Model Development

6.1.7 A 2004 Paramics micro-simulation model was developed. This was used as the Base model to test each of the scheme options that had progressed to the Stage 2 Assessment.

Description of Model

6.1.8 The existing road network was constructed and coded into the Paramics model to reflect, as far as possible, the physical characteristics of the A77(T) and key local roads in the Maybole area. The model area and location of the proposed scheme are shown in Figure 6.1.

Figure 6.1 – Modelled Area



6.1.9 A twelve hour time period (07.00 to 19.00 hours) was modelled. This period was chosen as it covers both the morning (AM) and evening (PM) peak periods, as well as the inter-peak period between the AM and PM peaks. In addition, the model contains a warm up period between 06.30 – 07.00 hours, which allows the network to be fully populated before the start of the modelled time period at 07.00 hours.

6.1.10 The following four vehicle classifications were modelled:

- Cars;
- LGVs;
- HGVs; and
- Buses and Coaches.

Matrix Building

6.1.11 The model matrices were developed using data from traffic surveys undertaken in 2004. The results of these surveys were presented in the Traffic Survey Report[80].

6.1.12 A matrix estimation process was next undertaken to produce a base trip matrix for each vehicle classification modelled. This process made use of the series of Junction Turning Counts and the Cordon Survey Counts undertaken in 2004.

6.1.13 The 2004 vehicle trip matrices were then assigned to the model network and the model was calibrated using the turning counts specified above. For this study, ten simulations of the Base model were undertaken using random seed values as explained in Section 2 (paragraph 2.42) of the Traffic Model Development Report[81].

Model Validation

6.1.14 A validation exercise was then undertaken to ensure that the Base model replicated the situation on the local road network in 2004. The validation was based on criteria set out in Volume 12 of the DMRB.

6.1.15 A comparison of modelled journey times and the results from journey time surveys indicated that the differences between the two were within the ranges specified in DMRB. In addition, a comparison between hourly modelled link flows and junction turning count data also indicated the differences were within the ranges specified in DMRB.

6.1.16 Both the modelled journey time and link flow results meet the required DMRB criteria. The model has therefore been validated to a base year of 2004, and is suitable for testing future road scheme options.

6.1.17 The Traffic Model Development Report[1] on the calibration and validation of the base model was submitted to Transport Scotland July 2007.

[80] A77 Maybole Transport Study, Traffic Survey Report: Atkins, May 2006

[81] A77 Maybole Transport Study, Traffic Model Development Report: Atkins, July 2007 (Document Ref: 5028091/05/02/003 Rev 1)

Traffic Forecasting

6.1.18 Forecasting involves predicting future traffic levels and distribution in Maybole both with and without the proposed bypass. This forecast traffic is then used to carry out an economic assessment to ascertain whether the proposed scheme is economically justifiable.

6.1.19 This section of the report documents the development of the future year Paramics networks and matrices for use in the traffic appraisal. It also gives details of the model data provided for input to the economic assessment.

Years of Assessment

6.1.20 Transport Scotland specifies that Trunk Road schemes should be appraised over a 60 year life cycle. Economic assessment requires that costs and benefits are calculated over the whole of this period. The year of opening of the scheme is anticipated to be 2012 and, consequently, the 60 year horizon is 2072. It also follows that the design year (15 years after opening) would be 2027.

6.1.21 National Road Traffic Forecast (NRTF) projections end in 2031, with no increase in traffic predicted beyond this point. Therefore each of the proposed schemes was only assessed in the Paramics model up to the year 2031. All future years past this date (up to 2072) will be a replication of 2031.

6.1.22 In addition, 2022 was assessed as an 'intermediate' year, so that an additional reference check could be made on the progress of the economic benefits between the opening year, 2012, and the end of traffic growth projections in 2031.

Future Year Network

6.1.23 A 'Do Nothing' traffic model network was created from the 2004 Base traffic model. This assumes that the road network does not change over the 60 year appraisal period. This, however, was deemed to be unrealistic due to the existing accident risks at the Smithston Bridge. Although no committed scheme exists at present for this accident cluster, it is likely that one would be introduced in the near future.

6.1.24 Further to discussions at a value management workshop with Transport Scotland, it was agreed that the minimum long term scheme at the Smithston Bridge would be to introduce traffic signals so that there is only one direction of traffic running under the bridge at any one time. A 'Do Minimum' traffic model was therefore developed which included vehicle activated traffic signals at the Smithston Bridge. These signals were assumed to be operational in 2012.

6.1.25 Twelve 'Do Something' model networks were developed from the 'Do Minimum' model, each including the traffic signals at the Smithston Bridge.

6.1.26 Alignment details for the Route Options were taken from detailed designs produced in accordance with DMRB, using the computer based design package, MX.

6.1.27 The 'Do Something' models are specified as follows:

- Option 1.1 Blue Alignment (S2);
- Option 1.2 Blue Alignment (S2) plus a Roundabout with the B7023;
- Option 1.3 Blue Alignment (WS2+1);
- Option 1.4 Blue Alignment (WS2+1) plus a Roundabout with the B7023;
- Option 2.1 Red Alignment (S2);
- Option 2.2 Red Alignment (S2) plus a Roundabout with the B7023;
- Option 2.3 Red Alignment (WS2+1);
- Option 2.4 Red Alignment (WS2+1) plus a Roundabout with the B7023;
- Option 3.1 Yellow Alignment (S2);
- Option 3.2 Yellow Alignment (S2) plus a Roundabout with the B7023;
- Option 3.3 Yellow Alignment (WS2+1); and
- Option 3.4 Yellow Alignment (WS2+1) plus a Roundabout with the B7023.

Future Year Matrices

6.1.28 Guidance in DMRB Volume 12 Chapter 12 Section 12.2, states that future year models should be developed using NRTF central growth factors. These are presented in Table 6.1 below.

Table 6.1 – NRTF Central Growth Factors

Years	Car	LGV	OGV1	OGV2	Bus / Coach
2004 - 2012	1.126	1.191	1.066	1.216	1.057
2004 - 2022	1.259	1.485	1.170	1.546	1.150
2004 - 2027	1.303	1.642	1.229	1.728	1.208
2004 - 2031	1.338	1.769	1.279	1.880	1.260

6.1.29 Future year matrices for 2012, 2022, 2027 and 2031 were produced by applying the agreed growth factors to the validated base matrices. Individual growth factors were applied to each vehicle classification for all road types.

6.1.30 No major committed development proposals were identified in the model area that were considered significant enough, in traffic generation terms, to be taken into account in the future year matrices.

Model Outputs

6.1.31 The following model outputs were obtained from the 2012, 2022, 2027 and 2031 future year models for input to the economic assessment:

- Traffic demand flows: – average hourly flows by vehicle classification for each time period;
- Journey Times: – average journey time by vehicle classification in each time period; and
- Distance: – journey distances.

6.1.32 The output data from the models was provided in twelve hour period (07.00 to 19.00 hours) and was broken down as required into the following time periods;

- Morning (AM) peak period – 07.00 to 10.00 hours;
- Inter-peak (IP) period – 10.00 to 16.00 hours; and
- Evening (PM) peak period – 16.00 to 19.00hours.

Model Results

6.1.33 The 'Do Nothing' Paramics models show that in all modelled years there are queues in Maybole town centre caused by right turning traffic and vehicles parked on the High Street. By 2031, queues caused by the right turning traffic and parked vehicles are predicted to stretch back southbound along the A77 beyond the town boundary.

6.1.34 The 'Do Minimum' model which includes the proposed signalisation of Smithston Bridge, shows that in addition to queues in Maybole town centre, slight queuing at the signalised Smithston Bridge is predicted. Refer to Section 3.1 of this report for details of the Do Minimum scheme.

6.1.35 In both the 'Do Nothing' and 'Do Minimum' the queues in the town centre lengthen considerably in future years, with trips through the town centre becoming significantly delayed.

6.1.36 With the introduction of the proposed bypass, the Paramics models indicate that all through traffic will bypass the town centre, reducing queues and delays to minimal levels.

6.1.37 These effects are demonstrated by examining average journey times between the southern and northern extremes of the model in different scenarios. A summary of the average journey times between the southern and northern extremes of the model is presented in Table 6.2. Option 3.2 has been chosen as being representative of the magnitude of changes modelled in the Do Something scenarios.

Table 6.2 – Average Journey Times

Scheme Option	Average Journey Time (min : sec)
'Do Minimum' 2012	21:00
'Do Minimum' 2031	27:24
Option 3.2 2012	17:43
Option 3.2 2031	18:16

6.1.38 Table 6.2 shows average journey times for both the 'Do Minimum' and Option 3.2 in 2012 and 2031. This demonstrates that in 2012 the scheme provides a travel time saving of 3min 17secs per vehicle between this zone pair, and by 2031 the saving is estimated to have grown to 9mins 8secs per vehicle.

