vectos microsim.

Levelling Up Fund Modelling Report

Warwickshire County Council

Stratford upon Avon Levelling Up Fund Modelling

March 2022

Levelling Up Fund Modelling

Stratford upon Avon, Warwickshire

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Contents

Appendices

1 Introduction

1.1 Vectos Microsim (VM) has been working with urban design consultants PJA, Warwickshire County Council and Stratford-upon-Avon Town Council, to assess the effect on the highway network of delivering measures aimed at enhancing the experience for non-motorised transport users within Stratford-upon-Avon town centre.

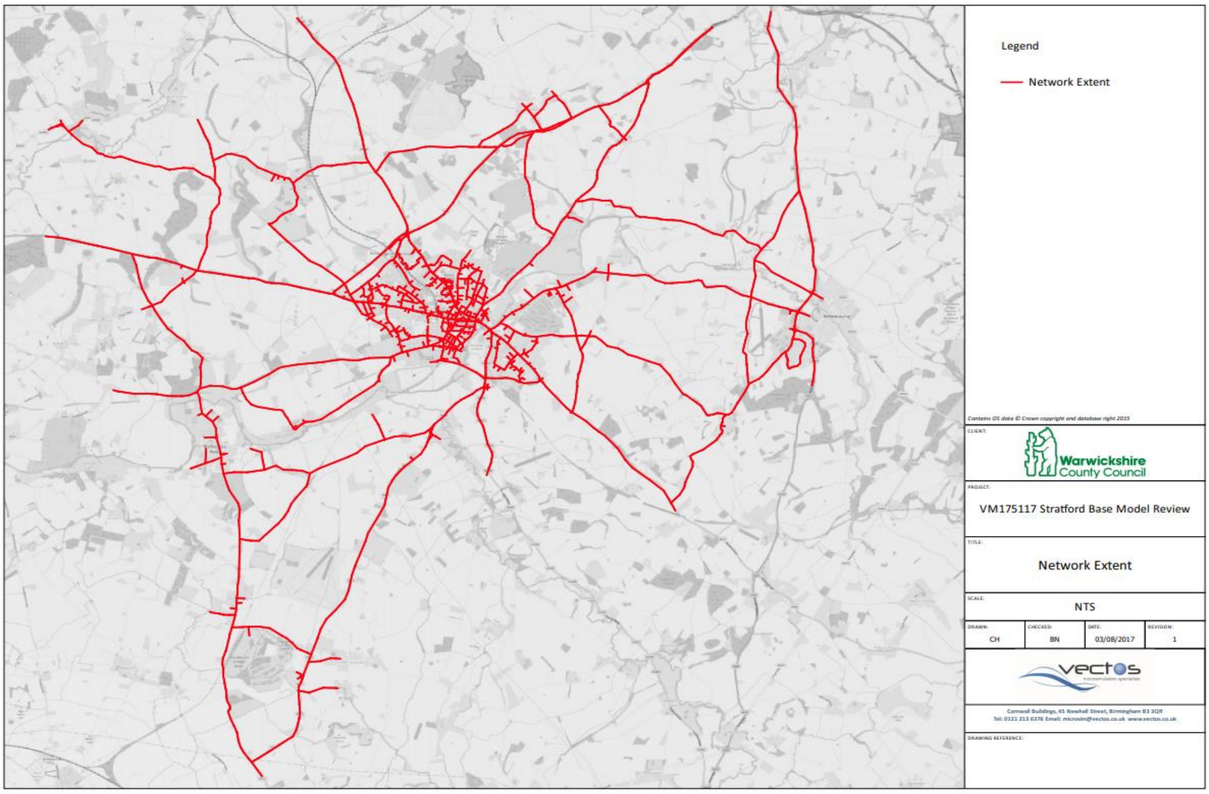
1.2 In order to support these proposals, VM has used the Stratford-upon-Avon Wide Area (SuAWA) traffic model to assess the effects of delivering a package of measures within the town, that have subsequently been submitted for funding consideration as part of the 'Levelling up Fund'.

1.3 This testing has focused upon the impact of a range of options for improvements targeted at non-motorised transport users, before identifying a preferred option, and reporting the likely traffic impacts associated with this option, across the town.

Background

1.4 This assessment has been undertaken within the Stratford-upon-Avon Wide Area (SuAWA) S-Paramics model. The model extent can be seen in **Figure 1**:

Figure 1: Network Extent



1.5 The SuAWA 2017 Base model was completed in late 2018. This Base model was then used to develop a 2023 and 2031 Reference Case scenario (including all consented developments and schemes), as well as a 2031 Core Strategy scenario (including both consented and allocated). These models have subsequently been used to inform the testing of proposals set out within this report.

1.6 Since the initial creation of the 2023 and 2031 Reference Case scenarios, several updates to these models have been undertaken, to include any sites that have become committed or 'reasonably foreseeable'. This includes the SuA2 employment site, along with residential sites at the Airfield House and LMA Bare Land sites.

1.7 There have also been a number of amendments to the models to ensure that all infrastructure is now based on the currently proposed drawings. The coding of the Birmingham Road scheme proposals within the model has been updated, to ensure that the capacity changes to the north of the town centre are accurately reflected within the modelling. Changes to the Shipston Road roundabout have also recently been made, to reflect the outcome of a Road Safety Audit which has recommended changes to the lane configuration, which is likely to result in a lower capacity scheme being delivered within this area.

Study Objectives

1.8 The core objective of assessment work is as follows:

- To assess the effects of a range of options, including various one-way and street closure arrangements, on the overall network performance, inclusive of calculating the predicted scheme Value for Money (VfM) via derivation of a Benefit Cost Ratio (BCR).
- Establish how changes in driver responses, particularly via increases in active mode usage will alter the conclusions drawn from the modelling.
- Assess how the inclusion of signal timings derived from the WCC LinSig models would impact on the conclusions.

Report Structure

1.9 The remainder of this report is set out as follows:

- Chapter 2 – Core Scheme Assessment
- Chapter 3 – Mode Shift Assessment
- Chapter 4 – Detailed Capacity Assessment
- Chapter 5 – Summary and Conclusions

2 Core Scheme Assessment

Introduction

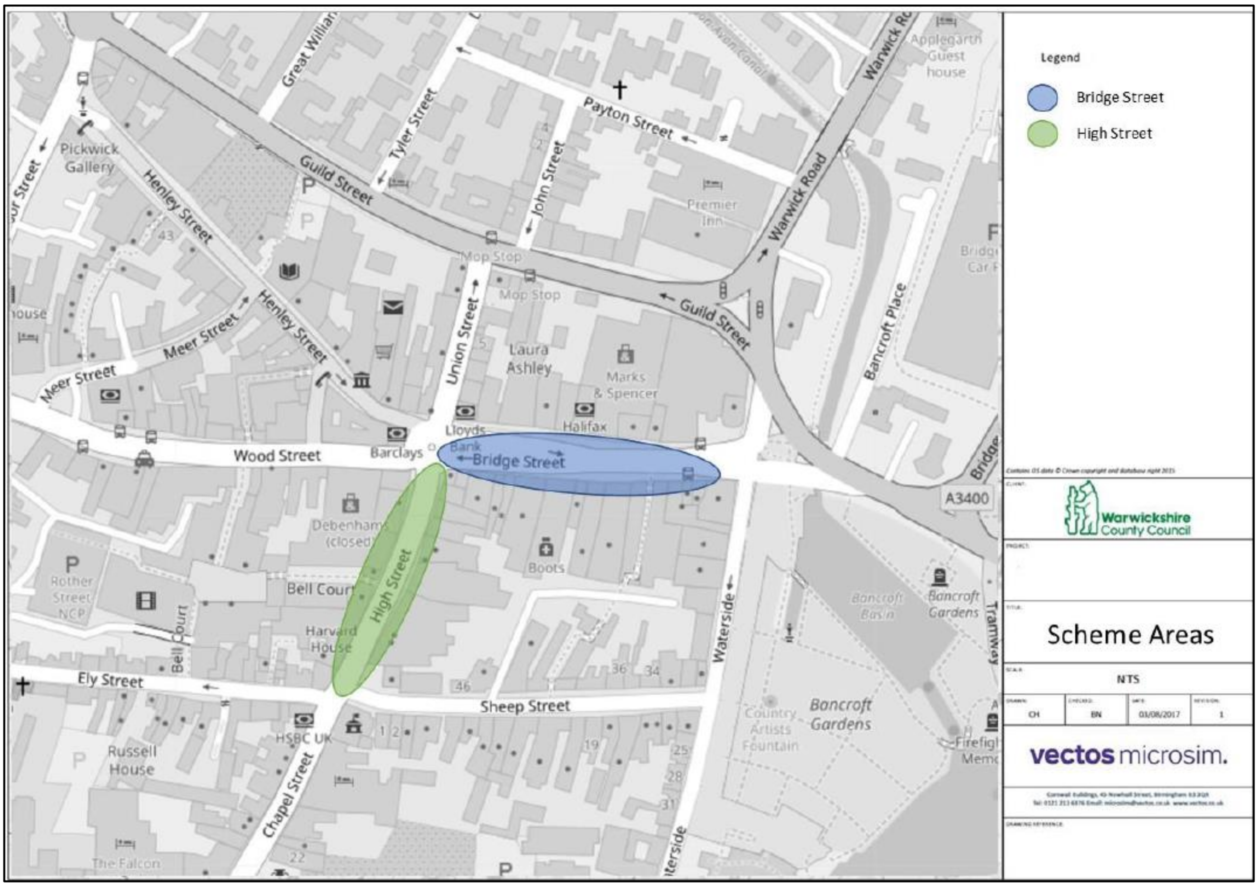
2.1 As detailed within the previous chapter, VM has been working with PJA, WCC and Stratford Town Council, to assess interventions intended to enhance the experience of active mode and sustainable transport users within Stratford-upon-Avon (SuA) town centre.

2.2 As part of the evidence gathering process, in support of these proposals, VM has used the Stratford-upon-Avon Wide Area traffic model to assess the effects of delivering a package of measures within the town centre that are to be submitted for funding consideration as part of the Levelling up Fund.

Scheme Treatment Testing

2.3 Prior to undertaking the option testing, it was first necessary to establish the parameters required to reflect an appropriate level of flow displacement within the town centre. The 2031 Reference Case model was used as the basis for this stage of testing. This testing focuses on Bridge Street and High Street areas as highlighted within **Figure 2.**

Figure 2: Scheme Locations



2.4 A series of adjustments have been made to parameters within the model, specifically relating to the areas outlined above. Speed limit changes have been used to reflect the delivery of a layout which discourages traffic from travelling through the area at high speed, and to reflect target speeds which are lower than those which occur today. Cost factors have also been adjusted; these control driver perception and, in effect, increasing the cost factor results in drivers perceiving a route as being 'more costly' and thus, they will seek to find alternative routes to avoid these 'costly' areas through optimisation of the routing costs calculations during the model runs.

2.5 Two parameters have been changed:

- Posted speeds have been adjusted to reflect 20mph and 10mph design speeds for the area.
- Cost factors of 2.0 have been added to the key links to reflect a design which it is expected will deter drivers based on perception of costs.

2.6 These parameters have been adjusted, incrementally, to identify the point at which they begin to take effect and a modest shift in traffic flows away from the areas has been observed within the model network.

2.7 The following table sets out the different combinations of parameter adopted through this stage of the modelling:

Table 1: Bridge Street/High Street Treatment Scenarios

Scenario	Bridge St	High Street
1.1 (Ref Case)	30mph	30mph
1.2	20mph	20mph
1.3	10mph	10mph
1.4	10mph + CF2	10mph + CF2

Initial Model Results

2.8 The effect that these changes have on the network has been considered initially by looking at reliability and mean delay. Reliability has been assessed by considering the stability and success rate of the models. A successful run has been deemed as such if the number of vehicles on the network is shown to increase from the start of the period, reach a peak level, and then fall as the period nears its end. This has been supported by visual observations of the models to ensure that in cases where this pattern is not present, that it is indeed a result of an unrealistic locking up of the network

2.9 It was identified that it was not until Scenario 1.4 that reliability issues became obvious within the modelling. This also appears apparent within the mean delay results presented in **Figure 3**. Analysis of **Figure 3** reveals that delays increase significantly in the AM period of scenario 1.4 which could be indicative of adverse effects arising from the scheme inclusion. It was also recognised, at this stage, that the effects contributed to the delays observed within scenario 1.4 may be indicative of a need to mitigate other areas of the network following the inclusion of the scheme proposals.

2.10 The level of flow displacement along Bridge Street and High Street has also been considered to understand the effects of each incremental change on traffic flows and how this accords with the wider scheme objectives which include encouraging active modes at the expense of motorised users. Any option which does not deliver a shift in flows away from the area would not be considered representative of the final scheme and so should be discounted.

2.11 The level of traffic flows on Bridge Street and High Street has been reviewed. For simplicity the total flow across the modelled peak travel periods (07:00-10:00 and 16:00-19:00) has been considered at a variety of locations as illustrated within **Figure 4**.

Figure 3: Network Mean Delay (seconds)

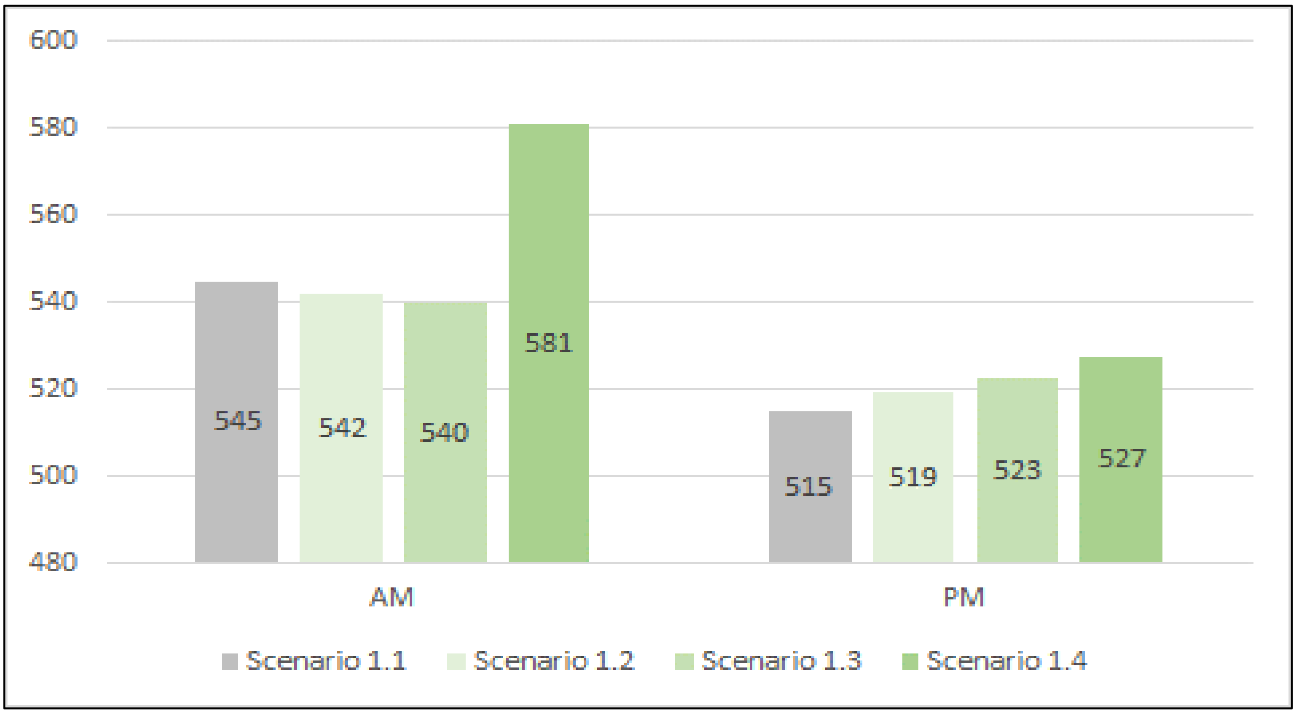
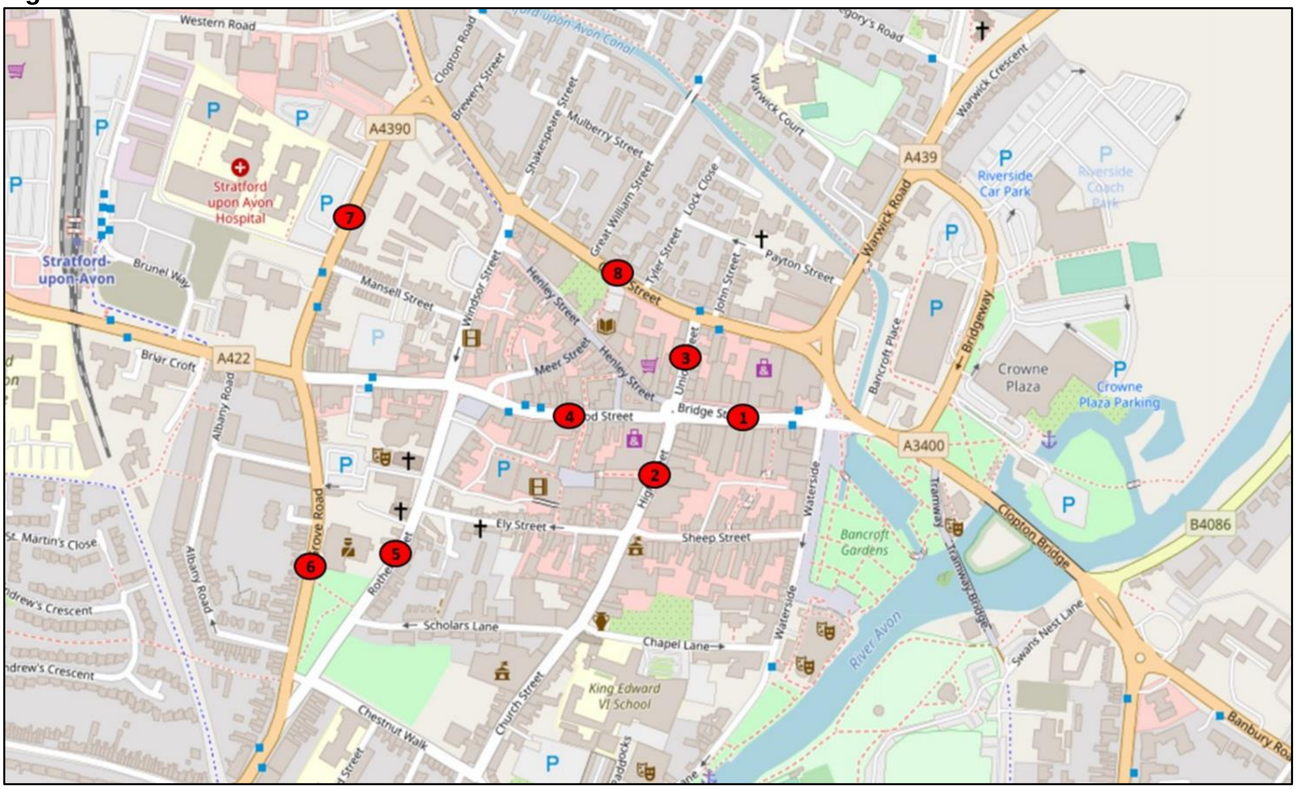


Figure 4: Link Flow Locations



2.12 The flow changes on Bridge Street and High Street are presented within **Figures 5 and 6**:

Figure 5: Bridge Street 6-Hour two-way flow (vehicles)

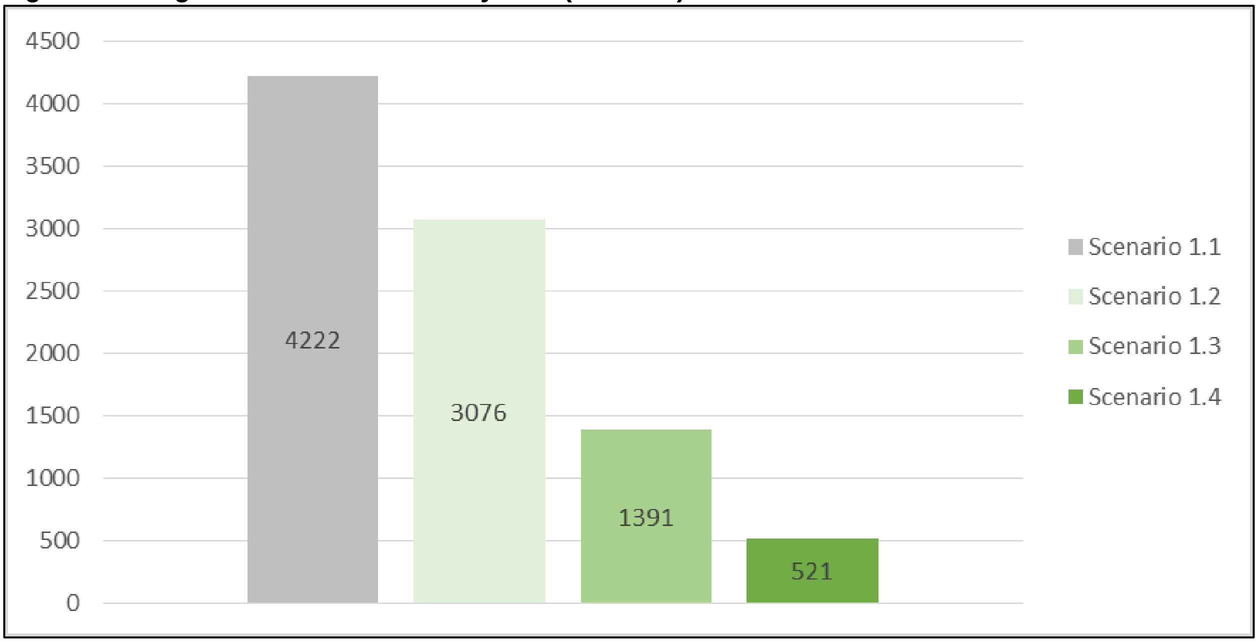
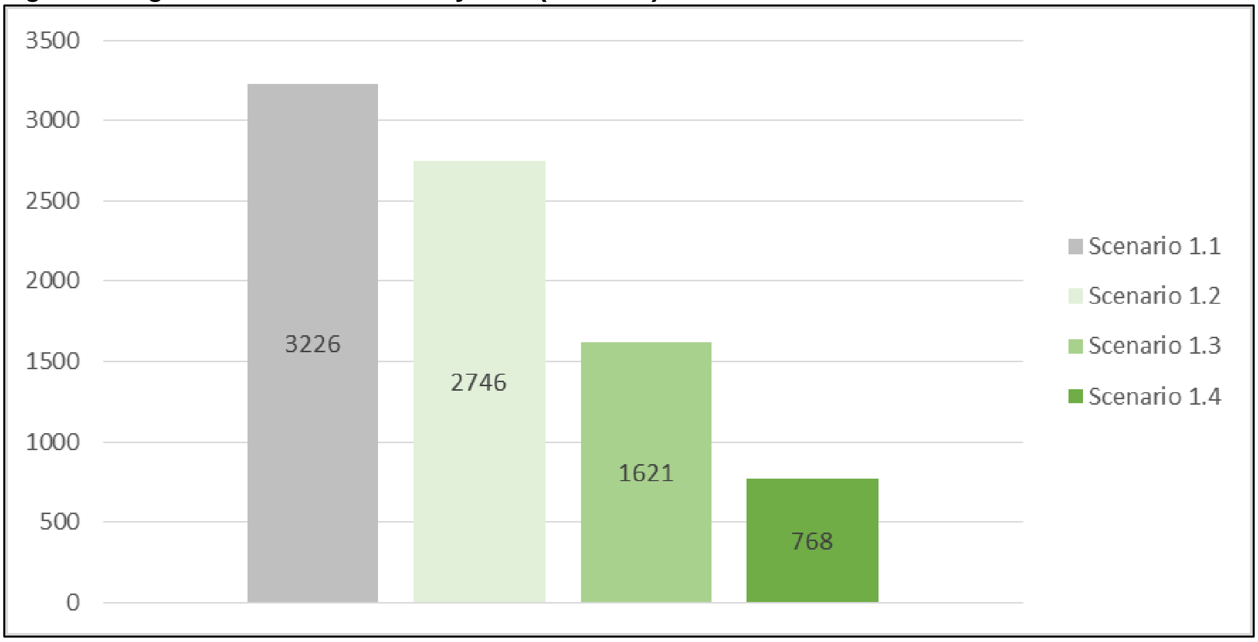


Figure 6: High Street 6-Hour two-way flow (vehicles)

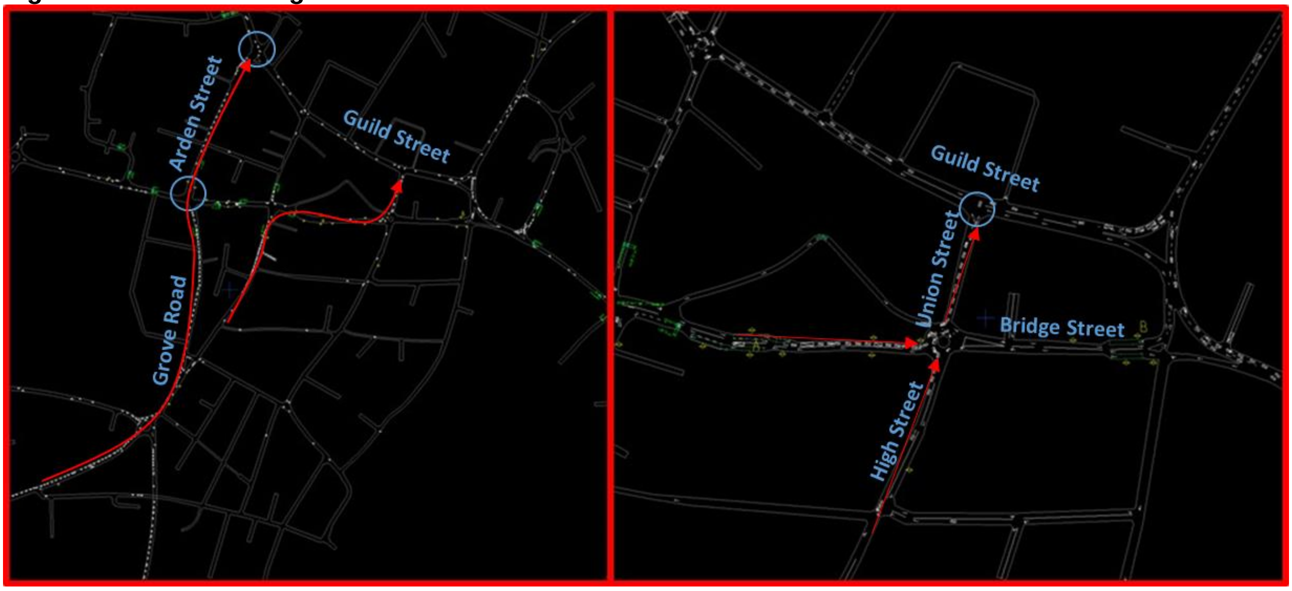


2.13 It is clear that Scenario 1.4 is the most effective at inducing reassignment away from Bridge Street and High Street. This scenario has then been reviewed further to understand what impacts contribute to the large increases in journey times observed with the earlier analysis of the mean delay within this scenario.

2.14 There are two main issues that prevent traffic from being able to move more freely through the model network. These issues are also more prevalent within the AM period and occur as follows:

- Traffic avoiding Bridge Street seeks to access Guild Street via Union Street and, at times, this was observed to cause the model to lock up as the traffic blocks back through a number of key junctions within the town centre.
- Traffic avoiding High Street reassigns to Grove Road and Arden Street instead. The signal configuration of these junctions is not optimised to cater for these movements.

