HEREFORDSHIRE COUNCIL

HEREFORD RELIEF ROAD

Interim Forecasting Report

Sustainable Option Packages
FINAL

August 2010

THE TRANSPORTATION CONSULTANCY

HEREFORDSHIRE COUNCIL

HEREFORD RELIEF ROAD

INTERIM FORECASTING REPORT

SUSTAINABLE OPTION PACKAGES

AUGUST 2010

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HEREFORDSHIRE COUNCIL **AUGUST 2010**

HEREFORD RELIEF ROAD INTERIM FORECASTING REPORT

SUSTAINABLE TRANSPORT OPTIONS

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1.0 INTRODUCTION

Introduction

1.1 This study, commissioned by Herefordshire Council (HC) examines the findings of implementing sustainable option packages for the Herefordshire region. This report should be read alongside the Hereford Multi Modal Model Forecasting Report produced by JMP consultants on behalf of HC and the Highways Agency (HA).

1.2 The JMP report examined the implications of potential housing development up to 2026 as proposed in the Regional Spatial Strategy (RSS) and its impact on the road network within Hereford and its surrounding area. The report considered five growth point development options against No Relief Road, an Eastern Alignment Relief Road and a Western Alignment Relief Road.

1.3 The results of JMP work concluded that the trips associated with the additional housing have a significant detrimental effect on the operation of the Hereford highway network. They found that by adding a Relief Road, on either a west or eastern alignment is forecast to provide some relief from the adverse effects and that the resulting network operation would be similar to that if the additional trips had not been introduced.

1.4 The JMP results indicated that of the four possible growth point housing and employment options that Option 3 (North South focused) together with the Relief Road on the eastern alignment provided the lowest overall cost of travel within the highway network model, whilst with a western alignment of the Relief Road it was housing Option 4 that gave the most favourable results.

1.5 This report has been produced to consider in more detail sustainable option packages and the resulting effects this would have to the road network within Hereford and the surrounding area with and without a Relief Road in conjunction with their best performing housing options. It should be noted the model does not predict the sustainable packages performance but assumes a certain percentage of modal shift has been attained and then assesses performance with and without the Relief Road.

2.0 OPTION TESTING

Option Testing

2.1 For each sustainable option package three different scenarios have been modelled these are 1) No Relief Road with Hereford Housing Option 3 and Housing Option 4; 2) Hereford Relief Road with an eastern alignment and Hereford Housing Option 3; and 3) Hereford Relief Road with a western alignment and Hereford Housing Option 4. Each scenario has been modelled for the future year of 2026 in both the AM and PM peak periods.

2.2 There are three sustainable option packages that have been proposed by HC are:-

- Continue with existing levels of investment (Option 1) – 10% modal shift from car to public transport;
- Increase levels of investment (Option 2) – 15% modal shift from car to public transport;
- Increase levels of investment including demand management (Option 3) – 20% modal shift from car to public transport.

2.3 Each sustainable transport option includes an element of the following:-

- Smarter Choices;
- Active Travel;
- Bus packages;
- Park and Ride;
- Rail packages;
- Car Parking packages;
- Infrastructure Improvements to the sustainable transport networks; and
- Road Safety.

2.4 The different sustainable option packages are discussed in greater detail below and have been summarised in Table 2.1:-

Option 1

2.5 The core principles of Option 1 are to continue with existing levels of investment in Herefords sustainable transport network and with similar levels of demand management, impacting on car users.

2.6 The Smarter Choices element of Option 1 includes development of travel plans, travel promotions, active travel information and development of park and share and park and cycle sites. DaSTS reports that a moderate to intensive smarter choices programme can substantiate between a 10-25% modal shift. As Option 1 is a moderate option it has been decided that a 10% modal shift from car to public transport (PT) cycling and walking can be applied within the modelling.

2.7 The active travel element of Option 1 includes the Connect2 Greenway scheme which is a new sustainable link that includes a new river crossing from Hereford Cathedral via Rotherwas industrial estate to Holme Lacy College. Promotion of active travel will be done through enhancements of existing infrastructure and through the delivery of new infrastructure for walking and cycling. It is also envisaged that the number of school trips by car will be reduced. Finally access arrangements from strategic sites to the existing highway network will be improved for pedestrians and cyclists. These active travel proposals assume a 10% modal transfer of trips will be applied to the modelling from car to

PT, cycling and walking.

2.8 For Option 1 bus services would also be improved by promotion and improving passenger waiting facilities. The Hereford transport hub would also be improved to allow for better modal interchange. These improvements would be allowed for within the 10% modal transfer of trips from car to PT, walk and cycle.

2.9 Two Park and Ride sites will also be included within the Option 1 model. The first consisting of 400 spaces will be located on the A49 north of Starting Gate roundabout and the second will be located on the A49 south at Rotherwas Access Road roundabout and will consist of 300 spaces.

2.10 Rail infrastructure will be improved between Hereford and Malvern and support will be ongoing for senior rail reductions. It is proposed that improvements to rail services would cause a transfer of 5% of car trips to be added to the PT trips for those destinations that lie outside the county to the East of Hereford.

2.11 Option 1 includes several changes to car parking within Hereford in terms of number of spaces, length of stay and pricing. The following changes are bulleted below:-

- Removal of car parking within Edgar Street Grid development site – 1.195 net spaces lost;
- Changes to St. Martins overlay car park – conversion to long stay only and provision of 93 spaces;
- Changes to Bath St car park – conversion to short stay only and provision of 77 spaces;
- New car park to be provided at the Country bus station – conversion from 100 long stay to 300 long stay and provision of 200 short stay spaces;
- New Council staff only car park at Plough Lane causing 300 spaces net increase; and
- City car park pricing will increase in line with inflation.

2.12 Option 1 proposes several changes to be made to the highway network these include a new link road as part of the Edgar Street Grid development between the A465 and A49 and corresponding reduction in the highway capacity between Newmarket St and Blueschool St to single lane flow. Vehicle movements will also be optimised and environments will be created to encourage active travel.

Option 2

2.13 The core principles of Option 2 are to increase levels of investment in Hereford`s sustainable transport network combined with an increase in demand management measures. Option 2 follows on from Option 1 but proposes the following changes and additions which are described below.

2.14 Option 2 expands upon Option 1 smarter choices by including localised branding and developing rail station travel plans. For Option 2 it has been decided that a 15% modal shift from car to public transport (PT), walk and cycle can be applied within the modelling.

2.15 Option 2 expands upon Option 1 active travel proposals by making substantial improvements to pedestrian facilities, at grade crossings on A49 Victoria Street / Eign St / Barton Rd, accelerated expansion of cycle routes and infrastructure and introducing city wide cycle hire schemes. These proposals like the smarter choices would be allowed for within the 15% modal transfer of trips from car to PT, walk and cycle.

2.16 Option 2 proposes to further enhance bus service provision and provide extra services. Buses would also benefit with the provision of bus lanes and priorities on the network at the following locations:-

- Bus Inbound lane to provided on the A465 (Commercial Road and Aylestone Hill from Folly Lane roundabout);
- A49 (Holmer Rd) inbound lane and signal priorities;
- A49 (Belmont roundabout to Bullingham Lane junction) provision of two way bus lane;
- B4399 (A49 Ross Rd to Hinton Avenue) provision of westbound bus lane and signal priorities.

2.17 Option 2 proposes to increase city car park pricing above the rate of inflation as opposes to Option 1 which increases car park pricing by the rate of inflation only.

2.18 The Park and Ride strategy adopted for Option 2 includes the expansion of the A49 South Park and Ride site by 100 spaces to 400 spaces and the addition of a new Park and Ride site consisting of 300 spaces on the A465 at Aylestone Park.

2.19 Option 2 proposes to make changes to the network in addition to those covered in Option 1 these include restricting access over the old bridge in order to allow bus, cyclists and pedestrians only. Broad St will also be restricted access to allow only bus, cyclists and pedestrians. Finally the highway capacity will be reduced in order to give buses priority on the highway network.

2.20 Finally Option 2 proposes to include a road safety element by reducing the speeds of residential areas off main roads from 30mph to 20mph.

Option 3

2.21 The core principles of Option 3 are to increase levels of investment in Hereford`s sustainable transport network and introduce a substantial increase in measures to manage demand for car use. Option 3 follows on from Option 2 but proposes the following changes and additions which are described below.

2.22 Option 3 expands upon Option 2 smarter choices by including personalised travel planning and implementing community lead travel plans. For Option 3 it has been decided that a 20% modal shift from car to public transport (PT), walk and cycle can be applied within the modelling.

2.23 For Option 3 it is proposed to make the maximum feasible improvements to active travel that is possible. These measures can be included within the modelling within the application of a 20% modal shift from car to PT, walk and cycle.

2.24 For buses within Option 3 it is proposed to expand concessionary travel for 16 to 19 year olds and implement real time information. Provision of bus lanes and priorities on the network are also added at the following locations in addition to those proposed in Option 2:-

- A465 (The Oval to Belmont Roundabout) installation of inbound bus lane and signal priorities; and
- A49 (Edgar Street roundabout to Belmont roundabout) installation of southbound bus lane and signal priorities.

