Technical Report

A4/A4174 Hicks Gate Roundabout Improvement Options

Prepared for

Bath and North East Somerset Council

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Acronyms and Abbreviations

B&NES	Bath and North East Somerset Council
PVB	Prevent Value Benefits

SECTION 1

Introduction

1.1 Background

The A4/A4174 Hicks Gate Roundabout is a key junction on the A4 between Bristol and Bath, and is located at the western end of the Keynsham Bypass. This is also the terminal junction at the southern end of the A4174 Ring Road route through East Bristol and the North Fringe. Not unexpectedly it is heavily trafficked in the weekday peak periods and at other times. The existing roundabout has four arms and is partially signalised, with the A4 East, A4174 and A4175 Durley Hill approaches under permanent signal control. The normal mode of control employed is SCOOT UTC, with the daily operation here controlled by Bristol City Council as part of the Bristol UTC network, albeit this junction being within the Bath and North East Somerset (B&NES) administrative area. **Figure 1.0** shows the location of this junction and other key adjacent junctions referenced in this report.

In the weekday morning peak period the operation of this junction is heavily affected by westbound queuing back from the A4 Bath Road/Emery Road junction in Brislington, which 'exit blocks' the roundabout in this direction. As a result traffic turning right from the A4174 Ring Road or proceeding straight-ahead from the Keynsham Bypass is unable to exit freely, leading to relatively static/slow moving circulatory queuing which extends around the south and east sides of the roundabout for extended periods. This westbound exit blocking on Bath Road also affects drivers attempting to turn left from Durley Hill. Furthermore, the 'excess' circulatory queuing created impedes traffic attempting the make the right turn movement from the Keynsham Bypass to the A4174, and also the straight-ahead and right turning movements from the A4175 Durley Hill. **Figure 2.0** shows the typical extent of queuing in this period, and critically the static or slow moving traffic affecting the whole length of the westbound A4 between Hicks Gate and the Emery Road junction in Brislington.

In the weekday evening peak period the exit blocking problems associated with the A4 Bath Road do not occur. Although there is queuing on this approach to Brislington it is not generally extensive enough to 'block back' to Hicks Gate. There is, however, regular queuing on the A4174 Ring Road approach which does not always clear in the first available green period. It should be noted that westbound queuing on the A4 Bath Road sufficient to reach back to Hicks Gate does occur from time to time in the weekday inter-peak period and also on Saturdays.

In view of it's already congested operation, and with the prospect of greater traffic pressure here with the build-out of the consented Somerdale development in Keynsham and other 'Core Strategy' development sites identified in the town, B&NES commissioned CH2M Hill to investigate potential improvement options for the Hicks Gate junction. In so doing no specific 'constraints' were set, such as for example no requirement for any on third party land. This would in any case severely restrict the level of improvement possible.

1.2 Structure of Report

Following this introductory chapter the remainder of the report content is structured as follows:

- Chapter 2: Development and Description of Options;
- Chapter 3: Operational Modelling;
- Chapter 4: Cost Estimating;
- Chapter 5: Evaluation of Benefits; and
- Chapter 6: Summary and Conclusions.

SECTION 2

Development of Options

2.1 Existing Traffic Flows and External Constraints

In developing the improvement options it should be recognised that the current queuing back from the A4 Bath Road/Emery Road junction in Bristol is not something that can be solved by any improvements made to Hicks Gate alone. The A4 Bath Road/Emery Road junction has only been recently improved by Bristol City Council, but the recurrent westbound congestion on the Bath Road approach is caused as much by capacity constraint on the downstream section of the A4 through Brislington and regular over-capacity conditions at the Brislington Hill/West Town Lane junction in particular. In other words there is no simple fix to remove this occurrence of exit blocking affecting the operation of Hicks Gate Roundabout, notably in the weekday morning peak period. In any event, any measures to address these problems in Brislington would lie within the remit of Bristol City Council as highway authority here.

Tables 2.1 and 2.2 below show the existing weekday 8:00-9:00am and 5:00-6:00pm turning flows at Hicks Gate Roundabout. In the morning peak hour the current exit flow to the A4 Bath Road towards Brislington in this period is 1,638vph. This is close to the link capacity of the single westbound lane available to general traffic not using the nearside access lane to the Brislington Park and Ride site, notwithstanding any constraint imposed by the signals at the Emery Road junction and beyond this.

