CITY AIRPORT DEVELOPMENT PROGRAMME
(CADP1) S73 APPLICATION

ENVIRONMENTAL STATEMENT

VOLUME 2: APPENDICES

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City Airport Development Programme (CADP1) S73 Application

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Appendix 9.3 Detailed Modelling Methodology

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Appendix 9.3 Detailed Assessment Methodology

Air Quality Model

9.1.1 The predictions of current (2019) and future air quality have been carried out using the ADMS-Airport and ADMS-Roads software tools. These use the same underlying dispersion model as the rest of the ADMS family, but with extensions to facilitate modelling airport and road sources respectively. ADMS-Airport incorporates a jet module specifically designed to represent the dispersion of emissions from moving aircraft and was selected by the Project for the Sustainable Development of Heathrow (PSDH) for use at Heathrow airport.

9.1.2 The model requires the user to provide a variety of input data, which describe the pollutant emissions arising from the proposed development, the meteorological conditions, and how the pollutants are released to air.

9.1.3 Pollutant emissions arise from a number of Airport-related sources, and the following were taken into consideration in this assessment:

- Aircraft main engines operating within the Landing and Take-off (LTO) Cycle, Auxiliary Power Units (APUs) and engine testing;
- Airside support vehicles and plant;
- Airport boiler plant;
- Fire training ground;
- Staff and passenger vehicle movements within the car parks; and
- Road traffic on Airport landside roads and on the local road network.

9.1.4 The approach to quantifying emissions from the Airport sources has been based on methodologies used in many assessments of air quality at UK airports, and, as far as was practicable, follows the advanced approach recommended by the International Civil Aviation Organisation (ICAO) in its Airport Air Quality Manual[1]. For all airside sources except aircraft brake and tyre wear, emissions of PM were assumed to represent both the PM_{10} and $PM_{2.5}$ fractions, based on the expected size distributions.

Aircraft Operations – Landing and Take-off Cycle (LTO)

9.1.5 The emissions arising from each aircraft movement have been calculated as the sum of the emissions for each part (‘mode’) of the LTO cycle, i.e. approach, landing roll, taxi-in, warm-up, taxi-out, hold, take-off roll, and climb. Details of each movement in the Baseline Year 2019 were provided by LCY, including date and time, aircraft type, runway, stand, and whether arrival or departure. Forecast movements and aircraft mix for all future scenarios were provided by York Aviation. A summary of the aircraft data used in this assessment is provided in Table 9-1 to Table 9-3.

Table 9-1: Aircraft Movements, 2019 and DM Scenarios

ICAO Code	Description	2019	2025	2027	2029	2031
A318	Airbus A318	525	0	0	0	0
AT45	ATR-45-600	0	2,740	2,740	2,740	2,740
AT75	ATR 72-212A	864	2,195	2,195	2,195	2,195
BCS1	Airbus A220-100 (formerly Bombardier CS100)	3,150	3,295	3,295	4,940	4,940
C56X	Cessna Citation Excel	952	783	1,096	1,409	1,409
C680	Cessna Citation Sovereign	397	1,268	1,776	2,283	2,283
CL35	Bombardier BD-100 Challenger 350	6	1,284	1,798	2,311	2,311

[1] ICAO (2020) Airport Air Quality Manual. Doc 9889, Second edition. https://www.icao.int/publications/Documents/9889_cons_en.pdf

ICAO Code	Description	2019	2025	2027	2029	2031
DH8D	Dash 8-400	11,966	3,840	3,840	3,840	3,840
E170	Embraer E170	9,330	0	0	0	0
E190	Embraer E190	45,923	57,170	56,070	41,745	24,355
E290	Embraer E190-E2	0	3,295	6,035	20,135	36,040
E295	Embraer E195-E2	0	0	2,195	8,295	9,780
E35L	Embraer Legacy 600	0	196	274	352	352
E55P	Embraer EMB-505 Phenom 300	379	525	734	944	944
FA7X	Dassault Falcon 7X	398	694	972	1,250	1,250
GLEX	Bombardier BD-700 Global Express	140	250	350	450	450
J328	Dornier 328JET	943	1,095	1,095	1,095	1,095
RJ85	RJ-85 Avroliner, BAe RJ-85	3,834	0	0	0	0
SB20	Saab 2000	2,073	0	0	0	0
	Other	3,170	0	0	0	0
	Total	**84,050**	**78,630**	**84,465**	**93,985**	**93,985**

Table 9-2: Aircraft Movements, DC Scenarios

ICAO Code	Description	2025	2027	2029	2031
A318	Airbus A318	0	0	0	0
AT45	ATR-45-600	2,740	2,740	2,740	2,740
AT75	ATR 72-212A	2,195	2,195	2,195	2,195
BCS1	Airbus A220-100 (formerly Bombardier CS100)	3,395	3,500	6,345	7,000
C56X	Cessna Citation Excel	783	783	783	0
C680	Cessna Citation Sovereign	1,268	1,268	1,268	0
CL35	Bombardier BD-100 Challenger 350	1,284	1,284	1,284	0
DH8D	Dash 8-400	3,940	4,045	4,045	4,045
E170	Embraer E170	0	0	0	0
E190	Embraer E190	52,940	18,875	14,490	17,235
E290	Embraer E190-E2	11,805	45,250	51,095	52,420
E295	Embraer E195-E2	0	14,555	17,260	24,270
E35L	Embraer Legacy 600	196	196	196	0
E55P	Embraer EMB-505 Phenom 300	525	525	525	0
FA7X	Dassault Falcon 7X	694	694	694	0
GLEX	Bombardier BD-700 Global Express	250	250	250	0
J328	Dornier 328JET	1,095	1,095	1,095	1,095
RJ85	RJ-85 Avroliner, BAe RJ-85	0	0	0	0
SB20	Saab 2000	0	0	0	0
	Other	0	0	0	0
	Total	**83,110**	**97,255**	**104,265**	**111,000**

Table 9-3: Aircraft Movements, Faster and Slower Growth Scenarios

ICAO Code	Description	2029 Faster Growth	2031 Slower Growth	2033 Slower Growth
A318	Airbus A318	0	0	0

ICAO Code	Description	2029 Faster Growth	2031 Slower Growth	2033 Slower Growth
AT45	ATR-45-600	2,740	2,740	2,740
AT75	ATR 72-212A	2,195	2,195	2,195
BCS1	Airbus A220-100 (formerly Bombardier CS100)	5,355	7,000	7,000
C56X	Cessna Citation Excel	0	783	0
C680	Cessna Citation Sovereign	0	1,268	0
CL35	Bombardier BD-100 Challenger 350	0	1,284	0
DH8D	Dash 8-400	4,045	4,045	4,045
E170	Embraer E170	0	0	0
E190	Embraer E190	17,235	15,585	15,585
E290	Embraer E190-E2	53,515	52,580	54,165
E295	Embraer E195-E2	24,815	20,350	24,165
E35L	Embraer Legacy 600	0	196	0
E55P	Embraer EMB-505 Phenom 300	0	525	0
FA7X	Dassault Falcon 7X	0	694	0
GLEX	Bombardier BD-700 Global Express	0	250	0
J328	Dornier 328JET	1,095	1,095	1,095
RJ85	RJ-85 Avroliner, BAe RJ-85	0	0	0
SB20	Saab 2000	0	0	0
	Other	0	0	0
	Total	110,995	110,590	110,990

9.1.6 All turbofan-type aircraft jet engines with a rated power greater than 26.7 kN are certified by the ICAO for emissions of NOx, HC, Smoke Number and, for newer engines, non-volatile particulate matter (nvPM). Certification results are published in the ICAO Emissions Databank[2]. In addition, a database of emissions indices for all commercially operational turboprop aircraft engines is kept by the Swedish Defence Research Agency (FOI)[3]. These databases contain fuel flow rates in kg/s and emission indices of individual pollutants in grams of pollutant per kilogram of fuel used; multiplying the emission index by the fuel flow gives the emission factor in g/s. Data is given at four thrust settings, representative of different modes of the LTO cycle.

