Annex 4: Emission Factor Toolkit Modelling

Background information on the Emissions Factor Toolkit

The Emissions Factors Toolkit (EFT) is published by Defra and the Devolved Administrations to assist local authorities in carrying out Review and Assessment of local air quality as part of their duties under the Environmental Act 1995.

The EFT allows users to calculate road vehicle pollutant emission rates for NO_x, PM_{10}, $PM_{2.5}$ and hydrocarbons for a specified year, road type, vehicle speed and vehicle fleet composition. Full details of the Emissions Factor Toolkit can be found online at http://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

The latest version of the emission factor toolkit has been used (version 4.2) for all calculations presented in this Annex.

The EFT can be used to provide a breakdown of emissions for conventional vehicle types which include 8 conventional vehicle categories (such as petrol and diesel cars) for the UK (plus taxis for London), and alternative vehicles such as hybrid petrol cars (depending on user information). A full list of the vehicle categories available are shown in the user guide, available on the DEFRA website[1].

Traffic data used to construct base models

City of York Council's strategic transport model (SATURN) has been used to estimate Annual Average Daily Traffic flows (AADTs) on each of the road links contained within the areas of air quality technical breach. A base (2011) and future year (2021) model were available to reflect baseline and future year network operating conditions. A list of schemes and developments that have been included in the future year 2021 model are shown in table 1 below[2].

In an attempt to understand the composition of traffic using the links within all technical breach area, traffic counts were undertaken by 'Nationwide Data Collection' using Automatic Number Plate Recognition (ANPR) camera systems. Two cameras were installed to allow bi-directional flows to be captured. A comparison of the manual and ANPR information demonstrated that 94% of complete Vehicle Registration Marks (VRM) or number plate records were captured. Whilst these counts were undertaken in 2010, they are considered representative of conditions in 2011 for the purposes of developing an accurate breakdown of the local vehicle

[1] http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html

[2] Targets for new housing provision and site allocations are currently under review and expected to be reduced. The traffic impact of new development in the city is therefore likely to be lower than the modelling undertaken during the development of AQAP3 suggests. Revised emission reduction figures for AQAP3 will be calculated once revised traffic growth figures for the city become available.

composition. The vehicle composition in the future 2021 year is considered to be comparable to that in the base 2011 year (with the exception of the modelled scenarios that consider alternative vehicle technologies).

Table 1: Developments included in the future year 2021 SATURN model

Type	Description	Local Plan Reference
MAJOR SCHEMES	Manor Lane - Hurricane Way Link	-
	A59 Bus Corridor	-
	York Central Link	-
	James St Link	-
	A59 Poppleton roundabout	-
	Great North Way roundabout	-
	A19 Shipton Rd rbt (Rawcliffe Bar)	-
	Clifton Moor Gate rbt	-
	Haxby Road roundabout	-
	Wigginton Road roundabout	-
	Strensall Road roundabout	-
	Clifton Moor Park and Ride	-
	Wetherby Road roundabout	-
	Wiggington Road Bus Priority	-
	Clarence Street Bus Priority	-
	Poppleton Park and Ride	-
	Askham Bar Park and Ride	-
	Germany Beck pinchpoint	-
	New Askham Bar Park and Ride	-
	Haxby Station	-
RESIDENTIAL USES	British Sugar	-
	Nestle South (a)	ST17
	Nestle South (b)	ST17
	Land adj Hull Road	ST4
	Land at Grimston Bar	ST6
	York Central	ST5
	N Monks Cross	ST8
	E Metcalfe Lane	ST7
	Moor Lane, Woodthorpe	ST10
	N Haxby	ST9
	Former Civil Service Sports Ground	ST2
	New Lane, Huntington	ST11
	Moor Lane, Copmanthorpe	ST10
	Manor Heath Rd, Copmanthorpe	ST12
	Terry's	ST16
	Germany Beck	ST22
	Castle Piccadilly	ST20

