Pell Frischmann

Southend Mesoscopic Modelling

Mesoscopic Modelling Validation Report

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Contents

1 Introduction 1
1.1 Background 1
1.2 Structure of this Report 1
2 Proposed Uses of the Model and Key Model Design Considerations 2
2.1 Proposed Uses of the Model 2
2.2 Key Model Design Considerations 2
3 Model Standards 3
3.1 Link Flow and Turning Movement Validation 3
3.2 Matrix Estimation 3
3.3 Journey Time Validation 4
4 Key Features of The Model 5
4.1 Introduction 5
4.2 Highway Link Structure 5
4.3 Zone Centroid Connectors 5
4.4 Time Periods 6
4.5 Demand Segment 6
4.6 Generalised Cost Parameters 6
5 Calibration and Validation Data 8
5.1 Introduction 8
5.2 Traffic Counts 8
5.3 Traffic Flow Validation 8
5.4 Journey Time Surveys for Validation 9
5.5 Convergence 9
6 Network Development 11
6.1 Introduction 11
6.2 Junction Coding 11
6.3 Links 12
6.4 Zone Connectors 12
6.5 Public Transport Services 12
6.6 Trip Matrix Development 12
7 Calibration and Validation 13
7.1 Methodology 13
7.2 Calibration Results 13
7.3 Validation Results 13
8 Summary and Conclusion 16
8.1 Summary of Model Development 16
8.2 Calibration and Validation 16

Figures

Figure 4-1 Model Extents....5
Figure 4-3 Zone Connectors....5
Figure 5-1 ATC and MCTC Locations as Collected in 2025....8
Figure 5-2 Journey Time Routes Defined for 2025 Base Model Validation....9
Figure 7-1 Matrix zonal cell value changes between prior and post (AM on left, PM on right)....14

Tables

Table 3-1 Link and Turning Flow Validation Criteria....3
Table 3-2 Matrix Estimation Significance Criteria....3
Table 3-3 Journey Time Validation Criteria....4
Table 5-1 Convergence Summary....9
Table 7-1 Calibration Link and Turns Results Summary....13
Table 7-2 Validation Link Results Summary....14
Table 7-3 Summary of Matrix Estimation changes....14
Table 7-4 Journey Time Results - AM....15
Table 7-5 Journey Time Results - PM....15

1 Introduction

1.1 Background

Pell Frischmann was commissioned by Southend-on-Sea City Council to update the 2018 base year Southend Mesoscopic Models to be reflective of 2025 traffic and highway network conditions. This has been requested for the weekday morning and evening peak periods (AM and PM; 08:00-09:00 and 17:00-18:00 respectively). This report contains an outline of the methodology used to create this updated version.

The model has been developed in PTV Visum, using a Simulation Based Assignment (SBA) which is a dynamic procedure that enables route choice between each OD pair in response to network conditions.

It has been prepared for in accordance with TAG guidelines for model development, calibration and validation.

This report refers to the update of the base year model, a key purpose of which was to provide a basis for modelling the local plan in 2035 and 2045. The inclusion of future year schemes and associated coding is included in chapter 7 of the Regulation 19 Modelling Technical Report.

1.2 Structure of this Report

This report is structured in the following way:

- Section 1: Introduction
- Section 2: Proposed Uses of the Model and Key Model Design Considerations
- Section 3: Model Standards
- Section 4: Key Features of the Model
- Section 5: Calibration and Validation Data
- Section 6: Network Development
- Section 7: Calibration and Validation
- Section 8: Summary and Conclusion

2 Proposed Uses of the Model and Key Model Design Considerations

2.1 Proposed Uses of the Model

The updated highway model can be used for the purposes of:

- Local Plan testing: forecasting traffic flows, testing updated road layouts, understanding network impacts and testing highway mitigation measures;
- Business Cases: contributing to the evidence base, used for options appraisal and scheme appraisal;
- Development Control: understanding highway network impacts of developments and associated network changes, and testing highway mitigation measures but is not intended for detailed junction design or operational assessment without further detailed modelling using the VISSIM model; and
- Policy: examination of highway network performance.

