HEREFORDSHIRE COUNCIL

HEREFORD RELIEF ROAD

Interim Forecasting Report

Revised Eastern Route Options

March 2011

THE TRANSPORTATION CONSULTANCY

HEREFORDSHIRE COUNCIL

HEREFORD RELIEF ROAD

INTERIM FORECASTING REPORT

REVISED EASTERN ROUTE OPTIONS

MARCH 2011

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HEREFORD RELIEF ROAD INTERIM FORECASTING REPORT

REVISED EASTERN ROUTE OPTIONS

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1.0 INTRODUCTION

Introduction

1.1 In September 2010, and as part of the Council's Core Strategy evidence base, a 'Hereford Relief Road Study of Options' report was prepared. The purpose of the study being to identify the engineering and environmental advantages and disadvantages associated with a western or eastern Relief Road and testing various packages of sustainable transport options. The conclusion of the study, which assessed possible route corridors around the city, recommended an inner western corridor to be included within the 'Preferred option: Hereford' document which was published for consultation in autumn 2010.

1.2 This further study, commissioned by Herefordshire Council (HC), considers the traffic implications of using a revised eastern route corridor with the same growth as proposed within the 'Preferred Options: Hereford' and also with reduced growth. The findings are compared to the western inner corridor, as currently proposed. This study examines the findings of the removal of the Lugg Meadows Corridor from the Eastern alignment between the A4103 and A438. The future development options used in the report were identified in the Hereford Multi Modal Model Forecasting Report produced by JMP consultants on behalf of HC and the Highways Agency (HA) and the interim sustainable options report produced by TPi consultants.

1.3 The Preferred Option: Hereford report identified a Western Relief Road and Housing Option 4 with Sustainable Transport Option 3 package. Four scenarios have been proposed as part of the revised eastern route options and the results have been compared to this preferred option scenario.

1.4 The Sustainable Transport Option 3 packages analysed in the interim sustainable options report included sustainable transport measures on the A49 which were forecast to be implemented with the construction of a Relief Road. This study examines the revised eastern route options and presumes no sustainable transport measures on the A49 can take place without the full construction of the relief road. Therefore the sustainable transport measures on the A49 have been removed from the sustainable transport option packages for all tested scenarios contained in this report.

1.5 The four scenario options that have been tested and analysed that form this report are summarised below and shown in Table 1.1:-

Scenario 1 Removal of Lugg Meadows Link from Eastern Alignment between A4103 and A438 with growth Housing Option 4 and Sustainable Transport Option 3 ('preferred option') but removal of A49 sustainable transport measures.

Scenario 2 As Scenario 1 with an upgraded link between A4103 and A438 based on the alignment of the existing Lumber Lane.

Scenario 3 As Scenario 1 with reduced housing (removal of Whitecross and Three Elms Sites).

Scenario 4 As Scenario 3 with Lumber Lane link.

Table 1.1 Summary of Revised Eastern Route Scenarios

Demand Scenario	***1***	***2***	***3***	***4***
Housing Growth Option 4	✓	✓	✓	✓
Sustainable Transport Option 3	✓	✓	✓	✓
Removal of Lugg Meadows Link	✓	✓	✓	✓
Removal of Sustainable Transport Measures on A49	✓	✓	✓	✓
Upgrade of existing Lumber Lane		✓		✓
Removal of Whitecross and Three Elms Development			✓	✓

1.6 Chapter 2 of the report discusses the modelling methodology used to model each of the Revised Eastern Route Scenarios. Chapter 3 to Chapter 6 of this report compare the scenarios which contain the full housing and development allocation, this includes the preferred option of the Western alignment, Scenario 1 and Scenario 2. Chapters 7 through to Chapter 10 discuss the impacts of reducing the proposed development quantum by removing the Whitecross and Three Elms development in Scenarios 3 and 4. Chapter 11 sets out the conclusions.

2.0 MODELLING METHODOLOGY

Introduction

2.1 The future year transport networks and demand matrices were directly taken from the previous forecasting work for the Sustainable Transport Option 3 networks for the Eastern alignment and the Housing Option 4 growth matrices. Details of which have been provided in the Hereford Relief Road Interim Forecasting Report for Sustainable Option Packages (August 2010) in Sections 2.0 and 3.0.

2.2 For Scenarios 1 and 3 the link between the A438 Ledbury Road and A4103 Worcester Road was removed from the Eastern Relief Road in the sustainable option 3 package networks. These networks were then assigned to the Housing Growth Option 4 matrices for the 2026 future year for both the AM and PM peak periods.

2.3 The Scenario 2 and 4 traffic networks were based upon the same networks as Scenarios 1 and 3 with the addition of a new link taken from the same alignment as the existing Lumber Lane which was not included in the Sustainable Transport Option 3 network. The Lumber Lane link was coded as a 60 mph single lane carriageway with a three arm roundabout at each end of the lane intersecting the A438 Ledbury Road and the A4103 Worcester Road. Each arm of the roundabout was coded as a 2 lane approach.

2.4 For each scenario network files the sustainable transport measures were removed from the A49. These included bus lanes and bus priority measures at traffic signals.

2.5 To construct the Scenario 3 and 4 demand matrices the associated proposed development at Whitecross and Three Elms was removed from the matrix for the 2026 am and pm peak periods. These newly formed matrices were then assigned to the Scenario 3 and 4 networks.

Variable Demand Modelling

2.6 After the completion of building the networks and demand matrices to represent the four scenarios for a 2026 AM and PM peak period, forecasting was undertaken using the DIADEM software in order to model variable demand.

2.7 The exact same methodologies and parameters used in the JMP Forecasting Report Chapter 2 and the Hereford Relief Road Interim Forecasting Report for Sustainable Option Packages (August 2010) in section 3.10 to 3.12 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.

2.8 The 2026 AM and PM No Relief Road models for each Sustainable Transport Option 3 and Housing Growth Option 4 with and without the Whitecross and Three Elms developments were pivoted off the 2008 base year for the respected peaks. The four scenarios were then pivoted off the relevant reference cost and demand output from the No Relief Road models with Housing Growth Option 4 with and without Whitecross and Three Elms development.

3.0 MODAL SPLIT

3.1 The DIADEM model contains a mode component, which allows modal shift and results in a new set of 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.

3.2 Tables 3.1 and 3.2 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.

Table 3.1 AM Pre-DIADEM Forecast Person Trip Totals

Scheme	***Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
Eastern Relief Road	Car	22102	22102	22102
	PT	4062	4062	4062
	Cycle	1936	1936	1936
	Walk	10370	10370	10370
	Total	**38470**	**38470**	**38470**

Table 3.2 PM Pre-DIADEM Forecast Person Trip Totals

Scheme	***Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
Eastern Relief Road	Car	23066	23066	23066
	PT	3119	3119	3119
	Cycle	1950	1950	1950
	Walk	13090	13090	13090
	Total	**41225**	**41225**	**41225**

3.3 Tables 3.1 and 3.2 show the fixed trip matrices before they are assigned to the networks through Variable Demand Modelling using DIADEM. It is therefore important that the demand is the same between Scenarios 1 and Scenario 2 and the preferred option since these options have the same level of demand in terms of future background growth, committed development and the required housing growth option.

3.4 Tables 3.3 and 3.4 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 3.3 AM Post-DIADEM Forecast Person Trip Totals

Scheme	***Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
Eastern Relief Road	Car	22566	20444	20456
	PT	3531	3532	3530
	Cycle	1938	1924	1921
	Walk	10459	10413	10405
	Total	**38494**	**36313**	**36312**

Table 3.4 PM Post-DIADEM Forecast Person Trip Totals

Scheme	*Mode*	*Demand Scenario*		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
Eastern Relief Road	Car	24800	21199	21208
	PT	2758	2752	2750
	Cycle	1915	1902	1901
	Walk	13026	12964	12962
	Total	**42499**	**38817**	**38821**

3.5 Comparing the three scenarios it can be seen that the total travel by all modes of trips, apart from walk, decreases between the pre and post DIADEM assignments for Scenarios 1 (without Lumber Lane link) and 2 (with Lumber Lane link). This indicates a suppression of trips in the network that are prevented from travelling onto the network due to a reduction in the models capacity. This does not occur in the Housing Option 4 Sustainable Option 3 (Preferred option) with a Western Relief Road scenario which indicates that the Western Relief Road does not suppress traffic as much as that of an Eastern Relief Road. The differences in trips by all modes between Scenarios 1 and 2 i.e. with and without the Lugg Meadows link are marginal.

4.0 MODEL PERFORMANCE STATISTICS

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

Non – Highway Models

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

- Total Distance (measured in person-kilometres); and
- Total Time (measured in person-hours).

4.3 The comparison of total distance travelled within the modelled network (Herefordshire County) for the AM model is shown in Table 4.1.

Table 4.1 AM Peak – Comparison of Total Distance Travelled (person-kilometres)

Mode	***Sub-Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
PT	Bus	9826	9823	9811
	Coach	406	434	436
	Rail	29151	29333	29415
	Sub-Total	**39383**	**39590**	**39662**
Cycle		7180	7172	7164
Walk		32527	32536	32509
Total		**79090**	**79298**	**79335**

4.4 For the non-car modes, it can be seen that the addition of Lumber Lane (Scenario 2) leads to a slight fall in the distance travelled by bus, coach and walk, the passenger kilometres travelled by rail marginally increases. The comparison for the PM model is shown in Table 4.2.

Table 4.2 PM Peak – Comparison of Total Distance Travelled (person-kilometres)

Mode	***Sub-Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
PT	Bus	8561	8712	8647
	Coach	0	0	0
	Rail	17217	17369	17388
	Sub-Total	**25778**	**26081**	**26035**
Cycle		6891	6906	6890
Walk		35504	35552	35472
Total		**68173**	**68539**	**68397**

4.5 As in the AM Model, it can be seen that in the PM model, the addition of a Lumber Lane link leads to a slight fall in passenger kilometres for the public transport, cycle and walk modes. Passenger kilometres travelled by rail however increase slightly between the no Lumber Lane and the addition of Lumber Lane scenarios.

4.6 Both the AM and PM peak models show an increase in total passenger kilometres between Scenarios 1 (without Lumber Lane) and 2 (with Lumber Lane) and the preferred Western Corridor as the levels of modal shift increases.

4.7 Table 4.3 and table 4.4 show the comparison of total travel time by non-car modes across scenarios and time periods.

Table 4.3 AM Peak Comparison of Travel Time (person-hours)

Mode	***Sub-Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
PT	Bus	711	709	708
	Coach	6	6	6
	Rail	332	333	334
	Sub-Total	**1048**	**1048**	**1048**
Cycle		479	478	478
Walk		8132	8134	8127
Total		**9659**	**9660**	**9653**

Table 4.4 PM Peak Comparison of Travel Time (person-hours)

Mode	***Sub-Mode***	***Demand Scenario***		
		Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane Link)*
PT	Bus	469	474	471
	Coach	0	0	0
	Rail	188	189	189
	Sub-Total	**657**	**663**	**660**
Cycle		459	460	459
Walk		8876	8888	8868
Total		**9335**	**10011**	**9987**

4.8 Comparing Scenarios 1 and 2 it can be seen that there is a small reduction in the total travel time for the non-car modes with the addition of a Lumber Lane link. Comparing the AM peak results with that of the Preferred Western Corridor the travel time for the non-car modes for Scenario 1 and 2 is higher. The PM peak non-car travel time by all modes combined is higher in both scenarios than that of the Preferred Western Corridor.

Highway Model

4.9 The latest highway models have assessed two different network scenarios with and without the Lugg Meadows Link using Housing Option 4 and Sustainable Option 3. A comparison has been based on network conditions using such measures as average speed, delays and queues in the network.

4.10 The comparisons of network performance for the AM and PM future year models are shown in Tables 4.5 and 4.6.

Table 4.5 2026 AM Peak – Summary of Highway Network Performance

Indicators	***Demand Scenario***		
	Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
Total Time / hrs	2161	2163	2167
Transient Queues / hrs	648	655	635
Over-Cap. Queues / hrs	1	9	0
Link Delays / hrs	61	72	86
Total Distance / km	81472	78712	81924
Total Trips Loaded / pcu	18359	18400	18409
Average Speed / kph	37.7	36.4	37.8

Table 4.6 2026 PM Peak – Summary of Highway Network Performance

Indicators	***Demand Scenario***		
	Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
Total Time / hrs	2547	2297	2326
Transient Queues / hrs	832	750	742
Over-Cap. Queues / hrs	39	15	11
Link Delays / hrs	83	64	77
Total Distance / km	89795	80223	83766
Total Trips Loaded / pcu	19765	19020	19027
Average Speed / kph	35.2	34.9	36.0

4.11 Comparison of the network statistics reveals how the model predicts conditions of the highway will change. The results show that there is a marginal worsening of travel conditions during the AM peak period for both Scenario 1 (without Lumber Lane link) and Scenario 2 (with Lumber Lane link) as compared to the Preferred Western Corridor. During the PM peak it is Scenario 2 that has the best overall network performance as compared to the Preferred Western Corridor and Scenario 1.

4.12 Comparing Scenario 1 with Scenario 2 (with the addition of a Lumber Lane link) shows an improvement in the overall network performance with speeds increasing in both peak periods. The addition of Lumber Lane reduced the number of link delay / hrs in the network and the number of transient queues.

4.13 During the AM peak period the model predicts that in Scenario 1 time spent in transient queues, link delays and average speed are all forecast to worsen as compared to Preferred Western Corridor network performance results. The AM network speed of 36.4kph is lower than that of 37.7kph for example. For the PM the average speed for Scenario 1 (without Lumber Lane link) equates to 34.9kph as compared to 35.2kph for the Preferred Western Corridor.

4.14 Scenario 2 (with the addition of a Lumber Lane link) improves upon the overall network performance of Scenario 1. Comparing the average network speed to the Preferred Western Corridor scheme the AM improves with a speed of 37.8kph as compared to 37.7kph, link delays are slightly higher with 86 link delay hours compared to 61. Over capacity queues are lower with 0 over capacity queue hours as compared to 1 over capacity queue hour. The PM peak for scenario 2 also compares favourably with the Preferred Western Corridor option with an improvement in average network speed of 36.0ph as compared to 35.2kph for the Preferred Western Corridor scheme. Over capacity queue hours reduce from 39 to 11, transient queues reduce from 832 to 742 and link delay hours reduce from 83 to 77.

4.15 Tables 4.7 to 4.8 give ranking to the summary of the network performance for Transient Queues/hrs, Over Capacity Queue/hrs, Link Delay/hrs and average speed/kph for the AM peak and PM peak respectively. The rankings reveal that Scenario 2 (with a Lumber Lane link) gives the best overall network performance closely followed by the Preferred Western Corridor. It appears the main reason why scenario 2 has a better overall network performance than the other two scenarios is due to the addition of the Lumber Lane upgraded link which provides some alleviation to the overall network performance. The benefits of the upgraded Lumber Lane in Scenario 2 are clearly seen in Tables 4.7 and 4.8 for both the AM and PM peak periods.

4.16 Combining both peak rankings, Scenario 1 (with the full housing allocation but without the Lumber Lane upgrade) has the worst ranking in terms of overall network performance. The Preferred Western Corridor option ranks the worst of all scenarios in the most congested peak hour the PM but ranks better than Scenario 1 in the AM peak.

Table 4.7 AM Peak – Network Performance Ranking Tables

Scenario	***Transient Queues/hrs***	***Rank***
Scenario 2 (with Lumber Lane link)	635	1
Preferred Western Corridor	648	2
Scenario 1 (without Lumber Lane link)	655	3
Scenario	***Over-Capacity Queues/hrs***	***Rank***
Scenario 2	0	1
Preferred Western Corridor	1	2
Scenario 1	9	3
Scenario	***Link Delays/hrs***	***Rank***
Preferred Western Corridor	61	1
Scenario 1	72	2
Scenario 2	86	3
Scenario	***Average Speed/kph***	***Rank***
Scenario 2	37.8	1
Preferred Western Corridor	37.7	2
Scenario 1	36.4	3

Source: Table 4.5

Table 4.8 PM Peak – Network Performance Ranking Tables

Scenario	***Transient Queues/hrs***	***Rank***
Scenario 2	742	1
Scenario 1	750	2
Preferred Western Corridor	832	3
Scenario	***Over-Capacity Queues/hrs***	***Rank***
Scenario 2	11	1
Scenario 1	15	2
Preferred Western Corridor	39	3
Scenario	***Link Delays/hrs***	***Rank***
Scenario 1	64	1
Scenario 2	77	2
Preferred Western Corridor	83	3
Scenario	***Average Speed/kph***	***Rank***
Scenario 2	36	1
Preferred Western Corridor	35.2	2
Scenario 1	34.9	3

Source: Table 4.6

5.0 ANALYSIS OF HIGHWAY MODEL RESULTS

Impact of Relief Road

5.1 Analysis was undertaken to assess the impact a Relief Road has on the main roads in and around Hereford and the differences between each of the scenarios. Table 5.1 shows the total flows on the main roads in Hereford for the 2026 future year for each of the scenarios for the AM and PM peak periods.

