Local Plan for Buckinghamshire

Initial transport impacts assessment

Buckinghamshire Council

March 2024

Final Report

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Background and purpose

Buckinghamshire Council is preparing the first Local Plan covering the whole county. The new Local Plan will set out where and how development will be permitted during the period 2021 to 2045. It will be used by the Council in deciding whether to permit or refuse planning applications for all kinds of development.

To inform the development of the new Local Plan, this study has forecast the possible transport impacts of housing and employment growth as set out in the existing former Buckinghamshire districts Local Plans and existing planning commitments made by the former district councils or by Buckinghamshire Council. This shows the transport impacts of what would happen to the network without a new Local Plan.

Specifically, the study has:

- forecast traffic levels, congestion, and vehicle emissions in 2045; and
- examined the potential for public transport to cater for some of the demand for travel to or from existing site allocations and existing planning commitments.

This assessment will be used to inform whether there is sufficient capacity within the highway network to meet the forecast demand arising from future site allocations in the new Local Plan.

Approach to traffic forecasting

Chapter 2 describes in detail the techniques and assumptions made in forecasting 2045 traffic.

All traffic forecasting was undertaken using the Buckinghamshire Strategic Traffic Model (BSTM) which is a strategic highway model covering the whole county and beyond. The model is owned and maintained by Buckinghamshire Council. The base year for the model is 2019, using a wide range of data and using approaches in line with Department for Transport guidance.

The BSTM predicts the routing of traffic on the highway network. The overall volume of traffic is determined by base year observed data, forecasts of underlying traffic growth in the UK, and by assumptions made about specific developments in Buckinghamshire.

The model is an 'assignment only' model. In other words, it does not consider re-timing of highway journeys, changes in overall highway travel demand due to changes in highway capacity, or people changing mode of travel (for example, to or from public transport or active modes). The model forecasts traffic in 2045 in the morning and evening peak hours and an average inter-peak hour.

The forecast model includes 'near certain' and 'more than likely' land use developments and highway improvement schemes. Major developments in the existing Local Plans (i.e., reasonably foreseeable developments) have also been included. The highway improvement schemes include the South East, Eastern and Southern Aylesbury Link Roads.

2019 traffic levels and highway network performance

Chapter 3 describes the performance of the highway network in 2019 according to the BSTM.

The highest traffic volumes are predicted to occur within the main towns (Buckingham, Aylesbury, High Wycombe and Amersham) and on routes to/from these locations (see Figure 3-1 and Figure 3-2). These routes include the A421 between Buckingham and Milton Keynes; the A41 between Aylesbury and Hemel Hempstead; the A355 between Amersham and Beaconsfield; and the M40 through Buckinghamshire.

Traffic congestion is measured as the difference between the average predicted journey time and the 'free flow' journey time (i.e. the time without any delays). According to the BSTM, some journeys take over 40% longer than in free-flow conditions (see Table 3-1 and Table 3-2). These results are based on journeys between 18 key locations. The locations where congestion is forecast to have a particular impact on the delays shown are:

- the High Wycombe / A404 / Marlow area;
- on routes into Aylesbury – including the A41 east-west and A418 towards Thame;
- in the Watford/ South-West Hertfordshire and South-East Buckinghamshire area; and
- on the M1, M25 and M4.

2045 traffic levels and highway network performance

Chapter 4 describes the forecast traffic levels and performance of the highway network in 2045 and how these are different from 2019.

Traffic levels

In the scenario tested, the total number of journeys on the highway network is forecast to increase by a third between 2019 and 2045 and total distance travelled by a quarter (see Table 4-1, Table 4-2, and Table 4-3). These figures include traffic on motorways and traffic travelling through Buckinghamshire and are broadly comparable to the South East average.

Excluding motorways, the largest absolute increases in traffic levels are forecast on the A41 east of Aylesbury, Bellingham Way in Aylesbury, and on the A4010 Risborough Road between Aylesbury and Princes Risborough (see Table 4-4). Traffic in Aylesbury is also significantly affected by the major link road improvements proposed for the town.

Traffic growth is partly due to journeys to and from existing Local Plan allocations and existing planning commitments. These journeys account for between 25% and 31% of the total growth in traffic between 2019 and 2045 (depending on time period). In 2045 these journeys account for between 9% and 11% of all journeys made in Buckinghamshire.

There is therefore some correlation between where traffic is forecast to grow the most and where most new development is expected, such as around Aylesbury, High Wycombe and Princes Risborough. However, higher traffic levels are also due to underlying growth in travel by cars, vans and HGVs, meaning that traffic is also increasing in places with less development, such as Chesham.

Network performance

Peak hour congestion is forecast to rise between 2019 and 2045; average delay per vehicle mile rising by 50%, average speeds falling by 6-7% and total hours of delay by nearly 90% (see Tables 4-1, 4-2 and 4-3). As above, these figures include traffic on motorways and traffic travelling through Buckinghamshire and are broadly comparable to the South East average.

Journey times by road are forecast to increase by up to a quarter (see Table 4-6 and Table 4-7). For example, a morning peak journey from Henley-on-Thames and High Wycombe is expected to take 36 minutes in 2045 compared to 29 minutes in 2019. Similarly, a journey in the evening peak from Prestwood to Wendover is forecast to increase from 24 to 29 minutes. Typically, the largest increases in journey time are expected in the southern half of the county.

The average travel time per journey remains similar, meaning that the average journey length is forecast to fall.

2019 and 2045 vehicle emissions

Chapter 5 presents forecasts of changes in air pollutants and greenhouse gas (carbon dioxide) emissions from road traffic between 2019 and 2045.

Pollutant emissions were estimated using DEFRA's Emissions Factors Toolkit; and traffic flow information from the BSTM-derived forecasts described above. Calculations were based on an average fleet composition for a given year and road type.

By 2045, emissions of NO_x are forecast to be 72% lower than in 2019, and CO_2 lower by 28% (see Table 5-2). Although traffic levels increase in this period, tailpipe emissions fall due to improvements in vehicle technology and the switch to electric vehicles.

The reduction in CO_2 emissions would be greater if traffic levels were to rise by less or were to fall. The highest increases in the amount of traffic (in terms of vehicle-miles) between 2019 and 2045 occur for trips to and from the Aylesbury, High Wycombe, Beaconsfield, Gerrards Cross and Buckingham areas. These locations are generally consistent with where the most development has been assumed.

Emissions of particulate matter due to brake and tyre wear are forecast to increase by 5-13% (depending on type of particulate). This increase is in part due to greater use of heavier electric vehicles and Sports Utility Vehicles.

These changes are broadly in line with the Department for Transport (DfT)'s National Road Traffic Projections 2022. The forecasts in the report differ slightly from BEIS other 2019 baseline estimates for Buckinghamshire due to the level of detail within the BSTM.

Wider impacts of forecast traffic growth

Chapter 6 discusses the potential impacts of the forecast growth and emissions in terms of air quality; climate change mitigation; economy and employment; and communities and health.

Air quality

Air quality is an important issue for many areas, and traffic is often a primary cause of air quality problems. There are nine AQMAs in Buckinghamshire that have been declared due to high levels of NO_2, the main source of which is road transport. These are in Aylesbury, Chesham, High Wycombe, Iver, Marlow, South Buckinghamshire, and Wycombe. Concentrations of NOx are highest in urban areas and close to the motorways. Independent analysis using the EEH Cadence Tool shows that reductions in NOx emissions by 2045 will be highest in the M40, M25 and M4 motorway corridors (which experience the highest traffic volumes). Minimising the number of vehicle-miles travelled by internal combustion engine (ICE) powered vehicles would deliver additional air quality benefits.

Climate change mitigation

Decarbonising our economy and society is one of the greatest challenges that we face. Unlike other sectors, emissions from the transport sector have not significantly fallen due to rising demand to travel and a trend towards larger and heavier cars.

Transport emissions per capita in Buckinghamshire are substantially higher than the national average (see Table 6-1). The mainly rural nature of the county results in longer journeys and higher car dependency; most of the transport emissions are from roads. Emissions per capita in the towns are lower than the county average.

Transport emissions need to fall quickly to meet carbon budgets and to reach net zero by 2050. ‘Business as usual’ behaviour will result in a significant gap between emissions and what we need to achieve, creating a significant challenge.

The reductions in CO_2 emissions described in Chapter 5 are the net effect of reductions in tailpipe emissions due to improvements in vehicle technology and the switch to electric vehicles; and increases in tailpipe emissions due to rising traffic levels. The reduction would be larger without the additional development-related vehicle trips arising from the existing site allocations and commitments

The levels of CO_2 emissions forecast for 2045 are significantly above the ‘Business as usual’ carbon pathway. Therefore, without further intervention, the expected levels of CO_2 emissions are much higher than necessary to reach net zero by 2040 and remain within Buckinghamshire’s overall carbon budget.

Economy and employment

High-quality transport connectivity is important to provide people with access to jobs and education and training; communities with poor accessibility to jobs and services can often suffer from social exclusion. Good connectivity is also important to provide businesses access to skilled labour markets, supply chains, customers, and other businesses in similar sectors. However, other factors such as the mix of business sectors, skills and quality of place are also important factors required for a high-performing economy.

Buckinghamshire has above-average productivity per worker. Productivity is driven by factors including business investment, exporting, innovation, and workforce skills. Effective transport connectivity is critical in enabling these factors.

Prior to the COVID-19 pandemic, a third of working residents travelled out of Buckinghamshire for work, to London, Berkshire, Oxfordshire, and Hertfordshire. Buckinghamshire also has several strategic economic assets which are likely to be major drivers of economic growth in the future. The highest concentrations of workers are in High Wycombe and Aylesbury. In general, activity is more clustered towards the south, including Gerrards Cross, Beaconsfield and Marlow.

The forecast additional traffic congestion and longer journey times will constrain productivity and growth by:

- limiting the ability of businesses to recruit skilled employees as the size of the labour market is reduced;
- reduce the attractiveness of the area as a place to live for higher-skilled workers;
- reducing business efficiency and increasing transport costs;
- constraining inward investment; and
- increase out-commuting to elsewhere.

Communities and health

Buckinghamshire is relatively wealthy, with high skills, higher resident incomes than the national average and the highest level of disposable income in England. Overall, there are relatively low levels of deprivation, especially in rural areas.

However, there are areas of higher deprivation within and around Aylesbury, High Wycombe, Chesham and some rural areas. Many of these areas are consistent with the focus areas identified for Opportunity Bucks (see Figure 6-8).

Health outcomes such as levels of cardiovascular disease, cancer and respiratory disease, are better than the averages for both the South East and England whilst life expectancy is significantly higher than the national average. However, there are pockets of lower life expectancy in Aylesbury, High Wycombe, Buckingham, and Burnham and elsewhere (see Figure 6-9).

Transport-related social exclusion occurs in locations with higher vulnerability to social exclusion through deprivation, and lower accessibility to key destinations. The areas at higher risk of transport related social exclusion in Buckinghamshire include Denham, Burnham, localised parts of High Wycombe, Princes Risborough, Chesham, and Buckingham.

The role of rail in enabling growth

Chapter 7 describes the current network of rail services and their potential to cater for some of the additional demand for travel resulting from the existing development site allocations and commitments.

There are four main heavy rail lines, all with services to and from London: the Chiltern Main Line, running to/from London Marylebone and serving a corridor including Beaconsfield, High Wycombe and Princes Risborough; the line from Marylebone to Aylesbury Vale Parkway, the West Coast Main Line and the Great Western Main Line. Buckinghamshire is also served by the Metropolitan Line of the London Underground from two termini at Chesham and Amersham.

East-West Rail is currently under construction in north Buckinghamshire with a station at Winslow. It will provide services between Oxford and Milton Keynes or Bedford.

There is potential for some of the new development-related journeys to be made by rail, especially where rail can offer an advantage over car travel in terms of journey time, cost, or convenience. Rail is likely to be most competitive for journeys to London, or other longer inter-urban journeys, rather than journeys to local town centres within Buckinghamshire.

The share of new development-related journeys using rail will also be affected by the proximity of the development to a station; whether the rail services link the development to key attractors; the service frequency; and the level of crowding of services. A relatively high share of existing site allocations and commitments are within a mile in the vicinity of an existing or planned railway station (see Figure 7-2). However, there are some gaps in rail connectivity which will constrain the attractiveness of rail services, for example making east-west ‘orbital’ journeys is difficult compared to north-south ‘radial’ journeys.

The amount of rail capacity which will be available in the future is determined by the rail industry planning process which seeks to accommodate demand growth by providing more capacity. Traditionally, alleviating crowding on services into central London during the peak periods is a key consideration. Before the COVID-19 pandemic there was considerable crowding on trains to and from Marylebone in the morning high peak hour. Since the COVID-19 pandemic, peak rail usage has fallen and there is less certainty about long-term trends; meaning that it is not possible to be definitive about spare rail capacity at this time.

Key findings and considerations

Chapter 8 describes the key findings identified in the study. They are:

1. Traffic levels and delays in 2019 are already high.
2. Traffic levels and delays are forecast to increase by 2045.
3. Emissions of NOx fall between 2019 and 2045 but particulate emissions rise.
4. CO_2 emissions fall by 2045 but not enough to meet carbon reduction pathways.
5. Traffic congestion imposes additional costs on the local economy.
6. There are pockets of urban and rural social exclusion in Buckinghamshire.
7. Rail could play an important role in increasing the sustainability of future growth

The study also identifies issues and options for consideration in the next stage of development of the new Local Plan for Buckinghamshire. Some of these relate to more than one key issue. A range of other factors beyond transport will also be relevant considerations in preparing the Local Plan and the recommendations made here will need to be weighed up alongside others.

The considerations relating to further analysis are:

- Examine options for **reducing current congestion** caused by existing journeys in areas where congestion is already more significant.
- Analyse **existing travel patterns and travel choices** to inform transport options in the Local Plan.
- Understand the **contribution of Local Plan-related traffic** to overall traffic levels and delays in 2045.
- Determine what measures may be required to close the gap between the expected **CO_2 emissions** and the Net Zero pathways.

The considerations relating to strategic patterns of growth, site locations and design are:

- Examine options to **minimise the amount of road traffic generated by the Local Plan site allocations**. Specifically:
    - **Locate sites close to existing centres** to minimise trip lengths and encourage active travel.
    - Encourage **mixed-use sites** which are more self-sufficient.
    - Ensure that sites are designed to put the **needs of those walking, wheeling, and riding first**.
    - Locate sites **close to existing public transport and active travel networks** or facilitate those networks as part of development planning.
    - Masterplanning of sites to be oriented around high-frequency bus services, with **mobility hubs** providing a wide range of local mobility options.
    - Encourage provision of **shared EV car clubs** to reduce car dependency.
    - Masterplanning and street design to encourage people-oriented streets, with parking located on the edges of the development area.
- Encourage provision of **fibre broadband and 5G** cellular connectivity at all sites.
- Examine options for further **reducing NOx emissions** from journeys to and from Local Plan site allocations.
- Enable provision of **electric vehicle charging infrastructure** for every home.
- Locate **residential properties** away from the busiest roads.
- Consider how residents and employees of new developments can be **encouraged to use sustainable travel modes.**
- Locate **employment sites close to existing or new residential areas**.
- Consider how the Local Plan can support delivery of the number and type of homes, and attractive places to encourage a **healthy labour market**.
- Encourage good transport connections to Buckinghamshire's **strategic economic assets**.
- Consider how the new Local Plan can support improved **accessibility to existing communities**.
- Consider how the Local Plan can enhance the **quality of place** for those who live and work in Buckinghamshire.

- Locate Local Plan sites where there is the **greatest potential for journeys by rail**.
- Encourage **good first/last mile connectivity** by sustainable travel modes to **nearby stations**.
- Consider the best way to connect the cluster of developments on the east side of **Aylesbury** into the rail network.
- Consider the potential for new stations to serve new development and additional services building on East West Rail to substantially improve **rail connectivity to new developments**.
- Consider the preferred strategy for public transport connectivity into **High Wycombe** from the south.

1. Introduction

1.1. Purpose of this document

Atkins has been commissioned by Buckinghamshire Council (BC) to undertake a modelling assessment of the highway network across the Buckinghamshire Council area using the Buckinghamshire Strategic Transport Model (BSTM). The purpose of this assessment is to determine the performance of the highway network in the 2019 base year and for the Local Plan for Buckinghamshire (LP4B) Do Minimum scenario which has a forecast year of 2045. This assessment will be used to inform whether there is sufficient capacity within the highway network to meet the forecast demand arising from future site allocations in the LP4B.

This study identifies the key areas of congestion in 2019 and 2045 and the impact of traffic growth on air quality and carbon emissions. It also provides a summary narrative of the potential for rail services to cater for some of the additional journeys arising from the Local Plan commitments and site allocations.

1.2. Background

The LP4B will serve as the main development plan for Buckinghamshire, and its purpose will be to set out where and how development will be permitted during the plan period (2021 to 2045). It will be used by the Council in deciding whether to permit or refuse planning applications for all kinds of development, including (but not limited to) homes, offices, warehouses, shops, leisure and sports facilities, and mineral extraction.

The Council is currently working on "growth scenarios" for the Local Plan.

1.3. Report Structure

The remainder of this report is structured as follows:

- Section 2 details the modelling approach used to develop the 2045 forecast scenario;
- Section 3 provides a review of the operation of the highway network in the baseline year;
- Section 4 discusses the operation of the highway network in the future year;
- Section 5 details the assessment of emissions and air quality;
- Section 6 considers forecast future traffic levels and its impacts;
- Section 7 considers public transport provision and capacity in the context of the future growth;
- Section 8 summarises the key findings of the study and make recommendations for further work.

2. Approach to traffic forecasting

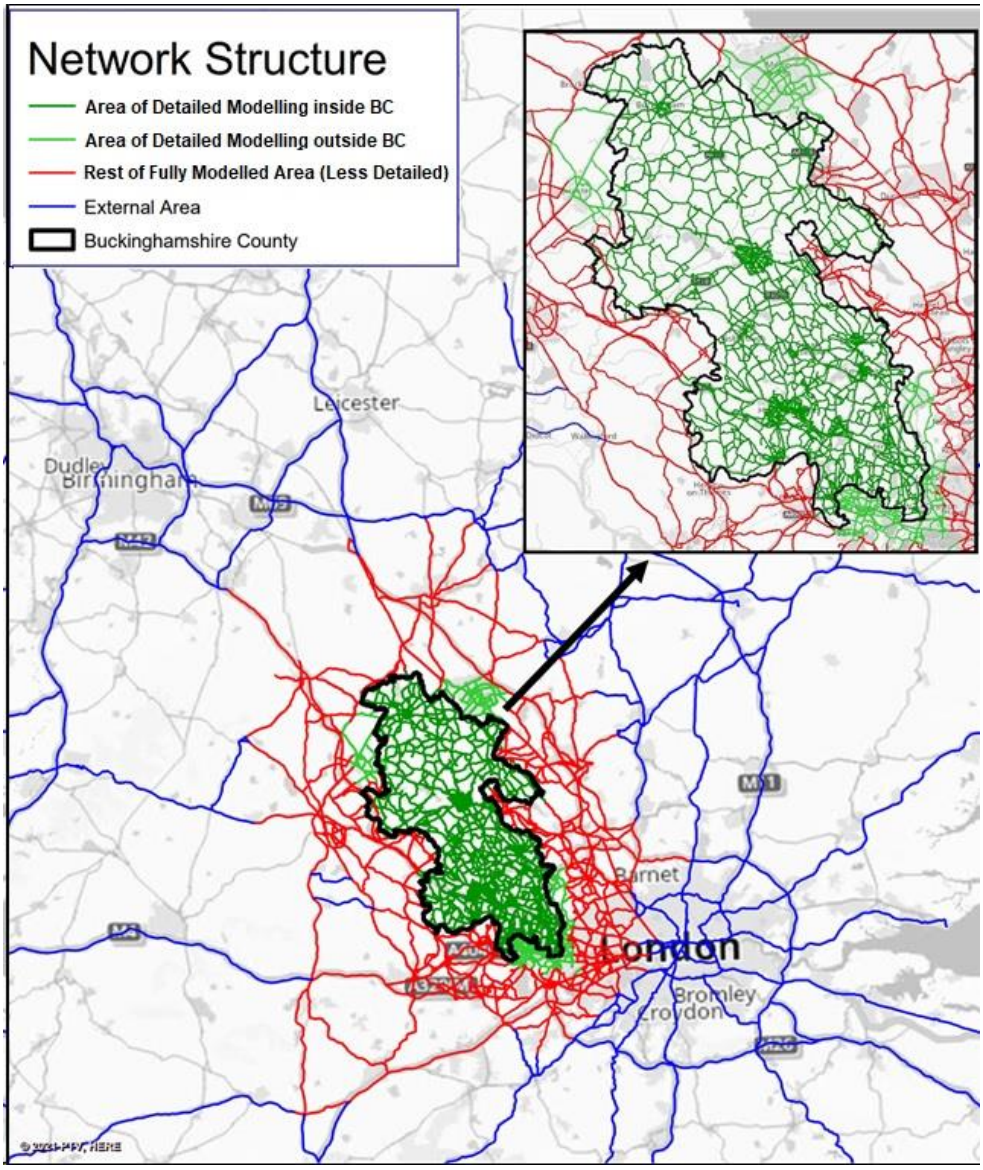
This chapter describes the traffic modelling methodology and assumptions used to develop the modelled scenario which is intended to reflect a possible set of land use assumptions for 2045. This scenario is referred to as the '2045 LP4B Do Minimum (DM) forecast scenario'.

2.1. Introduction to the highway model

The Buckinghamshire Strategic Traffic Model (BSTM) is a highway-only model developed using the VISUM software suite (version 21) with a base year of 2019. The model has been developed using a wide range of data including aggregated and anonymised mobile network data (MND) data, Teletrac GPS journey time data and traffic count data. The base model has been calibrated and validated in line with TAG (Government) guidance. The BSTM does not include a variable demand model, public transport or active modes which means that it only considers the routing of a predetermined number of vehicle trips on the highway network. Due to its strategic nature as a county model, the validation checks of the model were primarily focused on routes between towns and on entries to towns rather than within the key urban areas. Further details on the level of calibration and validation are provided in the Local Model Validation Report (March 2023).

The geographical extent of the model is shown in Figure 2-1.

Figure 2-1 BSTM model area



The time periods which the model forecasts for are:

- a morning peak hour: 08:00-09:00;
- an average inter-peak hour (of between 10:00-16:00); and
- an evening peak hour: 17:00-18:00.

Five vehicle user classes (types) are modelled as shown in Table 2-1.

Table 2-1 User Classes

User Class	Description	User Class	Description
1	Car – Commuting	4	Light Goods Vehicles
2	Car – Employer's Business	5	Heavy Goods Vehicles
3	Car – Other Purpose		

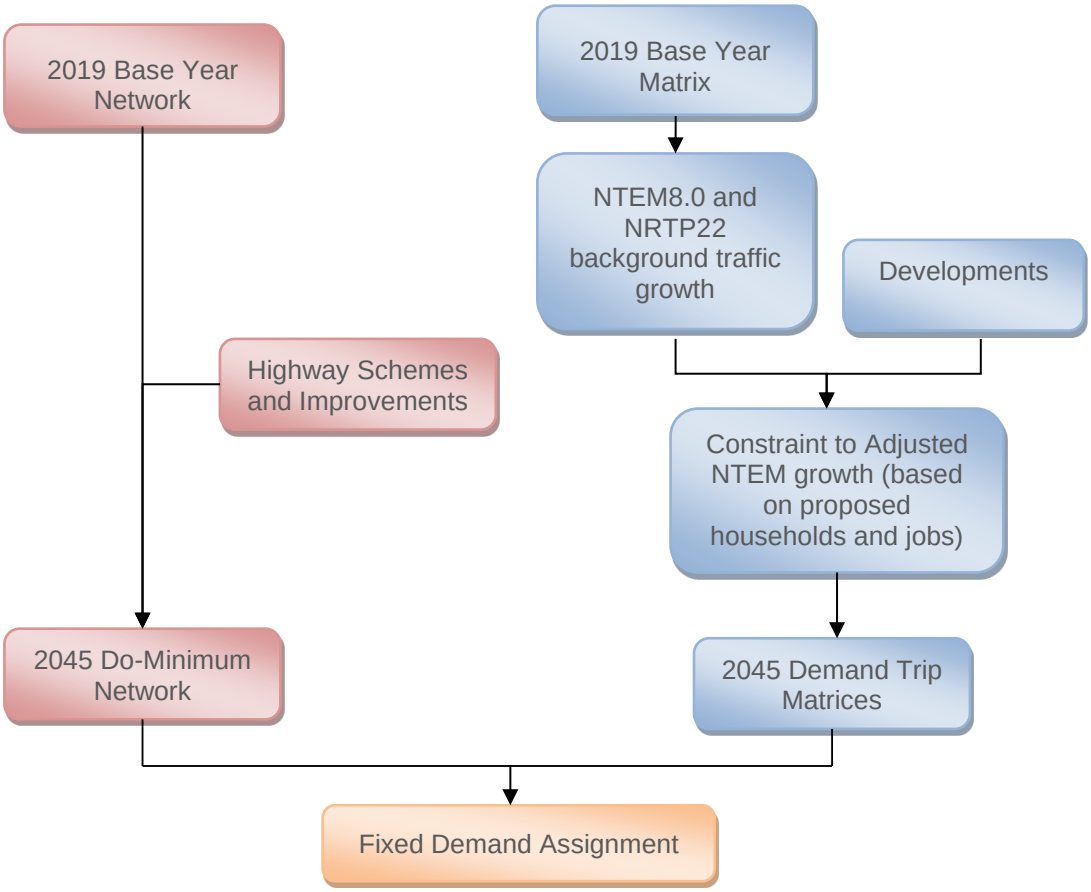
2.2. Overall approach to forecasting

For this study, a 2045 Do Minimum scenario has been developed which includes:

- committed developments and planned site allocations up to 2045; and
- committed transport infrastructure and mitigation measures included in existing plans.

The forecasting approach, along with the key inputs and outputs for each stage, is summarised in Figure 2-2.

Figure 2-2 Approach to forecasting



2.2.1. Treatment of uncertainty

TAG Unit M4 sets out the guidance for treatment of uncertainty in model forecasting. The uncertainty associated with each input assumption is used as a basis to develop and assess alternative forecast scenarios.

The key issues in assessing uncertainty are:

- the range of possible inputs;
- the likelihood of each input; and
- the interaction between different elements which affect inputs.

To analyse uncertainty, an uncertainty log has been prepared. This log highlights all the local and external uncertainties and factors likely to affect the traffic levels and delivery of scheme benefits. The uncertainty log includes an assessment of the uncertainty of each individual input by placing it into one of four categories, as defined in Table 2-2 (taken from TAG M4 Appendix A Table A2).

Table 2-2 Classification of future inputs

Probability of the Input	Status of site allocation / existing commitment
Near Certain (NC): The outcome will happen or there is a high probability that it will happen.	• Intent announced by proponent to regulatory agencies. • Approved development proposals. • Projects under construction.
More than likely (MTL): The outcome is likely to happen but there is some uncertainty.	• Submission of planning or consent application imminent. • Development application within the consent process.
Reasonably Foreseeable (RF): 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 (for example, deliverability) whose outcomes are subject to significant uncertainty.
Hypothetical (H): 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.

The forecast model includes ‘near certain’ and ‘more than likely’ developments and highway schemes. Given the purpose of this study to consider future local plan growth, major developments in the existing local plan (i.e., reasonably foreseeable developments) have also been included in the Do-Minimum scenario, as detailed in Section 2.4.

2.3. Development of the (forecast) highway network

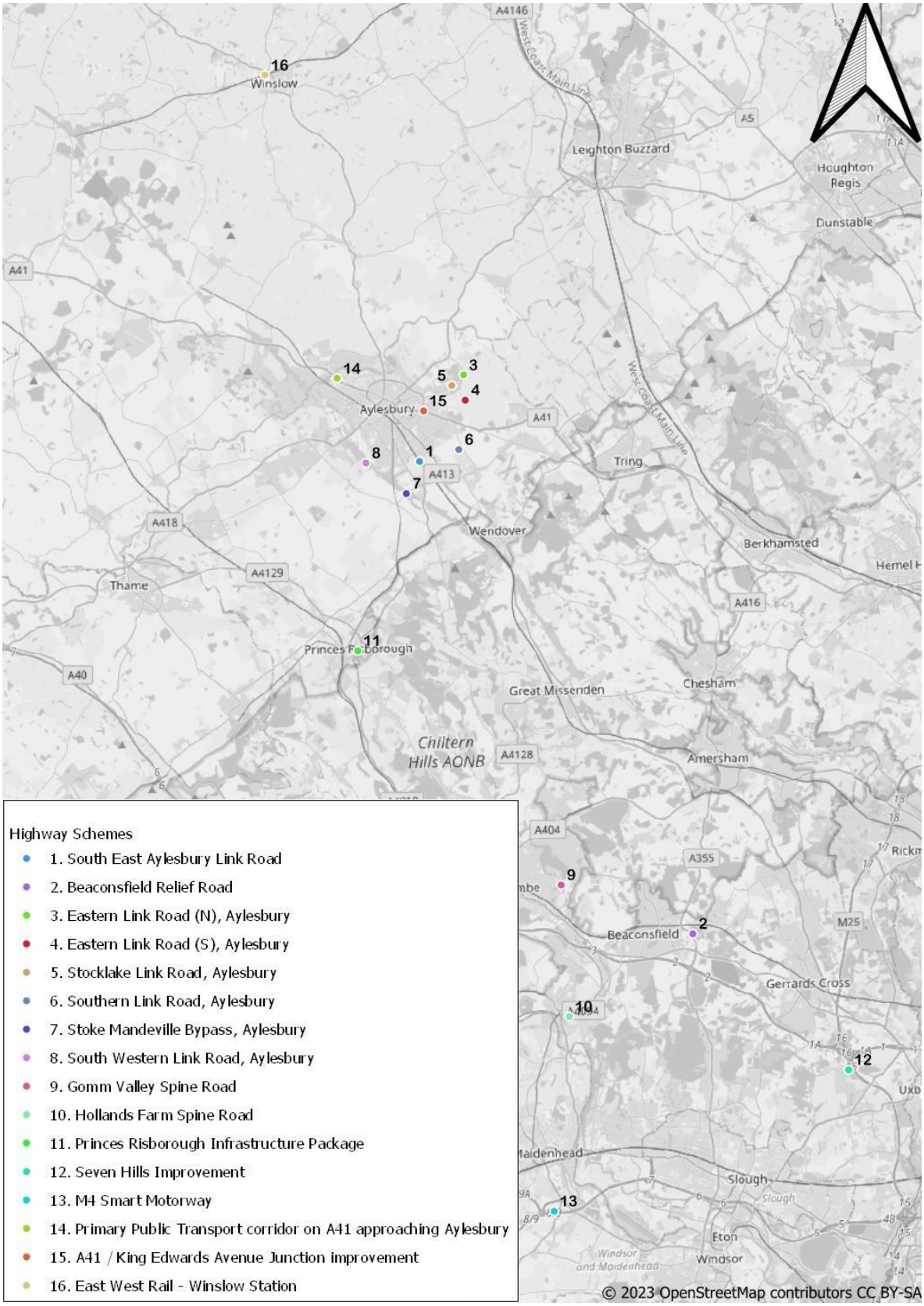
The forecast year ('Do Minimum') highway network for 2045 was developed using the 2019 base year modelled network as a starting point. The 2019 network was modified based on information on highway schemes and their level of certainty provided by BC. Table 2-3 lists the highway schemes which were 'near certain' and 'more than likely' which have been included in the 2045 Do Minimum network. The full uncertainty log for schemes is provided in Appendix A. Figure 2-3 shows the locations of the highway schemes included in the 2045 DM.

Table 2-3 2045 Transport schemes uncertainty log (included in the 2045 DM network)

Ref	Scheme	Details	Uncertainty
1	South East Aylesbury Link Road (SEALR)	New dual carriageway road connecting Lower Road, Aylesbury and Wendover Road (Hampden Hall Roundabout).	NC
2	Beaconsfield Relief Road	New single carriageway road connecting Pyebush Roundabout and Amersham Road (Near Hyde Gym)	NC
3	Eastern Link Road (N), Aylesbury (ELR)	New single carriageway road connecting Bellingham Way and A418	NC
4	Eastern Link Road (S), Aylesbury (ELR)	New single carriageway road connecting Bellingham Way with A41	MTL
5	Stocklake Link Road, Aylesbury	New single carriageway road (Bellingham Way) from Broughton Lane to Mike Griffin Wy	NC
6	Southern Link Road, Aylesbury (SLR)	New dual carriageway road from A41 (Woodlands Roundabout) to Wendover Road (Hampden Hall Roundabout) and new single carriageway road to Marroway Road (Near The Pony Fld)	MTL
7	Stoke Mandeville Bypass, Aylesbury	New single carriageway road from A4010 (near Fremantle Court) to South Western Link Road, Aylesbury (SWLR) bypassing Stoke Mandeville	NC
8	South Western Link Road, Aylesbury (SWLR)	New single carriageway road from Stoke Mandeville Bypass, Aylesbury to A418 Roundabout near Coldharbour Way	MTL
9	Gomm Valley Spine Road	New single carriageway road from Rayners Ave (near A40) to Cock Lane (Near Ashwells)	MTL
10	Hollands Farm Spine Road	New single carriageway road from Princes Road (Near A4094) to Hedsor Road (Near Ferry Lane)	MTL
11	Princes Risborough Infrastructure Package	New single carriageway road from Picts Lane to Longwick-cum-Ilmer / Mill Lane Jn. Junction Improvements along A4010 in Princes Risborough with Poppy Road/ Station Road/ The Avenue/ Peters Lane/ The Holloway Lane	RF
12	Seven Hills Improvement	Junction capacity improvement	NC
13	M4 Smart Motorway	M4 Capacity augmentation (i.e., 3 lanes to 4 lanes) from M4J12 to M4J3	NC
14	Primary Public Transport corridor on A41 approaching Aylesbury	Carriageway and junction changes on Bicester Road from A41/Paradise Orchard Jn to A41/Rabans Lane Jn	NC
15	A41 / King Edwards Avenue junction improvement (Aylesbury)	Junction capacity improvement	NC
16	East West Rail - Winslow Station	New rail station and associated car park	NC

Key: NC=Near Certain, MTL=More Than Likely, RF = Reasonably Foreseeable

Figure 2-3 Locations of 2045 transport schemes



2.4. Development of the forecast ‘demand matrix’

New demand matrices were built representing the trip origins and destinations expected in 2045. Matrices were built for each of the five user classes (vehicle types) and for each of the three time periods (morning peak, inter-peak and evening peak). The traffic growth for the 2045 forecast matrices has been determined separately for each user class.

The matrices were based on the 2019 base year, with underlying background traffic growth and specific development-related traffic growth added to the base year.

The development of the forecast matrices was undertaken in accordance with current DfT guidance contained in TAG Unit M4, which requires the use of the National Trip End Model (NTEM) for the derivation of travel demand growth factors.

Overall trip growth within each local authority area has been constrained to NTEM growth (adjusted for the LP4B land use assumptions).

2.4.1. Background traffic growth

The background (underlying) future year growth was derived using growth factors from the following sources:

- National Trip End Model (NTEM) 8.0 datasets, obtained from the TEMPRO database, have been utilised for car vehicle growth factors; and
- National Road Traffic Projections (NRTP2022) – National growth forecasts used in this study to derive Light and Heavy Goods Vehicle growth (released December 2022).

Different methodologies for light and other goods vehicles were applied as discussed in the following sections. The background growth factors are included in Appendix B.

2.4.1.1. Cars

The growth factors, by journey purpose, for cars within the study area were obtained from NTEM based on the geographical location of each zone.

For the background growth factors for former districts within the Buckinghamshire Council area (Aylesbury Vale, Chiltern, South Bucks and Wycombe), the alternative planning assumptions option in TEMPRO was used. The number of households and jobs for these former districts were calculated based on the proposed growth between 2019 and 2045 within the Uncertainty Log, excluding those households and jobs which are explicitly modelled as developments.

As the BSTM uses fixed demand assignments (i.e. no changing of time of day of travel or mode of travel), fuel and income adjustment factors have been applied from the TAG Databook (May 2023).

2.4.1.2. Light Goods Vehicles and Heavy Goods Vehicles

The NRTP2022 Projections were used to derive growth factors for Light Goods Vehicle and Other Goods Vehicle trips from 2019 to 2045. The growth factors were applied based on the geographical location of each zone.

2.4.2. Specific development-related trips

To more accurately model traffic growth across the study area, key developments have been included in the future year models. The estimation of development-related trips was based on existing site allocations in current district Local Plans and existing commitments. The assumption is that where these have not yet been developed, they will be carried forward into the new local plan.

Buckinghamshire Council provided an uncertainty log consisting of future and ongoing developments as of 2023 including their size, type, permission date and level of uncertainty. Given the purpose of this study to consider future local plan growth, major developments in the existing Local Plans (i.e. reasonably foreseeable developments in the uncertainty log) have also been included in the Do-Minimum scenario along with ‘near certain’ and ‘more than likely’ developments.

As the base model is 2019, completion data for 2019-2023 for residential and employment sites was also obtained to cover development growth during this period.

A number of development sites in the 2023 uncertainty log and in the 2019-2023 completion data were commenced prior to 2019. Therefore, the data were adjusted to include only the development expected beyond 2019. To do this the following assumptions were made:

- The Housing Supply Position statement for Aylesbury Vale, Chiltern, South Bucks and Wycombe from 2022 was used to identify and remove completions prior to 2021 from the 2023 uncertainty log data. The 2019-2023 completions data were used to infill dwellings for the period 2019 to 2021 for the relevant sites;
- It was assumed that for the large mixed sites, the same proportion of employment would have been built by 2019 as for the residential component.
- For sites which commenced development prior to 2019, within the 2019-2023 completions data, the following assumptions were made to identify the proportion built out by 2019 (as agreed with BC):
    - For residential sites: it was assumed there would be no development in the first year (i.e., year the development commenced), half the annual rate of build out in the 2nd and 3rd years, and then a uniform buildout rate for the remaining years to the completion date; and
    - For employment sites: there would be no development in the first year and then a uniform buildout rate for the remaining years to the completion date.
- Sites duplicated within the 2023 Uncertainty Log and 2019-2023 Completions data were identified to avoid double-counting.

Residential developments greater than 75 dwellings and employment sites greater than 40 two-way trips in the peak hours were explicitly included in the model (i.e. have a separate zone). The other developments were included in the background growth. A breakdown of the Do-Minimum scenario developments explicitly modelled, including their size, land use type and uncertainty classification is provided in Appendix C.

The locations of the Do-Minimum residential and employment developments modelled explicitly are shown in Figure 2-4 and Figure 2-5, respectively.

Figure 2-4 Locations of 2045 Do-Minimum residential developments

Figure 2-5 Locations of 2045 Do-Minimum employment developments

2.4.2.1. Trip rates

The number of trips generated by the proposed developments were calculated using the standard BSTM trip rates which were themselves obtained from the TRICS database (v7.7.1). These trip rates are shown in Table 2-4.

Table 2-4 Trip rates extracted from TRICS database

Development Type	Unit	Arrivals (number of vehicles)			Departures (number of vehicles)		
		AM	IP	PM	AM	IP	PM
Privately Owned Houses	1 dwelling	0.090	0.140	0.351	0.348	0.129	0.152
Mixed Private/Affordable Housing	1 dwelling	0.106	0.115	0.215	0.287	0.120	0.117
Office	100sqm	0.662	0.113	0.082	0.098	0.121	0.702
Business Park	100sqm	1.596	0.183	0.105	0.128	0.230	1.236
Food Retail (Convenience)	100 sqm	8.012	4.802	7.095	7.143	4.859	6.612
Food Retail (Superstore excl. Petrol station)	100 sqm	1.861	3.301	3.347	1.395	3.269	3.522
General Retail (shopping centre/local shops)	100 sqm	6.286	5.295	4.571	5.943	5.171	5.543
General Retail (Retail Park excl. food)	100 sqm	0.150	0.416	0.138	0.035	0.412	0.127
Industrial	100 sqm	0.263	0.193	0.094	0.142	0.192	0.245
Commercial Warehouse	100 sqm	0.763	0.195	0.237	0.104	0.201	0.733
Hotel	100 sqm	0.357	0.214	0.229	0.529	0.236	0.129

The following assumptions were applied to derive these trip rates:

- For those existing employment site allocations and existing commitments where only total site area was provided, it was assumed that Gross Floor Area is 40% of the site area.
- Where no employment land use split was provided, it was assumed that there is an even split between Office (B1), Industrial (B2) and Warehousing and Distribution (B8).

2.4.3. Trip distribution

The trip distribution for development trips (i.e., where trips are travelling to or from the site) was based on the trip distributions of nearby zones of a similar land use type.

2.4.4. Combining the demand matrices

The two components of traffic growth (background growth and development trips) were combined to produce demand matrices[1] for the morning peak, inter-peak and evening peak time periods for 2045. These matrices are considered to be an 'unconstrained' and therefore high growth scenario, i.e., the growth was not limited to that stated for the area in TEMPRO.

DfT guidance states that after the addition of developments to the background growth matrices, the growth in the matrices should then be constrained to the growth levels stated in TEMPRO (i.e., a lower growth scenario). The approach to constraining the matrices is described in the next section.

1 The matrices are the trips between each origin and destination.

2.4.5. Constraining the matrices to the site allocations and existing commitments data

The trip growth between 2019 and 2045 was constrained to Adjusted TEMPRO 8.0 (at district or regional level depending on the model area. NTEM utilises forecast changes in households and jobs, as well as other factors, to determine the forecast growth factors in TEMPRO. The household and job forecasts were modified[2] within TEMPRO 8.0, using the household and jobs projections in the LP4B uncertainty log data, to produce a new set of constraining growth factors for the former Buckinghamshire districts.

The growth in households and jobs between 2019 and 2045 for the LP4B DM are shown in Table 2-5. The number of jobs for employment sites has been derived using the GFA and standard employment densities from the Homes England Employment Density Guide (3rd Edition). For Chiltern, TEMPRO values for jobs have been used as no better data is currently available.

Table 2-5 Forecast growth in households and jobs used for constraining trip growth

District	Growth in number of households 2019-2045	Growth in number of jobs 2019-2045
Aylesbury Vale	20,573	18,545
Chiltern	669	2,629
South Bucks	1,047	2,418
Wycombe	7,459	5,243

The constraining growth factors are included in Appendix D. Constraining factors for LGVs and HGVs were based on NRTP2022.

It should be noted that in order to retain the integrity of the new development movements (i.e., trip generation and distribution), the development trips have been fixed during the constraining process. Hence, only the trip growth for existing zones (i.e., in the base year) is adjusted to give the required overall level of growth.

Table 2-6 compares the full pre-constrained matrices and the post-constrained matrices for the 2045 forecast year. The numbers represent all journeys in the model not only those in Buckinghamshire.

2 Using the alternative planning assumptions facility.

Table 2-6 Pre- and post-constrained matrix totals

Time Period	Journey purpose	Number of vehicle trips (unconstrained)	Number of vehicle trips (constrained)	Percentage change
Morning peak hour	Commuting	218,790	216,554	-1%
	Business	34,753	34,294	-1%
	Other	275,006	272,401	-1%
	LGV	796,726	795,757	0%
	HGV	302,885	302,522	0%
Inter-peak hour	Commuting	62,321	61,610	-1%
	Business	23,888	23,591	-1%
	Other	208,014	205,445	-1%
	LGV	769,245	768,266	0%
	HGV	289,871	289,615	0%
Evening peak hour	Commuting	203,865	201,085	-1%
	Business	34,903	34,302	-2%
	Other	300,976	296,901	-1%
	LGV	635,665	634,606	0%
	HGV	190,535	190,350	0%

The constraining process reduced the pre-constrained matrices by approximately 0.4 to 0.7%. This reduction occurred because the trip generation for the developments explicitly modelled exceeded the overall trip growth predicted by TEMPRO for the respective growth in households and jobs.

2.5. Methodology for assigning the 2045 demand

The demand matrices were ‘assigned’ to the 2045 highway network in the BSTM to predict routings and therefore traffic flows and congestion. Fixed demand assignments have been undertaken as the BSTM does not include a VDM component.

2.5.1. Calculation of generalised cost

The VISUM software on which BSTM is built calculates the ‘generalised cost’ of each journey as the sum of two parts, one based on time and the other based on distance. This requires two parameters: pence per minute (PPMn) and pence per mile (PPMi). Generalised cost is expressed as time in minutes (i.e., Time + (PPMi*Distance)/PPMn).

The values of time and distance used were based on the May 2023 TAG databook (v1.21) and are shown in Table 2-7. As with the base year, the values of time for the heavy goods vehicles were doubled in line with guidance.

Table 2-7 Forecast PPM and PPK Values for 2045

User Class	Morning peak hour		Inter-peak hour		Evening peak hour	
	PPMn	PPMi	PPMn	PPMi	PPMn	PPMi
Car - Commuting	28.61	6.76	29.08	6.76	28.71	6.76
Car - Business	42.66	13.23	43.72	13.23	43.28	13.23
Car - Other	19.74	6.76	21.03	6.76	20.67	6.76
LGV	30.92	17.04	30.92	17.04	30.92	17.04
HGV	61.59	56.70	61.59	56.70	61.59	56.70

PPMi: Pence per minute. PPMi: Pence per mile

3. 2019 traffic levels and network performance

3.1. Introduction

This chapter describes the performance of the highway network in 2019 based on model outputs from the BSTM. Traffic volumes and levels of congestion are described. Whilst this is a validated base year position, the results shown are synthetic in that they are derived from the model rather than being observed.

3.2. Volume of traffic

The level of traffic volume on the highway network in 2019 is shown in Figure 3-1 and Figure 3-2 for the morning peak and evening peak hours respectively.

