Warwickshire County Council

Warwick Strategic Transport Assessment

Warwick STA - Phase 3 Assessment

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Ove Arup & Partners Ltd
The Arup Campus
Blythe Gate
Blythe Valley Park
Solihull B90 8AE
United Kingdom
www.arup.com

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1 Executive Summary

1.1 Overview

Arup have been commissioned by Warwickshire County Council (WCC) and Warwick District Council (WDC) to undertake additional testing of the proposed Warwick Core Strategy (CS) allocations. This report builds upon the evidence presented within the Phase 2 Assessment report[1], and is intended to outline the impacts of a revised approach to the allocation of growth, herein referred to as the 'WDC Revised Allocation' strategy, on the Warwick and Leamington Road network.

1.2 Scenario Development

The demand allocation that has been tested within the model is one which has been amended slightly when compared to previous tests. The sites selected within the revised allocation still represent a combination of the sites allocated between the Preferred Option and Southern Focus Option which were tested during the previous phase of this assessment. The revised demands produced as a result of the Revised Allocation scenario strategy have been subjected to mode shift, internalisation and peak spreading procedures. Growth within both scenarios has been capped so as not to exceed the levels of growth predicted by the TEMPRO database, after adjustments for national trends (NTEM Adjusted TEMPRO).

1.3 Objectives of Assessment

A number of objectives have been addressed within this study, the primary objective of this study was, through the refinement of the existing modelling and scheme assumptions, to determine a series of 'significant' transport infrastructure measures which would need to be delivered to ensure that any approach to the allocation of growth, and the subsequent increase in vehicular demand that accompanies that growth, can be accommodated. A series of secondary objectives have been borne from this primary objective and are set out as follows:

- To determine the likely impacts of the revised approach to the allocation of growth within the Warwick and Leamington when delivered alongside the strategic transport infrastructure measures
- To gain an understanding of the potential, additional impacts, incurred as a result of increased Education provision, intended to accompany the revised allocation strategy
- To undertake sensitivity tests to determine the level of strategic and local impacts associated with the delivery or, conversely, failure to deliver, some key mitigation measures, namely; capacity enhancements to Portobello Bridge and the Warwick Town Centre improvements
- To begin to assess the feasibility of delivering a Park and Ride scheme to accompany the revised allocation strategy with particular attention being given to whether the principles of the scheme are feasible and

[1] 211439-19.R006 Warwick STA - Phase 2 Assessment, Arup, February 2013

whether the proposed mitigation measures can be enhanced to better accommodate the P&R services.

1.4 Mitigation Delivery Schedule

The primary objective of this element of work has been to begin to determine, in more detail, the appropriate mitigation strategy required to accompany the core strategy allocation whilst maintaining acceptable levels of network operation. The mitigation measures proposed within this work build upon those presented within earlier phases of the Strategic Transport Assessment work and, in a number of cases, represent those schemes which are most likely to be necessary irrespective of the growth allocations.

It should be noted that the mitigation measures proposed within this study as being necessary to accompany and facilitate the growth strategy are the strategic measures. The delivery of these measures is perceived to be either critical or extremely desirable in overcoming the cumulative impacts of the associated developments. The purpose of this work is not to determine appropriate access strategies of these sites, nor is it intended that localised impacts of each of the sites would be mitigated by the delivery of these strategic infrastructure measures. Localised issues such as thee should be dealt with as part of the planning process that will be followed by each of the individual sites.

At this stage the preferred mitigation strategy consists of 27 schemes, 16 of which have been classified as essential in maintaining network operation levels whilst 11 have been classified as desirable. At this stage it is believed that no unnecessary schemes are contained within the model network. It should be acknowledged that implementation of all of the schemes results in improved network performance when compared to the situation where the mitigation is not adopted. Furthermore, the results analysis in the following sections of this report demonstrates that, in spite of the application of the mitigation, the impacts of the development allocation strategy are not fully mitigated. Should any of the mitigation measures be removed these impacts would inevitably be further exacerbated.

1.5 Stages of Assessment

A staged approach to addressing the objectives set out previously has been adopted as follows:

- The revised approach to allocating growth within the area has been assigned to the model network and the mitigation measures proposed within that network have been optimised, refined or removed, to produce a network which contains what are considered to be the most critical mitigation measures.
- The performance of the model network when the revised allocation strategy has been assigned alongside the mitigation measures to create a 2028 Revised Allocation scenario. It is the outputs of this scenario that form the spine of the impact analysis assessment.
- Additional assumptions pertaining to the delivery of Education provision have then been included within the 2028 Revised Allocation scenario and again the outputs of this scenario have been assessed.
- The 2028 Revised allocation scenario network has been amended and the proposed Portobello Bridge capacity enhancements and the

Warwick town centre improvements a have each been removed to create two additional sensitivity tests (2028 RA – Bridge & 2028 RA – WTCI respectively) the outputs of which have been assessed.

- Finally, a series of assumptions regarding the delivery of a Park and Ride site located to the west of Europa Way, south of Gallows Hill, have been included within the modelling and some outline amendments have been made to the proposed mitigation measures to allocate priority to the P&R movements through the network wherever possible. The outputs from this scenario have then been assessed alongside those extracted form the2028 Reference Case and 2028 Revised Allocation scenarios.

1.6 Stage 1 - Revised Allocation/Optimised Network Testing

The first stage of this assessment was to review the performance of the model network following the allocation of the revised demand levels and network optimisation. The initial comparisons between the 2028 Reference Case and the 2028 Revised Allocation scenarios reveal the following conclusions:

- Inclusion of the Revised Allocation strategy demands will likely result in an increase in the average journey times and a reduction in average speeds that vehicles are able to achieve within the 2028 Revised Allocation network in comparison to the 2028 Reference Case conditions. These impacts occur in spite of the adoption of a proposed mitigation strategy.
- Analysis of the trip completion ratio within both Reference Case and Revised Allocation strategy indicates that, in general, the mitigation measures are able to accommodate the additional demand levels assigned during the AM period but that additional work may be required during the PM period to achieve similar levels of success.
- Adoption of the revised allocation strategy will potentially lead to a worsening of traffic conditions within the town centres but in other areas, adoption of the revised allocation, alongside the proposed mitigation measures has the potential to deliver improved conditions for road users in the form of reduced queuing and, in some cases improved journey times.
- Compared to earlier studies, the analysis of the network performance, alongside the revised allocation strategy, appears to indicate an improvement in the overall level of performance; in particular there are no observable increases in queuing which could be categorised as very severe.
- However, some impacts are inevitably going to be incurred as a result of the assignment of the additional demand levels onto the network.

1.7 Stage 2 – Revised Allocation plus Education testing

The second stage of this assessment was intended to begin to develop an understanding of whether the delivery of additional education provision, alongside the revised allocation strategy, would have a significant impact on the mitigation strategy that has been proposed to accompany the Revised Allocation strategy.

There is limited certainty regarding either the size or the location of the schools that are likely to be required in this area so the purpose of these assumptions and the accompanying outline impact assessment, is to provide a broad overview of the likely ability of the proposed mitigation measures to accommodate the additional increase in trips likely to be incurred within this area due to the increase in Home-Based Education trips in the area. Based on the outcome of this assessment the following conclusions have been drawn:

- It is reasonable to conclude that the inclusion of the schools in the areas around Europa Way to the south will not result in the need to alter, substantially, the schemes that have been proposed to accompany the Revised Allocation strategy.
- There is, however, likely to be a need for further optimisation of the mitigation proposed in this area, to be undertaken to ensure that the impacts of including the education provision can be kept to a minimum.

1.8 Stage 3 – Mitigation Sensitivity Testing

Following the completion of the Education sensitivity testing, a second series of sensitivity tests where undertaken which looked at the potential impacts of implementing a mitigation schedule, alongside the revised allocation strategy, which did not include either the Portobello bridge capacity enhancements or the Warwick Town Centre improvements. Both mitigation measures were removed from separate versions of the 2028 Revised Allocations scenario and the outputs of these scenarios were assessed. Based on the assessment of these scenarios the following conclusions were drawn:

- The benefits of implementing the capacity enhancements at Portobello Bridge are most likely to be localised as potentially network constraints both downstream and upstream of the proposed area of enhancement that limits the potential draw that would be anticipated by the delivery of the additional capacity.
- Whilst at this stage delivery of the bridge improvements are still considered desirable, some of the queuing analysis appears to indicate that the delivery of the bridge may draw more traffic through the network from the north, travelling southwards, which could indicate that the network conditions, without the capacity enhancements, act as a minor deterrent to through traffic which could, itself be a positive outcome.
- Further investigation of the benefits or otherwise pertaining to the delivery of the Portobello Bridge capacity enhancements are likely to be required before the value of delivering these works can be fully established. At this stage, given the likely costs of delivering the enhancements it has been concluded that the bridge should not be included within the process of allocating total estimated delivery costs to the mitigation schedule.
- However it has been concluded that delivery of the proposed Warwick Town Centre improvements, or schemes which conform in principle to those proposed within the modelling, has both local and strategic level benefits, particularly when considering the AM network performance. Without the schemes in place it appears impossible to ensure an

acceptable level of network operation can be delivered, particularly when considering the areas around Warwick town

1.9 AQMA Impact Assessment

Analysis of the potential impact on the AQMA sites within Warwick and Leamington has also been undertaken. This analysis revealed the following conclusions:

- That there is potential for negative impacts to be experienced in both Warwick and Leamington AQMA areas, particularly in the form of increased traffic movements.
- That the impact on Warwick AQMA area is likely to be far more severe if the Warwick Town Centre improvements are not implemented alongside the growth strategy.
- since signalisation schemes are proposed for both of the AQMA areas there is potential that these impacts can be further mitigated by additional optimisation of the proposed schemes within this area.,
- The opportunity for the delivery of the Park and Ride service and the potential for this to reduce car base trips in this area should also not be discounted.

1.10 Conclusions

Based on the outcome of this assessment the following conclusions have been documented:

- That there is a mitigation schedule available which can be implemented alongside the revised allocation strategy, and that the costs of implementing these mitigation measures is likely to be **£39.2 million** which on the basis of 8400 dwellings through allocated sites and 3600 dwellings through windfall sites. Thus, at this stage, the mitigation costs, per dwelling, equates to **£3,300** for transport infrastructure costs inclusive of £10 million contribution to Managed Motorways.
- In spite of the proposed mitigation schedule, there are inevitably going to be residual impacts that, at this stage, have not been mitigated, some of these impacts may at least be lessened by further mitigation measures and the appropriate access strategies associated with each of the individual sites that will be identified through the individual planning applications associated with each of the sites. Some impacts however, are likely to be fixed due to the limited available options for enhancements in those areas.
- That incorporating further provision for Education within the south (in the form of 3 primary schools and 1 secondary school) will not fundamentally alter the proposed mitigation schedule although some additional optimisation may be required.

1.11 Risks

It is recommended that the following risks are assessed at the earliest opportunity although it is acknowledged that the assessment of these risks prior to the adoption of the allocation strategy is, in some cases, unlikely to be possible:

- The impacts on areas not included within the modelling;
- The impacts of utility and service diversion costs attributed to any one scheme that may not have been considered at this stage (an average cost of service and utility works has simply been assigned to each scheme).
- Vertical alignment and gradient issues not considered at this stage.
- Specific risks pertaining to the delivery of one or more scheme on the network such as:
    - The physical risks to delivering the Managed Motorways scheme in the area required and the viability of the costs thereof;
    - The risks posed by the bridge over the M40 which carries traffic SB from the A452 to the M40 NB and its ability to accommodate the additional demand without significant enhancements;
    - The risk that the Barford Road bridge across the A452 poses to the proposals to widen the bridge.
    - The risk that limited highway capacity around the St Nicholas church Street may impede delivery of a scheme.

1.12 Further Considerations and Recommendations

This document has focussed on the highway network mitigation required in order to achieve an acceptable level of network performance when considering WDC Core Strategy allocation. The exercise has been based around modelling outcomes which primarily focus on car based trips. The potential benefits of P&R bus infrastructure have been considered to an extent and sustainable travel infrastructure has been factored into a nominal mitigation contribution within the cost estimates. However, there are wider ranging sustainable transport issues which need to be considered in conjunction with this report

It is critical that sustainable transport improvements form part of the mitigation package to support the housing and employment growth proposals within the District. Such improvements will:

- Contribute towards the delivery of sustainable development within the District;
- Maximise the number of journeys made by sustainable transport modes from trips generated as a result of new development;
- Reduce the impact of car based travel on the local and strategic highway network;
- Deliver an integrated approach to transport provision to serve new development; and
- Contribute towards the aims and objectives of the District Council's Garden Towns, Villages and Suburbs Prospectus.

Sustainable transport is an umbrella term which includes provision of bus services, bus infrastructure, park and ride, access to rail services, walking, cycling and behavioural measures (Smarter Choices). Appendix H sets out what sustainable transport improvements will be sought through the planning process to support development generally within the District. Specific measures to mitigate major development in South Warwick/Leamington Spa are also described in more detail.

The following outlines a series of recommendations that should be considered during any additional stages of the Strategic Transport assessment.

- Further work on calculating the costs of delivering the proposed Managed motorway works and an acceptable level of apportionment is recommended to be undertaken at the earliest opportunity as this represents a significant factor in the determination of the costs of delivering the associated mitigation infrastructure.
- That, once the preferred allocation strategy has been determined, consideration should be given to undertaking an assessment to confirm that the proposed mitigation will still operate within acceptable levels.
- That the potential impacts of any strategic reserve sites that come forward as part of the preferred allocation strategy are not likely to fundamentally change the nature of the mitigation that is proposed
- More detailed work is undertaken on sustainable transport requirements and the assumptions on mode share and mode shift are based on the outcome of these studies. Once the preferred allocation strategy has been identified, a sensitivity test should be undertaken to determine the importance of achieving the targets for mode share/shift and internalisation and to establish areas where further mitigation may be required should the targets, associated with the proposed sites not be realised.
- As more certainty emerges on the provision of Education facilities alongside the allocation strategy, further testing should be undertaken which includes more detailed assumptions regarding the access strategy including any additional pedestrian facilities, trip generation and the distribution thereof.
- Further detailed assessment of the potential benefits of the P&R should be undertaken although it is imagined that such testing would be intended to compliment an over-arching feasibility study of the P&R site meaning allowances for mode share and interception could be included within the modelling to allow a better understanding of both the benefits and impacts of delivery.
- More detailed consideration of the impacts of the allocation strategy on the Kenilworth area should be considered within any forthcoming stages of assessment as this has not been considered in detail within the current round of testing.
- Testing of a phased approach to the implementation of the mitigation strategy should be undertaken to determine which schemes are likely to be required at an early stage of the plan period and, conversely, which can be delivered towards the end of the plan period.

2 Introduction

2.1 Scope

Arup have been commissioned by Warwickshire County Council (WCC) and Warwick District Council (WDC) to undertake additional testing of the proposed Warwick Core Strategy (CS) allocations. This report builds upon the evidence presented within the Phase 2 Assessment report[2], and is intended to outline the impacts of a revised approach to the allocation of growth, herein referred to as the 'WDC Revised Allocation' strategy, on the Warwick and Leamington Road network.

2.2 Study Objectives

The objectives of this third phase of work are as follows:

- To derive an initial 'preferred network' based on the conclusions of the original Phase 2 work and test the impact of the assignment of demand associated with the Revised Allocation strategy on the preferred network.
- To refine the schemes contained within the Preferred network, removing any unnecessary schemes and documenting areas where risks exist or further work is likely to be required
- To assess, through a sensitivity test, the performance of the preferred network when new education trips are included within the area of development located to the south of Warwick
- To understand the level of strategic significance attributed to certain proposed mitigation measures, namely Portobello Bridge capacity enhancements and the Warwick Town Centre Improvements
- To review the proposed mitigation measures with a view to understanding what potential amendments could be made to better accommodate public transport services and provide commentary on the outcomes of any scheme implementation within the modelling.

In addition to the above objectives, a separate review of the proposed mitigation measures has been undertaken by WCC with a view to establishing the outline feasibility of the proposed schemes as well as indicative costs thereof.

In line with the level of assessment that is being undertaken, this review has been a strategic level review. It is not possible to construct detailed designs and cost estimates at this stage, partly due to the uncertain nature regarding the allocation of growth and partly because of the prohibitive level of time and resource required to produce such a detailed level of information.

The impact analysis that is presented within this report is intended to inform an assessment on the feasibility of the Revised Allocation strategy alongside the proposed mitigation measures. At this stage the level of assessment is not of a sufficient level of detail, nor has the mitigation strategy been reviewed comprehensively enough, to be considered as sufficient to fully mitigate the impacts and ensure the delivery of the proposed allocation. Rather it is intended to

[2] 211439-19.R006 Warwick STA - Phase 2 Assessment, Arup, February 2013

confirm what strategic elements of infrastructure are likely to be required to ensure that the allocated growth can be accommodated upon the existing network.

It is anticipated that the planning process associated with the individual sites will continue throughout the planning and adoption process and that each development will be supported by a separate planning application that will, in turn, be accompanied by a Transport Assessment (TA). As the planning process associated with the individual sites will be expected to deal in more detail with issues such as the associated access strategies and the mitigation of localised impacts incurred.

At this stage it should also be recognised that the purpose of this assessment is to determine an appropriate mitigation strategy necessary to accommodate all of the growth that is envisaged to occur across the duration of the plan period. Thus the mitigation proposed through this work reflects that which will be anticipated across the entire 2011 to 2028 plan period. The delivery of the mitigation measures proposed through this work is most likely to be achieved through a phased approach which mirrors the phased approach to the development of sites across the district. ***It is likely that, once the allocation strategy and mitigation measures have been defined for the plan period, work will need to be undertaken to understand the relative importance of the mitigation measures as well as to begin to inform the phasing strategy that will need to be determined to ensure that the appropriate mitigation measures are delivered at the appropriate times.*** Such work cannot be completed until the allocation strategy is adopted and the accompanying full mitigation schedule determined.

2.3 Background

The objectives set out previously are intended to build upon the work that has previously been completed with regards the testing of the WDC housing allocation.

It is intended that this report should be considered as building upon those previous stages of work which have been documented in independent, but complimentary, reports[3].

The nature of the strategic transport assessments completed to date mirrors the emergent nature of the development of the local plan itself. As is mentioned throughout the remainder of this report, there are a number of assumptions pertaining to the local plan that have yet to be fully determined, as such, this work and the preceding stages represent assessments based on the most up to date and current assumptions but should by no means be considered conclusive. Rather they are intended to advise on the potential implications on the relevant allocation strategies and accompanying mitigation schedules.

An overview of the process that has been followed prior to the commencement of this third phase of testing has been summarised as follows:

WDC Strategic Transport Assessment – Phase 1

The first phase of the strategic transport assessment comprised three separate elements. Firstly, a strategic transport assessment was undertaken using Strategic

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http://www.warwickdc.gov.uk/wdc/planning/planning+policy/local+development+framework/evidence+base/

modelling techniques. This formed a high level/low detail assessment which was intended to begin to inform WCC, WDC and the HA on the potential implications of a number of different allocation options. This work was then supplemented by an additional, more detailed, series of tests undertaken using the existing PARAMICS models of both Warwick & Leamington and Kenilworth and Stoneleigh. At this stage the assessments were based on four potential options and compared the differences between the Reference Case, Do Nothing (i.e. growth but no mitigation measures) and Do Something scenarios. One of the initial conclusions drawn from this work that has been carried forward throughout the rest of the STA is that the network will inevitably require the application of mitigation measures if it is to be able to accommodate the growth that is predicted through the allocation strategy irrespective of which allocation strategy has been tested. This is considered reasonable given the levels of growth that are represented by the Core Strategy options.

A final stage undertaken as part of this first phase of work was to bring together the Technical assessments and to present the key findings thereof alongside a detailed review of additional mitigation measures that could be delivered alongside the proposed approach to the allocation of housing across the District. This work on sustainability reviewed a wide number of the potential options that could be adopted alongside the allocation strategy across all sustainable modes. The principles regarding the implementation of sustainable modes set out within this note are still applicable today as they are valid irrespective of the allocation strategy adopted. However they cannot be determined further until a preferred option is determined as there is a need to tailor these measures specific to the sites proposed.

WDC Strategic Transport Phase 2

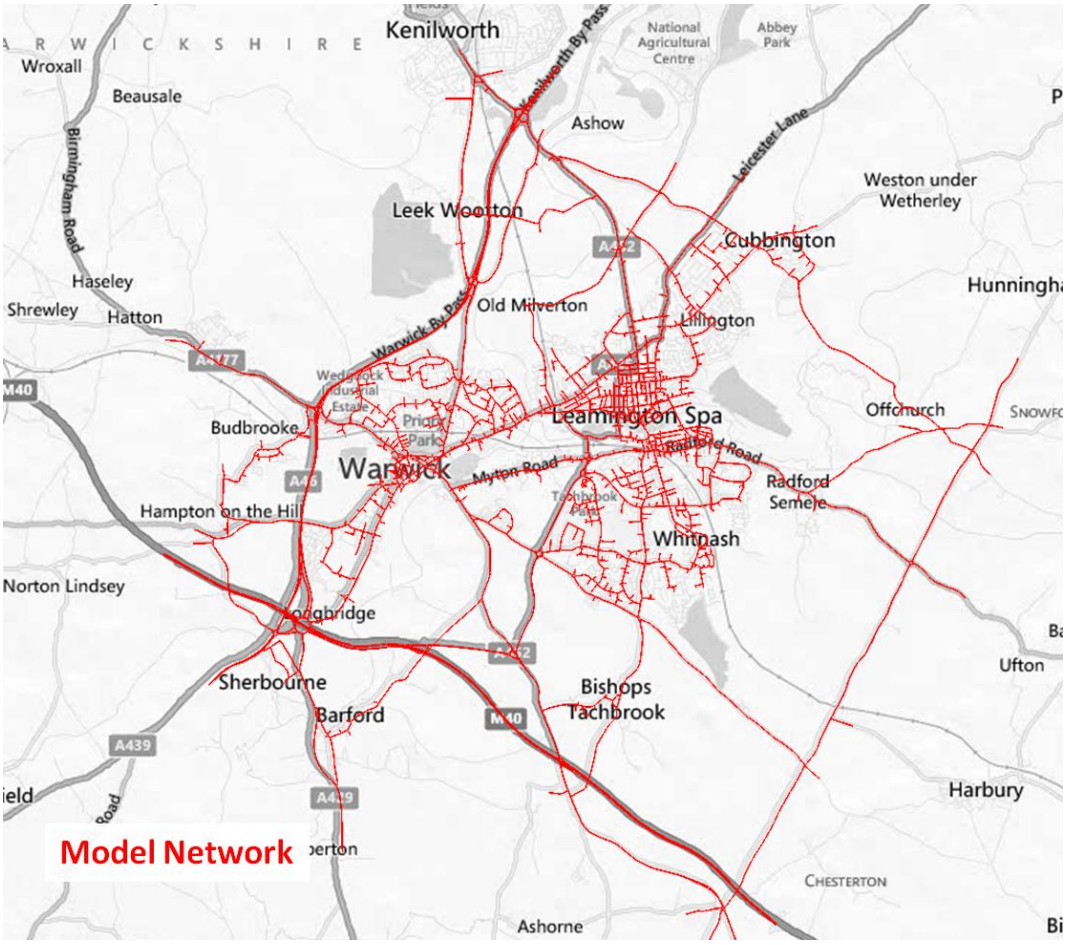
The second phase of the strategic transport assessment undertook a more detailed comparison of the potential impacts of two specific allocation strategies namely the Preferred Option and the Southern Focus. At this stage a more detailed review of the potential mitigation measures was undertaken and additional mitigation measures where included within the assessment dependent upon the option being tested. A number of additional sensitivity tests were completed which focussed on a variety of issues such as the impact of the Coventry and Warwickshire Gateway development and the strategic significance of the Northern Relief Road.

2.4 Study Area

Whilst some optioneering has been undertaken using the M40 PARAMICS model the study has largely focussed on the area encompassed by the Warwick and Leamington Wide Area PARAMICS model (WLWA).

An overview of the coverage of this model is provided within **Figure 1** on the following page.

Figure 1 -Warwick and Leamington PARAMICS model Coverage

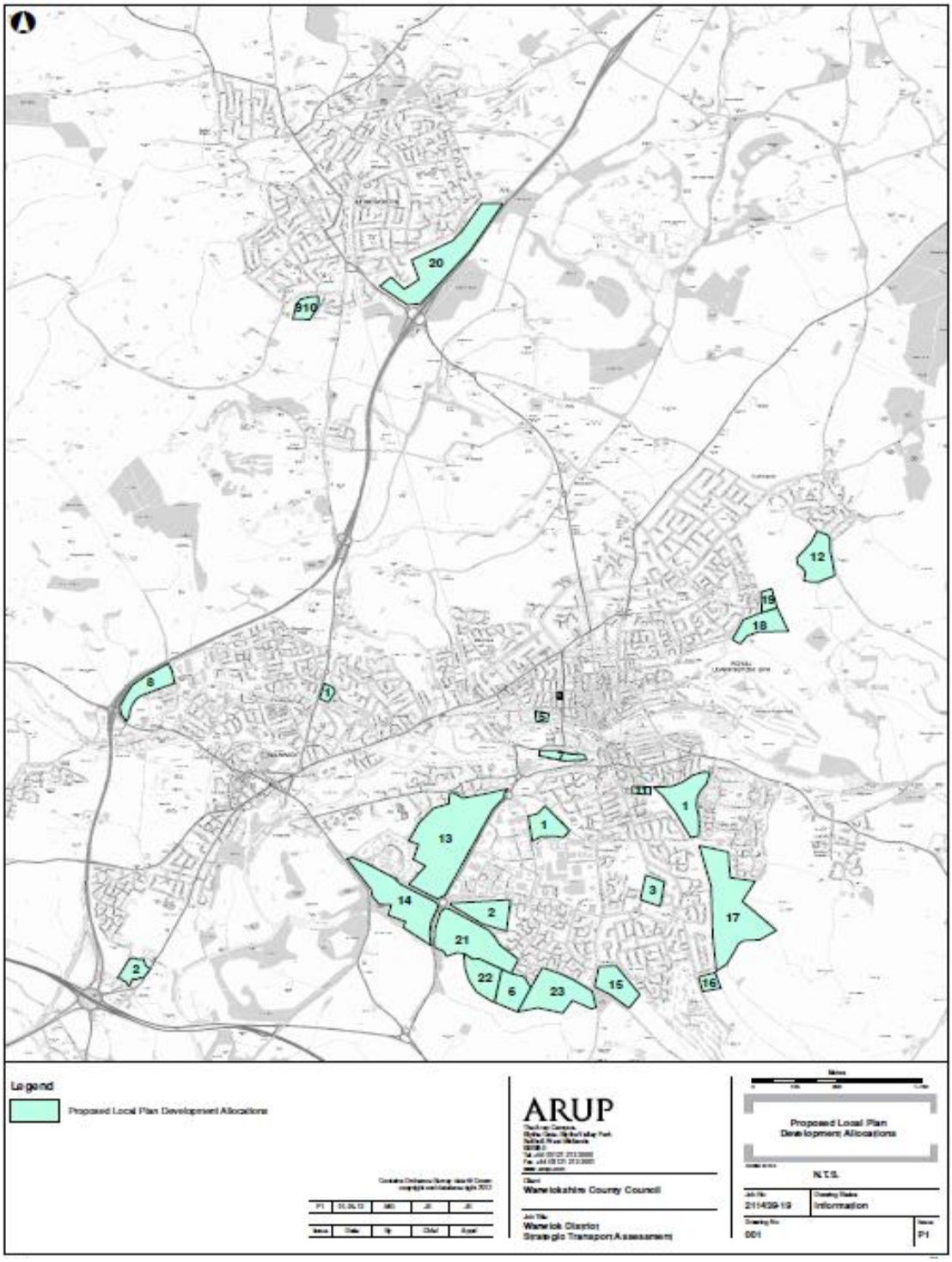


2.5 Core Strategy Allocation

The demand allocation that has been tested within the model is one which has been amended slightly when compared to previous tests. The sites selected within the revised allocation still represent a combination of the sites allocated between the Preferred Option and Southern Focus Option which were tested during the previous phase of this assessment.

The location of the sites that have been tested within the revised allocation is presented within **Figure 2** on the following page.

Figure 2 - Revised Allocation: Proposed Site Location Plan



The development schedule associated with the Revised Allocation is presented within the following **Table 1:**

Table 1- PARAMICS Model Scenario Development Schedule

Site Number	Location	Revised Allocation Housing	Employment (Ha)	PARAMICS Zone
1	Additional Windfalls with Gateway and Proactive Relocations	550		78, 85, 327, 160
2	Reallocation of Employment Land (e.g. 45 Tournament Fields and 25 Warwick Gardens)	500	0.92	157, 105
3	Ridgeway school	72		362
4	Leam Fire Station	59		41
5	Riverside House	59		326
6	Severn Trent Land - South Harbury Lane	225	0.83	907
7	Station Approach	150		63
8	IBM Car Park	100		160
9	Kenilworth School and	220		503
10	Kenilworth 6th Form College	120		503
11	Rangemaster	100		81
12	Thwaites	300		908
13	Myton Gardens	1150	2	902
14	South of Gallows Hill	635	2	903
15	Woodside Farm	250		901
16	Golf Lane	95		909
17	Whitnash East	650		910
18	Red House Farm	270		911
19	Red House Farm East of Eden Court (Green Belt)	50		912
20	Thickthorn (Green Belt)	770	6	900
21	South Harbury Lane (Lower Heathcote Farm)	620	2	904
22	South Harbury Lane (Lower Heathcoat Farm) - Additional Area	170	0.63	905
23	South Harbury Lane (Grove Farm)	440	1.62	906
24	Sustainable Villages	840	0	520, 209, 208, 206, 533, 518, 532, 201, 502

During the previous phase of testing, a sensitivity test was undertaken to establish the likely impacts of an option which progressed both with and without the Coventry and Warwickshire Gateway development. Within this round of testing the draw of the C&WG site has been included within all options. As a result the employment levels assumed within the rest of the allocation have been reduced. In total 16Ha of employment has been assumed to be delivered across multiple sites.

2.6 Report Structure

The remainder of this report is set out as follows:

- **Section 3** – outlines the development of the core option models
- **Section 4** – Presents and overview of the mitigation assumptions
- **Section 5** – Describes the Measures used to inform the analysis
- **Section 6** – Presents the outcome of the first stage of testing (2028 Reference Case vs. 2028 Revised Allocation Scenario)
- **Section 7** – Details the outcome of the Education Sensitivity Test
- **Section 8** – Documents the outputs for two, additional, mitigation sensitivity tests
- **Section 9** – Provides an overview of the initial 'Park & Ride' testing within the model.
- **Section 10** – Presents more specific details on the potential impacts on the AQMA areas
- **Section 11** – Documents the Summary and Conclusions
- **Section 12** – Outlines any Recommendations

3 Scenario Development

3.1 2028 Reference Case Model Revisions

Following on from the completion of the previous round of STA testing, an update to the 2018 and 2028 WLWA PARAMICS model Reference Cases has been completed. The objectives of this update were as follows:

- To remove a number of spurious zones contained within the original model network that did not control the assignment of demand but could adversely affect the derivation of distributions for assigning demand within the model.
- To make changes to reflect the closure of the Ridgeway and the diversion of existing demand, previously associated with the Ridgeway, to Woodloes School.
- Stoneleigh Park has now been granted consent and so was included as a committed development.
- The proposed scheme for the A46/Birmingham Road junction now appears unlikely to proceed and so the scheme assumed within the modelling is inappropriate as are the assigned committed development demands. Also, a hotel on the site has been granted permission and is now open. Thus, the proposed scheme for the 'IBM' junction was removed, along with the committed development demand, the network was reverted to the layout contained within the base model and the Hotel was included.

A comprehensive summary of the process followed during the update has been documented within a supporting Technical Note. A copy of this Technical Note has been provided within **Appendix A** of this report.

3.2 Core Strategy Demand Forecasting

In light of the revised allocation strategy that was to be tested within the modelling, it was essential that new demand matrices were forecast. This process was completed in line with the methodology adopted during previous stages of the WDC STA work.

3.3 Trip Generation

Residential Trip Generation

Trip generation for each of the sites has been derived for the peak hours based on trip rates provided by Warwickshire County Council and factored to encompass shoulder hours as per the methodology applied during the first phase of the PARAMICS STA modelling. This is based on the application of WCC's standard residential trip rates. The WCC standard, peak hour residential trip rate, per dwelling, is summarised within the **Table 2** on the following page.

Table 2 - WCC Standard Residential Trip Rate (per dwelling)

	In	Out	Total
0800 to 0900	0.12	0.48	0.6
1700 to 1800	0.48	0.12	0.6

These trip rates have then been factored to provide trip generation values for the shoulder hours of both AM and PM model periods. The methodology adopted is in line with that which was adopted previously. The following **Table 3** provides the factors used to extrapolate peak hour trip rates to encompass the entire AM (07:00 to 10:00) and PM (16:00 to 19:00) time periods:

Table 3 - Residential Trip Profiling Factors

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
In	65.10%	100.00%	101.90%	72.60%	100.00%	76.00%
Out	68.50%	100.00%	46.10%	96.40%	100.00%	97.90%
Average	66.80%	100.00%	74.00%	84.50%	100.00%	87.00%

The resultant, hourly trips rates, adopted to produce the development specific matrices are summarised within the following T**able 4**:

Table 4 - Residential Trip Rates

STA Trip Generation Rates	In	Out	Total
0700 to 0800	0.07812	0.3288	0.40692
0800 to 0900	0.12	0.48	0.6
0900 to 1000	0.12228	0.22128	0.34356
1600 to 1700	0.34848	0.11568	0.46416
1700 to 1800	0.48	0.12	0.6
1800 to 1900	0.3648	0.11748	0.48228

Employment Trip Generation

During previous iterations of the STA work, assumptions have been made regarding the likely composition of employment delivered through the allocation strategy. The employment has been split into three key classifications and then assumptions have been made regarding the proportions of each classification that are likely to come forward. It is not possible to make assumptions about which location is likely to deliver which element of the employment classification and so the classifications and proportions thereof have been aggregated to produce a universal employment trip rate. The classifications and proportions assumed are as follows:

- B1 Use – 70%
- B2 Use – 16%
- B8 Use – 14%

These proportions are in line with the proportions that have been adopted throughout earlier phases of the testing. Similarly the trip rates adopted for each

use are in line with those which were adopted during the first phase of the STA work[4]. The trip rates, by classification, are presented within the following **Table 5**:

Table 5 - Employment Trip Rates

	0800 to 0900		1700 to 1800	
	In	Out	In	Out
B1:	1.3	0.24	0.18	1.11
B2:	0.36	0.14	0.07	0.27
B8:	0.11	0.07	0.06	0.11

As with the residential trip generation, these peak hour trip rates have been profiled to encompass the shoulder hours within the AM and PM periods. The factors used to profile the trips rates across the period are consistent with those which have been used throughout the STA work and are summarised as follows:

Table 6 - Employment Trip Profiling Factors

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
In	55.60%	100.00%	58.00%	120.30%	100.00%	51.10%
Out	64.70%	100.00%	88.20%	87.30%	100.00%	35.60%
Average	60.20%	100.00%	73.10%	103.80%	100.00%	43.40%

The peak hour trip rates have been factored by the above shoulder hour factors, as well as the relative proportions of each classification, to produce a single set of universal employment trip rates that have been assigned to all employment sites assumed within the allocation. These trip rates are summarised within the following **Table 7**:

Table 7 - Employment Trip Rates (0.01 Ha)

	In	Out
0700 to 0800	0.55	0.13
0800 to 0900	0.98	0.20
0900 to 1000	0.57	0.18
1600 to 1700	0.18	0.73
1700 to 1800	0.15	0.84
1800 to 1900	0.07	0.30

The resultant, peak hour, trip generation levels assigned to the model as a result of the revised allocation strategy are summarised within **Table 8** on the following page.

[4] Warwick Dsitrict Council Strategic Transport Assessment Modelling, PARAMICS Testing & Results, JMP Consultants, 31 March 2021, Table 2.6, Page 8

Table 8- Revised Allocation, AM & PM Peak Hour Trip Generation

Site Number	Location	AM Trip Gen		PM Trip Gen	
		In	Out	In	Out
1	Additional Windfalls with Gateway and Proactive Relocations	56	224	224	56
2	Reallocation of Employment Land (e.g. 45 Tournament Fields and 25 Warwick Gardens)	120	211	207	110
3	Ridgeway school	7	29	29	7
4	Leam Fire Station	6	24	24	6
5	Riverside House	6	24	24	6
6	Severn Trent Land - South Harbury Lane	85	98	94	76
7	Station Approach	15	61	61	15
8	IBM Car Park	14	56	56	14
9	Kenilworth School and	22	90	90	22
10	Kenilworth 6th Form College	22	90	90	22
11	Rangemaster	10	41	41	10
12	Thwaites	31	122	122	31
13	Myton Gardens	263	465	457	240
14	South of Gallows Hill	214	271	263	191
15	Woodside Farm	26	102	102	26
16	Golf Lane	10	39	39	10
17	Whitnash East	66	265	265	66
18	Red House Farm	28	110	110	28
19	Red House Farm East of Eden Court (Green Belt)	5	20	20	5
20	Thickthorn (Green Belt)	536	385	359	467
21	South Harbury Lane (Lower Heathcote Farm)	213	265	257	190
22	South Harbury Lane (Lower Heathcoat Farm) - Additional Area	64	74	71	57
23	South Harbury Lane (Grove Farm)	167	192	185	148
24	Sustainable Villages	86	343	343	86
TOTAL		5677		5423	

3.4 Trip Discounting

In line with the earlier assessments, adjustments have been made to account for the impacts, on the trip generation of each of the sites, of internalisation and mode shift.

