8 APPENDIX 8.1 - AIR QUALITY

INTRODUCTION

8.1 The proposed development has the potential to cause air quality impacts as a result of vehicles travelling to and from the site. In order to assess NO_2 and PM_{10} concentrations at sensitive locations, detailed dispersion modelling was undertaken in accordance with the following methodology.

DISPERSION MODEL

8.2 Dispersion modelling was undertaken using the ADMS-Roads dispersion model (version 4.1.1.0). ADMS-Roads is developed by Cambridge Environmental Research Consultants (CERC) and is routinely used throughout the world for the prediction of pollutant dispersion from road sources. Modelling predictions from this software package are accepted within the UK by the Environment Agency and DEFRA.

8.3 The model requires input data that details the following parameters:

- Assessment area;
- Traffic flow data;
- Vehicle emission factors;
- Spatial co-ordinates of emissions;
- Street width;
- Meteorological data;
- Roughness length (z_0); and,
- Monin-Obukhov length.

8.4 These are detailed in the following Sections.

ASSESSMENT AREA

8.5 Ambient concentrations were predicted over the area NGR: 512550, 164100 to 515500, 167050. One Cartesian grid was used within the model to produce data suitable for contour plotting using the Surfer software package.

8.6 Reference should be made to Figure 8.6 for a map of the assessment area.

Traffic Flow Data

8.7 Traffic data for use in the assessment was provided by Transport Planning Practice Ltd, the Transport Consultants for the project. Flows were not available for all roads included within the modelling extents. As such, information for these links was obtained from the Department for Transport (DfT). The DfT web tool enables the user to view and download traffic flows on every link of the 'A' road and motorway network, as well as selected minor roads, in Great Britain for the years 1999 to 2017. It should be noted that the DfT web tool is referenced in DEFRA guidance (ref. 8.1) as being a suitable source of data for air quality assessments and it is therefore considered to provide a reasonable estimate of traffic flows in the vicinity of the site.

8.8 A summary of the traffic data is provided in Table A8.1.

Table A8.1: Traffic Data

Link	24-hour AADT Flow	HDV Proportion of Fleet (%)

		2017 Verif.	DM	DS	2017 Verif.	DM	DS
L1	Lammas Lane Eastbound	6,245	6,943	7,072	1.29	1.29	1.37
L2	Lammas Lane Eastbound Slow	6,245	6,943	7,072	1.29	1.29	1.37
L3	Lammas Lane Westbound Slow	6,245	6,943	7,072	1.29	1.29	1.37
L4	Lammas Lane Westbound	6,245	6,943	7,072	1.29	1.29	1.37
L5	Lammas Lane Roundabout	12,489	13,885	14,145	1.29	1.29	1.37
L6	Lammas Lane Slow from Roundabout	12,489	13,885	14,145	1.29	1.29	1.37
L7	Lammas Lane	12,489	13,885	14,145	1.29	1.29	1.37
L8	Lammas Lane Slow to Gyratory	12,489	13,885	14,145	1.29	1.29	1.37
L9	Portsmouth Road 40 South of Gyratory	11,987	13,327	13,576	0.73	0.73	0.77
L10	Portsmouth Road South of Gyratory	11,987	13,327	13,576	0.73	0.73	0.77
L11	Portsmouth Road South of Gyratory to High Street one way	11,987	13,327	13,576	0.73	0.73	0.77
L12	High Street to Church Street	20,658	22,967	23,324	1.34	1.34	1.41
L13	Church Street	12,686	14,104	14,325	1.64	1.64	1.71
L14	More Lane Slow	7,842	8,746	8,959	2.07	2.07	2.16
L15	More Lane	7,842	8,746	8,959	2.07	2.07	2.16
L16	Lower Green Road	5,196	5,795	6,013	4.64	4.64	4.69
L17	Lower Green Road Slow	5,196	5,795	6,013	4.64	4.64	4.69
L18	Station Road Slow	7,117	7,937	8,162	5.77	5.77	5.78
L19	Station Road South of Lower Green Road	7,117	7,937	8,162	5.77	5.77	5.78
L20	Station Road North of Lower Green Road	7,117	7,937	8,162	5.77	5.77	5.78

