Tonbridge and Malling and Sevenoaks Local Plans

Local Base Model Validation Report

April 2023

Kent County Council

KCC

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1.0	March 2023	Local Base Model Validation Report	PB/FF/ AB	MT	TK	CH
2.0	April 2023	Local Base Model Validation Report	PB/FF/ AB	MT	TK	CH

Distribution of copies

Revision	Issue approve	Date issued	Issued to	Comments
1.0	1.0	March 2023	Steven Timson (KCC) Nigel DeWit (TMBC) Hannah Gooden (SDC)	First draft for KCC, TMBC and SDC comment
2.0	2.0	April 2023	Steven Timson (KCC) Nigel DeWit (TMBC) Hannah Gooden (SDC) Kevin Bown (NH) Janice Burgess (NH)	For NH comment

Tonbridge and Malling and Sevenoaks Local Plans

Project No:	BESP0030
Document Title:	Tonbridge and Malling and Sevenoaks Local Plans – Local Base Model Validation Report
Revision:	2.0
Document Status:	Final
Date:	April 2023
Client Name:	Kent County Council
Project Manager:	Charlotte Herridge
Author:	Alessandra Bernardi, Melanie Tobias
File Name:	Stage 2 T&M and Sevenoaks - Local Model Validation Report v2 (Draft).docx

Jacobs U.K. Limited

Cottons Centre, Cottons Lane
London SE1 2QG
United Kingdom
T +44 (0)20 3980 2000

www.jacobs.com

Contents

Limitation Statement

The sole purpose of this technical report is to describe the processes by which the Tonbridge and Malling and Sevenoaks Local Transport Model has been developed and to present the calibration and validation standards achieved in order to demonstrate model accuracy and fitness for purpose. The report should be read in full with no excerpts out of context deemed to be representative of the report and its findings as a whole. This report has been prepared exclusively for Jacobs and Jacobs' end client (Tonbridge and Malling Borough Council, Sevenoaks District Council and Kent County Council) and no liability is accepted for any use of, or reliance on, the report by third parties.

Several of the figures within this report have been generated in the PTV VISUM software using OpenStreetMap® open source data, licensed under the Open Data Commons Open Database License (ODbL) by the OpenStreetMap Foundation (OSMF). The data is available under the ODbL. For more information see http://www.openstreetmap.org/copyright

1. Introduction

Following the completion of Stage 1 Initial Baseline Assessment in July 2022, Tonbridge & Malling Borough Council (TMBC), Sevenoaks District Council (SDC) and Kent County Council (KCC) sought consultancy support for the Stage 2 Detailed Transport Modelling of their Local Plans. Due to geographical proximity and the similarity of the scope of work between Tonbridge and Malling and Sevenoaks, an agreement has been made for joint working. This stage is intended to support the Regulation 19 of each Local Plan (LP) and includes the development of the base year, forecast baseline and option testing.

The current Tonbridge & Malling Borough Development Plan was adopted between 2007 and 2010 and provided the housing, employment and retail development needed for 2007-2021. The annual housing requirement will increase from the current Development Plan figure to up to approximately 839 homes/year from 2021 to 2040.

The current Sevenoaks District Core Strategy was adopted in 2011 and provides for the housing, employment and retail development needed for 2011-2026. The annual housing requirement will increase from the current Local Plan figure to up to approximately 714 homes/year from 2025 to 2040.

TMBC, SDC and KCC need to consider and consult on reasonable, alternative options for meeting housing and other development needs. As part of this process, TMBC, SDC and KCC commissioned Jacobs to undertake transport modelling to gather evidence on the transport implications of the emerging draft LPR options.

The objectives of LP assessments are to:

1. Assess the quality and capacity of transport infrastructure across the borough/district and its ability to meet forecast demands – this can be developed through the traffic modelling proposed here.

2. Assess the cumulative impacts of the LP development options on the borough's/district's transport network – this can be developed through the traffic modelling proposed here.

3. Identify proposals and potential measures to mitigate the impacts of development to inform the infrastructure requirements associated with the LP. This should include, but is not limited to:

    a. Identification of potential measures to enable and achieve higher levels of sustainable transport mode share across the borough/district.

    b. Identification of the potential barriers to the utilisation of sustainable transport modes across the borough/district.

    c. Identification of potential intervention measures on the transport network.

This Local Model Validation Report (LMVR) describes the processes by which the Kent Transport Model (KTM) has been used to develop the Tonbridge and Malling and Sevenoaks Local Transport Model and presents the calibration and validation standards achieved.

Following this introduction, this report is structured as follows:

- Section 2: Key Considerations
- Section 3: Kent Transport Model Overview
- Section 4: Tonbridge and Malling and Sevenoaks Local Transport Model
- Section 5: Summary of Data Collection
- Section 6: Calibration and Validation Data
- Section 7: Matrix Estimation
- Section 8: Local Model Suitability
- Section 9: Summary

2. Key Considerations

2.1 Proposed Use of the Model

The Tonbridge and Malling and Sevenoaks Local Transport Model has been developed using the existing 2019 Kent Transport Model (KTM) and a local model re-validation exercise has been undertaken using existing 2019 data and supplementary counts collected in 2022. The local model has been developed to assess the potential impacts of the proposed Regulation 19 Local Plan allocations for Tonbridge and Malling and Sevenoaks and could subsequently be used to understand any highway network improvements as a result of identified mitigation.

During the local model development processes, detailed analysis of all existing traffic survey data within Tonbridge and Malling and Sevenoaks, as well as the specification, collection, processing, and analysis of new 2022 datasets was undertaken. Adjustments and modifications to the modelled network were subsequently implemented to reflect the granularity needed to develop and appropriately detailed local model for Tonbridge and Malling and Sevenoaks; this included a full network review within the detailed model area. More information can be found in Section 4 of this report.

2.2 Consideration of COVID-19 Pandemic on Model Use

The Tonbridge and Malling and Sevenoaks Local Transport Model has been developed using mostly latest pre-COVID-19 pandemic data and is calibrated against 2019 conditions. The pandemic had a profound impact on travel demand by all modes during periods of national lockdown after March 2020 and again in January 2021. Using information published by the Department for Transport on the daily statistics for road traffic, rail passenger journeys and bus travel in Great Britain, Figure 2-1 shows the development of demand for travel by different modes in Great Britain since the start of the pandemic (March 2020) until December 2022.

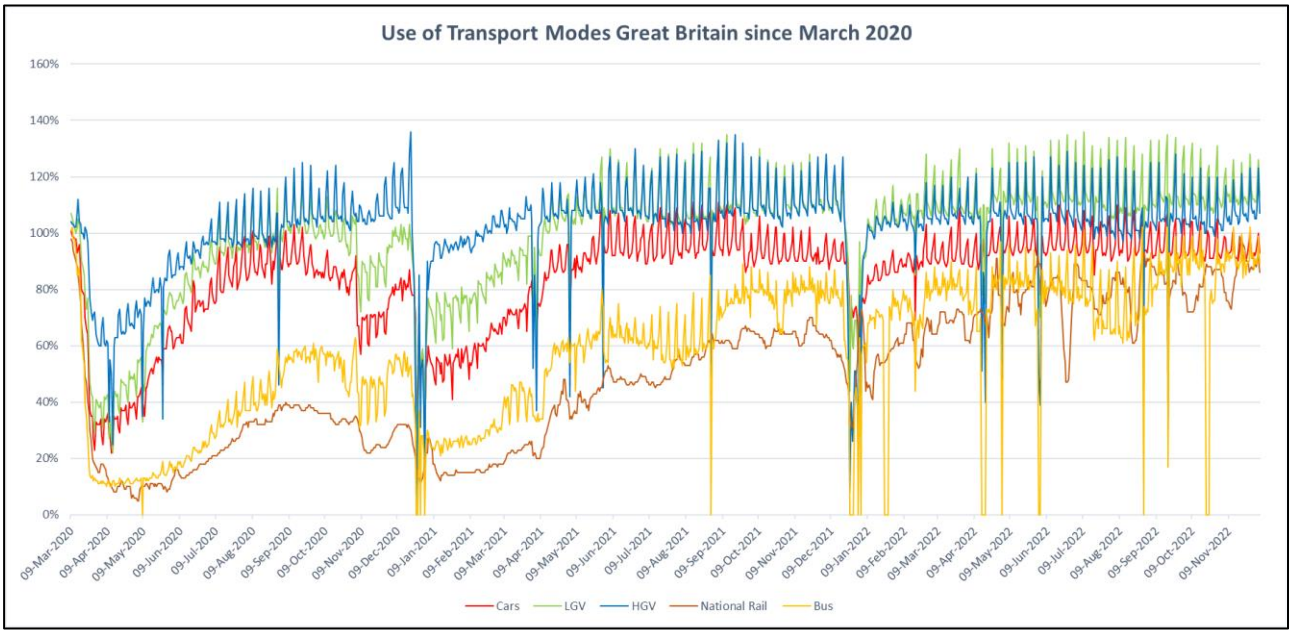

Figure 2-1- Use of Transport Modes in Great Britain since March 2020[1]

[1] Source: Jacobs analysis of DfT data from https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic, retrieved January 2023

Figure 2-1 shows a significant downturn in demand for all modes during periods of national lockdown after March 2020 and again in January 2021. During the summer of 2020, highway demand had recovered with HGV and LGV demand back to pre-pandemic levels and car demand close to pre-pandemic levels. Rail and bus demand continued to lie significantly below normal levels.

At Great Britain level, Figure 2-1 shows that highway demand during 2022 had returned to pre-pandemic levels, with LGV demand showing growth (green line); the graph also shows that highway demand remained relatively constant throughout 2022, with little growth or decline in comparison to pre-covid levels, or those shown in summer 2020 and 2021 when restrictions did not apply.

These trends, however, do not undermine the validity or usefulness of the model set up based on 2019 data because they are considered to be temporary effects driven by external factors rather than fundamental changes in the travel choice processes that the model is calibrated to reproduce. If there are to be long term effects, these will be driven by the input assumptions used to derive future travel demand rather than changes in the behaviour represented by the model's algorithms.

Future travel behaviour may be affected by a combination of:

- Personal concerns;
- Government policy;
- Changes in personal economic circumstances; and
- National or global economic changes.

At this stage, the likely long-term impacts of the pandemic can only be understood through scenario testing and our recommendation is that such scenarios should be run through the Tonbridge and Malling and Sevenoaks Local Transport Model to examine the potential range of outcomes. The scenarios should be developed through discussion and consultation with key stakeholders and should consider some of the factors listed in Table 2-1.

Pre-Pandemic Habits	Possible Drivers of Personal Behaviour Change	Possible Influencing Factors
Travel to work, dominated by public transport (towns and cities) and car (outside towns and cities)	• Long term trend towards more remote working • Possible modal shifts	• Higher levels of unemployment • Road space re-allocation • Reductions in public transport capacity • Land use changes
Travel to meetings, both short and long distance	• Possible reduction of face-to-face meetings	• Better availability and quality of online meeting facilities • More cost-conscious and environmentally friendly corporate travel policies
Visits to bars and restaurants	• Desire to return to normal	• Permanent closure of some bars and restaurants
Visits to friends and families	• Desire to return to normal	• More cost-conscious and environmentally friendly personal travel behaviour
Visits to theatres and museums	• Desire to return to normal	• Permanent closure of some theatres or museums
High Street shopping	• Lasting reduction due to new online shopping habits	• Increased availability of online shopping facilities • Closure of high street shops
Big summer holidays by air	• Increased environmental awareness	• Reduced airline capacity • Increased environmental taxes

Pre-Pandemic Habits	Possible Drivers of Personal Behaviour Change	Possible Influencing Factors
Weekend trips away by air	• As above	• As above

Table 2-1 – Influencing Factors for Post-Covid Behaviour Change

In the longer term, some changes in behaviour, together with re-enforcing external factors, could include:

- **Land use:** It is possible that the current travel restrictions lead to a new wave of decentralisation, with different land use patterns and lower densities of development over time. This may be re-enforced by the travel choices people make, with a shift to shorter, local journeys by car or bicycle;
- **Propensity to travel:** We have already seen some reductions in household trip rates in most developed countries over the last few years. This trend may be accelerated;
- **Trip Distribution:** Any longer-term changes to population or employment patterns will have an impact on trip distribution; and
- **Economic factors:** Longer term GDP growth may be impacted significantly by the pandemic.

Any such changes can be represented in the model through the modification of input assumptions on land use, trip rates, cost escalation, and economic growth.

3. Kent Transport Model Overview

3.1 Introduction

This section provides an overview of the 2019 Kent Transport Model (KTM) which was used as a basis for the Tonbridge and Malling and Sevenoaks Local Transport Model. Detailed information on the development of the Tonbridge and Malling and Sevenoaks Local Transport Model is presented in Section 4.

3.2 Kent Transport Model Summary

The key characteristics of the KTM are described in Table 3-1 below (items in blue text are relevant to the Tonbridge and Malling and Sevenoaks Local Transport Model). It should be noted that the local transport model developed for Tonbridge and Malling and Sevenoaks is a highway assignment model. No public transport assignment model was developed for this project.

Characteristic	Model Coverage
Model Structure	Peak hour highway assignment model Peak period public transport assignment model 24hr production-attraction variable demand model
Model Purpose	Built for KCC for their use in developing countywide strategies, understanding the combined strategic impact of highway schemes, and initial sifting of major scheme options.
Software Platform	Highway assignment model: VISUM version 2020 Public transport assignment model: EMME version 4.4.4.2 Variable demand model: EMME with VBA user interface
Assignment Methodology	Highway assignment model: VISUM Linear User Cost Equilibrium (LUCE) algorithm Public transport assignment model: Multiclass Frequency-based Optimal Strategies algorithm, with optional in-vehicle crowding functionality
Time Periods	Highway Assignment Model AM peak hour (08:00 to 09:00) Inter-peak period representing an average hour (between 10:00 and 16:00) PM peak hour (17:00 to 18:00) Public Transport Model AM peak period (07:00 to 10:00) Inter-peak period (10:00 to 16:00) PM peak period (16:00 to 19:00) Variable Demand Model 24-hour
Trip Matrices (Private Transport Modes)	Car Commute, Car Business, Car Other, LGV, HGV
Trip Matrices (Public Transport Modes)	Rail / Underground / Tramlink / Docklands Light Railway (DLR) / Romney, Hythe and Dymchurch Railway (RH&DR) Bus/Coach
Base Year	Neutral average weekday 2019

Table 3-1: Kent Countywide Model Summary

3.3 Model Coverage

In line with the DfT Transport Analysis Guidance (TAG), the network for the Kent Countywide Highway Assignment Model makes use of a tiered structure, with levels of detail reducing away from the centre of the study area. The breakdown of the network structure is therefore outlined broadly as:

- Fully Modelled Area:
  - Area of Detailed Modelling; and
  - Rest of the Fully Modelled Area.
- External Area.

The KTM is focussed on the area contained within the Kent local authority boundary (Area of Detailed Modelling) shown in Figure 3-1 below:

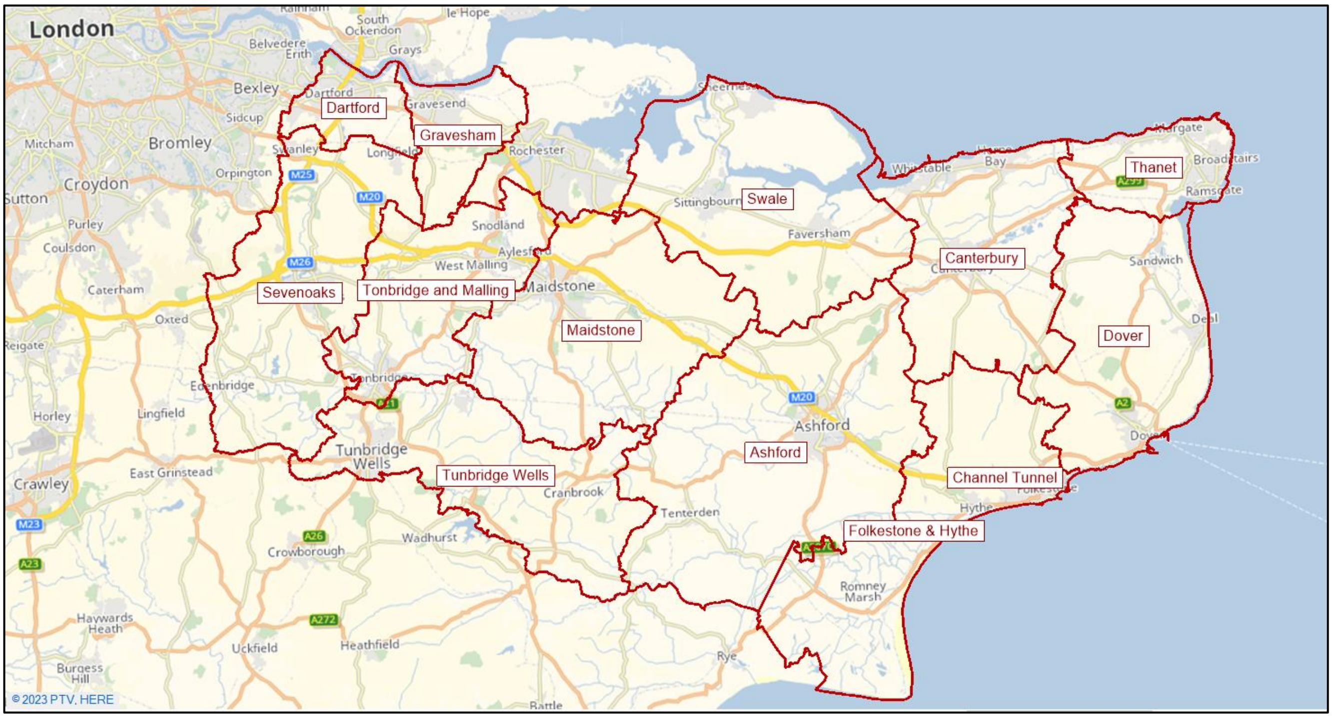

Figure 3-1: Model Study Area

Beyond the Area of Detailed Modelling (the 'buffer area'), the level of detail in the model is gradually reduced. The immediate surrounding area comprising the Rest of the Fully Modelled Area (Medway, parts of South-East London, Thurrock, Surrey, West Sussex and East Sussex), is modelled to a decreasing level of detail based on proximity from Kent, although highway capacity restraint is still considered at the link level. The remainder of mainland Great Britain forms the External Area of the model where only a skeleton network of key roads without capacity restraints are used.

3.3.1 Zones

The guidance states that the design of the zoning system should be closely related to the level of details in the assignment networks. Zones should be smallest in the Area of Detailed Modelling, becoming larger for the Rest of the Fully Modelled Area and progressively much larger for the External Area. At the boundary between the classifications of area type, it is important to avoid sudden changes in average zone size and a graduated approach is desirable. The primary building block for the zone system should be Census and administrative boundaries, and boundaries relating to national forecasts. The zoning system has been developed using the following administrative areas, with the intention of preserving National Trip End Model (NTEM) zone boundaries throughout:

- Lower Super Output Areas (LSOAs);
- Middle Super Output Areas (MSOAs);
- Local Authorities (LAs) / Greater London Boroughs; and
- Regions.

The lowest level of spatial detail used is LSOA and for areas where less spatial detail was required, zones were grouped into MSOAs, Local Authorities, London Boroughs (where applicable), and Regions. The zone system around Kent and the greater External Area can be seen (on the following pages) in Figure 3-2 and Figure 3-3 respectively with:

- LSOAs: Kent County, Medway, and areas of the of London Boroughs Bexley and Bromley in close proximity (1,222 zones);
- MSOAs: Areas at the boundary and in close proximity to the area covered by LSOAs (286 zones);
- Local authorities/London Boroughs: The rest of Eastern England and South East England (121 zones) and;
- Regions: The rest of the regions in England, as well as Scotland and Wales (8 zones).