2.25 The Park and Ride strategy adopted for Option 3 includes the expansion of the A49 South Park and Ride site by 100 spaces to 500 spaces and the addition of a new Park and Ride site consisting of 200 spaces on the A4103 at the Cattle Market.

2.26 The car parking strategy adopted within Option 3 includes increasing car park pricing significantly above the rate of inflation. On street charging will be introduced and residential parking schemes will be expanded.

2.27 Option 3 proposes to make changes to the network in addition to those covered in Option 2 these include a significant reduction in highway capacity due to bus priorities, implementation of Intelligent Transport Systems and freight restrictions within central Hereford.

2.28 Finally Option 3 expands upon Option 2` road safety proposals by installing car free zones at schools.

2.29 Table 2.1 summarises the three sustainable transport options and is shown below:-

Table 2.1 Summary of Sustainable Transport Options 1 to 3

		Option 1	Option 2	Option 3
Smarter Choices	Developing travel plans	X	X	X
	Travel promotions	X	X	X
	Active travel information	X	X	X
	Localised branding		X	X
	Developing Rail Station travel plans		X	X
	Personalised Travel Planning			X
	Community lead travel plans			X
	Development of Park and Share and Park and Cycle Sites	X	X	X
Active Travel	Connect 2 scheme	X	X	X
	Promotion of active travel through enhancements of existing infrastructure	X	X	X
	Promotion of active travel through new infrastructure delivery	X	X	X
	Reduction in the number of school trips by car	X	X	X
	New access arrangements from strategic sites to existing highway network	X	X	X
	Substantial improvements in pedestrian facilities		X	X
	At grade crossings on A49 Victoria Street (Eign Street and Barton Road)		X	X
	Accelerated expansion of cycle routes and infrastructure		X	X
	City wide cycle hire scheme		X	X
	Maximum feasible improvements			X
Bus	Serving changing customer needs	X	X	X
	Promotion of bus use	X	X	X
	Improvements to passenger waiting facilities	X	X	X
	Easing modal interchange – Hereford Transport Hub	X	X	X
	Improved service coverage and frequency		X	X
	Expansion of concessionary travel (16 to 19 year olds)			X
	Real time information			X
Park and Ride	A49 North Park and Ride Site – 400 spaces – located north of Starting Gate roundabout	X	X	X
	A49 South Park and Ride Site – 300 spaces – located at Rotherwas Access Road roundabout	X		
	A49 South Park and Ride Site - expansion by 100 spaces to 400 spaces		X	
	A49 South Park and Ride Site - expansion by 100 spaces to 500 spaces			X
	A465 (Aylestone Park) – 300 spaces		X	X
	A4103 Cattle Market site - 200 spaces			X

		Option 1	Option 2	Option 3
Bus Priority	A49 (Holmer Road) Inbound bus lane and signal priorities		X	X
	A49 (Belmont Roundabout to Bullingham Lane Junction) 2 way bus lanes		X	X
	A465 (Commercial Road and Aylestone Hill from Folly Lane Roundabout) Inbound lane		X	X
	B4399 (A49 Ross Road to Hinton Avenue) Westbound Lane and signal priorities		X	X
	A465 The Oval to Belmont Roundabout) Inbound Lane or signal priorities)			X
	A49 (Edgar Street Roundabout to Belmont Roundabout) southbound bus lane or signal priorities			X
Rail	Infrastructure Improvements between Hereford and Malvern	X	X	X
	Support ongoing senior rail reductions	X	X	X
Car Parking	Removal of car parking within ESG site – 1,195 net spaces lost	X	X	X
	Changes to St. Martins overlay car park – conversion to long stay only – 93 spaces	X	X	X
	Changes to Bath St car park – conversion to short stay only – 77 spaces	X	X	X
	New car park on Country bus station – conversion from 100 LS to 300 LS and 200 SS	X	X	X
	New Council staff only car park at Plough Lane – 300 spaces net increase	X	X	X
	Increase city car park pricing inline with inflation	X		
	Increase city car park pricing above rate of inflation		X	
	Increase city car park pricing significantly above rate of inflation			X
	Introduction of on-street charging			X
	Expanded residential parking schemes			X
Network changes	New ESG - Link Road (A465 to A49)	X	X	X
	To optimise vehicle movements and create environments which encourage active travel	X	X	X
	Reduced highway capacity between Newmarket St and Blueschool St to single flow	X	X	X
	Restrict access over the Old Bridge - access for bus, cyclists and pedestrians only		X	X
	Restrict Broad St to access only - access for bus, cyclists and pedestrians only		X	X
	Reduction in highway capacity due to bus priorities		X	
	Significant reduction in highway capacity due to bus priorities			X
	Intelligent Transport System			X
	Freight restrictions within central Hereford (Greyfriars Bridge – Eign St – Inner Ring Road)			X
Road Safety	20mph zones in residential areas off main routes		X	X
	Car free zones at schools			X

3.0 MODELLING METHODOLOGY

Introduction

3.1 The future year transport networks and demand matrices were directly taken from the JMP HMMM forecasting work for the scenarios described in paragraph 1.6 above. Each of the three sustainable transport options described above were then adopted within the JMP networks and demand matrices. The methodology in order to include each element described in paragraph 1.7 is summarised below.

Smarter Choices

3.2 In order to model smarter choices a percentage of the trips from the car matrix that are internal and travel within the county are removed and added to the car available PT, walk and cycle matrices based upon census splits. The percentage of trips removed from the car internal matrix was 10% in option 1, 15% in option 2 and 20% in option 3. The PT, walk and cycle matrices were then combined to form a PT car available matrix in order to forecast Variable Demand Modelling using DIADEM.

Active Travel

3.3 The changes in trips associated with the active travel schemes are included as part of the smarter choices modelling as described above. The Connect2 Greenway scheme which formed part of the active travel proposals was coded into the walk and cycle networks.

Bus Packages

3.4 The bus priority measures were coded into the SATURN highway networks for the following:-

- The A49 Holmer Road Inbound lane was accommodated by adding a third lane for bus only;
- Priority was given for public transport at the Asda Roundabout for public transport using St Martins St. St Martins St was banned for cars and HGV in order to form a bus only lane in both directions.
- Using existing highway spaces one inbound bus lane was coded to form one car/HGV lane and one bus lane travelling inbound from Holme Lacy Road to the Asda Roundabout on A49 Ross Road
- The inbound bus lane on the A465 Belmont Road was accommodated by widening from 2 to 3 lanes to form one bus only lane and one car/HGV lane northbound.
- The inbound bus lane on Holme Lacy Road was accommodated by widening from 2 to 3 lanes to form one bus lane and one car lane westbound commencing from the mini-roundabout at Hinton Avenue
- The inbound bus lane on the A465 Aylestone Hill commenced from Folly Lane and was accommodated by widening from 2 to 3 lanes to form a bus only lane and an inside lanes for car/HGV travelling southbound

Park & Ride

3.5 To model the effects of Park & Ride, the same methodology that JMP used in their Forecasting report was adopted assuming a 33% occupancy rate during the peak hours.

3.6 The A49 north site for example has an allocation of 400 spaces across all three sustainable options; it is assumed therefore that 300 spaces will be occupied during both peak periods. 300 hundred trips in the AM car matrix were identified as being likely to use a Park and

Ride site as their origins were north of the site and their destinations were in the city centre. These trips were then moved in the demand matrix so that the car trips were between the original origin and the Park and Ride site. Similarly, additional trips, with their origins at the Park and Ride site and their destinations in the city centre, were added into the public transport matrix. For the PM peak, it was assumed that 300 car users would use the Park and Ride site in the outbound direction. The car and public transport matrices were altered accordingly. This same methodology was applied to the A49 South, A465 and A4103 Park and Ride sites but the origins changed to those likely to use the sites from nearby zones.

Rail

3.7 In order to model improvements to rail the same methodology as used in the smarter choices packages was adopted. For rail 5 percent of the trips from the car matrix was removed from origins and destinations outside the county to the East of Hereford and added to the car available PT, walk and cycle matrices based upon census splits. The PT, walk and cycle matrices were then combined to form a PT car available matrix in order to forecast Variable Demand Modelling using DIADEM.

Car Parking

3.8 As part of the Sustainable options packages a number of changes to the Car parks within Hereford have been proposed as described in paragraph 1.15 above. To take account of these changes in the models, the destination trip ends associated with the Car Parks have been redistributed to the nearest parking zone.

Network Changes

3.9 Any physical infrastructure changes, such as restricting access to cars and freight restrictions for example, was coded into the highway networks. The road safety proposals were coded into the highway network by lowering the speeds to 20mph and reducing the capacity for the residential roads off the main routes.

Variable Demand Modelling

3.10 After the completion of building the networks and demand matrices to represent the three sustainable options and No Relief Road, Eastern Relief Road and Western Relief Road alignments for a 2026 AM and PM peak period forecasting commenced using the DIADEM software in order to model variable demand.

