Technical Note

Project:	**60343567 Highways England Spatial Planning Arrangement**	Job No:	**SX008.001**
Subject:	**Review of Brentwood Borough Local Plan Development Options – Evidence Base, Highway Modelling**		
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1. Introduction

1.1. This technical note has been prepared by AECOM, on behalf of Highways England (HE) to document a review of the evidence base (in the form of spreadsheet modelling) used to support the Brentwood Draft Local Plan (LP), which is currently out for consultation.

1.2. The Brentwood LP Development Options – Evidence Base, Highway Modelling assessment and reporting has been undertaken by Peter Brett Associates (PBA) on behalf of Brentwood Borough Council (BBC). This technical note should be read in conjunction with AECOM's separate review of the LP, which has been undertaken within a separate technical note, entitled 'TN_Draft Brentwood Local Plan Review_v4' (dated March 2016).

2. Summary of Methodology

2.1. As there is no validated traffic model for Brentwood, PBA have adopted an alternative approach using available information. OmniTRANS has been used to build a simplified model of Brentwood Borough. The defined zoning system and an Integrated Transport Network (ITN) layer were imported. Additional zones were created to represent the proposed areas for major development sites. The mean link speeds from TrafficMaster (including junction delays) were added to the links. This model allowed skim times and distances to be calculated for each zone pair. A base year assignment was undertaken on the basis of census data and a synthetic distribution based on the trip lengths and the relative attractiveness (land use) of various zones. This was judged to be approximately correct but did not undergo any formal validation process.

2.2. These time and distance skims were used to determine the distribution of development trips and also the assignment of those trips. In all of the assessed scenarios, the total level of trip growth resulting from planned developments was greater than the growth implied by TEMPro. Hence, there was no requirement to allow for additional developments. Indeed, the overall growth assessed was higher than that implied by national forecasts. The assigned turning movements of the development traffic at the assessed junctions were added to the observed turning movements to calculate future year scenarios. Hence, the future year assessments were not reliant on the base year assigned traffic flows.

Developments

2.3. According to the modelling report the expected developments in the LP can be placed into three categories:

- Committed housing developments for all options (brownfield sites and urban extensions);
- Committed employment developments;
- Various options for strategic housing developments.

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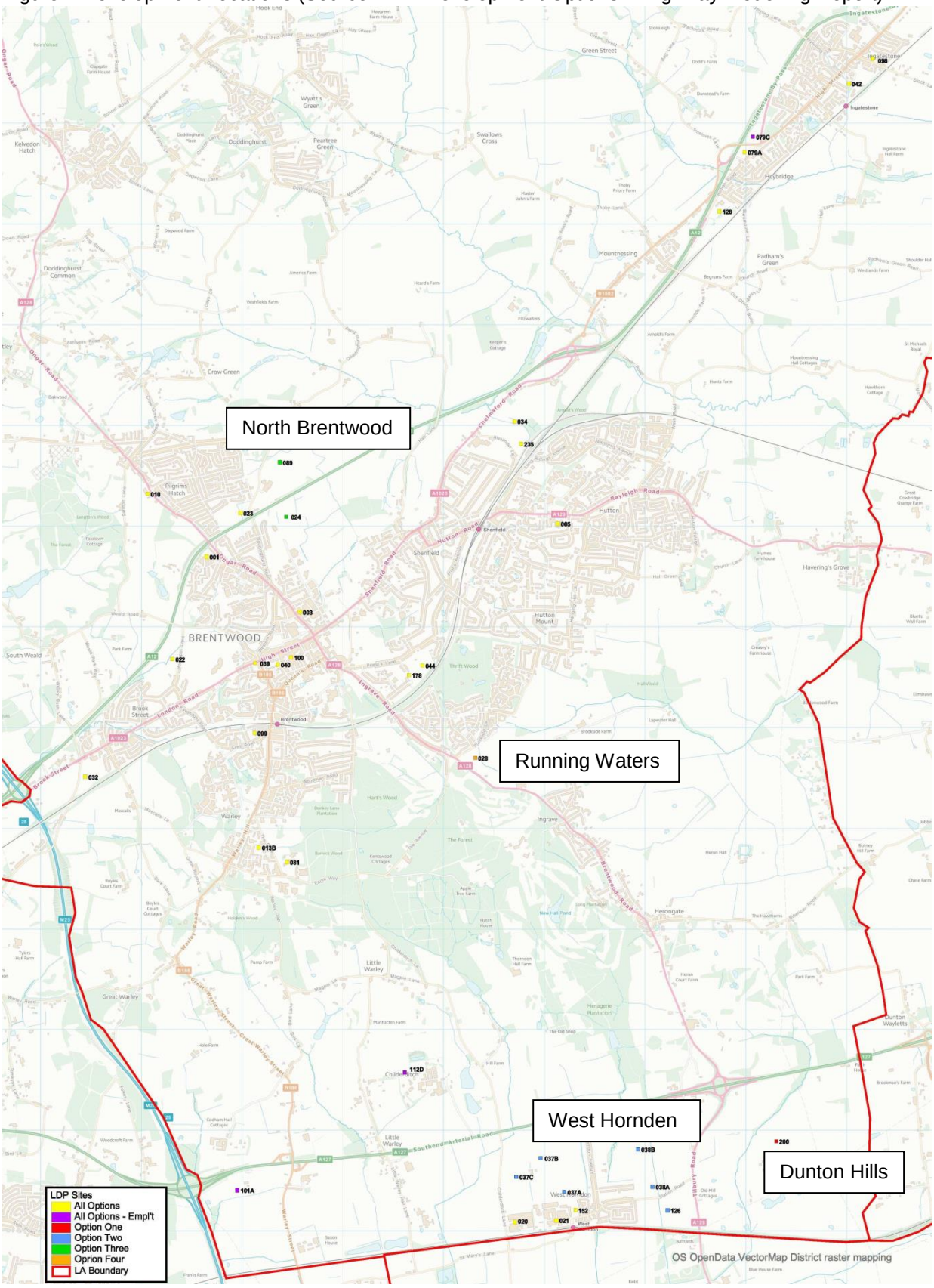
2.4. The development locations are shown in Figure 1.