Figure 3-1 Traffic volume: 2019 morning peak hour

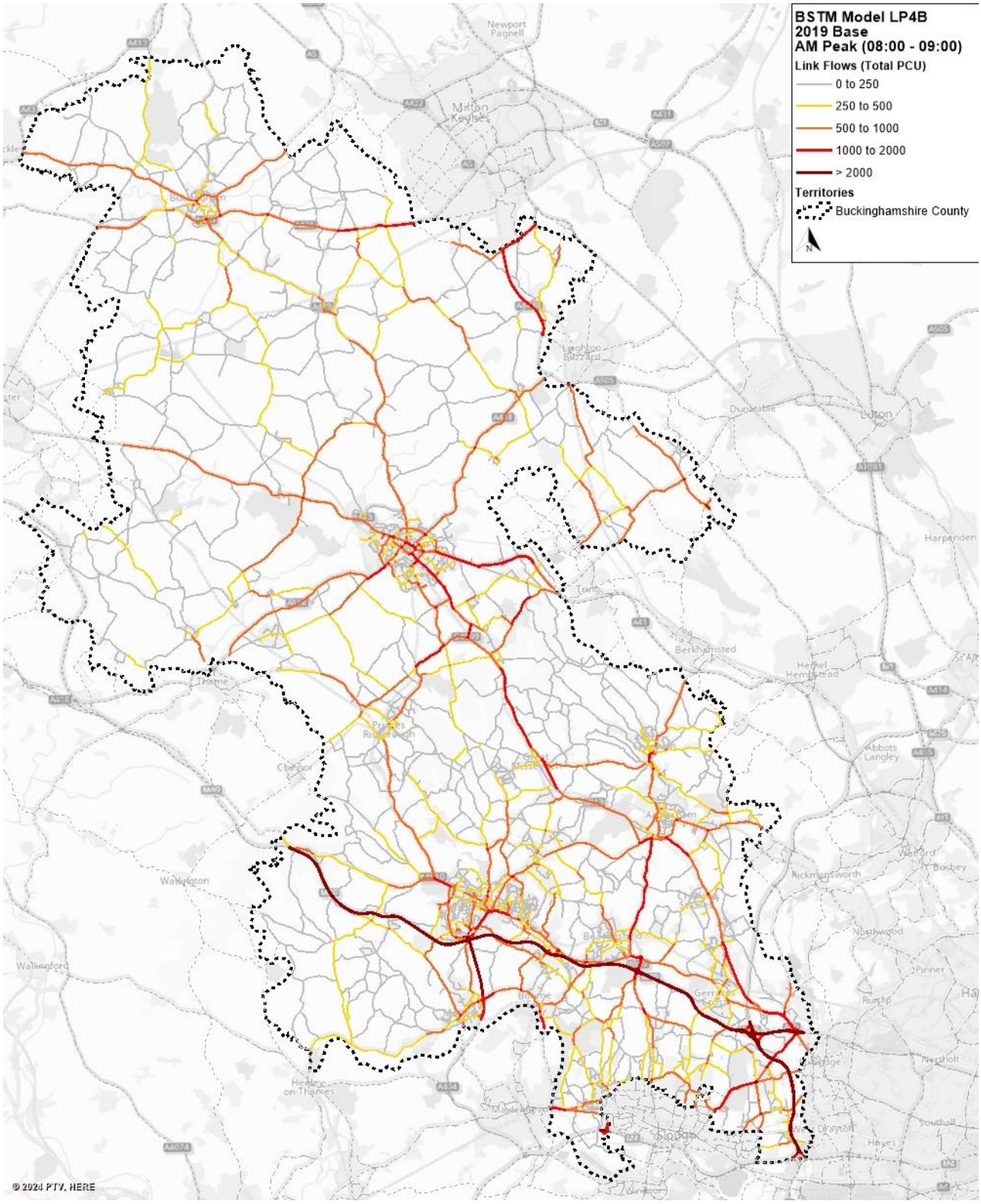


Figure 3-2 Traffic volume: 2019 evening peak hour

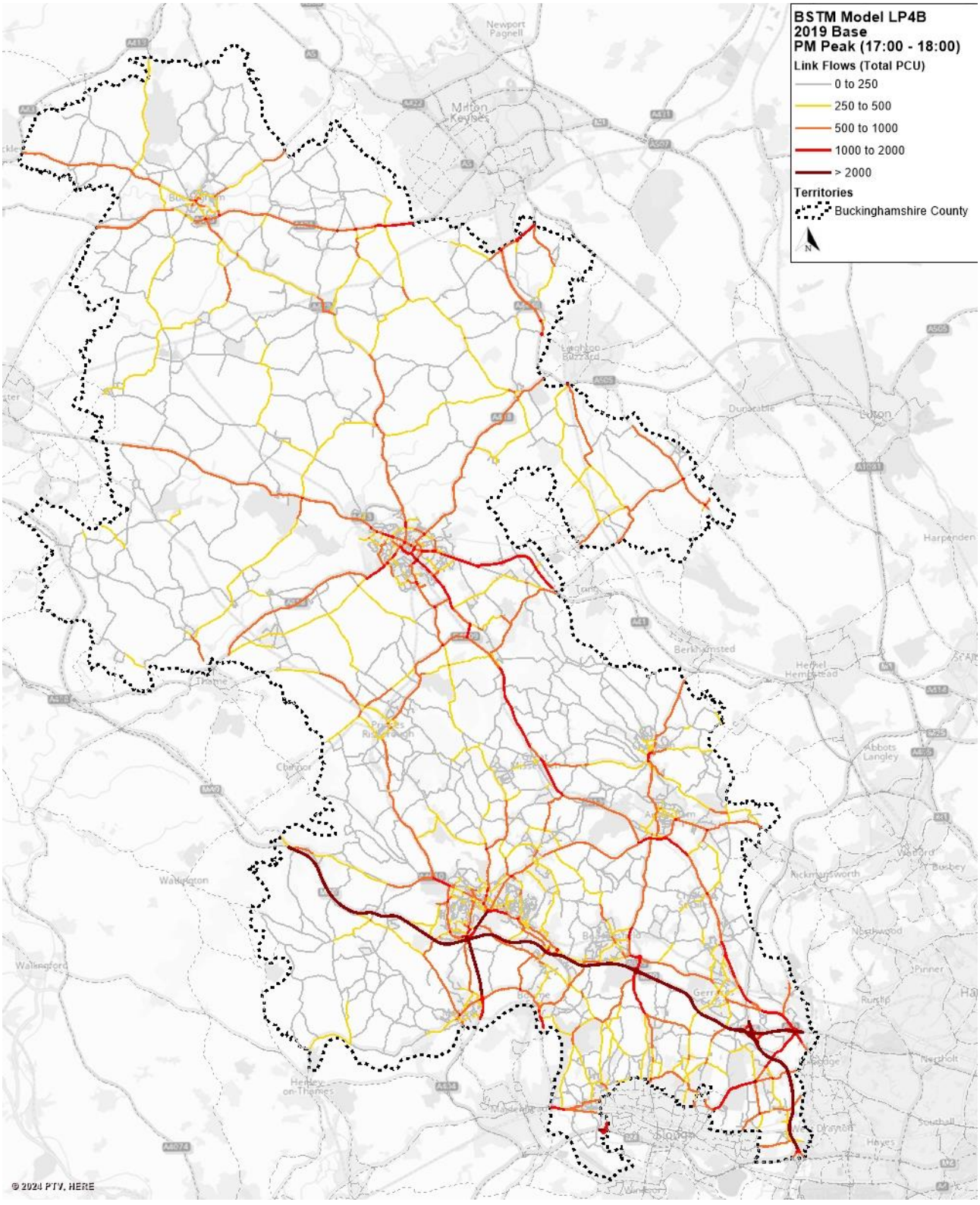


Figure 3-1 and Figure 3-2 indicate that the highest traffic volumes are predicted to occur within the key urban areas (Buckingham, Aylesbury, High Wycombe and Amersham) and on routes to/from these locations. The highest volumes occur on the following major roads within Buckinghamshire in the morning and evening peak hours:

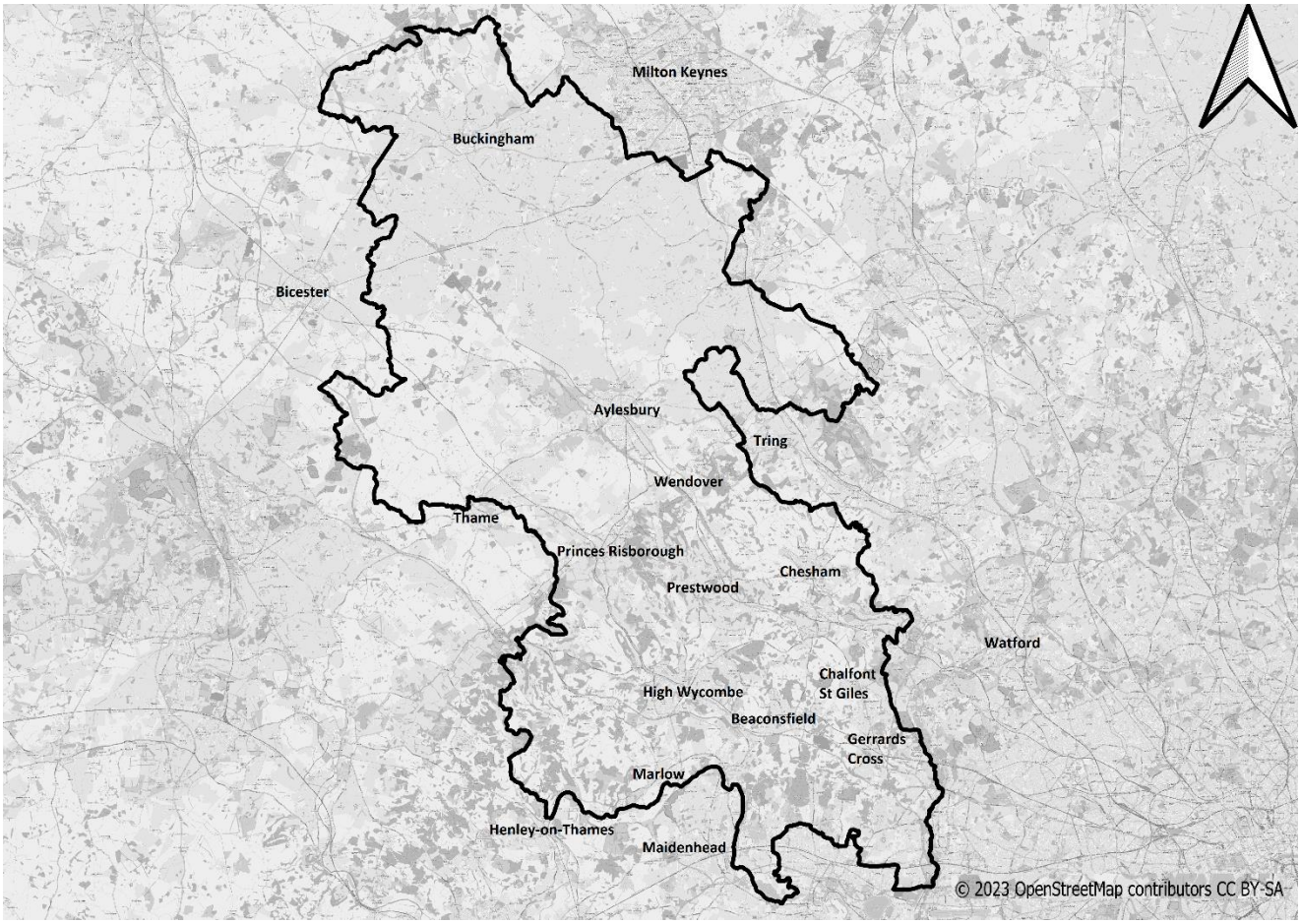
- A421 between Buckingham and Milton Keynes;
- A413 between Buckingham and Aylesbury;
- A418 between Aylesbury and Leighton Buzzard;
- A41 between Aylesbury and Hemel Hempstead;
- A41 between Aylesbury and Bicester;
- A413 between Aylesbury and Amersham/Chalfont St Giles/Gerrards Cross;
- A4010 between Aylesbury and Princes Risborough/High Wycombe;
- A355 between Amersham and Beaconsfield;
- A404 between Amersham and High Wycombe;
- M40 through Buckinghamshire;
- A418 between Aylesbury and Thame; and
- A404 between High Wycombe and Marlow/Maidenhead.

3.3. Traffic delays (congestion)

Patterns of congestion are presented in terms of the additional journey time forecast by the model compared to a journey made in 'free flow' conditions. Delays on modelled links and nodes (junctions) were both been extracted from the BSTM.

To understand journey times in Buckinghamshire, 18 locations were selected and the average journey time by all routes between each pair of locations was extracted from the model. These locations have been selected based on their population and the key routes identified in Section 3.1 and are shown in shown in Figure 3-3.

Figure 3-3 Locations used for journey time analysis



The difference between modelled congested travel times and free flow times are provided in Appendix E for all movements between these 18 locations. The journeys with the largest forecast delay (in percentage terms) are shown in Table 3-1 and Table 3-2 for the morning and evening peak hours respectively. These journeys are also shown in Figure 3-4 and Figure 3-5.

Table 3-1 Journeys with largest forecast % delay in 2019 base year – morning peak hour

Origin	Destination	Travel times (minutes)		Percentage difference
		Congested (assigned) time	Free flow time	
Watford	Milton Keynes	67	39	71%
High Wycombe	Maidenhead	25	17	48%
High Wycombe	Marlow	22	15	47%
High Wycombe	Gerrards Cross	29	20	47%
High Wycombe	Henley-on-Thames	29	21	43%
High Wycombe	Watford	43	30	40%
Thame	Aylesbury	25	18	40%
Watford	Tring	30	21	39%
Watford	Aylesbury	45	33	39%
Watford	Maidenhead	49	36	38%

Table 3-2 Journeys with largest forecast % delay in 2019 base year – evening peak hour

Origin	Destination	Travel times (minutes)		Percentage Difference
		Congested (assigned) time	Free flow time	
Watford	Milton Keynes	61	39	58%
Milton Keynes	Watford	63	41	54%
High Wycombe	Maidenhead	23	17	39%
High Wycombe	Gerrards Cross	27	20	38%
High Wycombe	Henley-on-Thames	28	21	36%
Thame	Aylesbury	24	18	35%
Watford	Chalfont St Giles	34	25	35%
Maidenhead	Watford	45	34	35%
Watford	Tring	29	21	35%
High Wycombe	Watford	41	30	34%

The locations where congestion is forecast to have a particular impact on the delays shown are:

- the High Wycombe / A404 / Marlow area;
- on routes into Aylesbury – including the A41 east-west and A418 towards Thame;
- in the Watford/ South-West Hertfordshire and South-East Buckinghamshire area; and
- on the M1, M25 and M4.

Further analysis has been undertaken to identify the causes of delays between these locations as discussed in the following sections.

Figure 3-4 Top ten journeys with largest forecast % delay in 2019 (morning peak)

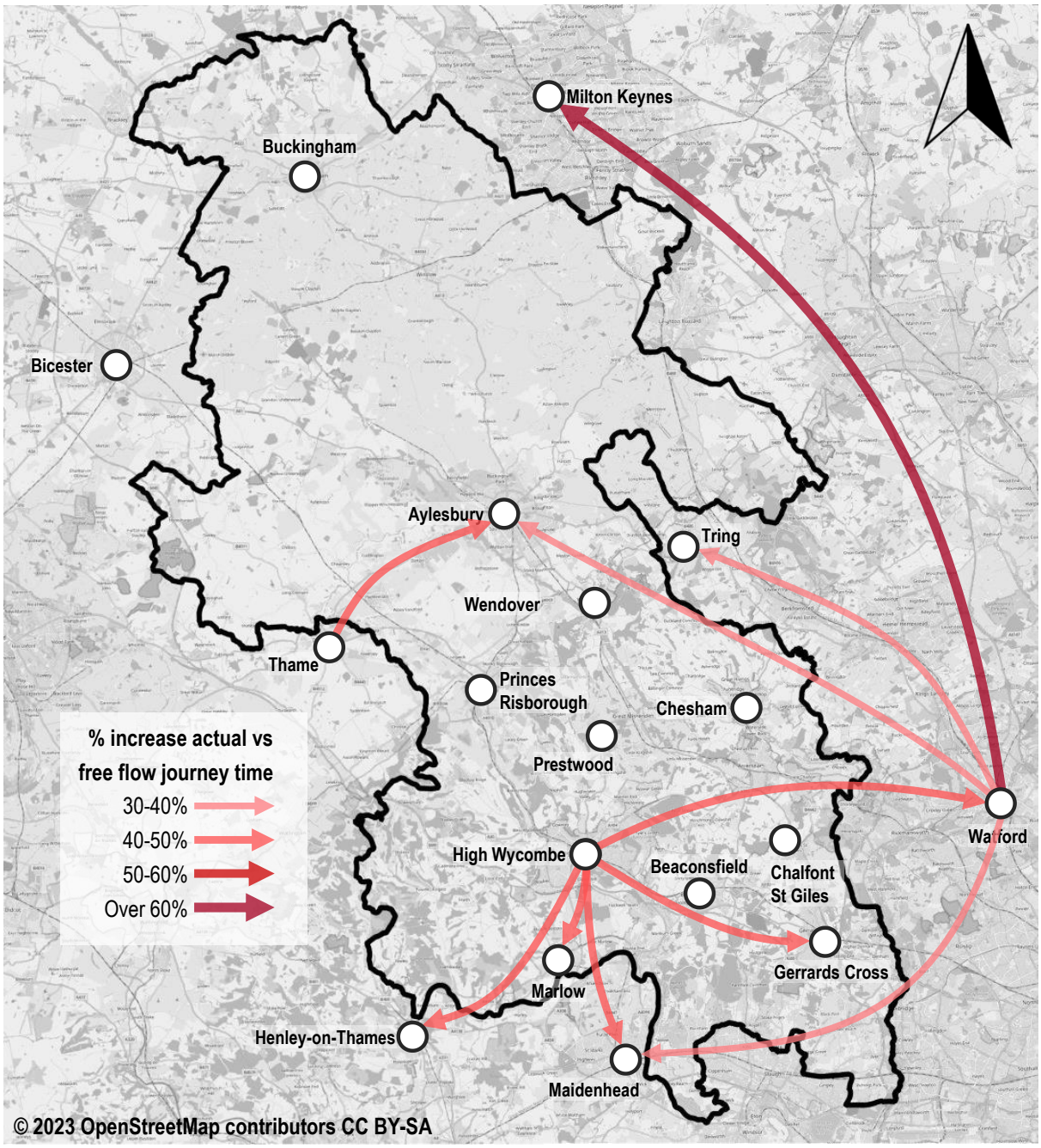
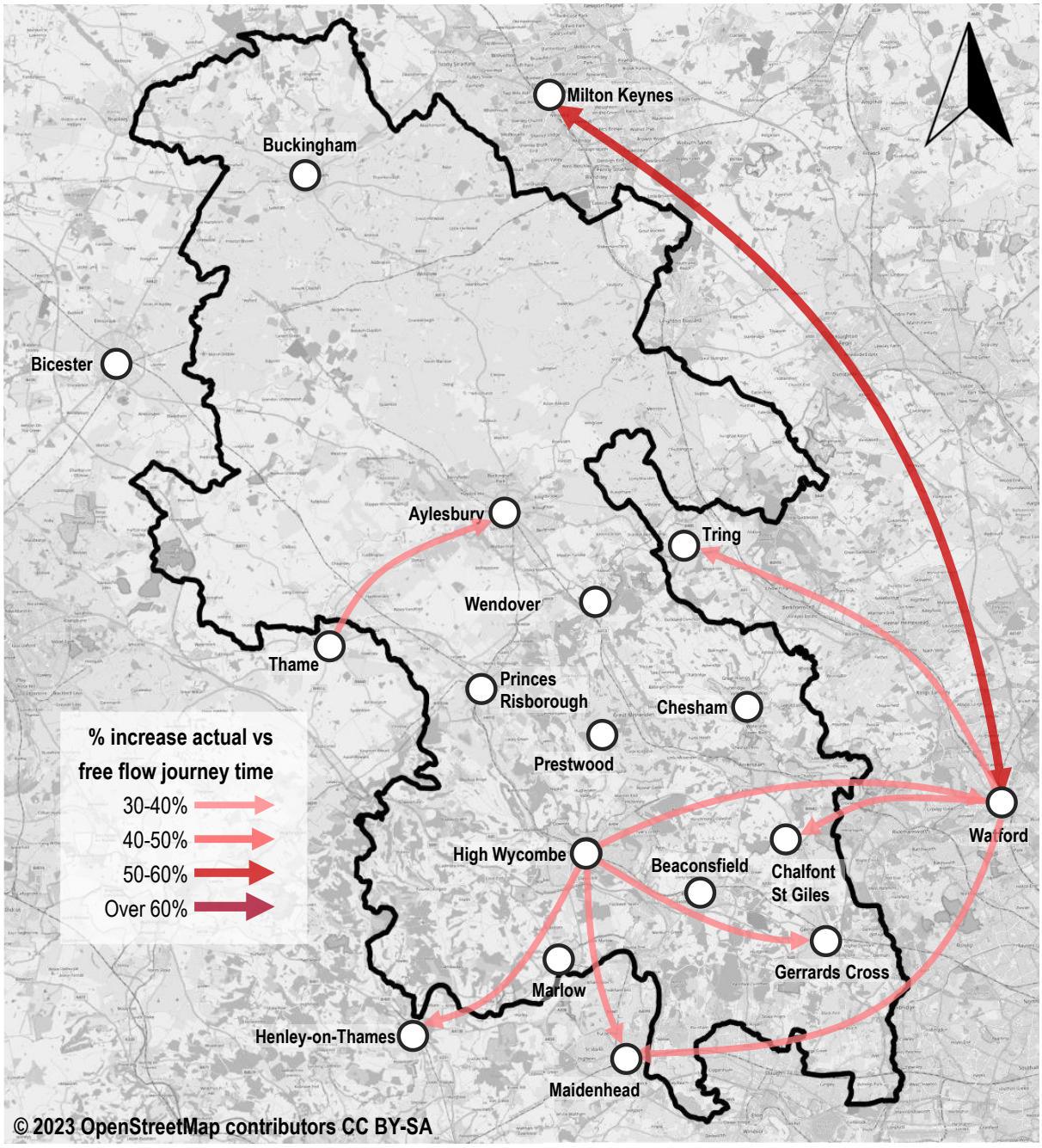


Figure 3-5 Top ten journeys with largest forecast % delay in 2019 base year (evening peak)



3.4. Link volumes and capacities

The ratio of the volume of traffic on a link to the capacity of the link ('V/C ratio') is a common indicator of causes of congestion. The V/C ratio for the highway network in 2019 are shown in Figure 3-6 and Figure 3-7 for the morning and evening peak hours, respectively.

The link volume/capacity ratio (V/C) is the volume of traffic as a percentage of the capacity of the highway link. A link with a V/C of greater than 85% will see a significant reduction in speed on that link whilst a link with a V/C of 100% is considered to be at capacity. It does not have any relationship to the capacity of the 'downstream' junction at the end of a link which can often be a more relevant determinant of the capacity of a road network overall.

Figure 3-6 and Figure 3-7 show that there are links approaching capacity or over capacity (shown in dark red), leading to delays in the morning and evening peak hours. These locations include the following (excluding the motorways):

- A421 between Buckingham and Milton Keynes (V/C of 70-80%);
- A413 London Road, between Wendover and Great Missenden (V/C of 70-100%);
- A413, between Amersham and Chalfont St Giles (V/C of 85-100%);
- A418 east of Aylesbury (V/C of 70-100%);;
- A40 London Road, High Wycombe (V/C of 85-100%); and
- A404, Amersham Road, High Wycombe (V/C of 70-100%).

Figure 3-6 Link volume/capacity– Base year 2019, morning peak hour

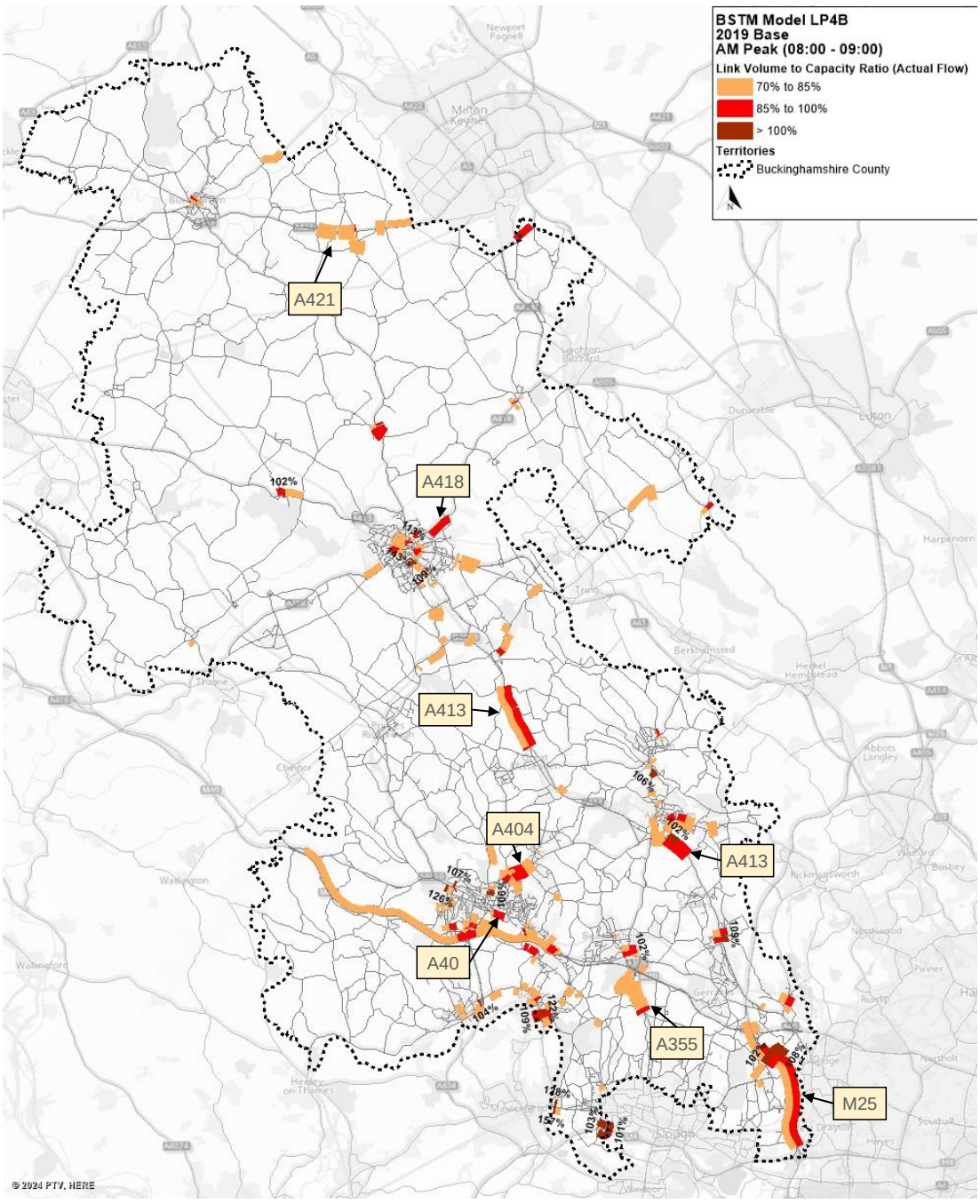
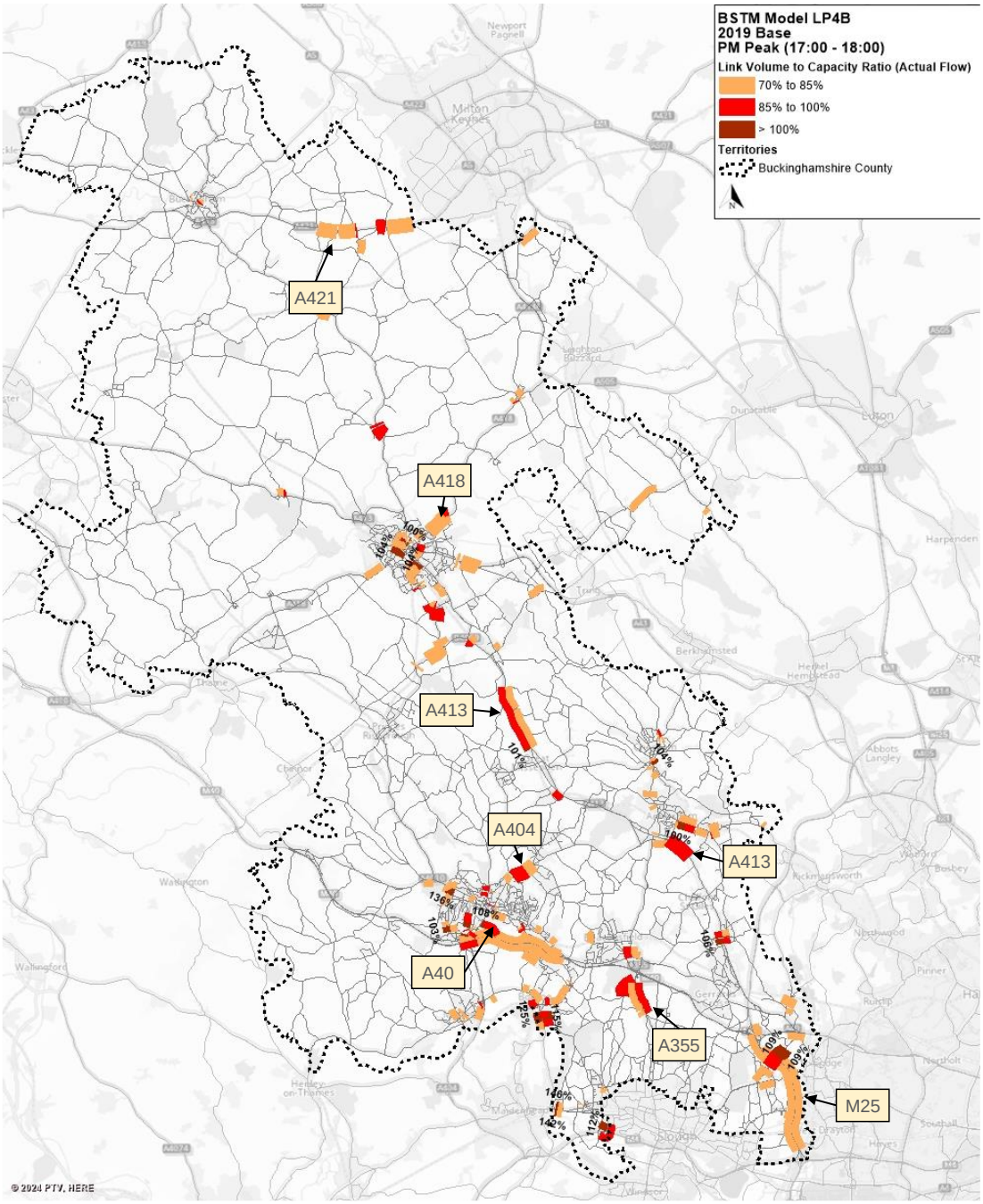


Figure 3-7 Link volume/capacity – Base year 2019, evening peak hour



3.5. Node (junction) volumes and /capacities

Node Volume/capacity (V/C) ratios for the highway network in 2019 are shown in Figure 3-8 and Figure 3-9 for the morning and evening peak hours respectively. As with link V/C a node V/C of greater than 85% is approaching capacity and a node V/C of 100% is at capacity. It is noted that the node V/C represents a flow weighted average of the approach volume/capacities so individual approaches or turns could be overcapacity even if the overall junction is within capacity. V/C ratios for nodes in the wider model area (i.e., outside Buckinghamshire) are not shown as these junctions do not have detailed junction coding.

Figure 3-8 Node (junction) volume/capacity– Base year 2019, morning peak hour

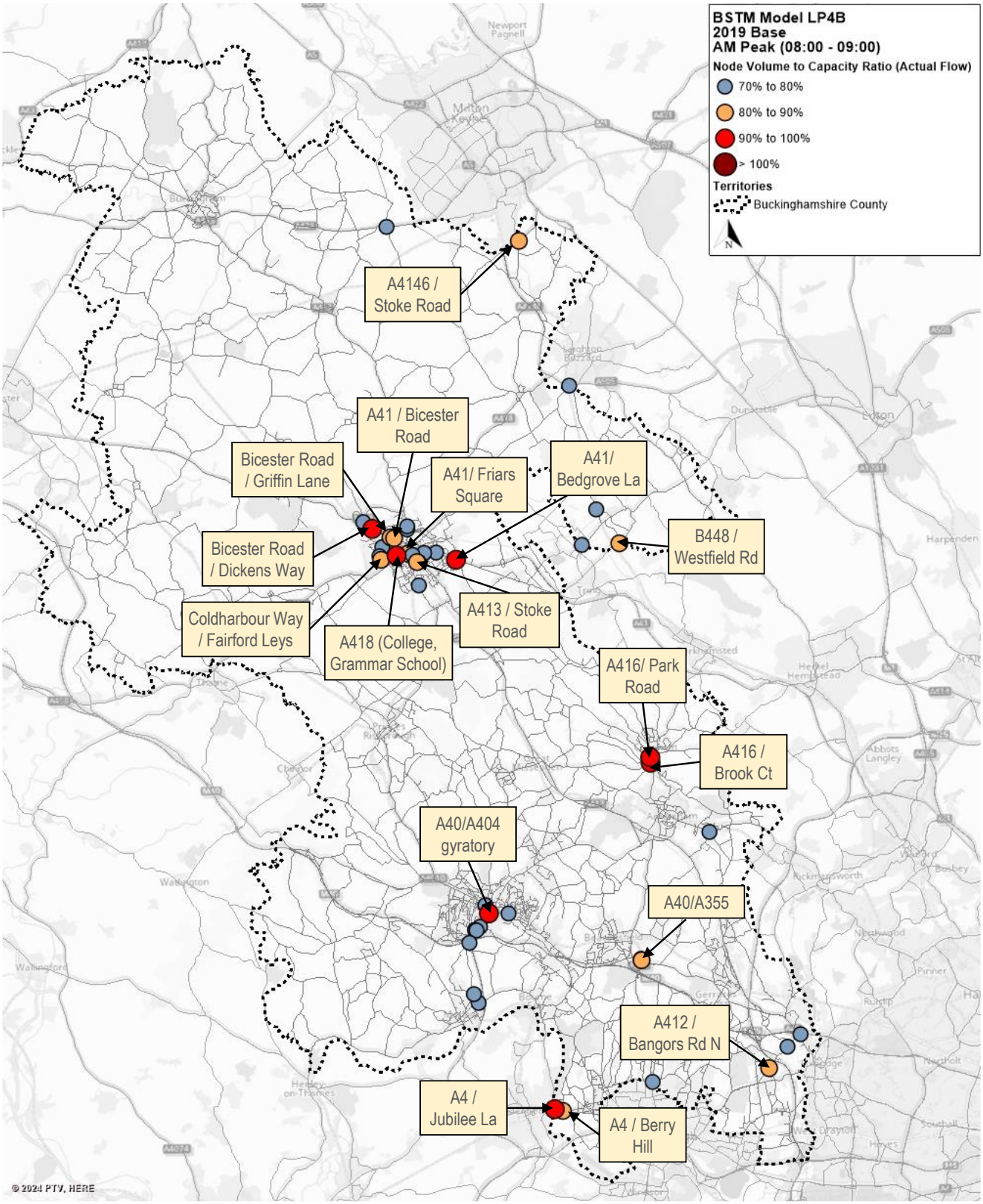


Figure 3-9 Node (junction) volume/capacity– Base year 2019, evening peak hour

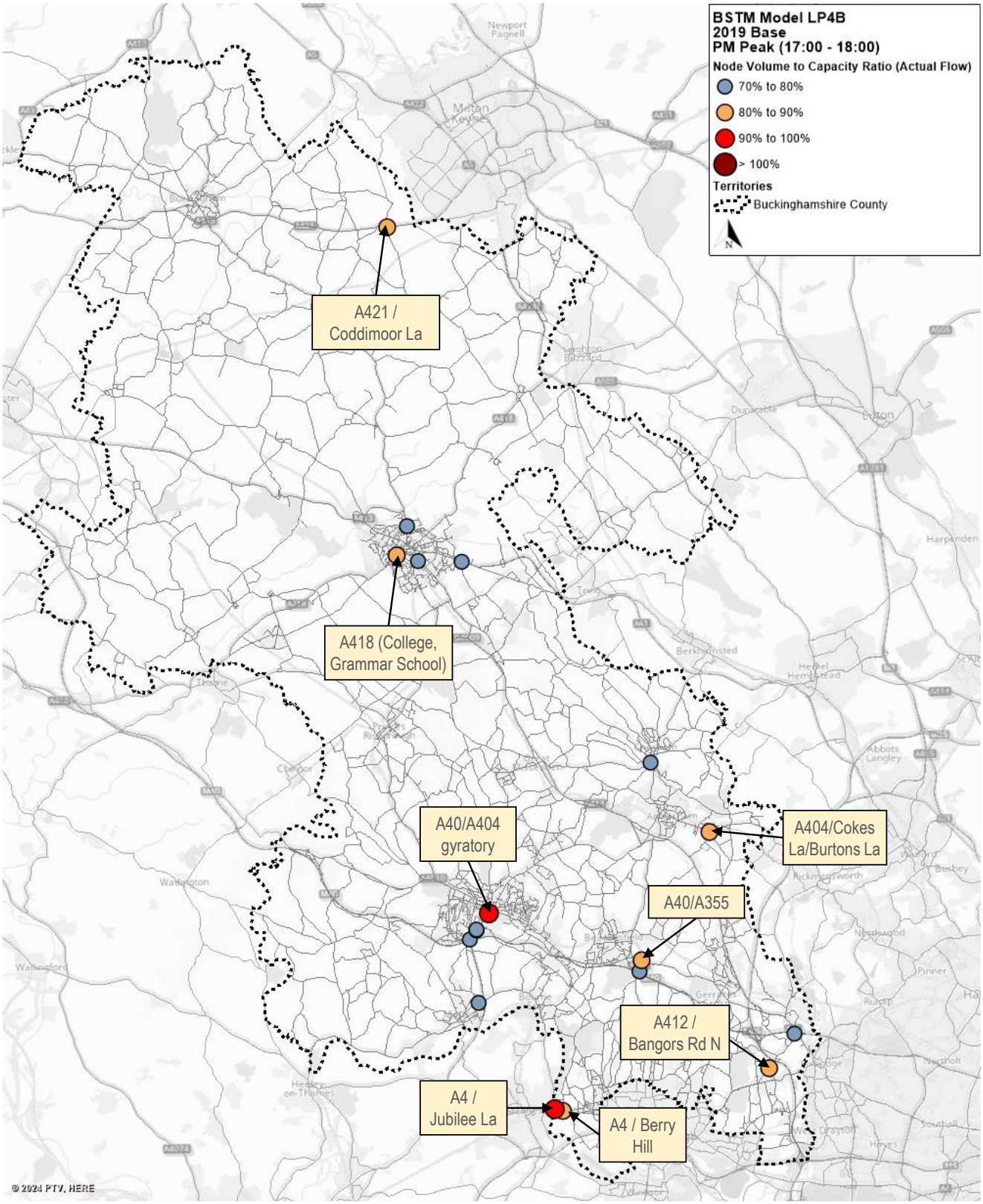


Figure 3-8 and Figure 3-9 show that the majority of capacity issues at junctions in the 2019 base year occur within the key urban areas of Aylesbury and High Wycombe. The capacity issues are more significant during the morning peak hour.

The key locations of junction congestion in the 2019 base year in the morning and evening peak hours are as follows:

- A4157/A41/Bicester Road roundabout, Aylesbury;
- A418/A41 junction, Aylesbury;
- A41/Walton Street, Aylesbury;
- A4157/Stocklake/Bellingham Way, Aylesbury;
- Bicester Road/Dickens Way/Jackson Road, Aylesbury;
- A416/Park Road, Chesham;
- A404/Burtons Lane, Amersham;
- M40 Junction 4 (High Wycombe);
- Marlow Hill/Marlow Road, High Wycombe;
- A404/A40, High Wycombe;
- A40/Ryemead Way/Micklefield Road, High Wycombe;
- A40/A355 Pyebush Roundabout, Beaconsfield;
- A40/Bangors Road North, Iver Heath.

The BSTM has not been developed to a high level of validation within the urban centres (e.g. Aylesbury and High Wycombe). However, the outputs give an indication of capacity issues in these areas that can be used to inform the overall picture of road network performance in Buckinghamshire.

4. 2045 traffic levels and network performance

4.1. Introduction

This chapter describes the forecast performance of the highway network in 2045 based on model outputs from the BSTM. The key changes between 2019 and 2045 are discussed and the key areas of congestion are identified.

4.2. Summary network statistics

Table 4-1 to Table 4-3 show the summary statistics for 2019 and 2045 for the Buckinghamshire Council area in the morning peak, inter-peak and evening peak periods respectively. This includes all traffic using Buckinghamshire road network.

The tables below show increases in traffic levels (vehicle miles) of 26-30% during peak periods. By comparison, the National Road Transport Projection (Core) is an 27% increase in daily traffic (vehicle miles) on all roads in the South East between 2015 and 2045[3]. These projections are however daily figures – growth in peak periods may be lower due to limited capacity. Traffic growth in Buckinghamshire as shown in the tables below is therefore broadly comparable to the Core National Road Traffic Projection for daily traffic growth in the South East in terms of vehicle miles.

Table 4-1 Summary assignment statistics – morning peak hour

Statistic	2019	2045	Absolute change	Percentage change
Total number of journeys (vehicles)[4]	152,946	208,450	+55,504	+36%
Total travel time (vehicle hours)	33,409	45,478	+12,069	+36%
Of which delay (vehicle hours)	5,428	10,277	+4,849	+89%
Total distance travelled (vehicle miles)	1,053,060	1,326,687	+273,627	+26%
Average journey speed (mph)	31.5	29.1	-2.4	-7%
Average delay per vehicle mile (seconds)	18.5	27.9	+9.3	+50%

Table 4-2 Summary assignment statistics – inter-peak hour

Statistic	2019	2045	Absolute change	Percentage change
Total number of journeys (vehicles)	102,090	139,868	+37,778	+37%
Total travel time (vehicle hours)	20,114	26,832	+6,718	+33%
Of which delay (vehicle hours)	1,476	2,762	+1,286	+87%
Total distance travelled (vehicle miles)	743,545	968,344	+224,798	+30%
Average journey speed (mph)	37.0	36.1	-0.9	-2%
Average delay per vehicle mile (seconds)	7.1	10.3	+3.1	+44%

3 https://www.gov.uk/government/publications/national-road-traffic-projections

4 Includes trip Using Buckinghamshire county road network

Table 4-3 Summary assignment statistics – evening peak hour

Statistic	2019	2045	Absolute change	Percentage change
Total number of journeys (vehicles)	152,946	206,186	+54,396	+36%
Total travel time (vehicle hours)	32,370	44,275	+11,905	+37%
Of which delay (vehicle hours)	4,782	9,041	+4,259	+89%
Total distance travelled (vehicle miles)	1,057,209	1,353,576	+296,367	+28%
Average journey speed (mph)	32.7	30.6	-2.1	-6%
Average delay per vehicle mile (seconds)	16.3	24.0	+7.8	+48%

The tables show similar percentage increases in the number of trips and the total travel time. This suggests that the average travel time is remaining broadly constant (at about 13 minutes per journey in the peaks and 12 minutes in the inter-peak). However, the total distance travelled increases by a smaller percentage, indicating that the average trip length is reducing. These findings are consistent with a scenario in people's travel time budgets are remaining broadly constant, but the distance travelled in that time is falling.

The consequence of shorter journeys but similar travel times is that average speeds are predicted to fall. There is a forecast reduction in average speeds of 7% in the morning peak, 2% in the inter-peak and 6% in the evening peak hour, between the 2019 base year and the 2045 future year assignment. The National Traffic Projection (Core) for the South East is for speeds on all roads to fall by a weighted average of 4.2% over the same period (5.6% excluding minor roads).

With these reducing speeds is a forecast increase in the amount of travel time which is due to delay (rather than the free-flow time). In all three time periods, the amount of travel time delay is expected to almost double (increasing by between 87% and 89%). The absolute numbers are significant, for example an increase in delay in Buckinghamshire of over 4,800 hours in each morning peak hour and average delay per vehicle mile increasing by over nine seconds.

4.3. Development trips

Journeys to and from the existing site allocations and existing commitments account for a proportion of the traffic growth described in the previous section. Table 4-4 shows the total forecast growth in highway journeys within Buckinghamshire and the share of those which are to/from the existing site allocation and existing commitments which were specifically represented in the model.

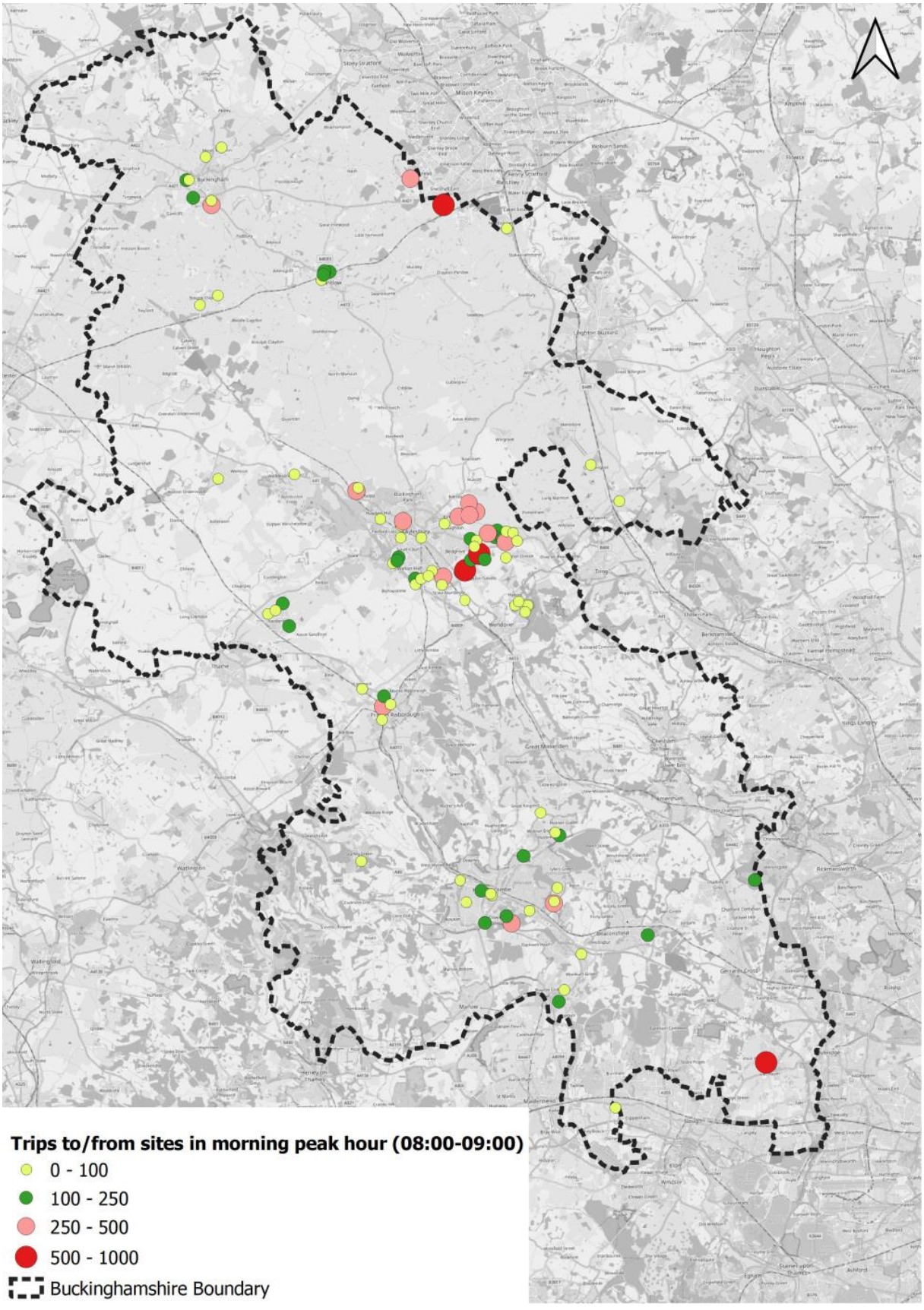
The table shows that these journeys account for between 25% and 31% of the total growth in traffic between 2019 and 2045. In 2045 these journeys account for between 9% and 11% of all journeys made in Buckinghamshire.

Table 4-4 Development trips as share of total traffic and growth

	Morning peak hour	Average inter-peak hour	Evening peak hour
Total journeys in 2019	152,496	102,090	151,790
Total journeys in 2045	208,450	139,868	206,186
Increase in total journeys 2019 to 2045	+55,504	+37,778	+54.396
Of which to/from allocations/commitments	+14,612	+9,319	+16,778
	26%	25%	31%
Share of total journeys which are to/from allocations/commitments	10%	9%	11%

The number of vehicle trips to/from the explicitly modelled developments is shown in Figure 4-1 for the morning peak hour. The growth is very similar for the evening peak hour.

Figure 4-1 Development trips 2019-2045: morning peak hour



There is significant planned growth from development at the following locations:

- south and east of Aylesbury;
- south and east of High Wycombe;
- west of Princes Risborough;
- Haddenham;
- North of Winslow;
- north-east of Wendover; and
- south and west of Buckingham.

4.4. Forecast changes in traffic volumes

4.4.1. County-wide perspective

The forecast change in traffic volumes between 2019 and 2045 is shown in Figure 4-2 and Figure 4-3 for the morning and evening peak hours respectively. An increase in traffic flow between 2019 and 2045 is shown in red and a reduction in traffic flow is shown in blue.

These figures show changes in traffic levels at a county-wide level. The sections of road with the highest increases are shown in Table 4-5.

Table 4-5 Roads with largest forecast increases in traffic 2019 to 2045 (combined directions)

Road	Morning peak hour		Evening peak hour 2019	
	2019	Increase to 2045	2019	Increase to 2045
A41 east of Aylesbury	2,078	+1,840	2,424	+2,230
M40 (east of Junction 2)	6,452	+1,000	8,748	+2,360
M25 (north of Junction 16)	11,047	+3,100	11,745	+2,840
A4010 Risborough Road between Aylesbury and Princes Risborough	1,472	+770	1,665	+530
Ellesborough Road between Princes Risborough and Wendover	712	+530	606	+610
A355 between Amersham and Beaconsfield	1,839	+630	1,679	+530
Bellingham Way, Aylesbury	407	+1440	404	+1210
A418 Oxford Road, Aylesbury	2,252	+390	1,515	+360
A404 (north of Daws Hill Lane), High Wycombe	2,907	+440	3,383	+500
Abbey Barn Lane, High Wycombe	549	-80	487	+310

Figure 4-2 Forecast change in traffic volume 2019 to 2045, morning peak hour (Buckinghamshire)

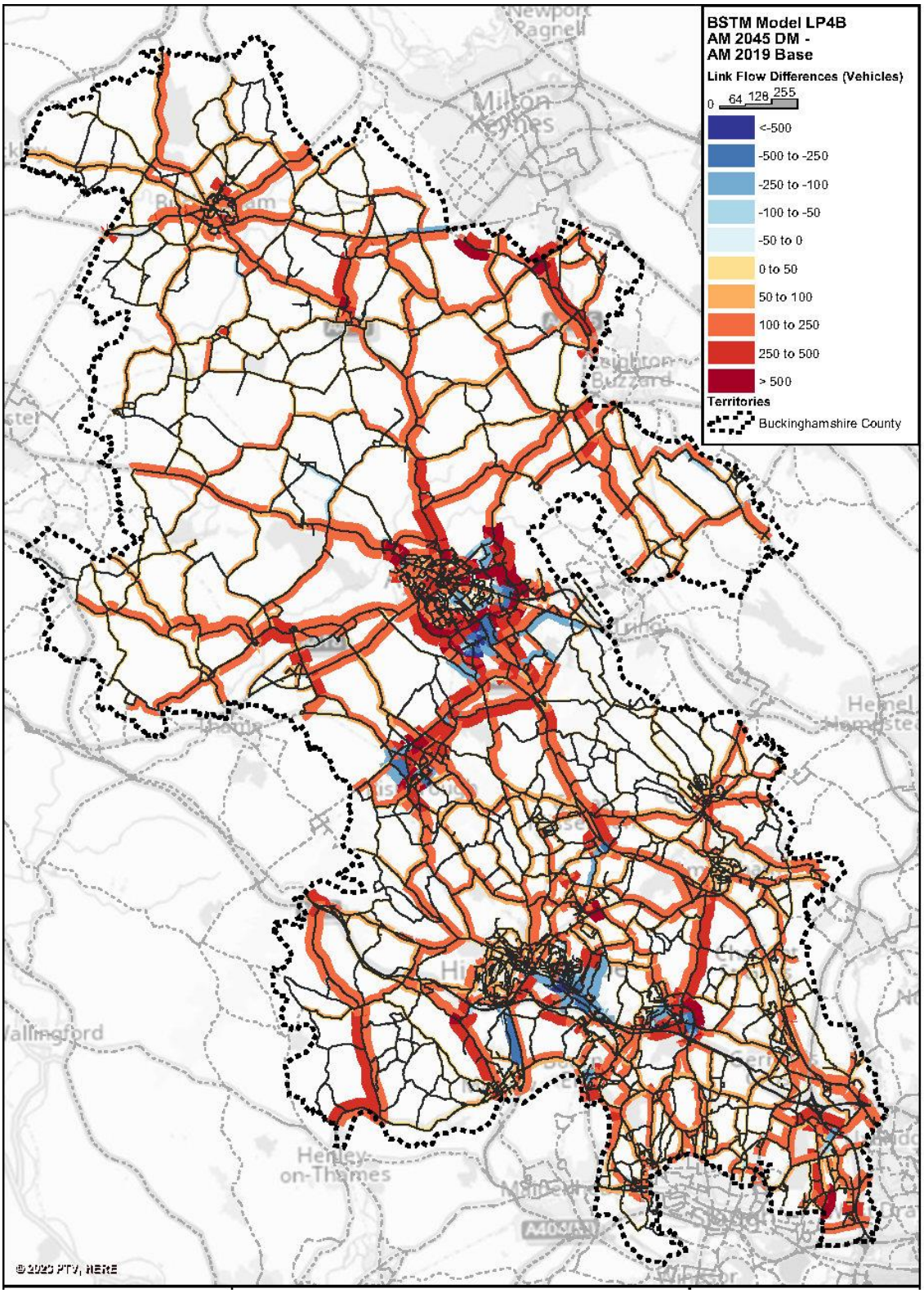
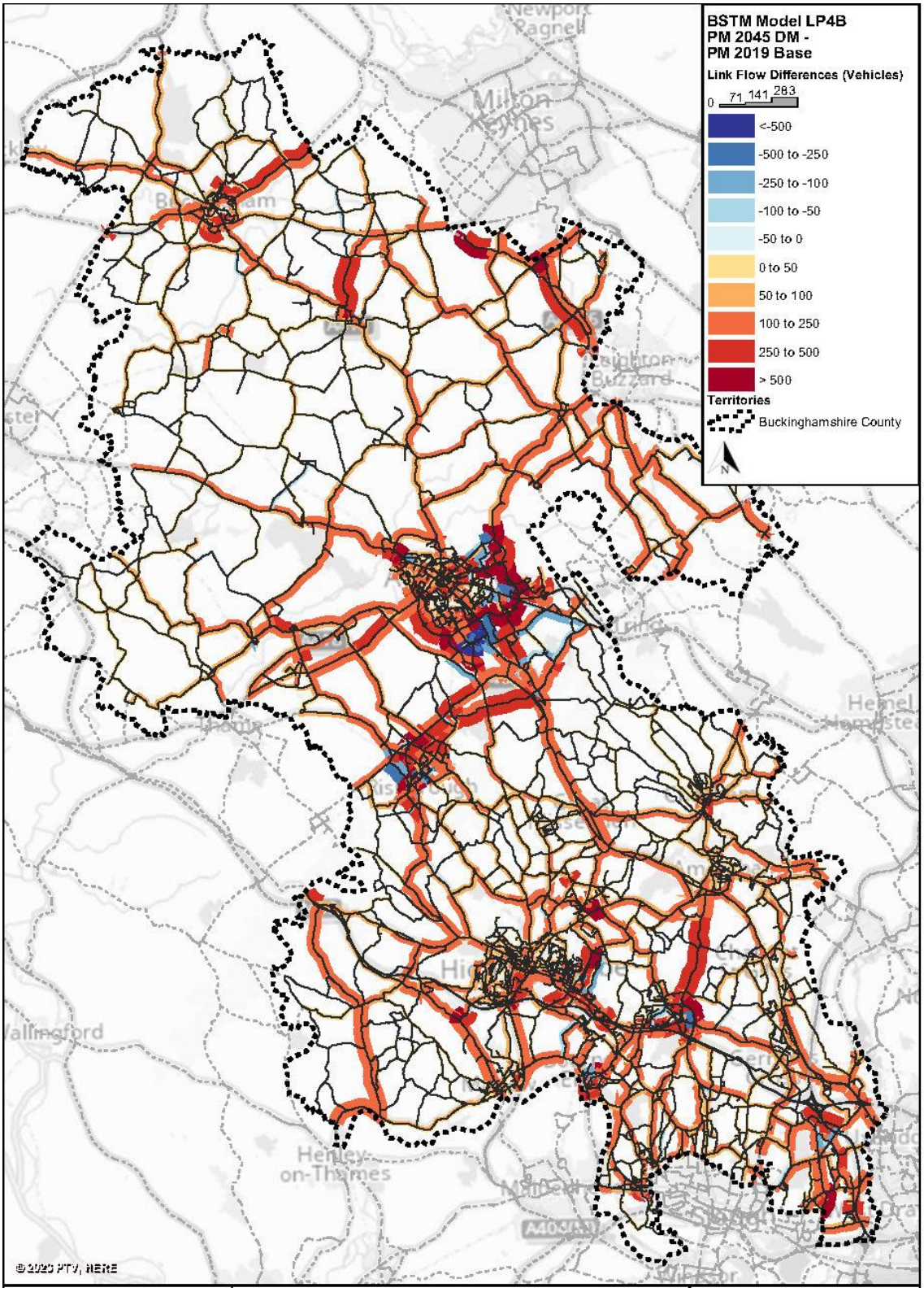


Figure 4-3 Forecast change in traffic volume 2019 to 2045, evening peak hour (Buckinghamshire)



4.4.2. Traffic in Aylesbury

Forecast changes in traffic volumes in Aylesbury between 2019 and 2045 are shown in Figure 4-4 and Figure 4-5 for the morning and evening peak periods respectively.