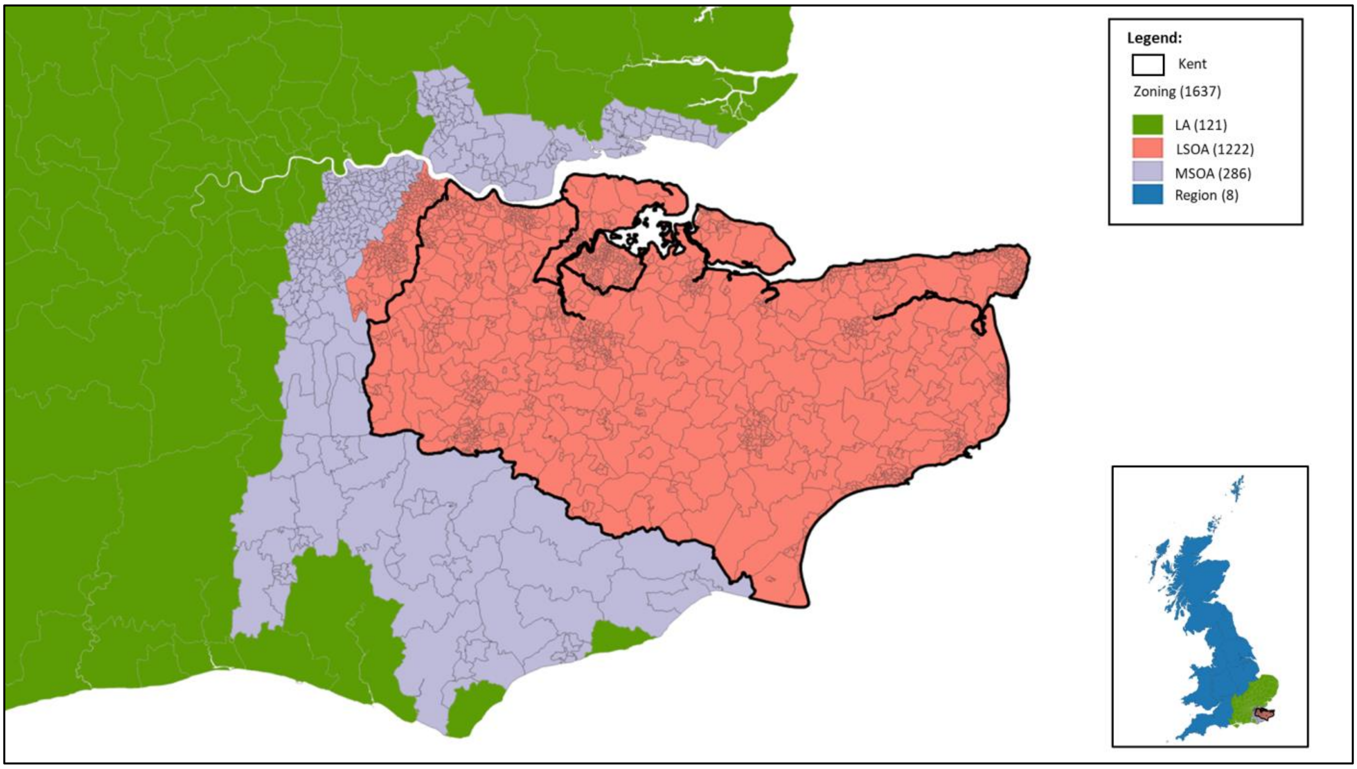

Figure 3-2: Model Zones – Kent

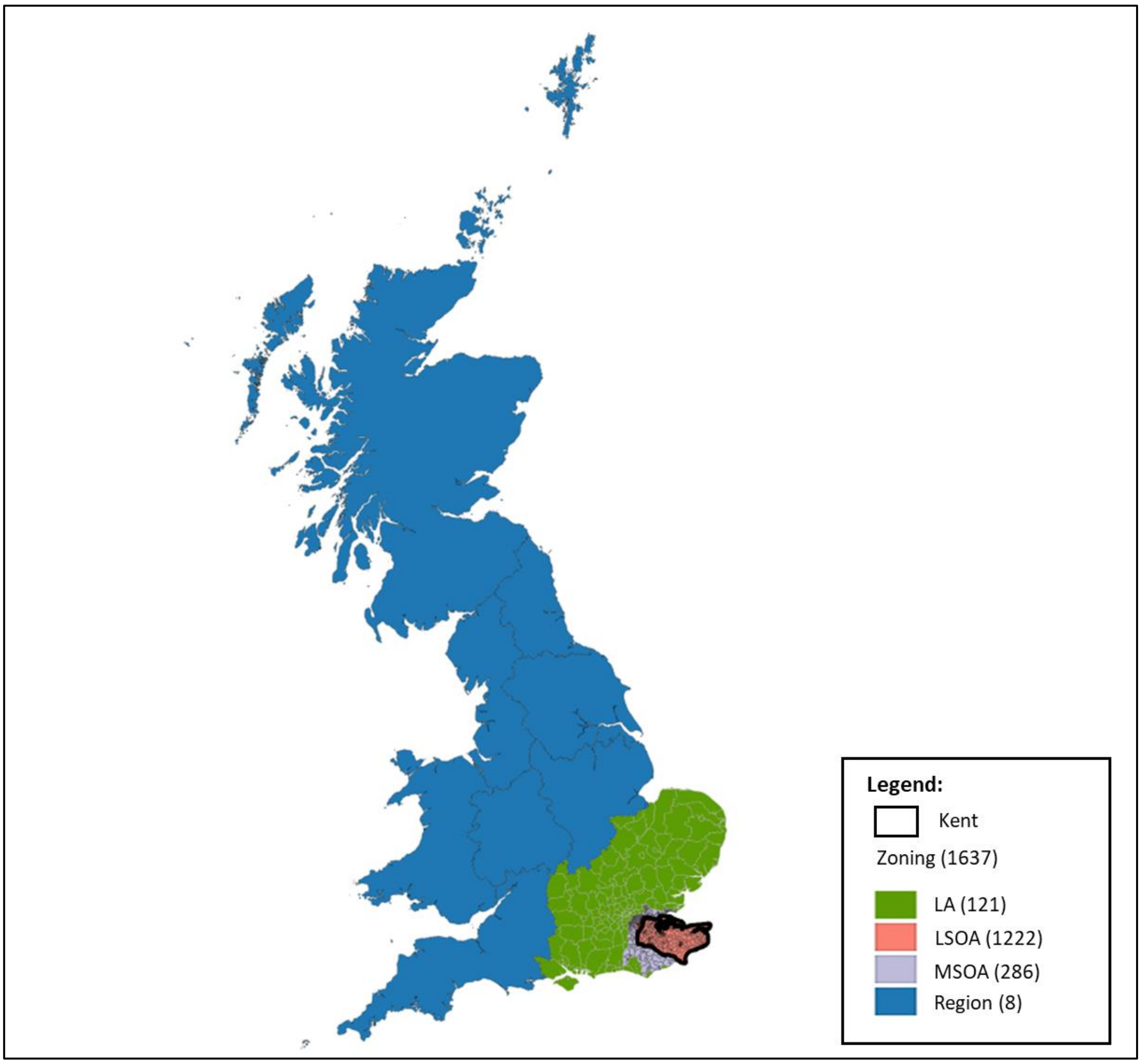

Figure 3-3: Model Zones – National

3.3.2 Network Structure

TAG Unit M3.1 Paragraph 2.4 highlights the requirements of the highway network structure for the Area of Detailed Modelling, the Rest of the Fully Modelled Area, and the External Area. The Fully Modelled Area needs to include "all roads that carry significant volumes of traffic" and generally "should be of sufficient extent to include all realistic choices of route available to drivers". In the External Model Area, only major highways of importance for strategic routing are coded.

Following this guidance, the KTM is focused on the area contained within the Kent County boundary (the Area of Detailed Modelling). The network in areas that border Kent (the rest of the Fully Modelled Area including Medway, parts of South-East London, Thurrock, Surrey, West Sussex and East Sussex) are also detailed with link capacity restraints. Beyond this, the level of detail in the model is gradually reduced. The South East of England is modelled to a lower level of detail and the remainder of mainland Great Britain is based on a skeleton network of key roads without capacity restraint. In the Fully Modelled Area the highway network therefore includes a very granular representation, with all except very minor local residential roads included. In the External Model Area, only major highways deemed to be of importance for strategic routing are coded.

The tiered approach to the highway network is summarised in Table 3-2:

	Area of Detailed Modelling	Rest of the Fully Modelled Area	External Area
Highway Network Coverage	All except some very minor residential roads	All except local minor roads	Key national SRN roads outside the area of focus
Node Coding	Signalised junction coding (accurate layout, signal timings); template priority and roundabout coding with local calibration refinement where required	Node capacity restraint and prohibited turns only included if strategically necessary	Buffer network; no node capacity restraint or turns prohibited
Link Speed-Flow Curves (Volume Delay Functions (VDFs))	Yes	Yes	No, fixed speeds

Table 3-2: Highway Network Density and Capacity Principles

The Fully Modelled Area includes all except very minor local and residential roads and enables any roads significantly affected by planned major schemes in forecasts to be modelled. The level of detail matches the size of the zones to allow realistic routing and loading onto the network. The extent of the highway network for the Fully Modelled Area is shown in Figure 3.4 below and the highway network of the External Model Area is shown in Figure 3.5 on the next page.

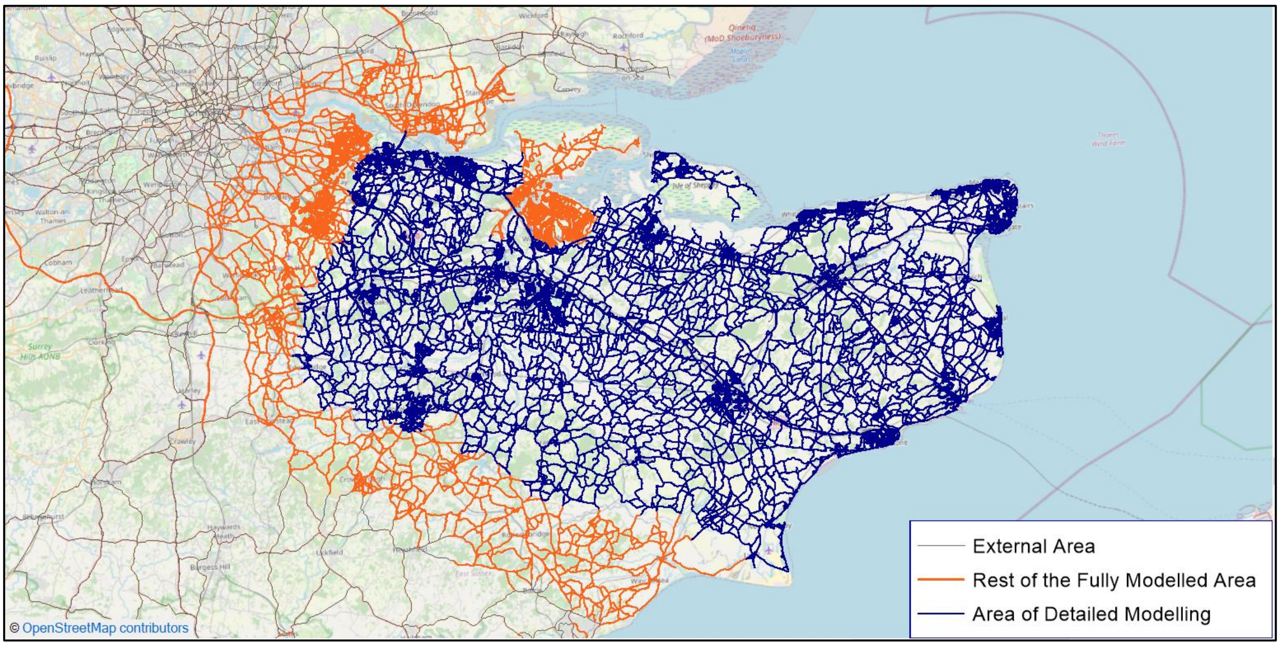

Figure 3-4: Fully Modelled Area Highway Network

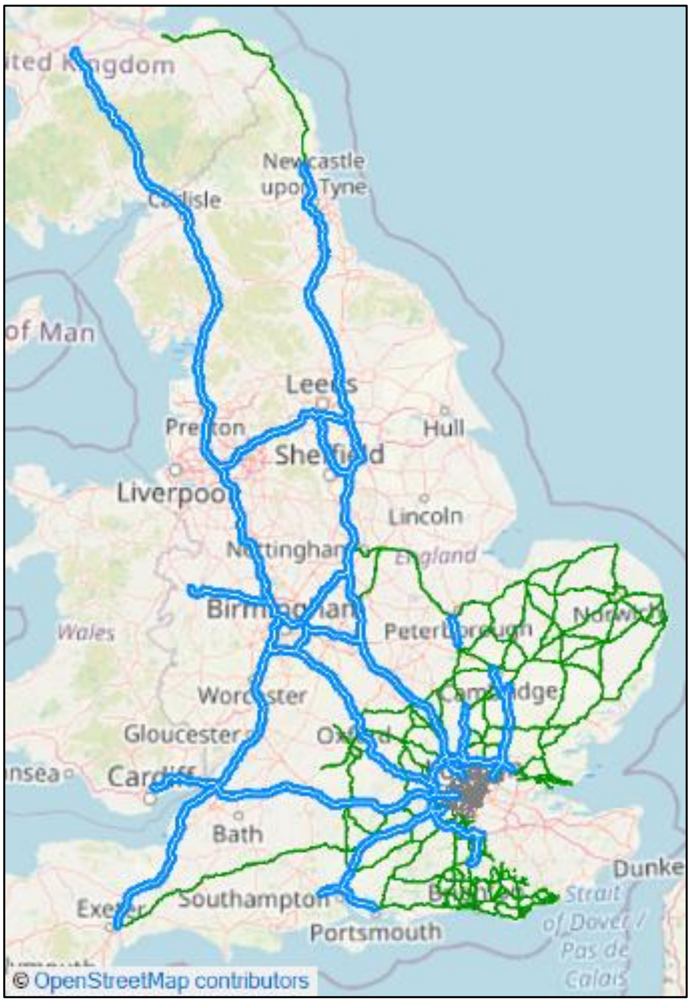

Figure 3-5: External Highway Network

3.4 Highway Assignment User Classes

The Kent Highway assignment VISUM model uses the following user classes:

- Car Commute;
- Car Employer's Business;
- Car Other;
- Light Goods Vehicles (LGVs); and
- Heavy Goods Vehicles (HGVs).

Within the model, all user classes have a Passenger Car Unit (PCU) factor of 1 with the exception of HGVs, for which an average PCU factor of 2.5 is applied. This is to reflect the greater size of HGVs in comparison with cars, with the assumption being that each HGV is equivalent to two and a half cars within the assignment.

Table 3-3 presents the correspondence between the journey purposes and the highway assignment user classes:

Highway Assignment User Class	Journey Purpose
Car Commute	Home-Based Work – HBW
Car Employer's Business	Home-Based Employer's Business – HBEB
	Non-Home-Based Employer's Business – NHBEB
Car Other	Home-Based Other – HBO
	Home-Based Shopping – HBShop
	Home-Based Education – HBEdu
	Non-Home-Based Other – NHBO
LGV	-
HGV	-

Table 3-3: Journey Purpose/ Assignment User Class Correspondence

3.5 Trip Matrix Development

Synthesised travel demand matrices were produced for private car and public transport trips using a bespoke gravity model. Following the guidance set out in TAG, this obtains a trip matrix consistent with National Trip End Model (NTEM) trip ends (from TEMPro v7.2) and observed trip length distributions (TLD) from the National Travel Survey (NTS) and Census-Journey-to-Work data. Initial travel costs for the gravity model were based solely on trip distance and then refined using full generalised costs from the assignment models in an iterative process. Mobile Network Data (MND) was collected over a 3-month period (March to June 2019). The synthesised demand matrices mentioned above supplement the Mobile Network Data (MND) to create final travel demand matrices.

3.6 Further Model Detail

Further detail about the development of the KTM can be found in the *Kent Countywide Model – Base Model Development and Validation Report*.

4. Tonbridge and Malling and Sevenoaks Local Transport Model

4.1 Overview

The KTM has been updated for the development of the Tonbridge and Malling, and Sevenoaks Local Transport Model. As in standard practice, should a model be required for a specific study within the detailed model area (such as a Local Plan review), then an additional review and updates will be needed to refine the validation in the local area. This enables additional focus on model quality in the specific area of interest.

Therefore, the Tonbridge and Malling and Sevenoaks Local Transport Model network has been developed based on the KTM using PTV VISUM 2020 software (the same software that was used to develop KTM) with necessary updates to check that the local network replicates base conditions. The base year 2019 has been retained due to Covid-19 impacts discussed in Section 2 and to be consistent with the observed 2019 Teletrac data. The highway assignment model represents a 'neutral' weekday in the following modelled time peak periods:

- AM peak hour (08:00 – 09:00); and
- PM peak hour (17:00 – 18:00)

These modelled hours were derived from the analysis of traffic counts throughout the study area to ascertain which hours contained the highest overall volume of traffic and the hours where the traffic volume was observed to be the highest at the majority of survey locations. More details regarding the data collection and analysis can be found in Section 5 of this report.

Figure 4.1 shows the detailed model area which includes Tonbridge and Malling Borough, Sevenoaks District and the key junctions outside their boundaries. The detailed model area is also where the VISUM Intersection Capacity Assessment (ICA) has been implemented to capture delays generated at urban junctions. For areas outside the detailed model area, junctions were not modelled in detail, but delays were captured through network links. Adjustments to the KTM network, zoning and zone connectors were also applied to simplify the external network that did not impact the study area directly (e.g., in Thanet, Dover, rest of London, Surrey, East Sussex etc).

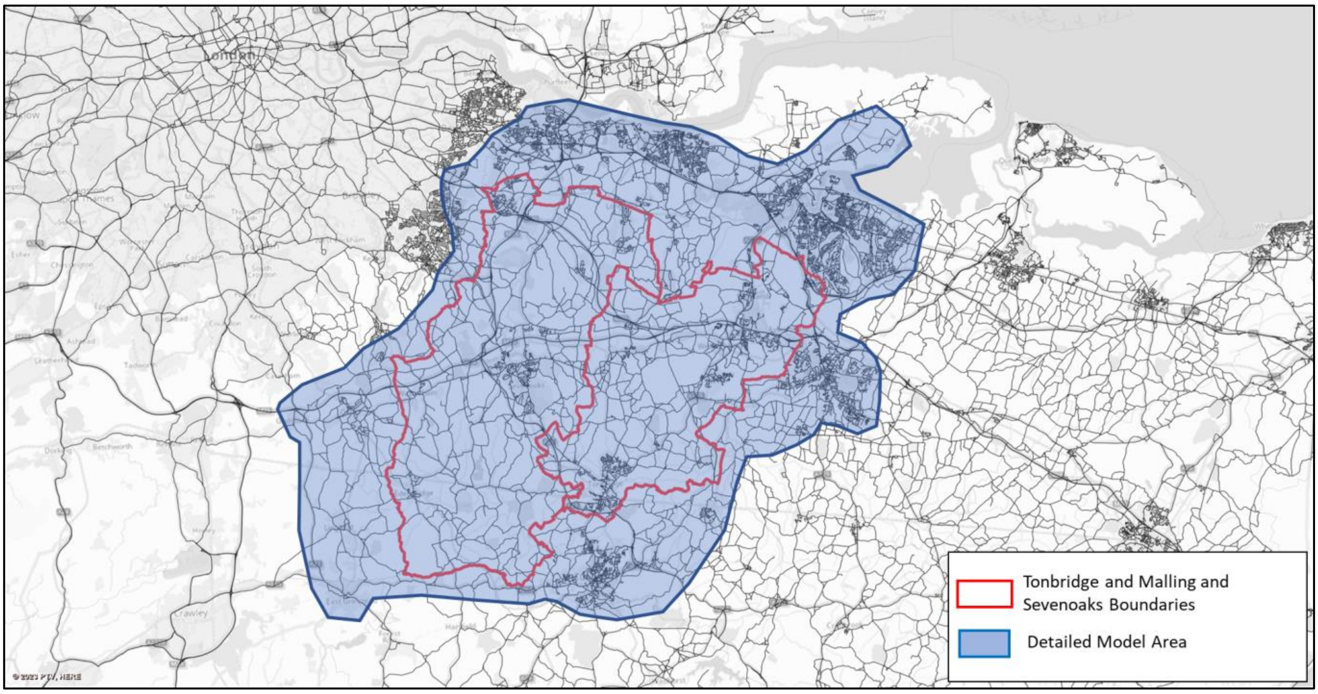

Figure 4-1: T&M and Sevenoaks Detailed Model Area

4.2 Zoning Structure

The zoning structure of the Kent Countywide Model was sufficiently detailed (as per the objectives and design of that model). Hence, the zone structure of the Tonbridge and Malling and Sevenoaks Local Transport Model remains consistent with the Kent Countywide Model in the detailed model area and key neighbouring authorities. No further base model zone disaggregation was undertaken, however, for the future model development any developments with above 50 houses or >1000 m2 for the commercial area will be explicitly modelled as new zones. This will then allow us to assess the impacts of the developments in detail. The residential and commercial developments that fell below the threshold mentioned above will be included in the existing zones.

Both detailed model area and zoning system have been agreed upon with National Highways.

4.3 Local Model Updates and Checks

The Tonbridge and Malling and Sevenoaks Local Transport Model has been checked and updated to replicate local base traffic conditions. The model validation has been recorded in a manner consistent with TAG in order to provide a robust understanding of the model quality as a basis for undertaking future scenario assessments.

4.3.1 Network Refinements

Network updates included local refinements in road infrastructure, verification of link and junction attributes, capacities, link free flow speeds, junction types and priorities. Network coding was checked initially, and throughout model calibration and validation against recent satellite imagery (Google Street View). Checks of link lengths, road classifications, and routing information (e.g., no turn, mandatory turn, no entry, access prohibited to specified vehicle types, access limited to specified vehicle types, and height restrictions) were undertaken and refined to be as accurate as possible. At the junctions located in the detailed modelled area, VISUM ICA was adopted to better capture the delays generated at junctions.

The location of the junctions with the ICA method implemented for Tonbridge & Malling and Sevenoaks are shown in Figure 4-2.

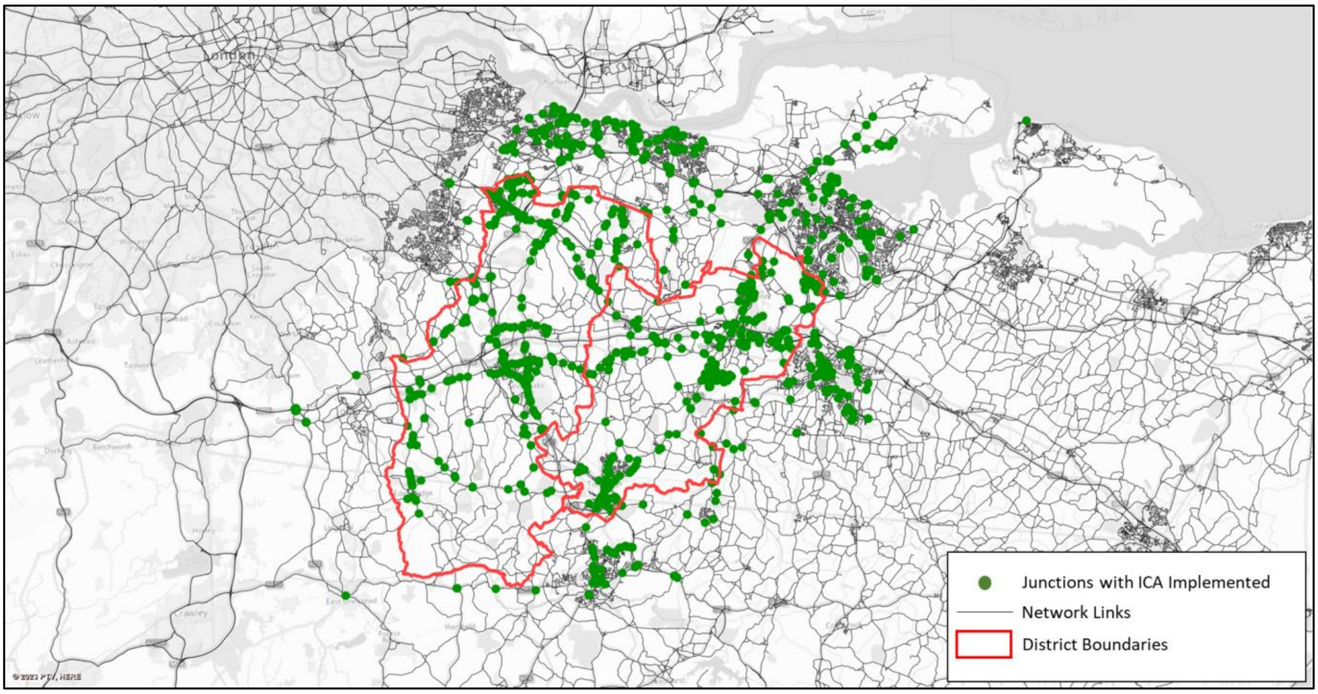

Figure 4-2: Junctions with VISUM ICA Method Implemented

4.3.2 Zone Connectors Review

Trips to and from zones are loaded onto the network from the zone centroid ('centre of gravity' of the zone) using specialised links known as centroid connectors. The points at which these connectors load on to the network was chosen to reflect actual access points and to avoid major junctions. The loading point for each connector was selected, based on professional judgement, as the most representative location for demand generated within the zone to enter and exit the network. For the detailed model area, every effort has been made, where possible, to avoid connectors joining the network at junctions or directly onto main roads.