Link		24-hour AADT Flow			HDV Proportion of Fleet (%)		
		2017 Verif.	DM	DS	2017 Verif.	DM	DS
L21	Claremont Lane	17,680	19,656	20,024	1.79	1.79	1.90
L22	Claremont Lane Northbound	8,840	9,828	10,012	1.79	1.79	1.90
L23	Claremont Lane Southbound	8,840	9,828	10,012	1.79	1.79	1.90
L24	Lammas Lane to Portsmouth Road	12,489	13,885	14,145	1.29	1.29	1.37
L25	High Street	28,129	31,273	31,759	0.98	1.34	1.41
L26	Portsmouth Road North of Gyratory	25,469	28,374	29,017	5.10	5.09	5.11
L27	Portsmouth Road North of Gyratory Northbound	12,734	14,187	14,508	5.10	5.09	5.11
L28	Portsmouth Road North of Gyratory Southbound	12,734	14,187	14,508	5.10	5.09	5.11
L29	Portsmouth Road	25,469	28,374	29,017	5.10	5.09	5.11
L30	Portsmouth Road to Station Road Junction, south	25,469	28,374	29,017	5.10	5.09	5.11
L31	Portsmouth Road to Station Road Junction, north	25,469	28,374	29,017	5.10	5.09	5.11
L32	Portsmouth Road north of Station Road	25,469	28,374	29,017	5.10	5.09	5.11
L33	Portsmouth Road to Scilly Isles Junction	25,469	28,374	29,017	5.10	5.09	5.11
L34	Scilly Isles Junction	21,569	23,980	24,208	1.65	1.65	1.69
L35	Portsmouth Road East of Kingston Bypass	15,050	16,732	16,892	1.14	1.14	1.17
L36	Hampton Court Way	21,628	24,046	24,275	2.03	2.03	2.08
L37	Kingston Bypass Eastbound Slow	14,014	15,581	15,729	1.63	1.63	1.67
L38	Kingston Bypass Eastbound	14,014	15,581	15,729	1.63	1.63	1.67
L39	Kingston Bypass Eastbound Junction with Manor Road	14,014	15,581	15,729	1.63	1.63	1.67

Link		24-hour AADT Flow			HDV Proportion of Fleet (%)		
		2017 Verif.	DM	DS	2017 Verif.	DM	DS
L40	Kingston Bypass Westbound Junction with Manor Road	14,014	15,581	15,729	1.63	1.63	1.67
L41	Kingston Bypass Westbound	14,014	15,581	15,729	1.63	1.63	1.67
L42	Kingston Bypass Westbound Slow	14,014	15,581	15,729	1.63	1.63	1.67
L43	Hampton Court Way/Portsmouth Road Junction	21,569	23,980	24,208	1.65	1.65	1.69
L44	Hampton Court Way Wide	21,628	24,046	24,275	2.03	2.03	2.08
L45	Hampton Court Way	21,628	24,046	24,275	2.03	2.03	2.08
L46	Hampton Court Way Slow	21,628	24,046	24,275	2.03	2.03	2.08
L47	Embercourt Road Roundabout	21,628	24,046	24,275	2.03	2.03	2.08
L48	Hampton Court Way north of Embercourt Road	21,628	24,046	24,275	2.03	2.03	2.08
L49	Hampton Court Way north of Embercourt Road	21,628	24,046	24,275	2.03	2.03	2.08
L50	Hampton Court Way Northbound	10,814	12,023	12,138	2.03	2.03	2.08
L51	Hampton Court Way Southbound	10,814	12,023	12,138	2.03	2.03	2.08
L52	High Street Southbound	7,471	8,306	8,435	1.34	1.34	1.41
L53	Portsmouth Road	25,469	28,374	29,017	5.10	5.09	5.11
L54	Church Street to Claremont	12,686	14,104	14,325	1.64	1.64	1.71
L55	Portsmouth Road South of Gyratory to High Street one way	11,987	13,327	13,576	0.73	0.73	0.77
L56	Church Street South	12,686	14,104	14,325	1.64	1.64	1.71
L57	High Street Canyon One Way	20,658	22,967	23,324	1.34	1.34	1.41
L58	High Street No Canyon One Way	20,658	22,967	23,324	1.34	1.34	1.41

