



SWDP 2019 Malvern Development Model

Worcestershire County Council

Traffic Impact Assessment

03 | FINAL

September 2019



SWDP 2019 Malvern Development Model

Project No: 694944CH
 Document Title: Traffic Impact Assessment
 Document No.: 03
 Revision: FINAL
 Date: September 2019
 Client Name: Worcestershire County Council
 Client No: -
 Project Manager: Chris Macdonald
 Author: Martin Baierl
 File Name: \\europe.jacobs.com\dc4\MFS\Projects\Transport\Projects\JIWHW100 - WCC\5. Project Work\A. Reporting\03 MDM Assessment\694944CH MDM SDWP19 v1.02.docx

Jacobs U.K. Limited

5 First Street,
 Manchester,
 M15 4GU

www.jacobs.com

© Copyright 2019 Jacobs U.K. Limited. The concepts and information contained in this document are the property of Jacobs. Use or copying of this document in whole or in part without the written permission of Jacobs constitutes an infringement of copyright.

Limitation: This document has been prepared on behalf of, and for the exclusive use of Jacobs' client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party.

Document history and status

Revision	Date	Description	By	Review	Approved
1	27 August 2019	Draft for Client Comment	MB	CMac	PS
2	18 September 2019	Client Comments Addressed	MB	CMac	PS

Contents

1.	Introduction.....	1
2.	The Malvern Development Model	2
2.1	MDM Junctions	2
2.2	MDM Junction Traffic Data	2
2.3	MDM Developments	6
2.4	Development Trip Rates.....	8
2.5	Base and Do-Minimum Traffic Data	9
2.6	Distribution and Assignment.....	9
3.	Assessment Scenarios	11
3.1	Do-Minimum Traffic Growth Utilising TEMPro	11
3.2	Other Aspects for Consideration	12
4.	Scenario 1A - North Site Extension (Cales Farm)	13
4.1	Scenario 1A Headline Results and Analysis	13
4.1.1	Overview.....	13
4.1.2	Distribution and Assignment.....	15
4.1.3	Junction Impacts.....	15
5.	Scenario 1B - Upper Howsell	16
5.1	Scenario 1B Headline Results and Analysis	16
5.1.1	Overview.....	16
5.1.2	Distribution and Assignment.....	18
5.1.3	Junction Impacts.....	18
6.	Scenario 1C - Hayslan Fields	20
6.1	Scenario 1C Headline Results and Analysis	20
6.1.1	Overview.....	20
6.1.2	Distribution and Assignment.....	22
6.1.3	Junction Impacts.....	22
7.	Scenario 1D - Sherrards Green	23
7.1	Scenario 1D Headline Results and Analysis	23
7.1.1	Overview.....	23
7.1.2	Distribution and Assignment.....	25
7.1.3	Junction Impacts.....	25
8.	Scenario 1E - Guarlford Road	26
8.1	Scenario 1E Headline Results and Analysis	26
8.1.1	Overview.....	26
8.1.2	Distribution and Assignment.....	28
8.1.3	Junction Impacts.....	28
9.	Scenario 1F - Blackmore Park.....	29
9.1	Scenario 1F Headline Results and Analysis	29
9.1.1	Overview.....	29
9.1.2	Distribution and Assignment.....	31

9.1.3	Junction Impacts.....	31
10.	Scenario 1G - A449 Pins Green (north of).....	33
10.1	Scenario 1G Headline Results and Analysis.....	33
10.1.1	Overview.....	33
10.1.2	Distribution and Assignment.....	35
10.1.3	Junction Impacts.....	35
11.	Scenario 1H - A449 Pins Green (south of)	37
11.1	Scenario 1H Headline Results and Analysis.....	37
12.	Scenario 1I - North End/Mayfield Road Employment	39
12.1	Scenario 1I Headline Results and Analysis	39
12.1.1	Overview.....	39
12.1.2	Distribution and Assignment.....	41
12.1.3	Junction Impacts.....	41
13.	Scenario 1J - Rose Farm/Hall Green/Guarlford Road.....	43
13.1	Scenario 1J Headline Results and Analysis.....	43
13.1.1	Overview.....	43
13.1.2	Distribution and Assignment.....	45
13.1.3	Junction Impacts.....	45
14.	Scenario 2 – Cumulative Malvern SWDP Impact.....	46
14.1	Scenario 2 Headline Results and Analysis.....	46
14.1.1	Overview.....	46
14.1.2	Distribution and Assignment.....	46
14.2	Junction Impacts.....	47
14.2.1	North Site extension (Cales Farm)	47
14.2.2	Upper Howsell	47
14.2.3	Hayslan Fields	47
14.2.4	Sherrards Green.....	47
14.2.5	Guarlford Road	48
14.2.6	Blackmore Park	48
14.2.7	A449 Pins Green (north of)	48
14.2.8	A449 Pins Green (south of).....	48
14.2.9	North End/Mayfield Road Employment	48
14.2.10	Rose Farm, Hall Green, Guarlford Road.....	48
14.3	Link Capacity Assessment	54
14.3.1	Highest V/C Ratios	54
14.3.2	Largest Increase in V/C Ratios.....	55
15.	Summary and Recommendations	57
15.1.1	Scenarios 1A-1J	57
15.1.2	Scenario 2	58
15.1.3	Next Steps	58

Appendix A. Capability Statement**Appendix B. Model Network Schematics****Appendix C. Model Output Tables**

C.1.1	Scenario 1A
C.1.2	Scenario 1B
C.1.3	Scenario 1C
C.1.4	Scenario 1D
C.1.5	Scenario 1E
C.1.6	Scenario 1F
C.1.7	Scenario 1G and 1H
C.1.8	Scenario 1I
C.1.9	Scenario 1J
C.1.10	Scenario 2

Figure Contents

Figure 2-1	MDM Junctions	3
Figure 2-2	SWDP Sites in Malvern	7
Figure 4-1	Proportion of North Site extension (Cales Farm) trips through each MDM junction	14
Figure 5-1	Proportion of Upper Howsell trips through each MDM junction	17
Figure 6-1	Proportion of Hayslan Fields trips through each MDM junction	21
Figure 7-1	Proportion of Sherrards Green trips through each MDM junction	24
Figure 8-1	Proportion of Guarlford Road trips through each MDM junction	27
Figure 9-1	Proportion of Blackmore Park trips through each MDM junction	30
Figure 10-1	Proportion of A449 Pins Green (north of) trips through each MDM junction	34
Figure 11-1	Proportion of A449 Pins Green (south of) trips through each MDM junction	38
Figure 12-1	Proportion of North End/Mayfield Road Employment trips through each MDM junction	40
Figure 13-1	Proportion of Rose Farm, Hall Green trips through each MDM junction	44
Figure 14-1	Proportion of all MDM development trips attributable to the North Site Extension (Cales Farm) development	49
Figure 14-2	Proportion of all MDM development trips attributable to the Hayslan Fields development	50
Figure 14-3	Proportion of all MDM development trips attributable to the Guarlford Road development	51
Figure 14-4	Proportion of all MDM development trips attributable to the A449 Pins Green (south of) development	52
Figure 14-5	Proportion of all MDM development trips attributable to the North End/Mayfield Road Employment development	53
Figure 14-6	Proportion of all MDM development trips attributable to the Upper Howsell development	49
Figure 14-7	Proportion of all MDM development trips attributable to the Sherrards Green development	50
Figure 14-8	Proportion of all MDM development trips attributable to the Blackmore Park development	51
Figure 14-9	Proportion of all MDM development trips attributable to the A449 Pins Green (north of) development	52
Figure 14-10	Proportion of all MDM development trips attributable to the Rose Farm, Hall Green, Guarlford Road development	53

Table Contents

Table 2-1	MDM Junctions	4
Table 2-2	Malvern SWDP Aspirations	6
Table 2-3	Committed Developments in the MDM	6
Table 2-4	Development traffic splits	8
Table 2-5	TRICS trip rates	8

Table 2-6 Development trips per hour	9
Table 3-1 Overview of model scenarios	11
Table 4-1 Most affected junctions by the North Site Extension (Cales Farm) development.....	13
Table 5-1 Most affected junctions by the Upper Howsell development	16
Table 6-1 Most affected junctions by the Hayslan Fields development	20
Table 7-1 Most affected junctions by the Sherrards Green development.....	23
Table 8-1 Most affected junctions by the Guarlford Road development	26
Table 9-1 Most affected junctions by the Blackmore Park development	29
Table 10-1 Most affected junctions by the A449 Pins Green (north of) development.....	33
Table 12-1 Most affected junctions by the North End/Mayfield Road Employment development	39
Table 13-1 Most affected junctions by the Rose Farm/Hall Green/Guarlford Road development	43
Table 14-1 Most affected junctions by the cumulative development impact.....	46
Table 14-2 Largest V/C ratios in Do-Something Scenario 2 (AM)	54
Table 14-3 Largest V/C ratios in Do-Something Scenario 2 (PM)	55
Table 14-4 Largest increase in V/C in Scenario 2 (AM)	55
Table 14-5 Largest increase in V/C in Scenario 2 (PM)	55
Table 15-1 Junctions recommended for further assessment in Scenario One (✓ = counts available, ✗ = counts required).....	57

Acronyms and Abbreviations

GFA	Gross Floor Area
MDM	Malvern Development Model
NTM	National Transport Model
SWDP	South Worcestershire Development Plan
TEMPro	Trip End Model Presentation Program
TRICS	Trip Rate Information Computer System
WCC	Worcestershire County Council

1. Introduction

The Malvern Development Model (MDM) is a spreadsheet-based facility enabling the assessment of traffic impact arising from a number of development sites within Malvern. The MDM is one of a series of models developed by Jacobs on behalf of Worcestershire County Council (WCC). These models have been produced to assist WCC in assessing the traffic impact and mitigation process resulting from proposed future residential, employment and other development sites throughout Worcestershire. A more detailed overview of the development, assumptions, methodology and capabilities of the MDM is given in the Capability Statement produced in August 2018, which can be found attached in full in Appendix A.

The MDM shows the uplift in total traffic flow through a number of key road links and junctions in Malvern as a result of new vehicle trips generated by proposed development sites. The analysis of the traffic impact informs subsequent recommendations as to which junctions require further junction specific assessments using appropriate junction modelling software.

Within Malvern a total of 14 residential and employment sites have been identified for inclusion within the emerging South Worcestershire Development Plan (SWDP). This report presents and discusses the traffic impact assessment of ten of these developments, filtered in agreement with WCC based upon an appropriate quantum threshold. These assessments will consider the traffic impact of the proposed developments both in isolation and in terms of their cumulative impact.

For the purposes of these assessments, in the absence of certainty as to build-out or phasing information it has been agreed with WCC that the individual site assessments will be undertaken using a 2019 do-minimum year. The cumulative assessment will be considered representative of a 2041 assessment year which is the end of the emerging SWDP period. The cumulative assessment will also include the committed Newlands development within the do-minimum.

The report continues by providing a brief explanation of the developments, trip generation and application of the MDM (Section 2). The report then details the modelled scenarios (Section 3) and subsequently presents their results (Sections 4 to Section 14). Finally, a summary of the results is provided alongside recommendations as to which, if any, junctions require further, junction specific assessments using appropriate junction modelling software (Section 15).

2. The Malvern Development Model

The MDM uses a variety of data sources to model new development traffic through the Malvern road network. The MDM allows for traffic impact assessments in the AM (08:00-09:00) and PM (17:00-18:00) peak hours. These peak hours have been defined through an analysis of historical traffic count data, the most recent being collected in 2018.

2.1 MDM Junctions

Within the MDM, a number of junctions have been identified that are either likely to incur a high proportion of new development traffic or are strategically significant within the Malvern road network. These junctions are typically in close proximity to a development site or are a major network junction within or surrounding the town.

In 2019, the MDM was updated to include the new 2018 traffic count data and future development aspirations in the area relating to the updated SWDP. These revised development allocations in turn helped to determine whether any additional junctions were required in the existing MDM.

The current version of the MDM contains a total of 75 junctions, the details of which are provided in Table 2-1 and shown within Figure 2-1 overleaf.

2.2 MDM Junction Traffic Data

Junction turning counts were undertaken by TRACSIS in November 2018 for 15 key junctions for which it was anticipated that the emerging SWDP would have an effect on, or were strategically important within the Malvern road network.

Due to the number junctions in the MDM and evolving nature of developing allocations, not all MDM junctions have baseline traffic data collected in 2018. For 19 additional junctions, previously utilised counts from 2011 were used as an approximation of actual traffic, noting that if any of these junctions require more detailed assessment, then the base traffic data will require updating.

The available traffic survey data for the MDM junctions is summarised in Table 2-1.

Figure 2-1 MDM Junctions

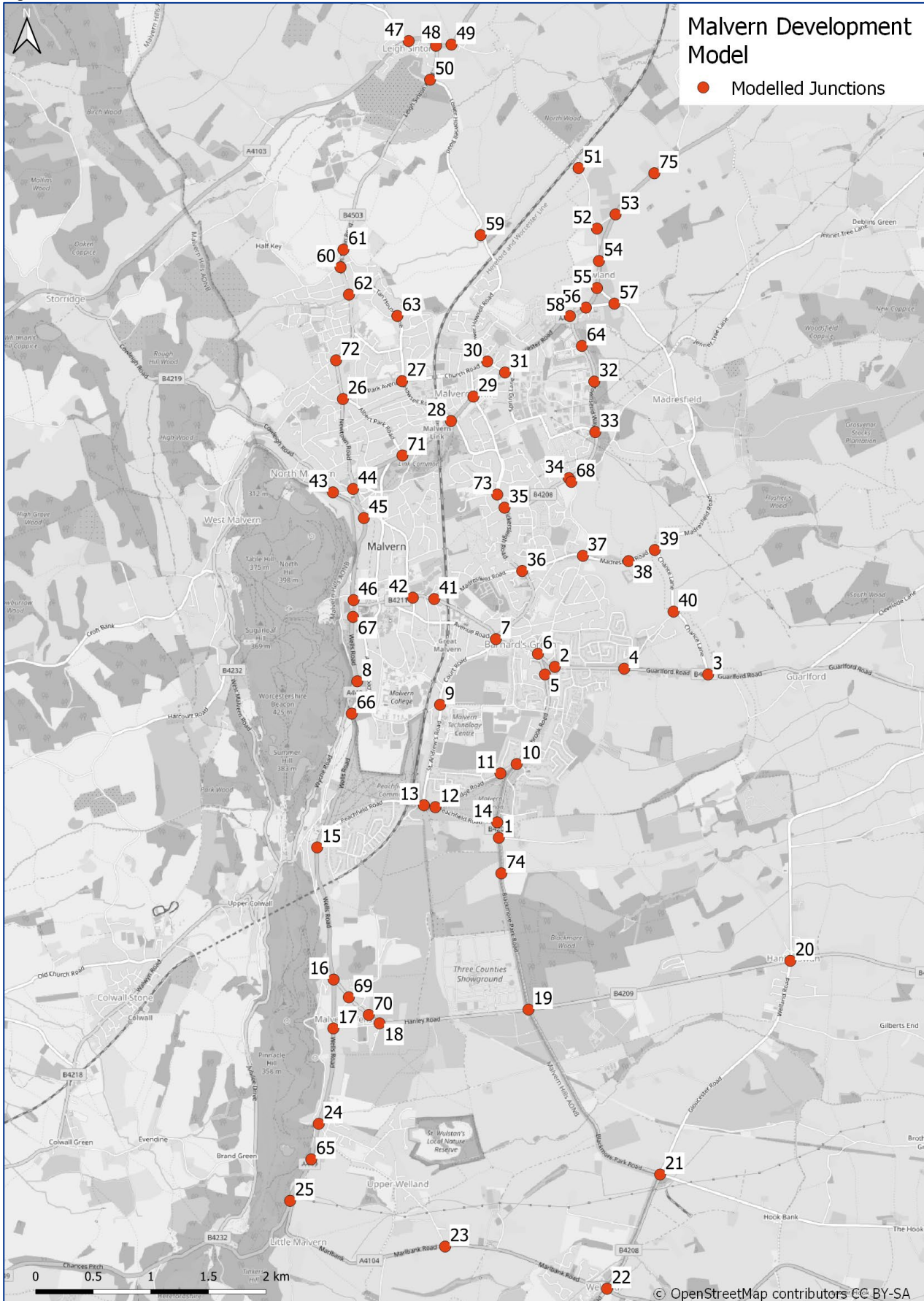


Table 2-1 MDM Junctions

Junction	Arms	Traffic Counts Available
1	B4208 North/Blackmore Park/B4208 South	-
2	B4211 West/B4211 East/Bye Road	2011
3	Chance Lane/B4211 East/B4211 West	-
4	Hall Green/B4211 East/B4211 West	-
5	B4208 North/Bye Road/B4208 South	2011
6	Pound Common/B4211 East/B4208 South/B4208 West	2011
7	B4211 West/B4208 North/Upper Chase Road/B4208 East/Ct Road/Ave Road	2018
8	A449 North/A449 South/Wyche Road	-
9	Ct Road/Minor Road/St Andrew's Road/Thirlstane Road	2018
10	B4208 North/B4208 South/Longridge Road	2018
11	Britten Drive/Longridge Rd North/Longridge Rd South	-
12	Longridge Road/Peachfield Rd East/Peachfield Rd West	-
13	St Andrew's Road/Peachfield Rd East/Peachfield Rd West	-
14	B4208 North/B4208 South/Peachfield Road	-
15	A449 North/Peachfield Road/A449 South	-
16	A449 North/B4209/A449 South	-
17	A449 North/Grundy's Lane/Green Lane/A449 South	-
18	B4209 North/B4209 East/Rothwell Road/Green Lane	-
19	B4208 North/B4209 East/B4208 South/B4209 West	2018
20	Worcester Road/B4209 East/Welland Road/B4209 West	-
21	Welland Road/Minor Road/B4208 South/B4208 West	-
22	B4208 North/A4104 East/B4208 South/A4104 West	-
23	Upper Welland Road/A4104 East/A4104 West	-
24	A449 North/Upper Welland Road/A449 South	-
25	A449 North/A4104/A449 South	-
26	B4503 North/Somers Park Ave/Albert Park Rd/B4503 South/Belmont Road	-
27	Upper Howsell Rd/Church Road/Howsell Road/Somers Park Ave	2011
28	Howsell Road/A449 North/Pickersleigh Road/A449 South	2011
29	Richmond Road/A449 North/Pickersleigh Ave/A449 South	2011
30	Lower Howsell Rd North/Lower Howsell Rd South/Church Road	2011
31	Lower Howsell Road/A449 North/A449 South	2018
32*	B4208 North/Devt Access/B4208 South/Grove Wood Road	2018
33*	B4208 North/Devt Access/B4208 South/Mansfield Road/Sandys Road	2018
34	B4208 North/N End Lane/B4208 South	2018
35	Pickersleigh Road/B4208 East/B4208 South/Hayslan Road	2018
36	B4208 North/Madresfield Road East/B4208 South/Madresfield Road West	2018
37	Mayfield Road/Madresfield Road East/Pound Bank Road/Madresfield Road West	2011
38*	Devt Access North/Madresfield Road East/Devt Access South/Madresfield Road West	-
39	Madresfield Road East/Chance Lane/Madresfield Road West	-
40*	Chance Lane North/Chance Lane South/Hall Green/Devt Access	-

Junction	Arms	Traffic Counts Available
41	Madresfield Road/B4211 East/B4211 West	-
42	Albert Road North/B4211 East/Albert Road South/B4211 West	2018
43	B4219/B4503/B4232 South/B4232 North	-
44	B4503 North/A449 North/A449 South/B4503 South/Hornycold Road	2018
45	A449 North/Bank Street/A449 South /B4232	-
46	A449 North/Edith Walk/B4211/A449 South	-
47	Sherridge Road/A4103 East/A4103 West	-
48	A4103 West/A4103 East/B4503	2018
49	A4103 North/Stocks Lane/A4103 West	-
50	B4503 North/Lower Howsell Road/B4503 South	2011
51*	Stocks Lane North/Devt Access East/Stocks Lane South/Devt Access West	-
52	Stocks Lane/A449 North/A449 South	-
53	A449 North/A449 South/Stocks Lane	2011
54	Stocks Lane/A449 North/A449 South	-
55	A449 North/Madresfield Road/A449 South	2011
56	A449 North/Madresfield Road/A449 South	2011
57	A449 North/Madresfield Road/A449 South	-
58*	Devt Access/A449 North/B4208/A449 South	2011
59*	Lower Howsell Rd North/Devt Access East/Lower Howsell Rd South/Devt Access West	-
60	B4503 North/B4503 South/Halfkey Road	2011
61*	B4503 North/Grit Lane/B4503 South/Access Road	2011
62*	B4503 North/Tanhouse Lane/B4503 South	2011
63	Tanhouse Lane North/Eastward Road/Tanhouse Lane South/Michael Crescent	2011
64*	B4208 North/Devt Access/B4208 South/Roman Way	2018
65	Holywell Road/A449 North/Kings Road/A449 South	-
66	A449 North/Abbey Road/A449 South/Foley Terrace	-
67	A449 North/B4211/A449 South	-
68*	B4208/North End Lane/Mayfield Road/Devt Access	2011
69	Wood Farm Road/Hanley Road South/Hanley Road North	2011
70	Development Access/Hanley Road South/Hanley Road North	2011
71	Albert Park Rd/Worcester Road East/Worcester Road West	-
72	Leigh Sinton Road North/Leigh Sinton Road South/Sayers Avenue	-
73	Pickersleigh Road North/Pickersleigh Road South/Pickersleigh Grove	-
74	Blackmore Park Road North/Access Road/Blackmore Park Road South	-
75*	A449 North/Access Road South/A449 South/Access Road North	-

* Some or all of the junction arms do not exist in the real world at this time. These arms have been added into the MDM to represent a development access for an SWDP site

2.3 MDM Developments

The purpose of the MDM is to assess the impact of new development traffic on the local network, subsequently advising which junctions should be subject to further, more detailed assessment using appropriate specialised junction modelling software such as ARCADY, PICADY, LINSIG or a micro-simulation model.

It is important to note that the MDM is for indicative purposes only and should only be used as a filtering tool to identify specific junctions requiring further investigation and more detailed analysis.

The updated MDM includes ten employment and residential sites, as detailed in Table 2-2 and shown within Figure 2-2. These developments are considered to constitute the vast majority of growth within Malvern to 2041 as part of the SWDP aspirations. Table 2-2 presents the development aspirations as well as the intended land use, hectare and number of dwellings where applicable. This table is based on information provided by WCC in spreadsheet *Malvern HA_latest 130519.xlsx* received on 14th June 2019.

Of the development aspirations for Malvern listed in Table 2-2, it was decided that Site 6, 10, 11 and 12 will not be assessed. Due to their small development quantum of less than 100 dwellings and/or less than 1.0 ha of employment land, the number of generated trips for these developments will be relatively low. Combined with the high-level nature of the spreadsheet model and with a view to completing a proportionate assessment, sites below this threshold have not been assessed at this time.

Table 2-2 Malvern SWDP Aspirations

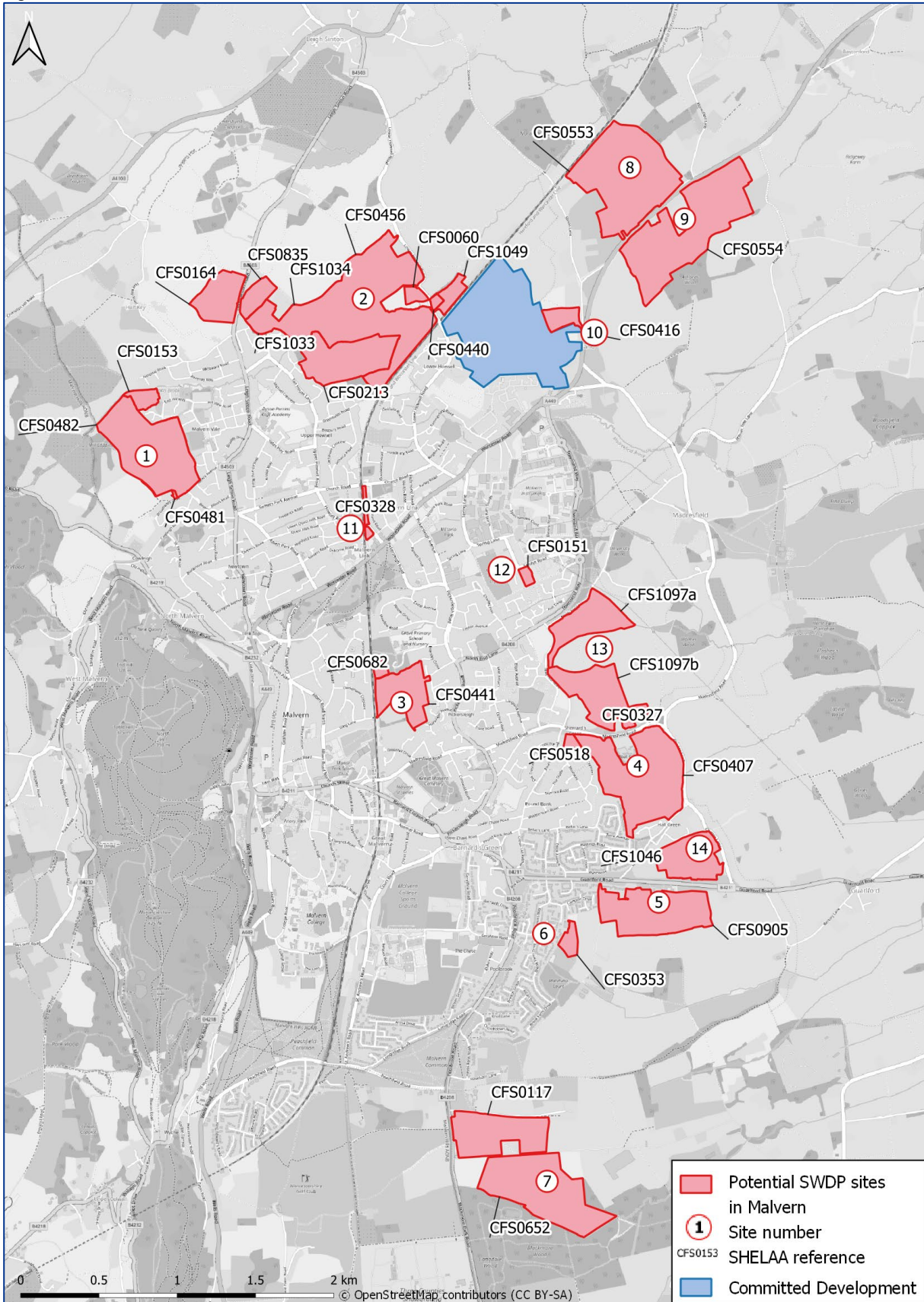
Site	CFS Reference	Site Name	Land use	Hectares	Dwellings	Assessed
1	CFS0153, 0481, 0482	North Site extension (Cales Farm)	Residential	24.99	495	✓
2	CFS0060, 0164, 0213, 0440, 0456, 0835, 1033, 1034, 1049	Upper Howsell	Residential	72	1200	✓
3	CFS0441, 0682	Hayslan Fields	Residential	9.46	187	✓
4	CFS0327, 0407, 0518	Sherrards Green	Residential	28.25	559	✓
5	CFS0905	Guarford Road	Residential	17.61	349	✓
6	CFS0353	Poolbrook	Residential	1.77	35	✗
7	CFS0117, 0652	Blackmore Park	Mixed	38.15	0	✓
8	CFS0553	A449 Pins Green (north of)	Residential	30.7	600	✓
9	CFS0554	A449 Pins Green (south of)	Residential	30.95	600	✓
10	CFS0416	Newland Cricket Ground and Public House	Residential	2.68	50	✗
11	CFS0328	Howsell Road, nr. Malvern Link Rail Station	Mixed	0.8	80	✗
12	CFS0151	Spring Lane Employment (Advantage Chemicals)	Employment	0.78	n/a	✗
13	CFS1097a, CFS1097b	North End/Mayfield Road Employment	Employment	20	n/a	✓
14	CFS1046	Rose Farm, Hall Green, Guarford Road	Residential	9.85	195	✓

In addition to the development aspirations, the MDM includes one committed development: Land at North East of Malvern Off Worcester Road (A449) Malvern (Newlands). The development to the North East of Malvern was granted planning permission in January 2019 (15/01625/OUT) for 800 dwellings and 40,000 sqm employment Gross Floor Area (GFA).

Table 2-3 Committed Developments in the MDM

Site	CFS Reference	Site Name	Land use	GFA (sqm)	Dwellings
	15/01625/OUT	Land at North East of Malvern Off Worcester Road (A449) Malvern (Newlands)	Mixed	40,000	800

Figure 2-2 SWDP Sites in Malvern



Of the above developments considered in the MDM, all but Site 2 (three accesses), Site 4 (three accesses) and Site 7 (two accesses) have been identified as having one point of access to the MDM network. The assumed traffic splits for the three sites with multiple accesses are shown in the table below:

Table 2-4 Development traffic splits

Site	Access	Access Name	Traffic Proportion	Equivalent Quantum
Site 2	a	West of Leigh Sinton Rd, via junction arm 61D	16.67%	200 dwellings
	b	East of Leigh Sinton Rd, via junction arm 61C/Grit Lane	41.67%	500 dwellings
	c	East of Lower Howsell Rd, via junction arm 59D	41.67%	500 dwellings
Site 4	a	North of Madresfield Rd, via junction arm 38A	10.55%	59 dwellings
	b	South of Madresfield Rd, via junction arm 38C	44.72%	250 dwellings
	c	Chance Lane via junction arm 40D	44.72%	250 dwellings
Site 7	a	Access Rd via junction arm 1B	50.00%	19.08 ha
	b	Access Rd via junction arm 74B	50.00%	19.08 ha

The MDM allows the assessment of any development either in isolation or collectively along with other future sites. This facility has been used as part of this traffic impact assessment of the ten sites.

The MDM does not take into account the potential for internalisation of trips or the potential for trips to travel directly between future development sites.

2.4 Development Trip Rates

Trip rates for each development have been sourced from the industry standard trip rates database, the Trip Rate Information Computer System (TRICS). Trip rates were calculated for residential (Houses privately owned) and employment (Office, Industrial Unit and Warehousing) developments sites for both arrival and departures in the morning and evening peak. For employment developments, an average trip rate composing of the three subcategories has been calculated. Trip rates obtained from TRICS (v.7.5.4) are presented within Table 2-5:

Table 2-5 TRICS trip rates

Trip rates per dwelling (residential), per 100m2 GFA (employment)	Arrivals		Departures		Two-Way Rates	
	AM	PM	AM	PM	AM	PM
Combined B1/B2/B8 Employment	0.603	0.097	0.123	0.506	0.726	0.603
B1 Employment	1.305	0.181	0.251	1.086	1.556	1.267
B2 Employment	0.442	0.075	0.076	0.352	0.518	0.427
B8 Employment	0.061	0.034	0.043	0.080	0.104	0.114
Residential – new	0.146	0.377	0.404	0.194	0.55	0.571

Employment land has been converted into GFA using a factor derived from the relationship between employment land and GFA on existing sites. Based on a sample of 46 developments for which land take and GFA have been identified, the average GFA factor is 0.46 (i.e. for every 1 hectare of land, 4,600 sqm of GFA is developed).

Trip rates have then been multiplied with the number of dwellings (for residential developments) or the number of gross floor area (GFA) in 100 square metres (for employment sites). The final trips produced and attracted per hour by each development used in the model are given in Table 2-6.

Table 2-6 Development trips per hour

Site	Development quantum		Arrivals		Departures	
	Dwellings	Employment GFA (100sqm)	AM	PM	AM	PM
North Site extension (Cales Farm)	495.00		72	187	200	96
Upper Howsell	500.00		73	189	202	97
Upper Howsell	500.00		73	189	202	97
Upper Howsell	200.00		29	75	81	39
Hayslan Fields	187.00		27	70	76	36
Sherrards Green	59.00		9	22	24	11
Sherrards Green	250.00		37	94	101	49
Sherrards Green	250.00		37	94	101	49
Poolbrook	349.00		51	132	141	68
Poolbrook	35.00		5	13	14	7
Blackmore Park		879.16	530	85	108	445
Blackmore Park		879.16	530	85	108	445
A449 Pins Green (north of)	600.00		88	226	242	116
A449 Pins Green (south of)	600.00		88	226	242	116
Newland Cricket Ground and Public House	50.00		7	19	20	10
Howsell Road, nr. Malvern Link Rail Station	80.00	36.87	34	34	37	34
Spring Lane Employment (Advantage Chemicals)		35.95	22	3	4	18
North End/Mayfield Road Employment		921.79	556	89	114	466
Rose Farm, Hall Green, Guarford Road	195.00		28	74	79	38
Total	4350	2753	2296	1906	2096	2237

2.5 Base and Do-Minimum Traffic Data

Count data to determine representative do-minimum traffic flows has been collected as described previously in Section 2.2. Ideally, traffic counts would be available at all junctions, but this is not always possible. In instances where no traffic counts are available, only development trip movements in the assessment years are presented and analysed.

Base traffic flows have been factored using TEMPro NTM (version 7.2, NTM AF15) local growth rates to provide representative do-minimum traffic flows for the assessment years where required. More information as to the application of TEMPro factors or other MDM development trips is provided within section 3.1.

2.6 Distribution and Assignment

Journey to Work Census data (Location of usual residence and place of work, WF01BEW Census 2011) has provided the likely origin and destination points for any residential or employment trips within and around Malvern. This has been used to inform the distribution and assignment of new development trips through the MDM network.

Development traffic is then assigned to the MDM network with the resulting traffic flows and turning movements captured. The trip assignment is an all-or-nothing methodology via the quickest route as defined by the Ordnance Survey OpenRoads GIS layer. This process was then sense checked against online routing software to ensure strategic routes such as the M5 and A38 were taken for longer distance journeys, as would be expected.

The assignment of development traffic creates the do-something scenarios. By comparing traffic flows in the do-minimum and do-something, both the number of new development trips and the percentage uplift in total traffic at each MDM study junction can be calculated.

It is important to consider both the uplift in total traffic and actual number of development trips through each study junction as low do-minimum traffic flows can accentuate percentage uplifts in total traffic. Conversely, the impact

of substantial development traffic can be obscured and understated in areas of high do-minimum traffic flows. The analysis provided within the assessments highlights where these factors may be having an influence on the proportional uplift figures.

3. Assessment Scenarios

A total of eleven assessment scenarios has been developed. These scenarios assess the traffic impact of the individual sites (Scenario 1A to Scenario 1J) and the cumulative traffic impact of all sites (Scenario 2). The scenarios and developments included are listed in Table 3-1.

Table 3-1 Overview of model scenarios

Scenario	Developments included	Assessment Year
Scenario 1A	North Site extension (Cales Farm)	2019
Scenario 1B	Upper Howsell	
Scenario 1C	Hayslan Fields	
Scenario 1D	Sherrards Green	
Scenario 1E	Guarford Road	
Scenario 1F	Blackmore Park	
Scenario 1G	A449 Pins Green (north of)	
Scenario 1H	A449 Pins Green (south of)	
Scenario 1I	North End/Mayfield Road Employment	
Scenario 1J	Rose Farm, Hall Green, Guarford Road	
Scenario 2 – Cumulative Impact	All the above – cumulative impacts (including Newlands development within do-minimum)	2041

For scenario 1A – 1J, development traffic impact is assessed in a 2019 Assessment Year. This assessment year was agreed with WCC in the absence of any detailed build-out or development phasing information of the SWDP sites at the time of writing.

The result of these scenarios will demonstrate the distribution of the development trips and will provide an initial indication of the MDM junctions that would be used by development traffic in 2019 if that development were fully occupied.

For scenario 2, the cumulative traffic impact of all developments is assessed in a 2041 Assessment Year as this is the final plan year of the SWDP when all development are assumed to be complete and fully occupied.

The results tables discussed in subsequent sections have been colour coded to help illustrate the degree of impact for both the raw increase in trips and the associated uplift in traffic. The colour thresholds are as follows:

Development Trips	Less than 20	20 to 50	50 to 100	100 to 1,000	More than 1,000
Percentage Uplift	Less than 5%	5% to 10%	10% to 50%	50% to 100%	More than 100%

Caution should be used when considering the percentage uplifts in total traffic because, as noted earlier, low do-minimum traffic flows can accentuate percentage uplifts in total traffic. Conversely, the impact of substantial development traffic can be obscured and understated in areas of high do-minimum traffic flows, particularly on key strategic routes.

Where do-minimum traffic flows are not available, no proportional uplifts in total traffic are calculated. If any junction is deemed to warrant further assessment and real do-minimum flows are unavailable, then it will be necessary to collect traffic data prior to assessment.

3.1 Do-Minimum Traffic Growth Utilising TEMPro

For scenario 1, background traffic growth to 2019 is accounted for by TEMPro factors.

In scenario two, all MDM development trips associated with SWDP development aspirations to 2041 are assigned to the highway network. It is therefore considered appropriate to not apply TEMPro factors within Scenario Two as the traffic growth normally accounted for by the TEMPro factors is accounted for by the SWDP developments.

Do-minimum flows in Scenario Two will therefore revert to the existing year (2019) as this will be representative of traffic levels prior to any Malvern SWDP traffic being generated and impacting upon the network.

In addition, the committed Newlands development will also be activated within the MDM and included within the scenario 2 do-minimum flows as this is assumed to have been constructed and fully occupied by 2041.

3.2 Other Aspects for Consideration

The MDM only considers development within the town of Malvern. Other Worcestershire developments, which may have an impact on the M5, A38 or other key regional links in the MDM are not assessed. This is because the MDM is designed to allow an indicative analysis of the effects of a specific development within Malvern rather than the wider Worcester area.

The aim of this report is to recommend those junctions that require a more comprehensive analysis and not to analyse the detailed operating conditions unique to each junction. The recommendations of this report will inform which junctions should undergo a more detailed level of junction modelling and assessment. The results will assist WCC, in conjunction with evidence from other studies and local knowledge of capacity issues, in assessing development impacts on local junctions.

4. Scenario 1A - North Site Extension (Cales Farm)

4.1 Scenario 1A Headline Results and Analysis

4.1.1 Overview

Table 4-1 below presents the 2019 do-minimum traffic flows and the traffic generated by North Site extension (Cales Farm) through MDM junctions. The distribution of development trips through MDM junctions is presented within Figure 4-1.

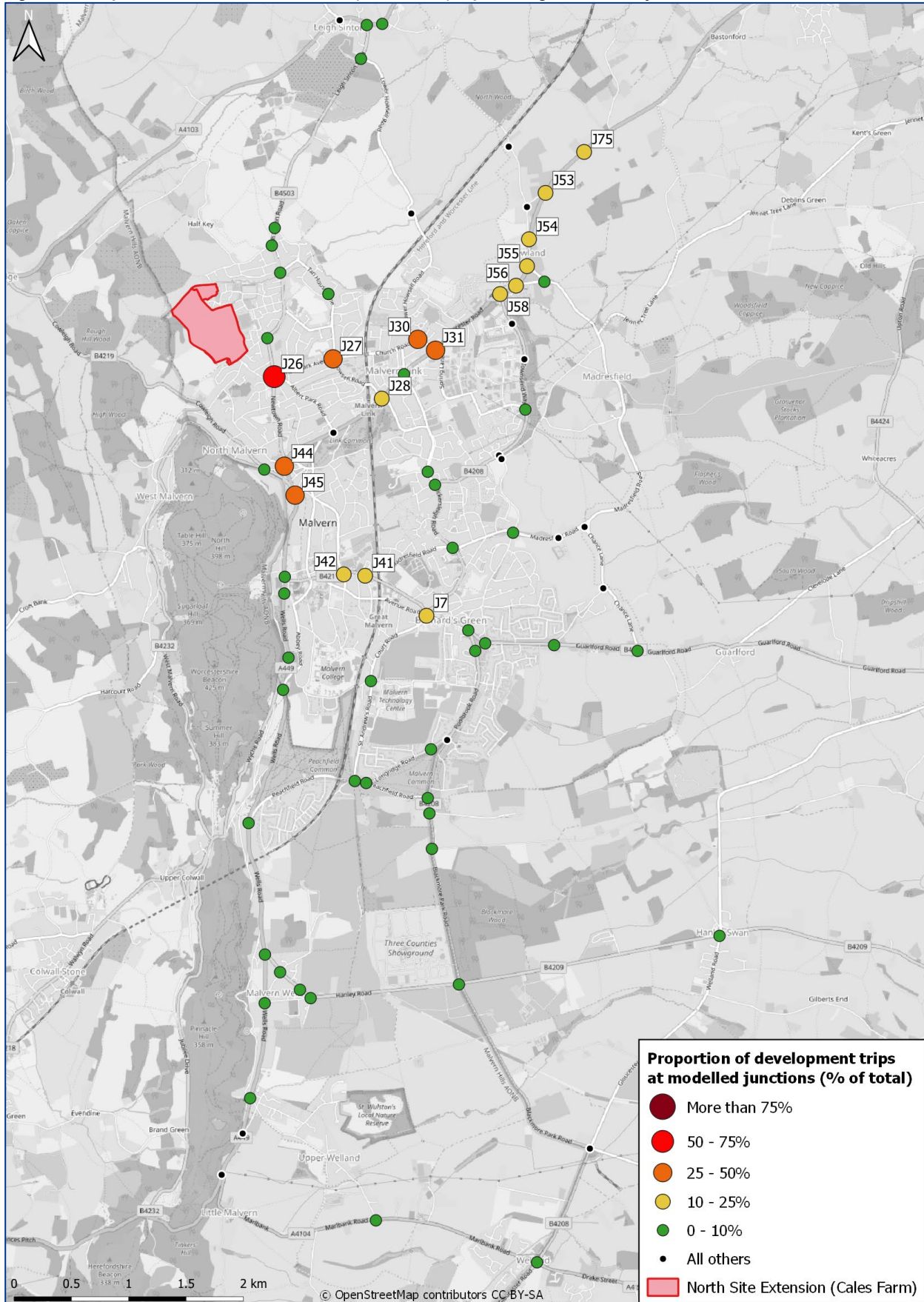
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix C and Appendix C.

Table 4-1 Most affected junctions by the North Site Extension (Cales Farm) development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
26	-	-	207	208	-	-	75%
27	898	808	86	79	10%	10%	30%
44	1,793	1,590	78	79	4%	5%	28%
30	747	755	80	71	11%	9%	27%
31	2,217	2,252	76	64	3%	3%	25%
45	-	-	68	71	-	-	25%
58	4,008	4,678	75	62	2%	1%	25%
56	2,549	2,558	75	62	3%	2%	25%
54	-	-	73	55	-	-	23%
55	2,454	2,443	73	55	3%	2%	23%
53	2,525	2,508	73	55	3%	2%	23%
75	-	-	73	55	-	-	23%
42	985	827	35	34	4%	4%	13%
28	1,814	2,250	31	30	2%	1%	11%
7	1,674	1,638	30	31	2%	2%	11%
41	-	-	30	31	-	-	11%

The MDM indicates a diverse severity range of junction impacts across the Malvern highway network as a result of the development. Across the whole network, the development generates a traffic uplift of 1.9% (1.7%) through MDM junctions in the AM (PM). Overall the development generates 259 trips in the AM and 296 in the PM peak hours. Development traffic accesses the network via Sayers Ave to the south of the development. As consequence, J26 on Leigh Sinton Road acts as key distributing junction for traffic to and from the site with 75% of development trips passing through it.

