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Technical Note

Project:	Chippenham Urban Expansion HIF		
Subject:	M4 Junction 17		
Author:	Reg 13(1)	Reviewed by:	Reg 13(1)
Date:	12/02/2019	Approved by:	Reg 13(1)
Version:	1.0		

1. Introduction

1.1. Introduction

Wiltshire Council are preparing a funding bid to be submitted to the Ministry of Housing, Communities and Local Government (MHCLG) through the Housing Infrastructure Fund (HIF). The bid seeks to fund a distributor road to the east of Chippenham, from Lackham roundabout of the A350 south west of the town to the A4 London Road, and from the A4 London Road to Parsonage Way in the north.

The objective of the distributor road is to aid the delivery of the homes and employment proposals of the Chippenham Urban Expansion. Without the distributor road, the level of development would cause unacceptable levels of delay through Chippenham town centre. However, the proposed growth will also lead to increases in congestion and delay at other points on the highway network, and to resolve these issues Wiltshire Council has proposed a number of mitigation schemes.

The mitigation schemes are proposed to be funded by existing CIL and strategic funds where necessary in the short term (by 2024, the opening year of the distributor road) or through expected CIL returns from the proposed development where schemes are required in the longer term. A mitigation scheme was considered necessary at M4 J17, to the north of Chippenham as initial testing of traffic growth suggested that by 2041 the junction would operate significantly over capacity.

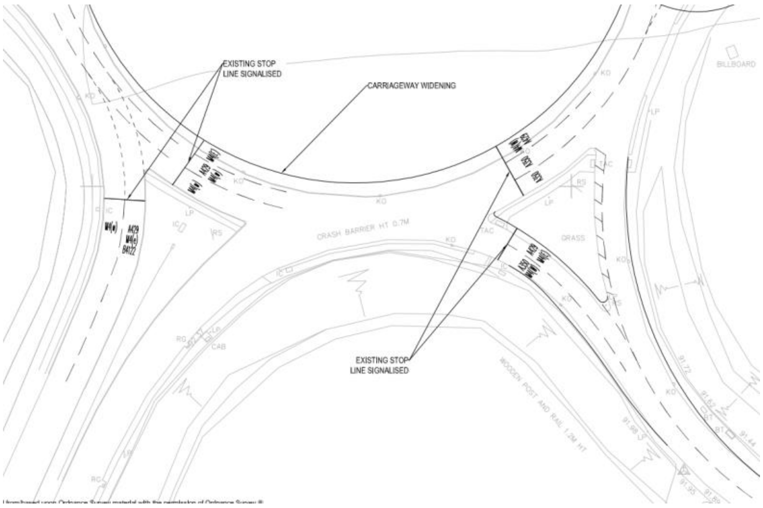
A meeting between Wiltshire Council's Chippenham Urban Expansion development team, Homes England and Highways England was held on the 30th January 2019. When informed of the need for mitigation at M4 J17, Highways England stated that without a committed funding source for the works they would not be in a position to issue an unconditional statement of support to the bid. Wiltshire Council do not currently hold a relevant funding source for the mitigation at M4 J17 and therefore are including it as part of the infrastructure to be funded by HIF.

1.2. Background

Junction 17 of the M4 is located in north Wiltshire, providing access to the motorway from the A350, A429 and B4122. Previously uncontrolled, a scheme completed in January 2019 introduced traffic signal control on the M4 eastbound and westbound off-slips, and the corresponding circulatory carriageway. All other arms remaining currently uncontrolled.

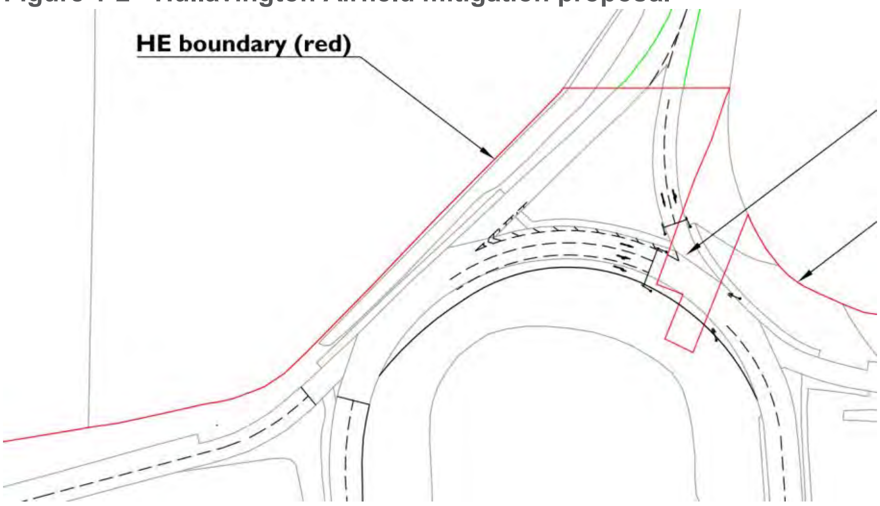
In August 2018, a planning application for Chippenham Gateway - a 1,000,000 sq ft of Class B8 commercial property - was approved with conditions to the south east of the junction. The development will be accessed via the B4122 approximately 400m from the junction. The planning application included a proposal (as shown in Figure 1-1) to signalise the B4122, the A350 and the conflicting circulatory carriageway, as well as widening the circulatory carriageway to three lanes in the southern section. Highways England's response to the planning application recommended approval with the condition that that scheme as shown was delivered by the developer.

Figure 1-1 - Chippenham Gateway proposed scheme



In August 2018, an outline planning application for up to 44,150 sq.m. of research and office commercial use was submitted for the Hullavington Airfield site to the north west of the junction. A mitigation scheme (as shown in Figure 1-2) has been proposed which signalises the A429 arm of M4 J17. At present the developer has not provided sufficient modelling information for Highways England to recommend approval of the planning application. Highways England's own modelled interpretation of the mitigation scheme suggests that the junction would not operate within capacity once development growth is added.

Figure 1-2 - Hullavington Airfield mitigation proposal



1.3. Purpose of this note

This note is intended to provide information to Highways England from which they will ascertain that a scheme proposed at M4 J17, and funded by Wiltshire Council's HIF application, will accommodate the level of growth associated with the aforementioned Chippenham Gateway, Hullavington Airfield and Chippenham Urban Expansion proposals.

The assessment of the operation of the junction within this note has made use of the LinSig junction model provided by Highways England to Wiltshire Council on the 6th December 2018.

2. Modelling methodology

2.2. Operational modelling methodology

A LinSig model was modified from a model supplied by Highways England which included the proposed Gateway development scheme for M4 J17 which consists of signalising all approaching arms and the circulatory apart from the A429 southbound approach. Changes to the current layout include offside flares which have been added to the circulatory at the B4122 and A350. The LinSig model has been assigned using delay-based assignment and run to optimise green splits and offsets for practical reserve capacity (PRC).

The model was modified to recalculate the intercept and slope for the priority of the junction of the A429 southbound approach using the ARCADY formula. This resulted in a similar slope and intercept value as in the supplied HE model, the slope being revised from 0.40 to 0.51 and the intercept value being revised from 1000 to 1166. Excess queue limiters have been added into the model of the souther circulatory links to assess the optimisation process by limiting queues to the available stacking space.

2.3. Network demand

Base demand

The initial step in establishing demand for the future year scenarios was to create a set of base flows with the methodology in detail in Appendix. Although a 2018 count (by Calidus for the Hullavington TA) was available there were some peculiarities in that some link flows were considerably different to other observed data. Rather than relying solely on the Calidus count, a range of three recent traffic surveys and WebTRIS data have been used to derive a 2018 observed traffic demand.

The data has been checked to ensure the that total entry, exit, circulatory and total flows are within ranges of each the observed data sources. These flows have been informally "calibrated" within LinSig to ensure that they are giving a realistic representation of the capacity and delay in the baseline scenario.

Forecast demand

The Wiltshire strategic highway model[1] has been utilised to determine how traffic demand would grow from the base model.

Two forecast years (2024 opening year and 2041 future year) have been established within the strategic highways model and are retained for the M4 J17 tests.

The two forecast year turning matrices for the junction have been extracted from the strategic model and the absolute difference in flows have been calculated. These have then been applied to the base demand from the LinSig model.

Additional traffic associated with the Hullavington Airfield (Dyson) scheme was not been included in the strategic model. Therefore, for scenarios including this scheme, the trips have been added on top of the core traffic forecast as per the development-only highway demand from the associated transport assessment.

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[1] Details of the model validation and traffic forecasting are found in the Wiltshire Strategic Model LMVR Dec 2018 Issue 1 and Chippenham Urban Extension HIF: Transport Modelling and Economics TN Issue 1

2.4. Scenario tests

The following scenarios were tested using the highway demand matrices.

- Do Min 1 – Core demand, gateway scheme
- Do Min 2 – Core + Chippenham UE demand, gateway scheme
- Do Som – Core + Chippenham UE demand + Hullavington,+ mitigation scheme design

2.5. Traffic forecasts

A summary of the total highway demand, entering Junction 17 (excluding the M4) for each scenario, is shown in Table 2-1.

Table 2-1 – Total Highway demand at Junction 17

Year	Demand Scenario	AM	PM	change vs obs			
				AM	PM	AM	PM
2018	Observed	4465	4488	-	-	-	-
2024	Core	4843	4825	8.5%	7.5%	379	337
2024	Core + Chip UE	4907	4865	9.9%	8.4%	442	377
2024	Core + Chip UE + Hullavington	5166	5106	15.7%	13.8%	701	618
2041	Core	5097	5149	14.2%	14.7%	633	662
2041	Core + Chip UE	5532	5485	23.9%	22.2%	1068	998
2041	Core + Chip UE + Hullavington	5791	5726	29.7%	27.6%	1327	1239

In summary, by 2041 there will be 14-15% core local plan growth (~600 extra trips).

With the urban extension this will rise to 22-24% growth (~400 extra trips), the Hullavington development is expected to increase this to 28-30% growth (~250 extra trips). Note that the urban extension assumes that there will be some reassignment of traffic based on the operational capacity and performance of the junction. The Hullavington additional trips are independent of any constraints.

It should be noted that the 2024 Core + Chip UE + Hullavington demand exceeds the 2041 core demand. The highway demand matrices, utilised in the operational modelling discussed next, can be found in Appendix B

A check on the recent growth and the short term projected growth at the junction slips has been undertaken. This utilised data from WebTRIS assessing the period from May 2014 to the end of 2018. The data suggests that the near-term forecasts for growth are broadly continuing the recent trend growth and can therefore be considered reasonable. The signalisation of the westbound slips resulted in a significant reduction in queuing and delay in the evening peak and the increase in demand post construction is reflected. There is not forecast to be significant growth on this arm.

3. Operational model output

3.2. Gateway Scheme (Do Min scheme)

There is currently planning consent for the Gateway scheme (design can be found in Figure 1-1**Error! Reference source not found.**) This is the assumed starting design for all scheme tests.

3.3. DM1 (Core Demand + Gateway Scheme)

This scenario includes core demand with the Gateway design. The LinSig results for the Gateway only scheme for 2024 are in appendix D.1.1 and D.1.2 and for 2041 are in appendix D.1.3 and D.1.4.

Table 3-1 - DM1 LinSig Results

	Time Period	PRC (%)	Total Traffic Delay (pcu/hr)
2024	AM	-20.4	118.2
	PM	-14.3	80.8
2041	AM	-24.5	139.1
	PM	-26.0	179.9

In the 2024 morning peak model, the Practical Reserve Capacity (PRC) is predicted to be -20.4%, demonstrating that the junction is operating over capacity. Two approaches are predicted to be over capacity; the eastbound off-slip and the A429 southbound approach. Furthermore, the circulatory carriageway at the A350 is predicted to be operating with a degree of saturation of over 90%. In the 2024 evening model, the PRC is predicted to be -14.3% with the A429 southbound approach operating over capacity and two lanes on the circulatory at B4122 operating with degrees of saturation over 90%.

The 2041 modelled results demonstrate a worsening performance compared to the 2024 results with reductions in reserve capacity and increases in delay. In the 2041 morning model, the PRC is predicted to fall to -24.5% with the A429 southbound approach, as well as, and two lanes on the circulatory operating over capacity. In the 2041 evening model, the PRC is predicted to fall to -26.0%, with the A429 southbound approach and two lanes on the circulatory at B4122 operating over capacity.

These results show that the gateway scheme is predicted to operate over capacity in 2024 and 2041 in both time periods with just local plan (core) growth.

3.4. DM2 (Core + Chippenham UE Demand, Gateway Scheme)

The second do-minimum scenario tests the core gateway scheme plus Chippenham HIF demand. For 2024 the results are shown in appendix D.1.5 and D.1.6 and for 2041 they are shown in appendix D.1.7 and D.1.8.

Table 3-2 – DM2 LinSig Results: Core plus Chippenham HIF Demand

	Time Period	PRC (%)	Total Traffic Delay (pcu/hr)
2024	AM	-23.2	136.5
	PM	-20.5	120.5
2041	AM	-45.4	298.5
	PM	-32.0	316.1

In the 2024 morning model, the predicted PRC is -23.2%, with the model forecasting that the M4 eastbound off-slip and the A429 southbound approach would operate over capacity. The 2024 evening model predicts that the PRC would be -20.5%, with the A429 southbound approach, the B4122 northbound approach and two lanes on the circulatory at the B4122 to all operating over capacity.

The 2041 modelled results predict a PRC of -45.4% in the morning peak and of -32% in the evening peak. In both time periods the M4 eastbound off-slip, and the A429 southbound approach are predicted to operate over capacity. The circulatory carriageway on the southern half of the roundabout is also predicted to operate over capacity in both 2041 assessed time periods.

All results predict that the Gateway Scheme will operate over capacity in 2024 and 2041 with and without the Chippenham HIF demand flows.

3.5. Proposed mitigation design

The proposed mitigation scheme associated with the Chippenham Urban Expansion consists of widening of approaches and the circulatory, as well as signalisation of all approaches. The M4 eastbound off slip includes a nearside flare. The A429 southbound includes a three-lane approach with nearside and offside flares. The A350 northbound approach includes an additional nearside flare to make a three-lane approach. The circulatory at B4122, A350 and A429 is widened to include full three-lane capacity with the overbridges remaining as two lanes.

The proposed drawing for the mitigation scheme can be found in Appendix C.

3.6. DS (Core + Chippenham UE + Hullavington demand, mitigation design)

This scenario includes the Chippenham UE demand as well as demand for the Hullavington planning application. The scenario also includes the proposed mitigation scheme outlined above. The full model results for 2024 are shown in appendix D.1.9 and D.1.10 and for 2041 in appendix D.1.11 and D.1.12.

Table 3-3 – DS LinSig Results: Future Growth plus Chippenham UE Demand

	Time Period	PRC (%)	Total Traffic Delay (pcu/hr)
2024	AM	-1.3	60.3
	PM	0.8	63.1
2041	AM	-5.6	84.4
	PM	-7.6	88.9

In the 2024 morning peak the PRC is predicted to be -1.3% and all lanes are predicted to operate within ultimate capacity. In the 2024 evening peak the PRC is predicted to be 0.8%, with all lanes also predicted to operate within capacity.

The modelled results predicted that in the 2041 the PRC in the morning peak will be -5.6% and -7.6% in the evening peak. In both peak periods the junction is predicted to operate within its ultimate capacity with significant decreases in modelled delay compared to the results presented in both DM scenarios.

4. Conclusion

This note has investigated the operation of M4 J17 under several scenarios. Despite the alterations proposed in mitigation of the approved Chippenham Gateway development, the addition of planned (Local Plan) growth indicates that the junction will operated over capacity by the first modelled year (2024). Both the M4 eastbound approach, and the northern A429 southbound approach are shown to experience over 100% degree of saturation. The issues are exacerbated in the second forecast year.

The addition of development traffic growth from the Hullavington site and Chippenham Urban Expansion proposals further reduce the operational efficiency of the junction.

The tests conducted on the approved Chippenham Gateway proposals suggest that M4 J17 will require further mitigation in order to remain within capacity, and that this mitigation would be needed by 2024.

As part of the infrastructure requirements for Chippenham Urban Expansion, a scheme at M4 J17 has been designed to mitigate for the additional demand generated by the proposed development. The scheme proposes to signalise the remaining uncontrolled arm of the junction (A429), widening three entries to the roundabout to include flares, and widening of the carriageway in the northern part of the circulatory.

The modelling indicates that the proposed mitigation scheme is able to operate within capacity in both forecast years and in both peaks.

Appendix A. Derivation of base demand

This section seeks to demonstrate how a “reliable” 2018 observed traffic matrix was derived.

A range of sources have been used to derive a 2018 observed traffic flow these include:

- JMP traffic survey (2016)
- PBA survey (2016)
- Callidus survey (Hullavington) (2018)
- WebTRIS data (http://webtris.highwaysengland.co.uk/, representing average weekday in May 2018.) Used in validation of traffic model.

These are shown in:

- Table A-1 – J17 Observed Data sources, PCUs: AM Peak hour (08:00 – 09:00)
- Table A-2 – J17 Observed Data sources, PCUs: PM Peak hour (17:00 – 18:00)

Note that all flows are in PCUs. The Callidus (Hullavington) traffic survey data specifies that vehicles are equivalent to PCUs. WebTRIS data has been converted the proportion of heavy vehicles and a PCU factor.

It has been assumed that the Callidus (Hullavington) survey, as the most recent source, is the best starting point for estimating the trip pattern at J17. Atkins opinion is that there was anomaly in the Callidus data, as there was an unusually high volume of trips from the A350 south and the M4 west travelling to the B4122 in both the peak periods. A check of volumetric flow on the B4122 based on the other counts, and sense checks in the region, suggested this movement was too high. It was replaced by PBA data as the start for a furness of, using TRIS June 2018 data as a target total for trips on the entry and exit slips.

The resulting observed data is found in:

- Table A-3 – J17 Observed Traffic, PCUs: AM Peak hour (08:00 – 09:00)
- Table A-4 – J17 Observed Traffic, PCUs: PM Peak hour (17:00 – 18:00)

The data has been checked to ensure the that total entry, exit, circulatory and total flows are within ranges of each the observed data sources. These flows have been informally “calibrated” within LINSIG to ensure that they are giving a realistic representation of the capacity and delay in the baseline scenario.

Table A-1 – J17 Observed Data sources, PCUs: AM Peak hour (08:00 – 09:00)

PBA Survey 2016	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South		486	495	824	50	1855	919
M4 West	511		253		109	873	1821
A429 North	401	225		248	100	974	1772
M4 East	545		106		82	733	1396
B4122	36	242	68	278		624	1788
Total	1493	953	922	1350	341	5059	

JMP Survey 2016	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South	0	378	369	716	49	1512	691
M4 West	458	0	194	0	83	735	1491
A429 North	349	225	0	166	63	803	1436
M4 East	375	0	155	0	77	607	1227
B4122	26	109	72	130	0	337	1562
Total	1208	712	790	1012	272	3994	

Hullavington Survey 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South		572	541	482	246	1841	762
M4 West	410		257		243	910	1612
A429 North	297	305		132	68	802	1513
M4 East	471		98		52	621	1569
B4122	39	114	113	132		398	1581
Total	1217	991	1009	746	609	4572	

TRIS June 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South							
M4 West						**921**	
A429 North							
M4 East						**699**	
B4122							
Total		**821**		**996**			

Table A-2 – J17 Observed Data sources, PCUs: PM Peak hour (17:00 – 18:00)

PBA Survey 2016	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South		444	485	578	45	1552	722
M4 West	520		214		129	863	1370
A429 North	495	303		75	100	973	1335
M4 East	655		158		105	918	1592
B4122	41	157	41	63		302	2131
Total	1711	904	898	716	379	4608	

JMP Survey 2016	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South	0	369	402	468	60	1299	851
M4 West	486	0	221	0	69	776	1288
A429 North	440	301	0	78	55	874	1166
M4 East	652	0	193	0	67	912	1411
B4122	24	192	82	83	0	381	2072
Total	1602	862	898	629	251	4242	

Hullavington Survey 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South	0	418	448	392	207	1465	738
M4 West	543		213		321	1077	1342
A429 North	358	374	0	98	97	927	1563
M4 East	628		119		83	830	1900
B4122	33	69	76	100		278	2022
Total	1562	861	856	590	708	4577	

TRIS June 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South							
M4 West						1023	
A429 North							
M4 East						957	
B4122							
Total		816		775			

Table A-3 – J17 Observed Traffic, PCUs: AM Peak hour (08:00 – 09:00)

Observed 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South	0	467	494	642	42	1645	762
M4 West	467	0	325	0	128	921	1573
A429 North	269	275	0	194	63	802	1453
M4 East	520	0	120	0	59	699	1246
B4122	32	92	102	173	0	398	1652
Total	1288	834	1041	1009	293	4465	

Table A-4 – J17 Observed Traffic, PCUs: PM Peak hour (17:00 – 18:00)

Observed 2018	A350 South	M4 West	A429 North	M4 East	B4122	Total	Circ
A350 South	0	375	390	501	36	1303	787
M4 West	605	0	268	0	149	1023	1271
A429 North	314	382	0	143	88	927	1418
M4 East	708	0	152	0	97	957	1575
B4122	25	61	65	126	0	278	2161
Total	1652	819	876	770	371	4488	

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Appendix B. Highway demand matrices

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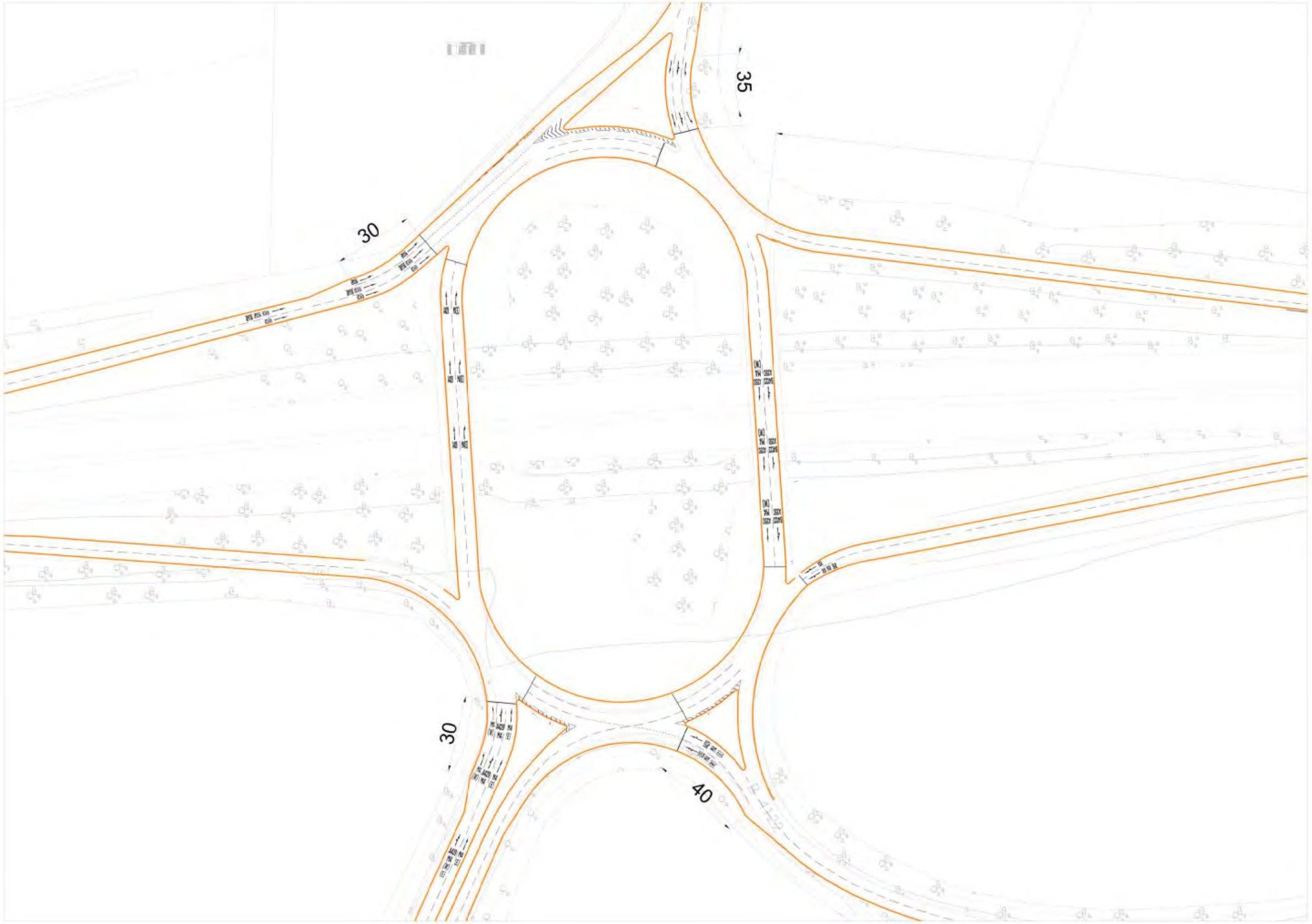
Appendix C. Chippenham Urban Expansion mitigation design



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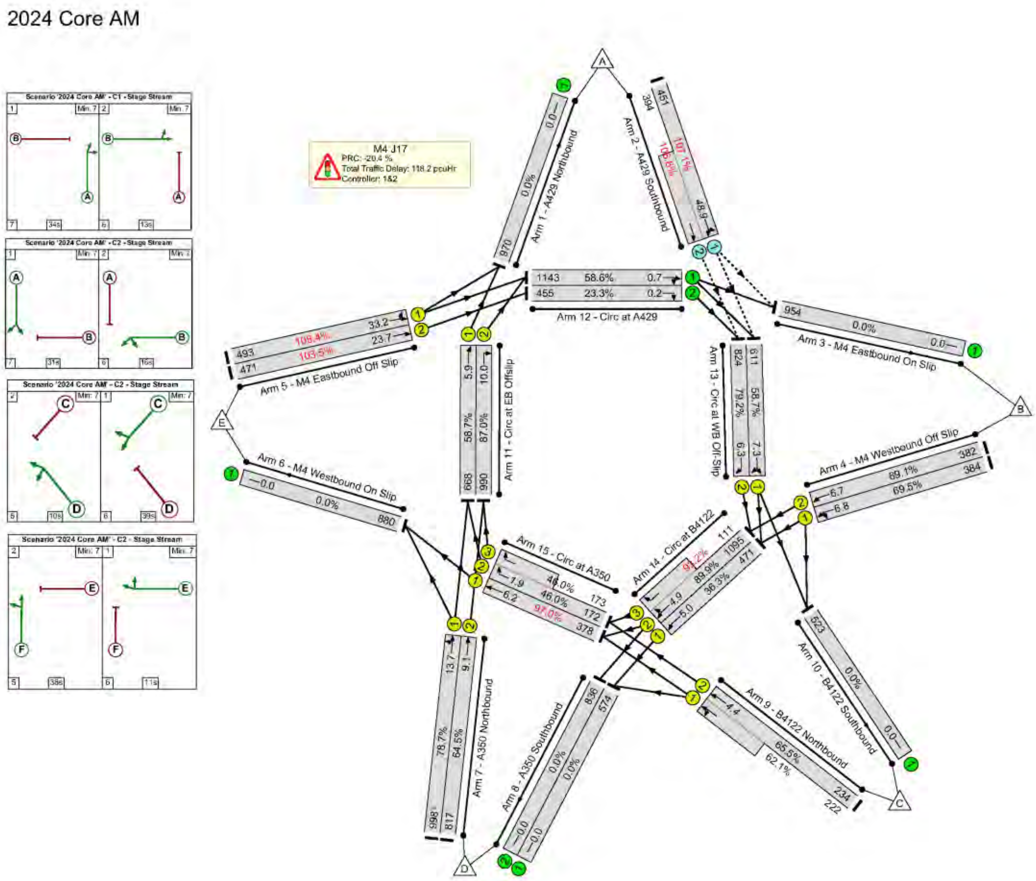
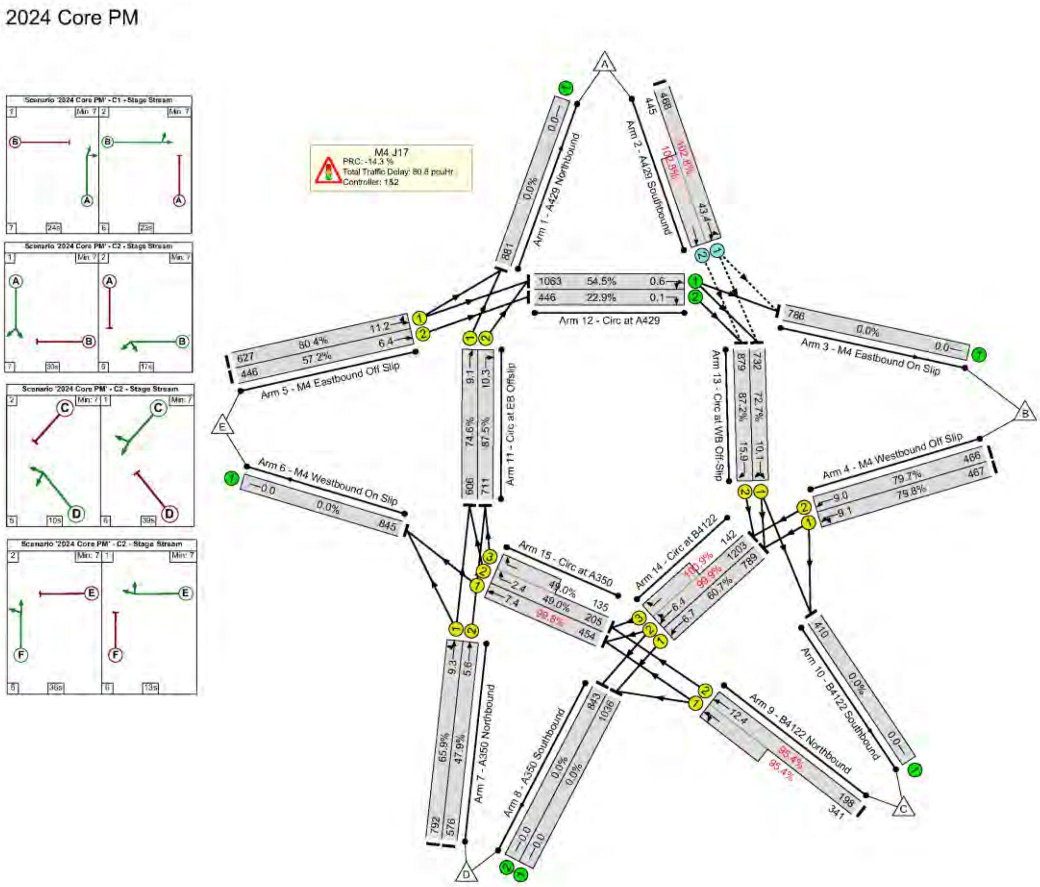
Appendix D. LinSig outputs

D.1.1. 2024 DM1 AM (Core) LinSig Results

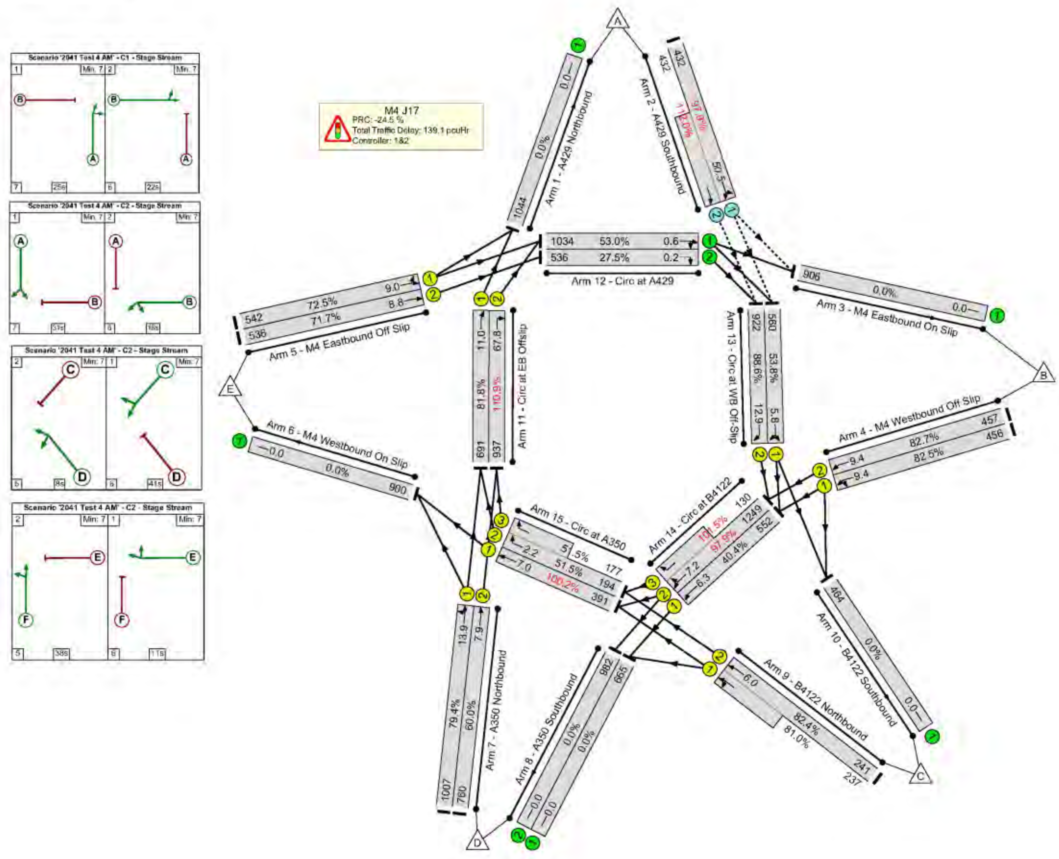


D.1.2. 2024 DM1 PM (Core) LinSig Results



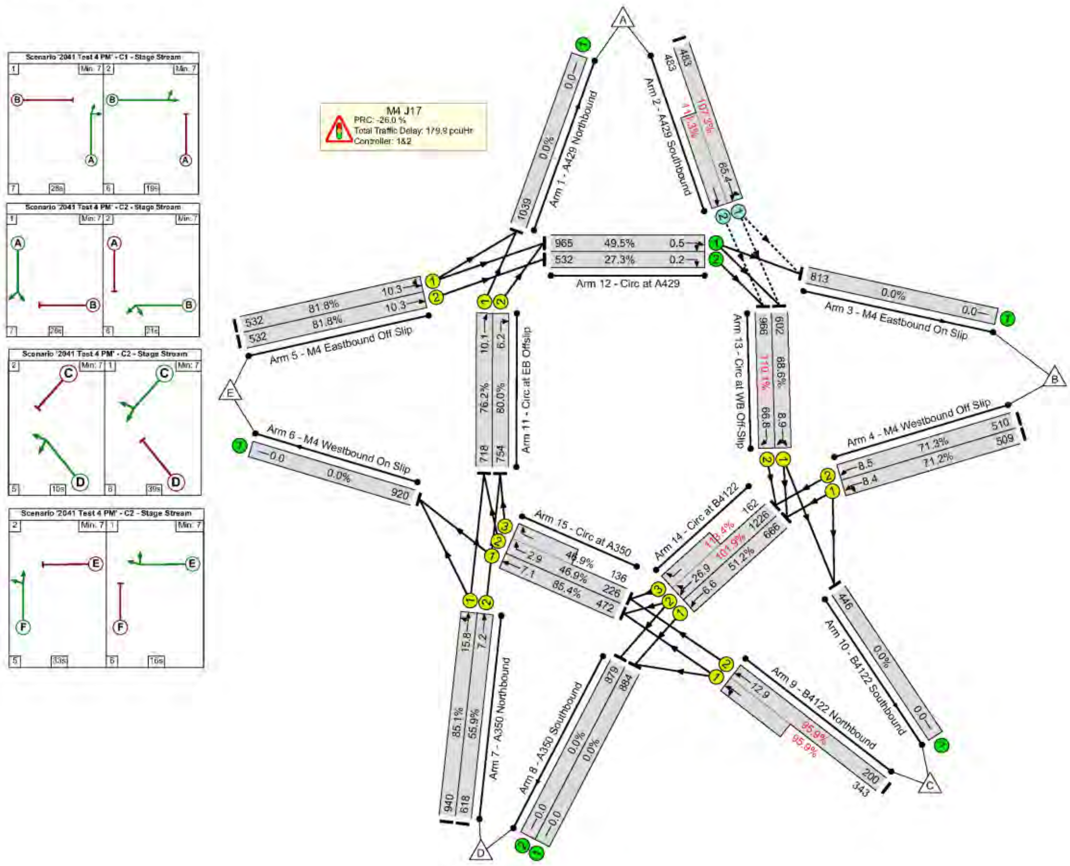
D.1.3. 2041 DM1 AM (Core) LinSig Results

2041 Core AM



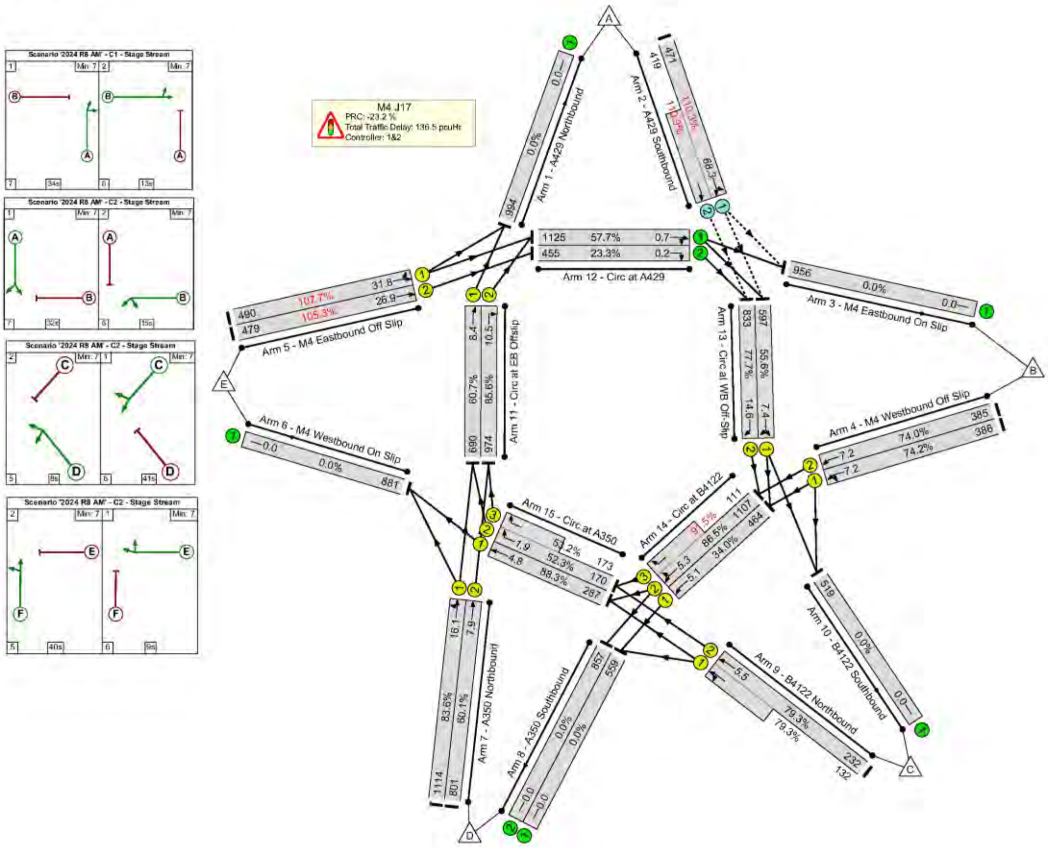
D.1.4. 2041 DM1 PM (Core) LinSig Results

2041 Core PM



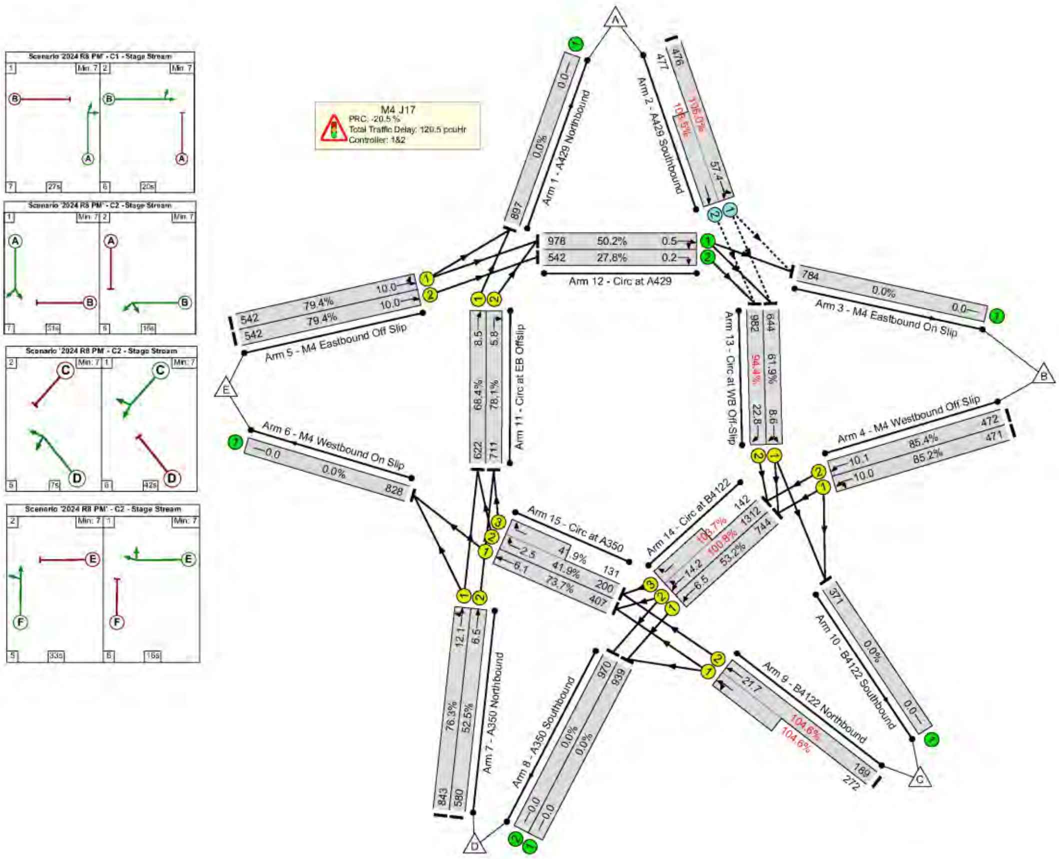
D.1.5. 2024 DM2 AM (Core + Chippenham UE) LinSig Results

2024 R8 AM



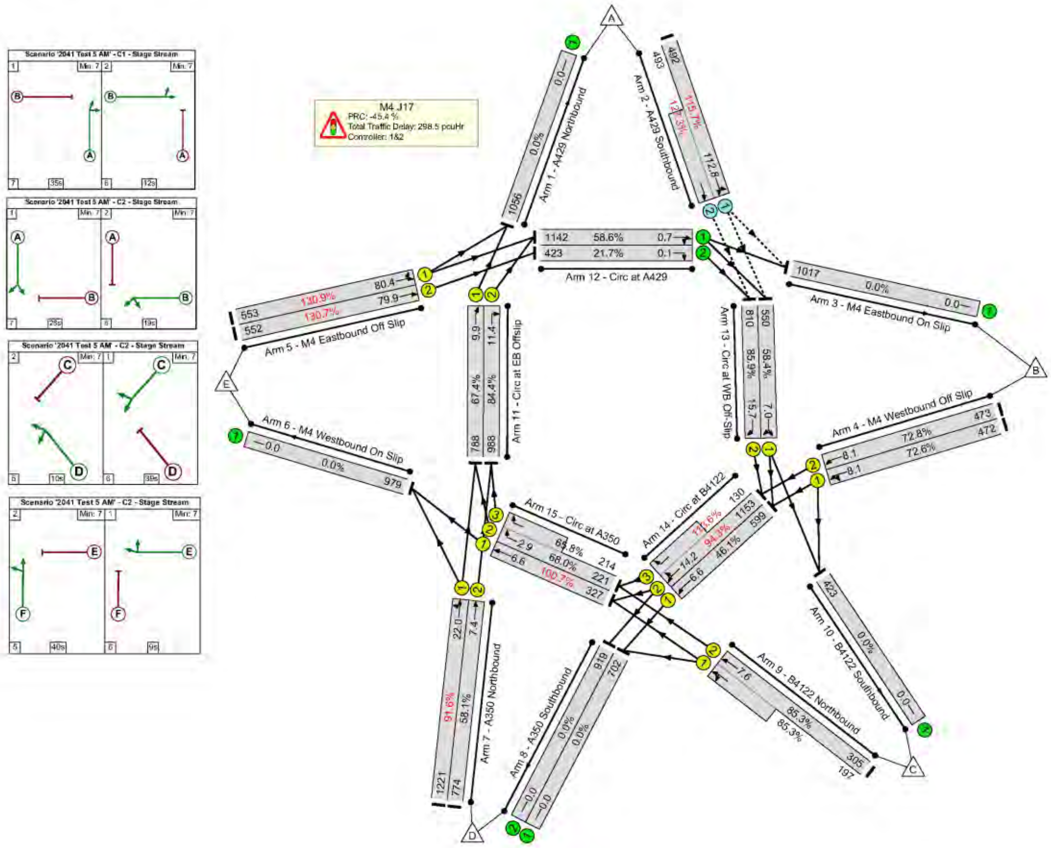
D.1.6. 2024 DM2 PM (Core + Chippenham UE) LinSig Results

2024 R8 PM



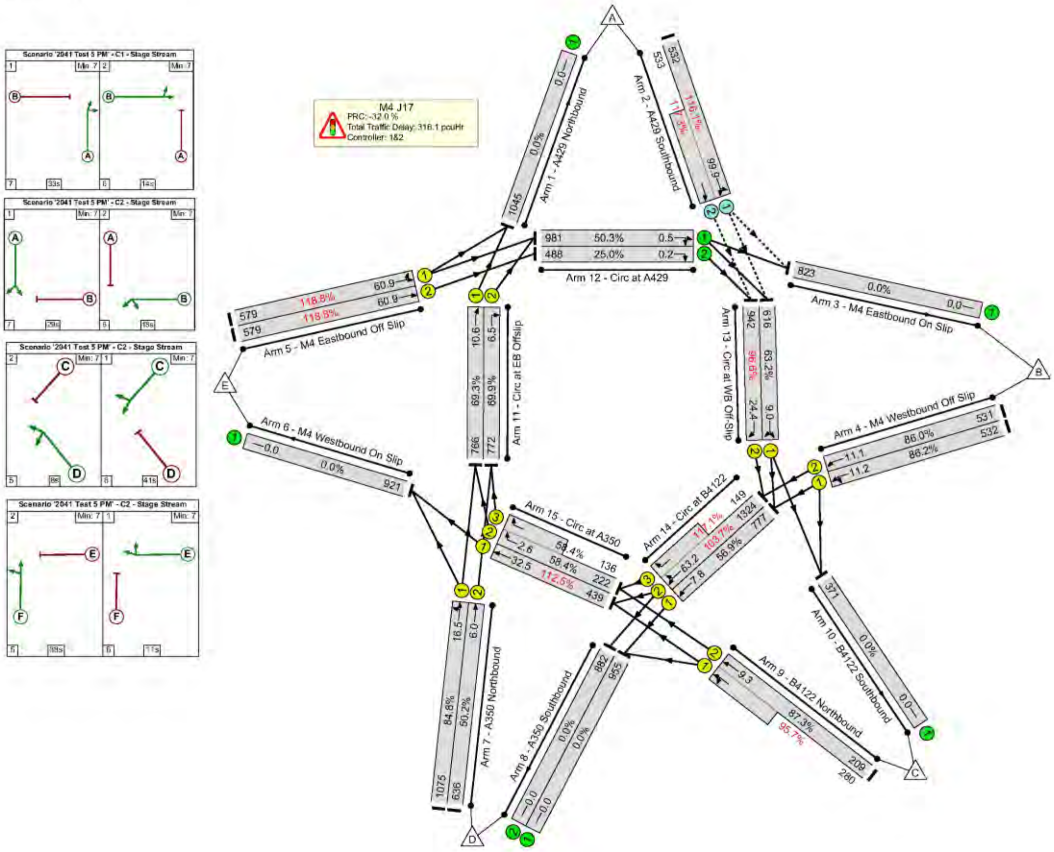
D.1.7. 2041 DM2 AM (Core + Chippenham UE) LinSig Results