Table 2.1 A4/A4174 Hicks Gate Roundabout: Traffic Volumes - Weekday 8:00-9:00am

Arm From	Arm To				
	A: A4 Bath Road	B: A4174 Ring Road	C: A4 Bypass	D: A4175 Durley Hill	TOTAL
A: A4 Bath Road	2	503*	383	419	1,307
B: A4174 Ring Road	794	0	350	211	1,355
C: A4 Keynsham Bypass	610	519	0	13	1,142
D: A4175 Durley Hill	232	442	121	0	795
TOTAL	1,638	1,464	854	643	4,599

Notes: * Segregated left turn filter lane

Table 2.2 A4/A4174 Hicks Gate Roundabout: Traffic Volumes - Weekday 5:00-6:00pm

Arm From	Arm To				
	A: A4 Bath Road	B: A4174 Ring Road	C: A4 Bypass	D: A4175 Durley Hill	TOTAL
A: A4 Bath Road	0	808*	571	471	1,850
B: A4174 Ring Road	633	0	530	390	1,553
C: A4 Keynsham Bypass	429	650	0	44	1,123
D: A4175 Durley Hill	167	324	164	0	655
TOTAL	1,229	1,782	1,265	905	5,181

Notes: * Segregated left turn filter lane

In developing the options it was thus accepted that this downstream capacity restraint and exit blocking would most likely remain in the future. As such, for example, any proposals to boost the westbound straight-ahead capacity of the A4 locally at Hick Gate were regarded as being of no benefit in that the potential capacity already available to this movement is already severely reduced by exit blocking when it occurs.

In previous assessment work done using the S-Paramics model of Keynsham, which includes the Bypass, the inclusion of a 'notional' link taking out the right turn A4 Keynsham Bypass-A4174 movement from Hicks Gate Roundabout was shown to generate a good degree of de-congestion benefit. No detail of any scheme was developed at the time, but the 'principle' and likely effect was established. The existing volumes show that the right turn flow from the A4 Keynsham Bypass to the A4174 Ring Road is quite significant in both peak periods. In the 8:00-9:00am hour this right turn is of similar magnitude to the westbound straight-ahead movement on the A4, but is actually greater in the 5:00-6:00pm period.

The effect of exit blocking means that, in the morning peak hour, this right turn flow generally gets caught up and impeded by the circulatory queuing on the roundabout resulting from this. This exacerbates the queuing on the bypass. As such, there would appear to be benefit in developing an improvement scheme centred on preventing or minimising the impedance to this movement. As mentioned above, the previous 'concept' scheme testing with S-Paramics suggested this would be very worthwhile in benefit terms.

In the evening peak period the existing traffic flows show that the approach flow on the A4 Bath Road is 1,850vph. In link capacity terms this represents a close to or maximum throughput at the two lane to one lane merge point just east of the Park and Ride exit. In the previous S-Paramics modelling work done using the Keynsham model for assessing the Somerdale and Core Strategy developments in the town there was assumed growth in the 3:00-7:00pm flow on the A4 Bath Road arm approaching the roundabout, with a proportion of this naturally expected to occur in the 'peak' 5:00-6:00pm. Looking at the network constraints on the A4 further west, and mindful of the fact that the flow in the eastbound single lane section between the Park and Ride exit and Ironmould Lane is already 1,850vph between 5:00-6:00pm, it is considered there is very little potential for this approach volume to increase over this hour. At present there are no queuing problems on the A4 Bath Road approach to Hicks Gate Roundabout in either peak hour. Traffic routing via the roundabout is required to 'give way', with sufficient gaps in the circulating flow generally available. The most significant circulatory movement across this arm is the right turn from the bypass. As such, any improvement taking out this movement would significantly increase the entry capacity of the A4 Bath Road arm. However, as noted above, the potential for the peak hourly traffic on this arm to increase is very low due to upstream network constraints.

In view of the constraints imposed by the capacity of the A4 Bath Road to the west of Hicks Gate Roundabout in both directions the improvement options have focused on improving operating conditions for the A4 Keynsham Bypass to A4174 movement. The three options developed to preliminary design level are described in the following sections.

2.2 Option 1

The Option 1 improvement scheme is shown on Drawing No 204269.CA.00.52.01 in **Appendix A**. This involves the provision of a displaced link connection between the A4 Keynsham Bypass and the A4174 to the NE of the roundabout. The link is primarily intended to remove right turning traffic from the westbound A4 from the roundabout, thus removing the current impedance to this movement created by the circulatory queuing around the south and east sides of the junction in the morning peak hour. However, in this case the infrastructure change proposed also includes a left filter link for traffic routing between the A4174 and the eastbound A4.