The 2045 model includes new sections of the orbital route: the South Western Link Road (SWLR), South East Aylesbury Link Road (SEALR), Southern Link Road (SLR) and Eastern Link Road (ELR). These new roads are all forecast to experience high traffic volumes of between 700 and 3,000 vehicles per hour (two-way) in the morning and evening peak hours.

Traffic is also forecast to increase on many of the other existing roads in Aylesbury, notably on Stocklake, New Street, Oxford Road (A418), Lower Road (Stoke Mandeville) and on all arterial routes entering Aylesbury.

There are forecast reductions in traffic on Station Road and Wendover Road (Stoke Mandeville) and on Aston Clinton Road. This is due to forecast re-routing of traffic from these roads to the new orbital routes.

Figure 4-4 Forecast change in traffic volume 2019 to 2045, morning peak hour (Aylesbury)

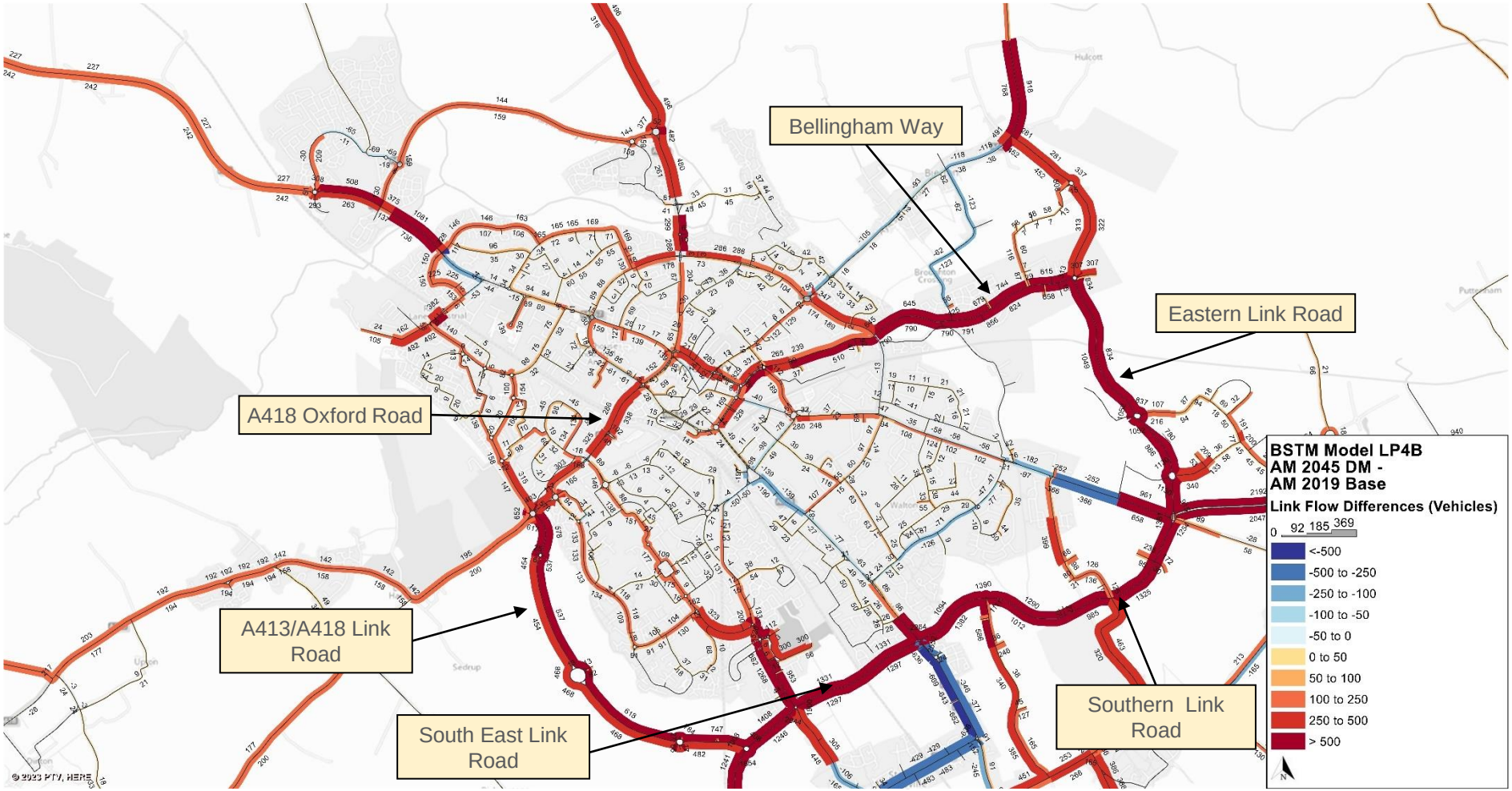
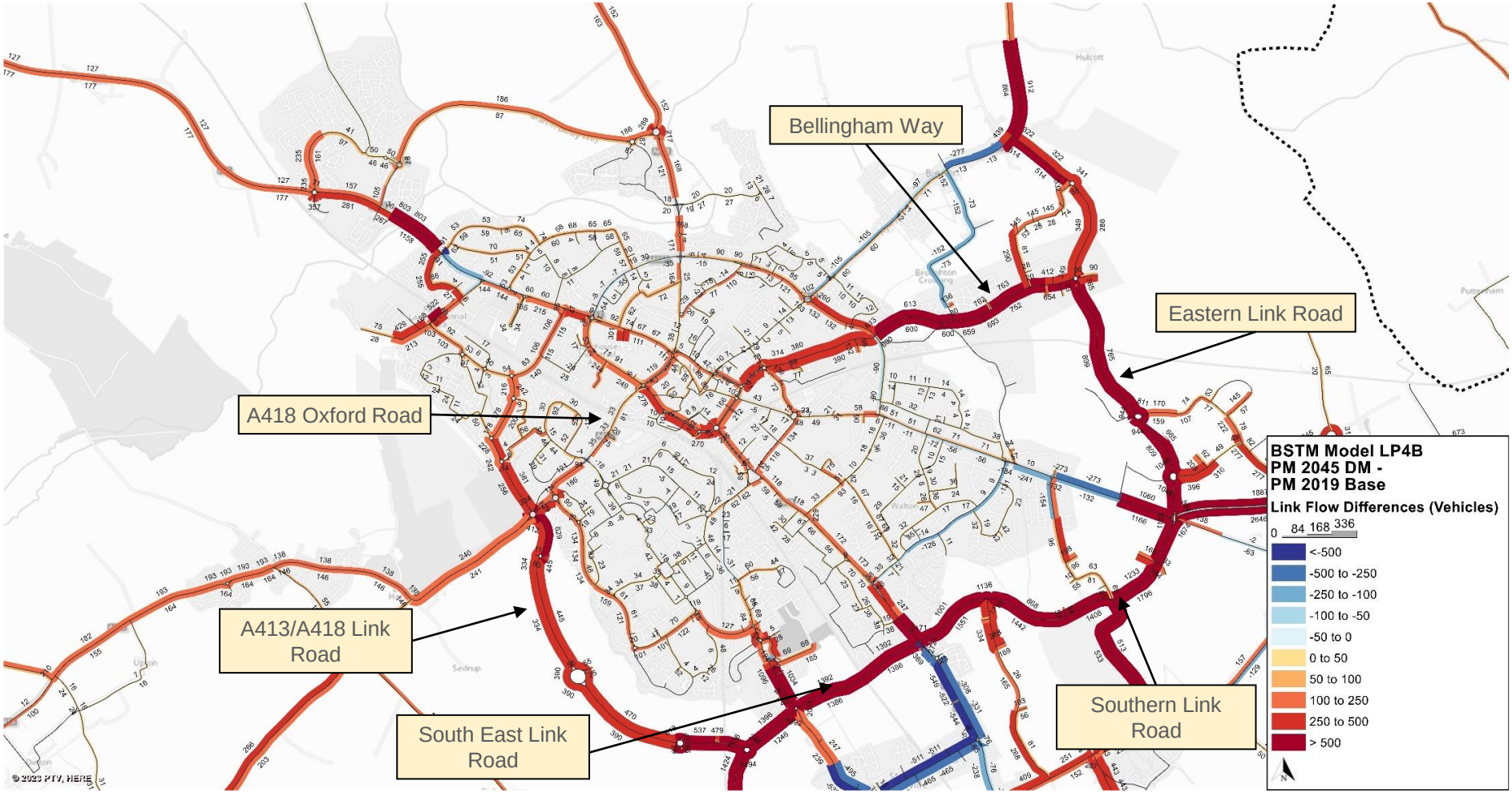


Figure 4-5 Forecast change in traffic volume 2019 to 2045, evening peak hour (Aylesbury)



4.4.3. Traffic in High Wycombe

Forecast changes in traffic volumes in High Wycombe between 2019 and 2045 are shown in Figure 4-6 and Figure 4-7 for the morning and evening peak periods respectively.

Congestion on the A40 London Road and M40 Junction 4 and provision of the new Gomm Valley Spine Road is forecast to cause re-routeing of traffic in the morning peak hour resulting in reductions in traffic volume on London Road and on the A404 (south of M40 Junction 4).

Figure 4-6 Forecast change in traffic volume 2019 to 2045, morning peak hour (High Wycombe)

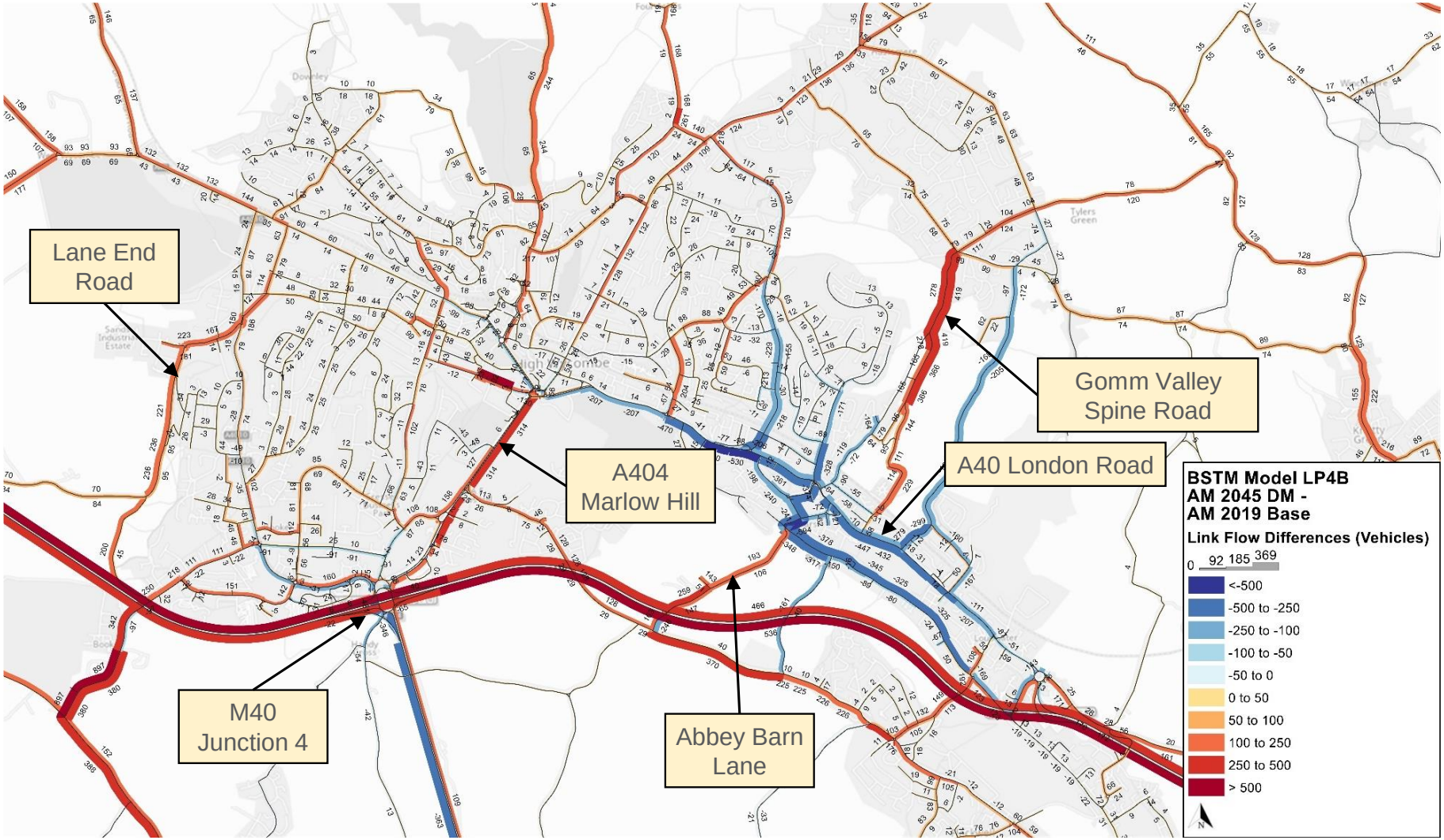
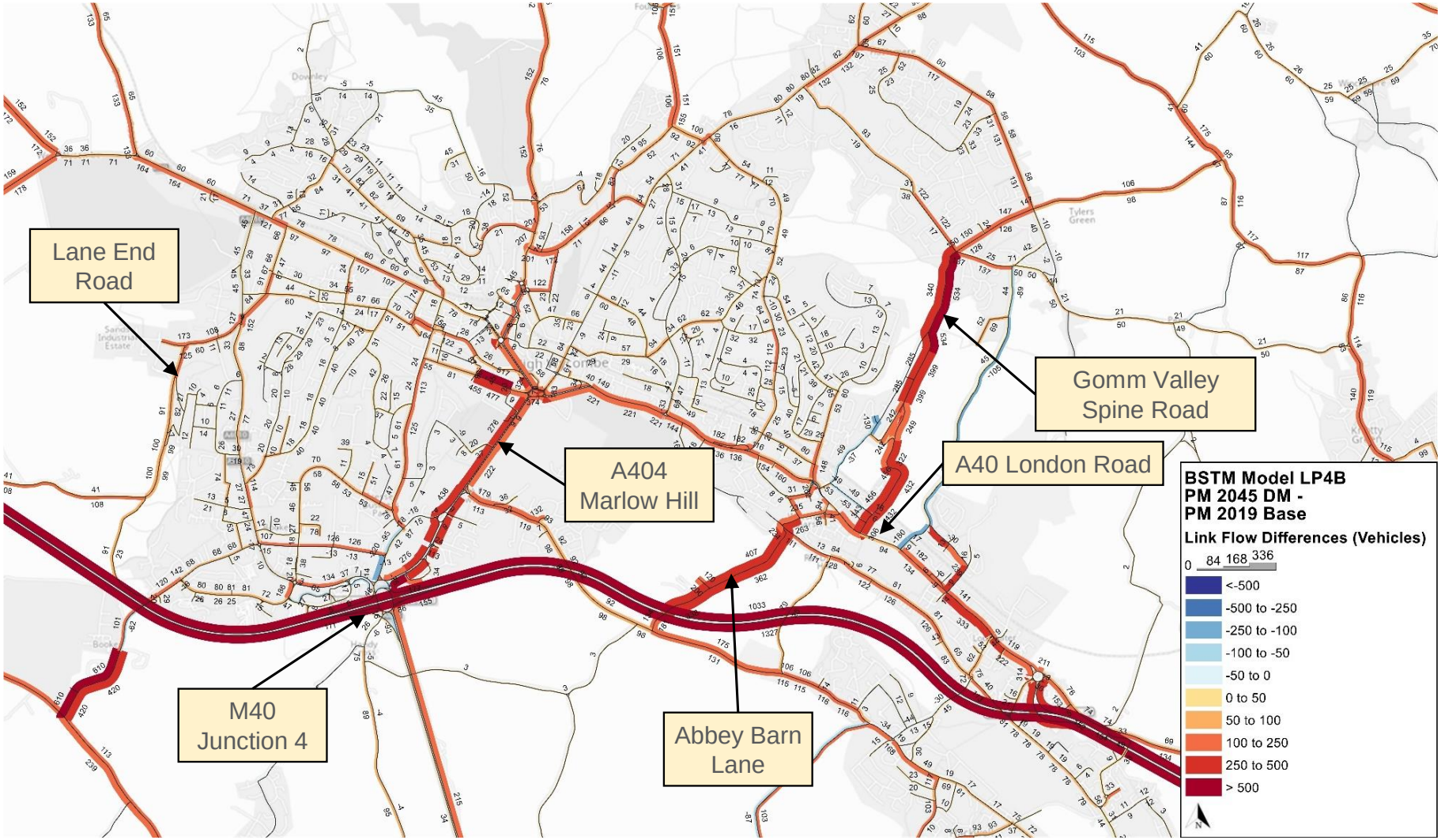


Figure 4-7 Forecast change in traffic volume 2019 to 2045, evening peak hour (High Wycombe)



4.4.4. Traffic in Chesham

Forecast changes in traffic volumes in Chesham between 2019 and 2045 are shown in Figure 4-8 and Figure 4-9 for the morning and evening peak periods respectively. In both time periods the largest absolute increases in traffic are on the A416 (St Marys Way) through the centre of the town adjacent to Lowndes Park and northwards to the Elgiva Roundabout (A416/White Hill). The number of vehicles on the southern part of this section increases by approximately 800 in the morning peak hour and approximately 500 in the evening peak hour (combined directions).

The additional traffic in the town centre is entering and leaving the area via the main radial roads in and out of Chesham. The radials with the largest increases in the morning peak hour are on White Hill to the north-east (+340 vehicles); Broad Street/Nashleigh Hill to the north (up to +250 vehicles); B485 Missenden Road to the west (+250 vehicles); Amersham Road to the south (+180 vehicles); and Waterside/Latimer Road to the south-east (+150 vehicles). Patterns are similar in the evening peak but with generally lower increases in traffic. The highest increases are on White Hill (+240 vehicles) and Missenden Road (+220 vehicles).

Figure 4-8 Forecast change in traffic volume 2019 to 2045, morning peak hour (Chesham)

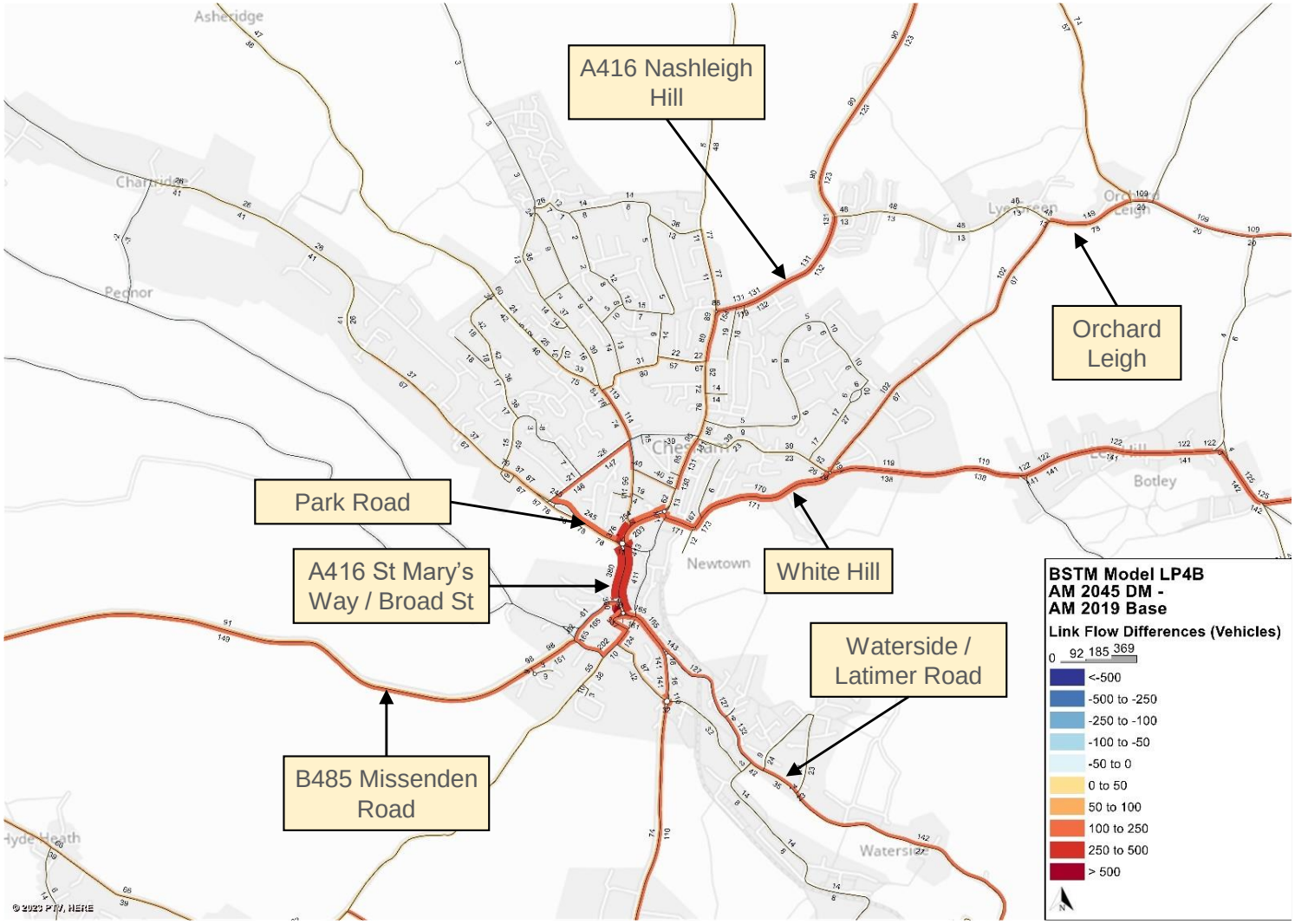
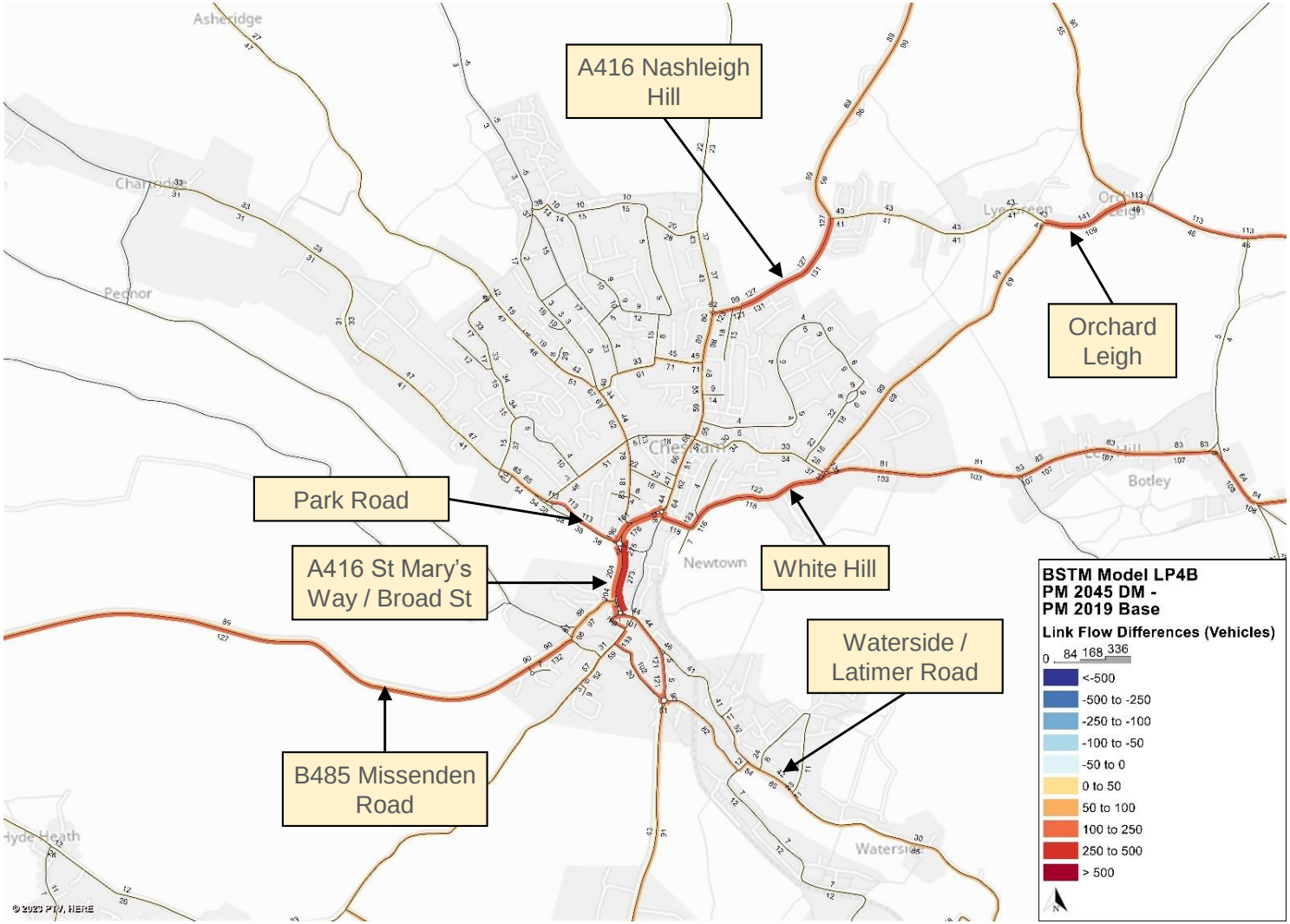


Figure 4-9 Forecast change in traffic volume 2019 to 2045, evening peak hour (Chesham)



4.4.5. Traffic in Amersham

Forecast changes in traffic volumes in Amersham between 2019 and 2045 are shown in Figure 4-10 and Figure 4-11 for the morning and evening peak periods respectively.

Overall, forecast increases in traffic are lower in Amersham than in Aylesbury and High Wycombe, in part due to lower levels of planned growth in Amersham.

In the morning peak, the highest forecast increases are on the A355 Gore Hill southbound towards Beaconsfield and on the A413 west of Gore Hill Roundabout. Increases are also notable on Rectory Hill and White Lion Road.

The pattern is similar in the evening peak, but with smaller increases. The A355 in both directions sees the largest increases, as does the A413 through Amersham (including London Road East). Increases are also notable on Stanley Hill and White Lion Road.

Figure 4-10 Forecast change in traffic volume 2019 to 2045, morning peak hour (Amersham)

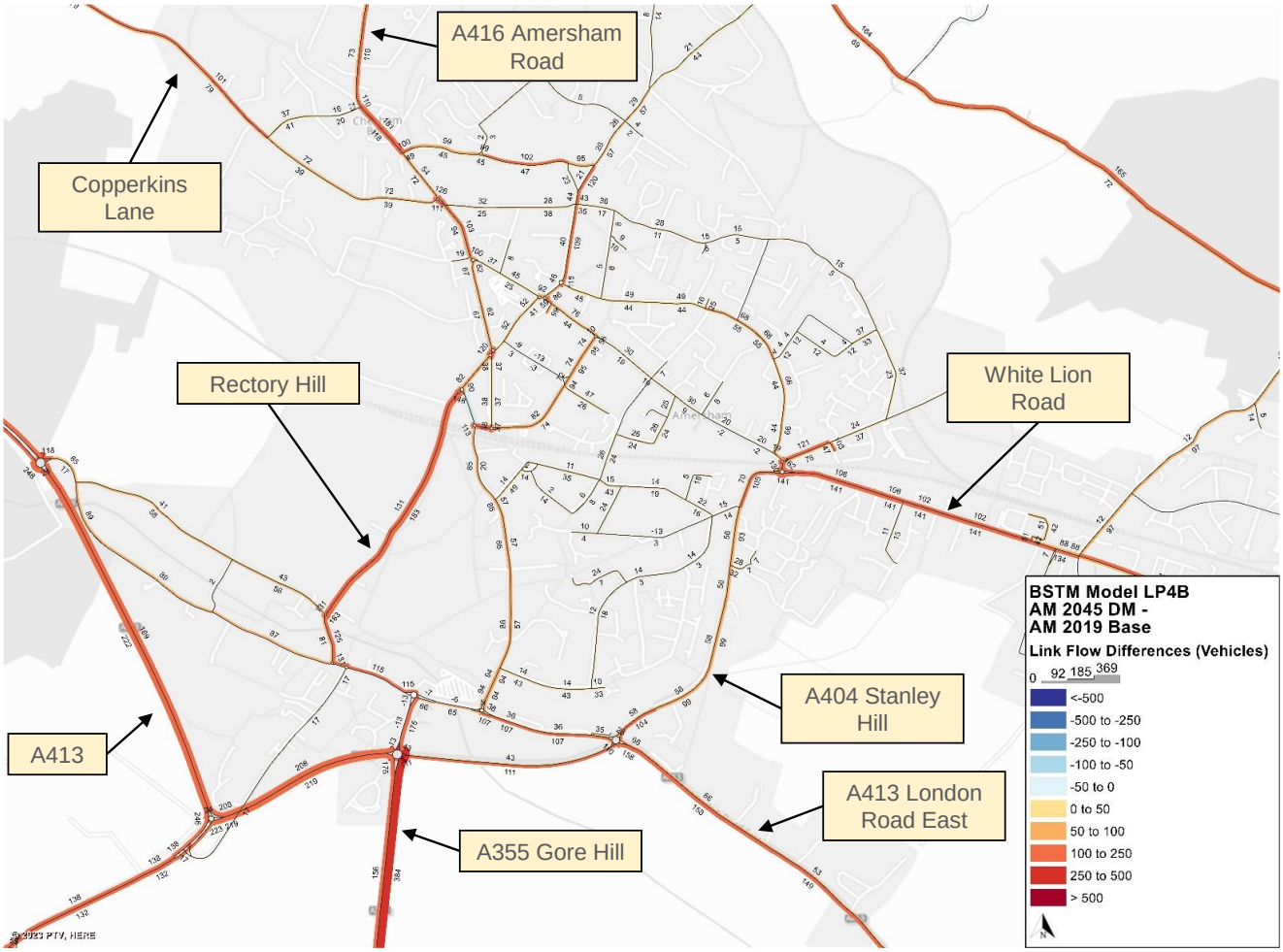
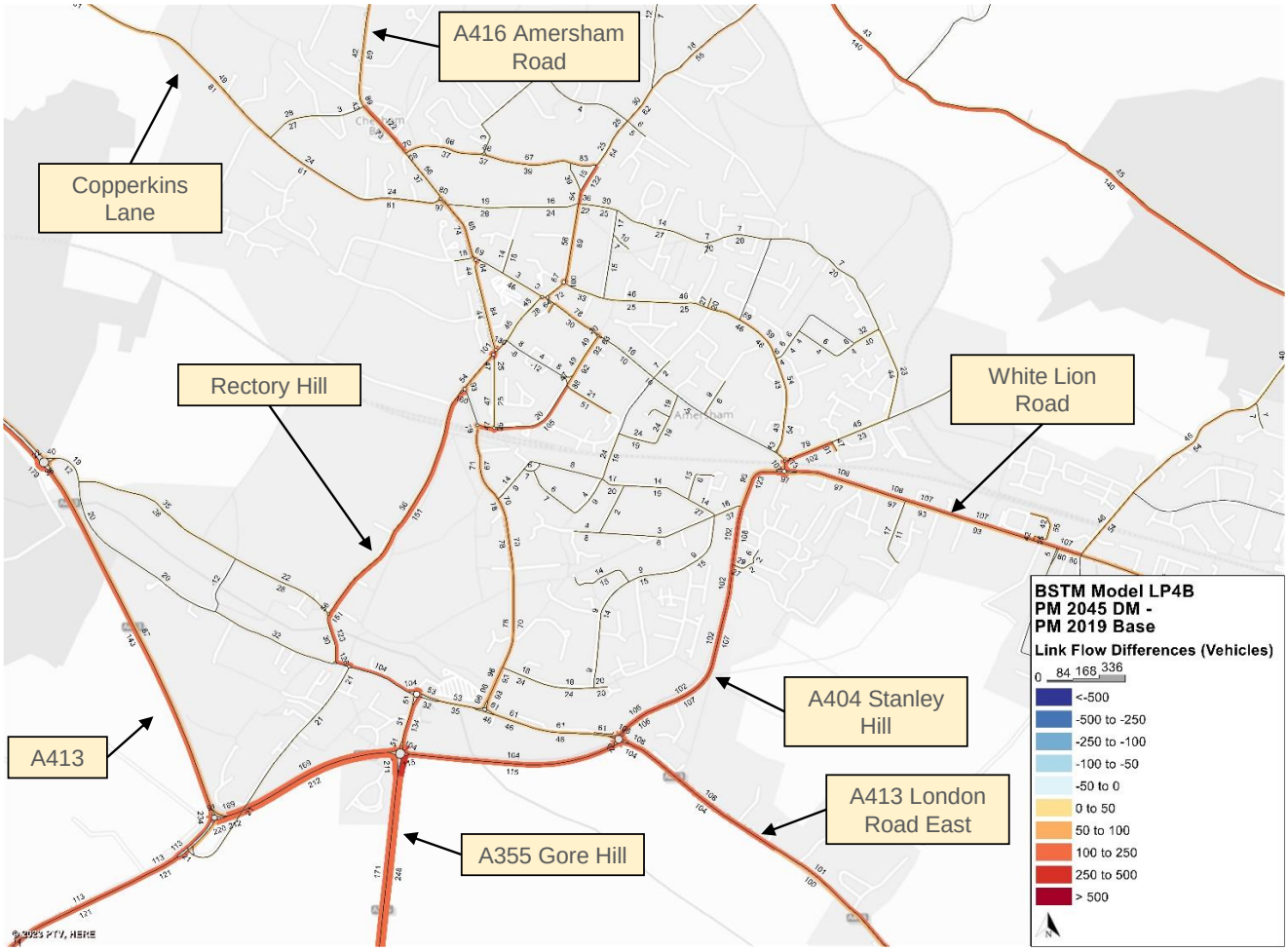


Figure 4-11 Forecast change in traffic volume 2019 to 2045, evening peak hour (Amersham)



4.5. Forecast changes in delays (congestion)

The change in travel times between the 18 key locations shown in Figure 3-3 between 2019 and 2045 has been analysed. The analysis indicates that the journeys with the highest forecast percentage increase in journey time are those shown in Table 4-6 and Table 4-7 for the morning and evening peak hours respectively. These journeys are also shown in Figure 4-12 and Figure 4-13. The outputs for all origin-destination movements are provided in Table 4-8 and Table 4-9 for the morning and evening peak hours respectively.

Table 4-6 Largest percentage increases in journey time between 2019 to 2045, morning peak hour

Movement		Travel times (minutes)			Increase in travel time 2019 - 2045
Origin	Destination	2019 free flow	2019 congested	2045 congested	
Henley-on-Thames	High Wycombe	21.8	29.0	36.0	24%
Marlow	Beaconsfield	21.4	26.6	32.9	24%
Maidenhead	High Wycombe	18.6	24.5	30.1	23%
Henley-on-Thames	Chalfont St Giles	30.7	37.1	45.5	23%
Marlow	Watford	33.2	41.9	51.0	22%
Chalfont St Giles	Marlow	25.4	27.5	33.4	22%
Henley-on-Thames	Beaconsfield	28.0	35.3	42.9	21%
Marlow	Chalfont St Giles	24.1	28.3	34.4	21%
Wendover	Prestwood	10.5	10.3	12.5	21%
Gerrards Cross	High Wycombe	22.6	27.8	33.3	20%

Table 4-7 Largest percentage increases in journey time between 2019 to 2045, evening peak hour

Movement		Travel times (minutes)			Increase in travel time 2019 - 2045
Origin	Destination	2019 Free flow	2019 congested	2045 congested	
Prestwood	Wendover	10.6	10.8	13.1	21%
Prestwood	Aylesbury	22.4	24.4	29.3	20%
Watford	Tring	21.3	28.7	34.2	19%
Aylesbury	Wendover	11.8	13.5	16.0	19%
Wendover	Aylesbury	12.4	14.0	16.5	18%
Amersham/Chesham	Aylesbury	27.8	29.1	34.3	18%
Henley-on-Thames	Watford	39.8	49.1	57.7	17%
Princes Risborough	Wendover	13.5	13.0	15.3	17%
High Wycombe	Wendover	21.7	23.3	27.2	17%
Watford	Wendover	28.5	37.1	43.4	17%

During the morning peak hour, the largest increases in delay between 2019 and 2045 are forecast in the south of Buckinghamshire. There are significant increases in delay to and from High Wycombe, Beaconsfield, Henley-on-Thames, and Marlow.

In the evening peak hour, the most significant increases in delay are forecast for journeys to and from Aylesbury, Wendover, Watford, and Princes Risborough. The key causes for the journey time delays for these movements are discussed in more detail in the following sections.

Table 4-8 Forecast change in delay between 2019 and 2045 (all movements), morning peak hour

		To																	
		Amersham/Chesham	Aylesbury	Beaconsfield	Bicester	Buckingham	Chalfont St Giles	Gerrards Cross	Henley-on-Thames	High Wycombe	Maidenhead	Marlow	Milton Keynes	Prestwood	Princes Risborough	Thame	Tring	Watford	Wendover
From	Amersham/Chesham		13%	18%	8%	10%	6%	9%	13%	11%	6%	16%	6%	3%	5%	6%	4%	15%	6%
	Aylesbury	16%		18%	9%	7%	15%	14%	11%	17%	11%	11%	9%	18%	13%	13%	6%	14%	16%
	Beaconsfield	9%	12%		9%	9%	8%	5%	10%	14%	9%	14%	6%	8%	7%	7%	5%	10%	6%
	Bicester	9%	6%	7%		6%	10%	10%	15%	9%	10%	7%	9%	7%	6%	5%	6%	4%	6%
	Buckingham	8%	1%	5%	5%		8%	7%	10%	7%	7%	4%	9%	7%	7%	3%	9%	12%	6%
	Chalfont St Giles	7%	12%	9%	12%	10%		4%	17%	11%	10%	22%	7%	6%	6%	6%	7%	13%	7%
	Gerrards Cross	7%	11%	10%	10%	6%	6%		14%	20%	7%	19%	9%	6%	4%	11%	11%	6%	7%
	Henley-on-Thames	17%	10%	21%	12%	8%	23%	6%		24%	12%	5%	10%	11%	7%	10%	9%	18%	10%
	High Wycombe	4%	11%	8%	6%	8%	5%	6%	6%		5%	8%	7%	3%	3%	4%	6%	11%	7%
	Maidenhead	5%	9%	7%	13%	9%	5%	0%	8%	23%		8%	14%	18%	10%	15%	10%	12%	5%
	Marlow	18%	12%	24%	12%	8%	21%	17%	4%	17%	4%		10%	11%	10%	6%	10%	22%	12%
	Milton Keynes	7%	9%	10%	8%	10%	9%	10%	12%	9%	11%	9%		9%	12%	11%	8%	12%	7%
	Prestwood	5%	15%	10%	6%	10%	14%	13%	9%	14%	8%	11%	7%		6%	6%	6%	10%	8%
	Princes Risborough	7%	14%	7%	6%	11%	8%	9%	9%	9%	11%	6%	11%	8%		9%	10%	15%	16%
	Thame	6%	13%	8%	3%	2%	7%	9%	8%	10%	8%	5%	9%	7%	7%		6%	11%	10%
	Tring	6%	4%	16%	4%	7%	9%	12%	11%	12%	11%	10%	8%	13%	15%	12%		18%	8%
	Watford	15%	13%	16%	3%	12%	7%	6%	16%	13%	13%	18%	12%	7%	14%	14%	19%		16%
	Wendover	16%	20%	19%	9%	11%	15%	14%	11%	17%	10%	10%	7%	21%	18%	12%	5%	14%	

Table 4-9 Forecast change in delay between 2019 and 2045 (all movements), evening peak hour

		To																
		Amersham/Chesham	Aylesbury	Beaconsfield	Bicester	Buckingham	Chalfont St Giles	Gerrards Cross	Henley-on-Thames	High Wycombe	Maidenhead	Marlow	Milton Keynes	Prestwood	Princes Risborough	Thame	Tring	Watford	Wendover
From	Amersham/Chesham		18%	9%	7%	14%	6%	5%	9%	5%	5%	9%	8%	4%	5%	5%	10%	15%	16%
	Aylesbury	11%		13%	9%	10%	11%	9%	9%	11%	9%	8%	11%	14%	13%	12%	6%	11%	19%
	Beaconsfield	7%	16%		9%	10%	2%	-3%	8%	4%	5%	8%	9%	7%	6%	5%	9%	12%	13%
	Bicester	5%	13%	9%		7%	9%	9%	15%	10%	12%	8%	8%	5%	5%	5%	11%	6%	5%
	Buckingham	12%	11%	12%	5%		11%	1%	9%	4%	9%	6%	7%	7%	5%	4%	7%	10%	14%
	Chalfont St Giles	6%	16%	5%	12%	13%		4%	12%	6%	10%	13%	8%	5%	6%	6%	8%	14%	14%
	Gerrards Cross	6%	14%	6%	10%	-2%	3%		8%	10%	8%	9%	9%	6%	7%	9%	10%	4%	12%
	Henley-on-Thames	13%	9%	15%	14%	11%	14%	7%		15%	13%	4%	11%	10%	8%	10%	10%	17%	11%
	High Wycombe	7%	14%	7%	11%	7%	7%	8%	9%		8%	10%	8%	10%	8%	7%	9%	14%	17%
	Maidenhead	4%	11%	3%	11%	8%	2%	1%	7%	14%		5%	10%	13%	12%	10%	-1%	9%	9%
	Marlow	11%	8%	13%	12%	8%	12%	13%	4%	12%	4%		8%	12%	7%	6%	9%	17%	11%
	Milton Keynes	9%	16%	8%	9%	8%	8%	9%	11%	7%	12%	9%		8%	11%	11%	10%	7%	8%
	Prestwood	2%	20%	6%	6%	4%	6%	5%	7%	5%	6%	11%	9%		7%	6%	11%	11%	21%
	Princes Risborough	4%	11%	4%	6%	9%	5%	4%	6%	3%	10%	2%	11%	6%		10%	11%	10%	17%
	Thame	3%	8%	5%	2%	1%	4%	7%	9%	3%	10%	4%	8%	4%	4%		5%	9%	9%
	Tring	8%	6%	8%	8%	5%	6%	7%	8%	7%	6%	6%	7%	7%	14%	11%		15%	10%
	Watford	14%	14%	15%	12%	11%	6%	7%	15%	11%	14%	16%	11%	10%	16%	15%	19%		17%
	Wendover	4%	18%	8%	6%	13%	6%	5%	7%	6%	5%	5%	7%	6%	17%	8%	5%	12%	

Figure 4-12 Top ten increases in delay between 2019 to 2045 (morning peak)

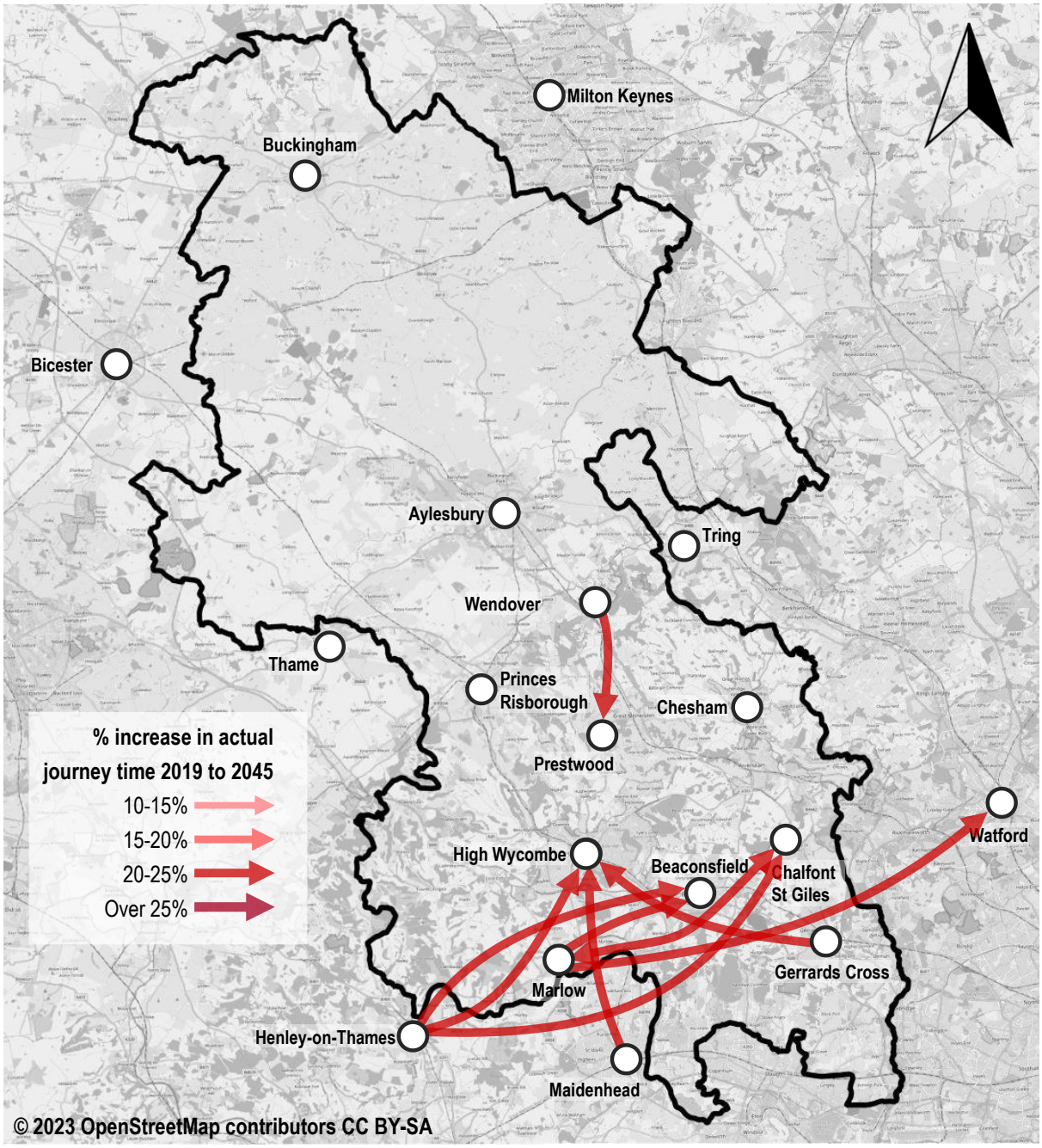
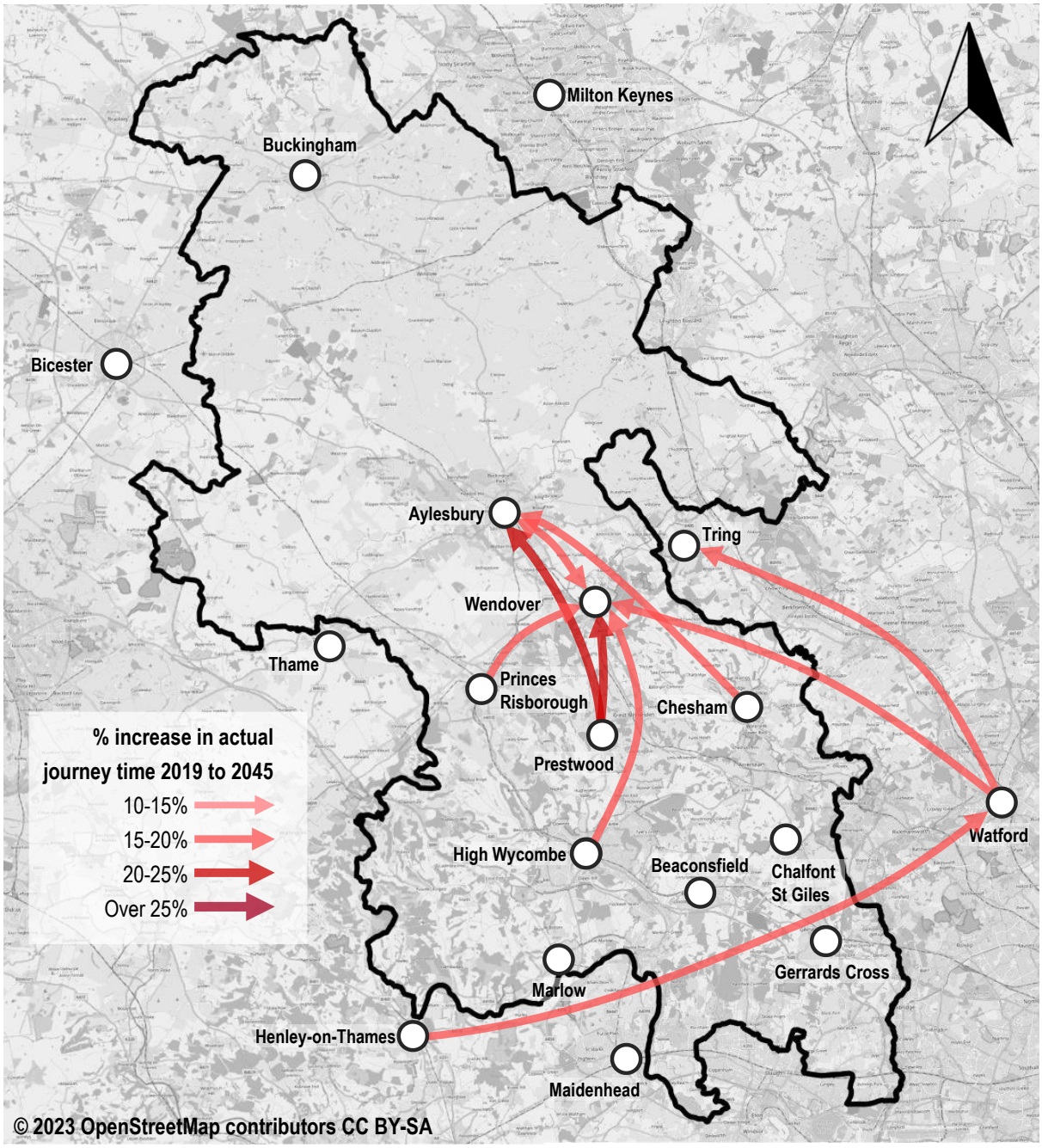


Figure 4-13 Top ten increases in delay between 2019 to 2045 (evening peak)



4.6. Link volume/capacity ratios

The link volume/capacity ratio (V/C) is the volume of traffic as a percentage of the capacity of the highway link. It does not have any relationship to the capacity of the 'downstream' junction at the end of a link which can often be a more relevant determinant of the capacity of a road network overall. A link V/C of greater than 85% suggests the link is approaching capacity and a link V/C of 100% is at capacity.