Network zone connectors have been reviewed and updated in the detailed model area where certain zones needed more than one connector to reflect the actual access points and to avoid erroneous queuing at nearby junctions, due to the ICA implementation at those nodes. In cases like this, connector shares were also coded in the model to estimate the use of each access point. In general, each model zone has one centroid connector, but there are some exceptions to this where appropriate.

4.3.3 Demand Segments

The segmentation of highway demand suggested by TAG Unit M2 is a minimum of Commute, Employer's Business, and "Other" trips. Therefore, in line with the KTM, the following user classes are used within the highway assignment:

- Car Commute;
- Car Employer's Business;
- Car Other;
- Light Goods Vehicles (LGVs); and
- Heavy Goods Vehicles (HGVs)

4.3.4 Demand Adjustment

The prior matrices from the Kent Countywide Model were updated (i.e., zones were aggregated to reflect the modification in the network outside the detailed model area) as part of the process discussed in Section 4.1 and were used as a starting point. Matrix estimation (ME) was then undertaken using the traffic count data from the Kent database and new traffic counts collected for this study. More information on the traffic data can be found in Section 5 of this report.

4.3.5 Assignment Method

Intersection Capacity Analysis (ICA) with Equilibrium Assignment, in conjunction with TAG recommended convergence criteria, has been used in the PTV VISUM software as an assignment method for the Tonbridge and Malling and Sevenoaks Local Transport Model. This means that, when generalised costs are calculated for the purposes of route choice, junction delays are calculated using Intersection Capacity Analysis (ICA) and are included within the generalised cost. The "Assignment with ICA" method also means that flow metering and blocking back is calculated. The Equilibrium assignment was used as a subordinate assignment procedure with the advantage that there is stable route distribution, and the calculation of the blocking back model is considerably faster than using the paths of other assignment methods.

4.3.6 Values of Time and Vehicles Operating Costs

The values of the pence per minute (ppm) as Value of Time (VoT) and pence per kilometre (ppk) as Vehicle Operating Costs (VOC) parameters used for the Tonbridge and Malling and Sevenoaks Local Transport Model highway assignment are based on the latest TAG Unit A1.3 guidance and Data Book available at the time of model development (November 2022 v1.20.1). Following TAG, the HGV Value of Time (VoT) values are doubled, consistent with the KTM.

Vehicle operating costs were derived using the tables provided in the National Highways calculation spreadsheet. Average speeds were extracted from an earlier interim version of the highway assignment model for use in this calculation. The average speeds used are shown in Table 4-1.

Time Period	Modelled Average Speed in Kent (kph)
AM	49.5
PM	48.4

Table 4-1 – Average Speeds by Time Period used in Vehicle Operating Cost Calculations

The final calculated values for highway VoT and VOC for the Tonbridge and Malling and Sevenoaks Local Transport Model are provided in Table 4-2.

The final input for implementation in VISUM is also shown in the table; the formats required being a coefficient for pence per metre (ppmetre) for VOC as a weighted ratio of the VoT pence per second (pps).

Time Period	User Class	2019 Base Year TAG Databook Value		2019 Base Year VISUM Units		2019 Base Year Final VISUM Coefficients	
		VoT (ppm)	VOC (ppk)	VoT (pps)	VOC (ppmetre)	VOT	VOC
AM	UC1 Car Commute	21.12	5.85	0.3520	0.0059	1	0.0059
	UC2 Car Business	31.50	12.16	0.5249	0.0122	1	0.0122
	UC3 Car Other	14.57	5.85	0.2429	0.0059	1	0.0059
	LGV	22.83	13.33	0.3804	0.0133	1	0.0133
	HGV (doubled VoT)	45.46	40.03	0.7577	0.0400	1	0.0400
PM	UC1 Car Commute	21.19	5.91	0.3532	0.0060	1	0.0059
	UC2 Car Business	31.95	12.25	0.5325	0.0123	1	0.0121
	UC3 Car Other	15.26	5.91	0.2543	0.0060	1	0.0055
	LGV	22.83	13.39	0.3804	0.0134	1	0.0134
	HGV (doubled VoT)	45.46	41.65	0.7577	0.0403	1	0.0404

Table 4-2: 2019 Highway Generalised Cost Parameters

5. Summary of Data Collection

5.1 Existing Traffic Data

5.1.1 Tonbridge and Malling

The Kent Transport Model database contains information on available traffic counts in the county. These are categorised by survey type, year and location. The available traffic counts in Tonbridge and Malling presented in Figure 5-1 from the last five years were selected for this study. Overall, there are 181 existing counts in the area and of which, 172 are ATCs (link counts) and 9 are fully classified turning counts (junction counts). As shown on map, the majority of the existing counts are located around Tonbridge Town Centre, while the rest are widely distributed in the northern and western part of the borough.

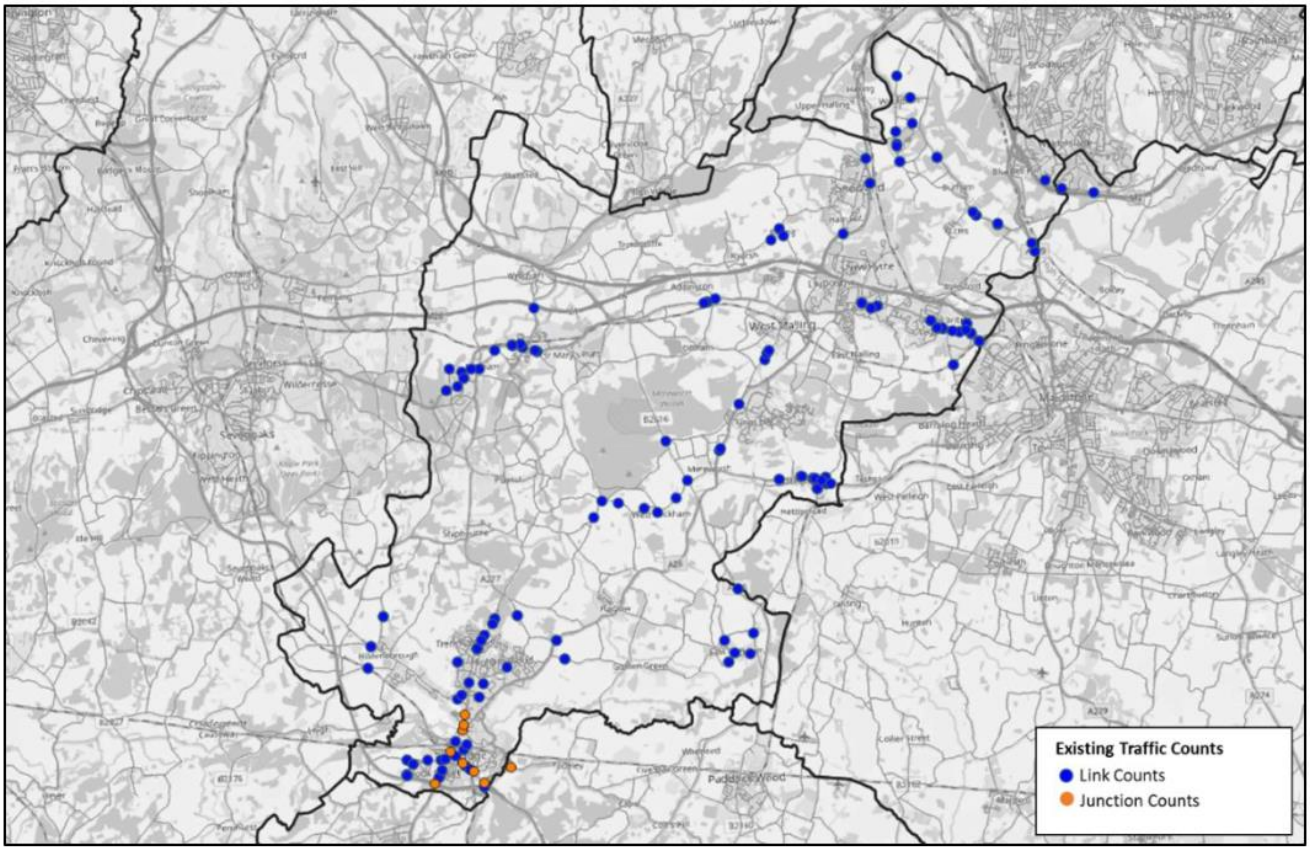

Figure 5-1: Existing Traffic Counts in Tonbridge and Malling

5.1.2 Sevenoaks

Similar to the above, the Kent Transport Model database also contains available traffic counts in Sevenoaks. There are 135 existing traffic counts in Sevenoaks from the last five years which are widely distributed across the district. Figure 5-2 shows the 135 existing ATCs in this area.

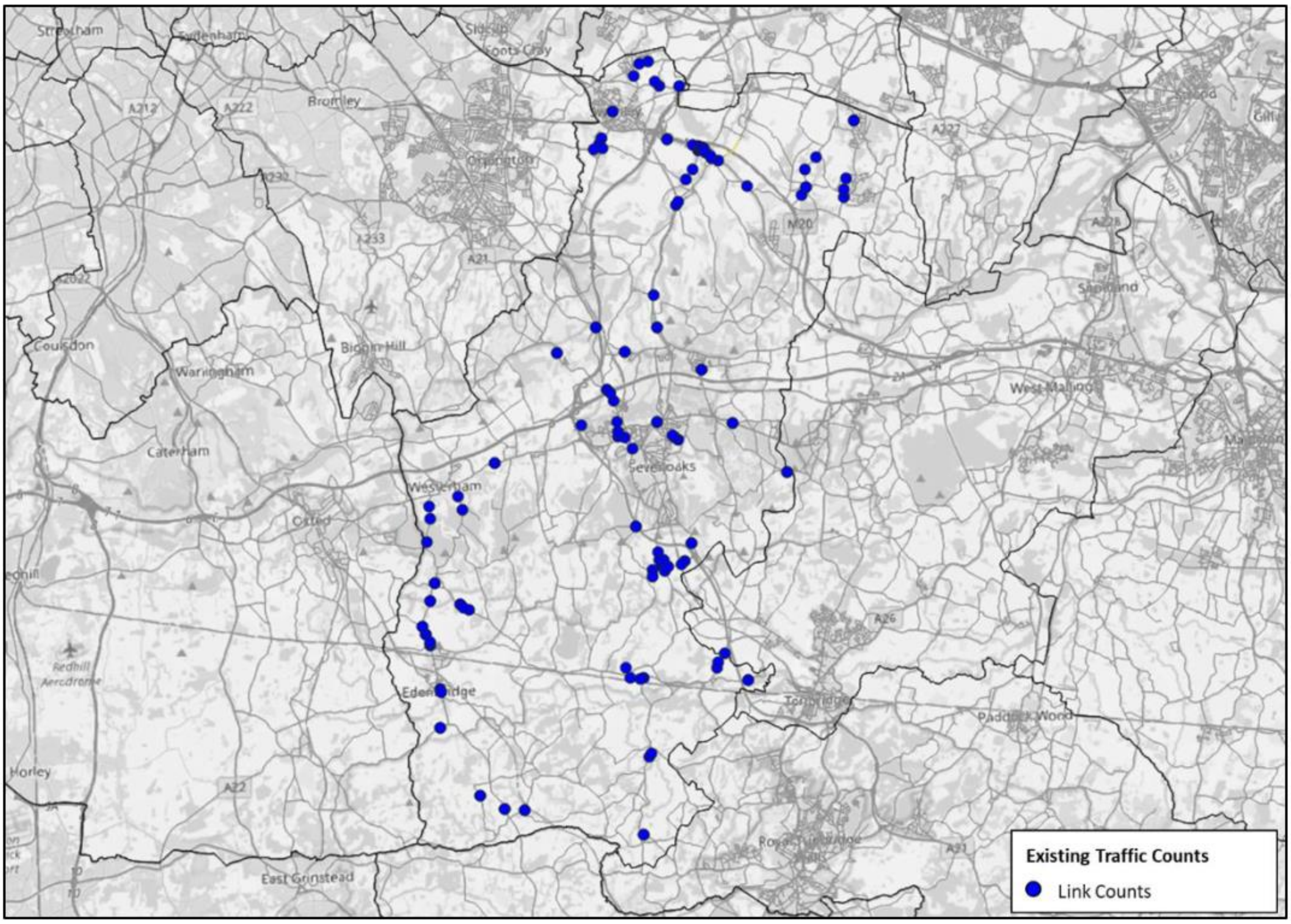

Figure 5-2 Existing Traffic Counts in Sevenoaks

5.2 Supplementary Data Collection

Based on the existing data available and the location of committed developments, a number of additional count locations were recommended during the Stage 1 work for supplementary data collection to enhance development of the base model for Tonbridge and Malling and Sevenoaks and the assessment of its future developments and schemes. Data collection was undertaken at 52 link count locations and 40 junctions count locations in October and November 2022.

For link counts, Automatic Traffic Counters (ATCs) were collected for two weeks and were fully classified by vehicle type, in 60-minute intervals.

For junction counts, fully classified Junction Turning Counts (JTCs) were collected on a neutral day (Tuesday, Wednesday, or Thursday) within the ATC 2-week data collection period. The data were collected between the hours of 07:00-19:00 (12-hour period) and was fully classified by vehicle type and split into 15-minute intervals.

5.2.1 Tonbridge and Malling

A total of 47 additional traffic counts (26 ATCs and 21 JTCs) were undertaken for Tonbridge and Malling. The locations and details of the ATCs are presented in Figure 5-3 and Table 5-1 while the JTCs are presented in Figure 5-4 and Table 5-2.

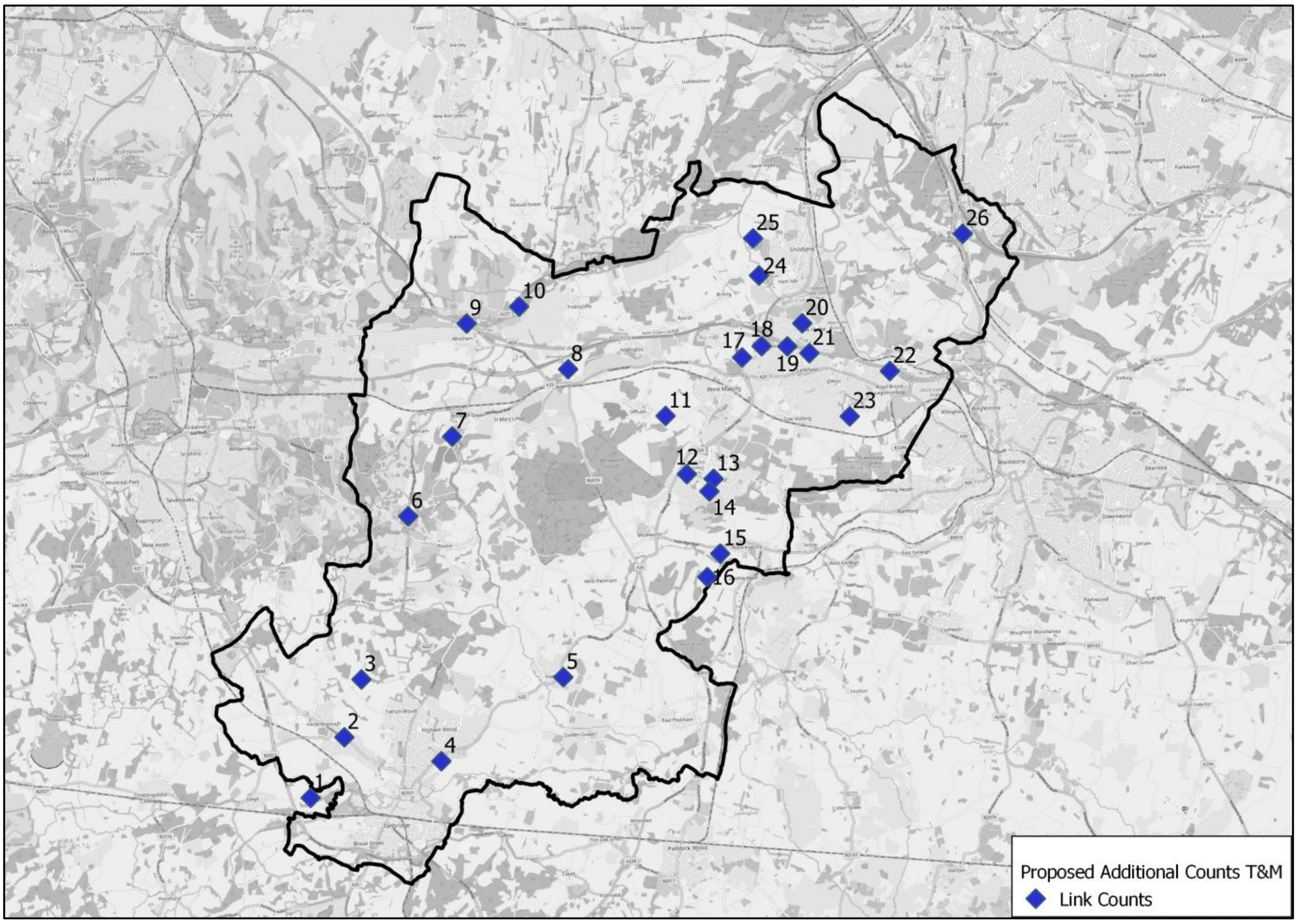

Figure 5-3: Additional ATCs locations in Tonbridge and Malling

ID	Location
ATC1	Powder Mill Lane between Manor Farm and Leigh Road
ATC2	B245 Tonbridge Road between Leigh Road and Brookmead
ATC3	Coldharbour Lane near Horns Lodge Lane
ATC4	A26 Hadlow Road between The Ridgeway and Higham Lane
ATC5	A26 Maidstone Road between Court Lane and Great Elms
ATC6	A227 Tonbridge Road between High Cross Road and Bewley Lane
ATC7	Thong Lane between Basted Lane and Dark Hill Road
ATC8	Ford Lane between Sandy Lane and Wrotham Water Road
ATC9	A20 London Road between A227 and Old Coach Road
ATC10	Gravesend Road between Fairseat Lane and Vigo Hill
ATC11	Teston Road between Church Road and Fartherwell Road
ATC12	Gibson Drive between A228 and Kings Hill Avenue
ATC13	Tower View between Hazen Road and Alexander Grove
ATC14	Discovery Drive between Elstar Place and Alexander Grove
ATC15	Old Road between Lloyd’s Labour and Pizien Well Road
ATC16	Nettlestead Lane between Lloyd’s Labour and Pizien Well Road
ATC17	A228 Ashton Way between A20 London Road and Park Road
ATC18	Castle Road between Oxley Shaw Lane and Park Road

ID	Location
ATC19	Lunsford Lane between Willow Road and Gighill Road
ATC20	Leybourne Way between Gighill Road and Tesco Lunsford Park
ATC21	New Hythe Lane between Kingfisher Road and Sheldon Way
ATC22	Hall Road between The Avenue and Station Road
ATC23	Kiln Barn Road near Ditton Quary Nature Reserve
ATC24	Snodland Road betweenLegge Lane and Sandy Lane
ATC25	Paddlesworth Road near Kent Downs AONB Boarder
ATC26	Maidstone Road between Barling Close and Laurie Gray Avenue

Table 5-1: Additional ATCs locations Tonbridge and Malling

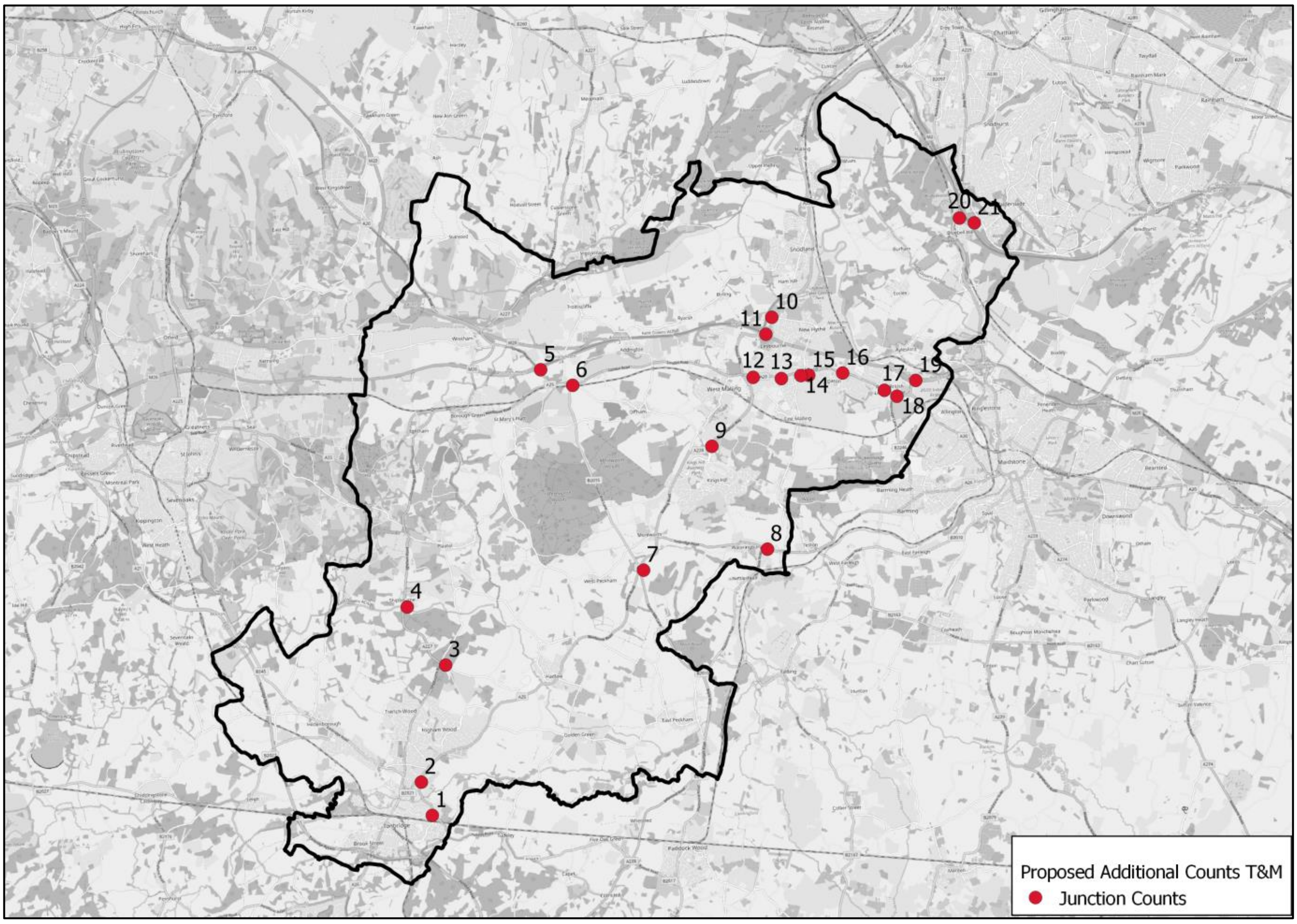

Figure 5-4: Additional JTC locations in Tonbridge and Malling

ID	Location
JTC1	A26 Woodgate Way / A26 Vale Road / Vale Road
JTC2	A26 Cannon Lane / A26 Hadlow Road / Hadlow Road
JTC3	A227 Shipbourne Road / Puttenden Road / Higham Lane
JTC4	A227 Ightham Road / Back Lane
JTC5	M26 J2A
JTC6	A20 London Road / Seven Mile Lane
JTC7	A26 Maidstone Road / Seven Mile Lane
JTC8	A26 Tonbridge Road / Red Hill / Bow Road
JTC9	A228 Ashton Way / Tower View
JTC10	A228 Castle Way / Leybourne Way
JTC11	M20 J4
JTC12	A20 London Road /Ashton Way / Castle Way / Oxley Shaw Lane
JTC13	A20 London Road / Lunsford Lane
JTC14	A20 London Road / New Road
JTC15	A20 London Road / New Hythe Lane
JTC16	A20 London Road / Station Road / New Road
JTC17	A20 London Road / Hall Road / Mills Road
JTC18	A20 London Road / Hermitage Lane
JTC19	M20 J5
JTC20	Lords Lees Roundabout
JTC21	Taddington Roundabout

Table 5-2: Additional MCCs locations in Tonbridge and Malling

5.2.2 Sevenoaks

For Sevenoaks, a total of 46 traffic counts (27 ATCs and 19 JTCs) were undertaken. The locations and details of the ATCs are presented in Figure 5-5 and Table 5-3 while the JTCs are presented Figure 5-6 and Table 5-4.