9.1.7 For each type of aircraft, emissions per aircraft movement have been calculated using emission factors and times in mode, based on the following equation:

Eij = ∑ (TIMjk*60) * (FFjk) * (EIjk) * (NEj)

Where:

Eij = Emissions of pollutant i in grams, produced by aircraft type j for each LTO cycle;

TIMjk = Time-in-mode for mode k in minutes for aircraft type j

FFjk = Fuel flow for mode k in kg/sec for each engine on aircraft type j

[2] ICAO (2021). ICAO Aircraft Engine Emissions Databank, version 28c. https://www.easa.europa.eu/domains/environment/icao-aircraft-engine-emissions-databank
[3] Swedish Defence Research Agency (2021) The Environmental Impact of Aircraft. https://www.foi.se/en/foi/research/aeronautics-and-space-issues/environmental-impact-of-aircraft.html

EIjk = Emissions index for each pollutant i in grams per kilogram of fuel, in mode k, for each engine used on aircraft type j; and

NEj = Number of engines on aircraft type j.

9.1.8 Airframe/engine assignments were based on actual data for all aircraft. For those aircraft types which may be fitted with more than one type of engine, the most common engine in the Airport fleet was chosen.

9.1.9 The approach used for the estimation of PM emissions arising from aircraft engines has undergone development in recent years. The ICAO Airport Air Quality Manual recommends the so-called First Order Approximation (FOA) version 4.0, but notes that nvPM measurements from the ICAO Databank should be used in preference to values estimated using FOA. This assessment therefore takes nvPM emission factors from the ICAO Databank where available, and uses FOA4.0 otherwise (for engines which are out of production). Volatile PM (vPM) emission factors are calculated using FOA4.0 for all engines.

9.1.10 Emissions of PM from the turboprop and smaller (business) jet aircraft, where no Smoke Number indices are available, have been disregarded, but these are considered to be negligible.

9.1.11 For certification purposes, ICAO has defined a 'reference' LTO cycle with four modal phases, extending to a ceiling height of 3,000 feet (915 metres). Emission factors are provided for 'take-off' (100% thrust), 'climb-out' (85% thrust), 'approach' (30% thrust) and 'idle' (7% thrust). In reality, aircraft rarely take-off at 100% thrust — the actual take-off thrust used being dependent on a combination of factors including take-off weight and weather conditions. Following discussion with the Airport, and in consideration of the short runway, a take-off thrust of 100% was used for all aircraft departures. This is a conservative assumption.

9.1.12 Take-off roll along runway, and initial climb to 1500 ft (457.5 m) was assumed to be at 100% thrust setting. Climb-out after throttle back from 1500–3000 ft (457.5–915m) was assumed to be at 85% thrust.

9.1.13 The majority of commercial jet aircraft operating at the Airport have reverse thrust capability, which may be deployed during the landing roll to increase the rate of deceleration. However, the Airport discourages the use of reverse thrust to reduce noise, and the airlines also try to avoid the use of reverse thrust to minimise fuel consumption. As a result, only a very small number of aircraft movements at the Airport utilise reverse thrust above idle during landing. The assumption used in the modelling has therefore been that aircraft engine thrust is reduced to idle (7%) for the landing roll (i.e. from the point of touchdown on the runway to the start of taxi); emissions from the small number of aircraft using reverse thrust above idle has been discounted as they are expected to make an insignificant contribution to total runway emissions.

9.1.14 Emission factors within the ICAO and FOI databases are usually stated for new engines. PSDH recommended adjustment factors to account for engine deterioration. However the ICAO Air Quality Manual recommends not making such adjustments, and this (more recent) advice has been adopted,

9.1.15 Times-in-mode have been derived from information provided by the Airport. Approach, landing roll, warm-up, hold, take-off roll and climb times were taken from CADP1 data; these are assumed to be unchanged in future scenarios. For taxi times, information has been derived from the Electronic Flight Progress System (EFPS) that monitors the time that aircraft operate engines on the ground from engine start-up to start-of-roll at departure, and following aircraft touch down until engine shut-down on stand, on arrival. For most movements in 2019, taxi times were derived from the EFPS data for the corresponding movement. For the remaining movements in 2019, where it was not possible to match the movement data to the EFPS data or some data items were missing, and for all movements in the future scenarios, taxi times were derived from tables of average times between each group of stands and each runway end. A summary of these data is provided in Table 9-4 and Table 9-5.

Table 9-4: Summary of Times In Mode

Mode	Time (minutes)
Warm-Up	5.3
Hold	2.3
Take-Off Roll	0.4
Initial Climb	1.4
Climb Out	1.0
Descent	4.4
Approach	2.1
Landing Roll	0.7
APU	0.2

Table 9-5: Summary of Taxi Times

Runway	Stand group	Taxi-in time (minutes)	Taxi-out time (minutes)
09	3–10	4.3	4.1
09	12–JC	8.0	6.0
09	21–28	3.1	4.7
27	3–10	2.9	6.5
27	12–JC	4.1	9.0
27	21–28	2.8	5.7

9.1.16 Emissions during climb-out and approach have been calculated to a ceiling height of 3000 feet (915 m).

Brake & Tyre Wear

9.1.17 An allowance has also been made for PM emissions arising from brake and tyre wear. The ICAO Airport Air Quality Manual does not offer a methodology for estimating brake and tyre wear emissions, so this assessment uses a methodology developed during the PSDH work[4].

9.1.18 For brake wear, an emission factor of 2.53×10^{-7} kg PM_{10} per kg Maximum Take-off Weight (MTOW) was assumed.

9.1.19 For tyre wear, the following relationship was used:

PM_{10} (kg) = $0.1 \times 2.23 \times 10^{-6} \times$ (MTOW kg) – 0.0874 kg, where MTOW > 55,000 kg;

PM_{10} (kg) = $2.41 \times$ (MTOW kg) / 55,000, where MTOW < 55,000 kg.

9.1.20 The mean size of particles from attrition processes such as brake and tyre wear tends to be much higher than for combustion processes, so in this case setting $PM_{2.5}$ emission factors equal to PM_{10} emission factors is likely to be overestimate $PM_{2.5}$ emissions. For this assessment, the same assumption has been used as in modelling work for Heathrow Airport[5], namely that $PM_{2.5}/PM_{10}$ ratios for road vehicles are appropriate. Emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2019[6] imply $PM_{2.5}/PM_{10}$ mass ratios of 0.4 for brake wear and 0.7 for tyre wear.

[4] Curran (2006) Method for estimating particulate emissions from aircraft brakes and tyres. Qinetiq/05/01827,
[5] Underwood et al (2010) Heathrow Airport Emission Inventory 2008/9. AEAT/ENV/R/2906 Issue 1, July 2020.
[6] EEA (2019) EEA/EMEP air pollutant emission inventory guidebook 2019 Chapter 1.A.3.b.vi Road transport: Automobile tyre and brake wear. http://www.eea.europa.eu/publications/emep-eea-guidebook-2019.

Auxiliary Power Units

9.1.21 Auxiliary Power Units (APUs) are used to provide power to larger aircraft when the main engines are not running. APUs are used to condition the aircraft cabin air when temperatures are uncomfortable, and are also required to start the main engines on some of the newer aircraft. Other requirements for APU use occur if there is an incompatibility between the aircraft system and the Fixed Electrical Ground Power (FEGP) or Mobile Ground Power Unit (MGPU) supplies, or if there is a technical fault.