Link volume/capacity ratios (V/C) for the highway network in 2045 for Buckinghamshire are shown in Figures 4-10 and 4-11 for the morning and evening peak hours, respectively. These data are derived from the BSTM. Due to the complexity of the modelled network and derivation of the V/C figures, the reader should consider the overall patterns of V/C rather than placing excessive emphasis on the V/C for a specific link, particularly shorter links.

Figure 4-14 link volume/capacity ratio- Forecast year 2045, morning peak hour

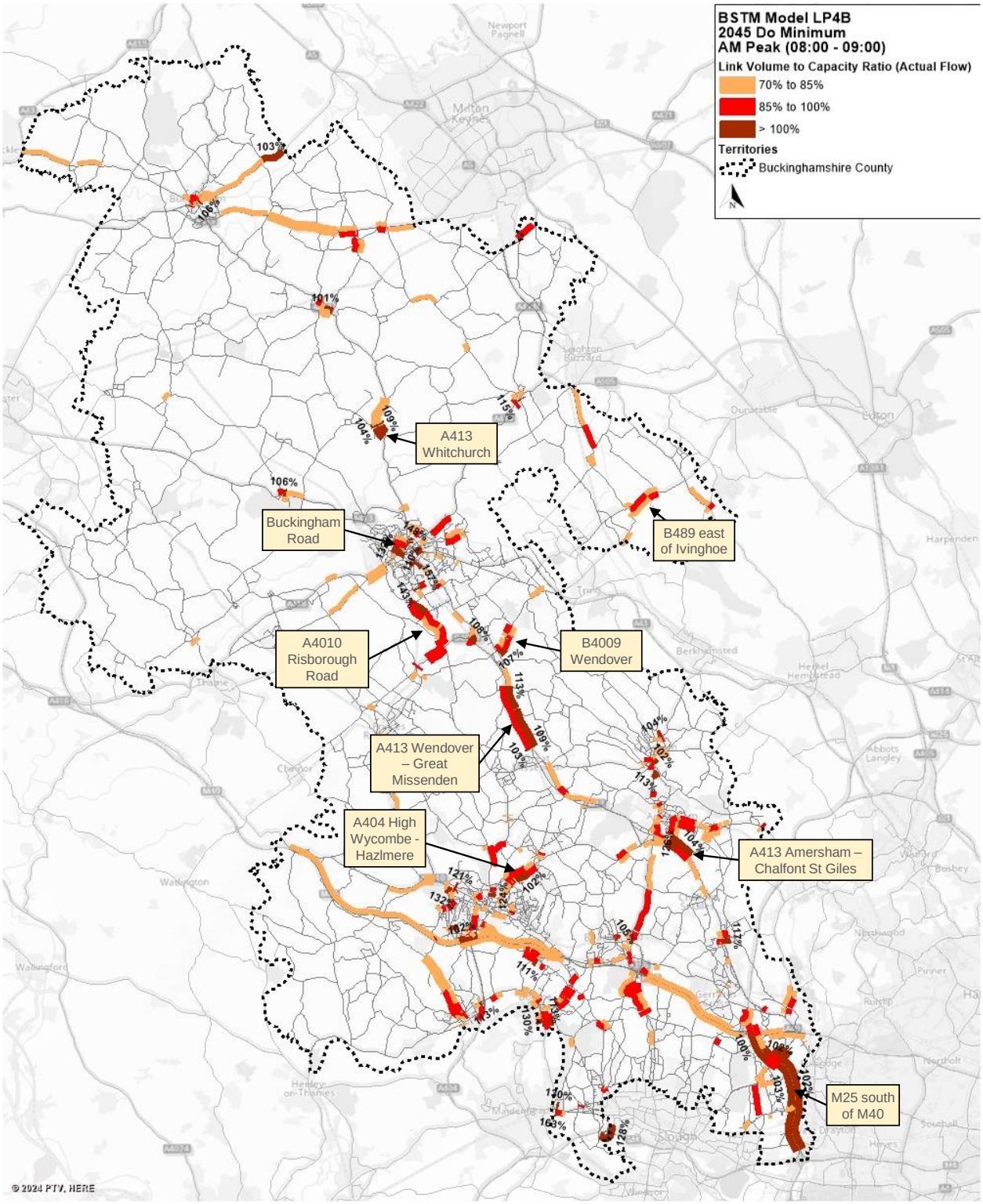


Figure 4-15 link volume/capacity ratio - Forecast year 2045, evening peak hour

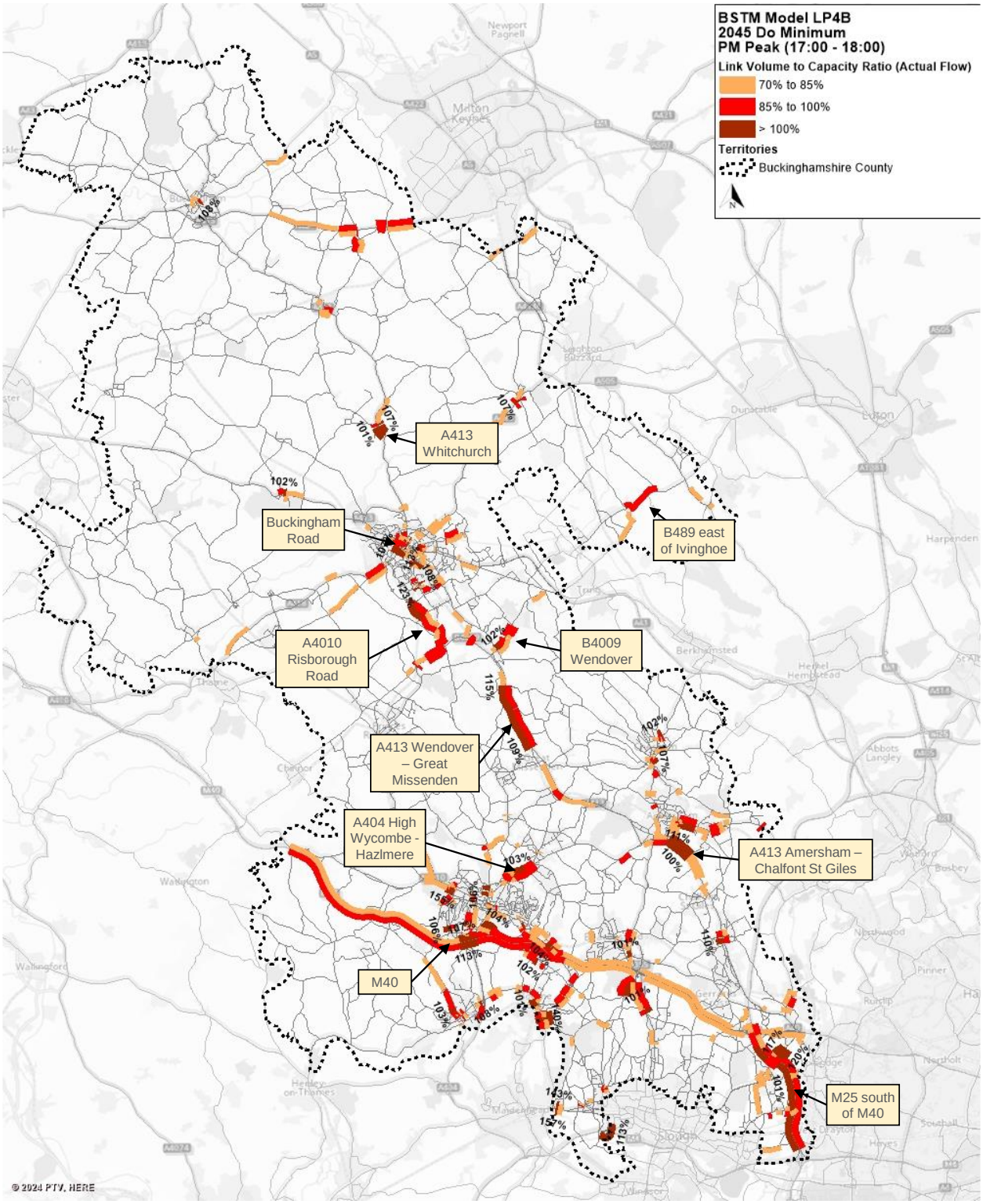


Figure 4-14 and Figure 4-15 show that the links with capacity issues in 2045 are similar to those in 2019 but the growth in traffic results in a number of links reaching 100% capacity (comparable maps for 2019 are shown in Figure 3-6 and Figure 3-7). The following links are predicted to be operating at or very close to capacity in 2045 in the morning and evening peak hours:

- A413 through Whitchurch (V/C >100%);
- A4010 Risborough Road, Stoke Mandeville (V/C of 70-100%);
- A413/A4156 Buckingham Road Aylesbury (V/C >100%);
- B489 east of Ivinghoe (V/C of 70-100%0);
- B4009 Wendover (V/C of 70-100%);
- A413 London Road, between Wendover and Great Missenden (V/C >100%);
- A413, between Amersham and Chalfont St Giles (V/C >100%);
- M40, south of High Wycombe at Junction 4 (V/C>100%);
- A404 between High Wycombe and Hazlmere (V/C>100%); and
- M25 south of the M40 (V/C >100%).

4.7. Node volume/capacity ratios

Node volume/capacity ratio (V/C) for the highway network in Buckinghamshire in 2045 are shown in Figure 4-16 and Figure 4-17 for the morning and evening peak hours, respectively. A node V/C of greater than 85% is approaching capacity and a node V/C of 100% is at capacity. It is noted that the node V/C represents a flow weighted average of the approach volume/capacities so individual approaches or turns could be overcapacity even if the overall junction is within capacity.

More detailed plots of Aylesbury, High Wycombe, Chesham and Amersham are shown later. Outside of these towns, the junctions forecast to have traffic volumes more than 90% of their capacity are:

- B488 / Tringford Road, Tring (morning peak); and
- A4 Bath Road / Jubilee Lane, Maidenhead (morning and evening peak).

Junctions forecast to be at 80-90% capacity are:

- A421 / Coddimor Lane / Whaddon Road, between Buckingham and Milton Keynes (morning and evening peak);
- A4146 / Stoke Road, south of Bletchley (morning peak);
- A4146 / B488, south of Leighton Buzzard (morning peak)
- High Street / Cheddington Road, Cooks Wharf (morning peak);
- B489 / Wingrave Road, Tringford, Hertfordshire (morning peak);
- ASELR / A413/A418 Link Road, Aylesbury (evening peak);
- A404 Amersham Road / Burtons Lane / Cokes Lane, Little Chalfont (morning and evening peak);
- A4155 / Wiltshire Road, Marlow (morning peak);
- Wycombe Road / Wiltshire Road, Marlow (morning peak);
- A4 Bath Road / Berry Hill, Taplow (morning and evening peak);
- A4155 / Sheepridge Lane, Bourne End (evening peak);
- Pyebush Roundabout - A40 / A355 Beaconsfield Eastern Relief Road (morning and evening peak);
- A412 / Southlands Road, Iver Heath (morning peak);
- M40 Junction 2, Beaconsfield (evening peak); and
- A412 / Bangors Road North / Thornbridge Road, Iver Heath (morning and evening peak).

4.7.1. Aylesbury

The junctions forecast to have the highest node volume/capacity ratios in Aylesbury in 2045 are shown in Figure 4-18 and Figure 4-19. As shown in the uncertainty log in Table 2-3, the forecasts assume completion of the South East Aylesbury Link Road, the Eastern Link Road (north and south), the Stocklake Link Road, Southern Link Road, South Western Link Road, Stoke Mandeville Bypass; and the A41 / King Edwards Avenue junction improvement.

There are several junctions approaching capacity, shown in yellow and orange in the figures and others close to capacity (shown in dark orange). Junctions are typically closer to capacity in the morning peak rather than the evening peak. Those junctions at 90% or more of capacity in the morning peak are forecast to be to the east and north-east of the town centre as follows:

- A4157/A41 Bicester Road roundabout;
- Coldharbour Way / Great Meadow Way;
- Coldharbour Way / Fairford Leys; and
- the entrance to the University of Bedfordshire.

These junctions are also amongst those closest to capacity in the evening peak along with Woodlands Roundabout (junction of the A41 and Aston Clinton Road).

4.7.2. High Wycombe

The junctions forecast to have the highest volume/capacity ratios in High Wycombe in 2045 are shown in Figure 4-20 and Figure 4-21. These tend to be concentrated along the A404 Marlow Hill corridor between the M40 (Junction 4) and the Abbey Way gyratory in the town centre, and the A40 London Road corridor.

There are several junctions in these corridors which are close capacity (shown in dark orange). In the morning peak hour, traffic on the A40 / A404 Abbey Way gyratory exceeds 90% capacity; whilst the Gordon Road / Princes Gate junction ad the Marlow Road / Marlow Hill junction are at 80-90%. There are also issues on various parts of M40 Junction 4.

The Abbey Way gyratory is also forecast to be above 90% capacity in the evening peak, as is the Marlow Road / Marlow Hill junction north of the M40. Indeed, the Marlow Hill corridor has a number of junctions in excess of 70% capacity including two directly north of the motorway junction. The A40 Abbey Way / Easton Street junction is also above 80% capacity in the evening peak.

4.7.3. Chesham

The junctions forecast to have the highest volume/capacity ratios in Chesham in 2045 are shown in Figure 4-22 and Figure 4-23. The junctions with the highest ratios tend to be those on the main A416 corridor passing north-south through the town.

In the morning peak hour, the Lowndes Park Roundabout (A416/Park Road) and the junction of the A416 St Mary's Way and Brook Court are both forecast to have traffic volumes above 90% of their capacity. To the north, the A416 Broad Street / White Hill junction is forecast to be at 80 to 90% of capacity.

Junction congestion is forecast to be less in the evening peak hour with the busiest junction being A416 St Mary's Way / Brook Court at 80-90% of capacity. The Lowndes Park Roundabout and the junction of Amersham Road and Moor Road are forecast to be at 60-70% capacity.

4.7.4. Amersham

The junctions forecast to have the highest volume/capacity ratios in Chesham in 2045 are shown in Figure 4-24 and Figure 4-25. The junctions in Chesham are generally less close to capacity than those in Aylesbury, High Wycombe and Chesham. The A404 White Lion Road / Cokes Lane junction is the one closest to capacity with a volume/capacity ratio of 80-90% in both the morning and evening peak hours.

All other junctions are below 80% capacity in both the morning and evening peak; fewer junctions are above 60% of capacity in the evening peak than in the morning peak. In the morning peak both the A416 Chesham Road / B4441 Sycamore Road junction and the A404 White Lion Road / A4154 Woodside Road junctions are forecast to have a volume/capacity ratio of 70-80%.

Figure 4-16 node volume/capacity ratio - Forecast year 2045, morning peak hour

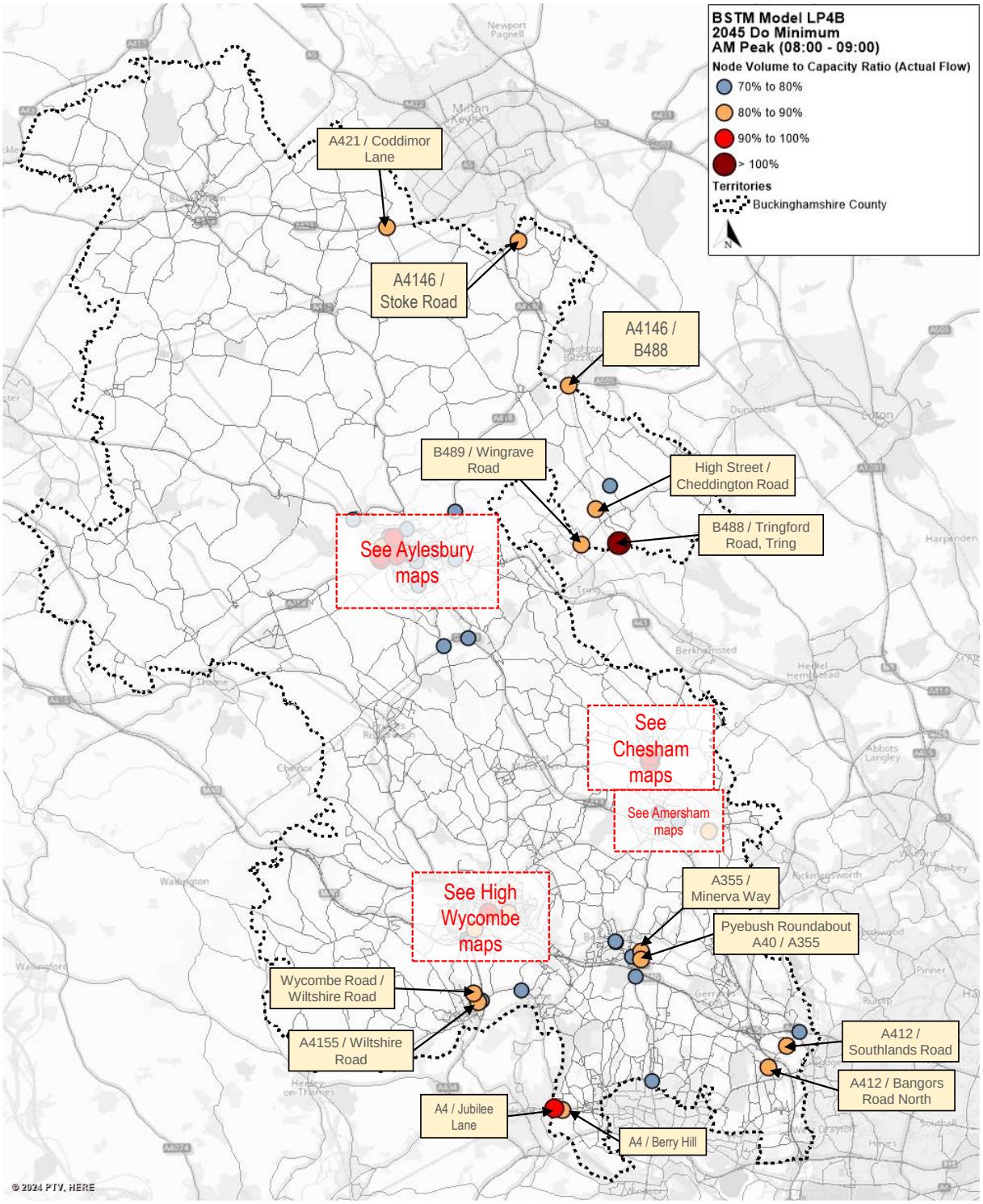


Figure 4-17 node volume/capacity ratio - Forecast year 2045,, evening peak hour

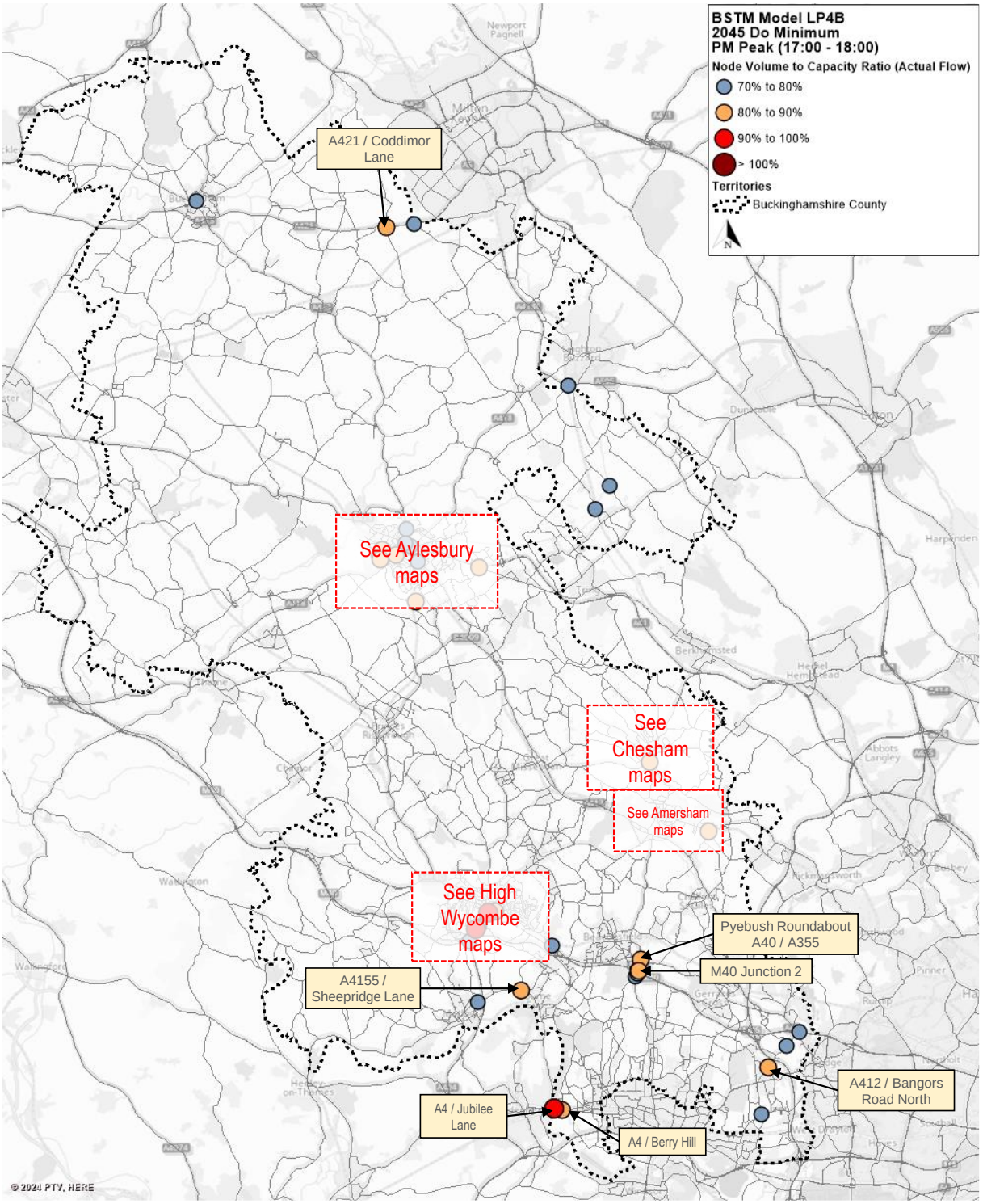


Figure 4-18 Node volume/capacity ratio: 2045 morning peak hour (Aylesbury)

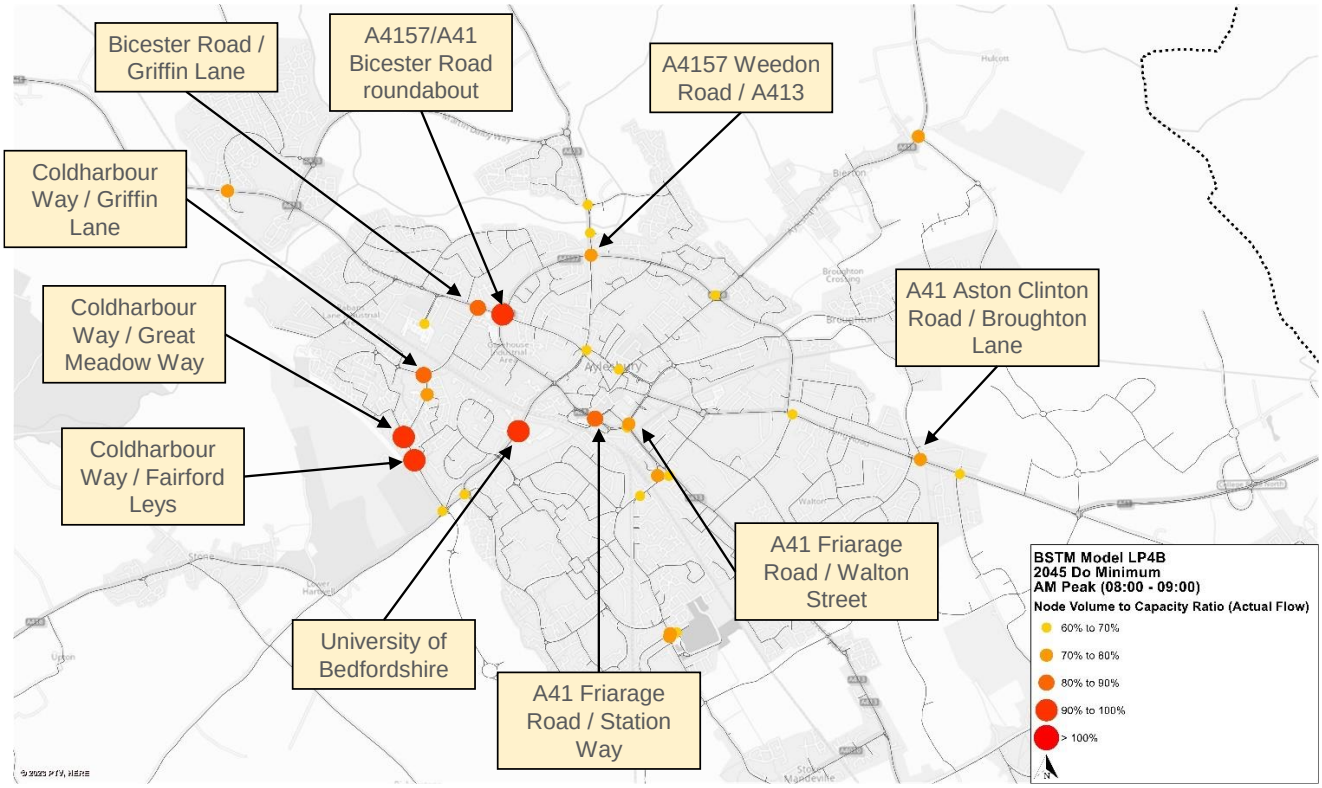


Figure 4-19 Node volume/capacity ratio: 2045 evening peak hour (Aylesbury)

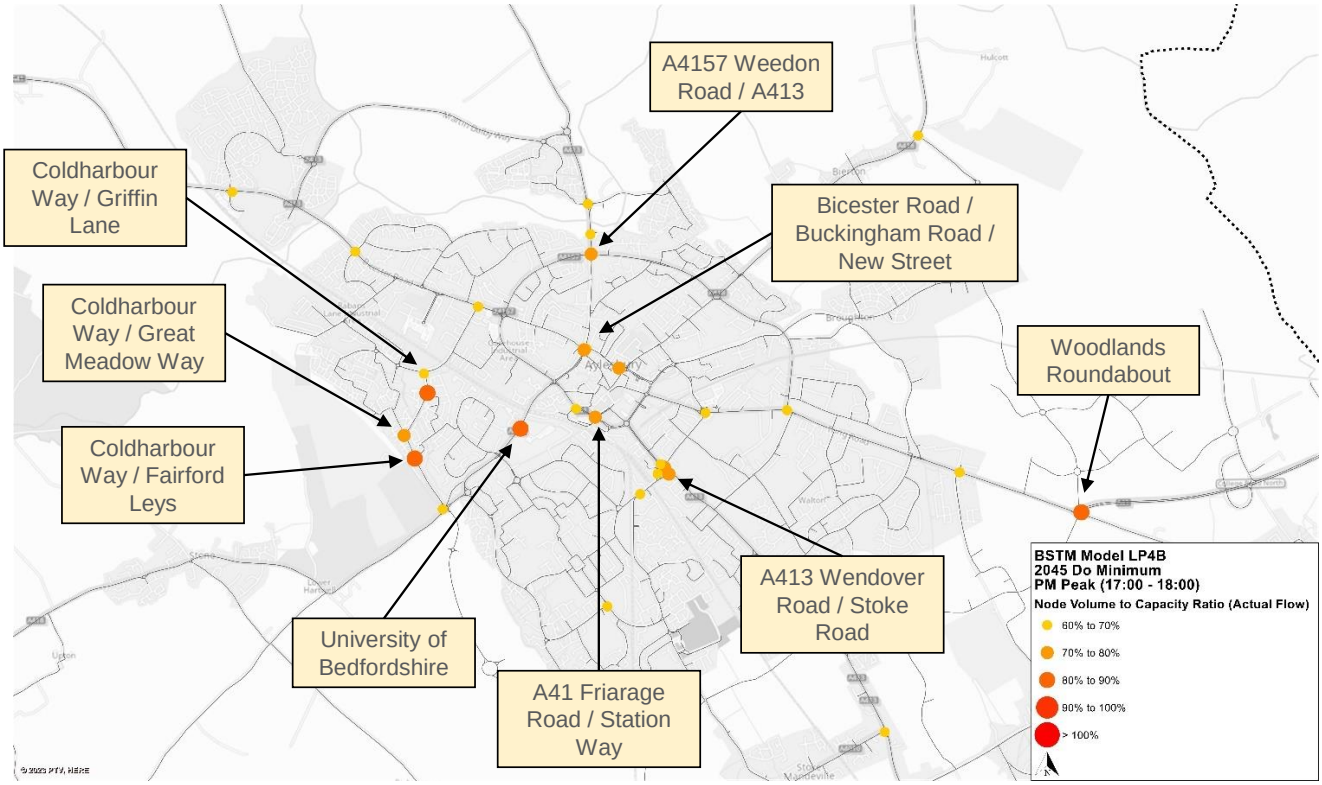


Figure 4-20 Node volume/capacity: 2045 morning peak hour (High Wycombe)

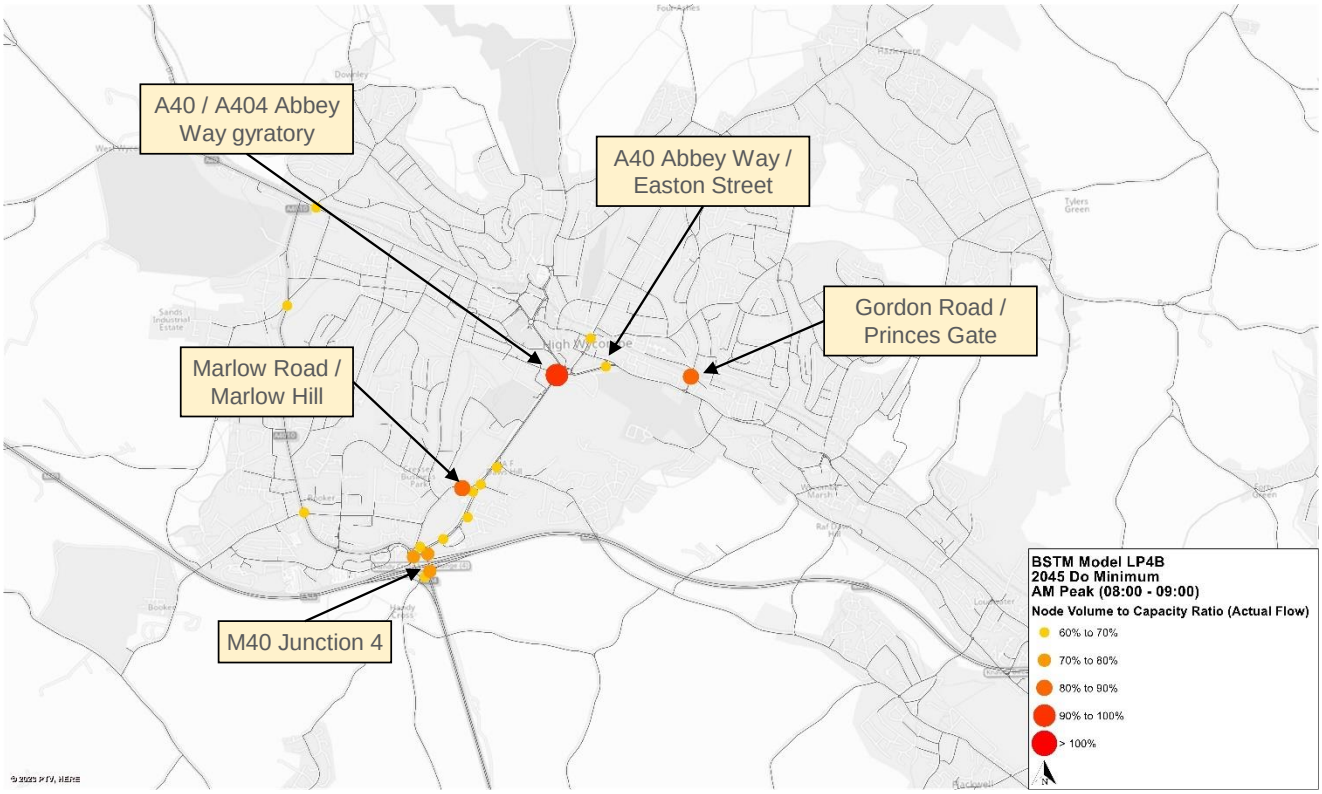


Figure 4-21 Node volume/capacity: 2045 evening peak hour (High Wycombe)

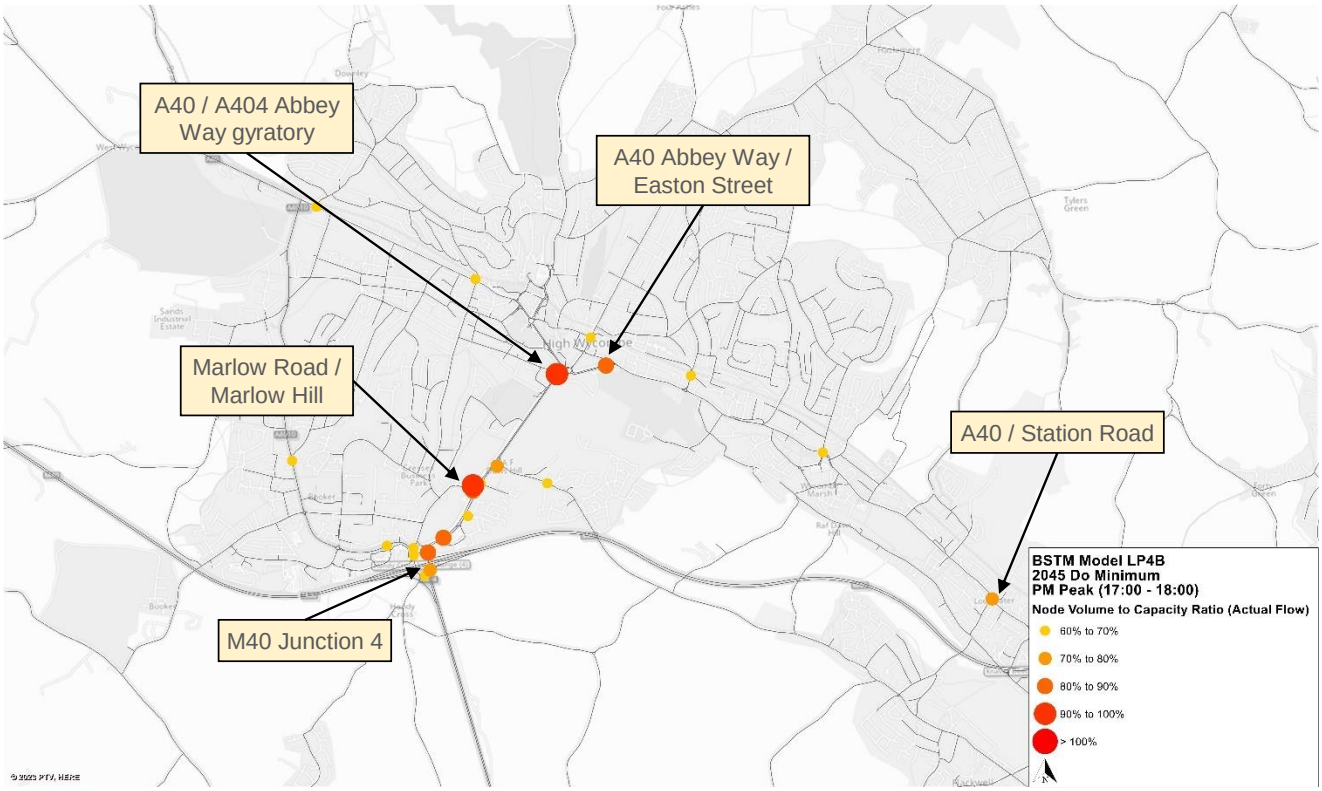


Figure 4-22 Node volume/capacity: 2045 morning peak hour (Chesham)

Figure 4-23 Node volume/capacity: 2045 evening peak hour (Chesham)

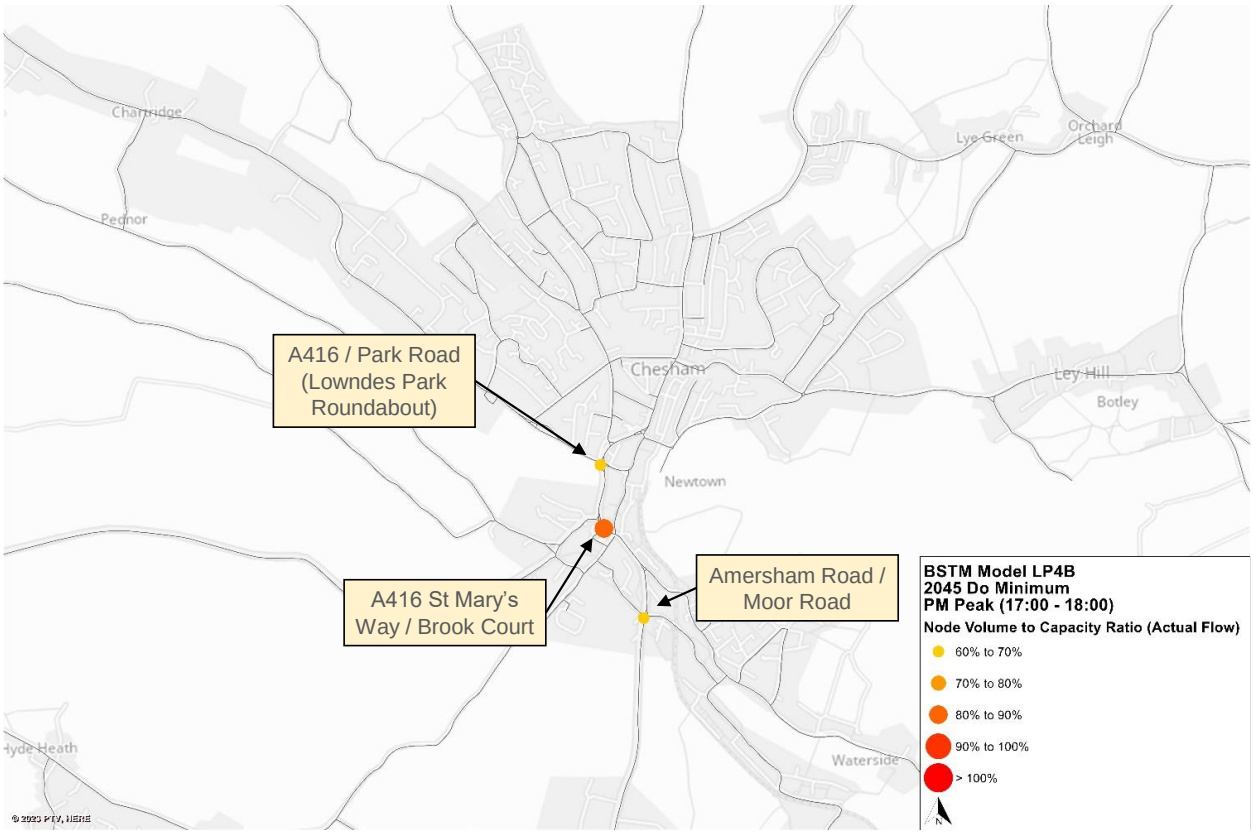


Figure 4-24 Node volume/capacity ratio: 2045 evening peak hour (Amersham)

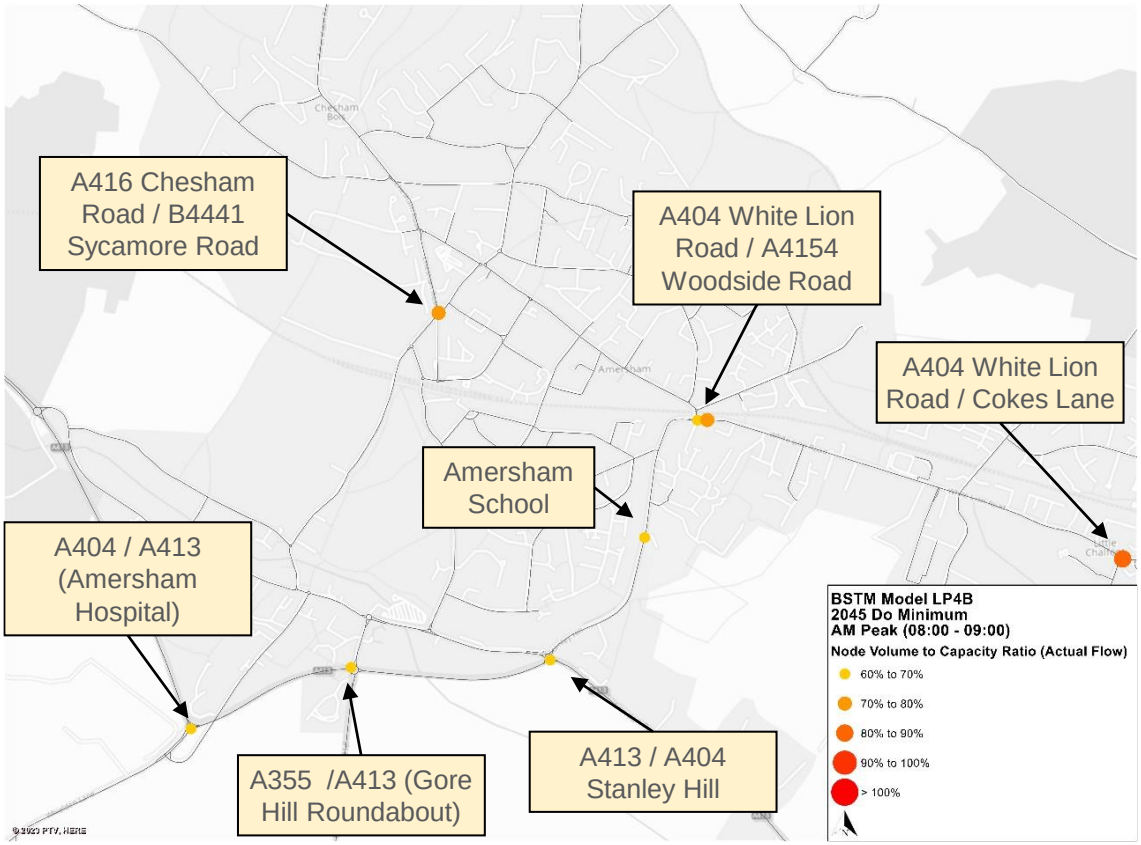
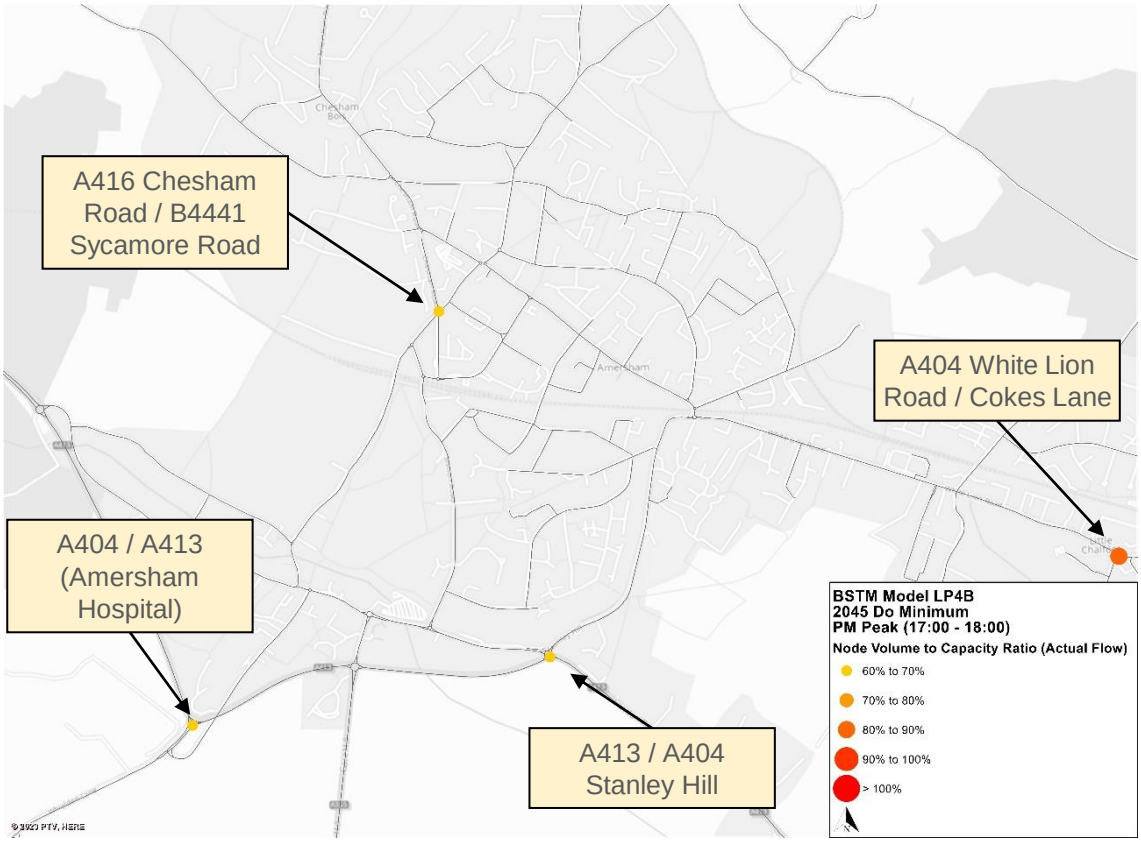


Figure 4-25 Node volume/capacity ratio: 2045 evening peak hour (Amersham)



5. 2019 and 2045 vehicle emissions

5.1. Introduction

An emissions assessment was undertaken to quantify the impact of the 2045 LP4B Do Minimum Scenario on air pollutant and greenhouse gas emissions from road traffic. This high-level emissions assessment has been prepared to understand the potential for the growth included in the 2045 scenario to impact air pollutant and greenhouse gas emissions over a 27-year period between 2019 and 2045.

The key air pollutants considered in this assessment are air pollutants (oxides of nitrogen (NO_x)); particulate matter (PM_{10}, $PM_{2.5}$); and the greenhouse gas (carbon dioxide (CO_2)).

5.1.1. Air pollutants

In most urban areas in the UK, the main local source of air pollutants is road traffic. Emissions from vehicle exhausts contain a complex mixture of pollutants including of key concern, oxides of nitrogen (a mixture of nitrogen dioxide and nitric oxide – dominated by the latter), and fine particulate matter (PM_{10} and $PM_{2.5}$). The quantities of each pollutant emitted depend upon the vehicle type, quantity and type of fuel used, engine size, speed of the vehicle and abatement equipment fitted. These pollutants are introduced briefly below.

5.1.1.1. Nitrogen dioxide

Nitrogen dioxide (NO_2) is a secondary pollutant produced by the oxidation of nitric oxide (NO). The pollutants NO and NO_2 are collectively termed oxides of nitrogen (NO_x). One third of UK NO_x emissions are from road transport[5]. The majority of NO_x emitted from vehicles is in the form of NO, which oxidises rapidly in the presence of ozone (O_3) to form NO_2. In high concentrations NO_2 can affect the respiratory system, whereas NO does not have any observable effect on human health at the range of concentrations found in ambient air. Elevated concentrations of NO_x can have an adverse effect on vegetation, including leaf or needle damage and reduced growth. Deposition of pollutants derived from oxides of nitrogen emission contribute to acidification and/or eutrophication of sensitive habitats.

5.1.1.2. Particulate matter

Particulate matter in vehicle exhaust gases consists of carbon nuclei onto which a wide range of compounds are absorbed. These particles have an effective aerodynamic diameter of less than 10 micrometres (µm). Particles in this size range are referred to as PM_{10}. Diesel engines produce the majority of particulate emissions from the vehicle fleet. Approximately 12 percent of PM_{10} emissions in the UK are derived from road transport[6]. Particulate matter is associated with a range of symptoms of ill health including effects on the respiratory and cardiovascular systems, on asthma and on mortality. There is evidence that exposure to a finer fraction of particles ($PM_{2.5}$, which typically make up around two thirds of PM_{10} emissions and concentrations) has a significant contributory role in human all-cause mortality and in particular in cardiopulmonary mortality[7].

5.1.1.3. Carbon dioxide

Carbon dioxide (CO_2) is a greenhouse gas and is used as an indicator of the wider scale, non-local effects of transport schemes. Exposure to CO_2 does not affect human health or ecology at ambient levels and so is not significant as a local air pollutant but is important for its national and international role in climate change.

5 Naei.beis.gov.uk. Pollutant Information Nitrogen Oxides - NAEI, UK. [online] Available at: https://naei.beis.gov.uk/overview/pollutants?pollutant_id=6.

6 Naei.beis.gov.uk. Pollutant Information – PM10 - NAEI, UK. [online] Available at: http://naei.beis.gov.uk/overview/pollutants?pollutant_id=24

7 Air Quality Expert Group (AQEG) Fine Particulate Matter (PM2.5) in the UK (2021), https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1212141150_AQEG_Fine_Particulate_Matter_in_the_UK.pdf

5.2. Methodology

5.2.1. Study Area

The study area for the assessment comprised the area within the county of Buckinghamshire.

5.2.2. Traffic data

Traffic data were provided from the highway modelling described in previous sections in the form of annual average daily traffic flows (AADT), the proportion of heavy-duty vehicles (HDV)[8], speed, road type[9], and road link lengths for the following scenarios:

- base year (2019)
- future year (2045), with the Buckinghamshire Local Plan (Do-Minimum – DM)

5.2.3. Emissions assessment

Pollutant emissions were estimated for each scenario using vehicle exhaust emission factors and traffic flow data. The change in mass emissions (both as a percentage and absolute) was calculated for the 2045 DM future year scenario compared to the 2019 base.

Annual vehicle exhaust emissions of NO_x, $PM_{2.5}$, PM_{10} and CO_2 for each road link (as one-way directional flows) were calculated using DEFRA's Emissions Factors Toolkit (EFT, version 11.0, November 2021)[10] for the 2019 base and 2045 DM future year scenarios. The EFT takes into consideration fleet composition using vehicle fleet information and projections for England as provided by the Department for Transport (DfT) and National Highways. All calculations are based on an average fleet composition for a given year and road type and whether that road is in London or outside. The emission calculations for the assessment assumed a road type of either Urban (not London), Rural (not London) or Motorway (not London) for all modelled roads.

The current EFT, however, predates announcements by the UK Government in 2021 on plans to increase the speed of electric vehicle uptake and does not take account of the Transport Decarbonisation Plan (TDP)[11] published in July 2021. Estimated future year emissions of CO_2 are therefore considered to be conservative.

