Stantec

Brentwood Borough Local Plan

Transport Assessment

On behalf of **Brentwood Borough Council**

BRENTWOOD BOROUGH COUNCIL

Project Ref: 28085 | Rev: AA | Date: January 2020

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Document Control Sheet

Date: Project Name: **Brentwood Borough Local Plan**

Project Ref: **28085**

Report Title: **Transport Assessment**

Doc Ref: **28085/2019TA**

Date: **03/01/2020**

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Prepared by:				
Reviewed by:				
Approved by:				
For and on behalf of Stantec UK Limited				

Revision	Date	Description	Prepared	Reviewed	Approved

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1 Introduction

1.1 Overview

1.1.1 Peter Brett Associates, now part of Stantec (PBA), has been commissioned by Brentwood Borough Council (BBC) to support the development of the borough's Local Plan (LP) and to provide support in the development of the transport evidence base. PBA has provided transport modelling support to assess the effects of the LP on the local and strategic highways in the borough, up to 2034, the end of the proposed plan period.

1.1.2 An LP is a document that sets out local planning policies and identifies how land will be used during a set plan period. It is a framework for development and infrastructure planning within a certain boundary and is very important in decision making on planning applications.

1.1.3 BBC is in the process of developing the new LP, which will provide the planning framework for the future growth and development for the Borough up to 2034. It is important that the LP promotes sustainable growth, and transport infrastructure design plays a key role in this objective.

1.1.4 This Transport Assessment (TA) is an assessment of the likely impacts associated with a preferred local plan scenario. The report sets out the approach to the transport modelling work, the results of the modelling and junction capacity assessments, highlights the junctions that may require mitigation, the sustainable measures that are proposed to support growth and the impact this has on the junction assessments, to enable the development sites to come forward. The assessment brief included a requirement to prioritise sustainable transport infrastructure requirements in the LP.

1.1.5 This report details the impacts of a single Local Plan Development option. The modelling work that has been undertaken is in line with the "Transport evidence bases in plan making and decision taking", published in March 2015.

1.1.6 The purpose of this work is to demonstrate how the highway network is likely to operate at a strategic level with the additional travel demand resulting from allocated development in BBCs proposed Local Plan. This report details the methodology and results of the assessment and provides an appraisal of the LP development in transport terms.

1.1.7 The appraisal has considered the broad impact of a preferred development allocation on local and strategic junctions. Detailed assessment of development impact and mitigation associated with any specific development is expected to be undertaken by promoters of individual sites at a later date as part of the planning application process. Assumptions made regarding the development size and quantum are understood to be correct as of July 2019.

1.2 Key Studies, Projects and Travel Influences

1.2.1 This assessment considers the LP period up to 2033. As the future of travel and transport is in a period of change, technology advances is likely to influence how we travel and if we travel far more than in the past, this, along with other developments within Brentwood and the surrounding area will influence the travel demand. This will result in changes up to 2033 that are very difficult to predict.

1.2.2 Currently, there are a number of transport schemes that are expected to be implemented in the area which will influence travel, but the actual impact is not known at this stage. This section sets out some of these schemes, whilst some of which have been considered within the assessment. There are also likely to be other changes that will occur within the Local Plan period, but these are less certain, and these scenarios may lead to travel behaviour which is much different from that seen today. To provide some context these are also discussed below.

1.2.3 These schemes and influences on travel behaviour highlight the uncertainty in future travel and potential impacts on the highway network. Whilst these factors will need to be borne in mind, the assessment of the Local Plan impacts have been undertaken, based on best knowledge and information available today.

A127 Corridor for Growth

1.2.4 A number of studies have been progressing, led by Essex County Council, on the A127 corridor between Southend-on-Sea in the East to the M25 in the west. The final section of this road is within the Borough, including M25 junction 29. The study involves all local authorities, as well as Highways England.

1.2.5 Within the Borough, this route is of strategic importance and much of the proposed growth is proposed along this corridor, including Dunton Hills Garden Village and Brentwood Enterprise Park.

1.2.6 Within the A127 Corridor for Growth study[1] there are individual pieces of work which are currently at various stages of planning and development, which are focussed on interchange capacity and/or safety improvements. Where information is available, this has been used to inform the modelling. The final outcomes from the study are not yet known and continued joint working with ECC and other neighbouring authorities will be important, so any outcomes from this study can feed through to the corridor study and consideration given to demonstrate this within a Statement of Common Ground with the highway authorities and neighbouring authorities. Where funding is known to exist for a scheme, these are included within the reference case modelling, otherwise these are included within Local Plan mitigation schemes.

M25 Junction 28 Study

1.2.7 Highways England is currently undertaking work to develop improvements at M25 Junction 28[2]. A preferred option has been developed for the junction which involves provision of an additional loop which removes northbound M25 to eastbound A12 traffic from the junction. This scheme has been considered in the context of the local plan development

Elizabeth Line

1.2.8 The Elizabeth Line is a major infrastructure project, which will provide rail services between Reading in the west and Shenfield in the east and will provide services across London. The project was expected to be completed by late 2018, however it has been delayed and is now expected to open in 2020. The Elizabeth Line will provide very frequent services from both Shenfield and Brentwood Stations, to and through London. At peak times the current planned timetable includes 12 services per hour from both stations to London[3], on top of the existing services that serve these two stations. This will provide a very large increase in capacity for rail travel, as well as the improved service frequencies. In addition, the Elizabeth Line will provide improved access to parts of London and beyond, including Heathrow, which were not previously served directly.

1.2.9 The Environmental Statement (ES) produced as part of the Crossrail Planning Application produced in February 2005, includes the expected transport impacts at both Shenfield and

[1] https://www.essexhighways.org/uploads/docs/nevendon-a127-corridor-for-growth-paper2.pdf
[2] https://highwaysengland.co.uk/projects/m25-junction-28-improvements/
[3] http://www.crossrail.co.uk/route/eastern-section/

Brentwood due to Crossrail within Appendix 8d, with separate sections on Brentwood[4] and Shenfield[5].

1.2.10 The ES states in Paragraph 16.8, that the impact at Brentwood is as follows:

'Passenger numbers with Crossrail are expected to increase by about 100 passengers entering and no change in passengers leaving the station in the morning peak period (a 4 per cent increase two-way on the without Crossrail scenario). The 2016 with Crossrail flows predicted at the station are about 2,600 two-way between 0700 and 1000 hours. The existing station building has sufficient capacity for the forecast passengers. There are sufficient traffic and transport facilities in the vicinity of this station to cater for the forecast passengers.'

1.2.11 Similarly, for Shenfield paragraph 18.44 of the ES states:

'Passenger numbers with Crossrail, are expected to change by about 100 additional passengers entering and no change in passengers leaving the station in the morning peak period (a 3 per cent increase in 2-way passenger flows). The 2016 with Crossrail flows predicted at the station are about 3,000 two-way between 0700 and 1000 hours. The existing station building has sufficient capacity for the forecast passengers. There are sufficient traffic and transport facilities in the vicinity of this station to cater for the forecast passengers.

1.2.12 No further information is available from the reporting, with regard to access mode or exact time of travel during the peak period. However, it is likely that for those commuting to London, the peak is likely to be before 8AM and the peak period for traffic within the towns.

1.2.13 Given the very small predicted impact from the Elizabeth Line, this is expected to have little impact on the Local Plan Assessment and any impact should be mitigated through sustainable travel measures.

Lower Thames Crossing

1.2.14 The Lower Thames Crossing is a proposed new road crossing of the River Thames which will connect the counties of Essex (north) and Kent (south). The scheme is being developed by Highways England, a decision on the preferred route for the crossing was made on 12 April 2017[6].

1.2.15 The planned route is expected to run from the M25 near North Ockendon, cross the A13 at Orsett before crossing under the Thames east of Tilbury and Gravesend. A new link road will then take traffic to the A2 near Shorne, close to where the route becomes the M2.

1.2.16 The Lower Thames Crossing Statutory Consultation commenced on October 10th 2018[7]. The main changes in flows, during the peak period, in Brentwood are on the A127 between M25 junction 28 and the A128 and the A128 south of the A127 junction. The forecast reporting released as part of the consultation evidence, does not provide detailed analysis of flow changes on the A128 and A127, however within the non-technical summary flow difference plots indicate that in both the AM and PM peak, the flows on these links will decrease by 100

[4] Online, access via:http://74f85f59f39b887b696f-ab656259048fb93837ecc0ecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/0/original/0017_r_ne15brentwoodstation1.pdf

[5] Online, access via: http://74f85f59f39b887b696f-ab656259048fb93837ecc0ecbcf0c557.r23.cf3.rackcdn.com/assets/library/document/0/original/0019_r_ne17shenfieldstation1.pdf

[6] Online, access via:https://www.gov.uk/government/news/new-lower-thames-crossings-to-cut-congestion-and-create-thousands-of-jobs

https://www.gov.uk/government/news/new-lower-thames-crossing to 500 PCU's. This is a result of trips to/from Thurrock now using the new link from the A13 to the new tie-in south of Junction 29, rather than the A128/A127. The report also indicates that some flows at M25 junction 29 will increase. Further information on the adjusted numbers is provided in section 10, with flow differences shown in Figure 10-4.

1.2.17 The LTC current proposed scheme has been assumed to be committed when considered as part of this TA and thus, this scheme and the likely traffic impacts (as known), have been included within the Reference Case modelling.

1.2.18 Once the next stage of work on the LTC scheme has been completed, and updated modelling work and model is available. There is a likely need to assess the Local Plan impact within this model.

Neighbouring Authority Local Plans

1.2.19 The neighbouring authorities to Brentwood are in various stages of developing their Local Plans and where information on these is available and within the overall model area, these have been considered and discussed further in Section 2.

1.2.20 Neighbouring authority growth is likely to have an impact on strategic routes through the Borough. As far as practicable this has been considered, either by directly allowing for proposed local plan development within neighbouring boroughs or through the application of ONS population growth factors. In addition, there will be opportunities to work with neighbouring local authorities to further address cumulative impacts as detailed proposals come forward This is likely to be the case, particularly on the A127, A12 and M25 junctions within the Borough.

1.2.21 Additional information on growth from other authorities has been explained in section 2.5.

Travel Trends

1.2.22 In addition, it is likely that other factors can influence on travel, such as:

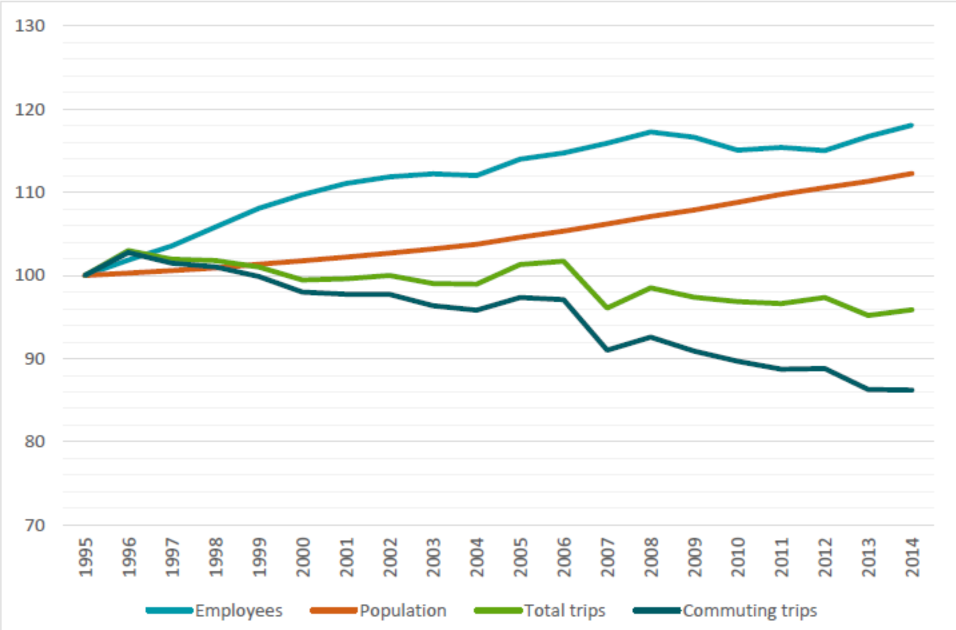
- connected and autonomous vehicles
- increased home working
- changes in working patterns
- demand responsive public transport

1.2.23 Technological advances can also influence how and when we travel and have an impact on capacity. This can have an impact on virtual mobility, as well as actual travel. Virtual mobility has led to a reduction in demand for travel at peak times, as more people are seen to take advantage of improvements in technology and more acceptance of agile working, which has resulted in increases in tele-working (or working from home) on a regular or irregular basis.

1.2.24 Analysis of NTS data shows that the number of commute trips and the number of commute trips per person per week is reducing over time (from 1995 to 2014) as shown in Figure 1-1.

1.2.25 This data is shown is shown as an Index, with a base of 100 set at 1995. Figure 1-1 shows that whilst population and the number of employees has increased, the number of commute trips has declined. National Travel Survey data has also indicated that the number of commute trips per person per year has fallen from 85 to 80 between 2011 and 2016. Whilst some of this can be put down to changes in demographics and an aging population, DfT have undertaken some research[8] that has indicated that the reduction in commute trips can, at least in part be put down to increased home working, both on a regular and occasional basis. Part time working has also increased.

1.2.26 All the above will likely have had an impact on traffic growth in the peak hours and with ever increases in technology and more acceptance of agile and flexible working patterns, this will influence the number of trips made during peak hours and people are likely to react in response to increasing congestion, in such a way to avoid travelling at peak times where possible.



(100 = indexed to 1995 Levels). Sources: Labour Force Survey, ONS, Population Estimates, National Travel Survey

Figure 1-1: Employees, Total Population, Total Journeys and Commuting Journeys in England

1.2.27 There have been indications that the reliance on private car overall is also falling in recent years. Figure 1-2 shows that whilst population has increased between 2002 and 2014, car traffic has remained static and car traffic per capita and average distance travelled has decreased over the same period. Whilst the past may not be a full indication of future trends, this should be considered important in the context of Local Plan growth.

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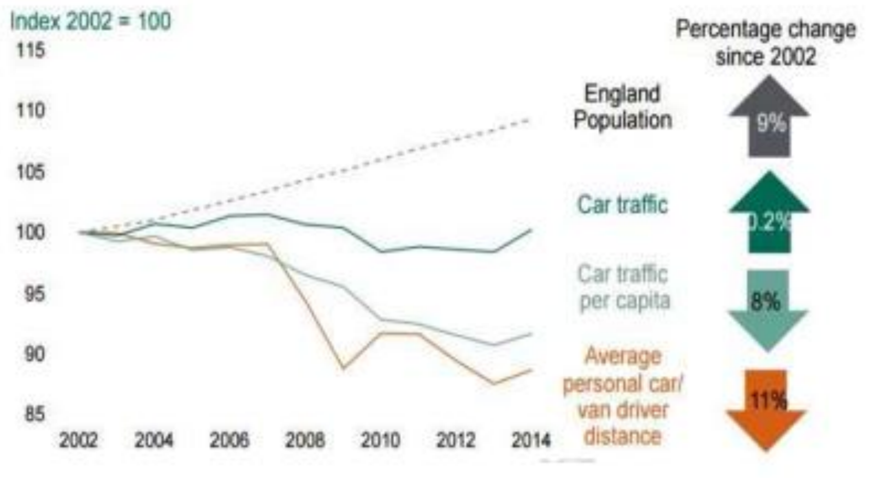
ment/uploads/system/uploads/attachment_data/file/657839/commuting-in-england-1988-2015.pdf



Source: On the Move 2, Dec 2016, Peter Headicar & Gordon Stokes on behalf of ITC

Figure 1-2: Traffic and Travel Trends 2002 to 2014

1.3 Future Local Plan Reviews

1.3.1 At this stage, schemes the actual impact of the schemes and projects detailed above, along with the possible changes in behaviour and technology are not yet known. Therefore, the possible effects of the potential schemes have not been quantified.

1.3.2 Regular reviews of the LP during the plan period are therefore recommended, to understand how changes to the network and behaviour would influence travel and ensure that any proposed mitigation is fit for purpose as the local plan progresses. Brentwood is situated in a region with significant growth prospects, for both development and infrastructure, therefore the impact of wider regional growth and large-scale infrastructure improvements will need to be monitored going forward.

1.4 Report Structure

1.4.1 Following this introduction this document is set out as follows:

- Section 2 details the LP development quanta that have been included within the assessment.
- Section 3 sets out the overarching methodology of the assessment.
- Section 4 provides the detailed spreadsheet trip generation and assignment methodology
- Section 5 sets out the approach to the junction modelling and junction assessments.
- Section 6 provides an overview of the junction modelling results.
- Section 7 sets out the sustainable measures expected during the LP period that may affect the junction model results.
- Section 8 sets out the results of trip assignment and junction capacity tests.
- Section 9 sets out the likely impacts of the Local Plan developments on the highway networks in neighbouring authorities.

- Section 10 details any additional highway mitigation that is identified to support the Local Plan, where it would be necessary to provide some additional highway capacity.
- Section 13 provides out a summary of the results included within the assessment and the conclusions of the report.

2 Local Plan Development

2.1 Overview

2.1.1 This Section sets out the Local Plan development scenario that has been included within the transport assessment. Information is also provided on other potential major influencing factors within the Local Plan period, which may lead to different scenarios playing out in the future.

2.1.2 Details of the development included within the Local Plan Growth Scenario were provided by BBC in the form of a spreadsheet on the 19th January 2018. This included information on the numbers of dwelling to be provided at each of the proposed sites and the site area in hectares and projected employment numbers for employment sites. Some subsequent updates have been included as a result of further discussions with BBC and some of the site promoters. These changes are reflected within the development information included within this section.

2.2 Housing

2.2.1 For residential developments, dwelling numbers were provided by BBC and these have been used to forecast the residential population by age band for each of the Local Plan sites. The mean numbers by age group per household, for all of Brentwood, from Census 2011 was used. The persons per household used to determine population are:

- 0 – 16 years 0.475 residents per dwelling
- 17 -64 years 1.469 residents per dwelling
- 65+ years 0.458 residents per dwelling

2.2.2 Details of the housing sites which are included within the Local Plan Growth Scenario including dwelling numbers and population by age group are shown in Table 2-1.

Table 2-1: Housing Sites

Site Ref.	Site Description	Dwellings	Estimated Residential Population (By Age Group)			
			0-16	17-64	65+	Total
041	Land at Hunter House, Western Road	48	23	70	22	115
311	Eagle and Child Pub, Shenfield	20	9	29	9	48
040	Chatham Way / Crown Street Car Park	31	15	46	14	74
039	Westbury Road Car Park	45	21	66	21	108
186	Land at Crescent Drive, Shenfield	55	26	81	25	132
003	Wates Way Industrial Estate	80	38	117	37	192

Site Ref.	Site Description	Dwellings	Estimated Residential Population (By Age Group)			
			0-16	17-64	65+	Total
081	Council Depot, Worley	123	58	181	56	295
117A & 117B	Ford Headquarters, Warley	350	166	514	160	841
002	Brentwood railway station car park	100	47	147	46	240
102	William Hunter Way	300	142	441	138	720
044 & 178	Land at Priests Lane	75	45	140	44	228
020	West Horndon Industrial Estate	200	95	294	92	480
021 & 152	West Horndon Industrial Estate	380	180	558	174	913
010	Sow and Grow, Ongar Road, Pilgrims Hatch	38	18	56	17	91
027	Land adj. to Carmel, Mascalls Ln	9	4	13	4	22
083	Land west of Warley Hill	43	20	63	20	103
032	Land East of Nags Head Lane, Brentwood	125	59	184	57	300
023	Land off Doddinghurst Road	200	95	294	92	480
263	Land east of Chelmsford Rd, Shenfield	215	102	316	99	516
034, 087, 235, 276	Officer's Meadow	510	242	749	234	1225
158	Land North of A1023 Chelmsford Road, Shenfield	100	47	147	46	240
128	Ingatestone Garden Centre	120	57	176	55	288
079A	Land adjacent to Ingatestone By-pass	57	27	84	26	137
106	Former A12 Work Site	41	19	60	19	98
076	Land South of Redrose Lane	30	19	59	18	96
077	Land South of Redrose Lane	40	27	82	26	134
075	Land off Stocks Lane, Kelvedon Hatch	30	14	44	14	72
194	Brizes Corner Field, Blackmore Road, Kelvedon Hatch	23	11	34	11	55
294	Chestnut Field, Blackmore Road	10	5	15	5	24
085B	Land adj. Tipps Cross Community Hall, Blackmore Rd	10	5	15	5	24
200	Dunton Hills Garden Village (plan period)	2700	1186	3672	1146	6004

2.3 Employment Site Allocations

2.3.1 Details of the employment sites are shown in Table 2-2. BBC provided site area and workplace numbers.

Table 2-2: Employment Sites

Site Ref.	Site Description	Area (Ha.)	Workplaces
101A	Brentwood Enterprise Park (M25 Junction 29 works site)	25.85	2100
079C	Land adjacent to Ingatestone by-pass (part bounded by Roman Road)	2.6	306
112D and 112E (a)	Childerditch Industrial Estate (extension 3 - southern growth to tree line)	3.53	122
101C/101B	Brentwood Enterprise Park (Codham Hall)	6.64	72
200	Dunton Hills Garden Village	5.5	647
109 and 187	Land at East Horndon	5.5	647
158	Land north of A1023, Shenfield	2	235
108	The Old Pump Works, Great Warley Street	0.79	27
111	Upminster Trading Estate	2.6	306
228	PERI site, Warley Street, Great Warley	5.36	631
112E (b)	Childerditch Industrial Estate (extension 2 - farm area)	3.62	125
321	McColls, Ongar Road	1.6	188
112A, 112B & 112C	Childerditch Industrial Estate	11.25	388
113A & 113B	Hallsford Bridge Industrial Estate	3.41	118
114	Hubert Road Industrial Estate	3.78	130
45	Hutton Industrial Estate	10.48	361
115	Brook Street Employment Area	1.25	147
118	BT Offices, London Road	3.5	412

Site Ref.	Site Description	Area (Ha.)	Workplaces
119	Canon Offices. Chatham Way, Brentwood	0.45	53
117	Ford Offices	2	235
020, 021 & 152	West Horndon Industrial Estate	2	69
121	Mellon House, Berkley House and 1-28 Moores Place, Brentwood	0.35	41
116	Warley Business Park (ex. Regus)	2.5	294

Note: The Codham Hall Employment Site numbers reflect existing employment site numbers, which are exclused from the data above

2.4 Redeveloped Employment Sites

2.4.1 There are a number of sites listed in the residential and employment allocations, which are currently employment sites. To meet the needs of the Local Plan, these sites are included and will be redeveloped, either as residential or mixed-use sites. These sites are provided in Table 2-3.

2.4.2 Information on areas and workplaces for these sites have been provided by BBC. The assessment process detailed later in this report will require the current uses to be removed prior to adding in the new developments listed in tables 2-1 and 2-2.

Table 2-3: Employment Sites Removed

Site Ref.	Site Description	Area (Ha.)	Workplaces
117	Ford Offices, Eagle Way, Brentwood	-3.25	-382
003	Wates Way Industrial Estate, Ongar Road	-0.96	-33
020, 021, 152	West Horndon Industrial Estate	-15.06	-519
081	Council Depot	-1.71	-201
110	Town Hall, Brentwood	-0.55	-65
114A	Regent House	-0.98	-115
121	Mellon House	-0.17	-20
013B	Warley Training Centre	-1.71	-201
120	47-57 Crown Street	-0.12	-14
125	North House	-0.18	-21

Site Ref.	Site Description	Area (Ha.)	Workplaces
116	Warley Business Park	-0.72	-85

3 Overview of Assessment Methodology and Inputs

3.1 Introduction

3.1.1 This Section sets out the approach to modelling the impact of the proposed Local Plan development on the local and strategic highway network within the Brentwood Borough.

3.1.2 In the absence of a suitable and up to date strategic modelling tool, a methodology was developed that is deemed to be a robust approach to assessing the impact and to inform the development of the Local Plan.

3.1.3 To derive traffic volumes for the assessment, a three-step approach has been used. This allows the highway impact to be assessed. The three stages are:

- Obtaining base data from observed counts – The Base Case Scenario
- Adding trips from committed developments within Brentwood and neighbouring authorities and applying additional background growth – The Reference Case Scenario
- Adding on trips associated with the Local Plan proposals – The Local Plan Growth Scenario

3.1.4 A very brief overview of the methodology is provided below, followed by information on some of the key inputs into each of the scenarios.

3.2 Overview of Assessment Methodology

3.2.1 To inform the assessment the following elements have been developed:

- A spreadsheet tool which is used to derive trip numbers within the study area
- An assignment tool, which provides a graphical presentation of the trips on the highway network and is used to provide forecast trips on a link and junction level within the study area; and
- Individual junction models, which take outputs from the assignment tool at a junction level and then used to determine the impact of the Local Plan.

3.2.2 The tools have been used in the following process:

- Junctions models have been built and validated against baseline delay data
- The Local Plan developments have been converted to population and employment inputs to the spreadsheet tool
- A zoning system has been set up within GIS that covers the study area
- The spreadsheet tool has generated forecast trip numbers by origin / destination
- The forecast traffic numbers have been assigned onto the highway network within the study area using the assignment tool

- Traffic flows and turning counts have been extracted from the assignment tool at junction level and fed into the junction models, to represent both Reference Case and LP Test Case

3.2.3 Further detail on the development of the spreadsheet and assignment tools is provided in Section 4 and further information on the development of the junction models is provided in Section 5.

3.2.4 The junction models form the basis of the Base Case Scenario, with each model using observed traffic count data, feeding into models which are then calibrated to represent base conditions as far as possible. The base year is 2017 and the data used for this is detailed further in Section 3.4.

3.2.5 The spreadsheet and assignment tools are used to derive future year flows for both the Reference Case and Local Plan Growth Scenarios, which are then extracted at junction level to feed into the forecast modelling and assessment process.

3.2.6 The modelling approach also allows for non-highway mitigation and sensitivity tests to be undertaken to indicate how sustainable travel measures may impact on the highway network performance at junction level, through removal of trips.

Assessment Scenarios

3.2.7 The following scenarios have been assessed:

i. Base Case: Traffic counts and trip rates collected in 2017

ii. 2033 Reference Case: Forecast year with no LP Growth

iii. 2033 LP Growth: Reference Case + LP Growth

3.3 Base Case – Junctions Modelled

3.3.1 As stated above the first step in the modelling was to develop a series of junction models. These are initially built to reflect current conditions and are then used to assess the future scenarios.

3.3.2 The junction models form the basis of the Base Case Scenario, with each model using observed traffic count data, feeding into models which are then calibrated to represent current conditions as far as possible. The base year is 2017 and the data used for this is detailed further in Section 3.4.

3.3.3 The steps undertaken were:

i. Identification of junctions that should be included within the assessment

ii. Collation and collection of traffic data

iii. Produce base year models and undertake calibration of the models

3.3.4 Model calibration is the process of adjusting the model, so that it represents current day observations as best as possible.

Step 1: Identification of Junctions to be Modelled

3.3.5 The process for identification of junctions to be modelled within the assessment utilised local knowledge from BBC and ECC, to highlight key junctions within the study area that would be directly impacted by Local Plan development and those indirectly impacted by the proposed Local Plan development which could exceed capacity. Existing data sources, including Teletrac Navman data have been utilised to identify junctions. The resultant junctions assessed and those omitted were agreed with ECC and BBC.

3.3.6 An initial list of junctions was drawn up with reference to local knowledge.

3.3.7 As part of previous study work, models for a number of junctions were developed using traffic data collected in 2012. These models formed part of work to inform the impact assessment for a number of different development options. The outputs from this analysis is reported in 'Brentwood Local Plan – Development Options – Highway Modelling', Peter Brett Associates, February 2018.

3.3.8 As part of the previous work, a total of 23 junctions were modelled. This included junctions on the Essex highway network, but at that time excluded the M25 junctions 28 and 29.

3.3.9 Following a review of this work, several junctions were shown to work well within capacity within the development option that most closely replicated the proposed Local Plan Growth Scenario which is being tested within this assessment and are thus have now been excluded from this study.

3.3.10 The junctions that have been removed from the new study are shown in Table 3-1, along with the highest RFC (Ratio of flow to capacity) for any particular arm at a junction.

3.3.11 The RFC indicates how close to capacity a junction is. If the RFC figure reaches 1.00 or above it is deemed to be over-capacity. Any figure below this then the junction is shown to have spare capacity. The results indicate that for all four junctions shown, that the RFC is well below the 1.00 critical value, with the Local Plan development scenario tested at that time.

Table 3-1: Omitted Junctions from New Study

Junction ID	Location	AM Peak Highest RFC	PM Peak Highest RFC
4	A128 Ongar Road/ Western Avenue	0.65	0.71
9	B185 Kings Road/B186 Queens Road	0.76	0.84
11	Weald Road/Western Road	0.49	0.69
21	A127 Westbound/Thorndon Avenue	0.64	0.49

3.3.12 The next step has been to review Teletrac Navman (previously TrafficMaster) plots and the location of the development within the Local Plan Growth Scenario to identify any additional junctions for consideration. These plots are shown in Figures 3-1 and 3-2 for the AM and PM peak respectively. Whilst these plots do not specifically show congestion and are based on link speeds during the peak periods, this gives an indication of junctions that may have issues but other external factors such as school drop off traffic or deliveries could influence link speeds.

3.3.13 Following a review of the location of the development sites and the plots, a number of additional junctions were identified for consideration. These were then considered against the likely impact from the Local Plan development allocations. Three additional junctions have been identified have now been included within the assessment. The following junctions have junctions have been identified but have been omitted:

- Woodman Road/Warley Hill, no impact from development traffic on Woodman Road which give priority to Warley Hill, therefore the impacts on Warley Hill are negligible.
- Woodman Road/Hartswood Road, Priority Junction, No impact from development traffic on Woodman Road.
- Sandpit Land/Ongar Road, Priority Junction, No Impact of development traffic on Sandpit Lane.
- Eagle Way/Hartswood Road Priority Junction, minimal impact from development with 40 trips travelling SB from Childerchurch Road in the AM and traffic and 49 trips travelling on Childerchurch Road in the PM, this combined with little congestion at the junction causes a negligible impact.
- Brentwood Road/Billericay Road Priority Junction, negligible traffic with 2 additional trips stemming from SLAA traffic on Billericay Road in the AM and PM and no historical congestion issues.
- Warley Road/Great Warley Road Priority Junction, no additional traffic caused by SLAA developments and no congestion issues.
- A10323 London Road/Kavanaghs Road, Priority Junction, no additional traffic caused by SLAA development traffic on Kavanaghs Road, minimal impact on uncongested priority junction.
- Brook Street/Nags Head Lane Signalised Junction, minimal impact from development traffic on Nags Head Road and Wigley Bush Lane.
- Shenfield Road/ Middleton Hall Lane, Priority Junction, No development traffic impact on Middleton Hall Lane.

3.3.14 Whilst other junctions within Brentwood and Shenfield are potentially operating over capacity, the impact from the Local Plan is negligible, so these are not included within the assessment.