Figure 4-1 Proportion of North Site extension (Cales Farm) trips through each MDM junction



4.1.2 Distribution and Assignment

Two key routes can be identified for development trips. From J26, The majority of traffic travels either southwards or eastwards as a result of trip-ends in Malvern or Worcester.

- 28% of development trips travel south through Newtown Road (J26, J44, J45), A449 Worcester Road, B4211 Church Street and up to J7 (Barnard's Green Road), where 10% of the total traffic follows the B4211 Guarlford Road towards Gloucester and the M5.
- 30% of development trips travel through Somers Park Ave, Church Road and onto the A449 Worcester Road, passing through Junctions 26, 27, 30, 31, 58, 56, 55, 54 and 53. 23% of development trips continue on the A449 towards Worcester and Birmingham.

Only 8% of development trips follow Leigh Sinton Road up north through J72. The remaining traffic either reaches the B4219 for westbound movements or nearby zones in the vicinity of the development.

4.1.3 Junction Impacts

Junction 26 is a five arm unsignalized junction effectively consisting of two staggered priority junctions. It receives around 200 additional trips in the AM and PM peaks as it is used by 75% of all development trips. All development trip movements impact upon the Belmont Road arm as this forms part of the quickest route between this junction and the development. This could potentially cause conflicts with north-south traffic flow on the main arm, which is Leigh Sinton Road. The staggered crossroads layout might further complicated and exacerbate conflicts, which could lead to local congestion around the junction and affect its operational performance.

Junction 27 a four-arm mini-roundabout. The junction will incur 30% of the trips generated by the development which equates to an uplift in total traffic of 10%. All development traffic will access/exit from Somers Park Ave and Church Road. This causes significant uplifts of 106% and 81% in the AM and PM on those arms. Together with the fact that the junction is in immediate proximity of a primary school with its own traffic patterns, such a stark increase on individual arms might potentially cause queuing on the affected arms.

Junction 30 is an unsignalized T-junction further east at the intersection of Church Road and Lower Howsell Road. It receives 27% of all development traffic, which would produce an uplift of 11% (9%) in the AM (PM). In the AM, development traffic would enter the junction from the minor Church Road arm and virtually all would turn right onto Lower Howsell Road. All these movements would have to give way to existing traffic flows between the two Lower Howsell Road arms. While the uplift is not particularly large in either relative or absolute figures, the minor to major right-hand turning movement in the AM peak could potentially affect the operational performance of the junction.

Junction 31 is a signalised T-junction at the intersection of A449 Worcester Road and Lower Hoswell Road southeast of J30. 25% of all vehicles to/from the development use this junction to turn left onto A449 Worcester Road. Due to comparatively high do-minimum traffic flows, this represents only a small increase in total traffic. However, this uplift might require the operation of the junction signals to be reviewed.

Junction 44 consists of two junctions, the signalised T-junction of A449 Worcester Road with Newton Road, and the unsignalized three-arm junction of Newton Road, Trinity Road and Hornyold Road in immediate proximity to the west of the signalised junction. 28% of total development traffic will use this junction, with all utilising the Newton Road arm. The majority of trips pass between the Newton Road and A49 Worcester Road South arms. Due to comparatively high do-minimum traffic flows, there is only a small proportional uplift in total traffic. However, this uplift might require the operation of the junction signals to be reviewed.

5. Scenario 1B - Upper Howsell

5.1 Scenario 1B Headline Results and Analysis

5.1.1 Overview

Table 5-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the Upper Howsell development through MDM junctions. The distribution of development trips through MDM junctions is presented within Figure 5-1.

Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix C and Appendix C.

Table 5-1 Most affected junctions by the Upper Howsell development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
61	1,205	1,252	366	419	30%	33%	58%
60	537	457	358	407	67%	89%	57%
62	-	-	340	377	-	-	53%
30	747	755	276	301	37%	40%	43%
59	-	-	262	299	-	-	42%
27	898	808	205	245	23%	30%	33%
58	4,008	4,678	184	159	5%	3%	25%
56	2,549	2,558	184	159	7%	6%	25%
54	-	-	171	132	-	-	23%
55	2,454	2,443	171	132	7%	5%	23%
53	2,525	2,508	171	132	7%	5%	23%
75	-	-	171	132	-	-	23%
44	1,793	1,590	147	141	8%	9%	21%
72	-	-	140	146	-	-	21%
26	-	-	136	143	-	-	21%
45	-	-	129	127	-	-	19%
28	1,814	2,250	117	138	6%	6%	19%
31	2,217	2,252	134	115	6%	5%	18%
29	2,116	2,180	94	121	4%	6%	16%
73	-	-	66	106	-	-	13%
35	1,567	1,482	60	98	4%	7%	12%

Across the whole network, the Upper Howsell development generates uplifts of 6.3% and 6.4% through MDM junctions in the AM and PM peaks. The site has three access points, two of which load onto J61 and Leigh Sinton Road, and the other loading onto J59 on Lower Howsell Road. From the 628 (718) trips generated in the AM (PM), 366 (419) access the network via Leigh Sinton Road, while 262 (299) load onto Lower Howsell Road.

Proportion of development trips at modelled junctions (% of total)

- More than 75%
- 50 - 75%
- 25 - 50%
- 10 - 25%
- 0 - 10%
- All others
- Upper Howsell

5.1.2 Distribution and Assignment

Due to its development quantum, Site 2 generates considerable uplifts in traffic on the key routes used for access/egress. The most affected junctions are Junctions 60, 61 and 62, which are all located on Leigh Sinton Road in immediate proximity of the site and are the first junctions for any route to and from the two western access points. These three junctions each carry more than 50% of the development traffic which corresponds to an additional 300 to 400 vehicles in the AM and PM peaks. For junction 60, this represents a 67% (AM) and 89% (PM) uplift in total traffic.

J59 (the eastern access point for the development) and J30 south of it on Lower Howsell Road incur 43% of development trips, which mostly routes south onto A449 Worcester Road. These additional 260 to 300 vehicles translate into a traffic uplift of 40%.

The development traffic accessing through the western access points shows a similar distribution pattern as the nearby North Site extension (Cales Farm). The two key routes for development traffic are southbound via Leigh Sinton Road, Newton Road and onto the A449 Worcester Road (J72, J26, J44 and J45) from which they travel either eastbound via Church Road and A449 Worcester Road (J27, J30, J31) or, to a lesser degree, southbound via Howsell Road and Pickersleigh Road (J28, J73, J35).

5.1.3 Junction Impacts

Junction 61 is currently a three-arm junction. For the purposes of this assessment, it has been assumed that the Grit Lane arm will be stopped up and replaced with a new crossroads junction serving two accesses to the Upper Howsell development. As a result, the junction receives a combined 57% of total traffic generated by the development, generating uplifts of 30% and 33% in the AM and PM peaks. Virtually all development trips route southbound onto Leigh Sinton Road. At this junction does not currently exist in the form which it has been modelled within the MDM, it is not practical to determine the impact of development trips at this junction using turning movements alone. Further assessment of the junction layout and design will be required as more details of the Lower Howsell development become available.

Junction 60 is a T-junction between Leigh Sinton Road as major arms and Half Key Road joining from the west as minor arm. A significant traffic uplift occurs on the junction, with 57% of development trips routing through it. However, the vast majority of these development trips pass directly between the major Leigh Sinton Road arms. Similarly, at Junction 62 to the south, all traffic generated by the development remains on Leigh Sinton Road. Therefore, whilst no major impacts on the performance of these junctions are expected, given the size of the Lower Howsell development and the proximity of J60 and J62 to the two western accesses, this view should be revisited as more details of the Lower Howsell development become available.

Junction 27 a four-arm mini-roundabout. The junction will receive a third of all development traffic, resulting in an overall uplift of 23% (30%) uplift in the AM (PM). Three quarters of development traffic will route through Upper Howsell Road into Church Road in the AM and a quarter into Howsell Road, a traffic uplift of 117% and 55%. In the PM, equal proportions will route from Church Road and Howsell Road into Upper Howsell Road, causing an uplift of 123% and 54% respectively. As all traffic has to give way to the traffic in the roundabout, queuing on these arms might increase, particularly on Upper Howsell Road and Howsell Road.

To the east of the development, Junction 59 does not currently exist but was modelled to represent the access junction on Lower Howsell Road just north of Whippets Brook. The junction serves as one of three access points to the Upper Howsell development which will be used for 43% of all trips generated. The main movement will be a right turn from the development access onto Lower Howsell Road in the AM and the opposite movement in the PM. Further assessment of the junction layout and design will be required as more details of the Lower Howsell development become available.

Junction 30 is an unsignalized T-junction further south at the intersection of Church Road and Lower Howsell Road. It is expected to receive 43% of total traffic which would result in an overall uplift of 37% (40%) in the AM (PM). Due to the banned right turn movement at J31 further south, traffic travelling to destinations in Malvern turn right onto Church Road, while traffic travelling to destinations east of Malvern remain on Lower Howsell Road.

Given the uplift in total traffic and range of turning movements at this junction, operational performance might be affected and impacts from the development should be assessed further.

6. Scenario 1C - Hayslan Fields

6.1 Scenario 1C Headline Results and Analysis

6.1.1 Overview

Table 6-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the Hayslan Fields development through the MDM study junctions. The distribution of development trips through MDM junctions is presented within Figure 6-1.

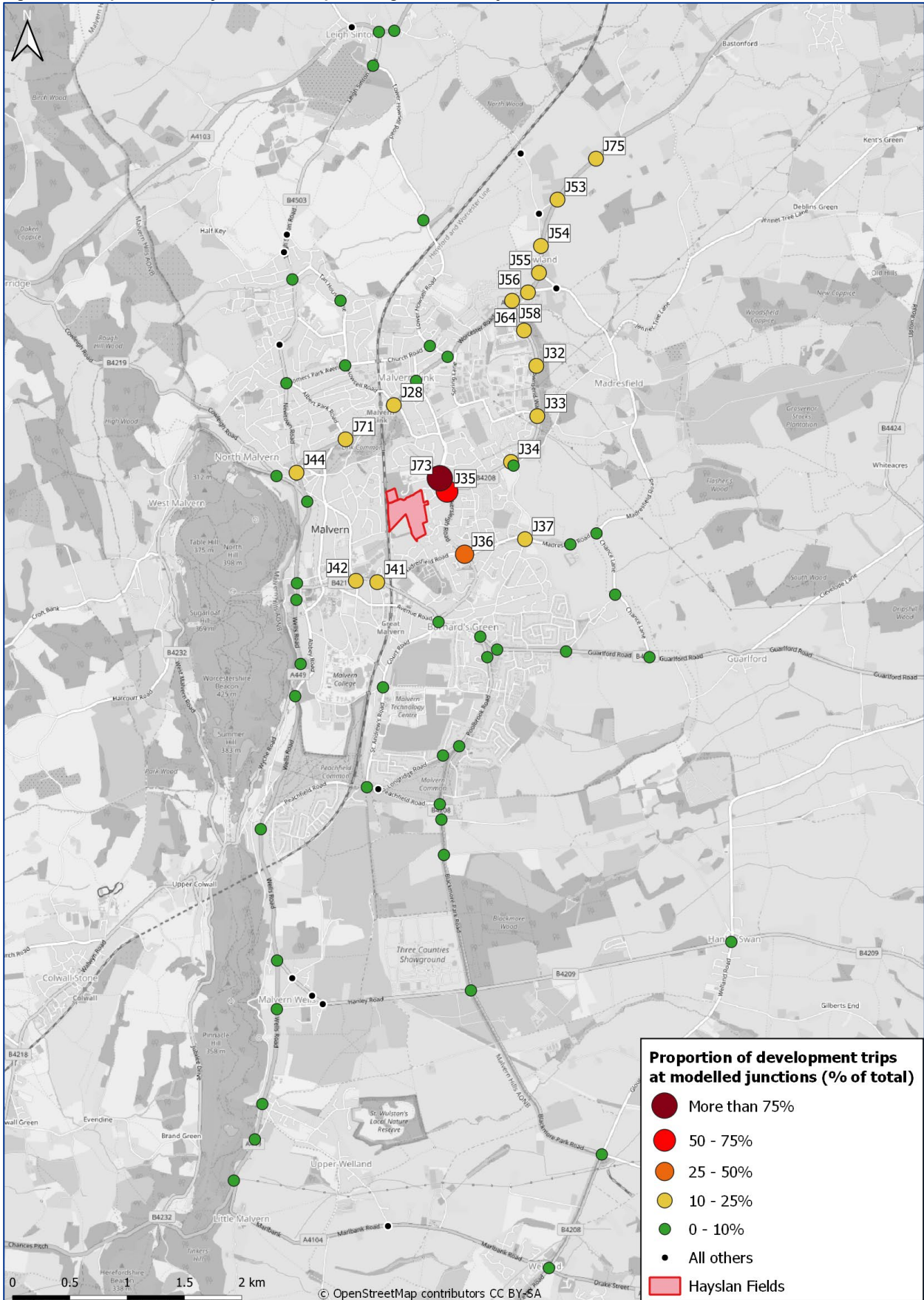
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix C and Appendix C.

Table 6-1 Most affected junctions by the Hayslan Fields development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
73	-	-	96	111	-	-	99%
35	1,567	1,482	65	69	4%	5%	64%
36	1,460	1,551	36	38	2%	2%	36%
28	1,814	2,250	18	31	1%	1%	23%
34	1,338	1,424	25	20	2%	1%	21%
33	1,555	1,660	24	17	2%	1%	20%
58	4,008	4,678	23	16	1%	0%	19%
56	2,549	2,558	23	16	1%	1%	19%
54	-	-	23	16	-	-	19%
55	2,454	2,443	23	16	1%	1%	19%
53	2,525	2,508	23	16	1%	1%	19%
75	-	-	23	16	-	-	19%
64	2,044	2,588	23	16	1%	1%	19%
32	1,613	1,712	23	16	1%	1%	19%
71	-	-	12	19	-	-	15%
44	1,793	1,590	9	16	1%	1%	12%
41	-	-	11	12	-	-	11%
37	966	960	11	11	1%	1%	11%
42	985	827	11	11	1%	1%	11%

Across the whole network, Site 3 generates an average traffic uplift of 0.9% and 0.8% through MDM junctions in the AM and PM peaks. The site's only access point loads onto Pickersleigh Road via junction 73, hence the vast majority of traffic routes through this junction, amounting to 96 vehicles in the AM and 110 in the PM.

Figure 6-1 Proportion of Hayslan Fields trips through each MDM junction



6.1.2 Distribution and Assignment

64% of development traffic routes through Junction 35 just south of J73 on Pickersleigh Road. From here, 20% of total traffic travels east onto North End Lane and Townsend Way for north-east movements towards Worcester (Junctions 34, 33, 32, 64, 58, 56, 55, 54, 53), while 36% continue south to J36, where trips split towards Junctions J41, 42 and J37.

The traffic turning left at J73 and going north joins the A449 Worcester Road at Junction 28 (23% of total) and continuing through Junctions 71 and 44.

6.1.3 Junction Impacts

Junction 73 is an unsignalised T-junction connecting Pickersleigh Road with Pickersleigh Grove. Virtually all development traffic uses J73. Most development trips right turn from Pickersleigh Grove onto Pickersleigh Road in the AM and the opposite in the PM. The relative uplift in total traffic cannot be determined as the do-minimum traffic level is unknown, however given the proximity of J73 to the development, it would be expected that further assessment of J73 will be required as more details on the Hayslan Fields development become available.

Junction 35 is the signalised four-arm junction south of Junction 73 on Pickersleigh Road with North End Lane and Hayslan Road. 64% of development traffic routes through this junction and it is a key distributing junction for Haylan Road development trips. There is also a range of traffic movements at this junction in the do-minimum, and therefore a high likelihood that the operational performance of the junction will be affected by development trips. It would be expected that further assessment of J73 will be required as more details on the Hayslan Fields development become available.

7. Scenario 1D - Sherrards Green

7.1 Scenario 1D Headline Results and Analysis

7.1.1 Overview

Table 7-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the Sherrards Green development through MDM junctions. The distribution of development trips through MDM junctions is presented within Figure 7-1.

Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 7-1 Most affected junctions by the Sherrards Green development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
38	-	-	196	227	-	-	68%
40	-	-	154	179	-	-	53%
39	-	-	145	169	-	-	50%
37	966	960	123	138	13%	14%	42%
54	-	-	78	79	-	-	25%
55	2,454	2,443	78	79	3%	3%	25%
57	-	-	78	79	-	-	25%
53	2,525	2,508	74	77	3%	3%	24%
75	-	-	74	77	-	-	24%
36	1,460	1,551	53	92	4%	6%	23%
3	-	-	42	54	-	-	15%
41	-	-	42	53	-	-	15%
42	985	827	41	53	4%	6%	15%
4	-	-	38	40	-	-	12%
35	1,567	1,482	30	48	2%	3%	12%
2	915	815	38	40	4%	5%	12%
73	-	-	27	43	-	-	11%

Across the whole network, the Sherrards Green development generates an average uplift in total traffic of 1.5% and 1.6% through MDM junctions in the AM and PM. The Sherrards Green development has three accesses, two of which load onto Junction 38 on Madresfield Road and one routing through Junction 4 onto Chance Lane.

Proportion of development trips at modelled junctions (% of total)

- More than 75%
- 50 - 75%
- 25 - 50%
- 10 - 25%
- 0 - 10%
- All others
- Sherrards Green

© OpenStreetMap contributors CC-BY-SA

7.1.2 Distribution and Assignment

Development traffic uses four key routes to and from the site.

- Eastbound on Guarlford Road via Junction 4 and 3 (12% of total) for trip ends east of Malvern
- Westbound through Junction 37, 36 41 and 42 on Madresfield Road and Church St (15% of total) for trip-ends within Malvern town centre,
- Northbound via Madresfield Road with a right turn on Junction 36, following Pickersleigh Road through Junctions 35 and 73 (11% of total) for trip-ends in northern Malvern,
- North-eastbound via Madresfield Road and Junctions 39, 57, 55 and 54 (25% of total), for trip ends north of Malvern.

Subsequently the junctions observing the largest proportions of total traffic are Junctions 38, 39 and 40 with 68%, 53% and 50% respectively, which translates into 144 to 227 vehicles per peak hour. Some junctions incur development trips from two or more of the sites' loading points.

7.1.3 Junction Impacts

Junction 38 is a junction created within the MDM to serve as an access junction for the Sherrards Green development. It will incur 68% of all trips generated by the development which equates to around 200 extra vehicles in the peak hours. At this junction does not currently exist in the form which it has been modelled within the MDM, it is not practical to determine the impact of development trips at this junction using turning movements alone. Further assessment of the junction layout and design will be required as more details of the Sherrards Green development become available.

Junction 40 is a currently three-arm junction of Chance Lane with Hall Green to the east of the development. The MDM has added a forth arm to serve as one of the three access points to the Sherrards Green development. Due to the direct access and traffic from the northern access points routing through Chance Lane, the junction will incur 53% of all development traffic. The largest flows are expected to be from the development access onto Chance Lane North in the AM and the opposite movement in the PM, which involves a turn from/to the minor arm onto/from the major arm. As with J38, further assessment of the junction layout and design will be required as more details of the Sherrards Green development become available.

Junction 39 is a T-junction located between the two accesses connecting Chance Lane and Madresfield Road. It receives 50% of total development trips and incurs trips from all three access points. These development trips fall across all turning movements at the junction. Given the proximity of J39 to the development and range of turning movements at this junction, its operational performance might be affected and the impacts from the development should be assessed further.

Junction 37 is a mini-roundabout with four arms connecting Mayfield Road, Madresfield Road and Pound bank Road. Located to the west of the development, it will incur 42% of all development traffic, resulting in an uplift of 13% (14%) in the AM (PM). These development trips fall across all turning movements at the junction except for southbound Mayfield Road movements as this is a prohibited movement. Given the proximity of J39 to the development and range of turning movements at this junction, its operational performance might be affected and the impacts from the development should be assessed further.

8. Scenario 1E - Guarlford Road

8.1 Scenario 1E Headline Results and Analysis

8.1.1 Overview

Table 8-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the Guarlford Road development through the MDM study junctions. The distribution of development trips through MDM junctions is presented within Figure 8-1.

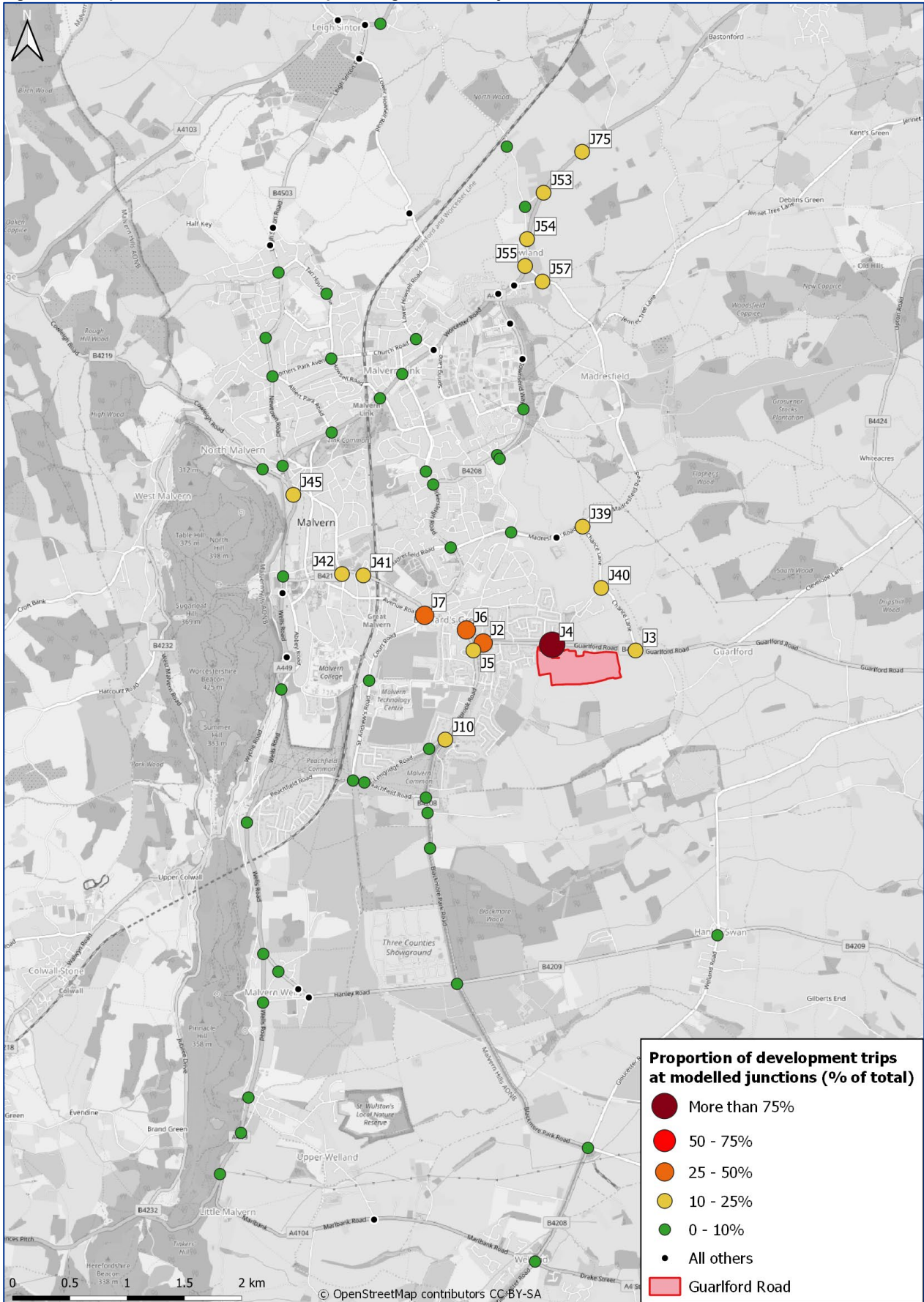
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 8-1 Most affected junctions by the Guarlford Road development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
4	-	-	155	180	-	-	86%
2	915	815	80	107	9%	13%	48%
6	1,121	1,414	64	82	6%	6%	37%
7	1,674	1,638	50	75	3%	5%	32%
40	-	-	51	40	-	-	23%
39	-	-	51	40	-	-	23%
54	-	-	48	36	-	-	22%
55	2,454	2,443	48	36	2%	1%	22%
57	-	-	48	36	-	-	22%
53	2,525	2,508	45	33	2%	1%	20%
75	-	-	45	33	-	-	20%
3	-	-	27	29	-	-	14%
41	-	-	19	36	-	-	14%
42	985	827	19	36	2%	4%	14%
5	395	224	16	25	4%	11%	11%
10	929	855	16	25	2%	3%	11%
45	-	-	14	26	-	-	10%

Across the whole network, the Guarlford Road development generates an average uplift in traffic of 1.1% and 1.3% through MDM junctions in the AM and PM peaks. The development generates a total of 183 trips in the AM and 209 trips in the PM, all of which access the road network via Guarlford Road between J3 and J4.

Figure 8-1 Proportion of Guarford Road trips through each MDM junction



8.1.2 Distribution and Assignment

Development traffic uses three predominant routes to and from the development:

- Westbound movements into Malvern on Guarlford Road and Barnard's Green Road (Junctions 4, 2, 6 and 7, which corresponds to 37% of traffic,
- Eastbound movements on Guarlford Road (Junction 3, 14% of development trips),
- Northbound movements through Hall Green, Chance Lane and Madresfield Road onto A449 Worcester Road (Junctions 4, 40, 39, 57, 55, 54), accounting for 22% of total traffic.

As most traffic uses the westbound or northbound route, Junction 4 (followed by Junction 6 and 2) experience the largest absolute increases in trips with an additional 155 (178) vehicles in the AM (PM).

8.1.3 Junction Impacts

Junction 4 is an unsignalized three arm junction serving Guarlford Road and Hall Green. Development traffic from the Guarlford Road site access the road network just to the east of Junction 4 and 86% of all development trips route through junction 4. There are two main movements for development traffic in the AM, one staying on the B4211 Guarlford Road and the other turning right onto Hall Green. The latter is a right turn from the major onto the minor arm and could therefore affect the operational performance of the junction as turning vehicles might cause queueing on the main arm. Further assessment of the junction layout and design will be required as more details of the development become available.

Junctions 2 and 6 are three arm priority junctions to the west of J4. Both junctions incur 37% of development trips. All movements travel between the two major arms and therefore no actual turning movements are forecast. In the absence of turning movements no significant impacts on the junction's performance are to be expected.

Junction 7 is a six-arm gyratory on Barnard's Green Road which receives 32% of all development traffic which mostly continues onto Court Road and Avenue Road in the AM and in the opposite direction in the PM, leading to a 12% or less uplift on these arms. J7 is a complex junction in the Malvern Road network and is a key distribution junction for development trips. Further assessment of the junction is recommended and given the layout of this junction, a micro-simulation model might be required to accurately model traffic flows and vehicle interaction.

9. Scenario 1F - Blackmore Park

9.1 Scenario 1F Headline Results and Analysis

9.1.1 Overview

Table 9-1 below presents the 2019 do-minimum traffic flows and the traffic generated by Blackmore Park through the MDM study junctions. The distribution of development trips through MDM junctions is presented within Figure 9-1.

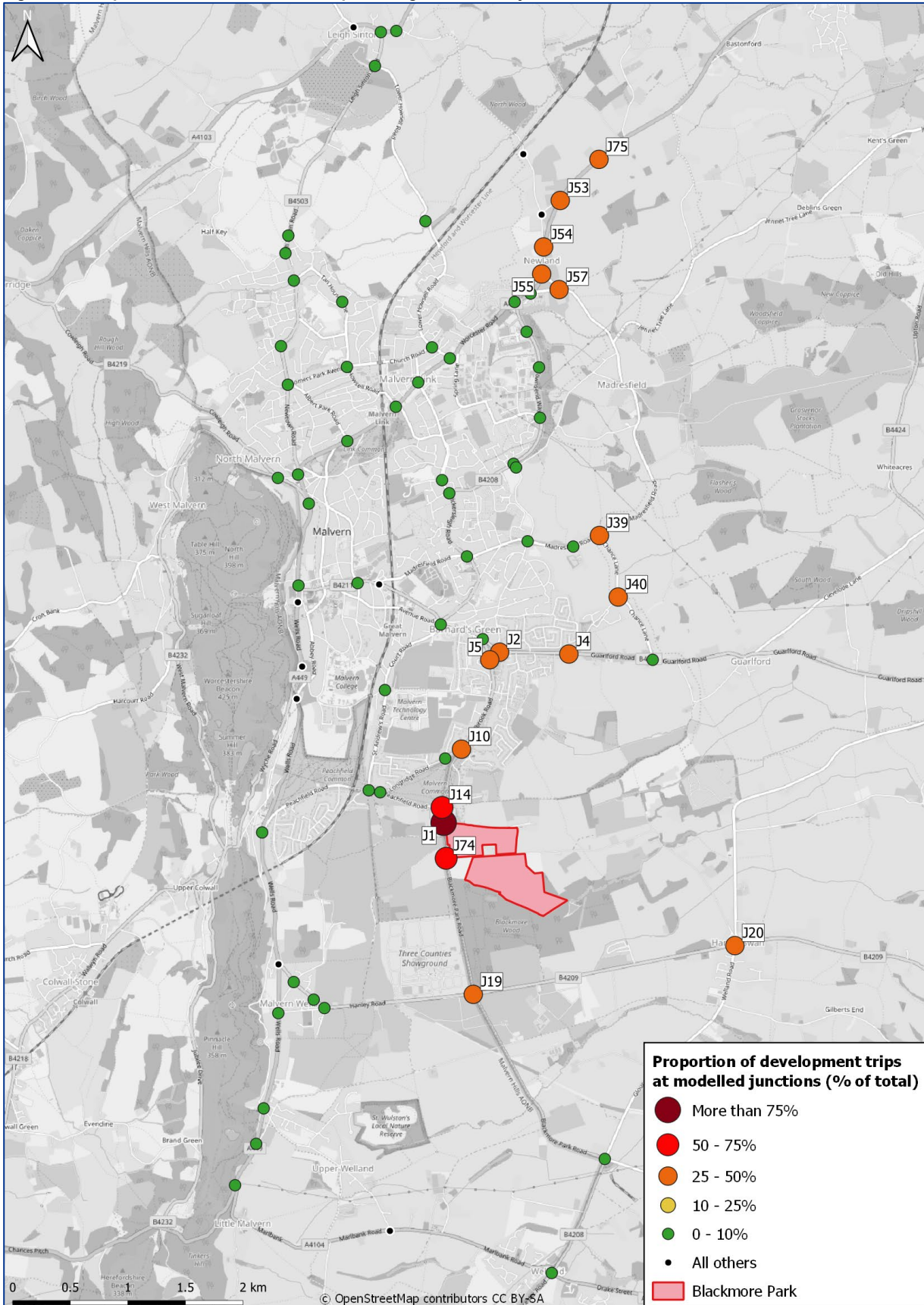
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 9-1 Most affected junctions by the Blackmore Park development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
1	-	-	954	865	-	-	78%
74	-	-	891	795	-	-	72%
14	-	-	678	623	-	-	56%
10	929	855	578	530	62%	62%	47%
5	395	224	566	520	143%	233%	46%
19	1,057	951	552	483	52%	51%	44%
2	915	815	510	490	56%	60%	43%
54	-	-	510	459	-	-	41%
55	2,454	2,443	510	459	21%	19%	41%
53	2,525	2,508	510	459	20%	18%	41%
75	-	-	510	459	-	-	41%
4	-	-	504	458	-	-	41%
39	-	-	498	455	-	-	41%
40	-	-	497	454	-	-	41%
57	-	-	497	454	-	-	41%
20	-	-	465	410	-	-	37%

Across the whole network, the Blackmore Park development generates an average traffic uplifts of 8.3% and 7.4% through MDM junctions in the AM and PM peaks. Blackmore Park is the origin or destination for a total of 1230 trips in the AM and 1107 trips in the PM, which are split evenly between its two accesses, Junction 74 and Junction 1.

Figure 9-1 Proportion of Blackmore Park trips through each MDM junction



9.1.2 Distribution and Assignment

Development traffic uses two predominant routes through the network:

- a northern route through Malvern via Poolbrook Road, Guarlford Road, Chance Lane, Madresfield Road and the A449 Worcester Road (Junctions 14, 10, 5, 2, 4, 40, 39, 57, 55, 54 and 53) which accounts for 41% of development trips
- a south-eastern route via B4209 Hanley Road and B4211 Powick Road (Junctions 19 and 20) towards the M5, which accounts for 37% of development trips.

9.1.3 Junction Impacts

Junction 1 is an unsignalised T-junction on the B4208 Blackmore Park Road south of Malvern. Serving as one of the two access points for the Blackmore Park employment site, it receives a 78% share of all development traffic and more than 950 vehicles in the AM and about 850 vehicles in the PM. In the AM, key development traffic movements on this junction are, in equal proportions, southbound on the B4208, southbound but turning left into the Blackmore Park site and northbound from the south turning right into the site. Hence the distribution of traffic to/from the north is roughly twice as large than to/from the south. Although do-minimum flows are unavailable, a significant traffic uplift can be expected on Junction 1 given the size of the development.

Junction 74 has been created in the MDM to serve as a new access junction to the Blackmore Park development. J74 receives 72% of traffic generated through the development and the traffic patterns are similar as to Junction 1.

With the large additional flows through junctions 1 and 74, significant impacts on the operational performance of these junctions can be expected. It would be expected that further assessments of Junctions 1 and 74 will be required as more details on the Blackmore Park development become available.

Junction 14 is a T-junction located at the intersection of B4208 Blackmore Park Road and B4208 Poolbrook Road with Peachfield Road north of Junction 1. 56% of total development traffic routes through the junction, which incurs between 600 and 700 vehicles in peak hours. Around 85% of traffic remains on the B4208 and does not interact with the minor Peachfield Road arm. The remaining 15% turns into/out of the Peachfield Road. These new major/minor arm movements, on top of existing movements, may affect the performance and operation of the junction given the substantial number of development trips passing between the two major arms. Further assessment of the junction should be undertaken as more detail on the Blackmore Park development becomes available.

Multiple junctions located on the key route from Blackmore Park to the A449 show similar impacts with a significant uplift of either traffic on the main arms (such as Junction 10, 14, 54, 57 and 75) or on turns to/from minor arms (Junctions 5, 2, 4, 40, 39 and 55).

Junction 5 is an unsignalized three-arm junction consisting of B4208 Poolbrook Road and Bye Road. 46% of total development traffic in excess of 500 vehicles route through this junction, which will incur an uplift in total traffic of 142% (AM and 231% (PM), which means traffic is expected to double in the AM and triple in the PM. The key movement of development traffic will be a left turn from Bye Road onto B4208 in the AM and a right turn from the B4208 onto Bye Road in the PM. Such a significant increase is likely to affect the junction performance but in conjunction with such a large proportion of right and left turns from the major arm onto the minor arm and vice versa, this is expected to have a detrimental effect on the operational performance.

Junction 2 is an unsignalized T-junction of B4211 Guarlford Road and Bye Road. Receiving 42% of all traffic generated from Blackmore Park, it incurs a 55% (60%) traffic uplift in the AM (PM) which translates into approximately 500 additional vehicles. On Junction 2, the main movement for development traffic in the AM is a left turn from the eastern arm of the B4211 onto Bye Road and a fifth of that traffic in the opposite direction. The PM sees the opposite movements with slightly lower traffic flow. For the main left turn in the AM and right turn in the PM, the additional development traffic represents a more than a twentyfold increase, which is a very significant change but also due to low current traffic levels for these turns. Such a high increase in traffic levels and the

importance of turns to and from the minor arms are likely to impact the operational performance of Junction 2 which therefore should be subject to a more detailed junction assessment.

Junction 4 is an unsignalized T-junction located on B4211 Guarlford Road at its intersection with Hall Green. It is forecast to receive 41% of development traffic, adding 450 to 500 vehicles in the peak hours. The additional traffic follows the same pattern as the other junctions on this route. In the AM, four fifths of traffic coming from the A449 turns right from Hall Green onto the western arm of the Guarlford Road, with a fifth doing the opposite movement. In both peaks, the main movement for development is a turn from/to the minor arm which is likely to impact the operational performance of the junction. It is therefore recommended that junction 4 is assessed in more detail as more details on the Blackmore Park development become available.

Junction 40 is an unsignalised three-arm junction of Hall Green and Chance Lane in Hall Green. Receiving 41% of total traffic or an additional 450 to 500 vehicles in the peak hour as the previous junctions, the additional traffic is also composed of flows from the A449 to the development and in the opposite direction, in the same (80-20) proportions as for the other junctions on the route. Likewise, the additional traffic turns to and from the minor arm with potential queueing and impacting the operational performance of the junction, equally warranting a further assessment of any impacts.

Junction 39 is an unsignalised three-arm junction of Chance Lane and Madresfield Road to the east of Malvern. The junction receives 41% of all development traffic, an additional 450 to 500 vehicles in the peak hours. As with the other junctions on this key route in the AM, 80% of the additional traffic is coming from the A449 via the eastern arm of Madresfield Road and turns left onto Chance Lane, with the remaining 20% taking the opposite route. In the PM, the dominant movements are reversed. As with previous junctions on this route, the large overall uplift and the significance of turns from/to minor arms indicate the need for further assessment of potential junction impacts.

Junction 55 is an unsignalized three-arm junction of the A449 and Madresfield Road to the northeast of Malvern. The model forecasts that 41% of traffic will route through this junction, implying a 21% uplift with some 450 to 550 extra vehicles. At this junction, the main development traffic movement in the AM is a left turn from the northern arm of the A449 onto Townsend Way with a counterflow a fifth of the main flow, and a right turn from Townsend Way onto the A449 in the PM. For the main development traffic movements, this is a threefold increase in the AM and an eightfold increase in the PM, as these are currently minor movements. The increased right and left turns from the main onto the minor arm and vice-versa are likely to be in conflict with the large flow that remains on the A449 and is thus expected to cause queueing and affect the junction's performance, which should be assessed in more detail as more details on the Blackmore Park development become available.

Junction 19 is an unsignalized crossroads at the Three Counties Showground south of Malvern at the intersection of the B4209 and the B4208. 44% of all development traffic will route through this junction, which generates a 52% uplift in traffic. The main movement of development traffic in the AM is a right turn from the B4209 East onto the B4208 North and the opposite left turn movement in the PM. Due to the large traffic increase and the importance of the major-minor arm turns in both peak hours and directions, a detrimental impact to the junction's operational performance should be expected. Junction 19 should be assessed in more detail as more details on the Blackmore Park development become available.

An additional five junctions (75, 53, 10, 57, 20) incur an uplift 37% or more which corresponds to 400 or more additional vehicles per hour. All these junctions with the exception of Junction 20 on B4209 south-east of Malvern are located on the route from Blackmore Park Road to the A449 Worcester towards Worcester and Birmingham, via Poolbrook Road, Guarlford Road, Hall Green, Chance Lane and Madresfield Road. These junctions will experience significant increases in traffic and hence and the development's impact on the operational performance of these junctions should subsequently be examined further, too.

10. Scenario 1G - A449 Pins Green (north of)

10.1 Scenario 1G Headline Results and Analysis

10.1.1 Overview

Table 10-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the A449 Pins Green (north of) development through the MDM study junctions. The distribution of total trips from the development through all junctions in the model is presented in Figure 10-1 below.

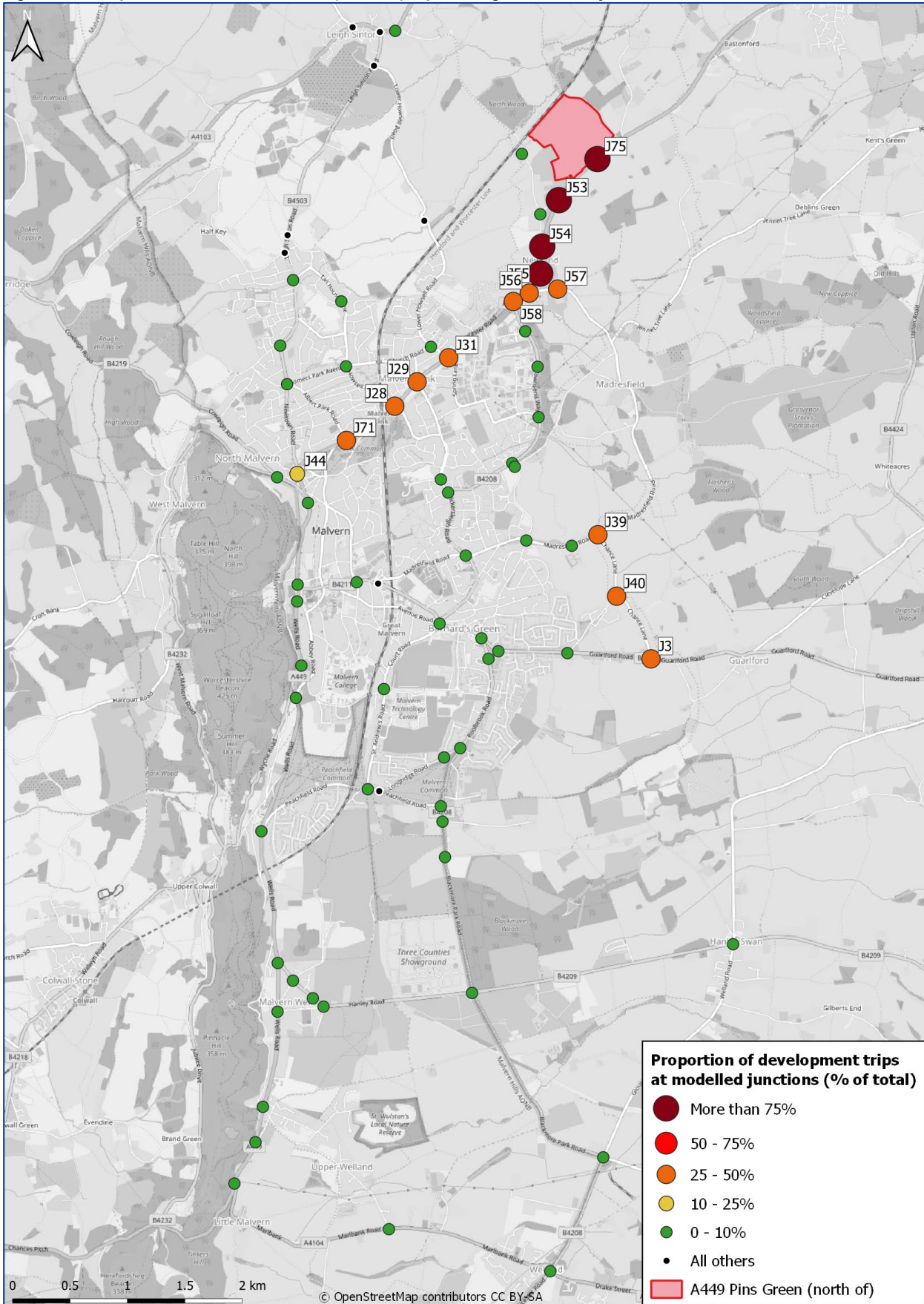
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 10-1 Most affected junctions by the A449 Pins Green (north of) development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
75	-	-	314	359	-	-	100%
53	2,525	2,508	275	317	11%	13%	88%
54	-	-	263	305	-	-	84%
55	2,454	2,443	263	305	11%	12%	84%
56	2,549	2,558	120	186	5%	7%	46%
58	4,008	4,678	120	186	3%	4%	46%
57	-	-	143	119	-	-	39%
39	-	-	142	119	-	-	39%
40	-	-	142	119	-	-	39%
3	-	-	142	119	-	-	39%
31	2,217	2,252	89	148	4%	7%	35%
29	2,116	2,180	83	134	4%	6%	32%
28	1,814	2,250	81	133	4%	6%	32%
71	-	-	71	119	-	-	28%
44	1,793	1,590	57	108	3%	7%	25%

Across the whole network, the development generates a total traffic uplift of 2.7% and 3.7% through MDM junctions in the AM and PM peaks. The development generates a total of 313 (359) trips in the AM (PM), all of which access the network through junction 75.

