Hertfordshire COMET: Local Plan Forecasting Report - LTP4

Project number: 60588905

June 2019

Quality information

Prepared by	Checked by	Approved by
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Revision History

Revision	Revision date	Approved by
Draft for comment	03 May 2019	SK
Final incorporating HCC Comments	05 June 2019	SK

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1. Executive Summary

1.1 Background to the Forecast

1.1.1 Hertfordshire County Council (HCC) has commissioned AECOM to produce a 2036 forecast using the COMET multi-modal transport model. The forecast scenario includes the Local Plan aspirations (all employment and dwelling growth, regardless of certainty) of the 10 Hertfordshire districts, as well as the growth aspirations in the following neighbouring areas: Central Bedfordshire, Luton, Buckinghamshire (all districts), part of Essex (i.e. Epping Forest, Harlow, and Uttlesford), and part of Cambridgeshire (i.e. South Cambs and Cambridge)[1].

1.1.2 The forecast year has been defined by HCC as 2036. This year was chosen as it aligns with the local plan review timescales in south west Hertfordshire, and is the furthest year into the future for which reasonable planning data projections are available. Where planning data did not forecast to 2036, NTEM[2] growth between the end point of the planning data and 2036 was applied. The forecast is based on growth assumptions in Hertfordshire and the surrounding areas (shown in Table 1-1) between 2014 and 2036 (as COMET has a Base Year of 2014).

1.1.3 Local Plan 4 (LP4) is the fourth local plan run that has been undertaken. LP4 includes the proposed transport schemes agreed with Hertfordshire districts in autumn 2018. It aligns with the Infrastructure Delivery Plans and Transport Strategies at the time such as the growth and transport plans and the A414 strategy. A full list of all transport schemes included in LP4 is detailed in Section 4. Compared to the COMET Base Year model, over 300 schemes are included in LP4. In addition to highways and public transport schemes, a range of mode shift schemes were included in LP4 and attempts to reduce areas of notable delay from the previous LP3 (Local Plan Run 3) were made.

1.1.4 LP4 also includes revised light and heavy goods vehicle (LGV/HGV) growth projections detailed in the Department for Transport's Road Traffic Forecast 2018 (RTF 2018). Growth projections of LGV/HGV traffic have significantly dropped in RTF 2018 compared to those used in previous 2031 Local Plan COMET scenarios (from RTF 2015). Similarly, buffer speed changes in RTF 2018 were implemented in LP4. These speed changes simulate changes in speeds on the wider road network outside of Hertfordshire. Sensitivity tests were undertaken to ensure the correct levels of traffic were observed in the simulation area from the buffer using the revised RTF 2018 projections.

1.1.5 Caution should be exercised when comparing the results of LP4 and LP3 (Local Plan Run 3). Primarily, the forecast years (2036 compared to 2031), transport networks and spatial distribution of developments are considerably different. LP4 includes a number of updates compared to LP3, such as the inclusion of planning data for Central Bedfordshire, updates from RTF 2015 to RTF 2018 and over 160 additional transport schemes. A direct comparison of the two Local Plan forecasts is therefore not possible; however high-level comparisons are made to provide indicative results and analysis

1.1.6 The forecast is a reflection of the total cumulative growth within the county rather than a test of any specific (set of) developments and/or schemes.

[1] For the rest of Great Britain, the growth in employment and population in the COMET forecast is based on NTEM 7.2 projections.
[2] NTEM is the National Trip End Model produced by the Department for Transport and forecasts the growth in trip origins-destinations for use in transport modelling. These forecasts take into account population, employment, housing, car ownership and trip rates.

Table 1-1: Growth Assumptions in Hertfordshire and selected neighbouring areas (2014-2036)[3]

Area	2036		Growth 2014 – 2036		Growth LP4 - LP3 (2031)	
	No. of Dwellings	No. of Jobs	Dwellings %	Jobs %	Dwellings %	Jobs %
Broxbourne	10,686	7,090	27%	17%	29%	-28%
Dacorum	19,859	1,494	31%	11%	84%	-34%
East Herts	21,083	3,310	36%	5%	17%	22%
Hertsmere	16,785	6,314	39%	14%	256%	93%
North Herts	19,637	7,632	35%	13%	22%	-11%
St Albans	17,749	6,213	30%	3%	101%	-55%
Stevenage	12,252	3,499	34%	7%	54%	-19%
Three Rivers	4,069	8,275	11%	22%	56%	101%
Watford	10,313	11,193	28%	19%	25%	46%
Wel Hat	18,660	12,602	41%	17%	53%	6%
Essex (Epping Forest, Harlow & Uttlesford)	32,307	23,018	26%	16%	1%	-25%
Luton	8,842	5,358	12%	5%	49%	-72%
Bucks	77,574	70,192	28%	18%	35%	11%
Cambs (South Cambs and Cambridge)	62,465	22,981	56%	13%	64%	48%
Central Bedfordshire	26,040	52,234	25%	51%	-22%	348%
Total	**358,321**	**241,406**	**31%**	**16%**	**36%**	**16%**

[3] Dacorum, Hertsmere and Welwyn Hatfield include some development sites with less certainty.

1.1.7 COMET is a multi-modal transport model suite that includes a Highway Assignment Model, Public Transport Model, and Variable Demand Model.

1.1.8 The reliability of the forecast results is dependent on the performance of the Base Year model, and a few areas of the model do not meet WebTAG performance criteria. The performance of the model relative to WebTAG guidelines was set out in a presentation to Hertfordshire on 9th March 2017. No Local Model Validation Report was prepared for the version of the Base Model used for this forecast.

1.2 Highway Network Results

1.2.1 In terms of highway trips originating in Hertfordshire, an increase of approximately 25% (at a 24 hour level) is forecast between 2014 and 2036. This increase is accompanied by a rise in travel distance of between 19% - 30% (depending on time period), but an increase in travel time of up to 43% (AM Peak). The relatively sharp rise in travel time compared to travel distance is indicative of increasing congestion, and corroborates the fall in average network speed of approximately 14% in the AM Peak.

Vehicle Flows and Congestion

1.2.2 Model results show significant congestion on key urban and inter-urban roads in 2036 – see section 7.3 for further details:

- Modelling shows the highest levels of congestion in the urban areas of Watford, St Albans, Hemel Hempstead, and Hatfield towns;
- Modelling shows congestion (although to a lower level) in the urban areas of Welwyn Garden City, Stevenage, Hitchin, Letchworth Garden City, Baldock and Bishop's Stortford;
- Modelling shows congestion on the A414 through Hemel Hempstead and between the M1 and A10;
- Various sections of the M25, A1(M) and M1 suffer from congestion; and
- There is congestion and delays on key strategic routes entering and exiting Hertfordshire from neighbouring Local Authorities.
- Reduced flows through central Hemel Hempstead due to downgraded A414 in LP4;
- Marginal flow differences on the A414 corridor west of the A10, the reduction of delays at the A414/Fifth Avenue junction in Harlow encourages traffic back onto the A414 east of the A10. This may affect the parallel A120 corridor further north. Reduced flows through Hertford on the A414 due to the Hertford Bypass;

1.2.3 Figure 1-1 to Figure 1-3 provide a selection of forecast highway model results. Note that "BY" refers to "Base Year", whilst "LP4" refers to the "Local Plan Run 4" (i.e. the current forecast).

Figure 1-1: Flow Difference on Key Corridors (2036 AM Peak minus 2014 AM Peak)

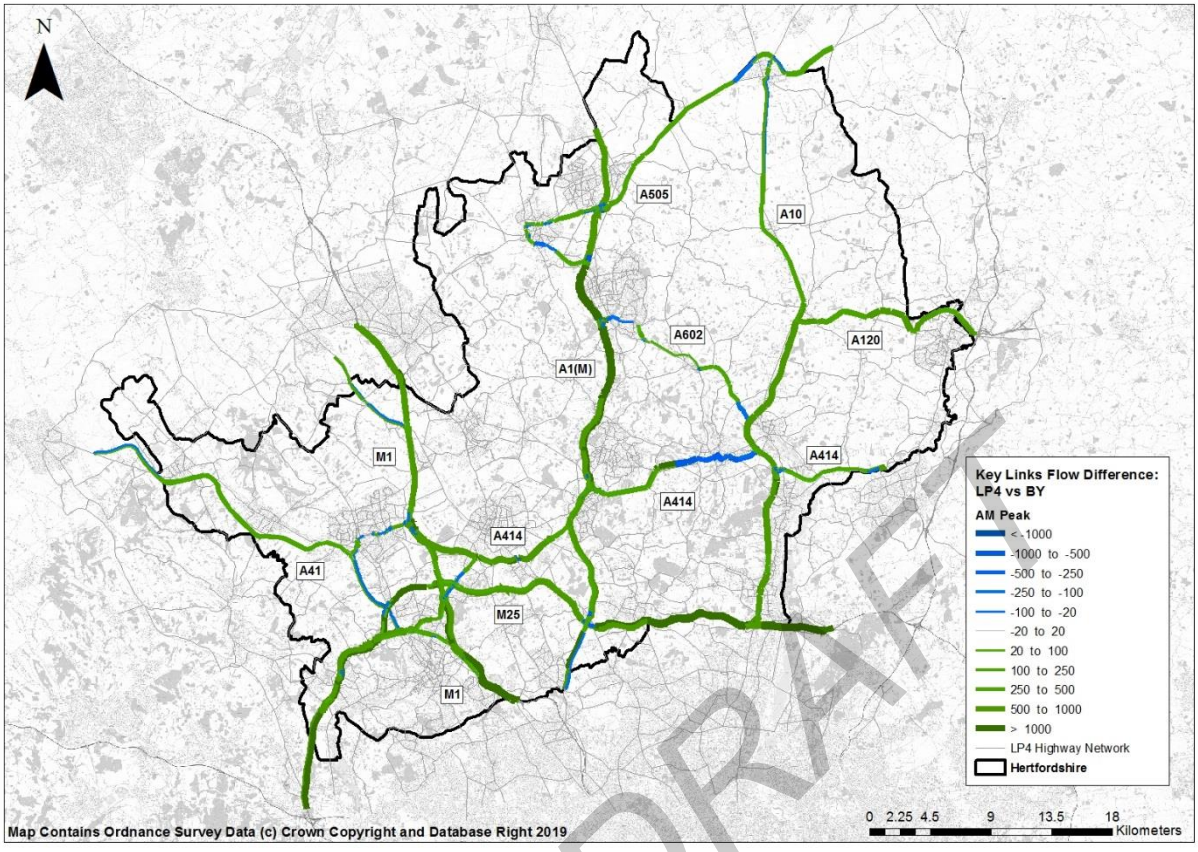


Figure 1-2: Volume over Capacity on Key Links (2036 AM Peak)

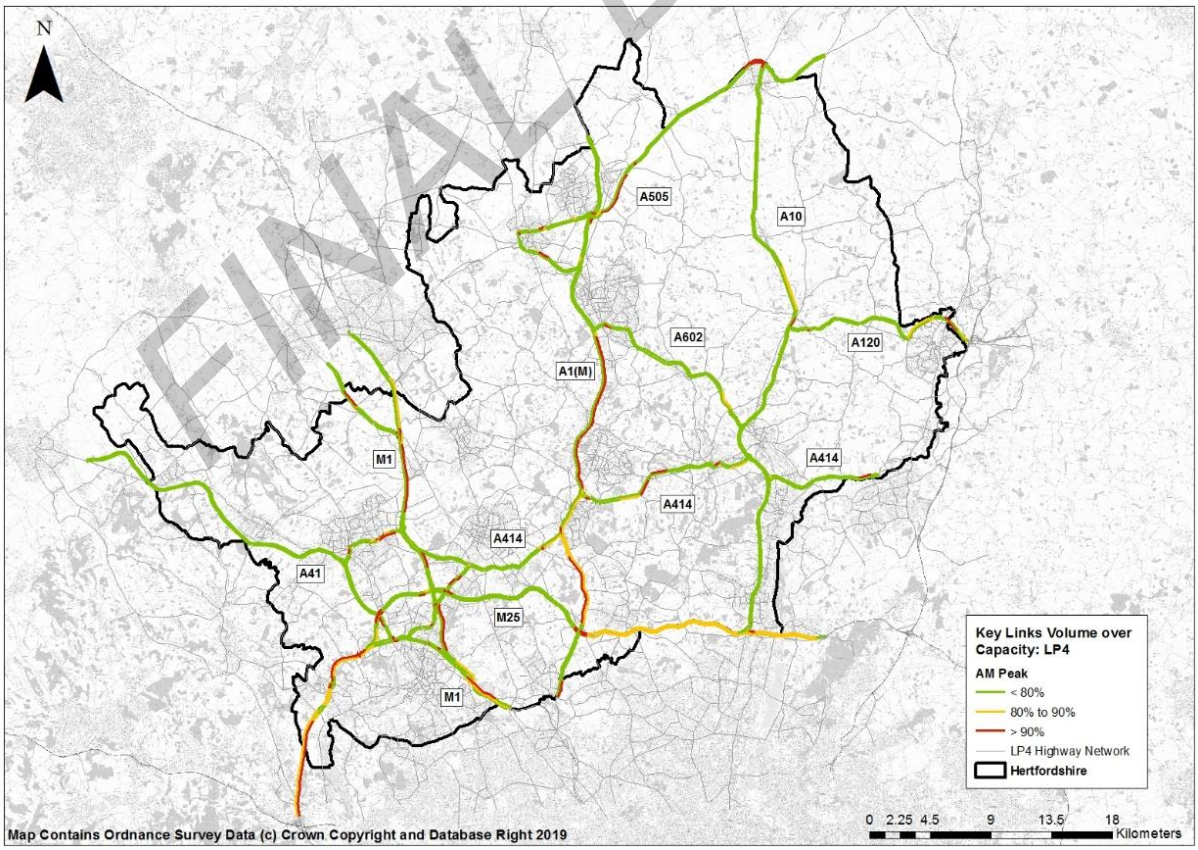
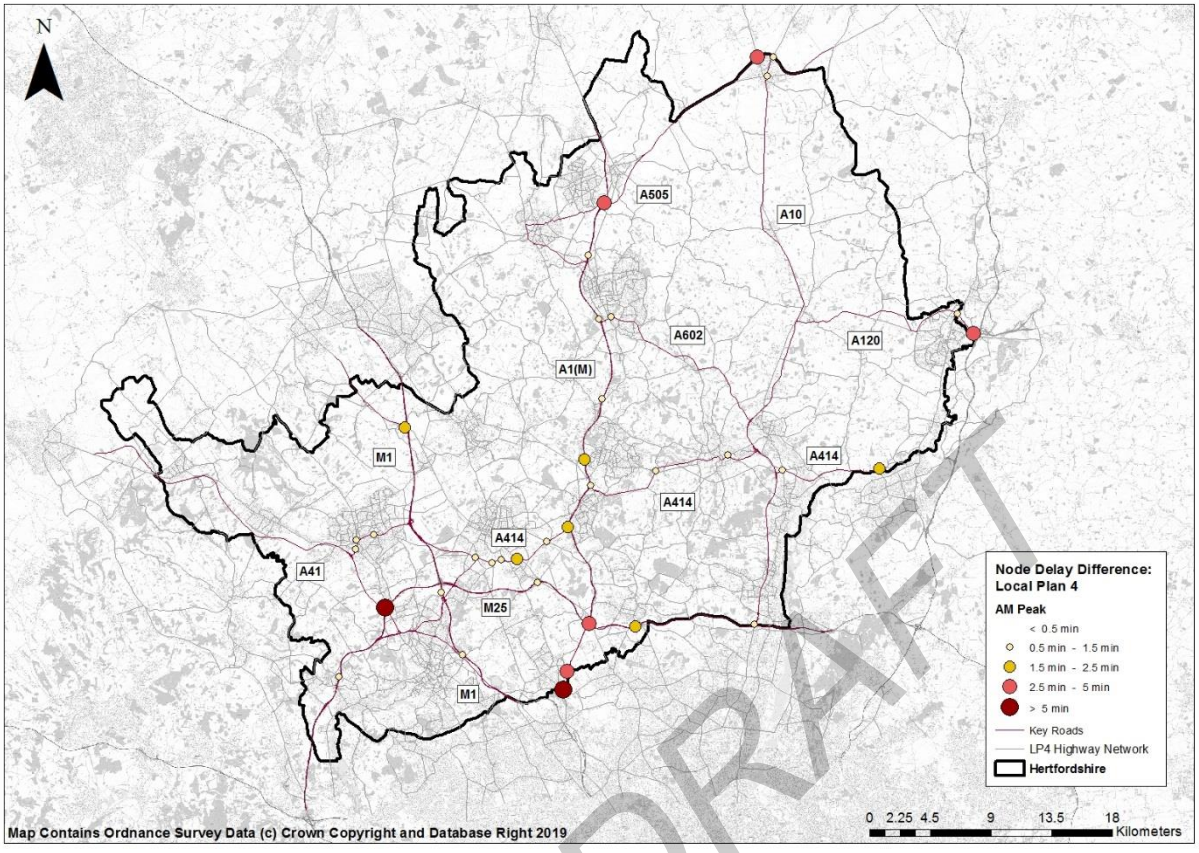


Figure 1-3: Delay at Key Junctions (2036 AM Peak)



Inter-urban Highway Journey Times

1.2.4 Increased vehicle flow and congestion in the Forecast Year cause a rise in the average journey time between urban areas in Hertfordshire. The tables below present the journey times between key towns in Hertfordshire in LP4.

1.2.5 These tables show journey times for the “average route”; therefore, some journeys will be considerably slower than the indicated values.

1.2.6 Towns in the south west of Hertfordshire, especially Watford, experience some of the greatest changes in journey times due to the congestion on the network.

Table 1-2: LP4 Journey times between key towns AM peak (mins)

	2036 LP4 AM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	34	62	74	78	29	38	38	43	60	71
	Cheshunt	37	0	29	41	46	21	25	34	42	39	41
	Borehamwood	57	30	0	36	29	34	31	35	38	33	35
	Rickmansworth	76	49	40	0	22	50	49	53	55	38	23
	Watford	71	44	25	20	0	46	45	48	48	31	24
	Hertford	29	18	35	50	52	0	10	20	25	34	45
	Welwyn Garden City	37	21	29	44	47	10	0	17	19	26	38
	Stevenage	40	32	39	54	57	21	23	0	11	33	45
	Hitchin	44	43	44	58	60	31	31	13	0	34	45
	St Albans	57	40	33	35	35	31	25	31	32	0	19
	Hemel Hempstead	65	47	36	30	32	40	37	40	41	22	0

Table 1-3 LP4 Journey times between key towns in IP (mins)

	2036 LP4 IP (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	32	50	68	63	28	36	37	41	52	61
	Cheshunt	35	0	24	40	35	20	24	33	40	36	39
	Borehamwood	52	29	0	34	25	31	26	32	34	30	34
	Rickmansworth	68	45	33	0	20	48	44	50	52	32	23
	Watford	61	38	22	16	0	41	37	43	43	27	21
	Hertford	27	17	25	43	38	0	10	20	25	28	37
	Welwyn Garden City	35	20	20	38	33	10	0	17	19	20	32
	Stevenage	37	29	27	45	40	20	17	0	11	29	39
	Hitchin	41	36	30	48	41	25	20	12	0	31	38
	St Albans	51	36	27	31	25	27	21	28	31	0	18
	Hemel Hempstead	61	40	30	23	21	37	32	38	38	18	0

Table 1-4 LP4 Journey times between key towns in PM peak (mins)

	2036 LP4 PM (min) Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	34	57	69	64	29	38	39	44	60	68
	Cheshunt	38	0	29	41	36	22	25	35	44	37	39
	Borehamwood	64	40	0	43	28	41	37	43	45	38	38
	Rickmansworth	79	54	41	0	19	56	53	59	61	37	30
	Watford	82	58	37	24	0	60	56	62	62	40	34
	Hertford	31	19	29	47	42	0	10	21	28	32	40
	Welwyn Garden City	39	23	23	41	36	10	0	20	22	24	34
	Stevenage	39	32	32	50	44	21	21	0	11	31	41
	Hitchin	43	40	32	50	42	27	21	12	0	32	39
	St Albans	61	40	29	35	26	34	25	32	32	0	19
	Hemel Hempstead	70	45	31	24	22	44	36	42	41	19	0

1.3 Public Transport Network Results

1.3.1 Forecast results also indicate that the rail network in Hertfordshire will experience an increase in passenger boardings by approximately 51% across the AM, IP and PM Peaks between 2014 and 2036. Bus travel, by comparison is likely to grow at a lower rate (7%) over the same period as a result of rising personal incomes that make rail's higher fares relatively more affordable.

1.3.2 Longer distance bus travel decreases as rail becomes a more attractive option, however some local movements by bus increase due to the linkages of new developments to bus routes.

2. Introduction

2.1 Background

2.1.1 The development of the COMET model suite was commissioned by Hertfordshire County Council (HCC) in February 2015 to provide a structured evidence base for assessing transport policies and strategies on a consistent basis across the county. COMET is a multi-modal model with variable demand modelling capability.

2.1.2 Following the work to date on developing the COMET Base Year (2014) model, HCC commissioned AECOM to produce a 2036 forecast including the Local Plan aspirations (all employment and dwelling growth, regardless of certainty) of the 10 Hertfordshire districts as well as the growth aspirations in the following neighbouring areas: Central Bedfordshire, Luton, Buckinghamshire (all districts), part of Essex (i.e. Epping Forest, Harlow, and Uttlesford), and part of Cambridgeshire (i.e. South Cambs and Cambridge)[4]. This test is known as the COMET 2036 Local Plan Run 4 (LP4).

2.1.3 LP4 includes the proposed transport schemes agreed with Hertfordshire districts in autumn 2018, and aligns with the Infrastructure Delivery Plans and Transport Strategies at that time. A full list of all transport schemes included in LP4 is detailed in Section 4. Compared to the COMET Base Year model, over 300 schemes are included in LP4. In addition to highways and public transport schemes, a range of mode shift schemes were included in LP4 and attempts to reduce areas of notable delay from the previous LP3 (Local Plan Run 3) were made.

2.1.4 LP4 also includes revised light and heavy goods vehicle (LGV/HGV) growth projections detailed in the Department for Transport's Road Traffic Forecast 2018 (RTF 2018). Growth projections of LGV/HGV traffic have significantly dropped in RTF 2018 compared to those used in previous 2031 Local Plan COMET scenarios (from RTF 2015). Similarly, buffer speed changes in RTF 2018 were implemented in LP4. These speed changes simulate changes in speeds on the wider road network outside of Hertfordshire. Sensitivity tests were undertaken to ensure the correct levels of traffic were observed in the simulation area from the buffer using the revised RTF 2018 projections.

2.1.5 The forecast is developed to test the impact of the updated Local Plan development information and revised set of transport infrastructure measures.

[4] For the rest of Great Britain, the growth in employment and population in the COMET forecast is based on National Trip End Model (NTEM) 7.2 projections.

2.2 Purpose of this Document

2.2.1 This document presents the steps taken to produce the forecast scenario and a summary of high level results across Hertfordshire's highway and public transport networks.

2.3 Caveats

2.3.1 Caution should be exercised when comparing the results of LP4 and LP3. Primarily, the forecast years, transport networks and spatial distribution of developments are considerably different. LP4 includes a number of updates compared to LP3, such as the inclusion of planning data for Central Bedfordshire, updates from RTF 2015 to RTF 2018 and over 160 additional transport schemes. A direct comparison of the two Local Plan forecasts is therefore not possible; however high-level comparisons are made to provide indicative results and analysis.

2.3.2 Analysis focuses on results from the AM peak (0800 to 0900) and PM peak (1700 to 1800), however, results will also be produced for the Inter peak (average hour between 1000 and 1600). Results from the Inter peak will only be reported if they vary considerably from those seen in the AM and PM peaks.

2.4 Previous Local Plan COMET Forecasting

2.4.1 Table 2-1 presents a summary of the previously prepared Local Plan forecasts prepared in COMET for HCC.

Table 2-1: Previous Local Plan COMET Forecasting

Base Year Version	Local Model Development and Validation Report	Summary of COMET Base Year Version	Relevant Previous Forecast Scenarios
COMET v1	May 2016 (v1)	Initial version of COMET	Hertfordshire COMET: **Local Plan** Forecasting Report: June 2016
COMET v2	November 2016 (v2)	Version of COMET based on v1 enhanced in the Watford area: Refinements to the highway matrix build process New intra-urban highway screenlines/cordons Additional highway data collection Enhancement of network detail in the town New bus passenger cordon around Watford Additional bus passenger data collection	Hertfordshire COMET: **Local Plan Do Minimum** Forecasting Report: January 2017 **Local Plan Do Something** Scenario – developed in early 2017. Outputs presented to HCC in February 2017, however, no forecasting report was produced.
COMET v3	No LMVR produced	Version of COMET based on v2 enhanced in St Albans district: New intra-urban highway screenlines/cordons Additional highway data collection Enhancement of highway network detail in the town, including coding of speeds on urban links in St Albans and Harpenden. New bus passenger cordon around St Albans Additional bus passenger data collection in St Albans and Harpenden	**St Albans Local Plan Do Minimum** scenario. Outputs presented to HCC in June 2017, however, no forecasting report was produced.
COMET v4	No LMVR produced	As above for Local Plan v3. Uses the same Base Year version as Local Plan 3 from v2 enhanced in St Albans district.	**Local Plan v3 2031** scenario. Outputs and report provided to HCC June 2018. **Current forecast** documented in this report – referred to as Local Plan v4 with forecast year of 2036.

2.5 Report Structure

2.5.1 This report covers the following areas:

- Forecast Approach
- Forecast Network Development
- Forecast Trip Matrix Development
- Forecast Assignments
- Highway Forecast Results
- Public Transport Forecast Results
- Summary and Discussion
- Appendices

3. Forecast Approach

3.1 Forecast Objectives

3.1.1 The objective of this forecasting exercise is to understand the cumulative effect of all Local Plan growth in Hertfordshire, whilst also considering the impact of growth in neighbouring authorities and the impact of potential transport schemes and strategies (see Table 1-1).

3.1.2 This document does not draw any conclusions for any specific individual development or scheme regarding its effect on the local or wider transport network. High level comparisons to LP3 are made, however the caveats in section 2.3 should be noted.

3.1.3 This forecast takes into consideration changes between 2014 and 2036 including increases in population, number of jobs and dwellings, rising costs of travel, and proposed transport infrastructure schemes. However, there is currently no allowance for factors that may fundamentally alter the nature of travel in Hertfordshire or elsewhere in Great Britain. These factors may include the introduction of new technologies (e.g. autonomous vehicles) or a significant shift in travel patterns relative to the Base Year model as a result of behavioural change.

3.2 Model Years

3.2.1 The forecast year has been defined by HCC as 2036. 2036 was chosen as the date aligning with the Local Plan reviews for the South West Herts planning authorities. In other districts local plan growth was projected forwards using NTEM growth. Where planning data did not forecast to 2036, NTEM growth between the end point of the planning data and 2036 was applied. No other forecasts with alternative model years have been created.

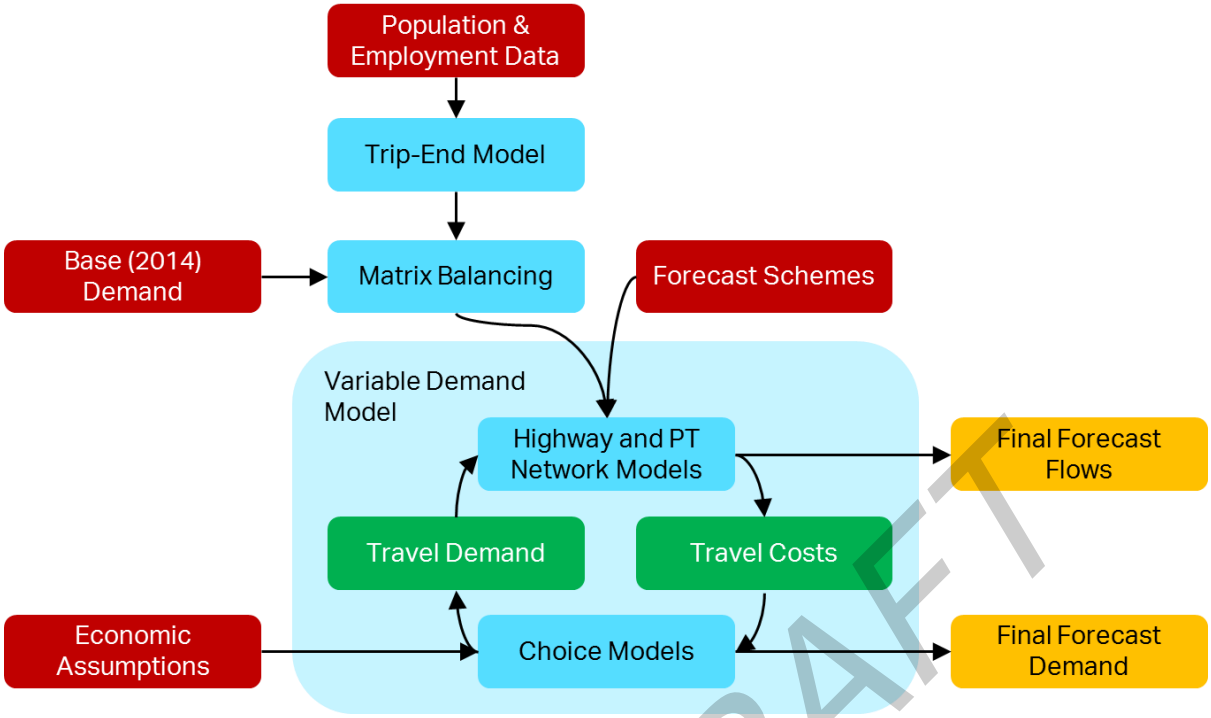
3.3 Treatment of Variable Demand

3.3.1 COMET includes a variable demand model which has been used in the preparation of forecast scenarios. The variable demand model is designed to estimate the effect of changes in transport infrastructure and travel cost upon patterns of demand. This considers changes in overall travel movements which is separate to modelling the way in which travellers respond to changes by choosing different routes (which is forecast by the highway and public transport assignment models). Further details of the treatment of variable demand can be found in Chapter 5.

3.4 Model Structure

3.4.1 COMET is a multi-modal model with a Highway Assignment Model developed in SATURN, a Public Transport Model in Emme and Variable Demand Model in Emme. The structure of the forecasting process, including the interaction between the demand models and assignment models is shown in Figure 3-1.

Figure 3-1: COMET Model Structure



4. Forecast Network Development

4.1 Public Transport Network

Forecast Public Transport Schemes

4.1.1 As confirmed by HCC, the large majority of schemes included in LP3 remained in LP4. These networks therefore formed the basis from which the highway and public transport networks of the 2036 LP4 have been created.

4.1.2 Schemes were taken from the district Local Plan IDPs and transport strategies such as the Growth and Transport plans and the A414 Strategy as well of proposed changes to interurban bus services and bus services linked to new developments.

4.1.3 Proposed changes to interurban bus services and those associated with new developments have been included. The new public transport schemes and services in Hertfordshire added during the creation of the forecast network are shown in Table 4-1 and Table 4-2.

Table 4-1: Modelled Public Transport Schemes in Hertfordshire

LPA (District)	Scheme type	Location	Location Details	Description of scheme	Modelled before?
Broxbourne	Bus scheme	High Leigh	New bus service High Leigh - Broxbourne Station	New bus service	LP3
Broxbourne	Bus scheme	Brookfield Centre	New bus service Waltham Cross station - Hertford Regional College	New bus service	LP3
Broxbourne	Bus scheme	Park Plaza	New bus service Park Plaza North - Waltham X bus station	New bus service	LP3
Broxbourne	Bus scheme	Brookfield Centre	Brookfield bus interchange improvement	Improved bus stops	LP3
Broxbourne	Bus scheme	Old A10	Bus stop improvement progamme at stops on old A10 (A1170 / B176)	Real time information and bus stop upgrade	LP3
Broxbourne	Bus scheme	Old A10	Selective Vehicle Detection providing priority for buses on old A10 (A1170 /B176) at Station Road / High Road (Broxbourne), A1170 / Vancouver Road, Church Lane / Turners Hill & Old Pond junction (Cheshunt)	Increase in bus speed / reduction in delay	LP3
Broxbourne	Capacity enhancement	WA railway line	Crossrail2 improvements	Increase in frequency between Cheshunt and Broxbourne associated with Crossrail2	LP3
Broxbourne	Capacity enhancement	WA railway line	New stations at Turnford and Park Plaza	2 trains per hour in off peak with a few additional trains	LP3

				in peak	
Dacorum	Bus service enhancements	Maylands area, Hemel Hempstead	Maylands	Improvement of Maylands bus services	LP3
Dacorum	Bus service enhancements	Luton - Hemel	M1	Dedicated coach Luton to Hemel along M1	No
Dacorum	New bus service	Hemel Hempstead	A414 corridor	New high frequency bus service running along A414 corridor	No
East Herts	Bus Scheme	Hertford A414 Gascoyne Way and Ware Road		Bus priority measures along A119 and A414	LP3
East Herts	Frequency change	Bishops Stortford rail	Bishops Stortford - Cambridge 2 additional fast trains per hour off-peak	1 train serving Bishops Stortford and 1 train serving Cambridge (Oct 2016)	LP3
East Herts	Frequency change	Bishops Stortford rail	WA line to Bishops Stortford & Harlow	Increased frequency to 9 trains per hour off peak	LP3
East Herts	Frequency change	Hertford East	Hertford East line	Increased frequency from Hertford East to / from Liverpool Street / Stratford	LP3
East Herts	New service	North and East of Ware	North and East of Ware	New circular bus service	LP3
East Herts	Service diversion	East of Stevenage	Gresley Way, Stevenage	Diversion of existing bus service through site	No
East Herts	Service diversion	Bishops Stortford South	Bishops Stortford South	Diversion of existing bus services through site	no
North Herts / Stevenage / Welwyn Hatfield / Hertsmere	Rail timetable change	Great Northern rail line	Great Northern rail line	Thameslink timetable changes	LP3
Hertsmere	Bus Scheme	Potters Bar	Cranborne Road Industrial Estate	New bus service	No
Hertsmere	Bus route change	Tyttenhanger		Diversion of existing bus services	No
North Herts	Bus scheme	Hitchin		Bus frequency improvements Hitchin - Letchworth	LP3

North Herts	Bus scheme	Hitchin		Bus frequency improvements Hitchin - Luton	LP3
North Herts	Bus scheme	Letchworth		Bus frequency improvements Letchworth - Stevenage	LP3
North Herts	Bus scheme	North Letchworth		Bus route extension	No
North Herts	Bus Scheme	Hitchin-Luton		Bus priority measures	No
North Herts	Bus Scheme	Baldock		Bus Access to Development - Baldock	No
St. Albans	Bus Scheme	St Albans	St Albans Abbey station - city station	SC1 Abbey Line Shuttle bus service	LP3 (some changes)
St. Albans	Bus scheme	Hatfield road corridor	Hatfield Road	Bus priority measures	No
St. Albans	Bus Scheme	London Colney-St. Albans		Improved London Colney-St Albans bus services	No
St. Albans	Bus Scheme	St. Albans-Hatfield		Increased frequencies and extended hours of operation.	No
St. Albans	Park & rail	Park Street	Park Street station	Potential new Park and rail facility south of A414 and east of A405 linked to existing / relocated Park Street station	No
Stevenage	Bus Scheme	Stevenage (south)	Hertford Road	Hertford Road Speed reduction measures & bus gate	LP 3
Stevenage	Rail scheme	Stevenage station	Stevenage Station	Provision of fifth platform	LP3
Stevenage	Bus Scheme	Stevenage St Nicholas		New services to north Stevenage	No
East Herts	Bus Scheme	East of Stevenage	Gresley Way, Stevenage	Diversion of existing service into development	No
Watford / St Albans	Rail Improvements	Watford - St Albans	Abbey Line	Frequency improvements	LP3 - (some change)
Watford	Bus service enhancements	Watford	Tolpits Lane to Hampermill Lane	Colne sustainable link (cycle / bus). New link over the River from Tolpits Lane to	No

				Hampermill Lane for buses / cycles	
Wel Hat	Bus schemes	Hatfield	Business park area - A1057 (Mosquito Way - Albatross Way), Albatross Way / Mosquito Way / Tamblin Way / Jetliner Way / Comet Way	Circular bus network with bus priority, improving facilities an improved interchange facilities	No
Wel Hat	New bus service	Symondshyde		New bus service	No
Wel Hat	Bus link	Welwyn Garden City	Shire Park	Bus only link	No
Wel Hat	Bus frequency	Welwyn Garden city - Luton		Frequency improvements	No
Wel Hat	Bus frequency	Hatfield - Luton		Frequency improvements	No
Wel Hat	Bus Improvements	Hatfield - St Albans	A1057 Hatfield Road	Bus priority measures	No
East Herts	Bus Improvements	724 route Heathrow to Harlow	724 route	Rationalisation of existing 724 route into route 724, & 302 - splitting it into sections with improved frequency over shorter distances	No
Dacorum	Bus Improvements	Watford	324 route	Rationalisation of existing 324 route, with increased frequency from Hemel to Watford	No
Dacorum	Bus Improvements	Hemel - Stevenage	300 /301 route	Rationalisation of existing route	No
Buckingham shire	New rail line	Oxford - Cambridge	Oxford - Cambridge	New rail link connecting Oxford and Cambridge	LP3
Luton	New LRT	Luton Airport	Luton Parkway - Airport	New LRT connection between Luton Parkway and Luton Airport	LP3

Table 4-2: Modelled Public Transport Schemes outside Hertfordshire

Scheme	District
East West Rail	Various
Light Rail scheme linking Luton Airport Parkway station to Luton airport	Luton

Bus Services

4.1.4 It is acknowledged that our ability to predict changes in the bus network over a 10-20 year period is very limited. As bus routes tend to change on a commercial basis, it is generally not possible to make specific forecasts about details of bus routes over the next 10-20 years. Accordingly, the model assumes no changes from the model Base Year other than the schemes identified in Table 4-1.