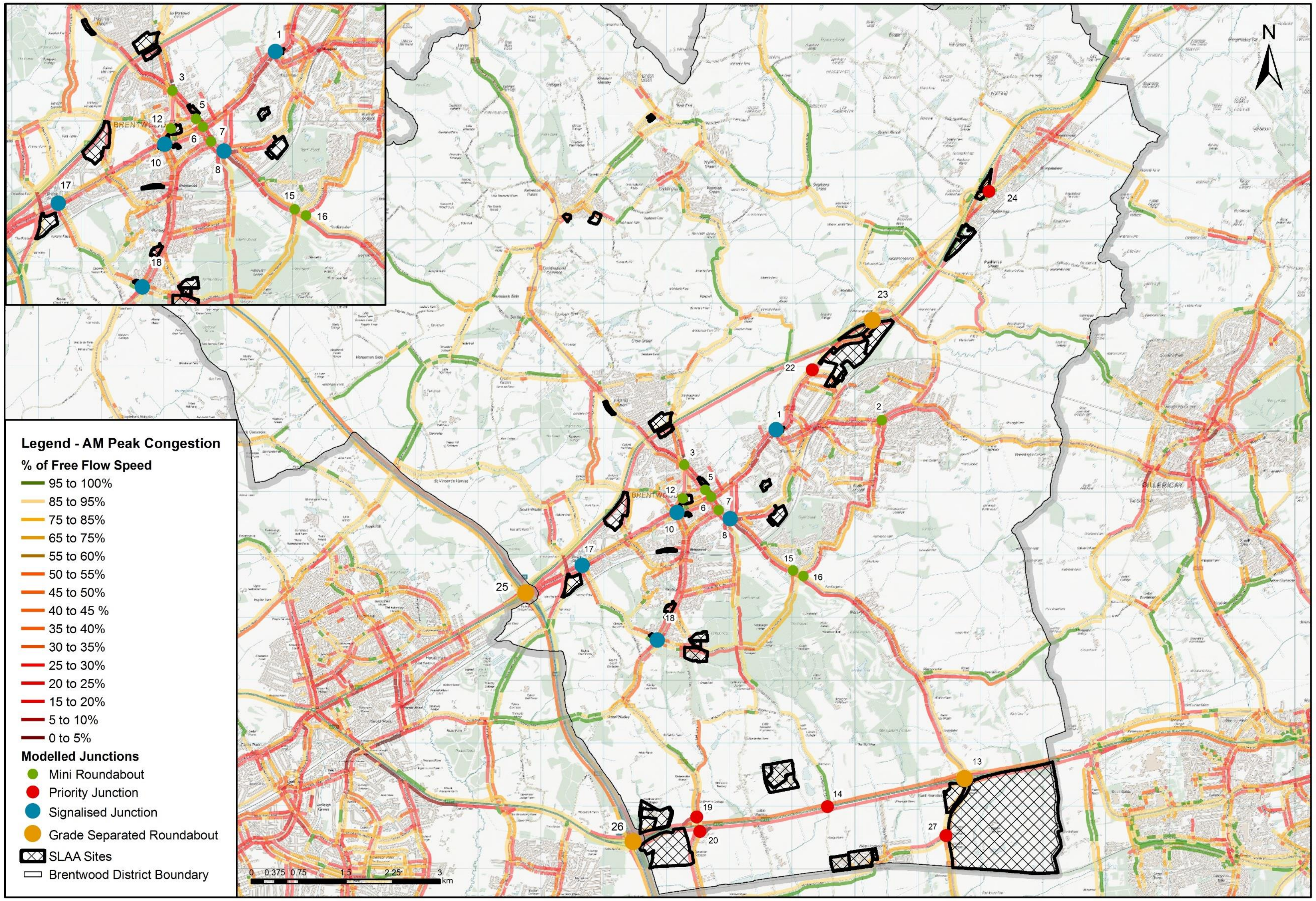


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Figure 3-1: Junction Locations for Assessment – AM Peak

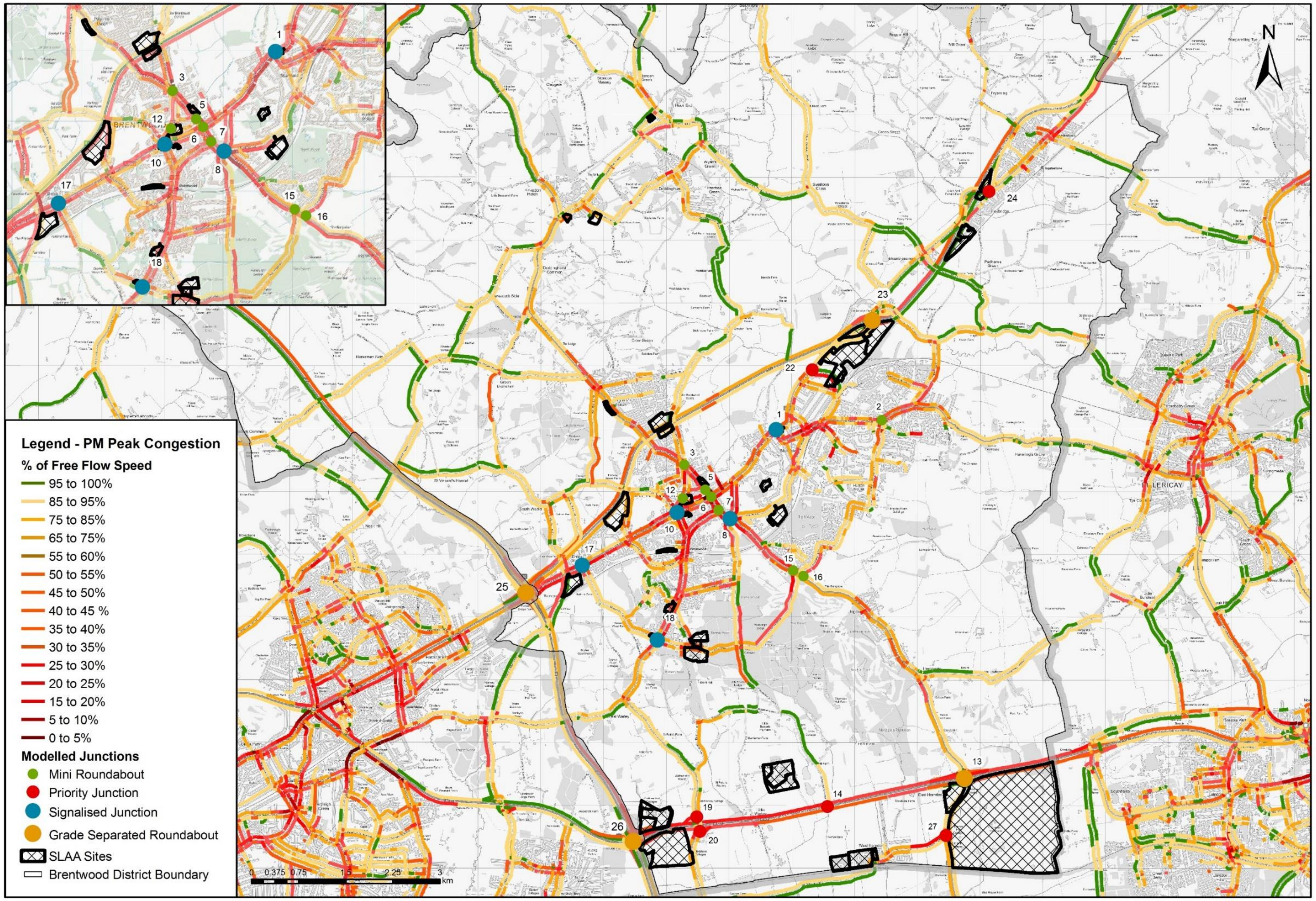

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Figure 3-2: Junction Locations for Assessment – PM Peak

3.3.15 The outcome of this was to produce a list of 21 junctions that have been modelled within the assessment. The full list of junctions that are modelled is summarised within Table 3-2 and are shown on Figure 3-1 and 3-2.

Table 3-2: Brentwood Local Plan Junctions Modelled

ID	Junction	Junction Type
1	A1023 Chelmsford Road / Hutton Road / A1023 Shenfield Road	Signalised Junction
2	A129 Rayleigh Road / Hanging Hill Lane	Mini Roundabout
3	A128 Ongar Road / Doddinghurst Road	Mini Roundabout
5	A128 Ongar Road/William Hunter	Priority Junction
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini Roundabout
7	A128 Ingrave Road / B186 Queens Road	Mini Roundabout
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised Junction
10	A1023 High Street/ B185 Kings Street	Signalised Junction
12	Western Road/William Hunter Way	Priority Junction
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Roundabout
14	A127 / Childerditch Lane	Priority Junction
15	A128 Ingrave Road / The Avenue	Double Mini Roundabout
16	A128 Brentwood Road /Running Waters	Double Mini Roundabout
17	A1023 Brook Street /Mascalls Lane	Signalised Junction
18	B186 Warley Hill / Eagle Way / B186 Warley Road / Mascalls Lane	Signalised Junction
19	B186 Warley Street / A127 eastbound	Priority Junction
20	B186 Warley Street / A127 westbound	Priority Junction
22	A1023 Chelmsford Road / Alexander Lane	Priority Junction
23	A12 Junction 12	Roundabout
24	Roman Road / A12 Slip	Priority Junction
27	A128 Tilbury Road/Station Road	Priority Junction

3.3.16 While the study area and junctions assessed provide a sufficient level of detail to assess the Publication Local Plan at a strategic level, there may be additional impacts from specific development sites on local junctions on the highway network, which will only become evident as development comes forward across the plan period and a more detailed assessment is undertaken at a local level. These impacts will need to be assessed by developers within Transport Assessments (TAs) as part of the planning process and any need for further mitigation will also need to be agreed and promoted by the respective developer.

3.3.17 It would be expected that more detailed highway impact modelling will be undertaken by developers for each development as they come forward. This will make use of more detailed and up-to-date assumptions around the make-up of developments on each site.

3.3.18 Any additional developer work would be expected to enhance the analysis at a more local level whilst supporting the strategic analysis in this Local Plan appraisal.

3.4 Traffic Data

3.4.1 As part of the earlier assessment, traffic data was collected to establish the baseline position of the highway network in Brentwood. This data was collected in 2012. To support the junction modelling for this study a review has been undertaken to identify any new data available for any of the junctions assessed.

Recent Traffic Surveys

3.4.2 At some junctions, more recent 2017 traffic survey data was made available either directly provided from Essex County Council or obtained from local Transport Assessments. Table 3-3 outlines the attributes of the 2017 data sources and which junctions will utilise this most up to date traffic counts for use in the junction assessments.

Table 3-3: 2017 Traffic Count Data Available

Junction ID	Date of survey	Location	Source	Junction Type
6	Thursday 2nd March 2017	Wilsons Corner, Brentwood	Essex County Council	Double Mini-Roundabout
8	Tuesday May 23rd 2017	Ingrave Road/Middleton Hall Lane/Seven Arches Road	Brentwood Preparatory School, Transport Assessment, Waterman Ltd	Signalised Junction
13	Wednesday 1st March 2017	A128 Halfway House, West Horndon	Essex County Council	Grade Separated Junction
24	Thursday 6th July 2017	A12 Junction 12	Residential Development, Ingatestone, Transport Assessment, WSP	Grade Separated Junction
27	2017 (no date given in TA)	A128 Tilbury Road/Station Road	East Horndon Industrial Park, Supplementary Transport Report, Redwood Partnership	Priority Junction

Updating Traffic Count Data

3.4.3 As previously stated, the previous assessments used traffic count data surveyed in 2012. It is noted that within DMRB Volume 12, Section 1, Part 1 states "*where trip information used in a traffic appraisal relies largely upon observations taken more than about 6 years ago it will be necessary to ensure that this information is still valid….*". Thus, a pragmatic approach was taken to produce new junction flows where applicable which is considered appropriate given the high-level nature of Local Plan assessment. Where no recent data was available but appropriate trend data was available nearby then this was used to derive factors to apply to the 2012 count data. Otherwise, factors were applied based on TEMPro.

TEMPro Growth

3.4.4 Table 3-4 below outlines the TEMPro trip end growth rates (factored using NTM traffic growth rates) that were applied to the previous 2012 data where no more recent count data was available. One more recent count is available for 2014, hence a factor is provided for 2014 to 2017, again based on TEMPro.

Table 3-4: TEMPro Growth Rates

Base Year	Future Year	Area	AM	PM
2012	2017	Brentwood	1.074	1.071
2014			1.043	1.041

Additional Analysis

3.4.5 Additional analysis has been undertaken to identify the suitability of the counts for use in the base junction models. The following section summarises the analysis undertaken for the junctions within Brentwood Town Centre and those in the outer areas. In the absence of time-series ATC data, which would identify trends, each junction has been looked at on a case by case basis, using comparison data that is available near the junction. Details of the approach are provided in Appendix A.

3.4.6 ECC has provided PBA with eleven counts with time series data between 2012 and 2017 to enable an assessment of change in traffic over time. Seven of these counts were identified as being suitable for the analysis. Through the examination of the traffic counts and junction turning flows it was identified that there was no clear pattern of traffic growth in the region.

3.4.7 On this basis it has been necessary to review each junction on an individual basis. The process involved looking at count data nearby and making a judgement on potential growth at the junctions being assessed. The following sections summarise the methodologies used for each junction, split between geographical areas.

Brentwood Town Centre

3.4.8 Table 3-5 below summarises the junctions located within Brentwood Town Centre that are to be modelled. Where traffic data has been updated. a factor has been applied to the junctions based on analysis undertaken if a newer comparable junction or ATC flows were available to produce a relevant factor. The final two columns indicate what the factor is, and the count used to derive this, where applicable. At locations where flows were identified to significantly differ between a comparable site or if no comparable site was available TEMPro growth has been applied. Further detail on derivation of data is provided in Appendix A.

Table 3-5: Brentwood Town Centre Junctions Assessments – Derivation of 2017 Base Year data

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factor Applied
3	A128 Ongar Road / Doddinghurst Road	Essex County Council	Mini Roundabout	Junction 6	AM and PM 2012 flows increased by 3%
5	A128 Ongar Road/William Hunter	Essex County Council	Priority Junction	-	AM and PM 2012 flows increased by 3%
7	A128 Ingrave Road / B186 Queens Road	Essex County Council	Mini Roundabout	Junction 6	AM 2012 flows increased by 3% PM 2012 flows increased by 10%
10	A1023 High Street/ B185 Kings Street	Essex County Council	Priority Junction	-	TEMPro growth for both peaks applied at 7% (2012 to 2017).
12	Western Road/William Hunter Way	Essex County Council	Priority Junction	-	TEMPro growth for both peaks applied at 7% (2012 to 2017).
15	A128 Ingrave Road / The Avenue	Essex County Council	Double Mini Roundabout (linked with J16)	-	AM 2012 flows decreased by 11 and PM growth of 3%
16	A128 Brentwood Road /Running Waters	Essex County Council	Double Mini Roundabout (linked with J16)	-	AM 2012 flows decreased by -11 and PM growth of 3%

3.4.9 Through the analysis undertaken at junction 6 where a more recent turning count from 2017 was available it was concluded that there was an average increase in flow of approximately 3% for both peak periods for arm A (junction 3 and 5), 3% for the AM peak and 10% for the PM peak for arm C (junction 7).

3.4.10 Additional analysis at junction 8, where 2017 turning count information was also made available, identified that traffic flows decreased by 11% in the AM peak when compared with 2012 turning movements, the PM peak showed a slight increase of 3%. As such, junctions 15 and 16 will have these factors applied.

Brentwood Outer Area

3.4.11 Tables 3-6 to 3- 8 summarise the junctions outside of Brentwood Town Centre that will have junction assessments undertaken.

3.4.12 Table 3-6 shows the group of junctions to the east of Brentwood, through analysis of the comparison of 2012, 2014 and 2017 junction turning counts taken at junction 6 it was identified that during the AM peak Arm A, A1023, Shenfield Road witnessed an increase of approximately 2%, whilst the PM peak flows remained flat. As a result, the junctions to the east, (junctions 1 and 2) will have their respective AM peak flow factored by 2%, whilst the PM peak will have no growth applied. For junctions 22 and 24 where no direct comparable data was available both have been factored from 2014 to 2017 using TEMPro growth for their respective peak periods.

Table 3-6: East of Brentwood Town Centre Junction Assessments – Derivation of 2017 Data

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factored
1	A1023 Chelmsford Road / A129 Hutton Road / A1023 Shenfield Road	Essex County Council	Signalised Junction	Junction 6	AM 2012 flows by 2% PM 0% growth.
2	A129 Rayleigh Road / Hanging Hill Lane	Essex County Council	Mini Roundabout	Junction 6	AM 2012 flows by 2% PM 0% growth.
22	A1023 Chelmsford Road / Alexander Lane	Essex County Council	Priority Junction	Junction 6	AM and PM flows by 2014 TEMPro growth of 4% (2014 to 2017)
23	A12/B1002/Roman Road	Mountnessing Scrapyard Transport Assessment,	Grade Separated Junction	-	AM and PM flows by 2014 TEMPro growth of 4% (2014 to 2017)

3.4.13 Table 3-7 shows details for both junctions 17 and 18 but with the lack of any comparison data it was concluded that these assessments will continue to use the 2012 turning flows, growthed up by TEMPro to 2017.

Table 3-7: West of Brentwood Town Centre Junctions Assessments – Derivation of 2017 Data

Junction ID	Location	Source	Junction Type	Factored
17	A1023 Brook Street /Mascalls Lane	Essex County Council	Signalised Junction	TEMPro Growth for Both Peaks of 7% (2012 to 2017)
18	B186 Warley Hill / Eagle Way / B186 Warley Road / Mascalls Lane	Essex County Council	Signalised Junction	TEMPro Growth of For Both Peaks 7% (2012 to 2017)

3.4.14 Table 3-8 shows the junctions focussed on the A127 corridor. Where available, Highways England ATC counts were compared to enable a comparison between 2012 and 2016 ATC flow data on the A127 and between the relevant arm at junction 14. The analysis showed a decrease in flows for both directions along the A127 as such the data at junction 14 has been factored down accordingly, both junctions 19 and 20 had no direct comparable data available and as such have used TEMPro growth from 2014 to 2017 to factor the original flows. The fall in trips is consistent with recent evidence from DfT studies, which indicate that trip rates i.e. the number of trips made per person is actually declining for commute trips for example.

Table 3-8: South Brentwood Town Centre Junction Assessments – Derivation of 2017 Data

Junction ID	Location	Source	Junction Type	Junction used for analysis	Factored
14	A127 / Childerditch Lane	Essex County Council	Priority Junction	Junction 14 and A127 ATC	AM 2012 flows by -5 and PM of -2%
19	B186 Warley Street / A127 eastbound	Essex County Council	Priority Junction	Junction 14 and A127 ATC	TEMPro Growth for Both Peaks of 4% (2014 to 2017)
20	B186 Warley Street / A127 westbound	Essex County Council	Priority Junction	Junction 14 and A127 ATC	TEMPro Growth of 4% (2014 to 2017)

M25 Junction Data

3.4.15 As the M25 junctions 28 and 29 were not included within the previous study, new data was sought for these two junctions.

3.4.16 No data was identified for junction 29, therefore new traffic count data was collected, to a specification agreed with Highways England, over three days from Tuesday 19th to Thursday 21st June 2018.

3.4.17 Data for Junction 28 was provided by Highways England and this data was collected on 15th and 16th November 2016. This data was not adjusted following checks with 2017 data adjacent to the junction, from the Highways England database, which indicated there had been no growth.

3.5 2033 Reference Case Inputs

3.5.1 The Reference Case model includes all known committed developments within Brentwood and additional information received from neighbouring authorities. In addition, background growth is also accounted for. Details of the approach are provided below.

Brentwood Committed Developments

3.5.2 Table 3-9 sets out the committed development sites within Brentwood that are included within the assessment. All of these sites are residential. The dwelling numbers are converted to population and these numbers are added to the spreadsheet, into the relevant zone.

Table 3-9: Brentwood Committed Developments

Site	Dwellings
Phase 4A - British Gas Site	53
Former Warley Hospital	50
W Hunter Way CP Site (102)	14
Former Highwood Hospital	103
43-53 Ingrave Road	11
Rear of 93 Queens Road	12
122-124 Station Rd	11
Rear of Sylvia Avenue	32
Glanthams House, Hutton Rd	13
Willowbrook P Sch, Hutton	55

Neighbouring Authority Developments

3.5.3 In addition to the BBC committed developments, any LP or committed developments within adjacent local authorities have also been considered, as these would likely have an impact on BBC transport network. The information included was that available at the time of undertaking the model development.

3.5.4 These have been added to the Reference Case Scenario, on which the Brentwood Local Plan developments have been tested. A number of developments within Basildon and Havering have been included as detailed below; however, no information has been made available for developments within Thurrock, therefore this growth has been considered within the background growth, rather than for specific sites.

Basildon Developments

3.5.5 The following developments within Basildon have been included within Reference Case Forecasts:

- Land West of Gardiners Lane South, Basildon – 660 Dwellings
- Land North of Dry Street, Basildon – 725 Dwellings
- West Basildon Urban Extension – 1000 Dwellings
- Land West of Steeple View, Dunton Road, Laindon – 140 Dwellings
- Land East of Noak Bridge, Wash Road, Basildon – 360 Dwellings
- East of Basildon – 2000 Dwellings

- Land North of Potash Road, Billericay - 150 Dwellings
- Land West of Tye Common Road, Billericay – 160 Dwellings
- Land south of London Road, Billericay – 180 Dwellings
- Land west of Mountnessing Road, Billericay – 280 Dwellings
- Land East of Frithwood Lane, Billericay – 330 Dwellings
- Land South of Windmill Heights, Great Burstead and South – 70 Dwellings
- Land west of Kennel Lane, Great Burstead and South Green – 70 Dwellings
- Land East of Greens Farm Lane, Billericay – 280 Dwellings
- Land east of Southend Road, Great Burstead and South Green – 220 Dwellings

Havering developments

3.5.6 The following developments in Havering have been included:

- Romford Strategic Development Area - 5,300 Dwellings
- Rainham and Beam Park Strategic Development Area – 3,000 Dwellings

Other Authorities

3.5.7 Specific developments in other authorities have not been included directly, however population growth has been included to incorporate other growth in the modelling. For example, whilst Chelmsford developments are not directly included within the modelling the growth is included using ONS population projections which would allow for any traffic from Chelmsford along the A12 to be modelled within the Reference Case.

3.6 2033 Local Plan Growth Inputs

3.6.1 Chapter 2 of this TA set out the inputs, in terms of jobs and homes that are included within the Brentwood Local Plan and have been considered in this assessment. The key inputs for the transport assessment of the Local Plan is the number of homes and jobs have been forecast or committed to, and their locations. These are the output of economic and spatial assessments.

3.6.2 The spreadsheet model has been used to derive future year flows for both the Reference Case and Local Plan Growth Scenarios, which have then been extracted at junction level to feed into the forecast assignment and junction modelling process.

3.6.3 The trips have been assigned to the highway network in Brentwood using OmniTRANS. A detailed methodology of the spreadsheet modelling and assignment has been provided in Chapter 4.

3.7 Resultant Population Data

3.7.1 Details of the population estimates within Brentwood, for each modelled scenario are shown in Table 3-10.

Table 3-10: Population Estimates by Scenario

Scenario	Population
2017 Base Year	77357
2033 Reference Case	80975
2033 Local Plan	95755

3.8 Summary

3.8.1 This section has set out the overarching methodology of the assessment. The Local Plan assessment inputs have been provided in detail in Chapter 3. Chapter 4 details the spreadsheet modelling and assignment methodology.

4 Spreadsheet Modelling and Assignment Tools

4.1 Introduction

4.1.1 As stated previously a spreadsheet tool has been developed to produce trip information for the end of plan period, so the impact can be assessed at a local junction level. In addition, a modelling software package known as OmniTrans has been used. OmniTrans in the context of this study, has only been used to understand how trips travel across the highway network (known as assignment) and to provide graphical outputs.

4.2 Overview of Approach

4.2.1 Transport modelling is undertaken based on a four-stage approach, which are as follows:

i. Trip Generation – The goal of trip generation is to predict the number of trips, that are generated by and attracted to each zone (see Section 4.3 for explanation of zones) in a study area. Further information on trip generation is provided in Section 4,4.

ii. Trip Distribution – This step determines how many trips will travel between each zone, such that every trip has a single origin zone and a single destination zone. Further information on trip distribution is provided in Section 4.5.

iii. Mode Choice – This step determines the mode of travel e.g. car, public transport, walking, Further information on Mode Share is provided in Section 4.6.

iv. Trip Assignment – This step determines which route within the network each trip will make, based on e.g. a highway network for car trips. Further information on assignment is provided in Section 4.7.

4.2.2 The bespoke modelling approach developed, utilises excel spreadsheets to inform the first three steps of this four-step modelling approach.

4.2.3 OmniTrans has been utilised for the fourth step – trip assignment – this is detailed further in Section 5.

4.3 Model Zoning System and Road Network

Zoning

4.3.1 The study requires the identification of the number of trips generated by development along the major road network links within the study area. This involves first identifying the origin of the trip, then identifying the destination and then deciding which route (road links) the trip is likely to travel between the origin and destination.

4.3.2 For the purposes of this strategic-level study, trip origins and destinations have been grouped into zones. This enables the magnitude of the flow of trips between zones to be calculated, with flows then being distributed onto the road network. This approach of identifying broad zones of origins/destinations and the flow of trips between them rather than identifying the flow of trips between individual origins and destinations is considered suitable for this study.

4.3.3 The zoning system that formed the geographical basis for the modelling work was constructed in a GIS and constituted proposed development zones and Census-based zones for the existing population. The Census-based zones were at single and multiple Output Area level within Brentwood BC, at Census ward level for neighbouring local authorities, and at local authority level to cover the wider area of London, Essex, Hertfordshire, and Kent. This is shown in Figure 4-1.

4.3.4 Additional zones were created to represent the proposed Local Plan development sites. By creating separate zones for each of the sites allows for some additional analysis to be undertaken on a site by site basis as necessary. The additional zones are shown in Figure 4-2 represented as points. Further information on Trip Generation in relation to the Local Plan development sites can be found in Section 4.4.

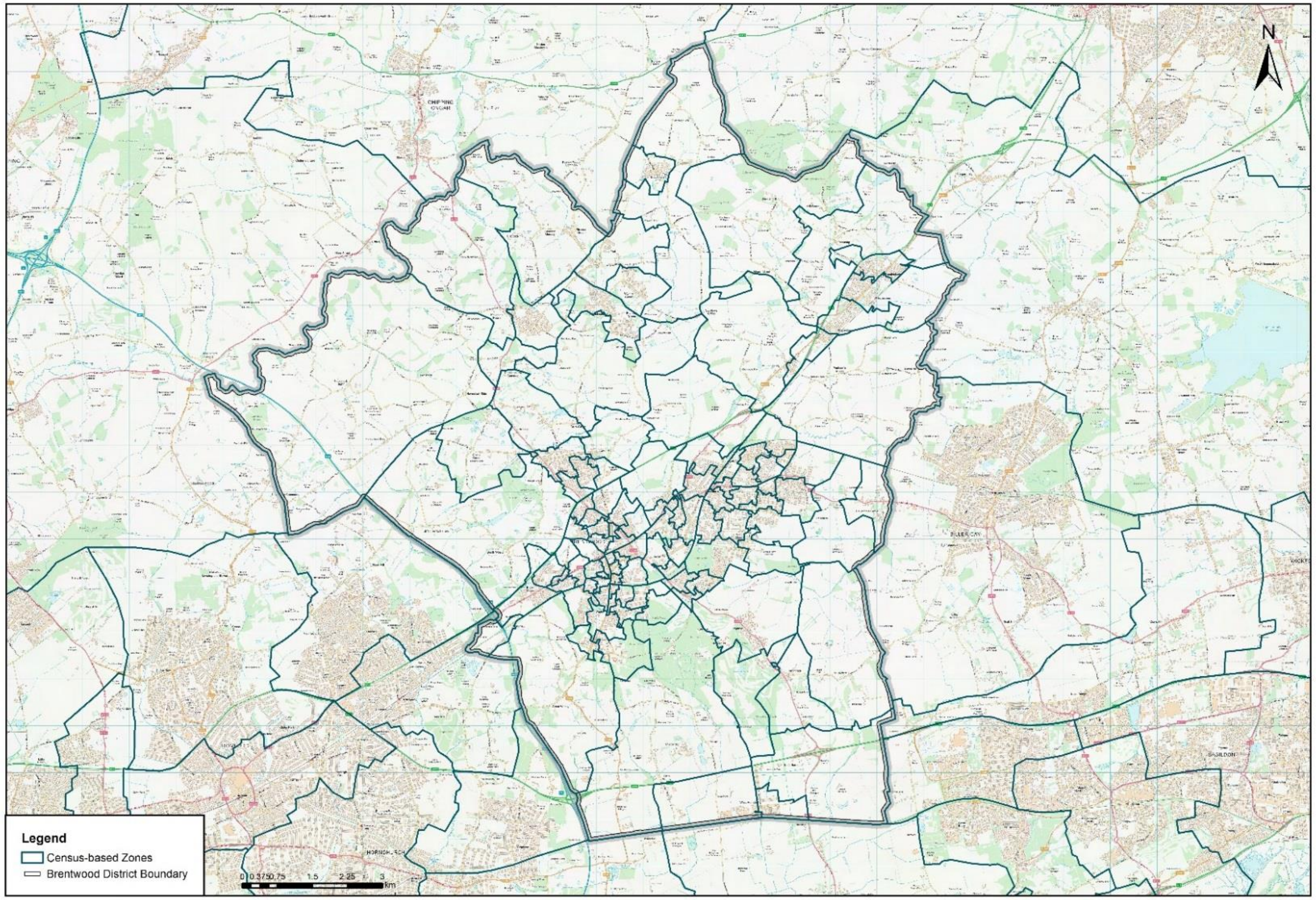

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Figure 4-1: Brentwood Local Plan Model Zones

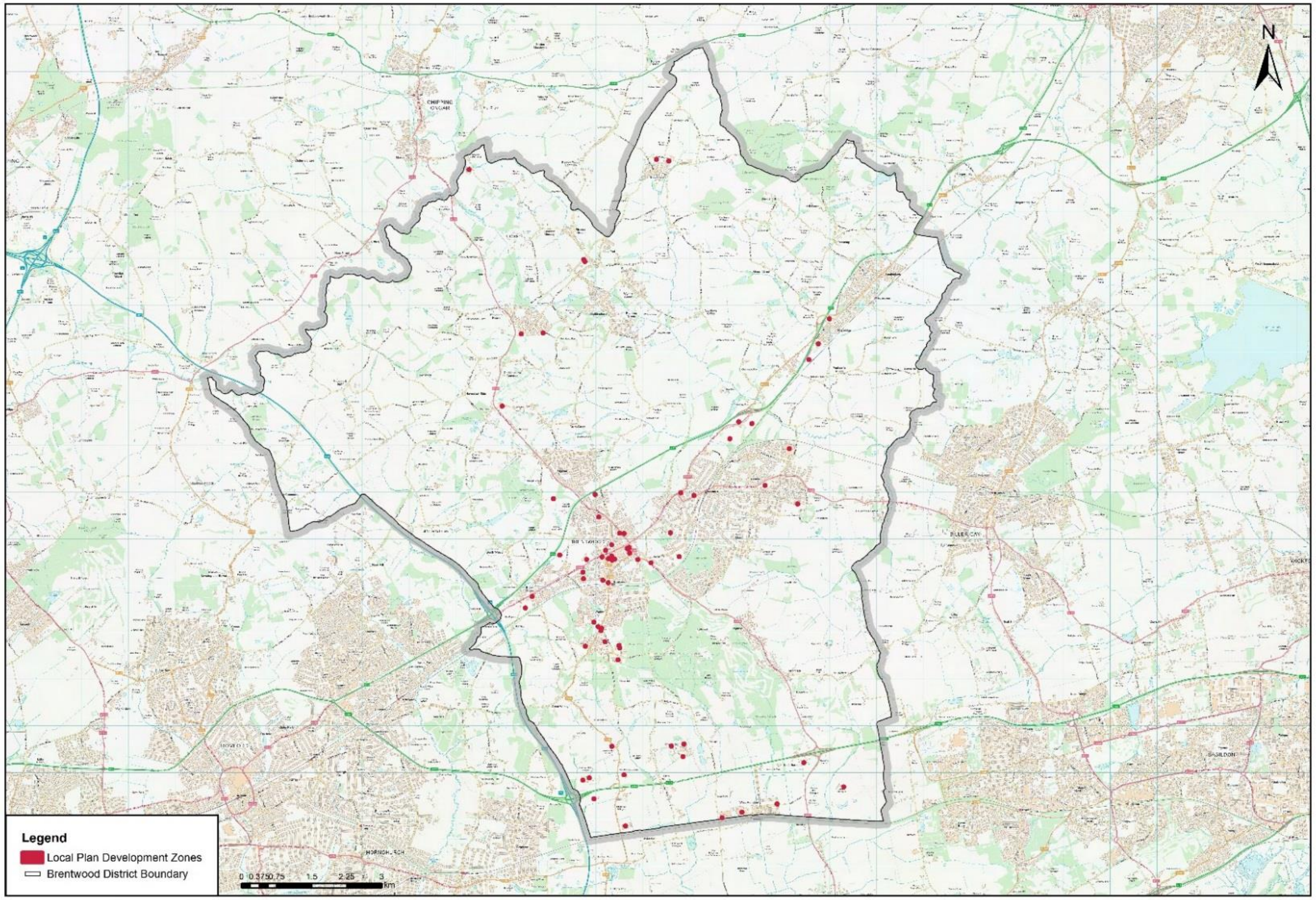

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Figure 4-2: Brentwood Local Plan Development Zones

Road Network and Zone Connectors

4.3.5 A road network has been developed from the Ordnance Survey Integrated Transport Network (ITN) digital road network for all of Essex. This data is complemented by mean link speeds extracted from TrafficMaster GPS data. The mean link speeds are obtained for the AM and PM peak hours modelled.

4.3.6 Each zone is represented by zone connectors. These are used to load trips from each zone on to the highway network. These were generated between each zone centroid(s) and its nearest node on the road network.

4.3.7 The road network and zoning system were imported into the OmniTRANS specialist transport modelling software. This was used to generate travel-time and distance matrices for use in the trip distribution and mode share elements of the spreadsheet-based trip modelling, and, after trip matrices had been calculated, assigning the trip matrices to the network to determine link flows and turning flows at junctions.

4.3.8 Except for the Dunton Hills development all development zones have one zone connector accessing to the highway network. The locations were deemed appropriate for the quantum of development. For Dunton Hills two connectors have been used to represent two access points. Both zone connectors represent accesses to the west onto the A128. One of which would tie into the existing A128/Station Road junction.