Link		24-hour AADT Flow			HDV Proportion of Fleet (%)		
		2017 Verif.	DM	DS	2017 Verif.	DM	DS
L59	Church Street South No Canyon	12,686	14,104	14,325	1.64	1.64	1.71

8.9 Reference should be made to Figure 8.6 for a graphical representation of the road link locations.

8.10 Road widths and vehicle speeds were estimated from aerial photography and UK highway design standards. These are provided in Table A8.2.

Table A8.2: Road Parameters

Link		Average Vehicle Speed (km/h)	Road Width (m)
L1	Lammas Lane Eastbound	45	7.1
L2	Lammas Lane Eastbound Slow	25	7.1
L3	Lammas Lane Westbound Slow	25	7.1
L4	Lammas Lane Westbound	45	7.1
L5	Lammas Lane Roundabout	25	7.8
L6	Lammas Lane Slow from Roundabout	25	13.2
L7	Lammas Lane	45	7.2
L8	Lammas Lane Slow to Gyratory	25	7.1
L9	Portsmouth Road 40 South of Gyratory	60	7.7
L10	Portsmouth Road South of Gyratory	45	6.9
L11	Portsmouth Road South of Gyratory to High Street one way	45	8.9
L12	High Street to Church Street	25	8.6
L13	Church Street	25	9.8

Link		Average Vehicle Speed (km/h)	Road Width (m)
L14	More Lane Slow	25	7.1
L15	More Lane	45	7.7
L16	Lower Green Road	45	7.1
L17	Lower Green Road Slow	25	7.1
L18	Station Road Slow	25	10.3
L19	Station Road South of Lower Green Road	45	5.4
L20	Station Road North of Lower Green Road	45	5.4
L21	Claremont Lane	45	7.9
L22	Claremont Lane Northbound	25	7.0
L23	Claremont Lane Southbound	25	5.7
L24	Lammas Lane to Portsmouth Road	25	6.0
L25	High Street	25	11.0
L26	Portsmouth Road North of Gyratory	25	8.1
L27	Portsmouth Road North of Gyratory Northbound	25	5.2
L28	Portsmouth Road North of Gyratory Southbound	25	5.4
L29	Portsmouth Road	45	8.5
L30	Portsmouth Road to Station Road Junction, south	25	10.4
L31	Portsmouth Road to Station Road Junction, north	25	12.5
L32	Portsmouth Road north of Station Road	60	8.8
L33	Portsmouth Road to Scilly Isles Junction	25	17.0

Link		Average Vehicle Speed (km/h)	Road Width (m)
L34	Scilly Isles Junction	25	9.2
L35	Portsmouth Road East of Kingston Bypass	60	7.8
L36	Hampton Court Way	60	10.0
L37	Kingston Bypass Eastbound Slow	25	8.0
L38	Kingston Bypass Eastbound	60	7.1
L39	Kingston Bypass Eastbound Junction with Manor Road	25	13.2
L40	Kingston Bypass Westbound Junction with Manor Road	25	8.8
L41	Kingston Bypass Westbound	60	7.2
L42	Kingston Bypass Westbound Slow	25	9.0
L43	Hampton Court Way/Portsmouth Road Junction	25	11.0
L44	Hampton Court Way Wide	60	13.2
L45	Hampton Court Way	60	10.6
L46	Hampton Court Way Slow	25	15.2
L47	Embercourt Road Roundabout	25	9.4
L48	Hampton Court Way north of Embercourt Road	25	15.2
L49	Hampton Court Way north of Embercourt Road	60	9.5
L50	Hampton Court Way Northbound	60	5.0
L51	Hampton Court Way Southbound	60	5.0
L52	High Street Southbound	25	8.6
L53	Portsmouth Road	60	8.5