The internalisation and modal shift factors were assigned to the developments as outlined within the following **Table 9** whilst the resultant derived hourly trip generation that has been attributed to each of the sites is presented, for the sites assumed within the revised allocation, within **Appendix B** of this report.

Table 9 – Internalisation & Modal Shift Adjustments

Site Number	Location	Internalisation	Mode Shift
1	Additional Windfalls with Gateway and Proactive Relocations		x
2	Reallocation of Employment Land (e.g. 45 Tournament Fields and 25 Warwick Gardens)	x (zone 105 only)	x
3	Ridgeway school		x
4	Leam Fire Station		x
5	Riverside House		x
6	Severn Trent Land - South Harbury Lane	x	x
7	Station Approach		x
8	IBM Car Park		x
9	Kenilworth School and		x
10	Kenilworth 6th Form College		x
11	Rangemaster		x
12	Thwaites		x
13	Myton Gardens	x	x
14	South of Gallows Hill	x	x
15	Woodside Farm		x
16	Golf Lane		x
17	Whitnash East		x
18	Red House Farm		x
19	Red House Farm East of Eden Court (Green Belt)		x
20	Thickthorn (Green Belt)	x	x
21	South Harbury Lane (Lower Heathcote Farm)	x	x
22	South Harbury Lane (Lower Heathcoat Farm) - Additional Area	x	x
23	South Harbury Lane (Grove Farm)	x	x
24	Sustainable Villages		x

A modal shift allowance was made for all sites of 15% whilst sites which contained an element of Residential and Employment were subject to a further 7.5% reduction to allow for internalisation. At this stage the mode shift factor has been applied on the basis that it is in line with what was adopted during the earlier STA work, the internalisation factor has been reduced to 7.5% as the employment assumed is lower than in previous tests and the locations are less certain, thus it was felt the adjustment down from 10% to 7.5% was appropriate. ***It is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without these assumptions attributed to the developments.***

The total demand, by hour, produced as a result of the aforementioned process is presented within the following **Table 10**:

Table 10 – Allocated Demand Levels

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
Demand	3691	5677	3338	4378	5423	3835

3.5 CS Redistribution and Peak Spreading

As well as applying modal shift and internalisation assumptions the earlier STA work had also allowed for peak spreading of the development trips to also be assumed within the models.

In addition, earlier analysis of the CS demands revealed that the levels of growth predicted were particularly high. These high levels of growth are particularly important when considering the need to assess the PM period through the PARAMICS model.

Because of the high levels of growth it was decided that consideration should be given to the application of a 'capping' procedure informed by analysis of the TEMPRO database.

3.5.1 Guidance

Latest guidance on forecasting within transport models indicates that growth rates should be corrected to avoid double counting and that this 'correction' should be based on a view as to the plausible overall likely growth within an area, informed by TEMPRO, rather than whether a development, or set of developments, is interpreted as being 'additional'.

The purpose of this approach is to minimise the potential for over estimation of forecasts which could, in turn, lead to over-engineered solutions to problems that may not necessarily be realistic. Furthermore, if growth within the scenario models is allowed to remain too high there is a chance that one or more scenarios may be discounted on the basis that the demand impacts cannot be satisfactorily accommodated on the network irrespective of the proposed mitigation measures.

The relevant extracts from the WebTAG guidance (3.15.2) are outlined as follows:

> ***"Where a particular development proposal is likely to have a significant impact on demand for transport on one of the roads or rail services***

> ***where transport measures are being considered, this should be allowed for by explicit modelling of trips associated with that development. Methods adopted for doing this need where possible to be consistent with those set out in the Transport Assessment for the development. It is important to ensure that modal split assumptions are realistic in the context of current planning policy guidance. The growth factors applied to non-development trips may then have to be adjusted downwards, to avoid double-counting of trips within the model."***
>
> ***"Similarly, the correction of growth rates to avoid double-counting should be informed by a view as to the plausible overall population, household or employment growth in the zone, not by a local argument as to whether or not the development can be seen as "additional" in terms of the derivation of the TEMPRO figures."***

It is recommended that a sensitivity test be undertaken during the next stage of testing whereby unadjusted growth is assigned to the model network in order to identify further areas that may require additional mitigation. Such schemes would be difficult to secure in the short term as the growth levels required to trigger the need for these schemes is hard to justify. The purpose of any sensitivity test would be to provide an indication of any further mitigation that may be required over and above that which can be attributed, and delivered, by the respective CS growth options.

The need to apply a capping procedure is further demonstrated by the fact that, during the initial modelling exercise, it was not possible to undertake an assessment of the impacts of each option within the PM model period on account of the inherent model instability within the respective options during the PM period. By applying a cap the impacts of model instability would be minimised.

3.5.2 Redistribution Methodology

The application of the cap to the levels of growth within the model was based on NTEM Adjusted TEMPRO factor for Warwickshire County. The AM and PM NTEM adjusted factors currently stand at **19.19%** and **19.92%** respectively.

Due to the relatively fixed nature of Education and HGV trips across the network it was decided that these should be excluded from the calculations as including them could result in a reduction in either Education or HGV demand that may not necessarily be realised as a result of the inclusion of the CS sites. Particularly as, at the moment, the details CS site compositions provided by WDC focus on housing and employment rather than education and so those demands should not be included within the calculations.

Furthermore, the original 2028 Reference Demands were interrogated for instances were internal growth was retained and this was removed. This is on the presumption that all growth that occurs in addition to committed developments is associated with the allocated sites. This approach is valid as analysis of the demands determined that the growth within the models, before redistribution, exceeded TEMPRO predictions and, therefore, the internal element of the growth could be removed to reduce the potential for double counting to occur.

The methodology for applying the capping procedure was as follows:

- Education and HGV trips were excluded from the calculations;

- External growth was allocated via the standard TEMPRO/NTEM factoring methodology.
- The level of demand within the 2011 model, less education and HGV, was calculated
- The level of internal demand likely to be assigned as a result of the interrogation of the TEMPRO database was calculated
- The resultant level of demand assigned to the model as a result of the revised allocation was calculated.
- If the level of demand assigned within the model as a result of the revised allocation was in excess of the TEMPRO predicted level then the net difference is assumed to be the volume of trips that redistribute as a result of the inclusion of the CS developments.
- The redistribution of trips in response to the inclusion of revised allocation developments was calculated by subtracting the applying the aforementioned reduction proportionally across the background matrices. This was done by comparing the demand within the revised allocation matrices to the Background matrices. This process meant that the reduction in trips was targeted to those zones which had the highest level of interaction with revised allocation sites.
- The reduction was calculated firstly by O-D (Origin – Destination) movements, secondly by O-D totals and finally proportionally across the entire matrix. The purpose of this approach is to ensure that the reductions that are applied are as focussed as possible. Simply reducing the entire matrix, proportionally, by the required level would result in a reduction in background trips in areas where there is little or no interaction with revised allocation sites.

Redistributing trips in the means that reductions in the number of background trips were achieved on a zone by zone basis, informed by the level of interaction between the existing zones and the new revised allocation demands. This means that zones which had a high level of trip interaction with revised allocation zones were likely to experience greater reductions in the background traffic generation totals than those with limited or no interaction with revised allocation zones. This limits the potential for reductions in background trips to materialise in areas where there is little or no interaction with revised allocation sites.

The impact of the redistribution procedure is outlined within the **Table 11** on the following page.

Table 11- TEMPRO Capping Overview

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
Base Model Demand (excluding HGV & Education)	32174	38778	29127	38790	44134	32609
Periodic	100078			115532		
2028 Reference Demands (Less HGV& Education & External Growth)	38731	39905	33468	43222	46833	39306
Periodic	112104			129360		
2009 to 2028 Ref	***12.02%***			***11.97%***		
Allocated Demands:	3691	5676	3337	4377	5423	3833
2028 + Revised Allocation	41574	45581	36352	47558	52242	43056
Periodic	123508			142855		
2009 to 2028 + Revised Allocation	***23.41%***			***23.65%***		
TEMPRO NTEM Target	119285	19.19%		138549	19.92%	
Reduction	-4222			-4305		
Proportion of CD Demand	-1227	-1887	-1109	-1382	-1713	-1211
Revised Allocation Demand Totals	40348	43695	35243	46175	50529	41845
Periodic	119285			138549		
2009 to 2028 + RA Adjusted	***19.19%***			***19.92%***		
Total Demand (Including HGV & Growth)	42667	53139	38625	49677	52574	43606
Periodic	134431			145856		
Net Growth	**18.00%**			**19.41%**		

3.6 Peak Spreading Methodology

As with earlier stages of the STA, peak spreading assumptions were applied after the redistribution since redistribution deals with demand across the entire period whilst peak spreading deals with hourly changes.

Once the revised CS demand totals had been derived peak spreading assumptions were applied. Since peak spreading assumptions had already been applied to the 2028 Reference Demands [5] then the application of further peak spreading assumptions has been applied only to the growth that could be considered as occurring in addition to the original 2028 Reference Case. Because of this principle, peak spreading assumptions were only applied to the difference in demand between the 2028 Reference Case model and the 2028 Revised Allocation demand levels.

The peak spreading assumptions applied were initially consistent with those outlined within the 2028 Future Year model development report and are summarised, for the AM and PM model periods, within **Table 12** and **Table 13** presented on the following page.

[5] Warwick District Council Strategic Transport Assessment Modelling, - PARAMICS Testing and Results, JMP Consultants, 17 April 2012

Table 12 – AM Peak Spreading Proportions

0700 to 0800	0800 to 0900	0900 to 1000
68%	6%	26%

Table 13 – PM Peak Spreading Proportions

1600 to 1700	1700 to 1800	1800 to 1900
54%	26%	20%

Peak spreading evidence and the derived trend data was based on observed Automatic Traffic Count (ATC) data collected annually at WCC cordon monitoring locations around the modelled area. After application of the above proportions it was apparent that there was a substantial shift in demand within the PM model period. The shift occurred to such an extent that the 16:00 to 17:00 demand levels exceeded those within the 17:00 to 18:00. Whilst there is potential for this situation to occur, the principle of peak spreading is such that vehicles are redistributed away from the most congested peak hour in response to congestion. As a result the PM peak spreading proportions were readjusted within the PM period to ensure that demand in the 1600 to 1700 hour did not substantially exceed the level of demand within the 17:00 to 18:00 peak hour.

Whilst testing without any application of peak spreading assumptions is not likely to yield acceptable results due to the general bias towards the peak hour, it is recommended that, once the final option for the allocation of growth is determined, testing is undertaken both with and without the revised PM spreading assumptions attributed to the model demands.

In order that this principle could be achieved 30% of the 16:00 to 17:00 increase was redistributed, proportionally, back across the 17:00 to 18:00 and 18:00 to 19:00 hours. By redistributing 30% the goal of ensuring that demand within the 16:00 to 17:00 and 17:00 to 18:00 hours was retained at comparable levels.

The resultant peak spreading proportions assigned to the PM period are summarised within the following **Table 14**:

Table 14 – Revised PM Peak Spreading Proportions

1600 to 1700	1700 to 1800	1800 to 1900
24%	43%	33%

The peak spreading proportions were applied to only those levels of growth that occur in excess of the levels contained within the 2028 Reference Case since the Reference Case had already been subject to some element of peak spreading.

The specific differences between the two scenarios relates primarily to the inclusion of the demand associated with the Revised Allocation strategy. If, however, peak spreading assumptions were applied only to those demands then it would result in a disproportionate shift in CS demand away from the traditional peak hour.

As a result, a more refined methodology was adopted whereby the assumption was that only 50% of the total traffic growth would be subjected to peak spreading. Furthermore 50% of the growth that was subjected to peak spreading would be associated with the Revised Allocation demands whilst the remaining 50% would be associated with the background matrices. This approach is reasonable given that Committed Developments and Forecast growth have already

been subjected to peak spreading during the development of the Reference Case whilst the Education and HGV trips are unlikely to be affected by peak spreading.

An overview of changes resulting from the application of the peak spreading procedure to is illustrated within the following **Table 15**:

Table 15- Peak Spreading Overview

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41050	49349	36850	46723	48878	41066
2028 Revised Allocation	42667	53139	38625	49677	52574	43606
Growth from 2028 Ref	1617	3789	1775	2954	3696	2539
Periodic Growth	7181			9189		
50% Peak Spread Total	3591			4595		
Peak Spreading Proportions	68%	6%	26%	24%	43%	33%
LDF Adjustments	1221	108	467	551	987	759
Background Adjustments	1299	-1795	497	967	-2297	1331
Assigned Hourly Demands	44631	50660	39125	50465	50353	45045
Difference	1964	-2478	499	788	-2221	1440

3.7 Demand Summary

The resultant Hourly demands assigned within the two key modelling scenarios are summarised within the following **Table 16**:

Table 16 - Scenario Demand Summary

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41353	49392	37066	46956	48973	41320
2028 Revised Allocation Demands	44662	50636	39133	50342	50372	45142

4 Mitigation Overview

4.1 Introduction

During each of the preceding stages of the Strategic Transport Assessment, a series of network interventions have been derived and tested alongside the various allocation strategies.

During this third phase of testing, more detailed analysis of the relative performance of the mitigation schemes was required. To accompany this analysis a high level feasibility review of the schemes was completed to understand if there are any obvious, significant, issues which would pose a barrier to delivery.

Furthermore, a review of the necessity of the schemes that had been proposed, in line with the grading schedule presented within the Second phase of STA work[6], was undertaken. Where appropriate, schemes have been removed or the extent reduced. The removal of any schemes, or the reduction in scale, should not be assumed to infer that a scheme is no longer necessary, rather, these changes have been applied in an attempt to keep the overall costs associated with the mitigation measures down as contributions towards these schemes will directly affect the viability of any proposed development.

4.2 Outline Mitigation Schemes

During the second phase of STA testing the mitigation packages were categorised into broad locations. These broad locations do not imply that the mitigation within each of the areas has to be implemented in entirety for benefits to be accrued but it should be considered that, where appropriate, the cumulative impact of implementing the mitigation within the areas outlined is likely to be substantial when compared to the benefits of implementing schemes in isolation.

The broad locations have been presented within **Figure 3** on the following page.

4.3 Network Review & Optimisation

The second phase of STA testing indicated that an option which focussed growth within the south would be unlikely to trigger the need for a northern relief road. Similarly the work indicated that, without a northern relief road, some element of works would be required within Warwick town centre. Thus, the Northern Relief Road was removed from the model network whilst the Warwick Town Centre improvements were retained.

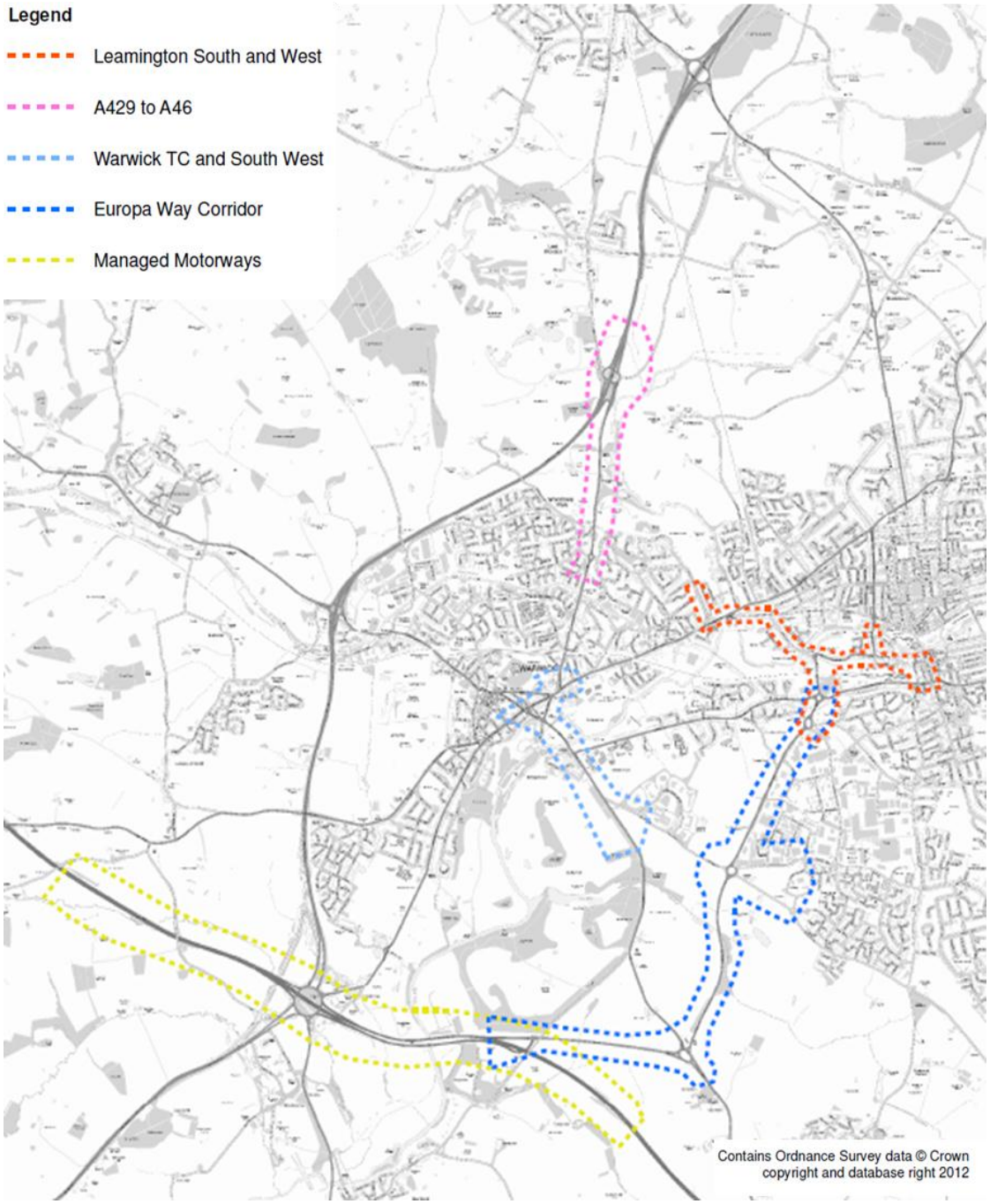
Testing also revealed that a signal strategy along the A452 to the North of Leamington Spa resulted in better overall levels of network operation than enhancing the existing roundabouts. As a result a signal scheme was adopted for the following junctions:

- A452 Kenilworth Road/Old Milverton Ln/Stoneleigh Road
- A452 Kenilworth Road/Bericote Road.

[6] 211439-19.R006 Warwick STA - Phase 2 Assessment, Arup, February 2013, Table 16, Page 33

Based on the outcome of the second phase of modelling it appeared that some account of the implementation of Managed Motorways (MM) would need to be included between Junction 14 and Junction 15 of the M40 across all scenarios. Thus, MM was retained within the scenario model.

Figure 3 - Broad Mitigation Areas



4.4 Schemes

Following the assignment of the revised demands on the updated model network the mitigation measures were reviewed and, if appropriate, amended in response to either the changes in conditions or as an outcome of the initial feasibility review.

In addition to the review of the mitigation measures that were previously proposed, a review of the network performance was undertaken and, in certain circumstances, a small number of additional mitigation measures were proposed.

Aside from those new mitigation measures which have been included as a result of this stage of the assessment, a comprehensive overview of the proposed mitigation measures was provided within the Second Phase STA report[7].

Wherever mitigation measures have been proposed the proposals have been based, as far as is possible, on schemes which either lie within the current highway boundary. Where third party land may be required this has been limited to land which lies within the boundaries of the proposed, allocated, sites.

A recap of the proposed mitigation measures, as well as an overview of any significant changes within the revised modelling, has been provided as follows:

A452 Thickthorn Roundabout

The proposed scheme has been retained as a signalised roundabout with a new, un-signalised, entry arm to serve the development site to the Northwest of the junction. The carriageway either side of the bridges has been widened to 3 lanes with 2 lanes retained on the bridges.

Kenilworth Gyratory

Proposals for this junction are in line with earlier proposals i.e. signalisation of the four entry arms onto the junction. Additional engineering will be required to ensure that the development which lies in the centre of the gyratory can be accessed satisfactorily.

A452/Bericote Road Roundabout

A signalised junction has now been assumed in this area. The A452 SB to Bericote Rd EB movement is separated out from the junction at an early stage although the point at which the A452 meets Bericote Road is also signal controlled.

A452/Blackdown Roundabout

The scheme proposed for this junction is now a four arm signalised cross-roads.

A429/Spinney Hill Roundabout

Proposals for this junction are in line with earlier proposals and largely involve the widening of all approaches.

B4099 Warwick New Road/Princess Drive Roundabout

The proposals for this junction are largely in line with the original proposals which involved the reconfiguration of the roundabout to a signalised 3 arm

[7] 211439-19.R006 Warwick STA - Phase 2 Assessment, Arup, February 2013, Section 4

priority junction. The B4099 WB approach has been reduced to one lane in each direction when compared to the original proposals.

A452 Adelaide Road/Avenue Road

In line with earlier STA work, a signalised junction has been adopted within this area.

A452 Adelaide Road/Dormer Place

As with the previous scheme, in line with earlier STA work, a signalised junction has been adopted within this area.

B4087 Bath Street/Spencer Street/High Street/Lower Avenue

The earlier STA work identified the need for reconfiguration of some links to one-way and that the introduction of signal control on at least three of the four entry points would be likely to improve conditions. The same scheme has been adopted during this phase of modelling but the signals have been further optimised using vehicle detection loops.

A425/Myton Road/Banbury Road Roundabout

The proposed signal scheme has been retained for this assessment in line with the earlier proposals.

A429 Smith St/St Nicholas Church Street

This junction has been signalised and the timings synchronised with the Coton End/Coventry Road signalised junction. The right turn from Smith Street to St Nicholas Church St has also been banned.

Castle Hill Gyratory

This junction has been signalised, the left turn from St Nicholas Church St SB to Banbury Rd SB is accommodated by a dedicated turn lane.

Emscote Road Greville Road

The assumptions for the scheme in this area are largely unchanged from those which were adopted during the previous phase of STA testing. The scheme involves signalisation of the junction. From the south the entry has been widened slightly and marked out as 3 lanes. There's a right turn filter into Bridge Street whilst two lanes can travel NB across the junction and merge back into one lane just west of the bridge. Bridge Street and Greville Road are signalised and Bridge Street is vehicle actuated. From the north there are two lanes in both directions between the junction and the bridge, one land facilitates the movement of traffic straight across the junction whilst the other acts as an extended right turn lane from Emscote to Greville Road. Towards the back of this lane a queue detector has been included to prevent right turning traffic from blocking back onto the bridge.

A452 Europa Way/Myton Road Roundabout

During the original STA work a four arm crossroads with dedicated left-turn slips was proposed for this area. Further investigation has revealed that a signalised roundabout may potentially be deliverable and so a signalised roundabout has now been assumed for this area. All entry approaches have been widened and a dedicated turning lane has been included to accommodate traffic travelling from Old Warwick Road WB to Europa Way SB. At this stage it is still not clear which is the best option to progress with and further, more detailed analysis of the options for mitigation at this junction is likely to be required before such a conclusion can be derived.

Shires Retail Park Roundabout

The initial scheme involved extensive reconfiguration into a three arm signalised junction with the Queensway and Tachbrook Park Road being combined into a single entry arm prior to entering into the main junction.. During the initial testing it was always held that the form of this roundabout could be maintained and a link across the centre of the junction used to increase the capacity of the north south movement. This 'hamburger' arrangement is what has been assumed within this next phase of testing.

A452 Europa Way Roundabout

The assumptions for the scheme in this area are consistent with the earlier STA work which involved additional widening of approaches and signalisation of at least four of the five entry arms.

A452 Grey's Mallory Roundabout

As with the previous scheme, the assumptions for this area are largely unchanged from those which were adopted previously. It should be noted that a dedicated lane has been included to better accommodate the A452 Banbury Rd to A452 Warwick bypass SB movement. However, works at Junction 12 may preclude the need for this movement by encouraging more traffic onto the M40 motorway and discouraging traffic from routing along the parallel B4100. Further investigation of this element of the scheme is likely to be beneficial; however, full signalisation is likely to be required as a minimum.

A452 Europa Way Corridor Part 1

Implementation of Dual carriageway along the entire length of the corridor between M40 J14 and Europa Way roundabout has been retained during this phase of testing.

A452 Europa Way Corridor Part 2

Dual carriageway along the entire length of the corridor between Europa Way roundabout and Europa Way/Myton Road roundabout has been retained.

C43 Gallows Hill/Warwick Tech Park

Sections of Gallows Hill between Europa Way and Banbury Road and specifically, the junctions therein, were extended to two lanes in both directions and this has been retained within this stage of the assessment.

A425 Banbury Road

Previously the length of the Banbury Road between Gallows Hill and Myton Road had been widened to 2 lanes in each direction. During this phase of assessment, primarily due to concerns around the ability of maintaining the access arrangements to Warwick School, the dual carriageway was removed. Instead, a two lane exit was included on the Banbury Rd SB exit of the new signalised junction with Myton Road up to the right turn lane into Bridge End a single lane has been reinstated south of this point. Northwards, two lanes have been introduced from the Gallows Hill junction which merges into the right turn into Warwick school, a single lane is then in operation until approximately 100m south of the Junction with Myton Road.

Managed Motorways

Managed Motorways (MM) is assumed to be delivered between J14 and J15 of the M40. Due to the size of the model and the complexities associated with testing MM within PARAMICS, coupled with the anticipated volume of runs and scenarios to be processed, it was not felt that the use of the ATM controller was appropriate to the level of detail of the tests being carried out and, as such, MM has simply been replicated through the inclusion of additional lanes on the motorway between J14 and J15, one in each direction, and enhanced merge facilities between the two junctions.

4.4.1 Additional Mitigation Measures

In addition to the schemes outlined previously, a number of new schemes have been included within the revised network. These have been outlined as follows:

A46/Birmingham Road 'Stanks Island'

The original STA work had assumed that a developer funded signalisation scheme would be in place at this junction prior to the assignment of the additional allocated demand. With that scheme in place no further works were proposed within the vicinity of this junction. As has been documented within the note outlining the latest update to the 2028 Reference Case, this scheme is now unlikely to be delivered and so was removed from the Reference Case. During the course of the testing however, it became apparent that a scheme was required at this junction and, as a result, a scheme was introduced which mirrored the earlier proposals (signalisation of four entry arms and widening of the East and West carriageway but with the bridges retained to 2 lanes) without the additional fifth arm.

Emscote Road/Portobello Bridge

This area of the network poses a significant constraint to movements within the immediate and wider road network due to the limited river crossing points between Warwick and Leamington. As a result it has been assumed that the bridge is either widened or a new bridge delivered, which can accommodate 2 lanes of traffic in each direction. A sensitivity test was undertaken to ascertain the impact should works on the bridge not be possible due to its status with English Heritage and this revealed a limited impact regarding the strategic influence of the scheme. As a result this scheme has been removed from the final cost calculations. Further details on this are available within Section 8 of this report.

Bericote Road/Stoneleigh Road Roundabout

The existing roundabout has been widened to include two lanes on the circulatory and on all approaches. An extended two lane exit has been included on the Stoneleigh Rd SB exit which is intended to increase the capacity of the Stoneleigh Rd SB flow across the junction.

Westhill Rd/Leicester Lane Roundabout

The existing roundabout circulatory has been widened to two lanes as have all of the entry arms.

4.4.2 Removed/Not Included Mitigation Measures

A number of mitigation measures have also been removed from the model network during this phase of assessment. These schemes should still be considered desirable but they are also considered less critical than those outlined previously. The schemes that have since been removed are outlined as follows:

- MOVA signalisation of the A46/A429/B4115 roundabout
- Signalisation of the slips at J13
- The Leamington Northern Relief Road

In addition to the schemes outlined previously, the initial Strategic Transport Assessments allocated ”town centre improvement” funding – this requirement has lessened as Warwick Town Centre and Leamington (Bath Street/Spencer Street works) schemes are assumed as having been progressed, as a result, additional funding for “town centre improvements” have been removed.

4.5 Strategic Road Network Considerations

There are a number of key junctions along the A46 which are affected by these proposals and, for some of these junctions, additional mitigation measures have also been proposed. The key mitigation proposals likely to affect the SRN are outlined as follows:

- Proposals to signalise Thickthorn roundabout and reconfigure the layout to 5 arms
- Proposals for minor widening and full signalisation of the ‘Stanks Island’. The proposed scheme is in line with an earlier ‘consented’

scheme with the exception that an additional arm entering onto the roundabout is not required.

- Assumptions regarding the delivery of MM, initially the modelling assumes between J15 and 14 of the M40 but it is assumed delivery would likely be implemented between, J15 and J12 of the M40 as delivery of MM between such a short section of motorway would be unlikely to comply with current standards and guidance.

Any testing of the aforementioned signal schemes has been undertaken using fixed time signals within the PARAMICS modelling. The impacts presented as a result of this approach are representative of a worst case as it is likely that a MOVA control strategy would be implemented rather than fixed times. Application of a MOVA control strategy is likely to yield additional benefits over and above those which are presented within this report.

In order that the benefits of implementing MOVA could be better understood a separate study has been undertaken by WCC and JMP consultants which indicates that inclusion of a MOVA control strategy, when compared to the performance of fixed time signals, significantly improves junction performance beyond that which is presented within the current wide area model[8].

With regards the implementation of MM, the Highways Agency has been consulted and provided feedback which confirms that there are no objections to the principle of implementing MM in this area but that further work may be required to determine that the scheme can physically be delivered within this area.

4.6 Mitigation Grading

The following provides an overview of the grading system applied to the current mitigation measures.

- **GRADE 1 - Strategically Essential** – A scheme identified at an early stage of the assessment that has been included within the modelling and is likely to be essential in maintaining network operation and conditions. Delivery of these schemes will serve a role of strategic importance in the context of maintaining overall network operation levels.
- **GRADE 2 - Strategically Desirable** - A scheme identified during the assessment that has been included within the modelling, implementation of the scheme is desirable to ensure maintenance of network operation and conditions. Further investigation may be required to determine whether the scheme is essential. Delivery of these schemes is likely serve a role of strategic importance in the context of maintaining overall network operation levels.
- **GRADE 3 –Locally Desirable** - A scheme identified during the assessment that has been included within the modelling, implementation of the scheme is desirable to ensure maintenance of network operation and conditions. Further investigation may be required to determine whether the scheme is essential. Delivery of these schemes is will serve a role of local importance in the context of maintaining the operational levels in the areas of close proximity to the scheme.

[8] MID3543.R001 – M40 J15 MOVA Study 220413, JMP Consultants, April 2013.

At this stage it is believed that no unnecessary schemes are contained within the model network. Furthermore, the schemes that have been categorised as desirable rather than essential tend to indicate schemes that are more likely to be triggered by proximate development. In some cases, the impacts that are addressed are likely to be of strategic importance to maintaining overall levels of network operation whilst in others the benefits of implementation are more likely to be focussed in the immediate area of the proposed mitigation measures. The grading and costs attributed to each of the schemes is summarised within the following **Table 17:**

Table 17 - Outline Mitigation Schedule

Scheme	Grade	Cost
Thickthorn Roundabout	Grade 1	£1,250,000
Kenilworth Gyratory	Grade 3	£300,000
A452/Bericote Roundabout	Grade 2	£1,250,000
A452/Blackdown Roundabout	Grade 1	£650,000
A452 Spinney Hill Roundabout	Grade 2	£450,000
Emscote Road/Greville Road	Grade 1	£750,000
Princes Drive/Warwick New Road	Grade 1	£350,000
Bath Street/High Street	Grade 1	£500,000
Adelaide Road/Avenue Road	Grade 2	£350,000
Dormer Place/Adelaide Road	Grade 2	£300,000
Myton Road Roundabout	Grade 1	£500,000
Priory Road/Smith Street/St Nicholas	Grade 1	£300,000
Castle Hill Gyratory Signals	Grade 1	£650,000
Europa Way/Myton Road Roundabout	Grade 1	£1,600,000
Shires Retail Park Roundabout	Grade 1	£1,250,000
Europa Way Roundabout	Grade 1	£900,000
Grey's Mallory Roundabout	Grade 2	£500,000
A46/Birmingham Road 'Stanks Island'	Grade 1	£1,400,000
Bericote Road Stoneleigh Road	Grade 3	£500,000
Kenilworth Road/Westhill Road	Grade 3	£500,000
Europa Way Corridor – Part 1	Grade 1	£5,550,000
Europa Way Corridor – Part 2	Grade 1	£2,950,000
Gallows Hill – 2 Lanes	Grade 1	£1,500,000
Banbury Road – 2 Lanes	Grade 2	£900,000
ATM "Managed Motor Ways"	Grade 1	£10,000,000
Sustainable Travel Infrastructure	Grade 1	£2,000,000
Virtual P&Rs	Grade 1	£2,000,000
Total		£39,150,000
Grade 1		£34,100,000
Grade 2		£3,750,000
Grade 3		£1,300,000

In all, exuding Portobello Bridge, 27 schemes are proposed within the study area, 16 schemes have been classified as Grade 1, and 8 schemes have been classified as Grade 2 whilst the remaining 3 schemes have been classified as Grade 3. This amounts to an approximate 60:40 split in classification between essential and desirable schemes.

It should be acknowledged that implementation of all of the schemes results in improved network performance when compared to the situation where any one of the mitigation schemes is not adopted. Furthermore, the results analysis in the following sections of this report demonstrate that, in spite of the application of all proposed mitigation measures, the impacts of the development allocation strategy are not fully mitigated. Should any of the mitigation measures be removed completely these impacts would inevitably be further exacerbated.

Images of the schemes have been extracted from the PARAMICS model and are presented alongside the schedule and any specific notes, for information purposes only, within **Appendix C** of this report.

4.7 Outline Cost Estimate

Excluding the costs associated with the Portobello Bridge capacity enhancements the following provides a breakdown of the indicative costs, by grade, of the proposed mitigation schedule:

- Grade 1 – £34,100,000
- Grade 2 – £3,750,000
- Grade 3 – £1,300,000

Costs have been calculated based on a high level review of the proposed mitigation measures completed by WCC. Included in the costs is an element attributable to highway works including utilities, an element attributable to the cost of implementing signals where necessary, the latter of which contains at least some account of any likely commuted sums, as well as an element attributed to the design and delivery costs. Design and delivery costs have been calculated at 48% of the costs of highway and signal works attributable to each scheme. The costs are based on average costs from a number of historical schemes within the urban Warwick District area. At this stage these costs are still high level estimates but they have been informed by WCC through an overarching review of the proposed schemes and so represent the most accurate costing that is available at this time given the current, strategic level of the assessment. A breakdown of the costs per scheme is provided within **Appendix C**.

4.7.1 Managed Motorways

The previously outlined costs attribute almost 25% of the required revenue to the delivery of Managed Motorways on the section of the M40 between Junction 15 and Junction 13. There has only been a very high level review of the potential for this scheme within the current phase of work and it is likely that a significant amount of additional work would be required to determine whether this level of contribution is either appropriate or proportionate.

An appropriate level of funding contribution is only likely to be fully determinable once the complete costs for delivering the scheme have been ascertained. The proportionality of the contribution also requires further work as

there are likely to be a number of contributing factors which trigger the need for MM in this area, the most significant of which is likely to constitute existing demand alongside forecast growth in strategic trips. Thus, any cost apportionment should be undertaken in consideration of the complexion of the demand which will benefit from the implementation of the scheme. Such an exercise has not yet been completed but work is on-going to understand the level of significance associated with the delivery of Managed Motorways. This work is important as it is important to understand whether there is a strong reliance on the delivery of MM when considering the life of the plan period and also to understand whether it is reasonable to conclude that the delivery of MM would be likely to be required towards the end of the plan period rather than the beginning as this is likely to have a bearing on the overall viability of the proposed sites.

4.7.2 Cost Summary

The total mitigation package cost is approximately £39.2 million which equates to an estimated per dwelling of cost of **£3,300** for delivery of all mitigation measures. This is based on 8,400 dwellings in allocated sites and 3,600 windfalls locations. The cost quoted is inclusive of a £10 Million contribution to MM.

The aforementioned costs do not, at this stage, include provision for alternative sources of funding such as major scheme funding or funding from other sources. Thus, the potential for the identification of additional funding sources should also be considered when reviewing the proposed costs.

Finally, at this stage, aside from the enhancements at Portobello Bridge, all schemes have been included within the cost calculation. Further, more detailed analysis may indicate that some of these schemes are wholly development specific, at which stage, they would no longer require inclusion within the cost calculations.

4.8 Risks and Issues

The feasibility of the proposed mitigation measures has been assessed at a very high level. There are 27 schemes within the modelling proposed for delivery and progressing each scheme through to a detailed design would be impractical at this stage. Thus, it should be acknowledged that the outline schemes, alongside the associated costs, will be subject to further design, optimisation and assessment throughout the plan period.

Furthermore, it should not be assumed that the schemes recommended through this study are fixed and will be delivered in the form described within this report. Rather it is intended that the schemes proposed are outline schemes which may change through further optimisation and detailed design that will precede the final delivery.

The following section outlines a number of risks that have been identified during the high level feasibility assessment:

- The impacts on areas not included within the modelling;
- The impacts of utility and service diversion costs attributed to any one scheme that may not have been considered at this stage (an average cost of service and utility works has simply been assigned to each scheme);

- The impact of land or safety issues not considered in detail within the initial assessment but that may arise during more detailed feasibility and design stages;
- Vertical alignment and gradient issues not considered at this stage; and
- Specific risks pertaining to the delivery of one or more scheme on the network such as:
    - The physical risks to delivering the Managed Motorways scheme in the area required and the viability of the costs thereof;
    - The risks posed by the bridge over the M40 which carries traffic SB from the A452 and its ability to accommodate the additional demand without significant enhancements;
    - The risk that the Barford Road bridge across the A452 at M40 J14 poses to the proposals to widening of the A452

The risks outlined previously represent those which have been identified through early feasibility assessments and are not exhaustive. Further more detailed assessment will be required.