6.1.39 These travel time savings largely accrue through vehicles re-routeing along the proposed scheme, bypassing queues and delays on Maybole High Street. Overtaking opportunities on the bypass enable vehicles that would be held up in platoons by slower vehicles (i.e. HGVs) to be released and to then travel at higher speeds until reaching the next source of delay.

6.2 Economic Benefits Associated with Journeys

Introduction

6.2.1 To assess the economic impact of changes in journey times and Vehicle Operating Costs (VOC), the Transport Users Benefit Appraisal (TUBA) program (version 1.7a) was used to process the outputs from the Paramics traffic models developed for each scheme.

6.2.2 The TUBA program is an economic assessment package for transport schemes developed for the UK Department for Transport (DfT).

6.2.3 TUBA calculates the value of the expected costs and benefits for users, private operators and the Government, both Local and Central, over a given appraisal period. To allow consistency and comparison between different projects, these costs and benefits are discounted and presented in 2002 values and prices.

6.2.4 The proposed scheme options are expected to deliver economic costs/benefits to users of the A77 trunk road due to changes in:

- Journey times; and
- Vehicle operating costs (VOC).

6.2.5 In addition, any changes in VOC will have a secondary impact on the indirect tax revenue received by the Government.

6.2.6 Where necessary, TUBA converts non-monetary values (i.e. time) to monetary values using standard parameter values outlined in the Transport Appraisal Guidance[82] (TAG) produced by DfT. All of the monetary costs/benefits are then discounted over the appraisal period, defined as 60 years including the opening year by Scot-TAG. The first 30 years is discounted at 3.5% and the second 30 years at 3.0%. For this project the opening year was assumed to be 2012 and the end of the appraisal period (the horizon year) was 2071 (i.e. 2012 + 59 years). Mid-evaluation years of 2022 and 2031 were included in the assessment to improve accuracy should the costs/benefits behave non-linearly over time.

Inputs to Tuba

6.2.7 The Paramics models produce trip and cost matrices for each scheme in a format that can be directly fed into the TUBA program. All the matrices were expressed as 19-by-19 arrays, representing all 19 zones across Maybole.

6.2.8 The following outputs from the Paramics models were loaded into the TUBA program to enable an economic assessment of the transport user benefits to be calculated:

- Trip matrices;
- Distance matrices; and
- Journey time matrices.

6.2.9 These matrices were the key determinants of user costs and benefits.

[82] Transport Analysis Guidance (TAG); Department for Transport, June 2005 www.webtag.org.uk

Forecasting Years

6.2.10 Vehicle trip matrices were produced from the Paramics model for each of the following forecast years:

- 2012 – Opening year;
- 2022 – Intermediate year;
- 2027 – 'Design' year; and
- 2031 – End of the traffic growth appraisal year.

Vehicle Classification

6.2.11 The trip matrices output from the model was divided into the following five sub-modes:

- Car;
- LGV;
- OGV1;
- OGV2; and
- Bus / Coach.

Time Periods

6.2.12 TUBA requires data for a full seven day period, therefore it was necessary to factor the twelve hour weekday results from Paramics to generate data for the remaining weekly periods. These periods were;

- Off-peak period (average hour between 19.00 – 07.00); and
- Weekend (average hour between 00.00 Friday – 23.59 Sunday).

6.2.13 The inter-peak period was used to represent the off-peak and weekend periods as this period had a relatively even two-directional traffic flow (i.e. there was no single dominant traffic movement in either direction). These conditions were considered to most closely represent the off-peak and weekend traffic flow situation on the A77.

6.2.14 An 'off-peak factor' was derived by dividing the average traffic flow/hour during an off-peak period by the average traffic flow/hour during an inter-peak period.

6.2.15 In addition, a 'Weekend factor' was derived by dividing the average traffic flow/hour during the Weekend period by the average traffic flow/hour during an inter-peak period.

6.2.16 The 'off-peak factor' and 'Weekend factor' were then combined with the results from each Paramics model to calculate weekly traffic flow data, which was used in economic analysis.

6.2.17 The TUBA program produces economic assessment outputs on a yearly basis. The different time periods were factored within TUBA to annualise them, based on the total used in the TUBA program of 8,760 hours/year.

Economic Assessment

6.2.18 A standard TUBA economics file was used with the number of vehicle modes reduced from the default eight to the five modes noted previously. The standard economics file contains several parameters, including value of time (VOT), VOC and taxation rates, all of which are taken from the DfT's TAG[83].

Scheme Costs

6.2.19 Scheme costs were developed as part of the Stage 2 DMRB Assessment. An optimism bias of 44% was applied to the expected capital costs in accordance with the latest guidance from Transport Scotland. The adjusted scheme costs are shown in Table 6.3 at 2007 prices. The costs were entered into TUBA in 'factor' prices (i.e. without V.A.T.).

6.2.20 It was assumed that all the schemes would have a net effect on operating costs. The impacts of delays due to roadworks during construction were considered separately using the Queues and Delays at Roadworks (QUADRO) program.

6.2.21 It was also assumed in the economic appraisal that all of the scheme costs would be borne by the Transport Scotland (i.e. Central Government).

[83] Transport Analysis Guidance (TAG); Department for Transport, June 2005 www.webtag.org.uk

Table 6.3 – Estimated scheme costs (£000's) including optimism bias at 2007 Q1 prices

Cost Type	Options												'Do Minimum'
	Blue Alignment				Red Alignment				Yellow Alignment				
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	
Preparation	1,779	1,810	1,900	2,042	2,008	1,796	2,135	1,925	1,333	1,309	1,412	1,390	108
Contingencies	2,554	2,598	2,728	2,934	2,887	2,580	3,069	2,765	1,910	1,875	2,024	1,991	149
Supervision	817	673	873	938	746	668	793	715	495	486	525	516	38
Construction	16,208	16,649	17,317	18,623	18,498	16,529	19,669	17,718	12,237	12,014	12,969	12,756	957
Optimism Bias	9,397	9,562	10,040	10,797	10,621	9,492	11,293	10,175	7,029	6,901	7,449	7,327	551
Total	**30,755**	**31,292**	**32,858**	**35,334**	**34,760**	**31,065**	**36,959**	**33,299**	**23,005**	**22,586**	**24,379**	**23,980**	**1,804**
Land	137	138	138	144	127	128	133	134	113	119	116	122	0
Operating	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Scheme Cost (TSC)	**30,892**	**31,430**	**32,996**	**35,478**	**34,887**	**31,193**	**37,092**	**33,433**	**23,117**	**22,705**	**24,495**	**24,103**	**1,804**

Note: Scheme costs are presented excluding VAT. 'Construction' costs from Tables 3.4 to 3.6 have been split in the above table into two constituent parts: 'supervision' and 'construction'.

Maintenance Costs

6.2.22 Maintenance costs for the ‘Do Minimum’ and ‘Do Something’ scenarios were calculated over a 60 year period from and including the opening year. An Optimism Bias of 44% was applied to Maintenance Costs, in accordance with the latest guidance from Transport Scotland. These costs are shown in Table 6.4.

Table 6.4 – Estimated scheme maintenance costs at 2005 Q2 prices

Scheme Option	Total Maintenance Cost to Government
’Do Minimum’	£13,036,234
Option 1.1	£27,919,918
Option 1.2	£28,760,308
Option 1.3	£28,901,673
Option 1.4	£28,156,110
Option 2.1	£27,898,551
Option 2.2	£28,721,887
Option 2.3	£28,576,326
Option 2.4	£27,831,462
Option 3.1	£27,781,570
Option 3.2	£28,367,310
Option 3.3	£28,205,890
Option 3.4	£27,618,333

6.2.23 The Total Maintenance Cost to Government presented in Table 6.4 comprises of both the cost to Funding Agency and the cost to Local Government, although both these costs are ultimately borne by Central Government. The maintenance cost in the Do Something scenarios is higher than in the Do Minimum because both the old detrunked A77 and the new A77 bypass will need to be maintained. Although Local Government will now be responsible for the detrunked section of the A77, and the Funding Agency responsible for maintaining the new A77, present guidance does not allow these different maintenance costs to be taken into account in the calculation of BCRgov and BCRfa.

6.2.24 The Total Maintenance costs presented in Table 6.4 have therefore been used in the calculations for both BCRgov and BCRfa.