9.1.22 Operational and Safety Information Notice (OSIN 04/12), issued by the Airport, requires the use of FEGP or MGPU whenever available and serviceable. APUs are required to be shut down as soon as practicable following arrival and not restarted until 10 minutes prior to departure, except when the ambient air temperature is below +5 °C or above +20 °C. Operators wishing to use APU when these temperature thresholds are exceeded, or where there are technical faults, are required to contact Air Traffic Control (ATC) who maintain a log of such events. An analysis of records indicates that such events are very uncommon, representing only <1% of all aircraft movements.

9.1.23 APU running times on arrival are dependent upon the availability of FEGP or MGPU; running times range from 1 to 5 minutes depending on how busy the Airport is. For the purpose of this assessment, a total APU running time of 13 minutes per LTO cycle has been assumed, which is likely to represent a worst case. Emissions for APUs have been calculated using the advanced approach as defined in the ICAO Airport Air Quality Manual, assuming a total running time of 13 minutes per LTO cycle (arrival + departure). This assigns different emission indices to different APU operating loads, i.e. start-up (no load), normal running (maximum Environmental Control System (ECS)), and high load (Main Engine Start (MES)). The assigned NOx, HC and PM emission rates are shown in Table 9-6.

Table 9-6: Summary of APU Emission Rates (g per LTO cycle)

Aircraft Group	NOx	PM	HC
Business jets/regional jets (seats < 100)	131	9.0	56
Smaller (100 ≤ seats < 200), newer types	140	6.5	45
Smaller (100 ≤ seats < 200), older types	140	11.6	13
Mid-range (200 ≤ seats < 300), all types	306	7.9	8
Larger (300 ≤ seats), older types	348	23.1	14
Larger (300 ≤ seats), newer types	549	5.2	10

Engine Testing

9.1.24 Ground running of aircraft engines is occasionally required for testing and maintenance purposes. Emissions for the 2019 Baseline Year were derived from the records of ground running provided to the Council in LCY's 2019 Annual Progress Report[7]. These records include the number, duration and power settings of ground runs, the aircraft involved, and the stands used.

9.1.25 Ground running emissions were calculated from the duration of the run, and the associated fuel use and emission indices for the power setting used (assumed to be 100% or 7%). The total annual ground running emissions were then apportioned as an average emission rate and included in volume sources across the apron areas.

9.1.26 For all future scenarios, pollutant emissions from ground running were estimated by scaling up the 2019 Baseline Year emissions based on the projected change in aircraft main-engine LTO emissions.

[7] LCY (2020) Annual Performance Report 2019. 1 June 2020.

Ground Support Equipment (GSE)

9.1.27 Emissions from GSE, i.e. airside vehicles and plant, are associated with the transport of passengers and cargo to aircraft, and servicing and refuelling of aircraft, etc. Mobile Ground Power Units (MGPUs) provide auxiliary power for those aircraft without access to FEGP, when necessary.

9.1.28 An estimate of emissions from these sources has been based upon fuel (untaxed “red” diesel) consumption statistics for 2019 provided by the Airport, with the data disaggregated by user group (e.g. Ramp Services, Operations etc.). A list of road vehicles with permanent airside passes for each user group was provided by LCY, including the vehicle registration number and vehicle type. A list of non-road mobile machinery (NRMM) used airside was also provided.

9.1.29 Emissions standards for road vehicles and NRMM depend on the date of registration. Where the age of the vehicle or plant item was known (e.g. from the registration number of road vehicles), the appropriate emissions standard was determined. For the remaining vehicles and plant items, a range of ages, and therefore emissions standards, was assumed. For the future scenarios, the registration year was adjusted by adding the assessment year minus 2019, and the emission standard determined for the adjusted registration year; the effect of this is to allow the newer standards to progressively penetrate the fleet while maintaining the fleet’s age profile.

9.1.30 Emission factors and fuel consumption for each road vehicle were taken from COPERT v. 5.5[8], assuming a vehicle speed of 20 km/h. Emission factors and fuel consumption for each item of NRMM were taken from the standards prescribed in the NRMM Directive[9]. A simple average of the emissions factors per unit fuel consumption factors was calculated; effectively, this assumes that each item of equipment is used equally. The total NOx and PM_{10} emissions were then calculated from the total fuel used.

Fire Training

9.1.31 Emissions associated with fire training exercises make a very small contribution compared to other Airport-related sources, but have been included in this assessment for completeness. LCY provided quantities of burnt material for 2019, which are summarised in Table 9-7.

Table 9-7: Quantities of Materials Used for Fire Training

Material	Quantity Used
Unleaded	184 litres
Wood	1133 kg
LPG	138 litres

9.1.32 Emissions data for the uncontrolled combustion of aviation kerosene (used for combustion of unleaded) and LPG were derived from the FAA Air Quality Handbook[10].

9.1.33 To estimate emissions from wood combustion, several possible sources of emission factors were considered, namely:

- The US Environmental Protection Agency publishes a variety of emission factors in its AP 42 document[11]. It includes emission factors for wood combustion in residential fireplaces, giving factors of 1.3 kg/t for NOx and 17.3 kg/t for PM_{10};

[8] European Environment Agency (2019) EMEP/EEA air pollutant emission inventory guidebook 2019. Chapter 1.A.3.b.i-iv Road transport 2019. https://www.eea.europa.eu/publications/emep-eea-guidebook-2019
[9] https://dieselnet.com/standards/eu/nonroad.php
[10] FAA (2022) Aviation Emissions and Air Quality Handbook. 29 March 2022. https://www.faa.gov/regulations_policies/policy_guidance/envir_policy/airquality_handbook
[11] US EPA (1996) AP 42, Fifth Edition, Volume I Chapter 1: External Combustion Sources. Section 1.9 Residential Fireplaces. https://www.epa.gov/sites/production/files/2020-09/documents/1.9_residential_fireplaces.pdf

- The National Atmospheric Emissions Inventory (NAEI) also publishes a range of emission factors[12]. Its factors for domestic combustion of wood are 1.1 kg/t for NOx and 7.1 kg/t for PM_{10}; and
- The NAEI emission factors for accidental straw fires are 2.25 kg/t for NOx and 11 kg/t for PM_{10}.

9.1.34 The three sources agree fairly closely. The NAEI accidental straw fire emission factors were used in this assessment, since NOx is the principal pollutant of concern and these are the highest factors for this pollutant.

Road Traffic

9.1.35 Emissions arising from traffic on the local road network were calculated using Defra's Emission Factors Toolkit (EFT) version 11.0[13]. Predictions are based on vehicle flow, composition (assumed to be the London fleet mix) and speed. The emission rates account for emissions of PM_{10} and $PM_{2.5}$ arising from brake and tyre wear and from road abrasion. Whilst PM emissions from entrainment (or "re-suspension") of other materials on the road are also widely considered to be important, there are currently no data upon which robust emission rates can be calculated; any re-suspension component has therefore been necessarily ignored.

9.1.36 Annual average daily traffic (AADT) flows, the proportions of Heavy Duty Vehicles (HDV) and average speeds for each road link were provided by Steer for the 2019 Baseline Year and all future year scenarios, and are summarised in Table 9-8 to Table 9-9. Flows include the effects of other committed developments. The CADP proposals include the provision of a new access road to the Airport, along Hartmann Road east from Woolwich Manor Way; this new link has been included for the appropriate future year scenarios. The road links included in the assessment are shown in Figure 9.1.

9.1.37 Road links for assessment against the air quality objectives are the same as those used in the CADP1 assessment for consistency. These were chosen to cover the road links with the greatest airport-related traffic increases, and therefore the greatest air quality impacts. In addition, a number of road links were modelled for assessment against the Limit Values. These were chosen to be representative of links which had exceedances of the Limit Value in 2019 (there are no forecast exceedances in 2030) according to Defra's modelling; these are not intended to form a full road network but to assess impacts at representative receptors 4 m from the road, for consistency with Defra's Limit Value assessment process.

