A421 CORRIDOR STUDY

Final Report

Buckinghamshire Council

March 2025

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This document has 165 pages including the cover.

Document history

Document title: Draft final Report

Document reference: v1

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
0.4	Draft chapters 1-4	CA	JC	LS	GGH	28/07/2023
0.5	Draft chapters 1-4	CA	JC	LS	GGH	07/08/2023
1.1	Draft chapter 5	CA	LS	GGH	GGH	21/02/2024
1.4	Draft Chapter 5 for client review	LS	LS	GGH	GGH	06/03/2024
2.	Full draft final report	LS, GGH	LS	LS, GGH	GGH	04/02/2025
3	Final report	LS, GGH	LS	LS, GGH	GGH	24/03/2025
3.1	Final report issued	LS, GGH	LS	LS, GGH	GGH	28/03/2025

Client signoff

Client	Buckinghamshire Council
Project	A421 CORRIDOR STUDY
Job number	5222660
Client signature/date	

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Executive summary

Background

The A421 is a strategic corridor running from the A43 south of Brackley in Oxfordshire to the A1 south of St Neots in Cambridgeshire. The 12-mile section between Finmere and Bottledump roundabout lies within Buckinghamshire and is the subject of this study. The corridor is largely rural, passing through the southern part of Buckingham and there is a series of small villages either side of the A421.

The corridor is an important local route acting as the main connection for villages and towns in the northern part of the Vale of Aylesbury. It also carries through traffic for longer-distance east-west journeys between the M40/A43, the M1 and A1.

The quality of public transport connectivity varies significantly across the study area. The main bus services in the area cover Bicester, Buckingham, Aylesbury and Milton Keynes and some infrequent bus services connect the surrounding rural villages. Buckingham, the largest town along the corridor, is not served by rail. Winslow Station, due to open in 2025, will be the closest Buckinghamshire rail station with rail services to Oxford, Bicester and Milton Keynes.

Study objectives

The objectives of this study were to understand the current and future situation in the corridor and to identify, assess and recommend a package of options to mitigate issues identified.

Working with local stakeholders, the study team established corridor objectives to represent some wider outcomes which could be delivered by the proposed intervention options. These corridor objectives were derived from the draft Local Transport Plan (LTP5) objectives: connecting our economy, decarbonising our transport system, and building places for people.

The corridor objectives are:

- #E1: Good public transport options between Buckingham and Winslow, Milton Keynes, Bicester and Brackley.
- #E2: Better public transport connections to the larger villages in the corridor.
- #E3: Viable active travel connections between Buckingham and Winslow, Milton Keynes, Bicester and Brackley/Silverstone.
- #E4: Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes/M1.
- #C1: Viable public transport connections to/from new housing and employment growth sites in the corridor.
- #C2: Biodiversity in the A421 corridor is enhanced.
- #C3: greater use of low and ultra-low emission vehicles.
- #P1: Improved road safety for pedestrians, cyclists and equestrians crossing the A421.
- #P2: Fewer and less severe accidents in the corridor.
- #P3: Reduced emissions and noise from traffic using the corridor.
- #P4: Buckinghamshire is walking and cycling friendly.

For the purposes of this study, particular emphasis was given to objective #E4. Objectives #E1, #E2 and #E3 were also considered to develop a multi-modal package of interventions.

Current and future challenges

There are current issues with traffic congestion on the corridor and this is notable in the south of Buckingham. Delays are also particularly significant when approaching roundabouts especially towards the eastern end of the route. Analysis using the Buckinghamshire Strategic Transport Model (BSTM) suggests delays on journeys between Buckingham and Milton Keynes by all routes typically add 32% to the 'free flow'[1] journey time.

The high number of HGVs travelling through Buckingham town centre are also seen to be problematic and there are 'rat running' issues in some local villages adjacent to the corridor.

Through the development of the Vale of Aylesbury Local Plan (VALP), the corridor was identified as needing to support significant local housing growth including four major development sites. The 2015 A421 corridor study by Jacobs assessed the performance of the corridor between Buckingham and Milton Keynes. This study estimated that an additional 3,000 to 4,000 vehicles could travel from the assumed 9,630 new homes in developments in the area in the morning and evening peak. This was expected to have a significant impact on traffic conditions along the A421 corridor and surrounding routes.

BSTM analysis forecasts that between 2019 and 2040, traffic is expected to increase by between 10% and 48% depending on location and time of day. Delays are expected to worsen by 15-30 seconds on the A421 towards Milton Keynes between the B4033 (Nash Road) roundabout and Bottledump roundabout. Increased delays are also expected on the A422 towards Stratford roundabout as well as delay increases of up to 90 seconds west of Buckingham near Radclive Road. Smaller junctions providing access/egress from local roads to the A421 are forecast to be markedly impacted by the increasing traffic on the corridor.

Mode shift to active transport is described in the 'Decarbonising Transport: a better, greener Britain, 2021' paper as 'one of the most cost-effective ways of reducing transport emissions', with a national target for 50% of journeys in cities and towns to be done by walking, wheeling or cycling by 2030. Bus services within the study area are relatively infrequent and there is a lack of off-road cycle paths between key destinations.

Intervention options

A 'long list' of 56 intervention options was drawn from previous studies, previous consultation feedback, a stakeholder workshop and experience of good practice from elsewhere. These ideas included bus service and bus infrastructure enhancements, rail and light rail, active travel projects, new roads, dualling, junction improvements and other road improvements.

A multi-criteria assessment framework was developed using national best practice and it was tailored to reflect local issues. The assessment criteria included aspects such as expected benefits, adverse impacts, acceptability, feasibility and affordability.

Nine options which were thought as likely to have at least a moderate benefit on the performance of the A421 (Objective #E4), were expected to offer high value for money, be feasible, publicly acceptable and affordable were then shortlisted for further assessment.

All nine options were improvements to the road network as the proposed schemes were able to be assessed with the tools and timescales available. They were also the most likely to significantly address the issues faced on the corridor. In addition, in response to requests from local stakeholders, a 'full A421 dualling' option was taken forward for further assessment despite its expected high cost because it was anticipated to provide the largest corridor transformation.

[1] Free flow refers to the ideal state of traffic conditions where vehicles can move continuously without interruption, delays, or significant reductions in speed. Free flow conditions typically occur at night when there is lower traffic volumes and road capacity is not exceeded, allowing vehicles to move freely.

Option assessment and recommendations

2040 ‘do minimum’

The 2040 ‘do minimum’ scenario is the best estimate of the traffic conditions in 2040. It takes into account traffic growth from committed developments and planned site allocations as well as committed transport infrastructure and mitigation measures included in existing plans. It is a representation of a future with no investment in transport infrastructure and services on the A421 corridor other than that which is already committed. Forecasting figures for this scenario show that the amount of traffic in the A421 corridor is expected to continue to increase and that the absolute increases are higher in the eastern end of the corridor. Delays are also expected to increase in a number of locations across the study area with journey times expected to increase by approximately two to three minutes along the length of the study area between 2019 and 2040, depending on direction and time period.

Full dualling

The option comprises dualling of approximately 16 kilometres of the A421 between the eastern end of the (dualled) Tingewick Bypass and Bottledump Roundabout (junction with Whaddon Road leading to Newton Longville). Forecast figures suggest that traffic volumes on the proposed dualled section would increase by up to 1,000 vehicles per hour (20-40%) in the peak hour. The additional traffic results in more delays at junctions meaning that journey times between Buckingham and Milton Keynes are forecast to only reduce by approximately three minutes.

The estimated cost for full dualling is over £300 million (excluding land costs) and although there would be some reduction in journey time, the scheme is expected to offer only low value for money. It is therefore recommended that the full dualling option is not considered further in relation to the objectives of this study.

Partial dualling

The option comprises dualling of approximately 1.6 kilometres of the A421 between the Coddimoor Road / Whaddon Road roundabout and Bottledump Roundabout. This includes necessary alterations at the two roundabouts.

Traffic forecasting predicts that traffic volumes on the proposed dualled section would increase by 6-7% with relatively modest changes to traffic further afield. Traffic congestion is also forecast to reduce only on the dualled section and some increases in delay are likely to be seen elsewhere due to the partial dualling. Journey times between Buckingham and Milton Keynes are forecast to reduce by only approximately 30 seconds.

It is recommended that the partial dualling option is not considered further in relation to the objectives of this study. The cost of the scheme and the limited benefits mean that it offers low value for money. Dualling this section, however, may remain a worthwhile consideration in future in terms of local access to developments in this area. Proposed access arrangements for the Shenley Park development have not been examined in this study as it is not yet committed and is subject to agreement as part of the development planning process. It is proposed that any further traffic assessment considers the interaction with any new access arrangements; this will be considered by within the ongoing development planning process.

Junction improvements on the A421

Five junctions with the highest forecast congestion in the future were selected for a detailed assessment of potential roundabout improvements. A package of alterations was designed for each junction to reduce delays. The proposed new roundabout to access the Shenley Park development has not been examined in this study as it is not yet committed and is subject to agreement as part of the development planning process.

Assessment of the proposed interventions for the London Road, A413 and B4033/Winslow Road roundabouts were found to result in a reduction of delays. Assumed improvements at the Whaddon (Coddimoor Lane) and Bottledump roundabouts resolved some but not all of the queuing and flow issues. These two easternmost roundabouts have the highest congestion and although not fully resolved, the proposed improvements are forecast to offer the highest benefits.

These proposed junction improvements are estimated to cost between £1 million and £2.5 million each (excluding land costs). It is recommended that all five junction improvement proposals be taken forward for further detailed assessment as they are expected to have positive impacts against several of the corridor objectives. It is likely that journey time savings from the roundabout improvements (in total) could be similar to those achieved by the full dualling option, although this cannot be verified within the scope of this report. Further assessment should also include examination of where measures to deter or calm traffic may be required in the surrounding villages.

Recommendations

It is recommended that the investment package that is taken forward should also reflect opportunities to improve maintenance, and minimise impacts of adverse weather, such as flooding (objective #E5). Improved road safety for pedestrians, cyclists and equestrians crossing the A421 (objective P1), measures to enhance biodiversity (Objective #C2) and promote use of low and ultra-low emission vehicles (Objective #C3) should also be included. Overall, it is clear that a wide range of different types of measures will be required in combination to support all of the corridor objectives.

Next steps

Buckinghamshire Council is currently investigating several public transport and active travel projects in the corridor including increasing bus service frequency between Buckingham, Winslow and Aylesbury and the creation of an interurban active travel corridor running from Buckingham-Stowe-Silverstone. These projects highlight the Council's multimodal approach to resolving the issues identified and achieving our objectives in the corridor. Further work is also required to progress the proposed roundabout improvement schemes and measures to improve road safety where the A421 is crossed by at-grade (non roundabout) junctions.

The most likely funding sources for these recommended improvements will be developer contributions as there is no certainty about if and when any other external funding sources would be forthcoming. Buckinghamshire Council will need to prioritise schemes for further feasibility assessment as and when funding becomes available.

The recommended options will inform discussions with developers and partners such as England's Economic Heartland and National Highways to secure appropriate investment in and around the corridor.

The development of new Local Transport Plan (LTP5) will also guide the implementation of the proposed schemes in line with Buckinghamshire transport policies and implementation plan.

1. Introduction

1.1. Background

The A421 is a strategic corridor in Buckinghamshire, providing regional connectivity between the A43 to Oxford and Milton Keynes. The corridor is an important local route acting as the main connection for villages and towns in the northern part of the Vale of Aylesbury. It is designated as part of England's Major Road Network. The A421 corridor is largely rural in nature but serves the town of Buckingham as well as a number of villages.

The corridor needs to support significant local growth as included in the recently adopted Vale of Aylesbury Local Plan (VALP), especially on the edge of Milton Keynes and Buckingham. As well as a large new site at Lace Hill (800 homes), there are four major Site Allocations set out in the VALP which will impact on this corridor. These are:

- D-NLV001 Land south of the A421 and east of Whaddon Road, Newton Longville – 1855 homes
- D-WHA001 Shenley Park, Whaddon - at least 1,150 homes, and a link road connecting into grid roads H6 and/or H7 at Milton Keynes
- D-BUC043 Land west of Aylesbury Vale District Local Plan (AVDLP) allocation BU1 Moreton Road, Buckingham - 130 homes
- D-BUC046 Land off Osier Way (South of A421 and East of Gawcott Road), Buckingham - 420 homes

In support of the VALP, in 2017 the Council published a Buckingham Transport Strategy (BTS) identifying future transport requirements in/around Buckingham up to 2033. In 2015 a further study (Jacobs, 2015) was undertaken into improvements at the eastern end of the corridor.

It was through the development of the VALP that the limitations of the corridor were highlighted, and it became evident that if the route was to continue to function efficiently for all users that a study of the full A421 corridor was required. This was to look at options to both maximise efficiency for traffic using this corridor (especially freight) and enable increased connectivity to the rural surroundings and future East West Rail station at Winslow, by all modes.

The sub national transport body, England's Economic Heartland (EEH) has recently completed an Oxford-Milton Keynes Connectivity Study, which includes this corridor. This has concluded that journey time reliability and safety measures are required to improve the corridor.

Following the cancellation of the Ox-Cam Expressway in 2020, National Highways have initiated an Oxford-Cambridge Roads Study. Early results have shown that this corridor requires improvement to provide a reliable alternative for east-west movements in the region and is used by a high proportion of freight vehicles.

1.2. Study objectives

The objectives of this study were:

- to understand the current situation in terms of the features of the corridor and its use;
- to understand how the situation may change in the future due to changing travel patterns (in part due to new development) and the effect of planned transport investments;
- to establish whether there is a need to intervene to improve future conditions in the corridor and the objectives of doing so;

- to identify and assess a range of options to mitigate issues and achieve the corridor objectives; and
- to recommend a package of interventions which reflect consideration of costs, funding, timescales and risks.

1.3. This report

This report is the primary output of the A421 Corridor Study. It contains:

- All pertinent information collated during the study process;
- A description of the processes used in undertaking the study; and
- The study findings and recommendations.

This report was developed in stages during the study from July 2023; with each chapter added as study milestones were reached, culminating in a complete draft Final Report issued in February 2025. The remainder of the report will be structured as follows:

- **Chapter 2** describes the features of the A421 corridor including traffic patterns and transport provision.
- **Chapter 3** sets out the key challenges and issues currently experienced on the corridor.
- **Chapter 4** describes how the challenges and issues may change in the future**.**
- **Chapter 5** describes the objectives established for the A421 in the study area and the potential options identified.
- **Chapter 6** describes the findings of the detailed option assessment and selection of the preferred options.
- **Chapter 7** summarises the key findings and recommendations.

The approaches used to undertake the study will be provided in the following appendices:

- Appendix A provides additional information and analysis to that presented in the main body of the report.
- Appendix B describes our approach to highway modelling.
- Appendix C describes our approach to public engagement and how this influenced the study process.
- Appendix D describes our approach to options and initial assessment.
- Appendix E provides additional information on detailed options assessment.
- Appendix F provides additional information regarding the junction modelling results.
- Appendix G provides details of initial cost estimates.
- Appendix H provides a summary of key literature used to inform the study.

2. The A421 corridor

2.1. Introduction

The A421 runs from the A43 south of Brackley in Oxfordshire to the A1 south of St Neots in Cambridgeshire. The 19-kilometre (12 mile) section of the A421 between Finmere Roundabout (A4421) in the west and Bottledump Roundabout (Whaddon Road) in the east lies within Buckinghamshire.

The A421 corridor is a strategic corridor in Buckinghamshire providing regional connectivity between the A43 to Oxford and Milton Keynes. The road runs between the M40/A43, the M1 and A1, so it also provides for longer-distance east-west journeys between these corridors.

The corridor is largely rural with a series of small villages and hamlets located to the north and south of the A421 including Newton Longville, Great Horwood, Padbury, Thornborough, Gawcott, Thornton, Whaddon and Nash. It therefore also has an important role as the main connection for these villages and towns in the northern part of the Vale of Aylesbury to the M40, A43, Brackley, Bicester and Oxford to the west and to Milton Keynes and the M1 in the east.

The rest of this chapter describes the A421 corridor in terms of its function, transport provision, travel patterns and environmental and community features. The primary focus of this study is the section of the A421 within Buckinghamshire (as shown in Figure 2-1). Consideration is however, given to issues between the A43 and the M1.



Figure 2-1 - A421 Corridor study area

2.2. Road description and features

Within the wider study area, the land uses surrounding the A421 can be categorised into:

- the western section between Barleymow Roundabout (A421/A43) and Bottledump Roundabout (A421/ Whaddon Road), and
- the eastern section between Bottledump Roundabout and the M1.

It should be noted that Bottledump Roundabout lies just outside of the Buckinghamshire Boundary in the Milton Keynes Council area.

On the western section, the road traverses through primarily agricultural land, bypassing smaller settlements such as Finmere and Tingewick. The road passes through the south of Buckingham, with five roundabouts located in this three-kilometre section, immediately connecting to both the town centre to the north, and Buckingham Industrial Estate and Lace Hill to the south. East of Bottledump Roundabout, the A421 passes through the urban area of Milton Keynes, through firstly (primarily) residential (e.g. Shenley Brook End, West Bletchley), then more industrial/commercial land use as the road passes through Kingston, Brinklow and Wavendon.

The A421 is single carriageway for most of its length, but there are two sections of dual carriageway:

- from Bottledump Roundabout travelling east towards Milton Keynes; and
- Tingewick bypass from the A421/A4421 roundabout to the A421/Main Street roundabout.

The A421 has a variety of junctions along the study area, with roundabouts primarily located at intersections with other ‘A’ roads and within the urban areas of Buckingham and Milton Keynes. A key junction is the A421/London Road roundabout which serves both Buckingham town with its northern arm and Tesco/Lidl to the south. London Road south of the A421 links to the villages of Padbury and Winslow.

Just to the west of the London Road junction is a Y-junction (left in, left out) that serves Buckingham Industrial Estate. Staggered junctions, T-junctions and Y-junctions are primarily located on the rural sections of single carriageway on the road, connecting private properties and smaller settlements such as Thornborough and Little Horwood to the A421.

Routes to and from Buckingham are single carriageways controlled by priority junctions; they are normally free flowing except in close proximity to Buckingham where congestion occurs. Speed limits (Figure 2-2) on the highway network around Buckingham are mainly 50mph or higher, with exception of the A421 directly south of the town which is 40mph (see Figure 2-2).

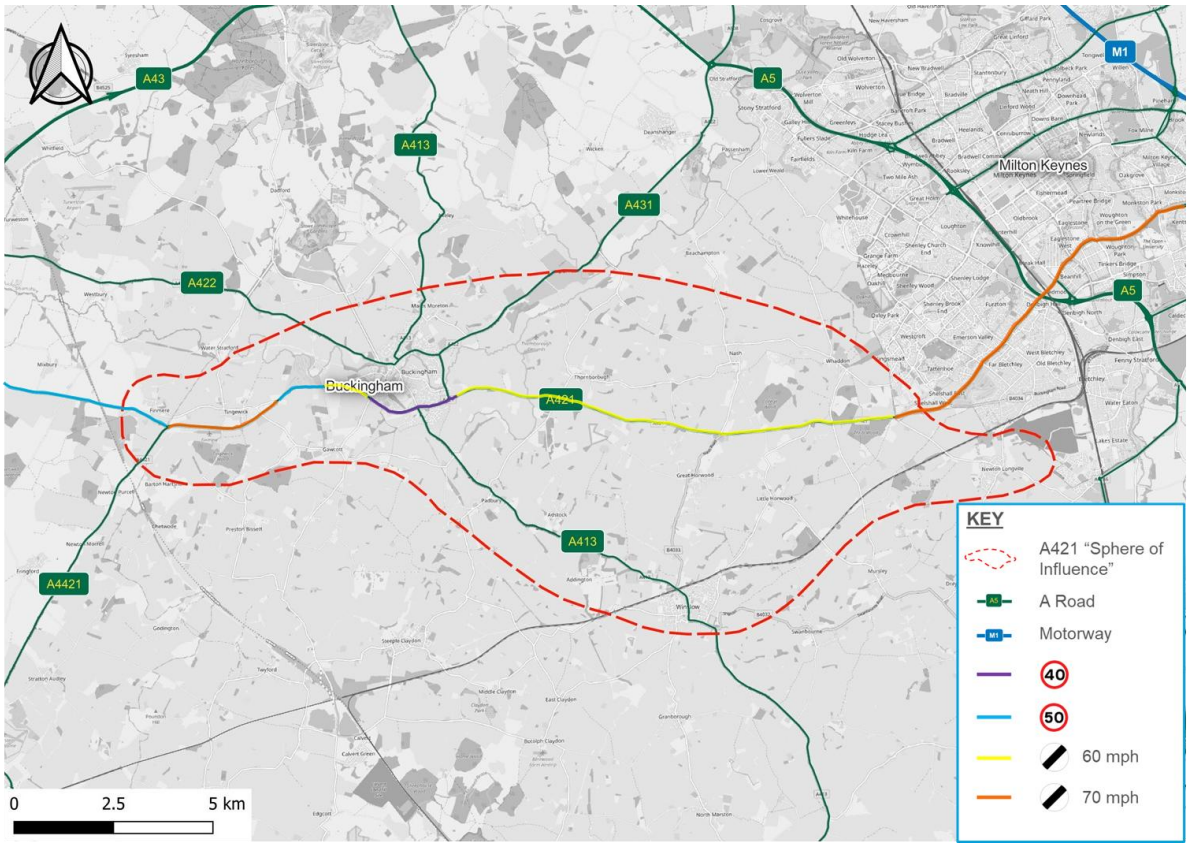


Figure 2-2 - A421 Speed limits

2.3. Current road traffic volumes

2.3.1. Traffic on the A421

Below are data from Automatic Traffic Counters on the A421 which record the number of vehicles passing the counter. Data are presented for a typical week (i.e. unaffected by school holidays or other seasonal variations) for two sites east and west of Buckingham.

Traffic volumes are shown for each hour of the day for an average of Tuesday to Thursday, and separately for Friday, Saturday, and Sunday.

2.3.1.1. West of Buckingham

Figure 2-3 and Figure 2-4 show hourly traffic volumes on the Tingewick bypass in the eastbound and westbound directions respectively near Kenneth Ross Bridge (ATC site 38).

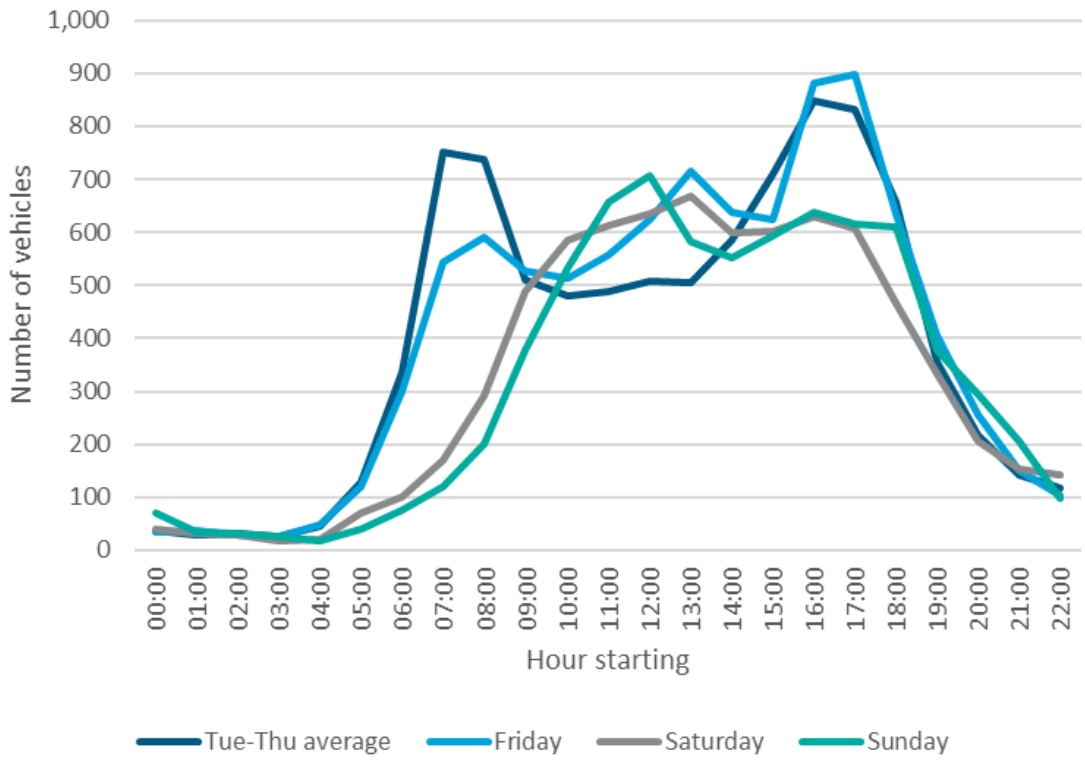


Figure 2-3 – Traffic volume: A421 Tingewick Bypass eastbound, w/c 6th March 2023

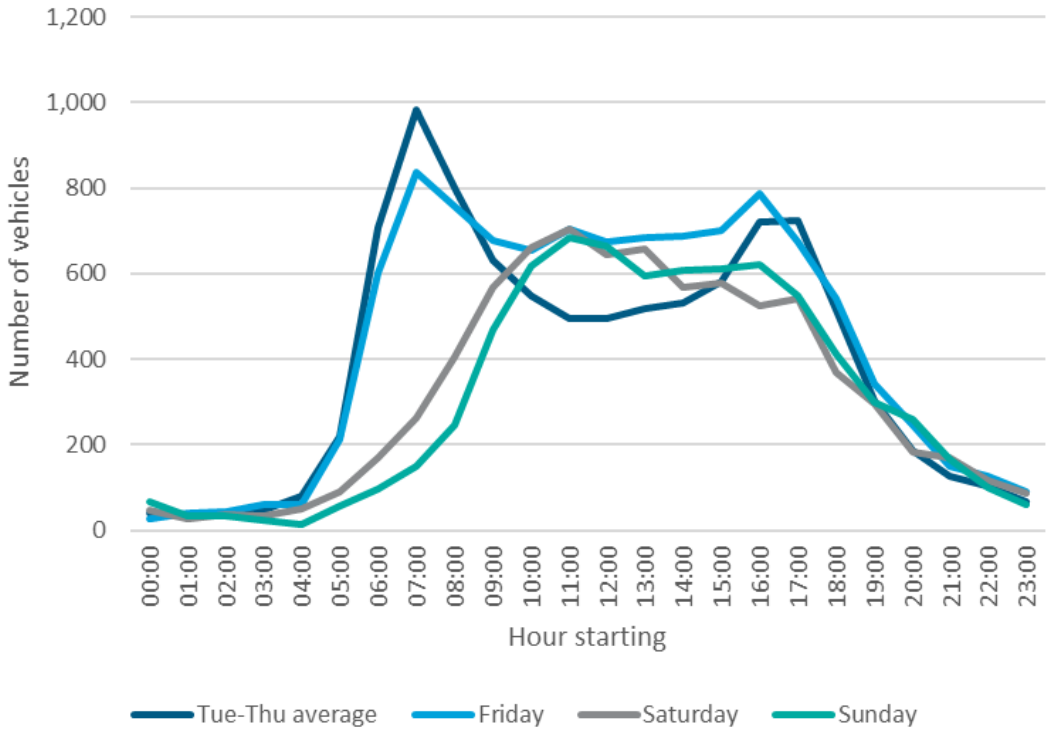


Figure 2-4 - Traffic volume: A421 Tingewick Bypass westbound, w/c 6th March 2023

The charts show morning and evening weekday peaks in both directions. Traffic volumes are highest on weekdays, peaking at 800-900 vehicle per hour eastbound in the evening peak and 800-1,000 vehicles per hour westbound in the morning peak; suggesting that the commuting movement to locations to the west of the counter are slightly higher than those to locations to the east. These volumes of traffic are well within the typical design capacity for a road of this type (rural all-purpose dual two-lane carriageway) of 1,400 vehicles per hour. Adjacent sections of the A421 are single carriageway roads where these traffic volumes are close to the typical design capacity (900 vehicles per hour)[2]. During the inter-peak period, Friday traffic volumes are higher than the Tuesday to Thursday average in both directions.

Weekend traffic volumes are typically lower than during the weekdays but are higher on both Saturdays and Sundays between 10:00 and 12:00.

2.3.1.2. Central Buckingham

Surveys at the A421/London Road roundabout mean it is possible to calculate weekday traffic volumes on the A421 east of London Road for the 07:00-19:00 period. These are shown in Figure 2-5 (eastbound) and Figure 2-6 (westbound).

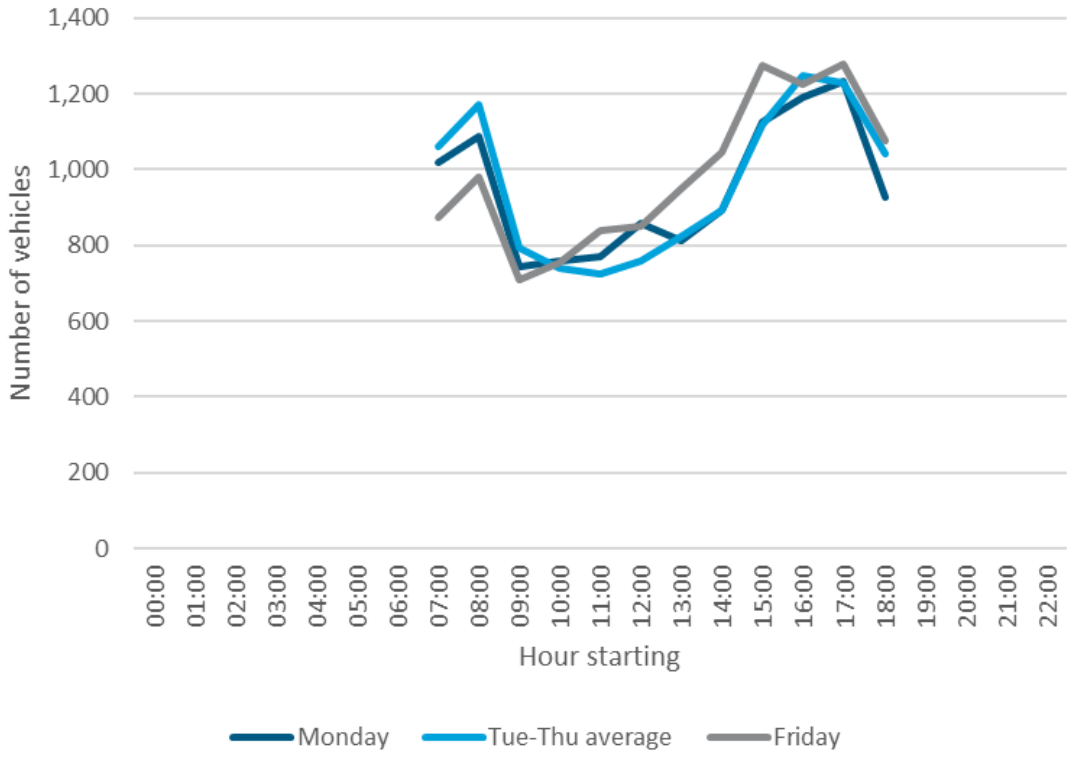


Figure 2-5 - Traffic volume: A421 east of London Road, eastbound, w/c 16th May 2024

[2] WebTAG Unit M3.1 (DfT, May 2020) Table D.3 states a typical design capacity of Type 1 roads (rural single carriageways) as 900 vehicles per hour per direction, and a maximum design capacity as 1,600 vehicles. For Type 2 roads (rural all-purpose dual 2-lane carriageways and motorways) the typical capacity is stated as 1,400 vehicles per hour per direction, and the maximum as 2,250 vehicles, but at or below 2,100 vehicles for rural all-purpose roads rather than motorways). It is worth noting however that, unless traffic volumes are close to the link capacity, traffic delays are typically a result of the capacity of the 'downstream' junction rather than the link itself.

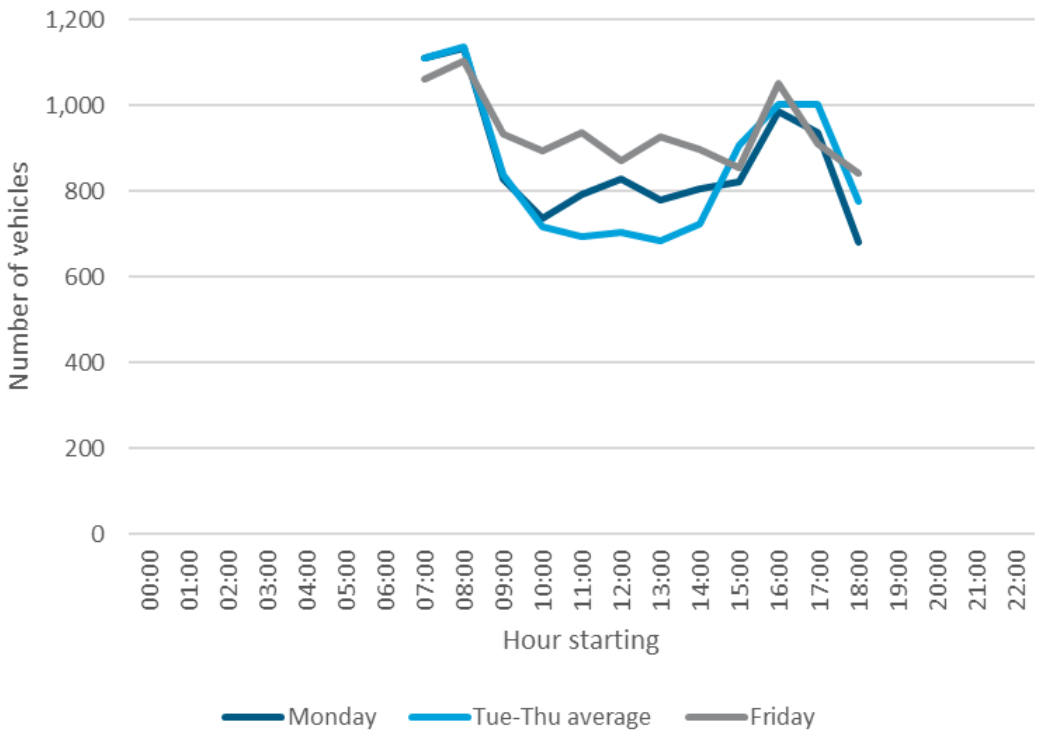


Figure 2-6 - Traffic volume: A421 east of London Road, westbound, w/c 16th May 2024

The charts show that there is relatively little difference between days of the week in the eastbound direction, though the evening peak is earlier on a Friday. In the westbound direction there is more variation between days, particularly in the inter-peak period. Peak traffic volumes are 1,200 to 1,300 vehicles per hour in the eastbound evening peak and 1,100 to 1,200 vehicles per hour in the westbound morning peak.

2.3.1.3. East of Buckingham

An automatic traffic counter (ATC site 39) is located on the A421 west of Bottledump Roundabout close to Bottledump Stables. However, due to technical issues the counter the most recent data available are for week commencing 13th September 2021. Most COVID-19 restrictions were removed in mid-July 2021 and in normal circumstances September can be considered a typical month. Given the circumstances these data should be treated with some caution.

Data is available for the westbound direction (towards Buckingham) only and this is shown in Figure 2-7.

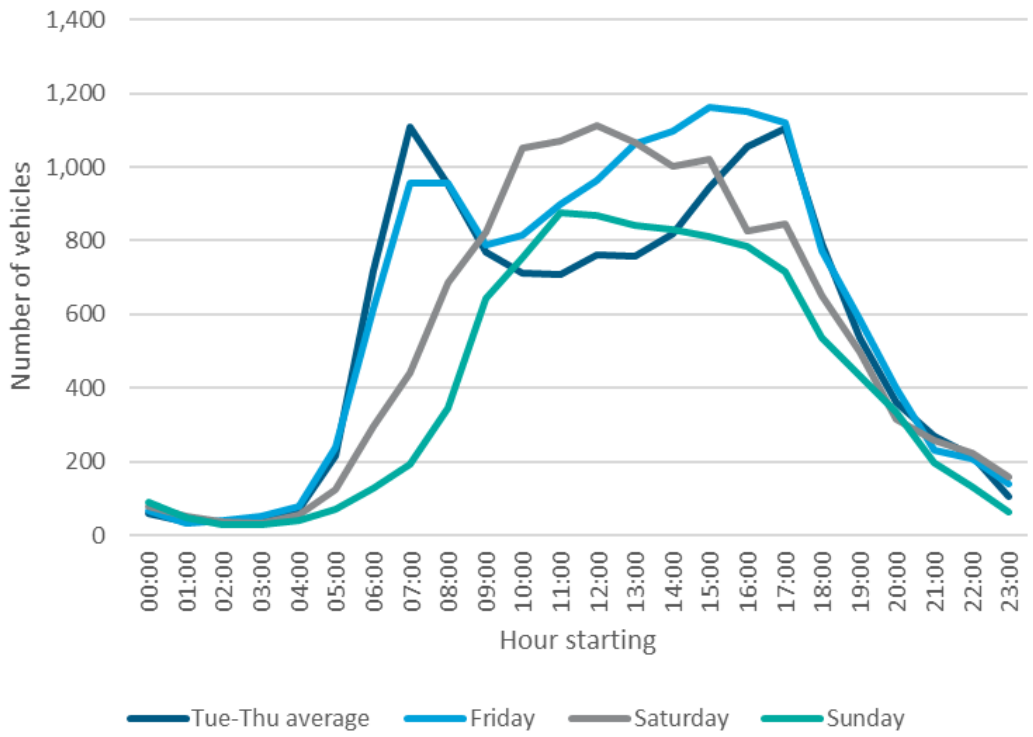


Figure 2-7 - Traffic volume: A421 west of Bottledump Roundabout, w/c 13th September 2021

The chart shows that traffic volumes at this site are higher than on the Tingewick Bypass. The weekday morning and evening peaks have traffic volumes of 1,000-1,200 vehicles per hour per direction which is above the typical design capacity of this standard of road, but within the theoretical maximum of 1,600 vehicles. Traffic volumes remain high throughout the inter-peak period on Fridays.

Inter-peak traffic levels on Saturdays are also high and exceed the Tuesday to Thursday average from 09:00 until 16:00.

2.3.2. Traffic movements at junctions

Data from turning count surveys have been used to understand patterns of traffic for three junctions on the corridor:

- The London Road roundabout in central Buckingham (surveyed on five days during May 2024);
- the A421/Tingewick Road (C137) roundabout to the west of Buckingham (Site CTC 79) and the A421/A413 roundabout to the south-east of Buckingham (Site CTC 77) (both surveyed on Tuesday 12th October 2021).

2.3.2.1. A421/London Road roundabout

The traffic movements at the A421/Tingewick Road roundabout are summarised in Table 2-1 for the period 07:00-19:00 on Thursday 16th May 2024. Figure 2-8 shows the percentage of traffic turning each way from each arm with the thickness of the lines proportionate to the number of vehicles making each movement.

		To				
		A421 (west)	London Rd (north)	A421 (east)	London Rd (south)	Total
From	A421 (west)	46	1,161	7,833	3,332	12,372
	London Rd (north)	1,366	8	890	3,539	5,803
	A421 (east)	7,206	598	3	2,858	10,665
	London Rd (south)	3,534	3,285	2,966	3	9,788
	Total	12,152	5,052	11,692	9,732	38,628

Table 2-1 – Turning movements at A421/London Road roundabout, 16th May 2024 07:00-19:00

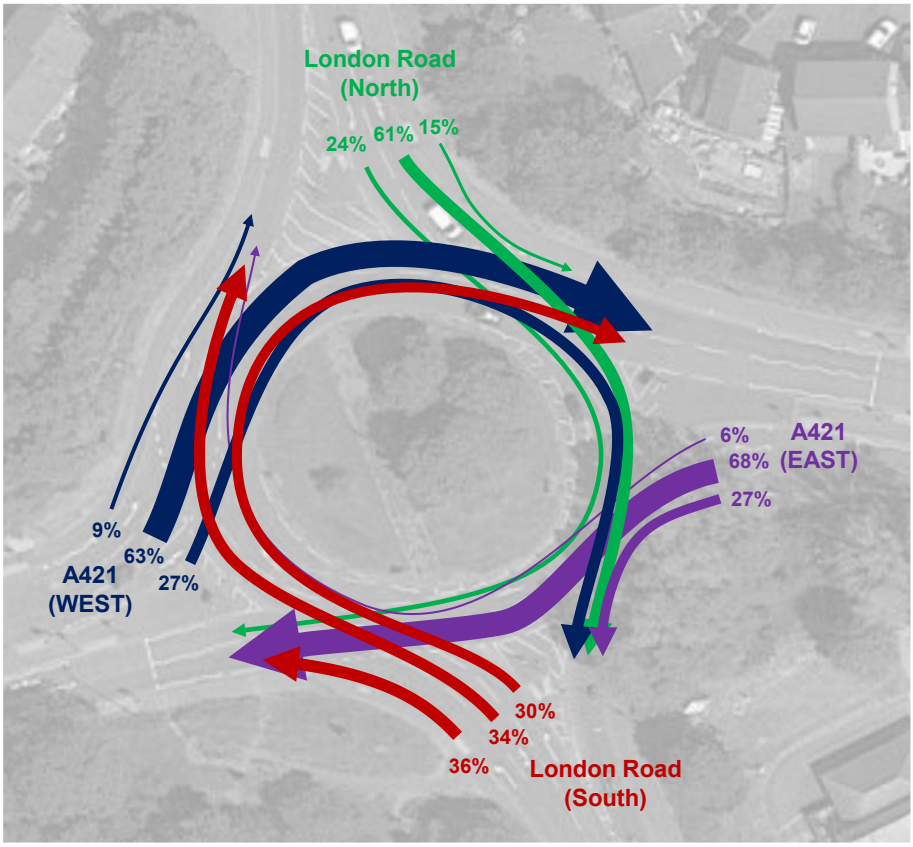


Figure 2-8 - Turning movements at A421/London Road roundabout, 16th May 2024 07:00-19:00

Interestingly, less than half (39%) of traffic is travelling through the junction on the A421. Nearly one in five vehicles (18%) using the junction are crossing the A421 on London Road, whilst the remaining 43% turned between the A421 and London Road (i.e. made a left or right turn).

The total traffic on the A421 (east) of 22,354 vehicles compares to 20,383 vehicles to the west of the A413 roundabout in the same time period in March 2023 traffic count (see Table 2-3).

The survey recorded traffic by vehicle type. The proportion of traffic in different vehicle types did not change significantly by time of day. The share of vehicles which were vans and lorries was lower from the London Road arms (12-13%) compared to the A421 arms (19-21%). Over 80% of vehicles were cars, as shown in Figure 2-9.



Figure 2-9 – Vehicle type, A421/London Road roundabout, 16th May 2022 07:00-19:00

2.3.2.2. A421/Tingewick Road roundabout

The traffic movements at the A421/Tingewick Road roundabout are summarised in Table 2-2 for the 12-hour survey period. Figure 2-10 shows the percentage of traffic turning each way from each arm with the thickness of the lines proportionate to the number of vehicles making each movement.

		To			
		A421 (west)	**Tingewick Rd**	**A421 (east)**	**Total**
From	**A421 (west)**	1	1,536	7,488	9,025
	Tingewick Rd	1,333	15	515	1,863
	A421 (east)	7,211	446	8	7,665
	Total	8,545	1,997	8,011	18,553

Table 2-2 - Turning movements at A421/Tingewick Road roundabout, 12th October 2021 07:00-19:00

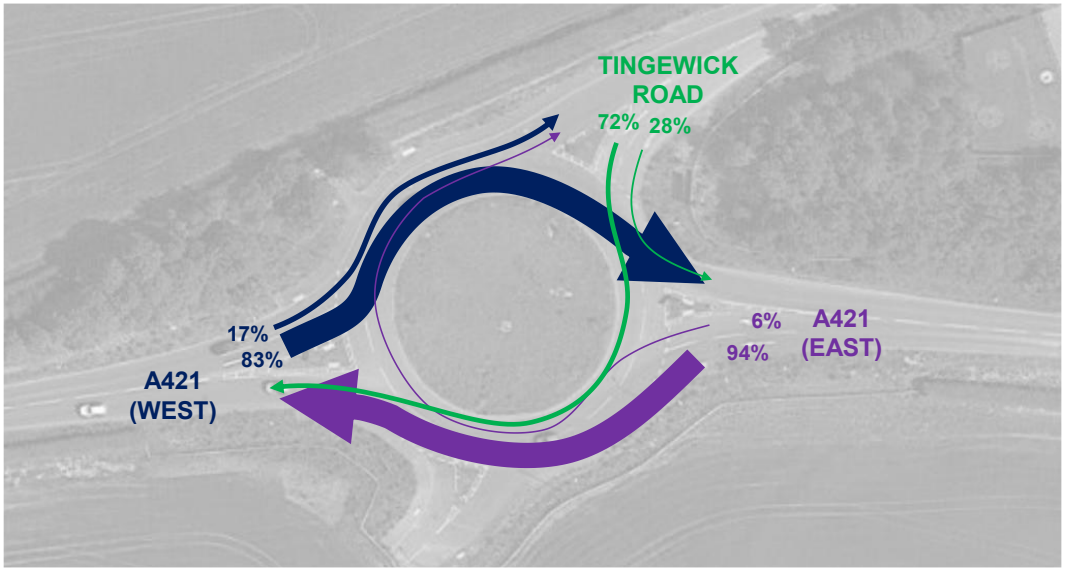


Figure 2-10 - Turning movements at A421/Tingewick Road roundabout, 12th October 2021 07:00-19:00

The majority (79%) of traffic through the roundabout is travelling along the A421 with the remaining 21% entering or leaving Tingewick Road. Three-quarters (75%) of traffic to/from Tingewick Road it to/from the (west).

The total traffic on the A421 (west) of 17,569 vehicles compares to 15,100 vehicles in the same time period on an average weekday from the March 2023 traffic count on the Tingewick bypass above.

The survey recorded traffic by vehicle type. The proportion of traffic in different vehicle types did not change significantly by time of day. The share of vehicles which were trucks/heavy trucks was lower on the Tingewick Road arm (6%) compared to the A421 (10-11%). Three-quarters (75%) of vehicles were cars, 14% vans and 10% trucks (rigid and articulated lorries) as shown in Figure 2-11.

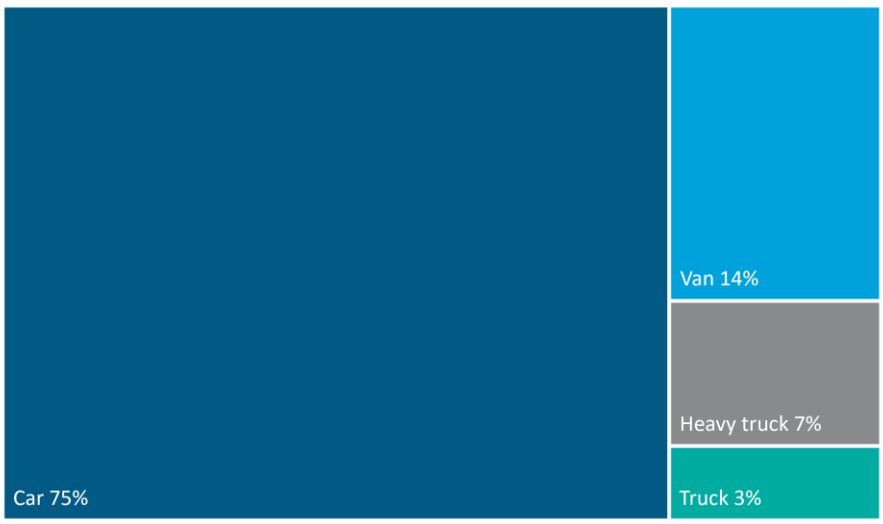


Figure 2-11 – Vehicle type, A421/A413 roundabout, 12th October 2021 07:00-19:00

2.3.2.3. A421/A413 roundabout

The traffic movements at the A421/A413 roundabout are summarised in Table 2-3 for the 12-hour survey period. Figure 2-12 shows the percentage of traffic turning each way from each arm with the thickness of the lines proportionate to the number of vehicles making each movement.

		To			
		A421 (west)	**A413**	**A421 (east)**	**Total**
From	**A421 (west)**	83	4,232	6,369	10,684
	A413	4,462	5	1,480	5,947
	A421 (east)	5,237	1,275	7	6,519
	Total	9,782	5,512	7,856	23,150

Table 2-3 - Turning movements at A421/A413 roundabout, 12th October 2021 07:00-19:00

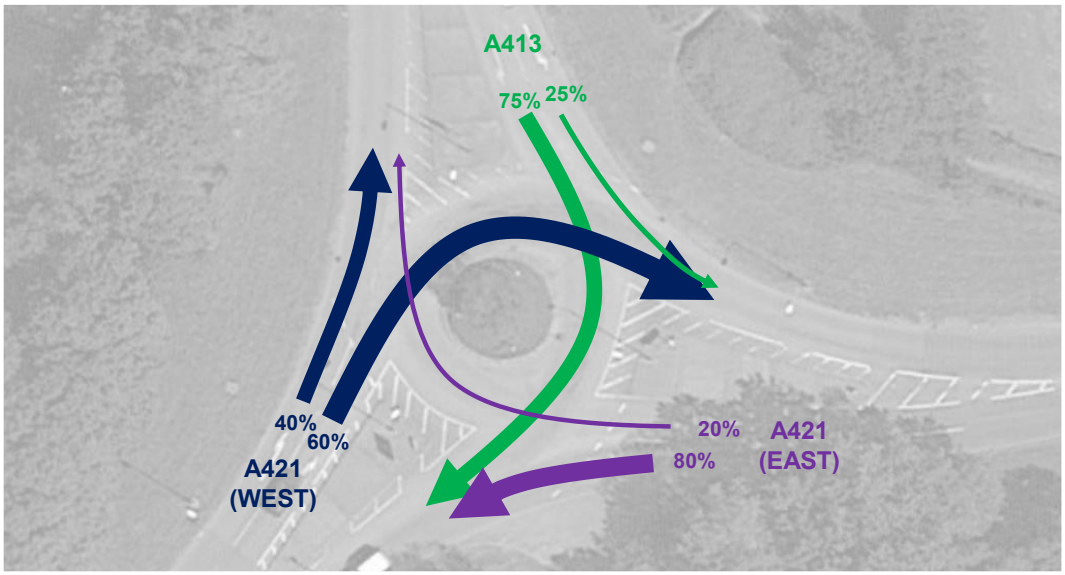


Figure 2-12 - Turning movements at A421/A413 roundabout, 12th October 2021 07:00-19:00

Just over half (51%) of traffic through the roundabout is travelling along the A421 with the remaining 49% entering or leaving the A413. The A413 interacts more with the A421 (west) than A421 (east) with over 75% of A413 traffic heading to or from the A421 (west).

The 6,519 vehicles approaching the roundabout from the A421 (west) compares to 10,487 westbound on the A421 near Bottledump Roundabout in September 2021 above.

The survey recorded traffic by vehicle type. The proportion of traffic in different vehicle types did not change significantly by time of day or arm of junction. Over three-quarters (78%) of vehicles were cars, 12% vans and 10% trucks (rigid and articulated lorries) as shown in Figure 2-13.



Figure 2-13 – Vehicle type, A421/A413 roundabout, 12th October 2021 07:00-19:00

2.3.3. Traffic patterns

To understand the origins and destinations of journeys using the A421, 'select link' analyses were undertaken using the Buckinghamshire Strategic Traffic Model (BSTM) for the 'base year' (2019) scenario. Note that although the base year is in the past, the outputs of the model is a calculated forecast checked against real observed data to 'validate' the model. All information in this section arising from the BSTM should therefore be treated as indicative rather than definitive. Further information regarding what is included within the BSTM, see Appendix B.

Journey origins and destinations were extracted from the model for all vehicles passing along three sections of the A421:

- the Tingewick Bypass;
- between Osier Way and London Road in Buckingham; and
- south east of Whaddon between Whaddon Road and V1 Snelshall Street.

Figure 2-14 shows the locations of these links and also the geographic sectors which have been used to define the origins and destinations of traffic on those links from the BSTM.

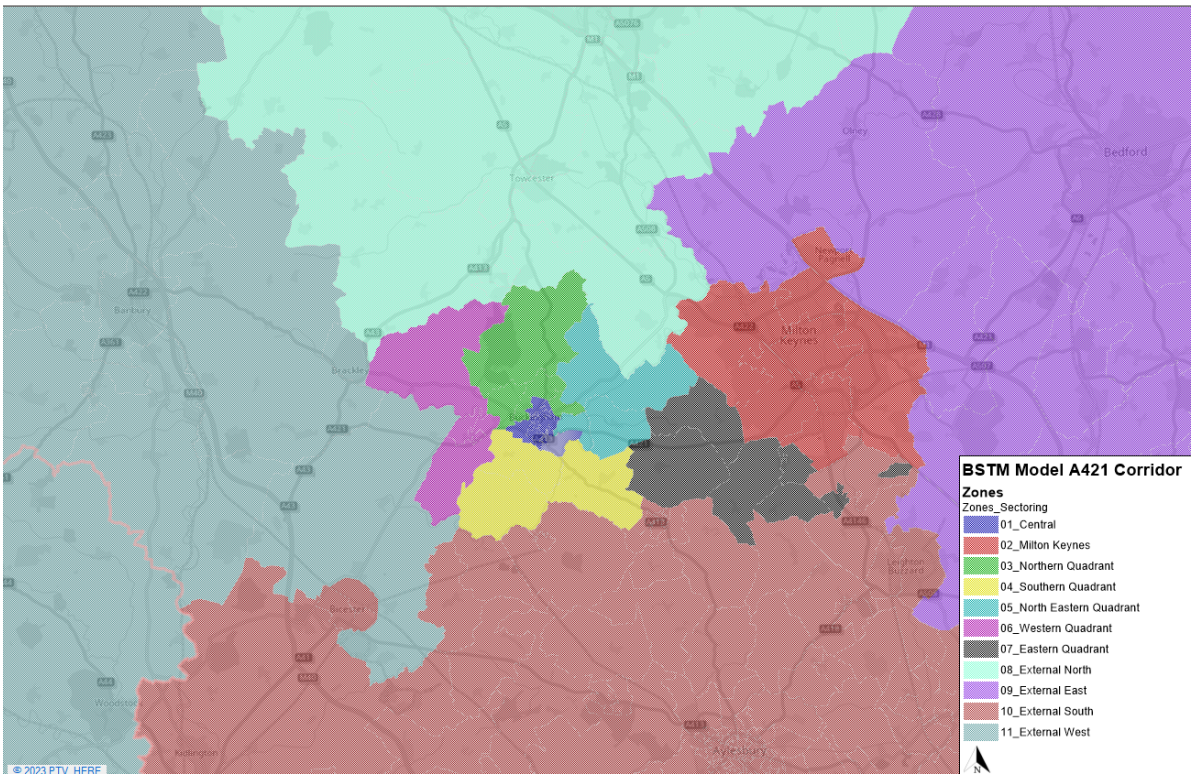


Figure 2-14 - Select link analysis links in BSTM

Maps from the BSTM showing the patterns of origins and destinations for the three sites in each direction (for the morning peak) are provided in Appendix A (Figure A-2 to Figure A-7). A selection of these is also reproduced in the section below.

2.3.3.1. Tingewick Bypass

Given its location, all traffic passing eastbound along the Tingewick Bypass originates from outside of the study area (the same is true of westbound destinations). As shown in Figure 2-15, the majority of traffic joins the bypass from the A4421 (from Bicester) rather than from the A421 (from the A43/Brackley).

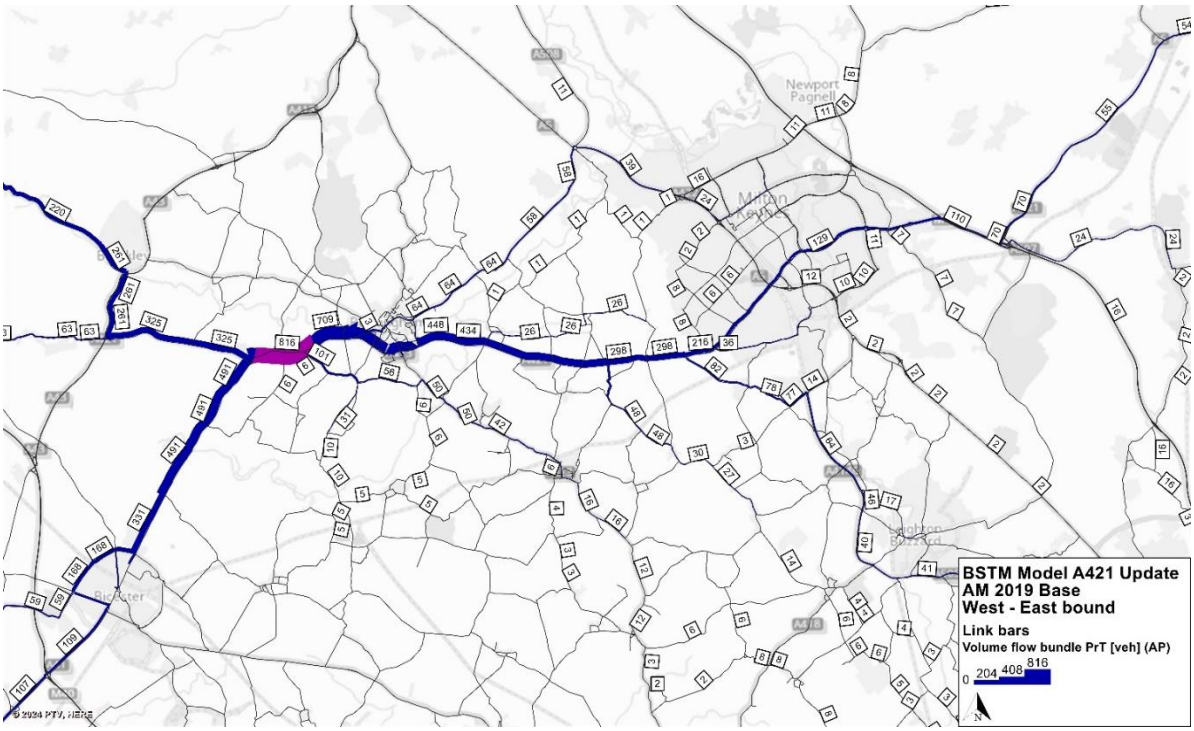


Figure 2-15 – Select link analysis: Tingewick Bypass eastbound (morning peak)

Of the traffic heading eastbound in the morning peak hour, 22% is destinated for Buckingham, 30% to Milon Keynes or further east, and a further 25% to elsewhere in the A421 corridor. Approximately 20% of traffic is heading south towards Aylesbury and beyond. This pattern is similar in the opposite directions in the evening peak hour but with 26% originating in Buckingham.

Overall, in the peak periods, 40-50% of traffic is through traffic (both origin and destination beyond the Finmere- Bottledump section of the A421). In the inter-peak period this figure is about 40%.

2.3.3.2. South of Buckingham

The dominance of the A4421 over the A421 as the origin route for traffic is also true for the section of the A421 south of Buckingham (and again as a destination route in the evening peak) as shown in Figure 2-16. Depending on time period and direction, about 50% of traffic passing Buckingham is travelling to/from the External South sector (which includes Bicester and Aylesbury). Approximately 50-60% of traffic on this link is travelling to or from Buckingham.

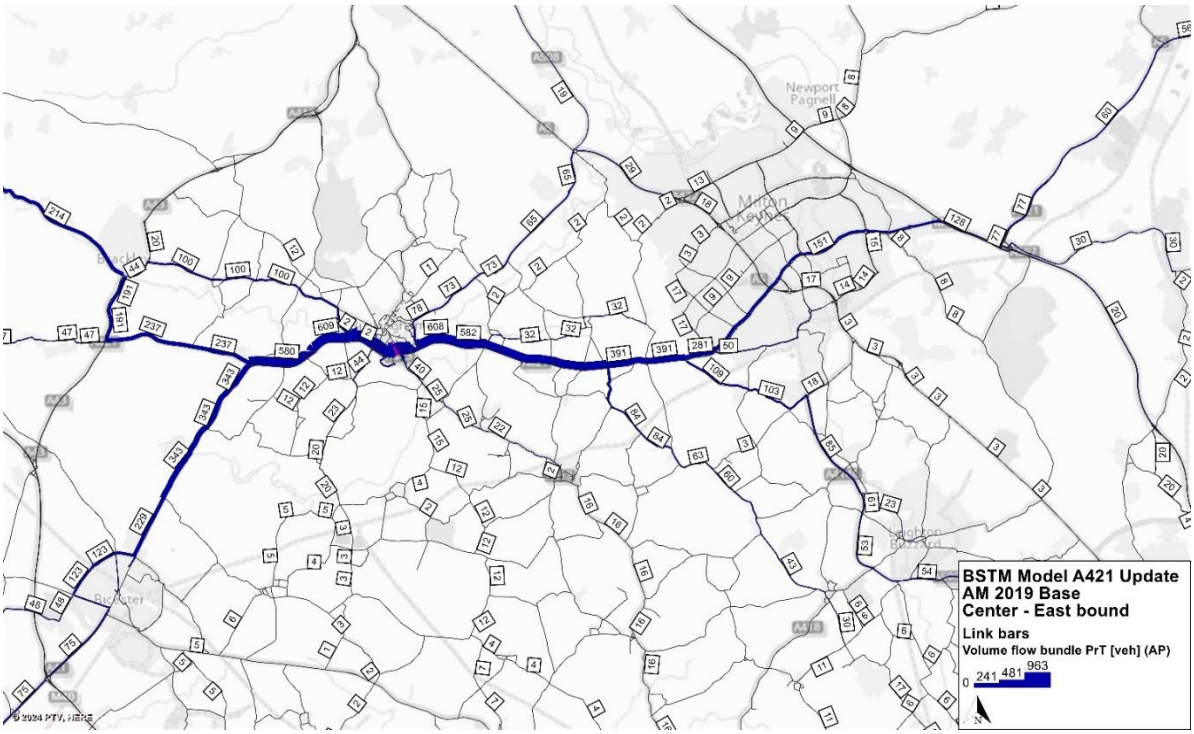


Figure 2-16 – Select link analysis: A421 Buckingham eastbound (morning peak)

Looking to the east, approximately 20-30% of traffic passing Buckingham on the A421 is travelling to or from Milton Keynes or further east. Overall, 15-20% of traffic on this section has both origin and destination in the Finmere-Bottledump corridor and approximately 30-40% is through traffic (i.e. both ends of the journey outside of this section).

2.3.3.3. Bottledump roundabout

Of the traffic travelling on the A421 west of Bottledump Roundabout, approximately 60% is travelling to/from the External South sector (Figure 2-17 shows notable traffic flows in the morning peak hour from Bicester, Winslow and Aylesbury along this link towards Milton Keynes). A further 10-15% is travelling to or from Buckingham. A high share of traffic (typically 85-90%) is heading to/from Milton Keynes or east of Milton Keynes.