Link		Average Vehicle Speed (km/h)	Road Width (m)
L54	Church Street to Claremont	25	8.3
L55	Portsmouth Road South of Gyratory to High Street one way	25	8.9
L56	Church Street South	25	8.7
L57	High Street Canyon One Way	25	9.4
L58	High Street No Canyon One Way	25	9.4
L59	Church Street South No Canyon	25	8.7

CANYONS

8.11 Where buildings or walls surround roads, pollutant dispersion patterns are altered which can lead to high pollutant concentrations.These street canyons can significantly influence air quality along a road and therefore it is important to take consideration of their effects when undertaking dispersion modelling.

8.12 The release of ADMS-Roads version 4.0.1.0 in December 2015 incorporated a number of new features including an advanced street canyon module, which have been retained in version 4.1.1.0. Advanced street canyon modelling allows a number of parameters to be included in the dispersion model in order to predict pollutant dispersion patterns which better reflect air flow within complex urban geometries.

8.13 Canyons have five principle effects on dispersion which can influence pollutant concentrations. These are:

- Pollutants are channelled along street canyons;
- are dispersed across street canyons by circulating flow at road height;
- Pollutants are trapped in recirculation regions;
- Pollutants leave the canyon through gaps between buildings - as if there was no canyon; and,
- Pollutants leave the canyon from the canyon top.

8.14 The combined modelling of these effects will result in concentration patterns unique to each canyon.

8.15 The canyon parameters used in the assessment are outlined in Table A8.3. It should be noted that for a number of links the parameters were included at 0m to represent the one-sided nature of these canyons.

Table A8.3: Canyon Parameters

Link	Parameter (m)

	Canyon Width to Left	Average Height of Buildings to Left	Canyon Length Left	Building Length Left	Canyon Width to Right	Average Height of Buildings to Right	Canyon Length Right	Building Length Right
L11	7.8	6.5	60.6	60.6	0.0	0.0	0.0	0.0
L55	8.8	11.0	75.3	58.7	14.3	9.0	75.3	68.2
L56	4.2	7.5	48.1	48.1	9.1	10.5	48.1	36.4
L12	15.1	10.0	95.2	81.0	0.0	0.0	0.0	0.0
L57	11.1	11.0	47.8	47.8	0.0	0.0	0.0	0.0
L25	18.2	11.0	85.6	65.3	14.9	11.0	85.6	61.8
L26	13.4	10.0	82.3	62.4	17.4	12.0	82.3	71.3

Emission Factors

8.16 In 2016, Air Quality Consultants Ltd (AQC) produced a spreadsheet entitled 'Calculator Using Realistic Emissions for Diesels' (CURED, versions V1A and V2A). This provided an alternative emissions calculator which took account of the large amount of evidence from real-world emissions tests showing that the European Environment Agency's COPERT and DEFRA's Emissions Factor Toolkit (EFT) were incorrect.

8.17 Since this time, a new EFT (v8.0.1) has been released by DEFRA. This includes COPERT 5 vehicle emission factors and fleet information, which now better reflect the predictions made by CURED V1A and V2A. However, AQC note there remains some uncertainty regarding how well the future vehicle fleet will perform in the real world. As such, in January 2018 AQC released CURED V3A. This has been formulated to simulate failure of Euro 6d to provide any benefits over and above those of Euro6c, providing a more pessimistic view of the performance of post-2019 diesel cars and vans. As such, CURED V3A was utilised in the dispersion modelling in order to provide a worst-case representation of future year NO_x emission factors.

8.18 As PM_{10} emission factors do not require adjustment, factors were calculated for the relevant traffic flows using the EFT (version 8.0.1) produced by DEFRA.

Meteorological Data

8.19 Meteorological data used in the assessment was taken from Heathrow Airport meteorological station over the period 1st January 2017 to 31st December 2017 (inclusive). Heathrow Airport meteorological station is located at NGR: 506947, 176515, which is approximately 13.1km north-west of the development. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

8.20 All meteorological records used in the assessment were provided by Atmospheric Dispersion Modelling (ADM) Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 8.2 for a wind rose of utilised meteorological data.