Further details of the assumptions used to calculate emissions are provided in Appendix E.

5.3. Results

Estimated annual emissions of NO_x, PM_{10}, $PM_{2.5}$ and CO_2 for each scenario assessed are provided in Table 5-1. Table 5-2 shows the change in emissions between the base year (2019) and the future year (2045 DM) scenario. By 2045, emissions of NO_x and CO_2 are expected to decrease overall from the base year (2019) by 72% and 28% respectively. This is despite an expected overall increase in traffic volume between 2019 and 2045. The decreases in NO_x and CO_2 are due to improvements in vehicle technology and the switch to electric vehicles, reducing tailpipe emissions.

Emissions of PM_{10} and $PM_{2.5}$ are expected to increase overall from the base year (2019) by 13% and 5% respectively. This is because particulate emissions from brake and tyre wear are not expected to reduce in future years because of greater use of heavier electric vehicles and Sports Utility Vehicles ('SUVs').

This is in line with national and regional data within the Department for Transport (DfT)'s published National Road Traffic Projections 2022[12], which show that despite a range of projected traffic growth scenarios, there is a decline in tailpipe NOx, PM_{10} and CO_2 emissions[13].

8 Heavy Duty Vehicles encompasses freight vehicles of more than 3.5 tonnes (trucks) or passenger transport vehicles of more than 8 seats (buses and coaches)

9 Urban and rural classifications were assigned based on Office for National Statistics (ONS) Middle Layer Super Output Areas (MSOA) regions https://data.gov.uk/dataset/2cf1f346-2f74-4c06-bd4b-30d7e4df5ae7/middle-layer-super-output-area-msoa-boundaries. Road types provided by Atkins Transport Planning team.

10 Emission Factors Toolkit (EFT) version 11.0 published November 2021, DEFRA and devolved administrations, https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.htm

11 Decarbonising Transport – A Better, Greener Britain (publishing.service.gov.uk)

12 National road traffic projections 2022 (publishing.service.gov.uk)

13 Note the DfT PM10 tailpipe emissions estimates do not include consideration of brake and tyre wear, which is included in the EFT emission estimates meaning that the EFT estimates show an increase whereas the DfT estimates show a decrease..

Table 5-1 Annual Emissions (tonnes per annum)

Pollutant	Base (2019)	Future Year (2045 DM)
NO_x	3,017	844
PM_{10}	219	248
$PM_{2.5}$	138	145
CO_2	1,555,021	1,121,898

Table 5-2 Change in annual link emissions between base (2019) and future year (2045 DM)

Pollutant	Change (tonnes per annum)	% Change
NO_x	-2,173	-72.0%
PM_{10}	29.3	+13.4%
$PM_{2.5}$	6.4	+4.6%
CO_2	-433,123	-27.9%

Table 5-3 shows the distribution of CO_2 emissions into two categories as direct CO_2 emissions from the tailpipe and indirect CO_2e emissions from electricity generation required for charging vehicles. In 2045 direct CO_2 emissions due to tailpipe emissions are expected to reduce by 29% whereas indirect emissions from the expected uptake of electric vehicles and electricity required for charging are showing an increase of 724%. Total tailpipe emissions are expected to reduce by 28%.

Table 5-3 CO_2 annual link emissions (tonnes per annum)

Pollutant	2019	2045	Change 2019-45	% Change
Direct CO_2 emissions from tailpipe	1,552,908	1,104,494	-448,414	-29%
Indirect CO_2e emissions from electric charging	2,113	17,404	15,291	724%
Total emissions	**1,555,021**	**1,121,898**	**-433,123**	**-28%**

The forecast levels of CO_2 emissions shown in Table 5-3 for 2045 of 1.122 $mtCO_2e$ are significantly higher than the 'Business as usual' carbon pathway in the Emissions Estimates and Pathways data provided by EEH. This pathway instead forecasts annual CO_2 emissions of 0.742 $mtCO_2e$ in 2045. CO_2 emissions shown in Table 5-1 have been calculated using the current version of DEFRA's EFT (version 11.0, November 2021), which, as stated above, is considered to be conservative as fleet assumptions within the toolkit predate the latest government policy on electric vehicle uptake and transport decarbonisation[14]. See Appendix E for further details.

A significant decrease in traffic will be required to meet carbon targets. This should be a consideration in the sites selected for inclusion in the new Local Plan for Buckinghamshire.

5.3.1. Comparison with EEH approach and results

The 2019 base year tailpipe emissions estimates can be compared with other 2019 baseline estimates for Buckinghamshire:

- the estimate in this report, based on detailed modelling: 1.555 $mtCO_2e$ (see Table 5-1);
- emissions Estimates and Pathways data for England's Economic Heartland: 1.417 $mtCO_2e$[15] (based on BEIS data, and less detailed than the estimates in this report); and

[14]It is likely that the EEH utilises a more recent version of the TAG databook than that on which the EFT v11 is based (TAG databook v1.17, Nov 2021). The difference between the EEH and EFT 2045 CO_2 estimates is broadly in line with the increased fleet penetration of EV within the current TAG databook (v1.21, May 2023) as compared to TAG databook v1.17, Nov 2021 with a 26%, 22% and 32% increase in EV cars, LGV and buses respectively.

15 Emissions Pathways Data for EEH: accessible via BEIS Tool - EEH, SE, & TE - Power BI

- the estimate of emissions from road transport in Buckinghamshire derived by the Department for Business, Energy & Industrial Strategy (BEIS) is 1.363 mtCO_2e[16].

The differences between the estimates are likely to be due in part to the level of detail within the BSTM compared to the traffic assumptions used in the EEH and BEIS datasets.

However, the differences are also in part due to the assumptions used by AtkinsRéalis and EEH. The CO_2 emissions calculation used for this study utilised the (then) current version of DEFRA's Emission Factor Toolkit (version 11.0, November 2021); this in turn was based on the DfT's TAG Databook (version 1.17, November 2021). These sources use older assumptions than those used in the EEH work, which used vehicle fleet assumptions from the more recent TAG Databook (v1.2.1, May 2023).

The EEH work also uses the current EFT (see above). Specifically, the EEH approach applies the following proportions of the vehicle fleet which are electric vehicles (based on TAG Databook (v1.2.1, May 2023)): 15% in 2025: 36% in 2030; and 62% in 2050. The equivalent EV fleet proportions based on TAG Databook (version 1.17, November 2021) are 5% in 2025; 16% in 2030; and 44% in 2050.

For the 2045 assessment year, the difference in the electric vehicle fleet assumption is therefore 39% (AtkinsRéalis) versus 66% (EEH) which is broadly in line with the difference between the AtkinsRéalis and EEH total emissions in 2045 of 1.122 vs 0.742 respectively.

For the 2019 base year, both approaches should use an electric vehicle fleet proportion of 1% so the c. 10% difference in CO_2 emissions estimate for 2019 will be a result of the traffic data used.

5.3.2. Summary

The results presented above show that, between the base year (2019) and future year (2045 DM), there would be a decrease in NOx and CO_2 emissions across the Buckinghamshire Council area. This decrease is a combined impact of increases in traffic volumes over the 27-year period (increasing emissions) and improvements in vehicle technology (reducing emissions). In aggregate, the increases are more than offset by the decreases.

Emissions of PM_{10} and $PM_{2.5}$, however, are expected to increase overall from the base year. This is because particulate emissions from brake and tyre wear will increase due to more traffic. The assumed take-up of electric vehicles will reduce tail pipe particulate emissions per vehicle mile but will not reduce brake and tyre wear emissions. The reduction in tail pipe particulate emissions is not sufficient to counteract the expected increase in traffic volume and associated brake and tyre wear.

5.3.3. Detailed spatial analysis of CO_2 emissions

The following figures show CO_2 emissions on a link-by-link basis. They provide an indication of the sections of road where the most tailpipe CO_2 is emitted by vehicles using them. This is useful to a point but, unlike other emissions which affect local air quality and therefore public health, the critical issue with regards to CO_2 is the overall level of emissions regionally, nationally and globally. Therefore, in seeking to identify measures to reduce transport-related greenhouse gas emissions, greater consideration should be given to the types of journeys being made (for example journey purpose, origin/destination and journey length) and vehicle type being used rather than the links where the emissions are occurring.

Figure 5-1 and Figure 5-2 show the total (direct and indirect) estimated annual CO_2 emissions per mile of road in 2019 and 2045 respectively. They are therefore an indication of the CO_2 intensity of traffic using each link. They show that CO_2 intensity is closely correlated to traffic volumes.

Figure 5-3 show the percentage change in total (direct and indirect) CO_2 emissions and on a link-by-link basis between 2019 and 2045. Figure 5-4 shows the percentage change for direct (tailpipe) emissions only. The maps show that emissions are forecast to reduce on many links on the network. This is due to improvements in vehicle technology and the switch to electric vehicles which reduce tailpipe emissions which outweighs increases in traffic volumes.

16 https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics-2005-to-2021

Notable exceptions to these reductions are roads on the outskirts of some urban centres, (notably, Aylesbury, Princes Risborough and Buckingham), which are expected to have increase in CO_2 emissions. These are locations where improvements in vehicle technology and greater electric vehicle fleet do not outweigh traffic growth due to the new traffic introduced by new and proposed development in those areas. In the case of Aylesbury, several of the links with increased CO_2 emissions are new road infrastructure that would be built during the period between 2019 and 2045 and will therefore be carrying traffic that was not present in 2019.

The largest absolute reductions in CO_2 emissions are on the motorway network as emissions are a function of the overall volume of traffic. The highest reduction (over 28,000 tonnes/year) is on the section of the M40 south of Junction 5. It is noted that indirect CO_2 emissions from electricity required for charging of vehicles using the motorway links are conversely expected to increase by the greatest magnitude over the 27-year period.

Figure 5-1 Total annual CO_2 emissions per mile: 2019

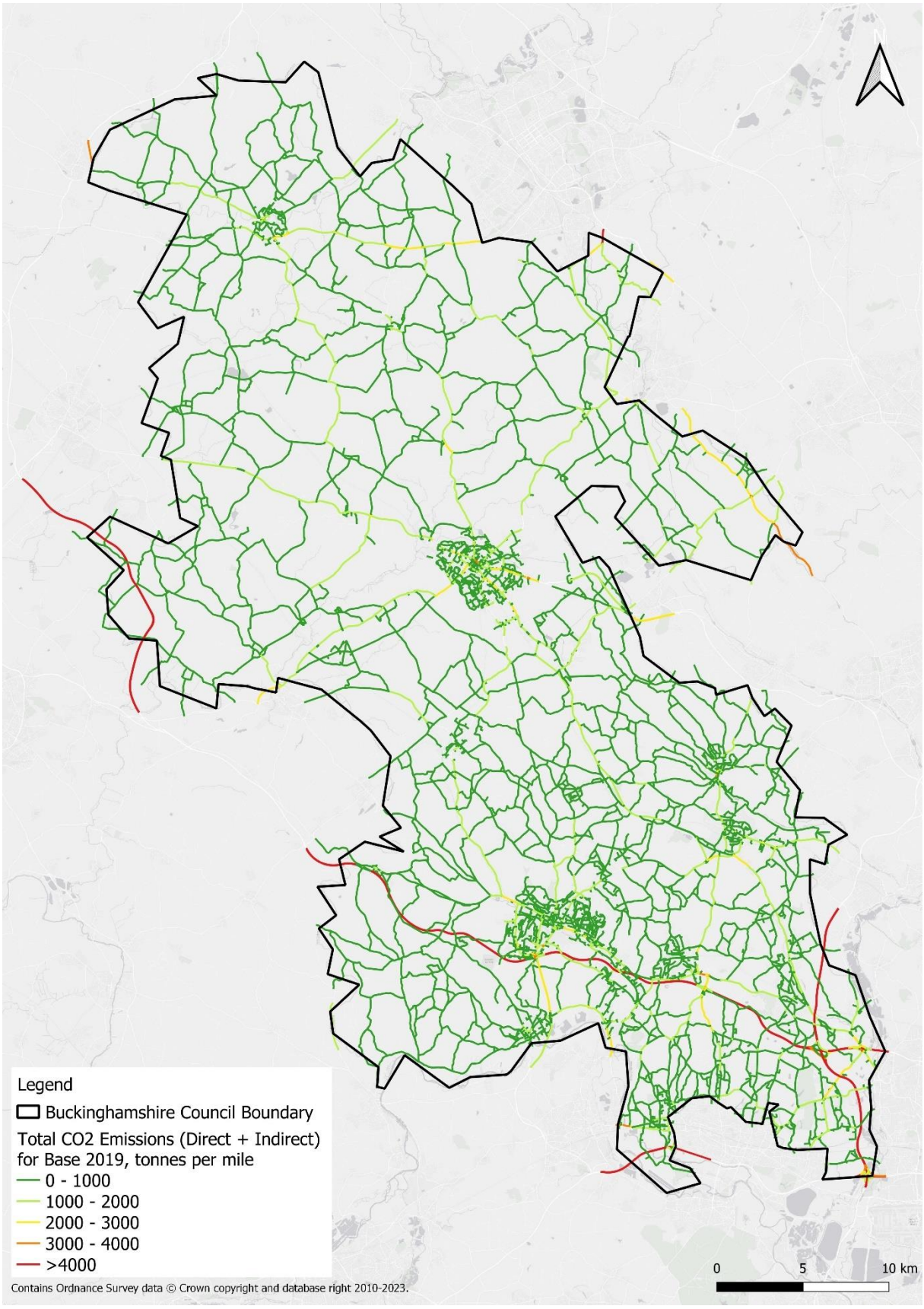


Figure 5-2 Total CO_2 emissions 2045

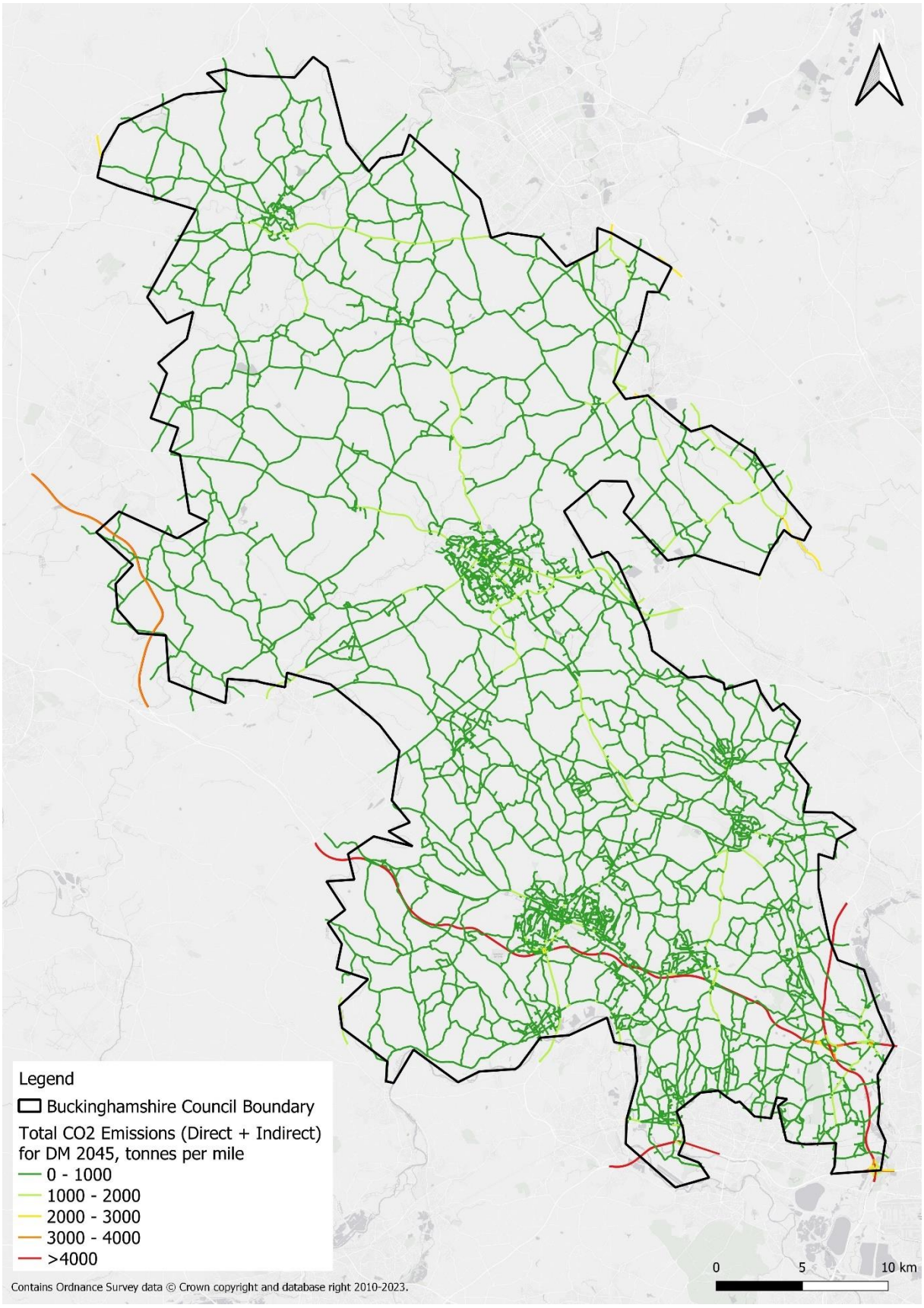


Figure 5-3 Percentage change in total CO_2 emissions between 2019 and 2045

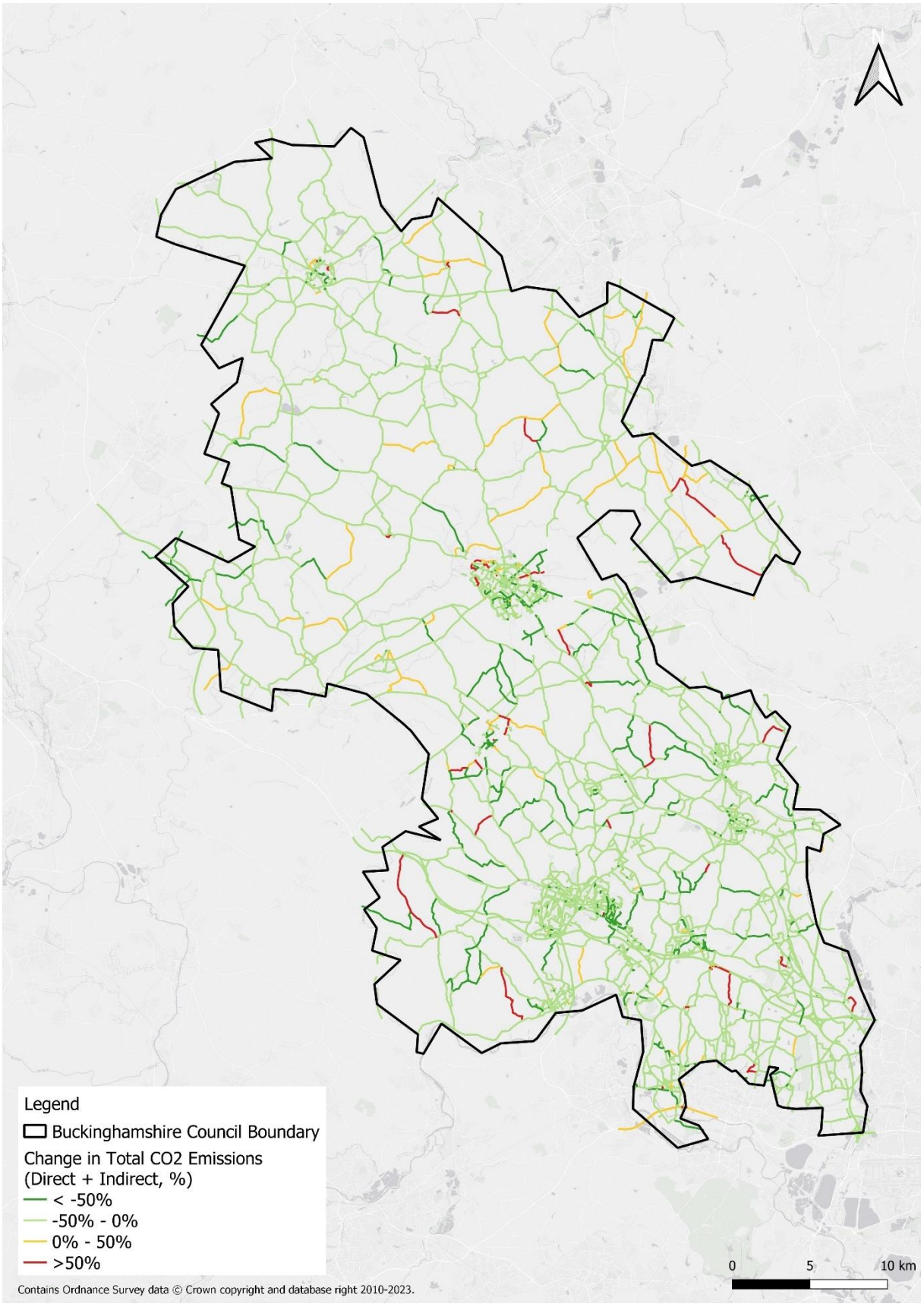
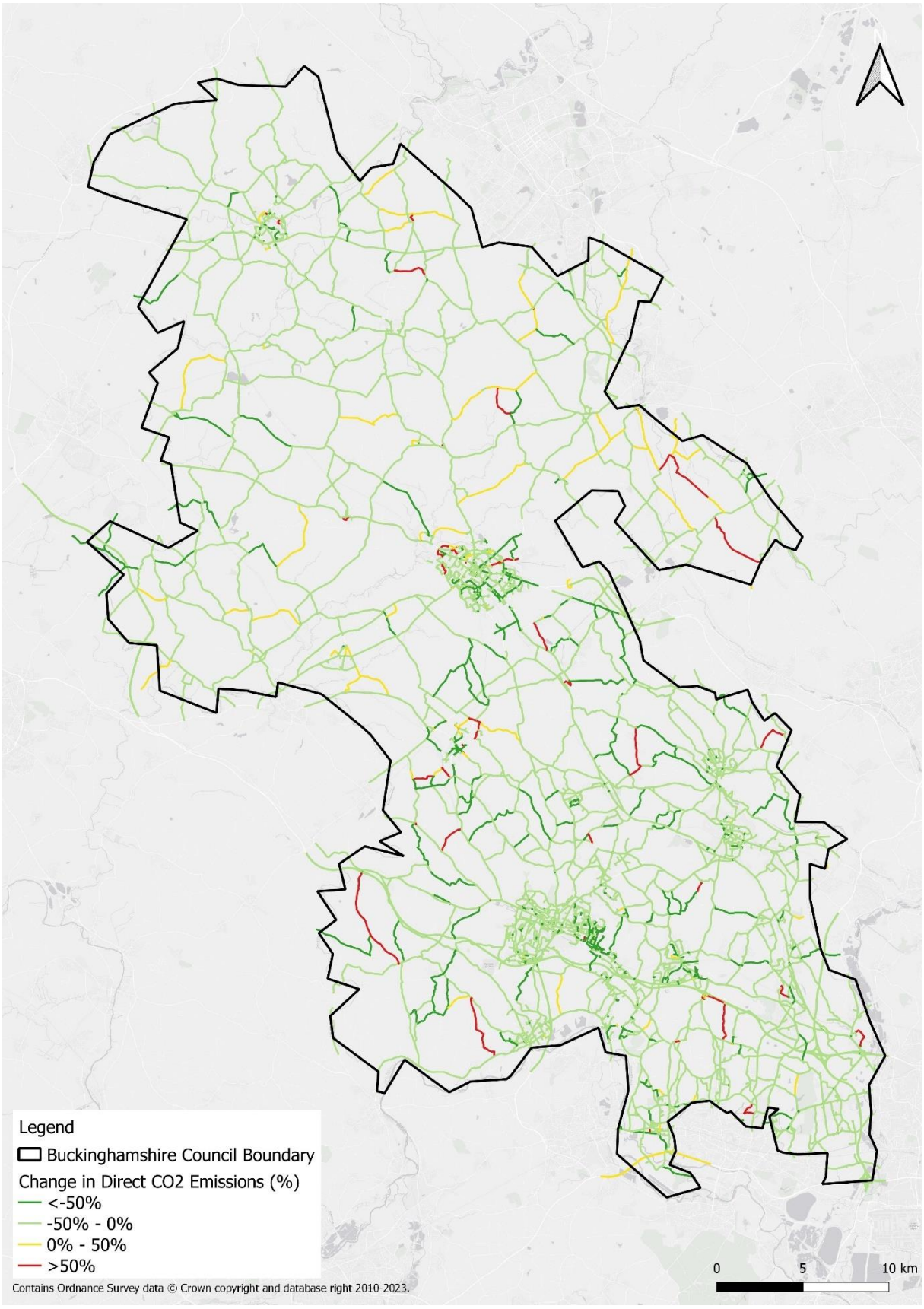


Figure 5-4 Percentage change in direct (tailpipe) CO_2 emissions between 2019 and 2045

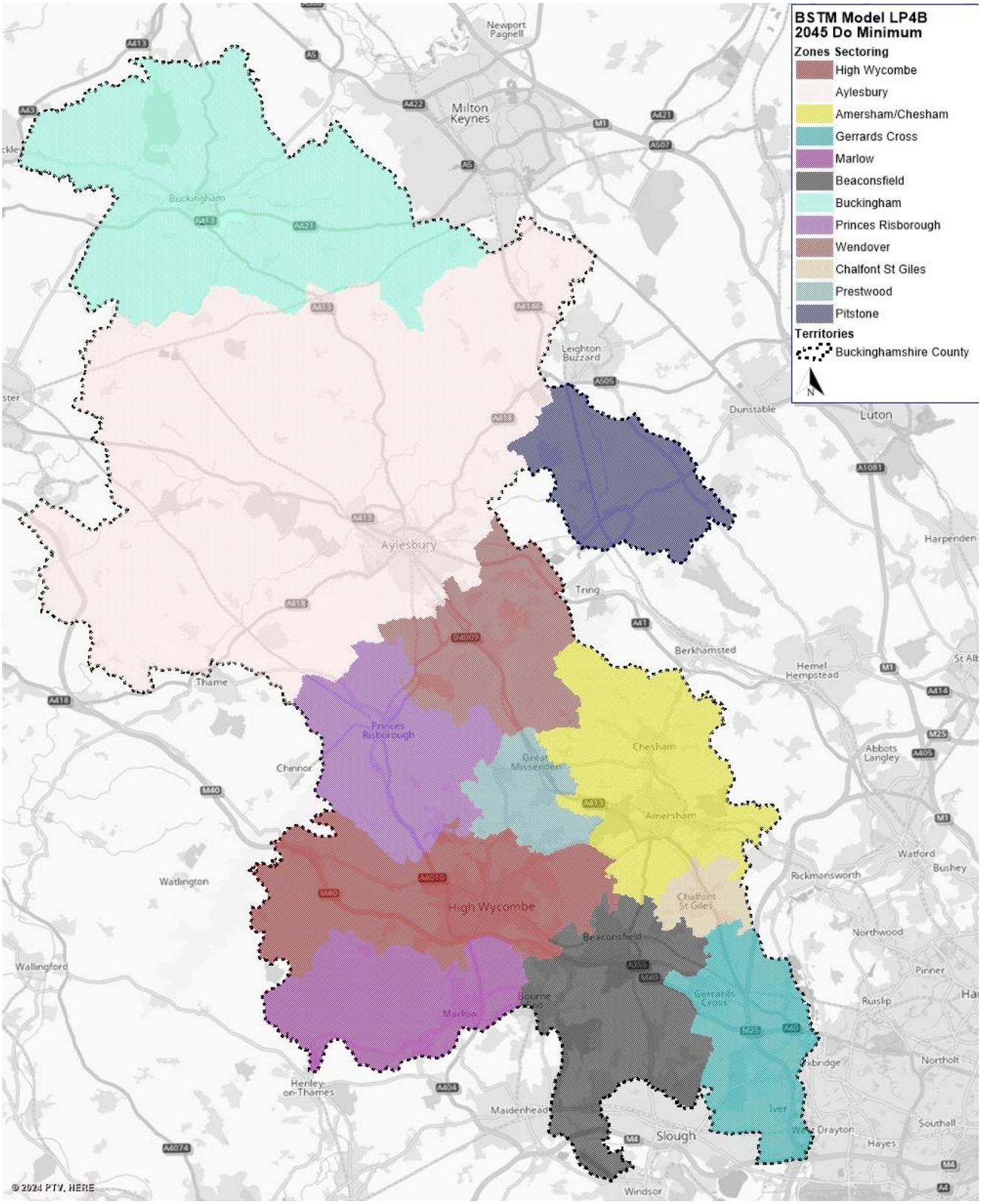


5.4. Carbon emissions sector analysis

For the carbon analysis, travel patterns from the BSTM have been summarised by aggregating together information stored on a zone-to-zone basis into a smaller number of larger ‘sectors’ where each sector represents several zones. The sector system is shown in Figure 5-5.

The change in vehicle miles between 2019 and 2045 at a sector-to-sector level has been used to estimate where carbon emissions will change the most. As discussed in Section 5.3, carbon emissions are the product of total distance travelled (vehicle miles) and emissions per mile (influenced by changes in fuel consumption and electric vehicle uptake). Taking a simplifying assumption that electric vehicle uptake is uniform, changes in vehicle miles can therefore be used to explore likely geographic variations in changes in carbon emissions across Buckinghamshire.

Figure 5-5 Sector system for carbon analysis



The forecast absolute increase in vehicle miles for each sector-to-sector movement are shown in Table 5-4. The external sector to external sector movements have been removed for ease of interpretation but it is important to note that most of the largest increases occur in these types of movement due to growth in background traffic levels. The total number of journeys to and from each sector is also shown, which includes journeys to and from the external sectors.

The highest increases in vehicle miles between 2019 and 2045 occur for trips to and from the Aylesbury (1.5 million vehicle miles), High Wycombe (785,000), Beaconsfield (570,000), Gerrards Cross (453,494,000) and Buckingham (453,000) sectors. These locations are generally consistent with where the most development has been assumed (see Figure 4-1) although the large increase in the Gerrards Cross sector is likely to be due to the close proximity to London and growth at the Pinewood economic asset.

The largest forecast increase is within the Aylesbury sector (172,000 vehicle miles) which is significantly higher than any other intra or inter-sector increase.

Table 5-5 shows the same growth but on a percentage basis. The largest percentage increases are to and from the Aylesbury sector (44% and 42% respectively), the Princes Risborough sector (41% and 39%) and the Buckingham sector (39% and 38% respectively). This demonstrates that, whilst the absolute growth to and from Princes Risborough and Buckingham is not the highest, the percentage increase is high.

Table 5-4 Forecast absolute changes in vehicle miles, 2019 to 2045 (1000s)

			To																										
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	Sector Number	Sector Name	High Wycombe	Aylesbury	Amersham/Chesham	Gerrards Cross	Marlow	Beaconsfield	Buckingham	Princes Risborough	Wendover	Chalfont St Giles	Prestwood	Bicester	Milton Keynes	Thame	Henley-on-Thames	Maidenhead	Pitstone	Watford	Luton	London	Hampshire	Slough	East of England	Oxfordshire	Midlands	Total
From	1	High Wycombe	67	29	10	7	12	18	1	8	4	1	9	3	2	12	28	17	0	11	6	57	46	13	12	10	32	414
	2	Aylesbury	29	172	9	2	5	4	20	30	21	1	7	23	41	41	14	4	5	53	61	70	53	5	29	35	90	825
	3	Amersham/Chesham	9	11	18	9	1	4	1	1	2	3	3	0	1	1	3	1	1	29	7	41	27	4	9	2	8	197
	4	Gerrards Cross	8	3	5	9	1	7	0	1	1	2	1	1	1	2	6	4	0	14	5	75	48	15	12	5	25	249
	5	Marlow	11	4	1	1	3	3	0	1	0	0	1	1	0	2	9	5	0	1	1	10	11	3	2	2	10	83
	6	Beaconsfield	20	5	5	7	3	12	1	2	1	1	2	2	1	4	11	12	0	10	5	63	37	16	12	10	54	294
	7	Buckingham	1	20	1	0	0	1	17	2	1	0	0	7	38	5	2	0	1	6	19	20	11	1	11	18	45	229
	8	Princes Risborough	9	27	1	1	2	2	2	7	3	0	2	1	1	8	4	2	0	3	3	8	8	2	3	3	9	111
	9	Wendover	4	22	2	1	1	1	1	4	3	0	2	1	1	2	1	1	0	7	4	9	5	1	3	2	6	82
	10	Chalfont St Giles	1	1	2	2	0	1	0	0	0	1	0	0	0	0	1	0	0	3	1	8	6	2	1	0	2	35
	11	Prestwood	9	8	3	1	1	2	0	2	2	0	3	0	0	1	2	2	0	4	1	8	6	1	2	1	4	65
	12	Bicester	3	25	0	1	1	2	8	2	1	0	0															473
	13	Milton Keynes	2	36	1	1	0	1	36	2	1	0	0															1,015
	14	Thame	13	49	1	2	2	3	6	9	2	0	1															912
	15	Henley-on-Thames	30	16	4	7	11	12	2	4	1	1	3															2,058
	16	Maidenhead	17	4	1	4	6	13	0	2	1	1	3															374
	17	Pitstone	0	5	1	0	0	0	1	0	0	0	0															31
	18	Watford	12	61	29	13	2	9	6	4	7	3	4															2,105
	19	Luton	6	59	6	5	1	4	18	4	3	1	1															3,078
	20	London	63	82	42	78	14	71	20	9	9	9	9															12,853
	21	Hampshire	53	64	25	45	11	36	14	9	5	5	8															9,062
	22	Slough	13	8	5	17	4	17	1	2	1	2	2															1,053
	23	East of England	13	33	10	13	3	13	11	4	3	1	2															6,957
	24	Oxfordshire	11	39	2	6	2	9	21	4	2	1	1															3,989
	25	Midlands	36	94	8	23	9	43	54	10	7	2	4															21,424
		Total	437	879	191	253	92	288	241	122	81	35	70	470	1052	900	2083	361	34	2073	3106	12777	9378	1028	6572	4082	21361	-

External sector to external sector

Note: Changes are for a 12-hour weekday.

Table 5-5 Forecast percentage changes in vehicle miles, 2019 to 2045

			To																								
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
	Sector Number	Sector Name	High Wycombe	Aylesbury	Amersham/Chesham	Gerrards Cross	Marlow	Beaconsfield	Buckingham	Princes Risborough	Wendover	Chalfont St Giles	Prestwood	Bicester	Milton Keynes	Thame	Henley-on-Thames	Maidenhead	Pitstone	Watford	Luton	London	Hampshire	Slough	East of England	Oxfordshire	Midlands	Total
From	1	High Wycombe	25%	48%	23%	23%	18%	23%	21%	29%	24%	26%	25%	28%	33%	26%	28%	25%	16%	30%	32%	28%	28%	27%	29%	26%	28%	27%
	2	Aylesbury	50%	53%	46%	49%	53%	47%	30%	65%	48%	51%	49%	30%	33%	36%	41%	49%	32%	49%	39%	49%	40%	42%	42%	33%	36%	42%
	3	Amersham/Chesham	22%	47%	18%	24%	23%	18%	32%	28%	21%	24%	24%	28%	27%	25%	30%	26%	12%	24%	25%	26%	30%	22%	24%	25%	25%	25%
	4	Gerrards Cross	25%	50%	19%	24%	17%	20%	39%	29%	27%	26%	25%	28%	29%	26%	27%	32%	15%	28%	29%	28%	31%	26%	28%	27%	29%	28%
	5	Marlow	18%	50%	16%	16%	13%	19%	14%	32%	24%	19%	20%	21%	31%	19%	21%	22%	17%	22%	22%	22%	23%	20%	20%	20%	23%	21%
	6	Beaconsfield	25%	46%	19%	19%	19%	21%	30%	33%	24%	23%	31%	31%	30%	26%	26%	27%	16%	28%	30%	27%	28%	24%	26%	26%	28%	26%
	7	Buckingham	22%	30%	37%	39%	15%	32%	31%	43%	30%	43%	40%	38%	44%	36%	31%	38%	13%	47%	48%	49%	42%	37%	41%	36%	35%	38%
	8	Princes Risborough	33%	63%	27%	31%	37%	31%	33%	42%	40%	32%	28%	33%	46%	38%	31%	32%	29%	34%	42%	34%	35%	36%	38%	31%	36%	39%
	9	Wendover	23%	49%	20%	29%	25%	23%	27%	38%	18%	26%	25%	29%	23%	30%	30%	31%	8%	23%	24%	30%	35%	29%	26%	29%	31%	30%
	10	Chalfont St Giles	29%	52%	26%	31%	22%	24%	40%	34%	28%	34%	30%	33%	31%	30%	30%	31%	20%	31%	33%	33%	37%	31%	30%	31%	33%	32%
	11	Prestwood	24%	47%	24%	25%	20%	27%	34%	29%	23%	28%	25%	30%	29%	29%	32%	30%	16%	28%	29%	29%	32%	26%	26%	30%	30%	29%
	12	Bicester	30%	32%	29%	27%	23%	29%	41%	41%	32%	37%	31%															30%
	13	Milton Keynes	31%	31%	28%	31%	30%	29%	47%	50%	25%	34%	29%															28%
	14	Thame	28%	37%	26%	25%	21%	26%	37%	40%	28%	28%	30%															29%
	15	Henley-on-Thames	29%	43%	30%	30%	23%	28%	30%	32%	31%	30%	34%															30%
	16	Maidenhead	26%	44%	25%	30%	22%	31%	34%	31%	33%	30%	33%															31%
	17	Pitstone	17%	33%	13%	16%	18%	16%	13%	26%	11%	21%	18%															19%
	18	Watford	30%	52%	24%	29%	24%	27%	44%	36%	26%	32%	30%															31%
	19	Luton	32%	42%	26%	28%	24%	27%	46%	43%	28%	33%	30%															29%
	20	London	31%	50%	28%	28%	23%	28%	44%	34%	33%	34%	32%															31%
	21	Hampshire	32%	45%	30%	31%	24%	29%	45%	40%	33%	34%	37%															29%
	22	Slough	28%	47%	24%	26%	22%	25%	36%	33%	32%	30%	30%															29%
	23	East of England	32%	46%	26%	28%	22%	26%	38%	40%	29%	31%	30%															26%
	24	Oxfordshire	28%	36%	24%	23%	21%	23%	38%	36%	26%	28%	32%															21%
	25	Midlands	30%	38%	26%	28%	24%	27%	41%	40%	32%	32%	33%															24%
		Total	29%	44%	25%	28%	22%	26%	39%	41%	31%	31%	30%	29%	28%	29%	30%	31%	19%	31%	29%	30%	29%	29%	26%	22%	24%	

External sector to external sector

Note: Changes are for a 12-hour weekday.

6. Wider impacts of forecast traffic growth

6.1. Introduction

This chapter discusses the potential impacts of the forecast growth and emissions in traffic described in Chapters 4 and 0. It describes the impacts of the forecast traffic growth under selected topics from the Scoping Report for the Sustainability Appraisal, specifically:

- air quality;
- climate change mitigation;
- economy and employment; and
- communities and health.

6.2. Air quality

6.2.1. Context

Air quality is an important issue for many areas, and traffic is often a primary cause of air quality problems. Air quality can be assessed by the concentration of various pollutants in the air. The air quality indicator is compiled from four key air pollutants: Nitrogen dioxide, Benzene, Sulphur dioxide, and Particulates. The levels of each pollutant are recorded at lower-layer super output area (LSOA). The Air Quality Index score for Buckinghamshire (average of all LSOAs) is 0.9, which is lower (better) than the National level of 0.95. Within Buckinghamshire, the Air Quality Index score is highest (worst) in the South (South Bucks) at 1.1, and lowest (best) in the North (Aylesbury Vale) at 0.83[17].

There are nine AQMAs in Buckinghamshire that have been declared due to exceedances of the annual mean national air quality objective for NO_2, the main source of which is road transport[18].

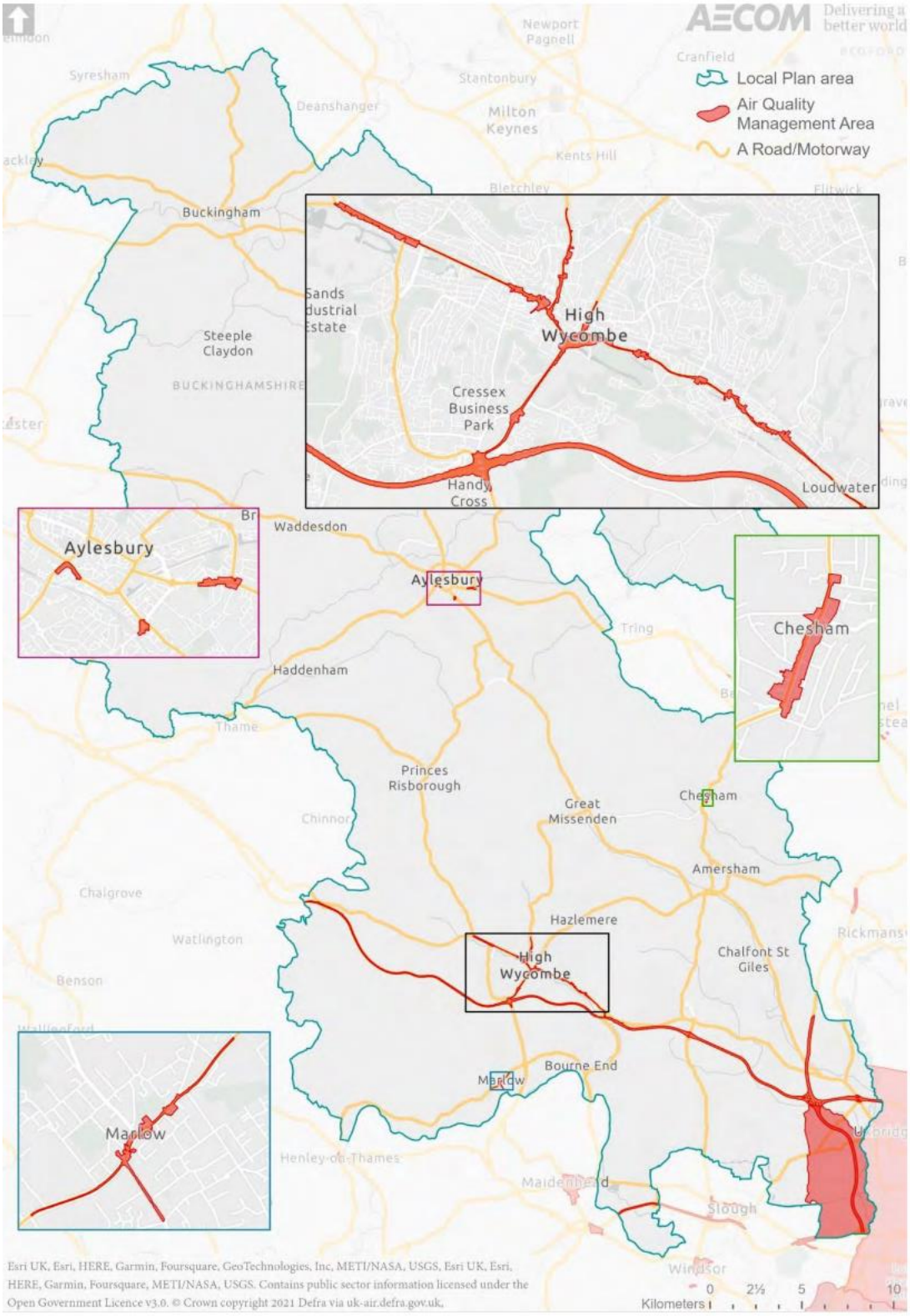
- **Aylesbury: Tring Road AQMA** (A41 Tring Road between the Oakfield Road/King Edward Avenue Junction and Queen Street);
- **Aylesbury: Friarage Road AQMA** (A418 Friarage Road and Oxford Road);
- **Aylesbury: Stoke Road AQMA** (the junction of the A413 Wendover Road, Walton St, and B4443 Stoke Road);
- **Chesham: Berkhamsted Road and Broad Street AQMA**;
- **High Wycombe AQMA** (the main arterial roads of High Wycombe including; West Wycombe Road, Oxford Street, Hughenden Road, Abbey Way, Marlow Hill, Bridge Street, Crendon Street, Queen Victoria Road, Easton Street, London Road and Amersham Hill);
- **Iver Parish Boundary AQMA** (entire parish of Iver bounded to the north, east and south by the M40, M25 and M4 respectively)**;**
- **Marlow AQMA** (sections of High Street, West Street and Spittal Street);
- **South Buckinghamshire AQMA** (M4, M25, M40 and adjacent land within former South Buckinghamshire district); and
- **Wycombe /** AQMA No.1: (M40 and adjacent land through former district of Wycombe).

Figure 6-1 shows the locations of Air Quality Management Areas (AQMAs).

17 https://bucksdataexchange.org/data/air-quality/

18 https://www.buckinghamshire.gov.uk/environment/sustainability-and-climate-change/energy-and-climate-change/the-climate-change-and-air-quality-strategy/climate-change-and-air-quality-strategy/air-quality/

Figure 6-1 Air Quality Management Areas in Buckinghamshire



Source: Scoping Report for the Sustainability Appraisal (SA) of the Local Plan for Buckinghamshire (Figure 3.1)

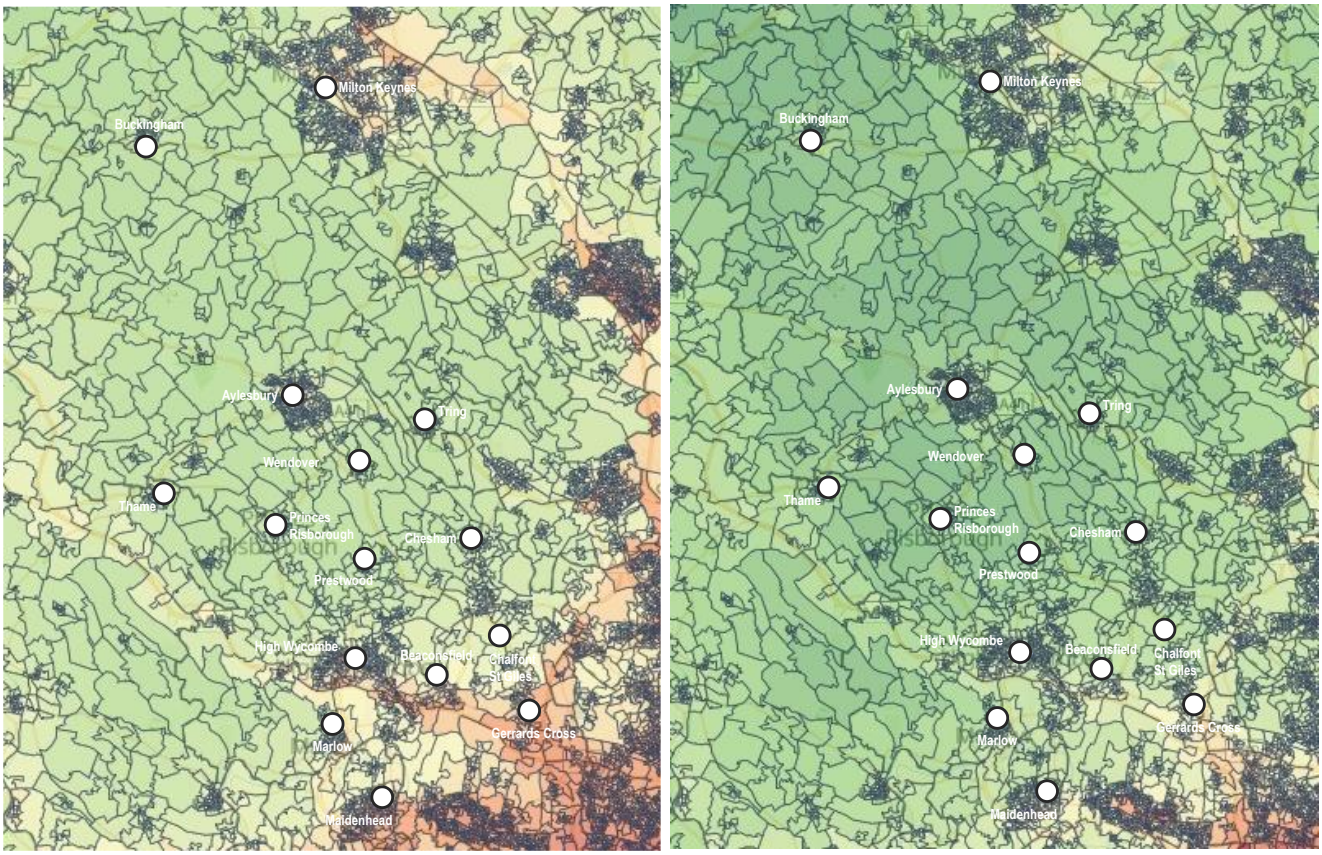
There is poor air quality in the south-east, which is strongly influenced by the very heavy volumes of traffic on the M25. The M4 (including Dorney) and M40 corridors are designated AQMAs: in the case of the M40, this stretches from London to the Oxfordshire boundary. There are also significant air quality challenges in Wycombe, together with localised challenges in Aylesbury and Chesham.

Air pollution is associated with a number of adverse health impacts. It is recognised as a contributing factor in the onset of heart disease and cancer. Air pollution particularly affects the most vulnerable in society: children, the elderly, and those with existing heart and lung conditions. There is also often a strong correlation with equalities issues because areas with poor air quality are also often less affluent areas. The mortality burden of air pollution within the UK is equivalent to 29,000 to 343,000 deaths at typical ages, with a total estimated healthcare cost to the NHS and social care of £157 million in 2017[19].

6.2.2. Impacts of forecast traffic growth

Figure 6-2 shows the variations in Nitrogen Oxides (NOx) across Buckinghamshire in 2017 and 2027 derived from the EEH Cadence Tool. This shows that concentrations were highest on the motorways and in the urban areas in 2017. By 2027, NOx is forecast to reduce significantly across all areas driven by improvements in emissions technology and greater use of electric vehicles.

Figure 6-2 NOx emissions across Buckinghamshire at LSOA level in 2017 and 2027



Source: EEH Cadence Tool.

These overall forecast reductions are consistent with the 72% reduction in NOx emissions in Buckinghamshire between 2019 and 2045 forecast in this study (see Table 5-1 and Table 5-2). Based on the above, reductions appear highest in the M40, M25 and M4 motorway corridors (which experience the highest traffic volumes) which will benefit the motorway-related AQMAs, including the Iver AQMA, shown in Figure 6-1. NOx emissions are also forecast to fall in the town centre AQMAs in Aylesbury, High Wycombe and Chesham.

Whilst these reductions in emissions are welcome, further lowering of NOx emissions through minimising the number of vehicle miles travelled by internal combustion engine (ICE) powered vehicles associated with Local Plan developments would deliver additional air quality benefits.

[19] Microsoft Word - ASR_2023_Buckinghamshire_Council_Final 0623 (buckinghamshire-gov-uk.s3.amazonaws.com)

6.3. Climate change mitigation

6.3.1. Context

Decarbonising our economy and society is one of the greatest challenges that we face. Good progress has been made over the last decade in decarbonising our energy system and from industry, but emissions from transport have remained stubbornly high. The challenge has been exacerbated by increased travel demand over the last three decades, due to increased population and economic activity, which have increased the number of journeys and amount of traffic on the network. Furthermore, more people are using larger vehicles, including Sports Utility Vehicles ('SUVs'), which are heavier and use more fuel, which have offset efficiency savings from improved engine technologies. SUVs also create more particulates from tyre wear.