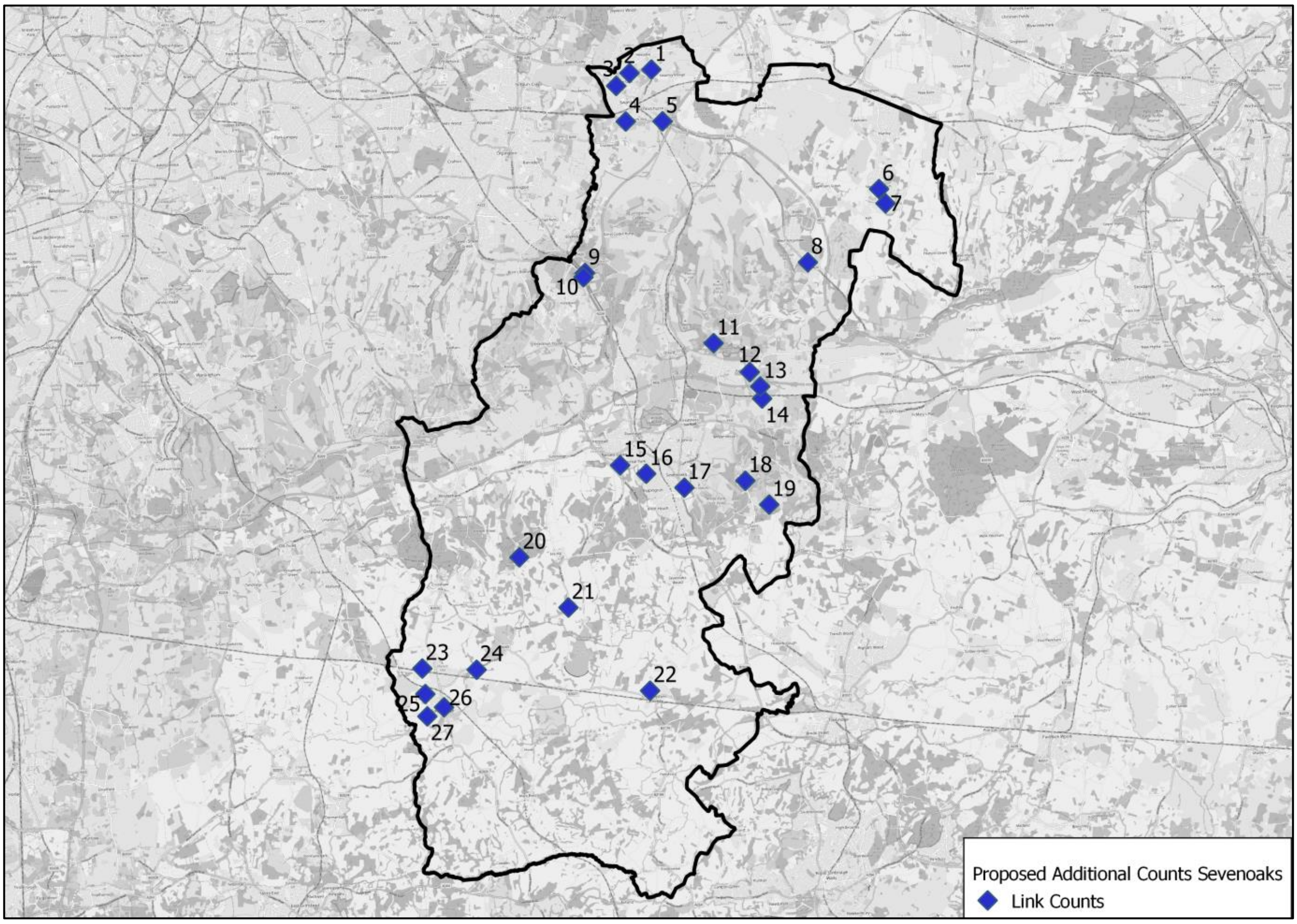

Figure 5-5: Additional ATCs Locations in Sevenoaks

ID	Location
ATC1	B258 Main Road between Squires Field and Egerton Avenue
ATC2	New Barn Road near College Road
ATC3	B2173 London Road between Brook Road and Walnut Way
ATC4	B258 Goldset Road between Pinks Hill and Green Court Road
ATC5	B2173 London Road between Wested lane and Searles Court
ATC6	Ash Road between West Yoke Road and Colt Stead
ATC7	Redhill Road between Westfield and Ash Road
ATC8	A20 London Road between Fawkham Road and Hever Avenue
ATC9	Orpington Bypass Road between Badgers Road and M25
ATC10	Old London Road between Watercroft Road and Shoreham Lane
ATC11	Rowdow Lane between Birchin Cross Road and Pilgrims Way East
ATC12	High Street between Church Lane and St Edith's Road
ATC13	M26 near Bushy Wood and Cockney's Wood
ATC14	Honey Pot Lane near Cockney's Wood
ATC15	Cold Arbor Road between Bessels Green Road and Back Lane
ATC16	Brittains Lane between Croft Way and Downsview Road
ATC17	A225 High Street between Rectory Lane and Six Bells Lane
ATC18	Park Lane near Sevenoaks Preparatory School

ID	Location
ATC19	Bitchet Green Road between Carter's Hill and The Coppice
ATC20	Toy's Hill Road between Scords Lane and Emmetts Lane
ATC21	Ide Hill Road near Chiddingstone
ATC22	Camp Hill between B2027 and Compassess Road
ATC23	Hilder's Lane between Ashcombe Drive and Troy Lane
ATC24	Four Elms Road between Swan Lane and Prettymans Lane
ATC25	Crouch House Road between Greshams Way and Orchard Drive
ATC26	B2026 between Lingfield Road and Stangrove Road
ATC27	Lingfield Road between Skeynes Road and Dwelly Lane

Table 5-3: Additional ATCs Locations in Sevenoaks

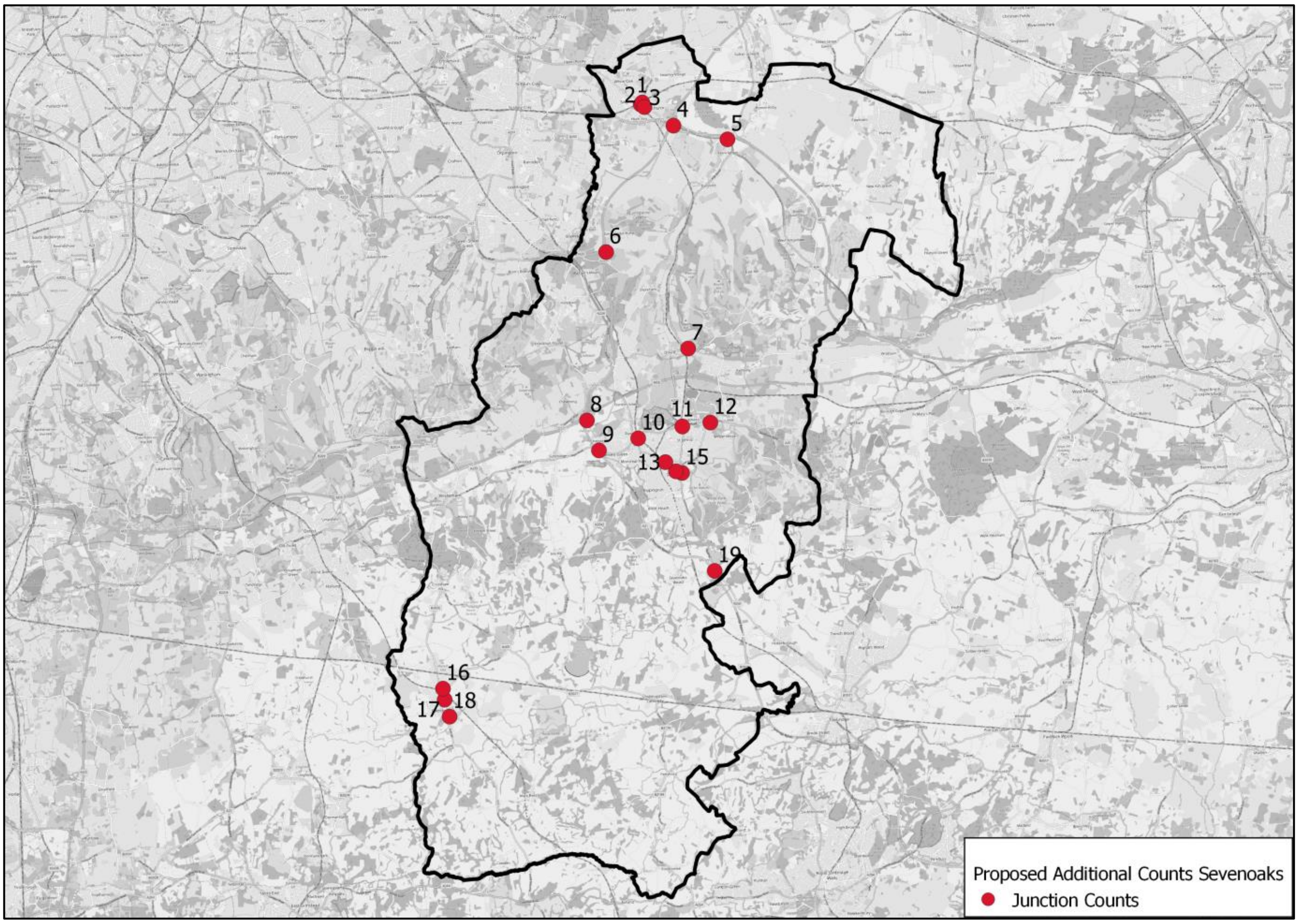

Figure 5-6: Additional JTCs Locations in Sevenoaks

ID	Location
JTC1	Bartholomew Way / Swanley Lane
JTC2	Nightingale Way / Swanley Lane / High Street
JTC3	High Street / Goldsel Road
JTC4	M25 J3
JTC5	A20 Main Road / A225 Dartford Road
JTC6	M24 J4
JTC7	A225 Station Road / Pilgrims Way East
JTC8	M25 J5
JTC9	A21 / A25
JTC10	A25 Maidstone Road / A224 London Road
JTC11	A25 Seal Road / A25 Bradbourne Vale Road / A225 Otford Road / A225 St John's Hill
JTC12	A25 Seal Road / Seal Hollow Road
JTC13	A224 London Road / B2020 St Botolph's Road / Granville Road
JTC14	A224 London Road / Pembroke Road / Argyle Road
JTC15	High Street / Pembroke Road / Suffolk Way
JTC16	B2026 Station Road / B2027 Four Elms Road
JTC17	B2026 / Station Road
JTC18	Mont St Aignan Way / B2026 High Street
JTC19	A21 / Morleys Road / A225 / B245

Table 5-4: Additional MCCs locations Sevenoaks

5.3 Data Processing

The existing and new traffic count data were analysed to calculate the average weekday peak hour traffic for the AM and PM. As discussed in the previous section, the base model year 2019 has been retained due to Covid-19 impacts and to match the 2019 Teletrac data. For the traffic counts undertaken before or after 2019, the following factors derived from TEMPro were used to match the base year.

Collection Year to Base Year	Average Growth factor (TEMPRO)	
	AM	PM
2015 to 2019	1.0399	1.0390
2016 to 2019	1.0395	1.0385
2017 to 2019	1.0260	1.0253
2018 to 2019	1.0128	1.0125
2021 to 2019	0.9747	0.9754
2022 to 2019	0.9679	0.9682

Table 5-5: Factors Applied to the Traffic Count Data

An analysis was then undertaken to confirm the peak hour for each traffic count site for both AM and PM. Figure 5-7 and Figure 5-8 present the summary of the analysis. As shown in the figures, the majority of the traffic counts show the peak hour of 08:00 to 09:00 in the AM and 17:00 to 18:00 in the PM.

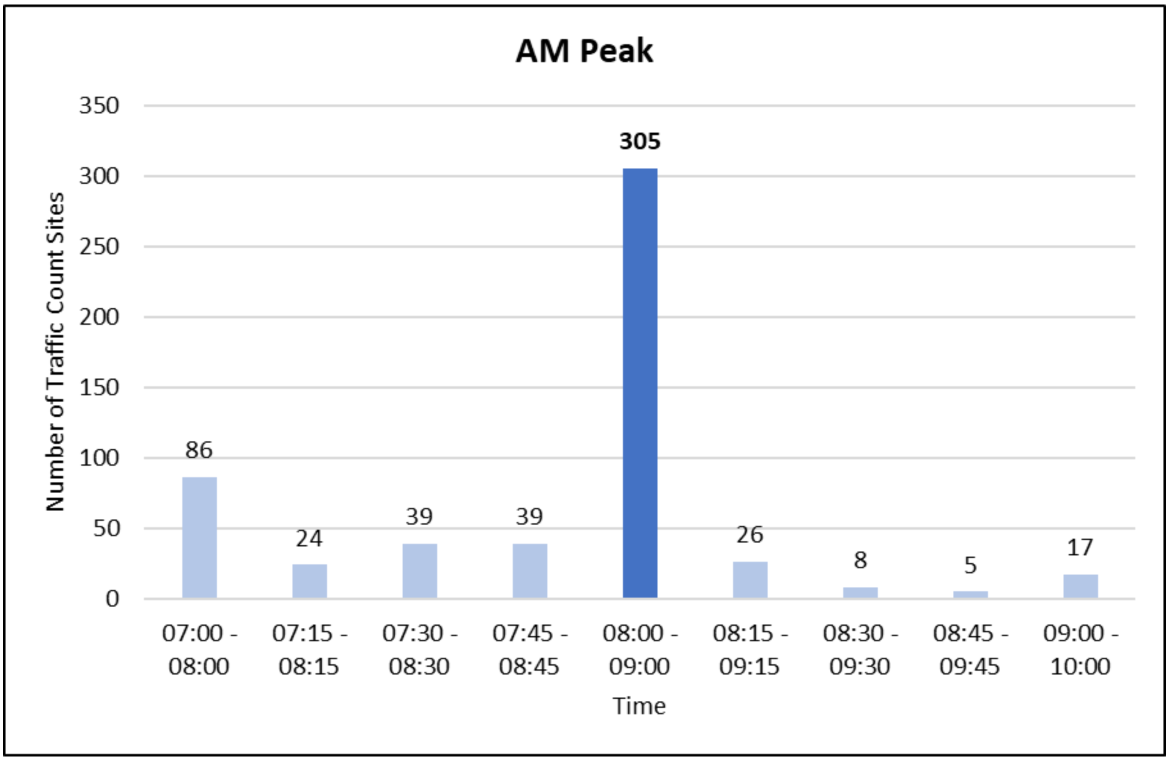

Figure 5-7: AM Peak Hour

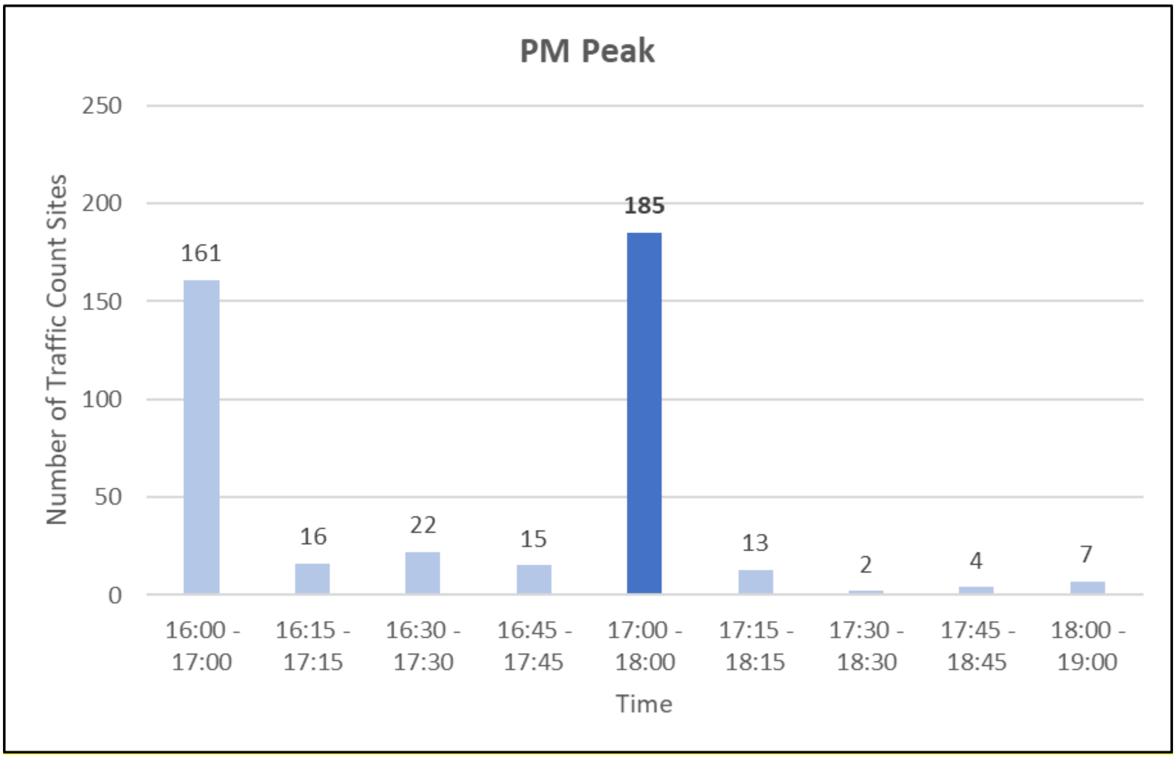

Figure 5-8: PM Peak Hour

5.4 Journey Times

In line with TAG Unit M3-1 Section 4.4.2, journey time data for the Tonbridge and Malling and Sevenoaks Local Transport Model was primarily sourced from DfT Teletrac (previously Trafficmaster) data. This dataset is made available to local authorities and is based on data gathered using satellite navigation devices installed in vehicles. It specifies travel times for links in the Integrated Transport Network (ITN). Travel times along set routes have been collated by aggregating the times for each of the ITN links along the route. The journey time data used in this study reflects Average Weekday Traffic (AWT) using Monday to Thursday data for neutral months in 2019.

A total of 28 journey time routes presented in Figure 5-9 were included in the base model development for Tonbridge and Malling and Sevenoaks.

