Accompanying documents:	*Epping TrafficMaster 2011-12 AM Cong.pdf*
	Epping TrafficMaster 2011-12 PM Cong.pdf

Technical note covering base year junction capacity modelling

- ***Background to study***

Essex Highways have been commissioned by Epping Forest District Council (EFDC) to undertake a study to assess the likely highway impact of preferred Local Development Plan (LDP) options on surrounding key links and junctions within the district. Specific reference has been paid to the urban conurbations of Epping, Waltham Abbey, Chipping Ongar, North Weald and villages south of Harlow.

In addition, Essex Highways have been tasked with identifying and reviewing transport measures to mitigate the highway impact of proposed developments so that, where achievable, a nil-detriment situation can be delivered.

Over the longer term, it is EFDC's intention to progress a study segmented into a series of development scenario tests. The first scenario test covers an assessment of 11,000 dwellings and 25 hectares of employment sites in Epping Forest district by 2036. Once the findings of this scenario test are reported to EFDC, it is understood that subsequent scenario tests will be undertaken and reported on, assessing varying levels of development in the district.

This technical note covers an initial assessment of key junctions throughout Epping Forest District in a 2013 base year. The purpose of reporting at this early stage is to provide EFDC with confidence that the base scenario being modelled accurately represents existing conditions experienced.

The base year assessment will then be compared with two future year assessments in 2026 and 2036, in order to appraise the impact of committed developments and LDP proposals on the road network throughout the district, using a spreadsheet traffic model. This will assist in providing a necessary evidence base to support the LDP framework.

- ***Proposed development sites and impacted junctions***

EFDC planners provided a list of residential and employment developments to be included within the LDP covering the period up to 2036. Table 1 below provides a breakdown summary of housing units and size of employment sites proposed across the district.

Area	Housing (units)	Empl (HA)
Buckhurst Hill	52	0
Chigwell	419	0
Epping	2,748	0.12
Harlow	7,837	1.6
Loughton	269	9.84
Lower Sheering	644	0
Nazeing	1,383	0.98
North Weald	2,260	8.2

Area	Housing (units)	Empl (HA)
Ongar	4,935	16.43
Roydon	1,044	0
Sheering	674	0
Theydon Bois	1,266	0
Thornwood Common	400	1.14
Waltham Abbey	2,879	18.55
Total	**26,810**	**56.86**

Table 1: Proposed LDP developments in Epping Forest District

This is in addition to a number of committed housing developments in Epping Forest District that are to be completed during the LDP assessment period. Committed developments are detailed in Table 2 below.

Area	Housing (units)
Buckhurst Hill	19
Chigwell	98
Epping	169
Harlow	0
Loughton	69
Lower Sheering	0
Nazeing	6
North Weald	48

Area	Housing (units)
Ongar	17
Roydon	0
Sheering	9
Theydon Bois	0
Thornwood Common	0
Waltham Abbey	134
Total	**569**