2041 R8 AM



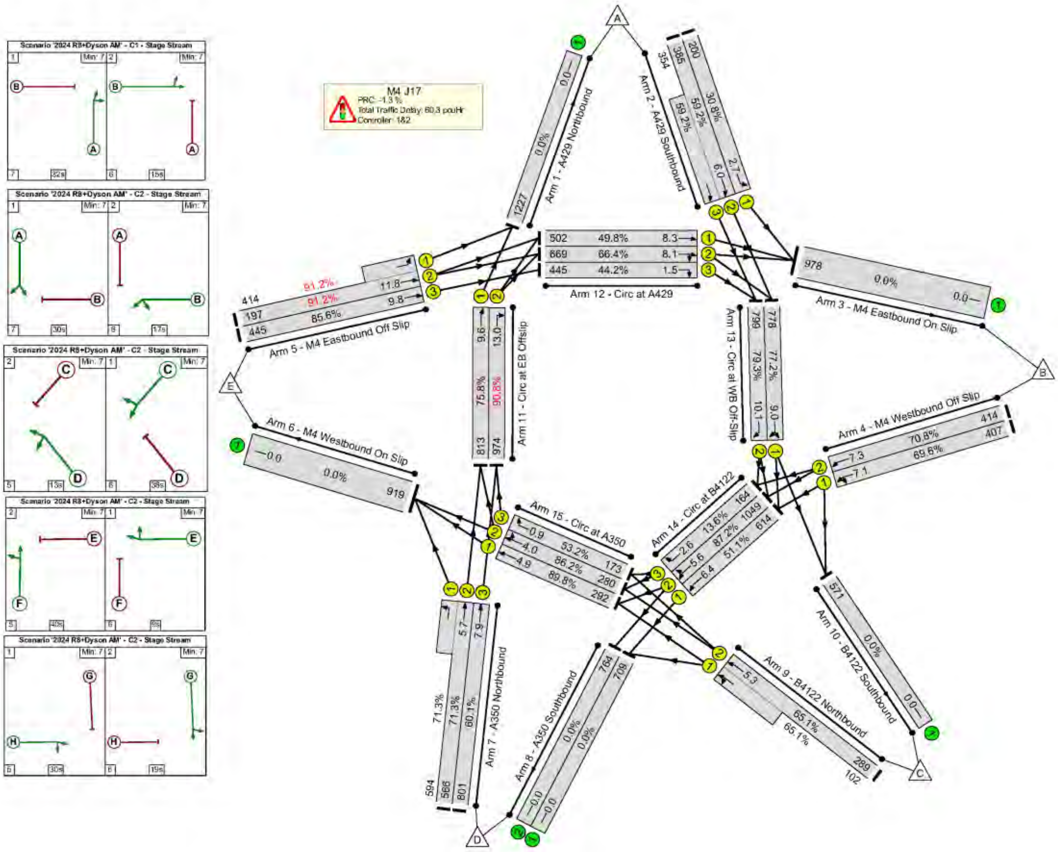
D.1.8. 2041 DM2 PM (Core + Chippenham UE) LinSig Results

2041 R8 PM



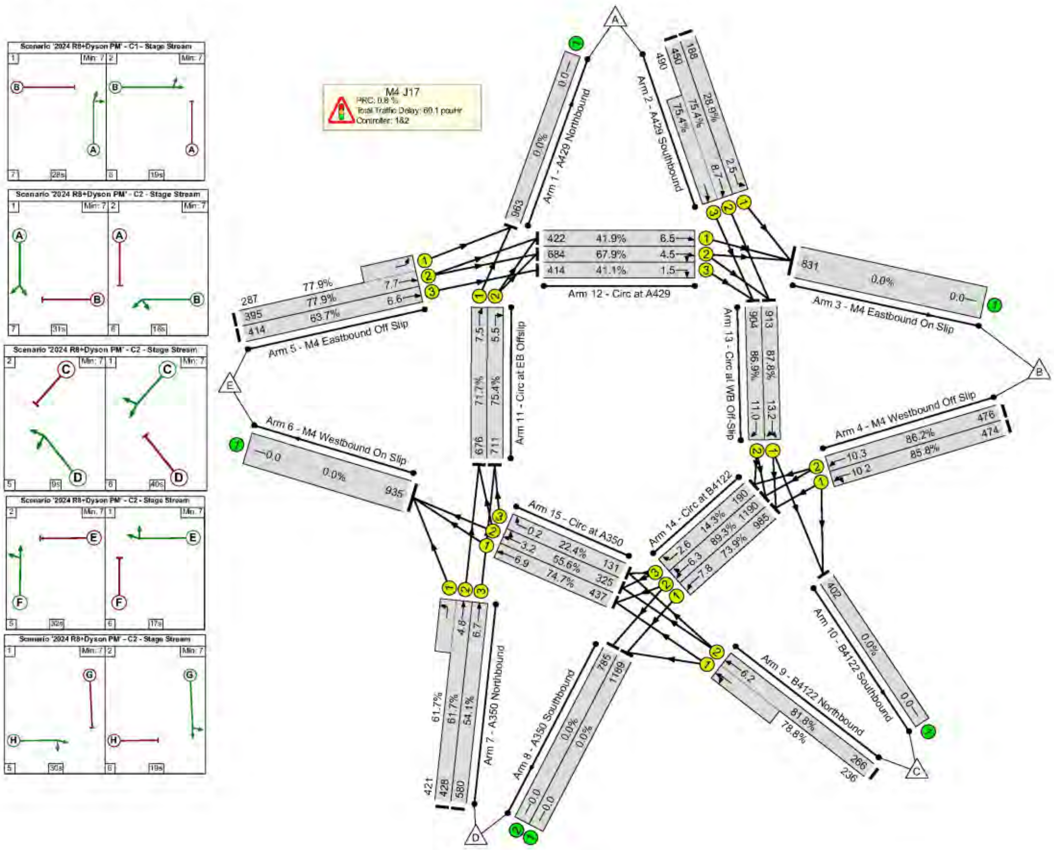
D.1.9. 2024 DS1 AM (Core + Chippenham UE + Hullavington) LinSig Results

2024 R8 + Dyson AM



D.1.10. 2024 DS1 PM (Core + Chippenham UE + Hullavington) LinSig Results

2024 R8 + Dyson PM



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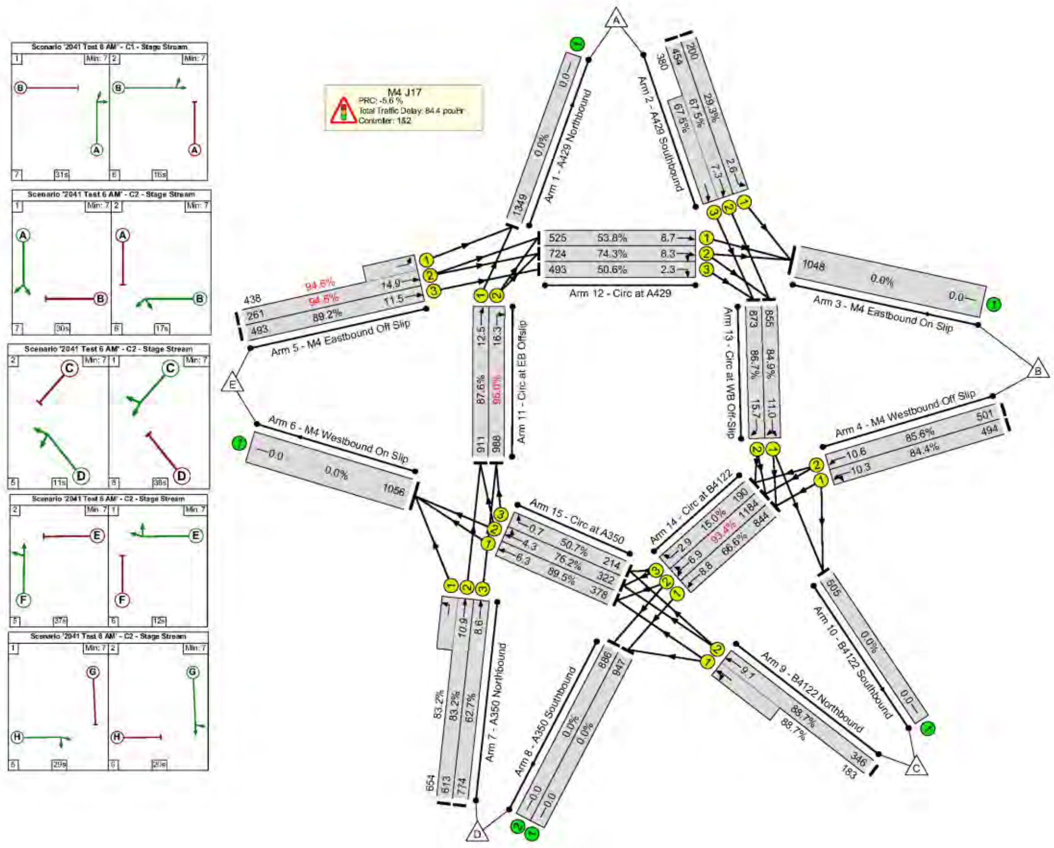
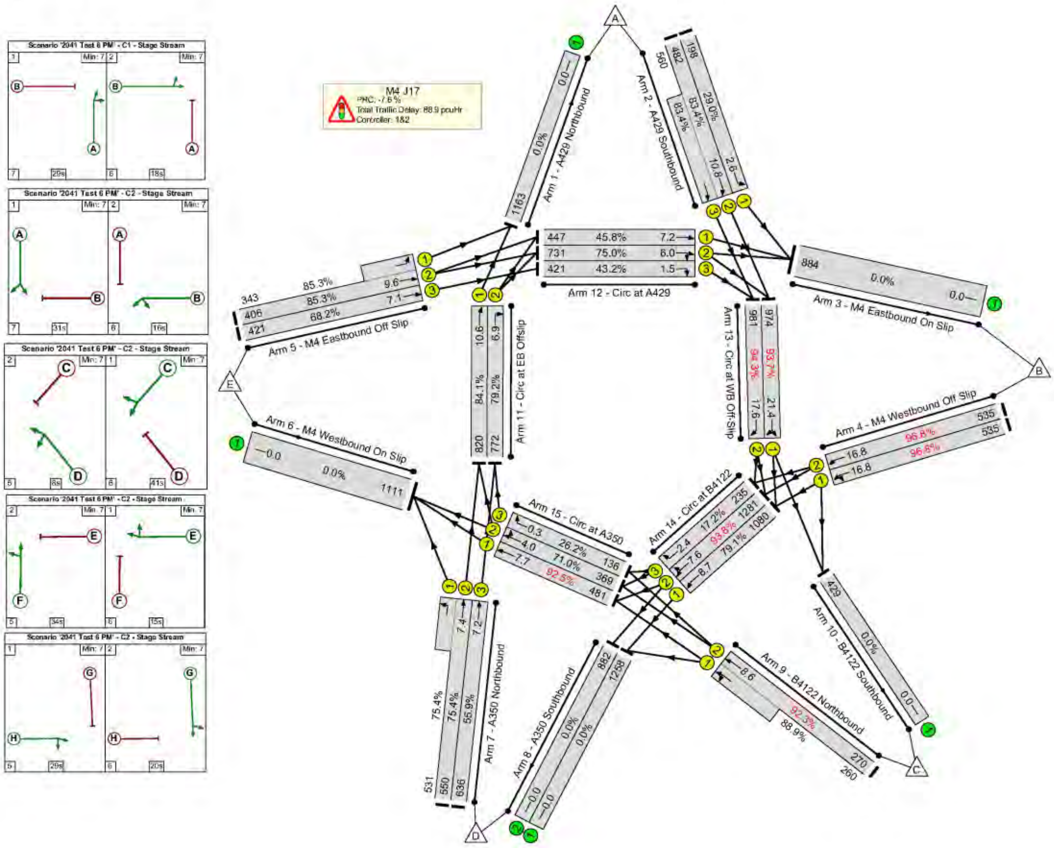
D.1.11. 2041 DS1 AM (Core + Chippenham UE + Hullavington) LinSig Results

2041 R8 + Dyson AM



D.1.12. 2041 DS1 PM (Core + Chippenham UE + Hullavington) LinSig Results

2041 R8 + Dyson PM



05 Wiltshire Council Spatial Planning letter of support

Reg 13(1) [redacted]

From: Reg 13(1) [redacted]
Sent: 20 March 2019 09:29
To: Reg 13(1) [redacted]
Cc: Reg 13(1) [redacted]
Subject: Housing Infrastructure Fund - Forward Funding Bid

Dear Reg [redacted]

I write to set out our comments in relation to the Council's Housing Infrastructure Fund(HIF) bid for Chippenham.

The scheme has a close fit with Chippenham's wider development plan context and will enable the upfront delivery of strategic infrastructure that is necessary to unlock future growth of the town.

Chippenham is designated as a Principal Settlement in the adopted Wiltshire Core Strategy, one of just three such settlements in Wiltshire. They are strategically important centres and the primary focus for growth in the County (Core Policy 1, Wiltshire Core Strategy 2006-2026, adopted January 2015). It is expected that Chippenham will continue to provide significant levels of new homes and jobs, together with supporting community facilities and infrastructure into the future.

The Chippenham Site Allocations Plan (adopted May 2017) allocates large scale mixed use, strategic sites, at the town. These sites have been planned to allow for a longer term pattern of growth at the town. The Plan's proposals safeguard the potential for future road alignments to the east and south, clearly indicating a need arising in the future for strategic road infrastructure improvements. Whilst preparing the Plan it was recognised that any future longer-term pattern of development would include roads to bridge the River Avon and link the A350 and A4, to unlock future phases of strategic housing growth, and maintain the resilience of the town's highway network to prevent unacceptable congestion and harm to the town centre (see Position Statement - Improving highway network resilience at Chippenham).

Work is underway to review the Wiltshire Core Strategy for the plan period 2016 to 2036. An employment land review reports that there is more market interest in Chippenham than any other town in the County, with business reporting a shortage of available land, and scope for more land to be allocated for new business and the expansion of existing employers (see Wiltshire Employment Land Review). The town has excellent transport links, being in close proximity to the M4, the A350 and is located on the main Bristol to London railway route. It will benefit further from electrification of the railway. This locational strength is a distinct reason for the town's important economic position. It is a focus for growth capitalising on the towns access to the M4 corridor, London and wider markets.

The Council's strategic housing land availability assessment shows a considerable amount of land being put forward by developers and land owners in the area (see Wiltshire Strategic Housing and Employment Land Availability Assessment). It is noted that all the land subject to the HIF bid is in this category. Work on housing needs has identified a housing market area centred on Chippenham (see Swindon and Wiltshire Housing Market Area Assessment). This evidence shows a step change increase in housing needs in the local area, an increase by more than 40%, in a wider context of continuing much the same or lower rates of house building elsewhere in the County.

Having taken into consideration the above factors, it is evident that there is a clear synergy between the ambition of the HIF bid to secure significant increases in housing at the town with current development plan strategy and its future direction.

Kind regards

Reg 13(1) [redacted]
Economic Development and Planning
Wiltshire Council
Email: Reg 13(1) [redacted]@wiltshire.gov.uk
Tel: Reg 13(1) [redacted]

Member of the SNC-Lavalin Group

Wiltshire Strategic 2018 Base Model

Local Model Validation Report

Wiltshire Council

November 2018

Notice

This document and its contents have been prepared and are intended solely as information for Wiltshire Council and use in relation to Report showing validation of the Wiltshire 2018 Base Model

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1. Introduction

1.1. Context

In 2017, Atkins produced the A350 Melksham Bypass Strategic Outline Business Case (SOBC) for Wiltshire Council, using the Melksham Transport Model (MTM). This model was cordoned from the A303 Stonehenge Model (which was itself derived from the South West Regional Transport Model (SWRTM, developed by Highways England). Extra refinement within the Melksham urban area was required, based on additional surveys, more detailed network coding and highway demand refinement. Whilst the MTM was sufficiently well calibrated within the Melksham area, outside of this region there was considerable model noise and uncertainty inherited from the SWRTM, which was to be expected as this model scope was defined to cover the strategic road network (SRN). The A350 Melksham Bypass SOBC study recommended that a new base model should be created with appropriate geographical scope, scale and detail.

In 2018, Wiltshire Council commissioned Atkins to scope out the additional traffic data required to enhance the existing A303 Stonehenge model (developed for Highways England) to develop a model which could be used to assess and appraise infrastructure schemes and development planning within the Wiltshire region. Atkins were then commissioned to develop the base model of Wiltshire.

This report outlines the steps taken to develop the Wiltshire 2018 base model, including the data collected, development of the model network and highway matrices and presents the output of the model calibration and validation process.

1.2. Potential uses of the model

The model is to be developed in accordance with the current Department for Transport (DfT) Transport Appraisal Guidance (TAG). See Section 2.4 for model standards. This is a general requirement when applying for major scheme business case funding from the DfT. The expected uses of the model will include, but not be limited to:

- Assessing the impacts of land developments or the impact of strategic infrastructure schemes; e.g. Chippenham Urban Expansion Housing Infrastructure Fund.
- Providing an evidential basis for informing business cases for specific transport schemes, e.g. A350 Melksham Bypass; A350 Phase 4 and 5 etc.
- Preparation of transport evidence to support transport strategy or a local plan review.
- Providing traffic forecasts to other analysis packages (local junction modelling software or micro-simulation e.g. LINSIG; Paramics, VISSIM etc)

In section 9 the recommended appropriate usage and limitations of the model are discussed.

1.3. Report structure

This report consists of the following sections:

2. Base model objective, specification and standards
3. Summary of data
4. Highway network development
5. Highway prior trip matrix development and
6. Impact of matrix
7. Model validation results
8. Variable demand
9. Summary

2. Base model objective, specification and standards

2.1. Objective and need for the model

Atkins' objective for the transport model of the Wiltshire and Swindon county regions is to provide a tool which can provide: **clear, transparent & plausible** highway transport forecasts, to inform planning and highway infrastructure decisions in a **fast, flexible** and **visual** way.

To achieve this, the strategy advocated within TAG, is to produce a model which accurately represents observed generalised travel costs (supply) and highway movements (demand). In order to be **proportionate**, it is recommended that the area of focus is within the region which the model sponsor requires analysis of the changes expected to occur.

As recommended in TAG, the model is pivot-point (or incremental) which means that it uses cost changes to estimate the change in the number of trips from a base matrix. The highway traffic forecasts will pivot off the transport model base costs and reference case trip patterns to form an important role in identifying and appraising future schemes and planning decisions in the Wiltshire & Swindon area.

An overview of how this objective was achieved, the limitations of the strategic model (Section 9.2) and the model appropriateness (Section 9.3) are discussed in the report summary.

2.2. Existing traffic models

South West Regional Transport Model (SWRTM, 2015)

The SWRTM was originally developed by Highways England during 2016, with a 2015 base year. The model has good coverage of the strategic network across the South West and includes junction simulation, as well as incorporating a Variable Demand Model (VDM) capability. Traffic forecasts were developed for 2021, 2031 and 2041.

A303 Stonehenge - Amesbury to Berwick Down Model (A303 Stonehenge, 2015)

The A303 Stonehenge model was developed by the Arup Atkins Joint venture (AAJV) on behalf of Highways England for PCF stage 2 of the Amesbury to Berwick Down scheme. The LMVR was issued in April 2017 but used data collected in 2015. The model used the SWRTM as a starting point and enhanced it around the area of the A303 ABD scheme (including Salisbury, Amesbury etc.) The model used locally collected RSI and additional ATC data and provided extra detail in the area equivalent to South/East Wiltshire. The forecast years for the model include 2026 (the expected opening year of the scheme), 2041 & 2051.

Melksham Transport Model (Melksham Model, 2017)

The Melksham Transport Model, developed in 2017 by Atkins, was derived from the A303 Stonehenge Model which was cordoned with Melksham at the centre, and more detail, including zone splitting, network amendments and traffic counts, was added. The base matrix development of this model was recalibrated to NTEM trips ends and observed calibration data around Melksham in 2017.

Swindon Strategic Transport Model (Swindon Urban Model, 2014)

The Swindon strategic transport model was developed by CH2M (Jacobs) with a 2014 Base year. The transport forecast model was developed by Atkins in 2017/2018. This covers the urban area of Swindon and includes forecast years for 2021 and 2036.

2.3. Model description and specification

2.3.1. Overall specification and modelling suite

The Wiltshire 2018 base model uses the A303 Stonehenge / SWRTM (with MTM localised improvements) as the primary starting point for further enhancement.

The highway component of the RTM modelling suite was developed using SATURN software. This highway model interacts with DIADEM which calculates travel demand based on changes in travel costs from the highway model (SATURN). This process iterates between demand calculations and highway assignments until equilibrium is reached with converged results

It is to be assumed that any parameters, processes or techniques used to develop the Wiltshire model suite is consistent with the Highways England RTMs, unless stated in this report.

2.3.2. Software version

The latest version of SATURN v11.4.07H was used for highway assignment.

2.3.3. Base year

The A303 Stonehenge / SWRTM was the starting point for further enhancement. Both model variants were developed using a 2015 prior matrix (derived from mobile phone data) and calibrated/validated with 2015 traffic flow counts and travel times.

Approximately 200 new traffic counts and ANPR surveys within the area of West Wiltshire were undertaken in June 2018 (see Section 3). In consultation and agreement with Highways England, the 2015 data from the wider area and the 2018 data in the localised area are sufficiently close in age to consider this model a 2018 base year without the need to apply growth factors to any of the traffic counts or the prior matrix outside the detailed model area.

2.3.4. Model time periods

The Wiltshire 2018 base model has been developed to represent an average 12-hour weekday in 2018 for the following time periods:

- AM average hour (0700-1000)
- Inter-peak average hour (1000-1600)
- PM average hour (1600-1900)

Any reference to AM, IP or PM (peak) refers to these time periods throughout this report, unless otherwise stated.

2.3.5. Demand segmentation

The OD trip matrices used for highway modelling are derived from the SWRTM and so comprise the same user classes, based on trip purpose and type of vehicle. Five user classes are modelled:

1. Car – business trips
2. Car – commuting trips
3. Car – other trips
4. Light goods vehicles (LGVs)
5. Heavy goods vehicles (HGVs)

The demand segmentation structure of the VDM differs from the highway only assignment. This is explained further in Section 8.

2.3.6. Generalised costs

This allows the model to take account of differences in users' value of time (VoT) and vehicle operating cost (VOC). For example, HGVs have different VOCs in comparison to cars and LGVs. The latter have been split into three trip purposes as the value of time differs between these types, i.e. vehicles on business trips are likely to have a higher value of time than, for example, a vehicle on a journey for leisure purposes.

This is explained further in Section 4.4, with base model generalised costs shown in Table 4-1.

2.3.7. Passenger Car Units

Demand in the SATURN traffic assignment is expressed in term of passenger car units (PCUs). The factors used to convert from vehicles to PCUs are listed in Table 2-1.

Table 2-1 - Passenger Car Unit Factors

Vehicle Type	PCU Factor
Car/LGV commuting	1.00
Car/LGV business	1.00
Car/LGV other	1.00
HGV	2.50

As applied in the SWRTM, the PCU factor for HGVs is a weighted average of the factors given in TAG for Rigid Goods Vehicles and Articulated Goods Vehicles. The weighting was applied using goods vehicle type splits on major roads within the study area from the Department for Transport's Annual Average Daily Flow – Data by Direction Major Roads[1].

2.4. Model standards

In general, the Wiltshire model standards are equivalent and consistent with those used for the SWRTM and A303 Stonehenge. The criteria utilised are found in the associated model validation reports. In summary, standard TAG acceptability guidelines have been utilised, with extra near criteria used which is consistent with those for all RTMs.

TAG unit M1.1 – "Principles of modelling and forecasting" states:

> *"It should be emphasised that it may not be necessary to use the most sophisticated or detailed models, nor is it likely to be appropriate to invest the highest proportion of resources to develop the best quality model at the expense of interpreting its outputs carefully and communicating its limitations".*

This report will primarily seek to present the base model outputs, carefully interpret the results and clearly communicate the sufficiency, implications (Section 9.1) and model limitations (Section 9.2).

A summary of the standards employed are discussed below.

2.4.1. Trip matrix validation

The reporting of the trip matrix validation is typically undertaken at a screenline/cordon level. TAG recommends that the differences between modelled flows and observed counts should be less than ±5% for all or nearly all screenlines.

In consistency with the RTMs, screenlines and cordons are considered *near* if the flows are within ±10%. This report will make it clear which screenlines: pass, fail or are near.

Trip matrix validation is presented and discussed in Section 7.1.

2.4.2. Individual link flow calibration

The two measures which are used for the individual link validation are GEH and flow. A link is considered successfully calibrated if one of these measures passes. For a model to be considered as suitably calibrated TAG Unit M3.1 states that 85% of individual links must pass these criteria.

The GEH measure uses the GEH statistic as defined below:

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

Where GEH is the GEH statistic, M is the modelled flow, and C is the observed flow

The flow measure is based on the relative flow difference between modelled flows and observed counts.

TAG Unit M3.1 describes the Link Flow and Turning Movements Validation Criteria and Acceptability Guidelines as shown in Table 2-2.

[1] http://www.dft.gov.uk/traffic-counts/download.php

An additional "near" criteria has been included which assumes that link flow validation is close with marginally relaxed criteria summarised below. This has been used to identify links which are considered good enough and allow focussed calibration on those areas of the model not falling within a pass or near criteria.

Table 2-2 - Link Flow and Turning Movement Validation Criteria and Acceptability Guidelines

Measure	Pass Criteria	Near Criteria
GEH	Less than or equal to 5	Less than or equal to 7
Observed flow less than or equal to 700 veh/h	Flow difference 100 veh/h or less	Flow difference 150 veh/h or less
Observed flow between 700 veh/h and 2,700 veh/h	Flow difference 15% or less	Flow difference 20% or less
Observed flow greater than 2,700 veh/h	Flow difference 400 veh/h or less	Flow difference 500 veh/h or less

Source: TAG Unit M 3.1 Table 2 provides "pass" criteria, "near" criteria is defined by either the RTM or Atkins.

The model link flow validation is presented and discussed in Section 7.2

2.4.3. Journey time validation

For journey time validation, the measure which should be used is the percentage difference between modelled and observed journey times, subject to an absolute maximum difference. TAG Unit M3.1 describes the Journey Time Validation Criterion and Acceptability Guideline as shown in Table 2-3.

Table 2-3 - Journey Time Validation Criterion and Acceptability Guideline

Criterion and Measure	Acceptability Guideline
Modelled times along routes should be within 15% (or 1 minute, if higher)	> 85% of routes

Source: TAG Unit M 3.1 Table 3

All comparisons are to be presented separately for each modelled period. There is no disaggregation presented by vehicle type. The Wiltshire model journey time validation is presented in Section 7.3.

2.4.4. Changes due to matrix estimation

Matrix estimation is a modelling technique that has become a standard feature in many traffic models. The purpose of matrix estimation is to produce a 'most likely' trip matrix that fits with available traffic count data. It is based on the theoretical procedure properly entitled 'Matrix Estimation from Maximum Entropy' and is generally referred to as ME2.

The process uses an iterative procedure to find a set of balancing factors for the origin-destination movements on each link with a traffic count to ensure that the assigned flows match the counts within certain user-defined limits. ME2 can be used to create a new trip matrix from scratch, but the best results are obtained when it is used to update an existing (prior) trip matrix. Within the SATURN suite, this process is run through the SATME2 program.

Traffic count data used for ME2 can be considered part of model calibration, but to properly validate the traffic demand distribution it is recommended that certain screenlines and cordon are not included within ME2. i.e. to allow validation of independent traffic count data.

Successive applications of ME2 should always use the same defined 'prior' trip matrix as an input, to prevent the process magnifying specific matrix changes on successive runs. For each modelled time period, matrix estimation needs to be applied separately for light (cars and LGVs) and heavy vehicles. TAG unit M3.1 suggests a set of benchmark criteria used to review the extent of changes due to matrix estimation relative to the prior matrix. These criteria are outlined in Table 2-4.

Table 2-4 - Matrix Estimation Change Criteria

Measure	TAG Benchmark Criteria	Additional RTM Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02 Intercept near zero R^2 in excess of 0.95	N/A
Matrix zonal trip ends	Slope within 0.99 and 1.01 Intercept near zero R^2 in excess of 0.98	N/A
Trip length distributions	Means within 5% Standard deviations within 5%	N/A
Sector to sector level matrices	Differences within 5%	Trips <100 have been excluded GEH Statistic & proportion of movements which change ±10%

TAG Unit M3.1, with modifications consistent with the RTMs.

The guidance identifies that any exceedances of the criteria above do not mean that the model is unsuitable for the intended uses. The performance of the model should be reviewed against these criteria and exceedances should be examined and assessed for their importance particularly in relation to the area of influence of the scheme to be assessed. For the Wiltshire model, the changes are described in Section 6.3 and detailed in Appendix E.

2.4.5. Assignment convergence criteria

The advice on model convergence is set out in TAG Unit M3.1 (Table 4) and is reproduced below in Table 2-5. The Wiltshire model convergence statistics are presented in Section 7.4.

Table 2-5 - Summary of Convergence Criteria

Convergence Measures	Type	Base Model Acceptable Values
Delta & %GAP	Proximity	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P1) < 1%	Stability	Four consecutive iterations greater than 98%

Source: TAG Unit M 3.1 Table 4

TAG convergence criteria values were adopted and the results presented separately for each modelled period.

2.4.6. Demand model convergence and realism testing

Realism testing is used to ensure that the model responds to changes in travel costs rationally, behaves realistically and with acceptable elasticities. This involves changing various components of travel costs to check whether the response of the VDM is consistent with general experience. Part of the calibration process involves adjusting the parameters in the VDM model until more acceptable results are obtained from such realism tests. It is recommended that these tests are started with initial logit parameters (i.e. the spread, sensitivity or scaling parameters - lamda and theta) based on median values in TAG Unit M2, Section 5.6.

The primary realism tests require that car fuel cost and car journey time elasticity tests are undertaken. Public transport generalised costs, including changes in fares are not modelled and hence public transport fare elasticites are not included.

The elasticities are calculated using model output from different runs using the base year model, from a converged run of the demand/supply loop.

For the Wiltshire model the VDM and realism testing is described and presented in Section 8.

Car Fuel Price Elasticities Targets

The car fuel cost elasticity required is the percentage change in car vehicle-kms with respect to the percentage change in fuel cost. The calculations should be carried out for a 10% or a 20% fuel cost increase. Car fuel elasticities are calculated using a matrix and network based test. The annual average fuel cost elasticity should lie within the **range -0.25 to -0.35** (overall, across all purposes).

TAG, states that target elasticities are considered more plausible if:

- the pattern of annual average elasticities shows values for employers' business trips near to -0.1, for discretionary trips near to -0.4, and for commuting and education somewhere near the average
- the pattern of all-purpose elasticities shows peak period elasticities which are lower than inter-peak elasticities which are lower than off-peak elasticities

Journey Time Elasticity Tests

The car journey time elasticity required is the change in car trips with respect to the change in journey time. I.e. as travel time increases there would be expected to be a resultant reduction in trips. TAG states that

> *"The output elasticities should be checked to ensure that model does not produce very high elasticities (no stronger than -2.0)".*

The approach adopted for testing the journey time elasticity is consistent with the "crude method" referenced in the hints and tips section of the Diadem Manual. This states the following:

DIADEM Manual Method

Elasticities with respect to car travel times are more problematic and require a more approximate approach. The elasticities of vehicle kilometres with respect to fuel costs and journey times are related as follows:

$$E^{time}=E^{fuel} * p^{time} / p^{fuel}$$

where

p^{time} is the cost of travel as a proportion of total generalised cost, and

p^{fuel} is the cost of fuel as a proportion of total generalised cost.

If you know the total vehicle kilometres, K, and the total vehicle hours, T, then you can calculate an average value

$$p^{time} / p^{fuel}= aT / bK$$

where

a is the cost per hour from the generalised cost function and

b is the cost per kilometre.

The elasticity of vehicle kilometres with respect to journey time can then be estimated as:

$$E^{time}=E^{fuel} * aT / bK$$

This formula will be used to demostrate that output elasticites are no stronger than -2.0.

Cost Damping

As per recommended guidance, realism testing is to be conducted initially without cost damping. The algorithm used was fixed step length (0.5).

VDM Convergence

It is of crucial importance that the demand model system converges to a satisfactory degree in order to have confidence that the model results are as free from error and noise as possible. In line with guidance, target %GAP values of 0.1% for the sub area and 0.2% for the entire model are used.

3. Summary of data collection

3.1. Introduction

The Wiltshire 2018 base model was developed using data collected for the development of the following models, (detailed in Section 2.2):

- SWRTM (2015 base)
- A303 Stonehenge Amesbury to Berwick Down (2015 Base)
- Melksham Transport Model (Atkins, 2017 Base)
- Swindon Transport Model (2014 Base)

Additional data was also collected to enhance the base model. One of the conclusions of the Melksham Transport Study (Atkins, 2017) was that there was insufficient transport data in the North West Wiltshire region. The A303 Stonehenge model provided some additional data in the Southern area, but the study recommended a series of volumetric traffic count data and localised distribution data (ANPR surveys) would be required. Subsequently the required traffic count and ANPR site locations were identified and an independent specialist company was commissioned to undertake the surveys.

This section of the report describes the additional data that was collected to update the A303 Stonehenge (& SWRTM) model. This includes:

- Volumetric traffic count data
- Automatic number plate recognition surveys
- TrafficMasterTM journey time data
- AddressBaseTM plus data

3.2. Volumetric traffic count data

This data was the primary source of traffic flow calibration and validation data, to ensure that traffic demand on each of the major and minor routes across the region was matching observed information.

The locations of the all the new Volumetric Count data (including ATC, TRIS and MCC data) sites are presented in Figure 3-1. There is a total of 738 link counts within the area of detailed modelling (AoDM, discussed in Section 4.1).

Automatic Traffic Counts

Automatic traffic counts were undertaken in eight main settlements in the West Wiltshire area by Intelligent Data Company (IDC). The survey data was collected over a three-week period in 15-minute intervals and classified according to the DfT-UK (GB DTp National Core Census) classification scheme.

The 186 ATC counts were undertaken throughout June/July 2018. The data was analysed and averaged into the peak periods identified in Section 2.3.4. Various logic and sense checks were undertaken to ensure consistency between nearby and adjacent sites, and linkages with the ANPR data.

Manual Classified Counts

Direction wise classified link counts were carried out at 11 locations during June 2018 (5^{th} -18^{th}) at 15-minute intervals for 2 weeks.

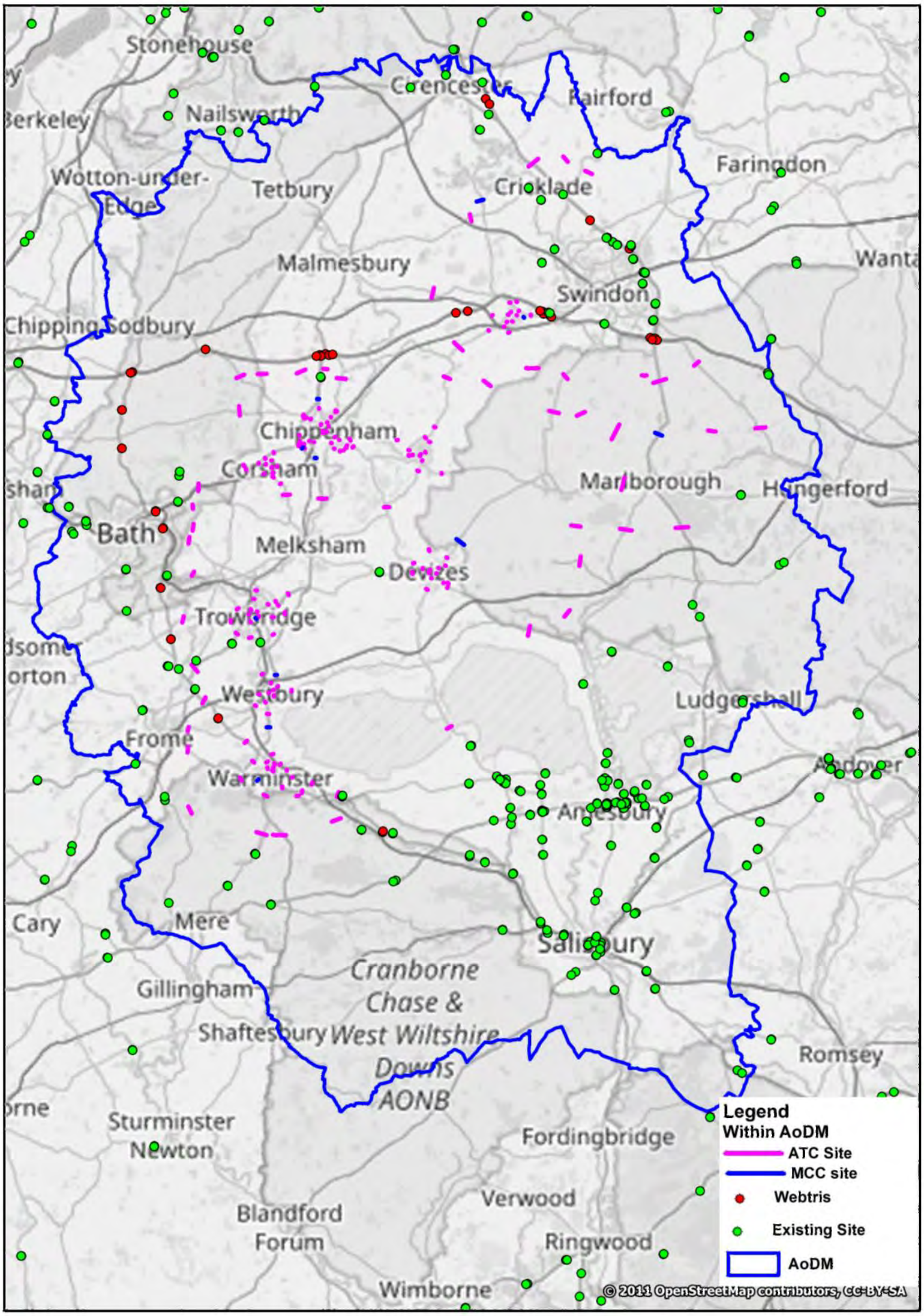
Existing Counts

The data collected was supplemented by data previously collected for the SWRTM, Melksham Transport Model and Swindon transport model. The counts from the A303 Stonehenge / SWRTM were collected or normalised to represent a 2015 Base year. The Swindon traffic counts were collected by Highways England in May 2014.

Webtris

Highways England provides a database of historic traffic count data. Relevant sites, within the AoDM, were included using May 2018 counts. Source: http://webtris.highwaysengland.co.uk/.

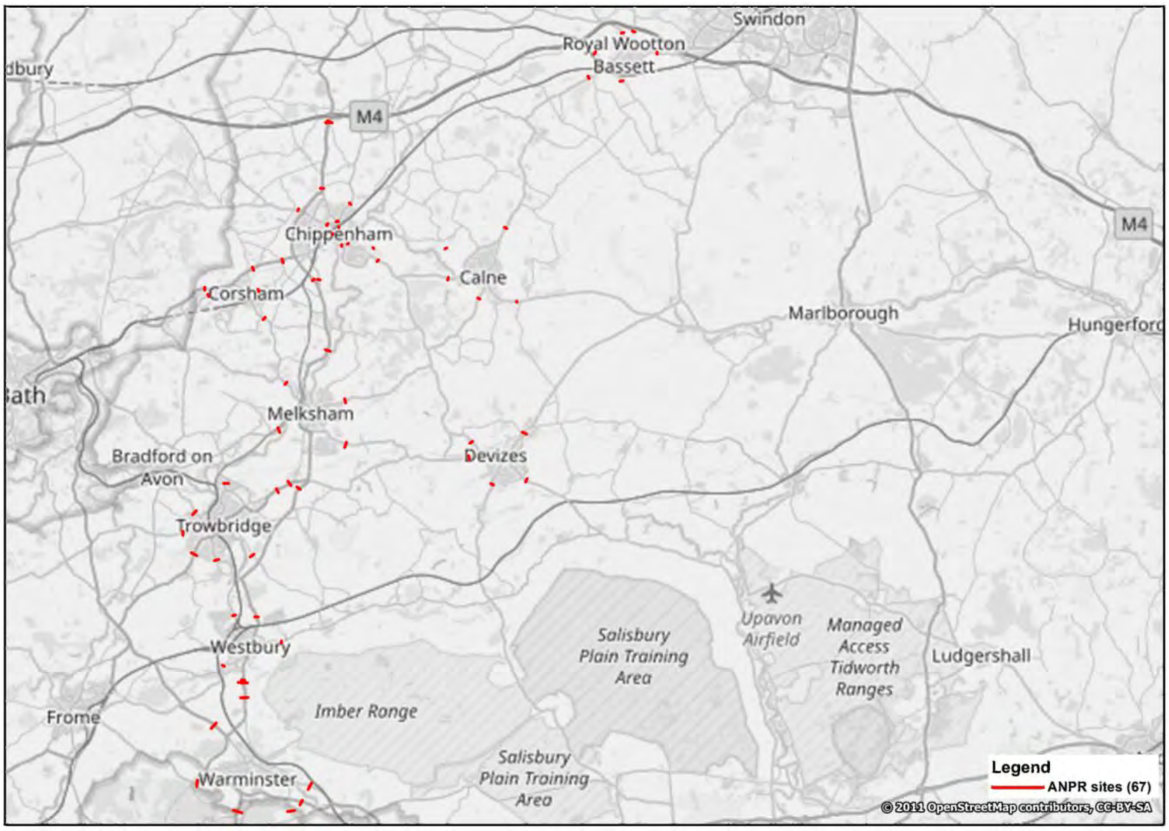
Figure 3-1 – Volumetric Traffic Count Data



3.3. Automatic number plate recognition surveys

As well as completing ATC and MCC, IDC also completed ANPR surveys in locations around the West Wiltshire area. Surveys were completed on a Tuesday and Wednesday at the beginning of June 2018 and recorded over a 12-hour time-period in 15-minute intervals. The counts were undertaken to form cordons around the main 9 settlements in the study area, allowing the movement of vehicles through and into each town to be understood. The locations of the all the ANPR sites are presented in Figure 3-2.

Figure 3-2 - ANPR survey Locations



The two days of ANPR data was combined with the ATC data to determine an observed cordon trip matrix for movements through each settlement. The results for each site are found in Appendix B.

This provides observed cordon flows in, out and through each of the main settlements in West Wiltshire; including:

- Chippenham
- Corsham
- Melksham
- Calne
- Devizes
- Trowbridge
- Westbury
- Warminster
- Royal Wotton Bassett

This information has been used for development of the prior trip matrix (see Section 5) and for a calibration check on the final model trip distribution. The final model base cordons are found Appendix B.

3.4. Cordon and screenline definition

For the Wiltshire & Swindon Base Model, the data collected was intended to define a range of cordons and screenlines within the Wiltshire region which would capture the highway travel demand for each of the main urban settlements within the region and the main east-west and north-south movements through the area, are presented in Figure 3-3.

Within this area there is limited route choice between or through settlements and summary reporting will focus on these key movements. The observed counts are presented in Table 3-1. The Base model assignment results are shown in Section 7.2 and Table 7-2.

Figure 3-3 - Cordons and Screenline Locations

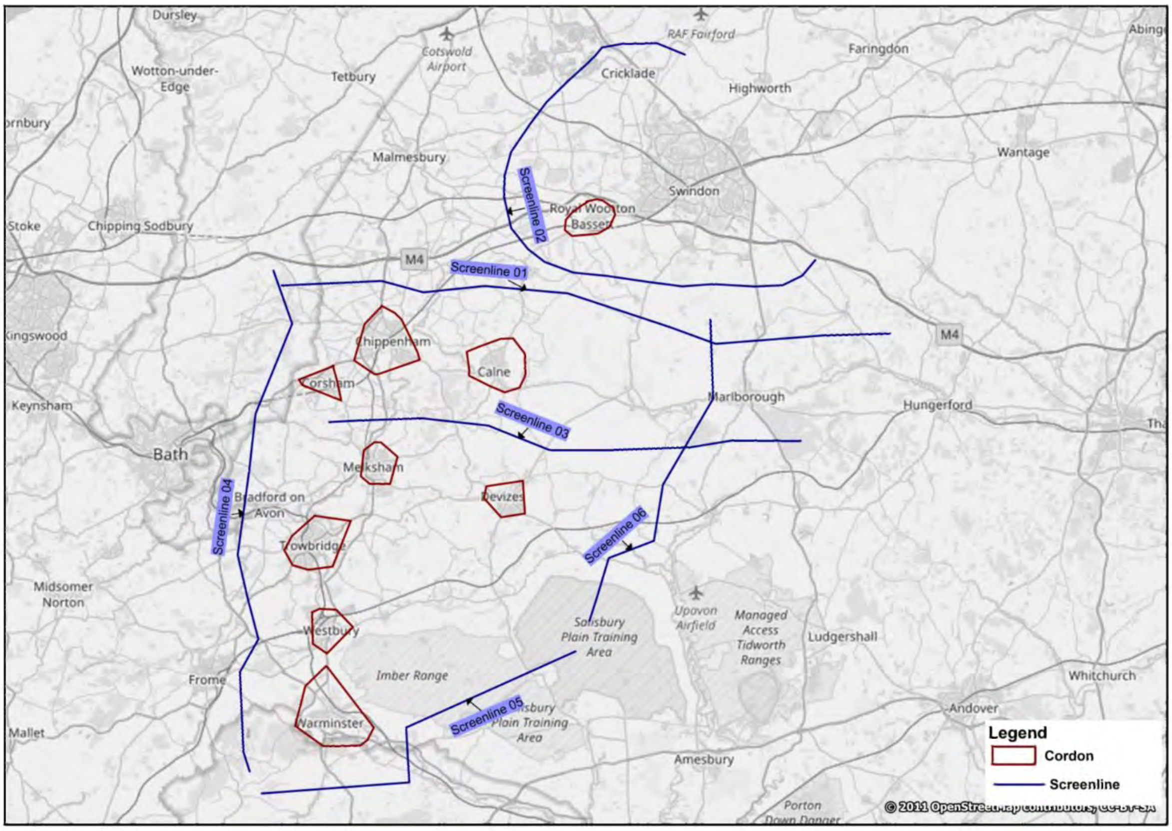


Table 3-1 - Cordon and Screenline Observed Traffic Flow Summary

Cordon / Screenline	Direction	No. links	AM	IP	PM
Calne	Inbound	5	1,571	1,439	2,172
	Outbound	5	2,141	1,360	1,680
Chippenham	Inbound	8	4,779	3,828	4,749
	Outbound	8	4,498	3,808	4,718
Corsham	Inbound	5	1,597	1,327	1,696
	Outbound	5	1,568	1,365	1,670
Devizes	Inbound	5	2,353	2,106	2,547
	Outbound	5	2,375	2,081	2,312
Melksham	Inbound	7	3,903	3,442	4,610
	Outbound	7	4,173	3,342	4,072
Trowbridge	Inbound	7	2,939	2,921	3,851
	Outbound	7	3,315	3,010	3,438
Wootten Bassett	Inbound	6	2,374	2,024	2,941
	Outbound	6	2,678	1,976	2,567
Warmister	Inbound	7	2,922	2,786	3,233
	Outbound	7	3,032	2,760	3,064
Westbury	Inbound	5	1,917	1,795	2,376
	Outbound	5	2,282	1,746	2,067
Screenline 1 North of Chippenham	NB	12	2,230	1,657	2,133
	SB	12	2,152	1,609	2,340
Screenline 2 Swindon	NB	12	2,632	1,879	2,445
	SB	12	2,380	1,845	2,757
Screenline 3 North of Melksham	NB	7	2,831	2,236	2,496
	SB	7	2,443	2,219	2,882
Screenline 4 West of Trowbridge	EB	11	3,963	3,123	4,203
	WB	11	4,001	3,173	4,024
Screenline 5 South of Westbury	EB	5	1,148	1,112	1,609
	WB	5	1,582	1,143	1,246
Screenline 6 East of Devizes	EB	5	1,121	670	714
	WB	5	749	716	1,055

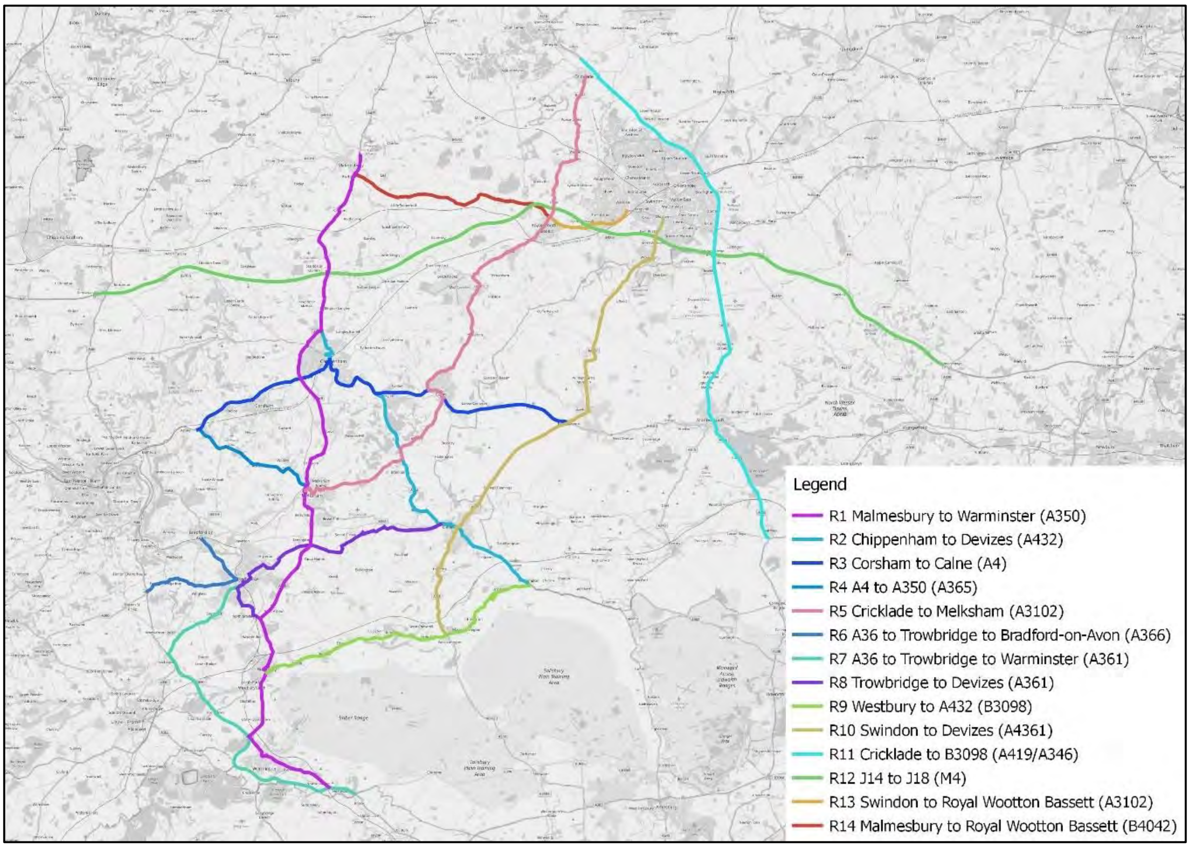
All Counts are in Total Vehicles

3.5. TrafficMaster™ journey time data

Trafficmaster™ Journey Time data was collected which represents network delay, for each modelled time period in September 2017 for all routes except Route 13 which is from June 2017[2]. Data from 2018 was not available at the time of model development. The routes for which data was collected are shown in Figure 3-4. Time and distance checks were made using online mapping to ensure the data had been processed as accurately as possible. The travel times, by period and trip distances, for each of the routes are shown in Table 3-2.