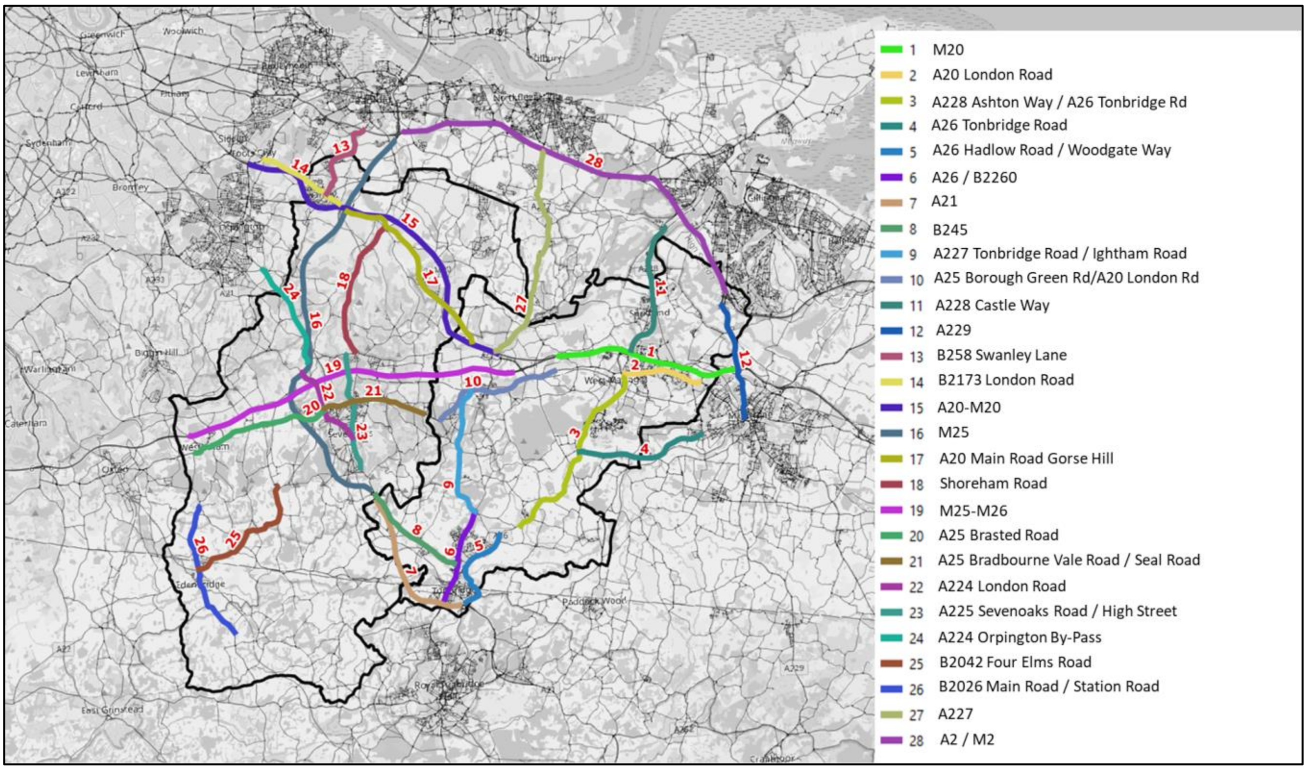

Figure 5-9: Journey Time Routes – Tonbridge and Malling and Sevenoaks

6. Calibration and Validation Data

The total number of final observed traffic count survey locations, after all the data cleaning and processing discussed in Section 5, consisted of around 375 unique surveys in the detailed model area. These were allocated to modelled links (many of which are two-way) to give 753 instances of volumetric data within the Tonbridge and Malling and Sevenoaks Local Transport Model that were available for use in model calibration and validation.

6.1.1 Screenlines

From this dataset, a total of 10 two-directional screenlines (20 in total) were designed for use in the calibration and validation of the Tonbridge and Malling and Sevenoaks Local Transport Model. The screenlines used in the model calibration and validation together with the number of counts included in each screenline are listed in Table 6-1.

Number	Name	Direction	No. Counts	Calibration / Validation
1	Swanley Town	IN	7	Calibration
2	Swanley Town	OUT	7	Calibration
3	New Ash Green – Badger's Mount	NB	10	Validation
4	New Ash Green – Badger's Mount	SB	10	Validation
5	Sevenoaks Town	IN	19	Calibration
6	Sevenoaks Town	OUT	19	Calibration
7	Westerham – Fordcombe	NEB	9	Validation
8	Westerham – Fordcombe	SWB	9	Validation
9	Edenbridge Town	IN	7	Calibration
10	Edenbridge Town	OUT	7	Calibration
11	Chatham – Snodland	NB	8	Validation
12	Chatham – Snodland	SB	9	Validation
13	Maidstone – West Malling	EB	9	Calibration
14	Maidstone – West Malling	WB	9	Calibration
15	Kings Hill – East Peckham	NB	9	Validation
16	Kings Hill – East Peckham	SB	9	Validation
17	Borough Green - Wrotham Heath	EB	8	Validation
18	Borough Green - Wrotham Heath	WB	8	Validation
19	Tonbridge Town	IN	17	Calibration
20	Tonbridge Town	OUT	16	Calibration

Table 6-1 – Screenlines in the Tonbridge and Malling and Sevenoaks Local Transport Model

In total there are 10 calibration screenlines and 10 validation screenlines. These are presented in Figure 6-1 together with the link count locations which are intersected by the screenlines.

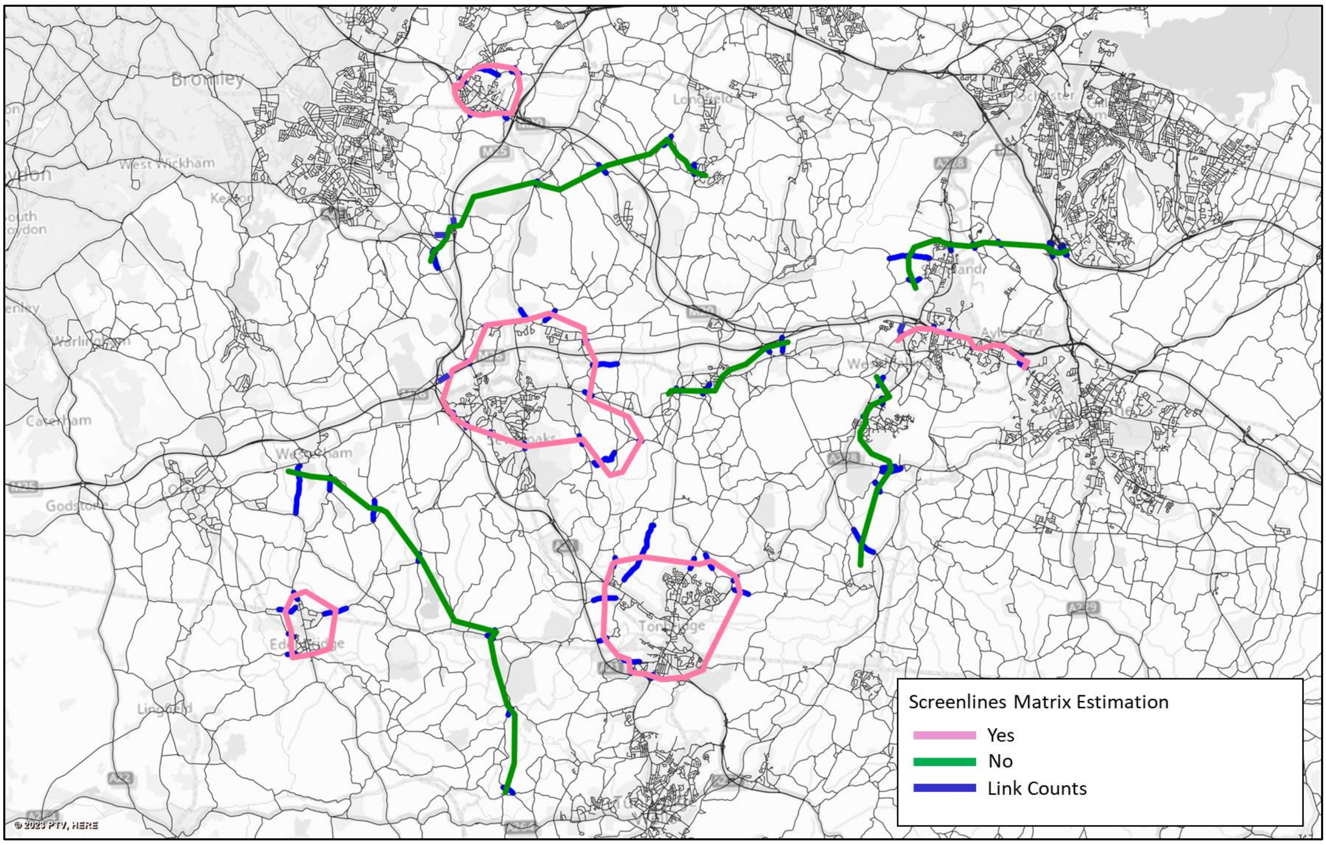

Figure 6-1 – Calibration and Validation Screenlines in the Tonbridge and Malling and Sevenoaks Local Transport Model

6.1.2 Link Counts

In addition to the above screenlines, a large number of remaining ATC locations (433 sites) were available for use as independent individual count validation sites (Figure 6-2). Quality and consistency checks were applied to this data throughout calibration and validation of the model and so the exact size of this independent validation dataset was subject to change, i.e., when individual counts were found to be inconsistent with counts at nearby locations during model calibration further checks were undertaken and then they were sometimes excluded from the dataset.

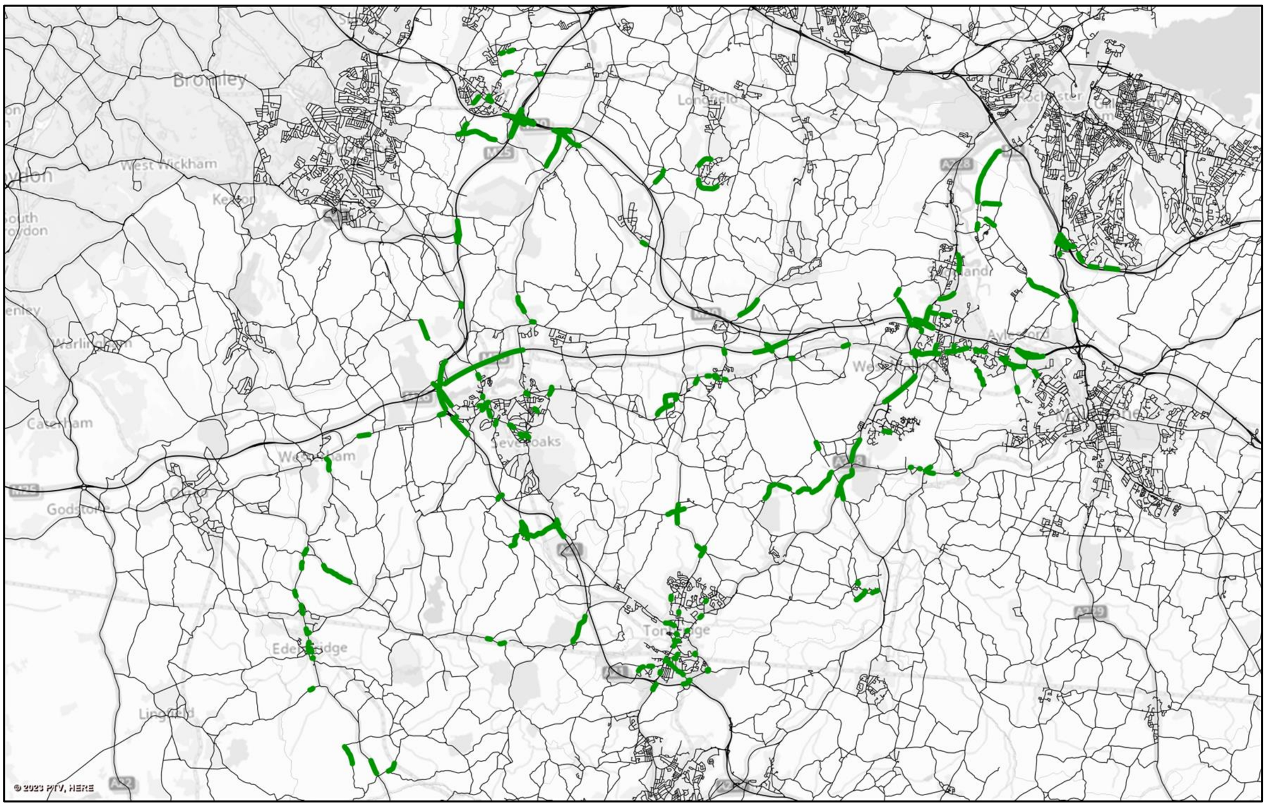

Figure 6-2 – Independent Validation Links

A number of independent calibration links (134 sites) were also included to predominantly help monitor the volume of strategic traffic, travelling through the entirety of the study area; these are presented in Figure 6-3.

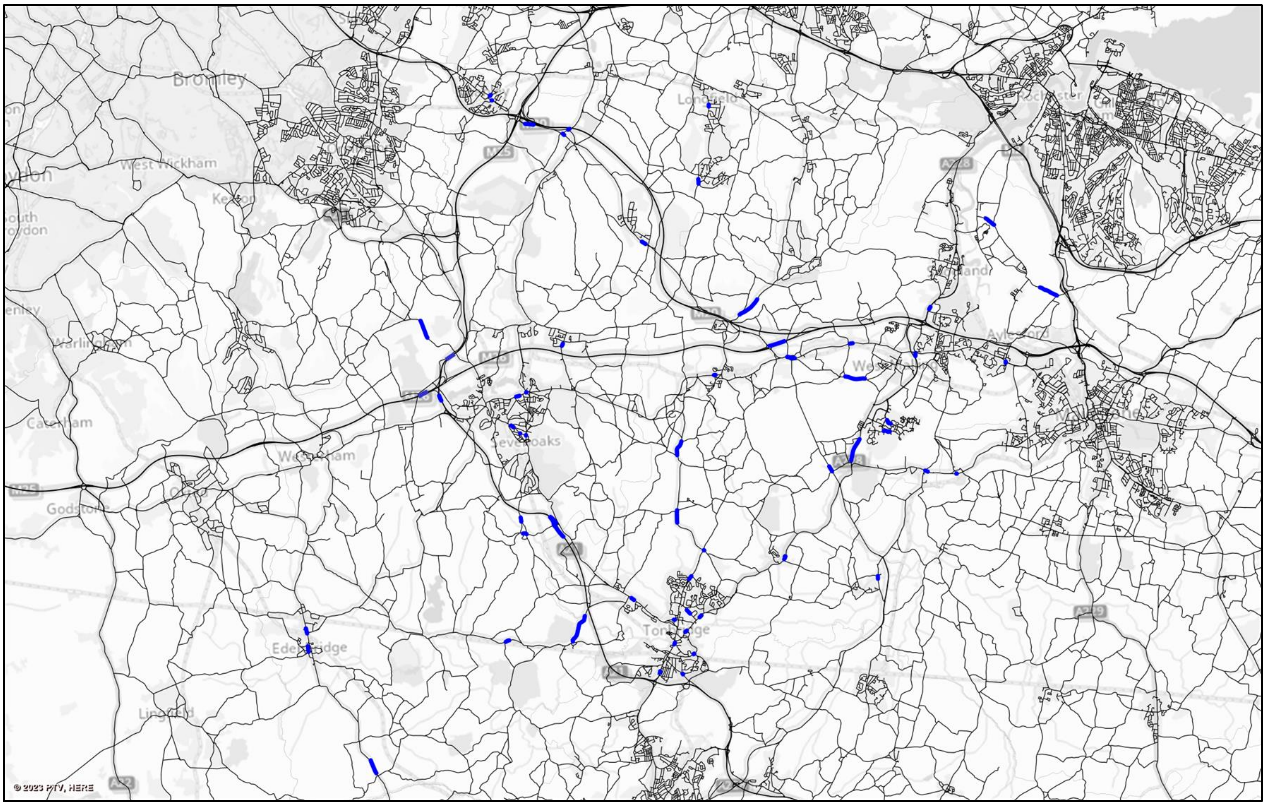

Figure 6-3 – Independent Calibration Links

The complete set of 753 link counts is shown in Figure 6-4.

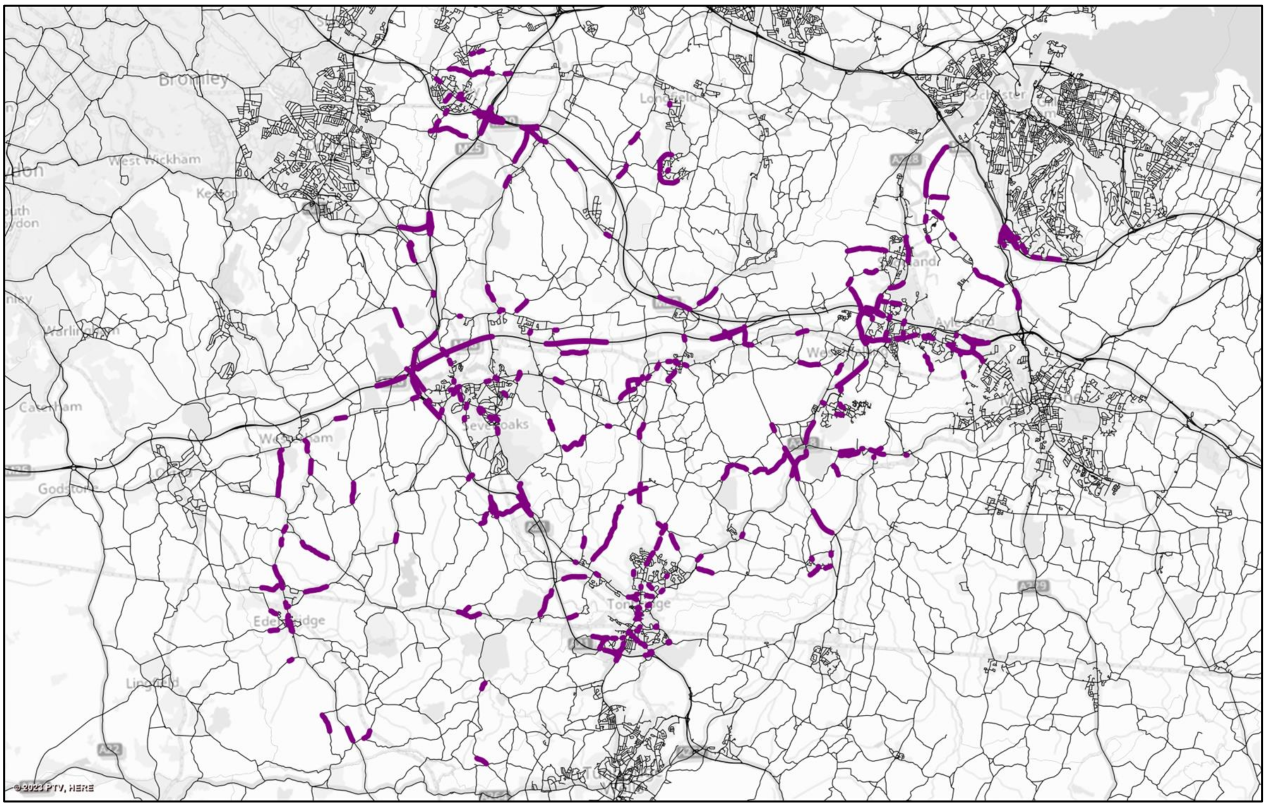

Figure 6-4 – Locations of All Link Counts

6.2 Journey Time Data for Highway Assignment Model Validation

As discussed in Section 5.4, Teletrac data for the year 2019 was collated and processed to form the journey time routes for the Tonbridge and Malling and Sevenoaks Local Transport Model validation process. A total of 28 bi-directional routes (giving 56 journey time routes for validation in total) have been specified for the local transport model and shown in Figure 5-9 in the previous section. These validation routes have been designed to include a range of road types in the study area as evenly as possible.

7. Matrix Estimation

Matrix estimation has been used, in combination with traffic count data, to produce a final updated demand matrix from the prior matrix supplied by the Kent Transport Model.

7.1 Matrix Estimation Procedure

The prior matrices from the Kent Transport Model were used as a starting point. After initial assignment and subsequent refinement of the modelled network, the matrices underwent a process of "matrix estimation" whereby trip matrices are adjusted to bring assigned flows closer to observed traffic count data. The "TFlowFuzzy" module within VISUM was used for this process. The VISUM manual contains full details of the specifics of the TFlowFuzzy process, but a high-level representation of the process is shown in Figure 7-1 below:

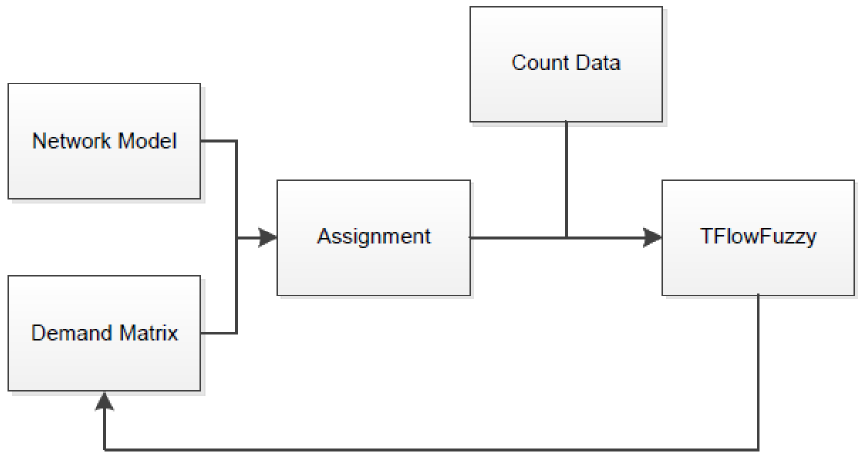

Figure 7-1: VISUM 'TFlowFuzzy' Matrix Estimation Process

Observed traffic count data at the screenline and link level discussed in the previous section were classified for Cars, LGVs and HGVs. The matrix estimation process was undertaken for those vehicle types and their matrices. TFlowFuzzy is able to apply matrix estimation over the three car matrices (Commute, Employer's Business and Other) to match the observed car traffic counts values.

A selection of screenlines, cordons and individual link counts discussed in the previous section, were selected for the purpose of matrix estimation. It is noted that at screenline and cordon level, constraints were applied by grouping individual link counts together. These were then incorporated into the matrix estimation instead of the individual link counts.

7.2 Measuring Changes Brought About by Matrix Estimation

7.2.1 Matrix Totals

TAG Unit M3.1 specifies that the changes brought about by matrix estimation should not be significant. Although not specified by TAG, the changes brought about by matrix estimation were first monitored at the overall matrix total level. Comparison of matrix totals between base matrices (Prior to ME) and revised matrices produced during the ME process (Post ME) by user class for each period are presented in Table 7-1:

Matrix	AM			PM		
	Prior	Post ME	Diff.	Prior	Post ME	Diff.
Car Commute	132,333	136,411	3.08%	116,870	118,816	1.67%
Car Business	40,958	42,159	2.93%	40,290	40,842	1.37%
Car Other	121,545	125,705	3.42%	198,181	201,015	1.43%
LGV	224,884	225,684	0.36%	189,068	189,199	0.07%
HGV	45,010	44,426	-1.30%	29,085	28,583	-1.73%

Table 7-1: Matrix Totals Comparison

7.2.2 Matrix Cell Values

Table 7-2 summarises the total (i.e Car+LGV+HGV) matrix cell regression statistics comparing the prior and post ME matrices for all trips. Matrix cell regression by user class is also presented in Appendix A.

R^2 value is a measure that provides information about the goodness of fit of a model. It is a statistical measure used to monitor the changes brought about by the matrix estimation. **Red** shows where the R^2 is less than 0.92 or where the slope is greater than 1.05 or less than 0.95, **amber** shows where the R^2 is between 0.92 and 0.95 or where the slope is within 0.95 and 0.98 or 1.02 and 1.05, and **green** shows where the R^2 is greater than 0.95 or where the slope is within 0.98 and 1.02.