5 Results Analysis

5.1 Overview

The following sections of the report are intended to present the results obtained from the detailed testing undertaken with both the WLWA and M40 models.

A tiered assessment has been adopted results analysis is still focussed on a strategic level assessment at this stage. The majority of results analysis that has been undertaken corresponds to the analysis undertaken during earlier stages of the assessment. However, as the level of detail required of the assessment has increased form that which was presented previously, there are some additional measures that have been included within this assessment. The additional measures consist of journey time analysis and, where appropriate, more detailed junction performance assessments.

All of the measures used to inform the assessment are outlined as follows:

5.2 Model Stability

Due to the deterministic nature of assignment within PARAMICS it is possible for vehicles to continue to attempt to enter a network even when congestion has reached such an extent that the network is effectively 'grid-locked'. In some cases the grid-lock can occur due to problems that will require mitigation, in other cases it can be something as simple as vehicles entering a mini-roundabout from all three approaches at exactly the same time.

When a model becomes grid-locked vehicles still continue to be assigned to the network and so delay begins to increase exponentially. It should be acknowledged that these issues may be occurring due to a need for mitigation in one or more areas of the model but, if the models do not lock up every time it can be concluded that the problem is not severe enough to cause the network to cease to function. Furthermore, the fact that some model runs are completed without mitigation indicates that a mitigation strategy can only provide additional improvements and should be deliverable.. If it is model error causing the issues then these results should also be discounted due to the fact that they cannot be considered realistic.

It should also be acknowledged that experience gained elsewhere in the application of PARAMICS micro simulation modelling, in projects of a similar size, has highlighted that the level of instability within the models is frequently improves as the options are looked at in more detail. Partly this is because of the fact that, as developments are progressed in isolation, more localised impacts are identified and mitigated than can be achieved during such a high level assessment and partly this is because the existing mitigation that has been proposed will be subject to further refinement and improvement beyond this stage of the assessment.

Twenty model runs were initially undertaken, where model stability has been particularly poor, the propensity for a model to lock up (and thus to be considered to have failed), is assessed to allow the reliability of the model network across the various scenarios to be better understood.

Additional runs were then collected to ensure that, where practicable, model outputs were based on a minimum of twelve runs per time period.

Based on an initial review of the model performance it was decided that an AM model run could be considered as having locked up whenever more than 8,500 vehicles are observed to remain on the model network at the end of the AM simulation period and 9,500 vehicles are observed to remain on the model network at the end of the PM simulation period. A greater level of latent demand is deemed acceptable during the PM than the AM due to the inherently higher level of variability contained within the PM scenario between each of the individual runs.

5.3 Number of Runs

Network statistics analysis has been based, consistently, on 10 runs per scenario due to the method of production, however, unless stated otherwise, all other statistics are based on a minimum of 10 runs and a maximum of 20 depending upon the number of successful runs collected.

5.4 Network Wide Statistics

A number of statistics used in the analysis have been obtained from analysing each individual trip that has occurred within the network. This information is collected within PARAMICS through the Trips-all file and contains information specific to each individual trip that has been completed within the model period. This information is then aggregated and processed to provide the following comparative statistics:

- **Average Distance (Km)** – The average distance travelled by a vehicle that completed their journey during the model simulation period.
- **Average Time (seconds)** – The average travel time of a completed trip during the model simulation period.
- **Average Speed (Km/h)** – The average speed travelled by all vehicles that completed a journey during the model simulation period.
- **Completed Trips (vehicles)** – The number of completed trips recorded during the model simulation.

The first three measurements are averages so can be used to compare between the various scenarios. The final measurement is an absolute and is dependent on congestion on the network (as this will prevent trips from completing) and the demand within the model (i.e. the number of trips actually trying to complete). As demand differs between scenarios, as well as small variations between runs of the same scenario, we cannot expect the number of completed trips to be the same. However, as the demands do not differ significantly it can still provide an indication of the relative congestion on each network.

The use of these statistics is in line with the methodology adopted during the previous Strategic Transport Assessment work.

5.5 Mean Speed Analysis

In order that an overview of the network performance can be obtained, mean speed plots for each option network have been produced.

One of the primary purposes of this stage of testing is to identify areas of the network that are either performing poorly or may require additional interventions to enable the respective growth strategy to be realised.

By using mean speed as a measure, areas that are classified as coming under stress can be determined as being either those which suffer low average speeds or those that experience a significant drop in the average speed when compared to the Reference Case conditions.

It should be noted that a reduction in mean speed does not always result in a worsening of conditions as vehicles may be slower moving but the management system may be such that throughput increases and correspondingly, queuing may be reduced. Similarly, a reduction in mean speed across a single band may not be as drastic as appears, it may imply a reduction from 20.1 mph to 19.9 mph rather than spanning the entire range of speed (i.e. 25mph to 15 mph).

The purpose of the mean speed analysis is to identify areas of the network where speeds are predicted to drop when compared to the 2028 Reference Conditions. This analysis should be undertaken in unison with the analysis of changes in other network conditions (queuing, throughput, flow, etc.) to allow a more thorough picture of the overall affects to be obtained.

Mean speed plots have been produced for all model scenarios and have been presented within **Appendix E** of this report.

5.6 Queue Lengths

A second, more detailed, level of analysis has been undertaken in the form of queue length analysis. Queue length analysis is intended to accompany the mean speed analysis as it provides a more detailed picture of the impacts at specific junctions within the model network.

At this stage the analysis of queue lengths has been based on the average hourly maximum queue length. Results presented for each junction are based on the worst performing single approach. The hourly maximum for each individual model run has been calculated and then the average of all runs has been calculated for each hour. The maximum of these values, across all hours, is reported as the maximum periodic average maximum queue length and is reported in vehicles.

The junctions for which average hourly maximum queue lengths have been calculated and compared are illustrated within Figure 14 on the following page. Junctions where queue differences have not been plotted on the maps simply represent junctions which did not trigger any of the assessment criteria across any one approach.

Queue difference plots have been produced for all model scenarios and have been presented within **Appendix F** of this report.

At this stage these results simply identify areas where further attention is required. A queue length increase of 50 vehicles does not necessarily mean that a scheme

will not work, it may indicate that further optimisation of the layout or any signal times are required. Furthermore it may not account for improvements on other arms of the same junction which, when investigated further, may contain additional capacity which could be unlocked to reduce the queue length on the offending approach.

The classification of differences used within the queue length analysis is outlined as follows:

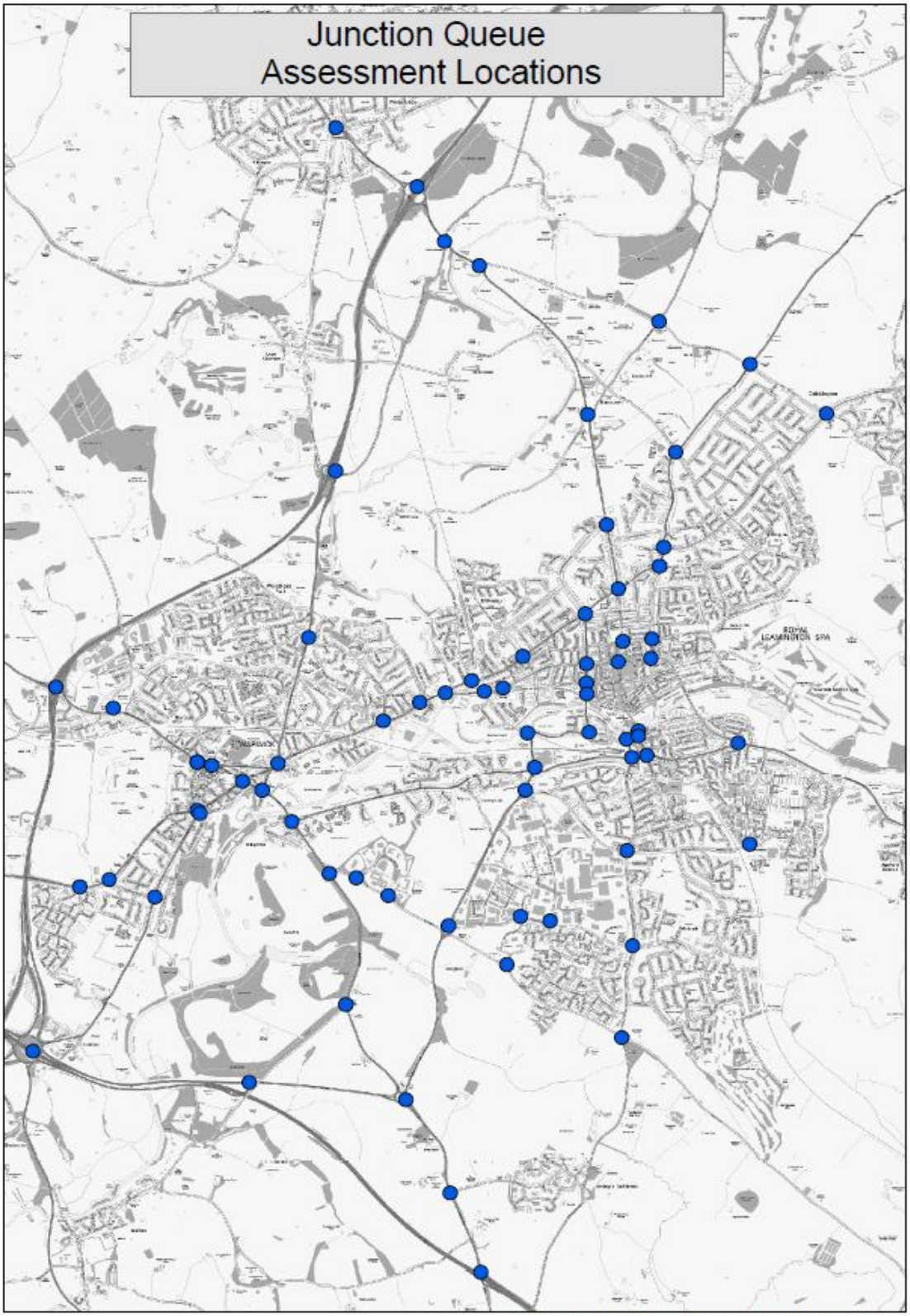
- **Queue Reduction** (a reduction in queue lengths of greater than 5 vehicles)
- **Moderate Increase** (an increase in queue lengths of between 15 and 30 vehicles)
- **Severe Increase** (an increase in queue lengths of between 30 and 50 vehicles)
- **Very Severe Increase** (an increase in queue length of over 50 vehicles)

The locations of the junctions that have been included within the assessment are outlined within **Figure 4** on the following page.

5.7 Detailed Junction Analysis

At certain times additional specific analysis of the performance of certain junctions has been included which may outline the impacts on queuing at one or more approach of a junction. This has been calculated using the 10 minute average maximum queue length, in vehicles calculated across the entire model period, and this information has been presented with confidence intervals to outline the degree of stability contained within the model runs from which the results are being reported. These results have been based on as many successful runs as are available for each scenario.

Figure 4 - Queue Assessment, Junction Locations



5.8 Journey Time Analysis

During the first phase of STA analysis some journey time routes were defined within the modelling and the time it takes vehicles to traverse these routes was collected and presented within the analysis. At that stage the purpose of analysis was simply to ascertain which routes experienced the lowest and greatest levels of delay across a number of different allocation options. Building upon that analysis, the purpose of the comparisons during this stage of work is to identify which areas of the network, when compared to the Reference Conditions, are likely to suffer the greatest changes in levels of delay when the allocated demand is assigned to the network.

In total 9 key routes were defined within the model network and these routes have been illustrated within **Figure 5** on the following page.

In order that the impact on delay across various routes can be better understood the routes have been dissected both by direction and into smaller sections thereof. The purpose of this disaggregation is to ensure that a sufficient sample size is collected from the analysis as the number of vehicles travelling across the entire length of a number of the routes is likely to be substantially smaller than the number of vehicles travelling along each of the component parts of the route.

Maps of each of the routes, by section and direction, have been presented within **Appendix D** of this report.

The average time it takes for vehicles to travel across each section of the route has been collected and aggregated for each scenario and then the level of deviation from the Reference Case conditions has been summarised using the following classification bands:

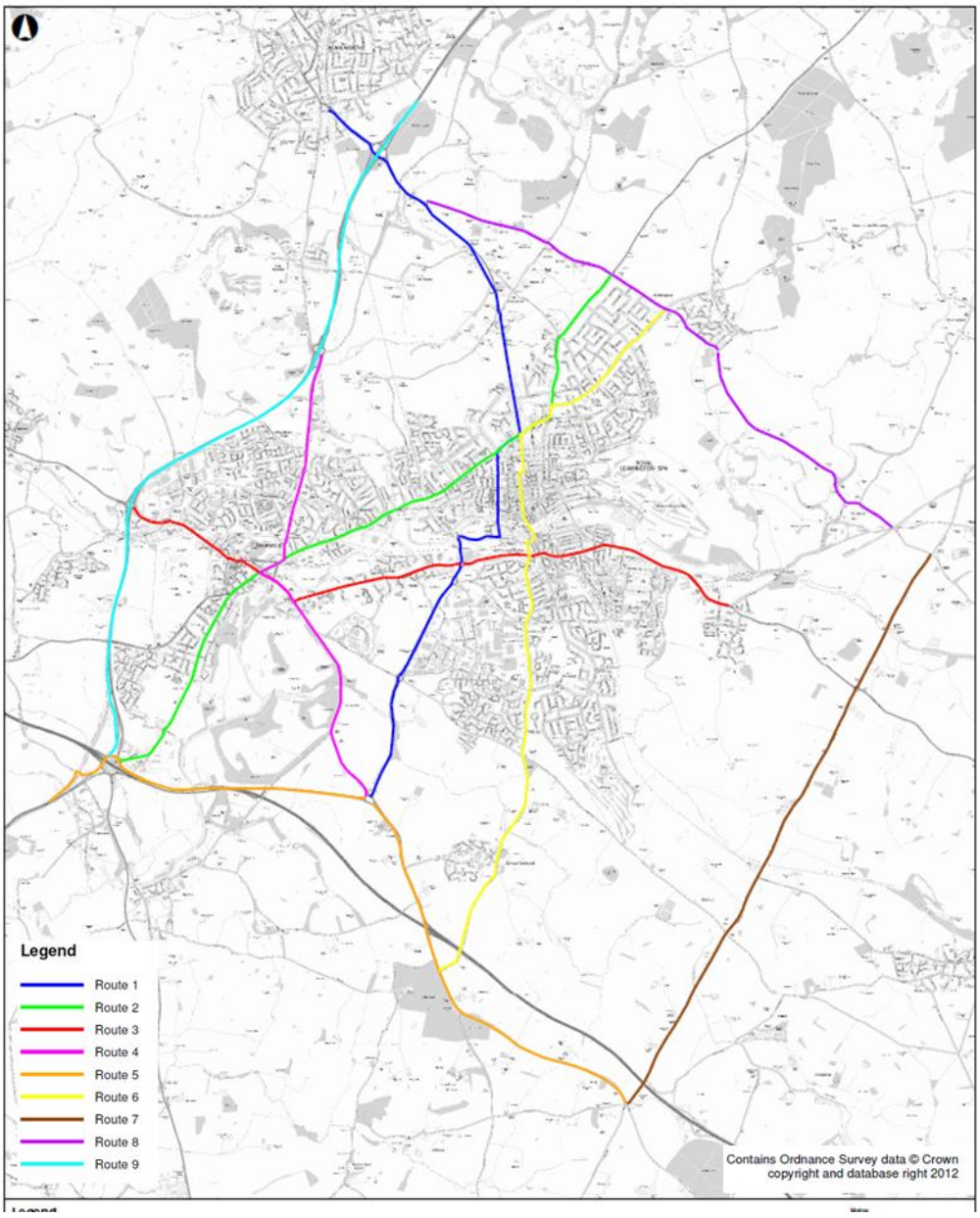
- **Delay Reduction -** A reduction in overall delay levels of -15% or more
- **No Significant Change -** A difference in journey times of between -15% and +15% falls within this category
- **Moderate Increase -** An increase in journey times of more than 15% but less than 25%
- **Severe Increase** – An increase in journey times of more than 25% but less than 50%
- **Very Severe Increase** – An increase in journey times, when compared to the Reference Case, of more than 50%

At this stage it was decided to classify journey time differences of between -15% and +15% as not significant as the intention is to highlight those areas which suffer the greatest impacts as these impacts are more pertinent to this stage of the assessment. The classifications adopted are in line with those that have been recommended by WCC and are such that they reflect the DMRB acceptability standards for comparisons between observed and modelled journey times. IT should be noted that although the current methodology does not consider an increase in delay of less than 15%, on a single section of a route, as significant,, during more detailed assessment stages, the potential for any increase in delay to be considered as being significant should not be discounted.

The benefit of undertaking analysis of delay on key routes, compared to simply reviewing the network wide average journey time alongside the mean speed

outputs, is that it begins to allow a more detailed picture of where the additional delays are likely to be incurred as well as highlight, in more detail, any areas which appear to benefit from the introduction of the allocated demand and associated mitigation measures.

Figure 5 - Journey Time Analysis Routes



5.9 Detailed Link Analysis

In addition to the aforementioned results analysis, detailed analysis of the changes in two way flow across pre-defined cordons have also been provided. These document the changes in two way flow across each individual cordon point as well as the changes in inbound and outbound flows across the entire cordons.

6 Revised Allocation/Optimised Network Testing

6.1 2028 Revised Allocation: Results Analysis

The first stage of this assessment was to review the performance of the model network following the allocation of the revised demand levels and network optimisation.

6.2 Model Stability

An initial assessment of the level of model stability was undertaken by comparing the number of completed runs against the number of runs assumed to have failed, as outlined earlier within section 5.2 of this report.

The apparent network stability exhibited within the AM and PM simulation runs across the two scenarios is illustrated within the following **Table 18**:

Table 18 - Model Stability Assessment 2028 Reference vs. 2028 Revised Allocation

	Reference Case	**Revised Allocation**
AM	85%	90%
PM	75%	70%

Given the relatively limited sample size of 20 runs it is reasonable to conclude, from the previous table, that there are no notable differences between the two scenarios when considering network stability. Both scenarios effectively demonstrate the same level of stability to within one run.

6.3 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 Reference Case and the Revised Allocation scenario.

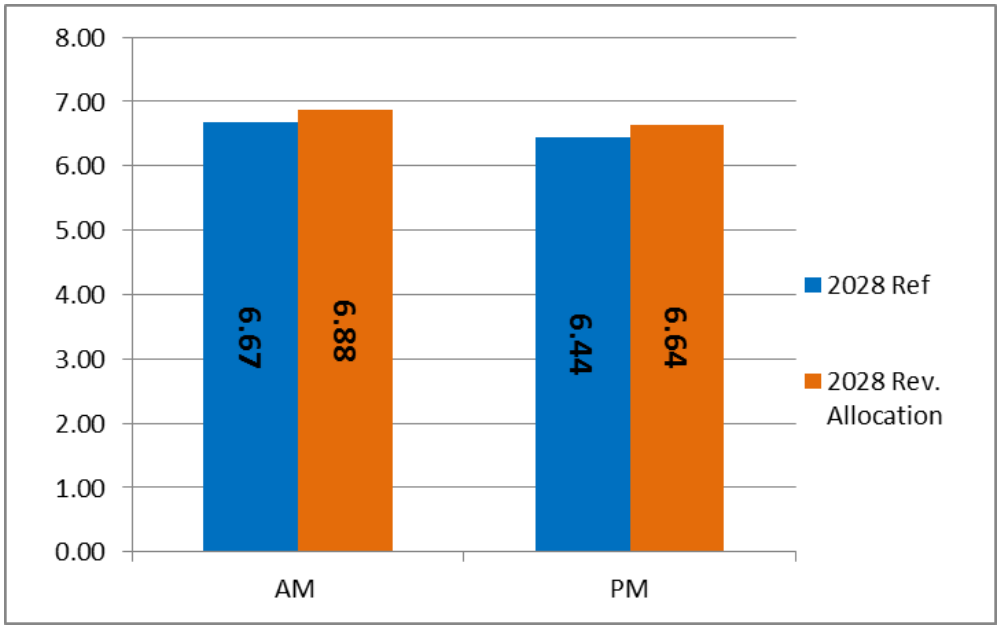
6.3.1 Average Journey Distance

Analysis of the average journey distance within each scenario, across the entire AM and PM model periods is presented within the **Figure 6** on the following page.

Analysis of the Figure 6 indicates very little difference between the two scenarios. An increase in the distance travelled may indicate an increase in the number of longer distance trips occurring within an option, or it may indicate an increased propensity for vehicles to reassign along longer routes in response to congestion.

A small increase in the distance travelled is always going to be likely due to the need to locate development on the periphery of the existing town network since that is where the available land is located.

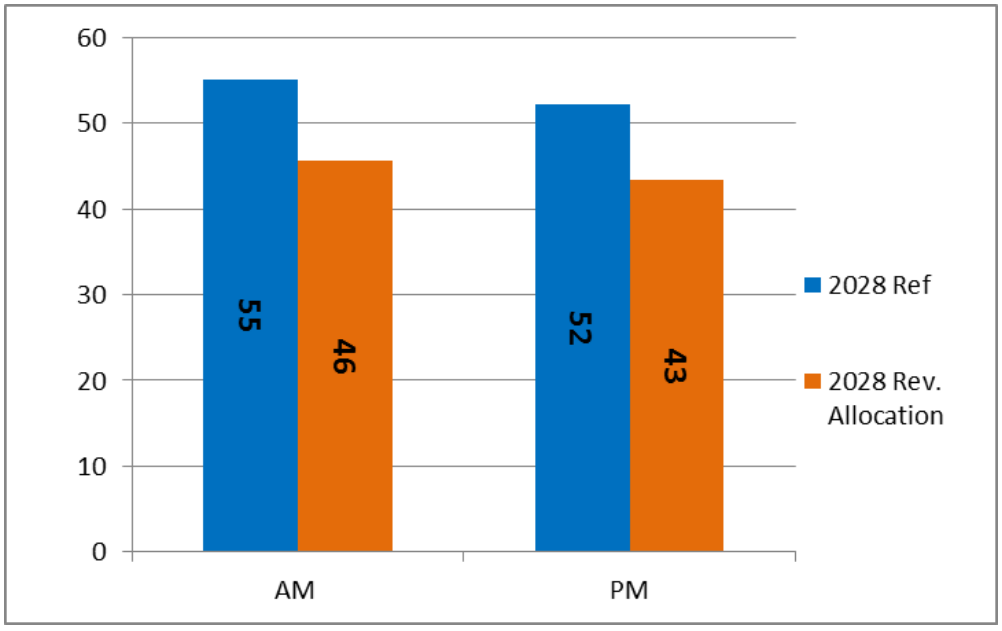
Figure 6 - Average Journey Distance (2028 Ref vs. 2028 RA), Km



6.3.2 Average Journey Speed

Analysis of the average journey speed (km/h) within the two scenarios, across the entire AM and PM model periods, is presented within the following **Figure 7**:

Figure 7 - Average Journey Speed (2028 Ref vs. RA), Km/h



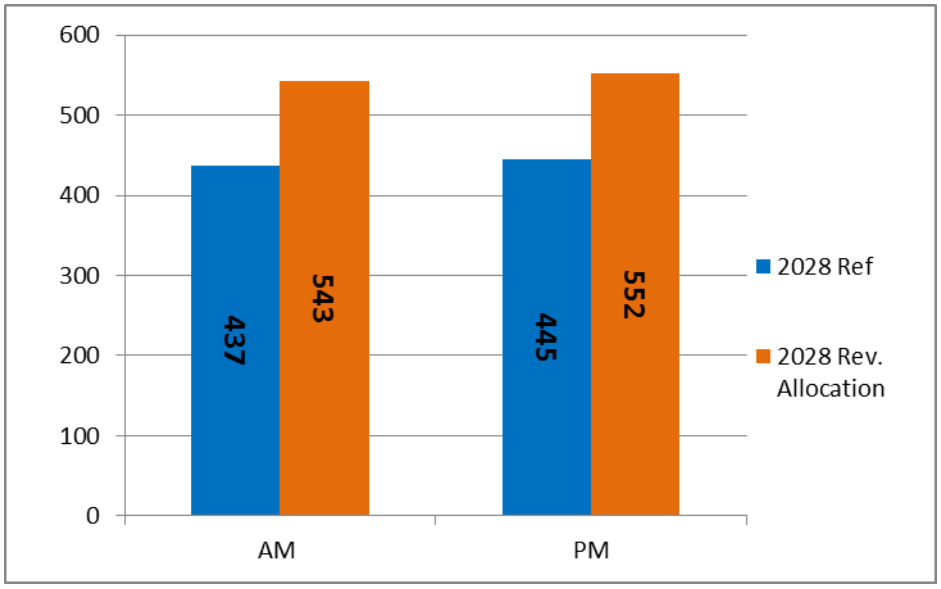
The previous Figure demonstrates that the allocation of the revised growth strategy results in a drop in the average speed of vehicles, on the network, of approximately 16% in both the AM and PM model periods. The drop in average speeds is consistent between both model periods and is likely to be indicative of the general effects of the assignment of the additional demand. Allocating additional demand is inevitably going to result in a drop in the overall average speed that vehicles are able to travel at within the network due to increased

friction incurred as a result of the additional movements within the network and the and resultant increase in congestion.

6.3.3 Average Journey Time (Seconds)

Analysis of the average journey time, in seconds, within each scenario, across the entire AM and PM model periods, is presented within the following **Figure 8:**

Figure 8 - Average Journey Time (2028 Ref vs. 2028 RA), Seconds



Analysis of the difference in average journey time across the scenarios indicates an increase in the time it takes to complete a journey when compared to the 2028 Reference Case conditions of around 24% during both AM and PM periods. A significant amount of this will be as a result of the additional demand that has been assigned across the network.

An incremental increase in delay is likely to be experienced as a result of these vehicles being added on to an already congested network. In some areas mitigation has been introduced to minimise these impacts and it is entirely possible that conditions in some areas will improve as a result of the schemes which accompany the allocated growth. However, overall, it can be assumed that there will be a general increase in the average time spent travelling on the network once the allocated demand has been assigned to the network.

6.4 Completed Trips

Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within F**igure 9** on the following page.

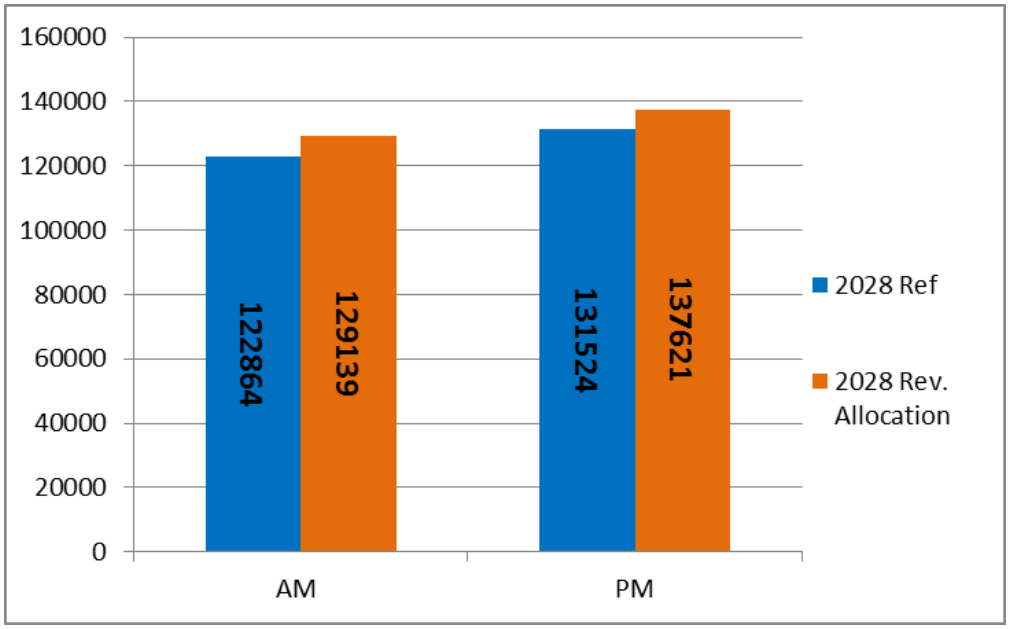
Analysis of Figure 9 indicates that there is an increase in completed trips of around 5%, in both the AM and PM periods respectively, when compared to the 2028 Reference Case.

Notably, the level of demand assigned within the Revised Allocation option is around 5.6% higher in the AM and 6.7% higher in the PM. This indicates that

when the mitigation is assigned to the network, it is largely able to accommodate the additional demand created by the allocation and that the AM performs better than the PM overall. It is worth noting that the increase in completed trips is lower than the increase in assigned demand between the two scenarios.

Because of the need for a cut off period it is never possible that 100% of the demand assigned within the model network will complete the entire journey by the end of the model period. Some trips will have only just started when the model ends whilst some may be released onto the network later due to congestion effects.

Figure 9 - Completed Trips (2028 Ref vs. SF vs. PO), Vehicles



To understand how much demand is either unreleased or left on the network at the end of the simulation period the number of completed trips has been compared against the total demand levels assigned within the model. This information has been presented within the following **Table 19**:

Table 19 Completed Trips Analysis (2028 Ref vs. 2028 RA)

	AM (07:00 to 10:00)			PM (16:00 to 19:00)		
	Demand	**Completed Trips**	**Completed %**	**Demand**	**Completed Trips**	**Completed %**
2028 Ref	127250	122864	96.55%	136667	131524	96.24%
2028 RA	134412	129139	96.08%	145864	137621	94.35%

The previous Table illustrates that, as a proportion of the demand assigned, the number of trips that are completed during the AM model period, is comparable between both scenarios whilst, in the PM, there is a reduction in the rate of trip completion within the Revised Allocation.

This indicates that, in general, the mitigation measures are able to accommodate the additional demand levels assigned during the AM period but that additional work may be required during the PM period to achieve similar levels of success.

6.5 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots for the three key model scenarios; 2028 Reference Case and 2028 Revised Allocation Scenario. The comments in the remainder of this section are based on observations of the predicted changes in peak hour mean speed across links within the model area during both AM (08:00 to 09:00) and PM (17:00 to 18:00) peak hours.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report whilst the specific drawing number pertaining to each element of the analysis has been provided within the accompanying title brackets.

6.5.1 2028 Reference Conditions (MS001 to MS004)

Analysis of the AM network conditions within the reference case reveals that both Warwick and Leamington town centres suffer from increased congestion. Low speeds are observed along Park Drive, Princes Drive and Emscote Road, particularly in the vicinity of Greville Road. Reduced speeds are also present along the Harbury Lane and Heathcote Lane approaches to Europa Way Roundabout. Furthermore, low speeds are also apparent on the Birmingham Rd links approaching Warwick from the A46 as well as on the A46 SB approach to the Thickthorn Roundabout.

Within the PM period, conditions along Park Drive, Princes Drive and Emscote Road appear to worsen. The speeds along the Myton Road and Old Warwick Road approaches to the roundabout with Europa Way are low as are those on the links approaching the Bath Street/High Street area of south Leamington. Speeds on Tachbrook Road appear lower in the regions near Harbury Lane and Shires Retail Park and speeds are also reduced on the links between Tachbrook Road and Europa Way. Similarly, Banbury Road speeds are lower on the section near St Nicholas Park.

6.5.2 2028 Revised Allocation Conditions (MS001 to MS004)

Analysis of the AM Revised Allocation network conditions reveals that, again, both Warwick and Leamington town centres suffer from the effects of congestion. The number of links within Leamington and Warwick Town Centres where speeds have dropped below 15 mph has increased when compared to the 2028 Reference Conditions. The speeds along the Park Drive, Princes Drive and Emscote Road corridor have dropped but the numbers of instances were speeds drop below 5 mph are limited. Notably, low speeds appear to be present in the areas of the Emscote Road/Charles St and Emscote Road/All Saints Road junctions. Furthermore, when compared to the Reference Case, the number of instances were speeds drop below 5 mph in the Heathcote area has also increased, this is likely to indicate that an increase in traffic movements traveling east/west along Heathcote and Harbury Lane conflict with northbound and southbound traffic trying to exit from the minor arms within the Heathcote area, as a result vehicles are queued for longer resulting in lower speeds in this area.

Within the PM period, conditions along Princes Drive appear to have improved. NB speeds along Emscote Road appear to have worsened on the approach to Greville Road. Speeds within the Bath Street/High Street area of Leamington are

lower than those present within the Reference Case. Speeds along Europa Way NB, particularly on the approach to Shires Roundabout have dropped. Speeds on the Gallows Hill EB approach to Europa Way roundabout have dropped when compared to the Reference Case. Speeds along the Europa Way Corridor SB between Europa Way roundabout and the M40 appear relatively unchanged.

6.5.3 Mean Speed Analysis - Summary

Analysis of the reference network plots reveals that, during the AM period, Warwick and Leamington town centres are already likely to suffer from reduced speeds and increased congestion by 2028 before the planned growth is allocated to the network and Warwick town centre appears to suffer the highest number of instances where speeds drop below 5 mph, during the AM all approaches to Warwick town centre suffer from low speeds whilst in the PM period this tends to be concentrated to the southeast of Warwick. In all cases these are issues which, without planned mitigation, will simply be exacerbated by the presence of further growth on the network.

The network conditions in the 2028 Revised Allocation scenario test appear to generally worsen, as would be expected, due to the increased levels of demand. This seems to be particularly obvious when reviewing the performance of the links in and around the town centre areas. There are some exceptions where increases in mean speeds are observed namely:

- There is an increase in mean speed on the SB approach to the Spinney Hill roundabout, although the links to the south of this demonstrate a substantial reduction in mean speed indicating that the conditions have been shifted southwards rather than mitigated.
- Mean Speeds on the A46 approaches to Thickthorn roundabout increase within the scenario model but, during the PM, as is discussed in more detail at a later stage, there is a drop in the mean speed approaching the roundabout from the south.
- Speeds on the Park Drive EB and Old Warwick Road EB approaches into Leamington appear to increase, particularly during the PM, within the Revised Allocation scenario but, correspondingly, speeds in the opposite direction reduce when compared to the Reference Case.

It should also be noted that the reduction in the average speeds on links in the Heathcote area, during the AM period, which is caused by the increased flow on the major links preventing traffic from exiting the minor arms, is symptomatic of the more detailed level of impacts that will need to be investigated further once proposed sites begin to come through the planning process.

6.6 Maximum Queue Length Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 Revised Allocation scenarios.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

6.6.1 AM Analysis (MQ001)

Analysis of the difference in queuing between the 2028 Reference and 2028 Revised Allocation scenarios, during the AM period, reveals the following:

- There are no instances of increases in queue lengths exceeding 50 vehicles on the network.
- The majority of junctions assessed that trigger the criteria experience something between a reduction in queuing levels and a maximum increase of 30 vehicles.
- Of the four junctions which experience increases of greater than 30 vehicles during the AM analysis, two are in locations where new schemes have been proposed, Bath Street gyratory and the Europa Way/Myton Road roundabout. The performance of the latter has improved considerably compared to the earlier STA analysis outputs whilst both schemes appear to result in increased throughput. The two aforementioned locations and Heathcote Lane/Tachbrook Road are signalised which means that additional benefits may be unlocked as a result of further signal optimisation.

6.6.2 PM Analysis (MQ002)

Analysis of the difference in queuing between the 2028 Reference and 2028 Revised Allocation scenarios, during the PM period, reveals the following:

- There are a larger number of instances whereby queues increase above 30 vehicles in the PM when compared to the AM but there are still no instances of very severe increases occurring.
- Aside from Thickthorn roundabout, which is discussed in more detail in the following section, the instances of queues increasing by more than 30 vehicles are concentrated around the Emscote Road/Warwick New Road corridor as well as to the South east of Warwick and Leamington. Furthermore;
- All instances where queues have increased by more than 30 vehicles occur at signalised junctions, further optimisation of the existing signal configuration adopted or proposed in these areas may further alleviate the impacts experienced.
- The majority of junctions included within the assessment experience either a reduction in queuing or an increase of no more than 30 vehicles, furthermore, queue reductions are observed as being achieved at a number of existing congestion ‘hot-spots’ including:
    - Shires Retail Park Roundabout
    - Europa Way/Heathcote Lane/Harbury Road Roundabout
    - Myton Road/Banbury Road Proposed Signals
    - St Nicholas Church St/Castle Hill

6.6.3 Detailed Queue Analysis - Thickthorn

In addition to the queue analysis set out previously, further analysis of the impact on queue lengths at Thickthorn Roundabout, specifically during the PM, has been undertaken.

Thickthorn has been specifically identified for more detailed analysis because it is the only junction on the strategic road network observed to experience increases of more than 30 vehicles when comparing the two scenarios.

Analysis of the increase in queue lengths between the two scenarios, during the PM period, reveals that it is largely influenced by a transposition of a queue on one approach to another approach between scenarios. During the Reference Case, very severe queues are experienced along the A46 SB approach to the Junction (Arm B), these are completely mitigated by the signals but this is at the expense of vehicles entering the junction from the A452 NB approach as this approach now suffers a substantial increase in queuing levels. These increases are sufficient to trigger the 30+ classification but do not necessarily depict the full picture. Increasing queuing on the A452 NB is likely to be more desirable than increased queuing on the A46 SB approach as there is substantial safety issues associated with the queuing of traffic back onto the A46 mainline.

