Worcestershire
Regulatory Services
Supporting and protecting you

Source Apportionment of Local Emissions of Nitrogen Dioxide in St Johns Air Quality Management Area

In fulfilment of Part IV of the
Environment Act 1995
Local Air Quality Management

March 2017

Local Authority Officer	Christopher Poole
Department	Land and Air Quality Team, Technical Services
Address	Worcestershire Regulatory Services Wyre Forest House Finepoint Way Kidderminster Worcestershire DY11 7WF
Telephone	01905 822799
E-mail	wrsenquiries@worcsregservices.gov.uk
Report Reference number	St Johns Source Apportionment FINAL
Date	March 2017

Table of Contents

List of Tables

Introduction

This 'Source Apportionment for St. Johns' report fulfils the requirements of the Local Air Quality Management (LAQM) process as set out in Part IV of the Environment Act (1995), the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 and the relevant Policy and Technical Guidance documents.

Policy guidance (LAQM.PG16) requires a Local Authority to produce an Air Quality Action Plan (AQAP) following declaration of an Air Quality Management Area (AQMA). In order to develop an appropriate plan it is necessary to identify the sources contributing to the objective exceedances within the AQMA.

Air Quality Objectives

The air quality objectives set out in the Air Quality (England) Regulations 2000, as amended by the Air Quality (England) (Amendment) Regulations 2002, provide the statutory basis for the air quality objectives under LAQM in England. The relevant objectives for the purpose of this assessment are set out in Table 1 below:

Table 1: UK Air Quality Objectives for Nitrogen dioxide (NO_2) - LAQM

Pollutant	Objective	Averaging Period	Obligation
Nitrogen Dioxide (NO_2)	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	All local authorities
	40µg/m^3	Annual mean	All local authorities

Declaration

Worcester City Council declared the St. Johns AQMA on 26th October 2014 following exceedances of the objective for annual average of nitrogen dioxide. A map of the AQMA including monitoring locations is provided in Appendix A.

Source Apportionment Approach

Emissions Factor Toolkit

The source apportionment assessment has been undertaken generally following the process outlined in technical guidance. LAQM.TG16 (paragraph 7.100) advises that 'source apportionment may be undertaken using a simple spreadsheet approach. For example, where road traffic emissions are the principal concern, the percentage contribution to total NOx emissions may be calculated using the appropriate emission factors.' This approach has been adopted for the St Johns source apportionment assessment utilising Defra's Emissions Factor Toolkit (EfT) v7.0.

Copies of the Emission Factor Toolkit input and outputs are shown in Appendix B.

Worcestershire County Council provided WRS with local bus fleet composition for First Group who provides about 80% of services in the City. This data was used as a proxy for all bus services in the City and the generalised Euro code compositions assumed in the EfT were amended accordingly to reflect the local circumstances providing a more accurate EfT output. A copy of current fleet composition is included in Appendix B.

WRS will review the EfT outputs based on any additional data on local bus fleet composition received in the future and provide a revised version of the Source Apportionment assessment and resulting AQAP as appropriate at the time.

Traffic Data

12 hour road traffic counts were collected at two locations within the AQMA in June 2016 for the purposes of this source apportionment assessment. The traffic counts have been scaled to 24 hour cycle using DfT table TRA037. The traffic counts and 24 Hours scaling calculations are presented in Appendix B.

Speed data has been recorded on several journeys back and forth through the study area using a mobile phone app 'Speedometer GPS'. The average speed data on each link and traffic split has been incorporated into Emissions Factor Toolkit v7.0 to determine the percentage contribution from vehicles.

Diffusion Tube Data

Worcester City Council monitors annual mean nitrogen dioxide concentrations using passive diffusion tubes located across the district. Four of these sites are located within the boundary of the St. John's AQMA. A plan showing the positions of diffusion tube monitoring locations is included in Appendix A. A fifth diffusion tube (Loc.BrM) is positioned just outside of the AQMA and therefore has been discounted for the purposes of this assessment. The monitoring positions within the AQMA are all located on drainpipes or street lights immediately adjacent to ground floor retail properties within the AQMA. Technical guidance advises relevant receptors in respect of annual average air quality objectives are residential properties which in the St Johns area are predominately located at first floor level above retail units. However, the pollutant concentrations at the monitoring positions are considered sufficiently representative for the purposes of determining individual sources of localised emissions.

LAQM.TG16 advises that as diffusion tubes are not the reference method, and passive diffusion typically results in a low accuracy, it is necessary to bias adjust the results based upon local or national collocation studies with chemiluminescent analysers.

A bias adjustment factor of 0.89 applied to diffusion tubes for 2016 was derived from local co-location study in Wychbold undertaken between March and September 2016. The bias adjustment factor correlates with the National Diffusion Tube Bias Adjustment Factor Spreadsheet 09/16 which reported 0.90 for 1st half of 2016 studies.

Table 2 below shows the bias adjusted annual averages for nitrogen dioxide at each of the monitoring locations within St John's AQMA.