5.2 The scenarios in Table 5.1 are the Preferred Western Corridor, Scenario 1 the removal of Lugg Meadows Link from Eastern Alignment between A4103 and A438 with growth Housing Option 4 (preferred option) and Sustainable Transport Option 3 but removal of A49 sustainable transport measures and Scenario 2 which is as scenario 1 but with Lumber Lane link.

Table 5.1 AM and PM Total Vehicular Flows

Road Type	***Road Name***	***Direction***	***Preferred Western Corridor***		***Scenario 1*** *(without Lumber Lane link)*		***Scenario 2*** *(with Lumber Lane link)*	
			AM	***PM***	***AM***	***PM***	***AM***	***PM***
Trunk Road	**A49**	NB	1725	1657	1679	1656	1615	1598
		SB	1332	1648	1214	1806	1164	1799
Primary Road	**A4103**	EB	495	402	464	458	522	491
		WB	760	486	870	637	839	703
	A465	NB/EB	572	389	489	518	438	478
		SB/WB	215	154	242	191	234	186
	A438	NB/EB	978	499	1050	648	1032	647
		SB/WB	495	718	529	968	529	948
	A4110	NB	400	286	443	474	435	443
		SB	361	332	315	425	309	424
	A438 Ledbury Road	EB	304	481	231	417	230	395
		WB	520	248	470	201	445	145
Non-Primary Road	**B4224**	EB	509	276	483	291	425	291
		WB	558	451	595	611	560	548
	B4399	EB	245	228	123	296	230	335
		WB	330	163	239	144	425	256
	Lumber Lane	NB	-	-	-	-	745	824
		SB	-	-	-	-	760	544
	Bodenham Road	NWB	273	275	334	296	355	296
		SEB	260	344	547	450	405	432
	Folly Lane	NB	150	78	81	86	125	73
		SB	61	117	32	125	47	110

5.3 The link flows with No Relief Road scenario were compared to that of the three scenarios. The total flow comparison for each type of roads is shown in Table 5.2

Table 5.2 AM/PM Comparison: Impacts of Highway Options on Existing Highway

Road Type	*Road Name*	*Direction*	*Preferred Western Corridor*		*Scenario 1* (without Lumber Lane link)		*Scenario 2* (with Lumber Lane link)	
			AM	***PM***	***AM***	***PM***	***AM***	***PM***
Trunk Road	**A49**	NB	-208	-325	-254	-326	-318	-384
		SB	-330	-508	-448	-350	-498	-357
Primary Road	**A4103**	EB	-67	-91	-98	-35	-40	-2
		WB	20	-141	130	10	99	76
	A465	NB/EB	5	-178	-78	-49	-129	-89
		SB/WB	-45	-22	-18	15	-26	10
	A438	NB/EB	-202	-319	-130	-170	-148	-171
		SB/WB	123	-362	157	-112	157	-132
	A4110	NB	-7	-323	36	-135	28	-166
		SB	1	-72	-45	21	-51	20
	A438 Ledbury Road	EB	-26	-37	-99	-101	-100	-123
		WB	37	-10	-13	-57	-38	-113
Non-Primary Road	**B4224**	EB	-118	-134	-144	-119	-202	-119
		WB	9	-103	46	57	11	-6
	B4399	EB	-39	-143	-161	-75	-54	-36
		WB	-46	-102	-137	-121	49	-9
	Lumber Lane	NB	-	-	-	-	-	-
		SB	-	-	-	-	-	-
	Bodenham Road	NWB	3	6	64	27	85	27
		SEB	-26	42	261	148	119	130
	Folly Lane	NB	57	-13	-12	-5	32	-18
		SB	28	-34	-1	-26	14	-41

5.3 The negative values show a decrease in link flows due to the Relief Road. The table clearly indicates that the revised Eastern Relief Road Options are providing benefit to the A49 and the majority of other primary and non primary roads in both peaks despite the removal of the Lugg Meadows Link.

5.4 Scenario 2 (with a Lumber Lane link) and the Preferred Western Corridor provide similar levels of relief overall to the primary and non primary roads in the network in both peak periods. Scenario 1 still provides relief to the Hereford network but not as much as the other two scenarios. The upgraded Lumber Lane is forecasted to carry a two way vehicular flow of up to 1500 and 1350 vehicles in the AM and PM peak periods respectively.

5.5 Figures 5.1 to 5.2 below show diagrammatic representation of the impact of the three different scenarios on the Hereford Transport Network in terms of traffic flow. Figures 5.1 to 5.2 show the difference in traffic flow between the Preferred Western Corridor option and scenario 1 (without a Lumber Lane link) for the AM and PM peak periods. The blue lines indicate that scenario 1 flows are higher than the Preferred Western Corridor forecast traffic flows and the green lines indicate that scenario 1 is predicted to have lower traffic flows than the Preferred Western Corridor.

Figure 5.1 Difference in traffic flows between the Preferred Western Corridor and Scenario 1 (without a Lumber Lane link) – AM Peak Traffic Volumes

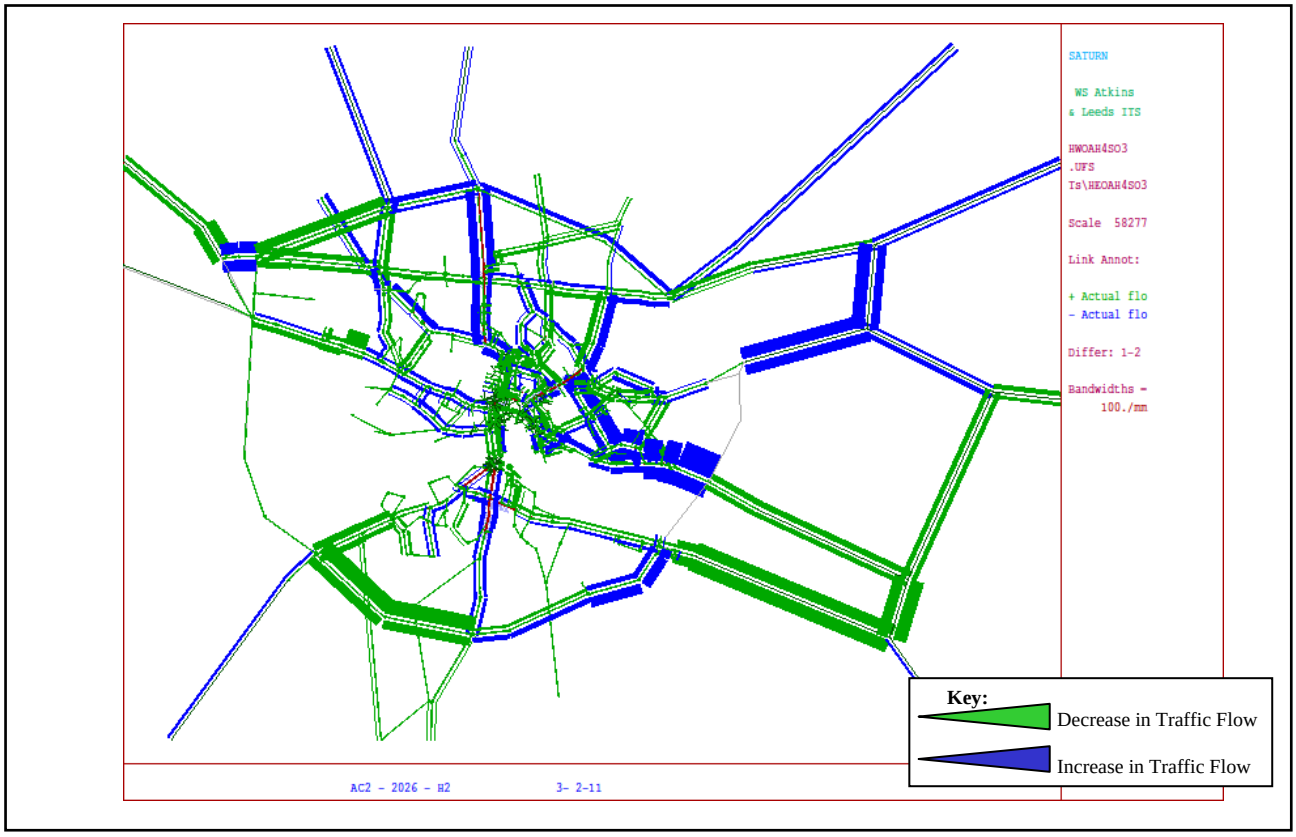
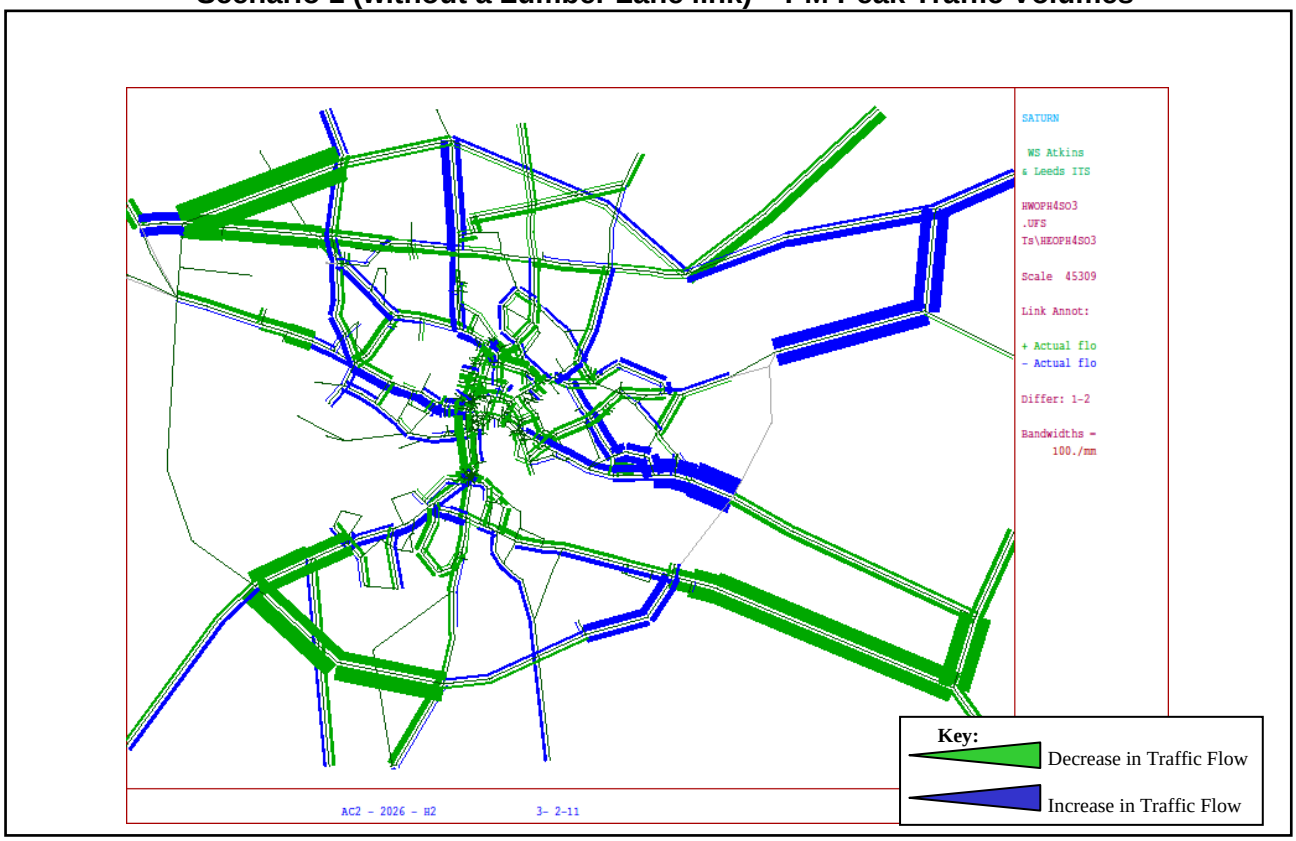


Figure 5.2 Difference in traffic flows between the Preferred Western Corridor and Scenario 1 (without a Lumber Lane link) – PM Peak Traffic Volumes



5.6 Figure 5.1 shows that Scenario 1 (eastern corridor without a Lumber Lane link) generally has more traffic present on the western part of the city in both peak periods in particular on roads such as A438 (Whitecross Road) and A4110 (Three Elms Road). This is to be expected as the Western Relief Road provides congestion relief on more western parts of the city over and above that of an Eastern Relief Road.

5.7 The impact of severing the link between the A438 Ledbury Road and A4103 Worcester Road for Scenario 1 can clearly be seen by the higher volumes in traffic flow compared to the western alignment on both the A438 Ledbury Road and the A4103 Worcester Road and also on the rural road at Bartestree which acts as a `rat-run` between the A438 and A4103.

5.8 Traffic is also higher on Hampton Park Road, Church Road, Folly Lane and Aylestone Hill when comparing Scenario 1 to the Preferred Western Corridor option indicating that the Eastern Relief Road option has a higher traffic flow using these routes within Hereford. Other routes which have more traffic flow in Scenario 1 than the preferred Western Relief Road option include Rotherwas Access Road, A49, Holmer Road, Newtown Road and in the AM peak the A49 and Holme Lacy Road.

5.9 Scenario 1 does decrease traffic flow when compared to the Preferred Western Corridor option on roads and junctions within Hereford Town Centre such as Greyfriars Bridge, Edgar Street and Newmarket Street.

5.10 Figures 5.3 to 5.4 below show the difference in traffic flow between the preferred Western Relief Road option and Scenario 2 (an eastern corridor with a Lumber Lane link) for the AM and PM peak periods. The blue lines indicate that Scenario 2 flows are higher than the Preferred Western Corridor forecast traffic flows and the green lines indicate that Scenario 2 is predicted to have lower traffic flows than the Preferred Western Corridor scheme.