	Designer Outlet	ST21
	N Clifton Moor	ST14
	Whinthorpe	ST15
EMPLOYMENT USES	Monks Cross North	-
	York Central	-
	Northminster Business Park	-
	Terry's	-
	Cement Works Monks Cross	-
	Ford Garage Jockey Lane	-
	Nestle South	-
	Hungate	-
	Plot 6b Monks Cross Drive	-
	Land N Monks Cross Drive	-

A Geographic Information System (ArcMap v.10) was used to identify the SATURN road links that fell within City of York Council's Air Quality Management Areas / areas of air quality technical breach (see Figure 1). Information was collated for each of these links and manually entered into the Emissions Factor Toolkit.

Results produced by the EFT are combined emissions (KG/Year) from all road links within all areas of technical breach (however, each road link has been modelled separately within the EFT, results available on request). The change (Δ) in emissions from the base scenario has also been expressed as a percentage reduction / increase.

A description of each of these scenarios is provided in table 2.

Figure 1: Example of GIS plot used to identify SATURN road links that fell within the Gillygate / Lord Mayors Walk technical breach area

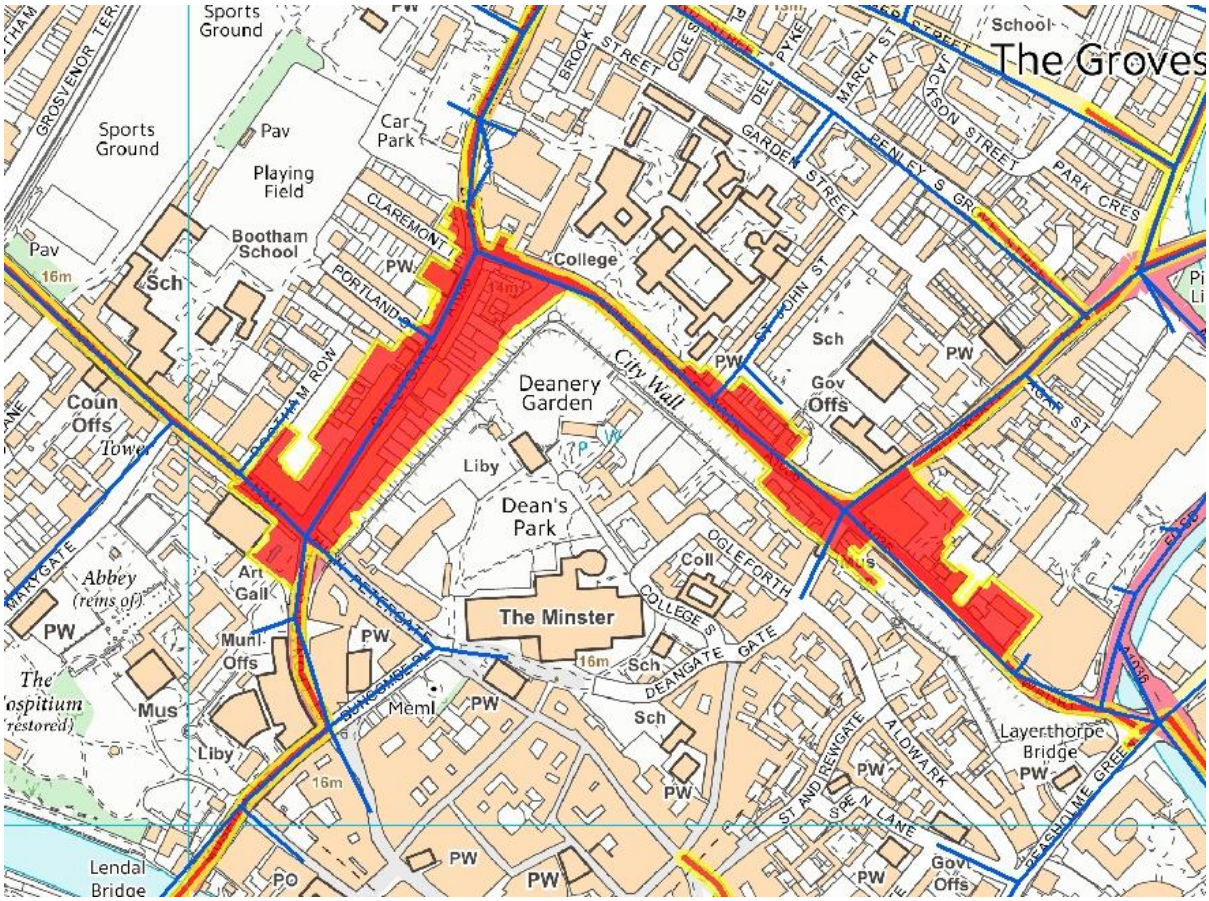

Table 2: Description of Modelled Scenarios

Scenario	Scenario Name	SATURN Data	EFT Modelled Year	Scenario details
A	Base 2014	2011	2014	Current year base case scenario using 2011 SATURN data and 2014 modelled EFT year.
B	2014 (2021 EFT)	2011	2021	A purely hypothetical scenario which looks at the impact of cleaner vehicles (2021 modelled EFT year) operating on a 2011 network
C	Base 2021	2021	2021	2021 Base case, with development traffic and 2021 modelled EFT year
D	2021 (2014 emissions)	2021	2014	A hypothetical scenario based on a 2021 SATURN model, but with a 2014 EFT modelled year. The scenario considers what would happen if traffic levels were to increase with development in the city, but emissions from vehicles did not fall in line with current EFT predictions. This is considered to be a very much worst case scenario in terms of vehicle emissions in the city in 2021.