Table 2: Annual Mean NO_2 Monitoring Results in St Johns AQMA

Site ID	Site Name	X OS Grid Ref	Y OS Grid Ref	Distance to Relevant Exposure (m) (1)	NO_2 Annual Mean Concentration (µg/m³)			
					2013	2014	2015	2016
KCP	King Charles Place o/s bakery LP 5372	384016	254399	FF 1.41	**43**	37.45	34.17	35.67
Stj1	Scott of Tattoo, 1A St. Johns	384137	254510	FF 1.48	**-**	**46.06**	**44.55**	**44.21**
Stj2	The Fortune House, 65 St. Johns	384013	254356	FF 1.53	-	31.85	29.31	30.06
Stj3	The Bell, 35 St. Johns	384046	254424	FF 1.53	-	**41.18**	35.42	34.48

Notes: Exceedances of the NO_2 annual mean objective of 40µg/m³ are shown in **bold**.

(1) All locations are located on the façade of ground floor retail properties. Measurement indicates approximate height to First Floor relevant (residential) receptor.

Background and Local Contributions

Technical guidance advises that determining '…the apportionment for NO_2 is not straightforward due to the non-linear relationship between the emissions of NO_2 and nitrous oxides (NOx). This is additionally complicated by the different proportions of NO_2 in the NOx emission for different sources, for example, petrol cars or diesel cars. The following advice therefore applies to NO_2 source apportionment:

- Background contributions: the national maps will give the total background NO_2 concentration. This should be apportioned to regional and local background using the ratio of the background NOx concentrations attributable to these two sources, which are also available in the national maps; and
- Local contributions: the local contribution to NO_2 is the difference between the total (measured or modelled) NO_2 and the total background NO_2. This is then apportioned to the local sources, for example, buses, HGVs, taxis, cars, using the relative contributions of these sources to the local NOx concentration.'

Regional and Total Background contributions of NOx and NO_2 for 2016, available from Defra website, have been used to calculate the contribution of local nitrogen dioxide for each relevant receptor (monitoring location) in the AQMA following the procedure laid out in LAQM.TG16 Box 7.5. The local contribution has then been apportioned to each vehicle class according to the results of the EfT. Calculations are presented in Appendix C and the results summarised in Tables 3 and 4 below:

Table 3: Measured Nitrogen Dioxide Concentrations and Contribution of Each Main Source Type to Total

	Annual Mean Concentration (ug/m^3)							
	Regional Background(1)	Local Background(2)	Cars	LGVs	HGVs	Buses	Motorcycles	Total
KCP	10.67	5.28	9.88	2.40	1.59	5.84	0.02	**35.67**
StJ1	10.67	5.28	11.56	3.27	3.13	10.28	0.02	**44.21**
StJ2	10.67	5.28	7.07	1.72	1.14	4.18	0.02	**30.06**
StJ3	10.67	5.28	9.28	2.25	1.49	5.49	0.02	**34.48**
	% contribution to total							
	Regional Background(1)	Local Background(2)	Cars	LGVs	HGVs	Buses	Motorcycles	Total
KCP	29.92%	14.79%	27.69%	6.72%	4.45%	16.37%	0.07%	100
StJ1	24.14%	11.93%	26.16%	7.40%	7.08%	23.24%	0.05%	100
StJ2	35.51%	17.55%	23.51%	5.71%	3.78%	13.90%	0.06%	100
StJ3	30.95%	15.30%	26.92%	6.53%	4.32%	15.91%	0.06%	100

Background split determined following technical guidance in Defra (Oct 2016) 'Background Concentration Maps User Guide':

(1) Regional background includes emissions from sources not in LA control e.g. Motorways outside of study area, Industrial sources, Domestic properties, Railways, Rural sources, Others

(2) Local background includes emissions from sources LA have some influence over e.g. Primary A roads, Minor Roads and Point sources in and outside of study area

Table 3 above demonstrates that the main contributors of emissions within the St Johns AQMA are Regional Background with between 24 and 35% of emissions and Cars with between 24 and 28%

contribution followed by Buses (14 to 23%) and Local Background (12 – 17%). As the LA is unable to influence Regional Background concentrations and Local Background concentrations are predominately a result of traffic sources on other local roads, it is more useful to consider the source apportionment of the local traffic sources in isolation for future improvement actions. Table 4 below demonstrates the local traffic contribution (i.e. minus the Background contributions) broken down further into petrol and diesel classifications in the EfT.

