London Borough of Hounslow

HIGHWAY IMPACT ASSESSMENT

West of the London Borough of Hounslow Local Plan Review: A Highway Impact Study

-

MARCH 2019

INTERNAL

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West of the London Borough of Hounslow Local Plan Review: A Highway Impact Study

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CONTENTS

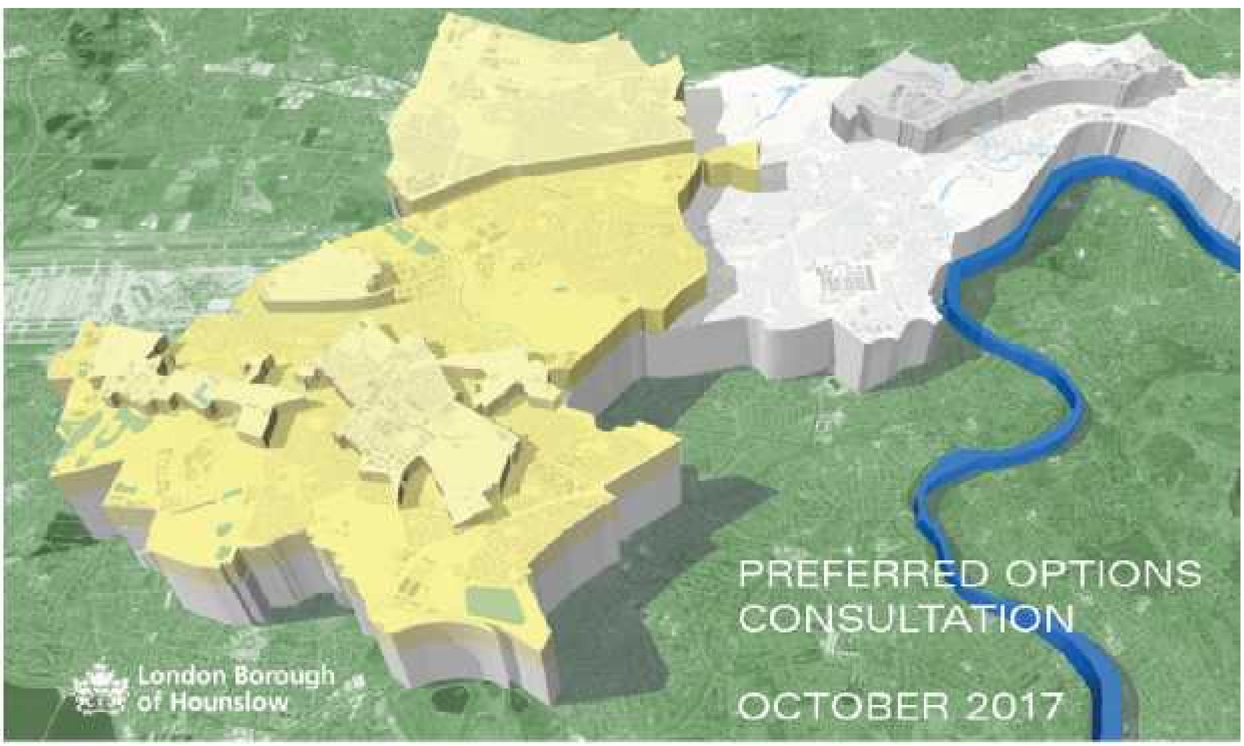
1. INTRODUCTION

1.1. CONTEXT OF THE STUDY

1.1.1. In August 2017, WSP was appointed by the London Borough of Hounslow (LBH) to undertake a highway impact assessment for its review of the *"West of the Borough Local Plan"*. The Local Plan was originally adopted in September 2015 and a review of this Local Plan is being undertaken.

1.1.2. The West of the Borough is shown in **Figure 1**. The area covers the western part of the Borough, comprising the wards of: Bedfont, Feltham West, Feltham North, Hanworth Park, Hanworth, Hounslow Heath, Hounslow West, Cranford, Heston West, Heston Central and Heston East. It is a strategically important location at the western 'gateway' to central London, adjacent to Heathrow Airport, with a large presence in the logistics industry and is where many of the Borough's residents live.

1.1.3. A number of strategic transport routes cross the area east to west, including the M4, A4 and A315, and the A312 north to south linking the M40 with the M3. Key rail routes also pass through the area east to west, namely the Waterloo to Weybridge line which runs through Feltham town centre, and the Piccadilly London Underground line which runs from central London to Heathrow Airport.



Source: London Borough of Hounslow. Preferred Options Consultation, October 2017

Figure 1 – Extent of the West of the Borough

1.1.4. To assess the highway impact of the development proposals, the study has used the latest version of Transport for London's (TfL's) West London Highway Assignment Model (WeLHAM). This is a SATURN highway assignment model covering West London. The base year model was developed to reflect 2012 network conditions and traffic. WeLHAM takes information on the number of trips and their expected origins and destinations from LTS, TfL's multi-modal strategic transport model of London and the surrounding area, and calculates their routes through the highway network based on journey times and distances.

1.2. STAGES OF THE STUDY

1.2.1. This assessment has followed TfL's *"Sub-regional Highway Assignment Models: Guidance on Model Use, Version 2.6"* (TfL, June 2017) and as such, has been completed in the following stages:

- **Stage 1:** Inception
- **Stage 2:** Base Year Model Audit
- **Stage 3a:** Forecast Year Model Audit and Refinement
- **Stage 3b:** Assessment of planning data and preparation of scenarios
- **Stage 4:** Highway Impact Assessment of Scenario 1 (Do Minimum) and Scenario 2 (Low Growth)
- **Stage 5:** Identification and assessment of mitigation measures under Low Growth (Scenario 3), testing of High Growth (Scenario 4) and production of this final report.

1.2.2. The tasks and outputs from each stage are illustrated in **Figure 2**.

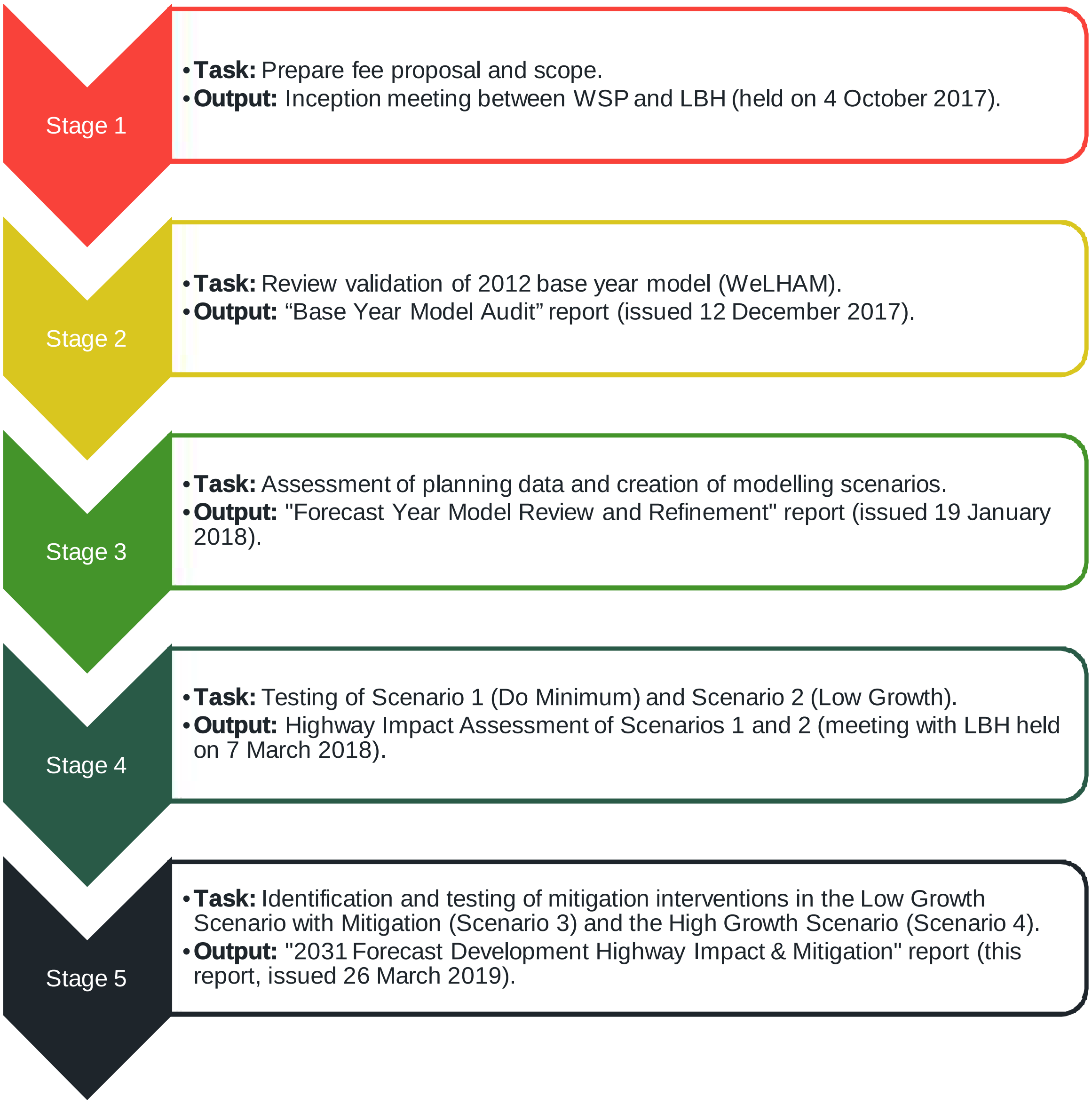


Figure 2 – Stages, Tasks and Outputs from the Study

1.3. CAVEATS

1.3.1. It must be understood from the outset of this study that:

- The WeLHAM model demonstrates a good level of validation in the Borough and along its boundaries. A complete review of the model validation is presented in “Base Year Model Audit” report (issued 12 December 2017), which concluded that *“The existing 2012 base year WeLHAM highway model is deemed to be sufficiently detailed and validated for the assessment of the highway impacts of the Local Plan development in the west of the London Borough of Hounslow”*.

- The growth associated with the additional development in the London Borough of Hounslow has been calculated using industry accepted growth rates in population and employment, along with forecasting methods stipulated in WebTAG and TfL's guidance.
- Heathrow Airport expansion is not a committed scheme and therefore, it has not been included in the assessment. However, it is appreciated that the impact of Heathrow Airport expansion on the transport network may need to be tested at some point.

- The mitigation measures tested are not exhaustive and other mitigation could help further reduce the transport impact from the proposed growth.

- To estimate the impact of the mitigation measures, a set of assumptions has been made about the potential mode shift associated with each of them and these are based on published evidence.

- The model is strategic in nature and local junction validation may be required if the model outputs are used in detailed junction assessments.

- The strategic nature of the model and the findings of this study do not in any way reduce the need for individual developments to have detailed, local transport assessments carried out which may identify additional specific impacts on the network (e.g. junction congestion) that require mitigation.

- The results of this study are only one element of a much wider evidence base needed to be considered in the development of further policy documents.

2. FORECAST SCENARIOS

2.1. DEVELOPMENT GROWTH

2.1.1. To inform the Local Plan assessment, WSP was provided with land-use quantum data by LBH for the development proposals in the West of the Borough. This has included information about the Great West Corridor (GWC) in the East of the Borough, the place policy areas in the West of the Borough and any Site Allocations (SA) spread across the whole Borough:

- West of Borough (see below for quantums being tested):
  - Heathrow Gateway
  - Airport Business Park
  - Bedfont
  - Cranford & Heston
  - Feltham
- Great West Corridor (5,253 households and 14,352 jobs by 2031):
  - West
  - Central
  - East
- 28 Site Allocations (2,980 households and 321 jobs by 2031).

2.1.2. It was agreed with LBH that four scenarios will be considered:

- **Scenario 1 (Do Minimum)** – An adjusted version of the existing LTS 7.1 Reference Case model, with background growth in the West of the Borough; full growth in the East of the Borough and full growth outside of the Borough.
- **Scenario 2 (Low Growth)** – As Scenario 1, plus additional 'low' growth in the West of the Borough.
- **Scenario 3 (Low Growth with Mitigation)** – As Scenario 2, but with mitigation measures to mitigate 'low' growth in the West of the Borough.
- **Scenario 4 (High Growth with Mitigation)** – As Scenario 3, but with additional growth in the West of the Borough.

2.1.3. **Table 1** summarises how the anticipated development growth in the West and East of Borough will vary between scenarios. The West of the Borough will be included in Scenarios 2-4 at varying levels of buildout. However, the GWC and the Site Allocations will be included within all of the scenarios at 100% of their total quantums.

2.1.4. A comparison between Scenarios 2-4 against Scenario 1 will demonstrate the impact of the West of the Borough development proposals.

Table 1 – Scenario Summary and Land-use Quantums

<table>
<tr><th rowspan="3">2031 Scenario</th><th colspan="6">West of Borough (WoB)</th><th colspan="2">East of Borough (EoB)</th></tr>
<tr><th colspan="5">Place Policy Area</th><th rowspan="2">Background Growth and Site Allocations (SA)</th><th rowspan="2">GWC</th><th rowspan="2">SA</th></tr>
<tr><th>Heathrow Gateway</th><th>Airport Business Park</th><th>Bedfont</th><th>Cranford & Heston</th><th>Feltham</th></tr>
<tr><td>Scenario 1: Do Minimum</td><td>0%</td><td>0%</td><td>0%</td><td>0%</td><td>0%</td><td colspan="3" rowspan="4">100% in every scenario</td></tr>
<tr><td>Scenario 2: Low Growth, No Mitigation</td><td>0%</td><td>100%</td><td>50%</td><td>100%</td><td>100%</td></tr>
<tr><td>Scenario 3: Low Growth, Mitigation</td><td>0%</td><td>100%</td><td>50%</td><td>100%</td><td>100%</td></tr>
<tr><td>Scenario 4: High Growth, Mitigation</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
</table>

2.1.5. The locations of the five place policy areas are shown in **Figure 3** and **Table 2** details the number of household and jobs proposed to come forward 2015-2031 and to be included within Scenarios

2-4. **Table 2 – West of Borough Land-use Quantums**

Place Policy Area	2015-2031 'Low' Growth (Scenarios 2 and 3)		2015-2031 'High' Growth (Scenario 4)	
	Households	Jobs	Households	Jobs
Heathrow Gateway	0	0	2060	10450
Airport Business Park	0	3826	0	3826
Bedfont Lakes	960	356	1919	713
Cranford & Heston	0	1078	0	1078
Feltham	4543	-477	4543	-477
TOTAL	**5,503**	**4,784**	**8,522**	**15,591**

2.1.6. Total growth in the 'high' growth scenario (Scenario 4) is higher than that forecast in the 'low' growth scenarios (Scenarios 2 and 3). The differences occur in the quantums for the Heathrow Gateway and Bedfont Lakes place policy areas.

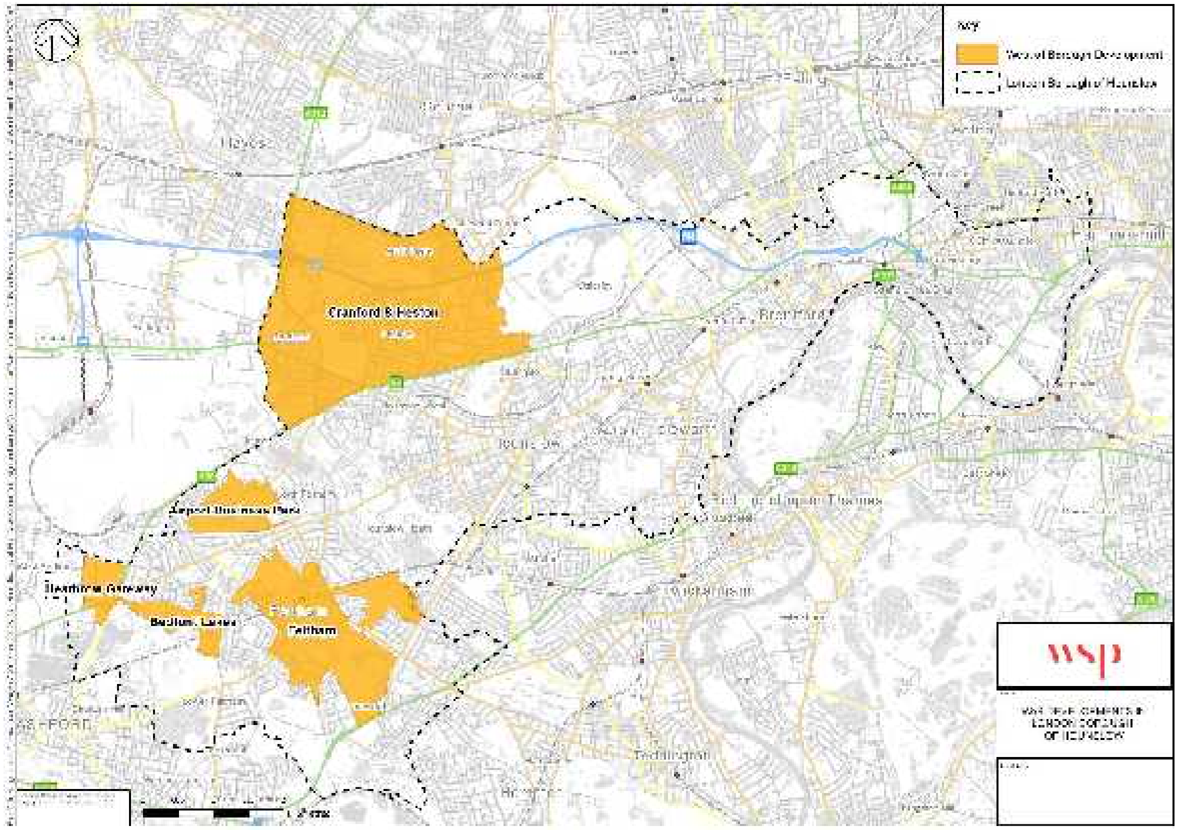


Figure 3 – Location of the five Places Policy Areas

GROWTH SUMMARY

2.1.7. A summary of the total growth within each of the scenarios is provided in **Table 3** and is presented in **Figure 4** to **Figure 9** by area of the Borough.

Table 3 – Growth

2031 Scenario	Description	Households		Jobs	
		WoB	EoB	WoB	EoB
Scenario 1: Do Minimum	‘DM Growth’ (Sc. 1) – includes background growth, Site Allocations and GWC	2,588	15,117	2,882	10,321
Scenario 2: ‘Low’ Growth **Scenario 3: ‘**Low’ Growth and Mitigation	LBH ‘Low’ Growth (Sc. 2/3), **in addition** to ‘DM Growth’ (Sc. 1)	+5,503	+0	+4,784	+0
Scenario 4: ‘High’ Growth and Mitigation	LBH ‘High’ Growth (Sc. 4), **in addition** to Scenario 2/3 Growth	+3,020	+0	+10,807	+0

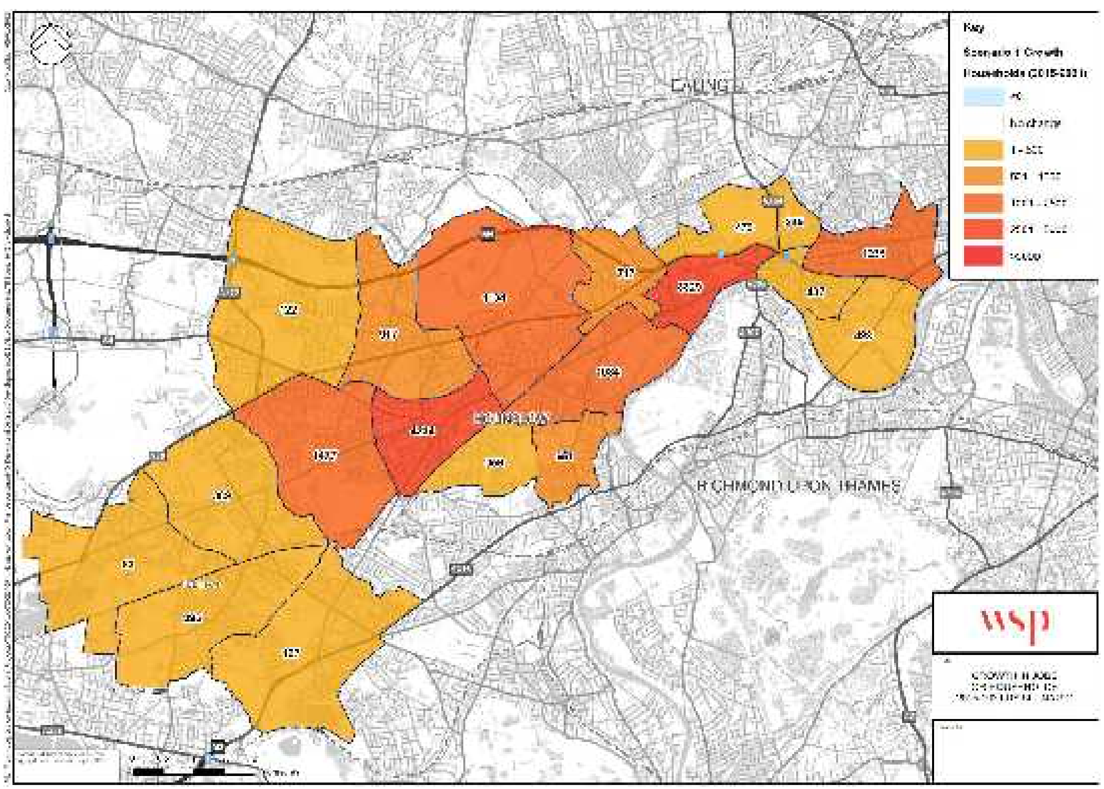


Figure 4 – Scenario 1 Growth. Households

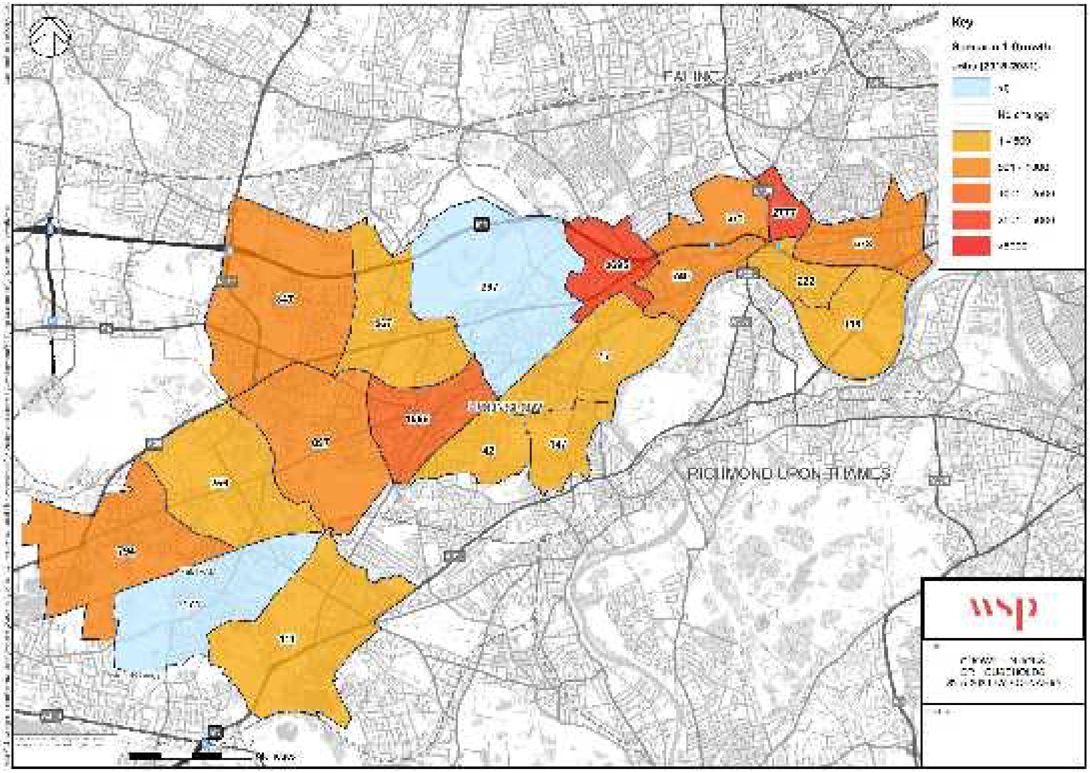


Figure 5 – Scenario 1 Growth. Jobs

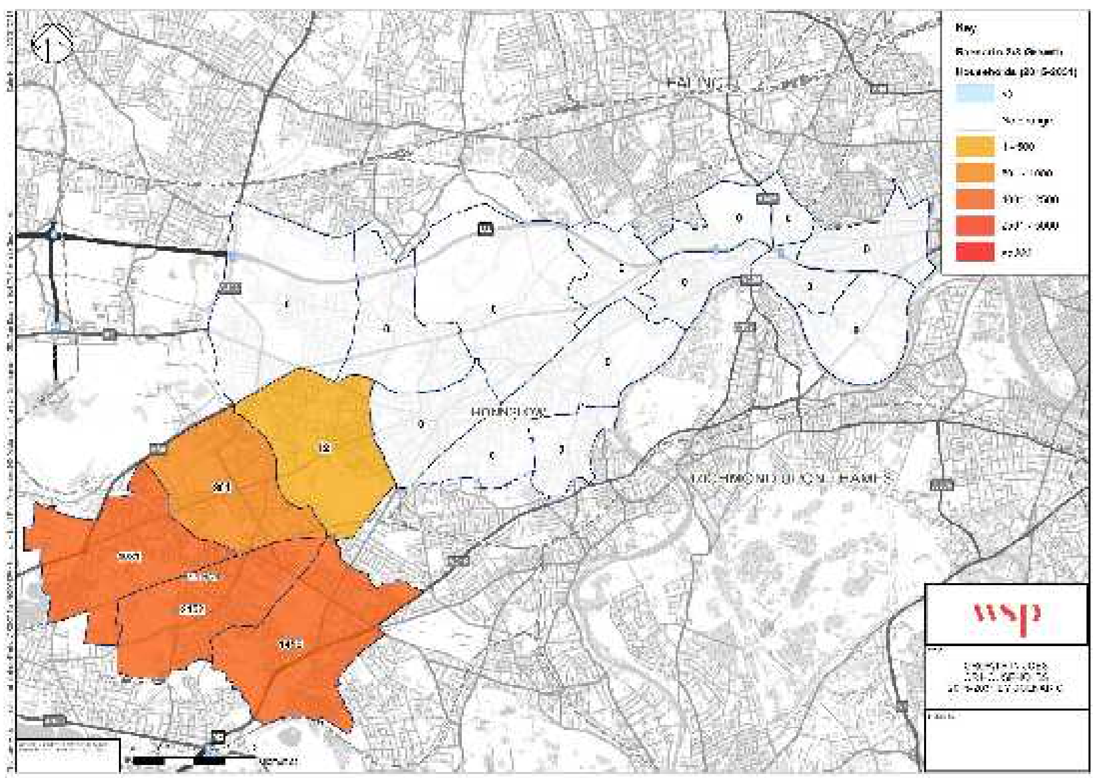


Figure 6 – Scenario 2/3 Growth – WoB 'Low' Growth. Households

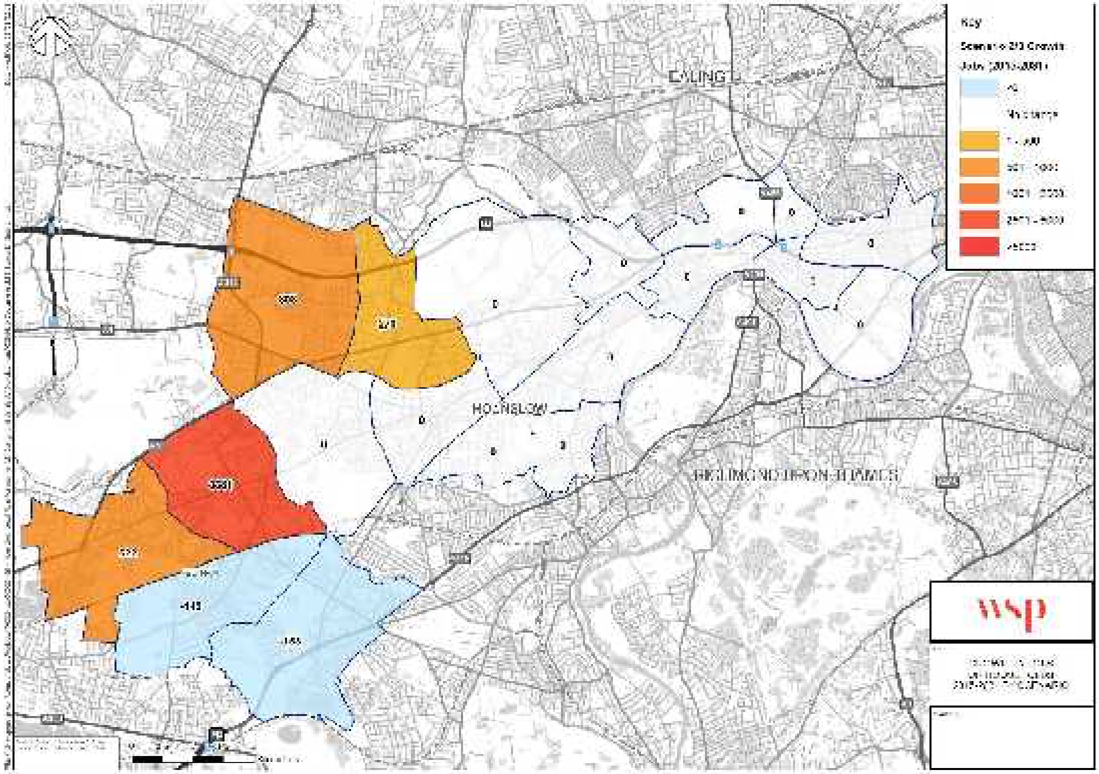


Figure 7 – Scenario 2/3 Growth – WoB 'Low' Growth. Jobs

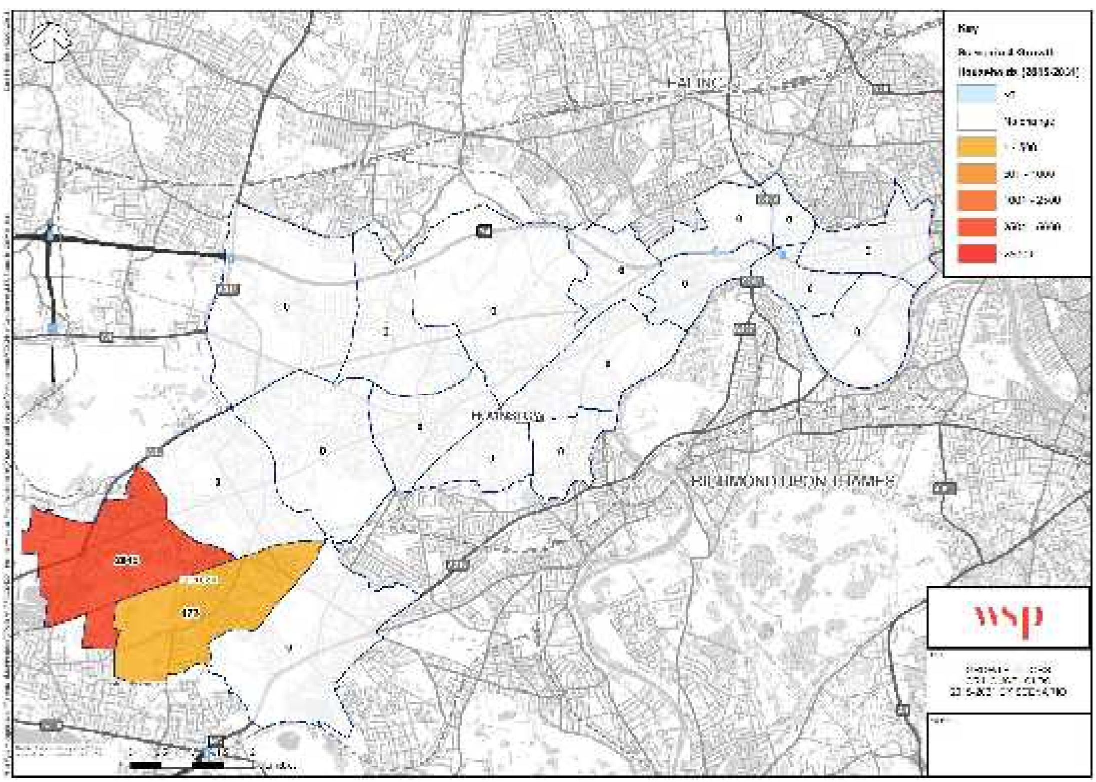


Figure 8 – Scenario 4 Growth – WoB 'High' Growth. Households

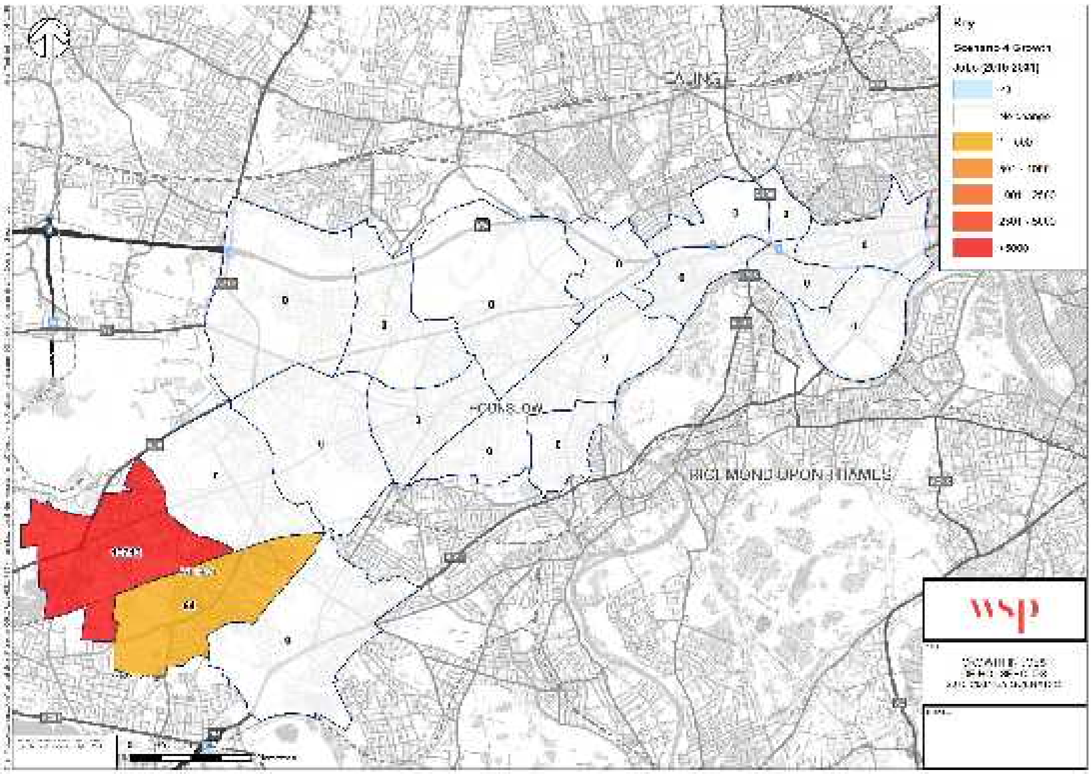


Figure 9 – Scenario 4 Growth – WoB ‘High’ Growth. Jobs

2.1.8. For further information on how each scenario was developed, refer to WSP’s *"Forecast Year Model Review and Refinement"* report (issued to LBH on 19 January 2018).

2.2. MITIGATION

2.2.1. A range of mitigation measures will be included in Scenarios 3 and 4 to understand whether the mitigation package is sufficient enough to offset the impacts of ‘low’ or ‘high’ growth in the West of the Borough.

2.2.2. To identify the areas where mitigation will be required, a comparison of junction Volume to Capacity (V/C) ratios between Scenario 2 and Scenario 1 was carried out. The analysis showed the junctions most impacted by ‘low’ growth and the top ten junctions are highlighted in **Figure 10**.

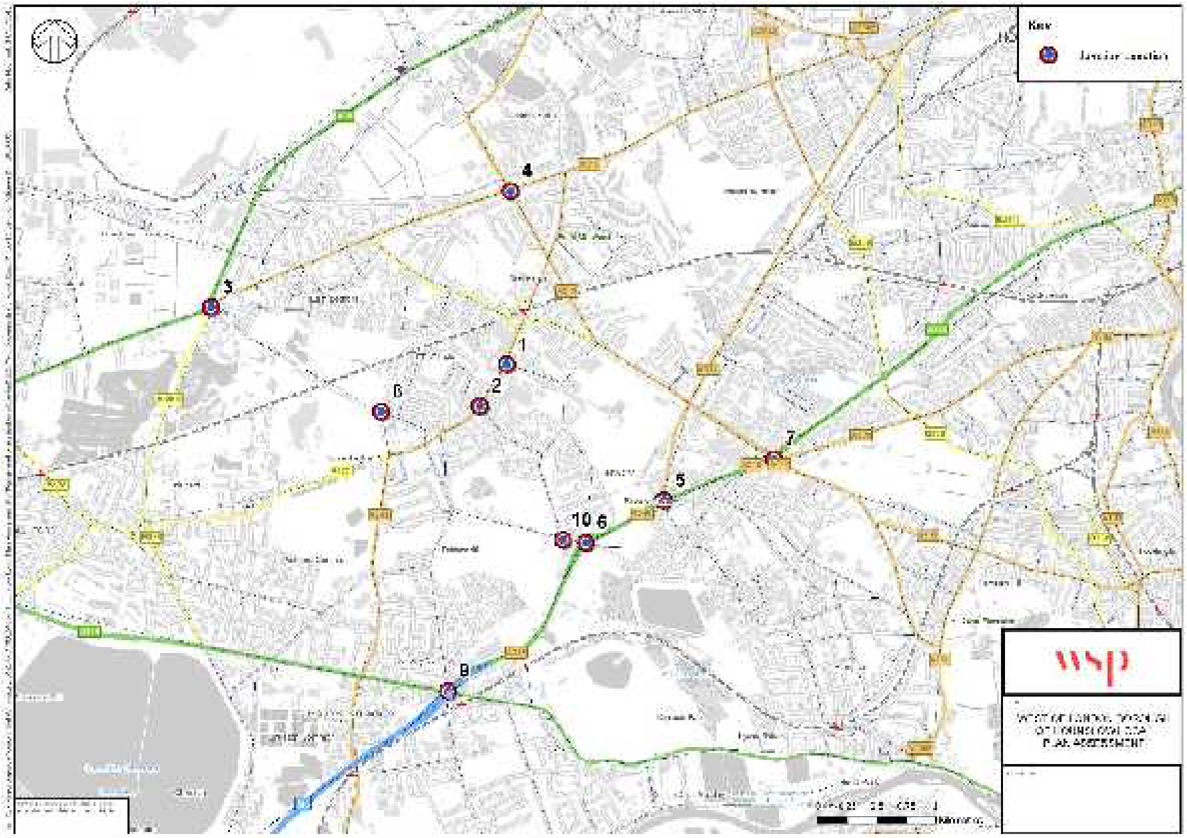


Figure 10 – Top Ten Junctions Impacted Most by 'Low' Growth' (Scenario 2 vs Scenario 1)

2.2.3. A mitigation package was then devised by LBH on the basis of the modelling outputs from Scenario 2 and considered:

- Bus priority
- New cycle route infrastructure
- Travel demand and parking management
- Junction improvements
- Signal optimisation at selected junctions

2.2.4. It should be recognised however, that the mitigation measures proposed and discussed are not exhaustive, and that other schemes could further help reduce the transport impact from the proposed 'low' or 'high' growth in the West of the Borough.

BUS PRIORITY

2.2.5. New bus priority infrastructure and the removal of on-street car parking along Feltham High Street and Faggs Road, which are likely to result in decreased bus journey times, has been considered.

2.2.6. Based on UK research discussed in *"An Analysis of Urban Transport"* (Cabinet Office Strategy Unit, 2009), the elasticity of bus demand to in-vehicle time for urban buses has been estimated to be in the range of -0.4 to -0.6. Therefore, assuming a 5% decrease in journey times along these two corridors, a 2.5% reduction in car trips was applied to highway trips in the cordon area to account for an increase in bus demand resulting from reduced bus journey times.

2.2.7. The area of impact was identified by taking origins and destinations within 640m of the Feltham High Street and Faggs Road corridors. This distance is widely considered to be an acceptable walking distance based on Public Transport Accessibility Level (PTAL) analysis studies within London.

NEW CYCLE ROUTE INFRASTRUCTURE

2.2.8. Improved cycling infrastructure along Feltham High Street, Bedfont Road, Staines Road and Bath Road could come about from the removal of on-street car parking along these routes.

2.2.9. Based on UK research documented in *"Cycling and Sustainability"* (Parkin, 2012), a 25% increase in cycling facilities would increase the number of cycle commuters by approximately 15%, given an elasticity of demand of 0.6 for cycling based changes in response to some sort of cycle facility. Therefore, assuming a 5% increase in cycle facilities along Feltham High Street, Bedfont Road, Staines Road and Bath Road corridors, a 3.0% reduction in car trips was applied to car trips in the area of impact.

2.2.10. The area of impact is model zones immediately adjacent to Feltham High Street, Bedfont Road, Staines Road and Bath Road.

TRAVEL DEMAND AND PARKING MANAGEMENT

Travel Demand Management

2.2.11. WebTAG Unit M5.2 (Modelling Smarter Choices, January 2014) sets out possible mode shifts resulting from each type of demand management strategy (**Table 4**). For the purposes of this study, the reductions in car trips in **Table 4** were halved to reflect more modest mode shifts. The factors were applied selectively, taking into account the trips and peaks that would be effected. For example, the impact of school travel plans was only reflected in the AM peak matrices, and any workplace travel plans have been assumed to have no impact on inter-peak demand.

Table 4 – Possible Mode Shift from Travel Demand Management

Smarter Choice Measure	Reduction in Car Trips	Increase in Non-Car Trips
Workplace Travel Plan	18% *(9% in this study)*	34% *(17% in this study)*
School Travel Plan	10% *(5% in this study)*	7% *(3.5% in this study)*
Targeted Marketing	8% *(4% in this study)*	14% *(7% in this study)*

Source: WebTAG Unit M5.2 (Modelling Smarter Choices)

Parking Management

2.2.12. In TfL's LTS model, car parking affects destinations and destination related mode choice in the model. For example, the commuting mode share is affected by car parking. LTS contains a parking model that iterates 3 times per demand model iteration (the demand model iterates 7 times). If spaces are all full in the destination zone, a trip can park in neighbouring zones and walk with an associated cost. If this cost is high, there may be a shift in mode choice away from car.

2.2.13. Car parking is input as available spaces per model zone (based on parking data from the 1999 parking supply survey, LATS 2001 data and other sources), by parking space type (public on-street / public off-street / private non-residential / private residential). This base year data is from datasets which may have no relation to reality in the LTS zones, and TfL advise not to change car parking supply in the Reference Case because the parking model is calibrated to this data.

2.2.14. In the LTS model, the number of parking spaces remains the same as the base year in all future years, except for private non-residential parking (office private parking) which decreases by 10% every 10 years (e.g. 10% reduction 2011-2021, 20% reduction 2011-2031 and 30% reduction 2011-2041).

2.2.15. To accompany the LTS' reduction in office private parking, a 50% reduction in car parking at new residential developments was applied to Scenarios 3 and 4.

Workplace Parking Levy

2.2.16. Although it was <u>not</u> modelled or included in the mitigation package assessed as part of this study in Scenarios 3 or 4, an option open to the London Borough of Hounslow is potentially the implementation of a Workplace Parking Levy (WPL) at targeted commercial development locations as part of its travel demand management strategy.