3.11 The exact same methodologies and parameters as described in the JMP Forecasting Report Chapter 2 were adhered to and used as part of this assessment. The assessments were evaluated using the `Method of Successive Averages` within the DIADEM program in order to reach acceptable convergence levels.

3.12 The 2026 AM and PM No ODR models for each sustainable Option 1 to 3 and housing Options 3 and 4 were pivoted off the 2008 base year for the respected peaks. For the Eastern alignment with housing option 3 the relevant sustainable option and peak periods were pivoted off the reference costs and demand output from the No Relief Road models with Housing Option 3. This process was repeated for Housing Option 4 and the western Relief Road alignment pivoting off the reference demand and costs associated with Housing Option 4 with No Relief Road models.

4.0 MODAL SPLIT

4.1 As the DIADEM model contains a mode component, which allows modal shift and results in a new set of new demand matrices which may be different from the reference matrices. Thus, a new demand matrix for each modelled mode (i.e. car, PT, cycle and walk) is obtained after running the model for each scenario. The new demand matrices are then assigned to the respective network to produce the forecasts of travelling conditions under each scenario.

4.2 Tables 4.1 and 4.2 show the pre DIADEM forecast person trip totals for car, public transport, cycle and walk demand matrices obtained from demand model for each modelled scenario for the AM and PM models respectively. For comparison, the total trips from the validated AM and PM base year models are also included.

Table 4.1 AM Pre DIADEM forecast person trip totals

Scheme	Mode	Demand Scenario							
		Housing Option 3				Housing Option 4			
		NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
Base	Car	19,921							
	PT	3,005							
	Cycle	850							
	Walk	6,043							
	Total	**29,818**							
No Relief Road	Car	-	24238	23015	21792	-	24284	23343	22102
	PT	-	3613	3816	3988	-	3685	3890	4062
	Cycle	-	1548	1744	1940	-	1538	1737	1936
	Walk	-	8528	9484	10441	-	8428	9399	10370
	Total	**-**	**37927**	**38059**	**38161**	**-**	**38235**	**38369**	**38470**
Eastern Relief Road	Car	-	24238	23015	21792	-	-	-	-
	PT	-	3613	3816	3988	-	-	-	-
	Cycle	-	1548	1744	1940	-	-	-	-
	Walk	-	8528	9484	10441	-	-	-	-
	Total	**-**	**37927**	**38059**	**38161**	**-**	**-**	**-**	**-**
Western Relief Road	Car	-	-	-	-	-	24284	23343	22102
	PT	-	-	-	-	-	3685	3890	4062
	Cycle	-	-	-	-	-	1538	1737	1936
	Walk	-	-	-	-	-	8428	9399	10370
	Total	**-**	**-**	**-**	**-**	**-**	**38235**	**38369**	**38470**

Table 4.2 Pm Pre DIADEM forecast person trip totals

Scheme	Mode	Demand Scenario							
		Housing Option 3				Housing Option 4			
		NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
Base	Car	21,053							
	PT	2,025							
	Cycle	863							
	Walk	8,365							
	Total	**32,306**							
No Relief Road	Car	-	25286	24047	22803	-	25580	24326	23066
	PT	-	2675	2881	3056	-	2736	2944	3119
	Cycle	-	1556	1756	1955	-	1547	1749	1950
	Walk	-	11211	12183	13155	-	11122	12106	13090
	Total	**-**	**40728**	**40867**	**40969**	**-**	**40985**	**41125**	**41225**
Eastern Relief Road	Car	-	25286	24047	22803	-	-	-	-
	PT	-	2675	2881	3056	-	-	-	-
	Cycle	-	1556	1756	1955	-	-	-	-
	Walk	-	11211	12183	13155	-	-	-	-
	Total	**-**	**40728**	**40867**	**40969**	**-**	**-**	**-**	**-**
Western Relief Road	Car	-	-	-	-	-	25580	24326	23066
	PT	-	-	-	-	-	2736	2944	3119
	Cycle	-	-	-	-	-	1547	1749	1950
	Walk	-	-	-	-	-	11122	12106	13090
	Total	**-**	**-**	**-**	**-**	**-**	**40985**	**41125**	**41225**

4.3 The tables show how demand changes from car to shift to PT, cycle and walk. The increase in modal transfer from car to sustainable transport can be clearly seen in both peak periods for each scenario with scenario 3 having the largest transfer at 20%.

4.4 Tables 4.3 and 4.4 show the post DIADEM forecast person trips for car, public transport, cycle and walk demand matrices obtained from demand model for each modelled scenario for the AM and PM models respectively.

Table 4.3 AM Post DIADEM forecast person trip totals

Scheme	Mode	Demand Scenario							
		Housing Option 3				Housing Option 4			
		NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
Base	Car	19,921							
	PT	3,005							
	Cycle	850							
	Walk	6,043							
	Total	**29,818**							
No Relief Road	Car	27024	24466	23204	22107	27126	24767	23525	22362
	PT	3009	3175	3295	3508	3072	3245	3447	3583
	Cycle	1208	1567	1580	1950	1201	1574	1770	1964
	Walk	6976	8739	8876	10616	6855	8668	9644	10578
	Total	**38216**	**37947**	**36955**	**38181**	**38254**	**38254**	**38386**	**38487**
Eastern Relief Road	Car	27195	24632	25598	22320	-	-	-	-
	PT	2934	3123	3212	3454	-	-	-	-
	Cycle	1186	1562	1524	1940	-	-	-	-
	Walk	6901	8635	8907	10473	-	-	-	-
	Total	**38216**	**37952**	**39241**	**38187**	**-**	**-**	**-**	**-**
Western Relief Road	Car	-	-	-	-	27293	24912	23699	22566
	PT	-	-	-	-	3008	3191	3398	3531
	Cycle	-	-	-	-	1185	1549	1747	1938
	Walk	-	-	-	-	6775	8608	9549	10459
	Total	**-**	**-**	**-**	**-**	**38260**	**38260**	**38393**	**38494**

Table 4.4 Pm Post DIADEM forecast person trip totals

Scheme	Mode	Demand Scenario							
		Housing Option 3				Housing Option 4			
		NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
Base	Car	21,053							
	PT	2,025							
	Cycle	863							
	Walk	8,365							
	Total	**32,306**							
No Relief Road	Car	28042	25448	24214	23064	28126	25702	24459	23293
	PT	2208	2404	2602	2749	2263	2463	2658	2809
	Cycle	1191	1553	1750	1938	1204	1577	1772	1961
	Walk	9548	11333	12311	13229	9410	11254	12243	13173
	Total	**40989**	**40738**	**40877**	**40980**	**41003**	**40996**	**41132**	**41236**
Eastern Relief Road	Car	28228	25622	24464	23313	-	-	-	-
	PT	2155	2309	2552	2701	-	-	-	-
	Cycle	1144	1464	1731	1921	-	-	-	-
	Walk	9468	11352	12141	13055	-	-	-	-
	Total	**40994**	**40747**	**40888**	**40990**	**-**	**-**	**-**	**-**
Western Relief Road	Car	-	-	-	-	28360	25881	24661	24800
	PT	-	-	-	-	2170	2411	2610	2758
	Cycle	-	-	-	-	1136	1537	1731	1915
	Walk	-	-	-	-	9343	11172	12141	13026
	Total	**-**	**-**	**-**	**-**	**41008**	**41001**	**41143**	**42499**

4.5 Comparing the No Relief Road options AM pre and post DIADEM assignments it can be seen that the car and walk demand matrices increase and the PT demand decreases. In other words the variable demand model is shifting trips back onto the car and walk matrix as the demand for travel by these modes is seen more favourable than the demand to use PT.

4.6 Looking at the East and West Relief Road demand matrices, as capacity increases in the model as a result of the implementation of a relief road the demand for travel by car becomes greater than that in the no relief road scenario. Demand trips that are using PT, walk and cycle in the no relief road scenario are higher than the east and west scenario implying that trips are shifting back to car with the implementation of a relief road.

4.7 The PM peak follows a similar pattern to the AM peak with a shift back to car and an increase in walk from PT between the pre and post DIADEM scenarios and increase in car demand between the No Relief Road and East and Western Relief Road scenario.

5.0 MODEL PERFORMANCE STATISTICS

5.1 Model performance statistics were collected for all modes after assigning the demand matrices obtained from the demand model.

Non – Highway Models

5.2 The following service indicators are used to assess the PT, cycle and walk model performance:-

- Total Distance (measured in person-kilometres)
- Total Time (measured in person-hours)

5.3 The comparison of total distance travelled within the modelled network (Herefordshire County) for the AM model is shown in table 5.1.