Table 2: Committed housing developments in Epping Forest District

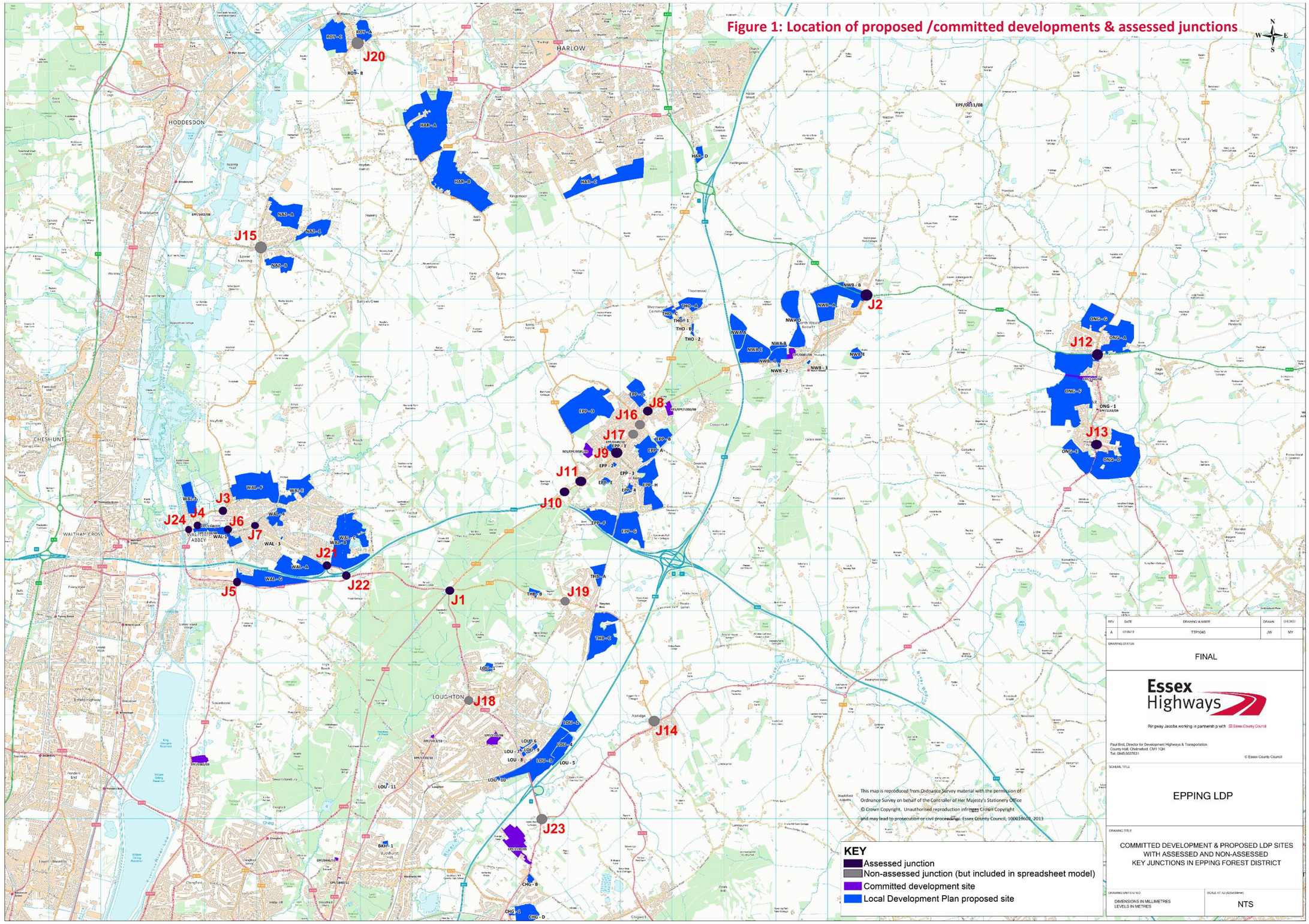
The locations of these developments are shown in Figure 1, along with the location of key junctions in the district that are expected to be impacted by the associated growth in traffic. The junctions are also listed in Table 3 below. Those itallicised in the table in grey are not included in the base year impact assessment as they are not in the immediate vicinity of development areas associated with the first scenario test, but have been included (along with the others) in the spreadsheet model.