2.2.17. WPL may be a particularly desirable option in or around the area of 'high' growth in order to help fund related local transport improvements. The revenue could derive from a charge on employers who provide workplace parking for their employees, with the end benefit of improving the transport environment for everyone in the local area.

2.2.18. In the East of the Borough around the Great West Corridor, transport modelling work carried out in 2018/2019 found that approximately £750 could be generated from each levied park space per annum, which translated into a 25% reduction in AM peak trips in the local area (1km radius).

2.2.19. In the West of the Borough, WPL could therefore potentially be an additional 'tool' to help achieve the mode shifts set out in **Table 4**.

JUNCTION IMPROVEMENTS

2.2.20. Two highway infrastructure schemes have been included in the West of the Borough, namely:

- A major highway improvement scheme at the Clockhouse Roundabout, including the construction of a short tunnel on the A30.
- Junction improvements to the Bedfont Road / Chertsey Road junction with the implantation of a give-way left-turn filter lane from Chertsey Road to Bedfont Road (westbound).

2.2.21. The impact of the junction improvements will be ascertained by running TfL's WeLHAM model.

SIGNAL OPTIMISATION

2.2.22. In line with TfL's guidance, in order to improve model convergence, signal optimisation was carried out at selected junctions across in all scenarios. **Figure 11** shows the locations of the junctions where signal optimisation was carried out, namely:

- M3 Junction 1
- A30 Clockhouse Roundabout
- A244 High Street / Browells Lane
- A244 High Street / Poplar Way

- A315 Staines Road / A244 Hounslow Road
- A315 Staines Road / A312 Faggs Road
- A315 Staines Road / Green Lane
- A316 / Hounslow Road / Bear Road
- A316 Chertsey Road / B358 Hospital Bridge Road
- Bedfont Road / Chertsey Road

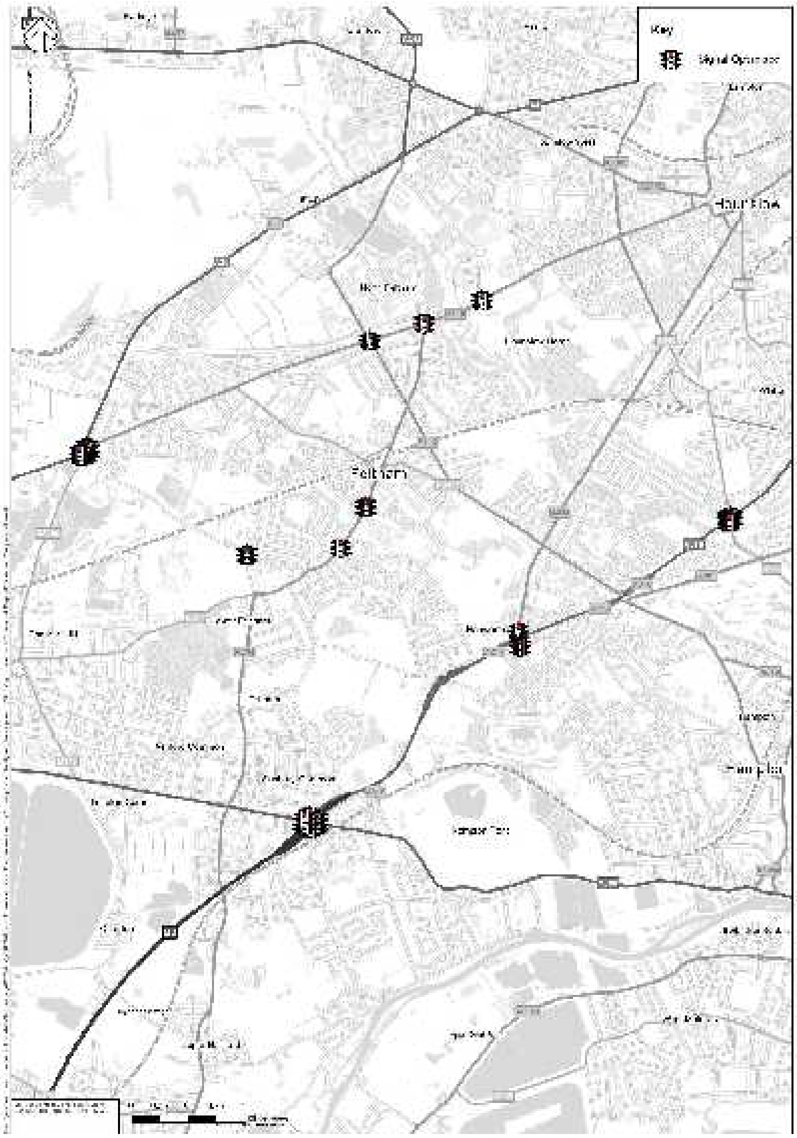


Figure 11 – Signal Optimised Junctions (implemented in all scenarios)

2.3. SUMMARY

2.3.1. Appendix A provides details on the number of car trips removed from the highway matrices for those measures where mode shift calculations were required outside of TfL's LTS model. These were bus priority, cycle route infrastructure and travel demand and parking management.

3. DEVELOPMENT IMPACT ASSESSMENT

3.1. INTRODUCTION

3.1.1. To determine the impact of additional development on the highway network, the following analysis has been undertaken for the 2031 AM peak, IP and PM peak hours:

- Journey times
- Actual flow differences
- vehicle delay differences
- Volume over Capacity (V/C) ratio differences

3.2. JOURNEY TIMES

3.2.1. To understand the impact on people's travel, journey time analysis has been undertaken on key routes. The routes used for this analysis are shown in **Figure 12** and are truncated versions of TfL's journey time routes used in the validation of the 2012 Base year model.

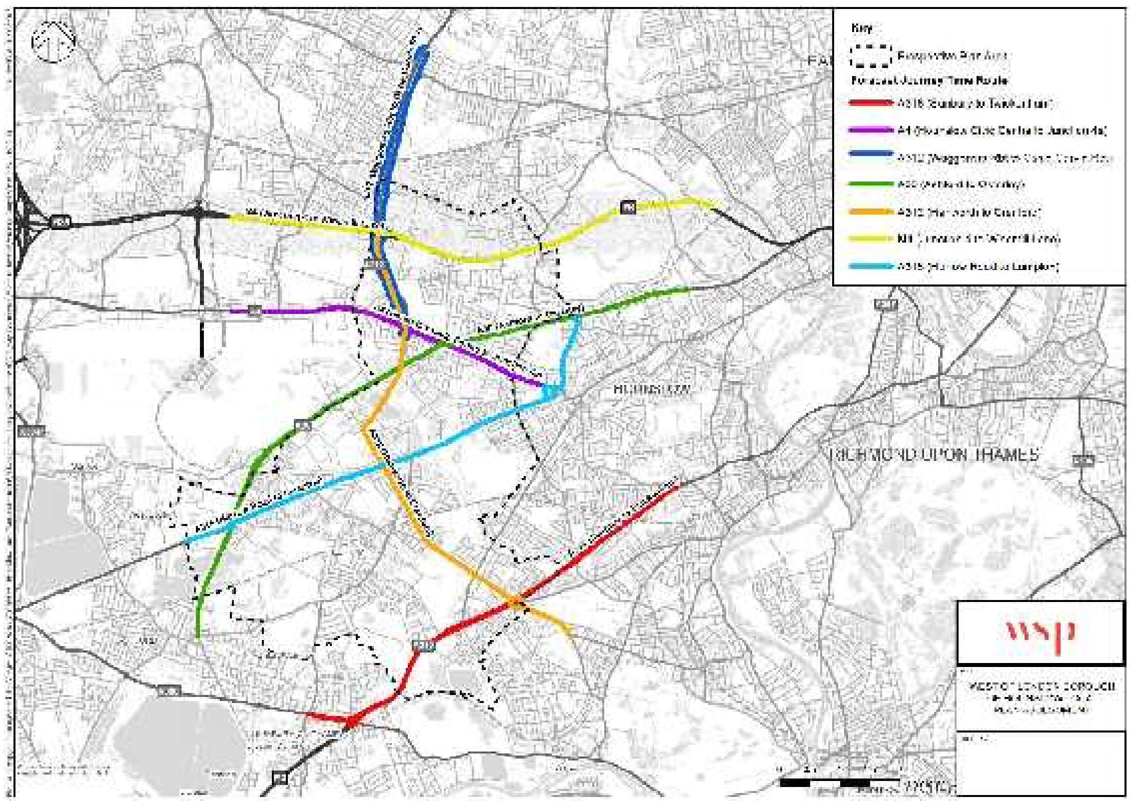


Figure 12 – Forecast Year Journey Time Routes

3.2.2. **Table 5**, **Table 6** and **Table 7** present total journey times and provide a comparison between:

- Scenario 2 vs Scenario 1
- Scenario 3 vs Scenario 2
- Scenario 3 vs Scenario 1
- Scenario 4 vs Scenario 3

Table 5 – AM Peak Journey Times

ID	Route Name	Dir.	AM Peak							
			Journey Time (seconds)				Journey Time Difference			
			Sc. 1	Sc. 2	Sc. 3	Sc. 4	2 vs 1	3 vs 2	3 vs 1	4 vs 3
1	A312 (Waggoners Rbt to Ossie Garvin Rbt)	NB	730	755	762	771	25	7	32	9
2	A312 (Ossie Garvin Rbt to Waggoners Rbt)	SB	1,258	1,264	1,249	1,259	6	-15	-9	10
3	M4 (Junction 4 to Windmill Lane)	EB	1,100	1,112	1,109	1,093	12	-3	9	-16
4	M4 (Windmill Lane to Junction 4)	WB	343	343	344	343	0	1	1	-1
5	A4 (Junction 4a to Hounslow Civic Centre)	EB	1,396	1,413	1,415	1,432	17	2	19	17
6	A4 (Hounslow Civic Centre to Junction 4a)	WB	1,632	1,664	1,641	1,655	32	-23	9	13
7	A30 (Ashford to Osterley)	EB	1,487	1,556	1,459	1,469	69	-97	-28	10
8	A30 (Osterley to Ashford)	WB	1,562	1,575	1,574	1,609	13	-1	12	35
9	A312 (Hanworth to Cranford)	NB	1,852	1,952	1,932	1,946	100	-20	80	14
10	A312 (Cranford to Hanworth)	SB	1,785	1,810	1,778	1,785	25	-32	-7	7
11	A315 (Harrow Road to Lampton)	EB	1,490	1,528	1,479	1,510	38	-49	-11	32
12	A315 (Lampton to Harrow Road)	WB	1,579	1,571	1,533	1,503	-8	-38	-46	-31
13	A316 (Sunbury to Twickenham)	EB	1,050	1,106	1,058	1,064	56	-48	8	6
14	A316 (Twickenham to Sunbury)	WB	765	770	760	761	5	-10	-5	1
Total			**18,029**	**18,419**	**18,094**	**18,202**	**390**	**-325**	**65**	**108**

Table 6 – IP Journey Times

ID	Route Name	Dir.	IP							
			Journey Time (seconds)				Journey Time Difference			
			Sc. 1	Sc. 2	Sc. 3	Sc. 4	2 vs 1	3 vs 2	3 vs 1	4 vs 3
1	A312 (Waggoners Rbt to Ossie Garvin Rbt)	NB	663	682	681	690	19	-1	18	9
2	A312 (Ossie Garvin Rbt to Waggoners Rbt)	SB	509	516	515	519	7	-1	6	4
3	M4 (Junction 4 to Windmill Lane)	EB	407	407	406	406	0	-1	-1	0
4	M4 (Windmill Lane to Junction 4)	WB	289	290	289	289	1	-1	0	0
5	A4 (Junction 4a to Hounslow Civic Centre)	EB	937	940	941	942	3	1	4	1
6	A4 (Hounslow Civic Centre to Junction 4a)	WB	926	930	926	931	4	-4	0	5
7	A30 (Ashford to Osterley)	EB	1,015	1,017	1,022	1,027	2	5	7	5
8	A30 (Osterley to Ashford)	WB	999	1,006	1,010	1,027	7	4	11	18
9	A312 (Hanworth to Cranford)	NB	1,199	1,226	1,221	1,230	27	-5	22	9
10	A312 (Cranford to Hanworth)	SB	1,234	1,258	1,243	1,247	24	-15	9	3
11	A315 (Harrow Road to Lampton)	EB	1,174	1,182	1,172	1,175	8	-10	-2	2
12	A315 (Lampton to Harrow Road)	WB	1,166	1,181	1,171	1,173	15	-10	5	2
13	A316 (Sunbury to Twickenham)	EB	533	534	533	532	1	-1	0	-1
14	A316 (Twickenham to Sunbury)	WB	636	640	638	639	4	-2	2	2
Total			**11,687**	**11,809**	**11,769**	**11,828**	**122**	**-40**	**82**	**59**

Table 7 – PM Peak Journey Times

ID	Route Name	Dir.	PM Peak							
			Journey Time (seconds)				Journey Time Difference			
			Sc. 1	Sc. 2	Sc. 3	Sc. 4	2 vs 1	3 vs 2	3 vs 1	4 vs 3
1	A312 (Waggoners Rbt to Ossie Garvin Rbt)	NB	972	978	967	989	6	-11	-5	22
2	A312 (Ossie Garvin Rbt to Waggoners Rbt)	SB	661	691	700	703	30	9	39	3
3	M4 (Junction 4 to Windmill Lane)	EB	1,669	1,678	1,674	1,650	9	-4	5	-24
4	M4 (Windmill Lane to Junction 4)	WB	341	341	339	335	0	-2	-2	-4
5	A4 (Junction 4a to Hounslow Civic Centre)	EB	1,666	1,712	1,690	1,682	46	-22	24	-8
6	A4 (Hounslow Civic Centre to Junction 4a)	WB	1,349	1,375	1,423	1,407	26	48	74	-16
7	A30 (Ashford to Osterley)	EB	1,945	1,970	1,962	1,927	25	-8	17	-35
8	A30 (Osterley to Ashford)	WB	1,479	1,529	1,499	1,520	50	-30	20	21
9	A312 (Hanworth to Cranford)	NB	2,185	2,224	2,207	2,247	39	-17	22	40
10	A312 (Cranford to Hanworth)	SB	2,186	2,253	2,177	2,207	67	-76	-9	30
11	A315 (Harrow Road to Lampton)	EB	2,058	2,099	2,104	2,057	41	5	46	-47
12	A315 (Lampton to Harrow Road)	WB	1,915	1,985	1,866	1,943	70	-119	-49	77
13	A316 (Sunbury to Twickenham)	EB	1,056	1,069	1,064	1,005	13	-5	8	-58
14	A316 (Twickenham to Sunbury)	WB	808	819	806	821	11	-13	-2	15
Total			**20,290**	**20,723**	**20,478**	**20,493**	**433**	**-245**	**188**	**15**

3.2.3. **Figure 13** graphically compares the total journey times on all routes for each scenario, in each peak.

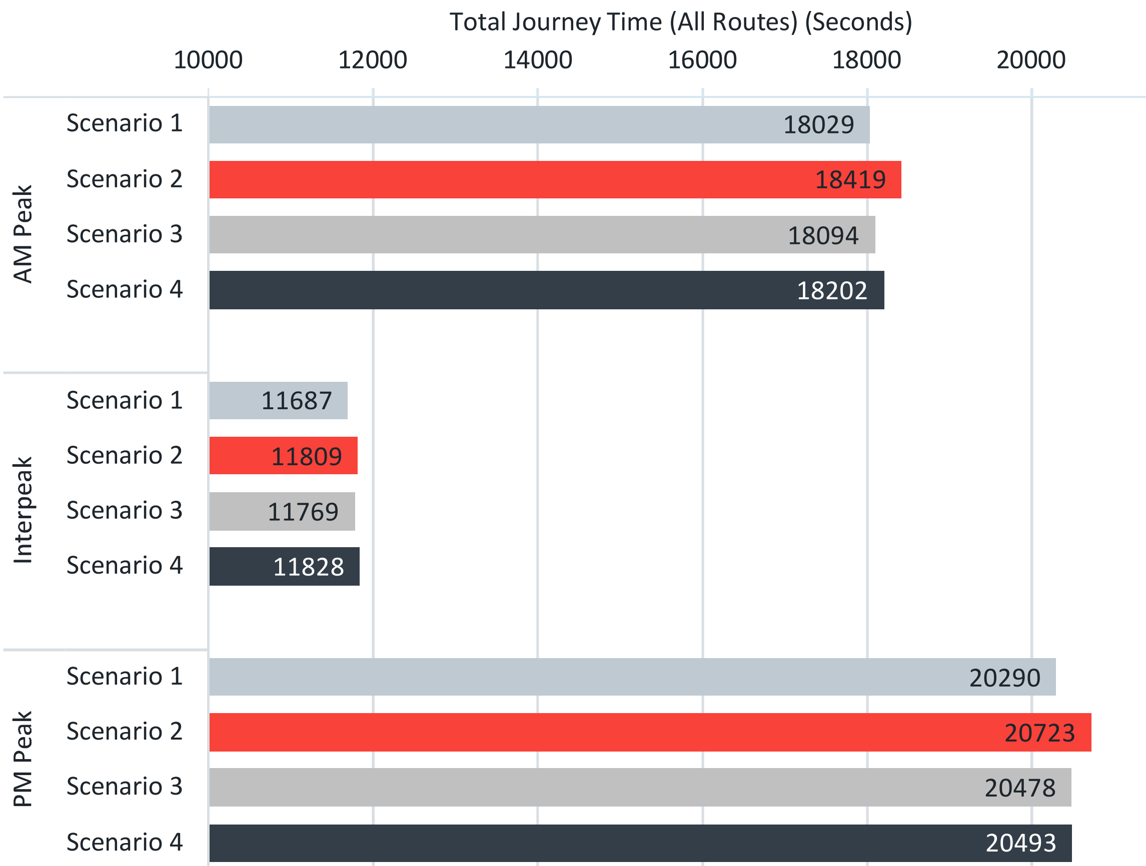


Figure 13 – Comparison of Total Journey Times (All Routes)

3.2.4. Analysis of **Figure 13** provides a picture of the forecast effects of 'low' and 'high' growth on the highway network. In summary:

- In all three peaks, total journey time increase between Scenario 2 ('low' growth) and Scenario 1 (Do Minimum) – this is expected with the introduction of additional 'low' growth development.
- Mitigation introduced in Scenario 3 ('low' growth with mitigation) results in decreased (or improved) journey times (comparison of Scenario 3 with Scenario 2). The mitigation offsets the impact of additional development, bringing journey times in Scenario 3 almost down to those in Scenario 1.
- Mitigation proposed in Scenario 4 ('high' growth with mitigation) is estimated to partially offset the impact of additional 'high' growth development. A comparison of Scenario 4 with Scenario 3 shows that the total journey times are higher in Scenario 4.
- The journey times in Scenario 3 and 4 are less than the journey times in Scenario 2 (except for in the IP). Scenario 2 does not contain mitigation, whereas Scenarios 3 and 4 contain a raft of mitigation measures, as discussed previously and detailed in Appendix A.

3.3. ACTUAL FLOWS

3.3.1. To establish the impact of the development on the highway network, actual flow plots (Appendix B.1) and actual flow difference plots (Appendix B.2) have been produced.

3.3.2. A comparison of Scenario 2 with Scenario 1 shows that increases in actual flow are mostly apparent in areas experiencing employment and/or residential growth, or on key routes travelling to/from the development areas. In particular, this applies to Feltham and Bedfont, with the largest flow differences observed on the A316, the M3 and on the A30 around the Clockhouse Roundabout, just south of the Airport Business Park development.

3.3.3. There are a few instances of actual flows in Scenario 2 decreasing with respect to Scenario 1 and this is a result of traffic rerouting onto other strategic routes (not residential roads) in the Borough

3.3.4. The impact of the mitigation package on the highway network can be seen when comparing the actual flows in Scenario 3 with those in Scenario 2. The mitigation package results in decreased actual flows across the West of the Borough as a whole, with the exception being the area around the Clockhouse Roundabout, especially on the A30, where actual flow increases are seen due to capacity improvements at the junction.

3.3.5. Due to 'high' growth in Scenario 4, the area around Bedfont Lakes and Heathrow Gateway experiences higher increases in actual flow than elsewhere in the West of the Borough, as shown on the plots comparing Scenario 4 with Scenario 3. It is evident that much of the traffic generated by these developments is attracted to the A30 and its mitigation scheme.

3.4. VEHICLE DELAYS

3.4.1. Delay plots (showing all delays >30 seconds in Appendix C.1) and delay difference plots (Appendix C.2) have been produced.

3.4.2. A comparison of Scenario 2 with Scenario 1 shows that delays on links generally increase in the West of the Borough. The changes are constrained mainly to the areas of growth, which is expected due to the introduction of additional highway trips onto the network in these growth areas.

3.4.3. The mitigation package introduced in Scenario 3, results in delay reductions on many links in the West of the Borough when compared with Scenario 2. There are very few instances of delays increasing. This indicates that the mitigation package largely offsets the impact of the additional development.

3.4.4. Mitigation in Scenario 4, is estimated to partially offset the impact of additional 'high' growth development. A comparison of Scenario 4 with Scenario 3 shows that the delay differences are low. As discussed below, it is the Volume to Capacity ratios between Scenarios 3 and 4 that exhibit the most change.

3.5. V/C RATIOS

3.5.1. To identify the junctions that are likely to exhibit increased queuing/or and delays, a comparison of Volume to Capacity (V/C) ratios in the Do Minimum and Do Something scenario was carried out. V/C ratio (Appendix D.1) and V/C ratio difference plots (Appendix D.2) have been produced.

3.5.2. To define V/C ratio firstly:

- V/Cs of <80% indicate that a junction is operating within capacity and with spare capacity.

- V/Cs of 80%-89% mean that a junction is still operating within, but is approaching capacity, with some queuing and delays.
- V/Cs of ≥90% indicate that a junction is operating above capacity, with substantial queues and delays.

3.5.3. When comparing Scenario 2 with Scenario 1, the vast majority of V/C increases are within 13%. Those links with V/C ratio increases are spread across the West of the Borough and are not necessarily within the immediate vicinity of the development areas. Development traffic takes up spare capacity on the local, less busy links, and the overall increase in traffic results in some links exceeding their capacity, although the increases are minimal in the majority of cases.

3.5.4. When the mitigation package is included in Scenario 3, the V/C increases observed when comparing Scenario 3 with Scenario 2 are once again small on the vast majority of links. As traffic changes its routing as a result of the mitigation schemes, the V/C increases are within 20% on the vast majority of links in the West of the Borough.

3.5.5. With 'high' growth in Scenario 4, the links in the area around Bedfont Lakes and Heathrow Gateway particularly experience increases in V/C ratio when a comparison of Scenario 4 is made with Scenario 3 (most notably in the PM peak). Increases of up to +13% are apparent with 'high' growth compared to 'low' growth and there are junctions which from below to over 90% V/C between Scenario 3 and Scenario 4, namely one or more approaches at the junctions of:

- A30 / Short Lane (AM peak)
- A30 / B378 Stanwell Road west of Bedfont (AM and PM peaks)
- A312 Faggs Road / A315 Staines Road (AM peak)
- A30 / Stanwell Road at Heathrow Airport (PM peak)

3.5.6. These and other junctions in proximity to Heathrow Gateway and Bedfont Lakes where the 'high' growth development impact is shown to be most felt prevalent from a V/C angle include:

- Junctions along the A30 corridor close to Bedfont Lakes e.g.:
  - A30 / Stanwell Road at Heathrow Airport *(V/C increase between Sc.3 and Sc.4 of up to **+12%**)*
  - A30 / Faggs Road *(V/C increase between Sc.3 and Sc.4 of up to **+4%)***
  - A30 / B378 Stanwell Road west of Bedfont *(V/C increase between Sc.3 and Sc.4 of up to **+13%**)*
- Clockhouse Roundabout (and links/junctions nearby), particularly:
  - A30 / Bedfont Road *(V/C increase between Sc.3 and Sc.4 of up to **+4%**)*
  - A30 / Short Lane *(V/C increase between Sc.3 and Sc.4 of up to **+8%**)*
  - Staines Road / Hatton Road *(V/C increase between Sc.3 and Sc.4 of up to **+8%**)*
- A312 Faggs Road / A315 Staines Road *(V/C increase between Sc.3 and Sc.4 of up to **+10%**)*
- A312 Faggs Road / Causeway *(V/C increase between Sc.3 and Sc.4 of up to **+2%**)*
- A308 Staines Bypass / Fordbridge Road *(V/C increase between Sc.3 and Sc.4 of up to **+2%**)*

3.5.7. Notwithstanding from considering the impact in the wider area, more detailed transport modelling, perhaps as part of a Transport Assessment(s), may be sought at these junctions in particular, to gain further insight into the impact of 'high' growth on the highway network, and identify the impact on junctions/links that were not included in the strategic WeLHAM model used in this study.

3.6. IMPACTS ON THE STRATEGIC ROAD NETWORK

3.6.1. It is evident that the impacts on the strategic road network are constrained to the actual flow differences on the M3 around Junction 1 in the companion of Scenario 2 with Scenario 1. The M3 between Junction 1 and 2 sees actual flow increases of up to 121 PCU/hr southbound in the AM peak, and up to 105 PCU/hr northbound in the PM peak.

3.6.2. There are very minimal changes in actual flow when a comparison is made between Scenario 3 and Scenario 2, and between Scenario 4 and Scenario 3. The M4 carriageways around Junction 4 also show very low actual flow changes in all of the comparisons, and across all of the peaks.

3.7. SOUTHERN RAIL ACCESS TO HEATHROW

3.7.1. The preceding development impact assessment has shown that the mitigation proposed as part of Scenario 4 is estimated to partially offset the impact of additional 'high' growth development. Enhanced mitigation may be required to offset, to an acceptable level, the impact of 'high' growth on traffic conditions immediately around Bedfont. Southern Rail Access to Heathrow (SRAtH) is one such possibility.

Context

3.7.2. SRAtH is a Government-proposed scheme to directly connect London Waterloo with Heathrow Terminal 5, with:

- 4 trains per hour (stopping at all stations on route) between London Waterloo and Heathrow, routed: 2 trains per hour via Richmond and 2 trains per hour via Hounslow.
- 2 trains per hour between Weybridge and London Heathrow (calling at all stations on route).
- 2 trains per hour (off-peak only) between Guildford and London Heathrow (calling at all stations on route).

3.7.3. In 2015, LBH commissioned WSP to design an SRAtH rail link which would connect both London Waterloo and Surrey to London Heathrow Airport and deliver a new rail station in the Bedfont area to unlock local development and regeneration, as illustrated in **Figure 14**. This work was based upon the above service specification.

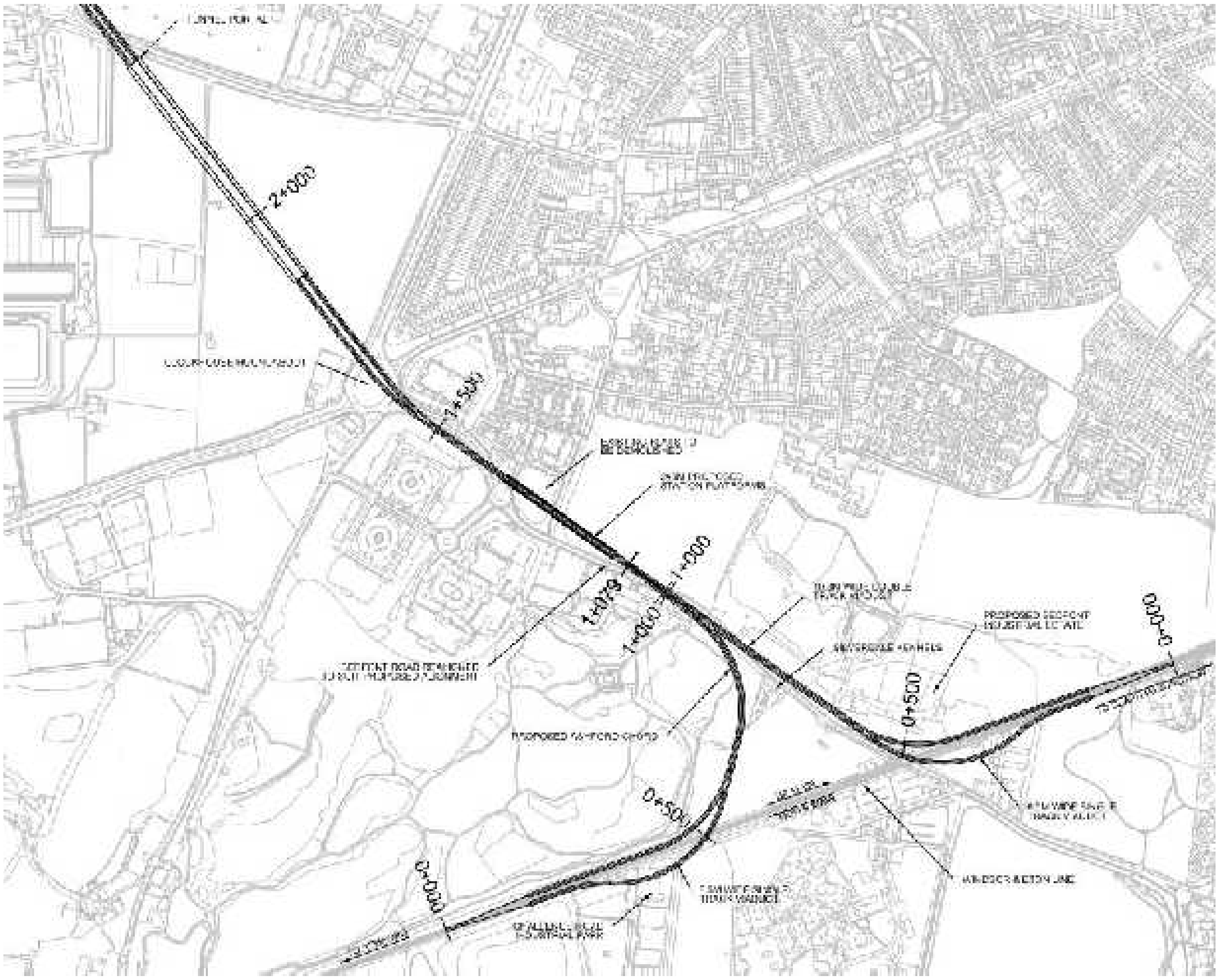


Figure 14 –Southern Rail Access Link through Bedfont (WSP, 2015)

3.7.4. A High Level Output Specification document originally outlined SRAtH as a conventional Government-funded scheme, without any new station. However, in 2018 the Government changed its policy and instead proposed that the private sector could fund and deliver the scheme via a Market Led Proposal structure. As such, LBH intended to propose the most economically advantageous route and station infrastructure, and contribute the marginal funding for a new station at Bedfont, rather than propose an entirely new SRAtH scheme which would have to have been locally funded.

3.7.5. As the 2018 Market Led Proposal exercise concluded, the overall SRAtH scheme, rather than LBH's specific design, is not at an appropriate level of design maturity yet to decisively select it for private delivery. The ultimate SRAtH design and funding responsibility is yet to be determined, although it is generally agreed that any new station in Bedfont would be funded directly by LBH.

Proposed Future Rail Service Increases: Elizabeth Line

3.7.6. Since 2018, LBH has been conducting further studies with WSP to determine the feasibility of extending future Elizabeth Line services to or beyond Bedfont Station, with Bedfont Station either serving as an Elizabeth Line terminus or as a through station on a service which continues toward or through Hanworth.

3.7.7. This could potentially add eight more trains per hour from central London, via Paddington and Heathrow Airport, to Bedfont Station, which could potentially triple SRAtH rail service levels to London Waterloo.

3.7.8. Since the Elizabeth Line is highly likely to begin services to Heathrow before the SRAtH link is built, the SRAtH link could be designed to accommodate this Elizabeth Line service extension to Bedfont Station immediately upon opening.

Impacts/benefits: Supporting Growth

3.7.9. Through the provision of new direct, high quality public transport links and integration with the wider national rail network, introducing SRAtH rail services at a new station in Bedfont will deliver a step change in accessibility to and from the Bedfont area, which will in turn support new housing and employment. The LBH has ambitions for significant amounts of new housing and employment in the Bedfont area as it is one of the only large, and largely undeveloped, sites within the Borough which offers the potential to deliver both a major rail infrastructure scheme and significant amounts of new development.

3.7.10. High quality public transport and good accessibility provide an opportunity to open up new sites and also increase the density of new and existing developments. The combination of scale and permanence of new rail station infrastructure offers the most significant opportunity to maximise new, transport-oriented development, as evidenced by the “Crossrail effect” on property developments and values in London.

3.7.11. Modal shift determination for the new rail link is currently uncertain, given the lack of both housing and public transport in the area. LBH’s ambitions for transport-oriented development of a material density around the new Bedfont Station would put thousands of new residences and jobs within a ten-minute walk of the new rail station which has four trains per hour to Waterloo, two trains per hour each to Weybridge and Guildford in Surrey, and potentially a full Elizabeth Line service pattern. It is likely that that is a threshold which most commuters would be satisfied with for active travel connections to a rail line.

3.7.12. Adding just one new station in isolation will likely only show a small and localised PTAL uplift, given the general lack of connectivity within the Bedfont area. Modal shift under the current development situation would likely be low, given the current lack of housing within the area. For a future ‘high’ growth scenario however, as PTALs do not directly correlate with modal shift, a low PTAL score for this area would not necessarily reflect the likely mode choice of new residents or employees in the Bedfont area. As an example, the current PTAL of the Bedfont area is quite low, at 1b, and the PTAL of nearby Feltham town centre is much higher, at 4, but the 2011 Census data for modal split (Table 8) indicates that both areas have identical modal splits for rail usage, despite having disparate respective distances to rail stations.

Table 8 – Modal Split: Bedfont Lakes and Feltham

Mode	Bedfont Lakes (PTAL 1)	Feltham (PTAL 4)
Train	8%	8%
Bus, minibus or coach	4%	22%
Taxi	0%	1%
Motorcycle, scooter or moped	1%	2%
Driving a car or van	81%	50%
Passenger in a car or van	2%	2%
Bicycle	1%	1%
On foot	2%	14%
Other method of travel to work	1%	1%

3.7.13. Due to the step-change in the magnitude of development borne about by the introduction of a brand new SRAtH service, PTAL or LTS modelling will be an incomplete assessment method for assessing the scheme, due to the following reasons.

- PTAL is not a measure of modal shift, and cannot predict rail modal share on the new rail link, as highlighted above, despite a potentially very frequent set of services to central London. The lack of modal shift information also makes highway demand extraction calculation and modelling difficult.

- Uplifts in area housing and jobs numbering in the thousands mean that new bus, cycle, and other active travel or public transport schemes will be needed, but these are currently unknown and therefore would not be reflected in any PTAL assessment at this time, rendering it inaccurately low for an area with such massive scale and rate of change.

- LBH Local Plan policies for transport-oriented, cycle-friendly, and car-free developments mean that new developments are likely to be very close to the station and create a particularly favourable environment for public transport use, above and beyond existing local precedents, so modal choices for the new developments are unlikely to resemble those of existing area conurbations in any meaningful way.

- The Elizabeth Line proposal is not yet mature enough to have been incorporated into the Local Plan. If Elizabeth Line services are added to the SRAtH services as soon as the 2020s but not included in the current PTAL and LTS assessments for the Local Plan, then there is a risk that artificially low quantitative results will produce development of inappropriately low density and decrease the area development value for the LBH.

3.7.14. Therefore, quantitative modelling, once more detailed rail and bus service designs are available, is the suggested way forward.

3.7.15. The 2017 Draft London Plan's Sustainable Residential Quality Matrix dictates a significant PTAL uplift for the area, above 4, is required in order to justify the development quanta envisioned in the LBH's 'high' growth scenario, and a future, more mature masterplan for Bedfont. This together with integrated rail, bus, and active travel infrastructure, would most likely achieve this. At present, the concept design for SRAtH is effectively increasing rail services in isolation, without spreading the breadth of transport accessibility within the area, leading to slight PTAL uplift, but creating an integrated and enhanced transport plan for the area to accompany the transport-oriented development would provide greater PTAL uplift.

4. SUMMARY AND CONCLUSIONS

4.1. SUMMARY

4.1.1. In order to assess the impact of the ‘low’ and ‘high’ growth development proposals on the road network in the London Borough of Hounslow, four scenarios were considered:

- **Scenario 1** – An adjusted version of the existing TfL’s LTS 7.1 Reference Case model, with background growth in the West of the Borough, full growth in the East of the Borough and full growth outside of the Borough.
- **Scenario 2** – As Scenario 1, plus additional ’low’ growth in the West of the Borough.
- **Scenario 3** – As Scenario 2, but with mitigation to mitigate ’low’ growth in the West of the Borough.
- **Scenario 4** – As Scenario 3, but with ’high’ growth in the West of the Borough.

4.1.2. A set of mitigation measures was identified for testing in Scenarios 3 and 4. In summary, these were:

- Bus priority
- New cycle route infrastructure
- Junction improvements
- Travel demand and parking management
- Signal optimisation at selected junctions (all scenarios)

4.1.3. To estimate the impact of each mitigation measure, a set of assumptions was made about the potential mode shift expected from each of the measures based on published evidence.

4.1.4. The modelled scenarios have been compared against each other to determine the impact of additional development on the highway network. The analysis has been undertaken for the 2031 AM, IP and PM peak hours and has considered:

- Journey times
- Actual flow differences
- Vehicle delay differences
- Volume over Capacity (V/C) ratio differences

4.2. CONCLUSIONS

4.2.1. Growth in the West of the London Borough of Hounslow has been shown to impact network performance. A comparison of delays and V/C ratios has revealed that the locations of the most impacted junctions/links are not necessarily located close to the areas of ‘low’ development, but instead are dispersed across the Borough. The impact of ‘high’ growth however is most felt in the local area immediately around Bedfont Lakes and Heathrow Gateway, suggesting further enhanced mitigation options, such as Southern Rail Access to Heathrow, may warrant further investigation.

4.2.2. Analysis of journey times showed that in all three peaks, total journey time increase between Scenario 2 (‘low’ growth) and Scenario 1 (Do Minimum). However, the impact of the ‘low’ growth is offset by the mitigation introduced in Scenario 3 which results in decreased (or improved) journey times. Journey times in Scenario 3 come down close to those in Scenario 1.

4.2.3. It has been demonstrated that the mitigation measures discussed in this report are likely to provide improved network conditions, as seen from the comparison of Scenario 3 with Scenario 2. However, the mitigation package will not bring traffic levels back to pre-development levels. Their introduction would reduce the impact of additional ‘low’ growth development in the Borough.

4.2.4. The mitigation proposed as part of Scenario 4 is estimated to partially offset the impact of additional ‘high’ growth development. A comparison of Scenario 4 with Scenario 3 shows that journey times are similar in each of these scenarios, but on further investigation, it is apparent that the V/C ratios at junctions/links in the area immediately around Bedfont Lakes and Heathrow Gateway change (for the worse) as a result of additional traffic on the network with ‘high’ growth.

4.2.5. It is important to realise that the mitigation measures tested are not exhaustive, other schemes could further help reduce the transport impact from the proposed ‘high’ growth. The Hounslow proposal for SRAtH could clearly do much to support increased development (as envisaged in the ‘high’ growth scenario), but in the event that SRAtH does not proceed, it may be possible to still achieve some level of mitigation via alternative proposals such as bus rapid transit.

4.2.6. Additionally, it is noted that the current masterplan for Heathrow’s third runway Development Consent Order (DCO), to be submitted in 2020, foresees a southern road tunnel linking Bedfont to the central terminal area. This is proposed to explicitly favour public transport utilisation and could therefore draw a significant number of new routes from and through the Feltham/Bedfont area looking to take advantage of reduced and reliable journey times to Heathrow Airport.

4.2.7. Finally, the strategic nature of WeLHAM and the findings of this study do not in any way reduce the need for individual developments to undertake detailed, local transport assessments which may identify additional specific impacts on the network (e.g. junction congestion) requiring mitigation and further analysis.