Figure 7: Areas of Congestion – Scenario 1.4



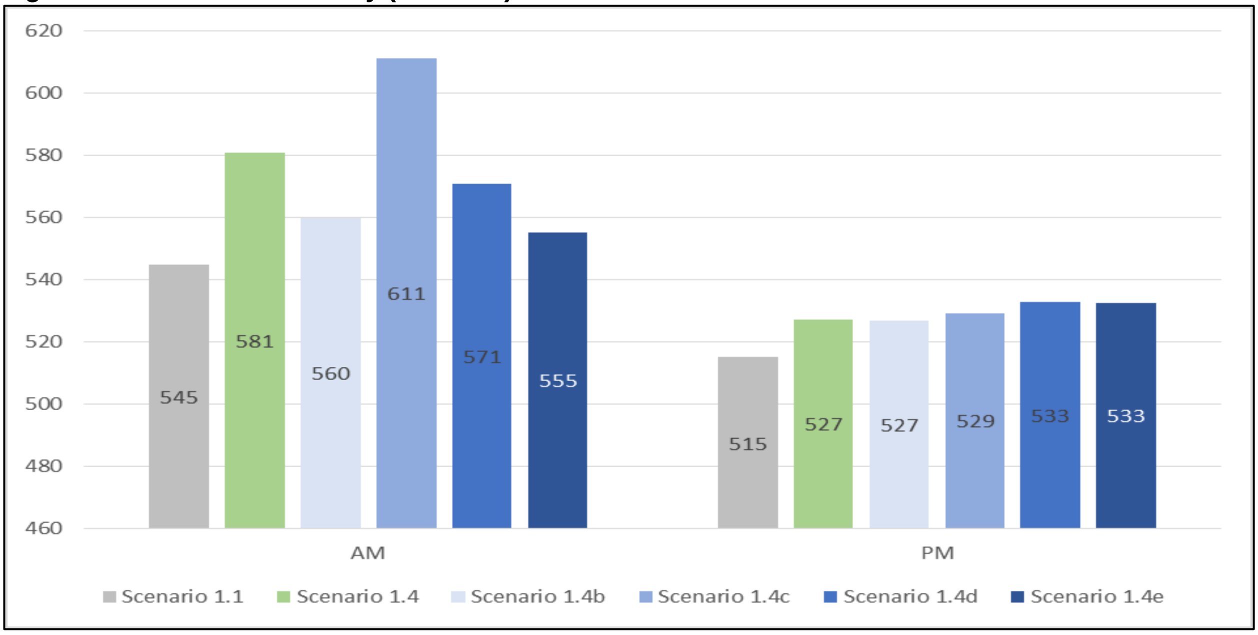
2.15 Therefore several variations of scenario 1.4 have been developed in order to assess how these effects can be minimised.

2.16 These scenarios are listed below:

- 1.4b – Treatment of Union Street per the parameters applied to Bridge Street
- 1.4c – Union Street Closed
- 1.4d – Union Street closed plus optimisation of the Arden Street/Birmingham Road and Grove Road/Arden Street junctions.
- 1.4e – Treatment of Union Street per the parameters applied to Bridge Street plus a right turn ban and optimisation of the Arden Street/Birmingham Road and Grove Road/Arden Street junctions.

2.17 Again these options have initially been assessed via a combination of stability review and network operation measured in terms of overall journey times. At this stage all of the models were considered sufficiently stable to represent viable scenarios. The resultant delays observed within each scenario are presented as follows:

Figure 8: Network Mean Delay (seconds)



2.18 During the PM, there is very little change between options however during the AM option 4e works best. This option would also retain the parking provision on Union Street and assumes that the treatment mirrors that of Bridge Street, additionally turning right out of Union Street has been banned. The effect that this has on traffic flows along the two links is illustrated within the following Figures:

Figure 9: Bridge Street 6-Hour two-way flow (vehicles)

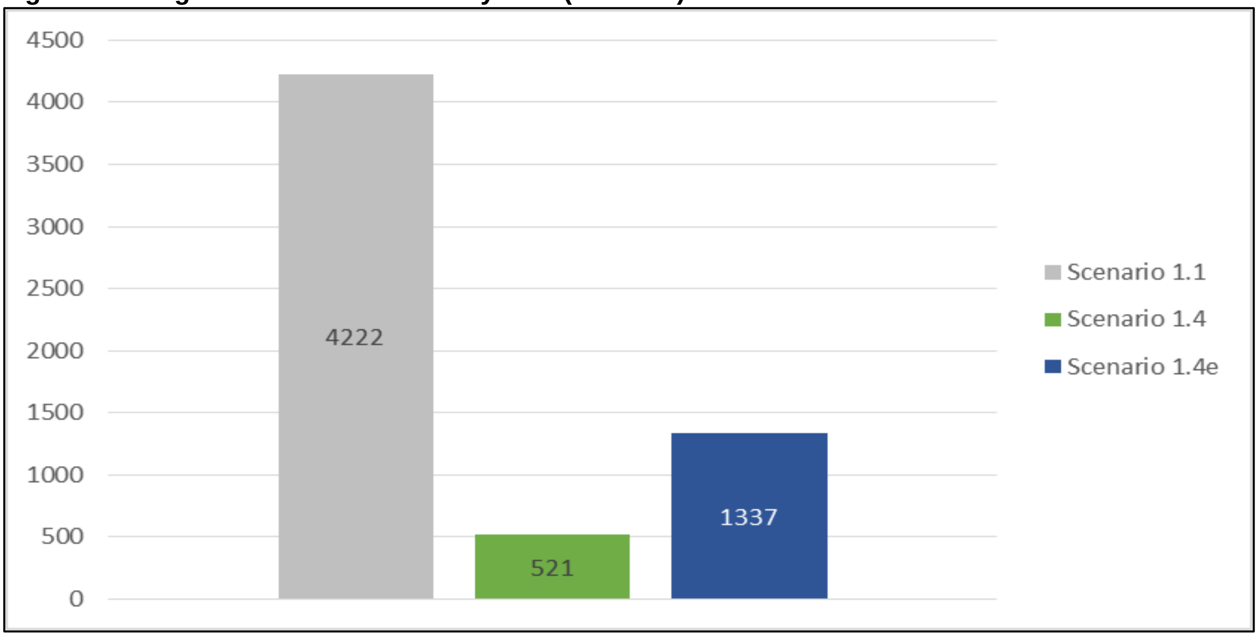
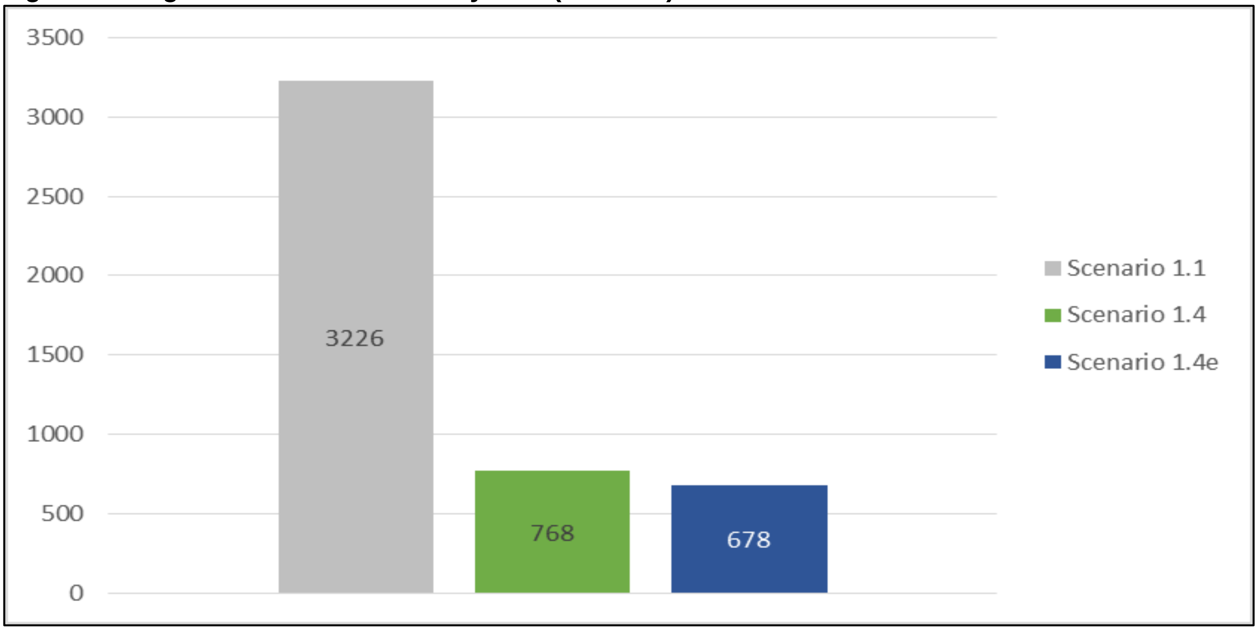


Figure 10: High Street 6-Hour two-way flow (vehicles)



2.19 The results reveal very little effect on High Street but Bridge Street flows increase, these are vehicles that otherwise could not utilise Bridge Street in earlier scenarios due to the effects of queueing back from Union Street blocking access to Bridge Street. The higher flow in this instance is desirable since the throttling effect is occurring as a result of queueing which will have negative implications on Air Quality and travel times equally. This scenario was considered an appropriate basis to move forward with further stages of analysis of the various schemes.

Scheme Option Assessment

2.20 In order to assess the alternative options for the town centre schemes four scenarios have been tested. These scenarios are all based on the 2031 Reference Case model and are listed in the table below

Table 2: Scheme Option Assessment Scenarios

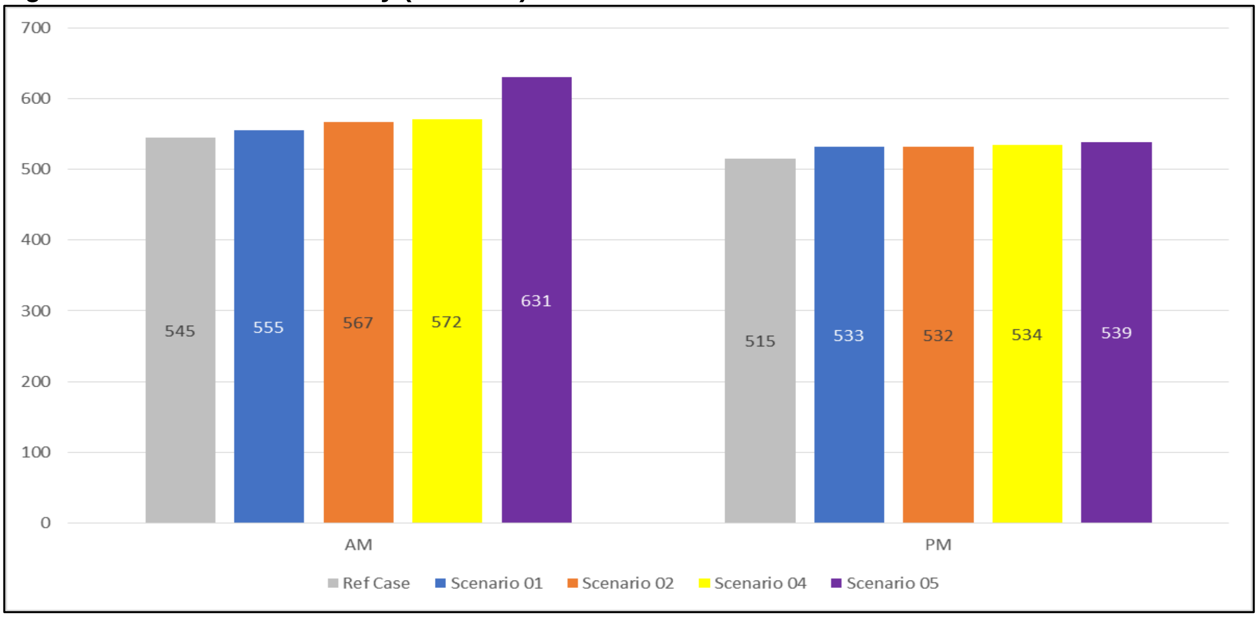
Scenario	Bridge St	High Street
1	2 way reduced speed/flow	2 way reduced speed/flow
2	2 way reduced speed/flow	1 way north bound only.
4	2 way reduced speed/flow	Full closure
5	Bus only	2 way reduced speed/flow

2.21 The scheme tested in the previous section is listed as Scenario 1 in this list. There is no Scenario 3, as the scheme proposed for this option focusses entirely on off-peak working and would have no bearing on the model results. All scenarios include the assumption of both High Street and Bridge Street being 10mph and an increased route cost has been applied to reflect the alternative layout.

Model Results

2.22 The network wide delays as a result of the various scenario configurations were collected and this are illustrated within the following figure:

Figure 11: Network Mean Delay (seconds)



2.23 The results indicate that the Scenario 5 network induces a large increase in journey times within the AM. Scenario 4 increases from the Reference Case are modest at around 5% whilst the other two configurations result in journey time increases of under 5%.

2.24 Removing Scenario 5 the remaining scenarios have been assessed to establish changes in traffic flows along the two links and this is presented within the following figures:

Figure 12: Bridge Street 6-Hour two-way flow (vehicles)

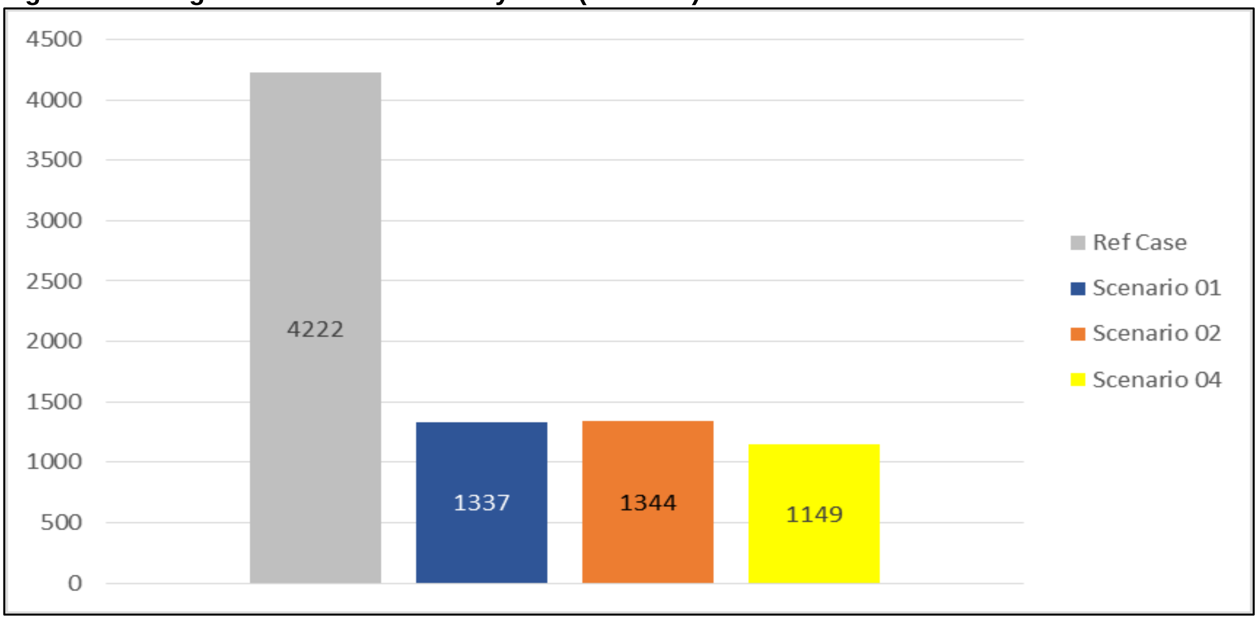
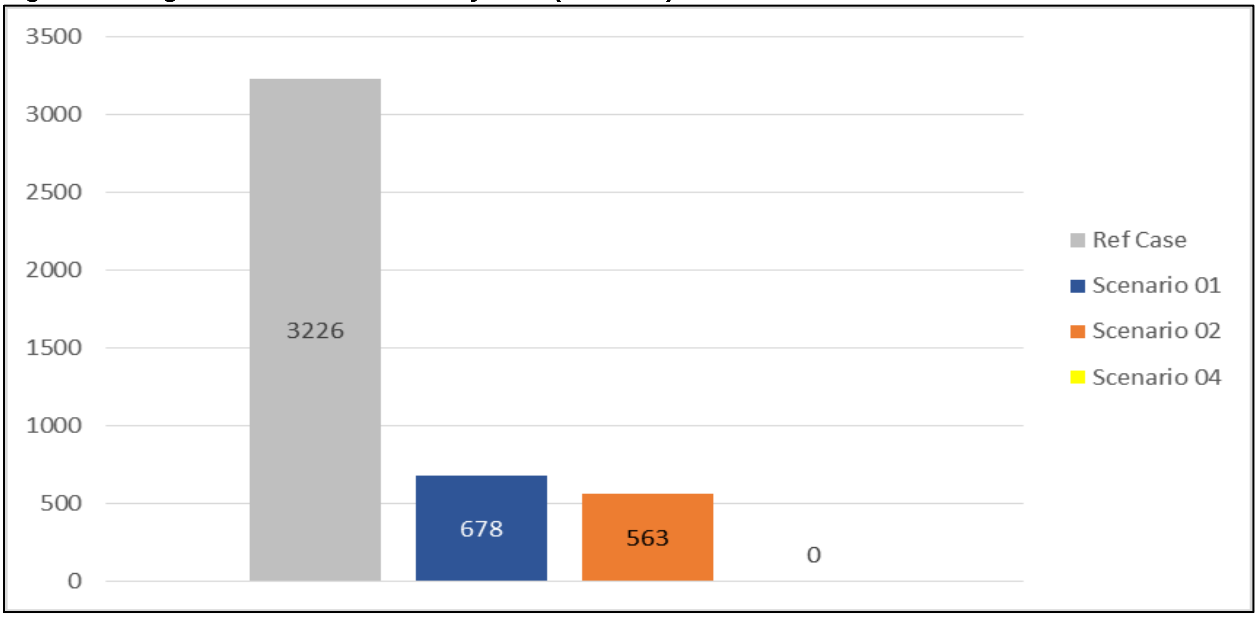


Figure 13: High Street 6-Hour two-way flow (vehicles)



2.25 The results show that making High Street NB only has very little impact on the total traffic flows observed on High Street showing that, after all other changes are applied, the SB flows are only a small element of remaining usage of the link and could, therefore, easily be displaced. The closure does impact upon Bridge Street but, over the 6 hours the drop is relatively modest. Scenario 1 or Scenario 2 are both able to be taken forward without issue. Scenario 4 delays are slightly higher although further optimisation of the network could reduce these further.

2.26 Given that retaining two-way access along High Street is a desirable outcome Scenario 1 was progressed to the detailed analysis stage. These results also show that when looking at the closure options, these are likely to be more easily accommodated during the inter-peak and PM periods than the AM. Partly this is due to the tidal nature of traffic which is moving out of Stratford in the AM and returning in the PM. Thus as closures are identified as possible within the scenarios tested to date, closures between 10:00 and 16:00 can likely be accommodated but it has not been possible to test this as the models only cover the AM and PM peak periods.

Final Scheme Appraisal

2.27 Based on the previous results a final scheme has been modelled. This involves:

- Changing the posted speeds on Bridge Street, Union Street and High Street to 10mph
- Adding a cost factor of two to all of these roads
- Banning the right turn out of Union Street.

2.28 The final scheme could also include a closure of High Street between 11:00 and 16:00 but, as these hours are not covered by the model, the effects of this have not been included in this assessment. The scheme proposals were tested in both the 2023 and 2031 SuAWA Reference Case models. Following this an assessment was conducted using the 2031 SuAWA Core Strategy models to assess the impact of these schemes in this higher growth scenario.

2.29 The higher growth scenario contains some schemes which, although desirable, are still at this stage considered aspirational and so this scenario has not been used when conducting the economic appraisal.

2.30 The Core Strategy model also involved some minor signal optimisation of the Bridge Street/Bridge Foot junction to improve traffic flows following the implementation of the proposals. With such limited intervention it is reasonable to consider that the testing represents a worst case and that the effect of the scheme proposals may be overstated as a result. As a result, the following six model scenarios have been run to inform this section of the appraisal:

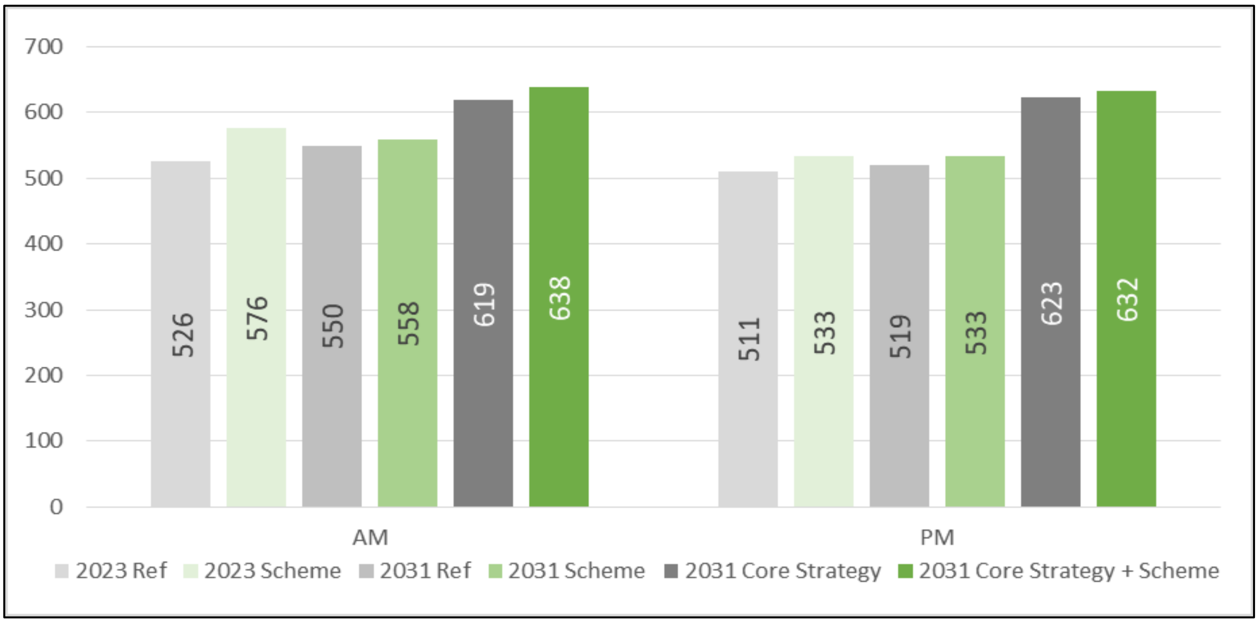
- 2023 Reference
- 2023 Reference + Scheme
- 2031 Reference
- 2031 Reference + Scheme
- 2031 Core Strategy
- 2031 Core Strategy + Scheme

2.31 The Reference Case denotes the scenario which includes all know permissions and scheme interventions whereas the Core Strategy also contains the remaining allocations and schemes which are expected to come forward as part of the Core Strategy but in some instances are considered to be aspirational at this stage and so there is not sufficient certainty around the proposals to enable them to be considered likely in their current form.

Network Wide Results

2.32 The effectiveness of the scheme has firstly been assessed by looking at network mean delay. This can be seen in the following figure:

Figure 14: Network Mean Delay (seconds)



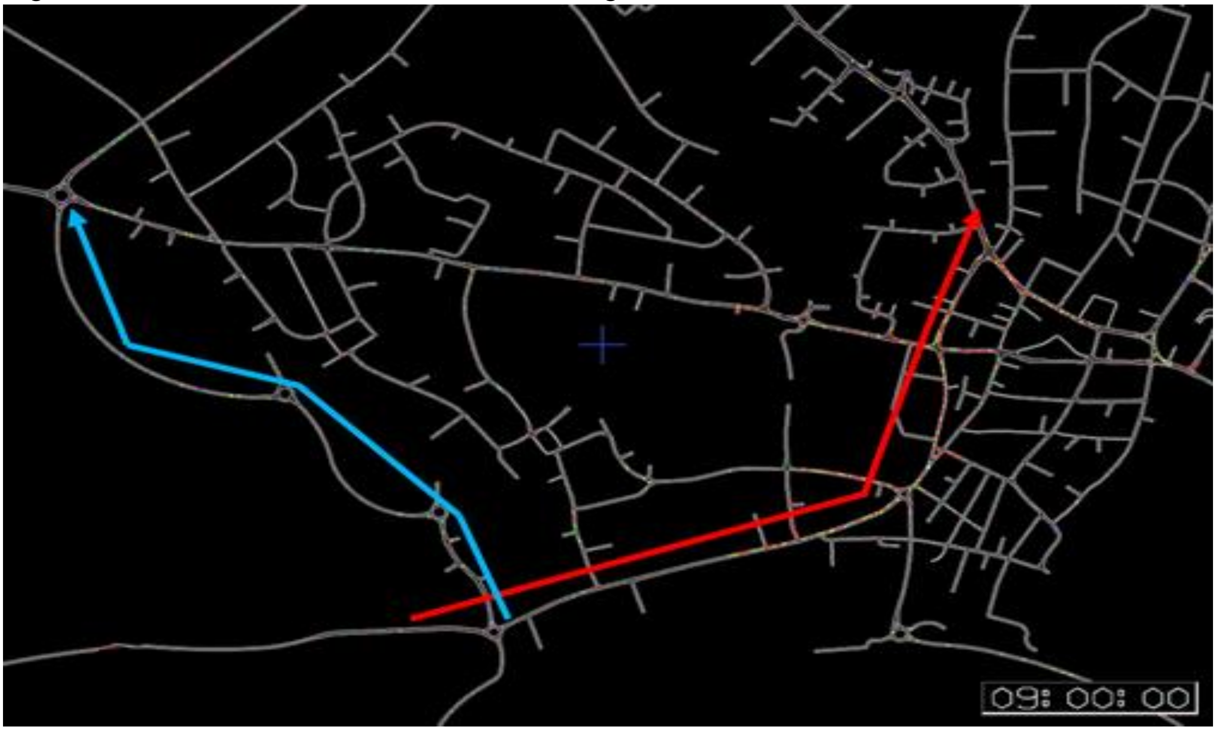
2.33 The network mean delay results show that in all scenarios the inclusion of the schemes results in some increase in delay in both the AM and the PM periods, generally this increase is around 10-20 seconds relative to the corresponding without scheme scenario.

2.34 The largest increases in delay relative to the reference case come in the 2023 + Scheme scenario with an increase in mean delay of 50 seconds in the AM and 22 seconds in the PM. The increase in delay is greater in 2023 than in either of the other scenarios as the West of Shottery Relief Road (WSRR) is not delivered in the 2023 scenario meaning there are fewer alternative routes for vehicles avoiding the town centre and therefore congestion on the available routes is significant.

2.35 The impact of the WSRR can be seen in **Figures 15 and 16.** Traffic travelling from the south-west of the town centre to the north of the town centre has to route along Grove Road and Evesham Road (red route) in the 2023 scenario whereas in 2031 they are able to use the WSRR (blue route) to avoid the congestion around the town centre. As such congestion on the red route is reduced in the 2031 scenarios relative to the 2023 scenario.