4.2 Highway Network

4.2.1 As confirmed by HCC, the large majority of schemes included in LP3 remained in LP4. These networks therefore formed the basis from which the highway and public transport networks of the 2036 LP4 have been created.

4.2.2 The forecast highway network is coded using the $INCLUDE file facility in SATURN, which allows for greater flexibility in coding and developing the supply network. The facility makes it simpler to update scheme files in the future year, providing greater capability for the model in assessing different infrastructure and development options that may have associated network improvements.

Forecast Highway Schemes

4.2.3 The key forecast highway network schemes included in the forecasts are shown in Table 4-3 (Hertfordshire) and Table 4-4 (outside Hertfordshire). The full list of schemes is available in Appendix III Section 10.3.

4.2.4 The proposed transport schemes were agreed with districts in winter 2018, and align with the Infrastructure Delivery Plans and Transport Strategies at that time.

Table 4-3: Key Modelled Highway Schemes in Hertfordshire

	Location Details	Description of scheme	Modelled in LP3?
M25 jct 25-27	Smart Motorway improvements	Widening of motorway to 4 lanes with hard shoulder running	LP3
M25 junction 25	M25 junction 25	M25 junction 25 RIS 2 capacity improvements - Option 2	LP3
Turnford / Brookfield	A10 Turnford junction to Halfhide Lane	New 4 lane Link road runs through to Halfhide Lane which then becomes Brookfield Lane W south of the retail park - SB onslip at the Turnford interchange is no longer assumed.	LP3
Brookfield Centre	Hells Wood Link Road between The Links and Hells Wood	New link road running between Turnford Link Road and A10 providing revised access into Brookfield and Tescos with closure of existing junction between Halfhide Lane and the Links	LP3
Hoddesdon	Essex Road / Dinant Link Road	New road alignment and bridge	No

A5 Dunstable	M1 - A5	M1 A5 Link Road	LP3
Hemel Hempstead	Between Boundary Way and Wood Lane End	New link between Boundary Way and Wood Lane End.	LP3
M1 Junction 8, Hemel Hempstead	M1 junction 8	Junction 8 - Major reconfiguration to provide direct access into Maylands	LP3
Maylands Area, Hemel Hempstead	A414 to B487 Redbourn Road	New spine road from B487 Rebourn Road to A414 St Albans Rd - dual carriageway up to new link from M1. Single carriageway north of here.	LP3 (some changes)
Maylands Area, Hemel Hempstead	Cherry Trees Lane and Buncefield Lane quietways	Closing the existing narrow country lanes within the industrial area of Cherry Trees Lane, Buncefield Lane (north) and Buncefield Lane (south) to through traffic	LP3
Hemel Hempstead	North Hemel	New link road between Redbourn Road and Leighton Buzzard Road	No
Hemel Hempstead	Fishery Road, Hemel Hempstead	Model closure of this link to non-bus vehicles.	LP3 (some changes)
M1 Junction 10	Junction 10 Southbound Onslip	Capacity Improvement	No
Tring	East Tring	Access road	No
Berkhamsted	South Berkhamsted	Access road	No
A120 Little Hadham	Little Hadham Bypass	New A120 bypass	A120
Buntingford	A10 Buntingford	Dualling of A10 southbound (London Road to existing DC by Westmill)	LP3
Harlow	New Link between Eastwick Road and A414 Edinburgh Way	Second River Stort crossing	LP3
Hertford	New bypass between A10 and A414 west of Hertford	New dual carriageway bypass	A414 DS
Bishops Stortford station area	Goods Yard Link	New link road between London Road and Dane Street, Bishops Stortford, for all vehicles.	LP3
M11 junction 8	M11 junction 8 capacity enhancements	Lane marking amendments & new dedicated free flow LT lane from M11 SB off slip	LP3
Bishops Stortford	A1250 east of Northgate End	Provision of new MSCP with new signalised access and signalisation of A1250 / Northgate End junction	No
M25 junction 18-25	M25 j18-25	Smart motorway with hard shoulder running	LP3
A1 (M) jct 6-8	A1 (M) jct 6-8	Widening of motorway to 3 running lanes between junctions 6-8.	LP 3
Baldock	New link road connecting North Baldock development to North Road and Royston Road	New bridge over railway & tie into A505 Baldock Bypass / Royston Road roundabout. Priority junction at North Road end.	LP 3
Baldock	A507 Clothall Road / Wallington Road / South Road to B656 Royston	New link road	LP 3

	Road, Baldock		
Letchworth	A505 / Norton Way, Letchworth	Signal optimsation	LP 3
Stevenage	B197 Gravely Rd / North road, Stevenage	Junction signalisation	LP3 (some change)
A414 North Orbital Road	A414 North Orbital Road	New access junction onto A414 and new spine road connecting to A5183 Radlett Road (south of Frogmore)	LP3
M25 junction 21a	M25 junction 21a	M25 junction 21a capacity improvements (Radlett Railfreight mitigation)	LP3
M25 junction 22	M25 junction 22	M25 junction 22 capacity improvements (Radlett Railfreight mitigation)	LP3
A1 (M) jct 6-8	A1 (M) jct 6-8	Widening of motorway to 3 running lanes between junctions 6-8.	LP 3
A1m junction 8	A1(M) J8 / A602 Letchworth junction	Junction reconfiguration	LP 3
A1m junction 8	A1(M) Junction 8 slip road improvements	Extend width of A1m north of junction 8 to allow a lengthened SB off slip	LP 3
Stevenage	A602 /Gunnels Wood Road, Stevenage	Upgrade of A602 / Gunnels Wood Road / GSK junction	LP 3
Rickmansworth	Uxbridge Road, Mile End, Rickmansworth	New access for 4fe secondary school - access proposed via new roundabout junction on Uxbridge Road (at junction with Long Lane)	LP3
Rickmansworth	A412 / A402 Rickmansworth	Additional capacity at the A412 / A404 roundabout to the west of Rickmansworth Town Centre	LP3 Amend
Hunton Bridge	M25 spur, Hunton Bridge	M25 spur approach to Hunton Bridge roundabout - widening approach / circulation or signalisation	LP3
Watford	Thomas Sawyer Way, Watford	New link road from Dalton Way providing access to Watford Health Campus	LP3
A1m junction 6	A1m junction 6 ramp metering	Switch on of installed ramp metering as part of final phase of A1m junction 6 improvement works	LP3
A1m junction 6 / B656 Codicote Road / Great North Road (Clock roundabout)	A1m junction 6 / Clock roundabout	A1(M) Junction 6 including Clock Roundabout junction capacity improvements	LP3
A414 Mill Green junction to Jack Oldings roundabout	A414 Mill Green - Jack Oldings roundabout	A414 section between Mill Green & Tescos reconfiguration	LP3
A1(M) Junction 4	A1m Junction 4 /Jack Oldings roundabouts	A1(M) Junction 4 improvements	LP3
A1 (m) junction 3	A1 (m) Junction 3 improvements	Signal optimisation and dualling	LP3
A1 (M) J 3	A1M Junction 3	Junction reconfiguration	No
Welwyn	Clock Roundabout and Welwyn Bypass	Reduce 2 lane dual carriageway section to single lane in each direction with improved off road cycling and walking facilities and new crossing facility	No
Welwyn Garden City	A1m junction 5	Junction closure	No

Table 4-4: Modelled Highway Schemes outside Hertfordshire

Scheme	Area
Oxford / Cambridge Expressway – new road link	Buckinghamshire
A5 – M1 Link & Woodside Link	Central Bedfordshire
M1 – A6 Link road	Central Bedfordshire
Town center ring road – lane relocation	Luton
Vauxhall Way – capacity enhancement	Luton
Gipsy lane – capacity enhancement	Luton

4.3 Road Traffic Forecasts 2018 (RTF 2018)

4.3.1 Road Traffic Forecasts 2018 (RTF 2018) present the latest forecast for traffic demand, congestions and emissions in England and Wales up to 2050. These are produced using the Department for Transport's National Transport Model. Data from the Road Traffic Forecasts is used in COMET to forecast LGV (Light Goods Vehicle) growth, HGV (Heavy Goods Vehicle) growth and buffer speed changes. Previous Local Plan forecasts in COMET have used data from RTF 2015, the latest available at the time. It is important to note the changes between RTF 2015 and 2018 are considerable.

4.3.2 The RTF2018 update rebases the model from 2003 to 2015 and considers recent evidence and input data. Since RTF 2015, the National Trip End Model has also been updated. The forecasts consider uncertainty around a number of key drivers of road traffic, including:

- Population growth;
- Trip rates;
- GDP & Income;
- Costs of driving;
- Young people's driving patterns and licence holding;
- Demand for goods: freight; and
- Technology.

4.3.3 RTF 2018 now provides growth rates and speed changes based on the different time periods included in the COMET model. RTF 2015 provided only a single speed regardless of time period.

4.3.4 The changes resulting from the new RTF 2018 traffic forecast assumptions are as follows:

- Expected freight growth for LGV and HGVs have been amended and are significantly lower than previous RTF projections; and
- Buffer speeds reduced relative to the Base Year to simulate the effect of rising congestion outside the simulation area. This speed reduction is based on Scenario 1 of RTF 2018 and is increased 4 fold to achieve forecast traffic growth in the buffer network. These speeds are marginally lower than those in LP3 which used RTF 2015. This approach was applied separately for each time period across the buffer network.

Modal Shift

4.3.5 In addition to the schemes listed in Table 4-1 to Table 4-4, HCC requested that the forecast scenario should include an element of modal shift (from highway to other modes) in selected areas to represent district's proposals to encourage sustainable travel and the impact of emerging Growth and Transport Plan sustainable measures. The areas where this modal shift has been simulated are as follows (also illustrated in Figure 4-1):

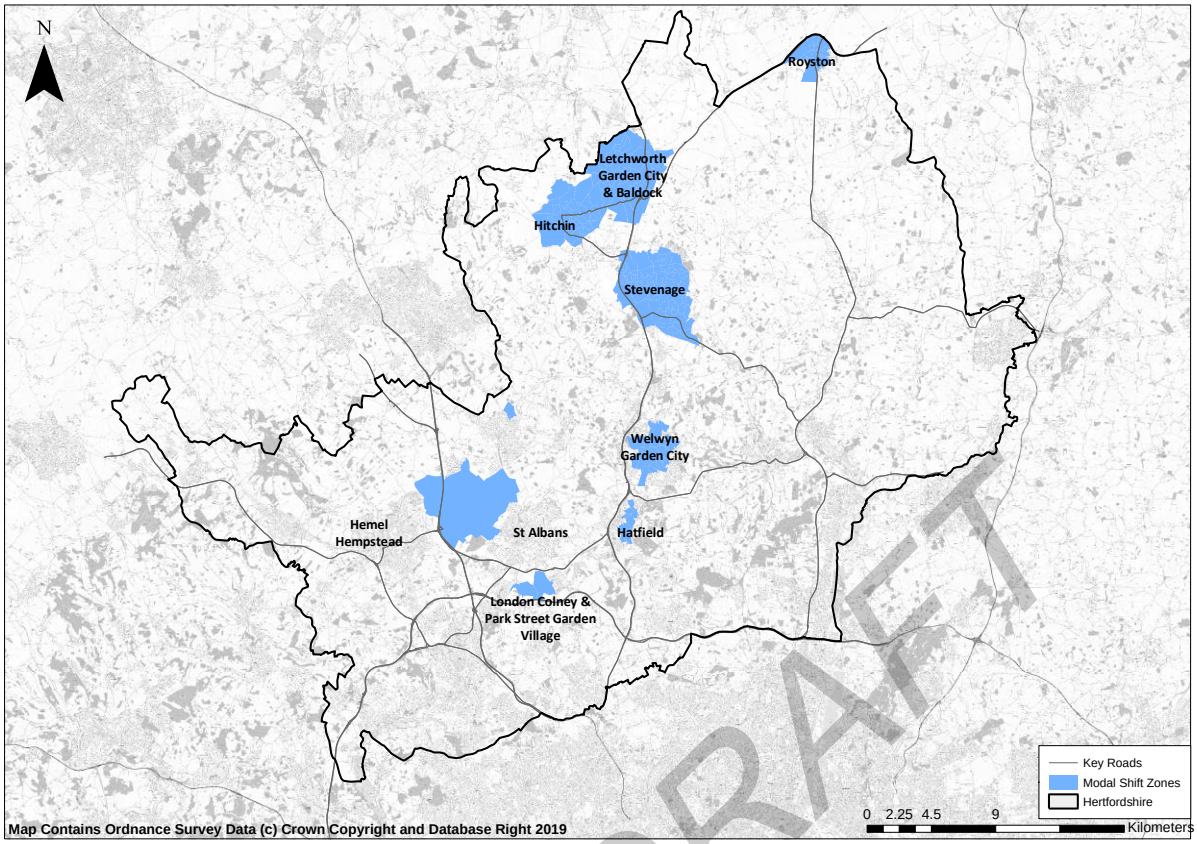
- Hitchin;
- Letchworth Garden City;
- Baldock;
- Royston;
- Stevenage;
- Welwyn Garden City;
- Hatfield;
- Hemel Hempstead; and
- St Albans.

4.3.6 Mode shift in St Albans is applied to reflect the high number of internal trips and to reduce the number of external trips on the network. Reflecting this in a more realistic manner would require changes to the VDM which is currently outside the scope of Local Plan forecasting.

4.3.7 The modal shift in the forecast scenario is achieved by applying a factor (in COMET's Variable Demand Model) to the cost of highway trips originating in the selected zones. By raising the cost of undertaking a journey by car, this factor encourages trips to be made by alternative means (i.e. public transport or sustainable travel). The level of modal shift specified by HCC and achieved for these zones is approximately 5%.

4.3.8 This is not a recommended approach to modelling modal shift in a multi-modal model (such as COMET) as no infrastructure to facilitate such behaviour change has been included in the forecast year network. This modelled modal shift is therefore not a result of COMET's Variable Demand Model representing behavioural change; rather, it is the result of a parameter adjustment that is currently not based on any specific interventions to the transport network. Once more specific scheme assumptions regarding the proposed sustainable travel initiatives are known, these should be coded into COMET as other forecast schemes already are.

Figure 4-1: Modal Shift Zones



Watford and Stevenage Developments – Car Parking Assumptions

4.3.9 There are several proposed residential developments in Watford and Stevenage that have been represented with lower levels of car ownership compared to the standard forecast assumptions. This is implemented in response to developer plans to provide a lower level of car parking at these locations. The sites where this adjustment has been implemented are as follows:

- Health Campus, Watford – 1,100 dwellings
- Ascot Road (Western Gateway), Watford – 920 dwellings
- Watford Junction, Watford – 2,777 dwellings
- North of Stevenage – 800 dwellings
- Stevenage West – 1,350 dwellings
- Combined town centre sites, Stevenage – 2,000 dwellings

4.3.10 The lower level of car ownership has been simulated by shifting 20% of residents in new developments from a “car-owning” category to a “non car-owning” category. This change is made in the IXICarOwn table (this is one of several inputs to the COMET TripEnd model).

Signalised Junctions and Network Checking

4.3.11 Signalised junctions associated with transport schemes have been checked to compare the levels of delay with the base year model. Signal timings have been optimised and adjusted in cases where significant delays were forecast.

4.3.12 Signal timings and phases have been adjusted by taking into account the location of delays or congestion where significant in LP3.

4.3.13 Furthermore, a check has been made of the forecast highway assignment to ensure that the implementation of the schemes has not led to implausible levels of delay, or any unrealistic re-routeing of traffic.

4.3.14 It should be noted that the increased planning assumptions, RTF 2018 changes and additional infrastructure schemes generated significant convergence issues compared to previous Local Plan scenarios. Every effort was made to optimise signals and reduce delays wherever possible, however this had to be considered alongside creating a stable, reliable forecast model scenario which converged in all time periods.

5. Forecast Trip Matrix Development

5.1 Overview

5.1.1 The forecast trip matrix is an estimation of future trips in COMET based on the available planning data (i.e. for Hertfordshire and selected neighbouring authorities – see Table 1-1) and growth assumptions for the rest of Great Britain (NTEM v7.2).

5.1.2 The COMET Trip End model is used to forecast future trip ends (total productions and attractions for each model zone). These trip ends are used to build a reference matrix for the forecast year (2036). This reference matrix is then adjusted based on the forecast Highway and Public Transport assignments through the Variable Demand Model (VDM), which further adjusts demand to take into account changes in transport infrastructure, travel times and costs. The resulting matrices constitute the forecast trip matrices.

5.2 COMET Trip End Model

5.2.1 A Trip End model has been built specifically for COMET as part of the COMET Base Year (2014) development. The COMET Trip End model is based on version 7.2 of the National Trip-End Model (NTEM) and its associated CTripEnd software. As part of the COMET Trip End development, NTEM has been re-zoned for COMET zones, and demographic data has been uplifted to 2014 based on TEMPRO projections. NTEM v7.2 trip rates remain unchanged. NTEM v7.2 is available at 5 year intervals from 2011 to 2051.

5.2.2 NTEM uses its own zoning system (7,700 zones covering England and Scotland, based on 2011 Census MSOAs) which is inconsistent with the COMET zone system. As a preliminary step, the original NTEM zones are converted to COMET zones using aggregation or disaggregation as appropriate.

5.2.3 The COMET Trip End model takes in estimates of planning data (population, households and employment) for each COMET zone, and produces “trip ends”, that is, estimates of the number of trips produced by and attracted to each zone in an average weekday, by demand segment and by year.

5.2.4 The model has also been streamlined to enable the software to be run from a command prompt without user intervention, and to export results in Emme format for the variable demand model, but its functionality is otherwise unchanged.

5.2.5 There are three key data tables in the Trip End model:

- Car Ownership: population segmented by household types and children. Households are distinguished based on the number of adults and car availability;
- Employment: Total number of jobs and households. Employment is segmented by industry; and
- Population: Population segmented by traveller types. These are defined as a combination of person type (age, gender and employment status) and household type.

5.2.6 Specifically, these tables are segmented in the following categories (See NTEM specification):

- Car Ownership (classification of Households by car ownership):
  - HHT1 persons in 1 adult households with no car;

  - HHT2 persons in 1 adult households with one or more cars;
  - HHT3 persons in 2 adult households with no car;
  - HHT4 persons in 2 adult households with one car;
  - HHT5 persons in 2 adult households with two or more cars;
  - HHT6 persons in 3+ adult households with no car;
  - HHT7 persons in 3+ adult households with one car;
  - HHT8 persons in 3+ adult households with two or more cars;
  - S1 Children (0 to 15), in 1 adult household with no car;
  - S2 Children (0 to 15),in 1 adult household with one or more cars;
  - S3 Children (0 to 15), in 2 adult household with no car;
  - S4 Children (0 to 15), in 2 adult household with one car;
  - S5 Children (0 to 15), in 2 adult household with two or more cars;
  - S6 Children (0 to 15), in 3+ adult household with no car;
  - S7 Children (0 to 15), in 3+ adult household with one car; and
  - S8 Children (0 to 15), in 3+ adult household with two or more cars.
- Employment:
  - E01 All Jobs;
  - E02 Households;
  - E03 Primary & Secondary schools;
  - E04 Higher Education;
  - E05 Adult education;
  - E06 Hotels, camp sites etc;
  - E07 Retail trade;
  - E08 Health / Medical;
  - E09 Services (business, other, postal/courier) & equipment rental;
  - E10 Industry, construction and transport;
  - E11 Restaurants and bars;
  - E12 Recreation and sport;
  - E13 Agriculture and fishing;
  - E14 Business; and
  - E15 Holiday accommodation and second residences.
- Population:
  - PT01 Children (0 to 15);
  - PT02 males in full time employment (16 to 64);
  - PT03 males in part time employment (16 to 64);
  - PT04 male students (16 to 64);
  - PT05 male not employed / students (16 to 64) - Unemployed plus other Inactive;
  - PT06 male 65+;
  - PT07 females in full time employment (16 to 64);
  - PT08 females in part time employment (16 to 64);

- PT09 female students (16 to 64);
- PT10 female not employed / students (16 to 64) - Unemployed plus other Inactive;
- PT11 female 65+;
- HHT1 persons in 1 adult households with no car;
- HHT2 persons in 1 adult households with one or more cars;
- HHT3 persons in 2 adult households with no car;
- HHT4 persons in 2 adult households with one car;
- HHT5 persons in 2 adult households with two or more cars;
- HHT6 persons in 3+ adult households with no car;
- HHT7 persons in 3+ adult households with one car; and
- HHT8 persons in 3+ adult households with two or more cars.

5.2.7 COMET Trip End model outputs trip end estimates for the following demand segments:

- HBW Home-Based Work;
- HBEB Home-Based Employer's Business;
- HBO Home-Based Other;
- NHBEB Non-Home-Based Employer's Business;
- NHBO Non-Home-Based Other;
- LGV Light Goods Vehicles; and
- HGV Heavy Goods Vehicles.

COMET Trip End Model Forecast Update

5.2.8 The COMET Trip End model has been updated to 2036 as part of the COMET LP4 Forecast Year (2036) development.

5.2.9 Detailed planning data (provided from districts via HCC) was provided for all Hertfordshire Districts and in selected adjoining areas (see Table 5-2 for a list of selected districts). NTEM v7.2 growth is used for the rest of the Great Britain. Growth assumptions can be found in Section 5.3.

5.2.10 The COMET Trip End model was updated by refreshing the three following tables (described in further detail above):

- Car Ownership (classification of Households by car ownership)
- Employment
- Population

5.2.11 HCC planning data provides estimates of dwellings and employment for the forecast year. In the absence of available population projections, it is derived by applying a population per dwelling assumption by NTEM zone from NTEM v7.2. These growth projections are split into the segments defined above for each table using NTEM original forecasts for each year.

5.2.12 In those areas outside Hertfordshire where no detailed planning data is available, NTEM v7.2 growth is used. Growth is calculated for each table, segment and zone and between NTEM 2014 (this year has been interpolated using 2011 and 2016 data) and the Forecast Year (2036). Since each segment is considered separately, the process accounts for the ageing population trend in UK demography just as NTEM does.

5.2.13 For “model development zones” (see **Figure 5-6**), population and household segmentation have been applied based on the NTEM zone where it is located geographically. Employment data segmentation is based on the land use provided by HCC for each site.

5.2.14 NTEM v7.2 is based on the 2011 Census, the same as COMET’s Trip End Model. Growth between the forecast year and base year is applied to the Trip End model using the formula below:

$$IXI_{FY} = IXI_{BY} * \frac{IXI\_NTEM_{FY}}{IXI\_NTEM_{2014}}$$

5.2.15 For zones and demand segments with no data for NTEM v7.2 in 2014 (value of zero), absolute growth is used following the formula below:

$$IXI_{FY} = IXI_{BY} + (IXI\_NTEM_{FY} - IXI\_NTEM_{2014})$$

Where:

- IXIFY refers to each of the Car Ownership / Employment / Population tables mentioned above for the Forecast Year (2036) in the COMET Forecast Year Trip End model
- IXIBY refers to each of the Car Ownership / Employment / Population tables mentioned above for the Base Year (2014) in the COMET Base Year Trip End model
- IXI_NTEMFY refers to each of the Car Ownership / Employment / Population tables mentioned above for the Forecast Year (2036) in the original NTEM v7.2
- IXI_NTEMBY refers to each of the Car Ownership / Employment / Population tables mentioned above for the interpolated Year (2014) from the original NTEM v7.2

NTEM Interpolated 2014 Year

5.2.16 NTEM v7.2 does not explicitly include 2014, however, this year is needed for the calculations described above. The Car Ownership / Employment / Population tables mentioned above have been estimated for 2014 by interpolating the same tables from NTEM between 2011 and 2016 years.

Additional Note on Conversions and Demolitions

5.2.17 The employment projections received from HCC contain a number of planned conversions to residential or other uses/demolitions, which involve the change or loss of certain types of employment land in some zones.

5.2.18 In most zones, the conversions/demolitions are directly accounted for in their COMET zone. For some zones, however, deducting the number of units to be demolished leads to negative values. This is due to discrepancies between the planning data and NTEM v7.2 employment allocations. To address this, where reduction of employment exceeds existing employment in a zone, the remaining reduction of employment has been subtracted from neighbouring zones proportionally to reconcile the data. This addresses planning data and NTEM v7.2 employment allocation discrepancies, respecting the total reduction in employment forecast for each area.

5.3 Forecast Planning Data

5.3.1 The forecast planning data for the following areas was collated and provided by HCC in terms of employment and dwelling growth by COMET zone. It is based on Local Plan information from autumn 2018.

- All 10 Hertfordshire districts;
- Luton;
- Buckinghamshire;
- Adjoining districts in Essex (Epping Forest, Harlow, and Uttlesford);
- Adjoining districts in Cambridgeshire (South Cambs and Cambridge); and
- Central Bedfordshire.

5.3.2 Within these areas, all sites (employment and dwellings) are incorporated into the forecast scenario regardless of certainty level. This includes growth categorised according to WebTAG definitions as “near certain”, “more than likely”, “reasonably foreseeable”, and “hypothetical”.

5.3.3 Planning data included for some of the south western Hertfordshire authorities includes some proposed potential sites that are less certain and not part of current local plan allocations.

5.3.4 Outside of Hertfordshire and the selected neighbouring authorities, growth assumptions are based on NTEM v7.2 projections.

5.3.5 Where planning data did not forecast to 2036, NTEM growth between the end point of the planning data and 2036 was applied as detailed in **Table 5-1**. The growth was added in the same way as windfall growth.

Table 5-1: NTEM Tempro uplifts applied in LP4 to create the 2036 LP4 scenario

District/Area	End point of Plan	Tempro uplift	Zones to be applied to
Broxbourne	2031	2031-2036	Unknown so add proportionately
Dacorum	2036	n/a	Unknown so add proportionately
East Herts	2033	2033 – 2036	Gilston (2066), NE Ware (2065)
Hertsmere	2036	n/a	Unknown so add proportionately
North Herts	2031	2031-2036	Unknown so add proportionately
St Albans	2036	n/a	Unknown so add proportionately
Stevenage	2031	2031-2036	Unknown so add proportionately
Three Rivers	2031	2031-2036	Unknown so add proportionately
Watford	2031	2031-2036	Unknown so add proportionately
Welwyn Hatfield	2032	2032-2036	Unknown so add proportionately
Buckinghamshire	2031	2031-2036	Unknown so add proportionately
South Cambridgeshire	2031	2031-2036	Unknown so add proportionately
Essex	2033	2033-36	Unknown so add proportionately
Luton	2030 (32 for housing)	2030(32)-36	Unknown so add proportionately
Central Bedfordshire	2035	2035-2036	Unknown so add proportionately

.

Dwelling Data within Hertfordshire and Selected Neighbouring Districts

5.3.6 Dwelling data provided by HCC is presented in Table 5-2, and is accompanied by a comparison with NTEM v7.2 projections. The data is provided spatially by model zone in Figure 5-1 (bespoke planning data area) and Figure 5-2 (Hertfordshire). The comparison with NTEM is provided for information only and does not inform the development assumptions within Hertfordshire and the selected neighbouring districts used in this forecast.

5.3.7 Dwelling growth includes completions since 2014, those currently in the planning system, plus an allowance for windfall sites, as well as Local Plan Allocations.

5.3.8 In some instances, sites have not been allocated by HCC to a specific COMET zone (e.g. where assumptions are made for windfall development). In addition some of the SW Herts authorities have included some development sites which are more uncertain and don't yet have a certainty status allocated within their Local Plans. In these cases, the dwellings have been split proportionately throughout the district according to the HCC dwelling growth assumptions in other zones in the district up to 2036. This applies to a relatively small number of dwellings.

5.3.9 Overall, there is assumed to be a net increase of approximately 151,000 dwellings between 2014 and 2036 in Hertfordshire. This total is significantly higher (~87,000 dwellings) than the NTEM projection, and is likely to be as such because all developments in the HCC data have been included (regardless of certainty), and because Local Planning Authorities own projections of housing need have increased in recent years.

Table 5-2: Dwelling Growth Assumptions in Hertfordshire and selected neighbouring districts (2014-2036)[5]

District	2036 HCC Dwellings	2036 NTEM v7.2 Dwellings	2036 Difference
Broxbourne	10,686	6,311	4,375
Dacorum	19,859	10,719	9,140
East Hertfordshire	21,083	13,854	7,229
Hertsmere	16,785	5,487	11,298
North Hertfordshire	19,637	17,716	1,921
St Albans	17,749	5,075	12,674
Stevenage	12,252	10,674	1,578
Three Rivers	4,069	3,618	451
Watford	10,313	5,393	4,920
Welwyn Hatfield	18,660	9,848	8,812
Essex (Epping Forest, Harlow & Uttlesford)	32,307	19,858	12,449
Luton	8,842	5,827	3,015
Buckinghamshire	77,574	53,074	24,500
Cambridgeshire (South Cambs and Cambridge)	62,465	42,271	20,194
Central Bedfordshire	26,040	33,398	-7,358
Total	**358,321**	**243,123**	**115,198**

[5] Dacorum, Hertsmere and Welwyn Hatfield include some development sites with less certainty.

Figure 5-1: Change in numbers of dwellings 2014-2036 by COMET model zone (wider zoom)

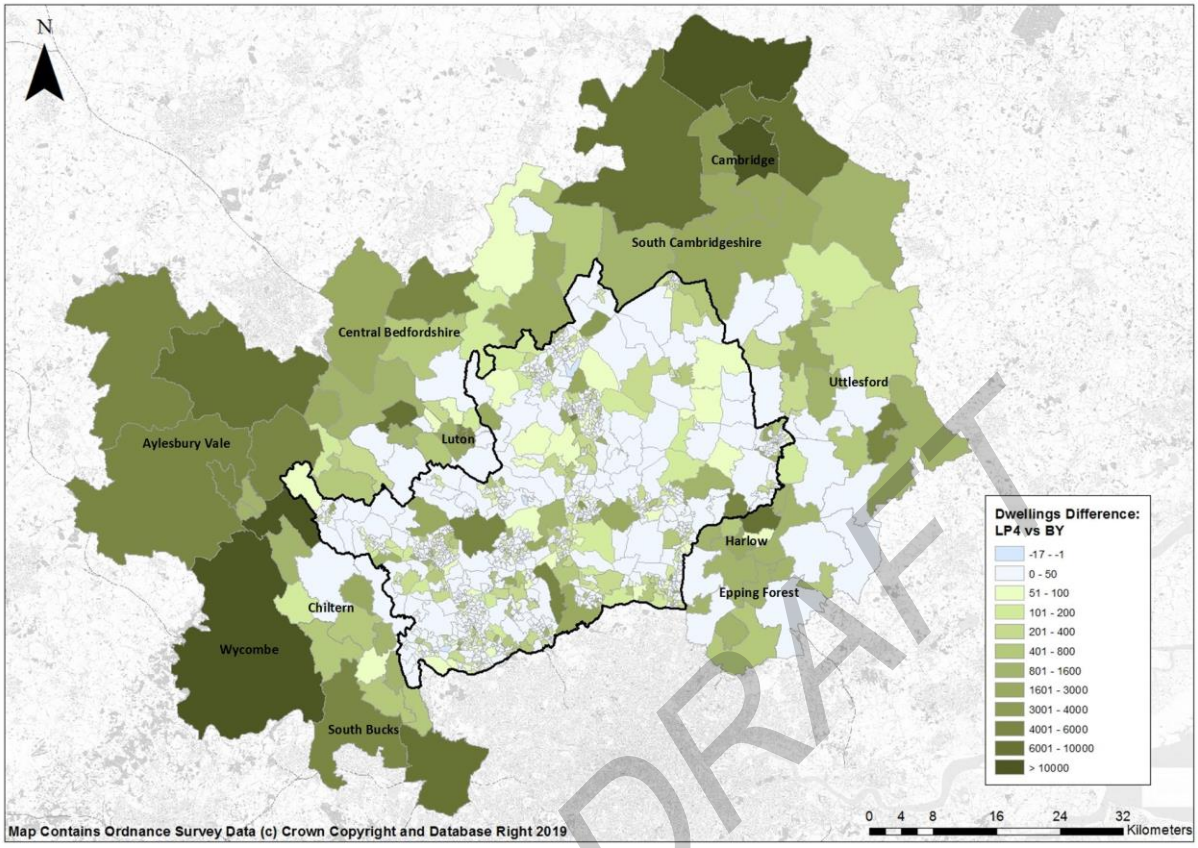
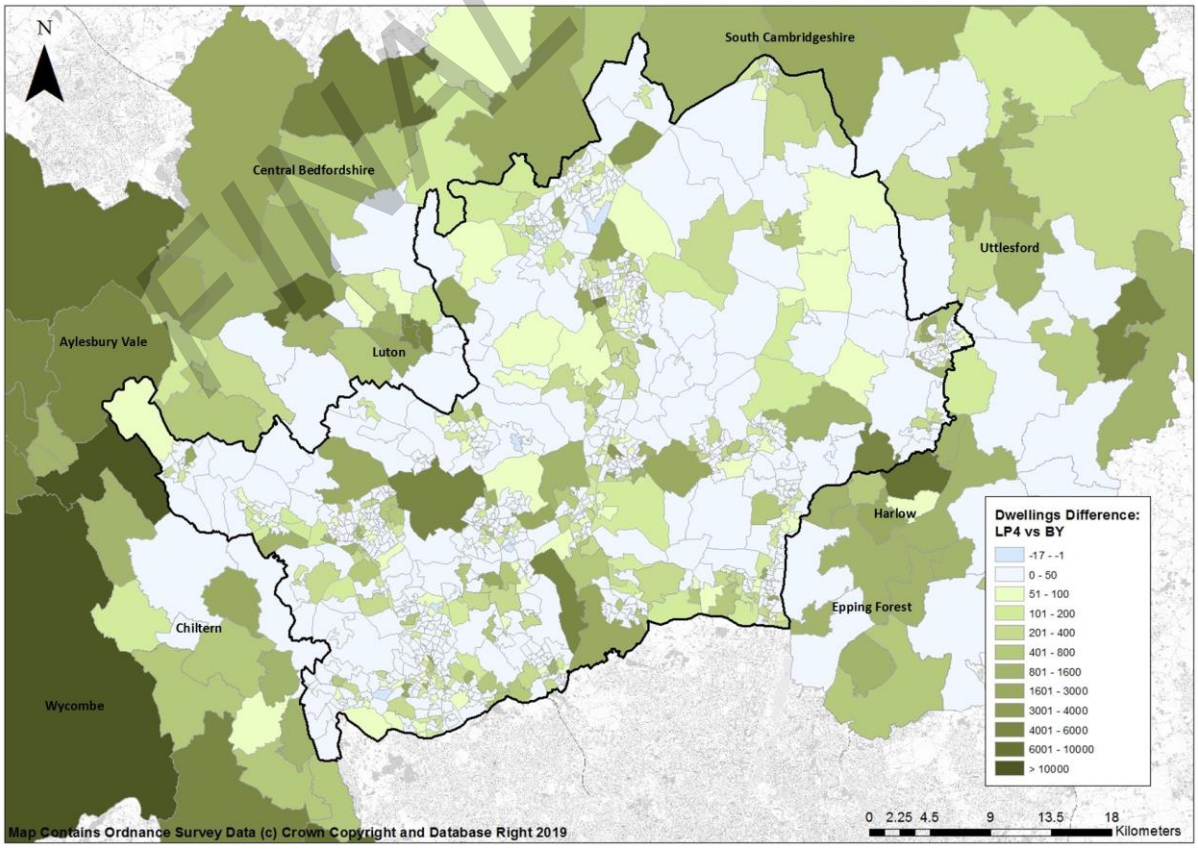


Figure 5-2: Change in numbers of dwellings 2014-2036 by COMET model zone (HCC zoom)



Employment Data within Hertfordshire and Selected Neighbouring Districts

5.3.10 Employment data provided by HCC is presented in Table 5-3, and is accompanied by a comparison with NTEM v7.2 projections. The data is provided spatially by model zone in Figure 5-3 and Figure 5-4. As with the dwelling data, the comparison with NTEM is provided for information only and does not inform the development assumptions within Hertfordshire used in this forecast.