Appendix A

MITIGATION SCHEMES

Mitigation Measures with Mode Shift Factors

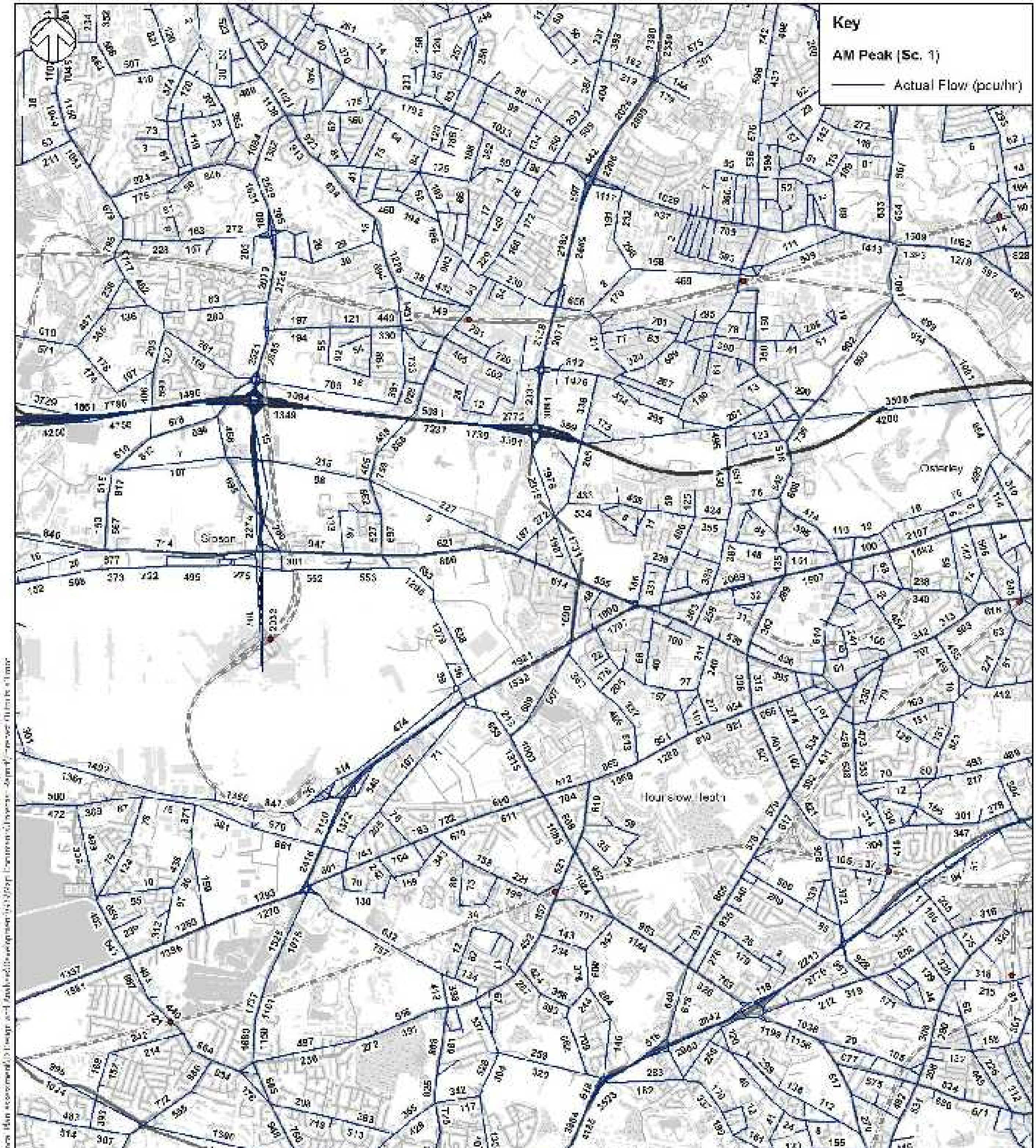
Focus	Mitigation Measure	Comment	Mode Shift Trips	Mode Shift Factor Applied			Scenario 3 Net Reduction in Car Trips			Scenario 4 Net Reduction in Car Trips		
				AM Peak	IP	PM Peak	AM Peak	IP	PM Peak	AM Peak	IP	PM Peak
Bus Travel	Decreased bus journey times along the Feltham High Street and Faggs Road (not TLRN) corridors as a result of new bus priority infrastructure, made way for by the removal of on-street car parking.	Based on UK research discussed in "An Analysis of Urban Transport, Cabinet Office Strategy Unit" (2009), the elasticity of bus demand to in-vehicle time for urban buses has been estimated to be roughly in the range of -0.4 to -0.6. Therefore, assuming a 5% decrease in journey times along these two corridors, a 2.5% reduction in car trips was applied to highway trips in the cordon area to account for an increase in bus demand resulting from reduced bus journey times.	Origins and destinations within 640m of the two corridors.	2.50%	2.50%	2.50%	21	18	25	21	14	25
Cycling	Improved cycling infrastructure along Feltham High Street, Bedfont Road, Staines Road and Bath Road through the removal of on-street car parking.	Based on UK research documented in "Cycling and Sustainability" (Parkin, 2012), a 25% increase in cycling facilities would increase the numbers of cycle commuters by approximately 15%, given an elasticity of demand of 0.6 for cycling based changes in response to some sort of cycle facility. Therefore, assuming a 5% increase in cycle facilities along these corridors, a 3% reduction in car trips was applied to highway trips in the cordon area to account for an increase in cycle infrastructure.	Zones fronting Feltham High Street, Bedfont Road, Staines Road and Bath Road.	3.00%	3.00%	3.00%	16	10	18	16	11	18
Travel Demand Management	Workplace Travel Plans at Employment Places	Mode shift factors were derived for Travel Demand Management from WebTAG Unit M5.2 (Modelling Smarter Choices). The factors as shown in the table below were applied to only those trips, which are targeted by each travel demand measure. For example, the impact of school travel plans has only been applied to Education trips. This resulted in the overall mode shift percentages (as reported in columns to the right) being lower than those included within the table below. 	AM destinations and PM origins within 1km of 10 worst junctions within the west of the London Borough of Hounslow	5.48%	-	3.69%	430	0	288	459	0	307
	Targeted Marketing at Residential Addresses		AM origins, PM destinations and Interpeak trips within 1km of 10 worst junctions within west of the London Borough of Hounslow	3.58%	3.67%	3.82%	252	328	278	268	374	295
	School Travel Plans		AM and Interpeak trips within the London Borough of Hounslow, given coverage of primary schools across the Borough.	0.52%	0.07%	-	152	10	0	157	10	0
	50% lower levels of parking at new commercial and residential developments.	The LTS already accounts for a decreasing year-on-year reduction in commercial parking. Therefore, only new residential developments have had a mode shift applied.	Origins and destinations at new proposed residential developments.	50% (new resi.)	50% (new resi.)	50% (new resi.)	116	87	105	118	80	107
						Total Net Reduction in Car Trips	**988**	**453**	**715**	**1,040**	**490**	**752**

Appendix B

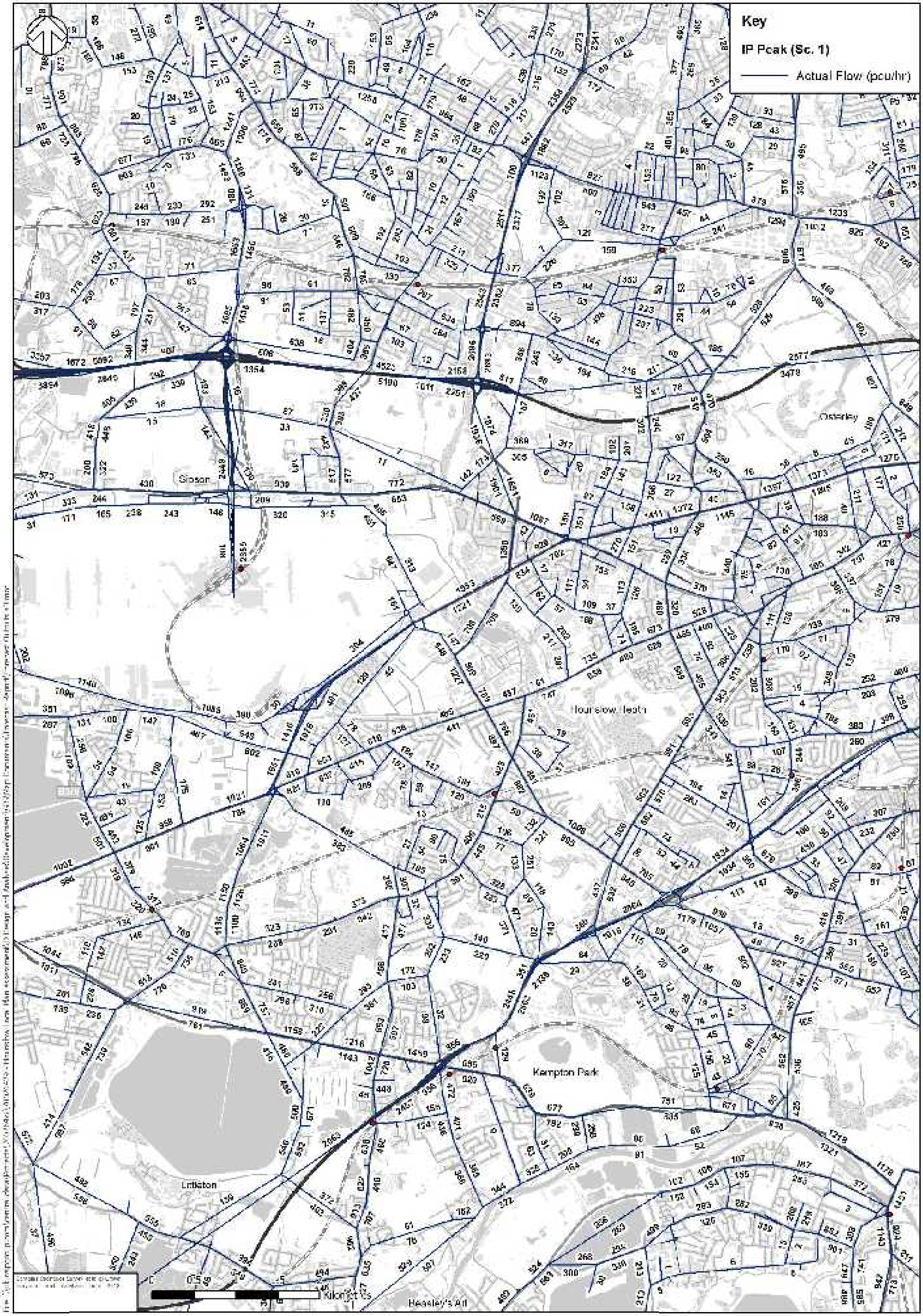
ACTUAL FLOW PLOTS

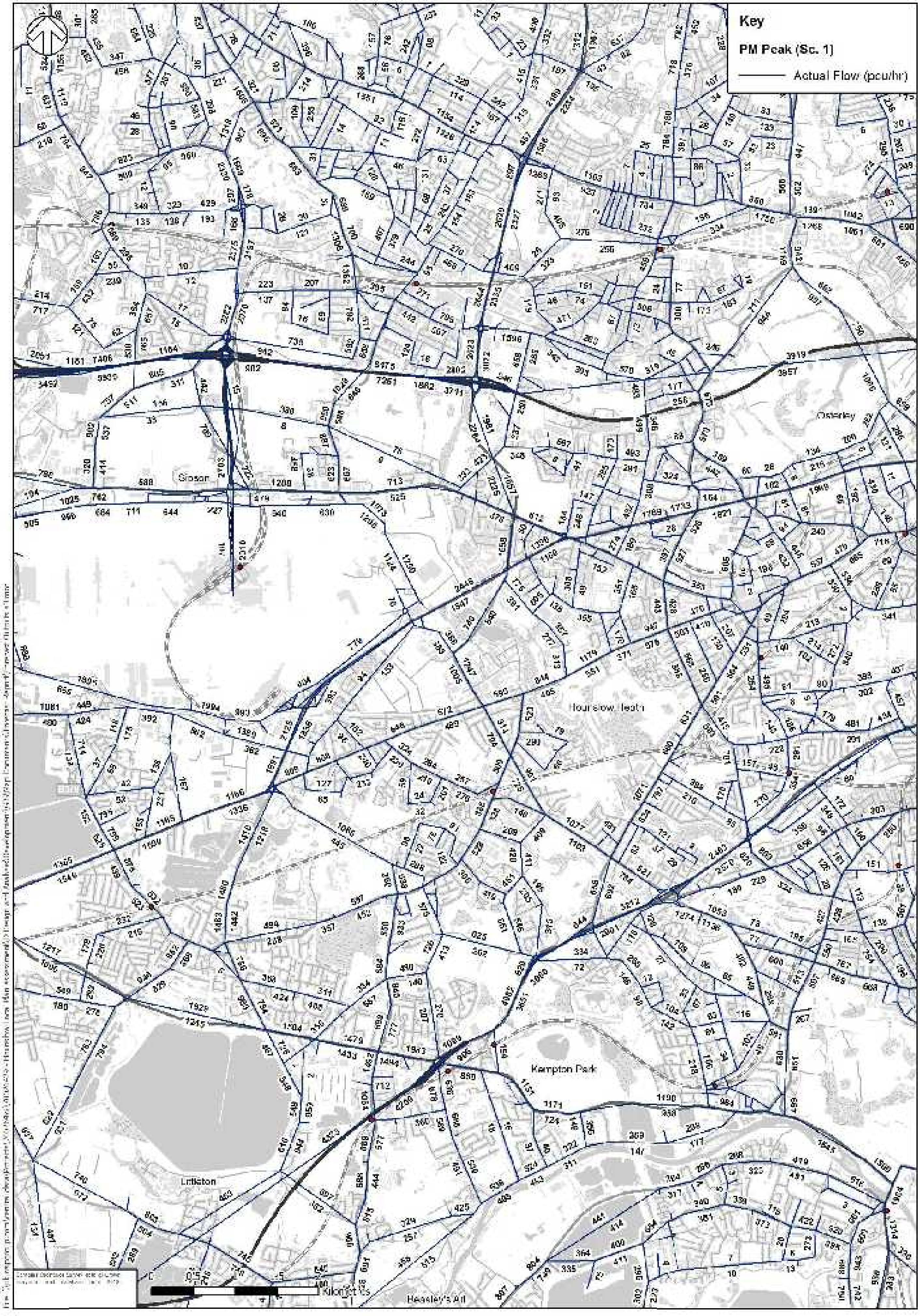
Appendix B.1

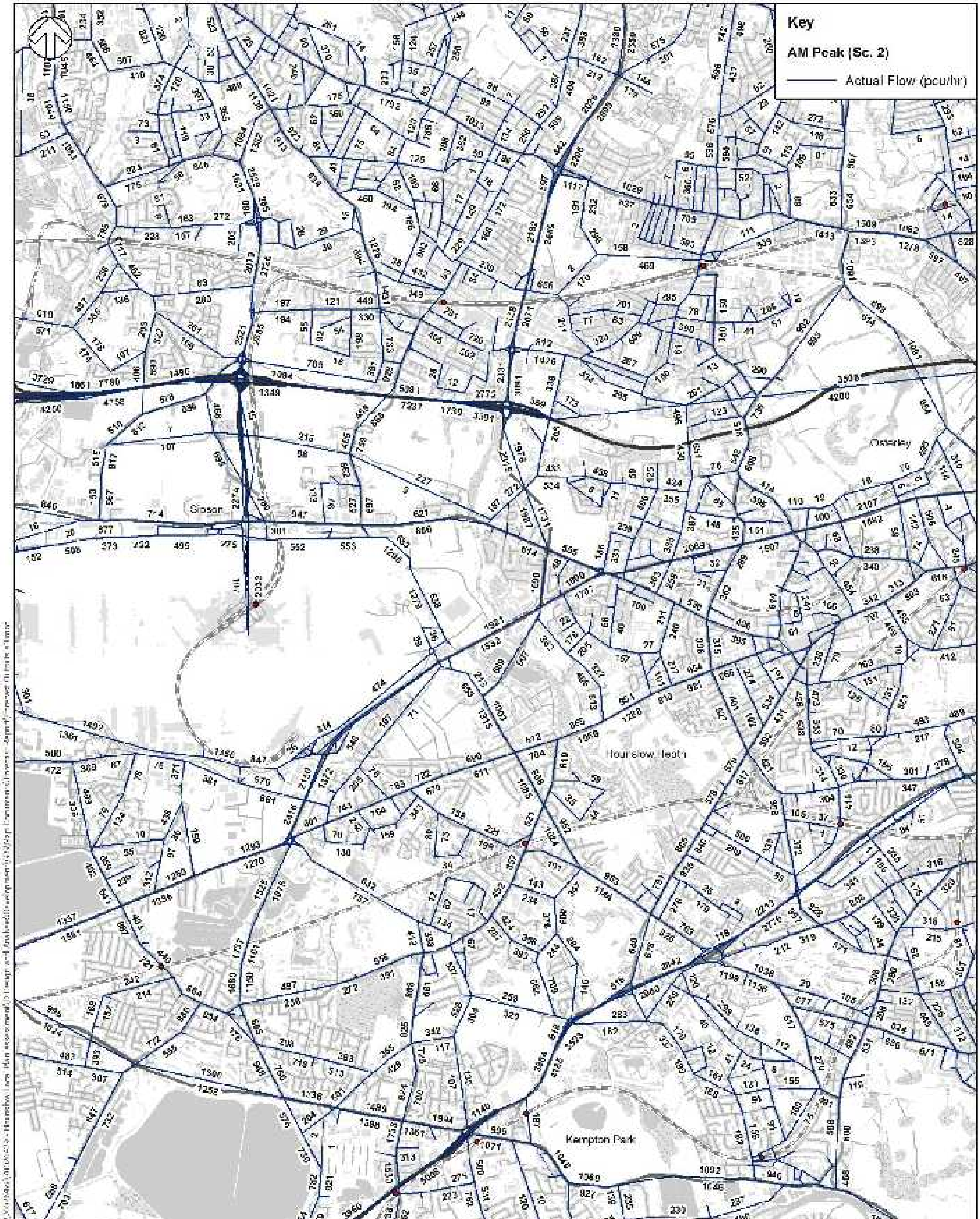
ACTUAL FLOW

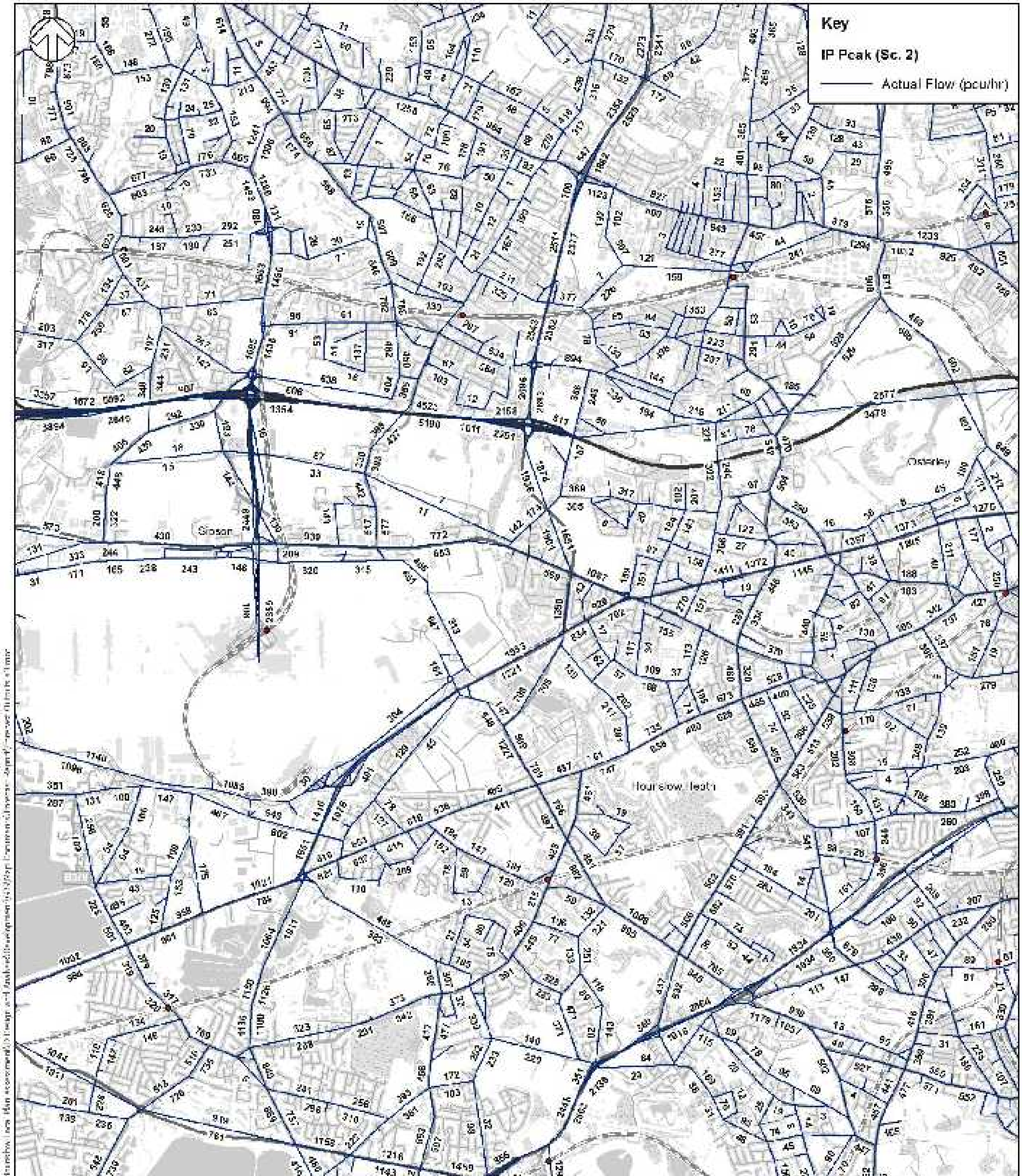


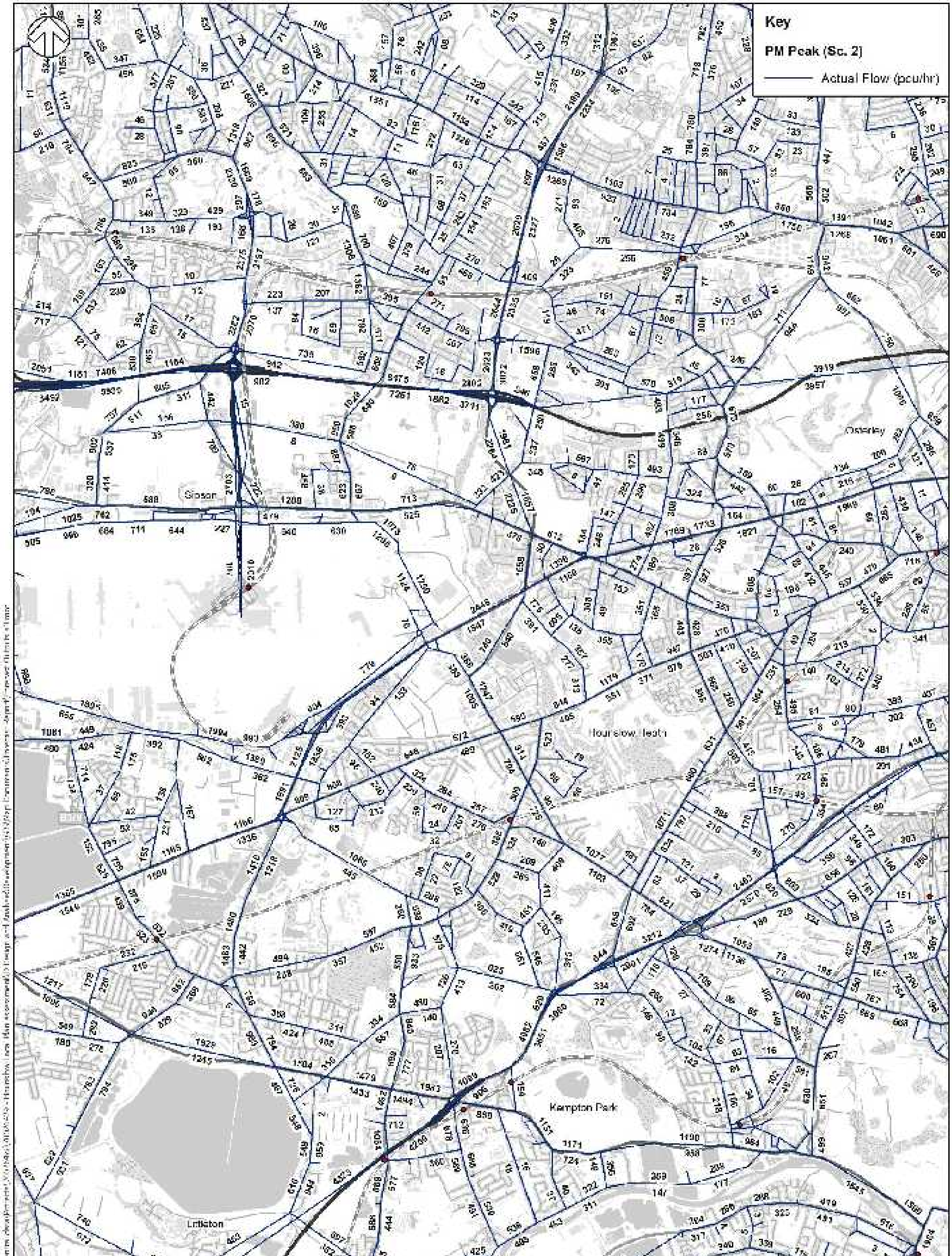
Key
AM Peak (Sc. 1)
Actual Flow (pcu/hr)
Osterley
Hounslow Heath
Kempton Park
Littleton
Kilometres


Key
IP Peak (Sc. 1)
Actual Flow (pcu/hr)
Osterley
Sipson
Hounslow Heath
Kempton Park
Littleton
Beasley's Ait
Kilometres

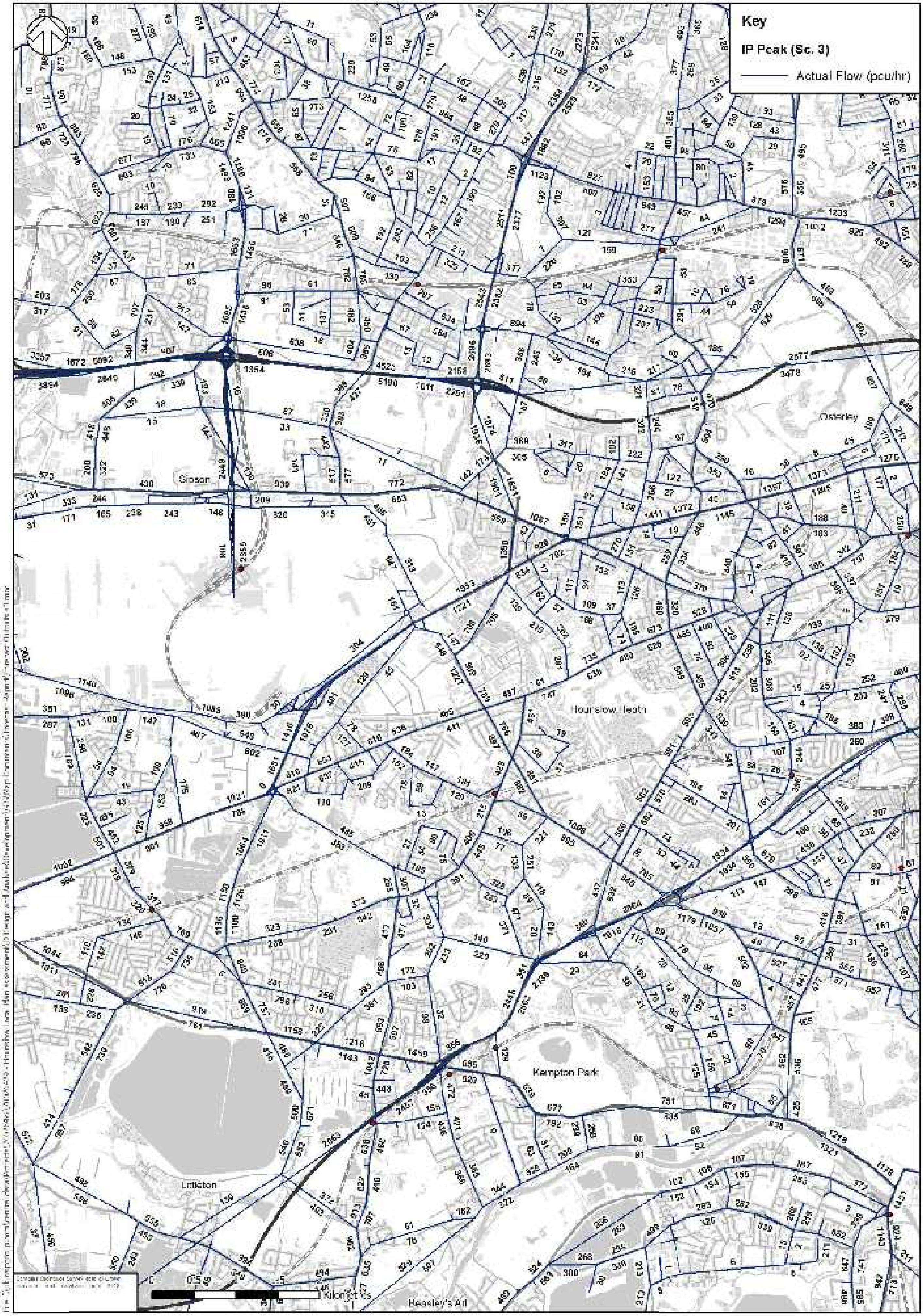

Key
PM Peak (Sc. 1)
Actual Flow (pcu/hr)
Osterley
Sipson
Hounslow Heath
Kempton Park
Littleton
Kilometres

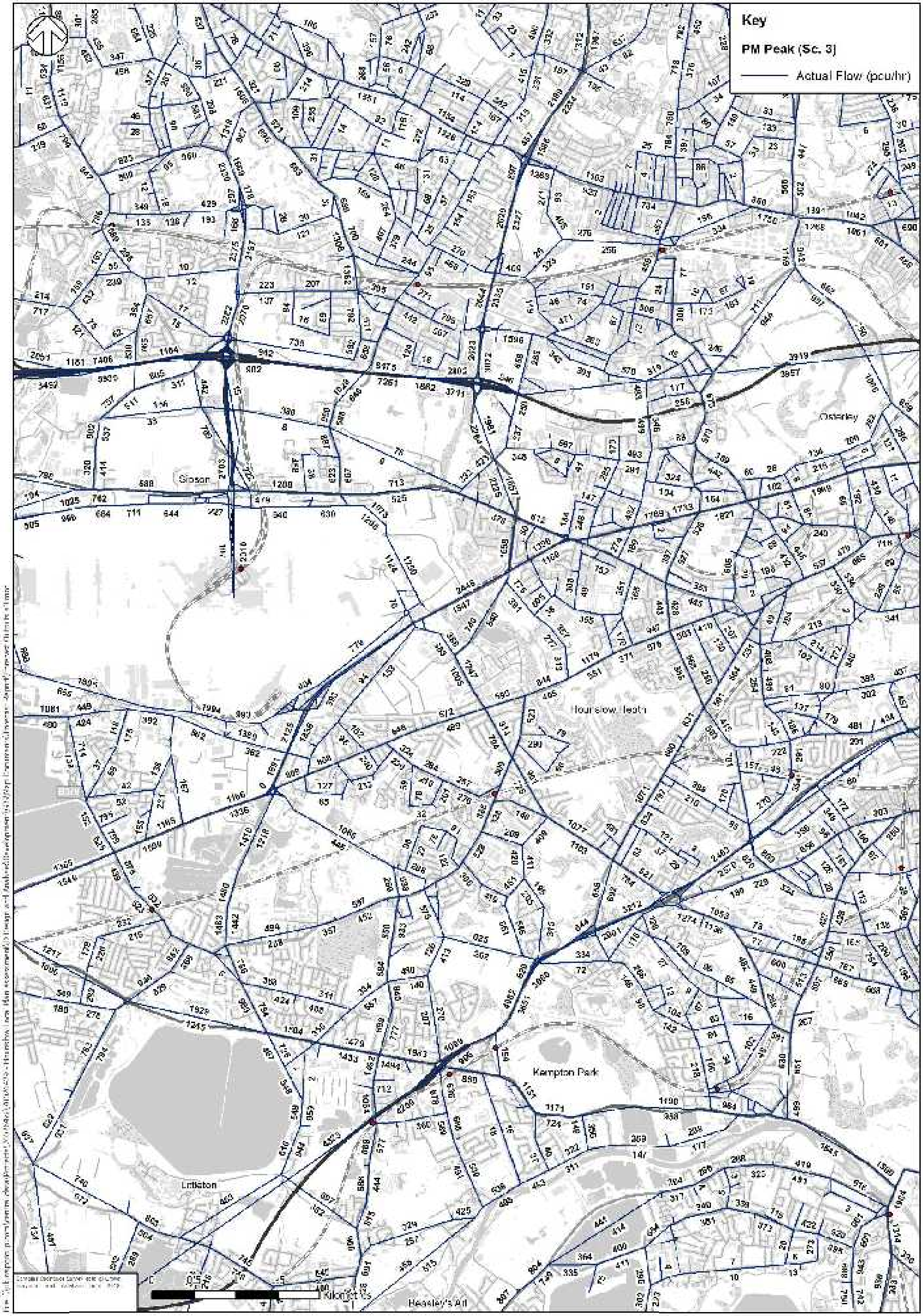

Key
AM Peak (Sc. 2)
Actual Flow (pcu/hr)
Osterley
Hounslow Heath
Kempton Park
Littleton
Beasley's Ait
0 0.5 1 1.5 2
Kilometres

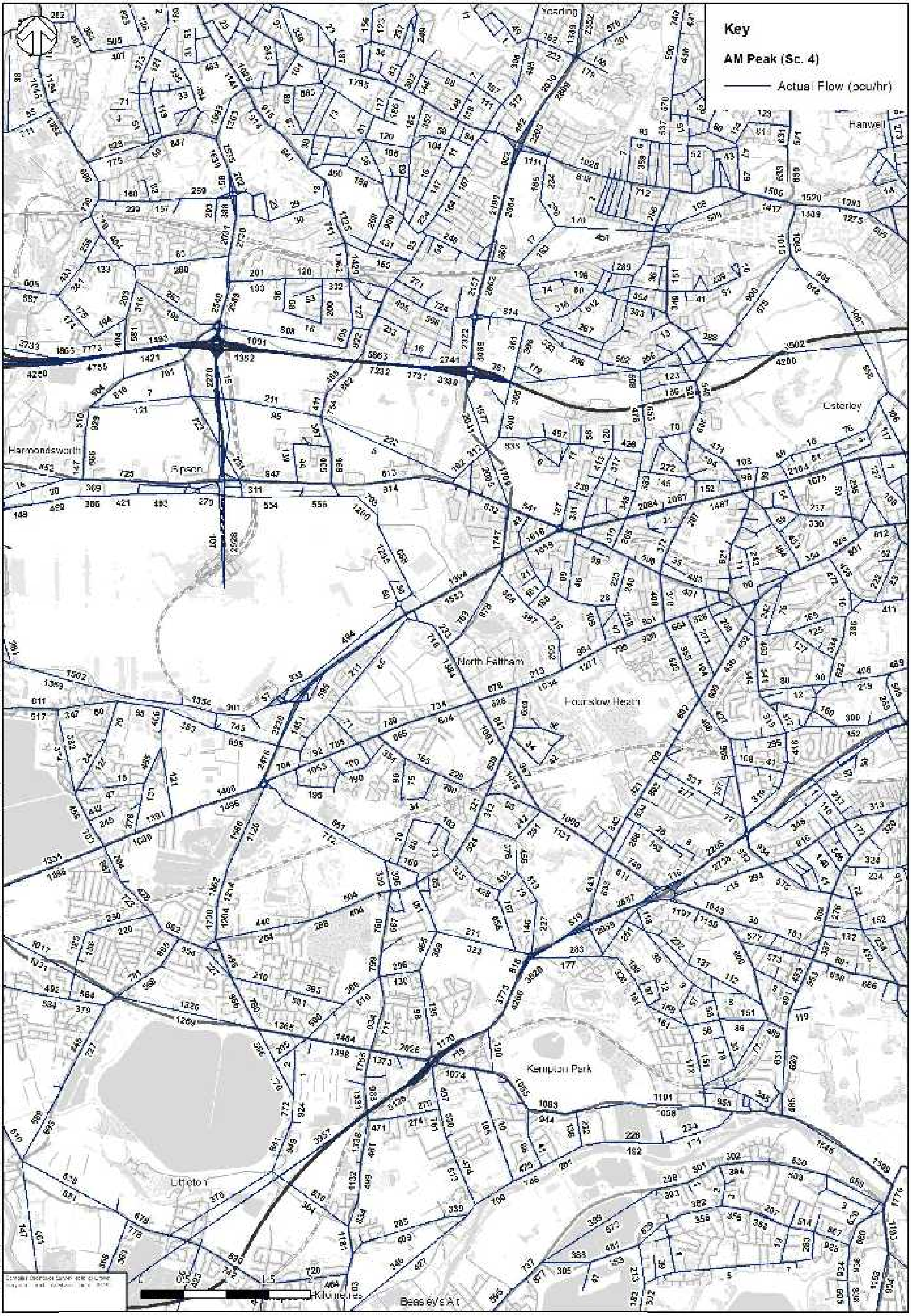

Key
IP Peak (Sc. 2)
Actual Flow (pcu/hr)
Osterley
Sipson
Hounslow Heath
Kempton Park
Littleton
Beasley's Ait
Kilometres

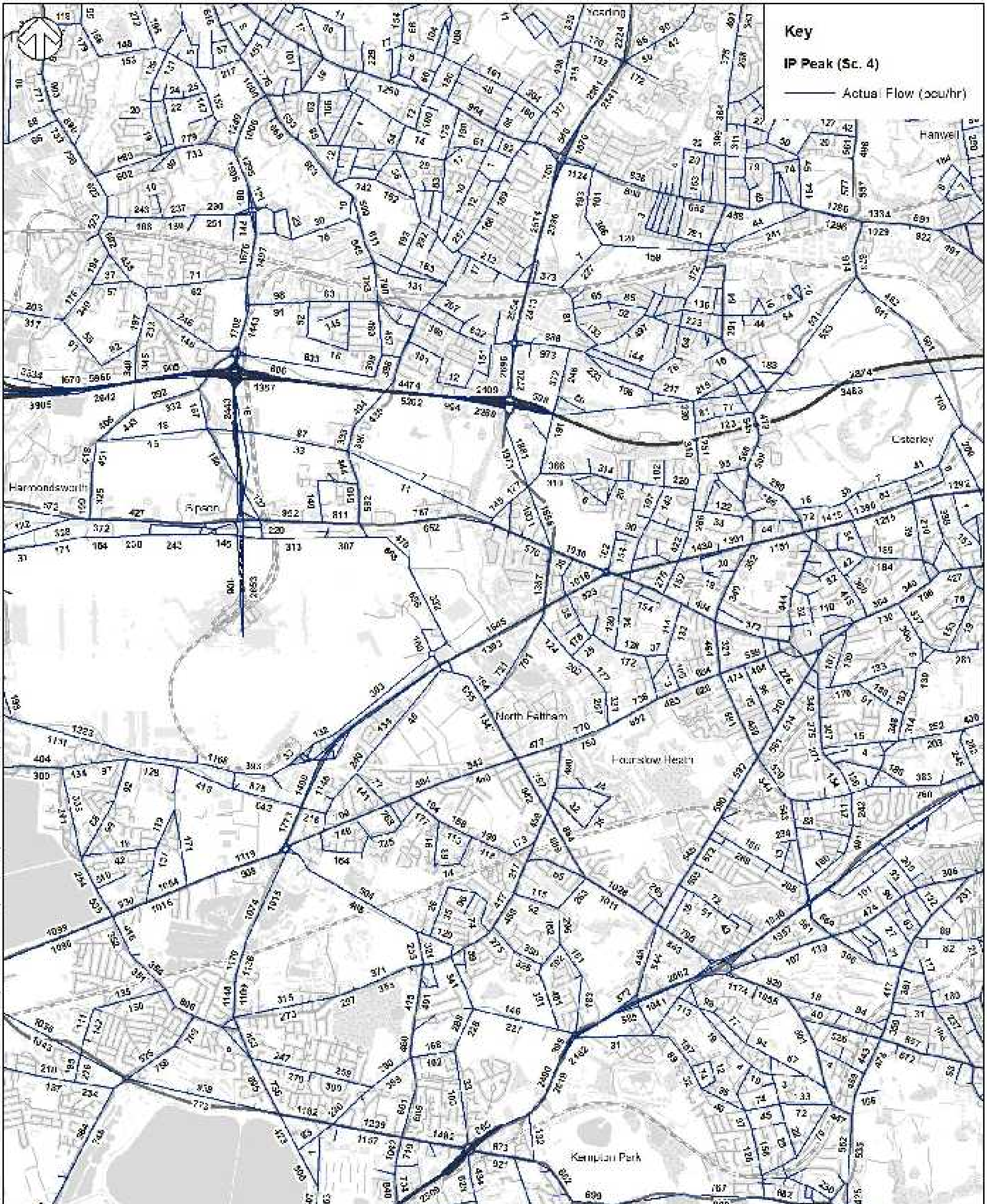

Key
PM Peak (Sc. 2)
Actual Flow (pcu/hr)
Osterley
Sipson
Hounslow Heath
Kempton Park
Littleton
Kilometres

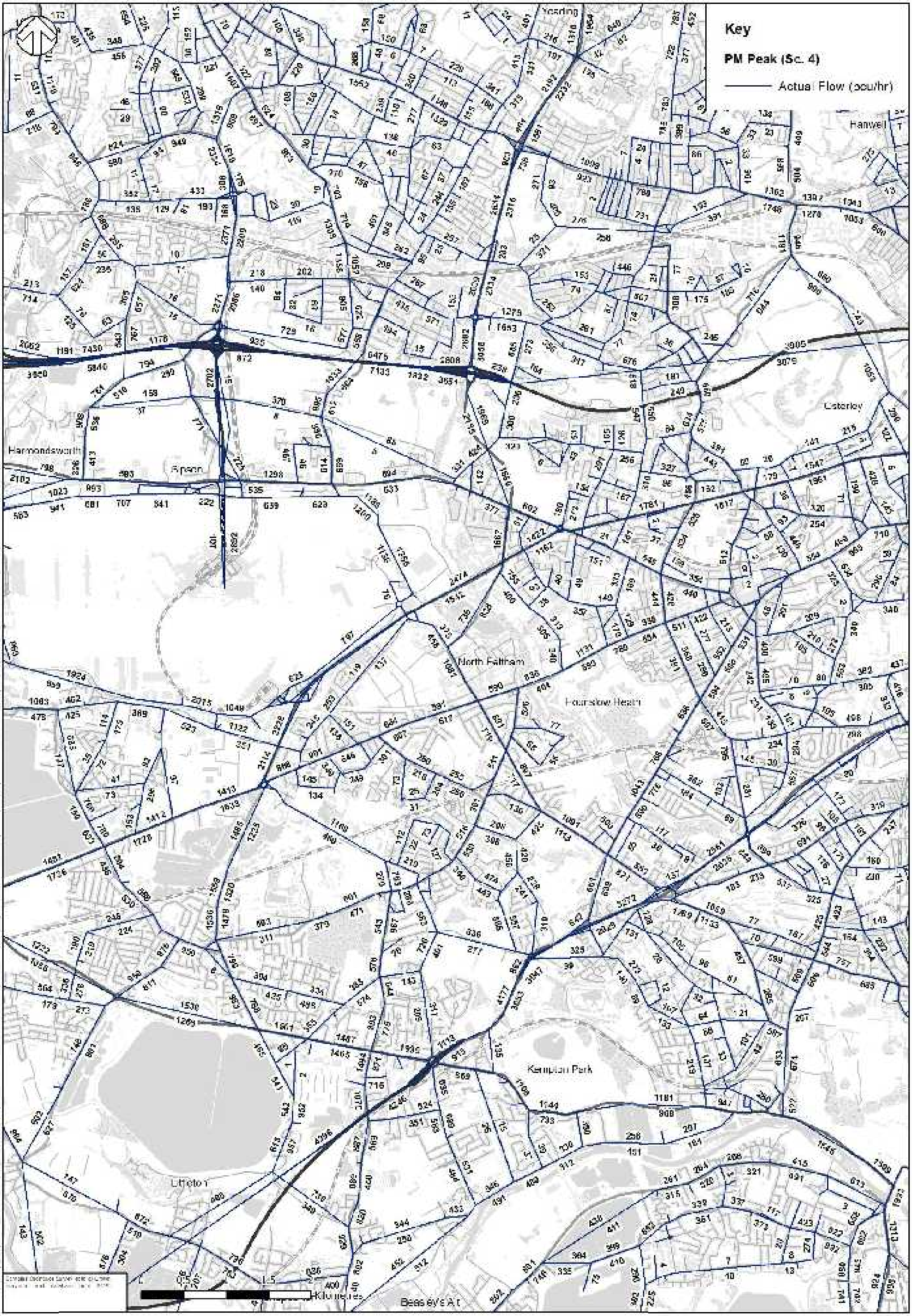
Key
AM Peak (Sc. 3)
Actual Flow (pcu/hr)
Osterley
Hounslow Heath
Kempton Park
Littleton
Beasley's Ait
0
0.5
1
Kilometres


Key
IP Peak (Sc. 3)
Actual Flow (pcu/hr)
Osterley
Hounslow Heath
Kempton Park
Littleton
Kilometres


Key
PM Peak (Sc. 3)
Actual Flow (pcu/hr)
Osterley
Sipson
Hounslow Heath
Kempton Park
Littleton
Kilometres
Beasley's Ait


Key
AM Peak (Sc. 4)
Actual Flow (pcu/hr)
Yeading
Hanwell
Harmondsworth
Sipson
Osterley
North Feltham
Hounslow Heath
Kempton Park
Littleton
Kilometres

