Appendix 13

Supporting Chapter 13 – Air Quality

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Appendix 13.1 - Background Concentrations

The background concentrations used for this assessment have been taken from DEFRA's UK background maps (as discussed in Section 13.2.28: Background Pollutant Concentrations). A full list of these background concentrations is presented in Table A13-1 below.

Table A13-1: Background Concentrations for Receptors

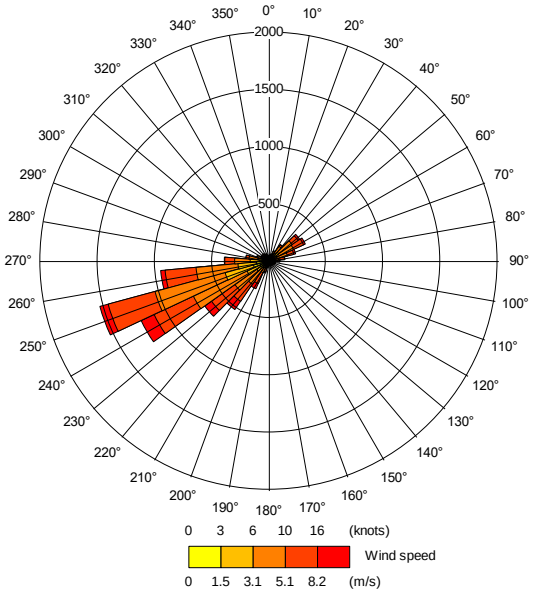
Site ID	Baseline Backgrounds (µg/m^3)		DM and DS Backgrounds (µg/m^3)			
	NO_2 (2017)	PM_{10} (2017)	$PM_{2.5}$ (2017)	NO_2 (2020)	PM_{10} (2020)	$PM_{2.5}$ (2020)
R1	10.4	12.7	7.1	9.1	12.3	6.7
R2	10.4	12.7	7.1	9.1	12.3	6.7
R3	10.4	12.7	7.1	9.1	12.3	6.7
R4	10.4	12.7	7.1	9.1	12.3	6.7
R5	10.1	10.3	6.4	8.8	9.9	6.1
R6	10.1	10.3	6.4	8.8	9.9	6.1
R7	11.6	12.0	7.0	10.1	11.6	6.7
R8	9.6	12.7	7.0	8.4	12.3	6.7
R9	11.0	11.9	7.1	9.6	11.5	6.7
R10	9.2	12.6	7.0	8.0	12.3	6.7
R11	12.2	12.6	7.3	10.6	12.2	6.9
R12	11.8	12.5	7.2	10.2	12.1	6.8
R13	11.8	12.5	7.2	10.2	12.1	6.8
R14	9.6	10.8	6.6	8.4	10.4	6.2
R15	9.6	10.8	6.6	8.4	10.4	6.2
R16	11.8	12.5	7.2	10.2	12.1	6.8
R17	11.0	11.9	7.1	9.6	11.5	6.7
R18	11.0	11.9	7.1	9.6	11.5	6.7
R19	9.6	12.7	7.0	8.4	12.3	6.7
R20	10.2	12.4	7.1	8.9	12.0	6.7
R21	10.2	12.4	7.1	8.9	12.0	6.7

13.2 - Meteorological Data

The meteorological dataset used in the assessment was recorded at the meteorological station at Edinburgh airport, Edinburgh, in 2017, located approximately 18 km to the north west of the Proposed Scheme. This site is considered to be representative of regional meteorological conditions and sufficient to satisfy the requirements of this assessment.

The meteorological data were used to produce a wind/stability rose shown below. This illustrates the wind direction and wind speed as a function of the proportion of the year.

Figure A13.1: Meteorological Data, 2017



Appendix 13.3 - Model Verification

The model was verified by comparison with AECOM NO_2 diffusion tube data gathered in 2015, after being annualised and bias-adjusted to represent annual mean concentrations in 2017. The model generally under-predicted annual mean NO_2 concentrations, when compared to monitoring data at the same locations, by more than 25%. The modelled results for NO_2, PM_{10} and $PM_{2.5}$ were therefore adjusted in accordance with the procedure detailed in Defra technical guidance note LAQM.TG(16) (DEFRA, 2018). This involved the comparison of modelled and measured road NO_X contributions to establish a single or multiple model bias-adjustment factors. These factors were then applied to all modelled road NO_X contribution predictions, before they were then converted to total NO_2 concentrations.