Table 5.1 Am Peak – Comparison of Total Distance Travelled (person-kilometres)

Scheme	Mode	Sub-Mode	Demand Scenario							
			Housing Option 3				Housing Option 4			
			NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
No Relief Road	PT	Bus	8093	8771	8655	9744	8317	9029	9413	10039
		Coach	420	443	430	442	401	423	420	430
		Rail	27883	29426	29391	29504	27664	29316	29334	29340
		Sub-Total	**36396**	**38640**	**38476**	**39690**	**36382**	**38768**	**39167**	**39809**
	Cycle		2354	4685	4744	7084	2478	4907	6148	7390
	Walk		11803	22036	22514	32560	11579	22273	27770	33199
	Total		**50553**	**65361**	**65734**	**79334**	**50439**	**65948**	**73085**	**80398**
Eastern Relief Road	PT	Bus	7891	8552	8392	9504	8038	-	-	-
		Coach	418	431	422	429	435	-	-	-
		Rail	27238	29246	28662	29297	27240	-	-	-
		Sub-Total	**35547**	**38229**	**37477**	**39230**	**35712**	**-**	**-**	**-**
	Cycle		2285	4645	4548	6983	2340	-	-	-
	Walk		11604	21748	22185	32067	11321	-	-	-
	Total		**49436**	**64622**	**64210**	**78280**	**49373**			
Western Relief Road	PT	Bus	7918	-	-	-	8114	8846	9206	9826
		Coach	408	-	-	-	393	407	400	406
		Rail	27605	-	-	-	27446	29040	29111	29151
		Sub-Total	**35932**	**-**	**-**	**-**	**35953**	**38293**	**38718**	**39383**
	Cycle		2332	-	-	-	2425	4754	5974	7180
	Walk		11662	-	-	-	11397	21835	27210	32527
	Total		**49926**				**49775**	**64882**	**71902**	**79090**

5.4 For the non-car modes, it can be seen that the addition of a relief road, on either alignment, leads to a slight fall in the distance travelled by public transport, cycle and walk. The comparison for the PM model is shown in table 5.2.

Table 5.2 Pm Peak – Comparison of Total Distance Travelled (person-kilometres)

Scheme	Mode	Sub-Mode	Demand Scenario							
			Housing Option 3				Housing Option 4			
			NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
No Relief Road	PT	Bus	6867	7612	8121	8726	7165	7874	8402	9038
		Coach	0	0	0	0	0	0	0	0
		Rail	14643	16761	16853	16937	14686	16895	17009	17113
		Sub-Total	**21509**	**24372**	**24974**	**25663**	**21851**	**24768**	**25411**	**26151**
	Cycle		2386	4582	5735	6865	2546	4831	6015	7180
	Walk		15372	25405	30669	35776	15288	25776	31226	36541
	Total		**39267**	**54359**	**61378**	**68304**	**39685**	**55375**	**62652**	**69872**
Eastern Relief Road	PT	Bus	6530	7205	7825	8453	6659	-	-	-
		Coach	0	0	0	0	0	-	-	-
		Rail	14478	16409	16883	16893	14359	-	-	-
		Sub-Total	**21009**	**23614**	**24707**	**25345**	**21018**	**-**	**-**	**-**
	Cycle		2235	4251	5644	6761	2330	-	-	-
	Walk		15079	24799	29966	34996	-14924	-	-	-
	Total		**38323**	**52664**	**60317**	**67102**	**38272**			
Western Relief Road	PT	Bus	6384	-	-	-	6605	7414	7930	8561
		Coach	0	-	-	-	0	0	0	0
		Rail	14635	-	-		14662	17015	17108	17217
		Sub-Total	**21019**	**-**	**-**	**-**	**21266**	**24429**	**25038**	**25778**
	Cycle		2318	-	-	-	2435	4631	5764	6891
	Walk		15171	-	-	-	15037	25123	30364	35504
	Total		**38508**				**38738**	**54183**	**61166**	**68173**

5.5 As in the AM Model, it can be seen that in the PM model, the addition of a Relief Road leads to a light fall in passenger kilometres for the public transport, cycle and walk modes. Passenger kilometres travelled by rail however increase slightly between the No Relief Road and Western Relief Road scenarios.

5.6 Both the AM and PM peak models show an increase in total passenger kilometres between scenarios 1 and 3 as would be expected as the levels of modal shift increases.

5.7 Table 5.3 and table 5.4 show the comparison of total travel time by non-car modes across scenarios and time periods.

Table 5.3 AM Peak Comparison of Travel Time (person-hours)

Scheme	Mode	Sub-Mode	Demand Scenario							
			Housing Option 3				Housing Option 4			
			NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
No Relief Road	PT	Bus	584	624	630	696	606	649	678	724
		Coach	6	6	6	6	6	6	6	6
		Rail	313	333	333	334	311	333	333	333
		Sub-Total	**902**	**963**	**969**	**1037**	**922**	**988**	**1017**	**1064**
	Cycle		157	312	316	472	165	327	410	493
	Walk		2951	5509	5629	8017	2895	5568	6942	8300
	Total		**4010**	**6784**	**6914**	**9526**	**3982**	**6883**	**8369**	**9857**
Eastern Relief Road	PT	Bus	572	614	615	686	587	-	-	-
		Coach	6	6	6	6	6	-	-	-
		Rail	305	331	325	332	306	-	-	-
		Sub-Total	**883**	**951**	**946**	**1024**	**899**	**-**	**-**	**-**
	Cycle		152	310	303	466	156	-	-	-
	Walk		2901	5437	5546	5658	2830	-	-	-
	Total		**3937**	**6698**	**6797**	**7148**	**3885**			
Western Relief Road	PT	Bus	572	-	-	-	592	637	665	711
		Coach	6	-	-	-	6	6	6	6
		Rail	310	-	-	-	309	330	331	332
		Sub-Total	**888**	**-**	**-**	**-**	**906**	**973**	**1002**	**1048**
	Cycle		155	-	-	-	162	317	398	479
	Walk		2916	-	-	-	2849	5459	6802	8132
	Total		**3959**	**-**	**-**	**-**	**3917**	**6749**	**8202**	**9659**

Table 5.4 PM Peak Comparison of Travel Time (person-hours)

Scheme	Mode	Sub-Mode	Demand Scenario							
			Housing Option 3				Housing Option 4			
			NO SO	SO1	SO2	SO3	NO SO	SO1	SO2	SO3
No Relief Road	PT	Bus	376	402	432	464	402	426	457	491
		Coach	0	0	0	0	0	0	0	0
		Rail	157	183	184	184	157	184	185	186
		Sub-Total	**533**	**584**	**616**	**649**	**559**	**610**	**643**	**677**
	Cycle		159	305	382	458	170	322	401	479
	Walk		3843	6351	7667	8944	3822	6444	7807	9135
	Total		**4535**	**7240**	**8665**	**10051**	**4551**	**7376**	**8851**	**10968**
Eastern Relief Road	PT	Bus	363	388	426	459	380	-	-	-
		Coach	0	0	0	0	0	-	-	-
		Rail	155	179	184	184	154	-	-	-
		Sub-Total	**518**	**567**	**609**	**643**	**534**	**-**	**-**	**-**
	Cycle		149	283	376	451	155	-	-	-
	Walk		3770	6200	7492	8749	3731	-	-	-
	Total		**4437**	**7050**	**8477**	**9843**	**4420**			
Western Relief Road	PT	Bus	355	-	-	-	376	406	437	469
		Coach	0	-	-	-	0	0	0	0
		Rail	157	-	-	-	157	185	186	188
		Sub-Total	**512**	**-**	**-**	**-**	**533**	**591**	**623**	**657**
	Cycle		155	-	-	-	162	309	384	459
	Walk		3793	-	-	-	3759	6281	7591	8876
	Total		**4459**				**4455**	**7181**	**8598**	**9335**

5.8 Again, it can be seen that there is a small reduction in the total travel time for the non-car modes when a Relief Road is added to each demand scenario and that the total travel time for non-car modes increases as the level of modal transfer rises between 10% and 20%.

Highway Model

5.9 The latest highway models have assessed different housing allocation scenarios with No Relief Road and a Relief Road to the West and to the East for the three proposed sustainable options. A comparison has been based on network conditions using such measures as average speed, delays and queues in the network.

5.10 The comparisons of network performance for the AM and PM base and future year models are shown in Tables 5.5 to 5.7.