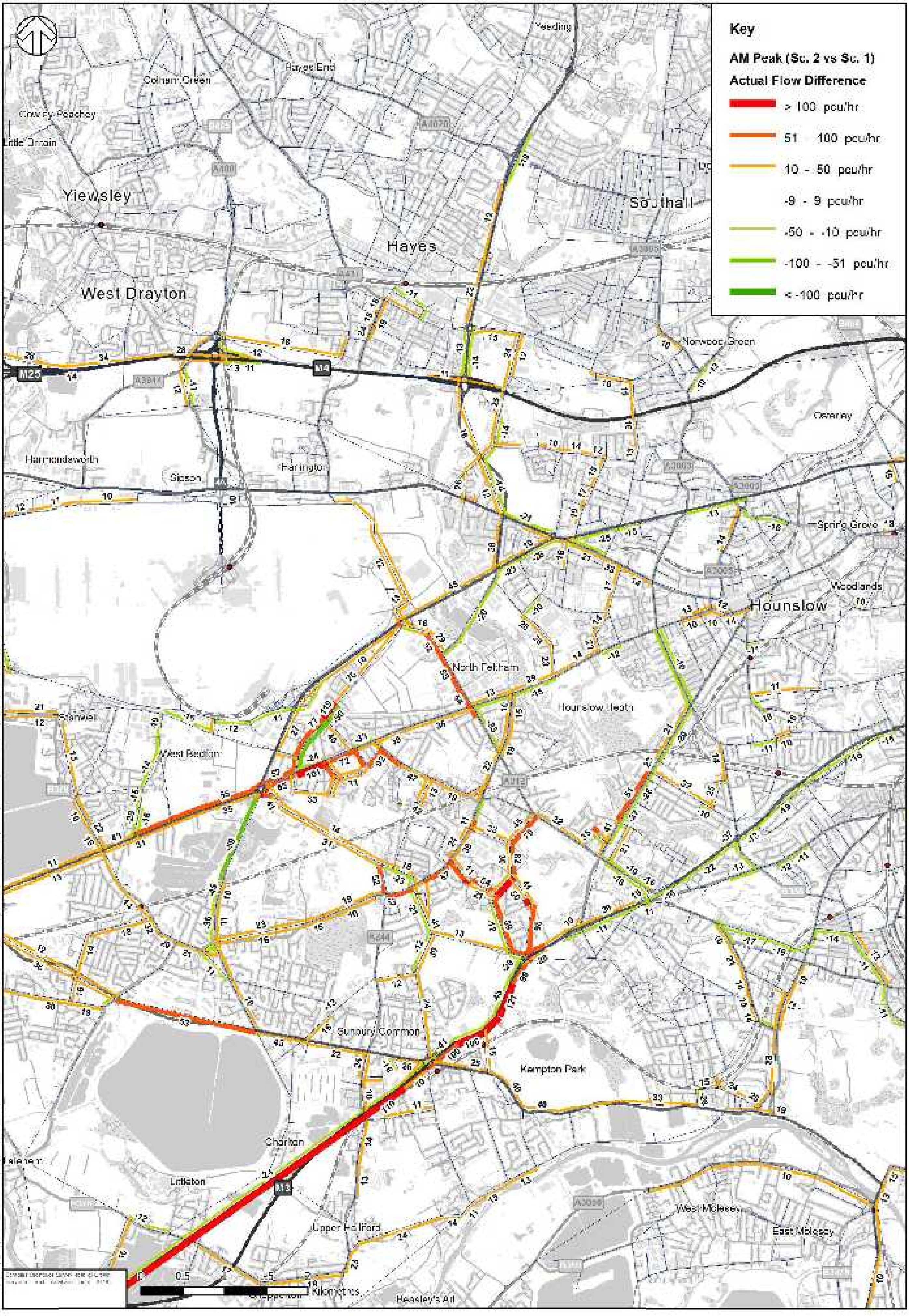

Key
IP Peak (Sc. 4)
Actual Flow (pcu/hr)
Yeading
Hanwell
Harmondsworth
Sipson
Osterley
North Feltham
Hounslow Heath
Kempton Park
Littleton
Kilometres

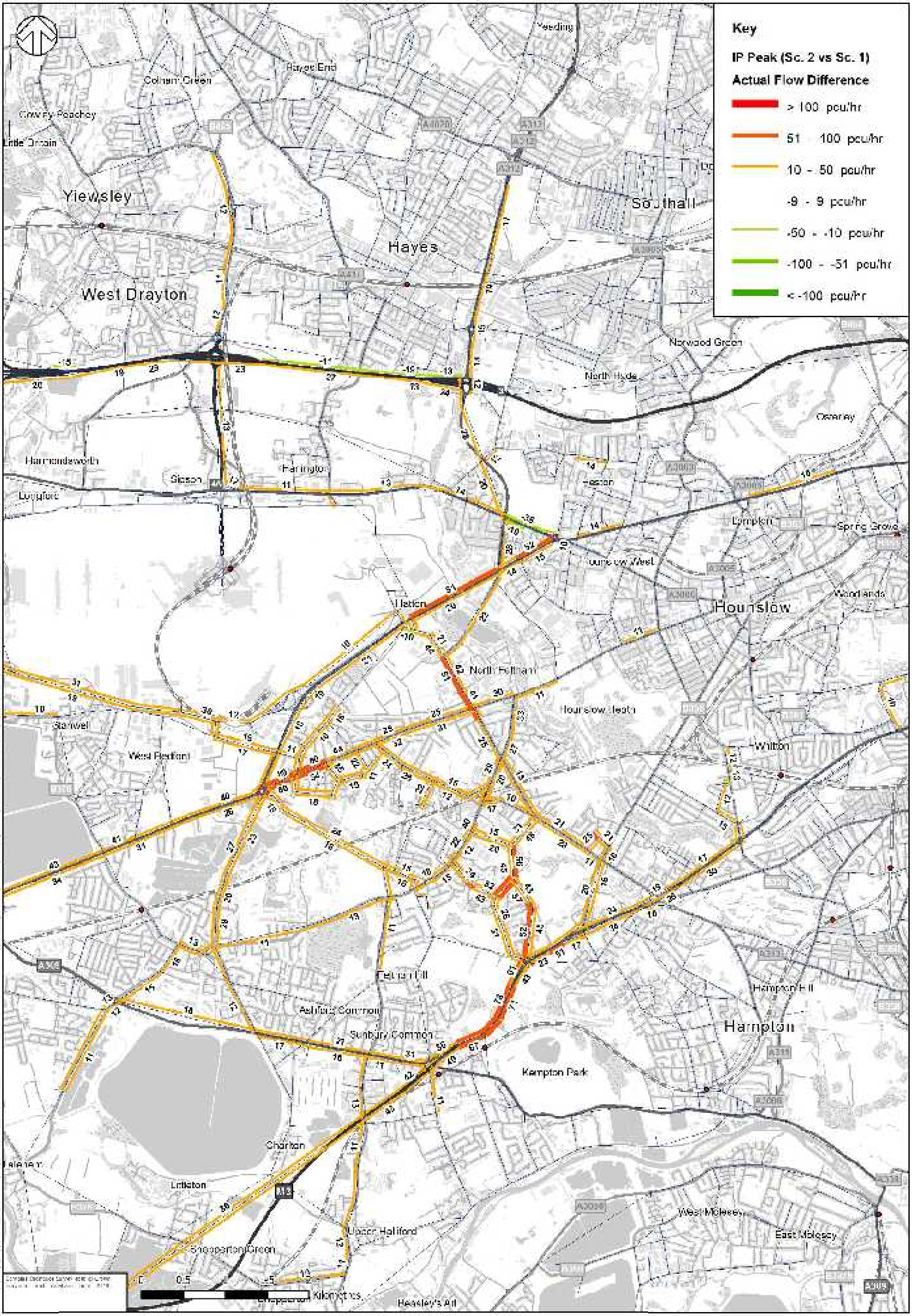


Key
PM Peak (Sc. 4)
Actual Flow (pcu/hr)
Yeading
Hanwell
Osterley
Harmondsworth
Sipson
North Feltham
Hounslow Heath
Kempton Park
Littleton
Kilometres

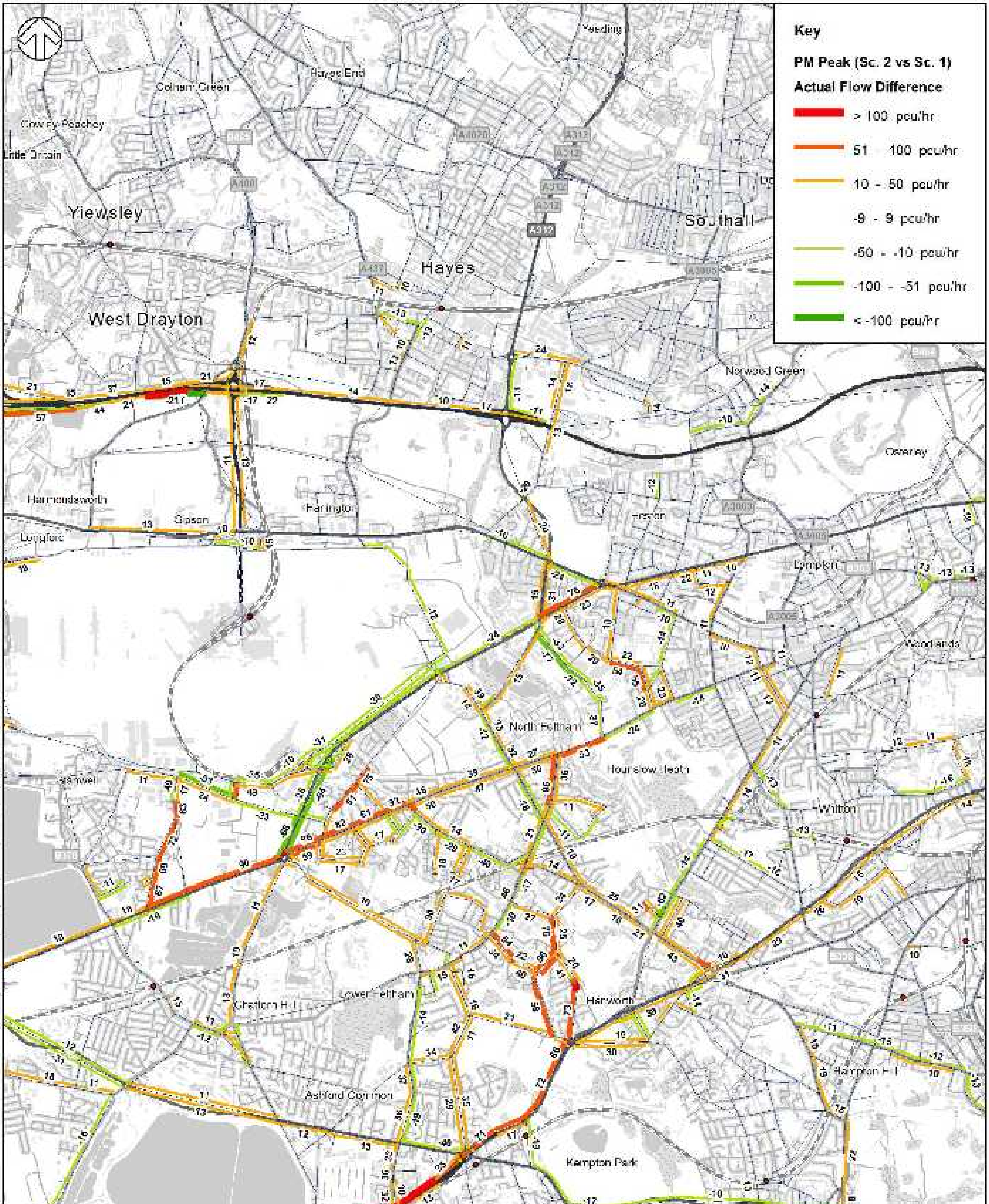
Appendix B.2

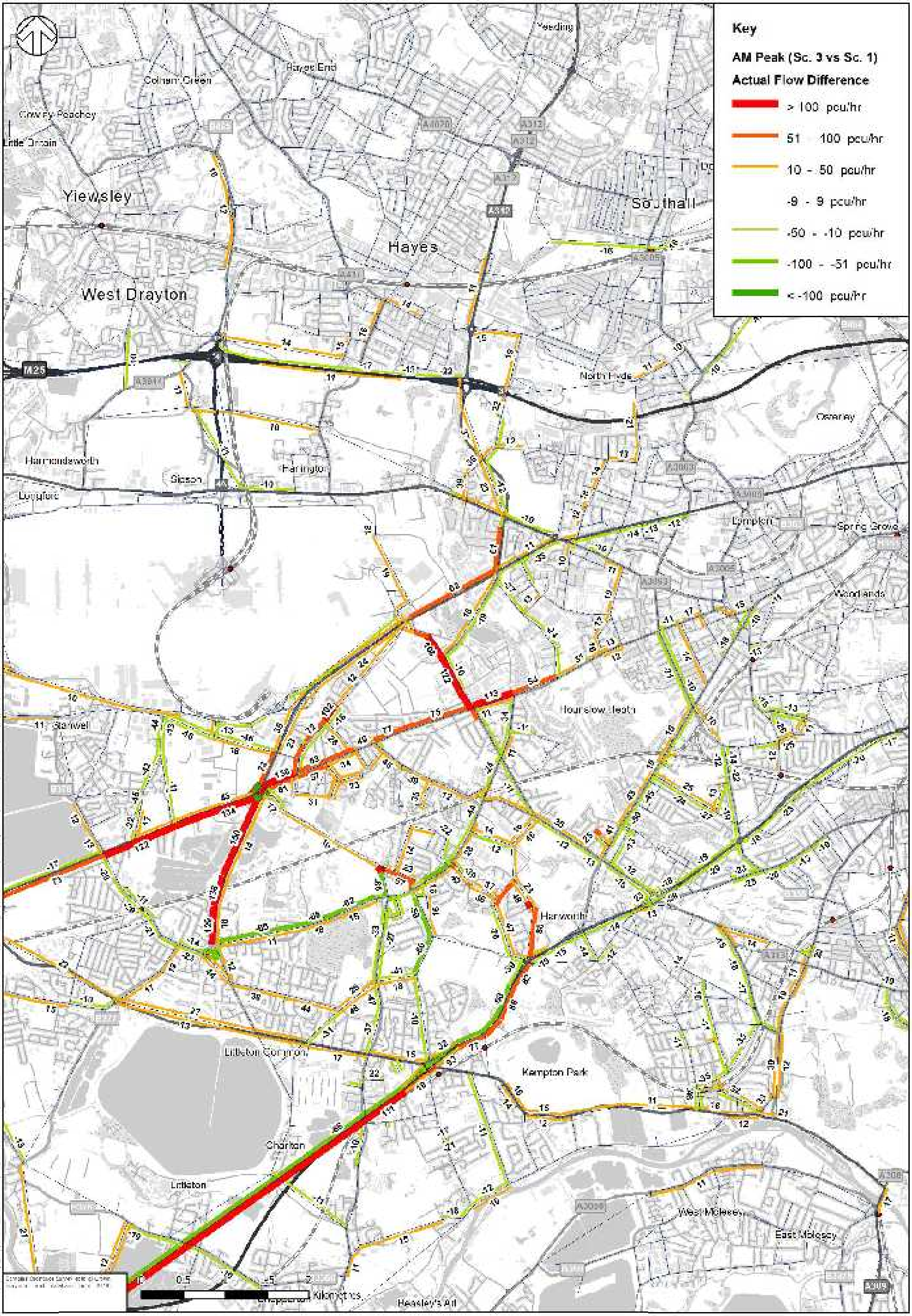
ACTUAL FLOW DIFFERENCE


Key
AM Peak (Sc. 2 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Colham Green
Cowley Peachey
Little Britain
Hayes End
Yeading
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Spring Grove
Woodlands
Hounslow
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Sunbury Common
Kempton Park
Charlton
Littleton
Upper Halliford
West Molesey
East Molesey
Shepperton
Kilometres
M25
M4
M3
A4

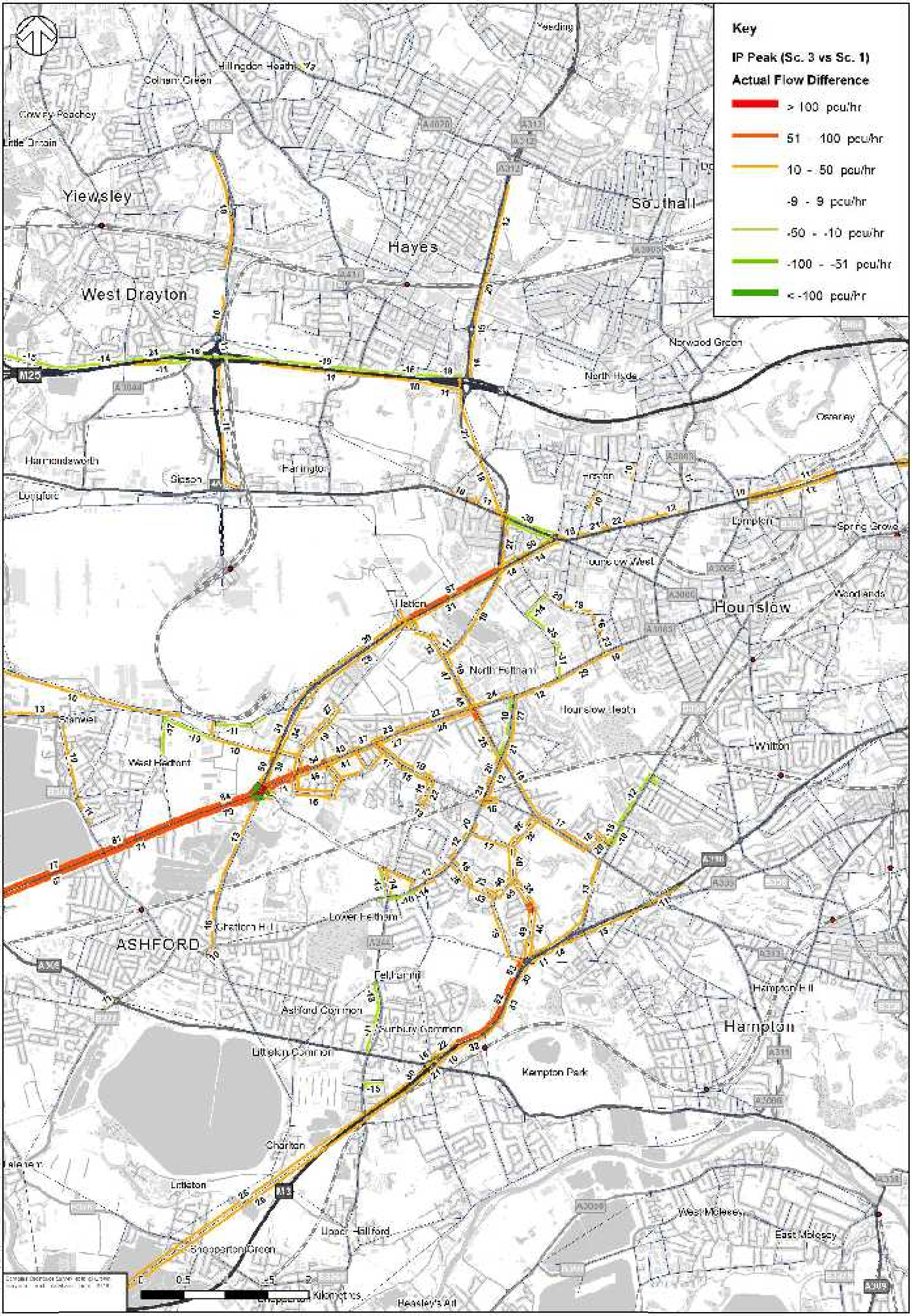


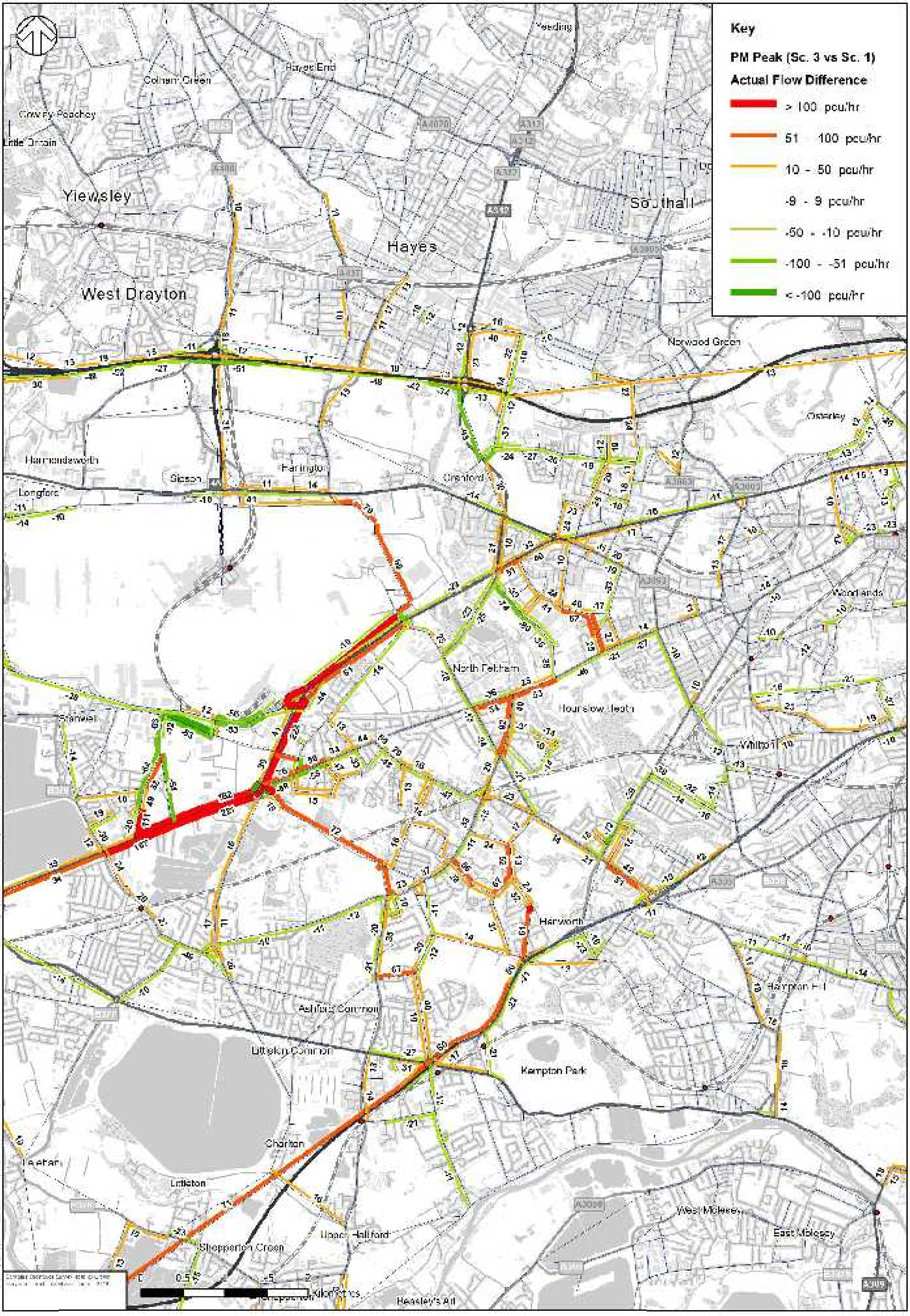
Key
IP Peak (Sc. 2 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Southall
West Drayton
Norwood Green
North Hyde
Osterley
Harmondsworth
Harlington
Sipson
Longford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Whitton
Feltham Hill
Ashford Common
Sunbury Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Kilometres

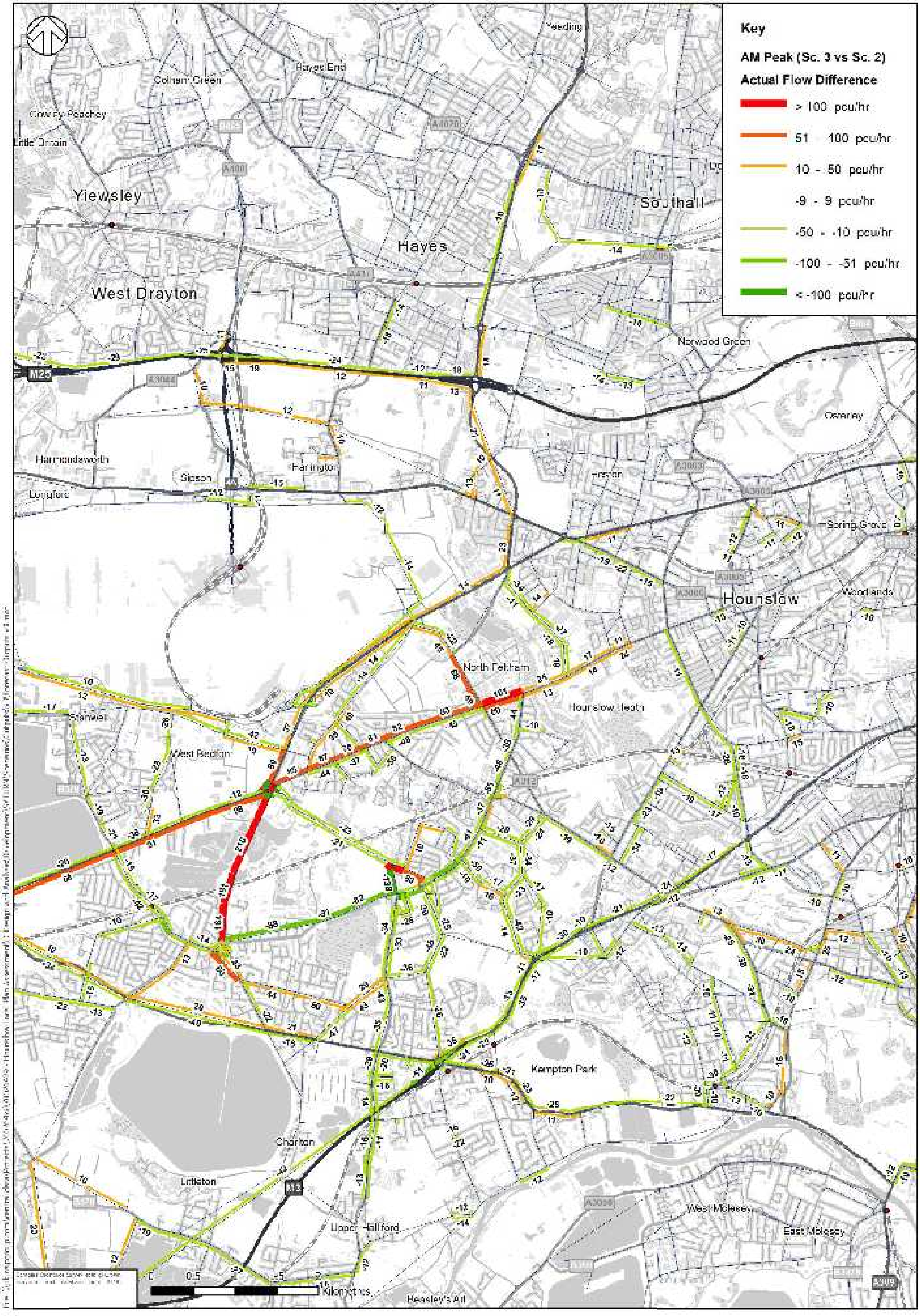

Key
PM Peak (Sc. 2 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Southall
West Drayton
Norwood Green
Osterley
Harmondsworth
Harlington
Longford
Cranford
Heston
Lampton
Woodlands
North Feltham
Hounslow Heath
Whitton
Stanwell
Hanworth
Lower Feltham
Chattern Hill
Ashford Common
Hampton Hill
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton
Beasley's Ait
0.5



Key
AM Peak (Sc. 3 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Hayes End
Colham Green
Cowley Peachey
Little Britain
M25
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Longford
Cranford
Spring Grove
Woodlands
Hounslow Heath
Stanwell
Hanworth
Littleton Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Kilometres


Key
IP Peak (Sc. 3 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Hillingdon Heath
Colham Green
Cowley Peachey
Little Britain
Yeading
Norwood Green
North Hyde
Osterley
Harmondsworth
Harlington
Sipson
Longford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Whitton
Stanwell
West Bedfont
ASHFORD
Chattern Hill
Lower Feltham
Feltham
Ashford Common
Sunbury Common
Littleton Common
Kempton Park
Hampton Hill
Hampton
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
M25
M3
A30
Kilometres
0
0.5
1.5
2


Key
PM Peak (Sc. 3 vs Sc. 1)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yeading
Hayes End
Colham Green
Cowley Peachey
Yiewsley
Southall
Hayes
West Drayton
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Stanwell
North Feltham
Hounslow Heath
Woodlands
Whitton
Hanworth
Hampton Hill
Ashford Common
Littleton Common
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait



Key
AM Peak (Sc. 3 vs Sc. 2)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Colham Green
Hayes End
Cowley Peachey
Little Britain
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Spring Grove
Hounslow
Woodlands
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Kempton Park
Charlton
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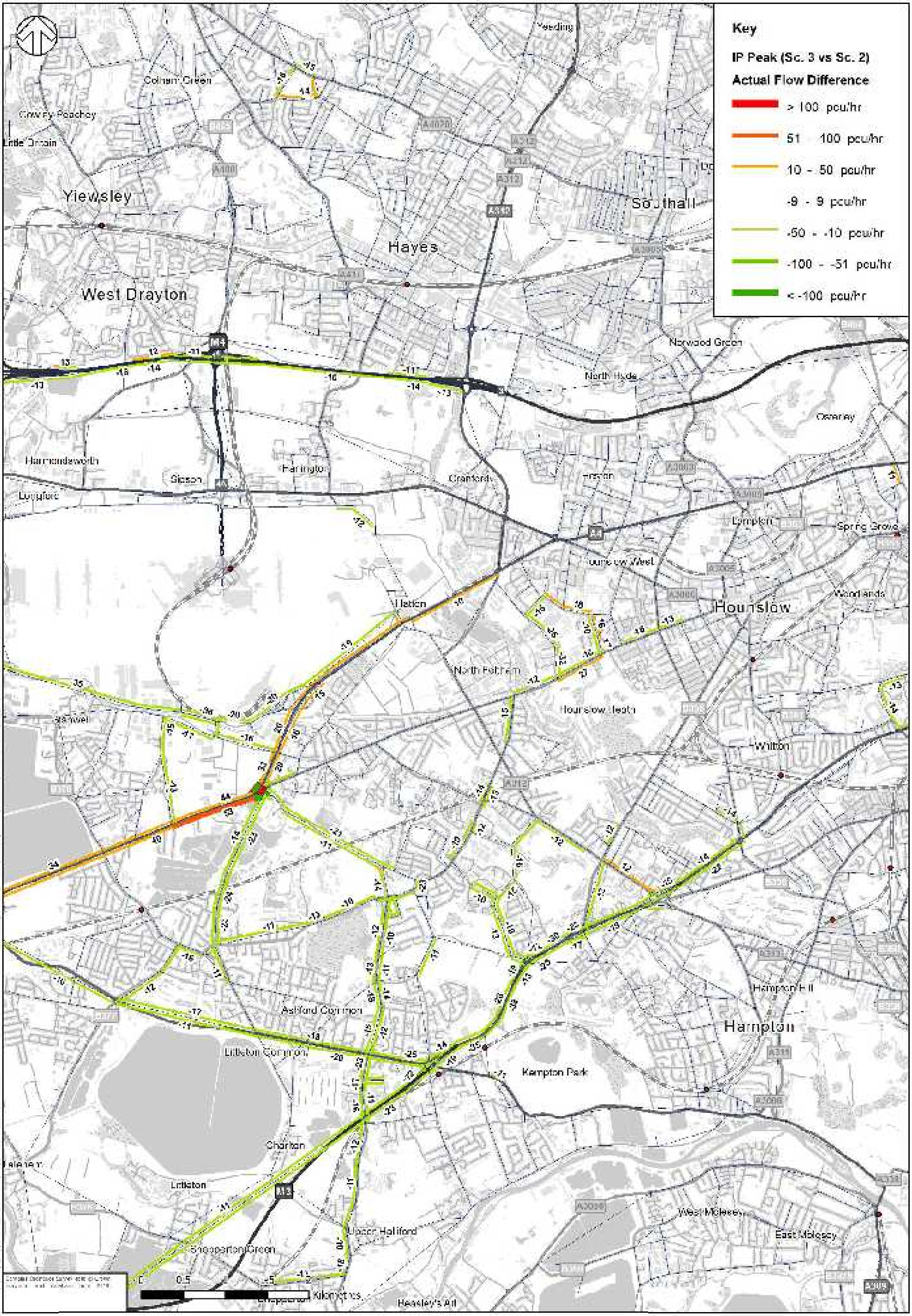
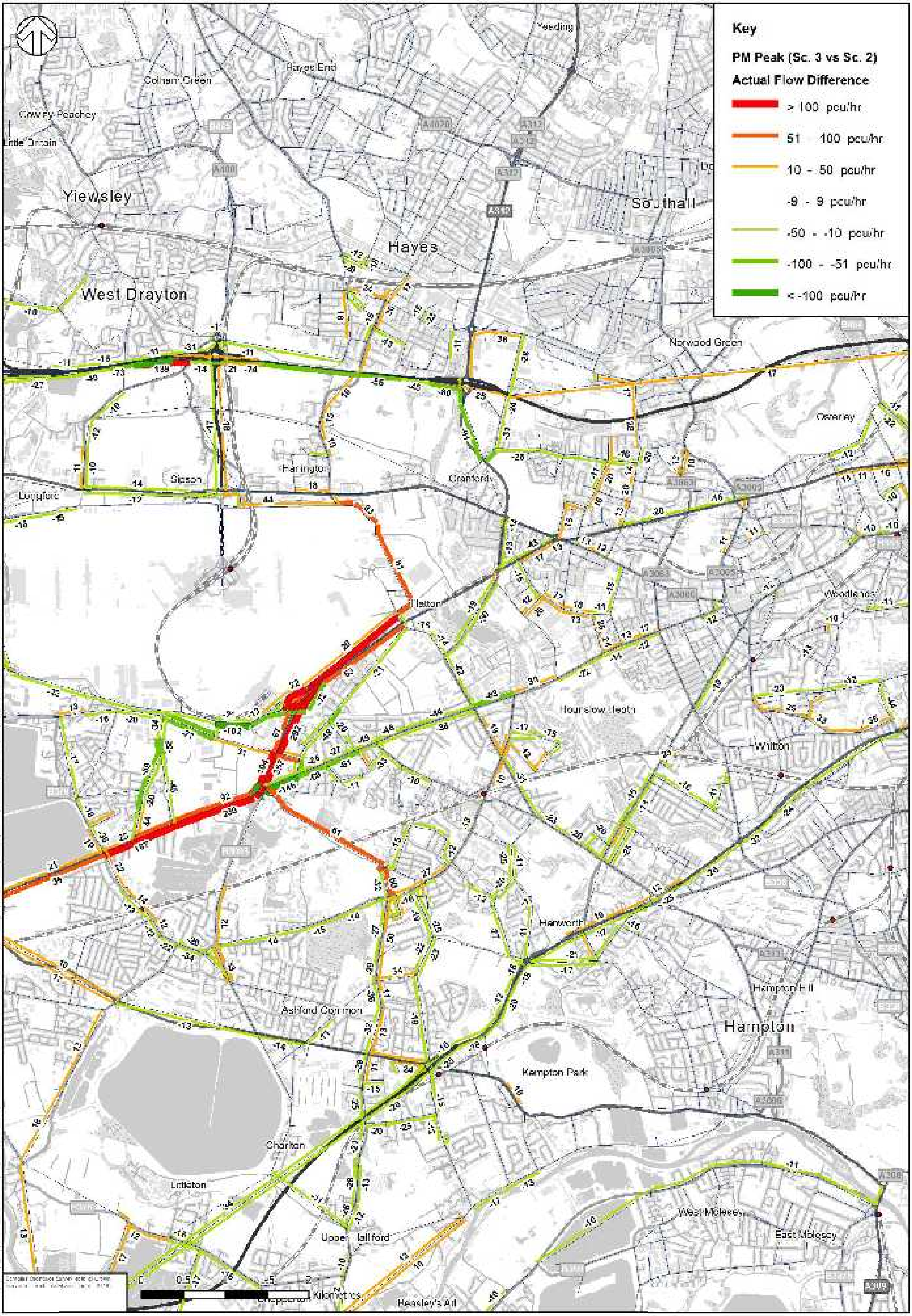
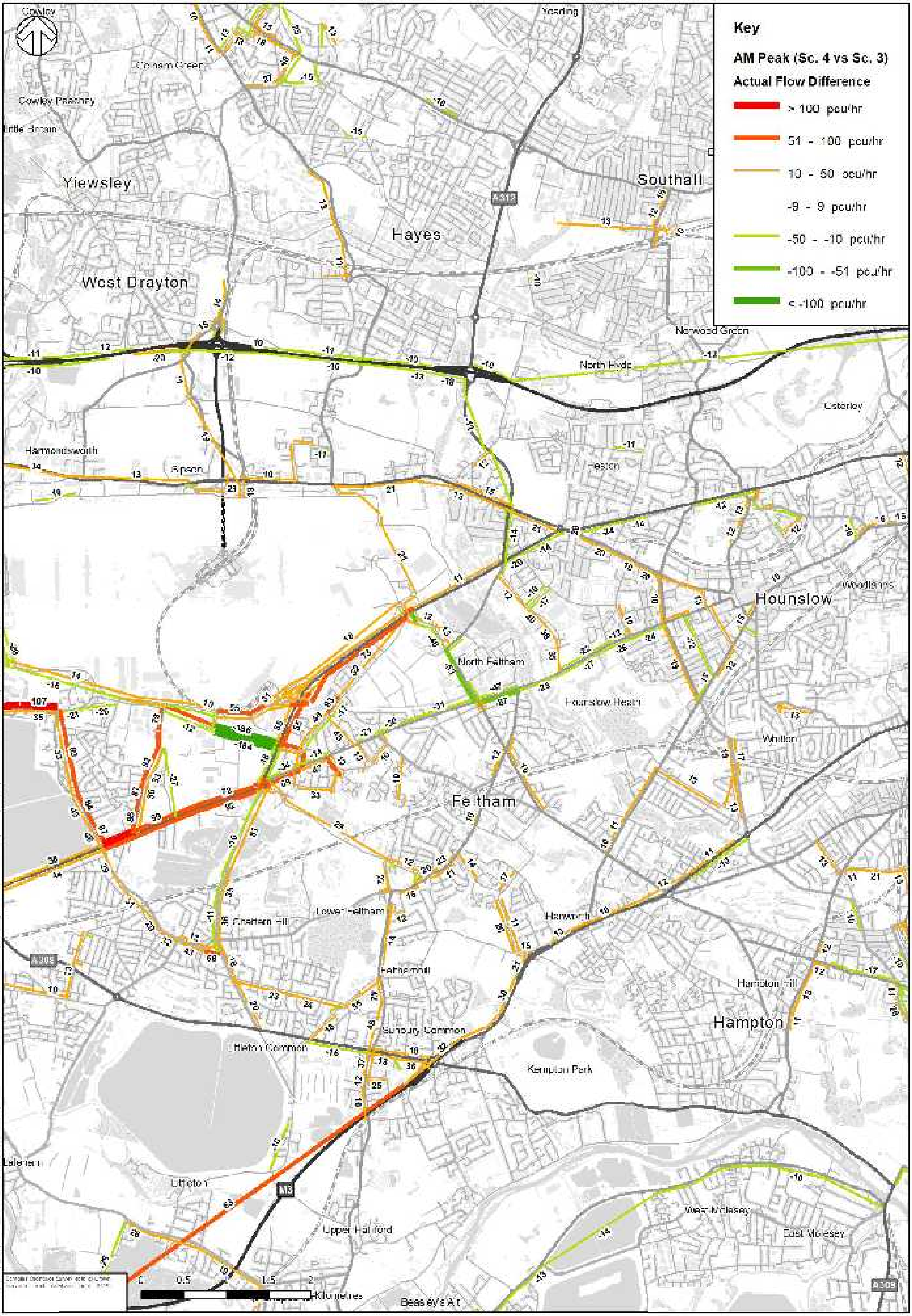
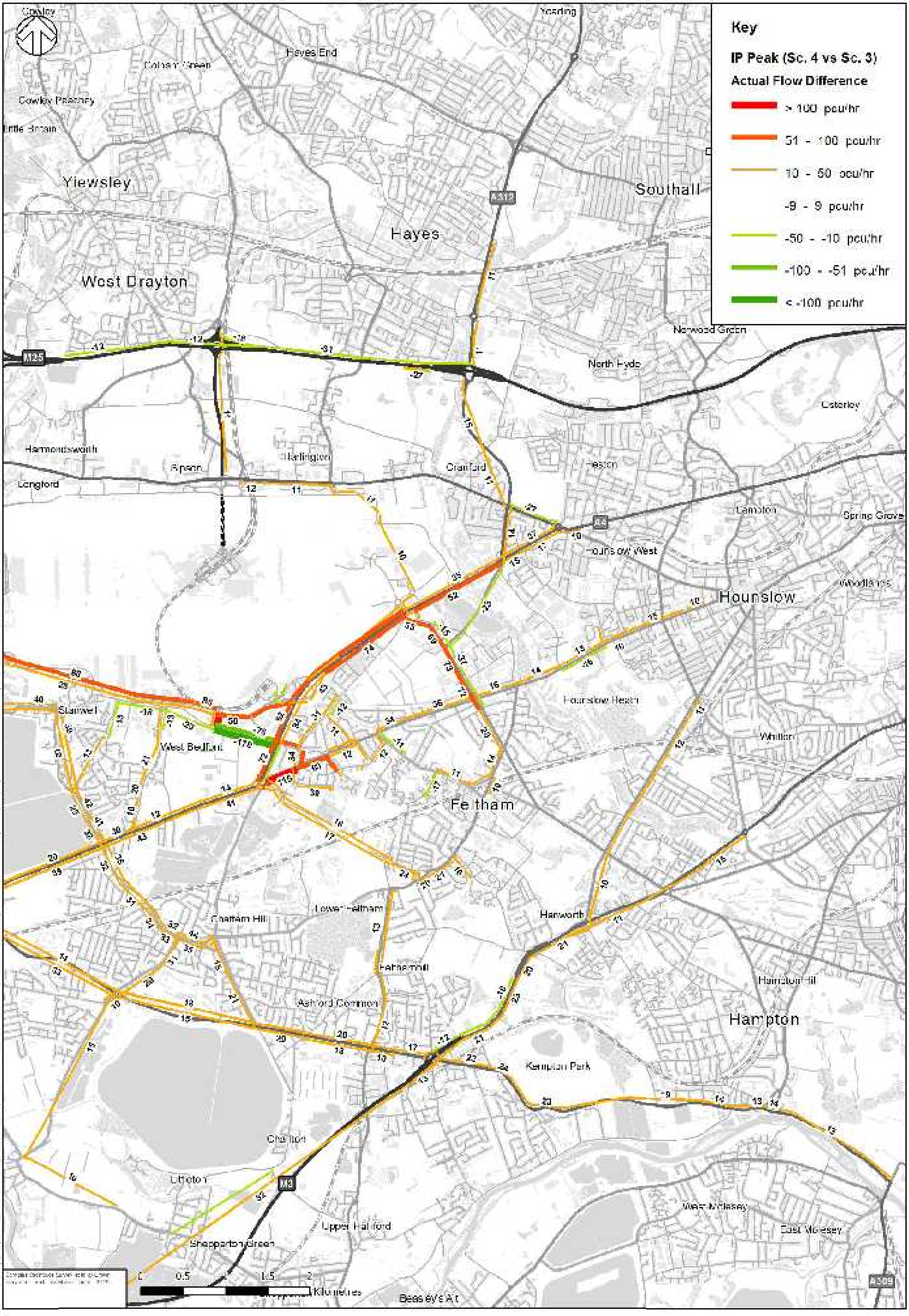
Upper Halliford
West Molesey
East Molesey
M25
M3
A312
A30
A4
Kilometres
0
0.5

