

Figure 6.22 – Difference in Flow as a Result of Implementing Banwell/Saltford/Churchill Bypass

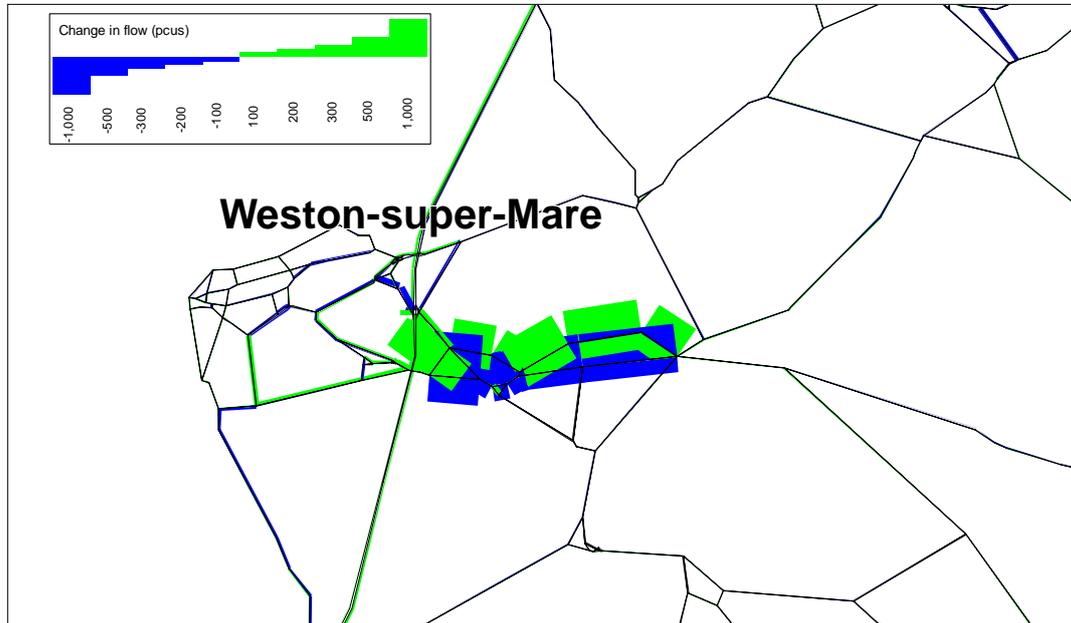
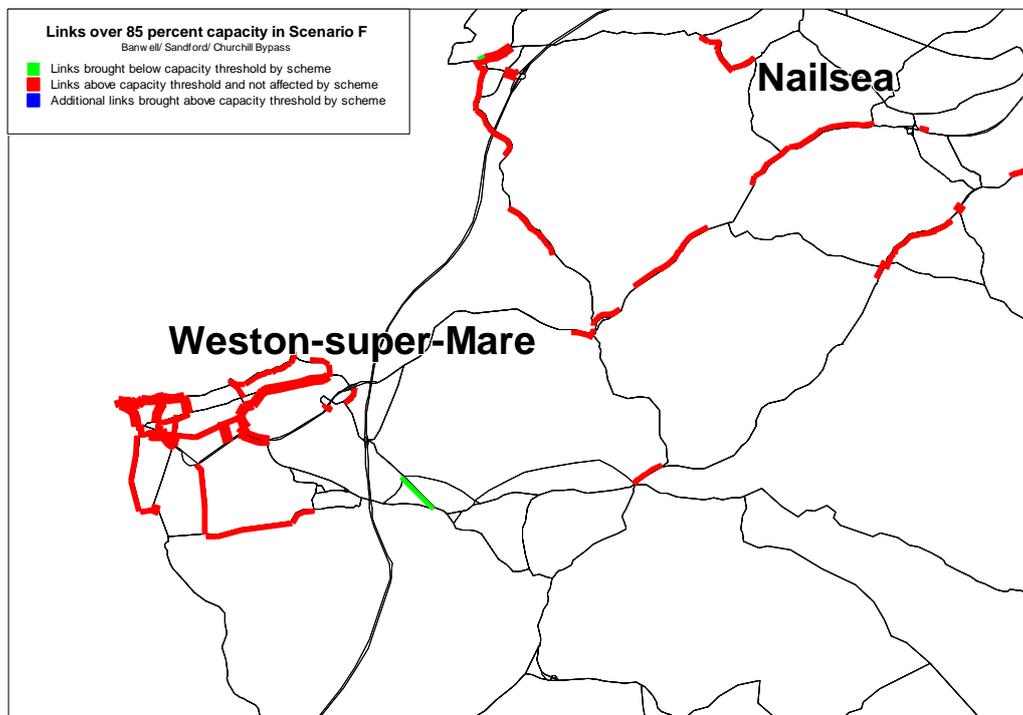


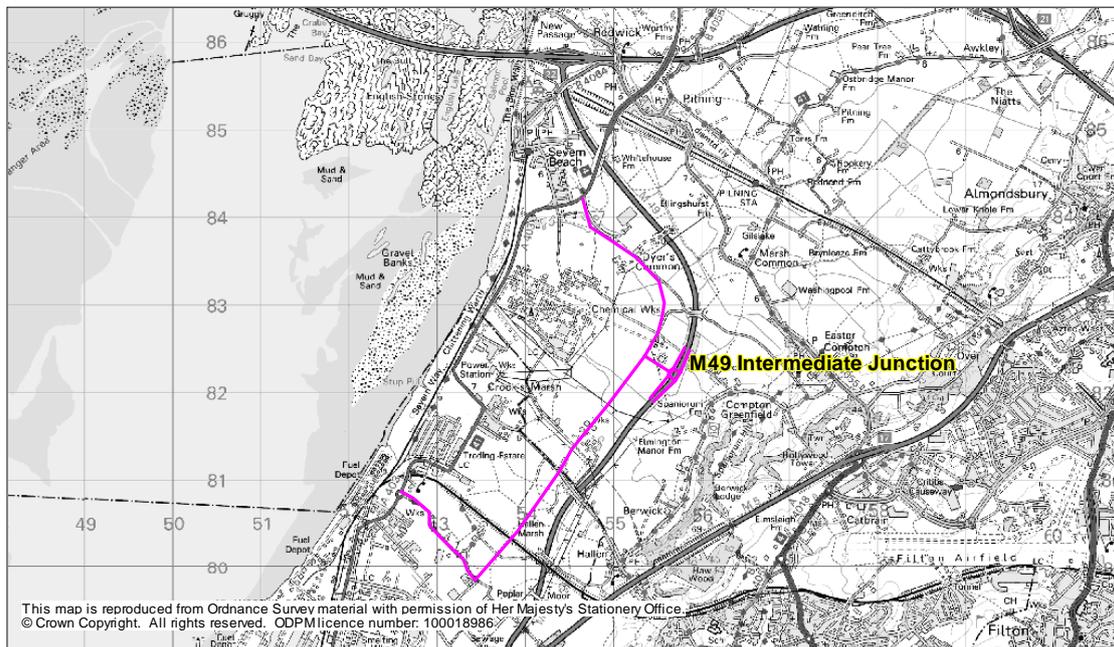
Figure 6.23 – Difference in Capacity Utilisation as a Result of Implementing Banwell/Saltford/Churchill Bypass



M49/Sevenside Intermediate Junction

- 6.106 The Sevenside area is due to experience moderate increases in employment by 2031, based on the projections used by the study. The Avonmouth and southern Sevenside area would gain about 4000 jobs by 2031 while for the north Sevenside area, the growth would be around 1200. Neither of these areas would have an increase in dwellings although there would be 200 extra houses in the area between the M49 and M5.
- 6.107 In the past, there have been proposals for more extensive development containing both industrial and residential uses. In association with these proposals, there were plans for significant enhancements to the strategic highway network with the construction of a new junction on the M49 linked to a new spine road through the core of the new development. The scale of the possible development has diminished in recent years, due in part to limits to the scope for residential development through the threat of flooding. The study examined the potential of the highway schemes in the light of the less ambitious development plans.
- 6.108 The alignment of the M49 Intermediate Junction and Spine Road scheme is shown in Figure 6.24.

Figure 6.24 – Alignment of M49 Intermediate Junction



Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

- 6.109 In the absence of significant levels of development in the vicinity, the impacts of the scheme on the study area traffic system are modest, as indicated by Table 6.16.

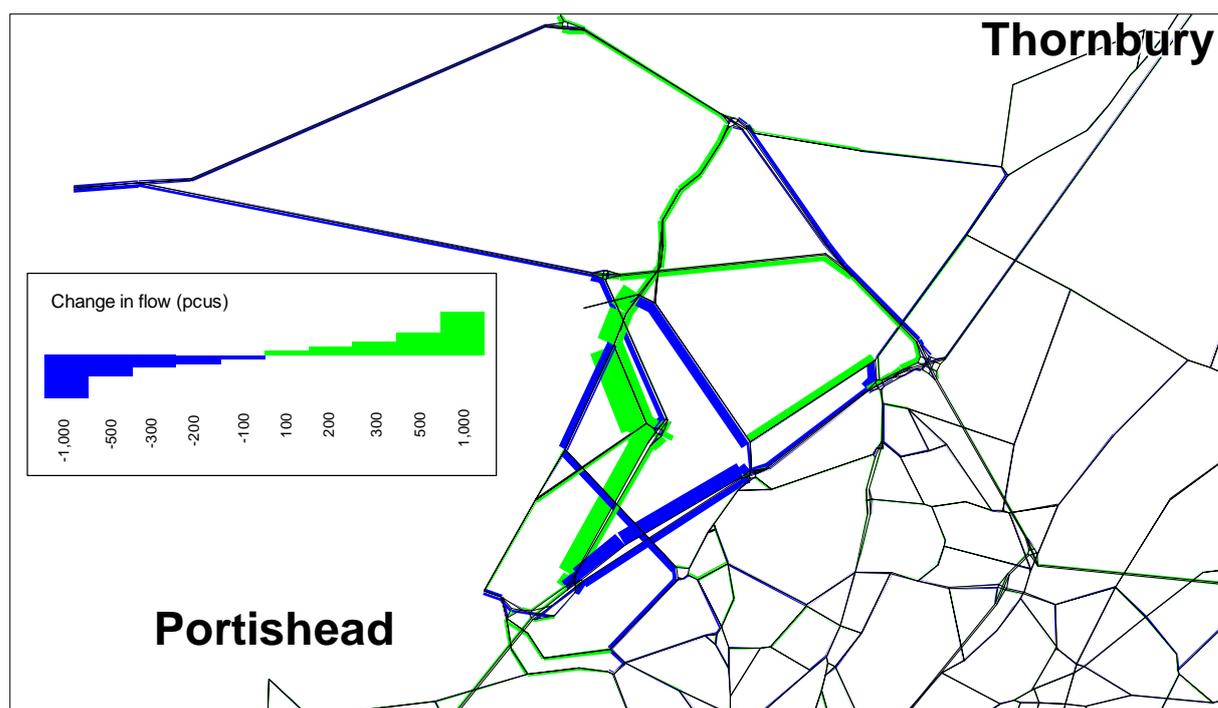
Table 6.16 – Key Impacts of M49 Intermediate Junction

Measure	Impact
Vehicle Trips	impact not significant
Vehicle Kilometres	impact not significant
Total Vehicle Delay on highway network (hours)	0.2% reduction
Average Vehicle Speed (Highway)	0.2% increase

6.110 The effect of the scheme on highway flows is shown in Figure 6.25. There is localised relief to the M5 between J17 and J18 and to the B4055. In addition, there are travel time savings of around 4 minutes for trips around the Severn Beach, Avonmouth and Portbury areas, although the volume of traffic enjoying these benefits is small.

6.111 These impacts are unlikely to justify the large cost of the scheme, and it has not been included in the GBSTS strategy.

Figure 6.25 – Difference in Flow as a Result of the M49 Intermediate Junction



MOTORWAY WIDENING AND JUNCTION IMPROVEMENTS

6.112 The schemes identified in the study Brief included a number of measures associated directly with the operation of the motorway network in the study area:

- ◆ Link Road from A370 to M5 Junction 20;
- ◆ Link Road from M4 to A4174;
- ◆ relief of M5 Junction 21; and

◆ M49 Intermediate Junction.

- 6.113 In most cases, these schemes are not designed to provide benefit to the motorway network; they are more concerned with relieving capacity problems on the local road network, although (as at M5 Junction 21) there are local conflicts at the motorway junctions between traffic wishing to access the motorway and through or crossing traffic.
- 6.114 Within this section, we concentrate on specific measures associated directly with the operation of the motorway system in the study area, examining capacity issues on links and at junctions within the area. The appraisal of measures (Chapter 8) also contains an objective review and comparison of the performance of links and junctions across the motorway network in the study area.
- 6.115 While the study has been progressing, the HA has been implementing schemes to improve the performance of the motorway network in the study area through the construction of climbing lanes on critical sections of the M4 and M5. These schemes form part of the Do Minimum network for the study.
- 6.116 The previous SWARMMS study recommended the widening of the M4 between Junctions 19 and 20 and the M5 between Junctions 15 and 17. One of the requirements of the study was to comment on these SWARMMS proposals. The assessment of the need for further widening of the motorway network has highlighted that the section on the M4 between Junction 19 (M32) and Junction 20 (M5 Almondsbury) will require widening from three to four lanes over the study period.
- 6.117 With some of the new developments planned close to the motorway junctions, for example at Junction 17 (Cribbs Causeway) and with existing pressures at Junction 16 (Aztec West), there will be a need for specific local measures to resolve the problems. These could include improvements to the design of Junctions 16 and 17 which, given the close proximity of the junctions, might also incorporate a widening of the main carriageway from three to four lanes in line with SWARMMS.