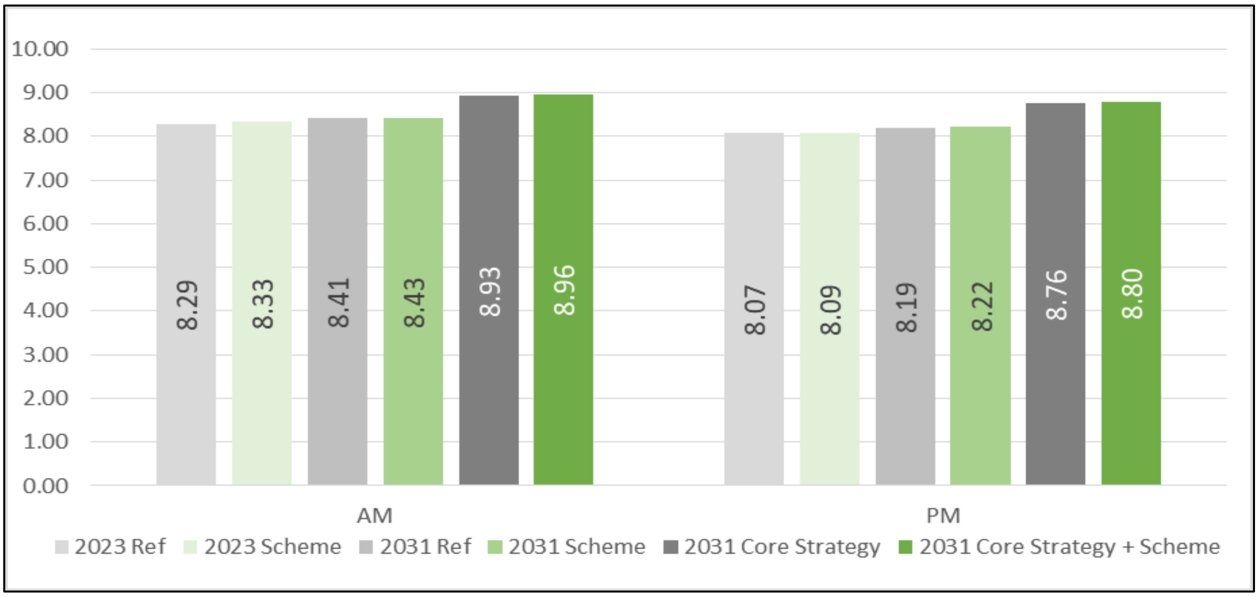
Figure 15: Grove Road and Evesham Road Congestion – 2023 + Scheme

Figure 16: Grove Road and Evesham Road Congestion – 2031 + Scheme



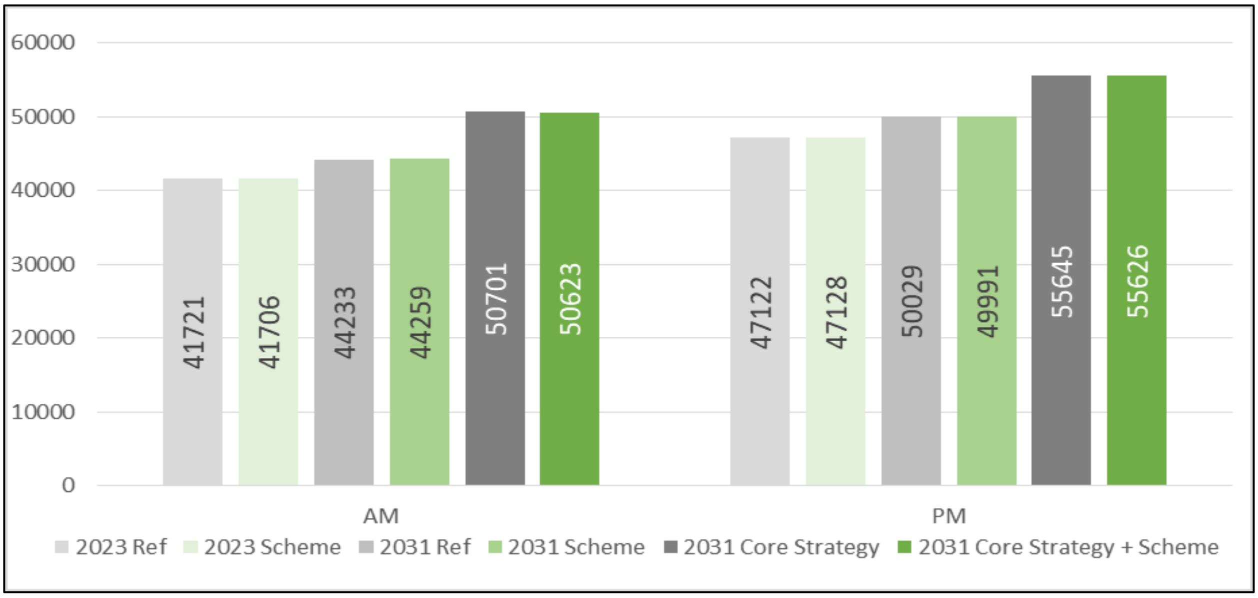
2.36 The analysis of the mean delay reveals that the extent of change in journey times, across the network, is notable but not necessarily severe. There is also a level of inherent variability within journey times which may be within the tolerances of these differences. At the network wide level, changes in journey times of between 10 to 15 seconds are unlikely to be discernible to drivers on the network although it is recognised that the proposals will put stress on certain parts of the network where these delays may be more noticeable. In addition to network mean delay, mean journey distance across the whole network was assessed. It can be seen in the below figure that the inclusion of the scheme proposals results in small increase in average journey distances as vehicles take slightly longer routes to divert around the town centre.

Figure 17: Network Mean Journey Distance (km)



2.37 There is a very small change in travel distances which is likely to be as a result of the scheme proposals but, similar to the delay analysis, is unlikely to be noticeable on a daily basis. The number of trips completed within the modelled period has also been assessed (**Figure 18**). These results show that there is no significant change in the number of completed trips with the inclusion of the schemes.

Figure 18: Total Completed Trips (vehicles)



2.38 On average there is a difference of 30 trips between the reference and scheme cases. Given that the average variation between model runs, across all scenarios, is 72 trips it is likely that these differences are just a results of the variation between model runs.

Journey Time Analysis

2.39 Following the assessment of the wider network impact journey times around Stratford town centre were assessed in order to quantify the local scheme impacts. The assessed routes can be seen in the **Figure 19**, whilst the peak hour journey time results are presented within **Table 3** and **Table 4** for the AM and PM peaks respectively. A journey time of 0 for any time period indicates that no vehicles travelled along that complete route in that scenario.

2.40 Analysis of **Tables 3 and 4** show that, in general, there is an increase in journey times around the town centre. With a marginal reduction in journey times through the town centre in a few instances. Journey times through the town centre are reduced NB on High Street in the AM and EB on Bridge Street in the AM and PM. These decreases in journey time relate to the reduced traffic on these routes as a result of the schemes encouraging reassignment of trips away from the town centre.

2.41 The analysis of the Core Strategy scenario also reveals that the general pattern of change is consistent between the 2031 Reference Case (Without and With scheme) and the 2031 Core Strategy scenario indicating that, as traffic volumes increase, the effects of the proposals vary comparably. Only one route shows a notable change and that is Town Centre 1 WB where an increase of around 200 seconds is observed.

2.42 This is primarily related to the signal configuration of the Birmingham Road/Arden Street junction. Additionally queues on the SB approach the Grove Road/Arden Street junction block back through the Birmingham Road/Arden Street junction in the Core Strategy scenario which in turn causes delays WB on Birmingham Road and Guild Street, Further optimisation of both of these junctions will likely need to be considered to minimise these effects.

Figure 19: Assessed Journey Time Routes

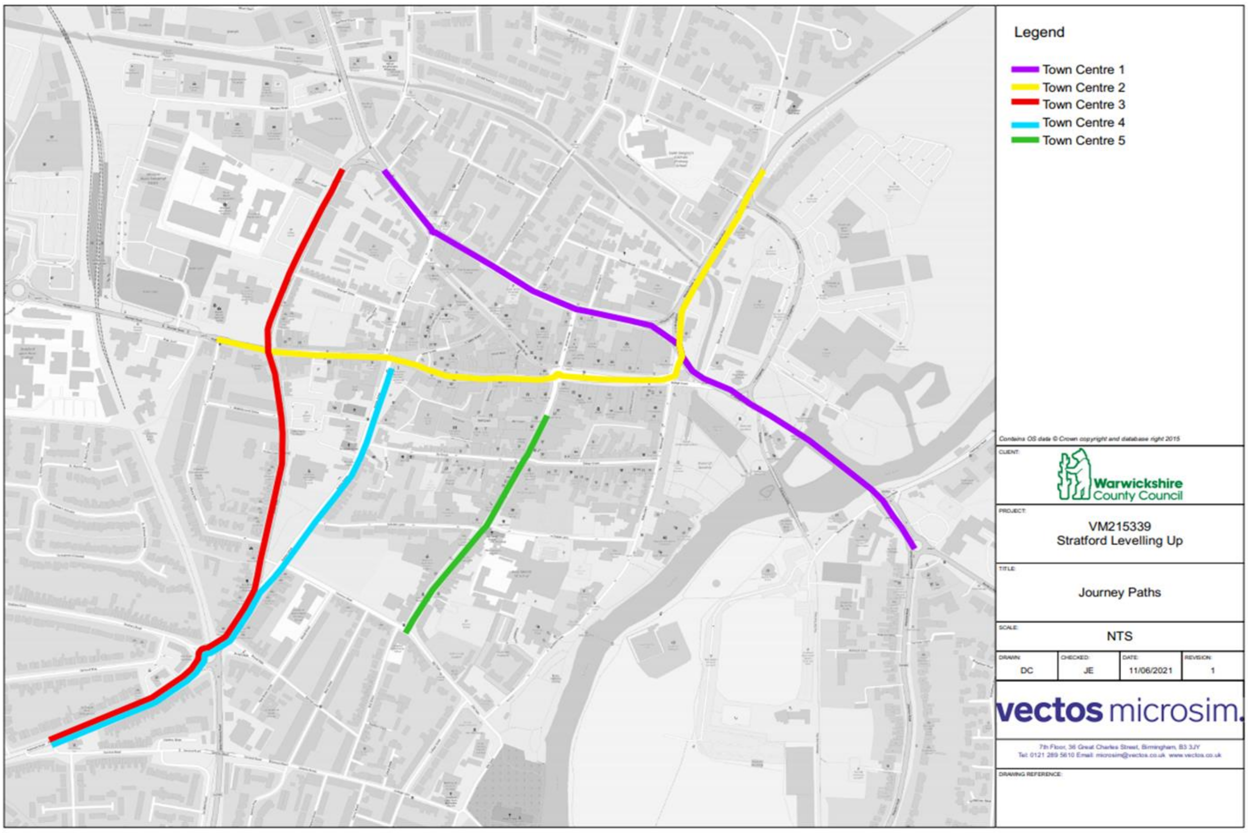


Table 3: AM Peak Hour (08:00-09:00) Journey Time Change with Scheme Inclusion

Route	2023 Ref	2023 Scheme	% Diff	2031 Ref	2031 Scheme	% Diff	2031 CS	2031 CS Scheme	% Diff
Route 1 EB	192	189	-1.9%	187	187	0.2%	229	219	-4.4%
Route 1 WB	239	291	21.5%	223	269	20.9%	283	275	-2.9%
Route 2 EB	299	233	-22.1%	246	206	-16%	550	226	-58.9%
Route 2 WB	239	0	100%	246	0	100%	273	0	100%
Route 3 NB	604	820	35.7%	458	597	30.3%	499	591	18.3%
Route 3 SB	146	182	25.1%	158	207	30.9%	134	148	10.8%
Route 4 NB	238	590	147.9%	256	503	96.6%	293	407	38.8%
Route 4 SB	124	202	62.4%	130	143	10.2%	187	187	0.1%
Route 5 NB	59	54	-8.5%	56	54	-4.4%	99	55	-44.4%
Route 5 SB	158	0	-100%	84	0	-100%	272	0	-100%

Table 4: PM Peak Hour (17:00-18:00) Journey Time Change with Scheme Inclusion

Route	2023 Ref	2023 Scheme	% Diff	2031 Ref	2031 Scheme	% Diff	2031 CS	2031 CS Scheme	% Diff
Route 1 EB	204	203	-0.2%	213	217	1.8%	269	264	-1.7%
Route 1 WB	185	215	16.2%	180	210	16.	271	481	77.4%
Route 2 EB	185	171	-7.7%	170	178	4.8%	172	171	-0.7%
Route 2 WB	259	251	-3.1%	221	251	13%	344	328	-4.7%
Route 3 NB	190	271	42.5%	189	277	46%	199	283	42.4%
Route 3 SB	158	187	18.2%	175	213	21%	200	188	-6.1%
Route 4 NB	141	142	1.2%	143	141	-1.5%	124	133	7.8%
Route 4 SB	394	393	-0.4%	327	396	21%	415	422	1.8%
Route 5 NB	38	52	35.9%	38	52	37%	39	52	33.5%
Route 5 SB	41	76	84.6%	40	53	30.%	40	57	43.8%

2.43 Where scheme case journey times of 0 seconds are recorded this indicates that no trips travel along the complete length of this route. Trips are required to travel from the first link to the last link on a route for Paramics to record a journey time along this path. Two routes where journey times of 0 are reported include a portion along either Bridge Street or High Street. This indicates that there are no trips using these routes as a direct result of the treatment applied to make these routes less attractive. The number of trips making these journeys was also relatively low (approx. 20 vehicles per hour max) prior to the proposals being included.

2.44 In the AM peak hour a reduction in EB journey times on route 2, through the town centre, is observed (**Figure 20**). This decrease is particularly pronounced in the core strategy model as the signal optimisation that is included in the 2031 Core Strategy + Scheme scenario reduces some congestion that existed in the Core Strategy model prior to any reassignment that occurs as a result of the town centre schemes. If the signal optimisation was included in the 2031 Core Strategy model it is likely that some of this journey time benefit would be removed.

2.45 The decrease in journey times is a direct result of the fact that the schemes encourage traffic away from the town centre and therefore congestion on this route is reduced, and this reduction in trips through the town centre can be seen in the 6-hour two-way flows on Wood Street (**Figure 21**). This figure shows that with the scheme in place flows are approximately a third of the levels they are in the 2023 or 2031 Reference Case.

2.46 With the scheme included the 2031 Core Strategy flows are slightly higher than 2031 flows. This is to be expected given the increased demand in the Core Strategy scenario. However, prior to scheme implementation the 2031 Core Strategy flows are below the levels of the 2031 Reference Case. This is due to increased congestion EB on Wood Street in the Core Strategy scenario. This congestion is a result of increased NB flow on High Street in the Core Strategy scenario causing increased congestion around the Wood Street/Bridge Street roundabout. This congestion encourages vehicles away from Wood Street and onto alternative routes.

Figure 20: Town Centre 2 AM Peak Hour (08:00-09:00) Journey Times

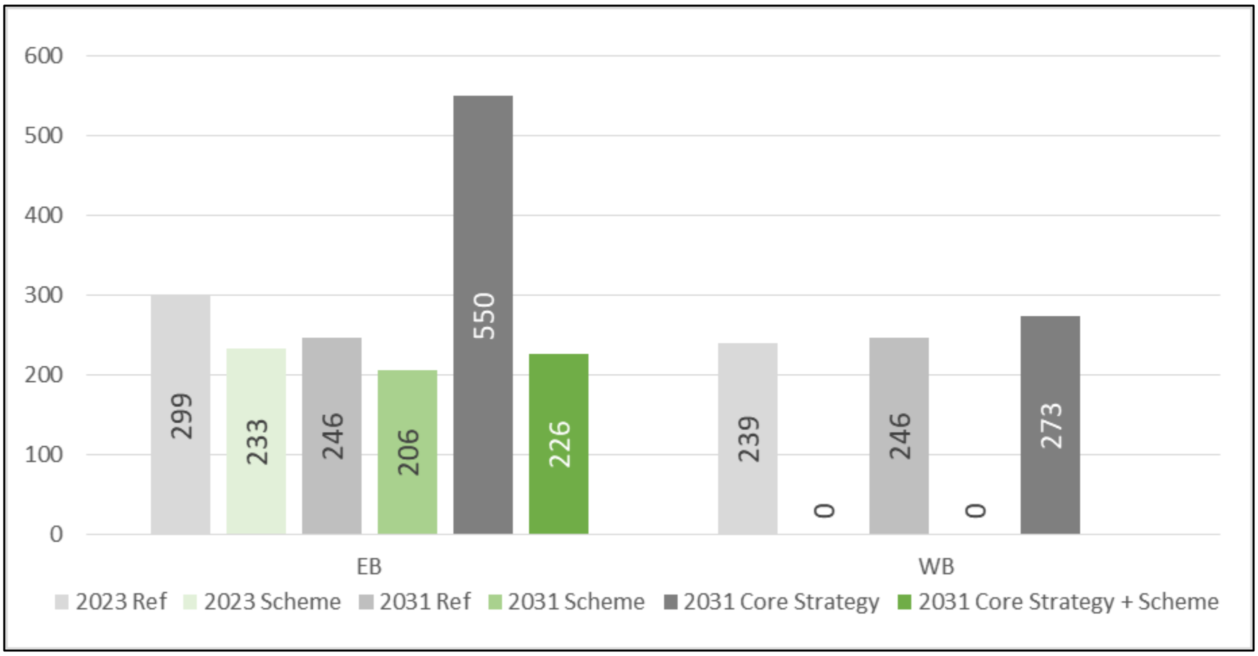
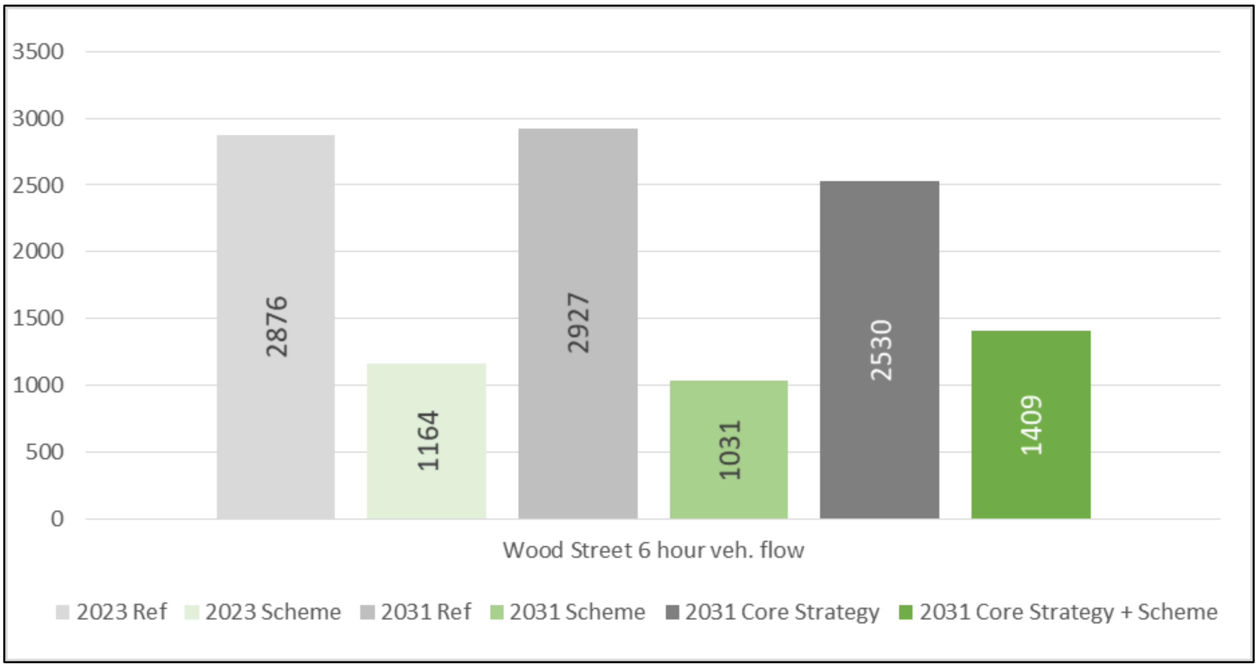


Figure 21: Wood Street 6-Hour two-way flow (vehicles)



2.47 The effects of the scheme on rerouting traffic round the town centre can be seen in the increases in delay on Routes 3 and 4 (**Figures 22-24**)

Figure 22: Town Centre 3 AM Peak Hour (08:00-09:00) Journey Times

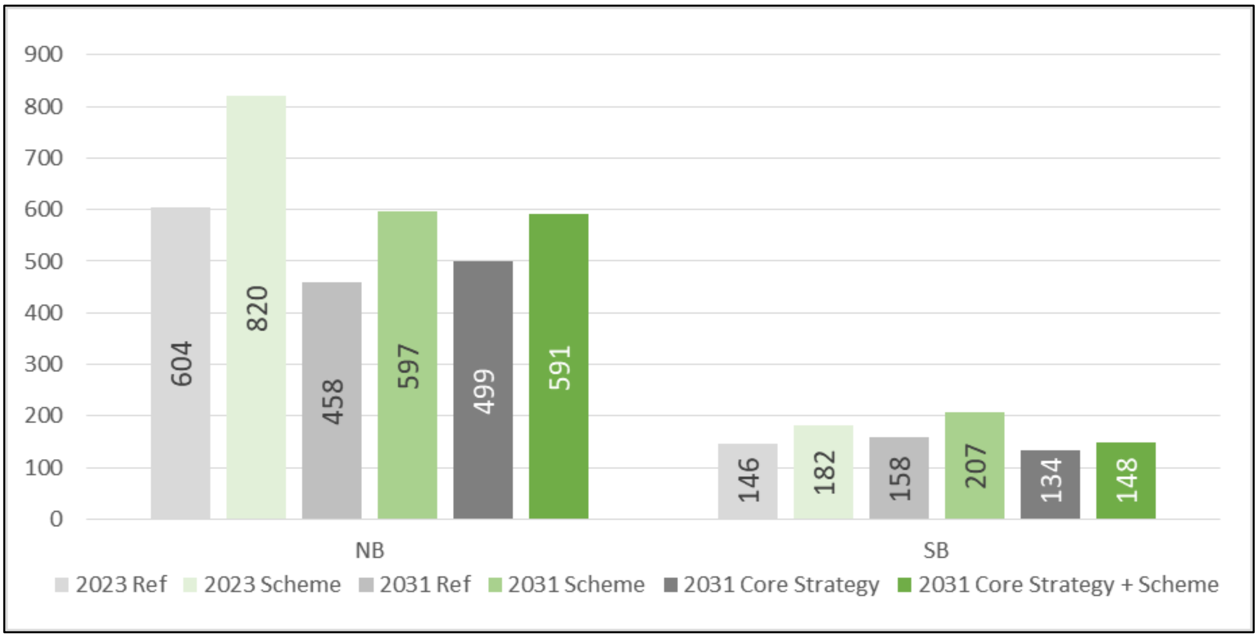


Figure 23: Town Centre 3 PM Peak Hour (17:00-18:00) Journey Times

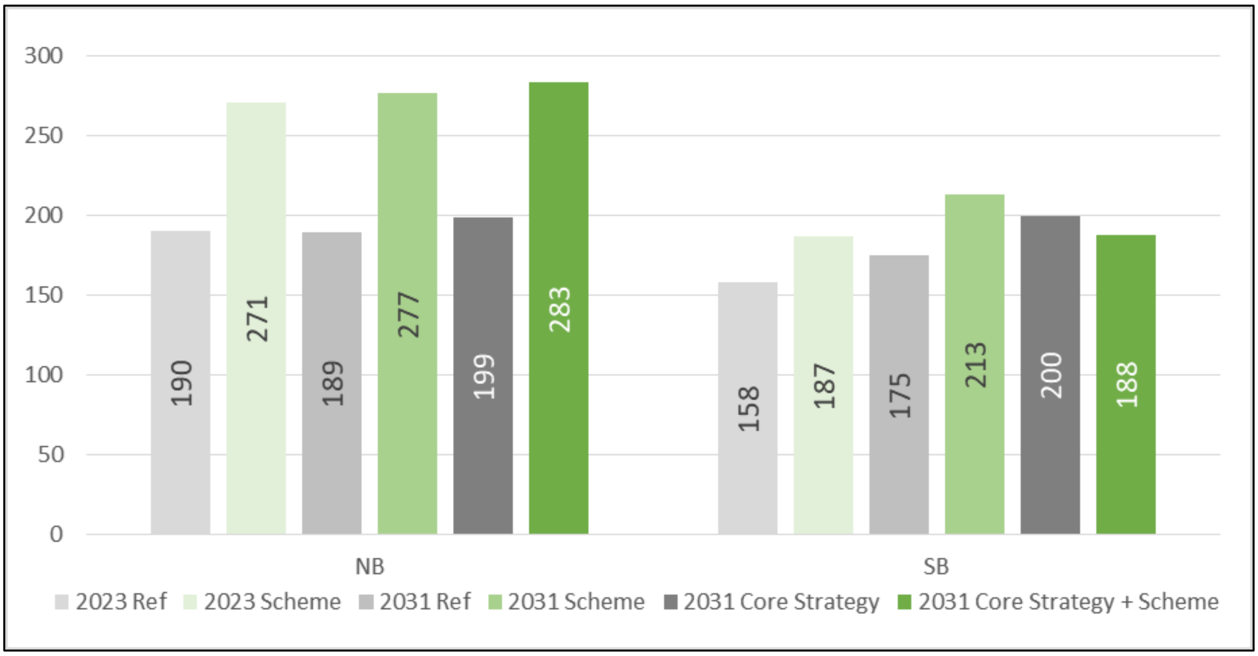
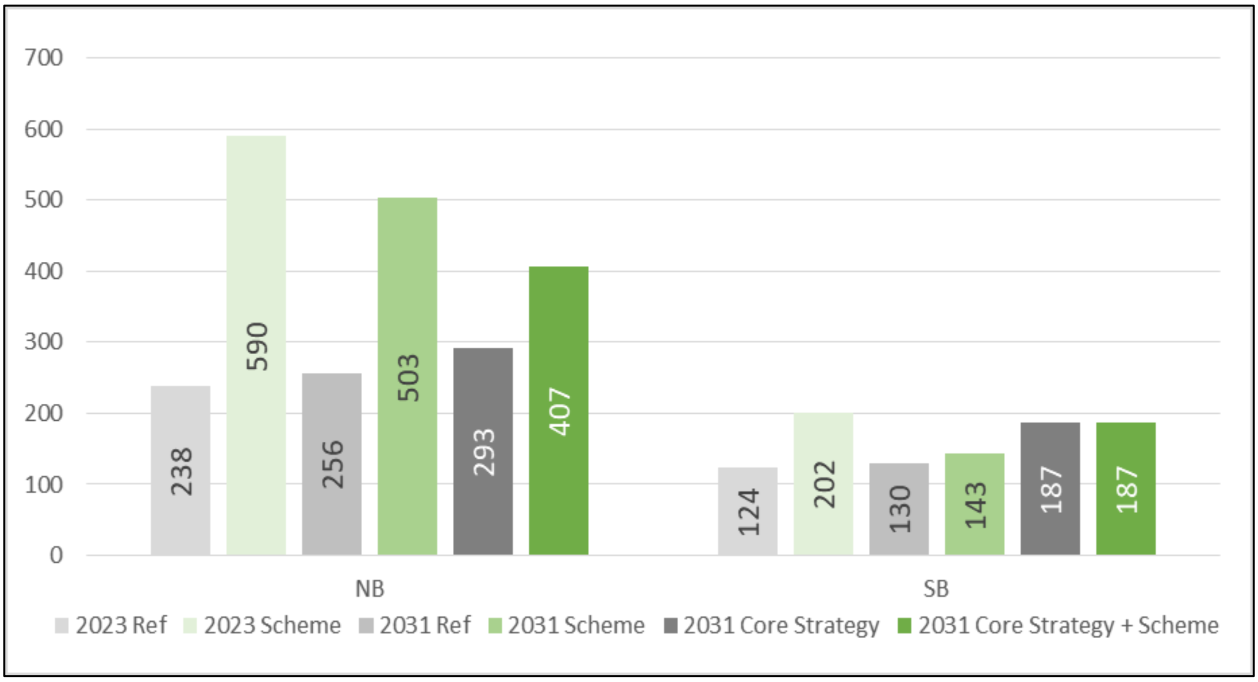


Figure 24: Town Centre 4 AM Peak Hour (08:00-09:00) Journey Times



2.49 These results show that on Route 4 in the AM and Route 3 in both the AM and PM there is a substantial increase in delay on these routes, particularly in the NB direction.