6.2.25 The scheme maintenance costs have been input into TUBA using a 60-year spend profile.

6.2.26 These costs do not include the effects of delay to traffic due to roadworks. These costs have been calculated outside the TUBA program using QUADRO. This process is documented in Section 6.3 of this report.

Cost Profiles

6.2.27 As the modelled opening year of the scheme was assumed to be 2012, scheme costs (construction, land, preparation and supervision) in TUBA were assumed to be incurred in 2010 and 2011.

6.2.28 The future maintenance profiles assumed for each option are shown in Appendix H.

Results

6.2.29 The outputs from TUBA are evaluated over 60 years and discounted to 2002 prices. The results from the Central Growth Scenario are summarised in Table 6.5. The values shown are the differences between each scheme and the Do Minimum scenario.

Table 6.5 – TUBA Results (Central Government)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_G) £'000s	Net Present Value (NPV_G) £'000s	Benefit to Cost Ratio (BCR_G)
Option 1.1	213,785	31,252	182,533	6.84
Option 1.2	218,499	32,105	186,394	6.81
Option 1.3	217,389	33,008	184,381	6.59
Option 1.4	223,685	35,082	188,603	6.38
Option 2.1	226,093	34,303	191,790	6.59
Option 2.2	229,771	31,775	197,996	7.23
Option 2.3	226,865	36,003	190,862	6.30
Option 2.4	236,453	33,607	202,846	7.04
Option 3.1	225,873	25,308	200,565	8.92
Option 3.2	231,713	25,436	206,277	9.11
Option 3.3	228,082	26,723	201,359	8.54
Option 3.4	236,329	26,372	209,957	8.96

6.2.30 The results suggest that all of the options deliver sufficient benefits to offset their costs. The Yellow route alignment, Options 3.1, 3.2, 3.3 and 3.4, deliver greater benefits than the Blue and Red alignments. Option 3.2 performs best overall with a BCR_G of 9.11.

6.2.31 As previously noted, it has been assumed in the economic appraisal that all of the scheme costs would be borne by Central Government. However, to assess the economic impact to Transport Scotland (i.e. Funding Agency) the effect of removing the cost of indirect taxation was calculated. These results are presented in Table 6.6.

Table 6.6 – TUBA Results (Funding Agency)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_{FA}) £'000s	Net Present Value (NPV_{FA}) £'000s	Benefit to Cost Ratio (BCR_{FA})
Option 1.1	209,621	27,088	182,533	7.74
Option 1.2	214,125	27,731	186,394	7.72
Option 1.3	213,370	28,989	184,381	7.36
Option 1.4	219,309	30,706	188,603	7.14
Option 2.1	221,960	30,170	191,790	7.36
Option 2.2	225,538	27,542	197,996	8.19
Option 2.3	222,915	32,053	190,862	6.95
Option 2.4	231,879	29,033	202,846	7.99
Option 3.1	221,604	21,039	200,565	10.53
Option 3.2	227,162	20,885	206,277	10.88
Option 3.3	223,583	22,224	201,359	10.06
Option 3.4	231,721	21,764	209,957	10.65

6.2.32 The results suggest that all of the options deliver sufficient benefits to offset their costs. Again, Option 3.2 performs best overall with a BCR_{FA} of 10.88.

6.2.33 BCR_{FA} is greater than $BCR_{Government}$ for each scheme because the cost of indirect taxation has been removed from the calculation for BCR_{FA}. All of the modelled Option results show a decrease in indirect taxation, largely because vehicles are using less fuel and so are paying less Duty and V.A.T. This reduction in revenues means an increased cost to the Government, but not to the Funding Agency. The formula used to calculate BCR(FA) is displayed below:

BCR (FA) = (PVB – PVC inc. ITR + PVC exc. ITR) / PVC exc. ITR

6.2.34 Most of the benefits in TUBA are generated by travel time savings. These are accrued through the reduction in delay caused by congestion in Maybole High Street and the overtaking opportunities afforded by the scheme options, as noted in Section 6.2.

6.2.35 The economic benefits generated by accident savings and through reduced vehicle delays associated with maintenance have not been modelled within TUBA. These have been modelled separately, and are discussed within the next section of this report.

6.3 Economic Benefits Associated with Roadwork Delays

Introduction

6.3.1 Temporary roadworks associated with the construction and maintenance of the proposed schemes have the potential to impose costs on road users in the form of delay, vehicle operating costs and accident costs. It is important that the impacts of these changes are taken into consideration when assessing the overall economic viability of a scheme.

6.3.2 In this case it is necessary to consider three scenarios:

- The costs imposed on users of the A77 as a result of the scheme construction;
- The costs imposed on users of the bypass as a result of the maintenance regime for the new scheme over the next 60 years; and
- The impact on the costs of users of the A77 as a result of the change in maintenance requirements caused by the reduction in traffic on the existing A77 through Maybole once the bypass is built.

6.3.3 The Queues and Delays at Roadworks (QUADRO) program, developed by the Transport Research Laboratory, is designed to assess the total cost of major road maintenance works. However, it can also be used to calculate the economic cost of roadworks associated with scheme construction.

6.3.4 QUADRO (Version 4/Revision 6) was used to assess the economic impact of the roadworks for each of the construction schemes as well as the 'Do Minimum' maintenance scheme and each of the proposed 'Do Something' maintenance schemes.

Traffic Management Arrangements

6.3.5 The construction and maintenance works included in the QUADRO assessments assume that the traffic management arrangements involve shuttle working through sites with a maximum length of 500 metres.

6.3.6 The maintenance durations for the 'Do Minimum' and 'Do Something' scenarios were estimated and are shown in Appendix H. These profiles were input into the QUADRO program with the duration of works being uplifted with an optimism bias of 10%. This is based on the guidance given in the NESA Manual for the assessment of Scottish trunk road schemes.

Input Data

6.3.7 Unless otherwise stated the standard values within the QUADRO program were used in the evaluation process. These standard values define a range of parameters including VOT, VOC, seasonality indices, tax rates, traffic growth, vehicle occupancy proportions, etc.

6.3.8 It should be noted that no costs were calculated for vehicle breakdowns along the construction site.

6.3.9 QUADRO requires a 'main' route and a 'diversion' route to be defined and the way that these were defined is detailed in the following sections.

Traffic Flows

6.3.10 Traffic flows were taken from each of the 2012 Paramics models and factored up to Annual Average Daily Traffic (AADT) for use in QUADRO. Traffic flows were calculated separately for each of the twelve scheme options, and also for the Do Minimum scenario.

6.3.11 QUADRO factors the annual flow to the year in which the roadworks take place using central growth forecasts.

6.3.12 Daily flow and HGV (%) profiles were calculated using the data from the ATC site and input to QUADRO. These profiles were defined by hour and direction for the following day types:

- Monday to Thursday;
- Friday;
- Saturday; and
- Sunday.

Construction Phase

6.3.13 It was assumed that the construction phase for the proposed schemes would be undertaken in 2011.

6.3.14 A separate QUADRO assessment was done for each of the two tie-in points of the proposed schemes to the A77 as shown in Figure 6.2.

6.3.15 A number of characteristics were input into the QUADRO program to describe the main route and these are summarised in Table 6.7.