Figure 5.3 Difference in traffic flows between the Preferred Western Corridor and Scenario 2 (Eastern corridor with a Lumber Lane link) – AM Peak

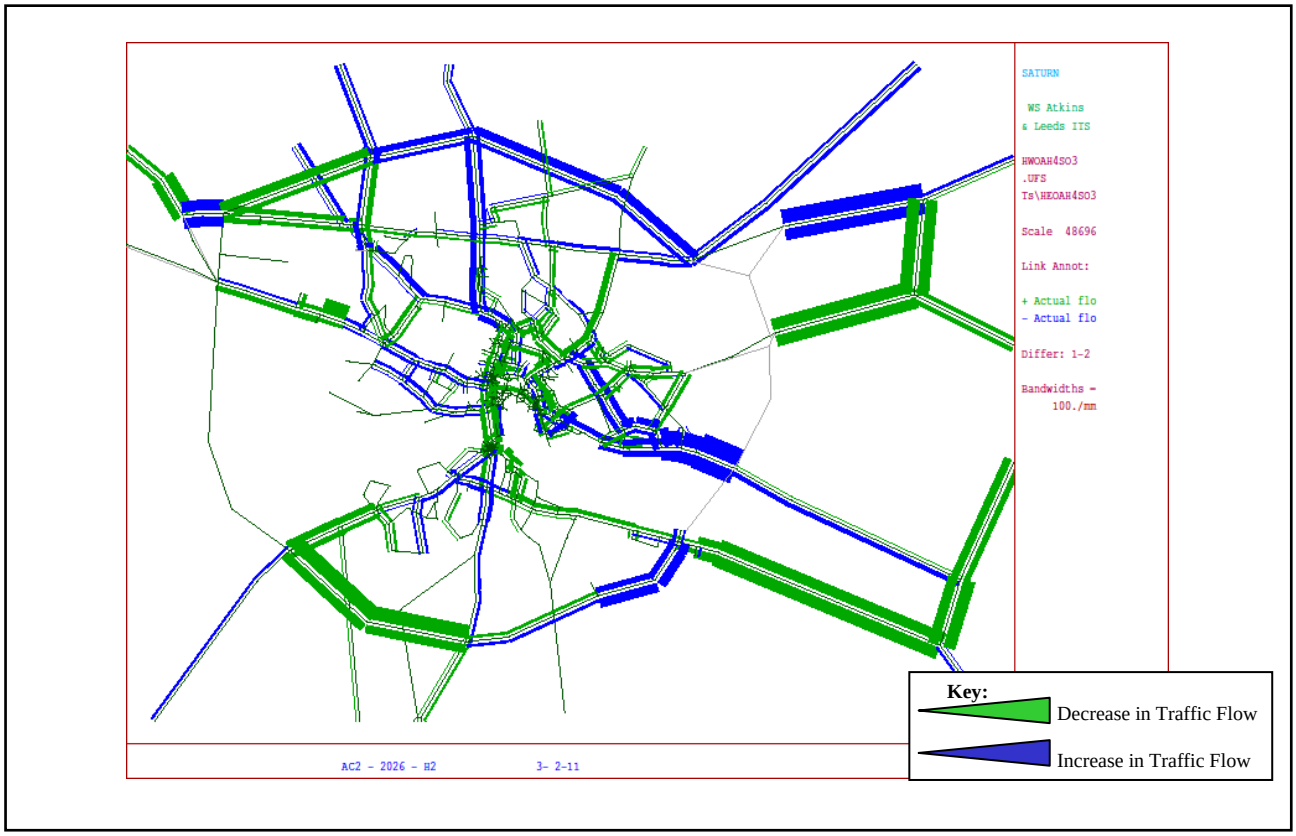
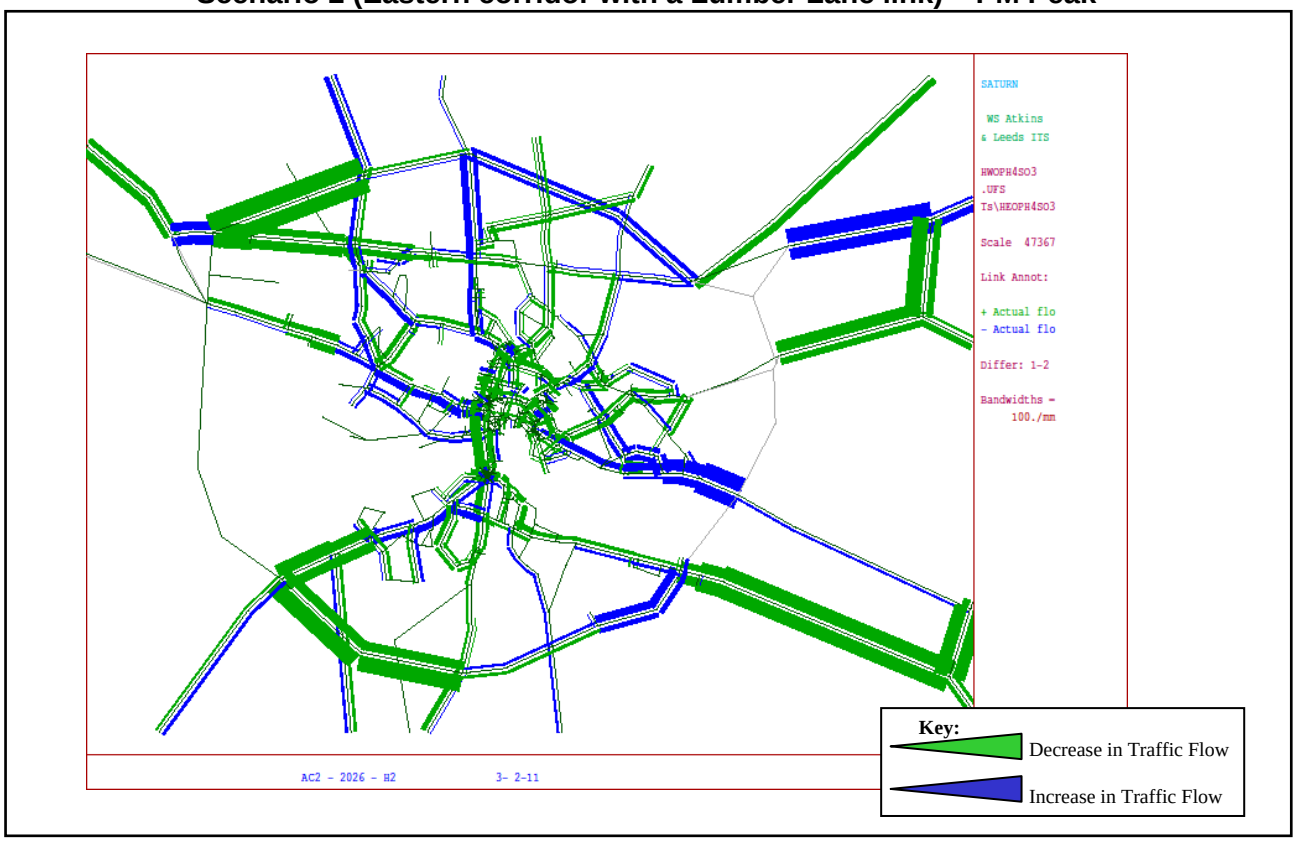


Figure 5.4 Difference in traffic flows between the Preferred Western Corridor and Scenario 2 (Eastern corridor with a Lumber Lane link) – PM Peak



5.11 Looking at both peak periods it can clearly be seen that Scenario 2 has a reduction in the levels of traffic flow on the A438 Ledbury Road and the rural road linking A438 to A4103 at Bartestree indicated by the green coloured links as compared to the blue coloured links on the same roads in Figures 5.1 and 5.2. This clearly shows that traffic switches from using this route and now uses the upgrade at Lumber Lane. As a result however traffic increases on Worcester Road when compared to the preferred western alignment and the thicker blue lines on the northern section of the Relief Road and on the A4103 Roman Road also indicate that traffic flow has increased on these roads with the inclusion of the upgrade at Lumber Lane.

5.12 Scenario 2 (which includes the upgrade at Lumber Lane) has more traffic on Hampton Park Road, Church Road and Folly Lane than the preferred western option, however the blue lines are slightly thinner than the Scenario 1 networks shown in Figures 5.1 and 5.2 indicating less of an impact than Scenario 1 on these roads than Scenario 2 when comparing to traffic levels for the preferred western option.

5.13 Similarly to Scenario 1, the Scenario 2 option does improve the traffic flow levels on roads and junctions within Hereford City Centre indicated by the predominance of green lines in both the AM and PM peak hour figures.

5.14 Figures 5.5 to 5.6 show the difference in traffic flow between Scenario 1 and Scenario 2 for the AM and PM peak periods. Both of these scenarios contain the full housing and development allocations however Scenario 2 includes the upgrade at Lumber Lane. The blue lines indicate that Scenario 1 flows are higher than Scenario 2 forecast traffic flows and the green lines indicate that Scenario 1 is predicted to have lower traffic flows than Scenario 2.

Figure 5.5 Difference in traffic flows between Scenario 1 (Eastern corridor without a Lumber Lane link) and Scenario 2 (with a Lumber Lane link) – AM Peak

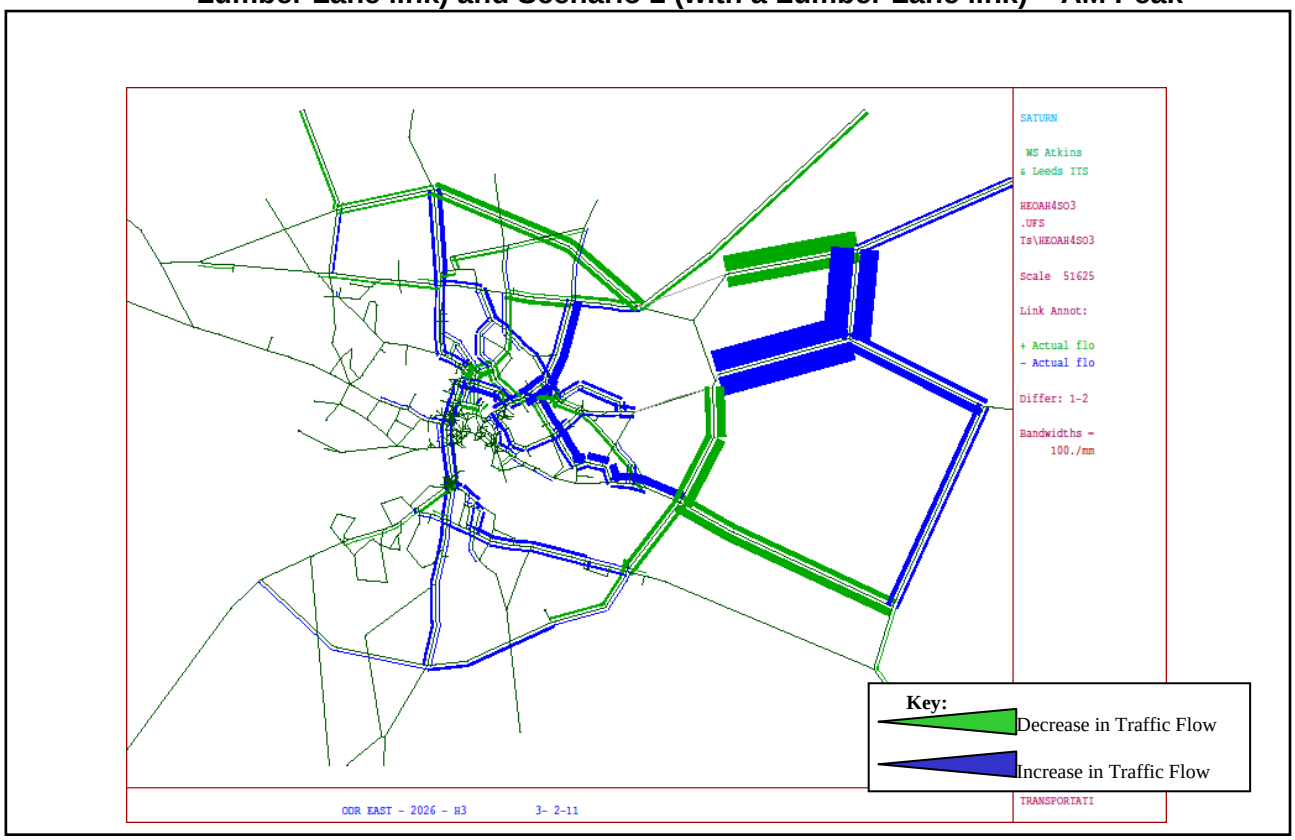
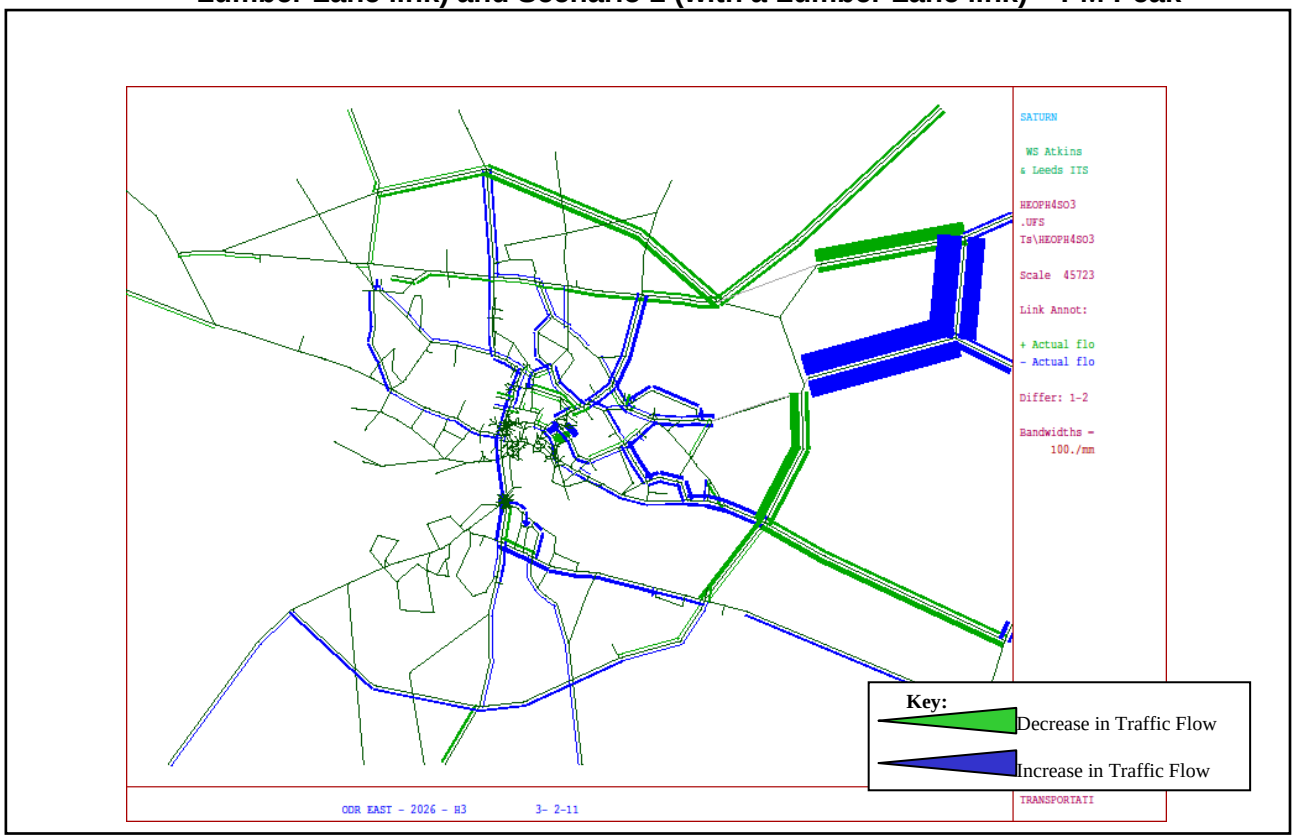


Figure 5.6 Difference in traffic flows between Scenario 1 (Eastern corridor without a Lumber Lane link) and Scenario 2 (with a Lumber Lane link) – PM Peak



5.15 Comparing Scenario 2 and Scenario 1 options it can be seen that Scenario 2 has less traffic volume within the city of Hereford than that of Scenario 1 indicated by the predominance of blue lines shown in Figures 5.5 and 5.6 for the AM and PM peaks respectively.

5.16 Looking at the Eastern Relief Road it can be clearly seen that in both peak periods that Scenario 2 is predicted to carry heavier volumes of traffic than Scenario 1 particularly on the eastern and northern sections of the Relief Road.

5.17 The figures also show the impact of an upgraded link at Lumber Lane in the network with the large reduction in traffic on the A438 Ledbury Road and the rural link road at Bartestree and the increase in traffic on the A4103 and A465.

Journey Time Analysis

5.18 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 all scenarios. Tables 5.3 and 5.4 show the comparison results.

Table 5.3 AM Peak – Comparison of Journey Times

Average Modelled Journey Time / mm:ss			
Route	***Preferred Western Corridor***	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
1	23:37	22:55	22:56
2	20:26	21:13	20:56
3	24:39	24:41	23:30
4	22:43	23:12	21:56
5	-	-	-
6	27:34	28:37	27:28
7	20:11	20:55	20:01
8	22:30	22:50	22:30
Total	**161:40**	**164:23**	**159:17**

Table 5.4 PM Peak – Comparison of Journey Times

Average Modelled Journey Time / mm:ss			
Route	***Preferred Western Corridor***	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
1	27:05	25:03	24:38
2	21:36	21:02	20:58
3	26:25	24:38	24:31
4	25:02	25:39	24:28
5	-	-	-
6	33:05	31:04	30:19
7	23:55	22:01	21:02
8	26:10	24:51	24:10
Total	**183:18**	**174:18**	**170:06**

5.19 It can be seen from the total times shown in Tables 5.3 and 5.4 that all modelled scenarios perform better in the AM peak than the PM peak period. Comparing Scenarios 1, 2 and the Preferred Western Corridor package, all of which contain the full housing and development allocation, shows that for the AM peak Scenario 2 has a better overall combined journey time of 159mins and 17secs compared to 161mins and 40secs for the preferred western alignment and 164mins and 23secs for Scenario 1 (without the Lumber Lane link road). During the PM peak the Preferred Western Corridor option has a higher combined journey time of approximately 13mins compared to that of Scenario 2 and 9mins higher journey time compared to Scenario 1.