M4 Widening between Junction 19 and Junction 20

- 6.118 As indicated above, the SWARMMS study identified the widening of the M4 between Junctions 19 and 20 as a key improvement to the motorway network. Our own analysis confirmed this conclusion. With each of the measures designed to encourage mode shift away from the private car (i.e. encouragement of alternative modes, Smarter Choices, public transport improvements and increased demand management), this section of the network consistently experienced flows at levels above 85% of available capacity throughout peak periods. It was the only section of the network to exhibit such high and consistent levels of congestion.
- 6.119 The widening of the section from three to four lanes in both directions can be achieved within the existing highway boundary. Table 6.17 summarises the economic performance of the scheme and confirms the strength of its performance.

Table 6.17 – Economic Performance of M4 Widening between Junctions 19 and 20

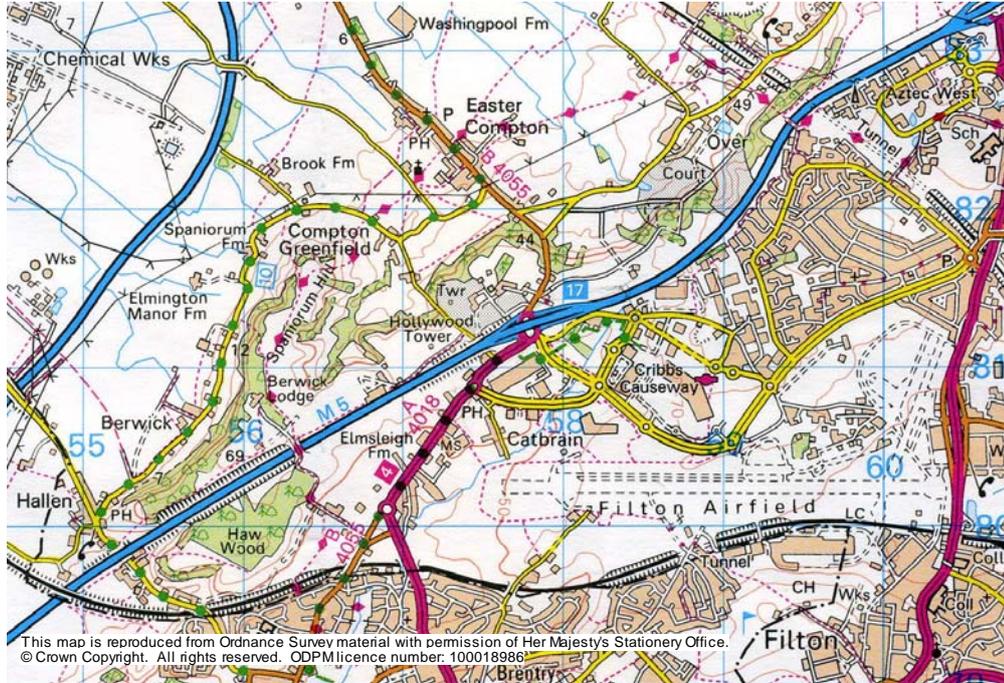
M4 Widening	
Cost (2005, Q1) £mill inc Optimism Bias	£55
Cost (2005, Q1) £mill excl Optimism Bias	£38
PVC (£mill, 2002 prices & values)	£-63
PVB (£mill, 2002 prices & values)	£286
NPV (£mill, 2002 prices & values)	£349
BCR	-4.5
BKR	10.4

- 6.120 The vast majority of benefits generated by the scheme are time savings. Those journeys using the widened section experience reduced delay and therefore shorter journey times. However, this effect is offset, to an extent, by increased delay on adjacent sections of the road caused by the increased volume of traffic attracted to the widened road. Therefore, for instance, a trip travelling the length of the M4 through the study area would typically save around a minute with the widening in place (in 2031, morning peak). However, trips from central Bristol, travelling eastward (via the M32 and M4) would experience slight journey time increases as they travel along the more congested section to the east of J19 but do not experience the benefits of the widened section.
- 6.121 The scheme also increases overall vehicle operating costs for both cars and HGVs. This is the result of a slight increase in average journey distance caused by drivers taking marginally longer routes to take advantage of the widened section. For HGVs, this distance effect is supplemented by an increase in average speed which causes a decrease in operating efficiency.
- 6.122 The changes in vehicle operating costs are a small part of total costs but, when considered over the full 60 year appraisal period, have a present value of over £130 million, offsetting approximately one third of the time savings. The increase in costs, particularly for HGV fuel, also results in a rise of over £100 million (present value) in indirect tax revenue received by government. This represents income to the public sector and is worth over 250% of the scheme's cost. The net impact of the widening is therefore to provide an income to the public sector. This results in a benefit or 'negative cost' on the denominator of the BCR measure and therefore produces a negative BCR, which in this case is not a useful measure of the economic performance of the scheme.
- 6.123 The Highways Agency's benefit cost comparison ratio (the BKR) is probably more useful in this context. This includes the public sector income as a benefit on the numerator of the ratio with only the scheme's capital and operating costs included in the PVC in the denominator. The value of the BKR for the M4 widening is over 10, confirming the strong economic performance of the scheme and its inclusion within the GBSTS strategy.

M5 Junction 17

6.124 M5 Junction 17 provides access to Cribbs Causeway, the large regional shopping centre (The Mall), as well as to the B4055 towards Easter Compton and Pilning and to the A4018 towards Bristol, see Figure 6.26.

Figure 6.26 – M5 Junction 17 and Surrounding Area



Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

6.125 Congestion occurs at busy times, particularly on Saturdays and this can cause backing up onto the motorway because the traffic cannot exit the motorway onto the roundabout. This congestion is likely to increase as more development takes place and traffic volumes increase.

6.126 Some work is programmed to be carried out shortly to improve the capacity of Junction 17:

- ◆ changes are to be made to the white lining of the off slips – on the southbound off slip this will encourage traffic to Cribbs Causeway to use two lanes of the slip road; and
- ◆ new signal controllers are to be installed and Microprocessor Optimised Vehicle Actuation (MOVA) will be implemented to replace the current fixed time signal controller – this will make the signals more reactive to the volumes of traffic on the various approaches to the junction.

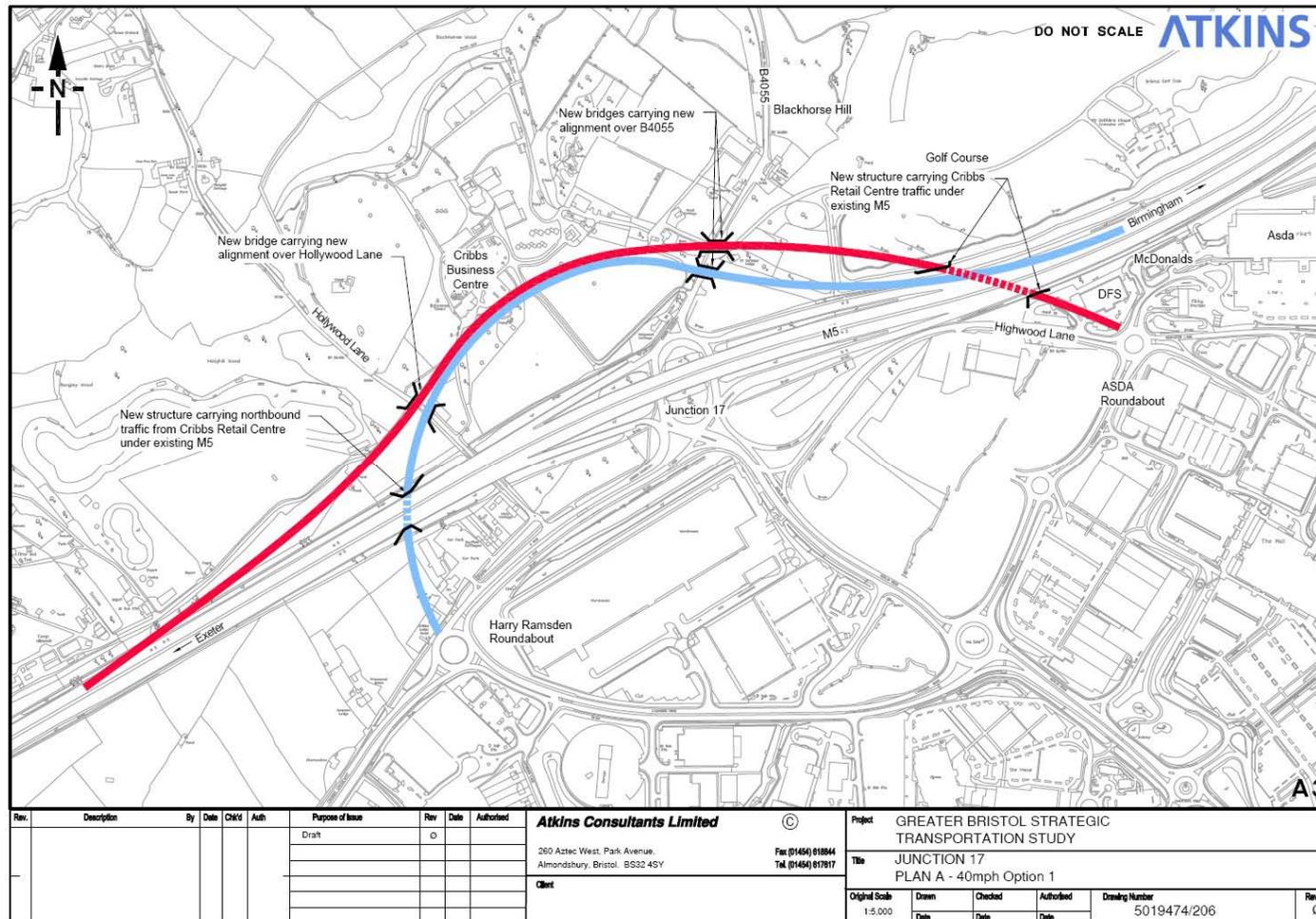
6.127 These changes will improve matters in the short term but, with further development and growth in traffic, a more radical solution will be required in the future.

6.128 With the currently proposed improvements to white lining and traffic signals, it is unlikely that any further significant capacity can be 'squeezed' out of the current junction layout. Other possible options are:

- ◆ close the section of the A4018 between Junction 17 and the first roundabout (Harry Ramsden)
 - this would reduce the number of routes accessing the roundabout;
 - by reducing the number of roads accessing the roundabout at Junction 17, this option would improve the operation of the junction;
 - however, this is only likely to produce a marginal improvement and would not be adequate in the long term.
- ◆ an underpass/flyover between the B4055 and the A4018 or Cribbs Causeway;
 - this would take out the through traffic on the A4018 or to/from Cribbs Causeway and the B4055;
 - however, traffic flows on the B4055 are relatively light and this option would not significantly reduce the traffic using the roundabout at Junction 17.
- ◆ close one or more slip roads to reduce the volume of traffic using Junction 17;
 - this could significantly reduce traffic using the junction;
 - however tests suggest that the redistributed traffic would cause more congestion at other motorway junctions and on local roads, and it is unlikely to be acceptable to the local authorities.
- ◆ construct a northbound off slip road that flies over the B4055 and then under the M5 to access Cribbs Causeway at the 'Asda' roundabout, together with a northbound on slip that leaves the A4018 at the Harry Ramsden roundabout, passes under the M5 and over the B4055 to join the M5 north of Junction 17.
 - this option (see Figure 6.27) would allow traffic from the south, wishing to access Cribbs Causeway, direct access to the Asda roundabout without using the roundabout at Junction 17;
 - similarly, traffic accessing the M5 to travel north from Cribbs Causeway and from the A4018 could join the motorway from the Harry Ramsden roundabout and avoid the Junction 17 roundabout;
 - this would significantly reduce traffic on the Junction 17 roundabout and, in particular, the right turning traffic that causes most of the conflict.

6.129 While Figure 6.27 represents a potential solution to the capacity issues at Junction 17, a number of variations of this scheme have also been identified. A detailed analysis of the alternatives is therefore necessary before completing a full appraisal of the scheme. However, such a detailed assessment is outside the scope of the Greater Bristol Model and the strategic study.