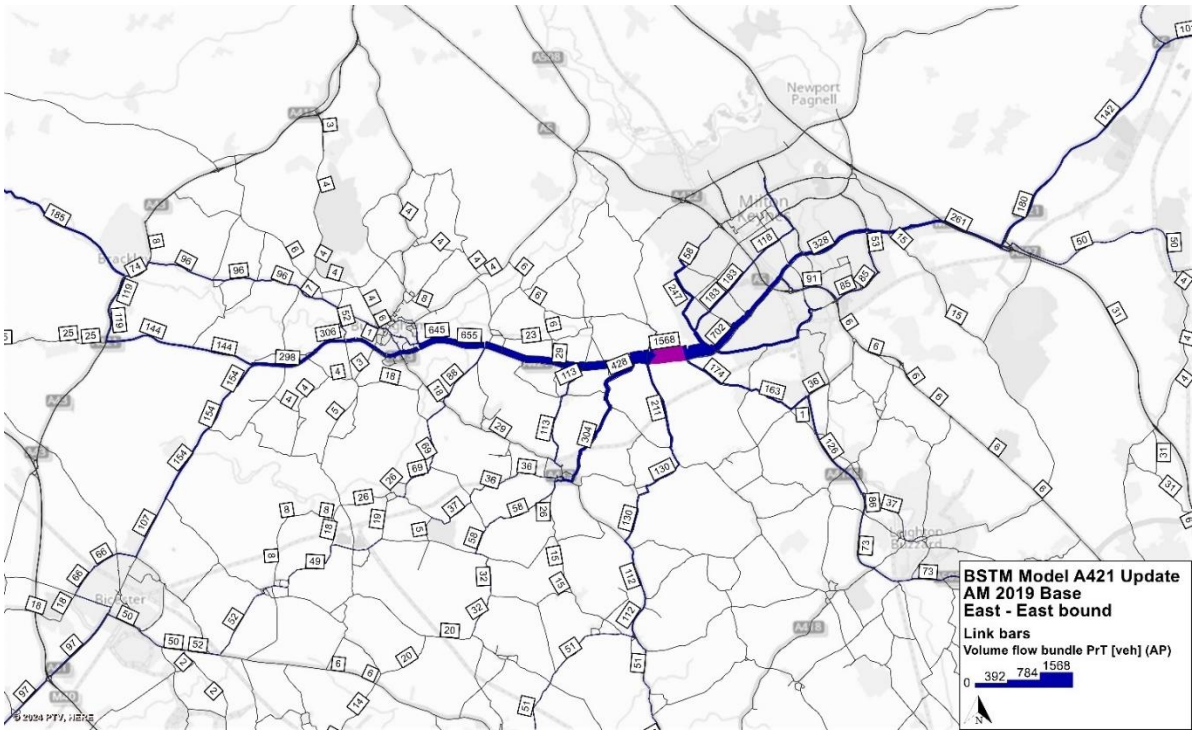


Figure 2-17– Select link analysis: A421 Bottledump eastbound (morning peak)

2.3.3.4. Summary

Table 2-4 summarises some of the key characteristics of travel patterns on the A421 at the three selected links discussed above. In the Buckingham area, approximately 30-40% of traffic has neither origin nor destination in the study area whilst at most 20% could be considered local to the corridor.

		Tingewick Bypass	Buckingham	Bottledump
Local vs through traffic (total = 100%)	**Local (origin & destination in corridor)**	0%	12-20% (peak) 16-20% (IP)	0-1%
	To/from corridor (origin or destination outside corridor)	46-60% (peak) 59-61% (IP)	45-54% (peak) 41-53% (IP)	35-42% (peak) 33-38% (IP)
	Through traffic (origin and destination outside corridor)	40-53% (peak) 39-41% (IP)	28-42% (peak) 31-39% (IP)	57-65% (peak) 62-67% (IP)
To or from Buckingham		22-41% (peak) 24-33% (IP)	36-55% (peak) 49-52% (IP)	9-16% (peak) 9-12% (IP)
To or from Milton Keynes		15-17% (peak) 11-16% (IP)	15-18% (peak) 13-24% (IP)	68-72% (peak) 74-76% (IP)

IP = 'inter peak' (between 10:00 and 16:00)

Table 2-4 - Summary of traffic patterns on selected links, peak and inter-peak

2.4. Public transport services

At present, public transportation provision within the study area primarily consists of rural and inter-urban buses. These routes provide connections between towns in the study area such as Buckingham and Winslow with settlements such as Milton Keynes and Aylesbury.

2.4.1. Bus services

National and local operators such as Stagecoach, Redline buses and Arriva run several services in the corridor, though few services use the A421 itself. The bus services in the study area can be categorised into three groups:

- frequent express services to between Bicester, Buckingham and Milton Keynes (the X5);
- semi-frequent services between Aylesbury, Bicester/Brackley, Buckingham and Milton Keynes;
- infrequent or quotidian buses connecting rural villages, often not operating on Sundays (and in some cases running only certain days of the month).

The bus services operating in the study area are shown in Table 2-5 and Figure 2-18. School day only services have not been included.

Service number	Operator	Route	Typical service (buses per direction and hours of operation)
X5	Stagecoach	Oxford – Bicester – Buckingham – Milton Keynes – Bedford *(via A422)*	Mon-Sun: 1 per hour (all day)
X6	Arriva	Aylesbury – Winslow – Buckingham – Milton Keynes *(via A422)*	Mon-Fri: 2 per hour (0600-2000) Saturday: 1 per hour (0700-2000) Sunday: No service
18	Langston & Tasker, Red Rose	Buckingham – Steeple Claydon – Bicester	Mon-Sat: 1 per 2 hours (0800-1600) Sunday: No service
54B	Winslow Bus	Whaddon – Nash – Great Horwood – Winslow	Wednesdays only: 2 per day
60 / 60A	Red Line, Red Rose, Z&S	Aylesbury – Padbury - Winslow – Buckingham	Mon-Fri: 1 per 2 hours (0700-1800) Saturday: 1 per 2 hours (0900-1700) Sunday: No service
68	Winslow Bus	Westcroft – Winslow	2nd and 4th Thursday of each month: 1 per day
131-134 / 151	Redline	Banbury/Brackley – Buckingham	Mon-Sat: 1 per 2 hours (0800-1700) Sunday: No service

Table 2-5 – Bus services in the study area (excluding school day services)

Services between Buckingham and Milton Keynes operate via the A422 rather than the A421, as shown in Figure 2-18. The A421 is however used by some services for part of their route, notably the X5 between Buckingham and Finmere.

The services to Milton Keynes and Aylesbury also provide important connections to the national rail network. The 60/60A route serving Winslow will also provide a connection to East-West Rail services once services begin operation in 2025. However, the relatively low frequency of the 60/60A bus services may not be attractive to rail passengers.

The 2017 Buckingham Transport Strategy noted that the strengths of bus services in the region are its relatively good spatial coverage and that there are services to rail stations at Milton Keynes and Aylesbury.

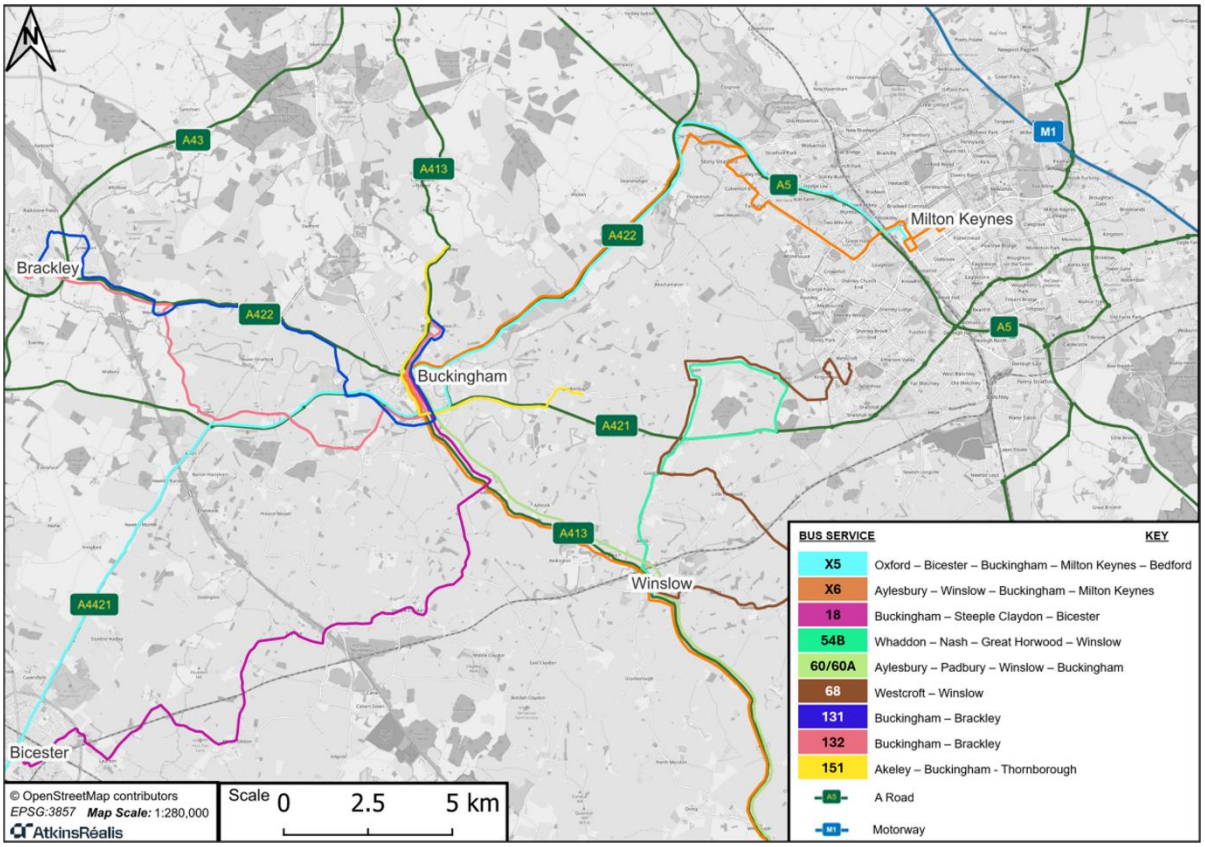


Figure 2-18 – Current bus services in the corridor

2.4.2. Rail services

Buckingham is not served by rail; the nearest stations to the corridor currently being in Aylesbury, Milton Keynes, Bletchley and Bicester.

The study area is set to receive a railway link to Oxford, Bicester and Milton Keynes with the construction of Winslow Railway station. This will provide the corridor with passenger railway services for the first time since the cessation of regular passenger rail services to Winslow and Buckingham in 1968 and 1966, respectively. Construction work on this section of East West Rail was completed in 2024, with testing now being undertaken (Network Rail, 2024)[3].

Milton Keynes Central station is located on the West Coast Main Line and is served by Avanti West Coast and London Northwestern Railway (West Midlands Trains), with regular services to London Euston and Birmingham New Street.

Bicester Village is located on the Oxford-Bedford line, operated and served by Chiltern Railways, with a regular service to London Marylebone and Oxford.

Aylesbury is located on the London-Aylesbury line, operated by Chiltern Railways serving London Marylebone in a journey time of around one hour.

[3] Network Rail, 2024. Bicester to Bletchley/Milton Keynes - Network Rail. Available at: First train completes test run between Oxford and Milton Keynes for East West Rail

Bletchley station is located just south of Milton Keynes and connects to the A421 via the B4034. It is situated on the West Coast Main Line and also junctions with the Bletchley-Bedford Marston Vale Line. Bletchley is operated by London Northwestern Railway (West Midlands Trains).

2.5. Walking & cycling facilities

2.5.1. Public rights of way

There is an extensive network of Public Rights of Way (PROW) in the corridor, primarily footpaths and bridleways. As shown in Figure 2-19, these are predominantly in rural areas, linking villages or extending from Buckingham. A number of these PROWs cross the A421. Whilst of value for leisure, they are not typically considered to be a realistic travel choice for the majority of journeys in the corridor outside of the settlements themselves, not least as there is a lack of off-road cycling facilities.

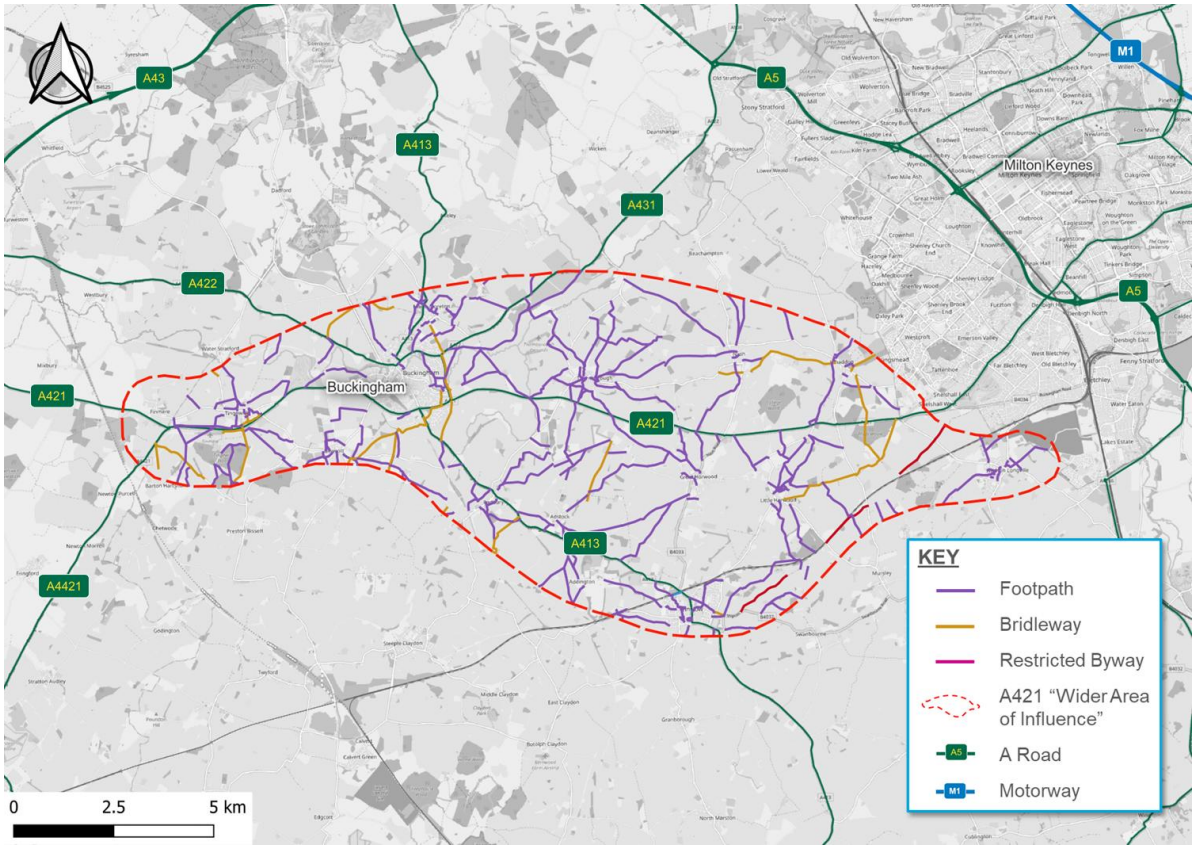


Figure 2-19 - A421 Corridor PROW Network

2.5.2. Pedestrian crossings on the A421

As shown in Figure 2-20, there are 14 pedestrian/PROW crossings on the A421 between the A43/A421 Roundabout and the B40434 (Buckingham Rd)/ A421 roundabouts. Of these:

- three (all in south Buckingham) are controlled crossings (see example in Figure 2-21);
- four are grade-separated crossings (bridges and underpasses); and
- seven are uncontrolled or informal crossings (see example in Figure 2-22).

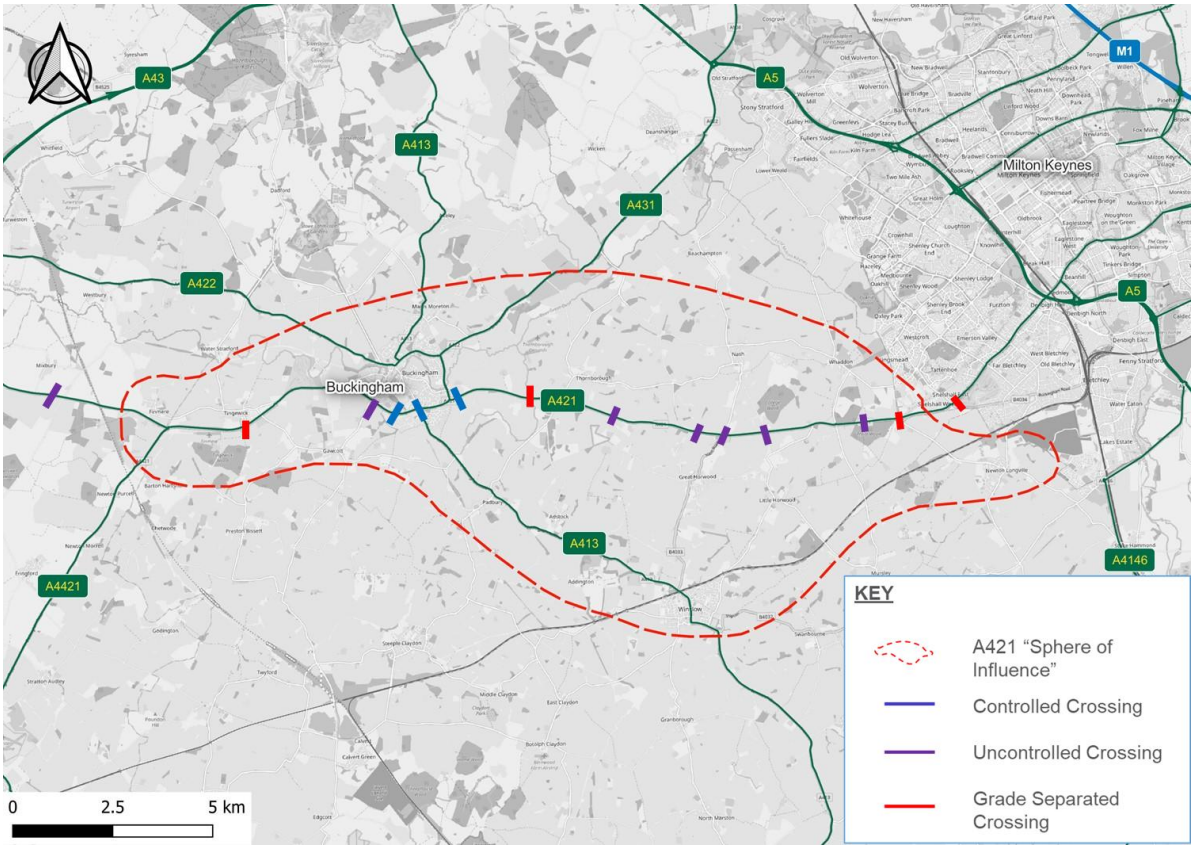


Figure 2-20 – Pedestrian crossings on the A421 [4]



Source: Google Maps (2021)

Figure 2-21 - Toucan crossing on the A421 between Buckingham and Lace Hill

[4] Data Extracted from: Open Street Map. Available at: https://www.openstreetmap.org/#map=12/51.9864/-0.8626; Ordnance Survey 'Oxford to Milton Keynes'. Available at: gps-routes.co.uk/routes/home.nsf/osmapdisp?openform&route=oxford-to-milton-keynes-cycle-route



Google Maps, 2021[5]

Figure 2-22 - Informal PROW Crossing on A421 80m East of Little Horwood Road A421 junction

2.6. Environmental and community features

Within the study area, there are several environmentally protected areas, such as Sites of Special Scientific Interest (SSSI) and Ancient Woodlands. Figure 2-23 includes areas of ancient woodland located immediately adjacent to the A421. This section of woodland is located between the Bottledump and A421/Whaddon Road/Coddimoor Lane roundabouts, which is currently single carriageway and consists of one lane per direction.

This carries specific implications for options which require any works entailing land encroachment on this section of the A421, such as road widening. A key consideration for any options requiring works between the A421/Padbury Road 'T' Junction and the A421/A413 roundabout is the crossing over Padbury Brook, which is identified as a flooding zone.

[5] Google Maps, 2021 https://www.google.co.uk/maps/@51.9837954,-0.8525289,3a,75y,278.53h,102.05t/data=!3m6!1e1!3m4!1sY9ppxRy-aWmYVR0g-UY_rg!2e0!7i16384!8i8192!5m1!1e1?entry=ttu

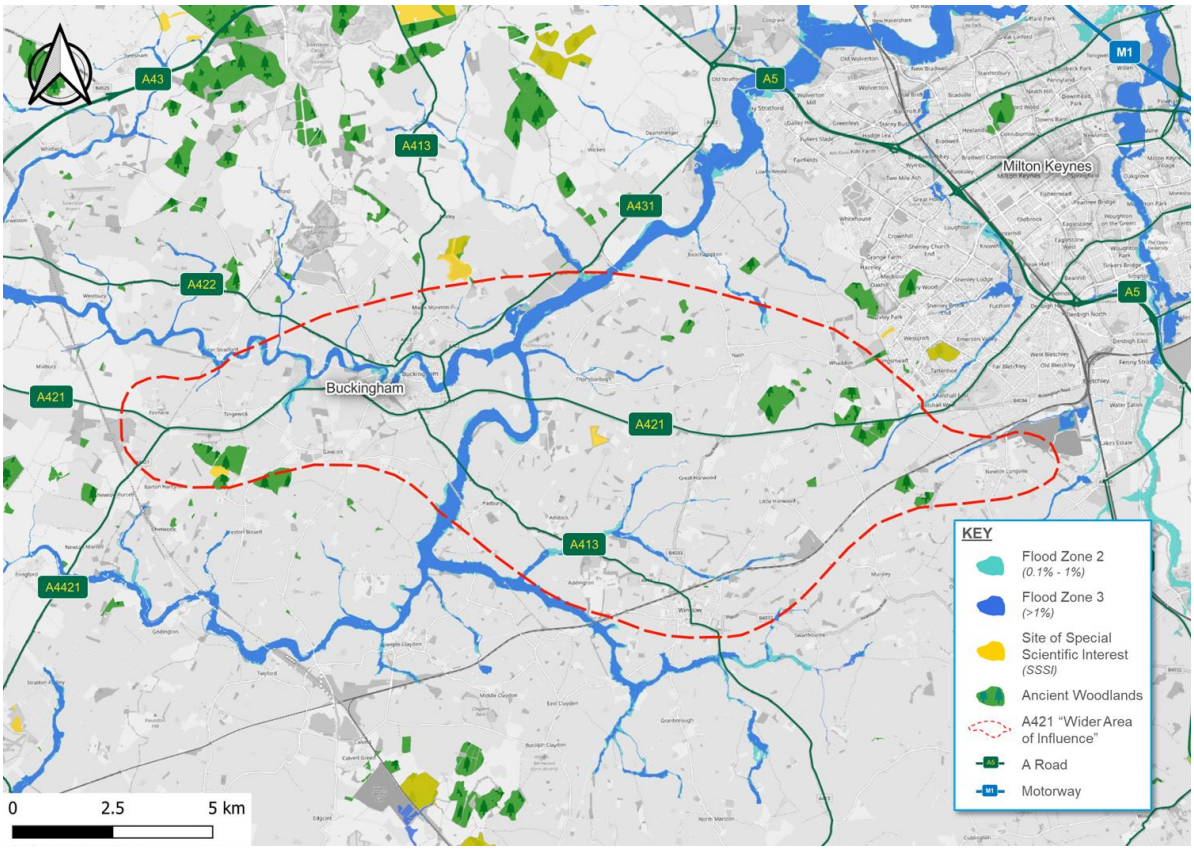


Figure 2-23 - Environmental management areas

There are no Air Quality Management Areas (AQMAs) within the study area. As detailed in the 2023 Air Quality Annual Status Report (Buckinghamshire Council, 2023) Nitrogen Dioxide (NO_2) levels are monitored at several locations across Buckinghamshire, with seven in Buckingham town centre, the closest locations to the A421 corridor. Over the last five years the diffusion tube monitoring indicates that levels of NO_2 have generally reduced, but an increase was observed in 2022 compared to 2021, which may have been affected by Covid. Note, no locations exceed the annual mean concentration[6] of NO_2 of 40 µg/m^3.

[6] Nitrogen dioxide (NO2) - GOV.UK (www.gov.uk)

3. Current challenges and issues

3.1. Introduction

This chapter provides a summary of the primary challenges and issues facing the A421 corridor now and expected in the future. The information is drawn from a number of previous studies as well as additional quantified evidence collated for this study.

The chapter is sub-divided into key themes:

- traffic congestion and unreliable journey times;
- through traffic in Buckingham;
- high traffic volumes in villages;
- limited alternatives to car travel for longer journeys;
- road safety; and
- air quality.

3.2. Traffic congestion and unreliable journey times

3.2.1. Congestion hotspots

A number of studies have previously identified there is congestion on the A421 at peak times. Analysis in 2015 (A421 Corridor Study, Jacobs 2015) found that vehicles were experiencing delays of over three minutes at the T junctions for Thornborough (morning and afternoon peak) and the A421/Warren Road intersection (morning peak only). Volume to capacity ratio (V/C) on the A421 between Bletchley and Whaddon Roundabout was >1.00 for three out of the four sections of road (eastbound) in the morning peak, and >1.00 for two out of four sections of road (both directions) in the evening peak.

Google live traffic has been used to provide an up-to-date consideration of areas of congestion during morning and evening peak hours between 22/06/2023 and 13/07/2023. The junctions were selected as informed by the Jacobs 2015 A421 Corridor Study including South Buckingham roundabouts, and roundabouts on the Milton Keynes approach. In addition, live traffic information has been collected on smaller T and Y junctions, which connect settlements such as Little Horwood and Thornborough to the A421, and rat running hotspots. Examples of rat running hotspots includes routes between Gawcott – Buckingham, Winslow – A421, Horwood – A421.

Areas of congestion noted in 2023 are:

- Milton Keynes approach roundabouts (see Figure 3- 1);
- South Buckingham (Severe congestion at peak hours, specifically around Lace Hill) (see Figure 3-2);
- Buckingham Town Centre (Severe congestion at peak hours) (see Figure 3-2);
- Finmere Roundabout; and
- rat running hotspots such as Thornton (to the A422), Whaddon, Gawcott.

It is also noted that for east-west journeys, the A421 isn't necessarily flagged as the fastest route on journey planning software between Barleymow Roundabout and the M1. A faster route is highlighted to leave the A421 at Buckingham and travel via the A422 and A5 (routing dependent on levels of congestion on the A421).

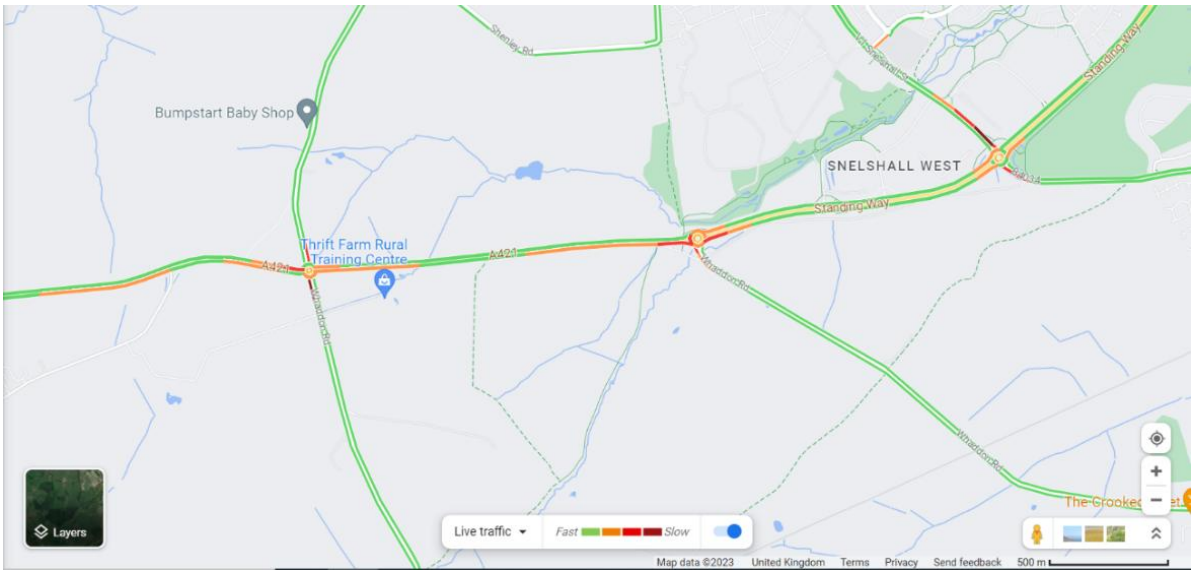


Figure 3- 1 - Congestion on Milton Keynes Approach Morning peak, Wed 28/06/2023

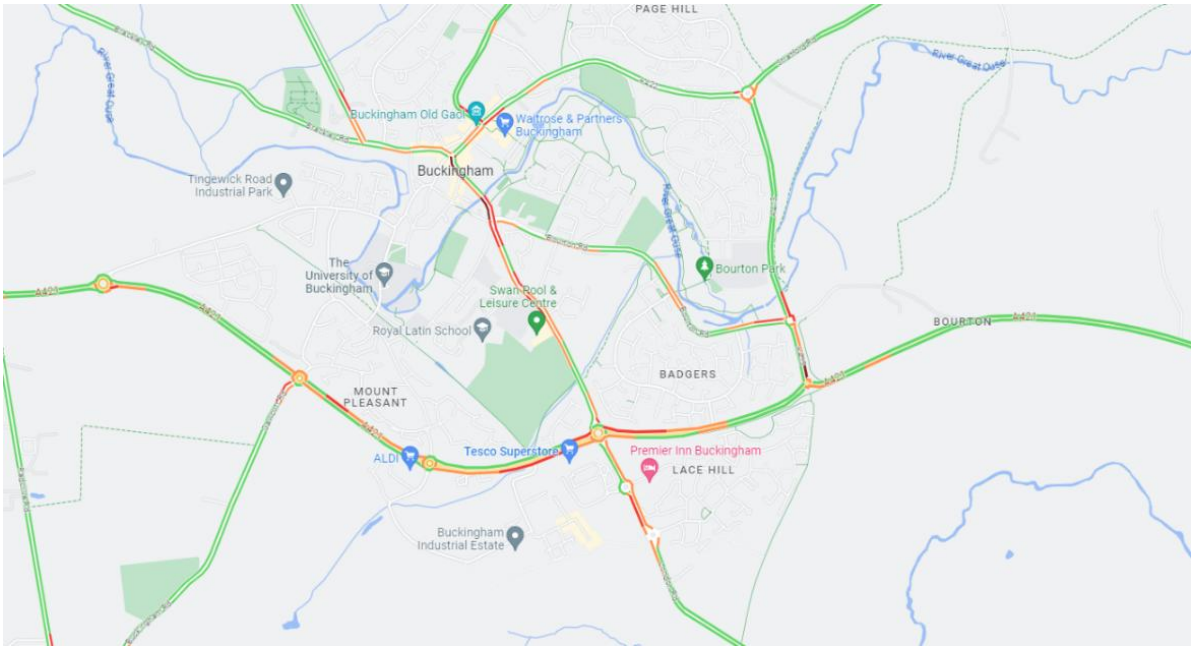


Figure 3-2 - Congestion at Buckingham Morning peak, Thu 29/06/2023

3.2.2. Journey time reliability

Google live traffic has also been used to monitor the reliability of journey times and during the morning and evening peaks between 22/06/2023 and 13/07/2023 on the A421.

- East-West journey times on the A421 within the Buckinghamshire boundary (Finmere Roundabout – Bottledump Roundabout, 19.7 kilometres).
- Total East-West journey times on the A421 between Barleymow Roundabout (A43) and M1 Junction 13.

The data review found that travel time for the 19.7 kilometres using the A421 (Buckinghamshire Boundary) generally ranged from 19 minutes (Friday 28/06/2023 morning peak) to 22 minutes, one outlier being a 28-minute journey time on this section of the A421 for the evening peak on Wednesday 28/06/2023, and a similar east-west journey time for the evening peak on Thursday 29/06/2023. Consistent locations where congestion was noted included the sections of road between Kenneth Ross Bridge (Tingewick) and West Buckingham, and the eastern section of road between Singleborough Lane and Bottledump roundabout. Average journey speeds ranged from 25.5 mph (41 km/h) to 37.9 mph (61 km/h) on this shorter route.

Journey times on the whole length of the A421 ranged from 40-59 minutes. At peak hours, the suggested route from East to West (and vice versa) often involved either rat runs or alternative routes, such as via the A422 and either A5 or M1 (see Figure 3-3 and Figure 3-4). The average journey speed on this route ranged from 26.3 mph(42.3km/h) to 39.3 mph (63.3 km/h).



Figure 3-3 - Eastbound journey time A43 to M1 J13 (Evening peak, Thu 29/06/2023)

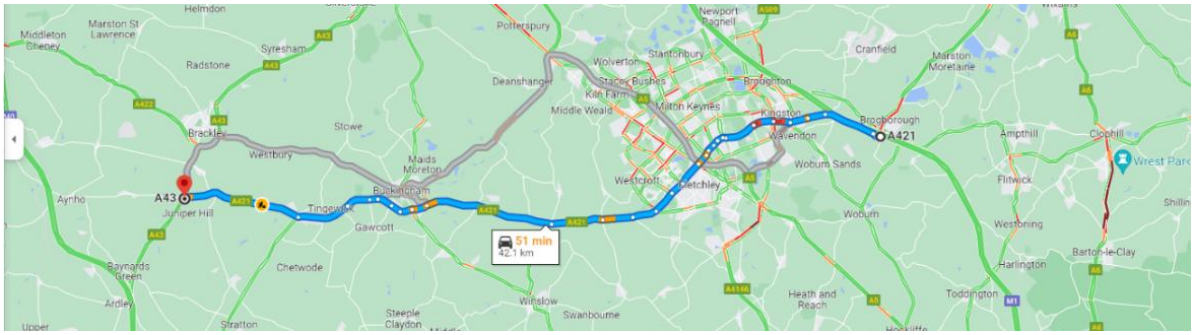


Figure 3-4 - Westbound journey time M1 J13 to A43 (Morning peak, Tue 04/07/2023)

3.3. Comparison to elsewhere in Buckinghamshire

To provide some context, delays on journeys between Buckingham and Milton Keynes have been compared with congestion on other journeys in Buckinghamshire. Table 3-1 shows selected examples of routes and the delay time as the percentage extra journey time over and above the 'free flow' time. There are other corridors where the delay is greater than 32% (meaning the A421 is not the fourth most-congested corridor in Buckinghamshire). 'Free flow' conditions are where drivers are able to drive at the speed limit. Free flow conditions often only occur during the quieter hours of the day in the late evening and early morning.

The journey times are the average times between these places by all routes, according to the BSTM.

The table shows that delays on journeys between Buckingham and Milton Keynes (by all routes) account for on average an additional 32% over and above the free flow time. This is less significant than some routes, such as between Henley and High Wycombe, but worse than some other routes, such as between Buckingham and Bicester.

Route (examples)	Extra journey time over and above 'free flow' time due to congestion
Henley-on-Thames to High Wycombe	+65%
Thame to Aylesbury	+58%
Aylesbury to Watford	+46%
Buckingham to Milton Keynes	+32%
Aylesbury to Milton Keynes	+20%
Buckingham to Bicester	+9%

Table 3-1 – Extra journey time over 'free flow' time in selected corridors

3.4. Through traffic in Buckingham

The 2017 Buckingham Transport Strategy identified a series of weaknesses, opportunities and threats regarding through traffic in Buckingham, which, as noted in the live traffic review, consistently experiences slow traffic speeds. They were as follows:

- Weaknesses: HGV levels through town centre are perceived to be too high. CTCs analysed as part of this study show at the A413/A421 roundabout shows 72 vans and 47 HGVs route from the town centre A413 arm during peak hour, whilst 63 vans and 36 HGVs route to the town centre A413 arm.
- Opportunities: discouraging through-traffic in town centre, modal shift away from car and use new stations such as Winslow and improved cycling/walking infrastructure.
- Threats: Increased traffic on A421 between the town centre and developments to the south and safety concerns of high-speed road around Buckingham which could become main access points for new developments.

3.5. High traffic volumes in villages

As identified in the 2015 Jacobs A421 Corridor Study, some local villages have high traffic volumes routing through them to the strategic road network during peak hours such as Newton Longville (800 vehicles in the morning peak) and Whaddon (600 vehicles in the evening peak), caused by 'rat running' through villages adjacent to the A421 corridor due to congestion (Jacobs, 2015).

Additional areas of congestion as identified in the live traffic review include Gawcott (Figure 3-5) and leading onto the A422 in Northeast Buckingham and Thornton (Figure 3-6).

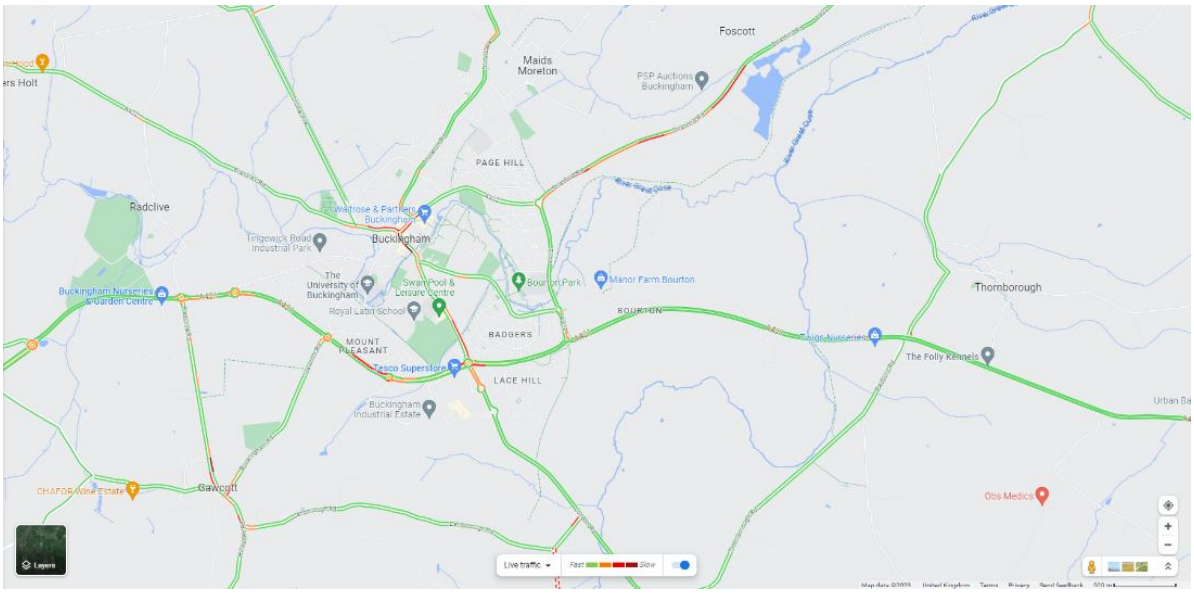


Figure 3-5 - Congestion at Gawcott, Buckingham. Monday 26/06 evening Peak

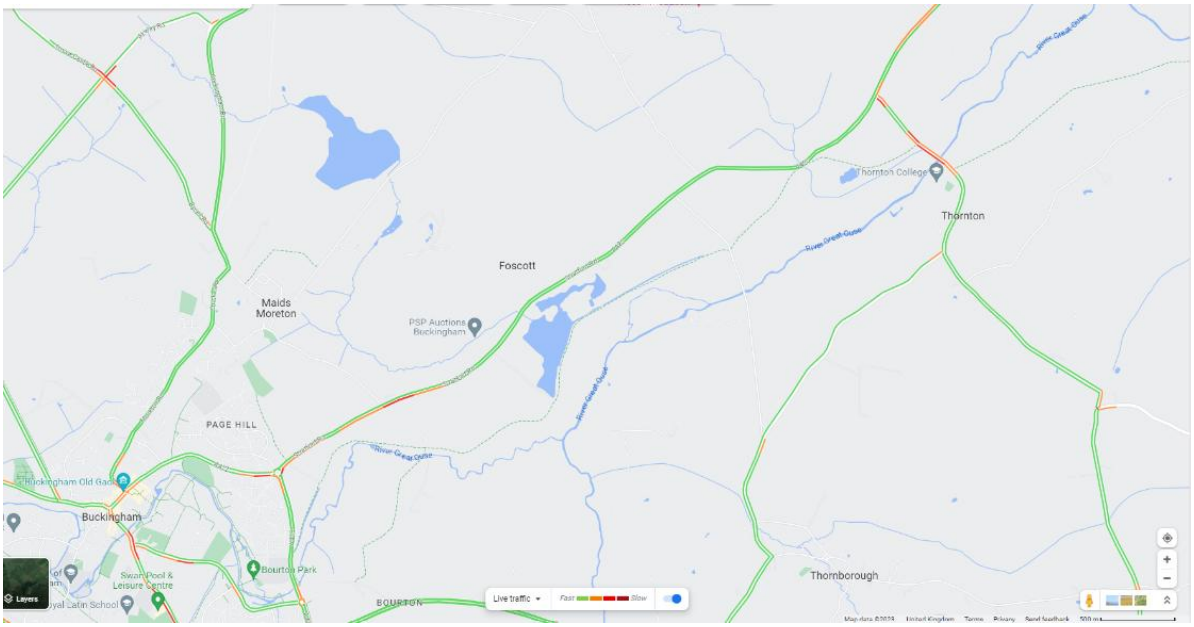


Figure 3-6 - A422 Congestion Tuesday 04/07 morning Peak

3.6. Alternatives to car travel for longer journeys

The literature and data review shows there to be limited alternatives to car travel for longer journeys, including:

- The lack of bus and active travel provision along the corridor, and high levels of car dependency in the study area.
- There is a lack of off-road cycle paths between key destinations.
- Although there are some good connections between towns, services are relatively infrequent. There are relatively poor bus connections to key employment hubs, education, and leisure facilities. This is most notable with regard to smaller settlements in the corridor, such as the Horwoods, Whaddon, Nash and Thornborough, which have no regular bus services to Buckingham or Milton Keynes.

- Although the town is set to receive a direct rail link, the suitability of the present bus connection from Winslow to Central Milton Keynes may merit further consideration. Although frequency on weekdays ranges from 1-2 buses per hour, the X60 route travels via Buckingham and the A422, leading to a total journey time of one hour, as opposed to 22 minutes driving, subsequently providing a poor alternative to private vehicles for people travelling between the two places.
- Issues regarding frequency of bus services are reflected in the mode share of bus, minibus, or coach for residents of the study area travelling between their home and workplace. Compared to a countywide figure of 1.4%, only 0.2% of residents in Newton Longville and Great Horwood MSOA commute to work by bus (ONS, 2021[7]). This figure is 0.8% for Buckingham South, Maids Moreton & Akeley, and 0.5% for Marsh Gibbon, Steeple Claydon and Tingewick MSOA (ibid).
- Bus mode share is closer to the countywide average in Winslow and Padbury (1.3%), and Buckingham North (1.6%) MSOAs, which are located within the Aylesbury – Buckingham – Milton Keynes bus corridors (ibid). Despite being located outside of the study area, connectivity by public transportation to Silverstone, or lack thereof, is also identified as a key issue in the region by England's Economic Heartland (see Figure H-1; Table H-1). At present, a bus journey between Buckingham and Silverstone involves no less than 2 hours of travel time, as opposed to an estimated journey time of 12 minutes by private vehicle[8].

3.7. Road safety

3.7.1. Road safety ratings

The International Road Assessment Programme (iRAP) prepares and collates road safety information globally. Based on road inspection data, iRAP provides star ratings for sections of road based on road inspection data; the higher the star rating, the safer the road.

iRAP Star Ratings are produced for each 100-metre section of road, based on the physical characteristics of the road. The measure represents the level of safety which is 'built in' to the road.

Figure 3-7 below shows the latest iRAP ratings for 'A' roads and motorways in the study area. As is the norm, the motorways are rated as being the safest roads. Most of the 'A' roads in the study area, including the A421, are considered to be 'low-medium risk' (i.e. the second-safest rating). The A413 between Buckingham and the A413 south of Towcester is rates as the least-safe road in the study area at 'medium risk'.

[7] ONS, 2021. Method of travel to workplace - Census Maps, ONS. Available at https://www.ons.gov.uk/census/maps/choropleth/work/method-of-travel-to-workplace/transport-to-workplace-12a/bus-minibus-or-coach?lad=E06000060

[8] Google Maps 2023. Buckingham to Silverstone. https://www.google.co.uk/maps/dir/52.0735409,-1.0260559/52.0008862,-0.9882262/@52.0140504,-1.0376691,15641m/data=!3m1!1e3!4m2!4m1!3e3?entry=ttu

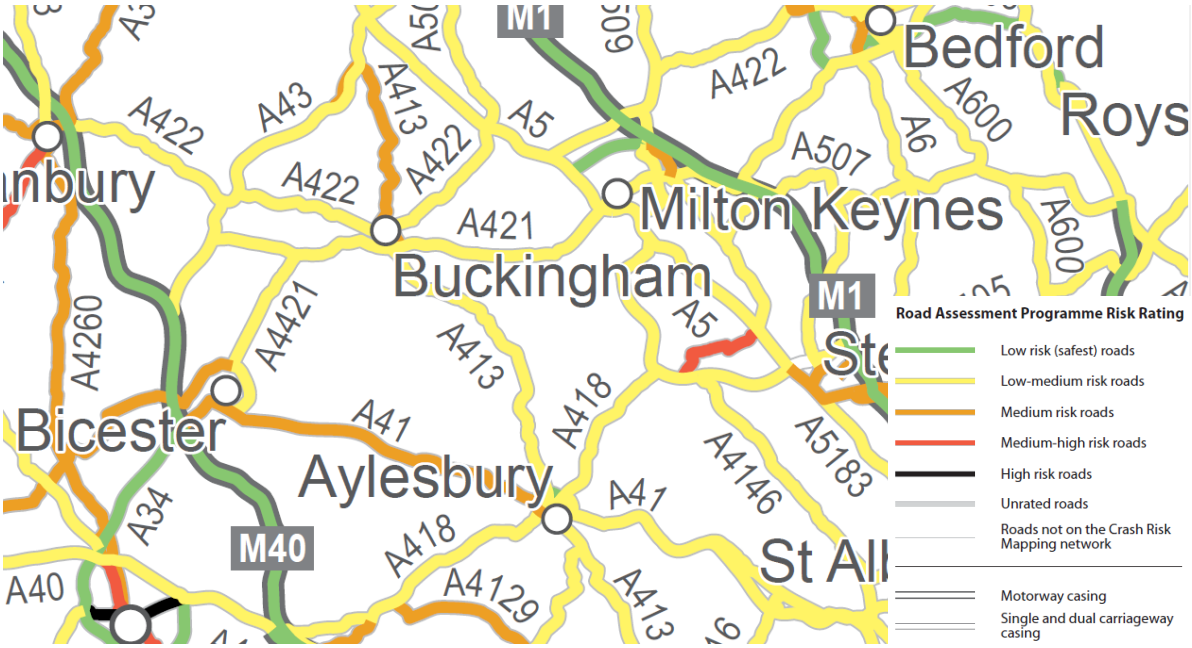


Figure 3-7 – iRAP star ratings, 2023

Source: https://irap.org/2023

The Road Safety Foundation produces data on the statistical risk of fatal or serious injury crash occurring. The risk is calculated by comparing the frequency of road crashes that result in death and serious injury with the amount of traffic on the road. This is therefore a measure of the observed risk rather than the safety 'designed in' to the road.

The crash risk classifications for the 'A' roads and motorways in the study are shown in Figure 3-8. The pattern is similar to the iRAP data: the motorways are the safest roads (per vehicle kilometre travelled) whilst the 'A' roads in the study area are all classified as 'low-medium risk roads'.

A5



Figure 3-8 – Road Safety Foundation Crash Risk Mapping, 2024

3.7.2. Accident clusters

STATS19 data on road traffic casualties are collected by police forces and published annually by the Department for Transport. Each incident records the number of casualties and whether their injuries are slight, serious or fatal.

The latest data available is for the period 2018 to 2022 inclusive. Figure 3-9 shows the locations of all accidents involving a serious or fatal casualty in the study area in this period.

The map shows that there was only one fatal accident in the A421 in the study area, occurring to the east of the B4033 roundabout in 2021. A second fatality occurred on the A421 just east of the A43. There were several other fatalities elsewhere in the study area, including three on the A422 and one on the B4033 near Winslow.

There were approximately 50 accidents involving a serious injury in the study area over the same period, of which eight were on the A421 at the following locations:

- the Gawcott Road roundabout (2018);
- just west of the London Road roundabout (2020);
- near Badgers Way, Buckingham (2022);
- south east of Bourton (2020)
- west of the B4033 roundabout (2021);
- Little Horwood Road offset junction (2018 and 2019); and
- Just west of Coddimoor Lane roundabout (2019).

Across the study area, the serious accidents during this period were fairly widely dispersed. However, there were a number of clusters of serious accidents including:

- on the A422 between Westbury and Buckingham;
- on the A422 south of Deanshanger; and
- on Great Horwood Road north of Winslow.

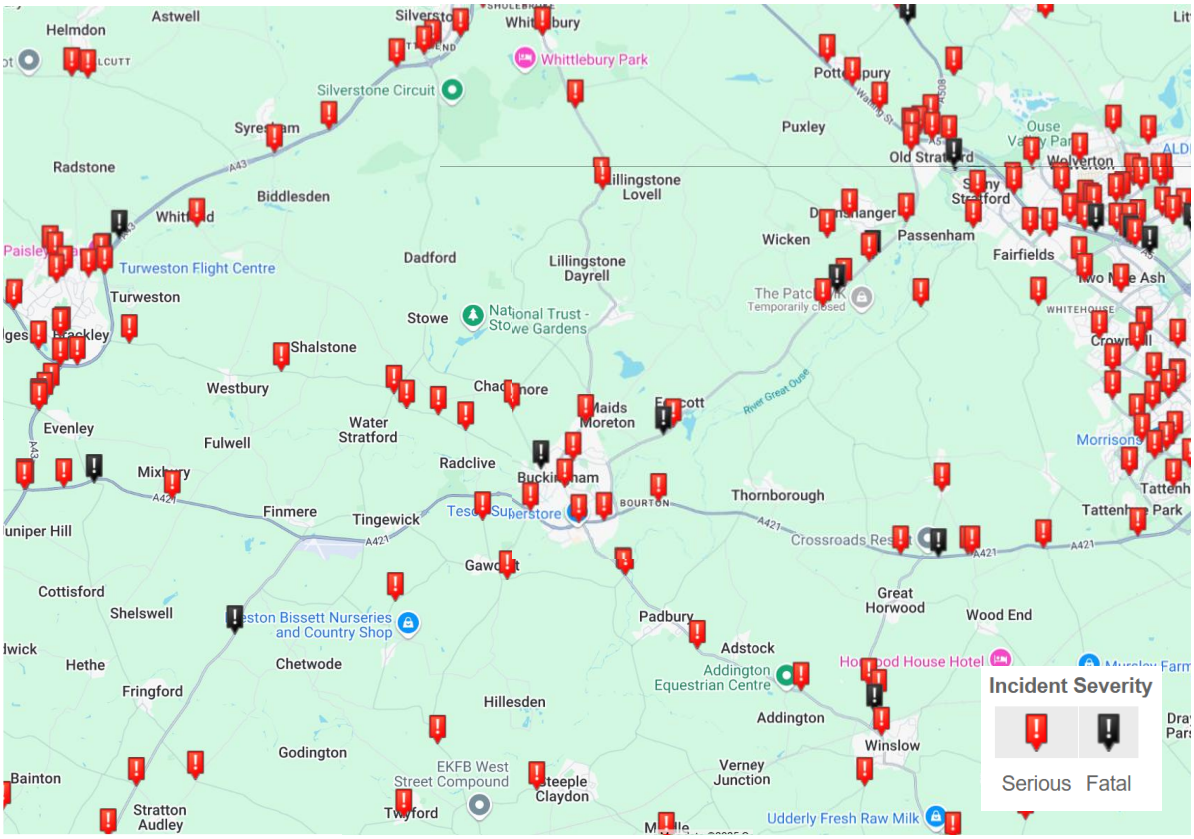


Figure 3-9 – Fatal and serious accidents, 2018-2022

Source: CrashMap.co.uk, 2024

Accidents involving pedestrians and cyclists were noted as a particular concern by some stakeholders. Locations noted include the London Road Roundabout and near Little Horwood Road.

The STATS19 data show that there was one pedestrian fatality between 2018 and 2022 in the study area: on the A422 south of Deanshanger. There were a further seven serious pedestrian casualties in the study area, of which one was on the A421 (just west of London Road).

There were a further seven serious cyclist casualties in the study period over the same period, predominantly on rural roads. One of the serious cyclist casualties was on the A421 at the Gawcott Road roundabout.

4. Future challenges and issues

4.1. Introduction

As identified in Sections 2 and 3, there are notable issues and areas of concern regarding transportation on the A421 corridor, such as congestion and junction performance, journey times, and the availability and quality of both active travel and public transportation infrastructure. This section considers future challenges and issues within the study area, both with regard to any changes in the aforementioned current issues, and future challenges, such as the potential impacts of proposed housing developments on congestion in the area. From a local policy and strategy perspective, this section also outlines the expected impacts of committed transport schemes.

4.1.1. Changes in traffic and delays

4.1.1.1. Forecast traffic levels

Table 4-1 shows the 2040 forecast year flows for eastbound and westbound at the selected links on the A421. It also shows the percentage increase in traffic compared to the 2019 base year model. Forecast traffic in 2040 is highest at the eastern end of the study area and lowest in the west. Eastbound morning peak traffic and westbound evening peak traffic is forecast to be highest. Traffic levels between the peak period are expected to be approximately 20% below the peak levels.

	Finmere/Tingewick		South Buckingham		Bottledump	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
Morning peak	897 +10%	1,250 +43%	1.185 +23%	1,416 +29%	1,735 +11%	1,547 +48%
Inter peak	759 +15%	726 +30%	969 +30%	989 +38%	1,223 +35%	1,178 +35%
Evening peak	1,080 +25%	1,111 +13%	1,369 +28%	1,091 +16%	1,763 +26%	1,579 +15%

Table 4-1 - 2040 forecast traffic (and change from 2019 base year model) on selected A421 links (vehicles/hr)

Between 2019 and 2040, traffic is forecast to increase at these locations by between 10% and 48%. The highest percentage forecast increases are typically in the westbound direction but increases of over 30% are fairly common.

4.1.1.2. Forecast delays

Figure 4-1 shows the difference in link delays for the morning peak, showing that existing delays are expected to worsen by 15-30 seconds on the A421 towards Milton Keynes between the B4033 roundabout and Bottledump roundabout. There are also increased delays on the A422 towards Old Stratford.

Figure 4-2 shows the difference in link delays for the evening peak, showing a similar pattern to the morning peak period.; an increase in delay is also seen eastbound between the Bottledump roundabout and the Whaddon Road/Coddimoor Lane roundabout.

West of Buckingham, an increase in delay of 60-90 seconds is forecast eastbound passing the garden centre approaching the Radclive Road / New College roundabout.

Delays are also noted on rural roads in and around villages during peak hours. There is a marked impact of this on smaller junctions providing access/egress from local roads to the A421, an issue that has the potential to be exacerbated by proposed new housing developments (if not properly mitigated), as shown in Figure 4-3 and Figure 4-4 in section 4.1.2.

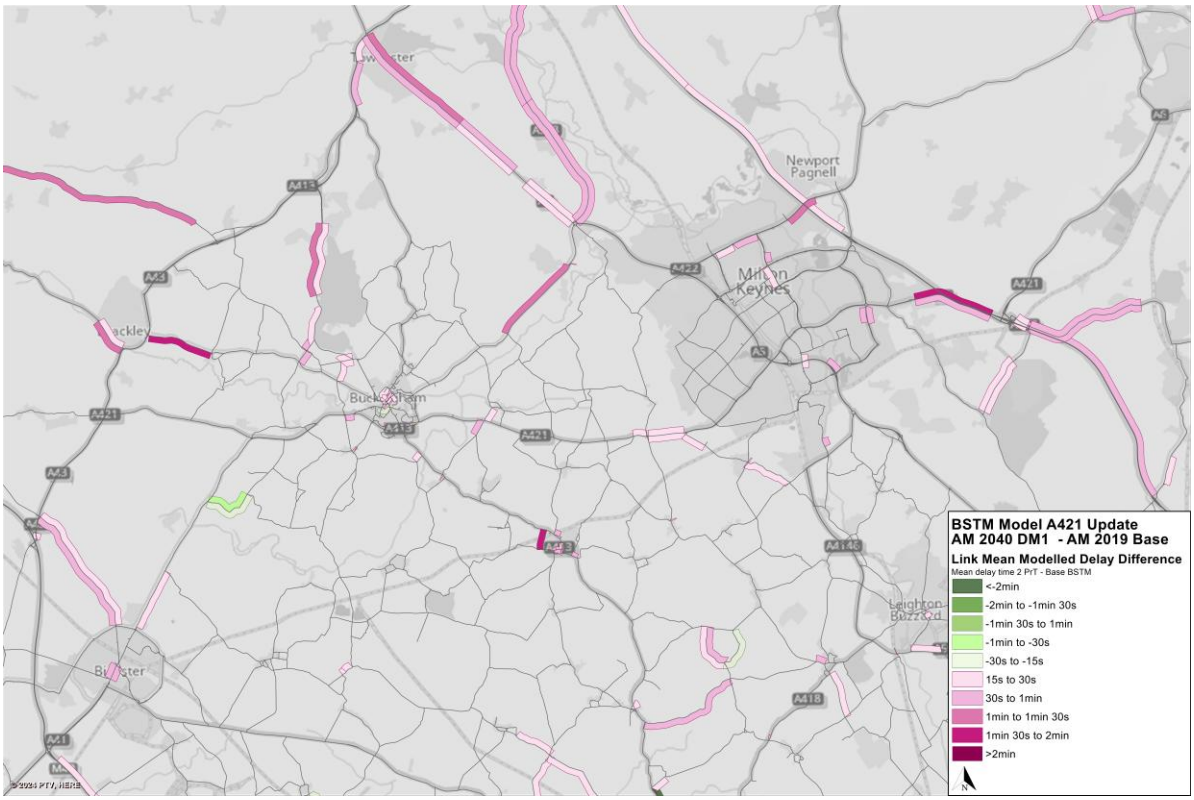


Figure 4-1 - Forecast link delays (differences) - morning peak

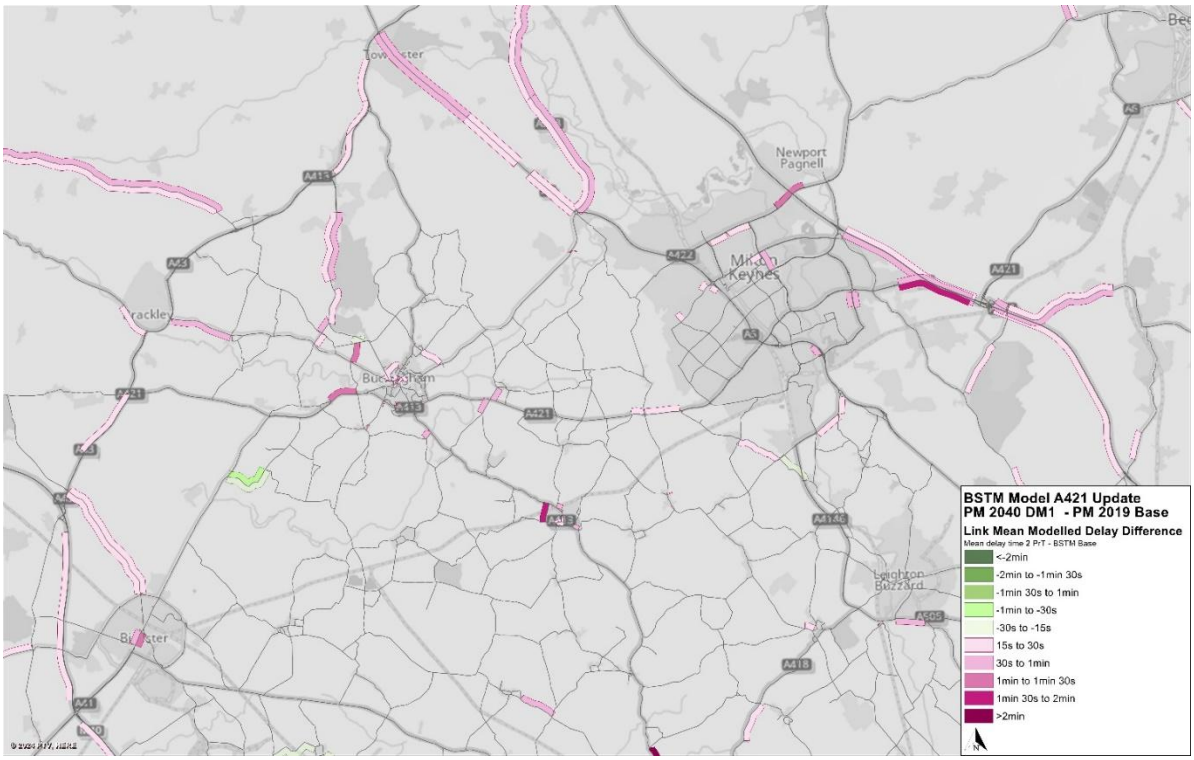


Figure 4-2 - Forecast link delays (differences) - for evening peak

4.1.2. Development-led traffic growth

The Jacobs 2015 corridor study outlined some of the key impact(s) that planned housing developments (totalling up to 9,630 dwellings), and subsequent population increase, will have on road capacity and performance (A421 Corridor Study, Jacobs 2015). This study also forecast network performance for 2031, using ONS data and the Countywide Model shows absolute traffic volumes were estimated to increase by 10-40% on the A421, with a predicted increase in 'rat running' through adjacent rural villages. Peak performance plots in the AM and PM for 2031 are as follows below in Figure 4-3 and Figure 4-4 (A421 Corridor Study, Jacobs 2015).