Table 4: Concentrations and Percentage Contribution of Emissions from Vehicle Classes to Local Traffic Source Total

Local Traffic Source Annual Mean Concentration (µg/m^3)									
	Cars			LGVs		HGVs	Buses and Coaches	Motorcycles	Total
	Petrol	Diesel	Others	Petrol	Diesel				
KCP	1.34	8.50	0.03	0.03	2.37	1.59	5.84	0.02	**19.72**
StJ1	1.59	9.94	0.03	0.04	3.23	3.13	10.28	0.02	**28.26**
StJ2	0.96	6.09	0.02	0.02	1.69	1.14	4.18	0.02	**14.11**
StJ3	1.26	7.99	0.03	0.03	2.22	1.49	5.49	0.02	**18.53**
Local Traffic Source % contribution to total									
	Cars			**LGV**		**HGVs**	**Buses and Coaches**	**Motorcycles**	**Total**
	Petrol	**Diesel**	**Others**	**Petrol**	**Diesel**				
KCP	6.81%	43.12%	0.15%	0.16%	12.00%	8.04%	29.60%	0.12%	100%
StJ1	5.64%	35.16%	0.12%	0.16%	11.41%	11.08%	36.36%	0.08%	100%
StJ2	6.81%	43.12%	0.15%	0.16%	12.00%	8.04%	29.60%	0.12%	100%
StJ3	6.81%	43.12%	0.15%	0.16%	12.00%	8.04%	29.60%	0.12%	100%

Table 4 above demonstrates the main contributors of emissions from local sources within the St Johns AQMA are diesel cars with between 35 and 43% of emissions followed by buses with 29 to 36%. Diesel LGVs (11 – 12%) and HGVs (8 – 11%) also make up sizeable contributions.

Air Quality Improvements Required

The degree of improvement required in order for the annual mean objective for nitrogen dioxide to be achieved is the difference between the highest measured or predicted concentration and the objective level (40µg/m^3). The highest nitrogen dioxide concentration at a representative location in the St Johns AQMA in 2016 is 44.21µg/m^3 at StJ1, requiring a reduction of 4.21µg/m^3 for the objective to be achieved.

However technical guidance advises that in terms of the reduction in emissions required it is more useful to consider nitrogen oxides (NOx). Therefore the road NOx reduction required for compliance with the national air quality objectives in St Johns AQMA has been calculated in accordance with LAQM.TG16 Box 7.6 utilising Defra’s NOx to NO_2 Conversion Spreadsheet v5.1. Calculations are included in Appendix C.

WRS experience shows that revocation of an AQMA is not appropriate unless measured concentrations are consistently below the objective to avoid 'bouncing' between revocation and re-declaration of borderline AQMAs. Therefore, the reduction in NOx required to achieve targets at 5% and 10% below the objective have also been calculated as this would provide more confidence to the LA that emissions of nitrogen dioxide are under control prior to considering revocation. A summary of the required reductions in NO_2 and NOx to achieve concentrations of 36, 38 and 40µg/m^3 at the worst receptor location, StJ1 is presented below in Table 5.

Table 5: Required reduction in Annual Mean Concentration at Worst Receptor location StJ1

Required reduction in NO_2/NOx Concentrations at Worst Receptor location StJ1			
	Required NOx reduction µg/m^3	Required NOx Reduction % of local sources	Equivalent NO_2 reduction µg/m^3
Reduction to objective 40 µg/m^3	10.4	16.84%	4.76
Reduction to 5% below objective 38 µg/m^3	15.18	24.59%	6.95
Reduction to 10% below objective 36µg/m^3	19.86	32.17%	9.09

Table 5 indicates a reduction of 16.84% of emissions or 4.76µg/m^3 would be required to reduce emissions to the objective level based on 2016 data. This report does not focus on how required reductions might be achieved as this will be the objective of a separate Air Quality Action Plan. However, in order to inform the focus of potential measures within the action plan Table 6 below demonstrates concentrations at Worst Case Location StJ1 assuming stepped nominal emissions reduction for each main vehicle category.

Table 6: Nominal Emissions Reduction for Each Vehicle Category

		Reduction in Emissions (µg/m^3)			
Vehicle Type	**10% reduction**	**20% reduction**	**30% reduction**	**40% reduction**	**50% reduction**
Cars	1.16	2.31	3.47	4.63	**5.78**
LGVs	0.33	0.65	0.98	1.31	1.63
HGVs	0.31	0.63	0.94	1.25	1.57
Buses	1.03	2.06	3.08	4.11	**5.14**
Total Vehicles	2.83	**5.65**	**8.48**	**11.31**	**14.13**

NB Bold figures indicate reductions that would achieve compliance with annual average objective for NO_2.

When compared with the equivalent NO_2 reduction required demonstrated in Table 5, the results highlight that targeting individual types of vehicle on these local roads in isolation would not lead to the annual mean objective being achieved unless the reductions are very large. In reality actions to improve emissions are likely to target more than one type of vehicle. Table 6 demonstrates that:

- Reducing total vehicle emissions from all vehicle types by around 20% or targeting a combination of 30% cars and buses would be potentially effective measures for achieving the objective at the measured Worst Receptor Location StJ1.

- Reducing total vehicle emissions from all vehicle types by between 20 and 30% or targeting a combination of >30% cars and buses would be potentially effective measures for achieving concentrations 5% below the objective at the measured Worst Receptor Location StJ1.