Figure 6.27 – M5 Junction 17 Improvements



M5 Junction 16

- 6.130 The junction between the M5 and A38 at Junction 16 is subject to considerable congestion during peak periods, with the position being exacerbated by the close proximity between Junction 16 and the access roundabout to Aztec West Business Park, located 350 metres to the south. There are three lanes in each direction between Aztec West and M5 Junction 16, with the southbound carriageway widened to four lanes on the approach to Aztec West roundabout. North of the M5, the A38 is a dual two lane road with the southbound carriageway widening to three lanes on the approach to Junction 16.
- 6.131 Junction 16 is located 1.1 kms south of the main Almondsbury Interchange between the M5 (Junction 15) and M4 (Junction 20). With the extensive levels of weaving activity over this section of the M5, the motorway is up to 12 lanes wide to accommodate the traffic movements. The westbound off slip at Junction 16 has been widened to four lanes with three lanes directed south onto the A38 towards Aztec West. The eastbound off slip is two lanes wide and there are three lanes for circulating traffic at the junction roundabout which is signal controlled.
- 6.132 The signal controlled roundabout junction on the A38 at Aztec West provides access to the Aztec West Business Park to the west and Bradley Stoke to the east. The signals are linked to the corresponding signals at M5 Junction 16. The two roads to the east and west of the roundabout are dual carriageways on their approaches to the junction. There is an uncontrolled single lane slip road that allows traffic from Aztec West to turn northwards onto the A38, forming a third lane on the A38 towards Junction 16. Bradley Stoke Way, to the east of the roundabout, is a two lane dual carriageway which widens to three lanes on the approach to the roundabout. There are three lanes for circulating traffic on the roundabout.
- 6.133 There are two further junctions within close proximity of the Aztec West roundabout. About 150 metres to the west is a roundabout which links different access roads within the Aztec West development. About 150 metres to the east, on Bradley Stoke Way, there is a traffic signal controlled junction with Woodlands Lane which provides access to the main business area of Bradley Stoke.
- 6.134 The heavy congestion in the morning peak period at Junction 16 is such that the traffic backs up on both off slip roads and can affect the mainline traffic on the M5, leading to regular delays and the danger of accidents on the motorway. At Junction 16, the bulk of traffic is entering or leaving the M5; only 15% of vehicles are travelling through the junction on the A38. Hence, there would be limited benefits from introducing new infrastructure to remove the A38 through traffic from the junction by introducing some form of bypass lane.
- 6.135 To ease the congestion on the eastbound off slip, it would be possible to increase capacity by providing an extended auxiliary lane to increase the number of lanes from two to three. However, this would probably require land acquisition with the potential for a public inquiry within the scheme approval process.
- 6.136 A principal factor behind the congestion is the lack of capacity in the peak periods at the Aztec West roundabout. Hence, there was merit in exploring potential schemes which would improve the operation at this junction and hence alleviate some of its

impact on M5 Junction 16. A number of potential measures were explored and the options which would justify more detailed examination were:

- ◆ construction of a southbound underpass for A38 traffic beneath the Aztec West roundabout – in the morning peak, about 40% of traffic is travelling through the junction on the A38 and hence removing these vehicles from the junction would significantly ease its operation and reduce the blocking back to M5 Junction 16. However, there is insufficient space between the two junctions to construct a full standard, grade-separated underpass and hence it will be necessary to restrict access to light vehicles, which form the overwhelming element of traffic in the peak periods.
- ◆ replacement of the Aztec West roundabout with a signal controlled junction incorporating a displaced right turn (DRT) which is contained in the HA toolkit and has been implemented at the A4311 Motorola intersection in Swindon. The concept behind DRT is to relocate one or more of the movements at a junction from the centre of the intersection, thereby reducing the number of conflicts and increase intersection capacity.
- ◆ the preceding options could be combined with a widening of the A38 which would increase the storage at the Aztec West roundabout junction although would not in itself raise capacity through the junction. Any widening would need to take into account constraints from the developments in Aztec West on the west and the potential need to relocate a gas governor station.

6.137 Within the study, it has been possible to identify these potential solutions to the traffic issues at the junction although, because the Greater Bristol Model does not permit detailed modelling of the operation of the two main junctions, it has not been feasible to undertake a detailed appraisal. It is therefore necessary for further work to be undertaken to produce a detailed appraisal of the option and to progress them in order to confirm their applicability in solving the extensive congestion at this location.

M32 Junction 1

6.138 The grade-separated intersection of the M32 Junction 1 with the A4174 Avon Ring Road includes a flyover for the M32 over the surface level roundabout carrying the A4174. The proximity between M32 Junction 1 and M4 Junction 19 results in traffic blocking back from M32 Junction 1 to the M4 and then onto the M4 eastbound and westbound off slip roads. The position is exacerbated by the volume of traffic on A4174 and the adjacent junction on both the western and eastern sections of the road.

6.139 A number of measures have been introduced on the roundabout in order to increase the effective capacity of the junction by improving the traffic circulation. Further planned measures include improvements to the northbound and southbound off slip roads to increase the queue storage capacity. In addition, there are plans to widen the A4174 from two to three lanes to the west of the M32 junction with the additional lanes being allocated to High Occupancy Vehicles. While this will increase the overall capacity of the road, further changes involve the introduction of a new signal controlled junction between the M32 and UWE to permit access to new development at Harry Stoke; it is likely that the creation of the new junction will reduce capacity on the A4174.

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- 6.140 Plans have also been prepared for the introduction of a new Park and Ride site to the north-west of M32 Junction 1 at Hambrook. As outlined in the description of park and ride sites in Chapter 5, the study has explored the potential operating designs for the site and has identified that there would be significant practical difficulties in any design that placed additional stress on M32 Junction 1 from either commuter traffic wishing to access/egress the site or the operation of the park and ride bus services. Hence, the view is that access to the site should be from the west rather than the east, with possible connectivity with the construction of the Stoke Gifford bypass and the detailed design of the Harry Stoke development.
- 6.141 A variety of measures are therefore planned to extract the maximum vehicle capacity from the M32/A4174 and it is likely that little further can be implemented without significant new construction work. This would probably need to involve the separation of the through traffic on the A4174 from the traffic moving between the M32 and A4174 through the creation of a segregated link. However, this is likely to represent a major design and construction exercise and the impact of demand management, public transport improvements and other measures in the vicinity before embarking on the new link.

Car Sharing and High Occupancy Lanes

- 6.142 Any increases in capacity on the motorway network, either on links or at junctions, will produce benefits to motorway users through reduced journey times and improved reliability. However, it is important that these benefits are not eroded through additional traffic which is induced or generated by the increase in capacity. Hence, measures designed to maintain or 'lock in' the benefits should be introduced in parallel with the other enhancements. The need to lock in the benefits is particularly important where local (short distance) commuting trips could be the main users of the additional capacity.
- 6.143 One of the most appropriate techniques to achieve the desired effect is the allocation of any additional lane for the use of car sharing or high occupancy vehicles (HOVs) for part or all of the day. Although there are local schemes within the study area (i.e. sections of the A4174 Avon Ring Road and the A370 near Long Ashton) and there is experience in the operation of HOV lanes on motorways outside the UK, particularly in the United States, there is no direct experience on the UK motorway network. The recently announced pilot scheme to introduce a car sharing lane on the short (one mile) section of the M6/M606 in West Yorkshire in 2007 will represent the first such measure. The scheme will be concentrated on the link between the southbound M606 and the eastbound M62. This is to be followed by a much larger pilot scheme to include a seven mile car sharing lane on the M1 between Junction 7 (Hemel Hempstead) and 10 (Luton Airport).
- 6.144 The success of these schemes will, of course, have a direct impact on the extension of the principle elsewhere on the UK motorway network. With that condition, there are two main locations where the introduction of a car sharing or HOV lane could be appropriate:
- ◆ M4 between Junctions 19 and 20; and
 - ◆ M5 between Junctions 18 and 19.

- 6.145 With the M4 between Junctions 19 and 20, attention will need to be given to the length and location of the car sharing/HOV lane. The distance between Junctions 19 and 20 is relatively short due to the allowance for the merging of traffic between the M4 and M5 at Junction 20 and the exit/entry slip roads at Junction 19. Hence, the scope for a major car sharing/HOV lane is limited. At the same time, it is likely to be difficult to include such a lane on the connections between M4 and M5 because of the extensive weaving operation. It may therefore be necessary to restrict the car sharing/HOV lane to the M4 alone, from Junction 19 and through Junction 20. Because of the weaving movements at the two junctions, the car sharing/HOV lane would probably need to be located in the outside lane. If it proves difficult to introduce an effective, safe scheme, it will be necessary to explore other techniques to control access to the widened section of road, for example ramp metering. However, this may only be appropriate in the westbound direction on the slip roads at Junction 19 with some difficulties in extending the principle to the eastbound direction.
- 6.146 The construction of a Second Avon Crossing (see below) would not include a direct widening of the M5 but would provide additional capacity on a parallel route between Junctions 18 and 19. It is expected that there would be a significant diversion of local traffic onto the new crossing which would therefore provide relief to the motorway. To avoid the released capacity being dissipated by the generation of additional trips, there would be the potential to create a car sharing/HOV lane on the M5 over this section. Although the motorway is not being widened, there are sufficient lanes to enable the conversion of one lane to the priority use. Further research would need to be undertaken into the appropriate design of the car sharing/HOV lane, taking into account the levels of weaving at Junctions 18 and 19 and the relatively high proportion of slow moving vehicles on the climb over the existing bridge.

ADDITIONAL HIGHWAY SCHEMES

- 6.147 The earlier section has examined the various highway schemes identified within the study Brief. In this section, we summarise the assessment of further improvements to the highway network, considering the following specific schemes:
- ◆ links to BIA and south Bristol from the south of the study area;
 - ◆ Second Avon Crossing;
 - ◆ A36 to A46 Link; and
 - ◆ Winterbourne and Stoke Gifford Bypass.

Links to Bristol International Airport and South Bristol from the South

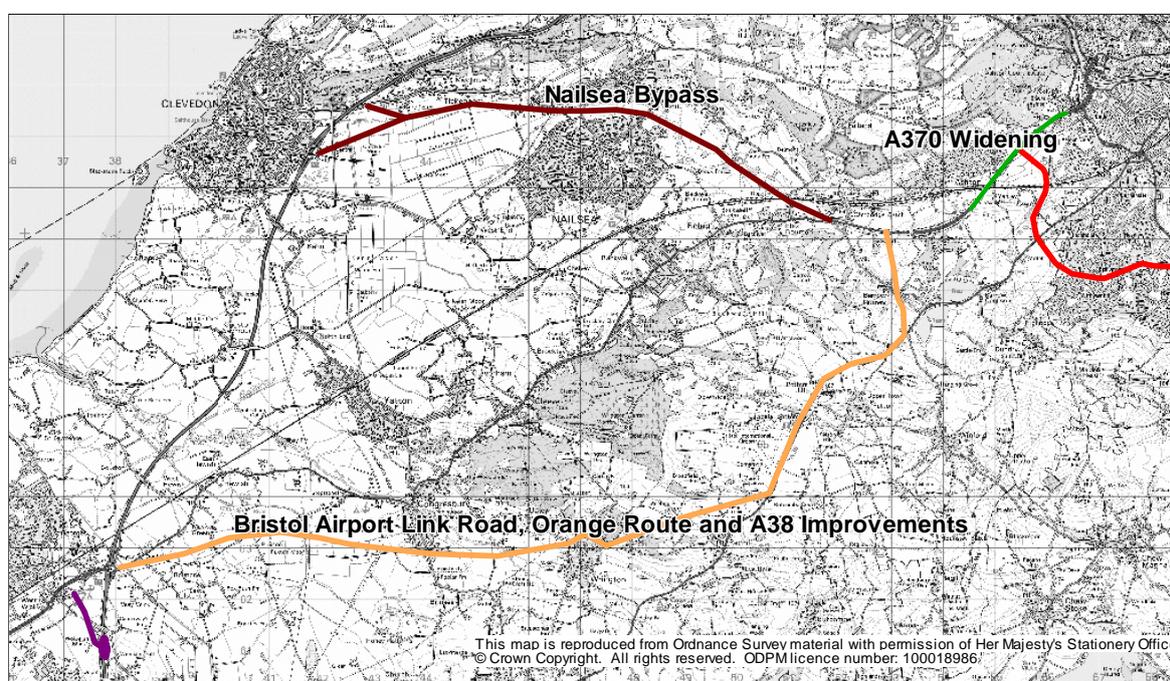
- 6.148 A number of different schemes have been examined to attend to the potential increase in traffic approaching Bristol from the south, including from Weston-super-Mare. In the future, there will be major increases in travel through this area, including the anticipated growth at Bristol International Airport (BIA) as well significant levels of additional residential and employment-related development in the Weston-super-Mare area and in Ashton Vale.

6.149 The two alternatives found to be most effective were:

- ◆ Direct link from the existing M5 Junction 21 to BIA – this new cross-country route would provide a direct link to the BIA from Weston-super-Mare. Early work indicated that the scheme would have little impact without associated measures to increase capacity on the A38 and provide a good quality onward route into south Bristol, and therefore the scheme includes:
 - widening of the A38 in the vicinity of the airport (in practice the road may need to be re-aligned to limit property acquisition);
 - A38-A370 Orange route (described earlier in this chapter) with a slightly revised alignment – this would split the Bristol-bound traffic between the A38 and the A370, avoiding putting excessive pressure on the A38 at the Barrow tanks junction; and
 - widening of the A370 to dual carriageway standard between the existing dualled section and the Cumberland Basin.
- ◆ Direct link from M5 Junction 20 north of Nailsea to A38, connecting to the A38-A370 link and South Bristol Ring Road (SBRR) – this new cross-country link to the north of Nailsea does not serve the BIA directly but would provide a more direct connection to the SBRR (described earlier). Again, the scheme was tested in conjunction with widening the A370 to dual carriageway standard.

6.150 The indicative alignments of the BIA and M5 Junction 20 link schemes are shown in Figure 6.28, with the locations of SBRR and the relocated M5 J21 shown for reference.