The proposed arrangement will require new signalled junctions on the A4 Bypass and A4174 arms in the vicinity of the roundabout. On the westbound A4 approach this is needed to safely facilitate the right turn 'cross-over' conflict with the eastbound A4. On the westbound approach to this junction the carriageway is shown widened to three lanes, largely by incursion into the existing central reserve. This is to allow the provision of a sheltered right turn lane of suitable length to accommodate any queuing right turners, whilst allowing straight-ahead traffic to continue to use both 'approach' lanes on the bypass to proceed through to the roundabout. Simply running the current outside approach lane on the bypass directly into the right turn lane for the 'cross-over' was not considered acceptable on safety grounds. This was due to the potential risk of driver confusion, and as such higher speed vehicles in the outside lane continuing on the A4 being forced to make a late lane change into the nearside lane.

On the A4174 approach an additional traffic signal controlled 'node' would be needed to safety cater for the right turning vehicles joining the Ring Road from the new link. Although the right turn 'feed' to the new link is only a single lane, it was decided to provide two lanes within the link itself in the direction of the A4174 to afford more queuing capacity. This is because the optimal co-ordination will not necessarily permit the right turning traffic entering the link to proceed uninterrupted through the downstream signals on a 'green wave', so sufficient 'holding' capacity for the right turn platoon is essential. The new signals on the A4174 necessary to ensure safe right turn egress from the proposed link will require signalling the current 'free flow' left filter lane from the A4 Bath Road, as well as traffic exiting via the roundabout to the Ring Road. However, the separate lanes catering for these two traffic streams could operate using the same signal phase and thus run concurrently. Given the proximity of these new signals to the roundabout exit it is considered that the present two lane to one merge on the A4174 exit should be modified to a single lane as shown.

In terms of signal co-ordination with the existing roundabout the most critical area is the southbound A4174 approach. During the stage controlling the A4174 entry to the roundabout it will be important to ensure that sustained discharge through the green period is not prevented or 'cut off' by the upstream signals controlling the Ring Road moving to red prematurely. It will also be essential to ensure that the back of the platoon is able to clear the downstream stop-line at the roundabout or, if any vehicles are caught 'at red', that the ensuing internal queue between stop-lines is not sufficient to block and impede the right turn from the new link.

As stated earlier, the proposed improvement also incorporates a filter for left turning traffic on the A4174, although this design element could be excluded. However, as third party land to the NE of the current Hicks Gate junction will be needed anyway to construct the works, there may be sense in securing the additional land needed to provide this. The drawing does identify potential 'Departures' from standard as this arrangement is not really covered by TD51/03 'Segregated Left Turn Lanes and Subsidiary Deflection Islands at Roundabouts', but might more readily be regarded as a connector road and as such covered in TD22/06 'Layout of Grade-Separated Junctions'. The latter obviously covers high speed roads, but southbound traffic on the A4174 at the approach to the diverge nose for this left turn link could still be travelling at some speed, and so lose control within the 90m radius bend. However, drivers at this point would be approaching the traffic signals, and as such drivers turning left may still be forced to slow by other vehicles proceeding ahead and preparing or expecting to stop. Furthermore, the segregated left filter lane catering for the A4 Bath Road to Ring Road movement has the same 90m inside radius, and arguably the potential speed of approach here is little different to what might be expected on the A4174 approach to this filter or connector link.

2.3 Option 2

Drawing No 204269.CA.00.52.02 in **Appendix B** shows a 'grade separated' alternative' for the westbound A4 to A4174 link. This avoids the need for a cross-over junction on the bypass, but to achieve any sort of acceptable link road alignment over the roundabout it would be necessary to take the approach alignment off to the south of the bypass as shown. The land on this side is already higher that the existing carriageway level, but some additional earthworks raising of the proposed link is considered necessary as shown to achieve the require headroom clearance to the structure where it passes over the SE circulatory section of the existing roundabout.

The drawing indicates some 'Departures from Standard' associated with the 90m inside radius of the curved viaduct structure needed to carry the link over the roundabout. Further earthworks and third party land acquisition on the NW side of the existing junction would then be needed to carry the new link down to a northbound juncture with the A4174. The likely 'departures' relate to:

- The approach gradient from the diverge nosing on the bypass to the start of the bridge structure. This is likely to exceed the maximum 6% grade for connector roads set out in TD22/06;
- The achievable centre-line horizontal radius of the road link over the viaduct (90m); which is more than two steps below the minimum desirable (127m) for a connector road with an design speed of 60B - 30mph (TD9/93); and
- The requisite Desirable Minimum Sight Stopping Distance (DMSSD) for a connector road with a design speed of 60B is 90m, which is unlikely to be achievable on the structure. It is considered that an DMSSD of 50m could be achieved, and note that Manual for Streets (MfS) considers that 43m is adequate DMSSD for a speed of 30mph. However, it is considered that DMRB standards would more properly apply here.