Figure 10-1 Proportion of A449 Pins Green (north of) trips through each MDM junction



10.1.2 Distribution and Assignment

Development traffic predominantly uses three routes through the network:

- Southbound following the A449 Worcester Rd into Malvern (Junction 75, 53, 54, 56, 58, 31, 29 and 28) up to Junction 71, where traffic splits up, following the A449 or going north or south. This route accounts for 46% of development traffic.
- Southbound to J55 then south via Madresfield Rd and Chance Lane to Guarlford Rd (Junctions 75, 53, 54, 55, 57, 39, 40 and 3). This route accounts for 39% of development traffic.
- Northbound towards Worcester on the A449. This route accounts for 12% of development traffic.

10.1.3 Junction Impacts

As all traffic uses junction 75 to access the network and 88% follow the A449 southbound towards Malvern, junctions 75, 53, 54 and 55 receive the largest amounts of development traffic. This corresponds to a 11% to 13% uplift for junctions 53 and 55. Despite this uplift appearing moderate, this is on top of high levels of do-minimum traffic.

Junction 75 is an unsignalised four-arm junction on the A449 Worcester Road in the north-west of Malvern. It doesn't exist currently and is planned to serve as access point for the two A449 Pins Green developments (north and south of the A449) hence the junction is forecast to incur 100% of the traffic generated by these two developments. The main movement in the AM is a right turn onto the A449 Worcester Road towards Malvern. In the PM, the opposite movement dominates as residents return home. This operation of any access junction to this development will need to be reviewed as more details on the development and the vehicular access arrangements become available.

Junction 53 and Junction 54 are located south of Junction 75 on the A449 Worcester Road towards Malvern. Both are unsignalized T-junctions of the A449 and Stocks Lane and receive 88% and 84% respectively of all development traffic. The increase in traffic is significant but, on both junctions, virtually all development traffic remains on the A449. Therefore, the additional traffic is unlikely to affect the operation of these two junctions.

Junction 55 is the three-arm junction of the A449 Worcester Road and Madresfield Road. It incurs 84% of total traffic which generates an 11-12% uplift in traffic volume. Two thirds of southbound development trips turn left onto Madresfield Road in the AM and the opposite movement in the PM, with the remaining third remaining on the A449. Due to the large increase in traffic on turning movements between Madresfield Road and the northern arm of the A449, the junction's operational performance is likely to be affected by the additional traffic generated by the development and it is recommended to assess the traffic impact in more detail.

Junction 56 is another unsignalized T-junction on the A449 Worcester Road at its intersection with Madresfield Road which receives 84% of all development traffic and incurs a traffic uplift of 11-12%. As with junctions 53 and 54 earlier, all traffic remains on the A449 moving towards Malvern in the AM and back from Malvern in the PM. With limited turning movements of current traffic and no additional turning movements, the additional traffic is unlikely to affect the operation of the junction.

Junction 58 is the four-arm roundabout at the intersection of A449 Worcester Road and Townsend Way in north east Malvern, receiving 46% of all development traffic but only incurring a 3-4% increase in the peak hours. However, this low proportional uplift is suppressed by high do-minimum flows. Further assessment of this junction should be considered as more details on the development become available.

Further along A449 Worcester Road, Junctions 31, 29, 28 and 71 receive 28 to 35% of all development traffic but only incurring a 4-7% uplift in the AM and PM. While turning movements of current traffic are important, development traffic adds virtually no additional turning movements. Only Junction 31 receives a small amount of new turning movements to/from the minor arm. The additional traffic on its own is therefore unlikely to affect the operation of the junction significantly.

Junction 39 is the three-arm junction of Madresfield Road and Chance Ln, which receives 39% of all development traffic. The largest movement in the AM is a right turn from the eastern arm of Madresfield Road onto Chance

Lane and its opposite movement in the PM. With this junction seeing a considerable increase in turning movements to/from minor arms it should be considered for more detailed assessments as more details on the development become available.

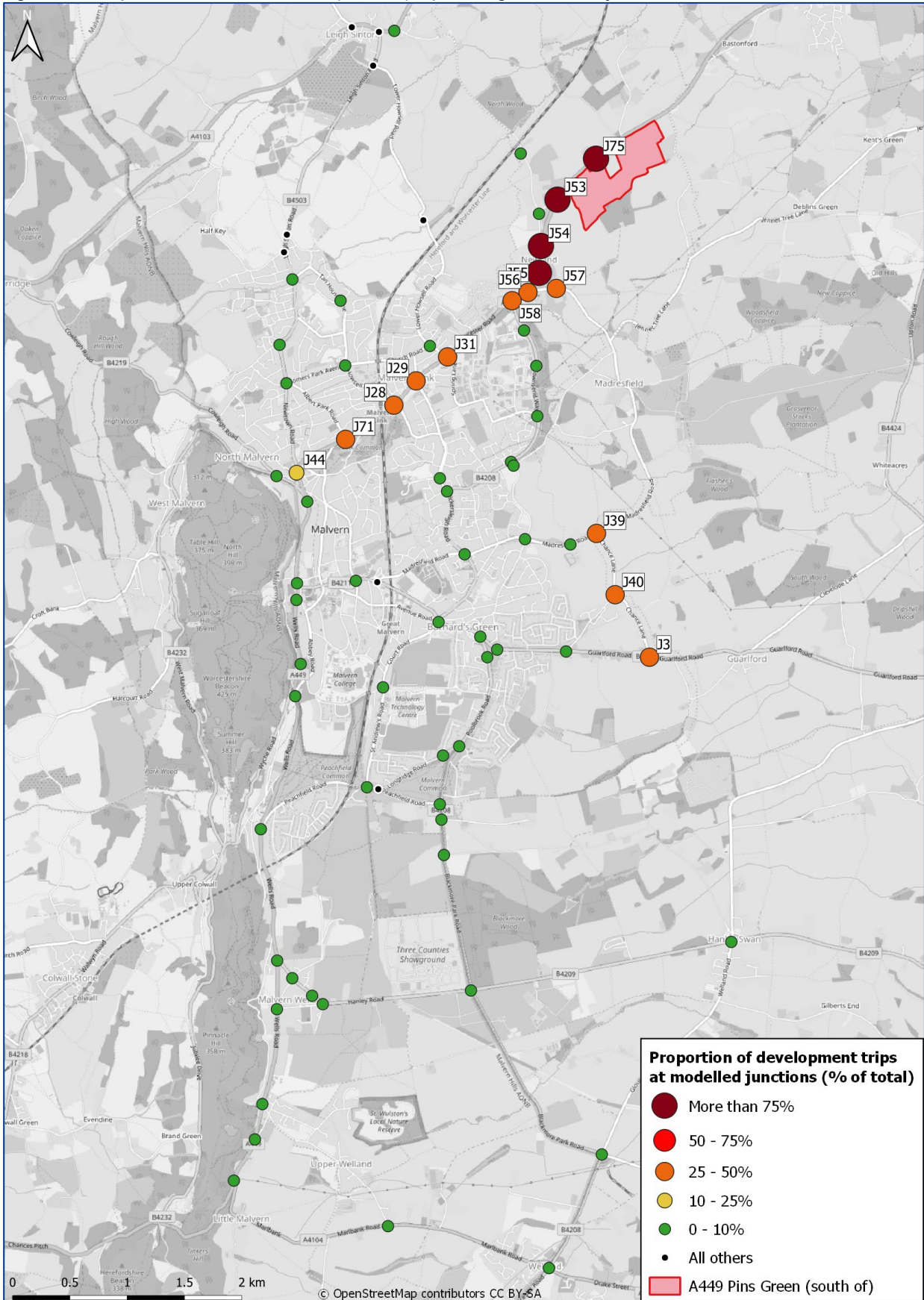
11. Scenario 1H - A449 Pins Green (south of)

11.1 Scenario 1H Headline Results and Analysis

The distribution of total trips from A449 Pins Green (south of) through all junctions in the model is presented in Figure 11-1. Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

The A449 Pins Green (south of) development is the same size and quantum as the A449 Pins Green (north of) development. Therefore, the trip generation, distribution and impact of the development is the same as assessed within the previous section, with the only difference being the orientation of turning movements at Junction 75 which serves as the development access.

Figure 11-1 Proportion of A449 Pins Green (south of) trips through each MDM junction



12. Scenario 1I - North End/Mayfield Road Employment

12.1 Scenario 1I Headline Results and Analysis

12.1.1 Overview

Table 12-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the North End/Mayfield Road Employment site through the MDM study junctions. The distribution of total trips from Site 13 through all junctions in the model is presented in Figure 12-1.

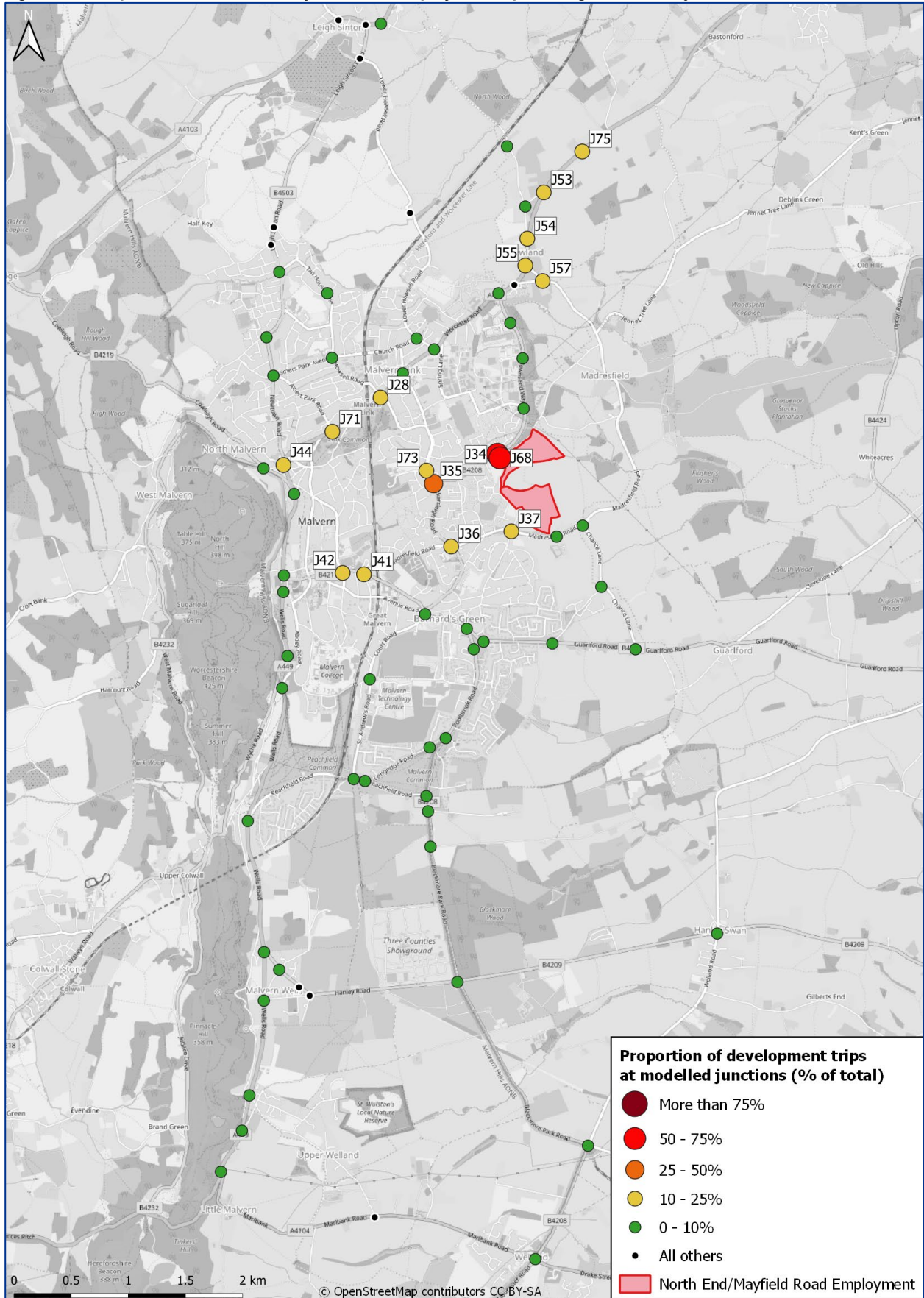
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 12-1 Most affected junctions by the North End/Mayfield Road Employment development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
68	407	306	499	356	123%	116%	70%
34	1,338	1,424	376	331	28%	23%	58%
35	1,567	1,482	321	250	20%	17%	47%
73	-	-	198	100	-	-	24%
54	-	-	115	154	-	-	22%
55	2,454	2,443	115	154	5%	6%	22%
57	-	-	115	154	-	-	22%
28	1,814	2,250	184	81	10%	4%	22%
36	1,460	1,551	116	144	8%	9%	21%
75	-	-	101	144	-	-	20%
53	2,525	2,508	101	144	4%	6%	20%
41	-	-	80	71	-	-	12%
37	966	960	123	26	13%	3%	12%
71	-	-	99	49	-	-	12%
42	985	827	78	66	8%	8%	12%
44	1,793	1,590	94	45	5%	3%	11%

Across the whole network, the North End/Mayfield Road development generates a total traffic uplift of 5.1% and 4.2% through MDM junctions in the AM and PM peaks. The development generates a total of 645 (580) trips in the AM (PM), all of which access the network through North End Lane to the north of the development.

Figure 12-1 Proportion of North End/Mayfield Road Employment trips through each MDM junction



12.1.2 Distribution and Assignment

Three predominant distribution routes for development traffic through the network can be identified.

- For trip-ends north of Malvern traffic turns right onto North End Lane, passes through Madresfield and joins the A449 towards Worcester (Junctions 68, 57, 55, 53 and 53), accounting for 22% of total traffic or 115 (154) trips in the AM (PM).
- All other trips exit/enter the development to/from the west. The majority of which pass through junctions 68 and 34 to access all trip ends in the north, centre and south of Malvern.
- Due to the one-way system on Mayfield Road to the south of J68, there are a number of tidal flow differences between development trip movements through junctions 68 and 34. For arrivals to the development from areas south of Malvern, the main access route is via J37. For departures however, trips to the south of Malvern must travel through Junctions 68, 34, 35 and 36.

12.1.3 Junction Impacts

Junction 68 is an unsignalized T-junction between Mayfield Rd with North End Lane at the north-western edge of the North End/Mayfield Rd development site. Located to the west of the development's access point, it incurs 70% of development traffic, adding around 500 (350) vehicles in the AM (PM), which equates to a doubling of total traffic. The dominant movement in both peak hours is between the two North End Lane arms, which is forecast to experience over a tenfold increase in turning movements. Due to the one-way system on Mayfield Road, development trips only exit Mayfield Road and turn right into North End Lane. This movement will be in conflict with the North End Lane movements. The narrow layout of the junction and large increase in conflicting right and left turning movements to and from the minor arms are likely to affect the operational performance of the junction. This will be further exacerbated by the proximity of a second junction immediately to the north (J34). Junction 68 should be subject to more assessments as information on the development become available.

Junction 34 is an unsignalised T-junction of B4209 Townsend Way/North End Lane and North End Lane located less than 50 metres north of J68. The junction receives 58% of all traffic generated by the development. In the AM, more than three quarters of vehicles come from the north-eastern arm of the B4208 and turn left onto North End Lane, causing a more than sevenfold increase of traffic from relatively low current levels. In the PM, just under two thirds of trips coming from the development turn left onto the south-western arm of the B4208, increasing the volume performing this movement more than eighteenfold. Such significant relative increases in turning movements between minor and major arms are likely to affect the operational performance of the junction. As noted above, there is also the possibility of operational issues at J68 immediately to the south and therefore both J68 and J34 should be considered further as more details of the development become known. This should also consider alternative access strategies to the development addressing both network operation and safety.

Junction 35 is a signalised, staggered four-arm crossroads consisting of B4208 North End Lane, the northern and southern arm of Pickersleigh Road and Haslan Road. The junction receives just under half of all development traffic and serves as a key distributing junction for development trips. The junction incurs an uplift in total traffic of 20% (17%) in the AM (PM). The dominant movement of development traffic in the AM is between the northern arm of Pickersleigh Road onto the B4208 North End Lane towards the development. For the PM, both key movements come from the eastern arm, the B4208 North End Lane, turning left onto the southbound B4208 Pickersleigh Road (slightly more than half of all trips, causing a 41% uplift) or onto the northern Pickersleigh Road arm towards the A449 (24% of all movements, causing a 53% uplift). The relatively large increases in individual turning movements of previously minor movements is likely to affect the junction's operational performance which should be considered further.

Junction 36 consists of two junctions, one being the mini-roundabout of B4208 Pickersleigh Road, Madresfield Road and Prospect Close. The second junction is the T-junction of B4208 Pickersleigh Road with Madresfield Road south of the mini-roundabout. 21% of total development traffic hits the junction, generating an 8% uplift compared to current levels. In the AM the key movement, with two thirds of development traffic, is from the western arm of Madresfield Road turning left onto the northern arm of B4208 Pickersleigh Road, which translates into a 56% increase from current levels. In the PM, two movements coming from the northern arm of the B4208 Pickersleigh Road share more than 40% of all development traffic and then either continue southbound on the B4208 Pickersleigh Road or turn right onto Madresfield Road (an 18% and 41% increase in these movements).

Given the large increase in turns and the changing relative importance of different movements compared to current levels, together with access traffic for the medical centre and surgery, and the presence of a supermarket at the corner of the southern junction, a more detailed assessment would allow to better understand the impacts on the two junctions' operational performance.

Junction 55 is an unsignalised three-arms junction of the A449 Worcester Road and Madresfield Road to the northwest of Malvern. As part of the key route to and from Worcester and Birmingham, the junction receives 22% of all development traffic, but due to the overall higher flows on the A449 this only results in a 5 and 6% increase in the peak hours. The main movement in the AM is a left turn from the eastern arm of the A449 Worcester Road onto Madresfield Road (increasing this movement by 68%). The PM sees a threefold increase in the right turn movement from Madresfield Road onto the eastern arm of the A449 Worcester Road. This movement will be in conflict from the heavy A449 flows. A detailed junction impact assessment is recommended as more details on the development become available.

Junction 28 is the unsignalised, staggered crossroads at the intersection of A449 Worcester Road, Pickersleigh Road and Howsell Road in Malvern Link. It receives 22% of all development traffic and incurs a 10% uplift in the AM but only a 4% one in the PM. All development trips utilise the Pickersleigh Road arm and pass between either the A449 south or Howsell Road arms. These movements will be in conflict with heavy A449 flows and have the potential to block the junction and significantly deteriorate its operational performance.

13. Scenario 1J - Rose Farm/Hall Green/Guarlford Road

13.1 Scenario 1J Headline Results and Analysis

13.1.1 Overview

Table 13-1 below presents the 2019 do-minimum traffic flows and the traffic generated by the Rose Farm/Hall Green/Guarlford Road development through the MDM study junctions. The distribution of total trips from the development through all junctions in the model is presented in Figure 13-1.

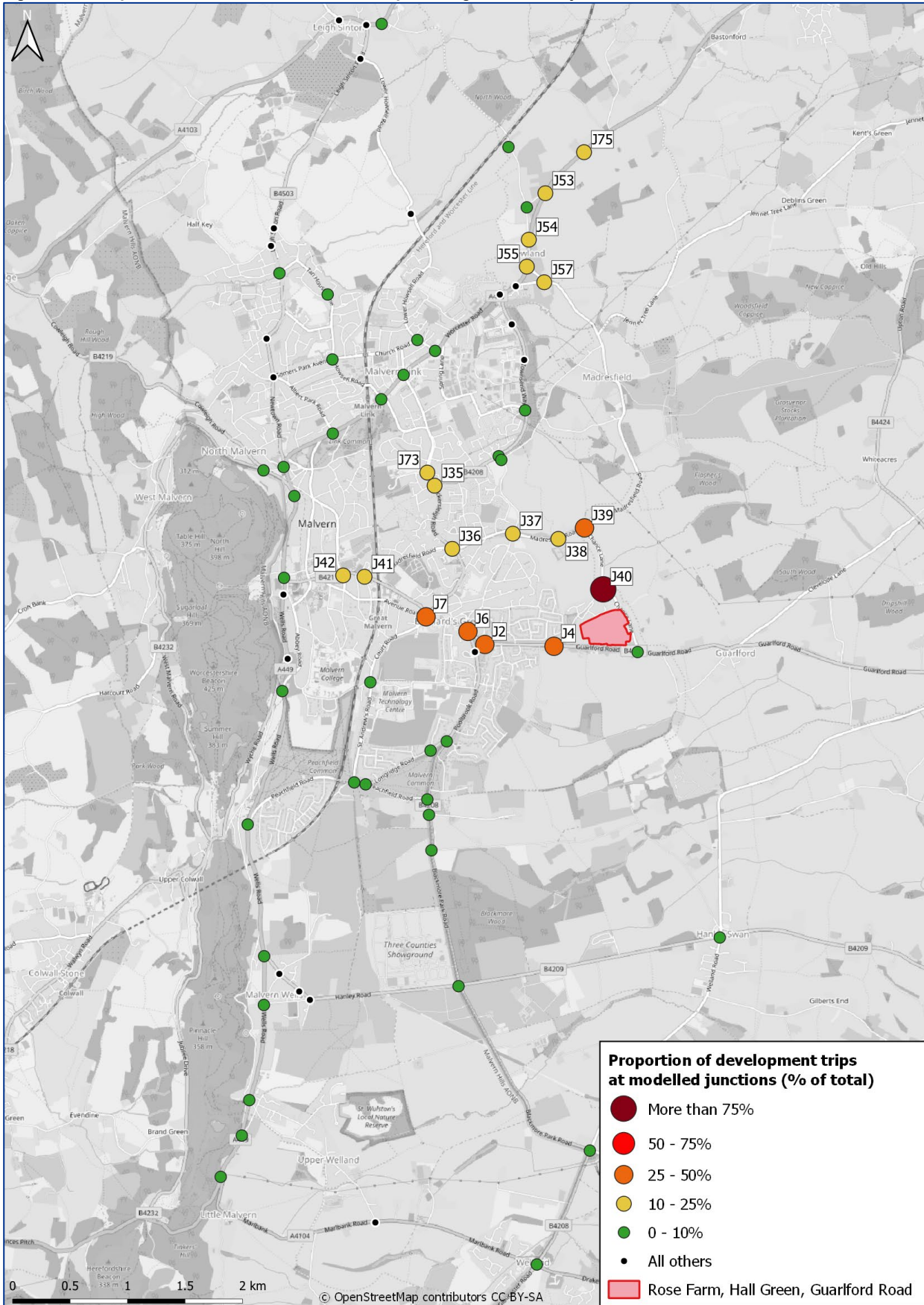
Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 13-1 Most affected junctions by the Rose Farm/Hall Green/Guarlford Road development

MDM Junction	2019 Do Minimum		Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
40	-	-	89	108	-	-	90%
39	-	-	50	52	-	-	47%
4	-	-	37	49	-	-	40%
2	915	815	35	46	4%	6%	37%
6	1,121	1,414	27	33	2%	2%	28%
7	1,674	1,638	24	31	1%	2%	25%
38	-	-	22	28	-	-	23%
37	966	960	21	27	2%	3%	22%
54	-	-	26	20	-	-	21%
55	2,454	2,443	26	20	1%	1%	21%
57	-	-	26	20	-	-	21%
75	-	-	24	16	-	-	18%
53	2,525	2,508	24	16	1%	1%	18%
35	1,567	1,482	11	18	1%	1%	13%
73	-	-	10	17	-	-	13%
41	-	-	9	16	-	-	11%
42	985	827	9	16	1%	2%	11%
36	1,460	1,551	7	17	0%	1%	11%

Across the whole network, the development generates a total traffic uplift of 0.6% and 0.7% through MDM junctions in the AM and PM peaks. The development generates a total of 102 (117) trips in the AM (PM), which all access the road network via Chance Lane to the east of the site.

Figure 13-1 Proportion of Rose Farm, Hall Green trips through each MDM junction



13.1.2 Distribution and Assignment

Three key movements to and from the development can be discerned.

- The largest movement is westbound, turning left onto Chance Lane, again left onto Hall Green and then turning right onto B4211 Guarlford Road and continuing onto Barnard's Green Road via Junctions 40, 4, 2, 6, and 7). Some traffic leaves this route at Junction 7 but the majority continues on Barnard's Green Rd and B4211 Church Street (Junctions 41 and 42). 25% of total traffic or 24 (31) vehicles use this route in the AM (PM), with 11% or just about 10 vehicles) continuing westbound on Church Street.
- The second largest movement is northbound onto the A449 towards Worcester via Chance Lane and a right turn onto Madresfield Road, joining the A449 just outside of Malvern (Junction 40, 39, 57, 55, 54, 53). Junction. 21% of total traffic take this route, adding 26 (20) vehicles in the AM (PM).
- The third major movement is northbound but taking left from Chance Lane onto Madresfield Road and turning right onto Pickersleigh Rd (Junctions 40, 39, 38, 37, 36, 35 and 73). 22% of total traffic turn left onto Madresfield Rd but slightly less than half turn right on Mayfield Rd at Junction 37, so that Junction 73 only receives 13% of total traffic (or 10/17 vehicles in the AM/PM).

13.1.3 Junction Impacts

Junction 40 is the currently three-arms unsignalized junction on Chance Lane with Hall Green, which has been turned into a four-arm junction in the MDM to provide access to the Sherrards Green development. Due to its proximity to the Rose Farm site in Hall Green just south of it, 90% of development traffic (the equivalent of 90 to 110 vehicles) will route through the junction. In the AM, development traffic will be coming from Chance Lane on the south, with one third or around 40 turning left into Hall Green and two thirds continuing northbound on Chance Lane. In the PM, half the development traffic is coming from Hall Green and turning right onto Chance Lane to continue southbound to the site, one third of development traffic comes from the northern arm of Chance Lane and also continues on Chance Lane southbound, while the remaining traffic does the opposite, northbound movement from the southern to the northern arm of Chance Lane. While the overall impact for each movement is less than 50 movements, a significant proportion turns to and from Hall Green which might interfere with existing traffic flows. It is thus recommended to assess the development impact on the junction in more detail.

Junction 39, the three-arms junction of Chance Lane and Madresfield Rd, is the second-most affected junction in this scenario, receiving 47% of all development traffic, representing about 50 additional vehicles. The largest movement of development traffic in the AM is a right turn from Chance Lane onto the eastern arm of Madresfield Rd and the opposite movement in the PM. However, these two arms form the priority arms at this junction so no actual turning movement is made. It is therefore not considered that the development will affect the operational performance of the junction

Junction 4 is the T-junction of Guarlford Rd with Hall Green west of the development. It receives 40% of total development traffic, but this amounts to less than 50 trips per peak hour. Development traffic is split in two distinct movements, a right turn from Hall Green onto the western arm of the B4211 and its opposite movement, a left turn from the western Guarlford Rd onto Hall Green. As this constitutes a turn from the minor onto the major arm and vice versa, this might cause some queueing but given the maximum movement of under 40 vehicles per hour, its impact should remain limited.

14. Scenario 2 – Cumulative Malvern SWDP Impact

14.1 Scenario 2 Headline Results and Analysis

14.1.1 Overview

Table 14-1 below presents the 2019 do-minimum traffic flows and the traffic cumulatively generated by all tested Malvern SWDP sites through the MDM study junctions.

Schematic maps and junction turning matrices detailing the movement of development trips through the MDM network can be found in Appendix B and Appendix C.

Table 14-1 Most affected junctions by the cumulative development impact

MDM Junction	2019 Do Minimum		Malvern SWDP Development Traffic		Traffic Uplift		Proportion of Total
	AM	PM	AM	PM	AM	PM	
75	-	-	1,649	1,649	-	-	33%
53	2,525	2,508	1,572	1,565	62%	62%	32%
54	-	-	1,570	1,562	-	-	32%
55	2,454	2,443	1,570	1,562	64%	64%	32%
40	-	-	1,167	1,127	-	-	23%
39	-	-	1,119	1,062	-	-	22%
57	-	-	1,064	1,015	-	-	21%
1	-	-	1,005	920	-	-	19%
74	-	-	941	851	-	-	18%
4	-	-	792	768	-	-	16%
2	915	815	771	750	84%	92%	15%
14	-	-	729	679	-	-	14%
5	395	224	662	651	168%	291%	13%
10	929	855	664	640	71%	75%	13%
58	4,008	4,678	536	615	13%	13%	12%
19	1,057	951	605	546	57%	57%	12%
56	2,549	2,558	536	614	21%	24%	12%
28	1,814	2,250	541	583	30%	26%	11%
35	1,567	1,482	553	547	35%	37%	11%
44	1,793	1,590	521	561	29%	35%	11%
68	407	306	575	447	141%	146%	10%
3	-	-	517	478	-	-	10%

Across the whole network, the Malvern SWDP development traffic generates an average traffic uplift of 30.9% and 31.5% through MDM junctions in the AM and PM peak hours.

14.1.2 Distribution and Assignment

In Scenario 2 the cumulative impacts are mostly felt on junctions forming part of key strategic routes for multiple developments. This is most prominently the case for the A449 Worcester Road to the north east of Malvern (Junctions 75, 53, 54, 55 and, to lesser extent Junctions 56, 58 and 31). The first four junctions are seeing the largest proportion of total Malvern SWDP traffic (32-33%), while the latter three junctions still incur 12%.

The second key strategic route is Chance Lane and Madresfield Rd to the A449 junction (Junctions 57, 39 and 40), which receive 21-23% of total development traffic. Junctions along Blackmore Park Rd (Junctions 74, 1, 14) carry up to 14% of total Malvern SWDP traffic, which is mostly due to their close proximity to the Blackmore Park site. Junctions 2 and 4 also experience 14 and 16% of total development traffic.

14.2 Junction Impacts

This assessment reviews the relative contribution of each Malvern SWDP development to the impacts forecast at key MDM junctions which were identified within scenario one.

14.2.1 North Site extension (Cales Farm)

The proportion of SWDP development trips attributable to the North Site extension (Cales Farm) site is shown in Figure 14-1.

Over half of the Malvern SWDP development trips impacting upon Junction 26 can be attributed to the North Site extension (Cales Farm) development. As established within scenario one, nearby junction 27 incurs a similar number of trips from this development, but this development's contribution as part of Malvern SWDP impacts is markedly lower as a result of other significant SWDP developments impacting upon this junction (namely Upper Howsell).

Junctions 23, 70 and 69, which are all located to the south of Malvern in Malvern Wells and Welland see a large proportion of around 50% of their development traffic generated by the North Site extension (Cales Farm), however the overall impact is low in absolute terms, as established within scenario one.

14.2.2 Upper Howsell

The proportion of SWDP development trips at each junction attributable to the Upper Howsell site is shown in Figure 14-6.

The Upper Howsell development contributes between 75% to 100% of all SWDP development trips going through Junctions 47, 59, 61, 60 and 72. All these junctions, with the exception of Junction 59, are located on Leigh Sinton Road, which serves as a key route for the two western access points of the development. Junction 59, as well as Junction 61, are the two junctions that serve as access points to the development.

Importantly, along the key strategic A449 corridor, the development consistently contributes over 25% to the total level of SWDP traffic impacting upon the junction. This is a reflection of the significant size of the development, and its central northern position in the Malvern highway network. In the vicinity of the development, the development contributes to over half of SWDP trips impacting upon junctions 27 and 30, both of which are key junctions in the local road network.

14.2.3 Hayslan Fields

The proportion of development trips attributable to the Hayslan Fields site is shown in Figure 14-2. Hayslan Fields is a small development compared to other Malvern SWDP sites. It contributes to a third of traffic on Junctions 32 and 64 which incur a low overall impact from SWDP sites.

Its largest contribution in absolute terms is on Junction 73 with some 200 vehicles that represent a quarter of the total impact, however this impact is diluted by other SWDP trip impacts as this junction is on a key north-south link within the local Malvern road network.

14.2.4 Sherrards Green

The proportion of development trips attributable to the Sherrards Green site is shown in Figure 14-7.

Logically, the development contributes a greater proportion of total SWDP trips to those junctions located in close proximity. There are exceptions to this rule however (such as J43, J15 and J16) where the distribution of developments and their assignment to key destinations results in apparent anomalies.

Junctions 39 and 40 (on the key north-south strategic route) receive in excess of 300 trips from the development, but this contribution equates to less than 25% of total SWDP trips.

14.2.5 Guarlford Road

The proportion of development trips attributable to the Guarlford Road site is shown in Figure 14-3 below. This demonstrates a modest contribution to junction impacts in the south east area of Malvern. This reflects both the modest size of the development and close proximity to a number of other SWDP developments. The impacts at junctions 6 and 11 are the only two junctions for which this development contributes to over 25% of total SWDP traffic.

14.2.6 Blackmore Park

The proportion of development trips attributable to the Blackmore Park site is shown in Figure 14-8 below.

Blackmore Park is the largest development assessed within Malvern and has a significant impact on multiple junctions, generating large traffic uplifts. The assignment of trips to/from the development has also led to the identification of the key north-south movement via Madresfield between the A449 and areas south of Malvern.

The development is the main contributor to impacts at junctions throughout the south of Malvern and still contributes to more than 25% of total SWDP trips on the A449 north of Malvern.

14.2.7 A449 Pins Green (north of)

The development on the A449 at Pins Green (north of) contributes to a high proportion of SWDP trips at a number of junctions on the A449 key strategic route. This reflects both the size of the development and positioning directly adjacent to the A449. This is further demonstrated by the development contributing to less than 25% of the overall SWDP trip impact at its own access junction (junction 75) and those immediately to the south (J53, J54 and J55).

Further south from junction 56 on, the proportional contribution of the development to the overall SWDP impact increases to over 25%. This is a result of the key north-south route via Madresfield splitting from the A449 by this point, on which other trips associated with SWDP sites in the south of Malvern (such as Blackmore Park and Rose Farm/Hall Green/Guarlford Road) will travel.

14.2.8 A449 Pins Green (south of)

The proportion of development trips attributable to the A449 Pins Green (south of) site is shown in Figure 14-4. The contribution of this development to the overall SWDP impact is the same as that set out for the neighbouring A449 Pins Green (north of) development.

14.2.9 North End/Mayfield Road Employment

The proportion of development trips attributable to the North End/Mayfield Road Employment site is shown in Figure 14-5. This demonstrates a modest contribution to junction impacts in the centre and east of Malvern.

Logically, the development contributes a greater proportion of total SWDP trips to those junctions located in close proximity (J35, J34 and J68), but there are exceptions to this rule however (such as J51 and J52) where the distribution of developments and their assignment to key destinations results in apparent anomalies. In close proximity to the development at junctions J33, J36 and J73, the development contributes to over 25% of all cumulative traffic.

14.2.10 Rose Farm, Hall Green, Guarlford Road

The proportion of development trips attributable to the Rose Farm, Hall Green, Guarlford Road site is shown in Figure 14-10. Due to its comparatively small size, the development contributes to less than 10% of total SWDP trips at all junctions in the immediate vicinity of the junction. This is also a result of several large developments in the same region of Malvern.