5.3.11 The data also includes permissions for conversion of employment space into residential use, the incidence of which is significant in some areas and shows up as an overall loss in job numbers.

5.3.12 Local planning authorities have less control over employment growth and therefore less information on likely growth by location. Much of the employment data provided for the Hertfordshire districts was in terms of employment floor space rather than jobs, and has therefore been converted to an estimated number of jobs by AECOM.

5.3.13 This conversion process is based on employment densities as defined in the Employment Densities Guide (November 2015 – Homes and Communities Agency). The employment densities used to calculate jobs are listed in section 10.1. For land use types not included in this guide, site data from TRICS has been used to generate an employment density value. Whilst the employment data used represents the most complete available projection of job growth in Hertfordshire, efforts should be made by HCC and the Local Planning Authorities in the future to minimise the need for the assumptions defined above.

5.3.14 Projected conversions/demolitions which involve the change or loss of a certain land use type have been taken into consideration during the employment data collation process. This reduces the risk of double counting job sites.

5.3.15 Overall, there is assumed to be a net increase of approximately 67,600 jobs between 2014 and 2036 in Hertfordshire. This total is significantly higher (~57,000 jobs) than the NTEM projection. As applies to the dwelling data, the reason for this difference is at least partly due to the inclusion of all employment sites in the HCC data regardless of certainty.

Table 5-3: Employment Growth Assumptions in Hertfordshire and Neighbouring Districts (2014-2036)

District	2036 HCC Jobs	2036 NTEM v7.2 Jobs	2036 Difference
Broxbourne	7,090	4,187	2,903
Dacorum	1,494	6,994	-5,500
East Hertfordshire	3,310	6,258	-2,948
Hertsmere	6,314	4,833	1,481
North Hertfordshire	7,632	6,117	1,515
St Albans[6]	6,213	6,806	-593
Stevenage	3,499	5,005	-1,506
Three Rivers	8,275	3,685	4,590
Watford	11,193	6,254	4,939
Welwyn Hatfield	12,602	7,206	5,396
Essex (Epping Forest, Harlow & Uttlesford)	23,018	13,874	9,144
Luton	5,358	10,410	-5,052
Buckinghamshire	70,192	26,628	43,564
Cambridgeshire (South Cambs and Cambridge)	22,981	18,507	4,474
Central Bedfordshire	52,234	11,670	40,564
Total	**241,405**	**138,434**	**102,971**

[6] St Albans District includes Maylands LEZ job growth of over 9,000 jobs but is counterbalanced by losses in other areas.

Figure 5-3: Change in numbers of jobs 2014-2036 by COMET model zone (wider zoom)

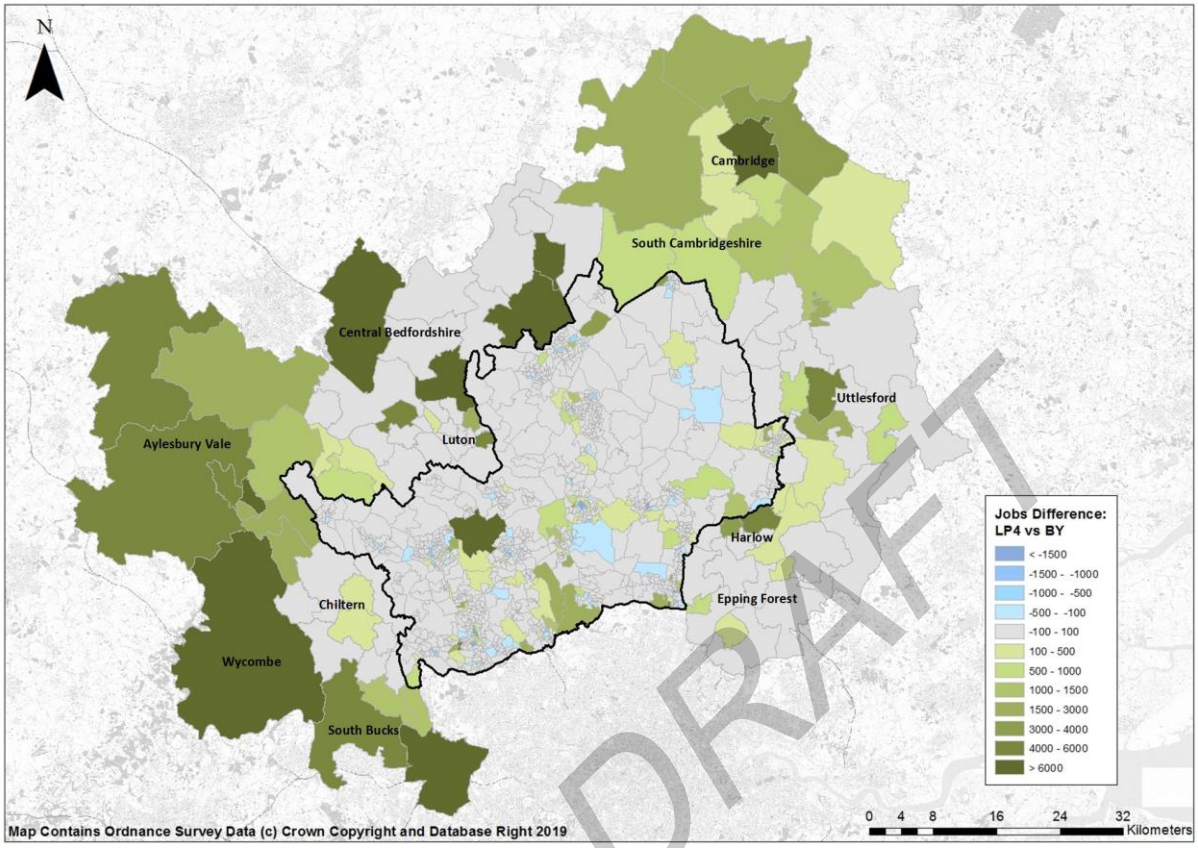
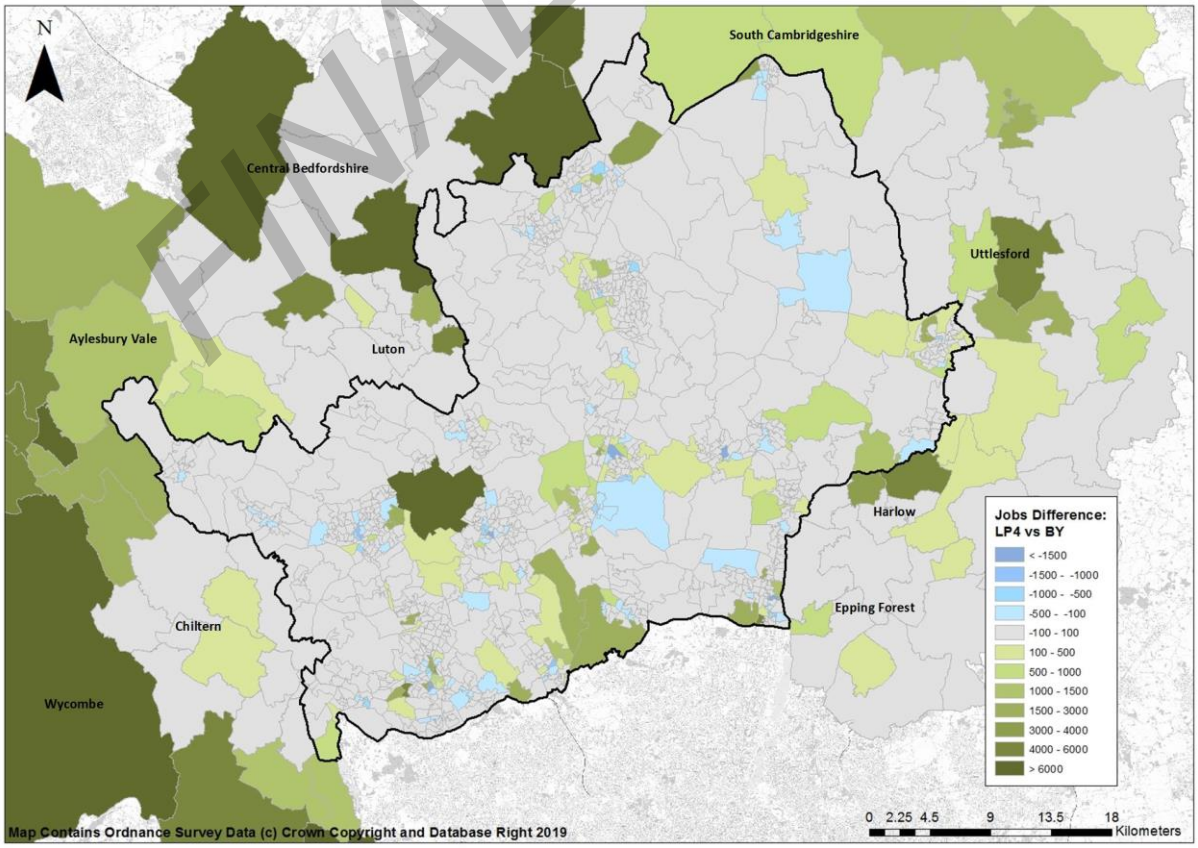


Figure 5-4: Change in numbers of jobs 2014-2036 by COMET model zone (HCC zoom)



Employment Data in Neighbouring Districts

5.3.16 The same assumptions and caveats explained for planning data within Hertfordshire also apply to the additional planning data provided for the 9 districts outside Hertfordshire.

5.3.17 HCC were unable to provide employment data at a zone level for Buckinghamshire and Cambridgeshire. The following assumptions were made in order to prepare zone level growth assumptions for these two counties:

- For Buckinghamshire, HCC provided a value for total jobs in 2031. NTEM was added between 2031 – 2036. These values were then distributed between COMET zones according to NTEM v7.2 proportions.
- For Cambridgeshire (South Cambs and Cambridge), HCC requested that the NTEM v7.2 projections were used as totals and to inform the distribution of job growth.

Planning Data outside Hertfordshire and Selected Neighbouring Districts

5.3.18 The availability of planning data outside Hertfordshire beyond the neighbouring districts is limited. Consequently, growth in terms of housing, employment and population in the rest of Great Britain is derived directly from NTEM v7.2.The 2014-2036 growth rates are in Table 5-4. It is worth noting that these growth figures are likely to be lower than growth being proposed through the Local Plan processes in these areas.

Table 5-4: NTEM 7.2 Growth Rates (for areas without bespoke planning data)

	2014-2036
Dwellings	18.51%
Employment	9.25%
Population	12.71%

5.4 Model Development Zones

Background

5.4.1 There are a number of locations in Hertfordshire where significant levels of growth (in terms of housing and/or employment) are anticipated in previously undeveloped areas. The trip patterns of these developments are likely to be materially different to those of the existing land use, and as such require special consideration in terms of forecast demand estimation and loading point(s) onto the network.

5.4.2 Given the Base Year model was set up with a limited number of development zones available in the model (50), care has been taken to minimise the number used at this stage (thereby leaving more available for later applications). To this end, developments are allocated to model development zones according to the selection process in Figure 5-5. The developments that meet the requirements are set out in Figure 5-6 with a corresponding table of development zones in Table 5-5. It should be noted HCC also requested some developments which didn't fully satisfy the criteria in Figure 5-5 be included as development zones. This is to future proof the model as it is anticipated that forecasting work may look to assess the impacts of these developments in isolation.

Figure 5-5: Model Development Zone Selection Process

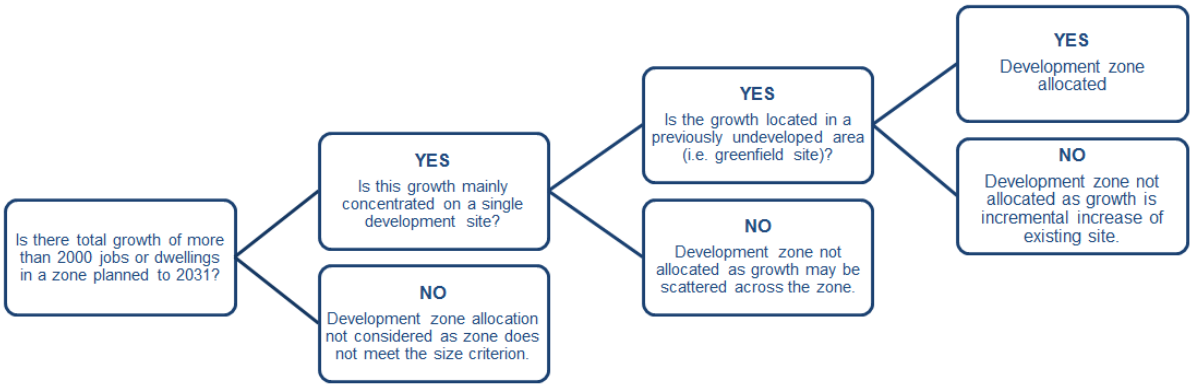


Figure 5-6: Model Development Zones (only shows sites that have a location allocated)

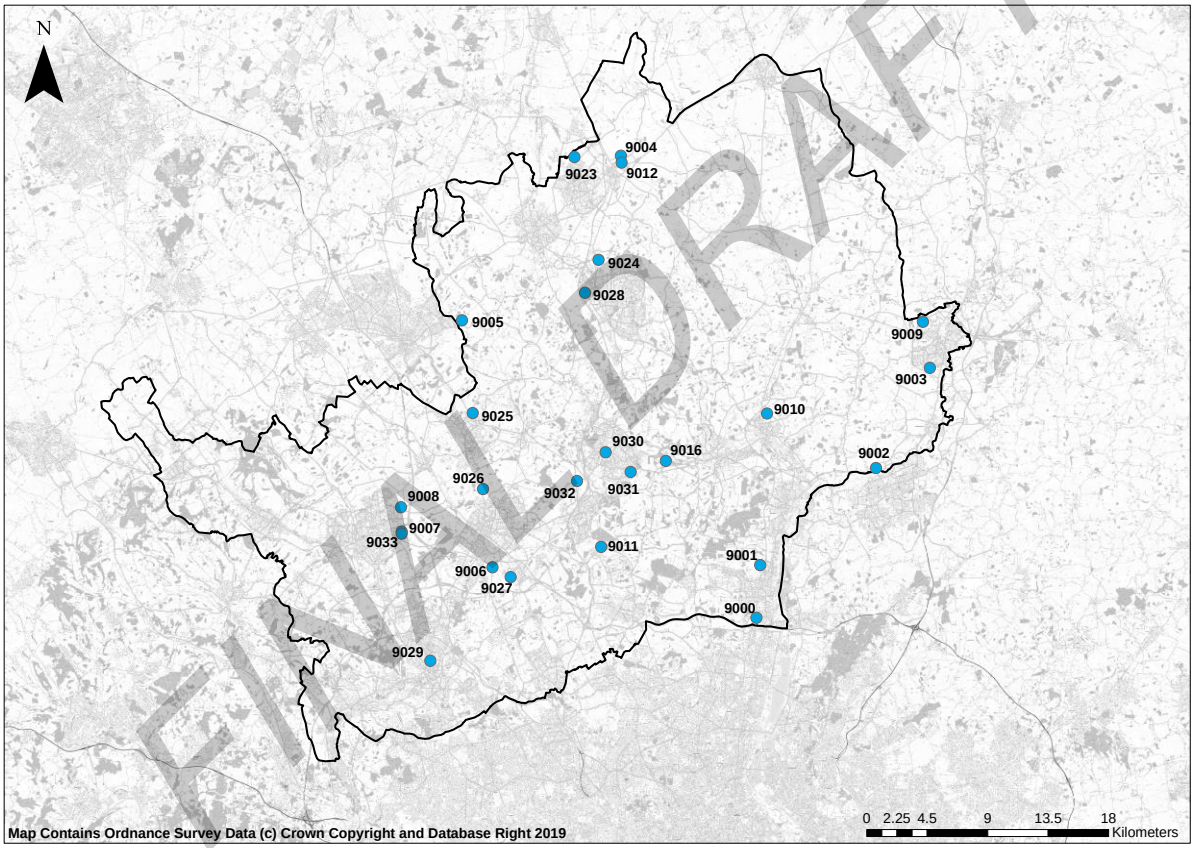


Table 5-5: List of all Development Zones shown in Figure 5-6 (excludes those were locations are not determined yet)

Zone Number	Description
9000	Park Plaza West
9001	Greater Brookfield Riverside Retail and Leisure Development
9002	The Gilston Area, north of A414
9003	Land South of Bishop's Stortford (Policy BIS7)
9004	Land north of Baldock
9005	Land west of Cockernhoe
9006	Park Street Garden Village
9007	East Hemel Hempstead South (Housing)
9008	East Hemel Hempstead North
9009	Bishop Stortford North
9010	Land North and East of Ware
9011	Marshmoor, part of mixed scheme
9012	Baldock South
9013 - 9015	Potential development sites in Dacorum
9016	Land adjoining Birchall Lane (EHDC site)
9017 - 9022	Potential Development sites in Hertsmere
9023	Letchworth North
9024	Land North of Stevenage (NHDC and SBC sites)
9025	North East Harpenden
9026	North St Albans
9027	West of London Colney
9028	Land West of Stevenage
9029	Watford Junction
9030	Broadwater Rd West
9031	South of Welwyn Garden City (Birchall W) (WHBC Site)
9032	Stanboroughbury
9033	East Hemel South (Employment)

Derivation of Development Zone Demand

5.4.3 Zones which are empty in the Base Model require special consideration in the demand model. The trip-end model generates estimates of trips from them as described in the section entitled COMET Trip End Model Forecast Update. However, it is not possible to apply proportional growth to the base matrix for these zones as the Base matrix has no associated demand.

5.4.4 A set of gravity models, calibrated by mode and purpose based on the distribution of the base matrices, have been created for the purpose of estimating distribution to and from development zones. The gravity model is often the preferred approach for solving the trip distribution problem in transport planning. It assumes that the interaction between two zones is inversely proportional to the distance between them, inversely proportional to the cost and/or time of travel between them, but is proportional to the amount of activity at each zone.

5.4.5 Because the incremental variable demand model will be applied to these zones as well as all others, the gravity models are based on base year generalised cost of travel, along with the trip-ends for the forecast year.

5.4.6 Having estimated the distribution of travel using a gravity model, the total level of trip-making for the development zones is then set to the trip ends from the trip-end model.

5.5 Variable Demand Modelling

Process

5.5.1 As a result of the updates described above, the COMET Trip End model for the Forecast Year outputs estimates of trip end growth between the Base Year (2014) and the Forecast Year (2036). The proportional growth implied by the trip-end model from Base Year 2014 to the forecast year is applied to the Base Year matrix to create an estimate of forecast demand, a "reference" forecast matrix (see WebTAG Unit M2 Variable Demand Modelling – section 2.5.5). For example, if the trip-end model has 100 trips for a zone in the base year, and 130 in 2036, and the base matrix has 60 trips, the forecast matrix will have 60*130/100=78 trips. A "matrix balancing" approach is used, where the reference matrices are controlled first to matrix rows (productions), and then to the matrix columns (attractions). This approach is repeated iteratively until the matrix "balances" both productions and attractions.

5.5.2 These are not the final forecast matrices. Final forecast matrices are developed from reference matrices by application of the variable demand model to take account of the effect of changes in transport cost over time on traveller behaviour.

5.5.3 The forecasted matrices are then adjusted iteratively by the VDM taking into account the forecast changes in generalised cost based on the Highway model and Public Transport model assignments. In effect, trips will be decreased between areas with increases in generalised cost (e.g. increase in congestion), and vice versa. The VDM includes components that adjust mode shares based on relative changes in cost between modes, adjust time period splits based on relative changes in cost between periods, and adjust attraction sites based on relative change in cost for travel to various attractions.

5.5.4 A bespoke add-on to the VDM has been created for the purpose of this forecast in order to simulate modal shift from highway to PT/sustainable modes. This add-on is described in more detail in paragraph 4.3.6.

Convergence

5.5.5 The convergence of the variable demand model is measured through %GAP[7] between iterations set out in Figure 3-1. The convergence of a variable demand model is closely linked to the convergence of the assignment models, however, in the case of the COMET, the lack of modelled congestion in the public transport model means there is no convergence to measure. Therefore, the convergence of the COMET variable demand model is strongly related to that of the highway assignment model, discussed further in Chapter 6.

[7] %GAP is the difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs. %GAP provides a measure of the proximity to equilibrium of the assignment.

5.5.6 The 2036 forecast is currently capped to 14 variable demand model iterations, and reaches an aggregate %GAP convergence of 0.13% (Hertfordshire productions). According to WebTAG M2 section 6.3.8: “Tests indicate that gap values of less than 0.1% can be achieved in many cases, although in more problematic systems this may be nearer to 0.2%”. The value achieved for COMET therefore within the upper limit indicated by WebTAG and may be improved as COMET is enhanced in future work.

5.6 Economic Parameters

5.6.1 The variable demand model uses economic parameters including values of time, fuel prices, etc. to calculate the generalised costs of travel. These vary over time, and forecast projections for the majority of these parameters are provided in WebTAG. The forecast values for these parameters are summarised in Table 5-6 alongside the base values and growth factors. Bus and rail fare change assumptions are not provided in WebTAG but are assumed to be a 1% year growth above inflation, based on recent trends.

Table 5-6: Economic Parameter Changes over Time, Fixed 2010 Prices[8]

Values	2014	2036	Change
Value of Time, Commuting (p/min)	17.41	25.809	48.2%
Value of Time, Business (p/min)	26.001	38.544	48.2%
Value of Time, Other (p/min)	7.946	11.78	48.3%
Value of Time, LGV (p/min)	16.877	25.018	48.2%
Value of Time, HGV (p/min)	42.19	62.543	48.2%
Petrol Price – Non work (p/litre)	120.0726	135.5867	12.9%
Diesel Price – Non work (p/litre)	125.3414	142.6365	13.8%
Petrol Car Fuel Consumption Factor	0.92947	0.58957	-36.6%
Diesel Car Fuel Consumption Factor	0.91382	0.6615	-27.6%
Car Fleet Proportion, Diesel	0.49642	0.50234	1.2%
Car Fleet Proportion, Electric	0.00131	0.05309	3952.7%
Rail Fares	Varied	Varied	24.5%
Bus Fares	Varied	Varied	24.5%
Car Passenger Occupancy	Varied	Varied	None

[8] Source: WebTAG Databook March 2017 v1.7 (except Rail Fares and Bus Fares which both rise at 1% per annum above inflation – this is in line with government policy for rail, and in line with recent historical trends for bus).

5.7 Forecast Growth Rates

5.7.1 The overall growth in highway trips from the demand model is summarised in Table 5-7.

5.7.2 "2014 Base" below refers to COMET Base Year. "2036 Local Plan" refers to COMET LP4 Forecast Year being reported in this document. "2036 Reference" is the demand as produced from the trip-end model before the variable demand model adjusts the matrices to take account of generalised cost changes.

5.7.3 The "2036 Reference" totals are thus based on the output of the trip-end model applied to the Base Year matrix before the variable demand model is run. It can be seen that the effect of the variable demand model on highway trips is quite small; almost all of trip growth results from increases in population and employment, not changes to transport infrastructure.

5.7.4 For commuting trips (most of which occur in the peak hours with more highway congestion), the reduction between "2036 Reference" and "2036 Local Plan" can be attributed to congestion and consequent modal shift.

5.7.5 The relatively high growth in Light Goods Vehicle trips (vans) relative to Heavy Goods Vehicle trips is consistent with current trends. Even though there is a small reduction in HGV trip numbers, the distance over which they travel is considerably longer in 2036. This was sense checked against the revised RTF 2018 assumptions.

5.7.6 There is no change in the number of freight trips (LGV and HGV) between the 2036 Reference forecast and the 2036 Local Plan forecast (i.e. the variable demand model process does not have any impact). This is due to the way in which COMET has been set up, and is in line with standard practice for freight forecasting.

Table 5-7: Highway Trip Growth over Time, 24 Hour Person Trips, Hertfordshire Productions Only

User Class	2014 Base	2036 Reference	2036 Local Plan	Change (2014 Base to 2036 Local Plan)
Commuting	436,391	495,865	485,690	11%
Business	130,504	153,810	153,813	18%
Other	2,069,063	2,634,091	2,658,790	29%
LGV	266,683	349,371	349,371	31%
HGV	66,272	63,395	63,395	-4%
All	**2,968,913**	**3,696,531**	**3,711,059**	**25%**

5.7.7 A directly comparable table for public transport results is shown in Table 5-8. Although population and employment changes still have a significant effect, here the impact of the demand model is proportionally much larger. The demand model increases travel, largely because while fares are modelled as increasing, income levels (values of time) are modelled as increasing more, so perception of fare falls.

5.7.8 It is also highlighted that there is no modelling of crowding within the public transport model (the increase in public transport trips is therefore unconstrained by congestion). Consequently, while the highway assignment model experiences increased congestion and thus an increase in generalised cost for car travel, this increase is not reflected in public transport, resulting in a mode shift.

Table 5-8: Public Transport Trip Growth over Time, 24 Hour Person Trips, Hertfordshire Productions Only

User Class	2014 Base	2036 Reference	2036 Local Plan	Change (2014 Base to 2036 Local Plan)
Commuting	111,505	116,739	129,903	17%
Business	9,710	11,203	12,198	26%
Other	138,192	164,169	190,164	38%
All	**259,407**	**292,110**	**332,266**	**28%**

5.7.9 For both modes (public transport and highway), “other” trips rise significantly, while commuting trips rise much less. This is due primarily to an ageing population, with a smaller proportion of people in employment. Forecast assumptions relating to the ageing profile of the population are derived from the National Trip-End Model (NTEM), version 7.2.

6. Forecast Assignments

6.1 Highway Assignment

Assignment Parameters

6.1.1 No changes have been made in terms of SATURN assignment options or parameters relative to the base year. For reference, a full list is provided in *Appendix II: SATURN Highway Assignment Parameters.*

Assignment Convergence

6.1.2 The convergence of the highway assignment has been measured according to standards set out in Table 6-1 (as stated in WebTAG M3.1 section 3.3.5). When a model does not achieve convergence criteria, it may produce large variations between iterations, "noise", leading to unreliable results.

6.1.3 It should be noted that the increased planning assumptions, RTF 2018 changes and additional infrastructure schemes generated significant convergence issues compared to previous Local Plan scenarios. Every effort was made to optimise signals and reduce delays wherever possible, however this had to be considered alongside creating a stable, reliable forecast model scenario which converged in all time periods

6.1.4 In SATURN terms, "percentage of links with flow change (P) <1%" is referred to as %FLOWS.

Table 6-1: Convergence Measures and Base Model Acceptable Values

Measure of Convergence	Base Model Acceptable Values
Delta and %GAP[9]	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) <1%[10] (%FLOWS)	Four consecutive iterations greater than 98% (measured as 97.5% plus in SATURN)

6.1.5 For reference, the 2014 base year highway assignment convergence values are given in Table 6-2. Previous experience suggests that a base year model should converge in approximately 30 iterations or fewer; however, the AM peak required more iterations to converge.

[9] %GAP is the difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs. %GAP provides a measure of the proximity to equilibrium of the assignment.
[10] The percentage of links on which flows change by less than 1% between iterations.

Table 6-2: Base Year Convergence Values

Time Period	Iterations	%FLOWS	%GAP
AM	44	98.1	0.010
IP	25	98.1	0.008
PM	30	98.7	0.022

6.1.6 The 2036 convergence values in terms of %FLOWS and %GAP are presented in Table 6-3, and show that both indicators meet WebTAG criteria in all time periods.

Table 6-3: 2036 Convergence Values

Time Period	Iterations	%FLOWS	%GAP
AM	55	98.8	0.043
IP	36	98.0	0.011
PM	30	97.7	0.022

6.2 Public Transport Assignment

Assignment Parameters

6.2.1 Other than the modelled schemes, the forecast 2036 public transport assignment is identical to the Base Year, except for the previously noted 1% increase per year in public transport fare and an increase in the passenger value of time in line with the demand model. The increases in fare and values of time above inflation are applied for both bus and rail travel.

Assignment Convergence

6.2.2 The public transport model does not model congestion, and as such there is no convergence to measure.

7. Highway Forecast Results

7.1 Simulation Area Statistics

7.1.1 This section provides a summary of simulation area statistics concerning the highway assignment. For reference, the 2014 Base Year model values are also given. All values only include travel within the time period simulated, and do not consider extra time and distance in later periods due to vehicles queued at over-capacity junctions.

7.1.2 Table 7-1 and the following figures show assignment statistics for all user classes combined. Other than *Total Trips Loaded,* all statistics refer to the simulation area only. For the equivalent assignment statistics by user class, see *Appendix IV: Highway Simulation Area Statistics by User Class.* Comparisons to LP3 results are also made.

7.1.3 In terms of Total Trips Loaded, the increase between the 2014 Base Year and 2036 Forecast Year is 21% in the AM Peak, 18% in the PM Peak, and 27% in the Inter-peak (reflecting the relatively uncongested network in the Inter-peak). The increase in travel distance is higher than or equal to the increase in trips, suggesting that highway trips are longer in the forecast relative to the Base Year. The total travel time increases at a faster rate than the total trips loaded and travel distance, suggesting the forecast network has higher levels of delay and congestion.

7.1.4 Over-capacity queueing[12] increases most significantly in absolute terms in the AM peak and Inter peak, however, a smaller percentage increase also occurs in the PM Peak. The smaller increase in over-capacity queueing in the PM Peak is likely to be a result of the already more congested Base Year starting point from which the forecast pivots. It is likely that the level of over-capacity queueing reaches a “ceiling” beyond which people choose to take alternative routes/modes to reach their destination. Transient queues[12] increase more evenly across the different time periods.

Table 7-1: Simulation Area Assignment Statistics – All User Classes including fixed flows

	AM Peak			Inter-peak			PM Peak		
	2014	**2036**	**Δ**	**2014**	**2036**	**Δ**	**2014**	**2036**	**Δ**
Total Trips Loaded	809,707	977,582	167,875 (21%)	590,845	752,334	161,489 (27%)	837,645	987,717	150,072 (18%)
Travel Distance (PCU km)[11]	4,631,257	5,668,237	1,036,980 (22%)	3,689,202	4,787,314	1,098,112 (30%)	4,743,326	5,647,574	904,248 (19%)
Total Travel Time (PCU hours)	91,858	131,066	39,208 (43%)	63,325	89,983	26,658 (42%)	106,499	135,052	28,553 (27%)
Average Speed (Kph)	50	43	-7 (-14%)	58	53	-5 (-9%)	45	42	-3 (-7%)
Over-Capacity Queues (PCU hours)[12]	10,362	24,358	13,996 (135%)	2,630	6,689	4,059 (154%)	22,354	29,977	7,623 (34%)
Transient Queues (PCU hours)[12]	13,954	21,032	7,078 (51%)	9,234	14,506	5,272 (57%)	14,452	20,224	5,772 (40%)

[11] PCU = Passenger Car Unit

[12] From SATURN manual section 8.4.1: "Delays (and queues) may be subdivided into two main components:

- "transient" or "under capacity" delays and
- "queuing" or "over capacity" delays

where, for example at traffic signals, the transient delays correspond to the time spent queuing during the red phase by vehicles which then depart during the green phase, whereas the queuing delays only occur for turning movements in excess of capacity where a permanent queue builds up which is unable to clear in a single cycle."

