



**Carlisle Local Plan
Transport Modelling
Report**

February 2015

Executive Summary

- i. The Carlisle Local Plan transport modelling report summarises the transport modelling study undertaken to assess the cumulative impact of the local plan proposals. The results of this study inform a further study which identifies potential transport improvements in Carlisle. This report summarises the methodology and results of the modelling study and forms part of the evidence base for the Carlisle Local Plan.
- ii. The study used the Carlisle transport model to assess the local plan proposals. The Carlisle transport model is a traffic model of the Carlisle urban area and the surrounding district. It covers the morning and evening weekday peak periods and was updated in 2013 following the opening of the Carlisle Northern Development Route.
- iii. The study considers future years of 2025 and 2030 in line with the plan period. Traffic growth was applied to the base traffic demand to take account of forecast changes in traffic demand in line with guidance from the Department of Transport.
- iv. The model was amended to include changes to the highway network, which include proposed site accesses for the development sites. The traffic generation and distribution of future developments was also estimated and included within the model.
- v. The results of the forecast scenarios were then analysed to assess the impact of the local plan proposals. The model outputs include traffic flows, queues, delays and the ratio of flow to capacity, which is a measure of congestion.
- vi. The results show that congestion and journey times are forecast to increase on key routes from 2013 to 2025, and the local plan proposals would have a further impact. The development at South Carlisle from 2025 is also shown to further increase congestion, as well as journey times along the London Road corridor.
- vii. The measures identified in the improvements study have also been tested in the strategic model as part of this study. The aim of this is to assess their cumulative impact. The results of this assessment show that the improvements would help to mitigate the transport impacts of the local plan.
- viii. Further details on the nature and cost of improvements proposed to support the Carlisle Local Plan are provided in the Carlisle Transport Improvements Study report by Parsons Brinckerhoff. A summary of this study which details the key themes and findings is also available. The improvements study informs Carlisle City Council's Infrastructure Delivery Plan, which forms part of the evidence base for the local plan.

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1 Introduction

1.1 Introduction

1.1.1 Cumbria County Council has undertaken a transport modelling study to help support the development of Carlisle City Council's Local Plan. The plan is the city council's strategy for growth from 2015 to 2030. The city council has a statutory duty to prepare a local plan, which will be used to guide development and inform planning decisions once adopted.

1.1.2 The purpose of the modelling study is to assess the cumulative transport impact of the local plan proposals. The study identifies locations on the highway network which are forecast to suffer increased delays as a result of the proposals.

1.1.3 This report summarises the methodology and results of the modelling study.

1.1.4 The results of this study are used in further work to help identify potential transport improvements in the Carlisle Transport Improvements Study. The improvements study informs Carlisle City Council's Infrastructure Delivery Plan, which forms part of the evidence base for the local plan.

1.2 Contents

1.2.1 The report includes the following information:

- The methodology of the transport study
- The assumptions used for forecasting future travel demand
- A summary of the key results
- Conclusions and recommendations

2 Methodology

2.1 Overview

- 2.1.1 The transport modelling study has been undertaken using Cumbria County Council's Carlisle transport model.
- 2.1.2 The methodology used was based on information available in the Department for Transport's Transport Analysis Guidance (TAG) and the Planning Practical Guidance document *Transport evidence bases in plan making*.

2.2 Carlisle transport model

- 2.2.1 The Carlisle transport model is a strategic SATURN traffic model of the Carlisle urban area and surrounding district. The model covers the morning and evening weekday period periods of 8–9am and 5–6pm. The model considers car, light goods vehicle (van) and heavy goods vehicle trips. The car trips are segmented by trip purpose.
- 2.2.2 The model was originally constructed with a base year of 2008. The model was subsequently updated to a base year of 2013 following the opening of the Carlisle Northern Development Route (CNDR).
- 2.2.3 The 2013 update of the model included updating both the highway network and the travel demand within the model. Following the update, the model outputs were compared against actual traffic data to validate the results of the model.
- 2.2.4 Further info on the structure of the Carlisle transport model and the 2013 update are provided in the following report:
- Local Model Validation Report, Cumbria County Council, February 2015

2.3 Forecasting

- 2.3.1 The study considered future years of 2025 and 2030 in line with the plan period. These future year scenarios contained various assumptions relating to potential changes to the highway network and traffic demand.
- 2.3.2 The future year scenarios considered in this study are shown below. More detail on each scenario is provided in Section 3.
1. 2025 Base
 2. 2025 Local Plan
 3. 2030 Local Plan
- 2.3.3 Traffic growth was applied to the base model to account for forecast changes in traffic demand. The growth was calculated based on best practice guidance and future housing targets.