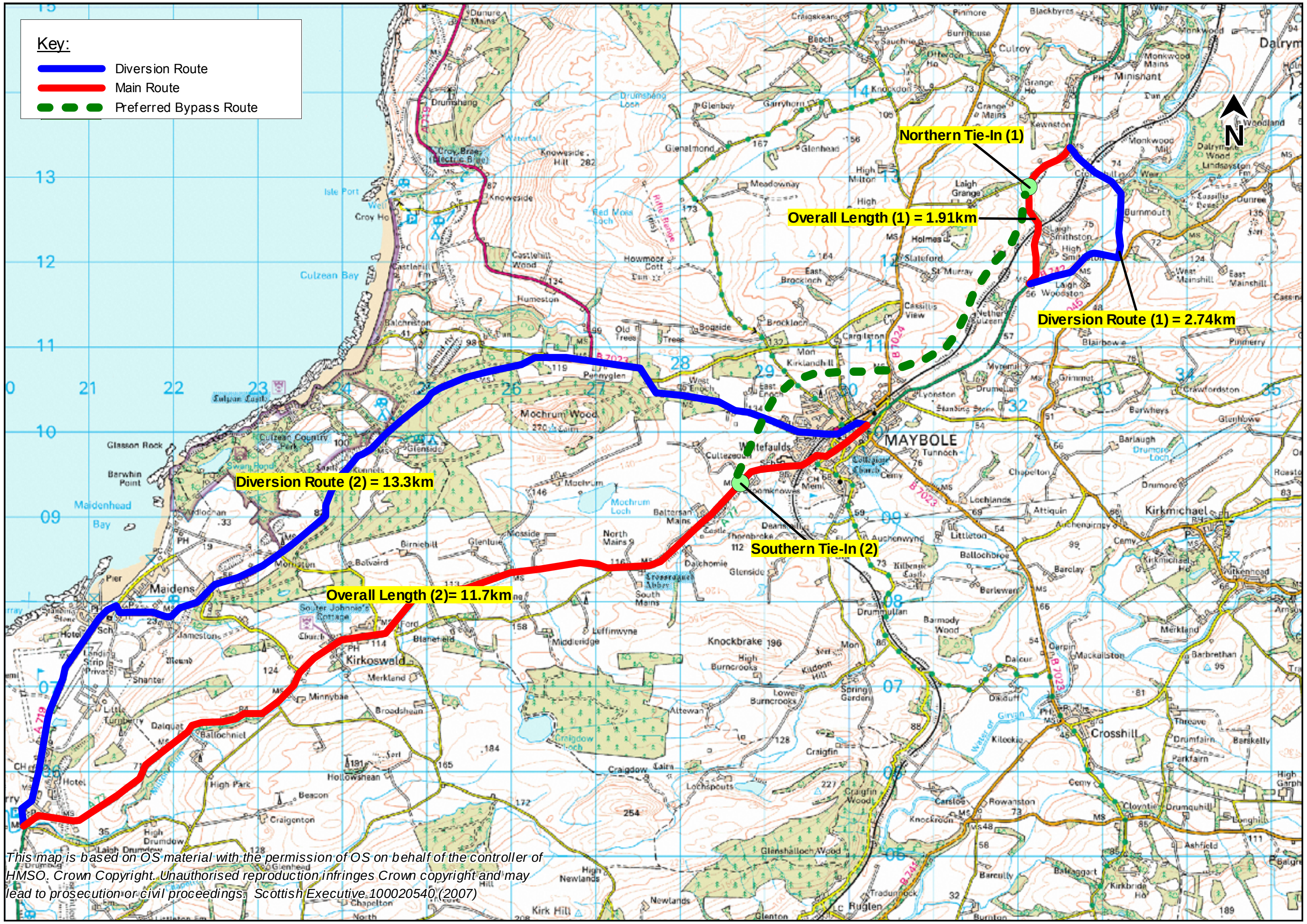
Table 6.7 – Main Route Characteristics - Construction

Description	Tie-In Point 1	Tie-In Point 2
Class	Rural single carriageway	Rural single carriageway
Accident Type	Older single 2-lane road	Older single 2-lane road
Length	1.9km	11.7km
Width	7.0 m	7.0 m
Hilliness	10 m/km	10 m/km
Bendiness	100 deg/km	100 deg/km
Average width of hardstrip	0 m	0 m
Average verge width	3 m	3 m
Side roads intersecting	0	5
Average sight distance	100m	100m
Speed limit	96 km/h	96 km/h

6.3.16 The diversion routes for the construction phase of each scheme are shown in Figure 6.2 overleaf.

6.3.17 It is estimated that on the B742, which is the proposed diversion route for tie-ins, there would be an average 24-hour two-way flow of 1,000. In addition, the Annual Average Daily Flow of 2,800 for the diversion route for tie in 2 (the A719) was taken from South Ayrshire Council's March 2005 report, 'The A77 Trunk Road through Maybole'.

Figure 6.2 – Main Route and Diversion Route



Maintenance

6.3.18 It was assumed that maintenance roadworks would be undertaken between 2012 and 2071.

6.3.19 A separate QUADRO assessment was done for the 'Do Minimum' scenario and for each of the proposed schemes. An assessment was also made of the existing A77, assuming the bypass is built. This uses the same main route data as the 'Do Minimum' scenario but with reduced traffic flows on the A77, and with the bypass assumed as the major diversion route.

6.3.20 A number of characteristics were input into the QUADRO program to describe these routes and these are summarised in Table 6.8.

Table 6.8 – Main Route Characteristics - Maintenance

Description	A77	Schemes
Class	Rural / Urban single carriageway	Rural single carriageway
Accident Type	Older single 2-lane road	Modern wide single 2/3 lane road with 1 metre hardstrips
Design Standard		TD9
Length	4.1km	Per Scheme Length
Width	7.0 m	7.3 – 10.0m
Hilliness	10 m/km	10 m/km
Bendiness	100 deg/km	50 deg/km
Average width of hardstrip	0 m	1 m
Average verge width	3 m	3 m
Side roads intersecting	0	0
Average sight distance	100m	700m
Speed limit/s	50 & 96 km/h	96 km/h

Outputs

6.3.21 Table 6.9 summarises the results of the individual QUADRO runs for the construction phase and Table 6.10 the results for each of the QUADRO runs for the maintenance phase, over the 60 year appraisal period.

Table 6.9 – Construction Phase QUADRO results

Construction	Overall Cost Impact £000's
Tie-in 1	£ 50,370
Tie-in 2	£ 48,909

Table 6.10 – Maintenance Phase QUADRO results

Operation	Overall Cost Impact £'000's
A77 existing situation - no bypass	£ 12,029,671
A77 with bypass as diversion route	£ 4,226,660
Option 1.1	£ 5,632,028
Option 1.2	£ 5,678,022
Option 1.3	£ 5,663,187
Option 1.4	£ 5,613,687
Option 2.1	£ 5,632,028
Option 2.2	£ 5,678,022
Option 2.3	£ 5,663,186
Option 2.4	£ 5,613,686
Option 3.1	£ 5,632,029
Option 3.2	£ 5,678,022
Option 3.3	£ 5,663,187
Option 3.4	£ 5,613,687

6.3.22 This approach represents a conservative analysis, as only two tie-in points have been assumed, with the possible junction with the B7023 not being considered. In the scenarios which include a roundabout with the B7023, the likely disruption due to roadworks would be lessened as vehicles would have a smaller detour during work on some sections of the bypass.

6.3.23 The overall cost impact of each option is the difference between the existing A77 traffic delay costs and the sum of the traffic delay costs on the new A77 and de-trunked A77 through Maybole. This can be summarised by the following calculation, in which all costs accrue from traffic delay at roadworks:

Total Impact = Existing A77 maintenance – (Scheme Construction + Scheme maintenance + Future maintenance of de-trunked A77)

6.3.24 It should be noted that although Transport Scotland will no longer be responsible for the cost of maintenance on the de-trunked A77 through Maybole itself, traffic delay costs associated with the maintenance of the old A77 are still included within the formula. Travel time savings from traffic travelling within Maybole Town Centre have been included in the overall benefits of the scheme, therefore it follows that delays associated with this traffic should be included within the overall costs of the scheme.

6.3.25 The final costs for each of the scheme options are shown in Table 6.11. A positive value indicates a saving in the costs imposed by roadworks between the 'Do Minimum' and 'Do Something' scenarios. The results show that all of the options offer very similar savings compared to the 'Do Minimum' scenario.

Table 6.11 – Total Scheme Maintenance Costs over 60 year appraisal period

Scheme	Overall Benefit
Option 1.1	£ 2,071,704
Option 1.2	£ 2,025,710
Option 1.3	£ 2,040,545
Option 1.4	£ 2,090,045
Option 2.1	£ 2,071,704
Option 2.2	£ 2,025,710
Option 2.3	£ 2,040,546
Option 2.4	£ 2,090,046
Option 3.1	£ 2,071,703
Option 3.2	£ 2,025,710
Option 3.3	£ 2,040,545
Option 3.4	£ 2,090,045