		AM	PM
Matrix Cell Regression Total Trips	Gradient	1.01	1.00
	Intercept	0.01	0.00
	R^2	0.95	0.96

Table 7-2: Matrix Cell Regression Analysis

The gradient and intercept values are close to one and zero. R^2 for all periods is 1.00 which is in line with TAG guidance. The data behind the summarised values in Table 7-2 are summarised in Figure 7-2 and Figure 7-3.

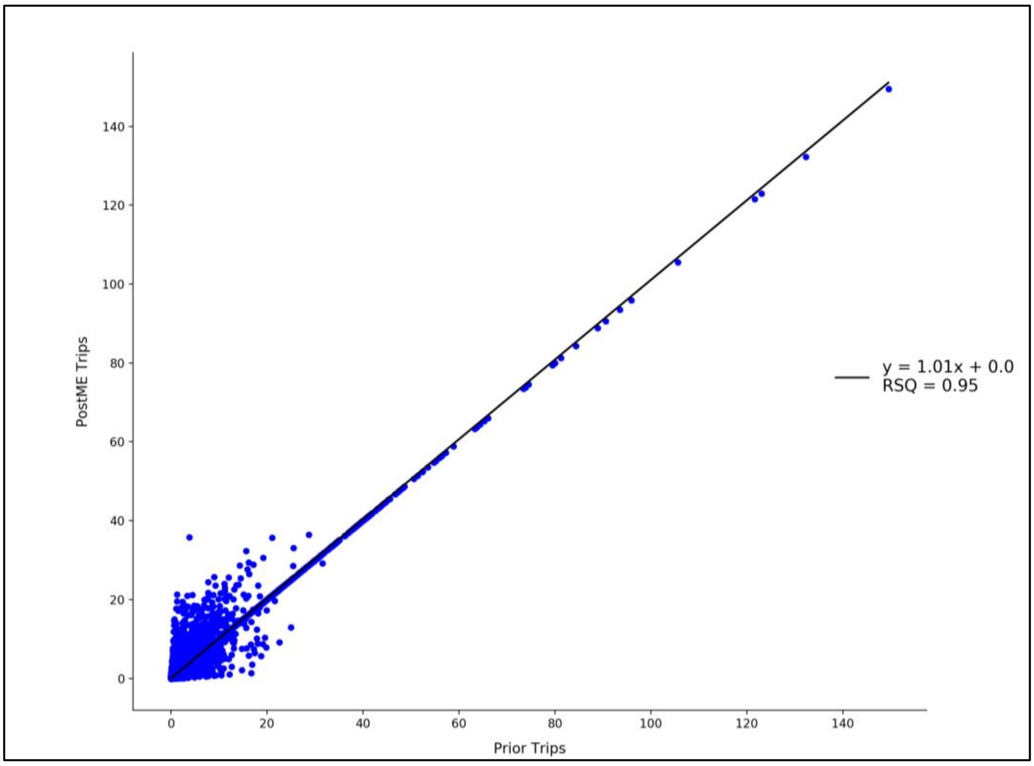

Figure 7-2: Matrix Cell Regression for Total Trips in AM Peak

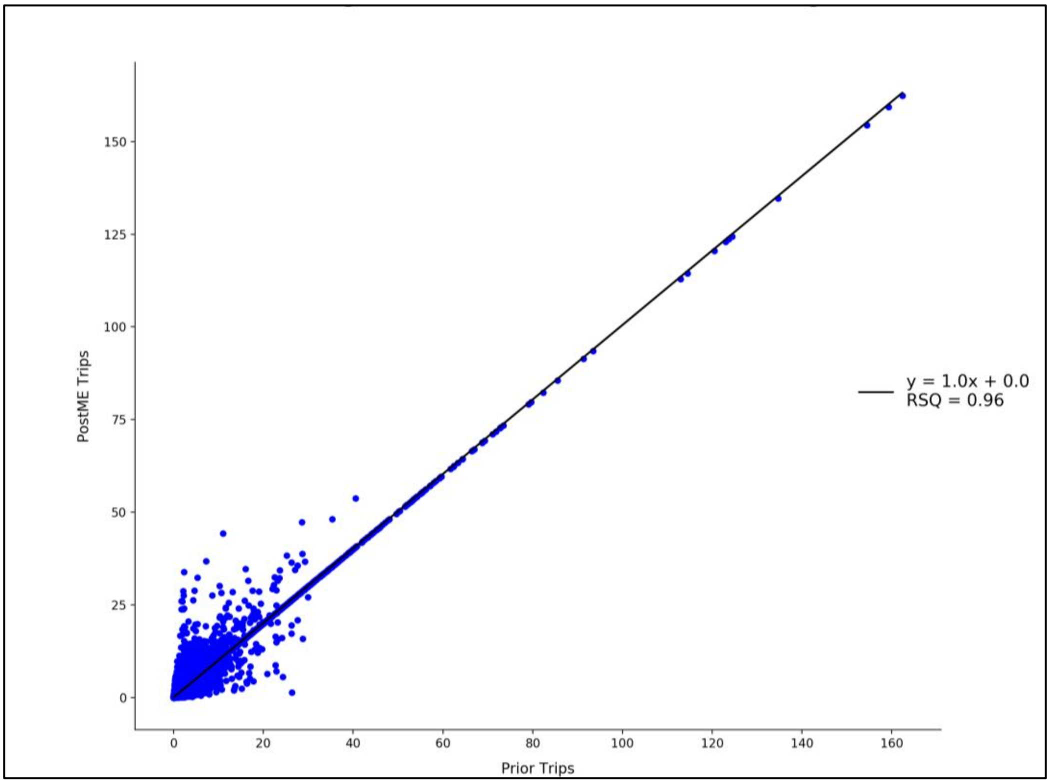

Figure 7-3: Matrix Cell Regression for Total Trips in PM Peak

7.2.3 Matrix Zonal Trip Ends

Table 7-3 summarises the total (i.e Car+LGV+HGV) matrix zonal trip ends statistics comparing the prior and post ME matrices for all trips. Matrix zonal trip ends by user class is also presented in Appendix A.

Red shows where the R2 is less than 0.95 or where the slope is less than 0.97 or greater than 1.03, **amber** shows where the R2 is between 0.95 and 0.98 or where the slope is between 0.97 and 0.99 or between 1.01 and 1.03, and **green** shows where the R2 is greater than 0.98 or where the slope is within 0.99 and 1.01.

		AM	PM
Matrix Zonal Trip Ends Origin	Gradient	1.04	1.00
	Intercept	1.53	2.65
	R^2	0.97	0.99
Matrix Zonal Trip Ends Destination	Gradient	1.01	1.01
	Intercept	5.63	1.31
	R^2	0.98	0.98

Table 7-3: Matrix Trip Ends Regression Analysis

The table above shows that the values shown are in line with the TAG guidance. The R^2 for all periods is 1.00 which is also in line with TAG guidance. The data behind the summarised values in Table 7-3 are summarised in Figure 7-4 to Figure 7-7.

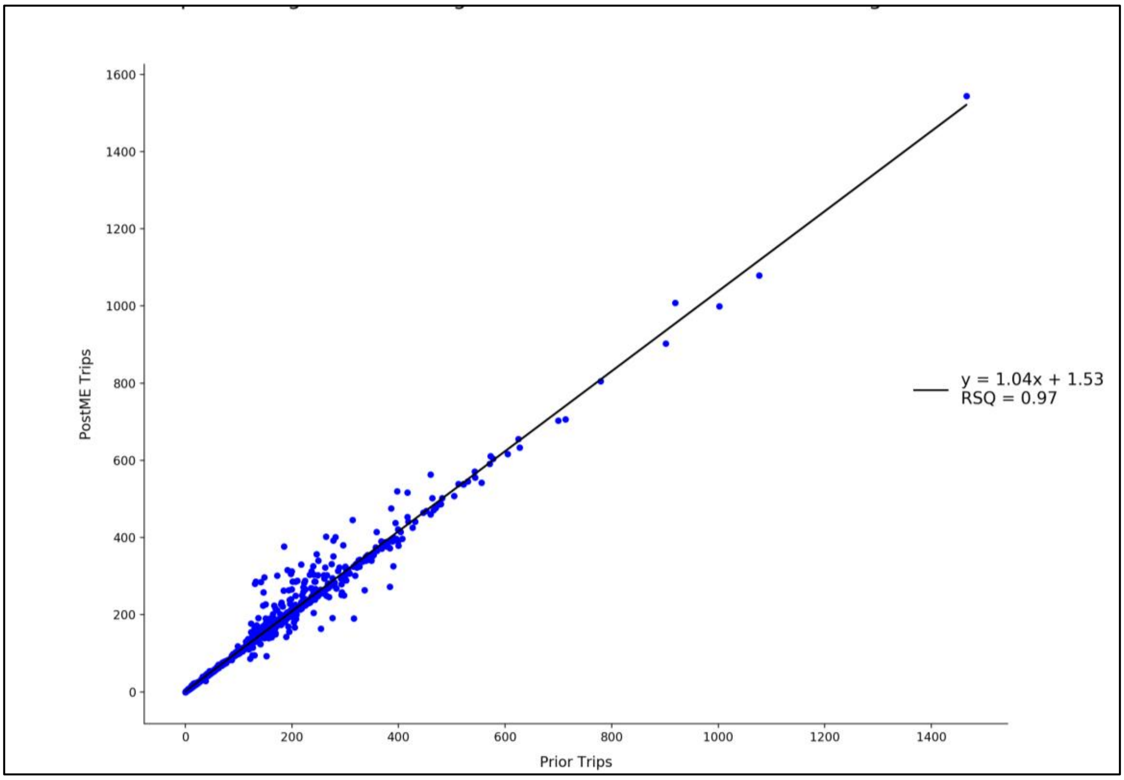

Figure 7-4: Trip Ends Regression for Total Origin Trips in AM Peak

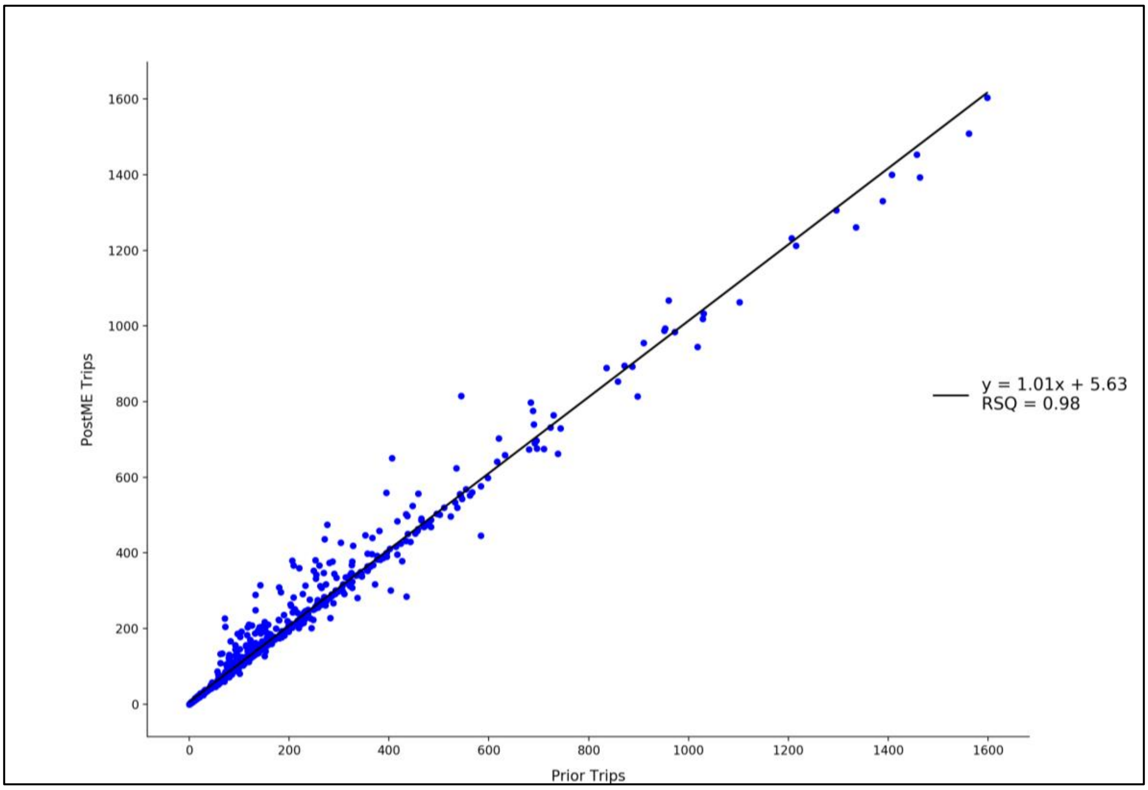

Figure 7-5: Trip Ends Regression for Total Destination Trips in AM Peak

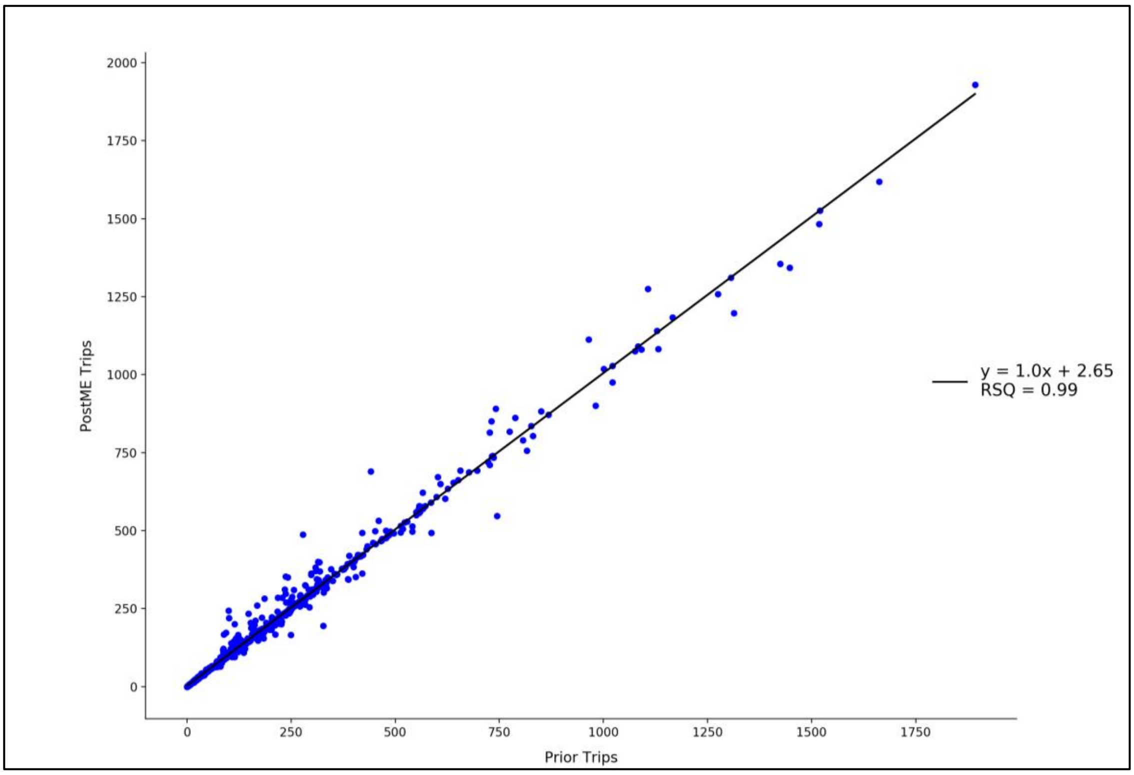

Figure 7-6: Trip Ends Regression for Total Origin Trips in PM Peak

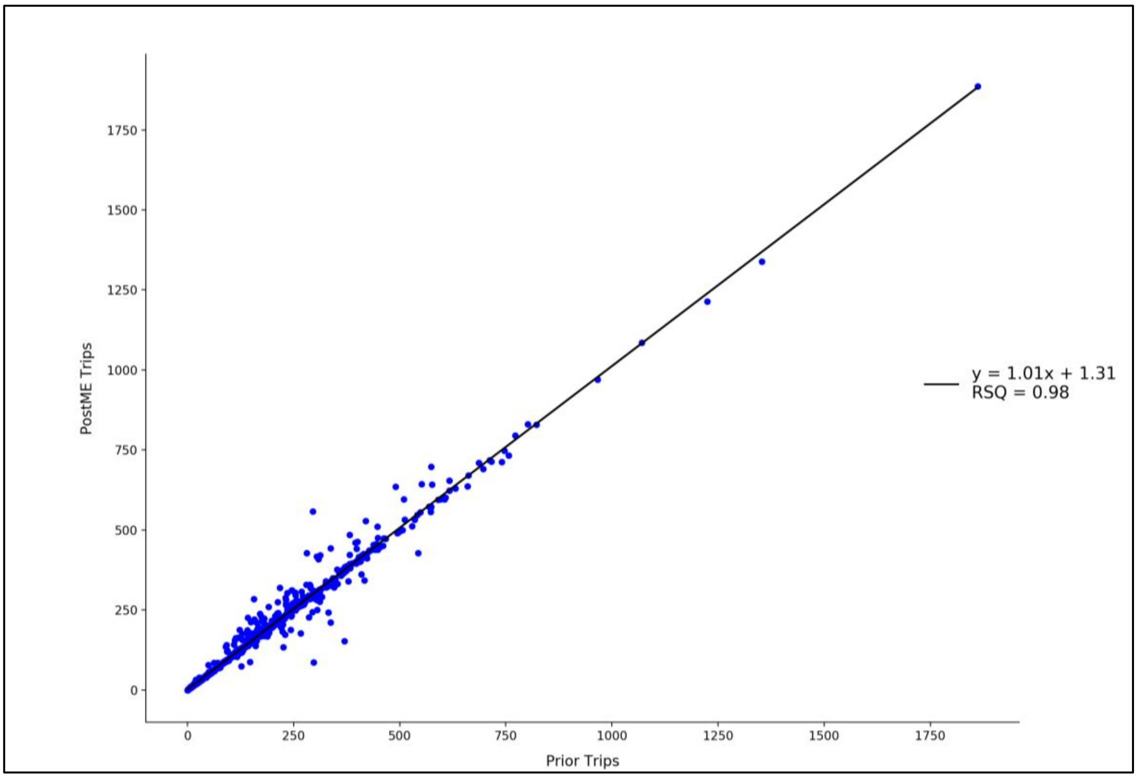

Figure 7-7: Trip Ends Regression for Total Destination Trips in PM Peak

7.3 Trip Length Distribution

Table 7-4 below provides the Trip Length Distribution (TLD) statistics comparing prior and post ME total matrices for each peak for all trips.

Red shows where the difference is greater than 10%, **amber** shows where the difference is between 5% and 10%, and **green** shows where the difference is less than 5%.

User Class	Metric		AM	PM
All Trips	Mean Travel Distance (km)	Prior	25.76	25.05
		PostME	25.54	25.02
		Difference	-0.9%	-0.1%
	Standard Deviation (km)	Prior	57.18	55.62
		PostME	56.59	55.48
		Difference	-1.0%	-0.3%

Table 7-4: Trip Length Distribution Analysis

As shown in the table above, the criteria are met in all time periods. The graphical outputs are shown in Figure 7-8 and Figure 7-9.

The output statistics per user class per time period can be found in Appendix B. The overall patterns of average trip lengths are in line with expectations, with car commute and other being the shortest, business being slightly longer, LGVs being longer, and HGVs the longest.

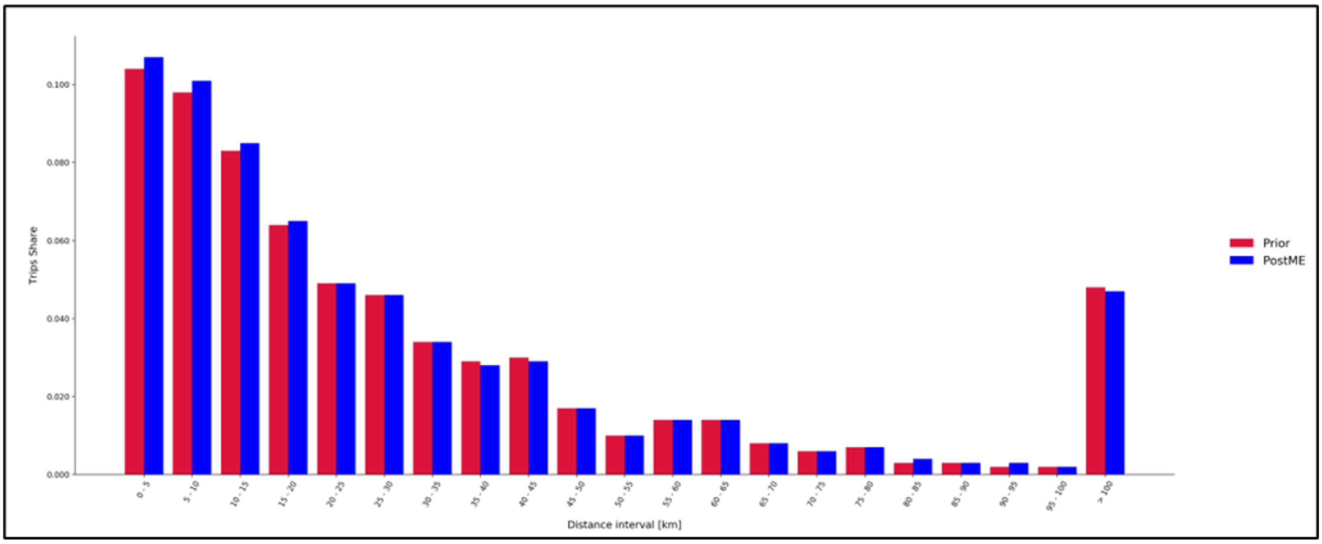

Figure 7-8: Trip Length Distribution Comparison, AM - All Modelled Trips

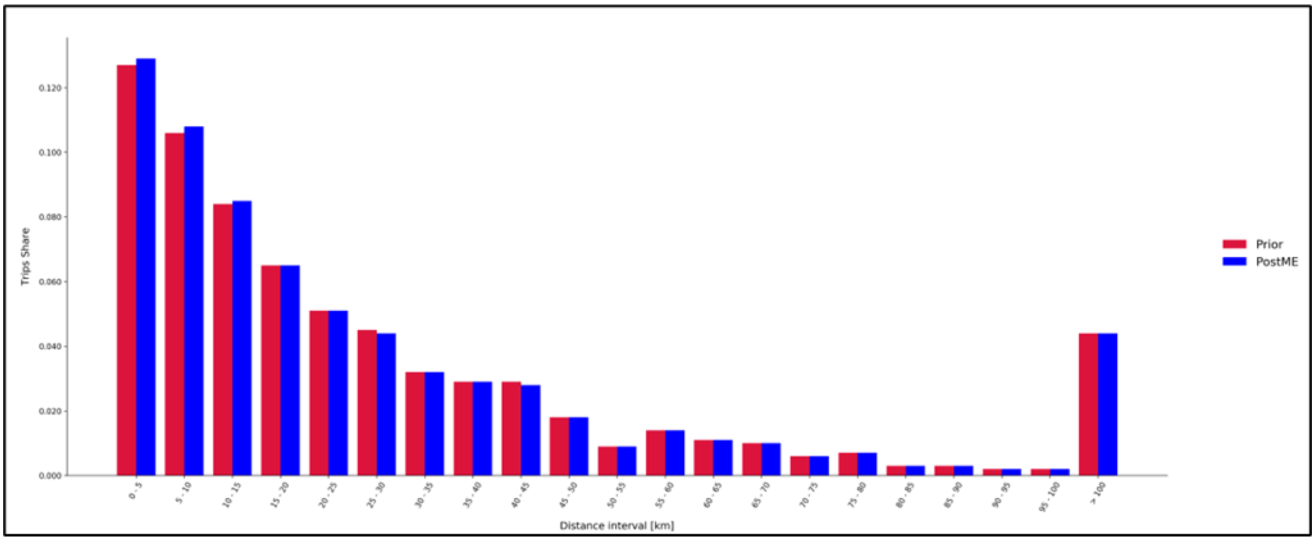

Figure 7-9: Trip Length Distribution Comparison, PM - All Modelled Trips

7.4 Sector Movements

Finally, TAG recommends a check on the matrix changes brought about by matrix estimation on a sector-to-sector basis. The TAG guidance on sector-to-sector comparisons of prior and post ME movements being within +/-5% is generally considered to be unrealistic, in particular, when prior matrices have been developed using Mobile Network Data (MND). It is however important to monitor the changes. Rather than comparing relative percentage differences between prior and post ME matrices, the GEH statistic was considered to be more informative. Table 7-5 provides a summary of the range of GEH statistics for all user classes for each time period for movements from, to, and within Tonbridge and Malling and Sevenoaks. The full sector-to-sector GEH matrices upon which this summary is derived can be found in Appendix C together with the actual difference.