On the A4174 it is considered that a traffic signal controlled junction would best be used to accommodate the right turning traffic joining the Ring Road from the nearside. This offers the advantage of adding a second lane on the final approach to the A4174 junction to take advantage of the two lane northbound exit geometry available. This two lane join would not be possible with a conventional merge arrangement, but this form of termination is not considered desirable anyway on safety ground just downstream of the left filter 'lane gain' at the roundabout exit. The left turn flow from the A4 Bath Road is around 800vph between 5:00-6:00pm. Drivers joining the A4174 in this nearside lane would obviously need to checks for 'gaps' in traffic in the outside lane before attempting a lane change, and are unlikely to do so immediately. In view of this, this level of traffic is likely to continue in the nearside lane through any 'merge' zone, creating difficulties for drivers joining the Ring Rind via the new link. However, this behaviour is similarly likely to lead to a high 800vph flow in the nearside A4174 lane at the signals between 5:00-6:00pm, with the utilisation of the outer lane much less (324vph).

One disadvantage of Option 2 compared to Option 1, albeit increased cost, is the need for third party land to the SE and NW of the roundabout. Land to the SE of the roundabout is affected by proposals for a new purpose built whole-time fire station and training facility, replacing the current part-time fire stations in Keynsham and Brislington. However, examination of the proposals showed that the land potentially needed for the connector road access onto the viaduct structure does not impact on this proposal. The consultation leaflet showing the proposed new fire station and land take is shown in **Appendix C**. It would be possible to 'add on' to the Option 2 improvements by creating a segregated left turn filter lane between the A4174 and the bypass, with a merge termination on exit. However, this would have created a third area of third party land-take so was excluded. This was included as a provision in Option 1 as the displaced right turn lane already affected third party land in the NE corner of the junction. As such it was considered sensible to try to

achieve the maximum operational benefit from improvements here as the need for land in this quadrant was already established.

2.4 Option 3

At the bequest of B&NES officers a third improvement options was examined involving no land take outside the highway. It was hopeful this could form part of a Local Growth Fund (LGF) bid if demonstrated to be worthwhile in operating terms. The principle was again to develop a link between the A4 Bypass and the A4174 to reduce impedance to this movement created by circulatory queuing in the weekday morning peak period. Drawing No 204269.CA.00.52.03 in **Appendix D** shows the form of layout developed.

The layout shows the creation of a two lane link through the central island as indicated, with access to this obtained via the outside approach lane on the A4 Bypass approach. Two lanes are proposed as shown to provide a degree of 'holding' or queue storage capacity within the link, as examination of the overall signal co-ordination showed that it would not necessarily be possible to provide a 'green wave' for traffic routing via this cross link. The inclusion of this link does, however, create a series of difficulties with achieving a safe exit from it onto the A4174 Ring Road as follows:

- A signalled exit from the link would be necessary, which will necessitate signalling the eastbound A4 Bath Road approach to the roundabout. This control will also need to deal with circulating traffic on the west side of the roundabout which, with the removal of the westbound A4 to A4174 right turn, will comprise straight-ahead and right turning traffic from Durley Hill. As such, a three stage Method of Control would be needed at this 'node'. This is less than ideal as the other three arms operate with two stages, so making sensible co-ordination awkward; and
- With a two lane signalled movement to the A4174 proposed from both the circulatory carriageway and the new 'through' link the short existing merge on exit would be inadequate and sub-standard (TD50-04). To address this the termination of the existing segregated left turn lane from the A4 Bath Road has been changed from a 'lane gain' to a merge, this allowing the exit from the roundabout to be continued as two full lanes. Whilst addressing the potential safety issue with platooned traffic in two lanes coming to a very short merge zone, it does mean the very high left turning flow from Bath Road in the 5:00-6:00pm period would now be forced to yield.

Another difficulty created by the need to signal the A4 Bath Road approach is the subsequent need to then achieve good 'front end' co-ordination with the downstream circulatory signals at the A4174 arm. The back of this entry platoon would also need to be cleared through this downstream stop-line by using an appropriate phase lag or delay, as any residual traffic caught 'on red' in this short internal circulating section could easily queue back and block egress from the 'through' link during its subsequent green phase.

In terms of access to the link there remains the risk that circulatory queuing on the south and east sides of the roundabout in the weekday 8:00-9:00am could still create an impedance effect. The presence of yellow box markings in this part of the junction now does not prevent right turning traffic from the A4174 from entering the roundabout and queuing across these. In view of this a solution which removes the need for the A4 Bypass-A4174 traffic to route via any part of the roundabout is considered preferable.