Figure 7-1: Travel Distance (Simulation Area only)

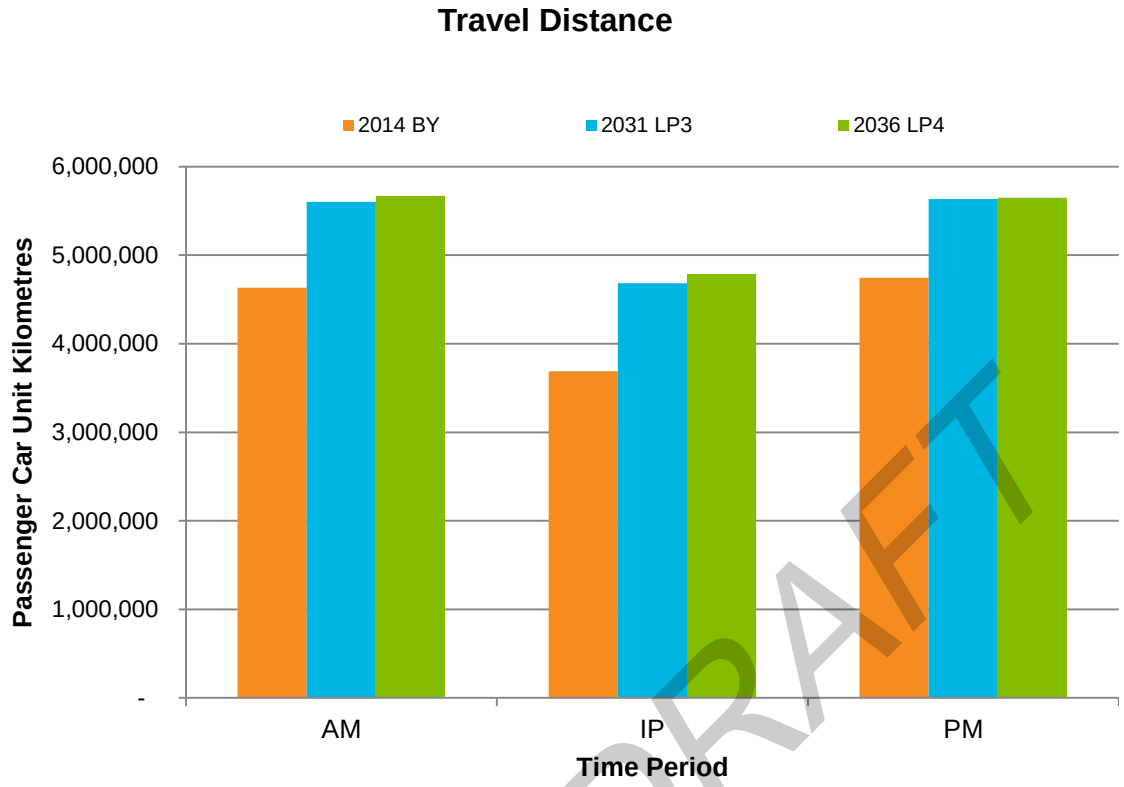


Figure 7-2: Total Travel Time (Simulation Area only)

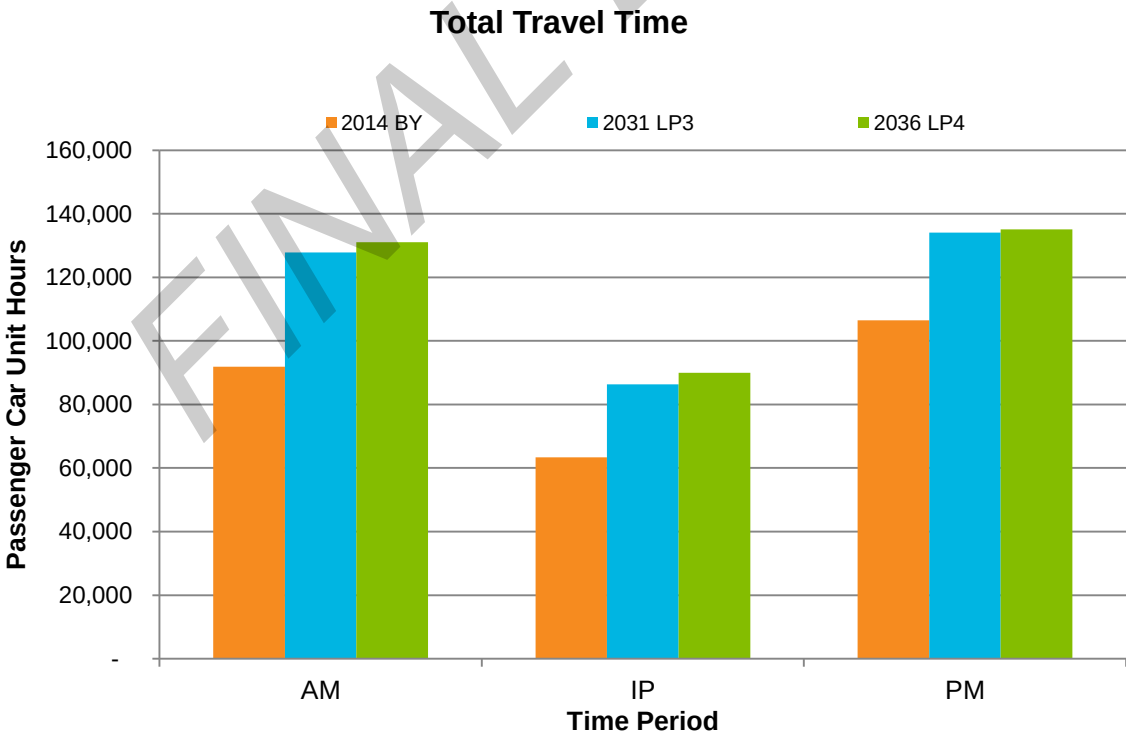


Figure 7-3: Average Speed (Simulation Area only)

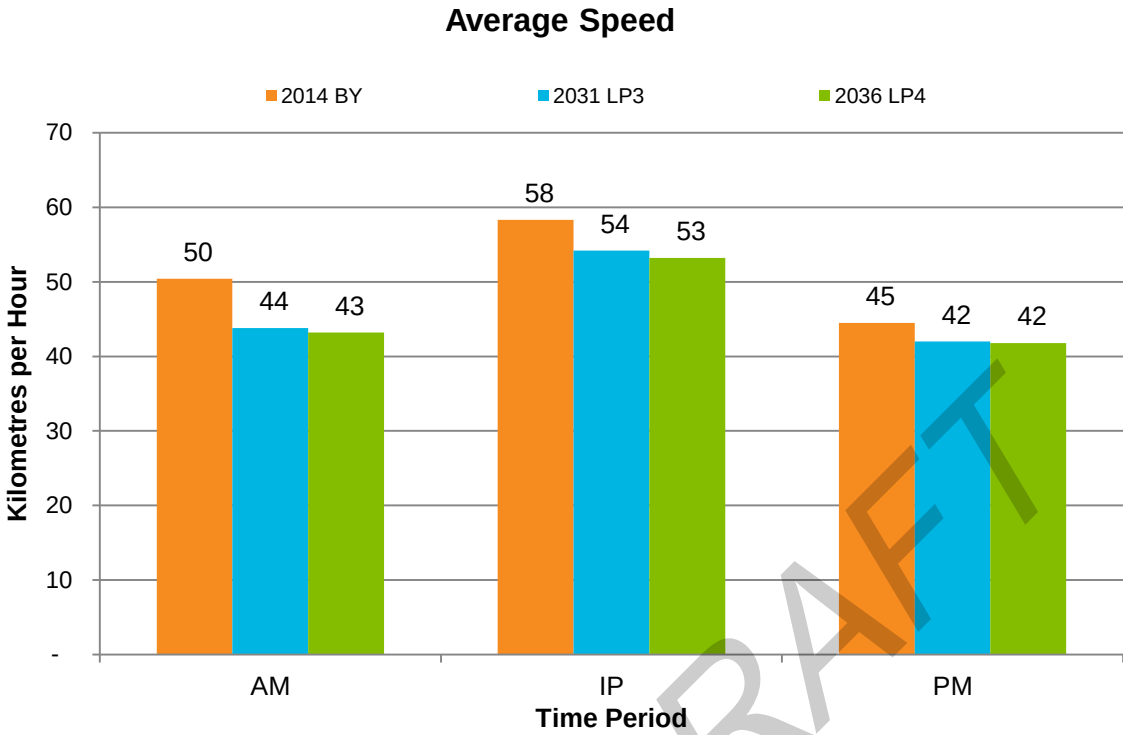
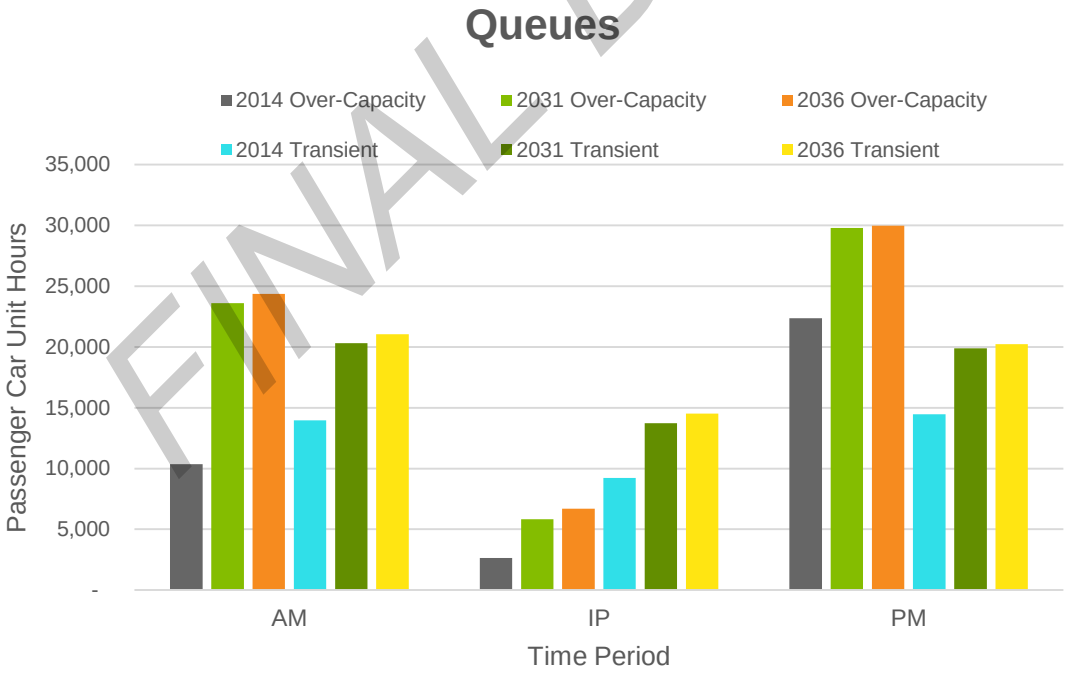


Figure 7-4: Queues (Simulation Area only)



7.2 Traffic Flows

7.2.1 The flow difference plots presented below display the change (in passenger car units) between the base year and forecast year in Hertfordshire.

7.2.2 Green bands indicate flow increase in the forecast, whilst blue indicates flow decrease. The thickness of the lines represents the volume of traffic. As expected, the greatest increases in absolute terms in vehicle flow occur on the strategic road network, however, most of the more minor links also experience traffic growth.

7.2.3 Notwithstanding some local re-routeing in town centres leading to flow reductions on some links, there are a number of notable impacts on strategic routes which are:

- The M40 is more popular for strategic north-south movements than the M1, partly due to delays around junctions 10 and 11 on the M1. The M1 is congested southbound in the AM peak and northbound in the PM peak.
- The A5 – M1 link added, this reduces traffic flows through Houghton Regis as flows re-route to use the link;
- The M1 carries more traffic between North London and the M25 compared to the Base Year;
- Marginal flow differences on the A414 corridor west of the A10, the reduction of delays at the A414/Fifth Avenue junction in Harlow encourages traffic back onto the A414 east of the A10. This may affect the parallel A120 corridor further north. Reduced flows through Hertford on the A414 due to the Hertford Bypass;
- Reduced flows through central Hemel Hempstead due to downgraded A414 in LP4;
- A1(M) experiences greatest increase in flows north of Hatfield compared to LP3. It is very congested between the M25 and Hatfield and Welwyn Garden City to Stevenage;
- Reduction in traffic flows on A405 approach to M25 J21a as traffic reroutes via spine road through Park Street area, via Burnt Oak Lane and through Bricket Wood;
- A41 approaching M25 junction 20 - delays on approach to junction lead to traffic re routeing onto Primrose Avenue and into Abbotts Langley;
- Increase in flows using the A602 as traffic reroutes off Stevenage Road; and
- Reduction in flows along A505 due to delays at A505/Old North Road junction which leads to rerouting onto Baldock Road.

Figure 7-5: 2036 AM Peak Flow minus 2014 AM Peak (Key Links)

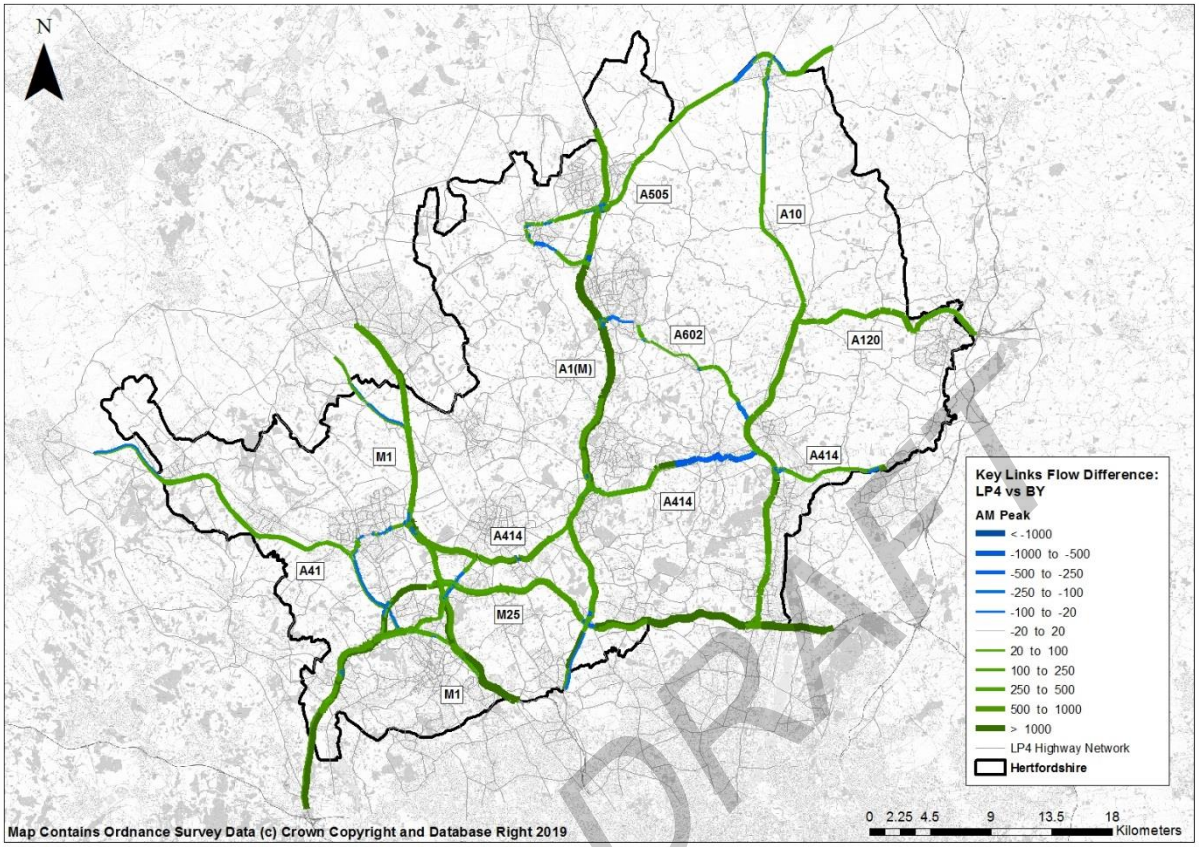


Figure 7-6: 2036 AM Peak Flow minus 2014 AM Peak (All Links)

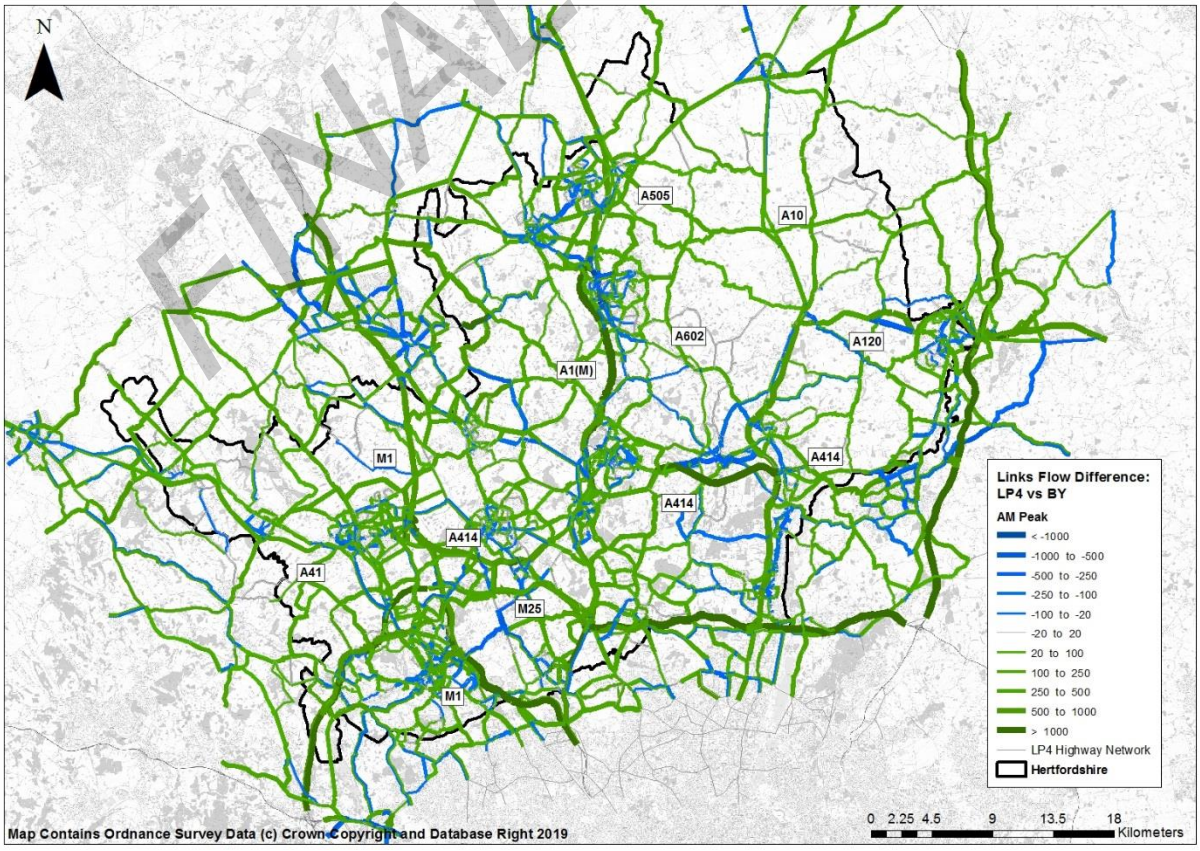


Figure 7-7: 2036 Inter-peak Flow minus 2014 Inter-peak (Key Links)

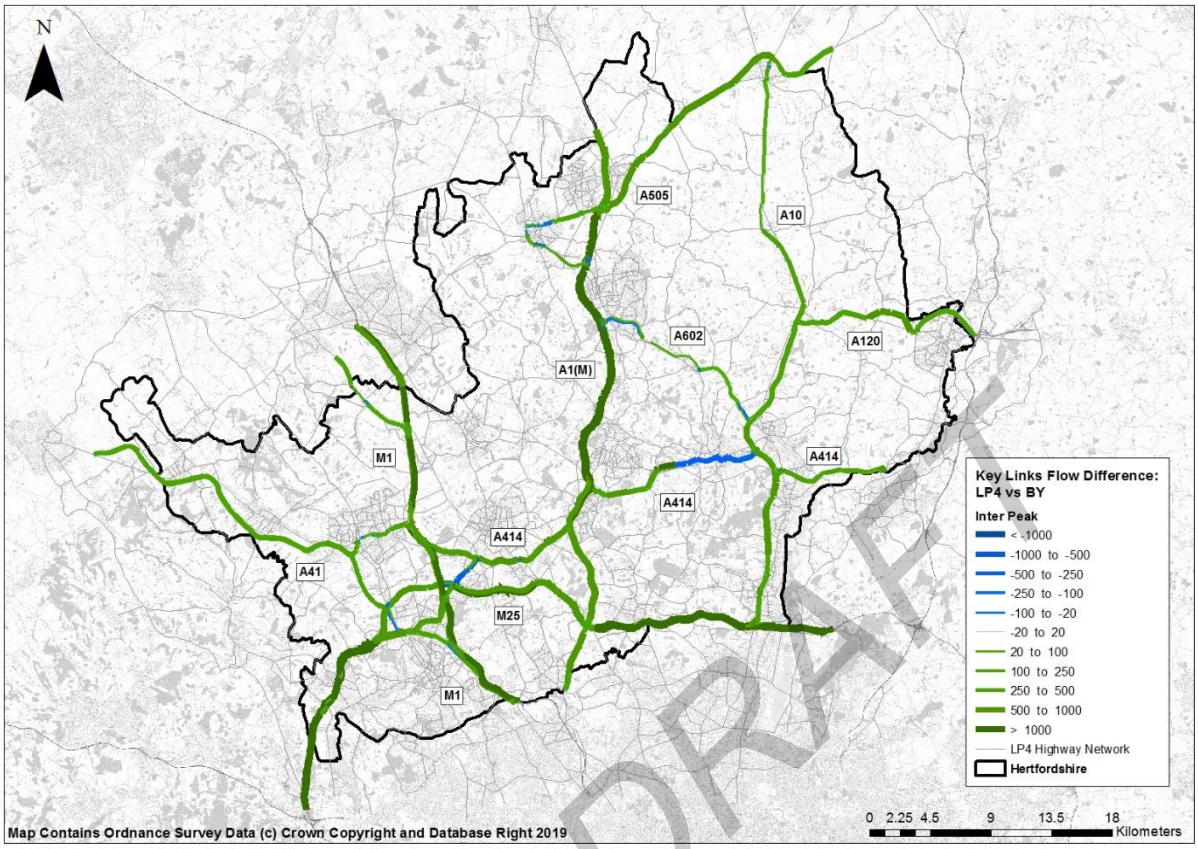


Figure 7-8: 2036 Inter-peak Flow minus 2014 Inter-peak (All Links)

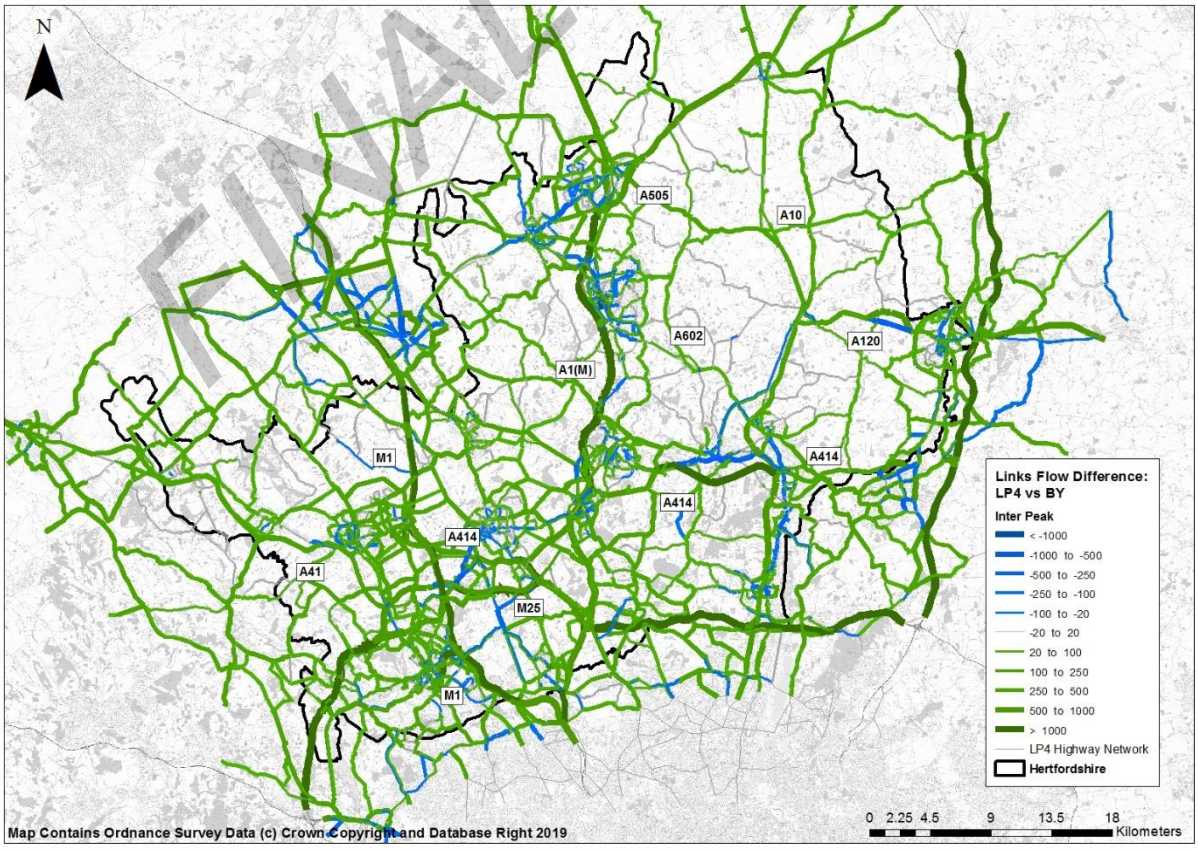


Figure 7-9: 2036 PM Peak Flow minus 2014 PM Peak (Key Links)

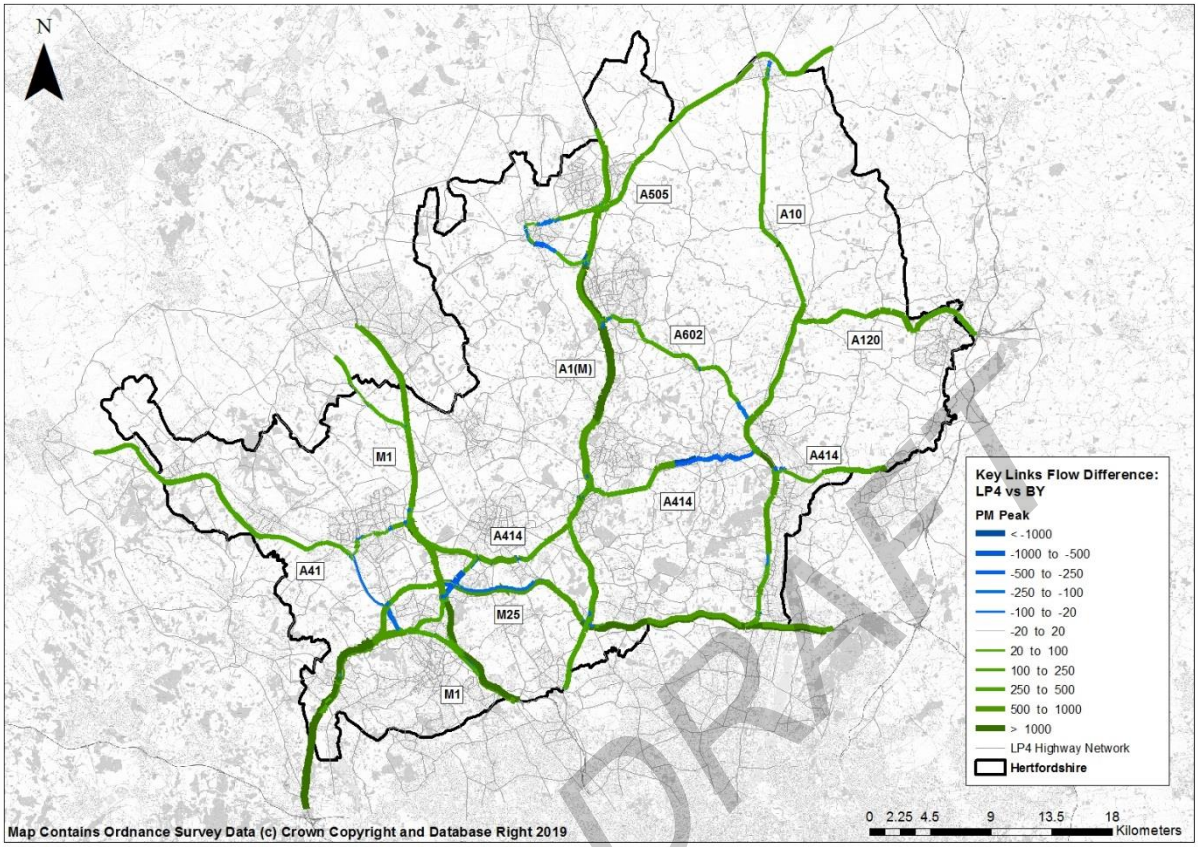
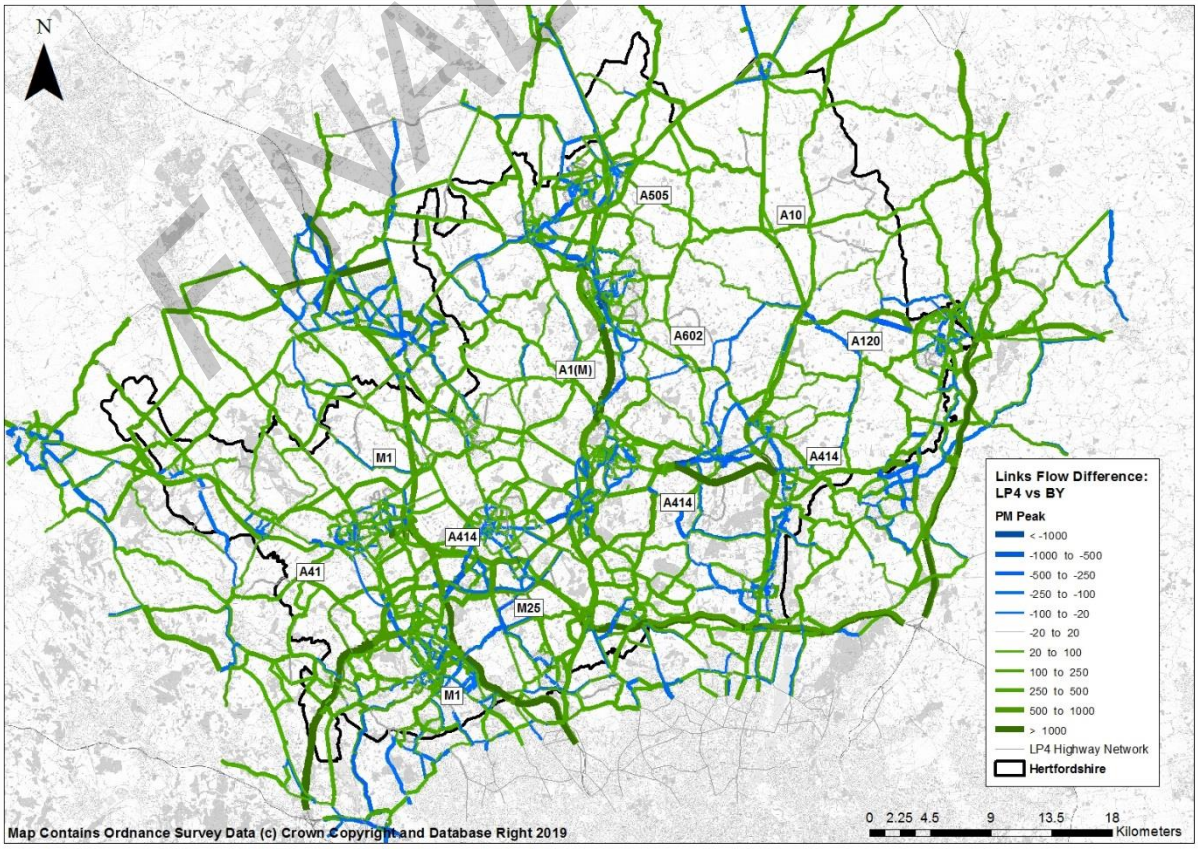


Figure 7-10: 2036 PM Peak Flow minus 2014 PM Peak (All Links)



7.3 Network Stress and Delays

7.3.1 Delays modelled in the highway assignment model are presented in the following sections in terms of link stress (volume over capacity – V/C) and junction (node) delay in minutes. Link stress (or V/C) represents the level of congestion along a link (road). Below 80% roads are expected to be relatively free-flowing with minimal delays. Between 80% and 90% roads will begin to show signs of congestion, speeds will lower and delays will occur at junctions. Over 90% the road will be very congested with low average speeds and delays expected at junctions.

7.3.2 The commentary given in the following sections is not intended as a comprehensive statement of network functionality, rather, points out where the main areas of congestion and delay are expected to occur on a corridor/strategic level given the assumptions inherent in these tests.

7.3.3 The reliability of the forecast results is dependent on the performance of the Base Year model, and that there are currently areas identified as not meeting WebTAG criteria.

7.3.4 Modelling shows the highest levels of congestion in the urban areas of Watford, St Albans, Hemel Hempstead, Hatfield, and Hertford towns. Modelling is also showing congestion (although to a lower level) in the urban areas of Welwyn Garden City, Stevenage, Hitchin, Letchworth Garden City, Baldock and Bishop's Stortford.

7.3.5 The following key roads in Hertfordshire also show evidence of congestion in the 2036 model forecast:

- Various sections of the M25, particularly in south west Hertfordshire;
- Various sections of the A1(M) and M1;
- East-west routes between Hemel Hempstead, St Albans and Hatfield;
- A505 near Letchworth Garden City and around Royston;
- Links around Maylands in Hemel Hempstead;
- Routes into around Harlow; and
- Sections of the A414 across Hertfordshire.

Link Stress

7.3.6 The figures in this section show the 2036 modelled link stress in terms of volume over capacity (V/C) for the three modelled time periods.

Figure 7-11: COMET 2036 AM Peak Link V/C (Key Links)

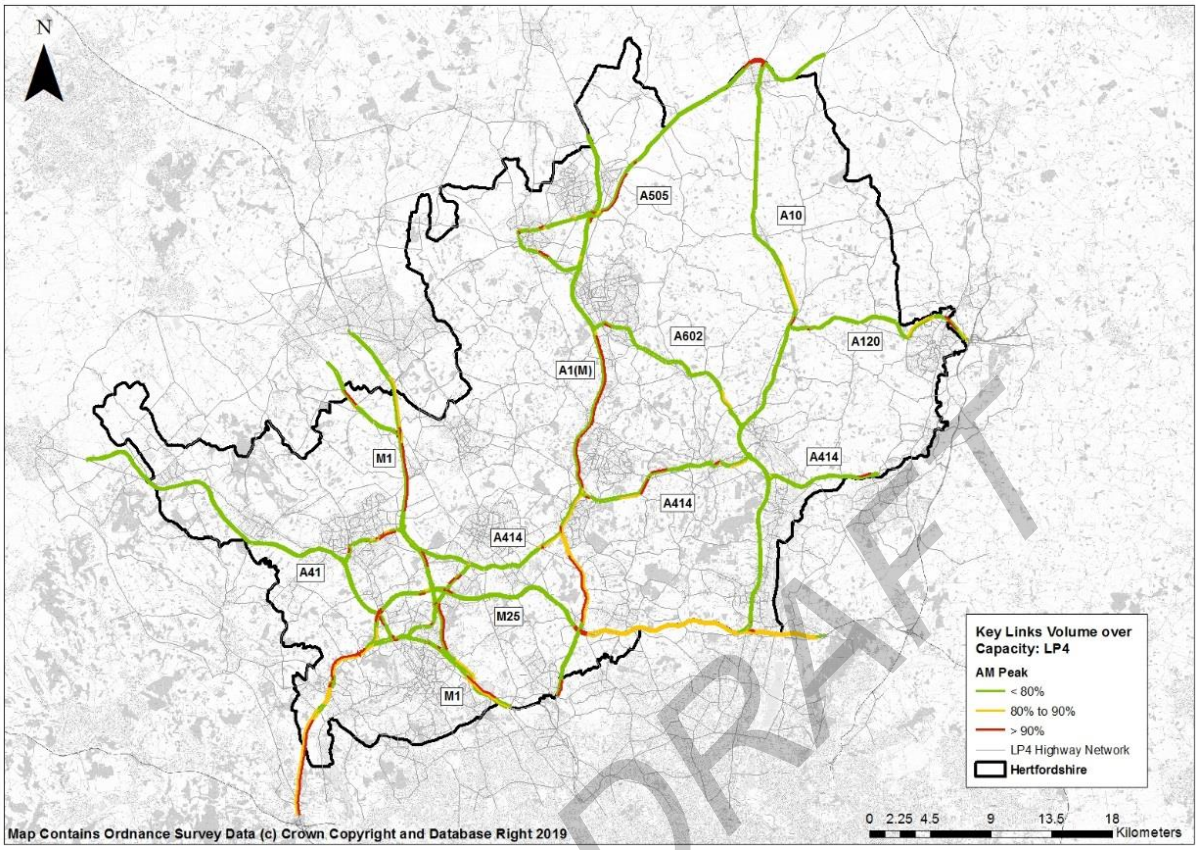


Figure 7-12: COMET 2036 AM Peak Link V/C (All Links)

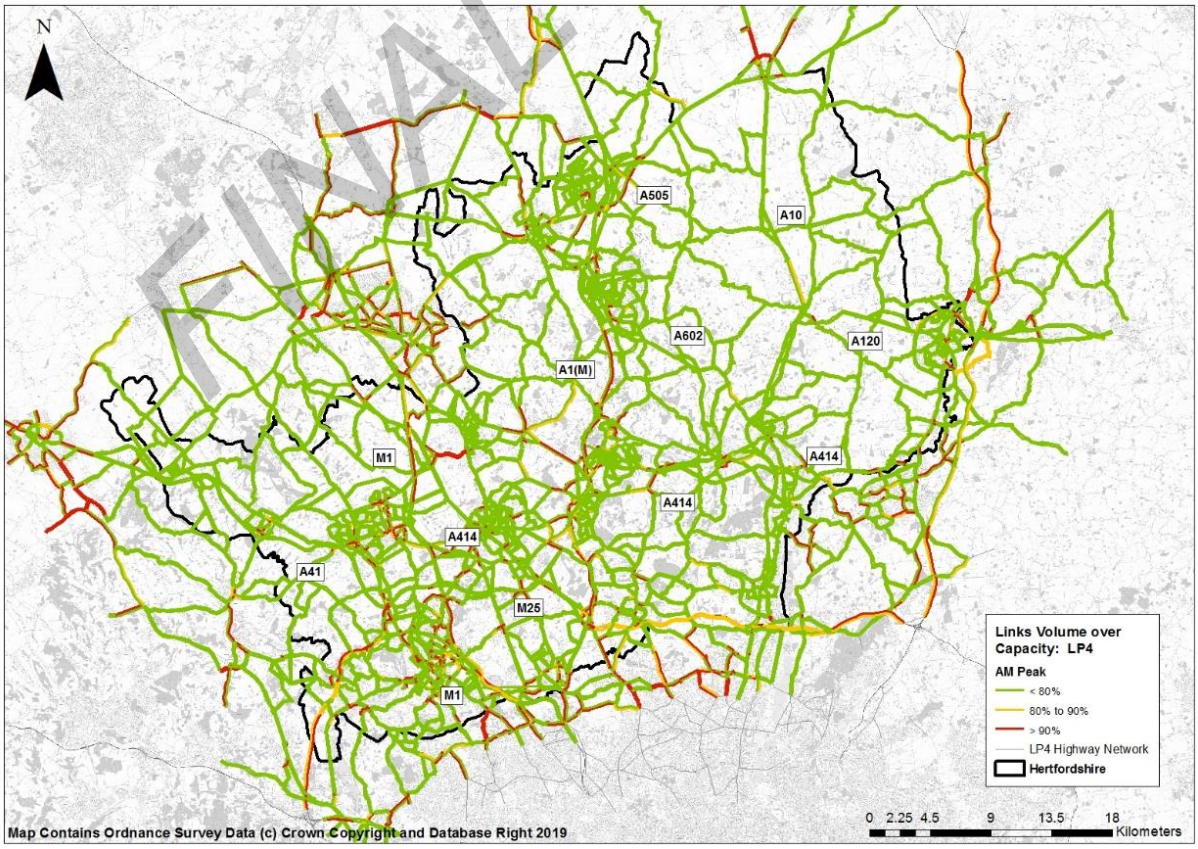


Figure 7-13: COMET 2036 Inter-peak Link V/C (Key Links)