Ref	Junction	Model
JC01	B1393 Epping Rd / B172 / A121 / A104 Epping New Rd (Wake Arms) (5-arm)	Epping
JC02	A414 High Rd / B181 High Rd (Talbot PH), North Weald (4-arm)	N Weald
JC03	B194 Abbeyview / Crooked Mile / Parklands, Waltham Abbey (5-arm)	W Abbey
JC04	B194 Abbeyview / B194 Highbridge St, Waltham Abbey (5-arm)	W Abbey
JC05	A112 Sewardstone Rd / A121 Meridian Way / Dowding Way, Waltham Abbey (4-arm)	W Abbey
JC06	Sun St / Sewardstone Rd / Monkswood Ave / Farm Hill Rd, Waltham Abbey (5-arm extended)	W Abbey
JC07	Farm Hill Rd / Honey Ln / Broomstick Hall Rd, Waltham Abbey (3-arm)	W Abbey
JC08	B1393 Thornwood Rd / B181 Epping Rd, Epping (3-arm)	Epping
JC09	B1393 High St / Station Rd / St John's Rd, Epping (4-arm extended junction)	Epping
JC10	B1393 High Rd / Theydon Rd, Epping (3-arm)	Epping
JC11	B182 Bury Ln / B1393 High Rd, Epping (3-arm)	Epping
JC12	A414 Chelmsford Rd / B184 High St / Fyfield Rd, Ongar (4-arm)	Ongar
JC13	A128 Brentwood Rd / A113 Coopers Hill, Marden Ash (4-arm)	Ongar
JC14	*A113 Ongar Rd / B172 Abridge Rd, Abridge (3-arm)*	*Loughton*
JC15	*B194 Nazeing Rd / North St / St Leonards Rd, Lower Nazeing (4-arm)*	*Nazeing*
JC16	*B1393 Palmers Hill / Stonnards Hill / B1393 High St / B181 Lindsey St, Epping (4 arm)*	*Epping*
JC17	*B1393 High St / Hemnall St, Epping (3 arm)*	*Epping*
JC18	*A121 Church Hill / A1168 Rectory Lane, Loughton (4-arm double mini)*	*Loughton*
JC19	Piercing Hill / B172 Coppice Row, Theydon Bois (4-arm)	Epping
JC20	*B181 High St / B181 Epping Rd / Harlow Rd, Roydon (3-arm)*	*Roydon*
JC21	M25 J28 / A121 north roundabout, Waltham Abbey	W Abbey
JC22	M25 J28 / A121 south roundabout, Waltham Abbey	W Abbey
JC23	*A113 High Rd / A1168 Chigwell Ln / A113 Abridge Rd, Loughton (Rolls Park Cnr)*	*Loughton*
JC24	A121 Station Rd / B194 Highbridge St / A121 Meridian Way, Waltham Abbey	Loughton

Table 3: Impacted junctions in Epping Forest District

Essex Highways

Figure 1: Location of proposed /committed developments & assessed junctions



KEY

- Assessed junction
- Non-assessed junction (but included in spreadsheet model)
- Committed development site
- Local Development Plan proposed site

REV	DATE	DRAWING NUMBER	DRAWN	CHECKED
A	02/05/13	TTP1045	JW	MY

DRAWING STATUS: FINAL

Essex Highways

Ringway Jacobs working in partnership with Essex County Council

Paul Bird, Director for Development Highways & Transportation
County Hall, Chelmsford. CM1 1QH
Tel: 0845 6037631

SCHEME TITLE: EPPING LDP

DRAWING TITLE: COMMITTED DEVELOPMENT & PROPOSED LDP SITES WITH ASSESSED AND NON-ASSESSED KEY JUNCTIONS IN EPPING FOREST DISTRICT

DRAWING UNITS U.N.O.: DIMENSIONS IN MILLIMETRES, LEVELS IN METRES

SCALE AT A2 (420x594mm): NTS

- ***Junction capacity appraisal - introduction***

The junction impact appraisal documented in this technical note focusses on the 2013 base year and the calibration of junction models to represent existing performance.

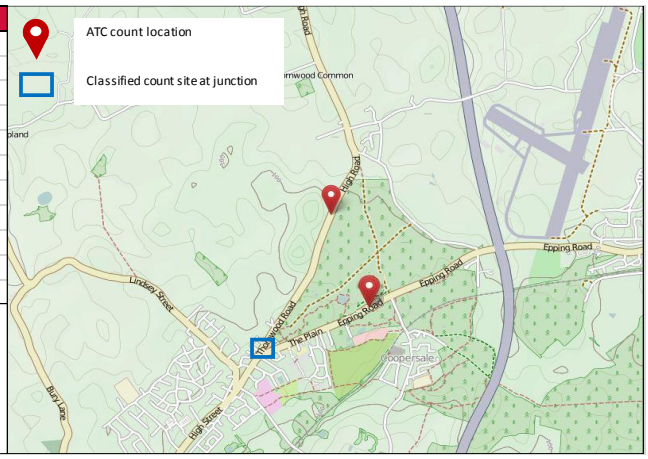
- ***Junction capacity appraisal – data collection***

One-day AM (0800-0900) and PM (1700-1800) peak hour classified junction counts were undertaken at junctions 1-20 over the survey period 2nd – 3rd July 2013. These were supplemented by a series of 7-day automatic traffic counts (ATCs) undertaken in the first week of July 2013. Whilst the ATCs were commissioned to assist with the development of the spreadsheet model (and will be documented in more detail in the full study report), where located close to a surveyed junction, these were used as a checking tool to assess the representativeness of the classified count data to an average day.