SECTION 3

Operational Modelling

3.1 Methodology

In order to test the effect of the three improvement options the S-Paramics model of Keynsham was used, with the network coding at Hicks Gate changed as appropriate. As with previous tests done using this models 30 'seed' runs or iterations were undertaken to obtain average journey time and delay statistics. The hours considered were the weekday 7:00-10:00am and 3:00-7:00pm periods. In view of this the operating 'benefits' of the schemes considered in economic terms in Chapter 5 are only for these periods, annualised and over 60 years. A LINSIG model was used to obtain the signal timings and optimal co-ordination needed with the Option 3 'cut through' link. For Options 1 and 2 the current SCOOT timings used at the roundabout were retained, and timings and offsets manually calculated for the offset signal junctions associated with these two variants.

3.2 Scenarios

The effect of the scheme was considered using the following scenarios:

- 2011 'base model' conditions. The calibrated/validated base model networks were altered to include each option improvement, and run with 'existing' flows. This gave an indication as to how each scheme would perform if implemented now; and
- A 2024 scenario with the Somerdale development and ancillary highway improvements in place. Other developments assumed to be built-out were K2A and K2B, and the Core Strategy housing allocations in SW Keynsham (KE4) and Keynsham East (KE3A). In addition to this the 'net' traffic impact expected with the Keynsham Town Centre improvement scheme was incorporated.

The reason for modelling two scenarios was to generate interpolated time saving benefits, if any, between 2011 and 2024 for economic assessment. This is because the expected Opening Year of any scheme taken forward at Hicks Gate would most likely be prior to 2024, so it was considered necessary to make a better reasoned estimate of the benefits likely to be attributable in the early years when the effect of discounting is far less.

3.3 Operational Results

3.3.1 S-Paramics Outputs

'Targeted' journey time and delay results for the various movements through Hicks Gate were extracted from the 2011 base model, the 2024 'Do Minimum' and the option tests for each of these years. This was considered better than using overall global network statistics for comparison, as it was felt that differential congestion effects elsewhere on the wider network might otherwise mask the localised operational impact of the Hicks Gate changes. The comparative route journey times through Hicks Gate and actual flow results for each hour in the 7:00-10am and 3:00-7:00pm periods in 2011 and 2024 are shown in **Appendix E**. In viewing the figures it should be noted that the average travel times for each route are based on journeys completed by the 'actual' flows. Furthermore the cumulative time tabulated is only based on these completed journeys. This is not a major issue when the overall actual inflow achieved over the period is broadly the same, but where the actual flow accommodated is markedly lower the cumulative time could be significantly understated. This because the congestion delay incurred by uncompleted journeys is not included.

3.3.2 Base-line Results - 2011

Tables E1 and E2 shows the results obtained for the 2011 'base matrix' tests with the three options. In the weekday 7:00-10:00am period (Table E1) the results show that both Options 1 and 2 result in appreciable time savings in all three hours. In contrast Option 3 is similar to the base-line in the 7:00-8:00am period, but thereafter the delays in the following hours are greater even though the actual flows accommodated are broadly the same. In the critical 8:00-9:00am period the delay savings attributable to Options 1 and 2 equate to circa 21 vehicle hours, whereas Option 3 results in around 19 vehicle hours of additional delay. Over the whole of the 7:00-10:00am period the delay saving predicted for Options 1 and 2 is expected to be around 51 vehicle hours, whilst the increased delay with Option 3 is 35 vehicle hours. Looking again at the 8:00-9:00am peak hour Options 1 and 2 show time savings of 3-4 minutes for the movement from the A4 Bypass to the A4174 (E-N), with other route times generally unaffected. With Option 3 there is small delay saving of just over a minute for this movement, but the travel time for traffic approaching on Durley Hill increases by around 3-4 minutes.

In the weekday 3:00-7:00pm period (Table E2) the results again show time savings For Options 1 and 2 in all modelled hours. In contrast Option 3 shows a severe deterioration in operating conditions. In view of this Option 3 is not considered further in this report as results suggest its implementation would actually make operating conditions much worse. In the critical 5:00-6:00pm peak hour Options 1 and 2 achieve overall time savings of 35 and 31 vehicle hours respectively. Over the whole 3:00-7:00pm period the overall savings predicted rise to 82 and 67 vehicle hours. Option 1 is higher because it additionally targets the left turn from the A4174.

3.3.3 Forecast Year Results - 2024

Table E3 shows that Options 1 and Option 2 continue to show a high level of delay time saving in the 7:00-10:00am period by 2024. In the 8:00-9:00am peak hour both schemes achieve time savings of circa 20 vehicle hours, and circa 70 vehicle hours over the entire period. As with the 2011 situation virtually all the saving is associated with the A4 Bypass to A4174 movement, with route time differences for other movements relatively small and in cases under a minute.