9.1.38 Emissions from the landside road network were calculated and assigned on a link-by-link basis. Road speeds were based on local speed limits, and were reduced close to junctions to take account of decelerating and accelerating vehicles, queuing and congestion.

Table 9-8: Total AADT, 2019 and DM Scenarios

Link name	2019	2025	2027	2029	2031
Royal Docks Road	26,973	31,720	31,930	32,140	32,038
Woolwich Manor Way (north of rdbt)	9,502	12,148	12,397	12,647	13,263
Royal Albert Way (east of Cyprus DLR)	16,368	21,940	23,750	25,560	25,872
Woolwich Manor Way (south of rdbt)	10,540	17,201	16,344	15,488	16,444
Pier Road	4,620	5,729	5,752	5,774	5,813
Connaught Road (east of Hartmann Road)	6,875	7,307	7,188	7,070	5,534
Hartmann Road (east of Connaught Road) - Western Airport Access	10,128	7,873	7,825	8,372	4,842
Hartmann Road (West of Albert Road) - Committed Eastern Airport Access	0	0	0	0	3,281
Connaught Road (east of rdbt)	12,541	11,829	12,083	12,336	10,326
Connaught Road (west of rdbt)	12,541	11,829	12,083	12,336	10,326
Connaught Bridge (south)	24,234	29,994	31,550	33,107	34,422

[12] NAEI (no date) Emission factors detailed by source and fuel. https://naei.beis.gov.uk/data/ef-all
[13] Defra (2021) Emissions Factors Toolkit. EFT v11.0. https://laqm.defra.gov.uk/air-quality/air-quality-assessment/emissions-factors-toolkit/

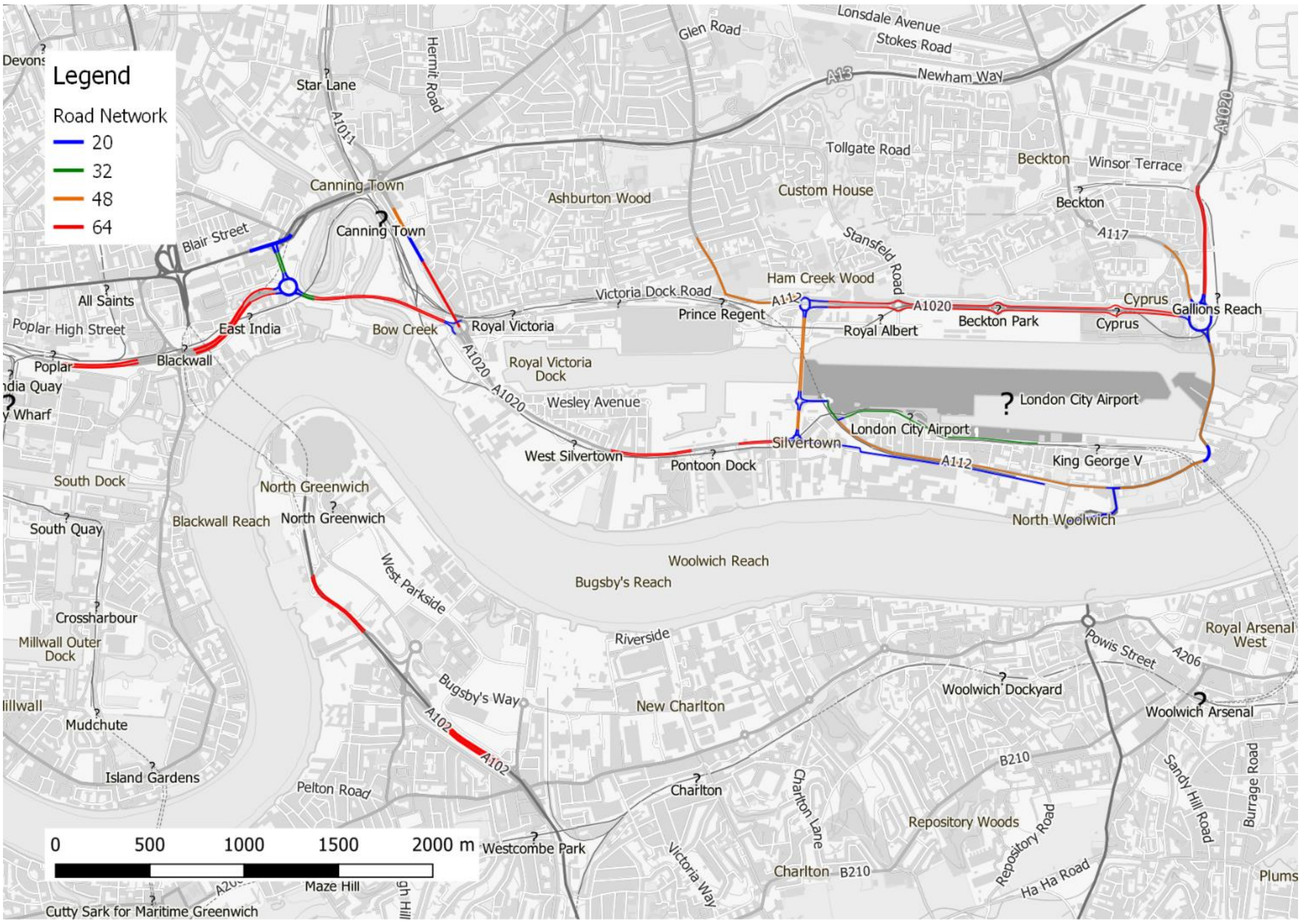
Link name	2019	2025	2027	2029	2031
North Woolwich Road (east of rbdt)	6,434	6,881	6,704	6,527	6,396
North Woolwich Road (west of rbdt)	23,855	30,597	32,568	34,539	36,390
Connaught Bridge (north)	20,355	26,953	28,555	30,158	29,580
Royal Albert Way (west of Stanfield Road)	18,188	26,042	28,000	29,958	30,155
Victoria Dock Road	11,960	14,061	14,282	14,504	14,771
Lower Lea Crossing (East of East India Dock Road)	42,797	46,798	48,445	50,092	51,349
Aspen Way (West of Slip to Lower Lee Crossing)	100,523	127,610	128,163	128,715	129,026
A13 East of A102	55,555	48,781	49,412	50,043	50,678
Leamouth Road	27,515	25,187	25,520	25,852	26,125
Silvertown Way (Slip to Lower Lea Crossing)	27,599	36,372	38,896	41,421	43,772
Silvertown Way (Overpass)	3,009	4,741	5,044	5,346	5,564
Silvertown Way (Between Caxton Street and Hallsville Road)	8,286	12,924	13,545	14,165	14,890
Blackwall Tunnel Northern Approach A12 (South of Abbott Road)	82,380	97,262	96,873	96,483	96,239
Limehouse Tunnel	74,627	82,798	83,225	83,652	84,197
West India Dock Road (West of Caster Lane)	29,557	28,607	28,711	28,815	28,781
Aspen Way (East of Upper Bank Street)	94,756	108,135	108,583	109,031	109,225
Blackwall Tunnel Southern Approach A12 (South of Boord Street)	105,282	141,074	142,442	143,811	145,260
Blackwall Tunnel Southern Approach A12 (North of Peartree Way)	97,087	113,711	115,711	117,712	120,195