The level of under-prediction at monitoring sites E and F, which were both located adjacent to the A7, north of the Sheriffhall Roundabout, was likely due to the level of congestion and stop-start traffic flow experienced on the approach to the roundabout. The unadjusted model was not able to account for the extent of increased emissions as a result of this. Because the level of model performance was similar at these two sites adjacent to the A7 to the north of the roundabout, and likely due to the same reason, the average factor calculated by the comparison of modelled and measured road NO_X was applied to the receptors in their vicinity, which they are considered to be representative of receptors R1, R2, R3 and R4.

At monitoring site C the model over predicted compared to monitored concentrations. However, to be conservative instead of using an individual adjustment factor to reduce model predictions at the single receptor location represented by this monitoring site (R12), road NO_X contribution predictions were adjusted by a factor of 1.0.

The level of under-prediction experienced at sites A, D and H were relatively consistent and it was considered that these locations represented areas of the model where there was less congestion than that experienced at sites E and F. The average factor calculated by the comparison of modelled and measured road NO_X at these three locations was applied to all other receptors in the model (R5 to R11 and R13 to R25), which were located adjacent to roads where traffic flow is considered to be less congested.

The process described above is summarised in Table A13-2, A13-3 and A13-4.

Table A0-21: Comparison of Modelled (unadjusted) and Monitored NO_2 Concentrations, 2017

Monitoring Site	Monitor Type	Monitored Total NO_2	Modelled Total NO_2	% Difference [(modelled-monitored)/monitored]
E	Diffusion Tube	31.4	18.3	-41.7
F	Diffusion Tube	34.1	16.9	-50.3
C	Diffusion Tube	18.1	18.2	+0.9
A	Diffusion Tube	34.4	23.9	-30.3
D	Diffusion Tube	26.7	20.7	-22.8
H	Diffusion Tube	24.6	15.8	-35.7

Table A0-13: Determination of the Road Contribution NO_X Bias-adjustment Factor/s

Monitoring Site	Monitor Type	Monitored Road NO_X	Modelled Road NO_X (unadjusted)	Factor (modelled/ monitored)	Modelled Road NO_X (adjusted)
E	Diffusion Tube	42.3	15.0	3.27	48.9
F	Diffusion Tube	48.2	12.3		40.1
C	Diffusion Tube	11.8	12.2	1.0	12.2
A	Diffusion Tube	46.1	23.6	1.98	46.8

Monitoring Site	Monitor Type	Monitored Road NO_X	Modelled Road NO_X (unadjusted)	Factor (modelled/ monitored)	Modelled Road NO_X (adjusted)
D	Diffusion Tube	28.7	16.2		32.2
H	Diffusion Tube	28.2	10.8		21.3

Table A0-4: Comparison of Modelled (adjusted) and Monitored NO_2 Concentrations, 2017

Monitoring Site	Monitor Type	Monitored Total NO_2	Modelled Total NO_2	% Difference [(modelled-monitored)/monitored]
E	Diffusion Tube	31.4	34.4	9.4
F	Diffusion Tube	34.1	30.4	-10.6
C	Diffusion Tube	18.1	18.1	0
A	Diffusion Tube	34.4	34.7	0.9
D	Diffusion Tube	26.7	28.4	6.3
H	Diffusion Tube	24.6	21.2	-13.7

Following adjustment, modelled annual mean NO_2 concentrations are within 25% of monitored NO_2 concentrations. The Root Mean Square Error (RMSE) is a statistical calculation used to demonstrate the robustness of the model. An RMSE value that is within 10% of the of the air quality objective value (4 µg/m^3) is considered the ideal. The RMSE calculated for the unadjusted model was 5.6 µg/m^3. The RMSE for the adjusted model was 2.5 µg/m^3.

Appendix 13.4 - Seasonal and Bias Adjustment

Due to the absence of council monitoring within the study area, AECOM undertook project specific monitoring of NO_2 concentrations between 2nd April 2015 and 2nd October 2015, using passive diffusion tubes. The monitoring was conducted in accordance with LAQM.TG(16) (DEFRA, 2018).