Figure 1 Development Locations (Source: PBA Development Options – Highway Modelling Report)



Committed Sites

2.5. Most of the committed housing sites (shown as yellow dots in Figure 1) are relatively small and will not have significant trip generation. There are a few places where sites (or combinations of sites) will have a significant impact. Three sites in West Horndon (south of the A127) are expected to include about 500 dwellings. A site close to the High Street in Brentwood is expected to include 200 dwellings.

Urban Extensions

2.6. The most significant urban extension involves 500 dwellings at Shenfield close to the A12 junction. A further 250 dwellings are expected near Doddinghurst Road in North Brentwood. There is no easy access to the A12 from the sites in North Brentwood.

Employment

2.7. The most significant employment site (shown as a purple dot in the south west of Figure 1) is Site 101A at Cobham Hall to the east of M25 Junction 29. The only access and egress is via Junction 29. The location of this site in the extreme south west of the borough and its proximity to the motorway means that many of the trips will originate from outside of the borough.

Strategic Housing

2.8. There are four alternative options for strategic housing allocations:

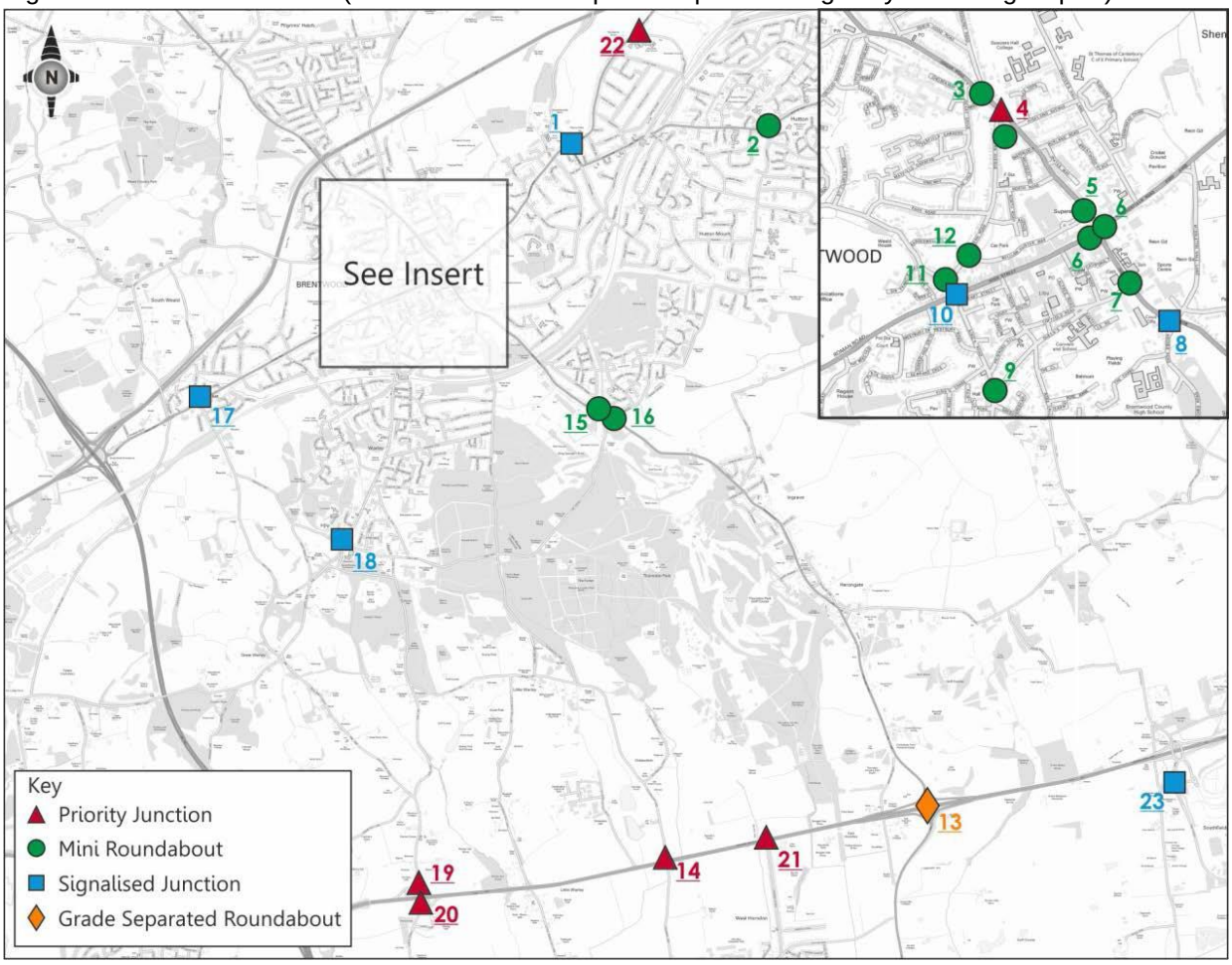
- 2500 dwellings at Dunton Hills Garden Village (shown as a red dot in the extreme south east of Figure 1);
- 2500 dwellings at sites in West Horndon (shown as blue dots in the south of Figure 1);
- 1170 dwellings at sites in North Brentwood (shown as green dots in the north of Figure 1); or
- 1000 dwellings at Running Waters (shown as an orange dot in the centre of Figure 1).

2.9. The strategic sites involve significantly more concentrated development than the brownfield sites and are generally larger than the urban extensions. AECOM understand that Option 1 has been taken forward for inclusion within the LP.

Junctions Modelled

2.10. A total of 23 junctions have been modelled as shown in Figure 2. The majority of these are within the Brentwood urban area or along the A127. None of the SRN junctions have been modelled.

Figure 2 Modelled Junctions (Source: PBA Development Options – Highway Modelling Report)



2.11. Base year turning counts have been undertaken at these junctions. Although modelling has not been undertaken at either of the motorway junctions, the forecast increase in traffic at these junctions is higher than at any other junction. With the exception of the motorway junctions, nearly all of the significant junctions which are affected by forecast development flows are included. Notable exceptions are the two left-in left-out junctions located between junctions 14 and 19/20 on the A127.

2.12. Roundabouts and priority junctions have been modelled using JUNCTIONS 8 software. LINSIG has been used for modelling signalised junctions. With the exception of Junctions 15 and 16, which are treated as a double mini-roundabout, no consideration is taken of potential interference between the junctions. This is only likely to be an issue for those closely-spaced junctions in the centre of Brentwood.