Figure 6.28 – Alignment of BIA and South Bristol Access Schemes



Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

- 6.151 Table 6.18 compares the key impacts of the BIA and M5 Junction 20 Link schemes with the details for the latter scheme repeated from Table 6.7 shown earlier.

Table 6.18 – Key Impacts of BIA and M5 Junction 20 Link Road

Measure	BIA Link	M5 Junction 20 Link
Vehicle Trips	0.2% increase	0.1% increase
Vehicle Kilometres	0.3% increase	0.3% increase
Total Vehicle Delay on highway network	2% reduction	1% reduction
Average Vehicle Speed (Highway)	1% increase	1% increase
Bus Passenger Kilometres	3% increase	1% increase

- 6.152 Overall, the BIA link scheme has around twice the impact on congestion across the study area as the M5 Junction 20 link, with a significant reduction in total vehicle delay of 2%. Figures 6.29 to 6.30 show the impact of the BIA link scheme both in terms of vehicle flow and capacity utilisation.
- 6.153 The BIA link provides a new route from Weston-super-Mare to the airport and south Bristol, giving substantial relief to the M5 between Junctions 21 and 19. In addition, there is relief to the A370 between Weston-super-Mare and Nailsea. In the north-east bound direction, almost two-thirds of the traffic on the BIA link is travelling into the study area from the South West. In the south-west bound direction, the scheme carries mainly local traffic heading for employment opportunities in Weston-super-Mare.
- 6.154 As well as providing a link to the M5 for traffic to and from Nailsea, the M5 Junction 20 link scheme also offers a new route into Bristol. There is relief to the M5 between J20 and J19, and to Junction 19 itself (see Figures 6.9 and 6.10 presented earlier). Some traffic is transferred from the A38 and A370 onto the M5 between J21 and J20, although this is insufficient to have a significant impact on the performance of this section of the M5. The flow differences (see Figure 6.9) show a strong movement between Nailsea and employment opportunities in Weston-super-Mare via the new link.
- 6.155 Both alternatives lead to an increased flow on the A370 near Long Ashton, but this is catered for by the A370 widening included in the two schemes.

Figure 6.29 – Difference in Flow as a Result of Implementing Airport Link Road

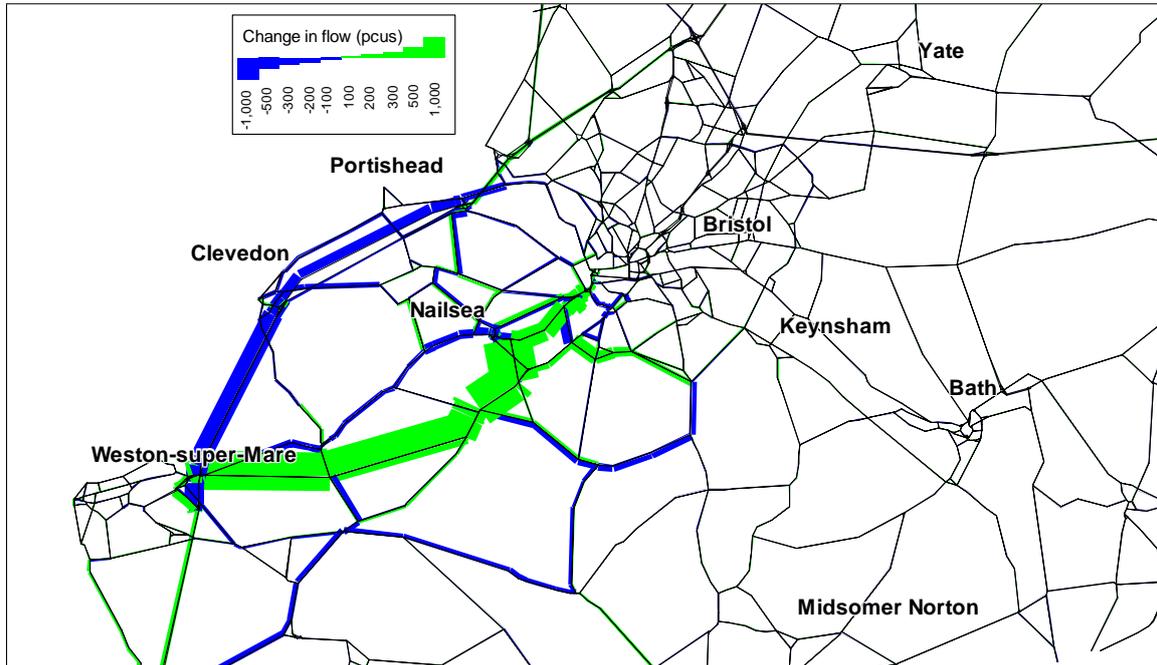
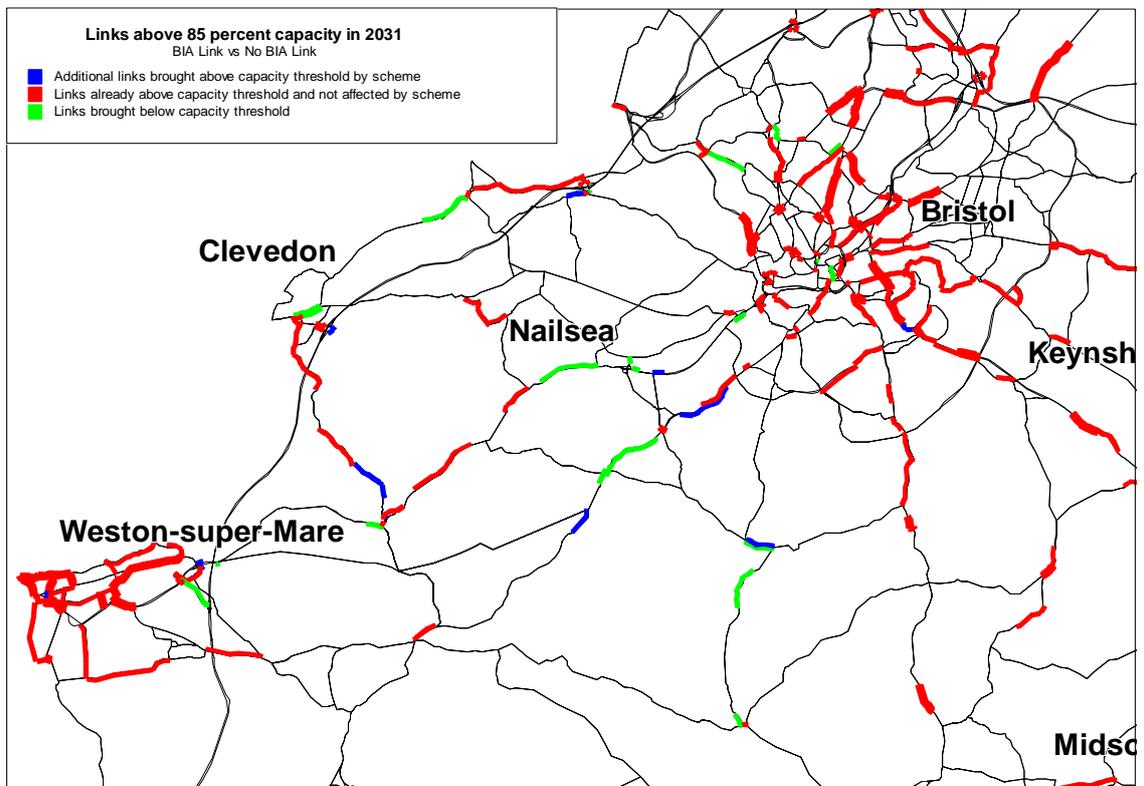


Figure 6.30 – Difference in Capacity Utilisation as a Result of Implementing Airport Link Road



6.156 Table 6.19 shows changes in morning peak journey times as a result of the two schemes. The BIA link would offer substantial journey time savings of 5-9 minutes on routes from Weston-super-Mare and Worle Parkway to the airport and central Bristol. There would also be a 5 minute saving for trips from the South West to the airport. By comparison, journey time savings with the M5 Junction 20 link are more modest.

Table 6.19 – Key Journey Times for BIA Link and M5 Junction 20 Link Schemes (morning peak period in minutes)

Route	No Link	BIA Link	M5 Junction 20 Link
Weston-super-Mare to Bristol City Centre	62	54	60
BIA to Bristol City Centre	28	20	27
Sedgemoor (Somerset) to BIA	42	37	41
Worle PT Interchange to BIA	29	24	28
Worle PT Interchange to Bristol City Centre	55	46	52

6.157 Table 6.20 indicates the economic performance of each scheme with the information for the M5 Junction 20 Link Road repeated from Table 6.8 given earlier. Both alternatives have a strong economic case, with a BCR of 5.4 for the BIA link and 3.1 for the M5 Junction 20 link.

6.158 With the BIA link, a large proportion of the benefits (nearly 30%) are experienced by trips travelling to and from the airport. Most of the rest of the benefits are gained by other journeys that are able to make direct use of the new link road, for instance, traffic travelling from the South West to south Bristol. Further benefits are generated by the congestion relief caused by the scheme across the wider area, bringing journey time savings for trips not making direct use of the scheme itself, for example traffic on the A370 between Nailsea and Weston-super-Mare.

6.159 With the M5 Junction 20 link, the time savings are primarily experienced by those drivers who can make direct use of the bypass, particularly those using it for local movements to and from Nailsea itself (making up around 30% of the overall benefits). The greatest benefits (typically 9 to 12 minutes per trip) are experienced by those using the bypass to travel between the Weston-super-Mare and Nailsea areas. The savings associated with these trips represent two-thirds of the benefits experienced by trips to and from Nailsea (i.e. around 20% of overall benefits).

Table 6.20 – Economic Performance of BIA and M5 Junction 20 Links

	BIA Link	M5 Junction 20 Link
Cost (2005,Q1) £mill, inc Optimism Bias	£128.7	£98.4
Cost (2005,Q1) £mill, excl Optimism Bias	£88.8	£67.9
PVC (£ mill, 2002 prices & values)	£60.4	£77.7
PVB (£ mill, 2002 prices & values)	£327.6	£241.8
NPV (£ mill, 2002 prices & values)	£267.2	£164.1
BCR	5.4	3.1

6.160 The analysis presented above has demonstrated the case for a new link from the M5 to south Bristol. The BIA link scheme has a stronger case than the M5 Junction 20 link in terms of transport impacts, and does more to improve accessibility to the airport. However, both schemes have significant environmental impacts as they pass close to SSSIs and other environmental designations. The engineering difficulties of constructing the BIA link scheme could be considerable as the route encounters steep terrain at Redhill, and may require substantial revisions to limit the amount of property acquisition. For these reasons, both schemes are likely to meet with considerable levels of debate during their development. Nevertheless, the GBSTS strategy includes a new link from the M5 to south Bristol as a long term measure. The exact alignment of the route will need to be subject to further analysis and appraisal.

Second Avon Crossing

6.161 The M5 between Junction 18 and Junction 19 represents one of the few crossings of the River Avon within the study area and hence is a critical part of the strategic road network. Incidents on this section of the motorway network have a widespread impact across the study area and beyond. One of the factors influencing the performance of this section of the motorway is the high proportion (10%) of trips formed by local traffic travelling between Junctions 18 and 19 which, together with goods vehicles accessing the Avonmouth and Royal Portbury Docks on either bank of the River Avon, produces significant volumes of weaving traffic on the section. This, together with the relatively steep gradients necessary for the motorway to reach a sufficient height to clear the River Avon, means that the link operates at less than the full theoretical capacity for a four lane dual carriageway motorway.