2.2 Key Model Design Considerations

As agreed with SCC, this updated highway model must:

- Accurately replicate AM and PM peak highway conditions as an average across neutral weekdays for 2025; covering volume of traffic, junction coding and journey times. This is in accordance with TAG guidelines
- Mimic the behaviour of separate user classes: Car, LGV and HGV with a high degree of accuracy.

This report exclusively covers the development of a 2025 base year Highway Assignment Model.

3 Model Standards

Model calibration and validation was set out in accordance with TAG Unit M3.1 Highway Assignment, outlined by the Department for Transport.

Calibration and validation were undertaken to account for how certain parameters cannot be modelled or given definitive values, hence other modelled parameters are adjusted to enable the correct volume of flows to traverse each link within the specified peak / or to enable the journey times to line up.

3.1 Link Flow and Turning Movement Validation

Link flow and turning movements are validated by:

- Comparing the absolute and percentage difference between modelled flows and counts; and
- The GEH statistic, defines as follows:

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

Where M represents the modelled flows and C the observed flows.

The criteria are outlined in more detail in **Table 3-1** below.

Table 3-1 Link and Turning Flow Validation Criteria

Criteria	Description	Guideline
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 2700 veh/hr	
	Individual flows within 400 veh/hr of counts for flows greater than 2700 veh/hr	
2	GEH < 5 for individual flows	> 85% of cases

3.2 Matrix Estimation

Matrix estimation has been employed as the observed and modelled counts after the prior assignment did not meet the TAG criteria. This meant that the prior matrix for each user class has been altered to be a better fit to the counts.

The guidance outlined in TAG for acceptable changes to the prior matrices are specified in Table 3-2 below.

Table 3-2 Matrix Estimation Significance Criteria

Measure	Significance Criteria
Matrix Zonal Cell Values	Slope within 0.98 and 1.02, intercept near 0, R in excess of 0.95
Matrix Zonal Trip Ends	Slope within 0.99 and 1.01, intercept near 0, and R in excess of 0.98
Trip Length Distribution	Means within 5%, standard deviations within 5%
Sector to Sector Level Matrices	Differences within 5%

3.3 Journey Time Validation

The journey time validation includes calculating a percentage difference between the observed and modelled journey time routes; the routes pass if they fall within this specified percentage. There is also an absolute maximum provided as part of the validation criteria. See **Table 3-3** for more details.

Table 3-3 Journey Time Validation Criteria

Criteria	Guideline
Modelled journey times along routes should be within 15% of observed journey times along the same routes. (Or 1 minute, if higher than 15%.)	> 85% of cases

4 Key Features of The Model

4.1 Introduction

The purpose of this section is to summarise the key features of the model.

4.2 Highway Link Structure

The extents of the highway road network are displayed in **Figure 4-1** below. Note that this has been kept largely consistent with the 2018 base mode, with the addition of Shopland Road / Wakering Road.



Figure 4-1 Model Extents

4.3 Zone Centroid Connectors

Every zone within the model has at least one centroid connector attached to it; this is the medium through which traffic traverses from the zone system and onto the road network. The exact locations at which this merges onto the network can be seen in **Figure 4-2** below. These locations must accurately mimic where traffic joins onto the highway network on the ground so as to avoid inaccurate loading patterns.