Trip Generation

2.13. Trip ends are grouped into zones, which is a standard procedure. Zone sizes are quite small in areas which are likely to generate a significant number of trips. Additional zones were created for major development sites.

2.14. Task 7 of the brief (detailed within Appendix A of the LP) implies that trip generation should use the TRICS database. However, the actual process used was somewhat different. Initially, the number of residents per household in development zones was determined on the basis of current mean value for Brentwood from census data. Person trip rates were extracted from the National Travel Survey (NTS) appropriate to the level of urbanisation. This is an acceptable source,

though the trip rates derived appeared (to the then Highways Agency) to be quite low. An investigation showed that current household size in Brentwood was lower than sites included in the TRICS database. In recognition that new households may not have the same characteristics as existing households, an upward adjustment of 11.6% has been made to match observations from the census. The most significant volumes of trips are home based trips to work and to education with relatively few trips for other purposes.

2.15. AECOM agree with the Highways Agency comment that the 8-9AM NTS trips rates appear very low, particularly when compared to TRICS, and agree with the use of the additional factor of 1.116 being applied to the NTS trips rates. The key uncertainty is whether the new developments will have trip rates similar to the current average for Brentwood or similar to TRICS, which appears to have a higher number of persons per household. The actual trips rate may be significantly affected by the type of dwelling.

2.16. It should be recognised that TRICS will give trips for a typical day, rather than for an average day. For example, an average day will include school summer holidays. In terms of junction assessments, a typical day may be more appropriate.

2.17. The process adopted has resulted in an increase in trip rates which is greater than the TEMPro growth rate for the area. Hence, AECOM are content that the growth assumptions are adequate.

Trip Distribution

2.18. The distribution and assignment of generated trips have been based on a network imported to OmniTRANS with mean link speeds derived from TrafficMaster. These journey times have been used in the calculation of the weights, which reduce as a function of distance and time.

2.19. All of the matrices developed are based on census data with a synthetic distribution rather than origin destination surveys. For work trips, a matrix of weights was calculated using distance weights derived from Census journey to work data. In principle, this is reasonable. As a consequence, zones are more attractive if they closer and if they have the particular development type. It would be expected that a considerable number of work trips would be to destinations outside of the borough. Very large spreadsheets have been provided which make the calculations. These appear to work in a manner which is consistent with the description but a full check has not been possible.

2.20. Education trips used a matrix of weights using schools as attractors. This is considered to be acceptable.

2.21. Non-home based trips are allocated on a double distribution method. It is considered that there is much uncertainty in this method. However, it only applies to a small number of trips, so is unlikely to make a significant difference to the assignment.

2.22. Car driver trips have used 2001 Census journey to work travel mode share for each origin destination combination. This is likely to be sufficiently close for the required purpose.

Assignment

2.23. Task 13 of the brief implies that Essex Highways expect that mitigation measures would be required at a number of junctions as performance would not be satisfactory. The aim would be to achieve a nil-detriment performance. This places significant emphasis on the correct routes being derived from the assignment.

2.24. The assignment of development trips is based on times derived from TrafficMaster mean link speeds. These are based on end-to-end trip times so they include junction delays. The additional

development trips are assumed not to impact on the route choice of base trips (which may be the case if nil detriment is actually achieved at all of the junctions). Some level of sense check has occurred with the assignment of development trips. PBA state that this gives a worst case as reassignment of base trips would give some relief to overloaded junctions.

2.25. There are a number of issues with this method.

- Only one route is used between each origin and destination;
- Use of multiple routes could result in additional congestion at other junctions;
- Each route used is based on mean link journey speeds. Travellers may choose their routes using other criteria.

2.26. It was recognised that this method of assigning development trips would result in one route being used between each zone pair. In addition, there should be no reassignment of existing trips to avoid increasing congestion resulting from the assignment of development trips. PBA considered that this would represent a worst case for congestion. This could be the case for the junctions on routes used by development traffic. It could underestimate traffic at junctions which would be affected by reassigning traffic and junctions on other routes which would be expected to be used between certain zone pairs.

2.27. The plots of development flows allow for some assessment of trip distribution and routes used. However, as there is more than one development site, the plots do not provide a full answer.