The journey time validation of the base model is presented in Section 7.3. Distance-Time graphs for the A350 are found in Appendix F. Any specific plots not provided in this report are available from Atkins upon request.

Figure 3-4 - Journey Time Routes



[2] June 2017 was chosen for Route 13 as there were road works on a major junction during September which were skewing the journey times on this route.

Table 3-2 - Observed Journey Times

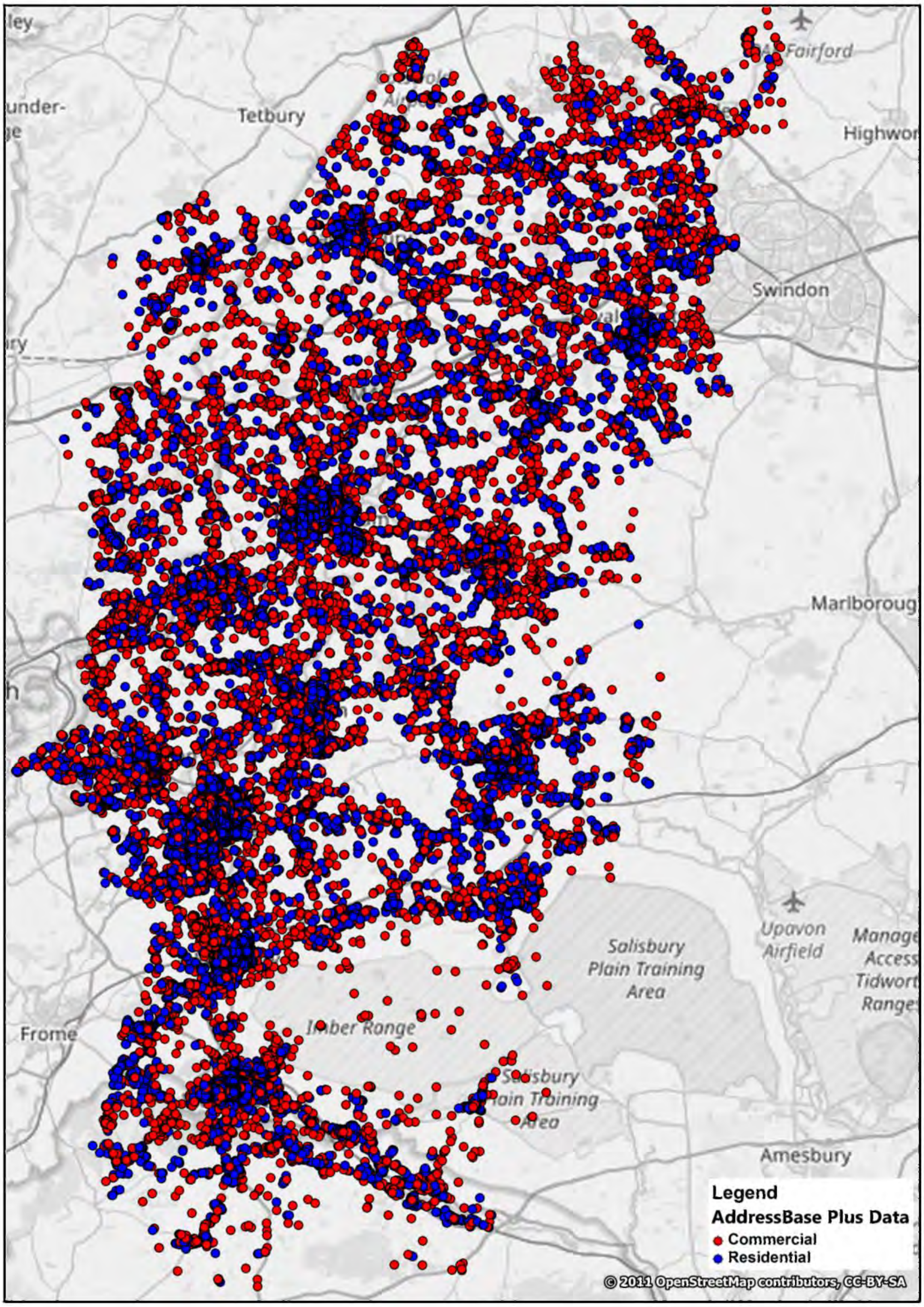
Route No.	Description	Dir	Distance (km)	AM	IP	PM
				(mins)		
1	Malmesbury to Warminster (A350)	NB	55	62	62	59
		SB	55	63	61	60
2	Chippenham to Devizes (A432)	NB	28	35	35	35
		SB	28	35	35	33
3	Corsham to Calne (A4)	EB	32	36	36	34
		WB	32	37	37	36
4	A4 to A350 (A365)	EB	10	11	11	10
		WB	10	11	11	11
5	Cricklade to Melksham (A3102)	NB	45	53	52	50
		SB	45	51	51	49
6	A36 to Bradford-on-Avon via Trowbridge (A366)	EB	11	15	15	15
		WB	11	16	15	15
7	Trowbridge to Warminster (A361 / A36)	NB	28	26	26	25
		SB	28	25	25	25
8	Trowbridge to Devizes (A361)	EB	21	27	26	25
		WB	21	24	25	24
9	Westbury to A432 (B3098)	EB	22	26	26	25
		WB	22	27	26	25
10	Swindon to Devizes (A4361)	NB	38	40	40	38
		SB	38	40	41	40
11	Cricklade to B3098 (A419 / A346)	NB	41	33	34	34
		SB	40	33	32	31
12	J14 to J18 (M4)	EB	66	35	35	34
		WB	66	34	35	34
13	Swindon to Royal Wootton Bassett (A3102)	EB	6	8	7	7
		WB	6	7	7	7
14	Malmesbury to Royal Wootton Bassett (B4042)	EB	15	14	14	14
		WB	15	14	14	13

Data is based on Trafficmaster Journey Time data from September 2017 for all routes except Route 13 (June 2017)
Distances are in km, travel time is in minutes. Distances are rounded to the nearest km and times are rounded to the nearest minute.

3.6. AddressBase™ plus data

AddressBase™ Plus gives up-to-date local authority addresses and OS MasterMap references which differentiates by commercial or residential property types as shown in Figure 3-5. This information was used to assist in zone factoring, splitting and disaggregation in the process of refinement of the initial prior trip matrix (see Section 5.1).

Figure 3-5 - AddressBase Plus Data



4. Highway network development

4.1. Area of detailed modelling

Within the SATURN software suite, highway networks can comprise either a **full simulation** network, in which the operation of individual junctions is fully simulated, or a less detailed **buffer** network, which features link distance and speed information. The strategic road network within the A303 Stonehenge / SWRTM is entirely 'simulated'. However, to reduce likely wider network convergence issues, model noise and reduce computational power and run times in regions outside the area of interest it was proposed to define an area of detailed modelling (AoDM). Within this region, the network is fully simulated and outside this area, the existing network is buffer.

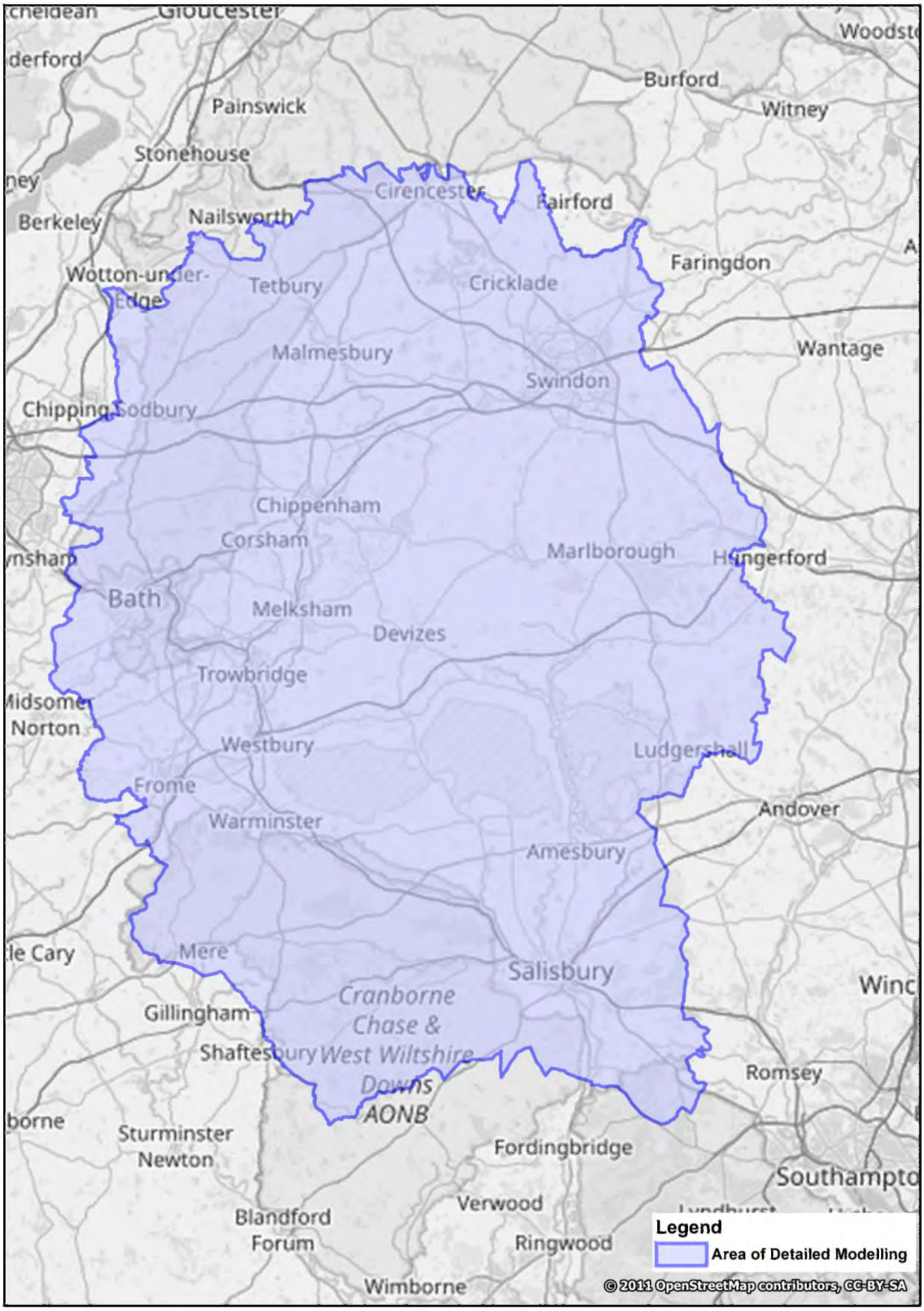
The initially proposed AoDM included only Wiltshire and Swindon, this was discussed with Wiltshire Council and Highways England. It was agreed that the AoDM would be extended to include a wider region which incorporated Bath and parts of South Gloucestershire and the Cotswolds to fully capture the network impacts of changes within Wiltshire.

The agreed AoDM is shown in Figure 4-1. The existing A303 Stonehenge / SWRTM network was converted (using SATBUF feature within SATURN) to buffer outside this area.

Whilst the focus of this report is within the AoDM, the model calibration data and processes (matrix estimation etc.) of the A303 Stonehenge / SWRTM models of the whole SW region has been retained. A summary of the model calibration and validation results is presented in Appendix C. This shows that the wider Wiltshire model retains the same level of calibration as the donor models.

A summary of the differences between the Full Simulation and Buffer variants of the Wiltshire model are presented in Appendix D. This shows that there is little difference between the two models and hence there is limited benefit in fully simulating the model outside the AoDM as this will only increase run times and likelihood of convergence and noise issues and hence reduce opportunities for sensitivity tests and plausible economic analysis within the AoDM.

Figure 4-1 - Area of Detailed Modelling (AoDM)

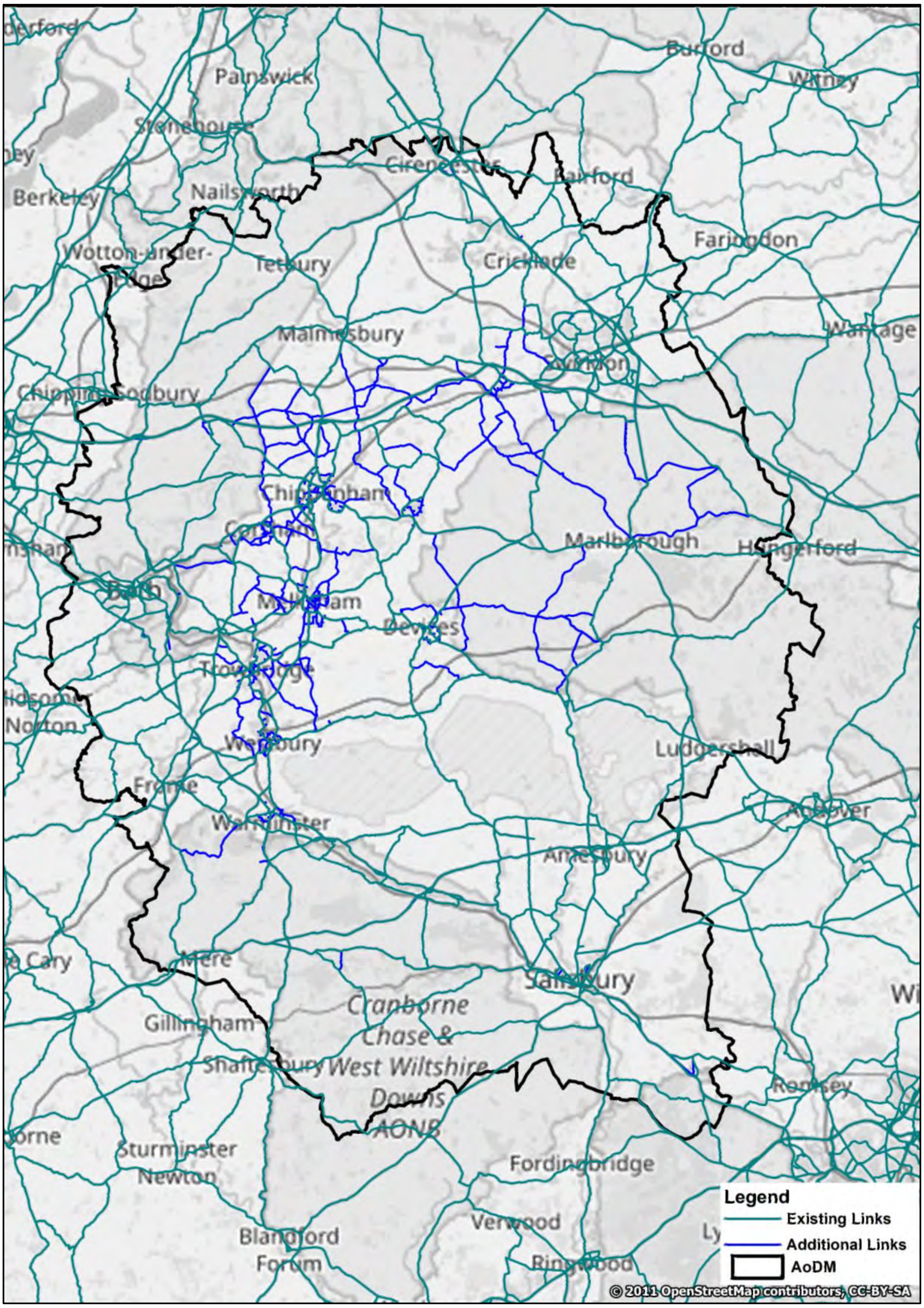


4.2. Network refinement within the AoDM

Within the AoDM, network additions and refinements were made. These include:

- Addition of local and minor roads (see Figure 4-2);
- Amendments to speed flow curves to reflect driver behaviour and speeds within towns;
- Extensive refinement of network coding to ensure realistic cost of travel throughout the AoDM. The results of the travel time validation are shown in Section 7.3.

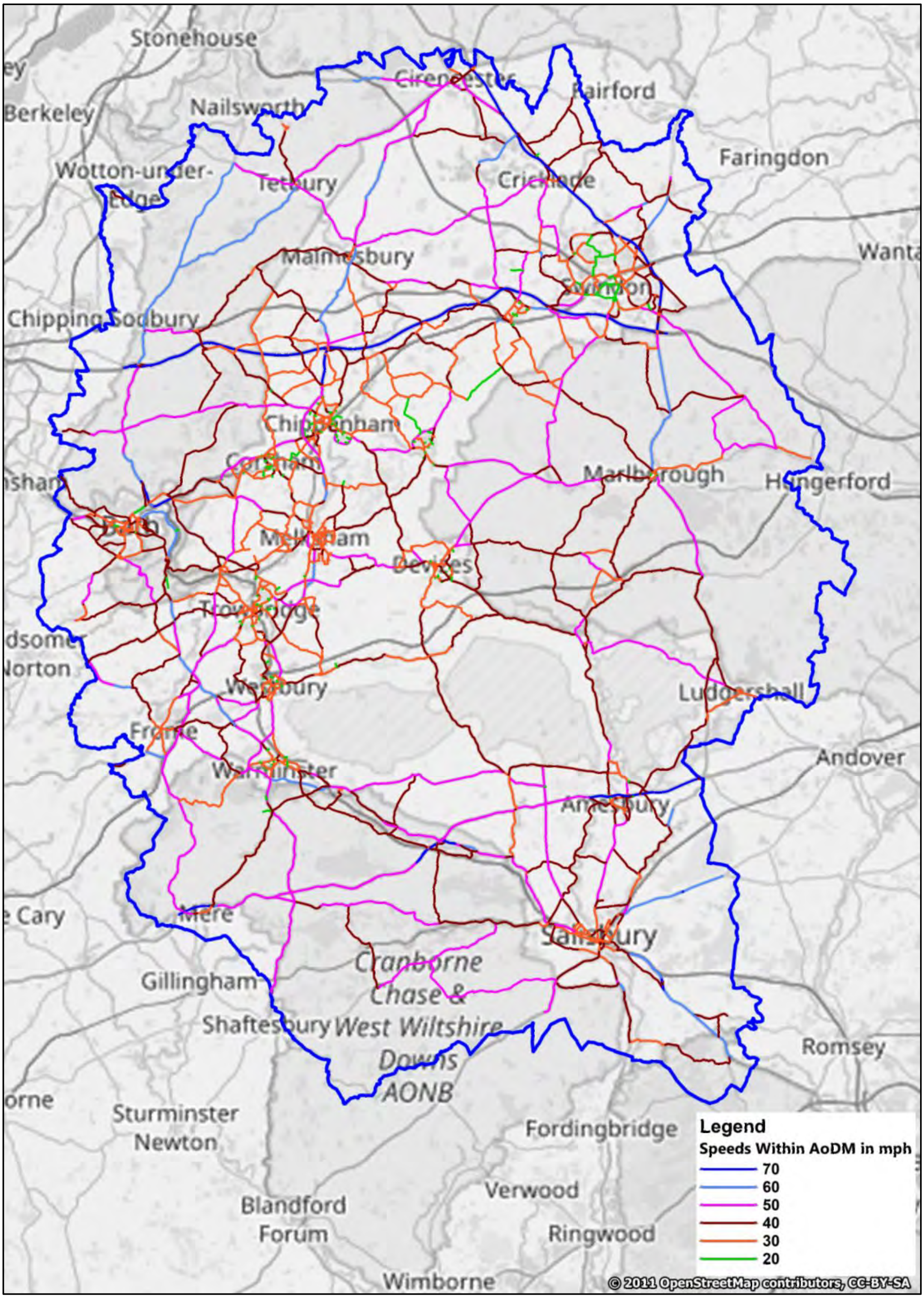
Figure 4-2 - Network Refinement



4.3. Capacity constraints

The cruise speeds and speed flow curves (SFC) used in the models are as shown in Figure 4-3. The SFC default values are consistent with the SWRTM and A303 Stonehenge models. The network coding standards used are consistent with the RTM coding manual v0.8 Final.

Figure 4-3 – AoDM Network Speeds



4.4. Generalised costs (Value of Time and Vehicle Operating Costs)

The generalised cost of travel is based on a combination of factors that drivers consider when choosing routes, mainly time and distance. Generalised cost parameters are used in a SATURN model to represent drivers' value of time by pence per minute (PPM) and distance by pence per kilometre (PPK).

Values of PPK and PPM can be set universally for the entire model or individually by user class. Where a choice of route exists (as in nearly all cases) these values are used to determine which available route has a lower 'cost' to the driver. Thus, if the PPK value is high, low cost routes will be those which minimise distance; conversely, if the PPM is high then low cost routes will be those that minimise the travel time.

The TAG databook Tables A1.3.1 and A1.3.2 provide monetary values of time, which can be used to derive values of time in an assignment model in terms of PPM. Similarly, Tables A1.3.10 to A1.3.12 in the databook provide parameters to calculate fuel costs and Table A1.3.15 provides parameters to calculate nonfuel vehicle operating costs. When added together, the fuel and non-fuel elements give the total vehicle operating costs in terms of PPK for different transport users. Unit A1.37 states that, in non-work time, it is assumed that drivers do not perceive non-fuel vehicle operating costs, and so these costs have been omitted from the overall calculation of generalised costs for commuting and other trips. The PPM and PPK parameters then give the overall generalised cost for each of the different user classes, those used for the base model are presented in Table 4-1.

Table 4-1 - Assignment Values of PPM & PPK

UC	Description	PPM (pence per minute)			PPK (pence per kilometre)		
		AM	IP	PM	AM	IP	PM
1	Car (Business)	30.88	31.64	31.32	12.27	12.27	12.27
2	Car (Commute)	20.71	21.04	20.78	5.78	5.78	5.78
3	Car (Other)	14.29	15.22	14.96	5.78	5.78	5.78
4	LGV	21.83	21.83	21.83	13.53	13.53	13.53
5	HGV	44.31	44.31	44.31	44.52	44.52	44.52

TAG Databook v1.10 May 2018

5. Highway prior trip matrix development and assignment

5.1. Prior trip matrix development

5.1.1. A303 Stonehenge / SWRTM Prior Trip Matrices

The prior trip matrices for the SWRTM were primarily informed by mobile phone data (MPD) rather than being developed from more traditional sources. Further details of the SWRTM and A303 Stonehenge prior trip matrix development are found in the associated model validation reports.

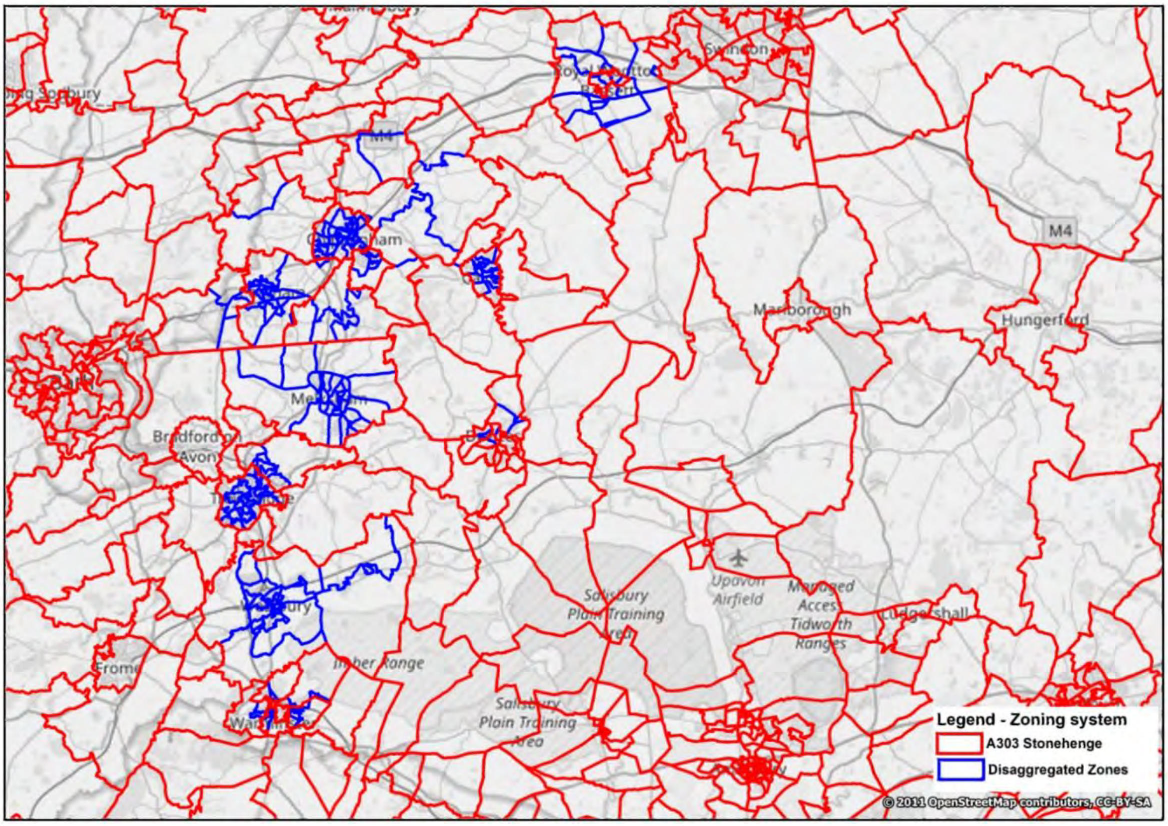
The Wiltshire prior trip matrix, was based on the A303 Stonehenge prior trip matrix (which utilised the Design Fix 2 (DF2) SWRTM prior trip matrix) and zone system which was initially based on MSOAs. This was assumed to provide a reasonable distribution for longer distance trips. The RTM Technical Consistency Group (TCG) advocated using new and alternative data sets to refine and disaggregate the MPD matrices to a spatially proportionate level of disaggregation. The zones within the existing model were refined to provide more detail in key urban areas.

5.1.2. Zone disaggregation

Within the AoDM (see Figure 4-1) a finer zoning system was identified with the intention of representing the loading of trips at a suitable level of detail (as shown in Figure 5-1). This process involved splitting, where required, the A303 Stonehenge / SWRTM zones into the new zone system based on the proportion of houses and employment in each zone and hence the relative proportionate production/attraction. The proportions of housing and employment was determined by the AddressBase™ Plus data described in Section 3.6.

The total demand was consistent with the MPD prior trip matrices from the A303 Stonehenge / SWRTM matrices. The total number of zones in the A303 Stonehenge model was increased from 2,033 to 2,250. This includes 23 additional empty zones which are to be used for forecast developments.

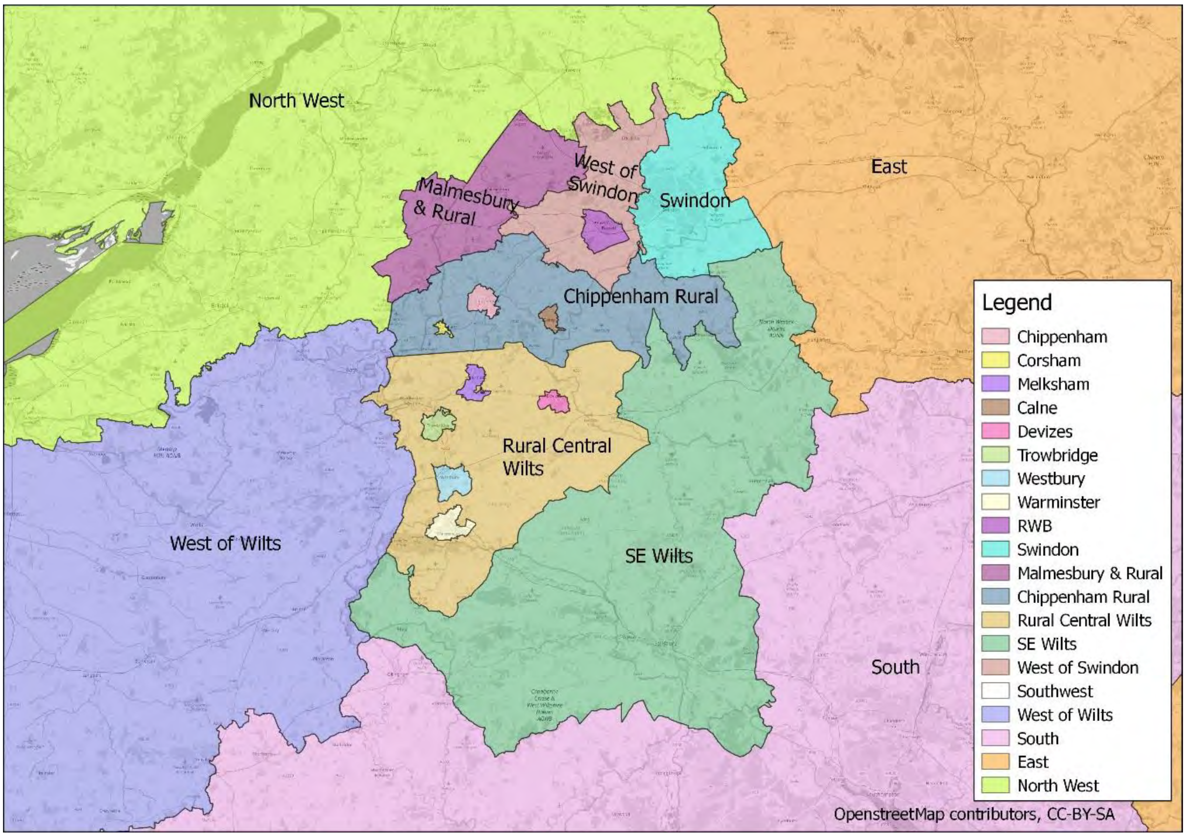
Figure 5-1 - Zone Disaggregation



5.2. Sector system

A sector system, used for model appraisal and matrix development and expected to be used for forecasting has been defined. This is presented in Figure 5-2.

Figure 5-2 - Sector System (20x20)



5.3. Prior trip matrix model assignment

Comparing an assignment of the prior trip matrices with observed traffic count data, with localised network enhancement (see Section 4.2) demonstrated that there was far too little traffic in and around the entire region and further refinement of the trip matrices was required. A high-level summary output is shown in Figure 5-2, and Table 5-1. The model standards and "near" criteria are presented in section 2.4.1 and 2.4.2)

A result of this deficiency in the demand matrix, required suitable remedial action, which is discussed in the next section.

Figure 5-2 - Initial Prior Trip Matrices Assignment Pass (Green), Near (Amber) and Fail (Red), AoDM.

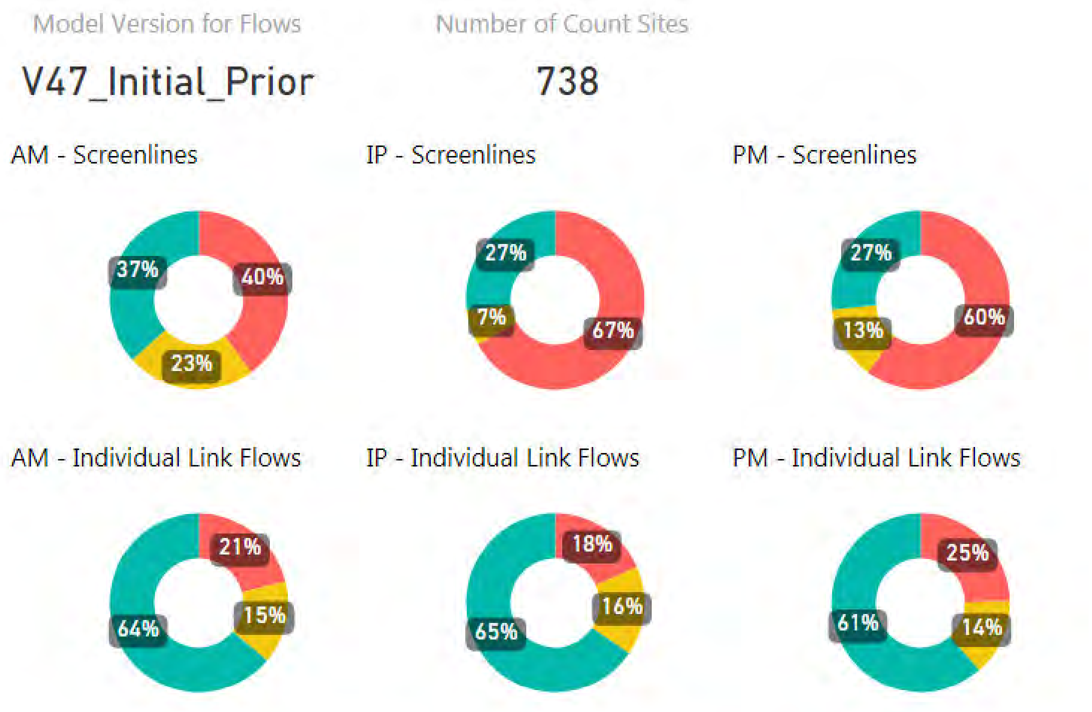


Table 5-1 - Total Traffic flows in AoDM: Observed vs Prior Trip Matrix Model

	Observed Flows (Vehs)	Modelled Flow (Vehs)	Flow Diff	% Diff
AM peak	346,691	340,453	6,238	-1.8%
Inter Peak	298,141	259,625	38,516	-12.9%
PM Peak	369,763	340,536	29,227	-7.9%

6. Impact of matrix estimation

6.1. Matrix estimation methodology

Assignment of the prior trip matrix (see previous section) showed that this was insufficient to meet TAG flow validation standards, hence use of matrix estimation was required.

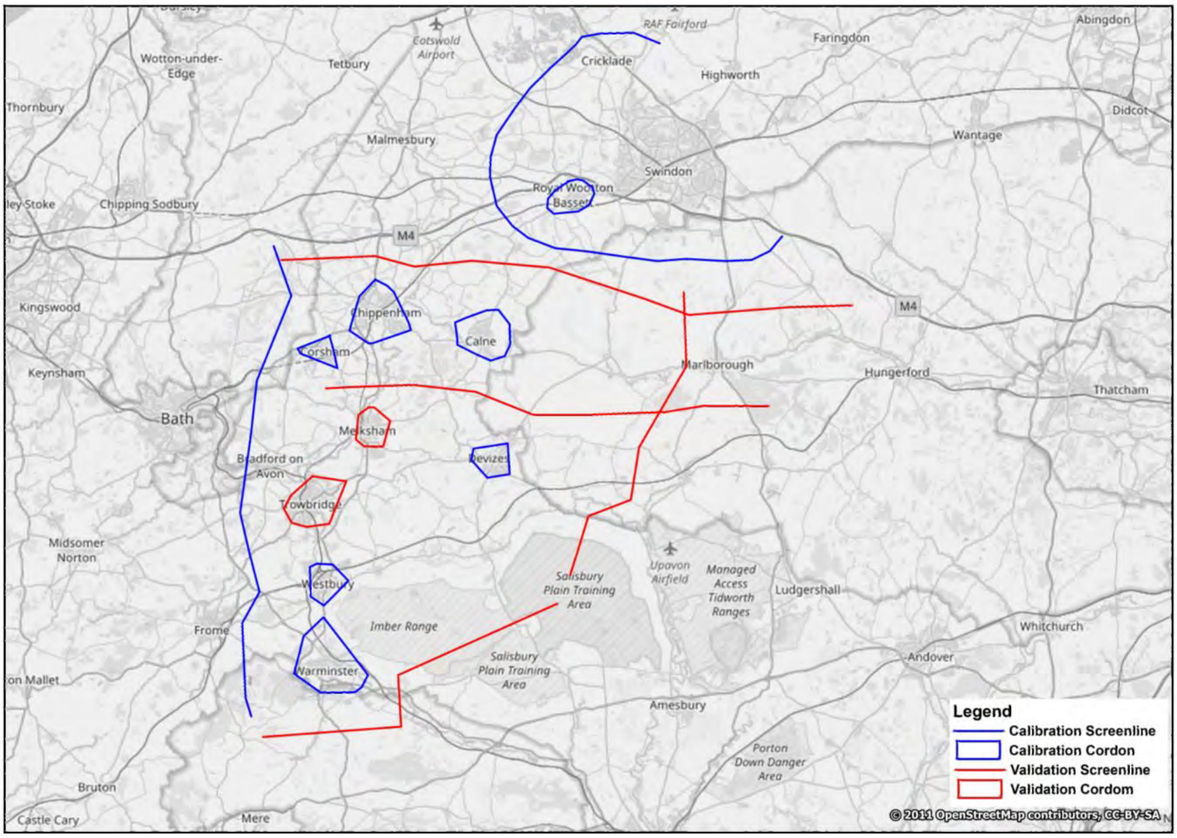
The process of matrix estimation (ME2, described in Section 2.4.4) and the parameters used for this modelling are broadly consistent with the A303 Stonehenge / SWRTM. These are summarised below:

- Cars/LGVs and HGVs are treated separately, by constraining them to observed count data. Cars have not been further subdivided, as it is not possible to distinguish between the trip purposes from the count data
- All traffic counts not specifically on a cordon or screenline have been used in this process
- All the calibration screenlines in the wider south west area from the A303 Stonehenge / SWRTM are consistent in this model
- XAMAX defines the maximum balancing factor used to limit excessive changes to the prior matrix. A value of two has been used for the car/LGV and five for HGV estimation. This reflects the relative confidence in the data used to develop the demand for each of these vehicle classes
- A convergence criteria value of 0.001 has been used

6.2. Identification of calibration screenlines

To reduce the impact of ME2, certain traffic counts on selected cordons and screenlines were used for validation, i.e. these counts were not included within ME2. Those selected for calibration in ME2 and kept separate for validation are shown in Figure 6-1 below.

Figure 6-1 - Calibration Screenlines and Cordons



6.3. Monitoring changes due to matrix estimation

This section provides a summary of the changes due to ME2 between the prior trip matrix and the final post ME2 trip demand matrices. The standards used to assess the changes presented are consistent with those required in TAG guidance and described in Section 2.4.4 and Table 2-4)

In general, the results presented demonstrate that the changes due to ME2 are considered to be within the recommended guidance and the final post ME matrix are suitable for model validation.

A more detailed output of the all the changes is presented in Appendix E.

6.3.1. Zonal cell values

The demand matrices are compared on a zonal basis to show that the change between the prior trip matrix and post ME2 matrix are within acceptance criteria. This has been done within the AoDM, the results and acceptance criteria are presented in Table 6-1. In general, it is considered that the changes are within acceptable limits.

Table 6-1 – Summary changes in Zonal Cell Values: Post ME2 vs Prior, within AoDM

AM	TAG Criteria	UC1	UC2	UC3	UC4	UC5	All
Slope	Within 0.98 and 1.02	0.97	0.98	0.99	0.99	0.95	0.99
Intercept	Near zero	0.00	-0.00	0.00	0.00	0.00	0.00
R^2	In Excess of 0.98	0.93	0.97	0.99	0.98	0.85	0.98
IP	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.98 and 1.02	0.99	0.98	0.99	1.00	0.95	0.99
Intercept	Near zero	0.00	0.00	0.01	0.00	0.00	0.00
R^2	In Excess of 0.98	0.94	0.96	0.97	0.99	0.84	0.97
PM	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.98 and 1.02	0.96	0.98	0.99	1.00	0.95	0.99
Intercept	Near zero	0.00	0.00	0.01	0.00	0.00	0.00
R^2	In Excess of 0.98	0.93	0.97	0.98	0.98	0.87	0.98

6.3.2. Trip ends

This section describes the change for the trip end totals for the full matrix are presented in Table 6-2 and Table 6-3.

Table 6-2 - Summary Changes in Origin Trip Ends: Post ME2 vs Prior, within AoDM

AM	TAG Criteria	UC1	UC2	UC3	UC4	UC5	All
Slope	Within 0.99 and 1.01	0.93	0.94	0.96	0.98	0.90	0.95
Intercept	Near zero	0.45	2.18	3.90	1.26	2.34	1.88
R^2	In Excess of 0.98	0.97	0.98	0.98	0.96	0.87	0.98
IP	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.99 and 1.01	0.97	0.96	0.97	0.98	0.87	0.98
Intercept	Near zero	0.58	1.93	7.46	1.78	2.56	2.51
R^2	In Excess of 0.98	0.95	0.97	0.97	0.93	0.83	0.98
PM	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.99 and 1.01	0.95	0.96	0.97	0.99	0.87	0.97
Intercept	Near zero	0.365	2.27	4.23	1.04	1.4	1.67
R^2	In Excess of 0.98	0.96	0.98	0.98	0.94	0.85	0.98

Table 6-3 - Summary Changes in Destination Trip Ends: Post ME2 vs Prior, within AoDM

AM	TAG Criteria	UC1	UC2	UC3	UC4	UC5	All
Slope	Within 0.99 and 1.01	0.94	0.95	0.969	0.98	0.90	0.96
Intercept	Near zero	0.35	1.37	2.82	1.21	2.35	8.11
R^2	In Excess of 0.98	0.96	0.98	0.99	0.96	0.87	0.98
IP	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.99 and 1.01	0.96	0.97	0.97	1.02	0.90	0.97
Intercept	Near zero	0.63	1.73	7.60	1.31	2.46	13.69
R^2	In Excess of 0.98	0.96	0.981	0.98	0.95	0.87	0.98
PM	**TAG Criteria**	**UC1**	**UC2**	**UC3**	**UC4**	**UC5**	**All**
Slope	Within 0.99 and 1.01	0.94	0.96	0.97	1.03	0.79	0.97
Intercept	Near zero	0.43	1.90	4.56	0.67	1.55	9.39
R^2	In Excess of 0.98	0.97	0.98	0.99	0.96	0.87	0.98

6.3.3. Trip length distribution

It is important that the ME2 process does not fundamentally alter the trip distributions and specially the trip length distributions (TLD). A high-level comparison of the TLD, by user class, is presented in Table 6-4. A more detailed comparison is presented in Appendix E.3

This shows that there is very little change in the mean trip length, with marginal increases in trip distance, post ME2 and a small decrease for heavy vehicles.

Table 6-4 – Mean Trip Length: Post ME2 vs Prior for whole model

Time Period	Trip Purpose	Prior	Post ME2	% Difference	Standard Deviation
AM Peak	Car - Business	77.85	79.19	2%	1%
	Car - Work	45.85	46.56	2%	1%
	Car - Other	35.48	36.01	2%	2%
	LGV	54.24	54.82	1%	1%
	HGV	114.22	109.27	-4%	-1%
	Light Vehicles	46.64	47.37	2%	1.3%
	Total	51.84	52.44	1%	0.5%
Inter Peak	Car - Business	75.74	76.58	1%	1%
	Car - Work	50.86	51.10	0%	1%
	Car - Other	35.54	35.77	1%	1%
	LGV	54.86	54.89	0%	1%
	HGV	114.32	109.80	-4%	-1%
	Light Vehicles	45.38	45.67	1%	1%
	Total	52.12	52.23	0%	0.5%
PM Peak	Car - Business	75.82	78.11	3%	4%
	Car - Work	47.94	48.68	2%	1%
	Car - Other	36.34	36.96	2%	2%
	LGV	53.54	54.14	1%	1%
	HGV	114.32	110.94	-3%	0%
	Light Vehicles	45.54	46.35	2%	2.3%
	Total	48.82	49.57	2%	1.5%

Distances in kilometres, for the whole model.

Light Vehicles are Cars and LGVs.

6.3.4. Sector to sector changes

In considering the differences on a sector to sector level it is important to avoid highlighting large percentage differences which represent only a small number of trips. As such all sector to sector movements with fewer than 100 trips in the prior matrix have been excluded from this analysis. In line with RTMs, the GEH statistic has also been assessed, along with the proportion of movements with less than ±10% change. Figure 5-2 shows the spatial coverage of the sectors which have been considered in this analysis. The percentage and GEH change in sector-to-sector movements, for each time period, is provided in Appendix E.4. A summary of these changes is shown in Table 6-5.

Table 6-5 - Sector to Sector Changes: Post ME2 vs Prior

Vehicle Type	Time Period	No. Cells with >100 Trips	% Cells with <5% change	% Cells with <10% change	% Cells with GEH <5 change
LVs	AM	136	73%	76%	73%
	IP	109	58%	65%	74%
	PM	135	62%	71%	70%
HVs	AM	21	62%	76%	71%
	IP	21	62%	67%	76%
	PM	17	65%	71%	88%
Total	AM	140	70%	76%	72%
	IP	114	57%	66%	76%
	PM	135	61%	71%	72%

A cell is defined as a sector to sector movement or sector pair. Note that all analysis has been undertaken on cells with >100 trips in the prior sector matrix.