In the 3:00-7:00pm period Table E4 shows some very large predicted time savings for Option 1 in the 5:00-6:00pm peak hour. Delay savings rise to circa 228 vehicle hours, with big journey time changes seen on the A4174 approach compared to the Do Minimum and Option 2. This is due to the effect of the segregated left filter lane, which results suggest will become more important as traffic demand on the A4174 approach increases over time. Over the whole period Option 2 is still predicted to achieve an overall delay saving of around 288 vehicle hours, with the straight ahead and right turning movement from the A4 Bypass and all movements from the A4 Bath Road benefiting. However, this is outweighed by the Option 1 time savings, which offers operating benefits to the A4174 as well as the two A4 approaches.

3.3.4 Overview

The operating results obtained using S-Paramics demonstrate conclusively that Option 3 is not a viable scheme, and in fact could make present and future operating conditions at Hicks gate worse. With existing 2011 traffic flows the results also show that Options 1 and 2 would offer a significant and similar level of time saving benefit in both the 7:00-10:00am and 3:00-7:00pm weekday periods, with delay reduction most pronounced in the 8:00-9:00am and 5:00-6:00pm 'peak' hours. However, by 2024, Option 1 is shown to out-perform Option 2 in that improvements additionally target the heavy left turn movement by the A4174. There are no capacity improvements proposed for the A4174 approach to Hicks gate roundabout with Option 2.

SECTION 4

Cost Estimating

4.1 Budget Cost Estimates

Budget cost estimates have been prepared for all three options. The cost for Option 3 was prepared prior to the S-Paramics results being fully available so is included in the cost summary table below. A breakdown of the specific items and quantities incorporated within each of the series estimates is available within a more detailed EXCEL costing spreadsheet. This can be made available on request.

Table 4.1 Budget Construction Cost Estimates

Series Category	Option 1	Option 2	Option 3
Series 0100: Traffic Safety & Management	£-	£-	£-
Series 0200: Site Clearance	£21,281.79	£14,797.14	£4,266.15
Series 0300: Fencing & Steps	£55,900.00	£87,640.00	£-
Series 0500: Drainage	£81,870.00	£137,491.00	£23,045.00
Series 0600: Earthworks	£59,161.94	£802,395.43	£58,504.01
Series 0700: Pavements	£524,759.56	£286,004.36	£97,500.40
Series 1100: Kerbs, Footways and Paved Areas	£33,005.16	£41,985.24	£4,791.45
Series 1200: Traffic Signs and Road Markings	£12,522.03	£24,916.31	£12,444.00
Series 1300: Street Lighting and Electrical Works	£63,219.60	£44,253.72	£16,065.60
Series 1700: Structures	£-	£5,000,000.00	£-
Series 2400: Brickwork, Blockwork and Stone Work	£-	£-	£-
Series 3000: Landscaping and Ecology	£7,920.50	£16,093.70	£4,000.00
SUBTOTAL	**£859,640.58**	**£6,455,576.90**	**£220,616.61**
ALLOWANCES			
ITS – Lump Sum	£60,000.00	£50,000.00	£20,000.00
Preliminaries - 10%	£85,964.06	£645,557.69	£22,061.66
Utilities (Major) -105	£-	£645,557.69	£-
Utilities (Minor) - 5%	£42,982.03	£-	£11,030.83
Estimating Tolerance -5%	£42,982.03	£322,778.84	£11,030.83
Restricted Working - 5%	£42,982.03	£322,778.84	£11,030.83
Environmental - 5%	£42,982.03	£322,778.84	£-
Optimism Bias @ 15%	£128,946.09	£-	£33,092.49
Optimism Bias @ 40%	£-	£2,582,230.76	£-
TOTAL	**£1,306,478.84**	**£11,347,259.57**	**£328,863.26**

The costs above do not allow for design and supervision, or critically third party land acquisition costs which will be a big issue with Option 2 where land outside the existing public highway will be needed to both the SE and NW of Hicks Gate. However, Option 1 will also involve third party land take to the NE of Hicks Gate, although with only a single area of land involved this may be within one ownership.

A higher level of Optimism Bias has been applied to Option 2 as estimated costs are considered to be much less certain with the high structures element involved.

SECTION 5

Economic Benefits

5.1 Methodology

The modelling results obtained for the Option 1 and Option 2 schemes have been used to re-estimate the annualised time saving benefits of the schemes in a 'assumed' 2016 Opening Year and the 2024 Forecast Year, and thereafter estimate the monetary benefits over 60 years. The following assumptions have been used to estimate the Present Value Benefit (PVB) of the two options as follows:

- An annualising factor was used to estimate the total delay savings for 2016 and 2024 in the 7:00-10:00am and 3:00-7:00 weekday periods. This assumed 240 working days per year;
- Total delay savings in 2016 (the assumed Opening Year) were obtained by interpolating between the estimated delay savings in 2011 and 2024. This interpolation was linear;
- WebTAG Unit 3.5.6 was used to determine market values of time (VOT) for vehicles. A figure of £12.60 per hour per average vehicle in 2010 was assumed;
- Future growth in the value of time was assumed. A conservative growth of 1.4% per annum was used, which is closer to the average growth in value of time for non-working time. This resulted in an estimate of £13.67/hour in 2016 and £15.31/hour in 2024. VOT growth was capped at the Design Year, so the growth factor applied at 2031 was subsequently used for all subsequent years to 2076;
- Monetary benefits were estimated for 2016 and 2024 by multiplying total delay savings in 2016 and 2024 by the vehicle 'average' values of time in 2016 and 2024 respectively;
- A stream of annual benefits was estimated by assuming linear interpolation between 2016 and 2024. Annual delay benefits were then frozen at the 2024 value until 2076, assuming a 60-year appraisal period; and
- A 3.50% discount rate was applied for the first 30 years and a rate of 3.0% thereafter over the 60-year appraisal period to generate the stream of discounted benefits. These were subsequently summed to give the Present Value of Benefits (PVB).

5.2 PVB Estimates

Table 5.1 shows the estimated discounted monetary benefits of the Option 1 and Option 2 improvement schemes in specific years and over the overall 60 year assessment periods. Note that time savings and hence monetary benefits occurring outside the weekday 7:00-10:00am and 3:00-7:00pm periods are not considered.

Table 5.1 Monetary Time Saving Benefits: Discounted to 2010

Year	Option 1 (£)	Option 2 (£)
2016: Scheme Opening	£0.689M	£0.508M
2024: Modelled Forecast Year: S-Paramics	£1.534M	£0.851M
2031: Design Year	£1.329M	£0.737M
2016-2076: Total PVB	**£50,853M**	**£28,901M**

The results show that whilst the expected monetary benefits of both options are expected to be equitable in the opening year, the savings expected with Option 1 escalate more rapidly with expected traffic growth to 2024. As mentioned earlier in this report this is because Option 1 additionally targets the A4174 approach, with the proposed left filter lane reducing delays on what is expected to be a heavily congested and over-capacity entry in the 5:00-6:00pm period by 2024.

The results show that the overall PVB with Option 1 is expected to be **£50.9M** compared to **£28.9M** with Option 2. As third party land costs associated with both options are uncertain at the present time no attempt is made to estimate a Present Value Cost (PVC) figure and so a Benefit Cost Ratio (BCR). However, looking at the estimated construction cost estimates in Chapter 4 it is probable that Option 2 would achieve a BCR of about 2 (£11.35M construction cost- current prices). However, at an estimated current construction cost of £1.3M it is clear that Option 1 would give a substantively better BCR than this given the expected PVB is also higher with this variant. Third party land acquisition costs would also be less than Option 2 as land outside the existing highway is only required to the NE of the roundabout.

The consideration of delay savings and hence monetary benefits over a 60 year period show that Option 1 significantly outperforms Option 2. Coupled with a lower construction cost and third party land impact makes this option the clear ‘preferred’ improvement scheme for implementation at Hicks Gate.

Summary and Conclusions

6.1 Overview

This report has considered options for improving the A4/A4714 Hicks Gate Roundabout to the NW of Keynsaham. This is a key junction on the A4 corridor between Bristol and Bath and forms the western terminal junction to the Keynsham Bypass. It also forms the southernmost junction on the A4174 Ring Road route through east Bristol and the North Fringe.

In the weekday morning peak period the operation of this junction is heavily affected by westbound queuing back from the A4 Bath Road/Emery Road junction in Brislington, which 'exit blocks' the roundabout is this direction. As a result traffic turning right from the A4174 Ring Road or proceeding straight-ahead from the Keynsham Bypass is unable to exit freely, leading to relatively static/slow moving circulatory queuing which extends around the south and east sides of the roundabout for extended periods. This in turn leads to westbound queuing on the Keynsham Bypass and southbound queuing on the A4174 Ring Road approach. In the morning peak hour the current exit flow to the A4 Bath Road towards Brislington in this period is 1,638vph. This is close to the link capacity of the single westbound lane available to general traffic not using the nearside access lane to the Brislington Park and Ride site, notwithstanding any constraint imposed by the signals at the Emery Road junction and beyond this.

