

Appendix: Air Quality

Annex 1: Combined Annex Document

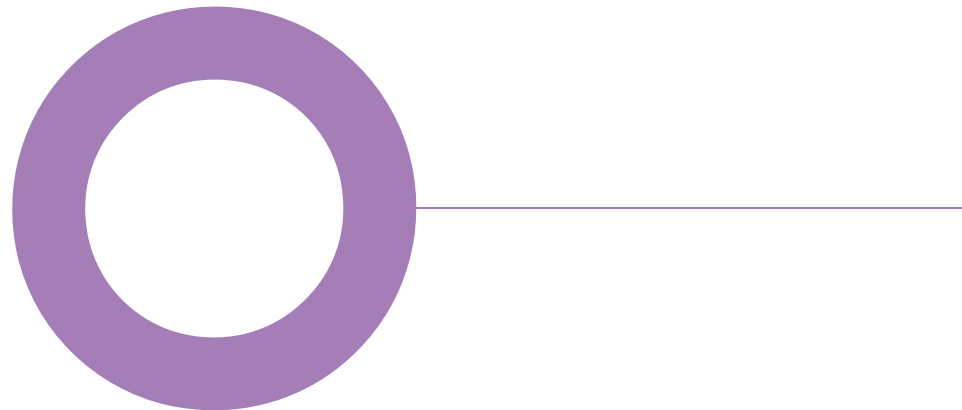
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Broad Street Mall.
Reading.
Inception (Reading) Sarl
(c/o Moorgarth Group Ltd).

AIR QUALITY
ES APPENDIX

REVISION 01 – 31 OCTOBER 2019



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
01	31/10/2019	First draft	AD	KW	CR

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Inception (Reading) Sarl (c/o Moorgarth Group Ltd)

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1. Dust Risk Assessment Methodology

Introduction

The IAQM guidance divides activities on construction sites into four types to reflect their different potential impacts:

- demolition;
- earthworks;
- construction; and
- trackout.

A series of steps then consider the potential impact due to:

- annoyance due to dust soiling;
- the risk of health effects due to increased exposure to PM₁₀; and
- harm to ecological receptors.

Step 1: Screen the Need for a Detailed Assessment

An assessment is required where there is a human receptor within 350 m of the site boundary, and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s), or where there is an ecological receptor within 50 m of the site boundary, and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is negligible, and any effects will be not significant.

Step 2: Assess the Risk of Dust Impacts

A site is allocated to a risk category based on two factors:

- the scale and nature of the works, which determines the potential dust emissions magnitude (Step 2A); and
- the sensitivity of the area to dust impacts (Step 2B).

These two factors are combined at Step 2C to determine the risk of dust impacts from each type of construction activity, with no mitigation applied.

Step 2A: Potential Dust Emissions Magnitude

The dust emission magnitude is classified as small, medium or large. Examples of how the potential dust emission magnitude for each activity can be defined are shown in **Table A1**.

Table A1: Examples of How the Dust Emission Magnitude can be Defined

Class	Example
Demolition	
Large	Total building volume >50,000 m ³ , potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20 m above ground level.
Medium	Total building volume 20,000 m ³ – 50,000 m ³ , potentially dusty construction material, demolition activities 10-20 m above ground level.
Small	Total building volume <20,000 m ³ , construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months.
Earthworks	
Large	Total site area >10,000 m ² , potentially dusty soil type (e.g. clay, which will be prone to suspension when dry to due small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes.
Medium	Total site area 2,500 m ² – 10,000 m ² , moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m – 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes.
Small	Total site area <2,500 m ² , soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter months.
Construction	
Large	Total building volume >100,000 m ³ , piling, on site concrete batching; sandblasting.
Medium	Total building volume 25,000 m ³ – 100,000 m ³ , potentially dusty construction material (e.g. concrete), on site concrete batching.
Small	Total building volume <25,000 m ³ , construction material with low potential for dust release (e.g. metal cladding or timber).
Trackout ^a	
Large	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.
Medium	10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m.
Small	<10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m.