Table 5.5 Base Year (2008) – Summary of Highway Network Performance

Indicator	AM Peak	PM Peak
Total Time / hrs	1,923	2,183
Transient Queues / hrs	673	823
Over-Capacity Queues / hrs	20	82
Link Delays / hrs	31	29
Total Distance / km	61,348	63,310
Total Trips Loaded / pcu	15,802	16,414
Average Speed / kph	31.9	29.0

Table 5.6 2026 AM Peak – Summary of Highway Network Performance

Scheme	Indicators	Demand Scenario			
		No Sustainable Option	Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
No Relief Road Housing Option 3	Total Time / hrs	2866	2431	2387	2299
	Transient Queues / hrs	1136	901	890	865
	Over-Capacity Queues / hrs	83	16	28	9
	Link Delays / hrs	66	53.8	53	50.2
	Total Distance / km	80480	74617	71291	69235
	Total Trips Loaded / pcu	21664	19656	18789	18036
	Average Speed / kph	28.1	30.7	29.9	30.1
Eastern Relief Road Housing Option 3	Total Time / hrs	2516	2195	2396	2034
	Transient Queues / hrs	810	653	776	582
	Over-Capacity Queues / hrs	4	0	7	0
	Link Delays / hrs	93	76	89	73
	Total Distance / km	90622	83070	85306	78239
	Total Trips Loaded / pcu	21773	19778	20439	18189
	Average Speed / kph	36.0	37.8	35.6	38.5
Western Relief Road Housing Option 4	Total Time / hrs	2657	2323	2276	2161
	Transient Queues / hrs	892	722	712	648
	Over-Capacity Queues / hrs	11	0	9	1
	Link Delays / hrs	88	68.4	63	61
	Total Distance / km	94672	87023	83557	81472
	Total Trips Loaded / pcu	21842	19970	19135	18359
	Average Speed / kph	35.6	37.5	36.7	37.7

Table 5.7 2026 PM Peak – Summary of Highway Network Performance

Scheme	Indicators	Demand Scenario			
		No Sustainable Option	Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
No Relief Road Housing Option 3	Total Time / hrs	3088	2653	2571	2453
	Transient Queues / hrs	1214	997	983	946
	Over-Capacity Queues / hrs	216	142	104	63
	Link Delays / hrs	65	49	52	47
	Total Distance / km	81840	74952	72181	70325
	Total Trips Loaded / pcu	22278	20253	19409	18628
	Average Speed / kph	26.4	28.2	28.1	28.7
Eastern Relief Road Housing Option 3	Total Time / hrs	2772	2396	2295	2338
	Transient Queues / hrs	926	782	714	735
	Over-Capacity Queues / hrs	87	21	5	5
	Link Delays / hrs	103	79	85	91
	Total Distance / km	93518	85535	83790	84855
	Total Trips Loaded / pcu	22424	20384	19778	19778
	Average Speed / kph	33.7	35.7	36.5	36.3
Western Relief Road Housing Option 4	Total Time / hrs	2863	2515	2653	2547
	Transient Queues / hrs	977	835	876	832
	Over-Capacity Queues / hrs	71	25	55	39
	Link Delays / hrs	98	75	90	83
	Total Distance / km	97652	89479	91615	89793
	Total Trips Loaded / pcu	22467	20559	20462	19765
	Average Speed / kph	34.1	35.5	34.5	35.2

5.11 Comparison of the network statistics for the No Relief Road scenario with the base year model reveals how the model predicts conditions of the highway will change if the growth point housing and employment sites for Option 3 are built with No Relief Road. The results show that with no sustainable measures in place there is a worsening of travelling conditions. With average speeds falling from 31.9 to 28.1kph in the AM peak and from 29.0

to 26.4kph in the PM peak.

5.12 Comparing the No Relief Road options across the sustainable option scenarios you can see that the average network speeds improve with the sustainable option scenarios. Option 1 has the best average network speed in the AM peak of 30.7kph and Option 3 has the best average speed of 28.7kph in the PM peak. The average speeds for all the sustainable options in both peak periods however are still lower than the 2008 base year indicating a worsening of travelling conditions.

5.13 In the AM model time spent in transient queues and link delays are all forecast to increase from the base year across all sustainable options which leads to the fall in average network speeds. Time spent in over-capacity queues reduces with the implementation of the sustainable option to similar levels experienced in the base model but the average network speed is still lower than the base year.

5.14 A similar impact is forecast for the PM peak with transient queues, link delays and over capacity queues forecast to increase from the base year. The time spent in over capacity queues for sustainable Option 3 however reduces from 82 to 63 hours when compared to the base year but transient queues and link delays are still higher than the base year hence the overall average speed of the model is still lower than the base year albeit marginally at 28.7 compared to 29.0kph.

5.15 With a Relief Road in place, it can be seen that there is a marked improvement in congestion across all sustainable option scenarios when compared to the No Relief Road option and the base year option.

5.16 Looking at the most congested peak period, the PM peak, time spent in over capacity queues significantly reduce for the sustainable options to between 5 and 21 hours with an eastern alignment and 25 to 55 hours with a western alignment compared to between 63 and 142 hours with No Relief Road.

5.17 Combining both peak periods examination of the highway network summary statistics reveals that Sustainable Option 3 on the Eastern alignment gives the best overall network performance. It is noted that the difference between the east and west alignments and between the sustainable options are not significant.

5.18 It appears the main reason why sustainable Option 3 has a better overall network performance than the other two sustainable transport options is due to the smaller number of highway trips assigned onto the network due to the 20% modal transfer to PT, walk and cycle thus allowing for greater spare capacity in the model over and above that of the other two sustainable transport options

6.0 ANALYSIS OF HIGHWAY MODEL RESULTS

Impact of Relief Road

6.1 Analysis was undertaken to assess the impact a Relief Road has on the main roads in and around Hereford and the differences between each sustainable option package. Table 6.1 below show the total flows on the main roads in Hereford for the 2008 base year and the 2026 future year scenarios with and without the relief road for the AM and PM peak periods.

Table 6.1 AM and PM Total Vehicular Flows

2008 Base Year				
Road Type	**Road Name**	**Direction**	**AM**	**PM**
Trunk Road	**A49**	NB	1783	1823
		SB	1563	2085
Primary Road	**A4103**	EB	583	498
		WB	645	527
	A465	NB/EB	745	902
		SB/WB	761	621
	A438	NB/EB	865	706
		SB/WB	365	947
	A4110	NB	377	229
		SB	261	480
Non-Primary Road	**B4224**	EB	502	196
		WB	331	432
	B4399	EB	199	307
		WB	441	256

No Relief Road Scenario								
Road Type	**Road Name**	**Direction**	**Sustainable Option 1**		**Sustainable Option 2**		**Sustainable Option 3**	
			AM	**PM**	**AM**	**PM**	**AM**	**PM**
Trunk Road	**A49**	NB	2106	1898	2027	1956	1933	1982
		SB	1764	2137	1748	2084	1662	2156
Primary Road	**A4103**	EB	690	582	581	462	562	493
		WB	734	579	709	674	740	627
	A465	NB/EB	478	554	617	513	567	567
		SB/WB	327	238	245	170	260	176
	A438	NB/EB	1137	755	1149	725	1180	818
		SB/WB	243	999	350	1047	372	1080
	A4110	NB	429	515	420	578	407	609
		SB	341	197	408	353	360	404
Non-Primary Road	**B4224**	EB	687	284	647	368	627	410
		WB	500	698	570	599	549	554
	B4399	EB	255	374	244	354	284	371
		WB	383	271	379	251	376	265

East Relief Road Scenario								
Road Type	**Road Name**	**Direction**	**Sustainable Option 1**		**Sustainable Option 2**		**Sustainable Option 3**	
			AM	**PM**	**AM**	**PM**	**AM**	**PM**
Trunk Road	**A49**	NB	1700	1553	1651	1570	1475	1871
		SB	1206	1827	1183	1761	1055	1917
Primary Road	**A4103**	EB	580	535	577	474	563	482
		WB	705	579	775	693	740	650
	A465	NB/EB	435	564	494	455	460	501
		SB/WB	280	226	235	160	239	222
	A438	NB/EB	966	603	977	590	893	609
		SB/WB	491	909	592	933	552	778
	A4110	NB	370	420	373	422	352	370
		SB	298	306	342	362	283	481
Non-Primary Road	**B4224**	EB	378	277	426	303	400	363
		WB	529	571	556	527	518	511
	B4399	EB	204	318	197	354	195	336
		WB	395	341	394	265	371	230
West Relief Road Scenario								
Road Type	**Road Name**	**Direction**	**Sustainable Option 1**		**Sustainable Option 2**		**Sustainable Option 3**	
			AM	**PM**	**AM**	**PM**	**AM**	**PM**
Trunk Road	**A49**	NB	1951	1751	1861	1748	1725	1657
		SB	1446	2038	1438	1969	1332	1648
Primary Road	**A4103**	EB	567	581	525	477	495	402
		WB	787	495	780	601	760	486
	A465	NB/EB	484	533	617	493	572	389
		SB/WB	290	231	205	164	215	154
	A438	NB/EB	969	544	983	541	978	499
		SB/WB	453	734	449	757	495	718
	A4110	NB	402	392	396	401	400	286
		SB	325	429	381	484	361	332
Non-Primary Road	**B4224**	EB	555	226	529	380	509	276
		WB	484	662	552	583	558	451
	B4399	EB	237	349	228	345	245	228
		WB	368	202	356	181	330	163

6.2 The link flows with No Relief Road scenario were compared to that of West and East with each sustainable option package. The total flow comparison for each type of roads is shown in Tables 6.2 to 6.5.