Table 9-9: Total AADT, DC Scenarios

Link name	2025	2027	2029	2031
Royal Docks Road	32,165	32,433	32,700	32,929
Woolwich Manor Way (north of rdbt)	12,174	12,430	12,686	13,389
Royal Albert Way (east of Cyprus DLR)	22,135	23,999	25,863	25,873
Woolwich Manor Way (south of rdbt)	17,483	16,649	15,816	17,469
Pier Road	5,736	5,758	5,781	5,824
Connaught Road (east of Hartmann Road)	7,612	7,530	7,448	5,565
Hartmann Road (east of Connaught Road) - Western Airport Access	8,731	10,192	10,825	6,572
Hartmann Road (West of Albert Road) - Committed Eastern Airport Access	56	136	428	4,454
Connaught Road (east of rdbt)	12,957	13,516	14,075	11,929
Connaught Road (west of rdbt)	12,957	13,516	14,075	11,929
Connaught Bridge (south)	30,587	32,279	33,970	35,567
North Woolwich Road (east of rbdt)	6,884	6,708	6,532	6,407
North Woolwich Road (west of rbdt)	31,172	33,279	35,386	37,491
Connaught Bridge (north)	27,505	29,234	30,963	30,045
Royal Albert Way (west of Stanfield Road)	26,284	28,312	30,340	30,259
Victoria Dock Road	14,370	14,641	14,912	15,125
Lower Lea Crossing (East of East India Dock Road)	47,207	48,937	50,668	52,120
Aspen Way (West of Slip to Lower Lee Crossing)	127,925	128,528	129,131	129,587
A13 East of A102	48,817	49,456	50,094	50,750

Link name	2025	2027	2029	2031
Leamouth Road	25,273	25,624	25,974	26,310
Silvertown Way (Slip to Lower Lea Crossing)	36,917	39,576	42,234	44,794
Silvertown Way (Overpass)	4,754	5,060	5,365	5,594
Silvertown Way (Between Caxton Street and Hallsville Road)	12,955	13,583	14,212	14,956
Blackwall Tunnel Northern Approach A12 (South of Abbott Road)	97,290	96,907	96,524	96,290
Limehouse Tunnel	82,987	83,442	83,897	84,533
West India Dock Road (West of Caster Lane)	28,665	28,778	28,892	28,884
Aspen Way (East of Upper Bank Street)	108,407	108,895	109,384	109,706
Blackwall Tunnel Southern Approach A12 (South of Boord Street)	141,221	142,608	143,996	145,487
Blackwall Tunnel Southern Approach A12 (North of Peartree Way)	113,832	115,848	117,864	120,377

Figure 9.1: Modelled Road Network



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Car Parks

9.1.39 Information on car park flows for the Baseline Year (2019) and all future year scenarios was provided by Steer and is shown in Table 9-10. For all future scenarios, the new decked and surface car park layouts were taken into consideration.

Table 9-10: Car Park Transactions per Day

Scenario	Short Stay	Main	Total
2019	925	671	1596
DM Scenarios:			
2025	828	601	1429
2027	794	576	1370
2031	754	354	1108
DC Scenarios:			
2025	1089	791	1880
2027	1046	759	1805
2031	1121	527	1647

9.1.40 The car park emissions for NOx and PM_{10} have been calculated using speed-related emissions factors contained within the EFT, to take account of travelling vehicles.

9.1.41 The travelling distance for a vehicle entering or leaving the car park has been assumed to be the length of the perimeter of the parking area, assuming an average vehicle speed of 5 km/h.

9.1.42 Specific consideration has also been given to "cold start" emissions for vehicles leaving the car park. Vehicles with cold engines emit more pollution than those with warm engines. To account for this, the additional emissions from cold starts have been calculated using BEIS cold start emission factors[14]. For simplicity, cold start emissions have been modelled as occurring within the car parks, but in reality will they be spread along the road network for a distance from the Airport.

9.1.43 Emissions of $PM_{2.5}$ have been assumed to be the same as for PM_{10}, as a conservative assumption.

Stationary Sources

9.1.44 Emissions arising from stationary sources at the Airport (e.g. gas-fired heating plant) were calculated from gas consumption data for 2019 provided by the Airport. Data are only available in an aggregated form for the terminal building, which includes use by the terminal main substation and three other gas supplies serving CAH, the Ledger Building and various cooking appliances used by the caterers. Emission rates for combustion of gaseous fuels have been obtained from the EMEP/EEA Emission Inventory Guidebook[15], which gives emission rates in grams of pollutant per gigajoule of energy (as fuel consumption). This has been used to calculate average annual emission rates based on the annual gas consumption, and assuming continuous operation throughout the year.

9.1.45 For future scenarios, the Airport confirmed that there is currently no intention to increase boiler plant capacity, but to provide a conservative approach it was assumed that gas consumption increased in proportion to the total number of passengers in each case as compared with the 2019 Baseline Year (see Table A4.22, Appendix 9.4).

[14] BEIS, Fleet-Weighted Emission Factors for Road Vehicles, March 2022 Update. https://naei.beis.gov.uk/data/ef-transport
[15] EMEP/EEA air pollutant emission inventory guidebook 2019. 1.A.4 Small combustion 2019. https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-4-small-combustion/view

Table 9-11: Assumed Gas Consumption

Scenario	Gas Consumption (kWh/y)
2019	1,055,564
DM Scenarios:	
2025	1,037,468
2027	1,109,563
2031	1,335,470
DC Scenarios:	
2025	1,120,246
2027	1,458,123
2031	1,859,917

9.1.46 The energy strategy for the Eastern Energy Centre no longer relies on gas-fired CHP and boilers, but will utilise on-site heat pumps and photovoltaics or will connect to a District Heating Heat Pump option. There will therefore be no emissions associated with the proposed principal energy strategy for the Eastern Energy Centre. There will, however be a requirement to install two 450 kVA diesel generators in the new East Pier and a single 66 kVA generator in the Western Energy Centre to provide life safety support systems. These will be tested for 30 minutes each month off-load, and annually under full load for one hour. Emissions from these have been estimated using typical generator efficiency data and emission rates from limits set by the Medium Combustion Plant Directive.

9.1.47 There is the potential for cumulative impacts to occur from existing or proposed energy centres in the area. This is generally of concern where new, tall buildings are located in the immediate vicinity of flues on adjacent buildings, and any potential for significant, cumulative impacts will be highly localised.

9.1.48 The energy strategy for the proposed Silvertown development to the west of Connaught Bridge will connect to the EON District Heating Silvertown Ectogrid, and there will be no associated emissions[16].

9.1.49 Emissions from the Engie energy centre at ExCel were considered in detail in the Environmental Statement prepared to accompany the planning application for the Western Gateway[17]. This confirmed the maximum predicted annual mean nitrogen dioxide process contribution to be 4.9 µg/m3, based on conservative operating assumptions. This related to an on-site receptor, and concentrations at off-site receptors were all much lower (<0.5 µg/m3).

9.1.50 The Royal Albert Dock scheme lies to the north of the Dock. Emissions from the on-site energy centre were considered in detail in the Environmental Statement prepared to accompany the planning application[18]. This confirmed the maximum predicted annual mean nitrogen dioxide process contribution to be <0.1 µg/m3, based on conservative operating assumptions.

9.1.51 It is concluded that the potential for significant cumulative effects from nearby energy centres can be discounted.

9.1.52 The Tate & Lyle factory, which lies to the south of the Airport, operates gas and gas-oil boilers. Due to the location of this installation relative to the Airport, and the height of the stacks, the emissions arising from these boilers have also been included within the model for completeness as part of the baseline. Emission

[16] The Silvertown Partnership. Permanent Energy Solution Study, prepared by Aecom.
[17] Entran (2020) Western Gateway Phases 2, 2a and 3. ES Volume 3, Appendix Air Quality, Annexes 1-10.

[18] URS (2015) Royal Albert Dock Hybrid Planning Application. Chapter 9 – Air Quality.

rates and stack parameters were provided by the Environment Agency and are summarised in Table 9-12. Emissions from the Tate & Lyle plant were assumed to remain unchanged for all future scenarios.