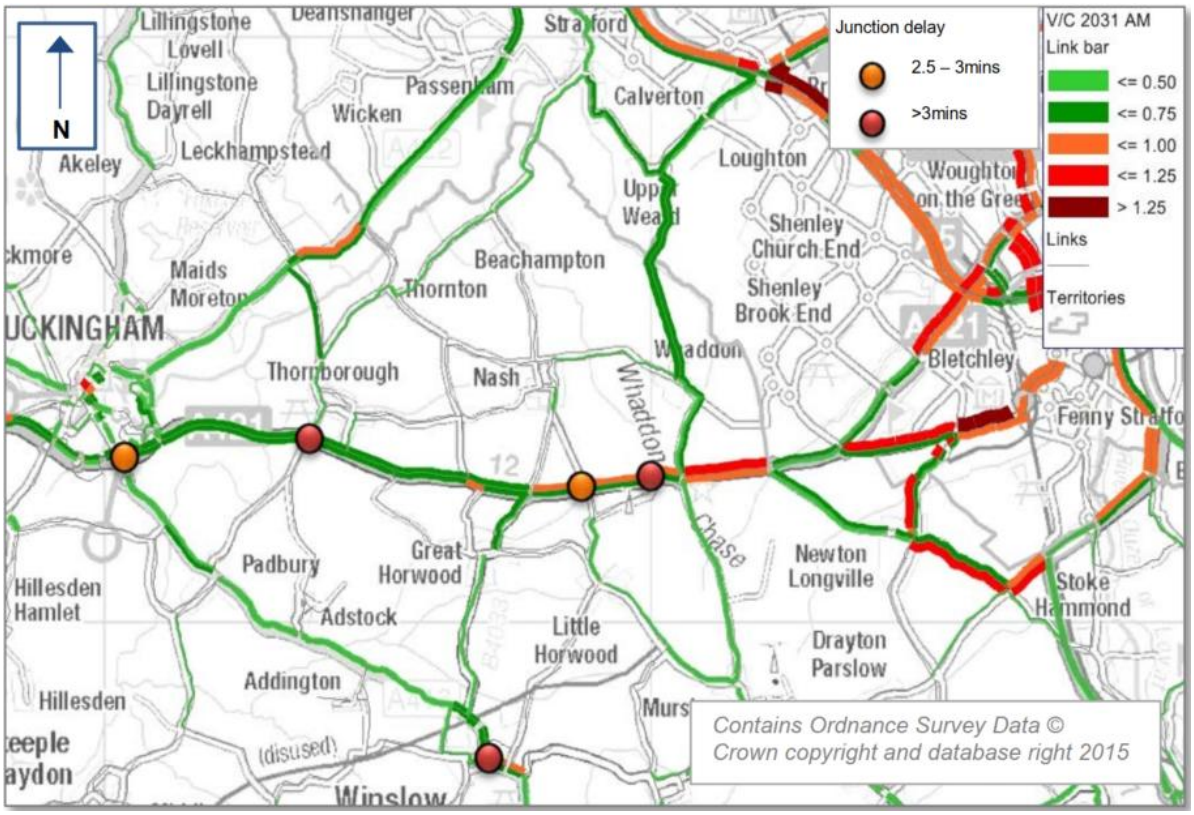


Figure 4-3 - A421 corridor forecast morning peak volume/capacity 2031

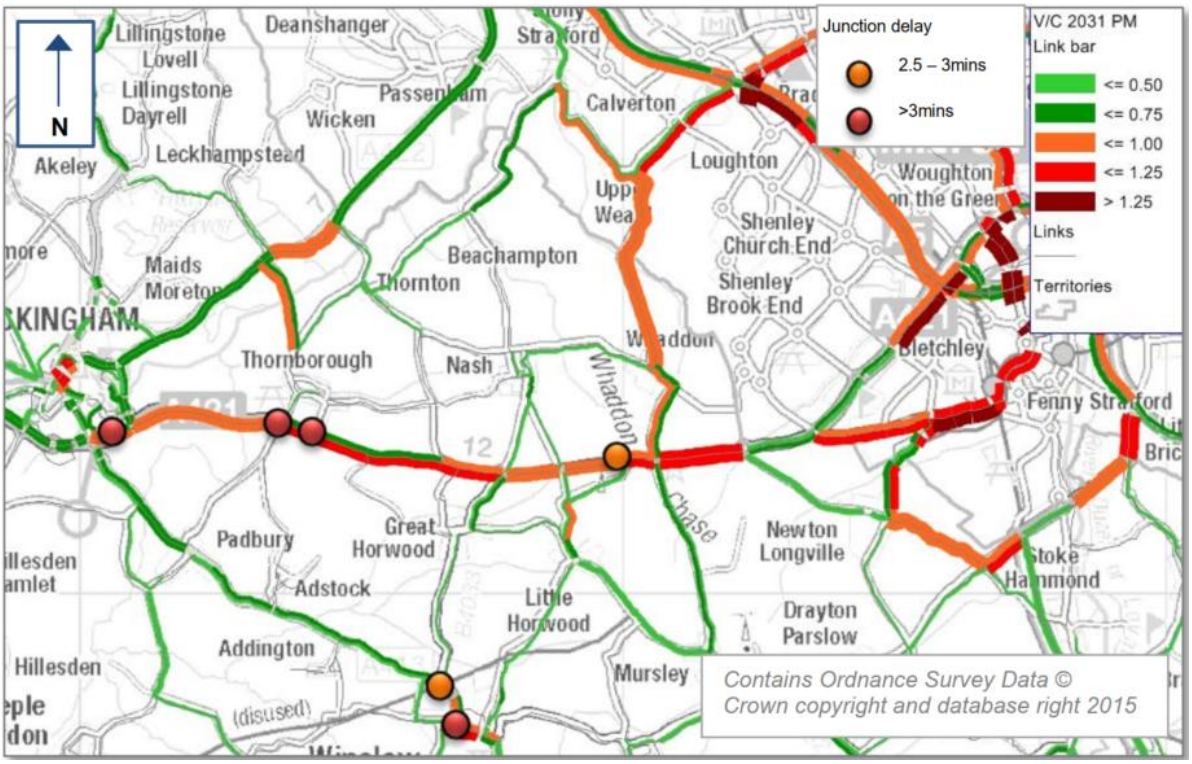


Figure 4-4 A421 corridor forecast evening peak volume/capacity 2031

The 2015 study also included a high-level assessment of a 'growth scenario', which considered future land use, and respective potential subsequent impact(s) on the transport network. The land use scenario considered both the 9,630 new dwellings on the A421 Corridor, and the additional ~33,000 new dwellings planned across the district. Using data on mode share and desire lines, a TRICS database was used 'to calculate broad indicative value for a potential development of 9,630 dwellings'[9]. The results showed that between 3,000 – 4,000 vehicles could originate from these locations during the AM peak and arrive during the PM peak. In this growth scenario, the majority of junctions in the study area would have a delay of 2.5 - >3mins, and the majority of the A421 between Buckingham and Bletchley would have a V/C of >1 (a V/C approaching 1 suggests the link is operating at its theoretical limit).

Areas of concern (predicted by 2031) were also identified, such as:

- Greater use of the A421 to access Buckingham and Milton Keynes, particular by commuters during the AM and PM peak periods.
- Increased pressure at junctions along the A421 prior to and adjacent to the potential development sites, particularly right turners from the south accessing the route to Milton Keynes during the AM peak.
- Increased 'rat-running' through villages adjacent to the corridor, particularly routes to and from the A4146, B4032 and A5, passing through the villages of Newton Longville, The Horwoods, Nash, Whaddon and Mursley.
- Traffic conditions, including increased queuing and congestion, and resultant air quality concerns within and around Winslow, Buckingham, and West Milton Keynes.

The Oxford to Milton Keynes Connectivity Study (England's Economic Heartland, 2022) identified the following as two of the four key principles of investment:

[9] Jacobs, 2015 p.20. A421 Corridor Study

- Supporting the regional economy by connecting people and businesses to markets and opportunities.
- Efficient movement of people and goods through the region and to international gateways.

This is noted with particular regard to East to West travel within the study area. The key employment hubs that could influence travel demand are: Buckingham town centre; South of the A421 near A414 (Buckingham Industrial Estate, Tesco, Aldi etc); Winslow town centre.

4.1.3. Development site details

As outlined in the 2021 VALP, there are several development sites within Aylesbury Vale, with delivery on the housing expected between 2020 – 2033. Of these sites, four are situated within the A421 Corridor (shown in Figure 4-5). These are:

- D-NLV001: Salden Chase (concept plan in Figure 4-6);
- D-WHA001: Shenley Park;
- D-BUC043: BU1 (Moreton Road); and
- D-BUC046: Osier Way (South of A421 and East of Gawcott Road).

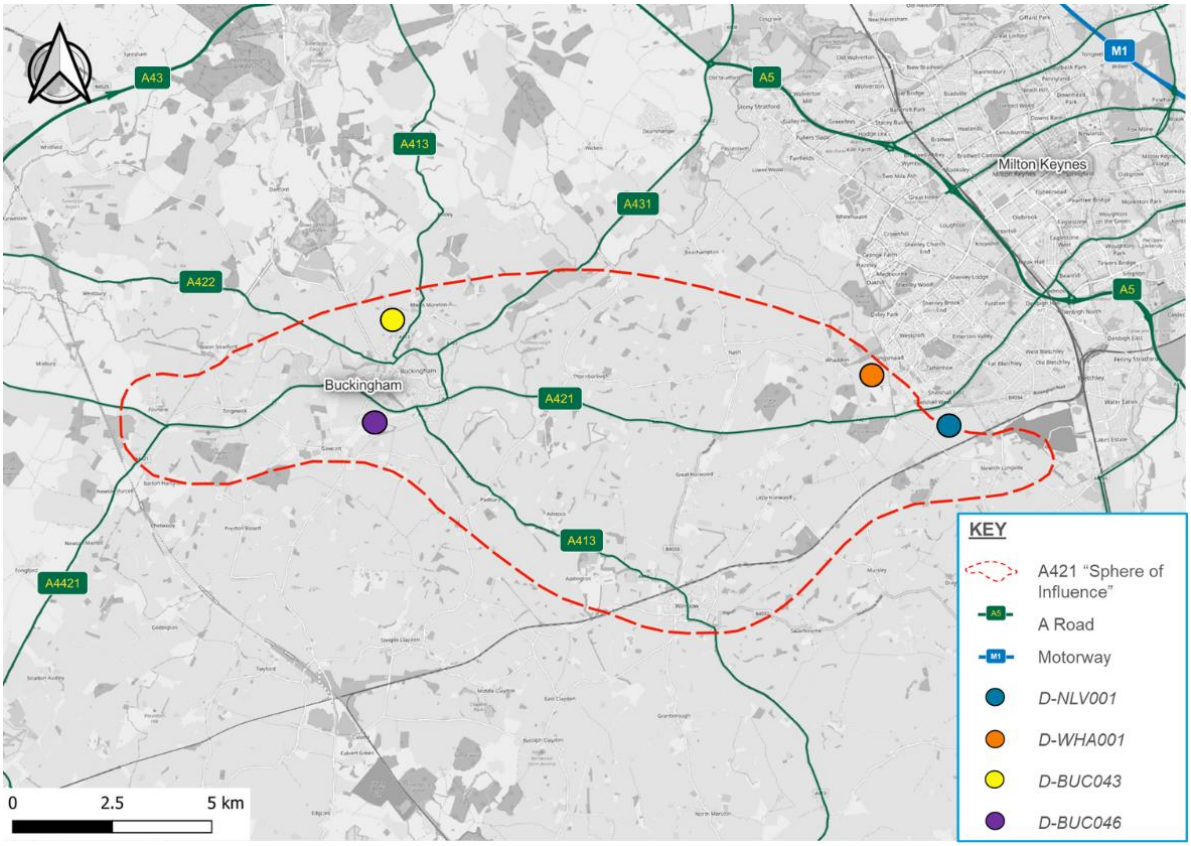


Figure 4-5 - A421 Corridor Development Site Locations



Figure 4-6 - Concept plan for Salden Chase showing the proposed new roundabout on the B4034 Buckingham Road

Three of the four proposed development sites within the A421 Corridor are located on or near the A421. The addition of ~3,500 houses adjacent to this trunk road could, if not appropriately mitigated by improved transportation infrastructure, add to the identified capacity constraints on the A421, creating or exacerbating key choke points on the road. Table 4-2 provides an overview of the development sites, including housing provision and delivery times. In addition, site specific requirements, as detailed in the Vale of Aylesbury local Plan (2021), are outlined.

Development	Location	Size	Housing delivery 2020-25	Housing delivery 2025-33	Site specific requirements
D-NLV001	South of the A421 and east of Whaddon Road	1,855	300	1,555	Improved Low Carbon infrastructure between Site and Newton Longville, Bletchley and MK Road access to Whaddon Road, A421 and Buckingham Road
D-WHA001	Shenley Park, Whaddon	>1,150	50	1,100	Required access to A421 - Modelling to evaluate whether the A421 between Bottledump Roundabout and Tattenhoe should be dualled Access to MK via H6, H7 (PV and PT) New roundabout on Buckingham Road

D-BUC043	BU1 (Moreton Road)	130	100	30	Satisfactory vehicle access to Buckingham
D-BUC046	Osier Way (South of A421 and East of Gawcott Road	420	130	290	Access to Gawcott Road

Table 4-2 - Proposed development Sites VALP 2021

4.2. Encouraging more use of sustainable modes of travel

4.2.1. National and local carbon reduction commitments

In 2019, the UK updated the 2008 Climate Change Act to make a legal commitment to reach Net Zero greenhouse gas (GHG) emissions nationally by 2050, as a national contribution to the international Paris Agreement commitments. It was the first country in the world to make such a commitment.

In addition to this domestic commitment, the UK has made international GHG reduction commitments through identifying Nationally Determined Contributions (NDCs) as required under the Paris Agreement. These identify the targets of reducing UK GHG emissions by 68% by 2030 and 81% by 2035 compared to 1990 levels.

Transport is the largest contributor to UK domestic greenhouse gas (GHG) emissions, responsible for 28% of emissions in 2022. In their report on the sixth carbon budget[10], the CCC indicated that surface transport sector emissions would need to reduce by approximately 70% between 2019 and 2035 to contribute to a Balanced Pathway that would meet the carbon budgets across all emissions generating sectors. Their recent report on the seventh carbon budget indicates that surface transport emissions would need to reduce by 86% between 2023 and 2040 to contribute to their current view of the Balanced Pathway.

The Oxford to Milton Keynes Connectivity Study (England's Economic Heartland, 2022) identified several key principles of investment including:

- achieving net zero no later than 2050, with an ambition to reach this by 2040; and
- improving quality of life and wellbeing through a safe and inclusive transport system accessible to all which emphasises sustainable and active travel.

The share of tailpipe carbon emissions from traffic in Buckinghamshire is shown in Figure 4-7 below. Two-thirds of emissions are estimated to come from cars, with the remainder from vans and HGVs. Overall, transport accounts for over 40% of total carbon emissions in Buckinghamshire, the largest single source. Transport carbon emissions in the county have remained fairly constant since 2005 before declining between 2020 and 2022 due to lower traffic levels during the COVID-19 pandemic[11].

[10] CCC (2020) Sixth Carbon Budget Report. Available at: Sixth Carbon Budget - Climate Change Committee (theccc.org.uk)

[11] Buckinghamshire Council Climate Change and Air Quality Strategy 2023 - 2024 Progress Report

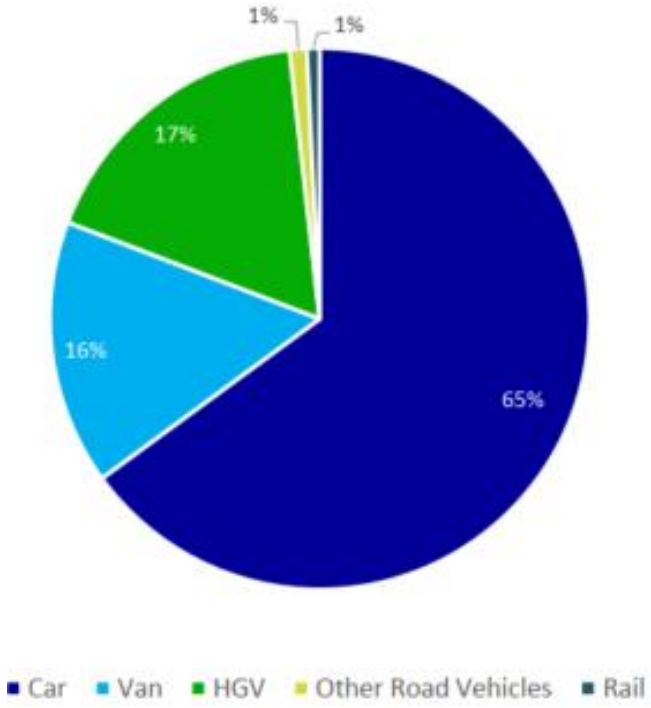


Figure 4-7 - Tailpipe carbon emissions by vehicle type in Buckinghamshire, 2019[12]

4.2.2. Measures to reduce carbon emissions

The national commitments to decarbonisation were accompanied by announcements and route maps, including the Transport Decarbonisation Plan (TDP)[13] in July 2021 which fed into the Government Net Zero Strategy (NZS)[14] in October 2021. The TDP set out the last government's commitments and the actions needed to decarbonise the transport system in the UK, including surface transport, aviation and shipping. It identifies six strategic priorities including:

- accelerating modal shift to public and active transport;
- decarbonising road transport;
- decarbonising how we get our goods; and
- place based solutions to emissions reduction.

A range of commitments are set out in the TDP, including restating intentions to invest in walking and cycling, as set out in the Gear Change vision for walking and cycling and to invest in in public transport, in line with the National Bus Strategy. The TDP also placed considerable emphasis on the move to a zero emissions fleet, building on the ban on petrol and diesel car and van sales announced in November 2020.

[12] Buckinghamshire Council, 2022 p.3. Buckinghamshire Electric Vehicle Action Plan. Available at: https://buckinghamshire.moderngov.co.uk/mgConvert2PDF.aspx?ID=43677

[13] DfT (2021) Decarbonising transport: A better, greener Britain. Available at: Transport decarbonisation plan - GOV.UK (www.gov.uk).

[14] HM Government (2021) Net Zero Strategy: Build Back Greener - Net Zero Strategy: Build Back Greener - GOV.UK

Buckinghamshire Council is currently preparing a new Local Transport Plan (LTP) which will set out transport policies across the county to 2040. Within the objectives of the LTP development there are commitments to its Climate Change & Air Quality Strategy and the promotion of sustainable and active travel. The Council is also preparing a new Local Plan for Buckinghamshire. The new Local Plan will include policies aimed at maximising sustainability of new developments from a transport perspective. These include:

- locating major developments close to existing public transport networks, particularly rail;
- diversifying, extending and enhancing public transport provision;
- creating safe and attractive walking and cycling routes for shorter journeys;
- supporting the provision of digital infrastructure to reduce the need to travel; and
- delivering low or zero carbon fuel infrastructure through new developments.

Research evidence collated by AtkinsRéalis for the Carbon Assessment Playbook suggests that measures which are likely to have the greatest impact on reducing transport-related carbon emissions are those which:

- reduce the need to travel (through shorter or fewer journeys);
- encourage a 'shift' to sustainable modes for longer journeys (i.e. encouraging more journeys by public transport);
- encourage uptake of low or zero-emission vehicles; or
- disincentivise travel by petrol- or diesel-powered vehicles.

Despite the reference to active travel in the TDP, this evidence suggests that measures which encourage active travel are unlikely to have a significant impact on transport-related carbon due to the short average length of such journeys and their ability to attract journeys from car journeys[15]. Such measures do however have a broad spectrum of alternative benefits including quality of life benefits, health benefits and improved connectivity for shorter journeys.

The Council does not support measures aimed at disincentivising travel by any form of vehicle but does have policies supporting measures which would achieve the other three outcomes listed above. Therefore, for the purposes of this study, measures which support these outcomes should be given weight.

4.2.3. Expected impacts of committed transport schemes

The Buckingham Transport Strategy was developed after the Aylesbury Vale Local Plan to support future planned growth in the town up to 2033. The main focus is on Buckingham, but the wider area and the impacts have been recognised.

Two key committed transport schemes were noted:

- **A413 Sustainable Travel scheme** (now complete) which includes a nine- kilometre shared cycle and footway adjacent to the A413 between Winslow and Buckingham and upgrades to three existing Bus stops with real-time passenger information and Wi-Fi access. The shared path terminates at the southern edge of Buckingham (A421).
- **East West Rail:** Winslow station will help with the east-west rail connections in the area which until now have been north-south focussed. This is expected to open in 2025, but timescales are indicative currently. With EWR offering rail travel as an alternative to cars, EWR can ease traffic on local roads by reducing people's reliance on cars. It gives people in the area more choice to travel sustainably, such as the use of Winslow station instead of driving to Milton Keynes and then to London.

[15] Interventions – Carbon Assessment Playbook

5. Corridor objectives and options

5.1. Introduction

One of the objectives of this study is to identify and assess a range of intervention options to overcome the challenges described in the previous chapters and support the achievement of a broader range of outcomes which are described by the corridor objectives. Specifically, the chapter:

- explains the rationale for establishing 'corridor objectives' and what they are;
- describes the process by which a long list of intervention options was identified; and
- describes the process by which these options were reduced to a more refined list for further consideration and assessment.

5.2. Corridor objectives

Resolving current problems and expected future problems is often a worthwhile objective. However, limiting thinking strictly to 'problem solving' can lead to tactical, rather than strategic, decision-making and lead to options which achieve other positive impacts to be ignored. Therefore, corridor objectives were established to represent some wider outcomes which options may also help to achieve (in addition to solving the challenges).

The corridor objectives were determined based on the three overarching transport objectives agreed for the new Local Transport Plan (LTP) for Buckinghamshire[16]. These are:

- **Connecting our economy**: The productivity of local businesses; inward investment and access to opportunities for residents are enhanced by fast, efficient, and reliable transport connections.
- **Decarbonising our transport system**: Carbon emissions from transport in Buckinghamshire (excluding motorways) are within our 2025-2050 carbon budget and are on track to reach net zero by 2050.
- **Building places for people**: Streets, neighbourhoods, and rights of way are designed to put the needs of people first, and to be safe and accessible for all.

For this study, the wording of these three overarching objectives was then modified and between three and five sub-objectives were then defined to reflect the specific issues in the A421 corridor. These objectives are shown in Figure 5-1.

[16] Public consultation on the LTP objectives was held in Spring 2022. The objectives shown above reflect comments received during that consultation. Completion of Buckinghamshire's Forth Local Transport Plan is dependent on publication of Department for Transport guidance on LTPs.



Figure 5-1 - Corridor objectives

Given the background to this study, particular emphasis was placed on sub-objective #E4: "Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes/M1". This sub-objective incorporates issues relating to traffic growth and rat-running through villages as it is anticipated that a better-performing A421 in the future would need to take account of traffic growth and would reduce the incentive for traffic to deviate onto surrounding local roads.

As the study progressed, the objectives relating to increased connectivity by all modes of travel (#E1, #E2 and #E3) also gained prominence. Whilst the options which support such outcomes were not subject to detailed assessment (as there was insufficient evidence or tools to do so), there is justification for including some of those options in the recommended package of interventions for further assessment.

5.3. Option identification

5.3.1. Option identification process

Options were identified which may be able to fully or partially:

- mitigate one or more of the current or future challenges identified; or
- achieve one or more of the corridor objectives.

All options were considered whether they were infrastructure schemes, service improvements or policy measures.

Options fulfilling these criteria were identified from the following sources:

- from previous local studies, notably the 'A421 Corridor Transport Study Buckingham to Milton Keynes' (Jacobs for Buckinghamshire County Council, March 2015) and the 'Buckingham Transport Strategy' (AECOM for Buckinghamshire County Council, January 2017);
- from other Buckinghamshire-wide studies and strategies (such as those for freight and active travel);
- from third-party studies in the area such as England's Economic Heartland's 'Oxford-Milton Keynes Connectivity Study (December 2022);
- from historic and current planning applications;
- from previous comments and consultation feedback from local stakeholders and members;
- a stakeholder workshop (see below); and
- from AtkinsRéalis' experience of good practice from elsewhere and professional judgement.

5.3.2. September 2023 workshop

A workshop was held on the 12th September 2023 at the Swan Pool Leisure Centre in Buckingham. The objectives of the workshop were:

- to explain the scope and objectives of the study;
- to share and validate the study team's understanding of the challenges and issues;
- to describe the draft corridor objectives;
- to gather stakeholder ideas on potential options; and
- to explain next steps and answer any questions.

The workshop was well-received in terms of the information shared. Stakeholders expressed a range of opinions on a range of topics; the impacts of traffic from proposed new developments were a particularly common theme.

All options identified by those attending the event were recorded and included in the long list of options.

Additional information about this workshop can be found in Appendix C.

5.3.3. Option long list

The options drawn from the sources described above were collated and grouped by type based on the mode of transport. Where options were the same or very similar, they were combined into a single option to avoid duplication.

A small number of options were discounted at this stage as they were outside the scope of this study. These options will be considered separately by Buckinghamshire Council. They related to:

- development and use of autonomous vehicles;
- moving the A421 into National Highways' Strategic Road Network; and
- introducing an ultra-low emission zone (ULEZ) in Milton Keynes.

The resultant long list contained 56 options and is provided in Appendix E. A short description of each option was prepared to provide sufficient clarity as to its nature and to inform the initial assessment and sifting. The options are summarised in Table 5-1.

Option type	Description	Option codes
Key bus service enhancements	Improvements to the service frequencies of bus services between Buckingham and Milton Keynes, Aylesbury, Winslow, Brackley, Banbury and Bicester	B-S1, B-S2, B-S3, B-S4
Local bus service enhancements	New or improved bus services in Buckingham or to/from rural communities and the proposed new development sites	B-S5, B-S6, B-S7, B-S8, B-S9, B-S10, B-I7
Bus infrastructure improvements	Measures to improve journey time reliability or bus speeds including an offline busway. A new bus station/mobility hub in Buckingham and a park & ride site west of Bletchley	B-I1, B-I2, B-I3, B-I4, B-I5, B-I6
Rail and light rail	New stations on East West Rail and a new light rail system between Buckingham and Milton Keynes.	R-1, R-2
Public transport promotion	Measures to promote use of public transport and car share, improved timetable integration (bus and rail) and integrated ticketing and information.	BC-1, BC-2, BC-3, BC-4
Active travel	Improvements to active travel infrastructure including cycle routes, walking and riding 'greenways', safety measures and better links to new developments.	AT-1, AT-2, AT-3, AT-4, AT-5, AT-6, AT-7
A421 dualling	Options to convert sections of the A421 into two-lane dual carriageway. Options can be added to achieve continuous dualling between Tingewick Bypass and Bottledump roundabout. Includes necessary junction improvements.	H-M1, H-M2, H-M3, H-M4
New roads	Buckingham Norther/Western Bypass, Stoke Hammond link road, a new offline A421 and a Bottledump-H6 link road.	H-M5, H-M6, H-M7, H-M9
A421 junction improvements	Improvements to the existing roundabouts along the A421 and grade-separation of A421 junctions.	H-M8, H-J1, H-J2, H-J3, H-J4, H-J5, H-J6, H-J7, H-J8, H-J9
Other road improvements	Including enhancing the A422, safety schemes and management of HGVs, road maintenance and flooding.	H-J10, H-S1, H-S2, H-O1, H-O2, H-O3, H-O4, H-O5

Table 5-1 - Summary of long list of options

5.3.4. Other projects in the corridor

Since this project has started, other projects have been identified (subject to funding) by Buckinghamshire Council including:

Public Transport

- Liaising with EWR on their Door-to-Door Strategy;
- Bus service frequency increase between Buckingham, Winslow, Aylesbury; and
- Bus service connections between developments.

Active Travel Schemes

- Buckingham to Silverstone Park (Buckingham Greenway)
- Railway Walk Path.

Freight Restrictions

- Freight rerouting potential around Buckingham Town Centre; and
- Signage improvements.

Highway Schemes

- Route upgrades and highway capacity improvements to mitigate traffic impacts from planned development on the A421.

5.4. Initial assessment and sifting

5.4.1. Assessment process

An initial assessment of all the options was undertaken to identify a short list for further consideration in later stages of the study. The initial assessment (or 'sift') was consistent with the Department for Transport's business case guidance, specifically by using the Early Assessment and Sifting Tool (EAST)[17].

EAST is a multi-criteria assessment framework which specifies a range of criteria against which options can be assessed at an early stage of their development and definition. The criteria relate to the five DfT business cases: strategic case, economic case, managerial case, financial case and commercial case.

The criteria were modified slightly to make them more relevant to this study whilst a number of the EAST criteria were not used at this stage as there was considered to be insufficient definition of options and/or due to time and budgetary constraints.

As part of the strategic case assessment options were assessed against the degree to which they may support the three overarching LTP objectives as well as positive impacts such as connectivity and reliability improvements. In addition, options were assessed against sub-objective #E4: 'Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes/M1' as this study was particularly interested in options which could achieve this outcome.

The criteria used for the assessment are shown in Table 5-2.

[17] Transport business case: assessment and process procedures - GOV.UK (www.gov.uk)

Each option was scored against each criterion using a five-point scale in terms of the option's expected impacts (positive and negative), feasibility, deliverability and cost. The assessment was based on professional judgement, experience and knowledge of similar options elsewhere. No option-specific forecasting or quantification was undertaken.

Prior to the assessment, a 'scoring guide' was prepared to assist in the scoring process. The guide, which can be found in Appendix D, poses questions which should be considered in scoring each option, and descriptions of what constitutes each score on the five-point scale, specific for each criterion.

The assessment scores are shown in Table D-2 in Appendix D.

Case	Criterion
Strategic	Scale of impact (against the three overarching LTP objectives)
	Scale of impact (against local objective #E4)
	Fit with wider transport and government objectives
	Degree of consensus over outcomes [not used]
Economic case	Connectivity
	Reliability
	Resilience [not used]
	Delivery of housing
	Carbon emissions
	Socio-distributional impacts [not used]
	Regeneration [not used]
	Air quality
	Noise impacts
	Natural environment, heritage and landscape [not used]
	Streetscape and urban environment [not used]
	Physical activity [not used]
	Injury or death
	Crime [not used]
	Access to a range of goods, services, people and places
	Severance [not used]
	Value for money [not used]
Managerial case	Implementation timetable
	Public acceptability
	Practical feasibility
	Quality of the supporting evidence [not used]
Financial case	Affordability
	Capital cost
	Revenue costs [not used]
	Cost risk [not used]
Commercial case	Flexibility of option [not used]
	Income generated [not used]

Table 5-2 - Initial assessment criteria

5.4.2. Selection of shortlist

The assessment scores were used to select a shortlist of options for further assessment later in the study. This can be done in several ways including adding up the scores for each option across all criteria and selecting those with the overall highest score (sometimes using weightings). Whilst this gives a prioritised list of options, the choice of scoring ranges (three-, five- or seven-point scales for example) and weightings can have unintended consequences and lead to spurious results, such as options which have high positive impacts being retained even though they are undeliverable.

An alternative approach was adopted for this study due to these issues and the early stage of development of the options which means that there is limited information on each option. Options were shortlisted on the basis of passing thresholds for what were deemed to be the criteria which will most affect decision-making. Only options which did not fall below any of these thresholds in any of the criteria were shortlisted. The thresholds were set fairly low because of the uncertainty of the scoring at this early stage of option development.

The criteria and thresholds used to sift from a long list to a short list are shown in Table 5-3.

Criterion	Retained if scored	Not shortlisted if scored
Local objective #E4	3: Moderate impact 4: Significant impact 5: Fully addresses	1: Very small overall impact 2: Minor impact
Value for money (expected benefits vs costs)	3: Neutral 4: High 5: Very high	1: Very low 2: Low
Public acceptability	2: Moderate opposition 3: Neutral 4: Moderate support 5: Strong support	5: Strong opposition
Practical feasibility	2: Less proven, feasibility issues 3: Proven, issues partially addressed 4: Proven, issues largely addressed 5: Proven, issues addressed	1: Unproven
Affordability	2: Unaffordable without major contribution 3: Affordable in future with contributions 4: Affordable with minor contributions 5: Fully affordable	1: Unaffordable

Table 5-3 – Sifting thresholds

Nine options exceeded all of the minimum thresholds shown above. All of the options are improvements to the road network, and mainly roundabout improvements. These options have the potential to reduce delays at these junctions in a way which is relatively quick to deliver, feasible and affordable.

No active travel or public transport options made the shortlist, largely as they were not expected to significantly reduce traffic volumes as individual measures on the A421 and/or were unaffordable. This is not to say however that the un-shortlisted schemes are not worthy of further consideration; in fact, many could collectively bring significant positive benefits to residents in the corridor and to through traffic and are likely therefore to be included in a wider package of interventions for the corridor. However, they are individually unlikely to support the primary objective of reducing delays and improving journey time reliability on the A421.

It may be appropriate once a preferred package of measures has been selected from the shortlist to reintroduce some of the options not shortlisted at this stage to deliver a wider range of benefits – for example traffic calming in villages (option H-O4).

5.4.3. Options taken forward for more detailed assessment

Some of the shortlisted options were taken forward for more detailed assessment in order to understand their potential impacts and key delivery issues. The options were selected with the client based on:

- the likelihood that the option would be beneficial in terms of Objective #E4;
- the tools available (the impacts of some options could not be assessed in detail with the tools available); and
- study timescales and budget.

In addition, and because a ‘full dualling’ option was anticipated to provide the largest benefits in relation to the corridor objectives, a combination of options H-M1, H-M2, H-M3 and H-M4 was also selected by the client for more detailed assessment. This was to understand the extent to which this would alleviate the traffic issues in the corridor.

Selection for detailed option assessment was not an indication that these were necessarily the best options and those which would form part of any final recommended package of interventions for the corridor.

The options which were taken forward for more detailed assessment in the next stage of the study are shown in Table 5-4. At this stage of the study, the descriptions were preliminary and subject to further refinement in the next stage.

Option code	Option name	Description
H-M1	A421 dualling: Whaddon Road – Bottledump roundabout	Dualling A421 between Whaddon Road/A421 junction and Bottledump Roundabout. Option includes necessary improvements at the two roundabouts.
H-M2 H-M3 H-M4	A421 dualling: Tingewick to Buckingham	In combination, dualling A421 between the eastern end of the Tingewick Bypass to the Whaddon Road/A421 junction. Option includes necessary improvements at the two roundabouts.
H-J1	Aldi/Osier Way roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J2	London road roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J4	A421/A413 roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J5	A421/B4033/Winslow Road roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J8	Whaddon (Coddimoor Lane) roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J9	Bottledump roundabout improvements	A range of possible options to improve the roundabout including physical modification of approach lanes and circulating lanes, signalisation, and/or revisions to pedestrian crossing arrangements.
H-J10	A422 improvements	Measures to reduce delays on the A422 between Buckingham and the A5. Includes junction improvements at A421/Stratford Road (Deanshanger) and further improvements at A421/A5 roundabout.
H-O1	HGV routing	Restriction of HGV through-traffic on the A422 between Brackley and Buckingham by use of a weight limit to encourage HGVs to use a more appropriate route from A43 to M1 such as the A421.

Table 5-4 – Options shortlist

6. Detailed options assessment

6.1. Introduction

The options shortlisted as described in the previous chapter (and shown in Figure 6-1) were subject to more detailed assessment. The assessment covered all five business case dimensions; with a focus on the criteria relating to the strategic and economic cases (given the early stage of development of the options).

Each option was assessed in terms of:

- impacts on traffic volumes in the corridor;
- impacts on congestion and journey times;
- potential cost (broad cost ranges) and potential funding sources;
- key risks; and
- overall scale of impact in terms of the corridor objectives.

The results of the assessment for each option are presented in the remainder of this chapter.

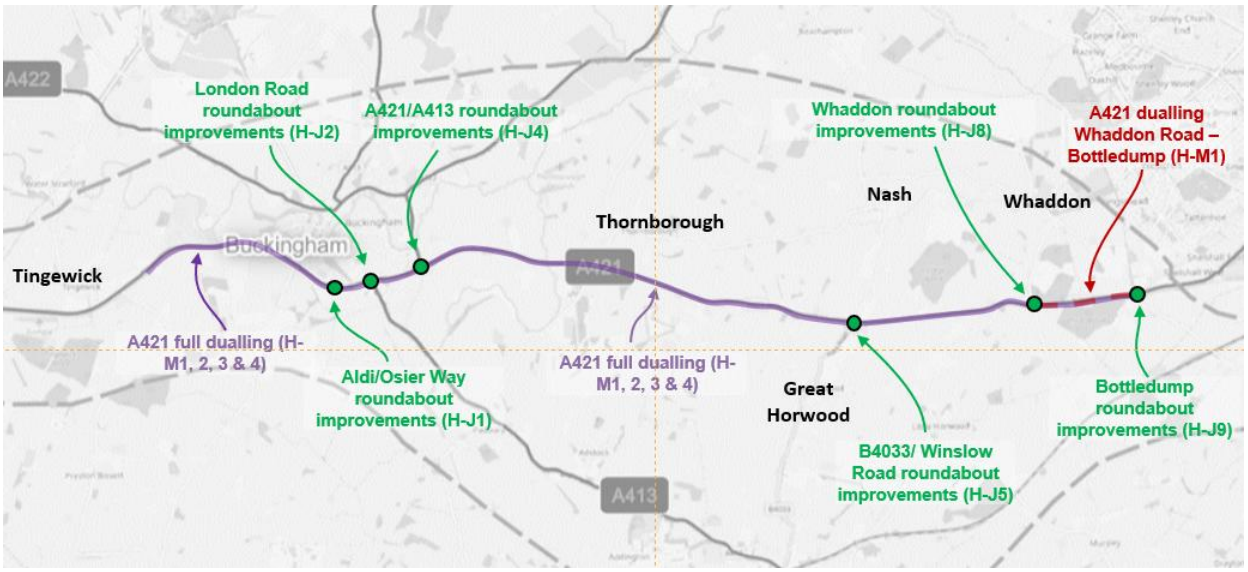


Figure 6-1 – Options subject to detailed assessment

6.2. 2040 ‘do minimum’

6.2.1. Introduction

The 2040 ‘do minimum’ scenario is the best estimate of the traffic conditions in 2040. It is the scenario which is compared with the scenarios which include proposed improvement options to identify the incremental impacts of those options.

The 2040 ‘do minimum’ scenario is derived from the 2019 ‘base year’ scenario by taking account of:

- underlying growth in traffic in the UK reflecting forecasts of economic growth;
- growth in traffic travelling to/from new employment, retail and housing developments in Buckinghamshire and the surrounding area opened, committed or ‘near certain’ between 2019 and 2040;

- delivered, committed or ‘near certain’ improvements to transport infrastructure and services.

6.2.2. Forecast changes in traffic volumes

Figure 6-2 and Figure 6-3 show the difference between forecast traffic volumes in the 2019 ‘base year’ and the 2040 ‘do minimum’ scenario, derived from the BSTM. The figures are therefore the forecast traffic increases between 2019 and 2040 without inclusion of any of the options presented in this report.

The figures below show that the amount of traffic in the A421 corridor is forecast to increase, and that the absolute increases are higher in the eastern end of the corridor. Typically, there is forecast to be 200-400 extra vehicles per hour on the A421 (combined directions) west of Buckingham and 400-600 extra vehicles per hour east of Buckingham. The increases are often higher in the ‘counter-peak’ direction (i.e. westbound in the morning and eastbound in the evening); this is likely to be because there is more ‘spare’ capacity in the counter-peak direction and therefore more potential for growth in the A421 corridor (rather an alternative corridor) especially for through traffic.

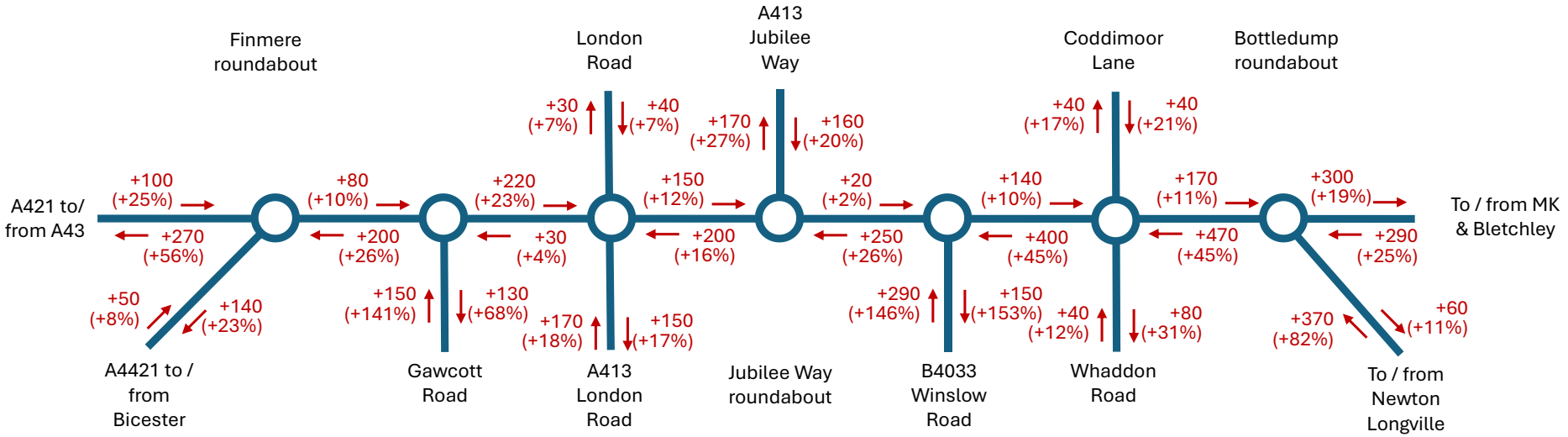


Figure 6-2 – Forecast change in traffic volumes between 2019 and 2040: 08:00-09:00

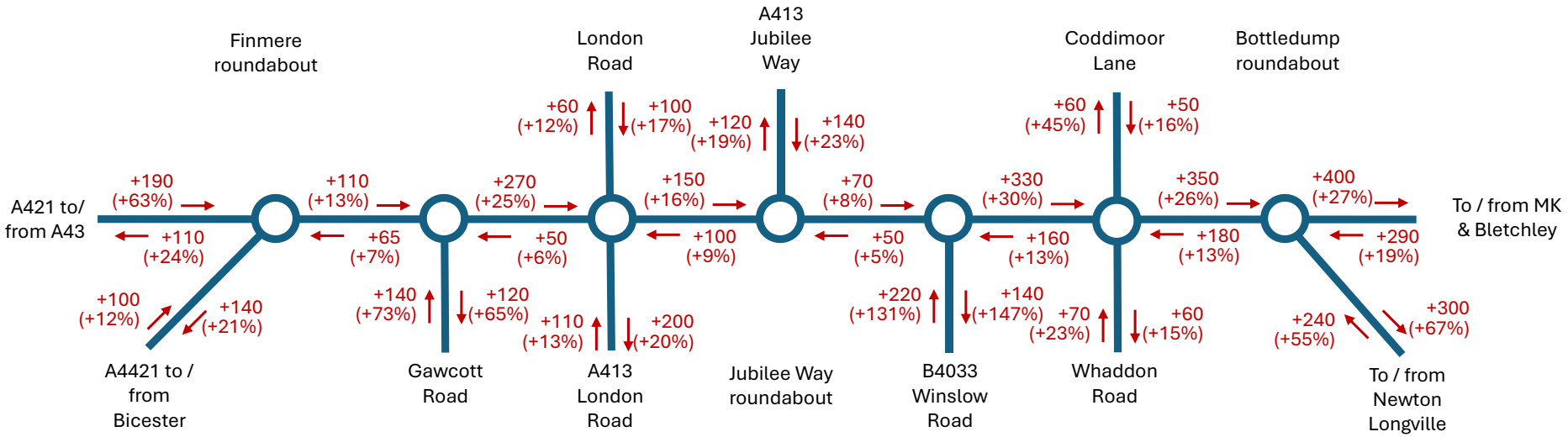


Figure 6-3 – Forecast change in traffic volumes between 2019 and 2040: 17:00-18:00

6.3. Forecast changes in congestion and journey times

The BSTM also predicts the changes in congestion (specifically 'delay') on the road network. Delay is the amount of time taken to travel along a section of road which is additional to the time it would take in 'free flow' conditions where drivers are able to drive at the speed limit. Free flow conditions often only occur during the quieter hours of the day in the late evening and early morning.

Figure 6-4 and Figure 6-5 show the forecast changes in delay between 2019 and the 2040 'do minimum' scenario. In general, it would be expected to see increases in delay where there is an increase in traffic (as shown in the preceding figures). However, large increase in traffic on roads which are not close to their theoretical capacity may not result in increases in delay, whilst small increases in traffic on roads close to their capacity could result in exponentially high increases in delay.

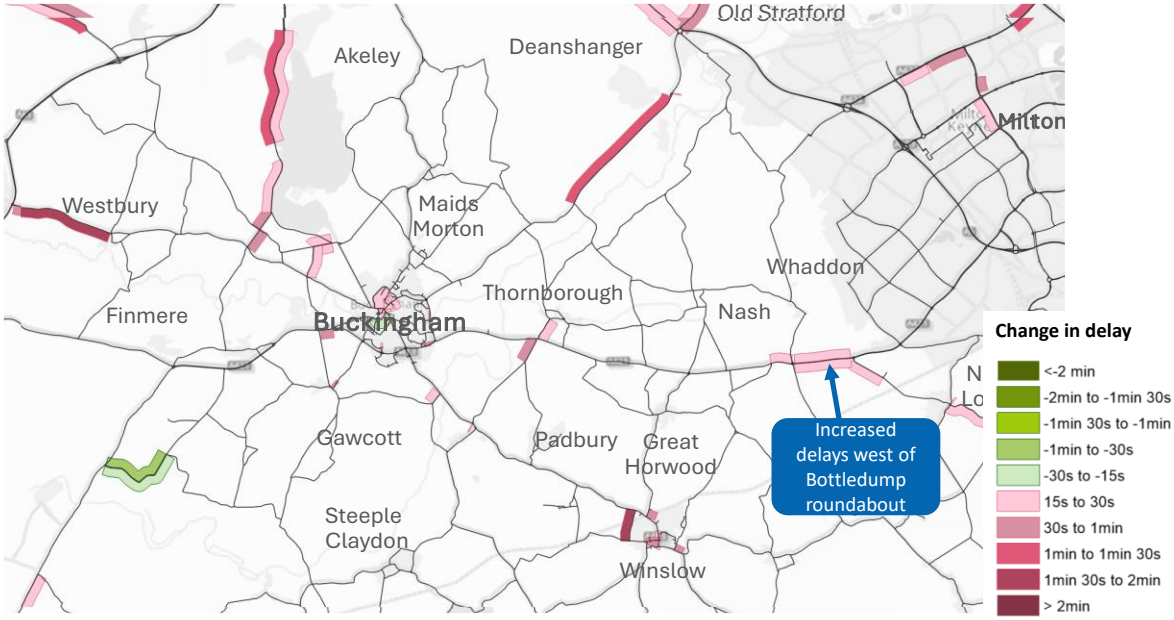


Figure 6-4 – Forecast change in delay in the morning peak hour: 2019 vs 2040 'do minimum'

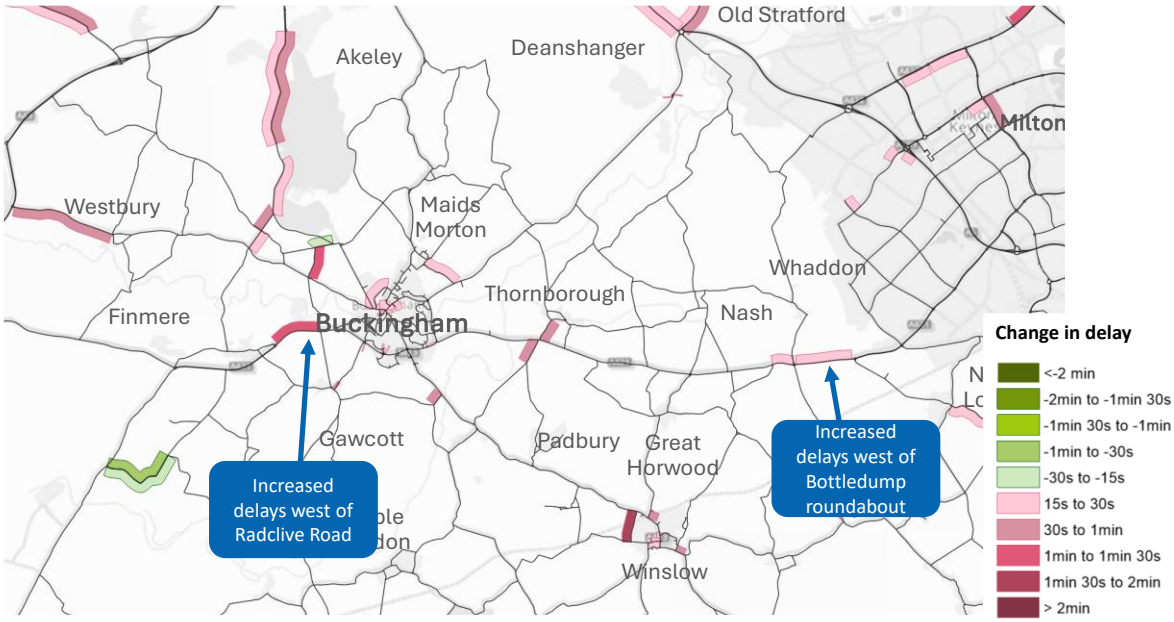


Figure 6-5 – Forecast change in delay in the evening peak hour: 2019 vs 2040 'do minimum'

The figures show that delays are expected to increase in a number of locations across the study area (noting that the model is better at predicting conditions on the main roads rather than the smaller local roads)[18]. The locations with increases of over 15 seconds include:

- the A421 east of Bottledump Roundabout (both directions in the morning peak hour, eastbound in the evening peak hour);
- the A421 eastbound west of Radclive Road (evening peak only); and
- the A422 southwest of Deanshanger (morning peak only).

The journey time along the route shown in Figure 6-6 has been used to compare the effects of the highway options tested on a typical journey. Table 6-1 shows the forecast journey times in each direction along this route in the 2019 base year and the 2040 'do minimum'. The 'delay impact' shown is the part of the journey time which is additional to the 'free flow' time (i.e. a measure of delay).

The table shows that journey times on this route are expected to increase by approximately two to three minutes between 2019 and 2040, depending on direction and time period. For example, the journey time from central Milton Keynes in the evening peak hour is forecast to increase from 26.8 minutes in 2019 to 28.8 minutes in 2040.

[18] Any decreases in delay are likely to be due to 'noise' within the model.

	Eastbound				Westbound			
Year, scenario and time period	**Free flow**	**Delay**	**Total**	**Delay impact**	**Free flow**	**Delay**	**Total**	**Delay impact**
2019 base year: morning peak	19.1	7.8	26.9	+41%	20.3	5.1	25.4	+25%
2019 base year: inter-peak	19.1	3.4	22.4	+18%	20.3	3.5	23.8	+17%
2019 base year: evening peak	19.3	5.3	24.6	+27%	20.5	6.3	26.8	+31%
2040 'do minimum': morning peak	18.5	10.7	29.2	+56%	19.1	9.2	28.3	+57%
2040 'do minimum': inter-peak	18.4	5.2	23.6	+28%	19.1	7.5	26.6	+39%
2040 'do minimum': evening peak	18.7	8.2	26.9	+44%	19.3	9.5	28.8	+49%

Table 6-1 – Change in journey time between Buckingham and Milton Keynes Central via A421 (mins)

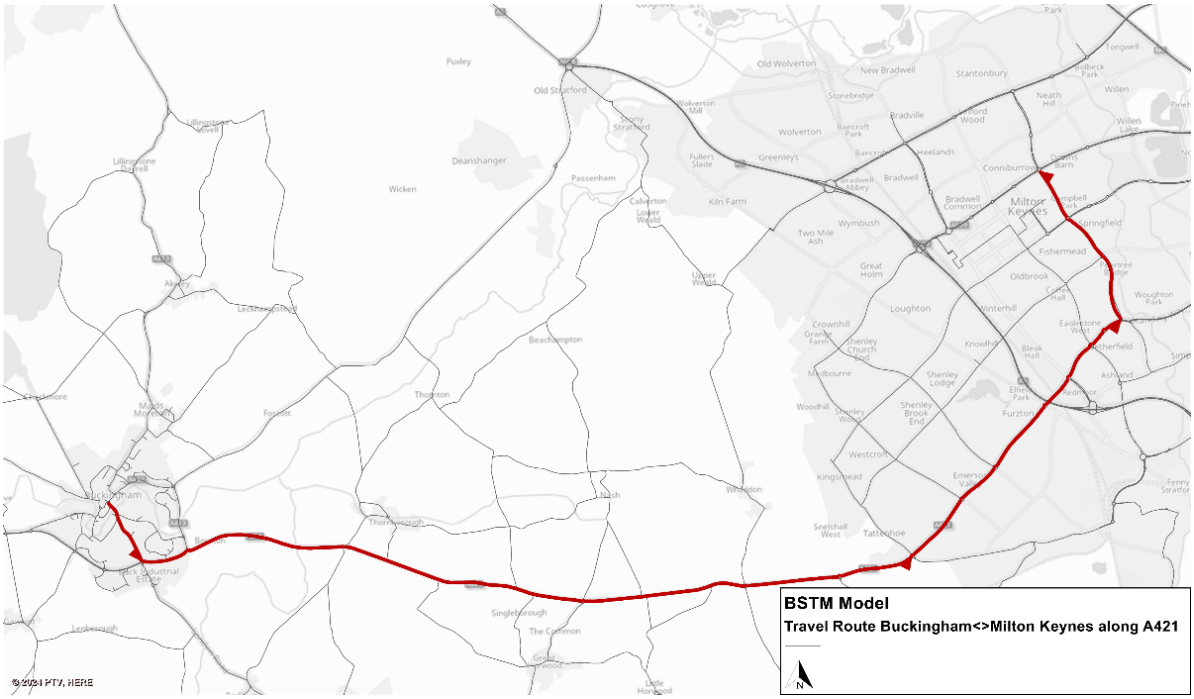


Figure 6-6 – Route used to assess modelled journey times

6.4. Full A421 dualling: Tingewick Bypass to Bottledump roundabout

6.4.1. Description of option

The option comprises dualling of approximately 16 kilometres of the A421 between the eastern end of the (dualled) Tingewick Bypass and Bottledump Roundabout (junction with Whaddon Road leading to Newton Longville). This section is shown in Figure 6-1.

The option is assumed to comprise:

- dualling on the road's current alignment (rather than to the north or south);
- two lanes in each direction;
- 70mph speed limit apart from section between junction at A421/Gawcott Road and junction of A421/A413 which is coded as 40mph.
- improvements to the entry and exit lane geometry of roundabouts along the section where necessary to accommodate the dualling between them[19];
- all roundabouts remaining 'at grade' i.e. on one level with no slip roads and under / over bridges;
- closure of the smaller junctions and/or restriction of priority junctions with side roads of the A421 to left in/left out only.

The purpose of this assessment is to ascertain the traffic impacts of dualling this section as a concept. Therefore, at this stage no allowance has been made for potential impacts of ground conditions, levels, land ownership, land designations, structures or utilities.

6.4.2. Approach to impact assessment

The option was tested using the BSTM in the 2040 forecast year for the morning, evening and inter-peak periods. The results from the forecast which assumes the dualling have been compared with the forecast for the 2040 'do minimum' scenario to identify the incremental effects of the option.

For the purposes of traffic modelling, full details of how each junction along the route was modelled, see Appendix E.1.

6.4.3. Results of impact assessment

6.4.3.1. Changes in traffic volumes

Forecast traffic volumes in the 2040 'do minimum' scenario (without the full dualling) were compared to those in the 2040 scenario with the full dualling. The difference between the two therefore shows the forecast incremental effect of the dualling in terms of traffic volumes.

The total amount of traffic in the BSTM, and the pattens of those journeys, is the same in the 'do minimum' and full dualling test. Therefore, the model is only predicting changes in the route each vehicle takes and does not take account of impacts such as re-timing of journeys, 'modal shift' between cars and other modes of transport, or long-term changes in where people choose to live or work.

[19] Note: these improvements are not the same as the individual junction improvements considered in detail later in this chapter due to different design requirements to accommodate dualling.

The forecasts suggest that traffic volumes on the dualled section would increase by between 500 and 1,000 vehicles in the morning peak hour and in the evening peak hour. These increases typically represent 20-40% extra traffic compared to the 2040 ‘do minimum’. The forecast increases in traffic are highest on the central section between the A413 Jubilee Way and the B4033 Winslow Road.

The forecasts suggest that the dualling of this section of the A421 effective at reducing traffic in the villages to the north and south of the corridor. However, it also draws much more traffic into the corridor from other routes because the dualling makes it a much more attractive choice.

These forecasts for the morning and evening peak hours respectively are shown in Figure 6-7 and Figure 6-8. The BSTM is a large strategic model calibrated to accurately predict traffic movements across the whole of Buckinghamshire and beyond. The model’s forecasts are therefore most robust on the main roads, and less robust on the smaller, local roads. Therefore, in interpreting the forecasts from BSTM it is recommended that readers look at the broad patterns of change rather than changes on individual local roads.

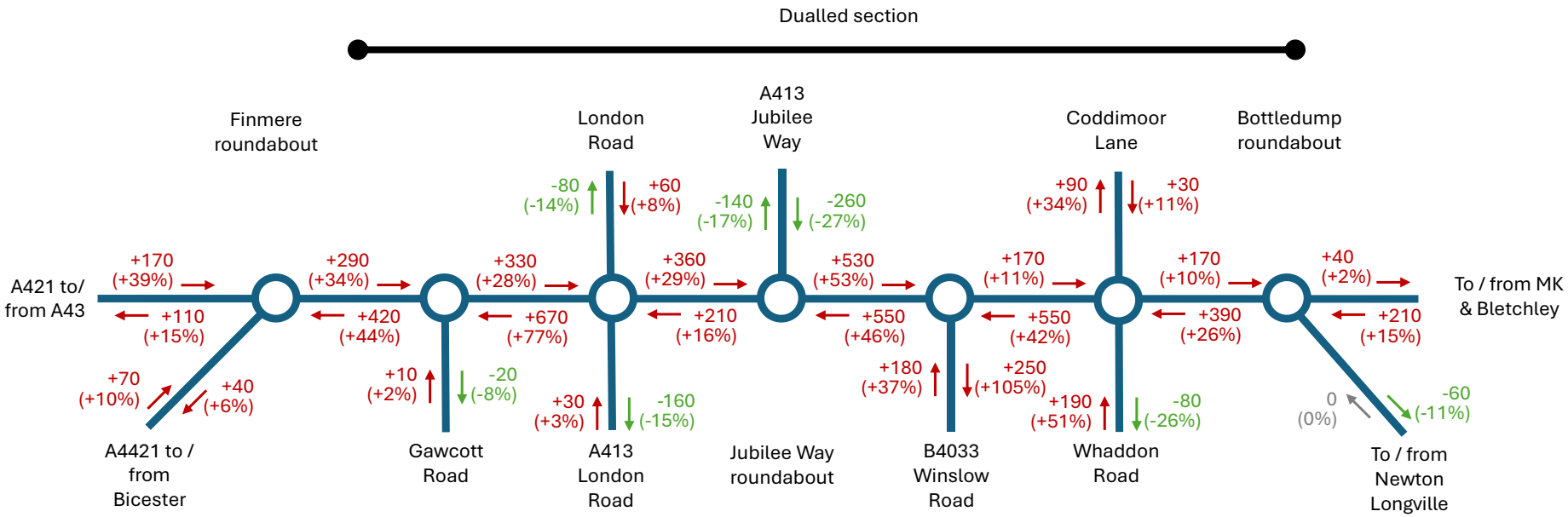


Figure 6-7 – Forecast % change in traffic volumes in the morning peak hour: full dualling vs 'do minimum'

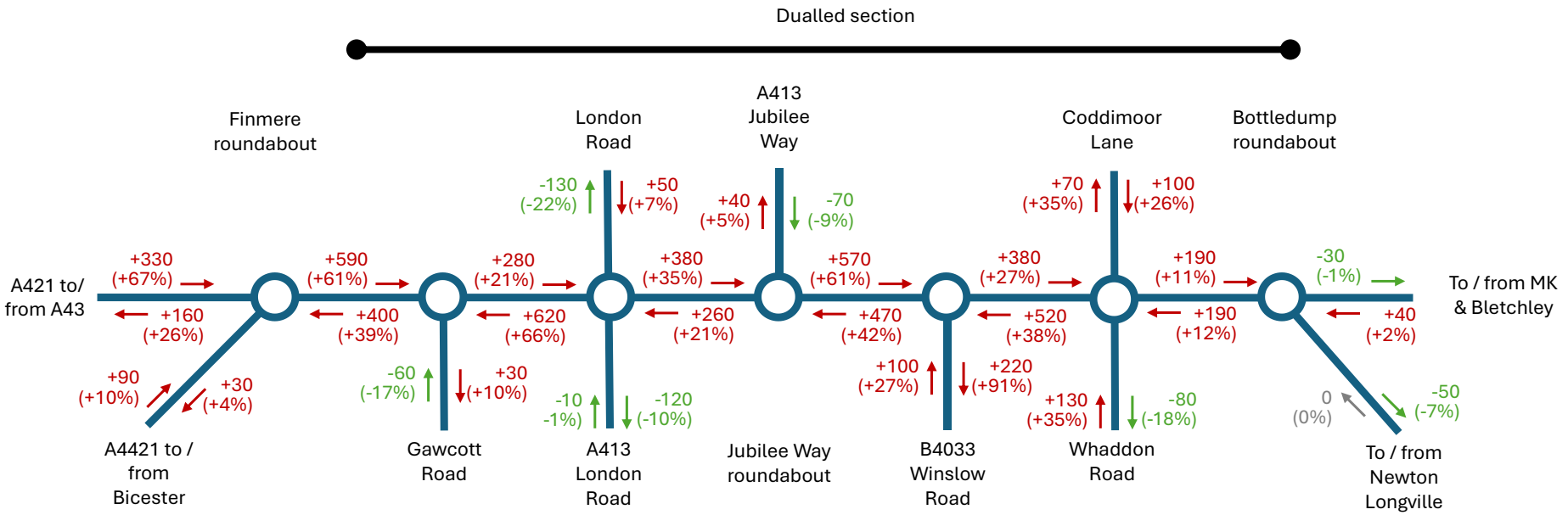


Figure 6-8 – Forecast % change in traffic volumes in the evening peak hour: full dualling vs 'do minimum'

6.4.3.2. Changes in congestion and journey times

Figure 6-9 and Figure 6-10 show the forecast changes in delay between the 2040 'do minimum' and the full dualling option on each highway 'link'. The figures only show changes of over 15 seconds. Note, the model also includes junction delays, which are not shown here.

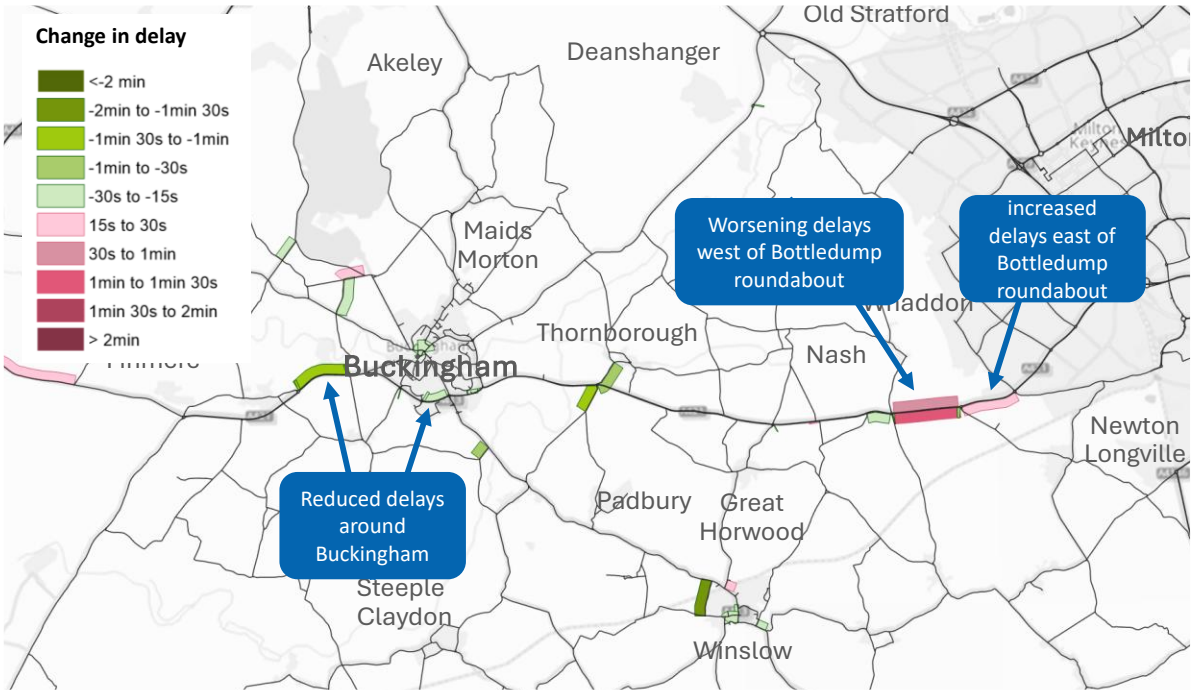


Figure 6-9 – Forecast change in delay in the 2040 morning peak hour: full dualling vs 'do minimum'

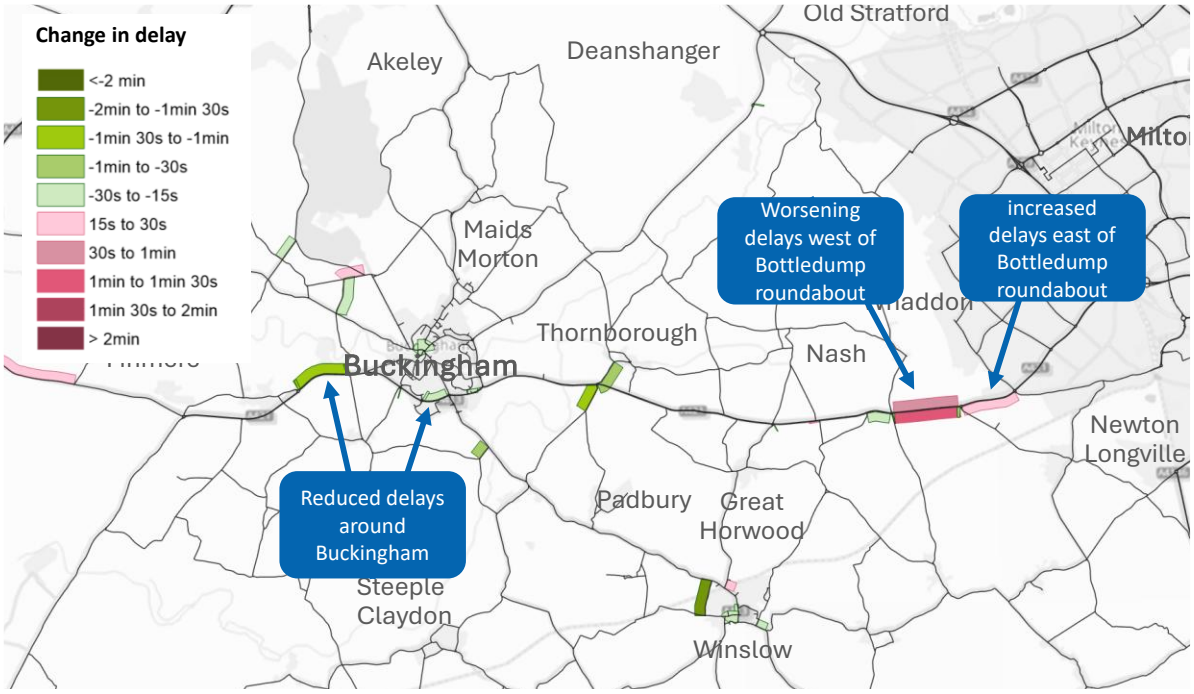


Figure 6-10 – Forecast change in delay in the 2040 morning peak hour: full dualling vs 'do minimum'

The figures show that delays in both directions are forecast to reduce on some sections of the A421. However, the modelling suggests that delays do not significantly fall on much of the A421 – believed to be because the delays in the 'do minimum' and the full dualling test tend to occur at the junctions rather than on the links between them. Delays are forecast to worsen east of Coddimoor Lane; this is likely because of the additional traffic using this section and the fact that the roundabouts in this area are already over capacity in the 2040 'do minimum'.