- 2.3.4 Committed changes to the highway network were included the model. These generally took the form of site accesses for specific sites.
- 2.3.5 The traffic demand related to specific development sites were added to the model. This involved estimating the traffic demand of each development, and distributing these trips across the model.
- 2.3.6 The model outputs were used to assess the impact of these scenarios. The model outputs include traffic flows, forecast junction capacity, queues and delays.
- 2.3.7 The outputs from the model have been used to inform a further study which identifies potential transport improvements in Carlisle. The improvements study identifies potential measures and costs and assesses their effectiveness using detailed modelling software.
- 2.3.8 The measures identified in the improvements report have also been tested in the strategic model as part of this study to assess their cumulative impact. This is important as improvements to capacity in one location may have further impacts at other locations.
- 2.3.9 Further details on the nature and cost of improvements proposed to support the Carlisle Local Plan are provided in the Carlisle Transport Improvements Study report by Parsons Brinckerhoff. A summary of this study which details the key themes and findings is also available.

3 Development scenarios

3.1 Introduction

- 3.1.1 A number of future year demand scenarios were considered as part of the study. The future year demand scenarios are summarised below:
1. 2025 Base
 2. 2025 Local Plan
 3. 2030 Local Plan
- 3.1.2 Scenario 1, *2025 Base*, is the reference case scenario. It includes development which is currently proposed and considered as likely to occur by 2025. Specifically, this scenario includes new developments which were completed between the model update in July 2013 and September 2014, and committed developments which have received planning permission. It also includes current planning applications as of October 2014 which have not yet been determined but where it is considered that planning permission is likely. This is not meant to be prejudicial to the planning process and is based on guidance on uncertainty as defined by Table A2 in TAG Unit M4 *forecasting and uncertainty*.
- 3.1.3 Scenario 2, *2025 Local Plan*, is the first local plan scenario. As well as the development in Scenario 1, it includes all development at sites identified within the local plan up to 2025. Some sites are also partially or wholly included in Scenario 1, for example if a planning application has already been submitted for part of a site. The development size of these sites in this scenario has been adjusted to ensure the total development size is not overestimated.
- 3.1.4 Scenario 3, *2030 Local Plan*, is the second local plan scenario. As well as the development in Scenario 2, it includes additional development identified within the local plan from 2025 to 2030 at the broad location of South Carlisle. Full detail is not yet available on the potential layout and distribution of development in this location due to the fact it is proposed for the end of the plan period. Therefore, broad assumptions have been made in regard to development demand and access to the highway network.
- 3.1.5 The estimated traffic demand for all developments in these scenarios was estimated using the TRICS database. TRICS is a database of traffic and person surveys from different development sites throughout the UK. TRICS is used to estimate the trip generation of a proposed development by selecting surveys from similar sites in the database based on use class, size and location. The output of TRICS includes a trip rate which estimates the traffic or person trip generation per unit of the proposed development.

3.1.6 A separate TRICS analysis was undertaken for each development type included in the future year scenarios. More details on the development assumptions and trip generation in each scenario is provided in the following sections. The trip rates and overall trip generation are provided in the appendix.

3.2 Scenario 1: 2025 Base

3.2.1 Scenario 1 consists of the following assumptions

- Developments which have been completed between July 2013 and September 2014
- Developments which have been granted planning permission
- Developments where planning application has been outlined as of October 2014 which have not yet been determined but are likely to receive planning permission.

3.2.2 Scenario 1 includes a mix of development types, and included residential, offices, light industrial and warehousing and other developments such as leisure or retail. A plan showing the location of development sites in Scenario 1 is provided in the appendix as Figure A1 in Appendix A.

3.2.3 The development included in Scenario 1 includes the following:

- 4,331 residential dwellings (including 242 student bedrooms)
- 198,744 square metres of B1/B2/B8 employment development
- Mixed/other developments, including:
 - 20,404 square metres of B1/B2 employment development
 - 1,500 square metres of D1 non-residential institution development
 - 154 bedroom hotels development
 - 7,446 square metres of A1 food/non-food retail development
 - 720 square metres of A3 restaurant/café development

3.2.4 A summary of the trip generation of developments in Scenario 1 is provided in Table 3.1. A detailed list of all the developments in this scenario and their trip generation is given in Appendix A.

Table 3.1: Scenario 1: 2025 Base trip generation

Development type	Vehicle trips			
	Morning peak		Evening peak	
	In	Out	In	Out
Residential	467	1,306	1,235	723
Employment	683	139	100	520
Mixed/other	620	323	638	831
Total	1,770	1,767	1,973	2,074

3.2.5 The site access for each development was taken from the relevant planning application. Details of the site access location are provided in Appendix A.

3.3 Scenario 2: 2025 Local Plan

3.3.1 Scenario 2 considers specific development sites identified in the local plan up to 2025. Similar to Scenario 1, it includes a mix of development types. A plan showing the location of development sites in Scenario 2 is provided in the appendix as Figure A2 in Appendix A.

3.3.2 The development included in Scenario 2 includes the following:

- 2,043 urban residential dwellings
- 1,260 rural residential dwellings
- 37,415 square metres of B2/B8 employment development
- Mixed/other development, including:
 - 8,175 square metres of A1 food retail development
 - 8,000 square metres of D1 non-residential institution development
- City centre regeneration proposals, including:
 - 27,260 square metres of A1 non-food retail development
 - 1,929 square metres of A3 restaurant/café development
 - 6,800 square metres of D2 leisure development

3.3.3 The precise nature of the city centre regeneration proposals is not currently known. The assumptions on the development size and type in the city centre are based on information available in the Carlisle City Centre Development Framework report from July 2014.