The analysis of the average maximum queue lengths, in vehicles, between the two scenarios, during the PM period, has been presented within the following Figures for Arm B (A46 SB) and Arm C (A452 NB) respectively

Figure 10 - Average Maximum Queue Length (Maw Veh./10 Minutes) Thickthorn Arm B (A46 SB) PM 16:00 to 19:00, 2028 Rev vs. 2028 Revised Allocation

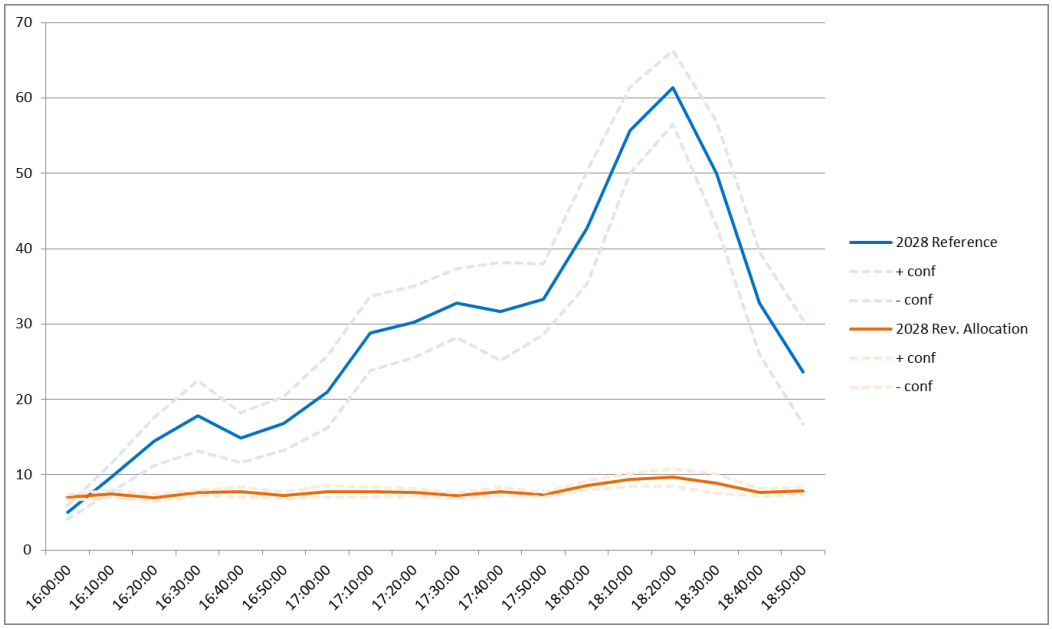
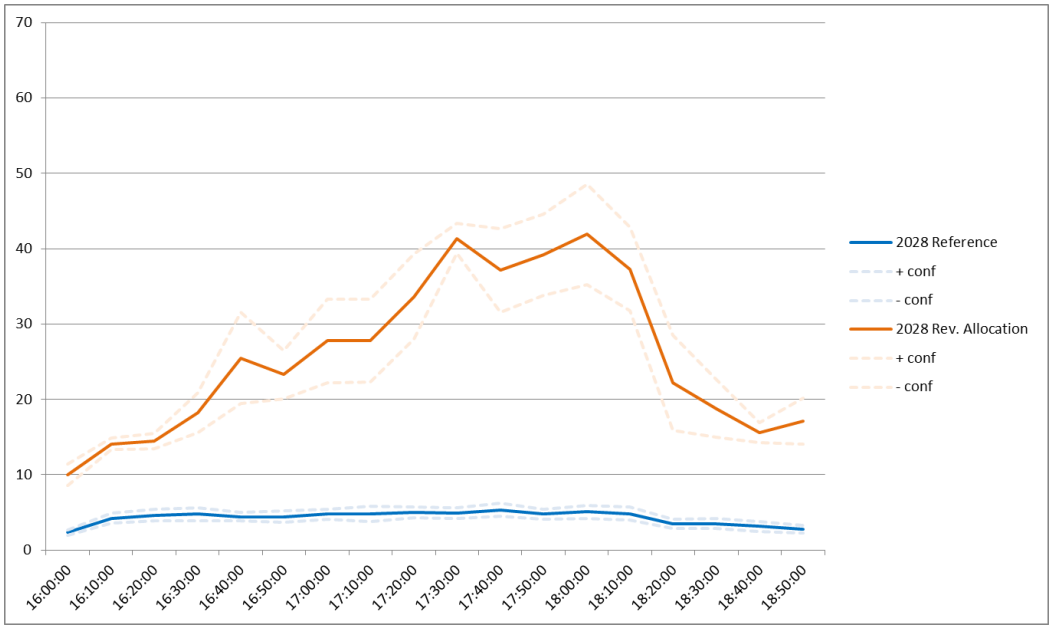


Figure 11 - Average Maximum Queue Length (Maw Veh./10 Minutes) Thickthorn Arm C (A452 NB) PM 16:00 to 19:00, 2028 Rev vs. 2028 Revised Allocation



Analysis of the previous figures reveals that queues with the potential to reach up to 60 vehicles in length are mitigated by the implementation of signals but that this leads to increases in the queue lengths along the A452 NB as the application of signal control in this area is likely to increase the level of flow which opposed the A452 entry arm.

In reality an intelligent method of signal control such as MOVA would be implemented at this junction and such an approach would be likely to better balance the level of queuing on each approach rather than the extreme switch that is apparent in the results presented within the previous section.

This also demonstrates how, on occasion, an increase in queuing may not necessarily be an entirely negative impact. In this case the queue increase occurs on an approach where the queue formation could be considered safer and easier to manage whilst queuing on an alternative approach which is removed would pose a safety concern.

6.6.4 Queue Analysis Summary

A summary of the findings obtained through comparing the changes in queuing between the 2028 Reference Case and 2028 Revised Allocation Scenario is provided as follows:

- During both the AM and PM periodic analysis there are now no instances of very severe increases in queuing levels.
- In all but one case queue increases of 30+ vehicles only occur in areas where junctions have been signalised and it is reasonable to conclude that further optimisation of these junctions will be likely to reduce these differences further.
- The only occasion where queues increase by 30+ vehicles in the vicinity of the Strategic Road Network (A46/M40) is Thickthorn roundabout and detailed analysis of the impacts on queuing levels

at this junction reveals that the increase in queuing presented does not reflect the significant reduction in queuing achieved along the A46 SB entry arm.
- Analysis of both AM and PM model outputs reveals that the majority of junction impacts range between a reduction in queuing and an increase of up to 30 vehicles.

6.7 Journey Time Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 Revised Allocation scenarios.

The maps which are referred to within the following analysis are presented within **Appendix D** of this report.

6.7.1 AM Analysis (MD001)

Analysis of the difference in queuing between the 2028 Reference and 2028 Revised Allocation scenarios, during the AM period, reveals the following:

- There are a number of instances where the increase in delay between the 2028 Reference Case and the 2028 Revised Allocation scenario can be categorised as severe. The areas where these increases have occurred appear to be concentrated on the arterial routes that dissect either Warwick or Leamington Towns.
- Routes on the periphery of the towns are less likely to suffer such severe increases in delay.
- The majority of routes on the outskirts of the towns do not appear to suffer from severe or very severe increase in delay; the only exceptions to this are the Fosse Way southbound between Offchurch and Harbury Lane and the B4100 between the Fosse Way and Grey's Mallory.
- There are a few instances whereby delay appears to reduce, most prominent of which is the reduction in delay through Warwick Town Centre along Emscote Road SB as well as the Banbury Rd NB and Myton Rd EB approaches to the Banbury Road/Myton Road junction.

6.7.2 PM Analysis (MD002)

Analysis of the difference in queuing between the 2028 Reference and 2028 Revised Allocation scenarios, during the PM period, reveals the following:

- There are a number of instances where the increase in delay between the 2028 Reference Case and the 2028 Revised Allocation scenario can be categorised as severe, although the occurrence is less than was observed when comparing the AM results.
- The areas where severe increases have occurred appear to be concentrated around the routes in to and through Leamington as well as the B4100 SB approach to the Grey's Mallory Junction.
- When assessing the performance of routes on the periphery of the towns it appears that most are unlikely to suffer notable increases

in delay, the only exception to this is the area to the Northwest around the A452 where severe increases in delay have been noted.
- When compared to the AM, the number of instances whereby delay appears to reduce has increased.
- The most prominent route to experience a reduction in delay is along the Europa Way Corridor between Princes Drive south to Longbridge.

6.7.3 Delay Analysis Summary

In general, the results appear to indicate that changes in delay levels, between scenarios are likely to be variable with some areas suffering increases in delay levels whilst reductions may be achievable in other areas. It should be remembered that any reduction in delay is achieved in spite of the general increase in demand levels across the entire network.

In both AM and PM analysis there are severe increases in delay along the Banbury Rd SB approach to Grey's Mallory. Although the classification is shown across the entire length of the route it is highly likely that this increase is incurred as a result of the signals at Grey's Mallory. In particular, the capacity enhancements along the Europa Way corridor are likely to draw additional traffic along this route which causes the signal timings at this junction to favour the Northbound and southbound movements over the B4100 approaches. This is evident in the analysis of the delay but is something that may be reduced through further optimisation of the signal timings at this junction.

Within both periods delays are also likely to increase along the B4087 leading up to the A452 north of Leamington indicating that further attention may be required in these areas, optimisation of existing signal junctions could help alleviate some of these issues.

Notably, within the AM, delay appears to increase on the Europa Way corridor Leading up to Princes drive but in the PM there are no significant increases in delay NB between the M40and Emscote Road. The same is true of the SB route between Park Drive and the M40. It is likely that these results indicate the constraints to demand that are presented by the area of network around Princes Drive/Park Drive as well as the Bath Street Spencer Street areas. During the AM traffic is drawn up the Europa Way corridor and capacity enhancements have been proposed to accommodate this draw. However, as you move northwards up the corridor the network becomes more restrictive and thus, large scale mitigation measures are more difficult to deliver and traffic is less able to move freely along the network. The situation is reflected to some extent to the North as well as delay along the A452 has increased in both AM and PM periods as well as SB along the A429. Increased allocation of demand in these areas may reduce delay to the South of Warwick but it would also exacerbate already present the issues along these corridors instead.

6.8 Detailed Link Analysis

The 2028 Revised Allocation scenario results that have been outlined previously represent the primary option for growth allocation within Warwick District. The results analysis presented within the following sections of this report details

sensitivity tests adopted to answer specific queries regarding the potential impacts of additional changes, namely;

- new schools;
- mitigation scheme removal; and
- Bus priority measures.

As such it is felt that detailed analysis of the changes in flow, particularly two way flows, between the Reference Case and the Revised Allocation Scenario need only be completed at this stage, using the primary scenario as the basis for assessing any potential differences. ***As more certainty regarding the sensitivity parameters becomes apparent it may be considered appropriate to undertake more detailed analysis of those scenarios at that stage***

6.8.1 Overview

In order to better understand the differences between the various options, more detailed analysis of the changes in two-way vehicular flow across various locations has also been undertaken, cordon flows have been extracted and analysed to assess inner and outer town centre traffic movements around both Warwick and Leamington towns.

6.8.2 Cordon Analysis

Cordon analysis has been undertaken for two cordons around Warwick and Leamington towns. Analysis of these outer and inner cordons provides an insight to the traffic movements around critical parts of the network, when the allocated demand is assigned to the network compared to the Reference Conditions.. An overview of the outer and inner cordon locations is provided within the following **Figure 12** and **Figure 13** presented on the following page.

Figure 12 - Warwick and Leamington Outer Cordon Locations

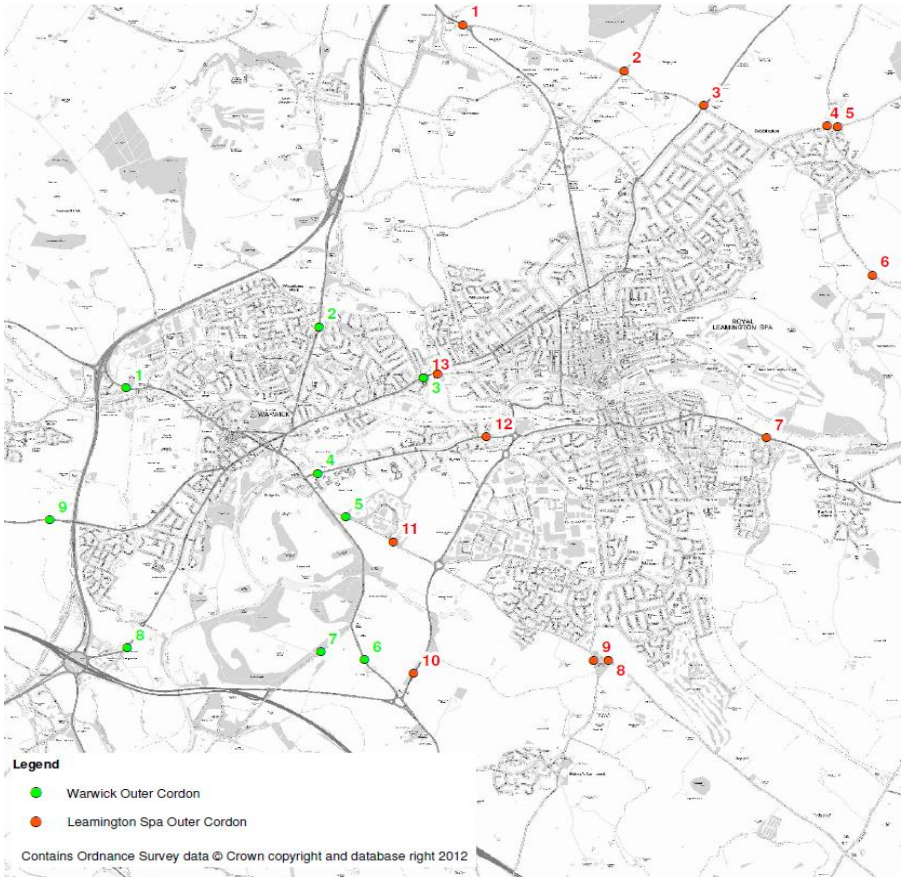
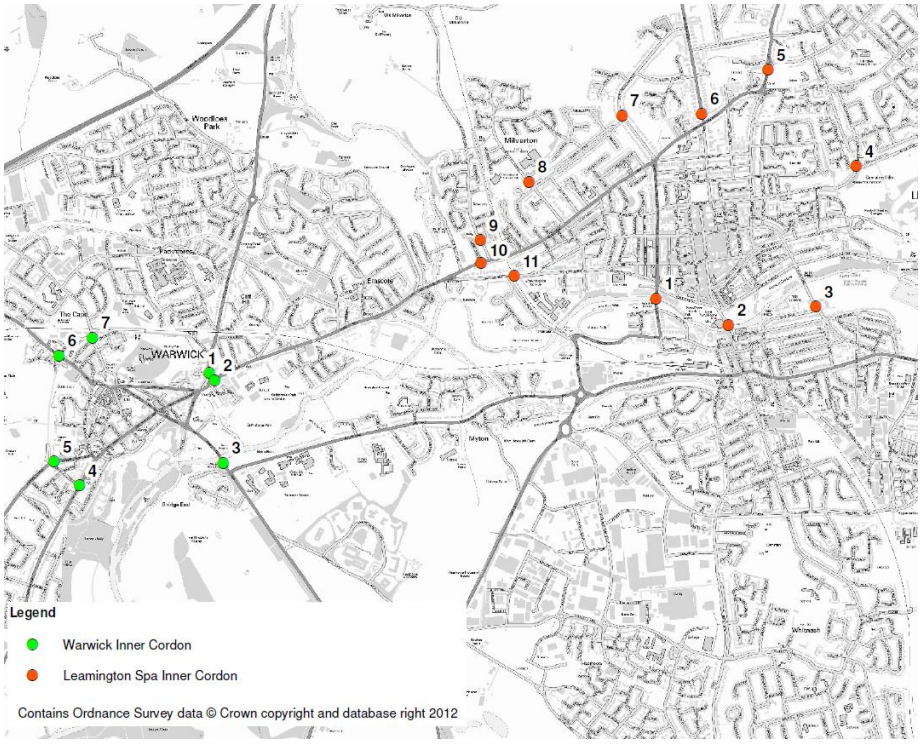


Figure 13 - Warwick and Leamington Inner Cordon Locations



6.8.3 Warwick Cordon Analysis

Warwick Outer Cordon

Analysis of the changes in two way flows, across all of the outer Warwick cordon points has been undertaken for the 2028 Reference and the 2028 Revised Allocation Scenario. The outcome of this Assessment has been presented within the following **Table 20:**

Table 20 - Warwick Outer Cordon Analysis: Changes in two way flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	2028 RA	Diff (veh)	Diff (%)	2028 Ref	2028 RA	Diff	Diff (%)
WOC-1 - Birmingham Road (A425)	6025	5582	-443	-7%	5712	5745	33	1%
WOC-2 - Coventry Road (A429)	5007	5683	676	14%	5447	6600	1152	21%
WOC-3 - Portobello Bridge (A445)	5997	5952	-45	-1%	6663	6568	-95	-1%
WOC-4 - Myton Road (A425)	2155	3166	1011	47%	2821	3112	291	10%
WOC-5 - Gallows Hill	3511	4451	940	27%	3492	4376	884	25%
WOC-6 - Banbury Rd / Europa Way	1822	1566	-256	-14%	1705	1730	25	1%
WOC-7 – Barford Road	1334	1763	429	32%	1034	1285	251	24%
WOC-8 - Stratford Road (A429)	3693	3803	109	3%	3648	3998	350	10%
WOC-9 - Hampton Road (A4189)	2137	2077	-60	-3%	1761	1900	138	8%

Analysis of Table 20 indicates that there are a number of locations which, over the entire AM and PM model periods, are likely to suffer from substantial increases in two way traffic flows.

During the AM the two-way flow on links located to the South of Warwick increases substantially. Around 1000 more vehicles use both Gallows Hill and Myton Road whilst over 400 more use Barford Road representing substantial increases when compared to the baseline levels. It is interesting to note that there is a corresponding drop in flow across Banbury Road within the 2028 Revised Allocation scenario, this is likely to indicate that, although the overall levels of demand in the south have grown, the schemes proposed along the Europa Way corridor are likely to draw traffic up that route as it runs parallel to the Banbury Road. The scheme at Myton Road roundabout and improvements along Gallows Hill make those routes more attractive as well which cumulatively leads to a reduction in vehicles using the Banbury Road to travel towards Warwick town centre during the AM period.

It is also interesting to note that, during the AM, the numbers crossing the Birmingham Road drop whilst the numbers crossing the Coventry road cordon

increase. This could indicate that the Coventry Road has become a more attractive route due to the works proposed at Spinney Hill Roundabout as well as improvements brought about due to the optimisation of the Coventry Road/Emscote Rad junction and synchronisation with newly proposed signals at Priory Rd/Smith St and Castle Hill/St Nicholas Church St.

During the PM the same locations appear to experience similar increases in flow (Myton Rd, Gallows Hill, and Barford Rd) but the magnitude of difference between the scenarios has lessened. Coventry Road still attracts more traffic than the Birmingham Road which remains largely static between the two scenarios.

In both percentage and absolute terms there appears to be a larger impact on the locations within the Southeast (Stratford Rd & Hampton Rd) during the PM than the AM.

It is interesting to note that despite the extensive works proposed at Portobello Bridge the overall volume of traffic in this area does not increase.

As well as analysing the two way volumes at each cordon point, the volume of traffic crossing the entire cordon has also been assessed. The purpose of this assessment is to understand the total volume of traffic traveling inwards towards Warwick and outwards towards the rest of Warwickshire. The outcome of this analysis has been presented within the following **Table 21**:

Table 21 - Warwick Outer Cordon Analysis: Changes in inbound/outbound flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	**2028 RA**	**Diff (veh)**	**Diff (%)**	**2028 Ref**	**2028 RA**	**Diff**	**Diff (%)**
IN	17784	18031	247	1%	14277	16192	1914	13%
OUT	13898	16013	2115	15%	18007	19122	1115	6%
TOTAL	31682	34044	2362	7%	32284	35313	3029	9%

Analysis of the previous table indicates that, overall, there is a growth in movements across the cordon points of around 7% in the AM and 9% in the PM. In general, within the AM there is an outward focus to the trip patterns whilst in the PM this is more balanced. There are a number of reasons why this situation may occur:

- The implementation of Managed Motorways may draw more traffic along the Europa Way corridor in the AM than the PM.
- A higher peak of congestion, during the AM, may make routes through Warwick less attractive than is the case during the PM.
- A substantial element of the allocated housing is to be located to the southeast and just outside the cordon locations, this may draw traffic out of the cordon as an attractor but, during the AM at least, it may not generate traffic that crosses into the cordon for the reasons outlined previously (i.e. the M40 is a more attractive route.)

Further, more detailed analysis of these travel patterns would be required before any more definitive conclusions could be drawn surrounding this issue.

Warwick Inner Cordon

Analysis of the changes in two way flows, across all of the inner Warwick cordon points has been undertaken for the 2028 Reference and the 2028 Revised Allocation Scenario. The outcome of this Assessment has been presented within the following **Table 22:**

Table 22 - Warwick Inner Cordon Analysis: Changes in two way flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	**2028 RA**	**Diff**	**Diff (%)**	**2028 Ref**	**2028 RA**	**Diff**	**Diff (%)**
WIC-1 - Coventry Road	2482	2516	34	1%	2884	2746	-138	-5%
WIC-2 - Coten End	2719	3349	629	23%	3188	3564	376	12%
WIC-3 - Banbury Road	5787	7267	1481	26%	5735	6904	1169	20%
WIC-4 - West Street	3717	3487	-230	-6%	3493	3604	110	3%
WIC-5 - Friars Street	1919	1995	76	4%	2105	2130	25	1%
WIC-6 - Saltisford Road	2997	3293	296	10%	3175	3098	-77	-2%
WIC-7 - Cape Road	1462	1619	157	11%	2768	3458	690	25%

Analysis Table 22 reveals that, during both the AM and PM periods, the largest increase in movements across any one location occurs across the Banbury road. This is to be expected given the increased movements occurring at the preceding cordon points which indicate that this is a heavily utilised route into Warwick that potentially benefits from the proposed improvements and thus, is more attractive in the future. The lack of alternative routes into Warwick from the South will also mean that forecast demands, in this area, that wish to travel to Warwick, are concentrated along this route whilst alternative routes are available to disperse traffic across the other cordon points.

It is interesting to note that the increase in movements across the Coventry Road outer cordon do not translate into an increase in movements downstream as the Coventry Road inner cordon point does not demonstrate a change in the AM and a minor reduction occurs in the PM. Instead there is an increase in the volumes crossing the Coton End inner cordon point. This must, to some extent, indicate that some traffic is entering and leaving the inner cordon via Coton End but downstream they are reassigning towards the Coventry road through the links in and around Emscote (Montague Road, All Saints Road, etc.)

Similarly, increases in the movements across Saltisford and Cape Road in the AM and Cape Road in the PM do not translate into increases in traffic movements out of the Birmingham Road outer cordon points. Inevitably there is going to be a draw between the areas that lie between the inner and outer cordon points and the new developments and this may account for some of these differences similarly

the mitigation proposed within the town centre may be altering the endemic travel pattern favouring certain routes into and out of the town.

As with the analysis of the outer cordon flows, analysis of the changes in the volume of traffic travel inbound and outbound has also been undertaken for both 2028 Reference and the 2028 Revised Allocation scenarios and this information has been presented within the following **Table 23**:

Table 23 - Warwick Inner Cordon Analysis: Changes in inbound/outbound flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	**2028 RA**	**Diff (veh)**	**Diff (%)**	**2028 Ref**	**2028 RA**	**Diff**	**Diff (%)**
IN	11535	12582	1047	9%	11339	12577	1237	11%
OUT	9548	10944	1396	15%	12008	12927	918	8%
TOTAL	21083	23526	2443	12%	23348	25503	2155	9%

Analysis of the previous table indicates that there is an increase in movements across the inner cordon, within the AM and PM periods, of 12% and 9% respectively.

6.8.4 Leamington Cordon Analysis

Leamington Outer Cordon

Analysis of the changes in two way flows, across all of the outer Leamington cordon points has been undertaken for the 2028 Reference and the 2028 Revised Allocation Scenario. The outcome of this Assessment has been presented within the **Table 24** on the following page.

Analysis of the Table 24 reveals that during the AM period the increase in traffic movements across the A452 are substantially higher, than the increases across all but one of the other cordon points. There are significant increases in movements across Myton Road, A452 Kenilworth road and Oakley Wood Road.

The large increases in the movements across Kenilworth Road may be attributable to a number of factors including:

- The location of a significant amount of development to the northwest of Thickthorn Roundabout;
- Improvements along the corridor drawing more traffic across this cordon point and;
- The prevalence of this route due to the production and attraction of trips between the two towns and the Coventry and Warwickshire Gateway.

The increases in movements across Oakley Wood Road occur during both AM and PM periods and are of a similar magnitude in both periods. This may indicate that, as the rest of the network becomes more congested, this route into and out of Leamington may become more attractive. Oakley Wood Road is very close to a number of the proposed allocations and will inevitably be influenced by this as well.

Table 24 – Leamington Outer Cordon Analysis: Changes in two-way flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	**2028 RA**	**Diff**	**Diff (%)**	**2028 Ref**	**2028 RA**	**Diff**	**Diff (%)**
LOC-1 - Kenilworth Road (A452)	7555	9261	1706	23%	8068	9333	1265	16%
LOC-2 - S of Stoneleigh	2512	2778	266	11%	2412	2339	-73	-3%
LOC-3 - Leicester Lane (A445)	2694	2799	105	4%	2810	2919	109	4%
LOC-4 - Coventry Road	470	422	-48	-10%	481	453	-28	-6%
LOC-5 - B4453	682	636	-46	-7%	702	692	-10	-1%
LOC-6 - Welsh Road	1134	1448	314	28%	1435	1921	486	34%
LOC-7 - Radford Road (A425)	4305	4327	22	1%	4711	4608	-103	-2%
LOC-8 - Harbury Lane	1872	2227	355	19%	1774	2187	413	23%
LOC-9 - Oakley Wood Road (B4087)	1910	2773	863	45%	1809	2650	841	46%
LOC-10 - Europa Way (A452)	7075	7251	175	2%	6680	7394	714	11%
LOC-11 - Gallows Hill	4073	4530	457	11%	4181	4431	251	6%
LOC-12 - Myton Road (A425)	2684	3396	713	27%	2271	2684	414	18%
LOC-13 - Portobello Bridge (A445)	5997	5952	-45	-1%	6663	6568	-95	-1%

The increases across the Myton Road cordon point, and correspondingly the Gallows Hill cordon point, correlate with the observations made during the assessment of the Warwick outer cordon as well, in so far as increased development within the southwest and capacity enhancements in the area of these links will lead to increased traffic volumes. It should be noted that an increase in traffic volumes does not necessarily equate to a worsening of conditions as it may be accommodated by the additional mitigation that is proposed. For example, flow across the Myton Road cordon points increases in all scenarios but correspond this back to the delay analysis presented within MD001 and MD002 of **Appendix D** and it can be seen that only Myton Rd EB in the AM suffers a severe increase in the levels of delay experienced along the route. Traffic volumes traveling in the opposite direction, as well as traffic travelling along Myton road in both directions during the PM, experience a reduction in overall delay levels when compared to the Reference Case and this occurs in spite of increased traffic volumes.

The levels of variation across the Leicester Lane, Coventry Road and B4453 cordon points, 3, 4 and 5 respectively, are such that they should not be considered significant.

When considering the change in flows across the Eastern cordon points, flow along Welsh Road and Harbury Lane increases but the flow along Radford Road remains static. This may indicate that sections of this route are at capacity and that growth on the more minor routes is to be expected instead, particularly given that Radford Rd is an A road and the alternative routes are B roads.

As has already been revealed through the analysis of the Warwick outer cordon, despite the proposed capacity enhancements in this area, vehicle movements across Portobello Bridge remains static between the two scenarios in spite of the overall increase in demand assigned within the model. This could indicate that other areas of the network are at capacity and so whilst improvements in delay and queuing are achievable, constraints elsewhere on the network may mean that the full benefit of the scheme is not being realised at this time.

Similar to the previous stages of cordon analysis, inbound and outbound flow levels across the entire Leamington Outer cordon have been collected and have been presented within the following T**able 25:**

Table 25 - Leamington Outer Cordon Analysis: Changes in inbound/outbound flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	2028 RA	Diff (veh)	Diff (%)	2028 Ref	2028 RA	Diff	Diff (%)
IN	22473	24827	2354	10%	22725	23885	1160	5%
OUT	20490	22973	2483	12%	21273	24296	3023	14%
TOTAL	42963	47799	4837	11%	43997	48180	4183	10%

Analysis of the previous Table indicates that the changes in the flow across the cordon are comparable during both the AM and PM periods with an increase in the region of 10% experienced in both. During the AM the increase is split fairly evenly between inbound and outbound movements but in the PM there is more of a bias towards the outbound movements.

Leamington Inner Cordon

Analysis of the changes in two way flows, across all of the inner Leamington cordon points has been undertaken for the 2028 Reference and the 2028 Revised Allocation Scenario. The outcome of this Assessment has been presented within the **Table 26** on the following page.

Table 26 - Leamington Inner Cordon Analysis: Changes in two-way flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	2028 RA	Diff	Diff (%)	2028 Ref	2028 RA	Diff	Diff (%)
LIC-1 - Adelaide Rd (A452	2047	1592	-456	-22%	2611	1932	-679	-26%
LIC-2 - Parade (B4087)	1603	1894	291	18%	1566	1763	196	13%
LIC-3 - Wiles Road (B4099)	2497	3036	539	22%	2682	2960	278	10%
LIC-4 - Leicester St	651	707	57	9%	374	433	60	16%
LIC-5 - Lillington Rd	3148	3289	142	4%	2373	2610	237	10%
LIC-6 - Kenilworth (A452)	2112	2467	355	17%	2078	2343	266	13%
LIC-7 - Northumberland Avenue	962	952	-10	-1%	538	587	49	9%
LIC-8 - Guy's Cliffe Avenue	599	601	1	0%	385	382	-3	-1%
LIC-9 - Old Milverton Road	519	576	57	11%	261	316	55	21%
LIC-10 - Rugby Road (A445)	950	1234	284	30%	1516	1832	316	21%
LIC-11 - Warwick New Road	2111	1803	-308	-15%	2107	1944	-163	-8%

Analysis of the previous table reveals that there is a substantial drop in movements across Adelaide Road in both AM and PM periods but this is accompanied by an increase in movements across Parade and Wiles Road. This could indicate a switch to these more minor routes, possibly as a result of pressures on the A452 through Leamington Town.

There is little change in the movements across Leicester Road, approaching Leamington from the West. Both Lillington Rd and Kenilworth Road experience increases in the movements across the cordon points which could partly be related to the increase in movements across the A452 outer cordon point just south of Thickthorn. Northumberland remains relatively unchanged which may indicate that this route is unlikely to attract any more traffic as a result of the revised allocation strategy. The changes in total movements across Guy's Cliffe Avenue and Old Milverton Road reflect a similar situation as the absolute differences between the two scenarios, during both the AM and PM periods, are relatively low.

It is interesting to note the drop in movements across Warwick New Road which may be indicative of capacity constraints downstream whilst, at the same time, the movements across Rugby Road increase. In the AM the totals almost cancel each other out which may simply indicate that the network is at capacity in this area and because of congestion on the minor roads between Rugby Road and Warwick

Road, vehicles are choosing to stay on Rugby road to travel between Warwick and Leamington. This would also correspond with the fact that there are no significant changes in the movements recorded crossing the Portobello bridge outer cordon points.

Analysis of the total inbound and outbound movements has also been undertaken and this has been presented within the following **Table 27**:

Table 27 - Leamington Inner Cordon Analysis: Changes in two-way flow (2028 Ref vs. 2028 RA)

	0700 to 1000				1600 to 1900			
	2028 Ref	2028 RA	Diff (veh)	Diff (%)	2028 Ref	2028 RA	Diff	Diff (%)
IN	17199	18152	953	6%	16490	17103	613	4%
OUT	13891	15508	1616	12%	17189	17727	538	3%
TOTAL	31090	33659	2569	8%	33679	34830	1151	3%

Analysis of the previous table indicates that there is an increase in movements across the inner cordon, within the AM and PM periods, of 8% and 3% respectively. It is interesting to note that despite the large changes across certain cordon points within the Leamington inner cordon the overall flow difference within the PM period is relatively limited, particularly considering the overall level of growth assigned to the model network.

6.8.5 Link Analysis Summary

A review of the difference in two way flow levels across the various cordons reveals that:

- During the AM the two-way flow on links located to the South of Warwick outer cordon increase substantially and, correspondingly, the numbers crossing the Birmingham Road drop whilst the numbers crossing the Coventry road cordon increase
- Despite the extensive works proposed at Portobello Bridge the overall volume of traffic in this area does not increase.
- The largest increase in movements across the Warwick inner cordon occurs across the Banbury road. This is to be expected given the increased movements occurring at the preceding cordon points and the lack of alternative routes into Warwick from the South
- The increase in movements across the Coventry Road outer cordon do not translate into an increase in movements downstream as the Coventry Road inner cordon point and similarly, increases in the movements across Saltisford and Cape Road in the AM and Cape Road in the PM do not translate into increases in traffic movements out of the Birmingham Road outer cordon points
- Traffic movements across the A452 Leamington outer cordon point are substantially higher, than the movements across all but one of the other cordon points.
- There are also significant increases in movements across Myton Road, A452 Kenilworth road and Oakley Wood Road outer cordon points.

- The increases in movements across Oakley Wood Road occur during both AM and PM periods and are of a similar magnitude in both periods. This may indicate that, as the rest of the network becomes more congested, this route into and out of Leamington may become more attractive.
- To the East of the Leamington outer cordon flows are static on the Radford Road but have increased across the two alternative minor roads. This may indicate that sections of this route are at capacity.
- Across Leamington inner cordon there is a substantial drop in movements across Adelaide Road which is accompanied by an increase in movements across Parade and Wiles Road potentially indicating a switch to these more minor routes, possibly as a result of pressures on the A452 through Leamington Town

It should be noted that an increase in traffic volumes does not necessarily equate to a worsening of conditions as it may be accommodated by the additional mitigation that is proposed

6.9 Summary

Analysis of a series of measures has been undertaken in an attempt to understand the likely impacts of adopting the Revised Allocation of growth.

Analysis of the network wide statistics revealed that, compared to the 2028 Reference Case, delay is likely to increase and speeds are likely to reduce when the additional growth is assigned irrespective of the additional mitigation measures.

As a proportion of the demand assigned, the number of trips that are completed during the AM model period, is comparable between both scenarios whilst, in the PM, there is a reduction in the rate of trip completion when assessing the Revised Allocation impacts, this could indicate further amendments are required within the PM to optimise the mitigation adopted alongside the allocated growth strategy.

Analysis of the reference mean speed network plots reveals that, during the AM, Warwick and Leamington town centres are already likely to suffer from reduced speeds and increased congestion by 2028 before the planned growth is allocated to the network. Warwick town centre appears to suffer the highest number of instances where speeds drop below 5 mph, during the AM all approaches to Warwick town centre suffer from low speeds whilst in the PM this tends to be concentrated to the southeast of Warwick. In all cases these are issues which, without planned mitigation, will simply be exacerbated by the presence of further growth on the network.

Analysis of the queuing on the network reveals no instances of very severe increases in queuing levels. Whilst, in all but one case queue increases of 30+ vehicles only occur in areas where junctions have been signalised meaning it is reasonable to conclude that further optimisation of these junctions will be likely to reduce these differences further. The only occasion where queues increase by 30+ vehicles in the vicinity of the Strategic Road Network (A46/M40) is Thickthorn roundabout and detailed analysis of the impacts on queuing levels at this junction reveals that the increase in queuing presented does not reflect the significant reduction in queuing achieved along the A46 SB entry arm.

Analysis of the changes in delay levels along key routes, between the two scenarios indicates that the impacts are likely to be variable with some areas suffering increases in delay levels whilst reductions may be achievable in other areas. It should be remembered that any reduction in delay is achieved in spite of the general increase in demand levels across the entire network. There are a number of occasions where very severe increases in delay are experienced between the 2028 Reference Case and the2028 Revised Allocation Scenario, these are likely to require further investigation to establish whether any additional mitigation measures are necessary to reduce these impacts. The scale and detail of this level of assessment pertains more to the assessment of the impacts of individual sites rather than at the strategic and cumulative level where triggers are more difficult to identify.

Changes in two way flow levels across the various cordon points seems to indicate that the biggest variation in the outer cordons occur to the Southwest of Warwick and the North of Leamington. To the Northwest of Warwick there is limited change in the movements across the Birmingham road but the movements across the Coventry Road to the North of Warwick increase substantially. In a number of cases increases in movements across the outer cordon areas do not translate directly to increases in the movements across the downstream inner cordon points.

6.10 Conclusion

The initial comparisons between the 2028 Reference Case and the 2028 Revised Allocation scenarios reveal the following conclusions:

- Inclusion of the Revised Allocation strategy demands will likely result in an increase in the average journey times and a reduction in average speeds that vehicles are able to achieve within the 2028 Revised Allocation network in comparison to the 2028 Reference Case conditions. These impacts occur in spite of the adoption of a proposed mitigation strategy.
- Analysis of the trip completion ratio within both Reference Case and Revised Allocation strategy indicates that, in general, the mitigation measures are able to accommodate the additional demand levels assigned during the AM period but that additional work may be required during the PM period to achieve similar levels of success.
- Adoption of the revised allocation strategy will potentially lead to a worsening of traffic conditions within the town centres but in other areas, adoption of the revised allocation, alongside the proposed mitigation measures has the potential to deliver improved conditions for road users in the form of reduced queuing and, in some cases improved journey times.
- Compared to earlier studies, the analysis of the network performance, alongside the revised allocation strategy, appears to indicate an improvement in the overall level of performance; in particular there are no observable increases in queuing which could be categorised as very severe.
- However, some impacts are inevitably going to be incurred as a result of the assignment of the additional demand levels onto the network.