The journey time along the route shown in Figure 6-6 has been used to compare the effects of the highway options tested on a typical journey. Table 6-2 shows the forecast journey times in each direction along this route in the 2040 'do minimum' and the full dualling scenario. The 'delay impact' shown is the part of the journey time which is additional to the 'free flow' time (i.e. a measure of delay).

	Eastbound				Westbound			
Year, scenario and time period	**Free flow**	**Delay**	**Total**	**Delay impact**	**Free flow**	**Delay**	**Total**	**Delay impact**
2040 'do minimum': morning peak	18.5	10.7	29.2	+56%	19.1	9.2	28.3	+57%
2040 'do minimum': inter-peak	18.4	5.2	23.6	+28%	19.1	7.5	26.6	+39%
2040 'do minimum': evening peak	18.7	8.2	26.9	+44%	19.3	9.5	28.8	+49%
2040 Full dualling: morning peak	16.9	5.1	26.2	+55%	17.6	8.1	25.7	+55%
2040 Full dualling: inter-peak	16.8	3.4	20.3	+20%	17.6	4.1	21.6	+22%
2040 Full dualling: evening peak	17.1	7.0	24.1	+41%	17.8	8.8	26.6	+50%

Table 6-2 – Change in journey time between Buckingham and Milton Keynes Central via A421 (mins)

The table shows that the total journey time is forecast to reduce by approximately three minutes, depending on which direction and time period. For example, the eastbound journey time in the morning peak is forecast to fall from 29.2 minutes to 26.2 minutes. This is a much higher reduction than from the partial dualling (of approximately 30 seconds). The changes in journey time are the net effect of potentially being able to travel more quickly along the dualled link (partly due to the 70 mph vs 60 mph speed limit), and the potentially longer time to traverse the roundabouts.

6.4.4. Impact in terms of the corridor objectives

In this section, the impact of the full dualling option is reported against the corridor objectives established at the start of the study. Objectives #E1 to #E4 are the primary objectives of the study.

The impact descriptions are qualitative but are informed by the evidence presented relating to this option. The impacts are summarised in Table 6-3.

OVERARCHING & corridor objectives	Impact	
CONNECTING OUR ECONOMY		
#E1: Good public transport options between Buckingham and Winslow, Milton Keynes, Bicester and Brackley	●○○	**Reduced delays on the A422 would improve reliability of bus services using that corridor.**
#E2: Better public transport connections to the larger villages in the corridor	○○○	**No impact.**
#E3: Viable active travel connections between Buckingham and Winslow, Milton Keynes, Bicester and Brackley/ Silverstone	●○○	**Potential to include parallel active travel corridors as part of the scheme design.**
#E4: Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes / M1	●●○	**Delays are reduced (and hence reliability improved) but delays at junctions remain.**
#E5: The A421 is well-maintained and protected from flooding	●●○	These features could be included into the scheme design and maintenance protocols.
DECARBONISING OUR TRANSPORT SYSTEM		
#C1: Viable public transport connections to/from new housing and employment growth sites in the corridor	○○○	No impact.
#C2: Biodiversity in the A421 corridor is enhanced	○○○	Enhanced biodiversity features could be included into the scheme design. Likely to be some adverse environmental impacts due to size of scheme.
#C3: Greater use of low and ultra-low emission vehicles	○○○	No impact.
BUILDING PLACES FOR PEOPLE		
#P1: Improved road safety for pedestrians, cyclists and equestrians crossing the A421	●○○	Potential to design-in improved crossing facilities for non-motorised users. However, traffic volumes through Buckingham and near other residential properties will increase.
#P2: Fewer and less severe accidents in the corridor	●●○	Road built to new standards, and reduction in dangerous overtaking manoeuvres are likely to improve road safety.
#P3: Reduced emissions and noise from traffic using the A421	○○○	Significant additional traffic will increase noise exposure. Reductions in brake and tailpipe emissions may be offset by the additional traffic volumes (further work required).
#P4: Buckinghamshire is walking and cycling friendly	●○○	Parallel active travel corridor and improved crossing facilities could be important features of the design.

Table 6-3 – Summary of the impact of Option H-M1/M2/M3/M4 against the corridor objectives

The table above shows that there are a number of corridor objectives which are expected to be unaffected by the full dualling option, particularly those relating to reducing carbon emissions and improving public transport. Indeed, it is likely that the additional highway capacity would lead to an overall increase in vehicle kilometres travelled, and therefore tailpipe carbon emissions, due to new car trips being created, and average trip lengths growing.

The full dualling option is however expected to have positive impacts against several of the corridor objectives. In particular, the detailed assessment shows that it would reduce journey times and delays (thereby improving journey time reliability); however, these reductions are unlikely to be sufficient to justify the costs of the project. Depending on how it would be designed, the full dualling could also improve road safety outcomes as the road would be built to a higher standard and safer crossing facilities provided for pedestrians, cyclists and equestrians.

6.4.5. Costs and funding

The total cost (excluding land costs) of the full dualling option is estimated to be over £300 million. A breakdown of the cost estimate for the full dualling option is shown in Table 6-4. Due to the size of the full dualling, the cost estimate has been calculated using a different method to the other options.

The cost of the dualling has been calculated on a *pro rata* basis based on the total estimated cost per kilometre of the partial dualling option (H-J1) as shown in Table 6-7. Additional costs have been added for improvements to junctions along the route, and for cycle subways.

Cost item	Cost estimate (m)	Notes
Main dualling costs	£294.00	Based on £21m per km
Improvements to the six roundabouts subject to detailed assessment	£11.15	
Improvements to 3 junctions at eastern end of route	£6.93	£2.31m per roundabout
New roundabout at Padbury Road	£4.62	Twice the cost of 3 eastern roundabouts
Cycle subways	£1.75	Five assumed
TOTAL ESTIMATED COST	£318.45	

Table 6-4 - Cost estimate for Option H-M1/M2/M3/M4: Full dualling

Funding options for a scheme of this size are currently extremely limited. As described in Section 6.5.4, historic sources of funding for major schemes are no longer available or subject to government policy decisions. Local funding sources, including developer contributions, would not be sufficient for this scheme, even if future devolution arrangements mean that more capital funding is available.

The only potential funding opportunities are:

- Adoption of the A421 by National Highways and funding of the scheme through a future National Highways Road Investment Strategy. Currently this appears unlikely and, even if adopted, National Highways is unlikely to invest (for the foreseeable future) in many schemes of this cost other than those already at an advanced stage of development. Should funding become available in future, it is unlikely that the full dualling would generate sufficient benefits to provide a strong enough value for money case when compared to other projects at a national scale.

- The recent announcements by the Government on the Oxford to Cambridge corridor becoming the 'Silicon Valley of Europe' may however change the picture. As with the previous 'OxCam Arc' concept, better strategic east-west connectivity is likely to form an important part of the latest proposals. As such there may be a stronger case for dualling the A421 between the A443 and M1 in the long-term.
- Future rounds of Large Local Major Schemes funding (or other new funds). In the near future these are unlikely given the pressure on Government infrastructure budgets. As above it is unlikely that the A421 dualling would offer as strong a value for money case as other schemes competing nationally for the same funding.

6.4.6. Key risks

As with the partial dualling, at this very early stage of development, it is not possible to be definitive about the planning and delivery risks associated with this option. Given the larger scale of this option, the risks will be commensurately higher.

However, the following potential areas of risk have been identified (an early activity should the option be progressed would be the development of a detailed risk register):

- uncertainty over costs, in particular the new junctions, land costs, structures and statutory undertakers' equipment;
- land availability, especially where there are properties in close proximity;
- potential requirements for compulsory purchase and demolition;
- the need for additional local junctions or modifications to existing ones;
- ground conditions and levels;
- impacts on environmental designations;
- impacts of additional traffic close to air quality and noise receptors, particularly residential properties in Buckingham;
- severance impacts and impacts on conditions for pedestrians, cyclists and equestrians (such as crossing facilities);
- disruption to traffic during construction;
- provision for local access to properties along the route (of which there are many);
- interaction with access arrangements for the proposed Shenley Park development;
- knock-on traffic effects (for example relocation of delays to elsewhere on the network and traffic in local villages);
- the increased attractiveness of the Stoke Road/Whaddon Road route via Newton Longville as a route between the A5 and A4146 and A43); and
- strategic traffic effects, particularly the forecast significant increase in traffic using the A421 corridor.

6.4.7. Summary and recommendations

The option comprises dualling of approximately 16 kilometres of the A421 between the eastern end of the Tingewick Bypass and Bottledump Roundabout. The proposal includes improvements to the roundabouts and junctions along the route to accommodate the dualling. The option tested has only been specified to a level of detail in order to enable testing of the concept in the traffic model.

Forecasts using the BSTM suggest that traffic volumes on the dualled section would increase by as much as 500 to 1,000 vehicles in the peak hours (i.e. 20-40%) as the A421 becomes a more attractive corridor for through traffic. Traffic growth could be higher than this as the BSTM does not include the effects of generation of new journeys because of the additional road capacity.

Congestion and delays are forecast to reduce on some sections of the A421. However, the additional traffic results in additional delays at the junctions. As a result, the option is forecast to only reduce journey times between Buckingham and Milton Keynes by approximately three minutes.

The full dualling option is expected to have positive impacts against several of the corridor objectives. In particular, the detailed assessment shows that it would reduce journey times and delays (thereby improving journey time reliability). The full dualling could also improve road safety outcomes.

The full dualling is estimated to cost over £300 million (excluding land costs). The value of the total time savings could be relatively high due to the number of journeys with lower journey times, but some of these benefits are being realised by journeys passing through the study area. The value for money of the scheme once land is taken into account is likely to be 'Low' and therefore unlikely to be prioritised for funding.

Funding options for a scheme of this size are currently extremely limited. No viable funding sources have been identified in the short to medium term.

At this very early stage of development, it is not possible to be definitive about the planning and delivery risks. Given the large scale of this option, numerous potential risks have been identified, including those relating to cost uncertainty, disruption during construction, adverse noise and air quality issues, and additional tailpipe and embodied carbon.

It is recommended that the full dualling option is not considered further in relation to the objectives of this study; many of the benefits of the scheme are likely to accrue for those travelling through the area (resulting in increased traffic). The very high costs mean the scheme is likely to be unaffordable and may offer only 'low' value for money. The risks associated with the dualling are substantial, including potential adverse impacts on communities, particularly in Buckingham, and impacts on the local environment.

6.5. Partial A421 dualling: Whaddon Road to Bottledump roundabout

6.5.1. Description of option

The option comprises dualling of approximately 1.6 kilometres of the A421 between the Coddimoor Road / Whaddon Road roundabout and Bottledump Roundabout (junction with Whaddon Road leading to Newton Longville). This is Option H-M1 in Table 5-4. This section is shown in Figure 6-11 below.



Figure 6-11 - Section of A421 assumed to be dualled. Source: Google Maps

The option is assumed to comprise:

- dualling on the road's current alignment (rather than to the north or south);
- two lanes in each direction;

- improvements to the entry and exit lane geometry of the roundabouts at either end of the section where necessary to accommodate the dualling between them; and
- the two roundabouts remain 'at grade' i.e. on one level with no slip roads and under / over bridges.

The purpose of this assessment is to ascertain the traffic impacts of dualling this section as a concept. Therefore, at this stage no allowance has been made for potential impacts of ground conditions, levels, land ownership, land designations, structures or utilities.

6.5.2. Approach to impact assessment

The option was tested using the BSTM in the 2040 forecast year for the morning, evening and inter-peak periods. The results from the forecast which assumes the dualling have been compared with the forecast for the 2040 'do minimum' scenario to identify the incremental effects of the option.

For the purposes of traffic modelling, it was assumed that:

- carriageway coded as 2 lanes in each direction, with 2 lanes entering and exiting junctions between junction of A421/Whaddon Road and Bottledump Roundabout; and
- 70mph speed limit.

6.5.3. Results of impact assessment

6.5.3.1. Changes in traffic volumes

Forecast traffic volumes in the 2040 'do minimum' scenario (without the dualling) were compared to those in the 2040 scenario with the dualling. The difference between the two therefore shows the forecast incremental effect of the dualling in terms of traffic volumes.

The total amount of traffic in the BSTM, and the pattens of those journeys, is the same in the 'do minimum' and dualling test. Therefore, the model is only predicting changes in the route each vehicle takes and does not take account of impacts such as re-timing of journeys, 'modal shift' between cars and other modes of transport, or long-term changes in where people choose to live or work.

The forecasts suggest that traffic volumes on the dualled section would increase by c. 200 vehicles in the morning peak hour and by c. 300 vehicles in the evening peak hour. These increases represent 6-7% extra traffic compared to the 2040 'do minimum'. The forecast increases in traffic are lower elsewhere, and negligible west of the A413 through Buckingham and beyond.

The forecasts suggest that the dualling of this short section of the A421 has a relatively small impact on choice of route. Commensurate reductions in traffic in the local roads to the north and south of the A421 indicate that the dualling does however draw some traffic away from the surrounding villages and onto the A421.

These forecasts for the morning and evening peak hours respectively are shown in Figure 6-12 and Figure 6-13. The BSTM is a large strategic model calibrated to accurately predict traffic movements across the whole of Buckinghamshire and beyond. The model's forecasts are therefore most robust on the main roads, and less robust on the smaller, local roads. Therefore, in interpreting the forecasts from BSTM it is recommended that readers look at the broad patterns of change rather than changes on individual local roads.

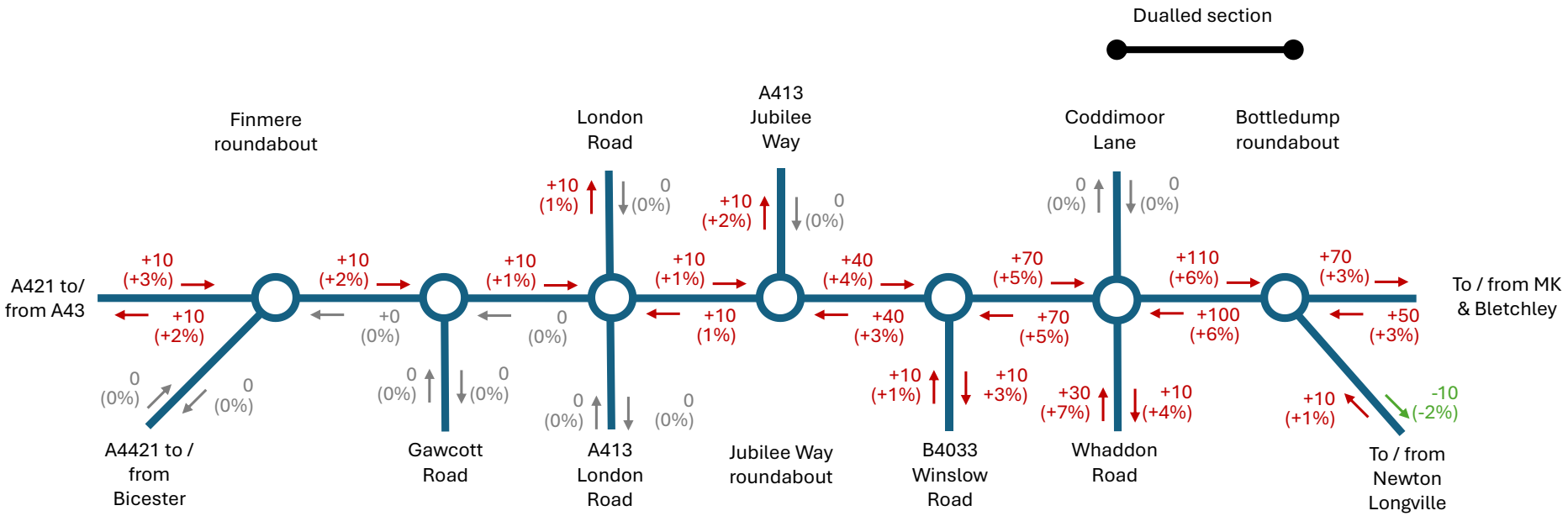


Figure 6-12 – Forecast % change in traffic volumes in the morning peak hour: partial dualling vs 'do minimum'

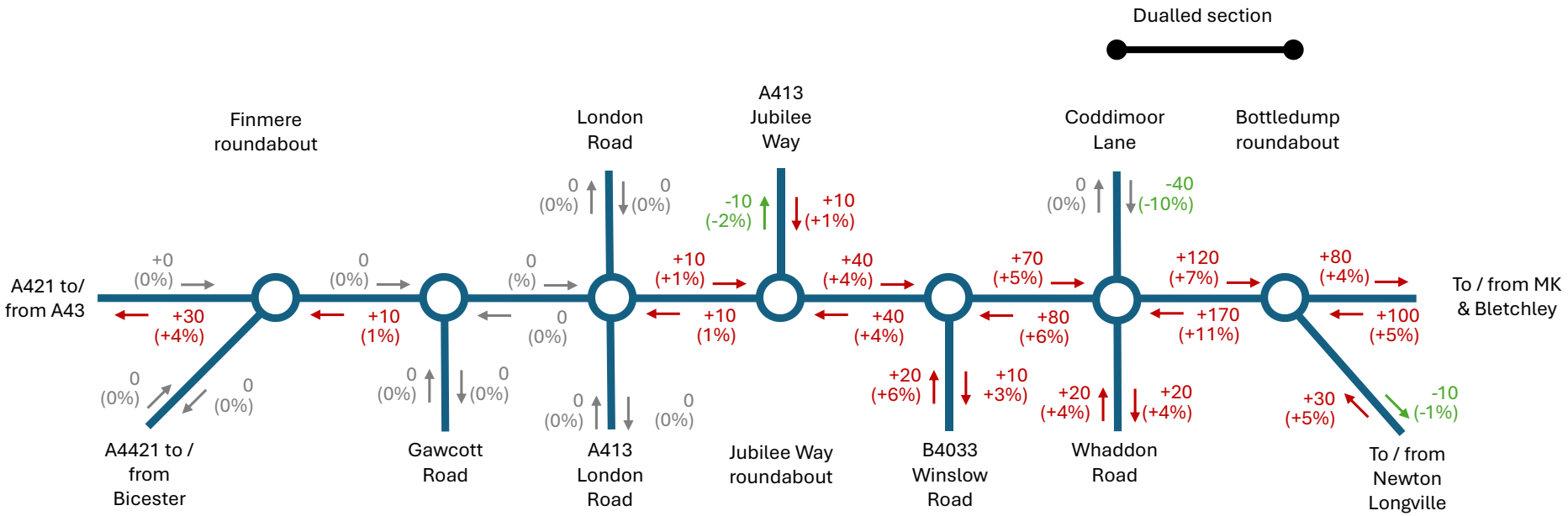


Figure 6-13 – Forecast % change in traffic volumes in the evening peak hour: partial dualling vs 'do minimum'

6.5.3.2. Changes in congestion and journey times

Figure 6-14 and Figure 6-15 show the forecast changes in delay between the 2040 'do minimum' and the partial dualling option on each highway 'link'. The figures only show changes of over 15 seconds.

The figures show that delays in both directions are forecast to reduce on the section of the A421 which is assumed to be dualled in both the morning and evening peak hour. However, the modelling suggests that delays in the westbound direction in the evening peak hour could increase west of Coddimoor Lane. This is likely to be because of the additional traffic using this section and the effects of that traffic merging back into a single lane.

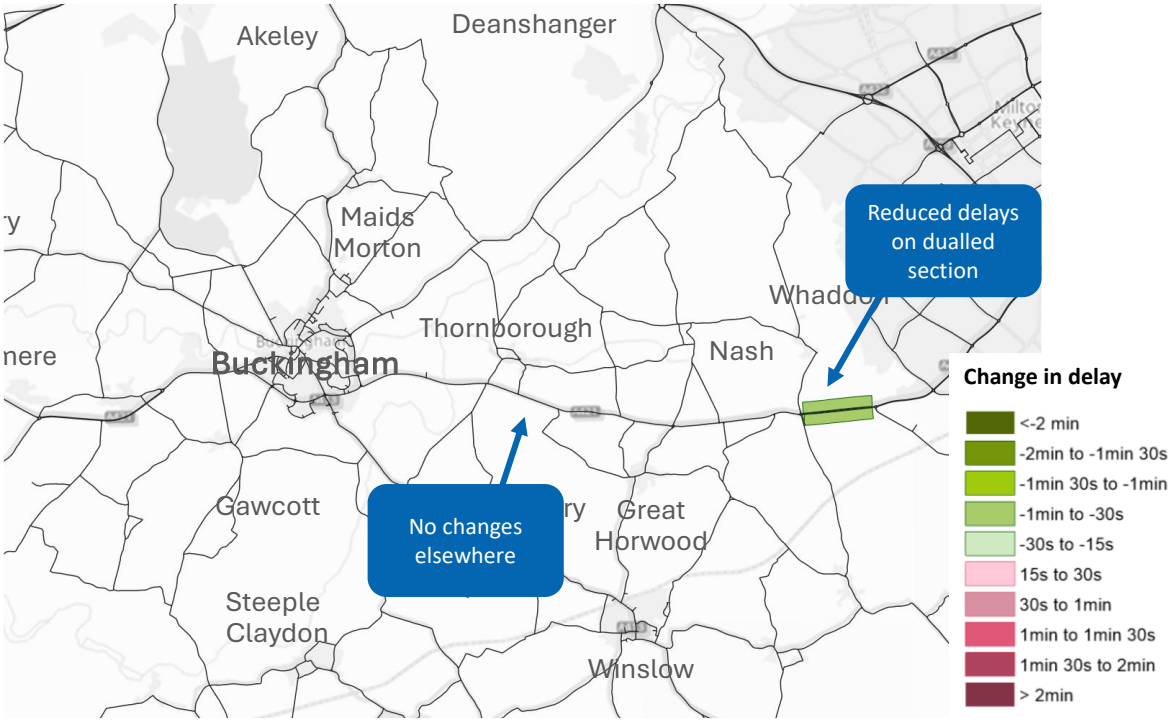


Figure 6-14 – Forecast change in delay in the 2040 morning peak hour: partial dualling vs 'do minimum'

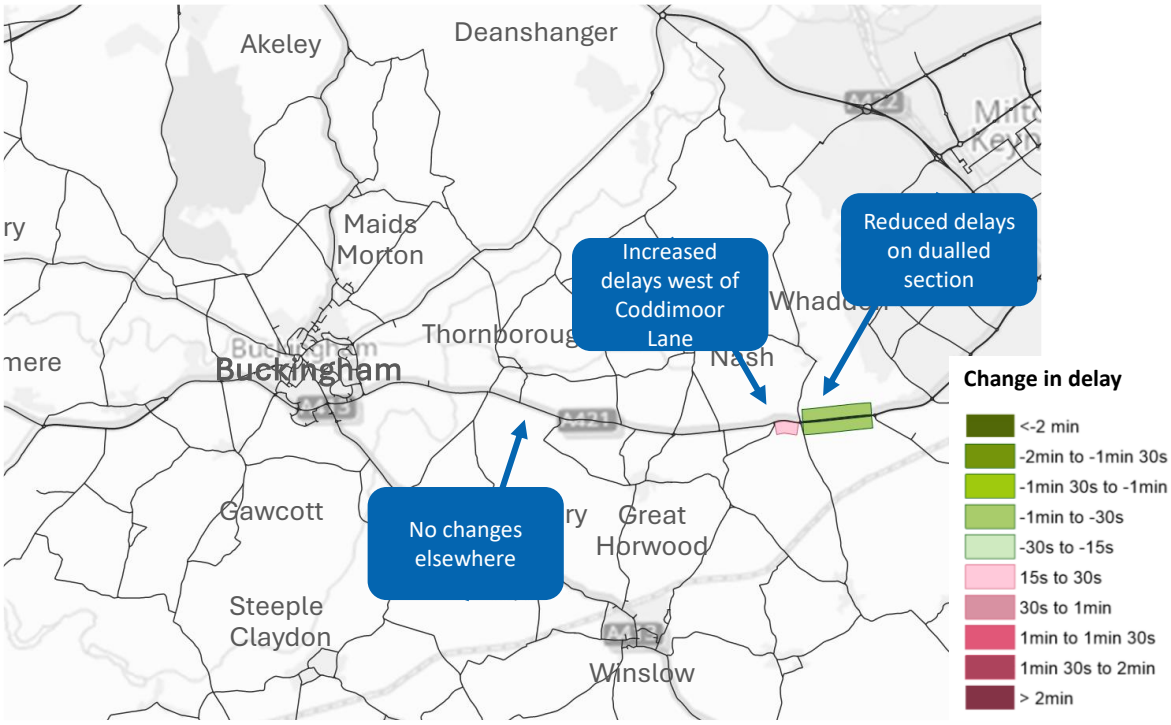


Figure 6-15 – Forecast change in delay in the 2040 morning peak hour: partial dualling vs 'do minimum'

The journey time along the route shown in Figure 6-6 has been used to compare the effects of the highway options tested on a typical journey. Table 6-5 shows the forecast journey times in each direction along this route in the 2040 'do minimum' and the partial dualling scenario. The 'delay impact' shown is the part of the journey time which is additional to the 'free flow' time (i.e. a measure of delay).

	Eastbound				Westbound			
Year, scenario and time period	**Free flow**	**Delay**	**Total**	**Delay impact**	**Free flow**	**Delay**	**Total**	**Delay impact**
2040 'do minimum': morning peak	18.5	10.7	29.2	+56%	19.1	9.2	28.3	+57%
2040 'do minimum': inter-peak	18.4	5.2	23.6	+28%	19.1	7.5	26.6	+39%
2040 'do minimum': evening peak	18.7	8.2	26.9	+44%	19.3	9.5	28.8	+49%
2040 Partial dualling: morning peak	18.3	10.3	28.6	+57%	18.9	8.2	27.9	+60%
2040 Partial dualling: inter-peak	18.2	4.9	23.1	+30%	18.9	5.7	24.6	+34%
2040 Partial dualling: evening peak	18.5	7.8	26.2	+42%	19.2	9.3	28.4	+52%

Table 6-5 – Change in journey time between Buckingham and Milton Keynes Central via A421 (mins)

The table shows that the total journey time is forecast to reduce by approximately 30 seconds, depending on which direction and time period. For example, the eastbound journey time in the morning peak is forecast to fall from 29.2 minutes to 28.6 minutes. This is a relatively small reduction given the expected cost of the dualling. The changes in journey time are the net effect of potentially being able to travel more quickly along the dualled link (partly due to the 70 mph vs 60 mph speed limit), and the potentially longer time to traverse the roundabouts, particularly where the dualling ends and the road reverts to a single carriageway in each direction (west of Coddimoor Lane).

6.5.4. Impact in terms of the corridor objectives

In this section, the impact of the partial dualling option is reported against the corridor objectives established at the start of the study. Objectives #E1 to #E4 are the primary objectives of the study.

The impact descriptions are qualitative but are informed by the evidence presented relating to this option. The impacts are summarised in Table 6-6.

OVERARCHING & corridor objectives	**Impact**	
CONNECTING OUR ECONOMY		
#E1: Good public transport options between Buckingham and Winslow, Milton Keynes, Bicester and Brackley	○○○	**No impact.**
#E2: Better public transport connections to the larger villages in the corridor	○○○	**No impact.**
#E3: Viable active travel connections between Buckingham and Winslow, Milton Keynes, Bicester and Brackley/ Silverstone	○○○	**No impact.**
#E4: Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes / M1	●○○	**Slightly shorter journey times. Reductions in delay (though some relocation of delays).**
#E5: The A421 is well-maintained and protected from flooding	●○○	These features could be included into the scheme design and maintenance protocols.
DECARBONISING OUR TRANSPORT SYSTEM		
#C1: Viable public transport connections to/from new housing and employment growth sites in the corridor	○○○	No impact.
#C2: Biodiversity in the A421 corridor is enhanced	●○○	Enhanced biodiversity features could be included into the scheme design.
#C3: Greater use of low and ultra-low emission vehicles	○○○	No impact.

OVERARCHING & corridor objectives	Impact	
BUILDING PLACES FOR PEOPLE		
#P1: Improved road safety for pedestrians, cyclists and equestrians crossing the A421	○○○	Negligible impact. Few non-motorised users in the area.
#P2: Fewer and less severe accidents in the corridor	●○○	Road built to new standards will improve road safety.
#P3: Reduced emissions and noise from traffic using the A421	○○○	Reductions in delays could reduce emissions but may be offset by additional traffic.
#P4: Buckinghamshire is walking and cycling friendly	○○○	No impact.

Table 6-6 – Summary of the impact of Option H-M1 against corridor objectives

The table above shows that the partial dualling option is expected to have positive impacts against several of the corridor objectives (including objective #E4), but that these impacts will not be particularly significant. It is expected to have no impact on several other corridor objectives. Construction of the dualled section will result in embodied carbon within the infrastructure itself; and the additional capacity provided by the partial dualling could lead to additional vehicle traffic and therefore additional tailpipe carbon emissions.

6.5.5. Costs and funding

Indicative option costs have been estimated for the highway options subject to detailed assessment. Estimates are based on unit rate out-turn costs for other similar projects. The cost estimates include allowances for (as necessary):

- removal of existing infrastructure and vegetation and general excavation;
- provision of kerbs, footways, verges, planting, trees, carriageway, surfacing, signs, street furniture, lighting, drainage and road markings;
- earthworks and retaining structures;
- pedestrian crossing facilities, signals, traffic control;
- unidentified works;
- preliminaries and traffic management;
- allowance for quantified risk assessment;
- contingency; and
- diversion of statutory undertakers' equipment.

No allowance has been made for land costs.

Full details of all the cost estimates are provided in Appendix G. The cost estimates require further refinement and understanding of ground conditions etc. to provide robust estimates.

The total cost (excluding land costs) of the partial dualling option is estimated to be nearly £30 million. A breakdown of the cost estimate for the partial dualling option is shown in Table 6-7. The estimate does not include costs associated with required improvements to the roundabouts at either end of the dualled section (which are estimated to be approximately £4 million).

Cost item	Cost estimate (m)	Notes
Construction costs	£13.67	
Construction costs (unidentified)	£3.42	25% of construction costs
Preliminaries & traffic management	£2.05	10% of construction costs
Construction total	**£19.14**	
Allowance for QRA	£1.91	10% of construction total
Contingency	£4.78	25% of construction total
Budget cost	**£25.85**	
Statutory undertakers' diversions	£2.56	10% of budget cost
TOTAL ESTIMATED COST	**£28.44**	

Table 6-7 - Cost estimate for Option H-M1: Partial dualling

Funding sources for a scheme of this cost are limited. Historically schemes of this size have been funded through a number of sources including:

- the Local Growth Fund (via the Local Enterprise Partnerships);
- Large Local Major schemes (through the Department for Transport);
- Major Road Network schemes (through the Department for Transport); and
- The Housing Infrastructure Fund (through the Ministry for Housing, Communities and Local Government).

However, many of these funds expire at the end of 2024/25 and applications closed some time ago. Future rounds of funding though these or similar sources are possible, but the current government has yet to confirm its approach.

The scheme cost exceeds what may have previously been funded through the National Productivity & Investment Fund. The A421 is not part of the Strategic Road Network (managed by National Highways) and is therefore not subject to funding through the Roads Investment Strategy.

The funding options which may be able to at least part-fund the scheme could include:

- Developer contributions (Section 106 agreements) - The partial dualling would improve performance of the A421 in the vicinity of two large, proposed developments though negotiations on both are at an advanced stage.
- Community Infrastructure Levy (CIL) - Should Buckinghamshire Council adopt a CIL scheme in the future, funding from this source may be available. However, the purpose of CIL to provide for strategic infrastructure needed to support multiple developments in an area may mean that the A421 is not seen as a priority, unless additional development is planned.
- National Highways - Adoption of the A421 by National Highways would see the road become part of the Strategic Road Network. Whilst there is some strategic rationale for this in the context of better east-west connections in southern England, adoption of the A421 does not currently appear likely. Further, in the short to medium term, National Highways budgets are expected to be more constrained and prioritised on maintenance and renewal projects (although some smaller improvement schemes are still expected).

- Buckinghamshire Council – There is currently little to no funding available for major road projects. Schemes of this nature would require a strong business case with approval and funding sought from the Department for Transport (DfT). Government funding has been declining since 2010 and with recent cancellations of road schemes due to financial constraints and strategic shifts in investments, it is unlikely that the council will be able to identify sufficient funding for the proposed A421 improvements.

6.5.6. Key risks

At this very early stage of development, it is not possible to be definitive about the planning and delivery risks associated with the options. However, the following potential areas of risk have been identified (an early activity should the option be progressed would be the development of a detailed risk register):

- uncertainty over costs, in particular land costs, structures and statutory undertakers' equipment;
- ground conditions and levels;
- impacts on environmental designations, including the ancient woodland to the south of the A421 in this location;
- disruption to traffic during construction;
- provision for local access to properties;
- interaction with access arrangements for the proposed Shenley Park development;
- knock-on traffic effects (for example relocation of delays to elsewhere on the network and traffic in local villages); and
- the increased attractiveness of the Stoke Road/Whaddon Road route via Newton Longville as a route between the A5 and A4146 and A43).

6.5.7. Summary and recommendations

The option comprises dualling of approximately 1.6 kilometres of the A421 between the Coddimoor Road / Whaddon Road roundabout and Bottledump Roundabout. This includes necessary alterations at the two roundabouts.

Testing using the BSTM forecast that traffic volumes on the dualled section would increase by 200 to 300 vehicles per hour in the peaks (a 6-7% increase) but by much less elsewhere. The option is unlikely to reduce traffic on surrounding local roads.

Traffic congestion is forecast to reduce on the dualled section but the partial dualling could lead to increased delays at other locations on the A421. The dualling is forecast to only reduce journey times between Buckingham and Milton Keynes by approximately 30 seconds.

The cost estimate for the partial dualling is nearly £30 million (excluding land costs). Once land costs are taken into account, the limited benefits of the option are expected to mean that the partial dualling offers low value for money.

Options for funding a scheme of this size are currently limited. Developer contributions are the most likely funding source but these may not be sufficient to cover the full costs of the scheme. The risks associated with the partial dualling are relatively small but not insignificant, particularly in terms of costs, feasibility and traffic impacts.

It is recommended for the reasons set out above that the partial dualling option is not considered further in relation to the objectives of this study. Dualling this section may remain a worthwhile consideration in terms of local access to developments in this area but that is a matter for the development planning process to consider.

6.6. A421 roundabout improvements

6.6.1. Introduction

There are numerous junctions along the A421 between Finmere and Bottledump roundabout. These include eleven roundabouts as well as many smaller priority junctions and accesses to property.

The roundabouts require traffic passing along the A421 to give way to circulating traffic, which can lead to delays. The priority junctions cause less delays for traffic on the A421 but can have safety issues where slower-moving traffic is pulling out onto or across the A421.

Observations of traffic conditions on the A421 from real-time data shows that junction delays appear to be most significant at six of the eleven roundabouts in the study area. These are shown in Figure 6-16.

Note that Bottledump roundabout is just within the boundary of the Milton Keynes administrative area but has been examined due to its importance for the A421 in the study area. The proposed new roundabout to access the Shenley Park development has not been examined in this study as it is not yet committed and subject to agreement as part of the development planning process.



Figure 6-16 – Locations of proposed roundabout improvements

The capacity of a roundabout is determined by a number of factors relating to the geometry of the roundabout including:

- the number of approach/joining lanes – more lanes can increase capacity;
- the length of the approach/joining lanes – longer lanes make it easier for vehicles to get into the right lane and potentially advance more quickly to the roundabout (meaning better use can be made of the lanes provided);
- the extent to which the provision of the approach lanes is consistent with the patterns of traffic using the roundabout;
- the configuration of the central island and the width and alignment of the circulating carriageway; and
- the number of exit lanes and length of the lane merge (where provided).

Signalising the roundabout can also increase capacity in some circumstances and where there is sufficient space for queuing traffic on the circulating carriageway.

Potential improvements to the geometry of each roundabout have been identified with the objective of increasing their capacity, particularly for the dominant traffic movements at each. The improvements comprise a package of alterations which provide alignments on the approaches to, and through, the roundabouts that give confidence to drivers to make full use of all lanes. These changes include:

- substantial lengthening of the approach lanes;
- better alignment of carriageways;
- improved approach signing and markings;
- modification to the use of approach lanes in terms of the movements allowed from them (left turn, straight on and/or right turn);
- lengthening of exit lanes and merges.

Sketch designs for each roundabout were prepared using the following three steps.

1. Assessment of the issues and problems occurring at the roundabout and how drivers use it which affects the roundabout's performance.
2. Development of concepts that will address these issues and problems.
3. Conversion of those concepts into clear sets of dimensions which can subsequently be used to model their performance.

In practice steps 2 and 3 form an iterative loop to refine the concepts.

6.6.2. Description of options

The proposed options for each roundabout, derived using the process described above, are shown in Table 6-8. No changes are proposed for the Aldi/Osier Way roundabout as the junction modelling (see later) suggests that this roundabout will still operate with an acceptable level of performance in 2040.

Diagrams showing the proposed changes are provided in Appendix E.

Roundabout	Summary of proposed improvements
H-J1: Aldi/Osier Way roundabout	• No changes proposed.
H-J2: London Road roundabout	• Approaching from the west: Carriageway widening to provide for a longer left-turn lane, removing vehicles from the other two lanes. • Approaching from the east: Carriageway widening to provide a dedicated left-turn lane towards the supermarket. • Approaching from the east: Space provided for a longer right-turn lane (which also allows ahead movements). Two full straight-ahead lanes thus provided. • Approaching from the south: widening of London Road from the vicinity of the car wash to provide two much longer approach lanes.
H-J4: A421/A413 roundabout	• Approaching from the west: Carriageway widening to provide for two longer approach lanes. Both lanes allow left-turn and straight-ahead. • Approaching from the east: Carriageway widening to provide for two longer approach lanes (from west of the pedestrian crossing).

Roundabout	Summary of proposed improvements
H-J5: A421/B4033/ Winslow Road roundabout	• Approaching from the east and west: Carriageway widening to allow for two much longer approach lanes. • Exiting roundabout to east and west: Widening of exit lanes to allow greater capacity for merging from two-lane roundabout.
H-J8: Whaddon (Coddimoor Lane) roundabout	• Approaching from the east and west: Carriageway widening to allow for two much longer approach lanes. • Exiting roundabout to east and west: Widening of exit lanes to allow greater capacity for merging from two-lane roundabout. • Approaching from the north: Widening to two lane approach to the A421. Short taper to encourage some ahead and all right turning traffic to use inner circulating lane. • Approaching from the south: Carriageway widening to allow two approach lanes.
H-J9: Bottledump roundabout	• Approaching from the east: Widening to three lane approach on the A421 east and to two full lanes on the circulating carriageway. Enables 2 lanes straight on plus dedicated left turn lane. • Exiting to west: Widening of exit width to the west to provide two longer lanes and ease merge.

Table 6-8 – Summary of proposed roundabout improvements

Further refinement of these concepts is recommended. Once concepts have been settled upon, and the initial assessment of cost and performance complete, development of feasibility designs for the concepts can be carried out. The design process will need to be appropriately detailed and exhaustive. The process we have followed reduces the risk of unnecessary design work in the next stage of scheme development.

6.6.2.1. Alternative options considered

The potential for a ‘hamburger roundabout’ was considered for the A421/A413 junction. This is a roundabout which allows for traffic on the main road (in this case the A421) to traverse through the roundabout island rather than around it. Signalising the roundabout to enable this is therefore required. The option was not progressed as alternative, easier, solutions were identified and due to challenges presented by coordinating traffic signals on this roundabout with those at the London Road roundabout.

The potential for a ‘jet lane’ was also considered for the A421/A413 roundabout. This would provide a dedicated and segregated lane to the south of the junction for traffic travelling westbound on the A421 through the junction. As above this was not taken further as cheaper alternatives were identified and jet lanes can have an unintended consequence whereby the jet lane unbalances the roundabout, which can lead to issues with other arms.

Although not selected for detailed assessment, some further consideration was given to improving the staggered crossings of the A421 (Padbury Road and Little Horwood Road). To improve safety at these junctions, it is recommended that it is worth examining whether these junctions should be converted to left in/left out arrangements only. This would remove the (most dangerous) right turn movements but would require vehicles wishing to turn right to find an alternative route or travel in the wrong direction on the A421 and turning around where appropriate (this is particularly an issue for the Padbury Road junction).

Small changes to the Bottledump and A421/Whaddon Road roundabouts are proposed as part of the S106 agreement for the Salden Chase/Park development (mainly relating to signage, lining and CCTV rather than capacity improvements), although the timeline for works is currently unknown[20]

6.6.3. Approach to impact assessment

A junction model was built for each of the six roundabouts using the Junctions 10 (ARCADY) software. Three different scenarios were created for the five roundabouts in Table 6-8, and two (excluding the 'do something' model for the Aldi/Osier Way roundabout):

- A 2019 base year model. The traffic patterns (turning movements and vehicle types) were taken from the BSTM 2019 Base Year scenario.
- A 2040 'do nothing' model without the proposed geometry improvements. The traffic patterns (turning movements and vehicle types) were taken from the BSTM 2040 'do minimum'.
- A 2040 'do something' model with the proposed geometry improvements. The traffic patterns (turning movements and vehicle types) were also taken from the BSTM 2040 'do minimum'.

As the 'do nothing' and 'do something' scenarios both used traffic patterns from the 2040 BSTM 'do minimum', the traffic passing through each roundabout was assumed to be the same for both scenarios. Further, use of this BSTM scenario means that the junction modelling assumed that there was no dualling on the A421.

Each junction and scenario were examined for the morning peak hour, inter-peak average hour and evening peak hour. Each junction model was built in isolation, meaning that the potential effects of changes at one junction on another was not tested. Further assessment using the junction models and/or the BSTM is required to understand the cumulative effect of all the junction improvements.

In identifying recommended improvements to each roundabout, consideration was given to signalising the A421/B4033, Whaddon (Coddimoor Lane) and Bottledump roundabouts with associated geometry improvements. The Linsig software was used to test the effectiveness of signalisation. The modelling showed that signalising the roundabouts resulted in poorer performance, in particular due to lack of space on the circulating lanes and approach lanes to 'stack' sufficient numbers of vehicles during signal cycles.

6.6.4. Results of impact assessment

The key factor considered in the assessment was comparison of queue lengths and ratio of the flow to capacity (RFC)[21] on each arm of the roundabout. Full details of the junction modelling, including the queue length and RFC values in each scenario are provided in a Technical Note in Appendix F.

The results are summarised in Table 6-9 overleaf.

[20] 24/02463/ADP | Submission of Reserved Matters (access, landscaping, appearance, scale and layout) for Spine Road 1A pursuant to Outline Planning Permission 15/00314/AOP comprising the access from the Buckingham Road roundabout to include access into Phase 1A, infrastructure works and associated drainage and landscape features and approval of Conditions 10 (Reserved Matters), 16 and 17 (Landscape), 25 and 26 (Drainage). | Land South Of The A421 West Of Far Bletchley North Of The East West Rail Link And East Of Whaddon Road Newton Longville and Planning Application: 23/02886/REM Accessed Dec 2024.

[21] RFC is the same as the volume/capacity ratio (or V/C).

Roundabout	2040 'do minimum	2040 'do something'
H-J1: Aldi/Osier Way roundabout	Roundabout has sufficient capacity.	Not tested.
H-J2: London Road roundabout	RFC >0.8 on the A421 approaching from the east in the morning and evening peak hours. Pedestrian crossings appear to have minor and short-lived impacts.	Proposed measures likely to resolve issues.
H-J4: A421/A413 roundabout	Within capacity other than in the morning peak hour where RFC >0.8 on all three arms.	Proposed measures likely to resolve issues.
H-J5: A421/B4033/ Winslow Road roundabout	Approaching capacity and will exceed by 2040.	Proposed measures likely to resolve issues. RFC >0.8 approaching from the A413 in the morning peak hour.
H-J8: Whaddon (Coddimoor Lane) roundabout	Currently at capacity and exceeding capacity by 2040. RFC >0.8 on the A421 approaching from the east and west in the morning peak and approaching from the west in the evening peak.	Assumed geometry improvements improve performance but do not resolve all the issues. RFC remains >0.8 approaching from the east in the morning peak. Signalisation results in queuing on the circulating lanes and is not seen as a solution.
H-J9: Bottledump roundabout	Currently at capacity and exceeding capacity by 2040. RFC >0.8 approaching on the A421 from the east and west in the morning and evening peak hour. RFC also >0.8 approaching from the east in the average inter-peak hour.	Assumed geometry improvements improve performance but do not resolve all the issues. RFC remains >0.8 approaching from the east and south in the morning peak hour; and from the east and west in the evening peak hour. Morning peak queue from the east exceeds 150 vehicles. Signalisation results in queuing on the circulating lanes and long queues on the A421 and is not seen as a solution.

Table 6-9 - Summary of junction modelling results

Further work to identify additional improvements, including on the side roads, is recommended for H-J8 Whaddon (Coddimoor Lane) roundabout. Similarly further work is recommended to develop a scheme for H-J9 Bottledump roundabout with three approach lanes from the east and two westbound ahead lanes through the roundabout.

Based on the assessment to date, improvements to the two easternmost roundabouts are likely to offer the best value for money as they are the most congested in the 2040 'do minimum' scenario. Improvements to the London Road junction could also be seen as a priority as there is a high amount of movement to and from London Road (due to more local journeys, such as to the supermarket) and more potential for improvements which benefit pedestrians and cyclists.

The improvements at all five junctions are forecast to deliver journey time savings which will be in excess of the cost estimates (see below). All five are therefore expected to offer 'High' value for money.

6.6.5. Impact in terms of the corridor objectives

In this section, the impacts of the roundabout improvement options are reported against the corridor objectives established at the start of the study. Objectives #E1 to #E4 are the primary objectives of the study.

The impact descriptions are qualitative but are informed by the evidence presented relating to this option. The impacts are summarised in Table 6-10.

OVERARCHING & corridor objectives	Impact	
CONNECTING OUR ECONOMY		
#E1: Good public transport options between Buckingham and Winslow, Milton Keynes, Bicester and Brackley	○○○	**No impact.**
#E2: Better public transport connections to the larger villages in the corridor	○○○	**No impact.**
#E3: Viable active travel connections between Buckingham and Winslow, Milton Keynes, Bicester and Brackley/ Silverstone	○○○	**No impact.**
#E4: Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes / M1	●●○	**Reductions in delays at junctions is the key benefit of these options.**
#E5: The A421 is well-maintained and protected from flooding	○○○	Negligible impact.
DECARBONISING OUR TRANSPORT SYSTEM		
#C1: Viable public transport connections to/from new housing and employment growth sites in the corridor	○○○	No impact.
#C2: Biodiversity in the A421 corridor is enhanced	●○○	Enhanced biodiversity features could be included into scheme designs.
#C3: Greater use of low and ultra-low emission vehicles	○○○	No impact.
BUILDING PLACES FOR PEOPLE		
#P1: Improved road safety for pedestrians, cyclists and equestrians crossing the A421	○○○	Improved crossing facilities could be designed-in to relevant junctions, but they are likely to reduce the delay benefits so may undermine case for schemes.
#P2: Fewer and less severe accidents in the corridor	●●○	Junctions should improve use of lanes and reduce conflicts. Junctions are often sites of accident clusters.
#P3: Reduced emissions and noise from traffic using the A421	●○○	Reductions in delays should reduce emissions.
#P4: Buckinghamshire is walking and cycling friendly	○○○	No impact.

Table 6-10 – Summary of the impact of the roundabout improvement options against the corridor objectives

The table above shows that there are a number of corridor objectives which are expected to be unaffected by the junction improvement options, particularly those relating to reducing carbon emissions and improving public transport. Indeed, it is likely that the improved performance of the junctions could lead to an overall increase in vehicle kilometres travelled, and therefore tailpipe carbon emissions, as driving becomes a more attractive option. These carbon impacts may however be offset by lower tailpipe emissions due a reduction in stop-start traffic approaching the roundabouts.

The individual roundabout improvement options are however expected to have positive impacts against several of the corridor objectives. In particular, the detailed assessment shows that they would reduce delays at the roundabouts. Indeed, it is possible that the journey time savings expected from the roundabout improvements (in total) could be similar to those achieved by the full dualling option, although this cannot be verified unless the scenario is run in BSTM.

6.6.6. Costs and funding

The improvements proposed for the junctions are estimated to cost between £1 million and £2.5 million each (excluding land costs). A breakdown of the cost estimate for each is provided in Table 6-11. The method used to prepare the estimates was consistent with the partial dualling option (see section 6.5.4 for details).

	Cost estimate (000s)				
Cost item	**H-J2**	**H-J4**	**H-J5**	**H-J8**	**H-J9**
Construction costs	£834	£476	£1,076	£1,076	£661
Construction costs (unidentified)	£209	£119	£269	£269	£166
Preliminaries & traffic management	£126	£72	£162	£162	£100
Construction total	**£1,169**	**£667**	**£1,507**	**£1,507**	**£927**
Allowance for QRA	£117	£67	£151	£151	£93
Contingency	£292	£167	£377	£377	£232
Budget cost	**£1,600**	**£925**	**£2,050**	**£2,050**	**£1,275**
Statutory undertakers' diversions	£240	£93	£205	£205	£191
TOTAL ESTIMATED COST	**£1,840**	**£1,020**	**£2,255**	**£2,255**	**£1,470**

Table 6-11 - Cost estimate for roundabout improvement options

Compared to the dualling options discussed above, the estimated costs of the junction improvement options make them potentially more affordable. However, the costs for each junction are still significant (additional land costs are likely to be relatively low as much of the proposed improvements are within existing highway boundaries).

The most likely potential funding sources for the junction improvement schemes are likely to be:

- Developer contributions, although as noted above, the level of contributions will depend on the level of impacts from the development and what stage the existing development proposals are in the planning process.
- Future developments in the corridor, including potential development around Winslow station in line with recent Government announcements on sustainable development close to stations.
- Future rounds of challenge funding such as next generation Local Growth Fund or Housing Infrastructure Fund. There is currently no certainty about if and when such funds will be forthcoming.

6.6.7. Key risks

At this very early stage of development, it is not possible to be definitive about the planning and delivery risks associated with the options. However, these are small schemes compared to the dualling options and therefore the risks will be commensurately smaller.

However, the following potential areas of risk have been identified (an early activity should the option be progressed would be the development of a detailed risk register):

- uncertainty over costs, in particular land and statutory undertakers' equipment;
- ground conditions and levels;
- disruption to traffic during construction; and
- knock-on traffic effects (for example relocation of delays to elsewhere on the network and traffic in local villages).

6.6.8. Summary and recommendations

Of the eleven roundabouts along the route, the six with the highest forecast delays were selected for more detailed assessment. Of those, changes in the geometry of the roundabouts were identified at five (the sixth roundabout being judged to not require improvement before 2040). The five are:

- H-J2: London Road roundabout;
- H-J4: A421/A413 roundabout;
- H-J5: A421/B4033/ Winslow Road roundabout;
- H-J8: Whaddon (Coddimoor Lane) roundabout; and
- H-J9: Bottledump roundabout.

The improvements comprise a package of alterations designed to reduce delays, such as longer and additional approach lanes and lengthening of exit lanes and merges. Concepts were developed and iterated for each, but further refinement of these concepts is recommended to find optimal solutions.

The impacts of each junction were forecast separately using individual junction models. No dualling is assumed. The forecasts suggest that the packages proposed for the London Road, A413 and B4033/Winslow Road roundabouts are likely to reduce delays. The Whaddon (Coddimoor Lane) and Bottledump roundabouts have the highest levels of congestion and delays, and the proposed improvements are not expected to fully resolve these issues. However, based on the assessment to date, improvements to these two easternmost roundabouts are likely to offer the highest benefits.

The roundabout improvement options are expected to have positive impacts against several of the corridor objectives. In particular, the detailed assessment shows that they would reduce delays at the roundabouts. Indeed, it is possible that the journey time savings expected from the roundabout improvements (in total) could be similar to those achieved by the full dualling option, although this cannot be verified until the scenario is run in BSTM.

The improvements proposed for the junctions are estimated to cost between £1 million and £2.5 million each (excluding land costs). Compared to the dualling options discussed above, the estimated costs of the junction improvement options make them potentially more affordable. A number of potential funding sources have been identified although they may only be available in the medium-term.

At this very early stage of development, it is not possible to be definitive about the planning and delivery risks associated with the options. However, these are small schemes compared to the dualling options and therefore the risks will be commensurately smaller.

It is recommended that all five junction improvement proposals be taken forward for further detailed assessment. For the London Road, A413 and B4033/Winslow Road roundabouts, the package of improvements should be refined further, junction modelling should be enhanced and detailed cost estimates prepared.

The two easternmost roundabouts are the highest priority as they are most congested and offer the highest benefits. The London Road roundabout is also a priority due to its importance to local movements in Buckingham.

Further work to identify additional improvements, including on the side roads, is recommended for H-J8 Whaddon (Coddimoor Lane) roundabout. Similarly further work is recommended to develop a scheme for H-J9 Bottledump roundabout with three approach lanes from the east and two westbound ahead lanes through the roundabout.

It is recommended that the five roundabout improvement packages are tested in combination (in BSTM or alternative) to understand the interaction between them and their overall impacts on traffic in the A421 corridor. This should include examination of where measures to deter or calm traffic may be required in the surrounding villages.

6.7. HGV routing

6.7.1. Option description

Concerns were raised during the first workshop about the number of heavy goods vehicles (HGVs) travelling through Buckingham town centre, for example on Stratford Road and Bridge Street / London Road.

An option was developed to examine the potential impacts of restrictions on HGV routing on HGV traffic in Buckingham town centre. There are numerous approaches to restricting HGVs (such as physical restrictions preventing wide vehicles passing through, weight restrictions, recommended and signed lorry routes). Requesting changes to satellite navigation routing is also possible but outside the control of the highway authority.

The form of the restriction has not been specified here. Rather, the test is a hypothetical examination of the potential traffic effects of removing HGVs.

6.7.2. Approach to impact assessment

The traffic effects of restricting HGVs in Buckingham were forecast using BSTM. For the purposes of modelling, it was necessary to assume a form of restriction, which was agreed to be as follows and shown in Figure 6-17:

- a ban on HGVs on the A422 between Brackley and central Buckingham; and
- a ban on HGVs on short sections of Dadford Road.

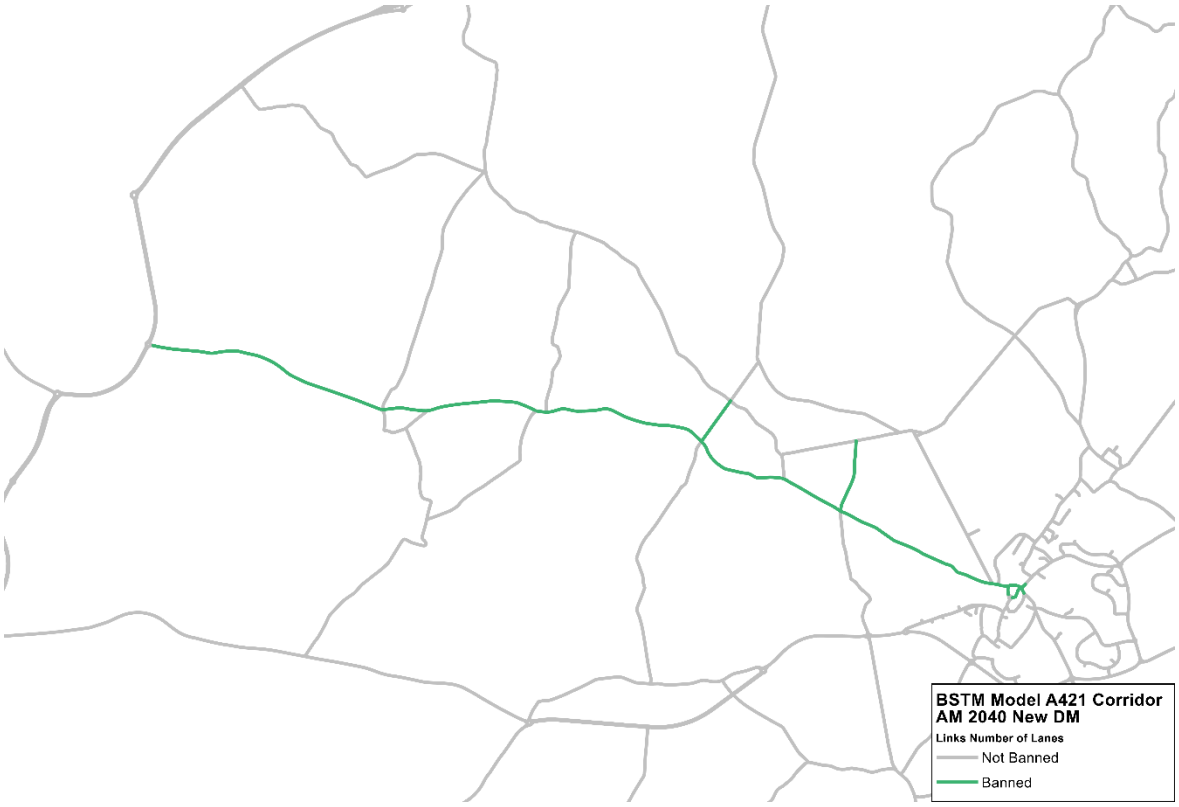


Figure 6-17 - Links with HGV ban

Absolute bans of this type are not proposed for Buckingham. The assumptions above are purely for modelling purposes.

The hypothetical HGV bans were tested in the 2040 'do minimum' morning peak hour, average inter-peak hour and evening peak hour scenarios.

6.7.3. Results of impact assessment

The forecast changes in HGV traffic between the 2040 'do minimum' and the 2040 'do something' with the HGV bans assumed are shown in Figure 6-18, Figure 6-19 and Figure 6-20 for the morning, inter-peak and evening peak periods respectively. Yellow lines indicate increases in the number of HGVs, blue lines represent decreases.

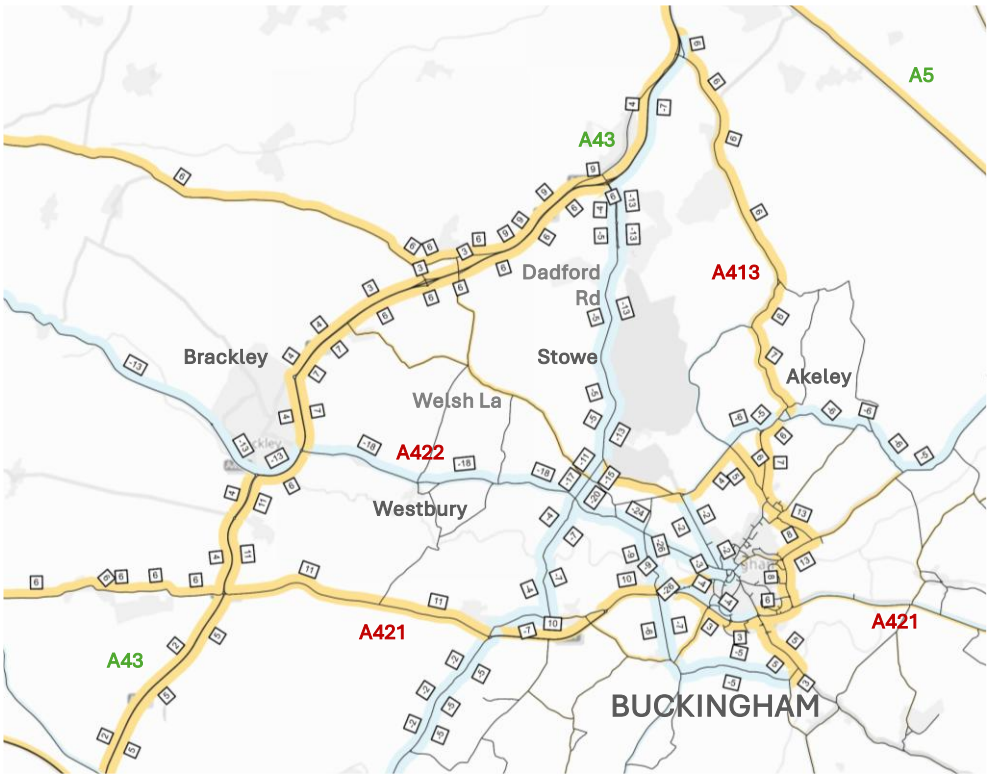


Figure 6-18 – Forecast change in HGV traffic volume resulting from HGV bans, 2040 'do minimum' morning peak hour



Figure 6-19 – Forecast change in HGV traffic volume resulting from HGV bans, 2040 'do minimum' average inter-peak hour



Figure 6-20 – Forecast change in HGV traffic volume resulting from HGV bans, 2040 'do minimum' evening peak hour

The BSTM forecasts show that the assumed bans result in re-routing of HGVs away from the A422 as would be expected, but also from the Dadford Road to/from the A43 to the north, Gawcott Road to the south and Buckingham town centre. The pattern is similar in all three time periods.

It is worth noting that the number of HGVs on the A422 in the 2040 'do minimum' is relatively low (15 to 25 HGVs per hour) and therefore the numbers of HGVs re-routing onto other roads is also low.

In the scenario tested, HGVs typically re-route onto other roads of similar or lower standard to the A422, such as the A413 through Akeley, as well as onto the A421 (parts of which are also single carriageway between the A43 and Buckingham). This highlights the potential unintended consequences of introducing HGV restrictions and therefore a need to carefully examine the potential impacts, intended and otherwise. Further work is therefore required, which could be incorporated within the work Buckinghamshire Council is undertaking on a strategy to reduce through traffic in general from Buckingham town centre.

6.7.4. Cost and funding

Due to the hypothetical nature of the option, it has not been costed. However, costs are likely to be relatively low. Measures could potentially be funded through sources such as developer contributions.

6.7.5. Key risks

As stated above, the key risk of introducing HGV restrictions is that HGVs re-route onto other roads which are potentially no more suitable or, in a worst case, are less suitable. The net effect could therefore be negative. Any re-routing also has the potential to have localised disbenefits, for example on properties close to the highways where the number of HGVs is likely to increase.