In the weekday evening peak period the exit blocking problems associated with the A4 Bath Road do not occur. Although there is queuing on this approach to Brislington it is not generally extensive enough to 'block back' to Hicks Gate. There is, however, regular queuing on the A4174 Ring Road approach which does not always clear in the first available green period. In the evening peak hour the existing traffic flows show that the approach flow on the A4 Bath Road from Bristol is 1,850vph. In link capacity terms this represents a close to or maximum throughput at the two lane to one lane merge point just east of the Park and Ride exit. In view of this there is considered to be very little potential for this approach volume to increase over this hour, unless the single lane section between this merge and Ironmould Lane was to be upgraded to provide a continuous two lane length between Emery Road and Hicks Gate Roundabout. However, this would be incumbent on Bristol City Council to undertake as highway authority for this part of the network.

Given the effective external constraints affecting the traffic capacity to and from the A4 Bath Road arm the development of options concentrated on improving capacity for the movement between the A4 Bypass and the A4174 Ring Road. The three options described and assessed in this report involve the following improvements:

- Option 1: Provision of an at-grade 'displaced' right turn link between the bypass and the A4174 across land to the NE of the roundabout. Signal control of the link at both ends would be required to facilitate 'cross-over' of the eastbound carriageway on the bypass, and safe egress onto the A4174. Unlike Options 2 and 3, this scheme incorporates a segregated left turn link for the reverse traffic movement between the A4714 and the bypass;
- Option 2: Provision of a grade-separated link between the bypass and the A4174. This would require third party land take to the SE and NW of the roundabout to provide connector road access/egress from a curved viaduct structure running on a SE-NW axis across the existing roundabout central island. Signal control would be needed at the new entry junction onto the A4174; and
- Option 3: Provision of a link through the roundabout central island to accommodate the right turn from the bypass to the A4174. Signalling the existing 'give' way' approach from the A4 Bath Road would be

necessary, as well as changing the termination of the left turn filter lane from this lane to a merge arrangement. This scheme could be delivered within existing highway land.

Schemes were tested using the existing S-Paramics model of Keynshams using the base 2011 7:00-10:00am and 3:00-7:00 models, and the Do Minimum 2024 scenario for the same time periods with the Somerdale and 'Core Strategy' developments in place.

6.2 Conclusions

The conclusions arising from the operational and economic assessments undertaken are as follows:

- Option 3 shows that changes necessary to provide a central island 'cut through' link for the bypass to A4174 movement would provide a relatively small benefit in the morning peak hour, but worse operating conditions in the evening peak period, significantly so by 2024. This is because the exit from this link to the A4174 would require signal control of the A4 Bath Road entry, and critically three stage control to cater for conflicts with both entry traffic from Bath Road and the circulatory movements from Durley Hill to the Ring Road and the A4 Bypass. In view of the adverse impacts predicted by the operational analyses no further consideration was given to this scheme;
- Option 1 predicts good time saving benefits in both the 2011 and 2024 assessment years. In the 7:00-10:00am period the only traffic movement experiencing a significant time saving is, as expected, that from the bypass to the A4174. In the 3:00-7:00pm period traffic on the A4 Bath Road approach is higher, and delays here also reduced with the removal of the conflicting right turn circulating movement from the bypass. This scheme critically includes a segregated left turn filter link on the A4174 approach which, by 2024, yields a considerable time saving benefit in the evening peak period. This is because congested over-capacity operating conditions are expected to occur on the A4174 Ring Road approach in 2024, and so the provision of the filter lane takes out a relatively high left turn component which would otherwise be forced to route via the signalled entry to the roundabout; and
- Option 2 again predicts good time saving benefits in both years assessed. The movements benefiting from the delay savings in the two weekday time periods are essentially the same. The one critical difference is that Option 2 makes no provision for a left turn filter lane from the A4174 to the bypass, with the result that the benefits associated in providing this in the evening peak period are not realised, unlike with Option 1.

The results of economic analyses show that whilst the expected monetary benefits of both options are expected to be equitable in the opening year, the savings expected with Option 1 escalate more rapidly with expected traffic growth to 2024. Results show that the overall PVB with Option 1 is expected to be **£50.9M** compared to **£28.9M** with Option 2. As third party land costs associated with both options are uncertain at the present time no attempt has been made to estimate a Present Value Cost (PVC) figure and so a Benefit Cost Ratio (BCR). However, looking at the estimated construction cost estimates it is probable that Option 2 would achieve a BCR of about 2 (£11.35M construction cost- current prices). However, at an estimated current construction cost of £1.3M it is clear that Option 1 would give a substantively better BCR than this given the expected PVB is also higher with this variant. Third party land acquisition costs would also be less than Option 2 as land outside the existing highway is only required to the NE of the roundabout.

The consideration of delay savings and hence monetary benefits over a 60 year period show that Option 1 significantly outperforms Option 2. Coupled with a lower construction cost and third party land impact makes this option the clear 'preferred' improvement scheme for implementation at Hicks Gate. As such, it is recommended that the concept of the displaced link advocated in Option 1 is taken forward for more detailed examination by B&NES