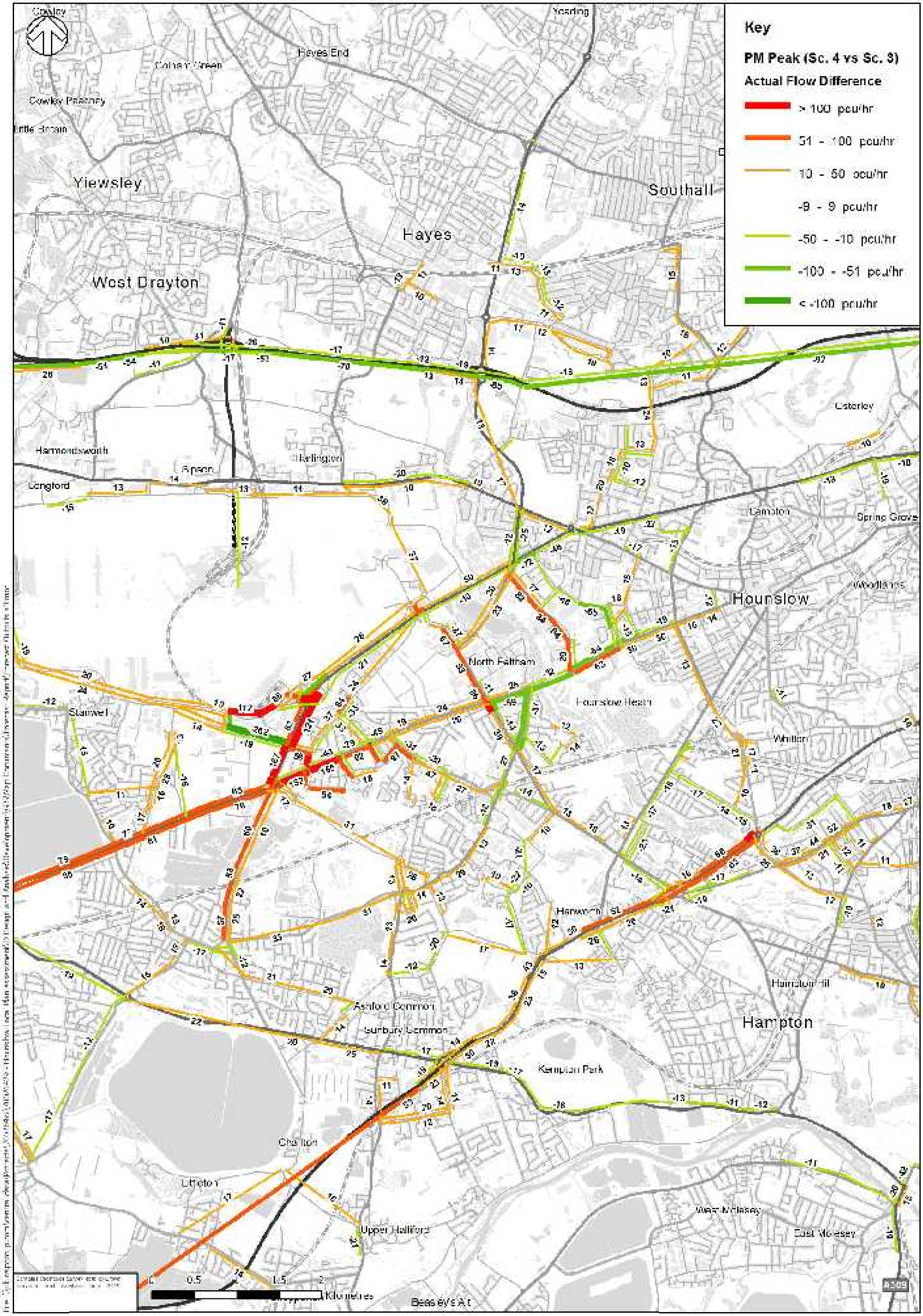

Key
IP Peak (Sc. 3 vs Sc. 2)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Hatton
North Feltham
Hounslow West
Hounslow
Hounslow Heath
Spring Grove
Woodlands
Whitton
Ashford Common
Littleton Common
Kempton Park
Hampton Hill
Hampton
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Colham Green
Cowley Peachey
Little Britain
Yeading
Lampton
Heston
Beasley's Ait
Kilometres
0
0.5


Key
PM Peak (Sc. 3 vs Sc. 2)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Drain
Yiewsley
Southall
Hayes
West Drayton
Norwood Green
Osterley
Sipson
Harlington
Cranford
Longford
Hatton
Woodlands
Hounslow Heath
Whitton
Hanworth
Hampton Hill
Hampton
Ashford Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Sheppert
Kilometres
Heasley's Ait



Key
AM Peak (Sc. 4 vs Sc. 3)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Heston
Hounslow
Woodlands
North Feltham
Hounslow Heath
Whitton
Feltham
Lower Feltham
Charlton Hill
Hanworth
Feltham Hill
Sunbury Common
Littleton Common
Kempton Park
Hampton Hill
Hampton
Laleham
Littleton
Upper Halliford
West Molesey
East Molesey
Cowley
Cowley Peachey
Yeading
A312
A308
A309
M3
0 0.5 1 1.5 2
Kilometres


Key
IP Peak (Sc. 4 vs Sc. 3)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Yiewsley
West Drayton
Hayes
Southall
Hounslow
Feltham
Hampton
Hayes End
Cowley Peachey
Harmondsworth
Longford
Sipson
Harlington
Cranford
Heston
North Hyde
Norwood Green
Osterley
Hounslow West
Lampton
Spring Grove
Woodlands
Hounslow Heath
Whitton
Stanwell
West Bedfont
Lower Feltham
Hanworth
Chattam Hill
Feltham Hill
Ashford Common
Hampton Hill
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
M25
M3
A312
A4
0 0.5 1 1.5 2
Kilometres

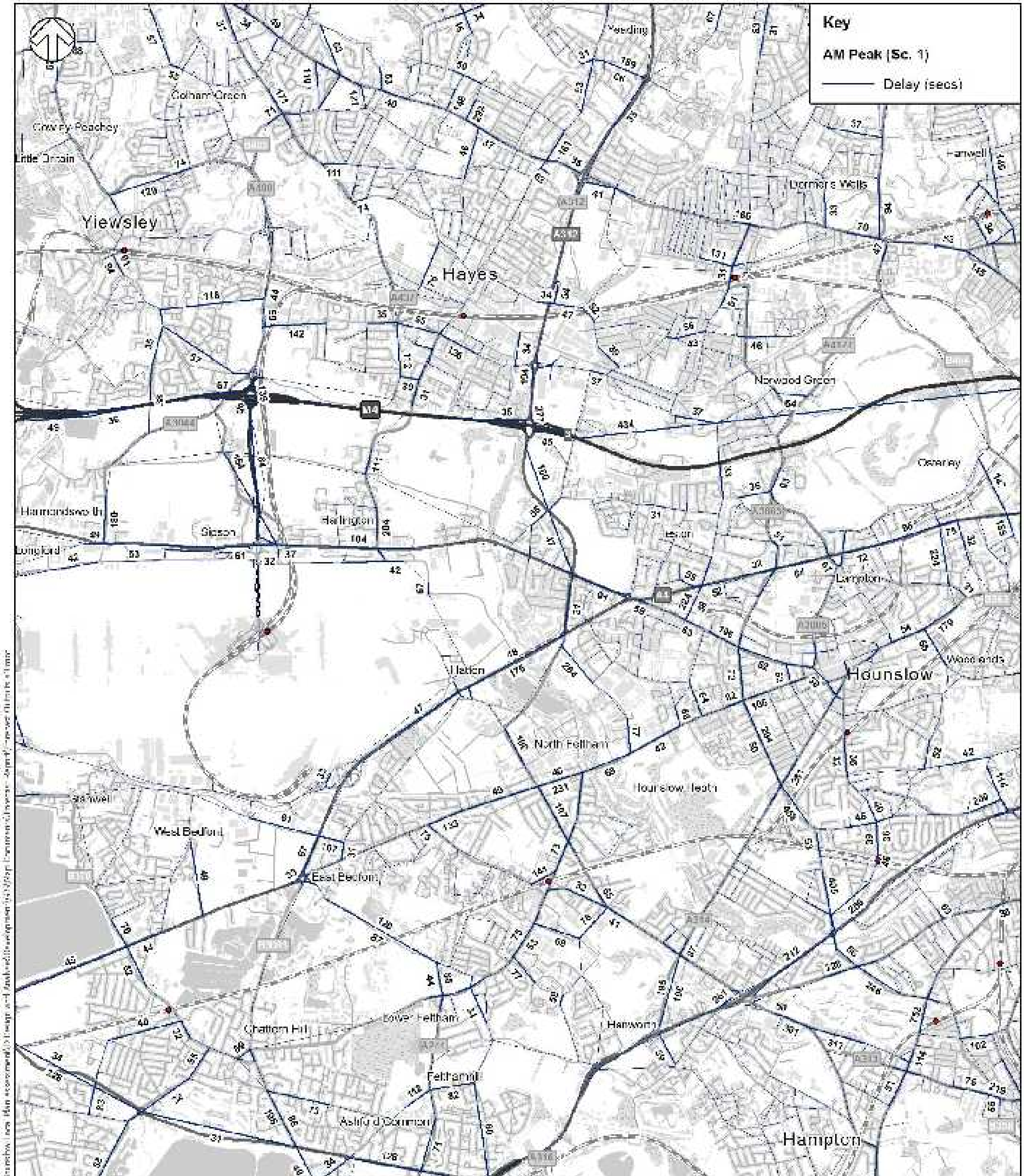

Key
PM Peak (Sc. 4 vs Sc. 3)
Actual Flow Difference
> 100 pcu/hr
51 - 100 pcu/hr
10 - 50 pcu/hr
-9 - 9 pcu/hr
-50 - -10 pcu/hr
-100 - -51 pcu/hr
< -100 pcu/hr
Cowley
Yeading
Hayes End
Colham Green
Cowley Peachey
Yiewsley
Southall
Hayes
West Drayton
Osterley
Harmondsworth
Harlington
Longford
Lampton
Spring Grove
Hounslow
Woodlands
North Feltham
Stanwell
Hounslow Heath
Whitton
Hanworth
Hampton Hill
Ashford Common
Sunbury Common
Hampton
Kempton Park
Charlton
Littleton
Upper Halliford
West Molesey
East Molesey
0 0.5 1 1.5 2
Kilometres
A309

Appendix C

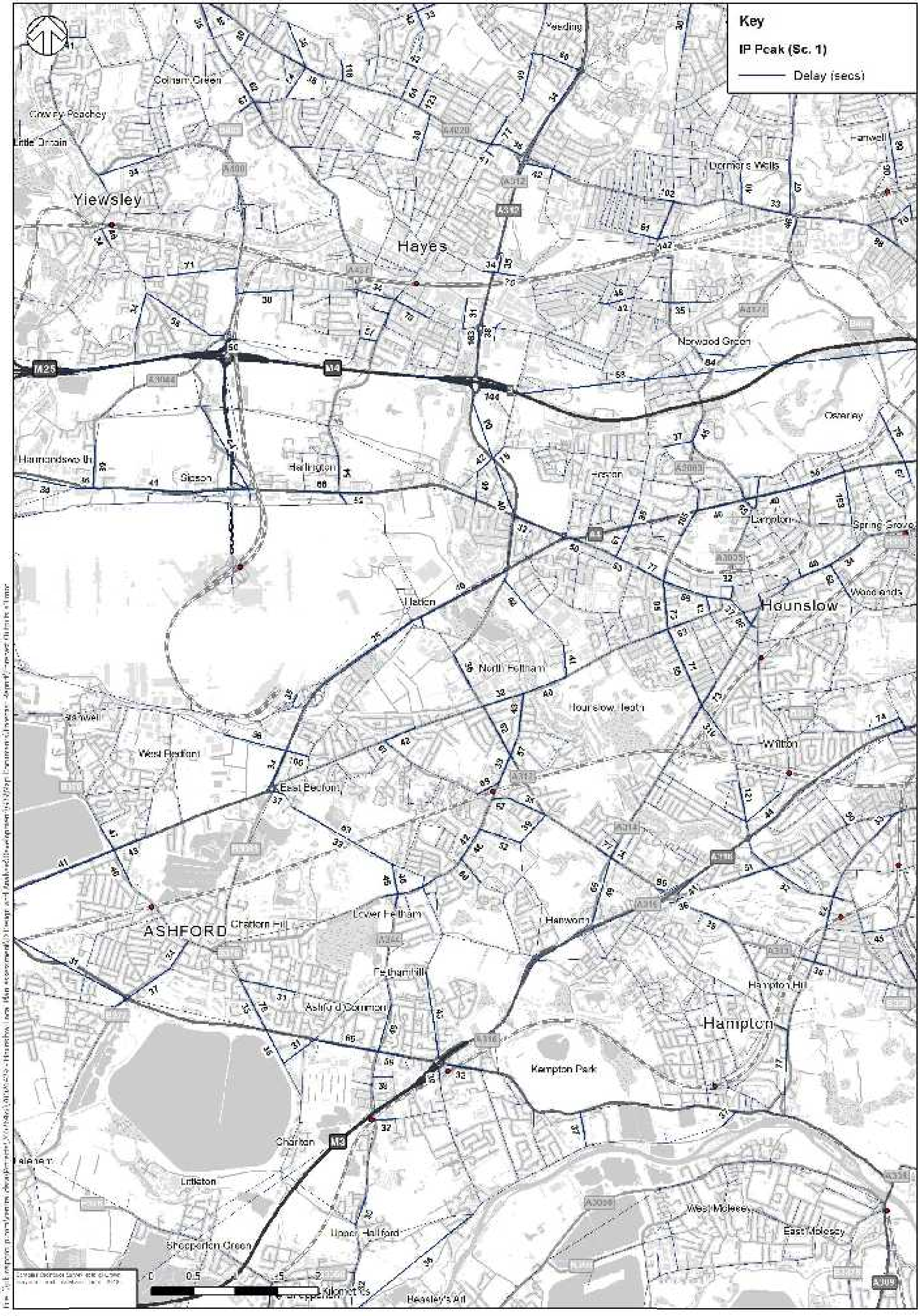
DELAY PLOTS

Appendix C.1

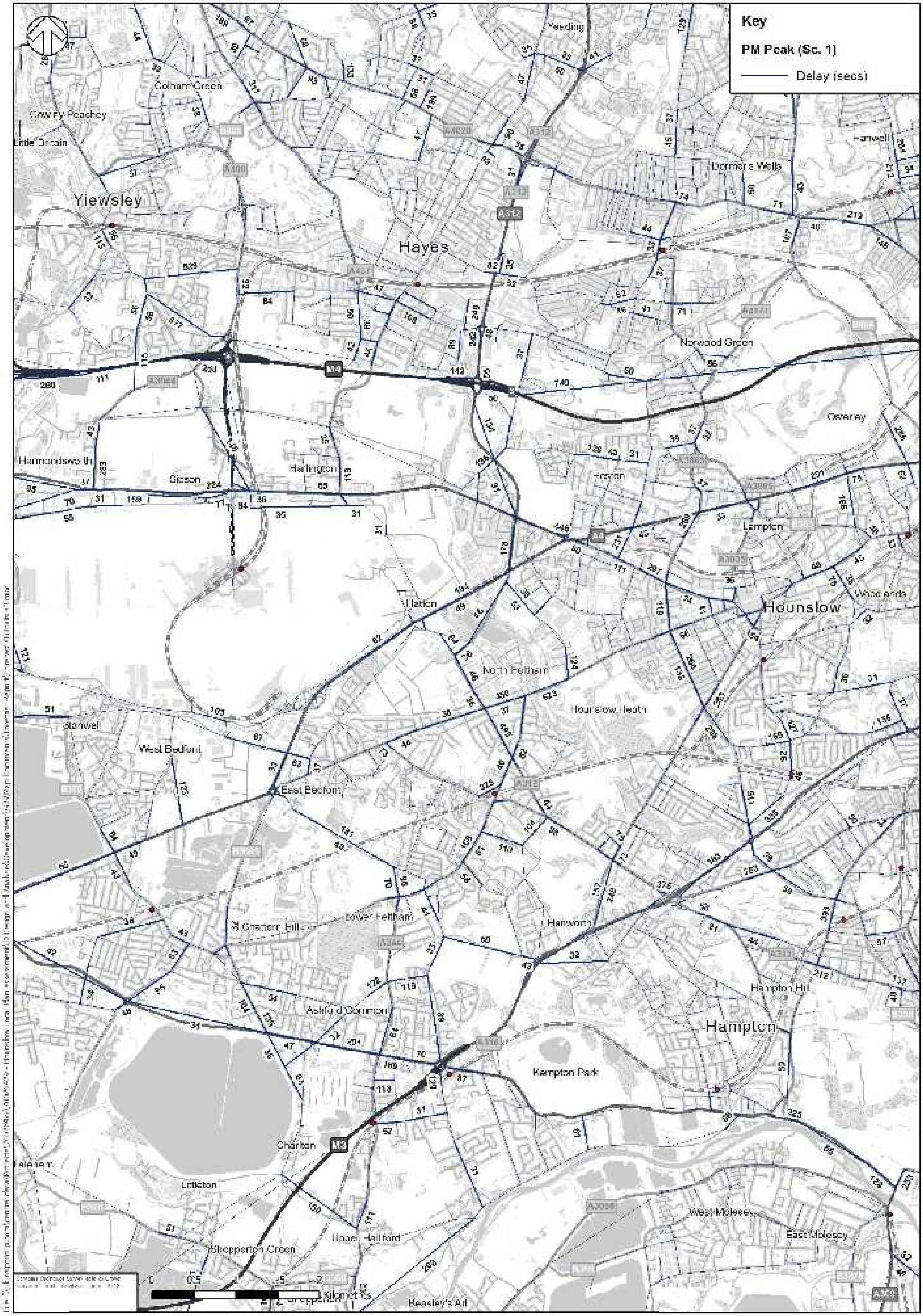
DELAY



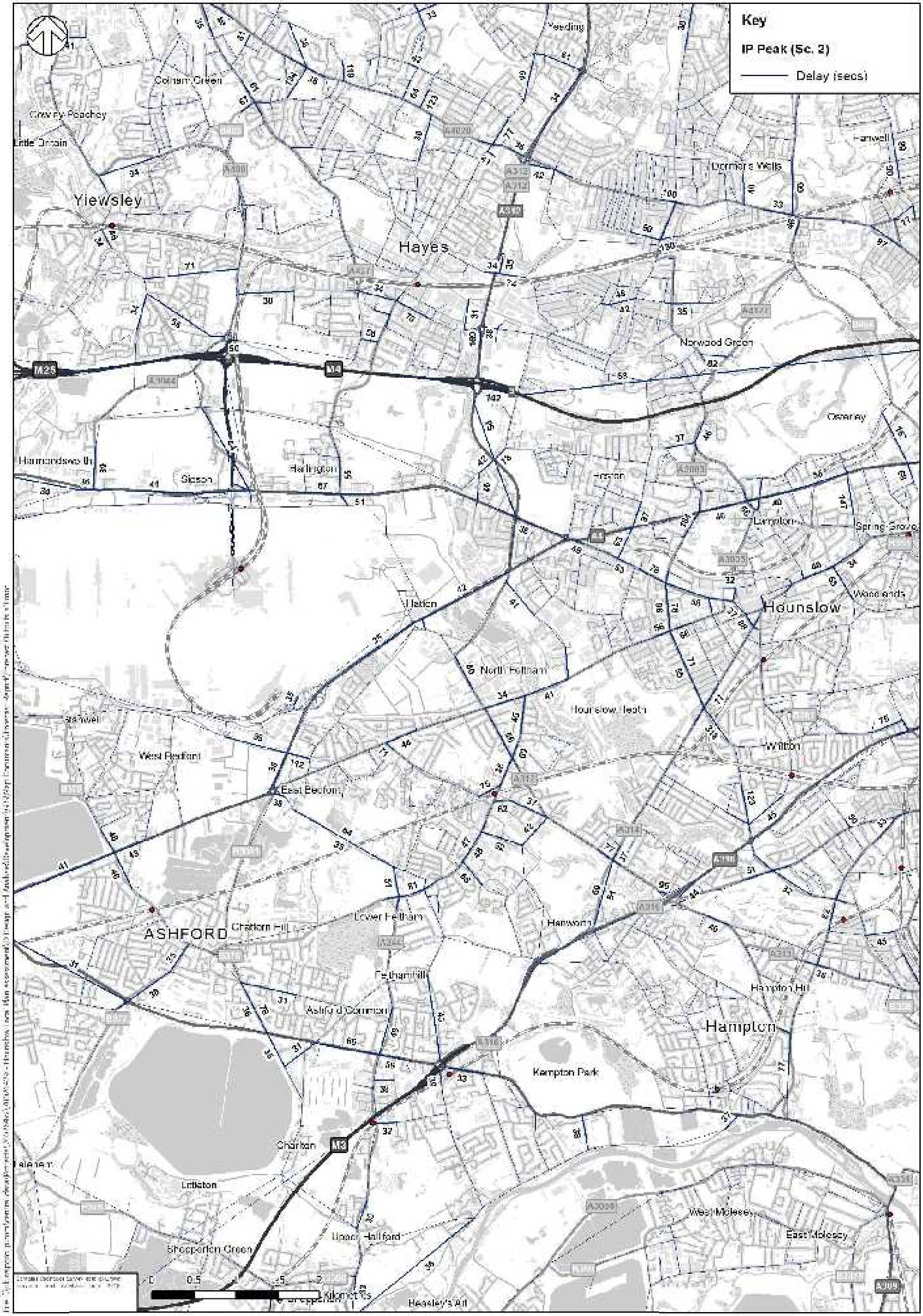
Key
AM Peak (Sc. 1)
Delay (secs)
Yeading
Colham Green
Cowley Peachey
Yiewsley
Hayes
Dormers Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Lampton
Hatton
Hounslow
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Chattern Hill
Lower Feltham
Hanworth
Feltham
Ashford Common
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
West Molesey
East Molesey
M4
A4
Kilometres
0 0.5 1 1.5 2

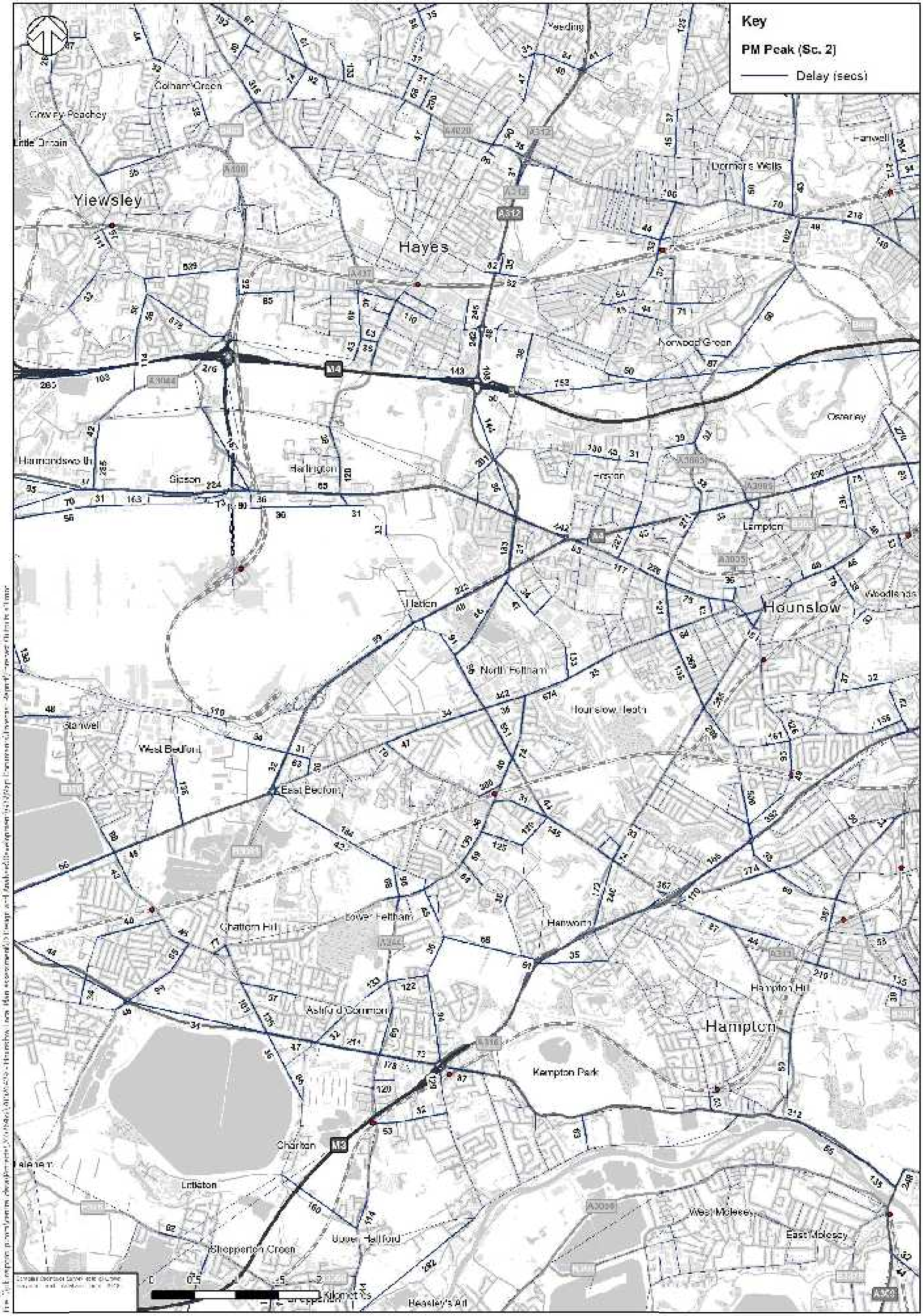


Key
IP Peak (Sc. 1)
Delay (secs)
Yiewsley
Hayes
Colham Green
Little Drain
Hammondsworth
Sipson
Harlington
Heston
Norwood Green
Osterley
Lampton
Spring Grove
Hounslow
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Whitton
ASHFORD
Lower Feltham
Hanworth
Feltham Hill
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Hanwell
Dormers Wells
M25
M4
M3
A4
Kilometres


Key
PM Peak (Sc. 1)
Delay (secs)
Yiewsley
Hayes
Colham Green
Dormers Wells
Norwood Green
Osterley
Sipson
Harlington
Heston
Lampton
Hounslow
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Hampton Hill
Ashford Common
Hampton
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Shepperton Green
Upper Halliford
Kilometres


Key
AM Peak (Sc. 2)
Delay (secs)
Yiewsley
Hayes
Colham Green
Cowley Peachey
Little Drain
Yeading
Hanwell
Dormer's Wells
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Lampton
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Lower Feltham
Chattern Hill
Hanworth
Feltham
Ashford Common
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
West Molesey
East Molesey
Beasley's Ait
M4
A4
Kilometres


Key
IP Peak (Sc. 2)
Delay (secs)
Yiewsley
Hayes
Hounslow
ASHFORD
Hampton
Colham Green
Cowley Peachey
Dormer's Wells
Norwood Green
Osterley
Harlington
Sipson
Hatton
North Feltham
Hounslow Heath
Lampton
Spring Grove
Woodlands
Whitton
West Bedfont
East Bedfont
Lower Feltham
Feltham Hill
Ashford Common
Hanworth
Hampton Hill
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
M25
M4
M3
A4
0 0.5 1 1.5 2
Kilometres


Key
PM Peak (Sc. 2)
Delay (secs)
Yeading
Colham Green
Crowy Peachey
Little Britain
Yiewsley
Hayes
Dormer's Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Chattern Hill
Hanworth
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
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Shepperton Green
Kilometres
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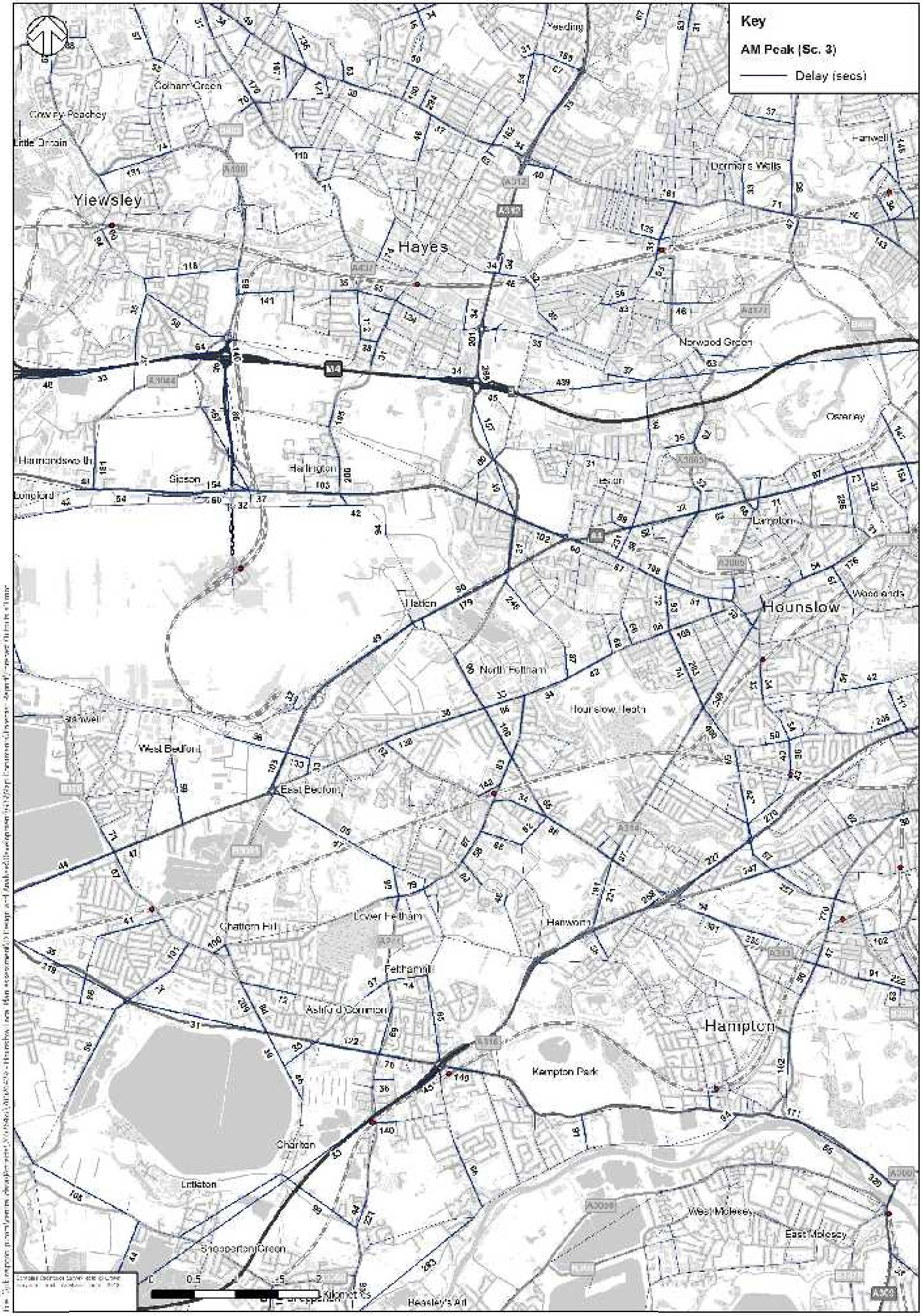
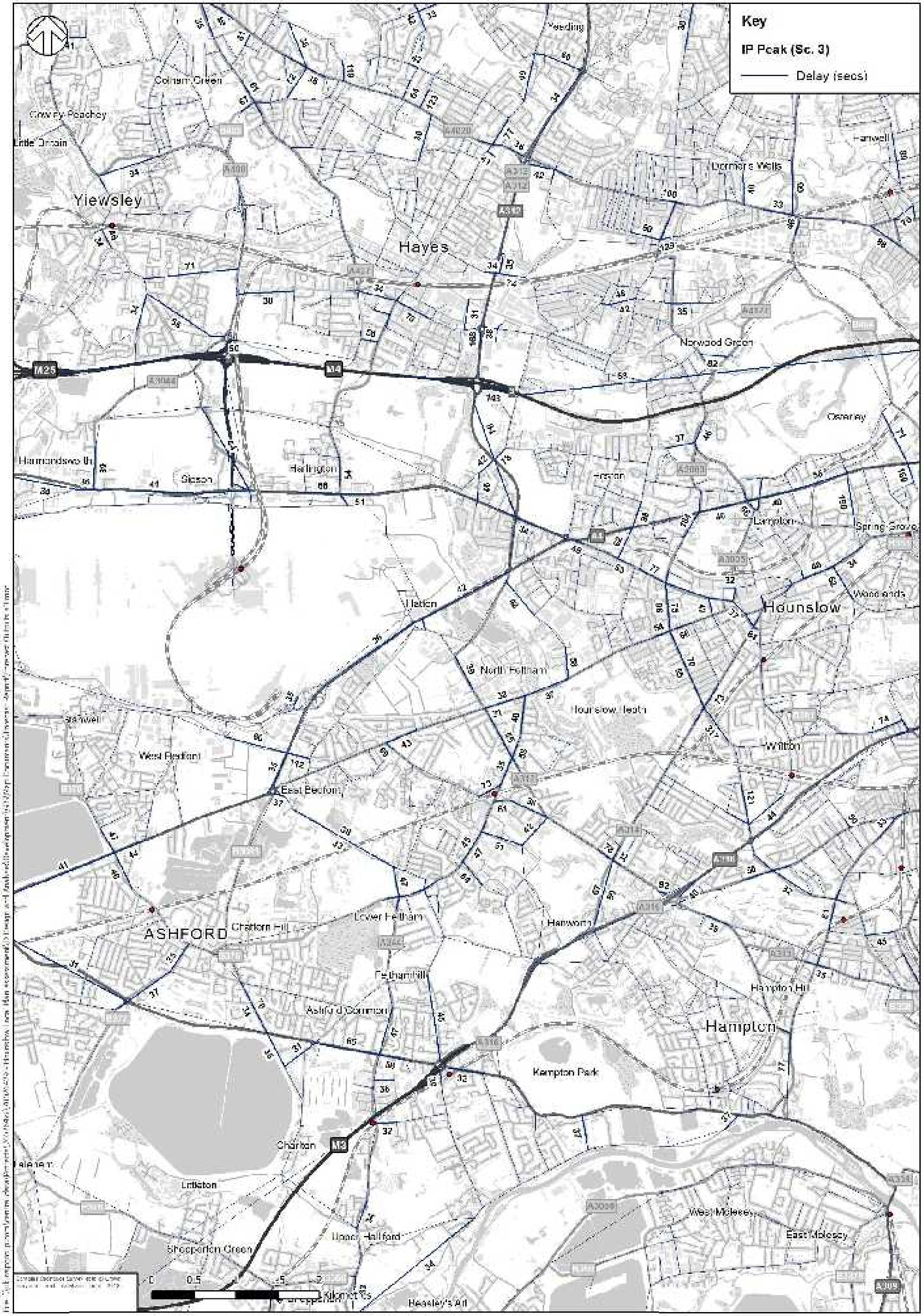
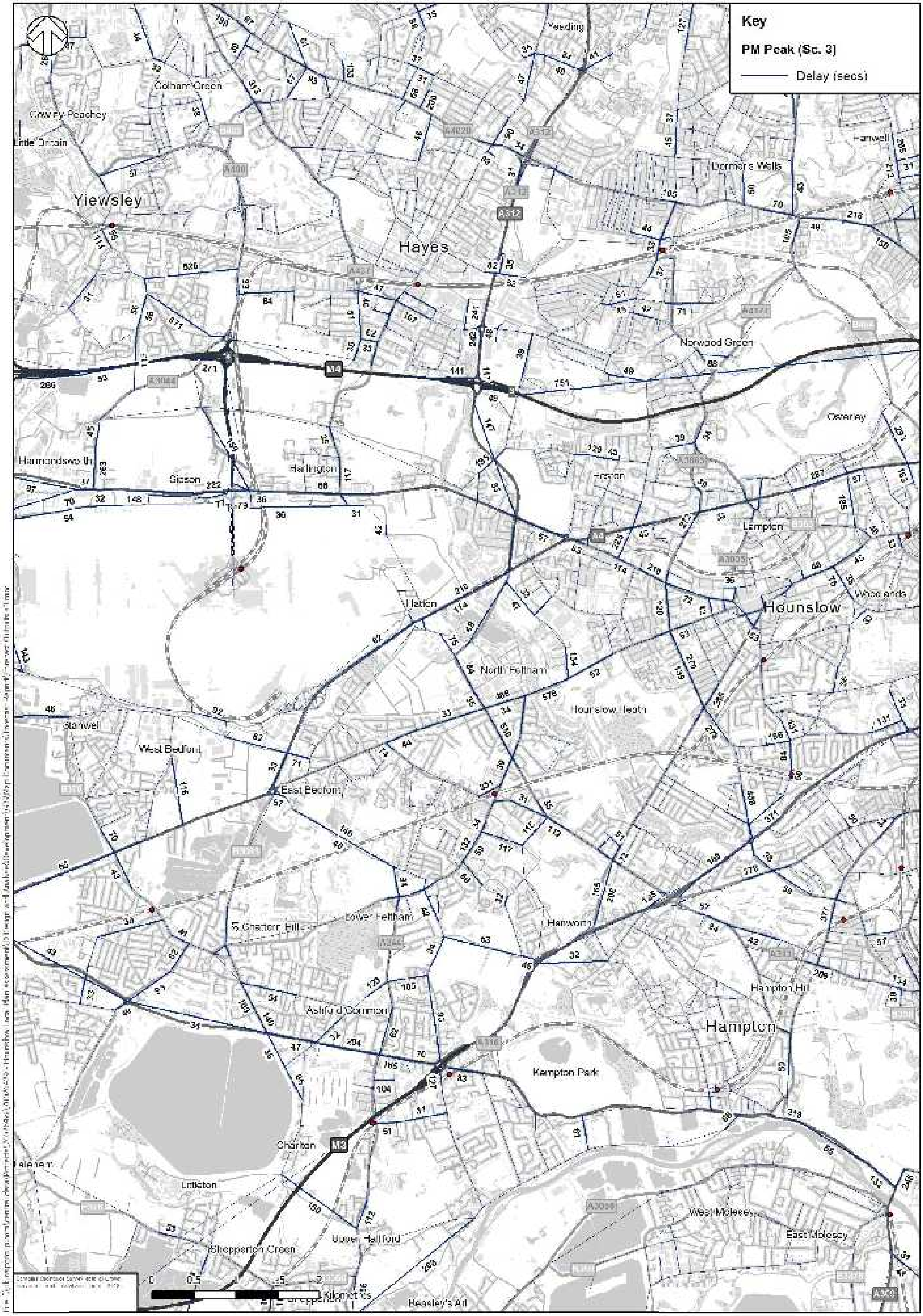
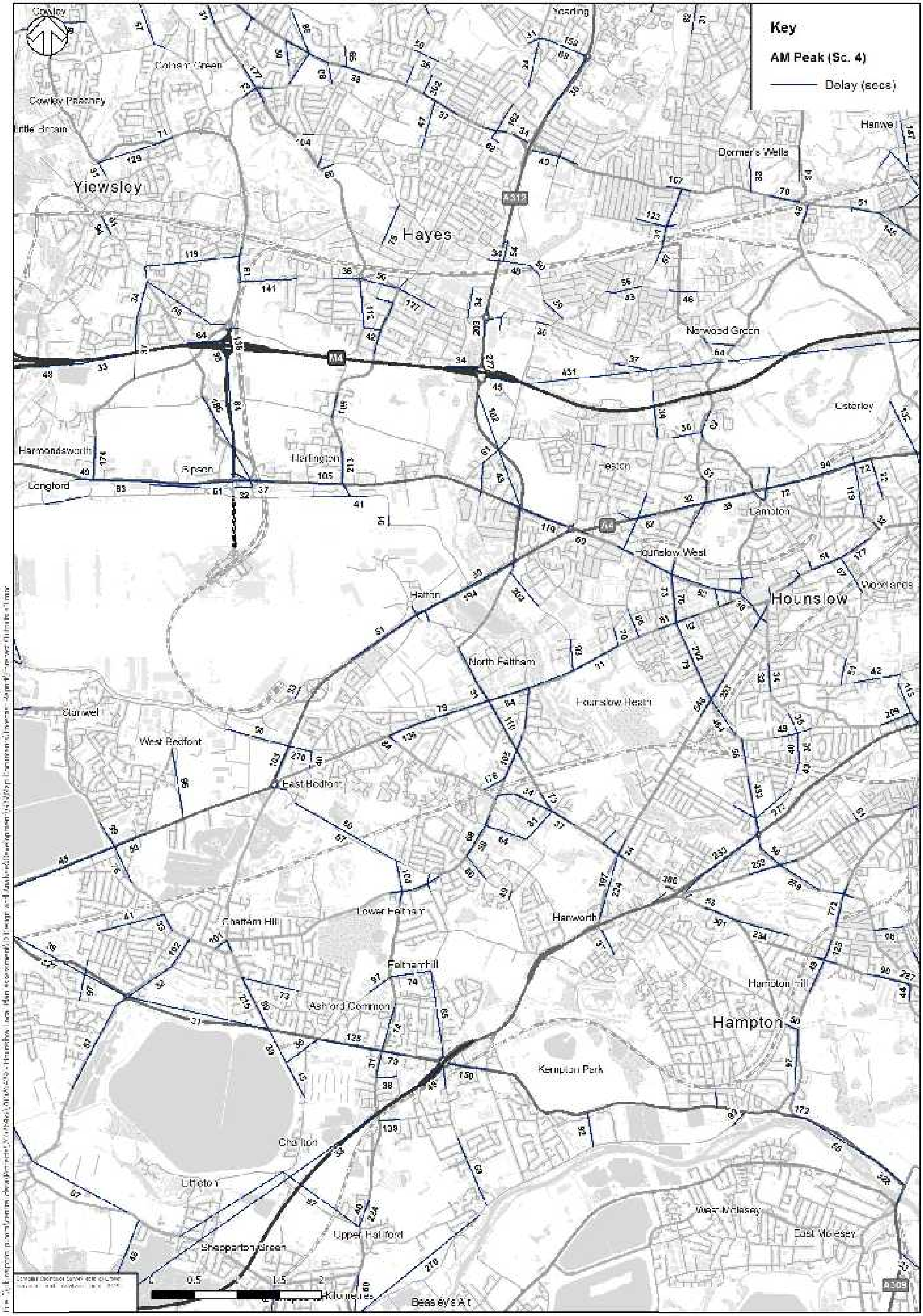
A4
A312
A437
A4020


Key
AM Peak (Sc. 3)
Delay (secs)
Yiewsley
Colham Green
Cowley Peachey
Little Drain
Hayes
Dormers Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Heston
Lampton
Hounslow
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Chattern Hill
Lower Feltham
Feltham
Hanworth
Ashford Common
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
West Molesey
East Molesey
Beasley's Ait
Kilometres
M4
A4



Key
IP Peak (Sc. 3)
Delay (secs)
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Dormers Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Spring Grove
Hatton
Hounslow
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Whitton
Hanworth
ASHFORD
Charlton Hill
Lower Feltham
Feltham Hill
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
Upper Halliford
West Molesey
East Molesey
Shepperton Green
Kilometres
M25
M4
M3
A4


Key
PM Peak (Sc. 3)
Delay (secs)
Yeading
Colham Green
Crowley Peachey
Little Drain
Yiewsley
Hayes
Dormers Wells
Hanwell
Norwood Green
M4
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
A4
Hounslow
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
M3
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Kilometres