Table 6-1 provides headline comparisons in carbon emissions between Buckinghamshire, the England's Economic Heartland region, and England and Wales.

Table 6-1 Transport carbon emissions headline statistics

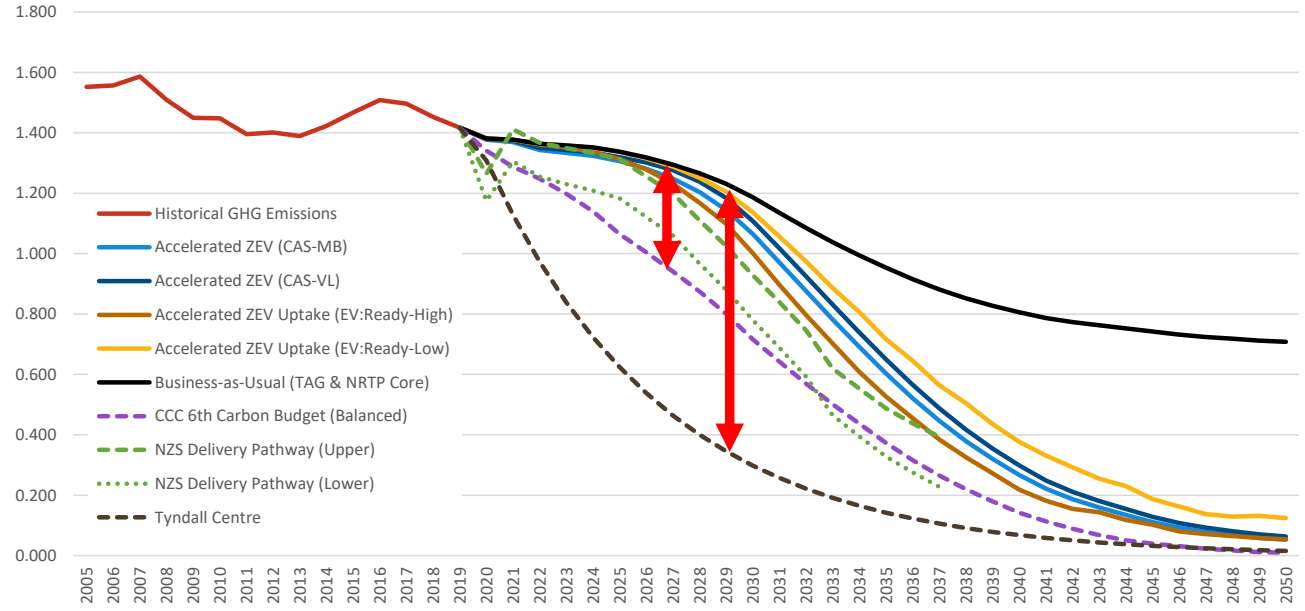
	Buckinghamshire	Heartland	England & Wales
Average emissions per capita (t CO_2) (2020)	4.3	4.9	4.6
Transport emissions, % of total (2012-20)	49.0%	41.1%	34.3%
Transport emissions, % of total (2020)	53.1%	44.5%	37.5%
Transport emissions per capita (t CO_2) (2020)	2.26	2.18	1.56

Source: EEH Cadence tool

Total emissions per capita (across all parts of the economy) in Buckinghamshire are lower than the national average. However, the proportion of emissions generated by transport are substantially higher than average, which means that transport emissions per capita are also significantly higher. This is due to the mainly rural nature of Buckinghamshire, in which people travel further to jobs and to access services with higher levels of car dependence for many journeys.

Transport emissions need to fall quickly, not just by 2050, but also in the short term towards 2030, to meet carbon budgets. Figure 6-3 shows total transport emissions in Buckinghamshire, both historic emissions from 2005 to 2019, and forecast emissions under different scenarios. Note the 2019 figure of 1.4 million tCO_2e is slightly lower than the 1.5 million tCO_2e estimated by AtkinsRéalis (see Table 3.5). These are compared with future potential 'pathways' for reducing emissions to Net Zero by 2050. Descriptions of each scenario are provided in Appendix G.

Figure 6-3 Historic and future emissions scenarios against transport decarbonisation pathways



Source: EEH Carbon tool

The red line shows historical emissions from 2005 to 2019. It shows that there has been virtually no change over the last two decades, with emissions hovering at around 1.5 $MtCO_2e$ per annum. The black line shows a business-as-usual forecast (based on DfT guidance rather than the DEFRA Emissions Factor Toolkit used in this study), assuming committed levels of growth in Buckinghamshire and a gradual shift to electric vehicles.

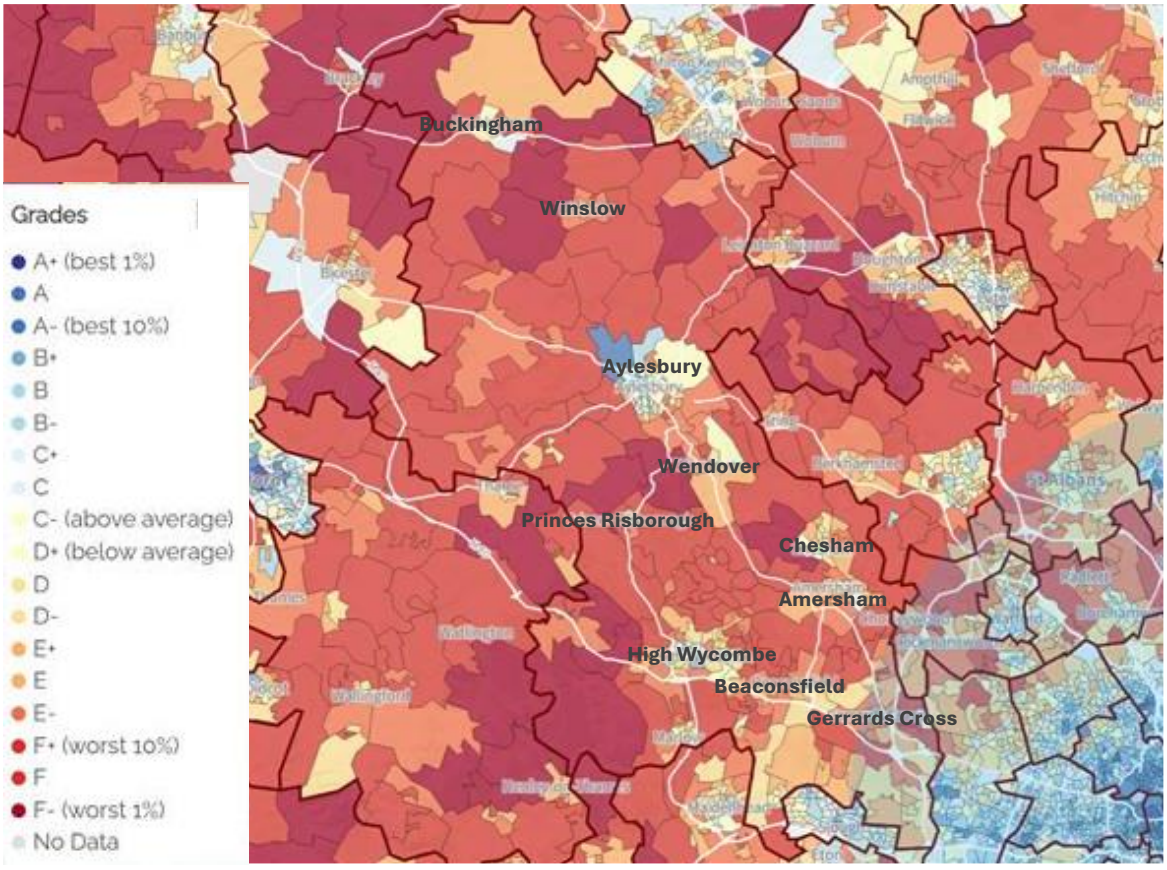
The gold, brown and blue lines show different scenarios with varying speeds of uptake of electric vehicles in response to the planned 2035 ICE sales ban. These show a significant acceleration in emissions reductions from the late 2020s, although there is considerable uncertainty. The dotted lines show different perspectives of the required speed in reductions in emissions. The red arrows show the scale of the gap between forecast emissions and the carbon pathways. The larger red arrow reflects the gap against the ambitious Tyndall pathway, and the smaller arrow shows the gap against the Climate Change Committee (CCC) pathway.

The scale of the gap will depend on the scale of ambition in Buckinghamshire and the future trajectory of transport emissions, but this gap will, in any case, be very significant, and poses a significant challenge to be addressed.

The road network generates the vast majority of carbon emissions from transport in Buckinghamshire. 45% of all road emissions are from the motorways in our area. 65% of emissions are from cars and 33% from vans and HGVs. Based on national data, it is estimated that 25% of emissions are from commuting, almost 20% from leisure trips, 15% from personal business, and 15% from visiting friends and family.

We are also able to understand how carbon emissions vary across Buckinghamshire. The CREDS place-based carbon calculator provides a tool for estimating emissions at a detailed spatial level[20]. Figure 6-4 shows the estimated car-based emissions per capita across the county. Areas with high car-based carbon emissions per person per year are shaded red, those with low emissions are shaded blue.

Figure 6-4 Car-based carbon emissions per capita in Buckinghamshire



Source: EEH Cadence tool, with data sourced from www.carbon.place

20 https://www.carbon.place/#8/51.482/-0.151

Most parts of Buckinghamshire have high emissions per capita, particularly in the rural areas, for example the Hambleden Valley, north of Princes Risborough, and The Claydons. Per capita emissions are lower in the towns, including High Wycombe, Aylesbury, and Buckingham, but they are still higher than in places such as Oxford and Slough. An exception is the Berryfields area to the north-west of Aylesbury (shown in blue).

The primary cause of these emissions is the total distance travelled by people living in each area. The distance travelled per person is particularly high in the area south-west of Aylesbury, around Marlow, and areas around Buckingham. People travel much shorter distances in towns and urban areas (this is evidenced in London and Oxford but can also be seen in Aylesbury and parts of High Wycombe.

Average distances travelled by car in towns are shorter because people are closer to jobs and services, and there are more transport options available. In the rural areas, people need to travel further to meet their daily needs, and there are fewer viable alternatives to driving.

6.3.2. Impacts of forecast traffic growth

6.3.2.1. Spatial distribution of CO_2 emissions increases

Figure 5-4 shows the change in direct (tailpipe) CO_2 emissions on a link-by-link basis between for the base (2019) and future year scenario (2045 DM). The figure shows that most roads are expected to see a decrease in CO_2 emissions. These decreases are the net effect of:

- reductions in tailpipe emissions due to improvements in vehicle technology and the switch to electric vehicles; and
- increases in tailpipe emissions due to rising traffic levels.

These net reductions occur despite additional traffic from existing site allocations and commitments. However, the reductions would be higher without the additional development-related vehicle trips arising from the existing site allocations and commitments and/or links currently forecast to experience small increases in emissions might see falling emissions were it not for the committed growth.

The largest reductions in CO_2 emissions are seen on the section of the M40 south of Junction 5 and generally absolute emissions reduce most on the motorways due to the volume of traffic. Reductions in emissions on motorways would consequently reduce emissions in the South Buckinghamshire, Wycombe and Iver AQMAs (which have been designated due to NOx exceedances, but CO_2 also contributes to poor air quality).

By contrast, CO_2 emissions are expected to increase on the outskirts of some urban centres, notably, Aylesbury, Princes Risborough and Buckingham; and also in more central parts of Princes Risborough and Aylesbury. In the context of existing AQMAs, this is of note in central Aylesbury where forecast increases are in the vicinity of all three AQMAs in the town.

6.3.2.2. Overall CO_2 emissions

Chapter 5 describes that the direct (tailpipe) CO_2 emissions in Buckinghamshire is forecast to reduce between 2019 and 2045 from 1.555 mtCO_2e to 1.122 mtCO_2e; a fall of nearly 30%[21]. Indirect emissions (from additional charging of electric vehicles) are forecast to increase sevenfold in the same period but by a relatively small 15.3 ktCO_2e.

However, the forecast levels of CO_2 emissions forecast for 2045 are significantly above the 'Business as usual' carbon pathway in the Emissions Estimates and Pathways data provided by EEH. This pathway is the one with the highest expected levels of carbon and estimates annual CO_2 emissions of 0.742 mtCO_2e in 2045.

Therefore, without further intervention, the expected levels of CO_2 emissions are higher than considered necessary to reach net zero by 2040 and remain within Buckinghamshire's overall carbon budget.

Transport carbon emissions are a function of distance travelled and the carbon intensity of the mode of travel used. The traffic growth described in Chapter 4 will result in additional demand for travel. Therefore, the Local Plan has the potential to limit transport carbon emissions arising from that additional demand by:

21 Section 5.3 highlighted the differences between our EFT-based methodology and the methodology used by EEH to generate their forecast estimates. Our approach estimated that emissions would reduce to 1.122 mtCO2e in 2045, a reduction of 28% from the 2019 base. The EEH methodology estimated 0.742mtCO2e, a reduction of 48% from the 2019 base. These differences are due to differences in methodologies for estimating the impacts of traffic growth and assumptions about improvements in vehicle efficiency and EV uptake, and highlight the inherent uncertainties in forecasting future emissions.

- reducing the need to travel (by locating new development near existing economic and service centres and by providing more facilities and services within the developments, making them more self-sufficient; and maximising the share of trips made by public transport, walking, wheeling, and cycling by locating new development close to existing public transport services and active travel infrastructure and providing additional services and infrastructure that would make public transport and active travel a more viable and attractive alternative to journeys by private car.

There is a notable contrast between the rural areas and the towns. In more urban areas, where average journey lengths are shorter, there are a wider range of travel choices, and lower levels of car dependency. It will be critical for the Local Plan to recognise the needs of our different areas in when developing a spatial strategy which supports decarbonisation of our transport system.

6.4. Economy and employment

6.4.1. Context

6.4.1.1. Introduction

High-quality transport connectivity is a critical component in a competitive economy. It is important because:

- people need to be able access good-quality jobs (if they are working age), or further and higher education (if they are training for future jobs);
- businesses need to draw on skilled labour markets within realistic commuting times; and
- businesses also need to access supply chains, customers, and other businesses in similar sectors.

Communities with poor accessibility to jobs and services can often suffer from social exclusion. For businesses, being able to access skilled employees is critical to business performance, and it is important to have enough people of working age, with the right skills, for firms to grow. This is a frequently cited challenge and is likely to become even more challenging in future with an ageing population.

Businesses also need to be able to easily access their supply chains and markets. In some cases, these are international or national, but for many businesses these are located locally or within the wider region. One of the characteristics of a high-performing economy is dense ‘clusters’ of similar businesses, which both collaborate and compete, driving innovation and new products and services.

It is important to note that transport is not the only factor required for a high-performing economy. Key factors also include a mix of high-growth sectors (e.g. the so-called ‘knowledge economy’, biotechnology, advanced manufacturing), a highly skilled labour market, and high-quality places that attract people and new businesses. However, effective transport connections help to connect businesses and people, and are a pre-requisite for a thriving economy.

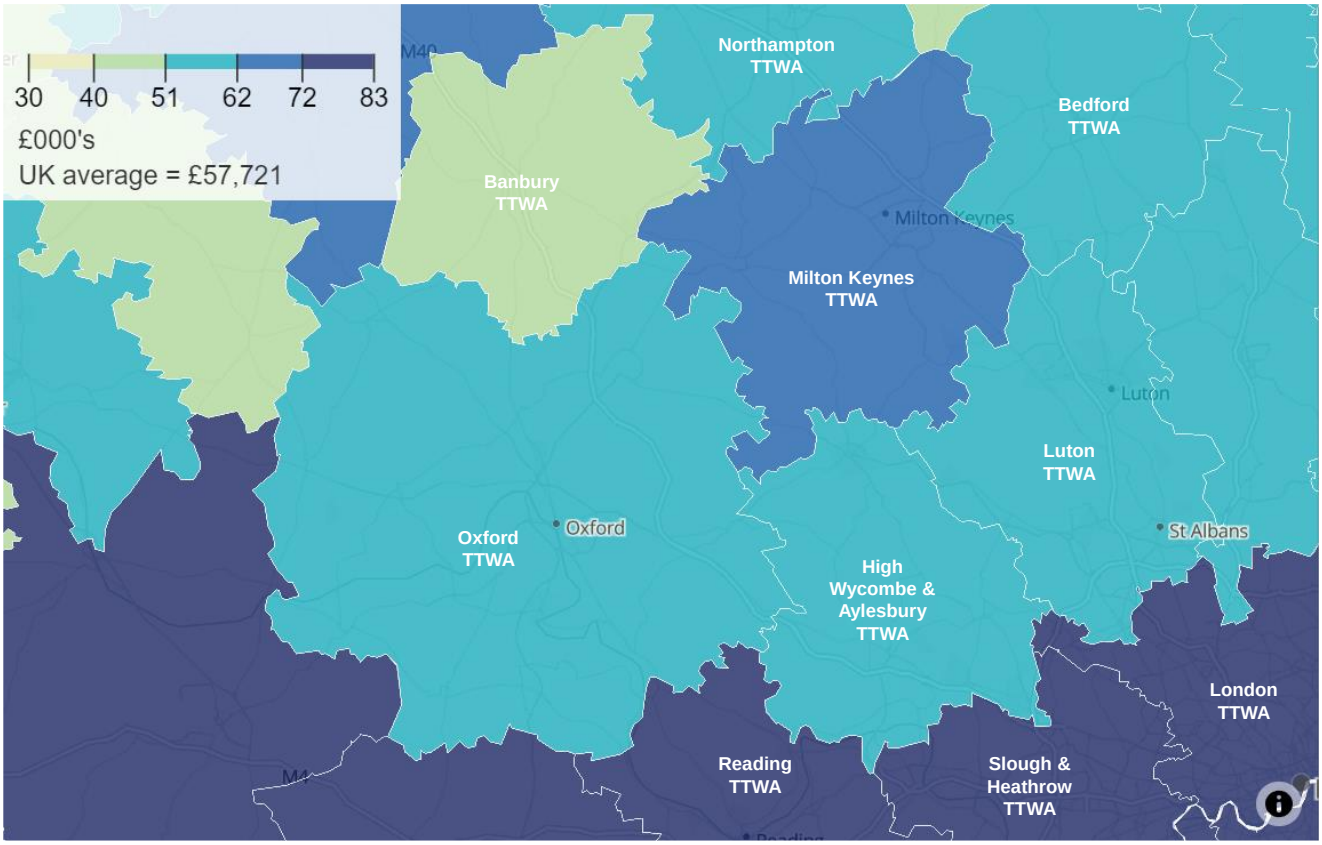
6.4.1.2. Productivity

Competitiveness is often expressed in terms of productivity, which is calculated from total output (Gross Value Added, GVA) divided by the number of jobs in an economy. Higher GVA per job implies higher productivity, which means that more economic output is achieved from the same number of workers.

The Office for National Statistics (ONS) has estimated productivity across different Travel to Work Areas (TTWAs) and derived an average UK productivity of £57,700[22]. The TTWAs around Buckinghamshire are shown in Figure 6-5.

22 https://www.ons.gov.uk/economy/economicoutputandproductivity/publicservicesproductivity/articles/productivityintownsandtraveltoworkareasuk/2019

Figure 6-5 Travel to work areas and average productivity in Buckinghamshire area



Source: ONS

Buckinghamshire is mainly covered by the High Wycombe and Aylesbury TTWA (£59,700) and Milton Keynes TTWA (£71,300), with the south-eastern area also extending into the highly productive Slough and Heathrow TTWA. The Milton Keynes TTWA is more productive than Aylesbury and High Wycombe: this is likely to be due to the scale of employment, industry structures and connectivity.

The productivity differences across the UK can be explained in part by industry structures: those areas with the highest productivity tend to have higher proportions of knowledge-intensive and high-technology services. However, most of the productivity factors are due to greater competitiveness within the same industries, which are caused by factors including business investment, exporting, innovation, and workforce skills. Effective transport connectivity is critical in enabling all of these factors.

Buckinghamshire forms part of England's Economic Heartland, an area that extends from Swindon and Oxford to Cambridge. It is regarded by many as one of the UK's most important strategic economic assets. However, one of the major constraints to growth in the region has been failure to build enough homes to meet the needs of a growing population. This has resulted in very expensive housing which is constraining the availability of skilled workers.

The Buckinghamshire Economic Intelligence Observatory[23] and Bucks Data Exchange[24] provide insightful data relating to the area's economy. Buckinghamshire has experienced very low GDP growth over the last 20 years, growing by 21% between 2001 and 2021 compared to 36% across England as a whole over the same period. It is important to understand the causes of this very low economic growth in Buckinghamshire. There are two factors influencing total economic output: total numbers of people living and working in our area, and the productivity of people working in our economy.

23 Home - Buckinghamshire Economic Intelligence Observatory (buckseconomy.co.uk)

24 https://bucksdataexchange.org/

6.4.1.3. People

The total population of Buckinghamshire in 2021 was estimated to be ~553,100, and it increased by ~9.5% (47,800) between 2011 and 2021, around 3% higher than the national increase over the same period[25]. We are located within a fast-growing area: the population of Milton Keynes increased by 15.3% over the same period.

Population in our area is forecast to rise to ~580,200 in 2043[26] (a 4.7% rise over 20 years), which suggests a significant slow-down compared to the last 10 years. Over the same period, population growth is forecast to be 3.6% in Milton Keynes, 3.5% in Hertfordshire, 9.9% in Central Bedfordshire and 11.3% in Northamptonshire.

The size of the working age population is important because this means more potential workers to meet the needs of the economy. Whilst the population of Buckinghamshire has grown, the proportion of working age population has declined (from 63.1% in 2011 to 61.4% in 2021)[27]. This means that the working age population has decreased by 1.7% over the last decade. This reflects national trends and is not unique to Buckinghamshire. But it has constrained the size of our labour market and has been a significant factor in constraining our economic growth over the last decade. A virtually static working age population over the next two decades will also be a major constraint to future growth.

Buckinghamshire has a high employment rate: in 2022, 84.6% of our working age population were in employment compared to 78.2% nationally. Buckinghamshire's unemployment rate was lower than the national average (2.6% versus 3.6%)[28]. Buckinghamshire has a lower economic inactivity rate than the national average (16% versus 22%), with a higher proportion of this group being retired than the national average[29]. This suggests that there are significant workforce supply pressures.

People living in Buckinghamshire are more highly skilled than the national average and earn more than the national average. According to the ONS Annual Survey of Hours and Earnings, median annual gross workers were around £35,300 per year[30]. This is higher than earnings in both the South East (~£33,900) and England (£31,500 per year).

In 2023, there were estimated to be just over 288,000 jobs in Buckinghamshire. When compared against the working age population of 341,000 (in this case defined as 16-64 years age), this translates into an employment density of 0.84. This means that there are fewer jobs than people of working age in Buckinghamshire. Buckinghamshire has one of the least self-contained labour markets in England[31].

Prior to the COVID-19 pandemic, a third of working residents travelled out of Buckinghamshire for work, to London, Berkshire, Oxfordshire and Hertfordshire. 28% of those working in the area travelled in from elsewhere[32]. Following the pandemic, more people are working from home or have adopted hybrid working, which will have important implications for commuting[33].

Despite these challenges, Buckinghamshire has a number of strategic economic assets. These assets are likely to be major drivers of economic growth in Buckinghamshire over the next two decades. There are strategic clusters located around Uxbridge and Gerrards Cross, High Wycombe and Marlow, Aylesbury, Westcott, and Silverstone. These are likely to be important drivers of economic need. It will be important to provide the right transport connections within and between these clusters to facilitate growth.

25 https://bucksdataexchange.org/data/2021-census-update/

26 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/latest

27 ONS 2021 – Lichfields analysis

28 Source: Annual Population Survey (ONS) / Annual Survey of Hours & Earnings (ONS) / Lichfields analysis

29 Jobs & Skills - Buckinghamshire Economic Intelligence Observatory (buckseconomy.co.uk)

30 Annual earnings in Buckinghamshire - Bucks Data Exchange

31 Jobs & Skills - Buckinghamshire Economic Intelligence Observatory (buckseconomy.co.uk)

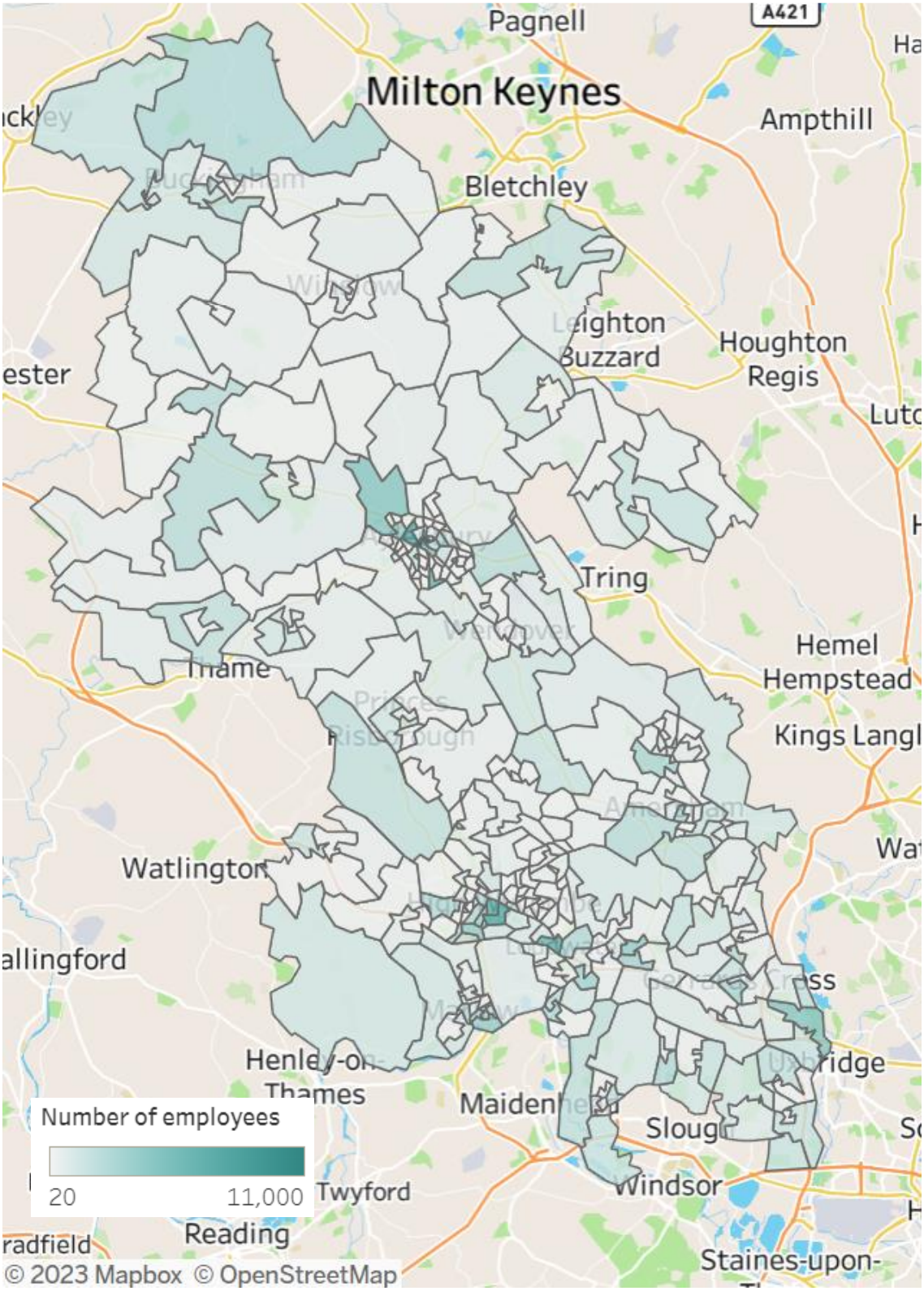
32 https://www.buckseconomy.co.uk/jobs-and-skills/

33 https://www.buckseconomy.co.uk/jobs-and-skills/

6.4.1.4. Economic geography

Figure 6-6 shows employment concentrations across Buckinghamshire, based on 2021 employment data.

Figure 6-6 Employment concentrations in Buckinghamshire



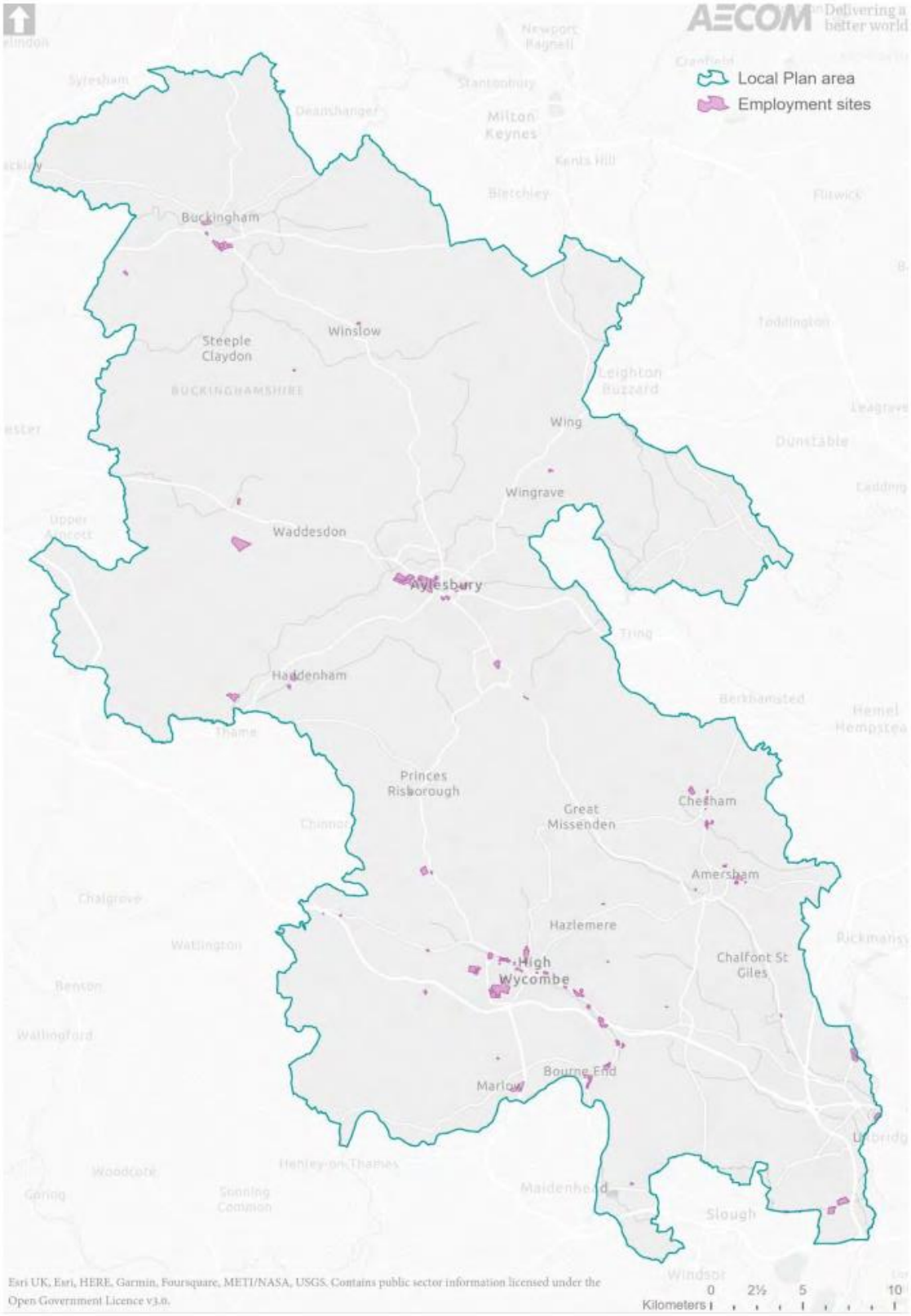
Source: Buckinghamshire Economic Intelligence Observatory[34]

34 Employment hotspots in Buckinghamshire - 2021 | Tableau Public

The highest concentrations of workers are, as expected, in High Wycombe and Aylesbury, which are the largest economic centres in Buckinghamshire. In general, activity is more clustered towards the south, including Gerrards Cross, Beaconsfield and Marlow. In the north, the largest employment locations are in Buckingham and areas adjacent to Milton Keynes. There is also significant employment across many rural areas, including the Chilterns AONB, for example the Hambleden Valley and Wendover area.

These employment data correlate well with the locations of employment identified in the Local Plan Sustainability Appraisal as shown in Figure 6-7.

Figure 6-7 Existing employment areas in Buckinghamshire



Source: Buckinghamshire Council (March 2023) Scoping Report for the Sustainability Appraisal of the Local Plan for Buckinghamshire, Figure 7.1

6.4.2. Impacts of forecast traffic growth

The additional traffic forecast by 2045 is expected to result in longer journey times for those travelling by car to work or on business, and for the movement of road freight. Figure 4-12 and Figure 4-13 show the journey times which are expected to increase the most (in percentage terms). Many of the largest increases are for journeys to or from Aylesbury and High Wycombe and are typically the journeys which already experience a significant element of delay (as shown in Figure 3-4 and Figure 3-5).

As described above, Aylesbury and High Wycombe are the two key employment centres in Buckinghamshire with the highest concentrations of employment. Increasing highway journey times will increase constraints on productivity and growth by:

Further limiting the ability of businesses to recruit people with the right skills to meet their needs because the effective size of the labour market is reduced. Significant numbers of people already commute into Buckinghamshire from other areas. Adding to ongoing skills challenges in Buckinghamshire, this could mean significant constraints to the supply of a skilled labour market to meet the needs of the economy. It is likely that we will need to continue to 'import' skilled workers from other areas, including places with a growing working age population, which will also pose challenges for our transport networks.

Traffic congestion reducing the quality of life in the area, reducing the attractiveness of the area as a place to live for higher-skilled workers.

Ineffective connectivity will inhibit growth in productivity which would otherwise occur due to agglomeration effects unlocking new inward investment. Traffic congestion and limited capacity in the transport network could have the potential to reduce business efficiency, reduce productivity and constrain future investment decisions.

Potentially preventing some of Buckinghamshire's high-value economic assets from reaching their full potential. The expected growth in traffic could act as a particular constraint to the creative sector around Pinewood, advanced propulsion at Westcott, life sciences clustered around Stoke Mandeville, and pharmaceuticals and digital across the south of the county.

Poorer highway network performance is also likely to entrench the existing challenge that many of the most skilled residents commute to London, enabled by fast rail links. There is also significant-out commuting to high value jobs in the Thames Valley economy. These are more likely to be journeys made by car, the lengthening of which could result in highly paid workers relocating outside of Buckinghamshire to be closer to those jobs.

6.5. Communities and health

6.5.1. Context

This section describes patterns of deprivation, health, and social exclusion in Buckinghamshire. Buckinghamshire Council's 'Opportunity Bucks' programme aims to provide opportunities for everyone in the county in terms of jobs, education, health and wellbeing, housing, community and safety. Many of the locations described below are within the 10 wards where health, work and education outcomes are currently poorer than elsewhere in Buckinghamshire which are the areas of focus for Opportunity Bucks:

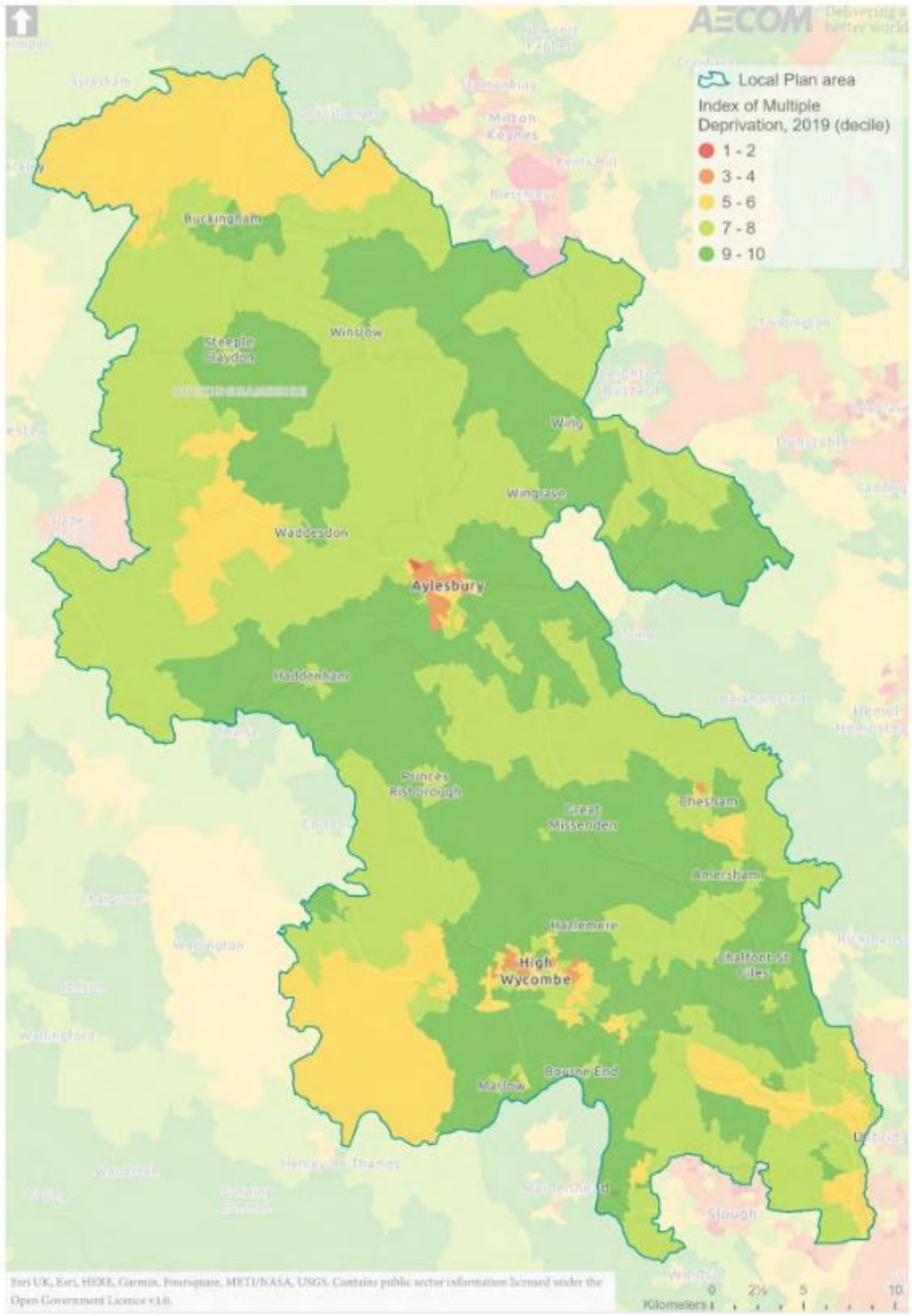
- Aylesbury North, Aylesbury North-West and Aylesbury South-West;
- Chesham; and
- the following wards in High Wycombe: (Abbey, Booker, Cressex & Castlefield, Ryemead & Micklefield, Terriers & Amersham Hill, Totteridge & Bowerdean and West Wycombe)

6.5.1.1. Deprivation

Buckinghamshire is relatively wealthy, with high skills, higher resident incomes than the national average and the highest level of disposable income in England. Overall, there are relatively low levels of deprivation, as shown in Figure 6-8.

However, this is not the complete picture. The lowest levels of deprivation are, in general, in the rural areas, with localised areas of higher deprivation within and around Aylesbury and High Wycombe, with also one LSOA in Chesham within the top 30% most deprived. However, this is not the complete picture. There are also challenges in places such as Stokenchurch, whilst the Hambleden Valley (west of Marlow), Westcott, Chesham, and the area north of Buckingham are mid-ranking. This indicates that there are some hidden deprivation challenges under the surface of an apparently prosperous county.

Figure 6-8 Index of Multiple Deprivation in Buckinghamshire, 2019

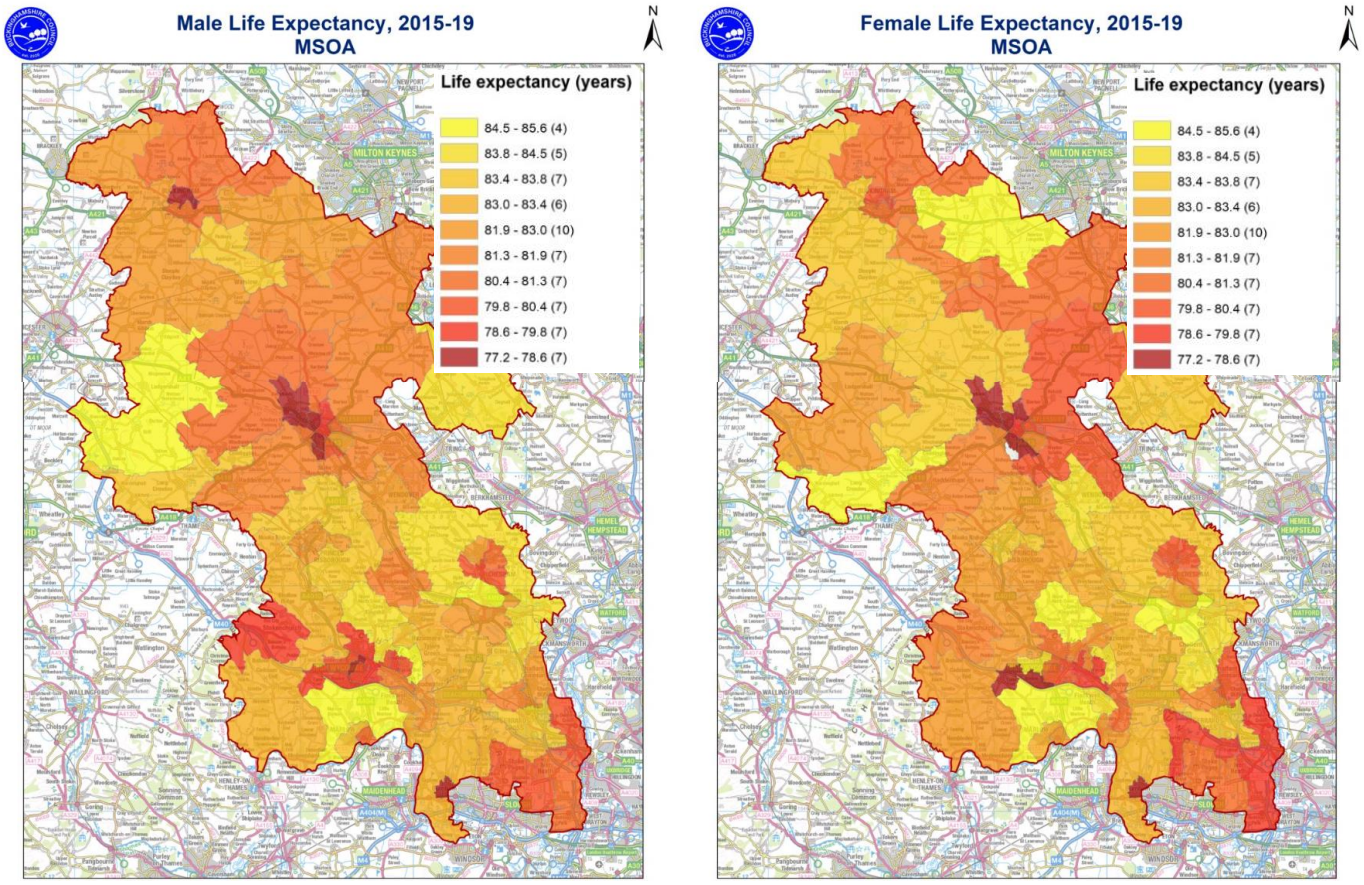


Source: Buckinghamshire Council (March 2023) Scoping Report for the Sustainability Appraisal of the Local Plan for Buckinghamshire, Figure 6.1

6.5.1.2. Health

Social challenges are reflected in health outcomes. Data on the Bucks Data Exchange indicates that the number of preventable early deaths from cardiovascular disease, cancer and respiratory disease is lower than the averages for both the South East and England[35]. Life expectancy, on average, is also significantly higher than the national average. However, Figure 6-9 shows that there are geographic variations.

Figure 6-9 Life expectancy in Buckinghamshire



Source: Bucks Data Exchange, Life expectancy in Buckinghamshire - Bucks Data Exchange

There is a significant range in life expectancy across the area, with broadly similar patterns between men and women, although men die earlier than women. There are challenges in localised hotspots of lower life expectancy in Aylesbury, High Wycombe, Buckingham, and Burnham. There are also challenges in Stokenchurch (lower than average for men) and Handy Cross (lower than average for women), and challenges in the south-eastern corner around Iver, Stoke Poges, and the Slough boundary.

6.5.2. Impacts of forecast traffic growth

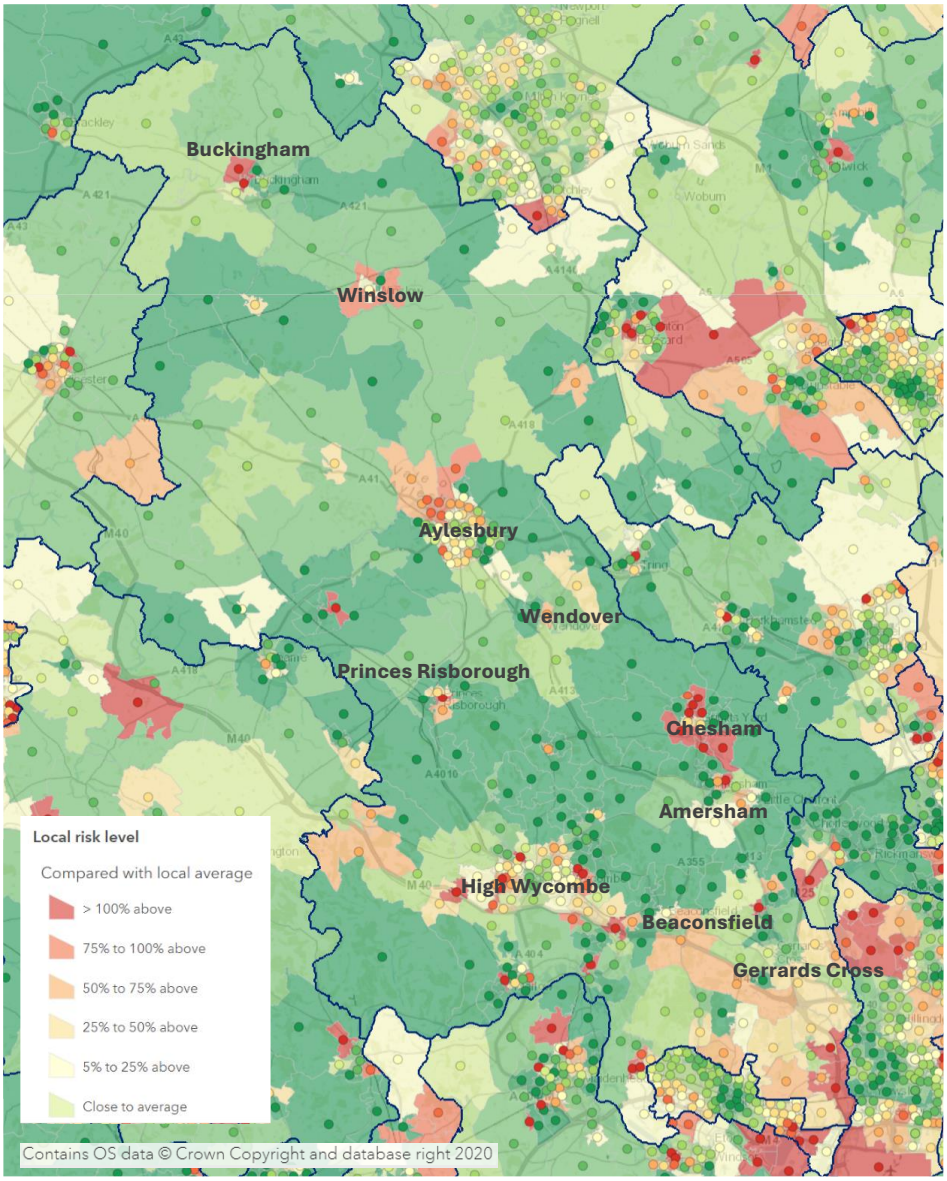
Transport for the North recently published research on Transport-related social exclusion (TRSE)[36]. The study developed a measure of TRSE risk at the LSOA level, based on combining accessibility scores and vulnerability scores (using Indices of Deprivation). It also developed a tool to map areas with high TRSE risk. Figure 6-10 shows TRSE risk levels in Buckinghamshire compared to the Buckinghamshire average. Areas with above-average risk variations extend across Buckingham, Winslow, High Wycombe, and Amersham/Chesham. This demonstrates that problems caused by poor accessibility are not just limited to rural areas.

Compared to the national average, risk of transport-related social exclusion in Buckinghamshire is low; there are relatively few nationally high-risk areas in Buckinghamshire. The areas which are higher-risk at a national level include Denham, Burnham, localised parts of High Wycombe, Princes Risborough, Chesham and Buckingham.

35 Early deaths in Buckinghamshire - Bucks Data Exchange

36 Transport-related-social-exclusion-in-the-North-of-England.pdf (transportforthenorth.com)

Figure 6-10 Transport-related social exclusion in Buckinghamshire (vs county average)



Source: TfN Social Exclusion tool, [Transport-related social exclusion in England (transportforthenorth.com)]

The underlying causes of these patterns are due to two components:

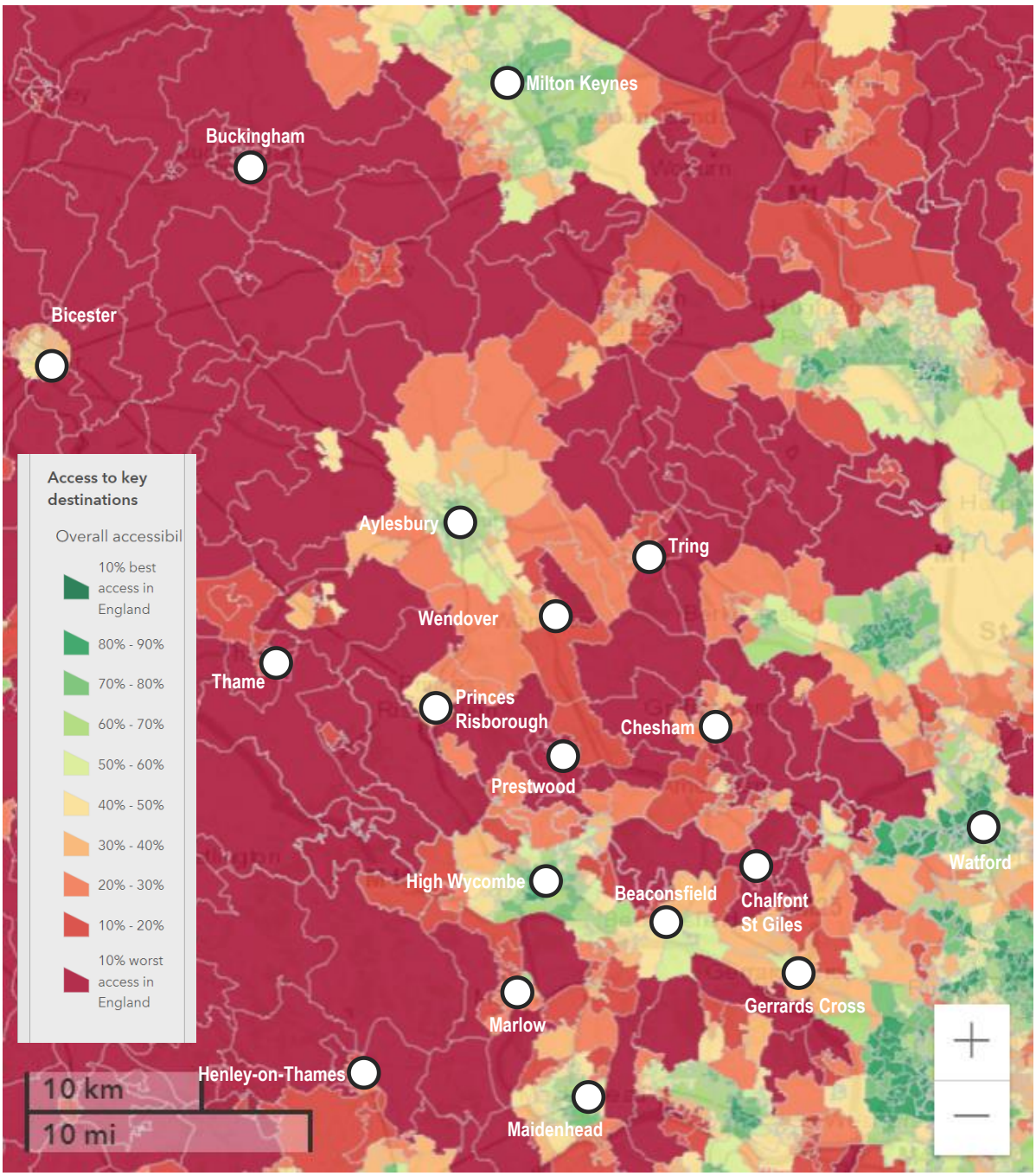
- vulnerability to social exclusion through deprivation; and
- accessibility to key destinations.