Table 6.2 AM Comparison: East Relief Road Minus No Relief Road

Road Type	Road Name	Direction	East Relief Road Minus No Relief Road		
			Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
Trunk Road	A49	NB	-406	-376	-458
		SB	-558	-565	-607
Primary Road	A4103	EB	-110	-4	1
		WB	-29	66	0
	A465	NB/EB	-43	-123	-107
		SB/WB	-47	-10	-21
	A438	NB/EB	-171	-172	-287
		SB/WB	248	242	180
	A4110	NB	-59	-47	-55
		SB	-43	-66	-77
Non-Primary Road	B4224	EB	-309	-221	-227
		WB	29	-14	-31
	B4399	EB	-51	-47	-89
		WB	12	15	-5

Table 6.3 AM Comparison: West Relief Road Minus No Relief Road

Road Type	Road Name	Direction	West Relief Road Minus No Relief Road		
			Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
Trunk Road	A49	NB	-155	-166	-208
		SB	-318	-310	-330
Primary Road	A4103	EB	-123	-56	-67
		WB	53	71	20
	A465	NB/EB	6	0	5
		SB/WB	-37	-40	-45
	A438	NB/EB	-168	-166	-202
		SB/WB	210	99	123
	A4110	NB	-27	-24	-7
		SB	-16	-27	1
Non-Primary Road	B4224	EB	-132	-118	-118
		WB	-16	-18	9
	B4399	EB	-18	-16	-39
		WB	-15	-23	-46

Table 6.4 PM Comparison: East Relief Road Minus No Relief Road

Road Type	Road Name	Direction	East Relief Road Minus No Relief Road		
			Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
Trunk Road	A49	NB	-345	-386	-111
		SB	-310	-323	-239
Primary Road	A4103	EB	-47	12	-11
		WB	0	19	23
	A465	NB/EB	10	-58	-66
		SB/WB	-12	-10	46
	A438	NB/EB	-152	-135	-209
		SB/WB	-90	-114	-302
	A4110	NB	-95	-156	-239
		SB	109	9	77
Non-Primary Road	B4224	EB	-7	-65	-47
		WB	-127	-72	-43
	B4399	EB	-56	0	-35
		WB	70	14	-35

Table 6.5 PM Comparison: West Relief Road Minus No Relief Road

Road Type	Road Name	Direction	West Relief Road Minus No Relief Road		
			Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
Trunk Road	A49	NB	-147	-208	-325
		SB	-99	-115	-508
Primary Road	A4103	EB	-1	15	-91
		WB	-84	-73	-141
	A465	NB/EB	-21	-20	-178
		SB/WB	-7	-6	-22
	A438	NB/EB	-211	-184	-319
		SB/WB	-265	-290	-362
	A4110	NB	-123	-177	-323
		SB	232	131	-72
Non-Primary Road	B4224	EB	-58	12	-134
		WB	-36	-16	-103
	B4399	EB	-25	-9	-143
		WB	-69	-70	-102

6.2 The negative values show a decrease in link flows due to the Relief Road. The table clearly indicates that the Relief Road is providing benefit to the A49 and the majority of other primary and non primary roads in both peaks.

6.3 Sustainable Option 3 with the western relief road provides the greatest relief overall to the primary and non primary roads in the network particularly in the PM peak period. This is to be expected given the lower numbers of highway vehicles assigned onto the network as a result of a 20% modal shift. Looking at the eastern alignment there is very little difference between the sustainable option packages in both peak periods despite the changes in modal shift from car to public transport, cycle and walk.

Journey Time Analysis

6.4 During the construction of the Base Year models, a total of eight routes through the city were surveyed and average journey times for each route were obtained in order to provide an assessment of the impacts on typical journey times in Hereford in each of the future year highway models. These routes are shown in figure 5-2 of JMPs forecasting report and have been extracted for the purpose of this report to compare journey times for the different sustainable options between no relief road, an eastern relief road alignment and a western relief road alignment. Tables 6.6 to 6.7 show the comparison results.

Table 6.6 AM Peak – Comparison of Journey Times

Scheme	Average Modelled Journey Time / mm:ss					
	Route	Sustainable Options				
		2008 Base	H3NOSO	H3SO1	H3SO2	H3SO3
No Relief Road	1	19:40	29:11	25:43	26:12	26:47
	2	18:40	25:06	22:37	24:22	23:50
	3	22:01	26:56	24:33	26:57	26:05
	4	21:44	24:06	21:35	24:05	23:40
	5	-	-	-	-	-
	6	18:37	35:17	32:08	32:01	31:26
	7	22:05	26:34	22:30	23:01	26:02
	8	20:16	27:49	25:12	25:16	25:09
	Total	**143:03**	**194:59**	**174:18**	**181:54**	**182:59**
Western Relief Road	**Route**	**H4NOSO**		**H4SO1**	**H4SO2**	**H4SO3**
	1	25:59		23:32	24:32	23:37
	2	21:49		20:40	21:11	20:26
	3	24:31		23:22	25:42	24:39
	4	21:21		20:03	23:11	22:43
	5	-		-	-	-
	6	30:16		28:48	28:31	27:34
	7	22:44		19:23	22:05	20:11
	8	24:18		22:33	23:06	22:30
	Total	**170:58**		**158:21**	**168:18**	**161:40**
Eastern Relief Road	**Route**	**H3NOSO**		**H3SO1**	**H3SO2**	**H3SO3**
	1	23:13		23:00	23:54	22:43
	2	21:33		20:29	22:34	20:50
	3	22:52		21:57	24:23	22:57
	4	20:04		19:24	22:01	21:27
	5	-		-	-	-
	6	29:19		27:41	29:11	26:51
	7	21:57		18:37	22:16	19:16
	8	23:10		21:50	23:23	22:08
	Total	**162:08**		**152:58**	**167:42**	**156:12**

Table 6.7 PM Peak – Comparison of Journey Times

Scheme	Average Modelled Journey Time / mm:ss					
	Route	Sustainable Options				
		2008 Base	H3NOSO	H3SO1	H3SO2	H3SO3
No Relief Road	1	22:12	34:43	31:56	31:43	30:04
	2	18:53	27:19	23:56	24:42	23:49
	3	23:01	29:09	26:04	27:20	26:13
	4	28:34	26:40	26:17	28:45	27:14
	5	-	-	-	-	-
	6	18:20	41:39	35:07	35:18	33:35
	7	14:11	28:43	26:33	26;01	28:19
	8	21:43	29:26	26:03	27:45	26:30
	Total	**156:54**	**217:40**	**195:56**	**201:34**	**195:44**
Western Relief Road	**Route**	**H4NOSO**		**H4SO1**	**H4SO2**	**H4SO3**
	1	28:49		26:33	27:36	27:05
	2	22:59		21:29	22:11	21:36
	3	25:12		23:01	25:55	26:25
	4	23:15		23:33	26:36	25:02
	5	-		-	-	-
	6	36:14		31:18	32:43	33:05
	7	24:23		21:11	24:31	23:55
	8	26:45		24:28	26:17	26:10
	Total	**187:36**		**171:33**	**185:49**	**183:18**
Eastern Relief Road	**Route**	**H3NOSO**		**H3SO1**	**H3SO2**	**H3SO3**
	1	27:22		25:32	25:48	23:38
	2	21:50		20:10	20:42	20:20
	3	23:43		21:54	23:51	23:28
	4	22:31		22:07	24:04	23:46
	5	-		-	-	-
	6	33:07		29:19	29:13	27:47
	7	24:43		22:23	20:26	20:12
	8	24:39		23:02	23:55	22:42
	Total	**177:55**		**164:27**	**167:59**	**161:53**

6.5 It can be seen from the total times shown in the tables that all modelled scenarios perform worse than the 2008 base year. During the PM peak for a 2026 future year the additional total delays are predicted to be one hour more than the 2008 base year.

6.6 The additional demand associated with the housing & employment options have led to higher journey times for the No Relief Road Option without sustainable option packages when compared to the three sustainable option packages. The same pattern occurs for the West & East Relief Road options with sustainable option packages having an overall lower journey time than the no sustainable option packages.

6.7 Provision of the Western Relief Road has resulted in a reduction of all journey times for both sustainable options 1 to 3 and the no sustainable option when compared to the No Relief Road options. Sustainable option 1 has the best journey time in the AM peak of 158 minutes & 21 seconds, 15 minutes 57 seconds quicker than the lowest journey time produced with No Relief Road. In the PM the lowest journey time is 171 minutes & 33 seconds which is 24 minutes & 11 seconds quicker than the lowest journey time produced with No Relief Road.

6.8 In both the AM & PM peaks of the Eastern Relief Road scenario, it can be seen that journey

time's in sustainable options 1 to 3 and the no sustainable option are lower than all options in the No Relief Road scenario. In the AM peak sustainable option 1 offers the best journey time of 152 minutes & 58 seconds and in the PM peak sustainable option 3 has the lowest journey time overall at 161 minutes & 53 seconds which are 25 minutes & 42 seconds and 33 minutes & 51 seconds lower than the corresponding lowest overall journey time recorded for the Relief Road options.

6.9 The results obtained support the data show in Tables 5.6 & 5.7 which show that provision of a Relief Road improves the overall average network speed when compared to the No Relief Road scenario.

Over Capacity Junctions

6.10 In the highway model, delays and queues at junctions are modelled explicitly. A junction that is operating at, or close to, its nominal capacity is likely to impose delays on vehicles using it.