Figure 14-1 Proportion of all MDM development trips attributable to the North Site Extension (Cales Farm) development

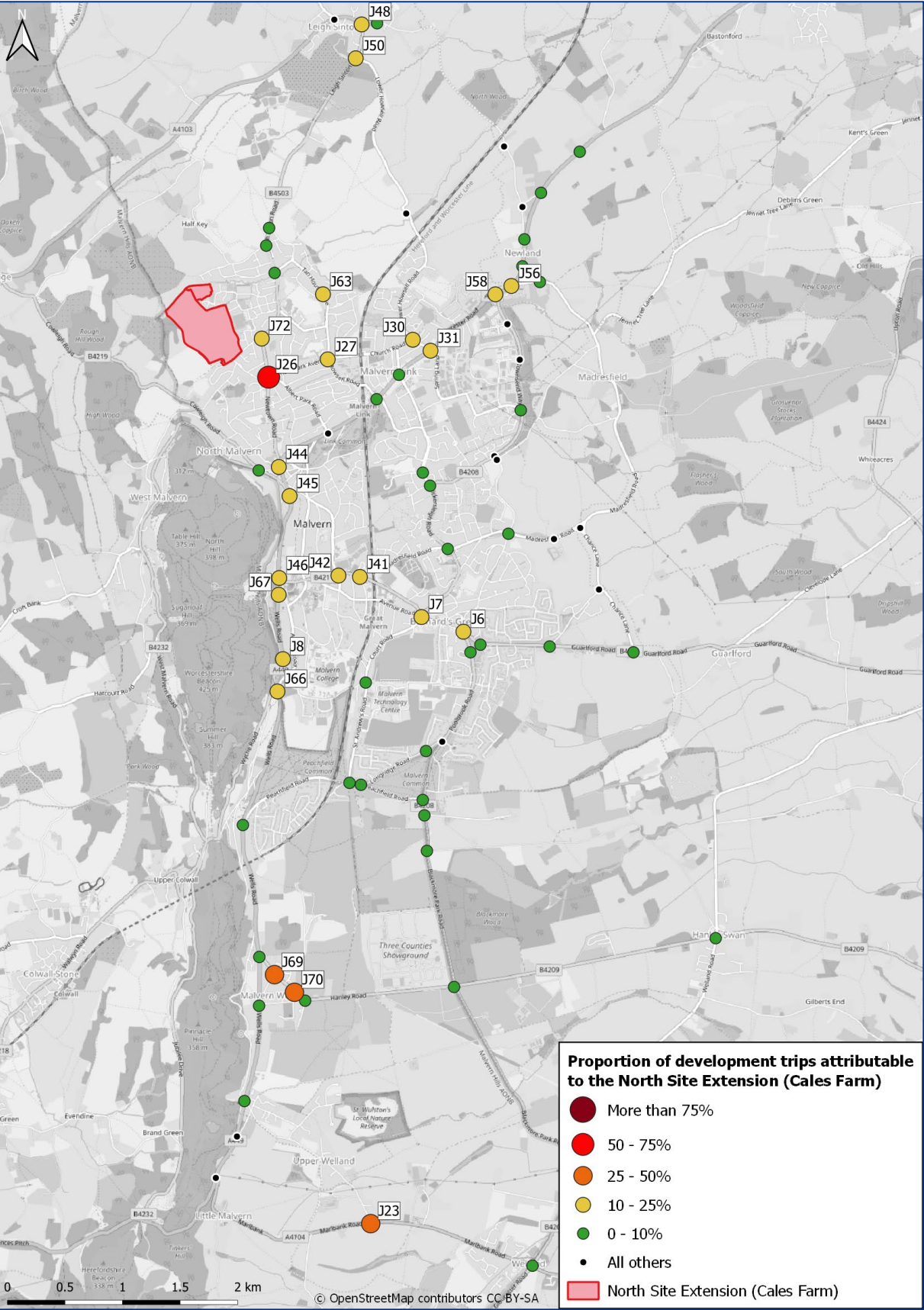


Figure 14-6 Proportion of all MDM development trips attributable to the Upper Howsell development

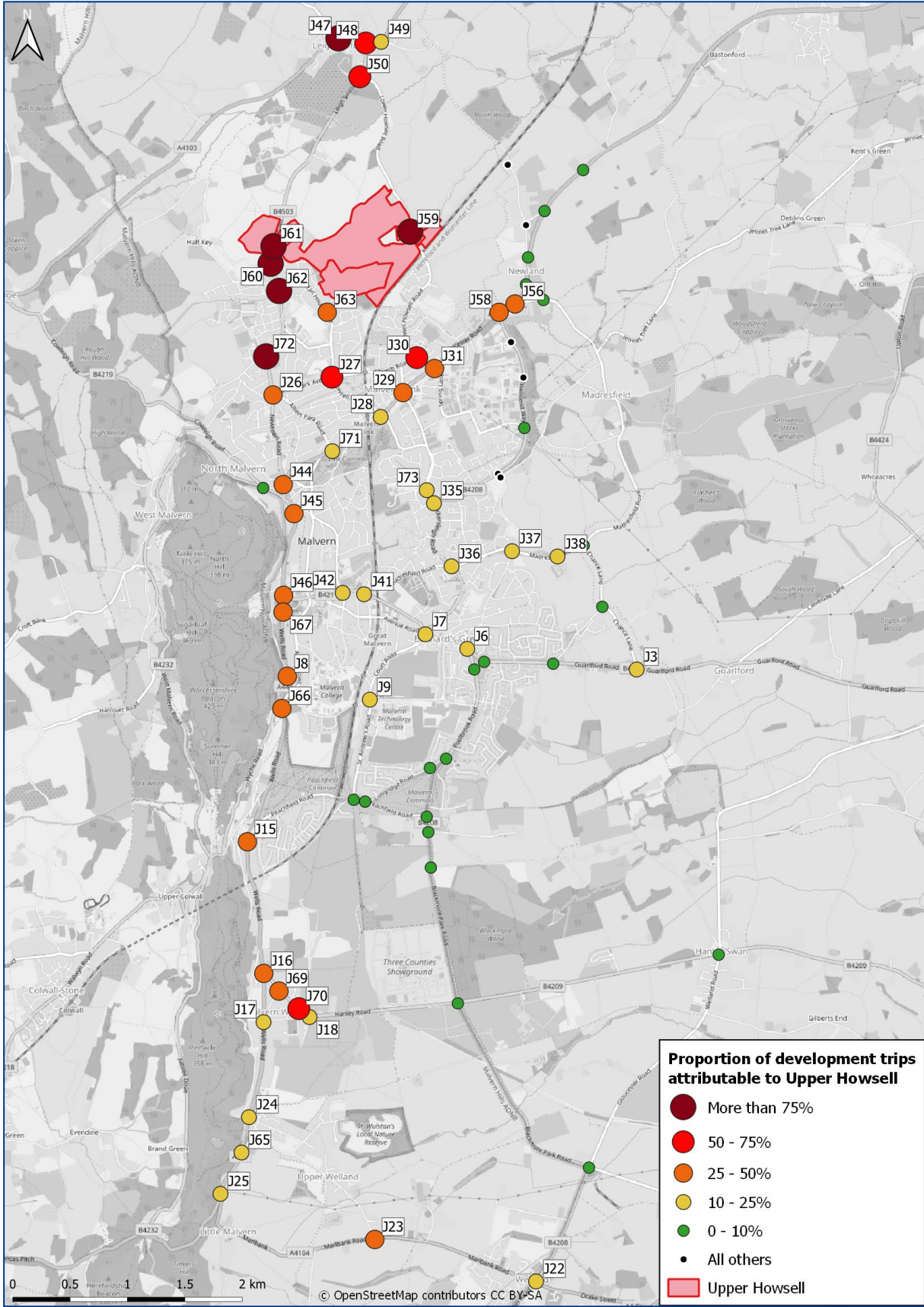


Figure 14-2 Proportion of all MDM development trips attributable to the Hayslan Fields development

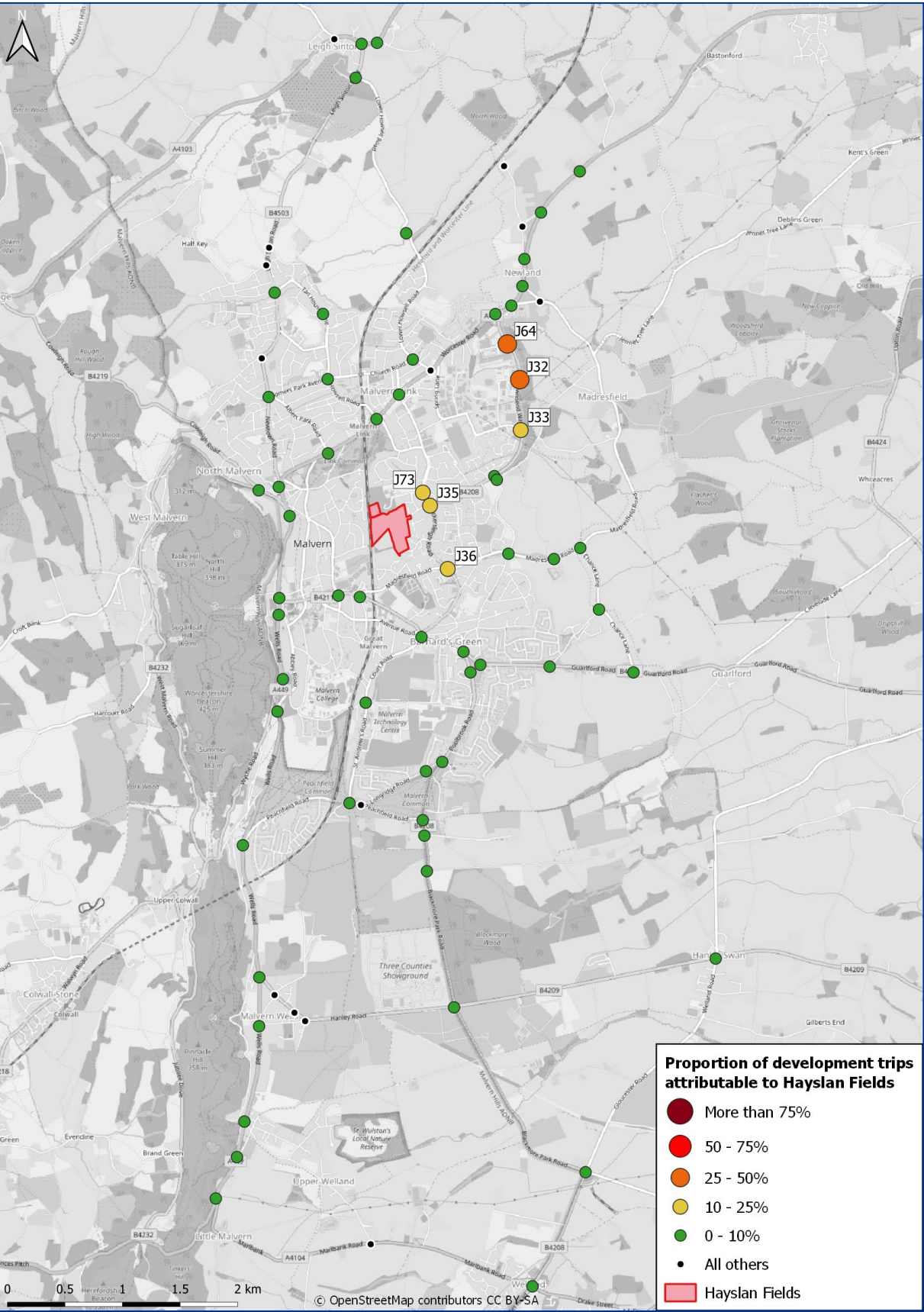


Figure 14-7 Proportion of all MDM development trips attributable to the Sherrards Green development

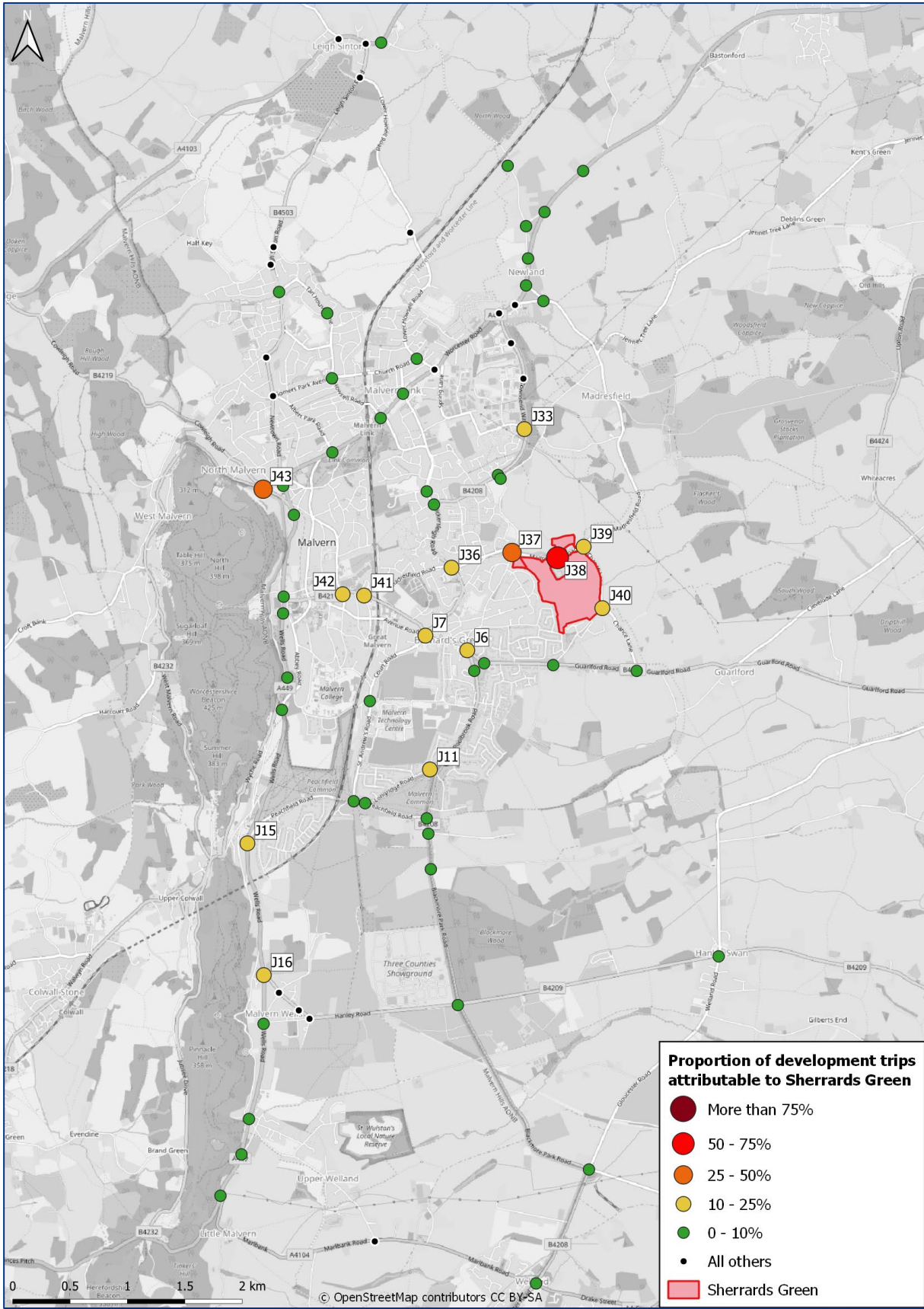


Figure 14-3 Proportion of all MDM development trips attributable to the Guarford Road development

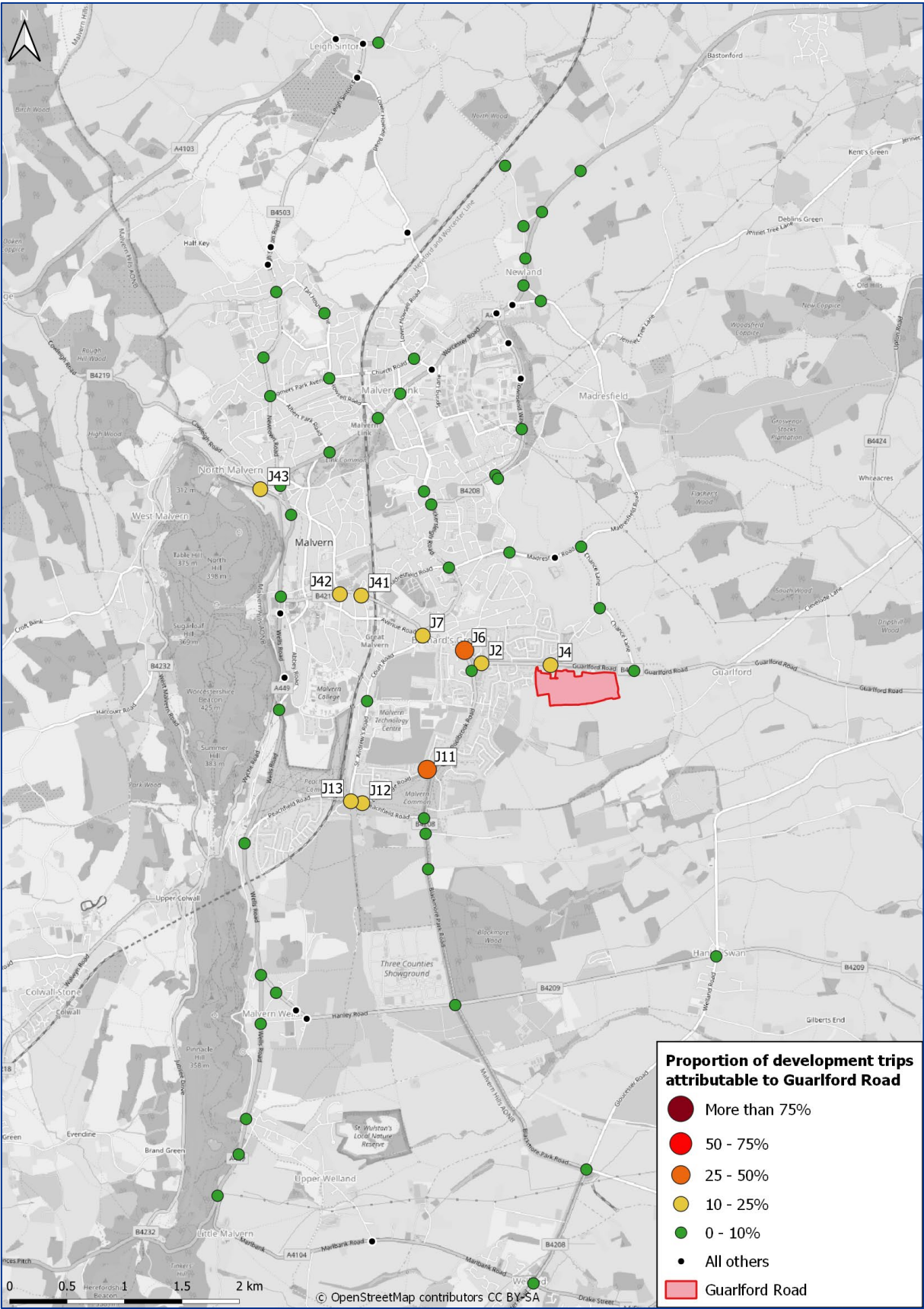


Figure 14-8 Proportion of all MDM development trips attributable to the Blackmore Park development

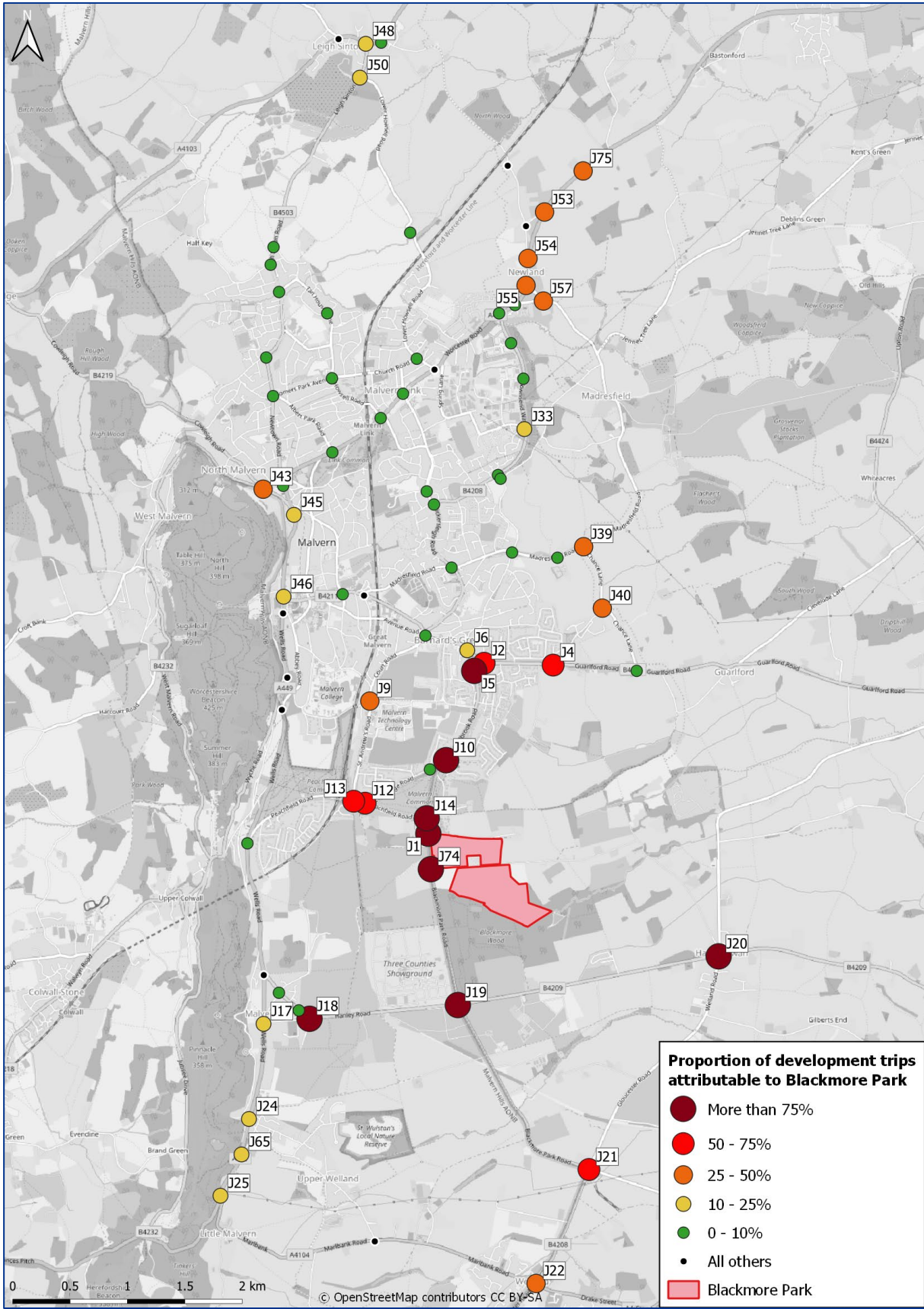


Figure 14-4 Proportion of all MDM development trips attributable to the A449 Pins Green (south of) development

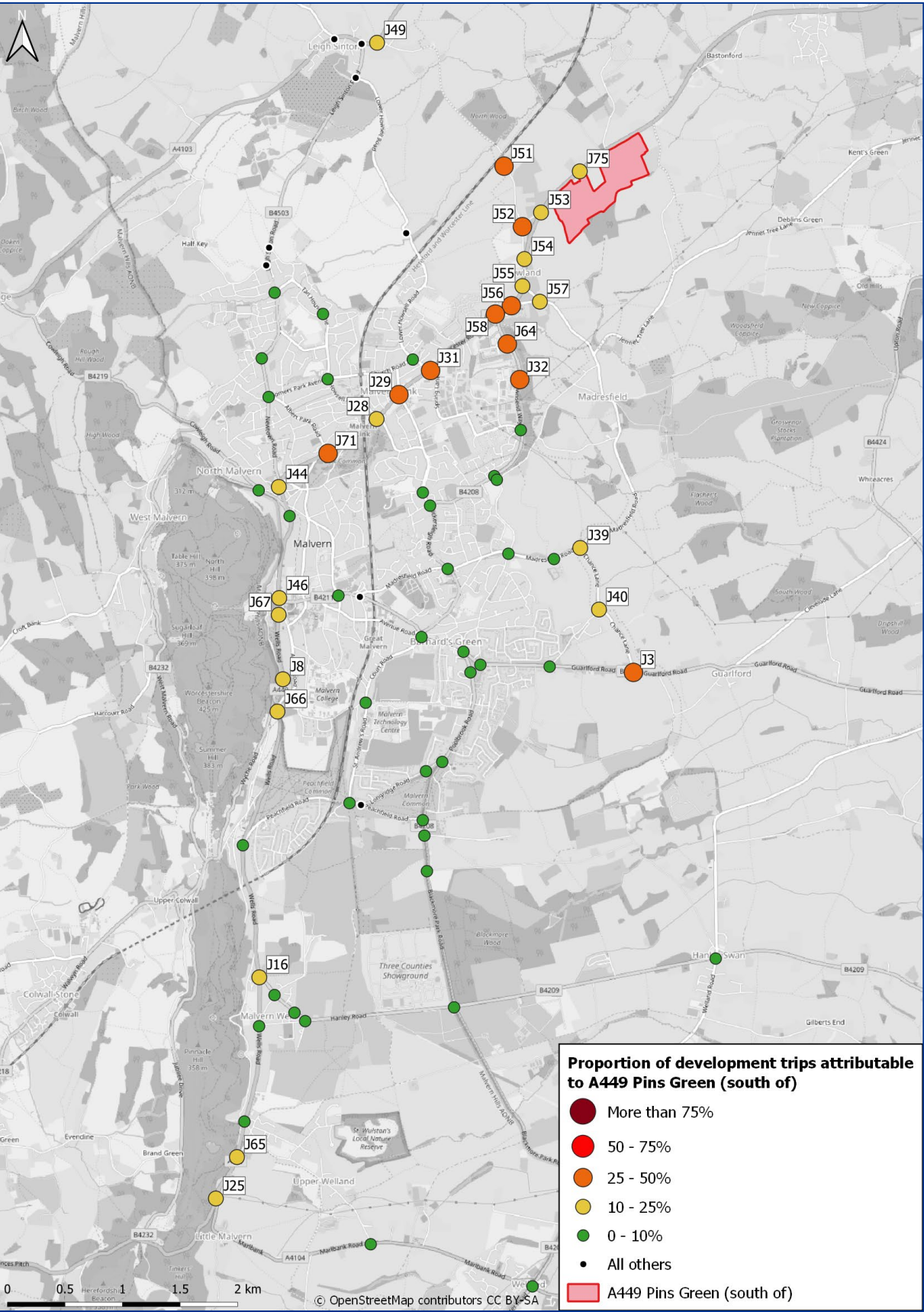


Figure 14-9 Proportion of all MDM development trips attributable to the A449 Pins Green (north of) development

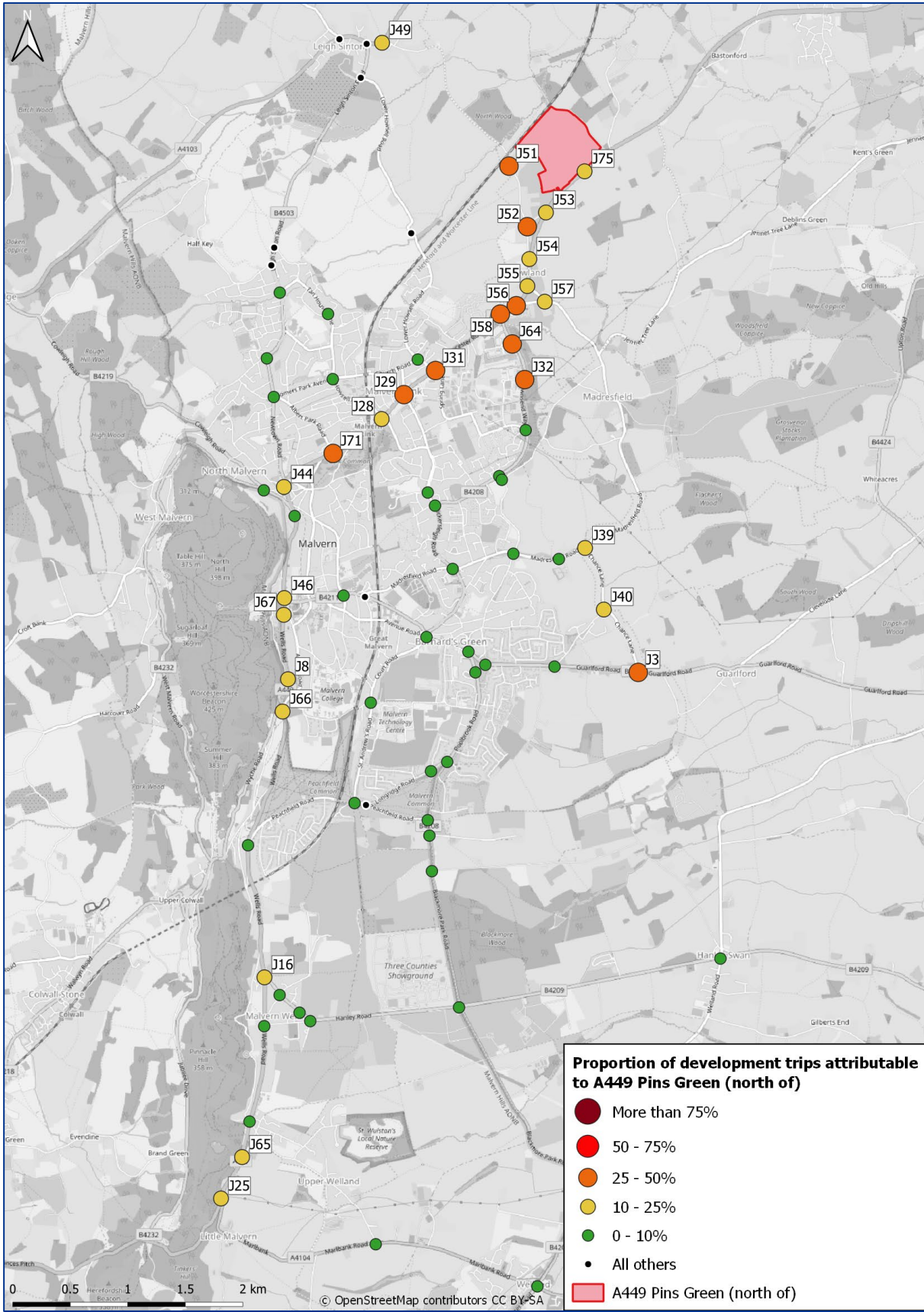


Figure 14-5 Proportion of all MDM development trips attributable to the North End/Mayfield Road Employment development

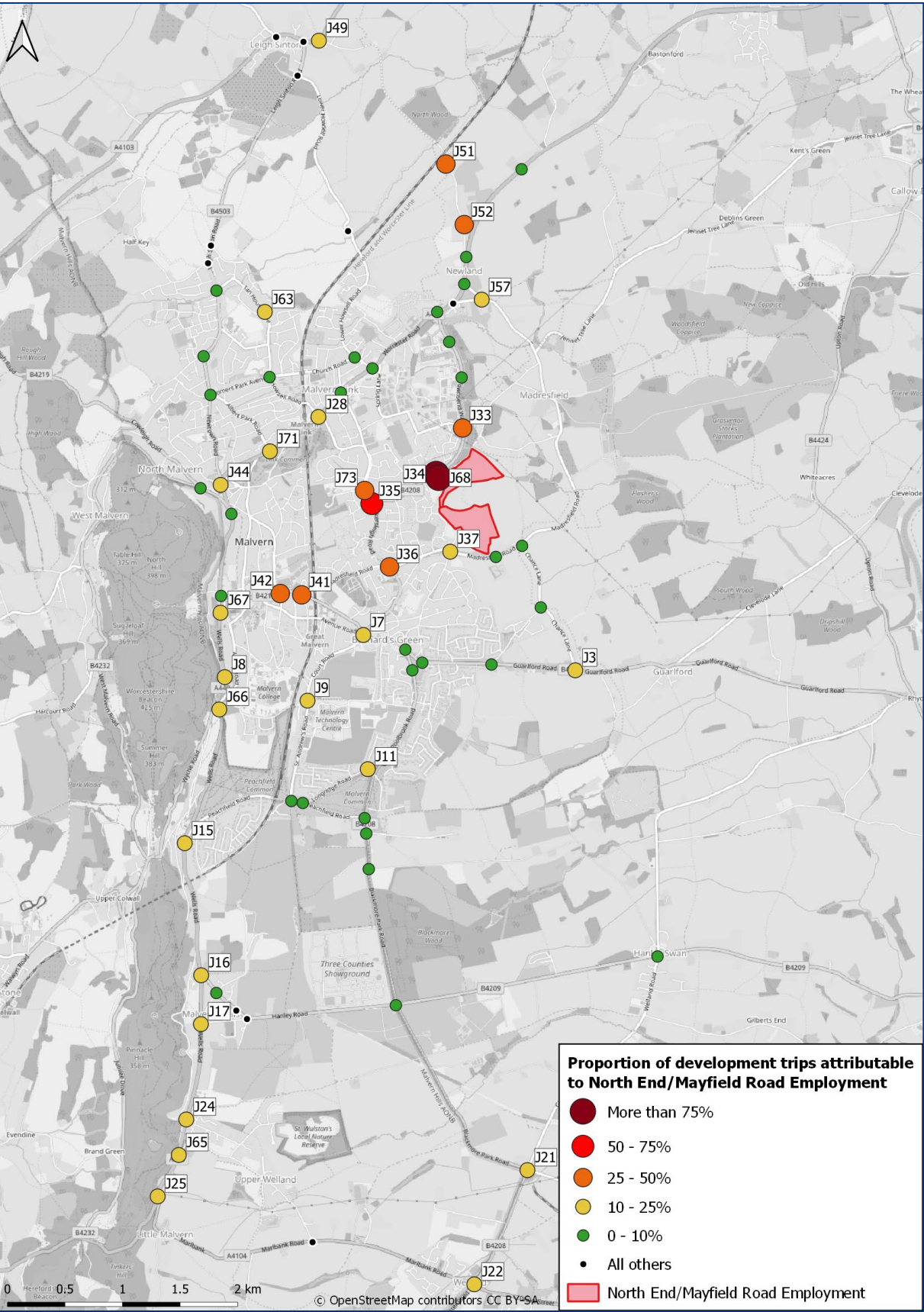
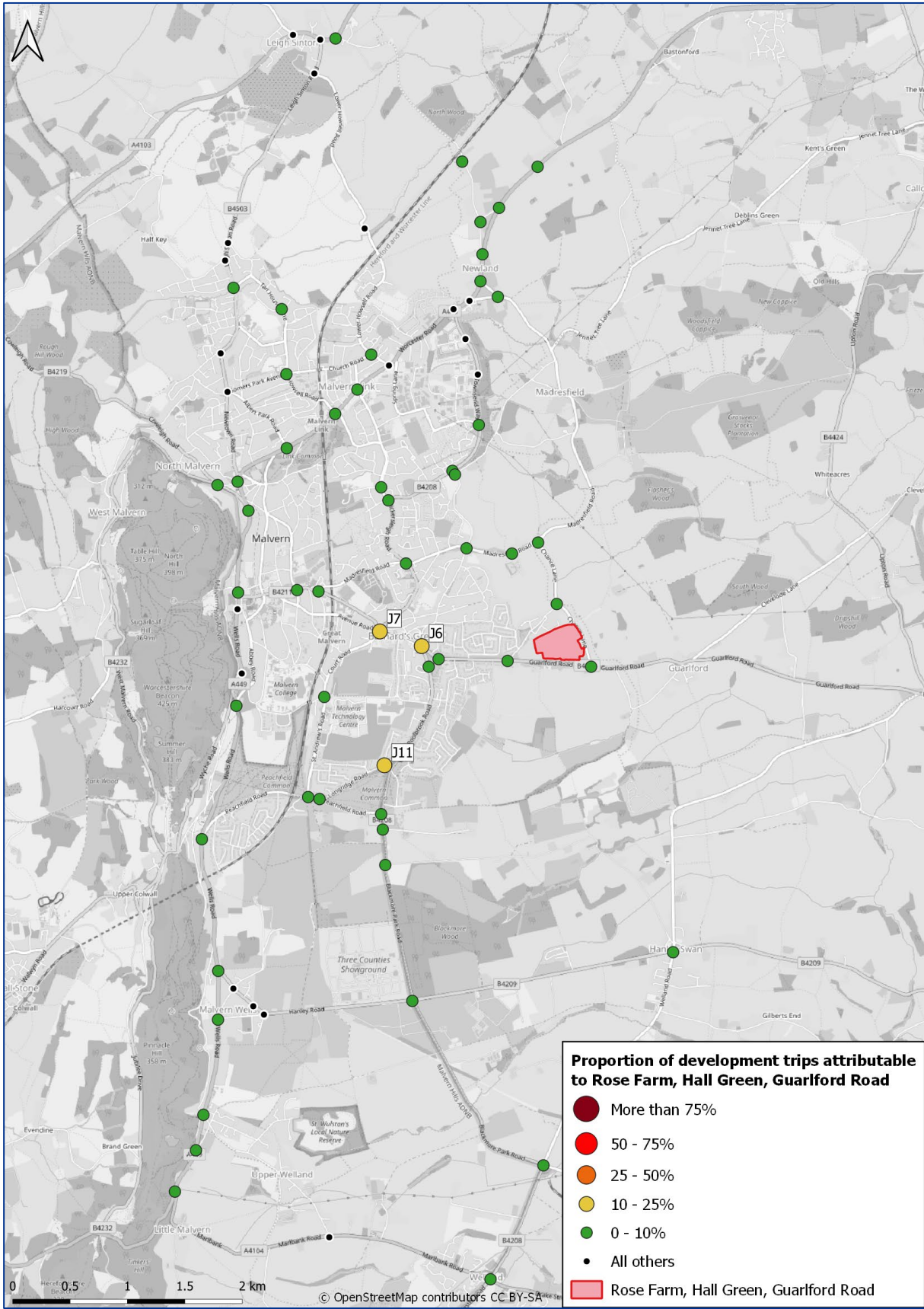


Figure 14-10 Proportion of all MDM development trips attributable to the Rose Farm, Hall Green, Guarlford Road development



14.3 Link Capacity Assessment

Link 'stress' has been estimated for each link on approach to a junction arm. This 'stress' is measured using the volume-over-capacity (V/C) ratio.

DMRB guidance (Volume 5 Section 1 TA 79/99) was used to estimate link capacities based on link classification and characteristics. This was done using:

- Carriageway width (estimated through satellite imagery or assumed standard lane width)
- Total number of lanes
- Urban/Rural and road type classification (single/dual carriageway or motorway)
- Share of HGV vehicles in the peak hour (where available)

V/C ratios will provide an additional assessment as to what extent higher traffic flows on key links as a result of Malvern SWDP development traffic will increase the link 'stress'. This will subsequently provide an indication as to the potential impact on the operational performance of the approaching junction arm.

Industry guidance typically states an 'acceptable' v/c threshold of 85% being the point above which operational performance will be undermined through the level of traffic.

It should be noted that the link capacity assessment undertaken here using DMRB guidance (Volume 5 Section 1 TA 79/99) is a high-level approach which is deemed suitable for the level of impact assessment derived from the MDM. Any outputs and conclusions drawn through this V/C assessment should be viewed alongside a consideration of the methodology of the MDM detailed within section 2.

14.3.1 Highest V/C Ratios

With all Malvern SWDP trips added onto the network, the highest V/C ratios are observed on the A449 in the north east of Malvern and in Malvern Link, on Poolbrook Road, Blackmore Park Road corridor and at one junction on Chance Lane and Madresfield Road. These routes are either key routes for traffic to and from Malvern or serve as access routes for large development sites.

Links with the highest V/C ratios are presented in Table 14-2 and Table 14-3. Note that as each junction consists of more than one approach link, a junction may appear on more than one row.

Table 14-2 Largest V/C ratios in Do-Something Scenario 2 (AM)

Junction	Road	V/C Do Minimum Traffic	V/C with Development Traffic
53	A449 Worcester Road (North)	83%	143%
55	A449 Worcester Road (North)	82%	142%
53	A449 Worcester Road (South)	61%	99%
58	A449 Worcester Road (South)	74%	95%
10	B4208 Poolbrook Road (North)	44%	92%
56	A449 Worcester Road (South)	65%	88%
56	A449 Worcester Road (North)	74%	85%
58	A449 Worcester Road (North)	71%	82%
55	A449 Worcester Road (South)	58%	80%
5	Bye Road	30%	80%
2	B4211 Guarlford Road (East)	23%	74%
57	Madresfield Road (North)	0%*	71%*
40	Chance Lane (North)	0%*	70%*

*Actual V/C ratio higher as no do-minimum data available

Table 14-3 Largest V/C ratios in Do-Something Scenario 2 (PM)

Junction	Road	V/C Do Minimum Traffic	V/C with Development Traffic
53	A449 Worcester Road (South)	75%	144%
56	A449 Worcester Road (South)	78%	105%
58	A449 Worcester Road (South)	76%	102%
55	A449 Worcester Road (South)	73%	100%
53	A449 Worcester Road (North)	68%	97%
55	A449 Worcester Road (North)	66%	94%
58	B4208 Townsend Way	84%	87%
36	B4208 Pickersleigh Road	58%	79%
28	A449 Worcester Road (South)	59%	78%
58	A449 Worcester Road (North)	65%	77%
31	A449 Worcester Road (North)	66%	75%
10	B4208 Poolbrook Road (South)	31%	73%
56	A449 Worcester Road (North)	62%	71%
75	A449 Worcester Road (South)	0%	70%
54	A449 Worcester Road (North)	0%*	70%*

*Actual V/C higher as no do-minimum data available

14.3.2 Largest Increase in V/C Ratios

As with the highest V/C ratios, the largest increases in V/C are also located on key routes through Malvern to/from Worcester/Birmingham (A449 Worcester Road) and the M5 (Guarlford Road) or on roads serving as access routes for large developments such as the A449 Pins Green, Blackmore Park or the Newlands development (A449, Poolbrook Road, Blackmore Park Road).

While this assessment considers the largest increase in V/C as a result of the SWDP development traffic, a large increase in V/C does not necessarily mean that the link or junction arm will exceed the V/C threshold. However, this assessment does provide an indication as to the links where a substantial increase in traffic as a result of SWDP traffic may increase the risk of operational issues at a later date through further development beyond the SWDP period.

The largest V/C increases in Scenario 2 are presented in Table 14-4 and Table 14-5 for the AM and PM peaks.

Table 14-4 Largest increase in V/C in Scenario 2 (AM)

Junction	Road	Increase in V/C	V/C with Development Traffic
57	Madresfield Road (North)	71.34%	71%
40	Chance Lane (North)	69.54%	70%
39	Madresfield Road (East)	65.08%	65%
53	A449 Worcester Road (North)	60.56%	143%
55	A449 Worcester Road (North)	60.21%	142%
54	A449 Worcester Road (North)	59.30%	59%
1	B4208 Blackmore Park Road (North)	54.56%	55%
2	B4211 Guarlford Road (East)	51.03%	74%
5	Bye Road	50.15%	80%
10	B4208 Poolbrook Road (North)	47.91%	92%

Table 14-5 Largest increase in V/C in Scenario 2 (PM)

Junction	Road	Increase in V/C	V/C with Development Traffic
75	A449 Worcester Road (South)	70%	70%

Junction	Road	Increase in V/C	V/C with Development Traffic
54	A449 Worcester Road (South)	70%	70%
53	A449 Worcester Road (South)	69%	144%
57	Madresfield Road (South)	65%	65%
4	B4211 Guarford Road (West)	62%	62%
55	Madresfield Road	62%	66%
39	Chance Lane	55%	55%
2	Bye Road	51%	62%
74	Blackmore Park Access Road	49%	49%
14	B4208 Blackmore Park Road	49%	49%

15. Summary and Recommendations

This report has presented, analysed and discussed the results of eleven scenarios in order to assess the impact of the proposed development sites on the Malvern road network. Specifically, new development trips have been assigned through the Malvern road network, using the MDM, and the movements have been examined through 75 selected junctions.

15.1.1 Scenarios 1A-1J

Scenarios 1A-1J assessed the impact of ten developments in the 2019 Assessment Year against 2019 do-minimum traffic flows on MDM junctions. The results of these ten scenarios demonstrated the distribution of development trips and provided an initial indication of the MDM junctions that will be used and impacted upon by development traffic. Table 15-1 summarises the junctions that, in at least one scenario, have been identified as requiring further assessment on their operational performance as more details about each development become available.

Table 15-1 Junctions recommended for further assessment in Scenario One (✓ = counts available, ✗ = counts required)

Jctn.	North Site Extension	Upper Howsell	Hayslan Fields	Sherrards Green	Guarford Road	Blackmore Park	A449 Pins Green (north of)	A449 Pins Green (south of)	North End/ Mayfield Road	Rose Farm, Hail Green
1						✗				
2						✗				
4					✗					
5						✗				
7					✓					
10						✓				
14					✗					
19						✓				
20						✗				
26	✗									
27	✗	✗								
28									✗	
30	✗	✗								
31	✓									
34									✓	
35			✓						✓	
36									✓	
37				✗						
38				✗						
39				✗		✗	✗	✗		
40				✗		✗				✗
53						✗				
55						✗	✗	✗	✗	
57						✗				
58							✗	✗		

Jctn.	North Site Extension	Upper Howsell	Hayslan Fields	Sherrards Green	Guarford Road	Blackmore Park	A449 Pins Green (north of)	A449 Pins Green (south of)	North End/ Mayfield Road	Rose Farm, Hall Green
59		×								
60		×								
61		×								
68									×	
73			×							
74						×				
75						×	×	×		

15.1.2 Scenario 2

Scenario 2 assessed the cumulative impact of ten developments and one committed development in the 2041 Assessment Year against 2041 do-minimum traffic flows on MDM junctions. The results of the scenario demonstrated the cumulative impact and distribution of development trips and provided an initial indication of the MDM junctions that will be used by development traffic.

With all SWDP sites applied to the MDM, there are extensive and significant traffic impacts at highway junctions throughout Malvern. Across the whole network, the Malvern SWDP development traffic generates an average traffic uplift of 30.9% and 31.5% through MDM junctions in the AM and PM peak hours.

Compared to scenario one, there is a much wider spread of development trips and associated impacts across the network. There is also a further increase in development trips at junctions which were already impacted upon from individual developments. The extent of this additional impact varies depending on the location of the junction relative to the distribution of SWDP developments and the strategic importance of that junction in the local Malvern network.

Typically, junctions with the highest development trip movements will be located on key routes which would naturally incur traffic movements completed as part of a longer distance strategic journeys. Key strategic routes identified and affected junctions are:

- The A449 Worcester Road north of Malvern, for trips to/from Worcester, Birmingham and M5 North (junctions 55, 54, 53 and 75);
- The A449 Worcester Road within Malvern, for north-south trips through Malvern (junctions 58, 31, 29, 28 and 71)
- Madresfield Road (and Chance Lane) as north-south link between the A449 and southern developments (junctions 57, 39 and 40);
- B4211 Guarford Road, serving as access to and from the M5 South (junctions 4 and 3);
- B4208 Poolbrook Road/Blackmore Park Road, mostly due to the Blackmore Park development and marginal contribution from other developments (junctions 19, 74, 1, 14, and 10).

15.1.3 Next Steps

As more detailed information becomes available on the individual Malvern SWDP allocations, the inputs to the MDM can be updated to inform a more refined assessment of the forecast traffic impact to be generated by that development in both the start of construction, year of opening, full occupation and end of the SWDP period. In turn this will add value to the outputs presented above as to which junctions should be considered for more detailed assessment as part of any emerging Transport Assessment to be developed in support of any planning application.

Appendix A. Capability Statement

5 First Street
Manchester M15 4GU
United Kingdom
T +44 (0)161 235 6000
F +44 (0)161 235 6001
www.jacobs.com

Subject	Capability Statement	Project Name	WCC Development Tools 2018-19
Attention	Martin Rowe (WCC)	Project No.	J1WHW100 - A.PN.CI.IWA06
From	Chris Macdonald (Jacobs)		
Date	August 2018		
Copies to	Peter Spencer (Jacobs)		

1. Introduction

1.1 Background

During 2007/08 Worcestershire County Council (WCC) required a series of development traffic tools in order to determine the impact that forthcoming development sites as part of the South Worcestershire Development Plan (SWDP) were likely to have on the WCC highway network.

Due to the size and isolated nature of many towns within Worcestershire, investment into sophisticated traffic models for these towns was not considered to be good value for money. WCC's transport consultants at that time (Halcrow) therefore proposed to develop a series of bespoke spreadsheet based traffic impact assessment tools in order to provide:

- A high level indication to WCC as to the traffic impact of certain development sites at key junctions within each town,
- Identify which junctions should be included within any subsequent Transport Assessments (TAs) for the development site being assessed,
- Provide developers with representative development flows for use in any recommended junction assessments.