4.3.9 Figure 4-3 illustrates the modelled highway network within the boundary of Brentwood District.

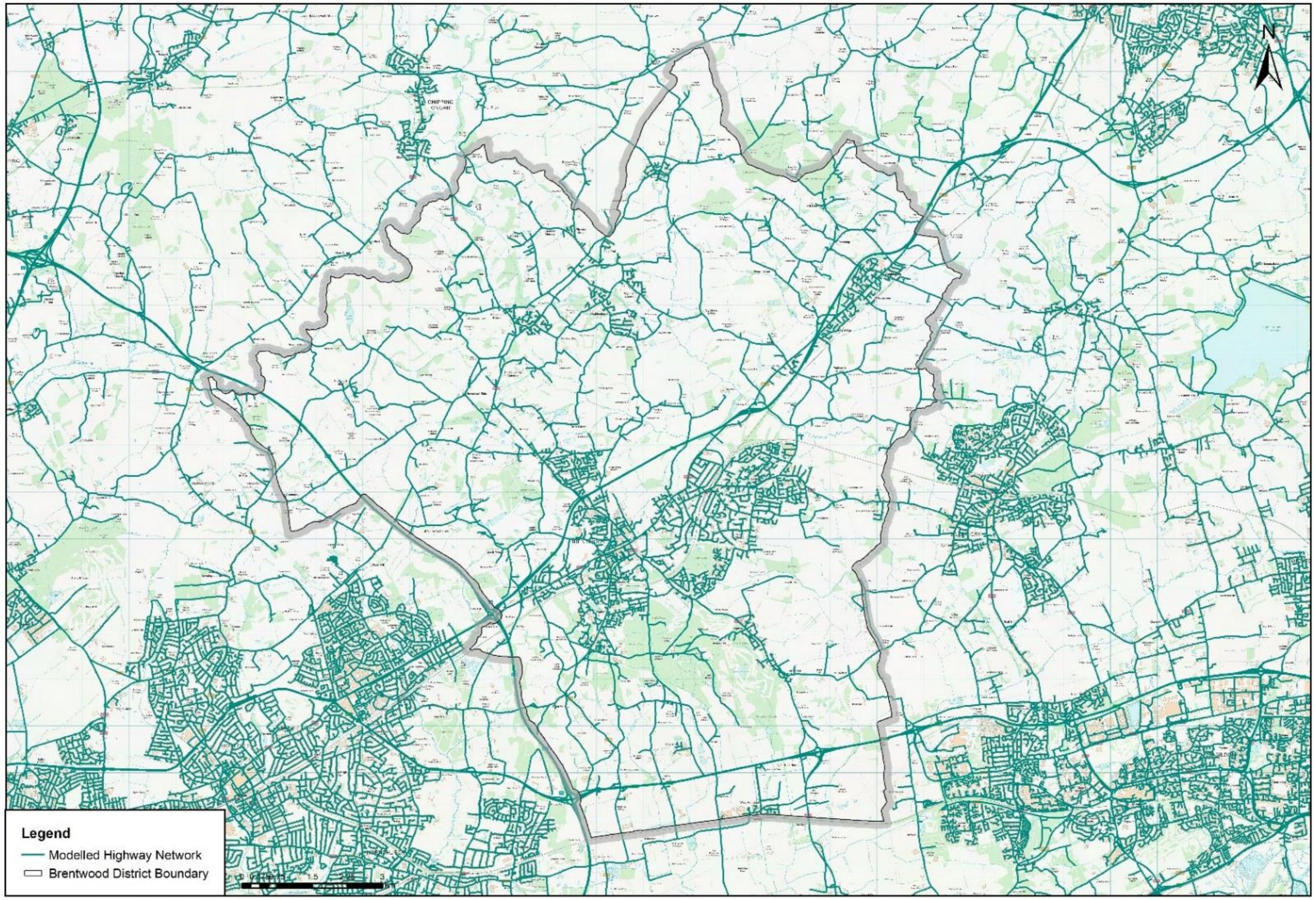
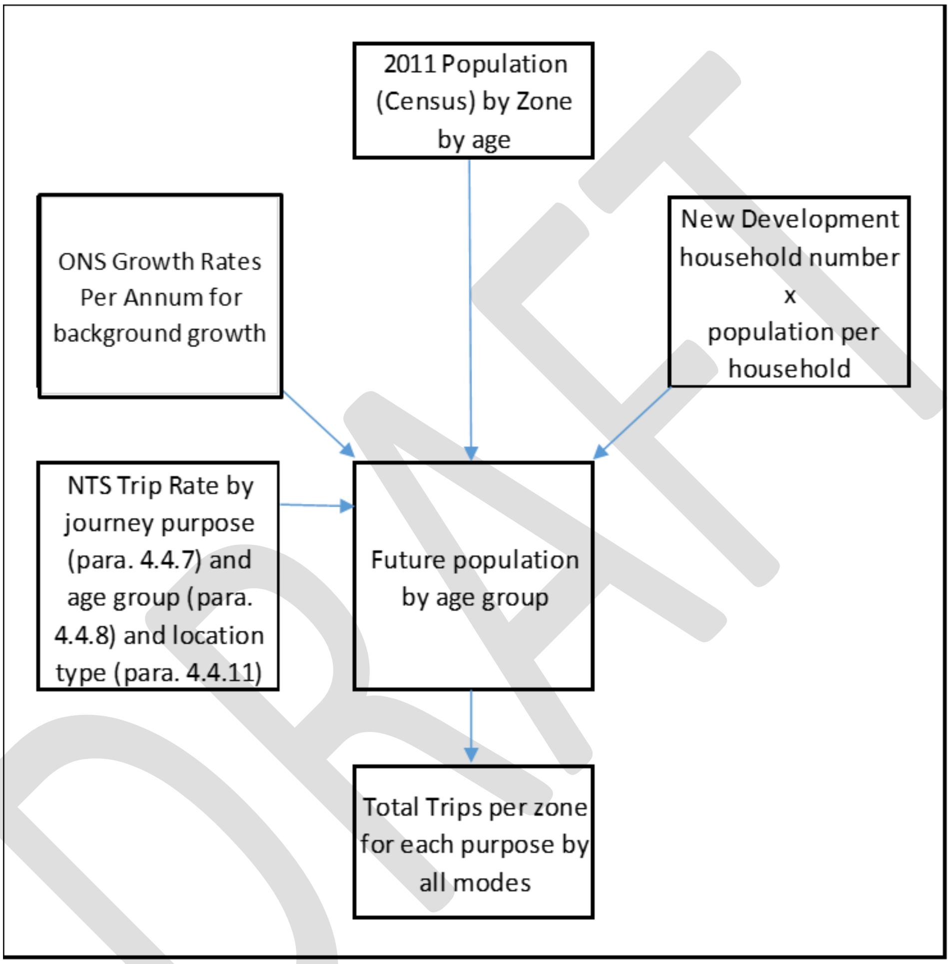


Figure 4-3: Modelled Highway Network

4.4 Trip Generation

4.4.1 The trip generation approach described here is undertaken in a consistent manner between base year trips and forecast trips. It is undertaken at a person trip level using population data as the basis of the assessment.

4.4.2 The origin of trips is assumed to be the residential dwellings. The number of trips generated by each zone have therefore been calculated by first, determining how many people live in each zone, and then considering how many trips each person is likely to make. The process is summarised in the flow chart and further detail provided below.



Identifying Residential Population Figures

4.4.3 Since the zones are set by the Census boundaries, the residential population figures in the Census 2011 have been used to determine the existing population of each zone.

4.4.4 In the case of the zones created to represent the future major development sites, for which population figures are not available, the residential population have been calculated by applying the mean number of residents per household for Brentwood (from Census 2011) to the number of proposed residential units for each site.

4.4.5 The growth in resident population to the required base and forecast years has been calculated using the Office for National Statistics (ONS) residential population projections (available for all years by local authority area), allowing for the increases in population from developments so as not to double-count the growth.

Person Trip Rate Assumptions

Residential trips

4.4.6 The trip generation starting point is total person trips. Person trip rates from the National Travel Survey (NTS) are applied to the residential population figures. Person trip rates appropriate to the area (level of urbanisation) have been extracted from the NTS.

4.4.7 Generated trips have been categorised by broad trip purpose as follows:

- Trips to/from work
- Trips to/from education establishments made by the student
- Trips to/from education establishments made by people escorting students
- Trips to/from food retail outlets,
- Trips to/from non-food retail outlets,
- Trips made for 'other' purposes, i.e. leisure, visiting friends, religious worship.

4.4.8 For each trip category, the number of trips generated by each of the following three age groups has been identified using Census age-group splits.

i. 0 to 16 years,

ii. 17 to 64 years,

iii. 65 years+

4.4.9 A 'Zone Data' sheet collated the number of proposed housing units and their estimated number of residents (by age band) for each residential development zone, and the estimated forecast number of employees for each employment development zone. Similarly, the number of residents (by age band) and workplaces was collated for each Census-based zone, using Census 2011 data.

4.4.10 Within the 'Trip Generation' sheet the number of home-based trips generated by each zone was calculated for the selected scenario and time-period. This used the zone data for the required user-option in conjunction with trip rates from the National Travel Survey (NTS).

4.4.11 NTS is a rich source of data which provides information on trip making patterns based in household surveys. All NTS data used in this project was extracted using population selection criteria appropriate for the size and location of Brentwood. This provided all-mode trip numbers generated for each broad purpose by the resident population of each zone (as home-to-purpose, purpose-to-home and non-home-based).

4.4.12 The home-based trip purposes modelled were work, education, escort-education, shop food, shop non-food and 'other'. Similarly, the non-home-based trip purposes modelled were work and other (non-home).

4.4.13 To account for different accessibility levels, depending upon the geographical of the proposed developments NTS data has been extracted for the following area classifications:

- Major Conurbation
- Urban City or Town

- Rural Town or Fringe
- Rural Village
- Rural Hamlet or Isolated Dwelling

4.4.14 Figure 4-4 shows the categories that were assigned to each of the census Output Areas (OA) based on the 2011 census.

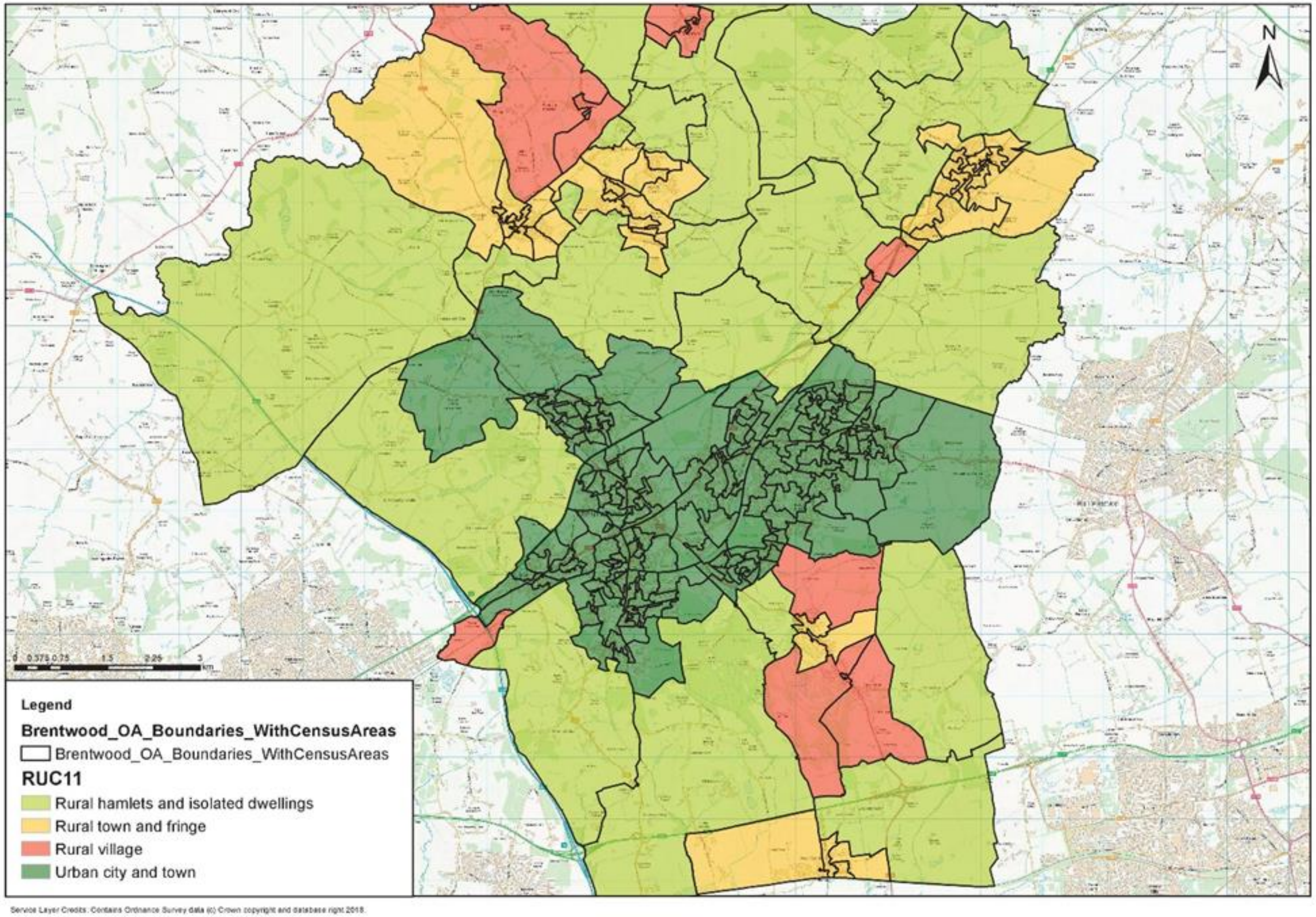


Figure 4-4: 2011 Census OA area classifications

4.4.15 The accessibility trip rates are detailed further in technical note 'Use of NTS to inform Trip Rates by Accessibility Level' which is included as Appendix B. This note sets out the derived NTS trip rates by accessibility level.

4.4.16 At the trip distribution stage (see Section 4.5), the employment elements of the tested sites attracted trips from existing (non-development) residential areas as well as the tested development sites. Therefore, it was necessary to calculate trips generated by all zones in the zoning system, and to include these in the 'Base' and 'Reference Case' options. Vehicular trip results from the 'Base' option was subtracted from the 'Reference Case' results and, similarly, results from the 'Reference Case' option were subtracted from results from each of the tested options to gain the net increase due to the baseline above 'existing' and the net increase due to each of the tested options above the baseline.

4.4.17 The initial model setup uses a trip rate based on trips per person for commuting, which is based on NTS data from 2016, but then calibrated to 2011 (base year for population data used).

4.4.18 To reflect a reduction in commute trips per person over time, NTS data has been reviewed to understand how trip frequency over time has declined for commute trips. Between 2011 and 2016 the number of car commute tips made per person per year has fallen from 85 trips to 80 trips. An equivalent reduction for trips per person per day shows that the current rate used in the model of 0.1289 trips per person in the AM peak would drop to 0.1213 trips. This reduction has been applied within the model.

Local Plan Sites – Trip Generation

4.4.19 The Local Plan development site vehicle trip generation is summarised below within Table 4-1. It should be noted that where there are negatives in the table, this indicates that the development site has an existing use with flows associated with it and the new development, will result in a reduction in vehicle trips.

Table 4-1: Local Plan Development Peak Hour Vehicle Trip Generation

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
1	041 Land at Hunter House, Western Road	3	16	12	4
2	311 Eagle and Child Pub, Shenfield	1	6	5	2
3	040 Chatham Way / Crown Street Car Park	1	9	8	2
4	039 Westbury Road Car Park	2	13	11	3
5	186 Land at Crescent Drive, Shenfield	3	19	15	5
6	003 Wates Way Industrial Estate	-5	22	19	-2
7	081 Council Depot, Warley	8	46	37	11

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
8	117A & 117B Ford Headquarters, Warley	-9	131	103	1
9	002 Brentwood railway station car park	6	32	26	8
10	102 William Hunter Way	15	89	73	20
11	044 & 178 Land at Priests Lane	6	34	26	8
12	020 West Horndon Industrial Estate	12	65	60	18
13	021 & 152 West Horndon Industrial Estate	-76	96	90	-66
14	010 Sow and Grow, Ongar Road, Pilgrims Hatch	2	13	10	3
15	027 Land adj. to Carmel, Mascalls Ln	1	3	3	1
16	083 Land West of Warley Hill	2	13	12	4
17	032 Land East of Nags Head Lane, Brentwood	9	53	40	12
19	023 Land off Doddinghurst Road	13	72	62	17
20	263 Land East of Chelmsford Rd, Shenfield	11	66	53	16
21	034, 087, 235, 276 Officer's Meadow	28	161	126	38
22	158 Land North of A1023 Chelmsford Road, Shenfield	68	46	37	59
23	128 Ingatestone Garden Centre	6	38	31	9
24	079A Land adjacent to Ingatestone By-pass	80	37	32	66
25	106 Former A12 Work Site	2	13	11	3
26	076 Land South of Redrose Lane	2	12	10	3
27	077 Land South of Redrose Lane	2	17	15	4
28	075 Land off Stocks Lane, Kelvedon Hatch	2	11	10	3
29	194 Brizes Corner Field, Blackmore Road, Kelvedon Hatch	1	9	7	2

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
30	294 Chestnut Field, Blackmore Road	1	3	3	1
31	085B Land adj. Tipps Cross Community Hall, Blackmore Rd	1	3	3	1
32	200 Dunton Hills Garden Village (plan period)	259	711	645	319
33	101A Brentwood Enterprise Park (M25 Junction 29 works site)	908	112	169	951
34	112D and 112E (a) Childerditch Industrial Estate (extension 3 - southern growth to tree line)	23	5	4	19
35	101C Brentwood Enterprise Park (Codham Hall Extension)	22	3	4	23
36	109 and 187 Land at East Horndon	153	21	31	160
37	101B Brentwood Enterprise Park (Codham Hall)	211	26	40	222
38	108 The Old Pump Works, Great Warley Street	9	1	2	9
39	111 Upminster Trading Estate	70	8	13	68
40	228 PERI site, Warley Street, Great Warley	141	16	27	136
41	112E (b) Childerditch Industrial Estate (extension 2 - farm area)	24	3	4	23
42	321 McColls, Ongar Road	48	6	9	49
43	112A, 112B & 112C Childerditch Industrial Estate	74	9	14	72
44	113A & 113B Hallsford Bridge Industrial Estate	24	3	4	24
45	114 Hubert Road Industrial Estate	36	5	7	36
46	45 Hutton Industrial Estate	92	21	18	72
47	115 Brook Street Employment Area	40	5	8	41
48	118 BT Offices, London Road	119	16	23	121
49	119 Canon Offices. Chatham Way, Brentwood	16	2	3	15

Zone	Development	AM		PM	
		Inbound	Outbound	Inbound	Outbound
50	121 Mellon House, Berkley House and 1-28 Moores Place, Brentwood	12	2	2	11
51	116 Warley Business Park (ex. Regus)	70	9	14	68
52	081 Council Depot	-47	-6	-9	-46
53	110 Town Hall, Brentwood	-18	-2	-4	-16
54	114A Regent House	-33	-4	-6	-34
55	121 Mellon House	-6	-1	-1	-6
56	013B Warley Training Centre	-52	-7	-10	-52
57	120 47-57 Crown Street	-4	0	-1	-4
58	125 North House	-6	-1	-1	-5
59	116 Warley Business Park	-22	-3	-4	-22

NTS and TRICS Trip Rate Comparison

4.4.20 As discussed above, trip rates for residential based trips are derived from NTS, similarly employment trips are derived within the distribution process based on trip distribution of housing trips and use of a gravity model. To provide further evidence that the modelling approach is adequate, a comparison of output trips from the model against a further source of data, known as TRICS, has been undertaken.

4.4.21 Whilst NTS provides observed trip rates based on household survey data, another source of information, which is typically used in transport assessments at an individual level, is TRICS. This provides trip rates based on surveys at existing sites and can provide a good source of data to inform trip rates for similar sites elsewhere. A comparison of both residential and employment trip rates from the model have been compared with TRICS and this comparison is also presented in Appendix C Dunton Hills is a mixed-use site and a separate comparison has been made between the modelled output trips and TRICS, which is also included within Appendix C.

4.5 Trip Distribution

4.5.1 This section provides a technical description of the trip distribution approach. Further detail of the trip distribution outputs is provided in Section 8.3. This utilises a gravity model approach dealing with home-based and non-homebased trips separately.

4.5.2 The home-based generated trips are distributed separately for each trip purpose using appropriate trip attractors and a distance matrix extracted from the OmniTRANS model. This distance matrix provides distances along the quickest routes for all origin and destination movements within the study area.

4.5.3 A normalised matrix of weights was applied to the generated work trips to distribute them across all zones. The matrix of weights is effectively a distance-based distribution profile, which determines the number of trips per person within a series of distance bands. For commute trips the profile was calculated using Census travel to work data. The weighting profile for work trips is shown in Table 4-2.

Table 4-2: Work Trips – Distribution Profile

Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Min Distance (KM)	0	0.5	1	2	3	4	5	7	10	15	20	30	50	80
Max Distance (KM)	0.5	1	2	3	4	5	7	10	15	20	30	50	80	
Weighting	272	187	150	121	100	84	45	22	10.0	5.4	1.5	0.6	0.07	0.01

4.5.4 For trip purposes, other than work trips the Census data could not be used for the distance weightings, so a gravity modelling approach based on NTS was used instead.

4.5.5 For the education trips, matrices of weights were calculated separately for each level; assuming education trips by the age 0-16 band was split 50-50 between primary school trips and secondary school trips, and Age 17-64 trips were to/from tertiary education.

4.5.6 The location of local stores was a component of the weights of both the shop-food trips and the shop-non-food trips. In addition, the shop-food trips used supermarket locations and the shop-non-food trips used various non-food retail locations, namely town centres, local retail parks, and larger shopping centres (Lakeside, Bluewater, Westfield).

4.5.7 For work trips a matrix of weights was calculated using distance weights (which reduce as the distance increases) derived from Census journey-to-work data for Brentwood, in conjunction with the number of workplaces in each zone.

4.5.8 Non-home-based trips were generated and distributed using a similar method to that of the home-based trips. However, a 'double-distribution' approach was necessary, where trips were distributed firstly to find the trip origins (using the origin-purpose's weights), then distributed again to find the trip destinations (using the destination-purpose's weights). The non-home-based modelled trip purposes were simply 'work' and 'other' (hence matrices were calculated for work-to-work, work-to-other, other-to-work and other-to-other).

4.6 Mode Share

4.6.1 The trip distribution stage (above) resulted in trip matrices for each purpose (home-based and non-home-based) for the selected option and time-period, for all transport modes combined. The next stage involved deriving the car-driver matrices from the all-mode matrices.

4.6.2 Walking and cycling trips were separated from the all-mode trip matrices to form non-walk-cycle matrices. The walk and cycle shares of trips for each distance band and trip purpose were derived from NTS data and used in this exercise. The NTS data provides a trip rate for cycle and walking trips by trip purpose and distance bands e.g. the number of people walking for home-based education has been split into distances, with a higher trip rate for short distance trips, falling as distance increases.

4.6.3 Table 4-3 shows the percentage of work and employers business trips that walk / cycle in the various distance bands.

Table 4-3: Walk and Cycle NTS distance bands and percentages for work and EB

Dist. Band (km)			HB Work and EB		
No.	**Lower**	**Upper**	**Walk**	**Cycle**	**Other**
1	0	0.5	74.8%	5.7%	19.5%
2	0.5	1	47.0%	7.9%	45.1%
3	1	2	27.5%	6.7%	65.8%
4	2	3	14.0%	8.4%	77.6%
5	3	4	3.2%	6.3%	90.5%
6	4	5	1.3%	2.1%	96.6%
7	5	7	0.4%	3.8%	95.7%
8	7	10	0.0%	1.6%	98.3%
9	10	15	0.0%	0.6%	99.4%
10	15	20	0.0%	0.4%	99.6%
11	20	30	0.0%	0.0%	100.0%
12	30	50	0.0%	0.0%	100.0%
13	50	80	0.0%	0.0%	100.0%
14	80	-	0.0%	0.0%	100.0%

4.6.4 For work-related trips, the car-driver trips were separated from the non-walk-cycle trips using the corresponding Census 2011 journey-to-work mode share for that origin-destination combination. For this modelling exercise, the development zones inherited the car-driver shares of the Census zones that they were located within. PT trips can be derived in the same way using the PT modes shares.

4.6.5 For the other trip purposes (not work related), the car-driver trips and PT trips were separated from the non-walk-cycle trips using the appropriate NTS mode shares for each time-period and trip purpose (including non-home-based purposes).

Resultant Car Driver Trip Matrices

4.7 Highway Trip Assignment

4.7.1 To inform the fourth step for highway trips, trip assignment, an ‘all-or-nothing approach’ utilising speed data from Teletrac Navman (previously Traffic Master), overlaid onto an OS network and utilising OmniTRANS software to provide a graphical interface. Link speeds were calculated for each link in the network using the mean travel time across all records of cars/light vehicles having travelled on the link, for each modelled time-period, by direction. This data was extracted from the Traffic Master data (as provided) and processed to gain mean link speeds using MS Access. The analysis used the appropriate records for the time-period under consideration. An assessment was made as to whether the link speeds were reasonable by assessing the resulting routes and times for a range of OD pairs in the Brentwood area in the constructed OmniTRANS project.

4.7.2 It should be noted that the OmniTRANS model uses a simple, time-based assignment and does not include any algorithms to represent the effects of increased congestion on traffic routing or mode share. The methodology has therefore provided a worst-case (robust) assessment of impacts on individual junctions. In this instance the worst-case means that the traffic assignment has not taken account of any impact of congestion in the future and how it would affect comparative journey times, therefore still assigning trips based on current levels of congestion. This is dealt with further in Section 6.5.

4.7.3 The method proposed for this work uses a hybrid spreadsheet modelling approach with the use of OmniTRANS to provide some inputs into the spreadsheet along with allowing for graphical outputs to be produced at the end of the modelling process. The outputs from the spreadsheet modelling has then been used to provide turning flows that feed into individual junction assessment models.

4.7.4 Whilst not being a true strategic modelling tool which allows for the reassignment impacts to inform route choice, in the absence of such a modelling tool, this method is felt to be a robust (albeit worst-case) appraisal and proportionate both in terms of outputs and cost, for local plan testing. As part of the latter stages of the work, consideration is given to potential of peak spreading, particularly where congestion is prevalent in the base year, for example in central Brentwood.

4.7.5 Following the mode share stage of the spreadsheet-based exercise, resultant vehicle (car-driver) trip matrices were formed by aggregating the car-driver matrices across all trip purposes, for each required time-period and modelling option. The vehicle matrices were assigned to the road network in OmniTRANS.

4.7.6 A spreadsheet was compiled presenting the net increases in vehicular flow resulting from the tested options, for each turning movement of each junction that required junction modelling, for the AM and PM peaks. For simple junctions, this information could be acquired by viewing the node data in OmniTRANS following the assignment stage, and for more complex junctions, cordon matrices were generated after defining a cordon around the junctions in OmniTRANS. This turning flow data for each junction was used as input data for the modelling of the individual junctions.

4.8 Advantages of the Proposed Methodology

4.8.1 The advantages of the application of the bespoke modelling approach are set out below:

i. The spreadsheet-OmniTRANS hybrid model allows trip rates derived from National Travel Survey (NTS) data to be used so that trip generation by purpose can be generated, thus allowing the trips for each purpose to be distributed separately using trip attractors and distance weights that are appropriate for each trip purpose. This is an advantage over merely using Census journey-to-work trip distribution data, which is only valid for work-related trips, to distribute trips for all purposes.

ii. The gravity-modelling approach used in a hybrid model is sensitive to the amount and proximity of attractors (e.g. workplaces), including attractors that are components of development sites (e.g. employment sites), which any pre-defined existing distribution (such as Census journey-to-work) cannot consider.

iii. Similarly, by first conducting the distribution stage on person trips (all modes) then conducting the mode share stage, the hybrid model ensures that an appropriate proportion of pedestrians and cyclists will make short-distance trips, including trips to/from development attractors.

iv. Use of the OmniTRANS network for the assignment of development trips, by-passes the need for a time-consuming manual assignment of development trips through junctions with large trip matrices as the starting point. The use of OmniTRANS also allows turning flows to be extracted efficiently and for graphical outputs from assignment to be produced.

4.8.2 The assignment within the OmniTRANS tool distributes traffic, between all origin and destination points, solely based on the quickest route. The link speeds are supplied from TrafficMaster, to provide average speeds on all links for the desired time-period. The modelling does not take account of congestion within the network, beyond that implicit within the TrafficMaster data, therefore not accounting for future traffic congestion. Effectively a single iteration of an 'all or nothing' assignment is undertaken.

4.8.3 To show the model is representative, a comparison between average speed data within GIS and the OmniTRANS model has been undertaken on a number of routes a summary can be found below in Table 4-4. Route plots, identifying the routes used for this can be found within Appendix D.

Table 4-4: Journey Time Route Comparison

Route	OmniTRANS Journey Time (AM)	Journey Time Planner (AM) 08:30	Journey Time (PM)	Journey Time Planner (PM) 5:30
A1023 Westbound	11 mins	7-12 mins	8 mins	7-14 mins
A1023 Eastbound	8 mins	7-14 mins	7 mins	7-12 mins
Ongar Rd/Ingrave Rd Northbound	10 mins	8-16 mins	10 mins	8-10 mins
Ongar Rd/Ingrave Rd Southbound	10 mins	8-14 mins	10 mins	8-12 mins
B186/A1023 Northbound	10 mins	9-14 mins	9 mins	9-12 mins
B186/A1023 Southbound	10 mins	8-14 mins	10 mins	9-12 mins
Hutton Football Club/A1023 Westbound	14 mins	12-20 mins	12 mins	12-16 mins
Hutton Football Club/A1023 Eastbound	14 mins	12-18 mins	12 mins	12-18 mins

4.8.4 Overall this shows that the model is representing, in the most part, a similar journey time to that shown within the journey time planner demonstrating that the model is fit for purpose.

4.8.5 The network used for the purposes of the assessment is the Ordnance Survey Integrated Transport Network (ITN), which is imported into the OmniTRANS suite to allow the assignment process to be undertaken and for geographically based graphics to be produced for trip distribution. The routing patterns associated with the developments included were checked to determine that they were sensible.

4.8.6 OmniTRANS then also allows for turning flows, from each development scenario, to be extracted for each of the junctions to be modelled.

4.8.7 Within the spreadsheet approach, sets of spreadsheets for the trip generation, distribution and mode share of person trips were created.

4.8.8 The method has six stages, as follows:

- Determining the zoning system
- Trip generation by zone for all trips within the study area at person trip level
- Trip distribution at person trip level
- Mode Choice – broken down into Walk/cycle, PT and car trips
- Assignment of road-based trips
- Junction modelling

4.8.9 The choice of options modelled within the spreadsheets and available to the user are:

- 2017 Base Year
- 2034 Reference Case Scenario
- 2034 Local Plan Growth Scenario

4.8.10 The choice of time periods modelled and available to the user were:

- AM Peak (0800-0900)
- PM Peak (1700-1800)
- 24 hours

5 Junction Modelling Overview

5.1 Overview

5.1.1 As stated previously, the outputs from the spreadsheet approach have been used within standalone junction models or VISSIM microsimulation, to provide an understanding of the performance of each junction being considered with the Local Plan development.

5.1.2 In total 23 junctions have been modelled and assessed using the relevant software packages. The details of the software package used for each junction provided in Table 5-1.

Table 5-1: Junctions Modelled and Modelling Software Used

No.	Junction	Junction Type	Modelling Software
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised Junction	LINSIG
2	A129 Rayleigh Road / Hanging Hill Lane	Mini Roundabout	JUNCTIONS 9
3	A128 Ongar Road / Doddinghurst Road	Mini Roundabout	JUNCTIONS 9
5	A128 Ongar Road / William Hunter Way	Mini Roundabout	VISSIM
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini Roundabout	VISSIM
7	A128 Ingrave Road / B186 Queens Road	Mini Roundabout	JUNCTIONS 9
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised Junction	LINSIG
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised Junction	LINSIG
12	Western Road / William Hunter Way	Mini Roundabout	JUNCTIONS 9
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Roundabout	JUNCTIONS 9
14	A127 / Childerditch Lane	Priority Junction	JUNCTIONS 9
15	A128 Ingrave Road / The Avenue	Double Mini Roundabout (linked with J16)	JUNCTIONS 9
16	A128 Brentwood Road /Running Waters	Double Mini Roundabout (linked with J15)	JUNCTIONS 9

No.	Junction	Junction Type	Modelling Software
17	A1023 Brook Street /Mascalls Lane	Signalised Junction	LINSIG
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised Junction	LINSIG
19	B186 Warley Street / A127 eastbound	Priority Junction	JUNCTIONS 9
20	B186 Warley Street / A127 westbound	Priority Junction	JUNCTIONS 9
22	A1023 Chelmsford Road / Alexander Lane	Priority Junction	JUNCTIONS 9
23	A12 Junction 12	Grade Separated Roundabout	JUNCTIONS 9
24	Roman Road / A12 Slip	Priority Junction (Staggered)	JUNCTIONS 9
25	M25 Junction 28	Grade Separated Roundabout	LINSIG
26	M25 Junction 29	Grade Separated Roundabout	TRANSYT
27	A128 Tilbury Road/Station Road	Priority	JUNCTIONS 9

5.1.3 The junction modelling software used for the assessments (LinSig, ARCADY, PICADY and TRANSYT) provide an indication of how individual junctions perform. A limitation with these tools is that there may be other influencing factors that affect junction performance that cannot be accurately modelled, such as parked vehicles, buses, delivery vehicles and potential interaction with other nearby junctions. Where these issues have been identified, it is anticipated that they will be considered in more detail at application stage.

5.1.4 For all junctions, the following peak periods have been used for the assessment and the same periods will be maintained in the study update. A review of traffic flows across Brentwood has been undertaken and the following peak hours have been determined:

- AM Peak: 08:00 to 09:00
- PM Peak: 17:00 to 18:00

5.2 Assessment Matrix Input Type for Junction Models

5.2.1 Junctions 9 and LinSig require different matrix inputs to accurately model different types of junctions. As such modelling undertaken within Junctions 9 has used direct matrix input, inserting the vehicle matrices in four 15-minute profiles, except for junctions 23 and 27 where only hourly data was available.

5.2.2 The junctions that require LinSig models, such as junctions 1, 8, 10, 17 and 18, have used flat hourly-profile matrices., This is because LinSig does not allow for direct matrices to be used within the junction modelling software.

5.2.3 Table 5-2 shows what Demand Matrix Profile was used for each junction in the assessment.

Table 5-2: Junction Input Matrix Profiles

Junction Number	Matrix Profile	Junction Number	Matrix Profile
1	Flat	16	Direct
2	Direct	17	Flat
3	Direct	18	Flat
7	Direct	19	Direct
8	Flat	20	Direct
10	Flat	22	Direct
12	Direct	23	Flat
13	Direct	24	Direct
14	Direct	27	Flat
15	Direct		

Model Calibration and Validation

5.2.4 As stated within PBA technical note 28085-BLPTM-TN01, Junctions 1 to 22 (attached as Appendix E) have been calibrated and validated based upon count data collected in 2012. For these junctions, quality assurance checks were undertaken to review the calibration of the models against the available data with changes made to the models when required.

5.2.5 Teletrac Navman (previously Traffic Master) data for Brentwood has been used to identify which arms of the junctions show delay and used to assist in the calibration of the models with observed traffic conditions. The use of Teletrac Navman shows general delay at junctions but not necessarily the cause of, for example, delay resulting from road works, unloading of vehicles or traffic situations which are not directly related to the operation of the junctions.

5.2.6 Previous 'General Observations' comments from Essex County Council (ECC) have been incorporated into this process where possible. It was raised previously that "*No account has been taken of uneven lane usage on approaches to junctions*". As part of the review of the previously created junction models, it was identified that following junctions should be created using Junctions 9 Lane Simulation Models to better anticipate the usage of lanes:

- Junction 7;
- Junction 13;
- Junction 15;

- Junction 16; and
- Junction 22.

5.2.7 Although Junctions 13, 15 and 16 were identified as part of this review to require a Junctions 9 Lane Simulation Model, due to limitations within both PICADY and ARCADY, the results of the modelling did not reflect the on-site conditions and were discounted. For this reason, standard simulation models have been used for these junctions.

5.2.8 For Junction 23 and 24, new junction models were created based upon the information found within respective Transport Statement located on the ECC planning portal. A review of these inputs was undertaking to ensure they were fit for purpose.

5.2.9 An element of validation was undertaken on the signalised junctions by reviewing the signal data sheets provided by ECC as well of analysis of the available video data. For this reason, no further validation process has been undertaken for the signalised junctions within the modelling scope.

5.2.10 Two models were provided to PBA by Atkins us for Junction 28 and 29 of the M25. Junction 28 is a LinSig model, whilst Junction 29 was created within TRANSYT. Both required an update and check to ensure the models were still fit for purpose.

5.3 Wilson's Corner

5.3.1 To assess the impact of the Local Plan development on Wilson's Corner a VISSIM microsimulation model has been developed this model incorporates the highway network shown within Figure 5-2. The model includes the Wilson's Corner double mini roundabout and Ongar Road / William Hunter Way Junction.

5.3.2 The base model has been approved by Essex County Council. The report entitled '*190612 - Wilsons Corner VISSIM Base*. PBA, 2019, makes reference to the base model development and its suitability as a tool to assess the impact of the emerging Local Plan development at the Wilsons Corner junction. Highland Avenue, Burland Road and Sawyers Hall Lane are also included within the model.