Roughness Length

8.21 The z_0 is a modelling parameter applied to allow consideration of surface height roughness elements. A z_0 of 1.0m was used to describe the modelling extents. This value of z_0 is considered appropriate for the morphology of the area and is suggested within ADMS-Roads as being suitable for 'cities, woodlands'.

8.22 A z_0 of 0.3m was used to describe the meteorological site. This value of z_0 is considered appropriate for the morphology of the area due to the large expanse of flat land use such as runways and surrounding grass land and is suggested within ADMS-Roads as being suitable for 'agricultural areas (max)'.

Monin-Obukhov Length

8.23 The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 30m was used to describe the modelling extents. This value is considered appropriate for the nature of the area and is suggested within ADMS-Roads as being suitable for 'cities and large towns'.

8.24 A minimum Monin-Obukhov length of 100m was used to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-Roads as being suitable for 'large conurbations > 1 million'.

Background Concentrations

8.25 Annual mean NO_2 and PM_{10} background concentrations for use in the assessment were taken from the DEFRA mapping study for the grid square containing the site, as shown in the main chapter text.

8.26 Background levels of NO_2 have been adjusted in accordance with the approach provided by AQC when using the CURED V3A emissions spreadsheet. This method uplifts the background concentrations predicted by DEFRA. The NO_2 concentrations before and after adjustment are outlined in Table A8.4.

Table A8.4: Adjusted Background Pollutant Concentration Predictions

Pollutant	Predicted Background Pollutant Concentration (µg/m^3)	
	2017	2027
NO_2 - Unadjusted	15.79	10.82
NO_2 - Adjusted	16.84	12.80

NO_x to NO_2 Conversion

8.27 Predicted annual mean NO_x concentrations were converted to NO_2 concentrations using the spreadsheet (version 6.1) provided by DEFRA, which is the method detailed within DEFRA guidance (ref. 8.1).

Verification

8.28 The predicted results from a dispersion model may differ from measured concentrations for a large number of reasons, including:

- Estimates of background concentrations;
- Uncertainties in source activity data such as traffic flows and emission factors;
- Variations in meteorological conditions;

- Overall model limitations; and,
- Uncertainties associated with monitoring data, including locations.

8.29 Model verification is the process by which these and other uncertainties are investigated and where possible minimised. In reality, the differences between modelled and monitored results are likely to be a combination of all of these aspects.

8.30 For the purpose of the assessment, model verification was undertaken for 2017 using traffic data, meteorological data and monitoring results from this year.

8.31 EBC undertook diffusion tube monitoring of NO_2 concentrations at 10 locations within the modelling extents during 2017. The results were obtained and the road contribution to total NO_x concentrations calculated following the methodology contained within DEFRA guidance (ref. 8.1). The monitored annual mean NO_2 concentrations and calculated road NO_x concentrations are summarised in Table A8.5.

Table A8.5: Verification - Monitoring Results

Monitoring Site	Monitored NO_2 Concentration ($\mu g/m^3$)	Calculated Road NO_x Concentration ($\mu g/m^3$)
Esher 1	37.1	42.03
Esher 4	33.4	33.70
Esher 7	39.2	46.90
Esher 8	38.6	45.50
Esher 9	28.7	23.58
Esher 10	28.5	23.16
Esher 11	32.7	32.16
Esher 13	31.5	29.55
Hinchley Wood 1	35.4	38.16
Hinchley Wood 2	30.8	28.04

8.32 The annual mean road NO_x concentrations predicted from the dispersion model and the 2017 road NO_x concentrations calculated from the monitoring results are summarised in Table A8.6.