Time Period	GEH	Sector-to-Sector Movements in GEH Range
AM	< 5	93.80%
	5 to 10	5.00%
	> 10	1.20%
PM	< 5	96.00%
	5 to 10	2.70%
	> 10	1.30%

Table 7-5: Matrix Estimation Changes – Sector to Sector Movements

This analysis shows that the majority of movements (at a sector level) from, to, and within Tonbridge and Malling and Sevenoaks are within GEH 5 through the matrix estimation process. Very few movements alter by greater than GEH 10. These adjustments are considered acceptable.

8. Model Suitability

Any adjustments to the model intended to reduce the differences between the modelled and observed data should be regarded as calibration. Validation then involves comparing modelled and observed data that is independent from that used in calibration process.

8.1 Overview

The modelling should adequately reflect the existing traffic situation to then be able to predict the future impact of traffic and network or development changes. The validation of the Tonbridge and Malling and Sevenoaks highway assignment has therefore been quantified in line with the guidance set out in TAG Unit M3.1 Paragraph 3.3.5:

- Assigned flows and counts totalled for each screenline or cordon, as a check on the quality of the trip matrices;
- Assigned flows and counts on individual links as a check on the quality of the assignment; and
- Modelled and observed journey times along routes, as a check on the quality of the network and the assignment.

TAG principles have been followed to enable reporting of the highway assignment model calibration and validation quality in a way consistent with that set out in TAG Unit M3.1.

8.2 Assignment Convergence

Equilibrium Assignment with ICA (Intersection Capacity Analysis) has been used for the assignment with "TAG-compliant" set as the convergence criteria within VISUM. The local model converges to a good standard using these criteria, with maximum GAP value of 0.001 and at least 98% of relative difference between previous and current iterations.

8.3 Quality Aspirations

The validation of the quality of the trip demand matrices has been undertaken by comparing the assigned flows against observed counts at calibration and validation screenlines and cordons. The criterion and aspirational quality standards for cordons and screenlines flows are defined in Table 8-1 below:

Criterion for Cordon/Screenline Flow Validation	Aspirational Quality Standards
Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines (i.e. 95%)

Table 8-1: TAG Cordon/Screenlines Flow Validation Quality Guidelines Used in Tonbridge and Malling and Sevenoaks Local Model

8.3.1 Calibration Screenlines

The locations of counts used for calibration (included in matrix estimation), and their grouping into screenlines were shown Figure 6-1 in the previous Section. The remaining counts not included in matrix estimation remained available for independent link validation (included in Figure 6-2)

Table 8-2 to Table 8-5 provide the modelled and observed screenline comparisons separately for cars and then for all vehicles for each time period for the calibrations screenlines. **Red** shows where difference is greater than 15%, **amber** between 5% and 15% and **green** where the difference is less than 5%.

At a screenline level, the tables below predict flows that closely match with the observed counts in all time periods at the calibration locations. Majority of the screenlines used for calibration is within the 5% threshold recommended by TAG, except for Swanley Town and Maidstone to West Malling. However, as presented in the tables, the GEH values for all screenlines are below 5 for both AM and PM. The comparison for individual links intersected for each screenlines also shows that majority of the counts met the GEH and flow criteria. Improvements in the calibration results have also been observed for all time periods when compared to previous results in the Kent Transport Model. Given the scope and purpose of the model, the results shown are deemed acceptable.

Calibration Screenlines	Direction	AM Peak - Cars				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
Swanley Town	IB	1,399	1,251	-148	-11%	4.1
Swanley Town	OB	1,500	1,372	-128	-9%	3.4
Sevenoaks Town	IN	5,677	5,722	45	1%	0.6
Sevenoaks Town	OB	5,089	5,103	14	0%	0.2
Edenbridge Town	IN	1,203	1,172	-31	-3%	0.9
Edenbridge Town	OB	1,304	1,284	-20	-2%	0.6
Maidstone – West Malling	EB	4,439	4,300	-139	-3%	2.1
Maidstone – West Malling	WB	5,432	5,130	-302	-6%	4.2
Tonbridge Town	IN	4,831	4,846	15	0%	0.2
Tonbridge Town	OB	4,152	4,055	-97	-2%	1.5

Table 8-2: Calibration Screenlines Modelled vs Observed Comparison – AM Peak Cars

Calibration Screenlines	Direction	AM Peak – All Vehicles				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
Swanley Town	IB	1,591	1,417	-174	-11%	4.5
Swanley Town	OB	1,710	1,575	-135	-8%	3.3
Sevenoaks Town	IN	7,252	7,249	-3	0%	0.0
Sevenoaks Town	OB	6,525	6,479	-46	-1%	0.6
Edenbridge Town	IN	1,471	1,420	-51	-3%	1.3
Edenbridge Town	OB	1,565	1,530	-35	-2%	0.9
Maidstone – West Malling	EB	5,444	5,275	-169	-3%	2.3
Maidstone – West Malling	WB	6,419	6,064	-355	-6%	4.5
Tonbridge Town	IN	5,492	5,515	23	0%	0.3
Tonbridge Town	OB	4,826	4,721	-105	-2%	1.5

Table 8-3: Calibration Screenlines Modelled vs Observed Comparison – AM Peak All Vehicles

Calibration Screenlines	Direction	PM Peak – Cars				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
Swanley Town	IB	1,569	1,402	-167	-11%	4.3
Swanley Town	OB	1,470	1,346	-124	-8%	3.3
Sevenoaks Town	IN	5,510	5,523	13	0%	0.2
Sevenoaks Town	OB	6,141	6,143	2	0%	0.0
Edenbridge Town	IN	1,273	1,247	-26	-2%	0.7
Edenbridge Town	OB	1,167	1,137	-30	-3%	0.9
Maidstone – West Malling	EB	5,439	5,448	9	0%	0.1
Maidstone – West Malling	WB	4,732	4,558	-174	-4%	2.6
Tonbridge Town	IN	3,693	3,752	59	2%	1.0
Tonbridge Town	OB	4,074	4,040	-34	-1%	0.5

Table 8-4: Calibration Screenlines Modelled vs Observed Comparison – PM Peak Cars

Calibration Screenlines	Direction	PM Peak – All Vehicles				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
Swanley Town	IB	1,777	1,599	-178	-10%	4.3
Swanley Town	OB	1,600	1,461	-139	-9%	3.6
Sevenoaks Town	IN	6,702	6,734	32	0%	0.4
Sevenoaks Town	OB	7,518	7,504	-14	0%	0.2
Edenbridge Town	IN	1,461	1,422	-39	-3%	1.0
Edenbridge Town	OB	1,337	1,300	-37	-3%	1.0
Maidstone – West Malling	EB	6,142	6,141	-1	0%	0.0
Maidstone – West Malling	WB	5,475	5,263	-212	-4%	2.9
Tonbridge Town	IN	4,162	4,218	56	1%	0.9
Tonbridge Town	OB	4,494	4,458	-36	-1%	0.5

Table 8-5: Calibration Screenlines Modelled vs Observed Comparison – PM Peak All Vehicles

8.3.2 Validation Screenlines

Validation relies on making similar comparisons to the ones made for calibration, but against independent screenlines i.e., those not used in the model building and calibration process (not used in matrix estimation). The validation screenline locations used for validation, were shown in Figure 6-1.

Table 8-6 to Table 8-9 provide the modelled and observed screenline comparisons separately for cars and then for all vehicles for each time period for the calibrations screenlines. **Red** shows where difference is greater than 15%, **amber** between 5% and 15% and **green** where the difference is less than 5%.

The summary of validation screenlines shows that in the AM, the model performs acceptably, except for the Kings Hill - East Peckham screenline where the total modelled flows are slightly lower than observed. In the PM, three additional screenlines shows differences of greater than 5%. Similar to the calibration screenlines, the comparison for individual links intersected for each of the validation screenlines also shows that majority of the counts met the GEH and flow criteria (i.e only 1 or 2 counts for each screenline did not meet the criteria). While there are screenlines with differences of greater than 5%, the GEH for all vehicles is below 10 in all time periods. Given the scope and purpose of the model, the results shown are deemed acceptable.

Validation Screenlines	Direction	AM Peak – Cars				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
New Ash Green – Badger's Mount	NB	3,553	3,505	-48	-1%	0.8
New Ash Green – Badger's Mount	SB	3,448	3,506	58	2%	1.0
Westerham – Fordcombe	NEB	1,027	1,009	-18	-2%	0.6
Westerham – Fordcombe	SWB	928	902	-26	-3%	0.9
Chatham – Snodland	EB	2,827	2,868	41	1%	0.8
Chatham – Snodland	WB	4,076	4,284	208	5%	3.2
Kings Hill – East Peckham	NB	3,684	3,286	-398	-11%	6.7
Kings Hill – East Peckham	SB	3,757	3,446	-311	-8%	5.2
Borough Green – Wrotham Heath	EB	1,871	1,889	18	1%	0.4
Borough Green – Wrotham Heath	WB	2,015	1,951	-64	-3%	1.4

Table 8-6: Validation Screenlines Modelled vs Observed Comparison – AM Peak Cars

Validation Screenlines	Direction	AM Peak – All Vehicles				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
New Ash Green – Badger's Mount	NB	4,687	4,638	-49	-1%	0.7
New Ash Green – Badger's Mount	SB	4,512	4,453	-59	-1%	0.9
Westerham – Fordcombe	NEB	1,253	1,224	-29	-2%	0.8
Westerham – Fordcombe	SWB	1,166	1,120	-46	-4%	1.4
Chatham – Snodland	EB	3,553	3,366	-187	-5%	3.2
Chatham – Snodland	WB	5,248	5,337	89	2%	1.2
Kings Hill – East Peckham	NB	4,232	3,803	-429	-10%	6.8
Kings Hill – East Peckham	SB	4,400	4,053	-347	-8%	5.3
Borough Green – Wrotham Heath	EB	2,359	2,405	46	2%	0.9
Borough Green – Wrotham Heath	WB	2,591	2,535	-56	-2%	1.1

Table 8-7: Validation Screenlines Modelled vs Observed Comparison – AM Peak All Vehicles

Validation Screenlines	Location	PM Peak - Cars				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
New Ash Green – Badger's Mount	NB	3,941	3,806	-135	-3%	2.2
New Ash Green – Badger's Mount	SB	3,832	3,832	0	0%	0.0
Westerham – Fordcombe	NEB	918	814	-104	-11%	3.5
Westerham – Fordcombe	SWB	929	875	-54	-6%	1.8
Chatham – Snodland	EB	3,077	2,852	-225	-7%	4.1
Chatham – Snodland	WB	3,865	3,292	-573	-15%	9.6
Kings Hill – East Peckham	NB	3,913	3,843	-70	-2%	1.1
Kings Hill – East Peckham	SB	3,736	3,482	-254	-7%	4.2
Borough Green – Wrotham Heath	EB	2,004	2,143	139	7%	3.1
Borough Green – Wrotham Heath	WB	1,902	1,964	62	3%	1.4

Table 8-8: Validation Screenlines Modelled vs Observed Comparison – PM Peak Cars

Validation Screenlines	Location	PM Peak – All Vehicles				
		Observed Flows	Modelled Flows	Actual Difference	% Actual Difference	GEH <5
New Ash Green – Badger's Mount	NB	4,690	4,558	-132	-3%	1.9
New Ash Green – Badger's Mount	SB	4,536	4,450	-86	-2%	1.3
Westerham – Fordcombe	NEB	1,043	946	-97	-9%	3.1
Westerham – Fordcombe	SWB	1,062	1,018	-44	-4%	1.4
Chatham – Snodland	EB	3,711	3,387	-324	-9%	5.4
Chatham – Snodland	WB	4,638	4,110	-528	-11%	8.0
Kings Hill – East Peckham	NB	4,426	4,321	-105	-2%	1.6
Kings Hill – East Peckham	SB	4,160	3,881	-279	-7%	4.4
Borough Green – Wrotham Heath	EB	2,381	2,601	220	9%	4.4
Borough Green – Wrotham Heath	WB	2,252	2,391	139	6%	2.9

Table 8-9: Validation Screenlines Modelled vs Observed Comparison – PM Peak All Vehicles

8.3.3 Link Counts

In addition, to the validation of total cordon and screenlines flows, TAG Unit M3.1 provides guidelines on the validation criteria for individual links. As a check on the quality of the assignment, the assigned flows on individual links need to be compared against an independent set of observed counts that were not used as part of the calibration process. The criteria for assessing the acceptability of the assignment are defined in Table 8-10 below and refers to the GEH Statistic measuring the difference between modelled and observed flows.

The GEH statistic is a form of the Chi-squared statistic that incorporates both relative and absolute errors, and is defined as follows:

$$GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$$

where M is the modelled flow, and C is the observed flow.

Criteria	Description	Quality Standards
1	Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases
	Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases
	Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases
2	GEH < 5 for individual flows	> 85% of cases

Table 8-10: TAG Link Flow Validation Quality Criteria Used in Tonbridge and Malling and Sevenoaks Local Model

Link performance was also analysed, there are a total of 753 counts on links within the final count database, 556 were used in model validation and 197 were used in model calibration; 206 link counts fell on screenlines. The link count performance for AM and PM Peak is summarised by calibration, validation and all link counts in Table 8-11 and Table 8-12 respectively. An additional threshold of GEH <10 has also been presented to better understand the level of difference between the modelled and observed flows.

In the AM, the calibration performance shows that 95% of the total counts met the TAG criteria, with 95% of car counts and 100% for LGVs and HGVs met the flow criteria. The validation performance show that the TAG criteria is met for LGVs and HGVs, with 99% of the counts meeting flow criteria or having a GEH less than 5. For cars and total vehicles, 83% met the flow or GEH criteria, which is deemed acceptable for the purposes of the scope. In addition, there are 25 and 28 validation count for car and total vehicles with GEH 6 meaning that 88% of the car and total vehicles validation counts meet flow criteria or GEH less than 6.

Overall, considering all link counts, 86% of the total counts meet the TAG criteria for all user classes and total vehicles combined.

User Class	Number of Counts	GEH <5	Flow Criteria Met	% GEH or Flow criteria Met	% GEH <10
All Link Counts					
Car	753	604	614	86%	93%
LGV	753	723	748	99%	100%
HGV	753	719	750	100%	100%
Total Vehicles	753	597	609	86%	93%
Calibration					
Car	197	183	182	95%	99%
LGV	197	197	197	100%	100%
HGV	197	197	197	100%	100%
Total Vehicles	197	181	178	95%	99%
Validation					
Car	556	421	432	83%	91%
LGV	556	526	551	99%	99%
HGV	556	522	553	99%	99%
Total Vehicles	556	416	431	83%	90%

Table 8-11: Final Matrix Performance, AM Peak

The final matrix performance for all link counts in the AM Peak has been presented in Figure 8-1. The **green** bars represent links which pass flow criteria or have a GEH less than 5; the **amber** bars represent links which don't meet flow criteria and have a GEH just outside criteria between 5-10; the **red** bars represent links with a GEH greater than 10.

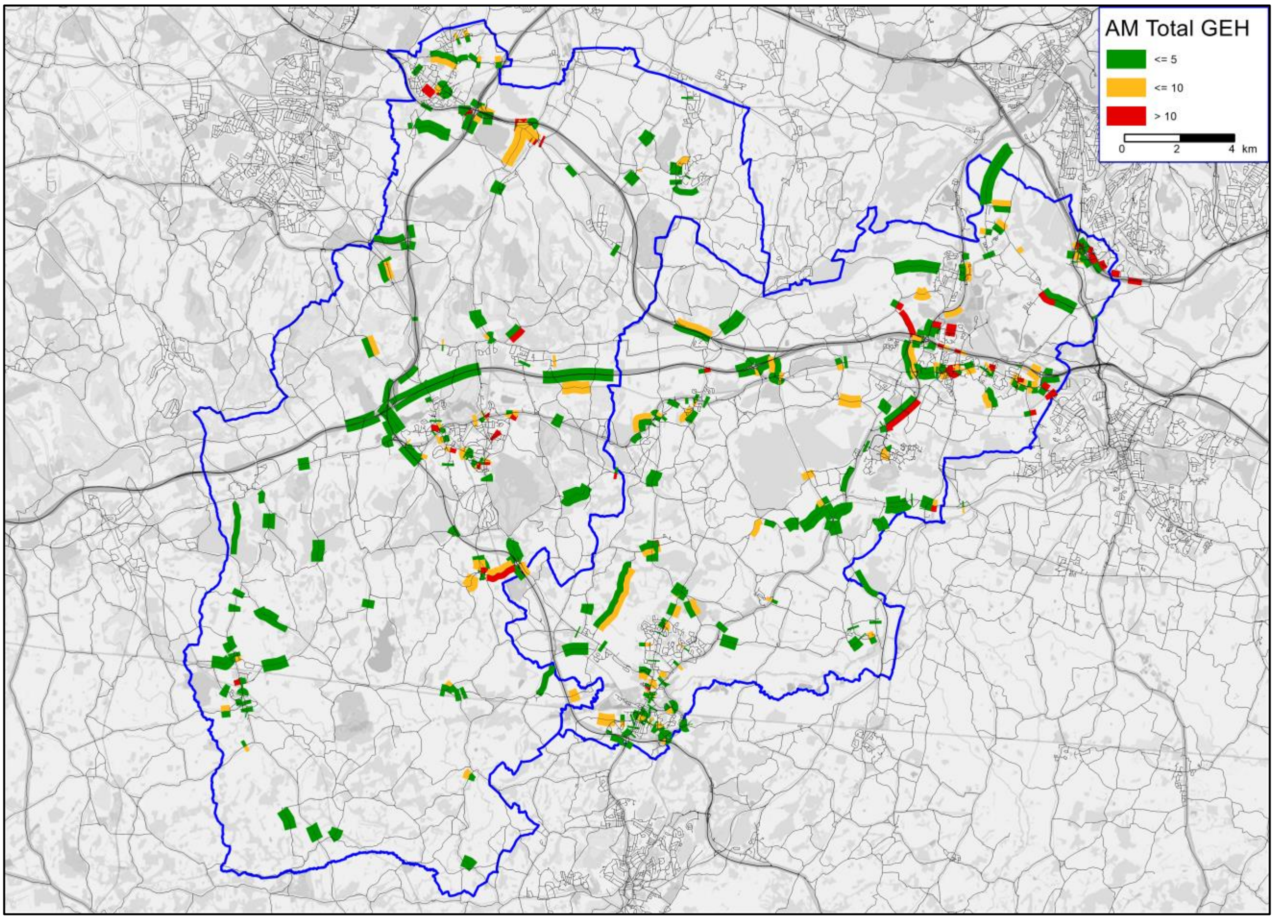

Figure 8-1 – All Link Counts Modelled vs Observed Flow Comparison – AM Peak

In the PM, the final calibration performance shows that the TAG criteria of greater than 85% of counts meeting flow or GEH is met for all user classes and total vehicles combined. The validation performance shows that TAG criteria is met for LGV and HGV user classes, with >98% of counts meeting flow or GEH criteria. For car and total vehicles, 81% and 79% respectively meet criteria, which is deemed acceptable for the purposes of the scope. In addition, there are 24 and 31 validation count for car and total vehicles with GEH 6, meaning that 85% of car and total vehicle counts meet flow criteria of GEH less than 6.

Considering all link counts, the total vehicles show that 83% of the total counts meet the TAG criteria, which is deemed acceptable considering the scope and purpose of the model. The individual user class also show that it reached the acceptable flow or GEH criteria which 85% for car, 99% for LGV and 100% for HGV.