7 Education Trip Impact Analysis

7.1 Overview

At this stage there is limited certainty regarding either the size or the location of the schools that are likely to be required in this area. However, the need for schools to be delivered in this area to serve the proposed residential developments is certain. As such, some initial assumptions based on details supplied by WCC Education department, about the size and location of the schools to be delivered in the south have been applied to the modelling.

The purpose of this outline impact assessment, is to provide a broad overview of the likely ability of the proposed mitigation measures to accommodate the additional increase in trips likely to be incurred within this area due to the increase in Home-Based Education trips in the area.

7.2 Education Assumptions

7.2.1 Schools

At this stage it has been assumed that the following schools will be required to accompany the proposed development to the South of Warwick:

- 1 x 210 places primary school to the West of Europa Way and South of Myton Road
- 1 x 210 place primary school in the area to the South of Harbury Lane and West of Oakley Wood Road, and;
- 1 x 420 primary school and a 900 place secondary school South of Harbury Lane and East of Europa Way

It is the latter which is most likely to result in additional problems due to the increase in movements across the Europa Way Roundabout. The locations of the schools within the model network are illustrated within **Figure 14** on the following page.

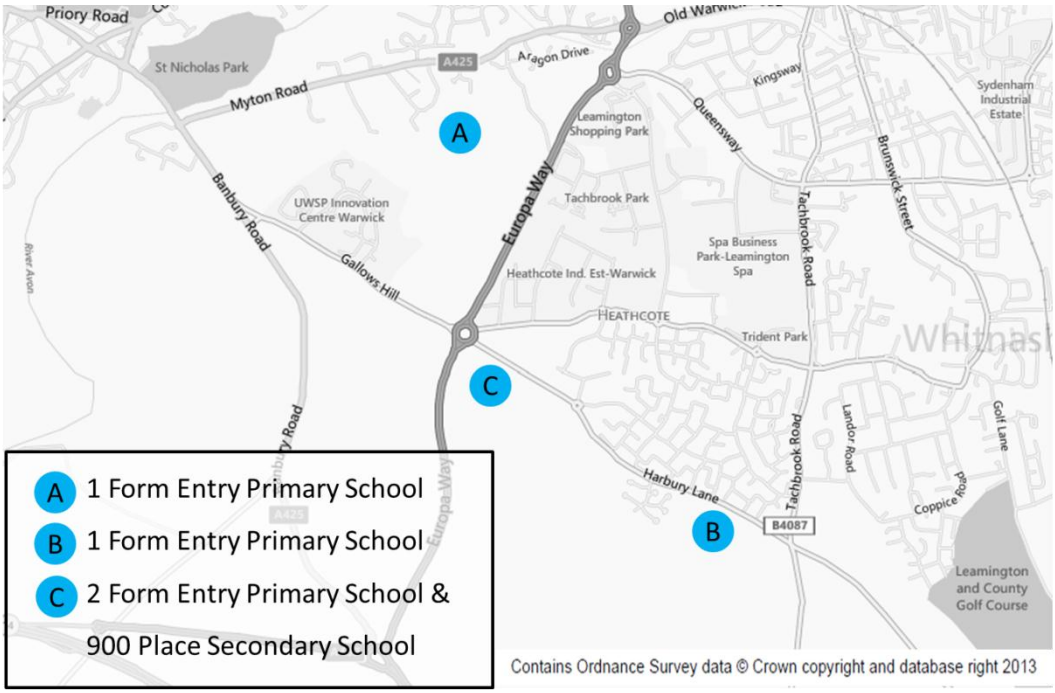
7.2.2 Trip Generation

To obtain a pupil based car trip rate for primary and secondary schools the Warwickshire County Council Pupil Origin Mode Share database was utilised. This database contains 2011 values for the method of travel, to each school, undertaken by each pupil within Warwickshire.

The survey data contains data for all modes of transport used included Walking, Cycling, Car, Car Share, Taxi, Public Transport and Dedicated School Bus modes and this information is split by Primary and Secondary School Types.

The total number of pupils surveyed was calculated and then the total number who responded with travel means of either Car or Taxi were collected and aggregated. The proportion using Car Share were then combined and halved to reflect the initial assumption of two pupils per car. This total was then compared to the pupil total to provide a pupil based car trip rate for both primary and secondary schools.

Figure 14 - School Location Assumptions



At this stage the assumptions contained within the trip methodology should be considered as robust as they rely on the assumptions that every car trip contained a single pupil and ever car share trip contained two pupils. This results in the creation of the maximum number of trips possible to assign to the schools within the model. Taxi trips are also assumed to simply behave like the standard car trips throughout this process.

Once there is more certainty regarding the magnitude and location of the schools within the area it may be pertinent to consider more detailed and refined testing of the impacts. At the same time further analysis of the access strategy and any necessary pedestrian facilities could also be undertaken.

In total 37.6% of primary School Pupils and 21.3% of secondary school pupils were assumed to travel by car. The resultant trip generation values calculated from this information, alongside the model zone numbers used to represent the schools, are presented within the following **Table 28**:

Table 28 - Education Trip Generation Summary

School	Class	Zone	Places	Car Base Pupil Trip Gen
A	Primary	952	210	79
B	Primary	950	210	79
C	Primary	951	420	158
C	Secondary	951	900	192

In total there are 508 car based trips predicted to be generated by the inclusion of the schools.

Demand over the modelled period was based on TRICS information utilised during the development of the original Warwick and Leamington PARAMICS

model[9] .For consistency, the same data was used to determine the level of hourly trip generation to be assumed within the model. Assuming that the schools are to be classified as urban schools the hourly trip generation values, extracted from TRICS, for both Primary and Secondary Schools are outlined within the following **Table 29**:

Table 29 - Hourly Education Trip Proportions, Urban Primary & Secondary Schools

Hour	Primary Schools		Secondary Schools	
	In	In	In	Out
07:00-08:00	8.34%	9.31%	9.31%	3.23%
08:00-09:00	85.83%	78.57%	78.57%	81.46%
09:00-10:00	5.83%	12.11%	12.11%	15.31%
15:00-16:00	69.71%	57.47%	57.47%	70.55%
16:00-17:00	11.02%	18.75%	18.75%	20.11%
17:00-18:00	8.94%	9.78%	9.78%	6.42%
18:00-19:00	10.33%	14.00%	14.00%	2.92%

Analysis of the previous Table reveals that the majority of education trips occur within the AM peak hour of 08:00 to 09:00. Similarly it also reveals that, during the PM period, the majority of education trips are likely to occur outside of the modelled period. As such it was determined that analysis of the impacts, within the PM period, was not necessary at this stage.

Furthermore, since, around 80% of all trip generation associated with schools occurs during the AM peak hour, coupled with the relatively low, overall levels of demand associated to the new schools, it was decided that, for this stage of the assessment, assigning all education based demand within the 08:00 to 09:00 period would provide a robust foundation upon which to base the assessment.

7.2.3 Trip Distribution

The following rules were adopted to distribute school traffic across modelled network:

- Primary school trip distribution would be focussed primarily on all adjacent new development and existing development zones.
- Where a new development zone did not lie adjacent to the proposed location of a primary school then trips between that zone and a primary school would be determined based on the closest primary school instead.
- Secondary School trips were distributed to all new development zones as well as the zones within the model that represent Bishops Tachbrook as this location would now fall within the catchment.
- The proportion of trips generated by each origin zone was determined based on the amount of demand already associated with that zone (i.e. zones which generated a large amount of demand would create more education trips than those with lower levels of overall demand).

[9] MID2535 LMVR Final 001 120710, JMP Consultants, July 2010

- Each trip associated with a school was assumed to be a drop-off meaning that, once it had arrived at the school, it would then proceed onwards to a final destination. This final destination zone, was determined by assigning trips leaving the schools to the same distributions as was assigned to the zones from which they had originated.

The result of adopting this methodology is to transform a single trip associated with a zone to a multiple trip. Instead of simply leaving the zone and arriving at the destination a trip now leaves the zone, arrives at the school then departs the school and arrives at the final destination.

These trips were assigned to a separate matrix level and their release onto the network was governed by the existing release profiles associated with the schools within the area. The trip generation associated with the origin zones was reduced to match the number of trips now travelling to the schools. Since each trip that travels to a school then travels on to the final destination then the overall trip generation associated with the schools effectively doubles.

The reductions in background demand were applied only to the background and Revised Allocation Matrices for simplicity.

An overview of this process is provided within the following **Table 30** although the actual trip generation values assigned within the modelling may vary due to the rounding and divisor used:

Table 30 - Education Sensitivity Test - Modelled Demands

Matrix Level	Original	Revised	Diff
1 (Background)	35102	34920	-181
2 (HGV)	1330	1330	
3 (Education)	8114	8114	
4 (Com Dev)	1128	1128	
5 (Growth)	0	0	
6 (Allocated Demand)	4987	4661	-327
7 (New Education)	0	1016	
Total	50660	51168	508

7.3 2028 Revised Allocation + Education Provision: Results Analysis

Once the Education scenario had been successfully derived, the second stage of the assessment focussed on the likely impact of education trips on the model network, specifically this stage of the assessment is concerned with the potential impact of locating a number of schools within the area to the Southwest of Warwick, around the Europa Way Corridor, that has been outlined for development allocation.

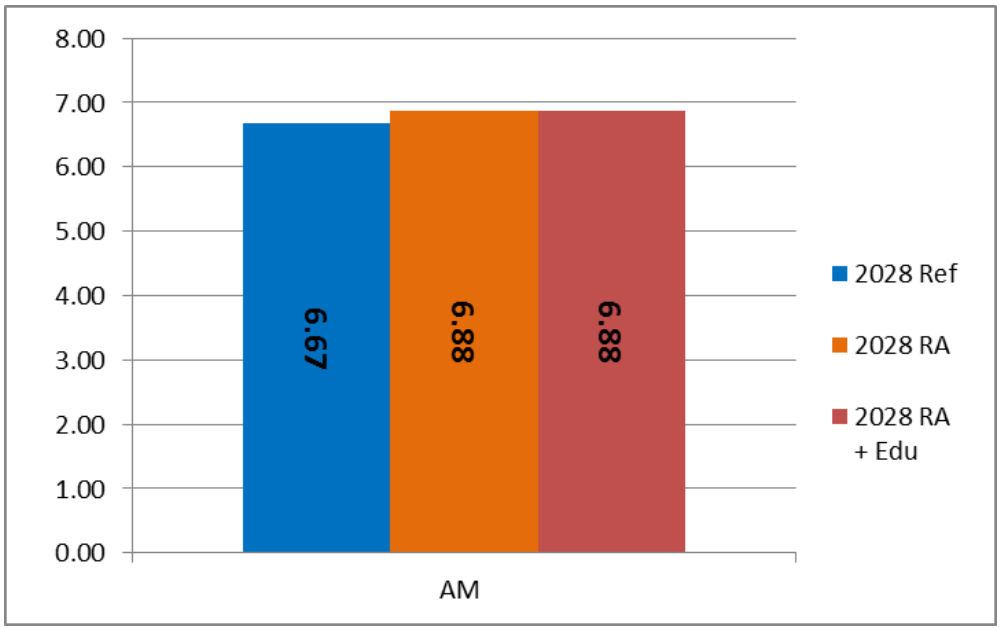
7.4 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 Reference Case and the Revised Allocation scenario.

7.4.1 Average Journey Distance

Analysis of the average journey distance within the original Reference and Revised Allocation scenario has been presented, alongside the RA + Education sensitivity test outputs, within the following **Figure 15**:

Figure 15 - Average Journey Distance (2028 Ref vs. 2028 RA vs. 2028 RA + Education), Km

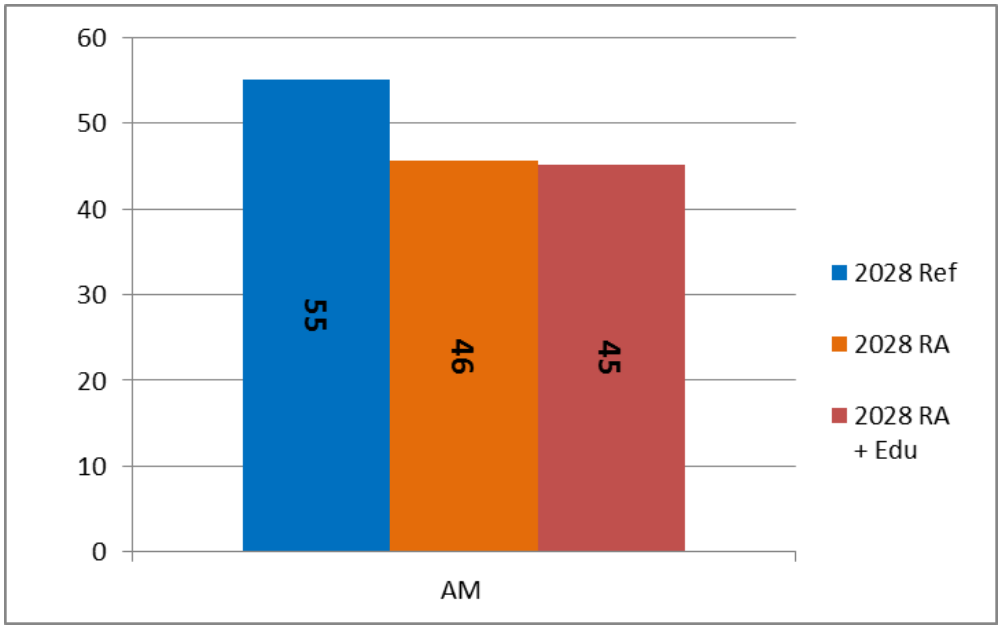


Analysis of the previous Figure indicates that there is no change in the average journey distance between the 2028 Revised Allocation scenario and the 2028 RA + Education. This is to be expected as although new shorter trips have been included between adjacent zones and schools, the trips then travel onwards to the ultimate destination. Additionally, the number of extra trips occurring as a result of the inclusion of the schools within the model, as a proportion of the overall demand levels, is low and as a result, unlikely to influence the overall results.

7.4.2 Average Journey Speed

Analysis of the average journey speed (km/h) within the original Reference and Revised Allocation scenario has been presented, alongside the RA + Education sensitivity test outputs, within **Figure 16** on the following page.

Figure 16 - Average Journey Speed (2028 Ref vs. 2028 RA vs. 2028 RA + Education), Km/H



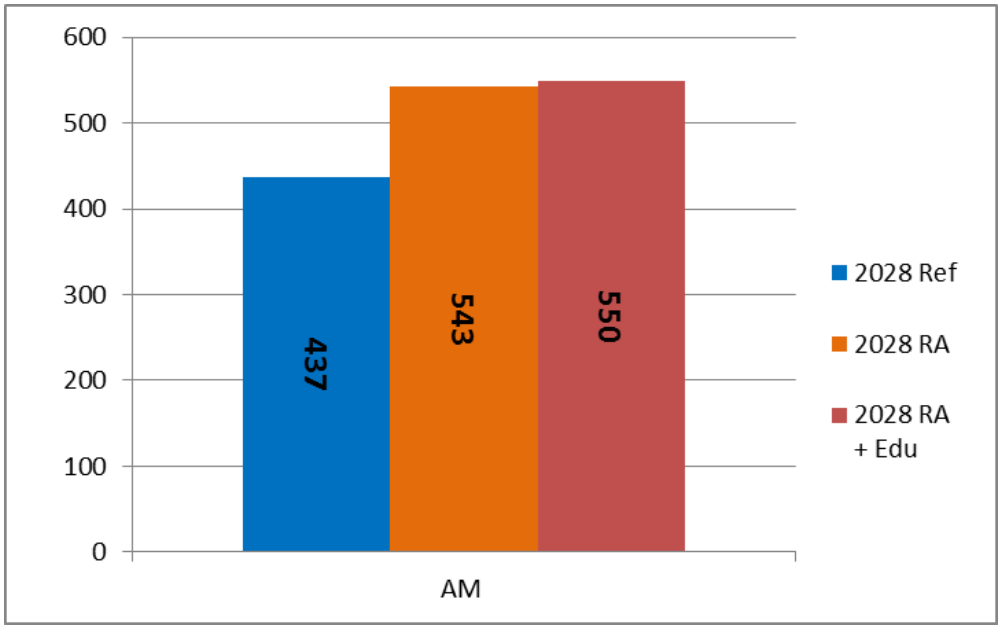
Analysis of the previous Figure indicates that there is a small difference in the average speeds vehicles travel through the 2028 Revised Allocation and the 2028 RA + Education scenario since, within the 2028 RA + Education scenario, speeds are marginally lower.

7.4.3 Average Journey Time (Seconds)

Analysis of the average journey time within the original Reference and Revised Allocation scenario has been presented, alongside the RA + Education sensitivity test outputs, within **Figure 17** on the following page.

Analysis of **Figure 17** indicates that there is a small increase in the average delay experienced by vehicles travelling through the 2028 RA + Education scenario when compared to the 2028 Revised Allocation scenario.

Figure 17 - Average Journey Time (2028 Ref vs. 2028 RA vs. 2028 RA + Education), Seconds



7.5 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots produced for the 2028 RA + Education Scenario. The comments in the remainder of this section are based on observations of the predicted changes in peak hour mean speed across links within the model area during the AM (08:00 to 09:00) peak hour.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

7.5.1 2028 RA + Education Conditions (MS009 to MS010)

Analysis of the AM network conditions within the 2028 RA + Education scenario has focussed on the southern area and specifically the area around Europa Way as this is the area most likely to be affected by the inclusion of the schools. In general the results do not appear to differ from those observed within the 2028 Revised Allocation scenario. The only exception to this is a drop in speeds along Harbury Lane Westbound. However, since the speeds only appear to drop a single band this difference could be overstated and since it occurs only in one area it is unlikely to be considered significant. Furthermore, no additional optimisation of the Europa Way roundabout scheme has been undertaken between the 2028 Revised Allocation and the 2028 RA + Education scenario it is likely that the scheme could be amended to overcome this issue.

Overall the inclusion of the schools has not substantially altered the mean speeds achieved on the links to the south when compared to the 2028 Revised Allocation scenario in which the schools are not present.

7.6 Maximum Queue Length Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 RA + Education scenario.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

7.6.1 AM Analysis (MQ003)

A comparison between the differences in queuing levels within the 2028 Reference and the 2028 Revised Allocation scenario has been compared to the difference in queuing levels between the 2028 Reference and the 2028 RA + Education scenario. The results indicate that there is no change in the results reported at all of the key locations surrounding the school, of most significance is the fact that the scheme at Europa Way roundabout still demonstrates a reduction in queuing despite the presence of the schools nearby.

Impacts at Grey's Mallory and Tachbrook Rd/Queensway have disappears whilst impacts at Longbridge appear to have worsened. Since the shift in impact is only by a single classification this could indicate that the current scheme performance is on the border between the two categories rather than be directly attributable to the specific test scenario.

In general it is apparent that the inclusion of the schools does not significantly change the network queuing levels when compared against the 2028 Revised Allocation scenario (i.e. when the schools are not included).

7.7 Journey Time Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 RA + Education scenario.

The maps which are referred to within the following analysis are presented within **Appendix G** of this report.

7.7.1 AM Analysis (MD003)

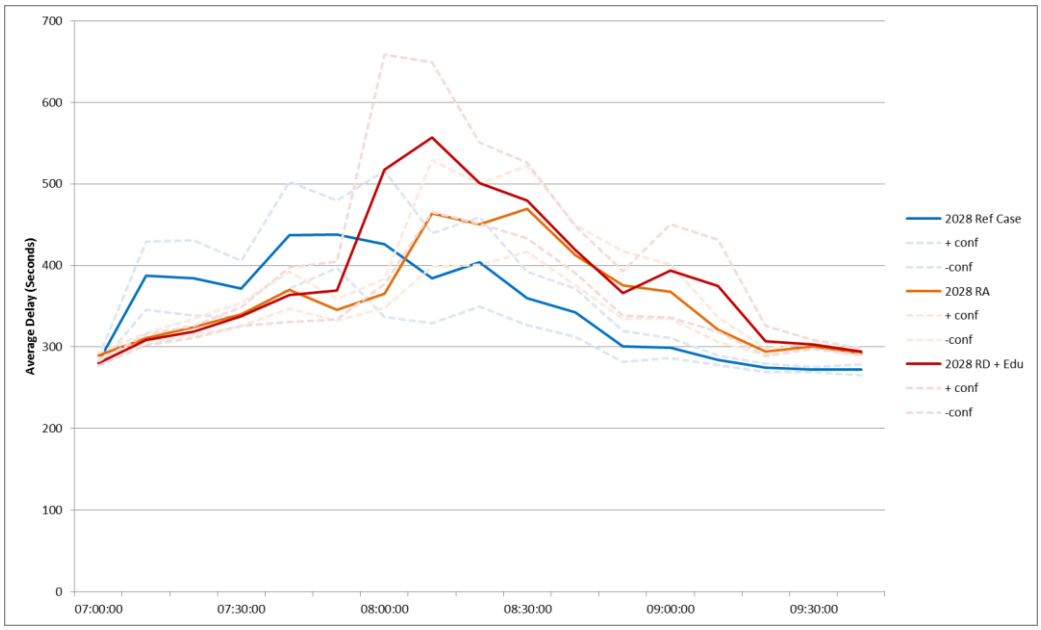
Analysis of the difference in queuing between the 2028 Reference and 2028 RA + Education scenarios, during the AM period, reveals that the results do not change substantially from those produced during the comparison between the 2028 Reference Case and the 2028 Revised Allocation scenario. The only notable difference is that when the schools are added the levels of delay experienced along the Banbury Rd NB and Warwick Bypass NB approaches to greys Mallory appear to have increased by a larger magnitude.

Initially, this appears to contradict the queuing analysis which indicates that queuing levels have dropped at this junction when compared to the original 2028 Revised Allocation assessment but this is likely to be indicative of a situation where the magnitude of the queue has reduced but it is present for a longer period, thus the maximum queue level reduces but correspondingly delay increases. Such a situation could occur due to the change in travel patterns within the area as a result of the inclusion of the schools. For example, the arrival pattern of trips through this area may influence the results as school trips are more likely to be

released onto the network at the busiest time within the hour, especially when considering that school based trips contribute substantially to the congestion levels within the peak hour in the first place.

Detailed analysis of the impact on delay between the 2028 Reference Case, 2028 Revised Allocation and the 2028 RA + Education scenario has been undertaken to assess the overall difference between the scenarios. The 10 average journey time, within each ten minute interval has been collected for all three scenarios and is presented, alongside the confidence intervals, within the following **Figure 18**:

Figure 18 - Average Journey Time, Route 5 Sec 1 NB, A452 Warwick Bypass (Banbury Spur), Seconds (2028 Ref vs. 2028 RA vs. 2028 RA + Edu)



Analysis of the previous figure reveals a clear divergence in levels of delay experienced, between the 2028 Revised Allocation and 2028 RA + Education scenarios, this occurs between 08:00 and 08:30 and may indicate a need for further optimisation of the proposals in this area when considering the impact of including the schools.

7.8 Summary

Analysis of a series of measures has been undertaken to assess the impact of including four schools south of Leamington, within the Revised Allocation sites.

Analysis of the network wide measures reveals that the network performance reduces slightly when the schools are included within the modelling. Whilst the average distance vehicles travel remains unchanged between the 2028 Revised Allocation and the 2028 RA + Education scenario the average speed vehicles travel at does drop marginally whilst the average delay increases. The margin of difference is, however, so low that the differences could at least be partly attributable to the inherent variability between runs.

Mean speed analysis reveals that the inclusion of the schools has not substantially altered the mean speeds achieved on the links to the south of Warwick and

Leamington when compared to the 2028 Revised Allocation scenario in which the schools are not present.

Similarly queuing analysis does not reveal any substantial differences in the performance of the 2028 Revised Allocation Scenario and the 2028 RA + Education scenario.

Analysis of the impact on the journey time routes within the model appears to indicate that when compared to both the 2028 Reference Case and the 2028 Revised Allocation scenarios delay on the A452 Warwick by-pass and Banbury Road approaches to Grey's Mallory roundabout increase. Detailed analysis reveals that this spike occurs within the 08:00 to 08:30 hour which is consistent with the assignment of the inbound school trips. The results do not indicate that a step change in what has been proposed at the junction is likely to be required but they do indicate that further optimisation of the schemes in this area are likely to be required in order that the schools can be successfully accommodated.

7.9 Conclusion

Based on the results analysed within the previous section of this report it is reasonable to conclude that the inclusion of the schools in the areas outlined within **Figure 14** will not result in the need to alter, substantially, the schemes that have been proposed to accompany the Revised Allocation strategy. The results do, however, highlight a need for further optimisation to be undertaken, most likely as detailed designs for mitigation in this area are progressed. It should also be remembered that the school trips that have been assigned within the aforementioned sensitivity test are based on the most robust assumptions regarding the trip generation and assignment parameters and any reduction in these parameters could potentially reduce any perceived gap between the scheme performances both with and without the schools in place. Finally, once the access strategy has been determined the junction configurations and pedestrian facilities that may also be required are likely to influence the overall level of impact incurred due to the presence of the schools.

8 Mitigation Sensitivity Testing

8.1 Overview

Mitigation proposals have been derived based on the modelling outputs and a review of the network operation. Whilst the mitigation schemes that have been reviewed and are believed to be, at least in principle, deliverable, there are some mitigation schemes that have been proposed t may be more difficult to deliver due to physical and environmental constraints.

This situation has occurred in more than one location throughout the course of the strategic transport assessments and wherever possible the mitigation schemes have either been tailored back or removed entirely.

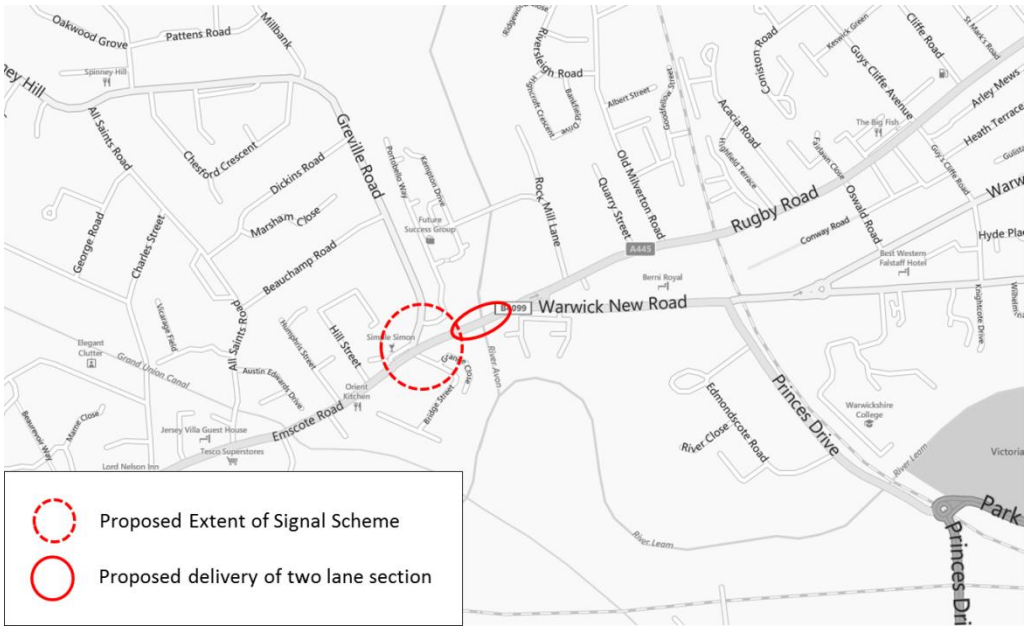
However, in a limited number of instances it has been acknowledged that the mitigation proposed may not be desirable, at least in the current state, but further testing is required to determine the impact of the removal of these mitigation measures. Two schemes were of particular concern, namely;

- The Bridge enhancements at Portobello Bridge due to existing network constraints and the current status of the existing structure
- The Warwick Town Centre improvements due to the constraints on the network within that area and the desire to discourage rather than encourage traffic movements around the town centre.

8.1.1 Portobello Bridge (2028 RA + Bridge)

The original scheme testing within the 2028 Revised Allocation scenario assumes the delivery of an additional lane in each direction, along Emscote Road, between Greville Road and Warwick New Road. The purpose of this capacity enhancement is to compliment the proposals at Emscote Road Greville road in so far as it provides a substantial increase in the stacking capacity for vehicles wishing to turn Right from Emscote Road SB to Greville Road northbound. It also provides an opportunity to deliver two lanes travelling northbound from just south of the Emscote Road junction with Greville road up to the Warwick New Road/Rugby Road junction. An overview of the extent of the proposals is provided within **Figure 19** on the following page and a more detailed sketch of the proposals, extracted from the modelling is presented within **Appendix C** (Drawing - 2013-03-13 13-47-43)

Figure 19 - Portobello Bridge Scheme Extent



The purpose of the Portobello Bridge sensitivity test, therefore, is to understand the implications, both network-wide and locally, of not delivering the capacity enhancements to the north of the Emscote Road / Greville Road junction.

8.1.2 Warwick town Centre Improvements (2028 RA + WTCI)

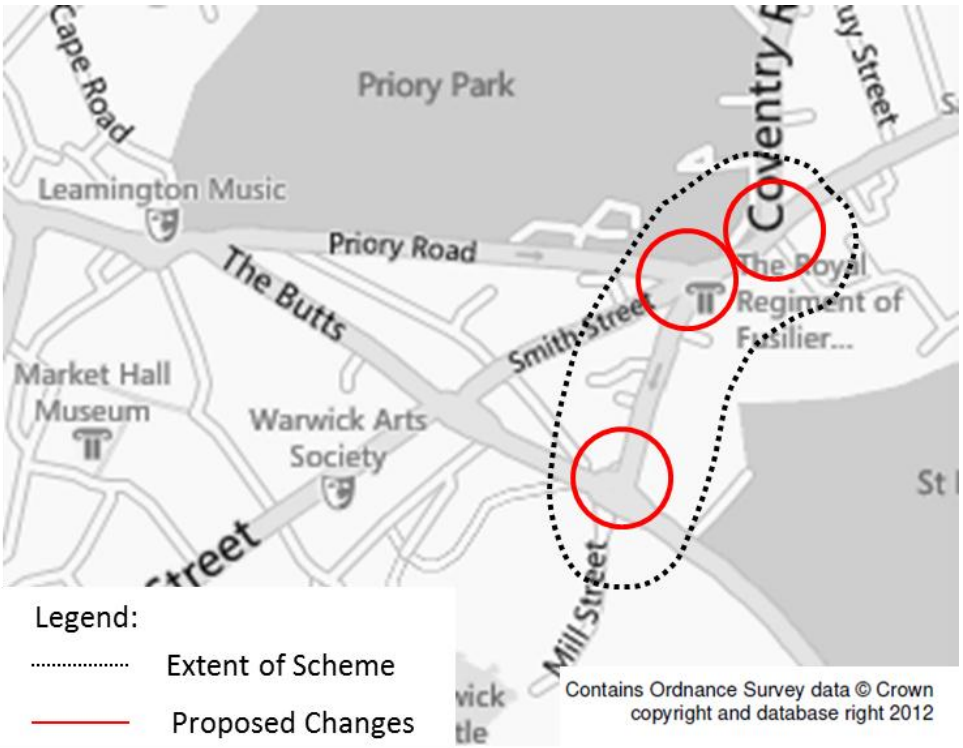
The original scheme testing within the 2028 Revised Allocation scenario assumes the delivery of a number of capacity enhancements in and around Warwick Town centre. The focus of these enhancements is to better facilitate movements through the town. It should be acknowledged that the schemes proposed within the modelling, at this stage, have not been tested to a sufficient level of detail to determine that they are the optimum solution, rather it is intended that the principle of what has been proposed should be implemented, in some for, alongside the proposed allocation strategy.

An obvious concern surrounding the implementation of this strategy is that this will result in an increase in the overall levels of traffic travelling through the town centre.

The extent of the schemes that have been considered as being contained within the extent of what is considered as the 'Warwick Town Centre Improvements' is outlined within **Figure 20** on the following page and comprises the following:

- Signalisation of the St Nicholas Church Street and Castle Hill gyratory (and possible reconfiguration thereof).
- Signalisation of Priory Road/Smith Street junction.
- Banning the right turn from Smith Street to St Nicholas Church Street
- Optimisation and synchronisation of the Coton End Coventry Road junction with the two new signalised junctions

Figure 20 - Warwick Town Centre Improvements: Scheme Extent



The primary function of these proposed works is to maintain the flow of traffic southbound from the A429 Coventry road, down St Nicholas Church Street and southwards along the Banbury Road. In reality these are movements which skirt the edge of the town centre rather than encroaching directly upon the town centre itself. However, when the works are not in place the town centre suffers from large increases in delay and lower speeds as blocking back from the St Nicholas Church Street/Castle Hill gyratory can affect a number of adjacent junctions within the town. 2028 Revised Allocation Mitigation Sensitivity Testing: Results Analysis

Warwick town centre mitigation proposals were removed from the 2028 Revised Allocation model network and the scenarios were then rerun. The results have been analysed within the following section of this report. Network wide statistics have been analysed for both options concurrently whilst the more detailed analysis has been undertaken on a scenario by scenario basis.

8.2 Model Stability

An initial assessment of the level of model stability was undertaken by comparing the number of completed runs against the number of runs assumed to have failed, as outlined earlier within **Section 5.2** of this report. The apparent network stability exhibited within the AM and PM simulation runs across the two scenarios is illustrated within the following **Table 31**:

Table 31 - Model Stability Assessment 2028 Reference vs. 2028 Revised Allocation

	Reference Case	2028 RA	2028 RA Bridge	2028 RA WTCI
AM	85%	90%	80%	10%
PM	75%	70%	75%	50%

Given the relatively limited sample size of 20 runs it is reasonable to conclude, from the previous table, that there are no significant concerns regarding the stability of the 2028 RA Bridge Scenario. However, when considering the performance of the 2028 RA scenario in which the town centre improvements have been removed, the performance of both model networks drops substantially. Within the AM the model stability drops to a 10% success rate which as an initial indicator, reveals that there are substantial issues likely to be experienced if the allocation scenario is progressed without some sort of town centre improvements being implemented alongside the allocation strategy. A drop to 50% in the PM also provides a good indication that potential issues may exist within the network.

In order to ensure the correct number of runs were available for use in the analysis of the Warwick town centre improvements the limit on the acceptable number of vehicles left on the network at the end of the simulation period was raised to 14000 vehicles.

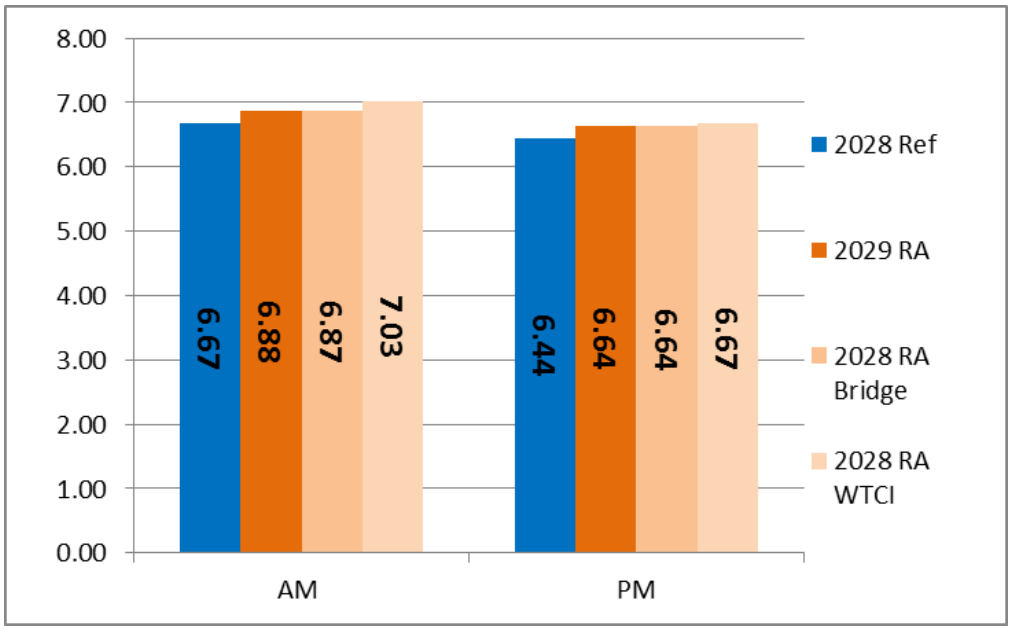
8.3 Network Wide Statistics

The following sets out the changes in network wide statistics between the 2028 Reference Case and the Revised Allocation scenarios including the Portobello Bridge and Warwick town centre sensitivity tests..