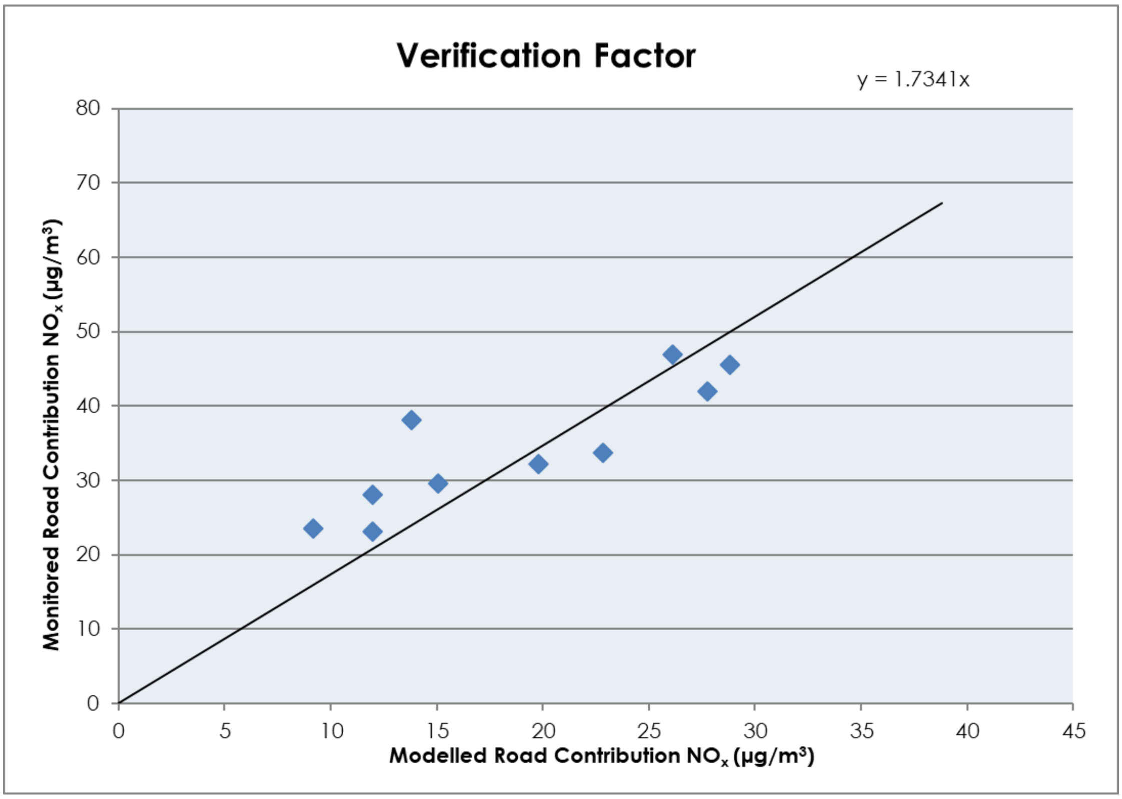
Table A8.6: Verification - Modelling Results

Monitoring Site	Monitored NO_2 Concentration ($\mu g/m^3$)	Calculated Road NO_x Concentration ($\mu g/m^3$)
Esher 1	42.03	27.74
Esher 4	33.70	22.84
Esher 7	46.90	26.14

Monitoring Site	Monitored NO_2 Concentration ($\mu g/m^3$)	Calculated Road NO_x Concentration ($\mu g/m^3$)
Esher 8	45.50	28.82
Esher 9	23.58	9.18
Esher 10	23.16	11.96
Esher 11	32.16	19.81
Esher 13	29.55	15.04
Hinchley Wood 1	38.16	13.82
Hinchley Wood 2	28.04	11.99

8.33 The monitored and modelled road NO_x concentrations were graphed and the equation of the trendline based on linear progression through zero calculated. This indicated that a verification factor of 1.7341 was required to be applied to all road NO_x modelling results, as shown in Graph A8.1.

Graph A8.1 NO_x Verification



8.34 Monitoring of PM_{10} concentrations is not undertaken within the assessment extents. The NO_x verification factor was therefore used to adjust PM_{10} model predictions in lieu of more accurate data in accordance with DEFRA guidance (ref. 8.1).