2.28. The existing turning movements have been derived from count information. The development flows have been added to these. Hence, the totals should be a reasonable approximation of the total flows with developments in addition to modelling the deterioration in performance.

3. Strategic Housing Developments

3.1. Plots are shown of flows from four development options in Appendices C and D of the PBA report. It is stated that these are exclusive of the baseline traffic flows. However, the plots appear to show more traffic on the M25 than that coming from the developments. The mechanism for excluding this traffic is not known. Hence, there is some doubt that the plots are entirely accurate.

Option One (Dunton Hills Garden Village) – PREFERRED OPTION

3.2. The Dunton Hills Garden Village development site is located to the south of the A127 (south of Modelled Junction 13 in Figure 2). The vast majority of the traffic goes to the A127 with only small amounts using more minor roads.

3.3. Once they have reached the A127, most trips head west towards the M25. The next highest proportion head east towards Basildon and Southend. The diagram is truncated, so it is not clear how far these trips go. A relatively small proportion of trips continue north to Brentwood.

3.4. The majority of the trips which head towards the motorway, turn to the north or the south rather than crossing over towards London. Even those with a destination in London will probably use the M25 to select the most appropriate radial. The flows on the A12 and the A1023 to Brentwood suggest that some trips use the M25 to select the most appropriate radial to head away from London. Some trips appear to be using the M25 and A12 to access zones in Shenfield rather than using the A128 and the A1023. Google Maps indicates that this may be the quickest route, but only slightly quicker than the route using more minor roads. The route using the M25 is also significantly longer. Hence, it is a reasonable expectation that a proportion of the development trips would use the A128 and A1023. This would have an impact on different junctions to those using the motorway route. If a proportion of trips to the A12 eastbound to Chelmsford were to use

the A128 and A1023 in preference to the M25 and A12, then the development flow through the centre of Brentwood could be increased significantly.

3.5. AECOM therefore consider that the assessment of the impact of Option 1 on the M25 junctions could be considered broadly robust. However, if a higher proportion of trips travelling to destinations east on the A12 travelled through the town centre and accessed the A12 at Junction 12, there could be a greater number of turning movements at that junction than is predicted by PBA.

3.6. It should be noted however that if junctions on the local network are predicted to be severely congested as a result of LP development and appropriate mitigation measures are not provided, this could encourage drivers to route away from the local road network and make use of the SRN, therefore increasing the impact on the M25 and A12.

3.7. AECOM understand that the trip generation associated with the Brentwood Enterprise Park is constrained by the level of residential development. Due to the limited information about the specific development size proposed for the site it has not been possible to fully check the trip generation associated with the site by using the TRICS database. It is therefore recommended that PBA demonstrate that the trip generation of the site is reasonably estimated for a development of the size proposed in the LP.

3.8. Table 1 follows this discussion of the impact of the four strategic options and shows the number of additional trips predicted on SRN junctions as a result of the potential development. PBA have not currently undertaken an assessment of the potential operation of the SRN following LP development.

Option Two (West Horndon Strategic Sites)

3.9. West Horndon is relatively close to Dunton Hills. Except in the local area around West Horndon, the road usage is similar to that from Dunton Hills. Usage of Childerditch Lane has been restricted in the model as this is a lower standard road which would not be suitable for the potential increase in traffic (and such movements could be deterred by the local highway authority). As a consequence, there is additional traffic using alternative junctions including the A128/A127 junction (Modelled Junction 13), Thorndon Avenue (Modelled Junction 21) and Little Warley Hall Lane (which is not modelled).

3.10. The flow diagrams in Appendix D indicate that this option could also have a notable impact on Junctions 28 and 29 of the M25, particularly at Junction 29, due to the relative distance between the development site and the Junction. Specific increases in traffic at these junctions are detailed in Table 1 below.

Option Three (North of Brentwood)

3.11. It is not possible to access the A12 at Brentwood North close to the development sites. Hence, trips to Chelmsford go in to the M25 and out again or use the A1023 through Shenfield. Google Maps suggests that trips would use the A1023 rather than the A12 which appears to differ from the assignment. Different junctions would be used if the traffic were to use a different route. The majority of trips heading to the A127 are assigned to the M25 rather than via the A128.