8.3.1 Average Journey Distance

Analysis of the average journey distance within the original Reference and Revised Allocation scenario has been presented, alongside the 2028 RA - Bridge and 2028 RA - WTCI sensitivity test outputs, within the following **Figure 21:**

Figure 21 - Average Journey Distance (2028 Ref vs. 2028 RA vs. 2028 RA Bridge vs. 2028 RA WTCI), Km



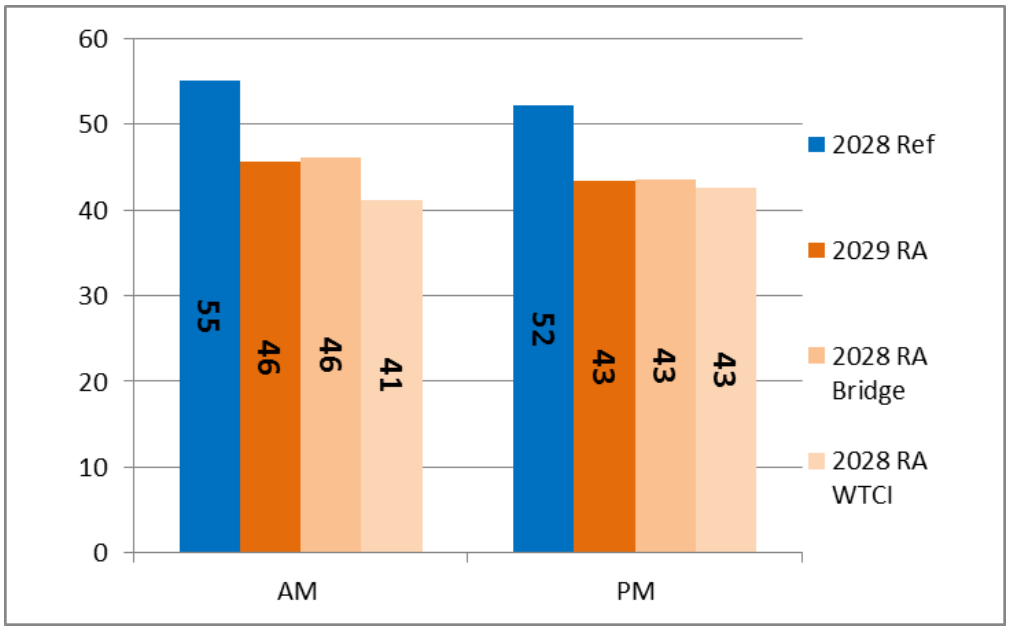
Analysis of the previous figure indicates that there is no notable change in the average journey distance travelled within both the Revised Allocation and the RA Bridge scenario. Considering the impact of the Town Centre improvements,

however, there is a clear increase in the distance travelled during the AM period. This could be indicative of vehicles incurring longer distance trips in order to avoid congestion on the primary route. Furthermore, if the town centre conditions are less favourable vehicles may choose to reassign to alternative routes which 'skirt around' the edge of the town centre rather than travelling through. The availability of such routes around the edge of Warwick town centre is, however, limited and so the likelihood is that the increase comes from more severe reassignment. Within the PM analysis there is a small increase in the average journey distance between the 2028 Revised Allocation scenario and the 2028 RA WTCI scenario. The magnitude of this difference however is not substantial and could be influenced, at least partly by the overall levels of model stability.

8.3.2 Average Journey Speed

Analysis of the average journey speed (km/h) within the original Reference and Revised Allocation scenario has been presented, alongside the RA Bridge and 2028 RA WTCI sensitivity test outputs, within the following **Figure 22:**

Figure 22 - Average Journey Speed (2028 Ref vs. 2028 RA vs. 2028 RA Bridge vs. 2028 RA WTCI), Km/H

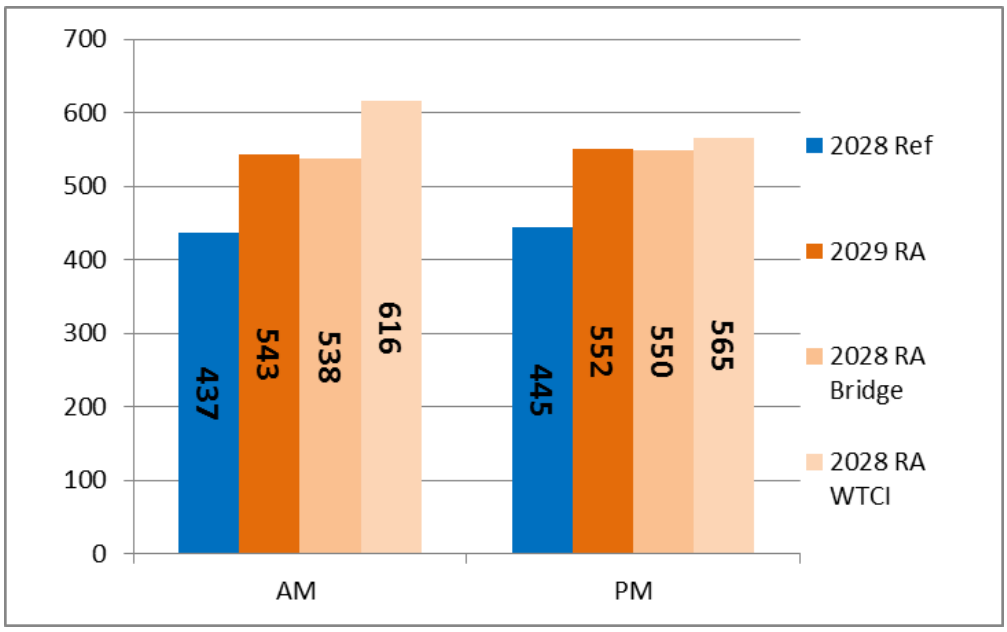


Analysis of Figure 22 indicates that there is no notable difference in the average speeds that vehicles travel upon all three scenario networks when considering the PM network performance. However, when considering the AM speeds in the "Without Town Centre Improvements" there is a clear drop in the average speeds that vehicles when compared to the alternative Revised Allocation test scenarios.

8.3.3 Average Journey Time (Seconds)

Analysis of the average journey time within the original Reference and Revised Allocation scenario has been presented, alongside the RA Bridge and 2028 RA WTCI sensitivity test outputs, within **Figure 23** on the following page.

Figure 23 - Average Journey Time (2028 Ref vs. 2028 RA vs. 2028 RA Bridge vs. 2028 RA WTCI), Seconds



Analysis of Figure 23 indicates that there is little difference in the level of delay experienced by vehicles travelling through either the Revised Allocation or the RA Bridge scenario networks. However delay levels appear to increase in the 2028 RA WTCI scenario. The largest increase is in the PM where delay increases by almost 15%. It should be remembered that this is the average for every vehicle on the network and since some trips should be unaffected by the removal of the Town centre mitigation this could indicate that some very severe increases in the overall levels of delay could be occurring.

8.4 Completed Trips

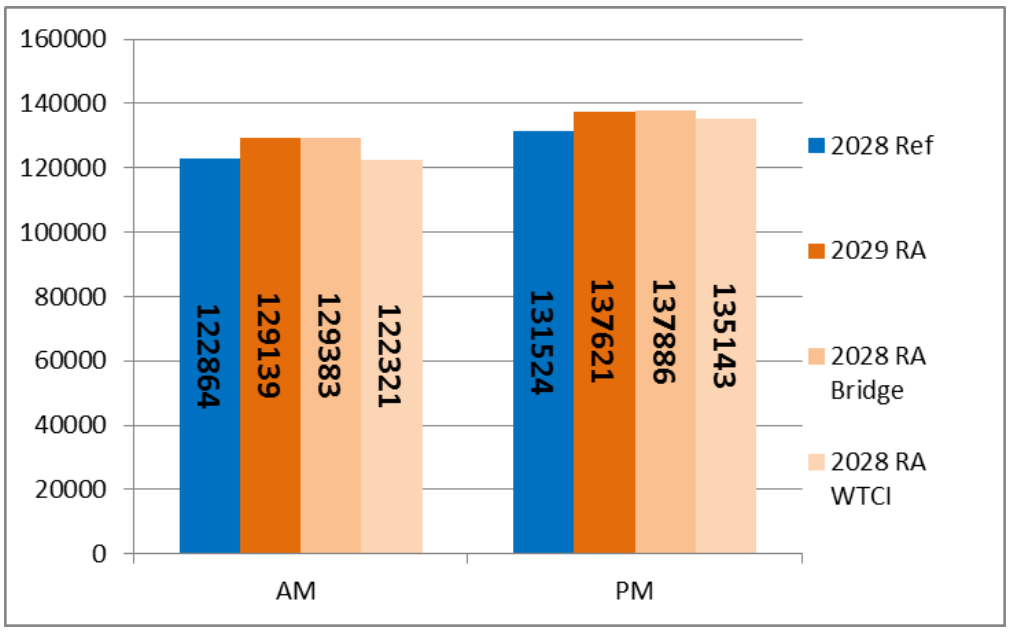
Analysis of the total number of completed trips within each scenario, across the entire AM and PM model periods, is presented within the **Figure 24** on the following page.

Analysis **Figure 24** indicates that there is an increase in completed trips of around 5%, in both the AM and PM periods respectively in both the Revised Allocation and the RA + Bridge scenario, when compared to the 2028 Reference Case.

However, when considering the 2028 RA + WTCI scenario results the number of completed trips drops by 2% in the PM period and the number of completed trips occurring within the AM period actually reduces when compared to the 2028 Reference Case.

The level of demand assigned within the Revised Allocation option is around 5.6% higher in the AM and 6.7% higher in the PM. These results appear to indicate that, overall, the removal of the additional capacity afforded by the additional two lanes across the bridge does not affect the ability of the road network to accommodate the additional demand assigned to the network as a result of the revised allocation strategy.

Figure 24 - Completed Trips (2028 Ref vs. 2028 RA vs. 2028 RA Bridge vs. 2028 RA WTCI), Vehicles



The removal of the town centre mitigation measures does, however, result in a substantial drop in the number of trips that are completed within the 2028 RA - WTCI scenario. Only 2% more trips are completed within the PM period than within the 2028 Reference Case whilst the drop that is experienced within the AM period is indicative of a severe impact on overall network performance. The removal of the WTCI measures alone not only results in the network being unable to accommodate the additional demand assigned to the model network but results in a drop in the level of trips completed compared to the 2028 Reference Case. Thus less trips are completed despite more demand, and an accompanying mitigation strategy, being included.

8.5 Detailed Results Analysis: 2028 RA - Bridge

The following sets out the detailed analysis of the impact of removing the additional capacity enhancements located around Portobello Bridge, on the surrounding highway network.

8.6 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots produced for the 2028 RA - Bridge Scenario. The comments in the remainder of this section are based on observations of the predicted changes in peak hour mean speed across links within the model area during the AM (08:00 to 09:00) and PM (16:00 to 17:00) peak hours.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

8.6.1 2028 RA - Bridge Conditions (MS011 to MS014)

Analysis of the AM network conditions within the 2028 RA - Bridge scenario has focussed primarily on the area surrounding Portobello Bridge. The focus of this analysis has largely been to identify areas where the mean speeds change in comparison to those extracted from the 2028 Revised Allocation scenario runs and, specifically those presented within the southern plots. This is because the purpose of this assessment is to begin to identify any potential impacts that may be incurred as a result of not delivering the additional Portobello Bridge capacity enhancements.

Analysis of the changes in the AM mean speeds between the 2028 Revised Allocation and the 2028 RA - Bridge scenario reveals very few notable changes, in mean speed, when the bridge is removed. Within the PM the situation is largely similar between the two scenarios. There are, however, a small number of instances where the mean speeds decrease further as a result of the removal of the bridges. Mean speeds within the 2028 RA - Bridge scenario appear lower than those within the 2028 Revised Allocation scenario along Princes Drive in both directions. This could indicate that it is this route that is likely to come under more pressure if the capacity enhancements are not delivered.

8.6.2 Mean Speed Summary

Having reviewed the changes in the mean speeds on links within the model network, between the 2028 Revised Allocation scenarios both with and without the additional bridge capacity enhancements, it appears that, within the AM model network, there are no obvious impacts incurred by the removal of the bridge. Furthermore, within the PM the additional impacts appear to be concentrated only in the Prince's Drive area between Warwick New Road to the North and Old Warwick Road to the south. At this stage the impacts appear limited.

8.7 Maximum Queue Length Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 Revised Allocation scenarios with and without the bridge improvements.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

The analysis has focussed on differences between the performance of the 2028 Revised Allocation Network and the 2028 RA - Bridge model network in and around the area of Portobello Bridge.

8.7.1 AM Analysis (MQ004)

Analysis of the difference in queuing conditions between the 2028 Reference Case and both the 2028 Revised Allocation and the 2028 RA - Bridge scenario reveals that, during the AM period, there are no notable changes in conditions on any of the junctions along Emscote Road, nor do the junctions along the parallel Myton Road or adjacent Princes Drive appear to be substantially affected by the removal of the capacity enhancements.

8.7.2 PM Analysis (MQ005)

Analysis of the difference in queuing conditions between the 2028 Reference Case and both the 2028 Revised Allocation and the 2028 RA - Bridge scenario reveals that,, during the PM period, the following impacts appear to occur:

- The propensity for large queue formation to the north of the Emscote Rd, Greville Road junction appears to actually reduce when the bridge is removed.
- Previously, within the 2028 Revised Allocation scenario, queue reductions had been achieved to the south of Warwick as well as at the Shires Retail park roundabout, these reductions do not occur when the capacity enhancements are removed.
- Furthermore, at the strategic level, comparing the two Revised Allocation scenarios reveals that the removal of the bridge results in a worsening of conditions at Longbridge but an improvement at Thickthorn.
- In general, conditions appear marginally worse to the North of Emscote road when the bridge is in place compared to when it is removed and, comparatively, conditions appear marginally worse in the south when the bridge is removed compared to when it is retained.

8.7.3 Queue Analysis Summary

In line with the mean speed analysis, a review of the changes in queuing levels between the Revised Allocation scenarios with and without the bridge improvements does not reveal any significant impacts as being incurred should the capacity enhancements not be delivered.

Within the PM however, the removal of the bridge, when compared to the network performance inclusive of the bridge, results in a marginal improvement in network performance to the north of Emscote Road and a marginal reduction in network performance to the south of Emscote Road. Whilst detailed analysis is necessary to determine the true level of significance contained within these results, these differences could indicate that including the bridge is likely to make Leamington, and more specifically Warwick towns, more accessible from the North. Removing the bridge could be encouraging more trips to stay on the A46 for longer which, in turn results in a minor worsening of conditions to the south compared to those which are incurred when the bridge is included. Whilst more detailed analysis would be required to determine the overall significance of the impacts incurred as a result of not delivering the capacity enhancements, this could indicate that the reduced capacity acts as a minor deterrent to trips travelling through the towns, within the PM, encouraging more vehicles to remain on the Strategic Road network for longer which, in turn, may be a more desirable outcome.

8.8 Journey Time Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 Revised Allocation scenarios with and without the bridge improvements.

The maps which are referred to within the following analysis are presented within **Appendix G** of this report.

8.8.1 AM Analysis (MD005)

Analysis of the difference in journey times between the Reference Case and the 2028 Revised Allocation scenarios both with and without the bridge enhancements reveals only four obvious impacts on the routes within the model, incurred as a result of the removal of the bridge, namely:

- Delay levels on Emscote Road to the North of the junction with Greville Road reduce when the bridge is removed.
- Similarly delay on the Warwick Bypass (Banbury Spur) NB approach to the Greys Mallory Junction also increase when the bridge is removed;
- Delay on the Stratford Rd NB approach into Warwick town reduces when the bridge is removed.
- Similarly, delay on the Coventry Rd SB approach into Warwick reduces when the bridge enhancements are removed.

8.8.2 PM Analysis (MD006)

Analysis of the difference in journey times between the Reference Case and the 2028 Revised Allocation scenarios both with and without the bridge enhancements reveals only two obvious impacts on the routes within the model, incurred as a result of the removal of the bridge capacity enhancements, namely; delay on the section of Tachbrook Rd between Harbury Lane and Queensway reduces when the bridge is removed whilst delay on the on the Warwick Bypass (Banbury Spur) NB approach to the Greys Mallory Junction also increase when the bridge is removed.

8.8.3 Delay Analysis Summary

In general, the changes in the level of delay experienced on key routes through the model network, both with and without the bridge capacity enhancements tends to reveal that in the AM conditions are likely to reduce on the Coventry Road and Stratford Rd approaches to Warwick town but increase on the Banbury Spur approach into Warwick and Leamington. Similarly the delay on Emscote road just to the north of the area of the proposed improvements also appears to increase when they are removed. Within the PM the affects appear even less pronounced with the only apparent increase in delay, incurred as a result of the removal of the bridge being incurred along the Warwick By-pass (Banbury Spur) NB approach to the Greys Mallory Junction.

8.9 Detailed Delay Analysis

The queuing and delay outputs presented at the strategic level do not appear to indicate a substantial benefit of delivering the capacity enhancements, as a result, more detailed analysis of the impacts on the local area was undertaken in order to ascertain what the likely changes in conditions along the Emscote Road corridor are likely to be both with and without the proposed improvements. Specifically, the analysis has focussed on the differences in the level of delay experienced

along the Emscote Road Route 2, section 2. A map of this route and all of the sections that it has been divided into is provided within **Appendix D** (Mean Delay Route 2).

8.9.1 Route 2 Section 2 Analysis

Route 2 Section 2 lies to the north of the proposed area which was outlined for the capacity enhancements. Previous analysis has indicated that, within the AM at least, levels of delay on this section of the route, for vehicles travelling northbound, are likely to increase. Similarly, the assumption is that the removal of the additional capacity enhancements will result in a reduction in the stacking capacity for vehicles wishing to turn right onto Greville road at the newly proposed signalised junction. In turn, this could potentially increase the levels of delay experienced within this area. Whilst these hourly differences may not be sufficient to signal a substantial change within the strategic level analysis detailed analysis of the pattern of delay across the entire period is more likely to determine if there are any significant changes within certain time periods contained within the peak period as well as the potential severity of any such changes. Aggregating data across the entire period does not take account of these inter period differences because of the strategic nature of the analysis.

Within the AM, analysis of Route 2 Section 2 SB reveals no discernible difference between the two revised allocation options (i.e. with and without the bridge enhancements). Analysis of Route 2 Section 2 NB, during the same period, reveals that the levels of delay are likely to increase when the bridge is removed and, more notable, the level of variation in the journey time that is experienced will increase significantly. It is interesting to note that the levels of delay experienced in both revised allocation scenarios are greatest towards the end of the peak hour and these larger journey times extend into the post-peak hour.

The highest point of divergence between the two revised allocation scenarios occurs at 09:10 when the journey times in the 2028 RA - Bridge scenario are 13% higher than the Revised Allocation scenario, over the 10 minute period, but 70% higher than the journey times within the 2028 Reference Case within the same ten minute period. This pattern is not reflected within the analysis of the Route 2 Sec 2 SB delay levels where the delay is at its highest around 08:40 and the magnitude of difference between the two Revised Allocation scenarios is fairly consistent.

The analysis of the average 10 minute journey times across Route 2 Sec 2, during the AM, is presented for the Northbound and southbound directions within **Figure 25** and **Figure 26** respectively.

Figure 25 - Route 2 Section 2 SB, Average 10 Minute Journey Time, Seconds (2028 Ref vs. 2028 RA vs. 2028 RA + Bridge) (AM 07:00 to 10:00)

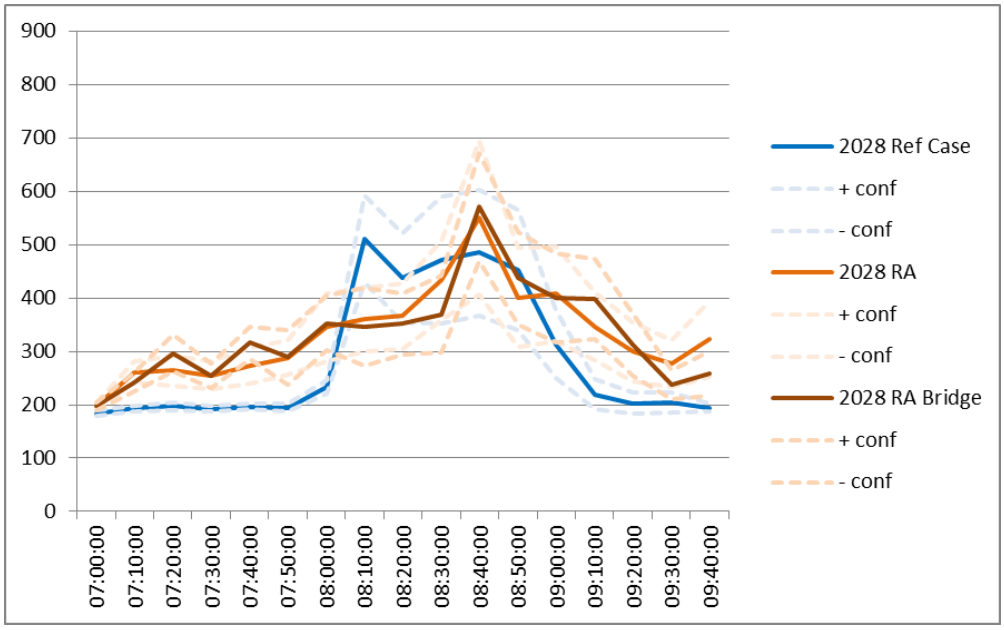
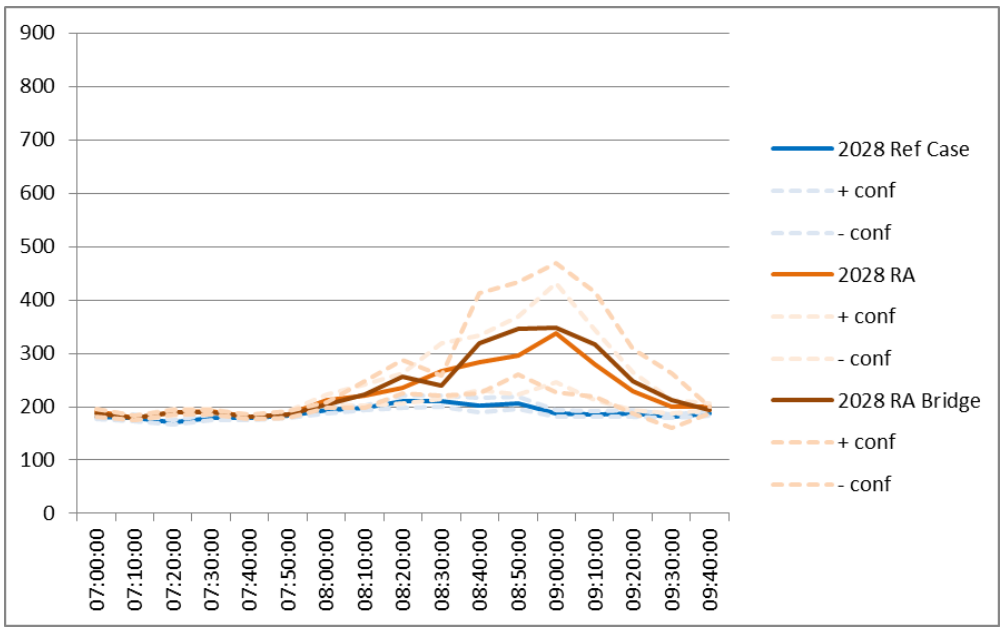


Figure 26 - Route 2 Section 2 SB, Average 10 Minute Journey Time, Seconds (2028 Ref vs. 2028 RA vs. 2028 RA + Bridge) (AM 07:00 to 10:00)



Analysis of the same routes during the PM period did not reveal a substantial difference in the level of delay experienced along the route when the bridge improvements were removed compared to the when they were included.

8.9.2 Detailed Delay Analysis – Summary

Analysis of the detailed differences in the levels of delay experienced on the section of Emscote road, upon which the capacity enhancements have been proposed does not reveal a significant difference in the performance of either the 2028 Revised Allocation network or the 2028 RA - Bridge network.

8.10 Detailed Results Analysis: 2028 RA + WTCI

The following sets out the detailed analysis of the impact of removing the additional Warwick Town Centre Improvements in the areas of Castle Hill, Smith Street and St Nicholas Church Street.

8.11 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots produced for the 2028 RA - WTCI Scenario for peak hour mean speed across links within the model area during the AM (08:00 to 09:00) and PM (16:00 to 17:00) peak hours.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

8.11.1 2028 RA - WTCI Conditions (MS015 to MS019)

Analysis of the AM network conditions within the 2028 RA - WTCI scenario has focussed primarily on the area surrounding Warwick town centre. The focus of this analysis has largely been to identify areas where the mean speeds change in comparison to those extracted from the 2028 Revised Allocation scenario runs and, specifically those presented within the southern plots. This is because the purpose of this assessment is to begin to identify any potential impacts that may be incurred as a result of not delivering the additional town centre schemes

Analysis of the Mean speeds experienced within the AM period of the 2028 RA – WTCI scenario reveals that there are a significant number of instances where mean speeds drop below 10 mph when compare to the 2028 Revised Allocation scenario. Mean speeds drop below 10mph on all approaches to the town centre. The number of instances within the town centre where speeds have dropped below 5 mph in the town centre have also increased substantially when compared to the 2028 Revised Allocation network performance.

When considering the network performance within the PM peak hour the impacts appear to be far less severe. The only obvious location where speeds appear to drop when compared to those experienced within the 2028 Revised Allocation is along the Banbury Rd NB leading to the Castle Hill gyratory. At this location there appears to be an increase in the number of links upon which the mean speed drops below 5 mph when compared to the 2028 Revised Allocation network performance.

8.11.2 Mean Speed Summary

Having reviewed the changes in the mean speeds on links within the model network, between the 2028 Revised Allocation scenarios both with and without the Warwick town centre improvements, it appears that, within the AM model network, there are significant impacts incurred when the town centre schemes have been removed. The impacts are experienced on all approaches into Warwick town centre as well as some of the links contained within the town centre as well. Within the PM the impacts largely appear to be experienced to the southeast of the town and, specifically along the Banbury Rd NB approach to the Castle Hill gyratory.

8.12 Maximum Queue Length Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case and 2028 RA - WTCI scenarios.

The maps which are referred to within the following analysis are presented within **Appendix F** of this report.

8.12.1 AM Analysis (MQ006)

Analysis of the difference in queuing conditions between the 2028 Reference Case and both the 2028 Revised Allocation and the 2028 RA – WTCI scenarios reveals that the number of instances where the increase in queue lengths is very severe has increased substantially. Previously no junction experienced increases that could be classified as very severe, however, once the town centre improvements have been removed there are 5 instances of very severe increases, most are on the periphery of the road network and are likely to be caused by the reassignment of traffic caused by congestion within Warwick town centre. Furthermore, previously mitigation measures had achieved reductions in queuing levels at a number of junctions including the Myton Road/Banbury Road roundabout and the Europa Way/Harbury Lane roundabout whereas now there are no reductions achieved in these and other areas and, in most cases severe increases in the queue lengths are now experienced.

8.12.2 PM Analysis (MQ007)

Analysis of the difference in queuing between the 2028 Reference Case and both the 2028 Revised Allocation and the 2028 RA – WTCI scenarios reveals that, during the PM, the removal of the town centre works does not result in an increase in the number of very severe increases in the level of queuing experienced at certain junctions within the model. However, the number of instances where the increase in queue lengths is severe has risen substantially. Furthermore, the number of instances where queue reductions have been achieved has also been reduced. The increases in queue lengths and, conversely, the reduction in occasions where queuing levels are improved, tend to be focussed around the approaches from the south. Three of the four key junctions along the Europa Way corridor (Grey's Mallory, Europa Way/Harbury Lane roundabout and Shires retail Park roundabout) all suffer a worsening in conditions when compared to the queue lengths experienced within the 2028 Revised Allocation Scenario.

8.12.3 Queue Analysis Summary

A summary of the findings obtained through comparing the changes in queuing between the 2028 Reference Case and the 2028 Revised Allocation/2028 RA - WTCI Scenarios is provided as follows:

- In both the AM and PM periods there is an overall, worsening of queuing experienced on the network when the town centre improvements are removed.
- The impacts within the PM period are far less severe than the AM with the increases in queuing from the 2028 Revised Allocation scenario tending to be focussed to the South East,

specifically along the Europa Way corridor and the Banbury Rd corridor into Warwick town.

- Within the AM the impacts of removing the town centre improvements appear both severe and widespread. In a number of locations the queue increases are categorised as very severe when the improvements are removed.
- Notably most of the very severe increases in queue lengths occurs at junctions on the periphery of the towns and thus, are likely to indicate impacts incurred as a result of rerouting in response to the congestion now experienced within Warwick town Centre.
- Furthermore, in some cases within the PM and almost all cases within the AM, where previously mitigation measures had achieved reductions in queuing levels there are now no reductions achieved in these and other areas and, in most cases severe increases in the queue lengths are experienced instead.

8.13 Journey Time Analysis

The following sets out some initial observations based on the differences in the levels of delay experienced on key routes within the scenario networks, between the 2028 Reference Case and 2028 Revised Allocation scenarios with and without the Warwick town centre improvements.

The maps which are referred to within the following analysis are presented within **Appendix G** of this report.

8.13.1 AM Analysis (MD007)

Analysis of the impacts on the level of delay, particularly experienced on routes through and approaching Warwick town centre, reveals that there are likely to be significant increases in the level of delay experienced in certain areas if the town centre improvements are not included. All of the routes into Warwick appear to suffer very severe increases in the level of delay experienced along the length of the route. The same is true for all but one of sections through Warwick town centre. Route 2 Section 2 SB appears to only suffer a moderate increase in journey times but this is likely to be due to the fact that this section performs poorly in the Reference Case network and so the potential for delay to increase substantially is limited.

In addition to the increases that are experienced in areas in close proximity to Warwick town centre there are notable increases in the level of delay experienced on some of the routes on the periphery of Warwick town, specifically increases in delay are experienced by vehicles travelling SB along the A46 to Longbridge Island as well as along the Warwick By-pass (Banbury Spur), Banbury Road and Europa Way corridors. This demonstrates that the proposed mitigation measures are likely to fulfil a role of strategic significance as well as local.

8.13.2 PM Analysis (MD008)

Analysis of the impact on the levels of delay experienced on key routes within the model network during the PM, both with and without the town centre

improvements, reveals that there are fewer differences in the levels of delay experienced when the town centre improvements are removed. The removal of the town centre improvements results in an increase in the levels of delay experienced along Warwick By-pass (Banbury Spur) and Europa Way NB to Shires Retail park which is likely to be indicative of this area of the network coming under additional pressure as a result of the scheme removal. Removing the town centre improvements appears to result in a reduction in the delay levels experienced on the Stratford Rd NB approach to Warwick town centre but this reduction corresponds with an increase in the levels of delay on the Smith street NB exit from Warwick town centre.

8.13.3 Delay Analysis Summary

In general, the changes in the level of delay experienced on key routes through the model network, increases substantially when the Town Centre Improvements have been removed. There are very severe increases in the level of delay experienced on every route into the town and almost every route through the town during the AM period. Furthermore, strategically important routes on the periphery of Warwick are also affected, most likely as a result of traffic reassigning away from the town centre in response to the congestion levels. Whilst in the PM the impacts appear less severe, only the approach into Warwick and Leamington from the south appears to suffer a substantial change with delay increasing on both the Warwick By-pass (Banbury Spur) Eastbound and Europa Way Northbound route into the towns from the M40.

8.14 Summary

Mitigation sensitivity tests have been undertaken to understand the impacts of removing the following schemes;

- The Bridge enhancements at Portobello Bridge due to existing network constraints and the current status of the existing structure
- The Warwick Town Centre improvements due to the constraints on the network within that area and the desire to discourage rather than encourage traffic movements around the town centre.

The purpose of the testing is to understand the significance to the network operation as a whole, of the delivery of these schemes. Variations of the 2028 Revised Allocation scenario have been produced within which the aforementioned mitigation measures have been removed.

Analysis of the impacts of removing the additional bridge capacity enhancements has revealed that the impacts experienced as a result of the scheme removal are largely concentred within the immediate area of the scheme. Removing the scheme does not appear to result in significant additional impacts being experienced on the wider network but localised impacts on the Emscote Road are likely. It should also be acknowledged that there is a likelihood that the benefits of delivering the additional capacity may not be fully realised due to additional constraints downstream of the proposed improvements, e.g. Emscote Road/Warwick New Road junction to the Northeast and Coton End/Coventry Road junction to the Southwest.

Analysis of the impacts of the removal of the proposed town centre improvements reveals that the impacts are potentially both severe and widespread. Substantial changes in the network wide performance measures are notable when the schemes are removed, particularly during the AM and this is accompanied, within the AM period, by reductions in the means speeds that vehicles travel at in and around the Warwick town area, increases in the level of queuing experienced at a number of key junctions within the area and significant increases in the level of delay experienced by vehicles travelling on key routes within the area. The impacts experienced appear to be of both local and strategic significance since a large number of the very severe increases in queuing and delay are experienced at locations that would be considered as peripheral to the towns and, specifically, the proposed town centre works. Removal of the town centre proposals within the PM appears to result in fewer impacts when compared to the overall level of network performance achieved with the improvements in place. There are, however, a increases in the number of junctions which suffer severe increases in queue lengths, when compared to the 2028 Revised Allocation network performance. Furthermore, the level of delay experienced on the Warwick By-pass (Banbury Spur) and Europa Way route into Warwick and Leamington increases when the town centre improvements are removed.

8.15 Conclusion

When considering the impact that the delivery of the bridge capacity improvements have on the network, it is reasonable to conclude from the analysis presented within the previous section of this report that the benefits of implementing the capacity enhancements at Portobello Bridge are limited particularly when considering the likely costs of undertaking such work. It is likely that there are network constraints both downstream and upstream of the proposed area of enhancement that limits the potential draw that would be anticipated by the delivery of the additional capacity. Whilst at this stage delivery of the bridge improvements are still considered desirable, some of the queuing analysis appears to indicate that the delivery of the bridge may draw more traffic through the network from the north, travelling southwards. Without the additional capacity enhancements the northern sections of the network perform better which could indicate that the network conditions, without the capacity enhancements, act as a minor deterrent to through traffic which could, itself be a positive outcome.

When considering the impact of delivering the Warwick Town Centre improvements it is reasonable to conclude that delivery of the proposed schemes, or schemes which conform in principle to those proposed within the modelling, has both local and strategic level benefit, particularly when considering the AM network performance. Without the schemes in place it appears impossible to ensure an acceptable level of network operation can be delivered, particularly when considering the areas around Warwick town. Very severe increases in the level of delay experienced on routes into the town occurs when the schemes are removed. As well as localised impacts, strategic impacts, in the form of increased queuing and delay levels, are experienced in areas that could be considered as peripheral to the area that would be expected to be affected by the inclusion of the schemes (A46 SB towards Longbridge and Europa Way Corridor).

Delivery of the Portobello bridge enhancements should be considered as an aspiration whilst delivery of the Warwick town centre improvements should be considered as essential.

9 Park & Ride Outline Feasibility

9.1 Overview

In addition to the testing presented previously, a further objective of this study, was to understand the potential for delivery of a Park and Ride site to the south of Warwick town.

At this stage the level of assessment required is not particularly detailed, rather it is intended to identify whether or not there is potential for a service to be accommodated within the proposed network without substantial impacts to all non-P&R users.

Thus, a series of assumptions regarding the possible routes of the P&R services and the frequency thereof were applied within the modelling. These assumptions where accompanied by additional amendments to the existing, proposed, mitigation packages to better accommodate the park and ride services. Mitigation amendments focussed largely on the delivery of Vehicle Actuated signals linked specifically to the Park and Ride services and the delivery of bus lanes and bus gates.

At this stage the level of detail of the assessment has not been sufficient enough to include assumptions on the usage, interception or mode shift achieved by the Park and Ride as more certainty on the site would be required before those parameters could be successfully defined.

9.2 Park & Ride Assumptions

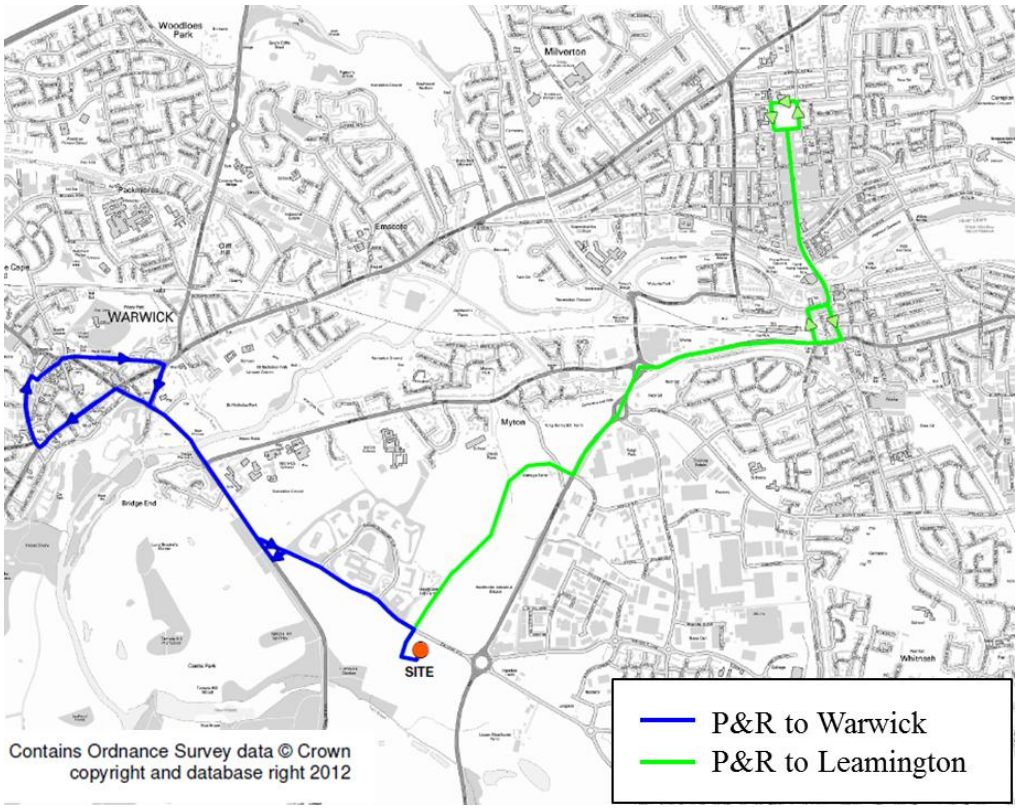
It has been assumed that the Park and Ride site will be located within the pocket of land to the southwest of the Europa Way roundabout and it will be served by a new link which adjoins onto a link through the proposed development site in this area running between Europa Way and Gallows Hill.

It has been assumed that two services would be served from the P&R site, one would run from the site northwards to Leamington Spa whilst one would run north-westwards towards Warwick town centre. Both the Warwick and Leamington services have been assumed to run on a loop which starts and ends at the P&R site. An overview of the routes and the location of the P&R site is provided within **Figure 27** on the following page.