6.11 The volume-to-capacity ratio is often used to denote how close to capacity a particular junction is. As the techniques used to estimate a junction's capacity were derived using statistical modelling techniques, there is always a degree of uncertainty regarding a calculation of a junction's capacity, thus for this reason, a junction operating at 85% of its calculated capacity is generally considered to be congested, as although it might appear to be operating within its calculated capacity, its actual capacity could be somewhat lower.

6.12 The SATURN models were interrogated in order to obtain the volume-to-capacity ratio at each modelled junction. Junctions operating at 85% of capacity and above are divided into three bands:-

- 85% to 100% - operating at or close to capacity, delays are to be expected;
- 100% to 120% - operating over-capacity, delays are likely to be considerable; and
- 120% and over – operating significantly over-capacity, delays will be considerable and could lead to widespread queuing.

6.13 The numbers of modelled junctions within each volume-to-capacity band are shown in Table 6.8 for the AM peak models and in table 6.9 for the PM peak models. Table 6.10 shows the over capacity for both peaks combined.

Table 6.8 Junctions Over Capacity – AM Peak

Volume to Capacity Ratio	**No Sustainable Option**				**Sustainable Option 1**			**Sustainable Option 2**			**Sustainable Option 3**		
	2008 Base	**No RR**	**East RR**	**West RR**	**No RR**	**East RR**	**West RR**	**No RR**	**East RR**	**West RR**	**No RR**	**East RR**	**West RR**
85% to 100%	14	35	20	10	26	11	19	26	20	15	21	8	13
100% to 120%	5	15	4	10	7	1	2	5	3	4	10	1	4
120% and over	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**19**	**50**	**24**	**29**	**33**	**12**	**21**	**31**	**23**	**19**	**31**	**9**	**17**

Table 6.9 Junctions Over Capacity – PM Peak

Volume to Capacity Ratio	No Sustainable Option				Sustainable Option 1			Sustainable Option 2			Sustainable Option 3		
	2008 Base	No RR	East RR	West RR	No RR	East RR	West RR	No RR	East RR	West RR	No RR	East RR	West RR
85% to 100%	20	22	19	25	19	18	21	10	17	10	14	12	13
100% to 120%	9	27	11	8	16	5	7	16	4	11	16	4	9
120% and over	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**29**	**49**	**30**	**33**	**35**	**23**	**28**	**26**	**21**	**21**	**30**	**16**	**22**

Table 6.10 Junctions Over Capacity – Both Peaks

Volume to Capacity Ratio	No Sustainable Option				Sustainable Option 1			Sustainable Option 2			Sustainable Option 3		
	2008 Base	No RR	East RR	West RR	No RR	East RR	West RR	No RR	East RR	West RR	No RR	East RR	West RR
85% to 100%	34	57	39	44	45	29	40	36	37	25	35	20	26
100% to 120%	14	42	15	18	23	6	9	21	7	15	26	5	13
120% and over	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**48**	**99**	**54**	**62**	**68**	**35**	**49**	**57**	**44**	**40**	**61**	**25**	**39**

6.14 Examination of these results, show that provision of a Relief Road on either alignment leads to a reduction in the number of over-capacity junctions. The eastern alignment has slightly less over-capacity junctions than the western alignment in all the sustainable option scenarios.

6.15 Figures 6.1 and 6.2 below show the location of the over capacity junctions for the no relief road scenario cumulative of all sustainable options for the AM and PM peaks respectively.

Figure 6.1 Junctions operating at >85% of capacity – AM Peak

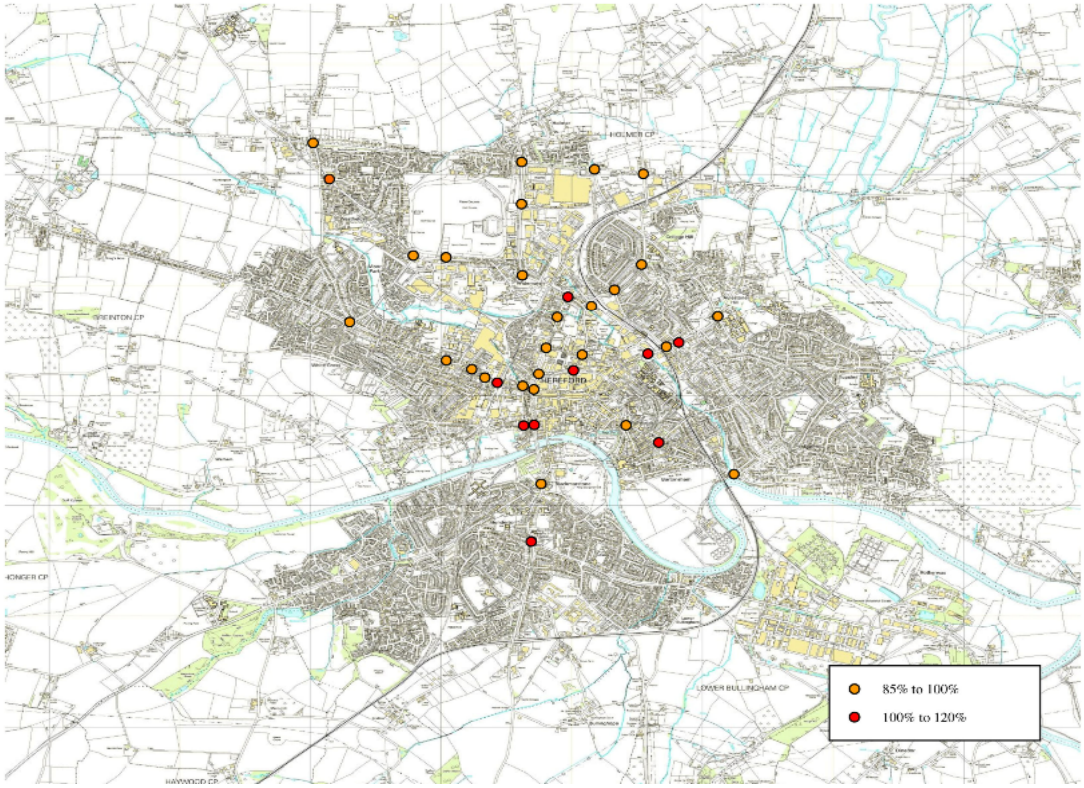
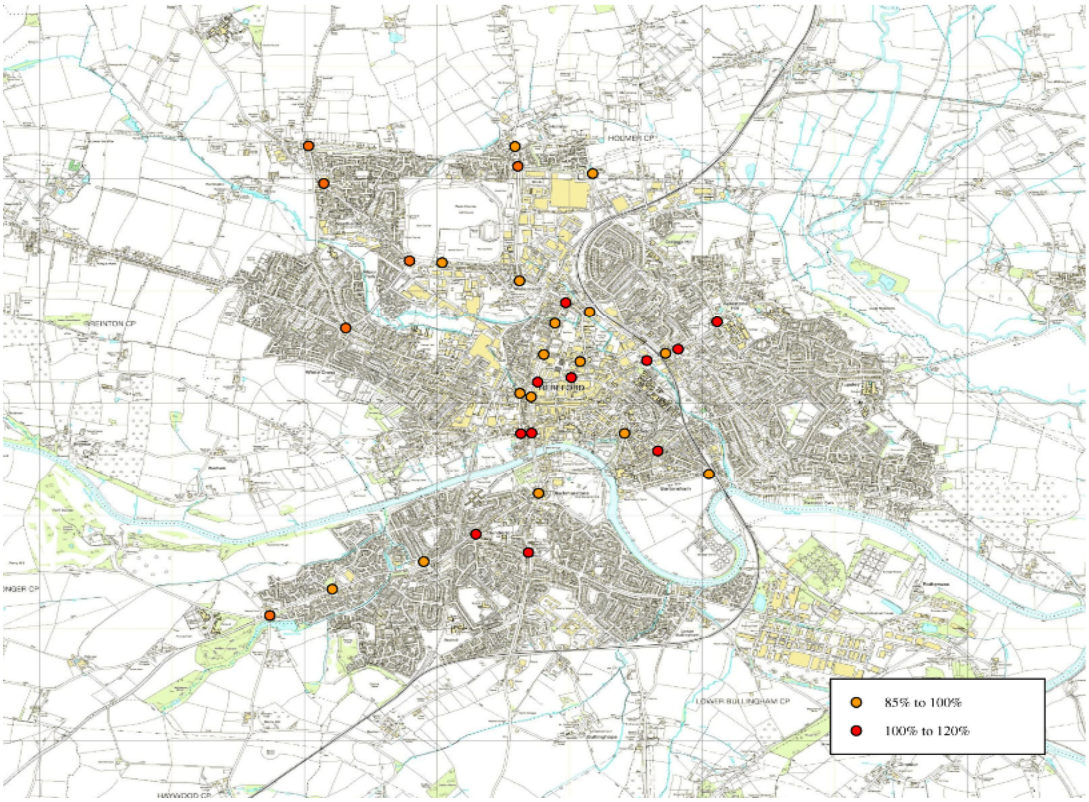


Figure 6.2 Junctions operating at >85% of capacity – PM Peak



6.16 The figures show the locations of the worst performing junctions, with the worst delays located on the eastern and central areas of the Hereford network such as New Market Street, Greyfriars Bridge and at junctions along the A465 Aylestone Hill and Commercial Road. The addition of an alignment therefore benefits these junctions and improves the overall network performance with the eastern alignment relieving more junctions than the western alignment. This is shown by the fact that the eastern alignment has less over capacity junctions than the western alignment.