6.7.6. Overall impact in terms of the corridor objectives

The option is likely to have little impact on the corridor objectives due to the relatively localised impacts and the small number of vehicles affected. Depending on the specific impacts of any HGV restriction, there could be positive effects in relation to the following corridor objectives under the 'Building places for people' theme on roads where HGV volumes decrease (but not necessarily on the A421 itself):

- #P1: Improved road safety for pedestrians, cyclists and equestrians.
- #P2: Fewer and less severe accidents in the corridor.
- #P3: Reduced emissions and noise from traffic using the corridor.
- #P4: Buckinghamshire is walking and cycling friendly.

6.7.7. Summary and recommendations

The exact form of HGV restrictions is to be determined, but the traffic modelling has identified that there is potential to re-route HGVs onto alternative routes away from Buckingham town centre. However, there is a risk of unintended effects and the potential options, and their impacts need to be better understood.

It is recommended that further information is gathered on the origins and destinations of HGVs within Buckingham town centre to:

- understand the extent to which HGVs are travelling to/from Buckingham town centre or through the town centre, and therefore the potential to reduce HGVs in the town centre; and
- identify potential options to restrict HGVs passing through the town centre and/or identify preferred routes for HGVs travelling to/from the town centre.

7. Key findings recommendations

7.1. Introduction

This final section provides a summary of the key findings of the assessment work undertaken, and the recommendations made in the report.

7.2. Full dualling of the A421

The option comprises dualling of approximately 16 kilometres of the A421 between the eastern end of the Tingewick Bypass and Bottledump Roundabout. The option tested has only been specified to a level of detail that will enable testing of the concept in the traffic model.

Forecasts suggest that traffic volumes on the dualled section would increase by up to 1,000 vehicles per hour (20-40%) in the peak hour, due to being a more attractive route option. However, the additional traffic results in more delays at the junctions meaning that journey times between Buckingham and Milton Keynes are forecast to reduce by only approximately three minutes.

This option is deemed as likely to improve road safety outcomes as designs would be expected to address and/or mitigate safety issues.

The full dualling is estimated to cost over £300 million (excluding land costs). Although there would be relatively high benefits from lower journey times, the scheme is expected to offer only 'low' value for money. The benefits of the scheme are also likely to be highest for through traffic with the potential for adverse impacts on local residents in terms of noise, air quality and severance.

Funding options for a scheme of this size are currently extremely limited. No viable funding sources have been identified in the short to medium term. There are also numerous potential risks associated with this option, including those relating to cost uncertainty, disruption during construction, adverse noise and air quality issues, and additional tailpipe and embodied carbon.

It is recommended that the full dualling option is not considered further in relation to the objectives of this study; many of the benefits of the scheme are likely to accrue to those travelling through the area at a substantial risk to local communities and the local environment.

7.3. Partial dualling of the A421

The option comprises dualling of approximately 1.6 kilometres of the A421 between the Coddimoor Road / Whaddon Road roundabout and Bottledump Roundabout. This includes necessary alterations at the two roundabouts.

Forecasting predicts that traffic volumes on the proposed dualled section would increase by 6-7% but that there would be relatively modest changes to traffic further afield including on local roads. Journey times between Buckingham and Milton Keynes are forecast to reduce by only approximately 30 seconds.

Due to the cost of the scheme and limited benefits, partial dualling is expected to offer low value for money. Sources of funding for a scheme of this cost are also limited and uncertain, and there are many areas of potential risk.

It is recommended for the reasons set out above that the partial dualling option is not considered further in relation to the objectives of this study. Dualling this section may remain a worthwhile consideration in terms of local access to developments in this area but that is a matter for the development planning process to consider.

7.4. Junction improvements on the A421

Five junctions were selected for detailed assessment of potential roundabout improvements. Those selected were those with the highest forecast congestion in the future. A package of alterations was designed for each junction intended to reduce delays.

The packages proposed for the London Road, A413 and B4033/Winslow Road roundabouts are likely to reduce delays. The Whaddon (Coddimoor Lane) and Bottledump roundabouts have the highest levels of congestion and delays, and the proposed improvements are not expected to fully resolve these issues. However, based on the assessment to date, improvements to these two easternmost roundabouts are likely to offer the highest benefits.

The proposed junction improvements are estimated to cost between £1 million and £2.5 million each (excluding land costs). It is recommended that all five junction improvement proposals be taken forward for further detailed assessment. For the London Road, A413 and B4033/Winslow Road roundabouts, the package of proposed improvements should be refined further, junction modelling should be enhanced and detailed cost estimates should be prepared.

The two easternmost roundabouts are the highest priority as they are most congested, and proposed improvements offer the highest benefits. Further work to identify additional improvements, including on the side roads, is recommended for Whaddon (Coddimoor Lane) roundabout. Similarly further work is recommended to develop a scheme for Bottledump roundabout with three approach lanes from the east and two westbound ahead lanes through the roundabout.

It is recommended that the five roundabout improvement packages are tested in combination (in BSTM or alternative) to understand the interaction between them and their overall impacts on traffic in the A421 corridor. This should include examination of where measures to deter or calm traffic may be required in the surrounding villages.

Several potential funding sources have been identified although they may only be available in the medium-term. It is not possible to be definitive about the risks associated with the options at this stage, however they are likely to be much lower than the dualling options.

7.5. HGV restrictions around Buckingham

The traffic modelling has identified that there is potential to re-route HGVs onto alternative routes away from Buckingham town centre. However, there is a risk of unintended effects and the potential options, and their impacts need to be better understood.

It is recommended that further information is gathered on the origins and destinations of HGVs within Buckingham town centre to:

- understand the extent to which HGVs are travelling to/from Buckingham town centre or through the town centre, and therefore the potential to reduce HGVs in the town centre; and
- identify potential options to restrict HGVs passing through the town centre and/or identify preferred routes for HGVs travelling to/from the town centre.

7.6. Options not assessed in detail

Most of the 56 options in the 'long list' (summarised in Table 5-1) would be expected to be supportive of several corridor objectives, as shown by the outcome of the sifting process (see Table D-2 in Appendix D). However, only nine options exceeded all of the minimum thresholds shown in Table 5-3. These thresholds include the requirement for the options to make at least a 'Moderate impact' in terms of primary corridor objective #E4, 'Reduced delays and more reliable journey times on the A421 between the A43 and Milton Keynes/M1'. This means that all nine options are improvements to the road network as they have the most potential to reduce delays. By contrast, no active travel or public transport options made the shortlist, largely as they were not expected to significantly reduce traffic volumes on the A421 and/or were unaffordable.

This is not to say however that the schemes that were not shortlisted are not worthy of further consideration; in fact, many could bring positive benefits.

As described elsewhere in this report, this study aims to identify, assess and recommend measures to address current and future challenges in the corridor and support achievement of the corridor objectives. The study approach, as summarised in Figure 7-1, has sought to identify a multi-modal package of measures by the consideration of measures that not only support objective #E4 but also support the other corridor objectives. Objectives #E1: 'Good public transport options between Buckingham and Winslow, Milton Keynes, Bicester and Brackley', #E2: 'Better public transport connections to the larger villages in the corridor' and #E3: 'Viable active travel connections between Buckingham and Winslow, Milton Keynes, Bicester and Brackley/Silverstone' were key in ensuring consideration was given to options for making it easier to travel on foot, by bicycle or by public transport.

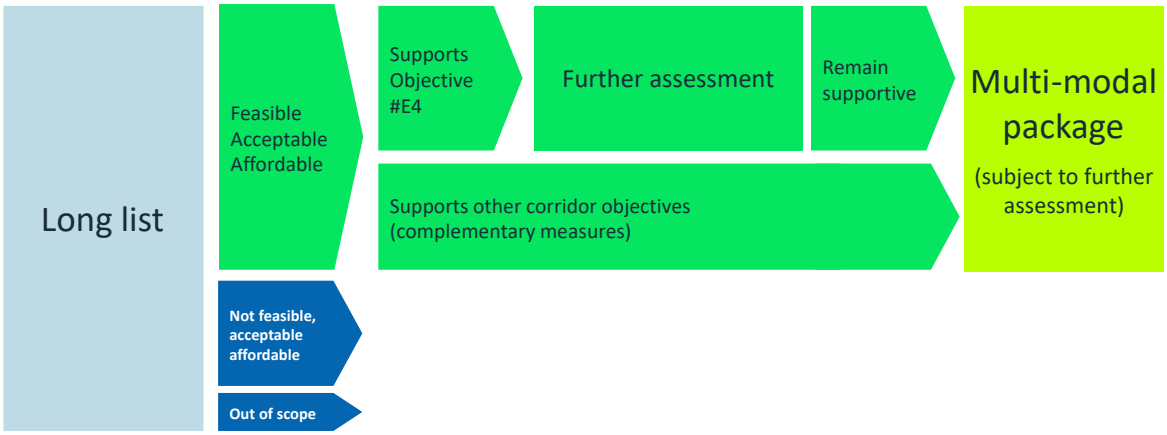


Figure 7-1 - Summary of package selection process

Measures to improve connections between the towns and villages in the study area by modes other than just the private car are critical to achieving many of the corridor objectives and, by implication, achievement of Buckinghamshire Council's wider objectives to be presented in the new Local Transport Plan. Positive outcomes resulting from greater travel choices include:

- reduced transport-related social exclusion;
- better public health through more active travel and better air quality (this in turn has positive impacts on economic productivity); and
- reduced carbon emissions from transport.

It is recommended that the investment package that is taken forward should also reflect opportunities to improve maintenance and minimise impacts of adverse weather, such as flooding (objective #E5). It should also include measures to enhance biodiversity (Objective #C2) and promote use of low and ultra-low emission vehicles (Objective #C3). Overall, it is clear that a wide range of different types of measures will be required in combination to support all of the corridor objectives.

7.7. Projects currently being progressed

Buckinghamshire Council is currently investigating several projects in the corridor and will shortly begin exploring some others. These projects highlight the Council's multimodal approach to resolving the issues and achieving our objectives in the corridor. They are:

- East West Rail 'Door to Door' Strategy – the Council is currently liaising with EWR Ltd to pull together a list of connectivity requirements and initiatives that will be beneficial to people working, visiting and living in Winslow and North Buckinghamshire and using the new station.
- Increase to half hourly bus services between Buckingham, Winslow and Aylesbury and expanded Sunday hourly service.
- Creation of an interurban active travel corridor running from Buckingham-Stowe-Silverstone. This is a key route on the Buckinghamshire Greenway linking the National Trust's estates at Stowe, Claydon, and Waddesdon by a continuous, high-standard active travel route.
- Upgrade the Buckingham Railway Walk path to a fully-fledged greenway route that is fully accessible for walking, wheeling and cycling. It will form part of the active travel network envisaged for Buckingham linking to the A413 Active Travel Corridor towards the forthcoming Winslow station and forming part of the Buckinghamshire Greenway.
- Passenger accessibility, bus access improvements and relocation of Buckingham town centre bus stand.
- New bus services and/or interchanges for the new developments.
- Active travel improvements in Buckingham town centre including crossing points on A421 and Tingewick Road.
- Freight routing and signage improvements around Buckingham town centre (a scoping study is underway);
- A421 route upgrades and highway capacity improvements linked to the mitigation of development traffic impacts e.g. Osier Way development.

Developer contributions are the main source of funding for the projects above. However, funding may not necessarily be available in full or in part and it may not cover the full costs of the proposed schemes. Further feasibility work is ongoing on these projects.

It is important to note that developer contributions must be directly related to the development's impacts and are usually ringfenced for specific purposes to make the development acceptable in planning terms. This ensures that contributions are proportional to the type and scale of development and that the funds are used to benefit the local community and infrastructure.

For example, transport related developer contributions for the Land Off Osier Way development site are earmarked for the relevant parts of Policy T3 of the Vale of Aylesbury Local Plan[22] within the settlement of Buckingham. This means that the funding can only be used for one or more of the specified schemes (within Policy T3). However, there are occasions where there are flexibility clauses, unspent funds or changes to development plans where some developer funding can be directed towards other priorities identified by the Council (and in agreement with the developer).

The findings of this study will provide a clearer picture of where to direct the available funding and budgets as they become available.

7.8. Next steps

The findings and recommendations of this report will be fully considered Buckinghamshire Council. They will be used:

- to prioritise which projects should be prioritised for further option design and feasibility assessment, particularly those where funding to deliver the projects may be available;
- to inform discussions with developers of sites in the corridor with the objective of securing appropriate investment in key transport infrastructure and services;
- to inform identification of external funding opportunities, including discussions with partners such as England's Economic Heartland and National Highways; and
- to inform the preparation of the new Local Transport Plan (LTP5), in particular the identification of policies and measures in the LTP, and the Implementation Plan.

[22] Policy T3 - Supporting local transport schemes, Vale of Aylesbury Local Plan (VALP)

APPENDICES

Appendix A. Additional information

A.1. The A421 corridor

A.1.1. Traffic origins and destinations

This section provides some additional detail on the origins and destinations of journeys in the corridor in the 2019 base year. The information is drawn from the BSTM traffic model.

The information is presented in the form of plots showing traffic flows to and from the selected link in the morning peak hour. The width of the blue lines is proportionate to the amount of traffic. Information is provided for three selected links along the A421:

- on the Tingewick Bypass in the west;
- in central Buckingham (west of London Road); and
- west of Bottledump roundabout in the east.

Origins and destinations are also shown in tabular form for all three modelled time periods. The tables show the number of journeys from and to each of the sectors shown in the figure below. The numbers on the table column headings relate to the sector numbers shown in the key.

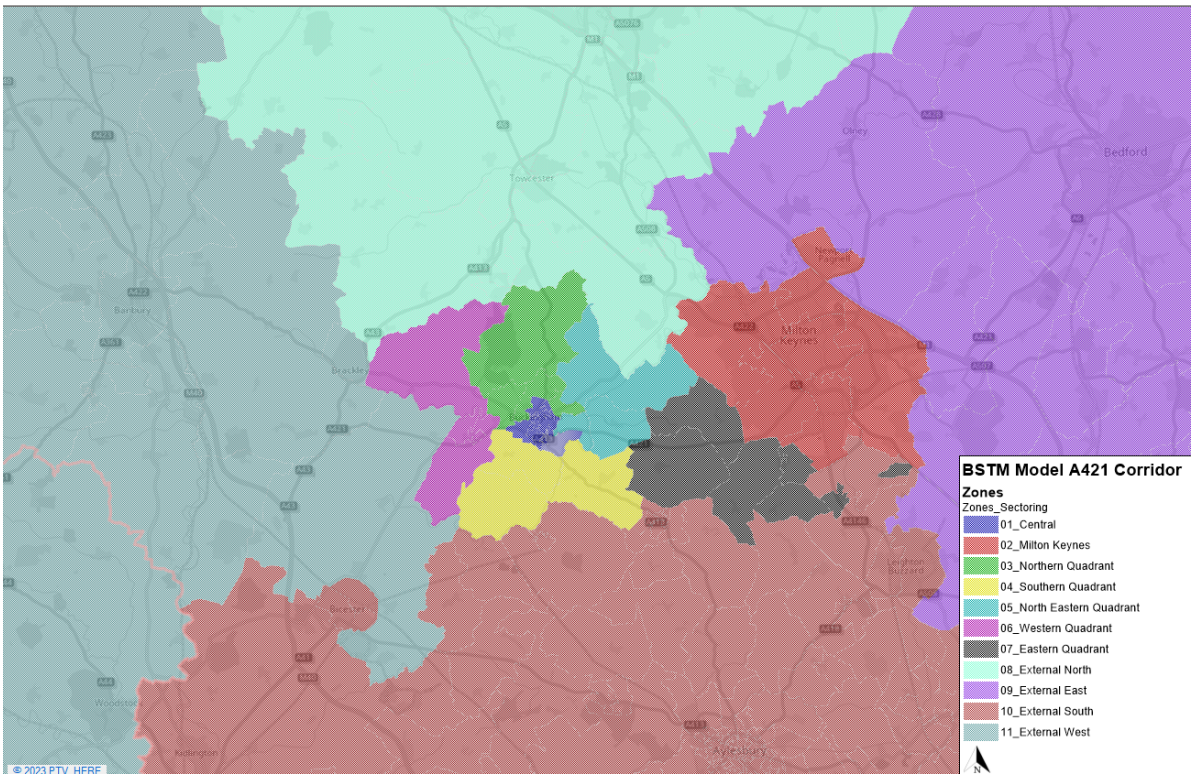


Figure A-1 – Select link analysis sectors

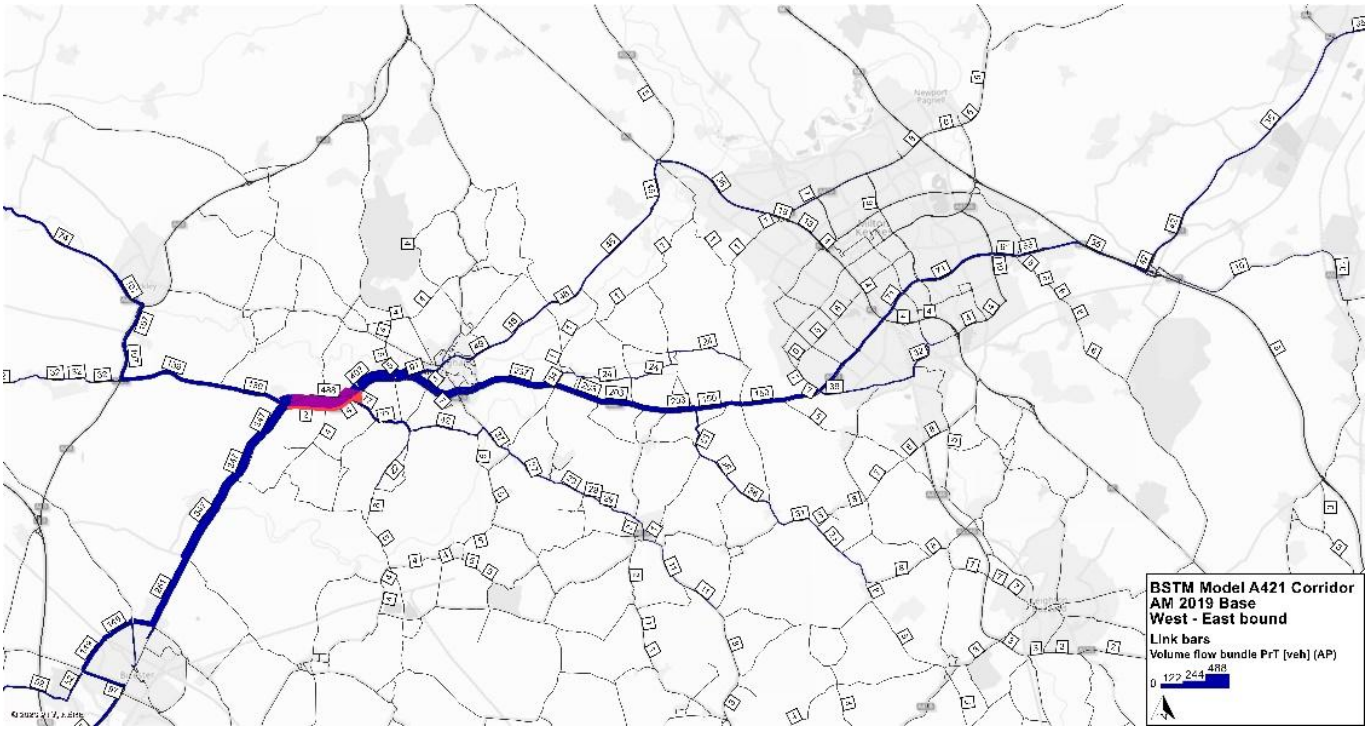


Figure A-2 – Select link analysis: Tingewick Bypass eastbound (morning peak)

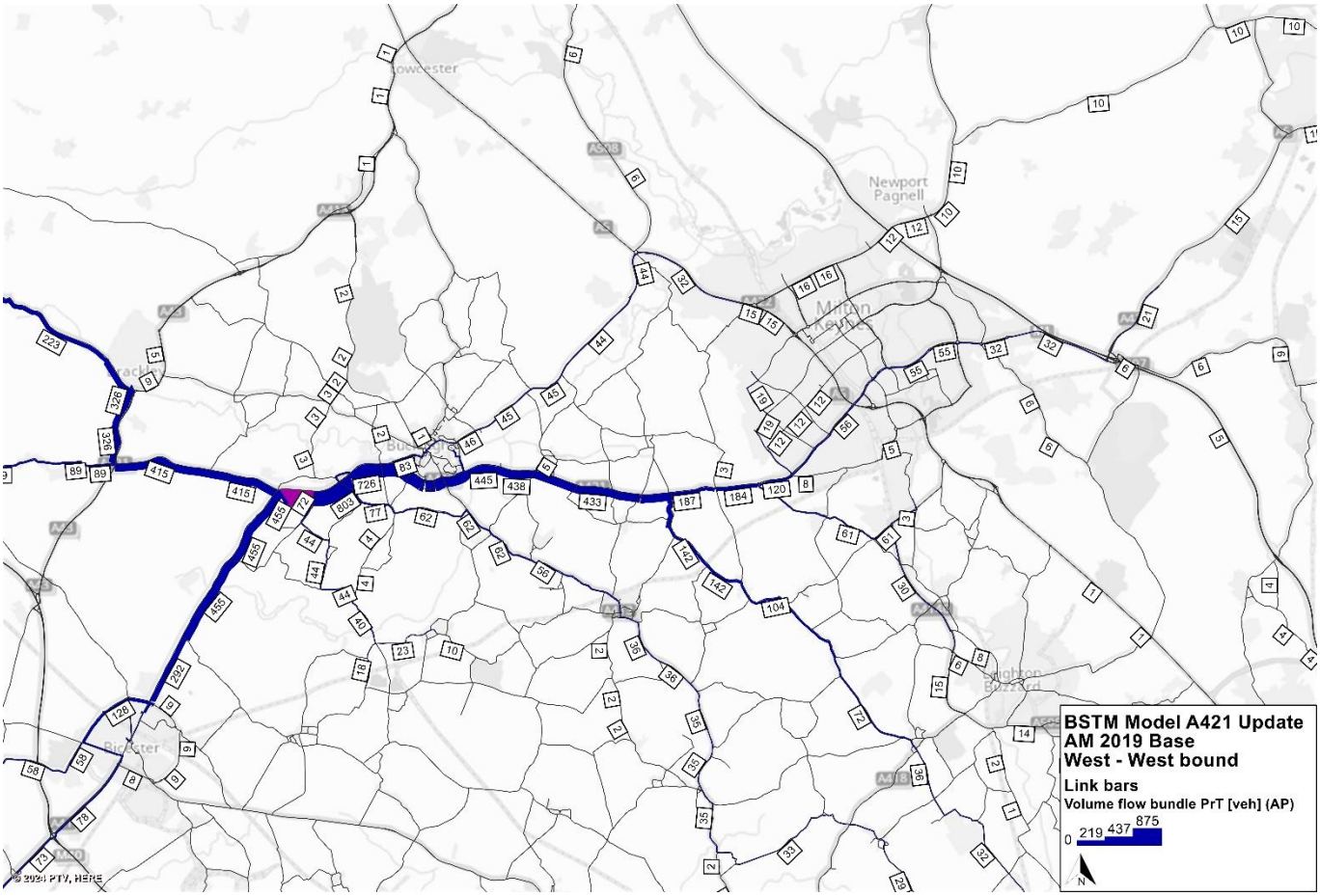


Figure A-3 – Select link analysis: Tingewick Bypass westbound (morning peak)

AM Peak	Tingewick Bypass									Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	1	0	0	0	2	0
9	0	0	0	0	0	0	0	0	0	0	0
10	88	9	21	13	2	34	70	11	57	5	0
11	93	5	23	15	3	69	62	8	51	170	0

Local-Local	**0**	**0%**
Local-external	379	**46%**
External-external	436	**53%**
Total	**816**	
To/from Buckingha	182	22%
To/from Milton Key	132	16%
To MK or E	241	30%
To corridor	379	47%

Inter-peak	Tingewick Bypass									Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0	0
10	129	6	10	5	1	63	74	9	52	5	0
11	88	3	10	3	3	67	28	5	28	68	0

Local-Local	**0**	**0%**
Local-external	388	**59%**
External-external	270	**41%**
Total	**658**	
To/from Buckingha	217	33%
To/from Milton Key	102	16%

PM peak	Tingewick Bypass									Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0	0
10	204	9	8	7	1	34	86	14	48	8	0
11	148	5	14	5	4	79	63	10	25	95	0

Local-Local	**0**	**0%**
Local-external	517	**60%**
External-external	348	**40%**
Total	**866**	
To/from Buckingha	352	41%
To/from Milton Key	149	17%

Table A-1 - Select link analysis: Tingewick Bypass - eastbound

AM Peak	Tingewick Bypass									Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	105	122
3	0	0	0	0	0	0	0	0	0	5	3
4	0	0	0	0	0	0	0	0	0	7	18
5	0	0	0	0	0	0	0	0	0	5	9
6	0	0	0	0	1	0	0	2	0	7	16
7	0	0	0	0	0	0	0	0	0	51	98
2	0	0	0	0	0	0	0	0	0	56	75
8	0	0	0	0	0	0	0	0	0	8	5
9	0	0	0	0	0	0	0	0	0	29	15
10	0	0	0	0	0	0	0	1	0	6	230
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**2**	**0%**
Local-external	449	**51%**
External-external	424	**48%**
Total	**875**	
To/from Buckingha	228	26%
To/from Milton Key	131	15%

Inter-peak	Tingewick Bypass									Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	76	58
3	0	0	0	0	0	0	0	0	0	4	2
4	0	0	0	0	0	0	0	0	0	7	4
5	0	0	0	0	0	0	0	0	0	5	3
6	0	0	0	0	2	0	0	2	0	5	9
7	0	0	0	0	0	0	0	0	0	82	85
2	0	0	0	0	0	0	0	0	0	41	20
8	0	0	0	0	0	0	0	0	0	6	3
9	0	0	0	0	0	0	0	0	0	31	14
10	0	0	0	0	0	0	0	0	0	23	77
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**2**	**0%**
Local-external	342	**61%**
External-external	216	**39%**
Total	**559**	
To/from Buckingha	134	24%
To/from Milton Key	62	11%

PM peak	Tingewick Bypass									Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	1	0	102	116
3	0	0	0	0	0	0	0	0	0	7	4
4	0	0	0	0	0	0	0	0	0	11	15
5	0	0	0	0	0	0	0	0	0	17	19
6	0	1	0	0	3	0	0	5	1	9	12
7	0	0	0	0	0	0	0	0	0	56	118
2	0	0	0	0	0	0	0	0	0	75	68
8	0	0	0	0	0	0	0	0	0	9	10
9	0	0	0	0	0	0	0	0	0	35	42
10	0	0	0	0	0	0	0	1	0	10	242
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**4**	**0%**
Local-external	492	**50%**
External-external	491	**50%**
Total	**987**	
To/from Buckingha	219	22%
To/from Milton Key	143	14%

Table A-2 - Select link analysis: Tingewick Bypass – westbound

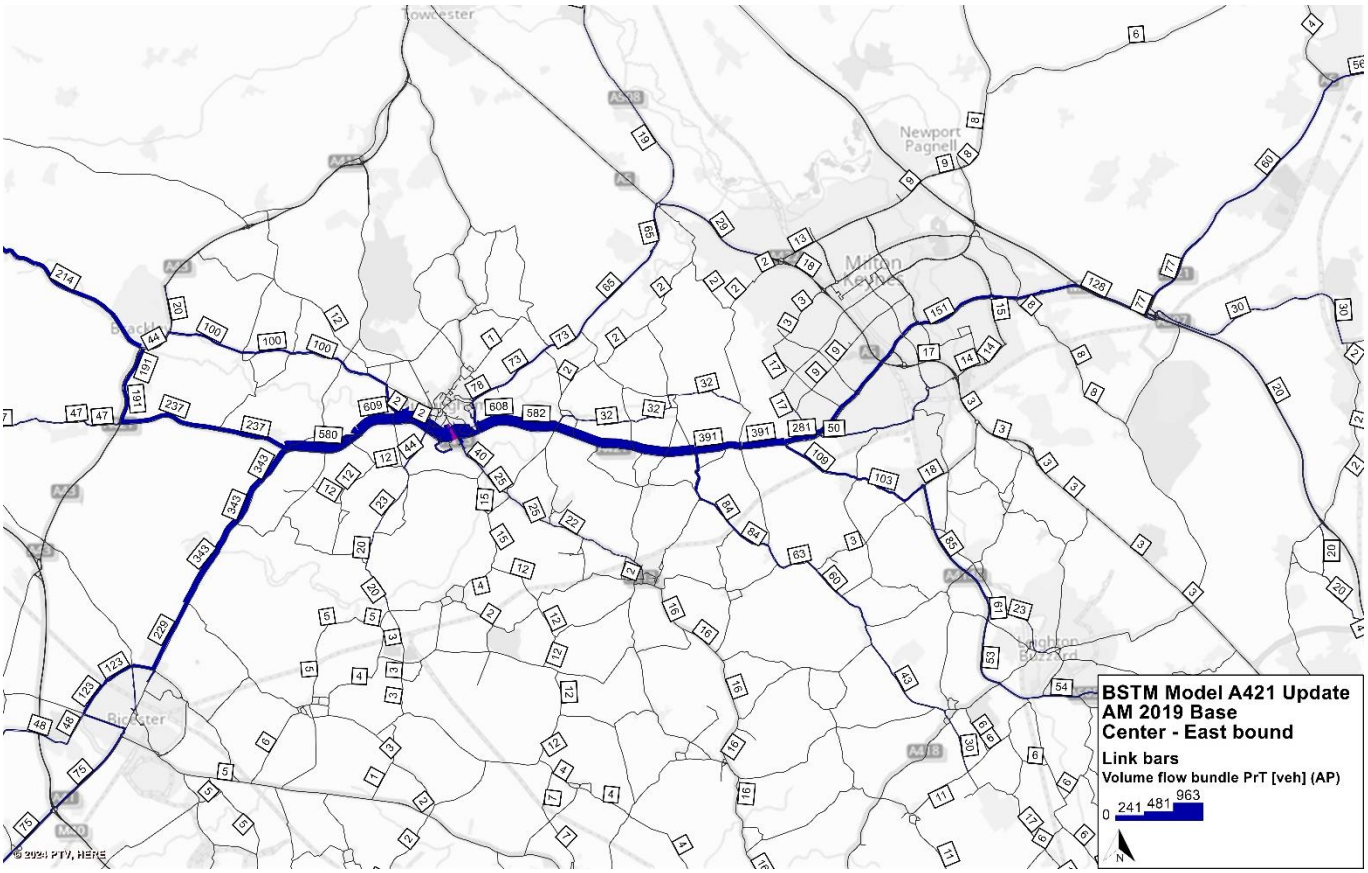


Figure A-4 – Select link analysis: A421 Buckingham eastbound (morning peak)

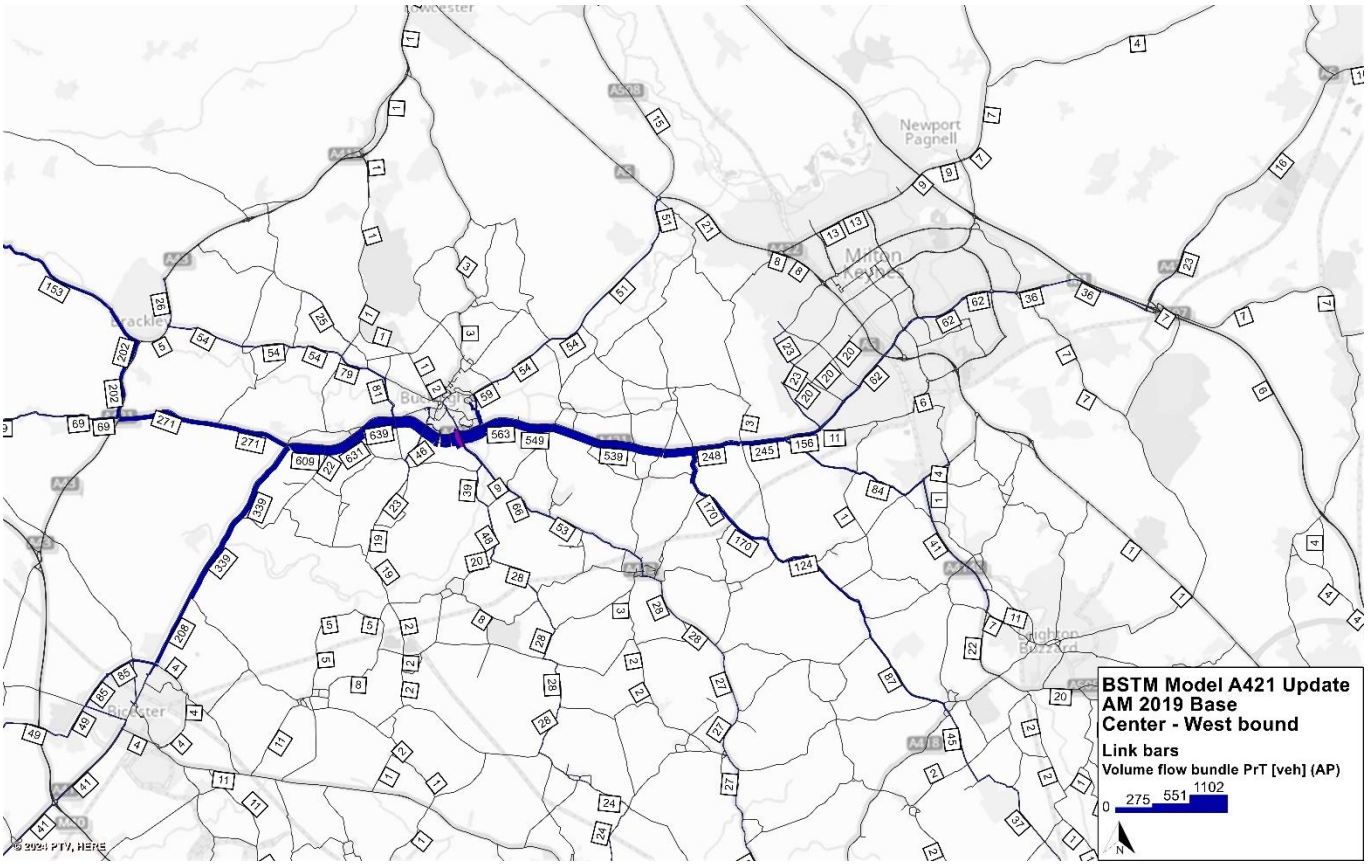


Figure A-5 – Select link analysis: A421 Buckingham westbound (morning peak)

AM Peak		Central Buckingham								Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	64	3	2	10	0	2	37	21	6	49	0
3	1	0	0	0	0	0	1	0	0	1	0
4	7	0	0	1	0	0	0	2	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	26	0	0	3	0	2	12	1	3	7	0
7	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	2	0	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0	0
10	69	1	0	11	0	35	55	9	56	3	0
11	68	0	0	23	0	83	67	3	57	158	0

Inter-peak		Central Buckingham								Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	65	2	6	2	0	1	6	5	1	51	0
2	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	12	0	0	0	0	0	1	5	1	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	29	0	0	0	0	0	3	1	1	1	0
7	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	114	0	0	3	0	63	60	7	43	4	0
11	74	0	0	2	0	67	28	2	37	51	0

PM peak		Central Buckingham								Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	107	3	18	4	0	2	20	7	4	92	0
3	3	0	0	0	0	0	1	0	0	0	0
4	17	1	0	1	0	0	3	12	2	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	32	0	0	2	0	1	14	3	2	4	0
7	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	1	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
10	164	1	0	5	0	34	66	12	43	7	0
11	116	0	0	6	0	86	73	1	24	79	0

Local-Local	**122**	**13%**
Local-external	432	**45%**
External-external	408	**42%**
Total	**963**	
To/from Buckingha	367	38%
To/from Milton Key	172	18%

Local-Local	**117**	**16%**
Local-external	398	**53%**
External-external	231	**31%**
Total	**747**	
To/from Buckingha	367	49%
To/from Milton Key	98	13%
To/from External S	396	53%
To/from MK or Ext	180	24%

Local-Local	**191**	**18%**
Local-external	578	**54%**
External-external	304	**28%**
Total	**1073**	
To/from Buckingha	589	55%
To/from Milton Key	177	16%
To/from External S	507	47%
To/from MK or Ext	252	24%

Table A-3 - Select link analysis: Buckingham – eastbound

AM Peak		Central Buckingham								Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	116	1	26	0	23	0	0	1	0	95	95
3	12	0	0	0	0	0	0	0	0	0	0
4	13	0	0	0	0	0	0	0	0	0	0
5	9	0	1	0	4	0	0	0	0	4	11
6	0	0	0	0	0	0	0	0	0	0	0
7	3	0	0	0	8	0	0	0	0	51	113
2	32	1	0	0	13	0	0	0	0	41	79
8	31	0	0	0	0	0	0	0	0	1	0
9	9	0	0	0	1	0	0	0	0	22	13
10	111	0	0	0	6	0	0	0	0	5	152
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**217**	**20%**
Local-external	572	**52%**
External-external	313	**28%**
Total	**1102**	
To/from Buckingha	577	52%
To/from Milton Key	165	15%

Inter-peak		Central Buckingham								Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	69	0	10	0	25	0	0	0	0	71	49
2	16	0	0	0	4	0	0	0	0	31	19
3	5	0	0	0	0	0	0	0	0	0	0
4	10	0	0	0	0	0	0	0	0	0	0
5	4	0	1	0	1	0	0	0	0	4	2
6	0	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	4	0	0	0	0	82	86
8	27	0	0	0	0	0	0	0	0	2	1
9	8	0	0	0	1	0	0	0	0	21	9
10	76	0	0	0	2	0	0	0	0	20	55
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**145**	**20%**
Local-external	295	**41%**
External-external	276	**39%**
Total	**717**	
To/from Buckingha	372	52%
To/from Milton Key	173	24%
To/from External S	364	51%
To/from MK or Ext	211	29%

PM peak		Central Buckingham								Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	47	0	6	0	36	0	0	1	0	73	78
3	4	0	2	0	0	0	0	0	0	3	0
4	5	0	0	0	0	0	0	0	0	0	0
5	6	0	3	0	3	0	0	0	0	15	16
6	0	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0	0	56	118
2	15	0	0	0	1	0	0	0	0	43	53
8	13	0	24	0	0	0	0	0	0	22	1
9	5	0	0	0	0	0	0	0	0	31	39
10	47	0	0	0	0	0	0	0	0	9	168
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**114**	**12%**
Local-external	465	**49%**
External-external	365	**39%**
Total	**943**	
To/from Buckingha	337	36%
To/from Milton Key	111	12%
To/from External S	466	49%
To/from MK or Ext	187	20%

Table A-4 - Select link analysis: Buckingham – westbound

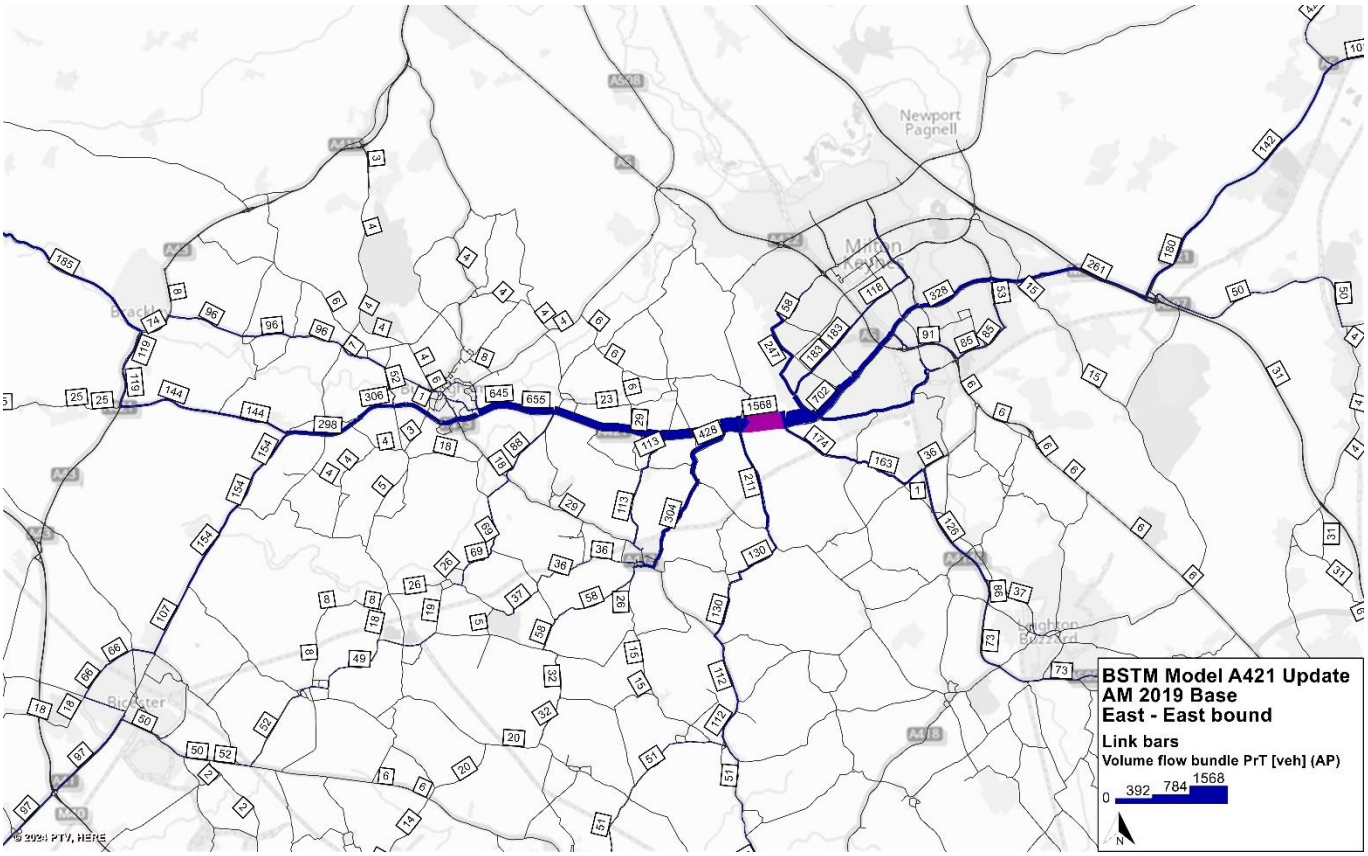


Figure A-6 – Select link analysis: A421 Bottledump eastbound (morning peak)

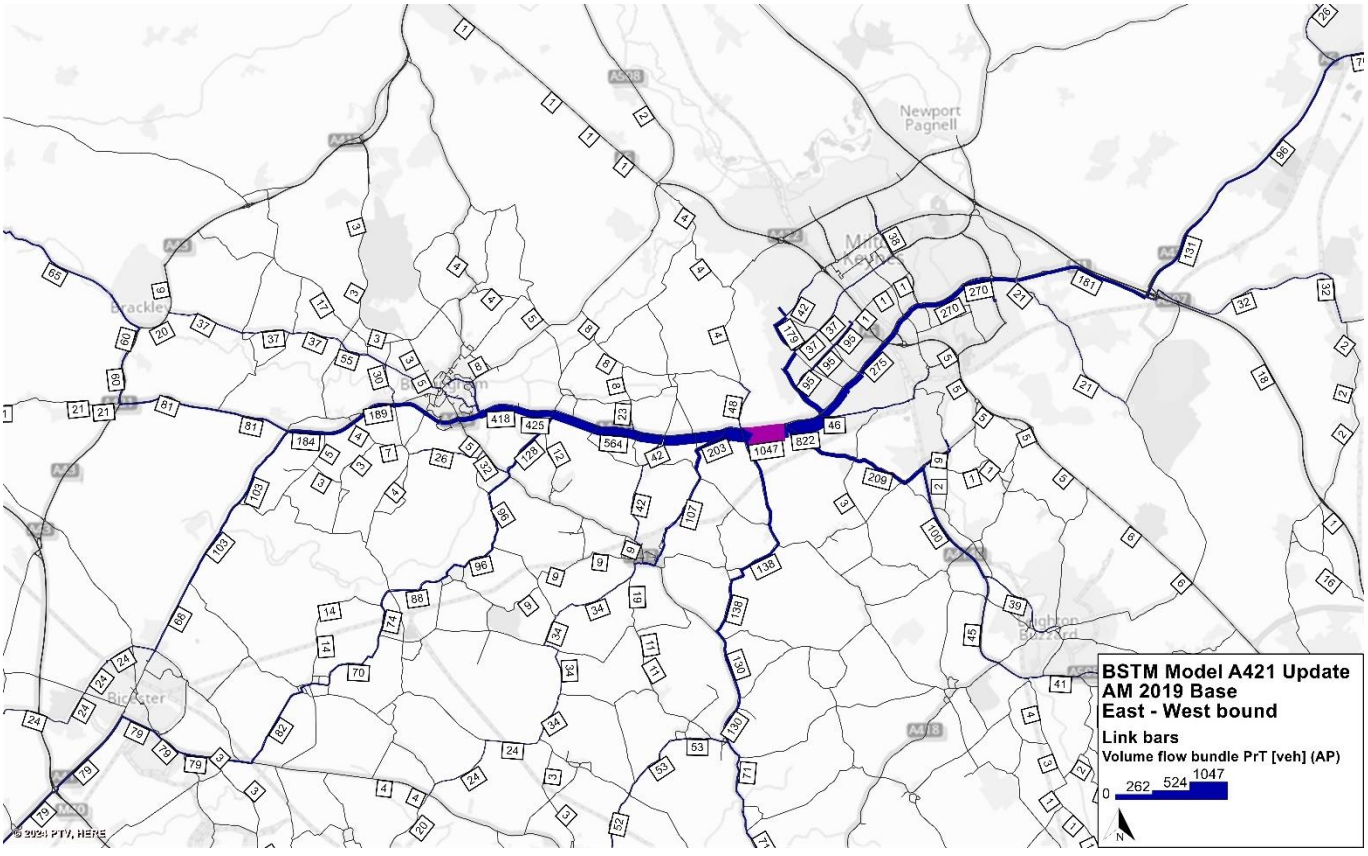


Figure A-7 – Select link analysis: A421 Bottledump westbound (morning peak)

AM Peak	Bottledump roundabout									Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	2	171	0	25	22	0
3	0	0	0	0	0	0	11	0	0	2	0
4	0	0	0	0	0	0	37	0	5	4	0
5	0	0	0	0	0	0	31	0	2	2	0
6	0	0	0	0	0	0	12	0	3	4	0
7	0	0	0	0	0	1	235	0	11	4	0
2	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	2	1	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	2	552	0	122	3	0
11	0	0	0	0	0	6	83	0	77	136	0

Local-Local	**3**	**0%**
Local-external	590	**38%**
External-external	975	**62%**
Total	**1568**	
To/from Buckingha	219	14%
To/from Milton Key	1133	72%
To/from MK or Ext	1377	88%

Inter-peak	Bottledump Roundabout									Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	1	61	0	7	11	0
3	0	0	0	0	0	0	4	0	0	2	0
4	0	0	0	0	0	0	20	0	3	2	0
5	0	0	0	0	0	0	19	0	2	3	0
6	0	0	0	0	0	0	4	0	1	1	0
7	0	0	0	0	0	1	131	0	11	4	0
2	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	1	0	0	1	0
9	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	4	383	0	99	5	0
11	0	0	0	0	0	7	47	0	47	27	0

Local-Local	**3**	**0%**
Local-external	296	**33%**
External-external	609	**67%**
Total	**907**	
To/from Buckingha	80	9%
To/from Milton Key	670	74%
To/from MK or Ext	839	92%

PM peak	Bottledump roundabout									Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	2	0	0	0	0	1	0	8	0	4	12
2	143	6	35	20	9	191	0	0	0	479	75
8	0	0	0	0	0	1	0	0	0	3	0
9	20	1	6	2	1	12	0	0	0	117	57
10	27	3	2	3	2	3	0	0	0	13	141
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	**4**	**0%**
Local-external	510	**36%**
External-external	885	**63%**
Total	**1399**	
To/from Buckingha	192	14%
To/from Milton Key	957	68%
To/from MK or Ext	1173	84%

Table A-5 - Select link analysis: Bottledump roundabout – eastbound

AM Peak		Bottledump roundabout								Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	4	1	0	0	1	1	0	7	0	3	5
2	149	9	18	18	20	129	0	0	0	462	121
8	0	0	0	0	0	2	0	0	0	11	0
9	22	1	8	5	6	42	0	22	0	232	106
10	34	5	6	5	6	9	0	1	0	26	47
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	8	1%
Local-external	510	33%
External-external	1028	66%
Total	1547	
To/from Buckingha	209	14%
To/from Milton Key	927	60%

Inter-peak		Bottledump Roundabout								Westbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	0	1	0	3	0	5	6
2	89	4	20	18	5	142	0	1	0	494	54
8	0	0	0	0	0	0	0	0	0	0	0
9	17	0	5	3	2	18	0	3	0	133	72
10	23	3	4	3	2	5	0	1	0	15	27
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	3	0%
Local-external	375	32%
External-external	800	68%
Total	1178	
To/from Buckingha	130	11%
To/from Milton Key	826	70%
To/from Ext S (10)	714	61%

PM peak		Bottledump roundabout								Eastbound	
From/to	1	3	4	5	6	7	2	8	9	10	11
1	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
7	2	0	0	0	0	2	0	10	0	4	7
2	154	6	35	22	11	203	0	1	0	598	82
8	0	0	0	0	0	1	0	0	0	5	0
9	23	0	6	2	2	21	0	10	0	152	62
10	29	3	2	3	2	4	0	0	0	39	77
11	0	0	0	0	0	0	0	0	0	0	0

Local-Local	5	0%
Local-external	550	35%
External-external	1025	65%
Total	1579	
To/from Buckingha	209	13%
To/from Milton Key	1112	70%
To/from Ext S (10)	917	58%

Table A-6 - Select link analysis: Bottledump roundabout – westbound

A.2. Current challenges & issues

A.2.1. Junction delays

This section provides a sample of the data collected during the google live traffic review as outlined in section 3.2.