5.20 Provision of the upgraded Lumber Lane link road has resulted in the reduction of the total journey time during both peak periods. The reduction in journey time that occurs in the AM peak period is approximately 5mins between Scenarios 1 and 2 without and with Lumber Lane. The corresponding reduction in total journey time for the PM peak is approximately four minutes between Scenarios 1 and 2.

5.21 Tables 5.5 and 5.6 have ranked in order each scenario by best performing total journey time for the AM and PM peak periods respectively.

Table 5.5 AM Peak – Journey Time Ranking Tables

Scenario	***Total***	***Rank***
Scenario 2	159:17:00	1
Preferred Western Corridor	161:40:00	2
Scenario 1	164:23:00	3

Source: Table 5.3

Table 5.6 PM Peak – Journey Time Ranking Tables

Scenario	***Total***	***Rank***
Scenario 2	170:06:00	1
Scenario 1	174:18:00	2
Preferred Western Corridor	183:18:00	3

Source: Table 5.4

5.22 Tables 5.5 and 5.6 show Scenario 2, with the inclusion of an upgrade to Lumber Lane, has the best overall total journey time in the network out of the full housing and development allocation scenarios in both peak periods. The Preferred Western Corridor performs better than Scenario 1 in the AM peak period however performs the worst of all scenarios during the PM Peak, the most congested peak hour.

Impact on A49 Trunk Road

5.23 In order to assess the impacts of the full housing growth scenarios on the operation of the A49 Trunk Road, journey times for a route running along the A49 between the priority junction at Portway and the priority junction near Pipe and Lyde, in both directions, were extracted from each SATURN highway model. The route is shown in Figure 5-3 under section 5.131 of JMPs HMM Forecasting Report.

5.24 Modelled Journey Times from the AM and PM models are shown in Table 5.7.

Table 5.7 AM/PM Peak – Comparison of Modelled Journey Times on A49

Direction	***AM Modelled Journey Time / mm:ss***		
	Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
NB	15:29	15:25	15:22
SB	14:51	15:37	15:18
Total	**30:20**	**31:02**	**30:40**
Direction	***PM Modelled Journey Time / mm:ss***		
	Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
NB	16:30	16:24	16:17
SB	15:42	15:08	15:10
Total	**32:12**	**31:32**	**31:27**

5.25 The results show that the PM peak period has a higher journey time, particularly for northbound traffic, on the A49 than the AM peak period. Comparing Scenario 1 with Scenario 2 it can be seen that the upgrade of Lumber Lane does marginally improve the overall journey time in both peak periods.

5.26 The Preferred Western Corridor performs the best out of all scenarios in the AM peak period for the combined journey time of northbound and southbound on the A49. In contrast in the PM peak the Preferred Western Corridor scenario performs worse than the compared eastern alignment scenarios however again the overall difference is marginal.

Over Capacity Junctions

5.27 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.

5.28 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.

5.29 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.

5.30 The numbers of modelled junctions within each volume-to-capacity band are shown in Table 5.8 for the AM peak models and in Table 5.9 for the PM peak models. Table 5.10 shows the over capacity for both peaks combined.

Table 5.8 Junctions Over Capacity – AM Peak

Volume to Capacity Ratio	***Preferred Western Corridor***	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
85% to 100%	13	16	11
100% to 120%	4	3	1
120% and over	0	0	0
Total	**17**	**19**	**12**

Table 5.9 Junctions Over Capacity – PM Peak

Volume to Capacity Ratio	***Preferred Western Corridor***	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
85% to 100%	13	16	10
100% to 120%	9	5	6
120% and over	0	0	0
Total	**22**	**21**	**16**

Table 5.10 Junctions Over Capacity – Both Peaks

Volume to Capacity Ratio	***Preferred Western Corridor***	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
85% to 100%	26	32	21
100% to 120%	13	8	7
120% and over	0	0	0
Total	**39**	**40**	**28**

5.31 Tables 5.8 to 5.10 show that provision of a Lumber Lane link road leads to a reduction in the total number of over-capacity junctions.

5.32 Table 5.10 which combine the results for both peak hours shows that Scenario 1, which has no upgrade to Lumber Lane, is the worse of the two eastern option scenarios in terms of the total number of junctions performing at over capacity in the network. The Preferred Western Corridor however has the highest number of junctions performing with a capacity above 100% with a combined total of 13 junctions in both peak periods.

5.33 Figures 5.7 to 5.12 show the location of the over capacity junctions for all three scenarios for the AM and PM peaks respectively.

Figure 5.7 Junctions operating at >85% of capacity – AM Peak Preferred Western Corridor

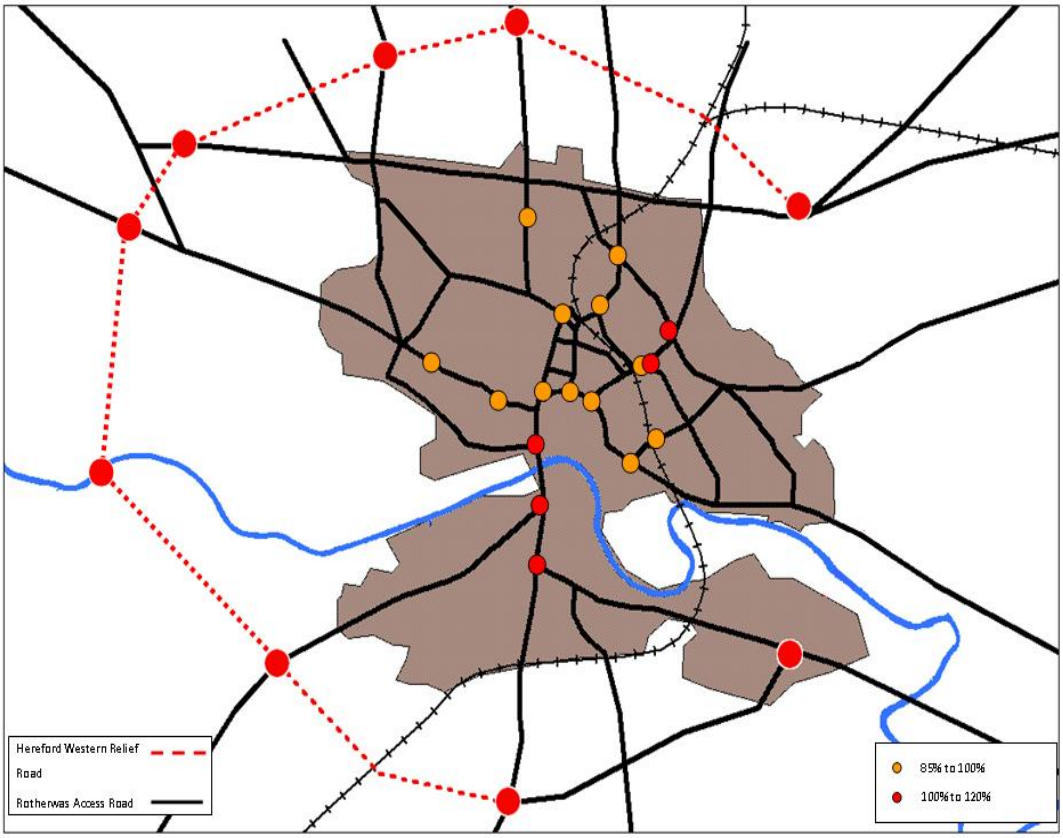


Figure 5.8 Junctions operating at >85% of capacity – PM Peak Preferred Western Corridor