6.4. Post ME2 sector matrices

It has been demonstrated that the changes resulting from ME2 are acceptable under the standards utilised for the development of the RTMs and those described in Section 2.4.4. The final, post ME2 (sector) matrices, used for model validation are presented in Figure 6-2, Figure 6-3 and Figure 6-4. The sector map, defining the regions is shown in Figure 5-2.

Figure 6-2 – Sector Matrix: AM Peak Period, Post ME2

	Chippenham	Corsham	Melksham	Calne	Devizes	Trowbridge	Westbury	Warminster	RWB	Swindon	Malmesbury	Chip Rural	Rural Cen	SE Wilts	West of Swin	South West	West	South	East	North	**Total**
Chippenham	1874	45	86	75	35	125	20	6	20	100	197	578	234	50	33	8	178	23	79	309	**4073**
Corsham	51	58	13	6	8	16	2	1	2	15	15	227	43	11	4	3	66	4	14	92	**651**
Melksham	108	30	299	9	28	129	22	5	1	23	26	162	588	110	4	5	160	34	15	89	**1849**
Calne	234	12	22	441	113	28	5	2	23	133	56	264	92	41	40	7	37	9	66	96	**1720**
Devizes	58	3	10	36	432	60	9	13	26	148	4	105	464	197	32	2	37	28	60	48	**1770**
Trowbridge	141	15	106	21	59	1616	106	50	5	50	30	260	1153	154	9	10	505	79	57	114	**4537**
Westbury	30	2	28	3	14	159	290	62	1	13	5	39	443	114	3	3	132	49	12	49	**1452**
Warminster	11	1	13	2	7	65	46	464	0	6	2	32	324	207	1	3	124	58	6	20	**1392**
RWB	45	3	2	12	17	3	1	0	50	562	60	102	12	34	91	5	14	12	106	118	**1252**
Swindon	72	9	15	19	46	20	6	2	298	22	247	293	52	281	750	41	60	120	1595	1380	**28**
Malmesbury	134	8	9	10	1	6	3	1	14	118	697	141	26	13	93	19	47	23	89	588	**2039**
Chipp Rural	667	173	60	222	45	83	11	5	50	232	136	1109	205	226	75	23	347	31	161	443	**4304**
Rural Central	216	34	391	59	632	1303	360	363	13	100	33	310	2662	430	24	17	793	146	89	232	**8205**
SE Wilts	52	2	21	11	186	51	29	86	35	352	13	249	286	14	38	25	228	3050	631	172	**19**
West of Swin	60	3	3	43	8	5	2	2	108	1043	143	133	13	21	271	9	22	22	135	487	**2535**
South West	4	0	2	0	1	4	3	1	5	50	18	13	10	35	7	169	2	1	0	1	**174**
West	138	49	74	11	35	344	114	157	8	75	72	485	800	319	16	2	58	2	0	6	**72**
South	22	4	14	5	27	37	46	30	20	171	19	72	141	2929	30	1	3	278	18	2	**306**
East	52	8	10	12	19	18	11	3	94	1532	76	187	47	411	151	0	0	14	1206	27	**1250**
North	310	51	88	29	20	107	49	28	129	1966	778	690	360	254	428	1	6	2	33	3306	**3353**
Total	**4278**	**510**	**1266**	**1026**	**1734**	**4181**	**1134**	**1282**	**903**	**29**	**2629**	**5451**	**7956**	**19**	**2099**	**174**	**72**	**301**	**1261**	**3345**	**5237**

Values are Highway Trip demand in Vehs, values in red in 1000s

Figure 6-3 – Sector Matrix: Inter Peak Period, Post ME2

	Chippenham	Corsham	Melksham	Calne	Devizes	Trowbridge	Westbury	Warminster	RWB	Swindon	Malmesbury	Chip Rural	Rural Cen	SE Wilts	West of Swin	South West	West	South	East	North	**Total**
Chippenham	2257	63	92	130	27	84	19	8	27	48	163	648	169	26	39	6	117	16	42	226	**4208**
Corsham	50	56	21	7	3	15	2	1	2	6	8	192	33	3	2	2	30	4	7	25	**467**
Melksham	112	22	358	18	14	107	15	5	2	13	12	87	457	24	3	2	70	15	10	59	**1405**
Calne	107	6	16	450	59	12	2	1	17	36	17	219	51	18	33	2	17	4	17	40	**1121**
Devizes	23	4	15	80	444	49	6	5	18	39	3	65	597	162	11	1	24	17	33	15	**1609**
Trowbridge	131	11	139	18	58	1648	196	74	4	24	10	99	1334	56	5	7	280	42	36	102	**4272**
Westbury	21	1	20	2	6	194	355	61	1	8	3	14	387	43	3	4	97	36	11	36	**1304**
Warminster	9	1	8	1	5	85	92	449	0	4	1	10	329	103	1	2	121	39	5	21	**1284**
RWB	23	2	3	21	12	3	1	0	59	418	18	46	10	18	78	3	10	8	46	82	**861**
Swindon	57	9	20	54	69	24	6	2	409	20	95	198	61	228	730	44	81	73	1113	1159	**25**
Malmesbury	125	11	19	17	2	13	4	1	29	115	591	113	32	12	80	14	40	21	83	456	**1780**
Chipp Rural	600	191	102	205	57	113	16	10	45	171	128	951	219	198	61	16	257	41	121	361	**3863**
Rural Central	167	34	447	57	601	1375	367	382	10	37	21	192	2369	263	12	12	682	115	57	209	**7408**
SE Wilts	24	4	33	21	165	64	55	103	21	247	11	269	263	12	19	34	247	2115	390	192	**16**
West of Swin	31	3	4	33	11	6	2	1	88	758	74	65	14	17	200	5	17	12	85	341	**1769**
South West	5	0	1	1	1	7	3	2	7	57	29	12	9	34	8	164	2	1	0	1	**168**
West	114	33	99	24	24	293	108	139	10	66	55	292	707	254	16	2	54	2	0	5	**65**
South	12	3	17	7	14	48	32	37	11	101	23	37	81	2086	19	1	2	222	10	2	**240**
East	45	12	16	27	31	31	10	5	51	1216	76	148	65	459	106	0	0	12	1036	24	**1075**
North	193	27	57	48	28	84	43	27	85	1292	459	318	199	174	367	1	5	2	21	3066	**3098**
Total	**4107**	**493**	**1486**	**1222**	**1632**	**4254**	**1334**	**1314**	**896**	**25**	**1795**	**3975**	**7384**	**16**	**1793**	**168**	**65**	**241**	**1070**	**3102**	**4718**

Values are Highway Trip demand in Vehs, values in red in 1000s

Figure 6-4 – Sector Matrix: PM Peak Period, Post ME2

	Chippenham	Corsham	Melksham	Calne	Devizes	Trowbridge	Westbury	Warminster	RWB	Swindon	Malmesbury	Chip Rural	Rural Cen	SE Wilts	West of Swin	South West	West	South	East	North	**Total**
Chippenham	2110	72	98	244	52	165	19	6	42	64	141	692	208	39	48	5	139	14	48	248	**4452**
Corsham	51	57	22	11	5	19	2	1	3	9	9	188	34	2	3	4	39	3	7	52	**520**
Melksham	55	21	318	20	15	127	18	6	1	18	15	72	381	18	2	3	61	11	8	45	**1215**
Calne	119	10	29	417	53	23	2	0	18	27	14	226	65	11	35	1	27	2	14	43	**1135**
Devizes	29	16	19	181	487	92	15	3	49	138	2	74	655	163	18	1	39	16	31	23	**2048**
Trowbridge	76	17	198	24	86	1654	244	84	2	46	11	97	1359	68	3	6	495	48	34	71	**4623**
Westbury	13	2	30	5	9	165	322	63	1	15	6	13	398	34	2	5	130	26	8	30	**1277**
Warminster	1	1	8	1	12	64	90	438	0	5	3	5	368	97	0	1	160	32	2	17	**1306**
RWB	23	2	4	37	21	6	1	0	37	393	25	58	14	19	101	2	11	7	43	118	**923**
Swindon	146	20	29	117	134	49	7	2	535	26	183	263	90	348	1177	44	111	107	1494	1877	**32**
Malmesbury	205	13	20	47	4	26	4	1	22	150	651	122	29	8	122	16	75	8	56	783	**2362**
Chipp Rural	666	255	169	248	96	244	30	11	74	302	142	1089	317	292	100	24	401	54	172	572	**5257**
Rural Central	172	65	627	85	612	1463	463	357	17	89	39	257	2720	310	14	12	863	116	65	222	**8567**
SE Wilts	35	10	52	35	155	99	94	236	65	346	14	280	355	14	34	35	343	2849	417	225	**20**
West of Swin	36	3	6	59	26	10	2	1	112	1111	102	94	22	28	237	5	23	16	126	415	**2433**
South West	6	1	1	1	2	6	3	1	4	34	14	13	7	25	6	183	2	1	0	1	**188**
West	225	95	141	23	52	567	164	174	11	69	52	467	1094	291	15	2	61	3	0	7	**76**
South	10	6	25	17	23	45	65	47	24	169	17	35	109	3110	36	1	2	275	15	1	**298**
East	62	12	39	69	59	45	10	8	208	1857	92	180	83	653	273	0	0	17	1343	33	**1398**
North	374	62	82	129	50	160	65	41	156	1960	596	411	299	204	497	1	6	2	27	3871	**3912**
Total	**4414**	**740**	**1919**	**1771**	**1953**	**5028**	**1620**	**1480**	**1380**	**32**	**2125**	**4633**	**8607**	**20**	**2722**	**188**	**75**	**301**	**1388**	**3918**	**5961**

Values are Highway Trip demand in Vehs, values in red in 1000s

7. Model validation results

7.1. Overview

In TAG Unit M3.1 **calibration** is defined as adjustments to the model intended to reduce the differences between the modelled and observed data. **Validation** is the process of demonstrating the quality of the model by comparing the model output with observed data, which should be independent of data used for model development.

This chapter outlines the outcomes from the calibration and validation of traffic flows, journey times within the AoDM and the model stability. The aim is to demonstrate that the model adheres to the standards presented in Section 2.4. All assignment results presented use the post ME2 highway traffic demand matrices discussed in Section 6.

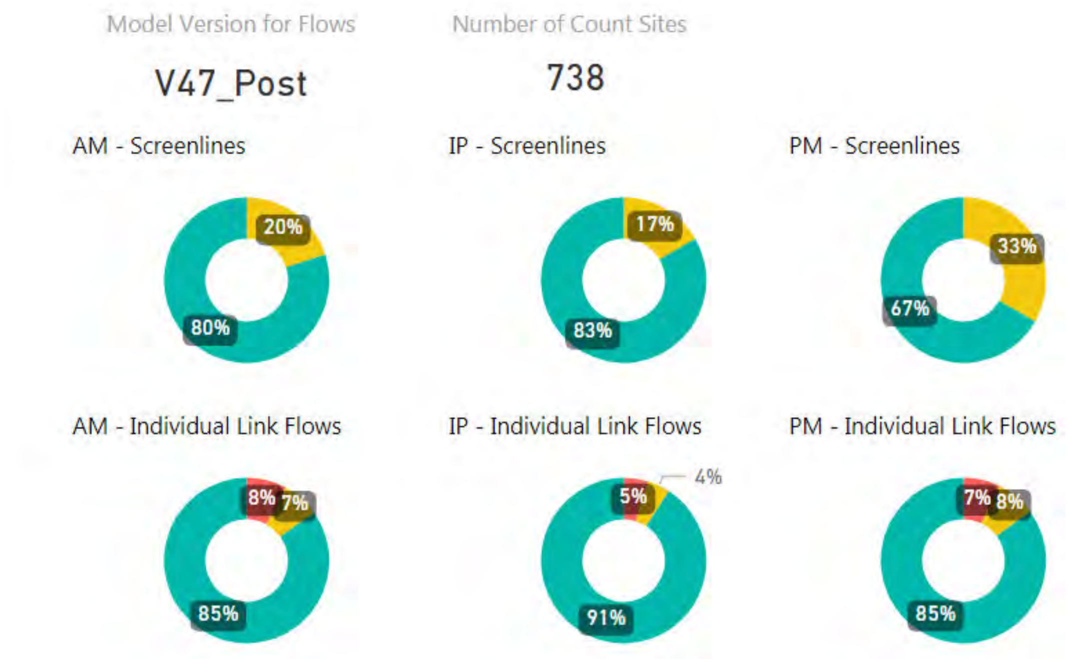
7.2. Traffic flow and routeing calibration and validation

The overall results of the screenline and cordon traffic flows and the individual link flow calibration and validation for total vehicles and lights are shown in Table 7-1. The total flows (model vs observed) for each screenline and cordon are shown in Table 7-2 (note that the observed data is presented in Table 3-1). Figure 7-1 shows the link flow validation in all time periods for all vehicles and light vehicles within the AoDM. This information shows a very high level of model validation.

A full set of data, for each of the 738 count sites within the AoDM is available from Atkins upon request. The wider level of validation within the South West region (outside the AoDM) is presented in Appendix C.

Table 7-1 - Traffic Flow Calibration & Validation Summary Post ME2, Total Vehicles

Measure	Cal or Val	No. Sites	Pass	Near	Fail
AM					
Screenlines (Two Directions)	Calibration	18	78%	22%	0%
	Validation	12	83%	17%	0%
	Total	30	80%	20%	0%
Link flows	Calibration	533	87%	7%	6%
	Validation	205	78%	9%	13%
	Total	738	85%	7%	8%
IP					
Screenlines (Two Directions)	Calibration	18	83%	17%	0%
	Validation	12	83%	17%	0%
	Total	30	83%	17%	0%
Link flows	Calibration	533	94%	3%	3%
	Validation	205	82%	8%	10%
	Total	738	91%	4%	5%
PM					
Screenlines (Two Directions)	Calibration	18	67%	33%	0%
	Validation	12	67%	33%	0%
	Total	30	67%	33%	0%
Link flows	Calibration	533	88%	6%	5%
	Validation	205	77%	11%	12%
	Total	738	85%	8%	7%



This includes all calibration and validation traffic count sites within the AoDM. Results show output for All Vehicles.

Table 7-2 – Cordon & Screenline Traffic Flow: Model vs Observed

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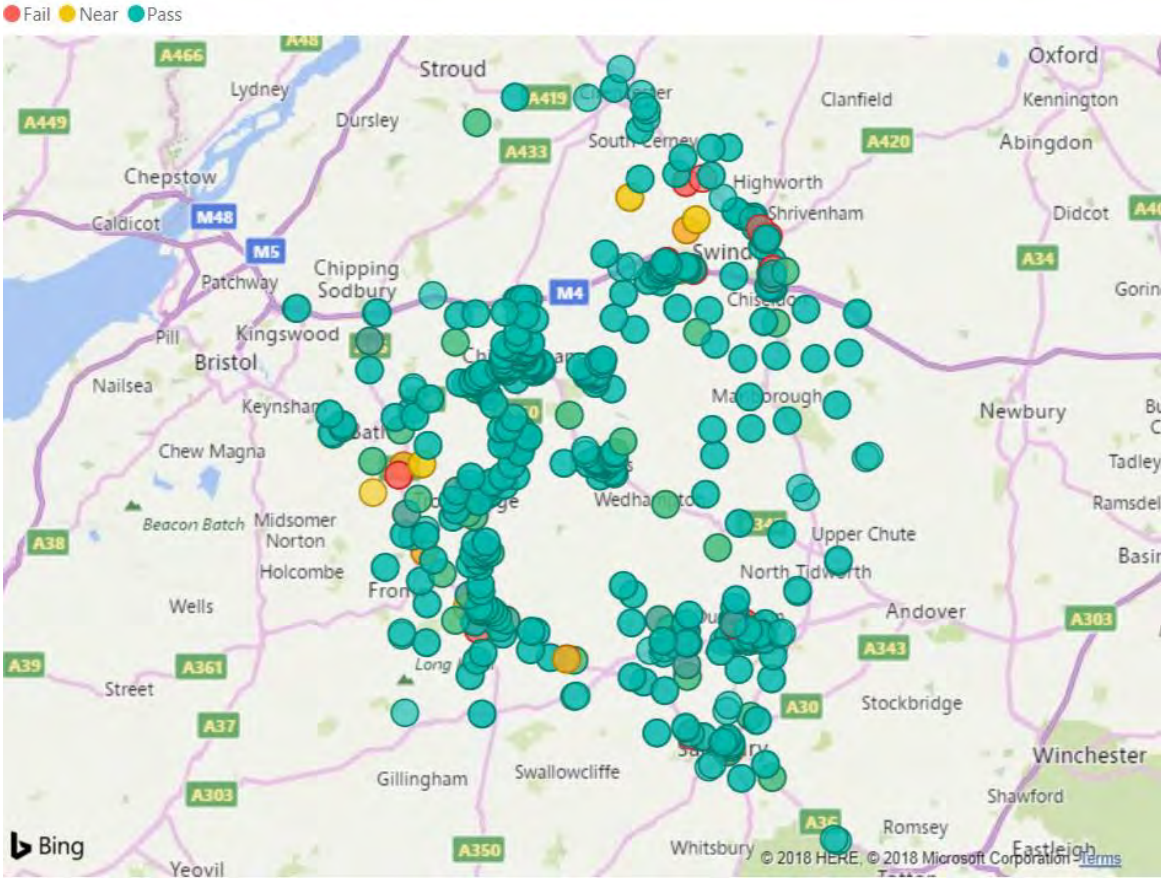
Figure 7-1 shows the locations or calibration and validation count sites in the AoDM. Using plots like this it was possible to ensure that areas of key interest (such as Chippenham) obtained a high level of calibration/validation so that future models would not encounter significant issues.

Figure 7-1 – Post ME2 Trip Matrix Link calibration/validation sites, for all vehicles in the AM



7.3. Journey time validation

The purpose of journey time validation is to show that the model is correctly replicating journey times, or entire route costs on key routes through the AoDM. The model standards utilised are shown in Section 2.4.3. The 14 routes (28 two-way) identified are presented in Figure 3-4. A summary of the total modelled journey time is shown in Table 7-3. This shows that all the routes are within the model standards and the route costs within the AoDM are assumed to be an accurate reflection of delays within the network.

Distance-Time graphs for the A350 are presented in Appendix F. All other graphs are available from Atkins on request.

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7.4. Assignment convergence stability

The level of stability and convergence achieved, as required within the model standards (see Section 2.4.5) are presented in Table 7-4. The results indicate that the model achieves a good level of convergence that complies with recommended criteria.

Table 7-4 - Assignment Convergence Statistics

AM Peak			Inter Peak			PM Peak		
Loop	% Flows	%GAP	Loop	% Flows	%GAP	Loop	% Flows	%GAP
11	97.7	0.0068	11	99	0.0023	12	98.9	0.0039
12	98.4	0.0065	12	98.3	0.0020	13	99.0	0.0030
13	99.4	0.0052	13	99	0.0025	14	99.2	0.0024
14	99.7	0.0029	14	99.5	0.0025	15	99.4	0.0021

8. Variable demand modelling

This section will be completed in Issue 2.

9. Summary

9.1. Overview

The cordon/screenline, link flow and journey time comparisons reported (Section 7), the VDM set-up and realism testing (Section 8) and the consistency of the model to retain the validation across the wider region (see Appendix C) demonstrate that the development work carried out for the Wiltshire 2018 base model has significantly improved the existing model within the AoDM (see Section 4.1) without compromising the wider integrity of the validated A303 Stonehenge / SWRTM models.

The results demonstrate that the traffic model has achieved the objectives discussed in Section 2.1 and is suitable, within the requirements of TAG, to be used to support the strategic appraisal of an infrastructure project or planning decision which is required to understand the impact on local roads or the SRN within Wiltshire and the AoDM.

The model is considered a suitable basis for generating highway traffic forecasts, consistent with DfT guidance and hence strategic assessment of highway mitigation measures and land developments.

9.2. Limitations of the model

This section describes the known model limitations. The recommended appropriate usage, in response to these limitations, is described in the next section.

9.2.1. Peak period

The model, as consistent with the A303 Stonehenge / SWRTM, utilises an average peak period, as opposed to a peak hour. This is likely to result in an underprediction of peak hour delay at a local junction level.

9.2.2. Intervention limitations

The model has been developed to assess strategic highway schemes. it has not been specifically developed to analyse and assess the following types of transport schemes and improvements:

- Pedestrian/Cycle Improvements e.g. localised carriage widening, minor improvements to traffic signal operation, standalone pedestrian crossing, cycle improvements etc.
- Certain types of infrastructure schemes e.g. linked or vehicle actuated (MOVA) traffic signal improvements, shared space or other more complex infrastructure
- Public Transport (PT) schemes e.g. Bus, Rail, LRT or metrobus schemes
    - As the model is consistent with the RTM, The model doesn't include a full PT element, it does include an estimation of rail demand but this is not a fully responsive element within the modelling set.
- Parking schemes e.g. changes to parking strategy or Park & Ride sites

In light of these limitations, Atkins recommend the following appropriate usage guidance.

9.3. Appropriate usage

It is recommended that the model could be used to assess schemes or developments of an "appropriate" scale or type. This "appropriateness" is difficult to quantify precisely and it is expected that any scheme or development should be assessed based on a **proportionate** approach and the limitations of this (and any alternate) model need to be clearly communicated, through collaboration and discussion with decision makers or stakeholders. It is recommended that any decision maker, or user, seek Atkins' advice on how to effectively utilise the Wiltshire strategic model. The following considerations are recommended to assist in the decision-making process.

9.3.1. Geographic area

The model has been developed to strategically assess the highway impact across the AoDM.

For a scheme or development assessment within the Swindon urban area, Atkins recommend usage of the Swindon model to understand the impact within this region. For a scheme or development which lies outside of the Wiltshire boundary, Atkins recommend engagement with Highways England or the appropriate Highway Authority to determine the most appropriate model or assessment tool depending on the nature and location of the assessment.

For schemes within the Wiltshire Authority boundary the Wiltshire strategic model is considered the most appropriate initial tool, unless a more detailed model is already available.

9.3.2. Scheme type

For a highway scheme of appropriate scale and type, the Wiltshire model is considered suitable for initial assessment. If the intervention to be assessed is of a type which the model has known limitations (such as: Pedestrian/Cycle Improvements, PT & Parking schemes) Atkins are able to provide advice on how to estimate/quantify the likely modal shift from vehicle trips or trip redistribution as a result of these types of intervention and calculate possible highway benefit and operational impact using the Wiltshire strategic model.

9.3.3. Donor model

The Wiltshire model is able to provide a strategic forecast and assessment of a highway intervention. For an analysis and assessment of local impacts, Atkins recommend that the strategic model act as a donor for a localised application. This may include developing, using the strategic model as an input (one, or more of) the following:

- A highway cordon of the SATURN model
- Use of bespoke local junction software e.g. LINSIG, ARCADY
- Development of a micro-simulation model (Paramics, VISSIM)

Depending on the purpose, nature and scale of the scheme or development to be assessed, Atkins advise that the strategic model is used in conjunction with local cordoned refinements or other software applications in order to meet the objectives of the assessment. It would be necessary to define an appropriate area of influence (which the strategic model could provide) with potential for localised recalibration and possible adjustments to reflect peak hour demand.

Appendices

Appendix A. Abbreviations

AADT	Annual Average Daily Traffic
AAWT	Annual Average Weekday Traffic
AM	Morning peak period
ANPR	Automatic Number Plate Recognition
AoDM	Area of Detailed Modelling
ARN	Affected Road Network
ASR	Appraisal Specification Report
ATC	Automatic Traffic Count
COBA	Cost Benefit Appraisal (software)
DF2	Design Fix 2 (Version No. of the Base SWRTM)
DfT	Department for Transport
DM	Do Minimum
DMRB	Design Manual for Roads and Bridges
DS	Do Something
EB	Eastbound
EB	Employer's Business
FMA	Fully Modelled Area
GEH	Statistic used to assess the quality of model validation, devised by GE Havers
HBEB	Home Based Employer's Business
HBO	Home Based Other
HBW	Home Based Work
HGV	Heavy Goods Vehicle
HOV	High Occupancy Vehicle
IAN	Interim Advice Note
IP	Inter-peak period
Kph	kilometres per hour
LGV	Light Goods Vehicle
LMVR	Local Model Validation Report
LSOA	Lower Layer Super Output Area
MCC	Manual Classified Count
MCTC	Manual Classified Turning Count
ME	Matrix Estimation
ME2	Matrix Estimation from Maximum Entropy
MPD	Mobile Phone Data
MSOA	Middle Layer Super Output Area
MVR	Model Validation Report
NB	Northbound

NHBEB	Non-Home Based Employer's Business
NHBO	Non-Home Based Other
NTEM	National Trip End Model
NTS	National Travel Survey
OD	Origin-Destination
OGV1	Goods Vehicle – 2 or 3 axle rigid
OGV2	Goods Vehicle – 4 axle rigid or 3+ axle articulated
ONS	Office for National Statistics
OP	Off-peak period
PA	Production-Attraction
PCF	Project Control Framework
PCU	Passenger Car Unit
PM	Evening peak period
PPK	Pence per kilometre
PPM	Pence per minute
RIS	Road Investment Strategy
RoF	Region of Focus (of the model)
RSI	Roadside Interview
RTM	Regional Traffic Model
SB	Southbound
S2	Single two lane carriageway
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SOBC	Strategic Outline Business Case
SRN	Strategic Road Network
SWRTM	South West Regional Traffic Model
TAG	Traffic Appraisal Guidance
TAME	Traffic Appraisal, Modelling and Economics
TCG	Technical Consistency Group
TDCR	Traffic Data Collection Report
TEMPro	Trip End Model Presentation Program
TIS	Trip Information System
TRL	Transport Research Laboratory
VDM	Variable Demand Model
VOC	Vehicle Operating Cost
VoT	Value of Time
vph	Vehicles per hour
WB	Westbound
WebTAG	Web-based Transport Appraisal Guidance issued by DfT
WebTRIS	Highways England Traffic Information System

Appendix B. ANPR & ATC data cordons

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Table C-1 - Screenline Comparison Outside AoDM, Total Vehicle flows

Screenline	Dir	AM				IP				PM			
		Obs	Wiltshire Model Flows	A303 Model Flows	% Diff	Obs	Wiltshire Model Flows	A303 Model Flows	% Diff	Obs	Wiltshire Model Flows	A303 Model Flows	% Diff
Athelney to Newbury	NB	5341	5471	5367	2%	4737	4762	4740	0%	5863	5875	5827	1%
	SB	5742	6174	5728	8%	4478	4710	4483	5%	5644	5745	5680	1%
Boscastle to West Looe	EB	2035	1961	2044	-4%	2262	2211	2270	-3%	2195	2172	2204	-1%
	WB	2080	2049	2088	-2%	2149	2112	2159	-2%	2266	2223	2271	-2%
Holsworthy to Exmoor	NB	1064	1034	1116	-7%	984	976	1000	-2%	1196	1103	1281	-14%
	SB	1141	1192	1150	4%	1049	1038	1069	-3%	1060	984	1179	-17%
Midlands – South West	NB	11511	11343	11583	-2%	11353	10899	11459	-5%	14109	13821	14115	-2%
	SB	13233	13214	13324	-1%	10713	10343	10840	-5%	12644	12526	12910	-3%
Nether Stowey to Lyme Regis	EB	5520	5420	5522	-2%	5689	5641	5675	-1%	6210	6200	6201	0%
	WB	5980	5972	5900	1%	5260	5273	5222	1%	5970	5985	5967	0%
New Forest	NB	5414	4791	4987	-4%	4087	3903	4082	-4%	4757	4356	4731	-8%
	SB	4914	4446	4097	9%	4105	3986	4105	-3%	5747	5699	5756	-1%
Penzance	EB	1224	1243	1224	2%	1384	1406	1384	2%	1345	1373	1348	2%
	WB	1252	1265	1251	1%	1370	1390	1370	1%	1447	1476	1451	2%
South East Boundary	EB	15777	15982	15631	2%	11303	11394	11373	0%	12351	12288	12303	0%
	WB	11390	11618	11509	1%	11710	12059	11817	2%	16125	16516	16068	3%

Appendix D. Full Simulation vs Buffer Output Summary

Prior to model development, a test was done using the disaggregated Stonehenge A303 prior matrix model and an early version of the refined network to understand the relative impact of fully simulating the model vs converting the model to buffer outside of the AoDM. This was primarily undertaken to reduce model run time and improve model convergence.

A cordon of the model was considered, but a decision was made to include the full network extents to ensure that long distance trips, through the AoDM, would be retained.

Below is a comparison output from each model variant. This demonstrates that there is relatively minimal change in the global statistics but that the model run time and convergence levels suggest that for sensitivity testing and forecasting that the simulation-buffer model is the recommended model to use for future iterations.

Table D-1 – AM Buffer vs Full Simulation, Model Development, Summary Stats

Statistics	AoDM Simulation & Outside AoDM Buffer	Full Simulation
Run Times (mins)	6	23
Total Assigned Trips (pcus)	1,816,107	1,816,107
Link Cruise Time (pcu-hrs)	1,343,927	1,350,002
Transient Queued Time (pcu-hrs)	18,977	22,450
Overcapacity Queued Time (pcu-hrs)	14,998	17,020
Total Travel Time (pcu-hrs)	1,377,902	1,389,472
Travel Distance (pcu-kms)	95,748,240	95,836,336
Average Journey Speed (kph)	69.5	69
Convergence	11	23
%GAP	0.003	0.011
%flows	99.3	98

This information is not the validated model

Table D-2 – IP Buffer vs Full Simulation, Model Development, Summary Stats

Statistics	AoDM Simulation & Outside AoDM Buffer	Full Simulation
Run Times (mins)	5	11
Total Assigned Trips (pcus)	1,390,915	1,390,916
Link Cruise Time (pcu-hrs)	992,343	962,163
Transient Queued Time (pcu-hrs)	8,649	13,469
Overcapacity Queued Time (pcu-hrs)	1,744	3,027
Total Travel Time (pcu-hrs)	1,002,736	978,659
Travel Distance (pcu-kms)	72,938,656	72,972,640
Average Journey Speed (kph)	72.7	74.6
Convergence	11	16
%GAP	0	0.004
%flows	99.1	98.5

Table D-3 – PM Buffer vs Full Simulation, Model Development, Summary Stats

Statistics	AoDM Simulation & Outside AoDM Buffer	Full Simulation
Run Times (mins)	6	20
Total Assigned Trips (pcus)	1,855,971	1,855,971
Link Cruise Time (pcu-hrs)	1,271,859	1,289,368
Transient Queued Time (pcu-hrs)	18,821	22,965
Overcapacity Queued Time (pcu-hrs)	17,439	20,151
Total Travel Time (pcu-hrs)	1,308,119	1,332,483
Travel Distance (pcu-kms)	92,261,992	92,404,184
Average Journey Speed (kph)	70.5	69.3
Convergence	11	22
%GAP	0.002	0.008
%flows	99	98.3

Appendix E. Changes due to ME2

E.1. Post ME2 vs Prior: Zonal Trip Ends

Figure E-1 - AM Origin Trip Ends All Vehicles

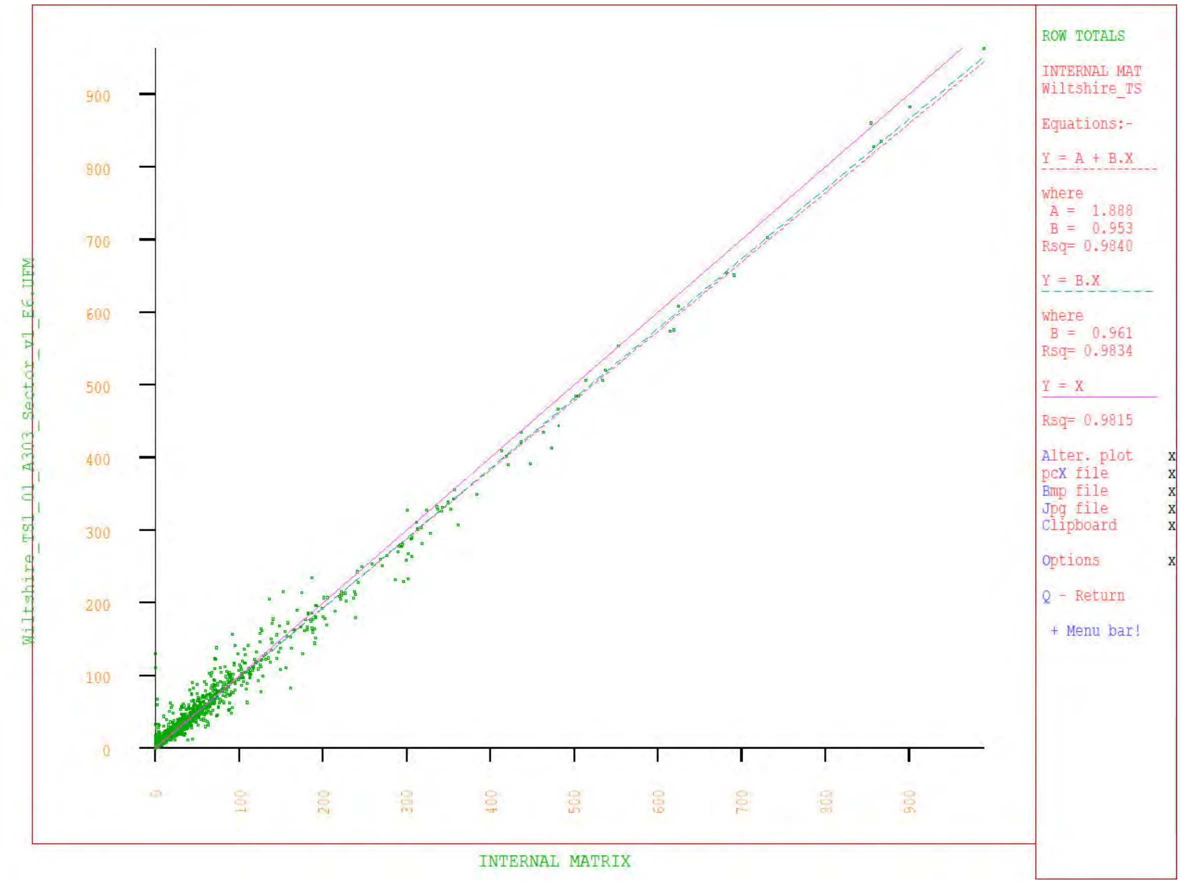


Figure E-2 - AM Destination Trip ends All Vehicles

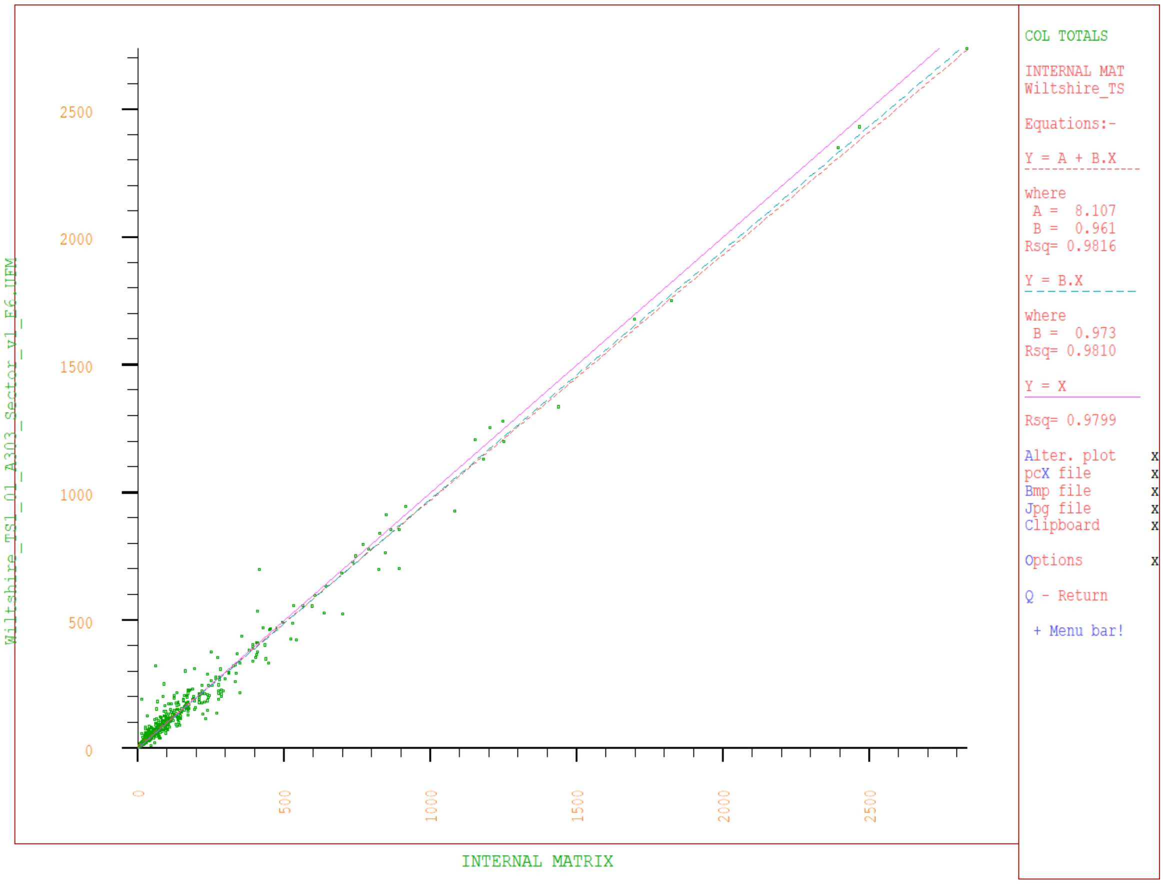


Figure E-3 - IP Origin Trip Ends All Vehicles

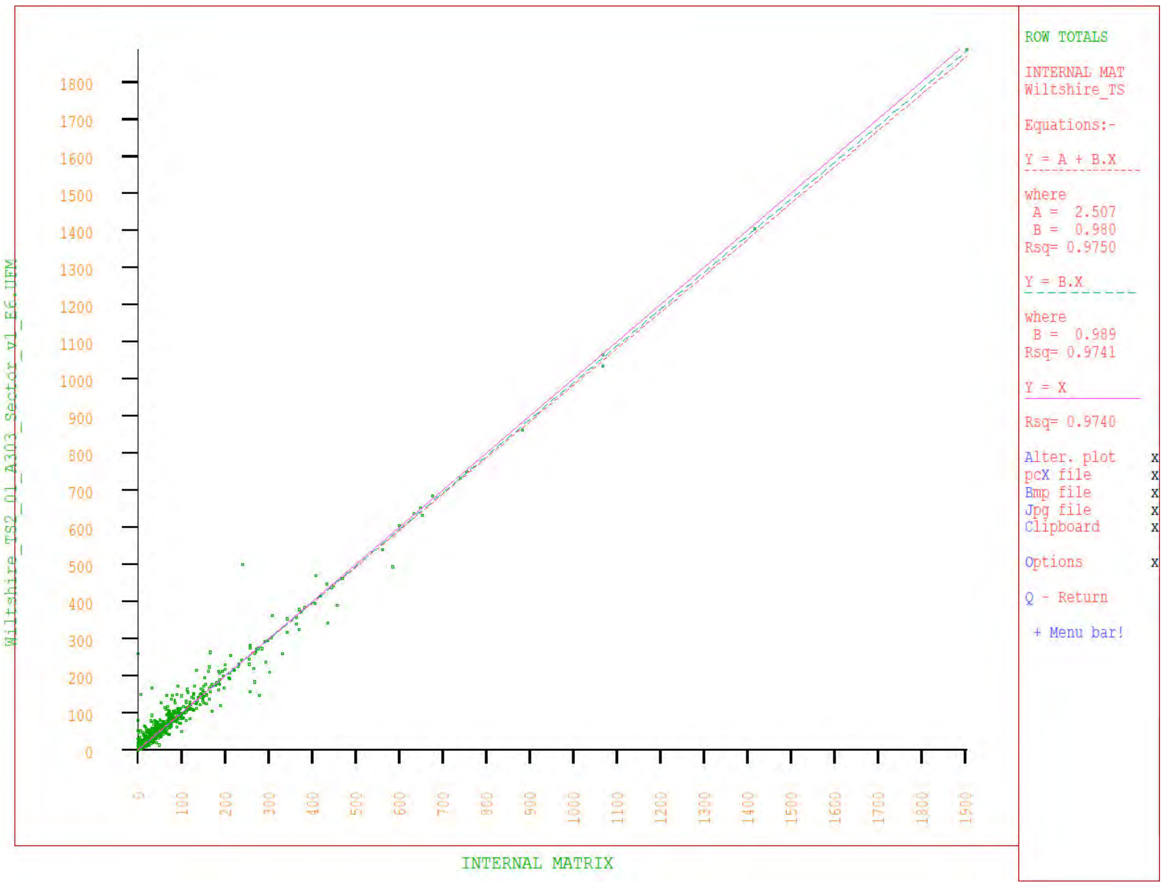


Figure E-4 - IP Destination Trip Ends All Vehicles

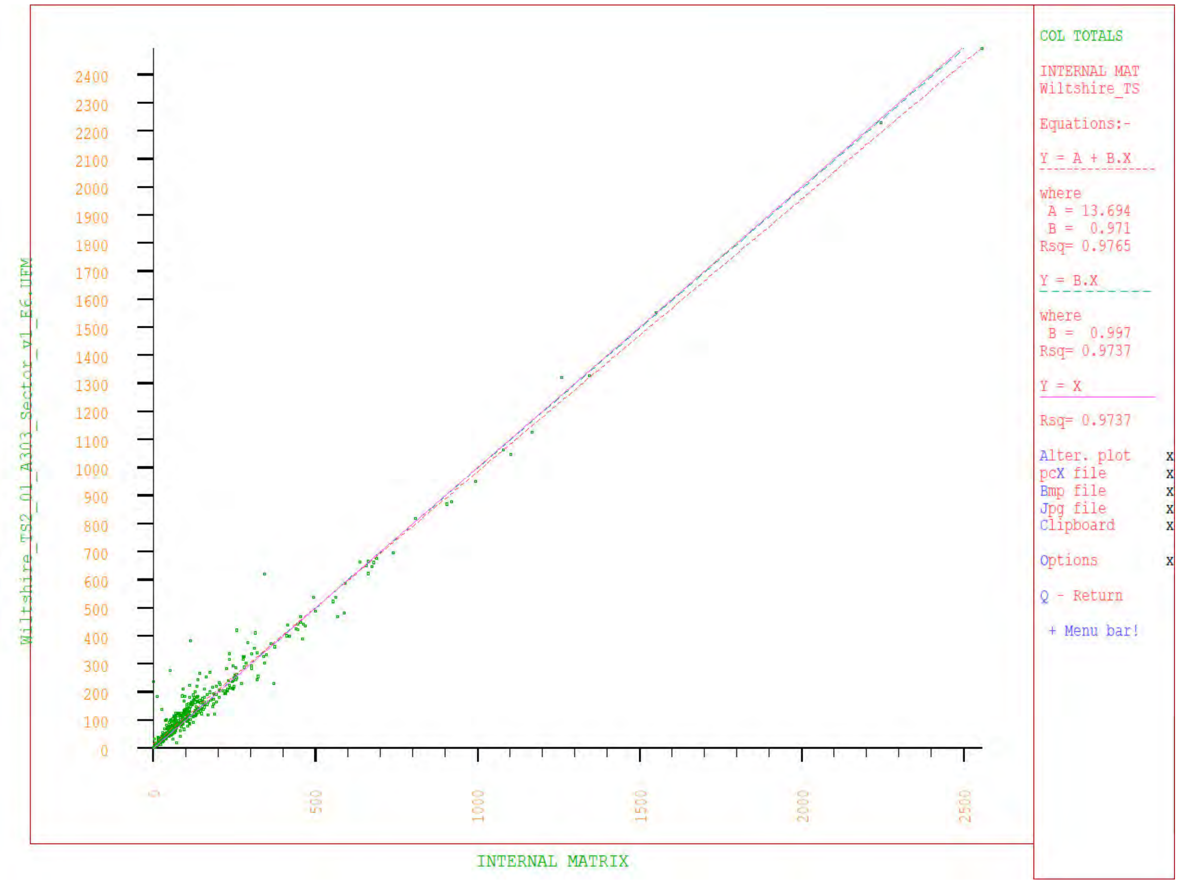


Figure E-5 - PM Origin Trip Ends All Vehicles

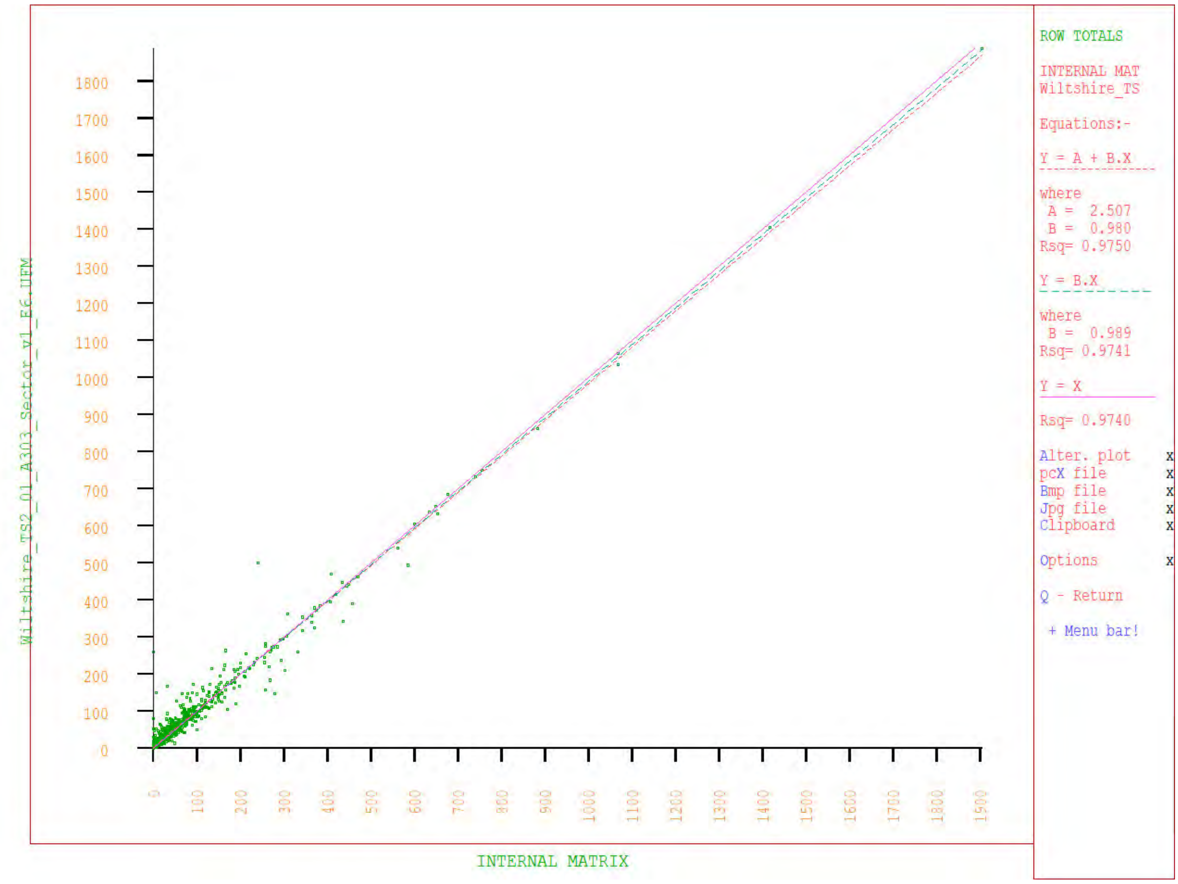
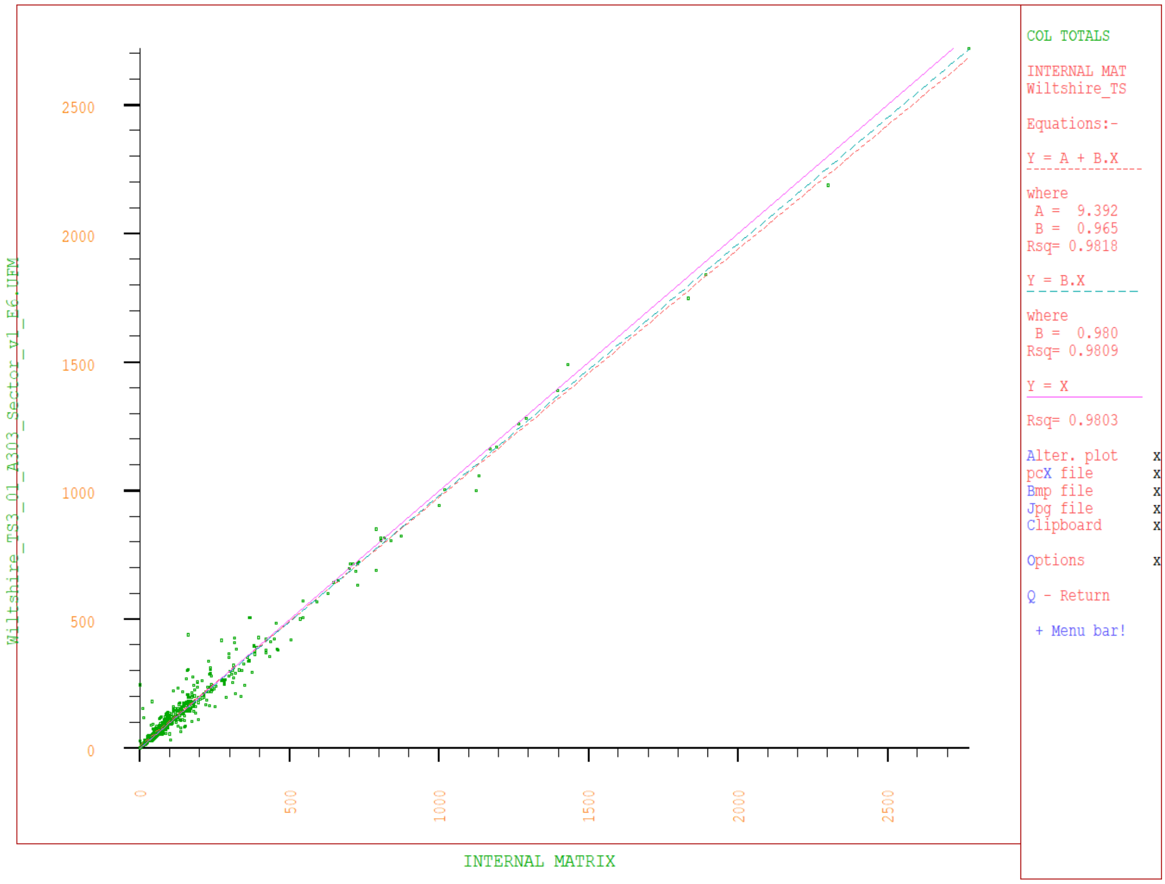