3.3.4 A summary of the trip generation of developments in Scenario 2 is provided in Table 3.2. A detailed list of all the developments in this scenario and their trip generation is given in Appendix A.

Table 3.2: Scenario 2: 2025 Local Plan trip generation

Development type	Vehicle trips			
	Morning peak		Evening peak	
	In	Out	In	Out
Urban residential	306	852	809	474
Rural residential	165	559	501	260
Employment	149	79	36	118
Mixed/other	278	209	561	538
City centre	316	64	364	506
Total	1,215	1,762	2,271	1,896

3.3.5 The site access for each development was assumed based on the location of the site and the surrounding highway network. This assumption was made for the purposes of this study and is not a preference of the council or prejudicial to future planning applications.

3.4 Scenario 3: 2030 Local Plan

3.4.1 Scenario 3 considers development at the broad location of South Carlisle identified in the local plan from 2025 to 2030. This includes residential and employment development.

3.4.2 The development included in Scenario 3 includes the following:

- 2,825 residential dwellings
- 40,000 square metres of B1/B2/B8 employment development

3.4.3 A summary of the trip generation of developments in Scenario 3 is provided in Table 3.3. A detailed list of all the developments in this scenario and their trip generation is given in Appendix A.

Table 3.3: Scenario 3: 2030 Local Plan trip generation

Development type	Vehicle trips			
	Morning peak		Evening peak	
	In	Out	In	Out
Residential	424	1,178	1,119	655
Employment	301	89	51	226
Total	725	1,267	1,170	882

3.4.4 The precise layout and exact quantum of development at South Carlisle is not currently known. It is anticipated that further information will be available as part of an extensive masterplanning process. However, to assess the impact of this development as part of this study, assumptions had to be made on the layout of development in this area.

3.4.5 It has therefore been assumed that a third of the residential development would be accessed from Durdar Road, a third from Carleton Road, and a third from Scalegate Road and Brisco Road. It has also been assumed that the employment development would be accessed from Newbiggin Road, east of Brisco Road.

3.5 Trip distribution

3.5.1 The trips generated by each new development were distributed across the model using a synthetic gravity model. A gravity model distributes trips based on an assumed relationship between the length of a trip and the number of trips made. Traffic is therefore distributed based on the total forecast traffic generation and the cost of travel between origins and destinations in the model.

3.5.2 The cost of travel varies depending on trip purpose, so a separate model was used for each trip purpose. The trips were disaggregated by purpose using data from NTEM.

3.5.3 Before distributing the trips generated by a new development, it was necessary to determine whether all the trips would be 'new' to the highway network. For example, a proportion of trips travelling to or from a new development may already be on the network, and would simply divert into the new development. Alternatively, if there are a number of developments nearby, one trip may be linked to multiple developments. Finally, and particularly for food retail developments, people may choose to switch their trip from an existing development to the new development.

3.5.4 For each development, an assumption was made on the proportion of diverted or 'pass-by' trips, linked trips and switched or 'reassigned' trips. For each of these, a separate process was used to distribute these trips on the network. The remainder of trips were assumed to be 'new' and were distributed using the gravity model as defined above.

3.5.5 For pass-by trips, the origin and destination of trips using the nearest key road was analysed. Based on this distribution and the proportion of pass-by trips, each pass-by trip was split into two new trips; one from the existing origin to the new development, and one from the new development to the existing destination.

3.5.6 For linked trips, the proportion of new trips was simply reduced accordingly. For reassigned trips, the proportion of reassigned trips was moved from similar developments in line with existing trip totals to the new development.

3.5.7 The gravity model used for trip distribution in this study was of the form

$$T_{ij} = \alpha O_i D_j f(c_{ij}) \quad (1)$$

where T_{ij} is the number of trips between origin i and destination j , α is a proportionality factor, O_i is the total number of trips starting at origin i , D_j is the total number of trips ending at destination j and $f(c_{ij})$ is a generalised function of travel costs known as the deterrence function.

3.5.8 The deterrence function used was of the form

$$f(c_{ij}) = c_{ij}^n e^{-\beta c_{ij}} \quad (2)$$

where c_{ij} is the cost of travel between origin i and destination j and n, β are parameters to be defined.

3.5.9 Finally, the furness procedure was applied to the future year matrix to ensure the trip totals for each development are correct.

3.5.10 It should be noted that the assumptions regarding the highway network and traffic demand in small rural settlements included in the model are simplistic. The network only includes key routes and traffic demand is aggregated into broad locations. This means that the costs used within the gravity model are often inaccurate for new trips that could potentially stay within the rural settlements. The result of this is that trips generated by new developments in rural locations are all external to that settlement. This represents a pessimistic assessment of trip generation on the wider highway network that is likely to be an overestimate.

3.5.11 Similarly, the assumptions regarding development at South Carlisle are simplistic, due to the current lack of detail regarding development in this area. It is expected that development at South Carlisle will not just include residential housing and employment development, but also a number of associated developments including schools, retail and community facilities. However, the trip generation has not included the effects of this associated development, and assumed no linked trips within the development. This means all residential trips generated are external to South Carlisle. This also represents a pessimistic assessment of trip generation on the wider highway network that is likely to be an overestimate.