A.2.1.1. South Buckingham

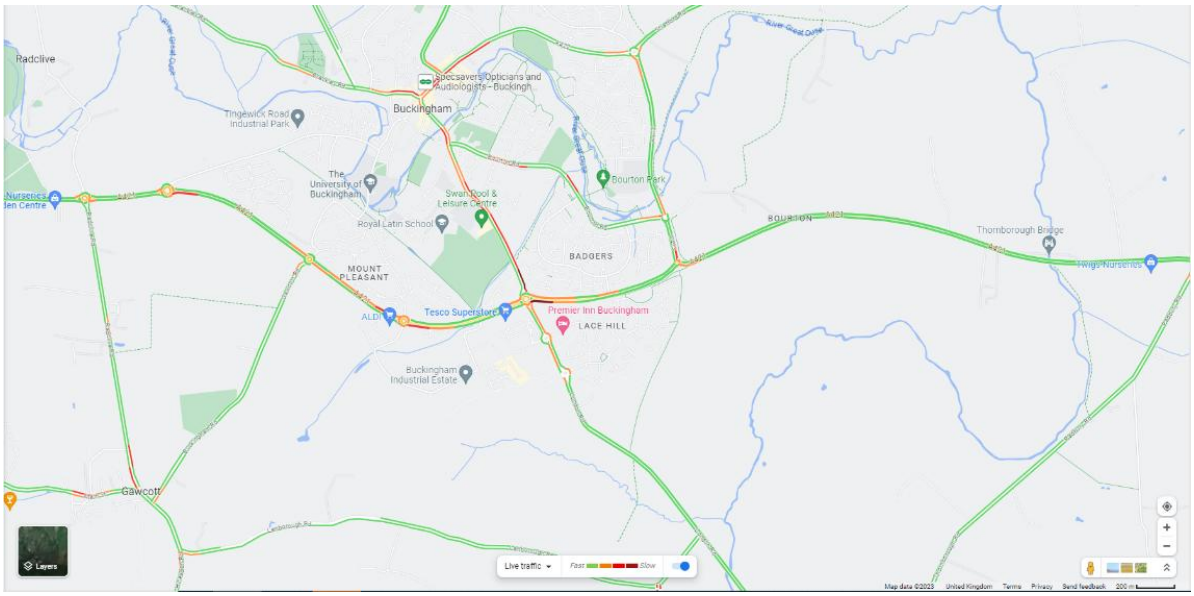


Figure A-8 - Tue 27/06/2023 Morning peak

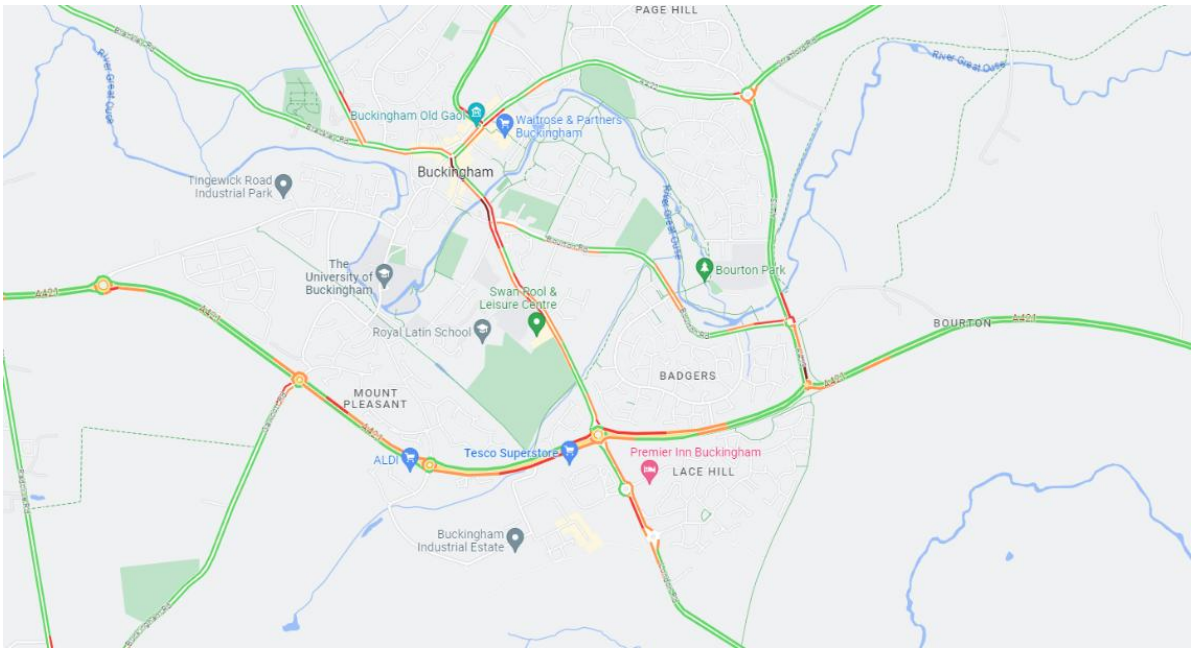


Figure A-9 - Thu 29/06/2023 Morning peak

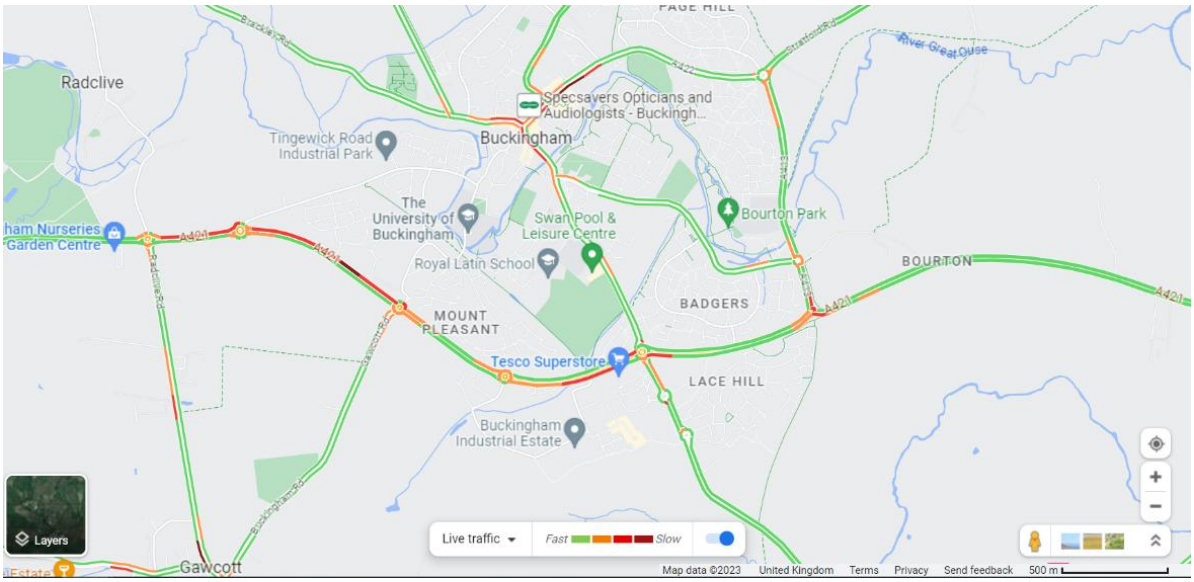


Figure A-10 - Thu 29/06/2023 Evening peak

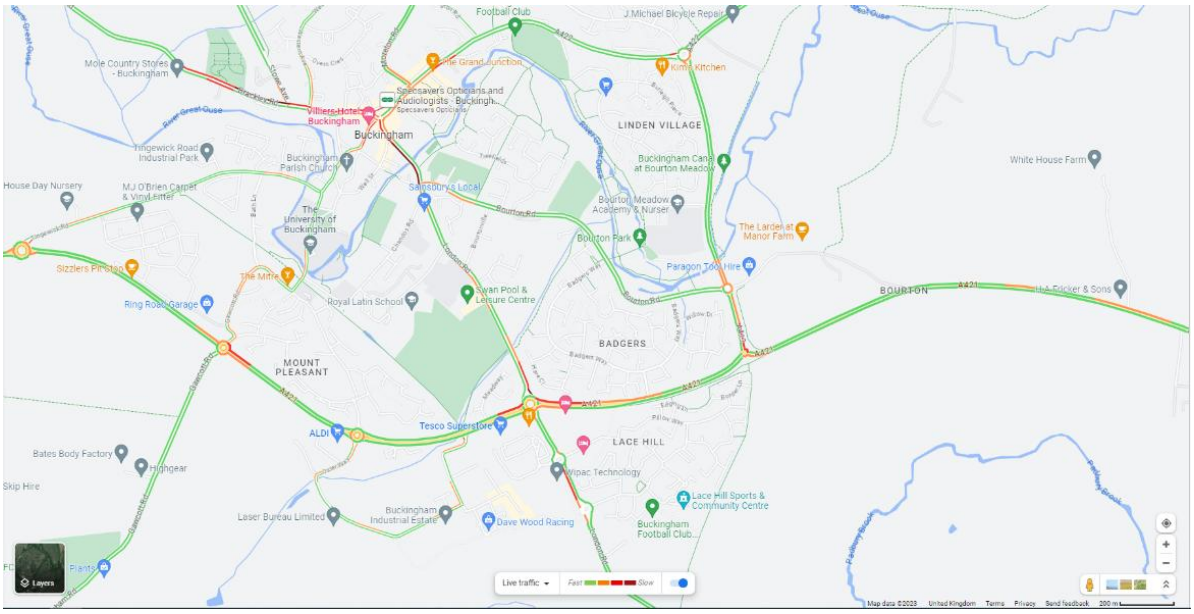


Figure A-11 - Mon 03/07/2023 Evening peak

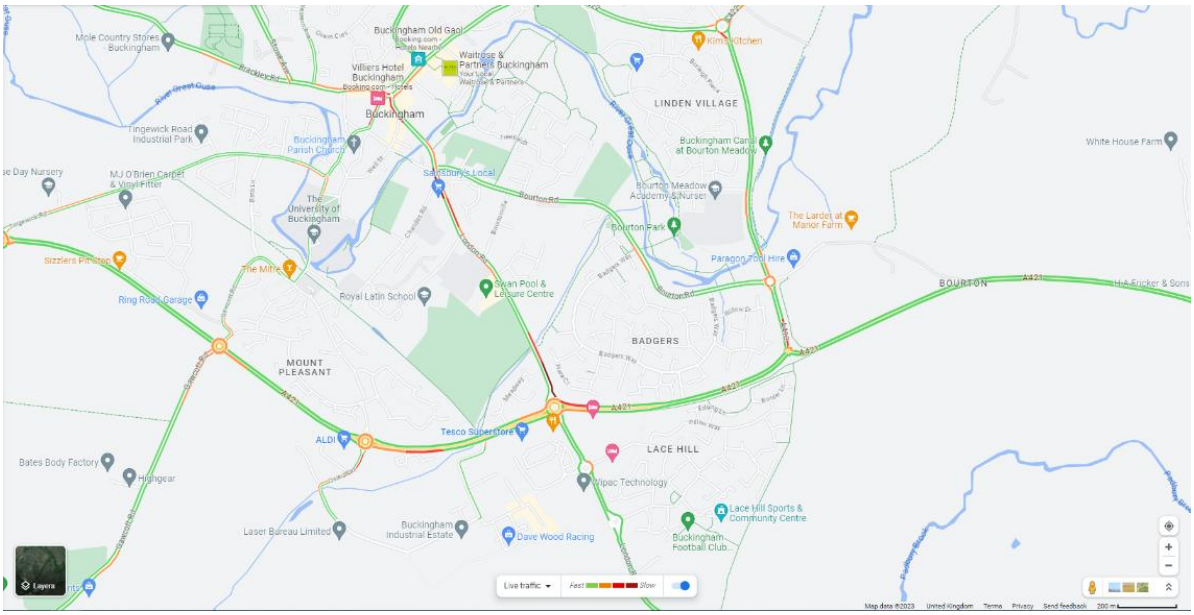


Figure A-12 - Fri 07/07/2023 Morning peak

A.2.1.2. Eastern section roundabouts

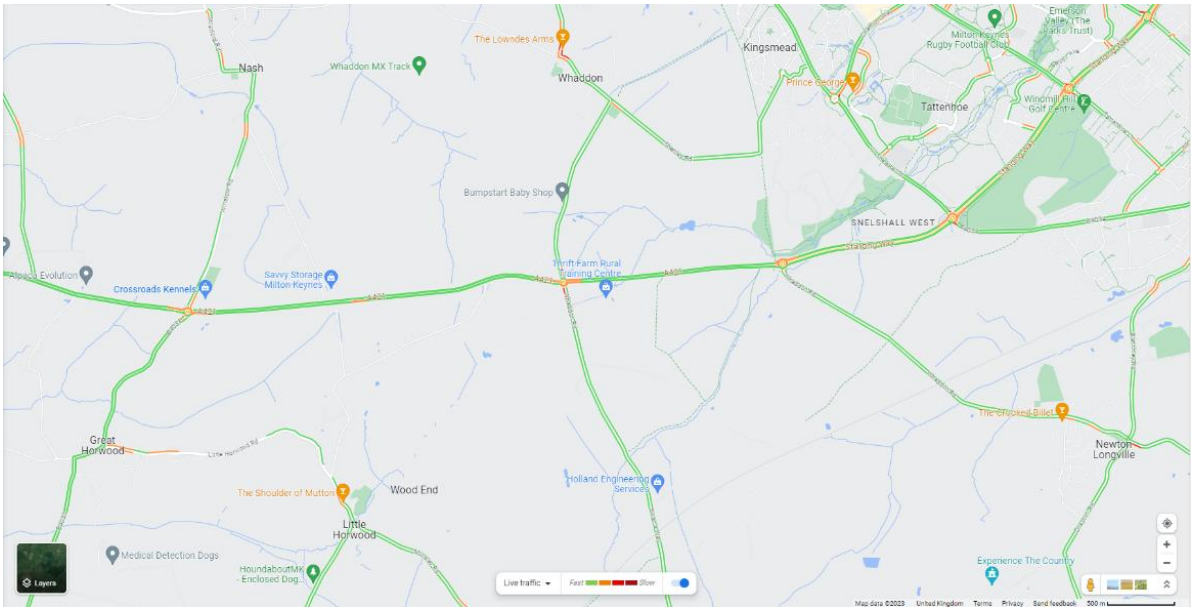


Figure A-13 - Fri 23/06/2023 Evening peak

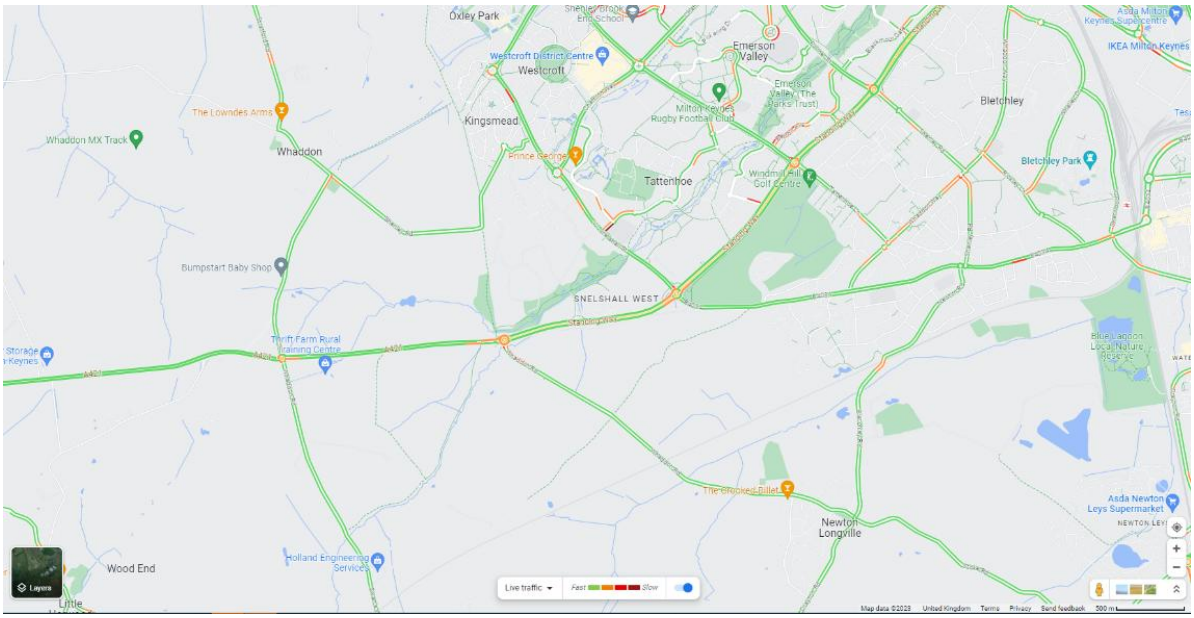


Figure A-14 - Mon 26/06/2023 Morning peak

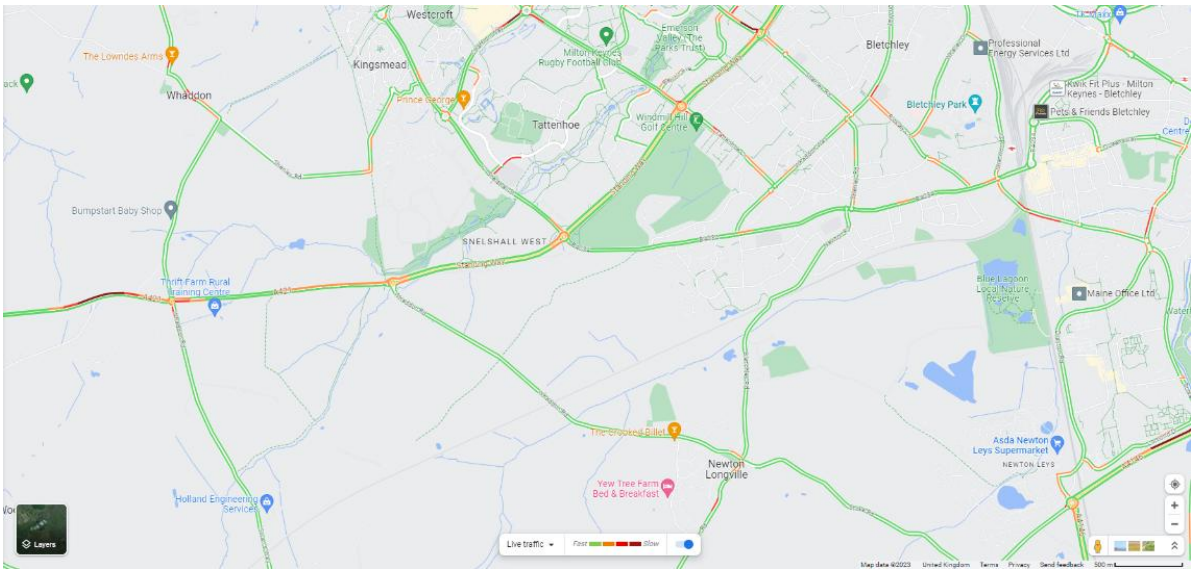


Figure A-15 - Tue 27/06/2023 Morning peak

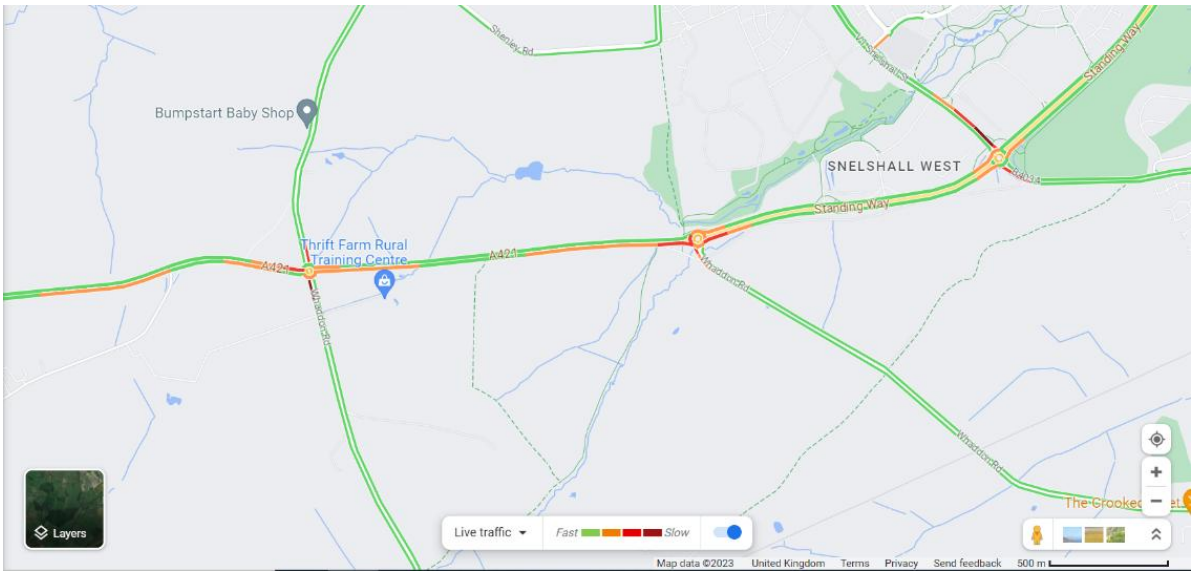


Figure A-16 - Wed 28/06/2023 Morning peak

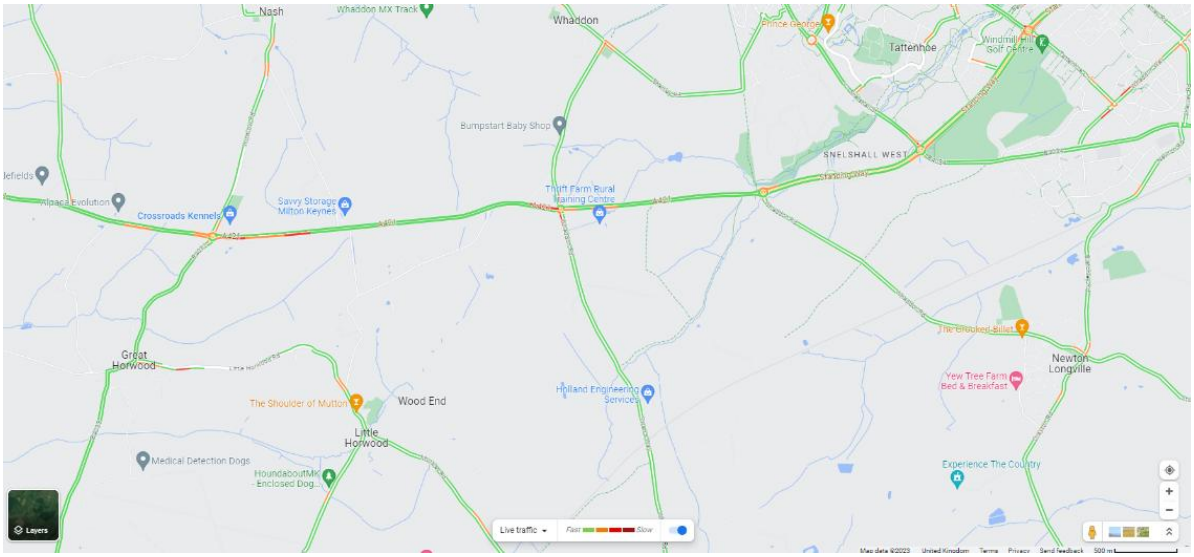


Figure A-17 - Tue 11/07/2023 Evening peak

A.2.1.3. Rat running routes

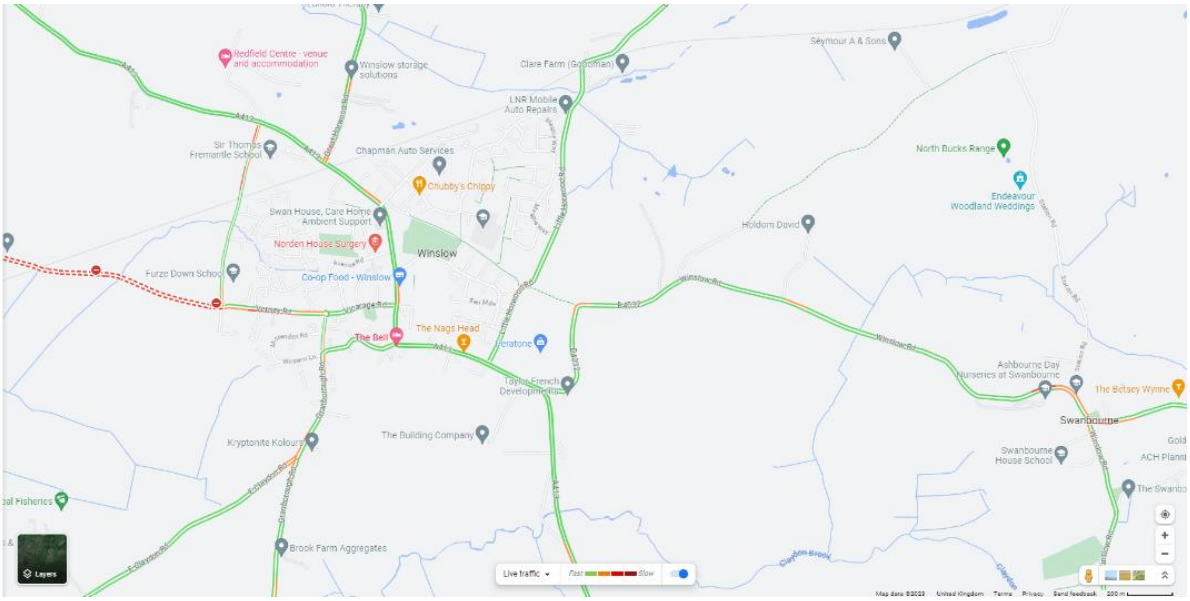


Figure A-18 - Winslow Fri 07/07/2023

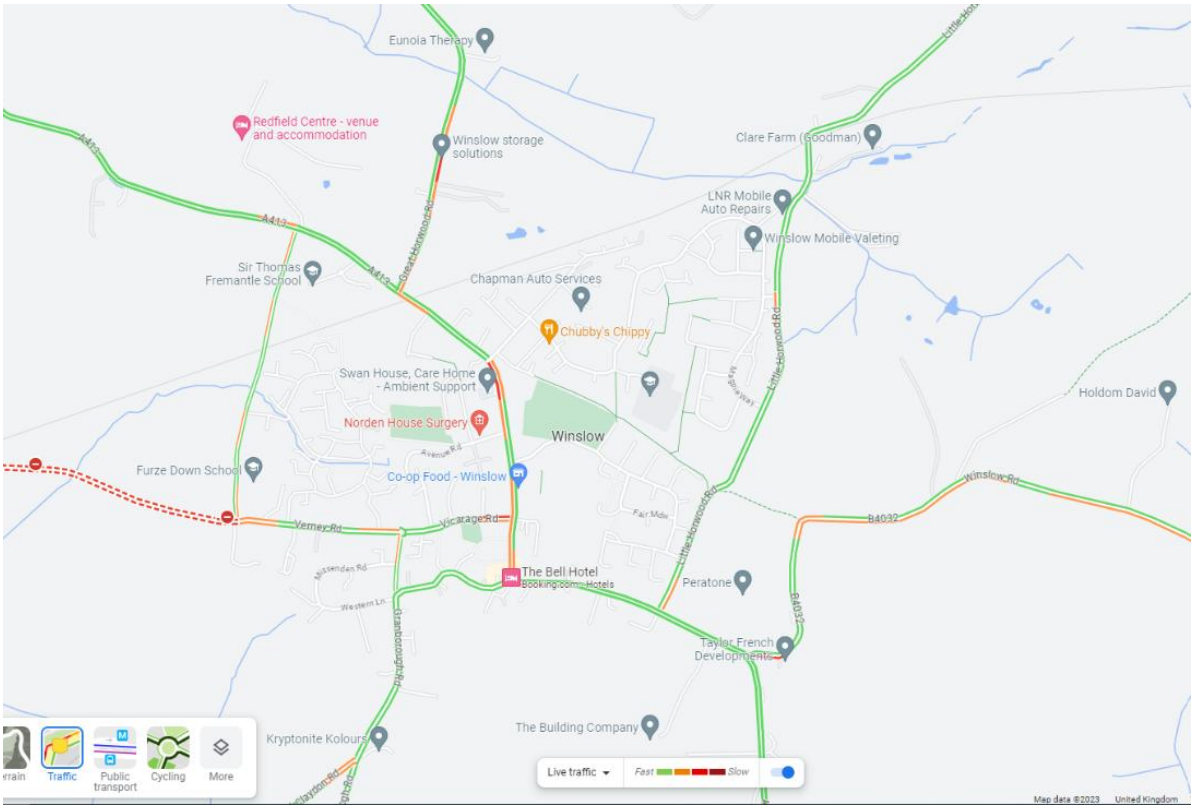


Figure A-19 - Winslow 13/07/2023 Morning peak

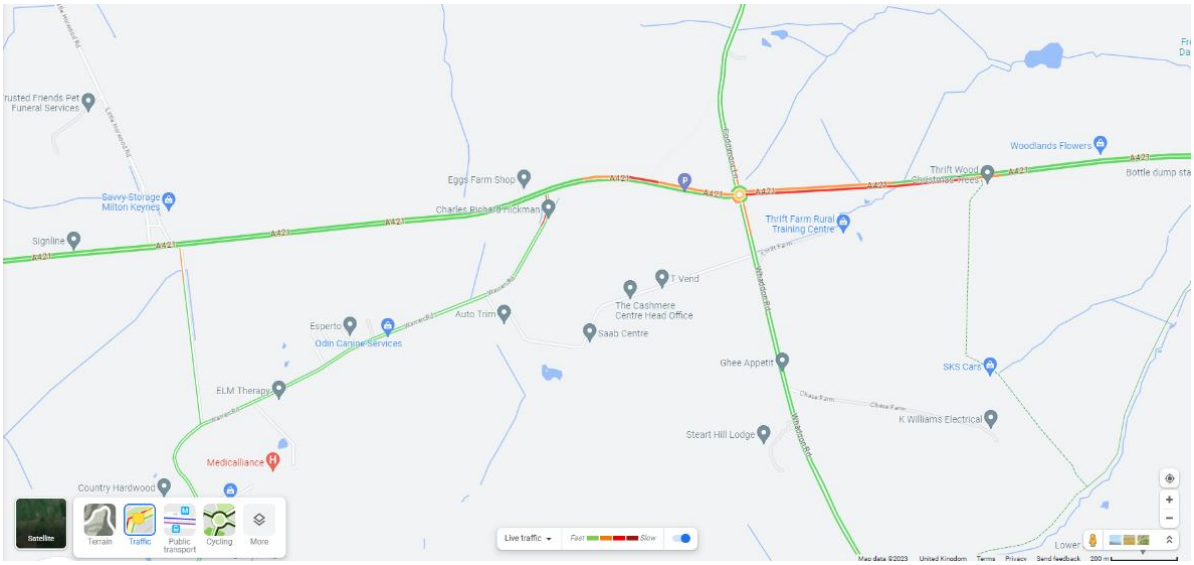


Figure A-20 - Little Horwood Access Road 13/07/2023 Morning peak

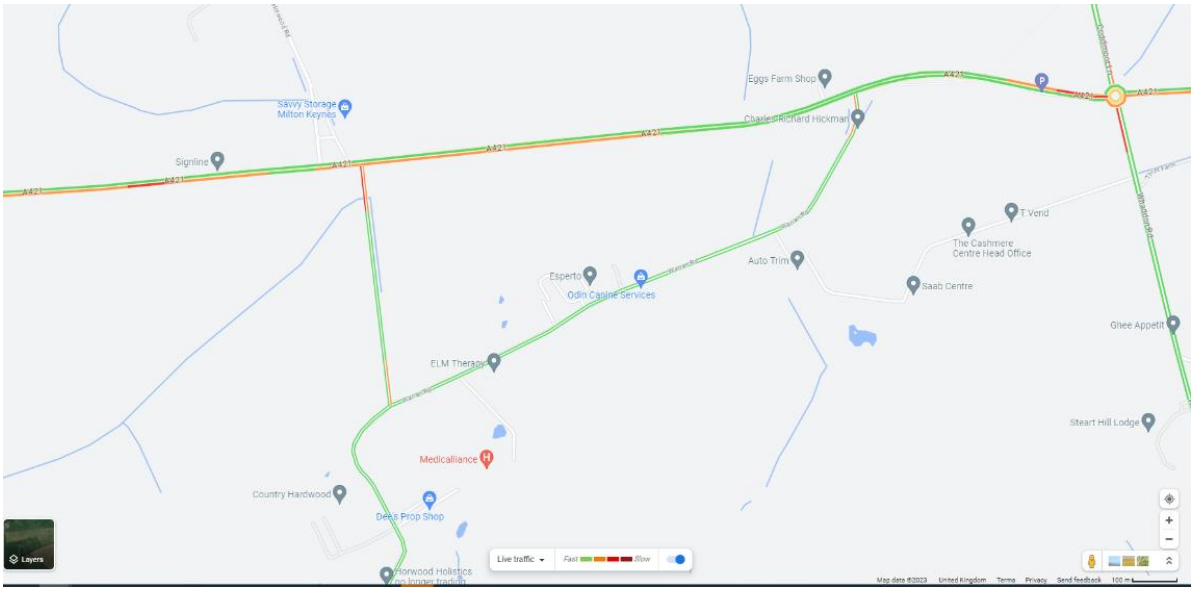


Figure A-21 - Little Horwood Access Road Tue 11/07/2023 Evening peak

Appendix B. Approach to highway modelling

Appendix C. Approach to engagement

C.1. Key Stakeholders

- Buckinghamshire Council Transport Strategy team
- Buckinghamshire Council Highways Development Management team
- Cabinet Member for Transport (as needed for key input)
- Local ward members: Buckingham East, Buckingham West, Winslow, Great Brickhill
- Buckingham Town Council
- Parish councils along the corridor

C.2. Objectives and Options Workshop

Representatives from the following stakeholders were invited to the initial workshop in September 2023.

- Buckingham West
- Buckingham East
- Winslow
- Great Brickhill
- Addington Parish Council
- Adstock Parish Council
- Akeley Parish Council
- Barton Hartshorn Parish Council
- Beachampton Parish Council
- Buckingham Town Council
- Calvert Green Parish Council
- Charndon Parish Council
- Chetwode Parish Council
- Dunton Parish Council
- Foscote Parish Council
- Gawcott-with-Lenborough Parish Council
- Granborough Parish Council
- Great Brickhill Parish Council
- Great Horwood Parish Council
- Hillesden Parish Council
- Hoggeston Parish Council
- Leckhampstead Parish Council
- Lillingstone Dayrell with Luffield Abbey Parish Council
- Little Horwood Parish Council
- Maids Moreton Parish Council
- Middle Claydon Parish Council
- Mursley Parish Council
- Nash Parish Council
- Newton Longville Parish Council
- Padbury Parish Council

- Preston Bissett Parish Council
- Radclive-cum-Chackmore Parish Council
- Shalstone Parish Council
- Steeple Claydon Parish Council
- Stoke Hammond Parish Council
- Swanbourne Parish Council
- Thornborough Parish Council
- Thornton Parish Council
- Tingewick Parish Council
- Weedon Parish Council
- Whaddon Parish Council
- Winslow Town Council

Appendix D. Options and initial assessment

Table D-1 - Long list of options

Option code	Option Name	Source	Mode	Option location	Option Description
B-S1	X60 bus service frequency enhancement	Workshop 12/9/23	Bus	MK - Buckingham - Aylesbury	Return to half-hourly frequency on the X60 (as was pre-COVID) on the A422 between Buckingham and Milton Keynes.
B-S2	Improved bus service Buckingham - Winslow	Atkins	Bus	A422 Buckingham - Winslow	Improved frequency of bus services between Buckingham and Winslow (including interchange with EWR). Increase from 1-2bph at irregular intervals to 2-3bph at regular intervals, running later in the evenings and on Sundays.
B-S3	Improved bus services between Buckingham and Brackley/ Banbury	Atkins	Bus	Banbury - Buckingham	Improved bus service frequency on A422 between Buckingham, Brackley and Banbury. Increase from 5 per day per direction M-F and 4 per day Sat to hourly Mon-Sat.
B-S4	Improved bus services between Buckingham and Bicester.	Atkins	Bus	Bicester - Buckingham	Improved bus service frequency on A421/A4421 between Buckingham and Bicester. Increase from 1bph (0800-1400, 1800-2000) Mon-Fri to 2bph throughout day Mon-Sat
B-S5	Lace Hill - Buckingham town centre shuttle bus	Workshop 12/9/23	Bus	Buckingham	New (free) shuttle bus service operating between Lace Hill to the south of the A421 and Buckingham town centre via London Road. Peak hours only? Assume perhaps 3 buses per hour.
B-S6	DRT in Buckingham	Workshop 12/9/23	DRT	Buckingham	DRT service to connect people to the town centre, Tesco, Health centres and stops on longer-distance bus routes.
B-S7	Rural bus services	Workshop 12/9/23; Jacob's study	Bus	Rural areas in A421 corridor	Increased frequency and/or new bus services to/from villages such as Thornborough, Horwoods, Gawcott, Whaddon: - 1 bph Buckingham - Thornborough - Nash - Whaddon - Shenley Park-Bletchley (c. 40mins) - uses new bus gate on Shenley Road. - 1 bph Bicester - Marsh Gibbon - Twyford - Gawcott - Buckingham - Every 2nd hourly service Brackley - Buckingham runs via Gawcott.

Option code	Option Name	Source	Mode	Option location	Option Description
B-S8	DRT or community transport services	Atkins; Workshop 12/9/23	Bus	Rural areas in A421 corridor	DRT/ Community Transport Improvements for rural areas between Buckingham, Winslow, Stoney Stratford and MK. Also, DRT in the south west of the study area (Tingewick, Gawcott etc?)
B-S9	Bus services developments - Bletchley	Atkins	Multi Modal	South West MK/Bletchley	Bus services between new development sites and Bletchley Station.
B-S10	Winslow - Buckingham - Silverstone Bus Route	Workshop 12/9/23	Bus	Winslow - Buckingham - Silverstone	New weekday-only employer-funded midi-bus service between Winslow, Buckingham, Stowe and Silverstone.
B-I1	Bus priority on the A421 between Buckingham and Milton Keynes	Atkins	Bus	Buckingham - MK (A421)	Bus priority measures on the A421 to speed up journeys and make them more reliable. Primarily improvements would be dedicated bus lanes approaching and through junctions rather than between junctions.
B-I2	Offline busway between Buckingham and Milton Keynes	Atkins	Bus	Buckingham - MK (A421)	Segregated offline busway between Buckingham and Milton Keynes) adjacent to A421 or further north.
B-I3	Buckingham bus station/bus hub	Atkins	Bus	Buckingham	Improvements to bus interchange in Buckingham. Possibly a 'mobility hub' also providing facilities for active travel etc.
B-I4	Park and ride west of Bletchley	Atkins	Bus	On A421 west of Bletchley	Bus park and ride site and associated bus service between the development sites and NLV and WHA and Bletchley/Milton Keynes.
B-I5	Bus priority on the A422 between Buckingham and Milton Keynes	Atkins	Bus	Buckingham - MK (A422)	Bus priority measures on the A422 to speed up journeys and make them more reliable. Primarily improvements approaching junctions rather than between junctions.
B-I6	A413 Bus Lane	Atkins	Bus	Lace Hill	Highway widening from Benthill Farm to Tesco bus stop, then swapping to an offside bus lane. Use the existing pedestrian crossings on the A421 to hold traffic entering the roundabout, allowing buses expedited access.

Option code	Option Name	Source	Mode	Option location	Option Description
B-I7	A413 Bus Re Routing	Atkins	Bus	Lace Hill	From A413, divert onto Needlepin Way (at southern roundabout), Pillow Way, Threads Lane, Linen Lane, to new bus-only link along current foot/bridlepath(?) to exit onto A421/A413 roundabout. Buses continue Bourton Road, Badgers Way, Hare Close to new bus-only link back onto London Road.
R-1	New EWR Station(s)	Workshop 12/9/23	Rail	EWR Route (Newton Longville/ Whaddon Road)	More rail stations on EWR between Bletchley and Winslow Serving Newton Longville and developments, for example at Newton Longville and Saldon Chase to serve new developments.
R-2	Light Rail Buckingham - Milton Keynes / tram in corridor	Workshop 12/9/23	Light Rail	Buckingham - Milton Keynes	Light Rail between Buckingham and Milton Keynes. Nominal route assumed.
BC-1	Bus promotion	Workshop 12/9/23	Bus	Study area	Campaigns to promote buses as a viable mode of travel.
BC-2	Timetable integration at Wilmslow	Atkins?	Bus, Rail	Study area	Timetabling coordination at Winslow Station between EWR and local bus services (e.g. to Buckingham).
BC-3	Integrated ticketing and RTPI	Jacobs?	Multi Modal	Study area	Integrated and accessible bus ticketing for inter modal/ route interchange.
BC-4	Promotion of rideshare		Bus	Rural Areas A421	Promotion of ride sharing especially in rural areas where public transport is less available.
AT-1	A413 cycle route Improvements	Atkins, Workshop 12/9/23	Cycle	Buckingham - Winslow	Upgrade the existing A413 shared use path between Buckingham town centre and Winslow.
AT-2	Buckingham - MK Greenway	Atkins, Workshop 12/9/23	Active Travel	Study Area	Greenway from Buckingham to Milton Keynes via segregated route adjacent to or further afield from the A421/A422. Assume same standards as other greenways planned for Buckinghamshire.
AT-3	Brackley & Bicester Greenways	Atkins	Active Travel	Buckingham to Brackley, Buckingham to Bicester	Greenways between Brackley, Bicester and Buckingham. Use former rail line between Brackley and Buckingham.

Option code	Option Name	Source	Mode	Option location	Option Description
AT-4	Pedestrian cycle detection systems	Atkins	Active Travel	A421	PCDS on active travel crossings of A421 and other roads in the corridor.
AT-5	Buckingham – Silverstone Greenway	Atkins	Active Travel	Buckingham - Silverstone	Assume standard greenway design features (ask Chris Greenwood).
AT-6	Grade-separated pedestrian crossings	Workshop 12/9/23	Crossings	Buckingham	Bridges/underpasses on A421 in south Buckingham (Bernwood Jubilee Way Crossing, A421/London Road Junction).
AT-7	Development site connections to Bletchley station	Atkins	Multi Modal	South West MK/Bletchley	Local active travel connections between new development sites and Bletchley Station.
H-M1	A421 dualling Whaddon Road - Bottledump	Workshop 12/9/23	Highways (Links)	Shenley Park (Whaddon Road/A421 Junction) - BDR	Dualling A421 from Shenley Park (Whaddon Road/A421 Junction?) - Bottledump Roundabout.
H-M2	A421 dualling Winslow Road - Whaddon Road	Atkins	Highways (Links)	A421 Horwood - MK	Dualling of the A421 between B4033/Winslow Road and Whaddon Road (with H-M1 to dual to Bottledump Roundabout)
H-M3	A421 dualling Buckingham - Whaddon Road	Atkins	Highways (Links)	Buckingham - MK	Dualling of the A421 between London Road Buckingham and Whaddon Road (and with HM-1 and H-M2 to Bottledump Roundabout)
H-M4	A421 dualling Tingewick-Buckingham	Workshop 12/9/23	Highways (Links)	Finmere - MK	Dualling A421 from Tingewick Bypass to London Road Buckingham (and with H-M1, H-M2 and H-M3 to dual to Bottledump roundabout)
H-M5	Buckingham North/Western Bypass A421 – A422	Stakeholders/ Atkins; Workshop 12/9/23	Highways (New)	Buckingham	Reduce through and HGV traffic in Buckingham Town Centre Bypass through North of Buckingham. Alignment as per Buckingham Neighbourhood Plan.
H-M6	Stoke Hammond Link Road (Bletchley southern bypass)	Workshop 12/9/23	Highways (New)	A421 to Stoke Hammons	New road from A421 to Stoke Hammond (SW of MK). Also, then on to M1 J13?
H-M7	New offline A421	Workshop 12/9/23	Highways (Links)	South of A421	Ring road south of A421 entering into Bletchley to improve flows. There should be wide entry and exits (3 lanes mentioned) to improve flows and no junctions. Approx alignment assumed.
H-M8	A421 grade separated junctions	Atkins	Highways (New, Junctions)	Study Area (A421)	Grade separation of junctions on the A421 between the A43 and Milton Keynes.

Option code	Option Name	Source	Mode	Option location	Option Description
H-M9	Bottledump - H6 link road	Workshop 12/9/23	Highways (Links, Junctions)	A421 East - Bottledump to Westcroft (MK)	New link road between H6 and the Bottledump Roundabout. Assume dual 2 lane.
H-J1	Aldi/Osier Way roundabout improvements	Atkins	Highways (Junctions)	Osier Way roundabout, Buckingham	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalistion, lengthening of approach diverges). Also ped/cycle and/or safety improvements.
H-J2	London Road roundabout improvements	Atkins	Highways (Junctions)	A421/London Road Junction, Buckingham	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalistion, lengthening of approach diverges). Also ped/cycle and/or safety improvements. Possible additional improvements on London Road.
H-J3	London road roundabout signal improvements	Workshop 12/9/23	Highways (Signalling)	A421/London Road Roundabout	Improvements to traffic light (signalised pedestrian crossing) positioning at A421/London Road Roundabout to reduce impacts on traffic.
H-J4	A421/A413 roundabout improvements	Atkins; Workshop 12/9/23	Highways (Junctions)	A421/A413 roundabout	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalistion, lengthening of approach diverges, dedicated left turn lane). Also ped/cycle and/or safety improvements.
H-J5	A421/B4033/Winslow Road roundabout improvements	Atkins; Workshop 12/9/23	Highways (Junctions)	A421/B4033/Winslow Road roundabout	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalistion, lengthening of approach diverges).
H-J6	Little Horwood Junctions closure	Workshop 12/9/23	Highways (junctions)	A421 Junction with Warren Road and Shucklow Hill (towards Little Horwood)	2 junctions both serving the small village of Little Horwood are just 0.7 miles away. Convert one or both of these junctions (presumably Little Horwood Road junctions) into left turn only, thus reducing the points at which traffic has to slow down.
H-J7	Little Horwood junctions roundabout	Workshop 12/9/23	Highways (junctions)	A421 Junction with Warren Road and Shucklow Hill (towards Little Horwood)	Replace offset junction with a roundabout to make it safer for cars to pull out from these two roads, when traffic is moving fast.

Option code	Option Name	Source	Mode	Option location	Option Description
H-J8	Whaddon roundabout improvements	Atkins; Workshop 12/9/23	Highways (Junctions)	A421/Whaddon Road / Coddimoor La roundabout	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalisation, lengthening of approach diverges).
H-J9	Bottledump roundabout improvements	Atkins; Workshop 12/9/23	Highways (Junctions)	A421/Whaddon Road/H8 roundabout	Improvements to reduce delays/increase capacity of the roundabout (e.g. signalisation, lengthening of approach diverges). Also ped/cycle and/or safety improvements.
H-J10	A422 Improvements	Atkins	Highways (Links, Junctions)	Buckingham - MK (A422)	Measures to reduce delays on the A422 between Buckingham and the A5. Includes junction improvements at A421/Stratford Road (Deanshanger) and further improvements at A421/A5 roundabout.
H-S1	A421 speed reduction	Atkins; Workshop 12/9/23	Highways (Safety)	Study Area (A421)	Traffic calming measures e.g. Chevrons, speed cameras to prevent speeding (update from crash maps for locations). Speeding information at risk areas.
H-S2	A421 junction safety schemes	Atkins; Workshop 12/9/23	Highways (Safety)	A421	Measures to improve road safety where A421 is crossed by at-grade (non roundabout) junctions. Listed as follows: - Padbury Road Staggered Junction - Little Horwood Road (and road opposite), - Warren Road - Ouse Valley Way (A422).
H-O1	HGV routing	Atkins; Workshop 12/9/23	Highways	Study Area	Ban HGV movements on A422 by use of a weight limit(s) to encourage HGVs to use a more appropriate route from A43 to M1.
H-O2	Road maintenance	Atkins	Highways	Study area (A421)	Undertake maintenance of the A421 in a way which ensures that its condition does not act as an impediment to efficient movement of traffic. Maximise planned over reactive maintenance and minimise delays due to roadworks.

Option code	Option Name	Source	Mode	Option location	Option Description
H-O3	Flooding	Atkins	Highways	Study area	Preventative measures to avoid road surface flooding (e.g. on A413 Buckingham - Winslow).
H-O4	Village traffic calming	Atkins	Highways (Safety)	Whaddon, Nash	Traffic calming and other treatments to deter rat-running through the villages such as Whaddon, Nash and Newton Longville.
H-O5	EV charging points	Atkins	Highways	Study Area (A421)	Promote roll-out of EV charging points
Out of scope	Autonomous Vehicles	Workshop 12/9/23	Highways (Vehicles)	A421 Corridor	Autonomous vehicles and taxis are the future and should be encouraged in the region to reduce congestion.
Out of scope	Trunk Road Status	Workshop 12/9/23	Highways (Strategic)	A421	Argue for A421 to be given trunk road status
Out of scope	ULEZ MK	Workshop 12/9/23	Highways (Links, Junctions)	MK	MK should adopt an ULEZ - implication that this would reduce the amount of through traffic using the A421.
Noted	Winslow	Workshop 12/9/23	Highways (Links, Junctions)	Winslow	Winslow will likely grow significantly due to the introduction of the EWR station. Any future transport improvements need to account for this.
Noted	Vehicle Access Points for New Developments		Highways (New)	New Developments	Connecting to A421 through new roads and junctions [What is this? Needs more explanation] Relief Road to Bottledump Roundabout for Whaddon New Development. Relief Road to Tattenhoe/ Bottledump for NLV new development

Table E2 – Initial assessment scoring guide

	Question(s)	Score of…. 1	2	3	4	5
STRATEGIC CASE						
Scale of impact (3 LTP objectives)	*To what extent does the option alleviate the identified problem or support achievement of the objective?*	Very small positive impact, possibly with undesirable consequences	Minor impact	Reasonably significant impact	Significantly alleviate problem / support objective (locally)	Fully solve problem or resolve objective locally (without any undesirable consequences)
Fit with wider transport and government objectives	*How does the option fit within and complement other policies and proposals affecting the study area or is there potential for conflict?*	Significant conflict with other policies / options affecting the study area or conflicts with other modes	Some conflict with other policies / options or modes	Overall, the option fits well with other policies affecting the study area	The option fits very well with other policies affecting the study area	Option complements other policies / proposals affecting the study area, has no negative impacts on other modes or outcomes and demonstrates 'doing more with less'
Fit with other objectives (not being used)						
Key uncertainties (not scored)	*What are the main uncertainties, especially those related to the government and strategic objectives? What are the most uncertain assumptions that have been made?*					
Degree of consensus over outcomes	*What consultation has taken place with relevant stakeholders?*	Little or no consultation has taken place yet, or has revealed a high level of disagreement about the option's ability to deliver the stated outcomes	Little consultation and/or strong reasons to suggest the outcomes are controversial	Some consultation has taken place with some agreement	Wide consultation and broad agreement on the outcomes, possibly one or two areas of disagreement remaining	Extensive consultation has taken place with a high degree of consensus on the outcomes.
ECONOMIC CASE						
Economic growth	***Connectivity**. Will journeys get shorter, quicker and/or cheaper? Relates to business travel (which includes freight) and commuters)*	Journey distance, time or cost unchanged, or worsened.	Journeys become slightly (>5%) shorter, quicker and/or cheaper.	Journeys become moderately (>10%) shorter, quicker and/or cheaper.	Journeys become significantly (>25%) shorter, quicker and/or cheaper.	Transformational change (>50%) in journey distance, time and/or cost

	Question(s)	Score of…. 1	2	3	4	5
	Reliability. *Will the option impact on the day-to-day variability in journey times or the average minutes of lateness? will there be any impact on the number of incidents?*	Variability of journey times or delay unchanged or worsens and/or number of incidents increases.	Slight improvement (reduction) in journey time variability or delay and/or reduction in the number of incidents.	Moderate improvement (reduction) in journey time variability or delay and/or reduction in the number of incidents.	Significant improvement (reduction) in journey time variability or delay and/or reduction in the number of incidents.	Transformational improvement (reduction) in journey time variability or delay and/or reduction in the number of incidents.
	Wider economic impacts. *Are there any impacts that would need to be considered in more detail later on in the appraisal process, should the option progress? (not scored)*					
	Resilience. *Does the option have an impact on the vulnerability of the network to terrorism, severe weather events or the effects of climate change?*	Increased vulnerability / worsened resilience	Slight reduction in vulnerability / improved resilience	Moderate reduction in vulnerability / improved resilience	Significant reduction in vulnerability / improved resilience	Transformational reduction in vulnerability / improved resilience
	Delivery of housing. *Will the option facilitate new housing? in some cases, the need for new development in a specific location will mean that the development will require some form of transport development to support it.*	No impact on delivery of housing, or delivery of housing becomes more difficult.	Facilitates delivery of a small number of new houses (<500)	Facilitates delivery of some new houses (>500)	Facilitates delivery of many new houses (>2,000)	Facilitates delivery of a large number of new houses (>5,000)
Carbon emissions	*What impact the option could have on carbon emissions either through changes in activity, an increase in embedded carbon, changes in the carbon content of fuel or changes in efficiency; and whether the change in carbon emitted is associated with the traded*	Option would lead to a substantial increase in carbon emissions due to more car travel and/or major new infrastructure.	Option would lead to moderate increase in carbon emissions due to more car travel and/or major new infrastructure.	Option would have little or no impact on carbon emissions	Option would lead to moderate reduction in carbon emissions due to more car travel and/or major new infrastructure.	Option would lead to significant reduction in carbon emissions due to more car travel and/or major new infrastructure.

	Question(s)	Score of…. 1	2	3	4	5
	or non-traded sectors.					
Socio-distributional impacts	*Might the option have negative or positive impacts on specific groups of people, including children, older people, disabled people, Black and Minority Ethnic communities, people without access to a car and people on low incomes? If so, can all of the expected negative impacts be eliminated?*	Significant or concentrated negative impacts on one or more group	Some negative impacts on one or more group	Little or no impacts	Some negative impacts on one or more group	Significant or concentrated negative impacts on one or more group
Regeneration	*Does the option have an impact on a targeted regeneration area where poor transport been identified as a constraint?*	No regeneration impact	Slight impact on other regeneration area	Slight positive impact on a regeneration area where transport is a constraint, or moderate impact on other regeneration area	Moderate positive impact on a regeneration area where transport is a constraint, or significant impact on other regeneration area	Significant positive impact on one or more regeneration areas where transport is a constraint.
Local environment	***Air quality.*** *Does the option have an impact on air quality? Is the area affected within an Air Quality Management Area?*	Adverse impact on air quality in an AQMA or significant adverse impact elsewhere.	Moderate adverse impact on air quality in an AQMA.	Little or no impact on air quality	Moderate positive impact on air quality in an AQMA.	Positive impact on air quality in an AQMA or significant positive impact elsewhere.
	Noise. *Is the option likely to impact on noise problems in the area?*	Significant adverse noise impacts on a small number of properties, or adverse impacts on a large number of properties	Moderate adverse noise impacts on large number of properties, or significant increases on a small number of properties	Little or no change in noise impacts	Moderate reductions in noise impacts on a large number of properties, or significant reductions on a small number of properties	Significant reductions in noise impacts on a small number of properties, or positive impacts on a large number of properties
	Natural environment, heritage and landscape*. Is the option likely to*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts

	Question(s)	Score of…. 1	2	3	4	5
	impact on physical and cultural characteristics of the land, the man-made historic environment (heritage), sense and identity of place and/or natural environment (including biodiversity and water)?					
	Streetscape and urban environment. *Is the option likely to affect the physical and social characteristics of the built and unbuilt urban environment and the way in which we perceive those characteristics?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
Well being	***Physical activity.*** *What impact is the option likely to have on physical activity in areas of deprivation or poor health?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
	Injury or deaths. *Will the option impact the number of people killed or injured in transport accidents, and/or the risk of travelling (e.g. injuries using stairs or escalators)?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
	Crime*. Is the option likely to reduce crime and/or perceptions of crime?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
	Terrorism. *Is the option likely to affect our vulnerability to terrorism. Not scored.*					

		Score of….				
	Question(s)	**1**	**2**	**3**	**4**	**5**
	Enabling people to enjoy access to a range of goods, services, people and places. *Does the option make it easier for people to access key locations (doctors, hospitals, supermarkets etc)? Does it make leisure trips quicker or cheaper? Does it make leisure trips more reliable?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
	Severance. *Does the option impact on movement by non-motorised modes (pedestrians, cyclists, equestrians)? Are some people (particularly children and old people) likely to be dissuaded from making journeys on foot, or they will be less attractive to others or whether people will be deterred to the extent that they reorganise their activities?*	Significant adverse impacts	Moderate adverse impacts	Little or few impacts	Moderate positive impacts	Significant positive impacts
Expected VfM category	*What is the value for money of the option in terms of benefits versus costs? It includes both the benefits and costs that can be counted in monetary terms and other non-monetised impacts such as regeneration and environmental effects*	Very low (costs several times higher than expected benefits)	Low (costs are 1-2 times the expected value of benefits)	Neutral (costs and value of benefits are expected to be similar)	High (benefits are expected to be 1-2 times costs)	Very high (benefits several times higher than the costs)
MANAGERIAL CASE						
Implementation timetable	*An estimate of the timescales for implementing the option, from inception to delivery*	Very long (more than 5 years)	Long (2-5 years)	Moderate (1-2 years)	Short (less than 1 year)	Very short (less than 3 months)

	Question(s)	Score of…. 1	2	3	4	5
	(this might include construction timescales or time for bringing legislation into force).					
Public acceptability	*Are there likely to be any issues around public acceptability of the option? Does the option require behavioural changes (like mode shift or seatbelt campaigns)? What stakeholder engagement has already taken place?*	Likely to be strong opposition and/or requirement for significant behavioural change	Likely to be some opposition or requirement for behavioural change which can be largely overcome / achieved	Public likely to have little opinion on acceptability	Likely to be some support with little or no opposition.	Likely to be strong support with little or no opposition.
Practical feasibility	*Has the option been tested and proven to be practical and effective? Is the governance and legal feasibility of the option agreed? Can the option be operated? Are there planning implications? If there is technology involved, is it proven, prototype or still in development?*	Unproven or very complex design, technology or infrastructure with multiple issues	Less proven or complex design, technology or infrastructure with numerous feasibility issues.	Proven or simple design, technology or infrastructure. Legal, planning and governance issues partially addressed but issues/risks remain	Proven or simple design, technology or infrastructure. Legal, planning and governance issues largely addressed	Proven or simple design, technology or infrastructure. Legal, planning and governance issues very minor or fully addressed
What is the quality of the supporting evidence?	*Is evidence from where similar options have been implemented elsewhere with transferable evidence on the likely impacts? How well-developed is the supporting evidence at this stage? Is it based on modelling?*	1. Low level of supporting evidence. Scheme in very early stages of development that has not been implemented elsewhere with little supporting data and/or analysis	Poor level of supporting evidence. May be some underlying data or some informal analysis	Reasonable level of supporting evidence. Good underlying data explaining the problem and some analysis of the outcomes	Good level of supporting evidence, possibly including some modelling and/or sensitivity testing demonstrating robust outcomes	High level of supporting evidence. Option has been modelled in detail or subjected to a Transport Business Case appraisal.
Key risks (not scored)	*What risks have been identified with regard to implementing such an option/project? How probable are they and are there interdependencies*					

	Question(s)	Score of…. 1	2	3	4	5
	with other sources of risk? Will the identified risks be actively managed/mitigated?					
FINANCIAL CASE						
Affordability	*What is the available budget within the relevant budget period? Is the project affordable in the current budget period or later? What sort of package of options is being put forward alongside the option under consideration?*	Unaffordable within current or future funding period	Unaffordable in current funding period and would require majority external contribution (e.g. from DfT)	Affordable in future funding periods but requires moderate external contributions	Affordable within required funding period dependent on minority contributions from external stakeholders.	Fully affordable within required funding period without the need for external contributions.
Capital cost (£m)	*What is the best estimate of the capital cost of the option? Capital costs should include all the costs involved in setting up the option and getting it up and running. In some cases, cost information may be very uncertain.*	Less than £50,000	£50,000 to £500,000	£500,000 to £5 million	£5 million to £50 million	Over £50 million
Revenue costs (£m)	*What are the running costs to keep the scheme in operation, including any subsidy costs?*	No operating costs	Less than £10,000 per annum	£10,000 to 50,000 per annum	£50,000 to £100,000 per annum	More than £100,000 per annum
Cost profile	*Do the cost estimates include all implementation, operation, maintenance and enforcement costs including administration? What are the costs (and savings) to business? In particular, you should consider whether there is the potential for disproportionate burden on small business and how this might be minimised. If the*					

	Question(s)	Score of…. 1	2	3	4	5
	option being considered is a regulation, what are the full/wider costs imposed?					
Overall cost risk	*Risk rating based on likelihood of outturn costs being higher than those stated above.*	High risk (substantially higher or very likely to be higher)	Moderate/high risk (likely to be quite a lot higher)	Moderate risk (moderately higher or likely to be higher)	Low/moderate risk (unlikely to be higher or only slightly higher)	Low risk (unlikely to be higher or only very slightly)
Other costs						
COMMERCIAL CASE						
Flexibility of option	*To what extent can the option be scaled up or down depending on the level of funding available? How easy would it be to stop the option/scheme once it has been put into operation? Or before it starts operating? How easily could the scheme be amended to fit with changing circumstances?*	Static, no ability to scale, amend or stop.	Very little potential to scale, amend or cancel option	Some potential to scale down or stop / amend the option	Moderate potential to scale option or stop / amend	Flexible. Option can be scaled or stopped / amended if necessary
Where is the funding coming from?	*Brief qualitative statement on how capital and running costs will be financed and the certainty of funding*					
Any income generated (£m)	*Will any income be generated by the option> If so, what is the best estimate? Have options for making beneficiaries pay for improvements been considered (e.g. fare increases)?*	No income generated / don't know	Income generated covers a minority of the operating costs	Income generated covers majority of the operating costs	Enough income generated to cover all operating costs	Enough income generated to cover any revenue costs and some / all of debt on capital costs

Table D-2 - Initial sifting assessment results

| | | Scale of impact | | | | | | Economic growth | | | | | |

Appendix E. Additional information on detailed options assessment

E.1. Full A421 dualling: junction concept

The separate slide deck included with this report as Appendix E.1 indicates how each junction has been considered for the full dualling scenario. These are high level interpretations to enable the appropriate coding to be included within the BSTM for this scenario.

E.2. Proposed roundabout geometry improvements

The following diagrams show the key features of the proposed geometry improvements at five roundabouts on the A421. They are sketches only and not to scale. Designs would be subject to further revision based on detailed feasibility, performance and cost assessment.

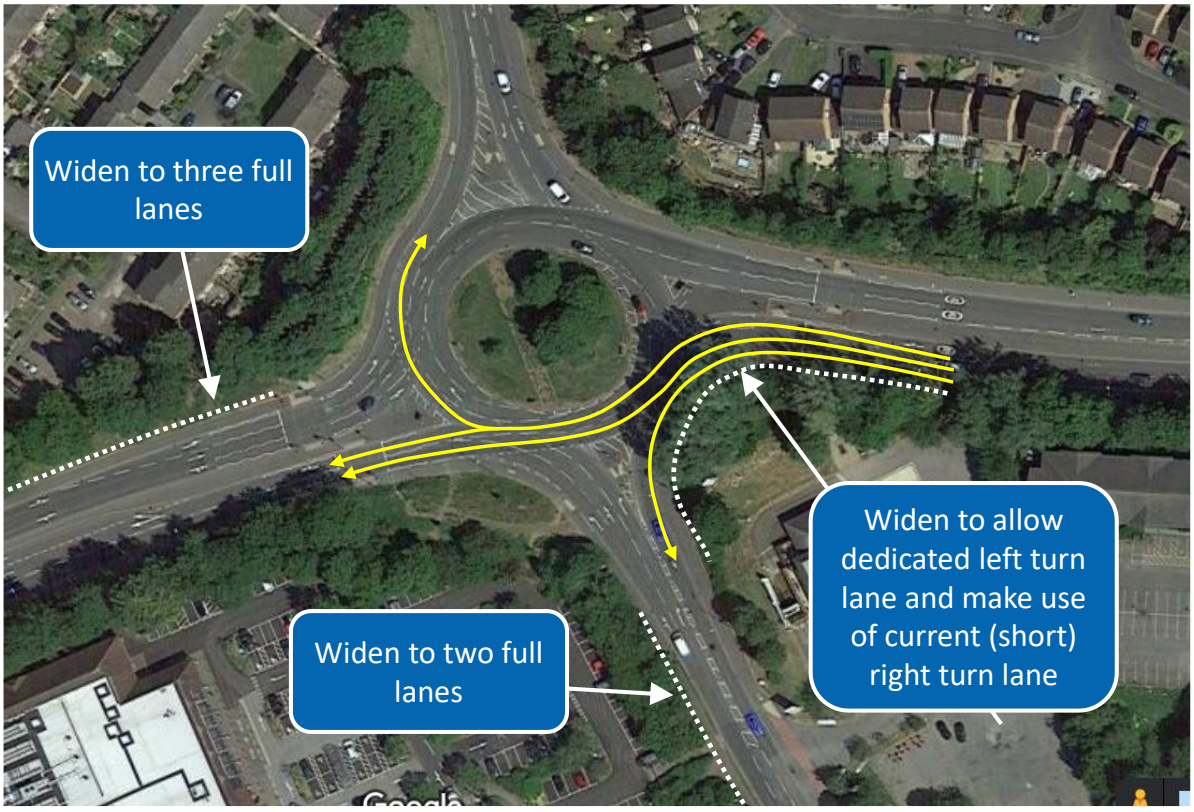


Figure E-1 – Option H-J1: Aldi/Osier Way roundabout

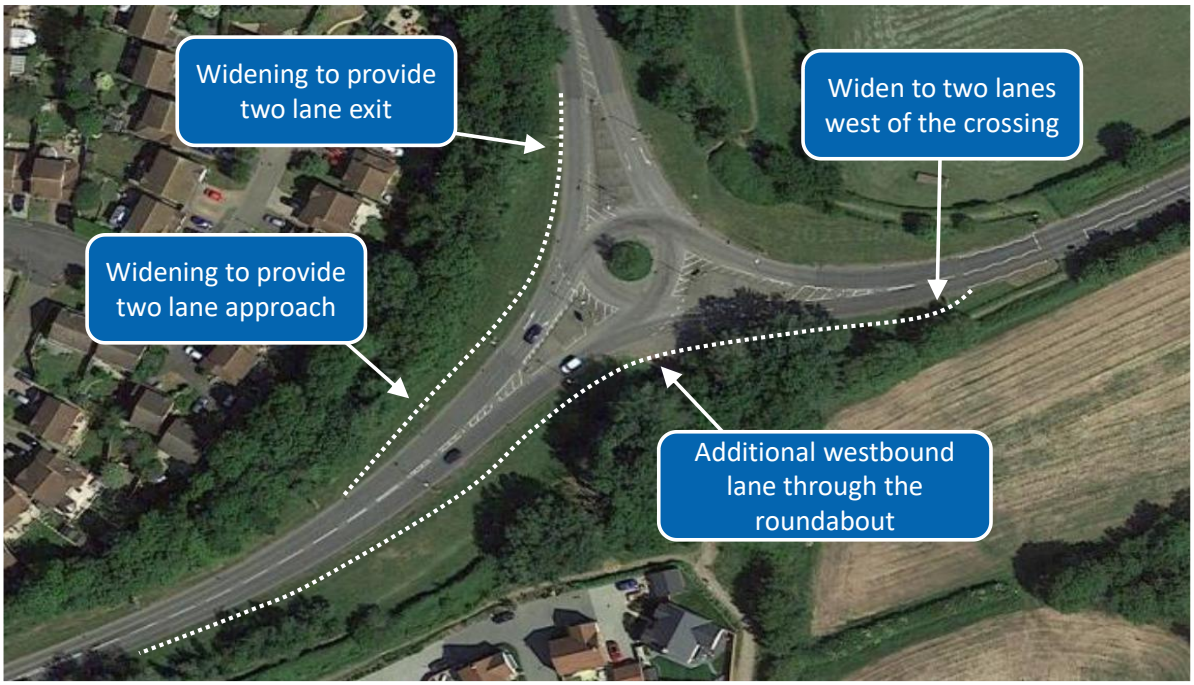


Figure E-2 – Option H-J2: London Road roundabout

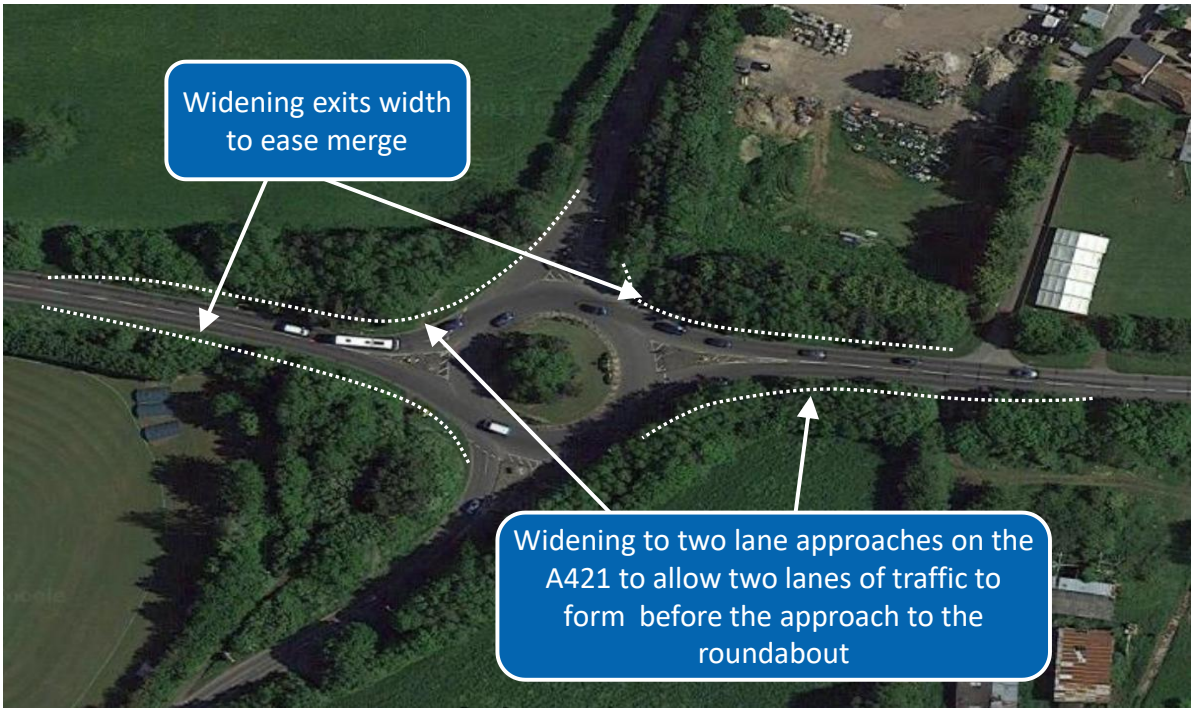


Figure E-3 – Option H-J4: A421/A413 roundabout

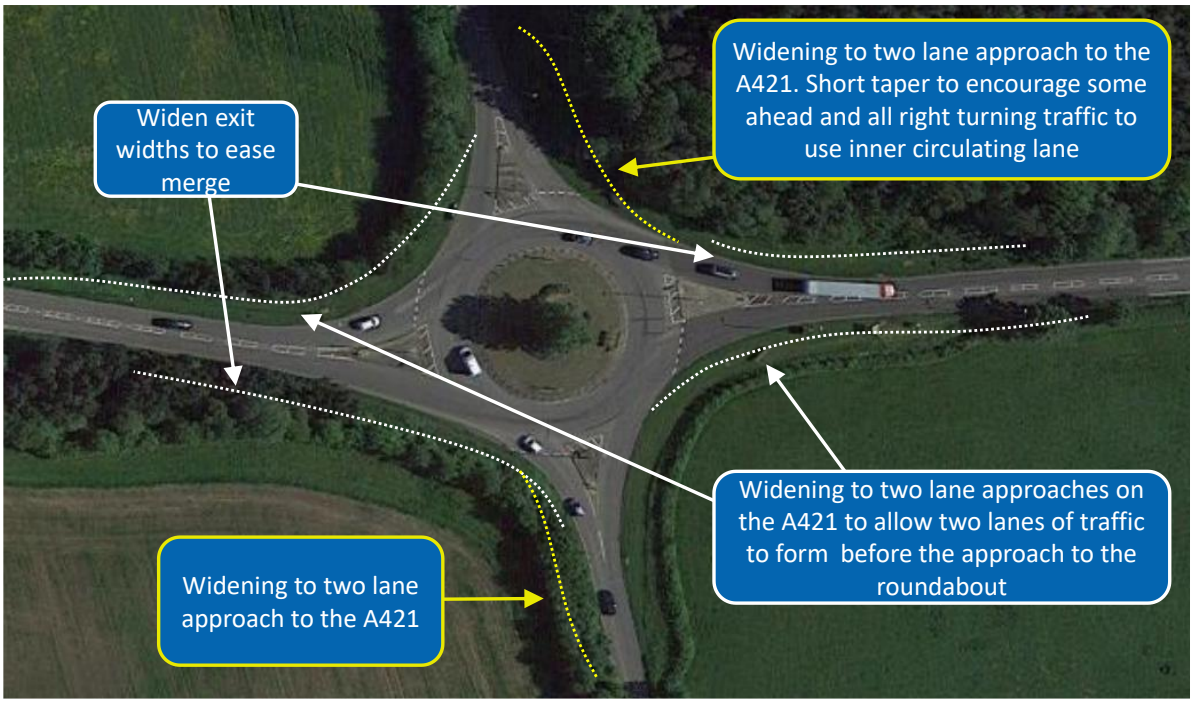


Figure E-4 – Option H-J5: Whaddon (Coddimoor Lane) roundabout

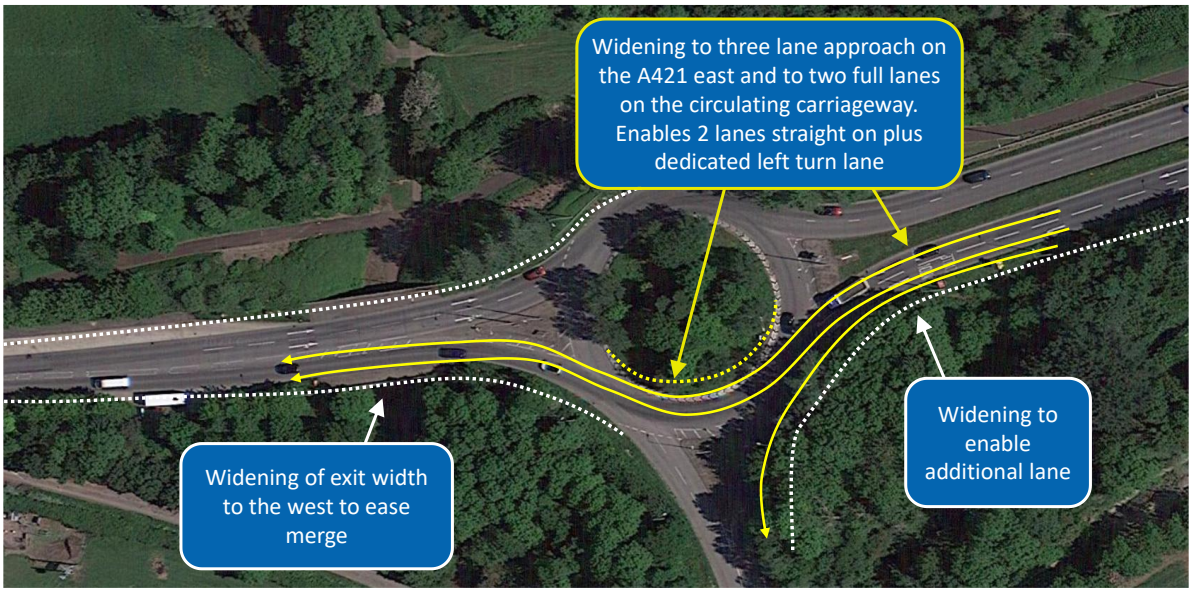


Figure E-5 – Option H-J8: Bottledump roundabout

Appendix F. A421 Junctions 10 and LinSig modelling outputs

The separate report included as Appendix F includes the technical outputs from the junction modelling. The findings are reported in a non technical way in Section 6 of this report.

Appendix G. Option cost models

The following tables present the cost estimates for the highway options. All costs are in 2019 prices and exclude inflation.

G.1. Dualling options

Item no	Description	Unit		Rate	Total
	Remove				
1	Kerb	m	100	£15.00	£1,500
2	Footway	m2	100	£35.00	£3,500
3	Carriageway	m2	50	£60.00	£3,000
4	Surfacing	m2	150	£35.00	£5,250
5	General Excavation	m3	50	£30.00	£1,500
6	Street Furniture	No	5	£35.00	£175
7	General Vegetation and Small Trees	No	1	£120.00	£120
8	Large Trees	No	1	£2,000.00	£2,000
	Provide				
1	Kerb	m	2,400	£110.00	£264,000
2	Footway	m2	8,000	£105.00	£840,000
3	Verge	m2	4,800	£65.00	£312,000
4	Planting (Swale)	m2	4,800	£25.00	£120,000
5	Planting (Meadow)	m2	0	£10.00	£0
6	Planting (Buffer)	m2	5,000	£40.00	£200,000
7	Culverts	No	2	£450,000.00	£900,000
8	Carriageway	m2	20,000	£155.00	£3,100,000
9	Surfacing	m2	2,000	£40.00	£80,000
10	Non Illuminated Signs	No	0	£505.00	£0
11	Illuminated Signs	No	0	£1,135.00	£0
12	Street Furniture	No	0	£190.00	£0
13	Street Lighting	No	0	£3,500.00	£0
14	Drainage (per gully)	No	100	£6,305.00	£630,500
15	Road Markings	Shift	4	£1,500.00	£6,000
	Earthworks				
1	Bulk Excavation	m3	0	£80.00	£0
	Bulk Fill in Flat Areas	m3	40,000	£90.00	£3,600,000
3	Bulk Fill in Sloped Areas	m3	20,000	£180.00	£3,600,000
3	Retaining (vertical face area)	m2	0	£635.00	£0
	Junctions				
1	Zebra	No	0	£14,000.00	£0
2	Crossing	No	0	£32,000.00	£0
3	2/3 Arms	No	0	£64,000.00	£0
4	4+ Arms	No	0	£127,000.00	£0
5	UTC/Scoot/MoC	No	0	£32,000.00	£0
	Sub Total				£13,670,000
	Not Yet Identified and Quantified %age	25		25%	£3,418,000
	Preliminaries and Traffic Management %age	15		15%	£2,051,000
	Construction Total				£19,139,000
	Allowance for QRA	10		10%	£1,913,900
	Contingency %age	25		25%	£4,784,750
	Budget Cost				£25,850,000
	Statutory Undertakers Diversions %age	10		10%	£2,585,000
	Total Esimated Cost			Total	**£28,435,000**

Costs exclude costs for improvements to junctions at either end of the dualled section.