Between 2010 and 2016, these tools were managed and maintained by Halcrow/CH2M (now Jacobs) and were highly valued by WCC, as demonstrated by WCC requesting that all proposed developments are applied to the relevant development model (note that due to WCC staffing changes this policy may no longer be applied/in place). Across this period, six development tools were developed:

- Malvern
- Droitwich
- Evesham
- Pershore
- Bromsgrove
- Redditch

Periodic updates were undertaken incorporating new data (such as the release of 2011 Census journey to work data), new development information (SWDP) and enhanced software (Microsoft Office).

In light of the emerging update to the SWDP, WCC have commissioned Jacobs to review and update the Malvern and Droitwich tools. This memorandum sets out a high level summary of the tools' methodology, the scope of the requirement updates, data collection requirements, potential enhancements and a capability statement.

1.2 Milestones

This memorandum covers milestone one of four, with the fourth being the use of the updated Malvern and Droitwich tools to specific development sites as they come forward as part of SWDP in 2019. The table below details the four milestones.

Table 1-1: 2018-19 WCC Development Tool Milestones and Tasks

Milestone	Task	Details	Timeframe
1	Scoping of updates required to support the update of the MDM and DDM and potential creation of a Strensham tool (SDM)	Review of existing models. Review of existing data location and age. Scope of new data collection to support updates to the tools. Scope requirements for a Strensham tool. Capability Statement.	Summer 2018
2	Data collection	Collection of new traffic data to support the updates to the Malvern and Droitwich tools. Collection of traffic data to support the Strensham tool if required.	Autumn 2018
3	Tool updates	Incorporate new traffic data and agreed enhancements into the Droitwich and Malvern Tools. Creation of Strensham tool if required.	Nov/Dec 2018
4	New development assessments	Application of the updated Malvern and Droitwich tools to specific development sites as they come forward as part of SWDP	2019

1.3 Purpose of Capability Statement

The purpose of the capability statement is to establish an understanding as to what the development tools are designed to do and what they should be used for. It is important to understand that these tools are not traffic models and therefore can only be used as a guidance tool and should not be used for detailed design purposes.

2. WCC Development Tools

2.1 Methodology

The models incorporate the steps of trip generation, trip distribution and trip assignment into their methodologies as summarised below:

- **Trip Generation** – based on extracted trip rates from TRICS or provided by the developer and applied to the development quantum
- **Trip Distribution** – based on journey to work (JtW) data contained within the 2011 Census dataset.
- **Trip Assignment** – based on a quickest route all-or-nothing assignment through a GIS network (OS Open Data network).

2.1.1 Trip Generation

Developments being tested either have their own trip rates provided by the developer or standard trip rates (agreed at the time with WCC). In the case of the former, a review of their robustness is undertaken. In the latter case, trip rates considered representative for the study area are extracted from the TRICS database for the peak hours.

For residential developments, Category A – Privately Owned Houses was chosen in line with good practice guidance. For employment sites, an average of the categories B1 (Offices), B3 (Industrial Units) and B8 (Commercial Warehousing) has been used. Actual vehicle trip numbers for the AM Peak (0800-0900) and PM peak (1700-1800) are then calculated by multiplying the dwellings or Gross Floor Area (GFA) with the corresponding trip rates per dwelling or 100sqm of Gross Floor Area for each development.

2.1.2 Trip Distribution

Generated vehicle trips are then distributed using JtW data from the 2011 Census (Location of usual residence and place of work (OA level) [WF01BEW]). The JtW data provides a likely distribution of employment trips between origins and destinations for the study area. It is assumed that each working person makes one full return commuting journey between home and workplace within a 24-hour period.

The 2011 Census JtW sample is factored to the AM and PM peak hour using National Travel Survey information about the distribution of commuting trips throughout the day (NTS table 0503). Likewise, these commuting trips are then converted into all-purpose trips using NTS data on trip purpose (NTS table 0502).

2.1.3 Trip Assignment

Traffic generated and distributed between origins and destinations is then assigned to the road network in the study area. The Ordnance Survey Open Roads GIS layer serves as road network. Arms of the junctions of interest within the study area are additionally coded into the network. Traffic between each origin and destination is assigned onto the network using an all-or-nothing methodology via the quickest route using an algorithm in GIS. Therefore, neither route choice or network capacity is considered as part of this assignment methodology.

Each time a route passes through a study junction, the entry and exit arm is captured providing the representative turning movement through that junction (e.g. 7A – 7B is a turning movement from arm A of junction 7 to arm B). The assignment of development traffic creates the do-something scenarios. By comparing traffic flows in the do-minimum and do-something, both the number of new development trips and the percentage uplift in total traffic at each study junction can be calculated.

2.2 Software

The development model has been developed as a spreadsheet-based tool (with Microsoft Excel), using a number of parameters and factors to compute trip generation and distribution. These trips are assigned through a GIS shortest-path-algorithm routing tool. Assigned flows are then used to obtain junction turning flows.

2.3 Outputs

Model outputs are then presented visually through maps produced in GIS (MapInfo/QGIS), through junction diagrams and numerically through spreadsheet output tables as illustrated by the following examples:

Figure 2-1 Example of a junction arm table

Junction	Enter	Exit	MoveIn	MoveOut	Movement	Enter Arm	Exit Arm	Census AM	Census PM	Counts AM	Counts PM	Count Year	2014 AM	2014 PM	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM
1	A	B	1Ain	1Bout	1Ain-1Bout	B4208 North	Blackmore Park	-	-	-	-	2001	-	-	-	-	-	-	-	-
1	A	C	1Ain	1Cout	1Ain-1Cout	B4208 North	B4208 South	465.21	323.18	-	-	2001	-	-	-	-	1.75	0.89	-	-
1	B	C	1Bin	1Cout	1Bin-1Cout	Blackmore Park	B4208 South	-	-	-	-	2001	-	-	-	-	-	-	-	-
1	B	A	1Bin	1Aout	1Bin-1Aout	Blackmore Park	B4208 North	-	-	-	-	2001	-	-	-	-	-	-	-	-
1	C	A	1Cin	1Aout	1Cin-1Aout	B4208 South	B4208 North	907.61	630.51	-	-	2001	-	-	-	-	1.28	2.63	-	-
1	C	B	1Cin	1Bout	1Cin-1Bout	B4208 South	Blackmore Park	-	-	-	-	2001	-	-	-	-	-	-	-	-
2	A	B	2Ain	2Bout	2Ain-2Bout	B4211 West	B4211 East	1,404.83	975.93	296	296	2011	294.82	295.91	293.64	294.73	-	-	0%	0%
2	A	C	2Ain	2Cout	2Ain-2Cout	B4211 West	Bye Road	-	-	204	76	2011	203.18	75.98	202.37	203.12	-	-	0%	0%
2	B	C	2Bin	2Cout	2Bin-2Cout	B4211 East	Bye Road	47.76	33.18	19	13	2011	18.92	13.00	18.85	18.92	-	-	0%	0%
2	B	A	2Bin	2Aout	2Bin-2Aout	B4211 West	B4211 East	634.89	441.06	220	280	2011	219.12	279.92	218.24	219.05	-	-	0%	0%
2	C	A	2Cin	2Aout	2Cin-2Aout	Bye Road	B4211 West	4.15	2.88	82	77	2011	81.67	76.98	81.35	81.65	0.08	0.04	0%	0%
2	C	B	2Cin	2Bout	2Cin-2Bout	Bye Road	B4211 East	20.08	13.95	37	9	2011	36.85	9.00	36.70	36.84	-	-	0%	0%
3	A	B	3Ain	3Bout	3Ain-3Bout	Chance Lane	B4211 East	-	-	-	-	2001	-	-	-	-	-	-	-	-
3	A	C	3Ain	3Cout	3Ain-3Cout	Chance Lane	B4211 West	-	-	-	-	2001	-	-	-	-	-	-	-	-
3	B	C	3Bin	3Cout	3Bin-3Cout	B4211 East	B4211 West	667.77	463.90	-	-	2001	-	-	-	-	1.06	2.17	-	-
3	B	A	3Bin	3Aout	3Bin-3Aout	B4211 East	Chance Lane	-	-	-	-	2001	-	-	-	-	-	-	-	-
3	C	A	3Cin	3Aout	3Cin-3Aout	B4211 West	Chance Lane	-	-	-	-	2001	-	-	-	-	-	-	-	-
3	C	B	3Cin	3Bout	3Cin-3Bout	B4211 West	B4211 East	1,595.32	1,108.27	-	-	2001	-	-	-	-	3.38	1.72	-	-
4	A	B	4Ain	4Bout	4Ain-4Bout	Hall Green	B4211 East	37.93	26.35	-	-	2001	-	-	-	-	-	-	-	-
4	A	C	4Ain	4Cout	4Ain-4Cout	Hall Green	B4211 West	-	-	-	-	2001	-	-	-	-	-	-	-	-
4	B	C	4Bin	4Cout	4Bin-4Cout	B4211 East	B4211 West	667.77	463.90	-	-	2001	-	-	-	-	1.06	2.17	-	-
4	B	A	4Bin	4Aout	4Bin-4Aout	B4211 East	Hall Green	-	-	-	-	2001	-	-	-	-	-	-	-	-
4	C	A	4Cin	4Aout	4Cin-4Aout	B4211 West	Hall Green	-	-	-	-	2001	-	-	-	-	-	-	-	-
4	C	B	4Cin	4Bout	4Cin-4Bout	B4211 West	B4211 East	1,557.39	1,081.92	-	-	2001	-	-	-	-	3.38	1.72	-	-
5	A	B	5Ain	5Bout	5Ain-5Bout	B4208 North	Bye Road	-	-	1	0	2011	1.00	-	0.99	1.00	-	-	0%	0%
5	A	C	5Ain	5Cout	5Ain-5Cout	B4208 North	B4208 South	478.26	332.25	-	-	2001	-	-	-	-	6.68	13.73	-	-
5	B	C	5Bin	5Cout	5Bin-5Cout	Bye Road	B4208 South	47.76	33.18	253	71	2011	251.99	70.98	250.98	251.91	-	-	0%	0%
5	B	A	5Bin	5Aout	5Bin-5Aout	Bye Road	B4208 North	-	-	1	0	2011	1.00	-	0.99	1.00	-	-	0%	0%
5	C	A	5Cin	5Aout	5Cin-5Aout	B4208 South	B4208 North	1,247.32	866.51	-	-	2001	-	-	-	-	17.44	8.87	-	-
5	C	B	5Cin	5Bout	5Cin-5Bout	B4208 South	Bye Road	24.23	16.83	115	135	2011	114.54	134.96	114.08	114.51	0.08	0.04	0%	0%
6	A	B	6Ain	6Bout	6Ain-6Bout	Pound Common	B4211 East	9.07	6.30	6	6	2011	5.98	6.00	5.95	5.97	-	-	0%	0%
6	A	C	6Ain	6Cout	6Ain-6Cout	Pound Common	B4208 South	39.30	27.30	90	92	2011	89.64	91.97	89.28	89.61	0.41	0.83	0%	1%
6	A	D	6Ain	6Dout	6Ain-6Dout	Pound Common	B4208 West	-	-	2	6	2011	1.99	6.00	1.98	1.99	-	-	0%	0%
6	B	C	6Bin	6Cout	6Bin-6Cout	B4211 East	B4208 South	-	-	1	2	2011	1.00	2.00	0.99	1.00	-	-	0%	0%
6	B	D	6Bin	6Dout	6Bin-6Dout	B4211 East	B4208 West	634.89	441.06	322	277	2011	320.71	276.92	319.43	320.62	-	-	0%	0%
6	B	A	6Bin	6Aout	6Bin-6Aout	B4211 East	Pound Common	-	-	0	0	2011	-	-	-	-	-	-	-	-
6	C	D	6Cin	6Dout	6Cin-6Dout	B4208 South	B4208 West	1,247.32	866.51	247	345	2011	246.01	344.90	245.03	245.94	17.44	8.87	7%	4%
6	C	A	6Cin	6Aout	6Cin-6Aout	B4208 South	Pound Common	-	-	0	0	2011	-	-	-	-	-	-	-	-
6	C	B	6Cin	6Bout	6Cin-6Bout	B4208 South	B4211 East	-	-	3	1	2011	2.99	1.00	2.98	2.99	-	-	0%	0%
6	D	A	6Din	6Aout	6Din-6Aout	B4208 West	Pound Common	-	-	0	0	2011	-	-	-	-	-	-	-	-
6	D	B	6Din	6Bout	6Din-6Bout	B4208 West	B4211 East	1,395.75	969.63	188	279	2011	187.25	278.92	186.50	187.19	-	-	0%	0%
6	D	C	6Din	6Cout	6Din-6Cout	B4208 West	B4208 South	438.96	304.94	131	241	2011	130.48	240.93	129.95	130.44	6.28	12.90	5%	10%

Figure 2-2 Example of a junction turns diagram

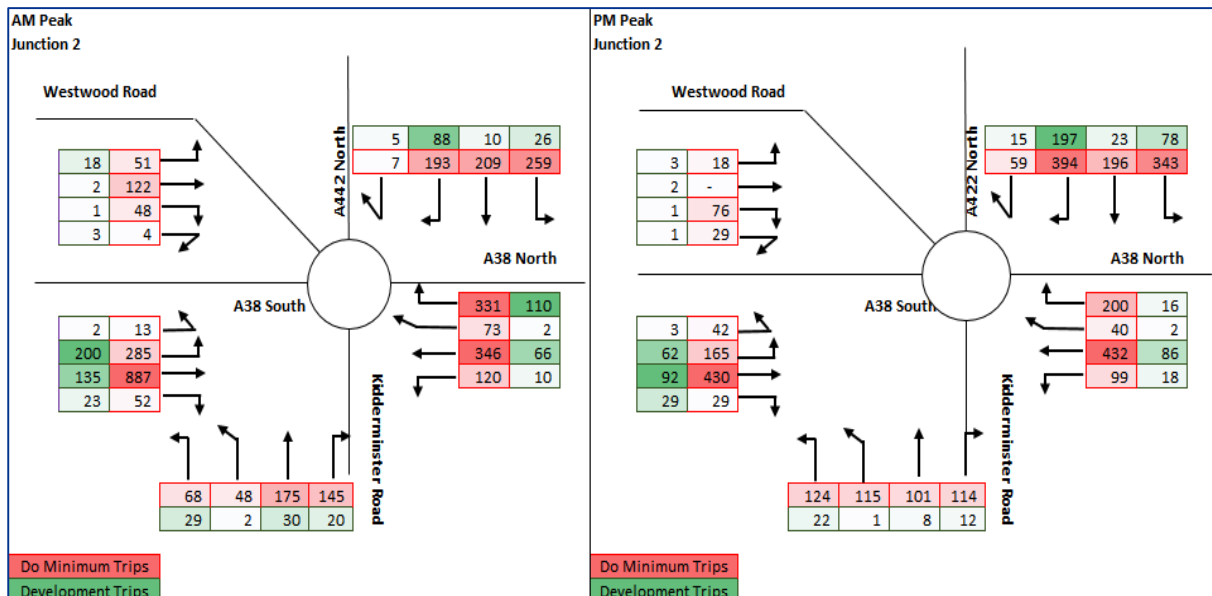
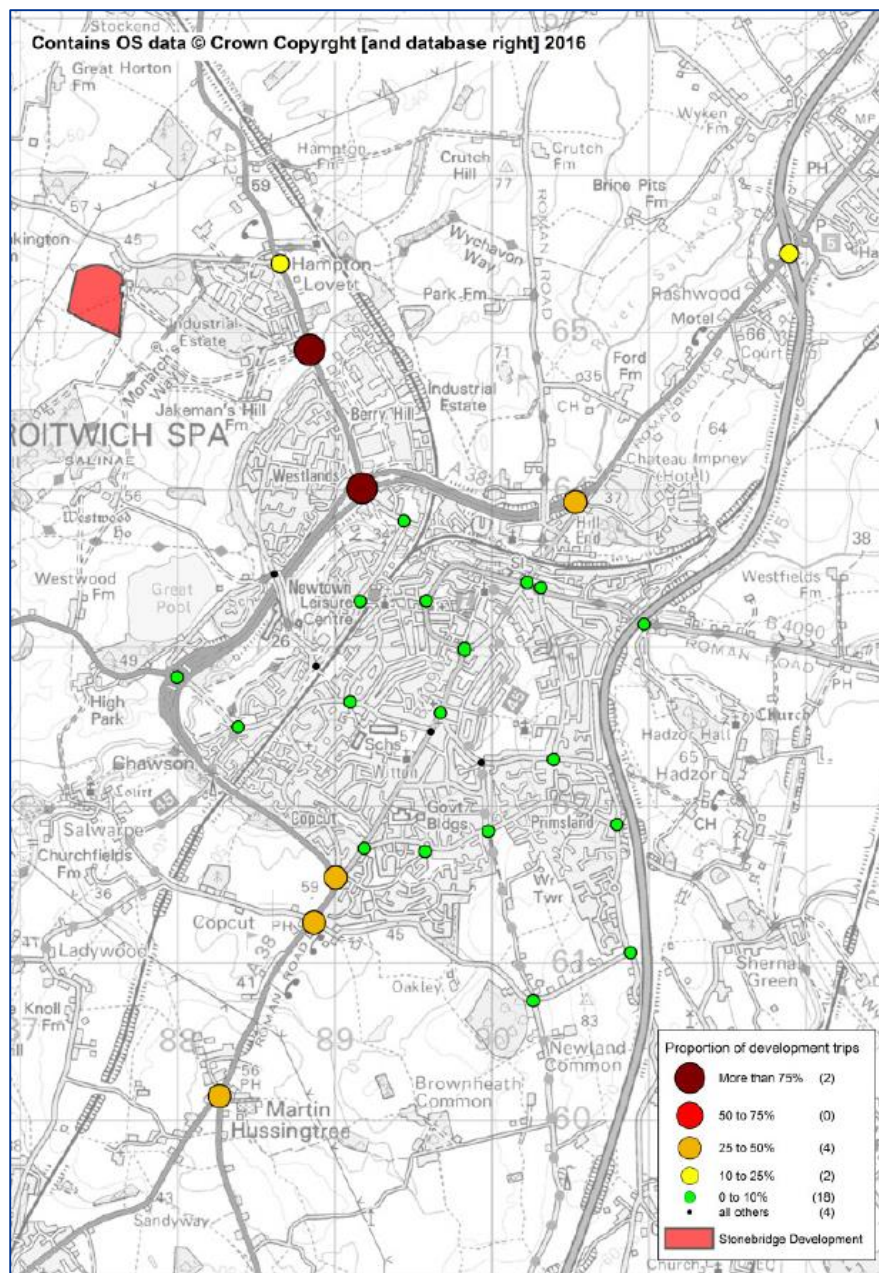


Figure 2-3 Example of a map representing a development's impact on each junction



3. 2018-19 Tool Update Requirements

3.1 Input Parameter Updates

The following data has been used for the previous development models:

- Land take to Gross Floor Area conversion factors
- TRICS residential and employment trip rates
- TEMPro growth factors
- 'Travel to Work' census data
- NTS trips by trip purpose and trip purpose by start time

- Development data (location, size, trip rates)
- Traffic data (Junction turning counts)

Table 3-1 Input Data Update Requirements

Data	Description	Status	Action
Land take to Gross Floor Area conversion factor	Factors to convert net land take into Gross Floor Area (GFA), accounting for the difference between land take and effective development size. GFA is the required input for employment trip rates calculation using TRICS.	Current data is from 2010	Update with more recent data
Trip rates	Trip rates sourced from TRICS database for residential and employment sites	Current data covers 01/2007 – 05/2014 (Malvern) respectively 01/2007 – 05/2015 (Droitwich)	Update all trip rates from TRICS to include latest available data
TEMPro Growth factors	Growth factors based on the National Trip End Model used to obtain traffic growth in future years	TEMPro v6.2 was used. Version 7.2 of TEMPro with updated factors is available. Model zones have changed to MSOA zones with version 7	Identify corresponding MSOA zones and obtain updated TEMPro growth factors using the latest TEMPro version 7.2
Traffic distribution	Traffic distribution is estimated using Travel to Work data (Location of usual residence and place of work (OA level) [WF01BEW])	Data from the Census 2011 was used. This is still the most recent census available.	No action required
Trips by trip purpose and trips by start time	The ratio of work to non-work trips and the ratio of day to peak hour trips is calculated with NTS data (NTS table 0502 and 0503).	Current data is sourced from NTS 2013. NTS 2017 has been published	Update ratios from NTS 2017 data
Development data	Size and location (and trip rates if available) of developments within the study area	Current data is based on South Worcestershire Development Plan from 2015. Latest adopted version is from February 2016	Agree on sites to be included and update development sites
Traffic count data	Traffic data for key junctions obtained from junction turning counts and automatic traffic counts	Current data is outdated (older than 5 years) or has not been collected	Agree on junctions to be modelled and collect turning counts for junctions to be modelled
Road network layer	Road network in the study area is sourced from the Ordnance Survey (OS) Open Roads network layer	Current layer is from 2012 (Malvern) and 2016 (Droitwich) might be outdated due to changes in the road network	Update OS Open Roads layer for the study areas

3.2 Potential Enhancements for 2018-19 Updates

Currently, the model calculates future turning movements for each modelled junction. While this illustrates changes caused by developments in both absolute numbers and relative change, this does not provide any indication regarding the impact of additional traffic on the link capacity and junction saturation flow.

A potential enhancement of the model could therefore consist in estimating the link stress calculated as the volume-over-capacity (V/C) ratio of links leading into the modelled junctions. Moving away from the optimal flow, an increased V/C ratio approaching or exceeding unity translates into a significant decreased travel speed and increased congestion.

Therefore, V/C ratios would provide an additional assessment of how development traffic contributes to traffic volume on key links and whether this additional traffic increases link stress significantly, i.e. causes the volume over capacity ratio to exceed the critical threshold (95%).

Calculating V/C for key links on the modelled junctions requires flow volume and capacities for the links to be assessed. In the unlikely case that link capacities are available, they would be the preferred option. Otherwise, the DMRB provides guidance on how to estimate link capacities based on road characteristics and classification.

If the DMRB estimation approach is to be used, the following link data is necessary along with the potential source of data:

- Lane width (estimated through satellite imagery or assumed lane width)
- Share of HGV vehicles in the peak hour (to be provided by ATC data collection)
- Urban/Rural and road type classification (single/dual carriageway or motorway)

Given this data, it is possible to provide an approximate assessment of the additional link stress caused by developments, complementing the change in turning movements.

4. Strensham

4.1 Overview

It is understood that there are early feasibility proposals for a new settlement to be constructed in south Worcestershire, specifically to the east of Upton-upon-Severn on the A38 corridor. The network in this area is rural in nature and sparse.

It is understood that a high level impact assessment of this potential development is required. Given the early stage of this development and limited details available at this time, a high level assessment is proposed.

The extent of the study area of the Strensham development assessment is proposed to cover the A38 corridor between Severn Stoke and M50 J1, and the A4104 between Baughton and Upton-upon-Severn. Specifically, four links and two junctions could be considered;

- The A38 to the north of the A4104;
- The A38 to the south of the A4104;
- The A4104 between the A38 and Baughton;
- The A4104 between the A38 and Upton-upon-Severn;

- The A4104 / B4211 roundabout within Upton-upon-Severn; and,
- M50 J1 (both the slip road roundabouts and slip roads)

4.2 Key Input Assumptions (to be agreed with WCC)

The following bullets set out the key input assumptions which will need to be sourced and agreed with WCC in order to complete the high level impact assessment.

- Estimated type and quantum of development
- Representative trip rates
- Loading point(s) on the road network
- Key routing and route choice decisions

4.3 Methodology

The assessment of the Strensham development will broadly follow the same methodology as the DDM and MDM, but without their tool set-up sophistication.

- **Trip Generation** – based on agreed representative trip rates and applied to the development quantum
- **Trip Distribution** – based on journey to work (JtW) data contained within the 2011 Census dataset.
- **Trip Assignment** – based on a quickest route assignment. Given the high level nature of this assessment, forecast demand to key destinations could be split between two or more alternative routes.

4.4 Impact Assessments

The following bullet points list out the proposed assessments which will be undertaken in order to determine the traffic impact assessment of the Strensham development. These assessments are considered to be suitably proportionate given the limited information available and number of assumptions surrounding the proposed development at this time.

- Link capacity assessments on the A38 and A4104 (in line with DMRB Vol 5 Section 1 Part 3 TA 79/99 Amendment No 1 Traffic capacity of urban roads and TA 46/97 Traffic flow ranges for use in the assessment of new rural roads)
- Junctions 9 assessment of the A4104 and B4211 roundabout in Upton-upon-Severn
- Junctions 9 assessment of the two slip road roundabouts at M50 J1
- Merge-diverge assessments of M50 J1 (in line with DMRB Volume 6 Section 2 Part 1 TD 22/06 Layout of grade separated junctions)

There exists a staggered priority junction between the A4104 and A38. It is assumed that if this development were to be constructed, then this junction would be extensively re-modelled. It is therefore not proposed to complete any assessment of this junction.

In addition, it would be possible for high level environmental assessments to be undertaken on key links in the area of the proposed development covering noise and air quality impacts.

4.5 Data Requirements

In order to complete the above assessments, the following data will be required:

- Geometric drawings of the A4104 and B4211 roundabout in Upton-upon-Severn;
- Classified turning counts at the A4104 and B4211 roundabout in Upton-upon-Severn;
- Geometric drawings of the two slip road roundabouts at M50 J1;
- Classified turning counts at the two slip road roundabouts at M50 J1;
- Classified link counts on the A38 to the north and south of the A4104; and,
- Classified link counts of the A4104 to the east and west of the A38.
- Speed limit information (if not gathered as part of the link counts)

5. Traffic Survey Scope

5.1 Existing Data Locations and Age

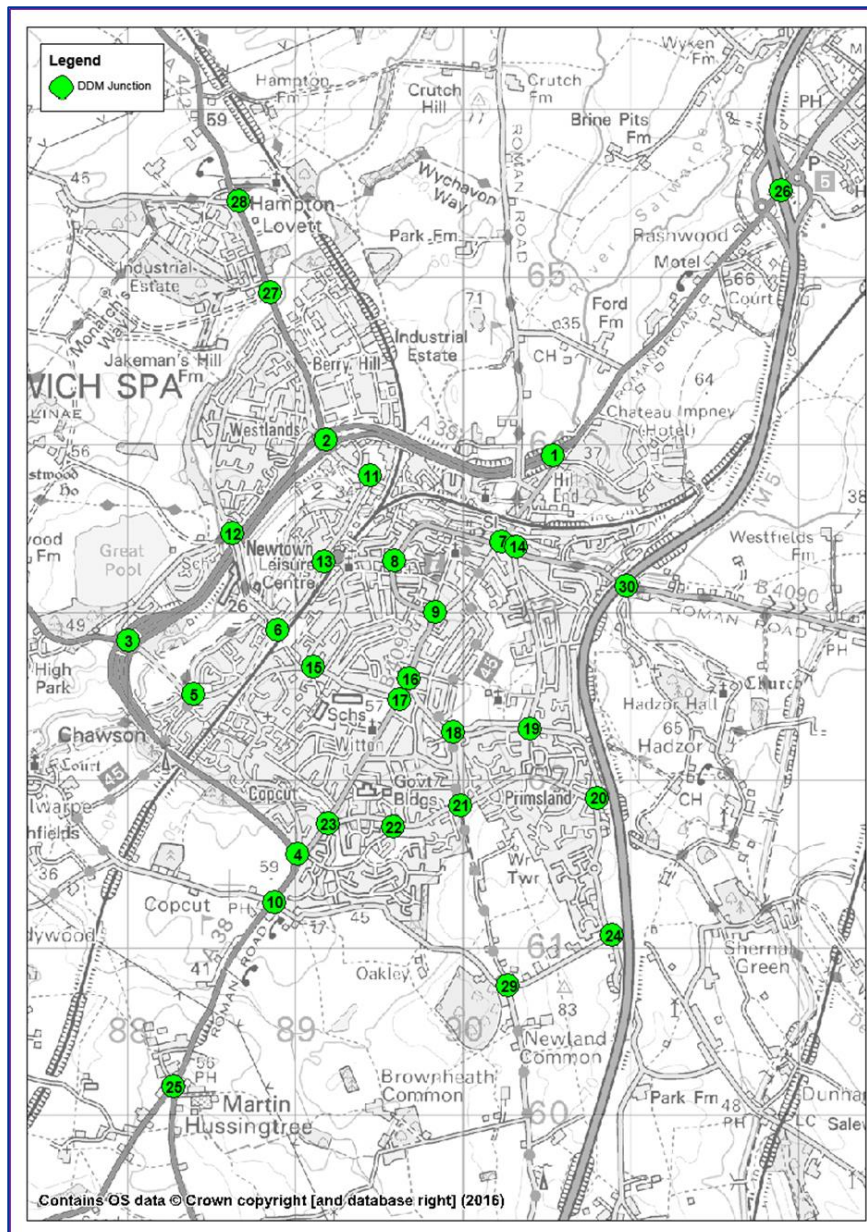
5.1.1 Droitwich

Existing Junctions in the DDM and available traffic count data

Junction ID	Arms	Traffic Count Available?	Count type	Data older than five years?
1	A38 North / B4065 Bromsgrove Road / A38 South	✓	Classified Turning Counts	Yes (2009)
2	Kidderminster Road North / A38 East / Kidderminster Road South / A38 West / Westwood Road	✓	Classified Turning Counts	Yes (2009)
3	Westwood Way / A38 North / Ombersley Way / A38 South / A4133	✓	Classified Turning Counts	Yes (2009)
4	Celvestune Way / B4090 Worcester Road / Addyes Way / A38 South / A38 West	✓	Classified Turning Counts	Yes (2009)
5	Ombersley Way East / New Chawson Lane / Ombersley Way West	✓	Classified Turning Counts	Yes (2009)
6	Briar Mill / Ombersley Way North / Ombersley Way South	✓	Classified Turning Counts	Yes (2009)
7	B4065 Bromsgrove Road / B4090 Hanbury Street / Queen Street / B4090 Saltway	✓	Classified Turning Counts	Yes (2009)
8	B4090 Saltway North / Covercroft / B4090 Saltway South / Ombersley Way	✓	Classified Turning Counts	Yes (2007)
9	Worcester Road / B4090 Worcester Road South / B4090 Saltway	✓	Classified Turning Counts	Yes (2007)
10	A38 North / Pulley Lane / A38 South / Copcut Lane	✓	Classified Turning Counts	Yes (2010)
11	Kidderminster Road East / Salwarpe Road / Honeymans Gardens / Kidderminster Road West	✗	n/a	n/a
12	Westwood Road / Briar Mill / Westwood Way	✗	n/a	n/a
13	Salwarpe Road / Ombersley Way East / Ombersley Way South / Ledwych Road	✗	n/a	n/a
14	B4090 Hanbury Road / The Holloway / B4090 Hanbury Street	✗	n/a	n/a
15	Stalls Farm Road / Old Coach Road / Celvestune Way	✗	n/a	n/a
16	B4090 Worcester Road North / Tagwell Road / B4090 Worcester Road South	✗	n/a	n/a

Junction ID	Arms	Traffic Count Available?	Count type	Data older than five years?
17	B4090 Worcester Road North / B4090 Worcester Road South / Old Coach Road	✗	n/a	n/a
18	Tagwell Road East / Newland Road / Tagwell Road West	✗	n/a	n/a
19	The Holloway / Tagwell Road East / Tagwell Road West	✗	n/a	n/a
20	Tagwell Road North / Primsland Way / Tagwell Road South	✗	n/a	n/a
21	Newland Road / Primsland Way East / Primsland Way West	✗	n/a	n/a
22	Elgar Crescent / Primsland Way East / Addyes Way / Primsland Way West	✗	n/a	n/a
23	B4090 Worcester Road North / Primsland Way / B4090 Worcester Road South	✗	n/a	n/a
24	Tagwell Road / Unnamed Road / Newland Lane	✗	n/a	n/a
25	A38 North / Pershore Lane / A38 South Droitwich Road	✗	n/a	n/a
26	M5 North Offslip / A38 North Worcester Road / Amphlett Way / M5 South Onslip / M5 South Offslip / A38 South / M5 North Onslip	✗	n/a	n/a
27	Kidderminster Road North / Kidderminster Road South / Pointon Way	✓	Classified Turning Count	No (2016)
28	A442 / Kidderminster Road / Wassage Way South	✗	n/a	n/a
29	Newland Road / Newland Lane / Newland Common Road / Pulley Lane	✗	n/a	n/a
30	B4090 Hanbury Road East / Hadzor Lane / B4090 Hanbury Road West	✗	n/a	n/a

Figure 5-1 Location of existing junctions in the DDM



5.1.2 Malvern

Table 5-1 Existing Junctions in the MDM and available traffic count data

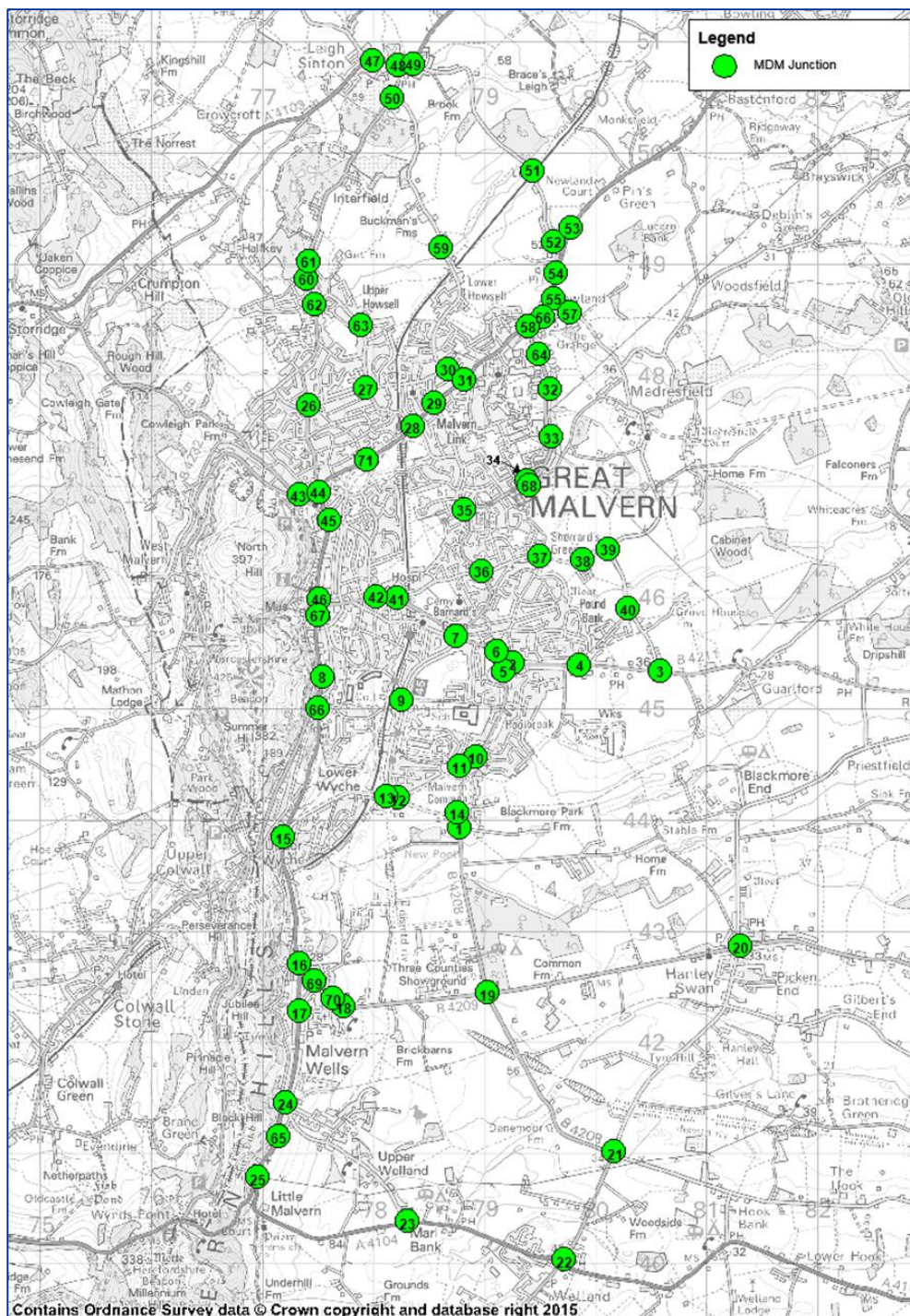
Junction	Arms	Traffic Count Available?	Count Type	Older than five years?
1	B4208 / Blackmore Park	✗	n/a	n/a
2	B4211 / Bye Road	✓	Classified Turning Counts	Yes (2011)
3	B4211 / Chance Lane	✗	n/a	n/a
4	B4211 / Hall Green	✗	n/a	n/a

Junction	Arms	Traffic Count Available?	Count Type	Older than five years?
5	B4208 / Bye Road	✓	Classified Turning Counts	Yes (2011)
6	B4211 / B4208	✓	Classified Turning Counts	Yes (2011)
7	B4211 / Upper Chase Road / B4208 / Ct Road / Ave Road	✗	n/a	n/a
8	A449 / Wyche Road	✗	n/a	n/a
9	Court Road / St Andrew's Road / Thirlstane Road	✗	n/a	n/a
10	B4208 / Longridge Road	✓	Classified Turning Counts	Yes (2011)
11	Britten Drive / Longridge Road	✗	n/a	n/a
12	Longridge Road / Peachfield Road	✗	n/a	n/a
13	St Andrew's Road / Peachfield Road	✗	n/a	n/a
14	B4208 / Peachfield Road	✗	n/a	n/a
15	A449 / Peachfield Road	✗	n/a	n/a
16	A449 / B4209	✗	n/a	n/a
17	A449 / Grundy's Lane / Green Lane	✗	n/a	n/a
18	B4209 / Rothwell Road / Green Lane	✗	n/a	n/a
19	B4208 / B4209	✗	n/a	n/a
20	Worcester Road / B4209 / Welland Road	✗	n/a	n/a
21	Welland Road / B4208	✗	n/a	n/a
22	B4208 / A4104	✗	n/a	n/a
23	Upper Welland Road / A4104	✗	n/a	n/a
24	A449 / Upper Welland Road	✗	n/a	n/a
25	A449 / A4104	✗	n/a	n/a
26	B4503 / Somers Park Avenue / Albert Park Road / Belmont Road	✗	n/a	n/a
27	Upper Howsell Road / Church Road / Howsell Road / Somers Park Avenue	✓	Classified Turning Counts	Yes (2011)
28	Howsell Road / A449 / Pickersleigh Road	✓	Classified Turning Counts	Yes (2011)
29	Richmond Road / A449 / Pickersleigh Avenue	✗	n/a	n/a
30	Lower Howsell Road / Church Road	✓	Classified Turning Counts	Yes (2011)
31	Lower Howsell Road / A449	✓	Classified Turning Counts	Yes (2013)
32	B4208 / Grove Wood Road	✗	n/a	n/a
33	B4208 / Mansfield Road / Sandy's Road	✗	n/a	n/a

Junction	Arms	Traffic Count Available?	Count Type	Older than five years?
34	B4208 / North End Lane	✓	Classified Turning Counts	Yes (2011)
35	Pickersleigh Road / B4208 / Hayslan Road	✓	Classified Turning Counts	Yes (2011)
36	B4208 / Madresfield Road	✗	n/a	n/a
37	Mayfield Road / Madresfield Road / Pound Bank Road	✓	Classified Turning Counts	Yes (2011)
38	Madresfield Road / Development Access	✗	n/a	n/a
39	Madresfield Road / Chance Lane	✗	n/a	n/a
40	Chance Lane / Hall Green	✗	n/a	n/a
41	Madresfield Road / B4211	✗	n/a	n/a
42	Albert Road / B4211	✗	n/a	n/a
43	B4219 / B4503 / B4232	✗	n/a	n/a
44	A449 / B4503 / Hornyold Road	✗	n/a	n/a
45	A449 / Bank Street / B4232	✗	n/a	n/a
46	A449 / Edith Walk / B4211	✗	n/a	n/a
47	Sherridge Road / A4103	✗	n/a	n/a
48	A4103 / B4503	✓	Classified Turning Counts	Yes (2011)
49	A4103 / Stocks Lane	✗	n/a	n/a
50	B4503 / Lower Howsell Road	✓	Classified Turning Counts	Yes (2011)
51	Stocks Lane / Development Access	✗	n/a	n/a
52	Stocks Lane / A449	✗	n/a	n/a
53	A449 / Stocks Lane	✓	Classified Turning Counts	Yes (2011)
54	Stocks Lane / A449	✗	n/a	n/a
55	A449 / Madresfield Road	✓	Classified Turning Counts	Yes (2011)
56	A449 / Madresfield Road	✓	Classified Turning Counts	Yes (2011)
57	A449 / Madresfield Road	✗	n/a	n/a
58	A449 / B4208	✓	Classified Turning Counts	Yes (2011)
59	Lower Howsell Road / Development Access	✗	n/a	n/a
60	B4503 / Halfkey Road	✓	Classified Turning Counts	Yes (2011)
61	B4503 / Grit Lane	✓	Classified Turning Counts	Yes (2011)

Junction	Arms	Traffic Count Available?	Count Type	Older than five years?
62	B4503 / Tanhouse Lane	✓	Classified Turning Counts	Yes (2011)
63	Tanhouse Lane / Eastward Road / Michael Crescent	✓	Classified Turning Counts	Yes (2011)
64	B4208 / Roman Way	✗	n/a	n/a
65	Holywell Road / A449 / Kings Road	✗	n/a	n/a
66	A449 / Abbey Road / Foley Terrace	✗	n/a	n/a
67	A449 / B4211	✗	n/a	n/a
68	BMX Track Development Access	✓	Classified Turning Counts	Yes (2011)
69	Hanley Road / Wood Farm Road	✓	Classified Turning Counts	Yes (2011)
70	Hanley Development Access	✓	Classified Turning Counts	n/a
71	A449 / Albert Park Road	✗	n/a	n/a

Figure 5-2 Location of existing junctions in the MDM



5.2 New Traffic Data Collection

As mentioned in the update requirements, it will be necessary to collect traffic data for key junctions and links in the model area to update the two developments models. For key junctions, this should be in the form of 12 hr junction turn counts. For key links, two-way 24hr automatic traffic counts (ATC) should be conducted as well.

The tables below summarize the required data collection for Droitwich (Table 5-2) and Malvern (Table 5-3 and Table 5-4).