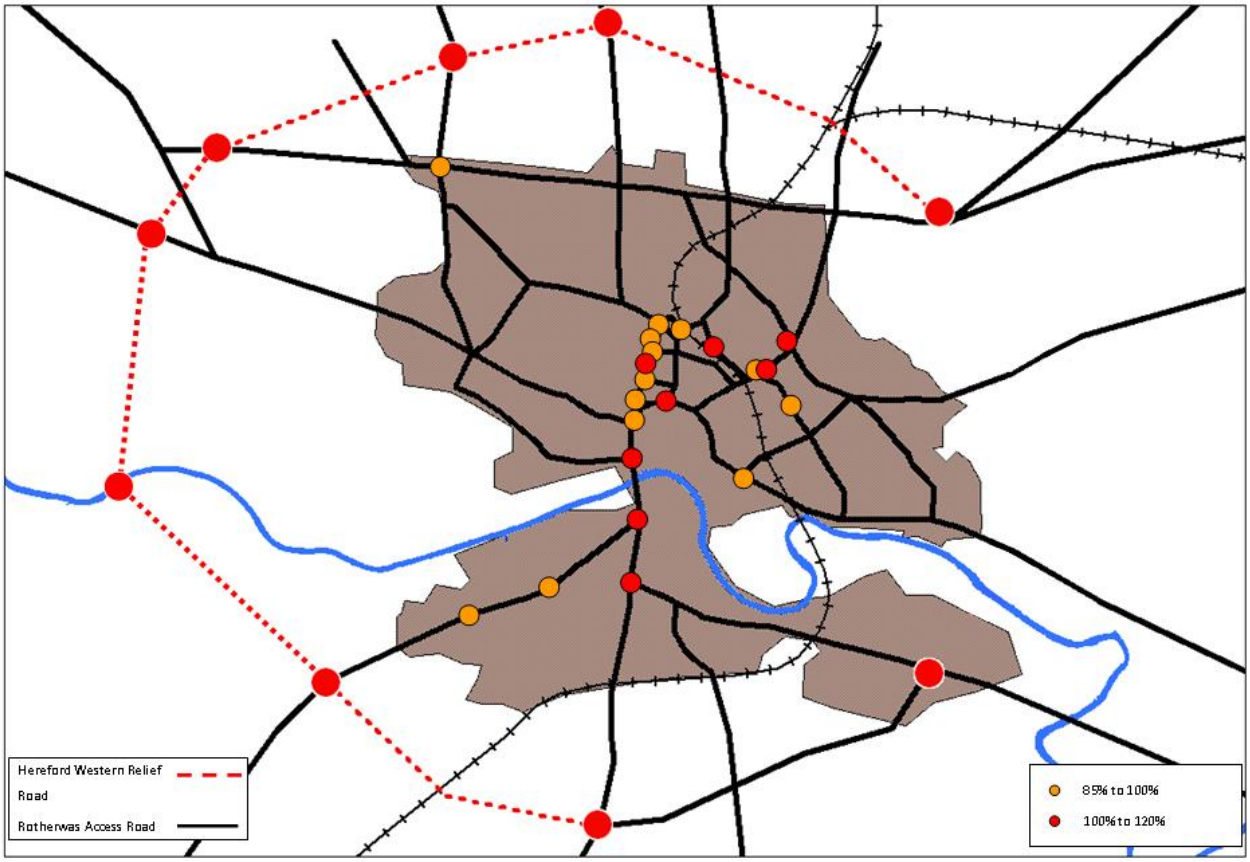


Figure 5.9 Junctions operating at >85% of capacity – AM Peak Scenario 1

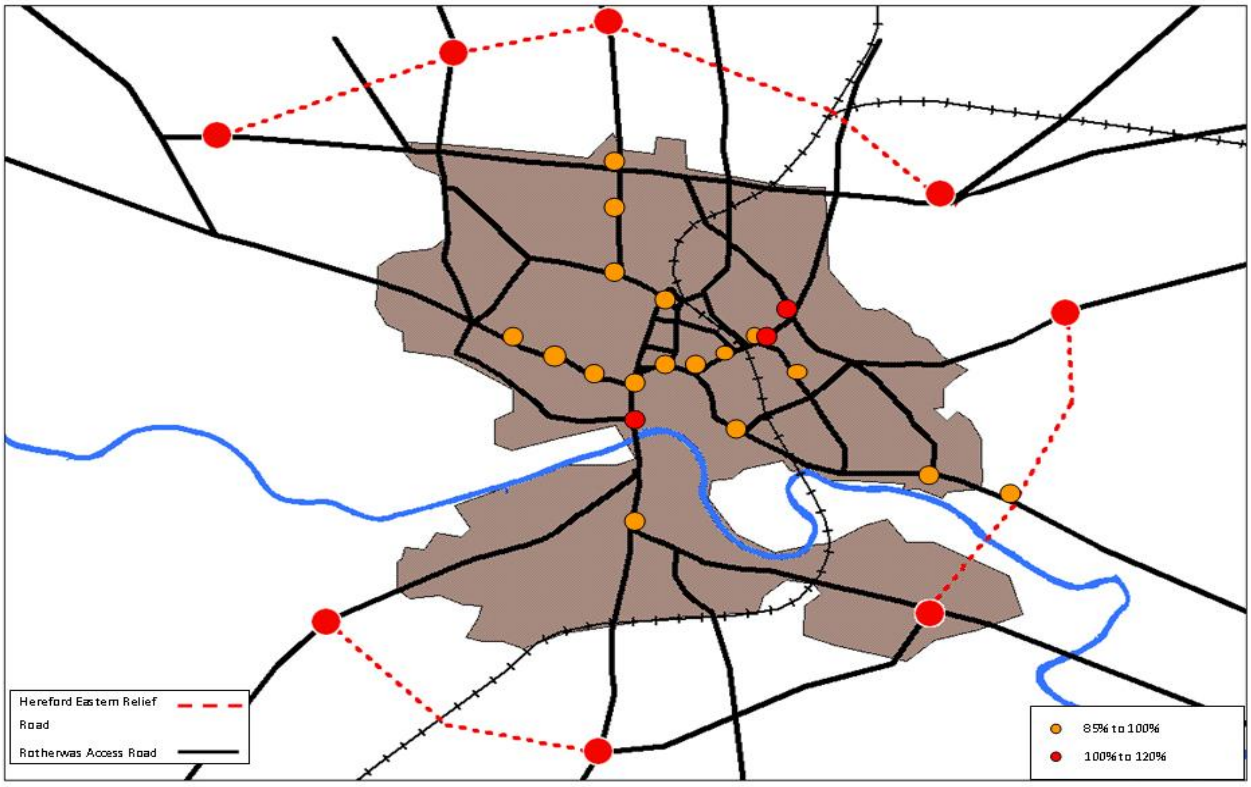


Figure 5.10 Junctions operating at >85% of capacity – PM Peak Scenario 1

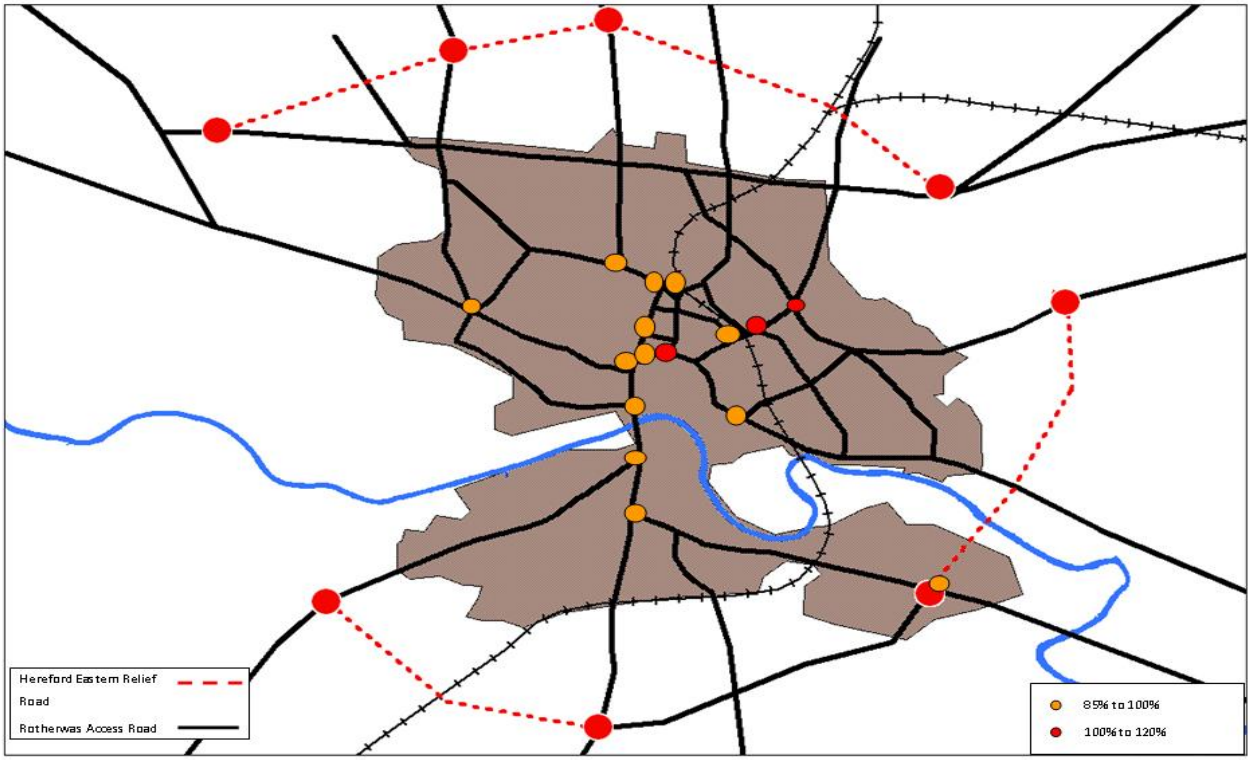


Figure 5.11 Junctions operating at >85% of capacity – AM Peak Scenario 2

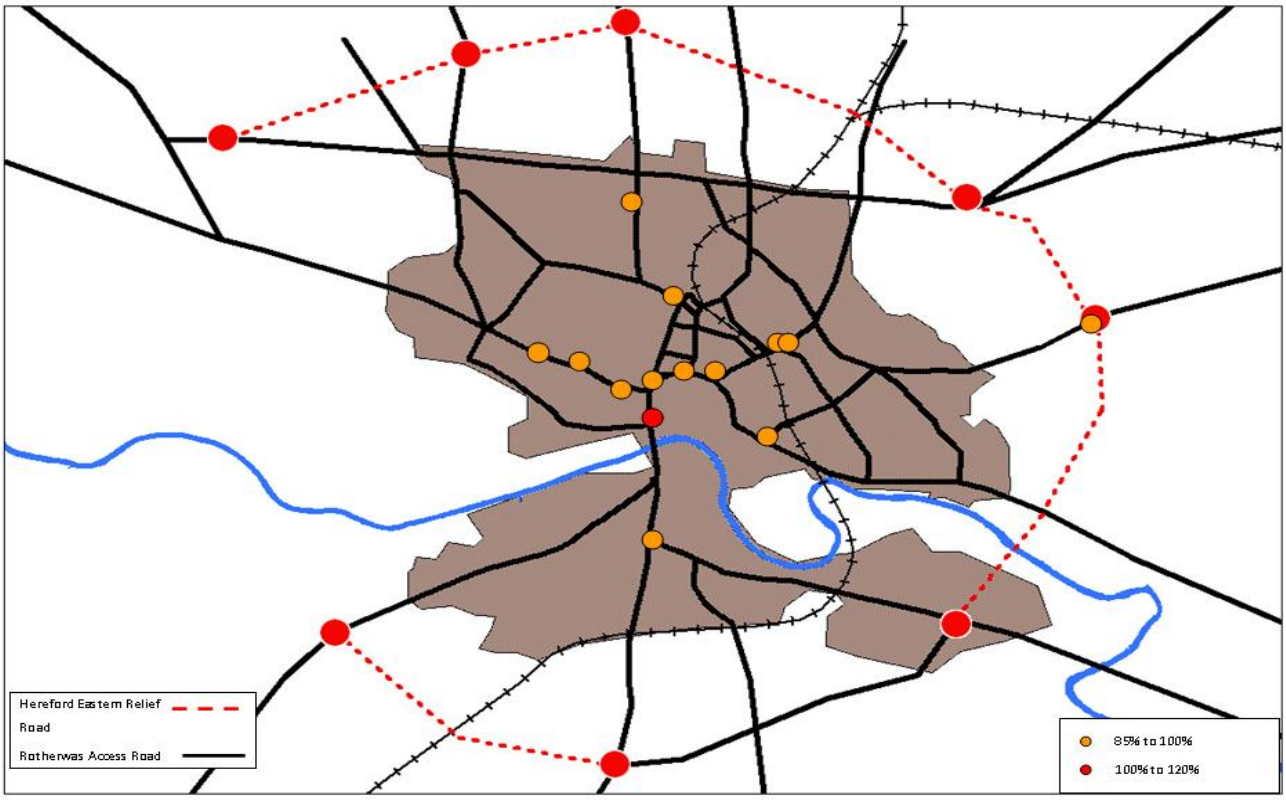
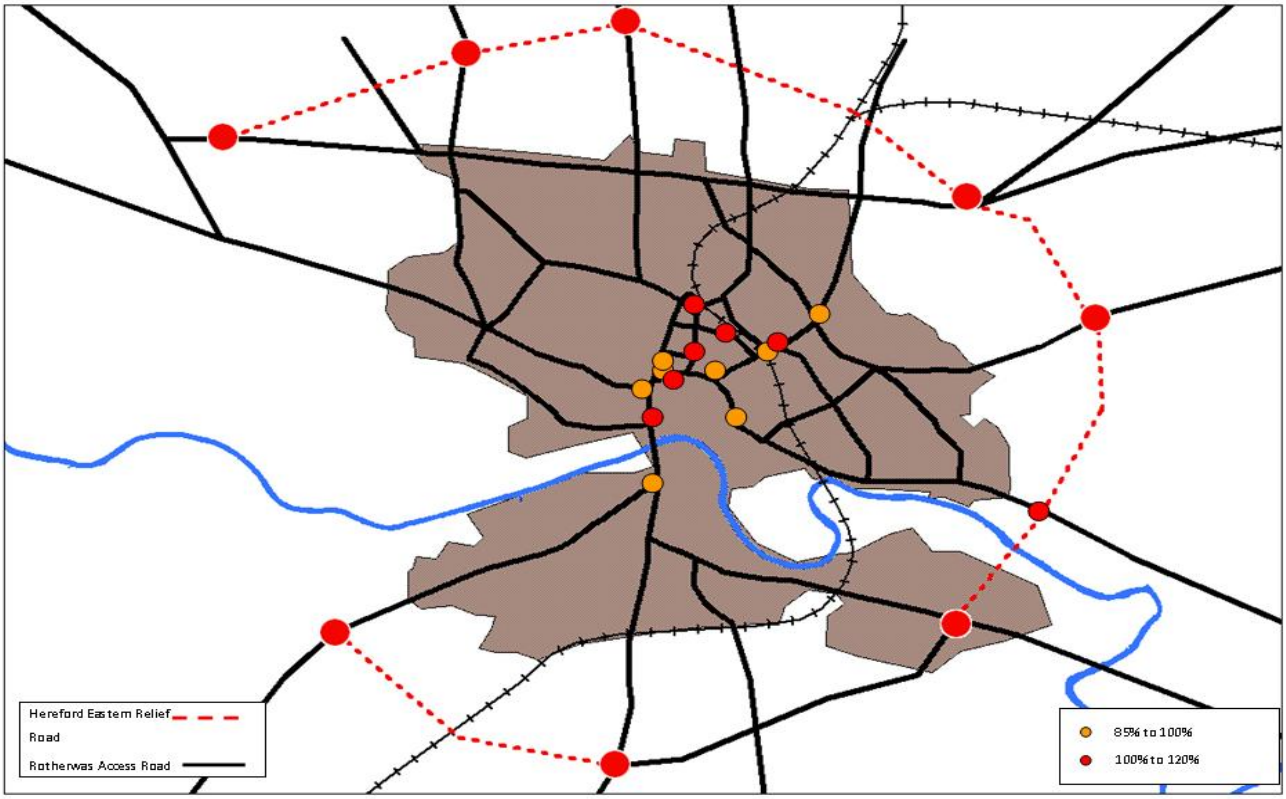


Figure 5.12 Junctions operating at >85% of capacity – PM Peak Scenario 2



5.34 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 Newmarket Street, Greyfriars Bridge and at junctions along the A465 Aylestone Hill and Commercial Road.

5.35 The figures also confirm that the revised Eastern Route Options provide more favourable congestion relief to the Hereford City Centre and Greyfriars Bridge as shown by the higher number of junctions at over capacity as shown in these areas in Figures 5.7 and 5.8 for the Preferred Western Corridor scheme. It is important to remember however that the Preferred Western Corridor has more trips assigned onto the network than either of the revised eastern route options and the congestion relief indicated by the figures above could be caused by trip suppression and not solely due to the impact of an eastern relief road.

5.36 The figures also illustrate the effects that Lumber Lane Link road has on reducing the capacity on the network shown in the Scenario 2 figures. This is especially noticeable on the A465 Aylestone Hill with the reduction in the number of over capacity junctions particularly in the AM peak period.

6.0 ECONOMICS

6.1 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.

6.2 The determination of the scenarios 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.

6.3 The total generalised costs of travel for the scenarios are shown in Table 6.1. The scenarios in Table 6.1 are the Preferred Western Corridor, Scenario 1 (the removal of Lugg Meadow Link from Eastern Alignment between A4103 and A438 with growth Housing Option 4 (preferred option) and Sustainable Transport Option 3 but removal of A49 sustainable transport measures) and Scenario 2 which is as scenario 1 but with Lumber Lane link.

Table 6.1 Total Costs of Travel

Period	***Total Generalised Cost of Travel / Hours of Generalised Time (£s)***		
	Preferred Western Corridor	***Scenario 1*** *(without Lumber Lane link)*	***Scenario 2*** *(with Lumber Lane link)*
AM	18,557	18,261	18,151
PM	19,709	19,036	18,966
Total	**38,266**	**37,297**	**37,117**

6.4 Table 6.1 shows that the total generalised cost of travel in both peak periods are very similar across all scenarios. Scenario 2 which has the inclusion of the Lumber Lane link road does reduce the overall cost of travel in both peak periods but the differences are marginal.

6.5 Both the eastern route options total costs of travel in both peak periods are slightly lower than that for the Preferred Western Corridor option.

7.0 MODAL SPLIT – REMOVAL OF WHITECROSS & THREE ELMS DEVELOPMENT

7.1 As stated in the introduction of this report the eastern route options have been further assessed to analyse the removal of the Whitecross and Three Elms developments. The Preferred Western Corridor has never been assessed with the removal of the Whitecross and Three Elms Development. The impact on the performance of the network after the removal of the Whitecross and Three Elms developments is discussed below. Scenario 3 is the eastern route option without the addition of Lumber Lane and Scenario 4 is the eastern route option with the addition of Lumber Lane.

7.2 Tables 7.1 and 7.2 show the pre DIADEM forecast person trip totals for car, public transport, cycle and walk demand matrices obtained from the demand model for each modelled scenario for the AM and PM models respectively.

Table 7.1 AM Pre-DIADEM Forecast Person Trip Totals

Scheme	***Mode***	***Demand Scenario***				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Eastern Relief Road	Car	22102	22102	22102	18643	18643
	PT	4062	4062	4062	3809	3809
	Cycle	1936	1936	1936	1672	1672
	Walk	10370	10370	10370	9769	9769
	Total	**38470**	**38470**	**38470**	**33893**	**33893**

Table 7.2 PM Pre-DIADEM Forecast Person Trip Totals

Scheme	***Mode***	***Demand Scenario***				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Eastern Relief Road	Car	23066	23066	23066	19516	19516
	PT	3119	3119	3119	2896	2896
	Cycle	1950	1950	1950	1717	1717
	Walk	13090	13090	13090	12561	12561
	Total	**41225**	**41225**	**41225**	**36690**	**36690**

7.3 The tables show the fixed trip matrices before they are assigned to the networks through Variable Demand Modelling using DIADEM. The tables show clearly the demand changes as a result of the removal of the Whitecross and Three Elms development in Scenario 3 and Scenario 4.

7.4 Tables 7.3 and 7.4 show the post DIADEM forecast person trips for car, public transport, cycle and walk demand matrices obtained from the demand model for each modelled scenario for the AM and PM models respectively.

Table 7.3 AM Post-DIADEM Forecast Person Trip Totals

Scheme	Mode	Demand Scenario				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Eastern Relief Road	Car	22566	20444	20456	19894	19905
	PT	3531	3532	3530	3308	3307
	Cycle	1938	1924	1921	1647	1644
	Walk	10459	10413	10405	9767	9758
	Total	**38494**	**36313**	**36312**	**34616**	**34614**

Table 7.4 PM Post-DIADEM Forecast Person Trip Totals

Scheme	Mode	Demand Scenario				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Eastern Relief Road	Car	24800	21199	21208	20677	20681
	PT	2758	2752	2750	2560	2558
	Cycle	1915	1902	1901	1667	1665
	Walk	13026	12964	12962	12395	12393
	Total	**42499**	**38817**	**38821**	**37299**	**37297**

7.5 Comparing the four scenario options pre and post DIADEM assignments it can be seen that with the removal of the Whitecross and Three Elms development (Scenarios 3 and 4) additional capacity in the network is created and as a result the demand for travel by car increases slightly between the pre and post assignments with the demand for PT decreasing slightly as people switch back to using the car as a mode of transport. The differences of travel by all modes between scenarios 3 and 4 i.e. with and without the Lugg Meadow link are marginal.

8.0 MODEL PERFORMANCE STATISTICS – REMOVAL OF WHITECROSS & THREE ELMS DEVELOPMENT

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

Non – Highway Models

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

- Total Distance (measured in person-kilometres); and
- Total Time (measured in person-hours).

8.3 The comparison of total distance travelled within the modelled network (Herefordshire County) for the AM model is shown in table 8.1.

Table 8.1 AM Peak – Comparison of Total Distance Travelled (person-kilometres)

Mode	***Sub-Mode***	***Demand Scenario***				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
PT	Bus	9826	9823	9811	9270	9257
	Coach	406	434	436	396	394
	Rail	29151	29333	29415	28700	28786
	Sub-Total	**39383**	**39590**	**39662**	**38366**	**38437**
Cycle		7180	7172	7164	6392	6381
Walk		32527	32536	32509	30439	30405
Total		**79090**	**79298**	**79335**	**75197**	**75223**

8.4 For the non-car modes, it can be seen that the removal of the Whitecross and Three Elms developments (Scenarios 3 and 4) reduced the total distance travelled, as there are less trips assigned onto the network. The addition of Lumber Lane (Scenario 4) leads to a slight fall in the distance travelled by bus, coach, cycle and walk, whilst the passenger kilometres travelled by rail marginally increases. The comparison for the PM model is shown in Table 8.2.

Table 8.2 PM Peak – Comparison of Total Distance Travelled (person-kilometres)

Mode	Sub-Mode	Demand Scenario				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
PT	Bus	8561	8712	8647	8106	8048
	Coach	0	0	0	0	0
	Rail	17217	17369	17388	16657	16669
	Sub-Total	**25778**	**26081**	**26035**	**24673**	**24717**
Cycle		6891	6906	6890	6193	6179
Walk		35504	35552	35472	33630	33558
Total		**68173**	**68539**	**68397**	**64496**	**64454**

8.5 As in the AM Model, it can be seen that in the PM model, the addition of Lumber Lane leads to a slight fall in passenger kilometres for the public transport, cycle and walk modes. Passenger kilometres travelled by rail however increase slightly between the no Lumber Lane and the addition of Lumber Lane scenarios.

8.6 Scenario 3 and Scenario 4 show a decrease when compared to the preferred Western Relief Road as would be expected with the lower number of trips due to the removal of the Whitecross and Three Elms development.