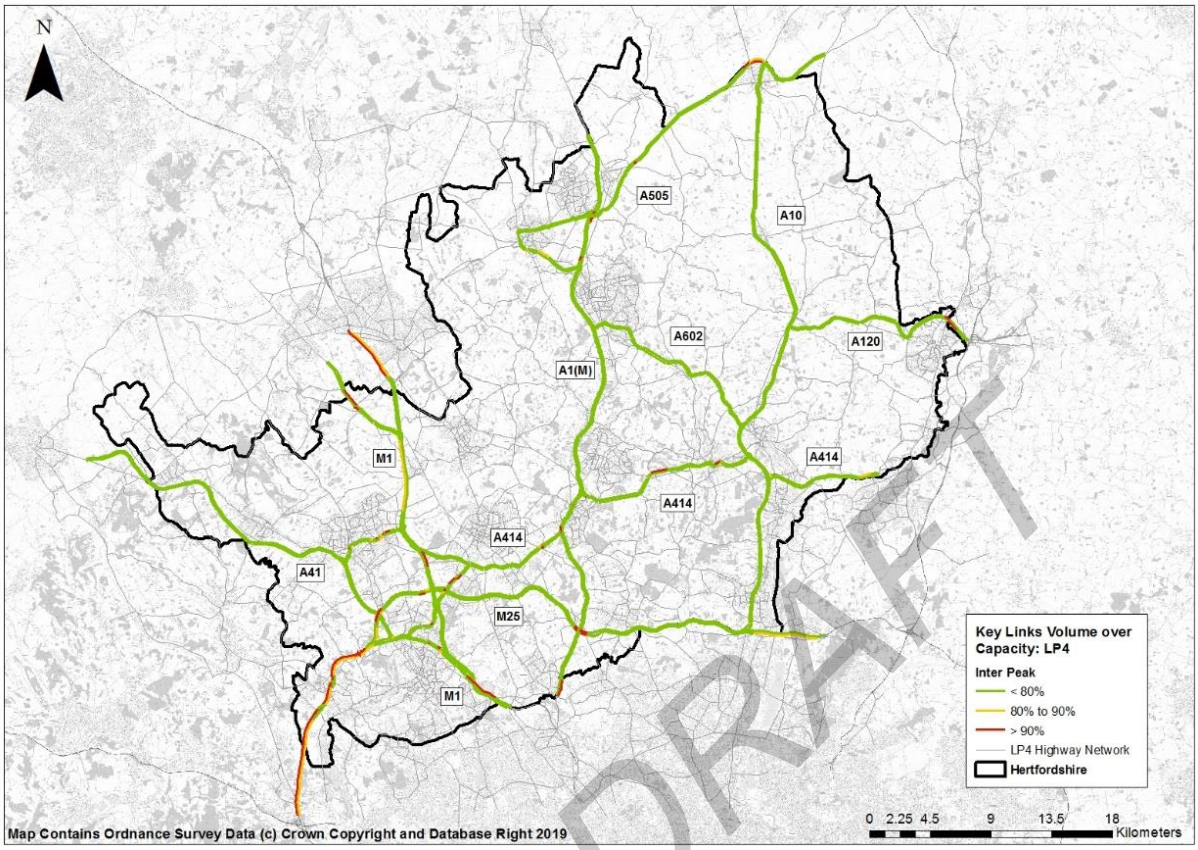


Figure 7-14: COMET 2036 Inter-peak Link V/C (All Links)

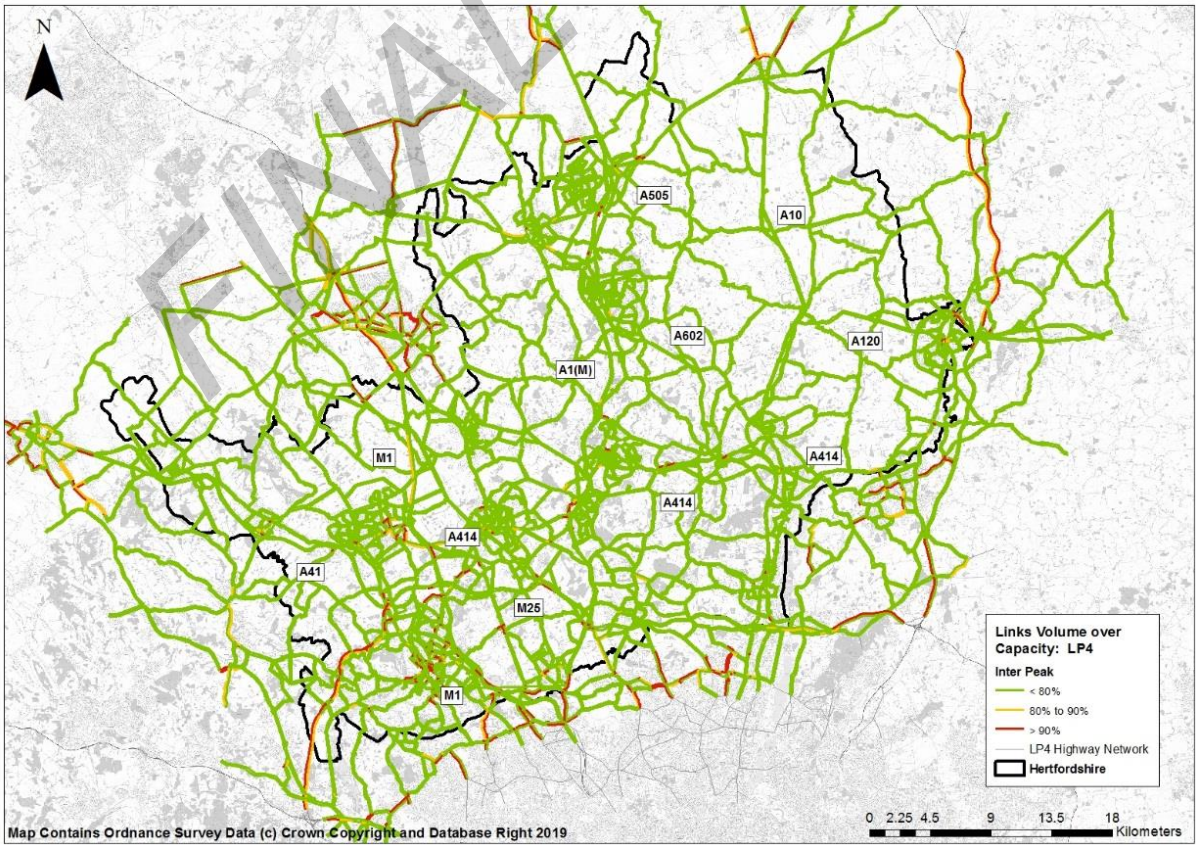


Figure 7-15: COMET 2036 PM Peak Link V/C (Key Links)

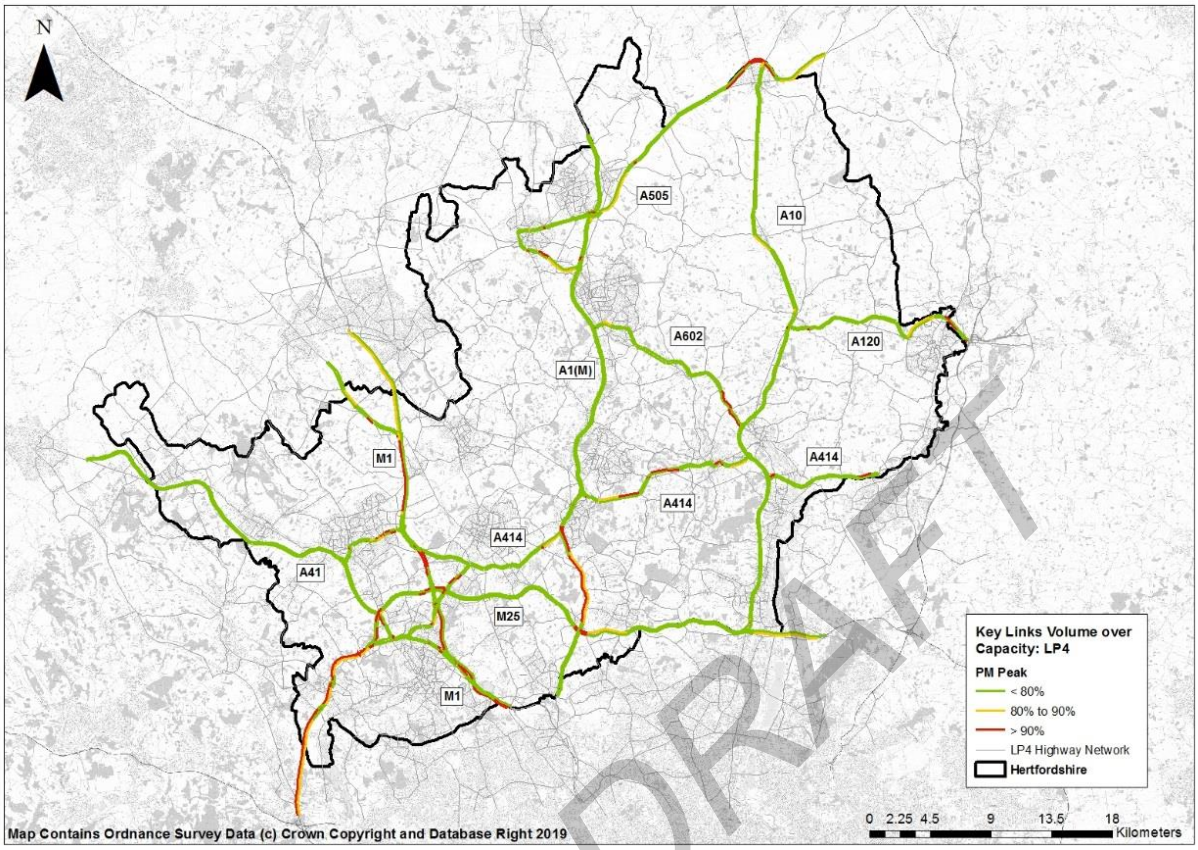
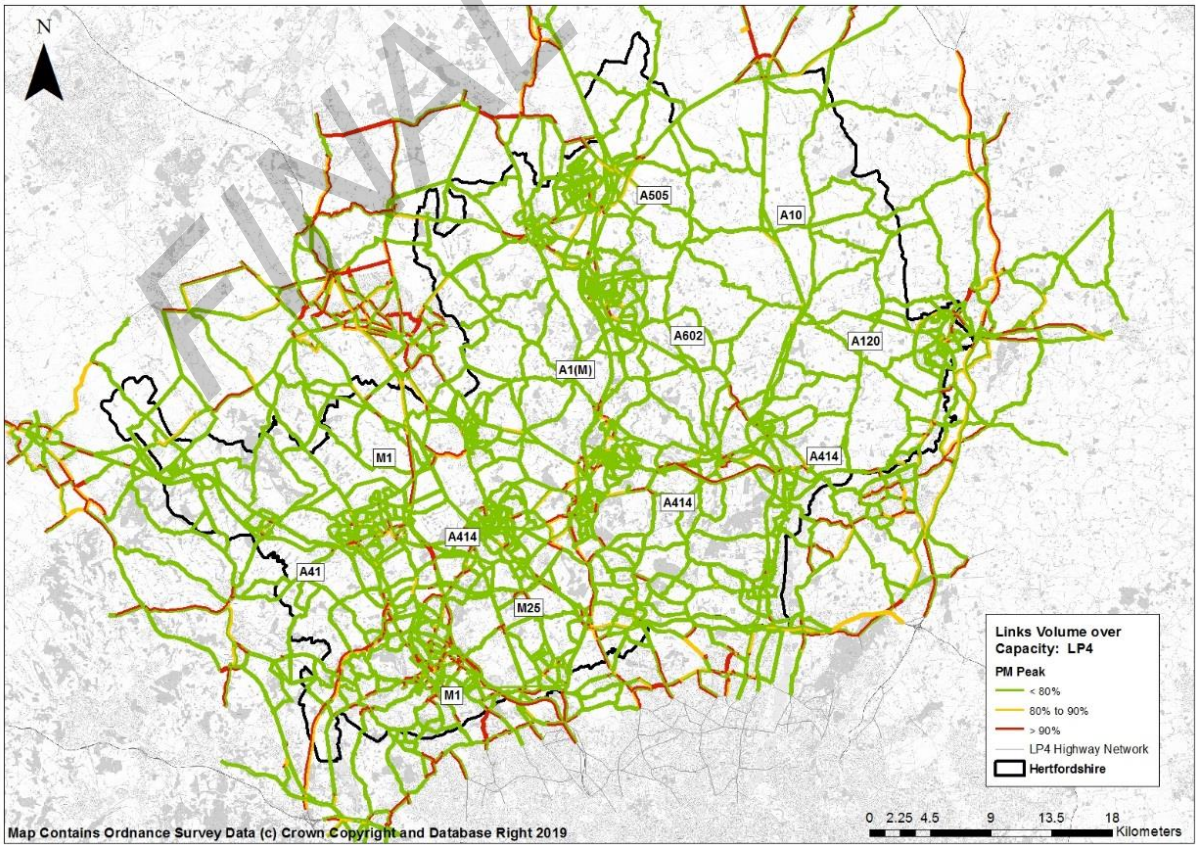


Figure 7-16: COMET 2036 PM Peak Link V/C (All Links)



Junction Delay

7.3.7 Junction delay per vehicle is presented in the following figures for the three modelled time periods in 2036. The delay shown for each junction is an average (weighted by vehicular flow) of the delays for each possible turn at that junction.

7.3.8 The level of junction delay near the urban area of Watford and the south west region of Hertfordshire. It can be recognised that the majority of delays are bounded along an area which is defined by the M25 and M1 motorways.

7.3.9 Along the strategic road network, significant delays are located at junctions 20 (A41) and 23 (A1(M)) on the M25. There are also notable delays on the A1(M) through Hertfordshire and particularly at junctions leading to and from the motorway.

7.3.10 Delays on A505 at both Old North Road junction and A10 junctions north of Royston cause rerouting in the area.

7.3.11 Delays on A1(M) southbound junction 9 diverge.

7.3.12 There are notable delays around Harlow and in key urban areas in Luton and north London bordering Hertfordshire.

Figure 7-17: COMET 2036 AM Peak Delay (Key Junctions)

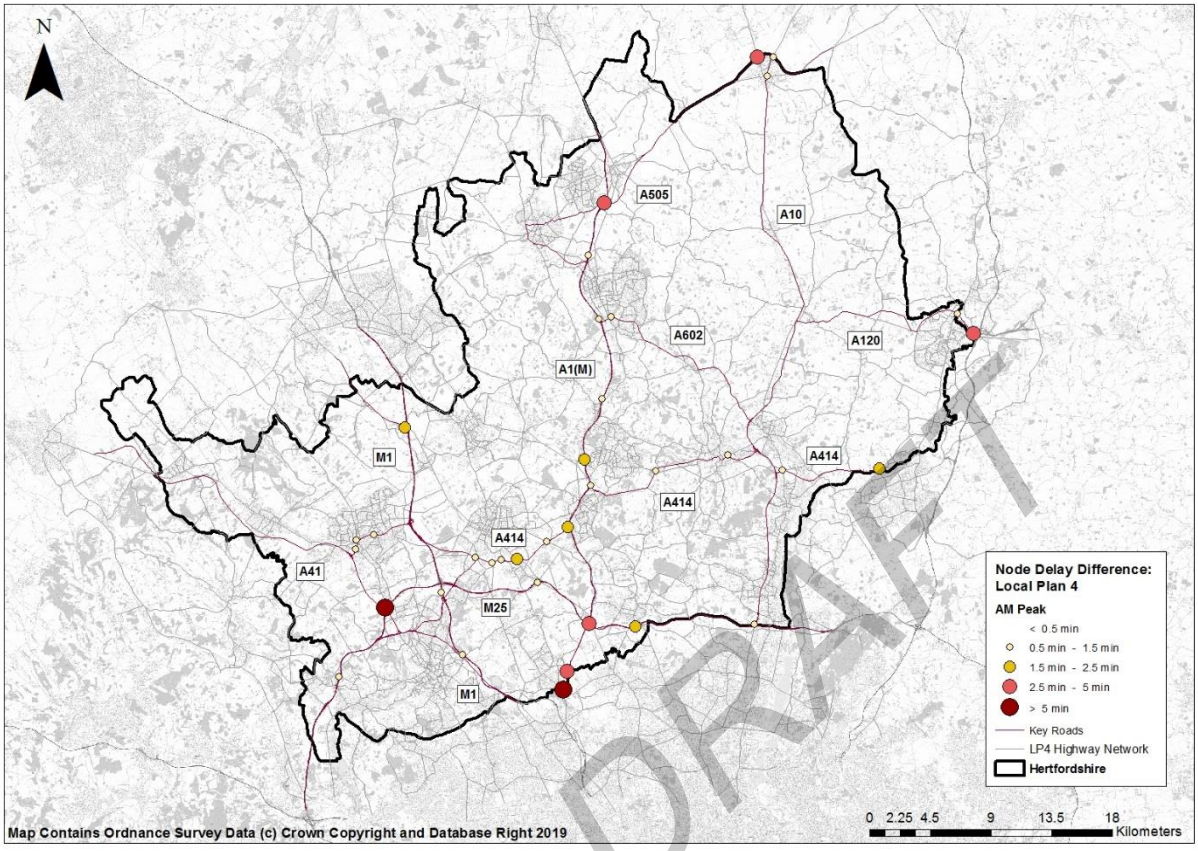


Figure 7-18: COMET 2036 AM Peak Delay (All Nodes)

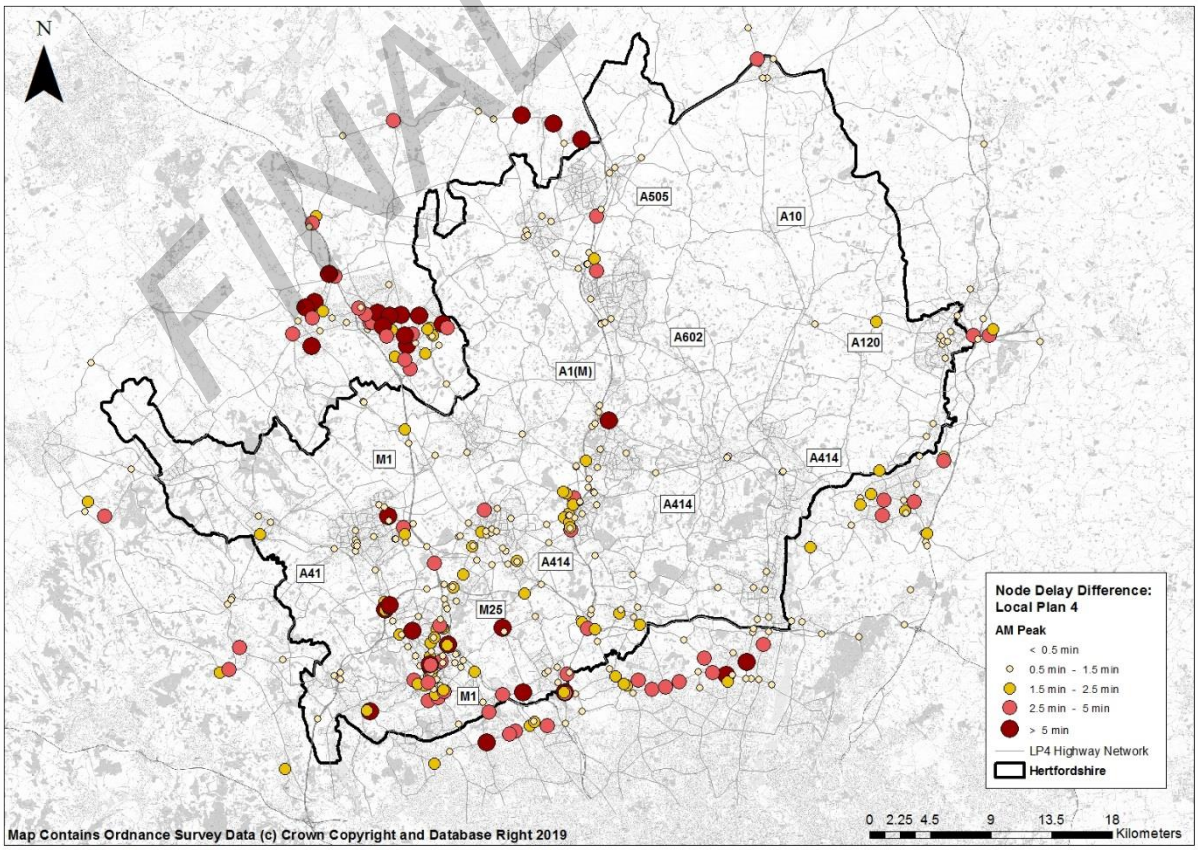


Figure 7-19: COMET 2036 Inter-peak Delay (Key Junctions)

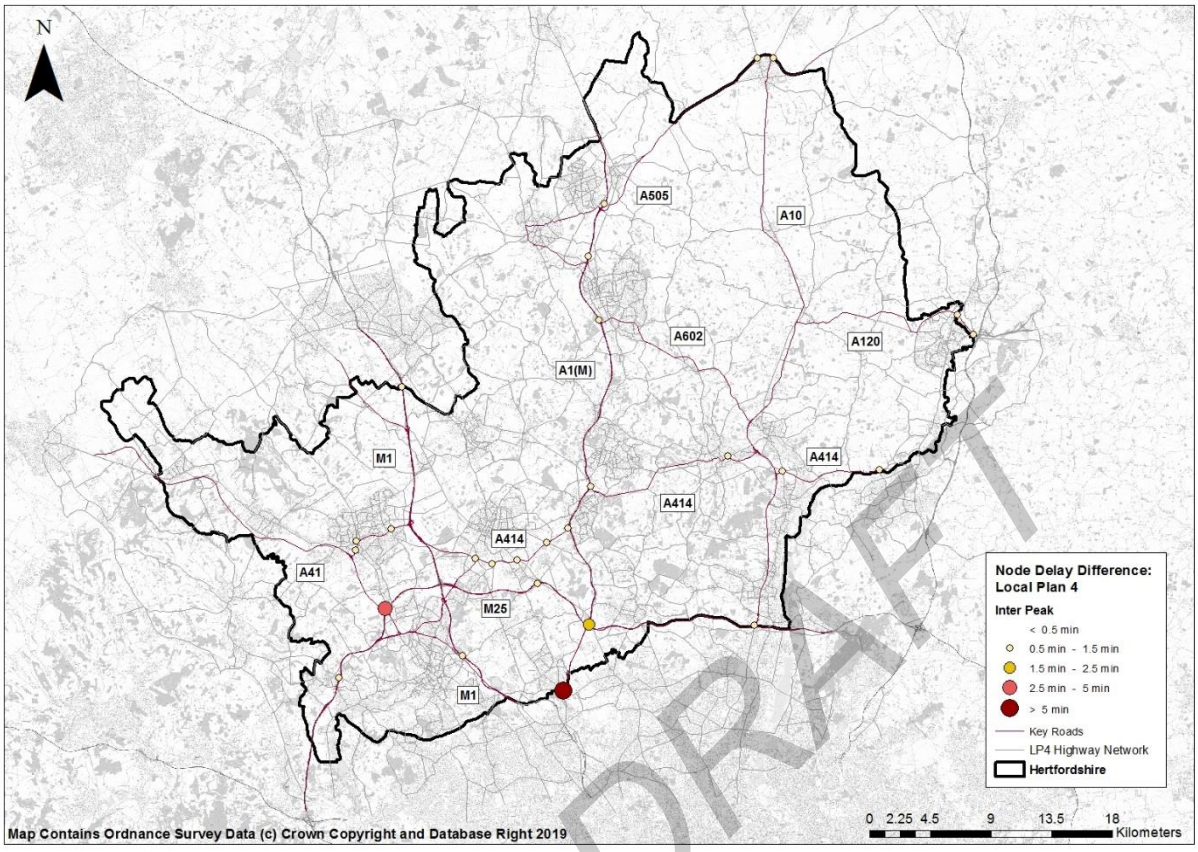


Figure 7-20: COMET 2036 Inter-peak Delay (All Nodes)

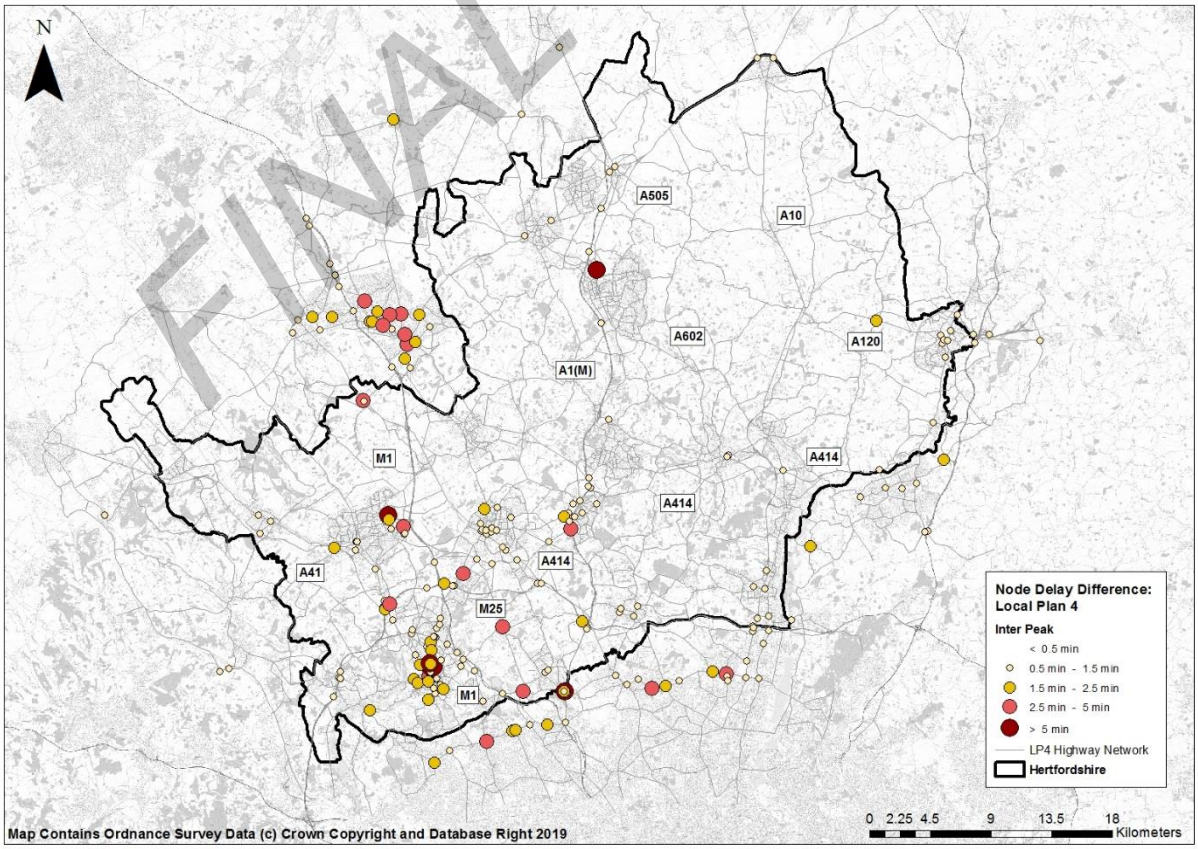


Figure 7-21: COMET 2036 PM Peak Delay (Key Junctions)

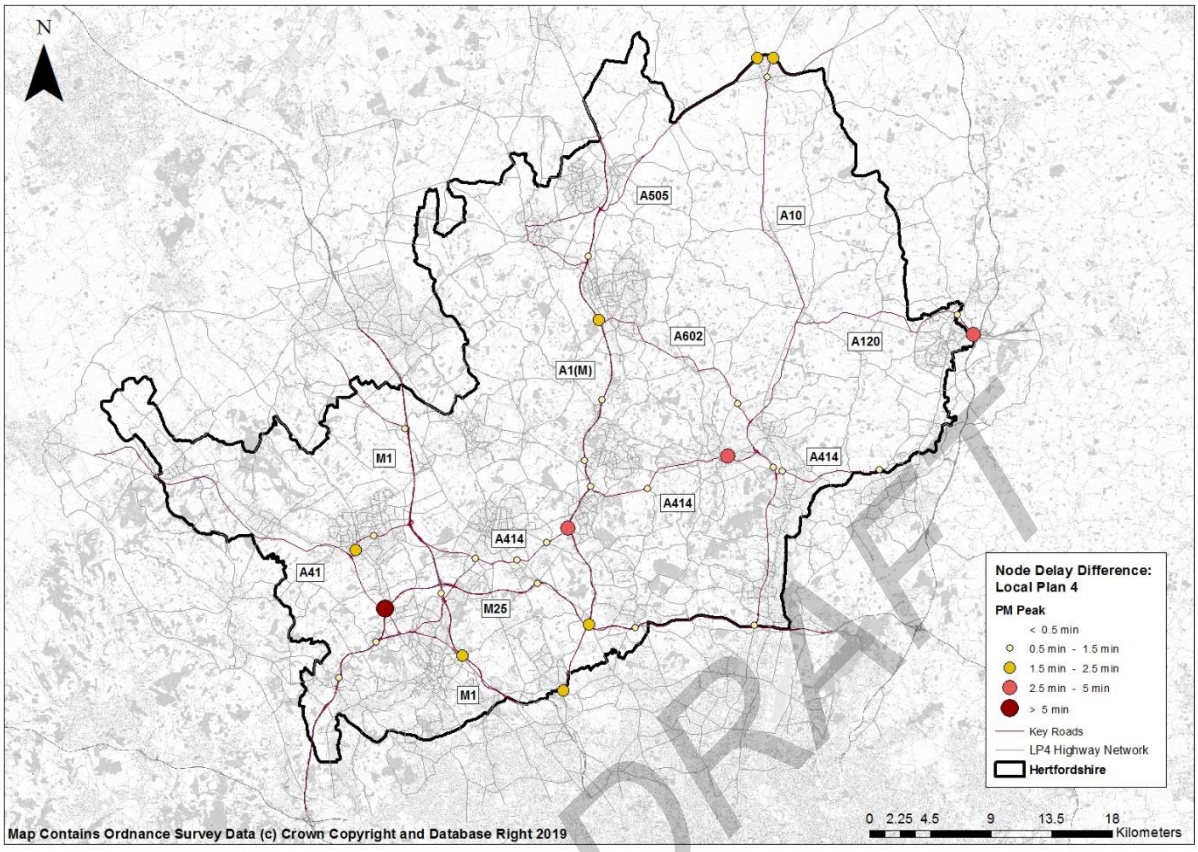
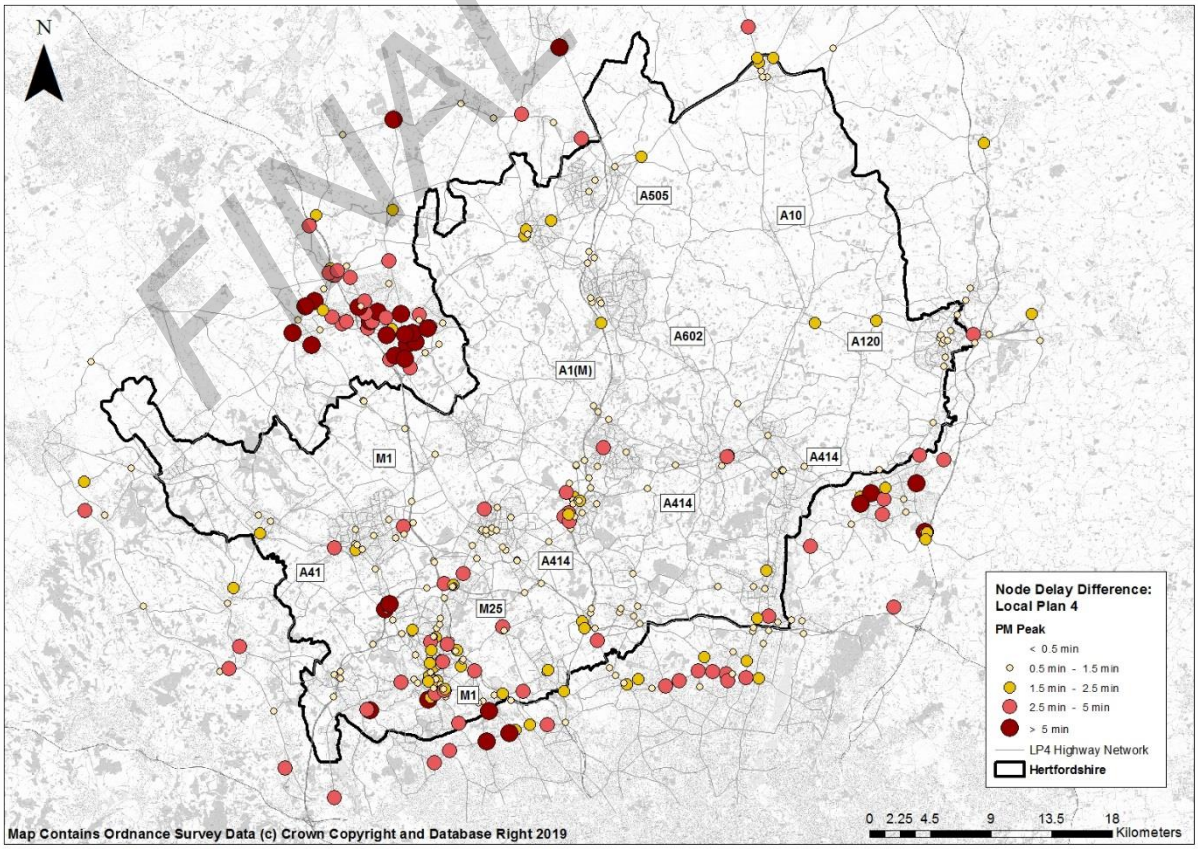


Figure 7-22: COMET 2036 PM Peak Delay (All Nodes)



7.3.13 The following figures show the node delay difference between the 2014 Base Year and 2036. Some reductions are noted along key links where signal optimisation has been undertaken in LP4. There are also notable reductions in Hertford which is to be expected as the Hertford Bypass is included in LP4.

7.3.14 Rerouteing flows that access Stevenage town centre causes changes in delays along the A1(M). Traffic flows from Hitchin rat-run into Stevenage on cross country routes and reduce delays observed at junction 7.