2.50 This increase in delay is the direct result of increased flow on these routes as drivers divert to avoid the town centre. The increases in flow on Rother Street and Grove road can be seen in the following figures:

Figure 25: Grove Road 6-Hour two-way flow (vehicles)

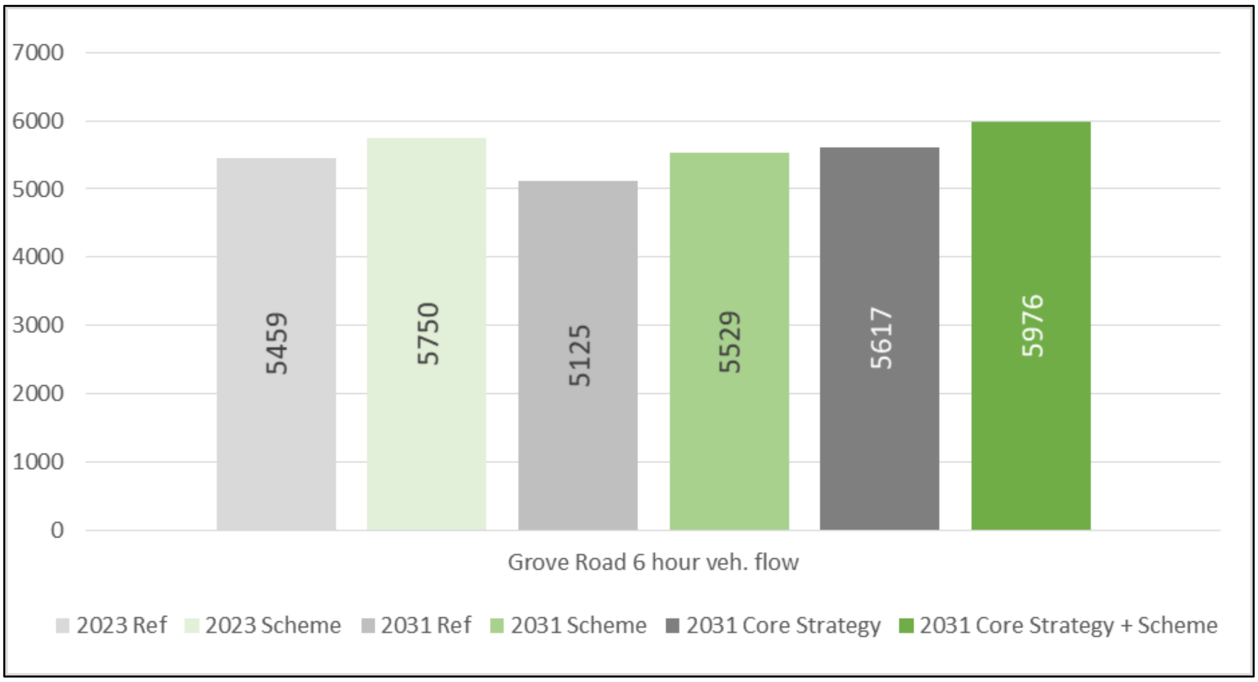


Figure 26: Rother Street 6-Hour two-way flow (vehicles)

2.51 The observed increases in delay on some routes are relatively large however given that the core goal of this scheme is to divert traffic away from the town centre such increases could be considered acceptable if the impacts on the town centre are positive. The effects of the schemes on traffic flows through the town centre can be seen in the flow results for Bridge Street, High Street and Union Street (locations 1,2 and 3 respectively on **Figure 27**) (**Figures 28-30**)

Figure 27: Link Flow Locations

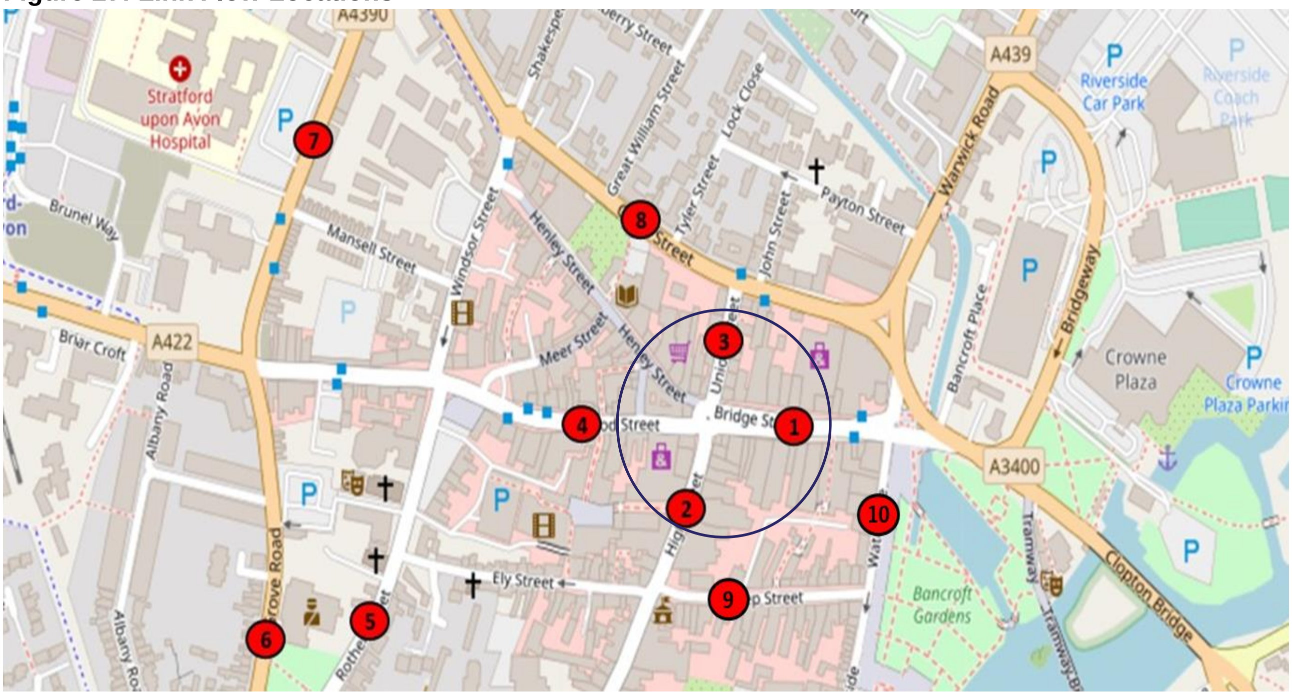


Figure 28: Bridge Street 6-Hour two-way flow (vehicles)

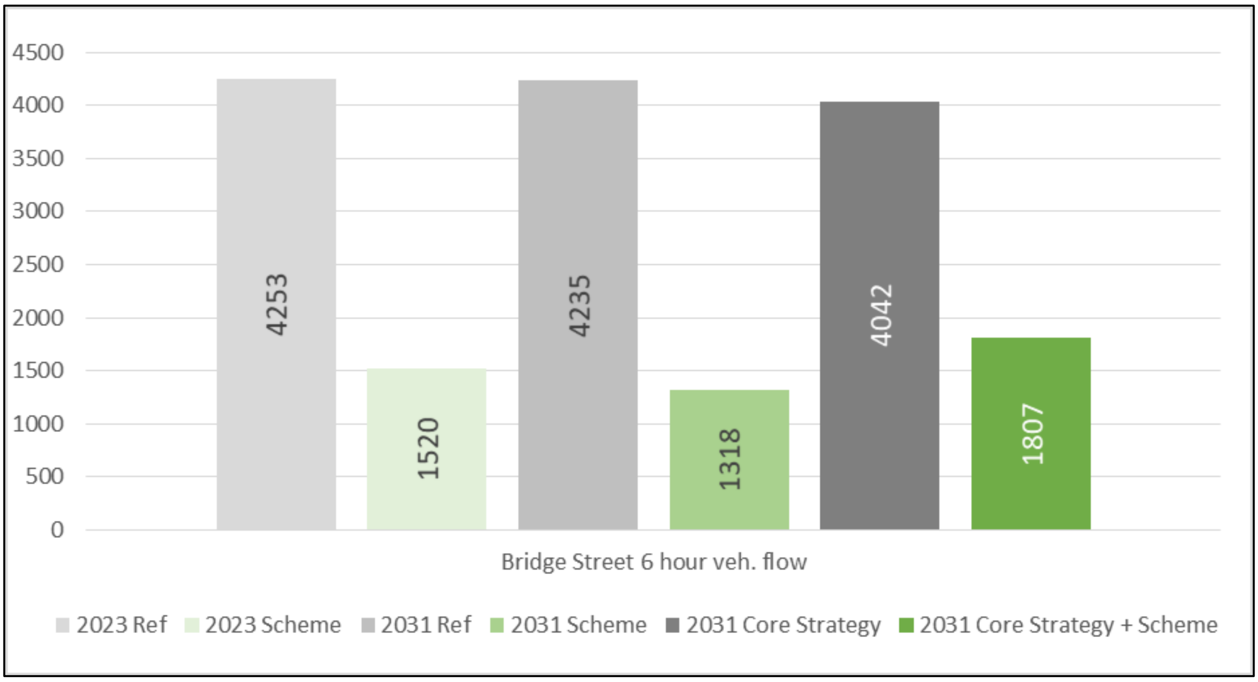


Figure 29: High Street 6-Hour two-way flow (vehicles)

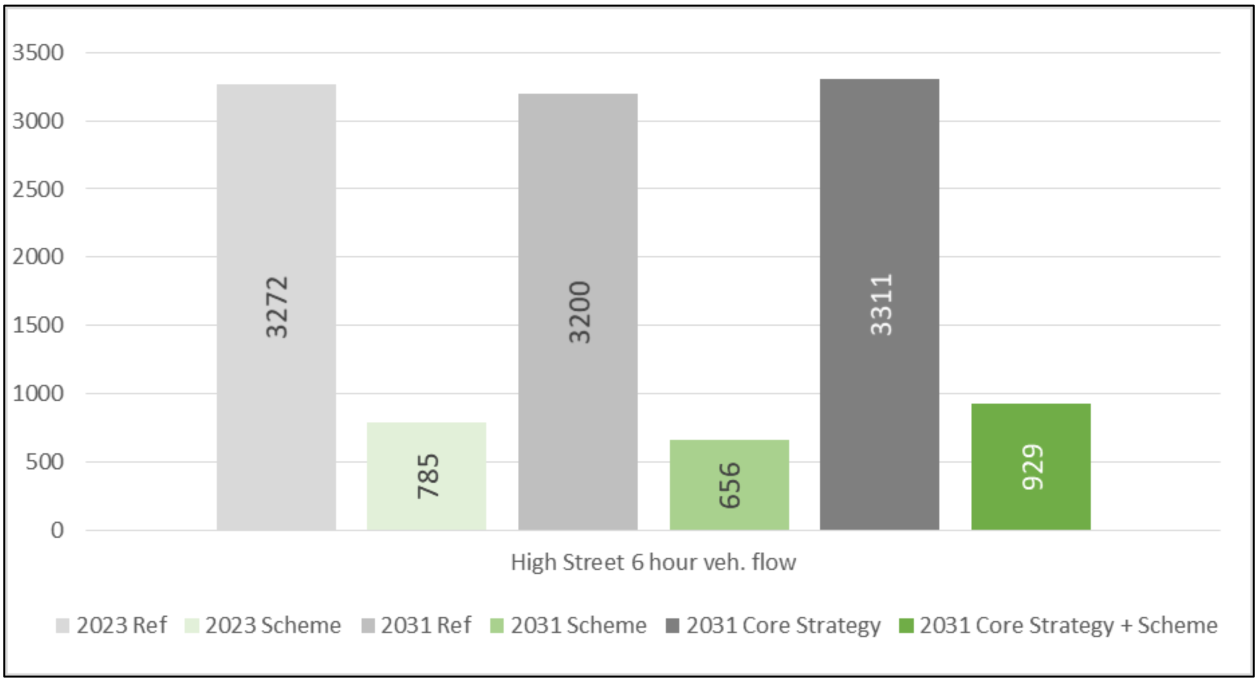
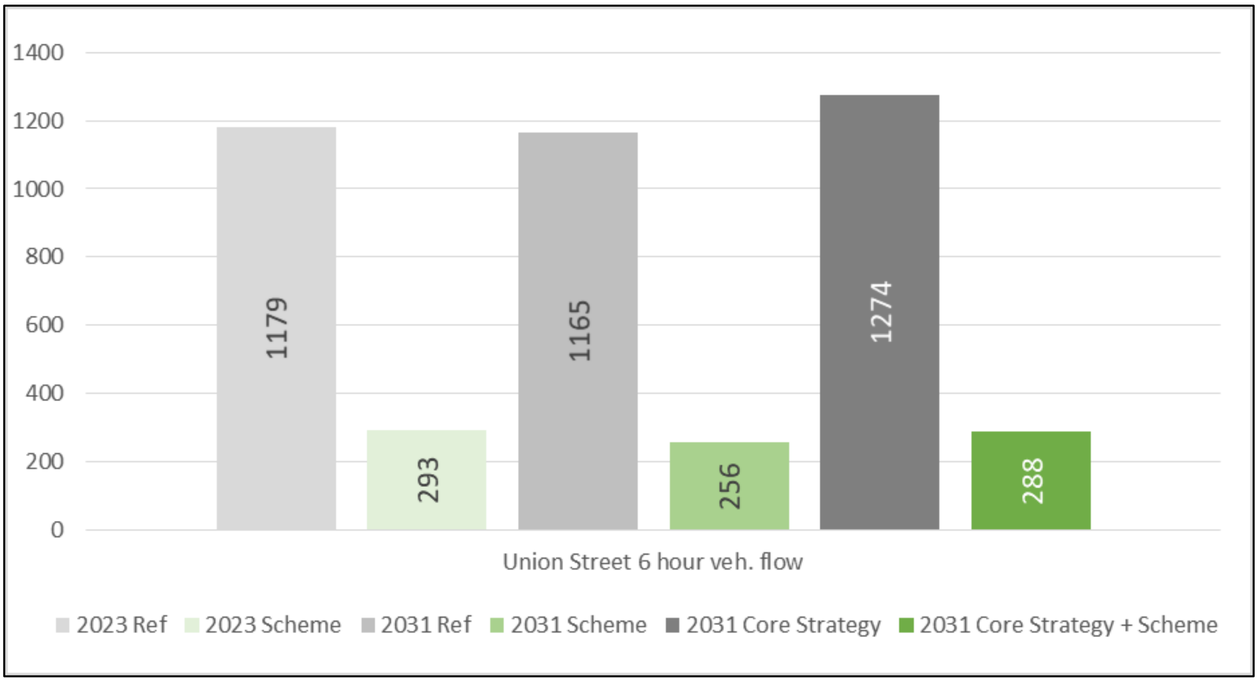


Figure 30: Union Street 6-Hour two-way flow (vehicles)



2.52 These figures show that the alterations to these streets is very effective, within the model, at reducing town centre traffic in all of the assessed scenarios. This provides comfort that the wider effects of the proposals observed through the modelling are based upon a level of reassignment which could be considered reasonable.

2.53 Both the 2023 and 2031 with scheme scenarios have fairly similar levels of traffic routing through the town centre. However in the 2031 Core Strategy + Scheme scenario there is slightly higher flow through the town centre. This is a result of both the higher growth in this scenario pushing more trips through all parts of the network. This increase in flow does not occur between the 2023 and 2031 Reference Cases as the presence of the WSRR in the 2031 scenario encourages some traffic that would otherwise route through the town centre to use this new alternative route. The effects of the WSRR in reducing traffic around the town centre are large enough to cancel out the traffic growth between 2023 and 2031.

2.54 The presence of the South-Western Relief Road (SWRR) in the 2031 Core Strategy Scenario also frees up capacity for some trips to reassign away from the town centre. This additional capacity relief draws a different traffic pattern in to the area and so certain routes experience an increase as a result. Essentially there is a dip in flows in areas in the 2031 Reference + Scheme due to congestion within the town centre discouraging trips from certain areas as well as the presence of the WSRR. Within the Core Strategy test, the SWRR relieves some congestion which, in turn, draws more traffic in to the area.

2.55 Further to the consideration of flows on Bridge Street, Union Street and High Street, it has also be determined that flows within the town centre should be considered on Sheep Street and Waterside, in order to understand the potential impacts on flows on this part of the network as a result of delivering the town centre schemes. The resultant flow impacts for these two routes are presented within the following figures.

Figure 31: Sheep Street 6-Hour two-way flow (vehicles)

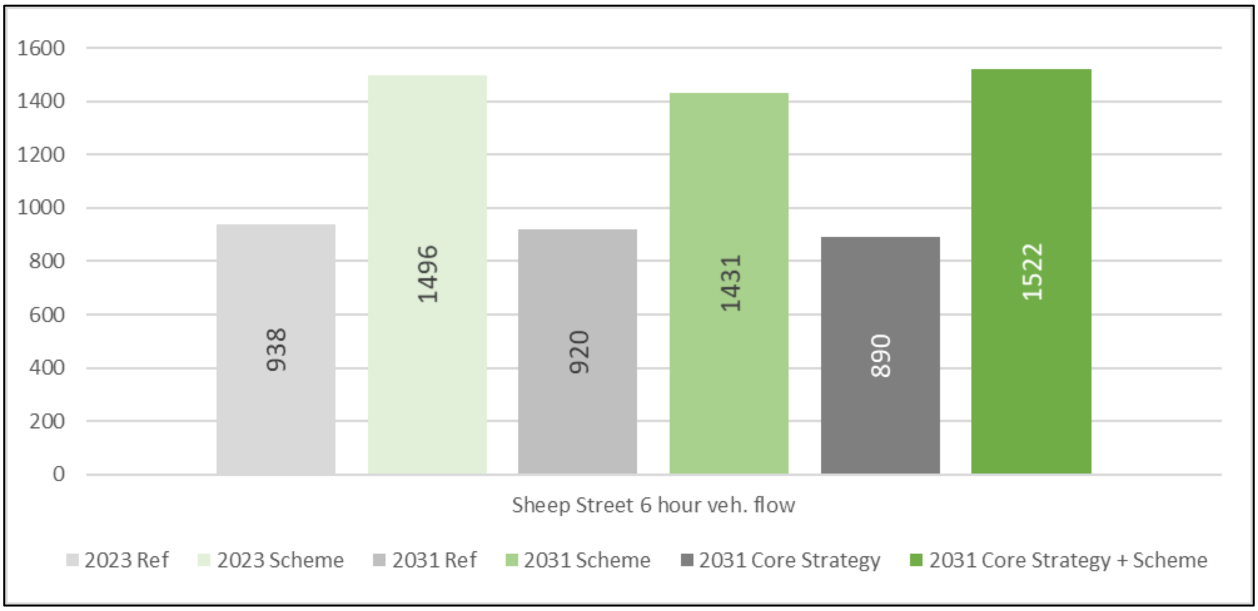
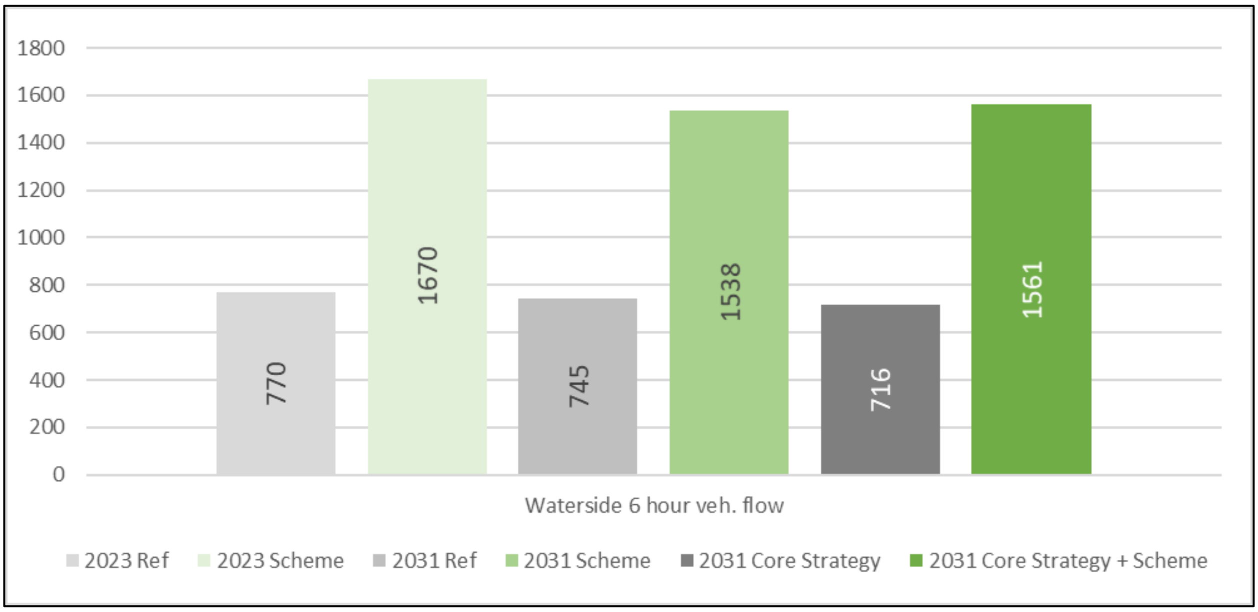


Figure 32: Waterside 6-Hour two-way flow (vehicles)



2.56 It is clear from **Figure 31** and **Figure 32** that the modelling is predicting that there will be impacts on both Sheep Street and Waterside arising from the delivery of the town centre schemes. These impacts equate to around 80-120 additional vehicles on these routes in each hour. Although this is clearly an impact, it is not considered particularly significant.

2.57 Overall the town centre results show that the reassignment of trips away from the town centre result in some increase in delay on routes around the edge of the town centre, in particular along the A4390 which accommodates a large proportion of the reassigned traffic.

2.58 The issues along the A4390 are partly mitigated by the signal optimisation that has been included at the Arden Street/Birmingham Road and Grove Road/Arden Street junctions but further optimisation and refinement in these areas should be considered before the schemes are finalised.

2.59 It is also important to note that any mode shift arising from the behavioural changes induced by these schemes has not been considered at this stage and therefore the observed increases in delay will be overstated.

Economic Assessment

2.60 Following the assessment of the finalised scheme an economic appraisal was completed to determine the Value for Money (VfM) arising from the investment costs required to deliver the scheme through the DfTs Transport User Benefits Appraisal (TUBA) software.

2.61 The economic assessment was undertaken using the Stratford-upon-Avon Wide Area (SuAWA) S-Paramics model which has been developed for both the AM (0700-1000) and PM (1600-1900) time periods. For the purposes of this assessment 4 scenarios have been developed and run:

- 2023 Reference
- 2023 Reference + Scheme
- 2031 Reference
- 2031 Reference + Scheme

Software

2.62 The economic appraisal of the scheme is based on the Benefit Cost Ratio (BCR). The BCR summarises the overall value for money of a scheme through the ratio of the benefits of a scheme relative to its costs, expressed in monetary terms.

2.63 The changes in travel times and vehicle operating costs experienced were assessed using version 1.9.13 of the TUBA software program. TUBA is a bespoke software package developed on behalf of the DfT to estimate the impacts of transport schemes in terms of the costs and benefits experienced by users and providers of the transport system, and the associated indirect taxation impacts. All impacts are considered in monetary terms.

2.64 TUBA provides a complete set of default economic parameters in its standard economics file, including values for variables such as values of time, vehicle operating cost data, tax rates, and economic growth rates. TUBA estimates costs and benefits experienced by users and providers of the transport system by comparing transport conditions in different scenarios by:

- Calculating user benefits by vehicle type and for each element of journey cost (i.e. travel time and vehicle operating costs - fuel and non-fuel)
- Calculate the changes in the indirect tax income received by the government (for highway schemes this primarily reflects the levels of indirect taxation incurred on fuel cost)
- Calculate the changes in the greenhouse gases emissions

Model Outputs

2.65 Model outputs were collected for all four modelled scenarios. Demands for two time periods were considered within the models:

- AM: 07:00 – 10:00
- PM: 16:00 – 19:00

2.66 To allow vehicles on the network to finish their trips, run off periods were included at the end of each 3 hour period to ensure all trips were considered within the assessment. However, no new vehicles were released in this period and the statistics are simply included within the final hour statistics for the AM and PM periods (09:00 - 10:00 for AM, 18:00 - 19:00 for PM).

TUBA Skim Preparation

2.67 A purpose-made Access database was used to collate the trips by Origin-Destination (OD) zone numbers and extract data on the number of trips, the travel time, and the travel distance.

2.68 This analysis is based on the “Trips-All” files produced by Paramics. These files contain details of all trips across the entire model network, listing their origin and destination points, trip time and trip length.

2.69 The data was split into two vehicle categories:

- Lights: Car & LGV
- Heavies: OGV1 and OGV2

2.70 The time slices were allocated to the modelled periods as seen below. Time slices 3 and 12 only contain an additional hour to allow for vehicles to finish their trips and should still be counted as covering only one hour for the purpose of the economic analysis.

- 1: 07:00 – 07:59
- 2: 08:00 – 08:59
- 3: 09:00 – 10:59
- 10: 16:00 – 16:59
- 11: 17:00 – 17:59
- 12: 18:00 – 19:59

Transport Economic & Forecast Assumptions

2.71 All scenarios have been modelled in Paramics for the 2023 and 2031 future years across the six time periods previously detailed.

2.72 It is noted that the inter-peak period has not been modelled and therefore it is not possible to quantify the impacts of the scheme during this time period.

2.73 As each peak period hour is modelled individually, a simple annualisation factor of 253 (representing the number of non-bank holiday weekdays in a year) has been applied to the AM and PM time periods. This converts the single day data derived from the model to the equivalent annual value based on the 253 working days within the average year.

2.74 The distance, time, and vehicle trips skims included two vehicle user classes, namely light and heavy vehicles. For the purpose of the TUBA assessment, these skims have been further factored to split into the following user classes:

- Car Business
- Car Commuting
- Car Other
- OGV1 Business
- OGV1 Commuting
- OGV1 Other

2.75 This was achieved by applying the default vehicle purpose split in TUBA. The scheme appraisal approach follows that set out in Section 3.3.3 (Valuing the transport scheme) TAG A2.2. One comparison is undertaken:

- DM vs DS: Without Scheme vs With Scheme

2.76 In all the scenarios, the accruing of benefits was capped at 2082, providing a 60 year appraisal period, assuming a start year of 2023. Based on the cost estimates provided by PJA it was assumed that the scheme would be delivered in 2023 with costs split with 10% occurring in 2021 and 45% in each of 2022 and 2023. The analysis was based on a total cost of **£18,058,470.00**.

2.77 A GDP value of 121.66 was used to convert the provided 2021 priced to 2010 as is required for TUBA. All monetary values presented in the following are in 2010 market prices and will need to be adjusted to current values for the final submission.