8.7 Table 8.3 and Table 8.4 show the comparison of total travel time by non-car modes across scenarios and time periods.

Table 8.3 AM Peak - Comparison of Travel Time (person-hours)

Mode	Sub-Mode	Demand Scenario				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
PT	Bus	711	709	708	663	662
	Coach	6	6	6	6	6
	Rail	332	333	334	326	327
	Sub-Total	**1048**	**1048**	**1048**	**995**	**995**
Cycle		479	478	478	426	425
Walk		8132	8134	8127	7610	7601
Total		**9659**	**9660**	**9653**	**9031**	**9021**

Table 8.4 PM Peak - Comparison of Travel Time (person-hours)

Mode	Sub-Mode	Demand Scenario				
		Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
PT	Bus	469	474	471	436	433
	Coach	0	0	0	0	0
	Rail	188	189	189	181	181
	Sub-Total	**657**	**663**	**660**	**617**	**614**
Cycle		459	460	459	413	412
Walk		8876	8888	8868	8407	8390
Total		**9335**	**10011**	**9987**	**9437**	**9416**

8.8 Comparing Scenarios 3 and 4 it can be seen that there is a small reduction in the total travel time for the non-car modes with the addition of Lumber Lane. Comparing the AM peak results with that of the Preferred Western Corridor and Scenario 1 and 2 the travel time for the non-car modes for Scenario 3 and 4 it is lower as would be expected with the removal of Whitecross and Three Elms. For the PM peak all four scenarios non-car travel time by all modes combined is higher than that of the Preferred Western Corridor with a Western Relief Road.

Highway Model

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8.9 The comparisons of network performance for the AM and PM future year models are shown in Tables 8.5 to 8.6.

Table 8.5 2026 AM Peak – Summary of Highway Network Performance

Indicators	Demand Scenario				
	Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Total Time / hrs	2161	2163	2167	2126	2131
Transient Queues / hrs	648	655	635	642	619
Over-Cap. Queues / hrs	1	9	0	8	0
Link Delays / hrs	61	72	86	68	82
Total Distance / km	81472	78712	81924	77708	81009
Total Trips Loaded / pcu	18359	18400	18409	17983	17993
Average Speed / kph	37.7	36.4	37.8	36.5	38.0

Table 8.6 2026 PM Peak – Summary of Highway Network Performance

Indicators	***Demand Scenario***				
	Preferred Western Corridor	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
Total Time / hrs	2547	2297	2326	2259	2296
Transient Queues / hrs	832	750	742	732	727
Over-Cap. Queues / hrs	39	15	11	13	12
Link Delays / hrs	83	64	77	63	76
Total Distance / km	89795	80223	83766	79406	83011
Total Trips Loaded / pcu	19765	19020	19027	18625	18628
Average Speed / kph	35.2	34.9	36.0	35.1	36.2

8.10 The results show that for Scenario 3 (with the removal of Whitecross and Three Elms development) the overall network performance as compared to the Preferred Western Corridor compares more favourably than that of Scenario 1 with the average speed increasing to 36.5kph in the AM peak and 35.1kph in the PM peak. Link delay hours are higher in Scenario 2 than that of the Preferred Western Corridor for the AM peak with 68 link delays hours compared to 61 link delay hours, however the PM peak is marginally better with 63 link delay hours as compared to 83 for the Preferred Western Corridor.

8.11 Scenario 4 with the addition of the upgraded Lumber Lane in place results in a marked improvement in congestion across both the AM and PM peaks as compared to all other scenarios including that of the Preferred Western Corridor option. Overall average network speed improves to 38.0kph in the AM peak and 36.2 in the PM peak. Link delay hours however are still higher in the AM peak at 82 hours but the transient queues are lower at 619 hours in the AM peak as compared to that of 648 hours for the Preferred Western Corridor scheme. This is as a result of the removal of the Whitecross and Three Elms development trips resulting in fewer trips being assigned to the network but also the upgrade of Lumber Lane does assist in improving the overall network performance.

8.12 Tables 8.7 to 8.8 give ranking to the summary of the network performance for Transient Queues/hrs, Over Capacity Queue/hrs, Link Delay/hrs and average speed/kph for the AM peak and PM peak respectively. The rankings reveal that Scenario 4 gives the best overall network performance closely followed by Scenario 2. It appears the main reason why Scenario 4 has a better overall network performance than the other three scenarios is due to the smaller number of highway trips assigned onto the network due to the removal of the Whitecross and Three Elms development trips combined with the addition of the Lumber Lane upgraded link which provides some alleviation to the overall network performance. The benefits of the upgrade Lumber Lane link is further confirmed by the good performance in the ranking tables for both AM and PM of Scenario 2 which includes the full allocation of housing.

Table 8.7 AM Peak – Network Performance Ranking Tables

Scenario	***Transient Queues/hrs***	***Rank***
Scenario 4	619	1
Scenario 2	635	2
Scenario 3	642	3
Preferred Western Corridor	648	4
Scenario 1	655	5
Scenario	***Over-Capacity Queues/hrs***	***Rank***
Scenario 4	0	1
Scenario 2	0	2
Preferred Western Corridor	1	3
Scenario 3	8	4
Scenario 1	9	5
Scenario	***Link Delays/hrs***	***Rank***
Preferred Western Corridor	61	1
Scenario 3	68	2
Scenario 1	72	3
Scenario 4	82	4
Scenario 2	86	5
Scenario	***Average Speed/kph***	***Rank***
Scenario 4	38	1
Scenario 2	37.8	2
Preferred Western Corridor	37.7	3
Scenario 3	36.5	4
Scenario 1	36.4	5

Source: Table 8.5

Table 8.8 PM Peak – Network Performance Ranking Tables

Scenario	***Transient Queues/hrs***	***Rank***
Scenario 4	727	1
Scenario 3	732	2
Scenario 2	742	3
Scenario 1	750	4
Preferred Western Corridor	832	5
Scenario	***Over-Capacity Queues/hrs***	***Rank***
Scenario 2	11	1
Scenario 4	12	2
Scenario 3	13	3
Scenario 1	15	4
Preferred Western Corridor	39	5
Scenario	***Link Delays/hrs***	***Rank***
Scenario 3	63	1
Scenario 1	64	2
Scenario 4	76	3
Scenario 2	77	4
Preferred Western Corridor	83	5
Scenario	***Average Speed/kph***	***Rank***
Scenario 4	36.2	1
Scenario 2	36.0	2
Preferred Western Corridor	35.2	3
Scenario 3	35.1	4
Scenario 1	34.9	5

Source: Table 8.6

9.0 ANALYSIS OF HIGHWAY MODEL RESULTS – REMOVAL OF WHITECROSS & THREE ELMS DEVELOPMENT

Impact of Relief Road

9.1 Analysis was undertaken to assess the impact a Relief Road has on the main roads in and around Hereford and the differences between each of the four scenarios. Table 9.1 shows the total flows on the main roads in Hereford for the 2026 future year for each of the four scenarios for the AM and PM peak periods.

9.2 The scenarios in Table 9.1 are the Preferred Western Corridor, Scenario 1 (the removal of Lugg Meadows Link from Eastern Alignment between A4103 and A438 with Housing Growth Option 4 (preferred option) and Sustainable Transport Option 3 but removal of A49 sustainable transport measures). Scenario 2 which is as scenario 1 but with Lumber Lane link. Scenario 3 is as scenario 1 with reduced housing (removal of Whitecross and Three Elms sites) and scenario 4 is as scenario 3 with Lumber Lane link.

Table 9.1 AM and PM Total Vehicular Flows

Road Type	***Road Name***	***Direction***	***Preferred Western Corridor***		***Scenario 1*** *(All homes, without Lumber Lane link)*		***Scenario 2*** *(All homes with a Lumber Lane link)*		***Scenario 3*** *(Reduced housing without Lumber Lane link)*		***Scenario 4*** *(Reduced housing with Lumber Lane link)*	
			AM	***PM***	***AM***	***PM***	***AM***	***PM***	***AM***	***PM***	***AM***	***PM***
Trunk Road	**A49**	NB	1725	1657	1679	1656	1615	1598	1726	1644	1652	1593
		SB	1332	1648	1214	1806	1164	1799	1154	1790	1117	1789
Primary Road	**A4103**	EB	495	402	464	458	522	491	477	463	528	491
		WB	760	486	870	637	839	703	873	637	832	689
	A465	NB/EB	572	389	489	518	438	478	492	483	533	439
		SB/WB	215	154	242	191	234	186	233	193	206	193
	A438	NB/EB	978	499	1050	648	1032	647	952	609	948	599
		SB/WB	495	718	529	968	529	948	597	928	590	889
	A4110	NB	400	286	443	474	435	443	370	470	360	431
		SB	361	332	315	425	309	424	337	416	317	408
	A438 Ledbury Road	EB	304	481	231	417	230	395	228	413	223	393
		WB	520	248	470	201	445	145	465	196	447	142
Non-Primary Road	**B4224**	EB	509	276	483	291	425	291	452	279	403	281
		WB	558	451	595	611	560	548	604	613	547	550
	B4399	EB	245	228	123	296	230	335	124	295	227	333
		WB	330	163	239	144	425	256	229	141	427	255
	Lumber Lane	NB	-	-	-	-	745	824	-	-	746	839
		SB	-	-	-	-	760	544	-	-	763	550
	Bodenham Road	NB	273	275	334	296	355	296	342	288	332	293
		SB	260	344	547	450	405	432	553	449	409	441
	Folly Lane	NB	150	78	81	86	125	73	79	88	132	67
		SB	61	117	32	125	47	110	30	118	32	111

9.3 The link flows with No Relief Road scenario were compared to that of four scenarios. The total flow comparison for each type of roads is shown in Tables 9.2.

Table 9.2 AM/PM Comparison: Impacts of Highway Options on Existing Highway

Road Type	*Road Name*	*Direction*	*Preferred Western Corridor*		*Scenario 1 (All homes, without Lumber Lane link)*		*Scenario 2 (All homes with a Lumber Lane link)*		*Scenario 3 (Reduced housing without Lumber Lane link)*		*Scenario 4 (Reduced housing with Lumber Lane link)*	
			AM	*PM*	*AM*	*PM*	*AM*	*PM*	*AM*	*PM*	*AM*	*PM*
Trunk Road	**A49**	NB	-208	-325	-254	-326	-318	-384	-207	-338	-281	-389
		SB	-330	-508	-448	-350	-498	-357	-508	-366	-545	-367
Primary Road	**A4103**	EB	-67	-91	-98	-35	-40	-2	-85	-30	-34	-2
		WB	20	-141	130	10	99	76	133	10	92	62
	A465	NB/EB	5	-178	-78	-49	-129	-89	-75	-84	-34	-128
		SB/WB	-45	-22	-18	15	-26	10	-27	17	-54	17
	A438	NB/EB	-202	-319	-130	-170	-148	-171	-228	-209	-232	-219
		SB/WB	123	-362	157	-112	157	-132	225	-152	218	-191
	A4110	NB	-7	-323	36	-135	28	-166	-37	-139	-47	-178
		SB	1	-72	-45	21	-51	20	-23	12	-43	4
	A438 Ledbury Road	EB	-26	-37	-99	-101	-100	-123	-102	-105	-107	-125
		WB	37	-10	-13	-57	-38	-113	-18	-62	-36	-116
Non-Primary Road	**B4224**	EB	-118	-134	-144	-119	-202	-119	-175	-131	-224	-129
		WB	9	-103	46	57	11	-6	55	59	-2	-4
	B4399	EB	-39	-143	-161	-75	-54	-36	-160	-76	-57	-38
		WB	-46	-102	-137	-121	49	-9	-147	-124	51	-10
	Lumber Lane	NB	-	-	-	-	-	-	-	-	-	-
		SB	-	-	-	-	-	-	-	-	-	-
	Bodenham Road	NB	3	6	64	27	85	27	72	19	62	24
		SB	-26	42	261	148	119	130	267	147	123	139
	Folly Lane	NB	57	-13	-12	-5	32	-18	-14	-3	39	-24
		SB	28	-34	-1	-26	14	-41	-3	-33	-1	-40

9.3 It can be seen that Scenarios 3 and 4 provide the greatest relief overall to the primary and non primary roads in the network in both peak periods which is to be expected given the lower numbers of highway vehicles assigned onto the network as a result of the removal of Whitecross and Three Elms development.

9.4 Figures 9.1 to 9.2 below show the difference in traffic flows between Scenario 1 and Scenario 3 for the AM and PM peak periods. These scenarios do not contain the upgrade at Lumber Lane and Scenario 1 contains the full housing and development allocations whilst Scenario 3 has the removal of Whitecross and Three Elms development. The blue lines indicate that Scenario 1 flows are higher than Scenario 3 forecast traffic flows and the green lines indicate that Scenario 1 is predicted to have lower traffic flows than Scenario 3.

Figure 9.1 Difference between traffic flows (Scenario 3 minus Scenario 1) – AM Peak

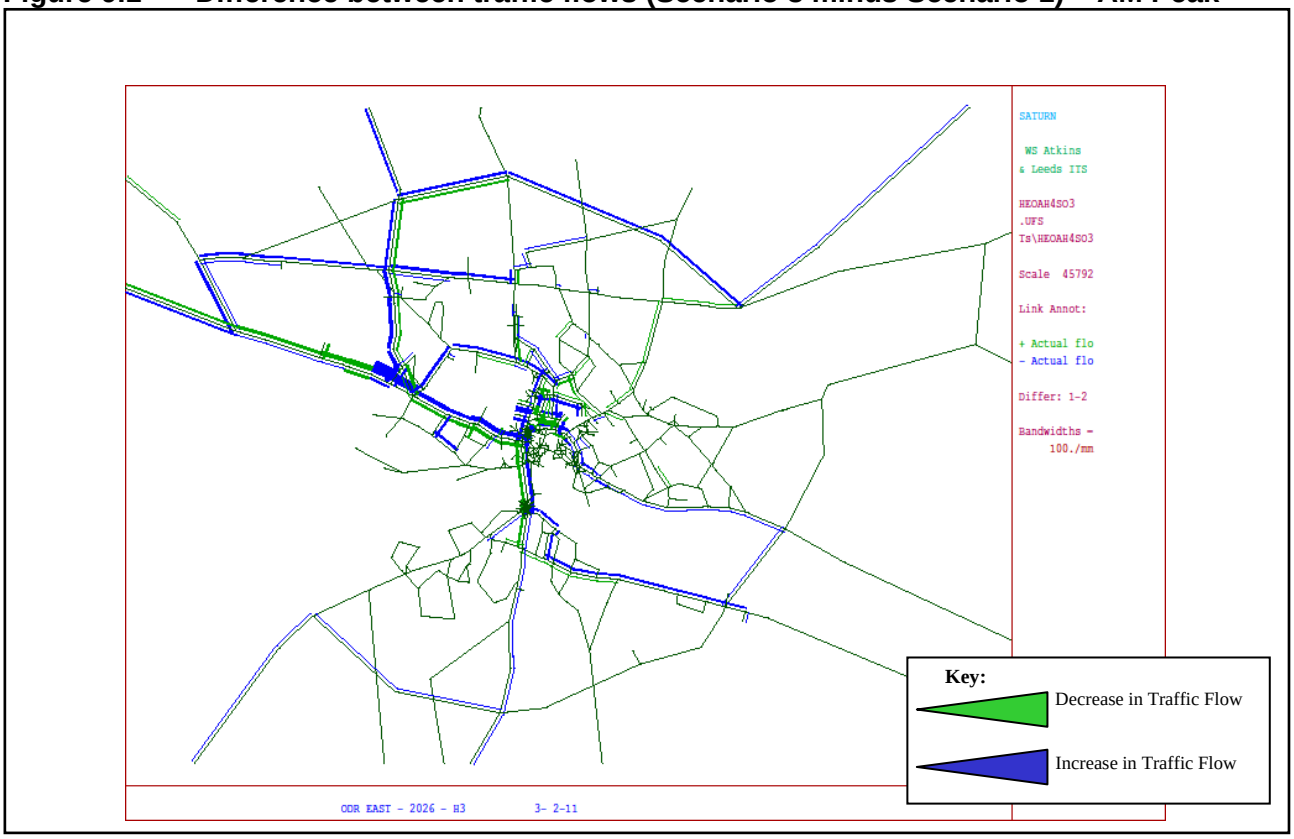
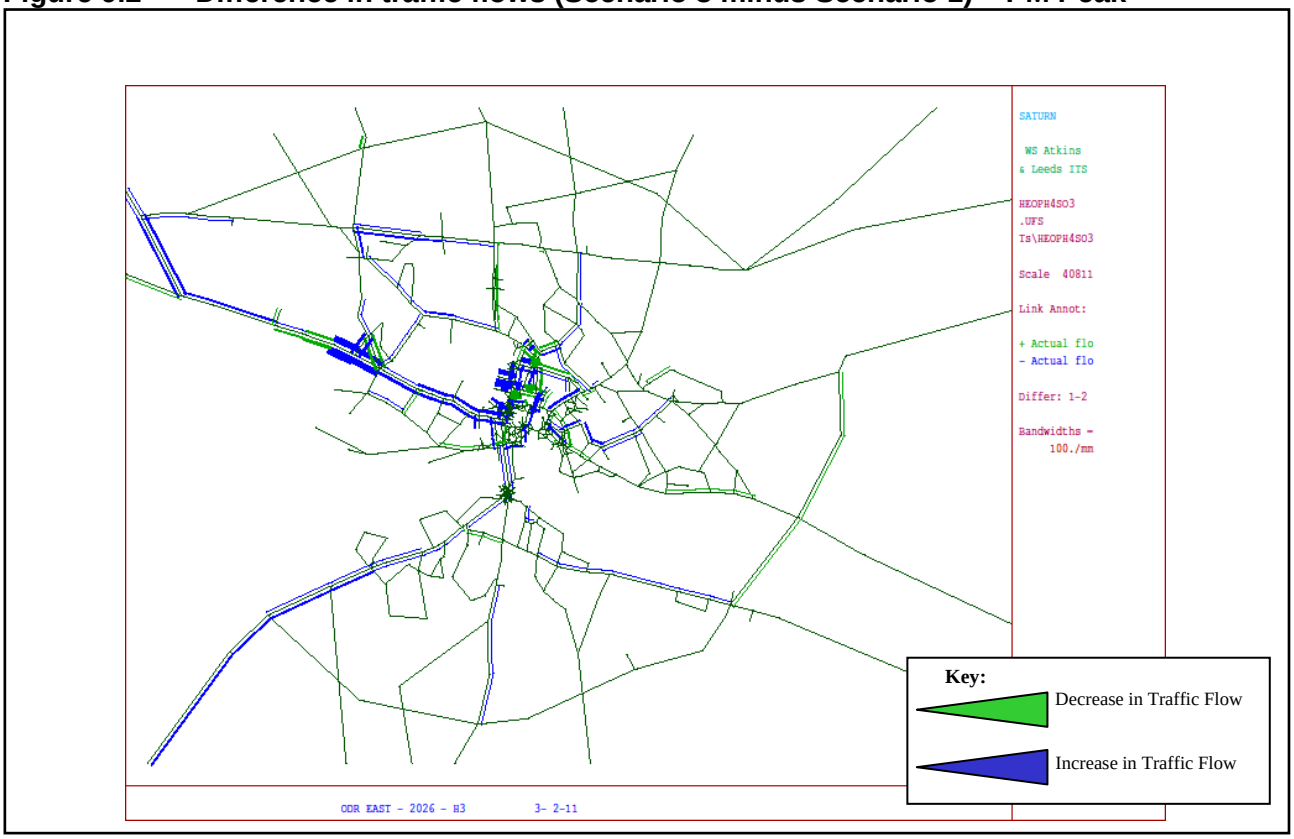