^a These numbers are for vehicles that leave the site after moving over unpaved ground.

Step 2B: Define the Sensitivity of the Area

The sensitivity of the area takes account of:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- in the case of PM₁₀, the local background concentrations; and
- site-specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.

The specific sensitivities of different types of receptor to dust soiling and PM₁₀ are shown in Table A2, Table A3 and Table A4.

Professional judgement should be used to identify where on the spectrum of sensitivity a receptor lies, taking account of specific circumstances, i.e. the first occupants of residential units on a phased development may be expected to be less sensitive to dust soiling.

The sensitivity of the area is then determined from the specific sensitivities of the receptors using the matrices set out in Table A5, Table A6 and Table A7. Professional judgement should be used to determine the final sensitivity of the area, taking account of:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between source and receptors;
- any conclusions drawn from analysing local meteorological data which accurately represents the area; and if relevant, the season during which the works will take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any other known specific receptor sensitivities.

Step 2C: Define the Risk of Impacts

The dust emission magnitude determined at Step 2A is combined with the sensitivity of the area determined at Step 2B to determine the risk of impacts with no mitigation applied. The level of risk for each activity is determined using the matrix in **Table A8**.

Step 3: Determine Site Specific Mitigation

The dust risk category determined at Step 2C has been used, along with the professional judgement of the consultant, to determine the appropriate level of mitigation at the site. The highly recommended and desirable mitigation measures set out in the IAQM guidance form the basis of the mitigation.

Step 4: Determine Significant Effects

The IAQM guidance is clear that, with appropriate mitigation in place, the residual effect will normally be 'not significant'.

Table A2: Sensitivities of People to Dust Soiling

Class	Principles	Examples
High	Users can reasonably expect enjoyment of a high level of amenity; or the appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land.	Dwellings, museum and other culturally important collections, medium and long term car parks and car showrooms.
Medium	Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or the appearance, aesthetics or value of their property could be diminished by soiling; or the people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land.	Parks and places of work.
Low	The enjoyment of amenity would not reasonably be expected; or property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or there is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land.	Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.

Table A3: Sensitivities of People to PM₁₀

Class	Principles	Examples
High	Locations where members of the public may be exposed for eight hours or more in a day.	Residential properties, hospitals, schools and residential care homes.
Medium	Locations where the people exposed are workers, and where individuals may be exposed for eight hours or more in a day.	Office and shop workers, but will generally not include workers occupationally exposed to PM ₁₀
Low	Locations where human exposure is transient.	Public footpaths, playing fields, parks and shopping streets.

Table A4: Sensitivities of Receptors to Ecological Effects

Class	Principles	Examples
High	Locations with an international or national designation and the designated features may be affected by dust soiling; or locations where there is a community of a particularly dust sensitive species.	Special Areas of Conservation (SAC) with dust sensitive features.
Medium	Locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or locations with a national designation where the features may be affected by dust deposition.	Sites of Special Scientific Interest (SSSI) with dust sensitive features.
Low	Locations with a local designation where the features may be affected by dust deposition.	Local Nature Reserves with dust sensitive features.

Table A5: Sensitivity of the Area to Dust Soiling Effects on People and Property ^a

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

^a For demolition, earthworks and construction, the distances are measured from the dust source, or the application site boundary. For trackout, the distances are measured from the side of the roads used by construction traffic. Without site-specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge or the road.

Table A6: Sensitivity of the Area to Human Health Effects ^a

Receptor Sensitivity	Annual Mean PM ₁₀	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m ³	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m ³	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m ³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m ³	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	>32 µg/m ³	>10	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	28-32 µg/m ³	>10	Medium	Low	Low	Low	Low

Receptor Sensitivity	Annual Mean PM ₁₀	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
		1-10	Low	Low	Low	Low	Low
		>10	Low	Low	Low	Low	Low
	<24 µg/m ³	1-10	Low	Low	Low	Low	Low
		>10	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

^a For demolition, earthworks and construction, the distances are measured from the dust source, or the application site boundary. For trackout, the distances are measured from the side of the roads used by construction traffic. Without site-specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge or the road.