6.4 Economic Benefits Associated with Accidents

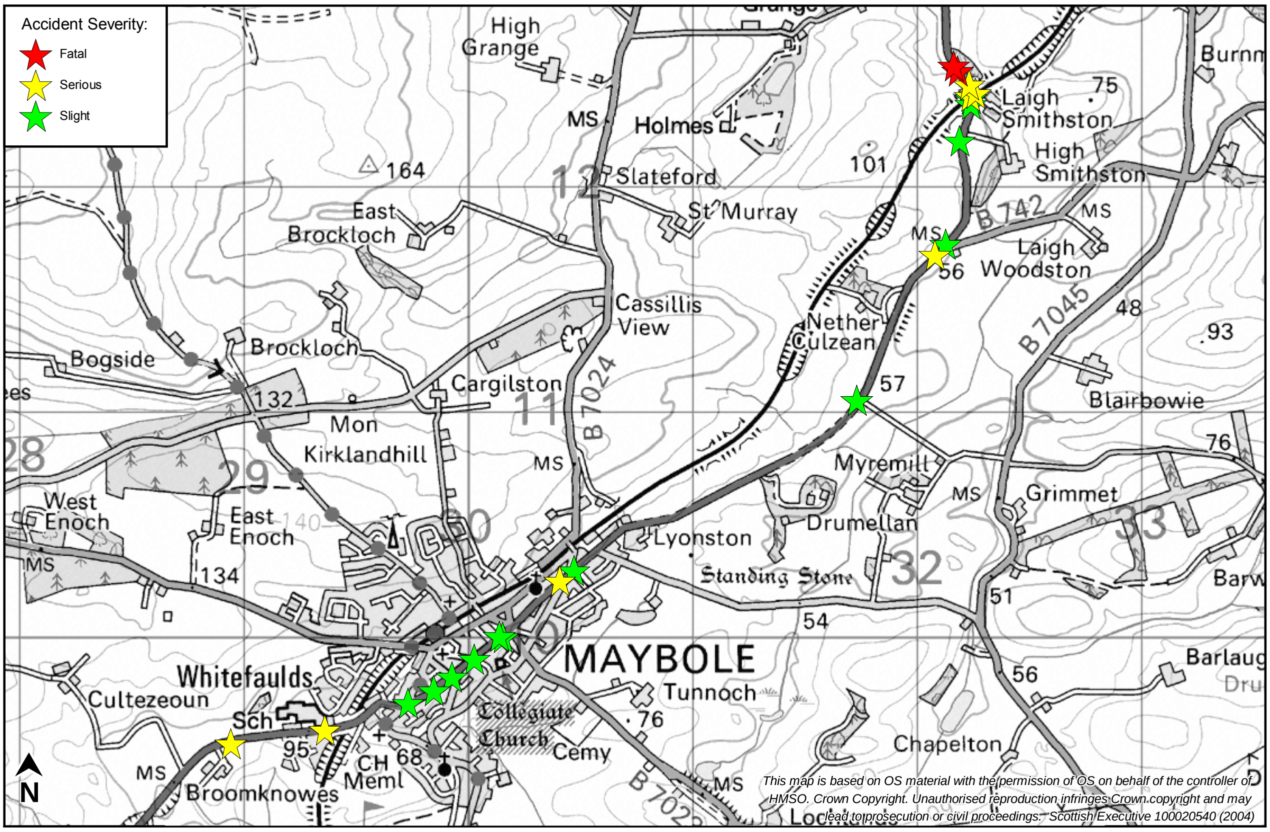
Introduction

6.4.1 The Scottish Executive's 'Network Evaluation from Survey and Assignment (NESA) program (version 05) was used to calculate the accident savings that are likely to be made on the existing A77 when traffic transfers onto the proposed bypass. In addition, the QUADRO runs produce accident results associated with roadworks which are incorporated into the final economic summary.

Local Accident History

6.4.2 Accident data was obtained for the section of the A77 being studied for the five year period between January 1999 and December 2003 from the Scottish Executive (now Transport Scotland). The data was analysed to obtain an accident rate for sections of the A77 adjacent to Maybole, and can be found in Appendix H. The location and severity of accidents in the vicinity of Maybole is shown in Figure 6.3.

Figure 6.3 – Accident Location and Severity (Jan '99 – Dec '03)



6.4.3 Accident savings as a result of the scheme are calculated as the difference between accident costs in the Do Minimum scenario and the accident costs in the Do Something scenarios over the 60 year appraisal period. Accident costs in the Do Something scenarios include both accidents on the new bypass and accidents on the old A77 passing through Maybole.

6.4.4 A comparison of the local accident rate between January 1999 and December 2003 and the Scottish trunk road average accident rate is shown in Table 6.12.

Table 6.12 – Existing Accident Rate

	Whole Route	Sub-sections of the Route			
		Town Centre	Rural A77	Smithston	Smithston Bridge
Link Length (km)	5.83	2.64	3.19	1.04	0.47
Observed Local Accident Rate	17.08	19.93	17.04	43.63	77.49
Scottish Trunk Road Average Accident Rate	25.54	39.89	16.25	16.25	16.25
NESA Default Accident Rates		84.40	38.10		

Notes: Accident Rates per 100 million vehicle kilometres
Average accident rates taken from Table 5(b), Road Accidents Scotland 2003, Scottish Executive, November 2004
NESA default Accident Rates taken from DMRB Volume 15, Table 6/5/1. NESA Road Category 2 assumed for Town Centre Accident Rates and Category 26 for Rural A77.

6.4.5 The results of the A77 in the town centre illustrate a lower observed accident rate than the NESA default average accident rate. However, observed accident rates for the rural sections of the A77 are higher than the NESA accident rates.

6.4.6 Figure 6.3 shows that the high level of accidents on the rural sections of the A77 can be largely attributed to the accident cluster site adjacent to Smithston Bridge. As part of the 'Do Minimum' scheme, it has been assumed that traffic signals will be introduced at this location, greatly reducing the overall accident risk on this rural section of the A77.

6.4.7 It is expected that the future accident rate adjacent to the Smithston Bridge will be the same as the observed accident rate on the rest of the A77.

6.4.8 NESA default accident rates have therefore been used within the assessment of predicted accident savings. These default rates better reflect the likely accident rate on the modelled section of the A77 if the accident cluster at the Smithston Bridge were removed.

6.4.9 The results of this NESA analysis are presented in an abridged Traffic and Economic Evaluation Report (TEER) form in Appendix H.

Projected Impact of the Road Improvements

6.4.10 The expected road safety benefits from the proposed scheme are set out below.

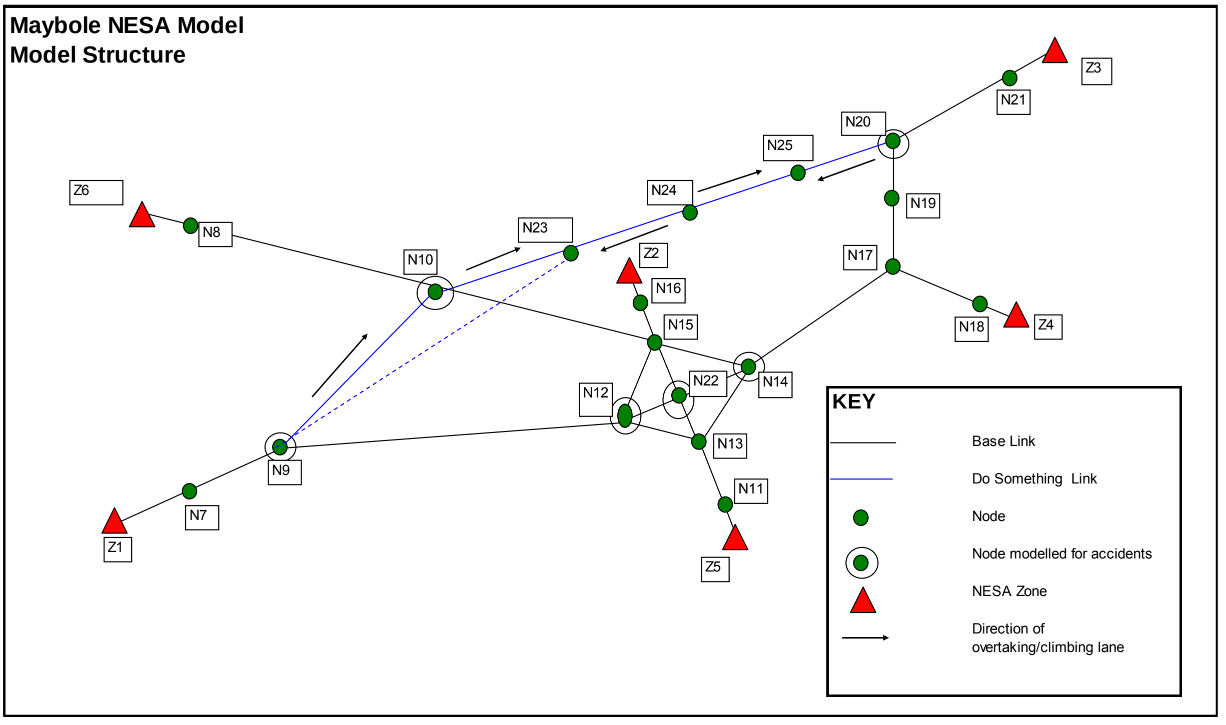
- Improved safety in Maybole town centre;
- Improved safety for overtaking on the bypass; and
- Downstream improvements in safety due to a reduction in driver frustration.

6.4.11 A NESA model was constructed to quantify the expected Accident Benefits arising from the proposed scheme within the Paramics model area. It was not possible to quantify any improvements in safety that might occur outwith the model area.