- ***Junction capacity appraisal – representativeness of classified count data***

Six ATC sites – five in Epping and one in Ongar (Marsden Ash) were identified as being suitable for use as a comparable check of the classified count data. Directional flows taken from the 5-day average peak hour automated counts were subsequently compared with corresponding junction arm peak hour entry and exit flows derived from the one-day counts. The results of the check are as follows:

Junction 8 - Epping		AM	PM
Thornwood Road NB	Junction Count	435	637
	ATC 5-day av	485	869
Thornwood Road SB	Junction Count	627	574
	ATC 5-day av	636	553
B181 Epping Road EB	Junction Count	547	811
	ATC 5-day av	633	337
B181 Epping Road WB	Junction Count	667	501
	ATC 5-day av	298	501



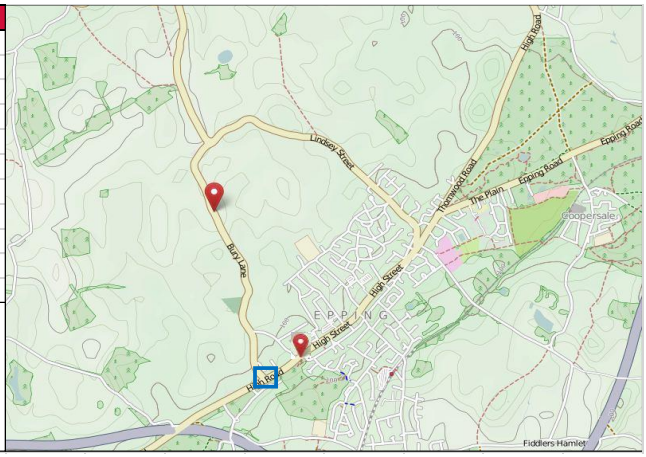
Essex Highways

Junction 10 - Epping		AM	PM
B1393 High Road (W) NB	Junction Count	738	853
	ATC 4-day av*	698	718
B1393 High Road (W) SB	Junction Count	1052	743
	ATC 4-day av*	839	792

Essex Highways

* ATC count data on Wed 3rd July was low in comparison with other surveyed weekdays. Therefore, the ATC average was taken over the remaining 4 days.

Junction 11 - Epping		AM	PM
B182 Bury Lane NB	Junction Count	217	309
	ATC 5-day av	200	266
B182 Bury Lane SB	Junction Count	425	280
	ATC 5-day av	333	247
B1393 High Road (E) NB	Junction Count	812	791
	ATC 5-day av	825	734
B1393 High Road (E) SB	Junction Count	727	801
	ATC 5-day av	646	776



Junction 13 - Marden Ash		AM	PM
A113 Romford Road NB	Junction Count	265	558
	ATC 5-day av	251	574
A113 Romford Road SB	Junction Count	570	286
	ATC 5-day av	554	277

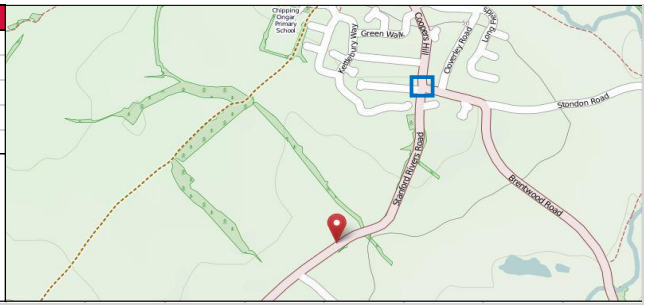


Table 4: Comparison of ATC link counts and classified counts

Comparison checks confirm that the peak hour traffic flows on the survey days 2-3rd July 2013 were largely representative of average peak hour flows across the week at the junctions surveyed.