Table A7: Sensitivity of the Area to Ecological Effects ^a

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

^a For demolition, earthworks and construction, the distances are measured from the dust source, or the application site boundary. For trackout, the distances are measured from the side of the roads used by construction traffic. Without site-specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge or the road.

Table A8: Defining the Risk of Dust Impacts

Sensitivity of the Area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Earthworks			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Sensitivity of the Area	Dust Emission Magnitude		
	Large	Medium	Small
Construction			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Trackout			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

1. Modelling Methodology

Roads

Model Inputs

Traffic Data

The AADT flows and vehicle fleet composition data have been provided by Connect Consultants Ltd. Speeds have been based on the speed limit for each road link, reduced to 20km/h within 25m of a junction stop line. The traffic data are shown in **Table A9**. Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by the DfT (DfT, 2018). The modelled road network is shown in **Figure 1**.

Table A9: Summary of Traffic Data used in the Assessment ^a

Road Link	AADT			HDVs (%)			Speed (km/h)
	2018	2022		2017	2022		
		wo	w		wo	w	
A4155 Caversham Road, west of A329	27616	28,889	28932	4.1	4.1	4.1	48
A329, South of Vastern Road	35468	37,103	37189	3.2	3.2	3.2	48
Chatham Street, west of A329	17623	18,435	18478	2.9	2.9	2.9	48
A329, between Chatham Street and Castle Hill (mainline flow only)	47350	49,532	49597	2.4	2.4	2.4	64
A4155 Castle Hill, west of A329	21596	22,591	22634	3.2	3.2	3.2	48
A329, south of Castle Hill	51939	54,333	54538	3.3	3.3	3.3	64
A33, south of A329/A33 split	13106	13,710	13861	3.4	3.4	3.4	64
A329, south of A33/A329 split	34585	36,179	36233	4.0	4.0	4.0	20
south to east link between A33 and A329	16019	16,757	16757	3.4	3.4	3.4	20
A329, west of A327 junction	22615	23,657	23711	2.3	2.3	2.3	20
A329 mainline flow at A327 junction	17058	17,844	17866	1.7	1.7	1.7	64
Southampton Street, south of A329	17011	17,795	17860	3.9	3.9	3.9	48
Friar Street, east of West Street	3505	3,793	3793	15.3	15.3	15.3	32
West Street, south of Friar Street	2702	2,924	2924	23.1	23.1	23.1	32
Oxford Road, east of Thorn Street	5209	5,637	5637	5.1	5.1	5.1	32
Oxford Road, east of Russell Street	6613	7,156	7156	3.2	3.2	3.2	48
Castle Street, east of access	3522	3,812	3865	4.0	4.0	4.0	32
Gun Street	1187	1,285	1285	24.8	24.8	24.8	32
Bridge Street, South of Castle Street	5940	6,428	6481	3.0	3.0	3.0	48
A329 Vastern Road	24932	26,980	27023	2.4	2.4	2.4	48
Castle Street, west of access	5579	6,038	6134	5.1	5.1	5.1	48

Emissions
Emissions have been calculated using the most recent version of the Emissions Factor Toolkit (EFT) v8.0.1 (Defra, 2018b). The traffic data were entered into the EFT in order to calculate a combined emission rate for each of the road links in the modelled network.