6.4.12 NESA is a computer program developed and maintained by the Scottish Executive for the traffic and economic appraisal of road schemes. In this instance NESA was only used to quantify expected Accident Benefits.

6.4.13 Figure 6.4 shows an indiciative diagram of the Maybole NESA model structure.

Figure 6.4 – Structure of the Maybole NESA model



6.4.14 The NESA model is a simplification of the Paramics network, containing six zones and 31 links.

6.4.15 The following link types were used within the NESA model:

- Link Type 2 – Urban single, 7.3m, non-central, 30mph
- Link Type 26 – Rural typical single, 7.3m, 60mph
- Link Type 27 – Rural good single, 7.3m, 60mph
- Link Type 30 – Rural good single with climbing lane, 10m, 60mph

6.4.16 New single-lane scheme links were coded as Link Type 27 rather than Link Type 26 to reflect the fact that they would be designed and built to the latest specifications, and would be in a better condition than existing single lane carriageways elsewhere in the network.

6.4.17 WS2 + 1 sections of the scheme were modelled as Link Type 30 for two lane sections of carriageway, and Link Type 27 for one lane sections.

6.4.18 Accidents on links and at junctions were modelled separately. This means that the user must specify which junctions should be taken into account within the program. In the Base and Scheme Options these are:

- A77 / Coral Glen / Ladyland Road
- A77 / Crosshill Road / Culzean Road
- A77 / Kirkland Street / Alloway Road
- A77 / New Roundabout SW of Maybole (scheme only)
- A77 / New Roundabout NE of Maybole (scheme only)
- A77 / B7023 proposed roundabout (Options 1.2, 1.4, 2.1, 2.4, 3.2, 3.4)

6.4.19 It should be noted that three junctions were modelled for accidents in the Base scenario and either five or six junctions in the Do Something scenarios, depending upon the particular option.

6.4.20 Base zone-to-zone 12 hour traffic demands were input into NESA. These were taken directly from the validated Base 2004 Paramics model. NESA assumes NRTF Central Growth in traffic when calculating projected benefits over a 60 year assessment period. The scheme opening year was assumed to be 2012.

6.4.21 The expected accident costs calculated in NESA and the expected benefits from the proposed schemes are summarised in Table 6.13.

Table 6.13 – Calculated accident costs and benefits

Scenario	Accident Cost (£m – 2002 prices)			Accident Benefits (£m – 2002 prices) Compared with Do Minimum		
	Link	Junction	Total	Link	Junction	Total
Do Minimum	19.3	5.72	**25.07**			
Blue 1.1	18.22	4.96	**23.18**	1.12	0.76	**1.89**
Blue 1.2	19.02	5.12	**24.14**	0.33	0.60	**0.93**
Blue 1.3	17.31	4.96	**22.27**	2.04	0.76	**2.80**
Blue 1.4	16.56	5.12	**21.68**	2.78	0.60	**3.39**
Red 2.1	18.19	4.96	**23.15**	1.15	0.76	**1.92**
Red 2.2	18.94	5.12	**24.06**	0.40	0.60	**1.01**
Red 2.3	17.29	4.96	**22.25**	2.06	0.76	**2.82**
Red 2.4	16.50	5.12	**21.63**	2.84	0.60	**3.44**
Yellow 3.1	18.01	4.96	**22.97**	1.33	0.76	**2.10**
Yellow 3.2	18.66	4.97	**23.64**	0.68	0.75	**1.43**
Yellow 3.3	17.14	4.96	**22.10**	2.20	0.76	**2.97**
Yellow 3.4	16.22	4.97	**21.19**	3.13	0.75	**3.88**

6.4.22 Table 6.13 shows that all of the proposed schemes are predicted to give accident benefits of between £0.93m and £3.88m at 2002 prices over the 60 year appraisal period. The scenario which is predicted to give the greatest accident benefit is Yellow 3.4, with an overall benefit of £3.88m.

6.4.23 Schemes with WS2+1 sections have higher accident benefits than those with D2 carriageway i.e. .3 and .4 have a greater benefit than .1 and .2 This is because accident rates on WS2+1 sections are lower than on S2 sections.

6.4.24 Accident benefits between the Do Minimum and Do Something scenarios are largely derived from a reduction in the amount of traffic travelling through Maybole Town Centre. This reduces the number of accidents on the urban links in Maybole and at the three specified junctions on the A77 itself.

6.4.25 Junction accident benefits are relatively small as there are either two or three extra scheme junctions in the Do Something scenarios compared to the Do Minimum situation. Overall junction accident benefits are still positive, as the reduction in the number of junction accidents in the centre of Maybole outweighs the expected number of accidents at the new scheme junctions.

6.4.26 Modelling junction and link accidents separately within NESA is likely to produce a conservative estimate of the junction benefits for the Maybole schemes. This type of assessment only takes into account accident benefits arising from specified junctions within the model. In reality, there are numerous priority junctions along the A77 in Maybole town centre, each of which would be expected to benefit from the reduction in traffic that the bypass schemes would provide.

6.4.27 NESA provides the option to use combined junction and link accident rates and costs. When this methodology is adopted, NESA uses higher combined accident rates on links. These rates assume a default junction density which is determined by link type. Individual junctions are not specified within the model.

6.4.28 As a sensitivity test, the NESA model was re-run using combined junction and link accident rates and costs. The results from this analysis are presented in Table 6.14.

Table 6.14 – Sensitivity Test of Calculated Accident Costs and Benefits

Scenario	Accident Cost (£m – 2002 prices)	Accident Benefits (£m – 2002 prices)
Do Minimum	44.2	
Blue 1.1	35.4	8.8
Blue 1.2	32.4	11.8
Blue 1.3	34.1	10.1
Blue 1.4	29.1	15.1
Red 2.1	35.4	8.8
Red 2.2	32.3	11.9
Red 2.3	34.1	10.1
Red 2.4	29.0	15.2
Yellow 3.1	35.2	9.1
Yellow 3.2	31.6	12.6
Yellow 3.3	33.9	10.3
Yellow 3.4	28.4	15.9

6.4.29 Table 6.14 shows that when the combined junction and link accident methodology is adopted, predicted accident benefits rise to between £8.8m and £15.9m over the 60 year appraisal period. As in the separate link and junction accident analysis, the Yellow 3.4 option has the biggest predicted accident benefits.

6.4.30 It is proposed that Accident Benefits derived from the separate link and junction analysis are used within the economic assessment of the Maybole schemes. This should ensure that the projected benefits of the different options are not over-estimated. However, it should be borne in mind that these are conservative estimates when compared with the figures derived from combined accident rates.

6.5 Results of Overall Economic Appraisal

6.5.1 Table 6.15 summarises the outputs from the TUBA, QUADRO, and accident analysis and presents them in a format that is compliant with NESA.

6.5.2 This analysis is presented for the central traffic growth scenario. Costs are discounted to 2002 (in multiples of a thousand pounds).

6.5.3 The discount rate used is 3.5% for the first 30 years and 3.0% for the next 30 years of the 60 year appraisal period. The results are presented as differences from the 'Do Minimum'.

6.5.4 A positive value in Table 6.15 indicates a benefit whereas a negative value is a disbenefit.

6.5.5 The overall economic results indicate that all the schemes achieve a positive NPV and BCR's of greater than 1.

6.5.6 It should be noted that in all of the schemes the costs are offset primarily by benefits from travel time. Future maintenance cost savings and accident benefits also contribute positively to the economic benefits of the schemes although to a much lesser extent.

6.5.7 The results shown in Table 6.15 indicate that all the schemes provide a positive economic return on the investment they require from the Government, however, Option 3.2 (Yellow Alignment, S2 with a roundabout with the B7023) provides the best economic return on the investment it requires, with a BCR_G of 9.1.

6.5.8 In relation to the funding agency, Transport Scotland, after removing indirect taxation all the schemes offer an increased economic return on investment. Again Option 3.2 provides the best economic return, with a BCR_{FA} of 10.9.

6.5.9 A full TEER form has been completed for Option 3.2 (Central Scenario) and is contained in Appendix H. The TEER form allows a record of all traffic and economic assessment methods and results for all schemes to be held in a database by Transport Scotland.