As monitoring was undertaken for 6 months only, the measured concentrations were seasonally adjusted following the procedure outlined in LAQM.TG(16) (DEFRA, 2018). Data recorded at Bush Estate, Eskdalemuir, Peebles, were used to seasonally adjusted the monitored concentrations. A ratio was derived between the period mean and the annual mean at these continuous monitoring sites. The average was then applied to the AECOM monitored to concentrations to determine the annual mean NO_2 concentrations.

In addition, the seasonally adjusted concentrations were biased adjusted using the national diffusion tube biased adjustment spreadsheet V06/18. A factor of 0.85 was applied.

Table A0-5: AECOM NO_2 Monitoring Data Adjusted

Site ID	Site Type	Period Mean (µg/m^3)[1]	Annualised Mean (µg/m^3)[2]	Bias-Adjusted Annualised Mean (µg/m^3)[3]
A	Roadside	35.6	40.4	34.4
B[4]	Roadside	27.8	15.0	12.7
C	Roadside	18.7	21.2	18.1
D	Roadside	27.7	31.5	26.7
E	Roadside	31.6	36.5	31.4
F	Roadside	34.2	38.3	34.1
G	Roadside	19.0	21.7	18.6
H	Roadside	24.7	28.4	24.6
I	Background	12.5	14.2	12.1

[1] Period means vary between tubes, because of data loss, but all data gathered between 02/04/2015 and 02/10/2018

[2] Annualised using the factor calculated for each diffusion tube site based on their periods of exposure and the relationship between data for that same period and the annual mean concentration data for 2017, gathered at a series of continuous monitoring stations within 50 miles of the study area (Bush Estate, Eskdalemuir and Peebles).

[3] Adjusted for diffusion tube bias using the National Diffusion Tube Bias Adjustment Spreadsheet made available by DEFRA (Bias Adjustment Factor of 0.85 (2015) applied to Annualised Mean concentrations).

[4] The Annualised Mean concentrations projected at diffusion tube Site B should be treated with caution, due to poor data capture.

Appendix 13.5 – Construction Phase Air Quality and Dust Risk Assessment

Step 1: Screen the Requirement for a Detailed Assessment

Sensitive receptors were identified and the distance to the site and construction routes were determined according to the examples of sensitivity shown in Table A0-6. According to the IAQM, an assessment will normally be required where there are sensitive receptors within 350 metres (m) of the boundary of a site and/or within 50 m of route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance. A human receptor, as considered within the IAQM guidance, is any location where a person or property may experience:

- The annoyance effects of airborne dust or dust soiling e.g. dwellings, industrial or commercial premises such as a vehicle showroom, food manufacturers, electronics manufacturers, amenity areas and horticultural operations; or
- Exposure to PM_{10} over a period relevant to the air quality objectives.

Ecological receptors within 50 m of the boundary of the site or routes used by construction vehicles on the public highway, up to 500 m from the site entrance, also need to be identified.

There are no ecological receptors which need to be considered as part of this assessment.

Table A0-6: Examples of Dust Sensitive Receptors

Sensitivity	Dust Soiling	Human Health	Ecological
High	Dwellings, Museum and other culturally important collections, Medium and long term car parks Car showrooms.	Residential properties. Hospitals, Schools Residential care homes	Locations with an international or national designation (e.g. SAC) and the designated features may be affected by dust soiling
Medium	Parks Places of work.	Office and shop workers, but will generally not include workers occupationally exposed to PM10, as protection is covered by Health and Safety at Work legislation.	Locations with a national designation (e.g. SSSI) where the features may be affected by dust deposition
Low	Playing fields Farmland (unless commercially-sensitive horticultural), Footpaths, Short term car parks Roads	Public footpaths, Playing fields, Parks Shopping streets.	Locations with a local designation where the features may be affected by dust deposition local Nature Reserve with dust sensitive features.

SAC: Special Area of Conservation; SSSI: Site of Special Scientific Interest

Step 2: Access the Risk of Dust Impacts

The risk of dust arising in sufficient quantities to cause annoyance and/or health effects was determined for each activity (demolition, earthworks, construction works and track out), taking account of:

- The scale and nature of the works, which determines the potential dust emission magnitude (small, medium or large) (Step 2A); and
- The sensitivity of the area (low, medium or high) (Step 2B).