Figure E-6 - PM Destination Trip Ends All Vehicles



E.2. Post ME2 vs Prior: Zonal Cell Values

Figure E-7 - AM cell by cell All Vehicles

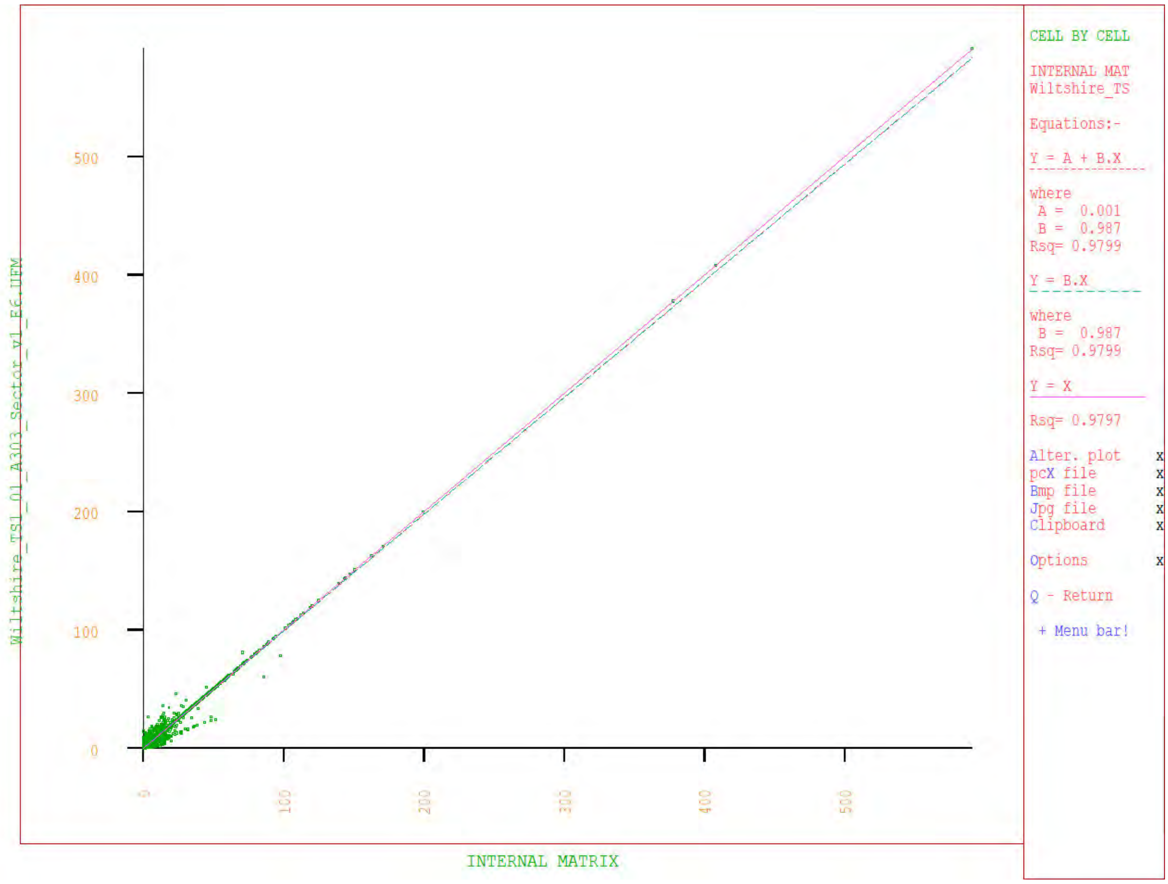


Figure E-8 - IP cell by cell All Vehicles

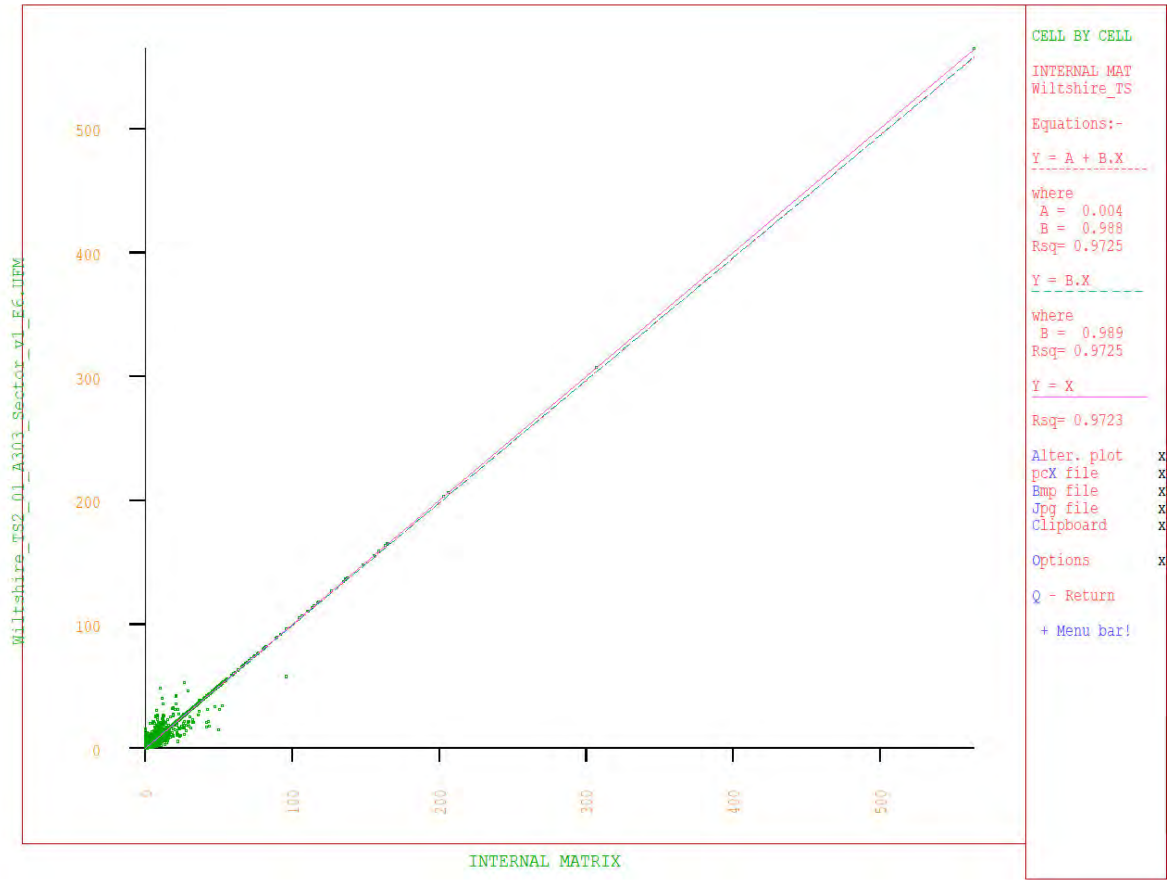
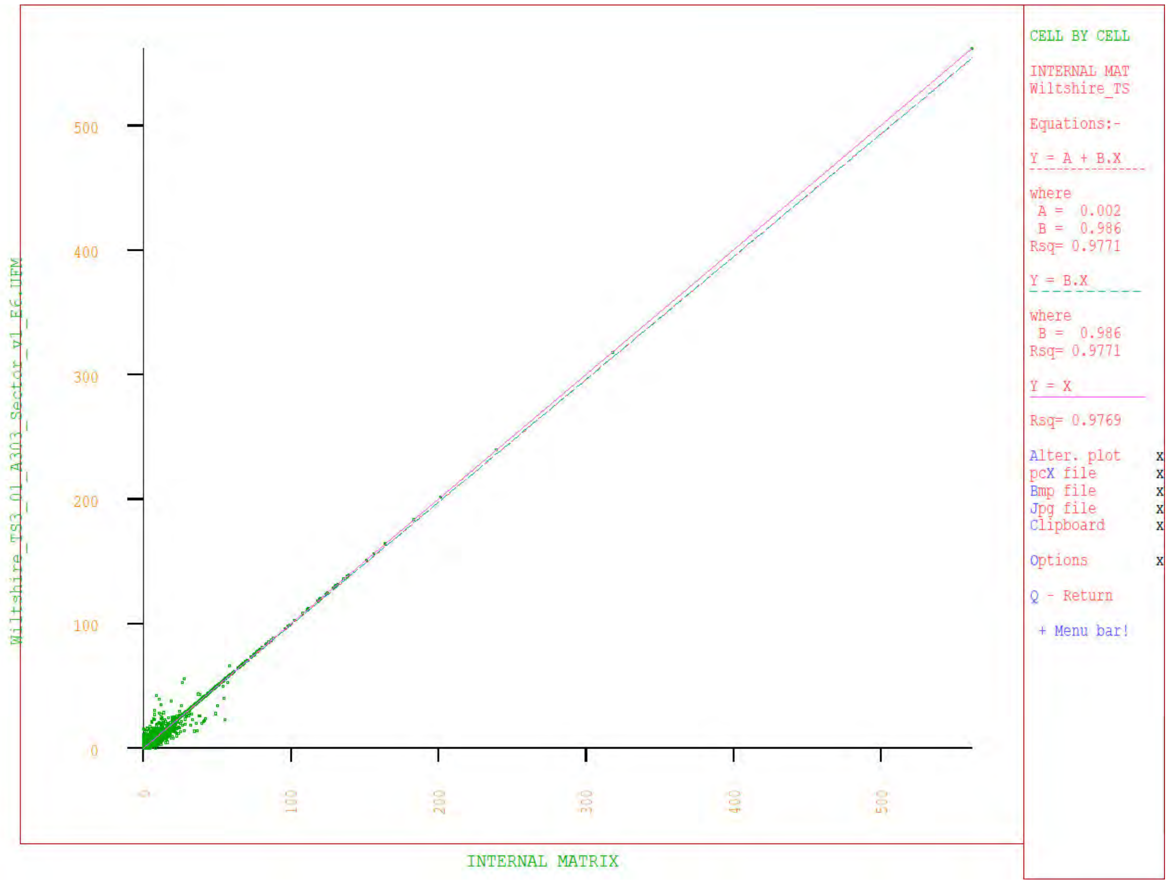


Figure E-9 - PM cell by cell All Vehicles



E.3. Post ME2 vs Prior: Trip Length Distributions

All Trip Length Distribution plots are shown for the whole model.

Figure E-10 - Trip Length Distribution AM

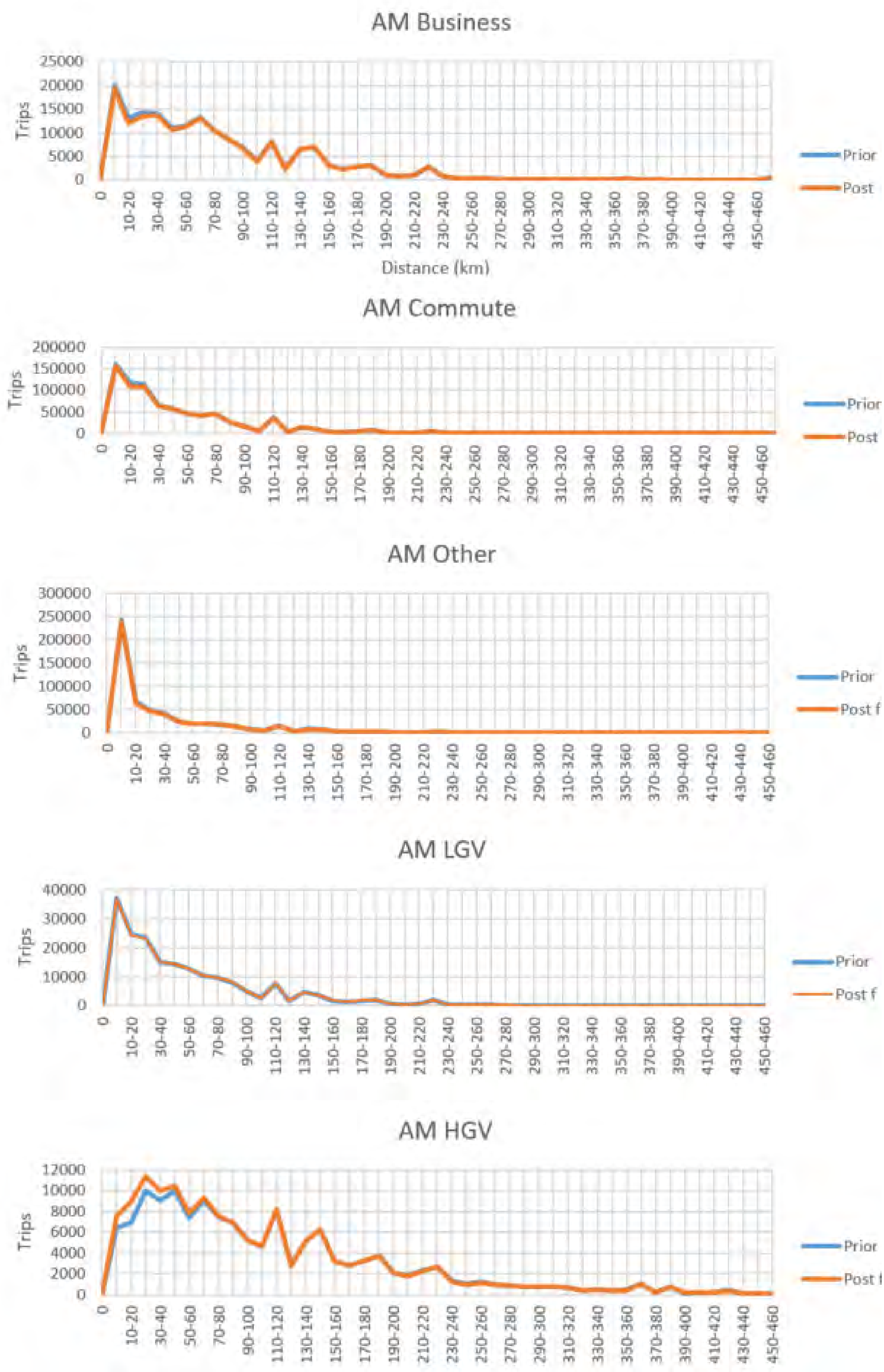


Figure E-11 - Trip Length Distribution IP

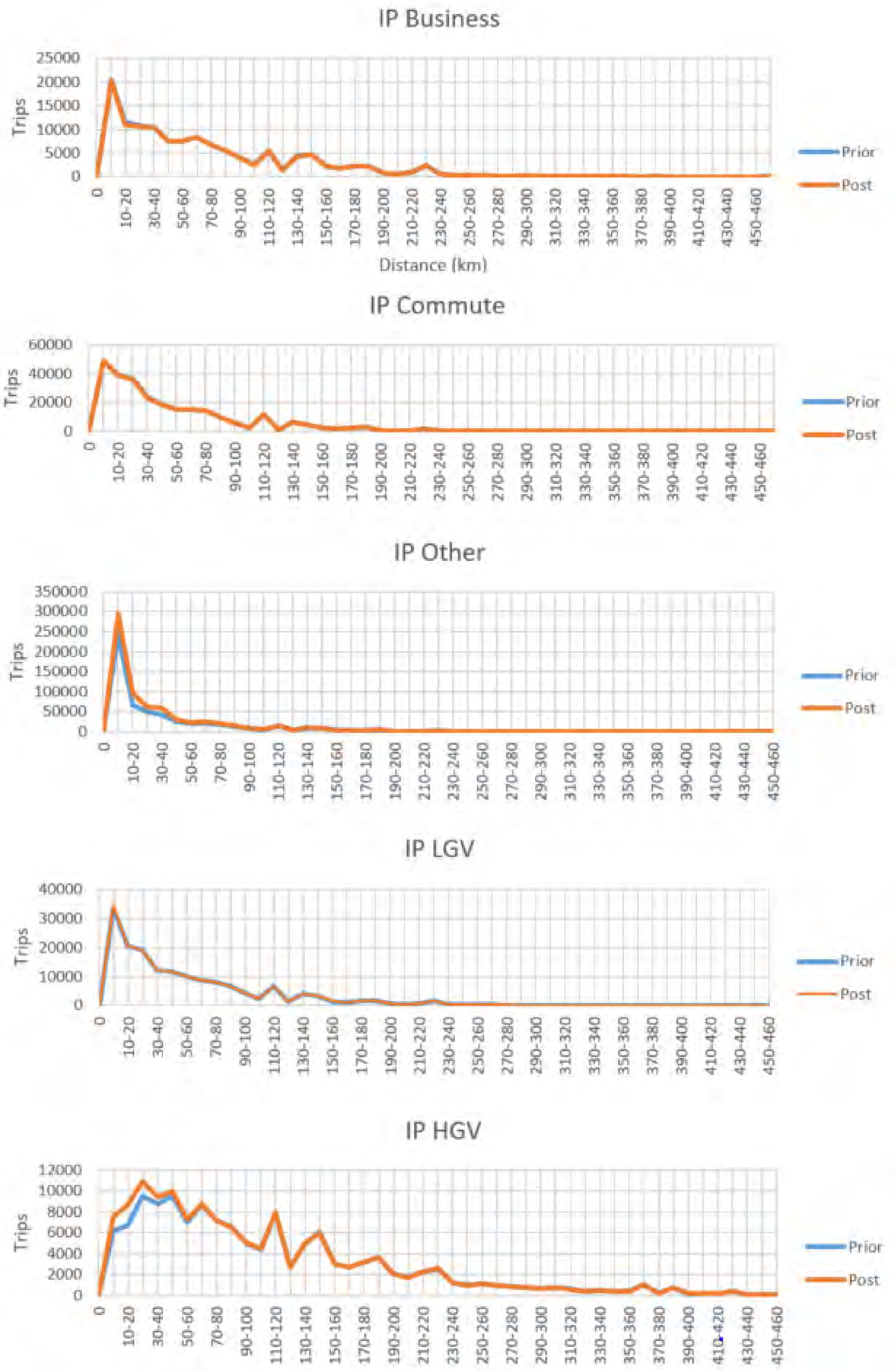
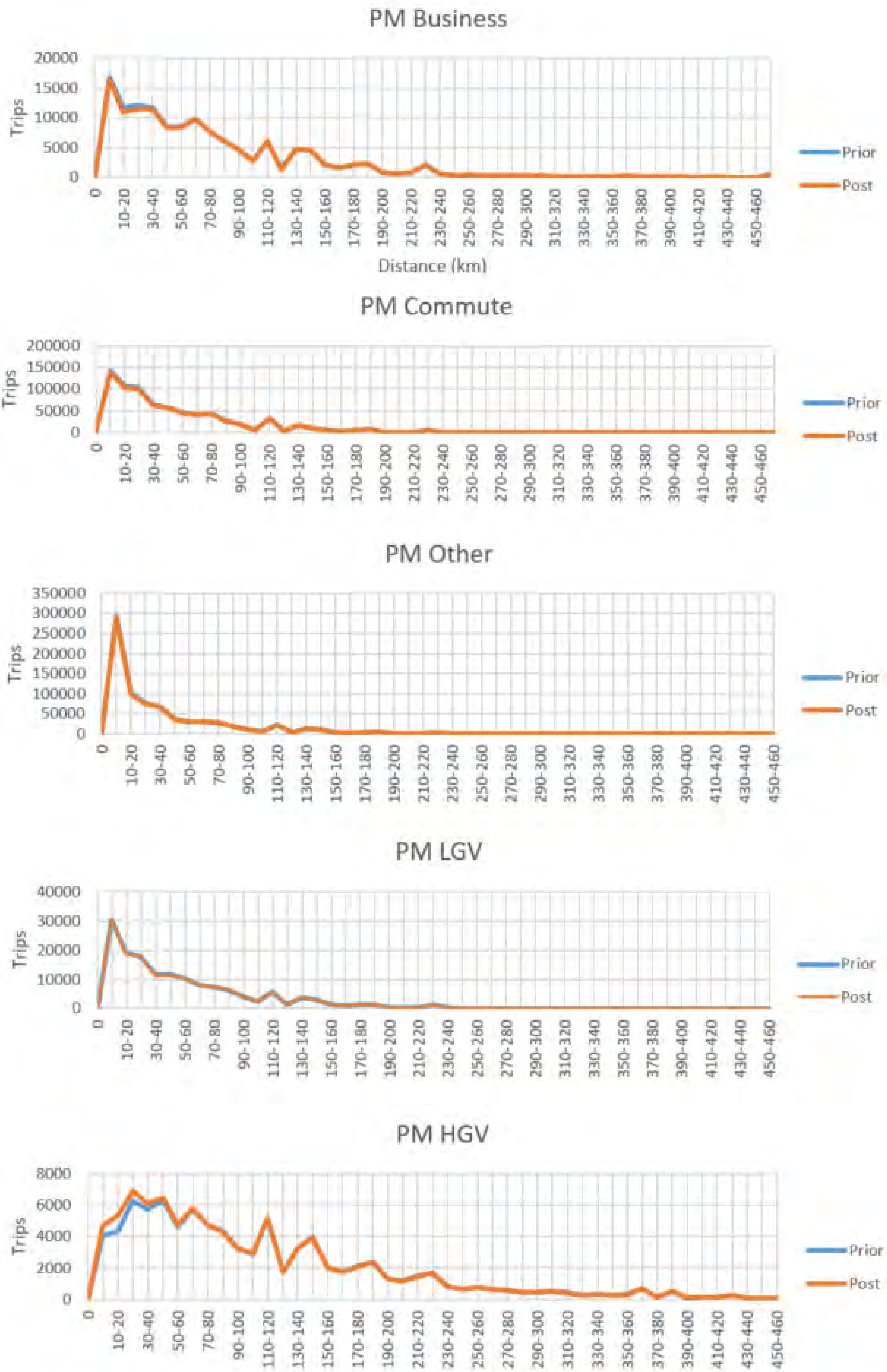


Figure E-12 - Trip Length Distribution PM



E.4. Post ME2 vs Prior: Sector to Sector Changes

Key	
Key	Change is less than 5%
	Change is between 5% and 10%
	Change is greater than 10%
	Prior Matrix has fewer than 100 trips

Figure E-13 – AM Sector to Sector % Change

AM Light Vehicles Sector to Sector changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	15%	74%	111%	21%	-37%	44%	130%	83%	-14%	-46%	-15%	21%	76%	13%	-7%	42%	-45%	-4%	-15%	1%	8%
2	0%	115%	23%	-6%	36%	-9%	27%	4%	3%	-30%	2%	5%	32%	106%	42%	225%	-38%	17%	11%	79%	11%
3	40%	51%	9%	-56%	90%	-14%	30%	6%	-79%	-26%	2%	3%	46%	173%	-50%	-39%	-24%	108%	-30%	3%	17%
4	38%	28%	-14%	-9%	2%	-19%	22%	-3%	-45%	-26%	6%	2%	-2%	-24%	-20%	87%	-36%	-51%	-1%	9%	-5%
5	-4%	-18%	11%	23%	-1%	-25%	38%	106%	102%	82%	-61%	16%	34%	30%	109%	-45%	-45%	-11%	103%	-3%	16%
6	45%	17%	65%	85%	0%	5%	222%	116%	-22%	10%	3%	44%	43%	99%	7%	-6%	-25%	78%	68%	-35%	16%
7	3%	-12%	-6%	-16%	-48%	20%	30%	82%	-65%	-24%	-23%	-15%	1%	69%	-41%	-36%	-40%	47%	-19%	-31%	4%
8	4%	-42%	26%	33%	-5%	-14%	183%	56%	-67%	-3%	-27%	21%	53%	28%	-40%	-32%	-27%	18%	-43%	-38%	28%
9	47%	120%	-27%	-13%	20%	-50%	-30%	-22%	29%	-10%	39%	79%	-16%	27%	14%	202%	-15%	-1%	32%	23%	7%
10	-37%	20%	10%	-56%	-38%	-32%	17%	-12%	-14%	-1%	24%	-26%	-31%	-24%	-21%	36%	-49%	-31%	-14%	-16%	-5%
11	9%	64%	56%	-21%	-66%	-13%	49%	121%	0%	-29%	-2%	-1%	26%	7%	-11%	164%	-34%	4%	-11%	4%	-2%
12	23%	21%	21%	4%	-10%	-8%	42%	42%	17%	-16%	-9%	1%	17%	-17%	36%	137%	-37%	-25%	-1%	17%	0%
13	12%	11%	11%	-23%	-3%	-7%	91%	77%	-27%	-13%	-29%	-10%	7%	5%	-3%	-26%	-30%	-5%	-16%	-37%	0%
14	17%	23%	41%	-18%	15%	1%	136%	21%	81%	-23%	-20%	-22%	-15%	-1%	50%	-27%	-5%	-5%	-34%	-29%	-4%
15	43%	128%	2%	-22%	-20%	-38%	34%	118%	1%	-14%	15%	37%	-8%	-17%	7%	104%	-5%	-12%	-4%	-1%	-4%
16	-9%	-51%	-23%	-28%	-58%	-55%	-8%	-71%	37%	-14%	17%	-21%	-52%	-36%	18%	-4%	-18%	0%	-11%	-13%	-5%
17	-25%	29%	23%	-35%	5%	-13%	118%	109%	-36%	-30%	-33%	-2%	7%	11%	-29%	0%	-1%	13%	-3%	-12%	-1%
18	-10%	4%	34%	-34%	-6%	5%	239%	3%	91%	-30%	-28%	-26%	3%	-11%	7%	-20%	-17%	-5%	-6%	4%	-5%
19	-27%	47%	-4%	-17%	16%	3%	57%	-41%	142%	-8%	-23%	-16%	-8%	-22%	45%	23%	-9%	-3%	0%	-1%	0%
20	-13%	45%	41%	-22%	-48%	-19%	58%	54%	27%	-6%	-19%	-11%	12%	-9%	-1%	14%	-19%	17%	0%	0%	0%
Total	12%	36%	20%	-8%	-3%	-3%	79%	63%	6%	-4%	-8%	-1%	16%	-2%	-5%	-4%	-5%	-5%	0%	0%	-1%

AM HGV Sector to Sector Changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	231%	218%	238%	549%	-34%	334%	1766%	440%	246%	-56%	-22%	258%	456%	208%	355%	12%	83%	63%	37%	3%	97%
2	69%	430%	179%	184%	52%	213%	956%	248%	54%	-14%	-14%	215%	278%	522%	66%	522%	544%	517%	105%	119%	186%
3	465%	298%	34%	192%	-55%	186%	666%	122%	-1%	72%	211%	132%	168%	184%	154%	285%	469%	-14%	-42%	92%	151%
4	792%	324%	79%	207%	296%	634%	554%	89%	6%	-50%	167%	173%	124%	132%	96%	231%	284%	84%	-46%	287%	227%
5	73%	-63%	-59%	352%	10%	-24%	110%	17%	217%	166%	-56%	105%	117%	170%	177%	-66%	-20%	28%	65%	-50%	80%
6	590%	399%	570%	367%	31%	90%	225%	-2%	80%	215%	266%	241%	123%	28%	324%	80%	261%	27%	5%	70%	111%
7	2111%	1387%	905%	3210%	275%	262%	100%	-53%	1166%	431%	1078%	889%	116%	-11%	1927%	20%	298%	-53%	-22%	69%	158%
8	316%	207%	89%	524%	94%	34%	-24%	61%	139%	4%	122%	91%	-16%	75%	285%	-39%	269%	31%	-55%	-41%	31%
9	156%	210%	-29%	136%	883%	188%	169%	-22%	141%	-47%	109%	170%	34%	456%	107%	140%	38%	299%	855%	47%	167%
10	-1%	119%	-3%	-20%	-2%	-11%	-35%	-82%	-15%	-7%	76%	50%	-53%	57%	-16%	-59%	-56%	-45%	-38%	-24%	-23%
11	-55%	-31%	26%	263%	-95%	55%	592%	100%	-34%	40%	0%	-22%	132%	148%	-26%	253%	3%	169%	156%	34%	47%
12	298%	304%	34%	252%	93%	92%	513%	101%	97%	11%	2%	156%	84%	82%	205%	181%	208%	138%	26%	116%	120%
13	905%	592%	511%	1301%	125%	192%	149%	23%	436%	97%	414%	264%	93%	51%	741%	62%	245%	69%	-23%	92%	120%
14	407%	138%	57%	165%	155%	69%	46%	40%	182%	6%	129%	50%	0%	103%	92%	-37%	178%	39%	22%	8%	66%
15	187%	153%	58%	381%	341%	449%	559%	91%	136%	47%	79%	296%	120%	322%	20%	223%	54%	432%	369%	31%	132%
16	-71%	-78%	26%	-61%	-74%	-26%	-52%	-15%	545%	6%	160%	-49%	-63%	41%	257%	72%	43%	-30%	-16%	-27%	53%
17	42%	396%	56%	86%	-50%	30%	212%	98%	-11%	-54%	-45%	168%	4%	173%	-26%	52%	44%	104%	10%	-5%	29%
18	196%	-17%	-12%	180%	171%	23%	-21%	61%	359%	-16%	440%	1%	-35%	137%	254%	-70%	67%	17%	23%	-4%	15%
19	119%	284%	-24%	-51%	-30%	-45%	104%	-58%	547%	-42%	300%	85%	-44%	29%	183%	-3%	53%	10%	1%	-2%	0%
20	13%	11%	207%	60%	-40%	75%	121%	-48%	14%	-27%	-32%	86%	103%	14%	-29%	7%	27%	6%	0%	0%	0%
Total	119%	160%	171%	172%	35%	67%	179%	19%	118%	-19%	53%	116%	38%	86%	87%	51%	48%	15%	1%	0%	2%

AM Totals Sector to Sector Changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	16%	78%	113%	26%	-37%	49%	337%	144%	1%	-46%	-15%	22%	84%	16%	14%	38%	-41%	-1%	-10%	1%	9%
2	0%	116%	24%	-4%	36%	-7%	92%	26%	6%	-29%	2%	5%	35%	114%	44%	255%	-31%	39%	20%	82%	13%
3	41%	51%	9%	-56%	89%	-12%	58%	16%	-78%	-24%	3%	3%	47%	174%	-48%	97%	-16%	79%	-31%	11%	19%
4	40%	30%	-14%	-9%	2%	-16%	29%	-1%	-45%	-26%	7%	3%	-2%	-24%	-20%	90%	-30%	-50%	-1%	18%	-4%
5	-3%	-19%	11%	24%	-1%	-25%	38%	106%	103%	85%	-61%	17%	35%	35%	110%	-45%	-45%	-10%	96%	-5%	17%
6	49%	20%	76%	87%	0%	5%	222%	112%	-19%	18%	7%	45%	43%	97%	16%	5%	-23%	66%	60%	-25%	17%
7	30%	11%	17%	28%	-48%	21%	30%	81%	-18%	1%	18%	-11%	2%	69%	29%	-30%	-37%	34%	-19%	-20%	7%
8	12%	-36%	29%	39%	-5%	-13%	178%	56%	-58%	-3%	-20%	22%	52%	28%	-27%	-33%	-23%	19%	-45%	-39%	28%
9	51%	128%	-27%	-12%	24%	-37%	27%	-22%	30%	-10%	40%	81%	-14%	30%	15%	195%	-8%	5%	55%	25%	10%
10	-35%	29%	9%	-55%	-34%	-29%	5%	-29%	-14%	-2%	25%	-25%	-34%	-20%	-21%	-26%	-51%	-34%	-15%	-17%	-5%
11	7%	58%	55%	-15%	-67%	-6%	240%	112%	-1%	-27%	-2%	-1%	33%	12%	-11%	169%	-31%	8%	-2%	5%	-1%
12	25%	22%	21%	5%	-9%	-7%	70%	46%	18%	-16%	-9%	1%	18%	-17%	40%	140%	-34%	-22%	0%	22%	1%
13	20%	15%	15%	-20%	-2%	-6%	91%	77%	-16%	-8%	-20%	-9%	8%	6%	15%	-13%	-27%	6%	-17%	-24%	1%
14	30%	35%	42%	-15%	20%	2%	132%	21%	82%	-23%	-13%	-21%	-15%	-1%	51%	-28%	-2%	-5%	-33%	-26%	-4%
15	49%	132%	5%	-21%	-16%	1%	173%	114%	1%	-14%	15%	40%	0%	-13%	7%	111%	3%	-5%	4%	-1%	-3%
16	-24%	-58%	-7%	-34%	-59%	-51%	-15%	-60%	91%	-5%	23%	-23%	-53%	-34%	36%	-4%	-16%	-3%	-12%	-15%	-4%
17	-22%	40%	25%	-27%	4%	-13%	122%	109%	-32%	-35%	-33%	0%	7%	12%	-29%	1%	0%	16%	-1%	-12%	-1%
18	8%	3%	22%	-28%	-4%	9%	186%	8%	102%	-27%	-6%	-25%	-1%	-10%	12%	-26%	-16%	-5%	-5%	3%	-5%
19	-15%	77%	-9%	-19%	3%	-12%	79%	-47%	155%	-10%	-13%	-14%	-18%	-20%	47%	16%	-1%	-3%	0%	-1%	0%
20	-11%	42%	57%	-16%	-47%	-13%	66%	33%	26%	-10%	-19%	-9%	19%	-7%	-2%	13%	-18%	14%	0%	0%	0%
Total	13%	39%	24%	-7%	-3%	-2%	82%	62%	8%	-4%	-7%	0%	17%	-2%	-4%	-4%	-5%	-4%	0%	0%	-1%

Figure E-14 – IP Sector to Sector % Change

IP Light Vehicles Sector to Sector changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	51%	92%	78%	22%	-18%	99%	20%	35%	33%	-33%	58%	64%	53%	35%	48%	63%	8%	15%	-7%	53%	48%
2	53%	85%	52%	16%	18%	13%	-17%	-19%	43%	-10%	23%	19%	24%	54%	63%	112%	15%	-4%	25%	28%	29%
3	139%	108%	17%	17%	40%	31%	-16%	-31%	-28%	-5%	61%	38%	37%	107%	11%	-35%	6%	65%	-10%	44%	33%
4	28%	28%	26%	15%	65%	29%	-13%	-13%	-17%	-32%	46%	19%	19%	-7%	-6%	14%	7%	-36%	-1%	24%	15%
5	-28%	62%	40%	78%	0%	13%	-6%	39%	91%	0%	-38%	43%	34%	43%	56%	-43%	-21%	-10%	107%	-41%	20%
6	194%	35%	60%	36%	14%	17%	144%	59%	-17%	29%	46%	46%	42%	78%	18%	-17%	-15%	81%	144%	-5%	30%
7	134%	54%	24%	5%	-1%	160%	42%	121%	-29%	2%	64%	22%	58%	115%	15%	7%	16%	157%	38%	-1%	60%
8	199%	38%	47%	26%	110%	92%	218%	68%	-11%	36%	106%	63%	90%	79%	18%	-30%	44%	68%	-22%	23%	77%
9	13%	58%	-25%	-14%	39%	-21%	-47%	-62%	47%	-4%	-19%	25%	-18%	10%	1%	14%	-9%	-11%	19%	4%	2%
10	-37%	47%	48%	-13%	67%	86%	25%	-18%	-1%	-1%	5%	-16%	21%	-29%	-6%	32%	18%	-34%	14%	8%	-1%
11	10%	35%	77%	-8%	-55%	57%	30%	-13%	16%	1%	-2%	6%	38%	14%	6%	32%	-24%	3%	2%	0%	2%
12	42%	20%	32%	2%	5%	23%	-21%	-8%	13%	-40%	20%	15%	10%	-32%	17%	35%	-17%	-20%	-17%	8%	5%
13	67%	50%	32%	9%	24%	46%	44%	78%	-11%	-31%	14%	13%	10%	3%	0%	-35%	-4%	20%	-2%	-8%	20%
14	1%	63%	69%	-21%	30%	49%	108%	31%	25%	-25%	10%	-12%	-11%	1%	-1%	-32%	-5%	-3%	-30%	-28%	-2%
15	10%	113%	18%	1%	67%	35%	3%	-5%	11%	-6%	-2%	43%	22%	-9%	6%	30%	20%	-20%	21%	4%	2%
16	6%	-32%	-32%	-15%	-40%	-23%	-25%	-57%	83%	43%	117%	-4%	-47%	-26%	35%	-1%	-8%	1%	-4%	-3%	-1%
17	-31%	-17%	-11%	-16%	-24%	-19%	7%	38%	-17%	-30%	-17%	-33%	-9%	12%	-12%	-7%	0%	4%	5%	-3%	-1%
18	-19%	8%	36%	-39%	-16%	35%	105%	17%	-3%	-21%	2%	-25%	-17%	-4%	9%	3%	-13%	-3%	-5%	10%	-3%
19	-40%	30%	-10%	-10%	68%	57%	21%	-41%	11%	-2%	-9%	-19%	-13%	-25%	22%	11%	14%	-5%	0%	0%	0%
20	-6%	0%	4%	-3%	6%	-21%	20%	14%	21%	28%	-4%	-11%	-13%	-17%	21%	-4%	-10%	14%	2%	0%	0%
Total	38%	33%	28%	9%	16%	27%	54%	58%	8%	-2%	4%	8%	18%	-1%	5%	-1%	-2%	-3%	0%	0%	0%

IP HGVs Sector to Sector Changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	267%	170%	317%	760%	-10%	297%	1869%	542%	241%	-24%	-40%	271%	645%	412%	321%	-24%	-36%	91%	59%	10%	103%
2	184%	572%	388%	430%	96%	321%	2190%	546%	147%	108%	20%	383%	631%	755%	182%	-41%	119%	226%	218%	35%	168%
3	516%	257%	35%	504%	-51%	380%	891%	223%	116%	86%	142%	181%	315%	93%	279%	42%	138%	-3%	-29%	52%	121%
4	336%	198%	397%	261%	845%	1227%	1225%	332%	9%	-57%	137%	143%	510%	396%	105%	185%	169%	388%	-42%	264%	214%
5	-24%	-7%	-33%	500%	14%	80%	272%	243%	1008%	38%	-92%	129%	161%	264%	455%	-63%	-13%	51%	24%	-63%	86%
6	725%	338%	373%	2303%	87%	102%	224%	-1%	748%	133%	202%	339%	148%	20%	1052%	41%	153%	-13%	-12%	33%	81%
7	2974%	2185%	1009%	3414%	443%	231%	144%	11%	1151%	486%	1076%	1256%	225%	17%	2059%	-48%	34%	-43%	4%	-14%	142%
8	398%	137%	80%	469%	57%	-46%	-62%	79%	103%	-3%	90%	89%	-46%	-29%	251%	-41%	36%	-21%	-82%	-72%	-25%
9	309%	96%	39%	48%	295%	276%	291%	28%	184%	52%	96%	232%	85%	477%	154%	167%	-14%	703%	432%	70%	146%
10	32%	200%	87%	-19%	23%	3%	-33%	-79%	-24%	-10%	27%	99%	-16%	89%	-22%	-44%	-56%	-37%	-50%	-23%	-21%
11	-46%	-24%	66%	382%	-91%	47%	668%	150%	64%	183%	0%	14%	245%	254%	14%	829%	52%	559%	201%	83%	112%
12	341%	364%	146%	381%	112%	154%	919%	217%	176%	47%	23%	270%	240%	176%	296%	58%	66%	96%	53%	85%	125%
13	864%	605%	397%	1083%	173%	177%	225%	41%	414%	44%	275%	255%	138%	35%	607%	-27%	44%	-27%	-35%	36%	65%
14	183%	335%	127%	192%	205%	86%	84%	171%	446%	47%	210%	95%	27%	85%	204%	19%	105%	47%	-16%	64%	68%
15	363%	83%	181%	181%	178%	436%	811%	197%	176%	94%	38%	332%	264%	410%	66%	344%	9%	459%	175%	63%	140%
16	-57%	-96%	-57%	-82%	-77%	-60%	-66%	12%	1336%	40%	712%	0%	-77%	70%	894%	63%	20%	-32%	-8%	-11%	47%
17	24%	246%	82%	261%	-31%	57%	247%	442%	168%	-27%	44%	172%	58%	117%	129%	42%	50%	93%	43%	4%	38%
18	73%	62%	24%	60%	139%	106%	-34%	180%	561%	-34%	424%	20%	-10%	98%	212%	-66%	74%	19%	16%	6%	16%
19	211%	507%	24%	-23%	-2%	-24%	14%	-56%	324%	-42%	261%	175%	-17%	23%	124%	12%	70%	11%	1%	0%	1%
20	0%	9%	91%	139%	-71%	48%	89%	-31%	65%	-19%	-5%	90%	28%	20%	6%	15%	23%	-9%	-1%	0%	0%
Total	142%	180%	151%	269%	59%	88%	198%	102%	197%	-15%	79%	150%	63%	82%	150%	46%	39%	15%	1%	0%	2%

IP Totals Sector to Sector Changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	51%	93%	80%	26%	-18%	105%	158%	79%	45%	-32%	56%	66%	68%	52%	67%	47%	4%	21%	5%	46%	50%
2	55%	86%	53%	20%	19%	17%	165%	33%	55%	8%	23%	20%	31%	92%	82%	95%	19%	4%	66%	29%	33%
3	140%	108%	17%	18%	40%	36%	31%	-13%	-25%	-1%	62%	38%	39%	106%	19%	-5%	12%	38%	-13%	46%	35%
4	30%	30%	27%	15%	66%	48%	31%	4%	-17%	-32%	49%	19%	22%	-5%	-5%	24%	19%	-26%	-3%	47%	16%
5	-28%	60%	40%	79%	1%	13%	-6%	40%	101%	3%	-40%	45%	35%	53%	65%	-44%	-21%	-7%	82%	-43%	21%
6	202%	37%	65%	48%	14%	17%	144%	58%	18%	38%	54%	48%	42%	75%	106%	-9%	-12%	48%	106%	0%	31%
7	279%	211%	74%	92%	0%	161%	43%	119%	115%	76%	215%	45%	59%	112%	341%	0%	17%	105%	30%	-3%	62%
8	212%	43%	50%	51%	109%	90%	215%	68%	2%	29%	103%	64%	89%	78%	50%	-32%	44%	54%	-35%	4%	75%
9	32%	62%	-24%	-13%	41%	4%	4%	-48%	48%	-4%	-16%	29%	-13%	15%	2%	27%	-10%	11%	40%	9%	5%
10	-32%	67%	51%	-13%	60%	70%	11%	-36%	-1%	-1%	6%	-14%	13%	-23%	-6%	-17%	-4%	-35%	7%	0%	-2%
11	9%	33%	76%	-2%	-56%	56%	154%	19%	17%	7%	-2%	6%	51%	25%	6%	71%	-16%	22%	13%	3%	4%
12	45%	21%	33%	3%	7%	24%	-1%	-3%	16%	-38%	20%	15%	12%	-31%	23%	36%	-15%	-18%	-14%	12%	7%
13	81%	55%	34%	12%	25%	47%	45%	78%	3%	-23%	28%	15%	11%	4%	34%	-34%	-4%	11%	-9%	-2%	21%
14	13%	83%	71%	-20%	38%	50%	107%	32%	32%	-23%	26%	-11%	-10%	1%	4%	-31%	-3%	-3%	-29%	-23%	-1%
15	34%	108%	25%	2%	69%	90%	164%	29%	12%	-5%	-1%	50%	41%	-3%	7%	53%	18%	-8%	27%	5%	4%
16	-7%	-43%	-40%	-20%	-42%	-27%	-30%	-50%	241%	41%	148%	-4%	-51%	-23%	133%	0%	-7%	-2%	-4%	-4%	-1%
17	-29%	-13%	-9%	-11%	-24%	-18%	12%	48%	6%	-30%	-14%	-31%	-8%	13%	5%	-5%	0%	7%	10%	-3%	0%
18	-7%	12%	34%	-37%	-13%	51%	80%	33%	19%	-25%	22%	-24%	-16%	-3%	16%	-6%	-11%	-3%	-3%	9%	-3%
19	-16%	71%	-4%	-10%	51%	36%	19%	-45%	19%	-5%	1%	-14%	-13%	-24%	24%	11%	19%	-4%	0%	0%	0%
20	-5%	1%	11%	2%	-3%	-15%	28%	7%	24%	15%	-4%	-8%	-9%	-15%	21%	-2%	-8%	8%	1%	0%	0%
Total	40%	36%	30%	11%	17%	28%	57%	59%	11%	-2%	5%	9%	19%	0%	6%	-1%	-1%	-3%	0%	0%	0%