3.12. Whilst AECOM recognise that the assignment of trips via the M25 rather than the A128 may underestimate the number of trips on the local highway network, AECOM consider that by assigning a significant proportion of traffic via the M25, this should result in a robust assessment of the impact of options three on Junction 28. However, if traffic routed via A1023, for access to the SRN for trips travelling along the A12 to / from the east the first point of contact could be at

A12 Junction 12. Therefore, by assigning the majority of these trips via M25 Junction 28 the modelling could be underestimating the impact of turning movements at A12 Junction 12.

Option Four (East of Running Waters)

3.13. This site is at a greater distance from the major roads than the other alternative options considered. Trips disperse via the A128, The Avenue and Running Waters. The choice of road used to travel to and from the A127 in the AM and PM peak differs. The choice of route makes a significant difference to the junctions used. In reality, there is likely to be a split with some relief for the most congested junctions but increases at less congested junctions.

3.14. Despite the distance of the strategic site option four from the SRN, there is predicted to be an increase in trips at both M25 Junction 28 and 29, the extent of which is outlined within the table below. The development is located in closer proximity to the A12 than Strategic Options 1 and 2 and is therefore likely to have a greater impact at Junction 12, while the impact at M25 Junction 29 may be less than Options 1 and 2. It should be noted that due to a lack of clarity on the flow diagrams in Appendix C, it has not been possible to calculate the increase at A12 Junction 12. It is recommended that this information is provided by BBC.

Table 1: Summary of the additional Local Plan development trips on the M25

Junction	**Increase in trips as a result of Local Plan development**							
	Option 1		**Option 2**		**Option 3**		**Option 4**	
	AM Peak	*PM Peak*	*AM Peak*	*PM Peak*	*AM Peak*	*PM Peak*	*AM Peak*	*PM Peak*
M25 Junction 28	518	509	519	504	620	641	552	528
M25 Junction 29	1128	1309	1090	1256	872	984	917	1059

4. Summary of Junction Performance

4.1. Task 4 in the Project Brief considers the calculation of the Ratio of Flow to Capacity (RFC) and Degree of Saturation (DoS). These are considered to be under stress when they reach 0.85 for a roundabout and 0.9 for a signalised junction. This will be based on both base traffic from the counts and development traffic. This should allow for an assessment of the extent to which performance has deteriorated and whether performance reaches a critical level.

4.2. As discussed earlier in this technical note, an assessment of the operation of the SRN junctions has not been undertaken within the Highway Modelling Report. Therefore it is not possible for AECOM to speculate on the potential operation of these junctions following Local Plan development.

4.3. Junction 17 (A1023 / Mascalls Lane / Spital Lane) and Junction 19/20 (A127 / B186) are located close to M25 Junctions 28 and 29 respectively and AECOM consider that any queuing back from these junctions towards the motorway could compromise the effective operation of these junctions. AECOM have primarily considered the operation of the junctions for Option 1, as this is the preferred option that has been taken forward for implementation in the LP.

4.4. At Junction 17 the A1023 approach to the junction (the approach of concern to HE) is predicted to operate over capacity in the AM peak, with Mean Max Queues (MMQ) expected to reach approximately 300m back from the junction. Whilst M25 Junction 28 is approximately 500m away, as the approach is over capacity it is likely that the full extent of the queue will be approximately 600m at the end of the peak hour. This could reach back to, and through, M25 Junction 28 and could therefore affect the operation of the junction and the M25 offslips.

4.5. At Junction 19 the A127 Eastbound offslip is predicted to operate significantly over-capacity in the AM peak, with queues predicted to reach approximately 1km, which could stretch back to M25 Junction 29.

5. Additional Issues Identified

5.1. Two further types of issues have been identified. Issues of the first type appear to be mistakes in the reporting.

5.2. In Tables 11-1 and 11-2, the description of junction 15 (Priority left-in left-out) is not consistent with the description in Table 2-1 (double mini-roundabout). Further descriptions that the operation of this junction is very much influenced by the level of mainline traffic suggests that this is not the junction described as Junction 15 in Section 2. Hence, it is unclear whether the reported values are meaningful. Some investigation is required as to what has been modelled as Junction 15.

5.3. Junction 21 is labelled as not applicable (N/A) for options 2 and 3. While this is correct for option 2 as the junction would be closed, there should be a value for option 3. The appropriate values should be inserted into Tables 11-1 and 11-2.