These factors were then combined to give the risk of dust effects with no mitigation applied, as Negligible, Low, Medium or High.

It should be noted that where detailed information was not available to inform the risk category, professional judgement and experience was used and a cautious approach adopted, in accordance with the guidance.

Step 2A: Define the Potential Dust Emission Magnitude

Demolition

No significant demolition works are anticipated.

Earthworks and Construction Works

Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. The classifications in Table A0-7 are based on examples of suitable criteria. Factors such as existing land use, topography, seasonality, duration and scale were also taken into consideration, where possible.

Table A0-7: Potential Earthworks Dust Emission Classification

Potential Dust Emission Classes	Criteria
Large	Total site area: >10,000 m^2 Potentially dusty soil type (e.g. clay) >10 heavy earth moving vehicle active at any one time Formation of bunds >8 m in height Total material moved >100,000 tonnes
Medium	Total site area: 2,500 - 10,000 m^2 Moderately dusty soil type (e.g. silt) 5 -10 heavy earth moving vehicle active at any one time Formation of bunds 4 - 8 m in height Total material moved 20,000 – 100,000 tonnes
Small	Total site area: <2,500 m^2 Soil type with large grain size (e.g. sand) < 5 heavy earth moving vehicle active at any one time Formation of bunds < 4 m in height Total material moved <20,000 tonnes Earthworks during wetter months

Track-out

Track-out is the transport of dust and dirt from the construction/demolition site onto the public road network, where it may be deposited and then re-suspended by vehicles using the local road network. The classifications in Table A0- are based on examples of suitable criteria. Factors such as vehicle size, speed, numbers, geology and duration were also taken into consideration, where possible.

Table A0-3: Potential Track-Out Dust Emission Classification

Potential Dust Emission Classes	Criteria
Large	50 HGV (>3.5t) outward movements in any one day Potentially dusty surface material Unpaved road length > 100 m
Medium	25 – 100 HGV (>3.5t) outward movements in any one day Moderately dusty surface material Unpaved road length 50 – 100 m
Small	< 25 HGV (>3.5t) outward movements in any one day Surface material with low potential for dust release Unpaved road length < 50m

Step 2B: Define the Sensitivity of the Area

The sensitivity of the area takes account of the following factors:

- The specific sensitivities of receptors in the area;

- The proximity and number of those receptors;
- In the case of PM_{10}, 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 sensitivity of the area is determined separately for dust soiling impacts on people and properties (Table A0-818) and human health impacts (

Table A0-9).

Table A0-81: Sensitivity of the Area to Dust Soiling Effects on People and Property

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

Table A0-9: Sensitivity of the Area to Human Health Impacts

Receptor Sensitivity	Annual Mean PM_{10} Concentration	Number of Receptors	Distance to Source				
			<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	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Step 2C – Define the Risk of Impacts

The dust emission magnitude determined at Step 2A should be combined with the sensitivity of the area determined at Step 2B to determine the risk of effects with no mitigation applied (Table A13-10 and

Table A0-11). This Step is undertaken for each activity undertaken on site.

Table A0-10: Risk of Dust Impacts - Earthworks and Construction Works

Sensitivity of Area	Dust Emission Classification		
	Large	**Medium**	**Small**
High	High	Medium	Low

Medium	Medium	Medium	Low
Low	Low	Low	Negligible

Table A0-11: Risk of Dust Impacts - Track-out

Sensitivity of Area	Dust Emission Classification		
	Large	**Medium**	**Small**
High	High	Medium	Medium
Medium	Medium	Low	Negligible
Low	Low	Low	Negligible

Step 3: Identify the need for Site Specific Mitigation

Based on the risk of effects determined in Step 2C for each activity, appropriate site-specific mitigation measures have been identified. Appropriate mitigation measures are set out in the IAQM Guidance.

Step 4: Define impacts and their significance

Finally the significance of the potential residual dust impacts, i.e. after mitigation, was determined. According to the IAQM Guidance the residual impacts assumes that all mitigation measures (recommended in Step 3) to avoid or reduce impacts are adhered to, and therefore the residual impacts should be considered to be 'not significant'.