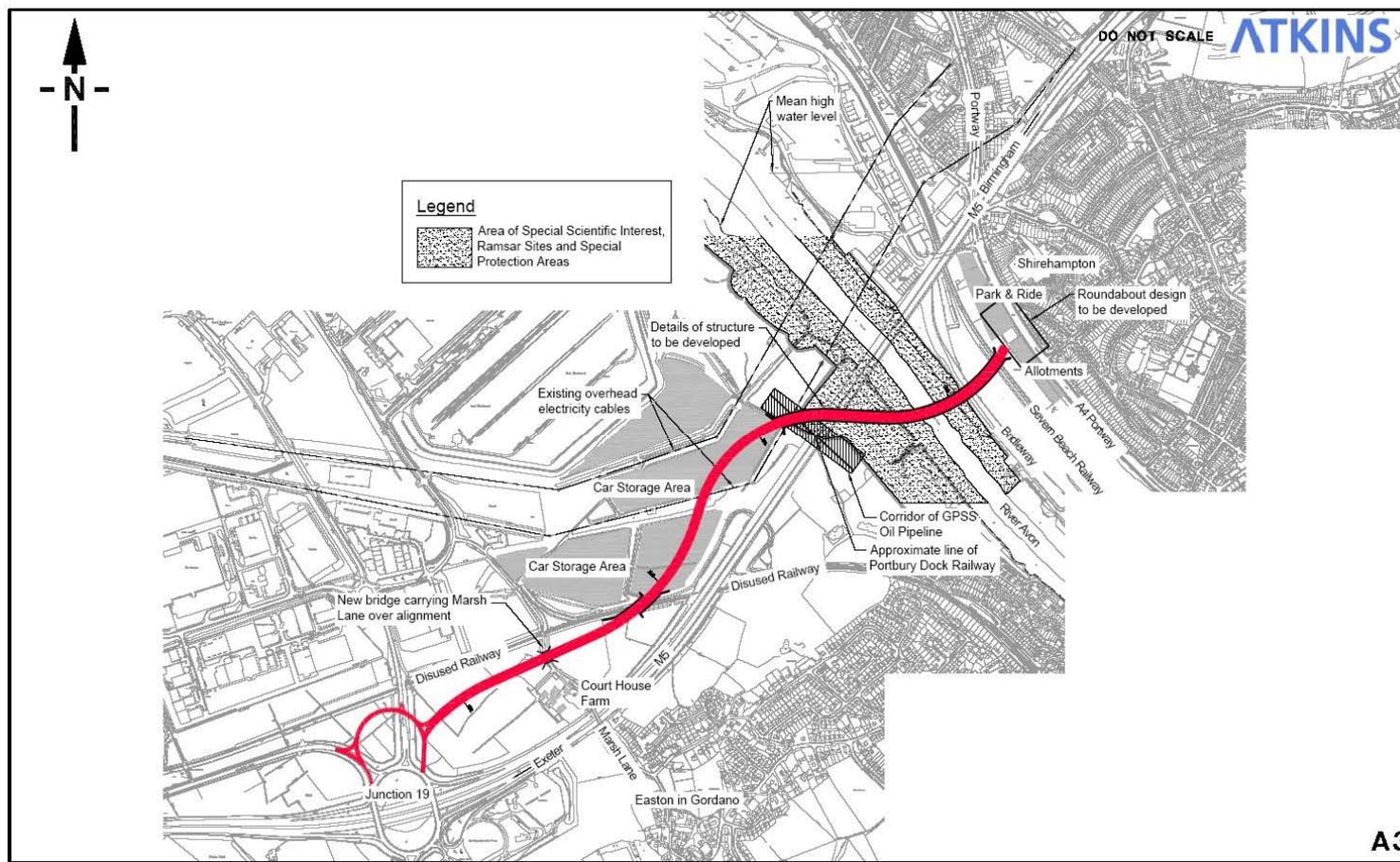
6.162 The importance of the link within the national and regional strategic network, and the lack of a significant alternative route, places considerable stress on the link within the operation of the network. This is exacerbated by the additional local connections which the link provides. The dependence of the regional highway network on the continued operation of the crossing, and the threats to network resilience if the

pressures on the crossing worsen, means that particular attention needs to be placed on exploring ways of easing its critical role.

- 6.163 Although perhaps a long term issue, it is important to acknowledge the continuing need for maintenance of the crossing and the impact that it would have on its operation, if alternative routes are unavailable. The problem on the link between Junctions 19 and 18 is exacerbated by local constraints in the operation of Junction 19 with the combined effects of access from Portishead, Royal Portbury Dock and Easton in Gordano services.
- 6.164 At the same time, there is a need to enhance the public transport access for Portishead and hence, it is desirable for the crossing to include multi-modal capabilities. Furthermore, the importance of port traffic needs to be taken into account with the specific issues associated with security and customs arrangements in the movement of goods, particularly between the two areas of the port on either bank of the River Avon.
- 6.165 The identification of the alignment for the crossing and the design of the scheme will need to take into account a number of potentially conflicting issues, including:
- ◆ the allocation of capacity between general traffic and public transport including rapid transit;
 - ◆ access to the two parts of the port, including security and customs aspects of freight movements;
 - ◆ the form of the crossing e.g. barrage or bridge and the type of opening mechanisms; and
 - ◆ access to the local road network and other transport infrastructure, e.g. Portway Park and Ride site.
- 6.166 A number of measures have been explored to relieve this section of the motorway. The most attractive option would be to provide a lower level crossing between Junctions 18 and 19. At the southern end, this would involve improvements to Junction 19 which currently experiences significant levels of congestion, especially for traffic from Portishead in the morning peak periods. It is probable that a 'dumbbell' style roundabout would be required to accommodate the additional arm. There may be scope to terminate the alignment at the existing roundabout on Royal Portbury Dock Road/Gordano Way. The preferred alignment of the link (shown in Figure 6.31) would follow the current path of the M5, starting from west of the motorway at Junction 19 and then moving between the current motorway supports and crossing over the River Avon and the Severn Beach rail line in order to link with the A4 to the east of the motorway in the vicinity of the park and ride site.
- 6.167 Other features of the initial design include:
- ◆ at this stage, the disused railway to Portishead has been treated as live for the purpose of this study and the proposed alignment therefore passes over the railway corridor on an overbridge;
 - ◆ the route passes through two car storage areas on an embankment as it gains height to clear the railway to Portbury Dock;

- ◆ the route would cross the railway to Portbury Dock via a bridge and from this point until after the railway line on the northern bank it would continue on a structure;
- ◆ the crossing of the River Avon would need to be via some form of an opening bridge or barrage since the river is navigable beyond this point and carries, amongst other traffic, tall ships at least once a year. After discussion with the Bristol harbour authorities, the guideline used for the structure was for a clear opening of 20 metres width with a vertical clearance of 10 metres at the high water mark. Various types of structures with an open aspect (to allow for the high tidal range) could serve as a crossing. These include swing and bascule type bridges that would allow the vast majority of river traffic to pass unhindered, thereby limiting the impact caused by bridge openings on vehicular traffic;
- ◆ a barrage and lock option was not developed in detail at this stage because it could have a very significant negative environmental impact and such a solution would require all craft to pass through a lock regardless of clearance, thereby increasing delays to traffic on the crossing;
- ◆ the route would cross the Severn Beach railway line on a bridge before dropping down to tie in with the A4 on a new junction in the vicinity of the Portway park and ride site;
- ◆ there are two sets of overhead electricity transmission lines to the west of the existing M5 Avonmouth Bridge and the proposed route passes underneath one of them and, depending on the exact alignment, could affect one of the pylons. It is assumed that pylons are carrying extra high voltage cables between 22kV and 132kV. Whilst it appears that there is adequate clearance between the cables and the proposed alignment this would need to be confirmed with the electricity company;
- ◆ the Government Pipeline and Storage System, which is a high pressure oil pipeline, passes in an east-west direction underneath span number 5 of the existing M5 Avonmouth Bridge. The proposed alignment would therefore cross the pipeline to the west of the existing bridge. This section of the alignment would be on a bridge and its piers would have to be designed so as not to interfere with the pipeline or the access to it.

Figure 6.31 – The Second Avon Crossing Option



6.168 Table 6.21 shows the key effects of the Second Avon Crossing scheme. The results show that the scheme would have a relatively modest impact, reducing total vehicle delay across the study area by 0.5%.

Table 6.21 – Key Impacts of Second Avon Crossing

Measure	Impact
Vehicle Trips	Impact not significant
Vehicle Kilometres	0.1% reduction
Total Vehicle Delay on highway network (hours)	0.5% reduction
Average Vehicle Speed (Highway)	0.2% increase

6.169 Figures 6.32 and 6.33 show the effect of the Second Avon Crossing on highway flows and capacity utilisation.

6.170 The new crossing attracts a two-way flow of over 3000 pcus per hour in the morning peak period, and reduces the flow on the existing M5 Avonmouth Bridge by around 1300 pcus per hour northbound and 900 pcus per hour southbound (see Figure 6.32). Around two-thirds of the traffic using the second crossing is travelling entirely within the study area, indicating that the scheme is successful in removing shorter distance trips from the national strategic road network.

6.171 Re-routing of traffic as a result of the scheme eases flows on the A369 and A370 while increasing traffic on the A4. However, there is very little impact on the motorway network outside the immediate vicinity of the scheme. The new route would allow some traffic from Portishead and Portbury to avoid the congested M5 Junction 19, but this would be counterbalanced by an increase in traffic leaving the M5 at Junction 19 to access the second crossing.

6.172 Table 6.22 indicates that the scheme has only a marginal effect on journey times.

Table 6.22 – Key Journey Times for Second Avon Crossing (morning peak period in minutes)

Route	Reference Case	Second Avon Crossing
Portishead to Bristol	29	28
Portbury to Avonmouth	12	12
Weston-super-Mare to Bristol	64	63

Figure 6.32 – Difference in Flow as a Result of the Second Avon Crossing

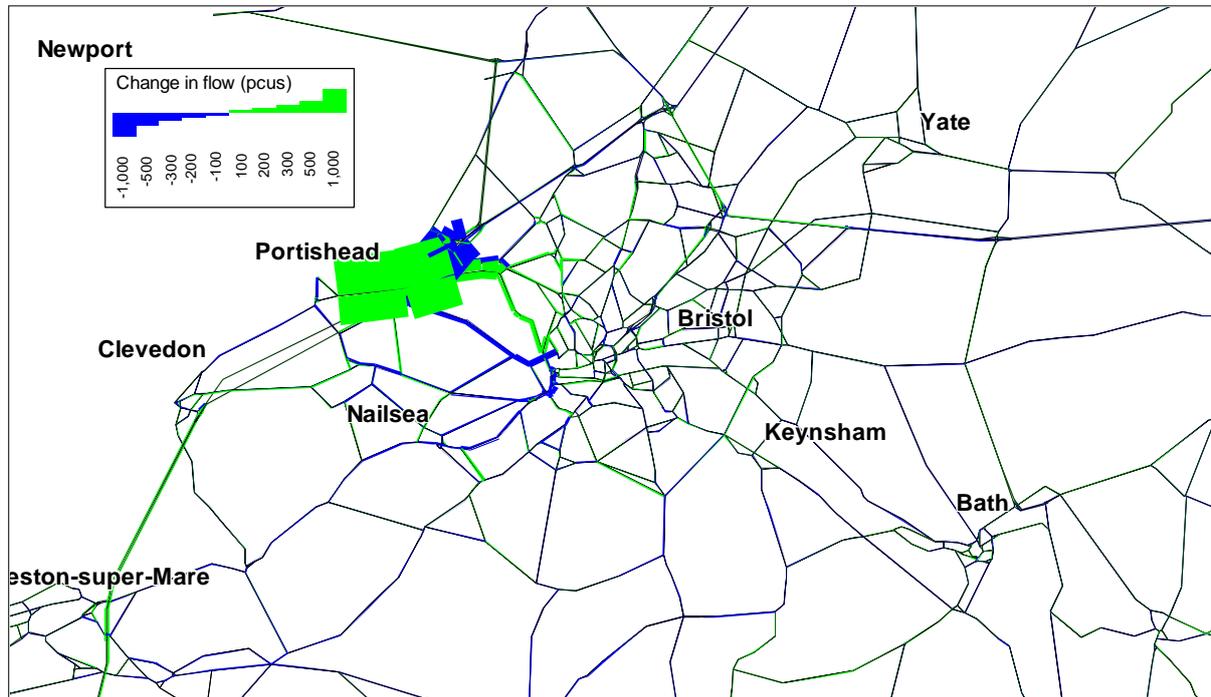
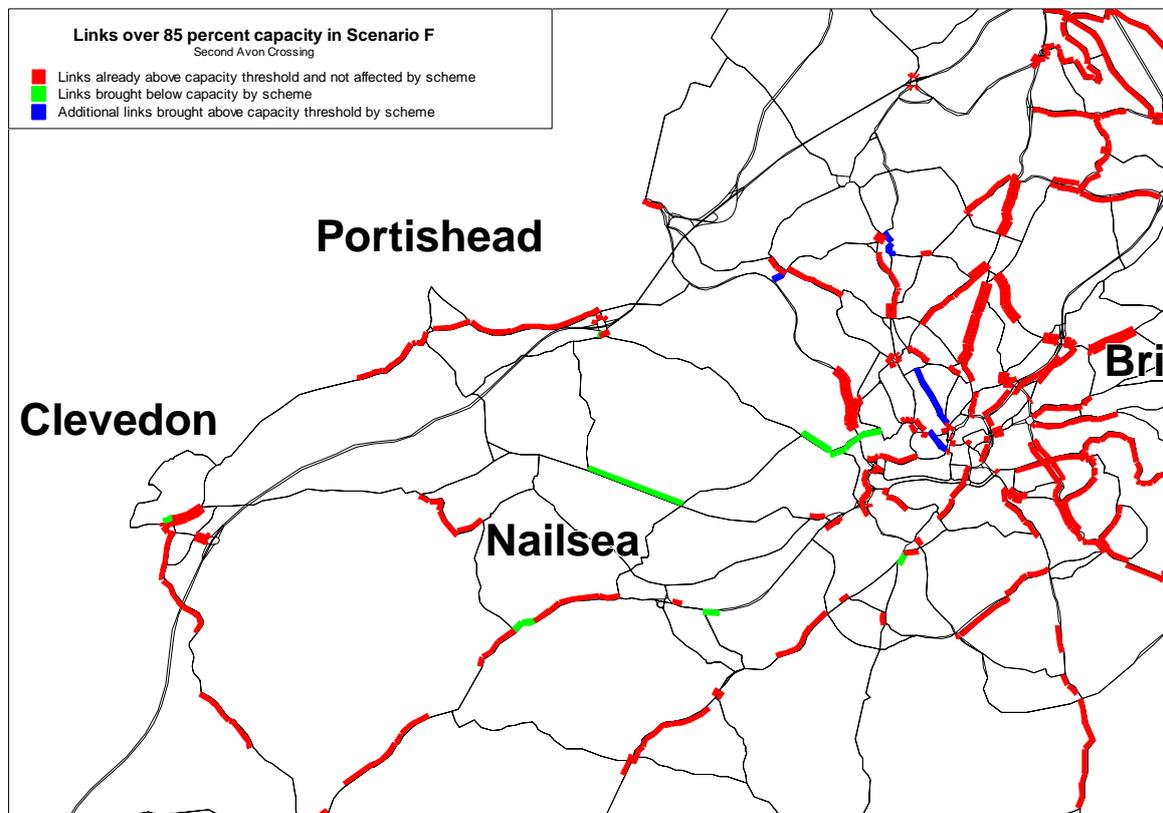


Figure 6.33 – Difference in Capacity Utilisation as a Result of Implementing Second Avon Crossing



6.173 Table 6.23 summarises the economic performance of the Second Avon Crossing scheme. The overall economic performance is reasonable, with a BCR estimated in the range 1.2 to 1.6, and an NPV of between £16 and £34 million. The range quoted reflects an uncertainty in the cost of the scheme – this would depend upon which of the potential structure solutions was selected.