E	2021 (1.5% Electric Car)	2021	2021	The situation in 2021, assuming 1.5% of all cars are converted to battery electric technology (it is anticipated that without Low Emission Strategy in place, this figure could realistically be achieved with no intervention from City of York Council).
F	LES 2021 (5% Electric Car)	2021	2021	With the Low Emission Strategy in place, it is anticipated that 5% of all cars could be converted to battery electric technology by 2021.
G	LES 2021 (90% Hybrid Bus)	2021	2021	A 2021 scenario where 90% of buses are converted to hybrid-electric technology
H	LES 2021 (90% Electric Bus)	2021	2021	A 2021 scenario where 90% of buses are converted to full electric technology

I	LES 2021 (5% Electric Car and 90% Electric Bus)	2021	2021	A 2021 scenario where 90% of buses and 5% of cars are converted to full electric technology.
J	LES 2021 (5% Electric Car and 90% Hybrid Bus)	2021	2021	A 2021 scenario where 5% of cars are converted to full electric technology and 90% of buses are converted to hybrid electric technology.
K	2021 - 1.5% Electric Car (2014 EFT)	2021	2014	As scenario E, but using 2014 emission factors
L	2021 LES - 5% Electric Car (2014 EFT)	2021	2014	As scenario F, but using 2014 emission factors
M	2021 LES - 90% Hybrid Bus (2014 EFT)	2021	2014	As scenario G, but using 2014 emission factors
N	2021 LES - 90% Electric Bus (2014 EFT)	2021	2014	As scenario H, but using 2014 emission factors
O	2021 LES - 90% Electric Bus 5% Electric Car (2014 EFT)	2021	2014	As scenario I, but using 2014 emission factors
P	2021 LES - 5% Electric Car 90% Hybrid Bus (2014 EFT)	2021	2014	As scenario J, but using 2014 emission factors