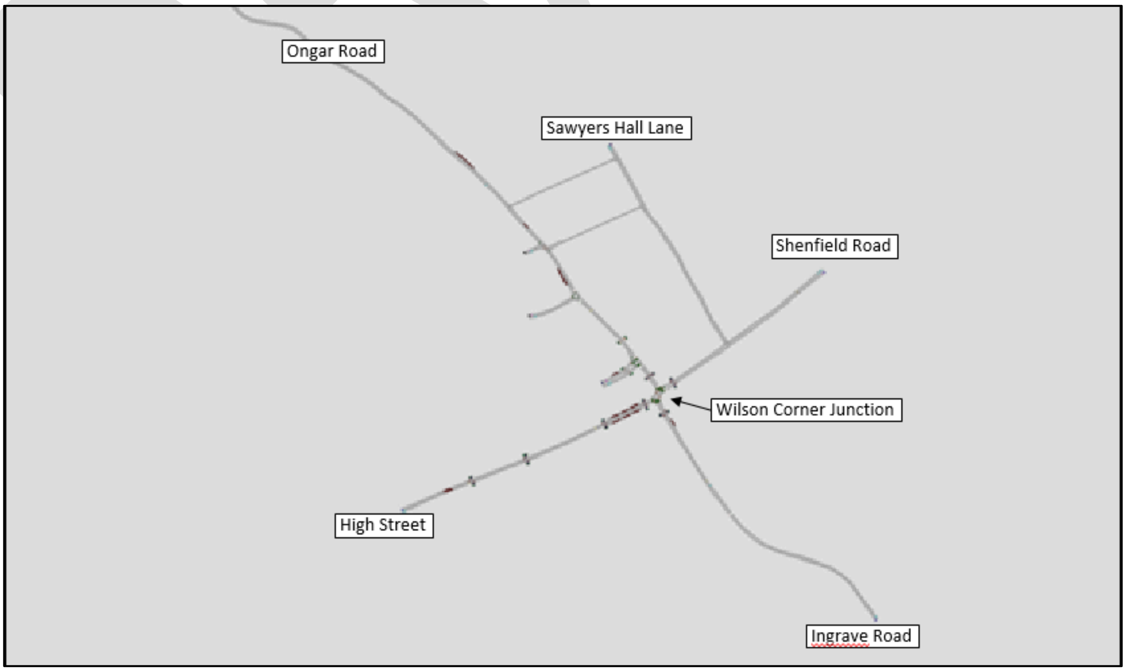


Figure 5-2: VISSIM Model Extent

6 Traffic Analysis

6.1 Overview

6.1.1 Through using OmniTRANS as a GIS tool, it is possible to assign the matrices described in Section 4, to a highway network. Initial assignments have been undertaken for the Reference Case model to get an understanding of the flows on the network.

6.1.2 The Reference Case flows demonstrate the traffic growth that would be expected between 2017 and 2034, without the Local Plan developments.

6.1.3 As this is an unconstrained model, these outputs are seen as the worst-case. The unconstrained flows have been used in the initial junction modelling tests. This exercise gives an idea on how an unconstrained network and junctions would perform and to inform the level of background growth that would be expected to maintain a reasonable level of service.

6.1.4 It would be expected that within a congested network, travellers would only accept a certain level of 'pain' from a congested network and would ultimately look to change behaviour, if a threshold is reached. Within this section, this is considered in the absence of a variable demand modelling approach which can reflect these behaviours.

6.2 Link Flow Checks

6.2.1 Table 6-1 and Table 6-2 shows the changes in flows on some key links within Brentwood for the AM and PM peaks respectively. These links are seen to be the main strategic links within the model area, which carry more longer distance traffic, either through Brentwood or with one trip end in Brentwood. These links are also currently at or close to capacity. This shows the base flows derived from observed counts and the reference case flows produced from the spreadsheet model. These flows shown are the unconstrained growth and do not take account of link capacities, which would influence the actual flow within the peak hours.

Table 6-1: Traffic Flow Comparisons – AM Peak

Road	Westbound			Eastbound		
	Base	**Ref.**	**% Change from Base**	**Base**	**Ref.**	**% Change from Base**
A12 East of M25 Junction 28	2887	3822	32%	2438	3271	34%
A127 East of M25 Junction 29	2773	3592	30%	2774	3806	37%
Brook Street East of M25 Junction 28	814	990	22%	1017	1413	39%

Table 6-2: Traffic Flow Comparisons – PM Peak

Road	Westbound			Eastbound		
	Base	Ref.	% Change from Base	Base	Ref.	% Change from Base
A12 East of M25 Junction 28	2707	3322	23%	3265	4358	33%
A127 East of M25 Junction 29	2881	3845	33%	2654	3794	43%
Brook Street East of M25 Junction 28	1121	1585	41%	1049	1233	18%

6.3 Congested Link Analysis

6.3.1 The outputs from the modelling represent the unconstrained background growth that could be expected between the base year and Local Plan horizon year.

6.3.2 As the growth in traffic is unconstrained, the flow plots show the worse-case scenario, without considering the link capacities, as well as current travel trends which seem to indicate that overall traffic is in fact not growing, as indicated in Section 3. The modelling showed that the link capacities at the A127, A12 and Brook Street were above their operational capacity. Due to the link capacity issues, trip distribution would change, TAG Unit M2 Section 4.5 outlines the Hierarchy of Choice Responses. The hierarchy of choice responses are route choice, time of day choice, mode choice and trip frequency.

6.3.3 As part of review of the network operation, link capacities have been checked. Theoretical link capacities are taken from the Design Manual for Bridges Volume 5, Section 1, Part 3 'Traffic Capacity on Urban Roads'.

6.3.4 Tables 6-3 and 6-4 illustrates the existing base flows and the additional flows associated with the Reference Case and Local Plan scenarios for the AM and PM peak periods, with the theoretical link capacity included.

Table 6-3: AM Link Flows on A12, A127 and A1023

Road	Westbound		Eastbound		Theoretical Link Capacity
	Base	Ref.	Base	Ref.	
A12	2887	3822	2438	3271	4000
A127	2773	3592	2774	3806	4000
A1023 Brook Street	814	990	1017	1413	900-1140

Table 6-4: PM Link Flows on A12, A127 and A1023

Road	Westbound		Eastbound		Theoretical Link Capacity
	Base	Ref.	Base	Ref.	
A12	2707	3322	3265	4358	4000
A127	2881	3845	2654	3794	4000
A1023 Brook Street	1121	1585	1049	1233	900-1140

6.3.5 In the AM peak, the A1023 Brook Street is already close to capacity in the eastbound direction, and close to capacity in the PM peak in both directions. The modelling indicates that additional demand from background traffic in the reference case, show flows in most cases well above the theoretical capacity of the link.

6.3.6 The A12 remains within capacity in most cases, however it is close to capacity in the westbound direction in the AM peak and eastbound in the PM peak.

6.3.7 For the A127, all flows during the Reference Case are just below the maximum link capacity.

6.4 Junction Capacity Checks

6.4.1 As stated above, initial junction modelling has been undertaken with the worst-case flows. This exercise highlighted a number of junctions where, in the reference case, the outputs were unrealistic and demonstrated excessive delays, which are well beyond what would be deemed a reasonable level of service, in terms of time delays and queues. Section 6.5 below sets out how this has been considered when undertaking the modelling, to allow a more realistic assessment to be undertaken, to ascertain the impact of the Local Plan.

6.4.2 The worst junctions are detailed below:

- A128 Ongar Road/William Hunter Way
- A128 Ingrave Road /B186 Queens Road
- A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters
- A1023 Brook Street/Mascalls Lane
- Warley Hill/Eagle Way
- M25 Junction 28
- M25 Junction 29

6.4.3 The A127/B186 junction is not included within this list, as there is a committed scheme which provides adequate capacity for the reference case growth.

6.5 Approach to Reflect Change in Behaviour Due to a Congested Network

6.5.1 The modelling work undertaken for the Brentwood Local Plan uses a trip generation and assignment approach which predicts future traffic based on current trip rates for peak hour travel and then assigns all traffic to the quickest route. There are some locations where this predictive method would lead to unsustainable and unrealistic levels of traffic, where the network would not be able to cope, either due to link capacity constraints or significant levels of congestion inherent in the delay and queue outputs from the modelling. The main locations are A12 and Brook Street and M25 junction 28.

6.5.2 An approach is put forward that has used existing evidence to help predict more realistic levels of traffic. This has been supported by TAG approach on variable demand modelling, where the hierarchy of choices has been used in the absence of a variable demand model. Evidence, where available, has been used to influence travel behaviour and therefore forecast movements.

6.5.3 Predicting future travel patterns is difficult, primarily due to the uncertainty around new and emerging technology and attitudes. The approach taken in this assessment is seen as pragmatic and has determined a reduction in background traffic compared to the original forecast.

6.5.4 The modelling undertaken does not take account of variable demand, which would enable the modelling of choice responses as a result of a congested network.

6.5.5 As stated in previously, the TAG guidance discusses how travel is influenced by congestion. Therefore, in the above cases it is likely that travellers would be influenced in their choice by the congestion on the links, with the hierarchy of choices as set out above.

6.5.6 The following elements have been considered in order to reflect how car travel may be influenced by congestion in the future and how this may change driving habits.

6.5.7 As part of looking at forecast traffic flows, the analysis has looked at the following:

- Route Reassignment
- Peak spreading
- Trip Frequency (Sensitivity)

Route Reassignment and Traffic Growth

6.5.8 Some traffic would use alternative routes. In the area around Brentwood, this is particularly the case for trips using the A12 and A1023 Brook Street, where the assignment assumes that all trips will use these roads in the case of many origin and destination movements, where in fact some would use alternative routes and the future traffic flows on these links are far higher than would be realised. Table 6-1 showed the traffic growth predicted within the model on these routes and demonstrated that the level of growth was high.

6.5.9 To determine a potential level of traffic that could be seen to reassign, a standard online route planner has been used to understand some typical journey times between competing routes in the peak hours between some key origin and destination routes where either congested links or junctions have been identified. For each of these routes the current model will assign all trips to the quickest route regardless of the level of congestion. It would be expected that at least some of the traffic would re-assign because of a congested network. Details of the key route comparisons, where reassignment has been considered.

6.5.10 The analysis shows that there are several potential alternative routes that could feasibly be taken to avoid the heavily congested areas around Brook Street and M25 Junction 28. As an example, a car trip with an origin in Romford and a destination in Brentwood town centre in the AM Peak for a trip departing at 7:55 on a typical weekday, has the following options:

- Option A (Main Route): Via A12, through to M25 junction 28 and Brook Street – Journey Time Range: 14-35 minutes Distance: 10.3km
- Option B (Southern Route): Via Gallows Corner/A127 and Warley Road – Journey Time Range: 18-30 minutes Distance: 12.6km
- Option C (Northern Route): Via Noak Hill and Weald Road – Journey Time Range: 18-28 minutes Distance 12.6km

6.5.11 In the above example, all traffic within the model will be assigned on Option A, whilst this is the shortest route and at the lower end of the range, is the quickest, it has the greatest variation in time and the upper range is higher than the other two routes. It is likely that some travellers would route on each of these options.

6.5.12 Through the DfT's TEMPro software, it is possible to obtain traffic growth figures by area and by road type. The data uses the National Trip End Model (NTEM), with growth adjusted using the National Transport Model (NTM). Between 2016 and 2033 the expected growth on rural trunk roads in Brentwood is expected to be 17.63% in the AM peak and 17.46% in the PM Peak. As shown in Tables 6-1 and 6-2, within the model growth is as high as 34% on trunk roads, as all traffic is assigned to these routes, rather than other routes locally, The National Transport Model will take account of this when determining the level of growth and is used here, along with the comparison of modelled and theoretical link capacities on some links identified within tables 6-3 and 6-4, as a proxy for potential levels of traffic that could reassign.

6.5.13 To reflect this the background growth on the A12 has been capped within the junction modelling within the reference case for Brentwood rural trunk roads.

6.5.14 Similarly, NTM shows that growth on urban principal roads within Brentwood is expected to be 13.1% in the AM peak and 12.93% in the PM peak. The modelling again shows that growth on the A1023 Brook Street, which is a principal route within Brentwood, is far higher than this as shown in Table 6-1 and 6-2 and the flows exceed link capacity, as shown in Table 6-3 and 6-4. Therefore, a similar approach has been taken to reduce the level of growth in the Reference Case. This approach has been applied within the junction models only and not within the spreadsheet tool.

Potential Diversion Numbers

6.5.15 Table 6-3 and 6-4 indicated the level of flow on Brook Street in the Reference Case in the AM and PM peak periods. This indicates the following:

- In the AM peak westbound, the Reference Case flows are within the range for link capacity on this type of link, therefore any re-assignment would be minimal. This rises by another 80 in the Local Plan test, with total flows just within the theoretical capacity.
- In the AM peak eastbound, the Reference Case flows are around 300 trips above the theoretical capacity, so could re-assign or travel at a different time or not travel at all. This rises by another 90 in the Local Plan test.
- In the PM peak westbound, the reference case flows are around 500 trips above the theoretical capacity. This rises by another 80 in the local plan test.
- In the PM peak eastbound, the Reference Case Flows are around 100 trips above the theoretical capacity. This rises by another 150 in the local plan test.

6.5.16 Table 6-5 sets out the additional trips that could be seen on each of the two diversion routes (routes B and C detailed in paragraph 6.5.11) due to reassignment. Two sets of figures are provided based on an assumption that 50% and 75% of trips would divert.

Table 6-5: Predicted Additional Trips on Alternative Routes

Time Period & Direction	Model Scenario	Route B		Route C	
		75%	**50%**	**75%**	**50%**
AM Peak Westbound	Reference Case	0	0	0	0
	Local Plan	0	0	0	0
AM Peak Eastbound	Reference Case	113	75	113	75
	Local Plan	38	23	38	23
PM Peak Westbound	Reference Case	188	125	188	125
	Local Plan	30	20	30	20
PM Peak Eastbound	Reference Case	38	25	38	25
	Local Plan	56	38	56	38

6.5.17 The figures in the table indicate that the biggest diversion is likely to occur in the PM peak in a westbound direction.

6.5.18 Trips within the model have also been removed from the A12. However, as this is a strategic route with very little opportunity for trips from Brentwood to access the road, it would be expected that any trips diverting, due to growth in background traffic beyond the theoretical capacity of the link, is more than likely to be longer distance traffic from Chelmsford and beyond, which would divert to routes further afield such as the A414.

Impact on Junctions from Diverting Traffic

6.5.19 TrafficMaster plots provided by ECC show the % speed on links in relation to free flow speed. Figure 6-1 and Figure 6-2 show these for the AM peak hour (0800-0900) and PM peak hour (1700-1800) respectively. The figures also show the potential southern and northern routes, which are deemed as alternatives to the A12/Brook Street (to avoid M25 junction 28). These have been used to understand whether the routes trips will be diverted to are likely to be adversely impacted upon in traffic congestion terms, as a result of traffic increases. The two diversion routes are shown on the plots.

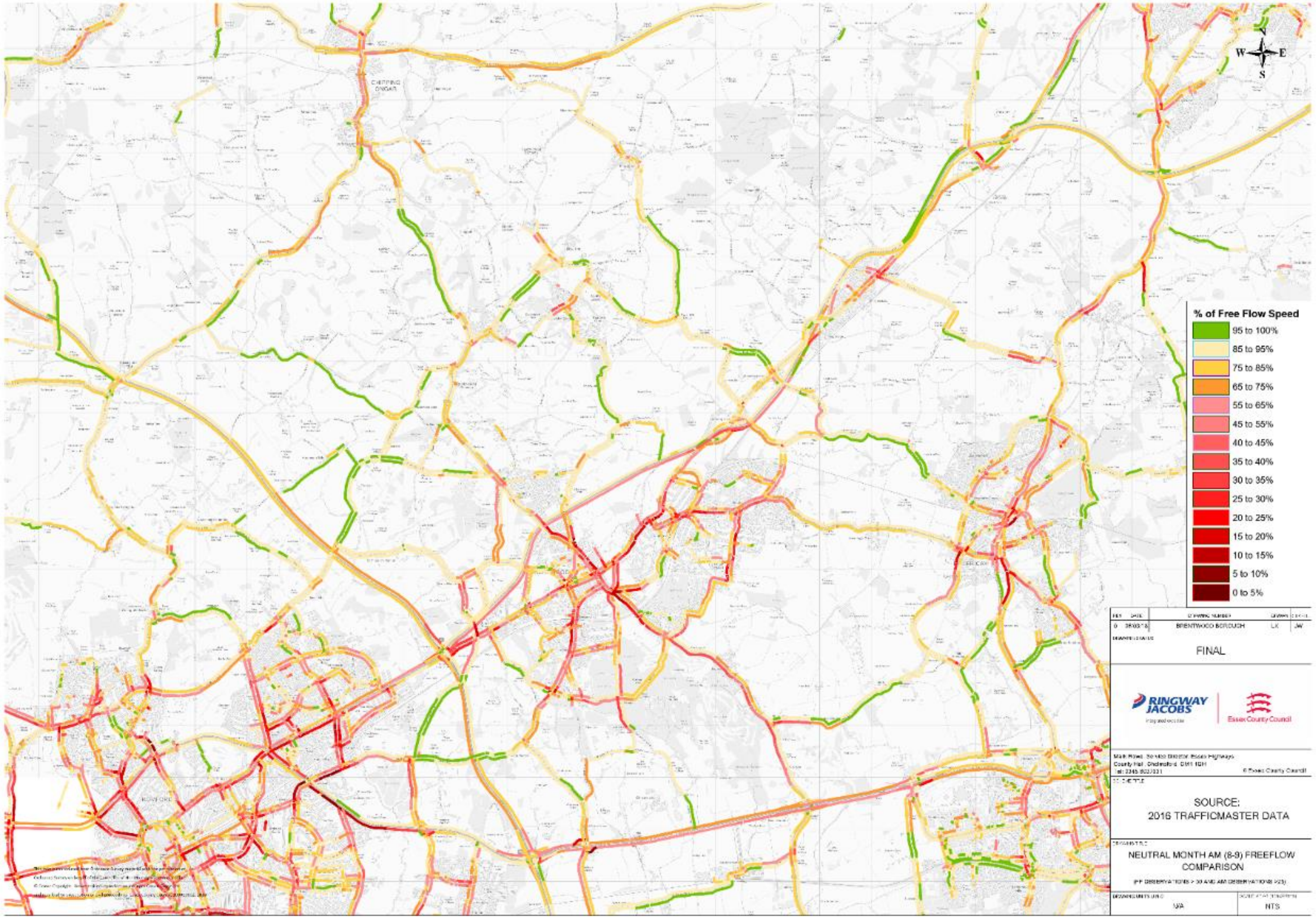


Figure 6-1: AM Peak Hour TrafficMaster Plot (A12 Reassignment)

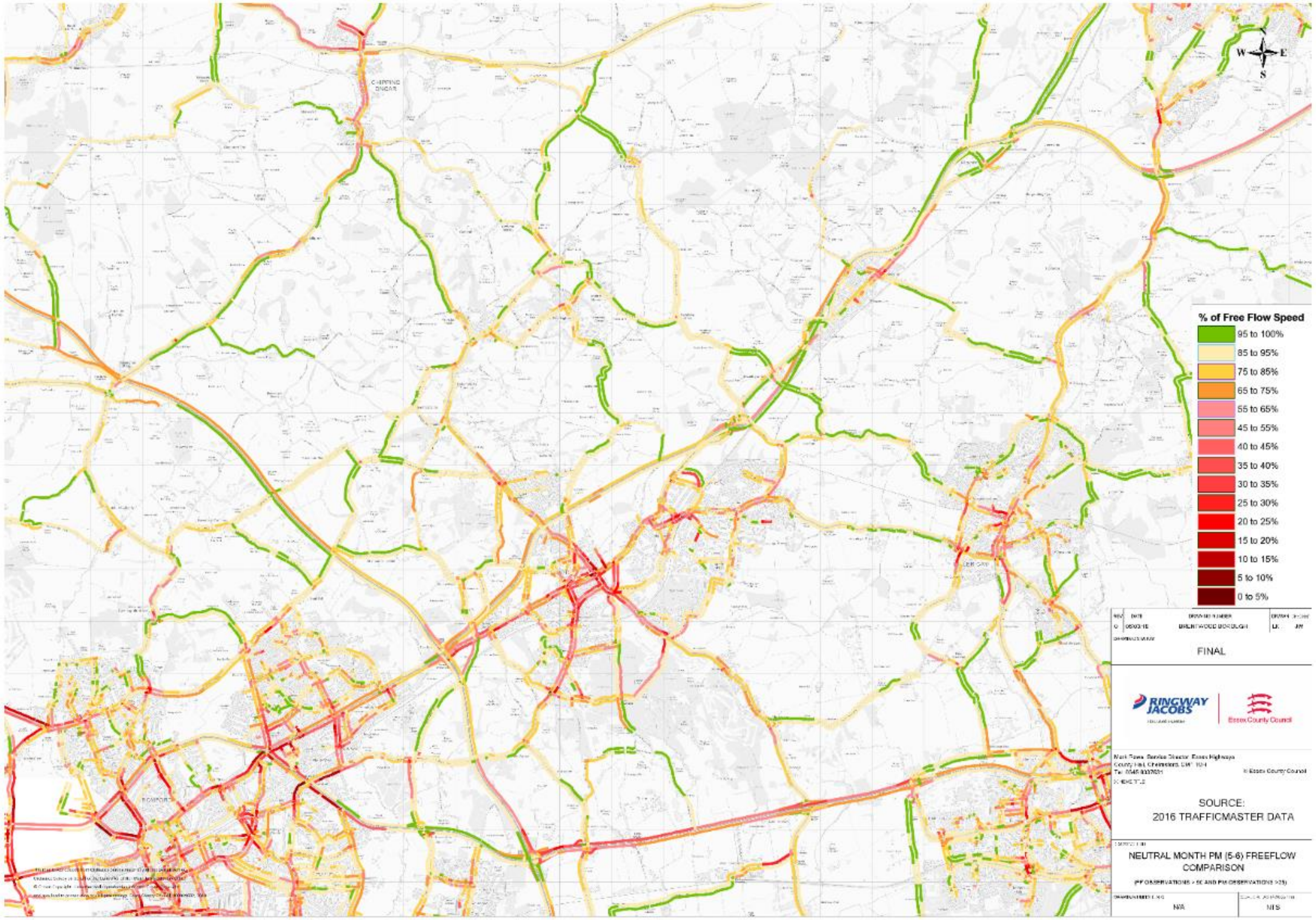


Figure 6-2: PM Peak Hour TrafficMaster Plot (A12 Reassignment)

6.5.20 The plots show that Route A (northern route) does not experience any congestion issues in either peak. Route B (southern route) shows that there are some limited delays on the approaches to the Mascalls Lane/Warley Road junction. This is considered further in Section 8.11.

Peak Spreading

6.5.21 For some locations, the impact of peak spreading has been considered. This has allowed for changes in timing of trips to be reflected within the assessment, where it has been identified that within the peak hour that there is a peak within the peak and the junction assessment indicates that the junction is at capacity now.

6.5.22 As stated within DMRB Volume 12 Section 2 Part 1 – Traffic Appraisal in Urban Areas, peak spreading occurs because of a congested network during the usual peak hour times of 08:00 to 09:00 and 17:00 to 18:00, thus resulting in people travelling earlier or later in the peak period to avoid being delayed and subsequently traffic becomes more spread in the peaks.

6.5.23 The effect of peak spreading can be reflected in a traffic model, where profiling is used across the peak, by adjusting the proportions of traffic allocated to each profiled period in the peak hour i.e. where 15-minute profiles have been used, these may be adjusted to reflect a flatter traffic profile across the peak hour. Alternatively, in junction modelling the effect of peak spreading can be simulated by inputting a flat profile to replicate the effects of traffic being evenly distributed throughout the modelled period.

6.5.24 In addition, where the peak hour is shown to already be congested and the flow profile already flat, a review of data has been undertaken to see if in future, this will indicate peak spreading into the shoulders, thus dampening growth in the actual peak hour.

6.5.25 Table 6-6 identifies which junctions and for which peak period a flat hour matrix has been included within the modelling to represent the effects of peak spreading.

6.5.26 The junctions below are those that were identified where there was the greatest need to consider the likelihood for additional peak spreading to occur in response to increasing junction delay.

Table 6-6: Junctions Modelled with A Flat Demand Matrix to Represent Peak Spreading

Junction No.	Junction Location	Peak Spreading Period
2	A129 Rayleigh Road / Hanging Hill Lane	PM
3	A128 Ongar Road / Doddinghurst Road	PM
5	A128 Ongar Road / William Hunter Way	PM
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	AM and PM
7	A128 Ingrave Road / B186 Queens Road	PM
13	A127 / A128 Brentwood Road / A128 Tilbury Road	AM
15	A128 Ingrave Road / The Avenue	AM and PM
16	A128 Brentwood Road /Running Waters	AM and PM
24	Roman Road / A12 Slip	AM

Trip Frequency

6.5.27 As stated in Section 1, there is evidence to suggest that trip frequency is declining, despite increases in population and the number of people in employment. Whilst some of this is due to changing demographics and an aging population, there are other reasons which the research suggests are behind this.

6.5.28 Advances in technology have enabled changes in how people work, with the increase in home working, both on a regular and occasional basis. Also, there has been an increase in part time working.

6.5.29 As the highway network becomes more congested the technological advances have facilitated the ability to change when people travel or not travel at all to avoid the worst congested periods. People can work from home prior to going to work later for example.

6.5.30 Whilst there is uncertainty around the continued trend, it is very likely that as technology improves, this will facilitate even greater flexibility and acceptance of agile working practices, which would result in lower trips, for commuting and business travel in the future. Due to the uncertainty, no reductions have been applied to reflect this within the modelling.

7 Sustainable Transport Infrastructure Assessment and Mitigation

7.1 Overview

7.1.1 To reduce the impact of developments on the overall road network within Brentwood Borough, alternative methods of transport other than the car should be promoted to lessen the impact of strategic development sites on the highway network. As required within NPPF and the Local Plan Transport Evidence base guidance, sustainable transport interventions have formed the main part of any mitigation required to provide additional mobility capacity within the system.

7.1.2 Providing additional highway capacity will only have a short-term impact and may be quickly taken up by suppressed traffic. Therefore, investment in providing alternatives is important.

7.1.3 This section considers potential sustainable transport measures that could be implemented within the local area to assist in reducing this impact. Whilst encouraging modal shift and healthier choices because of reduction in car usage, some measures could also be considered as alternatives to, or supporting physical improvements to highway mitigation. A qualitative desktop study has been undertaken to identify, where possible, any measures that could be developed regarding bus routes and improvements to cycling and pedestrian accesses.

7.1.4 Census travel to work data from 2011 for Brentwood residents indicates that 36.3% of travel to work trips are by car driver, of which around 30% take place within the Brentwood/Shenfield urban area. These trips are likely to be well under 8 kilometres or 5 miles, which demonstrates that there is potential for shifting short distance trips from car driver to sustainable modes, through promotion of sustainable travel. It should also be noted the car driver travel to work mode share for Brentwood residents is the lowest of all the Essex boroughs and districts. The figure for Essex is 40.4%, for Chelmsford it is 40.6% and Basildon it is 38%. The lower car use could be a reflection of higher rail use, which is discussed later in this section. It should be noted that census only provides the main mode of travel to work and does not indicate how commuters may be accessing e.g. rail. Promotion of sustainable travel to stations is therefore also key.

7.1.5 Brentwood Borough is in the process of developing a sustainable transport strategy to help address traffic and associated air quality issues within the town centre, this emerging strategy is outlined below. Elsewhere, this assessment focuses on the strategic development sites at the south of the Borough, which have the greatest impacts on the operation of the highway network due to their scale.

7.1.6 Within this section, an overview of Brentwood specific sustainable travel ideas is discussed. Whilst these have not been explicitly modelled as part of the assessment, such measures would bring about changes required to support delivery of the Local Plan and the developments can facilitate delivery of a packages of measures similar to that discussed in Section 7.2.

7.1.7 For the purposes of the modelling, specific evidence from the DfT Sustainable Travel Towns study has been used and this is detailed in Section 7.3.

7.2 Brentwood Specific Sustainable Transport Ideas

7.2.1 The potential to create an integrated sustainable transport network, linking railway stations, places of employment, new residential developments and existing development in the wider Brentwood area is key to achieving a reduction in car dependency. These elements can also influence other travel, where there is capacity already available or where it can be created through various travel initiatives. These will have an impact on travel, both related to specific

Local Plan sites, but also the wider community, as the Local Plan facilitates the investment required. The schemes will require funding through the Local Plan process and will be identified within the Infrastructure Delivery Plan (IDP).

7.2.2 Table 7-1 sets out a package of sustainable mitigation measures which specifically mitigate the direct and indirect impacts of the new development proposed in the draft Local Plan. Other measures were initially identified but were less certain in terms of their deliverability within Local Plan timescales and, following discussions with ECC, were excluded from consideration. These measures are being incorporated into the emerging Brentwood sustainable transport strategy. These are shown in Appendix F.

7.2.3 A key consideration of this strategy is to influence school travel, which is adding to congestion within Brentwood town centre in the AM peak. This creates not just issues with junction capacity but impacts on the ability of traffic to travel smoothly through the area, as parked vehicles cause conflicts. One example of how improvements could be achieved in a relatively cheap and achievable way is through the provision of a School Clear Zone which is a key element is reducing peak hour trips within Brentwood town centre. The concept is described in more detail in Section 7.2.8, but seeks to remove school related trips from the town centre and to encourage greater use of non-car modes for such trips. This will have a major impact on car trips within Brentwood town centre, particularly in the AM peak.

7.2.4 The south of the Borough is comparatively poorly served by sustainable transport options. Therefore, the substantial quantum of residential and commercial development proposed in the Draft Local Plan to the south of the Borough requires substantial financial investment in sustainable transport measures beyond that proposed around Central Brentwood. The southern corridor (A127 corridor) is seen as a major growth corridor and one of the main aims of any transport strategy will be to promote sustainable transport in the corridor and increasing sustainable transport options, aligned with the areas of growth.

7.2.5 A Primary sustainable measure proposed is to transform the current West Horndon station and car park in phases into a sustainable transport interchange. This will be linked to developments along the southern growth corridor, including Dunton Hills, Brentwood Enterprise Park and West Horndon developments. The phased changes will bring new regular buses services, plus secure cycling and walking infrastructure within 2 mins walk to a rail service connecting Southend and its Airport to the East to Central London and Fenchurch Street to the West.

7.2.6 The development phases of the new interchange will be aligned to Development Management agreements for investments from the development sites in Brentwood and potentially in the future from North Thurrock.

7.2.7 Like the School Clear Zone, the West Horndon Interchange proposal will require several other items outlined in Table 7-1 to work optimally. These are identified within the IDP.

Table 7-1: Sustainable Transport Measures

Item	Description	Timeline	Comment
1	Create School Clear Zone to restrict all vehicles from stopping, parking for drop off during AM/PM peaks from a specific area(s).	SHORT - MEDIUM	Parking allowed in legally designated car parks and spaces on the High St within the zone. Should reduce congestion at AM peak. Additional benefit of improving air quality at Wilson Corner. Public Transport exempt.
2	Deliver Park, Ride or Stride facilities for workers within Brentwood T.C. or drop/pick up	MEDIUM	Impact on local traffic patterns would need to be understood. Work needed with schools to re-educate parents. Consider an electric and ordinary bicycle hire scheme hub. Additional

Item	Description	Timeline	Comment
	off points for parents to drop off their children.		option to include bus service for schools from these hubs.
3	Plan and deliver in phases 'Quietway' cycle routes in Brentwood initially connecting Transfer Hubs to Town Centre schools	MEDIUM	Segregated routes where possible. Where not consider contra-flow cycling routes by creating new one-way streets. Consider 20mph in the zone.
4	Ban all large freight vehicle from stopping deliveries within the Central Brentwood zone and A128 corridor during AM/PM peaks.	MEDIUM	New developments sites won't compete with Central Brentwood as the retail centre. The larger population could lead to more large vehicles stopping for extended periods to service new developments and a busier High Street.
5	Policy requiring all new developments dependent on location to be 'Car light' and/or encourage e-vehicles.	SHORT	Difficult given political situation Consider partnership with car club company providing electric cars or low emission hybrids
6	Introduce a pedestrian wayfinding system like Legible London.	SHORT / MEDIUM	Residents and employees of new developments and the existing population should be encouraged to walk more.
7	Create and/or promote a multiple service App making access to smart car hire/ community buses/ booking bikes (including e-bikes) etc. easier.	SHORT	Partner with software organisation that creates community-based apps. Pays for itself through advertising
8	Introduce electrical parking points to encourage use of such vehicles and plan and deliver other IT infrastructure redundancy to allow future implementation of emerging SMART systems.	SHORT / MEDIUM	All new residential and commercial developments should include e-charging spaces for car clubs using e-vehicles and charging hubs for e-bikes. Important to facilitate sustainable north/south movements from DHGV to Central Brentwood.
9	Create through phases a new multi-modal interchange at West Horndon Station	MEDIUM	This interchange will serve the DHGV, Childerditch, West Horndon and Enterprise Development sites, plus any future Northern Thurrock developments.

School Clear Zones

7.2.8 To mitigate the impact of additional vehicular trips from Local Plan development and beyond on central Brentwood, a School Clear Zone could be provided. It would be enforced by a combination of traffic wardens, new CCTV and new traffic signage to restrict stopping and parking. Fines could be imposed for those vehicles caught breaking the restriction.

7.2.9 To facilitate a positive impact of this policy and therefore reduce traffic loading from the new developments, the following deliverables have been identified (and are outlined graphically in Appendix G).

- `Clear Zones would be defined by TRO, around each School based on at minimum within a 10-minute walk (400m) or a maximum within a 20-minute walk but easy cycle (800m). New signage and CCTV will be installed, and an information initiative undertaken with the parents in partnership with the schools affected. A 20mph speed limit will also be imposed within the Zone.

- Transfer/drop-off hubs. – Parking sites will be adapted to create new transfer hubs. These will offer Parents, Children and town centre workers/visitors, Cycle Hire Facilities with access to enhanced bus services and normal and electric bikes for to encourage 'Park and Ride or Stride' to their destination. Additional cycle parking facilities will be added to schools within the zone where required. A commercial contract will be tendered for the provision of the bikes to encourage all ages and abilities to use the service. Parents would sign up to a usage policy and their Children can pay and unlock the bikes for short trips to school and around the local area. The scheme would also be available to workers and visitors

- New bus stops where feasible will be incorporated within or relocated near to the entrance/exit to these facilities. If required existing bus service it, will be made more frequent given the guaranteed customer base these facilities will offer.

- A Pedestrian Wayfinding system - will be installed to encourage walking from the Stations within the borough and the new transfer hubs, given the Elizabeth Line opening in 2019

- Quiet Routes for cyclists will be identified running from the Transit Hubs. Where possible segregated routes will be created, or alternatively, contra-flow cycle lanes will be delivered on new one-way residential roads. Central Brentwood has a network of interconnected lanes which could also be restricted to pedestrian and cyclist use. Any deliveries to shops in these lanes to be undertaken outside of school peak hour.