Table 6.15 – Combined Economic Summary Tables

Impact	Blue Option				Red Option				Yellow Option			
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4
Consumer User Benefits (£m)												
Travel Time	81.42	83.69	82.85	86.03	86.54	88.39	86.73	90.24	85.82	88.88	87.06	91.05
Vehicle Operating Costs	3.04	3.28	2.99	3.18	3.00	3.06	2.94	3.12	3.14	3.25	3.09	3.19
Travel Time & Vehicle Operating Costs												
During Construction	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
During Maintenance	1.11	0.00	1.10	-0.04	1.12	-0.08	1.10	-0.04	1.01	-0.30	1.00	-0.25
Net Consumer Benefits	***85.53***	***86.92***	***86.90***	***89.13***	***90.61***	***91.32***	***90.72***	***93.27***	***89.92***	***91.78***	***91.09***	**93.95**
Business User Benefits (£m)												
Travel Time	118.55	120.59	120.74	123.49	125.41	127.15	126.14	130.85	125.40	127.96	126.38	130.37
Vehicle Operating Costs	10.11	10.25	10.19	10.31	10.49	10.52	10.44	11.55	10.85	10.91	10.38	11.00
Travel Time & Vehicle Operating Costs												
During Construction	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
During Maintenance	1.22	-0.35	1.20	-0.09	1.22	-0.14	1.20	-0.10	1.10	-0.39	1.08	-0.34
Net Business User Benefits	***129.84***	***130.45***	***132.08***	***133.66***	***137.07***	***137.48***	***137.74***	***142.26***	***137.31***	***138.44***	***138.27***	140.98
Total Present Value of TEE Impacts	**215.38**	**217.38**	**218.98**	**222.79**	**227.69**	**228.81**	**228.46**	**235.53**	**227.24**	**230.22**	**229.37**	**234.93**
Central Government Funding (£m)												
Investment Costs (Capital Costs)	22.56	22.98	24.19	26.10	25.65	22.79	27.35	24.52	16.56	16.24	17.62	17.32
Operating Costs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maintenance Costs												
Non-Traffic	-0.46	-0.23	-0.18	-0.38	-0.46	-0.24	-0.28	-0.48	-0.50	-0.34	-0.38	-0.54
Traffic Related	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Developer & Other Contributions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indirect Taxation	4.20	4.39	4.05	4.39	4.17	4.25	3.99	4.59	4.30	4.56	4.53	4.62
Net Impact	***26.30***	***27.14***	***28.06***	***30.11***	***29.35***	***26.81***	***31.05***	***28.63***	***20.35***	***20.46***	***21.77***	***21.40***
Local Government Maintenance Cost	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**	**4.99**
Present Value of Costs (PVC)	**31.29**	**32.12**	**33.04**	**35.09**	**34.34**	**31.79**	**36.04**	**33.62**	**25.34**	**25.45**	**26.76**	**26.38**
Present Value of Costs (PVC) (-) ITR	**27.09**	**27.73**	**28.99**	**30.71**	**30.17**	**27.54**	**32.05**	**29.03**	**21.04**	**20.89**	**22.22**	**21.76**
TEE Impacts (£m)												
Consumer User Impacts	85.53	86.92	86.90	89.13	90.61	91.32	90.72	93.27	89.92	91.78	91.09	93.95
Business User Impacts	129.84	130.45	132.08	133.66	137.07	137.48	137.74	142.26	137.31	138.44	138.27	140.98
Private Sector Provider Impacts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Accident Benefits	1.78	0.58	2.70	3.02	1.81	0.64	2.72	3.07	1.97	1.02	2.84	3.47
Present Value of Benefits (PVB)	**217.16**	**217.95**	**221.68**	225.80	**229.50**	**229.44**	**231.18**	**238.60**	**229.21**	**231.24**	**232.21**	**238.40**
Government Funding												
Present Value of Costs (PVC_G)	**31.29**	**32.12**	**33.04**	**35.09**	**34.34**	**31.79**	**36.04**	**33.62**	**25.34**	**25.45**	**26.76**	26.38
Present Value of Costs (PCV_{FA})	**27.09**	**27.73**	**28.99**	**30.71**	**30.17**	**27.54**	**32.05**	**29.03**	**21.04**	**20.89**	**22.22**	21.76
Overall Impact												
Net Present Value (NPV_G)	**185.87**	**185.83**	**188.63**	**190.71**	**195.17**	**197.65**	**195.14**	**204.98**	**203.86**	**205.79**	**205.45**	**212.02**
Benefit to Cost Ratio (BCR_G)	**6.9**	**6.8**	**6.7**	**6.4**	**6.7**	**7.2**	**6.4**	**7.1**	**9.0**	**9.1**	**8.7**	**9.0**
Net Present Value (NPV_{FA})	**190.07**	**190.22**	**192.69**	**195.10**	**199.33**	**201.90**	**199.13**	**209.57**	**208.17**	**210.36**	**209.99**	**216.63**
Benefit to Cost Ratio (BCR_{FA})	**7.9**	**7.7**	**7.5**	**7.2**	**7.5**	**8.2**	**7.1**	**8.1**	**10.7**	**10.9**	**10.2**	**10.7**

6.6 Sensitivity Analysis

Sensitivity Test 1 – Local Growth Rates

6.6.1 Guidance in DMRB states that future year models should be developed using NRTF central growth. An analysis of local traffic data on the A77(T) showed that historic traffic growth differed from NRTF central growth.

6.6.2 A sensitivity test was conducted whereby the Yellow Scheme Options (3.1, 3.2, 3.3 and 3.4) were re-run in Paramics using traffic growth rates which more closely reflected local conditions in the vicinity of Maybole.

6.6.3 The Yellow Options were chosen for this test, because the economic analysis presented in Section 6.5 clearly demonstrates that this alignment provides a higher return on investment than the Blue or Red options, and is therefore likely to be taken forward to the next planning stage.

Local Traffic Growth

A77 (T)

6.6.4 The STAG Part 1 Appraisal Report[84] noted that local historic ATC data on the A77(T) showed annual traffic growth of 2.9% per annum (pa) between 2000 and 2005. This is considerably higher than NRTF High Growth over the same period, which was 1.19% pa.

6.6.5 This figure of 2.9% pa is likely to be caused by an increase in ferry traffic between Scotland and Ireland, and continued development along the A77(T) between Ayr and Stranraer. Although the 2000 - 2005 local A77 traffic growth rates are considered representative of historic growth in the corridor, it is also recognised that this level of growth is unsustainable in the corridor over the medium to long term.

6.6.6 Taking this into account, annual local growth factors were gradually reduced between 2004 and 2031, so that by 2031 annual growth was capped to the same level as NRTF High Growth (1.0119).

Minor Roads

6.6.7 Historic traffic data on minor roads within Maybole indicated that traffic growth on these roads was much lower than that experienced on the A77. Analysis showed that traffic on minor roads was growing at a rate broadly comparable with NRTF Low growth.

6.6.8 A summary of the NRTF low and local traffic growth factors is shown in Table 6.16 and Table 6.17.

[84] A77 Maybole Transport Study, STAG Part 1 Appraisal Report: Atkins, April 2006

Table 6.16 – NRTF Low Growth Factors

Year	Car	LGV	OGV1	OGV2	Bus/Coach
2004 – 2012	1.099	1.159	1.036	1.184	1.028
2004 – 2031	1.225	1.608	1.157	1.711	1.137

Table 6.17 – Local Growth Factors

Year	Car	LGV	OGV1	OGV2	Bus/Coach
2004 – 2012	1.159	1.797	0.833	1.957	0.742
2004 – 2031	1.419	3.204	1.902	3.570	1.990

Summary

6.6.9 The final matrices for use in the sensitivity tests were produced from the validated Base matrices as follows: traffic on the A77(T) was growthed using the synthesised local high growth rates discussed above. All other traffic was growthed using NRTF Low Growth Factors. These matrices more closely reflect local traffic growth in the vicinity of Maybole than the matrices used in Central Growth Scenario.

Paramics Model Outputs

6.6.10 A summary of the average journey times between Zone 1 and Zone 4 in the sensitivity test is presented in Table 6.18. Option 3.2 has been chosen as it is representative of the magnitude of changes modelled in the Do Something scenarios.

Table 6.18 – Average Journey Times in Sensitivity Test

Scheme Option	Average Journey Time (min : sec)
Do Minimum 2012	20:10
Do Minimum 2031	29:53
Option 3.2 2012	17:48
Option 3.2 2031	18.10

6.6.11 It should be noted that the average journey time for only Option 3.2 has been shown to illustrate the differences between the ‘Do Minimum’ and ‘Do Something’. All other options show similar results.

6.6.12 The ’Do Minimum’ Sensitivity test Paramics model shows an increased level of through traffic on the A77(T) but a lower level of local traffic. The overall level of queuing on the A77 in Maybole town centre is predicted to be extensive, stretching back along the A77 beyond the town centre boundary. This is comparable with the queues in the Central Growth analysis.