Figure 7-23: 2036 AM Peak Delay minus 2014 AM Peak (Key Junctions)

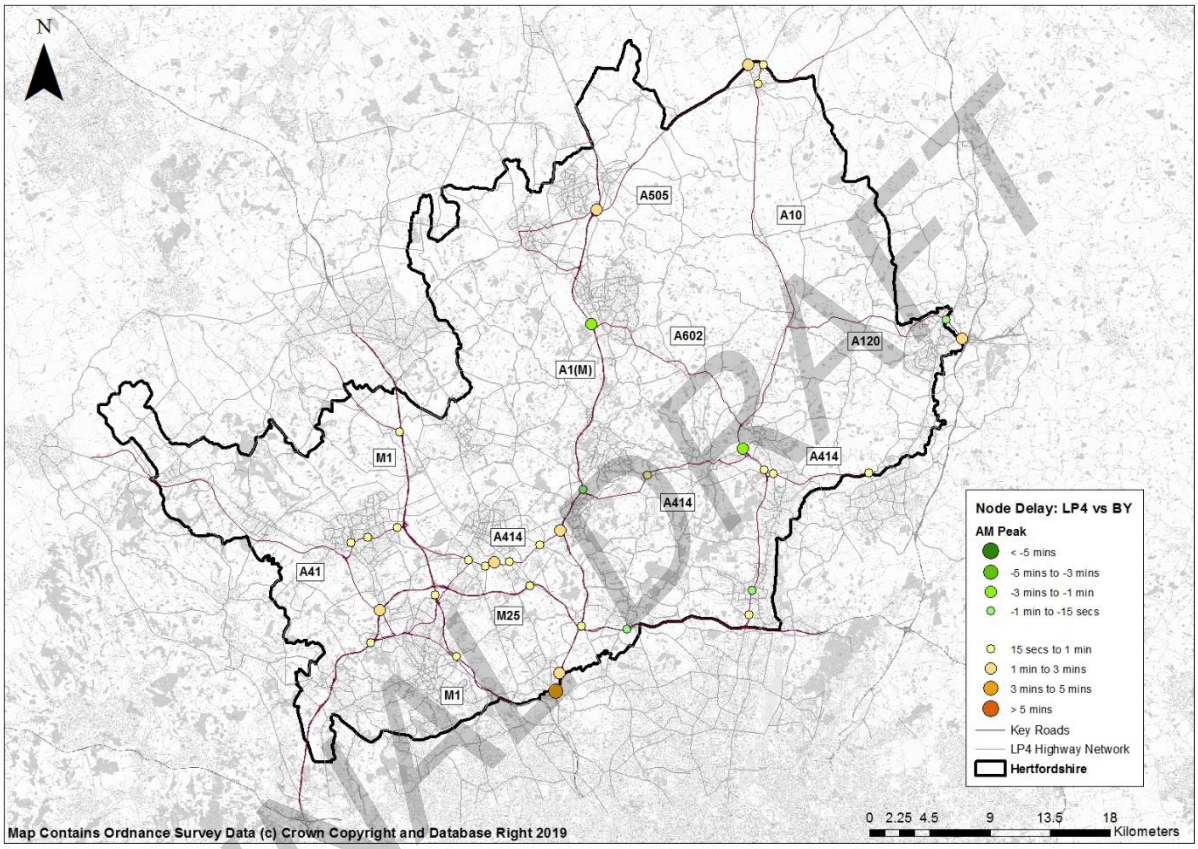


Figure 7-24: 2036 AM Peak Delay minus 2014 AM Peak (All Nodes)

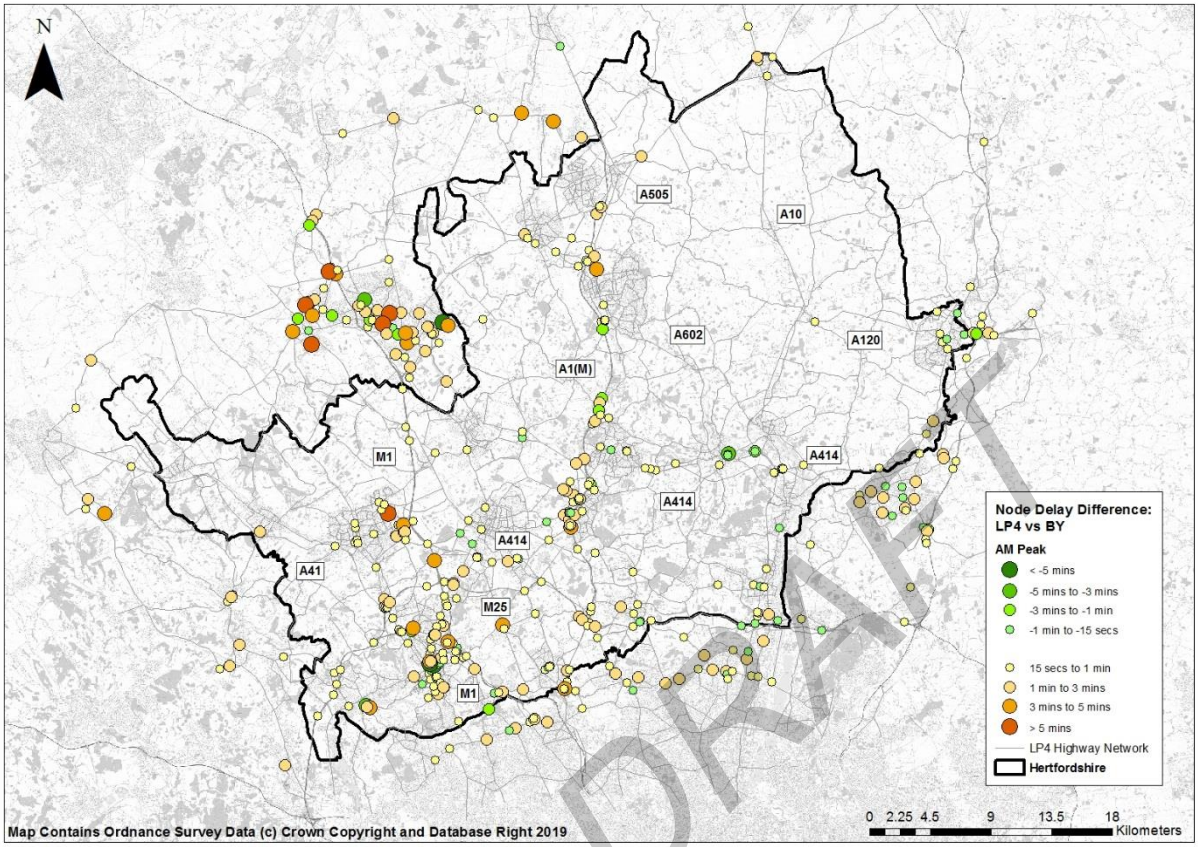


Figure 7-25: 2036 Inter-peak Delay minus 2014 Inter-peak (Key Junctions)

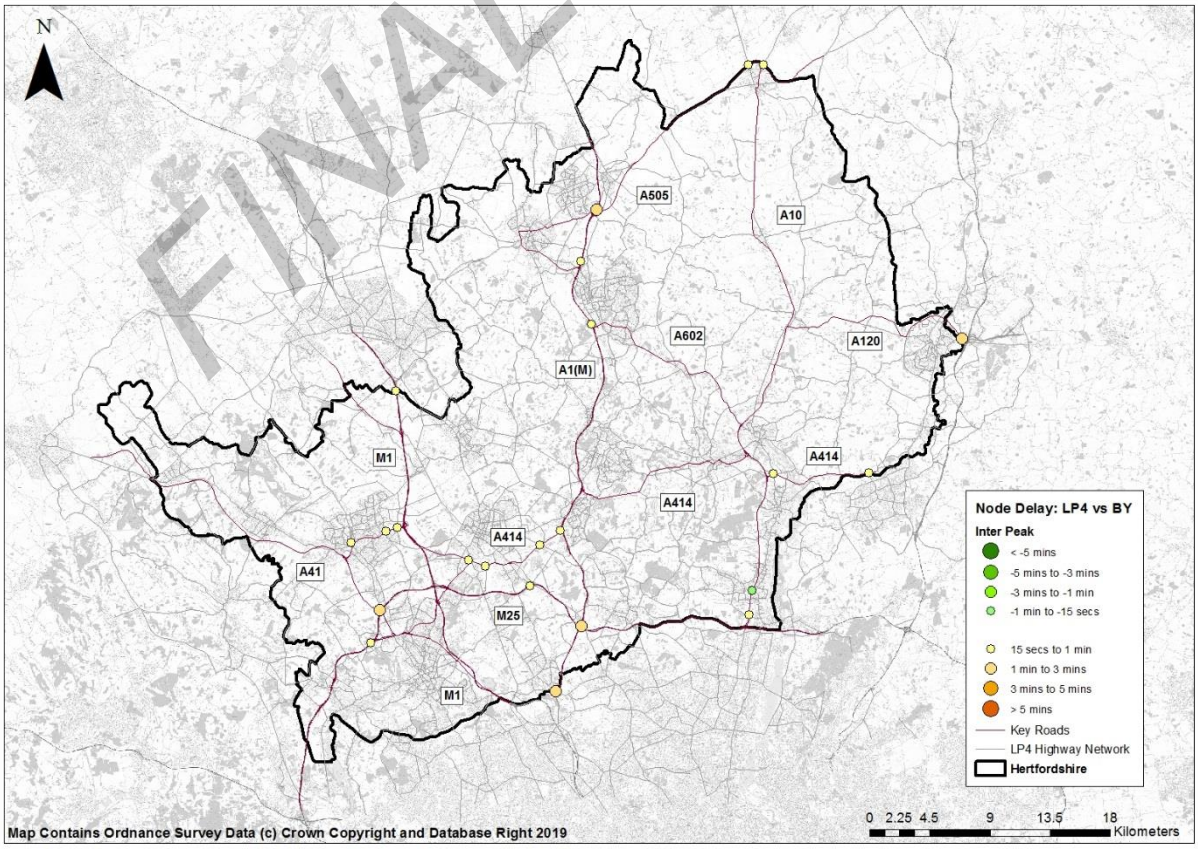


Figure 7-26: 2036 Inter-peak Delay minus 2014 Inter-peak (All Nodes)

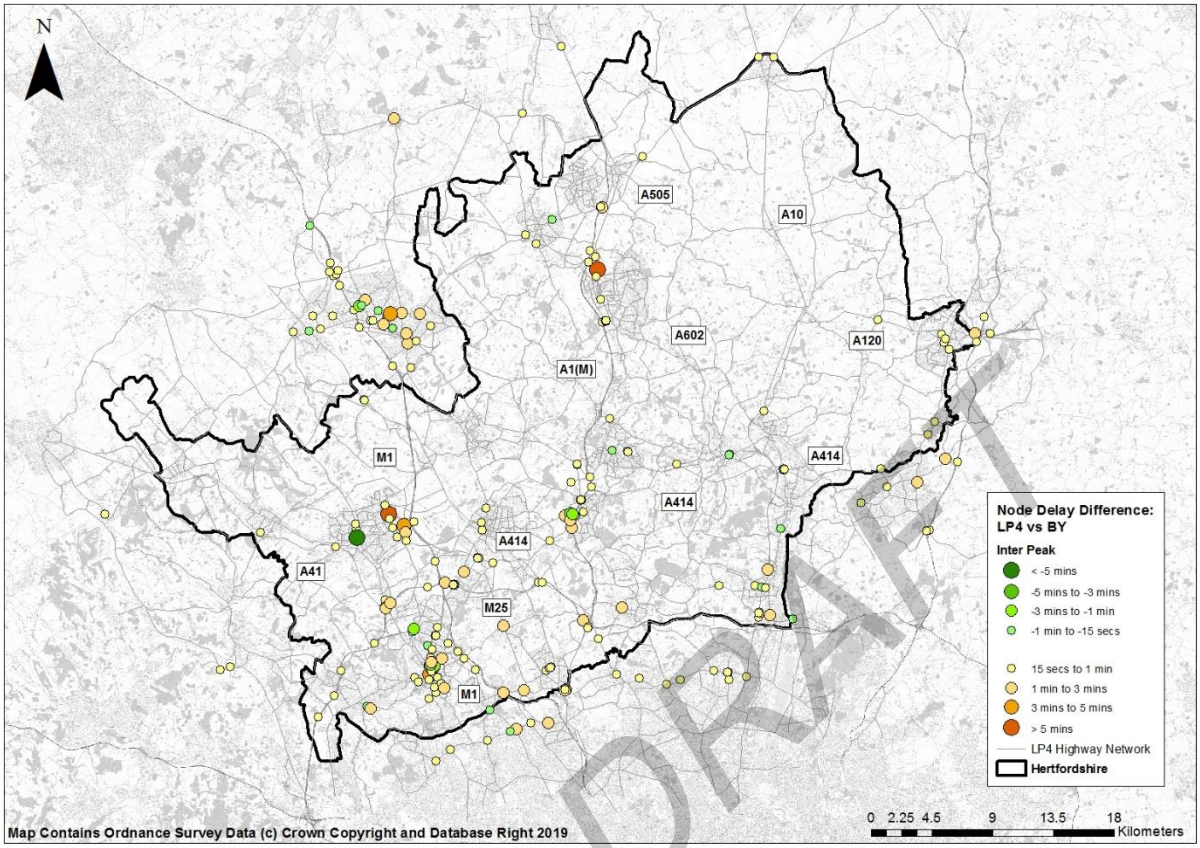


Figure 7-27: 2036 PM Peak Delay minus 2014 PM Peak (Key Junctions)

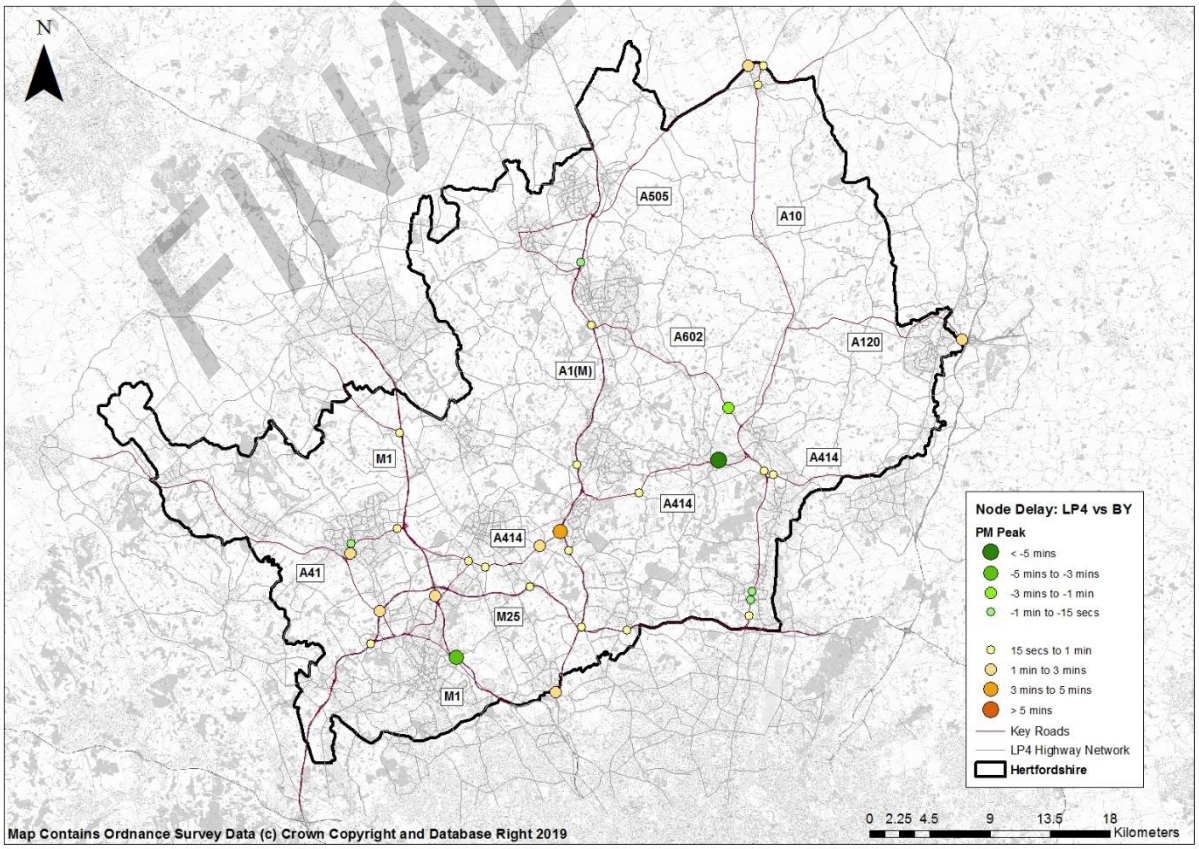
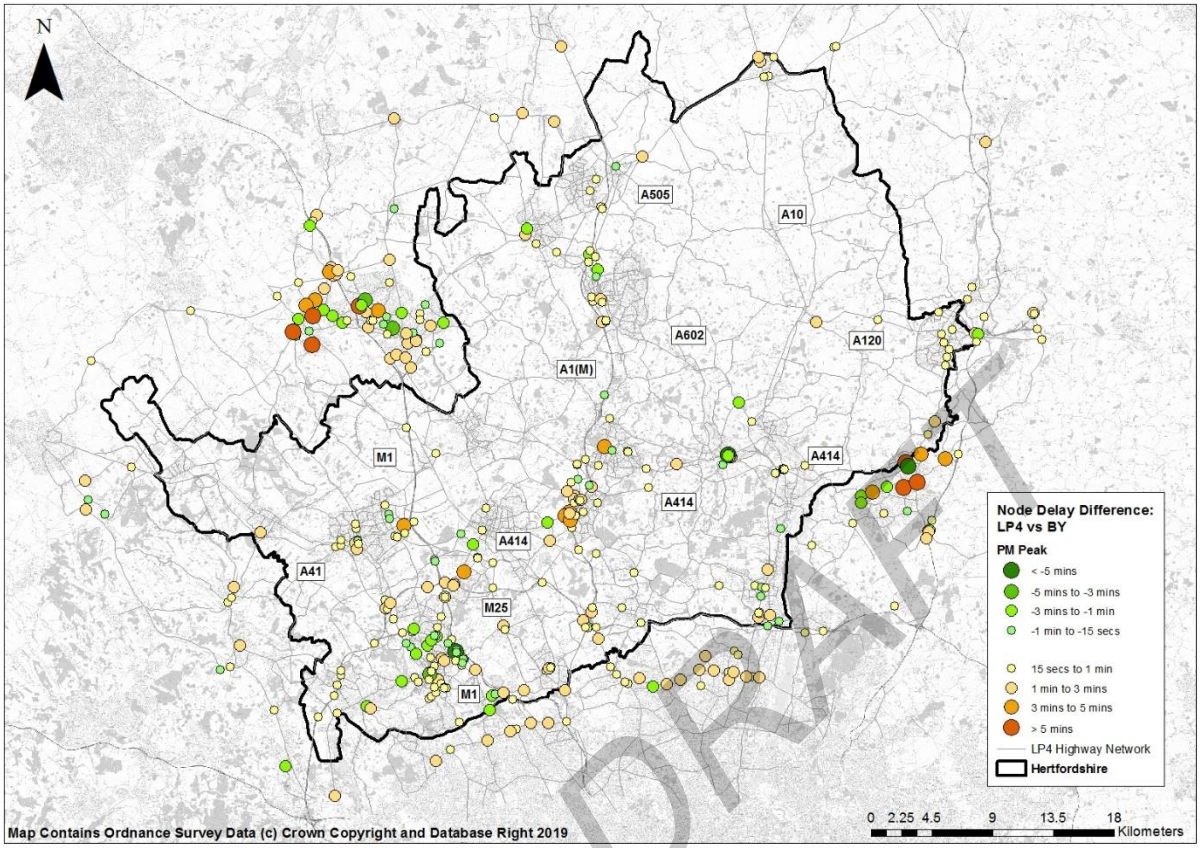


Figure 7-28: 2036 PM Peak Delay minus 2014 PM Peak (All Nodes)



Summary

7.3.15 The following table summarises the key highway flows, link stress and delay impacts noted from LP4 in the urban areas of Hertfordshire.

Table 7-2: LP4 Traffic Impacts in Key Hertfordshire Towns

Urban Area	Impacts Noted from LP4
Hemel Hempstead / Tring / Berkhamsted	• New northern link road provides a new route choice from Berkhamsted/Potton End across to Redbourn Road and M1 Junction 8 • Reduced flows on A414 through central Hemel from the A41 to Junction 8 • Increased flows around Maylands and linked to Hemel developments. Delays at some zone access points • Increased flows on M1 in both directions • Delays at M25 Junction 20 (A41) in the PM peak may be influencing route choice in the area • Increases in flows around Tring and Berkhamsted and strong linkages with rural routes across to the new A5-M1 and M1-A6 links
Watford	• Delays at junctions on A412 between Rickmansworth and Watford influences route choices between these towns • Increases in flows around the town centre and Watford junction linked to

	the new developments. Longest delays in the model are on Clarendon Road and impact routeing in the area • Increases in flows on M1 and A41 east of Watford. Some reductions between Radlett and Watford, possibly linked to delays at junctions crossing the A41 in either direction • Delays for east-west traffic crossing the A41 in both peak periods
Elstree / Borehamwood	• Increases in flows around both Elstree and Borehamwood town centres but some reductions in flows on cross country routes to/from London Colney and the M25 to the north • Delays at Stirling Corner continue to influence route choices in the area
St Albans / Harpenden	• Increased flows along the A414. New link between Radlett and Park Street allows an alternative to the A414/A405 linking to M25 Junction 21a • Delays at M25 J21a and along the A405 in the PM peak may be influencing route choice • Localised re-routeing around St Albans town centre – may be linked to the area wide 20mph zone • Local east-west routes between Hemel Hempstead and Hatfield show increases in flows • Increase in flows on A1081 between St Albans and Harpenden and on the B653 from Harpenden to the A1 via Wheathampstead
Hatfield / Welwyn Garden City	• Increased flows on the A1(M) past these towns and on routes to/from towns • Increased flows around the town centres but some localised re-routeing • Linkages with A414 with some rerouting through area to reach the Hertford Bypass
Stevenage / Hitchin / Baldock	• Increased flows on A1(M) past these towns with reduction in rat running between junctions on local roads due to the additional capacity on the A1(M) • Schemes on parallel route through Stevenage town centre introduce some delays due to the signalised junctions • Some changes in flows will be influenced by planning data in adjacent Luton and Central Bedfordshire
Broxbourne	• Increased flows on A10 and M25 • Some reductions on old A1170. May be linked to Crossrail 2 included in forecast scenario • Some negligible impacts on east/west rural routes to/from Broxbourne- these may be impacted by the Hertford Bypass
Hertford / Ware	• Flows on A414 influenced by the Hertford Bypass- large reductions on the existing A414 through Hertford • Rush Green delays reduced as bypass connects to Amwell roundabout

	instead • B158 between Hertford and A602 experiences flow reductions • Some increases on A1170/A119 between Amwell and Hertford via Ware. Presume this is for local traffic which doesn't wish to use the bypass
East Herts / Harlow	• Increased flows on A414 through Harlow but some localised re-routeing around the town which is linked to the additional junction 7a on the M11 and delays at most junctions in Harlow • Increased flows on A120 and using Little Hadham bypass with reduction in flow through the existing signalised junction • Increased flows around the outer link roads around Bishops Stortford and some localised re-routeing the town centre due to closure of Potters road • Reduction in flows between Stansted and Harlow via rural routes – presume the new M11 junction is providing a viable route choice.

7.4 Inter-urban Journey Times

7.4.1 Inter-urban journey times have been assessed in LP4 by skimming the time matrices in SATURN.

7.4.2 Increased vehicle flow and congestion in the Forecast Year cause a rise in the average journey time between urban areas in Hertfordshire. The tables below present the journey times between key towns in Hertfordshire compared to both Base Year, and to Local Plan v3 (2031).

7.4.3 These tables show journey times for the "average route"; therefore, some journeys will be considerably slower than the indicated values. Journey times are compared to the 2014 Base Year and LP3.

7.4.4 The following key points are observed in the journey time analysis:

- Compared to Base Year the AM peak shows the greatest increases in journey times with an average increase of 5 minutes, the PM peak increases by an average of 4 minutes;
- New infrastructure added compared to the Base Year has influenced journey time changes in some areas (e.g. A120 Little Hadham bypass has an impact on journey times to and from Bishops Stortford)
- Compared to LP 3 there is an average increase of 1 minute in all time periods;
- Total AM and PM journey times in 2036 are similar; and
- Towns in the south and west of Hertfordshire experience some of the greatest changes in journey times due to the congestion on the network.

Table 7-3 LP4 Journey times between key towns AM peak (mins)

	2036 LP4 AM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	34	62	74	78	29	38	38	43	60	71
	Cheshunt	37	0	29	41	46	21	25	34	42	39	41
	Borehamwood	57	30	0	36	29	34	31	35	38	33	35
	Rickmansworth	76	49	40	0	22	50	49	53	55	38	23
	Watford	71	44	25	20	0	46	45	48	48	31	24
	Hertford	29	18	35	50	52	0	10	20	25	34	45
	Welwyn Garden City	37	21	29	44	47	10	0	17	19	26	38
	Stevenage	40	32	39	54	57	21	23	0	11	33	45
	Hitchin	44	43	44	58	60	31	31	13	0	34	45
	St Albans	57	40	33	35	35	31	25	31	32	0	19
	Hemel Hempstead	65	47	36	30	32	40	37	40	41	22	0

Table 7-4 LP 4 Journey times between key towns in IP (mins)

	2036 LP4 IP (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	32	50	68	63	28	36	37	41	52	61
	Cheshunt	35	0	24	40	35	20	24	33	40	36	39
	Borehamwood	52	29	0	34	25	31	26	32	34	30	34
	Rickmansworth	68	45	33	0	20	48	44	50	52	32	23
	Watford	61	38	22	16	0	41	37	43	43	27	21
	Hertford	27	17	25	43	38	0	10	20	25	28	37
	Welwyn Garden City	35	20	20	38	33	10	0	17	19	20	32
	Stevenage	37	29	27	45	40	20	17	0	11	29	39
	Hitchin	41	36	30	48	41	25	20	12	0	31	38
	St Albans	51	36	27	31	25	27	21	28	31	0	18
	Hemel Hempstead	61	40	30	23	21	37	32	38	38	18	0

Table 7-5 LP4 Journey times between key towns in PM peak (mins)

	2036 LP4 PM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 2036	Bishop's Stortford	0	34	57	69	64	29	38	39	44	60	68
	Cheshunt	38	0	29	41	36	22	25	35	44	37	39
	Borehamwood	64	40	0	43	28	41	37	43	45	38	38
	Rickmansworth	79	54	41	0	19	56	53	59	61	37	30
	Watford	82	58	37	24	0	60	56	62	62	40	34
	Hertford	31	19	29	47	42	0	10	21	28	32	40
	Welwyn Garden City	39	23	23	41	36	10	0	20	22	24	34
	Stevenage	39	32	32	50	44	21	21	0	11	31	41
	Hitchin	43	40	32	50	42	27	21	12	0	32	39
	St Albans	61	40	29	35	26	34	25	32	32	0	19
	Hemel Hempstead	70	45	31	24	22	44	36	42	41	19	0

Table 7-6 Journey time comparisons between LP4 and Base Year in AM peak (mins)

	2036 LP4 - BY AM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs BY	Bishop's Stortford	0	1	5	8	13	0	0	1	2	2	5
	Cheshunt	4	0	3	6	12	2	0	4	4	4	6
	Borehamwood	11	10	0	8	8	8	7	8	8	6	8
	Rickmansworth	12	11	8	0	7	7	7	8	6	4	3
	Watford	14	13	5	2	0	9	10	10	6	6	4
	Hertford	0	-1	4	10	13	0	0	0	0	4	7
	Welwyn Garden City	-1	-4	3	9	13	0	0	0	0	3	5
	Stevenage	1	2	5	11	15	1	2	0	1	0	5
	Hitchin	2	3	2	9	13	2	1	1	0	0	7
	St Albans	1	5	2	6	8	4	2	1	1	0	2
	Hemel Hempstead	5	13	6	5	9	8	6	7	4	4	0

Table 7-7 Journey time comparisons between LP4 and Base Year in IP (mins)

	2036 LP4 - BY IP (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs BY	Bishop's Stortford	0	1	5	9	5	1	0	2	2	0	4
	Cheshunt	4	0	3	6	6	3	-1	4	4	5	7
	Borehamwood	9	8	0	4	7	7	6	6	6	5	8
	Rickmansworth	9	9	6	0	4	8	8	8	6	1	4
	Watford	8	8	3	0	0	7	7	7	5	3	3
	Hertford	-1	-1	2	6	6	0	0	0	0	2	5
	Welwyn Garden City	-2	-5	0	5	5	0	0	1	0	0	4
	Stevenage	1	1	2	6	7	1	2	0	0	1	6
	Hitchin	1	0	1	5	5	1	1	1	0	1	4
	St Albans	-2	5	1	4	3	1	1	1	0	0	0
	Hemel Hempstead	2	8	4	3	3	6	5	6	3	1	0

Table 7-8 Journey time comparisons between LP4 and Base Year in PM peak (mins)

	2036 LP4 - BY PM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs BY	Bishop's Stortford	0	2	3	4	5	0	1	2	3	2	6
	Cheshunt	2	0	5	6	6	2	0	3	4	5	6
	Borehamwood	16	16	0	14	9	12	13	12	13	10	8
	Rickmansworth	13	13	8	0	4	9	11	9	11	3	4
	Watford	13	13	6	0	0	10	10	9	8	2	2
	Hertford	-4	-4	3	7	6	0	0	0	0	2	5
	Welwyn Garden City	-4	-3	1	4	4	0	0	-2	-1	0	3
	Stevenage	1	0	4	8	7	1	4	0	1	1	5
	Hitchin	1	-1	1	5	2	1	1	1	0	1	2
	St Albans	-1	5	2	2	2	5	3	1	1	0	1
	Hemel Hempstead	12	11	5	2	3	10	7	3	2	1	0

Table 7-9 Journey time comparisons between LP4 and LP3 in AM peak (mins)

	2036 LP4 - 2031 LP3 AM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs LP3	Bishop's Stortford	0	1	2	2	4	1	1	1	1	0	2
	Cheshunt	0	0	0	1	2	-1	0	0	0	-1	0
	Borehamwood	3	1	0	2	2	2	2	1	2	2	0
	Rickmansworth	1	1	2	0	-2	0	1	0	0	0	0
	Watford	-1	-1	-1	-3	0	-1	-1	-2	-2	-3	-1
	Hertford	0	0	2	4	3	0	0	0	0	-1	2
	Welwyn Garden City	0	0	1	3	4	0	0	-1	0	0	0
	Stevenage	1	0	1	3	4	0	0	0	1	-2	1
	Hitchin	1	1	0	2	5	0	-1	1	0	-1	3
	St Albans	2	1	3	4	5	1	0	0	0	0	0
	Hemel Hempstead	2	3	3	2	3	1	2	1	1	0	0

Table 7-10 Journey time comparisons between LP4 and LP3 in IP (mins)

	2036 LP4 - 2031 LP3 IP (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs LP3	Bishop's Stortford	0	1	2	3	4	1	1	2	2	2	2
	Cheshunt	0	0	1	1	1	0	0	0	0	0	0
	Borehamwood	2	1	0	1	1	1	1	0	2	2	1
	Rickmansworth	2	0	2	0	2	1	1	0	2	1	1
	Watford	2	0	1	-1	0	2	1	0	0	1	1
	Hertford	0	0	0	1	2	0	0	0	0	1	1
	Welwyn Garden City	0	0	0	1	2	0	0	-2	0	0	0
	Stevenage	0	0	0	2	3	0	0	0	0	1	2
	Hitchin	0	0	0	1	0	0	0	0	0	0	0
	St Albans	0	1	1	1	2	0	0	-1	1	0	0
	Hemel Hempstead	1	1	2	1	1	1	1	0	0	0	0

Table 7-11 Journey time comparisons between LP4 and LP3 in PM peak (mins)

	2036 LP4 - 2031 LP3 PM (min)										
	Town	Bishop's Stortford	Cheshunt	Borehamwood	Rickmansworth	Watford	Hertford	Welwyn Garden City	Stevenage	Hitchin	St Albans	Hemel Hempstead
LP4 vs LP3	Bishop's Stortford	0	3	3	0	1	1	1	3	3	5	5
	Cheshunt	0	0	2	1	2	0	0	0	1	2	2
	Borehamwood	3	1	0	1	0	1	1	0	2	0	-2
	Rickmansworth	4	3	4	0	1	3	3	2	4	1	3
	Watford	3	1	2	-3	0	2	3	2	1	1	1
	Hertford	0	0	-1	1	3	0	0	0	0	2	1
	Welwyn Garden City	-1	-1	-1	1	2	0	0	-2	0	0	1
	Stevenage	0	-1	0	2	3	0	1	0	0	0	0
	Hitchin	0	-1	-1	1	0	0	-1	0	0	0	0
	St Albans	0	1	1	1	1	0	1	0	0	0	0
	Hemel Hempstead	4	2	2	0	1	1	2	0	0	0	0

8. Public Transport Forecast Results

8.1 Hertfordshire Statistics

8.1.1 The model forecast of change in public transport usage in Hertfordshire is summarised in the tables below. It should be noted that the COMET rail model does not consider capacity or passenger crowding, and is therefore unconstrained by congestion. While the model forecast is not considered implausibly high as a central assumption, it might require capacity improvements on the rail network to achieve.

8.1.2 As shown in Table 8-1, rail travel distance increases significantly (by 30%-57%), while bus travel distance falls slightly. Growth is generally larger in the inter-peak – this is due to the higher growth in "other" trips compared to commuting trips (see paragraph 5.7.9 for explanation of this trend).

Table 8-1: Public Transport Passenger Distance (passenger kms), Hertfordshire Only, Hourly

Period	Mode	2014 Base	2036 Local Plan	Change
AM	Rail	1,257,487	1,639,173	30%
IP	Rail	409,341	643,924	57%
PM	Rail	1,082,830	1,440,576	33%
AM	Bus	120,724	106,859	-11%
IP	Bus	116,638	108,908	-7%
PM	Bus	105,954	104,207	-2%

8.1.3 Table 8-2 presents the forecast results in terms of passenger boardings in Hertfordshire. It should be noted that whilst bus travel accounts for approximately 45% of total passenger transport boardings, it only represents a small minority (~10%) of total passenger distance. This is because rail trips are substantially longer. Bus demand in the AM and PM Peaks falls at a higher rate than in the inter-peak due to increased highway congestion in the peak hours.

8.1.4 The number of rail boardings in the AM Peak is much larger than in other periods, as much of the demand is heading outside Hertfordshire as commuting trips.

8.1.5 While the model forecast for rail growth is fairly high relative to other modes, it is quite likely to be lower than the actual growth that will occur. UK rail growth in the past two decades has been close to 4% per year, which if continued, would imply 95% growth from 2014 to 2036. While past trends may not continue, it is likely that the model's rail growth forecast is in fact conservative.

Table 8-2: Public Transport Passenger Boardings, Hertfordshire Only

Period	Mode	2014 Base	2036 Local Plan	Change
AM	Rail	18,872	25,893	37%
IP	Rail	4,083	7,637	87%
PM	Rail	5,415	9,417	74%
AM	Bus	8,785	9,061	3%
IP	Bus	8,994	9,792	9%
PM	Bus	6,841	7,392	8%

8.1.6 Table 8-3 shows the average public transport fare per journey. The fare values are the actual average fare paid by an average passenger (i.e. *(Sum of demand x Cost)/Sum of Demand*.

8.1.7 The average fare increase for rail trips is similar to the input fare growth assumption of 18% (see Table 5-6). It is very slightly larger for bus trips, suggesting some slight lengthening of the average trip. However, the overall average public transport fare increase is much larger than this, at over 30%. This is because demand has shifted from bus travel (which has lower fares) to rail travel (which has higher fares).

Table 8-3: Average Public Transport Fare per Journey, Hertfordshire Only, 2010 prices

Period	Mode	2014 Base	2036 Local Plan	Change
AM	Rail	£8.48	£10.28	21%
IP	Rail	£8.32	£9.84	18%
PM	Rail	£7.85	£9.58	22%
AM	Bus	£0.91	£1.17	28%
IP	Bus	£0.88	£1.13	29%
PM	Bus	£0.88	£1.14	30%
AM	All	£6.07	£ 7.96	31%
IP	All	£3.10	£4.87	57%
PM	All	£3.78	£5.76	52%

8.1.8 Table 8-4 shows the average public transport journey distance per journey. Neither bus nor rail average journey distance change significantly, however, the overall public transport journey distance is notably higher. This is because rail growth is predicted to be higher than bus growth, and rail trips are significantly longer in the first place.

Table 8-4: Average Public Transport Journey Distance (km), Hertfordshire Only

Period	Mode	2014 Base	2036 Local Plan	Change
AM	Rail	38.240	36.582	-4%
IP	Rail	37.761	34.583	-8%
PM	Rail	36.020	33.789	-6%
AM	Bus	8.877	8.843	0%
IP	Bus	7.705	7.533	-2%
PM	Bus	7.891	8.214	4%
AM	All	28.889	29.494	2%
IP	All	16.674	19.162	15%
PM	All	19.598	22.216	13%

Bus Passenger Flow

8.1.9 Flow difference plots for bus demand are presented below. These show the differences between 2036 and 2014 passenger flow. Red bars indicate an increase in flow, while green bars indicate a decrease. The greater the thickness of the line, the greater the flow difference.