Economic Analysis Results

2.78 The TEE table for this appraisal is shown in **Appendix A.**

2.79 Total impacts for each scenario, including the transport user benefits, indirect taxation revenues, and present value of costs (PVC), were calculated in TUBA and are presented in **Table 5**.

Table 5: Summary of TUBA Impacts in millions of £s

Scenario	TEE	Greenhouse Gases	Indirect Tax	PVC	Total Impact
DM vs DS	£-26.517	£-0.286	£0.768	£11.549	£-37.584

2.80 This results in a Benefit to Cost Ratio (BCR) of **-2.254**.

Summary

2.81 This core modelling assessment has identified that the preferred scheme for the town centre involves the closure of High Street to traffic between 11:00-16:00. Outside of these areas vehicles will be discouraged from using High Street and Bridge Street through signage and road design.

2.82 The modelling identifies a significant shift in traffic away from the town centre in the AM and PM peak periods. The analysis of the effects arising from the reassignment reveals that there are routes on the edge of the town centre, where traffic increases, and subsequently, delay, on routes around the town centre will be affected as a result.

2.83 These changes are localised however and the strategic level analysis indicates that the changes are marginal and would not necessarily be noticeable by most drivers on a daily basis. Some areas will experience more notable changes and these will likely require further investigation through the scheme design process but, at this stage, are not considered to be of a magnitude sufficient to justify halting the scheme promotion.

2.84 An economic appraisal of the scheme has then been conducted which produced a BCR of **-2.254**. While this alone does not represent good value for money, this assessment only considers the transport impacts and gives no consideration to the benefits to active mode users, or the reduction in traffic that may occur as a result of people shifting to active modes. It is likely that an assessment that fully considers these impacts would return in a positive value for money.

2.85 Following the results presented in this chapter, it is recommended that the likely mode shift as a result of these schemes should be included in future modelling assessments. The results provided to date are a worst case scenario of the effects of reassignment around the town centre. Modelling the likely mode shift would reduce the number of trips that are forced to reassign onto routes around the town centre and allow for a more realistic impact to be calculated.

2.86 The proposed signal junction optimisations will also need further review to confirm that the traffic flow alterations can be satisfactorily accommodated within the existing signalised junctions.

3 Mode Shift Assessment

3.1 The initial assessment of proposed schemes within Stratford upon Avon town centre, presented within Chapter 2, considered the effect of the changes to the highway on car movements. It did not account for any changes in traffic flows which may arise from the delivery of the scheme, and the potential for there to be a shift towards sustainable modes, as a result of the improvements to the active travel network derived from the proposals.

3.2 Following this initial assessment, further consideration has been given to how changes in traffic flows arising from the scheme proposals will alter the results presented to date. This chapter therefore provides a summary of the ‘mode shift’ analysis undertaken through the modelling and the results derived therefrom.

Background

3.3 The 2031 Reference Case model was used as the start for this stage of testing. This testing focuses on Bridge Street and High Street areas within the SuAWA model.

3.4 Three scenarios have been assessed within the modelling to understand the likely effects on the local network as well as wider changes predicted to arise as a result of the reassignment of traffic onto different routes around the town.

3.5 The tests run previously were all based on the 2031 Reference Case model where, four scenarios had been tested to assess the alternative operations for the town centre schemes. All scenarios included the assumption of both Bridge Street and High Street being 10mph, hence the increase route cost had been applied to reflect the alternative layout.

3.6 The main findings revealed that vehicles were discouraged from using Bridge Street and High Street through the changes in road layout and signage. Thus, the modelling considers a significant flow shift away from the town centre during in the AM and PM peak periods.

3.7 Following this, the objective of this stage of the assessment is to revisit the earlier modelling with a view to establishing how changes in driver responses, particularly via increases in active mode usage, will alter the conclusions drawn from the modelling to date.

Mode Shift Methodology

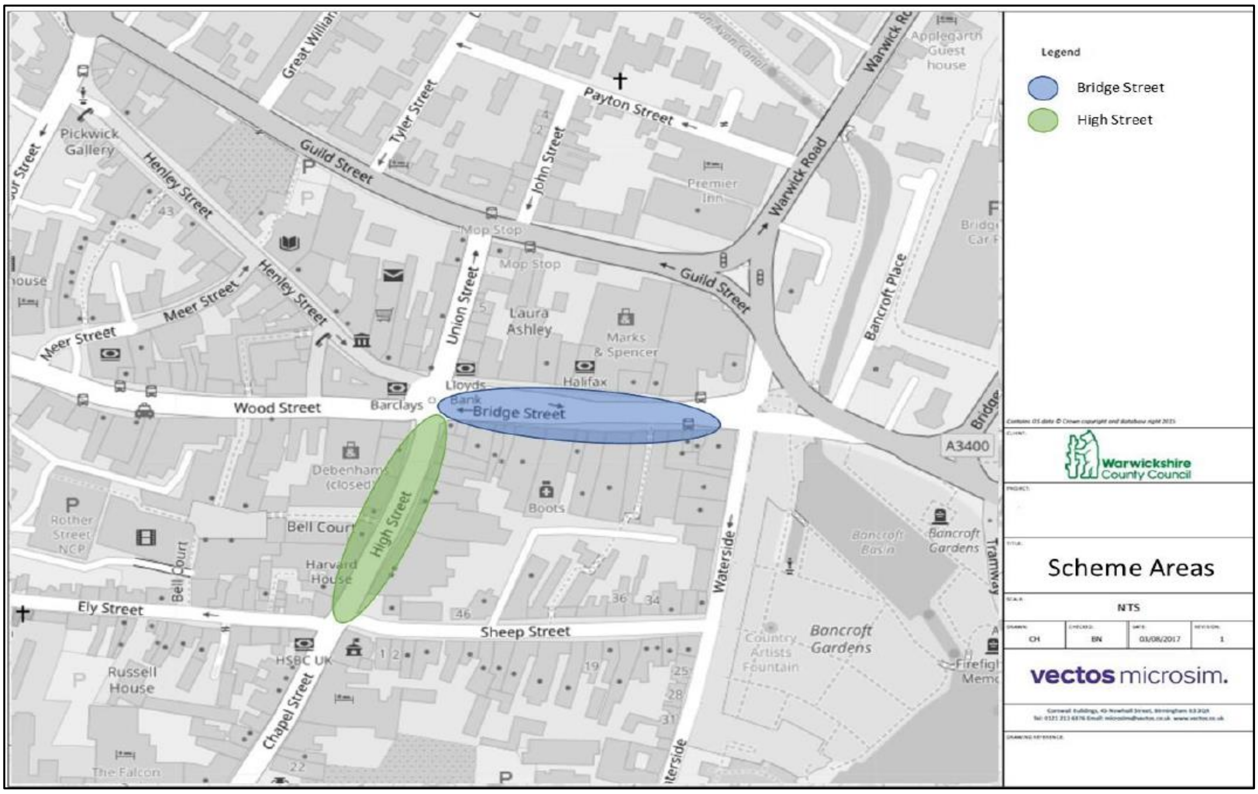
3.8 The proposed scheme is designed to encourage traffic away from the town centre, in terms of model coding this involves:

- Reducing speeds on Bridge Street, Union Street and High Street to 10mph.
- Adding on cost factor of two to all these roads.
- Prohibiting right turn out of Union Street.

3.9 In addition the final scheme involves closing High Street between the hours 11:00 and 16:00. This is not considered in the modelling assessments as the model only covers the AM (07:00-10:00) and PM (16:00-19:00) peak periods. The location of these schemes is shown in the **Figure 33**.

3.10 As part of the assessment of the proposals the Department of Transports Active Modes Appraisal Toolkit (AMAT) was used to define the likely benefits arising from the proposed changes in travel behaviour within the study area. The AMAT utilises daily cycling and walking inputs to derive the value for the proposals. Inputs were delivered for Union Street, High Street and Bridge Street and then an assumption was applied for a 20% uplift in those movements for the submission.

Figure 33: Scheme Locations



3.11 The movements identified within the AMAT are summarised within the following **Table 6**.

Table 6: AMAT Pedestrian and Cycle Inputs[1]

Scenario	Union Street		High Street		Bridge Street		Combined Flows	
	Ped	Cycle	Ped	Cycle	Ped	Cycle	Ped	Cycle
Daily (reference)	6,625	77	14,136	73	9,528	32	30,289	182
Daily (growth 20%)	7,950	92	16,964	87	11,433	39	36,347	218

3.12 Previously, these changes in movement were not accounted for within the highway modelling and, as such, the impacts on journey times for cars within the study area are likely to have been overstated.

3.13 It is expected that some of this increase would be achieved via a shift in behaviour away from private car and, as a result, that is what is being considered through this next stage of assessment.

[1] Data provided by PJA

Demand Adjustment Summary

3.14 The increase in movements associated with active models is contained within the 20% uplift identified within **Table 6**. This uplift represents the estimated level of change in pedestrian and cycling movements because of the proposed changes to the network.

3.15 These increases have therefore been used to identify the number of trips which may be removed from the light vehicle assignment matrices within the model. These adjustments have been applied on the following basis:

- Movement along High Street was used to inform the demand adjustments as High Street contains the highest flows and is likely to comprise a significant number of the movements observed on the other two links. This also avoids a risk of double counting occurring when demands are adjusted by assuming each pedestrian on each road is an entirely new trip.
- Traffic data for Bridge Street was assessed over the day to profile the volume of traffic observed within the area over 12 hours as the actual model only accounts for the AM and PM peak periods.
- Select Link Analysis was used to identify the origin and destination of trips observed using Bridge Street and, correspondingly, the average journey distance for those Origin/Destination pairs was calculated.
- The assumptions within the AMAT were reviewed to inform the average trip distances which would be intercepted by the different modes and then the maximum distance necessary to ensure that the overall average met the target was identified within the select link OD pairs.
- Journeys which fell within these distances were then assessed and adjustments made to account for a shift, over the course of the day, for car to active modes.

3.16 The application of these steps is explained in more detail as follows:

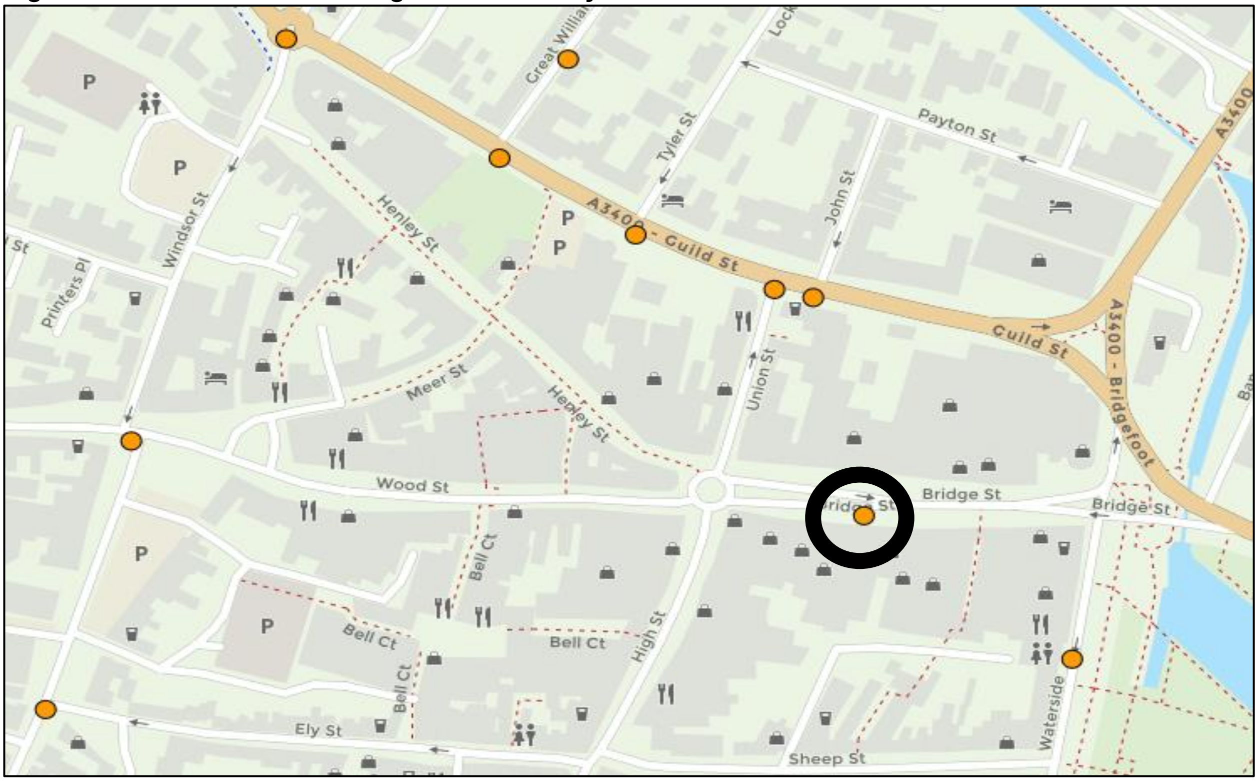
Mode Shift Demand Adjustments

3.17 The uplift in movement observed along High Street was used to inform the potential shift away from motorised vehicles arising from the scheme proposals. This predicted that there would be an increase of 2828 pedestrians and 14 cyclists across the day. The scheme is primarily focussed on increasing footfall within the town and so, as a result, the magnitude of change in cycling movement within the area is very limited with an increase of only 14 cyclists projected to occur within the area. As such, the decision was made to focus on the effect that changes in pedestrian flows would have on the network operation.

3.18 Having identified 2828 movements across the day, the next step required these changes to be translated into hourly flows. The simplest way to do this was to mirror the current flow profile of cars in the area and apportion out the reductions based on the number of cars surveyed within each individual hour.

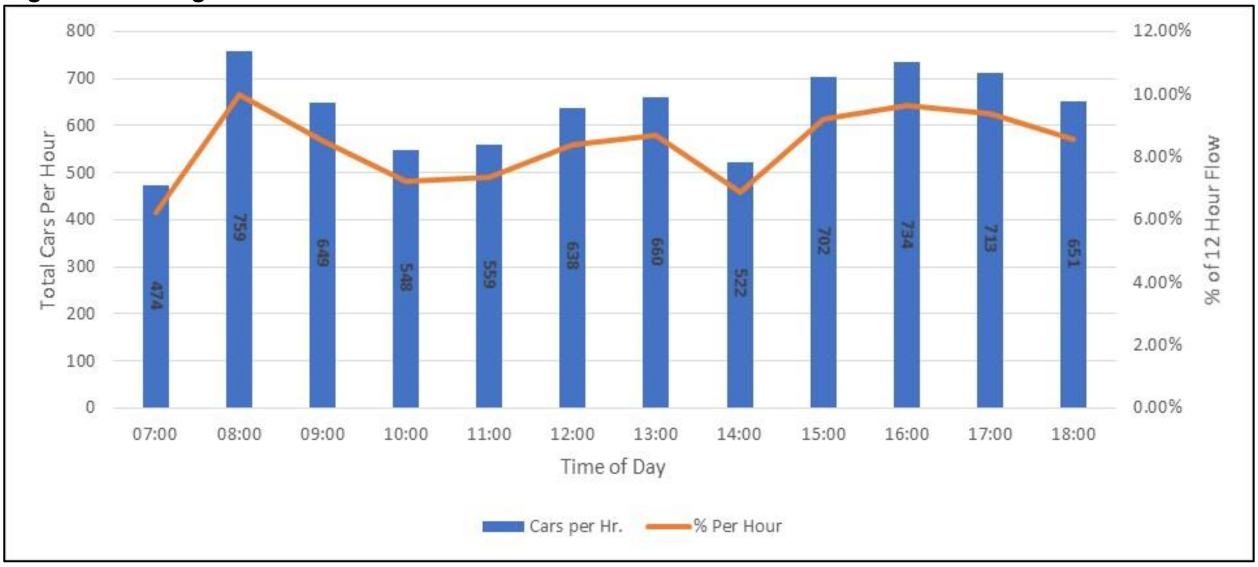
3.19 A count on Bridge Street was selected for this factoring. This site was selected following an interrogation of WCCs C2 Traffic Survey database to identify a suitable traffic survey dated between 01/01/2014 and 01/01/2020. This identified the Bridge Street count as the only one suitable for use. The location of this survey is shown on **Figure 34**.

Figure 34: Location of the Bridge Street Survey



3.20 The resultant flow profile identified on Bridge Street is illustrated within **Figure 35**:

Figure 35: Bridge Street 12 Hour Traffic Flow Profile



3.21 Analysis of the flow profile reveals that, outside of the 0700 hour, there is only a limited variation in traffic flows with the volume per hour comprising between 7 and 10% of the 12-hour total. These percentages were subsequently used to identify how many of the 2828 pedestrians would be intercepted on an hourly basis. This is summarised within the following **Table 7**:

Table 7: Hourly Pedestrian Intercept

Period	07:00	08:00	09:00	16:00	17:00	18:00
%	6.23%	9.98%	8.53%	9.65%	9.37%	8.56%
Ped Intercept	176	282	241	273	265	242

3.22 The pedestrian intercepts identified within the previous table were than used as a guide for the level of trips to be removed from the light vehicle assignment matrices within the model. In order that the appropriate ODs could be adjusted however, further analysis was required to identify the OD pairs appropriate to intercept. This was completed based on journey distance. The AMAT contains an assumption that an average trip length of 1.1 km will be intercepted by walking modes and so this trip length distance was used as a guide for identifying the OD pairs which could be shifted.

3.23 Firstly, OD pairs using Bridge Street were identified for the AM and PM peak hours using a process called select link analysis (SLA). SLA enables the trips that have used a link to be identified, these can be converted to OD pairs to identify the trip ends associated with the vehicles which have been captured on the links within the model. The distances that these trips are recorded at has then been identified via analysis of the Trips All file. This provides an indication of the average distance travelled between OD pairs. To allow for sufficient OD pairs to be isolated to achieve an intercept of journeys with an average journey distance of 1.1 Kilometres. This identified that trips up to 1.65 Kilometres would need to be included to ensure that the trips removed from the assignment matrices comprise an average trip length of 1.1 Km.

3.24 A review was then undertaken to identify the total number of trips making these movements, within the model, which also travelled through the study area and conformed to an average trip length of 1.1Km. This was applied to all matrix levels which controlled the assignment of light vehicles (matrix level 1, 3, 4 and 5). HGVs were omitted from the analysis. This resulted in the following trip totals being identified within the assignment matrices as meeting the criteria and therefore potentially able to be intercepted:

Table 8: Assignment Demand Trip Totals Averaging 1.1kn in Length

	AM1	AM2	AM3	PM1	PM2	PM3
Trip totals	88	156	107	161	200	157
% of total demand	0.6%	0.9%	0.8%	0.9%	1.1%	1.0%
target reduction	-176	-282	-241	-273	-265	-242

3.25 **Table 8** reveals that the model contains a lower number of short distance trips than could potentially be intercepted by the proposals. In this instance short distances trips within the model which use Bridge Street comprise around 1% of the total traffic demand within the model. This seems a reasonable assumption. It isn’t necessarily the case that all new pedestrian trips will be intercepted from existing motorised users and, furthermore, the proportion of shift could be bias towards the middle of the day when more retail and leisure trips are expected to occur. On that basis, for the purpose of this modelling exercise, accepting the imprecise nature of both the AMAT calculations and the estimated assignment matrices within the model, it was considered appropriate to simply remove the trips identified within **Table 8**.

3.26 A revised set of demands were then derived by removing these trips from the existing assignment matrices to account for the potential for changing modes in response to the scheme proposals within the model scenario. The pre and post adjusted hourly demand totals now assigned to the model are summarised within the following **Table 9**:

Table 9: Assignment Demand Totals (Pre and Post Adjustment)

	AM1	AM2	AM3	PM1	PM2	PM3
INPUT	14847	17612	13328	18138	18375	15177
OUTPUT	14759	17456	13221	17977	18174	15019
DIFF	-88	-156	-107	-161	-200	-157
% CHANGE	-0.6%	-0.9%	-0.8%	-0.9%	-1.1%	-1.0%

Model Scenarios

3.27 Having derived the 'with mode shift' demand totals for assignment within the model. The following three scenarios have been considered in this round of assessment:

- 2031 SUAWA Reference Case – predicted forecast year conditions inclusive of permitted development and infrastructure assumptions.
- 2031 SUAWA + Scheme – as per the Ref Case but with the scheme proposals included.
- 2031 SUAWA + Scheme + Mode Shift – As per the original scheme model but with additional adjustments to account for mode shift as described earlier within this chapter.

3.28 The initial two scenarios are in line with those reported within the Final Scheme Assessment section of Chapter 2, whereas the final scenario has been derived for the purpose of this stage of assessment.

Results Analysis

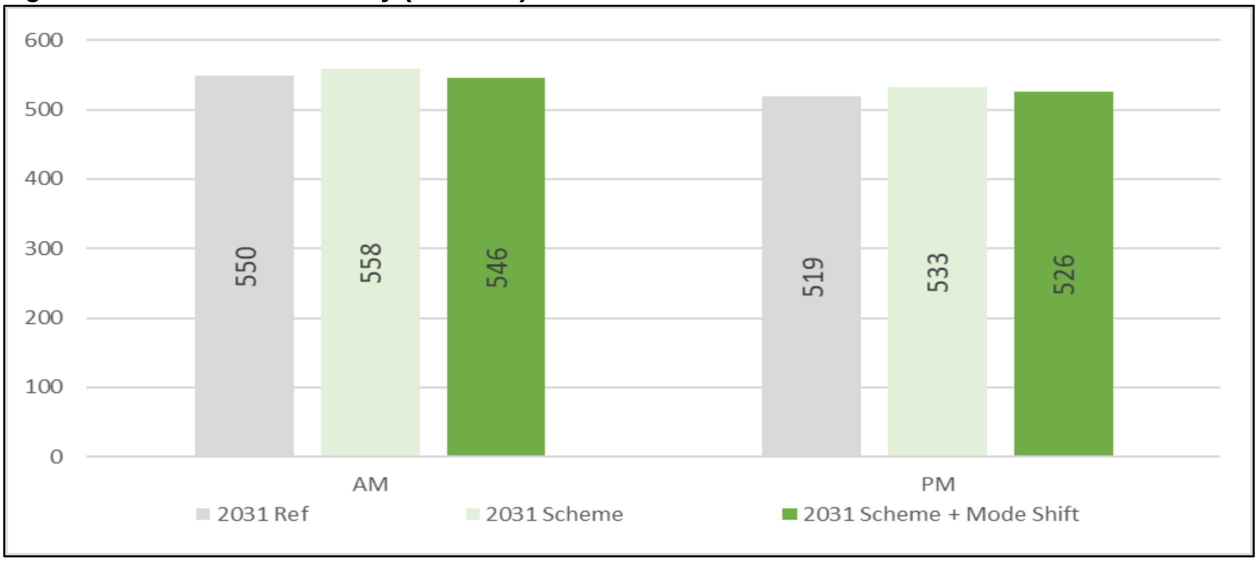
3.29 The following section assesses the difference in performance of the three model scenarios using a series of performance indicators which consider both network wide effect and local effects separately.

Network Wide Performance Indicators

3.30 The first stage of analysing the effect of the demand adjustments considers the effect that the proposals have on the network wide performance. This analysis is based on changes in several key indicators, specifically changes in mean delay and the total number of completed trips.

3.31 The first key indicator analysed is the Network Mean Delay, this measures the average time it takes for vehicles to complete their assigned trip through the model network. The Network Mean Delay results are presented in **Figure 36**.

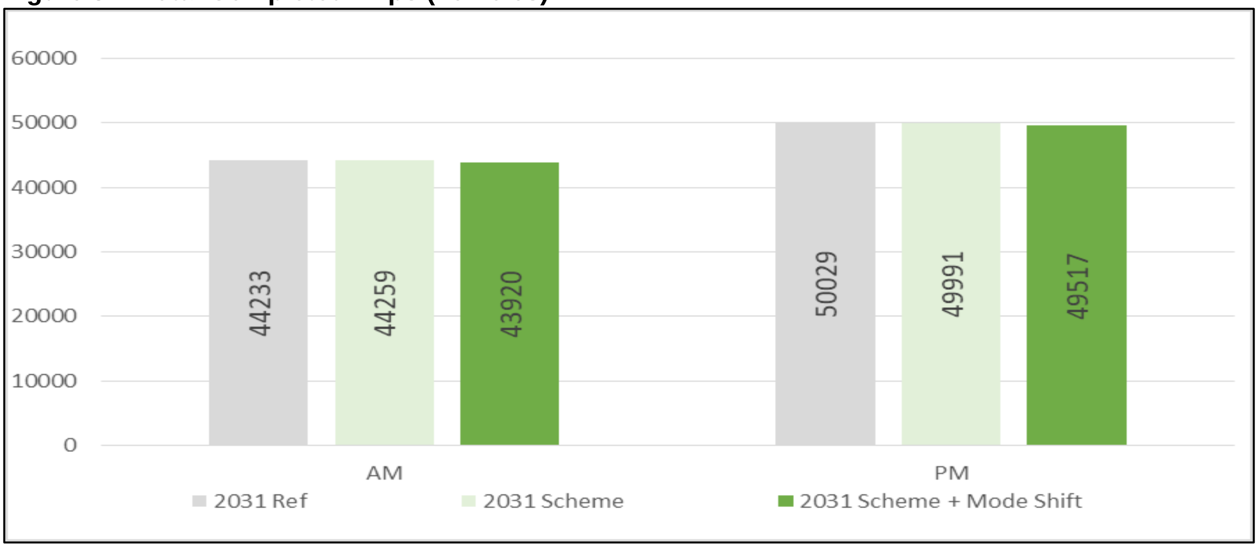
Figure 36: Network Mean Delay (seconds)



3.32 Analysis of **Figure 36** shows that delays increase slightly in the AM and PM period of 2031 Scheme, as identified in the previous reporting2. However, with the mode shift applied this increase in delays is reduced and, in the case of the AM period, entirely mitigated. The mode shift reduces delays in the PM but they do remain above Reference Case levels.

3.33 Following this analysis of Delay, the Total number of Completed Trips in each scenario has been assessed. This analysis shows how many vehicular trips have successfully completed their assigned trip within the modelled period. The competed trip results are shown in **Figure 37**.

Figure 37: Total Completed Trips (vehicles)



3.34 **Figure 37** shows that there is no substantial change in completed trips across all three scenarios, this indicates that the proposals do not introduce effects which will prevent vehicles from completing their assigned trips.

[2] Vectos Microsim, VM215399.TN01 – Traffic Modelling Appraisal Overview, July 2021

Localised Journey Time Impacts

3.35 Following the assessment of the wider network impact, the journey times around Stratford town centre have been assessed to identify any local scheme impacts. The routes which have been assessed are illustrated within **Figure 38** and the journey time information is presented within **Table 10** and **Table 11** for the AM and PM respectively.

3.36 A journey time of 0 for any time period shows that no vehicles travelled along that complete route in that scenario whilst changes of between +/- 15% are not highlighted as these are considered to fall within the level of acceptable tolerance.

3.37 These results show that, in the AM, some of the increases in journey times bought about by the scheme are mitigated by the application of the mode shift. With most routes having journey times close to the levels observed in the Reference Case.

3.38 The notable exception is Route 4 NB, along Rother Street, where a significant increase in delay (92.6%) over the Reference Case is still observed. This increase in delay on Route 4 NB is a result of the schemes diverting traffic away from the town centre as such, a significant increase in traffic volumes on Grove Road and Rother Street occurs. Increased pressure is placed on the junction between Rother Street and Greenhill Street as a result of this, hence the NB delay on Rother Street. While the mode shift does slightly reduce the NB flow on Rother Street this is still an increase over the reference case and therefore there is still an increase in queueing at this junction.