3.6 Summary of development scenarios

3.6.1 The forecast traffic demand from development sites is shown in Table 3.4. These totals are cumulative, so the 2030 Local Plan totals include traffic demand from Scenario 1, Scenario 2 and Scenario 3. The forecast pass-by trips traffic demand is shown in Table 3.5.

Table 3.4: Forecast development sites traffic demand

Time period	2013 Base	2025 Base	2025 Local Plan	2030 Local Plan
Morning peak	0	3,553	5,993	7,974
Evening peak	0	3,541	6,482	8,520

Table 3.5: Forecast pass-by trips traffic demand

Time period	2013 Base	2025 Base	2025 Local Plan	2030 Local Plan
Morning peak	0	160	231	231
Evening peak	0	293	544	544

- 3.6.2 The forecast traffic demand totals for each scenario is shown in Table 3.6. The totals shown include the additional traffic generation from specific development sites.

Table 3.6: Forecast traffic demand including specific development sites

Time period	2013 Base	2025 Base	2025 Local Plan	2030 Local Plan
Morning peak	23,780	30,006	31,757	34,492
Evening peak	23,359	29,589	31,580	34,432

4 Traffic growth

4.1 Introduction

4.1.1 Traffic growth is the change over time of the number of cars and goods vehicles on the highway network. When forecasting the performance of the highway network in the future, it is necessary to allow for changes in traffic demand.

4.1.2 Traffic growth can be split into two broad areas:

1. **New trips:** Changes in population, employment and car ownership directly affect how many vehicles travel on the highway network.
2. **Frequency of trips:** Changes in GDP, income and travel costs affect how frequently people travel

4.2 Forecast traffic demand

4.2.1 Growth in traffic demand in the future year scenarios was considered in line with the fixed demand approach defined in TAG Unit M4 *forecasting and uncertainty*. A fixed demand approach ignores effects such as induced or suppressed traffic due to changes in travel costs, and changes in travel choice such as peak spreading. A fixed demand approach was used so the impact of the proposed development can be clearly assessed between scenarios without the impact of other variables.

4.2.2 Uncertainty in relation to the growth factors has not been considered as part of the study. It is considered that this is not necessary as the key outputs of the study are the differing impacts between scenarios.

4.2.3 The National Trip End Model (NTEM) dataset represents the Department for Transport's standard assumptions about growth in travel demand. Access to the dataset is provided through the TEMPRO software.

4.2.4 TEMPRO was used to calculate growth factors for cars based on the future year, trip purpose, time period and the origin and destination of trips. The assumptions within NTEM were adjusted using the alternative assumptions facility within TEMPRO.

4.2.5 The Carlisle Local Plan has an annual average housing target of 565 dwellings from 2015, 70 per cent of which are to be in the Carlisle urban area. This was used as the baseline for future housing numbers. The housing numbers from the specific developments in each scenario were then subtracted from this baseline, and the housing assumptions within TEMPRO were adjusted to match this target.

- 4.2.6 This ensures that the impact of new housing is not double-counted by including the developments in the model directly as well as applying a growth factor. The growth factors still account for other forecast changes that may affect traffic growth, such as demographic changes and car ownership.
- 4.2.7 As a fixed demand approach was used, fuel and income factors were calculated using TAG Databook Table M4.2.1 *Forecast fuel price and income adjustment factors*. These factors are based on relationships between car travel, household income and fuel costs.
- 4.2.8 Growth factors for light goods vehicles and heavy goods vehicles were estimated from the National Transport Model, adjusted using local NTEM factors.
- 4.2.9 The forecast traffic demand totals for each scenario is shown in Table 4.1. The totals shown exclude the additional traffic generation from specific development sites. The traffic generation for specific sites is provided in Section 3.

Table 4.1: Forecast traffic demand excluding specific development sites

Time period	2013 Base	2025 Base	2025 Local Plan	2030 Local Plan
Morning peak	23,780	26,288	25,508	26,258
Evening peak	23,359	25,749	24,520	25,330

- 4.2.10 The growth factors used in the forecasting are provided in Appendix B.