- Community App – developed and delivered to make access to Sustainable Transport alternatives and community events easier. New development residents and workers will also find such an app invaluable to learn about the area, upcoming activities etc.

7.2.10 The measure has the added benefit of encouraging more physical activity for children, their parents, and all other users to walk or cycle from a reasonable distance – a maximum of a 20 minutes' walk from the schools or central Brentwood. In addition, air quality is likely to improve, and nuisance parking will be less prevalent.

7.2.11 Brentwood high schools and some primary schools are attractive, not only to residents within the Borough, but also for many children from the surrounding Essex and London authorities. Traffic generated by future developments from surrounding authorities have been considered within the background growth, outlined in the modelling methodology sections. Therefore, the additional schools have been considered. The five secondary schools (each with student numbers of more than 1000 pupils) located in Central Area of Brentwood generate a significant volume of parents dropping off and picking up their children. Each of these schools operate Sixth Forms some of whose pupils drive to school during the peak hours.

7.2.12 Figure 7-1 provides the origin of pupils by postcode, which has been summarised to show those travelling from the following origins:

i. Within the Borough

ii. Other Essex Authorities

iii. London Boroughs (Eastern Boroughs of Barking & Dagenham, Redbridge, Newham and Havering).

7.2.13 Within the data source there was no information for the private Brentwood School, the largest by area of the five.

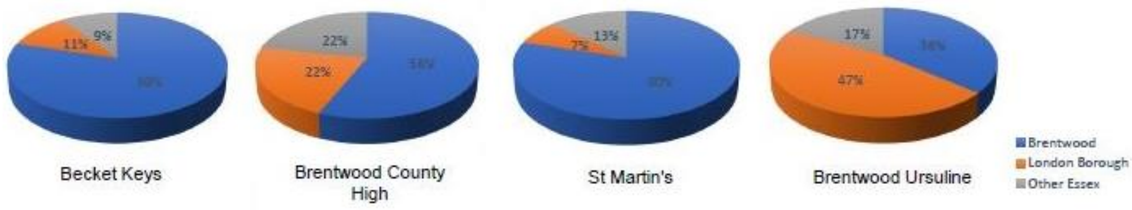


Figure 7-1: Origin of Pupils by Postcode

7.2.14 This activity shown above has a significant impact on the capacity of the local road network within the AM peak. A similar volume of traffic also appears later in the day, before the usual PM peak. While schools generally have a restricted parking zone adjacent to the entrances, there is no current method in place to prevent parents' parking on nearby streets. Nuisance parking currently takes place on private roads, blocks public roads and causes resident complaints. The roads surrounding the schools will therefore be protected in both school peak traffic times by enforceable 'stopping, parking and 20mph speed' restrictions.

Rail

7.2.15 There are three key railway stations that currently serve Brentwood and the wider area, all of which have the potential to benefit sustainable travel in the area.

7.2.16 The major growth within Brentwood is focused on the southern corridor and as detailed above, a key aim is for West Horndon Station to lay a vital role in promotion of sustainable transport, including provision of sustainable travel links and services between developments and the station.

7.2.17 All developments proposed within the north would be within easy reach of either Shenfield or Brentwood Station and promoting sustainable links between the developments would benefit both the new developments and the existing population of the towns.

7.2.18 Brentwood and Shenfield stations are located on the Great Eastern Mainline.

7.2.19

7.2.20

7.2.21 Table 7-2 summarises the relevant railway links that serve Brentwood and the wider area.

7.2.22 Currently, Brentwood station is served by TfL Rail services operating between Shenfield and London Liverpool Street at a frequency of six per hour throughout the week, and Abellio Greater Anglia services operating between Southend Victoria and London on Sundays only.

7.2.23 Shenfield is served by Abellio Greater Anglia services between Shenfield and Southend Victoria, at a frequency of three trains per hour to Southend Victoria, and one train per hour to Colchester Town, Ipswich, Braintree and Clacton-on-Sea. TfL Rail also operates quarter hourly services to London Victoria and from late 2018 it will be the terminus of the Elizabeth Line which will run between Reading and Heathrow Airport in the west through London.

Table 7-2: Current Railway Links

Service Operator	From	To	Frequency
TfL	Brentwood	London Liverpool Street	6 per hour
TfL	Brentwood	Shenfield	6 per hour
TfL	Shenfield	London Victoria	4 per hour
Abellio Greater Anglia	Brentwood	Southend Victoria	1 per hour (Sundays only)
Abellio Greater Anglia	Shenfield	Colchester Town / Ipswich / Braintree / Clacton-on-Sea	1 per hour

7.2.24 During 2014, JMP Associates undertook a station parking study for Shenfield prior to the development of the Elizabeth line. The Rail User Survey identified that 37% of people drive and park their car at the railway station. An additional 29% walk to the station and 7% travel by bus.

7.2.25 Figure 7-2 shows the modal split of users recorded in that study. This demonstrates that, with the introduction of better bus services to the station, there is potential to reduce car use for travel to Shenfield railway station, thereby reducing overall traffic on the local network.

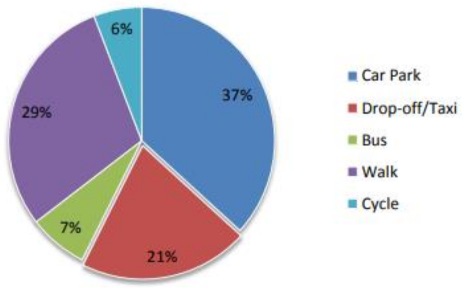


Figure 7-2: Modal Split of Rail User Respondents

7.2.26 West Horndon station is on the London, Tilbury and Southend Railway line and is served by C2C with two trains per hour to London Fenchurch Street and Shoeburyness. The parking area has been identified as at full capacity on most weekdays for commuters into London from the A127/A13 corridors. It is proposed that this station will form an integrated transport hub, supporting the new sites in the south of the Borough and future sites from Thurrock.

Census Travel to Work – Rail Mode Share in Brentwood

7.2.27 Rail travel plays an important role within Brentwood. The 2011 Census indicates that 15.8% of commuter trips by residents within Brentwood are by car, which compares to just 7% for Essex and 10.8% for Basildon and 9% for Chelmsford. This is reflective of the level of rail services in Brentwood and the importance of travel to London. The opening of the Elizabeth line will only assist in delivering extra capacity for rail use in the future and the Local Plan is an opportunity to further enable growth and moves away from the private car, through improving access to stations from developments and the wider area.

The Elizabeth Line

7.2.28 The new Elizabeth Line is a 118km railway under development crossing through the heart of London, enabling access between Reading and Heathrow in the west, through central London to Shenfield and Abbey Wood in the east. The full route is expected to be fully operational by December 2019.

7.2.29 The scheme will improve the station environment at both Brentwood and Shenfield stations, specifically in terms of non-motorised users and will provide enhanced public transport access, with new forecourt and pedestrian crossing facilities being installed at Brentwood. At Shenfield, additional bus facilities will be installed to cope with an increase in demand for public transport usage.

7.2.30 It is expected that the introduction of this new railway will assist in the reduction of some longer distance car trips within the Brentwood area and thus mitigating capacity issues at some of the identified junctions on the strategic network, including, for example, junctions on the M25 and A12. The attractiveness of the services may also result in increased delay at key junctions because of increased car travel to the railway stations. However, improvements to sustainable travel options to both Shenfield and Brentwood stations are anticipated, such as pedestrian and cycle infrastructure (including improved signing) and bus services. These will link both new and existing developments near the stations, and introduce new parking controls, where needed, to discourage parking around the stations, therefore reducing car travel.

7.2.31 Whilst it is expected that the Elizabeth line will have positive impacts on the highway network within the Borough, there is no adequate data available to assist with modelling these impacts. It would be expected that through promotion of sustainable travel to access the station, any local impact on the highway network can be managed accordingly.

West Horndon Public Transport Interchange

7.2.32 Within the Local Plan there is a recognition that provision of sustainable transport in the South of the Borough is poor. To mitigate the impact of the two employments sites and two residential sites, new area-specific sustainable transport measures will be implemented, centred around West Horndon, which is centrally located between the four sites. These measures will seek to deliver a minimal traffic impact for these sites on the existing the Highway infrastructure i.e. the A127, A128, and M25 J29. The measures would also seek to reduce the need for northward movements into central Brentwood. Any remaining northward travel will be electric car club vehicles, electric bikes (to deal with the topography) or Bus only.

7.2.33 It is proposed that over the lifetime of this Plan, the improvements to the station and associated bus and cycle infrastructure are phased to create a new interchange. An increased capacity on the existing rail services will be central to the new cycling, walking and bus movements of the new residents and employees accessing the four sites.

7.2.34 While a new Railway station would be the ultimate delivery goal, it will only happen if sufficient development also comes forward from Thurrock to make the business case for a new station viable. To support the developments within Brentwood’s draft Local Plan, it will be enough to:

- Alter and extend the existing Station building to include more Gate-lines and provide a new disabled access.
- Make vehicular and cycle site access and egress from the Interchange safer through alterations to the existing adjacent Highways

- Implement segregated cycle routes to all the surrounding developments.
- Ensure an interim bus service(s) connecting the development sites to the interchange is built into the development agreements to be funded for a minimum of 5 years. This should allow time for customer demand to build adequately for a commercial operator to take on the routes.

7.2.35 Appendix H shows the proposed option for the sustainable connections from the four sites to West Horndon Interchange and to the North.

Bus Services

7.2.36 Brentwood and the surrounding area are served by multiple bus operators, including First Bus, Stagecoach and Ensign Bus.

7.2.37 In the immediate area and most relevant to the Local Plan sites, First Bus routes 9, 351, 565 offer the potential to extend the routes to provide a service to the future developments. Route 9 currently offers a half hourly services between Brentwood Railway Station and Basildon Bus Station via Billericay. 351 is a half hour service between Brentwood Railway Station and Chelmsford Bus Station, and route 565 an approximate half hourly service between Brentwood Railway Station and Bulphan. Any route amendments are unlikely to occur in the short term but potential for existing routes to serve new developments currently off route. Any future route development could be incorporated within the planning application for associated developments.

7.2.38 Additional services operated by Stagecoach between Brentwood and Romford of a half hourly service and Ensign Bus between Warley and Ongar, stopping at Brentwood Railway Station operates an hourly frequency.

7.2.39 There is potential in the future to provide bus links between key residential areas, employment and railway stations, both existing and those proposed. There is an opportunity to provide services that link Dunton Hills (and Basildon), West Horndon Station, Brentwood Enterprise Park, Childerditch Business Park and Brentwood (including the station), which, if providing a high quality express service between these key origins and destinations, would provide a realistic alternative to the private car.

7.2.40 Where appropriate, new services could be provided by commercial operators. This will have an impact on mode share and potential reduction in future car travel, both for those that would directly benefit from new services in the new developments, as well as existing residents who would benefit from service improvements as well.

7.2.41 There is a longer-term aspiration for a Mass Rapid Transit System within South Essex.

Other Sustainable Transport Opportunities

7.2.42 Figure 7-3 illustrates the key public transport routes in relation to the Local Plan development sites. The ability to better connect the railway stations of Brentwood, Shenfield and West Horndon to the existing population centres and new areas of residential and employment development such as Brentwood Enterprise Zone or Dunton Hills, opens up the opportunity for developing better bus links between these sites. Additionally, there is an opportunity to encourage walkability for education trips and for existing people who live in the town, using Legible London type wayfinding infrastructure as an example.

7.2.43 There will be a need, as development progresses, to work closely with ECC, bus operators and developers of individual sites to identify these opportunities as development progresses. This can assist in encouraging people to consider using alternative modes of transport to the private car.

7.2.44 In addition, the proximity of new housing developments close to railway stations can provide the opportunity to improve cycling and walking infrastructure for shorter distance trips, to access rail services. This is particularly the case with Dunton Hills, where new opportunities to implement and improve links to Brentwood and Shenfield stations, benefitting both existing populations and new Local Plan development populations.

7.2.45 Additionally, the development of other schemes such as school drop-off zones, can encourage people to park outside of Brentwood town centre to walk, cycle or get an alternative mode of transport to school resulting in a reduction of congestion and delay during the peak periods within the town centre.

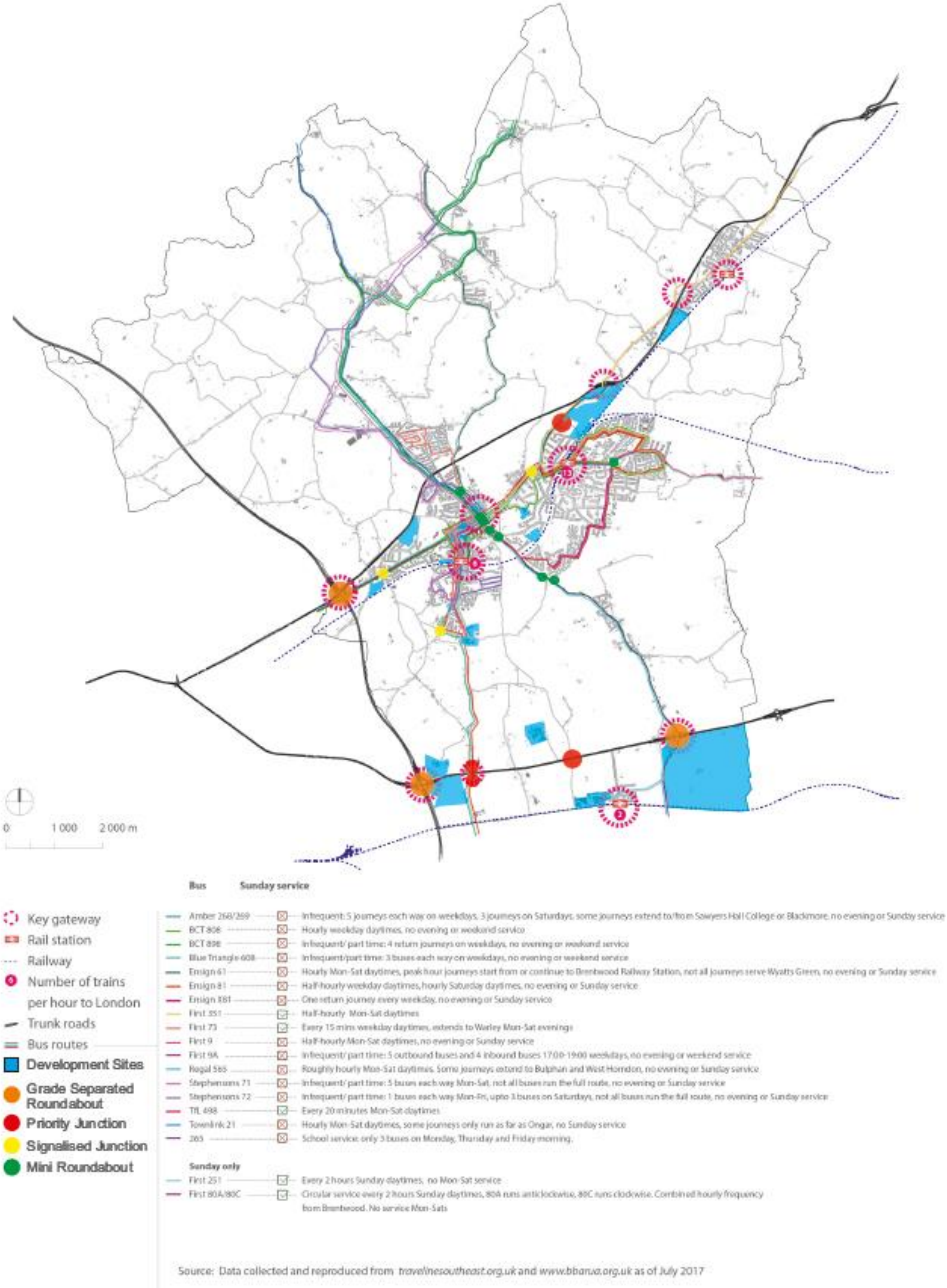


Figure 7-3: Public Transport Routes and Services

7.3 Application of Sustainable Transport Measures in the Model

7.3.1 The sustainable travel interventions discussed above provide examples of measures that could be introduced within the plan period to mitigate the traffic impacts. With the type of interventions proposed, these would be able to influence both travel associated with the Local Plan Developments and wider society. The suggested improvements for these in Brentwood include the following:

- bus services between new developments and existing developments
- School travel interventions (such as creation of school drop off zones away from congested town centre)
- Improved accessibility to stations through better interchange for buses (West Horndon)
- Improved cycle/walking facilities/signing/way marking (West Horndon, Brentwood and Shenfield).

7.3.2 The modelling methodology has been used to provide an indicative reduction in these elements where appropriate. This approach uses published evidence of the impact of sustainable travel measures and has been agreed as a suitable approach with Highways England.

7.3.3 Research published by the DfT demonstrates that there is a benefit from implementing Travel Plans and sustainable travel measures to achieve a mode shift from car use. This includes the following research:

- 'Making Personal Travel Plans Work' (DfT, 2007) – this reports a reduction in single occupancy vehicle trips of 12% across 12 DfT areas following to implementation of Personalised Travel Planning; and
- 'Smarter Choices – Changing the Way We Travel' (DfT, 2005) reports a reduction of between 5% and 9% in single occupancy vehicle trips in non-urban areas for commuting journeys following the implementation of a Workplace Travel Plan. The sites considered in this research included a wide range of employers in differing locations implementing a variety of measures.
- The report on "The Effects of Smarter Choice Programmes in the Sustainable Travel Towns": Full Report (Sloman et al., 2010).

7.3.4 Some of the headline results from the last of those listed above include:

- Car driver trips per resident of the three towns taken together fell by 9% between 2004 and 2008.
- Car driver distance per resident fell by 5% to 7% (for trips of 50km or less). Car use per head also fell nationally in comparable (medium-sized) urban areas during this period, but by a much smaller amount: a change of -1.2% for car driver trips and -0.9% for car driver distance.)
- Overall reductions in car traffic (based on counts) of the order of 2%, and more substantial reductions in inner areas, of the order of 7 to 8% overall.
- Bus use grew substantially in Peterborough and Worcester during the period of the Sustainable Travel Town work, whereas it declined in Darlington. Bus trips per resident of the three towns taken together increased by 10% to 20% (for trips of 50km or over) whereas there was a national decline of bus trips in medium-sized towns of 0.5% over the same period.

- There were positive results for cycling in all three towns, with particularly substantial growth in Darlington. Cycle trips per resident of the three towns taken together increased by 26 to 30%, whereas, according to the National Travel Survey, there was a national decline of cycle trips in medium-sized towns over an approximately similar period.

- Walking trips by residents grew in all three towns during the period of the Sustainable Travel Town work. Walk trips per resident of the three towns taken together increased by 10% to 13%, whereas, according to the National Travel Survey, there was a national decline in walk trips in medium-sized towns of at least 9% over an approximately similar period.

- The growth in bus use, cycling and walking cannot be explained by trip generation. In fact, at the aggregate level, the total number of trips per capita by all modes, as recorded in household surveys, fell by 1.1%.

- Although the largest behaviour changes were seen in short car driver trips, the largest reductions in distance travelled as a car driver came from medium and longer distance trips. Of the reduction in distance travelled for trips of <50km, about 45% of the reduction in car driver kilometres came from trips of 10 to 50km; about 40% from trips of 3 to 10km; and about 15% from trips of less than 3km. Table 7-3 shows the car trip reductions by distance from the Sustainable Travel Towns study.

Table 7-3: Change in Car Driver Trips from Sustainable Measures by Trip Distance[9]

	Up to 1km	**1.1 – 3km**	**3.1 – 5km**	**5.1 – 10km**	**10.1 – 50km**	**Over 50km**	**Total**
Car Trip Reduction	-22%	-14%	-10%	-6%	-3%	0%	-9%

7.3.5 The above evidence indicates that through a targeted approach to promoting and providing sustainable travel options, a reduction in distance travelled by car can be achieved.

7.3.6 To meet the requirements of NPPF and to be consistent with the guidance for Local Plans, the emphasis needs to be on sustainable transport and promoting this. The Local Plan offers up this opportunity within Brentwood to provide a comprehensive sustainable transport strategy, aligned with growth, that will provide greater opportunities for all and move away from the emphasis being on physical highway mitigation, which is shown to only provide a short-term solution, if nothing else is done.

7.3.7 Based on the above study, Table 7-4 sets out the level of achievable reductions that have been applied to the modelling to reflect sustainable transport measures for Local Plan sites. The set of measures set out should be able to achieve a level of trip reduction which equates to around half of that in the Sustainable Travel Towns research, but more could be achieved, therefore the modelling reflects a worse case assumption.

Table 7-4: Trip Reductions Applied to Local Plan Sites

	Up to 1km	**1.1 – 3km**	**3.1 – 5km**	**5.1 – 10km**	**10.1 – 50km**	**Over 50km**
Car Trip Reduction	-11%	-7%	-5%	-3%	-1.5%	0%

[9] Taken from Table 13 of https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/4420/chap13.pdf

7.3.8 In addition to an expected reduction in Local Plan associated car trips, the sustainable travel measures will also provide a reduction of traffic within the Brentwood and Shenfield urban areas, particularly for short distance trips. The introduction of sustainable travel interventions, which are made possible because of new development, is likely to have an impact on how existing users travel. For example, improved way marking, cycle and walking infrastructure and signing and improved public transport provision, could benefit those amongst the existing population.

7.3.9 Therefore, trip reductions shown in Table 7-5 have been applied to trips with an origin in the Brentwood and Shenfield built up areas.

Table 7-5: Trip Reductions Applied to Existing Brentwood and Shenfield Trips

	Up to 1km	1.1 – 3km	3.1 – 5km
Car Trip Reduction	-5%	-3%	-2%

7.3.10 This seems a proportionate and pragmatic approach and the reduction in trips is at a level which should be achievable in the future in the context of the modelling. It is recognised that Brentwood has a high car ownership, hence the use of reduced factors. A comparison of the car trips by distance within the model for Brentwood are shown in Table 7-6 and 7-7 for the AM and PM Peak respectively.

Table 7-6: Change in Car Driver Trips from Sustainable Measures by Trip Distance – AM Peak

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km
No Sustainable Measures	735	3123	2121	3284	12935	301
With Sustainable Measures Applied	703	3025	2077	3258	12896	301

Table 7-7: Change in Car Driver Trips from Sustainable Measures by Trip Distance – PM Peak

	Up to 1km	1.1 – 3km	3.1 – 5km	5.1 – 10km	10.1 – 50km	Over 50km
No Sustainable Measures	290	2093	1953	3234	14609	305
With Sustainable Measures Applied	275	2024	1911	3210	14565	305

8 Assessment Outputs and Results

8.1 Overview

8.1.1 This section summarises the outputs from the modelling process and includes link flow comparisons, trip distribution plots from the matrix assignment process and results from the junction tests.

8.1.2 The junction capacity has been tested for the following scenarios:

- Base Case: Traffic counts and trip rates collected in 2017
- 2033 Reference Case: Forecast year with no LP Growth
- 2033 LP Growth: Reference Case + LP Growth

8.1.3 In addition to the above scenarios, other scenarios have been tested within the reference case to reflect t any committed mitigation identified at the junctions and the impact on trip making as a result of congestion, as discussed in Section 6.

8.1.4 Within the Local Plan Model tests, the impact of the sustainable travel measures has been considered.

8.2 Traffic Flow Comparisons

8.2.1 Traffic flow plots have been produced which show the link flows at key locations on the network associated with the Reference Case. These take account of the reassignment analysis as detailed in Section 6. The flows represent the uplift in flows on each link and not the total flow. These are provided in Appendix I.

8.2.2 Traffic flow plots are also produced to show the traffic associated with the Local Plan development scenario. These plots include the reduction for sustainable travel as detailed in Section 7. These plots are provided within Appendix J.

8.3 Trip Distribution Plots

8.3.1 Distribution plots for trips associated with the Dunton Hills developments and for the Brentwood Enterprise Park for the AM and PM peaks are shown in Appendix K.

8.3.2 The purpose of the plots is to demonstrate that the distribution of trips within the modelling process are seen to be logical and the linkages between the development sites and the trip destination of trips from these sites is as would be expected in relation to e.g. trips from residential areas to main areas of employment and education.

8.3.3 Plots have been produced for the following LP sites in the AM and PM and are provided in Appendix K:

- Dunton Hills
- Enterprise Park
- Officer's Meadow
- William Hunter Way
- Ford Headquarters

- Land East of Chelmsford Road
- West Horndon

8.3.4 A description of the distribution pattern of trips for each of the above is provided below. The plots overall show that trip distribution is deemed to look logical. The influence of London is clear, with in the main, larger number of trips from the Local Plan sites heading west towards East London, either via the A127/A12 routes or the M25 towards junctions 30 (for Thurrock, Dagenham and Dartford) and 27 (for North London).

Dunton Hills

8.3.5 Figures 1 and 8 in Appendix K show the distribution of Dunton Hills in the AM and PM peak hours respectively. Due to the large scale and mixed use of the development the distribution is over a large area. In the AM the majority of the trips use the A127 towards the M25 and then split between north/southbound on the M25 and going inside the M25 which are likely to be commuter trips. Trips also go the centre of Brentwood which are a mixture of employment and secondary education trips. Trips to the east of the development use the A127 towards Basildon and further afield but also to the industrial estate in Laindon and to Billericay. The PM is generally the reverse of the AM.

Enterprise Park

8.3.6 Figures 2 and 9 in Appendix K show the distribution of Enterprise Park in the AM and PM peak hours respectively. With it being a large employment site located directly next to junction 29 of the M25 it attracts trips from a large area. The spreadsheet model showed the majority of the trips come from the south using the M25 in the AM however comparison against census journey to work data showed that it was likely some of these trips would use the A127 from inside the M25. A manual adjustment based on the census data was made and this approach was agreed with Highways England. There are also trips from the M25 north and also more local trips from areas such as Brentwood, Romford, Billericay and Basildon. The PM is generally the reverse of the AM.

Officer's Meadow

8.3.7 Figures 3 and 10 in Appendix K show the distribution of the Officer's Meadow in the AM and PM peak hours respectively. In the AM, there are 3 main routes, 1 internal to Brentwood and 2 externals. The internal distribution to Brentwood follows the A1023 Chelmsford Road southbound where there are high levels of employment and education land uses. The 1st external distribution follows the A12 westbound which splits at M25 J28 either following the M25 south or continue at the A12 westbound towards Harold Hill, these relate to commute and employer's business trips in the London area. The 2nd external distribution route is related to employment trips from the site to Billericay. The PM is generally the reverse of the AM.

William Hunter Way

8.3.8 Figures 4 and 11 in Appendix K show the distribution of William Hunter Way in the AM and PM peak hours respectively. The centrally located residential development generates most of it trips towards the M25 which then split between the M25 south/northbound and inside the M25, with trips generally being commute trips to the London area. There are also a small number of trips to the south and east. The PM peak hour is generally the reverse of the AM peak hour.

Ford Headquarters

8.3.9 Figures 5 and 12 in Appendix K show the distribution of the Ford Headquarters in the AM and PM peak hours respectively. In the AM peak hour, the 2 main destination areas of trips within

Brentwood are in the Warley Area where there is a primary school and in the centre of Brentwood where there are high levels of employment and education trips.

8.3.10 Trips going external from Brentwood are split between using junctions 28 and 29 of the M25 and of these trips the majority either go south on the M25 or carry on west inside the M25. The PM peak hour is generally the reverse of the AM with the exception of much fewer education trips from Warley and the centre of Brentwood.

Land East of Chelmsford Road

8.3.11 Figures 6 and 13 in Appendix K show the distribution of the Land East of Chelmsford Road in the AM and PM respectively. In the AM, there are 3 main routes, 1 internal to Brentwood and 2 externals. The internal distribution to Brentwood follows the A1023 Chelmsford Road southbound where there are high levels of employment and education trips. The 1st external distribution follows the A12 westbound which splits at M25 J28 either following the M25 south or continue at the A12 westbound towards Harold Hill. The 2nd external distribution route follows the Old Church Lane Road eastbound towards the Lake Meadows area. The PM is generally the reverse of the AM.

West Horndon

8.3.12 Figures 7 and 14 in Appendix K show the distribution of the West Horndon in the AM and PM respectively. In the AM there are 2 main routes. The 1st route, follows the A127 westbound and then splits at M25 J29, either following the A127 further west towards Harold Wood or following the M25 southbound. The 2nd route, follows the A128 Tilbury Rd northbound till the A127/A128 junction and then moves eastbound on the A127 towards Basildon. The PM is generally the reverse of the AM.

8.4 Junction Modelling - Base Case Scenario

8.4.1 The Base Models have been developed from observed traffic counts. These have been collated from the most recent data available as detailed in Section 3.

8.5 Junction Modelling - Reference Case Scenario

8.5.1 The Reference Case model flows have been extracted directly from the spreadsheet model. These flows are added directly to the base flows used in the Base Case Scenario at each junction.

8.5.2 The Reference Case flows are for the forecast year of 2033 and include all growth which is not associated with the Local Plan. This is to enable a direct comparison between the effects of the trips generated by the Local Plan developments and the expected growth that is forecast to occur in the same year.

8.5.3 As stated above and detailed in Section 6, the impacts of reassignment and peak spreading have been considered within the Reference Case Scenario. This is reflective of the fact that locations have been identified, where the worst-case traffic growth could not be accommodated and where therefore a proportion of drivers would make other choices.

8.5.4 Whilst there is some uncertainty around future travel behaviour, it is considered that this is a pragmatic approach in the absence of a Variable Demand Model, as it would not be expected for all drivers to choose to travel at peak times on certain routes, where these routes are shown to operate well beyond a reasonable level of service.

8.5.5 Peak spreading has been included for specific junctions during defined peak periods, further detail on this process has been summarised within section 6.

8.6 Junction Modelling - Local Plan Growth Scenario without mitigation

8.6.1 The Local Plan Growth Scenario are the developments identified by BCC which are likely to form the allocations in the Local Plan up to 2033, the development trips from these have been added on top of the trips generated by the Reference Case. The flows are taken directly from the spreadsheet models. These represent the worst-case prior to allowance for any sustainable transport mitigation.

8.7 Junction Modelling - Local Plan Growth with Sustainable Travel Mitigation

8.7.1 The junction modelling has been undertaken to reflect the sustainable travel measures, which was discussed in Section 7. The reductions stated have been applied to the modelling at this stage.

8.8 Committed Schemes

8.8.1 Two schemes have been identified which have been included within the junction modelling which are deemed to be committed and will be funded through other means. These are:

i. M25 Junction 28 provided by Highways England as the preferred option from a study for this junction;

ii. M25 Junction 29. The Highways England scheme proposed as part of the Lower Thames Crossing has been assumed to be committed; and

iii. A127/B186 Scheme provided by ECC

8.9 Consideration of Lower Thames Crossing

8.9.1 The outputs from the modelling tool do not account for impacts of the LTC scheme on traffic flows at junction 29, therefore some adjustments have been made to account for this. The information currently available is relatively limited but does indicate that there will be some movements where traffic flows will reduce, whilst there are others which are likely to see an increase. Tables 8-1 and 8-2 show the adjustments made to the models and traffic added or removed from the Reference Case flows.

Table 8-1: Flow Adjustments due to LTC – AM Peak Reference Case Flows

From	To	No LTC	With LTC	Difference	Change to Flow in Model
A127E	M25S	823	1095	272	250
	M25N	1806	1530	-276	-250
M25S	A127W	768	1622	854	850
	A127E	428	845	417	400
A127W	M25N	179	157	-22	0
	M25S	301	587	286	250
M25N	A127E	1320	1033	-287	-250
	A127W	206	155	-51	-50

Table 8-2: Flow Adjustments due to LTC – PM Peak Reference Case Flows

From	To	No LTC	With LTC	Difference	Change to Flow in Model
A127E	M25S	824	1198	374	350
	M25N	1783	1696	-87	-100
M25S	A127W	375	1268	893	850
	A127E	477	852	375	350
A127W	M25N	190	220	30	0
	M25S	331	900	569	550
M25N	A127E	1235	1145	-90	-100
	A127W	337	309	-28	0

1.1. In addition to the flow changes made due to LTC, a further adjustment was made to reflect trip distribution from London. The spreadsheet tool trip distribution for trips to and from London were seen to be far more dominant from the south than could be expected. Further analysis based on census travel to work data highlighted this. Therefore, a further adjustment was agreed with Highways England which resulted in a reduction in trips from the M25 south to A127 east and vice versa and an increase in trips remaining on the A127 mainline. These flow changes will not impact on any other junctions within the model.

8.10 Summary of Individual Junction Outputs

8.10.1 The following section summarises the findings from the junction modelling for each of the scenarios undertaken for each junction, as outlined previously within Table 5-2 and 5-3. The full summary results for each junction are shown within Appendix L and the junction modelling files are included as Appendix M.

8.10.2 The summary takes the following format, a brief description of the junction followed by a summary of the worst performing arms of the junction for the Base, the Reference Case (including trip changes) and Local Plan with Sustainable travel mitigation considerations.

8.10.3 The outputs from the modelling have been expressed as a factor, which refers to the ratio between flow and capacity. A figure of 1.00 represents the position where an arm or movement at the junction has reached the capacity of that arm or movement,

8.10.4 Within the urban area any reductions in delay may be sought by improving public transport and developing key non-motorised user routes between key centres of employment/other attractors and areas of residential development. Tables 8-3 and 8-4 give a summary of these junction tests for the AM peak and PM peak respectively, with the worst performing arm or movement identified.