User Class	Number of Counts	GEH <5	Flow Criteria Met	% GEH or Flow criteria Met	% GEH <10
All Link Counts					
Car	753	590	602	**85%**	**94%**
LGV	753	712	743	**99%**	**99%**
HGV	753	730	751	**100%**	**99%**
Total Vehicles	753	581	592	**83%**	**93%**
Calibration					
Car	197	186	184	**96%**	**98%**
LGV	197	195	197	**100%**	**99%**
HGV	197	197	197	**100%**	**100%**
Total Vehicles	197	186	184	**96%**	**97%**
Validation					
Car	556	404	418	**81%**	**92%**
LGV	556	517	546	**98%**	**99%**
HGV	556	533	554	**100%**	**99%**
Total Vehicles	556	395	408	**79%**	**91%**

Table 8-12: Final Matrix Performance, PM Peak

The final matrix performance for all link counts in the AM Peak has been presented in Figure 8-2. The **green** bars represent links which pass flow criteria or have a GEH less than 5; the amber bars represent links which don't meet flow criteria and have a GEH just outside criteria between 5-10; the **red** bars represent links with a GEH greater than 10.

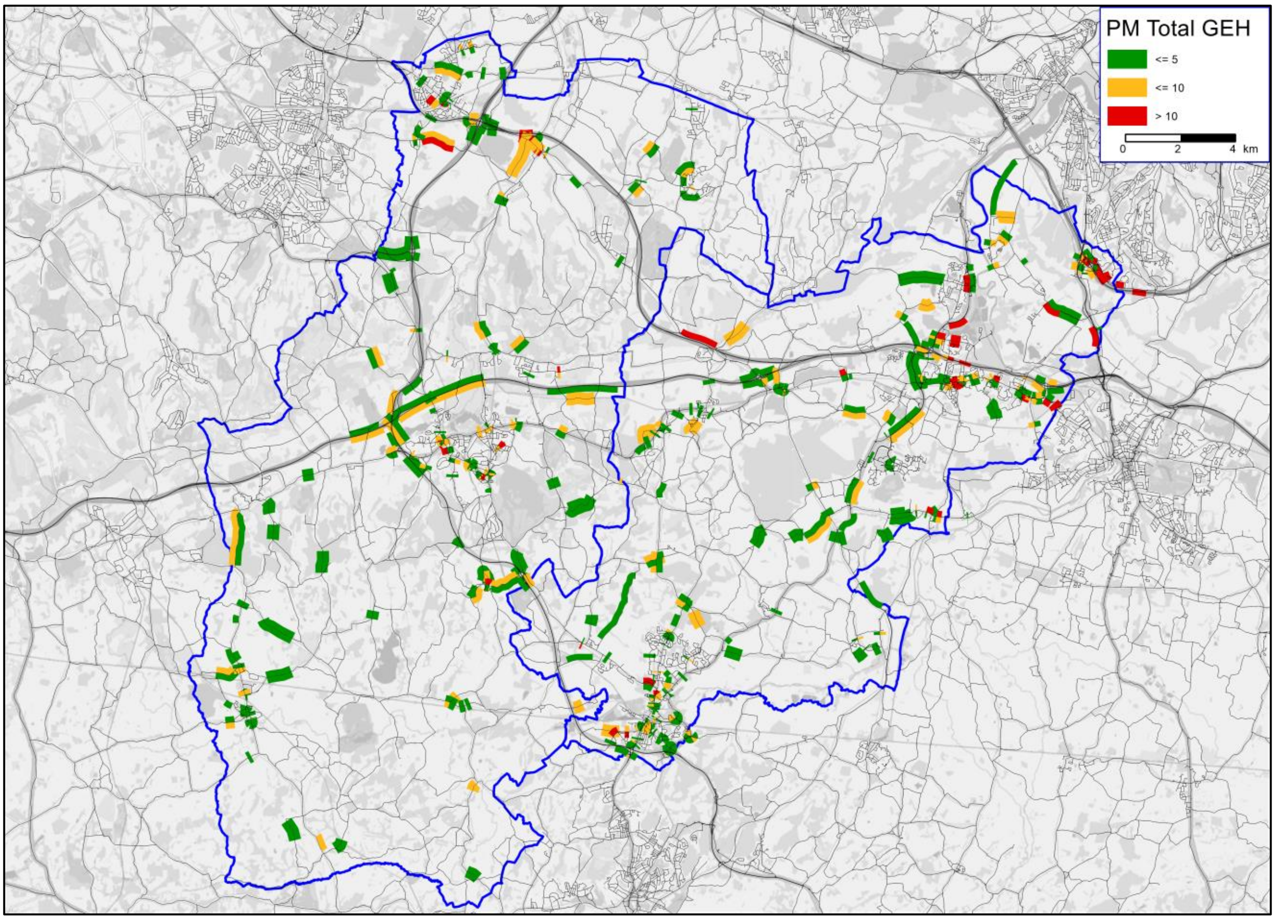

Figure 8-2 – All Link Counts Modelled vs Observed Flow Comparison – PM Peak

8.3.4 Journey Time Comparison

Finally, as a check on the quality of the network and the assignment, modelled and observed journey times along routes need to be compared against the criterion defined in Table 8-13:

Journey Time Validation Criterion and Guideline	Aspirational Quality Standards
Modelled times along routes should be within 15% of surveyed times (or 1 minute, if higher than 15%)	> 85% of cases

Table 8-13: TAG Journey Time Validation Guideline used in Tonbridge and Malling and Sevenoaks Local Model

Unit M3.1 Paragraph 3.3.16 states that for validation of journey times by vehicle type, it is necessary to obtain observed journey times by vehicle type to a level of accuracy which will allow a meaningful validation. As detailed above in Section 5.4, the observed journey time data was obtained from Teletrac data which does not contain sufficient accuracy to validate journey times by vehicle type. As such the model has been validated solely on modelled car journey times with no validation of journey times for goods vehicles or other vehicle classes.

Teletrac data was collected and processed for the Tonbridge and Malling and Sevenoaks validation. The routes used for model validation process are described in Section 5.1 of this report. A summary of the validation results is presented in Table 8-14. Overall, the result shows that 86% and 88% of all routes in the AM and PM are within the 15% acceptable range of journey time difference.

Time Period	All Routes
AM % of sections which validate:	86%
PM % of sections which validate:	88%

Table 8-14: Summary of Journey Time Validation

Table 8-15 and Table 8-16 summarise the model's performance over each journey time route for the AM peak and PM peak time periods respectively. Results show that majority of the routes are within the acceptable range, especially along the core area in Tonbridge and Malling and Sevenoaks. It should be noted that the 2019 observed journey time data for Route 1 reflects the roadworks along M20 (between M26 and M20 J6), converting this section of the road to a smart motorway. This impacted the highway capacity and average speeds, which were reduced then. Therefore, the base model incorporates the temporary impacts of these roadworks. This will be updated in the future model, reflecting the completion of work.

For the routes that fell outside of the 15% range, majority of it are marginally below the criteria. Route 28 along A2 and M2 shows that in the AM, the model is slower than observed in the westbound direction and in PM in the eastbound direction. This route is outside the study area and will not impact the local modelling in Tonbridge and Malling and Sevenoaks.

TAG recommends that, for the total route length, the modelled journey time is within 15% of the observed time, and this should ideally be the case for 85% of all routes. This simple comparison ignores the fact that modelled and observed journey times could deviate significantly from each other along specific sections of a route and the overall time still be within the specified acceptance criteria. To ensure the modelled delays and journey times are as accurate as possible throughout the length of the route, the model has been developed to try to ensure that the modelled times match the observed times not just for the total time along the routes, but also as vehicles progress along each route. The details and analysis of results for all local routes are presented in Appendix E.

Route	District / Borough	Description	Direction	Observed [min:sec]	Modelled [min:sec]	% Difference
1	Tonbridge and Malling	M20	01_EB	08:03	08:01	0%
		M20	01_WB	08:35	09:54	15%
2	Tonbridge and Malling	A20 London Road	02_EB	09:36	08:44	-9%
		A20 London Road	02_WB	09:39	08:32	-12%
3	Tonbridge and Malling	A228 Ashton Way / A26 Tonbridge Rd	03_SB	13:35	13:44	1%
		A228 Ashton Way / A26 Tonbridge Rd	03_NB	13:19	13:28	1%
4	Tonbridge and Malling	A26 Tonbridge Road	04_EB	10:03	10:01	0%
		A26 Tonbridge Road	04_WB	09:54	10:42	8%
5	Tonbridge and Malling	A26 Hadlow Road / Woodgate Way	05_SB	08:54	09:58	12%
		A26 Hadlow Road / Woodgate Way	05_NB	08:27	07:52	-7%
6	Tonbridge and Malling	A26 / B2260	06_SB	13:20	11:28	-14%
		A26 / B2260	06_NB	11:56	11:45	-2%
7	Tonbridge and Malling	A21	07_SB	05:09	04:59	-3%
		A21	07_NB	05:01	04:50	-4%
8	Tonbridge and Malling	B245	08_EB	08:14	08:18	1%
		B245	08_WB	07:37	08:40	14%
9	Tonbridge and Malling	A227 Tonbridge Road / Ightham Road	09_NB	08:40	07:29	-14%
		A227 Tonbridge Road / Ightham Road	09_SB	08:54	07:47	-13%
10	Tonbridge and Malling	A25 Borough Green Rd/A20 London Rd	10_EB	09:35	09:24	-2%
		A25 Borough Green Rd/A20 London Rd	10_WB	09:56	09:21	-6%
11	Tonbridge and Malling	A228 Castle Way	11_NB	08:53	08:38	-3%
		A228 Castle Way	11_SB	09:59	11:04	11%
12	Tonbridge and Malling	A229	12_SB	06:46	07:52	16%
		A229	12_NB	06:16	07:01	12%
13	Sevenoaks	B258 Swanley Lane	13_SB	08:24	07:03	-16%
		B258 Swanley Lane	13_NB	07:38	07:04	-7%
14	Sevenoaks	B2173 London Road	14_EB	07:58	07:36	-5%
		B2173 London Road	14_WB	09:59	07:54	-21%

15	Sevenoaks	A20-M20	15_EB	11:31	12:05	5%
		A20-M20	15_WB	12:58	12:15	-6%
16	Sevenoaks	M25	16_SB	16:11	14:43	-9%
		M25	16_NB	14:37	13:46	-6%
17	Sevenoaks	A20 Main Road Gorse Hill	17_SB	12:24	09:50	-21%
		A20 Main Road Gorse Hill	17_NB	10:39	10:47	1%
18	Sevenoaks	Shoreham Road	18_SB	10:14	09:20	-9%
		Shoreham Road	18_NB	10:24	08:56	-14%
19	Sevenoaks	M25-M26	19_EB	11:07	10:36	-5%
		M25-M26	19_WB	11:25	11:11	-2%
20	Sevenoaks	A25 Brasted Road	20_EB	13:59	13:34	-3%
		A25 Brasted Road	20_WB	13:33	13:14	-2%
21	Sevenoaks	A25 Bradbourne Vale Road / Seal Road	21_EB	08:40	08:47	1%
		A25 Bradbourne Vale Road / Seal Road	21_WB	11:00	11:51	8%
22	Sevenoaks	A224 London Road	22_SB	10:49	08:15	-24%
		A224 London Road	22_NB	09:54	08:39	-13%
23	Sevenoaks	A225 Sevenoaks Road / High Street	23_SB	12:41	11:43	-8%
		A225 Sevenoaks Road / High Street	23_NB	14:57	10:55	-27%
24	Sevenoaks	A224 Orpington By-Pass	24_NB	07:03	06:17	-11%
		A224 Orpington By-Pass	24_SB	06:58	06:14	-11%
25	Sevenoaks	B2042 Four Elms Road	25_SB	09:43	08:48	-9%
		B2042 Four Elms Road	25_NB	09:02	08:48	-3%
26	Sevenoaks	B2026 Main Road / Station Road	26_SB	10:17	09:42	-6%
		B2026 Main Road / Station Road	26_NB	10:51	09:54	-9%
27	External	A227	27_NB	15:11	15:07	0%
		A227	27_SB	20:09	15:14	-24%
28	External	A2 / M2	28_EB	13:26	14:08	5%
		A2 / M2	28_WB	13:43	20:30	49%

Table 8-15: Comparison of Modelled and Observed Journey Times – AM Peak

Route	District / Borough	Description	Direction	Observed [min:sec]	Modelled [min:sec]	% Difference
1	Tonbridge and Malling	M20	01_EB	09:38	10:23	8%
		M20	01_WB	08:16	07:51	-5%
2	Tonbridge and Malling	A20 London Road	02_EB	10:51	09:08	-16%
		A20 London Road	02_WB	09:13	09:40	5%
3	Tonbridge and Malling	A228 Ashton Way / A26 Tonbridge Rd	03_SB	11:49	12:24	5%
		A228 Ashton Way / A26 Tonbridge Rd	03_NB	12:28	13:31	8%
4	Tonbridge and Malling	A26 Tonbridge Road	04_EB	13:20	10:38	-20%
		A26 Tonbridge Road	04_WB	08:50	09:41	10%
5	Tonbridge and Malling	A26 Hadlow Road / Woodgate Way	05_SB	07:17	07:35	4%
		A26 Hadlow Road / Woodgate Way	05_NB	09:02	10:42	18%
6	Tonbridge and Malling	A26 / B2260	06_SB	12:17	10:55	-11%
		A26 / B2260	06_NB	12:43	11:53	-6%
7	Tonbridge and Malling	A21	07_SB	05:00	04:58	-1%
		A21	07_NB	04:58	04:41	-6%
8	Tonbridge and Malling	B245	08_EB	07:58	08:04	1%
		B245	08_WB	07:37	08:20	9%
9	Tonbridge and Malling	A227 Tonbridge Road / Ightham Road	09_NB	08:15	07:36	-8%
		A227 Tonbridge Road / Ightham Road	09_SB	08:29	07:32	-11%
10	Tonbridge and Malling	A25 Borough Green Rd/A20 London Rd	10_EB	09:28	10:15	8%
		A25 Borough Green Rd/A20 London Rd	10_WB	09:39	10:31	9%
11	Tonbridge and Malling	A228 Castle Way	11_NB	10:11	10:07	-1%
		A228 Castle Way	11_SB	08:33	08:18	-3%
12	Tonbridge and Malling	A229	12_SB	06:35	06:49	4%
		A229	12_NB	07:06	07:08	0%
13	Sevenoaks	B258 Swanley Lane	13_SB	07:43	07:04	-8%
		B258 Swanley Lane	13_NB	07:06	07:04	-1%
14	Sevenoaks	B2173 London Road	14_EB	09:07	08:02	-12%
		B2173 London Road	14_WB	08:18	07:36	-9%

15	Sevenoaks	A20-M20	15_EB	11:23	12:51	13%
		A20-M20	15_WB	11:01	11:03	0%
16	Sevenoaks	M25	16_SB	13:48	14:11	3%
		M25	16_NB	16:41	14:01	-16%
17	Sevenoaks	A20 Main Road Gorse Hill	17_SB	10:11	10:34	4%
		A20 Main Road Gorse Hill	17_NB	10:03	10:00	-1%
18	Sevenoaks	Shoreham Road	18_SB	08:25	08:51	5%
		Shoreham Road	18_NB	08:52	09:23	6%
19	Sevenoaks	M25-M26	19_EB	11:37	11:07	-4%
		M25-M26	19_WB	10:33	10:46	2%
20	Sevenoaks	A25 Brasted Road	20_EB	12:33	13:55	11%
		A25 Brasted Road	20_WB	11:42	12:38	8%
21	Sevenoaks	A25 Bradbourne Vale Road / Seal Road	21_EB	08:14	09:29	15%
		A25 Bradbourne Vale Road / Seal Road	21_WB	08:53	09:56	12%
22	Sevenoaks	A224 London Road	22_SB	09:35	07:58	-17%
		A224 London Road	22_NB	10:17	09:03	-12%
23	Sevenoaks	A225 Sevenoaks Road / High Street	23_SB	10:55	11:19	4%
		A225 Sevenoaks Road / High Street	23_NB	11:47	10:54	-7%
24	Sevenoaks	A224 Orpington By-Pass	24_NB	06:03	06:24	6%
		A224 Orpington By-Pass	24_SB	06:00	06:14	4%
25	Sevenoaks	B2042 Four Elms Road	25_SB	08:51	08:43	-1%
		B2042 Four Elms Road	25_NB	08:35	08:40	1%
26	Sevenoaks	B2026 Main Road / Station Road	26_SB	09:56	10:03	1%
		B2026 Main Road / Station Road	26_NB	10:15	09:35	-6%
27	External	A227	27_NB	15:29	16:04	4%
		A227	27_SB	14:48	14:36	-1%
28	External	A2 / M2	28_EB	14:46	19:28	32%
		A2 / M2	28_WB	13:01	14:10	9%

Table 8-16. Comparison of Modelled and Observed Journey Times – PM Peak

9. Summary

The Tonbridge and Malling, and Sevenoaks Local Transport Model was developed from the Kent Transport Model using PTV's VISUM 2020 software. The detailed model area covers Tonbridge and Malling Borough, Sevenoaks District and key neighbouring authorities close to the border in South London, Surrey, East Sussex, Tunbridge Wells, Maidstone, Medway, Gravesham and Dartford. The local transport model needs to follow a standard sufficient for the purpose of assessing the proposed Reg19 Local Plan Allocations, with due regard to Transport Analysis Guidance (TAG). Therefore, the model has been checked and enhanced using available data to ensure its appropriateness for developing Local Plan forecast scenarios for Tonbridge and Malling Borough and Sevenoaks District.

The local transport model represents a highway assignment only for an average 'neutral' 2019 weekday for the AM and PM peak hours. The demand utilises the 'prior' Kent Transport Model matrices where the zoning system has been retained in the detailed model area and neighbouring authorities and aggregated for the external zones that do not directly impact the study area.

TAG principles have been followed to enable reporting of model calibration and validation quality in a manner which is consistent with guidance. As with all strategic models, additional checks will be required during the forecasting phase of the project to ensure the model is predicting impacts as expected. These checks will be documented in subsequent deliverables (Tonbridge and Malling and Sevenoaks Forecasting Report).

Section 4 summarises the approach undertaken in developing the Tonbridge and Malling, and Sevenoaks Local Transport Model. Both network and demand refinements, together with other assumptions, are in line with standards used for strategic modelling.

Section 5 presents all the existing and new data collated to develop the local model. A total of 753 link counts located on key areas and roads have been included for traffic counts. For journey time, 28 routes (56 for both directions) have been checked and used in the model development. These data were also presented in **Section 6** and their use in model calibration and validation. The extent of traffic counts and journey time routes ensures that key corridors, roads and routes within the detailed model area are covered.

Section 7 confirms that the highway matrix estimation procedures set up for the local model are effective in adjusting the demand matrices to observed counts, without significantly modifying the trip end totals or trip length distributions. Trip end changes have been monitored and presented by user class and time period at zonal and sector levels.

Section 8 summarises the screenline, link count and journey time performance. For the screenlines, the flows closely match the observed counts in both AM and PM. Whilst some screenlines fall outside the % difference criteria, the GEH values for all these screenlines are below 5 for both AM and PM. The comparison for individual links intersected for each screenline also shows that majority of the counts meet the GEH and flow criteria.

In terms of link counts, all link counts in the AM show that TAG criteria of greater than 85% of counts meeting flow or GEH is met for all user classes and total vehicles combined. In the PM, the total vehicles are slightly below (83%) than 85%. However, each user class met the TAG criteria of greater than 85%. For the journey time, the results show that 86% and 88% of routes are within 5% of the observed journey time or have a difference of less than 1 minute. For the counts and journey time routes that fell outside the acceptable range, consideration should be given when drawing conclusions relating to these areas.

With the checks and updates described in this Report, the purpose of the model and the extent of the study area, the local model is considered to have a good standard of comparability of traffic flows with relevant observed counts, as well as a high comparability of journey times. It is therefore considered suitable for model forecasting of Local Plan scenarios for the spatial assessment of the highway impacts in Tonbridge and Malling Borough and Sevenoaks District, in combination with other analytical techniques, to provide an initial ranking and assessment of the highway impacts, challenges, and opportunities associated with various Local Plan options.

Glossary

Acronym	Definition	Description
ATC	Automatic Traffic Counts	Link count traffic surveys typically conducted for a period of one to two weeks. This is used to establish baseline link volume conditions, including the identification of peak hours.
GEH	Geoffrey E. Hayvers	A statistical formula used in traffic engineering, traffic forecasting and traffic modelling to compare two sets of traffic volumes.
ICA	Intersection Capacity Analysis	It is a feature of VISUM software that enables detailed evaluation of junction performance and represents blocking back and queuing (also known as flow metering).
JTC	Junction Turning Counts	Typically collected for one day within the period the ATCs are collected. This provides data compatible with the vehicle types represented in the traffic model.
LMVR	Local Model Validation Report	The report describes the assumptions and processes in developing the base transport model. It also presents the calibration and validation standards achieved with respect to link counts, screenlines and journey time information.
LoS	Level of Service	Provides a qualitative measure of how good the traffic situation is at a given junction. It is defined by six categories - LOS A to F representing the best and worst traffic conditions.
LSOA	Lower Super Output Areas	The geographical area for census statistics comprises between 400 and 1,200 households and usually has a resident population between 1,000 and 3,000 persons.
MSOA	Middle Super Output Areas	The geographical area for census statistics comprises between 2,000 and 6,000 households and usually has a resident population between 5,000 and 15,000 persons.
NTEM	National Trip End Model	Forecasts the growth in trip origin-destinations (or productions-attractions) up to 2051 for use in transport modelling. This data takes into account national projections of population, employment, housing, car ownership and trip rates.
NTS	National Travel Survey	A household survey designed to monitor long-term trends in personal travel and to inform the development of policy.
PCU	Passenger Car Unit	A measure used primarily to assess highway capacity for modelling purposes. Different vehicles are assigned different values according to the space they take up. For example, a car has a value of 1 and HGV is equivalent to 2.5 to reflect its greater size in comparison with cars (equivalent to two and a half cars).
SRN	Strategic Road Network	Comprise of motorways and some A roads in England managed by National Highways.
TAG	Transport Analysis Guidance	It provides information on the role of transport modelling and appraisal. It includes advice on developing, calibrating and validating highway and public transport assignment models.
TEMPro	Trip End Model Presentation Program	It is a software that summarises the growth forecast from the National Trip End Model (NTEM).
TLD	Trip Length Distributions	The number of trips from one trip matrix within length bands (i.e distance).
V/C Ratio	Volume/ Capacity Ratio	The ratio of the assigned traffic volume to the modelled link capacity.

Appendix A. Matrix Estimation Changes

Appendix B. Trip Length Distribution

Appendix C. Sector to Sector Movements

Appendix D. Link Counts Calibration and Validation

Appendix E. Journey Time Routes