Table 6.23 – Economic Performance of Second Avon Crossing

Second Avon Crossing	
Cost (2005,Q1) £mill, inc Optimism Bias	£85-£111
Cost (2005,Q1) £mill, excl Optimism Bias	£59-£77
PVC (£ mill, 2002 prices & values)	£58-£77
PVB (£ mill, 2002 prices & values)	£93
NPV (£ mill, 2002 prices & values)	£16-£34
BCR	1.2-1.6

6.174 The time savings produced by the scheme are primarily experienced by trips between the south and north of Avonmouth (for instance between Portishead and the North Fringe). However, the savings are fairly small-scale, typically 1 to 2 minutes, because the existing crossing already provides a direct and relatively uncongested route and the new route is slightly longer and involves traversing additional junctions. It is considered that the benefits to traffic over this section are probably underestimated with the model failing to fully represent the weaving activity between Junctions 18 and 19 and therefore understanding the benefits from the relief. Furthermore, the appraisal does not take into account the benefits from significantly improved resilience of the motorway network and alternative routes that would be provided in the case of incidents on the M5.

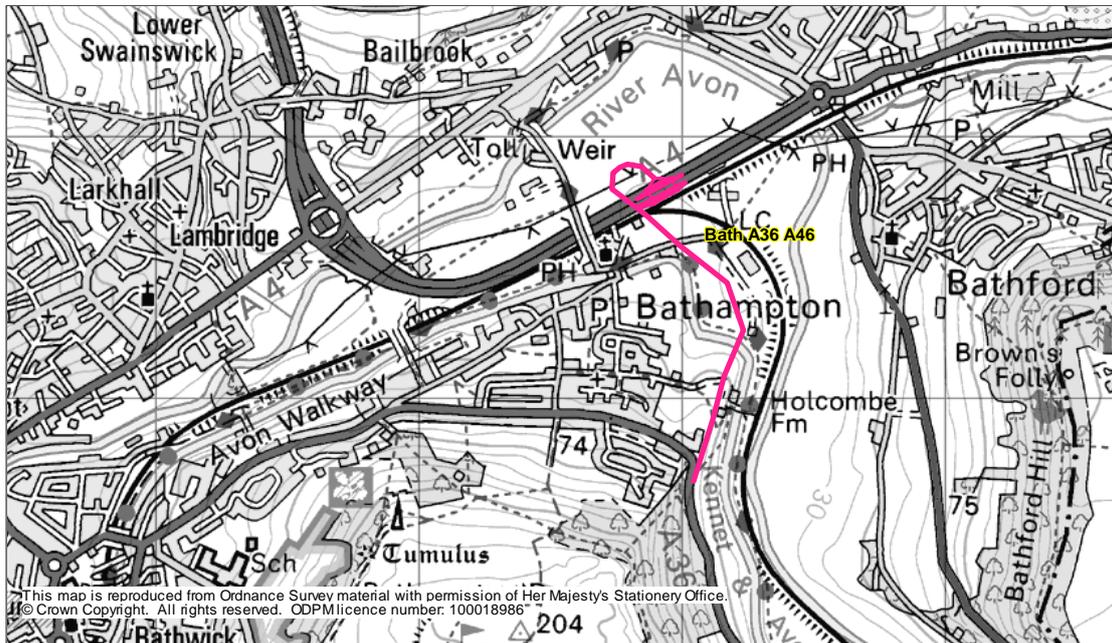
6.175 Furthermore, the new crossing would provide the alignment for one of the proposed rapid transit routes which links Portishead with Avonmouth, central Bristol and Whitchurch. The benefits from the rapid transit route are not included in the appraisal of the crossing. There could also be the potential for private finance, with the new scheme including a toll to contribute to the capital costs.

6.176 The Second Avon Crossing is included in the GBSTS strategy as a long-term measure. The scheme would also provide improved links to Portishead, both by road and by rapid transit.

A36-A46 Link

6.177 The link between the A36 and A46 to the east of Bath was examined within the Bristol Bath to South Coast study which recommended that additional work should be undertaken by the local authority in order to take the scheme further. Within the GBSTS study, further work has been undertaken to assess the strategic impacts of the scheme within the GBSTS study area. The alignment of the route is shown in Figure 6.34.

Figure 6.34 – Alignment of A36/A46 Link Road



Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

6.178 Table 6.24 shows the main impacts of the A36/A46 link road scheme. The scheme has a considerable impact on congestion, reducing total vehicle delay across the modelled area by 4% and raising the average speed by 2%.

Table 6.24 – Key Impacts of A36/A46 Link Road Scheme

Measure	Impact
Vehicle Trips	0.2% increase
Vehicle Kilometres	0.1% increase
Total Vehicle Delay on highway network (hours)	4% reduction
Average Vehicle Speed (Highway)	2% increase

6.179 Figures 6.35 and 6.36 show the impact of the A36/A46 link on the highway network, both in terms of vehicle flow and capacity utilisation. The main impact is that traffic is diverted to the A36/A46 route from the A363 through Bradford-on-Avon and the B3110 through Limley Stoke and around the southern edge of Bath. However, the re-routing effects are widespread, with reduced traffic flows within Bath, on the A431 and extending as far away as the A4174 Avon Ring Road.

6.180 Only 30% of the traffic using the scheme is travelling entirely within the study area, with the majority travelling to or from the West Wiltshire towns or further afield.

Figure 6.35 – Difference in Flow as a Result of A36/A46 Link Road

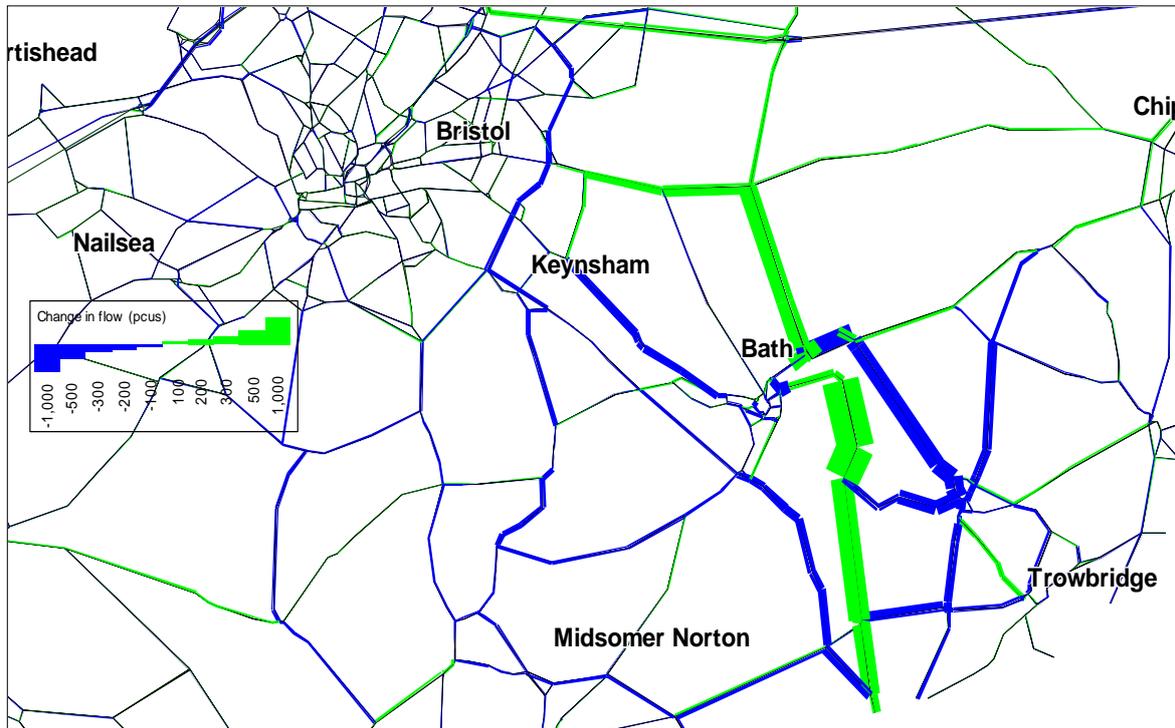
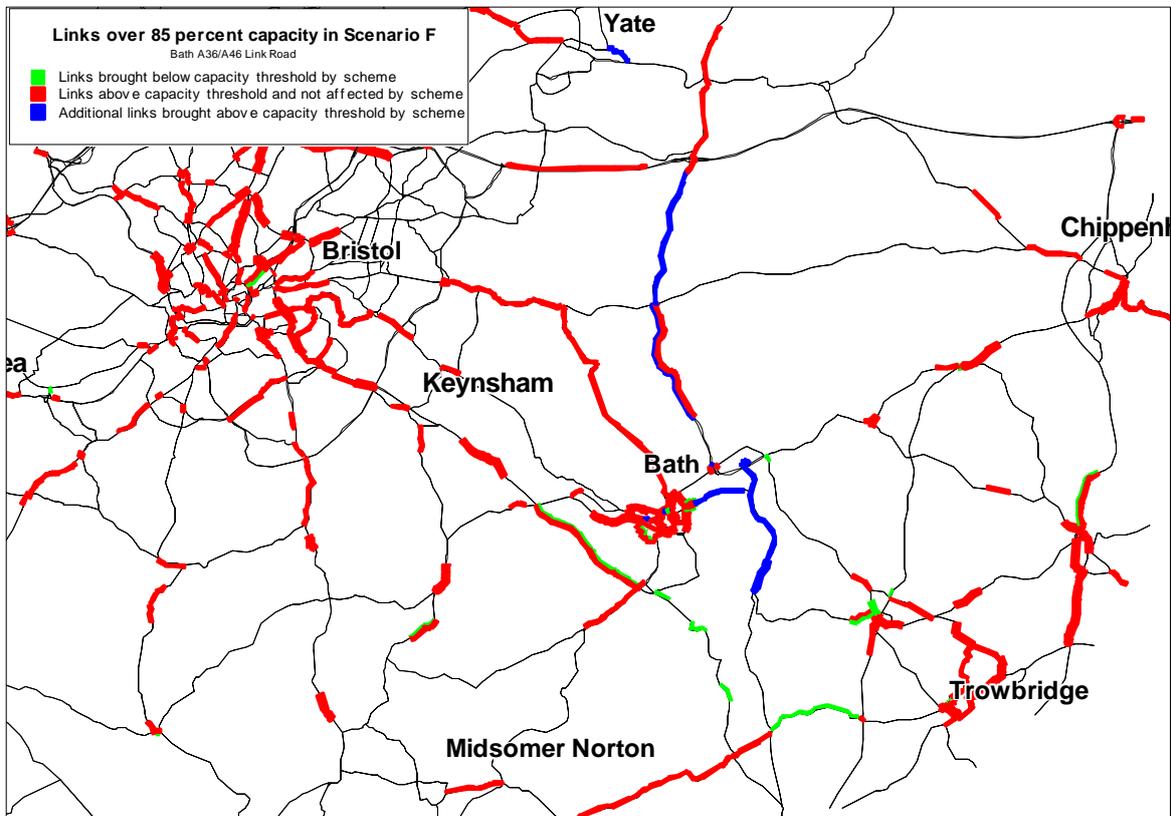


Figure 6.36 – Difference in Capacity Utilisation as a Result of A36/A46 Link Road



6.181 Table 6.25 shows that there are journey time savings of a few minutes for trips from the West Wiltshire towns to Bath but for longer distance journeys, the savings are potentially greater, for example, the model indicates a reduction in journey time of 18 minutes between Salisbury and South Wales.

Table 6.25 – Key Journey Times for the A36/A46 Link Road (morning peak period, in minutes)

Route	No Link	A36/A46 Link
Bradford on Avon to Bath	43	38
Trowbridge to Bath	65	64
Chippenham to Bath	46	44
Salisbury to Cardiff	148	130

6.182 Table 6.26 summarises the economic performance of the scheme. Overall the performance is very strong, with an NPV of £700 million and BCR of 27.

Table 6.26 – Economic Performance of the A36/A46 Link Road

A36/A46 Link Road	
Cost (2005,Q1) £mill, inc Optimism Bias	£46
Cost (2005,Q1) £mill, excl Optimism Bias	£29
PVC (£ mill, 2002 prices & values)	£27
PVB (£ mill, 2002 prices & values)	£725
NPV (£ mill, 2002 prices & values)	£700
BCR	26.6

6.183 The scheme's benefits are comprised of both savings experienced by those able to make use of the new, more direct link between the A36/A46 and those benefiting from congestion relief within Bath, Bradford on Avon and Trowbridge.