Key
AM Peak (Sc. 4)
Delay (secs)
Yiewsley
Hayes
Cowley Peachey
Colham Green
Yeading
Hanwell
Dormer's Wells
Norwood Green
Osterley
Harmondsworth
Longford
Sipson
Harlington
Heston
Lampton
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Chattam Hill
Lower Feltham
Hanworth
Feltham Hill
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
M4
A4
A312
A309
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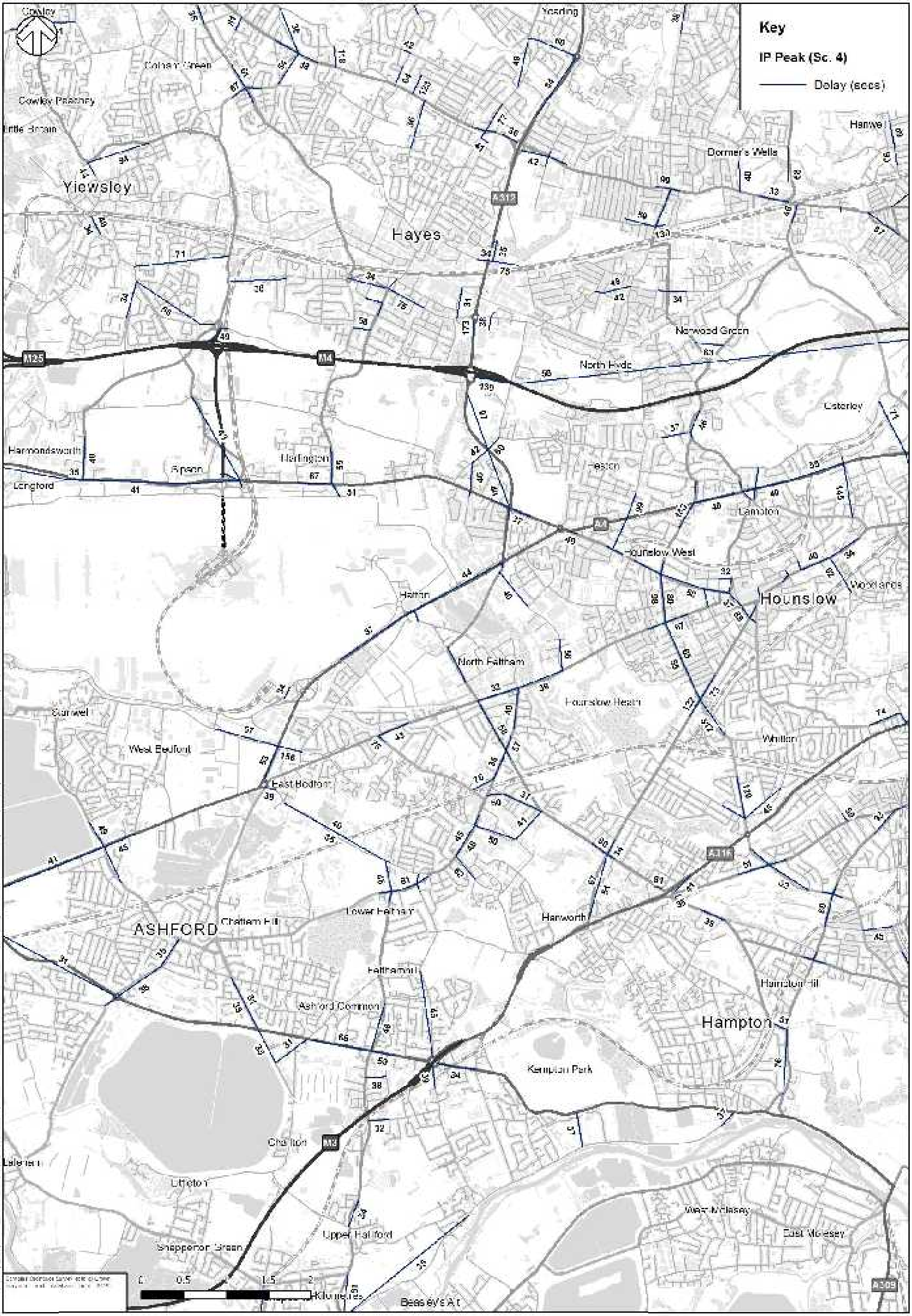
Kilometres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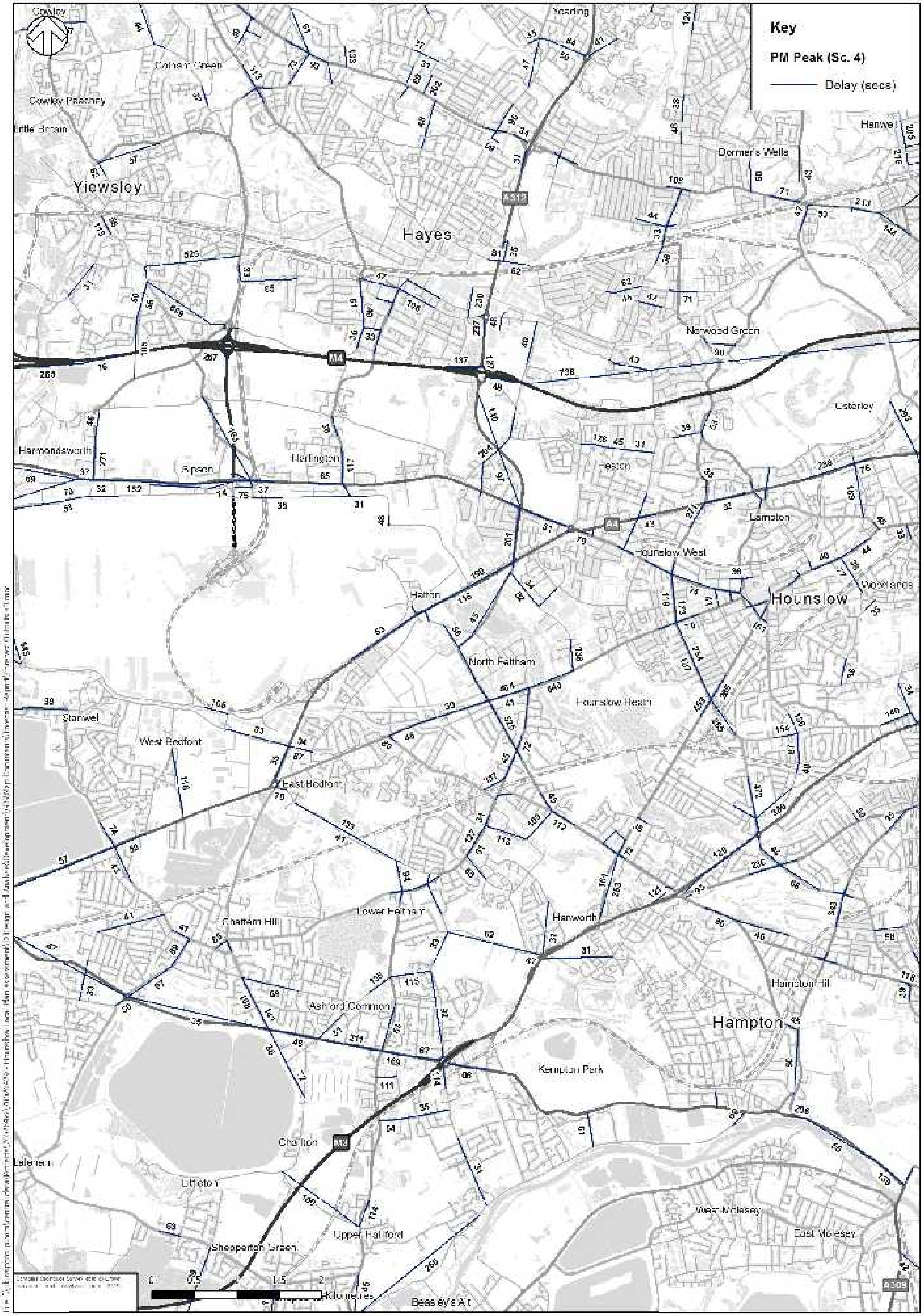
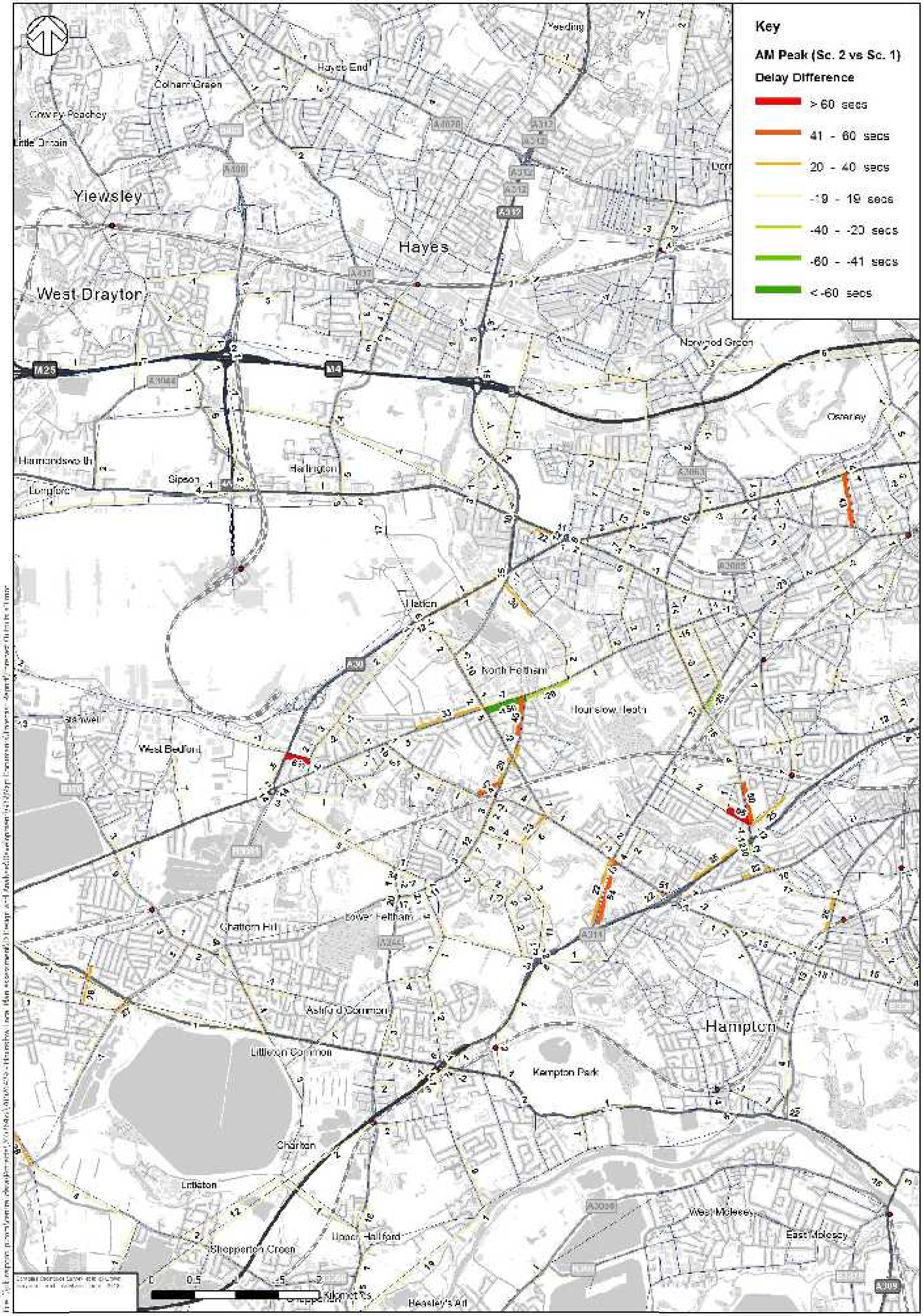
IP Peak (Sc. 4)
Delay (secs)
Cowley
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Yeading
Hayes
Hanwell
Dormer's Wells
A312
Norwood Green
North Hyde
M25
M4
Osterley
Harmondsworth
Longford
Sipson
Harlington
Heston
Lampton
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Whitton
Stanwell
West Bedfont
East Bedfont
A316
Lower Feltham
Hanworth
ASHFORD
Chattern Hill
Feltham
Hampton Hill
Ashford Common
Hampton
Kempton Park
Charlton
M3
Laleham
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Kilometres
Beasley's Ait
A309



Key
PM Peak (Sc. 4)
Delay (secs)
Cowley
Yeading
Colham Green
Cowley Peachey
Little Britain
Hanwell
Dormer's Wells
Yiewsley
Hayes
A312
Norwood Green
M4
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Hounslow West
A4
Hatton
Hounslow
Woodlands
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Chattam Hill
Hanworth
Hampton Hill
Ashford Common
Hampton
Kempton Park
Charlton
M3
Laleham
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
A309
Bessey's Ait
0
0.5
1.5
2
Kilometres

Appendix C.2

DELAY DIFFERENCE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Delay Difference
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41 - 60 secs
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yiewsley
Hayes
West Drayton
Colham Green
Cowley Peachey
Little Drain
Hayes End
Yeading
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Chattom Hill
Lower Feltham
Ashford Common
Littleton Common
Kempton Park
Hampton
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
M25
M4
A30
A312
A437
A314
A244
A3050
Kilometres
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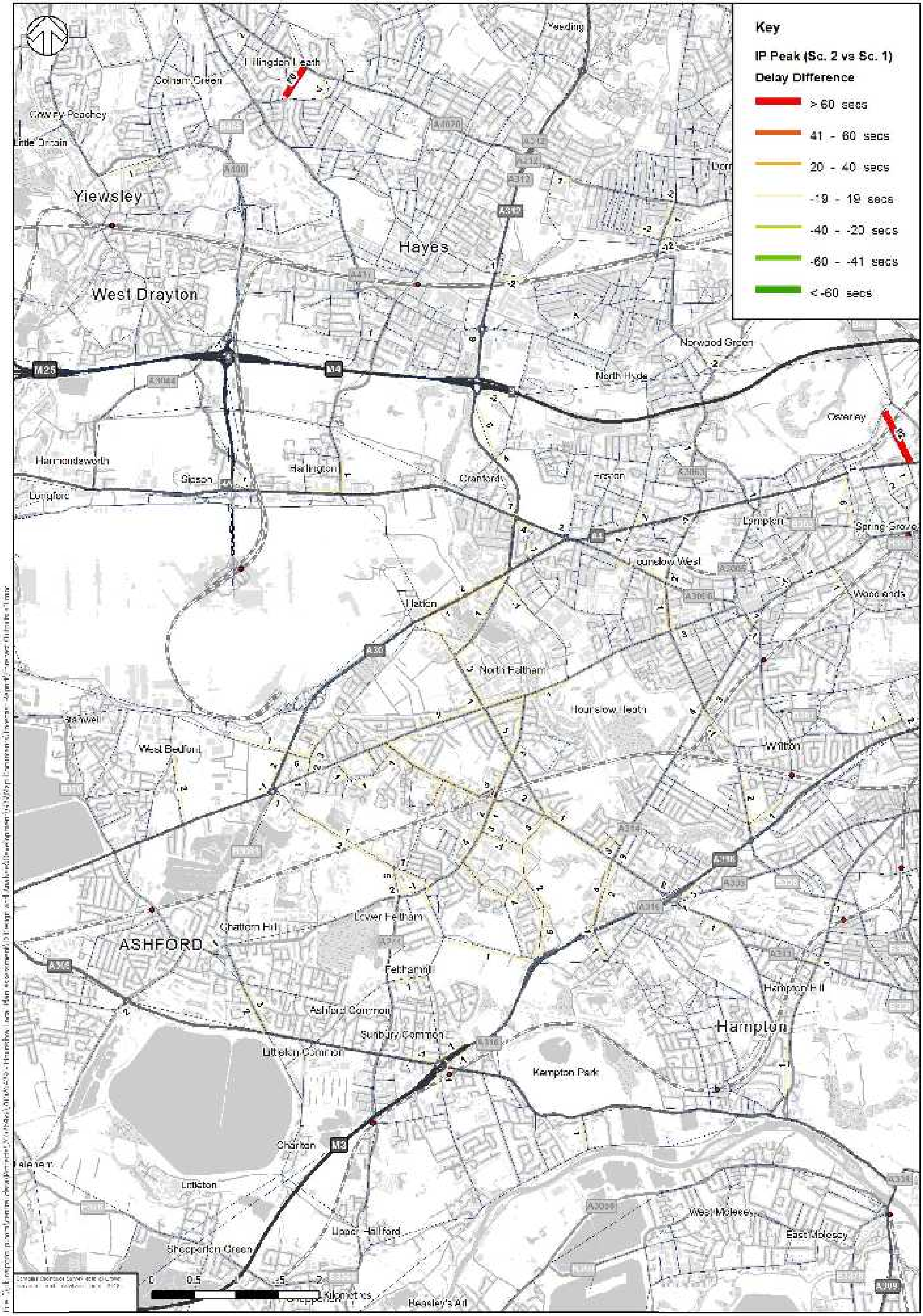
0.5
1
1.5
2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Delay Difference
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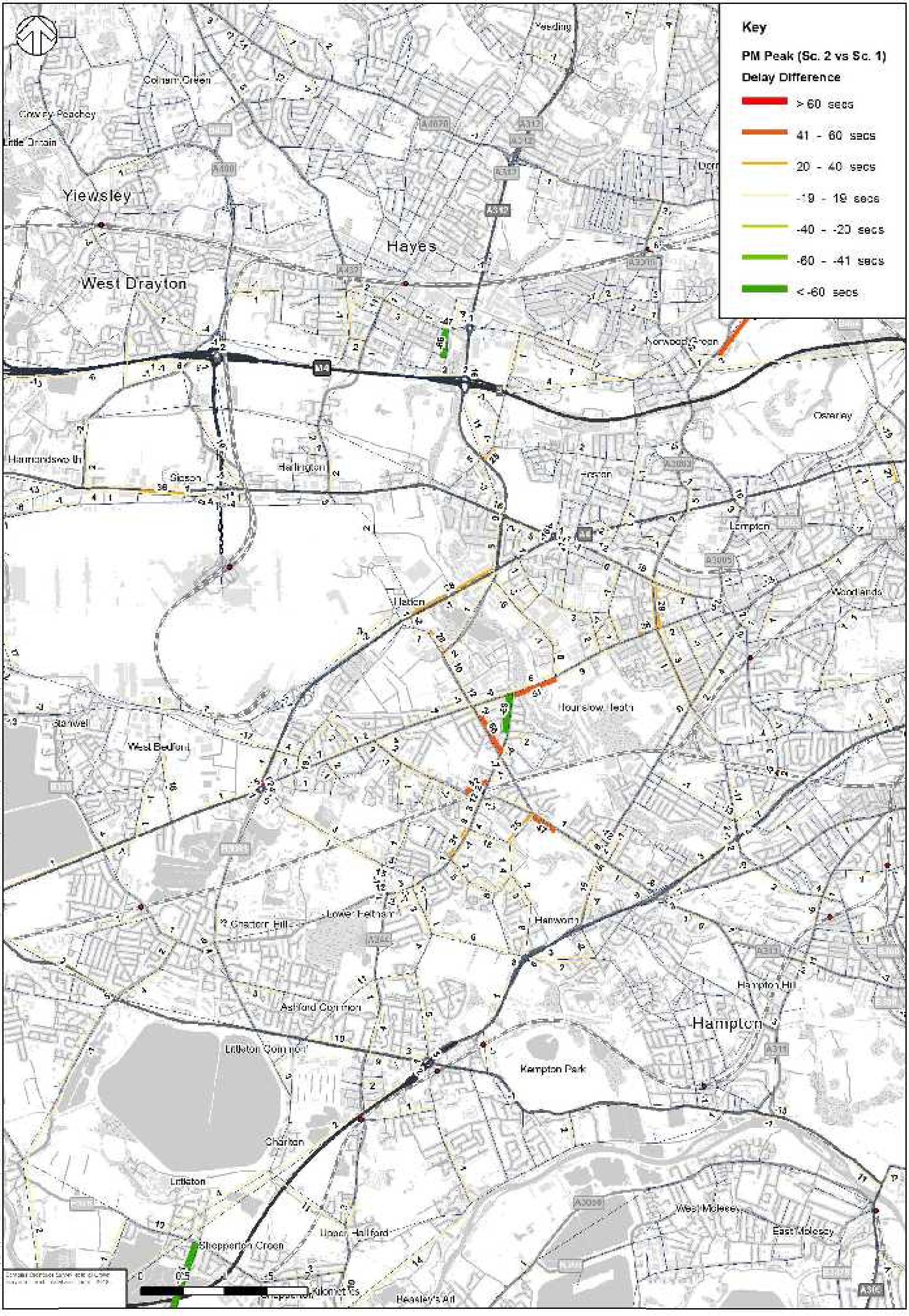
-60 - -41 secs
< -60 secs
Yiewsley
West Drayton
Hayes
Hillingdon Heath
Colham Green
Cowley Peachey
Little Britain
Yeading
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Longford
Cranford
Heston
Lampton
Spring Grove
Hounslow West
Hatton
Woodlands
North Feltham
Hounslow Heath
Whitton
West Bedfont
Stanwell
ASHFORD
Chattern Hill
Lower Feltham
Feltham Hill
Ashford Common
Sunbury Common
Littleton Common
Kempton Park
Hampton
Hampton Hill
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
M25
M4
M3
A4
A30
Kilometres
0 0.5 1 1.5 2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20 - 40 secs
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-40 - -20 secs
-60 - -41 secs
< -60 secs
Yeading
Colham Green
Cowley Peachey
Little Drain
Yiewsley
Hayes
West Drayton
Norwood Green
M4
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Woodlands
Hatton
Hounslow Heath
Stanwell
West Bedfont
Lower Feltham
Hanworth
Hampton Hill
Ashford Common
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
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Beasley's Ait
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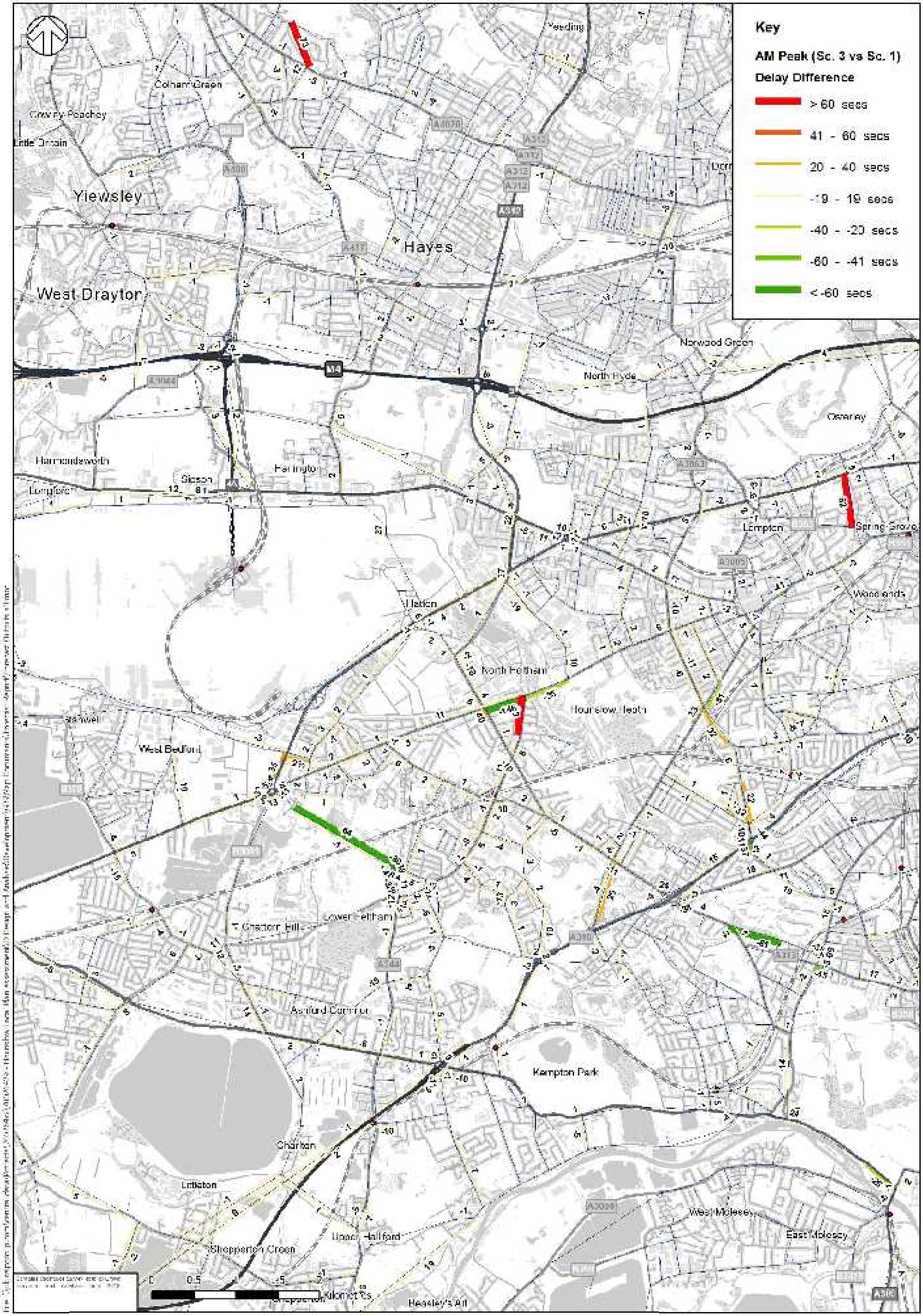
0.5
1
1.5
2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Delay Difference
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20 - 40 secs
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-40 - -20 secs
-60 - -41 secs
< -60 secs
Yeading
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
West Drayton
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Longford
Harlington
Lampton
Spring Grove
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Lower Feltham
Ashford Common
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
M4
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A3006
A3005
A3063
A244
A308
Kilometres
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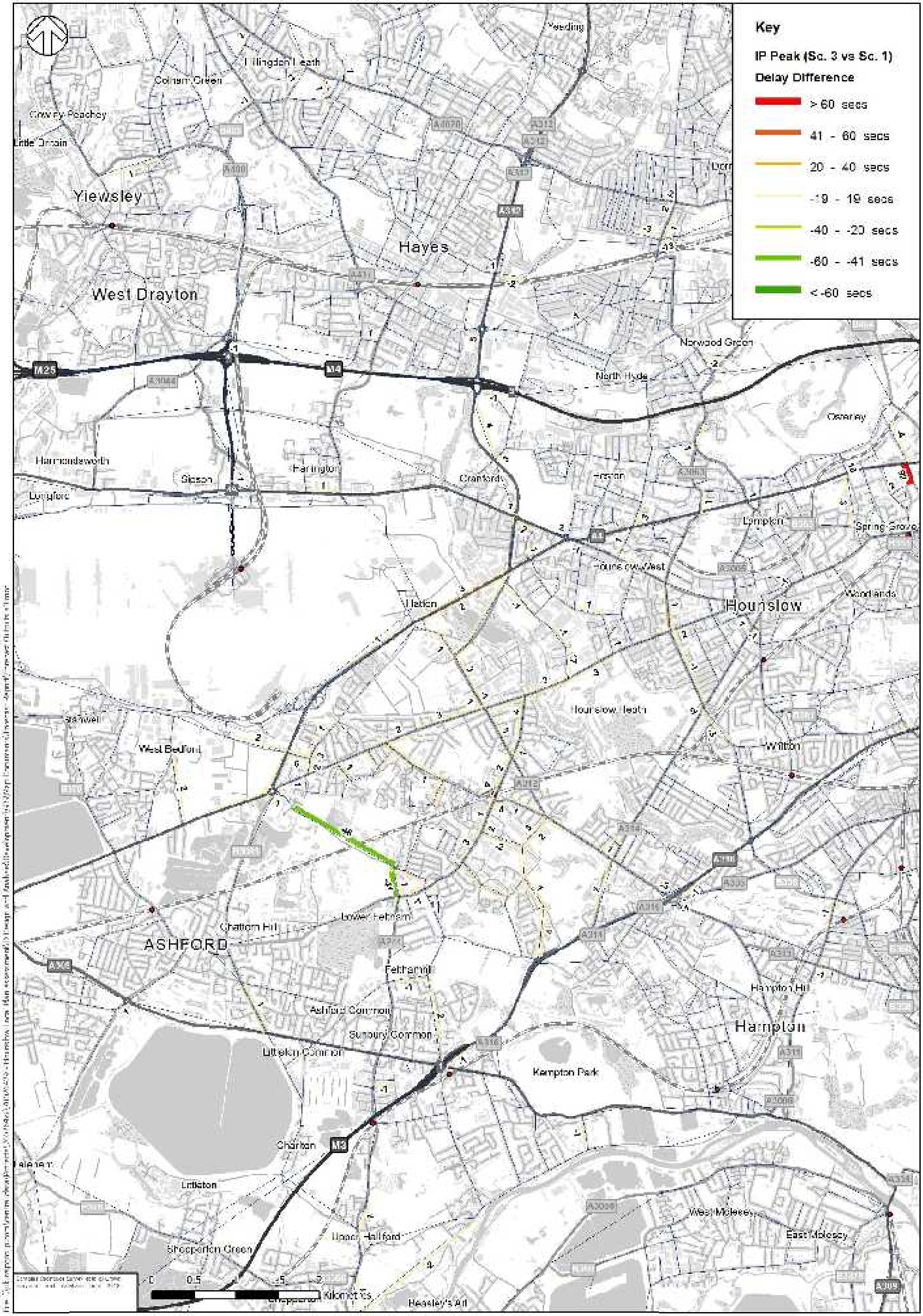
0.5
1
1.5
2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Delay Difference
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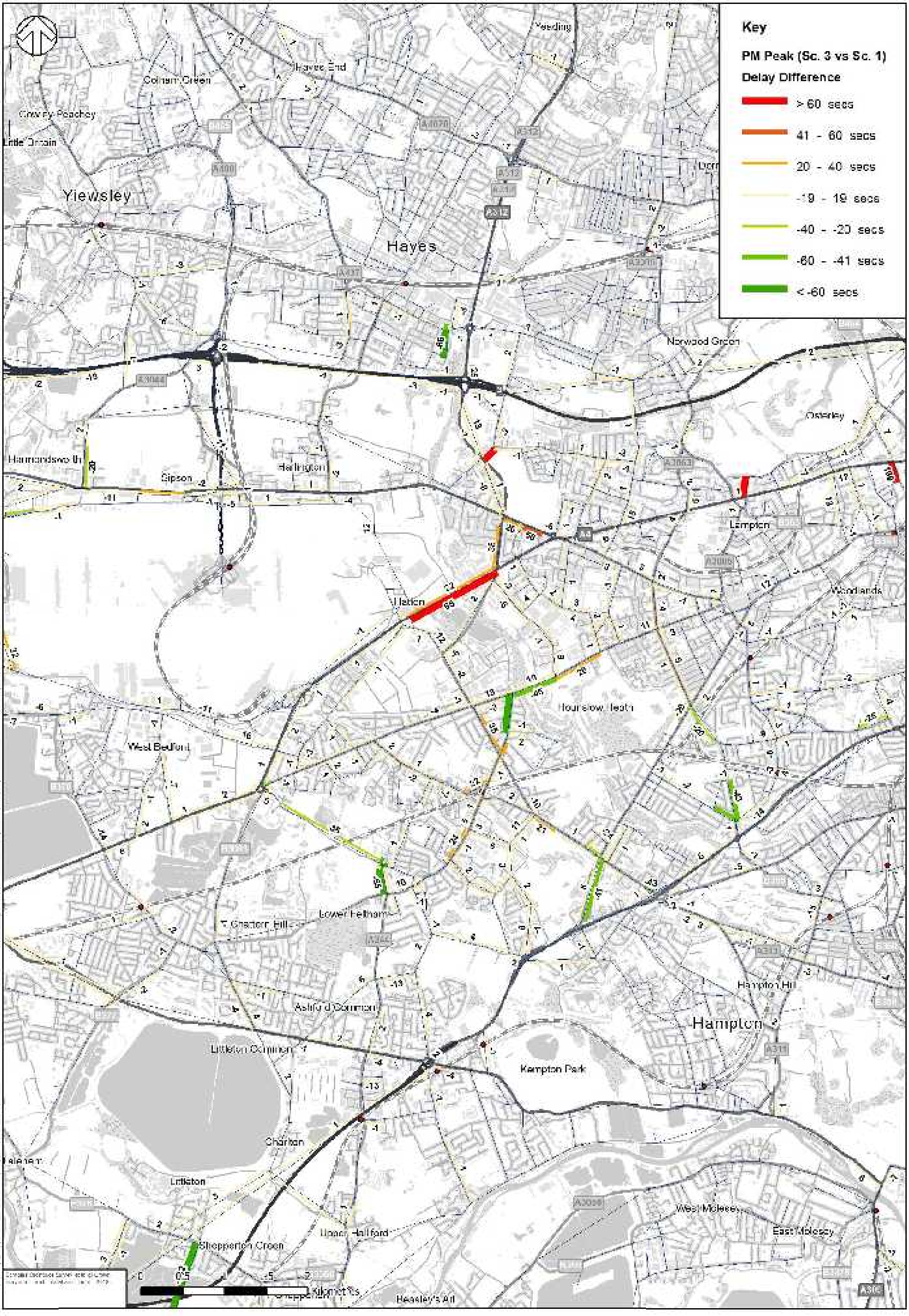
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yiewsley
West Drayton
Hayes
Hounslow
Hampton
ASHFORD
Hounslow West
Hounslow Heath
Norwood Green
North Hyde
Osterley
Spring Grove
Woodlands
Whitton
Hampton Hill
Kempton Park
Lower Feltham
Feltham
Ashford Common
Sunbury Common
Littleton Common
Chatham Hill
West Bedfont
Cranford
Harlington
Sipson
Harmondsworth
Longford
Colham Green
Cowley Peachey
Little Drain
Hillingdon Heath
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
M25
M4
M3
A4
0 0.5 1 1.5 2 Kilometres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Delay Difference
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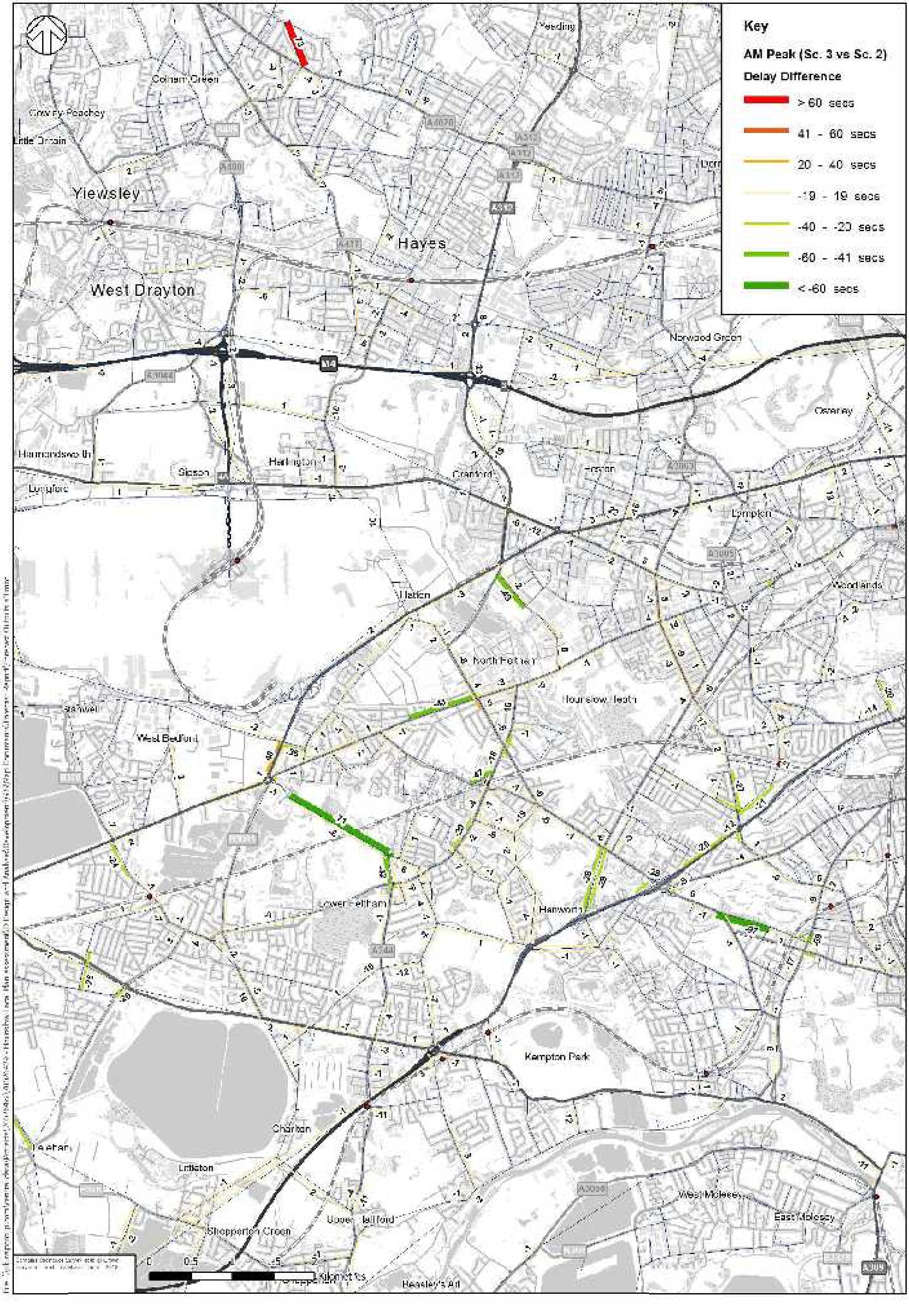
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yiewsley
Hayes
Hayes End
Colham Green
Cowley Peachey
Little Green
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Hatton
Hounslow Heath
West Bedfont
Lower Feltham
Ashford Common
Littleton Common
Kempton Park
Hampton Hill
Hampton
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
Woodlands
Kilometres