Accessibility is shown to be highest in the middle of Aylesbury and High Wycombe, and much lower (as expected) in rural areas (see Figure 6-11). In general, most of the areas with higher deprivation have higher levels of accessibility, which means that there is limited TRSE risk in Buckinghamshire.

However, some areas have higher vulnerability to social exclusion and poor accessibility. These include Buckingham, parts of Winslow and parts of Chesham. These areas are therefore at higher risk of worsening social exclusion as a result of increases in highway journey times, which will affect both journeys by car and road-based public transport. In the context of where traffic growth and increased delays are forecast to be highest, this may be a particular issue in Chesham.

Whilst deprivation may be less of an issue in the more rural parts of Buckinghamshire, there are localised areas of higher social exclusion in these areas. Poor accessibility across most of the rural areas of Buckinghamshire is likely to cause significant challenges for people without access to a car, as well as children and young people being dependent on parents and carers for transport to schools and other activities.

Figure 6-11 Access to key destinations



Source: TfN Social Exclusion tool, Transport-related social exclusion in England (transportforthenorth.com)

7. The role of rail in enabling growth

7.1. Existing rail lines and services

7.1.1. Heavy rail services

Currently the main heavy rail lines in Buckinghamshire are the four radial corridors to and from London:

The Chiltern Main Line, running to/from London Marylebone and serving a corridor including Beaconsfield, High Wycombe and Princes Risborough. Following a series of investments since the late 1990s, this is now essentially a double-track main line, with longer-distance services between London and Oxford or Birmingham plus shorter-distance services stopping more frequently and covering local and commuter markets. The basic Monday-Friday off-peak service pattern (in summer 2023) consists of a half-hourly London to/from Birmingham service, a half-hourly London to/from Oxford service, and an hourly local London to/from High Wycombe service. At peak times, there are variations, and some stations have additional services including occasional through-services to Aylesbury via Princes Risborough, although the number of these has reduced in recent timetable changes. There are further variations at weekends.

The London – Aylesbury Line via Amersham. It essentially provides an outer-suburban service. In part it uses London Underground infrastructure and indeed London Underground Metropolitan line trains run as far as Amersham with a branch to Chesham. The basic Monday-Friday off-peak service pattern is hourly or half-hourly between London and Aylesbury, with some trains continuing to/from Aylesbury Vale Parkway. Again, there are variations at peak times and at weekends. In addition to this, Underground trains run half-hourly to each of Amersham and Chesham, with additional trains at peak times.

The West Coast Main Line, running to/from London Euston and serving the eastern part of Buckinghamshire as it crosses in and out of the county. It is a four-track mixed-traffic main line with long-distance inter-city trains, local/commuter services and considerable freight traffic. The stations serving north-eastern Buckinghamshire on this route have local/commuter trains with a mixture of stopping patterns, providing two to four trains per hour per direction at any individual station in the basic off-peak service pattern. Again, there are variations at peak times and at weekends. Milton Keynes Central is also served by inter-city trains.

The Great Western main line serving the southernmost parts of the county between London Paddington, Reading and beyond. This, like the West Coast Main line, is a four-track mixed-traffic railway. Elizabeth line trains serve the outer-suburban stations on the main line in and near the south-eastern tip of the county. The Elizabeth line provides two or four trains per hour per direction at any individual station in the basic off-peak service pattern, with some variations at peak times. Great Western Railway trains provide additional services at the larger stations. In addition, Marlow and Bourne End are served by a single-track branch to Maidenhead on the main line, operating hourly off-peak. At peak times the line is split into separate Marlow-Bourne End and Bourne End-Maidenhead trains to allow a half-hourly frequency (with through-passengers being required to change trains at Bourne End).

A single-track line runs between Princes Risborough and Aylesbury. This is at most times in effect a branch line offering connections at Princes Risborough onto Chiltern Main Line services. The basic off-peak service is hourly, with variations at peak times. At some times of the day or week, this line's service consists of through trains between London and Aylesbury via Princes Risborough.

Service patterns and timetables change over time in response to circumstances. The descriptions given here are based on the summer 2023 timetable and should be seen as simply indicating the basic nature of each route.

7.1.2. London Underground services

Buckinghamshire is also served by the northern extremity of the Metropolitan Line of the London Underground. Metropolitan line services operate from two termini at Chesham and Amersham via Chalfont & Latimer station into central and east London, running non-stop between Wembley Park and Finchley Road. The journey time to King's Cross is approximately one hour from Amersham and Chesham although in practice for many passengers travelling to/from central London it will be quicker to use Chiltern services for some or all of the journey. Metropolitan line services do however offer connections to stations such as those in Hertfordshire and the London Borough of Harrow.

7.2. Lines under construction or proposed

A new rail line, East-West Rail (EWR), is currently under construction. It will cross the north of Buckinghamshire with a station at Winslow. It will provide services between Oxford and Milton Keynes or Bedford. There is a disused line from Aylesbury Vale Parkway which joins the EWR route at Steeple Claydon (although currently severed at that end). This had been intended to be upgraded for passenger service as part of the EWR project, but this is not currently a part of the scheme under construction.

High Speed 2 (HS2), currently under construction, passes through Buckinghamshire but with no stations in the county.

7.3. Potential for rail to cater for some of the new development-related trips

The existing site allocations and commitments will result in additional demand for travel to and from them. Whilst it is anticipated that most of these journeys will be made by car, there is potential for some of those new journeys to be made by other modes including public transport.

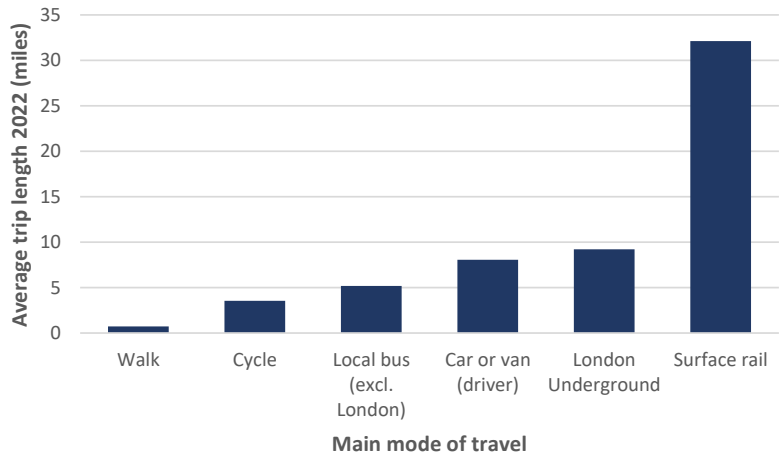
Rail services will be particularly attractive for access to and from new developments where they offer an advantage over car travel in terms of journey time, cost or convenience. Typically, this means for journeys which:

- are to/from locations where parking supply is limited or expensive (such as central London);
- the car journey is subject to significant traffic congestion resulting in slower, less reliable journeys; and/or
- are longer (where the journey time advantage of rail over car and bus is higher).

However, the relatively high cost of rail travel compared to a private car often counteracts these potential benefits of using rail.

The above typically means that rail is most competitive for journeys to London, or other longer inter-urban journeys, rather than journeys to local town centres. Rail services are less attractive for shorter journeys, with a national average trip length in 2022 of 32 miles (see Figure 7-1) compared to 8 miles for a car or van driver.

Figure 7-1 Trip length by mode, 2022



Source NTS0303

The share of new development-related journeys using rail will also be affected by:

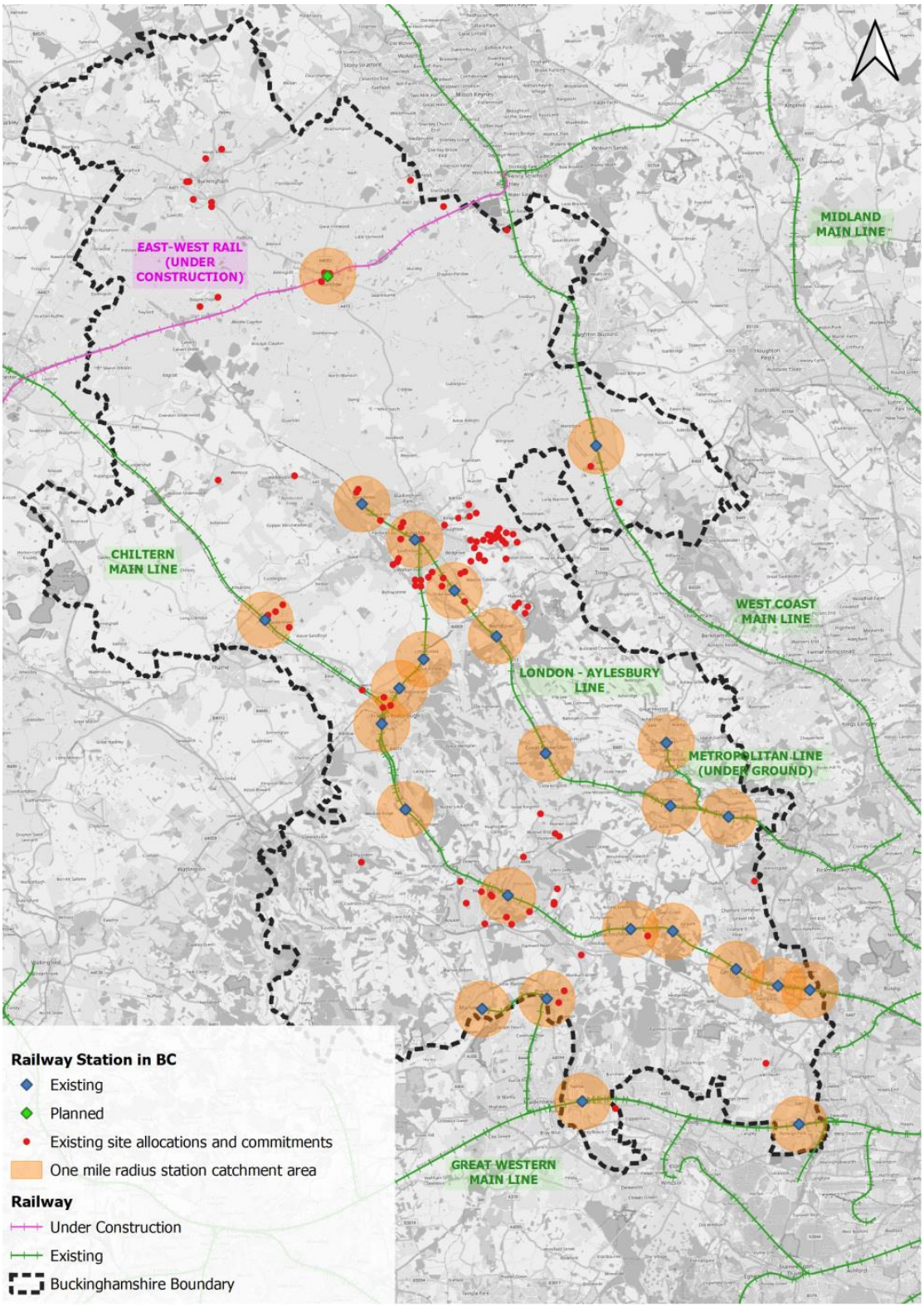
- the proximity of the development to a station;
- whether the rail services link the development to key attractors such as employment and retail hubs;
- service frequency; and
- rail capacity, for example the likelihood of getting a seat.

These are considered in turn below.

7.3.1. Station proximity

Figure 7-2 shows the locations of the existing site allocations in the existing adopted Local Plans and existing commitments and their proximity to railway stations in Buckinghamshire.

Figure 7-2 Existing site allocations and commitments and railway stations



As shown in the map, a number of existing site allocations and commitments are in the vicinity of an existing or planned railway station. Table 7-1 lists these.

Table 7-1 Clusters of existing site allocations and commitments that are relatively close to a station

Clusters of existing site allocations and commitments	Nearby station(s)
Winslow	Winslow (currently under construction on EWR)
Western and central Aylesbury and Stoke Mandeville	Aylesbury Vale Parkway Aylesbury Stoke Mandeville
Haddenham	Haddenham & Thame Parkway
Princes Risborough	Princes Risborough Monks Risborough
High Wycombe (a cluster of sites, some less close to the station than others)	High Wycombe
Beaconsfield (a cluster of sites)	Beaconsfield Seer Green
Bourne End	Bourne End
Cheddington	Cheddington
Taplow	Taplow

The remaining clusters are more remote from a station. Table 7-2 shows these, and their nearest stations.

Table 7-2 Clusters of existing site allocations and commitments that are more remote from a station

Clusters of existing site allocations and commitments	Nearest station(s)	Approximate distance (miles)
Buckingham	Wolverton, Milton Keynes Central or Bletchley	9-11
	Bicester North or Bicester Village	9-10
	Winslow (under construction)	5
Western Bletchley	Bletchley or Milton Keynes Central	3
Steeple Claydon	Bicester North or Bicester Village	7
	Winslow (under construction)	5
Wescott	Bicester North or Bicester Village	9
	Haddenham & Thame Parkway	6
	Aylesbury Vale Parkway	5
Waddesdon	Bicester North or Bicester Village	10-11
	Haddenham & Thame Parkway	5
	Aylesbury Vale Parkway	3
Eastern Aylesbury	Aylesbury or Stoke Mandeville	2
	Cheddington or Tring	5-6
Stokenchurch	Saunderton	3
	Princes Risborough	5
	High Wycombe	7
Newland Park	Chorleywood	2
	Gerrards Cross	3

Note: multiple stations are shown for each growth area, because the nearest individual station may not be the most appropriate depending on the journey required. The main options are shown in each case, but this list is not exhaustive.

7.3.2. Level of service and connectivity

A further aspect of rail's ability to serve the existing site allocations and commitments is the level of connectivity it provides. This includes both the geography of the rail network, and the service patterns and frequencies available. Timetables inevitably have to balance competing needs, such as local connectivity versus long-distance journeys, within the available capacity.

The site allocations and commitments along the Chiltern Main Line corridor with stations nearby have good connectivity to/from and between sites and commitments along the route, including those near High Wycombe station as well as those in Haddenham and Princes Risborough. Similarly, there is good connectivity to/from the central and western Aylesbury site allocations and commitments along the rail corridor via Amersham, and (for central Aylesbury) via the shuttle from Princes Risborough

However, there are considerable gaps in the rail connectivity, even where stations are available, such as:

- between Aylesbury and Buckingham, Winslow or Milton Keynes;
- between the parallel rail corridors – for example, between Aylesbury and Leighton Buzzard, or between High Wycombe and Amersham or Bourne End;
- Aylesbury to High Wycombe is potentially an important link but generally requires a change at Princes Risborough;
- the Princes Risborough-Aylesbury corridor is limited by its single-track nature; and
- although the Chiltern Main Line offers connectivity along its length, the ability to provide metro-style frequencies for its local stations in Buckinghamshire is constrained by the need to accommodate both local and longer-distance services.

7.3.2.1. Scale of potential growth in rail demand

This section gives a brief insight into the scale of potential growth in rail demand because of the existing site allocations and commitments. This is necessary as to date no formal forecasts of rail demand from these sites has been made. No formal forecasts of rail demand from these allocations and commitments have been made.

At the time of undertaking this study, sites have yet to be identified for the Local Plan in Buckinghamshire, and therefore further work will be needed later to estimate the growth in rail demand from the new allocations.

The population within the catchments of the existing rail stations has been estimated and compared to the populations assumed in the existing site allocations and committed sites. The rail catchment populations have been derived assuming each station has a potential catchment extending 6.2 miles from the station. This distance has been chosen to reflect the fact that a significant share of passengers is believed to drive to many of the stations in question. The figure is based on professional judgement and therefore the resultant analysis should be considered as indicative only.

The analysis was restricted to the Chiltern stations in Buckinghamshire (i.e., excluding Cheddington on the West Coast Main Line, Taplow and Iver on the Great Western Mainline and the Marlow Branch Line). Whilst there are a small number of existing site allocations or existing commitments in the catchments of stations on the Great Western mainline, these stations were not included in the analysis because:

- there are very few site allocations and committed sites in Buckinghamshire close to these stations; and
- there are site allocations and committed site nearby in neighbouring authorities which would mean the analysis is somewhat spurious.

The stations were combined into three groups based on the existing patterns and total catchment populations derived for each (see Figure 7-4 Rail capacity, standard class critical loads and crowding in the morning peaks, 2011-2022). Where part of a catchment fell within more than one grouping, the population was shared equally between each grouping. The resultant population estimates are shown in Table 7-3.

Table 7-3 Station catchment populations

Station group	Stations	Population within 6.2 miles of the stations
High Wycombe - West Ruislip	High Wycombe, Beaconsfield, Seer Green, Gerrards Cross, Denham, West Ruislip	828,500
Aylesbury - Chorleywood	Aylesbury Vale Parkway, Aylesbury, Stoke Manderville, Wendover, Great Missenden, Amersham, Chalfont & Latimer, Chorleywood	334,000
Haddenham & Thame Parkway and Aylesbury – High Wycombe	Haddenham & Tame Parkway, Little Kimble, Monks Risborough, Princes Risborough, Saunderton	165,900

Population data source: 2021 Census - TS008 – Sex – All Persons Dataset at the LSOA level.

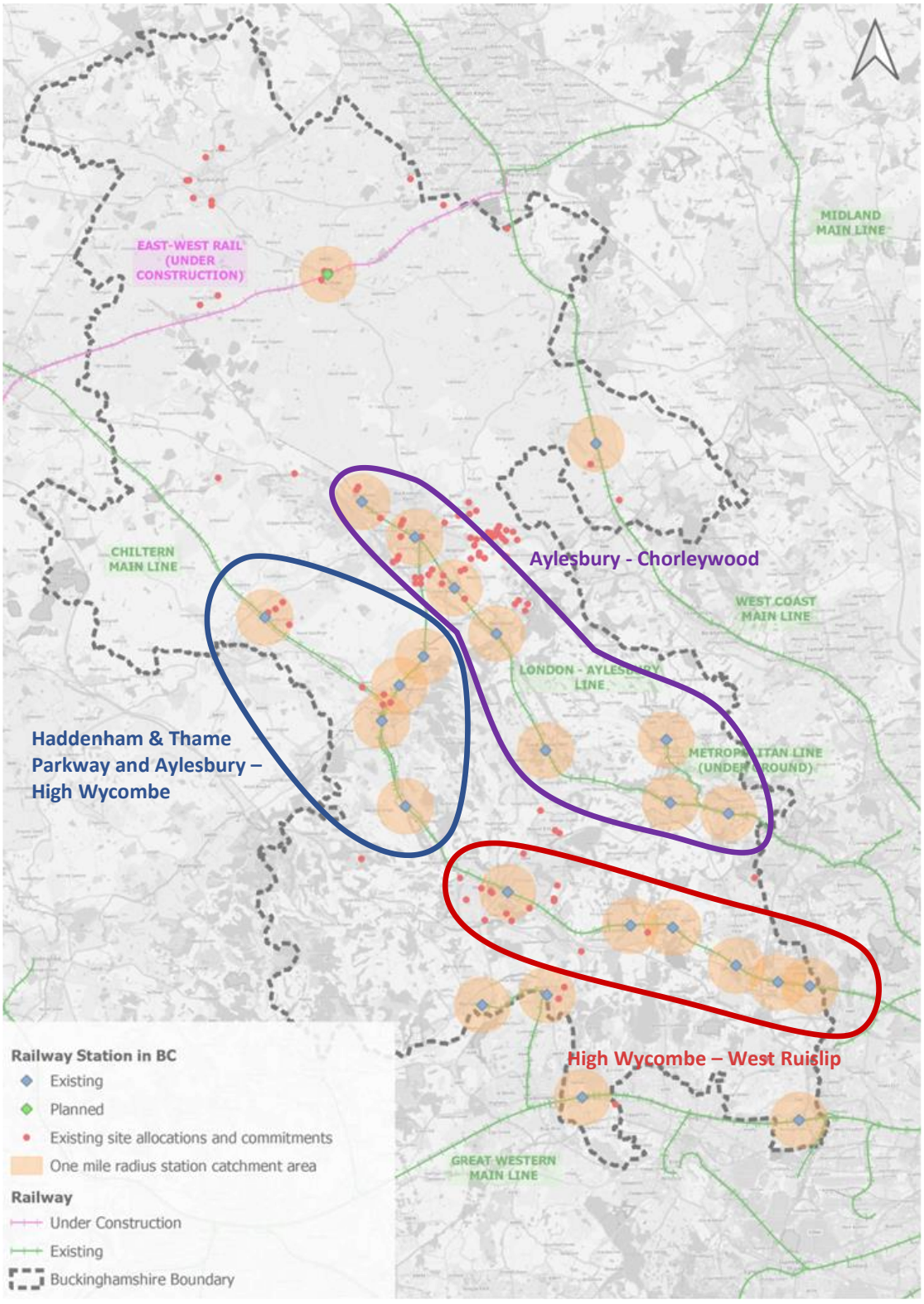
As can be seen, the increase is relatively small in the High Wycombe – West Ruislip group and the Haddenham and Aylesbury – High Wycombe group but is significantly higher in the Aylesbury – Chorleywood group. This analysis therefore suggests that it is in this corridor where rail passenger demand might be expected to increase the most as a result of existing site allocations and committed sites.

Table 7-4 Residential allocations and sites as share of station catchments

Station group	Population in station catchments 2021	Households in station catchments 2021	Homes in committed developments in station catchment	% increase in homes
High Wycombe - West Ruislip	828,500	330,080	4,630	1.4%
Aylesbury - Chorleywood	334,000	133,070	11,830	8.9%
Haddenham & Tame Parkway and Aylesbury – High Wycombe	165,900	66,100	2,010	3.0%

2021 households estimated based on 2.51 people per household (Buckinghamshire average from 2021 Census)

Figure 7-3 Station groupings used for analysis



Each residential site allocation and existing commitment was allocated to its closest station. The number of homes assumed for each development was then combined for each station group to give total homes within each station group catchment. These figures are shown in Table 7-4. The table also compares the number of additional homes to the current number of households in each station group catchment to show the percentage increase.

7.3.3. Providing additional rail capacity

7.3.3.1. Background

The rail industry seeks to forecast and accommodate demand growth by providing more capacity, for example through more frequent services or longer trains. This in turn may require investment in new infrastructure such as enhanced signalling, new tracks or longer platforms. Additional capacity can sometimes be achieved on a commercial basis, but in other cases (especially for peak commuter capacity increases) public-sector funding is required through the rail industry's long-term planning processes.

Traditionally the critical factor for capacity, particularly on commuter routes, has been crowding on peak period services into central London and other major cities and towns. For Buckinghamshire, this particularly relates to the morning peak into London on the radial routes.

Before the COVID-19 pandemic, the rail industry sought to respond to areas of existing or forecast crowding by adding further capacity where practical and funded. This was reflected in both incremental, tactical timetable changes at routine timetable change points and enhancement schemes identified through the industry's more strategic, long-term planning work. For this longer-term horizon, the publicly available evidence on future capacity and demand is generally derived from route studies and similar documents produced by Network Rail through its long-term planning process[37]. Before COVID-19, and particularly on the commuter routes where peak passenger capacity was a key issue, these studies and plans would include an exercise to forecast long-term demand.

Before the COVID-19 pandemic, and particularly on the commuter routes where peak passenger capacity was a key issue, an exercise to forecast long-term demand would have been carried out by Network rail. However, pre-pandemic analyses can no longer necessarily be relied upon as rail demand in the traditional commuter peaks has generally reduced (even on the busier mid-week days) and timetables amended in consequence. Furthermore, there is uncertainty over whether patronage per person will ever return to historic norms.

7.3.3.2. Crowding in 2022

The most recent DfT rail crowding statistics, published in July 2023, relate to demand in Autumn 2022[38]. Figure 7-5 shows the relevant data for Buckinghamshire's rail corridors into London. The data are published as totals for each London terminus. It is not possible to identify the crowding for passengers from any individual origin station, or on any one train. The data are therefore best seen as indicating the overall level of capacity constraint on each corridor.

37 https://www.networkrail.co.uk/running-the-railway/long-term-planning/

38 https://www.gov.uk/government/statistics/rail-passenger-numbers-and-crowding-on-weekdays-in-major-cities-in-england-and-wales-2022/rail-passenger-numbers-and-crowding-on-weekdays-in-major-cities-in-england-and-wales-2022

Table 7-5 Rail capacity, loads and crowding in the commuter peaks, autumn 2022

			Service provision				Passengers in excess of capacity (PiXC)		Passengers standing		Services with PixC		Services with passengers standing	
Peak	Type of peak	Station	Number of services	Standard class seats	Standard class capacity [note 1]	Standard class critical load [note 2]	Number	Per cent [note 3]	Number	Per cent [note 3]	Number	Per cent [note 4]	Number	Per cent [note 4]
AM peak arrivals	1 hour peak (0800-0859)	London Euston	21	8,906	12,009	9,312	596	6%	2,011	22%	6	29%	10	48%
		London Marylebone	10	3,740	4,388	4,456	668	15%	789	18%	6	60%	9	90%
		Paddington	23	11,681	25,186	15,041	76	1%	5,378	36%	1	4%	12	52%
	3 hour peak (0700-0959)	London Euston	61	23,924	32,523	23,011	1,396	6%	4,026	17%	12	20%	28	46%
		London Marylebone	33	10,675	13,035	10,166	884	9%	1,097	11%	8	24%	12	36%
		Paddington	66	31,752	68,169	33,743	76	0%	8,818	26%	1	2%	29	44%
PM peak departures	1 hour peak (1700-1759)	London Euston	18	7,036	9,962	6,339	190	3%	1,229	19%	2	11%	8	44%
		London Marylebone	11	3,466	4,284	3,231	229	7%	252	8%	2	18%	3	27%
		Paddington	22	10,748	22,801	11,891	236	2%	3,507	29%	1	5%	10	45%
	3 hour peak (1600-1859)	London Euston	59	23,100	31,383	19,912	393	2%	2,653	13%	5	8%	22	37%
		London Marylebone	33	9,854	12,066	8,562	439	5%	535	6%	5	15%	7	21%
		Paddington	63	30,326	65,583	32,889	272	1%	8,892	27%	2	3%	28	44%

Notes:

1 Includes standard class seats and, where permissible, an allowance for standing passengers.

2 The sum of the number of standard class passengers on each service at its point of highest load. This represents the highest number of passengers that needed to be accommodated.

3 As a percentage of standard class critical load.

4 As a percentage of total number of services.

Source: DfT, Peak rail capacity, standard class critical loads and crowding on a typical autumn weekday in London by station, annual from 2011 (RAI0213)

The count is taken at the point of highest loading on each route, which may not be the terminus itself. The data cover the three-hour morning and afternoon peak periods, and the one-hour 'high peak' within each of those. The measure of capacity is based on a certain amount of standing being tolerable (and regarded as within capacity) for shorter journeys on trains that are designed for this. The data therefore show both total numbers standing and the numbers above the standing capacity, known as passengers in excess of capacity (PiXC).

Because the data are totalled for the one-hour or three-hour periods, there may be cases where total capacity *across the period* exceeds demand but there are still PiXCs on the busiest trains.

There is considerable crowding on trains to and from Marylebone. In the morning high peak hour, (08:00-09:00), 18% of passengers were standing, most of whom were PiXCs, and most trains had PiXCs. Across the three-hour peak (07:00-09:00), although there were more seats than passengers in total, 11% of passengers were standing.

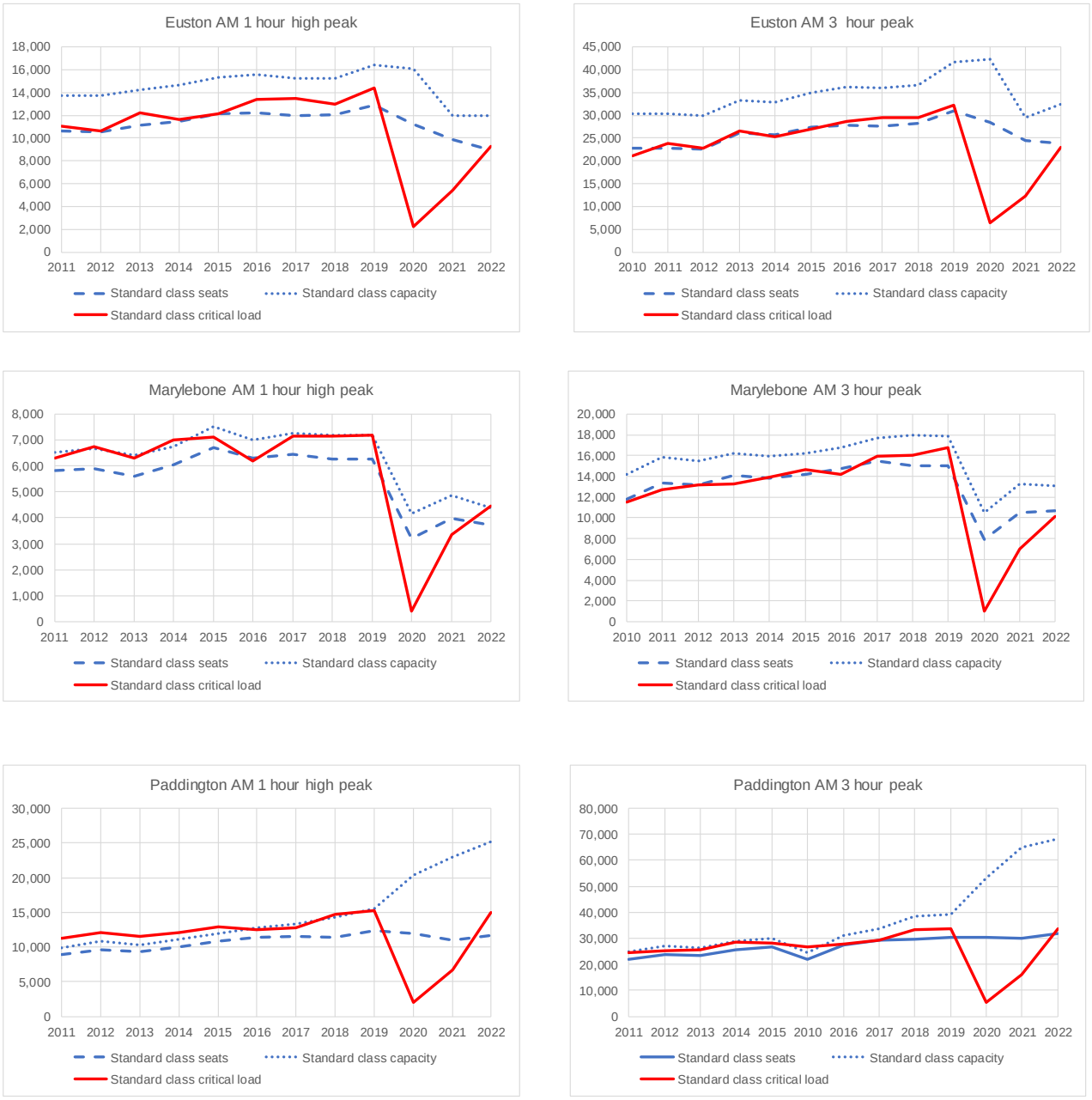
Trains to and from Euston were less crowded. In the morning high peak hour, 22% of passengers were standing but only 6% of passengers were PiXCs and only 29% of trains had PiXCs. The figures for the three-hour peak were broadly similar.

On trains to and from Paddington, 36% of passengers were standing in the morning high peak hour. However, this includes Elizabeth line trains which are designed with particularly high standing capacity, and only 1% of passengers were PiXCs (on just one train).

7.3.3.3. Relationship between 2022 crowding levels and historic capacity

The 2022 crowding levels should be seen in the in the context of lower demand and adapted service provision following the COVID-19 pandemic. As illustrated in Figure 7-4 for the morning peak period, both capacity and peak loadings (shown in red) have changed significantly since 2020.

Figure 7-4 Rail capacity, standard class critical loads and crowding in the morning peaks, 2011-2022



Source: DfT, Peak rail capacity, standard class critical loads and crowding on a typical autumn weekday in London by station, annual from 2011 (RAI0213)

The top four charts show that on the Euston and Marylebone corridors, the 2022 capacities and peak loadings were considerably lower than in 2019. This indicates an in-principle potential for pre-pandemic capacity to be restored in response to growing passenger demand including from the existing Local Plan site allocations and existing commitments.

On the Paddington corridor (bottom charts), the picture is different, with recent increases in standing capacity well above pre-COVID-19 levels (likely to reflect the new Elizabeth line trains). Demand is back to broadly pre-pandemic levels, and this too may at least partly reflect the Elizabeth line. There is, accordingly, considerable capacity headroom, but this is standing capacity which is most appropriate for shorter journeys rather than journeys from the Buckinghamshire stations.

7.3.3.4. Future demand and crowding

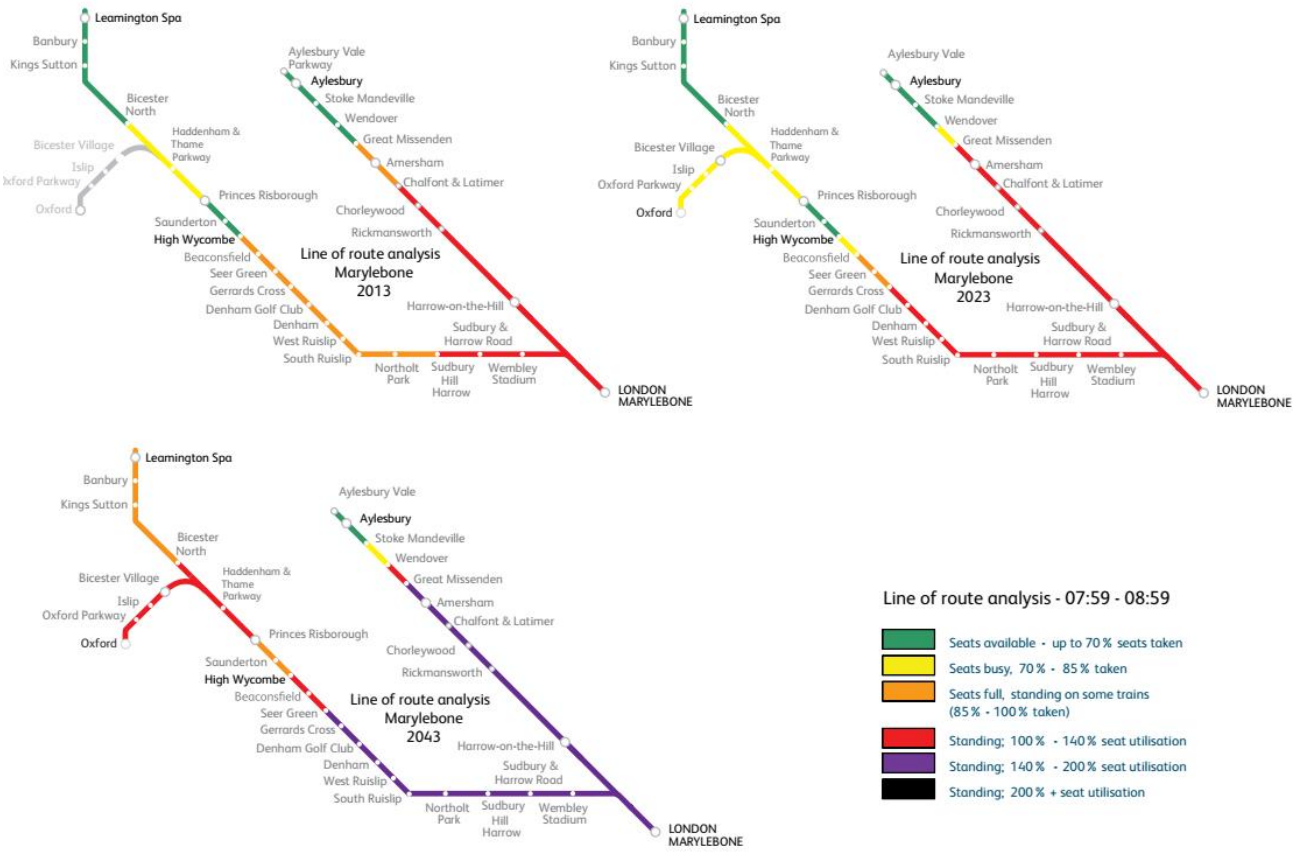
Pre-COVID long-term planning assessments of future demand and capacity are now of limited value. Although the industry's long-term planning continues, the focus has moved away from the traditional peak demand/capacity focus, with more of a focus on connectivity goals. We have not been able to identify any publicly available up-to-date assessments of future demand or capacity on the rail corridors serving Buckinghamshire. This section therefore provides commentary on the best available evidence (whether pre- or-post Covid).

Aylesbury line and Chiltern Main Line (Marylebone corridor)

The most recent available planning document is Network Rail's West Midlands and Chilterns Route Study (August 2017)[39]. It included addressing the need "to provide sufficient capacity for passengers travelling into central London Marylebone during peak hours", using 2023 and 2043 as planning horizons.

Its demand forecasts were based on a scenario from the 2013 Market Study for London and the South East. This was considered to be most credible scenario because it reflected the (then) recent growth observed in the study area. On this basis, the study forecast seat utilisation in the 'high peak' hour (07:59-08:59 arrivals in London). In 2043, without intervention, demand would be within the range of 140-200% of seating capacity arriving at London. Indeed, passengers would be standing on outer parts of the route such as Oxford to Princes Risborough, or inwards from High Wycombe. Figure 7-5 shows these forecasts.

Figure 7-5 High-peak arrivals seat utilisation into London Marylebone in 2013, 2023 and 2043



Source: West Midlands & Chilterns Route Study, Network Rail, 2017, Figure 3.6 . Data exclude London Underground Metropolitan line services.

The study identified that to meet the demand forecasts, capacity for 1,700 extra passengers would be needed by 2023, with this increasing up to 5,100 passengers by 2043.

39 https://sacuksprodnrdigital0001.blob.core.windows.net/regional-long-term-planning/North,%20West%20and%20Central/West%20Midlands%20and%20Chilterns%20Route%20Study%20Final.pdf

Options were tested for providing some or all of this additional capacity, in particular re-routing some services to terminate at Old Oak Common instead of Marylebone. The study drew this and other requirements together into a potential Chiltern Capacity Package of infrastructure to meet the anticipated demand.

More recently, the route's main operator (Chiltern Railways) has published its *RightRoute 2030 Vision* document setting out its long-term fleet aspirations[40]. This recognises that the route's communities are growing and that passengers are looking for more seats at key times. The aspiration includes a new fleet to deliver more and longer trains to respond to growing demand.

To confirm whether the 2017 work and the proposed Chiltern Capacity package remain valid, further technical work would be required to (in effect) re-calibrate it to reflect current growth expectations as well as the impacts of Covid and assumptions on any further post-Covid recovery.

West Coast Main Line (Euston corridor)

The most recent available planning document is Network Rail's West Coast South Strategic Advice (August 2023)[41]. This document does not assess future commuter demand against passenger capacity but rather presents a high-level examination of planning principles and potential priorities for capacity allocation and associated infrastructure requirements.

The report assumes that HS2 has been built in full between London and Crewe (technically known as 'Configuration State G') which then releases conventional network capacity through transfer of inter-city services to HS2. As HS2 Phase 2 and HS2 East have now been cancelled, the findings of this document are therefore now unsupported..

The study examined the opportunities for using that released capacity, and where conventional network constraints were still likely to exist post-HS2, and recommendations on addressing them. It tested scenarios covering a range of possible uses of capacity. The 'Peak Commuter' scenario for example involved an increased number of commuter train paths in the southbound morning peak, providing additional passenger capacity and journey opportunities compared to today.

Great Western Main Line (Paddington corridor)

The most recent available planning document is Network Rail's 2015 Western Route Study[42]. The study assumed that a number of rail network changes would be in place by 2019, including the Elizabeth line, which was expected to provide a step-change in capacity but also to stimulate further demand, and electrification of the Thames Valley branches (which has not yet taken place) which had been expected to increase on-train capacity. The study took a 'high growth' scenario from the earlier Market Study, based on employment, population and GDP forecasts of the time, to represent background growth.

The study defined the level of crowding in terms of passengers standing per square metre, with more than three passengers per square metre considered to be crowded conditions. In the 2026 forecast this level was expected to be reached from Southall and stations to the east. In 2041 the crowding was forecast to approach four passengers per square metre. The study identified near-term and long-term potential interventions to accommodate demand, including timetabling changes and infrastructure enhancements.

The route study also considered the Thames Valley branch lines, which is particularly relevant to the existing site allocations and existing committed sites at Bourne End on the Marlow branch. On the Marlow branch, demand was expected to exceed capacity (seated and standing) in the 2046 forecasting horizon. The study identified long-term potential for train lengthening to meet demand on the branches.

As with any pre-COVID-19 studies, the 2015 Route Study is now considerably dated, and its forecasts should not be taken as being up to date.

40 https://www.chilternrailways.co.uk/chiltern-railways-2030-vision

41 https://sacuksprodnrdigital0001.blob.core.windows.net/regional-long-term-planning/North,%20West%20and%20Central/West%20Coast%20South%20Strategic%20Advice%202023.pdf

42 https://sacuksprodnrdigital0001.blob.core.windows.net/regional-long-term-planning/Wales%20and%20Western/Western%20Route%20Study%20Final.pdf

7.4. Conclusions

Ultimately the locations of the existing site allocations and committed site is critical to rail's share of growth. There is considerable variation in the extent to which the individual allocations and committed sites give the opportunity for rail to contribute significantly. This will also be valid when looking at future site allocations in the Local Plan for Buckinghamshire. A focus on those locations with the greatest opportunity for sustainable travel patterns (by rail and other sustainable modes) would therefore be beneficial in terms of increasing the share of journeys to and from future Local Plan site allocations made by rail which in turn will reduce transport carbon emissions.

Future transport work may need to consider more detailed analysis of potential trip patterns from growth sites, and review future capacity on relevant rail services, to further inform the maximisation of sustainable travel options and existing/planned capacity.

7.5. Potential measures to increase rail's share of new journeys

In developing the LP4B there are a number of measures and policies which should be considered which would increase the share of journeys from the growth areas which are made by rail. This is not an exhaustive list and should be seen as part of an overall strategy in which other sustainable modes also play their part.

- **First/last mile connectivity:** Ensuring that future allocations within an existing station's local catchment area maximise their first/last mile connectivity to the station. Local consolidation centres and sustainable first/last mile freight delivery are likely to reduce demand for existing road space and reduce carbon emissions by encouraging a shift in passenger and freight movements on to the railway. This would apply particularly, for example, to allocations in Haddenham, Princes Risborough, and Aylesbury.
- Consider the best way to connect the **cluster of developments on the east side of Aylesbury** into the rail network. This should include considering a high-quality public transport link to Aylesbury and/or Stoke Mandeville stations. This could potentially be extended to Tring or Leighton Buzzard, to provide connectivity with locations such as Hemel Hempstead and Watford along the West Coast Main Line
- Consider the potential for **new stations** at Bletchley West (on EWR) and to the south of Aylesbury (on the line to Princes Risborough)
- **Delivery of the previously planned Aylesbury to Milton Keynes service** via EWR. The EEH's Oxford – Milton Keynes connectivity study[43] has proposed a package of measures including the Aylesbury link that is expected to increase daily return rail trips by 30%. This link would fill a considerable connectivity gap in its own right and has the potential to be a building-block for further improvements described below. (See also section 7.6 for how this links with the East West Main Line concept.)
- Consider the appropriate 'railheading' strategy for **Buckingham**, including the cluster of existing site allocations and commitments around its western side. 'Railheading' refers to situations where a location does not have a station of its own and passengers need to use other stations, perhaps some distance away, instead. Although Winslow will be Buckingham's nearest station, this would only be appropriate for trips to a limited range of locations towards Oxford. The Aylesbury to Milton Keynes service described above (if calling at Winslow) would, however, add considerable value to this for Buckingham-Aylesbury trips, at which point a high-quality public transport connection between Buckingham and Winslow may become more viable.
- Consider opportunities to make a **step-change investment in north-south rail connectivity** through Buckinghamshire. A direct service between High Wycombe, Aylesbury and Milton Keynes would open up new rail connectivity between these major centres. This may require, in addition to the Aylesbury – EWR link described above, investment in train path capacity and/or service resilience at locations south of Aylesbury. (See also section 7.6 for how this links with the East West Main Line concept.)

43 https://eeh-prod-media.s3.amazonaws.com/documents/Oxford-Milton_Keynes_connectivity_study.pdf

- Consider opportunities to create a direct **Oxford-Aylesbury service**, building on the Aylesbury-EWR link described above and requiring a new south-to-west connection at Claydon. (See also section 7.6 for how this links with the East West Main Line concept.)
- Holistically consider the preferred strategy for **connectivity into High Wycombe from the south** (including the Royal Borough of Windsor & Maidenhead and Slough). This should build on earlier work such as the M25 South West Quadrant Strategic Study and the 2020 study for Wycombe District Council into reopening the Bourne End – High Wycombe route. The solution may or may not be rail-based, and innovative alternatives could be considered.
- Further explore options for improved rail connectivity in the '**southern arc**' identified in the EEH/Network Rail Passenger Rail Study Phase 1 [44]. The southern arc concept is for an orbital route around north London between the Chiltern Route and West Anglia Main Line.

Buckinghamshire Council will not be able to deliver most of these potential measures alone as it has neither the powers nor funding; local connections to railway stations being the exception and within its control. However, the Council could seek to progress these or other measures through engagement with rail industry stakeholders and other partners. For example, the Council will work with England's Economic Heartland (EEH) and other local authorities on studies and other technical work to identify investments for inclusion in the sub-region's Investment Pipeline. The Investment Pipeline will contain multi modal opportunities and interventions which provide large benefits to the region in line with the EEH Transport Strategy and will look ahead to 2050.

The Council could also potentially seek funding contributions towards new stations and station connectivity measures through developer contributions linked to the larger site allocations and commitments.

7.6. Relationship with the East West Main Line concept

Network Rail's 2022 East West Main Line Strategic Statement outlines a vision for gaining the most from the investment that is already committed or planned through the East West Rail Programme (EWR)[23]. It uses the term 'East West Main Line' to represent the opportunity associated with an expanded scope that would secure a number of benefits and obtain greater long-term value from the EWR investment.

The statement does not specify a programme of works, infrastructure projects or a particular train service pattern. Instead, it highlights the available opportunity; suggests areas for further development work; and highlights how this relates to strategic integration with the rest of the network, including the need to avoid 'locking-in' short-term infrastructure decisions that make it difficult to harness this opportunity.

Of particular relevance here are the principle of passenger services that cover a wider area than currently planned for EWR, removing or reducing the need for passengers to interchange on longer trips, and the principle of an appropriate service frequency and pattern to best improve connectivity over a wider geographic area. The description below focuses on this element of the statement.

The statement takes as its baseline the proposed EWR programme, including the central section (Bedford-Cambridge) and the Aylesbury to Claydon leg of the western section, both of which are currently unfunded. It conducted high-level analysis of current and 'with EWR' generalised journey times, highlighting the radical improvements in inter-urban connectivity that EWR would produce within the area directly affected (essentially the Oxford/Aylesbury – Milton Keynes – Cambridge corridor). These include trips between Aylesbury and numerous locations such as Milton Keynes, Oxford, Bedford, and Cambridge, as well as between High Wycombe and a smaller range of locations.

It highlights, however, a number of areas of concern about how EWR interfaces with the existing network. Two of these are particularly relevant to Buckinghamshire growth:

- The Aylesbury-Claydon line: This is currently a single line. The statement reports that using it would require upgraded infrastructure to allow EWR services between Aylesbury and Milton Keynes, "with the nature of the enhancement determined by the capacity required over the long term." This highlights that decisions on the EWR Aylesbury-Claydon infrastructure need to recognise potential further demands on this line, such as are suggested in the Statement and also in the analysis presented in section 6.5 above.

[44] Link to England's Economic Heartland Rail Study Phase 1

- Bletchley/West Coast Main Line paths: The statement reports that the base EWR timetable specification may not be able to operate reliably in this area without further interventions. If those are required, a strategy should be in place that demonstrates how to make Milton Keynes a central hub for east-west services and to generate the maximum level of connectivity. This topic, which is echoed in the West Coast South Strategic Advice described above, is relevant to the ability to connect the existing site allocations and commitments into or via Milton Keynes as a major city destination and transport hub.

Applying this analysis to a wider area, it finds that improvements in passenger connectivity are modest or non-existent over that wider area. This is mainly due to the continued need for multiple interchanges when using EWR services. The East West Main Line concept of expanding the scope of passenger services on EWR aims to address this by providing for better-integrated services between major urban centres over the longer-term, through services that cover a wider geographic area than currently envisaged and thereby reducing or removing the need to interchange. This approach would also remove the need for some rail users to ravel through central London, releasing some capacity on those services. The statement sets this out as an opportunity, rather than as a specific service pattern or programme of works at this stage.

This is simply an indication of the opportunity, and the statement stresses that more detailed proposals should be made on the basis of subsequent development work.