Table 5-2 Suggested Junction Counts in Droitwich

Junction ID	Arms	Count Type
1	A38 North / B4065 Bromsgrove Road / A38 South	12hr Classified Turning Count
2	Kidderminster Road North / A38 East / Kidderminster Road South / A38 West / Westwood Road	12hr Classified Turning Count
3	Westwood Way / A38 North / Ombersley Way / A38 South / A4133	12hr Classified Turning Count
4	Celvestune Way / B4090 Worcester Road / Addyes Way / A38 South / A38 West	12hr Classified Turning Count
5	Ombersley Way East / New Chawson Lane / Ombersley Way West	12hr Classified Turning Count
6	Briar Mill / Ombersley Way North / Ombersley Way South	12hr Classified Turning Count
7	B4065 Bromsgrove Road / B4090 Hanbury Street / Queen Street / B4090 Saltway	12hr Classified Turning Count
8	B4090 Saltway North / Covercroft / B4090 Saltway South / Ombersley Way	12hr Classified Turning Count
9	Worcester Road / B4090 Worcester Road South / B4090 Saltway	12hr Classified Turning Count
10	A38 North / Pulley Lane / A38 South / Copcut Lane	12hr Classified Turning Count
11	Kidderminster Road East / Salwarpe Road / Honeymans Gardens / Kidderminster Road West	12hr Classified Turning Count
13	Salwarpe Road / Ombersley Way East / Ombersley Way South / Ledwych Road	12hr Classified Turning Count
16	B4090 Worcester Road North / Tagwell Road / B4090 Worcester Road South	12hr Classified Turning Count
17	B4090 Worcester Road North / B4090 Worcester Road South / Old Coach Road	12hr Classified Turning Count
19	The Holloway / Tagwell Road East / Tagwell Road West	12hr Classified Turning Count
21	Newland Road / Primsland Way East / Primsland Way West	12hr Classified Turning Count
24	Tagwell Road / Unnamed Road / Newland Lane	12hr Classified Turning Count
26	M5 North Offslip / A38 North Worcester Road / Amphlett Way / M5 South Onslip / M5 South Offslip / A38 South / M5 North Onslip	12hr Classified Turning Count
27	Kidderminster Road North / Kidderminster Road South / Pointon Way	12hr Classified Turning Count

Figure 5-3 Suggested traffic counts for junctions in the DDM



Table 5-3 Suggested Junction Counts in Malvern

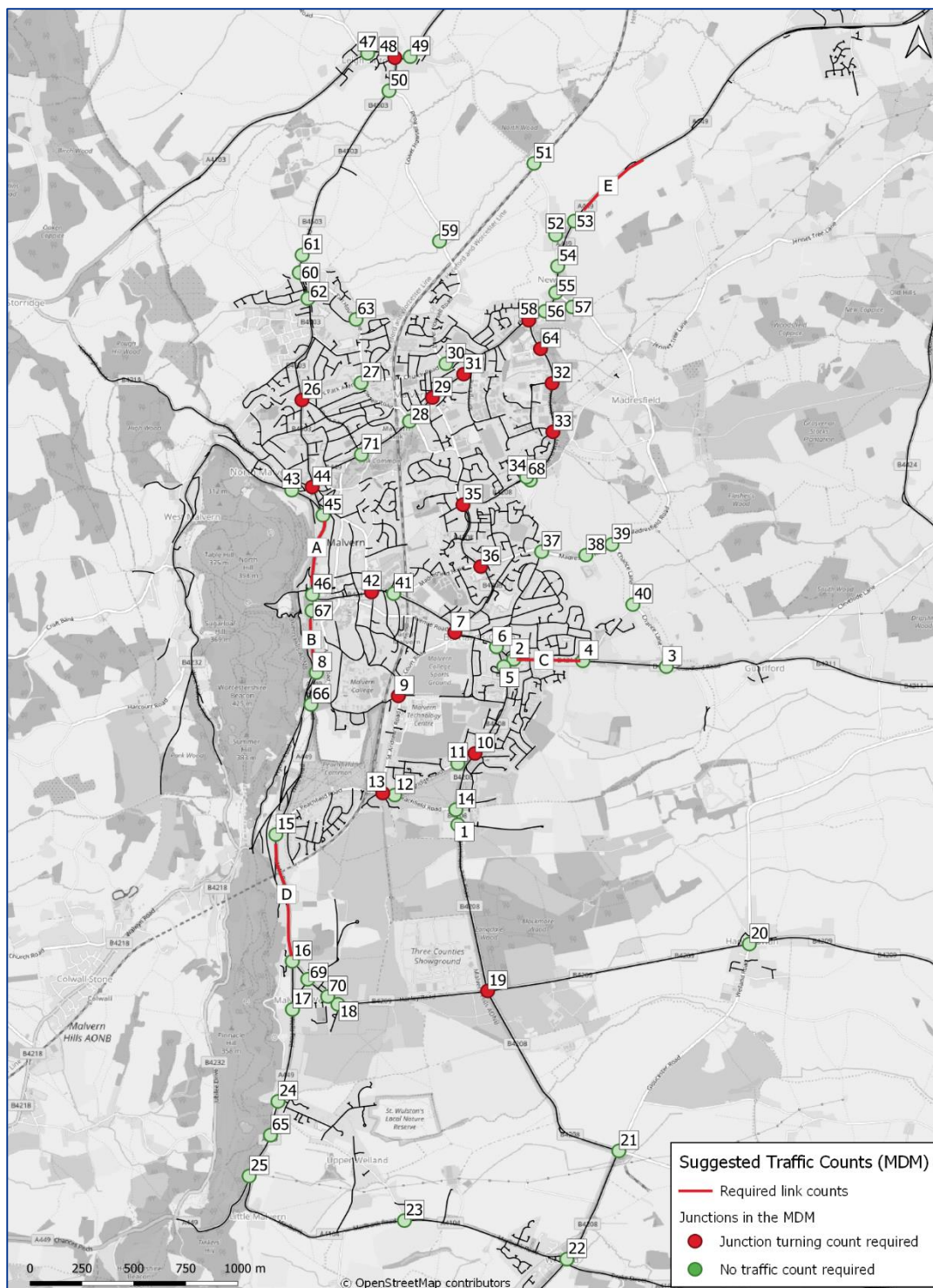
Junction	Arms	County Type
7	B4211 / Upper Chase Road / B4208 / Ct Road / Ave Road	12hr Classified Turning Count
9	Court Road / St Andrew's Road / Thirlstane Road	12hr Classified Turning Count
10	B4208 / Longridge Road	12hr Classified Turning Count
13	St Andrew's Road / Peachfield Road	12hr Classified Turning Count
19	B4208 / B4209	12hr Classified Turning Count

Junction	Arms	County Type
26	B4503 / Somers Park Avenue / Albert Park Road / Belmont Road	12hr Classified Turning Count
29	Richmond Road / A449 / Pickersleigh Avenue	12hr Classified Turning Count
31	Lower Howsell Road / A449	12hr Classified Turning Count
32	B4208 / Grove Wood Road	12hr Classified Turning Count
33	B4208 / Mansfield Road / Sandy's Road	12hr Classified Turning Count
34	B4208 / North End Lane	12hr Classified Turning Count
35	Pickersleigh Road / B4208 / Hayslan Road	12hr Classified Turning Count
36	B4208 / Madresfield Road	12hr Classified Turning Count
42	Albert Road / B4211	12hr Classified Turning Count
44	A449 / B4503 / Hornyold Road	12hr Classified Turning Count
48	A4103 / B4503	12hr Classified Turning Count
58	A449 / B4208	12hr Classified Turning Count
64	B4208 / Roman Way	12hr Classified Turning Count

Table 5-4 Suggested Link Counts in Malvern

Link	Location	Road	County Type
A	Link between junction 45 and junction 46	A449 Worcester Road	Two-directional ATC count
B	Link between junction 67 and junction 8	A449 Wells Road	Two-directional ATC count
C	Link between junction 2 and junction 4	B4211 Guarlford Road	Two-directional ATC count
D	Link between junction 15 and 16	A449 Wells Road	Two-directional ATC count
E	Link north of 53	A449	Two-directional ATC count

Figure 5-4 Suggested traffic counts for links and junctions in the MDM



6. Capability Statements

6.1 DDM and MDM

The Worcestershire development models are spreadsheet based tools designed to estimate the forecast traffic generation, distribution and assignment effect of traffic arising from new developments in Worcestershire.

There are certain elements of the methodology however which restrict the tools to only being an estimating facility, rather than a sophisticated model:

- **All-or-Nothing assignment** – demand between each origin and destination, only a single route is taken by all traffic demand. There is no route choice or reassignment within the development tools.
- **Quickest route assignment** – the route between each origin and destination is defined by the quickest route on an unconstrained network. This tends to lead to more major roads with higher speed limits attracting more origin and destination trips. There is practically no rat-running in the tools.
- **No capacity constraints** – the assignment methodology does not consider the existing or forecast level of traffic on each model link, nor does it consider the capacity of that link.
- **Single mode** – only Car trips are considered within the development tools.
- **No mode shifts** – outside of the trip rates, the tools do not consider shifts of vehicular traffic to sustainable transport modes such as walking, cycling or public transport.
- **No internalisation of development trips** – the tools do not consider the potential for development trips to travel between new development sites. They do however consider internalised trips within each new development as part of the derivation of representative trip rates.

The methodology employed is a first principles approach and the tools are it for purpose as an estimating and guidance facility. The outputs from the tools can be used to indicate which junctions should be assessed in more detail within emerging TAs and can provide an indication as to the likely network stress arising as a result. The output flows from the tools should not be used for design purposes however due to the assignment methodology employed.

6.2 Strensham

The assessment of the proposed Strensham development will be of suitably high level so to be proportionate to the level of detailed information available at this time. The trip generation, distribution and assignment methodology will be completed through the use of industry standard techniques and data sources.

It is understood that WCC anticipate the impact assessments to indicate severe stress on the local road network. This outcome cannot be assured in advance of their completion given the high level of these assessments. The outcome of these assessments should also be reviewed in the future, should more detailed information about the proposed development become available.

7. Summary

This note has set out a high level review as to the methodology and purpose of the Droitwich and Malvern Development Models, which have been used for a number of years to forecast the traffic impact generated by proposed developments in these towns.

With a view to future development aspirations and meeting the evolving needs of Worcestershire County Council, this note has identified a series of updates and enhancements to these development models and associated data collection requirements.

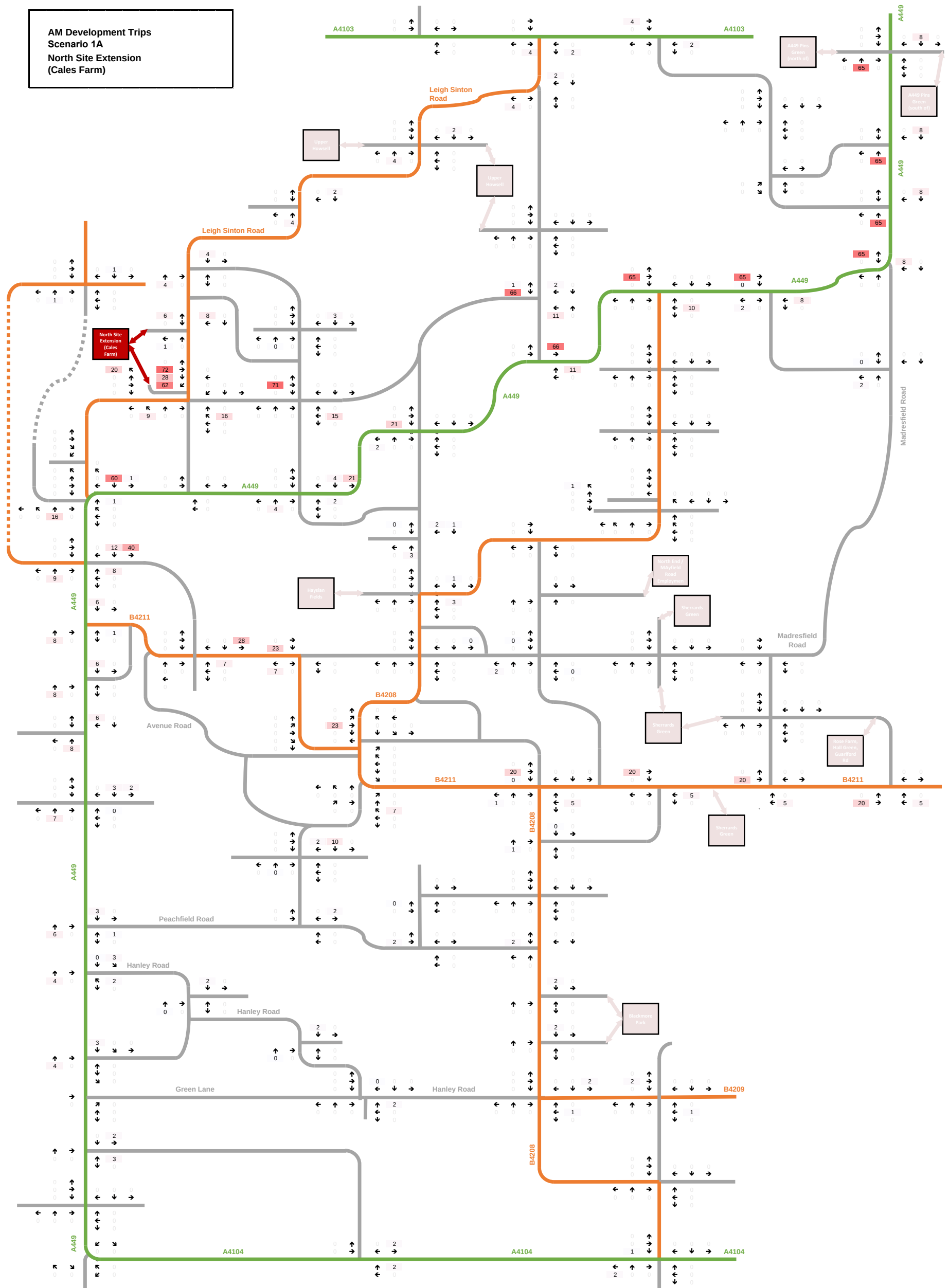
This note also contains a clear capability statement as to the scope of guidance which these models provide to aid decision making by Worcestershire County Council.

In summary:

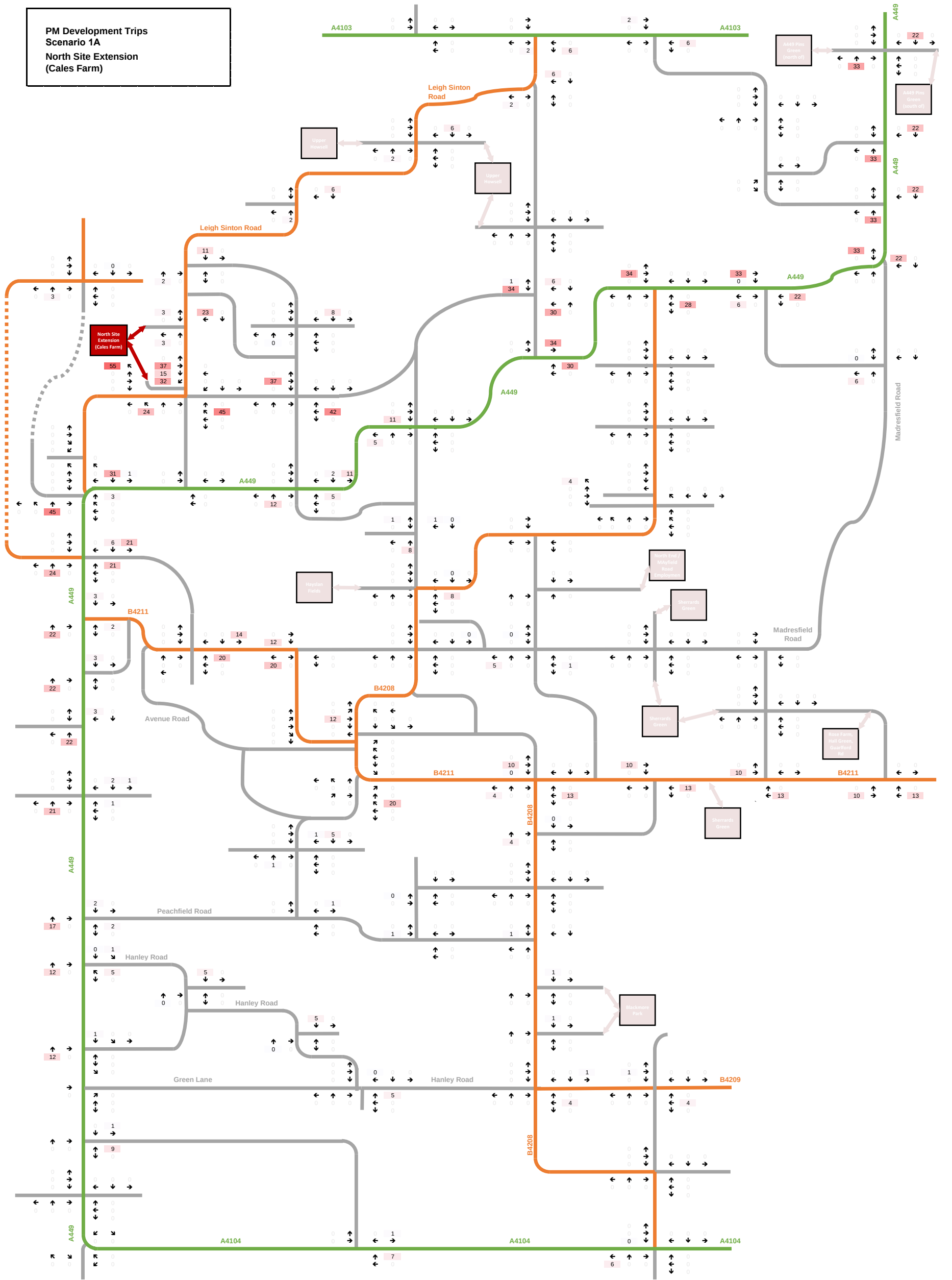
- Development Models are spreadsheet tools suitable for guidance and identification of more detailed transport assessment needs;
- It has been several years since these models were last used and as a result a number of input data parameters should be updated.
- As part of these updates, link stress – V/C ratio calculations are recommended as an enhancement to the level of development impact assessment provided by these models
- To support the above, data collection requirements have been identified
- In addition, a methodology for a high level assessment for Strensham has been set out.

Appendix B. Model Network Schematics

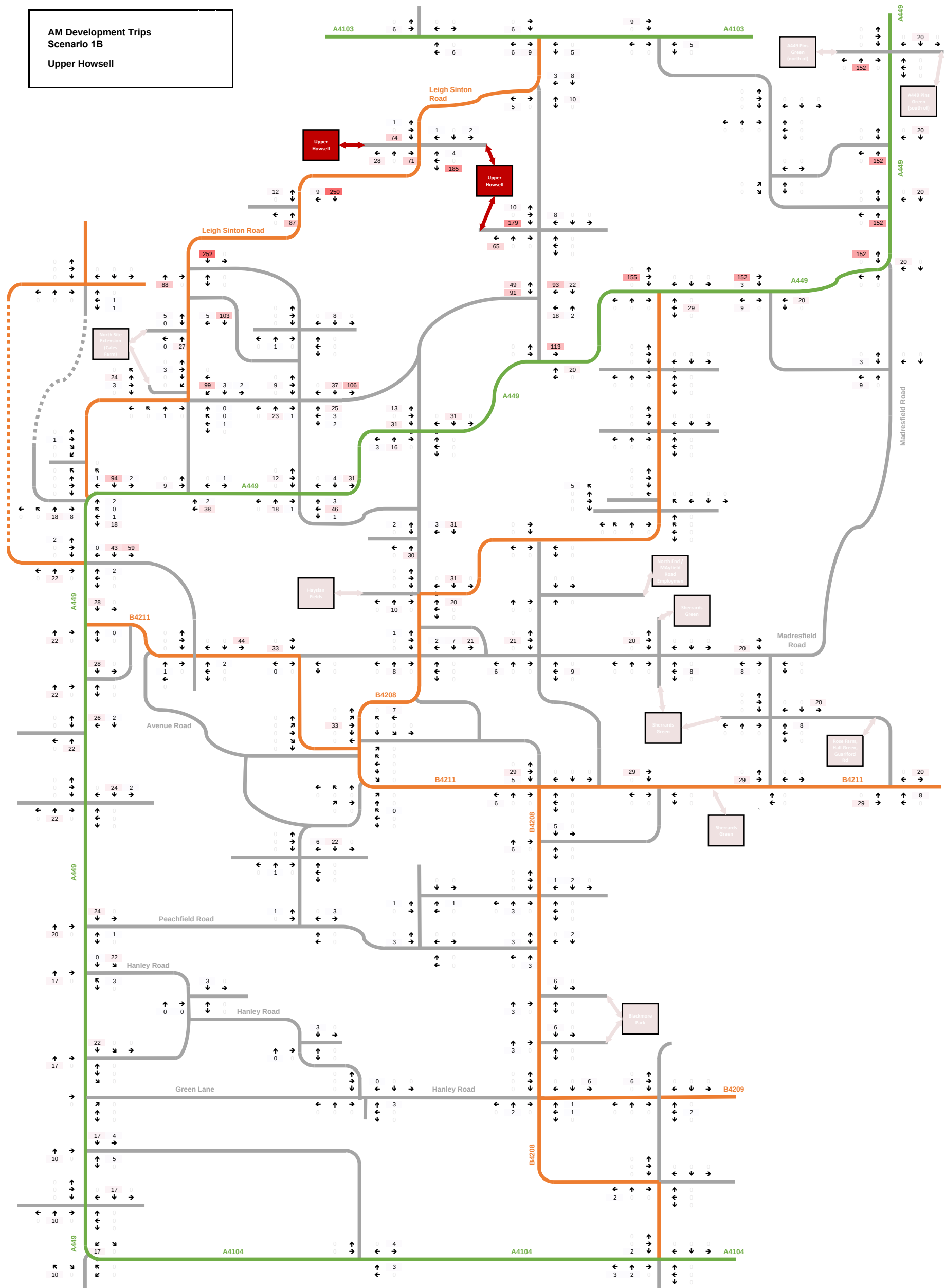
**AM Development Trips
Scenario 1A
North Site Extension
(Cales Farm)**



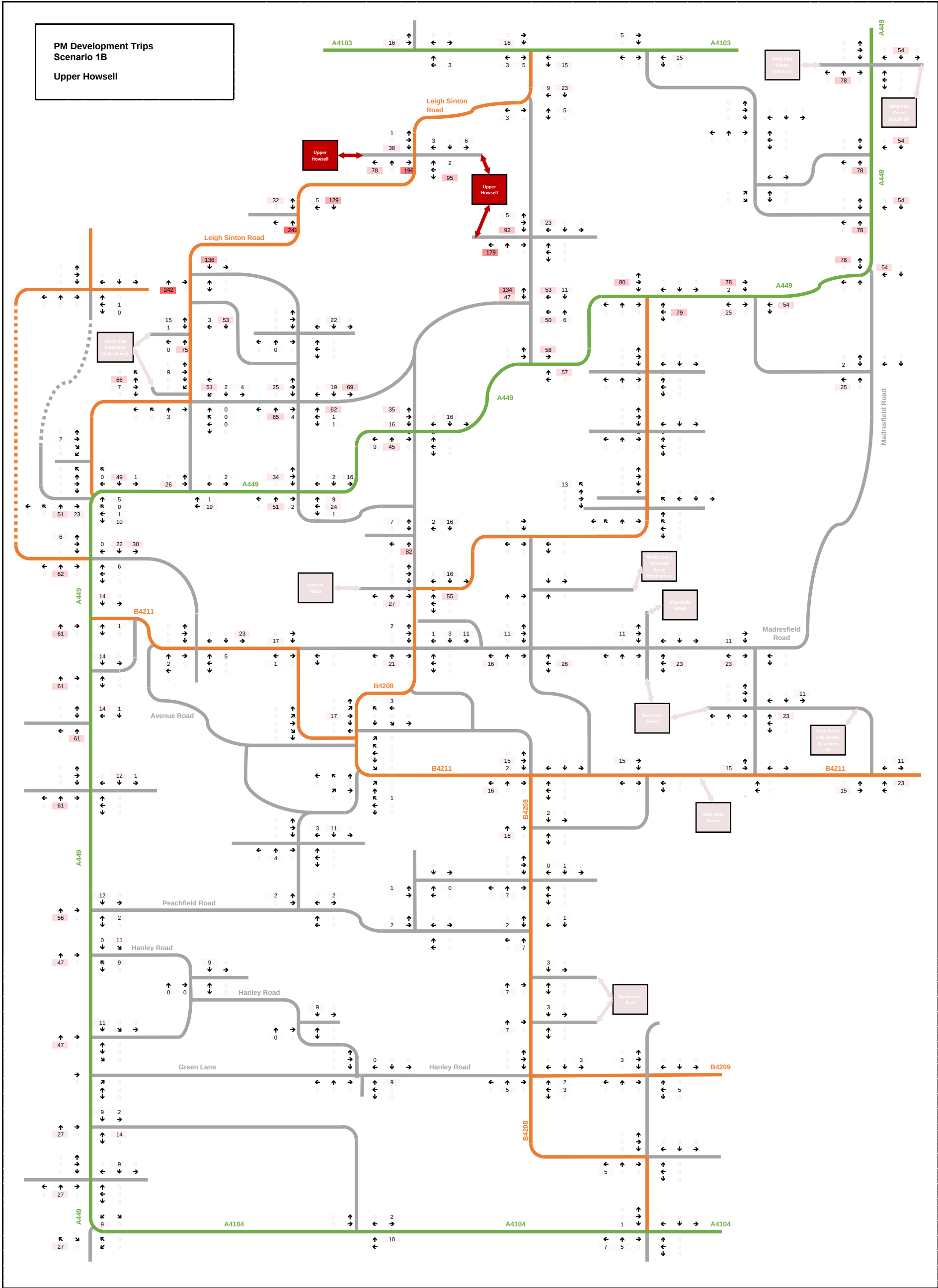
PM Development Trips
Scenario 1A
North Site Extension
(Cales Farm)



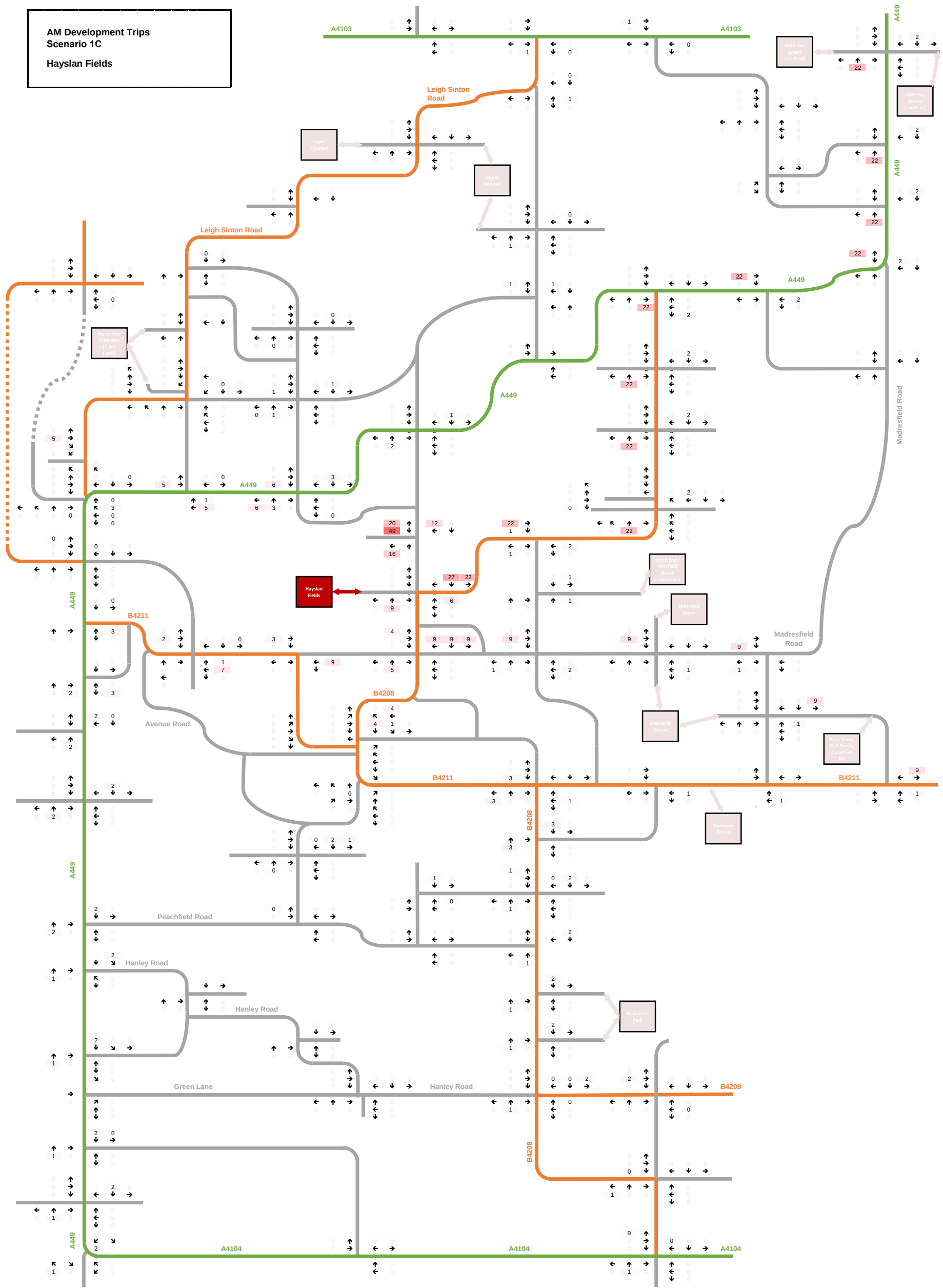
**AM Development Trips
Scenario 1B
Upper Howsell**



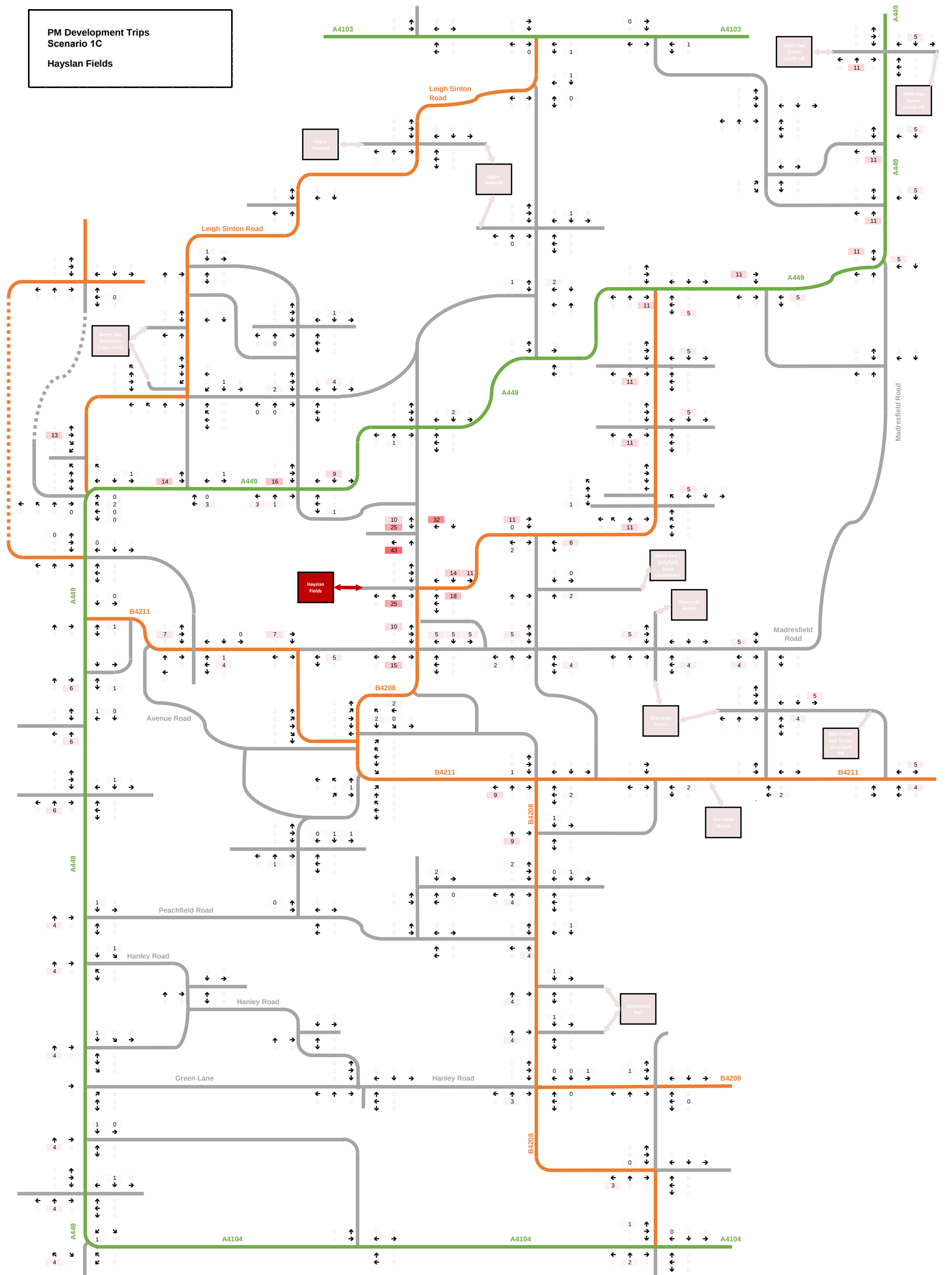
PM Development Trips
Scenario 1B
Upper Howsell



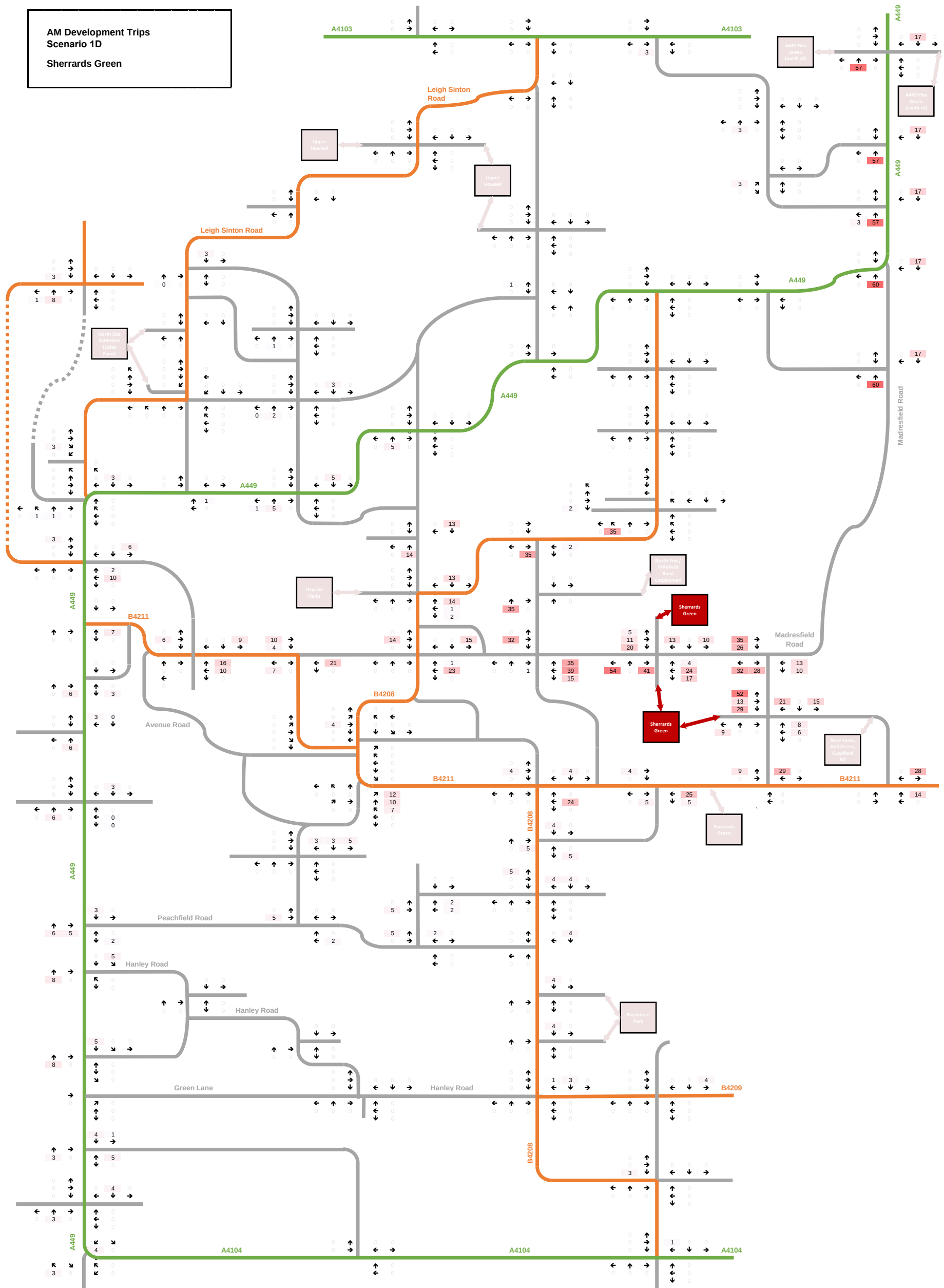
AM Development Trips
Scenario 1C
Hayslan Fields

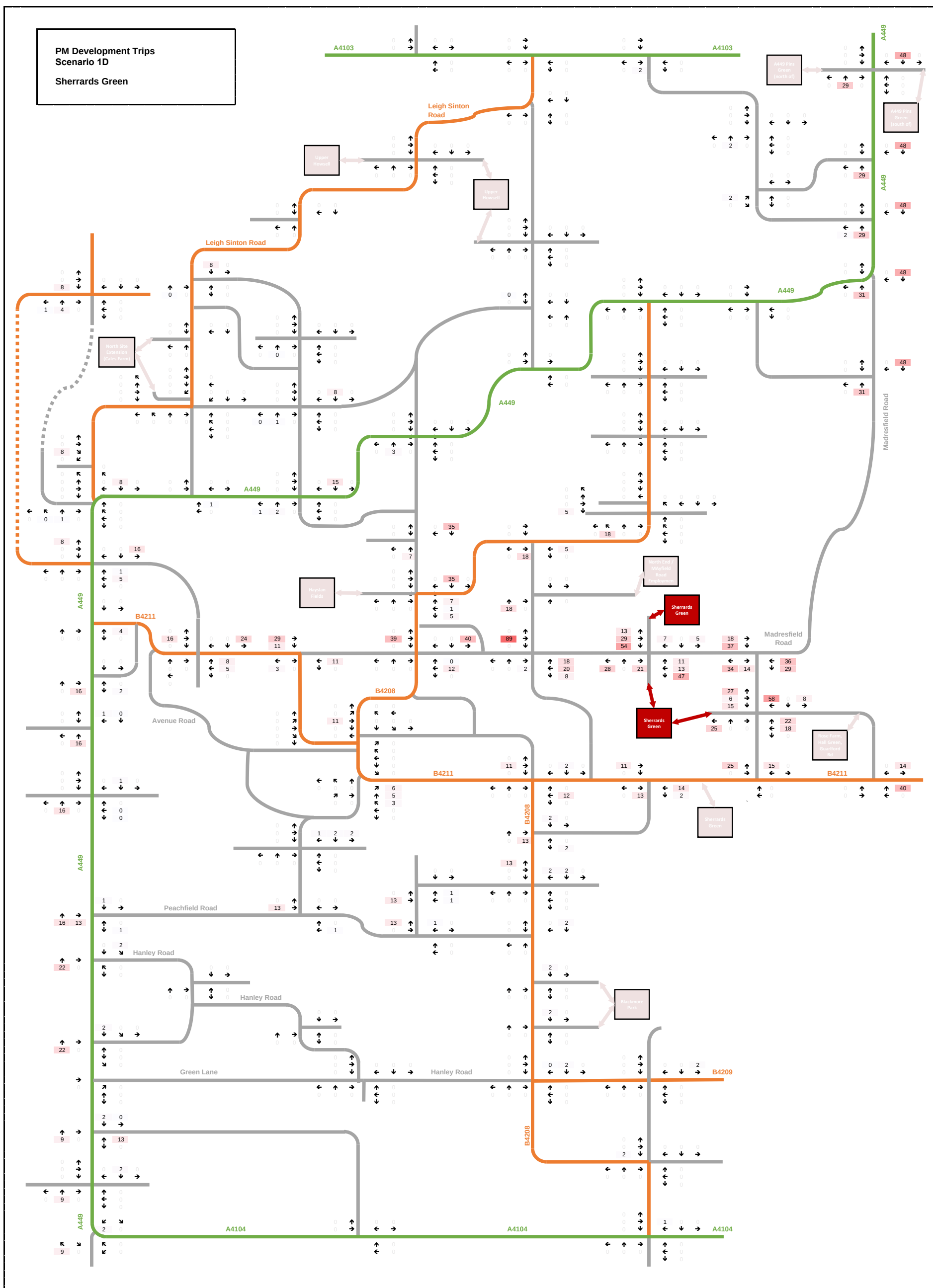


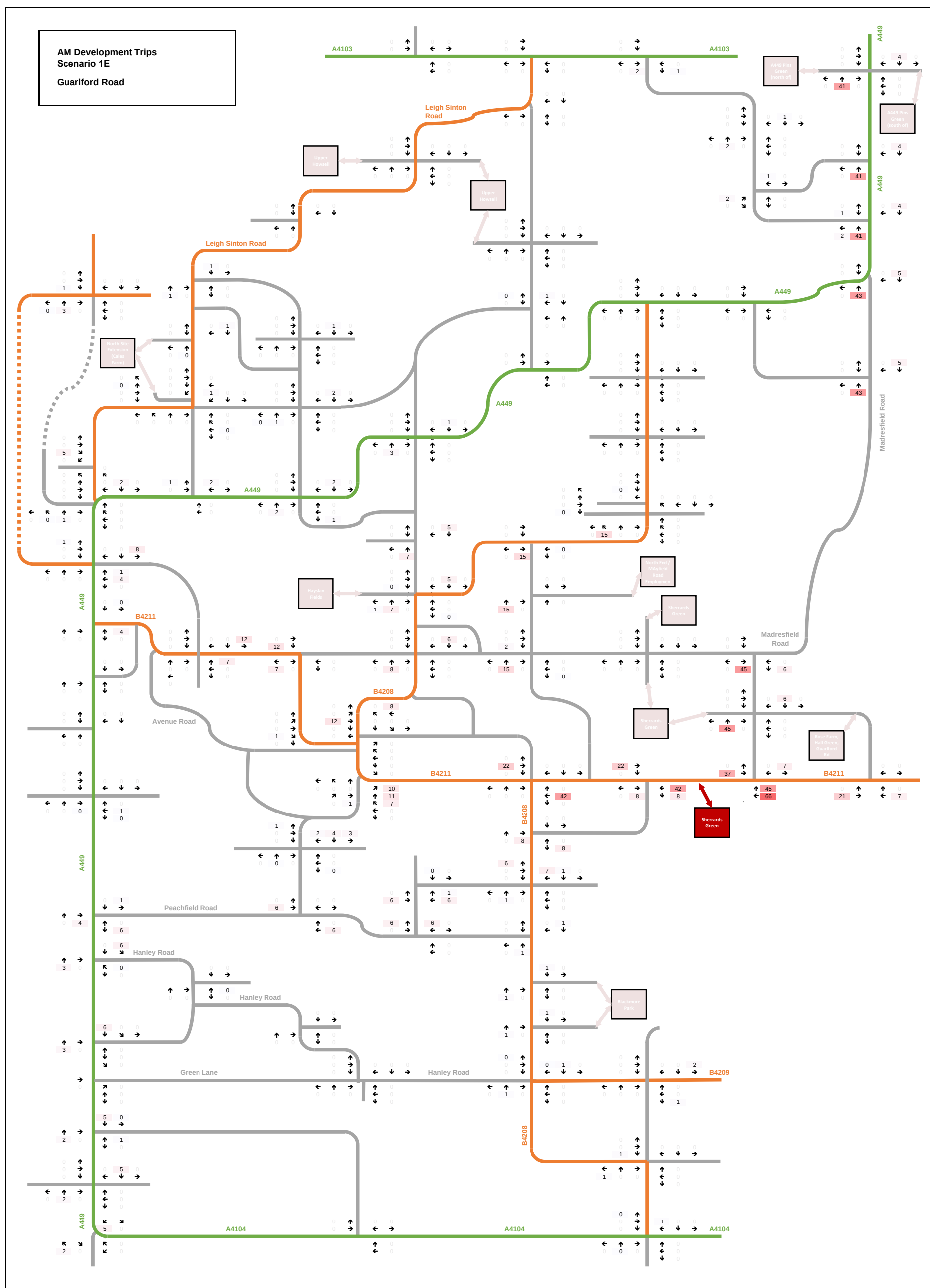
**PM Development Trips
Scenario 1C
Hayslan Fields**