Table G -1 - Cost estimate for Option M1: A421 partial dualling

	Per Km Cost of Dualling Between Junctions
	Includes for 2m enbankment and slope
	Full Carriageway Construction
	Full Footway and Cycleway
0.1	Assumed length included in each junction (each approach)
1.4	Distance between the junction (assuming 100m section coverd by junction)
£21,000,000	Per Km

	Full Dualling Bottledump to Tngewick including Junctions		
16	Total Length		
10	No of Junctons		
14	Effective Dualling Length		
£294,000,000	Dualling Cost		
£2,310,000	Add in junction A		
£1,840,000	Add in junction B		
£1,020,000	Add in junction C		
£2,255,000	Add in junction D		
£2,255,000	Add in junction E		
£1,470,000	Add in junction F		
£6,930,000	Add in 3 more times A for western junctions; Embleton Way, Tingewick Road and Radclive Road		
£4,620,000	Add in 2 times A for new roundabout at Padbury Road		
£317,000,000	Excluding grade separation for cyclists	10000	Indicative Cost for underpass per m2 road deck
1750000	Cycle Subways	35	Average Deck Sze - 5m by 7m
£320,000,000	Full Scheme to Tab X	5	Subways between Whaddon Road and the A413

Costs include costs for all proposed junction improvements.

Table G -2 - Cost estimate for Option M1/M2/M3/M4: A421 full dualling

G.2. Junction improvements

Item no	Description	Unit		Rate	Total
	Remove				
1	Kerb	m	500	£15.00	£7,500
2	Footway	m2	280	£35.00	£9,800
3	Carriageway	m2	250	£60.00	£15,000
4	Surfacing	m2	500	£35.00	£17,500
5	General Excavation	m3	650	£30.00	£19,500
6	Street Furniture	No	5	£35.00	£175
7	General Vegetation and Small Trees	No	900	£120.00	£108,000
8	Large Trees	No	3	£2,000.00	£6,000
	Provide				
1	Kerb	m	500	£110.00	£55,000
2	Footway	m2	280	£105.00	£29,400
3	Verge	m2	240	£65.00	£15,600
4	Planting (Swale)	m2	0	£25.00	£0
5	Planting (Meadow)	m2	240	£10.00	£2,400
6	Planting (Buffer)	m2	0	£40.00	£0
7	Trees	No	0	£1,000.00	£0
8	Carriageway	m2	1,400	£155.00	£217,000
9	Surfacing	m2	500	£40.00	£20,000
10	Non Illuminated Signs	No	4	£505.00	£2,020
11	Illuminated Signs/Bollards	No	4	£1,135.00	£4,540
12	Street Furniture	No	5	£190.00	£950
13	Street Lighting	No	4	£3,500.00	£14,000
14	Drainage (per gully)	No	17	£6,305.00	£107,185
15	Road Markings	Shift	0	£1,500.00	£0
	Earthworks		0		
1	Bulk Excavation	m3	300	£80.00	£24,000
2	Bulk Fill in Flat Areas	m3	1,400	£90.00	£126,000
3	Bulk Fill in Sloped Areas	m3	0	£180.00	£0
3	Retaining (vertical face area)	m2	0	£635.00	£0
	Junctions		0		
1	Zebra	No	0	£14,000.00	£0
2	Crossing	No	1	£32,000.00	£32,000
3	2/3 Arms	No	0	£64,000.00	£0
4	4+ Arms	No	0	£127,000.00	£0
5	UTC/Scoot/MoC	No	0	£32,000.00	£0
	Sub Total				£834,000
	Not Yet Identified and Quantified %age	25		25%	£209,000
	Preliminaries and Traffic Management %age	15		15%	£126,000
	Construction Total				£1,169,000
	Allowance for QRA	10		10%	£116,900
	Contingency %age	25		25%	£292,250
	Budget Cost				£1,600,000
	Statutory Undertakers Diversions %age	15		15%	£240,000
	Total Esimated Cost			Total	**£1,840,000**

Table G -3 - Cost estimate for Option H-J2: A421/London Road roundabout

Item no	Description	Unit		Rate	Total
	Remove				
1	Kerb	m	320	£15.00	£4,800
2	Footway	m2	140	£35.00	£4,900
3	Carriageway	m2	180	£60.00	£10,800
4	Surfacing	m2	320	£35.00	£11,200
5	General Excavation	m3	600	£30.00	£18,000
6	Street Furniture	No	7	£35.00	£245
7	General Vegetation and Small Trees	No	100	£120.00	£12,000
8	Large Trees	No	2	£2,000.00	£4,000
	Provide				
1	Kerb	m	320	£110.00	£35,200
2	Footway	m2	140	£200.00	£28,000
3	Verge	m2	220	£65.00	£14,300
4	Planting (Swale)	m2	0	£25.00	£0
5	Planting (Meadow)	m2	220	£10.00	£2,200
6	Planting (Buffer)	m2	0	£40.00	£0
7	Trees	No	0	£1,000.00	£0
8	Carriageway	m2	1,200	£155.00	£186,000
9	Surfacing	m2	320	£40.00	£12,800
10	Non Illuminated Signs	No	4	£505.00	£2,020
11	Illuminated Signs	No	4	£1,135.00	£4,540
12	Street Furniture	No	0	£190.00	£0
13	Street Lighting	No	4	£3,500.00	£14,000
14	Drainage (per gully)	No	9	£6,305.00	£56,745
15	Road Markings	Shift	0	£1,500.00	£0
	Earthworks		0		
1	Bulk Excavation	m3	0	£80.00	£0
2	Bulk Fill in Flat Areas	m3	600	£90.00	£54,000
3	Bulk Fill in Sloped Areas	m3	0	£180.00	£0
3	Retaining (vertical face area)	m2	0	£635.00	£0
	Junctions		0		
1	Zebra	No	0	£14,000.00	£0
2	Crossing	No	0	£32,000.00	£0
3	2/3 Arms	No	0	£64,000.00	£0
4	4+ Arms	No	0	£127,000.00	£0
5	UTC/Scoot/MoC	No	0	£32,000.00	£0
	Sub Total				£476,000
	Not Yet Identified and Quantified %age	25		25%	£119,000
	Preliminaries and Traffic Management %age	15		15%	£72,000
	Construction Total				£667,000
	Allowance for QRA	10		10%	£66,700
	Contingency %age	25		25%	£166,750
	Budget Cost				£925,000
	Statutory Undertakers Diversions %age	10		10%	£92,500
	Total Esimated Cost			Total	**£1,020,000**

Table G -4 - Cost estimate for Option H-J4: A421/A413 roundabout

Item no	Description	Unit		Rate	Total
	Remove				
1	Kerb	m	840	£15.00	£12,600
2	Footway	m2	650	£35.00	£22,750
3	Carriageway	m2	420	£60.00	£25,200
4	Surfacing	m2	840	£35.00	£29,400
5	General Excavation	m3	1,290	£30.00	£38,700
6	Street Furniture	No	4	£35.00	£140
7	General Vegetation and Small Trees	No	120	£120.00	£14,400
8	Large Trees	No	0	£2,000.00	£0
	Provide				
1	Kerb	m	840	£110.00	£92,400
2	Footway	m2	0	£105.00	£0
3	Verge	m2	840	£65.00	£54,600
4	Planting (Swale)	m2	0	£25.00	£0
5	Planting (Meadow)	m2	780	£10.00	£7,800
6	Planting (Buffer)	m2	0	£40.00	£0
7	Trees	No	0	£1,000.00	£0
8	Carriageway	m2	2,580	£155.00	£399,900
9	Surfacing	m2	840	£40.00	£33,600
10	Non Illuminated Signs	No	8	£505.00	£4,040
11	Illuminated Signs	No	8	£1,135.00	£9,080
12	Street Furniture	No	10	£190.00	£1,900
13	Street Lighting	No	10	£3,500.00	£35,000
14	Drainage (per gully)	No	29	£6,305.00	£182,845
15	Road Markings	Shift	0	£1,500.00	£0
	Earthworks		0		
1	Bulk Excavation	m3	0	£80.00	£0
2	Bulk Fill in Flat Areas	m3	1,240	£90.00	£111,600
3	Bulk Fill in Sloped Areas	m3	0	£180.00	£0
3	Retaining (vertical face area)	m2	0	£635.00	£0
	Junctions		0		
1	Zebra	No	0	£14,000.00	£0
2	Crossing	No	0	£32,000.00	£0
3	2/3 Arms	No	0	£64,000.00	£0
4	4+ Arms	No	0	£127,000.00	£0
5	UTC/Scoot/MoC	No	0	£32,000.00	£0
	Sub Total				£1,076,000
	Not Yet Identified and Quantified %age	25		25%	£269,000
	Preliminaries and Traffic Management %age	15		15%	£162,000
	Construction Total				£1,507,000
	Allowance for QRA	10		10%	£150,700
	Contingency %age	25		25%	£376,750
	Budget Cost				£2,050,000
	Statutory Undertakers Diversions %age	10		10%	£205,000
	Total Esimated Cost			Total	**£2,255,000**

Table G -5 - Cost estimate for Option H-J5: A421/B4033/Winslow Road roundabout

Item no	Description	Unit		Rate	Total
	Remove				
1	Kerb	m	840	£15.00	£12,600
2	Footway	m2	650	£35.00	£22,750
3	Carriageway	m2	420	£60.00	£25,200
4	Surfacing	m2	840	£35.00	£29,400
5	General Excavation	m3	1,290	£30.00	£38,700
6	Street Furniture	No	4	£35.00	£140
7	General Vegetation and Small Trees	No	120	£120.00	£14,400
8	Large Trees	No	0	£2,000.00	£0
	Provide				
1	Kerb	m	840	£110.00	£92,400
2	Footway	m2	0	£105.00	£0
3	Verge	m2	840	£65.00	£54,600
4	Planting (Swale)	m2	0	£25.00	£0
5	Planting (Meadow)	m2	780	£10.00	£7,800
6	Planting (Buffer)	m2	0	£40.00	£0
7	Trees	No	0	£1,000.00	£0
8	Carriageway	m2	2,580	£155.00	£399,900
9	Surfacing	m2	840	£40.00	£33,600
10	Non Illuminated Signs	No	8	£505.00	£4,040
11	Illuminated Signs	No	8	£1,135.00	£9,080
12	Street Furniture	No	10	£190.00	£1,900
13	Street Lighting	No	10	£3,500.00	£35,000
14	Drainage (per gully)	No	29	£6,305.00	£182,845
15	Road Markings	Shift	0	£1,500.00	£0
	Earthworks		0		
1	Bulk Excavation	m3	0	£80.00	£0
2	Bulk Fill in Flat Areas	m3	1,240	£90.00	£111,600
3	Bulk Fill in Sloped Areas	m3	0	£180.00	£0
3	Retaining (vertical face area)	m2	0	£635.00	£0
	Junctions		0		
1	Zebra	No	0	£14,000.00	£0
2	Crossing	No	0	£32,000.00	£0
3	2/3 Arms	No	0	£64,000.00	£0
4	4+ Arms	No	0	£127,000.00	£0
5	UTC/Scoot/MoC	No	0	£32,000.00	£0
	Sub Total				£1,076,000
	Not Yet Identified and Quantified %age	25		25%	£269,000
	Preliminaries and Traffic Management %age	15		15%	£162,000
	Construction Total				£1,507,000
	Allowance for QRA	10		10%	£150,700
	Contingency %age	25		25%	£376,750
	Budget Cost				£2,050,000
	Statutory Undertakers Diversions %age	10		10%	£205,000
	Total Esimated Cost			Total	**£2,255,000**

Table G -6 - Cost estimate for Option H-J8: Whaddon (Coddimoor Lane) roundabout

Description	Unit		Rate	Total
Remove				
Kerb	m	420	£15.00	£6,300
Footway	m2	80	£35.00	£2,800
Carriageway	m2	210	£60.00	£12,600
Surfacing	m2	420	£35.00	£14,700
General Excavation	m3	650	£30.00	£19,500
Street Furniture	No	0	£35.00	£0
General Vegetation and Small Trees	No	1	£120.00	£120
Large Trees	No	1	£2,000.00	£2,000
Provide		0		
Kerb	m	420	£110.00	£46,200
Footway	m2	0	£105.00	£0
Verge	m2	420	£65.00	£27,300
Planting (Swale)	m2	0	£25.00	£0
Planting (Meadow)	m2	420	£10.00	£4,200
Planting (Buffer)	m2	0	£40.00	£0
Bridge Works / Parapets	No	1	£150,000.00	£150,000
Carriageway	m2	1,300	£155.00	£201,500
Surfacing	m2	420	£40.00	£16,800
Non Illuminated Signs	No	4	£505.00	£2,020
Illuminated Signs	No	4	£1,135.00	£4,540
Street Furniture	No	5	£190.00	£950
Street Lighting	No	6	£3,500.00	£21,000
Drainage (per gully)	No	15	£6,305.00	£94,575
Road Markings	Shift	0	£1,500.00	£0
Earthworks		0		
Bulk Excavation	m3	0	£80.00	£0
Bulk Fill in Flat Areas	m3	370	£90.00	£33,300
Bulk Fill in Sloped Areas	m3	0	£180.00	£0
Retaining (vertical face area)	m2	0	£635.00	£0
Junctions		0		
Zebra	No	0	£14,000.00	£0
Crossing	No	0	£32,000.00	£0
2/3 Arms	No	0	£64,000.00	£0
4+ Arms	No	0	£127,000.00	£0
UTC/Scoot/MoC	No	0	£32,000.00	£0
Sub Total				£661,000
Not Yet Identified and Quantified %age	25		25%	£166,000
Preliminaries and Traffic Management %age	15		15%	£100,000
Construction Total				£927,000
Allowance for QRA	10		10%	£92,700
Contingency %age	25		25%	£231,750
Budget Cost				£1,275,000
Statutory Undertakers Diversions %age	15		15%	£191,250
Total Esimated Cost			Total	**£1,470,000**

Table G -7 - Cost estimate for Option H-J9: Bottledump roundabout

Appendix H. Literature Review

H.1. Buckingham Transport Strategy (AECOM, 2017)

The Buckingham Transport Strategy was developed after the Aylesbury Vale Local Plan to support future planned growth in the town up to 2033. The main focus is on Buckingham, but the wider area and the impacts have been recognised.

The strategy objectives are:

1. Behaviour Change – 'make it easier and more attractive to travel by active travel and public transport in particular within Buckingham'.
2. Ease of movement in town centre – 'improve transport access and movement in town centre'.
3. Improving Transport Options 'improve accessibility into Buckingham and to other urban centres.
4. Improving Journey Times – 'improve journey time reliability'.
5. Managing Congestion 'minimise the impact of future growth on traffic levels, congestion and air quality.
6. Transport Safety 'reduce the risk of death or injury on the transport network.

- The identified issues informed the options development and appraisal process, through which options packages for highway, bus, rail, active travel and integrated travel support were considered. These options were appraised for deliverability, feasibility and affordability, with those presenting with 'significant challenges' in two or more categories being a Bus Corridor to Milton Keynes and Dualling the study area. Options that scored as likely to be feasible/ deliverable included Modern Ticketing and Real Time Passenger Information (RTPI), and Promotion and Personal Travel Planning (PTP). Other options which scored high for feasibility were the provision of new bus routes, traffic calming measures, improvements to NCN 51 and the provision of pedestrian/cycle crossings. (A421 Corridor Study, Jacobs 2015).

H.2. Transport Improvements (Buckingham Transport Strategy 2017):

- Route upgrade along A413 and A421 – increase capacity and ease congestion which could include dualling.
- Buckingham Bypass running parallel to A421 – bypass unlikely to reduce congestion in town centre and would require significant funding.
- Junction Improvement Package: optimising signal timings and measures such as left turn slip on A422 / A413 junction.

H.3. Oxford to Milton Keynes Connectivity Study (England's Economic Heartland, 2022)

From this framework, five packages are identified to both meet immediate transportation needs, accommodate for, and catalyse future economic and population growth in the study area, shown in Figure H-1.

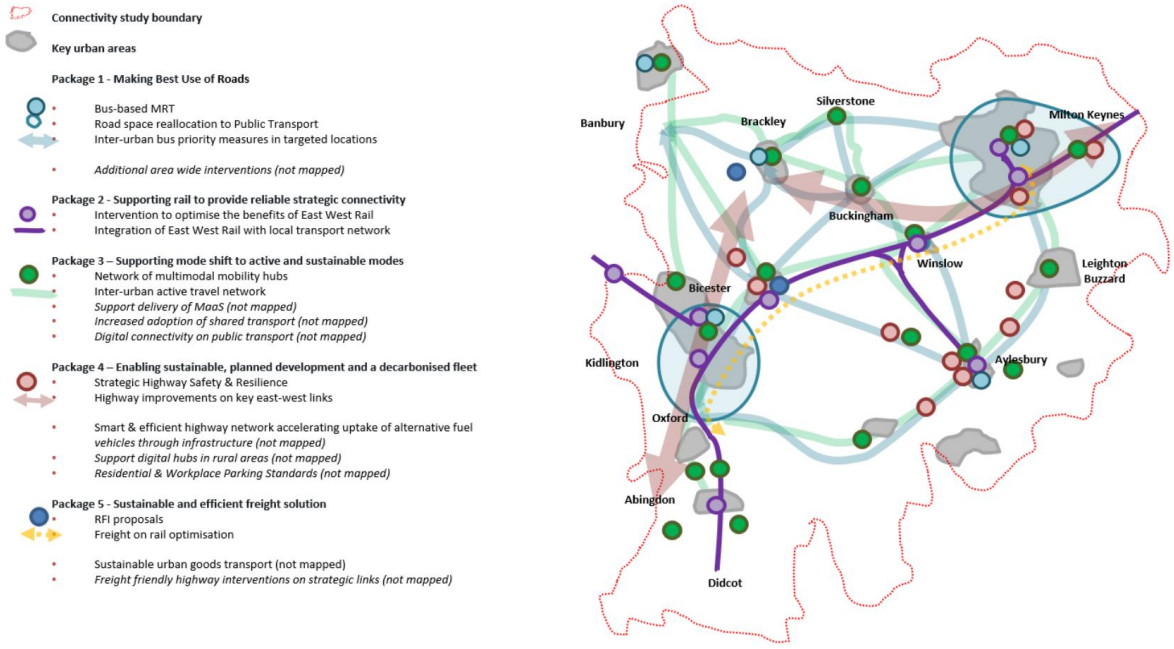


Figure H-1 - EEH Connectivity plan package identification[23]

The connectivity study outlines a series of challenges, options, and interventions for the A421 corridor. Firstly, EEH discuss present and projected issues of traffic in this space. Buckingham is identified as one of the key urban areas which 'experience(s) significant delay and congestion in the peak' hours[24]. Furthermore, adjacent smaller settlements are described as 'dependent on (Milton Keynes) for employment and some key services', whilst lacking both high quality bus and active travel infrastructure to connect these settlements with Milton Keynes. This has created a spatial and infrastructural landscape which is conducive to high levels of car dependency in the semi-rural and rural areas surrounding the town. Alongside commuting, the issue of unreliable journey times and present safety concerns on East-West highways in the region (with pinch points in strategic market towns) informs the critical success factors and interventions proposed by this study.

EEH's study identifies a series of critical success factors regarding the development of a sustainable, efficient and integrated transport network in the region including:

- CSF 3. Improved public transport connectivity enables planned development growth to be delivered sustainably.
- CSF 5. The area's towns, cities and rural communities are well connected by improved east/west transport corridors.
- CSF 8. Rural communities and market towns are well connected to the public transport network.
- CSF 11. Active travel mode share within and between our towns and cities increases.

The identified issues in the region and critical success factors informs a series of interventions, categorised into five packages. Table H-1 (below) presents the proposed interventions outlined by EEH in the A421 study area. Interventions such as BRT connections between Buckingham, Winslow, Silverstone and Brackley, alongside improvements to active travel in the area, are also proposed as part of the infrastructure packages in EEH's (2022) Peterborough – Northampton – Oxford Connectivity Study.

[23] England's Economic Heartland, 2022 p.14. Oxford – Milton Keynes Connectivity Study. Available at: Oxford-Milton_Keynes_connectivity_study.pdf (eeh-prod-media.s3.amazonaws.com)

[24] England's Economic Heartland, 2022 p.7. Oxford – Milton Keynes Connectivity Study. Available at: Oxford-Milton_Keynes_connectivity_study.pdf (eeh-prod-media.s3.amazonaws.com)

Table H-1 - EEH A421 Corridor Proposed interventions

Package	Overview	Interventions on A421 Corridor
Making Best Use of Roads	Bus Based MRT Road Space Reallocation to Public Transport Inter-urban bus priority measures in targeted locations	Improving bus connectivity between market towns, EWR stations and centres of employment Inter Urban bus priority measures in Brackley, Buckingham and Winslow
Supporting rail to provide regional strategic connectivity	Intervention to optimise the benefits of EWR Integration of EWR with local transport network	EWR Strategic Transport Interchange at Winslow
Supporting mode shift to active and sustainable modes	Network of multi modal mobility hubs Inter-urban active travel network	Improving active travel modes to bus or rail options Brackley – Buckingham – MK Greenway
Enabling sustainable, planned development and a decarbonised fleet	Strategic Highway Safety & Resilience Highway Improvements on key east – west links Smart & efficient highway network catalysing alternative fuels	Targeted improvements on East West Links Bletchley placemaking A421 Journey time reliability and future resilience
Sustainable and efficient freight solution	RFI proposals Freight on rail optimisation Sustainable urban goods transport Freight friendly highway interventions	No Mention

H.4. 2021 Vale of Aylesbury Local Plan (VALP) 2021-2033

The 2021 Vale of Aylesbury Local Plan (hereafter VALP) identifies a series of key interventions on the A421 corridor to alleviate congestion issues on the strategic road. The document outlines necessary highway, public transport, and active travel improvements to accommodate for population increase in the region as a result of the planned new housing developments along the A421 corridor. The paper outlines the location, size and delivery date of proposed housing developments in the Vale of Aylesbury, including four in the A421 Corridor Study area. These are further analysed using data from this paper in section 4.1.3. Alongside specific mitigations for proposed development sites, the 2021 VALP outlines protected and supported transport schemes for the region, with those located in the study area outlined in Table H-2 below.

Table H-2 - A421 Study Area protected and supported transport schemes

Settlement	Evidence base	Required mitigation measures	Delivery partner	Delivery mechanism/ funding
Buckingham	Buckingham Transport Strategy	Route upgrade on the A421 and A413 to dual – 2-lane standard (between Radcliffe	Developers	Developer contributions and grant funding

		Road roundabout and A421/ A413 roundabout (east))		
Buckingham	Buckingham Transport Strategy	Buckingham Left turn slip at A422/A413/Stratford Road roundabout	Developers	Developer contributions
Buckingham	Buckingham Transport Strategy	Buckingham Town-wide cycle network improvement	BC, Sustrans	Developer contributions
Buckingham	Buckingham Transport Strategy	Buckingham to Silverstone Park cycle route	BC, Sustrans	Developer contributions
Winslow	Buckingham Transport Strategy	Infrastructure to facilitate increase in bus frequency to Winslow Station	BC, Bus Operators, EWR	Operators – possible commercial service
Edge of MK	Buckinghamshire County Model	New roundabout access on A421 to serve Shenley Park and subject to more detailed traffic modelling possible dualling between new access and Bottledump roundabout and link road through the site connecting the A421 with H6and/or H7	MK, BC, Developers	Developer contributions

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Technical Note

Project:	A421 Corridor Study		
Subject:	Modelling Specification		
Author:	Dominic Dachs		
Date:	30/06/2023	Project No.:	5222660
Atkins No.:	5222660	Icepac No.:	
Distribution:	Angela Bond	Representing:	Buckinghamshire Council

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	For issue	DD	OS	AEA	GGH	30/06/2023

Client signoff

Client	Buckinghamshire Council
Project	A421 Corridor Study
Project No.	5222660
Client signature / date	

1. Introduction

Atkins has been commissioned by Buckinghamshire Council (BC) to assess the existing and future operation of the A421 corridor and to make recommendations to improve traffic flow efficiency as well as increasing sustainable travel options for residents.

This technical note details a review of the Buckinghamshire Strategic Transport Model (BSTM) in the key study area, considers its suitability for use in the study and outlines the proposed modelling approach. The BSTM will be utilised in the study to analyse the existing and future traffic conditions and traffic patterns along the corridor, identify areas requiring improvement and assess proposed improvement schemes.

2. BSTM Model Background and Suitability

The BSTM is a highway-only VISUM model representing an average weekday with a 2019 base year. This section provides background to the BSTM, focusing on the A421 Corridor area between the A43 and M1, and assesses its suitability for use in this study. The key aspects considered include the model extent, network detail, development of the demand matrices, the level of calibration and validation and the model forecasting approach. Further detail on the development of the BSTM base model is provided in the Local Model Validation Report (March 2023).

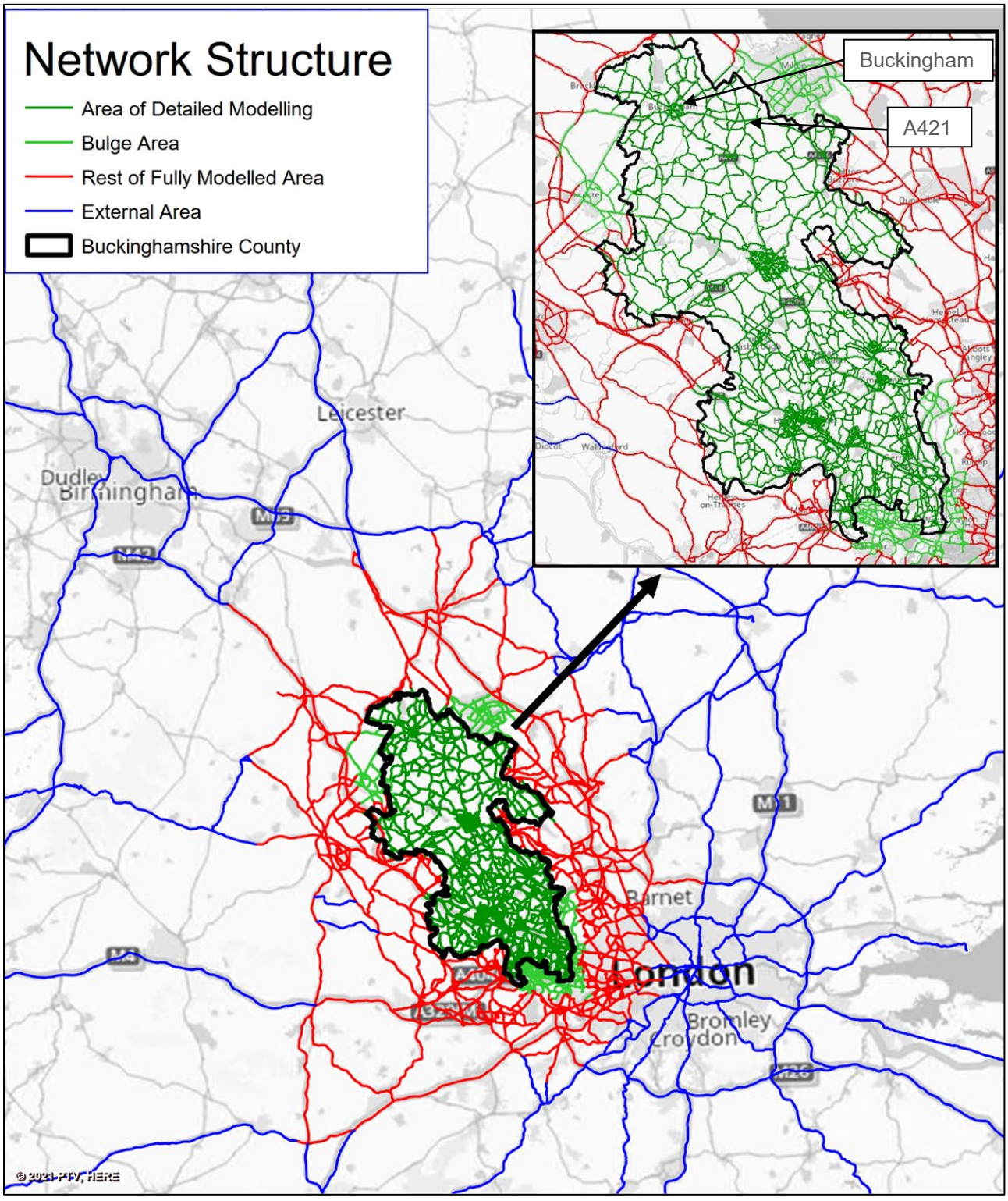
2.1. Model Extent

The BSTM comprises three different sub-areas with different levels of modelling detail included, as defined in TAG Unit M3.1:

- **Fully Modelled Area**, comprising of the following:
  - **Area of Detailed Modelling (AoDM)** - This is the area over which significant impacts of interventions are certain. The modelling detail is characterized by representation of all trip movements, small zones, very detailed networks and junction modelling
  - **Rest of the Fully Modelled Area (RoFMA)** - This is the area over which the impacts of interventions are considered to be quite likely but relatively weak in magnitude. The modelling detail is characterised by representation of all trip movements, larger zones, less network detail than for the AoDM and use of speed/flow modelling
- **External Area** - In this area impacts of interventions would be so small as to be reasonably assumed to be negligible. The modelling detail is characterised by a network representing a large proportion of the rest of Great Britain, a partial representation of demand (trips to, from and across the Fully Modelled Area), large zones, skeletal networks and simple speed/flow relationships or fixed speed modelling.

Figure 2-1 shows the extent of the three model areas in the BSTM. The AoDM covers the whole of Buckinghamshire. The majority of the A421 corridor is within the AoDM which extends from the A4421 in the west to Whaddon Road in the east. The A421 outside Buckinghamshire, between the A43 and the M1 is within 'Bulge Areas'. The Bulge Areas have a higher network density than the RoFMA but utilise a similar method for capturing delay. The Bulge Areas are designed to enable accurate routeing of traffic into and out of Buckinghamshire.

Figure 2-1 – Model Extent [1]

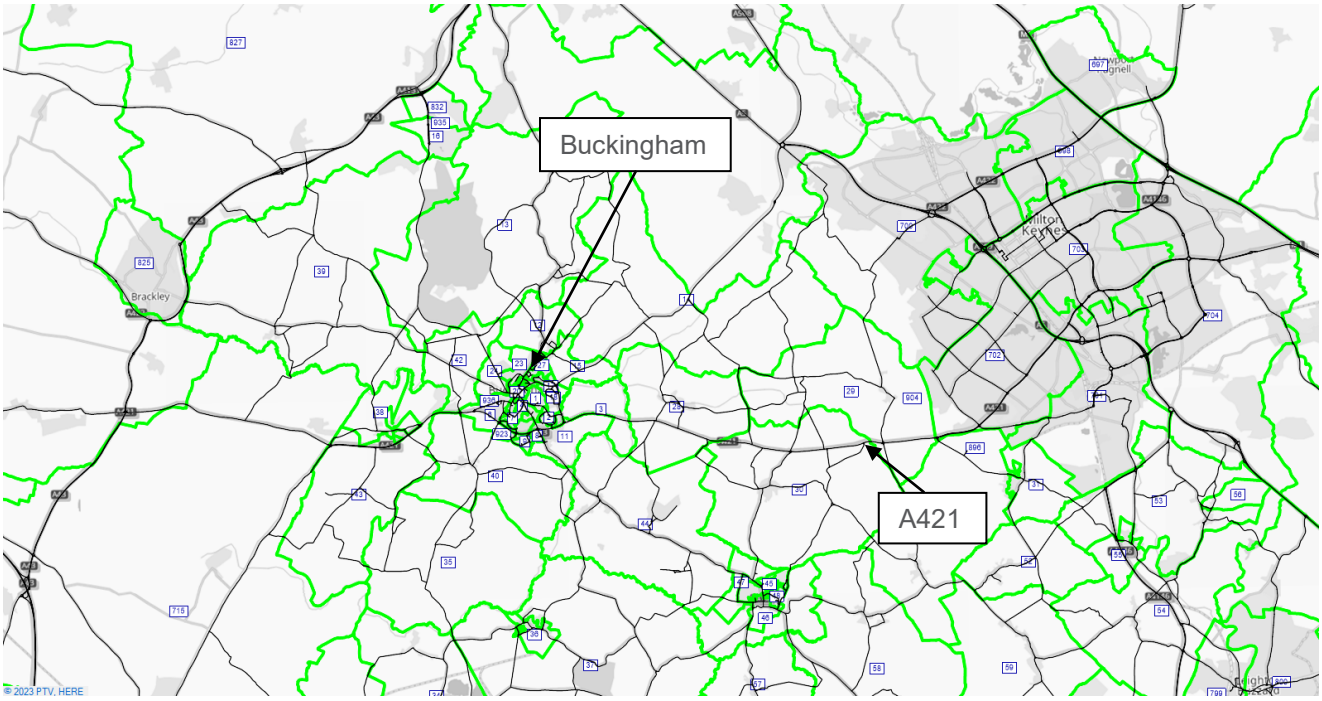


[1] Diagram taken from BSTM Local Model Validation Report, March 2023

2.2. Zoning System

Within Buckinghamshire, the model zones are predominantly aggregations of outputs areas. In urban centres, finer detail has been provided by splitting up output areas into several zones. The zoning system is shown in Figure 2-2 for the A421 corridor area.

Figure 2-2 – A421 Corridor Area Zoning System



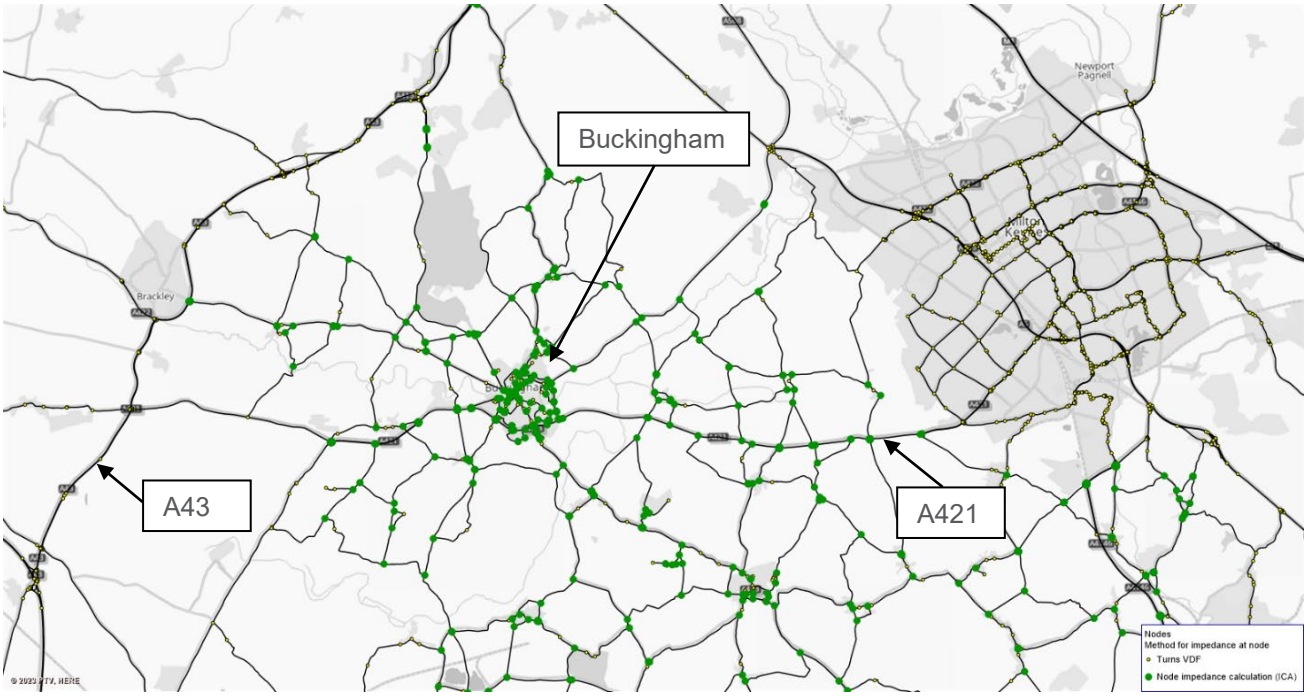
The model zoning in the A421 corridor area has a good level of granularity within Buckinghamshire but is coarser in the Bulge Area and external areas. The coarse zoning in Milton Keynes limits the accuracy of traffic flows and reliability of modelling results in this area.

2.3. Model Network

The BSTM includes all major and minor roads within Buckinghamshire and the Bulge Areas. Local roads have been included where they have an important role in facilitating access to major trip generating areas or providing through routes. Outside Buckinghamshire and the Bulge Areas only major roads have been modelled.

Figure 2-3 shows the network detail in the A421 Corridor and the junctions which have detailed junction coding (Intersection Capacity Analysis (ICA)). All key roads are included within the corridor and detailed junction coding is provided within the Buckinghamshire county border. Outside Buckinghamshire detailed junction coding is not provided so the BSTM will not enable the performance of these junctions to be accurately assessed and modelled journey times will be less reliable. It will not be possible, therefore, to accurately assess the impact of scheme improvements on the A421/A43 junction or junctions within Milton Keynes.

Figure 2-3 – Model Network – A421 Corridor



2.4. Demand Matrices

The BSTM base matrices have been developed using aggregated and anonymised mobile network data (MND) from 2019 provided specifically for this study by Telefonica. This data was augmented in the matrix development with other data sources including 2011 Census Journey to Work (JTW), National Travel Survey data (NTS), National Trip End Model (NTEM v7.2) and bespoke synthetic matrices to correct for known biases.

The Heavy Goods Vehicle matrices (HGVs) and Light Goods Vehicle (LGV) movements were derived from the South East Regional Transport Model (SERTM), with a base year of 2015, factored up to 2019 based on the 2018 Road Traffic Forecasts (RTF18).

The BSTM has the following modelled time periods:

- AM Peak 08:00-09:00 Peak Hour;
- Inter Peak 10:00-16:00 Average Hour; and
- PM Peak 17:00-18:00 Peak Hour.

The BSTM has five user classes used in the model assignment, as follows:

- Car – Business;
- Car – Commuting;
- Car – Other;
- LGV; and
- HGV.

2.5. Calibration and Validation

The level of link flow and journey time calibration and validation in the A421 Corridor area has been assessed to determine the suitability of the model for use in this study.

Two measures are used for individual highway link validation: flow difference; and the Geoffrey E Haver (GEH) measure. The flow difference is based on the relative flow difference between modelled flows and observed counts, with three different criteria set depending on the scale of observed flows. The GEH measure uses the GEH statistic as defined below:

$$GEH = \sqrt{\frac{(M-C)^2}{½(M+C)}}$$

Where: GEH is the GEH statistic;
M is the modelled flow; and
C is the observed flow.

TAG Unit M3.1 describes the link flow and turning movements validation criteria and acceptability guidelines as shown in Table 2-1.

Table 2-1 - Link Flow and Turning Movement Validation Criteria and Acceptability Guidelines

Criteria	Description of Criteria	Acceptability Guideline
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	>85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	>85% of cases
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	>85% of cases
2	GEH <5 for individual flows	>85% of cases

TAG states that the GEH and flow measures are broadly consistent and link flows that meet either criterion should be regarded as satisfactory.

2.5.1. Link Flow Calibration and Validation

Figures 2-4 and 2-5 show the links which have modelled total vehicle flows meeting the TAG validation criteria in the A421 Corridor area for the AM and PM peak hours respectively. Links which meet the TAG criteria are shown in green and those which fail are shown in red. Plots for the car calibration and validation and the Inter-Peak are provided in Appendix C.

Figure 2-4 – Link Calibration and Validation – AM Peak Hour

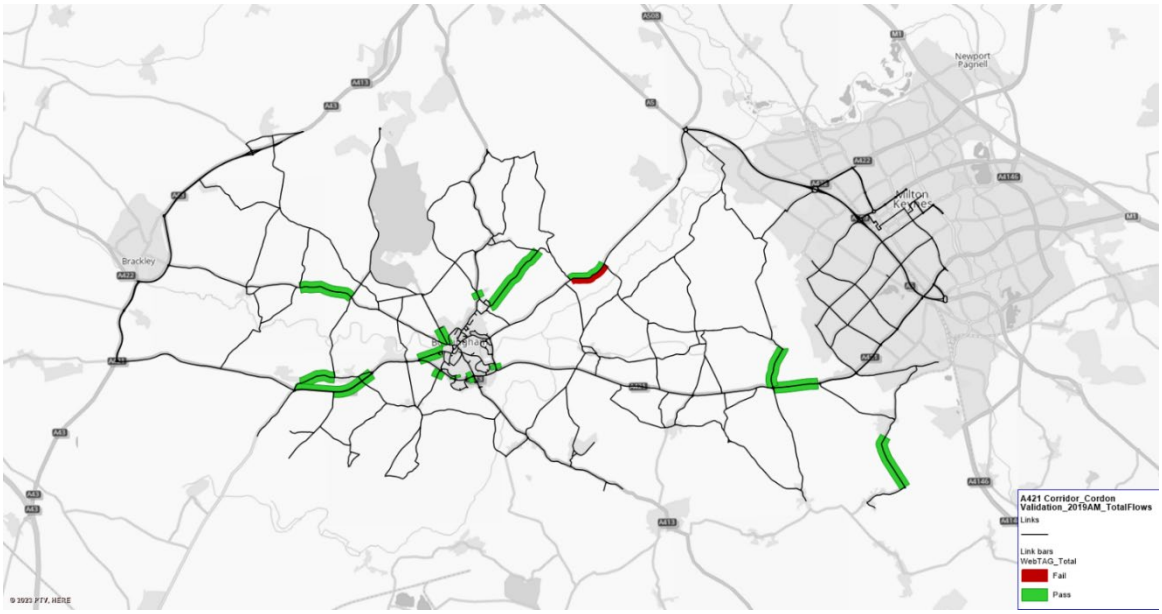


Figure 2-5 – Link Calibration and Validation – PM Peak Hour

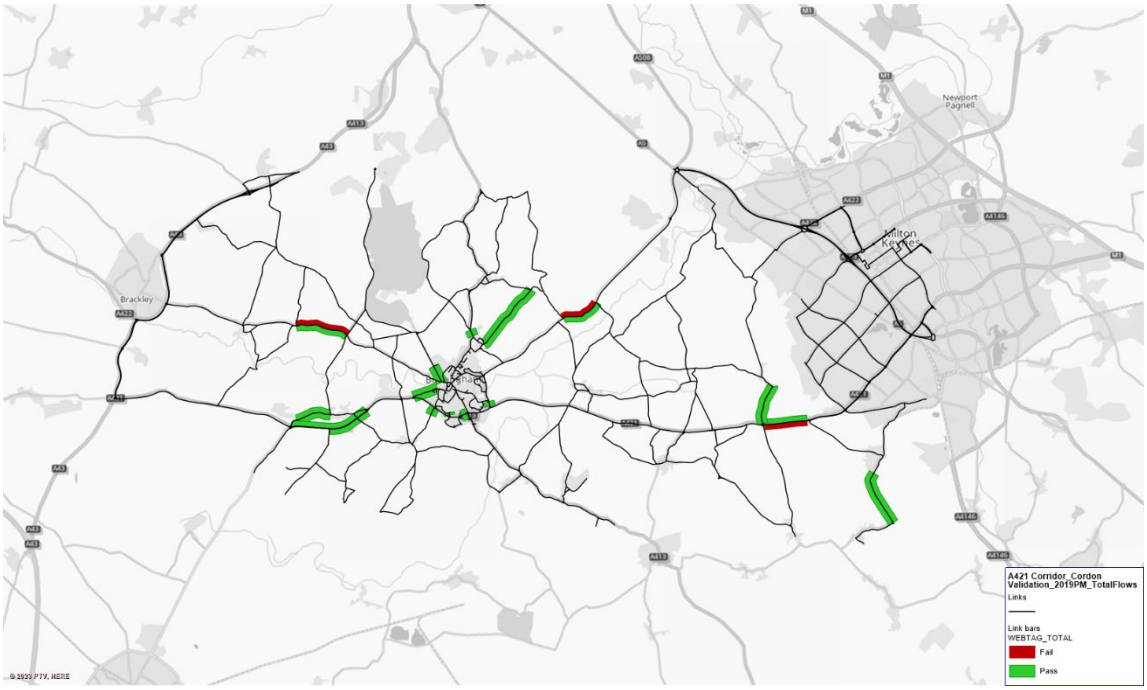


Table 2-1 summarises the percentage of links which have modelled flows meeting the TAG validation criteria for the A421 Corridor area.

Table 2-2 – Link Flow Calibration and Validation A421 Corridor

Individual Link Counts	AM Peak Hour		Inter Peak		PM Peak Hour	
	All Vehicles	Cars	All Vehicles	Cars	All Vehicles	Cars
% Pass Rate of counts	97% (31 out of 32)	100% (32 out of 32)	100% (32 out of 32)	100% (32 out of 32)	91% (29 out of 32)	100% (32 out of 32)

There is therefore considered to be a high level of link flow calibration and validation for both cars and total vehicles in the study area, for all three time periods, which provides confidence in the suitability of the model to represent existing traffic flows and form the basis for forecasting.

2.5.2. Journey Time Validation

Figure 2-6 shows the journey time routes used in the development of the BSTM. The observed journey time data is based on Teletrac GPS data. The validation of the routes within the A421 Corridor area have been extracted in Table 2-3.

Figure 2-6 – Journey Time Routes[2]

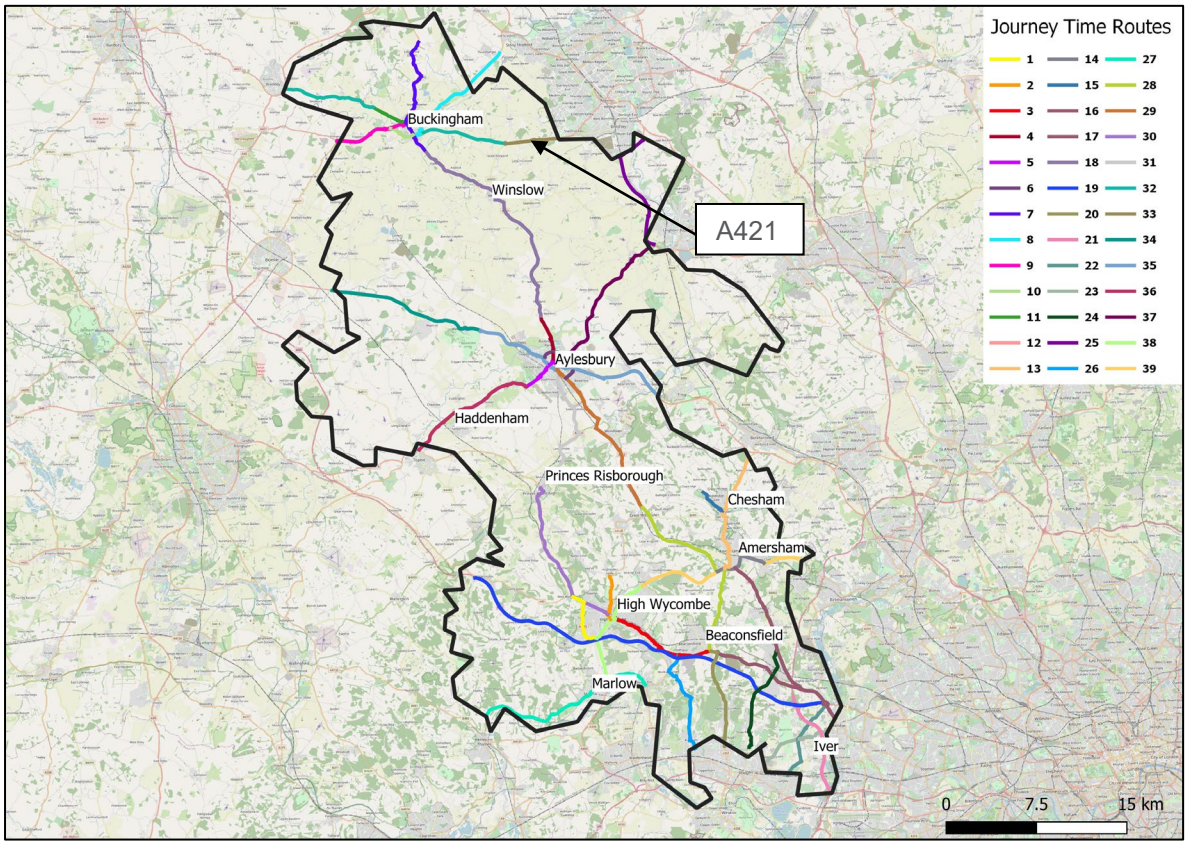


Table 2-3 – Journey Time Validation Summary

Route	Description	Direction	Percentage Difference between Modelled and Observed Journey Times		
			AM	IP	PM
7 (A413)	A413/ at Bycell Road --> A413/ near Benthill	SB	-4.8%	-0.2%	2.7%
	A413/ near Benthill --> A413/ at Bycell Road	NB	-5.0%	-2.0%	-6.0%
8 (A422)	A5/A508 roundabout --> A413/at Lenborough Road	SB	-7.3%	3.6%	-1.8%
	A413/at Lenborough Road --> A5/A508 roundabout	NB	-5.2%	5.5%	5.4%
9 (A421)	A422/at Globe Terrace --> A43/ Barleymow Roundabout	WB	-10.6%	-8.9%	-8.6%
	A43/ Barleymow Roundabout --> A422/at Globe Terrace	EB	-3.5%	-12.5%	-23.5%
10	A422/at Globe Terrace --> A421/ Tingewick Road	WB	-2.6%	5.1%	1.4%

[2] Taken from BSTM LMVR (March 2023)

Route	Description	Direction	Percentage Difference between Modelled and Observed Journey Times		
			AM	IP	PM
(A421)	A421/ Tingewick Road --> A422/at Globe Terrace	EB	8.2%	10.7%	-14.6%
11	A413/ near Benthill --> A422/ near Radclive	NB	-12.0%	-2.0%	-14.2%
(A422)	A422/ near Radclive --> A413/ near Benthill	SB	-6.5%	2.8%	-12.3%
12	A422/ near Radclive --> A421/A413 roundabout	EB	-7.5%	1.1%	-13.5%
	A421/A413 roundabout --> A422/ near Radclive	WB	-9.8%	-5.7%	-14.7%
18	A413/near Buckingham Park --> A421/413 roundabout	NB	-3.6%	-4.4%	1.9%
(A413)	A421/413 roundabout --> A413/near Buckingham Park	SB	3.7%	-5.3%	1.3%
32	A43/at Buckingham Road --> A421/B4033 roundabout	SB	2.4%	0.4%	0.2%
(A421)	A421/B4033 roundabout --> A43/at Buckingham Road	NB	-0.8%	0.4%	2.0%
33	A421/B4033 roundabout --> A421 Kents Hill Roundabout	NB	-6.1%	17.6%	12.8%
(A421)	A421 Kents Hill Roundabout --> A421/B4033 roundabout	SB	6.1%	6.3%	5.4%
Pass Rate			100%	94%	94%

Table 2-3 shows that journey times validate well. At least 94% of journey time routes in the area meeting the TAG criteria of having modelled journey times within 15% of observed in all each time period.

Routes 9, 10, 32 and 33 run along the A421 and meet the validation criteria with two exceptions. Route 33 northbound in the Inter-Peak is slightly outside the criteria with a difference between modelled and observed of 17.6%. Route 9 eastbound in the PM peak hour is also outside the criteria with a difference of 23.5%.

2.6. Forecasting

2.6.1. Forecasting Approach

The existing 2040 BSTM Do Minimum (DM) model has been developed using the following methodology:

- Significant Near Certain and More Than Likely developments (based on TAG Classifications shown in Table 2-4) have been modelled explicitly with trip generation based on Transport Assessments or TRICS 7.7.1 trip rates. Trip distributions have been based on donor zones of a similar land use type in a similar area. It is understood, however, that the development assumptions within the 2040 BSTM DM have not been agreed with BC;
- Background growth between 2019 and 2040 has been derived using growth factors from TEMPRO v7.2 (which was the latest version of TEMPRO at the time of the model development) with explicitly modelled dwellings and jobs excluded to avoid double-counting;
- As the BSTM is a fixed assignment model, fuel and income adjustment factors have been applied to the TEMPRO growth factors;

- The DfT's RTF18 growth factors have been applied for HGVs and LGVs;
- Near Certain and More than Likely highway schemes have been included within the forecast model; and
- No constraining of growth to NTEM growth has been applied to the combined development and background growth matrices.

It is noted that as no constraining has been applied to the forecast matrices, the overall growth between 2019 and 2040 is 4-7% higher for cars for the AM, IP and PM peak matrices than if they had been constrained. Constraining the matrices is not required unless the model is to be used for obtaining DfT funding. Further details on the differences between the model's unconstrained growth and TEMPRO growth, as well as the BSTM forecasting methodology, is provided in the Traffic Forecasting Technical Note (October 2021).

Table 2-4 – Classification of Uncertainty

Probability of the Input	Status
Near Certain: The outcome will happen or there is a high probability that it will happen.	Intent announced by proponent to regulatory agencies Approved development proposals, and Projects under construction
More than likely: The outcome is likely to happen but there is some uncertainty.	Submission of planning or consent application imminent, and Development application within the consent process
Reasonably Foreseeable: The outcome may happen, but there is significant uncertainty.	Identified within a development plan Not directly associated with the transport strategy/scheme, but may occur if the strategy/scheme is implemented Development conditional upon the transport strategy/scheme proceeding Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty
Hypothetical: There is considerable uncertainty whether the outcome will ever happen.	Conjecture based upon currently available information Discussed on a conceptual basis One of a number of possible inputs in an initial consultation process Or a policy aspiration

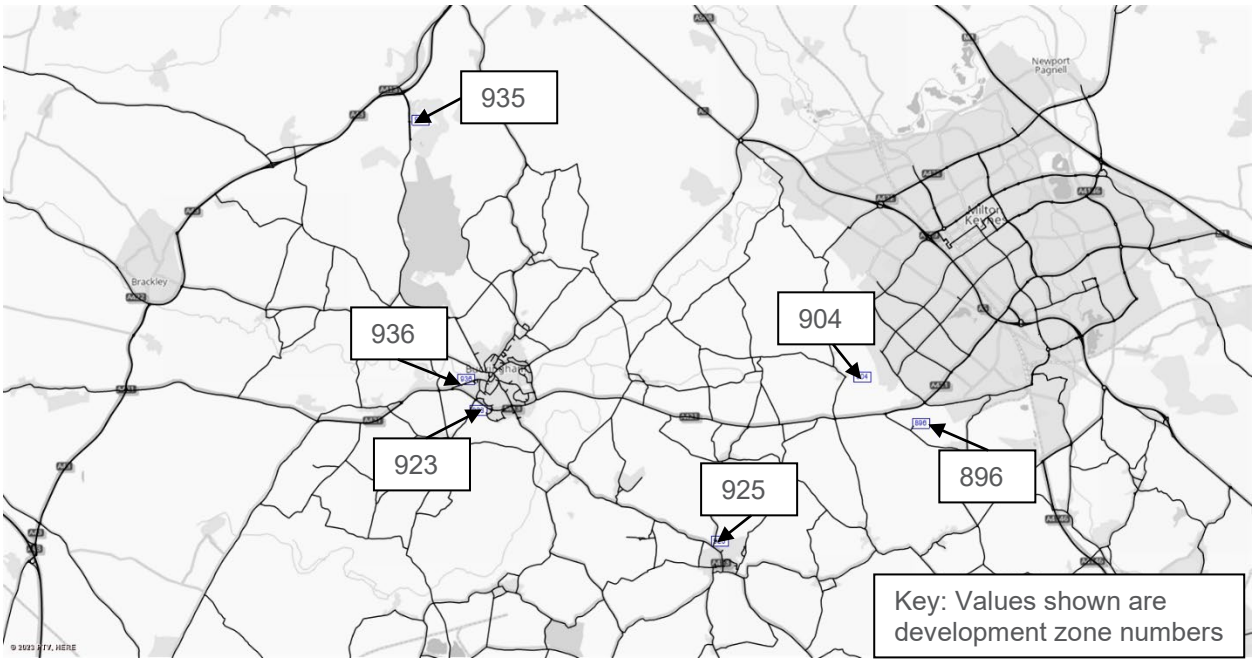
Table 2-5 shows the developments in the A421 corridor which are assumed in the 2040 DM. Their locations are shows in Figure 2-7.

Table 2-5 – Developments in A421 Study Area

Site reference	Site address	Type	Forecast Zone Number	Dwellings	Jobs
NLV001	Site west of Far Bletchley, at the south-western edge of Milton Keynes. Boundary A421 & A4034, disused railway and Whaddon Road. Adjoins residential of west Bletchley.	Residential	896	1,885	0

Site reference	Site address	Type	Forecast Zone Number	Dwellings	Jobs
WHA001	Shenley Road	Residential	904	1150	0
BUC046	Land off Osier Way (south of A421 and east of Gawcott Road) Buckingham,	Residential	923	420	0
WIN001	Land to east of B4033, Great Horwood Road	Residential	925	315	0
	Silverstone	Employment	935		4,152
	Land North Of A421 Tingewick Road Buckingham Buckinghamshire	Residential	936	450	0

Figure 2-7 – Location of Developments in A421 Study Area



2.6.2. NTEM and RTF Growth Comparison

The existing 2040 BSTM DM utilises the National Trip End Model (NTEM) v7.2 growth factors for cars and RTF18 growth factors for HGVs and LGVs. These growth factors have now been superseded by the NTEM v8.0 growth factors for cars and 2022 Road Traffic Projections (RTP22) for HGVs and LGVs.

Table 2-6 shows a comparison between the new and old growth factors for the period between 2019 to 2040.

Table 2-6 – Growth Factor Comparison of vehicle trips

Vehicle Type	Geographical Area	AM Peak Growth Factor (2019 to 2040)		PM Peak Growth Factor (2019 to 2040)		Daily Growth Factor (2019 to 2040)	
		NTEM7.2	NTEM8.0	NTEM7.2	NTEM8.0	RTF18	RTP22
Cars	Aylesbury Vale	1.21	1.15	1.22	1.16	N/A	N/A
LGVs	South-East	N/A	N/A	N/A	N/A	1.29	1.33
HGVs	South-East	N/A	N/A	N/A	N/A	1.11	1.13

Table 2-6 shows that the NTEMv8.0 growth factors for cars for 2019 to 2040 are approximately 6% lower than those from NTEMv7.2. The latest forecast growth factors for HGVs and LGVs, however, are 4% and 2% higher, respectively, than the RTF18 forecasts.

Therefore, the use of NTEMv7.2 growth factors provides a higher level of overall growth than NTEMv8.0 which will provide a robust assessment of the network performance. It is proposed to retain these growth factors for the A421 test as discussed in Section 3.3.

2.7. Model Suitability: summary

The review of the BSTM model network, calibration, validation and forecasting demonstrates the following:

- The network in the A421 Corridor area has a good level of detail with ICA junction modelling within Buckinghamshire;
- The A421 network outside Buckinghamshire includes all the key roads but does not have ICA junction modelling and is not suitable for assessing junction performance;
- The model zoning is of sufficient granularity within the Buckinghamshire area. Outside Buckinghamshire (e.g. Milton Keynes) the zoning is coarse which reduces the reliability of traffic flows in the area;
- The level of link flow calibration and validation in the corridor area within Buckinghamshire is very good and meets TAG criteria;
- The journey time validation in the A421 Corridor area is very good and meets TAG criteria. However, Route 9 eastbound on the A421, in the PM peak hour, is outside the criteria with a difference of -23.5% between modelled and observed journey times. The under-estimation of delays in this area will need to be taken into account when considering the performance of the A421; and
- The forecast models have been developed in line with TAG guidance but have utilised NTEMv7.2 growth factors which have now been superseded by more recent guidance, which either needs to be taken into consideration or justification provided as to why not. The forecast matrices have also not been constrained which would have reduced the overall level of traffic flow.

The BSTM provides a suitable basis for the strategic modelling for the A421 corridor study. The existing 2040 forecast model is considered to represent a high level of traffic growth which will be taken into account in the development of the modelling approach for the A421 Corridor study.

The BSTM has a number of limitations as a highway-only model which are considered in Section 3.4 of this note.

3. A421 Corridor Study Modelling Approach

This section sets out the proposed modelling approach for the A421 Corridor Study. Modelling outputs will be used within the study for the following key purposes:

- Analysis of existing and future traffic conditions and traffic patterns on the A421 Corridor;
- Identification of potential areas for improvement; and
- Assessment of proposed improvement options.

3.1. Scenarios

The following scenarios will be used or developed for this study:

- 2019 Base Model – this represents existing conditions in 2019 and is an existing model. No changes are required;
- 2040 A421 Do Minimum (DM) Core Growth – this is a new scenario, which will be developed from the existing 2040 DM model, which includes additional developments and highway schemes in the key study area to provide improved accuracy of forecast traffic flows;
- 2040 A421 Do Something (DS1-2) Core Growth – this is a new scenario - as for 2040 A421 DM Core with the proposed A421 Corridor Study improvement schemes included. It is assumed that two DS options will be assessed with core growth;
- 2040 A421 Do Minimum (DM) Low Growth – this is a new scenario – the trip matrices in the 2040 A421 DM Core scenario will be reduced to provide a lower level of traffic growth. This scenario will provide a low growth sensitivity test; and
- 2040 A421 Do Something (DS1-2) Low Growth – this is a new scenario - as for 2040 A421 DM Low with the proposed A421 Corridor Study improvement schemes included. It is assumed that two DS options will be assessed with low growth.

Table 3-1 summarises the supply and demand assumptions for the scenarios to be used for this study.

Table 3-1 – Scenarios to be modelled

Scenario	Demand (matrices)	Supply (network)
2019 Base	2019 Base – no change to existing	2019 Base – no change to existing
2040 A421 Do Minimum (DM) **Core Growth**	2040 DM + Additional developments within A421 corridor	2040 DM + committed highway schemes within A421 corridor
2040 A421 DM **Low Growth**	2040 DM with overall traffic growth reduced[3]	2040 DM + committed highway schemes within A421 corridor
2040 A421 Do Something 1-2 (DS1-2) **Core Growth**	As for 2040 A421 DM Core	As for 2040 A421 DM Core + Proposed A421 Corridor improvement Schemes for DS Option1-2
2040 A421 DS 3-4 **Low Growth**	As for 2040 A421 DM Low Growth	As for 2040 A421 DM Low Growth + Proposed A421 Corridor improvement Schemes for DS Option 3-4

The 2040 forecast model scenarios include both core (i.e. standard NTEM growth) and low growth. The assumptions for these scenarios are discussed in more detail in the following sections. A high growth scenario option has not been considered as the traffic growth assumptions in the proposed core scenario are already higher than standard core growth due to the use of NTEMv7.2 for car trips background growth and

[3] See #3.4

unconstrained matrices. The core growth assumptions also do not consider any potential reductions in traffic growth due to COVID-19.