- Reducing total vehicle emissions from all vehicle types by between 30 and 40% or targeting a combination of >40% cars and buses would be potentially effective measures for achieving concentrations 10% below the objective at the measured Worst Receptor Location StJ1.

Summary and Conclusions

Worcester City Council declared the St. Johns AQMA on 26th October 2014 following exceedances of the objective for annual average of nitrogen dioxide. Source apportionment of background and local sources to inform an Air Quality Action Plan has been undertaken using a simple spreadsheet approach comprising Defra's Emissions Factor Toolkit v7.0 utilising relevant traffic count and monitoring data.

This shows that the background concentration contributes a significant proportion of the overall concentration of nitrogen dioxide measured in the AQMA (36 to 53%). Cars, which make up the largest traffic volume (82 to 85%), contribute 40 to 50% of local traffic emissions within the AQMA, with diesel cars in particular responsible for a large proportion, 35 to 43%. Local buses contribute 29 to 36% of local traffic emissions.

Targeting individual types of vehicles on these local roads in isolation would not lead to the annual mean objective being achieved unless the reductions are very large (between 40 and 50%). However a reduction in total vehicle emissions of around 20% or targeting a combination of 30% cars and buses would be potentially effective measures for achieving the objective. Greater reductions will be required to achieve more sustainable targets of 5 or 10% below the objective.

Appendix A – Map of St Johns Air Quality Management Area

Appendix B – Emission Factor Toolkit v7.0 Input and Outputs

Table B 1: Traffic Count Data: A44 Bull Ring, St Johns

Site Number. 16090275

Road No. A44 | Location. Bull Ring, St. Johns, Worcester | Day&Date. Wednesday, 29.6.2016 | Remarks.

Hour Commencing		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Vehicles	Scaling factor	Scaled to 24hr	As % (for EFT)
Pedal Cycles	EB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.27		
	WB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.27		
	Both	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.27		
Motor Cycles	To	0	5	0	2	4	4	1	2	0	7	1	3	4	0	0	0	33	1.27	42	0.53519
	From	0	3	1	0	1	3	1	0	2	3	8	5	5	0	0	0	32	1.27	41	0.47393
	Both	0	8	1	2	5	7	2	2	2	10	9	8	9	0	0	0	65	1.27	83	0.50317
Cars	To	0	609	562	413	352	394	401	363	381	372	358	372	428	0	0	0	5005	1.27	6356	81.1709
	From	0	368	410	315	270	303	318	412	480	561	739	799	581	0	0	0	5556	1.27	7056	82.2867
	Both	0	977	972	728	622	697	719	775	861	933	1097	1171	1009	0	0	0	10561	1.27	13412	81.7541
Buses	To	0	12	18	18	26	22	21	18	26	22	20	21	15	0	0	0	239	1.27	304	3.87609
	From	0	21	21	21	21	24	19	23	24	27	23	18	12	0	0	0	254	1.27	323	3.76185
	Both	0	33	39	39	47	46	40	41	50	49	43	39	27	0	0	0	493	1.27	626	3.81638
Light Goods Vehicles	To	0	99	61	62	58	71	76	67	58	60	52	40	37	0	0	0	741	1.27	941	12.0175
	From	0	78	63	69	48	57	54	46	75	69	64	72	51	0	0	0	746	1.27	947	11.0486
	Both	0	177	124	131	106	128	130	113	133	129	116	112	88	0	0	0	1487	1.27	1888	11.5111
Smaller 2-Axle Lorries	To	0	3	4	6	8	4	5	7	5	5	5	1	3	0	0	0	56	1.27	71	0.90821
	From	0	2	9	6	8	4	2	7	2	5	2	2	1	0	0	0	50	1.27	64	0.74052
	Both	0	5	13	12	16	8	7	14	7	10	7	3	4	0	0	0	106	1.27	135	0.82056
Bigger 2-Axle Lorries	To	0	3	5	4	5	1	2	2	8	4	4	2	2	0	0	0	42	1.27	53	0.68115
	From	0	4	6	10	5	5	3	3	3	1	1	1	1	0	0	0	43	1.27	55	0.63685
	Both	0	7	11	14	10	6	5	5	11	5	5	3	3	0	0	0	85	1.27	108	0.658
3-Axle Rigid/Arti	To	0	0	3	0	2	3	0	3	3	0	0	0	0	0	0	0	14	1.27	18	0.22705
	From	0	2	1	2	2	3	3	1	0	0	0	1	0	0	0	0	15	1.27	19	0.22216
	Both	0	2	4	2	4	6	3	4	3	0	0	1	0	0	0	0	29	1.27	37	0.22449
Axles o more Rigid/Arti	To	0	5	6	4	4	2	2	4	5	2	1	1	0	0	0	0	36	1.27	46	0.58385
	From	0	3	7	11	6	8	6	2	5	2	4	2	0	0	0	0	56	1.27	71	0.82938
	Both	0	8	13	15	10	10	8	6	10	4	5	3	0	0	0	0	92	1.27	117	0.71218
Totals	EB	0	736	659	509	459	501	508	466	486	472	441	440	489	0	0	0	6166	1.27	7831	100
	WB	0	481	518	434	361	407	406	494	591	668	841	900	651	0	0	0	6752	1.27	8575	100
	Both	0	1217	1177	943	820	908	914	960	1077	1140	1282	1340	1140	0	0	0	12918	1.27	16406	100