Table 9-12: Summary of Tate & Lyle Emissions

Parameter	Natural Gas Boiler	Gas-Oil Boiler
Boiler Capacity (MW)	60	60
Stack Height (m)	93.5	93.5
Stack Diameter (m)	1.63	1.63
Stack Location (X,Y)	542250, 179907	542274,179904
Exhaust Gas Efflux Velocity (m/s)	22.3	24.9
Emission Temperature (°C)	140	170
NOx Emission Rate (g/s)	0.694	0.694
PM10 Emission Rate (g/s)	n/a	0.0059
Operating Conditions (hrs/yr)	8760	8760

Background Contributions

9.1.53 The ADMS-Airport model predicts pollutant concentrations from those sources of emissions that have been explicitly included in the model (as defined above). It is also necessary to take account of the contribution from other pollutant sources that are not explicitly included – normally referred to as the "background contribution".

9.1.54 Background pollutant concentrations were obtained from national background pollutant maps published by Defra. These include modelling background concentrations for the whole country, published in a 1 x 1 km grid. These are published as total background pollutant concentrations, but are broken down by source contribution including road, rail, airport, domestic, industrial and rural sources.

9.1.55 In order to avoid 'double counting' of airport-related pollution sources, the 'airport' contributions to the background mapped concentrations have been removed. The 'in-square' contributions of motorways, trunk roads and principal roads have also been removed from the background map calculations, as these sources are all explicitly included in the ADMS-Roads traffic model.

Meteorological Data

9.1.56 In the Scoping Opinion, LBN requested that the effect of varying meteorology on the predicted concentrations be undertaken (Issue AQ10). In this process, the model is verified for a baseline year and then the effects of varying meteorology are tested using between three to five datasets. These tests are predicated on an assumption that the activity data are not affected by changing meteorology. For airports, this is not the case for all activities, as the frequency of easterly and westerly operations on Runway 09 and Runway 27 is affected by the wind direction. However, this only affects the direction of take-off and landing; all other airport sources are not affected, and landside traffic emissions are also not affected. Such a spatial realignment of take-off and landing geometries is likely to affect predicted concentrations at the closest sensitive receptors, and a sensitivity test has been undertaken.

9.1.57 As such, hourly sequential meteorological data for 2017–2021 (the five 'met years') were obtained from the Meteorological Office station at the Airport. For the future scenarios, emissions were modelled for each of the five met years in turn, and for each receptor and pollutant, the greatest concentration from the five met years was selected. This ensures a worst-case assessment.

9.1.58 Runway use at the Airport is determined by wind direction. Runway 27 (westerly) is the most frequently used runway, with 69% of operations in 2019; however, when the wind direction is from the east, Runway 09 (easterly) is used. The Airport provided details of runway allocation for each departure and arrival during 2019. These data showed a strong correlation demonstrating that during easterly wind conditions (between 0 degrees and 180 degrees), aircraft operated from Runway 09, whereas during westerly wind conditions (between 180 degrees and 360 degrees), aircraft operated from Runway 27. Therefore, in the ADMS-Airport model, runway allocation has been determined by wind direction. During hours where winds occur in the sectors 10 - 180°, Runway 09 is assumed to be in use, and sources using Runway 27 are “switched off”. During hours with winds occurring in the sectors 190 – 360°, Runway 27 is assumed to be in use and sources using Runway 09 are “switched off”.

NOx to NO_2 Relationship

9.1.59 Nitrogen dioxide (NO_2) concentrations have been calculated from the predicted NOx concentrations using the NO_2 from NOx calculator available on the Defra air quality website[19]. For the purposes of the calculator, the contributions from the aircraft and other non-roads sources are included in the calculator’s “background” input term.

Spatial and Temporal Representation of Emissions

9.1.60 Emissions occur at different locations and over different time periods. The spatial representation of sources has been undertaken using a combination of line, point, area and volume sources. Aircraft taxiing and holding emissions were represented as line sources based on schematic taxi routes between the stands and the runway. Emissions during take-off roll were distributed between the start-of-roll point on the runway and the estimated point of ‘wheels-off’.

9.1.61 Aircraft movements, including taxiing, take-off, initial climb, climb-out, approach and landing roll-out are all contained within an “airfile” in ADMS-Airport. This file contains information on the geometry of individual aircraft, the engine exhaust parameters (exit velocity, temperature and diameter), the geometry of the LTO cycle (e.g. taxiway start and end points, take-off start and end points, approach start and end points etc.), the times in mode, and the aircraft emissions.

9.1.62 Each aircraft movement between spatial nodes is included as a separate line in the airfile. ADMS-Airport then treats each source as a series of fixed jet sources between each node point. Each line of the airfile is assigned an “NT number”, which is the number of fixed jet sources along its length. For each part of the LTO cycle, there is a maximum jet source spacing, which is used to calculate NT, i.e. NT = (distance between aircraft start and end points) / (max jet-source spacing), rounded up. The ADMS-Airport User Guide includes recommended maximum jet source spacings, which depend on mode. The assessment model used either the maximum jet source spacings from the User Guide, or a smaller spacing to reflect the relatively short distances at the Airport. These are given in Table 9-13.

Table 9-13: Maximum Jet Source Spacings (m)

Mode	Maximum Jet Source Spacing Used in Assessment	ADMS-Airport User Guide Recommendation
Take off	150	200
Initial climb	300	300
Climb out	700	700
Approach	700	700
Landing Roll	200	400
Hold	400	400
Taxiing	200	400

9.1.63 The emission rates contained within the airfile are annual average emission rates based on the number of movements of a particular aircraft or group of aircraft, assuming 100% usage of both Runway 09 and Runway 27. A time-varying emission file was then used to apportion the movements to the runways on an hour-by-hour basis, depending on wind direction.

[19] Defra (2020) NOx to NO2 Calculator. https://laqm.defra.gov.uk/air-quality/air-quality-assessment/nox-to-no2-calculator.

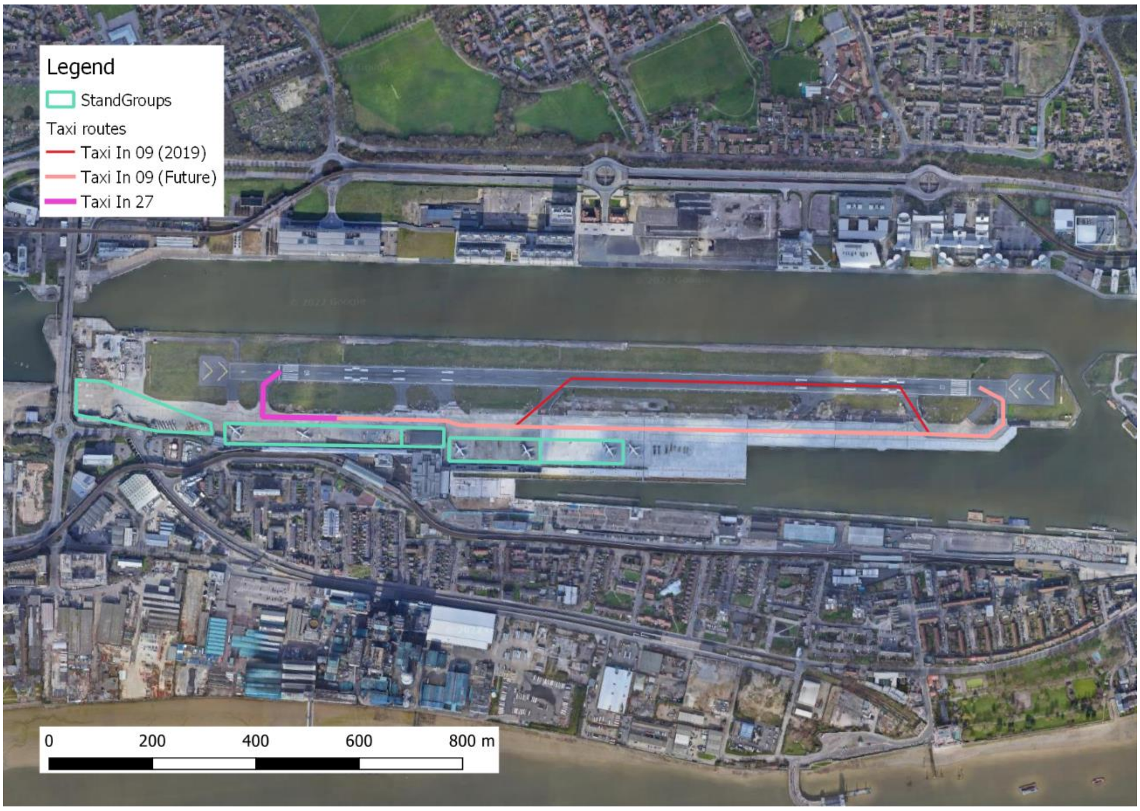
9.1.64 Dispersion of emissions has a slight dependence on hour of day, on average, since weather conditions tend to be different between night and day. A time-varying emission file was therefore used to reflect the different aircraft activity levels over the course of the week.