Figure 8-1: Bus Passenger Flow Change, 2014 to 2036, AM Peak Hourly Flow

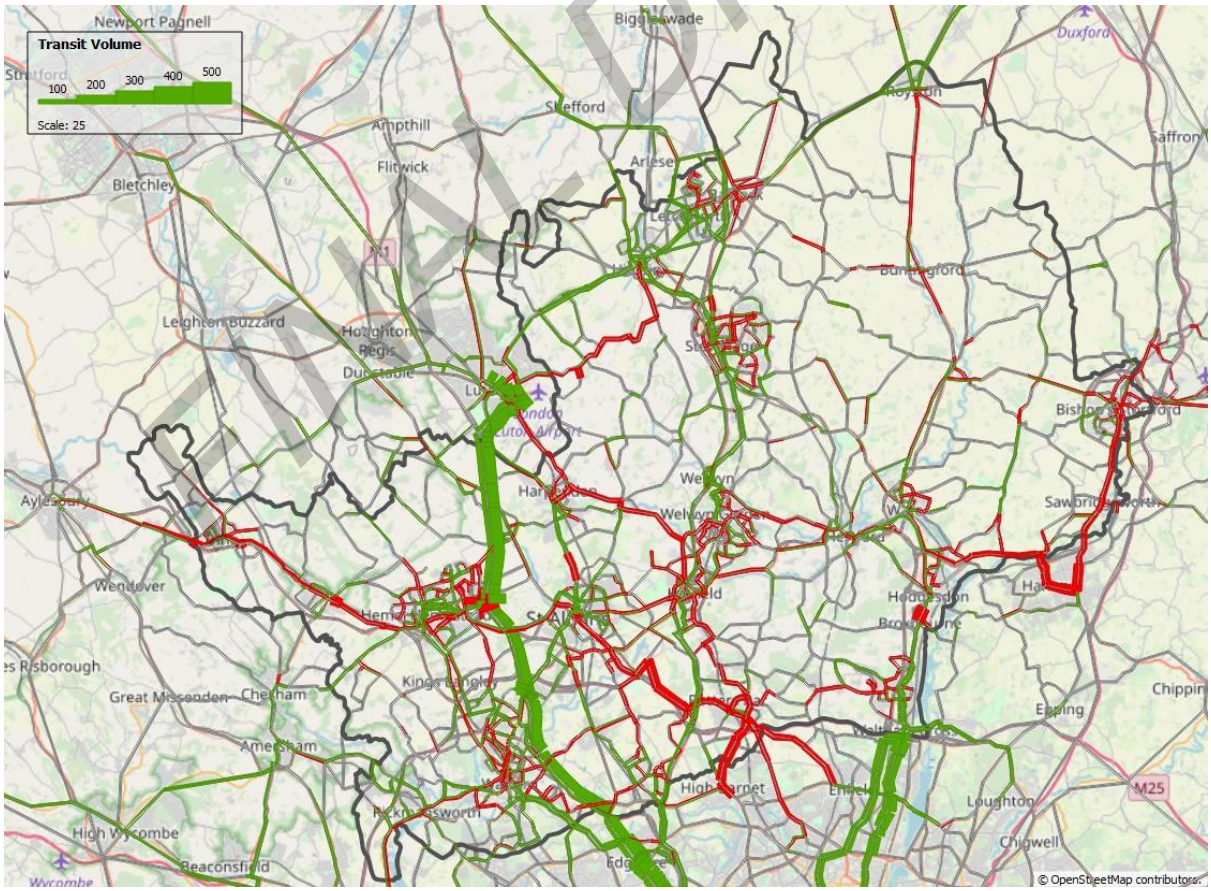


Figure 8-2: Bus Passenger Flow Change, 2014 to 2036, Inter peak Hourly Flow

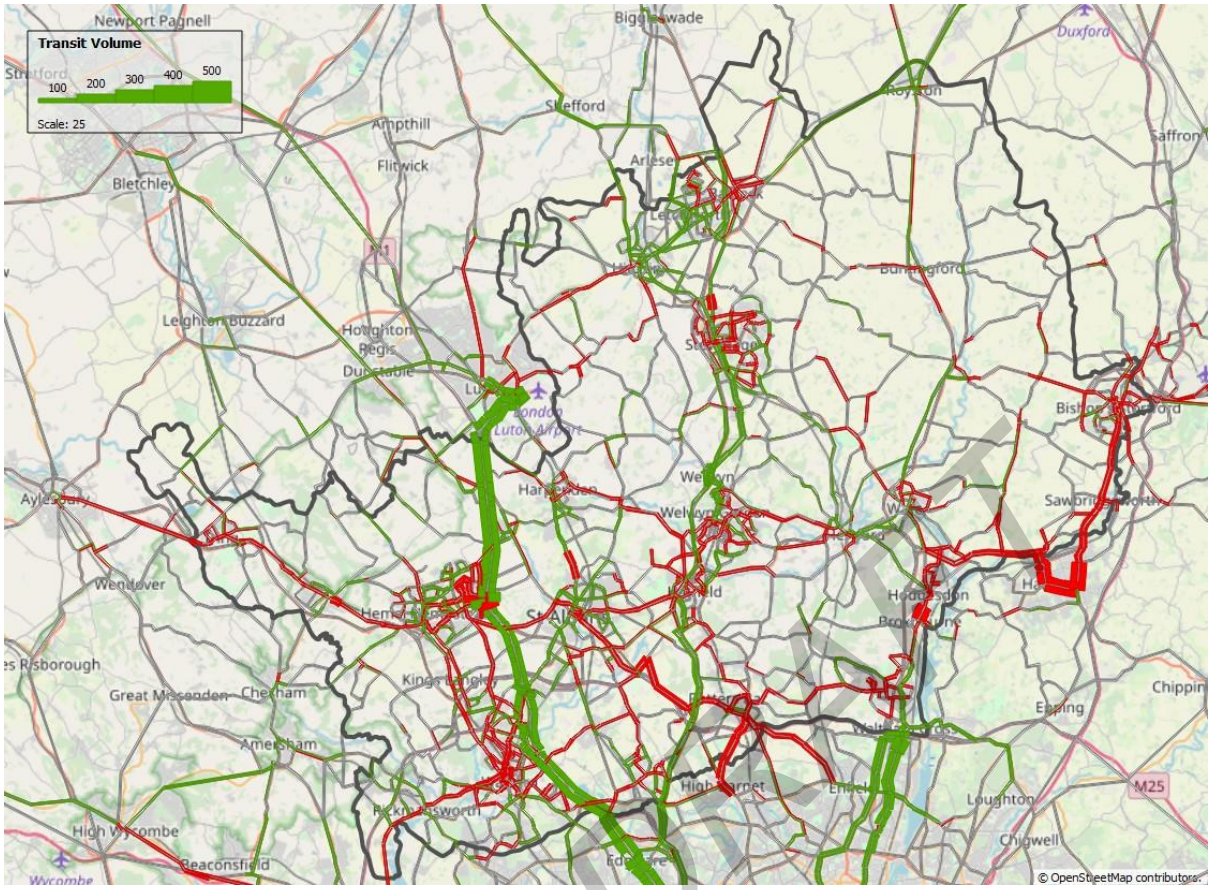
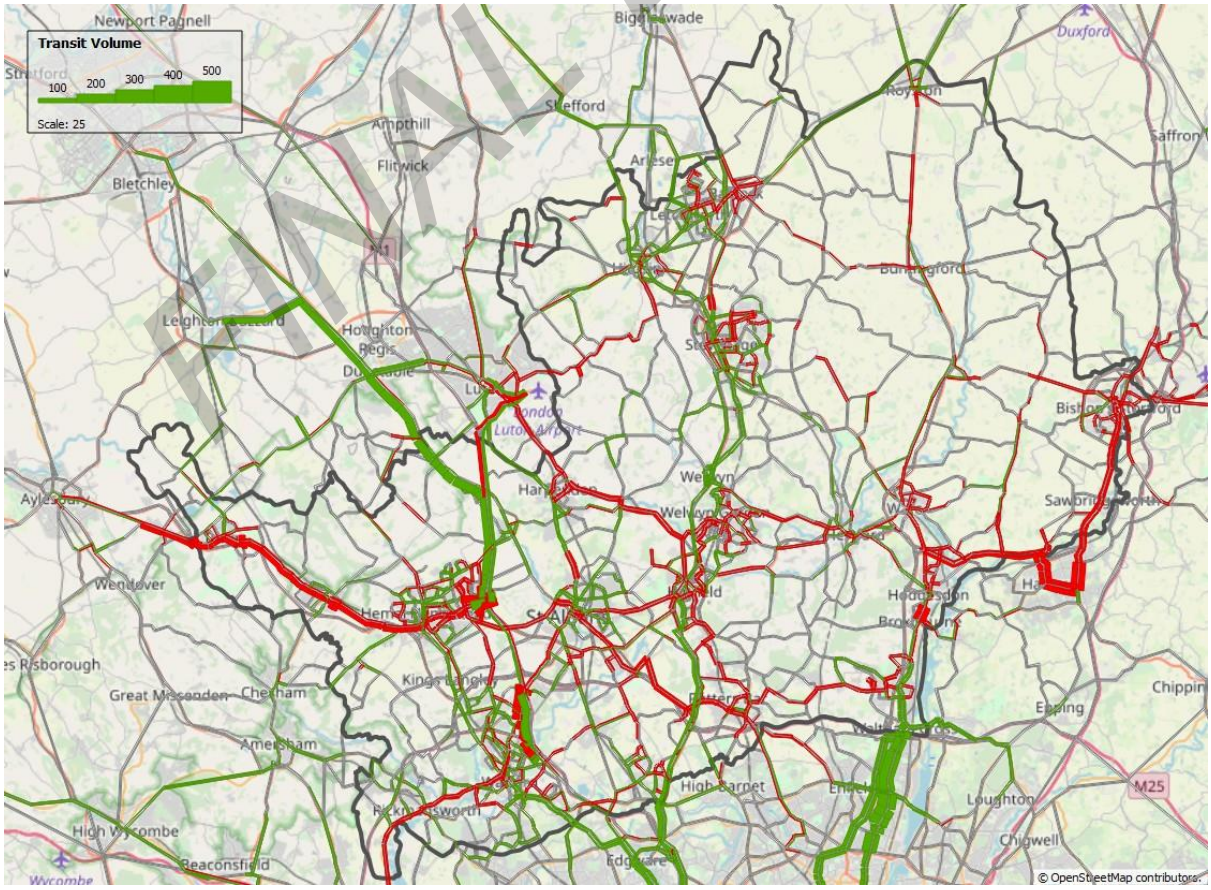


Figure 8-3: Bus Passenger Flow Change, 2014 to 2036, PM Peak Hourly Flow



8.1.10 The main increase in bus passenger flow is modelled between the Gilston development and Harlow town centre. The increased bus passenger flow is likely to be related to the introduction of an associated bus link into Harlow. This increase in passenger flow also continues (to a lesser extent) to Bishop's Stortford.

8.1.11 Links to new developments such as Radlett and Tyttenhanger Garden Village adjacent to the A414 corridor south west of St Albans can also be observed. There are also localised increases around Watford, Hemel Hempstead and Hatfield. Some changes may be linked to the VDM parameter applied which artificially raises the cost of highway trips from some new development areas.

8.1.12 The largest decrease in bus passenger flows is observed along M1 corridor (where rail services between Luton and London operate) with a decrease of up to ~400 passengers in the southbound direction during AM peak and of a similar magnitude in the northbound direction during PM peak. A similar pattern is noted from Broxbourne south along the A10 corridor into north London. This is due to:

- The growth in personal incomes is likely to be higher than the growth in rail fares. As incomes rise, rail becomes relatively more attractive than bus, so some demand moves from bus to rail (where the modes compete on the same corridor)
- Increasing congestion on the highway network encourages shift from bus (and highway) to rail (where the modes compete on the same corridor)

8.1.13 On the M1 corridor, for example, the decrease in bus passenger flow is likely to be related to a rise in rail passenger flow on Thameslink and Midland Main Line. The decrease in bus travel associated with this modal shift does not extend to any significant extent beyond Luton.

8.1.14 A decrease in bus passenger is also modelled along the Cheshunt-Enfield corridor (which has a competing and improved rail service - Crossrail2).

Rail Passenger Flow

8.1.15 Similar plots for rail flow are shown below. Of necessity, a different scale is used for the rail flows, as these are very much larger than bus.

Figure 8-4: Rail Passenger Flow Change, 2014 to 2036, AM Peak, Hourly Flow

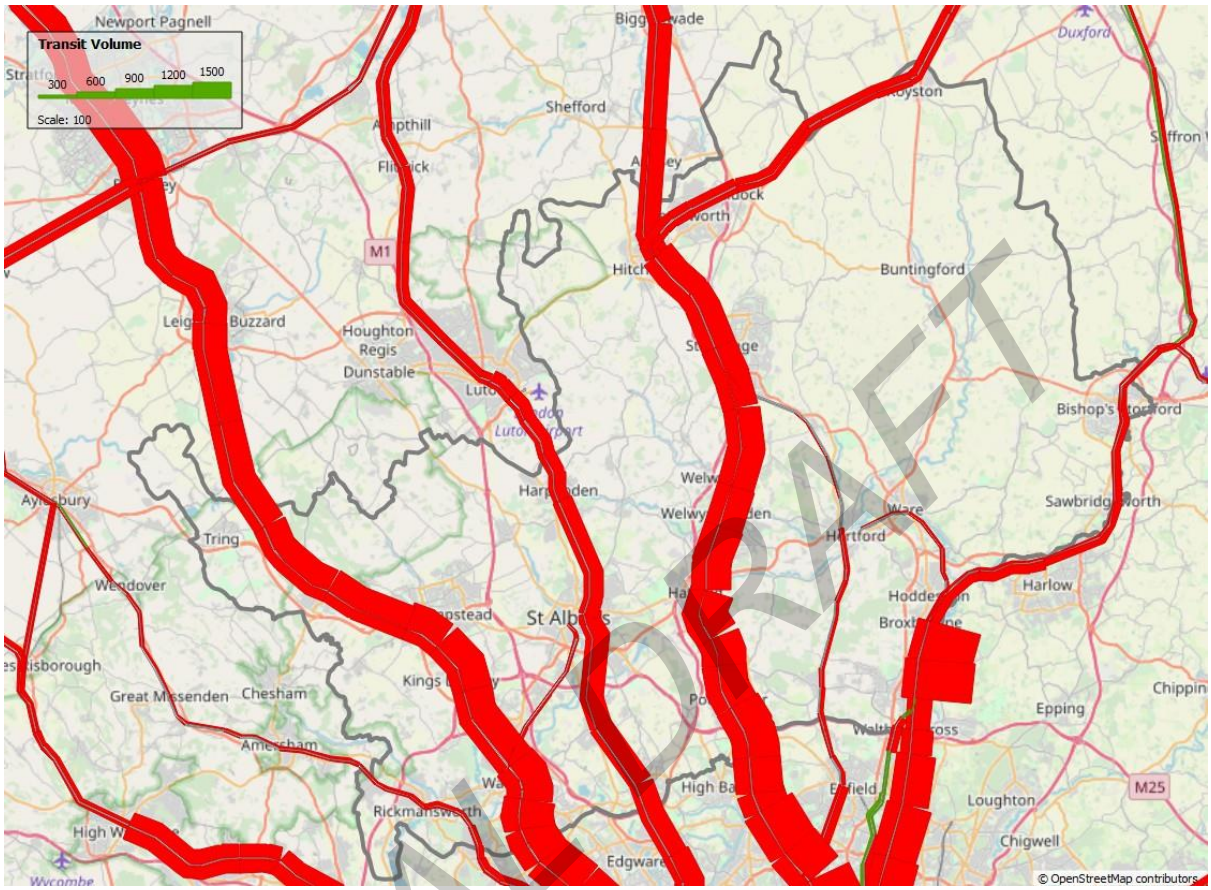


Figure 8-5: Rail Passenger Flow Change, 2014 to 2036, Inter peak, Hourly Flow

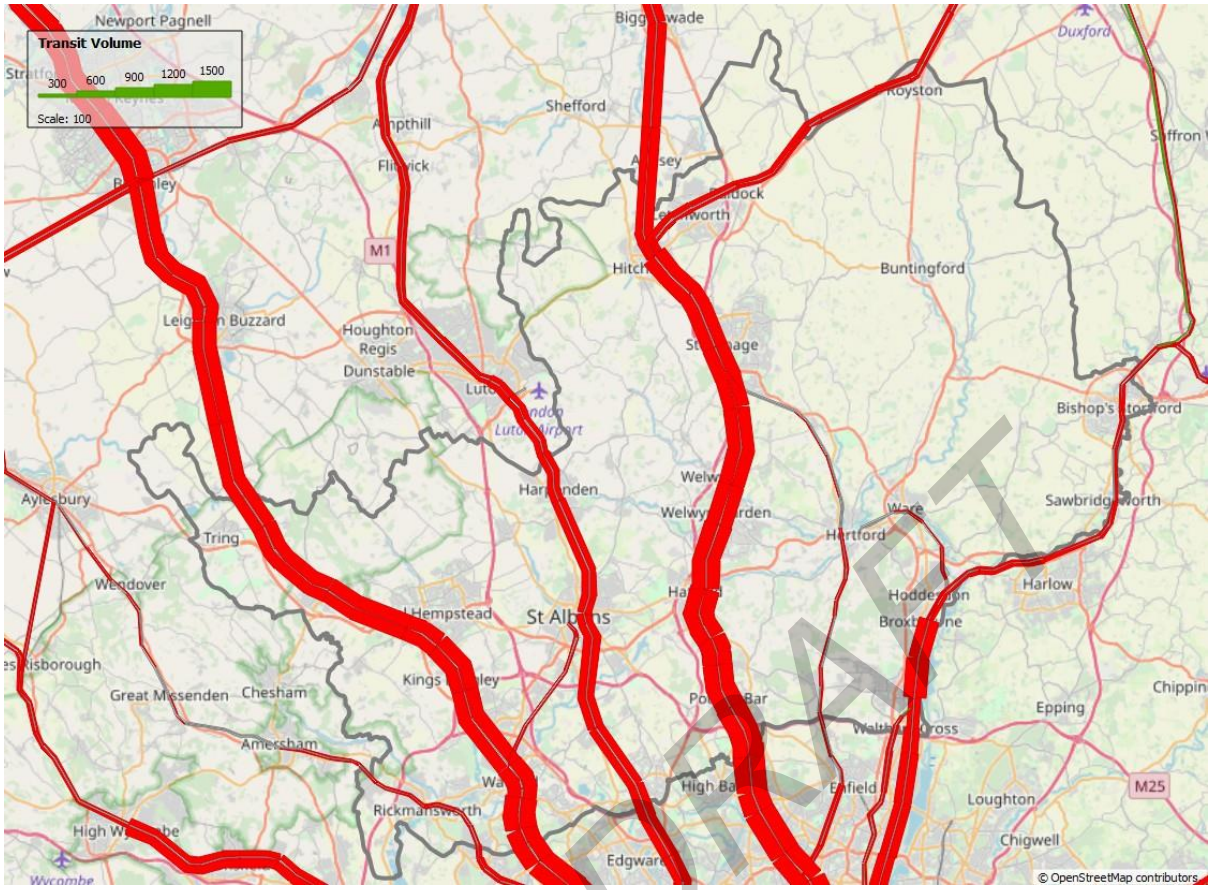
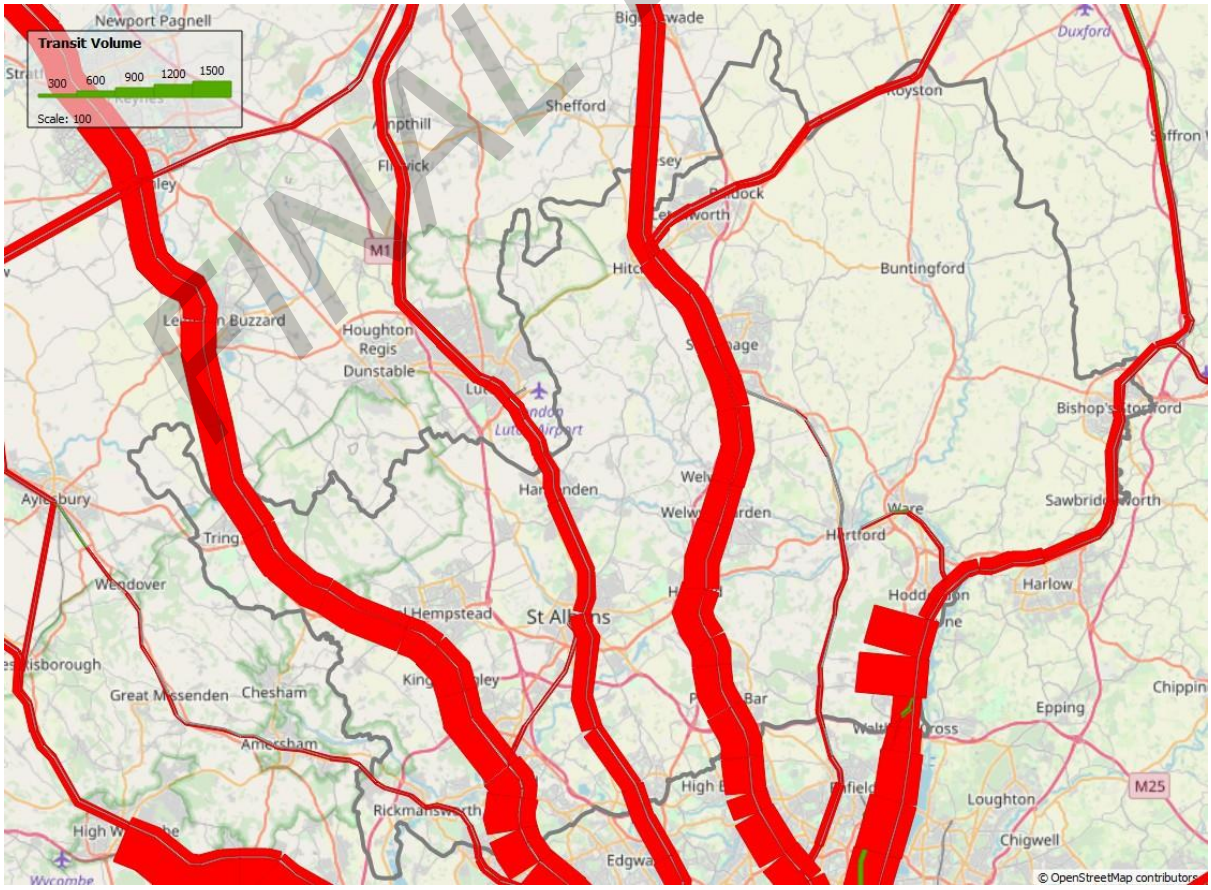


Figure 8-6: Rail Passenger Flow Change, 2014 to 2036, PM Peak, Hourly Flow



8.1.16 Apart from some switching of passenger demand from the London Overground service (between Cheshunt and Liverpool St) onto the West Anglia Mainline, all rail demand rises. The prominent rise is in north-south movements to and from London. This is to be expected given Hertfordshire's proximity to London, however some increases in east-west routes are also visible.

8.1.17 It must be acknowledged that as a multi-modal logit model, COMET is not an ideal tool for assessing most strategic rail schemes; this would more usually be done with a rail elasticity model based on the Passenger Demand Forecasting Handbook (PDFH).

8.1.18 As discussed above, the overall rail growth in COMET is significantly lower than might be expected from a rail elasticity model. It would be possible to use the COMET rail assignment model to develop a PDFH-style rail forecasting tool, but this is not the subject of this document.

9. Summary and Discussion

9.1 Summary

9.1.1 A 2036 forecast has been developed using COMET to understand the cumulative impact of Local Plan growth in Hertfordshire and selected neighbouring authorities[13] on the transport network.

9.1.2 This document outlines the forecasting approach, development of forecast networks and trip matrices, and presents the results in terms of highway and public transport assignments. This forecast shows that the variable demand, highway and public transport models all behave as expected and provide reasonable results.

9.1.3 In terms of highway trips originating in Hertfordshire, an increase of approximately 25% (at a 24 hour level) is forecast between 2014 and 2036. This increase is accompanied by a rise in travel distance of between 19% - 30% (depending on time period), but an increase in travel time of up to 43% (AM Peak). The relatively sharp rise in travel time compared to travel distance is indicative of increasing congestion, and corroborates the fall in average network speed of approximately 14% in the AM Peak.

9.1.4 Forecast results show some significant congestion on key urban and inter-urban roads in 2036:

- Various sections of the M25, particularly in south east Hertfordshire;
- Various sections of the A1(M) and M1;
- East-west routes between Hemel Hempstead, St Albans and Hatfield;
- A505 near Letchworth Garden City and around Royston;
- Links around Maylands in Hemel Hempstead;
- Routes into around Harlow; and
- Sections of the A414 across Hertfordshire

9.1.5 Rail boardings increase on average by 66% between 2014 and 2036, whilst bus boardings increase by 7%. Travel distance by rail in Hertfordshire increases significantly (by 30%-57%), while bus traveller distance falls slightly. Growth is generally larger in the inter-peak – this is due to the higher growth in “other” trips compared to commuting trips.

9.1.6 Longer distance bus travel decreases as rail becomes a more attractive option, however some local movements by bus increase due to the linkages of new developments to bus routes.

9.2 Discussion

Future Uncertainty and COMET Forecasts

9.2.1 The COMET forecasting methodology takes into consideration future changes in population, number of jobs and dwellings, as well as rising costs of travel and proposed transport infrastructure schemes.

[13] Central Bedfordshire, Luton, Buckinghamshire (all districts), part of Essex (i.e. Epping Forest, Harlow, and Uttlesford), and part of Cambridgeshire (i.e. South Cambs and Cambridge)

9.2.2 However, there is currently no allowance for factors that may fundamentally alter the nature of travel in Hertfordshire or elsewhere in Great Britain. These factors may include the introduction of new technologies (e.g. autonomous vehicles) or a significant shift in travel patterns relative to the Base Year model as a result of behavioural change. Such behavioural change may be brought about by factors such as changing demographic characteristics / consumer preferences, economic instability, climate change and globalisation.

9.2.3 Consequently, COMET forecasts should be viewed as possible representations of the future in Hertfordshire among a number of potentially different alternatives that require unconventional approaches to planning and investment in the county.

Sustainable Transport

9.2.4 It should be noted that the approach to modelling modal shift in a multi-modal model (such as COMET) should be based on the inclusion/coding of infrastructure to facilitate such behaviour change in the forecast network. Without doing so (as applies to this forecast) the modelled modal shift is not a result of COMET's Variable Demand Model representing behavioural change; rather, it is the result of a parameter adjustments that are currently not based on any specific interventions to the transport network. Once more specific scheme assumptions regarding the proposed sustainable travel initiatives are known, these should be coded into COMET as other forecast schemes already are.

Related HCC Projects

9.2.5 The forecast results presented in this document suggest that the usage of Hertfordshire's transport network will continue to grow until 2036. This is particularly the case during the peak hours and in the county's known congestion hotspots. One such hotspot is the A414 corridor that runs through the core of the county, and will be a major focus of growth in future housing and employment. The concentration of high levels of link stress, delays and congestion around the south west of Hertfordshire highlight the importance of the SW GTP (South West Herts Growth and Transport Plan).

9.2.6 These results therefore reinforce the critical nature of ongoing and related HCC projects including the A414 Corridor Strategy and Hertford Transport and Movement Package. These projects will contribute to the evidence-based development of interventions that promote sustainable and future-proof transport in Hertfordshire.

10. Appendices

10.1 Appendix I: Employment Densities used for Calculation of Jobs

Land Use Class	Area per FTE (m^2)	Comment
A1 (Retail)	18	Assumed value is the average of "High Street" (15-20) and "Foodstore" (15-20) in Employment Density Guide. Value for "Retail Warehouse" (90) is excluded as it is significantly higher and would distort the calculation.
A2 (Finance & Professional Services)	16.0	Directly from Employment Density Guide
A3 (Restaurants & Cafes)	18	Assumed average of range (15-20) in Employment Density Guide
A4 (Drinking Establishments)	46	Not available in Employment Density Guide, so derived from 47 TRICS sites.
A5 (Hot Food Takeaways)	59	Not available in Employment Density Guide, so derived from 28 TRICS sites.
B1(a) (Offices)	10	Assumed value is average of the 5 "General Office" types and Call Centres.
B1(b) (R&D Space)	50.0	Assumed value is average of given range (40-60)
B1(c) (Light Industrial)	47.0	Directly from Employment Density Guide
B2 (Industrial & Manufacturing)	36.0	Directly from Employment Density Guide
B8 (Storage & Distribution)	81	Assumed value is average of 3 "Storage & Distribution" use classes.
C1 (Hotels)	100	Value in Employment Density Guide is given in terms of hotel rooms, which is inconsistent with HCC planning data. Therefore, TRICS is used to derive a density value based on 40 sites.
C2 (Residential institutions)	100	Not available in Employment Density Guide, so derived from 49 TRICS sites.
D1 (Non-residential institutions)	36	Not available in Employment Density Guide, so derived from 203 TRICS sites.
D2 (Assembly and leisure)	71	Assumed value is the average of "Fitness Centres" (all types), "Cinema", and "Amusement & Entertainment Centres" in Employment Density Guide. Value for "Visitor & Cultural Attractions" (30-300) is excluded as its range is very large and would distort the calculation.
Sui Generis	92	Not available in Employment Density Guide, so derived from 26 TRICS sites.

10.2 Appendix II: SATURN Highway Assignment Parameters

LOGICAL PARAMETERS

AMY = F
ASHORT = T
ATLAS = F
AUTNUC = T
AUTOK = T
AUTONA = T
AUTOX = F
AUTOZ = F
BANKER = F
BB109 = T
BEAKER = T
BUSKER = T
CLIMAX(5) = T
COMPAS = F
CROWCC = F
CUMULO = F
DCSV = F
DIDDLE = T
DOUBLE = T
DUALEX = T
DUTCH = F
ERTM = F
EXPERT = T
EZBUS = T
FIFO = T
FOZZY = T
FREDDY = F
FREEKY = F
FREEXY = T
FREE77 = F
FREE88 = F
FUNNEL = F
ICING = F
ILOVEU = T
KERMIT = F
KINKY = T
KONAL = F
LCR108 = T
LEFTDR = T
LIST = T
MINDER = F
MONACO = T
M108 = T
MULTIC = T
NOXYC = F
NO333C = F
PARTAN = F
PHILIP = F
PRINT = F
PRINTF = F
PRSFD = F
QUEEN = F
QUIKSA = F
QRTP = F
Q105 = T
RAGS = T
RB106 = T
REDMEN = F
REFFUB = F
ROSIE = F
RTP108 = T
SATOFF = F
SATTIT = T
SAVEIT = T
SAVUFO = T
SECRET = F
SHANDY = T
SIGOPT = F
SIM109 = T
SIM111 = F
SOWHAT = F
SPARSE = T
SPEEDS = T
SPIDER = T
STOLL = F
STUART = F
SUZIE = F
SUZIEQ = T
TOPUP = T
UFC109 = T
UFC111 = T
UNIQUE = F
UPBUS = T
USEUFO = T
WHATHO = F
WINDY = T
WRIGHT = T
ZILCH = F
GIS7 = T

INTEGER PARAMETERS

IBUSVC = 1
IFCC = 2
IFRL = 1
IPERT = 0
IROCKY = 0
ISTOP = 98
KANGA = 9999
KARL = 50
KDF = 1
KLUNK = 1
KNOBS = 0
KOB = 0
KOMBI = 0
KONSTP = 5
KORN = 0
KPHMIN = 10
KPHMAX = 120
LCY = 120
LRTP = 60
LTP = 60
MANOFF = 0
MASL = 100
MASL_F = 0
MASL_M = 1
MAXDTP = 10
MAXLSF = 3000

MAXQCT = 60
MAXSPA = 30
MAXZN =99999
MCALG = 1
MCNUM = 0
MCCS = 3
MCGILL = 0
MCUBC = 0
MET = 0
MINLSF = 300
MINRED = 10
MINSAT = 500
MODET = 1
MYTVV = 5
NFT = 113
NIPS = 2
NISTOP = 4
NITA = 20
NITA_C = 256
NITA_F = 0
NITA_M = 3
NITA_S = 99
NITS = 30
NITS_M = 5
NOMADS = 5
NOPD = 0
NOPMAX = 1
NOTUK = 0
NUC = 25
NUCMIN = 1

REAL PARAMETERS

AFTERS = 0.5000
AK_MIN = 0.2000
ALEX = 5.7500
APRESV = 1.0000
BBKING = 0.9500
BCRP = 2.0000
BETA = 0.1000
BETA_2 = 0.1000
BETA_D = 0.1000
BETA_T = 0.1000
BTKNOB = 0.0000
BUSPCU(1) = 2.2000
BUSSPK = 0.0000
CAPMIN = 30.0000
COBAF = 1.0000
DEFCAP = 1250.0000
DMWL = 300.0000
DMWL2 = 2000.0000
FISTOP = 0.0500
FLAREF = 2.0000
FLAREX = 2.0000
FLPK = 0.0700
FLPH = 1.2000
FLPPS = 0.0160
FLPSS = 0.0050
FRED = 1.0000
GAP = 1.5000
GAPM = 1.0000
GAPR = 2.0000
GAPRF = 1.0000
GONZO = 1.0000
OBAMAX = 0.1000
PCNEAR = 1.0000
PMAX = 5.0000
POWER = -1.0000
PPK = 0.0000
PPM = 1.0000
QDMAX = 226.0000
QVCMIN = 0.7500
RESIDD = 0.0000
RESIDR = 0.0000
RSTOP = 97.5000
SHADOW = 0.0000
STPCPU = 1000.0000
STPGAP = 0.0500
SUET = 0.2000
TAX = 2.0000
TDEL = 3.0000
TIJMIN = 0.0000
UNCRTS = 0.0200
VCPCU = 1.0000
VCPCU(2) = 1.0000
VCPCU(3) = 2.3000
WLMIN = 300.0000
WLMAX = 2000.0000
W32D = 0.0010
W32T = 0.1000
W32KPH = 1.5000
XFSTOP = 0.0500
XYUNIT = 1.0000

CHARACTER PARAMETERS

COINS = 'PENCE'
CURNCY = 'POUNDS'
FILGIS = 'COMET.GIS'
UCNAME(1) = 'Car Commute'
UCNAME(2) = 'Car Employers Business'
UCNAME(3) = 'Car Other'
UCNAME(4) = 'LGV'
UCNAME(5) = 'HGV'
VCNAME(1) = 'Lights'
VCNAME(2) = 'HGV'
XYFORM = '2I10'

10.3 Appendix III: Full List of Highway Schemes

	Location Details	Description of scheme	Modelled in LP3?
M25 jct 25-27	Smart Motorway improvements	Widening of motorway to 4 lanes with hard shoulder running	LP3
M25 junction 25	M25 junction 25	M25 junction 25 RIS 2 capacity improvements - Option 2	LP3
Hoddesdon	A10 Link Hoddesdon	A10 Hoddesdon_Dumbell Roundabout - Dinant Link Road - New roundabout to permit access to High Leigh development	LP3
Waltham Cross	A10/Lieutenant Ellis Way / Churchill Way junction	Reconfiguration of the junction into a hamburger with access into (and out of) the Park Plaza West site at the Great Cambridge Road/Great Eastern Road signals.	LP3
Waltham Cross	A10 junction with Park Plaza	Modify existing 3 arm signal junction on A10 to provide at grade 4 arm junction for access into Park Plaza North & West	LP3
Waltham Cross	Lieutenant Ellis Way / Park Plaza W access	New 4 arm junction on Lieutenant Ellis Way to north of Park Plaza	LP3
Cheshunt	A10 /College Road	Implementation of right turn bans between A10 and College Road and free flow LT slip from A10 north to College Road E	LP3
Cheshunt	A10 /Church Lane	A10 / Church Lane at grade junction improvements	LP3
Turnford / Brookfield	A10 Turnford junction to Halfhide Lane	New 4 lane Link road runs through to Halfhide Lane which then becomes Brookfield Lane W south of the retail park - SB onslip at the Turnford interchange is no longer assumed.	LP3
Brookfield Centre	Hells Wood Link Road between The Links and Hells Wood	New link road running between Turnford Link Road and A10 providing revised access into Brookfield and Tescos with closure of existing junction between Halfhide Lane and the Links	LP3
Cheshunt	Church Lane / High Street	Reconfiguration of roundabout to provide signalised crossing junction & crossing points for pedestrians	LP3
Flamstead End	Church Lane / Flamstead End	Reconfiguration of roundabout to provide signalised crossing junction & crossing points for pedestrians	LP3
Turnford	Marriott Roundabout (Halfhide Lane/ A1170) capacity improvements	Provision of additional capacity	LP3
Waltham Cross	Fishpools junction (Winston Churchill Way / Monarchs Way) signalisation	Reconfiguration of junction to provide signalised junction & crossing points for pedestrians	LP3
Goffs Oak	Goffs Lane / Newgatestreet Road / Cuffley Hill signalisation	Reconfiguration of junction to provide signalised junction & crossing points for pedestrians	LP3