Figure E-15 – PM Sector to Sector % Change

PM Light Vehicles Sector to Sector changes in percentage

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	51%	92%	78%	22%	-18%	99%	20%	35%	33%	-33%	58%	64%	53%	35%	48%	63%	8%	15%	-7%	53%	48%
2	53%	85%	52%	16%	18%	13%	-17%	-19%	43%	-10%	23%	19%	24%	54%	63%	112%	15%	-4%	25%	28%	29%
3	139%	108%	17%	17%	40%	31%	-16%	-31%	-28%	-5%	61%	38%	37%	107%	11%	-35%	6%	65%	-10%	44%	33%
4	28%	28%	26%	15%	65%	29%	-13%	-13%	-17%	-32%	46%	19%	19%	-7%	-6%	14%	7%	-36%	-1%	24%	15%
5	-28%	62%	40%	78%	0%	13%	-6%	39%	91%	0%	-38%	43%	34%	43%	56%	-43%	-21%	-10%	107%	-41%	20%
6	194%	35%	60%	36%	14%	17%	144%	59%	-17%	29%	46%	46%	42%	78%	18%	-17%	-15%	81%	144%	-5%	30%
7	134%	54%	24%	5%	-1%	160%	42%	121%	-29%	2%	64%	22%	58%	115%	15%	7%	16%	157%	38%	-1%	60%
8	199%	38%	47%	26%	110%	92%	218%	68%	-11%	36%	106%	63%	90%	79%	18%	-30%	44%	68%	-22%	23%	77%
9	13%	58%	-25%	-14%	39%	-21%	-47%	-62%	47%	-4%	-19%	25%	-18%	10%	1%	14%	-9%	-11%	19%	4%	2%
10	-37%	47%	48%	-13%	67%	86%	25%	-18%	-1%	-1%	5%	-16%	21%	-29%	-6%	32%	18%	-34%	14%	8%	-1%
11	10%	35%	77%	-8%	-55%	57%	30%	-13%	16%	1%	-2%	6%	38%	14%	6%	32%	-24%	3%	2%	0%	2%
12	42%	20%	32%	2%	5%	23%	-21%	-8%	13%	-40%	20%	15%	10%	-32%	17%	35%	-17%	-20%	-17%	8%	5%
13	67%	50%	32%	9%	24%	46%	44%	78%	-11%	-31%	14%	13%	10%	3%	0%	-35%	-4%	20%	-2%	-8%	20%
14	1%	63%	69%	-21%	30%	49%	108%	31%	25%	-25%	10%	-12%	-11%	1%	-1%	-32%	-5%	-3%	-30%	-28%	-2%
15	10%	113%	18%	1%	67%	35%	3%	-5%	11%	-6%	-2%	43%	22%	-9%	6%	30%	20%	-20%	21%	4%	2%
16	6%	-32%	-32%	-15%	-40%	-23%	-25%	-57%	83%	43%	117%	-4%	-47%	-26%	35%	-1%	-8%	1%	-4%	-3%	-1%
17	-31%	-17%	-11%	-16%	-24%	-19%	7%	38%	-17%	-30%	-17%	-33%	-9%	12%	-12%	-7%	0%	4%	5%	-3%	-1%
18	-19%	8%	36%	-39%	-16%	35%	105%	17%	-3%	-21%	2%	-25%	-17%	-4%	9%	3%	-13%	-3%	-5%	10%	-3%
19	-40%	30%	-10%	-10%	68%	57%	21%	-41%	11%	-2%	-9%	-19%	-13%	-25%	22%	11%	14%	-5%	0%	0%	0%
20	-6%	0%	4%	-3%	6%	-21%	20%	14%	21%	28%	-4%	-11%	-13%	-17%	21%	-4%	-10%	14%	2%	0%	0%
Total	38%	33%	28%	9%	16%	27%	54%	58%	8%	-2%	4%	8%	18%	-1%	5%	-1%	-2%	-3%	0%	0%	0%

PM HGVs Sector to Sector Changes in percentage

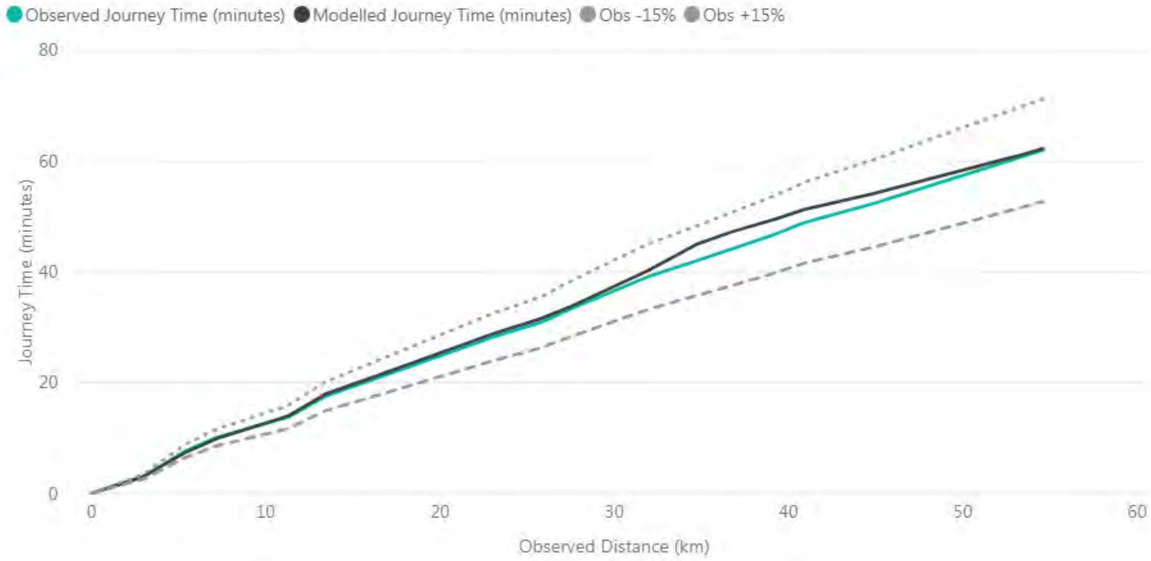
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	268%	67%	335%	1300%	18%	294%	825%	136%	409%	-55%	-47%	265%	375%	207%	187%	34%	-12%	94%	4%	9%	78%
2	103%	388%	496%	501%	57%	267%	947%	204%	510%	21%	-4%	259%	425%	420%	145%	-14%	145%	164%	124%	99%	144%
3	446%	158%	80%	239%	-45%	484%	789%	127%	28%	28%	202%	129%	390%	63%	52%	219%	279%	25%	-72%	-8%	136%
4	387%	47%	76%	231%	107%	288%	756%	119%	17%	-71%	-1%	50%	315%	17%	13%	214%	107%	38%	-80%	187%	122%
5	3%	-28%	-29%	462%	8%	109%	176%	84%	1003%	27%	-92%	64%	102%	126%	237%	-59%	-15%	-1%	-15%	17%	44%
6	717%	254%	239%	1473%	45%	119%	217%	-2%	493%	82%	330%	250%	160%	-1%	349%	91%	134%	-10%	-41%	-13%	56%
7	2413%	1216%	755%	3298%	426%	102%	232%	-9%	1184%	245%	1280%	824%	156%	-27%	1000%	-17%	58%	-10%	60%	-35%	110%
8	258%	9%	22%	384%	85%	-46%	-45%	29%	83%	-50%	97%	16%	-48%	-47%	57%	-57%	56%	2%	-89%	-71%	-26%
9	76%	-52%	-49%	42%	28%	27%	180%	-28%	150%	-21%	-6%	-3%	36%	80%	-2%	248%	-29%	170%	125%	-9%	21%
10	23%	17%	71%	135%	68%	4%	1%	-74%	83%	-14%	-9%	43%	-5%	33%	9%	-47%	-61%	-32%	-53%	-28%	-26%
11	-24%	-45%	111%	913%	-85%	69%	342%	13%	97%	61%	0%	-9%	137%	157%	-2%	661%	19%	263%	119%	97%	82%
12	285%	206%	225%	480%	61%	158%	568%	87%	303%	7%	-13%	171%	196%	76%	157%	95%	100%	55%	14%	108%	109%
13	990%	466%	446%	1368%	140%	205%	128%	30%	592%	36%	480%	247%	122%	-4%	406%	-37%	39%	-20%	-36%	21%	60%
14	280%	202%	290%	349%	161%	117%	275%	906%	930%	-54%	57%	51%	33%	83%	162%	32%	118%	57%	-19%	-6%	59%
15	342%	-12%	125%	582%	262%	258%	703%	105%	485%	145%	63%	210%	309%	399%	89%	306%	50%	594%	283%	21%	147%
16	-88%	-92%	-35%	-84%	-14%	4%	-30%	19%	611%	5%	27%	-79%	-53%	59%	73%	51%	13%	-42%	-12%	-17%	35%
17	42%	380%	105%	310%	3%	113%	336%	528%	92%	-43%	-59%	193%	79%	139%	-23%	24%	38%	67%	-4%	5%	29%
18	122%	29%	22%	179%	149%	48%	-3%	361%	1206%	-5%	302%	3%	-18%	61%	446%	-62%	38%	9%	5%	11%	8%
19	140%	113%	-15%	55%	3%	-53%	-2%	-5%	1684%	-12%	250%	36%	-47%	6%	456%	9%	51%	13%	0%	-2%	1%
20	-3%	-43%	95%	313%	-68%	22%	101%	58%	103%	-26%	-49%	7%	7%	27%	-28%	23%	17%	1%	-1%	0%	0%
Total	124%	83%	142%	433%	55%	75%	159%	169%	388%	-17%	30%	81%	46%	56%	99%	37%	29%	9%	0%	0%	1%

PM Totals Sector to Sector Changes in percentage

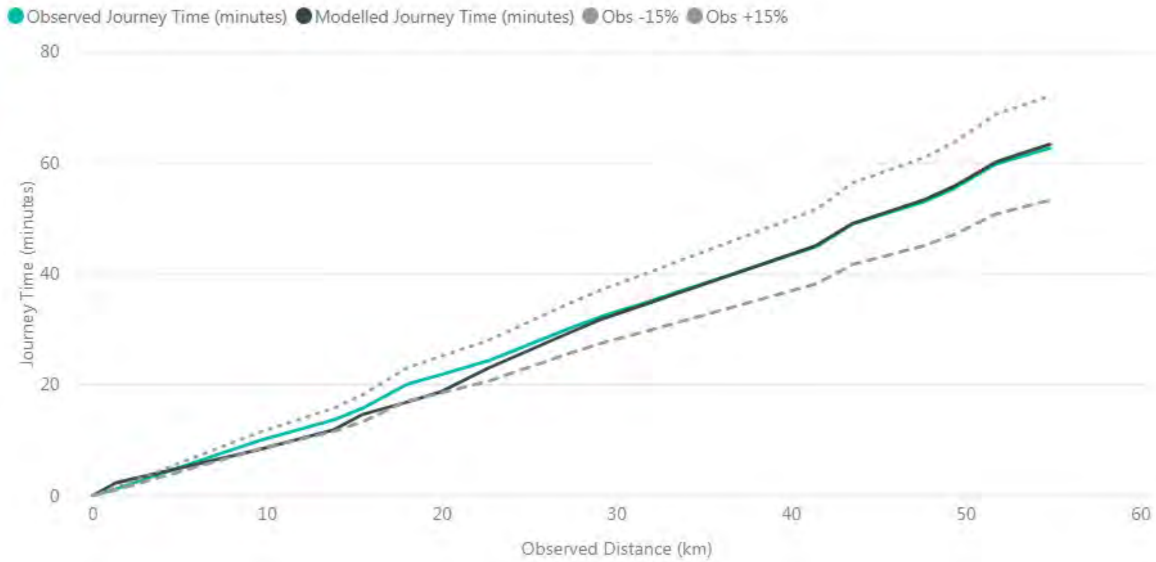
Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	20%	28%	34%	51%	-11%	75%	-4%	-37%	36%	-44%	0%	27%	19%	14%	35%	21%	-15%	-7%	-5%	-8%	17%
2	73%	151%	61%	18%	49%	25%	0%	-41%	127%	27%	51%	40%	29%	64%	145%	501%	34%	24%	101%	80%	54%
3	17%	68%	10%	-31%	78%	47%	-25%	-45%	-63%	38%	100%	21%	12%	58%	-18%	104%	-2%	10%	1%	21%	14%
4	57%	48%	33%	-3%	30%	70%	-19%	-60%	-26%	-54%	15%	9%	-5%	-35%	-23%	51%	14%	-54%	-4%	50%	4%
5	-45%	148%	86%	80%	-4%	32%	-42%	-50%	220%	84%	-68%	43%	2%	6%	70%	-26%	4%	-23%	134%	-17%	12%
6	-7%	0%	39%	-4%	15%	2%	80%	12%	-44%	51%	47%	5%	5%	29%	-23%	30%	6%	57%	100%	-42%	8%
7	92%	213%	115%	15%	54%	187%	45%	151%	24%	144%	347%	61%	99%	170%	121%	133%	100%	156%	49%	11%	89%
8	-49%	95%	51%	-29%	81%	87%	119%	63%	-60%	40%	203%	18%	78%	61%	-38%	-43%	87%	28%	-40%	1%	70%
9	24%	18%	-18%	4%	107%	2%	-40%	-71%	40%	-9%	19%	69%	-3%	30%	7%	96%	-1%	-1%	55%	25%	7%
10	-5%	15%	12%	-26%	61%	30%	-33%	-62%	-16%	-2%	18%	-17%	-8%	-27%	-5%	19%	30%	-32%	-3%	11%	-2%
11	-4%	8%	-3%	-11%	-66%	5%	-31%	-53%	-57%	-28%	-1%	-15%	-22%	-32%	-1%	167%	-6%	-43%	-30%	-5%	-8%
12	26%	22%	20%	-6%	9%	35%	-24%	-41%	25%	-23%	2%	9%	-1%	-14%	16%	133%	-3%	-20%	5%	6%	5%
13	26%	87%	44%	-11%	32%	43%	7%	44%	15%	24%	86%	28%	9%	-8%	18%	-14%	0%	0%	30%	-12%	17%
14	-8%	107%	68%	-29%	-3%	46%	47%	75%	165%	-14%	27%	-9%	-12%	-3%	45%	-5%	13%	-14%	-25%	1%	-4%
15	40%	46%	3%	11%	96%	32%	-8%	-49%	30%	8%	3%	70%	12%	23%	12%	124%	11%	4%	51%	2%	13%
16	22%	0%	-21%	-26%	-8%	15%	-34%	-53%	130%	27%	75%	28%	-41%	-21%	93%	-3%	-7%	-8%	20%	16%	-3%
17	-42%	-21%	-40%	-64%	-17%	-15%	-17%	2%	-41%	-41%	-48%	-37%	-14%	18%	-35%	-9%	-1%	-9%	3%	-12%	-3%
18	-50%	26%	32%	-30%	-23%	19%	91%	49%	114%	-12%	0%	-26%	-20%	-6%	63%	2%	3%	-5%	-3%	19%	-5%
19	-17%	-1%	35%	-4%	61%	45%	-29%	-21%	139%	-14%	-1%	-10%	-25%	-32%	72%	35%	23%	-8%	0%	0%	0%
20	-7%	-1%	-11%	37%	-1%	7%	19%	15%	46%	16%	-2%	-9%	-7%	-14%	14%	7%	-11%	23%	0%	0%	0%
Total	9%	22%	19%	3%	13%	19%	21%	40%	15%	-2%	1%	0%	5%	-5%	7%	-3%	-1%	-5%	0%	0%	-1%

Appendix F. Distance-Time Validation

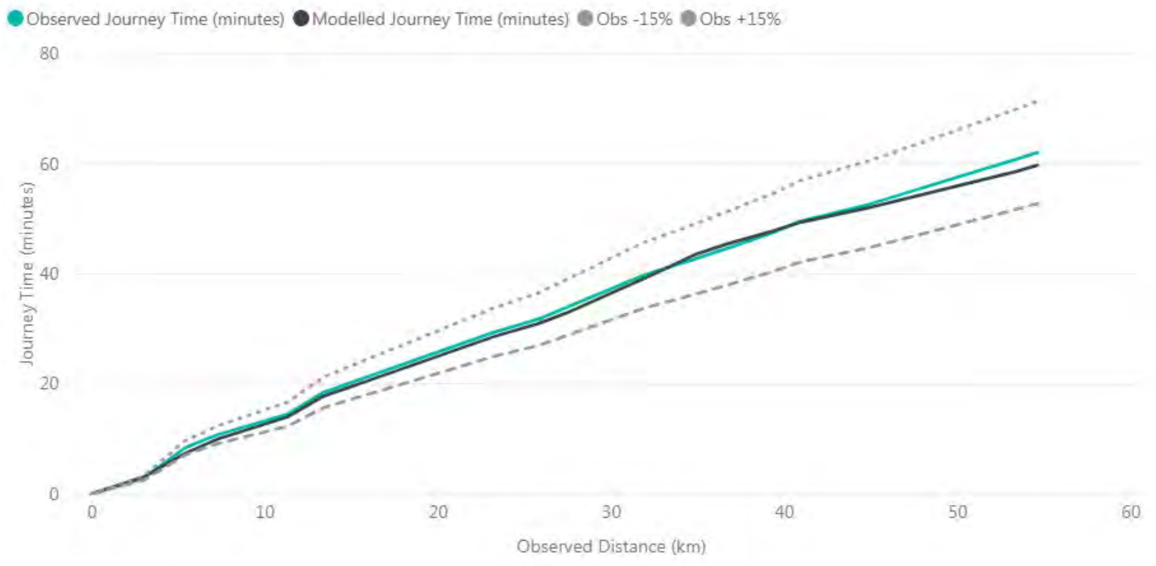
F.1. Route 1: A350 Northbound AM Peak



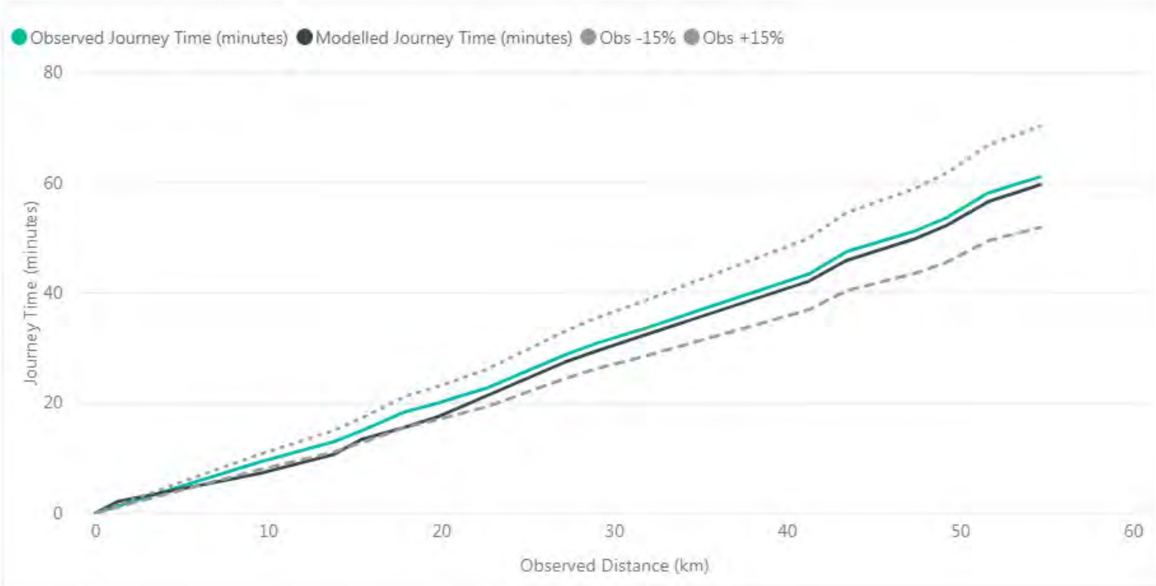
F.2. Route 1: A350 Southbound AM Peak



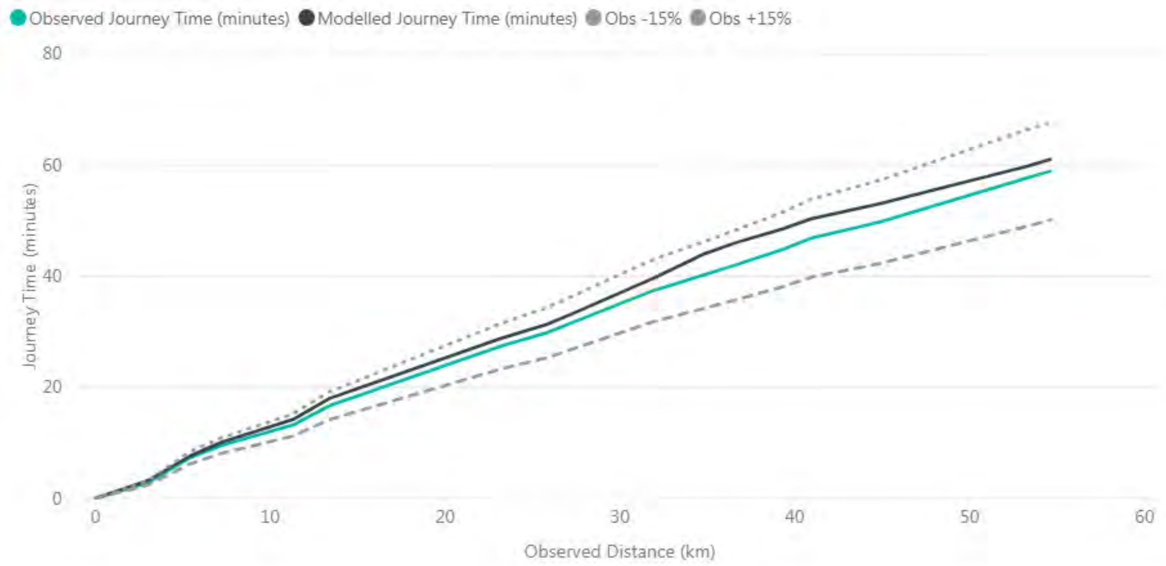
F.3. Route 1: A350 Northbound Inter Peak



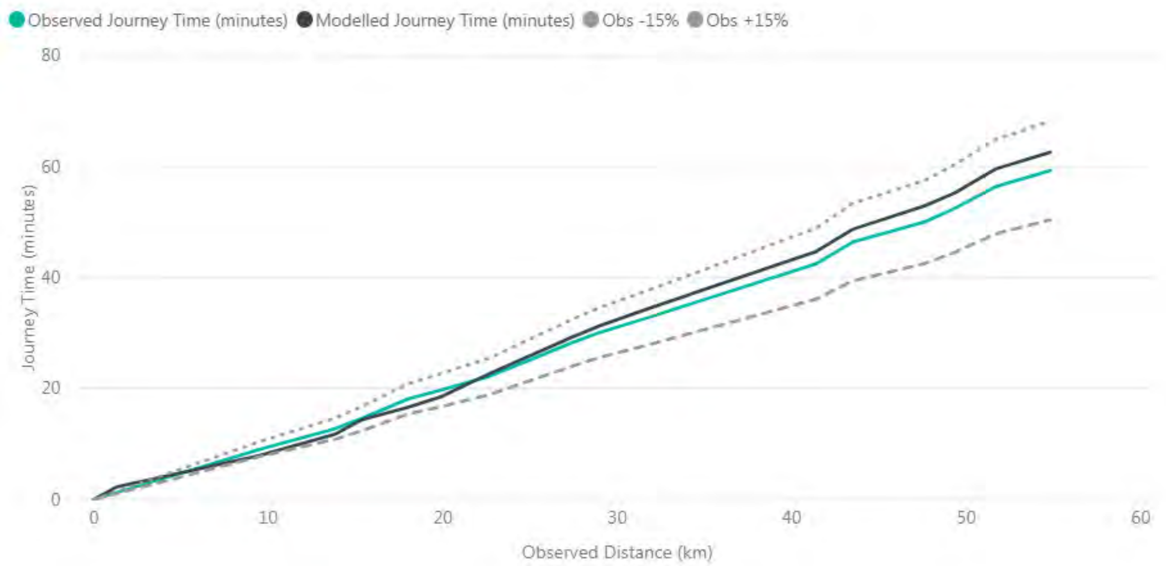
F.4. Route 1: A350 Southbound Inter Peak



F.5. Route 1: A350 Northbound PM Peak



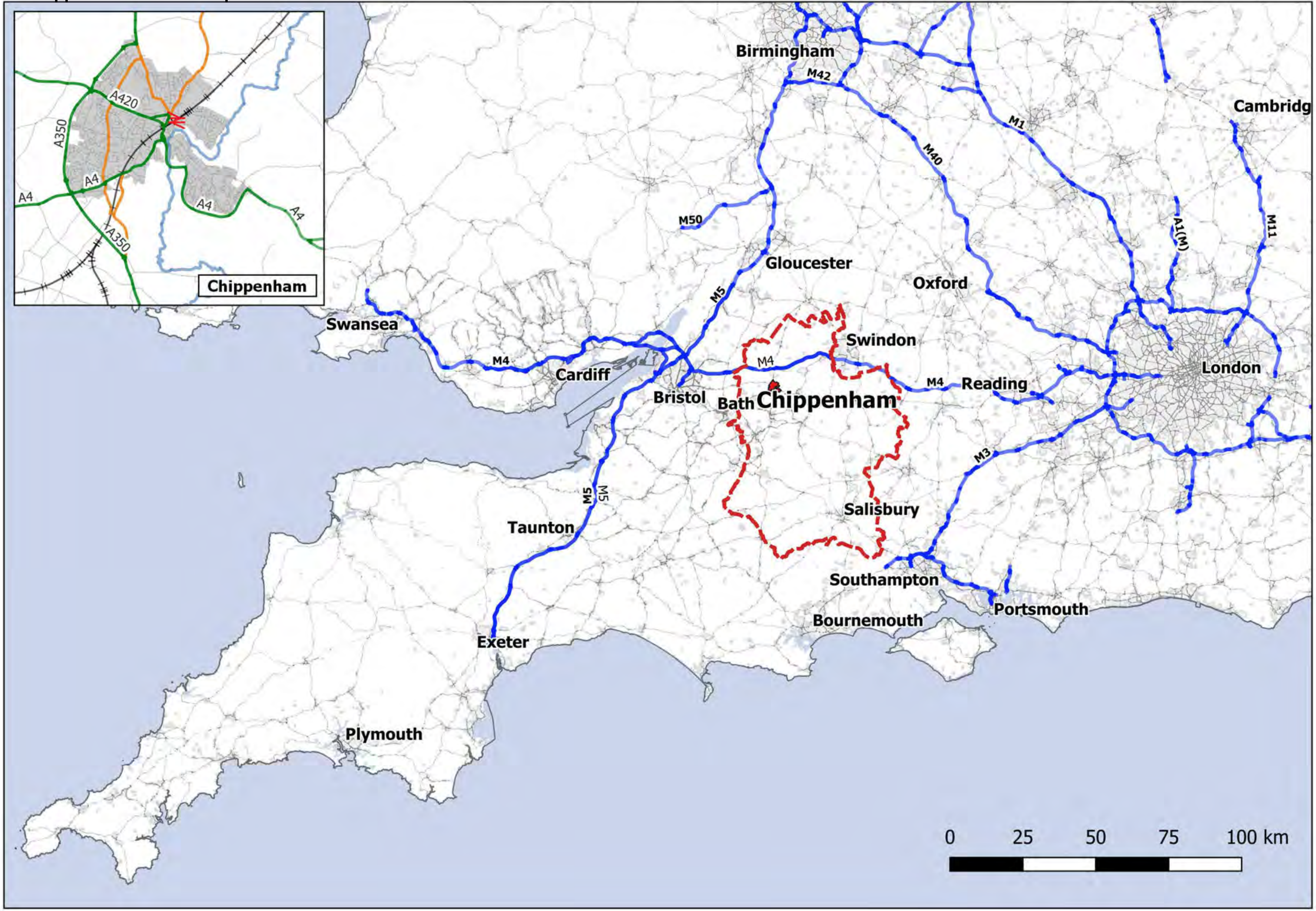
F.6. Route 1: A350 Southbound PM Peak



[redacted]
Atkins Limited
The Hub
500 Park Avenue
Aztec West
Bristol
BS32 4RZ

Tel: +[redacted]
Fax: [redacted]

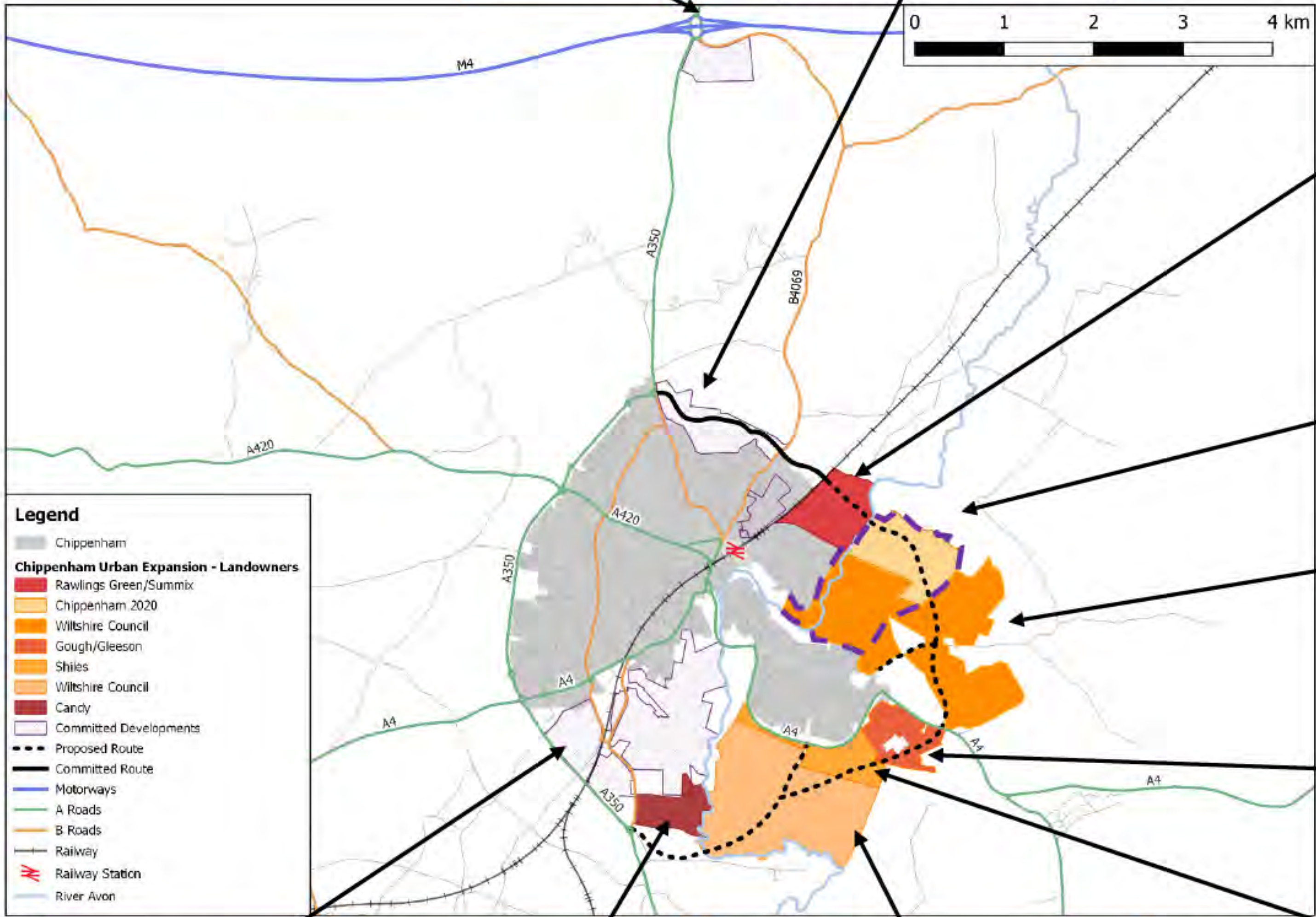
10a Chippenham context map



10b - Chippenham Urban Expansion Scheme map

HIF Funded mitigation:
M4 Junction 17

Committed Development:
North Chippenham/Bird's Marsh



Rawlings Green / Summix:
Reg 12(5)(e) [redacted]

Riverside / Chippenham 2020:
Reg 12(5)(e) [redacted]

Wiltshire Council B:
Reg 12(5)(e) [redacted]

Forest Farm, Gough / Gleeson:
Reg 12(5)(e) [redacted]

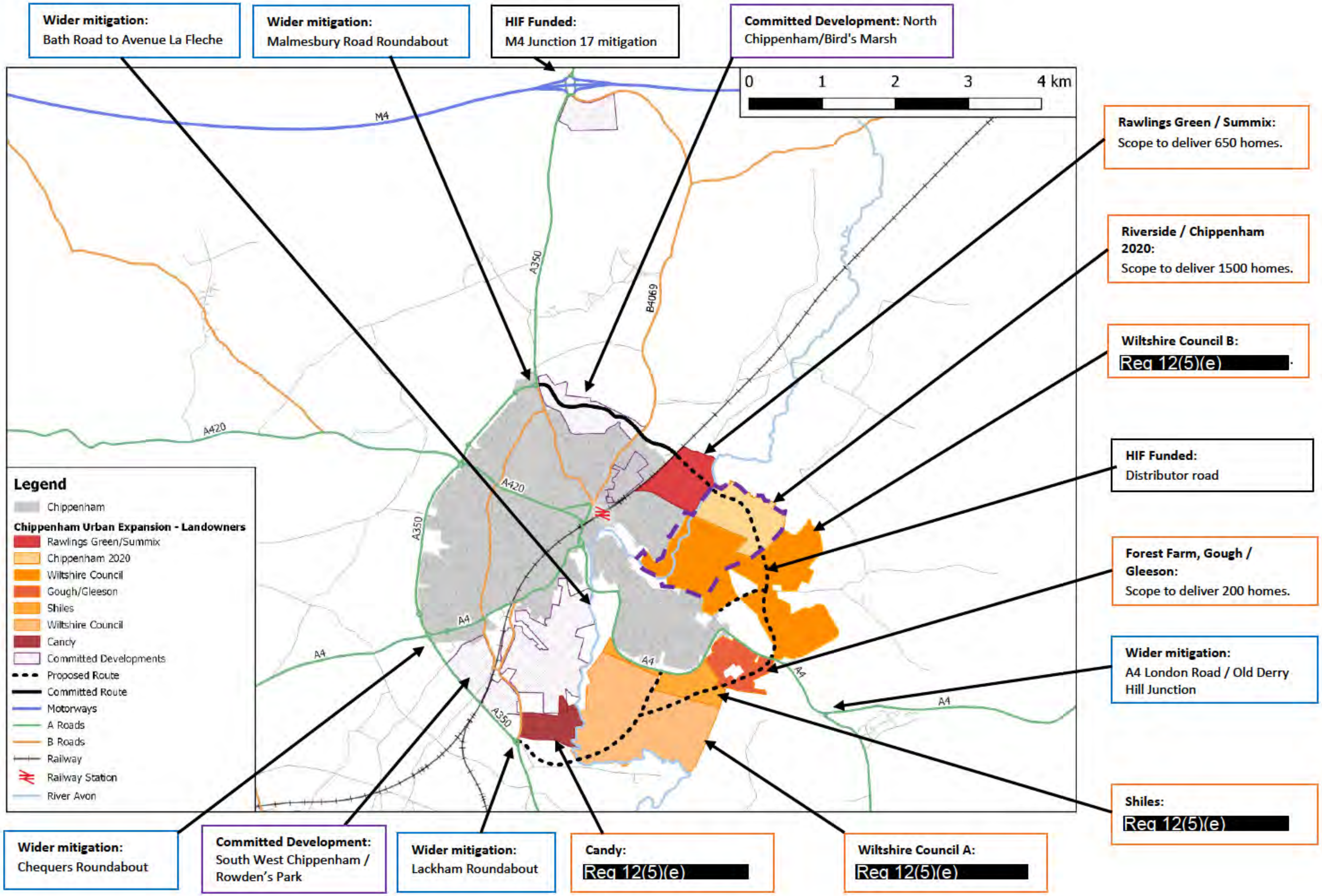
Committed Development:
South West Chippenham / Rowden's Park

Candy:
Reg 12(5)(e) [redacted]

Wiltshire Council A:
Reg 12(5)(e) [redacted]

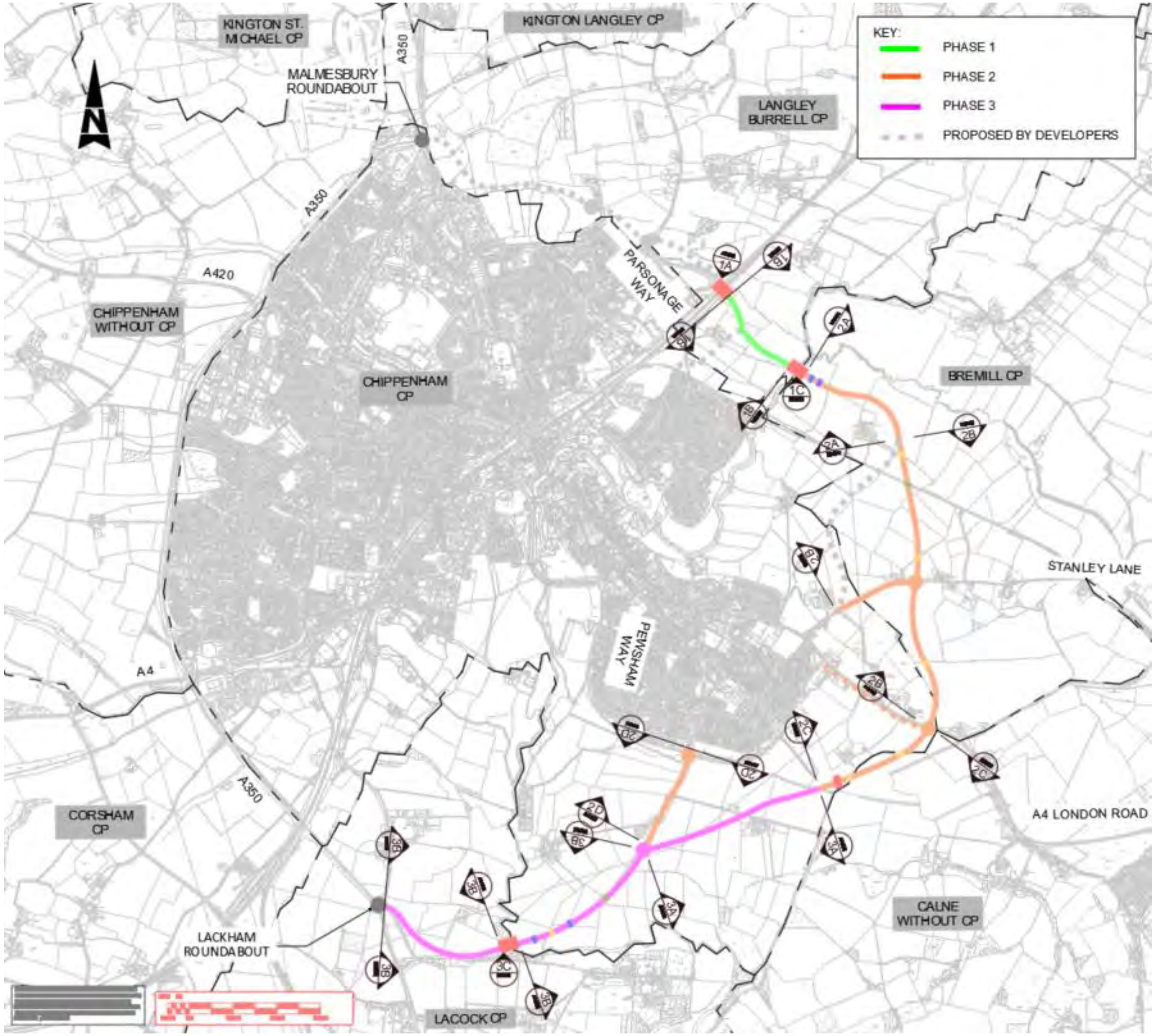
Shiles:
Reg 12(5)(e) [redacted]

10c Chippenham Urban Expansion Scheme Transport map



28 Construction Phasing - HIF distributor Road

HIF Chippenham - Construction Phasing



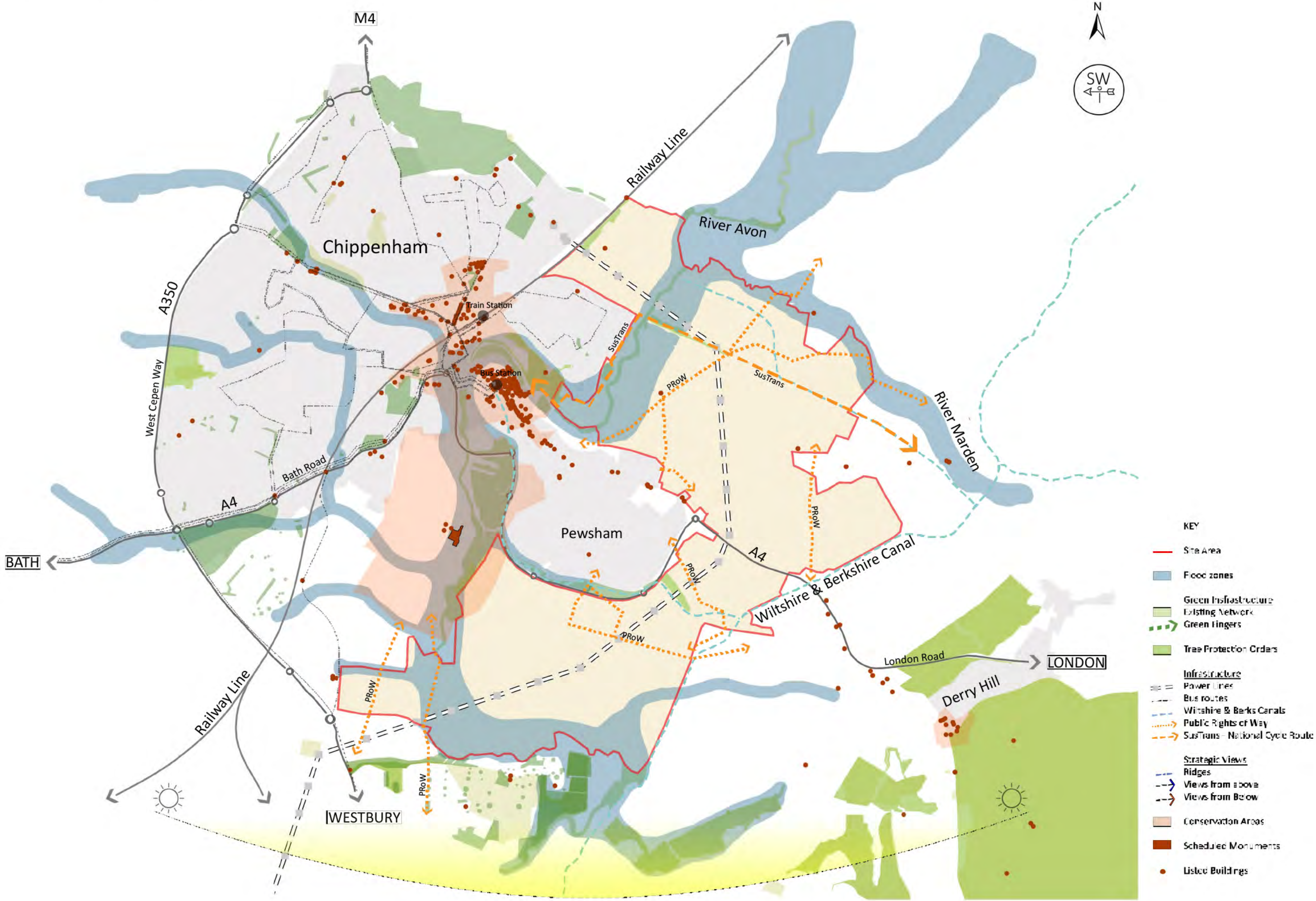
Phase 1 – Summix, Rail and River Bridge
1A) Rail Bridge
1B) Summix Road
1C) River Bridge North

Phase 2 – Developer Links & Distributor
2A) Chippenham 2020
2B) A4 to Chippenham 2020
2C) Enable Gough/Gleeson
2D) Shiles

Phase 3 – Wiltshire Southern Distributor
3A) Adjoining Gough/Gleeson:
3B) Lackham to Phase 3A/2D
2C) River Avon South

Contains *private* information

31 Environmental Constraints Map



Appraisal Summary Table

Date produced:	17 / 3 / 2019
Name of scheme:	ChippenhamHIF - Chippenham Urban Expansion Distributor Road.
Description of scheme:	Chippenham Urban Expansion Distributor Road - a distributor road routing to the south and eat of Chippenham from A350 Lackham roundabout to the south to Parsonage Way.