Discrepancies in count data at the Thornwood Road junction with B181 Epping Road, are likely to be explained by the location of St. Margaret's Hospital along the B181 in between the surveyed junction and ATC count site.

- ***Junction capacity appraisal – modelling software used***

Junctions8 Software (Formerly ARCADY / PICADY) version 8.0.2.316 was used in the capacity assessments of the roundabout junctions under appraisal in this study. LINSIG version 3.2.11.0 was used to assess the signalised junctions.

- ***Junction capacity appraisal – definition of modelling terms***

LOS = Level of Service

The Junctions8 software refers to Level of Service values contained in the Highway Capacity Manual (HCM 2000). In this instance, model outputs show the unsignalised level of service values for each peak hour, based on the average delay per arriving vehicle. The LOS system uses the following alphabetised categories:

***A** = Free flow*

***B** = Reasonably free flow*

***C** = Stable flow*

***D** = Approaching unstable flow*

***E** = Unstable flow*

***F** = Forced or breakdown flow*

Queue Length

The queue lengths stated in the capacity assessment results represent the average maximum queue lengths in Passenger Car Units (PCUs) on each approach arm across the peak hour. They are therefore indicative of queuing extents at the busiest point of the peak hour and are not representative of average conditions.

RFC = Ratio of Flow to Capacity

The ratio of flow to capacity provides a measure of the utilised capacity of a junction approach arm. Arms exceeding a ratio of 0.85 (i.e. 85% capacity utilised) are considered to be approaching capacity and characteristically have light-to-moderate levels of queued traffic flow. Arms exceeding a ratio of 1.00 (i.e. 100% capacity utilised) are considered to be over capacity and are characterised as having heavy volumes of queued traffic.

ARCADY results that exceed RFCs of 1.00 generate queue lengths that are subject to exponential growth. However, the instability of flows through over-capacity approach arms, results in an inherent difficulty in calibrating modelled outputs to observed conditions. For this reason, queue lengths attributed to over capacity approach arms should be seen as indicative rather than representative.

The capacity assessment tables at the end of this technical note use a colour-coding system to assist in appraisal:

- Arms with an RFC of less than 0.85 are coloured green
- Arms with an RFC between 0.85 and 0.99 are coloured amber
- Arms with an RFC of 1.00 or more are coloured red

DOS = Degree of Saturation

The degree of saturation is an output from LINSIG which provides a measure of the utilised capacity of a signalised junction approach lane. It is directly comparable to the RFC outputs obtained from ARCADY assessments (see above).

The colour-coding system used to categorise DOS in the model results tables is as follows:

- Lanes with a DOS of less than 85% are coloured green
- Lanes with a DOS between 85% and 99% are coloured amber
- Lanes with a DOS of 100% or more are coloured red

Vid = Video Reference

Video footage was recorded during peak hours on 3rd July 2013 at the first 20 junctions listed in Table 3. The installation of cameras was commissioned in order to facilitate manual classified turning count data collection, but has also been used as a calibration tool to appraise the accuracy of base model outputs via a visual comparison.

The colour-coding system used to categorise observed levels of congestion in the model results tables is as follows:

- Arms which are observed to have little-to-no congestion, or only transient queues at signalised junctions, are coloured green
- Arms which are observed to be moderately congested are coloured amber
- Arms which are observed to be heavily congested are coloured red

TM = TrafficMaster Data

It is recognised that the video footage acquired is representative of a single-day 'snapshot' only. Therefore, In order to boost the robustness of the base model calibration process, modelled outputs were also compared against TrafficMaster 2011/12 journey time data captured on main road links across the Epping Forest District.

Average speeds achieved during the peak hour were calculated for each link in the network and expressed as a percentage of night-time speed (as an estimate of free flow speed). This percentage of free flow speed was then used as an indicator to show areas of congestion on the road network.