Q	2021 LES - 10% Electric car	2021	2021	A 2021 scenario where 10% of cars are converted to electric technology. Undertaken as part of a sensitivity analysis looking at how electric car uptake can influence emissions from this vehicle sector.
R	2021 LES - 25% Electric Car	2021	2021	A 2021 scenario where 25% of cars are converted to electric technology. Undertaken as part of a sensitivity analysis looking at how electric car uptake can influence emissions from this vehicle sector.
S	2021 LES - 50% Electric Car	2021	2021	A 2021 scenario where 50% of cars are converted to electric technology. Undertaken as part of a sensitivity analysis looking at how electric car uptake can influence emissions from this vehicle sector.
T	2021 LES - 75% Electric Car	2021	2021	A 2021 scenario where 75% of cars are converted to electric technology. Undertaken as part of a sensitivity analysis looking at how electric car uptake can influence emissions from this vehicle sector.
U	2021 LES - 100% Electric Car	2021	2021	A 2021 scenario where 100% of cars are converted to electric technology. Undertaken as part of a sensitivity analysis looking at how electric car uptake can influence emissions from this vehicle sector. This scenario effectively removes all emissions associated with cars.
V	2021 Base with Detailed Option 3 Split	2021	2021	This is an alternative 2021 scenario that had been run using the ‘Detailed Option 3’ split in the EFT, which allows the user to specify the relative proportions of diesel and petrol cars (this is not possible with the ‘Alternative Technologies’ option used for the rest of the modelling work). This scenario should only be used to compare to scenario W below.

W	2021 with only petrol cars (remove all diesel cars)	2021	2021	This is a scenario that has been run to examine the impact of removing all diesel cars from the fleet. The total number of cars has not changed, but all cars are all modelled to be fuelled on petrol. The results of this scenario should be compared to scenario V only.
X	2021 (63.32% Electric Car)	2021	2021	A scenario that considers converting 63.32% of cars to battery electric technology. This scenario produces the same level of NO_x reduction as scenario H (which looks at converting 90% of buses to electric technology).

Results

Table 3 below shows the results for the base case scenarios. Base models have been constructed for 2014 and for 2021, to reflect current road network operating conditions and conditions in 2021 based on planned development in the city. The impact of additional traffic (assuming no improvement in vehicle emissions) and cleaner vehicle technology is also estimated in the table below by comparing specific scenarios.

Table 3: Base case scenarios

Scenario	Description	NO_x (KG/Year)	PM_{10} (KG/Year)
A	Base 2014	26329.0	1459.1
B	Base 2014 (2021 Emissions)	12299.9	1099.5
C	Base 2021	13773.1	1214.9
D	Base 2021 (2014 Emissions)	29355.1	1628.1

					Δ NO_x (%)	Δ PM_{10} (%)
A-C	Impact of additional traffic and cleaner vehicles	12556.0	244.2		47.7	16.7
A-B	Impact of cleaner vehicles only in 2014	14029.2	359.6		53.3	24.6
A-D	Impact of additional traffic only in 2021	-3026.1	-169.0		-11.5	-11.6

Note on table above – figures highlighted in red indicate where emissions have increased relative to the base case. Figures highlighted in green indicate where emissions have decreased relative to the base case.

Table 4 below shows the emission savings possible by converting a proportion of the bus and car fleet to electric and hybrid-electric technology. Percentage changes are expressed as a percentage of the 'Base 2021' scenario.

Table 4: Electric bus and car scenarios

Scenario	Description	NO_x (KG/Year)	PM_{10} (KG/Year)	Δ NO_x (KG/Year)	Δ PM_{10} (KG/Year)	Δ NO_x (%)	Δ PM_{10} (%)
C	Base 2021	13773.1	1214.9	-	-	-	-
E	2021 (1.5% Electric Car)	13683.0	1213.7	90.1	1.1	0.7	0.1
F	LES 2021 (5% Electric Car)	13472.8	1211.1	300.3	3.7	2.2	0.3
G	LES 2021 (90% Hybrid Bus)	12225.9	1197.6	1547.1	17.3	11.2	1.4
H	LES 2021 (90% Electric Bus)	9970.4	1089.3	3802.7	125.6	27.6	10.3
I	LES 2021 (5% Electric Car and 90% Electric Bus)	9670.1	1085.5	4102.9	129.3	29.8	10.6
J	LES 2021 (5% Electric Car and 90% Hybrid Bus)	11925.6	1193.9	1847.4	21.0	13.4	1.7
X	2021 (63.32% Electric Car)	9970.3	1167.8	3802.7	47.1	27.6	3.9

Table 5 below shows the results for the many of the same scenarios a shown in table 4, but assuming that vehicle emissions do not improve (from 2014). The base case emissions shown in table 5 are considered to be very much worst case.