It is noted that not all DS options will be modelled for both Core and Low Growth.

The following sections provide more detail regarding the model scenarios.

3.2. 2019 Base Model

No changes are proposed for the 2019 base model which has a good level of validation in the A421 corridor area.

3.3. A421 DM Core Scenario

The 2040 A421 DM Core scenario will be an enhanced version of the existing 2040 DM model through the addition of extra developments and committed highway schemes within the A421 study area.

An updated uncertainty log for the A421 corridor area has been provided by BC which is included in Appendix D. Table 3-2 summarises the developments to be included within the A421 study area, including those which are already included in the existing 2040 BSTM DM. These developments include 'near certain', 'more than likely' and 'reasonably foreseeable' developments. It is noted that a core scenario would normally only include 'near certain' and 'more than likely' developments based on TAG but reasonably foreseeable developments are proposed to be included for this scenario to provide improved weighting of trips in the study area. Residential developments which are less than 50 dwellings have been excluded as they will be accounted for within background growth. The locations of the residential and employment developments are shown in Figures 3-1 and 3-2 respectively.

Table 3-2 – Proposed Developments in A421 Study Area

Site Ref	Site	Type	Dwellings	Employment Site Area	Uncertainty	Comment
1	Land to South West of Milton Keynes, North East Aylesbury	Mixed	1855	2.07ha	NC	Including in existing DM with different number of dwellings and no employment
2	Shenley Park, Whaddon	Residential	1150	-	RF	Including in existing DM
3	Land off Osier Way (south of A421 and east of Gawcott Road), Buckingham	Residential	420	-	NC	Including in existing DM
4	Land to east of B4033 Great Horwood Road, Winslow	Residential	335	-	NC	Including in existing DM with different number of dwellings
5	Land north of A421 Tingewick Road, Buckingham	Residential	398	-	NC	Including in existing DM with different number of dwellings
6	Above Rumbolds Well & next to Field Farm (I), Buckingham	Residential	100	-	RF	New

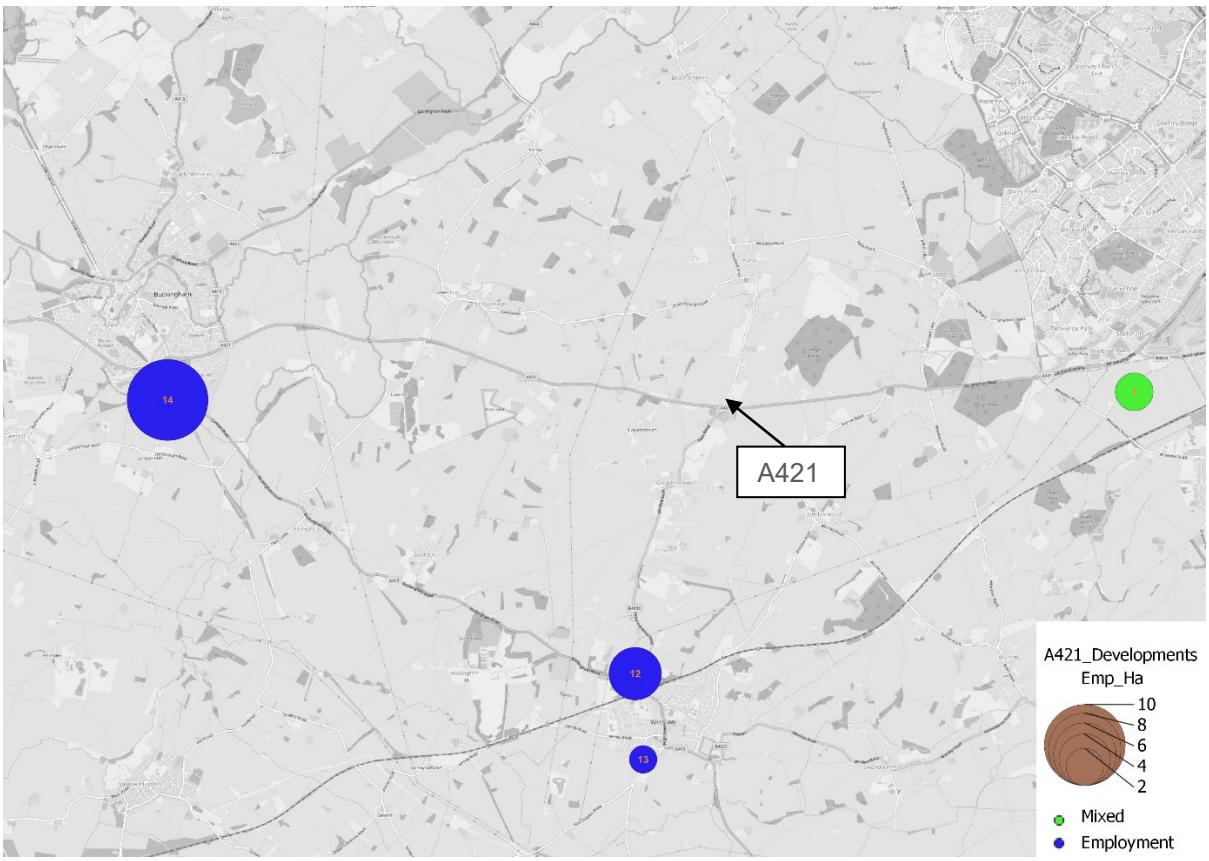
Site Ref	Site	Type	Dwellings	Employment Site Area	Uncertainty	Comment
7	Land West Of Moreton Road And Castlemilk, Buckingham	Residential	130	-	MTL	New
8	Land Off Walnut Drive And Foscote Road, Maids Moreton	Residential	163	-	NC	New
9	Land at Winslow Rugby Club, Winslow	Residential	55	-	RF	New
10	Land off Station Road, Winslow	Residential	63	-	MTL	New
11	Land South Of Buckingham Road Winslow Buckinghamshire	Residential	60	-	NC	New
12	North of Buckingham Road	Employment	0	4.2ha	RF	New
13	Tinkers End	Employment	0	1ha	RF	New
14	Land West of London Road, Buckingham	Employment	0	10ha	RF	New

(Note: NC = Near Certain, MTL = More than Likely, RF = Reasonably Foreseeable)

Figure 3-1 – Proposed Residential Developments Locations in A421 Study Area



Figure 3-2 – Proposed Employment Developments Locations in A421 Study Area



The forecast number of new trips generated by the new developments will be derived using Transport Assessments, where available, or the standard TRICS rates used in the development of the existing forecasts. For employment sites, it will be assumed that sites are evenly split between B1, B2 and B8 and that the Gross Floor Area (GFA) is 40% of the site area unless this information is provided in the TA. The trip distributions of new developments will be based on donor zones of a similar land use type in the local area.

In line with the existing 2040 BSTM DM, it is proposed to retain the use of NTEMv7.2 for the background growth factors and to keep the matrices unconstrained for a proportionate approach. The background growth will be adjusted to account for the additional households and jobs modelled explicitly using the alternative planning assumptions function. This approach will provide a robust assessment of the performance of the A421 corridor due to the resulting higher levels of traffic growth.

The following highway scheme will be included in this scenario as follows:

- Well Street width restriction and 7.5t Zonal town centre restriction with signage.

3.4. A421 DM Low Growth Scenario

A 2040 A421 DM Low Growth scenario will be developed from the A421 2040 DM Core scenario, as a sensitivity test, in line with TAG Unit M4. The guidance states the following:

- The proportion of base year demand to be removed (for low growth) is based on a parameter p which varies by mode. For highway demand at the national level, the value of p is 4%, reflecting uncertainty around annual forecasts from the National Transport Model (NTM), based on the macro-economic variables that influence the main drivers of travel demand.
- The proportion is calculated as follows:
    - for 1 year after the base year, proportion p of base year demand subtracted from the core scenario;

- for 36 or more years after the base year, proportion 6*p of base year demand subtracted from the core scenario;
- between 1 and 36 years after the base year, the proportion of base year demand should rise from p to 6*p in proportion with the square root of the years.

For the A421 Low Growth scenario the proportion of the base year demand to be removed would be 18.3%[4].

3.5. A421 DS Scenarios

The A421 DS scenarios will be developed by adding the proposed improvement options to the DM scenarios. It is expected that 3 to 4 DS options would be assessed as part of this study.

3.6. Model Outputs

Model outputs for the base and forecast modelled scenarios will include:

- Link flows (PCUs), Volume/Capacities, average speeds;
- Junction delays (for selected junctions); and
- Flow bundles (Select link analysis) and sectored matrices at 3 locations along the A421 to determine trip patterns.

3.7. Model Approach Limitations

Table 3-3 summarises the key limitations of the BSTM and the proportionate approach proposed for this study and the potential impact on the A421 Corridor Study modelling.

Table 3-3 – Model Approach Limitations

Limitations	Potential Impact for Study
No Variable Demand Model included in BSTM	The impact of redistribution of trips and mode shift due to the proposed scheme options cannot be assessed. The capacity improvements provided by the proposed options may be lower than modelled as the schemes could draw in additional traffic to the corridor.
No Public Transport or Active Modes included in BSTM	The impact of the scheme options on PT or active modes cannot be assessed.
No update to TAG Databook	The BSTM does not utilise the latest TAG Databook values of time and vehicle operating costs. This would only be expected to have a minor impact on route assignment as the BSTM does not include variable demand.
Impact of COVID-19 not accounted for in forecasts	COVID-19 is likely to have reduced overall growth in trip demand. As a result the core forecasts used for this assessment are likely to be robust.
Only one forecast year utilised for study.	The use of 2040 for this study will provide a good assessment of performance in the longer-term. The low growth assessment could act as a proxy for a more short-term assessment.
No ICA junction coding and coarse zoning outside Buckinghamshire	It will not be possible to use the BSTM to accurately assess the performance of junctions along the A421 in Milton Keynes or at its junction with the A43.

[4] Factor = SQRT(2040-2019)*4%

4. Summary

A review of the BSTM base and forecast models demonstrates that the model has a good level of network detail, calibration and validation in the key study area. It is considered that the BSTM provides a suitable platform for assessing existing and future traffic conditions in the A421 Corridor area and for assessing the impact of proposed improvement options.

A proportionate approach has been proposed for developing forecast scenarios for this study which includes developing an enhanced 2040 DM Core scenario with additional developments in the key study area. This scenario is considered to represent high levels of traffic growth due to the use of NTEMv7.2 growth factors (which are higher than the latest NTEMv8.0 factors), unconstrained matrices and no adjustments to account for COVID-19. A low growth scenario will be developed in line with TAG to provide a sensitivity test. A range of improvement schemes will be assessed using the model to determine their effectiveness and impact on the highway network.

Appendix A. 2040 BSTM DM Developments

Ref.	Description	District	Quantum of development		Likelihood
			Residential (Dwellings)	Commercial (Jobs)	
1	Princes Risborough Expansion	Wycombe	1,662	0	NC/MTL
2	Gomm Valley, High Wycombe	Wycombe	520	0	NC/MTL
3	Abbey Barn South, High Wycombe	Wycombe	550	0	NC/MTL
4	Land At Terriers Farm Kingshill Road, High Wycombe	Wycombe	500	0	NC/MTL
5	Bourne End, Hallands Farm	Wycombe	467	0	NC/MTL
6	Land off Amersham Road incl. Tralee Farm.	Wycombe	350	0	NC/MTL
7	Remainder of Leigh Street Employment Area	Wycombe	228	0	NC/MTL
8	Compair Broomwade, Hughenden Avenue, High Wycombe	Wycombe	260	0	NC/MTL
9	Lillys Walk	Wycombe	239	0	NC/MTL
10	Wycombe Sports Centre Marlow Hill High Wycombe	Wycombe	0	2,899	NC/MTL
11	Glory Park Avenue Wooburn Green Bucks	Wycombe	0	906	NC/MTL
12	Part of Gomm Valley and Ashwells, High Wycombe	Wycombe	0	667	NC/MTL
13	Wycombe Airpark (2)	Wycombe	0	391	NC/MTL
14	Staples, Queen Alexandra Road	Wycombe	0	292	NC/MTL
15	Stokenchurch business park expansion	Wycombe	0	251	NC/MTL
16	Land at Hampden Fields A	Aylesbury Vale	450	0	NC/MTL
17	Land at Hampden Fields B	Aylesbury Vale	1,050	0	NC/MTL
18	Land at Hampden Fields C	Aylesbury Vale	300	0	NC/MTL
19	Land at Hampden Fields D	Aylesbury Vale	0	171	NC/MTL
20	Land at Hampden Fields E	Aylesbury Vale	1,200	0	NC/MTL
21	Land at Hampden Fields F	Aylesbury Vale	0	1843	NC/MTL

Ref.	Description	District	Quantum of development		Likelihood
			Residential (Dwellings)	Commercial (Jobs)	
22	Land East Of Aylesbury (Kingsbrook) Broughton Crossing Bierton_Phase 1	Aylesbury Vale	615	0	NC/MTL
23	Land East Of Aylesbury (Kingsbrook) Broughton Crossing Bierton_Employment	Aylesbury Vale	0	402	NC/MTL
24	Land East Of Aylesbury (Kingsbrook) Broughton Crossing Bierton_Phase 2	Aylesbury Vale	623	0	NC/MTL
25	Land East Of Aylesbury (Kingsbrook) Broughton Crossing Bierton_Phase 3	Aylesbury Vale	719	0	NC/MTL
26	Site west of Far Bletchley, at the south western edge of Milton Keynes. Boundary A421 & A4034, disused railway and Whaddon Road. Adjoins residential of west Bletchley.	Aylesbury Vale	1,885	0	NC/MTL
27	Land between Oxford Road and Wendover Road 1	Aylesbury Vale	71	0	NC/MTL
28	Land between Oxford Road and Wendover Road 2	Aylesbury Vale	384	0	NC/MTL
29	Land between Oxford Road and Wendover Road 3	Aylesbury Vale	272	28	NC/MTL
30	Land between Oxford Road and Wendover Road 4	Aylesbury Vale	308	0	NC/MTL
31	Land between Oxford Road and Wendover Road 5	Aylesbury Vale	191	0	NC/MTL
32	Land between Oxford Road and Wendover Road 6	Aylesbury Vale	173	0	NC/MTL
33	Land between Oxford Road and Wendover Road 7	Aylesbury Vale	0	73	NC/MTL
34	Shenley Road	Aylesbury Vale	1,150	0	NC/MTL
35	AGT1_Land East of Lower road 1	Aylesbury Vale	750	0	NC/MTL
36	AGT1_Land East of Lower road 1a (school)	Aylesbury Vale	0	28	NC/MTL
37	AGT1_Land off Lower Road, Stoke Mandeville	Aylesbury Vale	125	0	NC/MTL
38	AGT1_South of Aylesbury	Aylesbury Vale	125	0	NC/MTL
39	Woodlands 1	Aylesbury Vale	530	0	NC/MTL
40	Woodlands 2	Aylesbury Vale	570	20	NC/MTL

Ref.	Description	District	Quantum of development		Likelihood
			Residential (Dwellings)	Commercial (Jobs)	
41	Woodlands 3	Aylesbury Vale	0	28	NC/MTL
42	Woodlands 4	Aylesbury Vale	0	391	NC/MTL
43	Woodlands 5	Aylesbury Vale	0	1,857	NC/MTL
44	Woodlands 6	Aylesbury Vale	0	172	NC/MTL
45	Woodlands 7	Aylesbury Vale	0	1,235	NC/MTL
46	Woodlands 8	Aylesbury Vale	0	353	NC/MTL
47	Woodlands 9 (recreation area)	Aylesbury Vale	0	0	NC/MTL
48	Woodlands 10	Aylesbury Vale	0	122	NC/MTL
49	RAF Halton 1	Aylesbury Vale	250	0	NC/MTL
50	RAF Halton 2	Aylesbury Vale	250	0	NC/MTL
51	RAF Halton 3	Aylesbury Vale	250	0	NC/MTL
52	RAF Halton 4	Aylesbury Vale	250	0	NC/MTL
53	Land off Osier Way (south of A421 and east of Gawcott Road) Buckingham,	Aylesbury Vale	420	0	NC/MTL
54	Manor Farm, land south of GU Canal Aylesbury Arm	Aylesbury Vale	350	0	NC/MTL
55	Land to east of B4033, Great Horwood Road	Aylesbury Vale	315	0	NC/MTL
56	Land north of Rosemary Lane	Aylesbury Vale	273	0	NC/MTL
57	Aston Clinton MDA 1	Aylesbury Vale	386	0	NC/MTL
58	Aston Clinton MDA 2	Aylesbury Vale	0	486	NC/MTL
59	College Farm, Aylesbury (part of AGT3)	Aylesbury Vale	250	0	NC/MTL
60	Berryfields Major Development Area (MDA) Aylesbury 1	Aylesbury Vale	678	0	NC/MTL
61	Berryfields Major Development Area (MDA) Aylesbury 2	Aylesbury Vale	0	209	NC/MTL

Ref.	Description	District	Quantum of development		Likelihood
			Residential (Dwellings)	Commercial (Jobs)	
62	Rabans Lane adj railway ln 1	Aylesbury Vale	200	0	NC/MTL
63	Rabans Lane adj railway ln 2	Aylesbury Vale	0	148	NC/MTL
64	Arla	Aylesbury Vale	0	1,889	NC/MTL
65	Silverstone	Aylesbury Vale	0	4,152	NC/MTL
66	Land North Of A421 Tingewick Road, Buckingham	Aylesbury Vale	450	0	NC/MTL
67	Wilton Park 1	South Bucks	304	0	NC/MTL
68	Wilton Park 2	South Bucks	0	101	NC/MTL
69	SP BP11- Area North of Iver Station 1	South Bucks	1,200	0	NC/MTL
70	SP BP11- Area North of Iver Station 2	South Bucks	0	359	NC/MTL
71	SP BP11- Area North of Iver Station 3	South Bucks	0	45	NC/MTL
72	Pinewood 1	South Bucks	0	759	NC/MTL
73	Pinewood 2	South Bucks	0	277	NC/MTL

(Key: NC = Near Certain, MTL = More Than Likely)

Appendix B. 2040 BSTM DM Highway Schemes

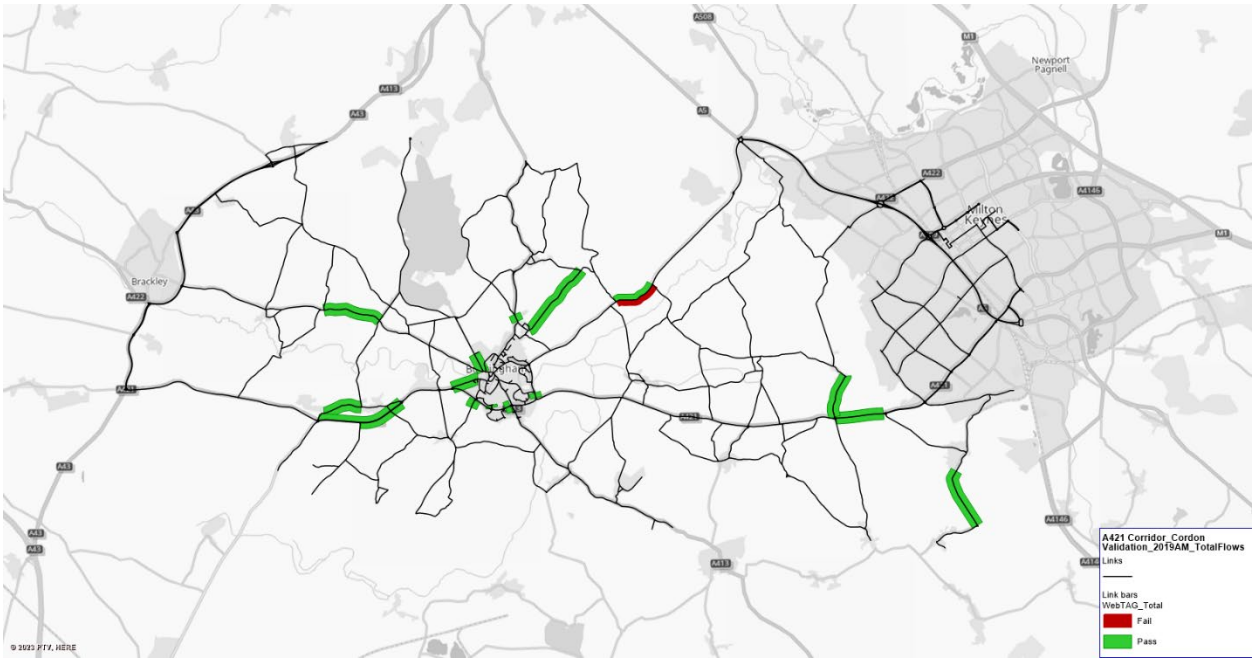
Scheme Name	Description	Location	Likelihood
Eastern Link Road (North)	Road scheme	Aylesbury Vale	Certain
Eastern Link Road (South)	Road scheme	Aylesbury Vale	Near Certain
Southern Link Road	Road scheme	Aylesbury Vale	Near Certain
SEALR	Road scheme	Aylesbury Vale	Near Certain
Stoke Mandeville Bypass	Road scheme	Aylesbury Vale	Near Certain
South Western Link Road	Road scheme	Aylesbury Vale	More than likely
Stocklake Road	Road scheme	Aylesbury Vale	Certain
Gomm Valley Spine Road	Road scheme	Wycombe	More than likely
Holland Farm Spine Road	Road scheme	Wycombe	More than likely
Princes Risborough Infrastructure Package	Road scheme	Wycombe	More than likely
A355 Relief Road	Road scheme	South Bucks	Certain
M4 Smart Motorway	Road scheme	South Bucks	Near Certain
Hollow Hill Lane	Road closure	South Bucks	More than likely
Seven Hills Improvement	Road scheme	South Bucks	More than likely
Iver Relief Road	Road scheme	South Bucks	More than likely

Appendix C. Calibration and Validation Plots

AM Peak Hour – Car Calibration and Validation



AM Peak Hour – Total Vehicle Calibration and Validation



Inter-Peak – Car Calibration and Validation



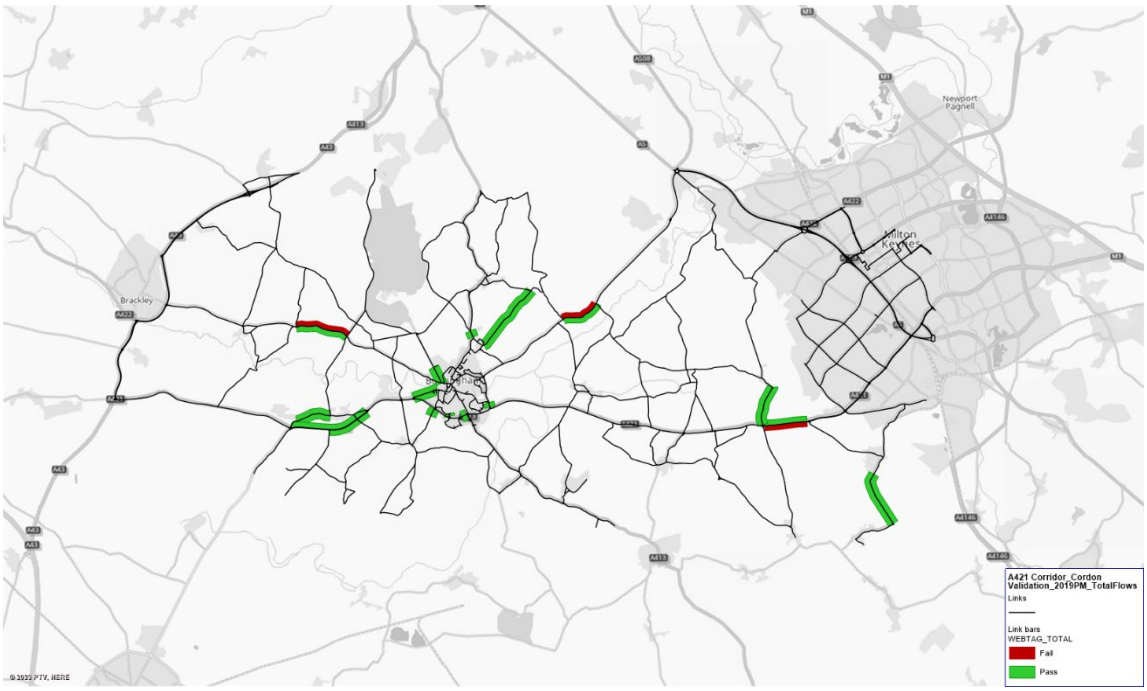
Inter-Peak – Total Vehicle Calibration and Validation



PM Peak Hour – Car Calibration and Validation



PM Peak Hour – Total Vehicle Calibration and Validation



Appendix D. Uncertainty Log

Development name	Planning references	Local / Neighbourhood Plan References	No. of dwellings	B1 floorspace	B2 floorspace	B8 floorspace	Employment area (ha)	Uncertainty status
Land to South West of Milton Keynes, North East Aylesbury	15/00314/AOP	NLV001	1855	-	-	-	2.07	Near certain
Shenley Park, Whaddon		WHA001	1150	0	0	0	0	Reasonably foreseeable
Land off Osier Way (south of A421 and east of Gawcott Road), Buckingham	19/00148/AOP 22/02689/ADP	BUC046	420	0	0	0	0	Near certain
Land to east of B4033 Great Horwood Road, Winslow	19/03482/AOP 21/04649/ADP 18/03422/AOP	WIN001	335	0	0	0	0	Near certain
Silverstone	17/01840/AOP 19/00532/ADP	E10	0	1000	0	0	-	N/A
Land north of A421 Tingewick Road, Buckingham	15/01218/AOP 17/04668/ADP 20/00885/ADP 20/00886/ADP		398	0	0	0	0	Near certain
Above Rumbolds Well & next to Field Farm (I), Buckingham		Buckingham Neighbourhood Plan (2015) - Site I	100	0	0	0	0	Reasonably foreseeable
Land at corner of Well and Bridge Streets (K), Buckingham		Buckingham Neighbourhood Plan (2015) - Site K	28	0	0	0	0	Reasonably foreseeable
St Rumbolds Well(J), Buckingham		Buckingham Neighbourhood Plan (2015) - Site J	39	0	0	0	0	Reasonably foreseeable
Land Adj 73 Moreton Road, Buckingham	15/04106/AOP 19/00902/ADP		13	0	0	0	0	More than likely
Land West Of Moreton Road And Castlemilk, Buckingham	20/00510/APP	Local Plan allocation (2021) - BUC043	130	0	0	0	0	More than likely
Land Off Gorrell Lane, Tingewick	17/01364/APP		12	0	0	0	0	Near certain
Land At Scotts Farm, Towcester Road, Maids Moreton	18/01385/AOP 21/02661/ADP	Local Plan allocation (2021) - MMO006	12	0	0	0	0	Near certain
Land Off Walnut Drive And Foscote Road, Maids Moreton	16/00151/AOP 23/01636/ADP		163	0	0	0	0	Near certain
Land at Winslow Rugby Club, Winslow		Winslow Neighbourhood Plan (2023) - Policy 2	55	0	0	0	0	Reasonably foreseeable
Land South Of Tinkers Drive, Winslow	18/04162/APP	Winslow Neighbourhood Plan (2014) - Site Policy 3 Ref 3(iii)	24	0	0	0	0	Near certain
Land off Station Road, Winslow	18/04590/APP	Winslow Neighbourhood Plan (2014) - Station Road	63	0	0	0	0	More than likely
Land South Of Buckingham Road Winslow Buckinghamshire	20/03556/AOP		60	0	0	0	0	Near certain
Cobb Hall Road, Newton Longville	15/02242/AOP		15	0	0	0	0	More than likely

Development name	Planning references	Local / Neighbourhood Plan References	No. of dwellings	B1 floorspace	B2 floorspace	B8 floorspace	Employment area (ha)	Uncertainty status
North of Buckingham Road		Winslow Neighbourhood Plan (2023) - Policy 5b	0	-	-	-	4.2	Reasonably foreseeable
Tinkers End		Winslow Neighbourhood Plan (2023) - Policy 5c	0	-	-	-	1	Reasonably foreseeable
Land West of London Road, Buckingham		Winslow Neighbourhood Plan (2015) - Site Q, Policy EE1	0	-	-	-	10	Reasonably foreseeable

TECHNICAL NOTE

A421 Corridor Study Junction Modelling

SUBJECT	PROJECT NO.	DATE
A421 Junctions 10 and LinSig modelling summary	5222660.904	3 December 2024

AUTHOR	DISTRIBUTION	REPRESENTING
AtkinsRéalis		

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	First Draft	LB				Dec 2024

TECHNICAL NOTE

1. Introduction

1.1 Background

Buckinghamshire Council has commissioned AtkinsRéalis to undertake a junction modelling assessment for six junctions along the A421 Corridor. The six junctions are all roundabouts and are located along the A421 between Buckingham and Milton Keynes. These junctions are:

- H-J1 - A421 / Osier Way (Aldi);
- H-J2 - A421 / London Road;
- H-J4 - A421 / A413;
- H-J5 - A421 / B4033 / Winslow Road;
- HJ-8 - A421 / Coddimoor Lane / Whaddon Road; and
- HJ-9 - A421 / Standing Way / Whaddon Road (Bottledump roundabout).

1.2 Purpose of this Note

This note presents a results summary of the junction modelling undertaken for the six roundabouts on the A421. All junctions were initially modelled in Junctions 10 (ARCADY) with an additional three (H-J5, H-J8 and H-J9) also being modelled in LinSig to see if a signalised roundabout option would be beneficial.

TECHNICAL NOTE

2. A421 Junctions 10 modelling summary

2.1 H-J1: Aldi/Osier Way roundabout

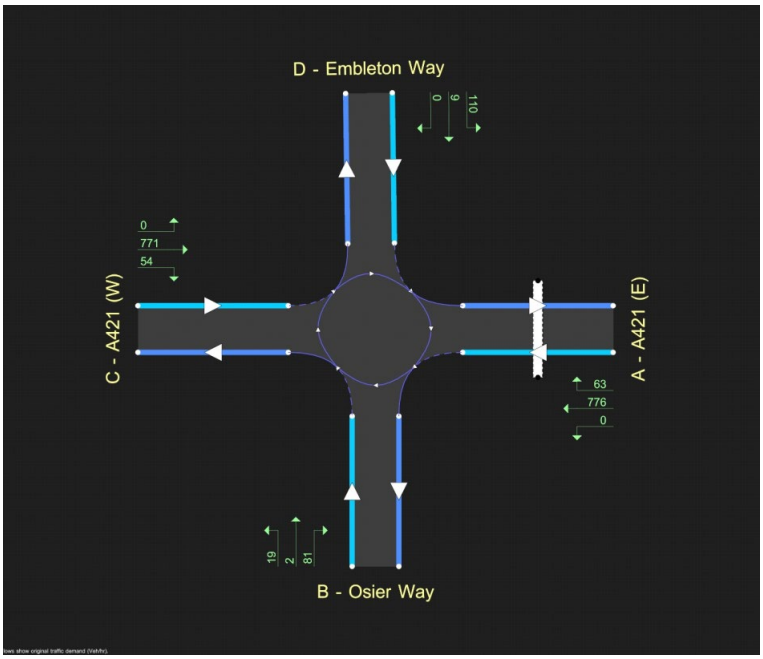


Figure 1 – H-J1: Aldi/Osier Way - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – A421 East	1.5	0.60	0.8	0.46	1.6	0.61
	Arm B – Osier Way	0.1	0.13	0.1	0.08	0.5	0.32
	Arm C – A421 West	1.6	0.61	1.0	0.51	1.7	0.63
	Arm D – Embleton Way	0.2	0.14	0.0	0.02	0.1	0.11
2040 Do Minimum	Arm A – A421 East	1.8	0.65	1.2	0.55	1.9	0.66
	Arm B – Osier Way	0.5	0.35	0.4	0.29	1.8	0.64
	Arm C – A421 West	2.4	0.71	1.4	0.59	3.1	0.76
	Arm D – Embleton Way	0.3	0.23	0.1	0.07	0.2	0.19

Table 1 – H-J1: Aldi/Osier Way roundabout - Junctions 10 Results

No capacity issues at this roundabout in any of the modelled scenarios.

2.2 H-J2: London Road roundabout

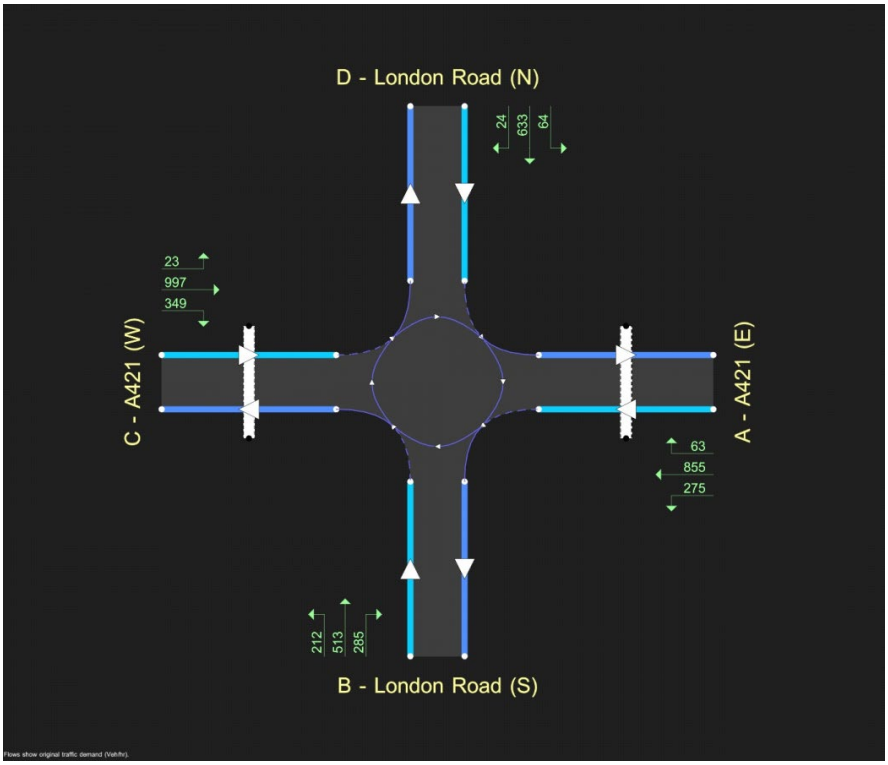


Figure 2 – H-J2: London Road roundabout - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – A421 East	3.3	0.77	1.1	0.53	2.7	0.74
	Arm B – London Road (S)	1.8	0.64	0.6	0.39	1.3	0.57
	Arm C – A421 West	1.1	0.53	0.7	0.40	1.3	0.57
	Arm D – London Road (N)	0.8	0.46	0.4	0.30	0.8	0.46
2040 Do Minimum	Arm A – A421 East	15.5	0.96	1.9	0.66	5.8	0.86
	Arm B – London Road (S)	4.5	0.83	1.0	0.49	2.0	0.67
	Arm C – A421 West	1.9	0.66	1.0	0.51	2.6	0.73
	Arm D – London Road (N)	1.4	0.58	0.6	0.36	1.7	0.63
2040 Do Something	Arm A – A421 East	1.5	0.61	0.7	0.41	1.2	0.54
	Arm B – London Road (S)	4.6	0.83	1.0	0.50	2.0	0.67
	Arm C – A421 West	1.9	0.66	1.0	0.51	2.6	0.73
	Arm D – London Road (N)	1.4	0.58	0.6	0.36	1.7	0.63

Table 2 – H-J2: London Road roundabout - Junctions 10 Results

There are capacity issues at this roundabout in the 2040 Do Minimum scenario but these are rectified in the 2040 Do Something scenario.

2.3 H-J4: A421/A413 roundabout

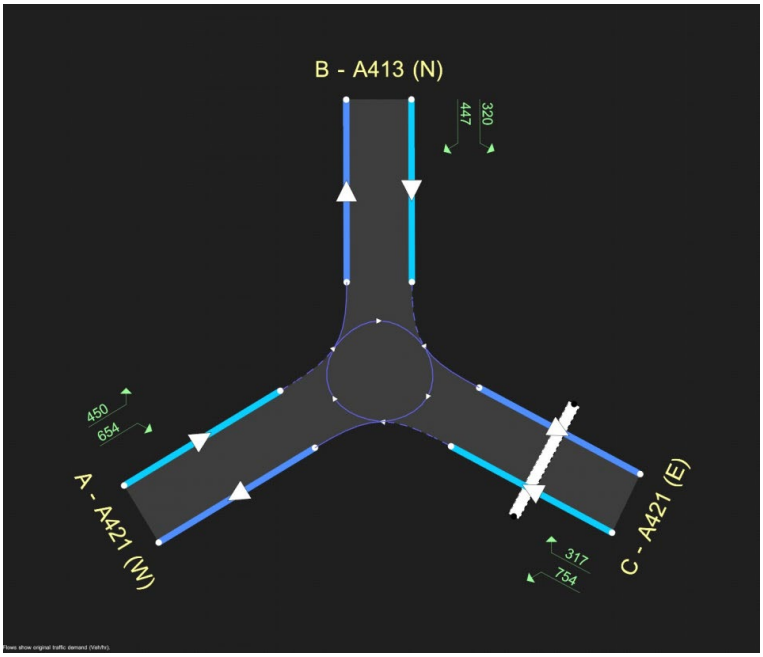


Figure 3 – H-J4: A421/A413 roundabout - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – A421 West	2.2	0.69	0.7	0.40	1.3	0.57
	Arm B – A413 (N)	1.8	0.64	0.4	0.27	0.8	0.44
	Arm C – A421 East	2.0	0.67	0.7	0.41	1.8	0.65
2040 Do Minimum	Arm A – A421 East	4.2	0.81	0.9	0.48	2.1	0.68
	Arm B – A413 (N)	4.3	0.82	0.5	0.32	1.4	0.58
	Arm C – A421 West	5.1	0.84	1.1	0.53	2.6	0.73
2040 Do Something	Arm A – A421 East	1.4	0.58	0.5	0.35	1.0	0.49
	Arm B – A413 (N)	4.2	0.82	0.5	0.32	1.4	0.58
	Arm C – A421 West	1.3	0.57	0.5	0.35	1.0	0.49

Table 3 – H-J4: A421/A413 roundabout - Junctions 10 Results

No capacity issues at this roundabout in any of the modelled scenarios.

2.4 H-J5: A421/B4033/Winslow Road roundabout

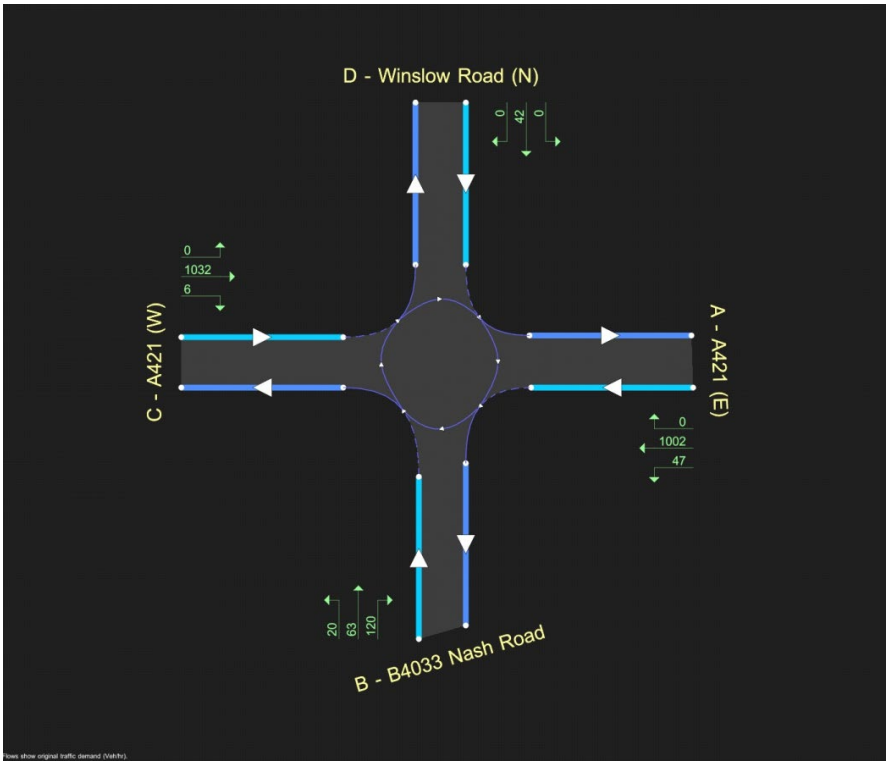


Figure 4 – H-J5: A421/B4033/Winslow Road roundabout - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – A421 East	2.4	0.71	1.2	0.55	3.3	0.77
	Arm B – B4033 Nash Road	0.4	0.28	0.1	0.11	0.3	0.25
	Arm C – A421 West	5.4	0.85	1.1	0.53	2.6	0.72
	Arm D – Winslow Road	0.1	0.07	0.0	0.02	0.0	0.03
2040 Do Minimum	Arm A – A421 East	6.6	0.88	2.7	0.73	5.0	0.84
	Arm B – B4033 Nash Road	2.7	0.74	0.4	0.30	1.3	0.57
	Arm C – A421 West	11.5	0.94	2.1	0.68	6.5	0.88
	Arm D – Winslow Road	0.1	0.11	0.0	0.03	0.1	0.12
2040 Do Something	Arm A – A421 East	5.8	0.86	2.5	0.72	4.5	0.82
	Arm B – B4033 Nash Road	2.4	0.71	0.4	0.29	1.2	0.55
	Arm C – A421 West	1.2	0.54	0.7	0.40	1.0	0.51
	Arm D – Winslow Road	0.1	0.10	0.0	0.03	0.1	0.11

Table 4 – H-J5: A421/B4033/Winslow Road roundabout - Junctions 10 Results

There are capacity issues at this roundabout in the 2040 Do Minimum scenario but these are mostly rectified in the 2040 Do Something scenario.

2.5 H-J8: Whaddon (Coddimoor Lane) roundabout

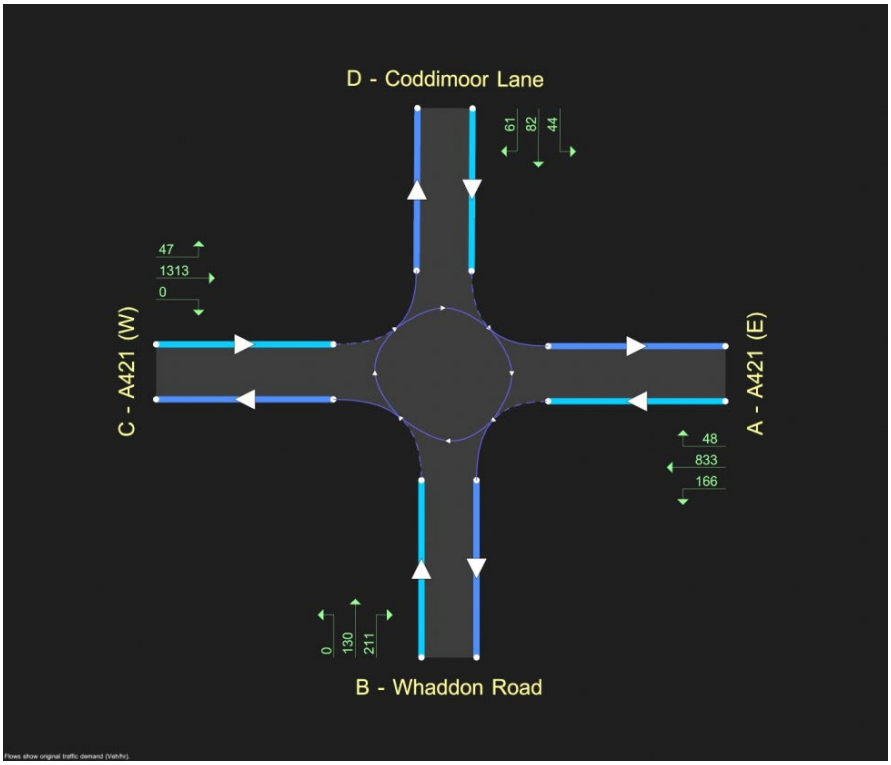


Figure 5 – H-J8: Whaddon (Coddimoor Lane) roundabout - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – A421 East	5.2	0.85	2.3	0.70	131.9	1.18
	Arm B – Whaddon Road	1.2	0.55	0.5	0.34	1.2	0.55
	Arm C – A421 West	107.4	1.15	1.5	0.61	6.2	0.87
	Arm D – Coddimoor Lane	0.8	0.45	0.2	0.17	2.7	0.74
2040 Do Minimum	Arm A – A421 East	190.8	1.25	14.0	0.95	289.2	1.35
	Arm B – Whaddon Road	2.3	0.70	0.9	0.48	2.3	0.71
	Arm C – A421 West	200.3	1.27	4.9	0.84	142.9	1.20
	Arm D – Coddimoor Lane	1.1	0.54	0.4	0.30	16.9	1.02
2040 Do Something	Arm A – A421 East	2.2	0.69	1.1	0.53	2.6	0.72
	Arm B – Whaddon Road	4.2	0.82	0.8	0.45	6.2	0.89
	Arm C – A421 West	2.5	0.71	0.9	0.47	2.0	0.67
	Arm D – Coddimoor Lane	2.2	0.70	0.4	0.28	40.9	1.20

Table 5 – H-J8 Whaddon (Coddimoor Lane) roundabout - Junctions 10 Results

This roundabout is overcapacity in the 2019 Base and 2040 Do Minimum.

The 2040 Do Something scenario does provide notable improvement but the modelling indicates that the Coddimoor Lane arm will still operate overcapacity with a RFC of 1.20 and a queue of 40.9 vehicles in the PM period. The Whaddon Road arm also operates overcapacity in the PM period with a RFC of 0.89, although the queuing on this arm is 6.2 vehicles which is deemed acceptable.

2.6 H-J9: Bottledump roundabout

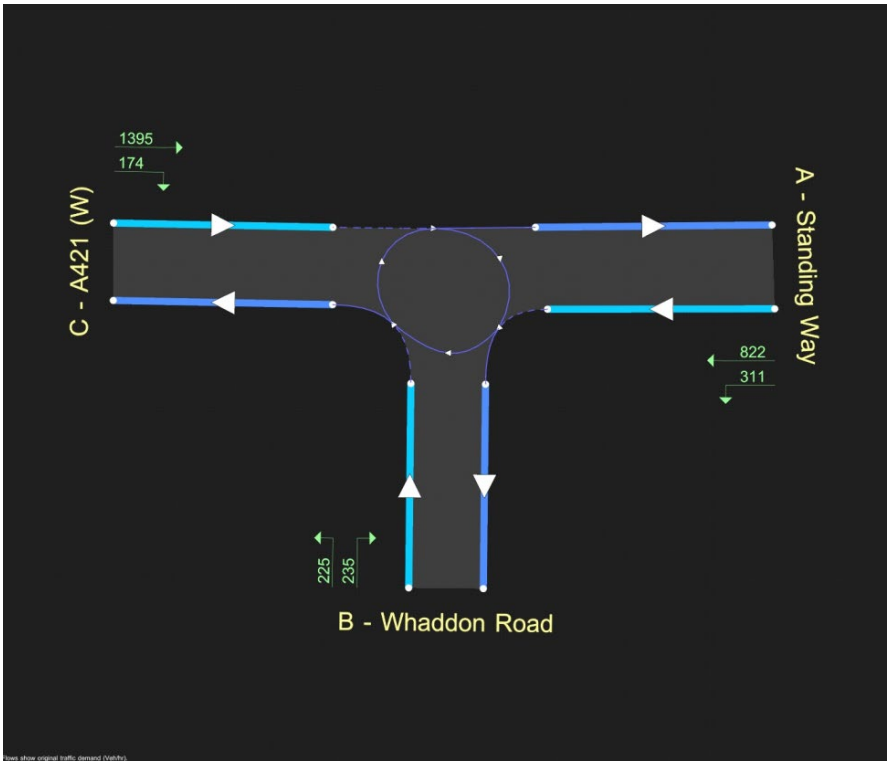


Figure 6 – H-J9: Bottledump roundabout - indicative model layout

	Link	AM peak hour		Average inter-peak		PM peak hour	
		Queue (Veh)	RFC	Queue (Veh)	RFC	Queue (Veh)	RFC
2019 Base	Arm A – Standing Way	2.3	0.70	1.3	0.57	10.9	0.93
	Arm B – Whaddon Road	0.7	0.41	0.4	0.30	1.0	0.49
	Arm C – A421 West	89.2	1.10	1.9	0.66	16.2	0.96
2040 Do Minimum	Arm A – Standing Way	7.2	0.89	4.1	0.81	131.2	1.13
	Arm B – Whaddon Road	6.7	0.88	1.0	0.51	2.7	0.73
	Arm C – A421 West	261.6	1.30	7.9	0.90	283.7	1.32
2040 Do Something	Arm A – Standing Way	8.2	0.90	4.0	0.81	151.6	1.16
	Arm B – Whaddon Road	5.9	0.87	1.0	0.51	2.4	0.71
	Arm C – A421 West	5.2	0.84	1.4	0.59	5.6	0.85

Table 6 – H-J9: Bottledump roundabout - Junctions 10 Results

This roundabout is overcapacity in the 2019 Base and 2040 Do Minimum.

The 2040 Do Something scenario does provide improvement on the A421 West arm but the modelling indicates that the Standing Way arm will still operate overcapacity with a RFC of 1.16 and a queue of 151.6 vehicles in the PM period.

3. A421 LinSig modelling summary

3.1 H-J5 A421/B4033/Winslow Road roundabout

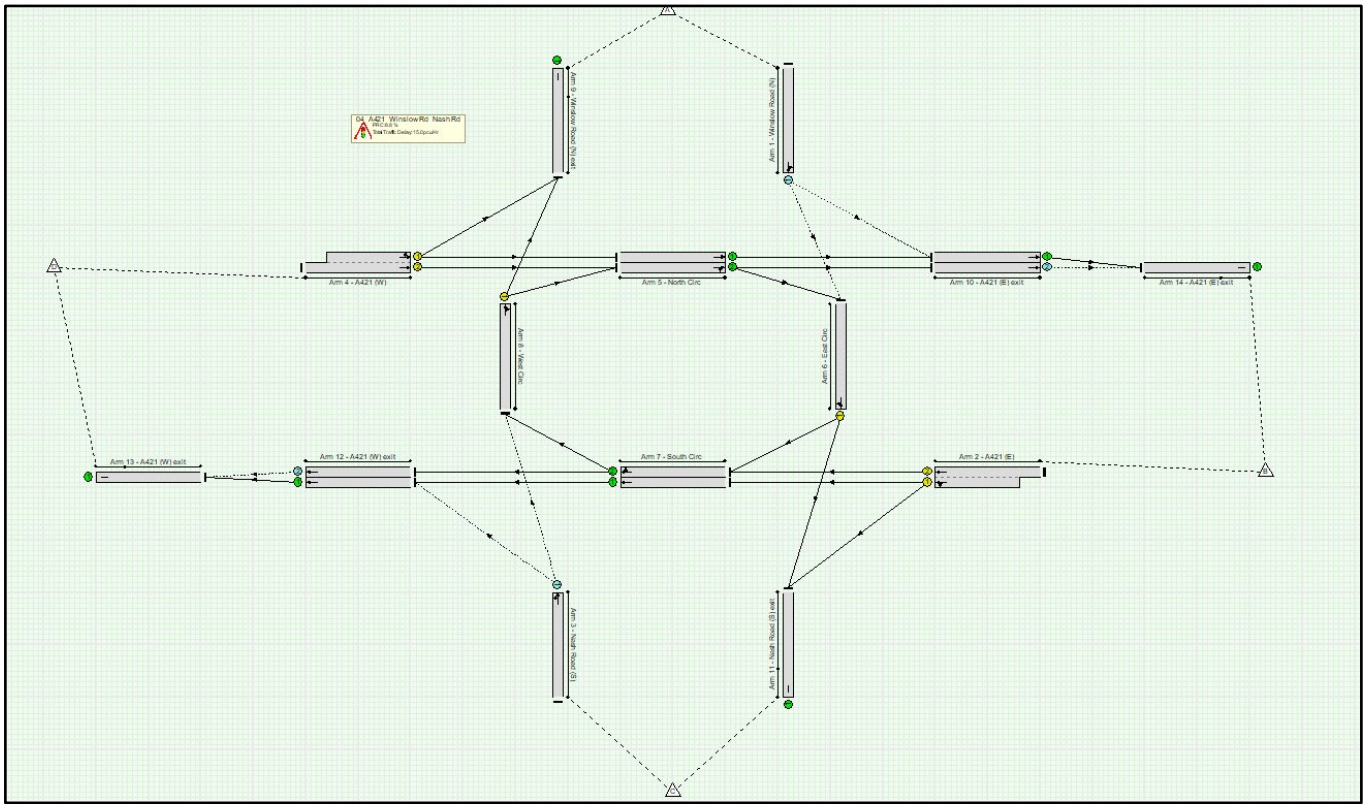


Figure 7 – H-J5 A421/B4033/Winslow Road - indicative model layout (LinSig)

2040 Do Something	AM peak hour		Average inter-peak hour		PM peak hour	
	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)
Arm A – A421 East	76.5%	11.7	62.9%	8.0	73.4%	10.7
Arm B – B4033 Nash Road	65.0%	2.8	24.6%	0.2	47.7%	0.8
Arm C – A421 West	84.1%	16.3	62.2%	8.6	82.0%	15.0
Arm D – Winslow Road	6.6%	0.0	1.9%	0.0	7.7%	0.0
	PRC 7.0%		**PRC 43.0%**		**PRC 8.8%**	
	Delay 16.75 pcuHr		**Delay 7.94 pcuHr**		**Delay 15.03 pcuHr**	

Table 7 – H-J5 A421/B4033/Winslow Road roundabout - LinSig Results

The results of the 2040 Do Something (with traffic signals) scenario indicate that the junction would operate within capacity. However, the east and west circulatory lanes would have peak hour queue lengths of 7 PCUs when there is only storage available for 2 PCUs. Therefore, this would cause blocking back on the junction to the detriment of the

A421 mainline eastbound and westbound flows. For this reason it is not recommended to introduce traffic signals at this junction.

3.2 H-J8 Whaddon (Coddimoor Lane) roundabout

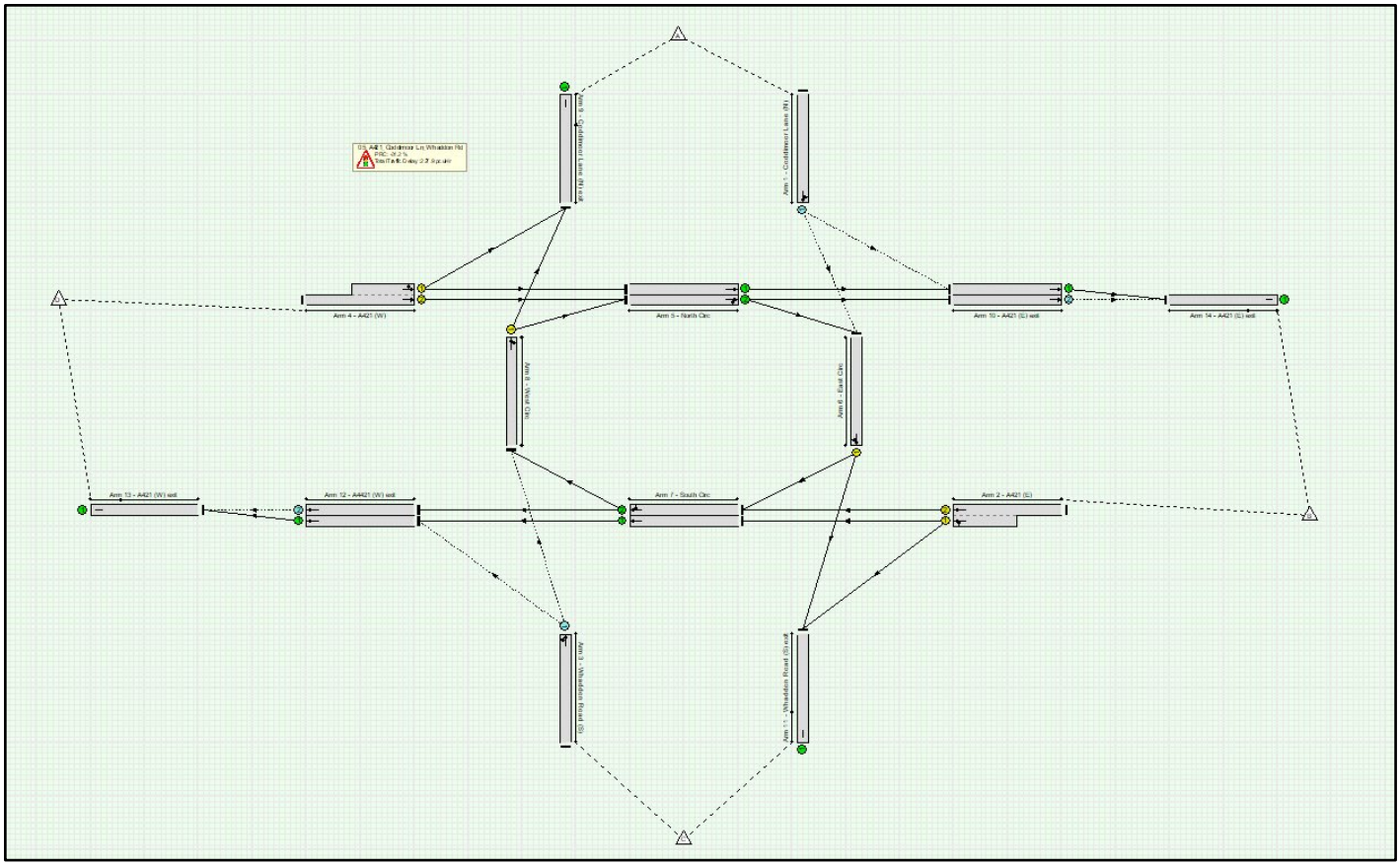


Figure 8 – H-J8 Whaddon (Coddimoor Lane) roundabout - indicative model layout (LinSig)

2040 Do Something	AM peak hour		Average inter-peak hour		PM peak hour	
	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)
Arm A – A421 East	106.7%	84.5	80.8%	13.4	112.9%	125.8
Arm B – Whaddon Road	40.6%	0.3	29.8%	0.2	45.5%	0.4
Arm C – A421 West	118.1%	149.9	79.6%	13.7	116.9%	135.8
Arm D – Coddimoor Lane	24.8%	0.2	15.7%	0.1	44.6%	0.4
	PRC -31.2%		**PRC 11.4%**		**PRC -29.9%**	
	Delay 227.93 pcuHr		**Delay 15.00 pcuHr**		**Delay 272.48 pcuHr**	

Table 8 - H-J8 Whaddon (Coddimoor Lane) roundabout - LinSig Results

TECHNICAL NOTE

The results of the 2040 Do Something (with traffic signals) scenario indicate that the junction would operate over capacity with long queues of over 100 PCUs on the A421 East and West arms. There are also issues with the east and west circulatory lanes which only have storage available for 2 PCUs. Such small storage capacity would cause blocking back on the junction to the detriment of the A421 mainline eastbound and westbound flows. Therefore, it is not recommended to introduce traffic signals at this junction.

3.3 H-J9 Bottledump roundabout

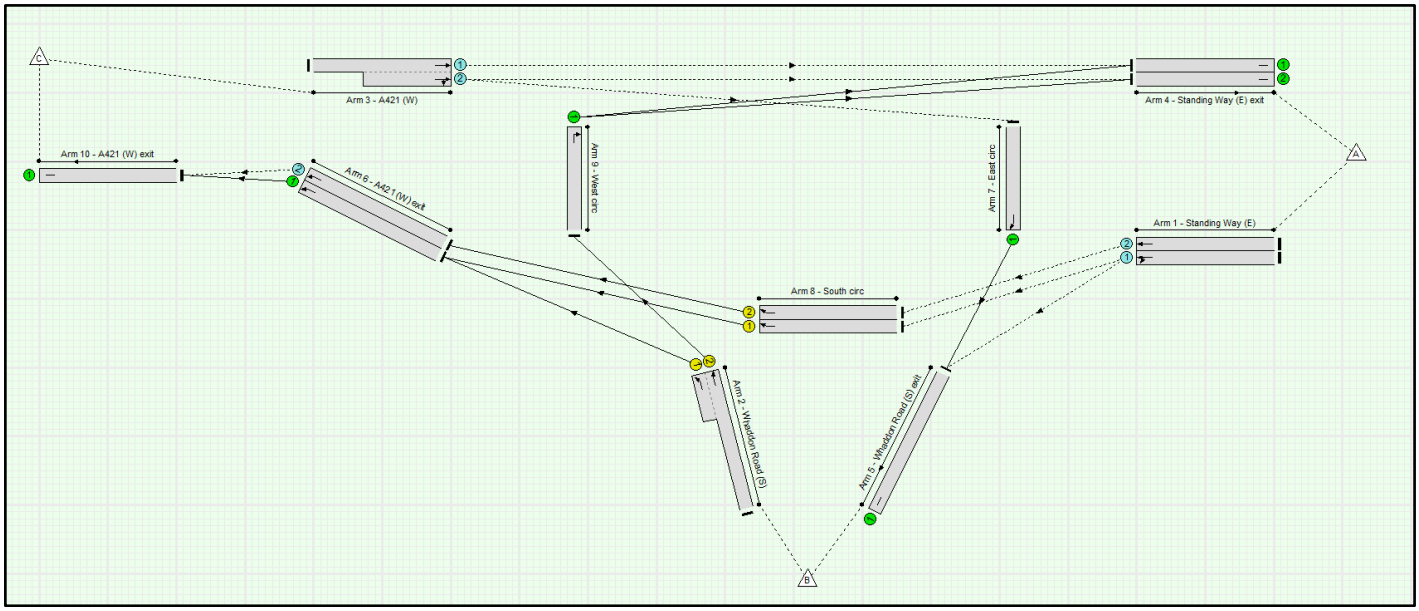


Figure 9 – H-J9 Bottledump roundabout - indicative model layout (LinSig)

2040 Do Something	AM peak hour		Average inter-peak hour		PM peak hour	
	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)	DoS%	MMQ (PCU)
Arm A – Standing Way	84.7%	2.7	76.6%	1.6	101.7%	63.4
Arm B – Whaddon Road	83.9%	9.7	68.6%	5.3	77.0%	8.6
Arm C – A421 West	100.7%	55.9	69.3%	3.5	104.0%	76.0
	PRC -11.9%		**PRC 17.4%**		**PRC -20.4%**	
	Delay 51.01 pcuHr		**Delay 14.14 pcuHr**		**Delay 168.89 pcuHr**	

Table 9 – H-J9 Bottledump roundabout - LinSig Results

The results of the 2040 Do Something (with traffic signals) scenario indicate that the junction would operate over capacity with long queues of over 50 PCUs on the A421 East and West arms. There is also an issue with the westbound circulatory lane which only has storage available for 2 PCUs. Such small storage capacity would cause blocking back on the junction. Therefore, it is not recommended to introduce traffic signals at this junction.

4. Summary

This technical note has presented a results summary of the junction modelling undertaken for six roundabouts on the A421 between Buckingham and Milton Keynes. All junctions were initially modelled in Junctions 10 (ARCADY) with an additional three (H-J5, H-J8 and H-J9) also being modelled in LinSig to see if a signalised roundabout option would be beneficial.

4.1 Junctions 10 (ARCADY)

The 2040 Do Something scenarios indicated that J1 to J4 will operate within capacity. They also showed that while J5 and J6 will operate better in the 2040 Do Something they will still be operating over capacity.

4.2 LinSig

J4 to J6 were each modelled in LinSig but all junction models showed longer queuing within the circulatory lanes than was physically present. This means blocking back on the junctions would occur to the detriment of the A421 mainline eastbound and westbound flows. The LinSig modelling also showed that it does not create any notable benefit over the Junctions 10 modelling and so it is not recommended to signalise these junctions.