The mapped TrafficMaster congestion analysis can be found in the separate PDF files that accompany this technical note:

- Epping TrafficMaster 2010-11 AM Cong.pdf

- Epping TrafficMaster 2010-11 AM Cong.pdf

The percentage of free flow speed categories shown in the maps, have been simplified into a colour-coding system used in the model results tables below as follows:

- Arms where average speeds are 50% or more of free flow speeds are coloured green
- Arms where average speeds are between 35% and 50% of free flow speeds are coloured amber
- Arms where average speeds are less than 35% of free flow speeds are coloured red

- ***Junction capacity appraisal – model results***

Junction 1 (Wake Arms PH) - Epping											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B1393 Epping Road	A	1	0.57			B	3	0.72			
B172	D	7	0.89			F	15	0.96			
A121 Golding's Hill	F	160	1.33			F	26	1.02			
A104 Epping New Road	F	82	1.30			F	164	1.52			
A121 Woodridden Hill	D	5	0.84			F	60	1.14			

Junction 2 (Talbot PH) - North Weald											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B181 Weald Bridge Road	A	0	0.19			A	0	0.18			
A414 High Road	B	4	0.81			A	1	0.53			
B181 High Road	A	1	0.43			A	1	0.47			
A414	A	1	0.45			B	2	0.70			

Junction 3 (Crooked Mile) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B194 Crooked Mile	A	1	0.52			A	1	0.44			
Parklands	A	1	0.48			A	1	0.39			
Crooked Mile	A	0	0.32			A	1	0.46			
Car park	A	0	0.02			A	0	0.02			
B194 Abbeyview	A	0	0.23			A	1	0.53			

Junction 4 (Highbridge St) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B194 Abbeyview	A	1	0.34	*	*	A	0	0.27			
Highbridge Street	A	1	0.33	*		A	0	0.25			
B194 Highbridge Street	A	1	0.46			C	6	0.85			
Powdermill Lane	A	0	0.05			A	0	0.15			

* Congestion seen in video footage and via TrafficMaster analysis, is the result of queues tracking back through Highbridge Street Roundabout from the signalised junction of Highbridge Street with Meridian Way. Highbridge Street Roundabout itself is shown in the analysis to be operating within capacity.

Junction 5 (Sewardstone Rd) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
Sewardstone Road	A	1	0.36			A	1	0.36			
A121 Dowding Way	A	1	0.52			A	1	0.37			
A112 Sewardstone Road	A	1	0.42			A	2	0.65			
A121 Meridian Way	A	1	0.34			A	1	0.46			

Junction 6 (Sun St) - Waltham Abbey											*Signalised Junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	DOS	Vid	TM	LOS	Queue Length	DOS	Vid	TM	
A121 Crooked Mile	-	17	89			-	10	79			
Monkswood Avenue	-	7	90			-	3	54			
Sun Street - *Left/Ahead*	-	3	51			-	2	29			
Sun Street - *Right*	-	14	101			-	10	88			
Sewardstone Road NB - *Left/Ahead*	-	4	53			-	7	69			
Sewardstone Road NB - *Right/Ahead*	-	8	89			-	12	82			
Sewardstone Road SB - *Left/Ahead*	-	10	62			-	20	94			
Sewardstone Road SB - *Ahead*	-	5	60			-	4	44			
Farm Hill Road	-	14	80			-	15	93			
Sewardstone Road NB	-	8	67			-	19	96			

Junction 7 (Honey Ln) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
Broomstick Hall Road	A	0	0.32			A	0	0.32			
Honey Lane	F	10	0.93			D	5	0.85			
Farm Hill Road	A	1	0.46			C	3	0.74			

Junction 8 (Thornwood Road) - Epping											*Signalised junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	DOS	Vid	TM	LOS	Queue Length	DOS	Vid	TM	
B1393 Thornwood Road - *Left/Ahead*	-	25	90			-	67	110			
B181 The Plain - *Left/Ahead*	-	26	94			-	160	168			
B1393 Palmers Hill - *Right/Ahead*	-	23	89			-	181	120			

Junction 9a (Station Rd) - Epping											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B1393 High Street RAB Link	C	5	0.85			C	5	0.85			
Station Road	F	22	1.08			F	5	0.87			
B1393 High Street	F	29	1.06			D	6	0.87			

Junction 9b (St. John's Rd) - Epping											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
St. John's Road	D	1	0.57			F	22	1.15			
B1393 High Street	E	10	0.95			F	76	1.28			
B1393 High Street RAB Link	C	5	0.85			B	3	0.72			