Table 8-3: Junction Modelling Summary Results – AM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised	83.1%	85.0%	90.0%

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
2	A129 Rayleigh Road / Hanging Hill Lane	Mini-Roundabout	0.98	1.02	1.04
3	A128 Ongar Road / Doddinghurst Road	Mini-Roundabout	1.00	1.04	1.11
5	A128 Ongar Road / William Hunter Way	Mini-Roundabout	0.96	1.11	1.21
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Double Mini-Roundabout	0.78	0.84	0.90
7	A128 Ingrave Road / B186 Queens Road	Mini-Roundabout	1.06	1.23	1.35
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised	96.3%	88.9%	97.5%
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised	86.1%	93.1%	108.8%
12	Western Road / William Hunter Way	Mini-Roundabout	0.84	0.82	0.86
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	0.94	1.45
14	A127 / Childerditch Lane	Double Priority	0.12	0.12	0.15
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.06	1.15	1.24
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	1.08	1.14	1.25
17	A1023 Brook Street /Mascalls Lane	Signalised	95.2%	100.8%	106.3%
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised	102.4%	108.3%	108.8%

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
19	B186 Warley Street / A127 eastbound	Priority (committed scheme - signalised)		88.2%	92.4%
20	B186 Warley Street / A127 westbound	Priority (mitigation signalised)		85.9%	87.6%
22	A1023 Chelmsford Road / Alexander Lane	Priority	0.08	0.09	0.09
23	A12 Junction 12	Grade Separated Gyratory	0.82	0.89	0.94
24	Roman Road / A12 Slip	Staggered Priority	0.79	0.91	1.14
25	M25 Junction 28	Grade Separated Gyratory	0.89	1.24	1.56
26	M25 Junction 29	Grade Separated Gyratory		152%	184%
27	A128 Tilbury Road/Station Road	Priority	0.54	0.62	0.97

Table 8-4: Junction Modelling Summary Results – PM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Signalised	0.91	0.96	1.03
2	A129 Rayleigh Road / Hanging Hill Lane	Mini-Roundabout	0.89	0.97	0.99
3	A128 Ongar Road / Doddinghurst Road	Mini-Roundabout	0.95	0.97	1.02
5	A128 Ongar Road / William Hunter Way	Mini-Roundabout	0.98	1.06	1.15
6	A128 Ongar Road / A1023 Shenfield Road /	Double Mini-Roundabout	0.78	0.71	0.72

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
	A128 Ingrave Road / A1023 High Street				
7	A128 Ingrave Road / B186 Queens Road	Mini-Roundabout	0.90	0.93	1.01
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Signalised	0.88	0.90	0.95
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Signalised	0.71	0.83	0.95
12	Western Road / William Hunter Way	Mini-Roundabout	0.84	0.86	0.95
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	1.00	1.72
14	A127 / Childerditch Lane	Double Priority	0.16	0.20	0.24
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.02	1.07	1.10
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	0.86	0.90	1.21
17	A1023 Brook Street /Mascalls Lane	Signalised	0.89	0.99	1.12
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Signalised	0.90	0.98	1.04
19	B186 Warley Street / A127 eastbound	Priority (committed mitigation signalised)	0.61	0.71	0.80
20	B186 Warley Street / A127 westbound	Priority (mitigation signalised)	1.02	0.67	1.4%
22	A1023 Chelmsford Road / Alexander Lane	Priority	0.08	0.09	0.09
23	A12 Junction 12	Grade Separated Gyratory	0.75	0.79	0.82

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan
24	Roman Road / A12 Slip	Staggered Priority	0.56	0.58	0.64
25	M25 Junction 28	Grade Separated Gyratory	0.84	1.22	1.76
26	M25 Junction 29	Grade Separated Gyratory		174%	194%
27	A128 Tilbury Road/Station Road	Priority	0.66	1.00	1.22

8.11 Junction Modelling Results Summary

8.11.1 Tables 8-3 and 8-4 show the performance of the junctions in the AM and PM peak hours, which are recognised as the worst case, in terms of traffic congestion. The results highlight that there are some junctions which are already over capacity in the Reference Case and others that are only over capacity in the Local Plan scenario.

8.11.2 The junctions that are shown to be over capacity in either the AM or PM peaks in the Local Plan Scenario are listed below. Junctions are deemed to be over capacity if they have a V/C greater than 1.00 or a degree of saturation over 100%. In both cases this means that the flow on at least one arm, within the peak hour, is greater than the capacity of the junction:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A129 Rayleigh Road/Hanging Hill Lane
- A128 Ongar Road/Doddinghurst Road
- A128 Ingrave Road/B186 Queens Road
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip/Roman Road, Ingatestone
- M25 Junction 28
- A128 Tilbury Road/Station Road

8.11.3 Some of these junctions are shown to be only just over desirable capacity in what is recognised as the most congested time on the network and this is modelled at the end of the plan period. Therefore, when considering mitigation, the level at which it is over capacity and in line with NPPF the severity of any change should be considered. A pragmatic view should be taken as to whether physical highway mitigation is the best way forward in this situation or whether more emphasis should be put on the provision of alternative sustainable transport measures, over and above the conservative estimate already made. This is also the case for many of the junctions which are within Brentwood town centre, where there are a large number of short distance trips which could reasonably be expected to shift to other more modes sustainable. Based on this criterion there is a need to consider the following junctions and discussed further in paragraph 8.11.5 onwards, below:

- A129 Rayleigh Road/Hanging Hill Lane
- A128 Ongar Road/Doddinghurst Road
- A128 Ingrave Road/B186 Queens Road
- A128 Tilbury Road/Station Road

8.11.4 Physical highway mitigation has been identified at the following junctions and this is detailed further in Section 10:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A128 Ongar Road/William Hunter Way
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip, Roman Road, Ingatestone
- M25 Junction 28
- M25 Junction 29

A129 Rayleigh Road/Hanging Hill Lane

8.11.5 This junction is shown to only be operating just over capacity in the AM peak only, therefore physical mitigation has not been suggested. The modelling indicates that the largest delay is on Hanging Hill Lane, with maximum delay increasing from around 112 seconds in the Reference Case to 124 seconds in the Local Plan Scenario. This 12 second increase is not deemed Severe.

8.11.6 The junction is located in central Shenfield, therefore there is also opportunities to reduce impact here through provision of improved cycle and walking links with the aim to reduce short distance trips.

A128 Ongar Road/Doddinghurst Road

8.11.7 This junction is over capacity in both peaks, however, in the PM peak it is only just so. In the PM peak, the largest delay is on Ongar Road North, with delay increasing from 50 seconds in the Reference Case to 67 seconds in the Local Plan Scenario.

8.11.8 In the AM peak, the largest delays are experienced on Doddinghurst Road. Delays increase from 159 seconds to 237 seconds on this approach arm.

8.11.9 During the AM peak, it is recognised that school traffic forms a high proportion of traffic in Brentwood town centre. Therefore, through targeting school traffic through sustainable travel measures as identified in Section 7, it would be possible to reduce traffic levels to such that this junction could operate within its current capacity.

8.11.10 In addition, a sensitivity test has been undertaken for peak spreading in the AM peak. This shows that if peak spreading occurred, just in the peak hour, i.e. traffic arrival profiles were flatter, then the junction would operate within capacity. This also demonstrates that the provision of mitigation at this junction is only required for a very short period and this further suggests that there is no requirement for physical mitigation measures.

A128 Ingrave Road/B186 Queens Road

8.11.11 As with the previous junction, this junction performs worse in the AM peak than it does in the PM peak. In the PM peak, it is shown to operate only just over capacity, with delays increasing from 67 to 101 seconds.

8.11.12 In the AM peak, Ingrave Road south experiences the largest delays.

8.11.13 A sensitivity test has been undertaken to understand the impact of a school travel planning measure such as the introduction of School Clear Zones, could impact on the junction in the AM peak. This test indicated, that whilst the junction would still operate over capacity, it would be better than the Reference Case Scenario.

8.11.14 In the PM peak, peak spreading within the peak hour has shown that the junction would then operate within capacity.

8.11.15 As a targeted sustainable travel campaign and investment in improvements to facilitate more sustainable travel to school is part of Brentwood's emerging overarching sustainable travel strategy, no further highway mitigation is considered.

A128 / Tilbury Road / Station Road – Priority Junction

8.11.8 Although the modelling results indicate that a mitigation scheme would be required here, one of the access points from the Dunton Hills development is expected to form a staggered junction or cross roads at this point, therefore it would be expected that a mitigation scheme is developed when this development comes forward as part of the required Transport Assessment for that development.

8.12 Wilson's Corner

8.12.1 The next forecasting stage of the VISSIM modelling for Wilson's Corner is the development of a Reference Case and Local Plan model scenarios, input matrices derived for the spreadsheet/ Omnitrans modelling were used to assign additional traffic to the base model network as absolute trips.

8.12.2 It should be noted that trip assignment in Omnitrans is based on mean link speeds and does not include any algorithms to represent the effects of increased congestion on traffic routing.

8.12.3 The technical note '191120 – Wilsons Corner Vissim Forecast Report, PBA 2019 outlines, in further detail, the process to develop these forecast models and their impact on the network assessed, with the key indicators including the impact on journey times and queueing on the approaches to the junction.

8.12.4 Table 8-5 below summarises the AM and PM peak period network performance statistics.

Table 8-5: Network Performance Statistics

	Measure	AM			PM		
		Base	2034 Reference Case	2034 Local Plan	Base	2034 Reference Case	2034 Local Plan
Peak 1	Delay (AVG)	77	198	270	82	163	270
	Speed (AVG)	14	12	11	14	14	11
	Latent Demand	3	4	55	8	32	42
Peak 2	Delay (AVG)	81	278	412	125	286	537
	Speed (AVG)	15	11	8	12	10	7
	Latent Demand	0	1	59	2	2	60

* [Peak 1 AM - 0730-0830, PM - 1630-1730] [Peak 2 AM - 0830-0930, PM – 1730 – 1830]

8.12.5 The assessment concludes, the initial modelling outputs indicate the Reference Case will have an impact on the performance of the local network in comparison with the 2019 Base Case particularly on Ongar Road, Ingrave Road and High Street approaches. Significant delays are predicted on Ongar Road in the AM and PM peaks and on Ingrave Road in the PM peak.

8.12.6 It should be noted that there is already significant congestion on the approaches to and at Wilsons Corner junction and so background growth would further aggravate delays in the Reference Case model. The local network is therefore sensitive to any further growth in traffic.

8.12.7 The addition of Local Plan development trips further increases delay on the approaches to the junction as additional traffic merely joins the back of a slow-moving queue.

8.12.8 The extent of the impact recorded is in part due to the static nature of the VISSIM models with drivers either reassigning to the wider network or changing their departure time to avoid increasing levels of congestion within Brentwood town centre. Understanding the extent to which drivers reassign can most reliably be established using a wider strategic model but in the absence of this information, the results presented above should be considered a worst-case scenario assessment.

8.13 A12 and M25 Merge Diverge Assessment

8.13.1 A merge diverge assessment has been undertaken at M25 junction 28 and 29. The results of the assessment are shown in Tables 8.6 and 8.7 and the output diagrams are shown in Appendix N.

8.13.2 The assessment determines what type of junction is required given a mainline and merge/diverge flow. The type of merges is listed below and also shown in Appendix N are:

- A – Taper Merge
- B – Parallel Merge
- C – Ghost Island Merge
- D – 2 Lane Merge
- E – Lain Gain
- F – Lane Gain with Ghost Island Merge

- G – 2 Lane Gain with Ghost Island
- H – Alternative Ghost Island Merge with Auxiliary Lane

8.13.3 The types of diverge are:

- A – Taper Diverge
- B – Ghost Island Diverge
- C – Lane Drop at Taper Diverge
- D – Ghost Island Diverge for Diverge
- E – 2 Lane Drop

Table 8-6: M25 Junction 28 Merge/Diverge Assessment – Results

Arm	Existing Layout	AM Peak	PM Peak
M25 Northbound On-slip	F	F	F
M25 Southbound Off-slip	D	D	E
A12 Eastbound On-slip	F	F	F
A12 Westbound Off-slip	A	D	D
M25 Southbound On-slip	F	F	F
M25 Northbound Off-slip	C	D	D
A12 Westbound On-slip	A or D	E	E
A12 Eastbound Off-slip	A	B	B

Table 8-7: M25 Junction 29 Merge/Diverge Assessment – Results

Arm	Existing Layout	AM Peak	PM Peak
M25 Northbound On-slip	E	F	E
M25 Southbound Off-slip	D	D	D
A127 Eastbound On-slip	A	*	*
A127 Westbound Off-slip	A	*	*

M25 Southbound On-slip	E	F	E
M25 Northbound Off-slip	C	E	D
A127 Westbound On-slip	A	D	D
A127 Eastbound Off-slip	A	*	*

*The merge/diverge doesn't fit one of the types

8.13.4 At junction 29 some of the merge/diverge types change as a result of the increase in traffic but of these only 2 change as a result of the local plan traffic which are the M25 Northbound On-slip and the M25 Southbound On-slip.

8.13.5 Where the merge/diverge doesn't fit one of the types it is due to the merge/diverge flow being a lot higher than the mainline flow. An example of a junction designed to accommodate this situation is on the A329M in Reading at the M4 J10.

9 Cross Boundary Impacts

9.1 Introduction

9.1.1 Brentwood Borough is bordered by several authorities and traffic associated with the proposed Local Plan will potentially impact on roads in these authority areas.

9.1.2 The Local Plan Transport Assessment does not at this time define any cross-boundary contributions associated with the cross-boundary impacts.

9.1.3 The following authorities border Brentwood.

- Chelmsford
- Basildon
- Epping Forest
- Thurrock
- Havering

9.1.4 The model outputs have been reviewed to see where the main cross boundary impacts occur as a result of the traffic associated with the Local Plan (LP) developments only.

9.1.5 Table 9-1 shows the flows in to and out of Brentwood to bordering authority areas and key links for both the AM and PM peak hours and Figures 9-1 and 9-2 show the Local Plan flows across the Brentwood Borough Council boundary in the AM peak hour (0800-0900) and PM peak hour (1700-1800) respectively. Further details of flows and potential impact for each authority are provided in the following sections.

Table 9-1: Cross Boundary Traffic Flows

Road	Local Authority	AM Peak (0800-0900)			PM Peak (1700-1800)		
		Inbound	Outbound	Total	Inbound	Outbound	Total
M25 South	Thurrock	630	250	880	340	700	2800
A127 Inside M25	Havering	146	146	292	80	188	852
A12 Inside M25	Havering	46	93	139	90	60	428
M25 North	Epping Forest	161	78	239	75	190	743
A128 North	Epping Forest	11	9	20	9	13	62
A12 East	Chelmsford	92	48	140	53	103	436
A129 East	Basildon	19	4	23	14	14	74

Road	Local Authority	AM Peak (0800-0900)			PM Peak (1700-1800)		
		Inbound	Outbound	Total	Inbound	Outbound	Total
A127 East	Basildon	240	230	470	230	230	1400
A128 South	Thurrock	56	42	98	44	57	297
St Marys Lane	Thurrock	8	77	85	96	-12	254
Childerditch Lane	Thurrock	41	31	72	24	8	176
Warley Street	Havering	28	-11	17	9	71	114

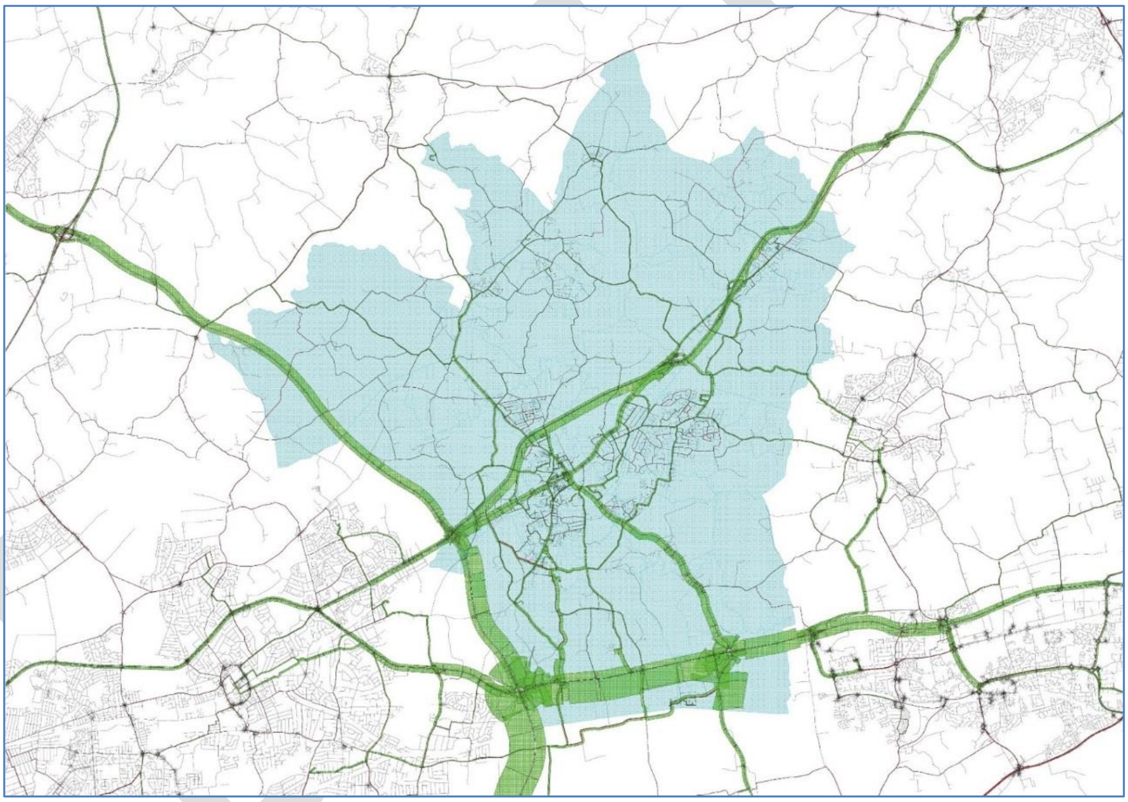


Figure 9-1: AM Local Plan Flows

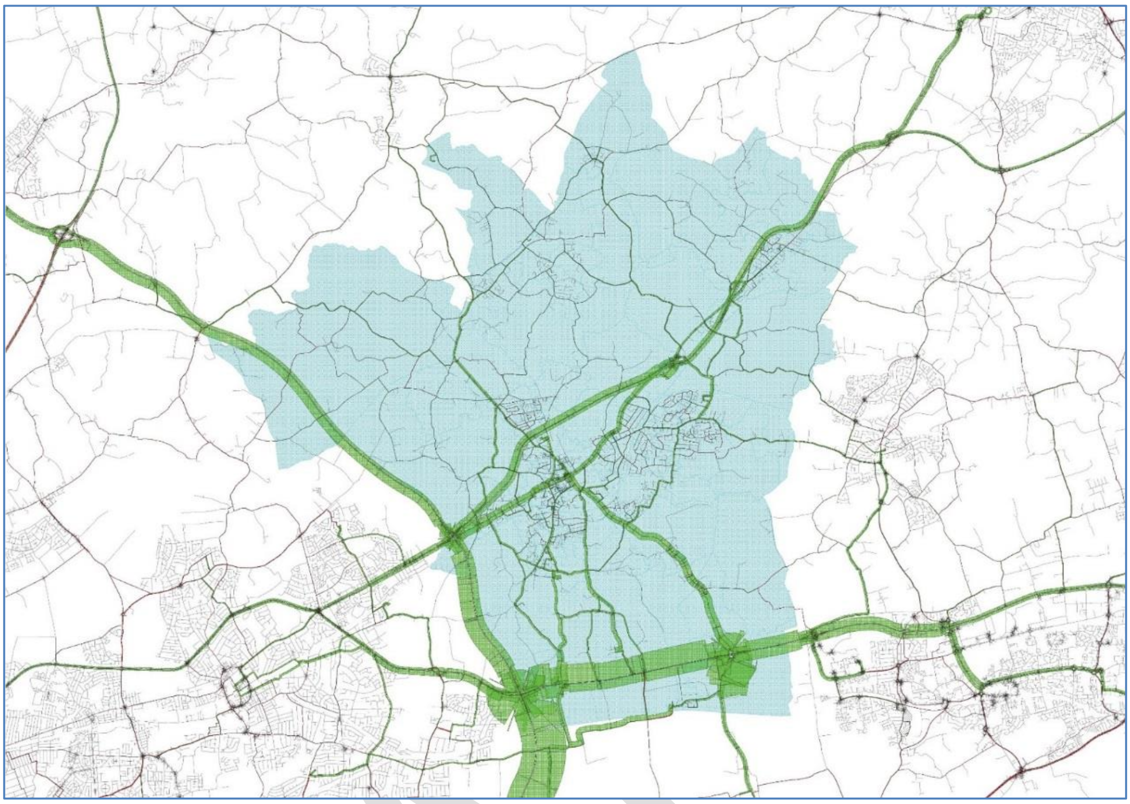


Figure 9-2: PM Local Plan Flows

9.2 Chelmsford

9.2.1 The Local Plan flows on the A12 eastbound out of Brentwood into Chelmsford are 48 and westbound into Brentwood are 92 in the AM peak. Over the same period to background traffic is assumed to increase by 547 and 499 into and out of Chelmsford in the AM peak.

9.2.2 In the PM peak, the LP flows on the A12 eastbound out of Brentwood into Chelmsford are 103 and westbound into Brentwood are 53. Over the same period to background traffic is assumed to increase by 618 and 382 into and out of Chelmsford in the PM peak.

9.2.3 Looking at specific junction impacts, the junction where the Brentwood Local Plan has the biggest impact within Chelmsford is the junction of the A12 and A414 Three Mile Hill. The flows associated with the Local Plan are shown on Figure 9-3 and Figure 9-4 at this junction.

Figure 9-3: A12/A414 - AM Peak Local Plan Flows

Figure 9-4: A12/A414 - PM Peak Local Plan Flows

9.2.4 The flows from the Brentwood Local Plan, impacting on Chelmsford are relatively small, therefore, the impact of the Brentwood Local Plan is seen as minimal on this route and any junctions along the A12. The largest flow increase is seen on the A414 south west bound from Chelmsford to the A12 in the AM peak, with a flow of 76 vehicles and on the A12 eastbound off-slip towards Chelmsford in the PM peak, with a flow of 63 vehicles.

Basildon

9.2.5 The two main cross boundary routes between Brentwood and Basildon are the A129 and A127.

9.2.6 The flows on the A129 as a result of the Brentwood Local Plan are minimal with 4 out of Brentwood and 19 into it in the AM peak and 14 vehicles in each direction in the PM peak. The impact on the A129 is therefore negligible.

9.2.7 The A127 flows are much larger with 230 vehicles out of Brentwood and 240 vehicles from Basildon in the AM peak and 230 vehicles in each direction in the PM peak. Over the same period to background traffic is assumed to increase by 596 and 519 into and out of Basildon in the AM peak and by 714 and 620 in the PM peak.

9.2.8 The impact on the A127/West Mayne junction is shown in Figures 9-5 and 9-6 for the AM peak and PM peak hours respectively.

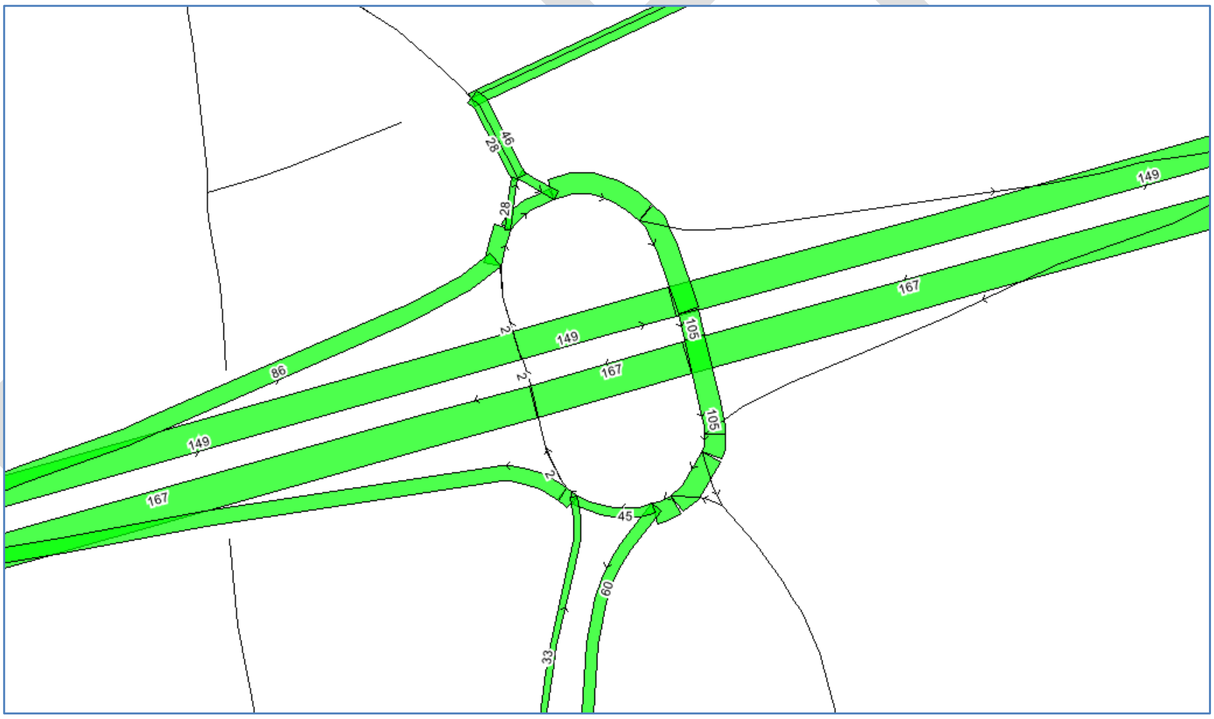


Figure 9-5: A127/West Mayne - AM Peak Local Plan Flows

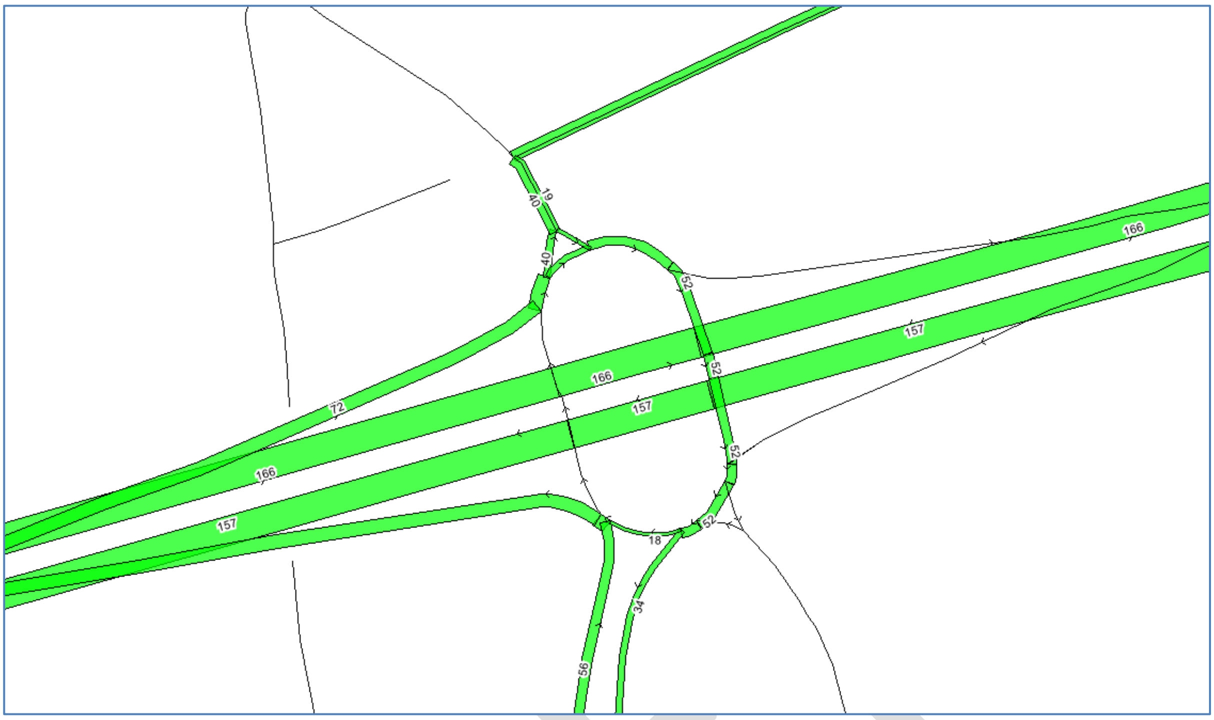


Figure 9-6: A127/West Mayne - PM Peak Local Plan Flows

9.2.9 The above indicates that there is likely to be minimal traffic increase on the West Mayne junction in terms of traffic flows, as a result of Brentwood Local Plan traffic in the AM and PM peaks. The largest traffic flow increases (excluding the A127 mainline flow) are on the eastbound A127 off-slip and the eastern part of the gyratory. Figures 9-7 and 9-8 show the Local Plan flows at the A127/A176 junction in the AM and PM peaks respectively.

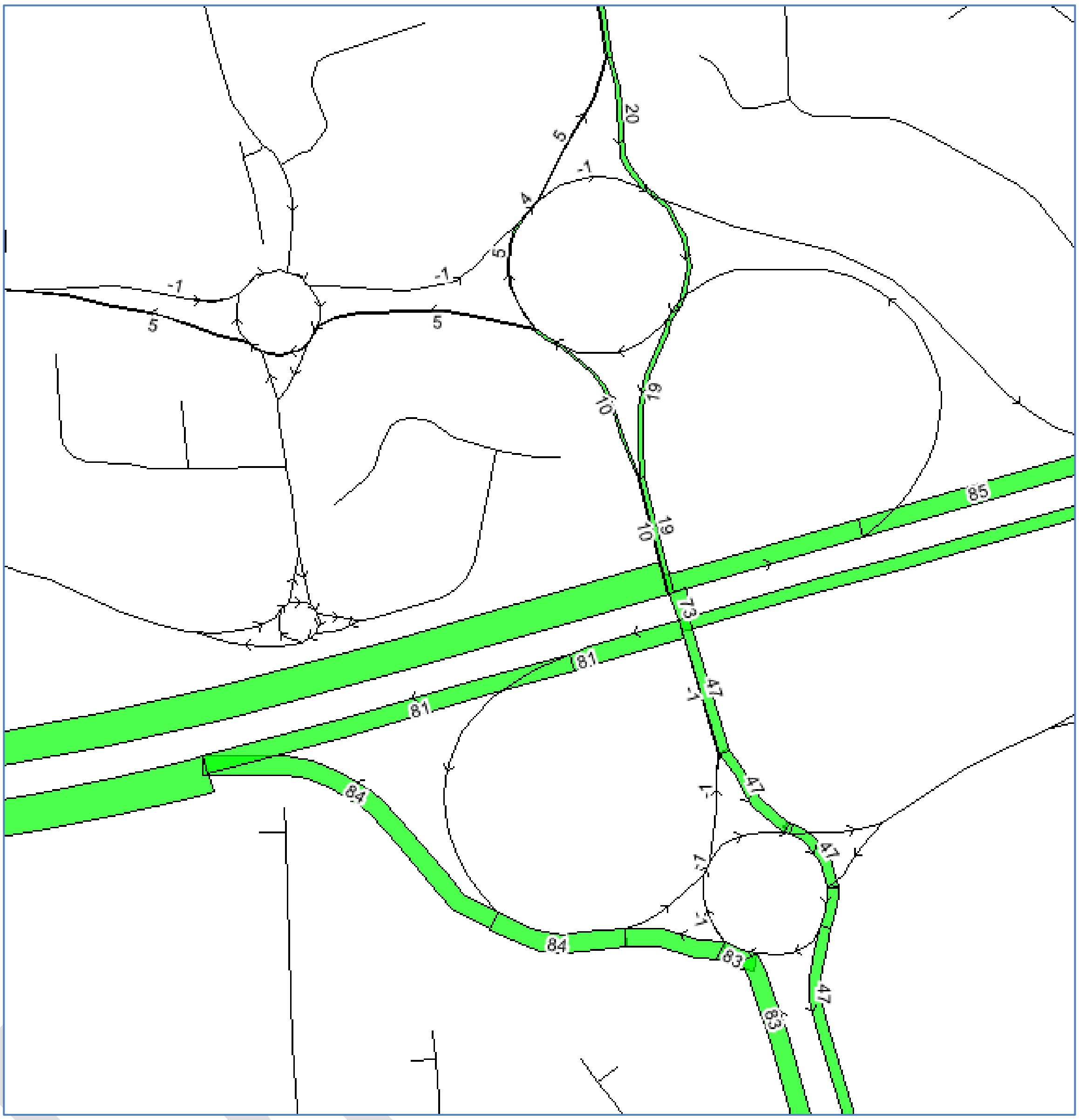


Figure 9-7: A127/A176 Basildon - AM Peak Local Plan Flows

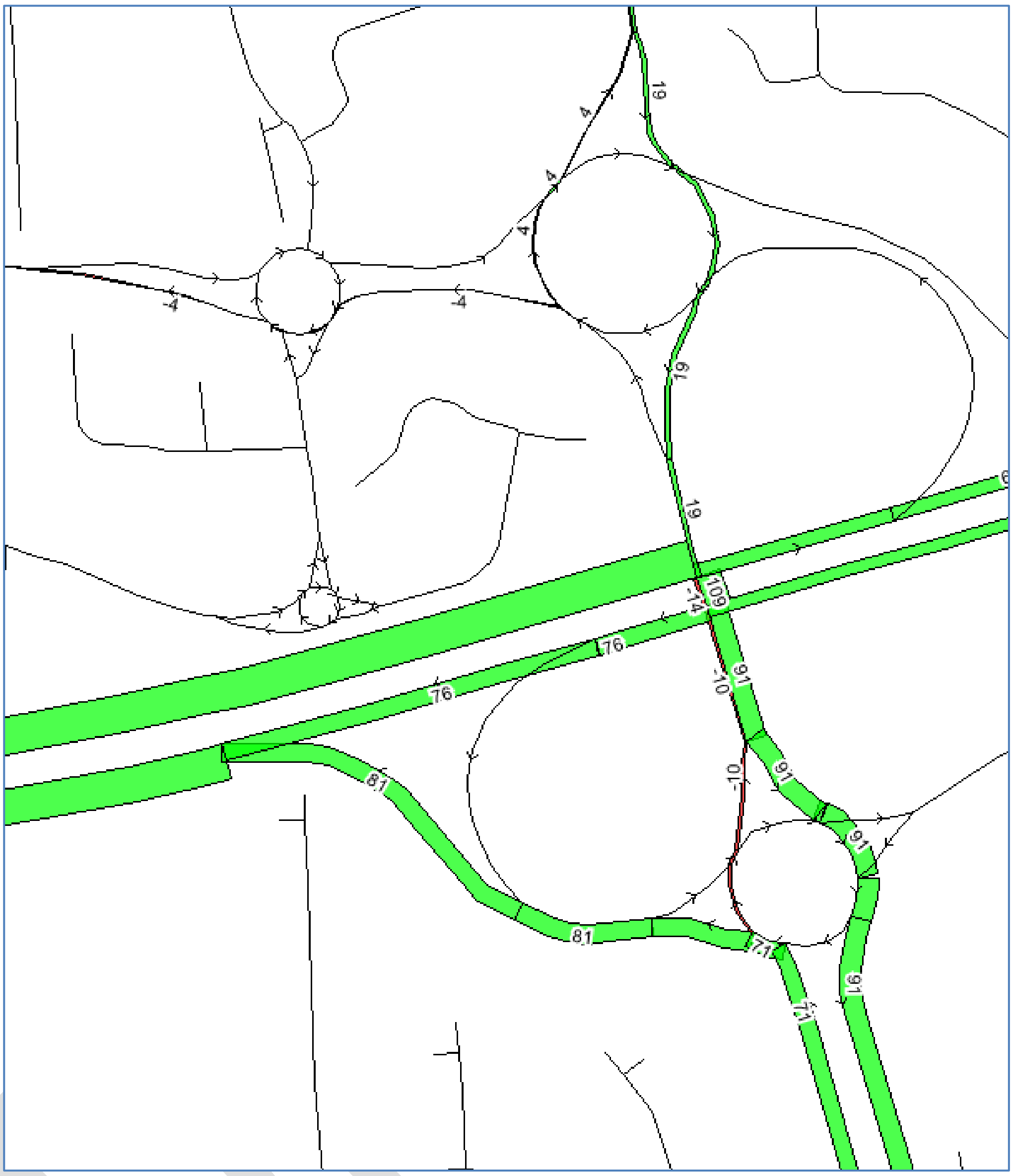


Figure 9-8: A127/A176 Basildon - PM Peak Local Plan Flows

9.2.10 The above indicates that the largest flows are northbound from Basildon in the AM peak and southbound to Basildon in the PM peak. The main flows between Brentwood and Epping Forest are on the M25 and the A128.