5 Results

5.1 Introduction

- 5.1.1 The forecast scenarios were created by amending the network to include new accesses, applying traffic growth and including additional development traffic to the validated base model.
- 5.1.2 The measures identified in the improvements report have also been tested in the strategic model as part of this study to assess their cumulative impact. This is important as improvements to capacity in one location may have further impacts at other locations.
- 5.1.3 The forecast scenarios also included a traffic signal optimising procedure. The signal timings contained within the model are fixed, and changes in traffic flow due to developments may result in the original timings becoming inappropriate. The majority of signalised junctions within Carlisle operate on a system which coordinates signal timings, so junction capacity at these locations may be underestimated without optimisation.
- 5.1.4 The results of the forecast scenarios were then analysed. The model outputs include traffic flows, queues, delays, and the Ratio of Flow to Capacity (RFC) for junctions and links in the model.
- 5.1.5 The RFC of a movement at a junction is a measure of the congestion of that movement. A movement with a capacity of 1,000 vehicles per hour and a traffic demand of 900 vehicles per hour has an RFC of 0.9.
- 5.1.6 The maximum ideal junction performance is when all movements have an RFC of around 0.85–0.9. A junction is defined as operating over capacity if it has a movement with an RFC greater than one. Over capacity junctions experience an increased sensitivity to variations in traffic flow which manifest in unreliable journey times and an increase in queuing.
- 5.1.7 The RFC results for key junctions in the model are included as Table C1 and Figures C1–C3 in Appendix C¹. This details the maximum RFC for any movement at each junction for each forecast scenario. This also details the results for the tested improvement schemes.
- 5.1.8 The RFC of a junction can be an abstract concept as it is not easy to relate to when travelling along a road. To counter this, the impact of development can also be assessed by using journey times. Five routes along key corridors have been selected for journey time analysis, with separate journey times calculated for each direction of travel. These routes are presented below.

¹ The RFCs presented in the appendix vary slightly when compared to those in the Carlisle Transport Improvements Study. This is due to minor amendments to the model to correct errors identified during the infrastructure study. These small variations do not alter the conclusions of either study.

- Scotland Road/Kingstown Road between Hardwicke Circus and the M6 J44
- Castle Way/Wigton Road between Hardwicke Circus and the CNDR
- London Road/ Botchergate/Carleton Road between The Crescent and the M6 J42
- Warwick Road/Victoria Place between Georgian Way and the M6 J43
- CNDR between Wigton Road and the M6 J44

5.1.9 Finally, it should be noted that these results are average results for the whole peak hour and represent what is forecast to typically occur. As junction operation approaches capacity junction performance becomes more sensitive to variations in traffic flow. This means that small changes in traffic flow can result in large increases in queuing and delay throughout the peak hour.

5.1.10 The following sections summarise the RFC and journey time results from the model for each scenario. The RFC figure for each peak period is from the movement with the highest RFC value.

5.2 2013 Base results

5.2.1 The 2013 Base model represents the current conditions on the Carlisle highway network. The results are taken directly from the validated model.

5.2.2 A summary of overall junction performance across the network is provided in Table 5.1. This gives the total number of junctions in the model approaching capacity, with an RFC greater than 0.9 but less than one, and those over capacity, with an RFC greater than one.

Table 5.1: 2013 Base: junction performance results

RFC criteria	Morning peak	Evening peak
No. junctions with 0.9 > RFC > 1.0	6	6
No. junctions with RFC > 1.0	0	2

5.2.3 The results shown that there are a handful of junctions operating close to capacity, and fewer junctions operating over capacity.

5.2.4 A summary of journey time performance across the network is given in Table 5.2. This gives the journey time in seconds and the average speed in kilometres per hour for the routes defined in Section 5.1.

Table 5.2: 2013 Base: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	420	30.1	420	30.1
Scotland Road southbound	3.52	421	30.1	432	29.3
Wigton Road eastbound	4.01	425	34.0	453	31.9
Wigton Road westbound	4.01	466	31.1	468	30.9
London Road northbound	5.15	585	31.7	565	32.8
London Road southbound	5.13	579	31.9	629	29.4
Warwick Road eastbound	2.86	337	30.5	366	28.1
Warwick Road westbound	2.87	387	26.7	423	24.5
CNDR northbound	8.29	555	53.8	552	54.1
CNDR southbound	8.28	539	55.3	544	54.8

5.2.5 The results show that there are existing delays on key routes within the city, although these are not excessive. The Warwick Road route is shown to have the slowest average speed.

5.3 Scenario 1: 2025 Base results

5.3.1 Scenario 1 consists of completed developments, developments with planning permission, and live planning applications as of October 2014.

5.3.2 A summary of overall junction performance across the network is provided in Table 5.3. This gives the total number of junctions in the model approaching capacity, with an RFC greater than 0.9 but less than one, and those over capacity, with an RFC greater than one.

Table 5.3: Scenario 1 2025 Base: junction performance results

RFC criteria	Morning peak	Evening peak
No. junctions with $0.9 > \text{RFC} > 1.0$	12	13
No. junctions with $\text{RFC} > 1.0$	5	5

5.3.3 The results shown that there is an increase in both the number of overcapacity junctions, and the number of junctions approaching capacity. This is as a result of additional traffic demand from new developments and other traffic growth factors.

5.3.4 A summary of journey time performance across the network is given in Table 5.4. This gives the journey time in seconds and the average speed in kilometres per hour for the routes defined in Section 5.1.

Table 5.4: Scenario 1 2025 Base: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	438	28.9	444	28.5
Scotland Road southbound	3.52	468	27.0	504	25.1
Wigton Road eastbound	4.01	466	31.0	503	28.7
Wigton Road westbound	4.01	488	29.6	487	29.6
London Road northbound	5.15	626	29.6	612	30.3
London Road southbound	5.13	588	31.4	655	28.2
Warwick Road eastbound	2.86	360	28.6	433	23.7
Warwick Road westbound	2.87	471	22.0	485	21.3
CNDR northbound	8.29	628	47.5	581	51.4
CNDR southbound	8.28	624	47.8	664	44.9

5.3.5 The results show a general increase in journey times from 2013, particularly on routes entering the city. This is due to the increase in traffic from background traffic growth and the opening of the specific sites identified within Scenario 1.