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Delay Difference
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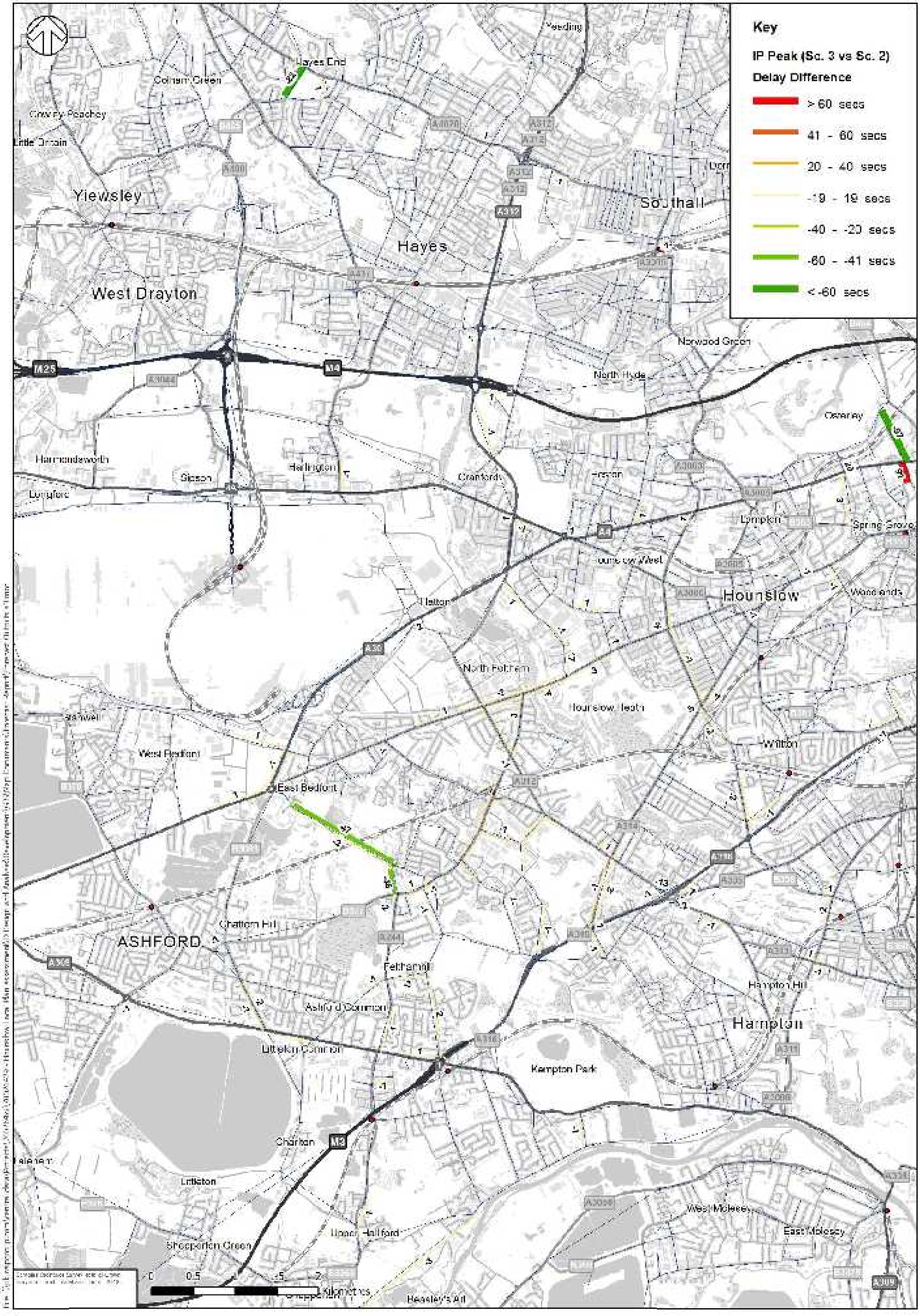
West Drayton
Hayes
Colham Green
Cowley Peachey
Little Britain
Yeading
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Longford
Cranford
Heston
Lampton
Hatton
North Feltham
Hounslow Heath
Woodlands
Stanwell
West Bedfont
Lower Feltham
Hanworth
Kempton Park
Charlton
Laleham
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
M4
0 0.5 1 1.5 2
Kilometres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IP Peak (Sc. 3 vs Sc. 2)
Delay Difference
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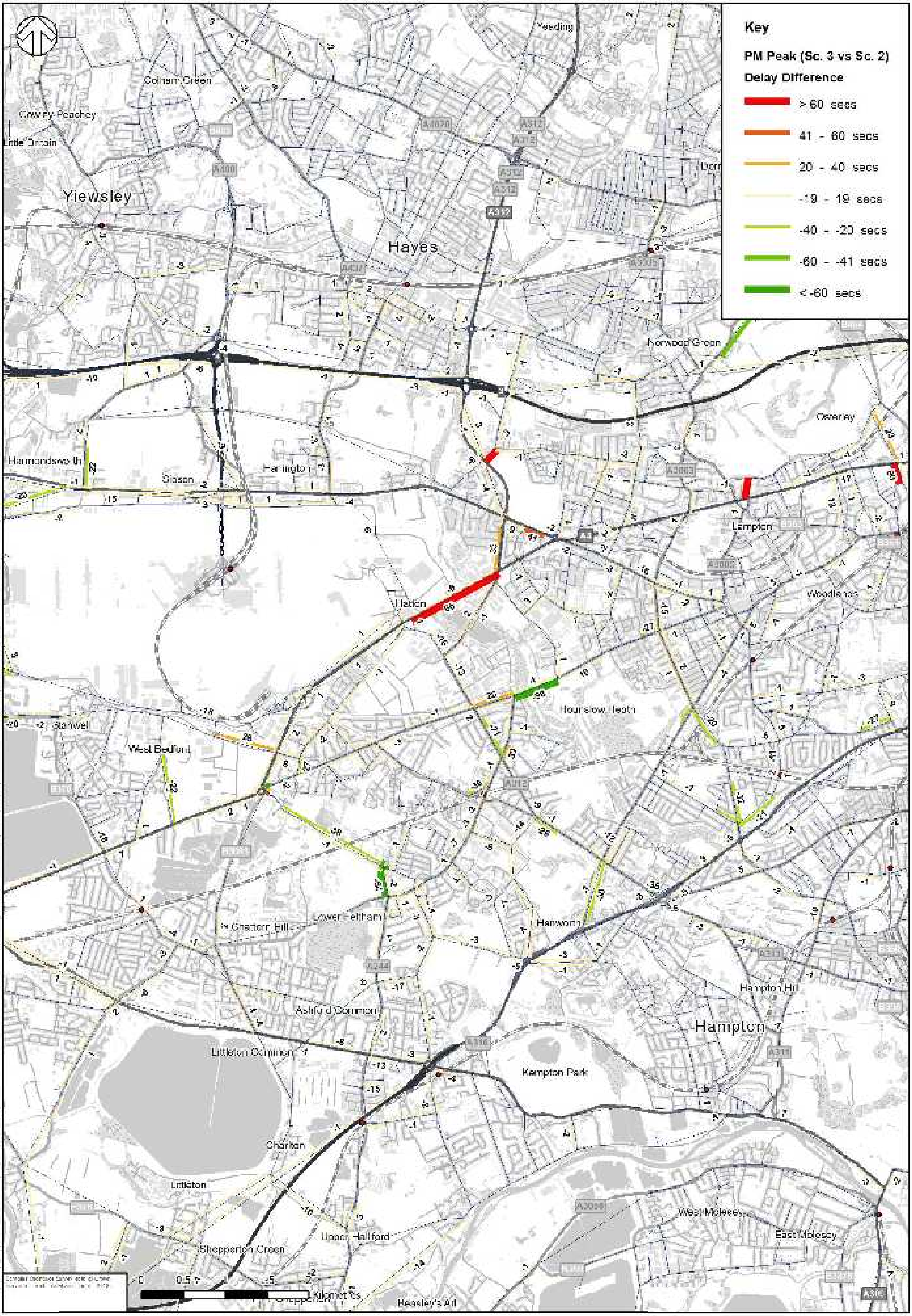
41 - 60 secs
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yeading
Hayes End
Colham Green
Cowley Peachey
Yiewsley
Hayes
Southall
West Drayton
Norwood Green
North Hyde
M25
M4
Harmondsworth
Sipson
Harlington
Cranford
Heston
Osterley
Longford
Lampton
Spring Grove
A4
Hounslow West
Hounslow
Woodlands
Hatton
A30
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
A312
A316
Chattern Hill
ASHFORD
A244
Feltham
Hampton Hill
Ashford Common
Hampton
Littleton Common
Kempton Park
Charlton
M3
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Beasley's Ait
0 0.5 1 1.5 2
Kilometres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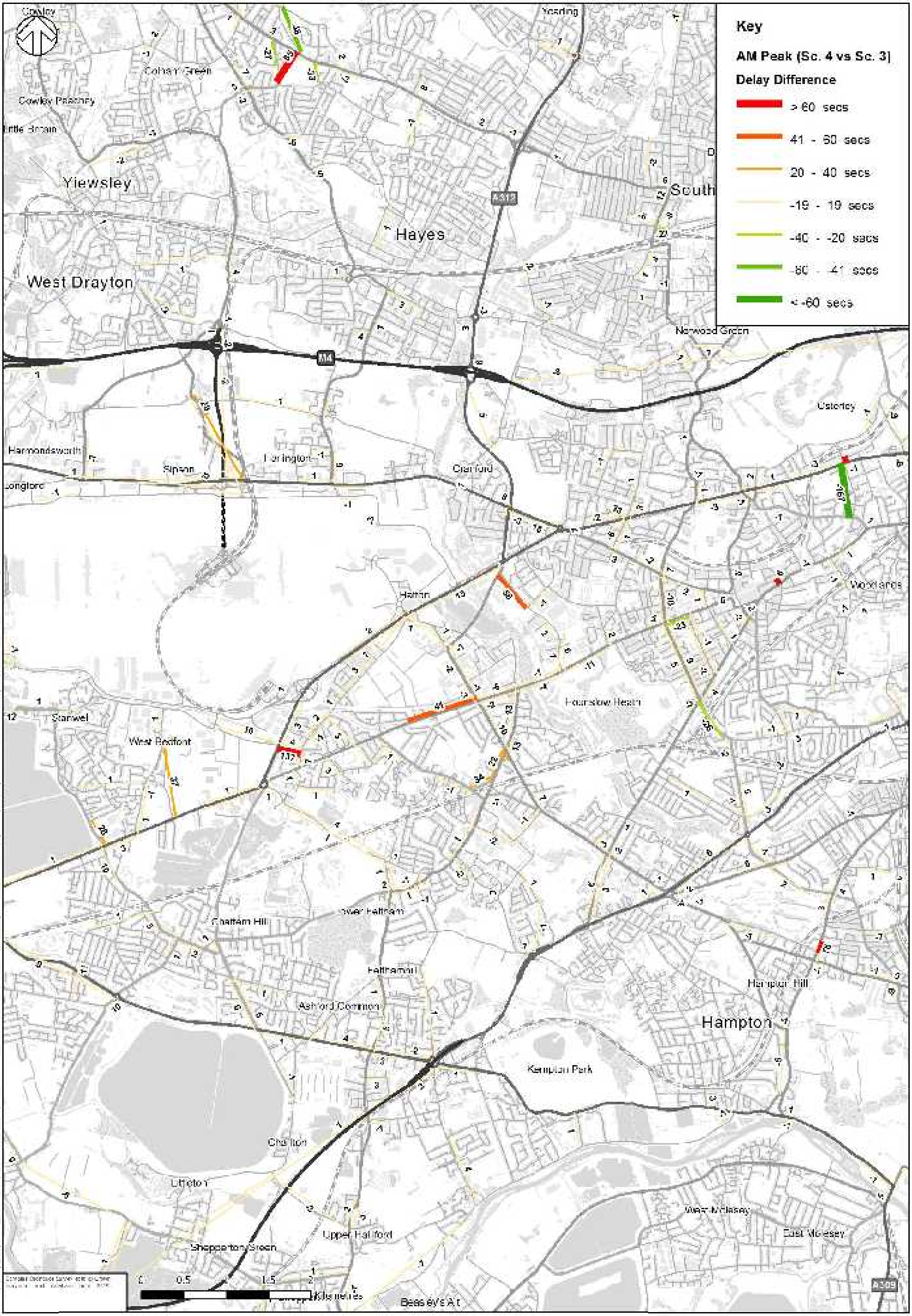
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yeading
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Lampton
Hatton
Woodlands
Hounslow Heath
Stanwell
West Bedfont
Hanworth
Lower Feltham
Ashford Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Shepperton Green
Upper Halliford
Beasley's Ait
Kilometres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AM Peak (Sc. 4 vs Sc. 3)
Delay Difference
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20 - 40 secs
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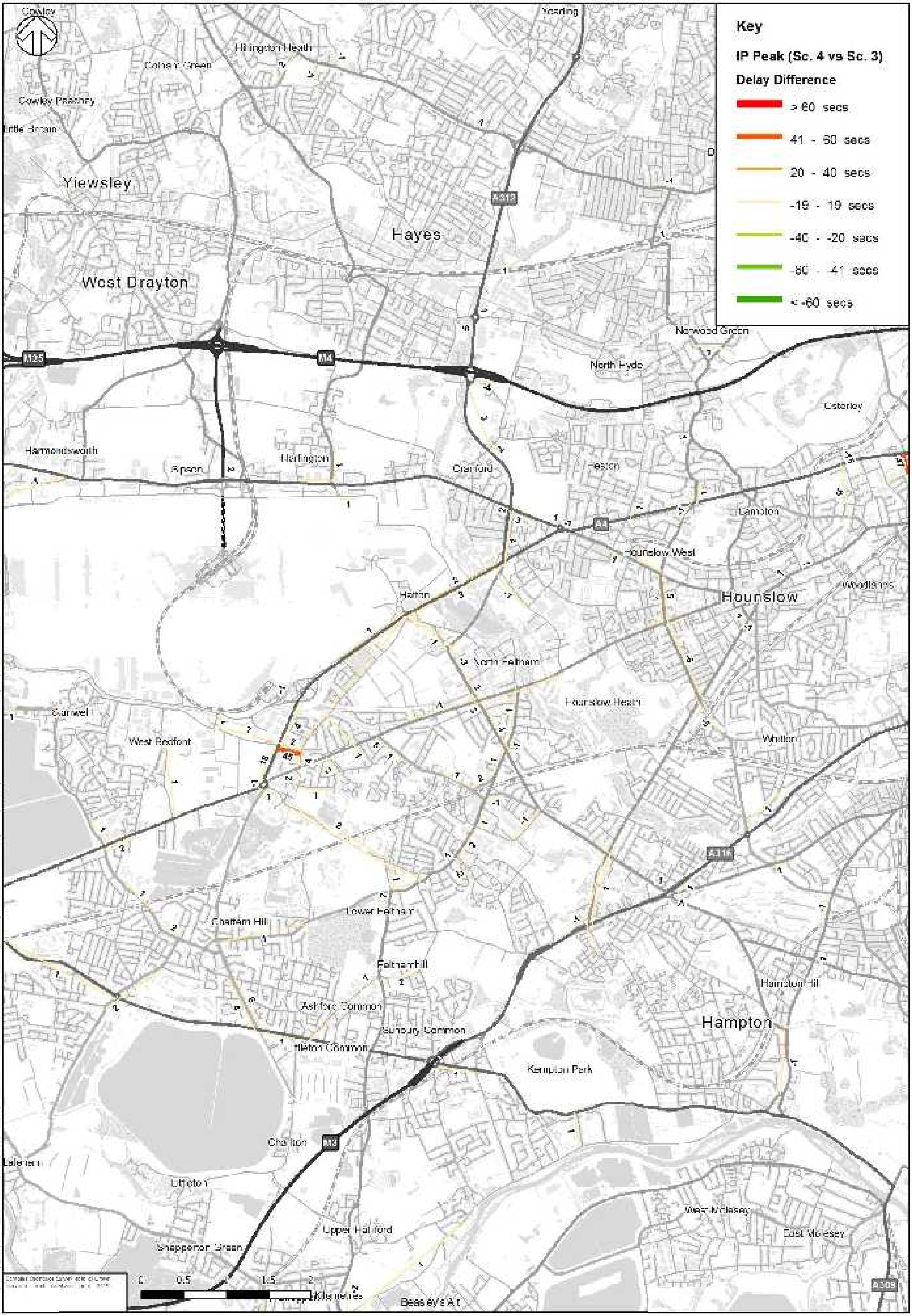
-40 - -20 secs
-60 - -41 secs
< -60 secs
Cowley
Yeading
Cowley Peachey
Yiewsley
Hayes
West Drayton
A312
Norwood Green
M4
Harmondsworth
Sipson
Harlington
Cranford
Osterley
Longford
Hatton
Woodlands
Hounslow Heath
Stanwell
West Bedfont
Lower Feltham
Feltham
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Bessey's Ait
A309
0
0.5
1
1.5
2
Kilometres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Delay Difference
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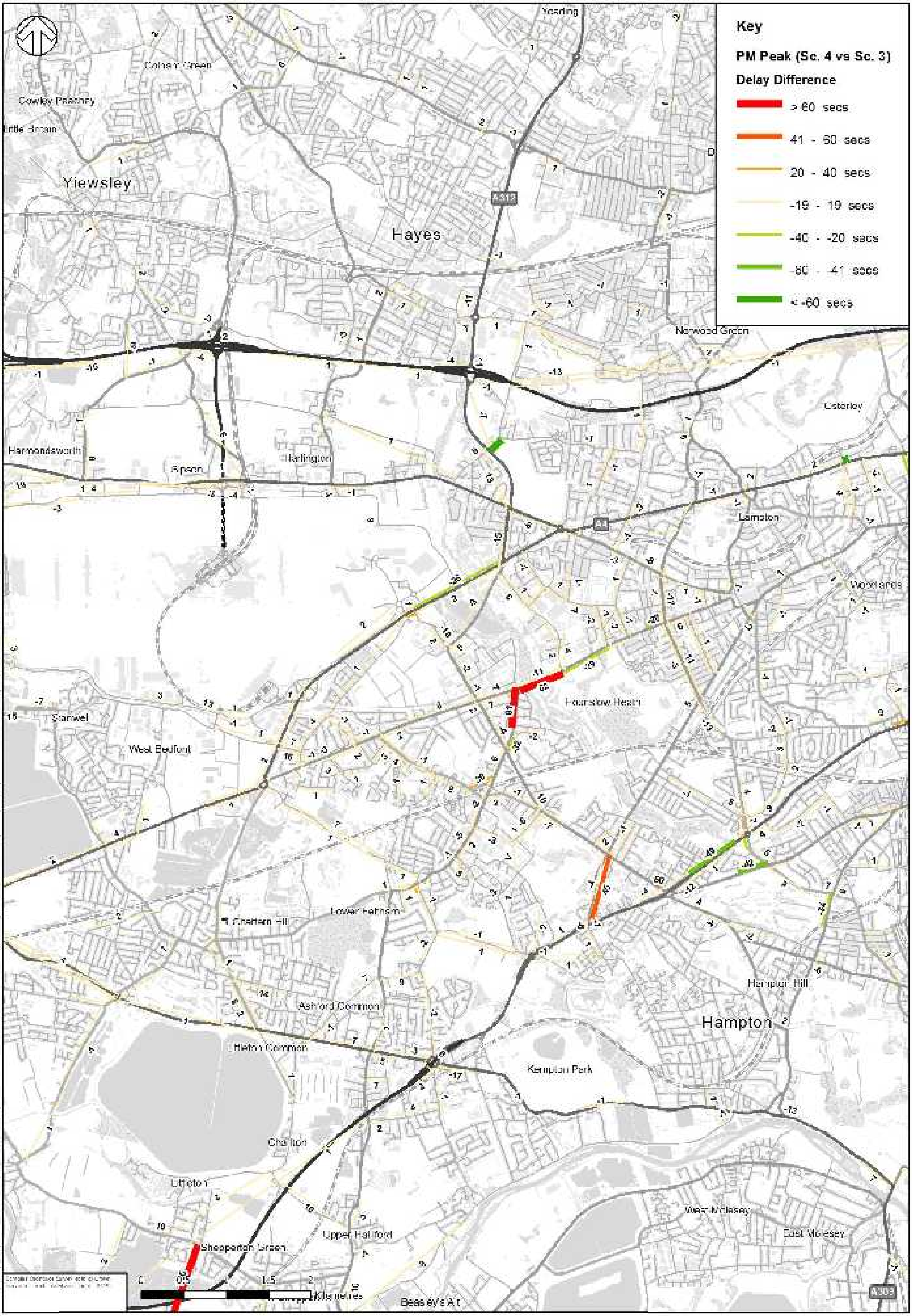
20 - 40 secs
-19 - 19 secs
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yiewsley
West Drayton
Hayes
Hounslow
Hampton
Cowley
Yeading
Hillingdon Heath
Colham Green
Cowley Peachey
Little Britain
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Heston
Lampton
Hounslow West
Hatton
Woodlands
North Feltham
Hounslow Heath
Stanwell
West Bedfont
Whitton
Lower Feltham
Feltham Hill
Ashford Common
Sunbury Common
Kempton Park
Hampton Hill
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
M25
M4
M3
A312
A4
A316
A309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Delay Difference
> 60 secs
41 - 60 secs
20 - 40 secs
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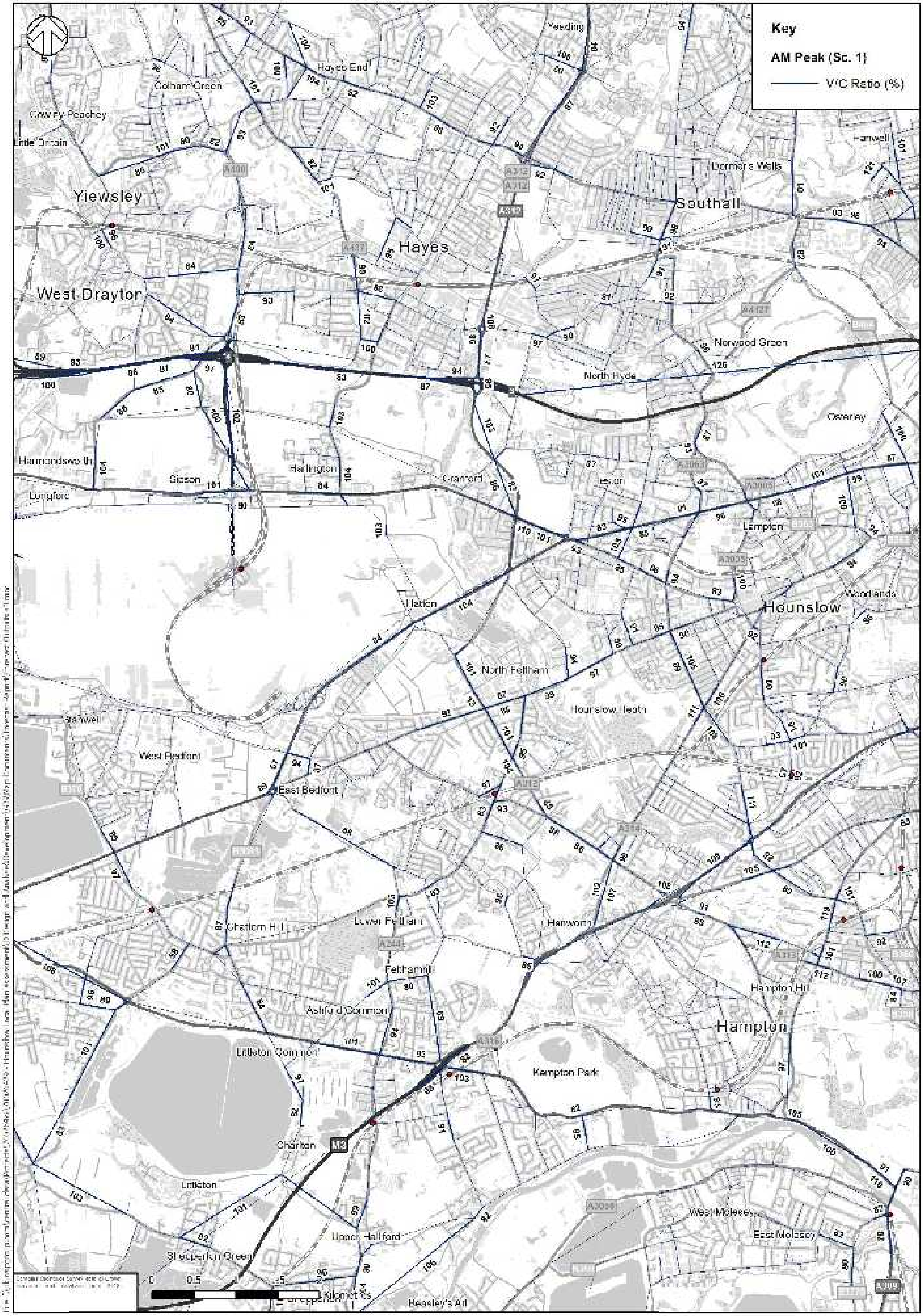
-40 - -20 secs
-60 - -41 secs
< -60 secs
Yeading
Cowley Peachey
Yiewsley
Hayes
A312
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Lampton
A4
Woodlands
Stanwell
West Bedfont
Hounslow Heath
Lower Feltham
Ashford Common
Hampton Hill
Hampton
Kempton Park
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Kilometres
A309

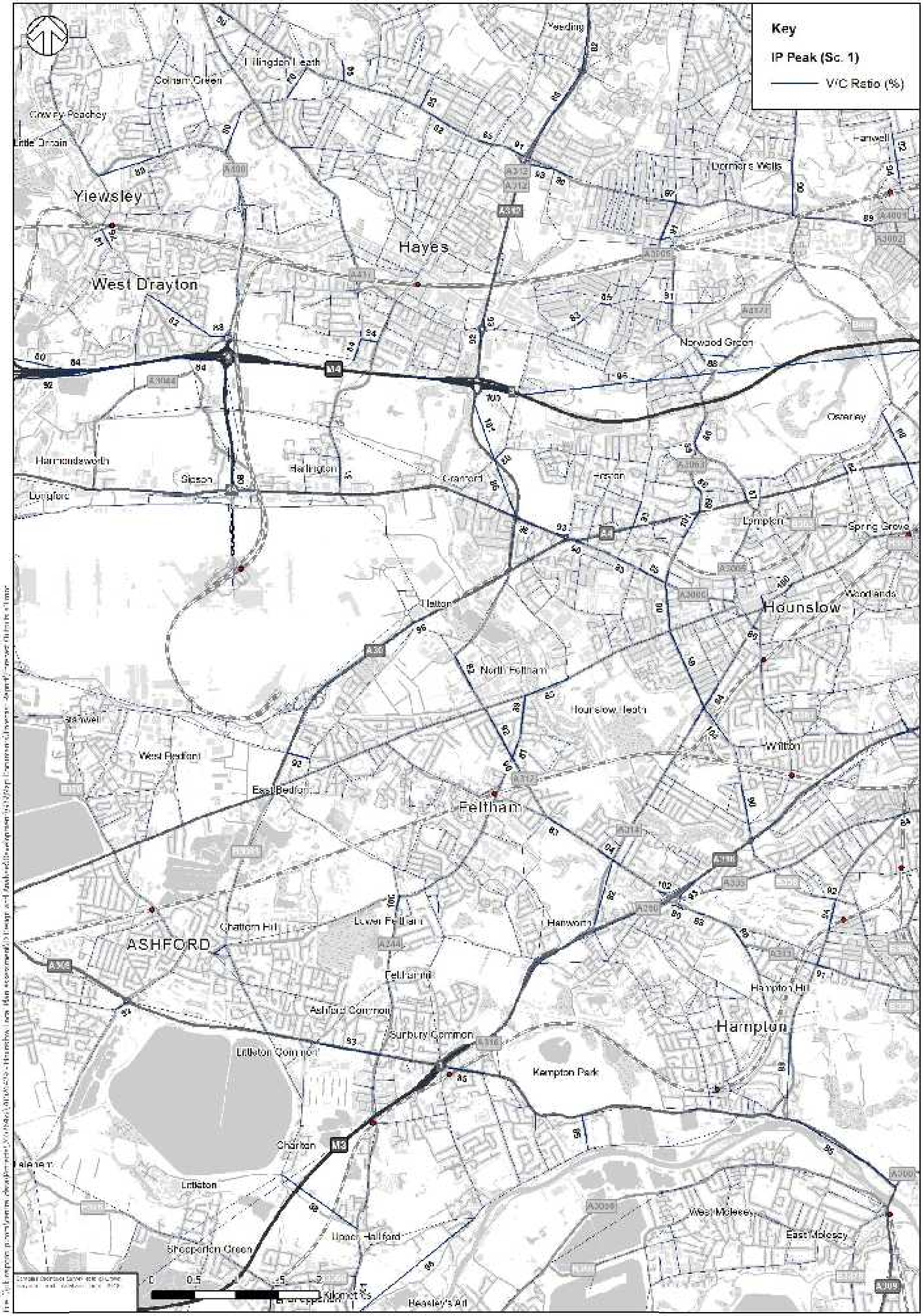
Appendix D

V/C RATIO PLOTS

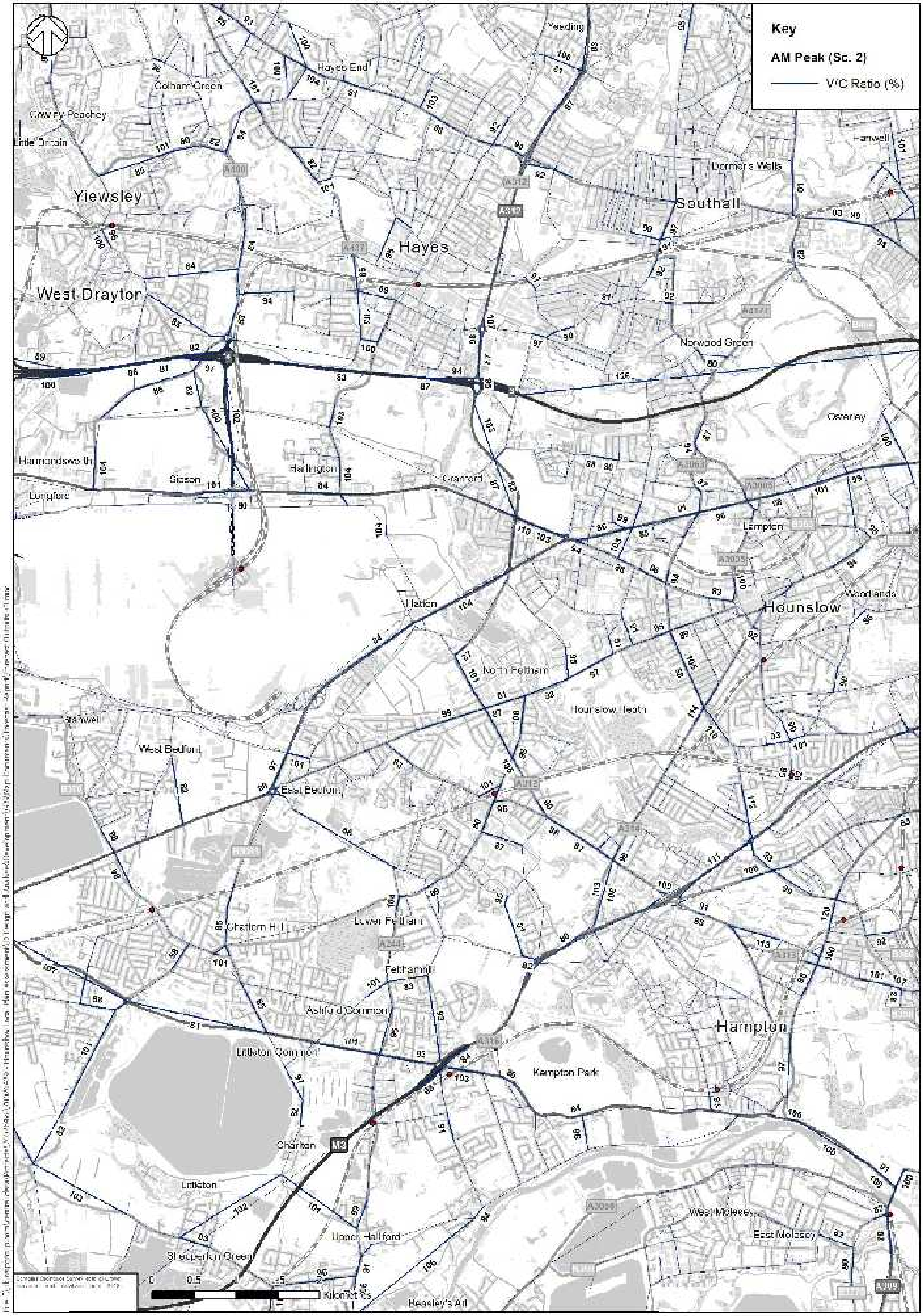
Appendix D.1

V/C RATIO


Key
AM Peak (Sc. 1)
V/C Ratio (%)
Yeading
Hayes End
Colham Green
Cowley Peachey
Yiewsley
Hayes
Southall
Dormers Wells
Hanwell
West Drayton
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Lampton
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Charlton Hill
Lower Feltham
Hanworth
Feltham
Ashford Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
M3
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Kilometres
Beasley's Ait


Key
IP Peak (Sc. 1)
V/C Ratio (%)
Yiewsley
West Drayton
Hayes
Hounslow
Feltham
ASHFORD
Hampton
Kilometres


Key
PM Peak (Sc. 1)
V/C Ratio (%)
Yiewsley
Hayes
Colham Green
Cowley Peachey
Little Drain
Yeading
Dormers Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Hatton
Woodlands
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Feltham
Ashford Common
Hampton Hill
Hampton
Kempton Park
Littleton Common
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Kilometres
A312
A4
M3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V/C Ratio (%)
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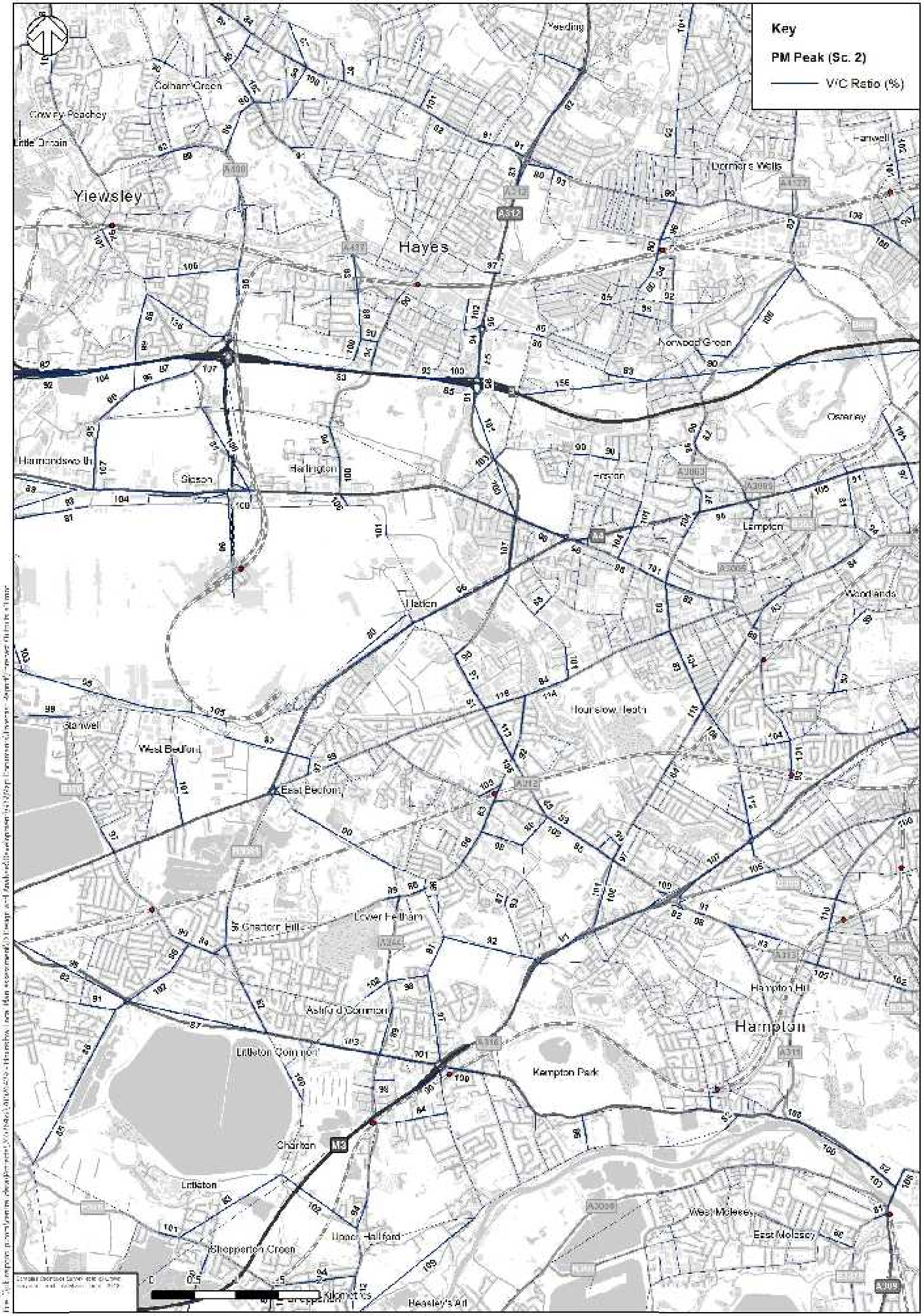
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yiewsley
West Drayton
Hayes
Southall
Dormers Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Lampton
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Feltham
Ashford Common
Littleton Common
Kempton Park
Hampton
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Kilometres
M3


Key
IP Peak (Sc. 2)
V/C Ratio (%)
Yeading
Hillingdon Heath
Colham Green
Cowley Peachey
Little Britain
Yiewsley
West Drayton
Hayes
Hanwell
Dormer's Wells
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Heston
Longford
Lampton
Spring Grove
Hatton
Hounslow
Woodlands
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Feltham
Hanworth
Chattern Hill
Lower Feltham
ASHFORD
Feltham Hill
Ashford Common
Sunbury Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Shepperton Green
Upper Halliford
Beasley's Ait
M4
M3
A4
A30
A312
A3006
A3005
A3063
A316
A305
A308
A244
0 0.5 1 1.5 2 Kilometres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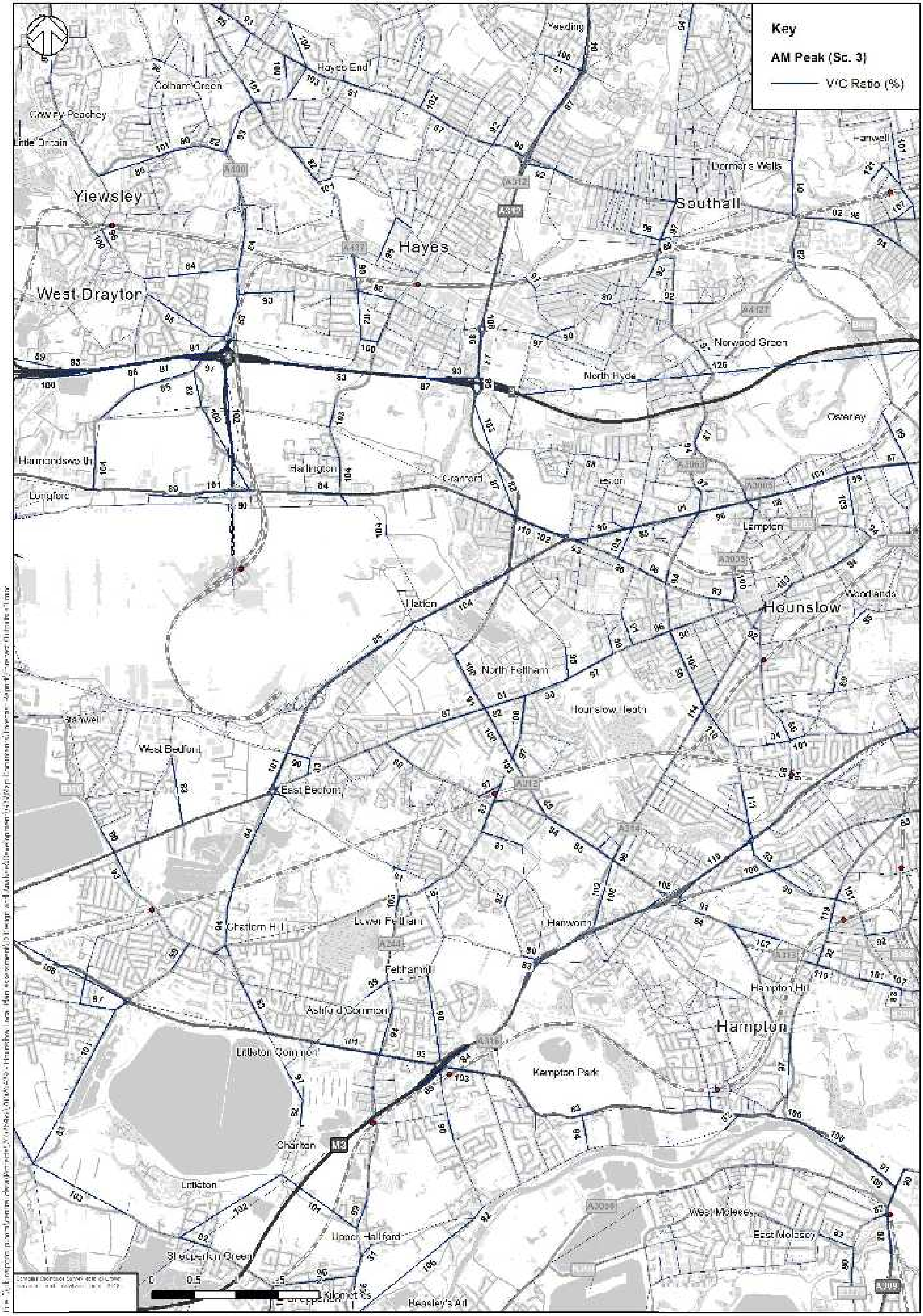
PM Peak (Sc. 2)
V/C Ratio (%)
Yiewsley
Hayes
Colham Green
Cowley Peachey
Little Drain
Yeading
Dormer's Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Hatton
Woodlands
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
St Grattons Hill
Ashford Common
Littleton Common
Kempton Park
Hampton Hill
Hampton
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Beasley's Ait
Kilometres
A312
A4
M3


Key
AM Peak (Sc. 3)
V/C Ratio (%)
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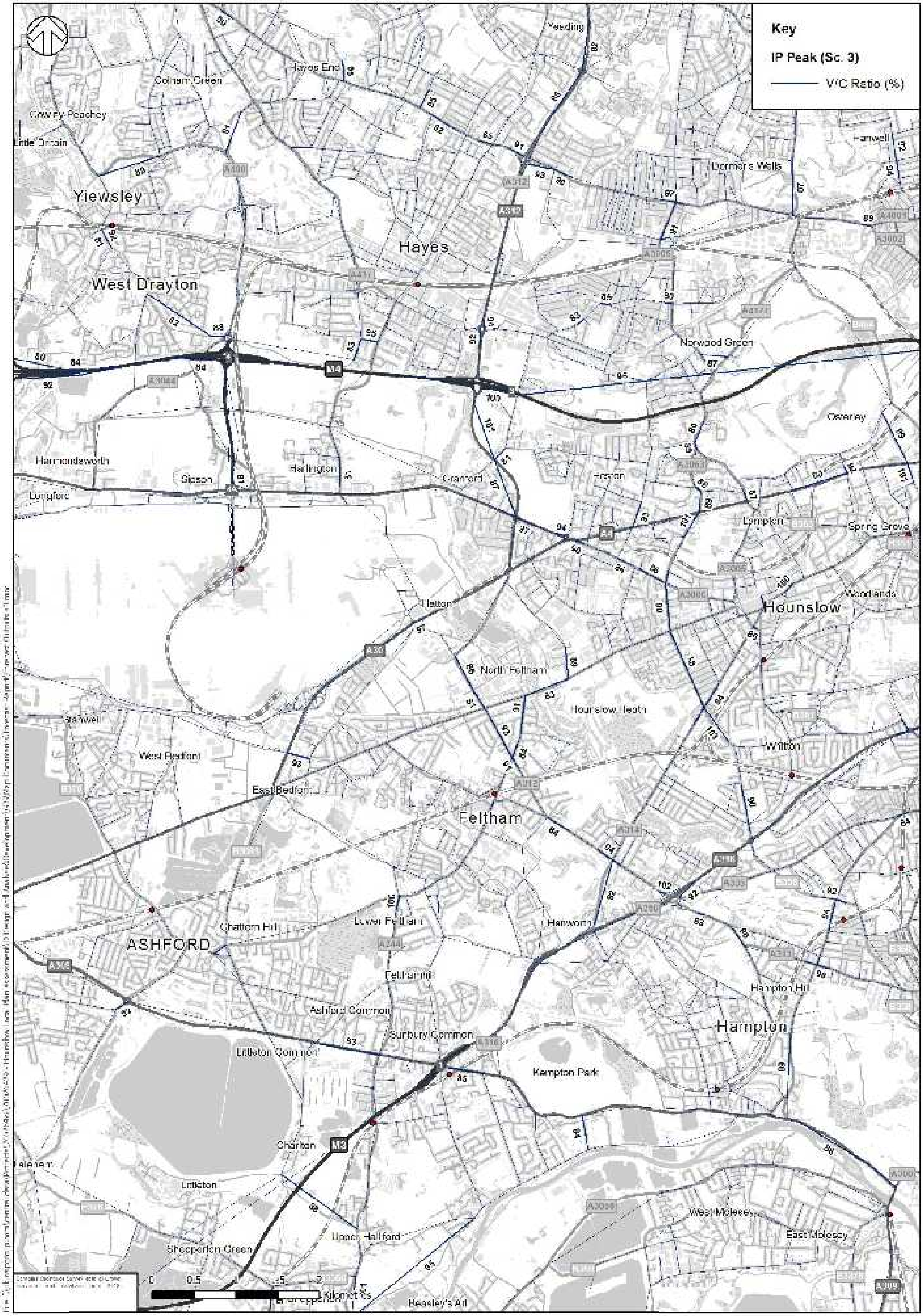
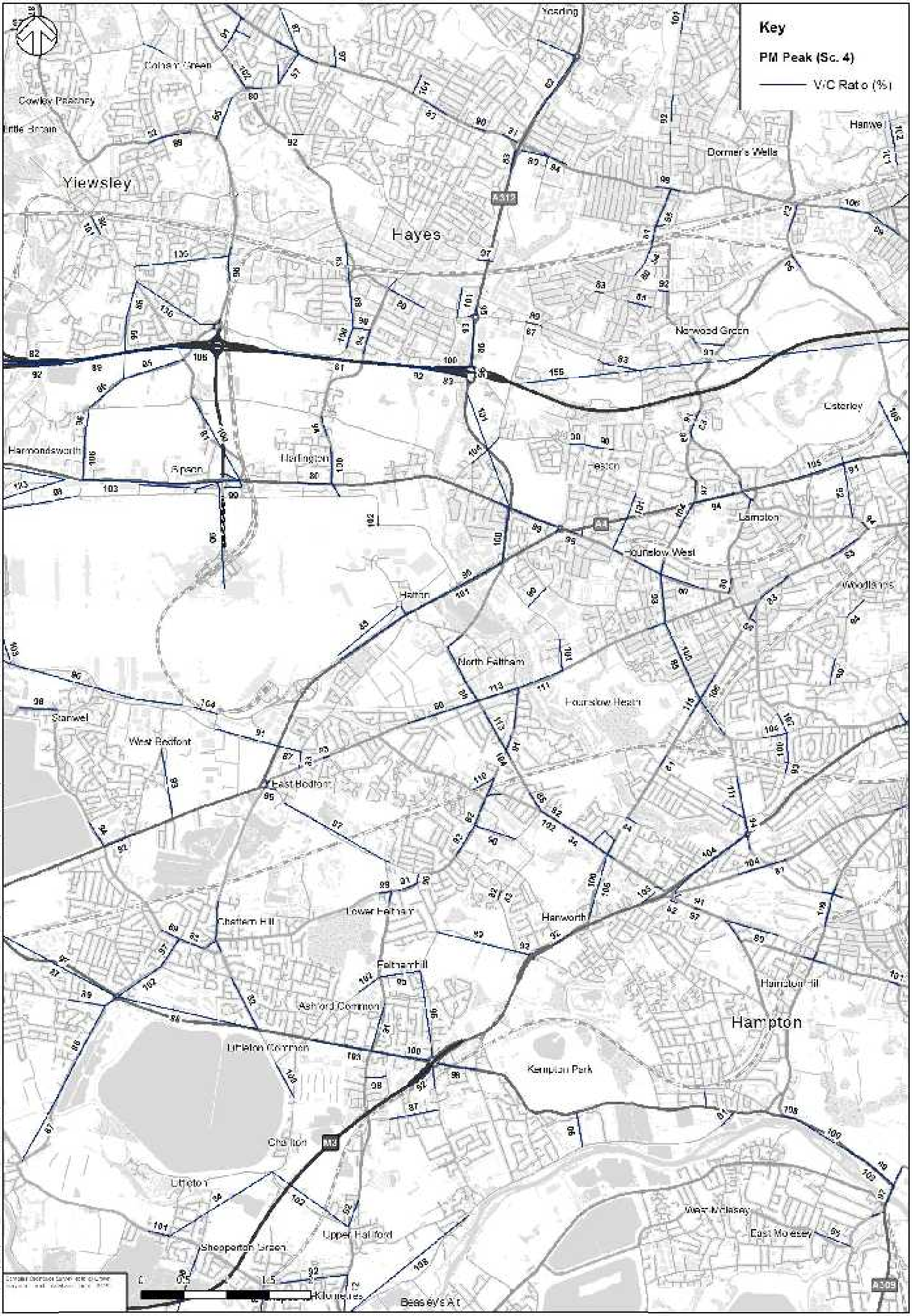
Colham Green
Cowley Peachey
Little Drain
Yiewsley
West Drayton
Hayes
Southall
Dormers Wells
Hanwell
Norwood Green
North Hyde
Osterley
Harmondsworth
Harlington
Longford
Cranford
Lampton
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Charlton Hill
Feltham
Hampton Hill
Ashford Common
Hampton
Littleton Common
Kempton Park
Charlton
M3
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Beasley's Ait
Kilometres
0
0.5
1
1.5