9.2.11 In the AM peak hour, flows out of Brentwood are 78 vehicles on the M25 northbound, with 161 vehicles southbound from Epping Forest to Brentwood.

9.2.12 Out of Brentwood in the PM peak hour the vehicle flows are 190 on the M25 northbound and southbound into Brentwood, the vehicle flow is 75.

9.2.13 It should be noted that not all the M25 trips will be starting within Epping Forest and some of this flow will come from/continue on the M25 further north west outside of Epping Forest.

9.2.14 On the A128 there is a flow of 9 vehicles from Brentwood northbound in the AM peak hour and 11 vehicles southbound, from Epping Forest.

9.2.15 On the A128 there is a flow of 13 vehicles out of Brentwood and 9 into Brentwood in the PM peak hour.

Epping Forest

9.2.16 The main traffic flows between Brentwood and Epping Forest are on the M25 and the A128.

9.2.17 In the AM peak hour, flows out of Brentwood are 78 vehicles on the M25 northbound, with 161 vehicles southbound from Epping Forest to Brentwood. Out of Brentwood in the PM peak hour the vehicle flows are 190 on the M25 northbound and southbound into Brentwood, the vehicle flow is 75. It should be noted that not all the M25 trips will be starting within Epping Forest and some of this flow will come from/continue on the M25 further north west outside of Epping Forest.

9.2.18 On the A128 there is a flow of 9 vehicles from Brentwood northbound in the AM peak hour and 11 vehicles southbound, from Epping Forest. On the A128 there is a flow of 13 vehicles out of Brentwood and 9 into Brentwood in the PM peak hour.

9.2.19 The above numbers show that the impact of the Brentwood Local Plan on roads in Epping Forest is minimal.

Thurrock

9.2.20 The main forecast traffic flow between Brentwood and Thurrock is via the M25 with a flow of 250 vehicles out of Brentwood and 630 vehicles into Brentwood in the AM peak hour. In the PM peak hour, there is a flow of 700 vehicles out of Brentwood and 340 into Brentwood on the M25. It should be noted that some of this flow will come from/continue on the M25 further south outside of Thurrock and therefore, not all the flows on the M25 will impact on Thurrock roads

9.2.21 On the A128 the flow from Brentwood is 42 in the AM peak hour and 56 into Brentwood. The equivalent flows in the PM peak hour are 57 vehicles from Brentwood and 44 in the opposite direction.

9.2.22 The other two cross boundary routes are on St Marys Lane and Childerditch Lane which have a two-way flow of 85 and 72 respectively in the AM peak hour and 84 and 32 in the PM peak hour. Apart from the traffic flow on the M25, these increases are not seen as substantial.

Havering

9.2.23 The main flows associated with the Brentwood Local Plan, which are shown to cross the boundary into Havering, would be on the A127 and A12, with a lesser impact on Warley Street.

9.2.24 The main flow between Brentwood and Havering are on the A127 with a flow of 146 in each direction in the AM peak hour. In the PM peak the A127 sees a flow of 188 out of Brentwood and 80 into it. Over the same period to background traffic is assumed to increase by 600 and 216 into and out of Havering in the AM peak and 380 and 439 in the PM peak.

9.2.25 On the A12 the flow is 93 out of Brentwood and 46 into it in the AM peak hour. On the A12 the flow is 60 out of Brentwood and 90 into it. Over the same period to background traffic is assumed to increase by 296 and 189 into and out of Havering in the AM peak and 208 and 308 in the PM peak.

9.2.26 A small two-way flow of 17 is seen on Warley Street in the AM peak hour. In the PM peak, the impact is higher on Warley Street with a flow of 71 vehicles from Brentwood and 9 vehicles to Brentwood.

9.2.27 The A127 and A12 converge at Gallows Corner in Havering and it is known that Gallows Corner is within an Air Quality Management Area and further assessment has been undertaken of flows associated with the Brentwood Local Plan at this junction.

9.2.28 Figure 9-9 and Figure 9-10 show the Local Plan flows at Gallows Corner in the AM and PM peaks respectively.

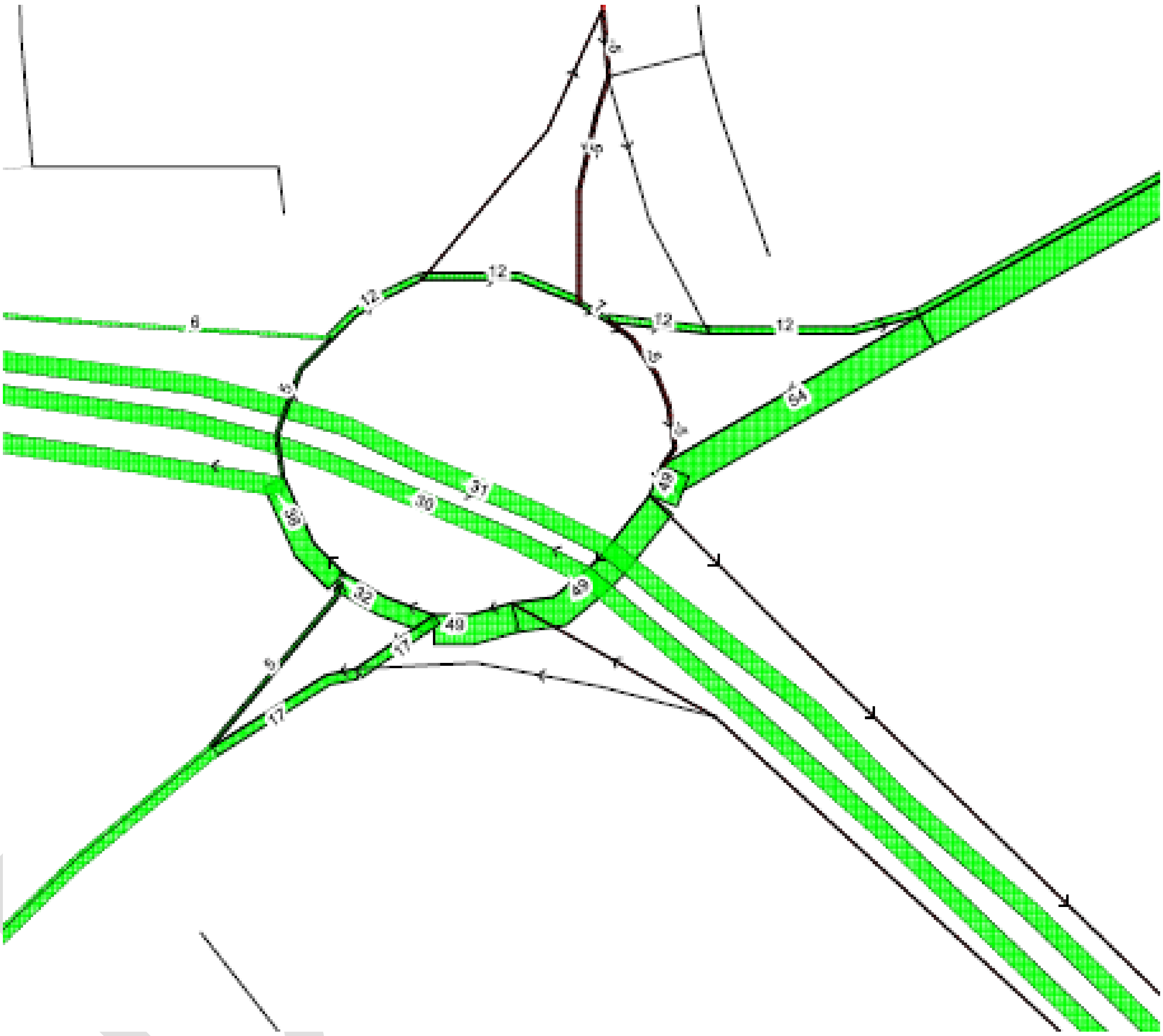


Figure 9-9: Gallows Corner - AM Peak Local Plan Flows

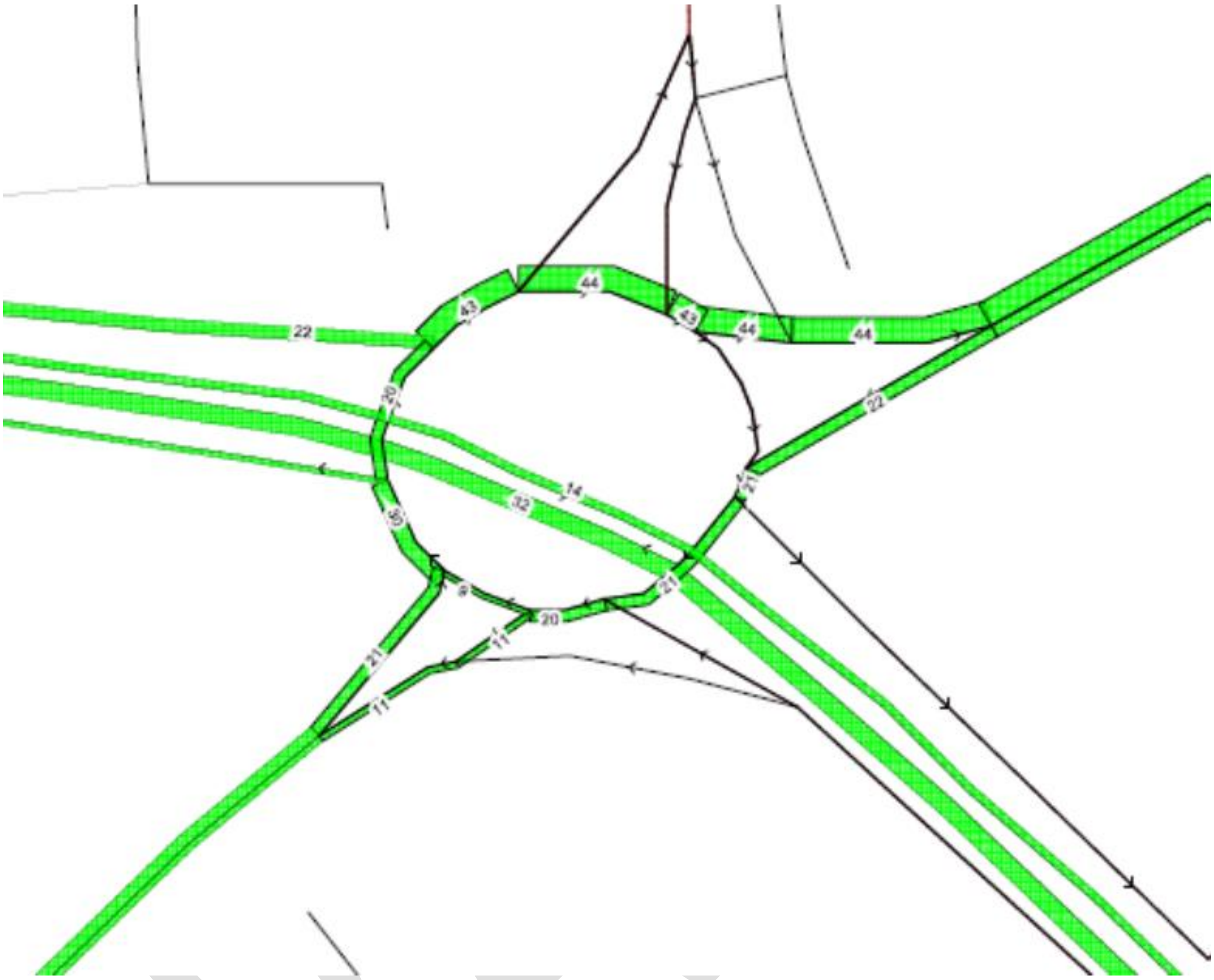


Figure 9-10: Gallows Corner - PM Peak Local Plan Flows

9.2.29 The figures show that the Brentwood Local Plan impact at Gallows Corner is relatively minor, with Local Plan trips dispersing on to the wider network, as demonstrated in the figures above.

10 Highway Mitigation

10.1 Overview

10.1.1 The following section summarises the proposed highway mitigation at junctions that were identified to operate well above operational capacity as a result of the Local Plan development and where other influences, such as peak spreading, would not have sufficient impact. It also provides detail of additional measures for those junctions that have existing mitigation provided but were still identified not to operate within capacity as a result of the Local Plan development.

10.1.2 This chapter sets out the potential high-level design and construction cost estimates for the possible scheme options put forward in the Brentwood Borough Local Plan to allow Brentwood Borough Council to include the options within their Forward Development Plan.

10.1.3 Where existing mitigation schemes are known to exist from other studies, these have been used as the starting point for mitigation design. These include:

- A127/A128 Scheme provided by ECC
- M25 Junction 29 taken from emerging Transport Assessment work associated with the Brentwood Enterprise Park.

10.1.4 Where no current mitigation measures are proposed, PBA have identified locations for suitable measures which can reduce delay. Where applicable junction models have been reassessed to identify if the mitigation measures are enough to reduce delay sufficiently to achieve an acceptable level of service.

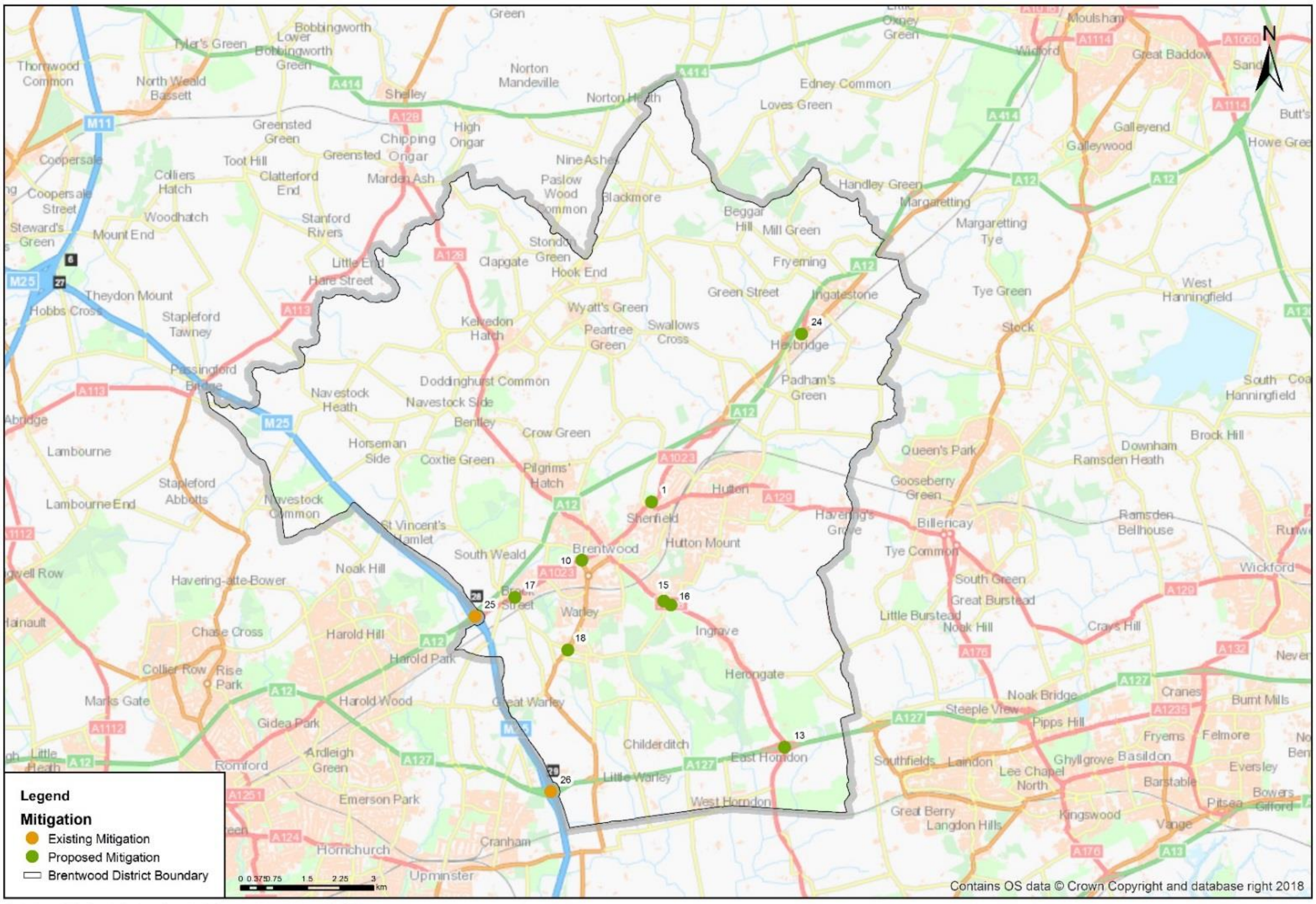
10.1.5 At this stage the mitigation measures are high level schemes which are to be taken forward for further detail design and assessment. Additionally, throughout the timeframe of the Local Plan all junctions should be reviewed to identify how they are operating, to show if further mitigation measures should be undertaken.

10.1.6 As outlined within Section 7 and Table 8-3 and illustrated on Figure 10-1 below four junctions have been identified to require mitigation. Existing mitigation measures are also included at orange locations, which have been assessed within the previous sections.

10.1.7 The new mitigation measures have been designed only for junctions 13, 15, 16, and 24. A summary of what measures have been assessed are summarised within Table 10-1 below and illustrated within Figure 10-1. The subsequent results for the mitigation can be found within the following section.

Table 10-1: Junction Mitigation Measures

Junction No.	Junction Location	Type	Mitigation to Be Considered
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	Left filters on all arms & Installation of signals at the end of the A127 westbound off-slip
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	Combined with junction 16, both junctions replaced with Traffic Signals.
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	Combined with junction 15. Both junctions replaced with Traffic Signals.
24	Roman Road / A12 Slip	Staggered Priority	A12 Slip road widening to provide dedicated left and right turn lanes. Traffic signals implemented
25	M25 Junction 28	Grade Separated	Widening of A12 eastbound off-slip and changes to signal timings
26	M25 Junction 29	Grade Separated	Left filter for M25 north to A127 east and through lane for M25 south to A127 east movement



Service Layer Credits: Contains Ordnance Survey data © Crown copyright and database right 2018

Figure 10-1: Junctions with Mitigation

10.2 Methodology

10.2.1 A desk top study exercise was carried out by PBA to assess the potential options that could be put forward.

10.2.2 Requirements for each of the proposed tasks needed to undertake the works were identified and discussed, with possible physical constraints identified such as topography, watercourse and buildings and above ground statutory apparatus etc. via a “desk top study” utilising aerial maps and a “virtual drive through”. Environmental investigation and scoping were limited to reviewing the DEFRA “Magic” website only.

10.2.3 The construction requirements for each of the tasks were discussed and agreed upon. Mitigation designs are based on past-experience of highway design, understanding of similar projects within the area and knowledge of locality. Any substantial construction issues such as new embankments, new bridges, rail crossings etc. were highlighted at this stage.

10.2.4 No investigation was carried out into specific land ownership details, or into the location details or cost of moving Statutory Undertakers and Utility Apparatus within the areas of the scheme. No additional design work will be carried out past the high-level plans found within this chapter. No design assessments were carried out at this stage to ascertain the buildability of the proposals except where any Health and Safety concerns were raised.

10.2.5 Level 1 cost estimates were produced, see Section 3 below for further details on cost estimates.

10.3 Costs

10.3.1 Costing at this stage are very high level based on professional judgement. All costs for each task have been based on the knowledge, skills and experience of the team and their understanding of similar recent projects and the locality. Therefore, no industry standard references (such as SPONS or similar) have been used at this stage of the design process.

10.4 Summary of Junction Mitigation

A127 / A128 Brentwood Road / A 128 Tilbury Road – Mitigation

ECC Mitigation Scheme

10.4.1 A mitigation scheme has been developed as part of the A127 Growth Study, this scheme is not currently committed or funded. Scheme details for the mitigation have been provided to PBA by ECC. The mitigation includes the introduction of dedicated left turning lanes on all arms, for the modelling of this junction, the left turns have been removed from the matrices. Additional analysis reviewing the merges has also been assessed. The scheme is shown in Figure 10-2.

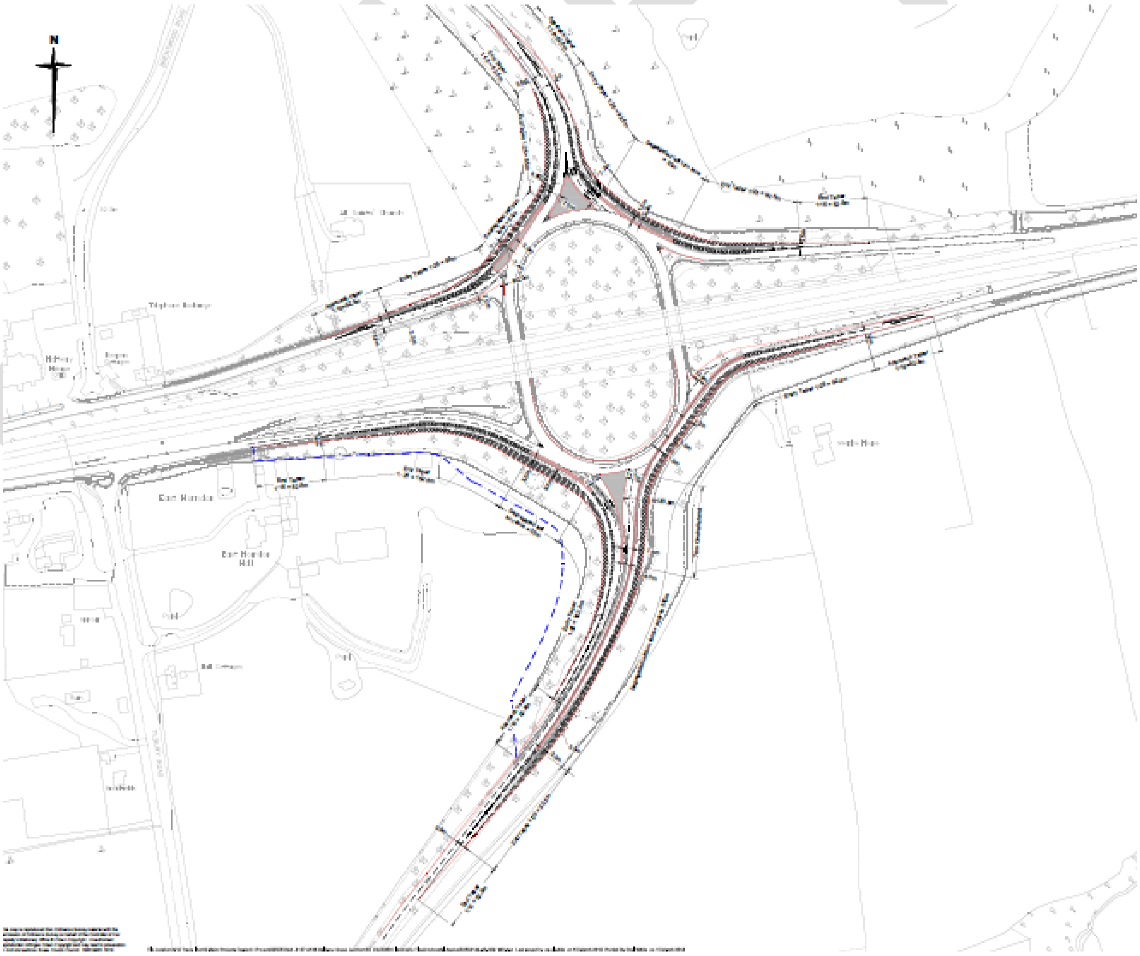


Figure 10-2: A127/A128 Mitigation Scheme

10.4.2 The mitigation measures reduce the impact of the preferred Local Plan Development on the junction and reduce the RFCs on all arms significantly. There are, however, still capacity issues on the A127 West with RFCs of 1.27 and 1.71 for the AM and PM peak respectively, showing the traffic using this arm is higher than the proposed mitigation is capable of handling.

10.4.3 A sensitivity test with accesses to the east and west from Dunton Hills indicates that the junction operates over capacity on the A127 westbound off slip arm at the junction, with RFCs of 1.10 and 1.58 for the AM and PM peak respectively, showing the traffic using this arm is higher than the proposed mitigation is capable of handling.

10.4.4 A merge diverge assessment has been undertaken, the results can be found within Appendix N.

Further Mitigation

10.4.5 The mitigation proposed outlined in Figure 10-3 includes:

- Enhancing the existing mitigation scheme proposed by Ringway Jacobs and Essex County Council by adding traffic signals to A127 eastbound slip lane exit.

10.4.6 Key Constraints:

- Statutory Utility Apparatus

10.4.7 Approximate cost: £300,000. This cost is only for the addition of the Traffic Signals to the A127 Eastbound exit arm. Costs associated with the Ringway Jacobs and Essex County Council mitigation have not been included.

Figure 10-3: A127/A128 Additional Mitigation

Mitigation Modelling Results

10.4.8 For the Local Plan Growth, the modelling shows that during the AM peak this arm of the junction operates well within capacity with the A127 east arm showing the largest degree of saturation at 103%. During the PM peak, however, the arm shows a degree of saturation of

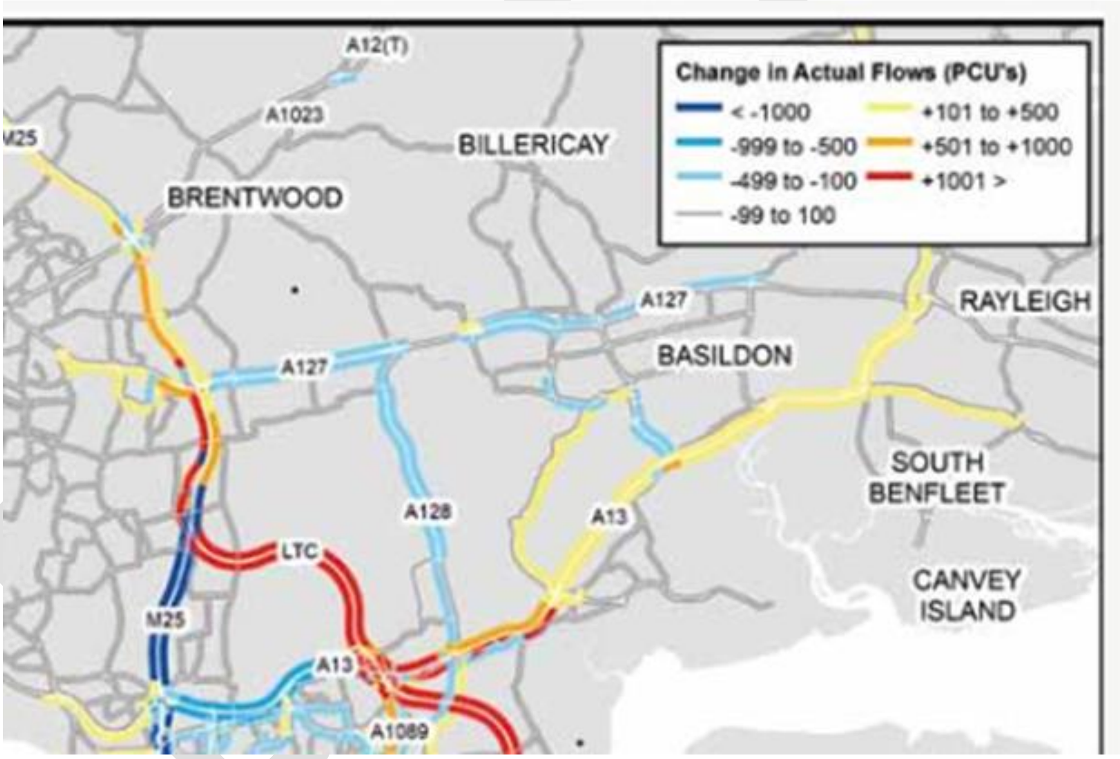
120%, although this is still over capacity, the operation of this junction has improved significantly.

10.4.9 For the Local Plan Growth sensitivity test with access from Dunton Hills to the east and west, the modelling shows that during the AM peak this arm of the junction operates well within capacity with the A127 east arm showing the largest degree of saturation at 70%. During the PM peak, however, the arm shows a degree of saturation of 95%, although this is near capacity, the operation of this junction has improved significantly.

Lower Thames Crossing Impact

10.4.10 It should be noted that the impact of the Lower Thames crossing may result in a reduction in this movement from the A127 west to the A128 south (indicated within earlier HE modelling), which has been identified as the worst performing arm at this junction. However, at this time there is no certainty to if and when the Lower Thames Crossing will be delivered.

10.4.11 Figure 10-4 shows the output from the Lower Thames Crossing modelling, indicating the level of flow reductions expected in the AM peak.



(Source: Lower Thames Crossing Statutory Consultation, Highways England, October 2018)

Figure 10-4: Indicative High-Level Impact of Lower Thames Crossing in AM Peak

10.4.12 The modelling indicates that there is likely to be a reduction in flows of between 100 and 499 on both the A127 and A128.

10.4.13 Figures 10-5 and 10-6 show the model outputs for flow differences between the Base and Reference Case and between the Reference Case and the Local Plan Scenarios (with both accesses from Dunton Hills onto the A128) respectively.

Figure 10-5: Flow Differences between Base and Reference Case (AM Peak)

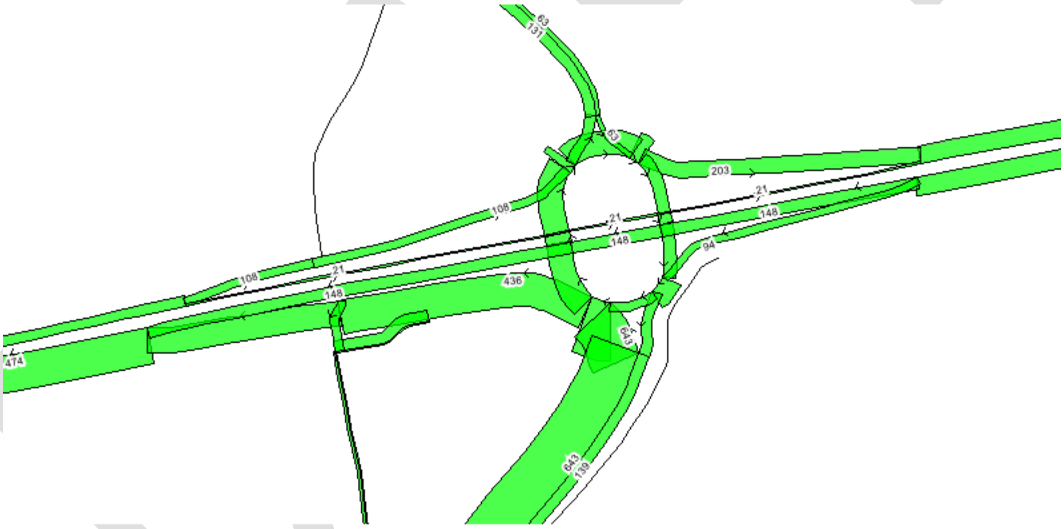


Figure 10-6: Flow Changes from Reference Case to Local Plan (AM Peak)

10.4.14 The flows indicate that the level of increase associated with the Local Plan and more specifically in this case, traffic from Dunton Hills, shows that the level of increase could be similar to the level of traffic reduction expected with the Lower Thames Crossing. The main flow change in the AM peak in the Local Plan modelling is from the A128 south to the A127 west. The opposite movement will see a similar change in the PM peak. This indicates that if the Lower Thames Crossing comes forward, there may not be a need for the additional mitigation identified on the A127 eastbound off-slip.

Sustainable Travel

10.4.15 In addition to other considerations above, the majority of the impact from traffic at this junction comes from Dunton Hills Garden Village. There is a very strong emphasis for sustainable travel from Dunton Hills and a key part of the sustainable travel strategy, will be to promote this. One such example are the links to West Horndon Railway station, along with physical improvements at the station. This will potentially lead to a further reduction in highway traffic, particularly for longer distance trips towards London. This is over and above the limited reductions already made in the assessment and is likely due to the emphasis in the southern growth corridor on sustainable transport measures.

A128 Ingrave Road / The Avenue / A128 Brentwood Road / Running Waters - Double Mini-Roundabout - Mitigation

10.4.16 The mitigation proposes to convert the Running Waters/ Brentwood Road roundabout into a signalised junction. The two signalised junctions will be linked to improve traffic management through the two junctions. The proposed mitigation is shown in Figure 10-7.

10.4.17 The existing A128 Brentwood westbound arm currently has a two-lane entry onto the roundabout. The modification of the existing roundabout into a signalised junction will involve the realignment of road markings to reduce the potential vehicle conflict through the junctions for vehicles travelling in lanes one and two.

10.4.18 The northbound approach to The Avenue/ Ingrave Road/ Brentwood Road roundabout would require minor widening to be undertaking in order to provide adequate lane widths on approach.

10.4.19 The two-lane merge occurring northwest of the proposed signal junction between The Avenue/ Ingrave Road/ Brentwood Road has been lengthened to reduce the potential for side swipes, queuing and drive aggression. It is noted that the south western side of the A128 Ingrave Road has a number of assets which could generate potential issues or increased costs associated with the proposed junction layout. Further assessment to determine the likely cost of moving these assets would need to be undertaken in order for a cost/ benefit review of the proposed mitigation.

10.4.20 The residential access road is proposed to have a stop line and signal provided to improve the safety of residents exiting the road.