Table B 2: Traffic Count Data - B4485, St Johns

														Site Number. 16090274							
Road No. B4485				Location. St. Johns, Worcester						Day&Date. Thursday, 23.6.2016				Remarks.							
Hour Commencing		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	Vehicles	Scaling factor	Scaled to 24hr	As % (for EFT)
Pedal Cycles	NB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.28	0	
	SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.28	0	
	Both	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.28	0	0
Motor Cycles	To	0	1	2	1	1	1	2	5	0	0	2	6	2	0	0	0	23	1.28	29	0.58929
	From	0	1	2	1	0	1	0	6	2	2	2	4	6	0	0	0	27	1.28	35	0.77586
	Both	0	2	4	2	1	2	2	11	2	2	4	10	8	0	0	0	50	1.28	64	0.67723
Cars	To	0	248	313	218	233	235	273	263	245	354	279	385	299	0	0	0	3345	1.28	4282	85.7033
	From	0	131	187	213	230	224	195	238	277	321	326	324	260	0	0	0	2926	1.28	3745	84.0805
	Both	0	379	500	431	463	459	468	501	522	675	605	709	559	0	0	0	6271	1.28	8027	84.9384
Buses	To	0	3	8	6	12	10	10	7	8	9	7	5	6	0	0	0	91	1.28	116	2.33154
	From	0	7	5	10	9	12	9	10	9	8	5	9	2	0	0	0	95	1.28	122	2.72989
	Both	0	10	13	16	21	22	19	17	17	17	12	14	8	0	0	0	186	1.28	238	2.5193
Light Goods Vehicles	To	0	41	36	30	28	33	42	34	31	43	41	25	8	0	0	0	392	1.28	502	10.0436
	From	0	36	31	37	39	40	28	28	25	33	37	32	14	0	0	0	380	1.28	486	10.9195
	Both	0	77	67	67	67	73	70	62	56	76	78	57	1	0	0	0	772	1.28	988	10.4565
Smaller 2-Axle Lorries	To	0	2	1	1	2	2	3	1	3	4	4	1	0	0	0	0	24	1.28	31	0.61491
	From	0	0	1	3	3	3	4	4	1	3	3	2	2	0	0	0	29	1.28	37	0.83333
	Both	0	2	2	4	5	5	7	5	4	7	7	3	2	0	0	0	53	1.28	68	0.71787
Bigger 2-Axle Lorries	To	0	3	0	2	3	3	2	2	1	3	0	0	0	0	0	0	19	1.28	24	0.48681
	From	0	2	1	1	2	3	2	1	2	0	0	0	0	0	0	0	14	1.28	18	0.4023
	Both	0	5	1	3	5	6	4	3	3	3	0	0	0	0	0	0	33	1.28	42	0.44697
3-Axle Rigid/Arti	To	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	1.28	3	0.05124
	From	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2	1.28	3	0.05747
	Both	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	4	1.28	5	0.05418
Axles o more Rigid/Arti	To	0	0	1	0	2	1	1	2	0	0	0	0	0	0	0	0	7	1.28	9	0.17935
	From	0	1	1	0	1	0	2	1	0	0	1	0	0	0	0	0	7	1.28	9	0.20115
	Both	0	1	2	0	3	1	3	3	0	0	1	0	0	0	0	0	14	1.28	18	0.18962
Totals	NB	0	298	361	258	281	285	334	315	288	413	333	422	315	0	0	0	3903	1.28	4996	100
	SB	0	178	228	265	285	283	240	289	316	367	374	371	284	0	0	0	3480	1.28	4454	100
	Both	0	476	589	523	566	568	574	604	604	780	707	793	599	0	0	0	7383	1.28	9450	100

Table B 3: Emission Factor Toolkit v7.0 Input

Select Pollutants

- [x] NOx
- [ ] CO2
- [ ] PM10
- [ ] PM2.5

Select Outputs

- [ ] Air Quality Modelling (g/km/s)
- [ ] Emissions Rates (g/km)
- [x] Annual Link Emissions

Additional Outputs

- [ ] Breakdown by Vehicle
- [x] Source Apportionment
- [ ] PM by Source

Advanced Options

- [x] Euro Compositions
- [ ] Alternative Technologies
- [x] Output % Contributions from Euro Classes

Click the button to:

Run EFT

Clear Input Data

Please Select from the Following Options:

Area	England (not London)
Year	2016
Traffic Format	Detailed Option 2

Select 'Basic Split' or 'Detailed Option 1 to 3' above

Export Outputs

- [ ] Save Output to New Workbook

File Name: St Johns Source Apportionment

SourceID	Road Type	Traffic Flow	% Car	% Taxi (black cab)	% LGV	% Rigid HGV	% Artic HGV	% Bus and Coach	% Motorcycle	Speed(kph)	No of Hours	Link Length (km)
Bull Ring Count 9 Combined	Urban (not London)	16406	81.75414151	0	11.51106983	1.478557052	0.936677504	3.816380245	0.50317387	28.8	24	0.074
B4485 Count 10 Combined	Urban (not London)	9450	84.93837194	0	10.45645402	1.164838142	0.243803332	2.519301097	0.67723148	25.4	24	0.134

Table B 4: Emission Factor Toolkit v7.0 Output

Source Name	Pollutant Name	All LDVs (%)	All HDVs (%)	Petrol Cars (%)	Diesel Cars (%)	Taxis (%)	Petrol LGVs (%)	Diesel LGVs (%)	Rigid HGVs (%)	Artic HGVs (%)	Buses /Coaches (%)	Motor cycles (%)	Full Hybrid Petrol Cars (%)	Plug-In Hybrid Petrol Cars (%)	Full Hybrid Diesel Cars (%)	Battery EV Cars (%)	FCEV Cars (%)	E85 Bioethanol Cars (%)	LPG Cars (%)	Full Hybrid Petrol LGVs (%)	Plug-In Hybrid Petrol LGVs	Battery EV LGVs (%)	FCEV LGVs (%)	E85 Bioethanol LGVs (%)	LPG LGVs (%)	B100 Rigid HGVs (%)	B100 Artic HGVs (%)	B100 Buses (%)
Bull Ring Count 9 Combined	NOx	52.56%	47.44%	5.64%	35.16%	0.00%	0.16%	11.41%	6.84%	4.24%	36.19%	0.08%	0.04%	0.00%	0.08%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
B4485 Count 10 Combined	NOx	62.35%	37.65%	6.81%	43.12%	0.00%	0.16%	12.00%	6.66%	1.39%	29.46%	0.12%	0.05%	0.00%	0.10%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

CNG Buses (%)	Biomethane Buses (%)	Biogas Buses (%)	Hybrid Buses (%)	FCEV Buses (%)	B100 Coaches (%)	All Vehicles (Annual Emissions (kg/yr except CO2 tonnes/yr))	All LDVs (Annual Emissions (kg/yr except CO2 tonnes/yr))	All HDVs (Annual Emissions (kg/yr except CO2 tonnes/yr))
0.01%	0.00%	0.00%	0.16%	0.00%	0.00%	284.784760	149.694	135.091
0.00%	0.00%	0.00%	0.13%	0.00%	0.00%	265.318298	165.432	99.886

Table B 5: Current Bus fleet (First) composition EFT Input and Outputs

Buses	Numbers in fleet	Proportion of Fleet	% of Fleet as AADT Bus Journeys in St John Bullring	Euro Contributions
1Pre-Euro I				
2Euro I				
3Euro II	2	3%	17	4.2%
4Euro III	40	54%	339	71.9%
5Euro IV	10	14%	85	11.4%
6Euro V_EGR				
7Euro V_SCR	9	12%	76	11.7%
8Euro VI	13	18%	110	0.8%
9Euro II SCRRF				
10Euro III SCRRF				
11Euro IV SCRRF				
12Euro V EGR + SCRRF				
Total	74	100%	626	100%

Appendix C – Source Apportionment Calculations

Table C 1: The local contribution apportioned to each vehicle class calculated for monitoring/receptor location KCP in accordance with LAQM.TG16 Box 7.5.

Box 7.5 calculation	Local Source %	NO_2 µg/m^3	Total %
T-NO_2 (Total (Monitored) nitrogen dioxide)		**35.67**	
TB-NO_2 (Total Background nitrogen dioxide[1])		15.95	
TB-NOx (Total Background nitrous oxides[1])		22.68	
RB-NOx (Regional Background nitrous oxides[1])		15.18	
Step 1: LB-NOx[2] = TB-NOx – RB-NOx		7.50	
Step2: RB-NO_2[3] = TB-NO_2 × (RB-NOx / TB-NOx)		**10.67**	29.92%
Step2: LB-NO_2[4] = TB-NO_2 × (LB-NOx / TB-NOx)		**5.28**	14.79%
Step3: L-NO_2[5] = T-NO_2 – TB-NO_2		**19.72**	
Step4: % of vehicles from EfT			
Petrol Cars (%)	6.81%	1.34	
Diesel Cars (%)	43.12%	8.50	
Full Hybrid Petrol Cars (%)	0.05%	0.01	
Full Hybrid Diesel Cars (%)	0.10%	0.02	
Total cars	**50.08%**	**9.88**	27.69%
Petrol LGVs (%)	0.16%	0.03	
Diesel LGVs (%)	12.00%	2.37	
Total LGVs	**12.16%**	**2.40**	6.72%
Rigid HGVs (%)	6.66%	1.31	
Artic HGVs (%)	1.39%	0.27	
Total HGVs	**8.04%**	**1.59**	4.45%
Buses/Coaches (%)	29.46%	5.81	
Hybrid Buses (%)	0.13%	0.03	
Total Buses	**29.60%**	**5.84**	16.37%
Motorcycles (%)	**0.12%**	**0.02**	0.07%
	100.00%	19.72	100.00%