5.4. Some through trips on the motorway appear to be designated as development trips. This is clear from the plots in Appendix D where there are more trips on the M25 passing northbound through Junction 29 than leave at the exit at Junction 28. Hence, there must be some trips which pass through both junctions with neither trip end in the Brentwood area. It is not clear whether this has any significance for the assessment.

5.5. It is reported that there seems to be some traffic reassignment within the option tests when the development traffic is added to the baseline traffic. According to the described methodology, this should not happen. The only reason why this may happen is if routes are closed as in Thorndon Avenue in Option 2. Some investigation is recommended as to why this happens.

5.6. Issue of the second type are consequences of the adopted process.

5.7. There are some zone pairs where there are at least two alternative routes. The choice of route will affect the junctions through which development traffic passes. Small changes in the assignment assumptions may result in significant differences in junction loading. The distribution and assignment has been based on certain assumptions for the values of time and distance.

5.8. Some of the routes used by development trips in the model may not be considered to be suitable by the local highway authority. In these cases, they may take action to prohibit or deter the movement. This would have the consequence of increasing the loading on the junctions of alternative routes. In some cases, this may result in other junctions being assessed as critical. Sensitivity tests could be undertaken which apply a penalty to unsuitable routes thereby encouraging development trips onto more major roads.

5.9. As discussed earlier in this note, no assessment is made of M25 junctions. The increase in the number of trips at M25 Junctions 28 and 29 is higher than at any of the junctions modelled. AECOM recommend that capcity tests are undertaken to determine the resultant operation performance at these junctions.

5.10. This type of assessment could have used a full highway assignment model had one been available. The assignment from such a model would differ in several important ways:

- The extent of increasing junction delays would affect route choice. This has two consequences:

- Several routes will be used by development trips between zone pairs;
- Existing trips may change route as a result of congestion caused by development trips;

- Increasing congestion may result in interference (blocking back) between junctions.

5.11. While the methodology used would show a worst case at some junctions, allowing for reassignment of trips may indicate a worst case at other junctions. Ultimately, this may depend on the level of mitigation. If full mitigation is provided, then the routes assigned may be used by all traffic. In reality, it is unlikely that full mitigation will be possible at these junctions with consequence reassignment to sub optimal routes. This may require mitigation measures at other junctions.

5.12. It is probable that the optimum strategy for Brentwood Borough Council would be to install some mitigation measures at the junctions assessed as being most congested but accept that it is not possible to achieve nil detriment by this method alone. Actions to reduce congestion on other routes could result in a reassignment of traffic away from the more congested routes which may be a more cost effective strategy depending on the relative costs and constraints of improvements.

6. Conclusion

6.1. This technical note has been prepared to review the Highway Modelling approach used to support the preparation of the Brentwood Local Plan. The review was intended to establish whether PBA's (Brentwood BC's consultants) approach to transport modelling will reasonably reflect the potential impact the Local Plan development could have on the strategic road network over the plan period.

6.2. AECOM has made a number of comments and recommendations throughout the note and these are underlined throughout for ease of reference.

6.3. In summary AECOM consider that the trip generation and distribution assumed by PBA can be considered reasonable. Some concerns have been raised regarding the assignment of trips across the network, primarily the decision to assign all trips between two zones to the same route, whereas in reality AECOM consider that a number of different routes may be used, particularly if routes become congested and users change to an alternative route to avoid the congestion.

6.4. However, AECOM consider that the current methodology could result in a robust impact at the strategic road network and therefore may be reasonable to take forward. If, however, the local highway authority plans to deter drivers from making use of certain routes or congestion hotspots cause a significant change in route choice, the total development trips on the strategic road network could alter from that presented within the Highway Modelling Report. The assessment undertaken suggests very high impacts to the SRN.

6.5. Junction capacity assessments of the strategic road network have not been presented within the Modelling Report, despite experiencing significant increases in trips at the junction as a result of development. It is recommended these are undertaken to determine the predicted operation of the junctions following Local Plan development and to determine what measures may be required to mitigate the impact. Consideration may also need to be given to undertaking merge/diverge assessments at various locations to determine whether changes are required to support the Local Plan development.