Contact:	
Name	Reg 13(1)
Organisation	Atkins
Role	Consultant

	Impacts	Summary of key impacts	Assessment: Quantitative	Assessment: Qualitative	Assessment: Monetary £(NPV)	Assessment: Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers	The distributor road is expected to provide benefits to existing users by providing an alternative route for journeys to the A350 from the east of Chippenham. The distributor road provides a route to the A350 avoiding the town centre. This will also benefit traffic flow in the town centre and users of the Chippenham highway network. Quantative analysis is monetised time benefits, split by journey time savings for the Value of the Transport Scheme for business users. - Monetary analysis is the Value of the Transport Scheme in terms of journey time and VOC savings for business users.	Value of journey time changes(£): £53.7m Net journey time changes (£): 0 to 2min: £11.2m 2 to 5min: £29.7m > 5min: £12.8m		£63.1m	
	Reliability impact on Business users	This has not been assessed at this stage.	Not applicable		-	
	Regeneration	This has not been assesed as it is not considered appropriate to the scheme.	Not applicable		-	
	Wider Impacts	The Chippenham Urban Expansion will generate additional demand on the highway network - which the HIF funded distributor road will mitigate. (Dis)benefits reflecting the transport external costs for all users, in terms of journey time savings, VOC and change to imperfect markets (the latter relating to both the value of the transport scheme and transport external costs).			-£74m	
Environmental	Noise	The quantified assessment using the transport model has identified noise benefits associated with the distributor road scheme. The scheme will reduce traffic flows in Chippenham town centre.			£13.7m	
	Air Quality	The quantified assessment using the transport model has identified air quality benefits associated with the distributor road scheme. The scheme will reduce traffic flows in Chippenham town centre.			£1.5m	
	Greenhouse gases	The scheme is likely to affect existing road traffic journey distances and speeds, thus potentially generating additional greenhouse gas emissions in the area.	Change in non-traded carbon over 60y (CO2e): -£2.98m Change in traded carbon over 60y (CO2e): -£0.02m		£3.0m	
	Landscape	The scheme would sit on the edge of the developed urban area of Chippenham and cut through existing landscape patterns and elements close to the edge of minor settlements and increase the level of disturbance in a slightly tranquil area. There will be adverse impacts and severance of several PRoWs and protected route of the Wiltshire and Berkshire Canal. With adequate land-take, there would be opportunity to provide earthworks design and screen planting to contain the disturbance and screen the new road from dwellings within the settlement edge and rural wedge. Possible creation of areas of small woodland would, in ime, increase the range of habitat currently present in the area. Mitigation planting for screening and for recreating severed or lost linear elements, would not have appreciable benefits for up	Not applicable	Moderate adverse		
	Townscape	Proposed scheme would cross rural land to the east of the residential areas of Chippenham. Some adverse impacts are anticipated on the existing appearance as a result of the scheme, but potential beneficial impacts on Human Interaction. There would however be filtered views of the scheme from settlement edges, which could be mitigated by careful design and screen planting. Impacts on Land Use, Cultural, Scale, Density and Mix and Layout are an icipitated to be neutral.	Not applicable	Neutral - slight adverse		
	Historic Environment	The proposed distributor road may have a large adverse effect on the historic environment. It could result in potential physical impacts on a Grade II Listed Building (Green Bridge, Langley Burrell: HE Index Ref: 1409180); and potential impacts on the setting of over 30 Grade II* and Grade II Listed Buildings, with particular concentrations in Notton, Lackham House and to the north-east, east and south-east of Pewsham. There could be an impact on the setting of a Scheduled Monument, the Moated Site and Fishponds East of Rowden Manor, HE Index Ref: 1013876), where views from the site to the south could be affected by the construction and operation of the distributor road, and the potential severance of he field systems that may form part of the monument's setting. There could be impacts on three Registered Parks & Gardens at Bowood (Grade I), Spye Park and Lacock Abbey (both Grade II), which are located on high ground approximately 3km to the south of Chippenham. Views from these sites could be interrupted by the construction and operation of he distributor road. There could be impacts on the historic character of five Conservation Areas during the construction and operation of the distributor road. These comprise he Rowden Conserva ion Area, Lacock Conservation Area, Derry Hill (Old) Conservation Area, Tytherton Lucas Conservation Area and Langley Burrell Conservation Area. The construction of the distributor road could result in the loss of archaeological remains in areas of new land take, which occur across the route of the distributor road. These are characterised by the recorded remains of medieval and post-medieval ridge and furrow and cropmarks relating to potential prehistoric/ early historic agricultural and settlement activity. It may also result in he loss of hedgerows that may be classified as important, as defined by the Hedgerow Regulations (1997).	Not applicable	Large adverse		
	Biodiversity	The distributor road has potential for impacts on the: Bath and Bradford on Avon Bats Special Area of Conservation (SAC), located approximately 6.5km west of the scheme and Mells Valley SAC, located approximately 26.5km south west of the Scheme at its nearest point. This would be through loss/ disturbance of commuting or foraging habitat for bats within the local area linked to this SAC (further assessment will be required before Scheme works commence). Two ancient woodlands are within 1km of the scheme. Lackham Ancient Woodland and Mortimers Ancient Wood Local Nature Reserve (LNR) are both within 1km of the scheme route. Lackham Ancient Woodland is located approximately 640m south of scheme. The scheme may result in he loss of hedgerows, agricultural habitats and ponds. Wood pasture, community forest, deciduous woodland, and Priority Habitats are present within 1km of the Scheme, these are not predicted to be impacted. There is one previously granted European Protected Species licences within 1km of he scheme (case ref- 2015-13668-EPS-MIT-2). Loss of trees, hedgerow, grassland, scrub and ponds could result in loss of areas potentially suitable for protected and/or notable species. Overall, due to the scale of the scheme and potential impacts to habitats of value to bats over a wide area, impacts to these SACs are possible. Compensation for the loss of habitat and landscape features damaged or lost as a result of the scheme could include re-planting of hedgerows lost and compensatory landscape design mitigation to compensate for the loss of grassland, scrub and ponds.	Not applicable	Slight adverse		

	Water Environment	The proposed scheme crosses Flood Zones 1, 2 & 3 & Surface Water floodplain areas, & could potentially reduce conveyance & storage. At local level, the floodplain is important in helping to reduce flooding to residential & commercial properties & is therefore considered to have high rarity. The River Avon is currently classified by the EA as "Moderate" for ecological & "Good" for chemical water quality ratings. The proposed scheme crosses an area designated as a Secondary A aquifer, formerly known as a minor aquifer, which is described as permeable layers capable of supporting water supplies at a local rather than strategic scale, with intermediate leaching potential. At this stage, the importance of the aquifer with respect to water supply & as a base flow to the tributary of the R Avon is not known & is therefore considered to have a High Rarity. The scheme has the potential to increase flood risk to residential and commercial properties, and potentially to have impacts on water quality. A detailed assessment would be required, including a Flood Risk Assessment and hydrological and hydraulic modelling. A WFD assessment would be required for the new watercourse crossings and impacts on groundwater. In addition, the presence of groundwater and associated risk from groundwater flooding should be investigated further. Mitigation measures such as SuDS and potentially compensatory flood storage would be required as part of the scheme and would	Not applicable	Large adverse		
Social	Commuting and Other users	The distributor road is expected to provide benefits to existing users by providing an alternative route for journeys to the A350 from the east of Chippenham. The distributor road provides a route to the A350 avoiding the town centre. This will also benefit traffic flow in the town centre and users of the Chippenham highway network. Quantative analysis is monetised time benefits, split by journey time savings for the Value of the Transport Scheme for commuting and other users. - Monetary analysis is the Value of the Transport Scheme in terms of journey time and VOC savings for commuting and o her users.	Value of journey time changes(£): £124.6m Net journey time changes (£) 0 to 2min: £31.7m 2 to 5min: £63.7m > 5min: £29.2m		Value of Transport Scheme (Commute & O her - Journey Time & VOC) £135.9m	
	Reliability impact on Commuting and Other users	At this stage this has not been assessed.	Not applicable	Slight beneficial		
	Physical activity	The scheme is expected to have a neutral impact on physical activity.	Not applicable	Neutral		
	Journey quality	Not assessed	Not applicable	Neutral		
	Accidents	The new distributor road is likely to reduce some of the collisions occurring in Chippenham centre due to removing traffic from those routes. However, the increased speeds and new junctions that will need to be created to accommodate the route may cause an increase in collisions to occur in these areas. Overall, the collisions will need to be appraised with model outputs to determine if the reduction in collisions are likely to be greater than any increases in collisions experienced along the new route.	Not applicable	Neutr		
	Security	At this stage the scheme is not expected to have an impact on security.	Not applicable	Neutral		
	Access to services	The new distributor road and some of the associated changes and new lane markings will require existing bus stops near the road to be moved or adapted, although the specifica ion and detail of this is not available at this time. Currently, it is believed that any changes to public transport in the area because of the scheme should lead to an improvement in services, either with upgraded facilities or improved journey imes in the town centre and through the scheme's route itself. There are several bus stops within 1km of the route, particularly where the distributor road crosses A4 London Road and joins Pewsham Way and Stanley Lane	Not applicable	Neutral		
	Affordability	At this stage it is not expected hat the scheme will have an impact on affordability.	Not applicable	Neutral		
	Severance	The impacted area for severance has been identified as a 1km buffer of the scheme area to account for he current road layout, proposed road layout, and effects on neighbouring roads and amenities. There are several amenities within the area that will attract vulnerable groups, including nursing homes, schools, community centres, parks and open spaces, and local shops. There are relatively low concentrations of vulnerable groups within distributor road scheme area. Whilst there are some high concentrations of vulnerable groups in the area, particularly children, hey are likely to benefit from the reduced vehicle flow on local roads, and hence, experience a reduction in both actual and perceived severance.	Not applicable	Neutral		
	Option and non-use values	At this stage it is not expected hat the scheme will have an impact on option & non-use values.	Not applicable	Neutral		
Public Account	Cost to Broad Transport Budget	This hasn't been quantified at this stage.	Not applicable	Neutral		
	Indirect Tax Revenues	(Dis)benefits reflecting indirect tax revenues relating to the value of the transport scheme for all users.			-£7.4m	

SNC·LAVALIN

ATKINS
Member of the SNC-Lavalin Group

Chippenham Urban Expansion Distributor Road

Environment TAG Report

Wiltshire Council

07 February 2019

Notice

This document and its contents have been prepared and are intended solely as information for Wiltshire Council and use in relation to the Environmental Appraisal Summary Table (AST).

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This document has 14 pages including the cover.

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
V1	For information	[redacted]	[redacted]	[redacted]	[redacted]	07/02/2019

Client signoff

Client	Wiltshire Council
Project	Chippenham Urban Expansion Distributor Road
Job number	5169497
Client signature / date	

Table of contents

Tables

1. Summary

This technical note details the findings of a Distributional Impact (DI) Appraisal undertaken for the Chippenham Urban Expansion distributor road scheme, henceforth referred to as the distributor road scheme.

Distributional impacts consider the variance of transport intervention impacts across different social groups. The analysis of DIs is mandatory in the appraisal process and undertaken in accordance with WebTAG guidance Unit A4.2 and is a constituent of the Appraisal Summary Table (AST). Both beneficial and adverse DIs of transport interventions are considered, along with the identification of vulnerable social groups that are likely to be affected. The environmental aspects considered as part of this assessment are highlighted in **Table 1-1** below:

Table 1-1 - Distributional Impact Appraisal Findings

Environmental Aspect	DI Appraisal findings
Noise	Slight adverse
Air Quality	Slight adverse
Greenhouse Gases	Slight adverse
Landscape	Moderate adverse
Townscape	Slight adverse
Historic Environment	Large adverse
Biodiversity	Slight adverse
Water Environment	Large adverse

2. Introduction

This technical note details the findings of an initial proportionate environment assessment, as agreed during co-development, undertaken for the Chippenham Urban Expansion distributor road scheme HIF submission. The scheme is henceforth referred to as the distributor road scheme.

The environmental aspects considered as part of this assessment are highlighted below.

- Noise;
- Air Quality & Greenhouse Gases;
- Landscape;
- Townscape;
- Historic Environment;
- Biodiversity; and
- Water Environment.

3. Noise

3.1. Methodology

The route corridor for the proposed distributor road was examined and a desktop study of baseline conditions and noise constraints was undertaken, which included mapping the following information:

- Noise Important Areas;
- Strategic Noise Mapping – LAeq,16h; and
- Strategic Noise Mapping – Lnight.

3.2. Assessment

There are two Noise Important Areas (NIAs) within 600m of the proposed distributor road route corridor which could be affected by changes in noise arising from additional traffic. There are approximately 1,600 human health receptors within 600m of the proposed route which could be affected.

There is limited existing noise level information in the form of strategic noise maps (available on extrium.co.uk). These maps are generally concentrated around major roads and railways and do not extend to areas along the length of the proposed scheme. From the data available, receptors close to Pewsham Way currently experience noise levels of 55dB LAeq,16h in the day and 50dB Lnight at night. Other areas along the length of the scheme either haven't been mapped, or are below 55dB LAeq,16h and 50dB Lnight.

At this time, there is no data available regarding the volume of traffic on the proposed road, therefore it cannot be determined what impact this road will have on the existing noise levels. Due to the relatively quiet nature of the study area, it is likely that the proposed road could increase the ambient noise levels, however, the resulting noise levels can be minimised to a low level after the consideration of appropriate mitigation measures.

3.3. Mitigation

Where the distance between the receptors and the road is beyond several hundred metres and over soft ground, the effectiveness of noise mitigation measures such as noise barriers and hard landscaping may be limited.

3.4. Impacts

Based on the above description of the study area, it is likely that construction activities will lead to perceptible noise impacts at existing sensitive receptors. However, these impacts would be short term and could be mitigated through effective use of Construction Environment Management Plan (CEMP).

Based on the above, the impacts are judged to be slight adverse.

4. Air Quality & Greenhouse Gases

4.1. Methodology

The proposed distributor road route corridor was examined, and a desktop study of baseline conditions and air quality constraints was undertaken.

GIS mapping of air quality constraints comprising two layers identified the following information:

- Air Quality Management Areas (the nearest being located in Calne, over 4 km east of the route corridor); and
- Local Authority air quality monitoring data of measured annual mean nitrogen dioxide concentrations (2017).

4.2. Local Air Quality

4.2.1. Assessment

There are no AQMAs or designated ecological sites within 200 m of the proposed distributor road route corridor which could be affected by changes in air quality arising from additional traffic emissions.

There are approximately 40 human health receptors within 200 m of the proposed route which could be affected. Existing air quality in the study corridor is good, with an average background pollutant concentration in 2017 of 7.6 µg/m3 for NO2 and 12.6 µg/m3 for PM10. Measured annual average total NO2 concentrations (background plus road contribution) in central Chippenham in 2017 ranged between 20 and 31 µg/m3, below the national objective of 40 µg/m3. Future background concentrations in the study area are forecast to fall to 6.0 µg/m3 and 12.3 µg/m3 for NO2 and PM10 respectively, in the proposed opening year of 2023.

4.2.2. Impacts

The potential impact of the scheme on local air quality is anticipated to be slight adverse.

4.3. Greenhouse gases

4.3.1. Assessment

The scheme will introduce a new source of greenhouse gas emissions from road transport. It may also serve to change journey distances due to traffic rerouting via the distributor road rather than through central Chippenham. The proposed scheme may also affect average vehicle speeds on existing and proposed routes.

Construction of the scheme would include additional embedded carbon emissions.

4.3.2. Impacts

The potential impact of the scheme on greenhouse gases is anticipated to be slight adverse.

5. Landscape

5.1. Methodology

A 2km offset from the scheme boundary was prescribed for the study area. Within this local character area, a baseline assessment has been conducted due to the early stages of the distributor road design. It is considered that significant effects are unlikely beyond this.

The assessment looks at the scheme design and alignment and considers the impacts at year one of opening. This approach has been undertaken due to the absence of a formal mitigation strategy and to enable the comparison of the impacts of the scheme as a result of its physical presence in the landscape.

Information was obtained from the following sources:

- Natural England: National Character Areas;
- Multi Agency Geographic Information on the Countryside (MAGIC);
- Wiltshire Landscape Character Assessment 2005;
- Wiltshire Planning Explorer;
- Ordnance Survey Mapping; and
- Aerial Imagery.

5.2. Assessment

There are no statutory national Landscape Designations present within 2km of the proposed distributor road route. The area is covered by Wiltshire Landscape Character Assessment LCA 12, Open Clay Vale. A relatively flat but rolling lowland landform with small - medium - large scale, irregular and regular shaped fields, both arable and pasture, bounded by hedgerows of varying quality.

The landscape is of moderate to high importance and valued at a local and regional level, providing a green buffer between settlements and busy transport corridors. The main landscape elements and features are not rare, with limited substitutability.

Settlement is limited to the fringes of Chippenham, with farms and dwellings, and small linear settlements along the minor roads and lanes. The area is relatively tranquil away from the main settlements and transport corridors. The protected Wiltshire and Berkshire canal runs in close proximity to the proposed route. The mainline railway crosses the landscape at the northern end of the study area.

The scheme would sit on the southern and eastern edge of the urban and sub-urban edge of Chippenham and cut through the existing landscape pattern and elements close to the edge of settlements which will increase the level of disturbance in a relatively tranquil area.

There will be adverse impacts and severance of several Public Rights of Way.

5.3. Mitigation

With adequate land-take, there would be opportunity to provide earthworks design and screen planting to contain much of the disturbance and screen the new road from dwellings within the settlement edge and rural wedge. Possible creation of areas of small woodland would, in time, increase the range of habitat currently present in the area. Mitigation planting for screening and for recreating severed or lost linear elements, would not have appreciable benefits for up to 15 years.

5.4. Impacts

Without mitigation at year 1, overall impacts are judged to be moderate adverse. Overall impacts after 15 years are judged to be slight adverse.

6. Townscape

6.1. Methodology

A baseline assessment has been conducted on the townscape due to the early stages of this design. It is considered that significant effects are unlikely beyond this.

The assessment looks at the scheme design and alignment and considers the impacts as at year one of opening. This approach has been undertaken due to the absence of a formal mitigation strategy and to enable the comparison of the impacts of the scheme as a result of its physical presence in the townscape.

Information was obtained from the following sources:

- Natural England: National Character Areas;
- Multi Agency Geographic Information on the Countryside (MAGIC);
- Wiltshire Landscape Character Assessment 2005;
- Wiltshire Planning Explorer;
- Ordnance Survey Mapping; and
- Aerial Imagery.

6.2. Assessment

The site is located to the south of the urban fringes of Chippenham and Pewsham which consist of residential and urban areas. The mainline railway crosses the proposed scheme at its northern edge. Rowden Manor and Rowden Conservation Area are distinct historic features in the area. Buildings are generally constructed using local materials of brick and tile.

Designated features are of high importance, and are valued at national level, with many features of moderate – low importance but valued at local level. Townscape features are not rare in the vicinity, with some opportunity for substitution at local level. No opportunity for substitution of designated features of national importance.

The proposed scheme would cross rural land connecting the A350 to the A4, and it would not fall within the urban area.

6.3. Mitigation

There may be filtered views of the scheme from settlement edges, which could be mitigated by careful design and screen planting.

6.4. Impacts

Neutral slight adverse impacts are anticipated on the existing appearance of the townscape as a result of the scheme, but there may be potential beneficial impacts on Human Interaction. Impacts on Land Use, Cultural, Scale, Density and Mix and Layout are anticipated to be neutral.

Overall, impacts on Townscape are judged to be slight adverse.

7. Historic Environment

7.1. Methodology

The data accessed was used to identify any potential direct physical effects, and effects on the setting of designated and non-designated heritage assets.

The following sources were accessed online:

- Wiltshire Council Historic Environment Record (HER): data from the HER covering the southern extents of Chippenham and Pewsham was accessed. This included a 500m search either side of the distributor road.
- Historic England online data for Listed Buildings, Scheduled Monuments, Registered Parks and Gardens and World Heritage Sites within 3km of the distributor road.
- Wiltshire Council online mapping was accessed for information relating to Conservation Areas.

7.2. Assessment

The proposed scheme could result in potential physical impacts on a Grade II Listed Building (Green Bridge, Langley Burrell: HE Index Ref: 1409180); and potential impacts on the setting of over 30 Grade II* and Grade II Listed Buildings, with concentrations in Notton, Lackham House and to the north-east, east and south-east of Pewsham.

There could be an impact on the setting of a Scheduled Monument; the Moated Site and Fishponds East of Rowden Manor, HE Index Ref: 1013876), where views from the site to the south could be affected by the construction and operation of the distributor road, and the potential severance of the field systems that may form part of the monument's setting.

There could be impacts on three Registered Parks & Gardens at Bowood (Grade I), Spye Park and Lacock Abbey (both Grade II), which are located on high ground approximately 3km to the south of Chippenham. Views from these sites could be interrupted by the construction and operation of the distributor road.

There could be impacts on the historic character of five Conservation Areas during the construction and operation of the distributor road. These comprise the Rowden Conservation Area, Lacock Conservation Area, Derry Hill (Old) Conservation Area, Tytherton Lucas Conservation Area and Langley Burrell Conservation Area.

The construction of the distributor road could result in the loss of archaeological remains in areas of new land take, which occur across the route of the distributor road. These are characterised by the recorded remains of medieval and post-medieval ridge and furrow and cropmarks relating to potential prehistoric/ early historic agricultural and settlement activity. It may also result in the loss of hedgerows that may be classified as important, as defined by the Hedgerow Regulations (1997).

7.3. Mitigation

We would propose the following approach to mitigation:

- Avoid impacts on heritage assets through design.
- Preserve archaeological remains in situ.
- If the above not possible, then preserve archaeological remains by record.
- Setting impacts mitigated through good design in consultation with the landscape and design team.

7.4. Impact

The proposed distributor road could potentially have a large adverse effect on the historic environment but this could be managed through appropriate mitigation.

8. Biodiversity

8.1. Methodology

The ecological information that is provided within the Appraisal Summary Table (AST) and the Transport Appraisal Guidance (TAG) Biodiversity Impact Worksheet was obtained from the following sources:

- Magic Maps (http://www.magic.gov.uk/);
- Natural England (https://designatedsites.naturalengland.org.uk/);
- Wiltshire Council District Planning Map (http://www.wiltshire.gov.uk/westwiltshirelocalplan/westwiltshiredistrictplanmapping.htm); and
- Where's the Path (https://wtp2.appspot.com/wheresthepath.htm).

The area around the linear scheme area was searched for statutory and non-statutory designated sites for nature conservation and habitats of principle importance that could be impacted by the scheme. The search was extended to 30km for Special Areas of Conservation (SACs) where bats are a qualifying feature.

Records of previously granted European protected species licence applications were also searched for. No records of protected/ notable species were searched for, this will be done during further assessments before the scheme works commence.

Surrounding habitat up to 500m from the scheme was examined using aerial imagery to identify any features such as woodland, hedgerows and waterbodies on which the scheme could pose ecological constraints.

8.2. Assessment

There are potential impacts on the Bath and Bradford on Avon Bats Special Area of Conservation (SAC), located approximately 6.5km west of the scheme and Mells Valley SAC, located approximately 26.5km south west of the scheme. This would be due to loss/ disturbance of commuting or foraging habitat for bats within the local area linked to this SAC.

Two ancient woodlands are within 1km of the scheme; Lackham Ancient Woodland and Mortimers Ancient Wood Local Nature Reserve (LNR). Lackham Ancient Woodland is located approximately 640m south of the proposed phase 1 and 3 of the scheme route. Mortimers Ancient Wood LNR is located approximately 870m west of the proposed Phase 1 route. Considering the distances of these ancient woodlands from the scheme and the nature of the proposals, it is considered unlikely that the scheme will result in impacts to these sites.

Pollution Prevention Guidelines (PPGs)/Guidance for Pollution Prevention (GPPs) and CIRIA pollution prevention guidance should be adhered to during works around the River Avon, which the scheme line crosses at points.

The scheme may result in the loss of hedgerows, agricultural habitats and ponds. Wood pasture, community forest, deciduous woodland, and Priority Habitats are present within 1km of the scheme, these are not predicted to be impacted.

There is one previously granted European Protected Species licence which allows destruction of a bat resting place. This was granted in 06/10/2015 and ends in 05/10/2020, for a brown long ear bat and soprano pipistrelle bat licence (case ref- 2015-13668-EPS-MIT-2) .

Loss of trees, hedgerow, grassland, scrub and ponds could result in loss of areas potentially suitable for protected and/or notable species. Overall, due to the scale of the scheme and potential impacts to habitats of value to bats over a wide area, impacts to these SACs are possible.

8.3. Mitigation

Compensation for the loss of habitat and landscape features damaged or lost as a result of the scheme could include re-planting of hedgerows lost and compensatory landscape design mitigation to compensate for the loss of grassland, scrub and ponds.

Mitigation for the loss of ecological features incurred is dependent on the nature of the scheme. For the proposed scheme, where there is not currently any infrastructure, it is likely that habitats will be lost, and compensation would be in the form of planting compensatory habitats. In this instance this would entail the re-planting of hedgerows lost and compensatory landscape design to compensate for the loss of grassland, scrub and ponds.

8.4. Impacts

The assessment scores that are given for the scheme were calculated using the desk study information against the criteria of overall assessment scores defined in the Biodiversity section of 'TAG Unit A3 Environmental Impact Appraisal' document guidance[1].

Overall impacts are anticipated as being slight adverse.

[1]https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/638648/TAG_unit_a3_envir_imp_app_dec_15.pdf

9. Water Environment

9.1. Methodology

The assessment was divided into 3 sections, corresponding to the proposed distributor road phases.

Data was obtained from the following sources:

- https://flood-map-for-planning.service.gov.uk/
- https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3005
- https://magic.defra.gov.uk/magicmap.aspx
- http://mapapps2.bgs.ac.uk/geoindex/home.html
- Bing Maps
- Google Maps

9.2. Assessment: Phase 1

This section is located in Flood Zones 2 and 3. The route crosses the River Avon and a number of its tributaries. North east of Plucking Grove, the route crosses the River Avon and a small watercourse/drain. At the northern extent of the route a water course that flows west along the Avon Valley Walk and forms a tributary to the River Avon is crossed before joining Pewsham Way. New watercourse crossings will be required in these locations. The River Avon flows through the route in a south easterly direction. The floodplain along this section is approximately 500m wide.

The risk of flooding from Surface Water (RoFSW) flood maps show parts of the distributor road phase 1 route are subject to high risk of surface water flooding at the 3.3% Annual Exceedance Probability (AEP) event. The route crosses a number of surface water flow paths associated with the River Avon, including a surface water flow path that flows south from Lower Lodge Farm and joins Cocklemore Brook, a tributary of the River Avon. Dependent on the proposals within these floodplain areas there is a potential for a loss of floodplain storage.

9.3. Assessment: Phase 2

The section is located entirely within Flood Zone 1.

The Risk of Flooding from Surface Water (RoFSW) flood maps show parts of the distributor road route are subject to high risk of surface water flooding at the 3.3% Annual Exceedance Probability (AEP) event.

The route crosses an existing watercourse multiple times that flows west along the Avon Valley Walk and forms a tributary to the River Avon. Dependent on the proposals within these floodplain areas there is a potential for a loss of floodplain storage.

9.4. Assessment: Phase 3

This section of the distributor road route is located in Flood Zone 2 and 3. The route crosses the River Avon and a number of its tributaries. North of where the route joins London Road there is a small watercourse/drain – this flows in to Pudding Brook (a tributary of the River Avon). South of where the route crosses Stanley Lane it crosses another small watercourse/drain, which flows into Pudding Brook. Between Stanley Lane and the North Wiltshire Rivers Route Cycle Path the route crosses a small watercourse/drain, which flows in to Pudding Brook. As a result, new watercourse crossings will be required in these locations. The River Avon flows through the route in a south easterly direction. The floodplain along this section is approximately 260m wide.

The Risk of Flooding from Surface Water (RoFSW) flood maps show parts of the phase 3 route are subject to a high risk of surface water flooding at the 3.3% Annual Exceedance Probability (AEP) event. The route also crosses a number of surface water flow paths. On the north side of the north Wiltshire Rivers Route Cycle Path the route crosses a small area of surface water ponding, near this location the route also crosses a small watercourse/drain. The surface water flow path associated with this small watercourse/drain connects in to Pudding Brook. In addition, where the route crosses the A4 London Road there is an area with significant ponding. Dependent on the proposals within these floodplain areas there is a potential for a loss of floodplain storage.

9.5. Assessment: all phases

An increase in impermeable area due to the new route will result in increased runoff generated in this area. Mitigation will be required to ensure that greenfield runoff rates are not increased as a result of the scheme and Sustainable Drainage Systems (SuDS) should be used where appropriate.

Discharge of pollutants from road runoff and the requirement for multiple new watercourse crossings, has the potential to impact the water quality of the watercourse and impact the Water Framework Directive (WFD) status. A WFD assessment will be required.

Discharge of pollutants from road runoff from the proposed route may introduce the risk of leaching to underlying aquifers. The geology of the area comprises of Kellaways formation and Oxford clay formation, overlain with mudstone. Some of the route is located within an area designated as a Secondary A aquifer, which is described as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an importance source of base flow to rivers. These are aquifers formerly classified as minor aquifers.

A Drainage Strategy will be required if this site is taken forward.

9.6. Mitigation: all phases

The River Avon, Pudding Brook and a number of surface water flow paths are crossed by the distributor road route. As a result, new culverts or watercourse diversions will be required. These will need to ensure conveyance of flows is maintained and floodplain storage is not reduced.

Mitigation measures (such as compensatory floodplain) are likely to be required to ensure that flood risk upstream and downstream of the route is not increased. Such mitigation would need to take into account the impacts of climate change. Hydrological and hydraulic modelling and mitigation testing will be required.

SuDS should be applied to ensure that water quantity and quality is managed for the site, both during construction and operation. This may include detention basins, wetlands, swales and filter strips amongst other features.

9.7. Overall Impacts

Overall, the proposed scheme, without mitigation, is considered to have a large adverse impact on water environment.

[redacted]
Atkins Limited
The Hub
500 Park Avenue
Aztec West
Bristol
BS32 4RZ

Tel: [redacted]
Direct: [redacted]
[redacted]**@atkinsglobal.com**

[redacted]

Technical Note

Project:	Chippenham Urban Expansion HIF		
Subject:	Rail Assessment		
Author:	Reg 13(1) [redacted]	Reviewed by:	Reg 13(1) [redacted]
Date:	20/03/2019	Approved by:	Reg 13(1) [redacted]
Version:	1		

1. Introduction

1.1.1. Wiltshire Council are preparing a funding bid to be submitted to the Ministry of Housing, Communities and Local Government (MHCLG) through the Housing Infrastructure Fund (HIF). The bid seeks to fund a distributor road to the east of Chippenham, from Lackham roundabout of the A350 south west of the town to the A4 London Road, and from the A4 London Road to Parsonage Way in the north.

1.1.2. This distributor road is designed to serve the Chippenham Urban Expansion – a development proposal by Wiltshire Council to deliver 7,500 homes and 1 million sqft employment in addition to the already committed development in the current adopted Local Plan.

1.1.3. This note considers the likely effect that the construction of the Chippenham Urban Expansion will have on the demand for rail use in the Chippenham area. The note is intended to provide additional supporting information to the main submission document as requested by Homes England on 22 February 2019.The approach reported in this technical was suggested, discussed and agreed with Homes England (Dan Hammond) on 22 February 2019.

Rail assessment methodology

2.1. Introduction

2. This section provides a description of the methodology implemented to produce indicative figures for the likely demand of rail trips generated by the Chippenham Urban Expansion.

2.1.1. 2.2. Summary of methodology

2.2.1. The methodology for assessing the increase in rail demand cause by the urban expansion has two main stages. The first stage is to determine a mode share for trips from and to the urban expansion. The second stage is to use this mode share, and the forecasts made for vehicle trip generation, to extrapolate from this the likely rail trips generated by the urban expansion.

2.3. Mode share

2.3.1. A number of data sources were used to inform a forecast mode share for trips generated by the Chippenham Urban Expansion. They include:

- NTEM 7.2 dataset.
- 2011 Census Travel to Work data.
- 2016/17 National Travel Survey (NTS).

2.3.2. 2011 Census travel mode share categories: “Taxi”, “Motorcycle, scooter or moped”, “Underground, metro, light rail, tram” and “Other method travel to work” were excluded because these travel modes form a negligible proportion in Chippenham.

2.3.3. 2016/17 National Travel Survey data categories: “Motorcycle”, “Other private transport”, “Bus in London”, “London Underground”, “Taxi/minicab” and “Other public transport” were also excluded. The categories “Other local bus” and “Non-local bus” were combined to form “Bus/coach”.

2.3.4. In data sources where walk trips are not distinguished by length, it has been assumed that 80% are less than a mile, and 20% are more than a mile, This is based on table NTS9903 of the 2016/17 National Travel Survey for “Rural Town and Fringe”. The category “Walk” has been defined to only include trips over 1 mile. This has been defined because the highway modelling undertaken as part of the Chippenham Urban Expansion HIF bid is at a strategic level. This means that there the modelling does not fully capture very short distance trips. The estimate of travel modal share is thus defined as:

- Walk over 1 mile.
- Cycle.
- Car driver.
- Car passenger.
- Bus/coach.
- Rail

2.3.5. The expected mode share for Chippenham residents has been calculated by assigning a weight to each of these data sets. It is assumed that the mode share for the Chippenham Urban Expansion is consistent.

2.3.6. NTEM 7.2 provides a specific travel mode estimate for Chippenham in 2024. However it is only an estimate and not based on actual observed source.

2.3.7. 2011 Census data is comprehensive, observed and locally specific, however it only applies to commute trips (which apply to ~40% of car trips by purpose in the peak periods) and is quite dated over 8-9 years old. Chippenham has a notably higher rail mode share than both the wider Wiltshire and SW region. This is due to the fact Chippenham has a well-connected train station which lies on the Great Western Mainline.

2.3.8. NTS data is actual observed data, over all trip purposes, but is not specific for Chippenham as it covers all rural and fringe towns in England.

2.3.9. Atkins have presented a weighting for each of these sources, based on professional judgement by reconciling the quality and quantity of each source. The mode share data, the Atkins weighting and the expected mode share of Chippenham residents is presented in Table 2-1 – Travel Mode share data.

Table 2-1 – Travel Mode share data[1]

Data Source	NTEM 7.2	Census	NTS	Forecast
Area	Chippenham	Chippenham	Rural Town and Fringe	Chippenham
Mode\Year	2024	2011	2016-2017	2024
Atkins Weighting	*50%*	*40%*	*10%*	-
Walk over 1 Mile	5%	3%	7%	**5%**
Cycle	2%	3%	1%	**3%**
Car Driver	59%	77%	59%	**66%**
Car Passenger	28%	7%	28%	**19%**
Bus/Coach	4%	2%	4%	**3%**
Rail	2%	7%	1%	**4%**

[1] The Chippenham area is defined as ONS Middle Layer Super Output Area's Wiltshire 009 (E02006652), Wiltshire 010 (E02006653), Wiltshire 011 (E02006654) and Wiltshire 014 (E02006656). The same is the case for Table 3-2.

2.4. Vehicle Demand

The strategic highway modelling undertaken as part of the Chippenham Urban Expansion HIF submission includes forecasts for the number of PCU trips generated by the Urban Expansion. This is presented in Table 2-2.

Table 2-2 – Chippenham Urban Expansion Vehicle trip generation

2.4.1.

Vehicle type\Time period	AM peak hour (08:00- 09:00)	Inter period (10:00- 16:00)	PM peak hour (17:00- 18:00)
Total PCUs	3547	2903	3934
Car	83%	82%	88%
LGV	12%	12%	8%
HGV	6%	6%	3%
Total Car Trips	2831	2281	3410

3. Rail demand assessment results

3.1. Results and analysis

3.1.1. By extrapolating data from **Table 2-1** and **Table 2-2** the trip generation, by mode, from the Chippenham Urban Expansion is presented in **Table 3-1**.

Table 3-1 – Chippenham Urban Expansion multi modal trips/hr trip generation

Mode	Mode Share	Two-way trips (trips/hr)		
		AM peak (08:00 - 09:00)	Inter peak (10:00 - 16:00) (Average Hour)	PM peak (17:00 - 18:00)
Walk over 1 Mile	5%	194	156	234
Cycle	3%	110	89	133
Car Driver	66%	2831	2281	3410
Car Passenger	19%	835	673	1006
Bus/Coach	3%	144	116	173
Rail/Underground	4%	170	137	205
Total	100%	4284	3452	5162

3.1.2. Results from Table 3-1 suggest that Chippenham Urban Expansion will result in a maximum of ~200 rail passenger trips per hour both departing and arriving at Chippenham station in the peak hour.

3.2. NTEM quality assurance

A sense check, using NTEM, of the projected total person trips generated by the urban expansion is presented in Table 3-2. The number of households in Chippenham in 2024 is projected to be 16,819. All these households are expected to generate approximately 11,300 person trips per peak period average hour. Note that this number excludes 80% of walk trips (considered to be non-strategic) and is an average hour over the peak period.

3.2.1.

Assuming an equivalent proportion of person and car trips is found in the Urban Expansion (i.e. 7,500 / 16,819) this generates ~5,000 person trips and 2,880 to 3,060 car trips. These numbers are very similar to the numbers presented in **Table 3-1**.

Table 3-2 – 2024 Chippenham Urban Expansion, NTEM forecast person trips

3.2.2.

Area / Time period	Year	Households	Person trips all modes	Car trips	Person trips	Car trips
			AM peak (08:00 - 09:00)		PM peak (17:00 - 18:00)	
Chippenham	2024	16,819	11,352	6,479	11,378	6,866
Chippenham Urban Expansion	-	7,500	5,062	2,889	5,074	3,062

Person trips exclude 80% of walk trips which are considered non-strategic

4. Summary

4.1.1.

In this technical note, a methodology has been presented for calculating a forecast number of rail passenger trips generated by the Chippenham Urban Expansion.

4.1.2.

An investigation of the data implies that ~**4%** of total person trips (over 1 mile) generated by the site will travel by rail, and the 7,500 houses will generate up to ~5,000 all mode person trips per hour.

4.1.3.

Therefore the assessment has identified that there are likely to be up to **200** two way rail passenger trips generated in a peak hour period.

4.1.4.

Assuming there is a train every 10 minutes arriving /departing from Chippenham station this is equivalent to approximately **30** extra passengers per train arriving and departing at the station. This is considered relatively low level of extra demand, and therefore intervention to mitigate against these extra trips is not considered appropriate for inclusion within Wiltshire Council's Chippenham Urban Expansion HIF submission.

SNC·LAVALIN

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Member of the SNC-Lavalin Group

Chippenham Urban Expansion Distributor Road

Distributional Impact Report

Wiltshire Council

07 February 2019

Notice

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This document has 26 pages including the cover.

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.00	1st Draft	Re	[redacted]	[redacted]		31/01/19
Rev 1.10	Updated from comments	Re	[redacted]	[redacted]		06/06/19
Rev 1.21	For issue	Re				07/06/19

Client signoff

Client	Wiltshire Council
Project	Chippenham Urban Expansion Distributor Road
Job number	5169497
Client signature / date	

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1. Introduction

This technical note details the findings of a Distributional Impact (DI) Appraisal undertaken for the Chippenham Urban Expansion distributor road scheme, henceforth referred to as the distributor road scheme.

Distributional impacts consider the variance of transport intervention impacts across different social groups. The analysis of DIs is mandatory in the appraisal process and undertaken in accordance with WebTAG guidance Unit A4.2 and is a constituent of the Appraisal Summary Table (AST). Both beneficial and adverse DIs of transport interventions are considered, along with the identification of vulnerable social groups that are likely to be affected.

1.1. Methodology

The approach outlined in the Department for Transport's (DfT) guidance (WebTAG A4.2) ensures that DI appraisals are proportionate to the scale of the issue and follow a standardised process to ascertain whether a full DI appraisal is required. The eight indicators considered within the DI appraisal are:

- Accessibility
- Accidents
- Air Quality
- Affordability
- Noise
- Security
- Severance
- User Benefits

This document carries out an initial DI appraisal and reports on the outputs from Step 1 and 2 of the guidance process: the 1st step: screening, and 2nd step: assessment, of distributional impacts, supported by socio-demographic profiling. This will then be updated to provide a full DI appraisal once the required modelling and data outputs are available.

Table 1-1 outlines the full DI appraisal process, detailing key decision-making points, as illustrated by the three identified steps.

Table 1-1 – Distributional impact appraisal process

Step		Description	Output
1	Screening	• Identification of likely impacts for each indicator	Screening Proforma.
2	Assessment	• Confirmation of the area impacted by the transport intervention (impact area). • Identification of social groups in the impact area. • Identification of amenities in the impact area.	DIs social groups statistics and amenities affected within the impact area.
3	Appraisal of Impacts	• Core Analysis of the impacts (including providing an assessment score for each indicator based on a seven-point scale – large beneficial to large adverse). • Full appraisal of DIs and input into AST.	Appraisal worksheets and AST inputs.

Source: DfT TAG Unit 4.2

1.1.1. Step 1 – Screening Process

The initial screening assessment considers the likely positive and negative impacts of the scheme options using the eight DI indicators in relation to specific vulnerable groups, including children, young adults, older people, people with a disability, Black and Minority Ethnic (BME) communities, people without access to a car, and people on low incomes.

The Screening Proforma published by the DfT requires consideration of all eight DI indicators and asks the analyst to provide the following information:

- Whether the scheme is likely to have any impacts on specific groups of people, including children, young adults, older people, disabled people, black and minority ethnic (BME) communities, people without access to a car, and people on low incomes;
- Whether the impacts are likely to be positive or negative, and an explanation of likely impacts; and
- What the next steps in the DI appraisal process should be.

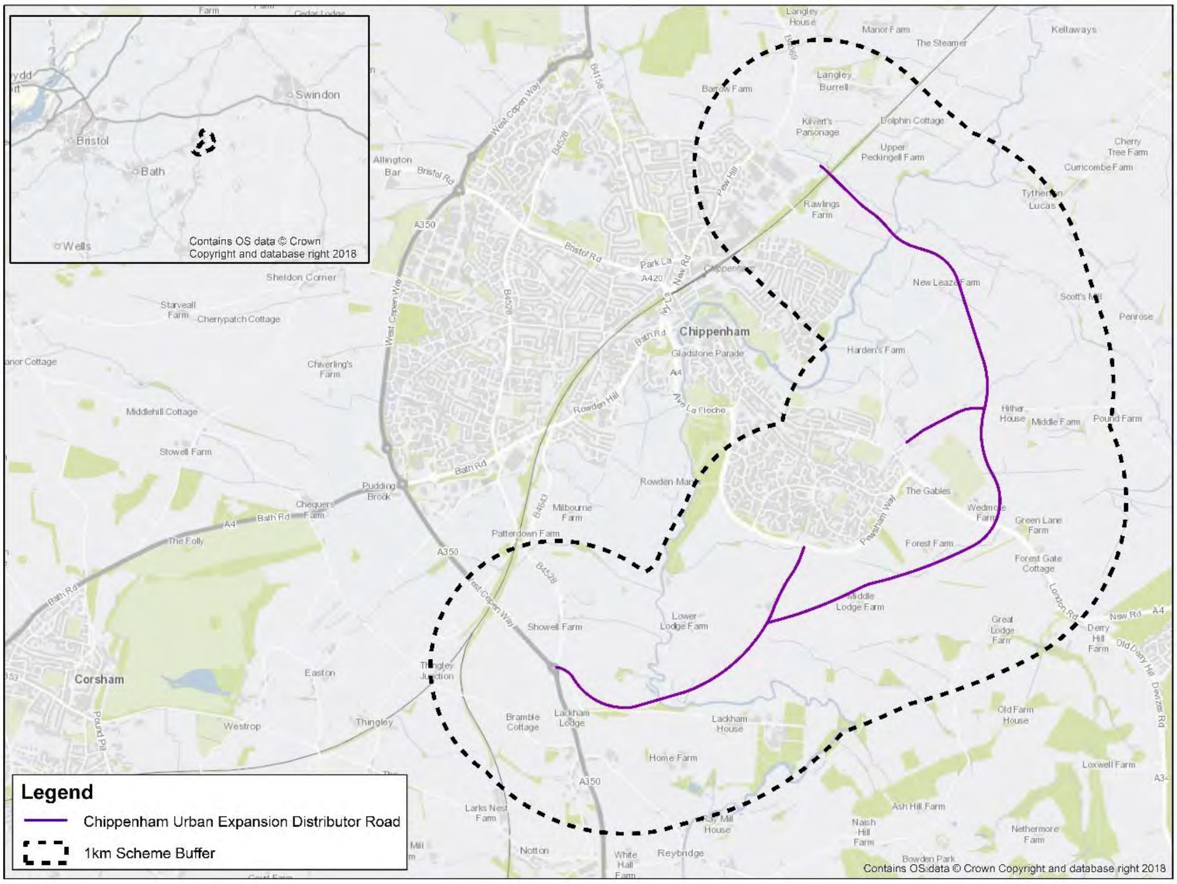
1.1.2. Step 2 – Assessment

Following on from the screening proforma (Step 1), the steps to complete the full DI appraisal, where required for each indicator, are described below.

1.1.2.1. Step 2a – Confirmation of the Area Impacted by the intervention

The screening provides a broad understanding of the areas likely to experience impacts because of the scheme options. Within Step 2a, a more detailed examination is required to investigate the spatial impacts of the scheme options. The area affected is likely to vary depending on the individual DI indicator being appraised. The current area to be assessed is referred to as the *Chippenham Urban Expansion Distributor Road* and is displayed graphically in Figure 1-1:

Figure 1-1 – Chippenham Urban Expansion Distributor Road scheme area



The entire scheme is within Wiltshire and so when examining how the socio-demographics of the scheme compares to the surrounding area, Wiltshire's population profile will be used as a comparator.

1.1.2.2. Step 2b – Identification of the Social Groups in the Impact Area

Step 2b requires the analysis of socio-economic and demographic characteristics to develop a profile of:

- The transport users that will experience changes in travel generalised costs resulting from the intervention;
- People living in those areas identified as likely to be affected by the intervention; and
- People travelling in areas identified as likely to be affected by the intervention.

The analysis uses common datasets and plots the proportions of vulnerable groups within the impacted area for each indicator. Table 1-2 sets out the groups of people to be identified in the analysis for each indicator, as defined in WebTAG Unit A4.2.

1.1.2.3. Step 2c – Identification of Amenities in the Impact Area

The concentration of social groups is based not only on the resident population but also on trip attractors/amenities that are within the impact area. Using desktop analysis, the local amenities which are likely to be used by the identified social groups for each DI indicator are identified. Amenity data allows for qualitative assessments and statements to be made, adding value to the DI appraisal and providing a wider assessment than just that of the resident population.

Table 1-2 - Scope of socio-demographic analysis for dis (Step 2b)

	User Benefits	Noise	Air Quality	Accidents	Security	Severance	Accessibility	Affordability
Income Distribution	✓	✓	✓					✓
Children: aged <16		✓	✓	✓	✓	✓	✓	
Young Adults: aged 16 to 24				✓			✓	
Older People: aged 70+				✓	✓	✓	✓	
Population with a disability					✓	✓	✓	
Population of Black Minority Ethnic origin					✓		✓	
Households without access to a car						✓	✓	
Households with dependent children							✓	

Source: DfT TAG Unit 4.2

The output of the assessment in Step 2 is then summarised and presented to provide evidence for the appraisal of impacts in Step 3.

1.1.3. Step 3 – Appraisal of Impacts

This step examines information collated in the previous steps to assess the potential impacts of the intervention on each indicator's social groups.

1.1.3.1. Step 3a – Core Analysis of Impacts

An assessment score is given for each indicator and each of the social groups under consideration. The seven-point scoring system follows the standard DfT appraisal measures:

Table 1-3 - Key to individual Distributional Impact Appraisal

Description	Score
Beneficial and the population impacted is significantly greater than the proportion of the group in the total population.	Large Beneficial
Beneficial and the population impacted is broadly in line with the proportion of the group in the total population.	Moderate Beneficial
Beneficial and the population impacted is smaller than the proportion of the group in the total population.	Slight Beneficial
There are no significant benefits or disbenefits experienced by the group.	Neutral
Adverse and the population impacted is smaller than the proportion of the group in the total population.	Slight Adverse
Adverse and the population impacted is broadly in line with the proportion of the group in the total population.	Moderate Adverse
Adverse and the population impacted is significantly greater than the proportion of the group in the total population.	Large Adverse

Source: DfT TAG Unit 4.2

1.1.3.2. Step 3b – Full Appraisal of DIs

The analysis undertaken in Step 3a provides an assessment score for each indicator and each of the social groups under consideration. In addition, a qualitative assessment will be provided for each indicator to describe the key impacts in each case. These will be summarised in the DI appraisal matrix. The scores and qualitative assessment are summarised in the appraisal matrix of Distributional Impacts with key findings presented in the 'key impacts' column.

2. Appraisal

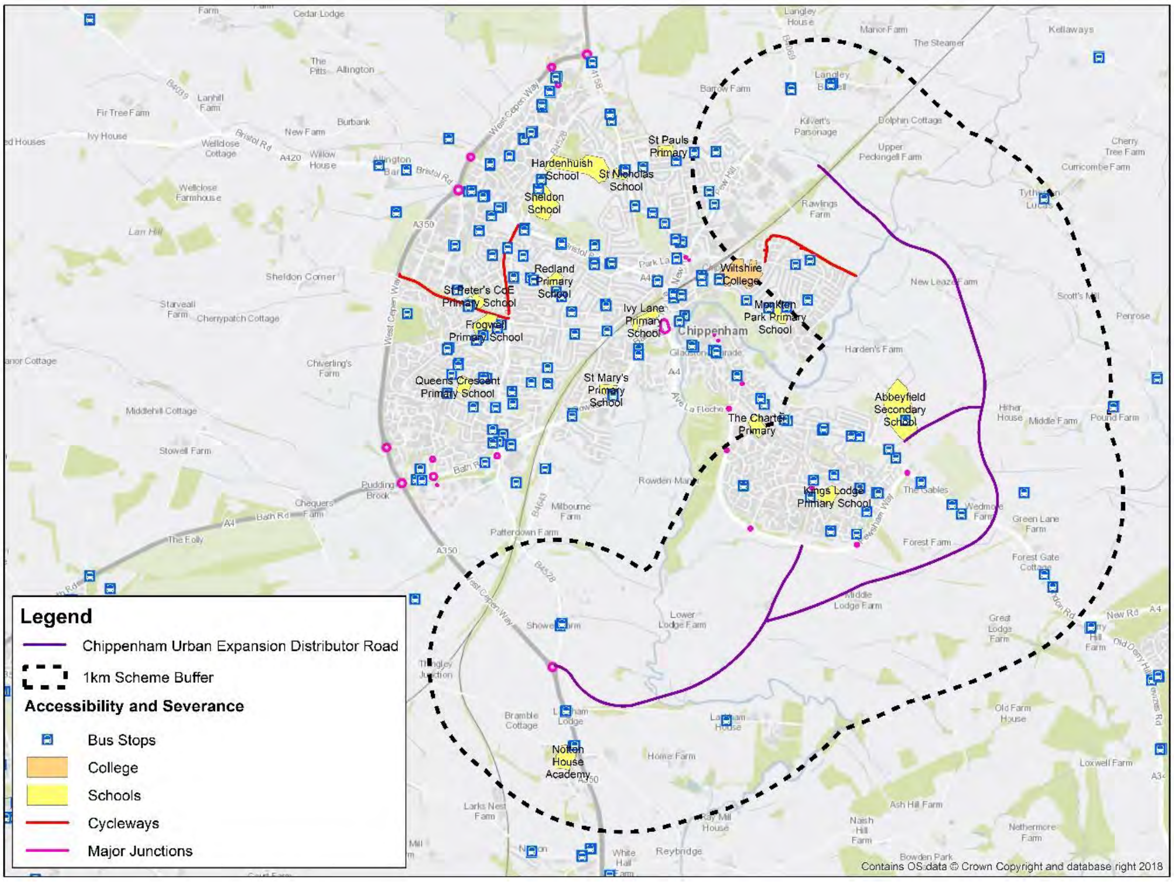
2.1. Accessibility

2.1.1. Step 1 – Screening

The proposed scheme does not include specific provisions for public transport. It is possible that the new distributor road and some of the associated changes and new lane markings will require existing bus stops near the road to be moved or adapted, although the specification and detail of this is not available at this time. Currently, it is believed that any changes to public transport in the area because of the scheme should lead to an improvement in services, either with upgraded facilities or improved journey times in the town centre and through the scheme's route itself.

There are several bus stops within 1km of the route, particularly where the distributor road crosses A4 London Road and joins Pewsham Way and Stanley Lane as shown in Figure 2-1.

Figure 2-1 - Bus stops in Chippenham



Source: DfT - National Public Transport Access Nodes (NaPTAN) and OpenStreetMaps

As the scheme does not focus on or effect the bus services or amount of public transport provided specifically, it is not recommended to carry out a full analysis of accessibility and so Steps 2 and 3 of the accessibility appraisal have not been carried out.