1) Data from Defra 2013 Background Maps for model year of 2016 for relevant local coordinates
2) Local Background nitrous oxides
3) Regional Background nitrogen dioxide contribution
4) Local Background nitrogen dioxide contribution
5) Local sources nitrogen dioxide contribution

Table C 2: The local contribution apportioned to each vehicle class calculated for monitoring/receptor location StJ1 in accordance with LAQM.TG16 Box 7.5

Box 7.5 calculation	Local Source %	NO_2 µg/m^3	Total %
T-NO_2 (Total (Monitored) nitrogen dioxide)		**44.21**	
TB-NO_2 (Total Background nitrogen dioxide[1])		15.95	
TB-NOx (Total Background nitrous oxides[1])		22.68	
RB-NOx (Regional Background nitrous oxides[1])		15.18	
Step 1: LB-NOx[2] = TB-NOx – RB-NOx		7.50	
Step2: RB-NO_2[3] = TB-NO_2 × (RB-NOx / TB-NOx)		**10.67**	24.14%
Step2: LB-NO_2[4] = TB-NO_2 × (LB-NOx / TB-NOx)		**5.28**	11.93%
Step3: L-NO_2[5] = T-NO_2 – TB-NO_2		**28.26**	
Step4: % of vehicles from EfT			
Petrol Cars (%)	5.64%	1.59	
Diesel Cars (%)	35.16%	9.94	
Full Hybrid Petrol Cars (%)	0.04%	0.01	
Full Hybrid Diesel Cars (%)	0.08%	0.02	
Total cars 13412.47	**40.92%**	**11.56**	26.16%
Petrol LGVs (%)	0.16%	0.04	
Diesel LGVs (%)	11.41%	3.23	
Total LGVs 1888.49	**11.57%**	**3.27**	7.40%
Rigid HGVs (%)	6.84%	1.93	
Artic HGVs (%)	4.24%	1.20	
Total HGVs 396.24	**11.08%**	**3.13**	7.08%
Buses/Coaches (%)	36.19%	10.23	
CNG Buses (%)	0.01%	0.00	
Hybrid Buses (%)	0.16%	0.05	
Total Buses 626.11	**36.36%**	**10.28**	23.24%
Motorcycles (%) 82.55	**0.08%**	**0.02**	0.05%
Total vehicles 16405	100.00%	28.26	100.00%

1) Data from Defra 2013 Background Maps for model year of 2016 for relevant local coordinates
2) Local Background nitrous oxides
3) Regional Background nitrogen dioxide contribution
4) Local Background nitrogen dioxide contribution
5) Local sources nitrogen dioxide contribution

Table C 3: The local contribution apportioned to each vehicle class calculated for monitoring/receptor location StJ2 in accordance with LAQM.TG16 Box 7.5.

Box 7.5 calculation	Local Source %	NO_2 µg/m³	Total %
T-NO_2 (Total (Monitored) nitrogen dioxide)		**30.06**	
TB-NO_2 (Total Background nitrogen dioxide[1])		15.95	
TB-NOx (Total Background nitrous oxides[1])		22.68	
RB-NOx (Regional Background nitrous oxides[1])		15.18	
Step 1: LB-NOx[2] = TB-NOx – RB-NOx		7.50	
Step2: RB-NO_2[3] = TB-NO_2 × (RB-NOx / TB-NOx)		**10.67**	35.51%
Step2: LB-NO_2[4] = TB-NO_2 × (LB-NOx / TB-NOx)		**5.28**	17.55%
Step3: L-NO_2[5] = T-NO_2 – TB-NO_2		**14.11**	
Step4: % of vehicles from EfT			
Petrol Cars (%)	6.81%	0.96	
Diesel Cars (%)	43.12%	6.09	
Full Hybrid Petrol Cars (%)	0.05%	0.01	
Full Hybrid Diesel Cars (%)	0.10%	0.01	
Total cars	**50.08%**	**7.07**	23.51%
Petrol LGVs (%)	0.16%	0.02	
Diesel LGVs (%)	12.00%	1.69	
Total LGVs	**12.16%**	**1.72**	5.71%
Rigid HGVs (%)	6.66%	0.94	
Artic HGVs (%)	1.39%	0.20	
Total HGVs	**8.04%**	**1.14**	3.78%
Buses/Coaches (%)	29.46%	4.16	
Hybrid Buses (%)	0.13%	0.02	
Total Buses	**29.60%**	**4.18**	13.90%
Motorcycles (%)	**0.12%**	**0.02**	0.06%
	100.00%	14.11	100.00%

1) Data from Defra 2013 Background Maps for model year of 2016 for relevant local coordinates
2) Local Background nitrous oxides
3) Regional Background nitrogen dioxide contribution
4) Local Background nitrogen dioxide contribution
5) Local sources nitrogen dioxide contribution

Table C 4: The local contribution apportioned to each vehicle class calculated for monitoring/receptor location StJ3 in accordance with LAQM.TG16 Box 7.5.