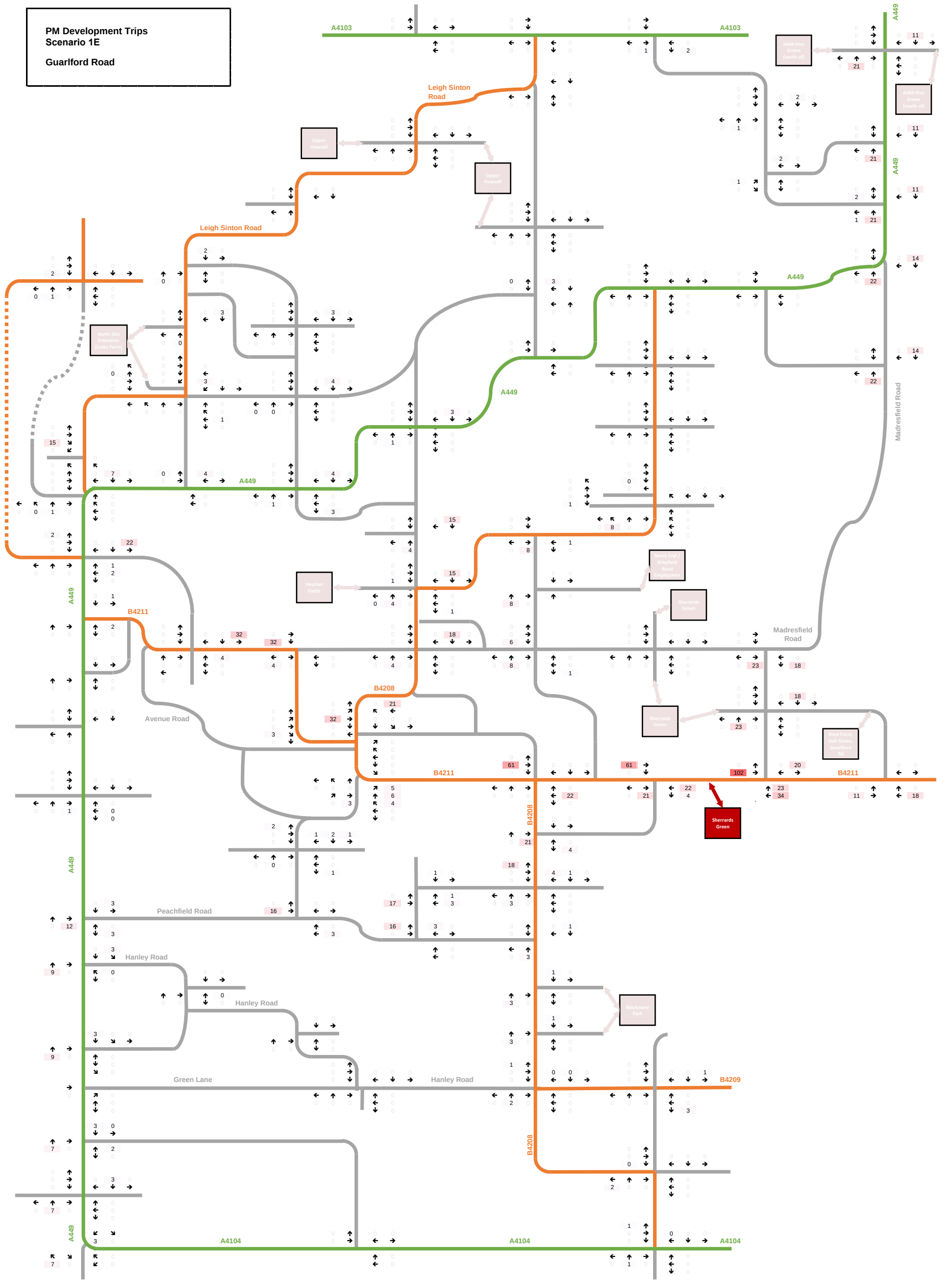
AM Development Trips
Scenario 1D
Sherrards Green



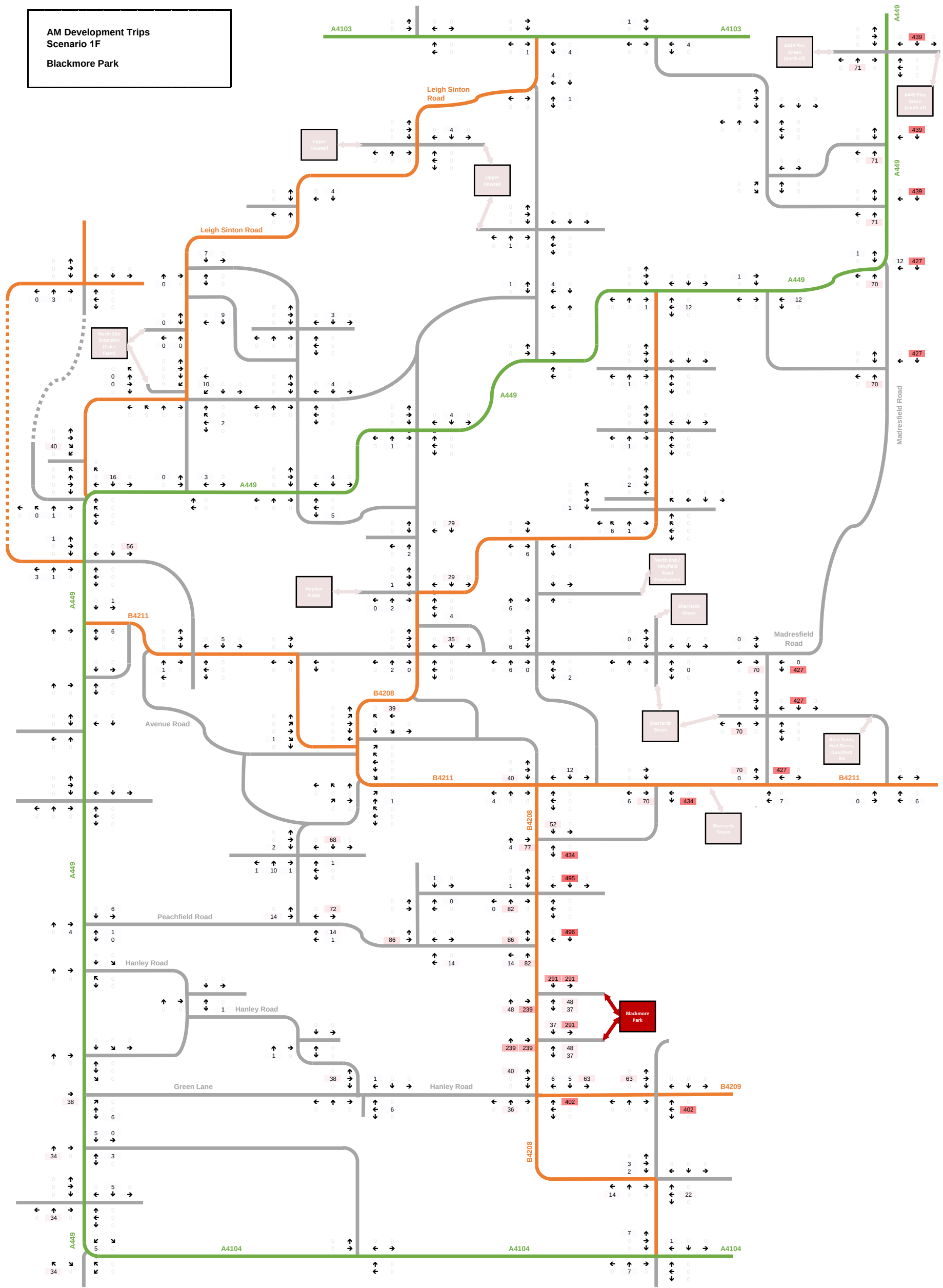




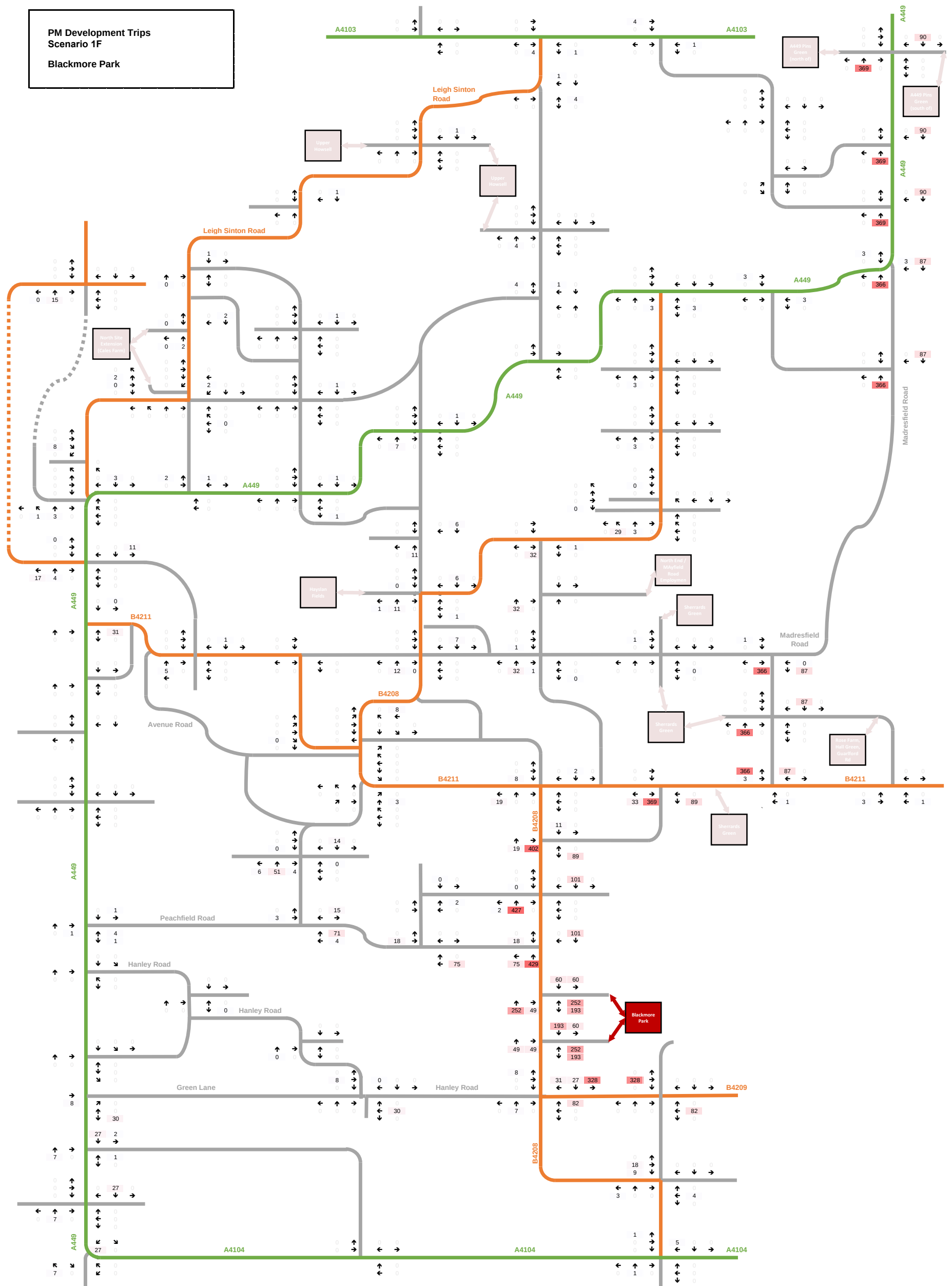
PM Development Trips
Scenario 1E
Guarford Road



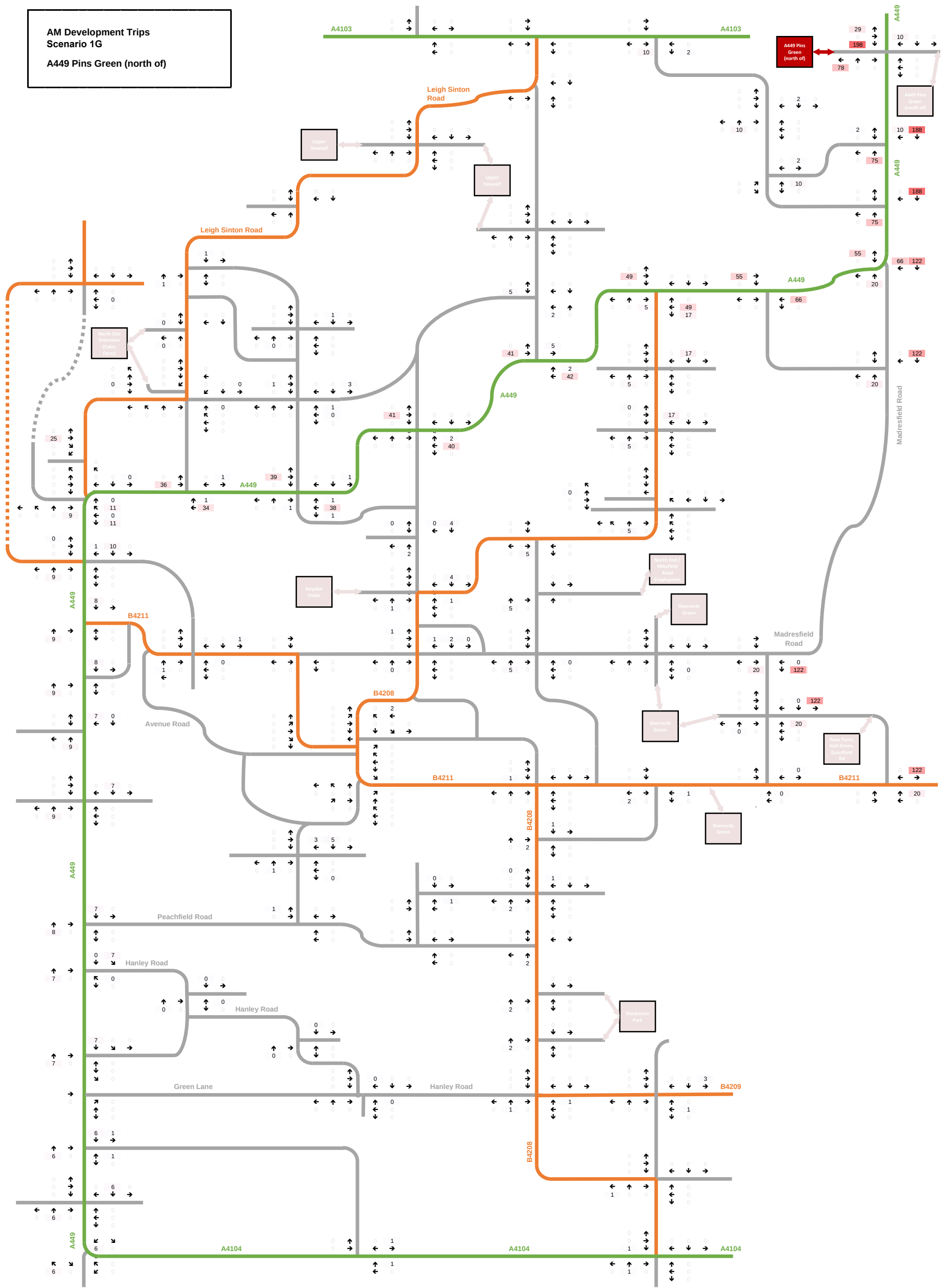
AM Development Trips
Scenario 1F
Blackmore Park

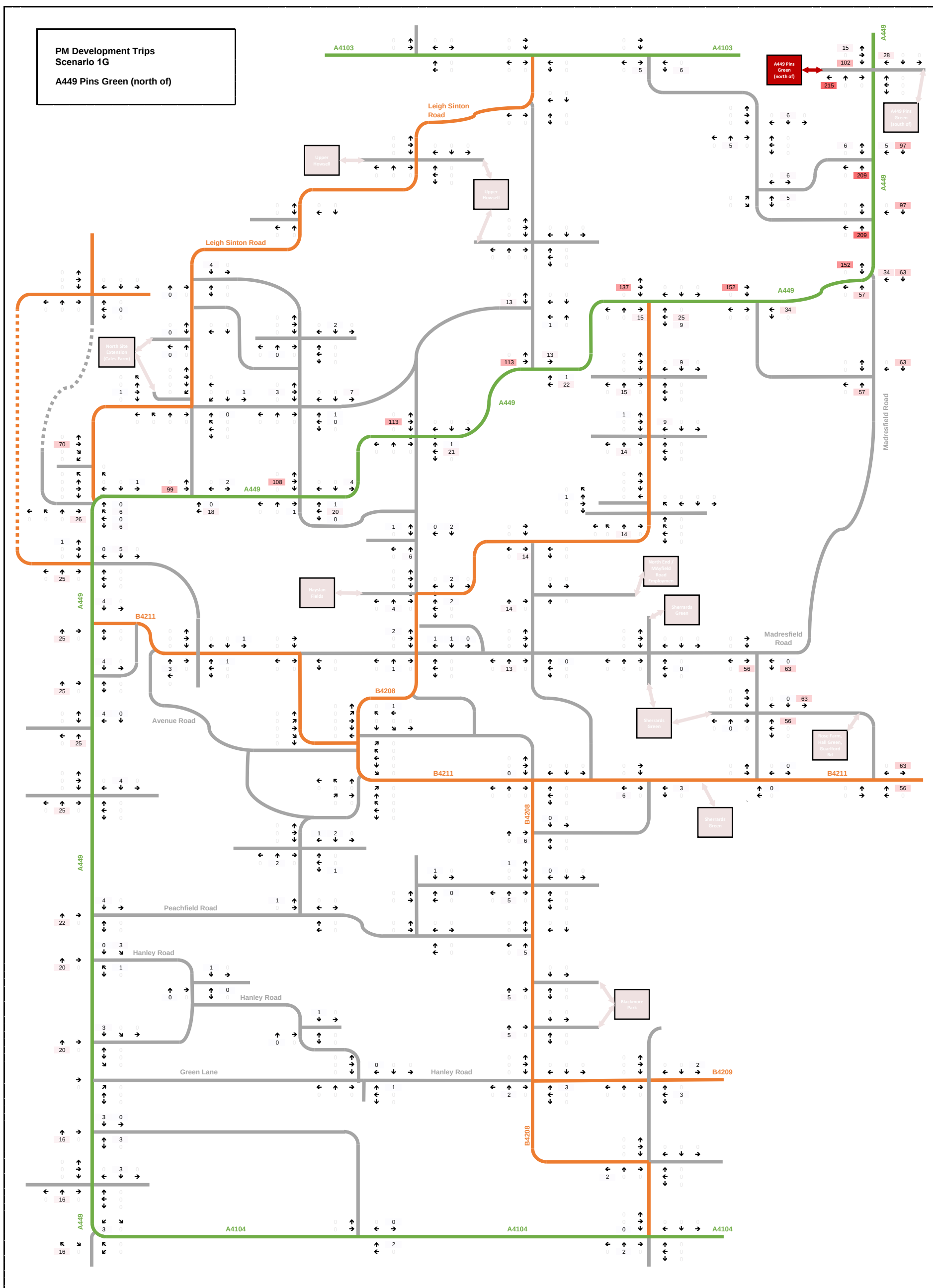


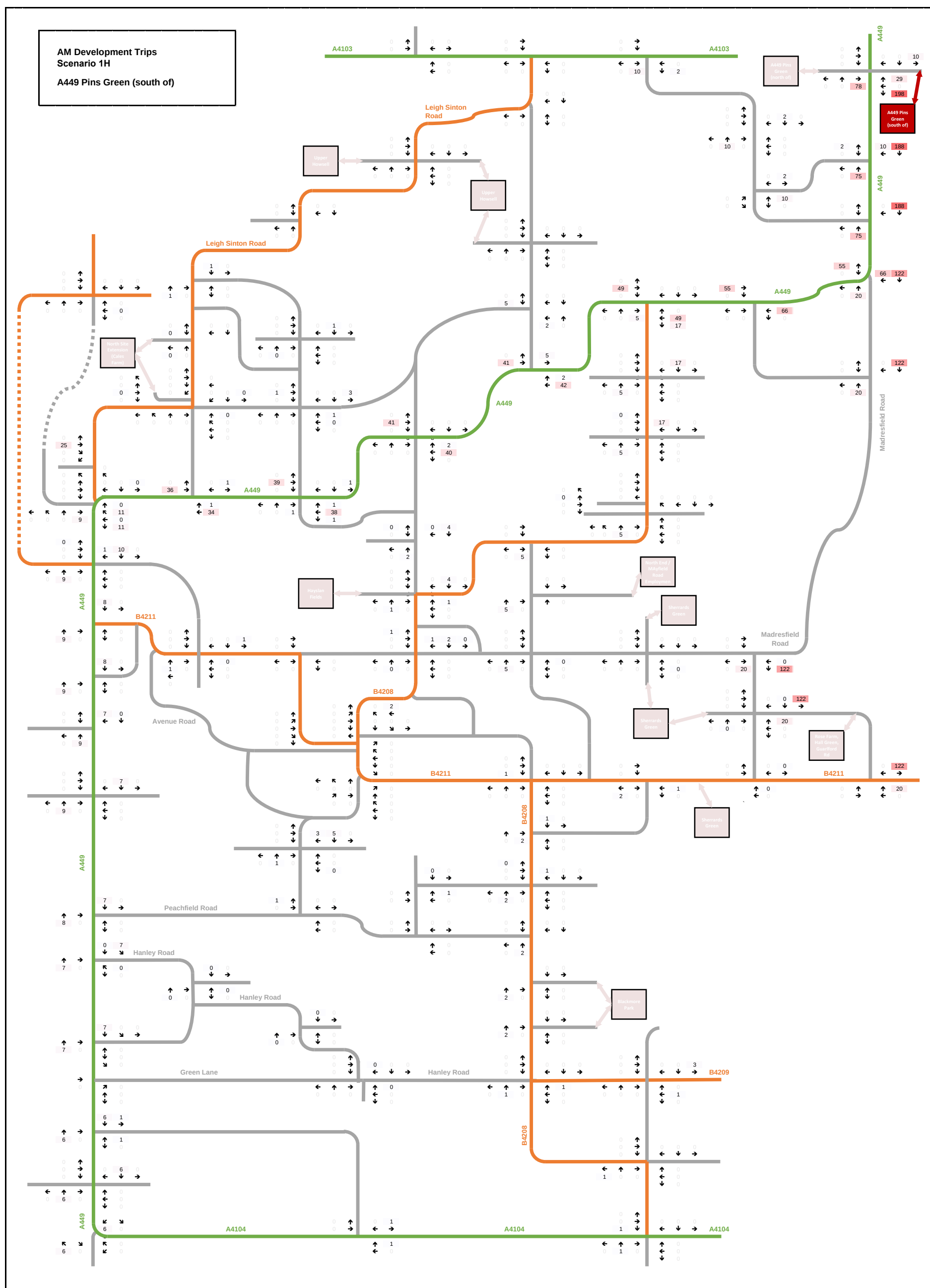
**PM Development Trips
Scenario 1F
Blackmore Park**

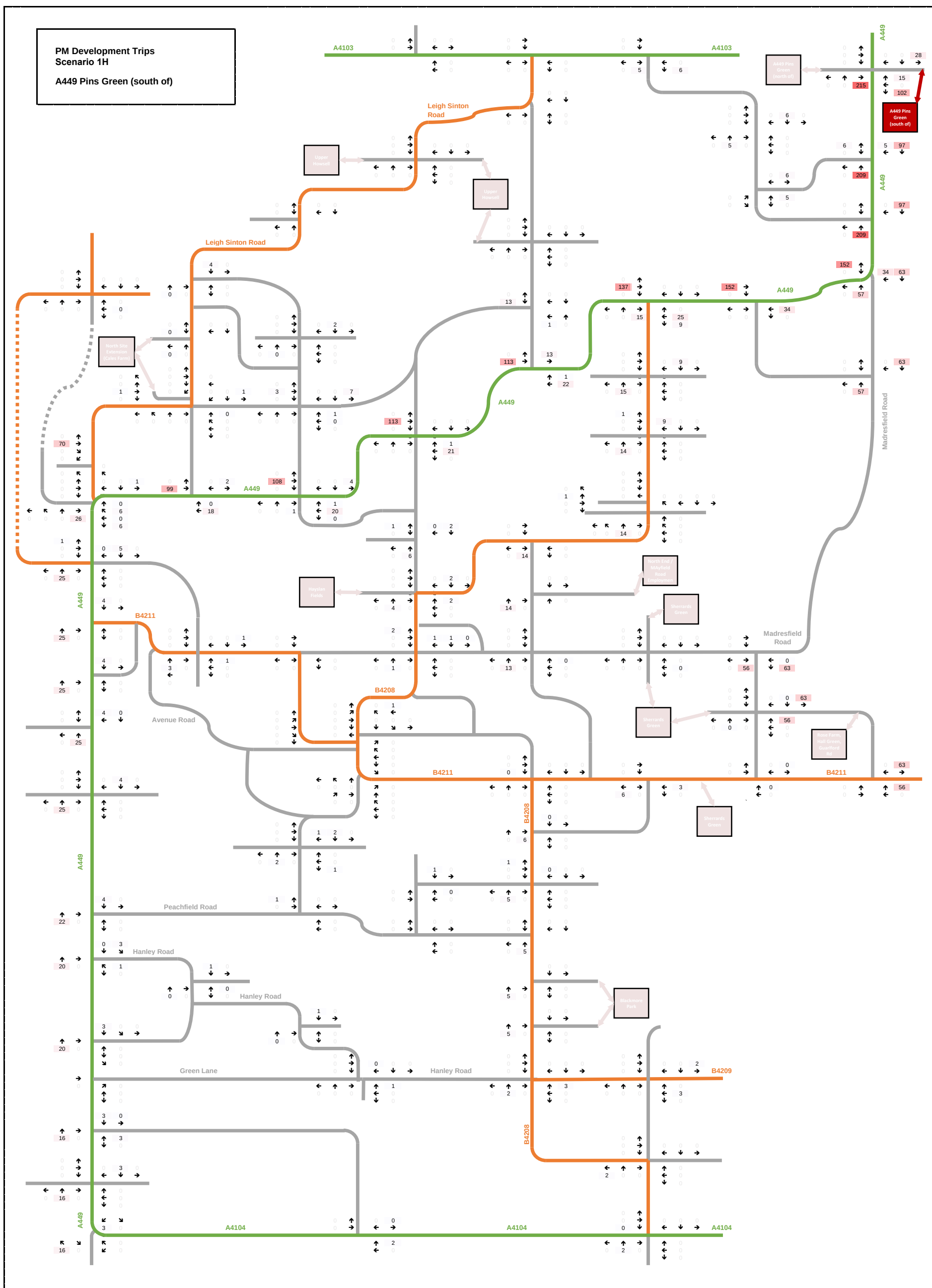


AM Development Trips
Scenario 1G
A449 Pins Green (north of)

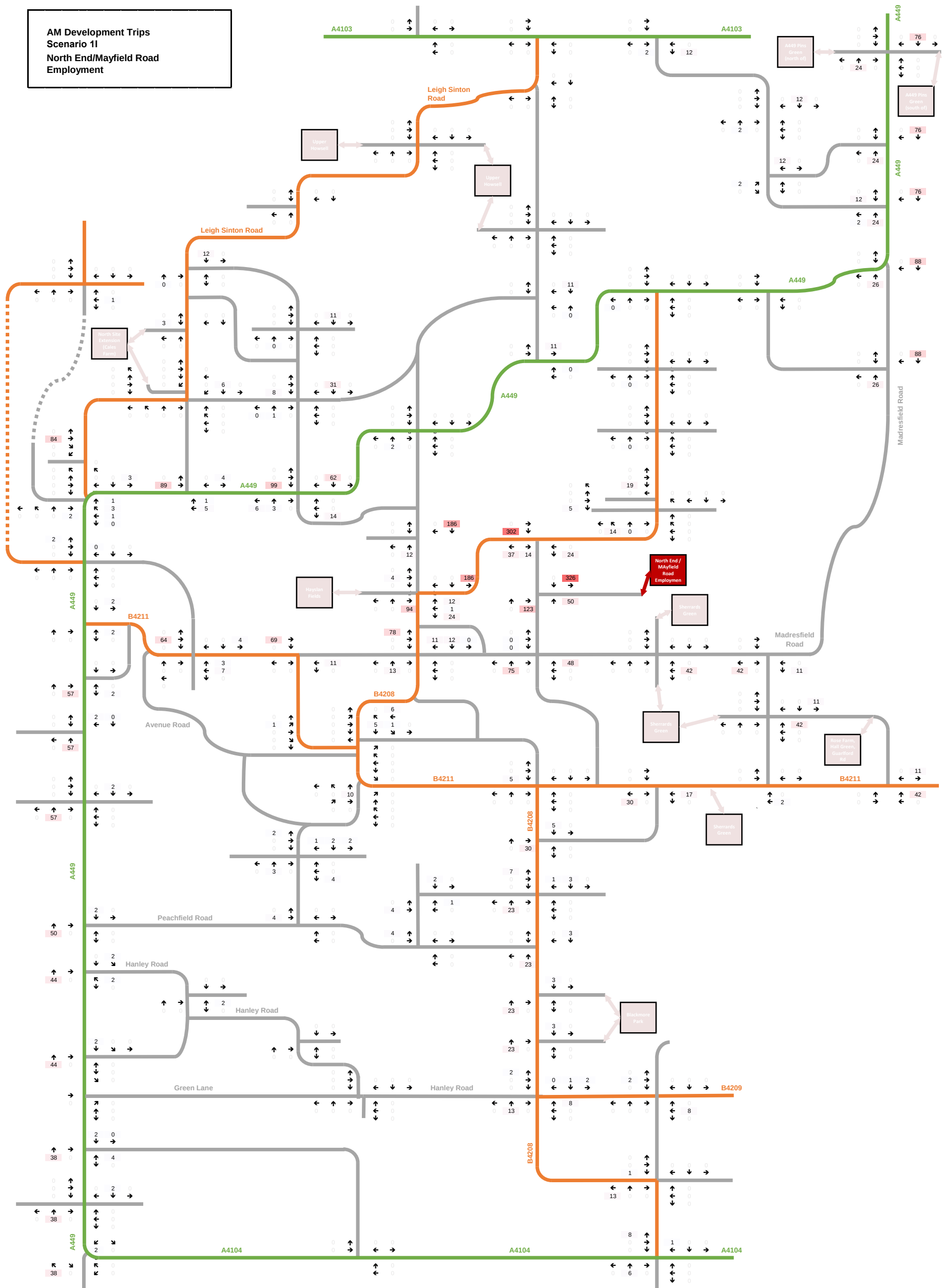




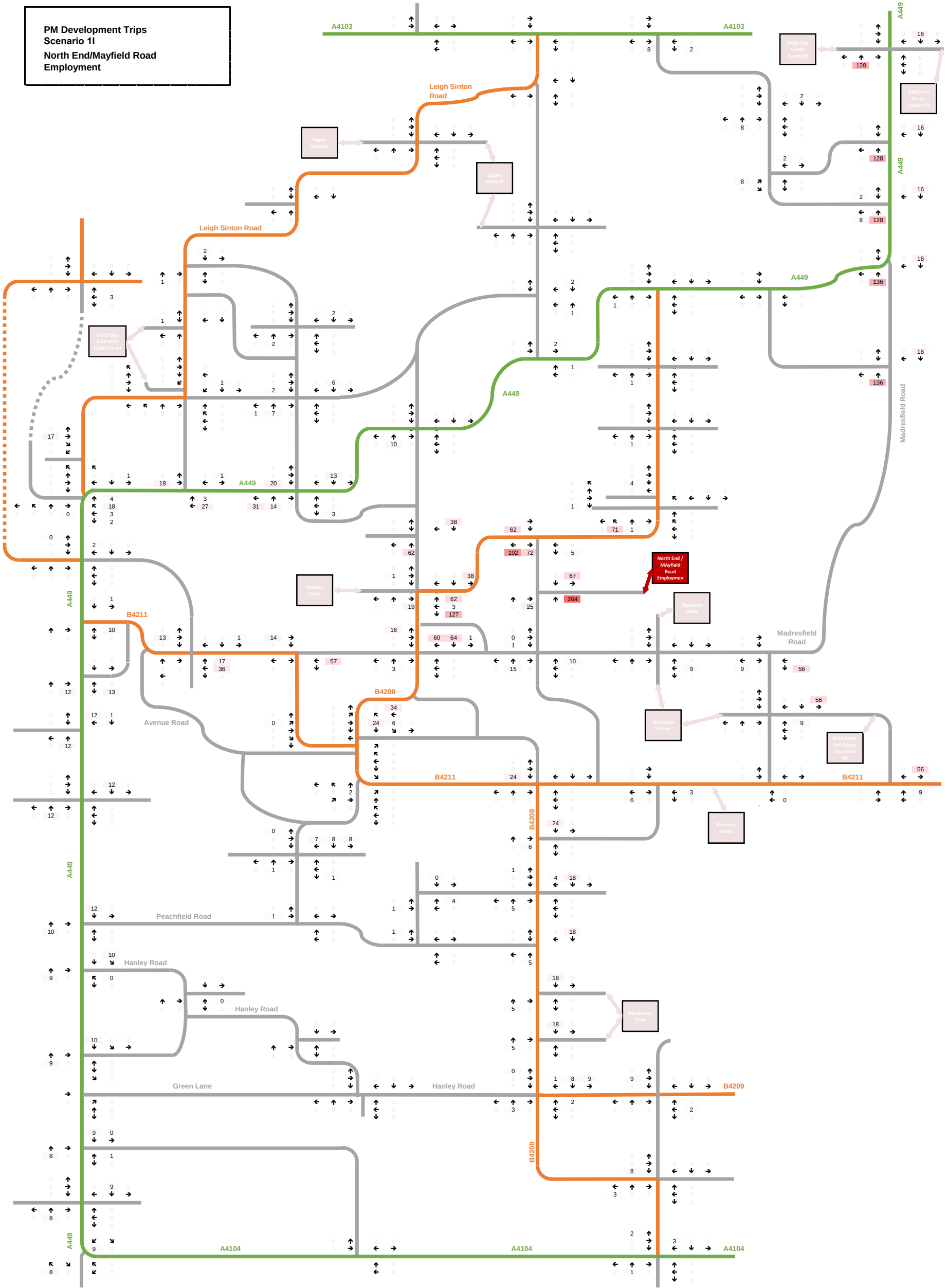




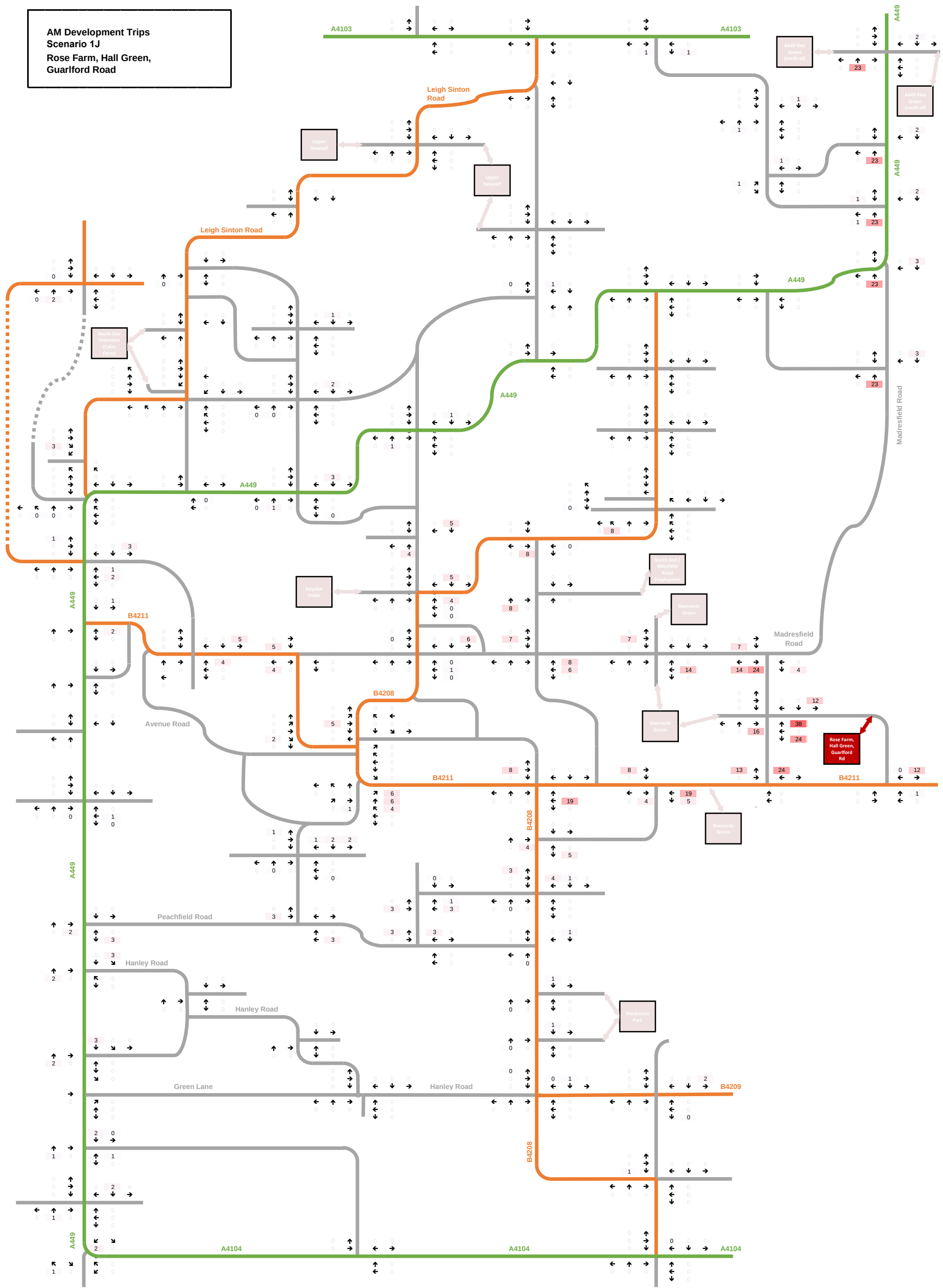
AM Development Trips
Scenario 11
North End/Mayfield Road
Employment