The services have been assigned timetables based on the likely perceived usage of both services. The timetables assigned to each of the services control the release of the P&R services within the station at the start point the time it takes them to travel round the route and return to the P&R site is dependent upon the level of network congestion and delay experienced en-route.

- Services between the P&R and Leamington start at 07:00 and 16:00 within the AM and PM respectively and are released every 9 minutes. This achieves 20 departures for each model period.
- Services between the P&R and Warwick start at 07:00 and 16:00 and run every 12 minutes. This achieves 15 departures for each model period.

Figure 27 - Park & Ride Route Assumptions



9.3 Scheme Enhancements

In order that the P&R bus movements through the network can be better accommodated, a series of amendments have been made to the model network. These amendments have been included with a view to giving priority to the movements of the P&R services through the network.

An initial overview of the changes proposed to accommodate the services is provided as follows:

- Vehicle detection is used to ensure that priority green time is allocated to the stages serving the P&R site and to allow buses to exit onto the new link between Europa Way and Gallows Hill.
- A Bus Lane has been introduced to allow buses to travel northwards to the signalised junction that serves the new link road and Gallows Hill.
- A bus gate allocates green time to a bus only stage and, depending on the stage currently in operation, reduces the green time allocated to the preceding stages.

At this stage the services split and the following amendments serve the P&R to Leamington service:

- The P&R continues northwards along a new link proposed to be delivered through the allocated site to the West of Europa Way.

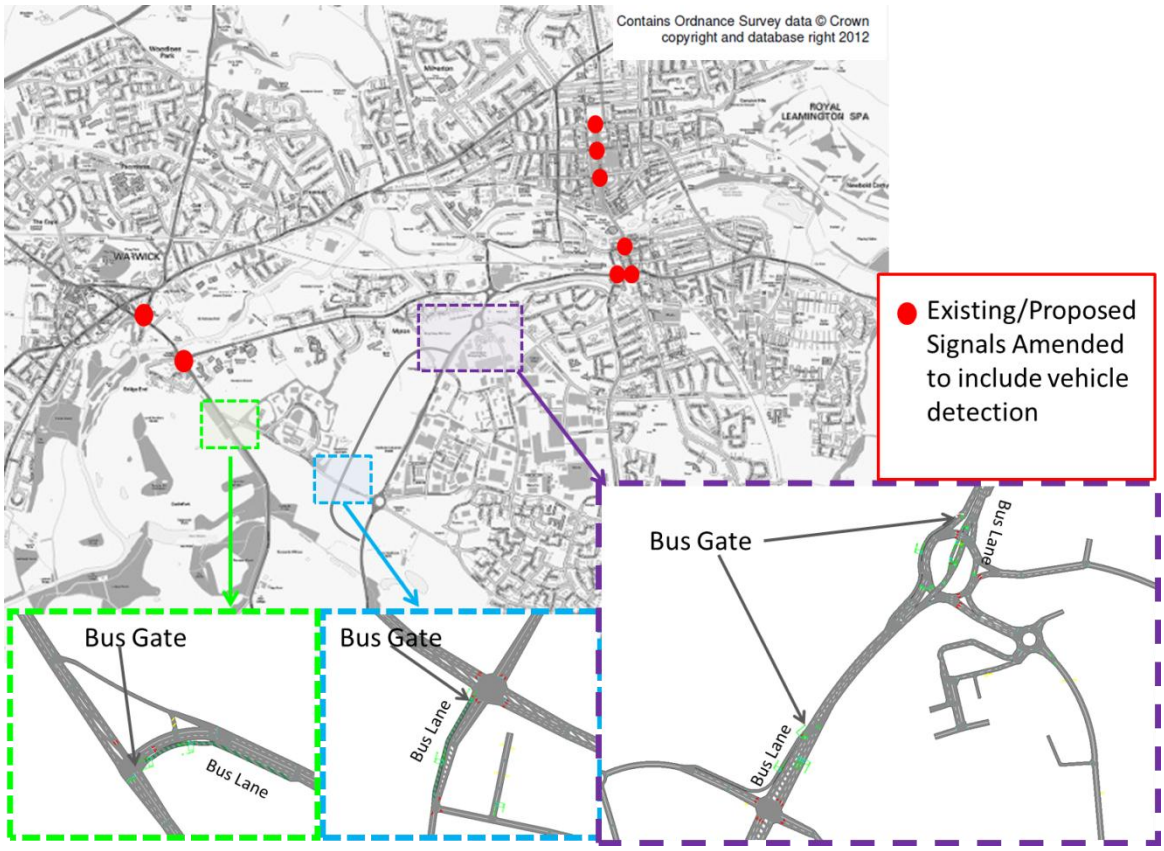
- The site to the East of Europa Way is also to be served by a new signalised access, a bus lane has been introduced to bypass this junction and then at a point along Europa Way NB, upstream from the new junction, a bus gate is introduced to allow buses to merge into the mainline traffic. In the opposite direction a detector loop has been included which allocates additional green time to the buses waiting to turn right, from Europa Way, onto the new link road.
- A bus lane begins again just south of the Shires Retail Park roundabout and enables the P&R service to largely bypass this junction and re-join the mainline, via a bus gate, just to the south of the Europa Way, Myton Road roundabout. In the opposite direction a bus lane has been added prior to the hamburger link that allocates green time to the buses a few seconds before other vehicles. This enables buses to enter the junction and merge onto the hamburger link via a bus gate prior to continuing southwards along Europa Way
- Vehicle Actuated signals utilise detector loops to extend the green time that favours the bus movements when a bus is detected prior to the proposed scheme located at the Old Warwick Road/Lower Ave, avenue Road, Bath Street gyratory. Signals have been located on three corners of the newly proposed gyratory scheme and these have all been allocated additional green time through vehicle detection.
- Detector loops have been used to reduce running stages and allocate additional green time to stages favouring the P&R movements, when a bus is detected from both North and Southern approaches, at the following junctions:
    - Regent's Place/Parade
    - Warwick St/Parade
    - Clarendon Ave/Parade

Similarly, the following additional enhancements have been included for P&R services travelling from the site to Warwick and back again:

- A Bus lane has been added to the Gallows Hill WB approach to the signalised junction with Banbury Road. A Bus only signal stage is then called to allow buses to exit Gallows Hill onto Banbury Rd NB ahead of the background traffic.
- Travelling northwards along Banbury Rd vehicle detector loops have been used to allocate additional green time to the stages serving the P&R routes whilst reducing the green time allocated to vehicles approaching from the minor arms. These loops allocated green time to the P&R services travelling form the North and the South.

A brief overview of these works is presented within **Figure 28** on the following page.

Figure 28 - P&R Proposed Network Interventions



9.4 Results Analysis

The following section of this report sets out the analysis of the impacts on the network of including the P&R facilities compared to the 2028 Reference Case and the 2028 Revised Allocation Scenario.

9.5 Feasibility Analysis

One of the primary concerns regarding the feasibility of the P&R option is whether the potential exists to deliver P&R services which offer comparable journey times to those that would be achieved by travelling in cars.

There are a number of fundamental issues concerning perceived route costs associated with switching between modes of transport and issues such as interchange penalties and walk times these have been considered at this stage. The purpose of the feasibility testing is to understand whether the principle of implementing a P&R is sound and what the potential is to deliver a service which can achieve journey times that are comparable to those which would be achieved by car.

The schemes that have been proposed to accompany the P&R service are based on a first sift of mitigation measures and no additional optimisation has been undertaken at this stage. This is partly due to time constraints in completing the full assessment and that this level of detail is in line with the level of assessment intended. Thus, the purpose is not to ensure that a bus can be accommodated with a comparable journey time to an approximate car based equivalent, rather the

purpose is to begin to identify whether such aspirations are potentially realistic and what the wider implications could be.

9.5.1 Feasibility Journey Time Comparisons

The first stage of this assessment concentrates on whether the implementation of the mitigation measures has the potential to deliver comparable and acceptable journey times experienced by both the P&R services and the approximate car based journey with the same destination.

To ensure that the route time were comparable a series of car based trips have been released onto the network at the same frequency as the buses. The paths of these vehicles through the network have been fixed and correspond with the paths that are followed by the P&R services although follow a more direct route as would be expected. The car based trips also follow a loop and return back to the starting point to make comparisons easier.

The car trips have been allocated a start point which lies just south of the Europa Way roundabout. Similar journey times have been extracted from the Reference Case and so Europa Way provides a more appropriate start point than the link between Europa Way and Gallows hill as this link does not exist within the Reference Case. Furthermore, trips travelling between the M40 and Leamington would be unlikely to use the newly proposed link and so it does not represent an appropriate starting point for the car based trips.

When considering the route that vehicles are likely to take from the M40 to Leamington, they are more likely to stay on Europa Way than deviate onto any of the parallel minor links that are proposed alongside the new developments, thus the journey times extracted for cars should be based on the assumption that they travel along this, faster, section of the network than the slower minor roads that run parallel.

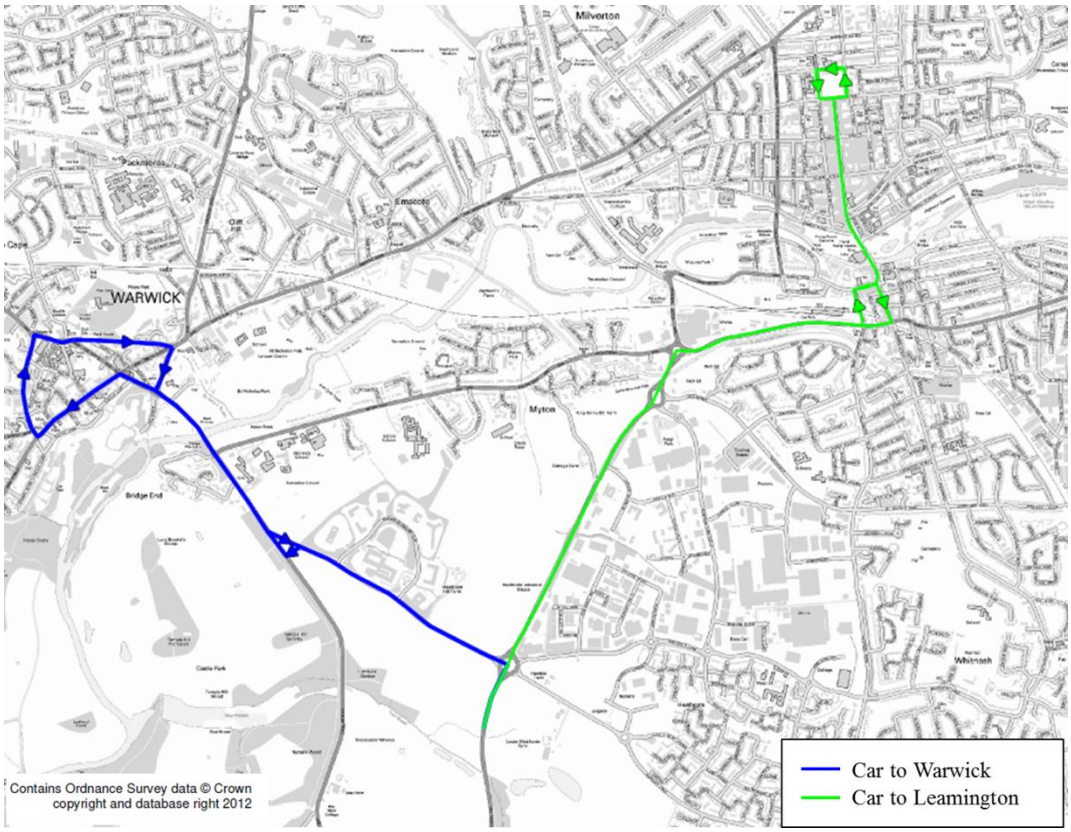
The P&R service routes that have been assessed are presented within the earlier

Figure 27 whilst the car equivalent routes used to inform the comparisons are presented within **Figure 29** on the following page.

In order that the journey times collected are comparable, at this stage, the journey time data for the car based journeys has been collected by releasing cars onto the model network at the same interval as the P&R services. Furthermore, as the routes vary in lengths the average journey time has been aggregated to present an average journey time per 1 kilometre, thus making the journey times more easily comparable than would be the case where they to represent the average time it takes to traverse routes of various lengths.

The same car based trips that have been defined within the 2028 RA + P&R scenario were also defined within the 2028 Reference Case and the 2028 Revised Allocation scenarios so that the baseline journey times could also be understood.

Figure 29 - Park & Ride 'Car Equivalent' Assessment Routes



Analysis of the journey times extracted for each of the routes defined within the model networks, across the AM and PM time periods, has been presented for all three scenarios within the following **Figure 30** and **Figure 31** respectively.

Figure 30 - P&R Journey Time Comparisons, seconds per km, Car & P&R service, AM (07:00 to 10:00) , (2028 Ref vs. 2028 RA vs. 2028 RA + P&R)

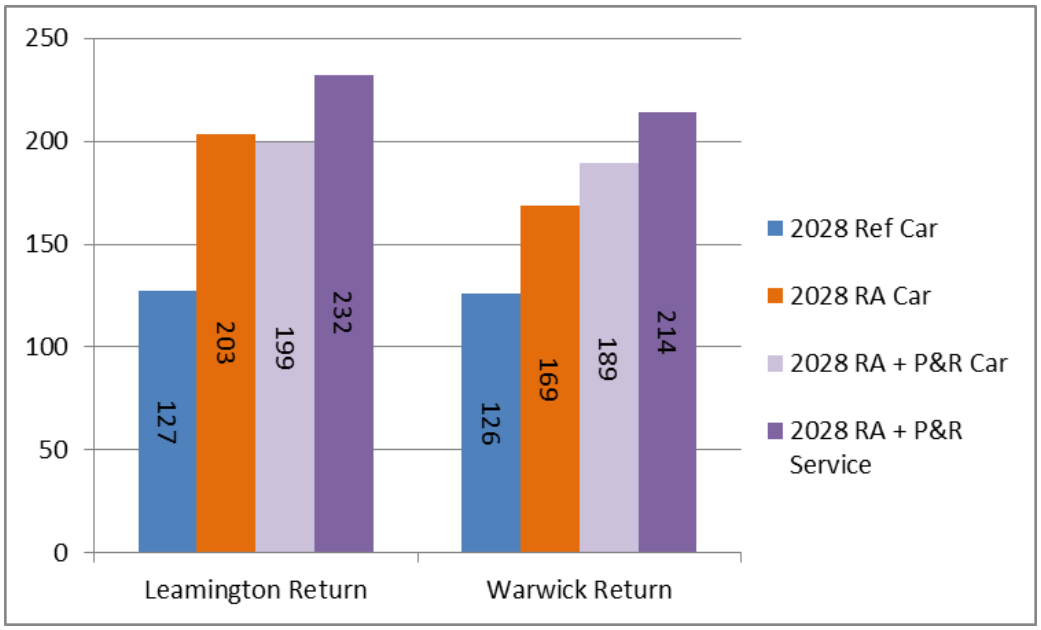
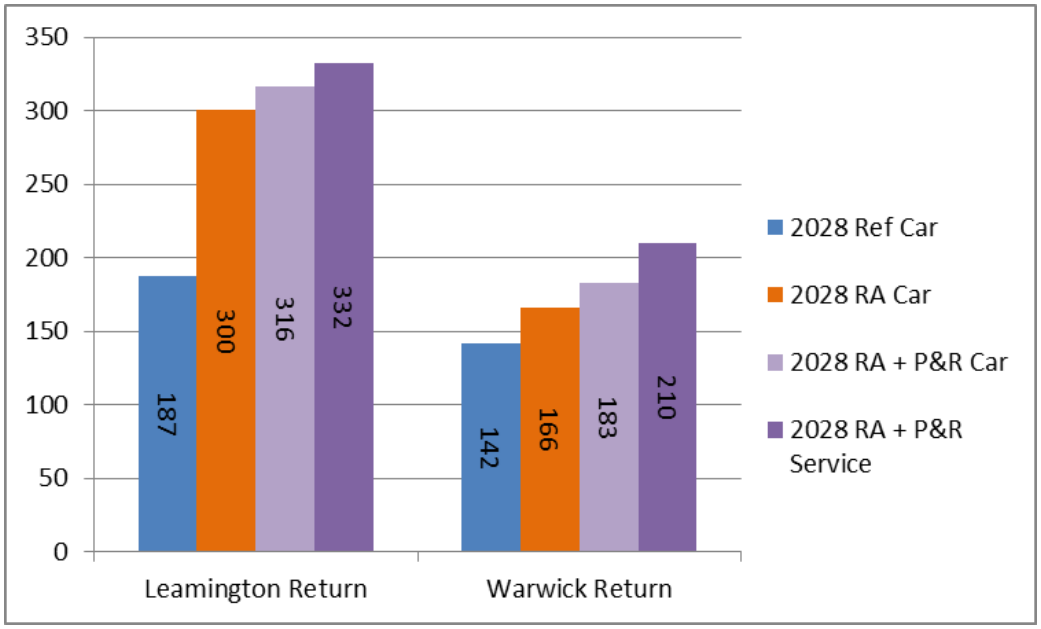


Figure 31 - P&R Journey Time Comparisons, seconds per km, Car & P&R service, AM (16:00 to 19:00) , (2028 Ref vs. 2028 RA vs. 2028 RA + P&R)



Analysis of the previous figures reveals that there is an increase in the journey times across all scenarios as the additional allocated demand is added and then also as the P&R measures are included. The largest single incremental increase in journey times occurs between the 2028 Reference Case and the 2028 Revised Allocation. When considering the impact on journey times experienced within the scenario tests inclusive of the P&R site there are small increases in the journey times experienced by car users and, similarly there are further increases on the journey times experienced by the P&R users.

Within the AM period the Warwick car based journey times increase between the 2028 Revised Allocation and the 2028 RA + P&R by 11% whilst the Leamington car based journey times actually decrease.

Within the PM both the Warwick and the Leamington car based journey times increase between the 2028 Revised Allocation and the 2028 RA + P&R scenarios by 5% and 10% respectively.

When considering the 2028 RA + P&R scenario and, specifically, the journey times achieved within that network, there is a tendency for journey times to take longer for the P&R services than the car based equivalents. At this stage journey times completed by the P&R services are at least comparable to the times experienced by the car based trips. Within the AM the P&R journeys are between 13% and 16% higher for trips going to Warwick and Leamington respectively whilst, within the PM, the same P&R trips are around 5% and 14%.

At this stage it is considered that the margin of difference between the scenarios is acceptable, particularly considering the assessment level is robust because of the following:

- Optimisation of the additional bus priority measures has been limited and there is likely to be additional benefits gained from refining the proposals.

- Similarly, the additional refinement is likely to improve the journey times experienced by the car based trips as well.
- The current proposals simply assume that the P&R is delivered within the current network conditions, it does not account for any shift away from the car and onto the P&R facilities, such a shift would reduce the congestion on the network which would, in turn, reduce the levels of delay experienced by both the P&R journeys and the car based equivalents.
- Furthermore, the analysis of journey times for the car based trips, at this stage, assumes an exact match on the departure profile, this assumes a limited release of vehicles within the period that is being tested. In reality the volume of trips on the network tends to correspond to the highest levels of congestion, this is more likely to result in higher average journey times than those presented previously, specifically for car based trips, but would require a more refined approach to the analysis to maintain consistency.

It should also be noted that this assessment takes no account of the walk, bus waiting and car parking space search times. As spaces within the town centre become increasingly scarce as higher demands are experienced. It may be the case that search and walk times exceed the wait and walk time experienced by P&R users.

9.6 Network Wide Statistics

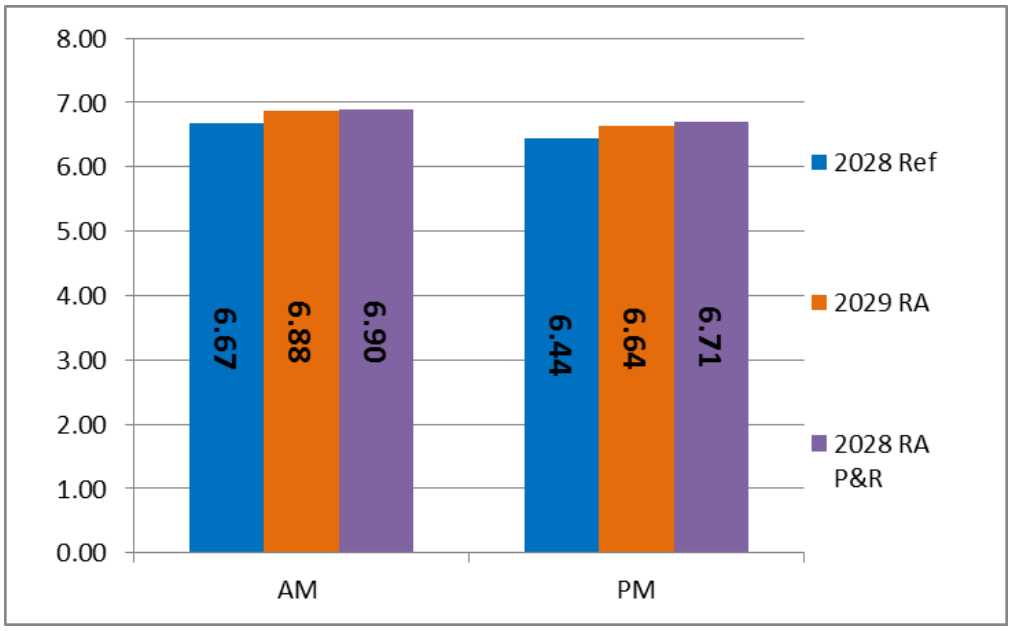
The following sets out the changes in network wide statistics between the 2028 Reference Case and the 2028 Revised Allocation scenarios with and without the P&R included.

9.6.1 Average Journey Distance

Analysis of the average journey distance within the original Reference and Revised Allocation scenario has been presented, alongside the 2028 Revised Allocation and the 2028 RA + P&R outputs, within the **Figure 32** on the following page.

Analysis of Figure 32 indicates that there is little difference in the average journey distance between the 2028 RA and 2028 RA + P&R scenarios within the AM. Within the PM however, an increase in the average journey distance appears between the 2028 RA and 2028 RA + P&R scenarios. This indicates that there is potential for the reassignment of some trips in response to the inclusion of the P&R measures. As congestion levels increase on the shorter routes, hastened by the additional delays incurred as a result of the inclusion of the P&R measures, vehicles elect to take slightly longer routes to avoid these delays. Thus an increase in the average journey distance is observable.

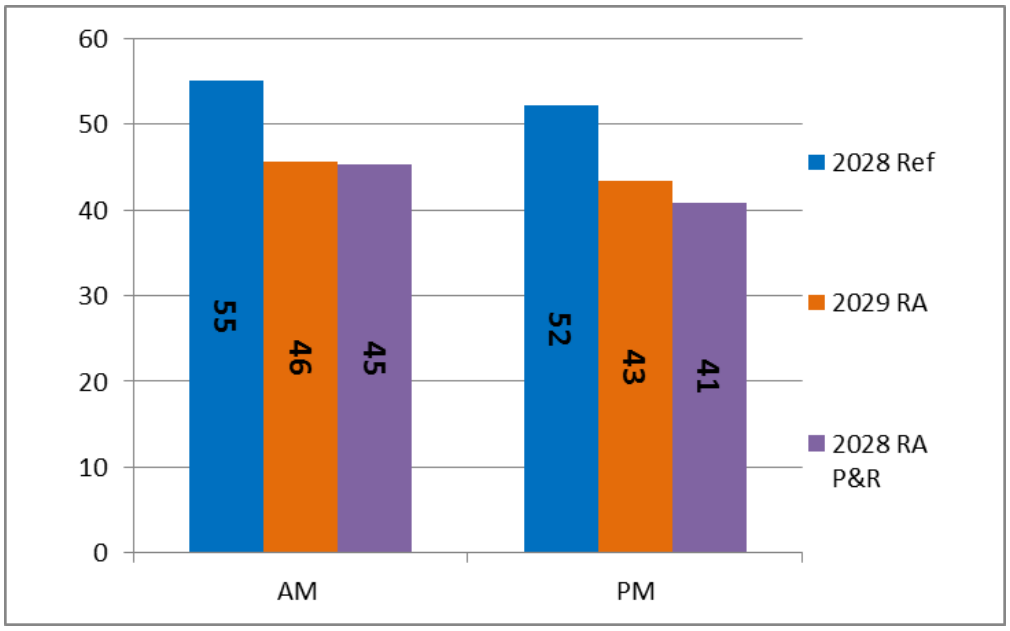
Figure 32 - Average Journey Distance (2028 Ref vs. 2028 RA vs. 2028 RA + P&R), Km



9.6.2 Average Journey Speed

Analysis of the average journey speed (km/h) within the original Reference and Revised Allocation scenario has been presented, alongside the 2028 Revised Allocation and the 2028 RA + P&R outputs, within the following **Figure 33**:

Figure 33 - Average Journey Speed (2028 Ref vs. 2028 RA vs. 2028 RA + P&R), Km/h



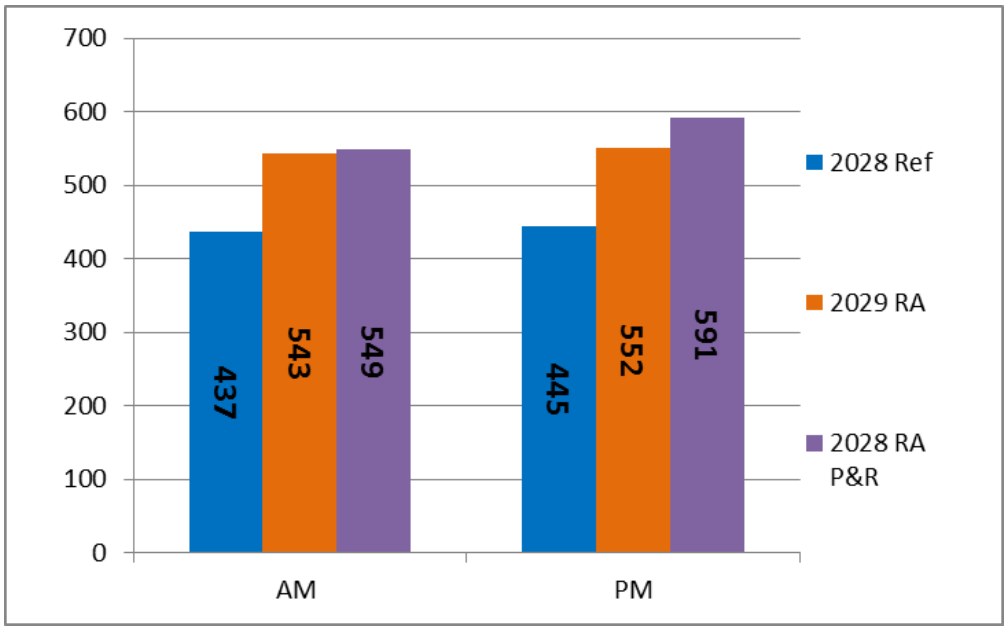
Analysis of **Figure 33** reveals that there is no significant difference in the speeds experienced within the 2028 RA and 2028 RA + P&R scenarios due to the very small magnitude of change present and the fact that this could be partly affected by the variation between runs.

Within the PM there is a small drop in speeds when the P&R is included. Whilst the magnitude of change could partly be influenced by the inherent inter-scenario variation, this is less likely as the lower speeds correspond to the increased journey distances and, thus, begin to indicate additional congestion impacts on the 2028 P&R network during the PM period.

9.6.3 Average Journey Time (Seconds)

Analysis of the average journey time, in seconds within the original Reference and Revised Allocation scenario has been presented, alongside the 2028 Revised Allocation and the 2028 RA + P&R outputs, across the entire AM and PM model periods, is presented within the following **Figure 34**.

Figure 34 - Average Journey Time (2028 Ref vs. 2028 RA vs. 2028 RA + P&R), Seconds



Analysis of the previous figure reveals that, in general, the changes in the level of delay experienced between scenarios, across both the AM and PM periods, corresponds to the observed changes in journey distance and average speed. Within the AM the magnitude of change between the 2028 RA and the 2028 RA + P&R scenarios is very small and so cannot be determined as being of a significant level at this stage. Changes in the journey time levels within the PM however are far more pronounced with an increase in overall delay of 7% occurring when the P&R network is included.

9.7 Mean Speed Analysis

The following sets out some initial observations of the mean speed plots produced for the 2028 RA + P&R Scenario. The comments in the remainder of this section are based on observations of the predicted changes in peak hour mean speed across links within the model area during the AM (08:00 to 09:00) and PM (16:00 to 17:00) peak hours.

The maps which are referred to within the following analysis are presented within **Appendix E** of this report.

9.7.1 2028 RA + P&R Network Conditions(MS019 to MS022)

Analysis of the differences in the mean speeds achieved on links within the 2028 RA + P&R network, when compared to the 2028 Revised Allocation network, reveals that there are very few notable differences between the two scenarios during the AM period. One obvious reduction in the mean speeds appears to occur along the Parade SB approach to the Spencer Street/Bath street corner of the proposed gyratory. This is likely to be affected by the proposed signal scheme in this area and how it is affected by the bus priority measures.

Analysis of the PM period differences appears to indicate a reduction in mean speeds, when the P&R is included. These differences occur around the A452 NB approach to the Thickthorn junction as well as the Warwick Rd northbound approach to the Kenilworth gyratory. This reduction occurs in an area which should be largely unaffected by the inclusion of the P&R and further investigation would be required to determine the full rationale behind this reduction. However, initial analysis could indicate that the A452 northbound from Leamington is likely to experience an increase in traffic levels as vehicles elect to take this route out of Leamington to avoid additional increases in congestion within the town that are incurred by the inclusion of the P&R measures. Mean speeds on the Princes Drive approach to Warwick New road also appear to reduce which could be indicative of vehicles reassigning along Princes Drive as a result of the congestion incurred within the town centres as a result of the inclusion of the P&R measures.

9.7.2 Mean Speed Summary

Analysis of the Mean Speed plots reveals that the impacts of implementing the P&R measures in their current format are likely to result in lower mean speeds being experienced around the Parade area in particular. Within the PM period there also appears to be a reduction in mean speeds in the area around the Thickthorn Roundabout and the A452. Although more detailed analysis is required to determine the rationale behind, it is likely to indicate that the A452 between Leamington and the A46 comes under increased pressure as a result of the currently proposed P&R measures.

9.8 Maximum Queue Length Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case as well as the 2028 Revised Allocation and 2028 RA + P&R scenarios.

The maps which are referred to within the following analysis are presented within A**ppendix F** of this report.

9.8.1 AM Analysis (MQ008)

Analysis of the difference in queuing levels between the 2028 Revised Allocation and 2028 RA + P&R scenarios reveals very little difference occurs between the two scenarios. Where differences do exist, the tendency appears to be for queues

to get marginally larger within the 2028 P&R scenario when compared to those recorded within the 2028 Revised Allocation scenario, during the AM period. There a few occasions where moderate increases are observed to occur within the 2028 P&R scenario where previously nothing had been recorded. These occurrences are located along Rugby Road. In addition to these increases there is one instance of an increase classified as "severe", when compared to the level contained within the 2028 Reference Case. This occurs at the Spencer Street/Parade corner of the proposed Lower Avenue/Avenue Road/Bath Street Gyratory. This is likely to indicate a requirement for further optimisation in this area before the impacts could be deemed acceptable.

9.8.2 PM Analysis (MQ009)

Analysis of the increase in journey times between the 2028 Reference Case and the 2028 RA + P&R scenario, when compared to the differences identified within the 2028 Reference Case vs. 2028 Revised Allocation analysis, within the PM period reveals the following:

- There are four occasions where the increase in queuing is very severe;
    - The queuing increase on Spencer Street/Batch Street corner of the gyratory is most likely caused by the introduction of the bus priority measures.
    - The queuing increase at Heathcote Lane/Tachbrook Rd is likely to be caused by vehicles re-assigning onto the route parallel to Europa Way
    - The reason behind queuing increases observed at Thickthorn and Kenilworth gyratory is less obvious although the general increase in queuing along the A452 between Leamington and the A46 could indicate that this route comes under additional pressure as a result of the P&R which has a knock-on effect at these two junctions due to increased vehicle movements from the A452 to the A46. Further detailed analysis would be required to achieve more certainty in the outputs being presented.
- The number of instances where queuing has increased in the Leamington area between High Street and Rugby Road could be indicative of the effects of reassignment in response to the congestion incurred by implementation of the P&R measures.

9.8.3 Queue Analysis Summary

Analysis of the strategic queuing outputs reveals that there are only a few additional increases which occur within the model network when the P&R is included compared to the situation within the 2028 Revised Allocation scenario. In one instance, when compared to the 2028 Reference Case queuing levels, the queue length increase has been categorised as severe. This increase occurs at Spencer Street/Parade corner of the proposed Lower Avenue/Avenue Road/Bath Street gyratory and is likely to indicate a need for further optimisation of the bus priority measures in this area. The remaining increases occur along the Rugby Road between the Warwick New Road junction to the south and the Lillington

Avenue junction to the North. This could be caused by the reassignment of some trips in response to the conditions created within the town centre as a result of the implementation of the P&R scheme.

Analysis of the differences observed within the PM period reveals a number of occasions where the queuing levels are likely to increase as a result of the implementation of the P&R. The increases indicate that there is potential for the P&R scheme to result in the reassignment of traffic away from Europa Way, due to the congestion levels and queuing incurred within this are. Following on from this, detailed analysis of the impacts in and around the A452 would be required to fully understand the implications of delivery of the P&R on this area.

9.9 Journey Time Analysis

The following sets out some initial observations based on the differences in queue lengths between the 2028 Reference Case as well as the 2028 Revised Allocation and 2028 RA + P&R scenarios.

The maps which are referred to within the following analysis are presented within **Appendix G** of this report.

9.9.1 AM Analysis (MD009)

Analysis of the increase in journey times between the 2028 Reference Case and the 2028 RA + P&R scenario, when compared to the differences identified within the 2028 Reference Case vs. 2028 Revised Allocation analysis, within the AM period reveals the following:

- Journey times along Rugby Rd NB increase further when the P&R is included (from a moderate increase to a very severe increase)
- Journey times experienced by vehicles travelling northwards through Leamington, along the A452 and the routes parallel to the Parade also increases when the P&R is included.
- Increases in delay are also likely along the Warwick By-pass (Banbury Spur) and Europa Way northbound routes into Leamington from the M40

9.9.2 PM Analysis (MD010)

Analysis of the increase in journey times between the 2028 Reference Case and the 2028 RA + P&R scenario, when compared to the differences identified within the 2028 Reference Case vs. 2028 Revised Allocation analysis, within the PM period reveals the following:

- Journey times on all routes between the towns and the A46 have increased.
- Delay on the route into Warwick and Leamington along the Warwick by-pass (Banbury Spur) and Europa Way NB has increased, most likely due to the implementation of the P&R priority measures.

- Delay levels on the Birmingham Road and Coventry routes which link Warwick and the A46 have increased in both directions.
- Levels of delay experienced by vehicles travelling northwards along the A452 have increased as have the levels of delay experienced by vehicles travelling along Bericote Rd westbound which runs parallel to the A452.

9.9.3 Journey Time Analysis Summary

The results presented within the delay analysis appear to correlate with the results that have been presented throughout this section of the report in so far as the impacts are more prominent within the PM period than the AM. Both AM and PM analysis appears to indicate that the A452 and Parade northbound routes through Leamington will suffer increases in the levels of delay experienced as a result of the P&R inclusion. Similarly, increases in delay experienced by vehicles travelling northwards along Warwick by-pass (Banbury spur) and Europa Way are also likely. Within the PM the analysis appears to indicate additional issues along routes into and out of the two towns, most likely caused as a result of traffic reassigning from the Europa way route into Warwick and Leamington, as a result of the inclusion of the P&R measures, which has a knock-on effects of displacing traffic and increasing congestion on routes on the periphery of the network.

9.10 Summary

Analysis of the impact of including the P&R within the existing 2028 Revised Allocation scenario indicates that it is likely that journey times delivered by the P&R services could be achieved at levels which are comparable to the equivalent journeys undertaken by car. Although further optimisation of the P&R measures as well as a refinement of the P&R assumptions would be required to confirm that this is the case. The analysis presented at this stage is considered robust because of the following reasons:

- Optimisation of the additional bus priority measures has been limited and there is likely to be additional benefits gained from refining the proposals.
- Similarly, the additional refinement is likely to improve the journey times experienced by the car based trips as well.
- The current proposals simply assume that the P&R is delivered within the current network conditions, it does not account for any shift away from the car and onto the P&R facilities, such a shift would reduce the congestion on the network which would, in turn, reduce the levels of delay experienced by both the P&R journeys and the car based equivalents.
- Furthermore, the analysis of journey times for the car based trips, at this stage, assumes an exact match on the departure profile; this assumes a limited release of vehicles within the period that is being tested. In reality the volume of trips on the network tends to correspond to the highest levels of congestion, this is more likely to result in higher average journey times than those presented previously, specifically for car based trips, but

would require a more refined approach to the analysis to maintain consistency.

Analysis of the network wide statistics indicates that the difference between the various scenario results within the AM is not of a sufficient magnitude to be considered as severe. However, within the PM there are notable increases in delay and corresponding reductions in the average speeds achieved by vehicles which indicates that further optimisation of the proposed measures is required.

Analysis of the mean speeds achieved within the model networks indicates that the Parade area of Leamington is likely to suffer from reduced speeds as a result of the implementation of the P&R measures. The queue analysis correlates with the mean speed outputs in so far as it identifies that the area between Avenue Road and Rugby road is likely to suffer some increases in queuing levels within both the AM and PM periods. Additional queue increases have also been identified, within the AM and PM periods, along Tachbrook Road. This route runs parallel to Europa Way, which is the area where a lot of the P&R priority measures are focussed and so the additional pressure may be as a result of the reassignment of traffic away from the Europa Way corridor due to congestion incurred through the implementation of the P&R measures. Within the PM the analysis of the queuing outputs appears to indicate that, in addition to the impacts identified within the AM analysis, queue increases have also been identified in the area surrounding Thickthorn roundabout and the Kenilworth Gyratory. This is in line with corresponding reductions in mean speeds in this area, which could indicate that traffic is likely to reassign along the A452 between Leamington and the A46 in response to the inclusion of the P&R measures.