6.184 There are substantial benefits within Bath, primarily as a result of the reduction in congestion on the A36 and A4 in the north east which occurs as traffic diverts to use the new link road. This congestion relief generates large time savings for trips made within Bath, particularly the north east area of the city, and those crossing between east and west Bath. Journey time reductions exceed 15 minutes in some cases and the savings within Bath represent over 25% of the total time savings brought about by the scheme.

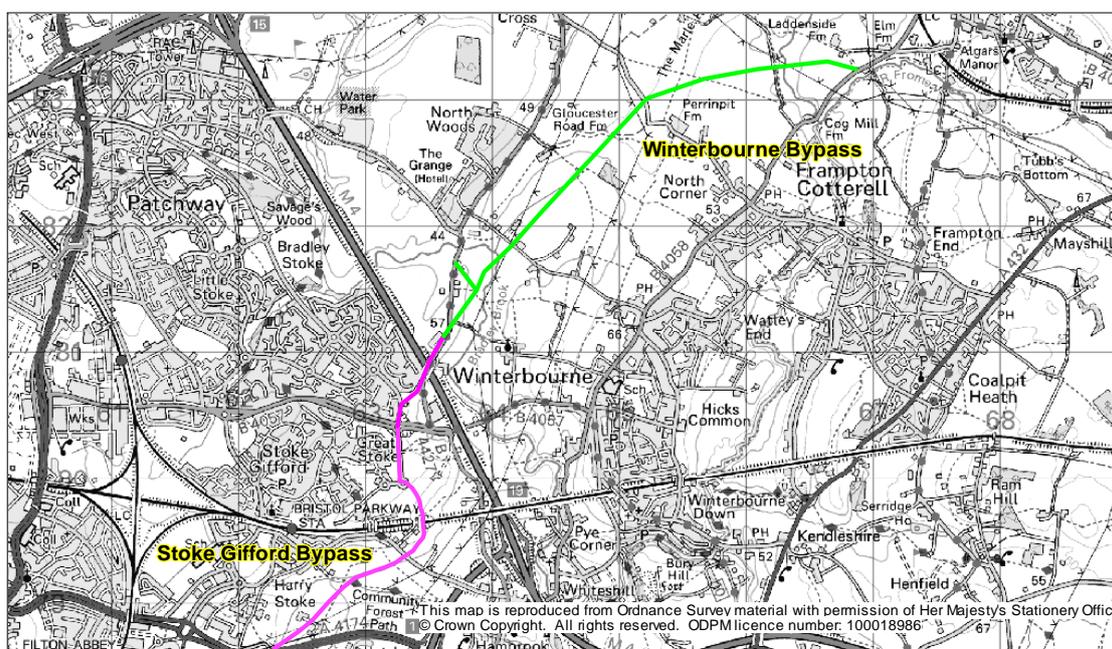
6.185 A Major Scheme Bid is currently being assembled for a package of transport measures with Bath. These take forward recommendations from the earlier Bristol Bath to South Coast Study and include measure designed to address the traffic problems caused by goods vehicles travelling through the area. It is therefore prudent to review the impact of these measures before embarking on the new A36 to A46 link.

- 6.186 Bradford on Avon and Trowbridge benefit from the rerouting of traffic from the A363 to the A36 which is encouraged by the link road. This reduces traffic within their congested central areas, providing considerable journey time savings for local trips.
- 6.187 The A36/A46 scheme has a considerable impact on congestion within Bath and is included in the GBSTS strategy as a long term measure.

Winterbourne and Stoke Gifford Bypasses

- 6.188 Several alternative options for a Winterbourne and/or Stoke Gifford bypass were tested. The most effective scheme was an alignment linking with the B4427 to cross the M5 and connect to the Great Stoke Way, with a southern connection joining the A4174 Avon Ring Road at the Coldharbour Lane junction. The alignments of the schemes are shown in Figure 6.37.

Figure 6.37 – Winterbourne and Stoke Gifford Bypass Alignments



Note: The schemes in this diagram are conceptual and defined for appraisal purposes.

- 6.189 Table 6.27 shows the main impacts of the Stoke Gifford and Winterbourne Bypass schemes. Two tests were carried out: the first including both schemes; and the second with just the Stoke Gifford Bypass. With both schemes, the impact on congestion in the North Fringe area was significant, with a reduction in total vehicle delay of 1.9%. With only the Stoke Gifford Bypass in place, the reduction in total vehicle delay would be 1.7%, suggesting that the majority of the benefits are derived from this section.

Table 6.27 – Key Impacts of Stoke Gifford and Winterbourne Bypass Schemes

Measure	Stoke Gifford + Winterbourne	Stoke Gifford
Vehicle Trips	0.1% increase	0.1% increase
Vehicle Kilometres	0.1% reduction	impact not significant
Total Vehicle Delay on highway network	1.9% reduction	1.7% reduction
Average Vehicle Speed (Highway)	1% increase	1% increase

6.190 Figures 6.38-6.41 show the impact of the Stoke Gifford and Winterbourne Bypasses on the road network, both in terms of vehicle flows (Figures 6.38 and 6.40) and capacity utilisation (Figures 6.39 and 6.41).

6.191 Both options would provide relief to the A38 and local roads in the North Fringe as well as some benefit to the M4 and M5. In particular, the schemes would provide relief to key junctions such as M4 J19 and M5 J16. While the Winterbourne Bypass provides additional relief to the B4058 crossing the M4 and to the A4174 Avon Ring Road, it also generates some extra traffic. This additional traffic limits the amount of congestion relief on some local roads in the North Fringe area.

Figure 6.38 – Difference in Flow as a Result of the Winterbourne and Stoke Gifford Bypasses

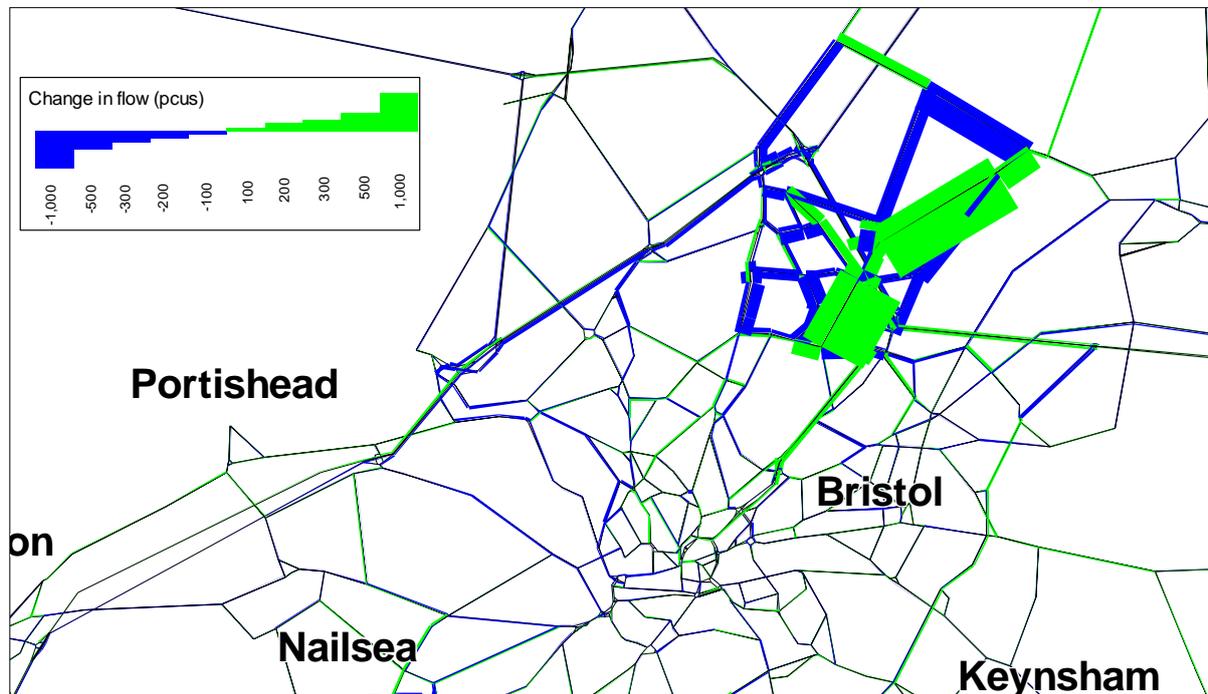


Figure 6.39 – Difference in Capacity Utilisation as a Result of the Winterbourne and Stoke Gifford Bypasses

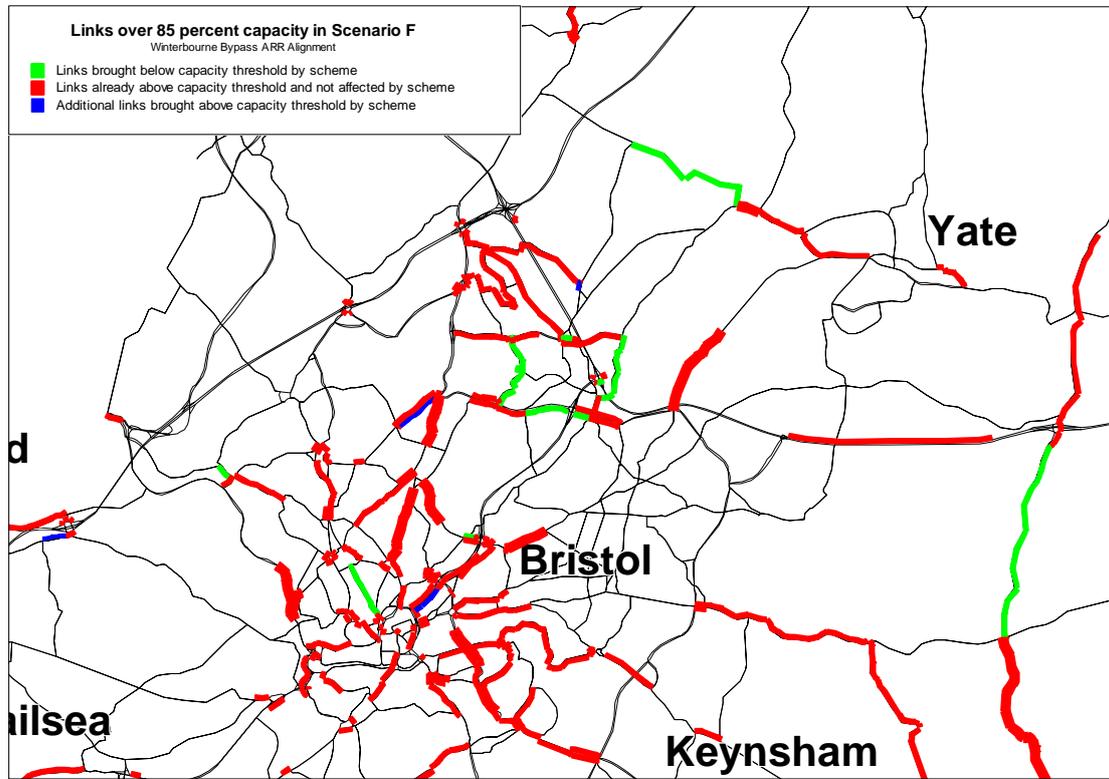
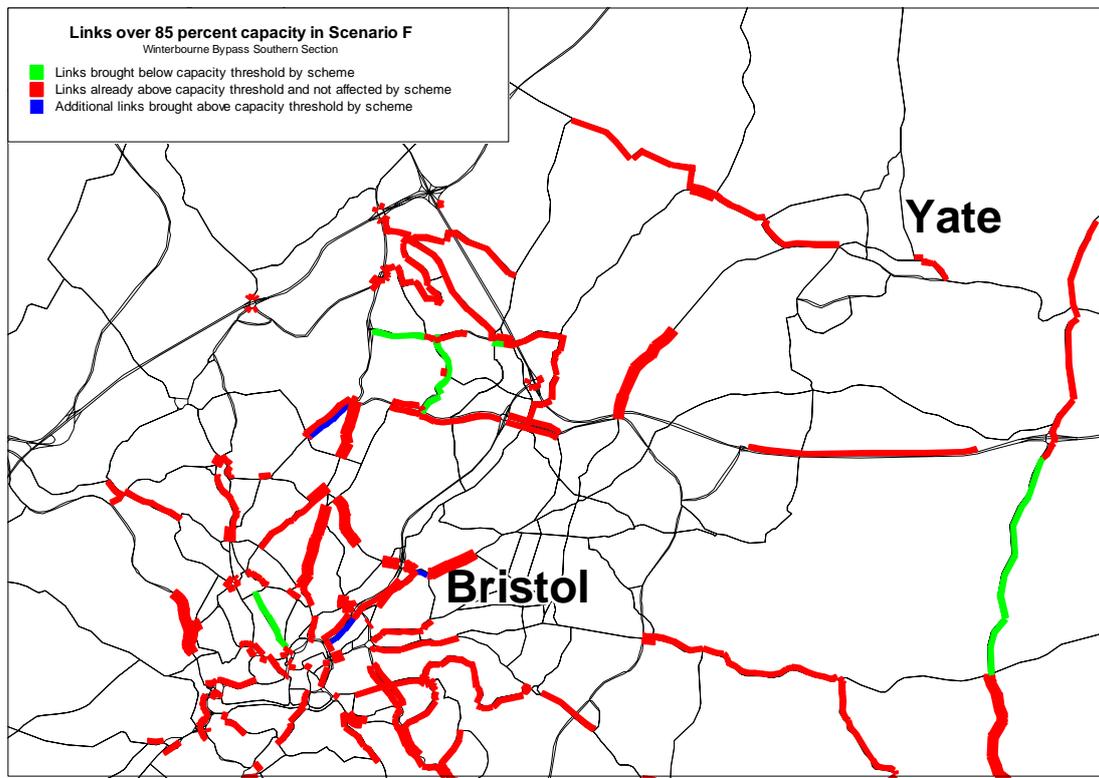


Figure 6.40 – Difference in flow as a Result of the Stoke Gifford Bypass



Figure 6.41 – Difference in Capacity Utilisation as a Result of the Stoke Gifford Bypass



6.192 In view of the traffic analysis, the economic assessment concentrated on the Stoke Gifford bypass. The economic performance of the scheme is summarised in Table 6.28. The overall economic performance of the scheme is strong, with an NPV and BCR of £258 million and 8.3 respectively, and this is despite making a substantial allowance in the capital costs for the possible grade separation of the Avon Ring Road/Coldharbour Lane junction.