Figure 9.2 Difference in traffic flows (Scenario 3 minus Scenario 1) – PM Peak



9.5 Figures 9.1 and 9.2 illustrate the impact of removing the Whitecross and Three Elms development from the forecasting scenarios. The predominance of blue lines in both figures clearly show that by removing the Whitecross and Three Elms development from the forecasting matrices results in less traffic on the Hereford Transport Network. As to be expected the main areas of traffic flow reduction occur on the western side of the city with the A438 Whitecross Road and the A465 Belmont Road being the most pronounced.

Journey Time Analysis

9.6 The same journey time routes as used in Chapter 5 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. Tables 9.3 and 9.4 show the comparison results for all the scenarios.

Table 9.3 AM Peak – Comparison of Journey Times

Average Modelled Journey Time / mm:ss					
Route	***Preferred Western Corridor***	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
1	23:37	22:55	22:56	22:57	22:44
2	20:26	21:13	20:56	21:02	20:35
3	24:39	24:41	23:30	23:53	23:28
4	22:43	23:12	21:56	23:16	21:49
5	-	-	-	-	-
6	27:34	28:37	27:28	27:30	26:53
7	20:11	20:55	20:01	22:27	21:18
8	22:30	22:50	22:30	22:43	22:04
Total	**161:40**	**164:23**	**159:17**	**163:48**	**158:51**

Table 9.4 PM Peak – Comparison of Journey Times

Average Modelled Journey Time / mm:ss					
Route	***Preferred Western Corridor***	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
1	27:05	25:03	24:38	24:50	24:31
2	21:36	21:02	20:58	21:04	21:08
3	26:25	24:38	24:31	24:23	24:34
4	25:02	25:39	24:28	25:10	24:10
5	-	-	-	-	-
6	33:05	31:04	30:19	30:22	30:11
7	23:55	22:01	21:02	23:21	22:46
8	26:10	24:51	24:10	24:42	24:17
Total	**183:18**	**174:18**	**170:06**	**173:52**	**171:31**

9.7 It can be seen that generally the additional demand associated with the housing & employment options of Whitecross and Three Elms have led to higher journey times for the Scenario 1 and 2 options as compared to that of Scenarios 3 and 4 without the Whitecross and Three Elms development.

9.8 Provision of the upgraded Lumber Lane link has resulted in the reduction of the total journey time during both peak periods. The reduction in journey time that occurs in the AM peak period is approximately 5 minutes between Scenarios 3 and 4 with and without Lumber Lane. The corresponding reduction in total journey time for the PM peak is approximately two minutes between Scenarios 3 and 4.

9.9 Tables 9.5 and 9.6 have ranked in order each scenario by best performing total journey time for the AM and PM peak periods respectively.

Table 9.5 AM Peak – Journey Time Ranking Tables

Scenario	*Total*	*Rank*
Scenario 4	158:51:00	1
Scenario 2	159:17:00	2
Preferred Western Corridor	161:40:00	3
Scenario 3	163:48:00	4
Scenario 1	164:23:00	5

Source: Table 9.3

Table 9.6 PM Peak – Journey Time Ranking Tables

Scenario	*Total*	*Rank*
Scenario 2	170:06:00	1
Scenario 4	171:31:00	2
Scenario 3	173:52:00	3
Scenario 1	174:18:00	4
Preferred Western Corridor	183:18:00	5

Source: Table 9.4

9.10 Looking at both tables Scenario 2, with the inclusion of an upgrade to Lumber Lane, has the best overall total journey time in the network out of the full housing and development allocation scenarios in both peak periods. Scenario 4 which excludes Whitecross and Three Elms development but includes an upgrade to Lumber Lane fares worse in the PM peak than Scenario 2 and only performs marginally better in the AM peak. Scenario 3 in the AM Peak period fares worse than the Preferred Western Corridor and Scenario 2, both of which contain the full housing and development allocation. In the PM peak Scenario 1 performs better than the western alignment but still has a higher combined journey time than that of Scenario 2.

Impact on A49 Trunk Road

9.11 The modelled Journey Times from the AM and PM models on the A49 Trunk Road are shown in Table 9.7.

Table 9.7 AM/PM Peak – Comparison of Modelled Journey Times on A49

Direction	AM Modelled Journey Time / mm:ss				
	Preferred Western Corridor	**Scenario 1** (All homes, without Lumber Lane link)	**Scenario 2** (All homes with a Lumber Lane link)	**Scenario 3** (Reduced housing without Lumber Lane link)	**Scenario 4** (Reduced housing with Lumber Lane link)
NB	15:29	15:25	15:22	15:30	15:21
SB	14:51	15:37	15:18	15:41	15:22
Total	**30:20**	**31:02**	**30:40**	**31:11**	**30:43**
Direction	**PM Modelled Journey Time / mm:ss**				
	Preferred Western Corridor	**Scenario 1** (All homes, without Lumber Lane link)	**Scenario 2** (All homes with a Lumber Lane link)	**Scenario 3** (Reduced housing without Lumber Lane link)	**Scenario 4** (Reduced housing with Lumber Lane link)
NB	16:30	16:24	16:17	16:26	16:17
SB	15:42	15:08	15:10	15:10	15:08
Total	**32:12**	**31:32**	**31:27**	**31:36**	**31:25**

9.12 The results show that the PM peak period has a higher journey time, particularly for northbound traffic, on the A49 than the AM peak period. Comparing the different scenarios it can be seen that the upgrade of Lumber Lane again does marginally improve the overall journey time in both peak periods shown in Scenario 3 compared to Scenario 4.

9.13 Comparing Scenario 1 to Scenario 3 and Scenario 2 with Scenario 4 with and without Whitecross and Three Elms development scenarios it can be seen that there is very little difference in both journey times northbound and southbound on the A49 in both peak periods.

Over Capacity Junctions

9.14 The numbers of modelled junctions within each volume-to-capacity band are shown in Table 9.8 for the AM peak models and in table 9.9 for the PM peak models. Table 9.10 shows the over capacity for both peaks combined.

Table 9.8 Junctions Over Capacity – AM Peak

Volume to Capacity Ratio	Preferred Western Corridor	Scenario 1 (All homes, without Lumber Lane link)	Scenario 2 (All homes with a Lumber Lane link)	Scenario 3 (Reduced housing without Lumber Lane link)	Scenario 4 (Reduced housing with Lumber Lane link)
85% to 100%	13	16	11	14	10
100% to 120%	4	3	1	3	1
120% and over	0	0	0	0	0
Total	**17**	**19**	**12**	**17**	**11**

Table 9.9 Junctions Over Capacity – PM Peak

Volume to Capacity Ratio	***Preferred Western Corridor***	***Scenario 1 (All homes, without Lumber Lane link)***	***Scenario 2 (All homes with a Lumber Lane link)***	***Scenario 3 (Reduced housing without Lumber Lane link)***	***Scenario 4 (Reduced housing with Lumber Lane link)***
85% to 100%	13	16	10	13	9
100% to 120%	9	5	6	5	8
120% and over	0	0	0	0	0
Total	**22**	**21**	**16**	**18**	**17**

Table 9.10 Junctions Over Capacity – Both Peaks

Volume to Capacity Ratio	***Preferred Western Corridor***	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
85% to 100%	26	32	21	27	19
100% to 120%	13	8	7	8	9
120% and over	0	0	0	0	0
Total	**39**	**40**	**28**	**35**	**28**

9.15 Examination of the results in Tables 9.8 to 9.10, show that provision of an upgraded Lumber Lane link leads to a reduction in the total number of over-capacity junctions. The removal of the Whitecross and Three Elms development has very little impact on reducing the number of junctions with a capacity of over 100% and junctions with a capacity of between 85 to 100% show a slight reduction.

9.16 Figures 9.3 to 9.6 show the location of the over capacity junctions for all scenarios without Whitecross and Three Elms Development for the AM and PM peaks respectively.

9.17 The figures show that without Whitecross and Three Elms development there is a slight reduction to the number of junctions with a capacity between 85 and 100% as shown by a slight decrease in the number of yellow dots. The figures also illustrate the effects that the upgraded Lumber Lane link has on reducing the capacity on the network. This is more noticeable on the A465 Aylestone Hill with the reduction in the number of over capacity junctions particularly in the AM peak period.