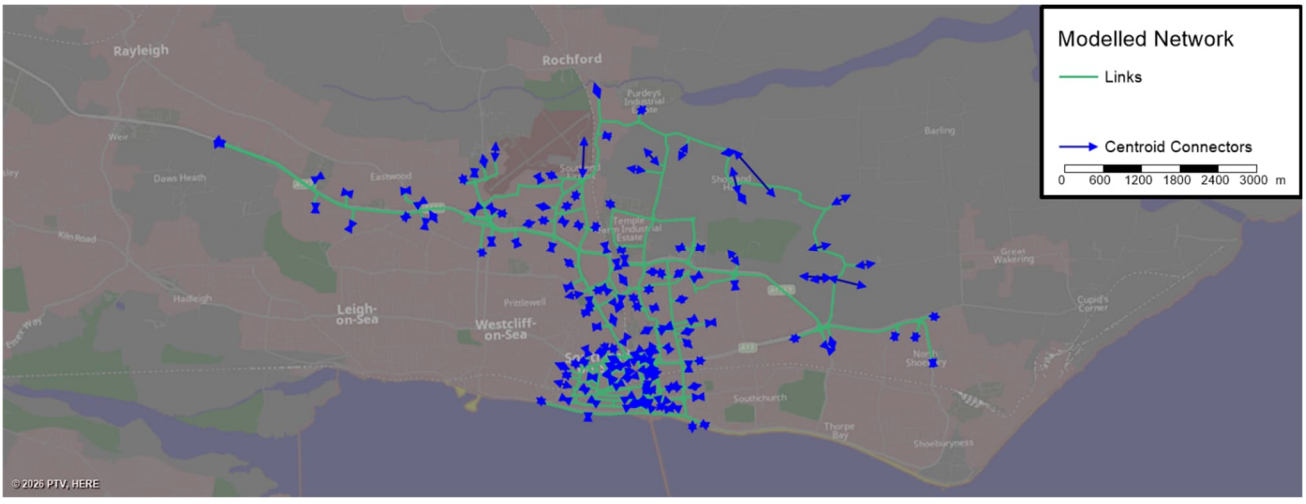


Figure 4-2 Zone Connectors

4.4 Time Periods

To update the base year mesoscopic models, both the AM and PM peaks were modelled. These retained the same peak hours from the 2018 models, which were namely:

- 08:00-09:00 (for the AM peak)
- 17:00-18:00 (for the PM peak)

Both peaks were initialised by a 30-minute warm up period. This was for the purpose of populating the model with traffic so that there would be a representative volume of traffic in the network / and thus representative network conditions during the main peak periods.

4.5 Demand Segment

The demand segments set up in the model are split in the following way:

- Car – Employers Business;
- Car – Commuting;
- Car – Other;
- Light Goods Vehicle (LGV's); and
- Other Goods Vehicle (OGV's).

4.6 Generalised Cost Parameters

Assignment of vehicles is based on the lowest cost route that combines both journey times, vehicle operating costs and toll charges, by means of a generalised cost.

The generalised cost coefficient values: pence per minute (PPM); and pence per kilometre (PPK) for model assignment are shown in Tables 3.1 and 3.2. These values are representative of 2023 price base, consistent with TAG Data Book v2.02 November 2025. The latest version of the TAG Data Book available was used in the mesoscopic modelling, as that model is the primary source of delays when assessing the local plan scenarios – and hence is using the most up to date inputs.

Table 4-1 AM Generalised Cost Coefficients

		Car Business	Car Commute	Car Other	LGV	HGV
2025	PPM	73.30	49.16	33.91	56.56	113.71
	PPK	17.16	8.41	8.41	19.24	56.20
2035	PPM	83.82	56.21	38.78	64.68	130.04
	PPK	12.87	6.03	6.03	15.32	50.68
2045	PPM	98.31	65.93	45.48	75.85	152.51
	PPK	10.59	4.60	4.60	13.71	48.92

Table 4-2 PM Generalised Cost Coefficients

		Car Business	Car Commute	Car Other	LGV	HGV
2025	PPM	74.36	49.32	35.51	56.56	113.71
	PPK	17.16	8.41	8.41	19.24	56.20
2035	PPM	85.03	56.41	40.61	64.68	130.04
	PPK	12.87	6.03	6.03	15.32	50.68
2045	PPM	99.72	66.15	47.63	75.85	152.51
	PPK	10.59	4.60	4.60	13.71	48.92

5 Calibration and Validation Data

5.1 Introduction

This section summarises the data used as part of the calibration and validation process.

The latter is usually undertaken as the original matrices, upon assignment, do not always yield acceptably close link / turning movement flows to observed data. The original matrices are therefore placed through matrix estimation, whereby OD pairs are strategically altered so that the observed and modelled flows do match.

The scope by which matrix estimation alters the matrices must be in line with criteria set out in TAG.