5.4 Scenario 2: 2025 Local Plan results

5.4.1 Scenario 2 consists of specific development sites identified in the local plan up to 2025, in addition to the development included in Scenario 1.

5.4.2 A summary of overall junction performance across the network is provided in Table 5.5. This gives the total number of junctions in the model approaching capacity, with an RFC greater than 0.9 but less than one, and those over capacity, with an RFC greater than one.

Table 5.5: Scenario 2 2025 Local Plan: junction performance results

RFC criteria	Morning peak	Evening peak
No. junctions with 0.9 > RFC > 1.0	25	20
No. junctions with RFC > 1.0	6	7

5.4.3 The results show a further increase in the number of junctions approaching capacity, but a small increase in the number of junctions operating over capacity.

5.4.4 A summary of journey time performance across the network is given in Table 5.6. This gives the journey time in seconds and the average speed in kilometres per hour for the routes defined in Section 5.1.

Table 5.6: Scenario 2 2025 Local Plan: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	446	28.4	473	26.7
Scotland Road southbound	3.52	511	24.8	527	24.0
Wigton Road eastbound	4.01	489	29.5	553	26.1
Wigton Road westbound	4.01	550	26.3	520	27.8
London Road northbound	5.15	672	27.6	626	29.6
London Road southbound	5.13	587	31.5	670	27.6
Warwick Road eastbound	2.86	375	27.4	475	21.7
Warwick Road westbound	2.87	525	19.7	521	19.9
CNDR northbound	8.29	703	42.5	626	47.7
CNDR southbound	8.28	681	43.8	720	41.4

5.4.5 The results show a further increase in journey times along all routes, particularly along the routes with the largest development sites. This indicates that the local plan sites would have an impact on journey times along these key routes.

5.5 Scenario 3: 2030 Local Plan results

5.5.1 Scenario 3 consists of development at the broad location of South Carlisle identified in the local plan from 2025 to 2030, in addition to the development included in Scenario 2.

5.5.2 A summary of overall junction performance across the network is provided in Table 5.7. This gives the total number of junctions in the model approaching capacity, with an RFC greater than 0.9 but less than one, and those over capacity, with an RFC greater than one.

Table 5.7: Scenario 3 2030 Local Plan: junction performance results

RFC criteria	Morning peak	Evening peak
No. junctions with $0.9 > \text{RFC} > 1.0$	31	29
No. junctions with $\text{RFC} > 1.0$	15	15

5.5.3 The results show further increases in the number of junctions approaching capacity and the number of junctions operating over capacity.

5.5.4 A summary of journey time performance across the network is given in Table 5.8. This gives the journey time in seconds and the average speed in kilometres per hour for the routes defined in Section 5.1.

Table 5.8: Scenario 3 2030 Local Plan: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	444	28.5	474	26.7
Scotland Road southbound	3.52	539	23.5	557	22.8
Wigton Road eastbound	4.01	502	28.7	573	25.2
Wigton Road westbound	4.01	568	25.4	536	26.9
London Road northbound	5.15	744	24.9	700	26.5
London Road southbound	5.13	601	30.8	683	27.1
Warwick Road eastbound	2.86	386	26.6	515	20.0
Warwick Road westbound	2.87	586	17.7	568	18.2
CNDR northbound	8.29	736	40.6	655	45.6
CNDR southbound	8.28	719	41.4	789	37.8

5.5.5 The results show a further increase in journey times along the London Road route, and a slight worsening along other routes. This shows that the development at South Carlisle would further impact journey times to the south of the city. The slight worsening of journey times on other routes is reflective of further background traffic growth since 2025.

5.6 Improvement schemes

5.6.1 The Carlisle Transport Improvements Study identifies a number of highway and sustainable transport improvements throughout Carlisle. These include junction improvements at key locations on the highway network and walking, cycling and public transport improvements to encourage mode shift and reduce reliance on car travel.

5.6.2 The impact of the improvements has been tested in the Carlisle transport model to assess the cumulative impact of the improvements. This is important as capacity improvements at one location have the potential to create additional problems in other areas.

5.6.3 Highway improvements at the following locations have been assessed:

- Hardwicke Circus
- Georgian Way/Victoria Place
- Currock Road/Crown Street
- Stanwix Bank/Brampton Road
- Scotland Road/Etterby Street
- Warwick Road/Eastern Way
- Warwick Road/Montgomery Way/Tesco
- Botchergate/ Tait Street/Crown Street
- London Road/Eastern Way

- Wigton Road/Caldcotes
- Shaddongate/Junction Street
- Wigton Road/Orton Road

5.6.4 It is not possible to directly assess the impact of the proposed sustainable transport improvements in the Carlisle transport model. However, the improvements study concludes that the successful implementation of these measures has the potential to reduce peak hour traffic demand by up to five per cent. The impact of these improvements has therefore been tested in line with this conclusion by reducing traffic demand by five per cent. Further details on the nature and cost of improvements proposed to support the Carlisle Local Plan are provided in the Carlisle Transport Improvements Study report by Parsons Brinckerhoff. A summary of this study which details the key themes and findings is also available.