Figure 9.3 Junctions operating at >85% of capacity – AM Peak Scenario 3

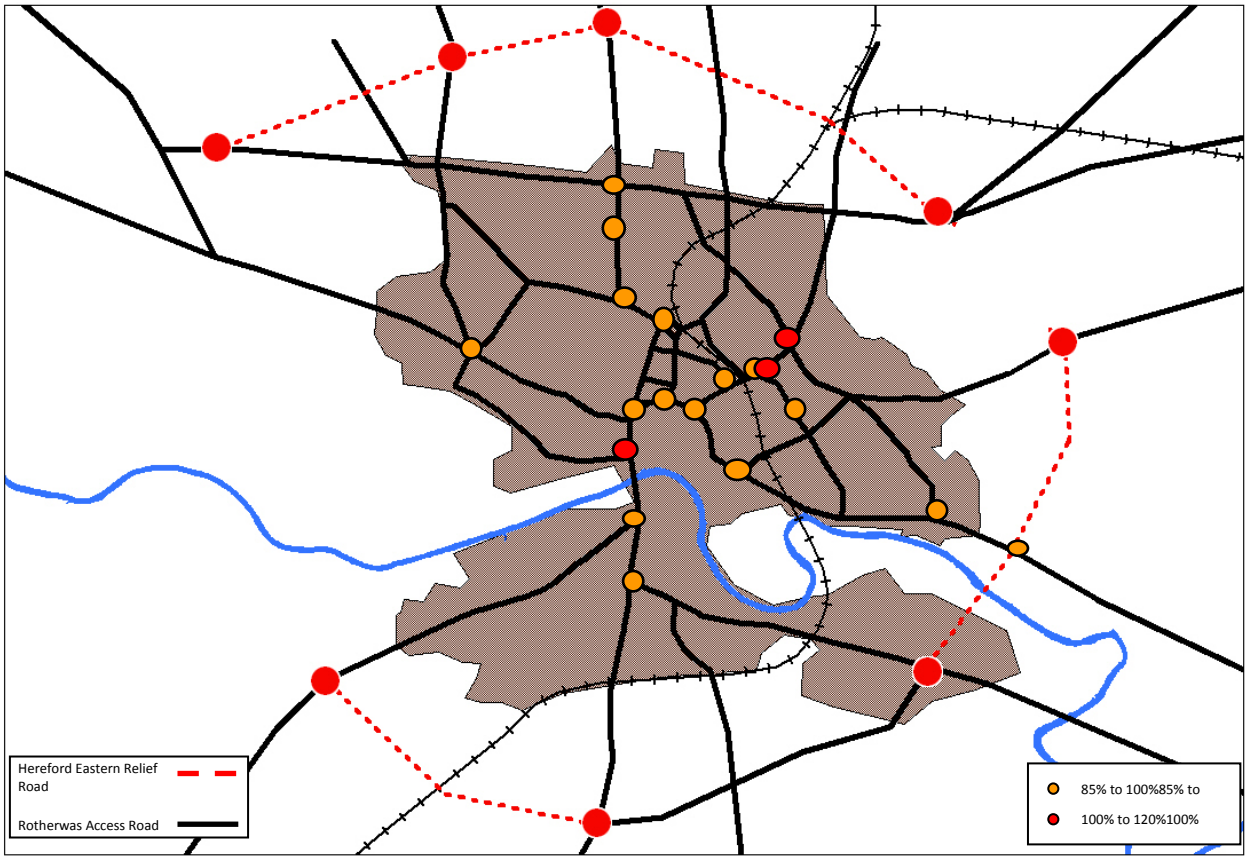


Figure 9.4 Junctions operating at >85% of capacity – PM Peak Scenario 3

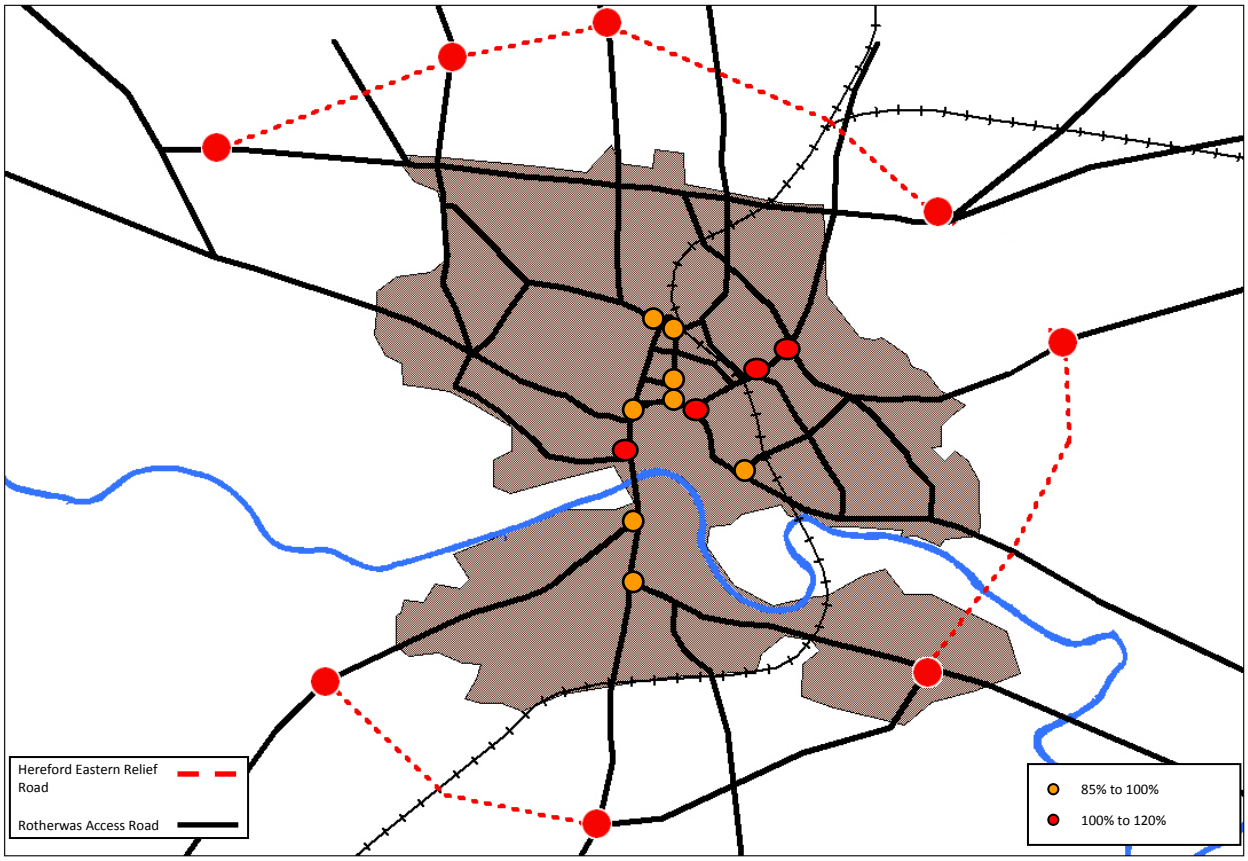


Figure 9.5 Junctions operating at >85% of capacity – AM Peak Scenario 4

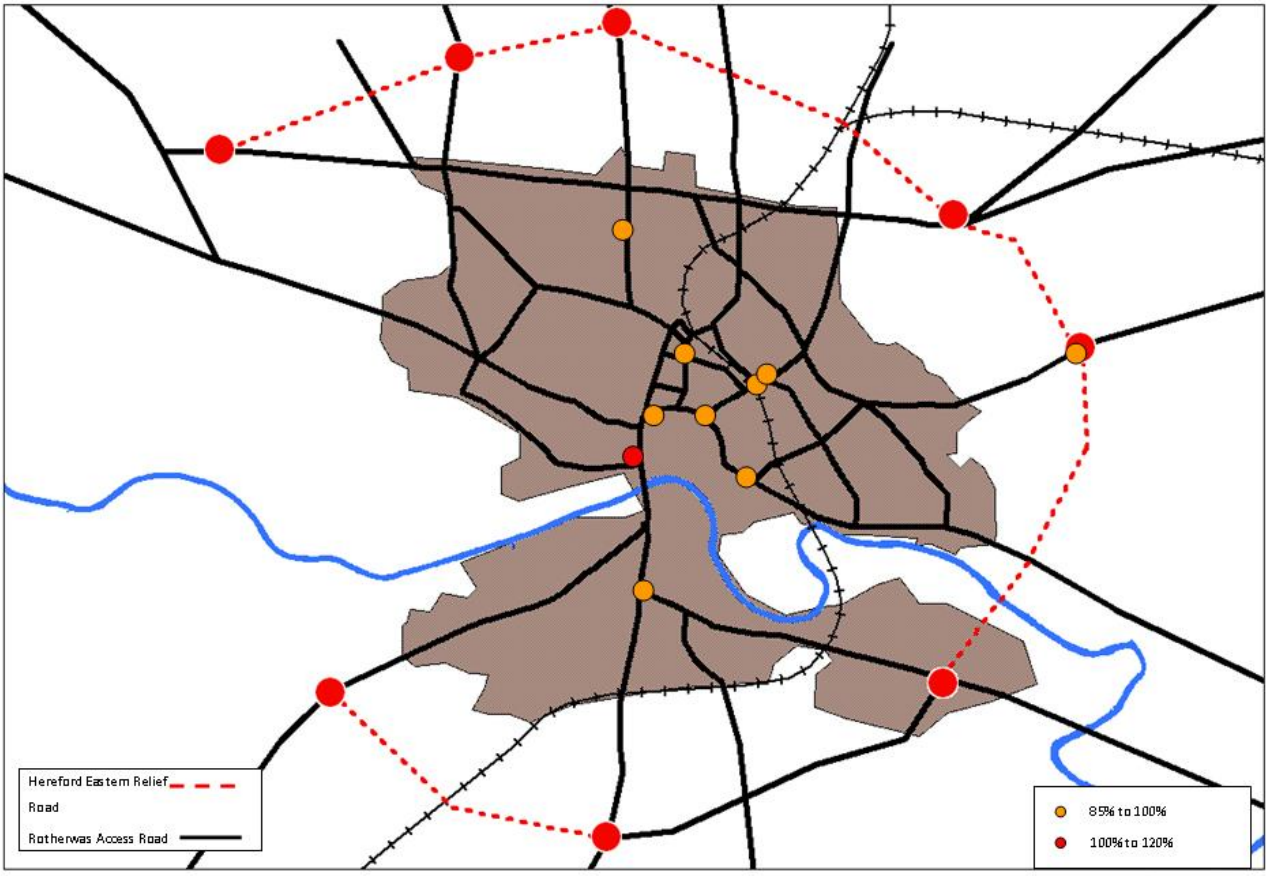
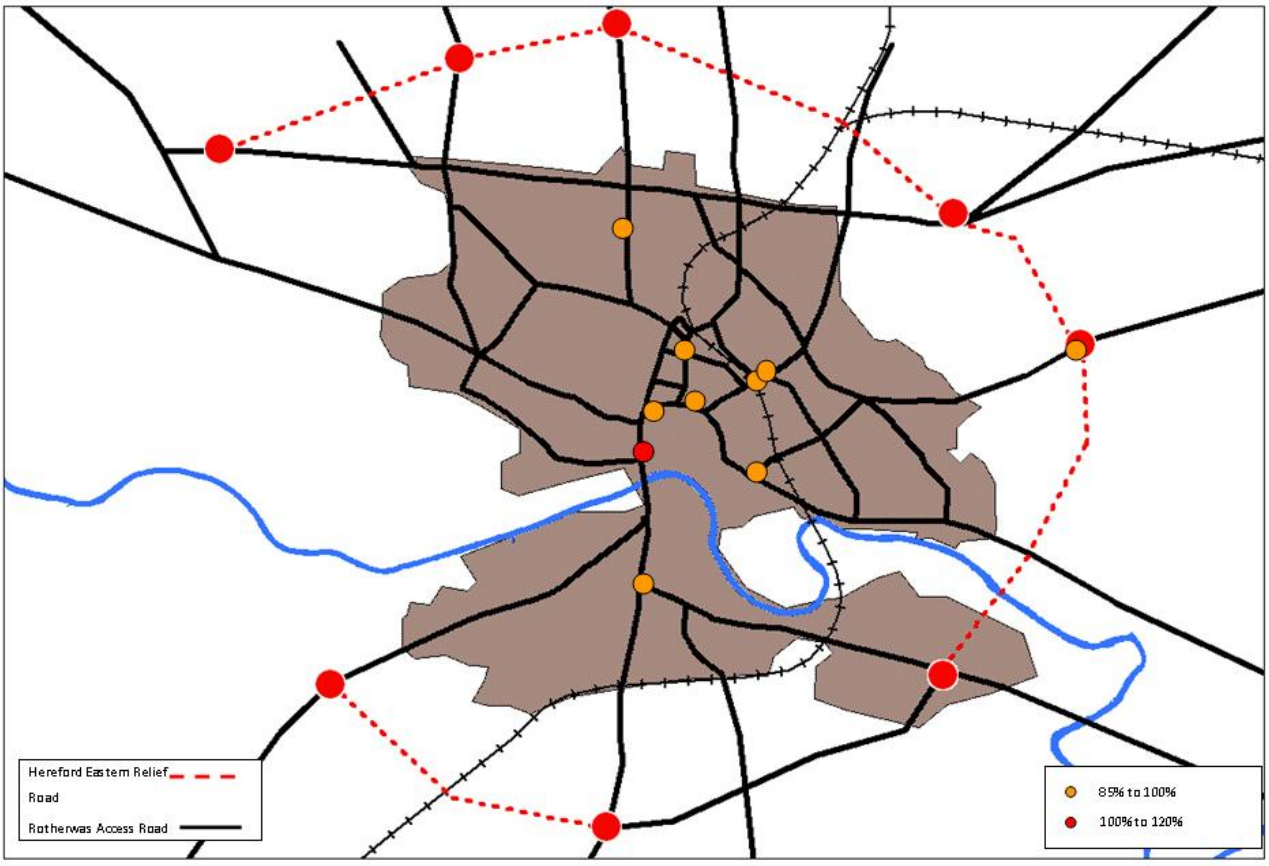


Figure 9.6 Junctions operating at >85% of capacity – PM Peak Scenario 4



10.0 ECONOMICS – REMOVAL OF WHITECROSS & THREE ELMS DEVELOPMENT

10.1 The total generalised costs of travel for the scenarios are shown in Table 10.1.

10.2 The scenarios shown in Table 10.1 are the Preferred Western Corridor, Scenario 1 (the removal of Lugg Meadows Link from Eastern Alignment between A4103 and A438 with growth Housing Option 4 (preferred option) and Sustainable Transport Option 3 but removal of A49 sustainable transport measures) and Scenario 2 (which is as scenario 1 but with Lumber Lane link.)

Table 10.1 Total Costs of Travel

Period	***Total Generalised Cost of Travel / Hours of Generalised Time (£s)***				
	Preferred Western Alignment	***Scenario 1*** *(All homes, without Lumber Lane link)*	***Scenario 2*** *(All homes with a Lumber Lane link)*	***Scenario 3*** *(Reduced housing without Lumber Lane link)*	***Scenario 4*** *(Reduced housing with Lumber Lane link)*
AM	18,557	18,261	18,151	18,259	18,139
PM	19,709	19,036	18,966	19,035	18,988
Total	**38,266**	**37,297**	**37,117**	**37,294**	**37,127**

10.3 Table 10.1 shows that the total generalised cost of travel in both peak periods are very similar across all scenarios. The removal of the Whitecross and Three Elms development does not have any significant impact on the total generalised cost of travel. Scenarios 2 and 4 which have the inclusion of the Lumber Lane link does reduce the overall cost of travel in both peak periods but the differences are marginal.

10.4 All four scenarios total costs of travel in both peak periods are slightly lower than that for the Preferred Western Corridor option.

11.0 CONCLUSIONS

11.1 This report has described the methodology to model four scenarios in relation to the revised eastern route options. Two of the revised eastern options have been tested using the Housing Option 4 with Sustainable Transport Option 3 demand option. The remaining two revised eastern options were assessed as above but with the removal of the Whitecross and Three Elms development form the demand option. The preferred western alignment has only ever been assessed using the full Housing Option 4 development allocation with the Sustainable Transport Option 3 demand option. Forecasts have been produced for a single future year of 2026 for an AM and PM peak period.

11.2 The revised eastern route options presume that no sustainable transport measures on the A49 can take place without the full construction of the Relief Road. The sustainable transport measures on the A49 have therefore been removed from the sustainable transport option packages for all tested scenarios.

11.3 The Variable Demand Modelling assignments showed that by removing the Lugg Meadows link from the Eastern Relief Road saw a reduction in the number of trips across all modes apart from walk as a direct result of the reduction in the road capacity (trip suppression). Inclusion of the upgraded Lumber Lane link appears to resolve the issue of trip suppression as the number of trips were broadly similar between the pre and post variable demand modelling assignments. A modal shift also occurred between PT and car as the models with the inclusion of the Lumber Lane link predicted that some PT trips have a higher cost of travel than the equivalent car trip.

11.4 Table 11.1 shows the average ranking of all five scenarios for both peak periods across all performance indicators i.e. average speed, link delays, queues, journey times, junction stress and travel cost.

Table 11.1 Summary Rankings

Scenario	***AM Rank***	***PM Rank***	***Average Rank***
Scenario 1 (without Lumber Lane link)	5	4	5
Scenario 3 (reduced housing without Lumber Lane link)	4	3	3
Scenario 2 (with Lumber Lane link)	2	1	2
Scenario 4 (reduced housing with Lumber Lane link)	1	1	1
Preferred Western Corridor	3	5	4

11.5 Comparing Scenario 1 and Scenario 2 with the Preferred Western Corridor, all of which contain the full housing allocation, it is Scenario 2 with the inclusion of Lumber Lane that ranks the best in both peak periods. The Preferred Western Corridor performs the worst of the three in the PM Peak, however when looking at both peak periods combined it is Scenario 1 which ranks the worst.

11.6 The removal of the Whitecross and Three Elms development from the demand matrices clearly has a positive effect on the performance indicators with Scenario 4 being the overall recommended option. Scenario 3 without Whitecross and Three Elms development is however outperformed by Scenario 2 that has the full housing and development allocation but has the inclusion of the Lumber Lane upgrade.

11.7 In terms of traffic flow volumes the Preferred western Corridor has lower traffic volumes on the eastern side of Hereford as compared to Scenario's 1 and 2. Traffic volumes on the western side of Hereford as compared to both Scenario 1 and Scenario 2 are only slightly higher, however both eastern alignments have lower traffic volumes present on the network in the central areas of Hereford.

11.8 For the full housing and development allocations for the revised eastern options it is Scenario 2 with the inclusion of Lumber Lane that compares more favourably to the preferred western alignment than Scenario 1 in terms of traffic volumes on the eastern side of Hereford.

11.9 The removal of the Lugg Meadows corridor on the revised eastern options provides beneficial improvements to the city of Hereford over and above a no Relief Road option. When compared to the Western Corridor the results of the overall network performance indicators are broadly similar, however traffic volumes are higher on the main radial and local routes on the eastern parts of the City of Hereford. Lugwardine and Bartestree also experience higher traffic volumes than the Western Relief Road option.

11.10 The inclusion of the Lumber Lane upgrade in Scenarios 2 and 4 alleviates traffic flow on the A438 Ledbury Road, Folly Lane, Aylestone Hill and on the A49 Holmer Road and Ross Road. The inclusion of Lumber Lane also results in much lower traffic flows than Scenario's 1 and 3 in Lugwardine and Bartestree but results in higher traffic volume on the A4103 Worcester Road and the A465 to and from Bromyard.

11.11 In addition the inclusion of an upgraded link to Lumber Lane, although still experiencing higher traffic volumes on the eastern side of Hereford greatly improves the situation as compared to Scenario's 1 and 3 without Lumber Lane. Lugwardine and Bartestree in particular benefit from a reduction in traffic flow as a result of upgrading Lumber Lane. Junctions on the eastern side of the city such as on the A465 Aylestone Hill also experience relief in terms of junction stress, however the A4103 Worcester road and A465 to and from Bromyard do experience higher traffic volumes.

11.12 Overall in terms of the network performance indicators the inclusion of the Lumber Lane upgrade is beneficial to the overall network performance of the revised eastern options and it compares favourably to that of the Preferred Western Corridor. The removal of the Whitecross and Three Elms development trips improve the overall network performance further although Scenario 2 with the full housing allocation still has marginally better results than Scenario 3 with less housing but no Lumber Lane link.

11.13 This study has only addressed the traffic implications of an upgraded Lumber Lane link and has not identified the engineering and environmental issues surrounding this route unlike previous routes assessed within the 'Hereford Relief Road – Study of Options' Study. Further work will be required to evaluate these environmental issues which include impact on Lugwardine Bridge and other heritage assets in the village of Lugwardine itself.