The statement considers that this extended service concept could generate additional mode shift from road to rail on a number of corridors. These include (of particular relevance to Buckinghamshire) the A43 / A421 corridor between Bicester and Milton Keynes where there are persistent congestion issues at especially at peak times which affects the A421's function as a strategic route

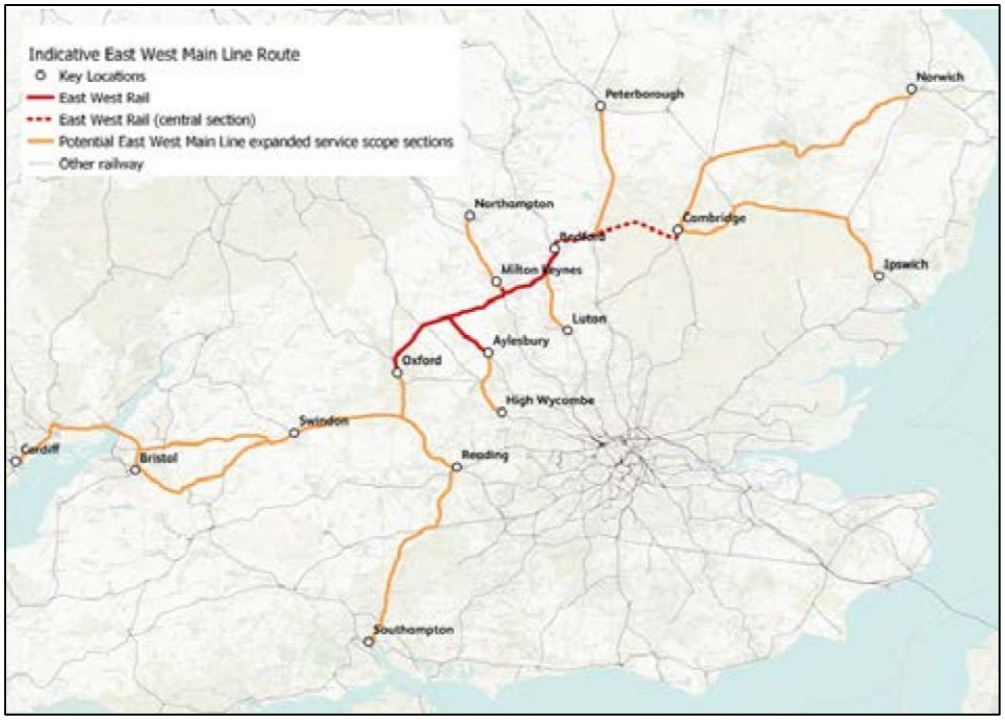
Figure 7-6 shows the statement's map of potential service scope sections for further investigation. The statement suggests that an EWML could involve:

- 'Core' stopping services which serve all stations between Oxford, High Wycombe, Aylesbury, Milton Keynes and Cambridge. The High Wycombe leg of this corresponds in principle to the north-south main line idea suggested in section 6.5 above.
- Fast services using EWR as a core section, between Bristol/Southampton/Cardiff at one end and Northampton/Peterborough/Norwich/Ipswich at the other. Milton Keynes would be a hub for both fast and stopping services. This would further support rail connectivity for the relevant site allocations and existing commitments.
- A secondary set of extended services, including between Oxford and Aylesbury. This would correspond to the Oxford-Aylesbury link set out in section 7.5 above.

This is simply an indication of the opportunity, and the statement stresses that more detailed proposals should be made on the basis of subsequent development work.

The statement considers that this extended service concept could generate additional mode shift from road to rail on a number of corridors. These include (of particular relevance to Buckinghamshire) the A43 / A421 corridor between Bicester and Milton Keynes where there are persistent congestion issues at especially at peak times which affects the A421's function as a strategic route

Figure 7-6 Potential EWML service scope sections for further investigation



Source: Network Rail, East West Main Line Strategic Statement (2022), Figure 12

Although uncertain at this stage, future development of the East West Main Line has the potential to influence the location of growth in Buckinghamshire. Conversely, growth allocated through the Local Plan and neighbouring Plans could help support the delivery of this major rail infrastructure.

The EEH transport Strategy sets out a five-point action plan that promotes the delivery of East West Rail and mass rapid transit systems as the catalyst for the transformation of the regions strategic public transport networks. EEH is working with the East West Railway Company, Network Rail, neighbouring Sub-national Transport Bodies, and local partners to identify opportunities to realise the longer-term potential of the East West Main Line in support of economic activity and planned housing growth. This will ensure that where the East West Main Line intersects existing main lines the opportunity is taken to establish regionally significant transport hubs and the opportunities created by this investment are used to shape the location of future economic and housing growth proposals.

8. Key findings and recommendations

8.1. Introduction

This final section identifies key findings from the study. The key findings identify the potential impacts of additional travel to/from existing and committed site allocations. This then informs the transport considerations for the next stage of preparing the Local Plan for Buckinghamshire, specifically how the transport considerations relate to the approach to strategic patterns of growth, site locations and design.

It is noted that a range of other factors beyond transport will also be relevant considerations in preparing the Local Plan and the recommendations made here will need to be weighed up alongside others.

8.2. Key finding #1: Traffic levels and delays in 2019 are already high

Chapter 2 shows that in 2019 traffic volumes are particularly high in the key urban areas (Buckingham, Aylesbury, High Wycombe, and Amersham) and on inter-urban roads such as the A41 between Aylesbury and Bicester and the A355 between Amersham and Beaconsfield. These high traffic levels mean that some parts of the road network already (in 2019) experience significant delays compared to 'free flow' conditions. Delays are highest in the High Wycombe / A404 / Marlow area; on routes into Aylesbury; in the Watford/ South-West Hertfordshire and South-East Buckinghamshire area; and on the M1, M25 and M4.

For some journeys between key selected centres (for example between High Wyclombe and Gerrards Cross) delays can add 30-40% to journey times in the peak periods.

Considerations for the new Local Plan for Buckinghamshire

Recognise that congestion is already significant in some of the areas where future site allocations may be located. Examine options for reducing current congestion caused by existing journeys in those areas.

Analyse existing patterns of travel mode choice, journey frequency and average journey length with the objective of understanding drivers of travel choices which can be used to inform transport aspects of the Local Plan. For example, average journey length is high south west of Aylesbury and around Marlow.

8.3. Key finding #2: Traffic levels and delays will increase by 2045

The number of road journeys in Buckinghamshire is forecast to increase by a third between 2019 and 2045 and total distance travelled by a quarter. This increase is a combination of background traffic growth and additional journeys to and from the existing site allocations and commitments.

Journeys to and from the existing site allocations and existing commitments account for between 25% and 31% of the total growth in traffic between 2019 and 2045. In 2045 these journeys account for between 9% and 11% of all journeys made in Buckinghamshire.

The highest increases in the amount of traffic (in terms of vehicles miles) between 2019 and 2045 occur for trips to and from the Aylesbury, High Wycombe, Beaconsfield, Gerrards Cross and Buckingham areas. There is therefore some correlation between where traffic is forecast to grow the most and where most new development is expected. Traffic growth is also significant in some locations with less existing allocations and commitments, such as Chesham.

Peak hour congestion is forecast to rise between 2019 and 2045; average delay per vehicle mile is forecast to increase by 50% and journey times by up to a quarter. Typically, the largest increases in journey time are expected in the southern half of the county.

Considerations for the new Local Plan for Buckinghamshire

Examine options to minimise the amount of road traffic generated by the Local Plan site allocations. For example:

- Locate sites as close as possible to existing centres of employment, retail, education, and other service provision to minimise trip lengths and encourage active travel. Spatial proximity has been demonstrated to reduce vehicle miles travelled and average journey length is shorter in urban areas.
- Encourage mixed-use sites which include local retail, education, and other services within them to make them more self-sufficient.
- Ensure that sites are designed to put the needs of those walking, wheeling, and riding first to encourage short journeys to be made by active travel modes.
- Locate sites close to existing public transport and active travel networks which offer a realistic alternative to travel by private cars for journeys beyond the site. Where such networks do not exist, examine how they can be provided. This is particularly an issue in the expansion areas to the east and south of Aylesbury (which are some way from the town centre), and also in Princes Risborough, Wendover, Buckingham, and High Wycombe.

Encourage provision of fibre broadband and 5G cellular connectivity at all sites.

Undertake further analysis to understand the contribution of Local Plan-related traffic to overall traffic levels and delays in 2045.

8.4. Key finding #3: Emissions of NOx fall between 2019 and 2045 but particulate emissions rise

There are nine AQMAs in Buckinghamshire that have been declared due to exceedances of the annual mean national air quality objective for NO_2, the main source of which is road transport. By 2045, emissions of NO_x are forecast to be 72% lower than in 2019. This reduction is due to improvements in vehicle technology and the switch to electric vehicles.

However, emissions of particulate matter due to brake and tyre wear are forecast to increase by 5-13% (depending on type of particulate). This increase is in part due to greater use of heavier electric vehicles and Sports Utility Vehicles.

Considerations for the new Local Plan for Buckinghamshire

Examine options for further reducing NOx emissions from journeys to and from Local Plan site allocations.

These options will include those described under Key finding #2 but could also include for example the provision of electric vehicle charging infrastructure for every home.

It is however important to note that a higher share of electric vehicles in the fleet will not reduce particulate matter. This will require measures to reduce all vehicle traffic within and close to Local Plan site allocations.

8.5. Key finding #4: CO_2 emissions fall by 2045 but not enough to meet carbon reduction pathways

In 2019 transport carbon emissions per capita in Buckinghamshire were slightly below the England and Wales average (see Table 6-1) and higher in rural areas than urban areas. Transport emissions need to fall quickly; not just by 2050, but also in the short term towards 2030, to meet carbon budgets.

Tailpipe emissions of CO_2 are forecast to be 28% lower in 2045 than in 2019 (see Table 5-2). This fall is due to improvements in vehicle technology and the switch to electric vehicles which offset increases in traffic levels. Nearly half (45%) of emissions are from motorway traffic.

However, the forecast levels of CO_2 emissions forecast for 2045 are significantly above the 'Business as usual' carbon pathway in the Emissions Estimates and Pathways data provided by EEH (see Figure 6-3). This pathway is the one with the highest expected levels of carbon and estimates annual CO_2 emissions of 0.742 $mtCO_2e$ in 2045. Therefore, without further intervention, the expected levels of CO_2 emissions are higher than considered necessary to reach net zero by 2040 and to remain within Buckinghamshire's overall carbon budget.

Further, CO_2 emissions are expected to increase in places where growth is expected: on the outskirts of some urban centres, notably, Aylesbury, Princes Risborough and Buckingham.

Considerations for the new Local Plan for Buckinghamshire

Further analysis is recommended to determine what measures may be required to close the gap between the expected CO_2 emissions and the Net Zero pathways. Although approximately half of transport carbon emissions in Buckinghamshire are from motorway traffic, some of this traffic is to or from locations in the county.

This analysis could inform consideration of the level of acceptability of these measures and the level of ambition 'built in' to the Local Plan to achieve reduction in carbon emissions. Integrated land use and transport planning is a key opportunity to reduce emissions through:

- improved proximity between people and services and employment;
- improved physical connectivity by active and sustainable modes of transport; and
- improved digital connectivity (such as provision of 5G and fibre broadband).

Examine options to minimise the amount of road traffic generated by the Local Plan site allocations (as described under Key Finding #2).

Consider how residents and employees of new developments can be encouraged and supported in adopting more sustainable and active travel choices. Evidence shows that transitional points in people's lives (such as moving home) can influence travel choices and behaviour towards a less carbon and car dependent future *(for example Dargay, J. and Hanly, M., 2007. Volatility of car ownership, commuting mode and time in the UK. Transportation Research Part A: Policy and Practice, 41(10))*

8.6. Key finding #5: Traffic congestion is adversely affecting the local economy

The Buckinghamshire economy is more productive than the national average and has a high employment rate; but expensive housing is constraining the labour market. Good transport is one of the factors required for a high-performing economy (along with the mix of high-growth sectors, a highly skilled labour market, and high-quality places that attract people and new businesses).

Existing traffic delays are inhibiting access to good-quality jobs and education for Buckinghamshire residents. It is also affecting how our businesses access skilled labour markets, supply chains, customers, and other businesses in similar sectors.

Further increases in journey times will exacerbate these impacts, reduce the attractiveness of the area to higher-skilled workers, reduce productivity and constrain future investment decisions, constrain growth of key economic assets, and potentially entrench the existing challenge that many of the most skilled residents commute to London, enabled by fast rail links.

Considerations for the new Local Plan for Buckinghamshire

Locate employment sites close to existing transport networks, including public transport networks.

Locate employment sites close to existing or new residential areas which can act as a local labour market for employers on the site.

Consider how the Local Plan can support delivery of the following to encourage growth in localised labour markets:

- sufficient new homes in the right places;
- delivery of the right mix of housing type and cost; and
- enhancement of place to attract high-skilled employees.

Encourage good transport connections to Buckinghamshire's strategic economic assets to grow to their full potential. Examine options for maximising accessibility to these sites by active travel and public transport modes.

Seek to understand congestion effects on existing businesses. Examine the measures which could reduce those effects and promote more sustainable business operations.

8.7. Key finding #6: There are pockets of urban and rural social exclusion in Buckinghamshire

Some parts of Buckinghamshire have higher vulnerability to social exclusion and poor accessibility. These include Buckingham, parts of Winslow and parts of Chesham. These areas are therefore at higher risk of worsening social exclusion due to increases in highway journey times, which will affect both journeys by car and road-based public transport. In the context of where traffic growth and increased delays are forecast to be highest, this may be a particular issue in Chesham.

Whilst deprivation may be less of an issue in the more rural parts of Buckinghamshire, there are localised areas of higher social exclusion in these areas. Poor accessibility across most of the rural areas of Buckinghamshire is likely to cause significant challenges for people without access to a car, as well as children and young people being dependent on parents and carers for transport to schools and other activities.

Considerations for the new Local Plan for Buckinghamshire

Consider how the new Local Plan can support improved accessibility to existing communities (and employment sites), especially those with higher levels of social exclusion.

Consider how the Local Plan can enhance the quality of place, and attract regeneration and inward investment in existing communities, especially those with higher levels of social exclusion.

Examine in more detail the contribution of poor accessibility to social exclusion and deprivation in Buckinghamshire.

8.8. Key finding #7: Rail could play an important role in increasing the sustainability of future growth

The existing site allocations and commitments will result in additional demand for travel to and from them. Whilst it is anticipated that most of these journeys will be made by car, there is potential for some of those new journeys to be made by other modes including rail, especially those to London, or other longer inter-urban journeys. Rail services are less attractive for shorter journeys.

The share of new development-related journeys using rail will also be affected by the proximity of the development to a station; whether the rail services link the development to key attractors such as employment and retail hubs; service frequency; and rail capacity, for example the likelihood of getting a seat.

Some existing site allocations and commitments are in the vicinity of an existing or planned railway station (see Figure 7-2). But there is considerable variation in the extent to which the individual allocations and committed sites give the opportunity for rail to contribute significantly.

The amount of capacity on the rail network in the future to deal with additional passengers from Local Plan allocations and commitments is unknown. However, the long-term rail industry planning process typically seeks to provide additional capacity where demand is forecast to grow. It is therefore reasonable to expect that there will be sufficient rail capacity in future to serve new developments near the stations.

Considerations for the new Local Plan for Buckinghamshire

Seek further information on current rail capacity and rail industry plans and processes for providing additional capacity in the future.

Locate Local Plan sites where there is the greatest potential to maximise the share of journeys to and from them which are made by rail (and other sustainable modes of travel).

Encourage good first/last mile connectivity by sustainable travel modes between Local Plan site allocations and the railway station where the site is within an existing station's local catchment area.

Consider the best way to connect the cluster of developments on the east side of Aylesbury into the rail network. This should include considering a high-quality public transport link to Aylesbury and/or Stoke Mandeville stations.

Consider the potential for new stations at Bletchley West (on East West Rail) and to the south of Aylesbury (on the line to Princes Risborough) to support sustainable development around them.

Explore with partners the potential to deliver the previously planned Aylesbury to Milton Keynes service via East West Rail. Rail services between Winslow and Aylesbury would provide significant additional connectivity opportunities from Buckingham, including the cluster of existing site allocations and commitments around its western side, into the rail network. At this point a high-quality public transport connection between Buckingham and Winslow may become more viable.

Consider opportunities for other new services making use of East West Rail infrastructure such as a direct service between High Wycombe, Aylesbury and Milton Keynes; and a direct Oxford-Aylesbury service.

Holistically consider the preferred strategy for public transport connectivity into High Wycombe from the south. The solution may or may not be rail-based, and innovative alternatives could be considered.

Appendices

Appendix A. Highway schemes uncertainty log

Scheme name	Source	Included in DM	Uncertainty status	Legacy area
South East Aylesbury Link Road	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	Aylesbury
Beaconsfield Relief Road	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	South Bucks
Eastern Link Road (N), Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	Aylesbury
Eastern Link Road (S), Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	More than likely	Aylesbury
Stocklake Link Road, Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	Aylesbury
Southern Link Road, Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	More than likely	Aylesbury
Stoke Mandeville Bypass, Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	Aylesbury
South Western Link Road, Aylesbury	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	More than likely	Aylesbury
Gomm Valley Spine Road	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	More than likely	High Wycombe
Hollands Farm Spine Road	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	More than likely	High Wycombe
Princes Risborough Infrastructure Package	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Reasonably foreseeable	High Wycombe
Hollow Hill Lane closure	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	N	Hypothetical	South Bucks
Seven Hills Improvement	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	South Bucks

Scheme name	Source	Included in DM	Uncertainty status	Legacy area
Iver Relief Road	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	N	Hypothetical	South Bucks
M4 Smart Motorway	Buckinghamshire Countywide Model Update - Traffic Forecasting Technical Note (October 2021)	Y	Near certain	South Bucks
North East Aylesbury Link Road, Aylesbury	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Western Link Road, Aylesbury	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Handy Cross M40 Jn 4 improvements	High Wycombe Transport Strategy	N	Hypothetical	High Wycombe
A421 Route upgrade	Buckingham Transport Strategy	N	Reasonably foreseeable	Aylesbury
A413 Route Upgrade	Buckingham Transport Strategy	N	Reasonably foreseeable	Aylesbury
Western Link Road, Buckingham	Buckingham Transport Strategy	N	Hypothetical	Aylesbury
Buckingham Bypass, parallel to A421	Buckingham Transport Strategy	N	Hypothetical	Aylesbury
Junction improvement package through signal optimisation - Buckingham	Buckingham Transport Strategy	N	Reasonably foreseeable	Aylesbury
Bus connection to Winslow rail station	Buckingham Transport Strategy	N	Near certain	Aylesbury
Park and Ride allocation at Bottledump roundabout		N	Reasonably foreseeable	Aylesbury
Rerouting freight on to A421, A413 and A41 to bypass Buckingham Town Centre		N	Hypothetical	Aylesbury
Network safety measures at the triple roundabout junction outside the Royal Buckinghamshire Hospital	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury

Scheme name	Source	Included in DM	Uncertainty status	Legacy area
Restrict through traffic within Aylesbury Town Centre	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Implement a low emission zone for the centre of Aylesbury	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Aylesbury Park & Ride	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Improve transport links to Aylesbury Railway Station	Aylesbury Transport Strategy	N	Reasonably foreseeable	Aylesbury
Upgrade the existing bus station in Aylesbury town	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Primary Public Transport corridor on A41 approaching Aylesbury	Aylesbury Transport Strategy	Y	Near certain	Aylesbury
Primary Public Transport corridor on A418, A413, B4443 approaching Aylesbury	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Upgrades to Stoke Road Bridge with provision for bus or cycle lanes	Aylesbury Transport Strategy	N	Hypothetical	Aylesbury
Expansion of the London's travel zone system to High Wycombe	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
Development of a High Wycombe and surrounding towns travel zone	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
North-south bus priority corridor on the A404 Marlow Hill	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire

Scheme name	Source	Included in DM	Uncertainty status	Legacy area
East-west bus priority corridor on the A40 London Road and West Wycombe Road	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
Old Oak Common rail connectivity interventions	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
Increase capacity on the rail line between Princes Risborough and Aylesbury	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
Demand responsive flexible bus services and integrated ticketing - High Wycombe	High Wycombe Transport Strategy	N	Near certain	Bucking-hamshire
Optimisation of town centre traffic signals	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
Additional demand management / pricing mechanisms: congestion charging, low emissions zones	High Wycombe Transport Strategy	N	Hypothetical	Bucking-hamshire
East West Rail - Winslow Station	EWR	Y	Near certain	
Demand responsive flexible bus services, Aylesbury	Rural Mobility Fund	N	Near certain	Bucking-hamshire
A41 / King Edwards Avenue Junction improvement	HIF	Y	Near certain	
Aylesbury – linked with EWR	EEH Transport Strategy	N	Reasonably foreseeable	
Impacts of London ULEZ		N	Reasonably foreseeable	

Scheme name	Source	Included in DM	Uncertainty status	Legacy area
Aylesbury LCWIP town-wide walking and cycling network and links to surrounding settlements	Aylesbury Garden Town LCWIP	N	More than likely	Aylesbury
High Wycombe LCWIP town-wide walking and cycling network and links to surrounding settlements	High Wycombe Transport Strategy	N	More than likely	High Wycombe
Buckinghamshire Greenway (north-south county walking and cycling corridor)	Forthcoming Buckinghamshire LCWIP	N	More than likely	Bucking-hamshire
Buckinghamshire-wide LCWIP, inter-settlement walking and cycling link proposals	Forthcoming Buckinghamshire LCWIP	N	Hypothetical	N/A

Appendix B. Background growth factors

Background growth factors 2019 to 2045

		AM Peak					Inter Peak					PM Peak				
	TEMPRO Zone	Commuting	Business	Other	LGV	HGV	Commuting	Business	Other	LGV	HGV	Commuting	Business	Other	LGV	HGV
Region	EAST	1.2608	1.2705	1.3040	1.3897	1.1500	1.2448	1.2662	1.3126	1.3897	1.1500	1.2483	1.2677	1.2938	1.3897	1.1500
Authority	Three Rivers	1.2187	1.2366	1.2817	1.3897	1.1500	1.2093	1.2526	1.2987	1.3897	1.1500	1.2080	1.2353	1.2759	1.3897	1.1500
Region	EM	1.2784	1.2850	1.3679	1.3963	1.1055	1.2656	1.2807	1.3798	1.3963	1.1055	1.2662	1.2834	1.3471	1.3963	1.1055
Region	LON	1.3021	1.3065	1.3419	1.3676	1.0876	1.2885	1.2911	1.3536	1.3676	1.0876	1.2959	1.3000	1.3369	1.3676	1.0876
Authority	Hillingdon	1.2885	1.2826	1.3051	1.3676	1.0876	1.2667	1.2645	1.3077	1.3676	1.0876	1.2813	1.2781	1.2992	1.3676	1.0876
Region	NE	1.2928	1.3000	1.2856	1.4203	1.0925	1.2709	1.2863	1.2860	1.4203	1.0925	1.2781	1.2931	1.2826	1.4203	1.0925
Region	NW	1.2864	1.2891	1.3072	1.3564	1.1222	1.2673	1.2792	1.3136	1.3564	1.1222	1.2731	1.2835	1.3011	1.3564	1.1222
Region	SCOTLAND	1.2996	1.3031	1.2550	1.3720	1.0887	1.2712	1.2879	1.2513	1.3720	1.0887	1.2827	1.2954	1.2579	1.3720	1.0887
Region	SE	1.2567	1.2643	1.2860	1.4068	1.1576	1.2408	1.2593	1.2931	1.4068	1.1576	1.2449	1.2615	1.2774	1.4068	1.1576
Authority	Slough	1.2585	1.2587	1.2555	1.4068	1.1576	1.2388	1.2412	1.2574	1.4068	1.1576	1.2476	1.2532	1.2509	1.4068	1.1576
Authority	Windsor and Maidenhead	1.2299	1.2380	1.2479	1.4068	1.1576	1.2152	1.2364	1.2519	1.4068	1.1576	1.2181	1.2362	1.2399	1.4068	1.1576
Authority	Aylesbury Vale	1.1973	1.2090	1.1952	1.4068	1.1576	1.1796	1.2150	1.2011	1.4068	1.1576	1.1835	1.2075	1.1924	1.4068	1.1576
Authority	Chiltern	1.2003	1.2097	1.1815	1.4068	1.1576	1.1809	1.2162	1.1825	1.4068	1.1576	1.1854	1.2073	1.1795	1.4068	1.1576
Authority	Milton Keynes	1.2485	1.2668	1.3123	1.4068	1.1576	1.2345	1.2698	1.3366	1.4068	1.1576	1.2349	1.2628	1.3044	1.4068	1.1576
Authority	South Bucks	1.1572	1.1629	1.1657	1.4068	1.1576	1.1436	1.1602	1.1675	1.4068	1.1576	1.1474	1.1613	1.1615	1.4068	1.1576
Authority	Wycombe	1.1611	1.1662	1.1695	1.4068	1.1576	1.1451	1.1645	1.1738	1.4068	1.1576	1.1492	1.1644	1.1649	1.4068	1.1576
Authority	Cherwell	1.2742	1.2755	1.2986	1.4068	1.1576	1.2576	1.2609	1.3029	1.4068	1.1576	1.2644	1.2726	1.2927	1.4068	1.1576
Region	SW	1.2743	1.2793	1.3493	1.3616	1.0848	1.2594	1.2745	1.3606	1.3616	1.0848	1.2614	1.2775	1.3324	1.3616	1.0848
Region	WALES	1.2791	1.2848	1.2544	1.3720	1.0887	1.2610	1.2742	1.2521	1.3720	1.0887	1.2664	1.2805	1.2538	1.3720	1.0887
Region	WM	1.2823	1.2869	1.3561	1.4167	1.1165	1.2689	1.2816	1.3694	1.4167	1.1165	1.2707	1.2842	1.3415	1.4167	1.1165
Region	YH	1.2723	1.2766	1.2979	1.3588	1.1200	1.2544	1.2673	1.3042	1.3588	1.1200	1.2592	1.2722	1.2910	1.3588	1.1200

Appendix C. Uncertainty log developments explicitly modelled

Uncertainty log: explicitly modelled developments

Development name	No. of dwellings (post-2019)	No. of Jobs (post-2019)	Eastings	Northings	Legacy area	Uncertainty status
Princes Risborough Expansion Area (REMAINING)	990	42	479993	204298	Wycombe	Reasonably foreseeable
Gomm Valley, High Wycombe 1	1,000	-	492479	192116	Wycombe	Reasonably foreseeable
Gomm Valley, High Wycombe 2	-	167	492479	192116	Wycombe	Reasonably foreseeable
Abbey Barn South Reserve Site, Abbey Barn Lane, High Wycombe	550	268	487429	191389	Wycombe	Near certain
Land at Terriers Farm, Kingshill Road, High Wycombe	418	-	488065	195193	Wycombe	More than likely
Hollands Farm (north), Bourne End	400	-	489928	186865	Wycombe	More than likely
Land off Amersham Road, including Tralee Farm, Hazlemere (REMAINING)	249	-	489803	196518	Wycombe	Reasonably foreseeable
Land Including Leigh Court Wheelers Yard Commercial Sq Birch Malvern And Llanberis Houses Leigh Street, High Wycombe	226	88	485613	193223	Wycombe	Near certain
Site Of Former Wycombe Sports Centre, Marlow Hill, High Wycombe	-	2,690	485778	191443	Wycombe	Near certain
Glory Park Avenue Wooburn Green Bucks, EN BUCKS	-	906	491235	189619	Wycombe	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 1	450	-	484954	211867	Aylesbury	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 2	1,050	-	484954	211867	Aylesbury	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 3	300	-	484954	211867	Aylesbury	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 4	-	91	484954	211867	Aylesbury	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 5	1,200	-	484954	211867	Aylesbury	Near certain
Land Between Wendover Road And Aston Clinton Road, Weston Turville 6	-	1,635	484954	211867	Aylesbury	Near certain
Kingsbrook, Land East of Aylesbury, Broughton Crossing, Aylesbury 1	565	-	484953	214899	Aylesbury	Near certain
Village 3 (Sub Phase 3.3), Land East Of Aylesbury (Kingsbrook), Aylesbury	-	1,860	485119	214513	Aylesbury	Near certain
Kingsbrook, Land East of Aylesbury, Broughton Crossing, Aylesbury 2	572	-	484953	214899	Aylesbury	Near certain
Kingsbrook, Land East of Aylesbury, Broughton Crossing, Aylesbury 3	660	-	484953	214899	Aylesbury	Near certain
Land to South West of Milton Keynes, North East Aylesbury	1,855	-	483465	232461	Aylesbury	Near certain
Land At South West, Aylesbury 1	71	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 2	384	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 3	272	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 4	308	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 5	191	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 6	173	-	481252	211416	Aylesbury	More than likely
Land At South West, Aylesbury 7	-	-	481252	211416	Aylesbury	More than likely
Shenley Park, Whaddon	900	-	481769	233738	Aylesbury	Reasonably foreseeable
AGT1 South Aylesbury	868	-	483245	211172	Aylesbury	More than likely
Aylesbury Woodland, College Road North, Aylesbury 1	530	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 2	570	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 3	-	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 4	-	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 5	-	2,133	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 6	-	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 7	-	1,233	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 8	-	469	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 9	-	-	486193	213451	Aylesbury	Near certain
Aylesbury Woodland, College Road North, Aylesbury 10	-	-	486193	213451	Aylesbury	Near certain
RAF Halton, Wendover 1	188	-	488063	209505	Aylesbury	Reasonably foreseeable
RAF Halton, Wendover 2	188	-	488063	209505	Aylesbury	Reasonably foreseeable
RAF Halton, Wendover 3	188	-	488063	209505	Aylesbury	Reasonably foreseeable
RAF Halton, Wendover 4	188	-	488063	209505	Aylesbury	Reasonably foreseeable
Land off Osier Way (south of A421 and east of Gawcott Rd), Buckingham	420	-	469211	232675	Aylesbury	Near certain
Land to east of B4033 Great Horwood Rd, Winslow	335	-	476820	228539	Aylesbury	Near certain
Land West Of Churchway, Haddenham	273	-	474042	209490	Aylesbury	Near certain
Land North Of Aston Clinton Road (Former Aston Clinton MDA Site), Weston Turville	369	417	484858	213399	Aylesbury	Near certain
Berryfields Major Development Area (MDA) Aylesbury 1	737	-	478723	215691	Aylesbury	Near certain
Berryfields Major Development Area (MDA) Aylesbury 2	-	233	478723	215691	Aylesbury	Near certain
Land To The East And West Of Rabans Lane Aylesbury	200	-	479525	214558	Aylesbury	Near certain
Arla Foods Ltd, Aylesbury Dairy, Samian Way	-	220	487964	213386	Aylesbury	Near certain
Land North Of A421 Tingewick Road Site, Buckingham	285	-	468733	233474	Aylesbury	Near certain
Former Defence School Of Languages (Wilton Park), Minerva Way, Beaconsfield	304	-	495837	190498	South Bucks	Near certain
Land Between Longwick Road & Mill Lane, Princes Risborough	360	-	479993	204298	Wycombe	More than likely
Land At Haddenham Glebe, Stanbridge Road, Haddenham	325	-	474578	208330	Aylesbury	Near certain
Newland Park, Gorelands Lane, Chalfont St Giles	306	-	501188	193800	Chiltern	Near certain
Land At Haddenham Airfield, Thame Road, Haddenham	154	-	473369	209028	Aylesbury	Near certain
Westonmead Farm, Aston Clinton Road, Weston Turville	157	-	485313	213220	Aylesbury	Near certain
Slate Meadow, Stratford Drive, Wooburn Green	150	-	490322	187536	Wycombe	Near certain
Building 3, Bear Brook Office Park, Walton Street, Aylesbury	144	-	482129	213367	Aylesbury	Near certain
The Wycliffe Centre, Horsleys Green	139	-	478700	194883	Wycombe	Near certain
Land West Of Moreton Road And Castlemilk, Buckingham	130	-	469806	235095	Aylesbury	More than likely
Land To The South Of Aston Clinton Road, Weston Turville	121	-	485193	212865	Aylesbury	Near certain
Land East Of Lower Road, Stoke Mandeville	97	-	483306	210682	Aylesbury	Near certain
Ashwells Field, Cock Lane, Tylers Green	109	-	489928	193358	Wycombe	Near certain
Land off Amersham Road, including Tralee Farm, Hazlemere	101	-	489803	196518	Wycombe	More than likely
Above Rumbolds Well & next to Field Farm (I), Buckingham	100	-	468855	233781	Aylesbury	Reasonably foreseeable
Molly's Field, Land Adjacent, Addison Road, Steeple Claydon	99	-	469480	226642	Aylesbury	Near certain
Leo Laboratories, Longwick Road, Princes Risborough	98	-	480371	203835	Wycombe	Near certain
Castlefield Development Area, Chairborough Road, High Wycombe	97	-	484729	192541	Wycombe	Near certain
Land North Of Sandholme And East Of Buckingham Road, Steeple Claydon	74	-	470506	227183	Aylesbury	Near certain
Land South Of Aylesbury Road, Aston Clinton	93	-	486990	212238	Aylesbury	Near certain
Land North East of the village, Waddesdon	75	-	474883	216984	Aylesbury	More than likely
Land Surrounding Oxford House, Oxford Road	117	-	480950	213370	Aylesbury	Near certain
North of Buckingham Road	-	702	476588	228579	Aylesbury	Reasonably foreseeable
Land West of London Road, Buckingham	-	1,672	470143	232350	Aylesbury	Reasonably foreseeable
AGT3 Aylesbury north of A41 (REMAINING)	600	-	485966	213621	Aylesbury	Reasonably foreseeable
Plot 6000/6010, Westcott Venture Park, High Street	-	305	470519	216734	Aylesbury	Near certain

Development name	No. of dwellings (post-2019)	No. of Jobs (post-2019)	Eastings	Northings	Legacy area	Uncertainty status
Unit 4 Plot A Symmetry Park, Land Off Samian Way	-	286	487399	213647	Aylesbury	Near certain
Land Between Railway And Ercol Furniture, Summerleys Road, Princes Risborough	-	108	479884	202952	Wycombe	Near certain
Land South Of River Wye And Foundry Site Between Translux Mill And Chapel Lane, High Wycombe	-	173	484365	193785	Wycombe	Near certain
RAF Daws Hill, Daws Hill Lane, High Wycombe	377	129	487026	191745	Wycombe	Near certain
Land Off Walnut Drive And Foscote Road, Maids Moreton	163	-	470716	235636	Aylesbury	Near certain
Former Gas Works Site Lilys Walk High Wycombe Buckinghamshire	209	-	486198	192932	Wycombe	Near certain
Land Adjacent To Furze Lane	185	-	476420	228073	Aylesbury	Near certain
Land at Huntercombe Park (former Pfizer Pharmaceuticals) Huntercombe Lane South Burnham	165	-	493241	180811	South Bucks	Near certain
Alton House Business Park, Gatehouse Way	163	-	480967	214053	Aylesbury	Near certain
Land Off Lower Road	132	-	482745	211487	Aylesbury	Near certain
Abbey Barn South Reserve Site Abbey Barn Lane High Wycombe Buckinghamshire	129	-	488968	197649	Wycombe	Near certain
Land At Lower Road	127	-	482536	211193	Aylesbury	Near certain
Land West Of Mentmore Road, Partridge Close And Barkham Close	100	-	491833	217525	Aylesbury	Near certain
Unit 1, Triangle Business Park, Quilters Way	90	-	484639	209806	Aylesbury	Near certain
Sewage Treatment Works Bassetsbury Lane High Wycombe	88	-	488339	192054	Wycombe	Near certain
Buckingham House Desborough Road High Wycombe Buckinghamshire	85	-	486123	193016	Wycombe	Near certain
OS Parcel 9166 Boxer Road & OS Parcel 6576 Walnut Tree Lane, Barn Road, Longwick	81	-	478751	204714	Wycombe	Near certain
Land South of Newton Leys, Drayton Road	75	-	487044	231016	Aylesbury	Near certain
Land Adjacent To Allotment Gardens Mars	74	-	493463	215461	Aylesbury	Near certain
Gatehouse Quarter & Gatehouse Road	-	398	481083	214318	Aylesbury	Near certain
Land At Oakfield Road, Stocklake	-	138	483455	214170	Aylesbury	Near certain
Land to east College Road North	-	269	487633	213188	Aylesbury	Near certain
Wipac Group, London Road	-	725	470138	232602	Aylesbury	Near certain
land at Haddenham Airfield, Thame Road	-	180	473794	209228	Aylesbury	Near certain
Pinewood	-	2,409	501837	183395	South Bucks	More than likely

Appendix D. Constraining growth factors

Constraining growth factors 2019 to 2045

		AM Peak					Inter Peak					PM Peak				
	TEMPRO Zone	Commuting	Business	Other	LGV	HGV	Commuting	Business	Other	LGV	HGV	Commuting	Business	Other	LGV	HGV
Region	EAST	1.2608	1.2705	1.3040	1.3897	1.1500	1.2448	1.2662	1.3126	1.3897	1.1500	1.2483	1.2677	1.2938	1.3897	1.1500
Authority	Three Rivers	1.2187	1.2366	1.2817	1.3897	1.1500	1.2093	1.2526	1.2987	1.3897	1.1500	1.2080	1.2353	1.2759	1.3897	1.1500
Region	EM	1.2784	1.2850	1.3679	1.3963	1.1055	1.2656	1.2807	1.3798	1.3963	1.1055	1.2662	1.2834	1.3471	1.3963	1.1055
Region	LON	1.3021	1.3065	1.3419	1.3676	1.0876	1.2885	1.2911	1.3536	1.3676	1.0876	1.2959	1.3000	1.3369	1.3676	1.0876
Authority	Hillingdon	1.2885	1.2826	1.3051	1.3676	1.0876	1.2667	1.2645	1.3077	1.3676	1.0876	1.2813	1.2781	1.2992	1.3676	1.0876
Region	NE	1.2928	1.3000	1.2856	1.4203	1.0925	1.2709	1.2863	1.2860	1.4203	1.0925	1.2781	1.2931	1.2826	1.4203	1.0925
Region	NW	1.2864	1.2891	1.3072	1.3564	1.1222	1.2673	1.2792	1.3136	1.3564	1.1222	1.2731	1.2835	1.3011	1.3564	1.1222
Region	SCOTLAND	1.2996	1.3031	1.2550	1.3720	1.0887	1.2712	1.2879	1.2513	1.3720	1.0887	1.2827	1.2954	1.2579	1.3720	1.0887
Region	SE	1.2567	1.2643	1.2860	1.4068	1.1576	1.2408	1.2593	1.2931	1.4068	1.1576	1.2449	1.2615	1.2774	1.4068	1.1576
Authority	Slough	1.2585	1.2587	1.2555	1.4068	1.1576	1.2388	1.2412	1.2574	1.4068	1.1576	1.2476	1.2532	1.2509	1.4068	1.1576
Authority	Windsor and Maidenhead	1.2299	1.2380	1.2479	1.4068	1.1576	1.2152	1.2364	1.2519	1.4068	1.1576	1.2181	1.2362	1.2399	1.4068	1.1576
Authority	Aylesbury Vale	1.4041	1.4101	1.4063	1.4068	1.1576	1.3871	1.4035	1.4144	1.4068	1.1576	1.3921	1.4080	1.4075	1.4068	1.1576
Authority	Chiltern	1.2046	1.2134	1.1860	1.4068	1.1576	1.1854	1.2183	1.1872	1.4068	1.1576	1.1901	1.2110	1.1845	1.4068	1.1576
Authority	Milton Keynes	1.2485	1.2668	1.3123	1.4068	1.1576	1.2345	1.2698	1.3366	1.4068	1.1576	1.2349	1.2628	1.3044	1.4068	1.1576
Authority	South Bucks	1.2043	1.2152	1.2122	1.4068	1.1576	1.1905	1.2204	1.2142	1.4068	1.1576	1.1920	1.2146	1.2064	1.4068	1.1576
Authority	Wycombe	1.2334	1.2349	1.2437	1.4068	1.1576	1.2165	1.2273	1.2481	1.4068	1.1576	1.2225	1.2329	1.2400	1.4068	1.1576
Authority	Cherwell	1.2742	1.2755	1.2986	1.4068	1.1576	1.2576	1.2609	1.3029	1.4068	1.1576	1.2644	1.2726	1.2927	1.4068	1.1576
Region	SW	1.2743	1.2793	1.3493	1.3616	1.0848	1.2594	1.2745	1.3606	1.3616	1.0848	1.2614	1.2775	1.3324	1.3616	1.0848
Region	WALES	1.2791	1.2848	1.2544	1.3720	1.0887	1.2610	1.2742	1.2521	1.3720	1.0887	1.2664	1.2805	1.2538	1.3720	1.0887
Region	WM	1.2823	1.2869	1.3561	1.4167	1.1165	1.2689	1.2816	1.3694	1.4167	1.1165	1.2707	1.2842	1.3415	1.4167	1.1165
Region	YH	1.2723	1.2766	1.2979	1.3588	1.1200	1.2544	1.2673	1.3042	1.3588	1.1200	1.2592	1.2722	1.2910	1.3588	1.1200

Appendix E. 2019 Travel Time Delay

Table E1 - Percentage difference between congested and free flow travel time, morning peak hour 2019

From \ To	Amersham/Chesham	Aylesbury	Beaconsfield	Bicester	Buckingham	Chalfont St Giles	Gerrards Cross	Henley-on-Thames	High Wycombe	Maidenhead	Marlow	Milton Keynes	Prestwood	Princes Risborough	Thame	Tring	Watford	Wendover
Amersham/Chesham		7%	0%	0%	6%	3%	7%	17%	7%	9%	14%	13%	0%	0%	0%	11%	27%	0%
Aylesbury	3%		7%	7%	6%	7%	9%	2%	8%	10%	5%	11%	5%	11%	29%	21%	29%	13%
Beaconsfield	0%	8%		16%	7%	0%	3%	9%	2%	10%	1%	6%	0%	0%	0%	6%	36%	0%
Bicester	1%	24%	21%		5%	18%	22%	17%	26%	21%	10%	17%	0%	2%	11%	23%	27%	2%
Buckingham	15%	31%	17%	7%		17%	15%	11%	0%	14%	6%	22%	0%	0%	6%	5%	14%	23%
Chalfont St Giles	5%	10%	0%	9%	8%		1%	13%	10%	24%	8%	9%	0%	0%	1%	2%	31%	1%
Gerrards Cross	8%	8%	3%	9%	5%	0%		14%	23%	22%	9%	12%	0%	9%	10%	9%	6%	1%
Henley-on-Thames	21%	7%	26%	13%	7%	21%	27%		33%	28%	0%	13%	15%	0%	21%	2%	27%	0%
High Wycombe	7%	9%	7%	24%	0%	6%	47%	43%		48%	47%	7%	0%	0%	3%	8%	40%	0%
Maidenhead	5%	8%	6%	9%	5%	6%	21%	25%	32%		3%	14%	14%	12%	11%	23%	36%	2%
Marlow	18%	11%	24%	7%	4%	17%	25%	2%	34%	11%		9%	0%	0%	3%	5%	26%	0%
Milton Keynes	11%	8%	10%	4%	3%	9%	14%	7%	10%	12%	3%		9%	3%	9%	13%	20%	13%
Prestwood	0%	13%	0%	0%	9%	0%	4%	32%	10%	33%	9%	8%		0%	5%	10%	14%	0%
Princes Risborough	0%	14%	0%	0%	0%	0%	0%	0%	3%	18%	0%	11%	0%		11%	8%	20%	0%
Thame	0%	40%	0%	9%	7%	0%	21%	2%	2%	19%	3%	20%	0%	5%		9%	18%	4%
Tring	10%	34%	8%	16%	5%	5%	15%	1%	9%	23%	4%	14%	6%	9%	10%		34%	18%
Watford	28%	39%	26%	24%	16%	34%	15%	26%	25%	38%	25%	71%	16%	24%	22%	39%		34%
Wendover	0%	24%	5%	0%	12%	5%	7%	0%	6%	9%	0%	11%	0%	1%	12%	26%	32%	

Some congested travel time are less than free flow travel times due to differences in routeing and method of junction delay calculations for free flow travel times.

Table E2 - Percentage difference between congested and free flow travel time, evening peak hour 2019

From \ To	Amersham/Chesham	Aylesbury	Beaconsfield	Bicester	Buckingham	Chalfont St Giles	Gerrards Cross	Henley-on-Thames	High Wycombe	Maidenhead	Marlow	Milton Keynes	Prestwood	Princes Risborough	Thame	Tring	Watford	Wendover
Amersham/Chesham		6%	0%	0%	8%	3%	1%	12%	1%	0%	6%	8%	0%	0%	0%	4%	22%	0%
Aylesbury	0%		2%	8%	9%	3%	3%	0%	4%	2%	4%	16%	4%	3%	23%	24%	27%	14%
Beaconsfield	0%	7%		15%	8%	0%	9%	5%	0%	2%	0%	7%	0%	0%	1%	2%	24%	3%
Bicester	0%	8%	14%		5%	11%	14%	10%	18%	13%	6%	8%	0%	1%	8%	13%	17%	0%
Buckingham	3%	8%	4%	6%		5%	5%	6%	0%	8%	3%	6%	5%	0%	3%	1%	17%	9%
Chalfont St Giles	2%	10%	0%	13%	10%		5%	15%	5%	19%	8%	6%	0%	0%	2%	1%	30%	7%
Gerrards Cross	7%	8%	3%	13%	9%	0%		14%	23%	14%	7%	10%	0%	0%	12%	9%	6%	6%
Henley-on-Thames	18%	3%	23%	11%	6%	18%	23%		28%	22%	0%	6%	20%	0%	18%	2%	23%	0%
High Wycombe	6%	11%	6%	24%	0%	6%	38%	36%		39%	33%	8%	5%	1%	5%	10%	34%	6%
Maidenhead	8%	14%	11%	13%	8%	7%	23%	26%	28%		5%	8%	19%	14%	12%	7%	35%	8%
Marlow	15%	10%	21%	12%	6%	14%	20%	0%	26%	7%		5%	18%	6%	2%	8%	22%	3%
Milton Keynes	9%	22%	9%	8%	12%	10%	13%	13%	10%	11%	6%		11%	8%	14%	15%	54%	16%
Prestwood	0%	9%	0%	0%	10%	0%	0%	20%	0%	20%	2%	8%		0%	5%	11%	5%	2%
Princes Risborough	0%	7%	0%	1%	0%	0%	13%	0%	0%	8%	2%	2%	0%		12%	9%	2%	0%
Thame	0%	35%	0%	12%	6%	0%	16%	18%	0%	14%	2%	10%	0%	10%		10%	16%	7%
Tring	0%	19%	1%	12%	3%	4%	10%	0%	3%	1%	3%	11%	3%	3%	8%		26%	15%
Watford	28%	30%	25%	20%	13%	35%	14%	24%	22%	30%	21%	58%	11%	19%	19%	35%		30%
Wendover	0%	8%	0%	0%	9%	0%	0%	0%	0%	0%	0%	10%	0%	0%	10%	22%	26%	

Appendix F. Fleet assumptions used for emissions calculation

The $kgCO_{2e}$/mile emissions have been calculated based on the Defra Emission Factor Toolkit (EFT). The Defra EFT includes projections of how the vehicle fuel types and ages of vehicles will change over time and therefore provides an emission rate per year, per vehicle type/vehicle fuel type for a given vehicle speed.

The emissions calculated are based on:

- the mix of vehicle types (cars, light good vehicles, heavy duty vehicles (heavy goods vehicles and buses));
- the mix of vehicle fuel types (petrol, diesel and electric);
- the mix of vehicle ages; and
- the vehicle speeds and vehicle volumes predicted from the scheme specific traffic model.

The work was undertaken using the most recent version of the EFT at the time (v11 published in November 2021). EFT v11 assumptions:

- Includes data relating to the UK vehicle fleet and associated emissions for the period between 2031 and 2050 inclusive.
- Includes uptake rates of electric vehicles, aligned to electric vehicle penetration rates as described in the worksheet labelled 'A1.3.9' of DfT's Databook (version 1.17, November 2021 for all road types (motorways, urban and rural) listed in the EFT.
- However, the assumptions on greater uptake rates of electric vehicles predate announcements by the Government in 2021 on plans to increase the speed of electric vehicle uptake and do not take account of the Transport Decarbonisation Plan (TDP) published in July 2021.

Assumptions in EFT v11 also:

- Predate the announcement by the Government in July 2021 to end the sale of new petrol and diesel vehicles by 2030, and that all new cars and vans will be required to be fully zero emission at the tailpipe by 2035. Assumptions within EFT v11 are for a phase out by the target date of 2040.
- Predate the announcement by the Government in November 2021 to phase out new, non-zero emission heavy goods vehicles weighing 26 tonnes and under by 2035, with all new HGVs sold in the UK to be zero emission by 2040. Assumptions within EFT v11 do not include any electrification of heavy goods vehicles.

Since the technical work was undertaken, EFT has been updated with v12.01.1 (released December 2023). V12.01.1 also does not include electrification of HGVs.

Appendix G. Carbon emissions scenarios

Below are descriptions of the carbon emissions scenarios presented in Figure 6-3.

Scenario	Description
Accelerated ZEV (CAS-MB)	Common Analytical Scenarios (Mode Balanced Scenario). Assumes 13% of fleet are EVs by 2025, then 41%, 70%, 88%, 96% and 99% in 2030, 2035, 2040, 2045 and 2050 respectively. This is considered to be a future of high and fast uptake of electric vehicles. In this scenario their costs are equalised to the average of petrol and diesel. This removes the cost advantage, resulting in decarbonisation with a lower car mode share than in the Core and Vehicle-led Decarbonisation scenario.
Accelerated ZEV (CAS-VL)	Common Analytical Scenarios (Vehicle Led scenario). Same EV fleet assumptions as CAS-MB (i.e. a high and fast uptake of electric vehicles). However, the current cost advantage compared to petrol and diesel vehicles is maintained. This results in the demand for road travel increasing, so that the modal share of road travel is increased relative to the other modes.
Accelerated ZEV Uptake (EV: Ready-High)	Localised market forecast (high). Assumes 13% of fleet are EVs by 2025, then 44%, 76%, 92%, 97% and 99% in 2030, 2035, 2040, 2045 and 2050 respectively.
Accelerated ZEV Uptake (EV: Ready-Low)	Localised market forecast (low). Assumes 8% of fleet are EVs by 2025, then 28%, 56%, 79%, 91% and 95% in 2030, 2035, 2040, 2045 and 2050 respectively.
Business-as-usual (TAG & NRTP Core)	Based on the latest assumptions in the DfT TAG Guidance. Assumes 15% of fleet are EVs by 2025, then 36%, 52%, 62%, 66% and 67% in 2030, 2035, 2040, 2045 and 2050 respectively.
CCC 6th Carbon Budget (Balanced)	Committee for Climate Change (CCC) Sixth Carbon Budget. Advice to ministers on the limits to be adopted as carbon budgets and how this can be achieved. Three 'explanatory scenarios' and a 'Balanced Pathway' (shown in chart). Underpinned by analysis of different measures. Pathway would put the UK on track to meet national statutory carbon budgets and Net Zero by 2050.
NZS Delivery Pathway (Lowe and Upper)	The Net Zero Strategy set out an indicative 'delivery pathway' of emissions reductions to meet our climate targets up to Carbon Budget 6 (2033-37) and stay on track for net zero by 2050. Covered all sectors including transport. A range of reductions is given. The chart shows the lower and upper boundaries of the range. Informed by CCC's analysis but reflects Government policy decisions of how best to achieve targets. Quantified Carbon Reduction guidance will require LTAs to present this as guiding context on local meaning of carbon budgets.
Tyndall Centre	Tyndall Centre is a research organisation based at the University of Manchester. This pathway allocates more of the global budget to developing countries thus presenting steeper decline rates required in the UK Proportions local authority carbon budgets from this. Does not distinguish budgets/pathways by sector. Indicative transport pathway therefore derived as the equivalent proportion of total whole-economy emissions transport accounted for in 2019.

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