6.6.13 The results from the sensitivity test show increased travel time savings between the northern and southern extremes of the model than were experienced in the Central Growth scenario. This is to be expected, as congestion in the Do Minimum scenario along the existing A77(T) in Maybole is likely to be greater in the sensitivity test, due to higher levels of traffic growth.

TUBA Model Outputs

6.6.14 The resulting outputs from TUBA for the sensitivity test were evaluated over 60 years and discounted to 2002 prices, and are summarised for Central Government and Funding Agency in Table 6.19 and Table 6.20. The values shown are the difference between the 'Do Minimum' and scheme scenarios.

Table 6.19 – Sensitivity Assessment TUBA Results (Central Government)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_G) £'000s	Net Present Value (NPV_G) £'000s	Benefit to Cost Ratio (BCR_G)
Option 3.1	260,242	23,856	236,386	10.91
Option 3.2	265,429	23,374	242,055	11.36
Option 3.3	263,472	24,807	238,665	10.62
Option 3.4	270,118	24,316	245,802	11.11

Table 6.20 – Sensitivity Assessment TUBA Results (Funding Agency)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_{FA}) £'000s	Net Present Value (NPV_{FA}) £'000s	Benefit to Cost Ratio (BCR_{FA})
Option 3.1	257,425	21,039	236,386	12.24
Option 3.2	262,940	20,885	242,055	12.59
Option 3.3	260,889	22,224	238,665	11.74
Option 3.4	267,566	21,764	245,802	12.29

6.6.15 The same pattern of results found in the Central Growth Yellow scenarios is produced by the sensitivity tests. Option 3.2 returns the highest BCR_G and BCR_{FA}, and all of the calculated BCRs are higher than those returned by the Central Growth Scenario tests. This reflects the greater travel time savings within the sensitivity tests.

NESA Summary

6.6.16 Table 6.21 summarises the outputs from the TUBA, QUADRO and accident analysis, and presents them in a format that is compliant with NESA.

6.6.17 It should be noted that the NESA and QUADRO runs conducted for the Central Growth Yellow Options were not re-calculated for the sensitivity test due to the expected minimal impact that the revised traffic flows would have upon the values.

Table 6.21 – Sensitivity Assessment Combined NESA Summary (Table 15C)

Impact	Yellow Option Sensitivity Assessment			
	3.1	3.2	3.3	3.4
TEE Impacts (£m)				
Consumer User Impacts	107.43	108.79	109.05	110.92
Business User Impacts	154.44	155.52	156.06	158.16
Private Sector Provider Impacts	0.00	0.00	0.00	0.00
Accident Benefits (£m)	1.97	1.02	2.84	3.47
Present Value of Benefits (PVB)	**263.85**	**265.32**	**267.95**	**272.56**
Government Funding (£m)				
Present Value of Costs (PVC_G)	**23.89**	**23.39**	**24.84**	**24.33**
Present Value of Costs (PCV_{FA})	**21.04**	**20.89**	**22.22**	**21.76**
Overall Impact				
Net Present Value (NPV_G) (£m)	239.96	241.94	243.10	248.23
Benefit to Cost Ratio (BCR_G)	**11.0**	**11.3**	**10.8**	**11.2**
Net Present Value (NPV_{FA}) (£m)	242.81	244.44	245.72	250.79
Benefit to Cost Ratio (BCR_{FA})[85]	**12.4**	**12.6**	**11.9**	**12.4**

6.6.18 The results show that all of the Yellow options deliver sufficient benefits to offset their costs. As in the Central Growth Scenario, Option 3.2 performs best with a BCR_G of 11.3 and a BCR_{FA} of 12.6

6.6.19 It should be noted that in all of the schemes, the costs are offset primarily by benefits from travel time. Future maintenance cost savings and accident benefits also contribute positively to the economic benefits of the schemes, although to a lesser extent.

6.6.20 The results indicate that for all Yellow options, the sensitivity assessment using local growth rates delivers a higher benefit than the central growth assessment.

Summary

6.6.21 The sensitivity assessment using a combination of Low Growth and Local Growth factors indicate that in the 'Do Minimum' scenario extensive queuing and delay would still occur in Maybole Town centre in future years.

6.6.22 The results of the subsequent economic assessment indicate that all the Yellow options provide an improved positive economic return on the investment when compared to the schemes assessed using central growth factors.

6.6.23 The analysis indicates Option 3.2 (Yellow Alignment, S2 with a roundabout with the B7023) would still provide the best economic return on the investment it requires, with a BCR_G of 11.3.

[85] Note that BCR(FA) is calculated using the formula presented in Section 6.2. The PVB presented in Table 6.21 includes the effects of indirect taxation

6.6.24 In addition, in respect of the funding agency Transport Scotland, all the schemes would provide a positive economic return on the investment after removing the indirect taxation, with Option 3.2 again providing the best economic return, with a BCR_{FA} of 12.6.

Sensitivity Test 2 – Capped Traffic Growth

6.6.25 A further sensitivity test was conducted whereby the Yellow Scheme Options (3.1, 3.2, 3.3 and 3.4) were tested with Central Traffic Growth which was capped at 2012. i.e. Traffic levels throughout the 60 year appraisal period remain at 2012 levels.

6.6.26 The Yellow Options were chosen for this test, because the economic analysis presented in Section 6.5 clearly demonstrates that this alignment provides a higher return on investment than the Blue or Red options, and is therefore likely to be taken forward to the next planning stage.

6.6.27 This sensitivity test did not require Paramics to be re-run. The 2012 Paramics output files for each model were fed into TUBA for each of the design years after 2012, which had the effect of capping traffic growth.

6.6.28 It should be noted that the NESA and QUADRO runs conducted for the Central Growth Yellow Options were not re-calculated for this sensitivity test due to the expected minimal impact that the revised traffic flows would have upon the values.

NESA Summary

6.6.29 Table 6.21 summarises the outputs from the TUBA, QUADRO and accident analysis, and presents them in a format that is compliant with NESA.

6.6.30 The resulting outputs from TUBA for Sensitivity Test 2 were evaluated over 60 years and discounted to 2002 prices, and are summarised for Central Government and Funding Agency in Table 6.22 and Table 6.23. The values shown are the difference between the 'Do Minimum' and scheme scenarios.

Table 6.22 – Sensitivity Assessment TUBA Results (Central Government)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_G) £'000s	Net Present Value (NPV_G) £'000s	Benefit to Cost Ratio (BCR_G)
Option 3.1	39.05	21.46	17.58	1.8
Option 3.2	44.67	21.20	23.46	2.1
Option 3.3	39.50	22.68	16.82	1.7
Option 3.4	47.38	21.88	25.50	2.2

Table 6.23 – Sensitivity Assessment TUBA Results (Funding Agency)

Scheme Option	Present Value of Benefits (PVB) £'000s	Present Value of Costs (PVC_{FA}) £'000s	Net Present Value (NPV_{FA}) £'000s	Benefit to Cost Ratio (BCR_{FA})
Option 3.1	38.62	21.04	17.58	1.8
Option 3.2	44.35	20.89	23.46	2.1
Option 3.3	39.04	22.22	16.82	1.8
Option 3.4	47.27	21.76	25.50	2.2

6.6.31 All of the Yellow schemes provide a positive BCR. Option 3.4 provides the greatest benefits with an NPV(Gov) of £25,500,000 and a BCR(Gov) of 2.2. Option 3.2, which comes out ahead in the Central Growth and Sensitivity Test 1 scenarios, provides an NPV(Gov) of £23,461,000 and a BCR(Gov) of 2.1.

6.6.32 Option 3.4 is therefore slightly more favourable than Option 3.2 in Sensitivity Test 2. This is because Option 3.4 has higher accident benefits than 3.2, and in this sensitivity test these form a higher proportion of the overall benefits of each scheme. Accident benefits are therefore more economically significant than in the Central Scenario.

6.6.33 Both Option 3.2 and 3.4 return the same BCR(FA) as BCR(Gov) (when rounded) when the effects of indirect taxation are considered.

Summary

6.6.34 The output BCRs are greatly reduced when compared to the Central Growth scenario tests. Capping traffic growth to 2012 levels has the effect of reducing traffic congestion within Maybole Town Centre, and reducing travel times in the Do Minimum models. As a result, less travel time savings result from vehicles bypassing the town in the Option tests.

6.6.35 Capping traffic growth at 2012 acts as a further test to the proposed schemes, but it is extremely likely that traffic levels will continue to grow beyond 2012. However, this sensitivity test demonstrates that even with extremely minimal levels of traffic growth, each of the Yellow Maybole scheme options provides a positive BCR over the 60 year appraisal period.

6.6.36 The results show that both Option 3.2 and Option 3.4 have extremely similar BCRs in this scenario.