5.2 Traffic Counts

Traffic counts (link and turning counts) were collected across various neutral days throughout 2025 to help re-calibrate the demand matrices in the form of automatic traffic counts and manual turning counts.

Manual turning counts have been used for individual turns at junctions in many cases. However, the turns in the model sometimes consist of more than one link (particularly at larger roundabouts), which makes comparison more difficult against these counts. Therefore, the turning counts have sometimes been split into in and out link counts at approaches and exits to these junctions.

Traffic flows have been compared at individual sites in isolation, with cordon and screenline flows not being assessed against the calibration criteria. Count locations are as observed in **Figure 5-1** below.

The model has been calibrated against 116 link counts and 122 turning counts.



Figure 5-1 ATC and MCTC Locations as Collected in 2025

5.3 Traffic Flow Validation

An independent set of 50 traffic counts was used for validation. This accounts for 30% of counts; these were not fed through the matrix estimation procedure and provide greater assurance into the model.

5.4 Journey Time Surveys for Validation

Journey time routes have been defined along key corridors to assess the likeness in journey times. This comes to a total of 10 routes when taking direction into account. These can be seen in **Figure 5-2** below:



Figure 5-2 Journey Time Routes Defined for 2025 Base Model Validation

Observed journey times were collected from INRIX data as an average across all Tuesdays, Wednesdays and Thursday that fall in the following months:

- April
- May
- June

Data was screened for outliers and if any were found these were removed to not skew the journey times.

5.5 Convergence

The base year mesoscopic model was run with twelve seeds, which allows for variation in the modelling that can be akin to drivers setting off at slightly different times, and hence different interactions between vehicles at junctions. These twelve seeds were interrogated for their %GAP (the difference between costs along the chosen routes and those along the minimum cost routes, summed across the whole network and expressed as a percentage of the minimum costs) and their overall vehicle-hours, to see how stable the models converged.

Table 5-1 Convergence Summary

Time Period	%GAP (lowest)	%GAP (highest)	%GAP (average)	Veh -Hrs (lowest)	Veh -Hrs (highest)	Veh -Hrs (average)
AM (08:00 - 09:00)	0.003317	0.004529	0.003980	6126.9	6310.9	6210.3
PM (17:00 - 18:00)	0.002037	0.003894	0.002624	6436.3	6658.5	6541.9

The values in this Table 5-1 show that the range of values for %GAP and total vehicle-hours in the model are reasonably modest, and that the average (mean) falls fairly in the middle of these ranges.

This is an indication that the models have converged similarly. In addition, the %GAP is also below the criterion of being below 0.1%.

The variability is something that cannot be fully eliminated within this type of modelling – as a consequence we have averaged journey time outputs and link flows when comparing validation results. The values are relatively stable, but any forecast modelling should look at the spread of values from random seeds and be sure to interpret results accordingly.

6 Network Development

6.1 Introduction

This section summarises the network development process. This was largely kept consistent with the 2018 base model. An extension was made to include Shopland Road / Wakering Road, this does not contain major junctions – but provides a better starting point for testing greenbelt developments in that area.

6.2 Junction Coding

Junctions within the simulation area were coded to a high level of detail for the assignment. This is outlined for roundabouts, signalised junctions and priority junctions below.

6.2.1 Roundabout Coding

The roundabout coding was kept consistent with what was found in the 2018 base models.

This included coding roundabouts as multiple nodes and links to enable realistic lane choice. In cases where each approach was one lane, the roundabout was coded as a single node as there is no lane choice. The SBA look ahead distance was defined on each approach.

6.2.2 Priority Junctions

Priority junction coding was kept consistent with what was found in the 2018 base models.

Priority junctions define both a major flow and a minor flow, where the minor flow “gives-way” to the major flow by waiting at a give-way line until there is a sufficient gap to make the desired lane turns. This gap has been modelled through the SBA critical gap attribute,

A related attribute is the SBA follow up gap, which defines the minimum time between vehicles turning from the minor arm of a junction.