9.1.65 Climb-out and approach trajectories have been calculated from information provided by LCY. This includes the minimum angle of approach (5.5 degrees) as well as indicative times between lift-off and throttle-back, approach and landing, and estimated aircraft speeds during these movements.

9.1.66 Emissions from airside ground activities, including the use of APUs and GSE, airside vehicle movements, aircraft ground runs, and aircraft main engine idling on stand (the time between engine start-up and start of taxi-out on departure) have been modelled as a series of volume sources, covering the main apron areas (for future scenarios, these are Stands 3-10, Stands 12-15 and Jet Centre, and Stands 21-28). GSE emissions are low-level and have therefore been modelled as volume sources with a depth of 3 m and a source centre height of 1.5 m. APU, aircraft ground running, and aircraft main engine idling emissions have an initial release height, as the jet engines/APU units are elevated on the aircraft fuselage, and the emissions are hot, giving them a degree of buoyancy. To account for this, APU and aircraft ground running emissions have been modelled as volume sources with a depth of 15 m and a source centre height of 7.5 m.

9.1.67 Stand groups, taxi routes and hold points are shown in Figure 9.2 and Figure 9.3.

Figure 9.2: Modelled Stand Groups and Taxi-In Routes



Imagery ©2022 The GeoInformation Group

Figure 9.3: Modelled Stand Groups, Taxi-Out Routes and Hold Points

Imagery ©2022 The GeoInformation Group

9.1.68 Emissions from the car parks were modelled as volume sources with a depth of 3 m. Emissions from the terminal building, fire training area and engine testing were represented as area sources, at terminal roof or ground level height as appropriate. Emissions from the Tate & Lyle gas and gas-oil boilers were represented as point sources.

Model Verification

9.1.69 The process of model verification refers to a comparison between the predicted and locally-measured pollutant concentrations. Model verification may or may not result in an adjustment of predicted results depending on the outcomes and / or the source types being considered.

9.1.70 Comparison of the annual mean modelled nitrogen dioxide concentrations in 2019 with monitored concentrations at sites within the Airport's and LBN's AQMS (two continuous monitors and sixteen diffusion tube sites) shows the model over-predicts concentrations by around 9%, on average, as shown in Figure 9.4 and Table 9-14. Figure 9.4 shows the monitored versus modelled concentrations, along with a regression line (forced to pass through zero) (red line), the 45° line (solid black line) which represents perfect fit between modelling and monitoring, and lines representing 25% above and 25% below perfect fit (black dashed lines). The crosses are mostly to the right of the 45° line, indicating that the modelled concentrations are greater than the monitored concentrations. Modelled results are within 25% of the monitored concentrations at all but one receptor.

Figure 9.4: Monitored versus modelled annual mean nitrogen dioxide concentrations

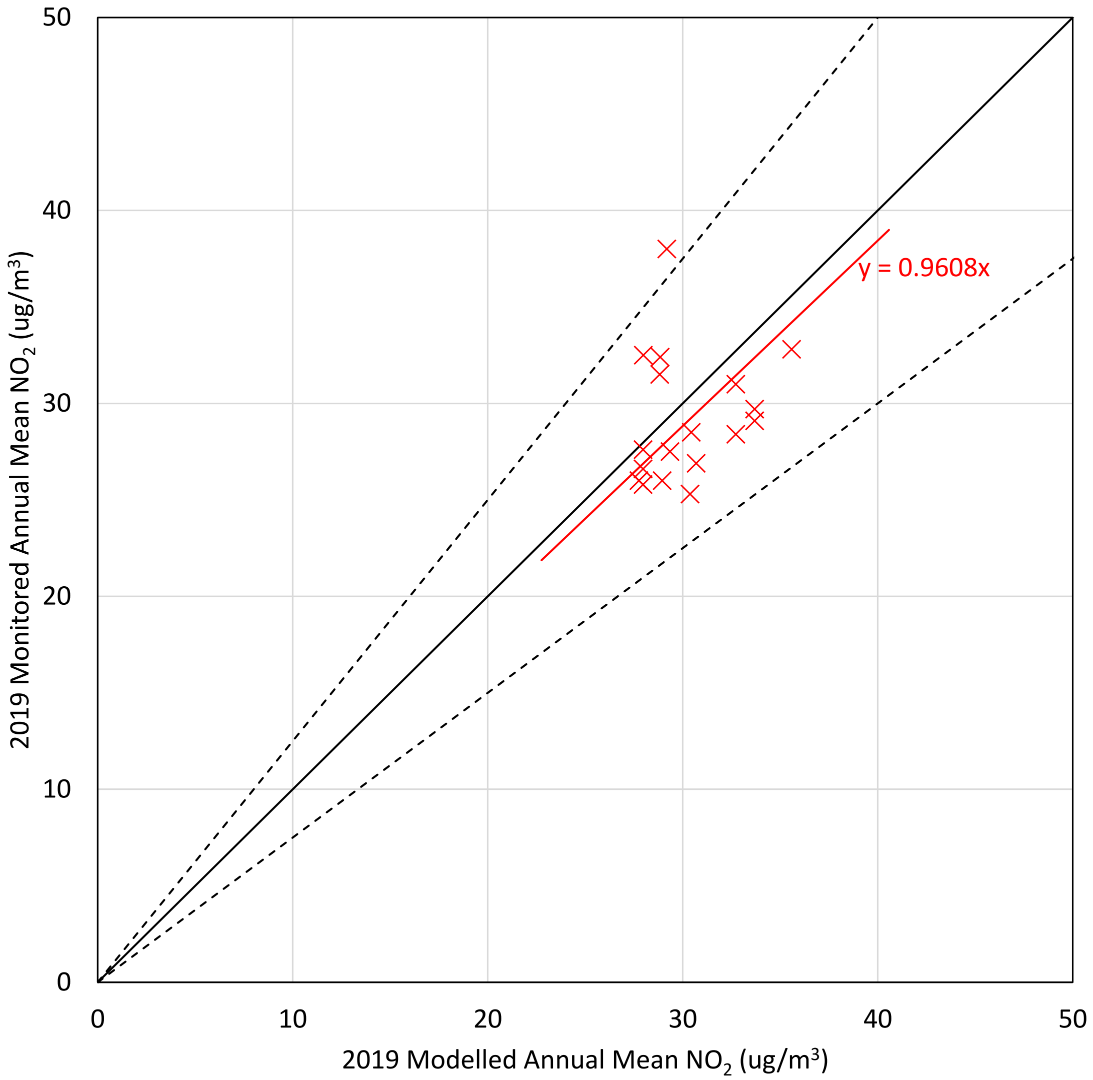


Table 9-14: Monitored versus modelled annual mean nitrogen dioxide concentrations