Key
IP Peak (Sc. 3)
V/C Ratio (%)
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Drain
Hanwell
Dormer's Wells
Yiewsley
Hayes
West Drayton
Norwood Green
M4
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Heston
Lampton
Spring Grove
Longford
A4
Hatton
Hounslow
Woodlands
A30
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Whitton
Feltham
Hanworth
Chattern Hill
Lower Feltham
ASHFORD
Hampton Hill
Ashford Common
Sunbury Common
Hampton
Littleton Common
Kempton Park
M3
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Kilometres
Beasley's Ait


Key
PM Peak (Sc. 3)
V/C Ratio (%)
Yeading
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Dormer's Wells
Hanwell
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Woodlands
Hatton
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Feltham
Ashford Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Kilometres
M3
A4
A312


Key
AM Peak (Sc. 4)
V/C Ratio (%)
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
West Drayton
Hanwell
Dormer's Wells
Southall
A312
Norwood Green
North Hyde
Osterley
Harmondsworth
Longford
Sipson
Harlington
Cranford
Heston
Lampton
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Chattern Hill
Lower Feltham
Hanworth
Feltham
Ashford Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
M3
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
A309
Beasley's Ait
0
0.5
1.5
Kilometres

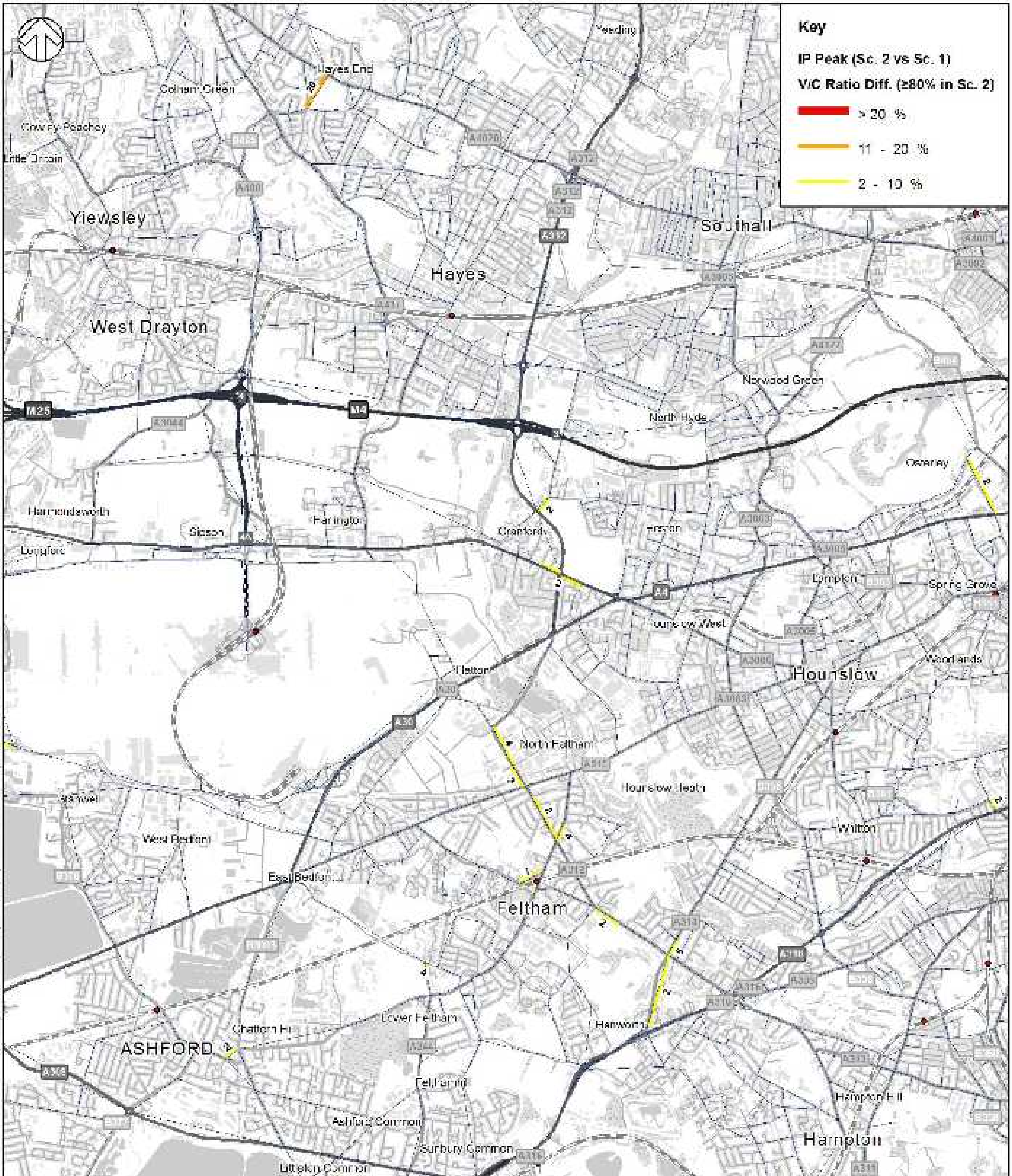

Key
IP Peak (Sc. 4)
V/C Ratio (%)
Cowley
Yeading
Hillingdon Heath
Colham Green
Cowley Peachey
Little Britain
Hanwell
Dormer's Wells
Yiewsley
Hayes
West Drayton
Norwood Green
North Hyde
Osterley
Harmondsworth
Harlington
Cranford
Heston
Longford
Lampton
Spring Grove
Hounslow West
Hatton
Hounslow
Woodlands
North Feltham
Hounslow Heath
West Bedfont
East Bedfont
Whitton
Feltham
Hanworth
Lower Feltham
Chattern Hill
ASHFORD
Feltham Hill
Hampton Hill
Ashford Common
Sunbury Common
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
M4
M3
A312
A30
A4
A316
A308
A309
0
0.5
1
1.5
2
Kilometres


Key
PM Peak (Sc. 4)
V/C Ratio (%)
Yeading
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Hanwell
Dormer's Wells
Norwood Green
Osterley
Harmondsworth
Sipson
Harlington
Heston
Lampton
Hounslow West
Woodlands
Hatton
North Feltham
Hounslow Heath
Stanwell
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Chattern Hill
Feltham Hill
Ashford Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Kilometres
Beasley's Ait
A312
A4
M3
A309

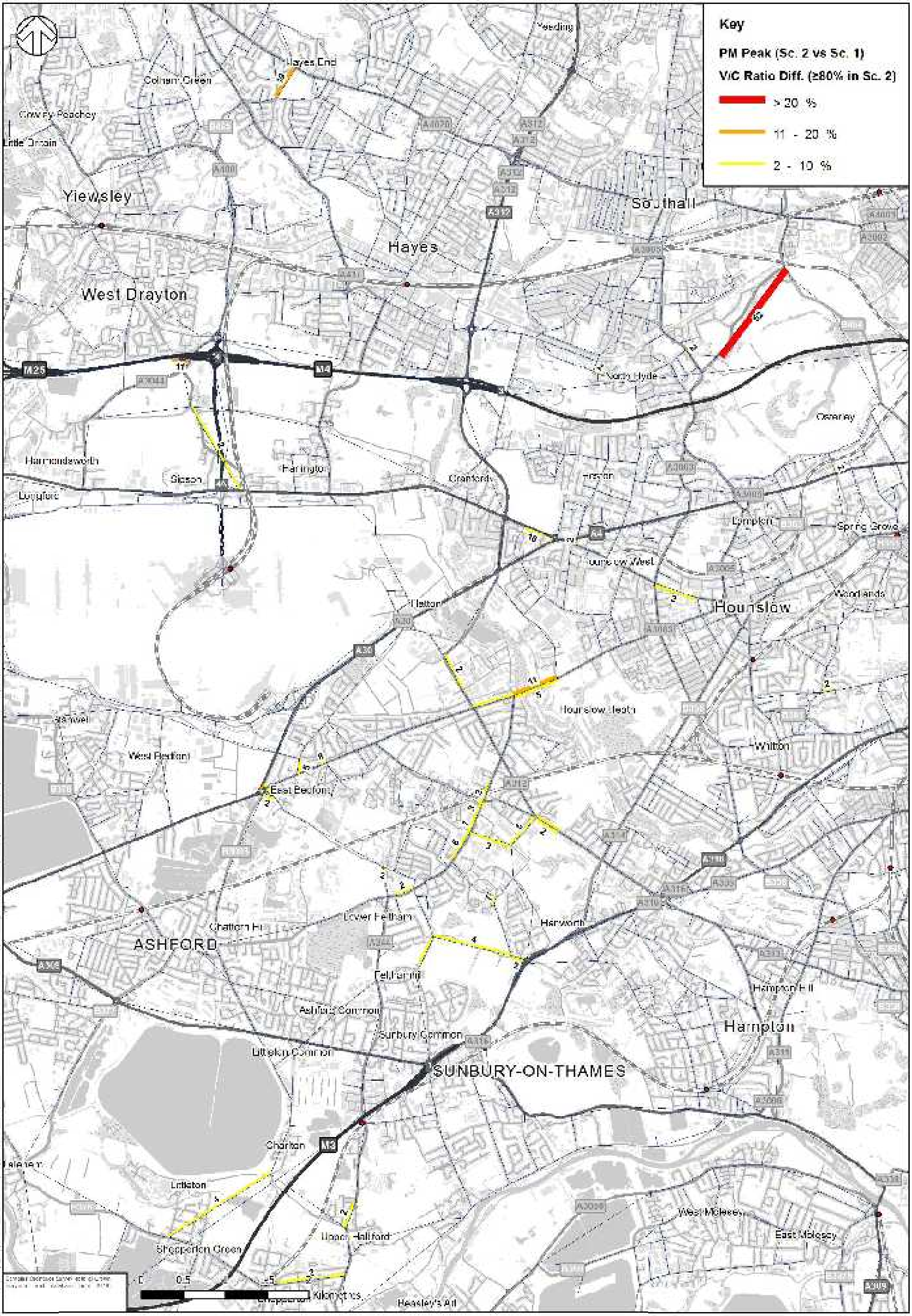
Appendix D.2

V/C RATIO DIFFERENCE

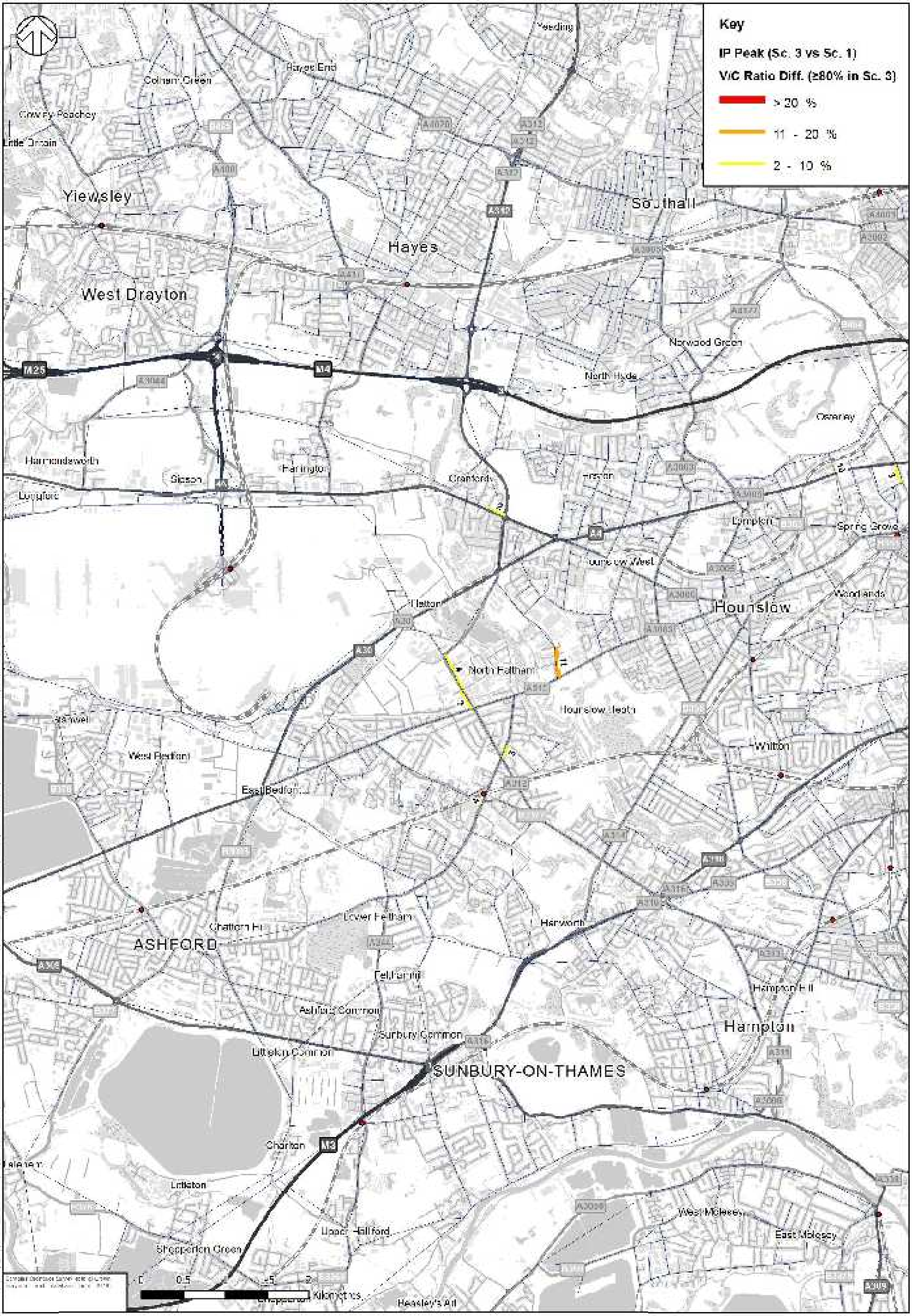

Key
AM Peak (Sc. 2 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 2)
> 20 %
11 - 20 %
2 - 10 %
Yeading
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yiewsley
Hayes
Southall
West Drayton
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Heston
Longford
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Hanworth
Lower Feltham
Chattern Hill
ASHFORD
Feltham Hill
Ashford Common
Sunbury Common
Hampton Hill
Hampton
Littleton Common
Kempton Park
Charlton
Laleham
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Shepperton
Kilometres
M25
M4
M3
A30
A312
A4020
A3006
A3005
A316
A308
A309
A3050

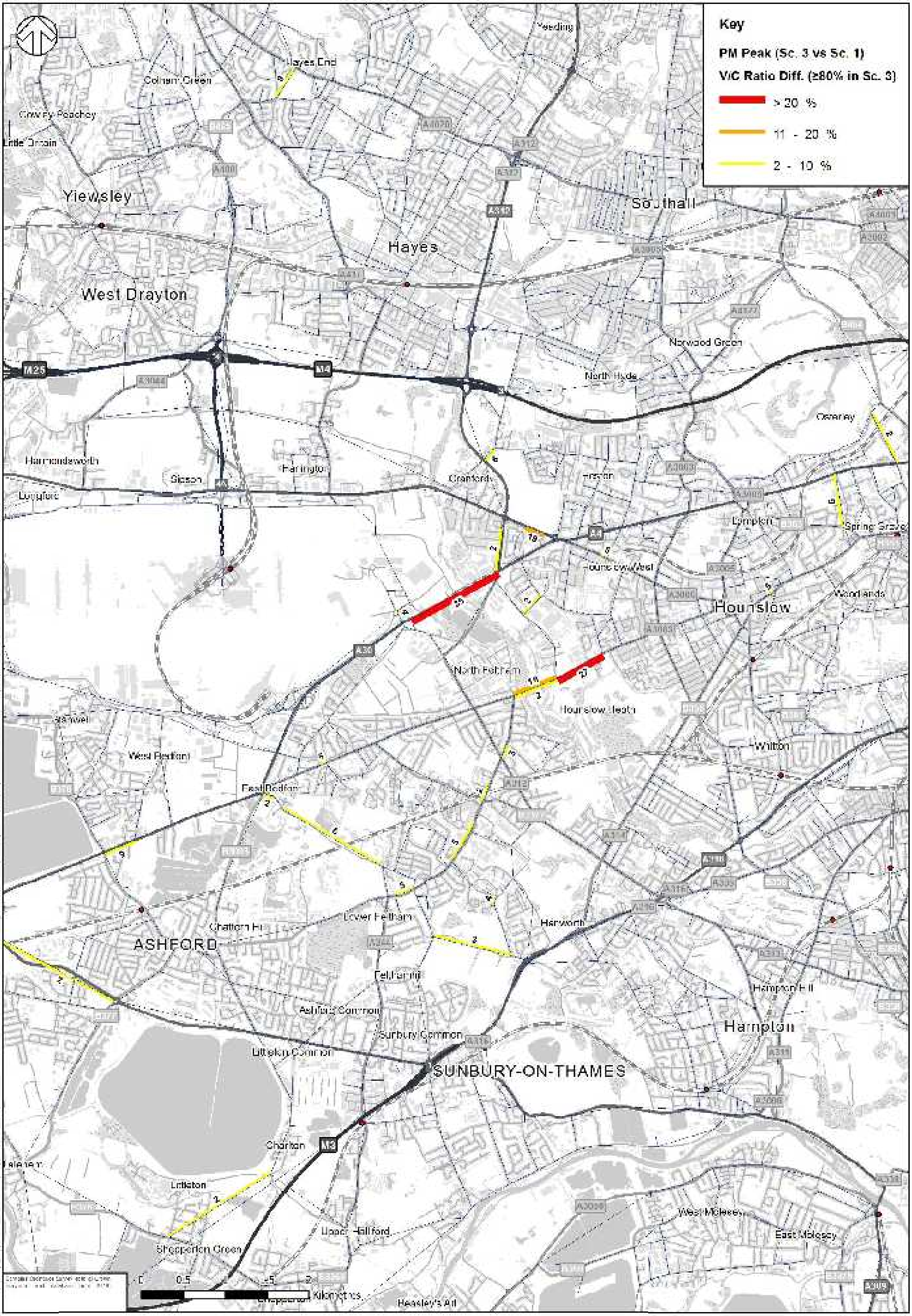


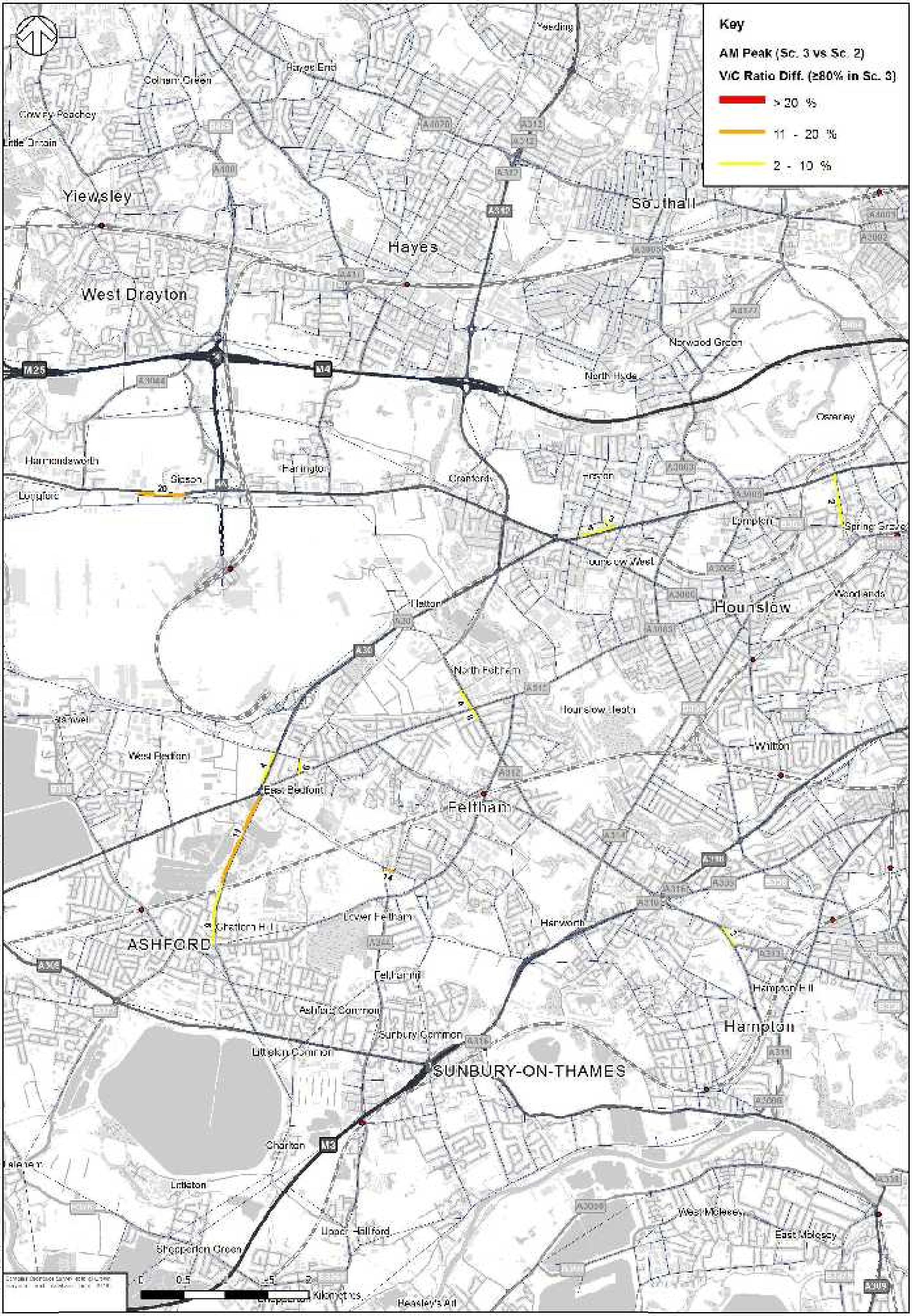
Key
IP Peak (Sc. 2 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 2)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yeading
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
Hatton
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Feltham
Hanworth
Lower Feltham
ASHFORD
Chattern Hill
Feltham Hill
Hampton Hill
Hampton
Ashford Common
Sunbury Common
Littleton Common
SUNBURY-ON-THAMES
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Kilometres
M25
M4
M3
A4
A30
A312
A4020
A316

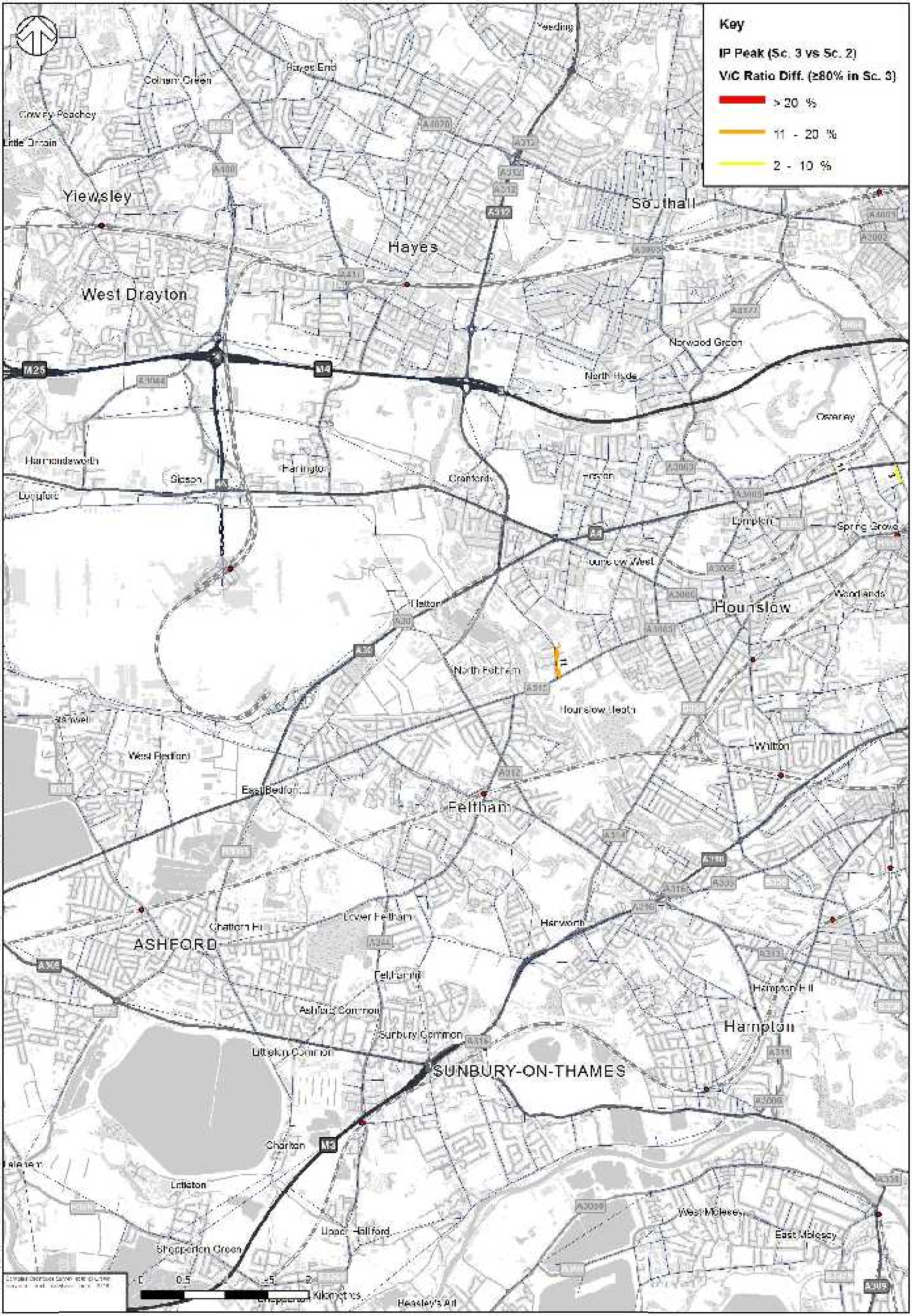

Key
PM Peak (Sc. 2 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 2)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hayes End
Colham Green
Cowley Peachey
Little Britain
Yeading
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Longford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Hatton
Woodlands
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Lower Feltham
Chattern Hill
ASHFORD
Hanworth
Feltham
Ashford Common
Sunbury Common
Littleton Common
SUNBURY-ON-THAMES
Hampton Hill
Hampton
Charlton
Littleton
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Kilometres
0
0.5
M25
M4
M3
A4
A30
A312
A4020
A408
A437
A3005
A3006
A3063
A316
A244
A308
A311
A314
A3050
A309
A313
A315


Key
AM Peak (Sc. 3 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hayes End
Colham Green
Cowley Peachey
Little Britain
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Longford
Harlington
Cranford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Hatton
Woodlands
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Feltham
Hanworth
Lower Feltham
Chattern Hill
ASHFORD
Feltham Hill
Ashford Common
Sunbury Common
Littleton Common
Kempton Park
Hampton
Hampton Hill
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
M25
M4
M3
A30
A312
A4020
A408
A4
A3006
A315
A314
A316
A308
A244
A3044
0
0.5
1
1.5
2
Kilometres


Key
IP Peak (Sc. 3 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hounslow
ASHFORD
Hampton
SUNBURY-ON-THAMES
Colham Green
Hayes End
Cowley Peachey
Little Britain
Harmondsworth
Sipson
Longford
Harlington
Cranford
Heston
Norwood Green
North Hyde
Osterley
Lampton
Spring Grove
Hounslow West
Hatton
North Feltham
Hounslow Heath
Woodlands
Whitton
West Bedford
East Bedfont
Lower Feltham
Chattern Hill
Feltham
Hanworth
Hampton Hill
Ashford Common
Sunbury Common
Littleton Common
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Beasley's Ait
M25
M4
M3
A4
A30
A312
0 0.5 1 1.5 2 Kilometres

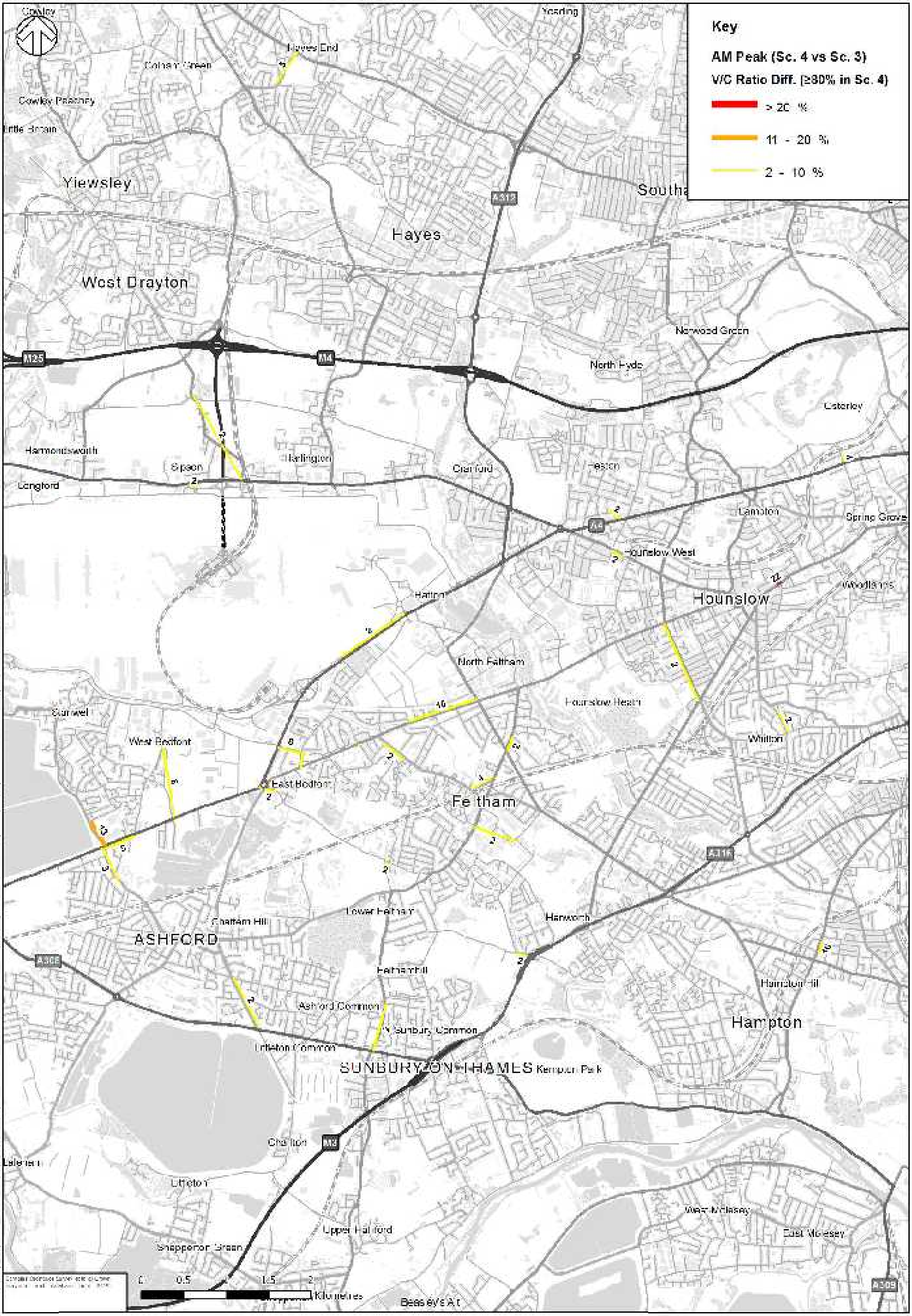

Key
PM Peak (Sc. 3 vs Sc. 1)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hayes End
Colham Green
Cowley Peachey
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Cranford
Heston
Longford
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Chattern Hill
ASHFORD
Feltham
Ashford Common
Hampton Hill
Hampton
Sunbury Common
Littleton Common
SUNBURY-ON-THAMES
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Kilometres
M25
M4
M3
A30
A312
A4


Key
AM Peak (Sc. 3 vs Sc. 2)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
Hayes
Southall
West Drayton
M25
M4
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Longford
Harlington
Cranford
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
Hatton
A30
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Feltham
ASHFORD
Lower Feltham
Hanworth
Hampton Hill
Hampton
Ashford Common
Sunbury Common
Littleton Common
SUNBURY-ON-THAMES
Charlton
M3
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Colham Green
Cowley Peachey
Little Britain
Hayes End
Yeading
0
0.5
Kilometres

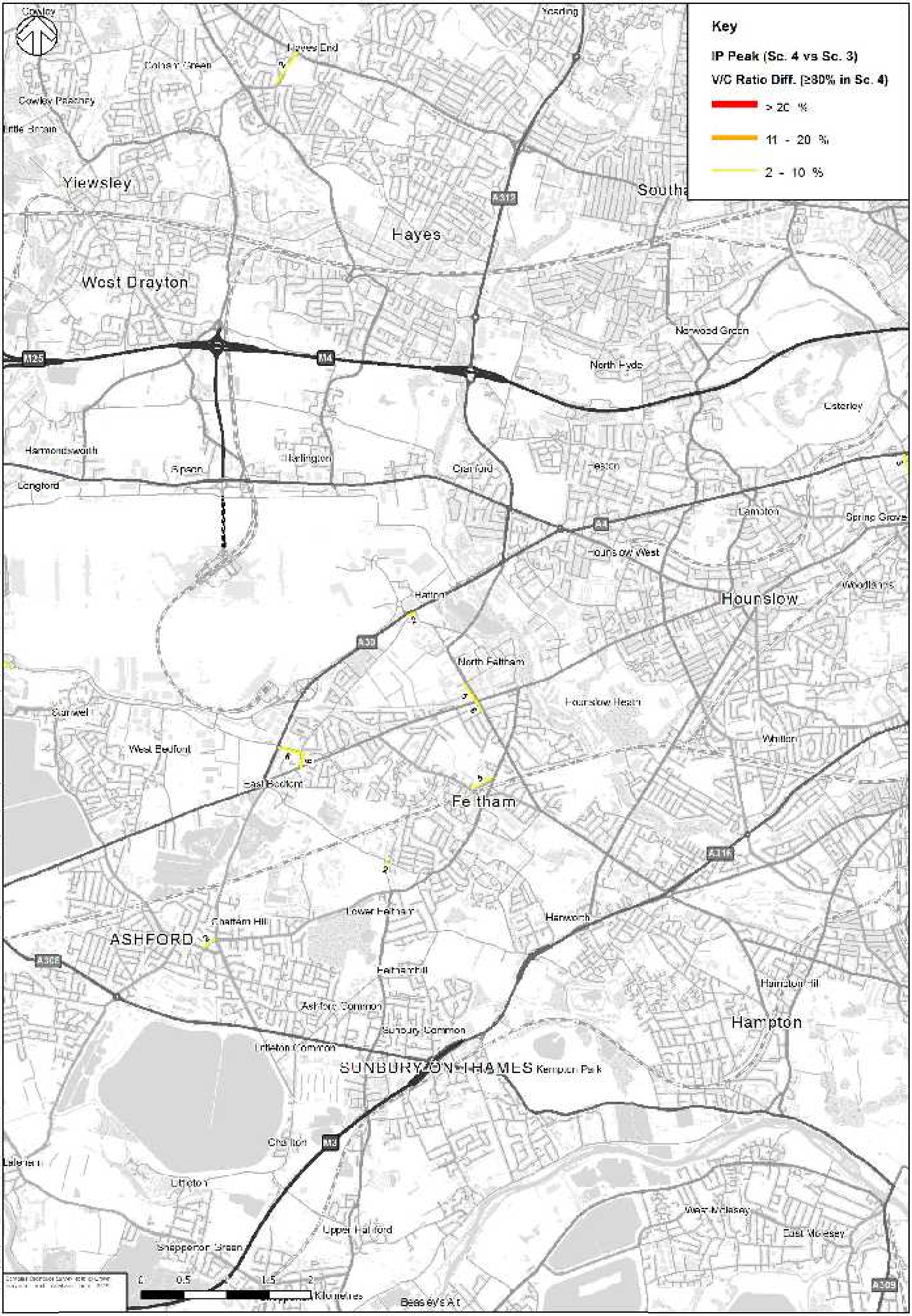


Key
IP Peak (Sc. 3 vs Sc. 2)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Hounslow
Feltham
ASHFORD
Hampton
SUNBURY-ON-THAMES
M25
M4
M3
0 0.5 1 1.5 2 Kilometres

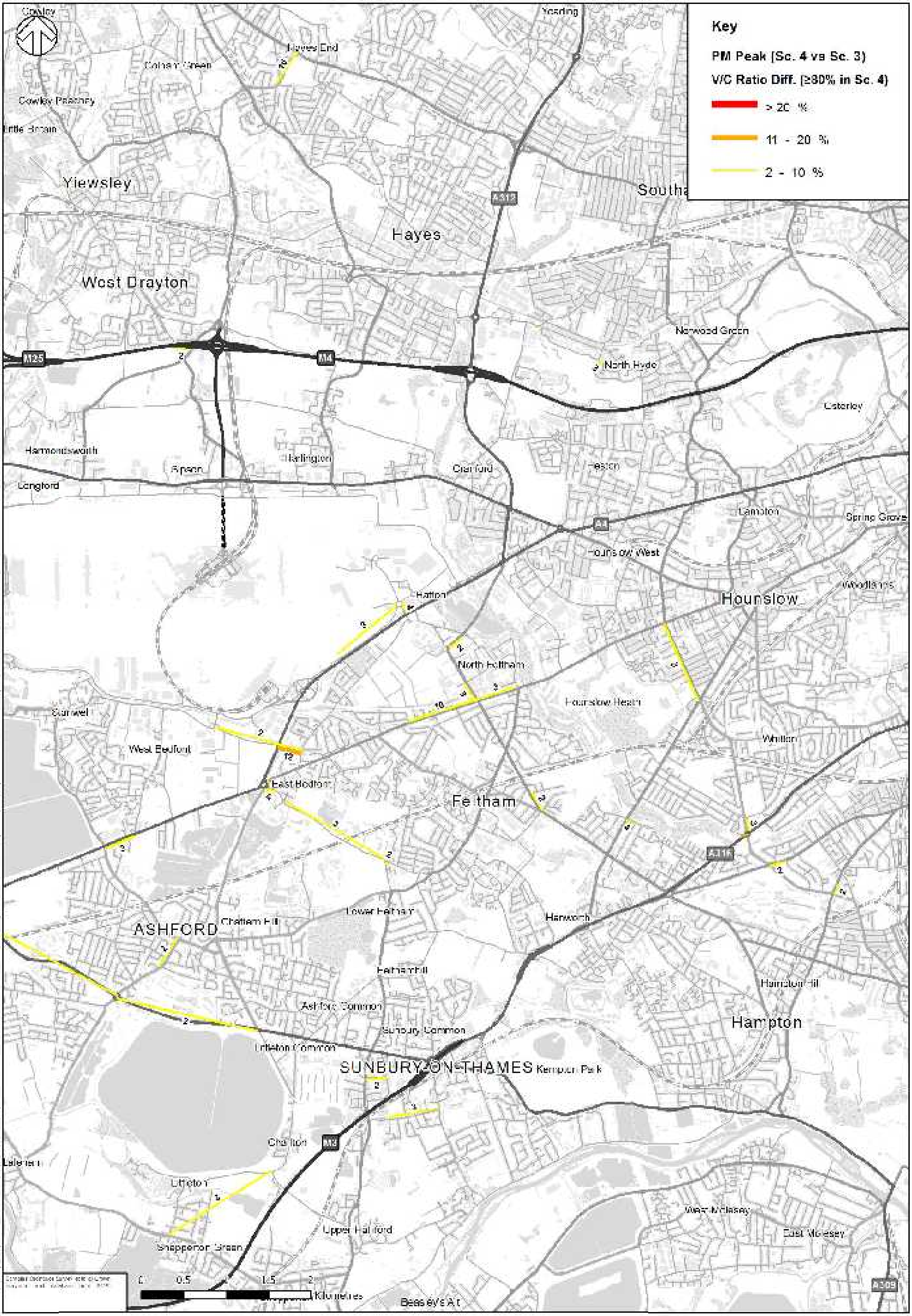

Key
PM Peak (Sc. 3 vs Sc. 2)
V/C Ratio Diff. (≥80% in Sc. 3)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
West Drayton
Hayes
Southall
Colham Green
Cowley Peachey
Hayes End
Yeading
Norwood Green
North Hyde
Osterley
Harmondsworth
Sipson
Harlington
Longford
Cranford
Heston
Lampton
Spring Grove
Hounslow West
Hounslow
Woodlands
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Feltham
Hanworth
Lower Feltham
Chattern Hill
ASHFORD
Feltham Hill
Ashford Common
Sunbury Common
Littleton Common
SUNBURY-ON-THAMES
Hampton Hill
Hampton
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
M25
M4
M3
Kilometres



Key
AM Peak (Sc. 4 vs Sc. 3)
V/C Ratio Diff. (≥80% in Sc. 4)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
Hayes
West Drayton
Southa
Hounslow
Feltham
ASHFORD
Hampton
SUNBURY-ON-THAMES
Kempton Park
Hayes End
Cowley Peachey
Harmondsworth
Longford
Sipson
Harlington
Cranford
Heston
Norwood Green
North Hyde
Osterley
Lampton
Spring Grove
Hounslow West
Woodlands
Hatton
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Chattern Hill
Lower Feltham
Hanworth
Feltham Hill
Ashford Common
Sunbury Common
Littleton Common
Hampton Hill
Charlton
Littleton
West Molesey
East Molesey
Upper Halliford
Shepperton Green
Yeading
M25
M4
M3
A4
A312
A316
A308
A309
0
0.5
1
1.5
2
Kilometres



Key
IP Peak (Sc. 4 vs Sc. 3)
V/C Ratio Diff. (≥80% in Sc. 4)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
Hayes
West Drayton
Hounslow
Feltham
ASHFORD
Hampton
SUNBURY-ON-THAMES
Kempton Park
M25
M4
A312
A4
A30
A316
A308
M3
Norwood Green
North Hyde
Harmondsworth
Longford
Cranford
Heston
Osterley
Lampton
Spring Grove
Hounslow West
Hatton
North Feltham
Hounslow Heath
Whitton
West Bedfont
East Bedfont
Lower Feltham
Hanworth
Feltham Hill
Ashford Common
Sunbury Common
Littleton Common
Charlton
Littleton
Upper Halliford
Shepperton Green
West Molesey
East Molesey
Hampton Hill
Hayes End
Cowley Peachey
Kilometres


Key
PM Peak (Sc. 4 vs Sc. 3)
V/C Ratio Diff. (≥80% in Sc. 4)
> 20 %
11 - 20 %
2 - 10 %
Yiewsley
Hayes
West Drayton
Hounslow
Feltham
ASHFORD
Hampton
SUNBURY-ON-THAMES
North Feltham
Hounslow Heath
Hounslow West
East Bedfont
West Bedfont
Lower Feltham
Hanworth
Ashford Common
Sunbury Common
Littleton Common
Kempton Park
Shepperton Green
Upper Halliford
West Molesey
East Molesey
Harmondsworth
Longford
Cranford
Heston
Norwood Green
North Hyde
Osterley
Spring Grove
Lampton
Whitton
Hampton Hill
Hatton
Harlington
Hayes End
Cowley Peachey
Yeading
M25
M4
M3
A312
A4
A316
A309
0
0.5
1
1.5
2
Kilometres

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Basing View
Basingstoke, Hampshire
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