10.4.21 A further review of the modelling undertaken for Junction 15 & 16 has highlighted the preferred solution is to have a four-lane carriageway between the two roundabouts. This will provide dedicated left turn lanes to increase the capacity between the junctions.

10.4.22 Widening at the A128 approach to the mini roundabout with ‘Running Waters’ at the give way line has been widened to reduce the risk of side swipe collisions through the junction. This would reduce/ potentially remove the existing footway and would require an extension of the existing culvert or construction of a new footbridge. Consultation with the Local Drainage Authority would be required at an early stage. A number of existing trees would need to be removed and alongside a number of existing traffic signs and street lighting would need to be relocated.

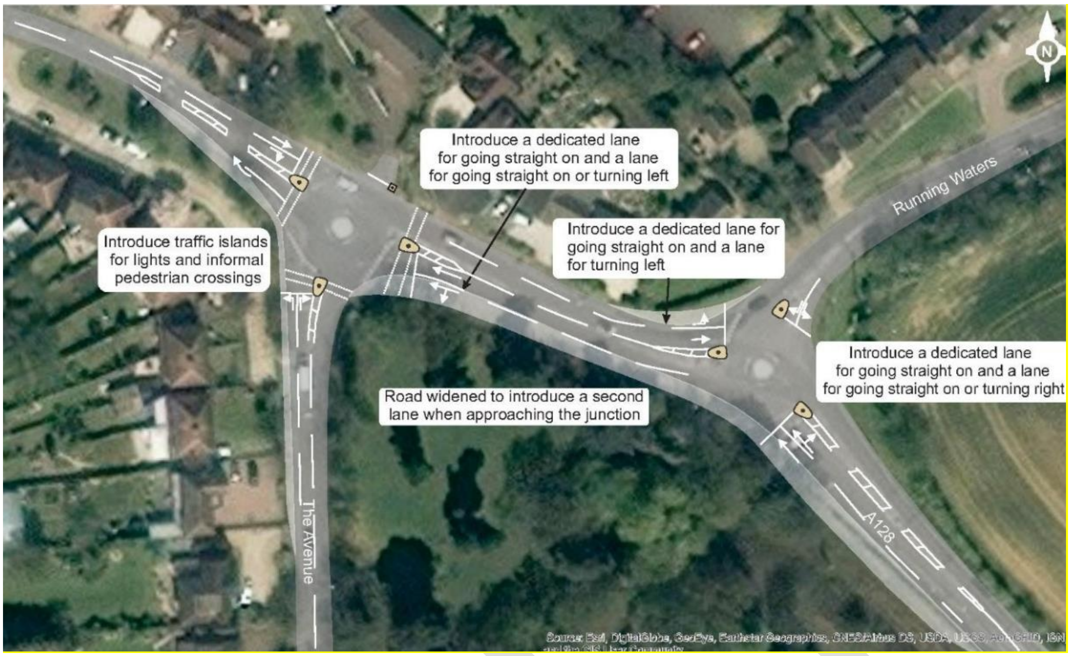


Figure 10-7: A128 Ingrave Road / The Avenue/ A128 Brentwood Road/ Running Waters

10.4.23 Key Constraints:

- Land Ownership
- Existing Road signs and street lighting
- Statutory Utility apparatus
- Land Drainage Ditch along southern edge of A128 Brentwood Road
- Existing trees and hedgerows

10.4.24 The approximate cost of the mitigation is £3m.

Mitigation Modelling Results

10.4.25 Tables 10-2 and 10-3 show the outputs from the modelling for the mitigation scheme at this junction. The outputs for this option are shown with Local Plan development in place and compared against the base model and the Reference Case flows with the existing layout.

Table 10-2: Running Waters Junction Mitigation Modelling Results – AM Peak

Arm	AM peak (08:00-09:00)			
	Base	Ref with existing	LP with Existing	LP with mitigation
Ingrave Rd	106%	113%	126%	89%
Running Waters	108%	112%	121%	105%
Brentwood Rd	107%	114%	127%	111%
The Avenue	90%	115%	114%	68%

10.4.26 The mitigation in the AM reduces the level of saturation with the Local Plan developments to a level lower than in the reference case and the existing layout. Therefore, the mitigation scheme is seen to mitigate the impact of the local plan development at this junction.

10.4.27 A couple of arms are still over a 100% but through the addition of MOVA and sustainable transport measures, which could bring about a mode shift from private car to cycling and walking for short distance trips within the Brentwood urban areas, it may be possible to reduce this even further.

Table 10-3: Running Waters Junction Mitigation Modelling Results – PM Peak

Arm	PM peak (17:00-18:00)			
	Base	Ref with existing	LP with existing	LP with mitigation
Ingrave Rd	62%	67%	74%	91%
Running Waters	46%	51%	60%	102%
Brentwood Rd	86%	90%	121%	109%
The Avenue	102%	107%	110%	108%

10.4.28 In the PM the junction operates slightly over capacity with the Local Plan developments and mitigation and is seen to operate slightly worse than the Reference Case with existing layout. As with the AM the addition of MOVA and sustainable transport measures within Brentwood urban area, could bring the saturation down and the junction would operate within capacity.

B1002 / A12 Off-slip / Roman Road – Staggered Priority Junctions

10.4.29 The mitigation proposed outlined in Figure 10-8 includes:

- Widening of A12 Off-Slip Road to facilitate dedicated left and right turn lanes.
- Traffic signals proposed at A12 Off-Slip / Roman Road junction.
- Provision of a splitter island to allow left and right turn manoeuvres to operate independently and alleviate stopping sight distance concerns.

10.4.30 Key Constraints:

- Existing road signs and street lighting columns/ connections
- Land ownership and potential requirement for third party land
- Embankment remodelling on the western side of the A12 Slip Road

10.4.31 Approximate costs: £450,000

Figure 10-8: Junction 24 - B1002 / A12 Off-slip / Roman Road – Staggered Priority Junctions

Mitigation Modelling Results

10.4.32 Modelling the Preferred Local Plan development in the mitigation scheme shows that the junction operates within capacity. In the AM peak period, the highest degree of saturation shown was 47% on the Roman Road East and in the PM period 57% was shown on the A12 off slip.

A127/B186

10.4.33 A mitigation scheme has been developed for the A127/B186 junction to facilitate the additional traffic associated with Brentwood Enterprise Park. A sketch of the proposed junction layout put forward is shown in Figure 10.9. The proposed modification to the junction includes:

- Construction of a second bridge over the A127 to the west of the existing bridge;
- Upgrading and widening of the existing T-junctions to 3-way signalised junctions with new dedicated right turn lane onto the A127 merge lanes;
- No modification to the existing diverge and merge lanes from/to the A127; and
- Localised realignment and widening of the B186 to the north and south of each new signalised junction.

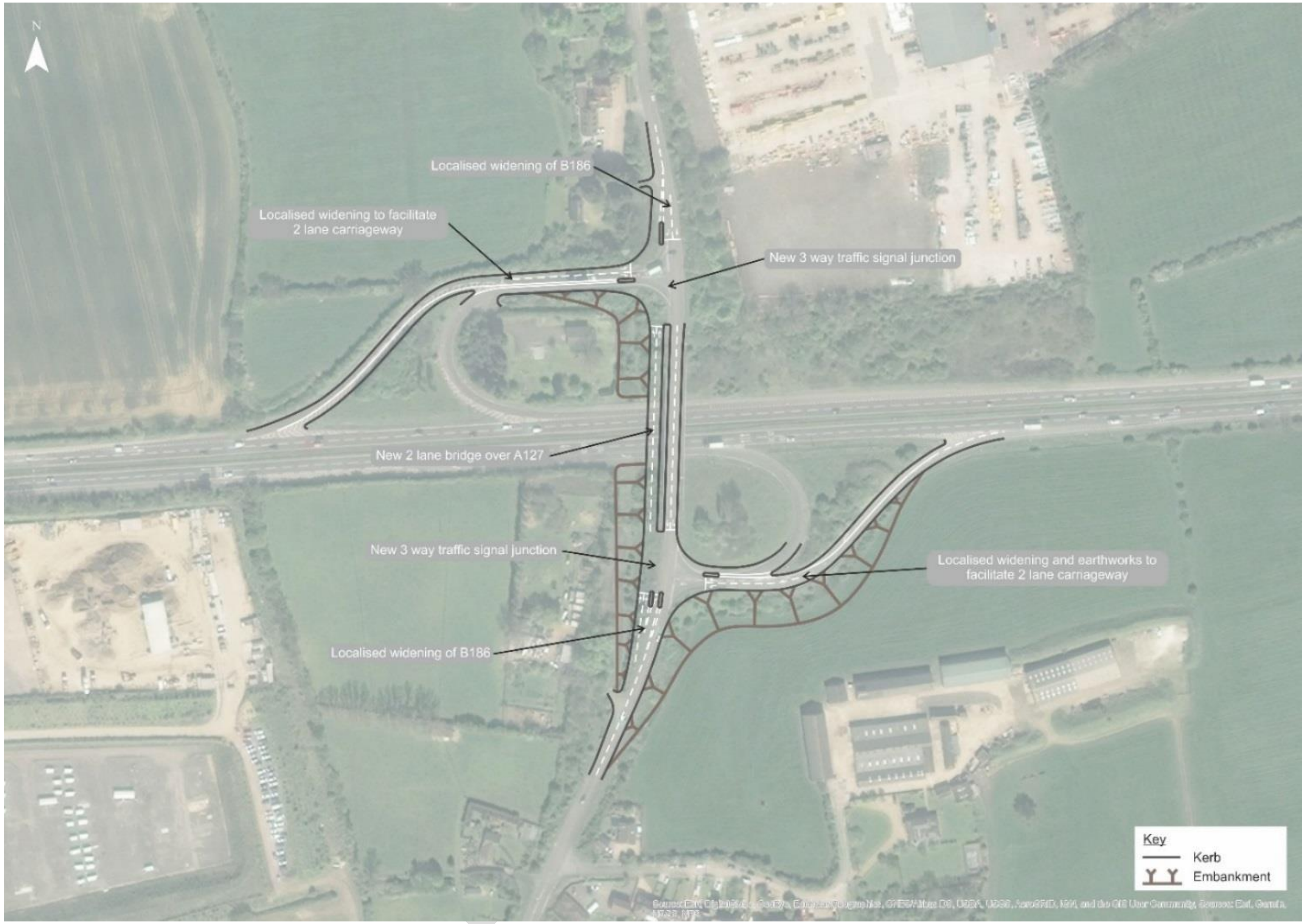


Figure 10-9: A127/B186 Proposed Mitigation Scheme Layout

10.4.34 The scheme proposed are very high level at this stage and several key constraints and issues have been highlighted. The key constraints and issues to note include:

- Land ownership.
- Existing property access.
- Encroachment on property boundary – specifically property located to the northwest of the northern junction.
- Statutory Utility apparatus.
- Existing traffic camera equipment.
- Existing trees and hedgerows.
- Existing traffic signs and street lighting will need relocation/ reconfiguring (includes relocation of existing A127 traffic signage and street lighting).
- Relocation and new road safety barriers required.
- Modification of the existing merge lanes onto the A127 would generate a departure from standard, not recommended.
- Major earthworks required to support construction of new bridge. This could include sheet piling of embankments due to land ownership constraints.
- New 3-way traffic signalised junction would not be the most efficient use of land. Junction could be oversized for volume of traffic moving through it.

Junction Modelling

10.4.35 Junction modelling has been undertaken using LinSig. Modelling has been undertaken for the with and without Lower Thames Crossing Scenarios and for the reference case and with Local Plan development.

10.4.36 The Local Plan scenario includes all traffic associated with all Local Plan development in the Borough, up to the end of the plan period.

10.4.37 Comparisons have been made between the ECC scheme with Reference Case flows and the proposed scheme with Local Plan flows.

10.4.38 Tables 10-4 and 10-5 show the results of the modelling for the AM peak for the southern and northern junctions respectively and Tables 10-6 and 10-7shows the results for PM peak hours.

Table 10-4: A127/B186 Junction Modelling Results – Southern Junction – AM Peak

Scenario	B186 (SB - overbridge) Ahead Left	B186 (SB - overbridge) Ahead	A127 (WB Slip) Left	A127 (WB Slip) Right	B186 (South junction - NB) Ahead	B186 (South junction - NB) Ahead Right
2033 Reference Case (ECC Scheme)	66.6%	-	18.5%	73.8%	-	84.6%
2033 Local Plan B186 BEP Access (Mitigation Scheme)	34.5%	86.8%	33.0%	86.6%	24.6%	79.2%

Table 10-5: A127/B186 Junction Modelling Results – Northern Junction – AM Peak

Scenario	B186 (North Junction - SB) Ahead Right	A127 (North Junction - NB) Left	A127 (North Junction - NB) Ahead	A127 (EB Slip) Left	A127 (EB Slip) Right
2033 Reference Case (ECC Scheme)	78.4%	85.9%		51.3%	85.1%
2033 Local Plan B186 BEP Access (Mitigation Scheme)	70.4%	18.0%	84.2%	38.5%	85.1%

Table 10-6: A127/B186 Junction Modelling Results – Southern Junction – PM Peak

Scenario	B186 (SB - overbridge) Ahead Left	B186 (SB - overbridge) Ahead	A127 (WB Slip) Left	A127 (WB Slip) Right	B186 (South junction - NB) Ahead	B186 (South junction - NB) Ahead Right
2033 Reference Case (ECC Scheme)	66.0%	-	62.1%	67.4%	-	65.8%
2033 Local Plan B186 BEP Access (Mitigation Scheme)	54.7%	97.1%	22.3%	98.8%	17.6%	97.3%

Table 10-7: A127/B186 Junction Modelling Results – Northern Junction – PM Peak

Scenario	B186 (North Junction - SB) Ahead Right	A127 (North Junction - NB) Left	A127 (North Junction - NB) Ahead	A127 (EB Slip) Left	A127 (EB Slip) Right
2033 Reference Case (ECC Scheme)	66.6%	66.6%		25,2%	65.7%
2033 Local Plan B186 BEP Access (Mitigation Scheme)	75.3%	17.1%	41.3%	24.1%	73.1%

10.4.39 The results of the junction modelling show that with the Brentwood Enterprise Park access on to the B186, the mitigation scheme modelled operates within capacity in both the AM and PM peaks.

M25 Junction 28

10.4.40 TO BE COMPLETED

Figure 10-10: M25 Junction 28 Mitigation

M25 Junction 29

10.4.41 With the aim to mitigate the impact of the Local Plan growth, a number of mitigation schemes have been examined and two elements have been found to have a significant impact on junction performance.

- The provision of a left filter from the M25 north to A127 east; and
- A fly-through for traffic from M25 south to A127 east.

10.4.42 These schemes are shown indicatively in Figure 10-11. The left filter will require the closure of the existing Codham Hall access to all traffic. A further sketch is shown in Appendix A.

Figure 10-11: M25 Junction 29 – Fly-Through and Additional Left Filter

10.4.43 Modelling has been undertaken to understand the impact of these in isolation and then as a joint scheme. Results are shown in Tables 10-8 and 10-9 for the left filter scheme only in the AM and PM peaks and in Tables 10-10 and 10-11 with the addition of the fly-through. The Reference Case results are provided again for easy comparison.

10.4.44 It should be noted that the fly-through in isolation did not provide the necessary additional capacity to mitigate the impact of the Local Plan growth.

Table 10-8: TRANSYT Model Results – Additional Left Filter – AM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	**Delay (S)**	**Queue (PCU)**	**Total Delay (PCU-hr/hr)**	**DoS (%)**	**Delay (S)**	**Queue (PCU)**	**Total Delay (PCU-hr/hr)**
M25 N	Left	106%	156.3	46.62	794.51	1%	26.09	0	732.31
	Ahead & Left	130%	462.26	145.02		27%	29.13	2.52	
	Ahead								
Codham Hall Lane		40%	21.83	0.92		N/A	N/A	N/A	
A127 E	Ahead & Left	142%	936.16	329.42		148%	992.89	365.26	
	Ahead								
M25 S	Ahead & Right	122%	496.33	101.56		146%	876.2	161.14	
	Right	152%	992.3	146.06		146%	881.4	161.4	
A127 W	Ahead & Left	99%	98.15	21.2		98%	92.38	20.26	
	Ahead	99%	98.15	21.2		98%	92.38	20.26	

Table 10-9: TRANSYT Model Results – Additional Left Filter – PM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)	DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)
M25 N	Left	98%	77.54	27.9	1077.85	1%	23.86	0.07	1006.23
	Ahead & Left Ahead	133%	489.95	161.69		35%	28.06	3.7	
Codham Hall Lane		38%	18.71	0.84		N/A	N/A	N/A	
A127 E	Ahead & Left Ahead	125%	655.53	287.1		151%	931.98	424.04	
M25 S	Ahead & Right	174%	1371.48	168.54		164%	1429.36	203.83	
	Right	126%	526.13	94.21		122%	456.26	93.37	
A127 W	Ahead & Left	172%	774.1	169.07		164%	724.57	158.65	
	Ahead	164%	727.4	159.64		164%	724.57	158.65	

Table 10-10: TRANSYT Model Results – Additional Left Filter and Fly-Through – AM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)	DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)
M25 N	Left	95%	55.36	25.40	543.56	2%	37.05	0	354.68
	Ahead & Left	117%	317.43	107.92		67%	57.34	3.81	
	Ahead								
Codham Hall Lane		37%	19.11	0.82		N/A	N/A	N/A	
A127 E	Ahead & Left	84%	19.65	25.48		88%	34.47	20.69	
	Ahead								
M25 S	Ahead & Right	142%	838.89	138.58		133%	656.47	132.02	
	Right	136%	695.1	117.41		133%	649.1	132.37	
A127 W	Ahead & Left	137%	521.44	76.71		98%	92.38	20.26	
	Ahead	137%	521.44	76.71		101%	118.78	23.79	

Table 10-11: TRANSYT Model Results – Additional Left Filter and Fly-Through – PM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	**Delay (S)**	**Queue (PCU)**	**Total Delay (PCU-hr/hr)**	**DoS (%)**	**Delay (S)**	**Queue (PCU)**	**Total Delay (PCU-hr/hr)**
M25 N	Left	93%	50.22	22.18	898.81	2%	38.07	0.09	617.30
	Ahead & Left	126%	495.31	144.25		109%	432.62	48.56	
	Ahead								
Codham Hall Lane		40%	22.51	0.84		N/A	N/A	N/A	
A127 E	Ahead & Left	95%	41.31	43.55		113%	431.75	306.80	
	Ahead								
M25 S	Ahead & Right	231%	2414.06	169.84		135%	671.94	121.65	
	Right	155%	1038.53	176.73		135%	674.91	122	
A127 W	Ahead & Left	232%	1041.45	223.24		97%	63.42	26.27	
	Ahead	151%	634.07	140.83		118%	303.88	75.21	

1.2. The results above indicate that with just the left filter, overall junction delay is reduced to a level below that of the Reference Case with the LTC scheme. However, queues on the A127 east and M25 south in both peaks are still slightly worse than the Reference Case.

1.3. When the fly-through is added, the overall junction delay is well below the Reference Case. Queues on the M25 south arm are similar to those of the Reference Case.

1.4. Overall the addition of the left filter provides the greatest relief and could be implemented at an earlier stage. The addition of the fly-through provides relief to the M25 south arm.

1.5. The schemes will need to be considered in the context of the LTC scheme and timescales.

Scheme Costs

1.6. Very high-level scheme costs have been produced and are shown below:

New bridge over A127	£12m
Improved road inside gyratory	£5m
M25 southbound left turn filter	£10m
Contingency 50%	£13.5
Total	£38.5m

1.7. This should be seen as a very high-level cost based on limited information available at this stage and allows a reasonable level of contingency and is for the purpose of informing early discussions only.

M25 Junction 29 – No LTC

10.4.45 A sensitivity test has been undertaken without the LTC to understand how the junction would operate without it, The results are shown in Tables 10-12 and 10-13 for the AM and PM Peak respectively.

Table 10-12: TRANSYT Model Results – Additional Left Filter and Fly-Through No LTC – AM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)	DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)
M25 N	Left	102%	106.01	42.75	979.93	2%	37.05	0.02	1001.12
	Ahead & Left Ahead	128%	430.64	162.63		80%	73.25	11.28	
Codham Hall Lane		42%	23.3	0.91		-	-	-	
A127 E	Ahead & Left Ahead	189%	1113.8	779.98		169%	891.22	709.54	
M25 S	Ahead & Right	93%	61.81	23.5		154%	668.13	275.32	
	Right	94%	66.36	17.8		98%	75.29	24.99	
A127 W	Ahead & Left	102%	154.94	20.22		73%	38.83	9.14	
	Ahead	102%	145.94	20.22		73%	38.83	9.14	

Table 10-13: TRANSYT Model Results – Additional Left Filter and Fly-Through No LTC– PM Peak

ARM	LANE	Reference Case				Local Plan			
		DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)	DoS (%)	Delay (S)	Queue (PCU)	Total Delay (PCU-hr/hr)
M25 N	Left	99%	82.07	31.15	1133.08	2%	36.16	0.09	1189.91
	Ahead & Left Ahead	132%	483.24	169.77		87%	87.07	14.04	
Codham Hall Lane		39%	20.2	0.81		-	-	-	
A127 E	Ahead & Left Ahead	162%	718.65	597.57		196%	914.91	909.78	
M25 S	Ahead & Right	129%	941.34	186.24		152%	655.76	252.73	
	Right	186%	574.72	102		95%	65.59	20.49	
A127 W	Ahead & Left	136%	516.09	74.13		85%	46.48	13.46	
	Ahead	96%	81.32	18.31		85%	46.48	13.46	

10.4.46 In the AM the overall delay increases slightly. The left filter and fly-through would mitigate the impact on the majority of the arms with the exception of the M25 S Ahead & Right.

10.4.47 In the PM the overall delay again increases slightly. As with the AM the DoS increase on the M25 S Ahead and right and also on the A127 E

10.5 Highway Mitigation - Junction Assessment Summary

10.5.1 The results of the junction modelling for the junctions where highway mitigation has been provided, showing the degree of saturation for the worse performing arm are shown in Tables 10-12 and 10-13.

Table 10-12: Junction Modelling Summary Results where Highway Mitigation Required – AM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Mitigation
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	0.94	1.03
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.06	1.15	0.94
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	1.08	1.14	1.11
24	Roman Road / A12 Slip	Staggered Priority	0.79	0.91	0.47

Table 10-13: Junction Modelling Summary Results where Highway Mitigation Required – PM Peak

Junction No.	Junction Location	Type	Baseline	Reference	Local Plan + Mitigation
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Grade Separated Gyratory	0.85	1.00	1.20
15	A128 Ingrave Road / The Avenue	Double Mini-Roundabout	1.02	1.07	1.06
16	A128 Brentwood Road /Running Waters	Double Mini-Roundabout	0.86	0.90	1.09
24	Roman Road / A12 Slip	Staggered Priority	0.56	0.58	0.57

10.5.2 The results in the tables above indicate that for most of the junctions where mitigation is provided, the junction operates better than within the Reference Case without the mitigation.

10.5.3 The A127/A128 junction is shown to work within capacity in the test undertaken with consideration of the Lower Thames Crossing Flows. The Lower Thames Crossing is currently in the plan to open in 2027, which will be within the Local Plan period.

10.5.4 For Running Waters, as stated previously, the inclusion of MOVA and an allowance for sustainable transport measure, will more than likely lead to the junction operating much closer or even within capacity.

10.6 Signalised Junctions

10.6.1 The following signalised junctions are shown to be over-capacity in at least one of the peaks:

- A1023 Chelmsford Road/ A129 Hutton Road/A1023 Shenfield Road
- A1023 High Street/B185 Kings Road/ A1023 London Road/Weald Road
- B186 Warley Hill/Eagle Way/B186 Warley Road/Mascalls Lane
- A1023 Brook Street/Mascalls Lane

10.6.2 Each of these junctions are shown to operate close to or only just above a reasonable level of capacity. Therefore, implementing a more dynamic form of urban traffic control, is likely to provide the additional capacity to improve performance of these junctions.

10.6.3 Microprocessor Optimised Vehicle Actuation (MOVA) is one form of control which is shown to lead to significant increases in capacity at junctions, as it is more responsive to actual traffic conditions. It can provide up to 3% additional capacity and reduce delays by as much as 10% in some cases, which is far higher than would be required to operate each of the junctions at a reasonable level of service and under capacity.

10.6.4 The cost of implementing MOVA would be around £170,000 per junction.

10.7 Overall Junction Summary

10.7.1 Table 10.14 sets out an overall summary of the position of each of the junctions assessed, as part of this Local Plan Transport study.

Table 10-14: Junction Summary

Junction No.	Junction Location	Conclusion
1	A1023 Chelmsford Rd / A129 Hutton Rd / A1023 Shenfield Rd	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
2	A129 Rayleigh Road / Hanging Hill Lane	Impact not deemed severe – no mitigation required
3	A128 Ongar Road / Doddinghurst Road	Town Centre junction where sustainable transport mitigation will be required
5	A128 Ongar Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
6	A128 Ongar Road / A1023 Shenfield Road / A128 Ingrave Road / A1023 High Street	Operates below capacity - No mitigation required

Junction No.	Junction Location	Conclusion
7	A128 Ingrave Road / B186 Queens Road	Town Centre junction where sustainable transport mitigation will be required
8	A128 Ingrave Road / Middleton Hall Lane / Seven Arches Road	Operates below capacity - No mitigation required
10	A1023 High Street / B185 Kings Road / A1023 London Road / Weald Road	Implementation of MOVA (or similar) as a mitigation should provide adequate capacity
12	Western Road / William Hunter Way	Town Centre junction where sustainable transport mitigation will be required
13	A127 / A128 Brentwood Road / A128 Tilbury Road	Mitigation Scheme Provided
14	A127 / Childerditch Lane	Operates below capacity - No mitigation required
15	A128 Ingrave Road / The Avenue	Mitigation Scheme Provided
16	A128 Brentwood Road /Running Waters	Mitigation Scheme Provided
17	A1023 Brook Street /Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
18	B186 Warley Hill / Eagle Way / B186 Warley Rd / Mascalls Lane	Implementation of MOVA (or similar) as a mitigation should provide additional capacity
19	B186 Warley Street / A127 eastbound	Funded ECC Scheme Provides adequate capacity
20	B186 Warley Street / A127 westbound	Funded ECC Scheme Provides adequate capacity
22	A1023 Chelmsford Road / Alexander Lane	Operates below capacity - No mitigation required
23	A12 Junction 12	Operates below capacity - No mitigation required
24	Roman Road / A12 Slip	Mitigation Scheme Provided
25	M25 Junction 28	Further work required with HE and other authorities
26	M25 Junction 29	Further work required with HE and other authorities
27	A128 Tilbury Road/Station Road	Likely to form access point for Dunton Hill development, therefore a scheme would be developed as part of a Transport Assessment supporting a Dunton Hills Planning application

11 Summary and Conclusions

11.1 Overview

11.1.1 PBA have been commissioned by BBC to support the development of the transport evidence base to support the Borough's Local Plan. The specific work being undertaken by PBA is to provide transport modelling support, to assess the impact of the LP on the local and strategic highways in the Borough, up to the end of the proposed plan period in 2033.

11.1.2 This work follows on from the previous work undertaken by PBA where a number of options for development have been tested[10]. This work now pertains to the modelling of a single Local Plan Development option. The modelling work has been undertaken in line with the National Planning Policy Guidance "Transport evidence bases in plan making and decision taking", March 2015.[11]

11.1.3 In preparing this assessment extensive consultation has been undertaken with the relevant highway and planning authorities. A Steering Group comprising officers of BBB, ECC and HE was formed to help guide the methodology and scope of the assessment work and to provide feedback on the outcomes of the junction assessments.

11.1.4 This Transport Assessment summarised:

- the approach undertaken for the modelling work,
- the results of the modelling and junction assessments,
- highlights those worse performing junctions that may require mitigation,
- identified sustainable measures that are proposed to reduce peak highway flows to enable the development sites to come forward.

11.1.5 The Local Plan modelling is at a high level considered appropriate to the strategic nature of the work. It is also considered to provide a worst-case assessment of proposed Local Plan development since it combines robust assumptions regarding background traffic growth and impacts arising from proposed local plan development within neighbouring authorities, with robust assumptions regarding trip generation. The purpose of the modelling work is to understand how the network copes at a strategic level. It is not intended to model the impact of individual access junctions for individual sites, as this would be expected to be undertaken by promoters of individual sites at a later date.

11.2 Spreadsheet Modelling

11.2.1 The assignment within the OmniTRANS tool distributes traffic, between all origin and destination points, solely on the basis of the quickest route. The link speeds are supplied from TeletracNavman, to provide average speeds on all links for the desired time period. The modelling does not take account of congestion within the network, beyond that implicit within the data, therefore not accounting for future changes to traffic congestion. Effectively a single iteration of an 'all or nothing' assignment is undertaken.

11.2.2 The network used for the purposes of the assessment is the Ordnance Survey Integrated Transport Network (ITN), which is imported into the OmniTRANS suite to allow the assignment process to be undertaken and for geographically based graphics to be produced

[10] Brentwood Local Plan Modelling Report 2016

[11] https://www.gov.uk/guidance/transport-evidence-bases-in-plan-making-and-decision-taking

for trip distribution. The routing patterns associated with the developments included were checked to determine that they were sensible.

11.2.3 Turning counts have been extracted from OmniTRANS, from each development scenario, which have been fed into the junction models.

11.3 Junction Assessments

11.3.1 A total of 23 junctions have been modelled and assessed, using a combination of Junctions 9, ARCADY and PICADY models for priority or roundabout junctions or LinSig for signalised junctions; additionally, TRYNSYT has been used to model J29 of the M25. Table 5-1 summarised what type of junction they are, priority, signalised or roundabout and what modelling software has been used for the assessment.

11.3.2 Where possible, each base model has been calibrated and validated using available data to ensure the base models best represent on site conditions which have been taken forward for additional assessment.

11.3.3 Two additional core tests have been assessed. The first is the Reference Case scenario, which includes flows extracted directly from the OmniTRANS model for the forecast year of 2033 and include all growth which is not associated with the Local Plan and which have been added on top of the base flows used for the Base assessment. The second is the Local Plan Growth Scenario, this includes all known Local Plan developments identified by BBC which are likely to form the allocations in the Local Plan after 2033. These trips have been added on top of the trips generated in the Reference Case scenario.

11.3.4 From the assessments, it was identified that a number of junctions, specifically J13, J14, J19, J20, J25 and J26 (with the latter two being most effected by the Lower Thames Crossing scheme) are likely to be influenced more by non-Local Plan development. These junctions will be required to be monitored throughout the Local Plan period to identify any additional impact from other schemes, such as the Lower Thames Crossing Project, the A127 study and any highway effect from the opening of the Elizabeth Line in 2019.

11.4 Sustainable Measures

11.4.1 The Local Plan Guidance for developing the transport evidence base for Local Plans, as well as National Planning Policy Framework, identify that the evidence should be built around sustainable travel and providing opportunities to enhance sustainable transport, through the Local Plan process and to assist in delivery of the plan.

11.4.2 A desktop study has been undertaken to assess potential sustainable transport measures that could be implemented within the local area to assist in reducing this impact. Whilst encouraging modal shift and healthier choices as a result of reduction in car usage, some measures could also be considered as alternatives or supporting mitigation measures other than infrastructure improvements proposed in the local area.

11.4.3 The approach to consideration of sustainable transport, has utilised evidence from the DfT Sustainable Travel Towns study, which identified the success of implementing measures in three demonstration towns and the level of switch from private car that was achieved. We have also highlighted within the report, Brentwood specific sustainable measures, which could come forward through the Local Plan process, which could have potential to bring about a greater shift from the private car to more sustainable measures.

11.4.4 The Local Plan Guidance notes that such measures should be considered prior to any consideration of physical highway mitigation, which may provide short term relief at junctions, for the short time period where after they may again be over capacity.

11.4.5 The Local Plan development, should be an opportunity to re-balance the investment in transport, with far greater emphasis on sustainable travel, from improved signing and way-marking to upgraded public transport, as well as travel planning measures, that will bring benefit to both new Local Plan sites and existing population within the Borough.

11.5 Physical Mitigation Requirements

11.5.1 Following the consideration of sustainable travel mitigation, it has been identified that a number of junctions may still require physical mitigation, as a result of the impact of the Local Plan developments.

11.5.2 Specific mitigation measures have been designed for the following junctions:

- A1023 Chelmsford Road/A129 Hutton Road/ A1023 Shenfield Road
- A1023 High Street/B185 Kings Road/A1023 London Road/Weald Road
- A127/A128
- A128 Ingrave Road/The Avenue
- A128 Brentwood Road/Running Waters
- B186 Warley Hill/Eagle Way/Warley Road/Mascalls Lane
- A12 Slip, Roman Road, Ingatestone

11.5.3 A desktop study was carried out to assess the potential options that could be put forward for subsequent testing. Requirements for each of the proposals was identified and any physical constraints identified, no investigation to land ownership or costs involving the moving of Statutory Undertakers and Utility Apparatus was undertaken. The measures also include an initial cost.

11.5.4 The models including the mitigation measures on the Reference Case and Local Plan flows identified that they were successful in reducing predicted delay at the junctions. In some cases, the RFC or degree of saturation was still over capacity but showed significant decrease in comparison with the no mitigation scenarios.

11.6 Conclusion

11.6.1 The transport work identified within this report has demonstrated that through sustainable transport measures and in some cases, limited physical highway improvement works, the impact of the Local Plan can be mitigated and that there are no major residual impacts that might prevent the delivery of the Local Plan development.

11.6.2 The evidence provided in this report shows that the Local Plan is deliverable, and any impact can be mitigated, through either sustainable travel interventions or physical highway mitigation. Through concentrating investment on improving sustainable transport, this will benefit all residents within the borough, not just those in the new developments.

11.6.3 Some traffic impacts on the Strategic Road Network, extending beyond Brentwood, may require further mitigation. In these instances, Highways England and relevant authorities will be consulted and collaborated with to examine these issues further.

Appendix A Count Data Analysis

Appendix B NTS Accessibility

Appendix C NTS Trip Rates v. TRICS

Appendix D Journey Time Routes

Appendix E Junction Model Calibration Note

Appendix F Sustainable Transport Measures - Central and Northern Brentwood

Appendix G Potential Park Ride and Stride Hub Sites

Appendix H Sustainable Transport Measures - Southern Brentwood

Appendix I Reference Case Flows

Appendix J Local Plan Flows

Appendix K Trip Distribution Plots – Dunton Hills and Brentwood Enterprise Park

Appendix L Junction Modelling – Summary Outputs

Appendix M Full Junction Modelling Files

Appendix N Merge/Diverge Assessments