Figure 38: Assessed Journey Time Routes

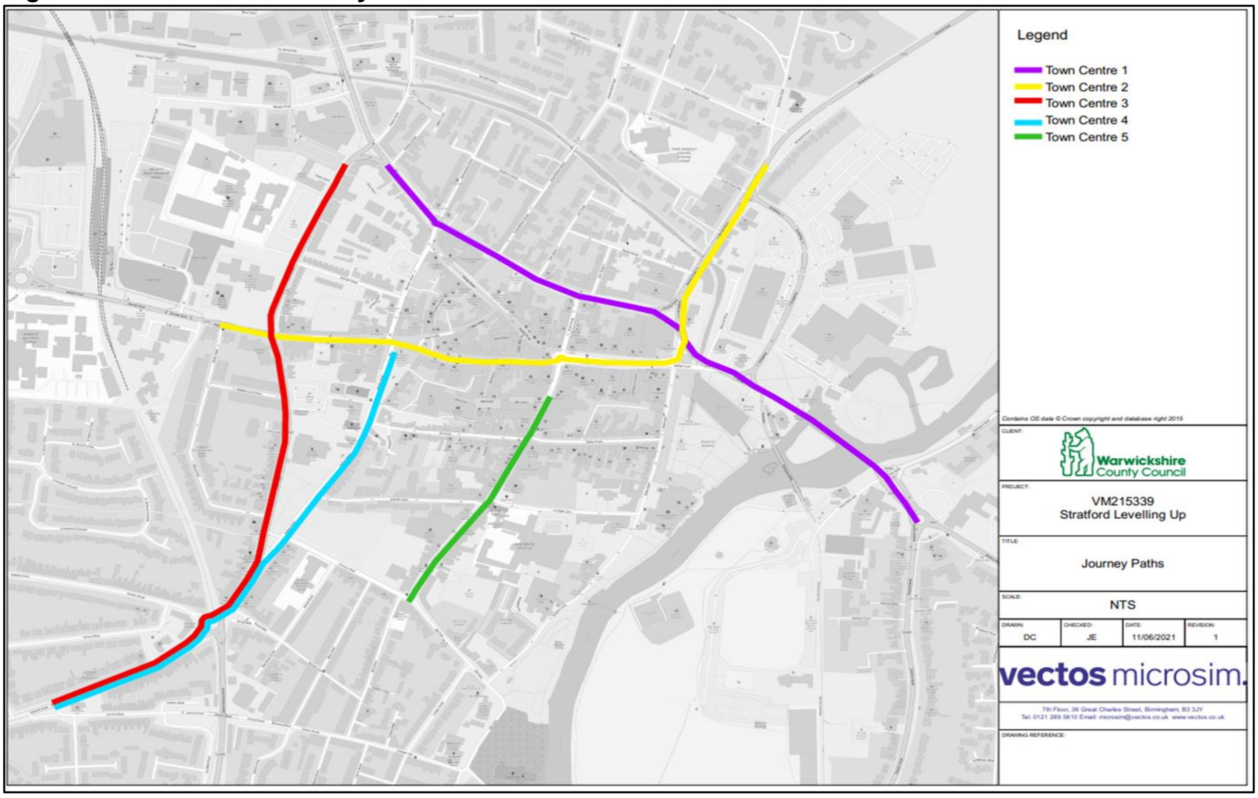


Table 10: AM Peak Hour (08:00-09:00) Journey Time (seconds) Changes

Route	2031 Ref	2031 Scheme	% Ref v Scheme	2031 Scheme + Mode Shift	% Ref v Scheme + Mode Shift	% Scheme v Scheme + Mode Shift
Route 1 EB	187	187	0.2%	184	-1.8%	-2.0%
Route 1 WB	223	269	20%	252	13.2%	-6.4%
Route 2 EB	246	206	-16.4%	198	-19.8%	-4.0%
Route 2 WB	246	0	-100.0%	0	-100.0%	-100.0%
Route 3 NB	458	597	30.3%	539	17.6%	-9.7%
Route 3 SB	158	207	30.9%	177	12.1%	-14.3%
Route 4 NB	256	503	96.6%	493	92.6%	-2.0%
Route 4 SB	130	143	10.2%	135	3.7%	-5.9%
Route 5 NB	56	54	-4.4%	54	-3.8%	0.6%
Route 5 SB	84	0	-100.0%	69	-18.2%	100.0%

Table 11: PM Peak Hour (17:00-18:00) Journey Time (seconds) Changes

Route	2031 Ref	2031 Scheme	% Ref v Scheme	2031 Scheme + Mode Shift	% Ref v Scheme + Mode Shift	% Scheme v Scheme + Mode Shift
Route 1 EB	213	217	1.8%	212	-0.4%	-2.2%
Route 1 WB	180	210	16.6%	206	14.4%	-1.9%
Route 2 EB	170	178	4.8%	170	0.3%	-4.3%
Route 2 WB	221	251	13.5%	0	-100.0%	-100.0%
Route 3 NB	189	277	46.1%	259	36.7%	-6.5%
Route 3 SB	175	213	21.8%	214	22.0%	0.2%
Route 4 NB	143	141	-1.5%	140	-2.1%	-0.6%
Route 4 SB	327	396	21.3%	452	38.3%	14.0%
Route 5 NB	38	52	37.1%	51	36.6%	-0.4%
Route 5 SB	40	53	30.9%	98	143.0%	85.5%

3.39 In the PM the mode shift slightly reduces journey times on most routes compared to the 2031 Scheme scenario. However this still represents a significant increase over Reference Case journey times on most routes.

3.40 The most noticeable route is Route 5 SB, along High Street, where a significant increase in delay (143.0%) over the Reference Case are observed. Following the application of the mode shift there are slight improvements on most routes over the initial scheme, with the exception of Route 5 SB. However as a result of the scheme inclusion flows on High Street are fairly low therefore a high level of variability in journey times is to be expected and this is not considered to be a significant result.

3.41 **Table 11** shows that even with the mode shift PM journey times on a number of routes are above reference case levels. However, it is notable that the PM journey times are generally lower than the AM equivalents. Based on AM network performance it can be assumed that the network can accommodate this level of delay.

Wider Journey Time Impacts

3.42 As part of this mode shift assessment the impact of the town centre proposals on journey times across the wider model network has also been assessed.

3.43 The assessed routes are shown in **Figure 39**. Of particular interest are routes 1,2,3 and 4, these routes cross the town centre and so are the most likely to be impacted by the proposals.

3.44 The wider journey time results are shown in **Tables 12 and 13** for the AM and PM peaks, respectively.

3.45 These results have been categorised using a standard WCC grading system to identify how severe any changes are. The categories are as follows:

- 1 – More than 15% decrease in journey time
- 3 – -15% to 15% change in journey time (No Significant Change)
- 4 – 15 to 25% increase in journey time
- 5 – 25 to 50% increase in journey time
- 6 – More than 50% increase in journey time

Figure 39: Assessed Wider Journey Time Routes

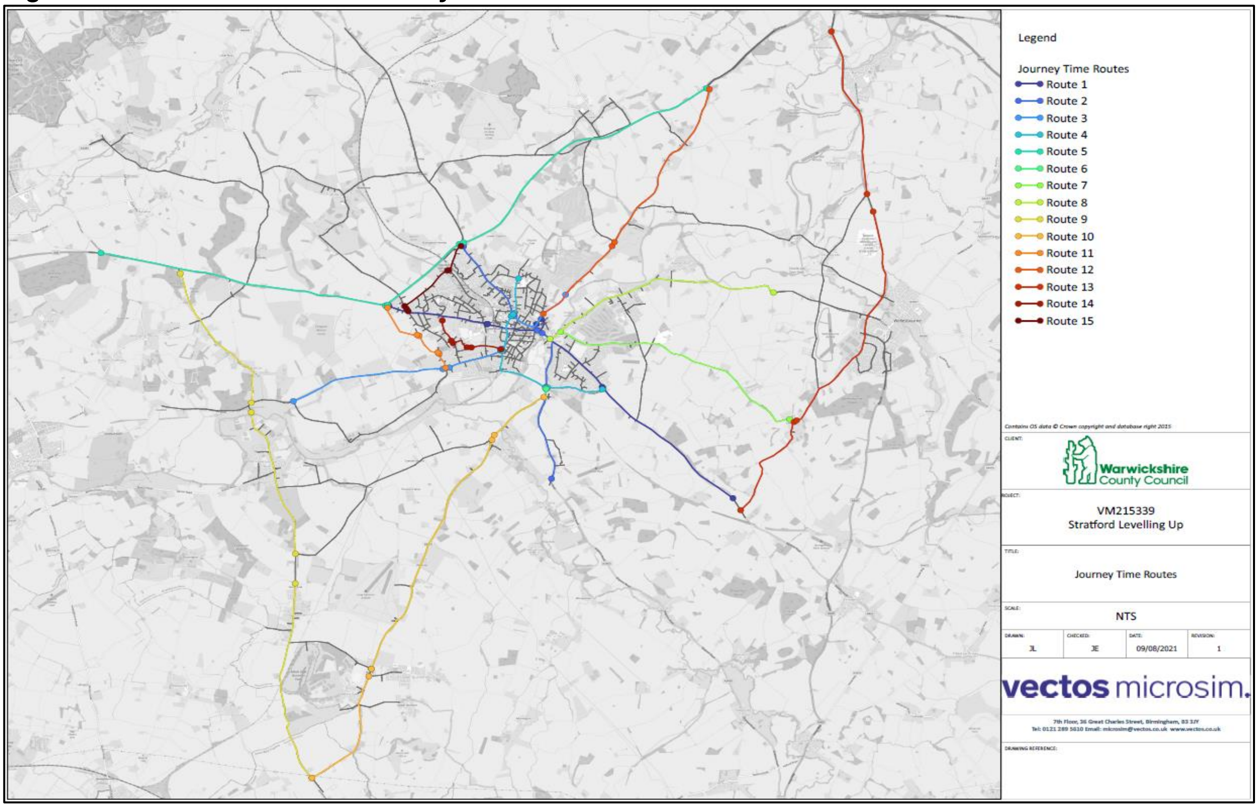


Table 12: AM Peak Hour (08:00-09:00) Wider Journey Time Changes

Route	2031 Ref	2031 Scheme	% Diff Ref & Scheme	Category	2031 Scheme + Mode Shift	% Diff Ref & Scheme + Mode Shift	Category
Route 1 EB	707	741	4.8%	3	718	1.5%	3
Route 1 WB	641	658	2.8%	3	653	2.0%	3
Route 2 SB	571	581	1.8%	3	577	1.2%	3
Route 2 NB	561	613	9.4%	3	590	5.3%	3
Route 3 WB	587	679	15.7%	4	621	5.9%	3
Route 3 EB	539	618	14.6%	3	582	7.9%	3
Route 4 SB	364	427	17.2%	4	397	9.2%	3
Route 4 NB	363	416	14.8%	3	396	9.2%	3
Route 5 EB	617	634	2.8%	3	621	0.8%	3
Route 5 WB	579	572	-1.1%	3	573	-1.0%	3
Route 6 NB	361	360	-0.1%	3	360	-0.1%	3
Route 6 SB	364	364	0.1%	3	364	0.1%	3
Route 7 WB	296	293	-0.8%	3	295	-0.3%	3
Route 7 EB	291	292	0.2%	3	291	-0.2%	3
Route 8 WB	380	354	-6.9%	3	353	-7.0%	3
Route 8 EB	287	287	-0.2%	3	287	-0.2%	3
Route 9 NB	668	666	-0.3%	3	665	-0.4%	3
Route 9 SB	687	686	-0.2%	3	689	0.2%	3
Route 10 NB	507	507	-0.1%	3	507	0.0%	3
Route 10 SB	497	497	0.0%	3	497	0.0%	3
Route 11 SB	115	115	-0.2%	3	115	-0.2%	3
Route 11 NB	114	114	0.1%	3	114	-0.1%	3
Route 12 NB	343	282	-17.7%	1	281	-18.0%	1
Route 12 SB	300	281	-6.2%	3	281	-6.4%	3
Route 13 NB	564	563	-0.2%	3	564	0.0%	3
Route 13 SB	574	569	-0.9%	3	570	-0.8%	3
Route 14 SB	176	210	19.0%	4	197	11.6%	3
Route 14 NB	170	171	0.5%	3	170	0.0%	3
Route 15 SB	155	150	-2.9%	3	152	-1.9%	3
Route 15 NB	159	161	1.2%	3	157	-1.1%	3

3.46 **Table 12** reveals that the inclusion of the town centre proposals results in journey time increases on several routes. Route 3 WB and Route 4 SB travel across the town centre and the increase is therefore a direct result of the town centre proposals. Route 14 SB is along the West of Shottery Relief Road (WSRR). The delay on here is linked to the increased congestion NB on Grove Road with the scheme proposals causing traffic to reassign to the new link road.

3.47 The addition of the mode shift does, to some extent, mitigate these impacts, bringing the increases on most routes to less than 15% with all routes experiencing a level of change which lies within acceptable tolerances and one route, Route 12 NB, continues to experience a reduction in journey times as the scheme proposals make it more difficult to cross the town centre, encouraging trips from the south west of SuA travelling to the A46 route via Birmingham Road rather than Warwick Road.

Table 13: PM Peak Hour (17:00-18:00) Wider Journey Time Changes

Route	2031 Ref	2031 Scheme	% Diff Ref & Scheme	Category	2031 Scheme + Mode Shift	% Diff Ref & Scheme + Mode Shift	Category
Route 1 EB	746	744	-0.3%	3	737	-1.3%	3
Route 1 WB	641	669	4.3%	3	657	2.4%	3
Route 2 SB	721	818	13.4%	3	801	11.1%	3
Route 2 NB	586	660	12.6%	3	661	12.9%	3
Route 3 WB	574	608	5.9%	3	583	1.6%	3
Route 3 EB	475	518	9.1%	3	514	8.2%	3
Route 4 SB	367	425	15.8%	4	410	11.9%	3
Route 4 NB	401	430	7.1%	3	412	2.6%	3
Route 5 EB	766	786	2.5%	3	756	-1.3%	3
Route 5 WB	668	682	2.1%	3	665	-0.4%	3
Route 6 NB	358	358	0.1%	3	358	0.0%	3
Route 6 SB	367	367	0.0%	3	367	0.2%	3
Route 7 WB	292	292	0.0%	3	291	-0.2%	3
Route 7 EB	292	292	0.1%	3	291	-0.4%	3
Route 8 WB	344	334	-2.7%	3	322	-6.2%	3
Route 8 EB	287	286	-0.3%	3	286	-0.2%	3
Route 9 NB	681	678	-0.5%	3	680	-0.2%	3
Route 9 SB	690	695	0.8%	3	700	1.4%	3
Route 10 NB	504	504	0.0%	3	504	-0.1%	3
Route 10 SB	499	499	0.1%	3	500	0.2%	3
Route 11 SB	115	116	0.1%	3	115	-0.2%	3
Route 11 NB	115	115	0.0%	3	115	-0.4%	3
Route 12 NB	417	406	-2.6%	3	394	-5.6%	3
Route 12 SB	284	284	0.2%	3	283	-0.2%	3
Route 13 NB	562	556	-1.1%	3	559	-0.6%	3
Route 13 SB	571	565	-1.1%	3	565	-1.1%	3
Route 14 SB	173	173	-0.1%	3	173	0.0%	3
Route 14 NB	170	170	-0.1%	3	170	0.1%	3
Route 15 SB	160	164	2.9%	3	160	0.1%	3
Route 15 NB	261	299	14.8%	3	313	20.0%	4

3.48 **Table 13** shows that, in the PM, the scheme has a lower impact on journey times across the model than is observed through analysis of the AM.

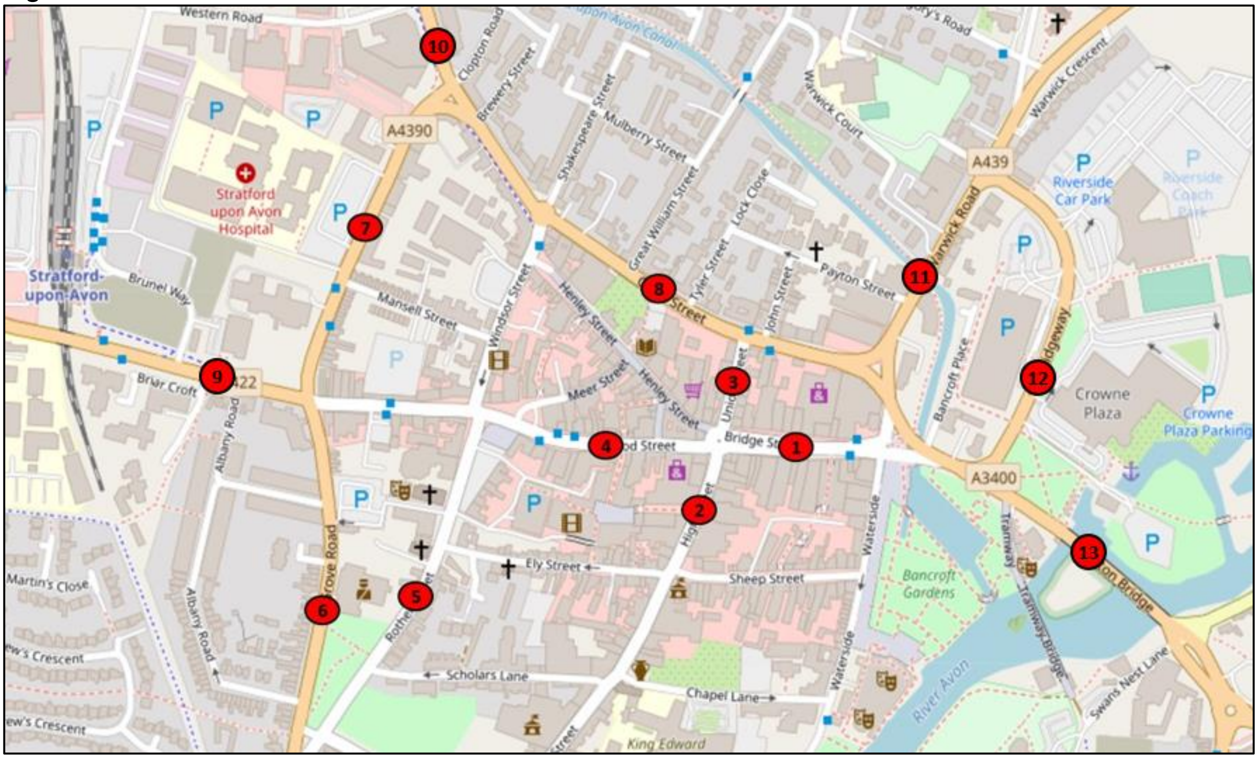
3.49 The only notable increase is on Route 4 SB, which is partially mitigated by the mode shift with increases now falling below the 15% level. In the PM the mode shift appears to result in a slight increase in journey times on route 15 SB, given that the change between the with and without mode shift is small (14 seconds) it is considered likely that this is more likely related to the variability between model runs than being as a consequence of the mode shift assumptions.

3.50 The previous analysis reveals that the mode shift assumptions begin to mitigate some of the adverse effects of the scheme proposals which have been observer to occur in the form of journey time increases. At the network wide level, introduction of the scheme and the associated mode shift actually results in a modest improvement relative to the Reference Case (i.e. Do Nothing) scenario.

Traffic Flow Changes

3.51 Following this assessment of journey time impacts the changes in the link flows at a number of locations around the town centre have been assessed to identify is there are any issues associated with the reassignment of the traffic flow around the town between the different scenarios. The link traffic flows are all located in the same locations as were assessed for the Levelling Up Funding Submission however, additional five locations are added onto the link flow locations within **Figure 40**.

Figure 40 Link Flow Locations



3.52 As no specific guidance exists around what constitutes a significant change in flow between scenarios the GEH measure has been used to determine the level of significance of each change. Studies have demonstrated that analysis of the GEH values, when considering the variability of specific counts relative to the long-term average, revealed that the GEH criteria tends to demonstrate patterns in the variation of observed traffic flows between different time periods which are similar to those which are used to inform the acceptability of a specified level of model calibration[3].

3.53 As observed data varies by a similar distribution (94% of DfT road types returned a GEH of less than 5 when comparing single sites to long term averages) it is reasonable to use this method to determine whether a change in flows between model scenarios is also significant. Since long term average counts when compared to the single site return a GEH of less than 5 in the majority of instances then a GEH 5 is considered an appropriate benchmark for measuring the significance of any change between scenarios. The traffic flow changes are presented within **Tables 14-16** for the AM and PM peaks, and a combined 6-hour two-way link flow, respectively.

[3] The GEH Measure and Quality of The Highway Assignment Models, European Transport Conference, Olga Feldman, Transport Ford London, October 2012

Table 14: AM Peak Hour (08:00-09:00) Two-Way Link Flow Changes

Link Flow Location	2031 Ref	2031 Scheme	2031 Scheme + Mode Shift	Ref v Scheme		Ref v Scheme + Mode Shift	
				% Change	GEH	% Change	GEH
Bridge Street (1)	832	429	373	-48.5%	16.06	-55.2%	18.72
High Street (2)	692	236	207	-65.9%	21.16	-70.1%	22.87
Union Street (3)	259	48	44	-81.6%	17.08	-83.1%	17.51
Wood Street (4)	394	261	234	-33.6%	7.32	-40.6%	9.02
Rother Street (5)	414	507	479	22.4%	4.33	15.8%	3.09
Grove Road (6)	773	770	794	-0.3%	0.09	2.7%	0.76
Arden Street (7)	1166	1173	1186	0.6%	0.19	1.7%	0.57
Guild Street (8)	1222	1426	1406	16.7%	5.61	15.1%	5.08
Alcester Road (9)	1433	1340	1316	-6.4%	2.48	-8.1%	3.14
Birmingham Rd (10)	1456	1382	1378	-5.1%	1.96	-5.3%	2.07
Warwick Road (11)	1797	1713	1639	-4.7%	2.01	-8.8%	3.83
Bridgeway (12)	1249	1214	1198	-2.8%	0.99	-4.1%	1.47
Clopton Bridge (13)	2006	1945	1882	-3.1%	1.39	-6.2%	2.81

Table 15: PM Peak Hour (17:00-18:00) Two-Way Link Flow Changes

Link Flow Location	2031 Ref	2031 Scheme	2031 Scheme + Mode Shift	Ref v Scheme		Ref v Scheme + Mode Shift	
				% Change	GEH	% Change	GEH
Bridge Street (1)	808	242	203	-70.1%	24.72	-74.9%	26.91
High Street (2)	562	122	111	-78.4%	23.81	-80.2%	24.56
Union Street (3)	190	55	42	-71.2%	12.21	-77.8%	13.72
Wood Street (4)	653	220	195	-66.2%	20.69	-70.1%	22.22
Rother Street (5)	244	309	295	27.1%	3.96	21.0%	3.11
Grove Road (6)	1022	1067	1083	4.4%	1.41	6.0%	1.90
Arden Street (7)	1280	1468	1460	14.7%	5.07	14.0%	4.86
Guild Street (8)	1143	1444	1413	26.4%	8.38	23.7%	7.57
Alcester Road (9)	1345	1267	1246	-5.8%	2.16	-7.3%	2.74
Birmingham Rd (10)	1485	1331	1323	-10.4%	4.11	-10.9%	4.33
Warwick Road (11)	1547	1434	1398	-7.3%	2.94	-9.7%	3.89
Bridgeway (12)	1490	1451	1428	-2.6%	1.02	-4.2%	1.64
Clopton Bridge (13)	2108	2007	1949	-4.8%	2.23	-7.5%	3.53

Table 16: Combined 6-Hour Two-Way Link Flow Changes

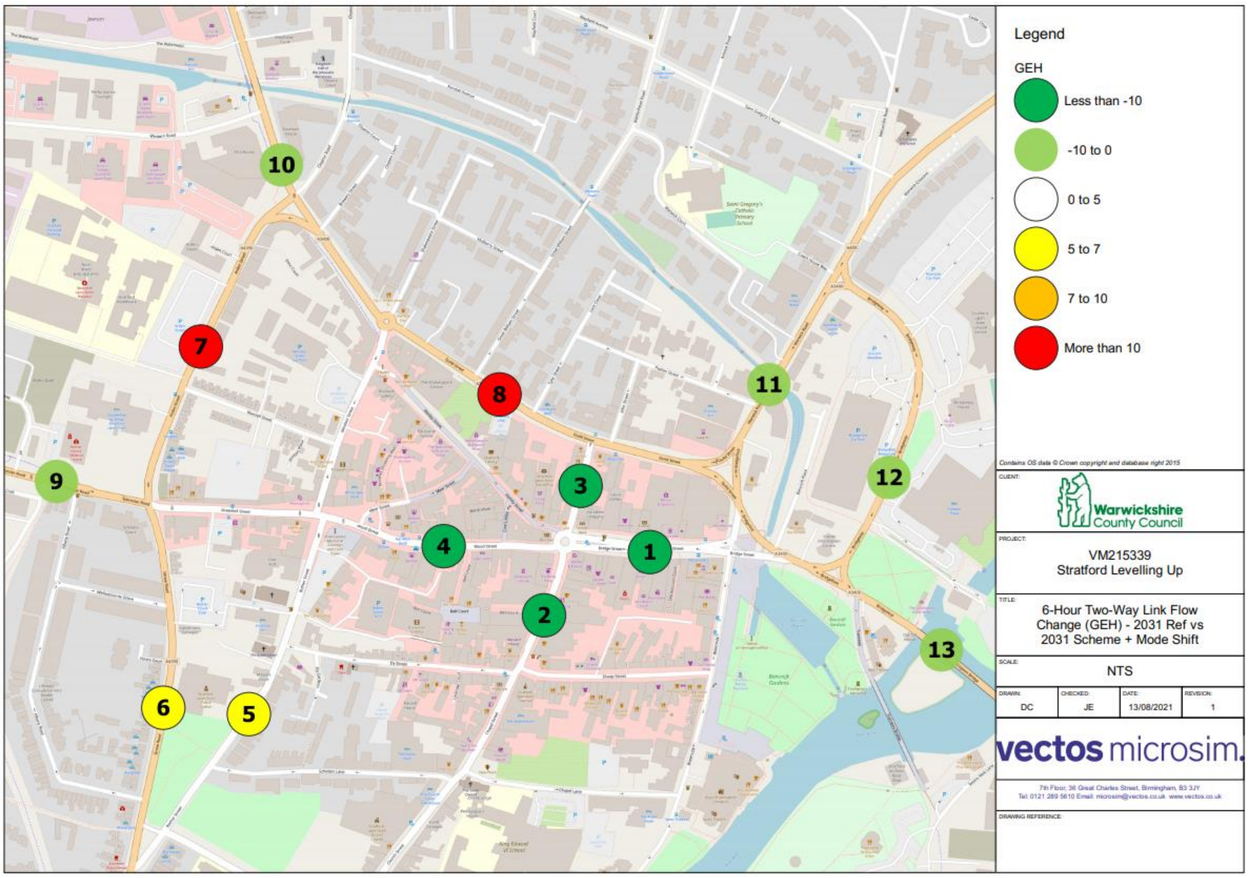
Link Flow Location	2031 Ref	2031 Scheme	2031 Scheme + Mode Shift	Ref v Scheme		Ref v Scheme + Mode Shift	
				% Change	GEH	% Change	GEH
Bridge Street (1)	4235	1318	1153	-68.9%	55.36	-72.8%	59.38
High Street (2)	3200	656	580	-79.5%	57.94	-81.9%	60.27
Union Street (3)	1165	256	211	-78.0%	34.10	-81.9%	36.38
Wood Street (4)	2927	1031	929	-64.8%	42.60	-68.3%	45.50
Rother Street (5)	1822	2221	2123	21.9%	8.88	16.5%	6.78
Grove Road (6)	5125	5529	5612	7.9%	5.53	9.5%	6.64
Arden Street (7)	6466	7448	7449	15.2%	11.78	15.2%	11.78
Guild Street (8)	6348	7950	7832	25.2%	18.94	23.4%	17.62
Alcester Road (9)	7140	6808	6679	-4.6%	3.97	-6.5%	5.54
Birmingham Road (10)	8472	8001	8008	-5.6%	5.20	-5.5%	5.11
Warwick Road (11)	8934	8259	8089	-7.5%	7.27	-9.4%	9.15
Bridgeway (12)	7442	7117	7023	-4.4%	3.80	-5.6%	4.92
Clopton Bridge (13)	11402	10888	10692	-4.5%	4.87	-6.2%	6.76

3.54 For the majority of the link flow locations, and most noticeably for the locations directly impacted by the proposals (Bridge Street, High Street, Union Street and Wood Street), there is a reduction in traffic flow with the implementation of the scheme proposals. These flow reductions are then enhances by the application of the mode shift assumptions. This highlights the effectiveness of the proposals in reducing town centre traffic in order to enhance the possibility for active travel.