Hoddesdon	Dinant Link Road / Amwell Street (Sun Roundabout) capacity improvements	Additional lane on eastern arm of roundabout	LP3
Hoddesdon	Hertford Road / Ware Road additional lanes	Roundabout improvements to provide additional eastbound & southbound lanes	LP3
Hoddesdon / Broxbourne / Turnford / Cheshunt	Old A10 (A1170 Ware Road / Charlton Way/ High Road/ B176 Cheshunt Wash / High Street / Turners Hill/ Crossbrook Street	Provision of traffic calming	LP3
Broxbourne Station	Broxbourne Station access improvements	Replace priority give way junction with signalised junction incorporating pedestrian facilities	LP3
Hoddesdon	Essex Road / Pindar Road	Reconfiguration of junction to provide additional capacity	No
Hoddesdon	Essex Road / Dinant Link Road	New road alignment and bridge and	No
Cheshunt	Turnford Road / College Road (Old Pond roundabout) & Turnford Road / Windmill Lane	Old Pond junction improvement	No
Hemel Hempstead	Swallowdale Lane / Three Cherry Trees Lane, Hemel Hempstead	Junction Signalisation	LP3
Hemel Hempstead	A414 Breakspear Way / Maylands Lane, Hemel Hempstead	Lane reallocation	LP3
Hemel Hempstead	The Avenue, Hemel Hempstead	Development site Secondary site access onto The Avenue (extension of existing spur)	LP3
Hemel Hempstead	A4147 Link Road (Location between Piccotts End Road and Aycliffe Drive), Hemel Hempstead	New roundabout access	LP3
Hemel Hempstead	Fletcher Way, Hemel Hempstead	T Junction onto Fletcher Way, Hemel Hempstead	LP3
A5 Dunstable	M1 - A5	M1 A5 Link Road	LP3
A4146 Water End	A4146 Waterend	A4146 HGV ban at Waterend	LP3
Hemel Hempstead	Bedmond Road / Leverstock	Bedmond Road / Leverstock Junction Upgrade	LP3
Hemel Hempstead	Leighton Buzzard Road / Combe Street, Hemel Hempstead	Junction Signalisation	LP3
Berkhamsted	Kingshill / Shootersway, Berkhamsted	Junction Signalisation	LP3
Berkhamsted	High Street Corridor	Extension of 20mph zone and pedestrian crossing facilities	LP3

Tring	Icknield Way, Tring	New junctions to development (LA5) with associated highway improvements, including new cycle and pedestrian routes.	LP3
Bovingdon	Chesham Road / Molyneaux Avenue	New access to LA6 development	LP3
Hemel Hempstead	Leighton Buzzard Road / Queensway Roundabout	Junction reconfiguration including part-time signals with widening.	LP3
Hemel Hempstead	Between Boundary Way and Wood Lane End	New link between Boundary Way and Wood Lane End.	LP3
Hemel Hempstead	Link Road / Redbourn Road roundabout		LP3
Hemel Hempstead	Redbourn Road / Shenley Road, Hemel Hempstead	Reconfiguration of junction	LP3
Hemel Hempstead	Station Road / St Johns Road / Heath Lane, Hemel Hempstead	New mini roundabout	LP3
Hemel Hempstead	London Road / Nash Mills Road / Red Lion Lane, Hemel Hempstead	Signal optimisation	LP3
Hemel Hempstead	Fishery Road / Northridge Way, Hemel Hempstead	Junction signalisation	LP3
Hemel Hempstead	Maylands Avenue / Wood Lane End, Hemel Hempstead	Signal optimisation	LP3
Hemel Hempstead	Two Waters Road / London Road, Hemel Hempstead	Rearrangement of junction & signal optimisation	LP3 (some changes)
Hemel Hempstead	Leighton Buzzard Road north of Plough Roundabout	Signal optimisation	LP3
M1 Junction 8, Hemel Hempstead	M1 junction 8	Junction 8 - Major reconfiguration to provide direct access into Maylands	LP3
Hemel Hempstead	A414 / Green Lanes	Interim at grade signalisation scheme	LP3
Maylands Area, Hemel Hempstead	A414 to B487 Redbourn Road	New spine road from B487 Rebourn Road to A414 St Albans Rd - dual carriageway up to new link from M1. Single carriageway north of here.	LP3 (some changes)
Maylands Area, Hemel Hempstead	Cherry Trees Lane and Buncefield Lane quietways	Closing the existing narrow country lanes within the industrial area of Cherry Trees Lane, Buncefield Lane (north) and Buncefield Lane (south) to through traffic	LP3
Maylands Area, Hemel Hempstead		New pedestrian / cycle crossings in Maylands area -	LP3
Redbourn	Redbourn Area	HGV restrictions on B487 and A5183	LP3
Hemel Hempstead	Plough Roundabout - plus closure of Lawn Lane arm	Bus priority lanes on A414 WB, Station Road and Two Waters Road approaches	No
Hemel Hempstead	A414 Hemel Hempstead	Multi-Purpose Street	No

Hemel Hempstead	North Hemel	New link road between Redbourn Road and Leighton Buzzard Road	No
Hemel Hempstead	Apsley / Two Waters Road	Ped / cycle improvement.	No
Hemel Hempstead	A4251 London Road Hemel Hempstead	Model as reduced speed along link to simulate impact of cyle lane and road narrowing	No
Hemel Hempstead	Lawn Lane arm of Plough Roundabout	No access to roundabout for vehicles	No
Hemel Hempstead	Fishery Road, Hemel Hempstead	Model closure of this link to non-bus vehicles.	LP3 (some changes)
M1 Junction 10	Junction 10 Southbound Onslip	Capacity Improvement	No
Tring	East Tring	Access road	No
Berkhamsted	South Berkhamsted	Access road	No
Bishops Stortford	A120 / Stansted Road junction, Bishops Stortford	Junction capacity improvements associated with Bishops Stortford North development	LP3
Bishops Stortford	A120/A1250 W (Tescos junction) Bishops Stortford	Additional lanes on approach arms	LP3
Bishops Stortford	A1250 Hadham Road, Bishops Stortford	New access from Bishops Stortford North development to A1250 Hadham Road	LP3
North Bishops Stortford	New spine rode through Bishops Stortford North development with new access onto A120	30mph single carriageway road connecting A1250 Hadham Road with A120 and B1004 Rye Street. E	LP3
North Bishops Stortford	Rye Street / Michaels Road, Bishops Stortford	New access from Bishops Stortford North (ASR5) development to Rye Street	LP3
A602 Ware - Watton at Stone	A10 /A602 junction and A602 / Anchor Lane junction & A602 Anchor Lane to Watton	signalisation and upgrade of A10 / A602 junction, upgrade of Anchor Lane junction, realignment of A602	LP3
A602 Stevenage	A602 / Hertford Road	Junction Signalisation	No
A120 Little Hadham	Little Hadham Bypass	New A120 bypass	A120
Sawbridgeworth	New site access on land north of West Road, Sawbridgeworth.	New priority junction on Cambridge Road	No
Bishops Stortford	Manor Links, Bishops Stortford	New development access	LP3
North and East of Ware	A1170 Wadesmill road / A10 junction, Fanhams Hall Road and B1004 Widbury Hill	1.New arm on A1170 / A10 roundabout and signalisation. 2.Access onto B1004 Widbury Hill East of Ware. 3. Two Accesses are joined by a distributor Road in between which also intersects with Fanhams Hall Road	LP3
Stansted Abbotts	A1170 NB approach to A414 /A1170 Amwell roundabout	Remove the existing Bus Ln on Ware Rd approach to A10 Amwell Rbt	LP3

Buntingford	A10 Buntingford	Dualling of A10 southbound (London Road to existing DC by Westmill)	LP3
Buntingford	A10 / London Road, Buntingford	Capacity enhancements to junction	LP3
Hertford	St Andrews Street / Old Cross junction, Hertford	Signal optimisation.	LP3
Sawbridgeworth	A1184/West Road/Station Rd junction, Sawbridgeworth	Upgrades of A1184/West Road/Station Rd junction	LP3
Sawbridgeworth	A1184/High Wych Road junction, Sawbridgeworth	Signalise existing junction	LP3
Hertford	A10 /A414 (Rush Green) roundabout, Hertford	Additional capacity on A10 SB off slip	LP3
Welwyn Garden City	A414/B195 Birchall Lane/Cole Green Lane	Capacity improvements identified through WHBC junction design study	LP3
Harlow	New Link between Eastwick Road and A414 Edinburgh Way	Second River Stort crossing	LP3
Hertford	New bypass between A10 and A414 west of Hertford	New dual carriageway bypass	A414 DS
Harlow	Fifth Avenue, Harlow	Central Stort crossing (widening of Fifth Avenue between Eastwick Road and Edinburgh Way (Burnt Mill roundabout), Harlow	LP3
Harlow	A414 / Eastwick junction Harlow	Replacement of roundabout with signalised junction and provision of new arm to north providing bus access to Gilston development	LP3 Amend
Gilston area	A414 west of Eastwick & Eastwick Road	New accesses and internal distributor road for Gilston development	LP3 Amend
Bishops Stortford	Bishops Stortford between Whittington Way, St James Way and Obrey Way	Revise accesses to include roundabout connecting small portion of northern part of development (125 homes) to Whittington Way. Main access now via roundabout on A1184 St James Way and secondary priority access onto Obrey Way. Although a spine road runs through the site only buses will be able to run straight through.	LP3 Amend
Bishops Stortford station area	Goods Yard Link	New link road between London Road and Dane Street, Bishops Stortford, for all vehicles.	LP3
Harlow	M11 junction 7	M11 junction 7 short term capacity enhancements	LP3
Stansted Abbotts	A414 /A1170 Amwell roundabout	Capacity upgrade / signalisation	LP3
Stevenage	A602 / Gresley Way	Upgrading of the existing Gresley Way/A602 roundabout to signals	LP3 Amend
Bishops Stortford	A120 / A1250 (Birchanger) junction signalisation	Signalisation of existing junction and provision of rear access from Motorway Service area	No

M11 junction 8	M11 junction 8 capacity enhancements	Lane marking amendments & new dedicated free flow LT lane from M11 SB off slip	LP3
Bishops Stortford	A1250 / London Road (Hockerill junction)	Signal optimisation - signals are being refurbished	No
Buntingford	London Road, Buntingford	Reduced speed limit from 40 - 30mph	No
Standon	A120 / Station Road, Standon	Signalisation of junction	No
Bishops Stortford	South street (between Newton road and Bridge Street)	Road closure during peak hours	No
Bishops Stortford	A1250 east of Northgate End	Provision of new MSCP with new signalised access and signalisation of A1250 / Northgate End junction	No
East of Stevenage	Gresley Way, Stevenage	Provision of new signalised accesses from East of Stevenage development (EOS1)	No
Bishops Stortford	Rye Street, Bishops Stortford	Introduction of traffic calming measures, improvements of pedestrian footpaths and crossing facilities.	No
Borehamwood	Borehamwood – Station Road/Theobald St/Allum Lane junction	Upgrade of junction to continental roundabout	LP3 (some changes)
Borehamwood	Elstree Way Corridor	Junction improvement with replacement of the Tesco roundabout with signals	LP3
M25 junction 18-25	M25 j18-25	Smart motorway with hard shoulder running	LP3
Borehamwood	A1 / A411 Barnet Lane (Stirling Corner) - Borehamwood	Changes to signal staging and timing	LP3
Potters Bar	Darkes Lane / The Walk junction by station	Junction improvements	No
Potters Bar	Baker Street	New on street cycle lanes within existing road width	No
Bushey	A409 Common Road / A4140 High Road	Rephasing of signals	No
Bushey	Sandy Lane / A41 junction	Rephasing of signals	No
A41 corridor	A41 corridor parallel to M1	Signalisation strategy to link junctions	No
Watford	A4008 /Radlett Road roundabout	Convert to signalised junction & optimise timings	No
Elstree	Elstree Crossroads - A411 Watford Rd / A5183 Elstree Hill	New junction layout	No
Radlett	Park Road / Watling Street	Convert to signalised junction & optimise timings	No
Shenley	B556/ B5378 roundabout north of Shenley, S of M25 Jct 22	Convert to signalised junction & optimise timings with potential widening of approaches	No
Dancers Hill	A1081 / Trotters Bottom / Dancers Hill rbt	Convert to signalised junction and optimise timings	No

Potters Bar	B556 / Baker Street / Darkes Lane	Rephase signals	No
Borehamwood	A1 / A5135 junction	Rephasing of signals	No
Bushey	Bushey Hall Road, Bushey Grove Road, Greatham Road	Traffic calming & pedestrian enhancements	No
A1 (M) jct 6-8	A1 (M) jct 6-8	Widening of motorway to 3 running lanes between junctions 6-8.	LP 3
Baldock	New link road connecting North Baldock development to North Road and Royston Road	New bridge over railway & tie into A505 Baldock Bypass / Royston Road roundabout. Priority junction at North Road end.	LP 3
Hitchin	Woolgrove Road/ Cambridge Rd/ Willian Road Hitchin	Signal optimisation	LP 3
Hitchin	Pirton Road / A505 / Upper Tilehouse St/ Wratten Rd , Hitchin	Junction signalisation	LP 3
Hitchin	Upper Tilehouse St / A602/ Paynes Park, Hitchin	Junction signalisation	LP 3
Hitchin	A602 / B656 / Gosmore Rd/ St John's Road, (Hitchin Hill rbt)	Junction signalisation	LP 3
Hitchin	Bancroft / Hermitage Road, Hitchin	Improve signalised junction and pedestrian phasing	LP 3
Hitchin	Queen Street / Hermitage Road. Hitchin	Improve signalised junction and pedestrian phasing	LP 3
A1m junction 9	A1 (M) J9 Letchworth Gate / A505 Letchworth	Signalise all arms of roundabout & optimise existing signal entry (NB offslip)	LP 3
A1m junction 8	A1(M) J8 / A602 Letchworth junction	Junction improvements	LP 3
Baldock	Station Road / Royston Rd/Clothall Rd , Baldock	Signal optimisation	LP 3
Baldock	A507 Clothall Road / Wallington Road / South Road to B656 Royston Road, Baldock	New link road	LP 3
Letchworth	A505 / Norton Way, Letchworth	Signal optimsation	LP 3
Stevenage	B197 Gravely Rd / North road, Stevenage	Junction signalisation	LP3 (some change)
Hitchin	Non-strategic roads	Assume 20mph as general assumption in Hitchin on non-strategic routes	LP 3

Letchworth	Non-strategic roads	Assume 20mph as general assumption in Letchworth on non-strategic routes	LP 3
Royston	Non-strategic roads	Assume 20mph as general assumption in Royston on non-strategic routes	LP 3
Hitchin	Station Approach / B556 Hitchin	Hitchin Station access improvements to improve pedestrian, bus and cycle access	LP3
Royston	A505 /A10 Roundabout Royston	Widening of roundabout approach arms	LP 3
Royston	A505/A1198 Roundabout Royston	Widening of roundabout approach arms	LP3
Royston	A10/Newmarket Road / Melbourn Street Roundabout, Royston	Widening of junction approach arms	LP 3
Great Wymondley	Willian Road, Arch Road, Hitchin Road & Graveley Road, Great Wymondley speed reductions.	Reduce speed coded on these roads to 20mph to simulate impact of traffic calming in village	LP3
Little Wymondley	Stevenage Road & Priory Lane, Little Wymondley speed reductions	Reduce speed coded on these roads to 20mph to simulate impact of traffic calming in village	LP3
Graveley	B197 High Street, Graveley speed reductions	Reduce speed coded on High Street to 20mph to simulate impact of traffic calming in village	LP3
Codicote	B656 High Street, Bury Lane, Heath Lane and St Albans Road speed reductions	Reduce speed coded on these roads to 20mph to simulate impact of traffic calming in village	LP3
Knebworth	B197 Stevenage Road, London Road, Watton Road, Station Road & Gun Road speed reductions	Reduce speed coded on these roads to 20mph to simulate impact of traffic calming in village	LP3
Titmore Green / Symonds Green	Stevenage Road & Fishers Green Road speed reductions	Reduce speed coded on these roads to 20mph to simulate impact of traffic calming in village	LP3
Royston	York Way, Royston	New left in left out access from York Way onto A505	LP3
A1 (M) Jct 8		Junction improvements	LP3 (some change)
Hitchin	A600 Bedford Road, Hitchin	On-carriageway cycle route	No
Hitchin	A600 Bedford Road, Hitchin	Bedford Road Pedestrian Crossings	No
Hitchin	B656 Walsworth Road, Hitchin	Hitchin Rail Station to Town Centre Cycle Route	No
Letchworth	A505 Hitchin - Letchworth	A505 cycle route and junction treatment for cycle priority	No
Baldock - Letchworth	Baldock- Letchworth	Baldock to Letchworth Cycle Route via Works Road, Letchworth Rail Station and	No

		Broadway	
Letchworth - Stevenage		Upgrade existing National Cycle Route between Letchworth and Stevenage	No
Stevenage to Hitchin		Cycling route between Hitchin and Stevenage via little Wymondley.	No
Letchworth		Reconfigure B197/A505 junction to remove the need for buses to complete a U-turn.	No
Royston	Melbourn Greenway to Royston	Pedestrian and cycle improvements	No
Royston	A505 / Newmarket Road junction	Construction of a new roundabout onto A505,Royston	No
Hitchin	Stotfold Road & High Dane	New development access	No
Letchworth	North of Letchworth	New development access	No
East of Luton	A505 Luton Road	New roundabout on A505	No
A414 North Orbital Road	A414 North Orbital Road	New access junction onto A414 and new spine road connecting to A5183 Radlett Road (south of Frogmore)	LP3
M25 junction 21a	M25 junction 21a	M25 junction 21a capacity improvements (Radlett Railfreight mitigation)	LP3
M25 junction 22	M25 junction 22	M25 junction 22 capacity improvements (Radlett Railfreight mitigation)	LP3
Park Street	A414 / A405 (Park Street)	A414 / A405 (Park Street) roundabout signalisation	LP3
Colney Heath	A414 / Colney Heath Lane / High Street	A414 Colney Heath longabout safety scheme	LP3
Chiswell Green	A405 / B4630 Watford Road, Chiswell Green	New Arm to roundabout to serve new hotel development	LP3
Harpenden	A1081 Luton Road, Harpenden	Development access	LP3
Harpenden	A1081 Luton Rd / Redbourn Lane, Harpenden	A1081 Luton Rd / Redbourn Lane capacity enhancements	LP3
Harpenden	A1081 Luton Rd /Station Road, Harpenden	A1081 Luton Rd /Station Road capacity enhancements	LP3
Harpenden	A1081 Luton Road / The Common, Harpenden	A1081 Luton Road / The Common capacity enhancements	LP3
St Albans	Sandpit Lane, St Albans	Oaklands development new access onto Sandpit Lane	LP3
St Albans	Sandpit Lane / House Lane, St Albans	Sandpit Lane / House Lane enlargement of existing roundabout	LP3
St Albans	Sandpit Lane / Marshalswick Lane, St Albans	Sandpit Lane / Marshalswick Lane junction improvements	LP3
St Albans	Sandpit Lane / Coopers Green Lane, St Albans	Sandpit Lane / Coopers Green Lane junction improvements	LP3
St Albans	Sandpit Lane / Barnfield Road, St Albans	Sandpit Lane / Barnfield Road junction improvement	LP3

London Colney	A414-A1081-London Colney Roundabout	A414-A1081-London Colney Roundabout junction improvement	LP3
St Albans	St Albans Road/Sandridge Road/Marshalswick Lane/Beech Road	St Albans Road/Sandridge Road/Marshalswick Lane/Beech Road - junction improvement	LP3
St Albans	A5183 Redbourn Road/A4147 Bluehouse Hill/Batchwood Drive Roundabout, St Albans	A5183 Redbourn Road/A4147 Bluehouse Hill/Batchwood Drive Roundabout junction improvement	LP3
Wheathampstead	B653 Cory Wright Way/Marford Road, Wheathampstead	B653 Cory Wright Way/Marford Road, Wheathampstead junction improvement	LP3
St Albans	A4147 Hemel Hempstead Road / King Harry Lane St Albans	A4147 Hemel Hempstead Road / King Harry Lane junction improvement	LP3
Harpenden	A1081 Luton Road/ Park Hill Junction, Harpenden	A1081 Luton Road/ Park Hill Junction optimisation	LP3
St Albans	Hatfield Road/Station Road, Smallford Roundabout	Hatfield Road/Station Road, Smallford Roundabout junction improvement	LP3
St. Albans City Centre	Central St Albans	Expanded 20mph zone in St Albans including Victoria Street, Bricket Road and Catherine Street.	No
St Peters Street	A1081 St Peter's Street Pedestrian Crossing	New pedestrian crossings (various points)	LP3
St. Albans City Centre	Peahen Junction	Signal reconfiguration	No
A414 Park Street rbt- A1(M) J3	A414 Smart Traffic Management	Speed limit changes	No
London Colney	High Street	Speed limit reduction.	No
London Colney	Non-strategic roads	A 20mph speed limit introduced on all roads within London Colney	No
St Peters Street/Victoria Street	St Peter's Street/Victoria Street	Junction Reconfiguration.	No
Chiswell Green Corridor	A405/B4630 Watford Road	Junction signalisation	No
Coopers Green Lane	Coopers Green Lane	Speed limit reduction	A414 DS
Chiswell Green Corridor	B4630 Watford Road	Traffic calming measures	No
London road corridor	London Road/Watsons Walk/Lattimore Road junction alterations	Junction reconfiguration	No
Harpenden	A1081 Harpenden Town Centre & Station Road	Traffic calming measures	No
Harpenden	North East Harpenden Access	New access from North East Harpenden development site (site NEH)	No

Chiswell Green	Chiswell Green Lane	New access from Chiswell Green development (site CG)	No
Park Street	A5183 Frogmore & A414	New access from Park Street Garden Village	No
London Colney	Shenley Lane	New access from West of London Colney development	No
St Albans	A1081 Harpenden Road	New access from North of St Albans development	No
A1 (M) jct 6-8	A1 (M) jct 6-8	Widening of motorway to 3 running lanes between junctions 6-8.	LP 3
A1m junction 8	A1(M) J8 / A602 Letchworth junction	Junction reconfiguration	LP 3
A1m junction 8	A1(M) Junction 8 slip road improvements	Extend width of A1m north of junction 8 to allow a lengthened SB off slip	LP 3
Stevenage	A602 /Hertford Road Stevenage	Signalisation and capacity improvements at existing junction (A602 phase 1 improvement works)	LP 3
Stevenage	Stevenage Costco-New Access on Southern and Northern accesses.	Signalised on Northern Access and New Southern Access	LP 3
A1m junction 7		Lengthening of SB off slip	LP 3
Stevenage	A602 /Gunnels Wood Road, Stevenage	Upgrade of A602 / Gunnels Wood Road / GSK junction	LP 3
Bragbury End	A602 Bragbury End	New development access	LP 3
Stevenage (town centre)	Lytton Way between Swingate and Six Hills Way	Close Lytton Way between Swingate and Six Hills Way to traffic except buses.	LP 3
Stevenage (south)	Hertford Road, Stevenage	Hertford Road Speed reduction measures & bus gate	LP 3
North Stevenage	Stevenage road/A602	Signalisation and Bus Priority - Stevenage Road/A602	No
Bedwell	Letchmore Road area	On-carriageway cycle routes	No
Stevenage to WGC	B197	Cycle route between Stevenage and Welwyn Garden City, via Knebworth, Woolmer Green, Oaklands and Welwyn.	No
Letchworth - Stevenage		Upgrade existing National Cycle Route between Letchworth and Stevenage with increased cycle priority and provision of on carriageway route through Graveley and into Stevenage via North Road	No
Abbots Langley	Woodside Road, Abbots Langley	New roundabout serving development north of Meadowside junction	LP3
Rickmansworth	Uxbridge Road, Mile End, Rickmansworth	New access for 4fe secondary school - access proposed via new roundabout junction on Uxbridge Road (at junction with Long Lane)	LP3
Rickmansworth	A412 / A402 Rickmansworth	Additional capacity at the A412 / A404 roundabout to the west of Rickmansworth Town Centre	LP3 Amend
Hunton Bridge	M25 spur, Hunton Bridge	M25 spur approach to Hunton Bridge roundabout - widening approach / circulation or signalisation	LP3

Watford	Glen Way and Grove Mill Lane at junctions with Hempstead Road (Watford)	Junction reconfiguration	LP3
Watford	Eastbury Road / Deacons Hill, Watford	Junction reconfiguration	LP3
M25 junction 20	M25 Junction 20	Capacity improvements	No
Rickmansworth	A404 Riverside Drive, Church St Roundabout	Partial signalisation	No
Watford	Thomas Sawyer Way, Watford	New link road from Dalton Way providing access to Watford Health Campus	LP3
Watford		Implement 20 mph zone in defined areas	LP3
Watford	A411 Hempstead Road / The Avenue (Town Hall) junction, Watford	Modification to roundabout, new exit from central Avenue car park onto A411	LP3
Watford	Ascot Road	Additional bus lanes	No
Watford	Ascot Road, Whippendell Road, Rickmansworth Road	Road Space Consolidation	No
A414/Holwell Lane roundabout	A414/Holwell Lane roundabout improvements	New development access and minor capacity improvements	LP3
A414/B195 Birchall Lane/Cole Green Lane	roundabout improvements	Capacity improvements identified through WHBC junction design study	LP3
A1m junction 6	A1m junction 6 ramp metering	Switch on of installed ramp metering as part of final phase of A1m junction 6 improvement works	LP3
A1m junction 6 / B656 Codicote Road / Great North Road (Clock roundabout)	A1m junction 6 / Clock roundabout	A1(M) Junction 6 including Clock Roundabout junction capacity improvements	LP3
Welwyn Garden City	A1000 Bessemer Road / Waterside / B195 Black Fan Road (Mundells Gyratory)	Mundells gyratory improvements	LP3
Welwyn Garden City	Broadwater Road / Bridge Road	Octabout	LP3
A414 Mill Green junction to Jack Oldings roundabout	A414 Mill Green - Jack Oldings roundabout	A414 section between Mill Green & Tescos reconfiguration	LP3
A1(M) Junction 4	A1m Junction 4 /Jack Oldings roundabouts	A1(M) Junction 4 improvements	LP3
A1 (m) junction 3	A1 (m) Junction 3 improvements	Signal optimisation and dualling	LP3
Hatfield	A1001 Comet Way / A1057 (Comet roundabout), Hatfield	Comet roundabout capacity improvements	LP3 (some change)

Stanborough	A6129 / Coopers Green Lane / B197 Great North Road / Brocket Road, Stanborough	Junction reconfiguration	LP3
A414 / A1000, Mill Green	A414 / A1000 junction improvement	Junction reconfiguration	LP3
B195 Birchall Lane,	Birchall Lane	Birchall Lane improvements and new development accesses	LP3
Hatfield	A1001 Comet Way / Wellfield Road (Airfield) junction, Hatfield	Junction reconfiguration	LP3
Coopers Green Lane / Green Lane, near Hatfield	Coopers Green Lane / Green Lane, near Hatfield	Junction reconfiguration	LP3
Hatfield	A1057 St Albans Road / Ellenbrook Lane, Hatfield	Junction reconfiguration	LP3 (some change)
A1000 and South Way over-pass, South Hatfield	A1000 and South Way over-pass improvements	Extend SB on-slip to provide extra slip capacity	LP3
Welwyn Garden City	A1000 Chequers / Broadwater Road	Junction reconfiguration	LP3
Hatfield	A1000 Great North Road / B6426 St Albans Road East (Red Lion junction), Hatfield	Signal optimisation	LP3
Brookmans Park	A1000 /Swanley Bar Lane	Junction reconfiguration	LP3
Cuffley	Plough Hill / Station Road	Junction reconfiguration	LP3
Brookmans Park	A1000 /Hawkshead Road	Junction reconfiguration	LP3
A1000 /Shepherds Way, Brookmans Park	A1000 / Shepherds Way junction improvement	Optimisation of existing signals	LP3
Welham Green	A1000 /Dixons Hill Road	Junction reconfiguration	LP3
Hatfield	Hatfield - College Lane/Cavendish Way Corridor	Replace the existing roundabouts with signalised junctions	No
A1 (M) J 3	A1M Junction 3	Junction reconfiguration	No
Hatfield	Hatfield - Cavendish Way/Queensway Corridor	Traffic management measures	No
Hatfield	Hatfield - Cavendish Way/Queensway Corridor	Cavendish Way bus lane	No
Hatfield	Hatfield - Cavendish Way/Queensway Corridor	Cavendish Way-Bishops Rise junction reconfiguration	No
Hatfield	Travellers Lane	Traffic calming measures along length of corridor	No

Hatfield	Comet Way	Comet Way corridor reconfiguration	No
Coopers Green Lane	Coopers Green Lane NE of Hatfield Avenue (towards Welwyn Garden City)	Reduced traffic speeds and pedestrian and cycle provision	No
Lemsford	B653/Lemsford Village/Green Lanes junction	Junction reconfiguration	No
Mill Green	A414 EB onslip at Mill Green junction	Junction reconfiguration	No
Welwyn Garden City	Knightsfield / Shire Park (Tescos) entrance	Junction reconfiguration	No
Welwyn Garden City	Howardsgate / Parkway / Stonehills / Fretherene Road	Urban realm improvements	No
Welwyn Garden City	Black Fan Road / Herns Lane / Ridgeway	Junction reconfigurations	No
B197 corridor	B197 corridor (Clock Roundabout Welwyn - Stevenage)	B197 Sustainable Travel Corridor with footway / cycleway improvements, traffic calming & bus priority	No
Welwyn	Clock Roundabout and Welwyn Bypass	Reduce 2 lane dual carriageway section to single lane in each direction with improved off road cycling and walking facilities and new crossing facility	No
Welwyn Garden City	A1m junction 5	Junction closure	No
Hatfield aerodrome	Coopers Green Lane & Albatross Way	New development accesses	No
M1 - A5	M1 -A5	New link between M1 and A5 north of Dunstable	LP3
Oxford - Cambridge	Oxford - Cambridge	Oxford - Cambridge Expressway	No
M1 jnc 11a - A6	M1 jnc 11a - A6	New link between M1 and A6 around North Luton	LP3
Luton	Town centre ring road	Reallocation of lanes on part of town centre ring road	No
Luton	Vauxhall Way	Dualling of Vauxhall Way between Stopsley Way / Hitchin Road and Kimpton Road	No
Luton	Gipsy Lane	Widening of Gipsy Lane	No

10.4 Appendix IV: Highway Simulation Area Statistics by User Class

Table 10-1: Simulation Area Assignment Statistics – Car Commuting (PCU = Passenger Car Unit)

	AM Peak					Inter-peak					PM Peak				
	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031
Travel Distance (PCU km)	1,437,884	1,586,388	1,613,249	12%	2%	233,873	276,167	288,247	23%	4%	1,402,415	1,540,300	1,538,316	10%	0%
Total Travel Time (PCU hours)	30,562	38,638	39,568	29%	2%	4,735	5,952	6,278	33%	5%	33,249	38,570	38,628	16%	0%
Average Speed (Kph)	47	41.1	40.8	-13%	-1%	49.4	46.4	45.9	-7%	-1%	42.2	39.9	39.8	-6%	0%
Over-Capacity Queues (PCU hours	3,404	7,005	7,117	109%	2%	188.1	435.6	514.7	174%	18%	7,044	8,674	8,631	23%	0%
Transient Queues (PCU hours)	4,900	6,437	6,621	35%	3%	786.2	1,042	1,090	39%	5%	4,646	5,856	5,916	27%	1%

Table 10-2: Simulation Area Assignment Statistics – Car Employers Business (PCU = Passenger Car Unit)

Car Employers Business															
	AM Peak					Inter-peak					PM Peak				
	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031
Travel Distance (PCU km)	561,623	614,801	647,254	15%	5%	369,784	414,055	440,412	19%	6%	758,054	834,843	844,785	11%	1%
Total Travel Time (PCU hours)	9,192	11,924	12,689	38%	6%	5,400	6,823	7,346	36%	8%	12,502	15,467	15,843	27%	2%
Average Speed (Kph)	61.1	51.6	51	-17%	-1%	68.5	60.7	60	-12%	-1%	60.6	54	53.3	-12%	-1%
Over-Capacity Queues (PCU hours	769	1,760	1,948	153%	11%	159.7	410	501.6	214%	22%	1,576	2,364	2,597	65%	10%
Transient Queues (PCU hours)	1,109	1,693	1,794	62%	6%	610.9	958	1,030	69%	7%	1,312	2,002	2,007	53%	0%

Table 10-3: Simulation Area Assignment Statistics – Car Other (PCU = Passenger Car Unit)

	AM Peak					Inter-peak					PM Peak				
	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031
Travel Distance (PCU km)	1,347,248	1,710,802	1,854,319	38%	8%	1,771,458	2,326,566	2,530,153	43%	9%	1,441,050	1,825,401	1,912,835	33%	5%
Total Travel Time (PCU hours)	28,573	41,179	44,788	57%	9%	32,495	45,674	50,049	54%	10%	35,840	47,340	49,599	38%	5%
Average Speed (Kph)	47.2	41.5	41.4	-12%	0%	54.5	50.9	50.6	-7%	-1%	40.2	38.6	38.6	-4%	0%
Over-Capacity Queues (PCU hours	3,403	7,724	8,371	146%	8%	1319.6	3208.8	3879.3	194%	21%	8,012	11,012	11,422	43%	4%
Transient Queues (PCU hours)	4,610	6,819	7,423	61%	9%	5053	7,601	8,307	64%	9%	5,237	7,418	7,806	49%	5%

Table 10-4: Simulation Area Assignment Statistics – LGV (PCU = Passenger Car Unit)

	AM Peak					Inter-peak					PM Peak				
	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031
Travel Distance (PCU km)	419,598	613,201	602,658	44%	-2%	366,533	542,393	536,332	46%	-1%	414,482	579,425	579,184	40%	0%
Total Travel Time (PCU hours)	9,507	15,354	15,161	59%	-1%	6,728	10,427	10,449	55%	0%	10,081	14,577	14,335	42%	-2%
Average Speed (Kph)	44.1	39.9	39.8	-10%	0%	54.5	52	51.3	-6%	-1%	41.1	39.7	40.4	-2%	2%
Over-Capacity Queues (PCU hours	1,303	3,114	3,098	138%	-1%	296.8	743.5	828.6	179%	11%	2,075	3,215	3,008	45%	-6%
Transient Queues (PCU hours)	1,612	2,604	2,661	65%	2%	1068.5	1,725	1,793	68%	4%	1,548	2,339	2,394	55%	2%

Table 10-5: Simulation Area Assignment Statistics – HGV (PCU = Passenger Car Unit)

	AM Peak					Inter-peak					PM Peak				
	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031	2014	2031	2036	Δ 2036 - 2014	Δ 2036 - 2031
Travel Distance (PCU km)	759,722	899,750	772,474	2%	-14%	827,649	1,015,648	885,292	7%	-13%	546,459	651,527	562,602	3%	-14%
Total Travel Time (PCU hours)	10,564	14,209	12,210	16%	-14%	10,393	14,171	12,500	20%	-12%	7,873	10,383	8,926	13%	-14%
Average Speed (Kph)	71.9	63.3	63.3	-12%	0%	79.6	71.7	70.8	-11%	-1%	69.4	62.8	63	-9%	0%
Over-Capacity Queues (PCU hours	580	1,398	1,212	109%	-13%	243.5	671.8	635.6	161%	-5%	724	1,184	1,091	51%	-8%
Transient Queues (PCU hours)	1,000	1,625	1,386	39%	-15%	859.4	1,576	1,410	64%	-11%	679	1,149	944	39%	-18%