These two attributes were kept consistent with what was input into the model in the inherited 2018 base models. During calibration minor adjustments were made to reflect updated network conditions such as a change in visibility and the impact this has on driver behaviour.

6.2.3 Signalised Junctions

Signal data was provided by Southend-on-Sea City Council to inform signals in the 2018 base model. The 2025 model retained these values as a starting point. LinSig models have been provided for a number of junctions and have been used during calibration to aid in calibration of signals. LinSig models along Victoria Ave allowed for some coordination to be modelled which aided in calibration.

6.3 Links

6.3.1 Cruise Speed Updates

In 2018, mean cruise speeds were updated in the simulation network using TrafficMaster data, and adjustments were made to the speed limit where this was too high.

Links for the most part have retained these values, except where the speed profile didn't match 2025 highway conditions.

6.3.2 Banned Links/Turns

Where required across the network, restrictions have been placed upon certain links throughout the simulation network. These links represent vehicle movement restrictions, such as bus lane or OGV restrictions. In some locations where banned turns may be expected, they have been included to allow for deliveries to and from zone movements.

6.4 Zone Connectors

A review of zone connectors was undertaken within the study area. These were amended or adjusted to better reflect traffic loading conditions.

6.5 Public Transport Services

Bus services with at least one bus during the AM and PM peak intervals have been modelled. This is to accurately reflect the decrease in available capacity / delay caused by these additional vehicles on the road network.

6.6 Trip Matrix Development

The 2018 prior matrix was built as a cordon from the SoSMMM highway model. These matrices were then further disaggregated into the mesoscopic zoning system. This underwent a change through matrix estimation so as to better fit 2018 count data, yielding a post matrix.

For this project, the existing Southend 2018 model has been updated to reflect 2025 conditions through the incorporation of recent traffic data, calibration and validation exercises. The validated 2025 model is considered appropriate for the strategic assessment of Local Plan growth and mitigation. A new strategic model with a 2025 base is currently being developed and, as individual planning applications come forward, further testing can be undertaken using the most up-to-date modelling tools and evidence available at that time, which may identify the need for further mitigation measures.

7 Calibration and Validation

7.1 Methodology

To calibrate the model, count data for links, turns and main turns was input into the model for each 15-minute interval during the peak period, but not the warmup period as traffic hasn't realistically built up onto the network yet. This served as a comparison against modelled flows, aiming for it to meet the TAG threshold of validation (which is defined in an earlier section).

A Matrix Estimation procedure was then employed, where the prior matrix is refined so that the matrix fits the count data more appropriately. Different weightings can be used for links/ turns/ zones using the method of least squares, essentially telling Visum the level of importance of each count in the Matrix Estimation procedure.

This was individually applied to each 15-minute interval matrix within the modelled peaks; the output is a post matrix which is assigned to the network to yield a more "accurate" picture of traffic flows.

During the calibration process, minor network changes have been made where there's an excess or lower extent of delay compared to 2025 highway conditions and matrix estimation falls short of aiding with that. This encompasses things like:

- Signal timing changes;
- Changing the SBA look-ahead distance for lane choice; and
- Changing the SBA critical-gap and follow-up gap attributes.

7.2 Calibration Results

A set selection of links and turns was put through a Matrix Estimation (ME) procedure to refine the prior matrices so that upon assignment they led to flows that matched the counts within a suitable degree of accuracy (as defined in the TAG set of guidance). The results can be witnessed in the table below:

Table 7-1 Calibration Link and Turns Results Summary

Time Period	Number of Links	Link passing	% Pass	Number of Turns	Turns passing	% Pass
AM (08:00 - 09:00)	116	101	87%	122	119	98%
PM (17:00 - 18:00)	116	102	88%	122	114	93%

The links from the AM and PM time periods both pass (above 85%), and the turns are very good at 98% and 93%, respectively, also passing.