3.55 There are some areas where significant flow increases are observed. These are generally on the larger major roads around the town centre, in particular Arden Street and Guild Street. The increase on these links is because the inclusion of schemes results in traffic reassigning away from routes through the town centre onto roads around the town centre. These changes are most pronounced when considering the 6-hour flow change (**Table 16**) with GEH values over 10 but much less significant during the busiest AM and PM peak hour periods.

3.56 The routes which experience a significant increase in flow are the larger major roads around the town centre. Therefore these routes are appropriate to carry additional traffic away from the minor roads through the town centre. **Figure 41** illustrates the areas where the largest changes in flow occur, with increases in flow marked in red and decreases in green.

Figure 41 6 Hour Two-Way Link Flow Changes (GEH) 2031 Ref vs 2031 Scheme + Mode Shift



3.57 This figure shows that the most significant increases in flow are located on major roads, capable of handling this additional traffic. These increases in flow are therefore considered to be acceptable. Generally, these increases in flow are slightly reduced by the application of the mode shift assumptions.

Summary

3.58 The mode shift assessment documented within this report follows on from the core modelling assessment of the proposed changes to the town centre highway layout. This stage of the assessment considered the impact of users switching to active modes in response to the scheme proposals. The proposed mode shift was calculated using the numbers contained within the Department of Transports Active Modes Appraisal Toolkit (AMAT) and local survey data used to support the initial scheme appraisal.

3.59 The core assessment revealed that, as a result of the inclusion of the scheme proposals, some road users would experience dis-benefits in the form of increased travel times. Having accounted for mode shift, the indication is that these adverse effects remain on the network but the magnitude is reduced and, furthermore, when considering the operation of the network as a whole, there is potential for modest improvement across the network within the AM if the circa a 1% shift to walking for High Street users is achieved.

3.60 The inclusion of the mode shift reduces the impacts previously observed with both overall network wide statistics, and town centre journey times, being closer to those observed in the Reference Case after the adjustments are applied.

3.61 Thus, it is reasonable to conclude that the residual impacts, which were already considered to lie within acceptable tolerances, will be improved if a relatively modest mode shift of less than 1% is achieved following the introduction of the scheme proposals.

4 Detailed Capacity Assessment

Introduction

4.1 The testing reported thus far has focused upon the impact of a range of options for improvements targeted at non-motorised transport users, before identifying a preferred option, and reporting the likely traffic impacts associated with this option, across the town. These impacts consisted of reduced traffic flows within the town centre itself, but an increase in traffic on edge of town routes, which could potentially begin to experience increased delays and congestion. In particular, the A4390 Grove Road/Arden Street corridor was identified as a route likely to experience additional traffic flows.

4.2 The original testing revealed that the changes which were being considered through the modelling would be unlikely to severely impact the network operation and, as a result, it was recommended that the schemes be taken forward for further consideration.

4.3 The modelling work reported thus far has included manual adjustments to the signal times at key junctions within the town, to accommodate the changes in traffic flows induced by the scheme proposals. The intention of this stage of testing is to revisit the modelling, and focus on the adjustments applied to the signalised junctions within the model.

4.4 Within this testing, signal times will be optimised through LinSig, meaning each scenario is assessed on an equal basis, whilst also allowing for more detailed analysis of the local junctions to be completed.

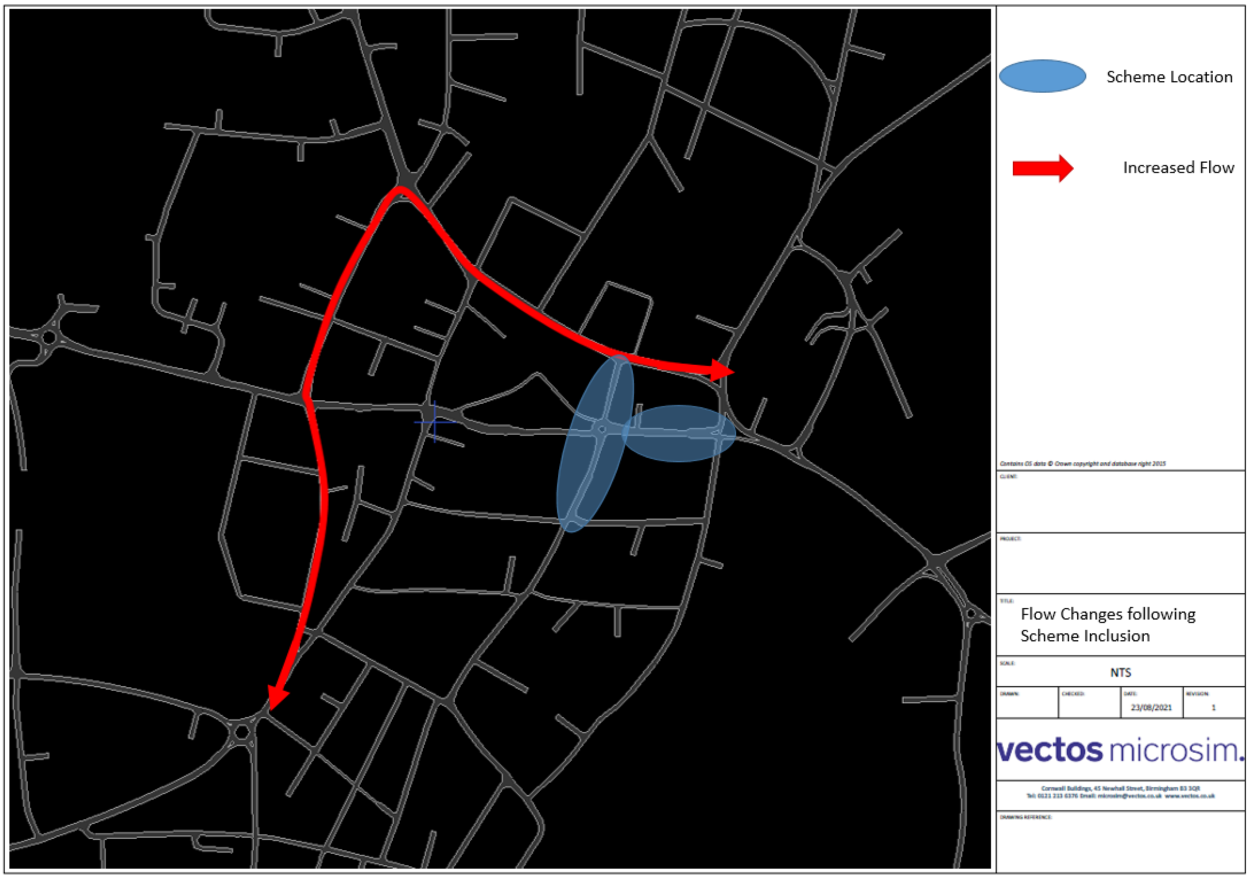
Background

4.5 The work undertaken thus far has identified a package of proposed schemes for Stratford-upon-Avon town centre, intended to improve accessibility for non-motorised transport users within the town. The final scheme involved making changes to the layout of Bridge Street, High Street and Union Street and included the closure of High Street to general traffic between 1100-1600, with the inclusion of traffic calming, and revised road signage to discourage traffic from using these routes outside of these hours. In addition to this, a right turn ban was implemented on Union Street, at the junction of Guild Street/Union Street, to discourage traffic from using Union Street in lieu of Bridge Street.

4.6 The resultant analysis undertaken within the SuAWA Paramics models indicated that the proposed measures would reduce traffic flows within the town centre and therefore likely to be successful in terms of improving the environment for active travel modes.

4.7 The analysis also indicated that there were likely to be changes in traffic flows on routes just outside of the town centre, with a shift of traffic onto routes around the edge of the town, where increases in queues and delay were identified. This was most notable in the form of an increase in south to north movements through the Alcester Road/Arden Street/Grove Road junction and an increase in the right turn movement from Arden Street to Guild Street at the Birmingham Road/Guild Street/Arden Road junction. This pattern is demonstrated within **Figure 42**.

Figure 42 Edge of Town Flow Increases following Scheme Inclusion



4.8 The modelling to date has also indicated that, because of the proposals, some traffic may reassign to alternative routes to avoid the town centre completely. This was demonstrable via the increase in traffic using the Shottery Western Relief Road.

4.9 The analysis thus far has concluded that any traffic impacts arising through the delivery of the scheme proposals are likely to be localised. The analysis has also suggested that signal timing optimisation would likely be required in response to predicted changes in traffic flows, to ensure the changes can be accommodated. This is focused at three signal junctions (detailed in the following section), which lie on routes around the edge of the town centre, which are anticipated to experience the most notable changes in flows as a result of delivering the scheme proposals.

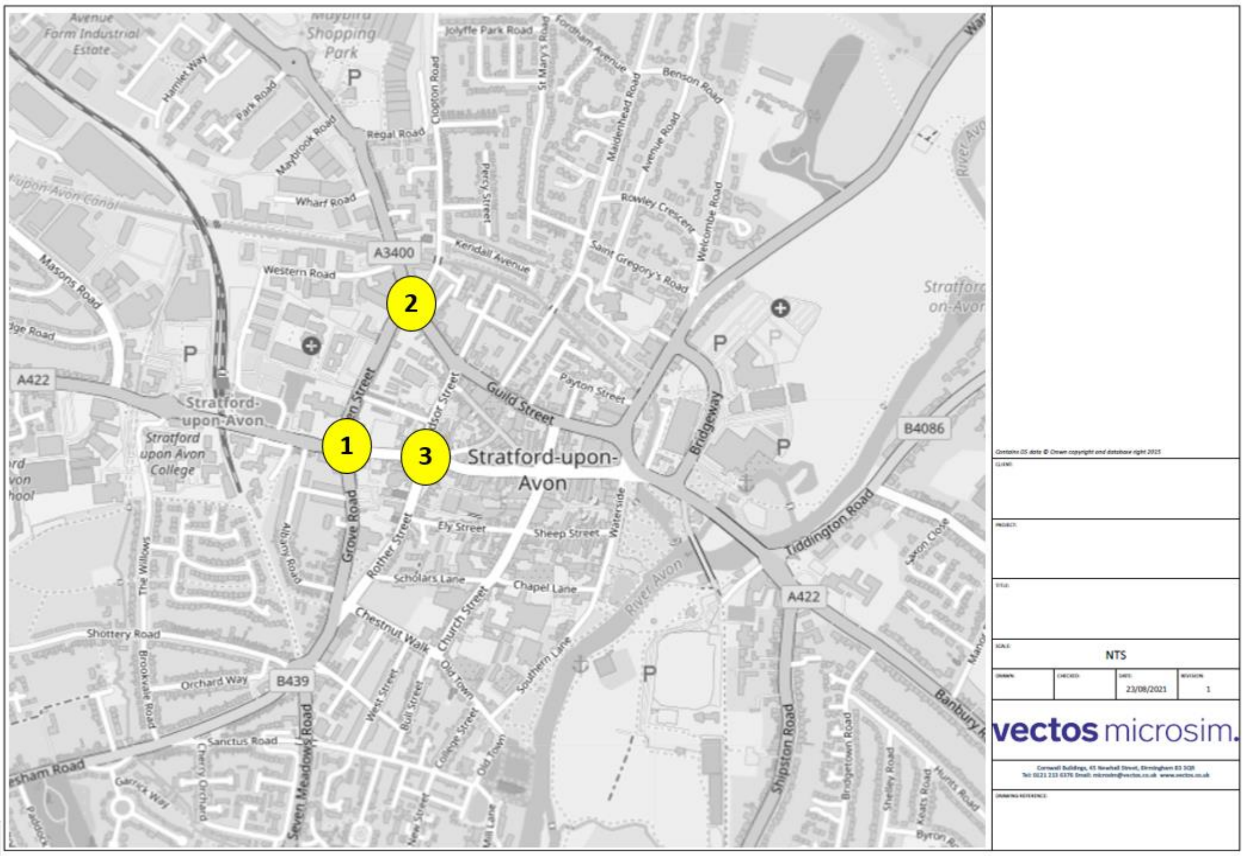
4.10 On the above basis, the objective of this stage of the assessment is to make use of the previous model scenarios, to assess how the inclusion of signal timings derived from the WCC LinSig models would impact on the conclusions. Additionally, the LinSig analysis will also provide an understanding of how each junction will likely operate in isolation following the scheme implementation.

Modelling Approach

4.11 The first stage of the assessment required optimisation of the signalised junctions on the edge of the town centre, using LinSig to review the signal timings, as well as the original model scenarios to provide the input traffic flows. To support this assessment, WCC provided the LinSig models, which have been updated using traffic flows from the future year model scenarios, for the following locations:

- Junction 1 - Alcester Road/Arden Street/Grove Road
- Junction 2 - Birmingham Road/Guild Street/Arden Street
- Junction 3 - Greenhill Street/Rother Street/Windsor Street

Figure 43 Junction Locations



4.12 In terms of the assessment, the predicted performance of the junctions, once the schemes are delivered (Reference Case + Schemes), are compared with scenarios in which no changes to the existing layout are made (Reference Case).

4.13 For the purpose of this assessment, the performance of each junction has been assessed through LinSig which also provides a set of ‘optimised’ signal times, which account for the differing traffic flows in each scenario. These optimised signal timings are then fed back in to the Paramics models, so that each model scenario contains traffic signals optimised to the respective flow conditions therein.

4.14 For initial stage of assessment, ‘LinSig’ software has been utilised, which is an industry standard tool used to indicate the performance of the signalised junction under a given set of traffic flows. LinSig calculates the ‘degree of saturation’ (DoS), expressed as a percentage, for each approach to the junction being assessed. Any approach where the DoS is predicted to exceed 90% is highlighted in red within the results presented in the following tables, on the basis that this indicates that the approach is close to or over-capacity.

4.15 Alongside this, the 'mean max queue' (MMQ) is calculated, to represent the average position of the furthest vehicles from the stop line in each cycle. The 'Practical Reserve Capacity' (PRC) for the junction as a whole is also calculated, which reflects the spare capacity across the junction for additional traffic. A positive PRC figure indicates that the junction has spare capacity, whilst a negative PRC figure suggest that the junction is over capacity and experience congested conditions.

LinSig Modelling Assessment

4.16 LinSig models for each of the junctions have been run using flows extracted from the respective SuAWA model scenarios from the original scheme assessment work.

Traffic Flows

4.17 Traffic flows from the following SuAWA model scenarios have been input to the junction assessments:

- 2023 Reference Case
- 2031 Reference Case
- 2031 Core Strategy

4.18 The 2023 and 2031 Reference Case scenarios are reflective of all consented sites and infrastructure up to 2023 and 2031 respectively, whilst the 2031 Core Strategy scenario also included all allocated sites and associated infrastructure including the South-Western Relief Road. In each scenario, background traffic growth is included within the models in line with WebTAG guidance.

4.19 It is important to highlight that the 2023 Reference Case traffic flows are likely to be very optimistic, since these demands are predicated on a build out rates for consented developments which are unlikely to have been achieved over the last 2 years, meaning that the traffic volumes associated with the consented developments in this model scenario are likely to be higher than actually realised by this point.

4.20 In addition to the above, traffic volumes have not been adjusted to reflect different working patterns, or potential model shift changes cross the town in the future.

4.21 The flows have been extracted for three key signalised junctions which are expected to experience a change in traffic flows within the town centre. A detailed review of each of these junctions has revealed the following:

Alcester Road/Arden Street/Grove Road Junction (see Figure 44):

- Increase in flows from Grove Road to Arden Street (south to north movement)
- Increase in flows from Arden Street to Alcester Road (north to west movement)
- Increase in flows from Alcester Road to Arden Street (west to north movement)
- Reduction in flows from Alcester Road to Greenhill Street (west to east movement)

- Reduction in flows from Greenhill Street to Alcester Road (east to west movement)

Birmingham Road/Arden Street/Guild Street Junction (see Figure 45):

- Increase in flows from Arden Street to Guild Street (south to east movement)
- Increase in flows from Guild Street to Arden Street (east to south movement)

Greenhill Street/Rother Street/Windsor Street (see Figure 46):

- Increase in flows from Windsor Street to Greenhill Street (north to west movement)
- Increase in flows from Windsor Street to Rother Street (north to south movement)
- Reduction in flows from Wood Street to Greenhill Street (east to west movement)
- Reduction in flows from Greenhill Street to Wood Street (west to east movement)
- Reduction in flows from Windsor Street to Wood Street (north to east movement)

Figure 44 Alcester Road/Arden Street/Grove Road Flow Changes

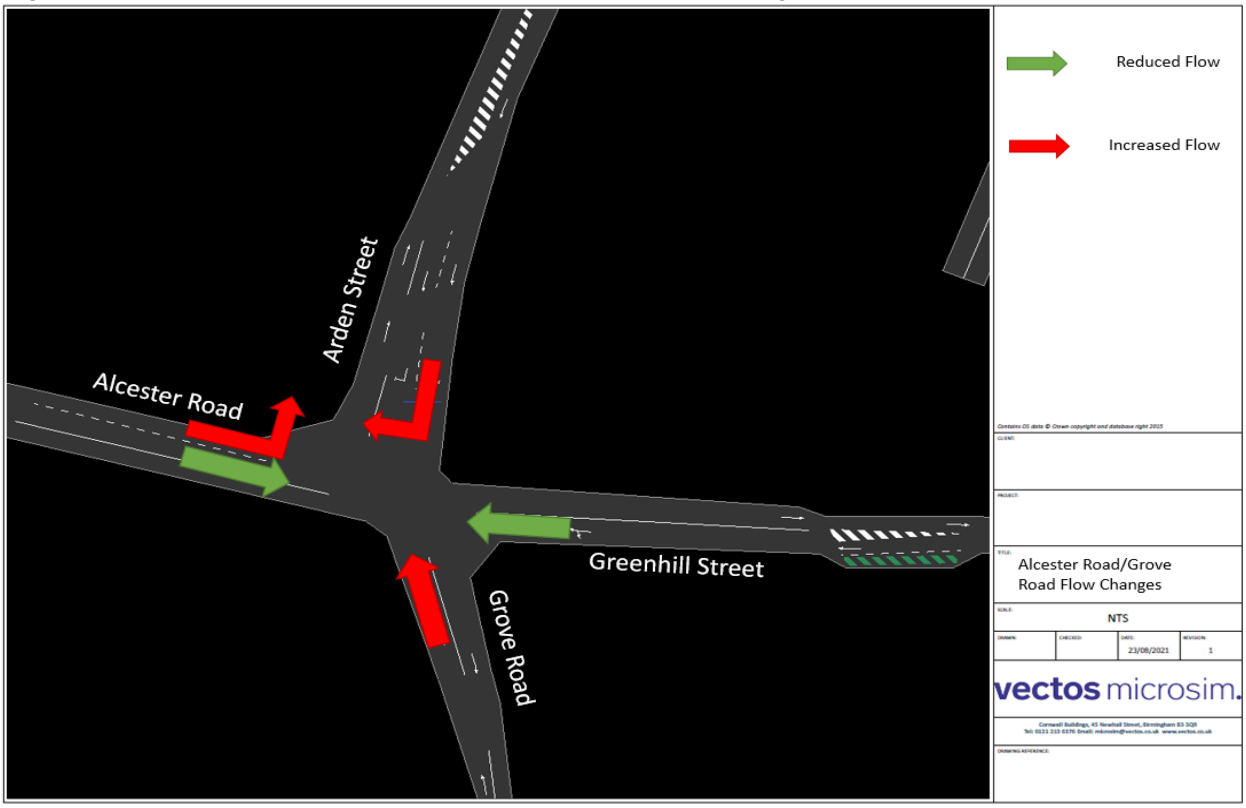


Figure 45 Birmingham Road/Arden Street/Guild Street Flow Changes

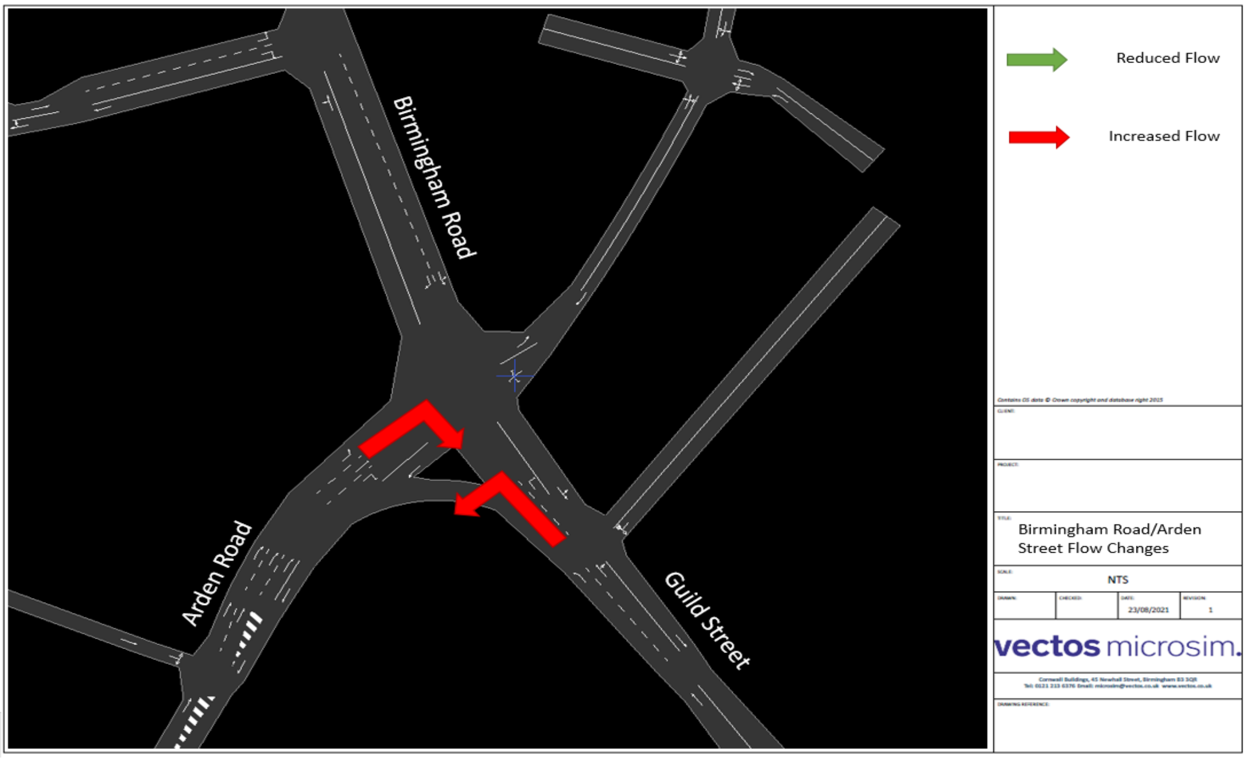
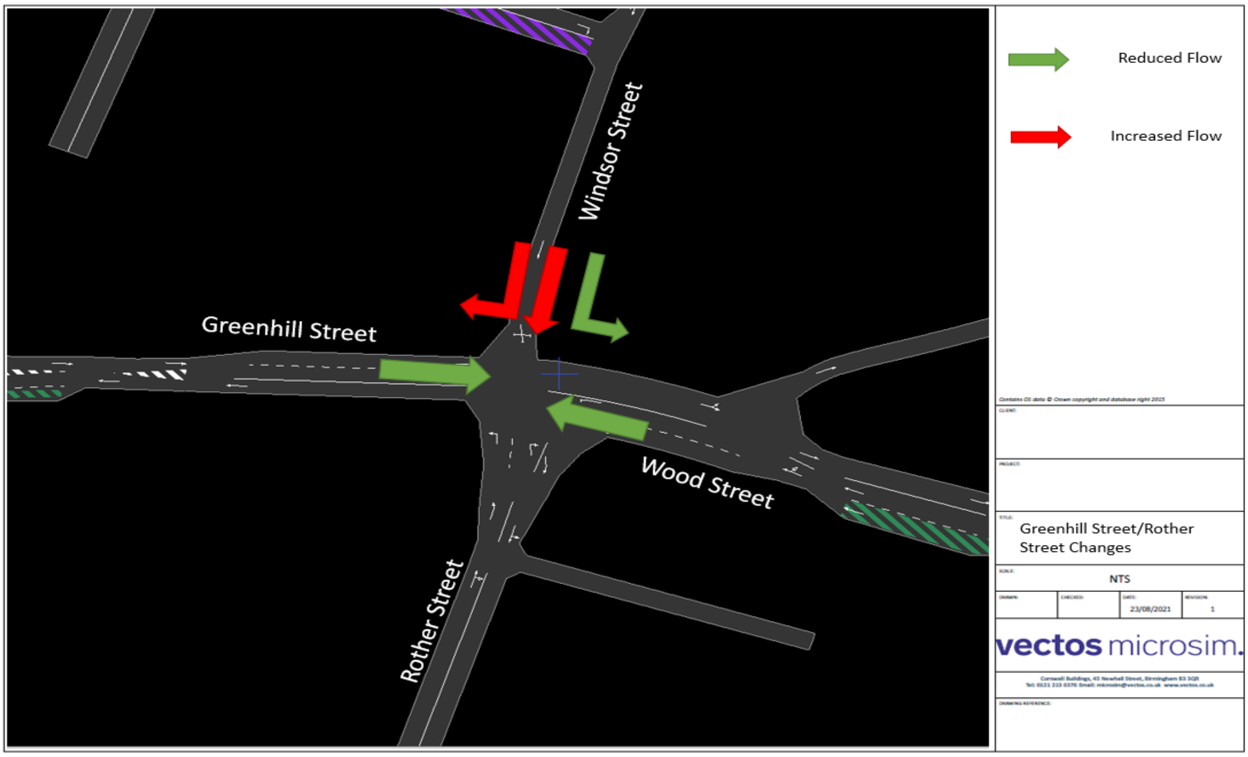


Figure 46 Greenhill Street/Rother Street/Wood Street Flow Changes



Modelling Results

4.22 As detailed, the scenarios have been assessed using 2023 and 2031 Reference Case, along with the 2031 Core Strategy model traffic flows. For the purposes of this testing, no allowance for modal shift has been included within the flows assessed. The resultant outputs from the LinSig modelling are presented in the following tables for the 2031 Reference Case scenarios only, with the outputs from the 2023 Reference Case and 2031 Core Strategy presented within **Appendix B**.