2.1.2. Step 2 – Assessment

Given the lack of scheme impact on public transport and accessibility, the assessment of accessibility has not been carried out.

2.1.3. Step 3 – Appraisal

Following from the assessment and screening stage, the lack of scheme impact on public transport and accessibility has made the appraisal stage unnecessary and has therefore not been carried out.

2.2. Accidents

2.2.1. Step 1 – Screening

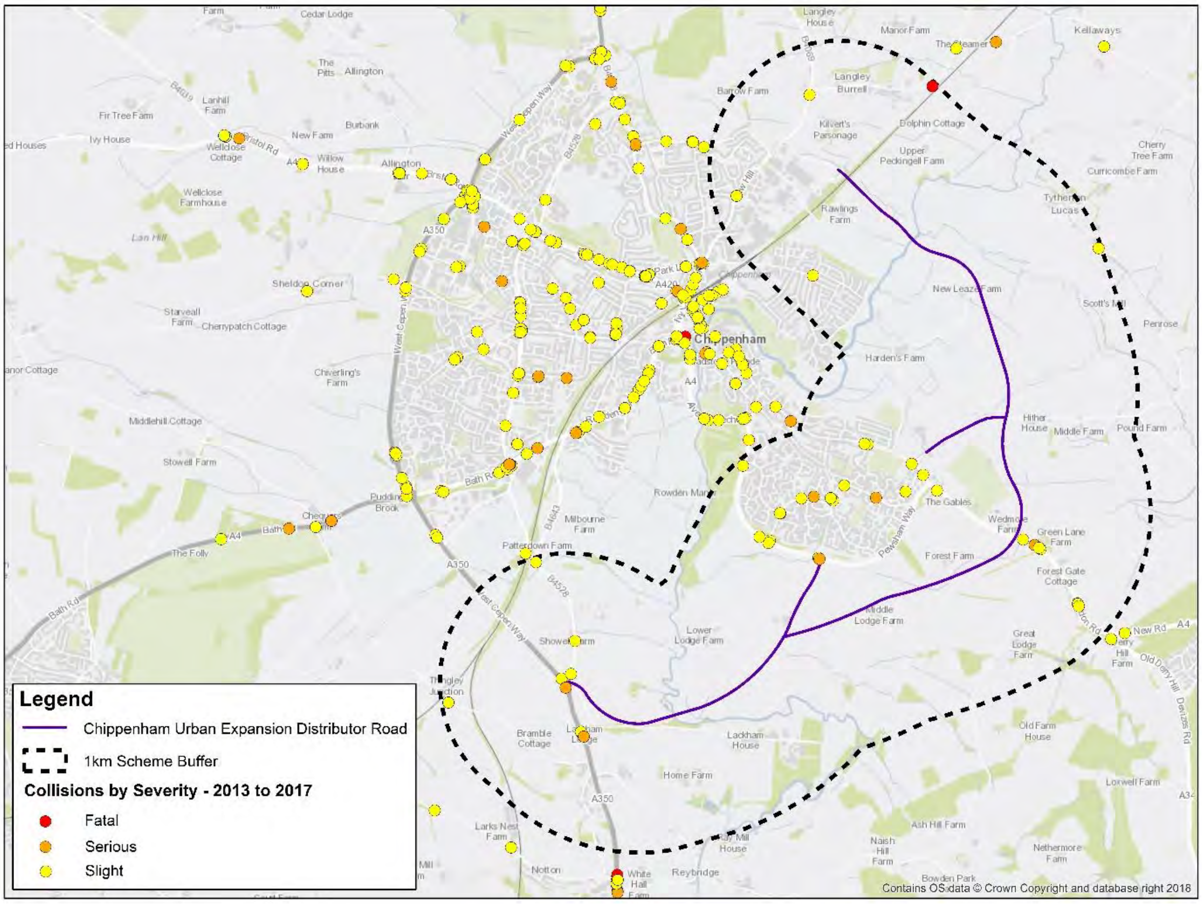
The centre of Chippenham has a high number of collisions currently, particularly along the A4/Bath Road and the A420. Reducing collisions would be an important outcome from delivering the scheme and the introduction of a new distributor road is likely to remove much of the through traffic on the town centre roads, particularly along the A4. Given the anticipated change in collision levels, they will need to be examined further to assess the full impact of the scheme.

2.2.2. Step 2 – Assessment

Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts, or any links with significant changes in vehicle flow, speed, %HGV content or any significant change (>10%) in the number of pedestrians, cyclists or motorcyclists using road network should be examined.

The approach for the DI appraisal of collisions generally uses modelling outputs to identify the impacted area for the collision assessment, however, this is currently unavailable for the distributor road scheme. As such, this assessment is based upon past collision rates from the previous 5 years (01/01/2013 to 31/12/2017) reported from the DfT national collision database, using STATS19 data. The collisions are graphically displayed in Figure 2-2 and presented in Table 2-1.

Figure 2-2 - Collisions in Chippenham 01/01/2013 to 31/12/2017



Source: DfT Accident Database

Table 2-1 - All collision casualties (2013 - 2017)

Casualty Type	Distributor Road 1km Buffer Scheme Area		All Causalities (England Rate)	
	N	%	N	%
Vulnerable Users				
Pedestrians	4	10.00%	121,610	12.9%
Cyclists	4	10.00%	97,137	10.3%
Motorcyclists	12	30.00%	96,882	10.3%
Male drivers aged 16 to 24	13	32.50%	218,932	23.3%
Vulnerable Groups				
Under 16	3	7.50%	81,813	8.7%
People aged 70+	4	10.00%	57,781	6.1%
Deprivation				
Occurred in 20% most deprived LSOAs in UK	0	0.00%	-	-
Occurred in 20% least deprived LSOAs in UK	29	72.50%	-	-
Total Casualties	40	100.0%	941,477	100.0%

Source: DfT Accident Database

Identification of key amenities in the collision impact area has not been completed in detail at this stage to maintain a proportionate assessment. This DI appraisal therefore assumes presence of all vulnerable groups within the assessment, both in terms of travelling around the impact area and within the daytime population whilst visiting local amenities.

As evidenced by the data, there is an abnormally high percentage of collisions occurring with motorcyclists and male drivers aged 16 to 24 compared to the national average, about 30% compared to 10% nationally. Likewise, the collisions appear to be concentrated in the least deprived areas of the country, with 72.5% of the 40 total collisions within 1km of the scheme occurring in such areas.

The new distributor road is likely to reduce some of the collisions occurring in Chippenham centre due to removing traffic from those routes. However, the increased speeds and new junctions that will need to be created to accommodate the route may cause an increase in collisions to occur in these areas. Overall, the collisions will need to be appraised with model outputs to determine if the reduction in collisions are likely to be greater than any increases in collisions experienced along the new route.

2.2.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.3. Air Quality

2.3.1. Step 1 – Screening

Changes in vehicle routes and proximity to residents are likely to give rise to changes in air pollutants along the route, which may impact on receptors near the route. The land surrounding the scheme is largely rural and therefore there are few properties nearby, however the road alignment will bring the road closer to some receptors. In contrast, reductions in vehicle traffic in Chippenham centre is likely to cause improvements in local air quality. Therefore, the impact on local receptors, including sensitive receptors will need to be examined.

2.3.2. Step 2 – Assessment

An assessment of noise impacts has been conducted and is reported in the Chippenham Urban Expansion HIF Transport and Economics Technical Note.

2.3.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.4. Affordability

2.4.1. Step 1 – Screening

One of the aims of the distributor road scheme is to reduce congestion in Chippenham town centre and improve journey times for all users, which may have positive cost impacts. The distribution of benefits across different areas will need to be examined, utilising the DfT's Transport User Benefits Assessment (TUBA) model outputs that are currently in production.

2.4.2. Step 2 – Assessment

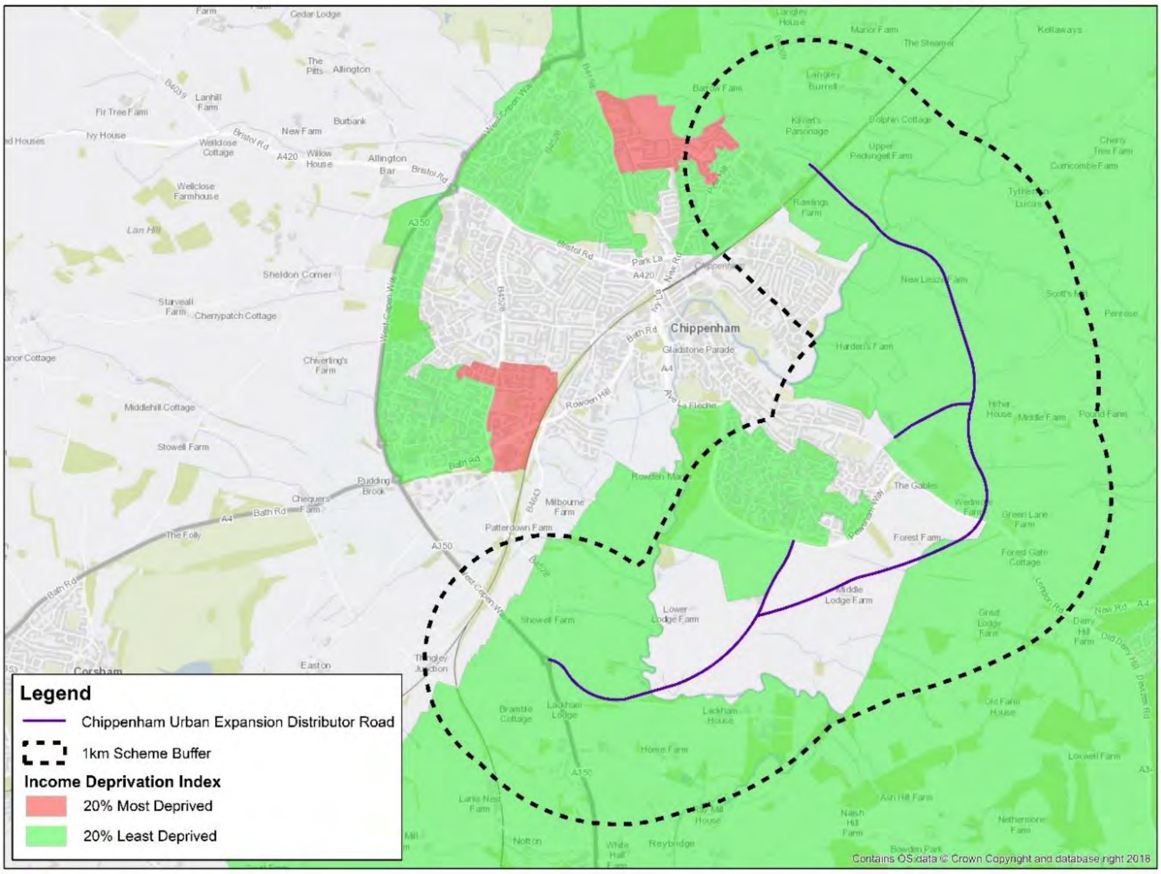
Table 2-2 and Figure 2-3 provide an overview of the different income groups living within the scheme area.

Table 2-2 - Income deprivation quintile group

Income Group	Distributor Road scheme area	Wiltshire	England
Quintile 1 (most deprived)	0.0%	0.2%	20.0%
Quintile 2	0.7%	2.2%	20.0%
Quintile 3	18.1%	7.4%	20.0%
Quintile 4	2.0%	53.3%	20.0%
Quintile 5 (least deprived)	79.3%	36.9%	20.0%

Source: Ministry of Housing, Communities, and Local Government, 2015

Figure 2-3 – Income deprivation quintile group



Source: Ministry of Housing, Communities, and Local Government, 2015

Identification of key amenities in the affordability impact area has not been completed in detail at this stage to maintain a proportionate assessment. The immediate and surrounding areas may have a few amenities in addition to the previously identified schools and these will need to be examined further at a later stage.

2.4.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.5. Noise

2.5.1. Step 1 – Screening

The introduction of a new distributor road will impact the noise levels for neighbouring receptors (including sensitive receptors such as schools). Although large sections of the scheme are located in relatively rural areas where there are fewer properties, the overall increased volume of traffic in the area using this new route means that the noise impact on local receptors, including sensitive receptors such as schools will need to be examined.

2.5.2. Step 2 – Assessment

An assessment of noise impacts has been conducted and is reported in the Chippenham Urban Expansion HIF Transport and Economics Technical Note.

2.5.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.6. Security

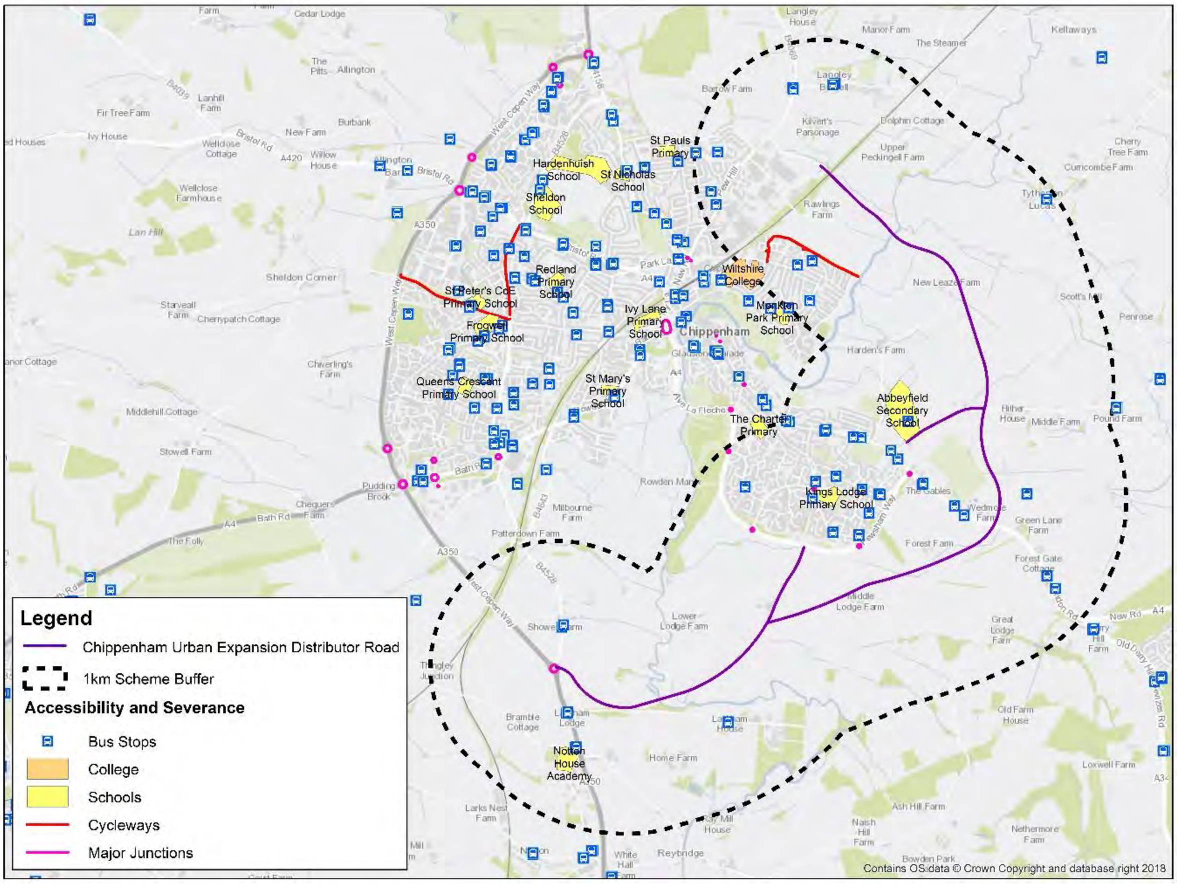
2.6.1. Step 1 – Screening

Any changes to pedestrian or cyclist facilities along the route may have an impact on security due to changes in aspects such as visibility and lighting. These particularly effect certain vulnerable groups like children and women more than others and so will need to be examined further to assess the full impact of the scheme.

2.6.2. Step 2 – Assessment

Due to the extent of the assessment area for the distributor road scheme, there are several amenities within the area that will attract vulnerable groups; hence adding to the movements and daytime population of those considered vulnerable to a transport scheme impact on security. These amenities include nursing homes, community centres, parks and open spaces and local shops. Additionally, there are four schools located within 1km of the distributor road scheme, indicating modest levels of movements from children and their parents/carers around the locality. This is particularly evident at Abbeyfield Secondary school where a link to the local roads and the distributor road is proposed as shown in Figure 2-4:

Figure 2-4 – Schools and amenities in Chippenham



Source: DfT - National Public Transport Access Nodes (NaPTAN) and OpenStreetMaps

Features of the scheme that are likely to affect personal security have not been confirmed at this stage. However, it is likely that there will be a slight improvement for all users, given aspects such as improved lighting and carriageway/footway alignment changes, although this is unlikely to impact many people. It is unknown at this stage whether there will be any provision for personal security measures (such as CCTV).

The scheme is predominantly aimed at improving driver experience and safety on the motorway and at the roads leading into the new route. Limited public transport will use the link, and while there are NMU users in the vicinity, they will not be the primary beneficiaries of the scheme.

The vulnerable group population makeup of the area is presented below in Table 2-3:

Table 2-3 - Security assessment

Vulnerable Group	Distributor road scheme	Wiltshire	England
Children (aged under 16)	20.2%	19.0%	18.9%
Older People (aged 70+)	21.1%	25.6%	23.2%
Women	50.4%	50.8%	50.8%
Black and Minority Ethnic Groups	3.6%	3.4%	14.6%

Source: 2011 Census aggregate data

There are not any particularly high concentrations of vulnerable groups within the scheme area and the proportions are generally in line with the wider ratios of these groups in Wiltshire. The exception to this is the relatively low concentration of older people within the scheme area (21.1%), given that Wiltshire overall has a greater concentration of elderly people (25.6%) than England as a whole (23.2%). As such, the impacts of the scheme on this group will be less than otherwise expected.

2.6.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.7. Severance

2.7.1. Step 1 – Screening

One of the distributor roads aims is to reduce congestion in Chippenham town centre, which is likely to experience a reduction in vehicle traffic due to traffic rerouting to take advantage of the new route. Although the existing roads like the A4/Bath Road, A420, and Langley Road cause a high level of severance, the reduction in traffic due to the new alternative route could make it easier for pedestrians and cyclists to cross the road and move throughout Chippenham. The present configuration has been identified as a barrier to encouraging active travel and some of the new facilities may be improved by the new road, particularly along routes leading up to the new road. As such, changes in severance, particularly for vulnerable groups will need to be examined further to assess the full impact of the scheme.

2.7.2. Step 2 – Assessment

The impacted area for severance has been identified as a 1km buffer of the scheme area to account for the current road layout, proposed road layout, and effects on neighbouring roads and amenities. There are several amenities within the area that will attract vulnerable groups, including nursing homes, schools, community centres, parks and open spaces, and local shops.

There are four schools and 1 college located within 1km of the road option, indicating some movement from children and their parents/carers to and from the area.

The most notable reduction in severance in the study region will be for those travelling along the A4/Bath Road, A420, and Langley Road where there is an anticipated overall reduction of traffic levels and hence a reduction in both actual and perceived severance. This may have a positive impact upon the high proportions of older people, children, and no car households in this area. However, the new road will cause new instances of severance to occur elsewhere in Chippenham, particularly along the new road itself and where it links with local roads like Stanley Lane and Pewsham Way. The vulnerable groups within the scheme area are presented in Table 2-4:

Table 2-4 - Severance assessment

Vulnerable Group	Distributor Road scheme area	Wiltshire	England
Children (aged under 16)	20.2%	19.0%	18.9%
Older People (aged 70+)	21.1%	25.6%	7.8%
Women	50.4%	50.8%	50.8%
Proportion of households without access to a car or van	32.8%	29.7%	29.1%

Source: 2011 Census aggregate data

As shown in the above table, there are relatively low concentrations of vulnerable groups within distributor road scheme area. Whilst there are some high concentrations of vulnerable groups in the area, particularly children, they are likely to benefit from the reduced vehicle flow on local roads, and hence, experience a reduction in both actual and perceived severance.

2.7.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

2.8. User Benefits

2.8.1. Step 1 – Screening

One of the aims of the scheme is to reduce congestion in and around Chippenham and improve overall journey times for all users. Therefore, the distribution of the scheme benefits across different areas and social groups will need to be examined.

2.8.2. Step 2 – Assessment

Table 2-5 provides an overview of the different income groups living within the scheme area. An assessment of user benefits has been conducted and is reported in the Chippenham Urban Expansion HIF Transport and Economics Technical Note.

Table 2-5 - User Benefits assessment

Income Group	Distributor Road Scheme	Wiltshire	England
Quintile 1 (most deprived)	0.6%	0.2%	20.0%
Quintile 2	1.9%	2.2%	20.0%
Quintile 3	0.0%	7.4%	20.0%
Quintile 4	20.2%	53.3%	20.0%
Quintile 5 (least deprived)	77.3%	36.9%	20.0%

Source: Ministry of Housing, Communities, and Local Government, 2015

Identification of key amenities in the user benefits impact area has not been completed in detail at this stage to maintain a proportionate assessment. The immediate surrounding area does not have many amenities save for a few schools and a college, however, there may be some in the nearby villages and these will need to be examined further at a later stage.

2.8.3. Step 3 – Appraisal

The appraisal step has not been carried out at this stage.

3. Summary

3.1. Conclusion

In summary, the distributional impacts related to the Chippenham Urban Expansion Distributor Road could have some serious effects on several vulnerable groups living in the east of Chippenham, whilst simultaneously providing benefits for those living in Chippenham centre and elsewhere.

The scheme could alleviate a proportion of the traffic volumes in Chippenham town centre, with associated decreases in collisions and noise expected, whilst concurrently improving local air quality. Likewise, user benefits and affordability are likely to be improved due to improved facilities and decreased journey times. Traffic congestion is expected to reduce because of traffic using the distributor road, rather than travelling through the town centre.

However, these gains may be offset elsewhere, where the distributor road may place more traffic on the local roads to the east of Chippenham, that feed in to the distributor road scheme. Likewise, given the presence of four schools within 1km of the scheme and proposed link roads running adjacent to one school, as well as a higher than average concentration of children and households without access to a vehicle, the distributional impacts of the scheme on aspects such as severance could be considered adverse however the impact on the town centre could be considered beneficial.

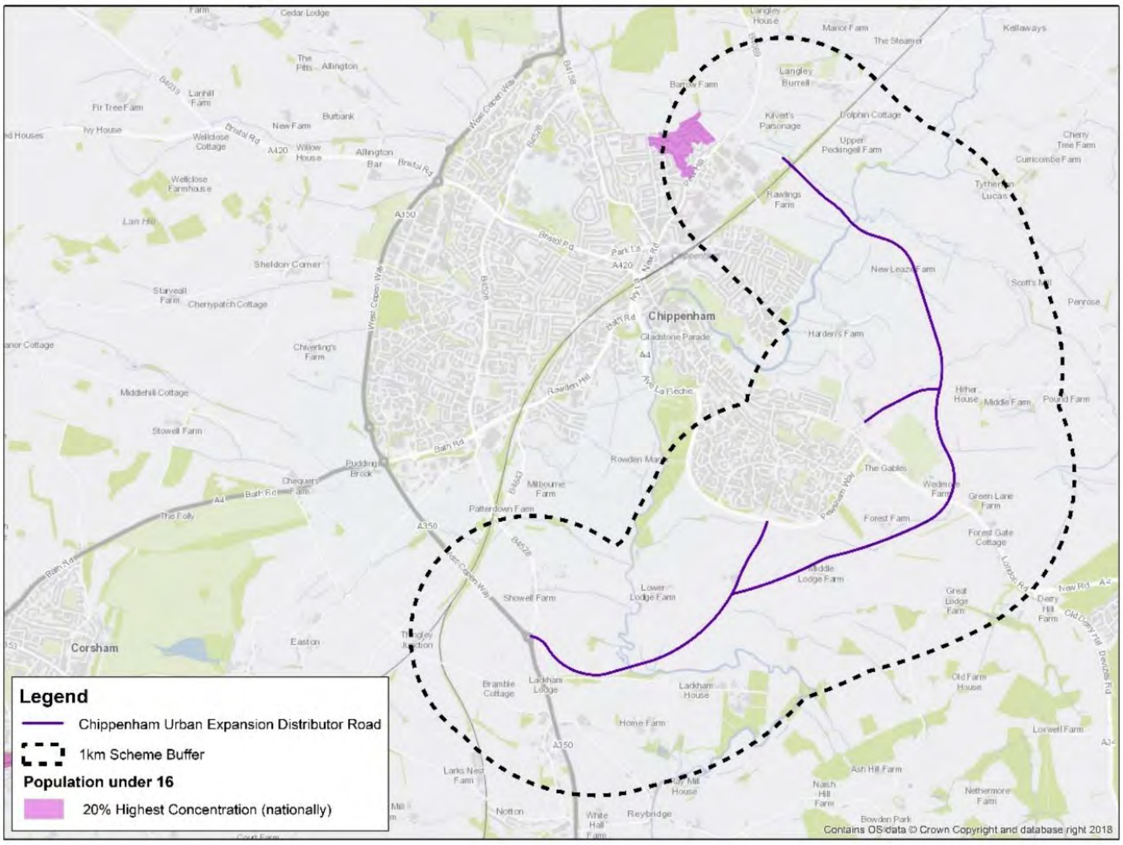
3.2. Next Steps

In examining the next stage of the project, a full DI appraisal (step 3 of the WebTAG guidance) is recommended for each of the different distributional impact elements, except for *Accessibility,* as the scheme does not provide any specific provisions directly relating to public transport. The next appraisal stage should also incorporate feedback from Wiltshire Council and other relevant stakeholders on this DI report, as well as include further assessment and analysis from future outputs of transport modelling for the scheme, resulting in a more detailed appraisal.

Appendices

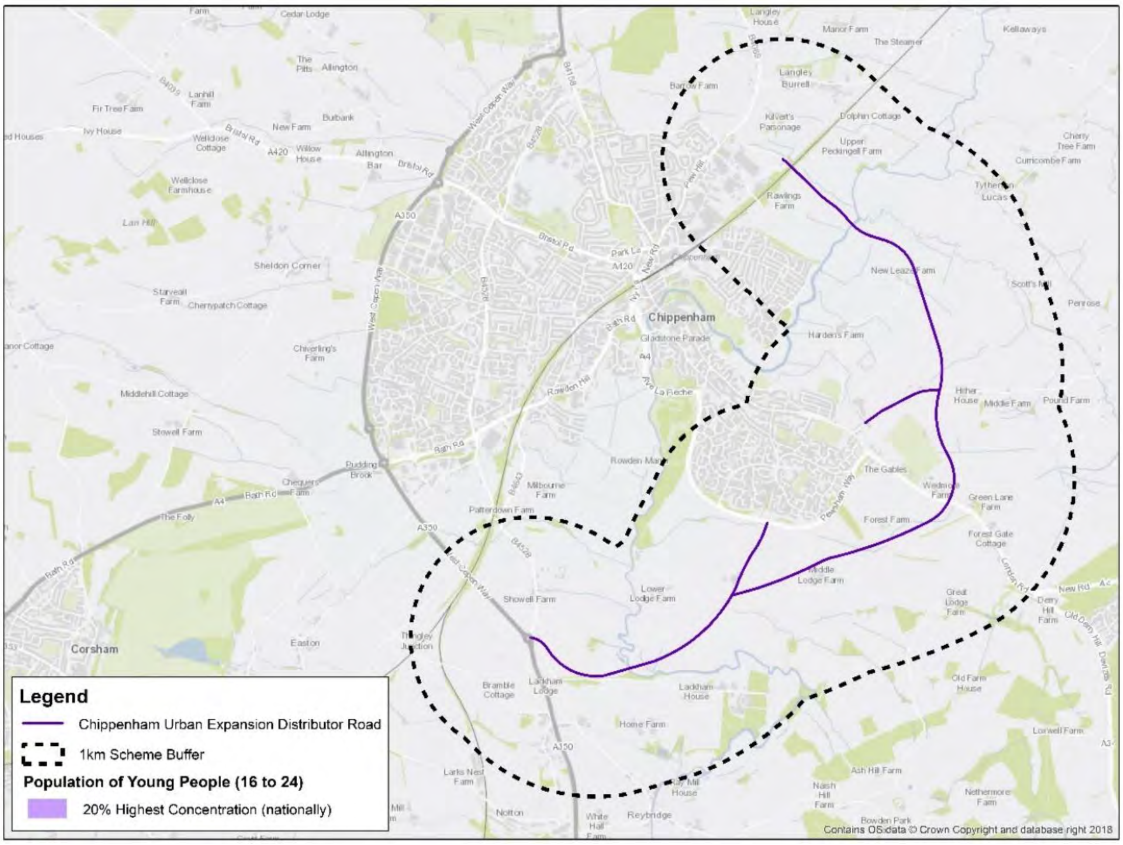
Appendix A. DI Mapping

Figure 3-1 – Population under 16



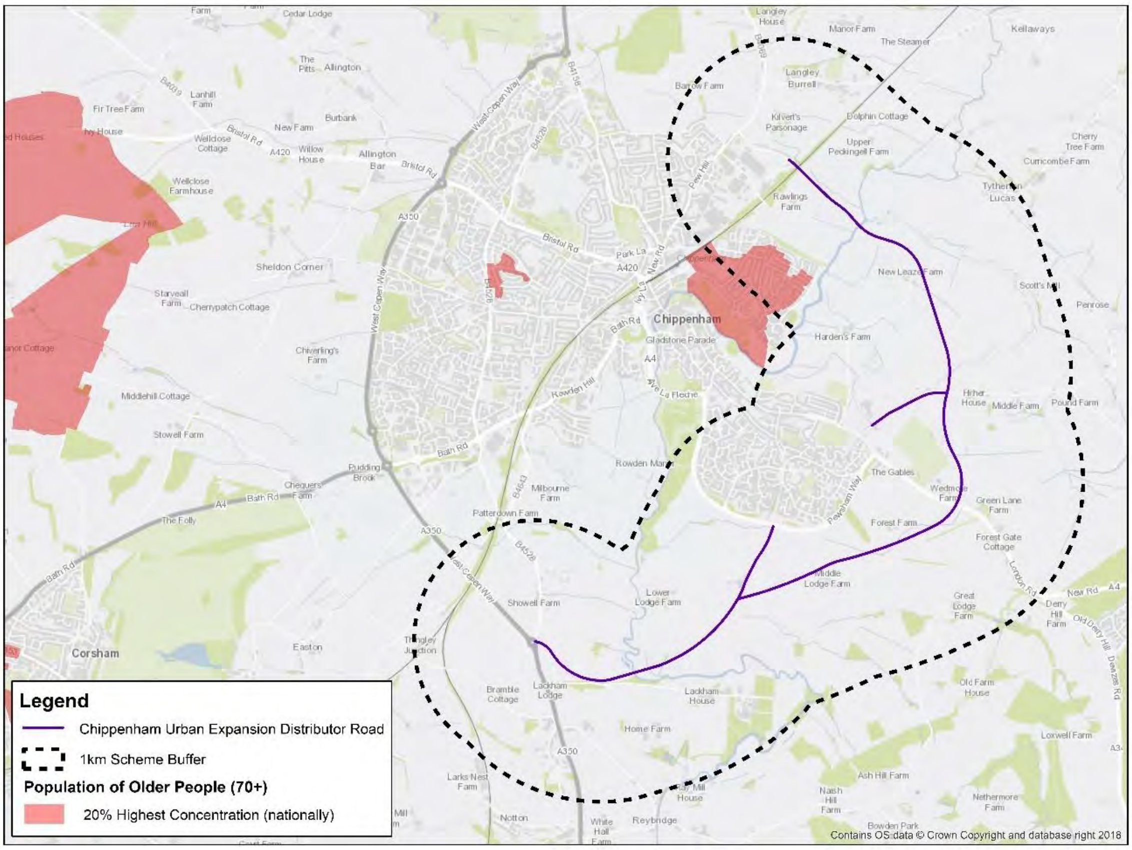
Source: 2011 Census aggregate data

Figure 3-2 – Population of young people (16 to 24)



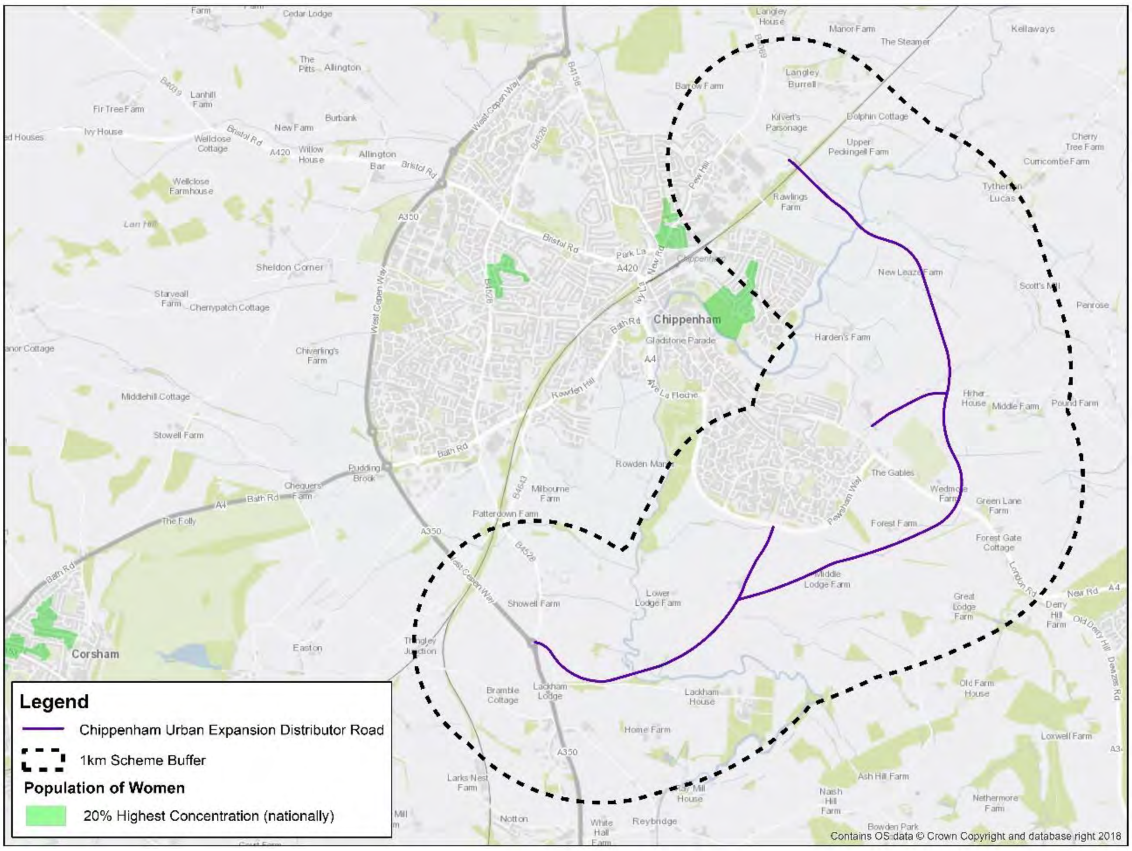
Source: 2011 Census aggregate data

Figure 3-3 – Population of old people (70+)



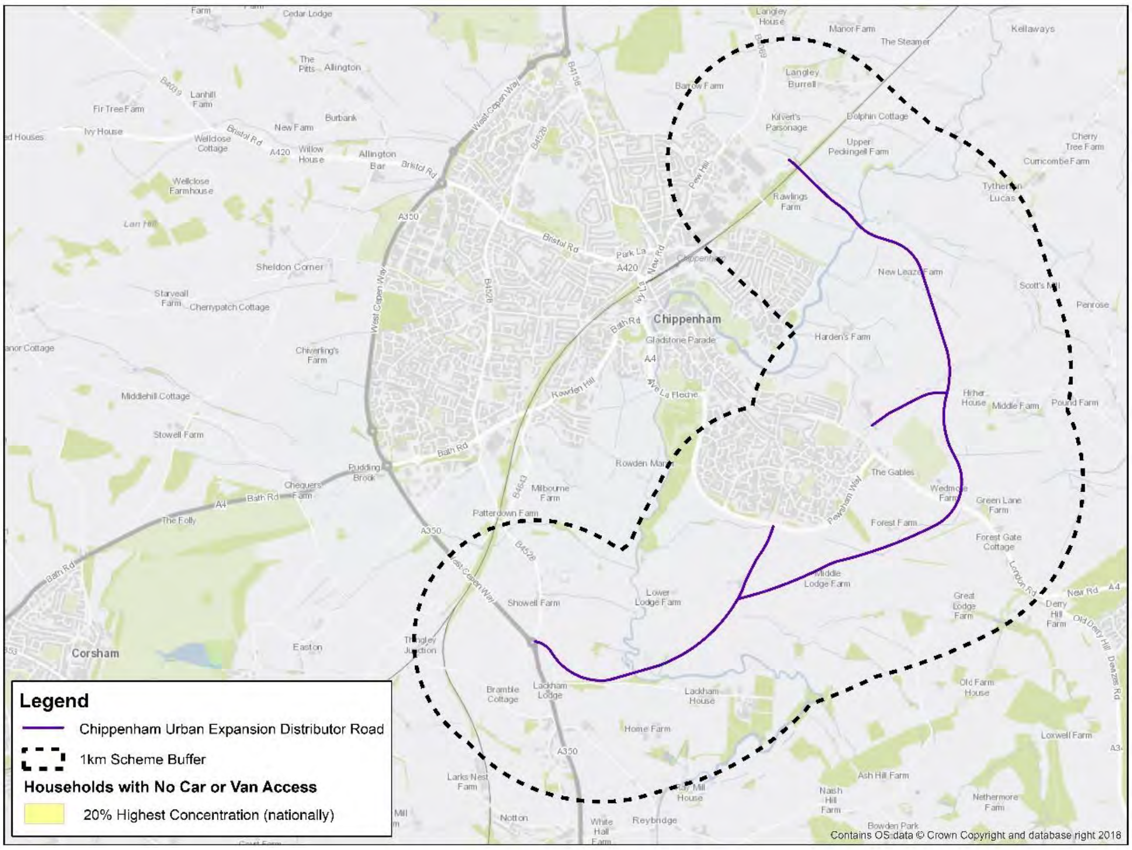
Source: 2011 Census aggregate data

Figure 3-4 – Population of women



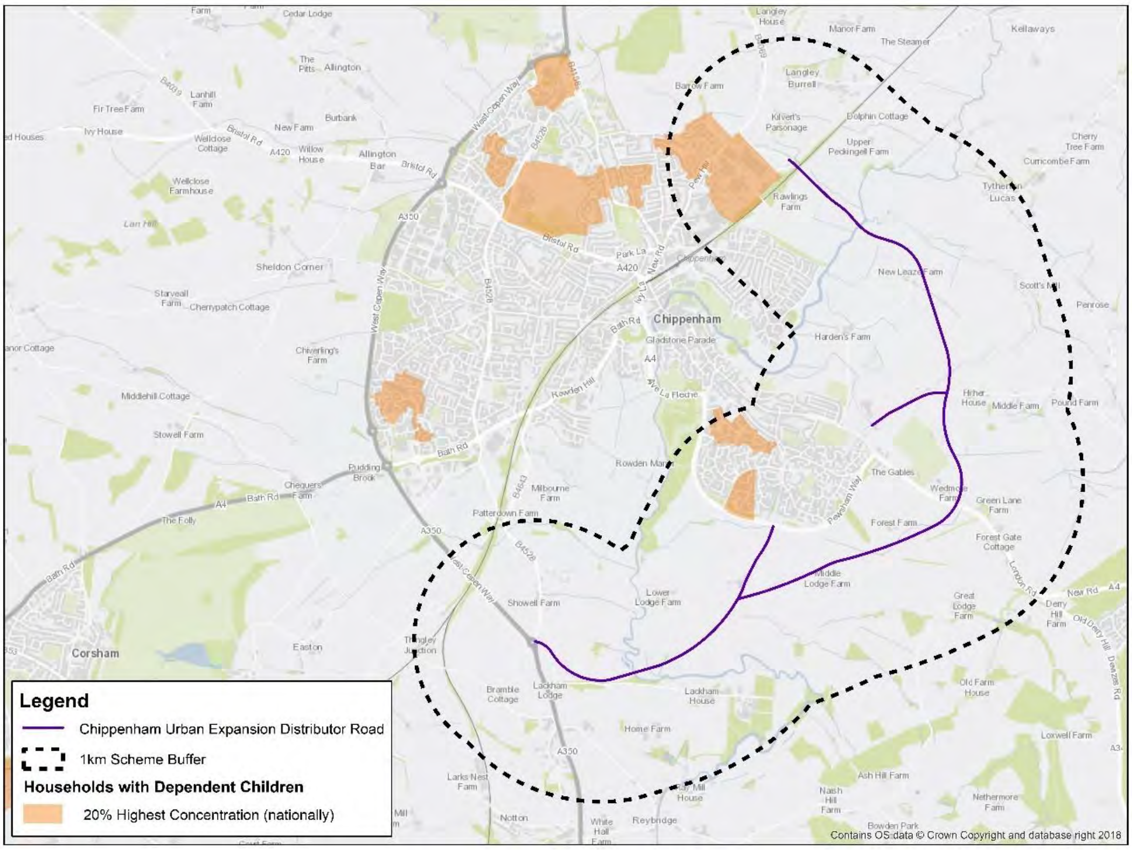
Source: 2011 Census aggregate data

Figure 3-5 – Households with no access to car or van



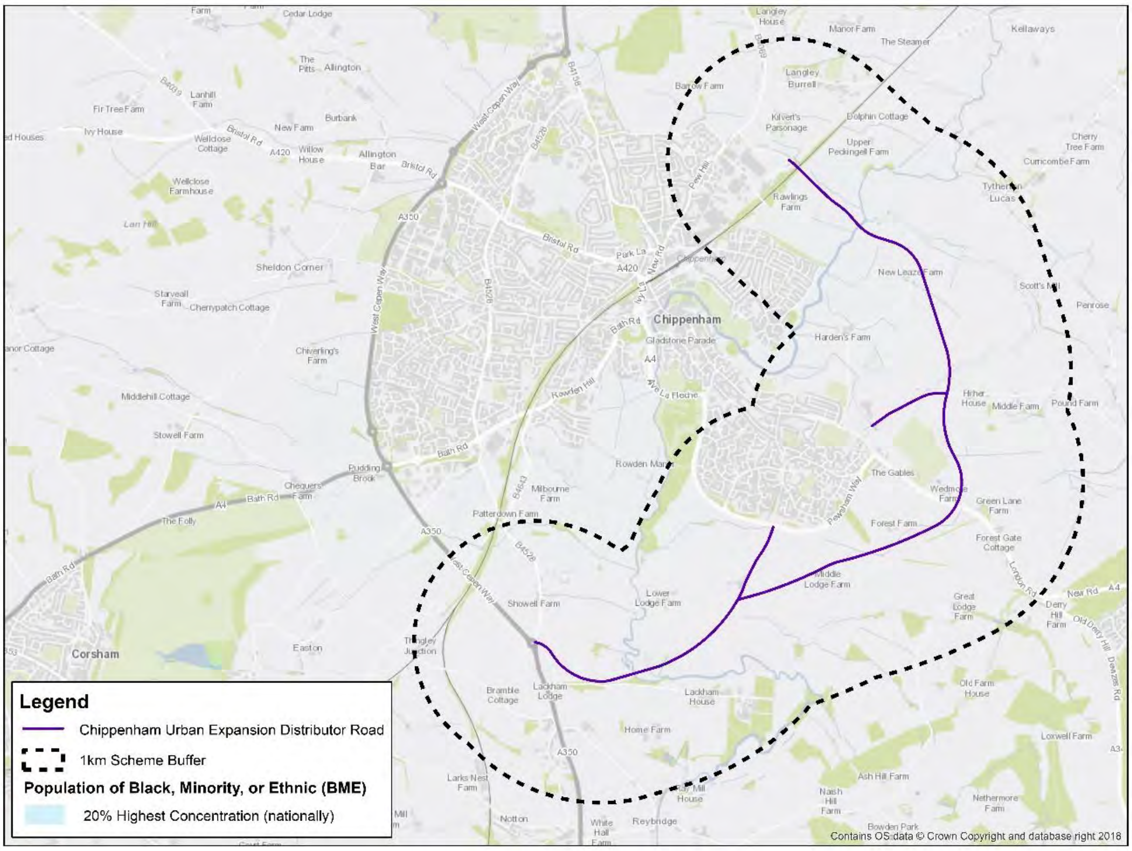
Source: 2011 Census aggregate data

Figure 3-6 – Households with dependent children



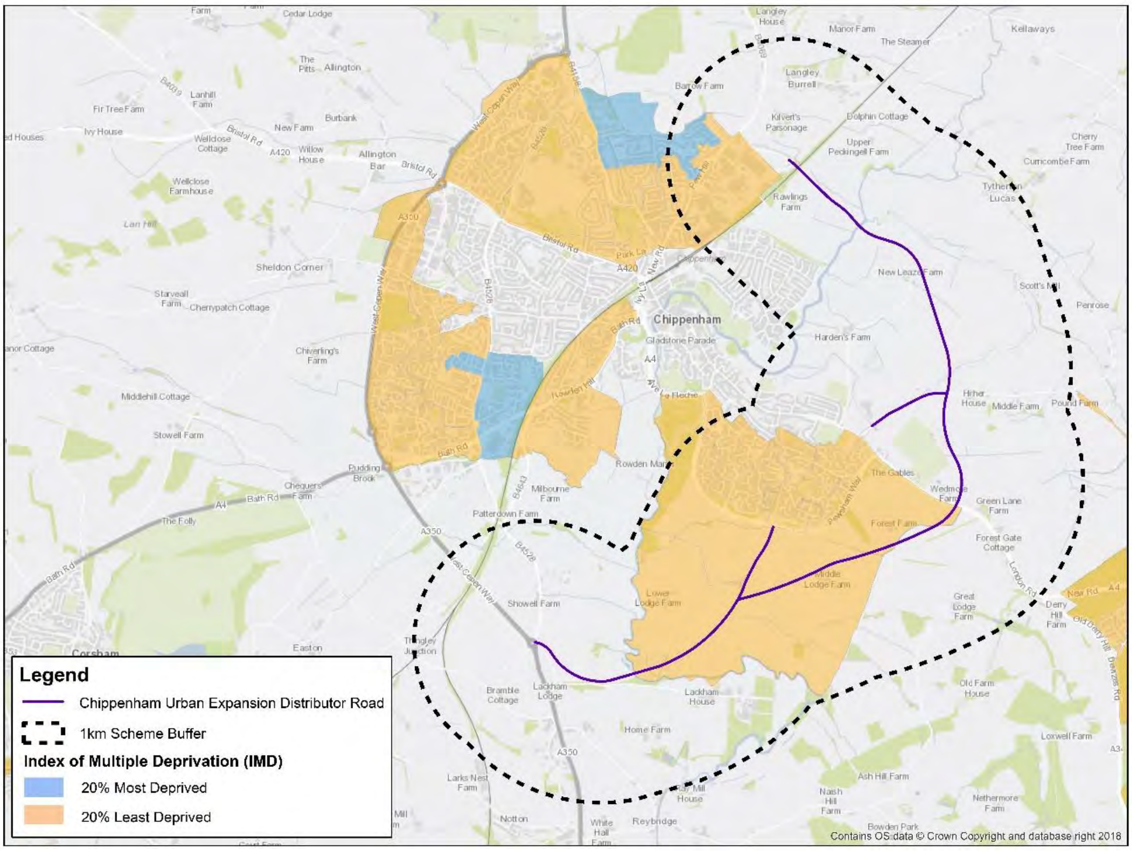
Source: 2011 Census aggregate data

Figure 3-7 – Population of black, minority, and ethnic group (BME)



Source: 2011 Census aggregate data

Figure 3-8 – Index of Multiple Deprivation (IMD)



Source: Ministry of Housing, Communities, and Local Government

[redacted]
Atkins Limited
The Hub
500 Park Avenue
Aztec West
Bristol
BS32 4RZ

Tel: [redacted]
Direct: [redacted]
[redacted]**@atkinsglobal.com**