7.3 Validation Results

7.3.1 Counts

A set selection of links was validated against the TAG criteria without being put through a Matrix Estimation procedure to ensure robustness. Turns were used for calibration and are therefore not included in validation. The results are summarised in the table below:

Table 7-2 Validation Link Results Summary

Time Period	Number of Links	Link passing	% Pass	Number of Turns	Turns passing	% Pass
AM (08:00 - 09:00)	50	44	88%	-	-	-
PM (17:00 - 18:00)	50	43	86%	-	-	-

Again, the link counts in validation are greater than 85%, and both time periods pass.

Following Matrix Estimation, the post matrices were compared with the prior matrices to see how much they had changed by. DfT's TAG M3.1 document says that Matrix Estimation should not be used solely to achieve the flow validation criteria at the expense of significantly changing the demand matrix patterns. In order to monitor these changes, scatter plots of matrix zonal cell values from before and after ME, along with regression statistics, were produced. These can be seen in Figure 7-1, with Table 7-3 showing a summary of the values.

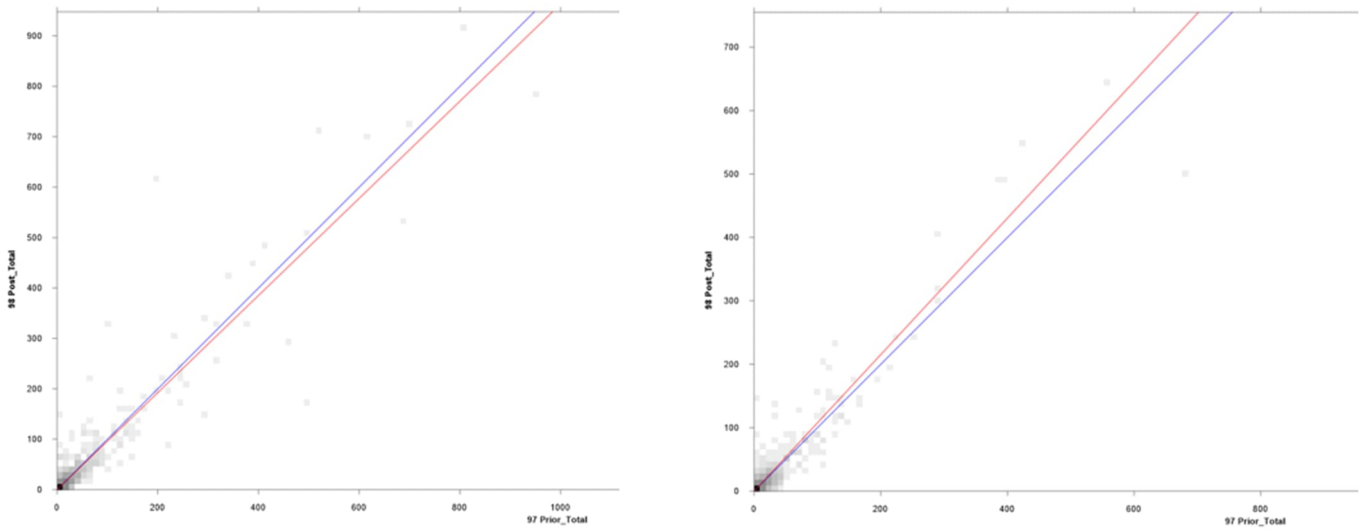


Figure 7-1 Matrix zonal cell value changes between prior and post (AM on left, PM on right)

Table 7-3 Summary of Matrix Estimation changes

Time Period	Slope	Intercept	R^2 value
AM	0.96	0.04	0.89
PM	1.08	-0.04	0.88

TAG M3.1 states that the slope should be between 0.98 and 1.02, the intercept should be near zero, and the R^2 should be in excess of 0.95. The values shown in the table for these matrices are slightly outside these ranges; however, the base matrix is based upon older data, which is a likely reason for why the matrix has changed a little more than preferred.

Having tested route choice in the model, it is believed that growth in the OD demand will result in growth in the correct link-flows which gives us confidence in model outputs.

7.3.2 Journey Times

With regards to the journey time validation, Table 3-3 gives us the criterion for what should be measured and a guideline for acceptability. Figure 5-2 shows the routes selected.