6.17 Each of the sustainable options reduces the number of junctions over capacity as compared to no sustainable option. There is again little to choose between the three sustainable options in terms of which is best at reducing the largest number of over capacity junctions in the network.

6.18 The No Relief Road scenario sustainable Option 2 shows the lowest number of total junctions over capacity of 57. This compares well to the total given for the do minimum scheme without housing options (shown in table 5-17 of JMPs forecasting report) of 62 junctions over capacity in the network, however both scenarios still have over 20 junctions with a capacity above 100% in the highway model indicating a congested network. The corresponding figures for the East and West alignments show a marked improvement with only 7 and 15 junctions with a capacity above 100% respectively.

7.0 ECONOMICS

7.1 Currently no economic assessment of the scheme option using the current multi modal model has been undertaken in accordance with current guidance using the TUBA (Transport User Benefit Appraisal) software program. As the work undertaken so far has been only to assess the broadly defined transport and development strategies identified for Hereford a full economic assessment for all the various scenarios was not deemed necessary.

7.2 The determination of the preferred combinations of sustainable options, housing and Relief Road packages was undertaken by calculating the generalised cost of travel in each highway network. The total cost of travel was calculated by taking into account the time spent travelling (summed over all modelled vehicles) and the distance travelled (again summed over all vehicles). In effect, the travel cost was a combination of time and distance. This means that the option which produced the lowest overall travel time was not necessarily the option which produces the lowest overall cost of travel. The costs of the AM peak model were added to those of the PM peak model and no future year inter peak model has been undertaken.

7.3 For the situation without a Relief Road, the total generalised costs of travel are shown in Table 7.1.

Table 7.1 Total Costs of Travel – No Relief Road

Period	Total Generalised Cost of Travel / Hours of Generalised Time (£s)			
	No Sustainable Option Housing Option 3	**Sustainable Option 1 Housing Option 3**	**Sustainable Option 2 Housing Option 3**	**Sustainable Option 3 Housing Option 3**
AM	17,743	17,117	16,196	19,970
PM	19,010	18,353	18,527	21,007
Total	36,753	35,470	34,723	40,977
Period	**No Sustainable Option Housing Option 4**	**Sustainable Option 1 Housing Option 4**	**Sustainable Option 2 Housing Option 4**	**Sustainable Option 3 Housing Option 4**
AM	18,019	17,406	17,658	20,277
PM	19,435	18,702	18,905	21,421
Total	37,454	36,108	36,563	41,698

7.4 Table 7.1 shows that in the situation without the Relief Road, the option that provides the lowest overall cost of travel is Sustainable Option 2 with Housing Option 3. Sustainable Option 3 has a higher cost of travel than all other options including no sustainable option with both Housing Options 3 and 4.

7.5 With a Relief Road on an Eastern Alignment with Housing Option 3, the total costs of travel are shown in Table 7.2.

Table 7.2 Total Costs of Travel – Eastern Relief Road with Housing Option 3

Period	Total Generalised Cost of Travel / Hours of Generalised Time (£s)			
	No Sustainable Option	Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
AM	16,430	16,087	16,534	17,948
PM	17,412	17,024	17,081	18,751
Total	33,842	33,111	33,615	36,699

7.6 Table 7.2 shows that the sustainable Option 1 package provides the lowest overall travel cost with the Eastern Relief Road. Sustainable Option 3 package has a higher overall total cost of travel than the no sustainable option package.

7.7 With a Relief Road on a Western Alignment and housing Option 4, the total costs of travel are as shown in Table 7.3.

Table 7.3 Total Costs of Travel – Western Relief Road with Housing Option 4

Period	Total Generalised Cost of Travel / Hours of Generalised Time (£s)			
	No Sustainable Option	Sustainable Option 1	Sustainable Option 2	Sustainable Option 3
AM	16,919	16,520	16,754	18,557
PM	17,896	17,518	17,720	19,709
Total	34,815	34,038	34,474	38,266

7.8 Sustainable Option 1 provides the lowest overall travel cost with a Western Relief Road in place. Like the Eastern relief road scenario sustainable option 3 has the highest overall cost of travel than all other options. Of all the modelled scenarios, the situation with Sustainable Option 1 with the Eastern Alignment provides the lowest overall travel cost.

7.9 The results show that the greater the number of sustainable packages the greater the travel cost as shown with Sustainable Option 3 which has the highest overall travel cost of all packages including the no sustainable option. This is believed to be caused by junction delays and worsening travel times as a result of increased bus lanes in the highway network particularly on the A49 through the city centre.

7.10 It should be noted the difference between the overall cost of travel between the east and west alignments is marginal. Sustainable Option 1 and Sustainable Option 2 packages also have very similar costs of travel. The overall cost of travel for a No Relief Road option are higher than the cost of travel for a east or western alignment when comparing each individual sustainable transport scenario.

8.0 CONCLUSIONS

8.1 This report has described the methodology to model sustainable transport option packages with and without a Hereford Relief Road in conjunction with housing development options in 2026 using the existing Hereford Multi-Modal Model constructed by the transport consultants JMP.

8.2 Three sustainable option packages have been modelled each with different levels of investment in Herefords sustainable transport network and measures to manage demand for car use.

8.3 Forecasts have been produced for a single future year of 2026 for an AM and PM peak period. Each sustainable option has been assigned to three different future year networks and scenarios. These are a No Relief Road scenario with housing allocations Options 3 and 4, a Relief Road with an eastern alignment and housing Option 3 allocations and a western Relief Road with housing Option 4 allocations.

8.4 The Variable Demand Modelling assignments showed that for each sustainable transport option that despite a modal transfer of trips from car trips to PT, cycle and walk trips some trips would shift back to use car as a form of transport. The greatest shift occurred between PT and car as the model predicts that some PT trips have a higher cost of travel than the equivalent car trip.

8.5 Provision for sustainable options are forecast to provide some relief for the congestion problems experienced in Hereford. Provision of a Relief Road on either east or west alignments greatly increases the benefits. In overall performance terms with a Relief Road, conditions on the highway network are in the majority of cases better than conditions under the Do-Minimum scenario however for a No Relief Road situation even with sustainable transport measures in place this is not always the case.

8.6 Sustainable option packages improve the overall journey times recorded in the model as compared to the no sustainable transport options. The sustainable options recorded overall journey time across the eight critical journey time routes through and across the city with no relief road is higher than the 2008 base year scenario by up to one hour in the PM peak the most congested peak hour. The addition of a relief road improves the overall journey times by over 30 minutes, when compared to the best sustainable package with no relief road, during the most congested peak hour.

8.7 Of the sustainable options option 1 performs best in terms of delay as the greater sustainable investment includes an overall reduction in network capacity to support the measure. Of the relief road options, the eastern routes perform best in terms of reducing delay within the city. Many of the junctions that are sensitive to queues and delay in the model are on the east side of the City and as such the eastern relief road has the greatest improvement in these areas, resulting in the overall best results.

8.8 Sustainable Option 3 has the highest overall cost of travel than all other sustainable transport scenarios. The Sustainable Option 3 model shows a greater propensity for highway traffic shifting routes and travelling greater distances with longer journey times across the network. One of the main reasons for this was the provision of bus lanes on the A49 and the A465 to Belmont Road roundabout which resulted in traffic re-routing to alternate routes and destinations that had a smaller cost of travel in terms of time and distance.

8.9 It should also be noted that that the model does not show that the modal shift assumed can be achieved and in the case of Sustainable Option 3 the 20% modal transfer of trips from car, cycle and walk and the provision of bus lanes on the A49 could be difficult to achieve in

practice in terms of changing peoples travel behaviour and the current Highways Agency stance of not allowing bus lanes on the A49.

8.10 No full economic assessment (using TUBA) has currently been undertaken comparing the different sustainable transport options with and without the Eastern / Western Relief Road. In terms of the overall cost of travel it is Sustainable Option 1 with an eastern alignment that has the lowest cost of travel however the range of results are narrow and there is no clear option over another. The No Relief Road costs of travel are however higher than the Relief Road scenarios.

8.11 It is clear that provision of sustainable transport options improves the congestion of Hereford with the housing options in place but with No Relief Road the highway network is still congested and there is no guarantee such sustainable mode shift could be achieved. The provision of a Relief Road combined with sustainable packages significantly improves the network performance of Hereford and greatly reduces the congestion within Hereford city centre to levels over and above a do minimum scenario with the housing options in place. The overall benefits between an eastern alignment and western alignment are marginal.