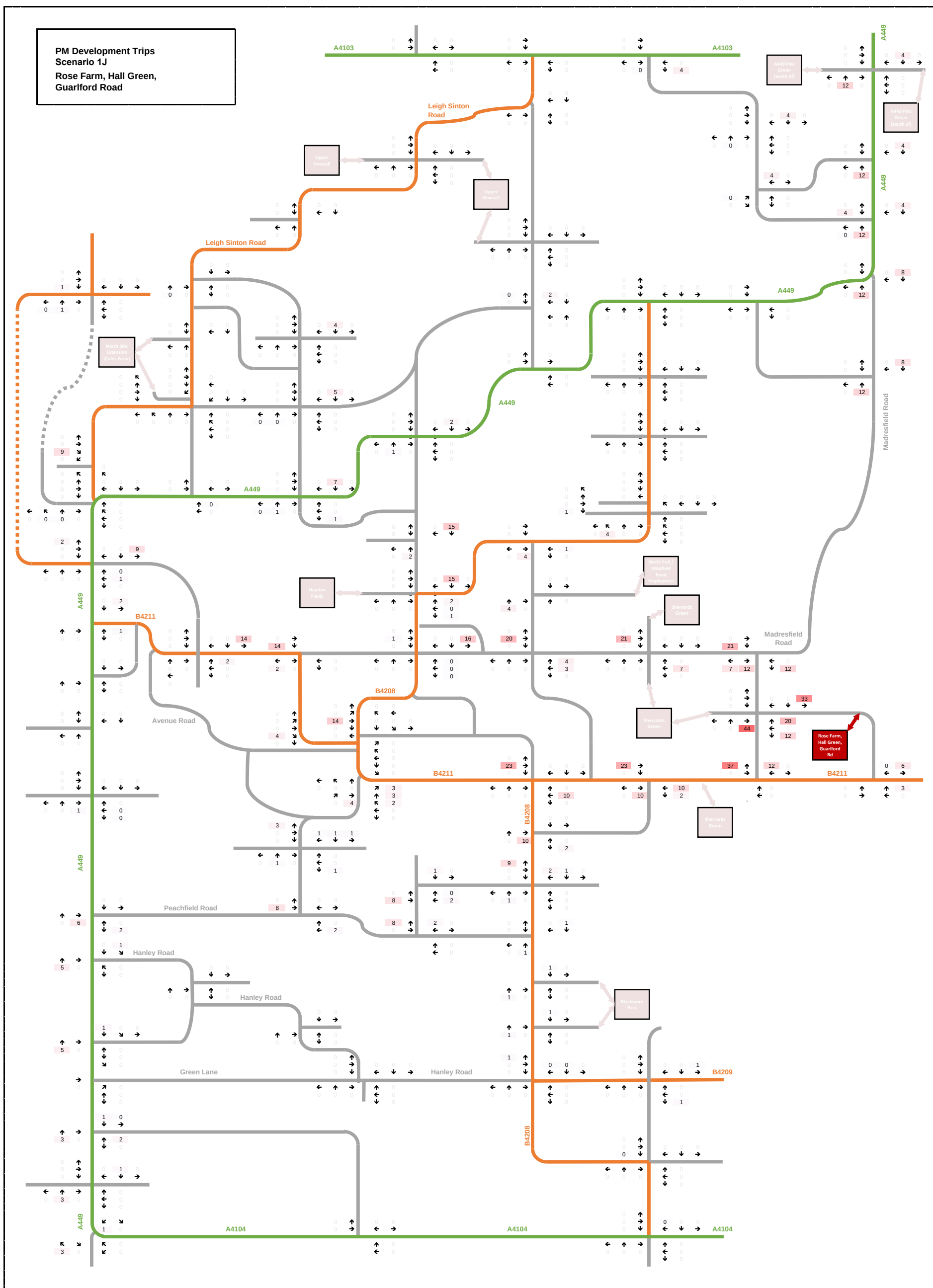


PM Development Trips
Scenario 11
North End/Mayfield Road
Employment



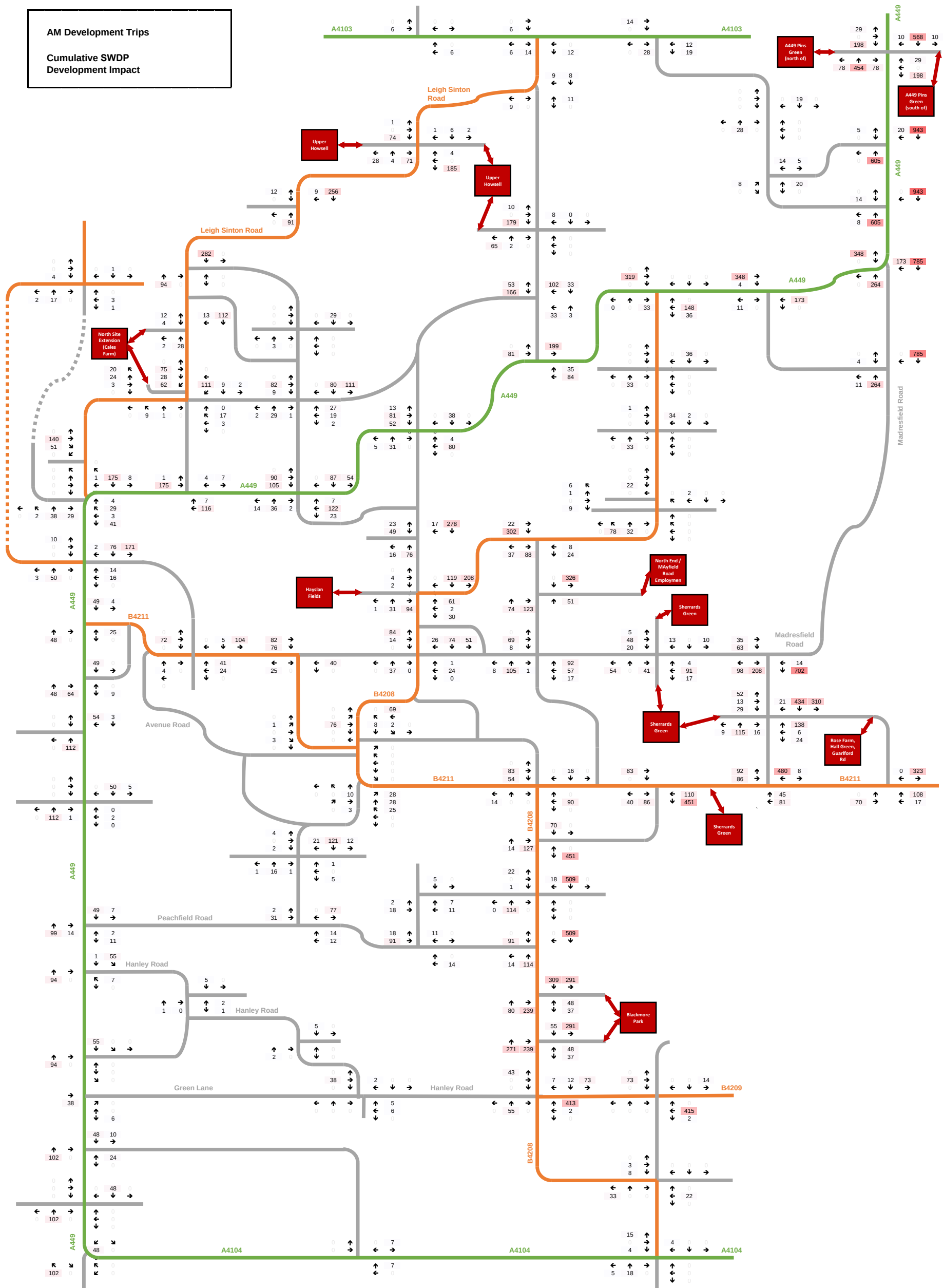
AM Development Trips
Scenario 1J
Rose Farm, Hall Green,
Guarlford Road

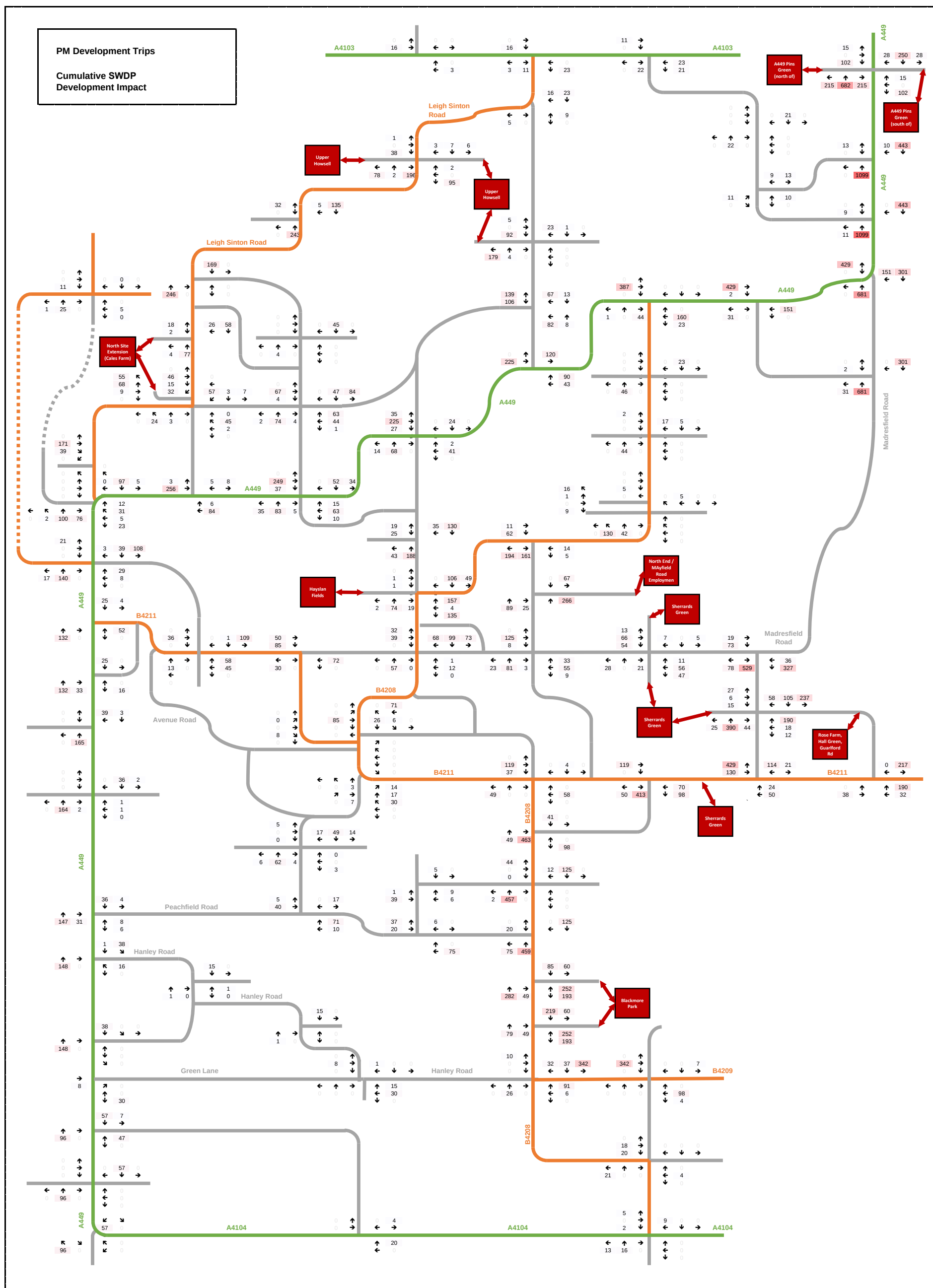




AM Development Trips

Cumulative SWDP
Development Impact





Appendix C. Model Output Tables

C.1.1 Scenario 1A

Junction	DoMin AM	DoMin PM	Dev't AM	Dev't PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	2	1	-	-	0%
2	915	815	25	23	3%	3%	9%
3	-	-	25	23	-	-	9%
4	-	-	25	23	-	-	9%
5	395	224	2	4	0%	2%	1%
6	1,121	1,414	26	27	2%	2%	10%
7	1,674	1,638	30	31	2%	2%	11%
8	-	-	13	25	-	-	7%
9	601	468	12	7	2%	2%	3%
10	929	855	-	-	0%	0%	0%
11	-	-	0	0	-	-	0%
12	-	-	2	1	-	-	0%
13	580	474	2	1	0%	0%	0%
14	-	-	2	1	-	-	0%
15	-	-	10	21	-	-	6%
16	-	-	9	19	-	-	5%
17	-	-	7	14	-	-	4%
18	-	-	2	5	-	-	1%
19	1,057	951	3	5	0%	0%	1%
20	-	-	3	5	-	-	1%
21	-	-	-	-	-	-	0%
22	-	-	3	6	-	-	2%
23	-	-	5	8	-	-	2%
24	-	-	5	10	-	-	3%
25	-	-	-	-	-	-	0%
26	-	-	207	208	-	-	75%
27	898	808	86	79	10%	10%	30%
28	1,814	2,250	31	30	2%	1%	11%
29	2,116	2,180	23	16	1%	1%	7%
30	747	755	80	71	11%	9%	27%
31	2,217	2,252	76	64	3%	3%	25%
32	1,613	1,712	-	-	0%	0%	0%
33	1,555	1,660	1	4	0%	0%	1%
34	1,338	1,424	-	-	0%	0%	0%
35	1,567	1,482	4	9	0%	1%	2%
36	1,460	1,551	0	0	0%	0%	0%
37	966	960	2	6	0%	1%	2%
38	-	-	-	-	-	-	0%
39	-	-	-	-	-	-	0%
40	-	-	-	-	-	-	0%
41	-	-	30	31	-	-	11%
42	985	827	35	34	4%	4%	13%
43	-	-	2	4	-	-	1%
44	1,793	1,590	78	79	4%	5%	28%
45	-	-	68	71	-	-	25%

Junction	DoMin AM	DoMin PM	Dev't AM	Dev't PM	Uplift AM	Uplift PM	Proportion of Total
46	-	-	14	27	-	-	7%
47	-	-	-	-	-	-	0%
48	1,484	1,391	6	8	0%	1%	2%
49	-	-	6	8	-	-	2%
50	820	691	6	8	1%	1%	2%
51	-	-	-	-	-	-	0%
52	-	-	-	-	-	-	0%
53	2,525	2,508	73	55	3%	2%	23%
54	-	-	73	55	-	-	23%
55	2,454	2,443	73	55	3%	2%	23%
56	2,549	2,558	75	62	3%	2%	25%
57	-	-	3	6	-	-	2%
58	4,008	4,678	75	62	2%	1%	25%
59	-	-	-	-	-	-	0%
60	537	457	6	8	1%	2%	2%
61	1,205	1,252	6	8	0%	1%	2%
62	-	-	8	13	-	-	4%
63	226	220	3	8	1%	4%	2%
64	2,044	2,588	-	-	0%	0%	0%
65	-	-	-	-	-	-	0%
66	-	-	13	25	-	-	7%
67	-	-	13	25	-	-	7%
68	407	306	-	-	0%	0%	0%
69	304	206	2	5	1%	2%	1%
70	203	206	2	5	1%	2%	1%
71	-	-	-	-	-	-	0%
72	-	-	16	30	-	-	8%
73	-	-	6	11	-	-	3%
74	-	-	2	1	-	-	0%
75	-	-	73	55	-	-	23%

C.1.2 Scenario 1B

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	8	10	-	-	1%
2	915	815	29	15	3%	2%	3%
3	-	-	58	49	-	-	8%
4	-	-	29	15	-	-	3%
5	395	224	11	19	3%	8%	2%
6	1,121	1,414	39	34	4%	2%	5%
7	1,674	1,638	41	22	2%	1%	5%
8	-	-	50	75	-	-	9%
9	601	468	29	18	5%	4%	3%
10	929	855	6	9	1%	1%	1%
11	-	-	2	1	-	-	0%
12	-	-	3	2	-	-	0%
13	580	474	4	3	1%	1%	1%
14	-	-	8	10	-	-	1%
15	-	-	45	70	-	-	9%
16	-	-	43	67	-	-	8%
17	-	-	39	58	-	-	7%
18	-	-	3	9	-	-	1%
19	1,057	951	9	13	1%	1%	2%
20	-	-	7	8	-	-	1%
21	-	-	2	5	-	-	1%
22	-	-	7	14	-	-	2%
23	-	-	7	11	-	-	1%
24	-	-	36	52	-	-	7%
25	-	-	27	36	-	-	5%
26	-	-	136	143	-	-	21%
27	898	808	205	245	23%	30%	33%
28	1,814	2,250	117	138	6%	6%	19%
29	2,116	2,180	94	121	4%	6%	16%
30	747	755	276	301	37%	40%	43%
31	2,217	2,252	134	115	6%	5%	18%
32	1,613	1,712	-	-	0%	0%	0%
33	1,555	1,660	5	13	0%	1%	1%
34	1,338	1,424	-	-	0%	0%	0%
35	1,567	1,482	60	98	4%	7%	12%
36	1,460	1,551	39	39	3%	3%	6%
37	966	960	36	53	4%	5%	7%
38	-	-	29	34	-	-	5%
39	-	-	29	34	-	-	5%
40	-	-	29	34	-	-	5%
41	-	-	34	18	-	-	4%
42	985	827	47	30	5%	4%	6%
43	-	-	2	1	-	-	0%
44	1,793	1,590	147	141	8%	9%	21%
45	-	-	129	127	-	-	19%
46	-	-	51	76	-	-	9%
47	-	-	12	19	-	-	2%

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	26	39	2%	3%	5%
49	-	-	14	20	-	-	3%
50	820	691	26	39	3%	6%	5%
51	-	-	-	-	-	-	0%
52	-	-	-	-	-	-	0%
53	2,525	2,508	171	132	7%	5%	23%
54	-	-	171	132	-	-	23%
55	2,454	2,443	171	132	7%	5%	23%
56	2,549	2,558	184	159	7%	6%	25%
57	-	-	12	27	-	-	3%
58	4,008	4,678	184	159	5%	3%	25%
59	-	-	262	299	-	-	42%
60	537	457	358	407	67%	89%	57%
61	1,205	1,252	366	419	30%	33%	58%
62	-	-	340	377	-	-	53%
63	226	220	8	22	4%	10%	2%
64	2,044	2,588	-	-	0%	0%	0%
65	-	-	27	36	-	-	5%
66	-	-	49	75	-	-	9%
67	-	-	50	75	-	-	9%
68	407	306	-	-	0%	0%	0%
69	304	206	4	9	1%	4%	1%
70	203	206	3	9	2%	4%	1%
71	-	-	50	48	-	-	7%
72	-	-	140	146	-	-	21%
73	-	-	66	106	-	-	13%
74	-	-	8	10	-	-	1%
75	-	-	171	132	-	-	23%

C.1.3 Scenario 1C

Junction	DoMin AM	DoMin PM	Dev't AM	Dev't PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	3	5	-	-	4%
2	915	815	1	2	0%	0%	1%
3	-	-	10	8	-	-	9%
4	-	-	1	2	-	-	1%
5	395	224	6	11	1%	5%	8%
6	1,121	1,414	6	12	1%	1%	9%
7	1,674	1,638	9	6	1%	0%	7%
8	-	-	5	7	-	-	6%
9	601	468	4	3	1%	1%	3%
10	929	855	4	6	0%	1%	5%
11	-	-	1	2	-	-	1%
12	-	-	-	-	-	-	0%
13	580	474	0	0	0%	0%	0%
14	-	-	3	5	-	-	4%
15	-	-	4	5	-	-	4%
16	-	-	3	5	-	-	4%
17	-	-	3	5	-	-	4%
18	-	-	-	-	-	-	0%
19	1,057	951	3	5	0%	0%	4%
20	-	-	2	1	-	-	1%
21	-	-	1	3	-	-	2%
22	-	-	1	3	-	-	2%
23	-	-	-	-	-	-	0%
24	-	-	3	5	-	-	4%
25	-	-	3	4	-	-	4%
26	-	-	0	1	-	-	0%
27	898	808	3	6	0%	1%	5%
28	1,814	2,250	18	31	1%	1%	23%
29	2,116	2,180	3	4	0%	0%	3%
30	747	755	2	3	0%	0%	2%
31	2,217	2,252	-	-	0%	0%	0%
32	1,613	1,712	23	16	1%	1%	19%
33	1,555	1,660	24	17	2%	1%	20%
34	1,338	1,424	25	20	2%	1%	21%
35	1,567	1,482	65	69	4%	5%	64%
36	1,460	1,551	36	38	2%	2%	36%
37	966	960	11	11	1%	1%	11%
38	-	-	10	8	-	-	9%
39	-	-	10	8	-	-	9%
40	-	-	10	8	-	-	9%
41	-	-	11	12	-	-	11%
42	985	827	11	11	1%	1%	11%
43	-	-	0	0	-	-	0%
44	1,793	1,590	9	16	1%	1%	12%
45	-	-	0	0	-	-	0%
46	-	-	3	2	-	-	2%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Dev't AM	Dev't PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	1	1	0%	0%	1%
49	-	-	1	1	-	-	1%
50	820	691	1	1	0%	0%	1%
51	-	-	-	-	-	-	0%
52	-	-	-	-	-	-	0%
53	2,525	2,508	23	16	1%	1%	19%
54	-	-	23	16	-	-	19%
55	2,454	2,443	23	16	1%	1%	19%
56	2,549	2,558	23	16	1%	1%	19%
57	-	-	-	-	-	-	0%
58	4,008	4,678	23	16	1%	0%	19%
59	-	-	1	1	-	-	1%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	0	1	-	-	1%
63	226	220	1	1	0%	0%	1%
64	2,044	2,588	23	16	1%	1%	19%
65	-	-	3	4	-	-	4%
66	-	-	4	7	-	-	5%
67	-	-	5	7	-	-	6%
68	407	306	1	2	0%	1%	2%
69	304	206	-	-	0%	0%	0%
70	203	206	-	-	0%	0%	0%
71	-	-	12	19	-	-	15%
72	-	-	-	-	-	-	0%
73	-	-	96	111	-	-	99%
74	-	-	3	5	-	-	4%
75	-	-	23	16	-	-	19%

C.1.4 Scenario 1D

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	4	2	-	-	1%
2	915	815	38	40	4%	5%	12%
3	-	-	42	54	-	-	15%
4	-	-	38	40	-	-	12%
5	395	224	13	17	3%	8%	5%
6	1,121	1,414	32	25	3%	2%	9%
7	1,674	1,638	32	25	2%	2%	9%
8	-	-	9	17	-	-	4%
9	601	468	11	5	2%	1%	3%
10	929	855	12	17	1%	2%	5%
11	-	-	9	15	-	-	4%
12	-	-	7	14	-	-	3%
13	580	474	7	14	1%	3%	3%
14	-	-	4	2	-	-	1%
15	-	-	15	31	-	-	7%
16	-	-	13	25	-	-	6%
17	-	-	13	25	-	-	6%
18	-	-	-	-	-	-	0%
19	1,057	951	4	2	0%	0%	1%
20	-	-	4	2	-	-	1%
21	-	-	3	2	-	-	1%
22	-	-	3	2	-	-	1%
23	-	-	-	-	-	-	0%
24	-	-	13	25	-	-	6%
25	-	-	7	11	-	-	3%
26	-	-	-	-	-	-	0%
27	898	808	5	9	1%	1%	2%
28	1,814	2,250	11	18	1%	1%	5%
29	2,116	2,180	5	3	0%	0%	1%
30	747	755	1	0	0%	0%	0%
31	2,217	2,252	-	-	0%	0%	0%
32	1,613	1,712	-	-	0%	0%	0%
33	1,555	1,660	37	23	2%	1%	10%
34	1,338	1,424	37	23	3%	2%	10%
35	1,567	1,482	30	48	2%	3%	12%
36	1,460	1,551	53	92	4%	6%	23%
37	966	960	123	138	13%	14%	42%
38	-	-	196	227	-	-	68%
39	-	-	145	169	-	-	50%
40	-	-	154	179	-	-	53%
41	-	-	42	53	-	-	15%
42	985	827	41	53	4%	6%	15%
43	-	-	12	13	-	-	4%
44	1,793	1,590	8	17	0%	1%	4%
45	-	-	20	30	-	-	8%
46	-	-	7	4	-	-	2%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	-	-	0%	0%	0%
49	-	-	3	2	-	-	1%
50	820	691	-	-	0%	0%	0%
51	-	-	3	2	-	-	1%
52	-	-	3	2	-	-	1%
53	2,525	2,508	74	77	3%	3%	24%
54	-	-	78	79	-	-	25%
55	2,454	2,443	78	79	3%	3%	25%
56	2,549	2,558	-	-	0%	0%	0%
57	-	-	78	79	-	-	25%
58	4,008	4,678	-	-	0%	0%	0%
59	-	-	-	-	-	-	0%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	3	8	-	-	2%
63	226	220	1	0	0%	0%	0%
64	2,044	2,588	-	-	0%	0%	0%
65	-	-	7	11	-	-	3%
66	-	-	9	17	-	-	4%
67	-	-	9	17	-	-	4%
68	407	306	35	18	9%	6%	9%
69	304	206	-	-	0%	0%	0%
70	203	206	-	-	0%	0%	0%
71	-	-	1	1	-	-	0%
72	-	-	-	-	-	-	0%
73	-	-	27	43	-	-	11%
74	-	-	4	2	-	-	1%
75	-	-	74	77	-	-	24%

C.1.5 Scenario 1E

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	2	4	-	-	2%
2	915	815	80	107	9%	13%	48%
3	-	-	27	29	-	-	14%
4	-	-	155	180	-	-	86%
5	395	224	16	25	4%	11%	11%
6	1,121	1,414	64	82	6%	6%	37%
7	1,674	1,638	50	75	3%	5%	32%
8	-	-	-	-	-	-	0%
9	601	468	9	7	2%	2%	4%
10	929	855	16	25	2%	3%	11%
11	-	-	14	21	-	-	9%
12	-	-	12	19	-	-	8%
13	580	474	12	19	2%	4%	8%
14	-	-	2	4	-	-	2%
15	-	-	11	17	-	-	7%
16	-	-	9	13	-	-	6%
17	-	-	9	12	-	-	5%
18	-	-	-	-	-	-	0%
19	1,057	951	2	4	0%	0%	2%
20	-	-	3	4	-	-	2%
21	-	-	2	3	-	-	1%
22	-	-	2	3	-	-	1%
23	-	-	-	-	-	-	0%
24	-	-	8	11	-	-	5%
25	-	-	7	9	-	-	4%
26	-	-	2	5	-	-	2%
27	898	808	2	5	0%	1%	2%
28	1,814	2,250	5	8	0%	0%	3%
29	2,116	2,180	4	4	0%	0%	2%
30	747	755	1	3	0%	0%	1%
31	2,217	2,252	-	-	0%	0%	0%
32	1,613	1,712	-	-	0%	0%	0%
33	1,555	1,660	15	9	1%	1%	6%
34	1,338	1,424	15	9	1%	1%	6%
35	1,567	1,482	14	21	1%	1%	9%
36	1,460	1,551	14	22	1%	1%	9%
37	966	960	17	14	2%	2%	8%
38	-	-	-	-	-	-	0%
39	-	-	51	40	-	-	23%
40	-	-	51	40	-	-	23%
41	-	-	19	36	-	-	14%
42	985	827	19	36	2%	4%	14%
43	-	-	4	4	-	-	2%
44	1,793	1,590	9	22	1%	1%	8%
45	-	-	14	26	-	-	10%
46	-	-	4	3	-	-	2%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	-	-	0%	0%	0%
49	-	-	3	3	-	-	2%
50	820	691	-	-	0%	0%	0%
51	-	-	3	3	-	-	2%
52	-	-	3	3	-	-	2%
53	2,525	2,508	45	33	2%	1%	20%
54	-	-	48	36	-	-	22%
55	2,454	2,443	48	36	2%	1%	22%
56	2,549	2,558	-	-	0%	0%	0%
57	-	-	48	36	-	-	22%
58	4,008	4,678	-	-	0%	0%	0%
59	-	-	-	-	-	-	0%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	1	2	-	-	1%
63	226	220	1	3	1%	2%	1%
64	2,044	2,588	-	-	0%	0%	0%
65	-	-	7	9	-	-	4%
66	-	-	1	1	-	-	1%
67	-	-	-	-	-	-	0%
68	407	306	15	8	4%	3%	6%
69	304	206	0	0	0%	0%	0%
70	203	206	-	-	0%	0%	0%
71	-	-	2	5	-	-	2%
72	-	-	1	3	-	-	1%
73	-	-	12	19	-	-	8%
74	-	-	2	4	-	-	2%
75	-	-	45	33	-	-	20%

C.1.6 Scenario 1F

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	954	865	-	-	78%
2	915	815	510	490	56%	60%	43%
3	-	-	6	4	-	-	0%
4	-	-	504	458	-	-	41%
5	395	224	566	520	143%	233%	46%
6	1,121	1,414	56	30	5%	2%	4%
7	1,674	1,638	40	11	2%	1%	2%
8	-	-	-	-	-	-	0%
9	601	468	83	75	14%	16%	7%
10	929	855	578	530	62%	62%	47%
11	-	-	1	2	-	-	0%
12	-	-	100	93	-	-	8%
13	580	474	100	93	17%	20%	8%
14	-	-	678	623	-	-	56%
15	-	-	11	6	-	-	1%
16	-	-	-	-	-	-	0%
17	-	-	44	38	-	-	3%
18	-	-	45	38	-	-	4%
19	1,057	951	552	483	52%	51%	44%
20	-	-	465	410	-	-	37%
21	-	-	41	35	-	-	3%
22	-	-	16	12	-	-	1%
23	-	-	-	-	-	-	0%
24	-	-	43	36	-	-	3%
25	-	-	39	34	-	-	3%
26	-	-	13	5	-	-	1%
27	898	808	4	1	0%	0%	0%
28	1,814	2,250	9	2	0%	0%	0%
29	2,116	2,180	5	8	0%	0%	1%
30	747	755	5	5	1%	1%	0%
31	2,217	2,252	-	-	0%	0%	0%
32	1,613	1,712	1	3	0%	0%	0%
33	1,555	1,660	10	32	1%	2%	2%
34	1,338	1,424	10	32	1%	2%	2%
35	1,567	1,482	37	19	2%	1%	2%
36	1,460	1,551	38	20	3%	1%	2%
37	966	960	14	34	1%	4%	2%
38	-	-	1	1	-	-	0%
39	-	-	498	455	-	-	41%
40	-	-	497	454	-	-	41%
41	-	-	-	-	-	-	0%
42	985	827	6	6	1%	1%	1%
43	-	-	3	15	-	-	1%
44	1,793	1,590	56	16	3%	1%	3%
45	-	-	61	33	-	-	4%
46	-	-	6	31	-	-	2%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	5	5	0%	0%	0%
49	-	-	5	5	-	-	0%
50	820	691	5	5	1%	1%	0%
51	-	-	-	-	-	-	0%
52	-	-	-	-	-	-	0%
53	2,525	2,508	510	459	20%	18%	41%
54	-	-	510	459	-	-	41%
55	2,454	2,443	510	459	21%	19%	41%
56	2,549	2,558	13	5	1%	0%	1%
57	-	-	497	454	-	-	41%
58	4,008	4,678	13	5	0%	0%	1%
59	-	-	1	4	-	-	0%
60	537	457	4	1	1%	0%	0%
61	1,205	1,252	4	1	0%	0%	0%
62	-	-	7	2	-	-	0%
63	226	220	3	1	1%	0%	0%
64	2,044	2,588	1	3	0%	0%	0%
65	-	-	39	34	-	-	3%
66	-	-	-	-	-	-	0%
67	-	-	-	-	-	-	0%
68	407	306	6	32	1%	10%	2%
69	304	206	1	0	0%	0%	0%
70	203	206	1	0	0%	0%	0%
71	-	-	3	3	-	-	0%
72	-	-	10	4	-	-	1%
73	-	-	31	17	-	-	2%
74	-	-	891	795	-	-	72%
75	-	-	510	459	-	-	41%

C.1.7 Scenario 1G and 1H

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	2	5	-	-	1%
2	915	815	3	9	0%	1%	2%
3	-	-	142	119	-	-	39%
4	-	-	0	0	-	-	0%
5	395	224	3	6	1%	3%	1%
6	1,121	1,414	1	0	0%	0%	0%
7	1,674	1,638	2	1	0%	0%	1%
8	-	-	17	29	-	-	7%
9	601	468	8	6	1%	1%	2%
10	929	855	3	6	0%	1%	1%
11	-	-	1	1	-	-	0%
12	-	-	-	-	-	-	0%
13	580	474	1	1	0%	0%	0%
14	-	-	2	5	-	-	1%
15	-	-	15	26	-	-	6%
16	-	-	14	24	-	-	6%
17	-	-	14	23	-	-	6%
18	-	-	0	1	-	-	0%
19	1,057	951	2	5	0%	1%	1%
20	-	-	4	4	-	-	1%
21	-	-	1	2	-	-	0%
22	-	-	2	3	-	-	1%
23	-	-	1	2	-	-	1%
24	-	-	13	22	-	-	5%
25	-	-	11	19	-	-	5%
26	-	-	1	2	-	-	0%
27	898	808	5	11	1%	1%	2%
28	1,814	2,250	81	133	4%	6%	32%
29	2,116	2,180	83	134	4%	6%	32%
30	747	755	6	14	1%	2%	3%
31	2,217	2,252	89	148	4%	7%	35%
32	1,613	1,712	22	24	1%	1%	7%
33	1,555	1,660	5	14	0%	1%	3%
34	1,338	1,424	5	14	0%	1%	3%
35	1,567	1,482	6	8	0%	1%	2%
36	1,460	1,551	5	5	0%	0%	2%
37	966	960	5	14	1%	1%	3%
38	-	-	0	0	-	-	0%
39	-	-	142	119	-	-	39%
40	-	-	142	119	-	-	39%
41	-	-	-	-	-	-	0%
42	985	827	3	5	0%	1%	1%
43	-	-	0	0	-	-	0%
44	1,793	1,590	57	108	3%	7%	25%
45	-	-	20	32	-	-	8%
46	-	-	17	29	-	-	7%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	-	-	0%	0%	0%
49	-	-	12	11	-	-	4%
50	820	691	-	-	0%	0%	0%
51	-	-	12	11	-	-	4%
52	-	-	12	11	-	-	4%
53	2,525	2,508	275	317	11%	13%	88%
54	-	-	263	305	-	-	84%
55	2,454	2,443	263	305	11%	12%	84%
56	2,549	2,558	120	186	5%	7%	46%
57	-	-	143	119	-	-	39%
58	4,008	4,678	120	186	3%	4%	46%
59	-	-	-	-	-	-	0%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	2	4	-	-	1%
63	226	220	1	2	0%	1%	0%
64	2,044	2,588	22	24	1%	1%	7%
65	-	-	11	19	-	-	5%
66	-	-	16	28	-	-	7%
67	-	-	17	29	-	-	7%
68	407	306	5	14	1%	4%	3%
69	304	206	1	1	0%	0%	0%
70	203	206	0	1	0%	0%	0%
71	-	-	71	119	-	-	28%
72	-	-	0	0	-	-	0%
73	-	-	7	9	-	-	2%
74	-	-	2	5	-	-	1%
75	-	-	314	359	-	-	100%

C.1.8 Scenario 1I

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	27	23	-	-	4%
2	915	815	47	10	5%	1%	5%
3	-	-	53	65	-	-	10%
4	-	-	2	0	-	-	0%
5	395	224	34	30	9%	13%	5%
6	1,121	1,414	5	24	0%	2%	2%
7	1,674	1,638	23	66	1%	4%	7%
8	-	-	59	25	-	-	7%
9	601	468	13	26	2%	5%	3%
10	929	855	34	28	4%	3%	5%
11	-	-	7	5	-	-	1%
12	-	-	4	1	-	-	0%
13	580	474	4	1	1%	0%	0%
14	-	-	27	23	-	-	4%
15	-	-	52	22	-	-	6%
16	-	-	47	19	-	-	5%
17	-	-	46	19	-	-	5%
18	-	-	-	-	-	-	0%
19	1,057	951	27	23	3%	2%	4%
20	-	-	10	11	-	-	2%
21	-	-	15	10	-	-	2%
22	-	-	15	10	-	-	2%
23	-	-	-	-	-	-	0%
24	-	-	44	18	-	-	5%
25	-	-	40	17	-	-	5%
26	-	-	6	1	-	-	1%
27	898	808	41	16	5%	2%	5%
28	1,814	2,250	184	81	10%	4%	22%
29	2,116	2,180	2	10	0%	0%	1%
30	747	755	11	3	1%	0%	1%
31	2,217	2,252	11	3	0%	0%	1%
32	1,613	1,712	0	1	0%	0%	0%
33	1,555	1,660	38	77	2%	5%	9%
34	1,338	1,424	376	331	28%	23%	58%
35	1,567	1,482	321	250	20%	17%	47%
36	1,460	1,551	116	144	8%	9%	21%
37	966	960	123	26	13%	3%	12%
38	-	-	42	9	-	-	4%
39	-	-	53	65	-	-	10%
40	-	-	53	65	-	-	10%
41	-	-	80	71	-	-	12%
42	985	827	78	66	8%	8%	12%
43	-	-	1	3	-	-	0%
44	1,793	1,590	94	45	5%	3%	11%
45	-	-	2	2	-	-	0%
46	-	-	4	10	-	-	1%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	-	-	0%	0%	0%
49	-	-	14	11	-	-	2%
50	820	691	-	-	0%	0%	0%
51	-	-	14	11	-	-	2%
52	-	-	14	11	-	-	2%
53	2,525	2,508	101	144	4%	6%	20%
54	-	-	115	154	-	-	22%
55	2,454	2,443	115	154	5%	6%	22%
56	2,549	2,558	-	-	0%	0%	0%
57	-	-	115	154	-	-	22%
58	4,008	4,678	0	1	0%	0%	0%
59	-	-	-	-	-	-	0%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	12	3	-	-	1%
63	226	220	11	5	5%	2%	1%
64	2,044	2,588	0	1	0%	0%	0%
65	-	-	40	17	-	-	5%
66	-	-	59	24	-	-	7%
67	-	-	59	25	-	-	7%
68	407	306	499	356	123%	116%	70%
69	304	206	2	0	1%	0%	0%
70	203	206	-	-	0%	0%	0%
71	-	-	99	49	-	-	12%
72	-	-	3	1	-	-	0%
73	-	-	198	100	-	-	24%
74	-	-	27	23	-	-	4%
75	-	-	101	144	-	-	20%

C.1.9 Scenario 1J

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	1	1	-	-	1%
2	915	815	35	46	4%	6%	37%
3	-	-	13	9	-	-	10%
4	-	-	37	49	-	-	40%
5	395	224	8	13	2%	6%	10%
6	1,121	1,414	27	33	2%	2%	28%
7	1,674	1,638	24	31	1%	2%	25%
8	-	-	-	-	-	-	0%
9	601	468	7	7	1%	1%	6%
10	929	855	8	13	1%	1%	10%
11	-	-	7	11	-	-	8%
12	-	-	6	9	-	-	7%
13	580	474	6	9	1%	2%	7%
14	-	-	1	1	-	-	1%
15	-	-	5	7	-	-	6%
16	-	-	4	6	-	-	5%
17	-	-	4	6	-	-	5%
18	-	-	-	-	-	-	0%
19	1,057	951	1	1	0%	0%	1%
20	-	-	2	2	-	-	2%
21	-	-	1	0	-	-	1%
22	-	-	1	0	-	-	1%
23	-	-	-	-	-	-	0%
24	-	-	4	6	-	-	5%
25	-	-	3	4	-	-	3%
26	-	-	-	-	-	-	0%
27	898	808	2	5	0%	1%	3%
28	1,814	2,250	5	9	0%	0%	6%
29	2,116	2,180	2	3	0%	0%	2%
30	747	755	1	2	0%	0%	1%
31	2,217	2,252	-	-	0%	0%	0%
32	1,613	1,712	-	-	0%	0%	0%
33	1,555	1,660	8	5	1%	0%	6%
34	1,338	1,424	8	5	1%	0%	6%
35	1,567	1,482	11	18	1%	1%	13%
36	1,460	1,551	7	17	0%	1%	11%
37	966	960	21	27	2%	3%	22%
38	-	-	22	28	-	-	23%
39	-	-	50	52	-	-	47%
40	-	-	89	108	-	-	90%
41	-	-	9	16	-	-	11%
42	985	827	9	16	1%	2%	11%
43	-	-	3	2	-	-	2%
44	1,793	1,590	4	9	0%	1%	6%
45	-	-	7	12	-	-	9%
46	-	-	3	3	-	-	3%
47	-	-	-	-	-	-	0%

Junction	DoMin AM	DoMin PM	Devt AM	Devt PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	-	-	0%	0%	0%
49	-	-	2	4	-	-	3%
50	820	691	-	-	0%	0%	0%
51	-	-	2	4	-	-	3%
52	-	-	2	4	-	-	3%
53	2,525	2,508	24	16	1%	1%	18%
54	-	-	26	20	-	-	21%
55	2,454	2,443	26	20	1%	1%	21%
56	2,549	2,558	-	-	0%	0%	0%
57	-	-	26	20	-	-	21%
58	4,008	4,678	-	-	0%	0%	0%
59	-	-	-	-	-	-	0%
60	537	457	-	-	0%	0%	0%
61	1,205	1,252	-	-	0%	0%	0%
62	-	-	0	0	-	-	0%
63	226	220	1	4	1%	2%	2%
64	2,044	2,588	-	-	0%	0%	0%
65	-	-	3	4	-	-	3%
66	-	-	1	1	-	-	1%
67	-	-	-	-	-	-	0%
68	407	306	8	4	2%	1%	6%
69	304	206	-	-	0%	0%	0%
70	203	206	-	-	0%	0%	0%
71	-	-	0	0	-	-	0%
72	-	-	-	-	-	-	0%
73	-	-	10	17	-	-	13%
74	-	-	1	1	-	-	1%
75	-	-	24	16	-	-	18%

C.1.10 Scenario 2

Junction	DoMin AM	DoMin PM	Dev AM	Dev PM	Uplift AM	Uplift PM	Proportion of Total
1	-	-	1,005	920	-	-	19%
2	915	815	771	750	84%	92%	15%
3	-	-	517	478	-	-	10%
4	-	-	792	768	-	-	16%
5	395	224	662	651	168%	291%	13%
6	1,121	1,414	257	268	23%	19%	5%
7	1,674	1,638	255	269	15%	16%	5%
8	-	-	170	207	-	-	4%
9	601	468	184	161	31%	34%	3%
10	929	855	664	640	71%	75%	13%
11	-	-	43	60	-	-	1%
12	-	-	134	138	-	-	3%
13	580	474	136	143	23%	30%	3%
14	-	-	729	679	-	-	14%
15	-	-	184	232	-	-	4%
16	-	-	158	202	-	-	4%
17	-	-	193	223	-	-	4%
18	-	-	51	53	-	-	1%
19	1,057	951	605	546	57%	57%	12%
20	-	-	504	451	-	-	10%
21	-	-	66	63	-	-	1%
22	-	-	50	56	-	-	1%
23	-	-	14	24	-	-	0%
24	-	-	184	208	-	-	4%
25	-	-	150	153	-	-	3%
26	-	-	365	366	-	-	7%
27	898	808	362	389	40%	48%	8%
28	1,814	2,250	541	583	30%	26%	11%
29	2,116	2,180	303	437	14%	20%	7%
30	747	755	388	416	52%	55%	8%
31	2,217	2,252	399	478	18%	21%	9%
32	1,613	1,712	69	68	4%	4%	1%
33	1,555	1,660	148	209	10%	13%	4%
34	1,338	1,424	482	447	36%	31%	9%
35	1,567	1,482	553	547	35%	37%	11%
36	1,460	1,551	313	382	21%	25%	7%
37	966	960	358	337	37%	35%	7%
38	-	-	300	307	-	-	6%
39	-	-	1,119	1,062	-	-	22%
40	-	-	1,167	1,127	-	-	23%
41	-	-	224	237	-	-	5%
42	985	827	251	261	25%	32%	5%
43	-	-	28	43	-	-	1%
44	1,793	1,590	521	561	29%	35%	11%
45	-	-	342	365	-	-	7%
46	-	-	126	213	-	-	3%
47	-	-	12	19	-	-	0%

Junction	DoMin AM	DoMin PM	Dev't AM	Dev't PM	Uplift AM	Uplift PM	Proportion of Total
48	1,484	1,391	38	53	3%	4%	1%
49	-	-	73	77	-	-	2%
50	820	691	38	53	5%	8%	1%
51	-	-	47	43	-	-	1%
52	-	-	47	43	-	-	1%
53	2,525	2,508	1,572	1,565	62%	62%	32%
54	-	-	1,570	1,562	-	-	32%
55	2,454	2,443	1,570	1,562	64%	64%	32%
56	2,549	2,558	536	614	21%	24%	12%
57	-	-	1,064	1,015	-	-	21%
58	4,008	4,678	536	615	13%	13%	12%
59	-	-	263	304	-	-	6%
60	537	457	368	416	69%	91%	8%
61	1,205	1,252	376	427	31%	34%	8%
62	-	-	376	415	-	-	8%
63	226	220	32	49	14%	22%	1%
64	2,044	2,588	69	68	3%	3%	1%
65	-	-	150	153	-	-	3%
66	-	-	169	207	-	-	4%
67	-	-	170	207	-	-	4%
68	407	306	575	447	141%	146%	10%
69	304	206	9	17	3%	8%	0%
70	203	206	7	15	4%	7%	0%
71	-	-	310	362	-	-	7%
72	-	-	171	184	-	-	4%
73	-	-	460	440	-	-	9%
74	-	-	941	851	-	-	18%
75	-	-	1,649	1,649	-	-	33%