Table 7-4 and Table 7-5 show the results of the journey time route validation. The guideline is for over 85% of routes to be within the criteria. In the AM period, all ten periods achieve this (100%). In the PM period, all but one route achieves this (90%). As a result, the journey time validation has passed.

Table 7-4 Journey Time Results - AM

JT Route	Distance	Total Observed Time	Total Modelled Time	Absolute diff	Percentage diff	Validated?
1_EB	12.8 km	00:26:10	00:26:29	-00:00:19	-1.2%	YES
1_WB	12.8 km	00:27:50	00:26:39	00:01:11	4.3%	YES
2_SB	6.2 km	00:14:04	00:13:38	00:00:25	3.0%	YES
2_NB	6.3 km	00:15:56	00:14:09	00:01:47	11.2%	YES
3_SB	4.9 km	00:09:08	00:08:13	00:00:54	9.9%	YES
3_NB	4.9 km	00:09:12	00:09:23	-00:00:11	-2.0%	YES
4_SB	2.2 km	00:05:22	00:05:33	-00:00:11	-3.6%	YES
4_NB	2.2 km	00:05:21	00:05:41	-00:00:19	-6.1%	YES
5_EB	2.2 km	00:06:19	00:05:36	00:00:44	11.6%	YES
5_WB	2.2 km	00:07:53	00:06:58	00:00:55	11.6%	YES
						100%

Table 7-5 Journey Time Results - PM

JT Route	Distance	Total Observed Time	Total Modelled Time	Absolute diff	Percentage diff	Validated?
1_EB	12.8 km	00:26:48	00:29:23	-00:02:36	-9.7%	YES
1_WB	12.8 km	00:27:21	00:27:26	-00:00:05	-0.3%	YES
2_SB	6.2 km	00:13:59	00:12:45	00:01:14	8.9%	YES
2_NB	6.3 km	00:17:40	00:14:54	00:02:46	15.6%	NO
3_SB	4.9 km	00:09:52	00:09:12	00:00:39	6.7%	YES
3_NB	4.9 km	00:12:02	00:11:30	00:00:32	4.5%	YES
4_SB	2.2 km	00:05:25	00:04:56	00:00:30	9.2%	YES
4_NB	2.2 km	00:06:27	00:05:42	00:00:45	11.6%	YES
5_EB	2.2 km	00:07:17	00:07:39	-00:00:22	-5.0%	YES
5_WB	2.2 km	00:08:47	00:08:30	00:00:17	3.2%	YES
						90%

8 Summary and Conclusion

8.1 Summary of Model Development

Pell Frischmann has been commissioned by Southend-on-Sea City Council to create a 2025 base year mesoscopic model of the Southend local area. This will be essential for testing a variety of future year growth scenarios and interventions.

Models have been created by updating the inherited 2018 base year models to reflect 2025 conditions in terms of traffic demand and the network supply. The two peak periods that have been modelled are:

- The AM Peak (08-00 – 09:00)
- The PM Peak (17:00 – 18:00)

These have both been supplemented by a 30-minute warm up period to populate the model with flows.

The model has been developed and updated using a dynamic SBA assignment in PTV Visum which simulates vehicle movements on an individual level.

8.2 Calibration and Validation

Link and turn calibration show that they pass in both AM and PM time periods. For validation, the link counts also pass, as do the journey times, which pass with 100% and 90% for AM and PM.

In terms of convergence, %GAP for all seeds of the models is below 0.1%, and relatively stable across seeds.

Although the changes between the prior and post matrices following Matrix Estimation fall marginally outside the recommended guidance thresholds, the model has achieved the relevant TAG calibration and validation criteria and demonstrates strong overall performance against observed 2025 conditions. Taking the evidence as a whole, the model is considered sufficiently robust for strategic Local Plan forecasting, growth assessment, mitigation testing and wider transport assessment. The model is therefore suitable for identifying the potential transport impacts of planned development and informing mitigation strategies, whilst recognising that future planning applications may require more detailed assessment using the Council's VISSIM model or other appropriate modelling tools.

While the results are relatively stable between random seeds – any forecasts should consider the impact across a range of random seeds rather than single seeds only.