Analysis of the impacts on the levels delay experienced on key routes within the network, both with and without the P&R included, largely correlates with the analysis of the other statistics. It reveals that the impacts within the AM appear to be largely concentrated in the areas in close proximity to the proposed P&R measures whilst within the PM period, in addition to the close proximity impacts, there are additional impacts incurred on more peripheral routes into and out of the towns as well as the routes through the town.

9.11 Conclusions

The initial analysis set out in the previous section of this report, when considering the potential feasibility and impacts of delivery of a P&R site to be located within the pocket of land to the southwest of the Europa Way/Harbury Lane roundabout reveals the following conclusions:

- That delivery of a P&R site in this area which has the potential to generate a service with journey time which is comparable to similar journeys undertaken by car is feasible.
- That additional optimisation and refinement of the proposed measures designed to accompany the P&R services is required to improve the likely impacts, specifically within the PM period.
- Alongside that refinement of the proposed mitigation, additional optimisation of schemes on alternative routes into the town, which may experience increases in traffic levels as a

result of the inclusion of the P&R and the subsequent reassignment of traffic, should also be considered.

It should be noted that this assessment only considers the viability of using a P&R bus service from the south and to the town centres compared with making a car based trip on the same journey. Further detailed studies will be required to analyse factors such as;

- identify potential patronage
- interception rate of traffic along the route
- sensitivity of demand to car parking price changes at the P&R site and within the town centres
- required parking
- whether the P&R can be self-sustaining

The exercise has only considered a site to the south of Warwick and Leamington. This is because

- the focus of growth is in this area and thus has potential to mitigate a higher proportion of the impact
- the site location would be able to serve both town centres
- the number of highway mitigation schemes identified in this area which can more easily be adapted to provide bus priority systems would help to provide a viable service
- the existing and new bus services that are required for the southern quantum of development would also be able to serve the P&R

However it is also noted that there is potential for a similar type of service to be provided to the north of Leamington on the A452. This section of road suffers from congestion on route into the town centre and could benefit from a P&R service which could help reduce the reliance on car based trips within the town centre. The corridor benefits from a high frequency of bus services that could serve a P&R site, however, the potential to provide bus priority infrastructure on this corridor is limited. Similar studies to those suggested would be required to understand the economic case and potential benefits realised by implementing such a scheme.

Further details on P&R are included within the Sustainable Transport technical note included in Appendix H of this report.

10 AQMA Analysis

10.1 Overview

Additional analysis of the potential impact on the AQMA sites within Warwick and Leamington has also been undertaken.

There are two AQMA locations within Warwick and Leamington. The AQMA area within Warwick covers the majority of the town centre and includes Saltisford, The Butts, Jury Street, Smith Street and Bowling Green Street. The AQMA location within Leamington includes Spencer Street, Bath Street, Tachbrook Road and Clement Street. The locations of the Warwick and Leamington AQMA areas are illustrated within the following Figure 35 and Figure 36 respectively:

Figure 35 - Warwick Town AQMA sites

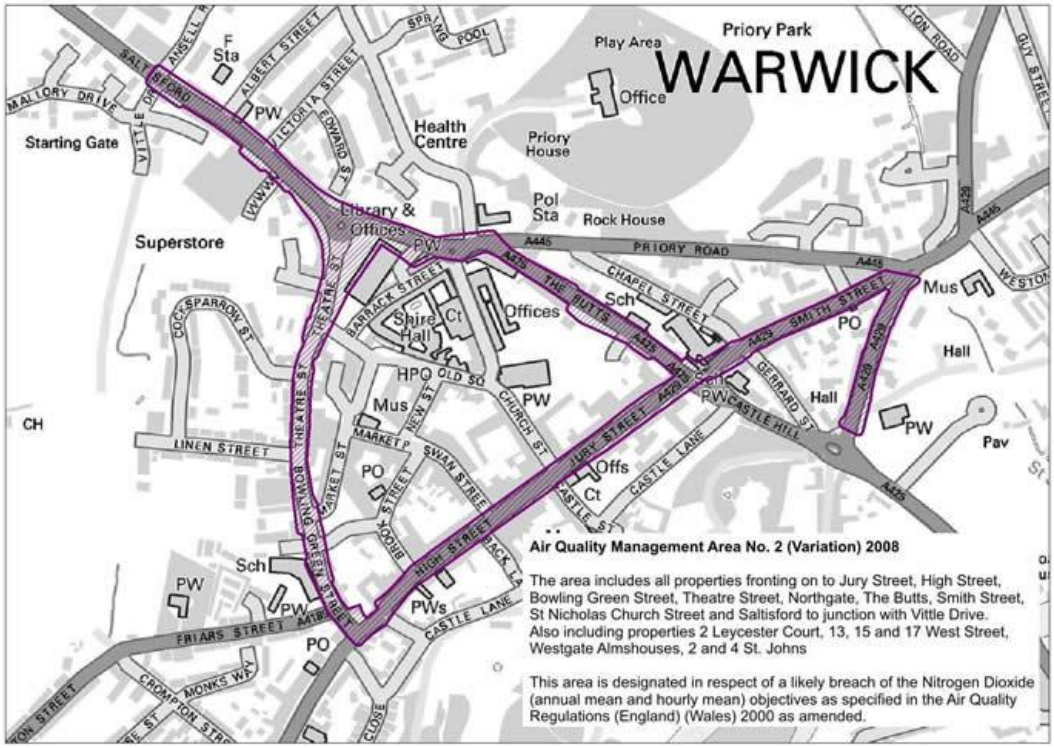
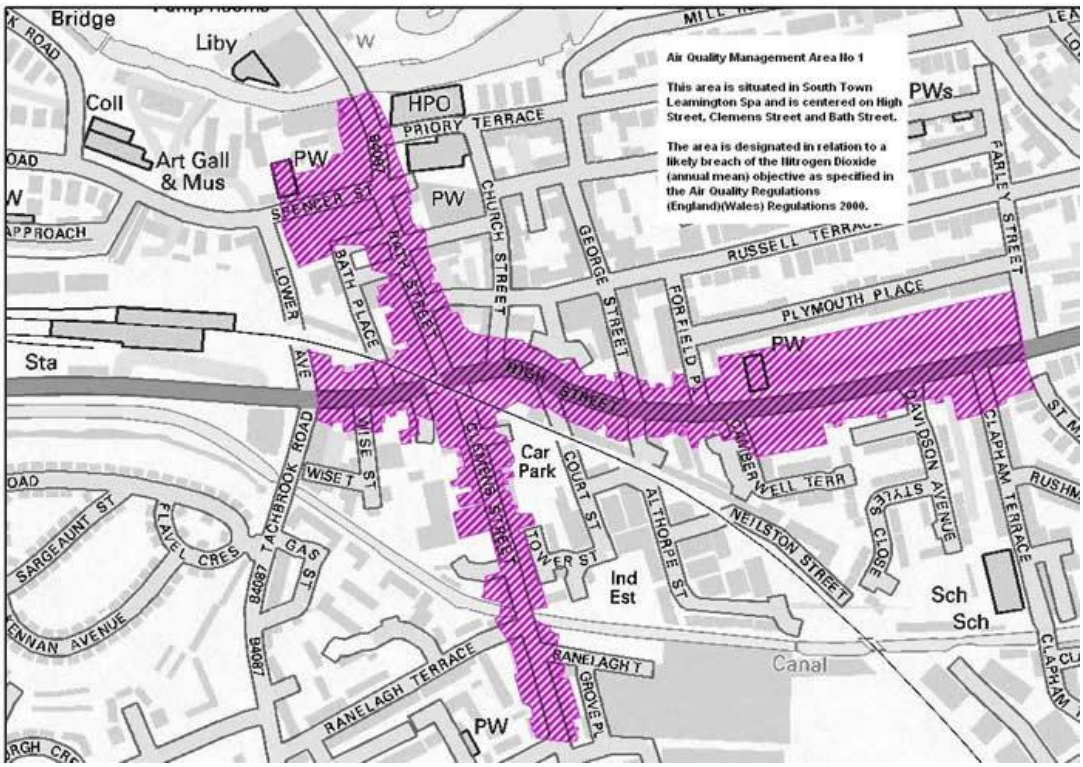


Figure 36 - Leamington AQMA Area



10.2 Warwick AQMA analysis

Analysis of the changes in flow at key locations within the Warwick AQMA site, during the AM and PM peak hour, has been assessed for the following scenarios:

- 2028 Reference Case
- 2028 Revised Allocation
- 2028 RA - WTCI

Analysis has been undertaken inclusive of the scenario within which the Warwick Town Centre Improvements have been removed in order that a better understanding of the role that these works play in accommodating movements within the AQMA area of Warwick can be better understood. Analysis has been undertaken for both AM and PM peak hours and has been presented within the following Table 31 and Table 32 respectively:

Table 32 - AM (08:00 to 09:00) Warwick AQMA Movement Analysis (2028 Ref vs. 2028 RA vs. 2028 RA - WTCI)

Location	Dir.	2028 Ref	2028 RA	Diff	2028 RA - WTCI	Diff
Saltisford	SB	590	676	86	507	-82
	NB	636	550	-86	385	-251
The Butts	SB	387	437	50	345	-42
	NB	459	550	91	418	-41
Bowling Green Street	SB	326	342	15	257	-69
	NB	914	747	-167	466	-448
Jury Street	WB	379	278	-101	223	-156
	EB	404	458	54	277	-127
Smith Street	WB	489	589	99	301	-188
S Nicholas Church Street	SB	882	1172	290	817	-65
Total				331		-1470

Table 33 - PM (17:00 to 18:00) Warwick AQMA Movement Analysis (2028 Ref vs. 2028 RA vs. 2028 RA - WTCI)

Location	Dir.	2028 Ref	2028 RA	Diff	2028 RA - WTCI	Diff
Saltisford	SB	732	658	-74	657	-75
	NB	621	584	-37	601	-20
The Butts	SB	390	405	14	482	92
	NB	384	589	205	370	-13
Bowling Green Street	SB	537	485	-52	483	-54
	NB	556	593	37	603	47
Jury Street	WB	454	347	-106	391	-63
	EB	531	554	23	504	-27
Smith Street	WB	786	549	-236	660	-125
S Nicholas Church Street	SB	885	986	101	1111	226
Total				-124		-11

It should be noted that the analysis in the previous tables has been extracted for the peak hours only and presents the impact on a particular section of each road rather than the entire length. Thus the results would not correlate directly with the earlier cordon analysis as links such as Castle Hill and Priory Road are excluded from the analysis as are the internal town centre links such as Northgate Street and Barrack St.

Initial analysis of the previous Tables indicates that, within the AM and PM peak hours, the flows within the AQMA areas are likely to increase, when compared to the Reference Case, when the TCI improvements are in place during the AM but drop when the WTCI proposals are removed. Removal of the TCI measures results in a reduction in flow on every single link within the AQMA area during the AM.

During the PM there is a reduction in traffic movements within the AQMA in both of the revised allocation scenarios although the magnitude of difference is relatively small. When considering each of the locations in isolation it is clear within the 2028 RA scenario that there is an increase in vehicles travelling SB along St Nicholas Church Street during the AM period and an increase in the movements along the Butts NB during the PM period.

In order to better understand the impacts of the Revised Allocation scenario, on the selection of links within the AQMA area that are being assessed, analysis of the mean speed (MPH) that vehicles are travelling along the links at has also been undertaken. This analysis has been presented within the following Table 33 and Table 34 for the AM and PM periods respectively:

Table 34 - AM (08:00 to 09:00) Warwick AQMA Mean Speed (MPH) Analysis (2028 Ref vs. 2028 RA vs. 2028 RA - WTCI)

Location	Dir.	2028 Ref	2028 RA	Diff	2028 RA - WTCI	Diff
Saltisford	SB	13.3	6.9	-48%	7.1	-47%
	NB	27.8	22.5	-19%	15.9	-43%
The Butts	SB	6.0	4.4	-26%	3.8	-37%
	NB	18.1	23.4	30%	19.7	9%
Bowling Green Street	SB	12.2	13.7	12%	16.4	34%
	NB	9.0	7.0	-22%	6.6	-27%
Jury Street	WB	4.4	2.8	-37%	1.6	-65%
	EB	15.7	15.1	-3%	16.1	3%
Smith Street	WB	24.7	15.2	-39%	6.6	-73%
S Nicholas Church Street	SB	9.2	12.4	34%	6.3	-32%

Table 35 - PM (17:00 to 18:00) Warwick AQMA Mean Speed (MPH) Analysis (2028 Ref vs. 2028 RA vs. 2028 RA - WTCI)

Location	Dir.	2028 Ref	2028 RA	Diff	2028 RA - WTCI	Diff
Saltisford	SB	18.2	14.5	-20%	14.8	-19%
	NB	28.3	25.1	-11%	24.3	-14%
The Butts	SB	9.5	6.8	-28%	6.6	-31%
	NB	21.5	21.9	2%	25.1	17%
Bowling Green Street	SB	16.9	17.7	5%	19.0	13%
	NB	9.0	7.4	-17%	8.8	-2%
Jury Street	WB	7.5	6.2	-17%	4.6	-39%
	EB	19.0	17.3	-9%	20.5	8%
Smith Street	WB	14.8	6.7	-54%	18.9	28%
S Nicholas Church Street	SB	18.2	16.2	-11%	15.8	-13%

Analysis of the previous Tables reveals that, in most cases, the speeds are lower within the Revised Allocation scenarios than they are within the Reference Case. During the AM period, however, there is a more severe drop in speeds when the Town Centre improvements are not included within the model network than is

otherwise experienced. Within the AM it is particularly notable that the speeds along St Nicholas Church St actually increase despite this area experienced the largest single increase in vehicular movements, when compared to the Reference Case, of any of the locations within the AQMA.

10.3 Warwick AQMA Summary

In general the results appear to indicate a negative impact on the AQMA areas with a general increase in traffic coupled with a reduction in average speeds. The impacts are, however, significantly reduce by the implementation of the town centre improvements which appear to result in higher average speeds being achieved as a result of the implementation of these schemes, compared to the situation that is likely should the schemes not be delivered.

10.4 Leamington AQMA Analysis

Analysis of the changes in flow at key locations within the Leamington AQMA site, during the AM and PM peak hour, is presented within the following Table 35 and Table 36 respectively.

Analysis of Tables 36 and 37 reveals that, in general, although movements captured at specific locations, and inevitably the movements through the area, vary between the Revised Allocation and the Reference Case Scenario, the net effect of the changes is minimal, particularly during the AM period. During the PM period there is a reduction in the number of movements captured within the AQMA analysis but this still represents a reduction in movements of less than 4% when compared to the 2028 Reference Case.

Table 36 - AM (08:00 to 09:00) Leamington AQMA Movement Analysis (2028 Ref vs. 2028 RA)

Location	Dir.	2028 Ref	2028 RA	Diff
Spencer Street	WB	605	824	219
	EB	126	0	-126
Bath Street	SB	527	492	-34
High Street (E of Bath Street)	WB	316	165	-150
	EB	502	746	244
High Street (W of Bath Street)	WB	257	0	-257
	EB	871	1033	162
Clement Street	SB	371	395	23
	NB	234	342	108
Tachbrook Road	SB	394	378	-15
	NB	721	577	-143
Total				30

Table 37 - PM (17:00 to 18:00) Leamington AQMA Movement Analysis (2028 Ref vs. 2028 RA)

Location	Dir.	2028 Ref	2028 RA	Diff
Spencer Street	WB	809	1081	272
	EB	121	0	-121
Bath Street	SB	815	683	-132
High Street (E of Bath Street)	WB	404	314	-90
	EB	458	674	215
High Street (W of Bath Street)	WB	358	0	-358
	EB	891	897	6
Clement Street	SB	498	487	-11
	NB	239	364	126
Tachbrook Road	SB	508	532	25
	NB	730	614	-117
Total				-186

As with the analysis of the impacts within the Warwick AQMA boundary, analysis of the mean speeds recorded on the links within the Leamington AQMA area, during the AM and PM peak hours has also been undertaken. This information is presented within **Table 38** and **Table 39** for the AM and PM periods respectively

Analysis of the Tables 38 and 39 reveals that the average speed along the links selected within the AQMA areas is likely to drop, when compared to the 2028 Reference Case.

Table 38 - AM (08:00 to 09:00) Leamington AQMA Mean Speed Analysis (2028 Ref vs. 2028 RA)

Location	Dir.	2028 Ref	2028 RA	Diff
Spencer Street	WB	13.5	10.8	-20%
	EB	28.0	0.0	
Bath Street	SB	14.9	6.8	-54%
High Street (E of Bath Street)	WB	28.7	28.4	-1%
	EB	30.8	10.9	-65%
High Street (W of Bath Street)	WB	27.2	0.0	
	EB	12.7	4.9	-62%
Clement Street	SB	33.4	32.5	-3%
	NB	9.5	3.5	-64%
Tachbrook Road	SB	30.5	30.5	0%
	NB	9.4	3.1	-67%

Table 39 - PM (17:00 to 18:00) Leamington AQMA Mean Speed Analysis (2028 Ref vs. 2028 RA)

Location	Dir.	2028 Ref	2028 RA	Diff
Spencer Street	WB	11.4	10.4	-9%
	EB	29.5	0.0	
Bath Street	SB	10.9	6.3	-42%
High Street (E of Bath Street)	WB	28.8	28.8	0%
	EB	28.8	11.2	-61%
High Street (W of Bath Street)	WB	20.0	0.0	
	EB	16.1	5.5	-66%
Clement Street	SB	30.0	31.9	6%
	NB	3.1	3.9	25%
Tachbrook Road	SB	30.4	30.5	0%
	NB	6.2	3.5	-43%

10.5 Leamington AQMA Summary

In general the results appear to indicate a negative impact on the AQMA areas with a general increase in traffic coupled with a reduction in average speeds. It is inevitable that the additional demand that is being assigned to the model network will result in an increase in the movements across the AQMA areas. However, at this stage, it is not clear what the results would indicate where the Bath Street, Spencer Street improvements not included.

Anecdotally these improvements were added to the model to maintain traffic movements across this area as testing without these schemes in place resulted, on occasion, in the model scenario locking up with delay increasing exponentially. Thus, further analysis may be required to ascertain what the levels of impact on the AQMA area would be were the proposed network interventions not included.

10.6 Conclusions

Analysis of the impacts of the growth allocation strategy on the AQMA areas reveals the following conclusions:

- That there is potential for negative impacts to be experienced in both Warwick and Leamington AQMA areas, particularly in the form of increased traffic movements.
- That the impact on Warwick AQMA area is likely to be far more severe if the Warwick Town Centre improvements are not implemented alongside the growth strategy. The RA with proposed mitigation scenario presents flows which are much higher compared to the "without town centre improvements" scenario. This is because vehicles are stationary or slow moving and continue to be so over a longer period, idling traffic being a major contributor to urban pollutants.

Since signalisation schemes are proposed for both of the AQMA areas there is potential that these impacts can be further mitigated by additional optimisation of

the proposed schemes within this area. Furthermore, the opportunity for the delivery of the Park and Ride service and the potential for this to reduce car based trips in this area should also be considered.

11 Summary & Conclusions

11.1 Summary

11.1.1 Overview

Arup have been commissioned by Warwickshire County Council (WCC) and Warwick District Council (WDC) to undertake additional testing of the proposed Warwick Core Strategy (CS) allocations. This report builds upon the evidence presented within the Phase 2 Assessment report[10], and outlines the impacts of a revised approach to the allocation of growth, herein referred to as the 'WDC Revised Allocation' strategy, on the Warwick and Leamington road network.

11.1.2 Scenario Demands

The sites selected within the revised allocation represent a combination of the sites allocated between the Preferred Option and Southern Focus Option which were tested during the previous phase of this assessment. The revised demands produced as a result of the Revised Allocation scenario strategy have been subjected to mode shift, internalisation and peak spreading procedures. Growth within both scenarios has been capped so as not to exceed the levels of growth predicted by the TEMPRO database, after adjustments for national trends (NTEM Adjusted TEMPRO).

The total demand, by hour, predicted to occur as a result of the Revised Allocation strategy is presented within the following **Table 40**:

Table 40 – Allocated Demand Levels

	0700 to 0800	0800 to 0900	0900 to 1000	1600 to 1700	1700 to 1800	1800 to 1900
Demand	3691	5677	3338	4378	5423	3835

These demands have been subject to a redistribution methodology intended to cap internal growth to the level predicted through the NTEM adjusted TEMPRO factor for Warwickshire. As a result of the application of these processes the resultant hourly demands assigned within the two key modelling scenarios are summarised within the following **Table 41**:

Table 41 - Scenario Demand Summary

	07 to 08	08 to 09	09 to 10	16 to 17	17 to 18	18 to 19
2028 Reference Demands	41353	49392	37066	46956	48973	41320
2028 Revised Allocation Demands	44662	50636	39133	50342	50372	45142

11.1.3 Study Objectives

The objectives of this phase of strategic transport assessment work are as follows:

[10] 211439-19.R006 Warwick STA - Phase 2 Assessment, Arup, February 2013

- To derive an initial 'preferred network' based on the conclusions of the original Phase 2 work and test the impact of the allocation of the revised allocation on the preferred network
- To refine the schemes contained within the Preferred network, removing any unnecessary schemes and documenting areas where risks exist or further work is likely to be required
- To assess, through a sensitivity test, the performance of the preferred network when new education trips are included within the area of development located to the south of Warwick
- To understand the level of strategic significance attributed to certain proposed mitigation measures, namely Portobello Bridge capacity enhancements and the Warwick Town Centre Improvements
- To review the proposed mitigation measures with a view to understanding the potential amendments that could be made to better accommodate public transport services and provide commentary on the outcomes of any scheme implementation within the modelling.

To take account of sustainable modes of transport and make robust assumptions with regards to the likely reduction in development related traffic through the implementation of sustainable infrastructure.

11.1.4 Stages of Assessment

A staged approach to addressing the objectives set out previously has been adopted as follows:

- The revised approach to allocating growth within the area has been assigned to the model network, discounted to take account of sustainable modes of travel using both identified and emerging sustainable transport infrastructure and the highway mitigation measures proposed within that network have been optimised, refined or removed, to produce a network which contains what are considered to be the most critical mitigation measures.
- The performance of the model network when the revised allocation strategy has been assigned alongside the mitigation measures to create a 2028 Revised Allocation scenario. It is the outputs of this scenario that form the spine of the impact analysis assessment.
- Additional assumptions pertaining to the delivery of Education provision have then been included within the 2028 Revised Allocation scenario and again the outputs of this scenario have been assessed.
- The 2028 Revised Allocation scenario network has been amended and the proposed Portobello Bridge capacity enhancements and the Warwick town centre improvements a have each been removed to create two additional sensitivity tests (2028 RA – Bridge & 2028 RA – WTCI respectively) the outputs of which have been assessed.
- Finally, a series of assumptions regarding the delivery of a Park and Ride site located to the west of Europa Way, south of Gallows Hill, have been included within the modelling and some outline amendments have been made to the proposed mitigation measures to allocate priority to the P&R movements through the network wherever possible. The outputs from this scenario have then been assessed alongside those extracted form the2028 Reference Case and 2028 Revised Allocation scenarios.

11.2 Mitigation Schedule

The primary objective of this stage of the STA was to refine the mitigation measures and gain a better understanding of those measures which are likely to prove critical in ensuring that the cumulative impacts of the revised allocation strategy can be mitigated and the additional demand levels accommodated without severely impeding the overall level of network performance.

In total the delivery of 28 schemes, including significant contributions towards sustainable transport infrastructure, have been identified as likely to meet the objectives of ensuring that the demand assigned to the network as a result of the Revised Allocation strategy is at least partly mitigated whilst the overall level of network operation is maintained, albeit with some residual impacts likely to occur. 27 schemes have been included within the cost schedule and the estimated cost of delivering these schemes is currently **£39.2 million**, this is subject to the status of Managed Motorway funding being confirmed.

Delivery of these 27 schemes is necessary to ensure that the network can continue to operate in light of the additional demand levels proposed. The demand levels which are currently assumed equate to the delivery of 8400 dwellings through allocated sites and 3600 through windfall sites. Thus, at this stage, the mitigation costs, per dwelling, equates to approximately **£3300 per dwelling.**

11.2.1 Stage 1 - Revised Allocation/Optimised Network Testing

Analysis of the network wide statistics revealed that, compared to the 2028 Reference Case, delay is likely to increase and speeds are likely to reduce when the additional growth is assigned irrespective of the inclusion of the additional mitigation measures.

An analysis of the trip completion ratio revealed that, during the AM period the majority of additional demand assigned to the network can be accommodate but, within the PM period, this was not the case, indicating a potential need for further optimisation of the mitigation measures within this period.

Analysis of the impacts on mean speeds achieved on links within the network revealed that, in almost every case, where low speeds exist within the 2028 Reference Case, these low speeds are likely to be exacerbated by the inclusion of the additional, allocated demand whilst queuing analysis reveals no instances of very severe queue increases between the 2028 Reference Case and the 2028 Revised Allocation scenario. Analysis of the queuing on the network reveals no instances of very severe increases in queuing levels. Whilst, in all but one case queue increases of 30+ vehicles only occur in areas where junctions have been signalised meaning it is reasonable to conclude that further optimisation of these junctions will be likely to reduce these differences further. Changes in the perceived level of delays experienced on key routes within the two model networks indicates that impacts are likely to be variable with some routes experiencing betterment whilst others suffer increases.

The additional, detailed, link flow analysis revealed that changes in two way flow levels across the various cordon points seems to indicate that the biggest variation in the outer cordons occur to the Southwest of Warwick and the North of Leamington. To the Northwest of Warwick there is limited change in the movements across the A4177Birmingham Road but the movements across the

A429 Coventry Road to the North of Warwick increase substantially. In a number of cases increases in movements across the outer cordon areas do not translate directly to increases in the movements across the downstream inner cordon points.

11.2.2 Sensitivity Testing

A series of sensitivity tests have been undertaken to test the potential impact of a number of amendments to the proposed 2028 Revised Allocation strategy, namely:

- Increased Education provision
- Removal of either the Portobello Bridge or Warwick Town Centre capacity enhancements
- Provision of a Park and Ride

The impacts analysis pertaining to the increase education provision identified a number of instances where the level of impact may increase from that experienced prior to the inclusion of the additional education assumptions. However, the assumptions included within that assessment were felt to be robust and likely to be representative of a worst case scenario. Thus it was determined that the inclusion of the education provision was unlikely to fundamentally change the nature of the proposed mitigation measures but that additional optimisation of the proposed schemes was likely to be required.

The analysis of the impact of removing the Portobello Bridge capacity enhancements appeared to indicate that the majority of additional impacts would be localised. There are likely to be constraints on the Emscote road which prevent the true benefits of unlocking capacity in the area of the Bridge from being realised. The scheme is still considered desirable, and further investigation of the impacts of including the scheme are recommended to be completed at a later stage, however, due to the relatively localised nature of the benefits of delivery, coupled with the likely costs of implementation, the costs for the implementation of this scheme where excluded from the mitigation schedule costs that have been assigned at a per dwelling level.

The analysis of the impact of removing the Warwick town centre improvements reveals that the mitigation measures are likely to serve a role of strategic importance in maintaining the overall level of network operation despite the fact that they are located within Warwick town centre. Routes into and through the town are likely to suffer substantial increases in the overall level of delay. These impacts are most severe within the AM period. Furthermore, the increased congestion and reduced speeds that occur within the town centre (slow moving and idling traffic being a major contributor to air pollution), when the schemes are removed, drives traffic to find alternative routes between their original and destination which avoid the town centre. The consequence of this increase is that areas peripheral to Warwick town centre all appear to suffer severe increases in queuing and delay. Since even with the proposed mitigation measures, the capacity of the network is finite, removal of the additional capacity provided by the town centre enhancements results in other areas of the network becoming saturated with vehicles travelling longer distances at lower speeds to get to their destinations. As a result it is concluded that the delivery of the proposed mitigation measures which at least follows the principle of those schemes

included within the modelling, is critical to the delivery of the revised allocation strategy.

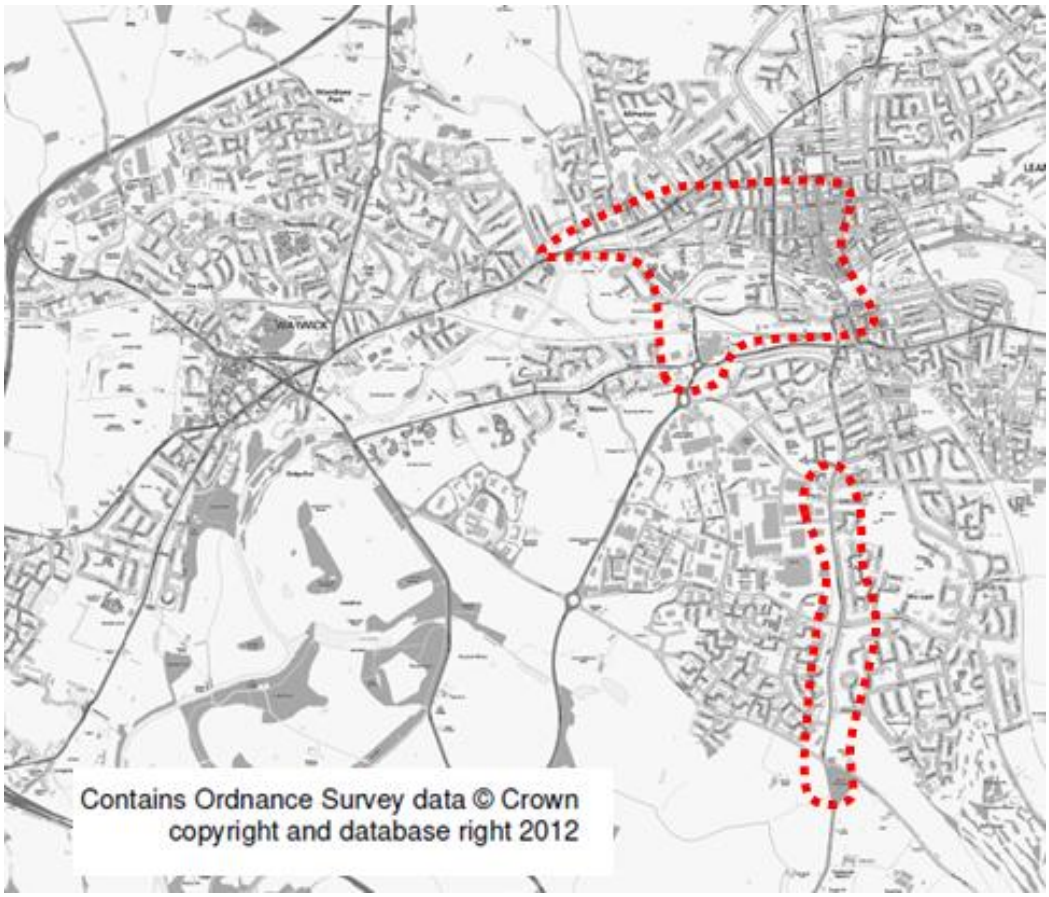
The outline feasibility testing of the P&R has determined that the prospects of delivering a P&R service in the area outlined, which can provide car competitive journey times, is at least possible. Further optimisation of the proposed mitigation is likely to be required before the impacts of delivering the P&R service on the wider can be fully understood. However, the initial testing reveals promising results, particularly within the AM, in so far as the impacts on the wider network are limited despite the reduction in capacity of some proposed schemes in order that the P&R services can be accommodated. At this stage no adjustments have been made for mode shift as a result of the delivery of the P&R, nor has a detailed level of optimisation been undertaken with regards to the amendments to the existing mitigation as well as proposals for any additional mitigation such as bus lanes and bus gating, etc.

11.2.3 Residual Impacts

Frequently throughout the majority of the previous stages of work, the impacts that appear to occur most prominently are in and around the Leamington area. Notably the impacts occur in areas where the network capacity is constrained and where the options for enhancements are limited. There are impacts predicted in and around Warwick town centre mostly relating to increases in delay but, in general, the impacts appear lower than those within the Leamington area. This indicates that the proposed Warwick Town Centre improvements, at least partly, mitigate the impacts of the additional growth.

There are impacts likely on the approach to Leamington from the South, as the amount of available highway land reduces around the Princes Drive/Old Warwick Road areas the options available to deliver additional mitigation measures correspondingly reduce. Thus frequently residual impacts are likely to occur in these areas as well. Similarly there are often impacts recorded as occurring along the Tachbrook Road corridor which runs parallel to Europa Way. This route is a secondary route to the Europa Way corridor and improving this corridor may have the unintended consequence of encouraging more traffic away from the Europa Way corridor and onto this secondary route. As a result, aside from minor optimisation of the existing signalised junctions, no further amendments have been proposed on this corridor at this stage. This may be an issue that proximate development sites may wish to consider further within the planning process. The areas which have most frequently experienced residual impacts during the course of the testing are illustrated within **Figure 37** on the following page.

Figure 37 - Areas of Residual Impact



11.3 Conclusions

Based on the outcome of this assessment it is reasonable to conclude the following:

- That there is a mitigation schedule available which can be implemented alongside the revised allocation strategy, and that the costs of implementing these mitigation measures is likely to be **£39.2 million** which on the basis of 8400 dwellings through allocated sites and 3600 dwellings through windfall sites. Thus, at this stage, the mitigation costs, per dwelling, equates to **£3,300** for transport infrastructure costs inclusive of £10 million contribution to Managed Motorways.
- In spite of the proposed mitigation schedule, there are inevitably going to be residual impacts that, at this stage, have not been mitigated, some of these impacts may at least be lessened by further mitigation measures and the appropriate access strategies associated with each of the individual sites that will be identified through the individual planning applications associated with each of the sites. Some impacts however, are likely to be fixed due to the limited available options for enhancements in those areas.
- That incorporating further provision for Education within the south (in the form of 3 primary schools and 1 secondary school) will not

fundamentally alter the proposed mitigation schedule although some additional optimisation may be required.

- That the delivery of Warwick town centre improvements which conform, at least in principle, to those that have been proposed within the modelling, unlocked network wide benefits as well as localised benefits and, as a result, the delivery of these schemes is considered to be of strategic importance.
- Finally; that the principle of the delivery of a P&R to the south of Warwick is sound and, whilst further detailed analysis is required to confirm this, it is likely that a service can be delivered which can deliver a sustainable alternative to car based journeys from the south to both Warwick and Leamington.

12 Further Considerations and Recommendations

It is recommended that the following risks are assessed at the earliest opportunity although it is acknowledged that the assessment of these risks prior to the adoption of the allocation strategy is, in some cases, unlikely to be possible:

- The impacts on areas not included within the modelling;
- The impacts of utility and service diversion costs attributed to any one scheme that may not have been considered at this stage (an average cost of service and utility works has simply been assigned to each scheme).
- Vertical alignment and gradient issues not considered at this stage.
- Specific risks pertaining to the delivery of one or more scheme on the network such as:
    - The physical risks to delivering the Managed Motorways scheme in the area required and the viability of the costs thereof;
    - The risks posed by the bridge over the M40 which carries traffic SB from the A452 to the M40 NB and its ability to accommodate the additional demand without significant enhancements;
    - The risk that the Barford Road bridge across the A452 poses to the proposals to widen the road.
    - The risk that limited highway capacity around the St Nicholas Church Street may impede delivery of a scheme.

In addition to the above identified risks, there are a number of assumptions that have been included within the modelling that may require further detailed analysis at an appropriate stage within the assessment period.

A final risk that needs to be considered is that which is posed by the impact of the allocation strategy on the transport network within Kenilworth town. Kenilworth town is not contained within the extent of the current Warwick and Leamington PARAMICS model and so may require an additional more detailed assessment once the allocation strategy has been determined.

12.1 Recommendations for Future Assessments

The following outlines a series of recommendations that should be considered during any additional stages of the Strategic Transport assessment.

- Further work on calculating the costs of delivering the proposed Managed motorway works and an acceptable level of apportionment is recommended to be undertaken at the earliest opportunity as this represents a significant factor in the determination of the costs of delivering the associated mitigation infrastructure outlined within this report.
- That, once the preferred allocation strategy has been determined, consideration should be given to undertaking an assessment to confirm that the proposed mitigation will still operate within acceptable levels.

- That the potential impacts of any strategic reserve sites that come forward as part of the preferred allocation strategy are not likely to fundamentally change the nature of the mitigation that is proposed
- That the assumptions on mode share, mode shift, and internalisation are reviewed and, once the preferred allocation strategy has been identified, a sensitivity test is completed to determine the importance of achieving the targets set out previously and to establish areas where further mitigation may be required should the targets, associated with the proposed sites, regarding mode share and internalisation, not be realised.
- As more certainty emerges on the provision of Education facilities alongside the allocation strategy, further testing should be undertaken which includes more detailed assumptions regarding the access strategy including any additional pedestrian facilities, trip generation and the distribution thereof.
- Further detailed assessment of the potential benefits of the P&R should be undertaken although it is imagined that such testing would be intended to compliment an over-arching feasibility study of the P&R site meaning allowances for mode share and interception could be included within the modelling to allow a better understanding of both the benefits and impacts of delivery.
- More detailed consideration of the impacts of the allocation strategy on the Kenilworth area should be considered within any forthcoming stages of assessment as this has not been considered in detail within the current round of testing.
- Testing of a phased approach to the implementation of the delivery of the planned housing and employment and the mitigation strategy should be undertaken. This will determine which schemes are likely to be required at an early stage of the plan period and, conversely, which can be delivered towards the end of the period.