Box 7.5 calculation	Local Source %	NO_2 µg/m³	Total %
$T\text{-}NO_2$ (Total (Monitored) nitrogen dioxide)		**34.48**	
$TB\text{-}NO_2$ (Total Background nitrogen dioxide[1])		15.95	
TB-NOx (Total Background nitrous oxides[1])		22.68	
RB-NOx (Regional Background nitrous oxides[1])		15.18	
Step 1: LB-NOx[2] = TB-NOx – RB-NOx		7.50	
Step2: $RB\text{-}NO_2$[3] = $TB\text{-}NO_2$ × (RB-NOx / TB-NOx)		**10.67**	30.95%
Step2: $LB\text{-}NO_2$[4] = $TB\text{-}NO_2$ × (LB-NOx / TB-NOx)		**5.28**	15.30%
Step3: $L\text{-}NO_2$[5] = $T\text{-}NO_2$ – $TB\text{-}NO_2$		**18.53**	
Step4: % of vehicles from EfT			
Petrol Cars (%)	6.81%	1.26	
Diesel Cars (%)	43.12%	7.99	
Full Hybrid Petrol Cars (%)	0.05%	0.01	
Full Hybrid Diesel Cars (%)	0.10%	0.02	
Total cars	**50.08%**	**9.28**	26.92%
Petrol LGVs (%)	0.16%	0.03	
Diesel LGVs (%)	12.00%	2.22	
Total LGVs	**12.16%**	**2.25**	6.53%
Rigid HGVs (%)	6.66%	1.23	
Artic HGVs (%)	1.39%	0.26	
Total HGVs	**8.04%**	**1.49**	4.32%
Buses/Coaches (%)	29.46%	5.46	
Hybrid Buses (%)	0.13%	0.02	
Total Buses	**29.60%**	**5.49**	15.91%
Motorcycles (%)	**0.12%**	**0.02**	0.06%
	100.00%	18.53	100.00%

1) Data from Defra 2013 Background Maps for model year of 2016 for relevant local coordinates
2) Local Background nitrous oxides
3) Regional Background nitrogen dioxide contribution
4) Local Background nitrogen dioxide contribution
5) Local sources nitrogen dioxide contribution

Table C 5: Nitrous Oxides and Nitrogen Dioxide equivalent reduction required calculated for monitoring/receptor location StJ1 utilising Defra's NOx to NO_2 Conversion Spreadsheet v5.1 in accordance with LAQM.TG16 Box 7.6.

Box 7.6 Calculation	NO_2 $\mu g/m^3$	Reduction required %
Step1 Total NOx	84.42	
Step2 TB-NOx (Total Background nitrous oxides[1])	22.68	
Step3 Local Sources NOx	61.74	
Step4 NOx equivalent for NO_2 40µg/m^3	**51.34**	
Step4 NOx equivalent for NO_2 38µg/m^3	46.56	
Step4 NOx equivalent for NO_2 36µg/m^3	41.88	
Step 5 NOx reduction required for 40µg/m^3	**10.40**	**16.84%**
Step 5 NOx reduction required for 38µg/m^3	15.18	24.59%
Step 5 NOx reduction required for 36µg/m^3	19.86	32.17%
Local NO_2 reduction required for 40µg/m^3	**4.76**	
Local NO_2 reduction required for 38µg/m^3	6.95	
Local NO_2 reduction required for 36µg/m^3	9.09	

1) Data from Defra 2013 Background Maps for model year of 2016 for relevant local coordinates

Table C 6: Defra's NOx to NO_2 Conversion Spreadsheet v5.1 for LAQM.TG16 Box 7.6 calculation at StJ1

Local Authority:		Worcester			Year: Traffic Mix:	2016 All other urban UK traffic
Site ID	Diffusion tube NO_2, µg m^{-3}	Background NO_x	µg m^{-3} NO_2	Road NO_x, µg m^{-3}		Notes
StJ1	44.21131911		15.947928	61.74		
KCP	35.67084759		15.947928	41.12		
StJ2	30.06452083		15.947928	28.57		
StJ3	34.48072713		15.947928	38.39		
Limit	40		15.947928	51.34		
Minus 5%	38		15.947928	46.56		
Minus10%	36		15.947928	41.88		

References

Defra (Apr 2016) Local Air Quality Management Technical Guidance LAQM.TG(16)

Defra (Oct 2016) Background Concentration Maps User Guide