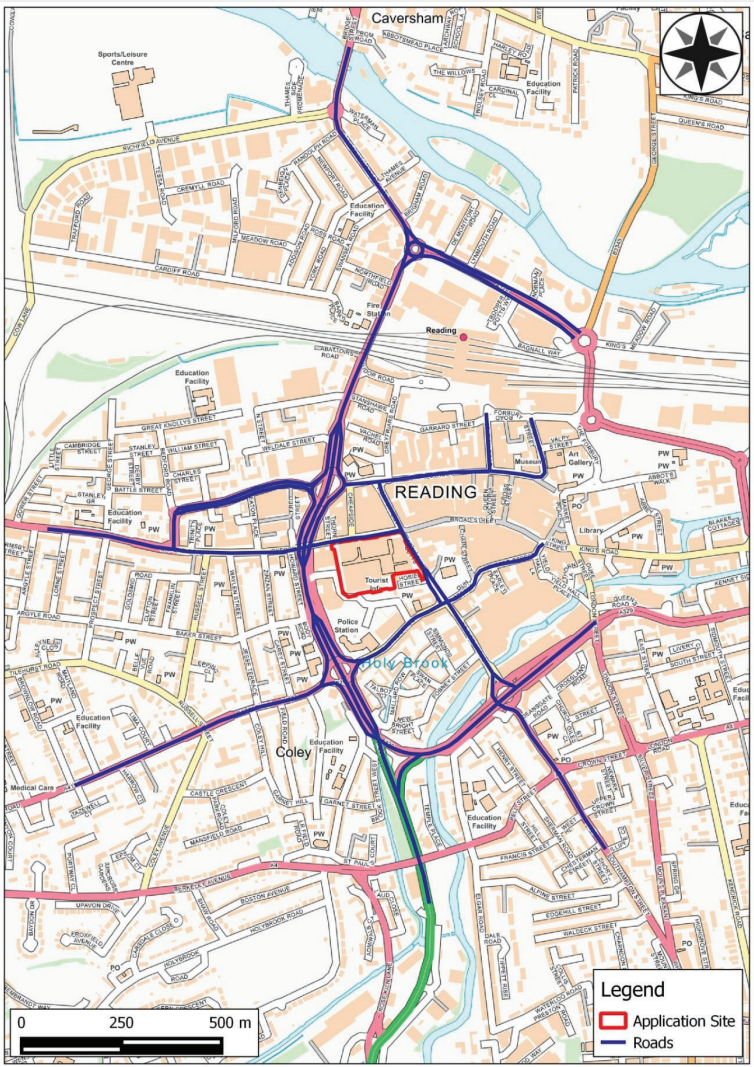


Figure 1: Modelled Roads. Contains Ordnance Survey data © Crown copyright and database right 2019.

Meteorological Data

The model has been run using the full year of meteorological data that corresponds with the most recent set of nitrogen dioxide monitoring data (2018). The meteorological data has been taken from the monitoring station located at Heathrow Airport, which is considered suitable for the area.

Background Concentrations

Background concentrations have been assumed to be the same as those published by Defra (Defra, 2018b). These cover the whole country on a 1 km by 1 km grid and are published for each year from 2017 to 2030. The current maps have been verified against measurements undertaken during 2017. Background concentrations used in this assessment are provided in Table A10.

Table A10: Summary of Background Concentrations used in the Assessment

Grid Square	Concentration ($\mu\text{g}/\text{m}^3$)					
	2018			2022		
	NO ₂	PM ₁₀	PM _{2.5}	NO ₂	PM ₁₀	PM _{2.5}
471500, 174500	23.3	16.8	11.8	20.5	16.1	11.2
4715000, 173500	27.7	16.2	11.2	24.1	15.3	10.5
470500, 173500	24.0	16.4	11.5	20.7	15.5	10.9
471500, 172500	21.7	16.6	11.7	18.8	15.9	11.1
470500, 172500	19.2	15.4	10.9	16.5	14.7	10.3

Verification

The verification process seeks to minimise uncertainties associated with the air quality model by comparing the model output with locally measured concentrations. The model has been verified against 2018 data from the RD1 automatic monitoring site and diffusion tube monitoring sites DT15, DT18, DT19, DT20, DT33, DT34, DT37, DT39, DT42, DT43, DT47, DT51, DT52 and DT53. The verification methodology is described below.

NO₂

Most NO₂ is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO₂). The model has been run to predict the 2018 annual mean NO_x concentrations at the monitoring sites.

The model output of road-NO_x has been compared with the 'measured' road-NO_x, calculated from the measured annual mean NO₂ concentrations and the background concentrations using the NO_x from NO₂ calculator v7.1 published by Defra (Defra, 2018b).