5.6.5 A summary of the impact of the highway improvements is shown in Table 5.9.

Table 5.9: Highway improvements: junction performance results

Scenario	RFC criteria	Morning peak	Evening peak
Scenario 2: 2025 Local Plan	No. junctions with 0.9 > RFC > 1.0	15	19
	No. junctions with RFC > 1.0	7	5
Scenario 3: 2030 Local Plan	No. junctions with 0.9 > RFC > 1.0	27	25
	No. junctions with RFC > 1.0	11	12

5.6.6 The results show that there is a small reduction in the number of over capacity junctions in Scenario 2, with a larger decrease in the number of junctions approaching capacity. A reduction in the number of both the number of over capacity junctions and junctions approaching capacity is also shown in Scenario 3. This shows that the highway improvements would successfully reduce congestion in Carlisle.

5.6.7 The impact of the highway improvements on journey times is shown in Table 5.10 and Table 5.11 for Scenario 2 and Scenario 3 respectively.

Table 5.10: Scenario 2 2025 Local Plan with highway improvements: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	451	28.1	486	26.1
Scotland Road southbound	3.52	490	25.9	518	24.4
Wigton Road eastbound	4.01	491	29.4	553	26.1
Wigton Road westbound	4.01	550	26.2	524	27.5
London Road northbound	5.15	656	28.3	621	29.9
London Road southbound	5.13	605	30.5	711	26.0
Warwick Road eastbound	2.86	370	27.8	442	23.3
Warwick Road westbound	2.87	473	21.9	459	22.5
CNDR northbound	8.29	710	42.0	632	47.2
CNDR southbound	8.28	657	45.3	707	42.2

Table 5.11: Scenario 3 2030 Local Plan with highway improvements: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	452	28.0	490	25.8
Scotland Road southbound	3.52	519	24.4	541	23.4
Wigton Road eastbound	4.01	502	28.8	593	24.3
Wigton Road westbound	4.01	566	25.5	538	26.8
London Road northbound	5.15	718	25.8	660	28.1
London Road southbound	5.13	620	29.8	738	25.0
Warwick Road eastbound	2.86	385	26.7	475	21.6
Warwick Road westbound	2.87	532	19.4	490	21.1
CNDR northbound	8.29	748	39.9	656	45.5
CNDR southbound	8.28	702	42.5	767	38.9

- 5.6.8 The results show that the impact on journey times varies depending on the route.
- 5.6.9 A summary of the impact of both the sustainable transport improvements and highway improvements is shown in Table 5.12.

Table 5.12: Sustainable improvements: junction performance results

Scenario	RFC criteria	Morning peak	Evening peak
Scenario 2: 2025 Local Plan	No. junctions with 0.9 > RFC > 1.0	10	15
	No. junctions with RFC > 1.0	5	2
Scenario 3: 2030 Local Plan	No. junctions with 0.9 > RFC > 1.0	17	21
	No. junctions with RFC > 1.0	8	7

5.6.10 The results show a further reduction in both the number of overcapacity junctions and the number of junctions approaching capacity in both scenarios. This suggests that the successful implementation of the sustainable transport measures would reduce congestion throughout Carlisle.

5.6.11 The impact of both the sustainable transport improvements and the highway improvements on journey times is shown in Table 5.13 and Table 5.14 for Scenario 2 and Scenario 3 respectively.

Table 5.13: Scenario 2 2025 Local Plan with sustainable improvements: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	450	28.1	486	26.0
Scotland Road southbound	3.52	487	26.0	514	24.6
Wigton Road eastbound	4.01	492	29.3	557	25.9
Wigton Road westbound	4.01	552	26.1	519	27.8
London Road northbound	5.15	652	28.4	621	29.9
London Road southbound	5.13	609	30.3	715	25.8
Warwick Road eastbound	2.86	368	28.0	441	23.3
Warwick Road westbound	2.87	470	22.0	463	22.3
CNDR northbound	8.29	708	42.2	625	47.8
CNDR southbound	8.28	667	44.7	708	42.1

Table 5.14: Scenario 3 2030: Local Plan with sustainable improvements: journey time summary results

Route	Length (km)	Morning peak		Evening peak	
		Time (s)	Speed (kph)	Time (s)	Speed (kph)
Scotland Road northbound	3.52	451	28.1	488	25.9
Scotland Road southbound	3.52	510	24.9	540	23.5
Wigton Road eastbound	4.01	506	28.6	599	24.1
Wigton Road westbound	4.01	562	25.7	533	27.1
London Road northbound	5.15	711	26.1	659	28.1
London Road southbound	5.13	609	30.3	742	24.9
Warwick Road eastbound	2.86	374	27.5	478	21.5
Warwick Road westbound	2.87	522	19.8	481	21.5
CNDR northbound	8.29	735	40.6	655	45.6
CNDR southbound	8.28	705	42.3	770	38.7

5.6.12 The results show that the improvements have only a slight effect on journey times along key routes.

5.7 Summary

5.7.1 A summary of the junction performance results for all scenarios is presented below in Table 5.15. The summary shows how the number of over capacity junctions is expected to increase in each scenario. It also shows the cumulative impact of the improvement options, which successfully reduce the number of over capacity junctions.