Receptor name	Measured NO2	Modelled NO2
LCA-CAH	29.7	33.7
LCA-ND	26.6	28.0
LCA 01	28.4	32.7
LCA 02	31.0	32.7
LCA 04	27.6	28.0
LCA 05	26.0	29.0
LCA-06	26.9	30.7
LCA 07	31.5	28.8
LCA 08	25.3	30.4
LCA 09	29.1	33.7
LCA 10	32.8	35.6
LCA 11	32.4	28.9
LCA 12	28.5	30.4
LCA 13	26.0	27.8
LCA 14	32.5	28.0
LCA 15	27.5	29.4
LCA 18	25.8	28.0
NHM-S 91	38.0	29.2

9.1.71 LAQM.TG22[20] provides guidance on the evaluation of model performance. Based on the data shown in Figure 9.4, the calculated correlation coefficient is 0.20, the Root Mean Square Error (RMSE) is 3.7 µg/m^3, and the Fractional Bias is -0.04. LAQM.TG22 notes that where RMSE values are above 25% of the objective (i.e. 10 µg/m^3) that model inputs and verification should be checked. It further notes that ideally an RMSE within 10% of the air quality objective (i.e. 4 µg/m^3) would be achieved. The model performance in this assessment meets both the 25% and 10% tests, and is considered to be good.

9.1.72 The ideal value for the Fractional Bias is 0.0; the calculated value of -0.04 is not large and represents the model over-predicting concentrations. In view of the small amount of bias, which is in the direction of over-predicting concentrations, the NOx/NO_2 model has not been adjusted, which is a conservative assumption.

9.1.73 The Airport undertakes PM_{10} monitoring at City Aviation House (CAH) and $PM_{10}/PM_{2.5}$ monitoring at KGV House. The annual mean PM_{10} concentrations measured at CAH and KGV in 2019 were 21.4 µg/m^3 and 16.6 µg/m^3 respectively; these compare with modelled concentrations of 18.4 µg/m^3 and 18.3 µg/m^3 respectively. This suggests the model may be underpredicting, although the spread in monitored concentrations makes firm conclusions difficult. The modelling suggests that the PM_{10} concentrations are dominated by the background (the airport, roads and other explicitly modelled sources contribute just 0.13 µg/m^3), so the discrepancy is most likely to be largely due to uncertainties in the Defra background maps. Since the concentration is only about half of the objective, the PM_{10} model has not been adjusted.

9.1.74 The annual mean $PM_{2.5}$ concentration measured at KGV in 2019 was 10.6 µg/m^3; this compares with a modelled concentration of 12.2 µg/m^3. In isolation, this suggests the model is overpredicting, but it is also plausible that $PM_{2.5}$ follows the same pattern as PM_{10} identified in the previous paragraph, and the model is underpredicting. The modelling suggests that the $PM_{2.5}$ concentrations are dominated by the background, so again, the discrepancy is most likely to be due to uncertainty in the Defra background maps. Considering that data from only a single monitor is available, and since the concentration is only about half of the objective, the $PM_{2.5}$ model has not been adjusted.

Odours

9.1.75 There is no straightforward way to quantify the potential odour effects associated with airport operations. There is no published evidence to suggest that there are any physiological health effects associated with exposure to VOCs at the concentrations at which airport odours are detectable, and the principal concern is related to nuisance or loss of amenity. A number of studies have attempted to draw comparison between an expansion in airport operations and the number of complaints that are received. One of the largest reported surveys was undertaken by Stansted Airport Ltd between August and November 2005[21], during which period the airport invited some 14,000 local residents to report any incidents of odour annoyance. During the survey period, only a very small number (99 in total) of responses were received, the majority of these from residents living a relatively large distance from the airport. The study concluded that:

"One of the critical aspects of the work has been the low levels of data and information gathered following requests to the local community. There are no persistent reports of odour as there are with noise for example. Without further accurate data and information it is not possible to draw many conclusions about correlations between odour and other factors such as meteorological data because any such correlations would not stand up to statistical challenge and would be supposition. So, although general trends have been found that when prompted, a small number of people living locally will indicate that they have experienced an odour occurrence, it has not been possible to deduce any of the causes or factors related to odour occurrences from this study"

9.1.76 The Stansted study also included an assessment of the relationship between odour complaints and the number of air traffic movements at four major airports (Heathrow, Gatwick, Manchester and Birmingham). The

[20] Defra (2022) Local Air Quality Management: Technical Guidance (TG22). August 2022. https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf
[21] BAA (2008). Generation 2 Environmental Statement Volume 4: Air Quality.

study concluded that there was no clear relationship between odour complaints and the number of aircraft movements, and that the number of complaints recorded each year, even at large airports such as Gatwick and Birmingham, are extremely low and in single figures.

9.1.77 As part of the legal agreement associated with the 2009 planning approval, LCY commissioned a pilot study to investigate VOC concentrations and the prevalence of airport-related odours[22]. The study comprised of walk-around surveys to record the presence of odours, and included VOC monitoring using a low sensitivity (ppb) Photo-Ionisation Detector (PID). Several important conclusions were drawn from this study:

- Airport-related odours were perceived in the vicinity of LCY at times when measured VOC concentrations remained at background concentrations. Given the relatively high odour threshold of aviation kerosene (1,000 to 10,000 ppb), it was concluded airport-related odours are probably associated with organic hydrocarbons produced by the pyrolysis of kerosene in the jet engine, i.e. associated with what are sometimes called 'burnt' hydrocarbons; and
- The greatest potential for odour emissions is believed to occur during aircraft taxi movements after landing, when thrust settings are low and the engine components are very hot.

9.1.78 A commonly-applied approach in some airport assessments is to base the odour assessment on the change in aircraft-related VOC emissions. However, there is no evidence to correlate total aircraft-related VOC concentrations with the human perception of odours. Moreover, given that airport odours are unlikely to be related to total VOCs, any such correlation is expected to be very weak.

9.1.79 A variation on this general modelling approach was undertaken at Copenhagen Airport in 2002[23]. This study quantified odour emissions from aircraft engines using actual fuel flow and emissions measurements, odour panel results, engine specific data and aircraft operational data, and used this information to predict odour concentrations. Important outcomes from the study were a calculated odour emission rate from the aircraft engines of 57 Odour Units (ou_E) per milligram of hydrocarbon, and the identification that the majority of the odorous emissions (97%) occurred whilst aircraft engines were running at idle. The calculations were carried out for only a limited number of engine types (predominantly the JT8D-219, which is not in use at the Airport) and the study recognised that "the uncertainties become large when the experimental data is used to estimate the odour emissions for all aircraft engines".

9.1.80 Notwithstanding the above caveats, the outcome of the Copenhagen study has been used in a study to assess potential odour effects at Farnborough Airport[24]. The study included measurements of VOCs and an olfactometry study, but the results were inconclusive and no use was made of the data in forming any conclusions. The study also used the odour emission rate derived from the Copenhagen study, only taking account of aircraft emissions during idle mode (on stand and taxiing), which produced results that seemed credible in comparison to the records of odour complaints.

9.1.81 A similar approach has been adopted for this assessment. Hydrocarbon emissions have been quantified from aircraft operations using the approach outlined above. An odour emission rate of 57 OUE/mg-HC has then been applied.

[22] AQC (2010). Measurement of Volatile Organic Compounds (VOC) Concentrations and Odours. Report No. 1004/5/F1.
[23] Morten Winther, Uffe Kousgaard and Arne Oxbøl (2006) Calculation of odour emissions from aircraft engines at Copenhagen Airport. Science of the Total Environment 366 218–232
[24] Ove Arup (2009) Rushmoor Borough Council: Farnborough Airport odour assessment. 209721.