Table 17 2031 Reference Case Model Results - Alcester Road/Arden Street/Grove Road

	2031 Reference Case				2031 Reference Case + Schemes			
	0800-0900		1700-1800		0800-0900		1700-1800	
Approach	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**
Alcester Road	24	87.2%	13	77.5%	22	85.8%	19	79.5%
Greenhill Street	13	68.9%	15	72.6%	13	71.7%	15	80.6%
Arden Street	10	74.4%	25	77.3%	10	72.6%	20	81.5%
Grove Road	30	88.5%	17	62.0%	30	86.8%	23	75.6%
PRC (%)	**1.7%**		**16.1%**		**3.7%**		**10.4%**	

4.23 The results presented within **Table 17** demonstrate the predicted operation of the Alcester Road/Arden Street/Grove Road signal junction following the assessment in the LinSig models using 2031 Reference Case scenario flows.

4.24 The results indicate that the junction is predicted to operate within capacity during the AM period, in 2031 Reference Case conditions, with no notable change in the operation of the junction predicted to occur once the schemes are introduced. This is likely to be a direct result of the increase in north/south flows through the junction being balanced out by a reduction in east/west flows, meaning that signal timings within LinSig have been optimised to provide more green time to the north/south movement, without having a detrimental impact on the east/west queues recorded.

4.25 Within the PM period, there is predicted to be a more notable impact, with the overall capacity reducing once the schemes are introduced, and queue increases occurring on the Alcester Road and Grove Road approaches. Despite this, the LinSig modelling suggests that the overall junction performance will continue to operate within capacity during this period.

Table 18 2031 Reference Case Model Results – Birmingham Road//Guild Street/Arden Street

	2031 Reference Case				2031 Reference Case + Schemes			
	0800-0900		1700-1800		0800-0900		1700-1800	
Approach	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**
Birmingham Road	14	79.3%	13	76.8%	17	85.0%	14	89.0%
Guild Street	10	68.1%	16	76.7%	10	70.4%	15	80.9%
Arden Street (ahead/left)	8	57.8%	8	49.6%	6	46.1%	7	42.7%
Arden Street (right)	10	76.8%	11	76.6%	13	82.5%	21	89.1%
Clopton Road	6	80.1%	9	75.5%	6	84.7%	10	85.8%
PRC (%)	**12.4%**		**17.2%**		**5.9%**		**1.0%**	

4.26 The results presented within **Table 18** demonstrate the predicted operation of the Birmingham Road/Guild Street/Arden Street junction in 2031 Reference Case conditions.

4.27 The results indicate that the junction is predicted to operate well within capacity during the AM period, in 2031 Reference Case conditions. With the inclusion of the town centre scheme proposals, the operation of the junction is predicted to worsen slightly, with minor queue increases occurring on the Birmingham Road and Arden Street (right turn) movements, which again ties in with the predicted traffic flow changes around the town as a result of including the schemes on the network. Despite this increase, the modelling predicts that the junction will continue to operate within capacity.

4.28 The PM results indicate that the junction is predicted to operate within capacity in the 2031 Reference Case conditions, and that the inclusion of the schemes will have an impact on the overall junction performance. In the 'With Schemes' scenario, queue impacts are most notable on the Arden Street approach to the junction, however, the modelling suggests that the junction will continue to operate within capacity.

Table 19 2031 Reference Case Model Results – Greenhill Street/Rother Street/Windsor Street

	2031 Reference Case				2031 Reference Case + Schemes			
	0800-0900		1700-1800		0800-0900		1700-1800	
Approach	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**	**MMQ**	**DoS%**
Greenhill Street	3	45.9%	6	59.0%	4	56.3%	3	42.3%
Wood Street	6	73.5%	9	80.4%	1	26.3%	1	31.9%
Rother Street	2	37.6%	2	39.8%	4	61.9%	5	63.9%
Windsor Street	7	71.5%	7	79.3%	10	78.0%	6	63.5%
PRC (%)	**22.5%**		**11.9%**		**15.3%**		**40.8%**	

4.29 The results presented within **Table 19** demonstrate the predicted operation of the Greenhill Street/Rother Street/Windsor Street junction in 2031 Reference Case conditions. The results indicate that the junction is predicted to operate well within capacity across the AM and PM periods.

4.30 The modelling indicates that with the introduction of the proposed schemes within the town centre, the junction is actually predicted to result in an improved operation. This is largely a result of the changes in traffic patterns associated with the schemes, most notably the reduction in east/west and west/east flows.

LinSig Modelling Summary

4.31 It is clear from the results presented for the LinSig modelling, that the implementation of the proposed schemes within the town centre, and the resultant changes in traffic patterns, is predicted to have an impact on two of the three key signalised junctions on the edge of the town. The LinSig analysis has suggested that the Arden Street/Alcester Road/Grove Road and Birmingham Road/Guild Street/Arden Street junctions will both experience some minor queue increases and reductions in the overall capacity compared with the Reference Case conditions.

4.32 It is important to highlight that on-street, each of these junctions operate on a SCOOT system, whereby signal timings are able to respond to queue conditions across the day. In contrast to this, the LinSig models are based upon a fixed set of signal timings across the peak hours, which are optimised as far as possible in an attempt to maintain the highest PRC possible. On this basis, the LinSig results should be considered as a worst case scenario, with the reality being that signal timings will constantly change across the hour in an attempt to manage any queues and maintain an acceptable level of junction operation. Further to this, the LinSig modelling is based upon a fixed set of flows, and therefore the potential for re-routing is not captured. On the basis of the above, the results presented should be considered robust and largely a reflection of a 'worst-case' scenario.

Paramics Modelling Assessment

4.33 Following the LinSig assessment detailed above, a revised set of optimised signal timings for each scenario has been derived for each junction. At this point the LinSig results have demonstrated some worsening of the performance of specific junction approaches, as a result of the changes in traffic flow patterns following the inclusion of the scheme proposals.

4.34 As highlighted in the previous section, there is scope for this impact to be reduced on the basis that the signal timings at the junctions concerned would be controlled by a dynamic SCOOT system, that would alter green times in response to queue conditions, whilst there is also the likelihood that traffic would avoid the town centre altogether if significant queues around any of these junctions were to be realised.

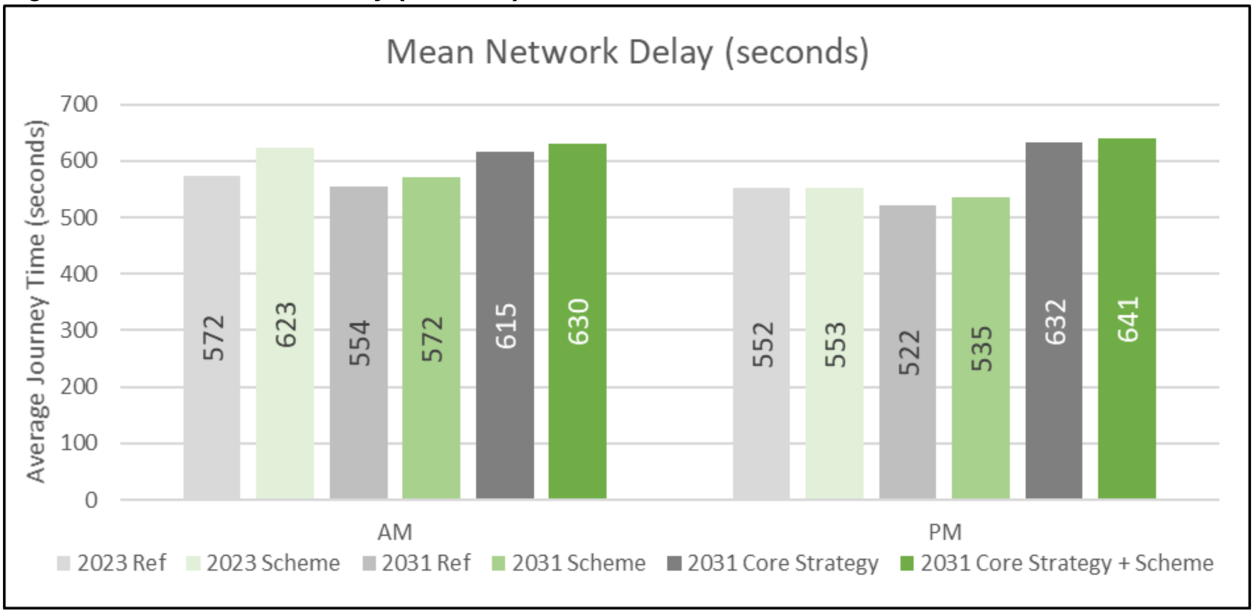
4.35 As part of this updated assessment, including the optimised signal timings from LinSig, into the Paramics models, enables the scheme proposals to be considered at a strategic level on a consistent basis (whereas previously signal times had been adjusted manually and only in certain scenarios).

4.36 The Paramics models contain 'signal plans' for the junctions considered, which enables the on-street SCOOT system to be replicated within the models. The signal timings derived from LinSig have been included within the latest Paramics models. Based upon these updated timings, the Paramics model then enables the extension of the inputted green times to minimise queues that form, (i.e. can broadly replicate a SCOOT signal control system).

Network Wide Delay

4.37 As per the original scheme assessment report4 the initial means of assessing the impacts of the proposals, at a strategic level, involves a review of the 'network mean delay'. This compares the average journey times for every vehicle, and enables a means of comparing the relative changes between scenarios, in delay experienced by road users, at a strategic level. This analysis has been repeated following the inclusion of the updated signal timings at the signal junctions outlined above.

Figure 47 Network Mean Delay (seconds)



4.38 The results presented within **Figure 47** demonstrate relatively minor changes in the level of delay recorded at a network wide level once the schemes are included within the network. The results indicate that once the schemes are included, there is predicted to be around a 9% increase in journey times across the entire network in the AM period in the 2023 Reference Case scenario,

[4] VM215339.TN001 Levelling Up Modelling Assessment

reducing to a 3% increase in the 2031 Reference Case scenario, and a 2% increase in the Core Strategy scenario. This is similar to the level of delay reported in the mode shift scenario within the original modelling assessment (prior to the optimisation of signal timings). The PM results show a smaller impact, with journey time increase of less than 1% in the 2023 Reference Case, 2% in the 2031 Reference Case scenario, and only 1% in the Core Strategy scenario. Given the nature of the schemes, this level of change would be considered to be well within acceptable tolerances.

4.39 It is important to note that these changes in network wide delay are in-line with the results presented within the previous assessment, and although the numbers change, the overall pattern and magnitude of strategic level delay impacts remain the same within this updated assessment. As per the previous assessment, the most significant increase in delay is predicted to occur in the 2023 scenarios, which is largely reduced in the later scenarios once the West of Shottery Relief Road (WSRR) is included within the network.

Localised Journey Time Analysis

4.40 Following the network wide impact analysis, more localised changes within the town centre have been considered. For the purposes of this assessment, the journey time analysis undertaken within the original testing has been repeated, with the intention of confirming whether the previously identified conclusions remain the same, now that the model signal timings have been optimised for all scenarios. The routes across the town centre for which journey times have been assessed are shown in **Figure 48** whilst the results are presented within **Table 20** and **Table 21** for the AM and PM peak hours respectively. Instances where journey times have changed by more than 15% have been highlighted within the tables.

Figure 48 Journey Time Routes Assessed

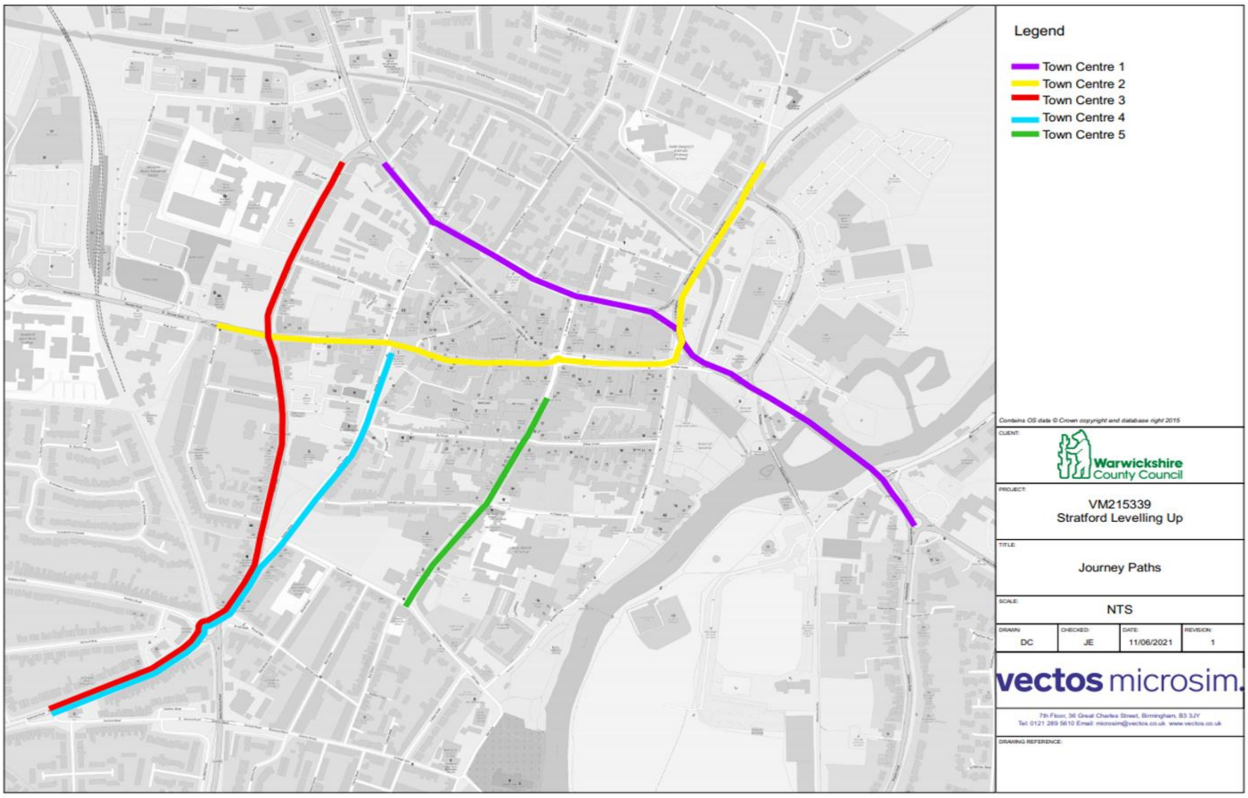


Table 20: AM Peak Hour (08:00-09:00) Journey Time Change with Scheme Inclusion

Route	2023 Ref	2023 Scheme	% Diff	2031 Ref	2031 Scheme	% Diff	2031 Core Strat	2031 Core Strat + Scheme	% Diff
Route 1 EB	195	187	-4.10%	186	190	2.15%	224	228	1.79%
Route 1 WB	247	335	35.63%	181	230	27.07%	262	428	63.3%
Route 2 EB	387	269	-30.4%	248	237	-4.44%	465	252	-45.1%
Route 2 WB	333	0	-100%	238	0	-100%	290	0	-100%
Route 3 NB	632	564	-10.7%	338	384	13.61%	440	390	-11.3%
Route 3 SB	174	186	6.90%	148	187	26.35%	138	152	10.4%
Route 4 NB	279	538	92.8%	227	313	37.8%	270	375	38.9%
Route 4 SB	169	167	-1.1%	152	144	-5.2%	201	178	-11.4%
Route 5 NB	82	54	-34.1%	84	54	-35.7%	84	55	-34.5%
Route 5 SB	141	0	-100%	86	0	-100%	369	0	-100%

4.41 The AM peak hour results presented within **Table 20** demonstrate the following changes to journey times, once the proposed town centre schemes are included within the modelling:

- **Route 1** – negligible change in journey times in an EB direction, more noticeable increase in a WB direction – *no change from previously reported conclusions*
- **Route 2**- Reduction in journey times in an EB direction, no journey times recorded for WB traffic – the introduction of the schemes mean that no traffic uses this route – *no change from previously reported conclusions*
- **Route 3 –** Increase in journey times in SB direction across all scenarios. Some reductions in journey times in a NB direction (2023 Reference and 2031 Core Strategy), with an increase in NB journey times in the 2031 Reference scenario – *this represents a change from the previously reported conclusions – the impact in this updated assessment predicted to be significantly lower than previously reported*
- **Route 4 –** Increase in NB journey times, negligible change in SB journey times - *no change from previously reported conclusions*
- **Route 5** – Reduction in NB journey times, no SB journey times recorded due to no traffic using this route once the schemes introduced – *the results for this route show a more notable reduction in NB journey times compared with the previous assessment*

Table 21: PM Peak Hour (17:00-18:00) Journey Time Change with Scheme Inclusion

Route	2023 Ref	2023 Scheme	% Diff	2031 Ref	2031 Scheme	% Diff	2031 Core Strat	2031 Core Strat + Scheme	% Diff
Route 1 EB	236	226	-4.24%	251	247	-1.59%	260	243	-6.54%
Route 1 WB	281	288	2.49%	166	228	37.3%	249	312	25.3%
Route 2 EB	193	198	2.59%	210	231	10.0%	267	234	-12.3%
Route 2 WB	301	0	100%	263	0	100%	347	0	100%
Route 3 NB	369	336	-8.94%	367	317	-13.6%	480	381	-20.6%
Route 3 SB	256	281	9.77%	239	309	29.2%	181	186	2.76%
Route 4 NB	214	248	15.8%	173	212	22.5%	155	186	20.0%
Route 4 SB	531	477	-10.7%	465	441	-5.16%	375	353	-5.87%
Route 5 NB	42	52	23.1%	39	52	33.3%	49	52	6.12%
Route 5 SB	46	0	100%	41	0	100%	42	0	100%

4.42 The PM peak hour results presented within **Table 21** demonstrate the following changes to journey times, once the proposed town centre schemes are included within the modelling:

- **Route 1** – negligible change in journey times in an EB direction, noticeable increase in journey times in a WB direction – the magnitude of journey time increases in the WB direction is far lower in this updated assessment than presented within the original assessment, particularly in the Core Strategy scenario
- **Route 2**- No significant change in journey times in an EB direction, no journey times recorded for WB traffic – the introduction of the schemes mean that no traffic uses this route – no change from previously reported conclusions
- **Route 3 –** Increase in journey times in SB direction across all scenarios. Reductions in journey times in a NB direction across all scenarios– this represents a change from the previously reported conclusions – the impact in this updated assessment predicted to be significantly lower than previously reported, with the schemes predicted to deliver an improvement in journey times in a NB direction
- **Route 4 –** Increase in NB journey times, negligible change in SB journey times - no change in the conclusions although magnitude of increase in NB journey times is higher than previously reported
- **Route 5** – Minor increases in NB journey times, no SB journey times recorded due to no traffic using this route once the schemes introduced – no change in the previously reported conclusions for this route

4.43 As per the original analysis undertaken, the latest results demonstrate instances of increases in journey times across the town centre once the schemes are included within the models.

4.44 The previous analysis indicated that further optimisation of signal timings at the Alcester Road/Arden Street/Grove Road junctions and Birmingham Road/Guild Street/Arden Street junctions would likely be required to address the significant increases in modelled journey times on Route 1 WB and Route 3 NB and SB

4.45 Following the input of the signal timings optimised within LinSig, it is clear that there is a notable improvement on the previously modelled journey times on Route 3. The results indicate that once the schemes are included, journey times on this route, in a northbound direction, are predicted to reduce, over Reference Case conditions, suggesting an improvement in network conditions in this area. This is largely due to the reduction in east to west/west to east flows through the Alcester Road/Arden Street/Grove Road junction, once the schemes within the town centre are included, which enables increased green time to be allocated to the north/south movement.

4.46 This is further assisted by the dynamic signal control, included within Paramics, which enables green time for the south to north movement to be further increased in response to queues on the northbound entry arm. With the reduction in flows on the east/west movement, this increase in green time for the northbound movement can be accommodated when required across the hour (i.e. when queues build) without worsening the east/west approach queue lengths.

4.47 The consequence of this is the potential for journey times on this section of the network to actually reduce slightly (as shown for the PM peak hour results) once the schemes are included, and signal timings optimised.

4.48 Further to this is, it is clear that through the process of optimising the signal timings across this part of the network, the previously reported journey time impacts Route 1 WB have reduced, most notably in the PM period.

Paramics Modelling Summary

4.49 The analysis presented within this stage of the report has focused on the strategic level delay impacts, and localised journey time impacts, predicted to occur once the proposed town centre schemes are delivered, and the signal timings at each key signalised junction around the town centre are optimised on a consistent basis.

4.50 The analysis indicates that the conclusions drawn from the original modelling assessment broadly remain applicable, with increases in network wide delay predicted to occur, which reduce significantly once the West of Shottery Relief Road is delivered (in the post-2023 scenarios).

4.51 The localised journey time impact has again largely shown impacts consistent with the original assessment, however, this analysis has now demonstrated that the previously flagged impacts on Route 1 WB and Route 3 NB and SB could largely be mitigated through the inclusion of the signal timings optimised in LinSig, alongside the dynamic signal control plans included within the Paramics modelling.

4.52 On this basis the updated assessment has indicated that there is sufficient capacity at the signalised junctions around the edge of the town centre to accommodate any traffic re-assigning to avoid the town centre following the inclusion of the proposed schemes.

Summary

4.53 The detailed capacity assessment revisited the original work, focusing on the adjustments applied to the signalised junctions within the model. Within this testing, signal times have been optimised through LinSig, meaning each scenario is assessed on an equal basis, whilst also allowing for more detailed analysis of the local junctions to be completed.

4.54 The LinSig modelling undertaken indicated that there are likely to be some increases in queues at the Alcester Road/Arden Street/Grove Road and Birmingham Road/Guild Street/Arden Street junctions, once the schemes within the town centre are delivered, however, both of these junctions are predicted to operate within capacity despite these increases. Any increase in queueing is largely a result of an increase in south to north traffic movements at the Alcester Road/Arden Street/Grove Road junction and right turning south to east traffic movements (Arden Street to Guild Street) at the Birmingham Road/Guild Street/Arden Street junction.

4.55 Following this, the signal timings optimised through the LinSig models have been imported into the Paramics models, and the models re-run to assess the predicted impacts both at a strategic and localised impact. It is important to note that within the Paramics model, the on-street SCOOT dynamic signal control system is replicated through 'signal plans', which enables an extension of green-times in response to changing queueing patterns across the peak hours.

4.56 This dynamic control capability within the modelling has a positive impact on the model performance around the junctions concerned, with the Paramics modelling indicating that any increase in delay following the inclusion of the town centre scheme proposals, at both a strategic and localised level will be limited. The results presented within this chapter demonstrate that delay is expected to only increase slightly in the AM period, whilst journey times on the A4390 Grove Road corridor could potentially reduce during the PM period given the opportunity to increase the green-time for the south/north movement on this corridor, as a result of the significantly reduced east/west on Alcester Road/Greenhill Street flows, following the inclusion of the schemes.

4.57 The modelling indicated that, with the optimised signal timings derived through LinSig, applied consistently across each scenario, alongside the dynamic signal control which is included on-street (and replicated within the Paramics models), the conclusions from the core modelling assessment remain valid, insofar as the town centre schemes could be delivered without a significant impact on the performance of the network at either a localised or strategic level.

5 Summary

5.1 Vectos Microsim (VM) has been working with urban design consultants PJA, Warwickshire County Council and Stratford-upon-Avon Town Council, to assess measures aimed at enhancing the experience for non-motorised transport users within Stratford-upon-Avon town centre. In order to support these proposals, VM has made use of the Stratford-upon-Avon Wide Area (SuAWA) traffic model to assess the effects of delivering a package of measures within the town.

5.2 The testing undertaken around the scheme proposals, as documented within this report, has been undertaken in three key stages, these are summarised as follows:

Core Modelling Assessment

5.3 This core modelling assessment has identified that the preferred scheme for the town centre involves the closure of High Street to traffic between 11:00-16:00. Outside of these areas vehicles will be discouraged from using High Street and Bridge Street through signage and road design.

5.4 The modelling identifies a significant shift in traffic away from the town centre in the AM and PM peak periods. The analysis of the effects arising from the reassignment reveals that there are routes on the edge of the town centre, where traffic increases, and subsequently, delay, on routes around the town centre will be affected as a result.

5.5 These changes are localised however and the strategic level analysis indicates that the changes are marginal and would not necessarily be noticeable by most drivers on a daily basis. Some areas will experience more notable changes and these will likely require further investigation through the scheme design process but, at this stage, are not considered to be of a magnitude sufficient to justify halting the scheme promotion.

5.6 An economic appraisal of the scheme has then been conducted which produced a BCR of **-2.254**. While this alone does not represent good value for money, this assessment only considers the transport impacts and gives no consideration to the benefits to active mode users, or the reduction in traffic that may occur as a result of people shifting to active modes. It is likely that an assessment that fully considers these impacts would return in a positive value for money.

Mode Shift Assessment

5.7 The mode shift assessment documented within this report follows on from the core modelling assessment of the proposed changes to the town centre highway layout. This stage of the assessment considered the impact of users switching to active modes in response to the scheme proposals. The proposed mode shift was calculated using the numbers contained within the Department of Transports Active Modes Appraisal Toolkit (AMAT) and local survey data used to support the initial scheme appraisal.

5.8 The core assessment revealed that, as a result of the inclusion of the scheme proposals, some road users would experience dis-benefits in the form of increased travel times. Having accounted for mode shift, the indication is that these adverse effects remain on the network but the magnitude is reduced and, furthermore, when considering the operation of the network as a whole, there is potential for modest improvement across the network within the AM if the circa a 1% shift to walking for High Street users is achieved.

5.9 The inclusion of the mode shift reduces the impacts previously observed with both overall network wide statistics, and town centre journey times, being closer to those observed in the Reference Case after the adjustments are applied.

5.10 Thus, it is reasonable to conclude that the residual impacts, which were already considered to lie within acceptable tolerances, will be improved if a relatively modest mode shift of less than 1% is achieved following the introduction of the scheme proposals.

Detailed Capacity Assessment

5.11 The detailed capacity assessment revisited the original work, focusing on the adjustments applied to the signalised junctions within the model. Within this testing, signal times have been optimised through LinSig, meaning each scenario is assessed on an equal basis, whilst also allowing for more detailed analysis of the local junctions to be completed.

5.12 The LinSig modelling undertaken indicated that there are likely to be some increases in queues at the Alcester Road/Arden Street/Grove Road and Birmingham Road/Guild Street/Arden Street junctions, once the schemes within the town centre are delivered, however, both of these junctions are predicted to operate within capacity despite these increases. Any increase in queueing is largely a result of an increase in south to north traffic movements at the Alcester Road/Arden Street/Grove Road junction and right turning south to east traffic movements (Arden Street to Guild Street) at the Birmingham Road/Guild Street/Arden Street junction.

5.13 Following this, the signal timings optimised through the LinSig models have been imported into the Paramics models, and the models re-run to assess the predicted impacts both at a strategic and localised impact. It is important to note that within the Paramics model, the on-street SCOOT dynamic signal control system is replicated through ‘signal plans’, which enables an extension of green-times in response to changing queueing patterns across the peak hours.

5.14 This dynamic control capability within the modelling has a positive impact on the model performance around the junctions concerned, with the Paramics modelling indicating that any increase in delay following the inclusion of the town centre scheme proposals, at both a strategic and localised level will be limited.

5.15 The modelling indicated that, with the optimised signal timings derived through LinSig, applied consistently across each scenario, alongside the dynamic signal control which is included on-street (and replicated within the Paramics models), the conclusions from the core modelling assessment remain valid, insofar as the town centre schemes could be delivered without a significant impact on the performance of the network at either a localised or strategic level.

APPENDIX A

TEE Tables

APPENDIX B

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