Table 5.15: Summary of over capacity junction performance results

Scenario	Morning peak	Evening peak
2013 Base	0	2
Scenario 1: 2025 Base	5	5
Scenario 2: 2025 Local Plan	6	7
Scenario 2: 2025 Local Plan with highway improvements	7	5
Scenario 2: 2025 Local Plan with highway and sustainable improvements	5	2
Scenario 3: 2030 Local Plan	15	15
Scenario 3: 2030 Local Plan with highway improvements	11	12
Scenario 3: 2030 Local Plan with highway and sustainable improvements	8	7

5.7.2 The summary table shows that the number of over capacity junctions is forecast to increase in the future as a result of additional development.

- 5.7.3 The highway improvements are forecast to result in a small change in the number of over capacity junctions in 2025 with the local plan, compared to the base scenario. In 2030, there is a further decrease in the number of over capacity junctions. The results in the previous sections detail how the improvements reduce the number of junctions approaching capacity in both scenarios.
- 5.7.4 The sustainable transport improvements are shown to reduce the number of over capacity junctions in both the 2025 and 2030 local plan scenarios when compared to the base scenario.
- 5.7.5 The journey time results showed that journey times on key routes are forecast to increase in the future as a result of additional development.
- 5.7.6 The results for the highway and sustainable transport improvements show that these are only forecast to have a slight effect on journey times along key routes. This indicates that more significant delays may be present for traffic wishing to access these routes, rather than traffic using this route.
- 5.7.7 This can be considered by analysing the average speed of vehicles across the whole of Carlisle. Table 5.16 shows the average network speed in kilometres per hour across Carlisle for all forecast scenarios and improvement options. The average speed in 2013 is shown to be above 48 kph (30 mph) due to the inclusion of roads with a higher speed limit, such as rural roads.

Table 5.16: Average speed across Carlisle in kilometres per hour

Scenario	Morning peak	Evening peak
2013 Base	49.5	48.6
Scenario 1: 2025 Base	46.6	45.8
Scenario 2: 2025 Local Plan	44.4	44.0
Scenario 2: 2025 Local Plan with highway improvements	44.6	44.3
Scenario 2: 2025 Local Plan with highway and sustainable improvements	46.0	45.1
Scenario 3: 2030 Local Plan	42.6	41.9
Scenario 3: 2030 Local Plan with highway improvements	42.8	42.3
Scenario 3: 2030 Local Plan with highway and sustainable improvements	44.5	43.8

- 5.7.8 The results for the forecast scenarios show that the average speed is expected to decrease with the new development sites, which correlates with the journey time results.
- 5.7.9 The results also show that the improvement scenarios have the effect of increasing the average network speed. This shows that whilst the improvements have only a slight effect on journey times on key routes, they are successful in reducing overall network delay.

5.7.10 The results therefore demonstrate the junction improvements and the successful implementation of the sustainable transport improvements would help mitigate the transport impact of the local plan.

6 Conclusion

6.1 Summary

- 6.1.1 The results of the forecast scenarios have been analysed to assess the impact of the local plan proposals. This included assessing the number of junctions forecast to operate over capacity and the journey times along key routes within Carlisle.
- 6.1.2 The results forecast that the Carlisle Local Plan proposals would increase congestion, based on the maximum RFC of junctions, compared to the base scenario. The sites allocated to 2025 would only have a small effect on the number of over capacity junctions, but would increase the number of junctions close to capacity. Journey times are forecast to increase on key routes in the city, particularly on routes where a large proportion of development is located.
- 6.1.3 The development at South Carlisle from 2025 to 2030 would further increase the number of junctions close to capacity and the number of over capacity junctions. The results show that journey times would increase on all routes as a result of an extra five years traffic growth. However, the development at South Carlisle would also increase journey times on London Road.
- 6.1.4 The outputs from the model have been used to identify areas of Carlisle which are forecast to experience increased queuing and delay with the local plan proposals. This information is used in further work to help identify potential highway improvements in Carlisle and the cost of delivering these improvements. This improvements study also includes measures to increase the use of walking, cycling and public transport, along with indicative costs.
- 6.1.5 The impact of the measures proposed in the improvements study has also been assessed in the transport model. The results of this assessment show that the highway improvements and successful implementation of the sustainable transport improvements would help mitigate the transport impacts of the local plan.
- 6.1.6 Further details on the nature and cost of improvements proposed to support the Carlisle Local Plan are provided in the Carlisle Transport Improvements Study report by Parsons Brinckerhoff. A summary of this study which details the key themes and findings is also available. The improvements study informs Carlisle City Council's Infrastructure Delivery Plan, which forms part of the evidence base for the local plan.