6.193 The benefits are primarily time savings and over 90% of these are experienced on journeys to and from the North Fringe due to the benefits of the more direct and less congested route options offered by the scheme. Average time savings per journey are typically between 3 and 8 minutes.

Table 6.28 – Economic Performance of Stoke Gifford Bypass

Stoke Gifford Bypass	
Cost (2005,Q1) £mill, inc Optimism Bias	£43
Cost (2005,Q1) £mill, excl Optimism Bias	£30
PVC (£ mill, 2002 prices & values)	£35
PVB (£ mill, 2002 prices & values)	£293
NPV (£ mill, 2002 prices & values)	£258
BCR	8.3

6.194 The Stoke Gifford Bypass provides substantial relief to roads in the North Fringe including the A38 and B4057 Winterbourne Road. There would be some relief to the motorway network itself, and the scheme would also aid the movement of strategic traffic by reducing congestion at the interface of the local and strategic road networks. In addition, the scheme allows improved access to Bristol Parkway station, and would assist the introduction of the new rapid transit corridor and park-and-ride facilities discussed in Chapter 5. Further work is needed to examine alternative junction arrangements to minimise the impact on the A4174 Avon Ring Road, but nevertheless, the overall case for the scheme is strong, and it has been included in the GBSTS strategy as a long term measure. In the absence of any development north of the M4, the section of the Winterbourne Bypass north of the motorway does not add significantly to the benefits of the scheme, and is not included.

POTENTIAL IMPLEMENTATION PROGRAMME

6.195 An implementation programme for the highway elements of the strategy could include:

- ◆ in the short term:
 - measures to make better use of the existing highway network;
 - initial sections of the South Bristol Ring Road from the A370 to A38 (Red route) and from the A38 to Hengrove;
- ◆ in the medium term:
 - completion of the South Bristol Ring Road, with the section from Hengrove to Hicks Gate;
 - M5 J21 relocation
 - M4 widening from J19-J20; and
- ◆ in the long term:
 - second Avon crossing;
 - Stoke Gifford and Winterbourne Bypass;
 - A36/A46 Link Road;
 - new link from M5 to south Bristol.

6.196 The precise timing of the schemes will need to take into account a number of factors including the state of preparation of the scheme, the timing of residential and employment developments associated with the scheme and the necessary stages within the statutory planning process. For the larger schemes, the preparation time could be significant and hence although they are allocated to the medium or long term, work to develop the schemes may need to start at an early date. In some circumstances, it will be vital that the scheme is in place before developments can be introduced. Hence, it would be necessary to accelerate the highway scheme. Further refinement of the programme will therefore be necessary as the individual schemes are progressed.

SUMMARY

- 6.197 The approach adopted within the study for the development of the transport strategy concentrated on examining and promoting alternatives to the private car before considering improvements to the highway network. This was designed to ensure that highway measures are only considered after all other possibilities have been explored. Within the highway improvements themselves, the emphasis was placed on making best use of the existing infrastructure before examining the need for schemes which increase highway capacity.
- 6.198 The examination of highway improvements was undertaken against the background of significant growth in the demand for travel in line with a 25% rise in population and 20% growth in employment by 2031. The identification of enhancements to highway capacity took direct account of the location, scale and timing of these developments; in some cases, additional highway infrastructure is necessary to connect new developments into the existing network.
- 6.199 The emphasis in identifying measures to make best use of the highway network in the study area concentrated on the existing infrastructure and capacity on the motorway and major trunk roads, although many of the measures are also suitable for the local network:
- ◆ **planned maintenance** should continue to be programmed to minimise disruption by avoiding periods of peak daily and seasonal flows, including the main summer holiday periods;
 - ◆ wider measures to **reduce incidents** through better driving training, increased enforcement, stricter penalties and greater use of advanced warning signs;
 - ◆ continued development of **incident management** by speeding up detection, evidence collection and documentation, incident clear-up and the initiation of diversionary routes; and
 - ◆ wider application of **signing, surveillance and automated systems** including active traffic management techniques.
- 6.200 The assessment of capacity enhancements across the study area's highway network considered a number of potential new schemes and appraised the full range of impacts before developing a preferred package of improvements. The identification of schemes concentrated on those which would have a direct impact on the strategic highway movements across the study area. The schemes within the strategy would not be the only highway measures which would generate potential enhancements; local measures, outside the scope of GBSTS, could also have merits but would need to be progressed separately by the local authorities. Hence, the schemes identified in the strategy are concentrated on the strategic highway network in the area.
- 6.201 The principal schemes which the study recommended should be taken forward included:
- ◆ **South Bristol Ring Road between A4 and A38**
South Bristol experiences severe congestion on the constrained highway network in the area together with restricted accessibility to other parts of the study area, particularly the new employment areas of the North Fringe. Accessibility would be enhanced by extension of the Avon Ring Road with an

indicative alignment from the junction with the A4 at Hicks Gate, following a new alignment south-west of Whitchurch to the A37, then running south of Hengrove before heading north to junction at Hartcliffe Way and Hengrove Way and finally, following an on-line alignment through Withywood before skirting Highridge Common to the A38. The scheme produces significant benefits through reduced delays across south Bristol, creating major new connections between south Bristol and the major employment areas. The scheme shows a strong economic performance with NPV of £950 million and BCR of 16.

- ◆ A38 – A370 Link

Extension of the South Bristol Ring Road from A38 through to the A370, with the study's preferred alignment following the path of the earlier Red route. The scheme provides relief to the congestion on the B3130 through Barrow Gurney and produces a strong economic performance with NPV of £70 million and BCR of over 8.

- ◆ Links between south Bristol and M5

Current congestion levels on the highway network on the approaches to south Bristol from the south west would be exacerbated by planned future developments in housing and employment together with growth at BIA. The study identified alternative schemes to improve the connections to south Bristol and from the M5 motorway and the South West. The northern route would link M5 Junction 20 to the A370 near Long Ashton along an alignment to the north of the B3130 and would include bypasses for Nailsea, Tickenham and Wraxhall. The southern route would link M5 Junction 21 at Weston-super-Mare with BIA and northwards to the A370 with a bypass of Barrow Gurney. Outline alignments for the schemes have been identified for the purposes of the appraisal but considerable detailed work is necessary in order to identify potential environmental and other constraints. Both alternatives have strong transport economic case with a NPV of £270 million and a BCR of over 5 for the Junction 21 route and a NPV of £160 million and BCR of 3 for the Junction 20 option.

- ◆ Improvements to M5 Junction 21

Current conflict at this junction, between traffic wishing to access the M5 and through movements on the A370 between Weston-super-Mare and Congresbury/south Bristol, will worsen with future growth in traffic. The most effective approach identified by the study is to separate the two movements by constructing a replacement junction to the south of the current Junction 20 which would be accessed by a new link to the A370 in Weston-super-Mare. The existing Junction 20 would be closed for access to the M5 and would therefore be restricted to A370 traffic alone. The scheme produces a strong economic performance with a NPV of £150 million and a BCR of 3.

- ◆ M4 Widening between Junctions 19 and 20

The need to increase the capacity from three to four lanes in each direction on this section of the motorway was highlighted by forecast traffic flows consistently exceeding 85% of current capacity. Considerable journey time savings are achieved producing a NPV of £350 million. Due to an increase in distances travelled and a rise in vehicle operating costs, there is a growth in government indirect tax revenue which produces a negative BCR (-5). Despite this anomaly, the overall scheme performance is strong.

- ◆ M5 Junctions 16 and 17 and M32 Junction 1

Problems at Junction 16 are created by a combination of high traffic levels to/from Aztec West and the North Fringe, conflicts between through traffic on the A38 and motorway access/egress and the proximity of Junction 16 with Almondsbury Interchange. Junction 17 serves the Cribbs Causeway regional shopping centre as well as other local destinations and experiences significant congestion, particularly on Saturdays. High traffic volumes through M32 Junction 1 create peak period congestion difficulties, exacerbated by the proximity to M4 Junction 19. Schemes to improve the operation of these junctions have been identified including the enhancement of the on and off slip roads and changes to the local road network and produce benefits to traffic movements. A more detailed assessment of operation of the junction is required, which is outside the scope of the study, before a full appraisal of the scheme can be completed.

- ◆ Second Avon Crossing

M5 between Junction 18 and 19 is one of the few crossings of the River Avon and is a critical section of the region's strategic road network. Incidents on this section have a widespread impact across the region and traffic levels are influenced by high levels of local traffic including movements to, from and between the two port areas on opposite banks of the river. The proposed second crossing would relieve the motorway and its junctions and improve access to Portishead and Avonmouth. The study has identified a potential low level crossing including an opening bridge or barrage which, in addition to carrying normal traffic, would also include a rapid transit link to Portishead. Because the scheme runs parallel to existing infrastructure, the journey time savings are low with a NPV of £30 million and BCR of 1.6 although this excludes the benefits from rapid transit and the improved resilience of the highway network.

- ◆ A36 to A46 Link Road

The link road was recommended for further development by the earlier Bristol Bath to South Coast study. Located to the east of Bath, it produces significant benefits within Bath, through reduced congestion in the city on the A4 and A36, and traffic relief in the west Wiltshire towns of Trowbridge and Bradford-on-Avon. The overall economic performance is strong with a NPV of £700 million and BCR of 27 but there are significant environmental impacts which will need to be considered in the further development of the scheme.

- ◆ Winterbourne and Stoke Gifford Bypasses

The scheme provides substantial relief to roads in the North Fringe including A38 and B4057 Winterbourne Road. The majority of the benefits occur south of the M4 and the northern section does not significantly add to the benefits and hence should not be progressed unless there are changes to developments in the area. The Stoke Gifford bypass and southern section of the scheme produces a NPV of £260 million and BCR of 8 and hence should be progressed further.

6.202 A number of additional schemes for highway capacity improvement were examined but were not included in the GBSTS strategy.

- ◆ M4 to A4174 Link Road

The potential alignment for the scheme would involve close inter-relationship with M4 Junction 19 and a number of alternative designs were examined with the

most effective being the construction of a new M4 junction (18A) with access limited to motorway traffic to/from the east and closure of the east-facing slip roads at the existing Junction 18. Such a scheme in isolation recorded a NPV of £270 million and BCR of 1.2 but the generation of additional traffic on the M4 to the east of the new junction would create the need to add an additional lane on the M4 through to Junction 18 and hence the scheme was not recommended by the study.

- ◆ A4 Salford Bypass

The scheme would relieve the congestion from traffic passing through the village but would involve high construction costs due to the terrain through which it would pass. Hence, the scheme's economic performance, with a NPV of £17 million and BCR of 1.2, does not justify its inclusion in the strategy; although it produces some local relief, the strategic benefits are limited.

- ◆ A37 Whitchurch Bypass and Callington Road Link

These two schemes were identified as providing local relief to the highway network rather than having a strategic impact and hence were not included in the strategy although they produced a reasonable economic performance. Some of the benefits from the Whitchurch bypass would be achieved by the wider South Bristol Ring Road.

- ◆ Clutton and Temple Cloud Bypass

The construction of bypasses for the two neighbouring villages on the A37 would provide local relief but would not have a strategic impact.

- ◆ Banwell, Churchill and Sandford Bypasses

The three adjacent communities on the A371, A368 and A38 experience local congestion which is exacerbated by the restricted capacity through the village centres. The study examined the impact of a series of bypasses to provide relief to the villages and identified that, because the use of bypasses would increase the length of journeys, the net impact of the schemes was diminished such that the overall NPV was -£2 million with a BCR of 0.96. The scheme was therefore considered to have local rather than strategic merits and was not included in the GBSTS strategy.

- ◆ M49/Sevenside Intermediate Junction

Projected increases in employment within the Sevenside area are not sufficient to justify the potential highway improvements which include a new junction on the M49 and construction of a Spine Road through the main development area. While there are potential travel time savings for traffic to/from Sevenside, the volume of traffic is small and the benefits do not justify the high scheme costs.