Junction 10 (Theydon Road) - Epping											*Signalised junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	DOS	Vid	TM	LOS	Queue Length	DOS	Vid	TM	
B1393 Epping Road (East) - *Left/Ahead*	-	28	82			-	17	66			
Theydon Road	-	13	87			-	11	77			
B1393 Epping Road (West) - *Right/Ahead*	-	28	91			-	23	77			

Junction 11 (Bury Ln) - Epping											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B182 Bury Lane	C	2	0.68			A	1	0.43			
B1393 High Road (East)	F	25	1.02			F	21	1.00			
B1393 High Road (West)	C	4	0.82			C	6	0.86			

Junction 12 (Wantz Service Stn) - Ongar											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
B184 Fyfield Road	B	2	0.67			A	1	0.57			
A414 Chelmsford Road	C	6	0.86			A	1	0.52			
B184 High Street	B	3	0.71			B	3	0.75			
A414 Epping Road	A	1	0.54			B	3	0.76			

Junction 13 (Coopers Hill) - Marden Ash (Ongar)											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
A113 Coopers Hill	F	14	0.96			C	3	0.73			
A128 Brentwood Road	B	2	0.66			A	1	0.53			
A113 Stanford Rivers Road	A	1	0.37			C	3	0.77			
St. James Avenue	A	0	0.04			C	0	0.09			

Junction 19 (Piercing Hill) - Theydon Bois											*Priority junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
Piercing Hill	F	6	0.89			C	2	0.66			
B172 Coppice Road (East) R-T	A	0	0.32			B	1	0.40			
The Green	E	3	0.76			E	4	0.80			
B172 Coppice Road (West) R-T	A	0	0.05			A	0	0.06			

Junction 21 (M25 J26 Northern RAB) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
Old Shire Lane	A	0	0.19			A	0	0.15			
Honey Lane RAB Link	A	1	0.42			A	1	0.57			
M25 Off Slip	A	0	0.27			A	1	0.44			
Honey Lane	A	1	0.37			A	0	0.23			

Junction 22 (M25 J26 Southern RAB) - Waltham Abbey											*Roundabout junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	RFC	Vid	TM	LOS	Queue Length	RFC	Vid	TM	
M25 Off Slip	A	1	0.39			A	0	0.20			
A121 Honey Lane	F	65	1.09			A	1	0.36			
A121 Dowding Way	A	1	0.43			A	0	0.30			
Honey Lane RAB Link	A	1	0.51			A	0	0.26			

Junction 24 (Station Road) - Waltham Abbey											*Signalised junction*
Arm	**AM PEAK**					**PM PEAK**					
	LOS	Queue Length	DOS	Vid	TM	LOS	Queue Length	DOS	Vid	TM	
Beaulieu Drive	-	1	19			-	1	17			
B194 Highbridge Street (East)	-	35	100			-	61	113			
Meridian Way	-	21	95			-	12	68			
B194 Highbridge Street (West)	-	31	102			-	116	112			

Junction approach arms that are identified from video footage and/or TrafficMaster analysis to be struggling with capacity, are largely shown in the Junctions 8 and LINSIG models as having higher RFC / DOS values. Therefore, there is confidence that the 2013 base model results are replicating general patterns of congestion currently experienced at each roundabout.

Modelled junctions with arms operating noticeably above capacity are as follows:

- Junction 1 (Wake Arms PH) – Epping
- Junction 8 (Thornwood Road) – Epping
- Junction 9a (Station Rd) - Epping
- Junction 9b (St. John's Rd) – Epping
- Junction 22 (M25 J26 Southern RAB) - Waltham Abbey
- Junction 24 (Station Road) - Waltham Abbey

Of these, junctions 1, 8 and 24 are shown to have approach arms with queues exceeding 100 PCUs in length. As stated earlier, such queue extents should be considered indicative. However, the severity of congestion modelled might warrant undertaking saturation flow surveys on the affected arms in order to further improve calibration to existing conditions. Any additional surveys would be subject to confirmation from EFDC that modelled queue lengths at the identified junctions are acknowledged as being excessive.