The slope of the best-fit line between the 'measured' road-NO_x contribution and the model derived road-NO_x contribution, forced through zero, has been used to determine the adjustment factor (Figure 2). The adjustment factor of 2.563 has been applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. The NO_x to NO₂ calculator has then been used to determine total NO₂ concentrations from the adjusted modelled road-NO_x concentrations and the background NO₂ concentrations.

The results imply that the model has under-predicted the road-NO_x contribution. This is a common experience with this and most other models.

PM₁₀ and PM_{2.5}

PM₁₀ is measured at the RD1 automatic monitoring site and an adjustment factor for PM has been calculated as follows:

- Measured PM₁₀ : 24 $\mu\text{g}/\text{m}^3$
- Background PM₁₀ : 16.8 $\mu\text{g}/\text{m}^3$
- 'Measured' road-PM₁₀ (Measured PM₁₀ – Background PM₁₀): 7.18 $\mu\text{g}/\text{m}^3$
- Modelled road-PM₁₀ = 1.45 $\mu\text{g}/\text{m}^3$
- Road-PM adjustment factor: $7.18/1.45 = 4.96$

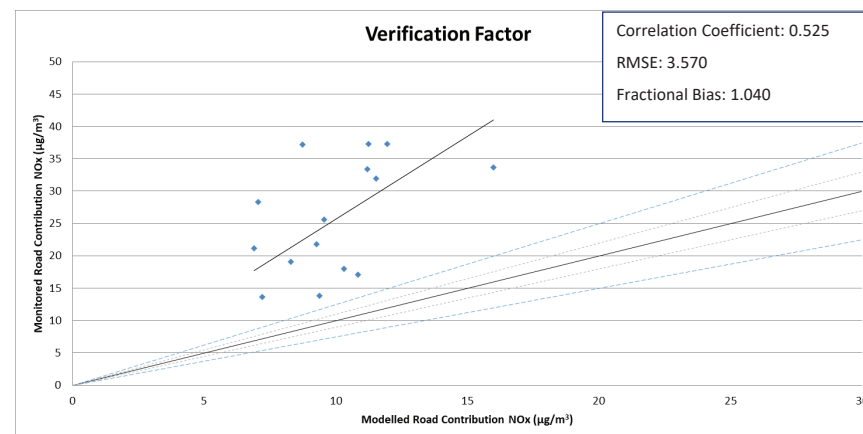


Figure 2: Comparison of Measured Road NO_x to Unadjusted Modelled Road NO_x Concentrations.

Statistical Analysis of Model Performance

LAQM.TG (16) recommends three statistical procedures that should be applied to evaluate model performance and assess the overall uncertainty. These are:

- Root mean square error (RMSE) defines the average error or uncertainty of the model. Ideally a RMSE within 10% of the air quality objective which is being assessed would be derived (for the annual mean NO₂ objective the ideal RMSE would be < 4 $\mu\text{g}/\text{m}^3$). Where the RMSE is greater than 25% of the objective being assessed (i.e. 10 $\mu\text{g}/\text{m}^3$ for the annual mean NO₂ objective) it is advised to revisit the model parameters and verification;
- Fractional bias identifies whether the model has a tendency to under-predict (positive value) or over-predict (negative value). The ideal value is zero but may range from +2 to -2; and
- Correlation coefficient provides a measure of the linear relationship between modelled and measured data. Values range between zero (no relationship) and 1 (perfect relationship).

The values for each of these methods are provided in Figure 2.

Sensitivity Analysis

There is some uncertainty with regard to future reductions in road traffic NO_x emissions used in the EFT and the background maps. Therefore, a sensitivity analysis has been undertaken which assumes that there are no reductions in emission factors for road traffic from the baseline year.

The model inputs are as described above; however, emission factors and Defra background concentrations from the verification year (2018) have been used with the future year traffic data to predict 'no emissions reduction' NO₂ concentrations.

For PM, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used.

2. References

Defra. (2018a). *UK-AIR: Air Information Resource*. Retrieved from <http://uk-air.defra.gov.uk/>

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