Table 5: Electric bus and car scenarios (2021 Saturn, 2014 EFT)

Scenario	Description	NO_x (KG/Year)	PM_{10} (KG/Year)	Δ NO_x (KG/Year)	Δ PM_{10} (KG/Year)	Δ NO_x (%)	Δ PM_{10} (%)
D	Base 2021 (2014 EFT)	29355.1	1628.1	-	-	-	-
K	2021 - 1.5% Electric Car (2014 EFT)	29213.8	1624.9	141.3	3.1	0.5	0.2
L	2021 LES - 5% Electric Car (2014 EFT)	28884.1	1617.7	471.0	10.4	1.6	0.6
M	2021 LES - 90% Hybrid Bus (2014 EFT)	25046.2	1547.3	4309.0	80.8	14.7	5.0
N	2021 LES - 90% Electric Bus (2014 EFT)	19961.1	1486.6	9394.0	141.5	32.0	8.7
O	2021 LES - 90% Electric Bus 5% Electric Car (2014 EFT)	19490.1	1476.2	9865.1	151.9	33.6	9.3
P	2021 LES - 5% Electric Car 90% Hybrid Bus (2014 EFT)	24575.1	1536.9	4780.0	91.2	16.3	5.6

Table 6 shows the emissions savings possible by converting a proportion of the 2021 car fleet to battery electric technology. It is considered that with City of York Council's intervention, the percentage of electric cars can be increased in 2021 from 1.5% to 5%. A figure of up to 5% is considered to be a realistic estimate of the proportion of electric cars on York road network in 2021 with a Low Emission Strategy in place.

Table 6: Electric car sensitivity testing

Scenario	Description	NO_x (KG/Year)	PM_{10} (KG/Year)	Δ NO_x (KG/Year)	Δ PM_{10} (KG/Year)	Δ NO_x (%)	Δ PM_{10} (%)
C	Base 2021	13773.1	1214.9	-	-	-	-
E	2021 (1.5% Electric Car)	13683.0	1213.7	90.1	1.1	0.7	0.1
F	LES 2021 (5% Electric Car)	13472.8	1211.1	300.3	3.7	2.2	0.3
Q	2021 LES - 10% Electric car	13172.5	1207.4	600.6	7.4	4.4	0.6
R	2021 LES - 25% Electric Car	12271.7	1196.3	1501.4	18.6	10.9	1.5
S	2021 LES - 50% Electric Car	10770.3	1177.7	3002.8	37.2	21.8	3.1
T	2021 LES - 75% Electric Car	9268.9	1159.1	4504.2	55.7	32.7	4.6
U	2021 LES - 100% Electric Car	7767.5	1140.5	6005.6	74.3	43.6	6.1

Table 7 shows the emissions savings possible by removing all diesel cars from the areas of technical breach. In this scenario, the number of cars is kept constant between the base case and the scenario under consideration (the diesel cars removed are assumed to be replaced with petrol cars).

Table 7: Removing diesel cars (number of cars the same but all petrol engine)

Scenario	Description	NO_x (KG/Year)	PM_{10} (KG/Year)	Δ NO_x (KG/Year)	Δ PM_{10} (KG/Year)	Δ NO_x (%)	Δ PM_{10} (%)
V	2021 Base with Detailed Option 3 Split	12590.7	1213.7	-	-	-	-
W	2021 with only petrol cars (remove all diesel cars)	9769.8	1211.1	2820.9	2.6	22.4	0.2