Cambridge South East Transport Phase 2

Environmental Statement

Appendix 6.1 Further Information on Air Quality Method

31st July 2023

Emissions inventory

6.1.1 An emissions inventory was compiled for Cambridge and the surrounding area for 2019 (base year) and 2026 (opening year) using Cambridge Environmental Research Consultants Ltd's (CERC) emissions inventory toolkit (EMIT), version 3.9.0. Although the opening year used for the modelling was 2026, the Proposed Development opening year is expected to be 2027. However, using 2026 is conservative, given that emissions should decrease in future years.

Major road traffic emissions

Traffic flows

6.1.2 Traffic flows and speeds for 2019 and 2026 were taken from the Proposed Development traffic model provided by Atkins, version 8.1 for 2019 and version 8.3 for 2026. Additional speed data were provided for the Proposed Development and these were used in the modelling. The traffic data comprised morning peak (AM), inter peak (IP), afternoon peak (PM), and annual average daily traffic (AADT) flows and speeds for cars, light goods vehicles (LGVs), heavy good vehicles (HGVs) and buses. Traffic flows provided were in the form of straight line links and were mapped onto Ordnance Survey Mastermap road geometry.

Emission factors

6.1.3 Traffic emissions of nitrous oxides (NO_x), nitrous dioxide (NO_2), particulate matter less than 10 microns in diameter (PM_{10}) and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) were calculated from traffic flows using Defra's Emission Factor Toolkit (EFT) version 11.1. The EFT emission factors include PM_{10} and $PM_{2.5}$ emissions both from exhaust and non exhaust sources, i.e. brake, tyre and road-wear. Emissions factors of ammonia (NH_3) were taken from Air Quality Consultants Calculator for Road Emissions of Ammonia (CREAM) model V1A.

6.1.4 Emissions were calculated separately for the AM, IP, PM and off-peak periods and aggregated to give average emission rates. The emissions data include primary NO_2 emission factors for each vehicle type, resulting in accurate road-by-road NO_x and NO_2 emission rates.

6.1.5 Note that there is uncertainty surrounding the current emissions estimates of NO_x from all vehicle types, in particular diesel vehicles, in these factors. In order to address this discrepancy, the NO_x emission factors were modified based on recently published Remote Sensing Data (RSD) for vehicle NO_x emissions. Scaling factors were applied to each vehicle category and Euro standard. These factors do not change over time but, as separate factors are applied to each Euro standard, the overall impact of the factors changes over time.

Vehicle fleet composition

6.1.6 The traffic emission factors described above are defined for different vehicle types representing combinations of fuel type, engine type (Euro category) and engine size. Road-by-road emission rates are calculated by applying emission factors for each vehicle subcategory and multiplying by the total traffic flow and the proportion of the total made up of each vehicle type.

6.1.7 The vehicle fleet composition was calculated from Automatic Number Plate Recognition (ANPR) data recorded in Cambridge in June 2017 and projected to 2019 and 2026 using the EFT fleet projection tool. The Council provided the number of electric buses and the number of each Euro-category bus in 2019 and expected for 2026; these numbers were used to derive a bus fleet composition assumption as shown in Table A6.1.1.

Table A6.1.1 Bus fleet composition for Cambridge

Year	Euro IV		Euro V		Euro VI		Electric	
	No.	%	No.	%	No.	%	No.	%
2019	26	15%	81	48%	60	36%	2	1%
2026	0	0%	77	46%	60	36%	32	19%

Buses

6.1.8 The buses to be used on the Proposed Development will be hybrid buses and were modelled as:

- Euro VI south of Francis Crick Avenue
- Electric north of Francis Crick Avenue

Time-varying emissions profiles

6.1.9 The variation of traffic flow during the day was taken into account by applying a diurnal profile to the road emissions. The diurnal profile was calculated from the 2017 automatic number plate recognition (ANPR) data combined with the AM, IP, PM and AADT flows from the traffic model and were applied to all modelled roads. The profiles are shown in Figure A6.1.1.

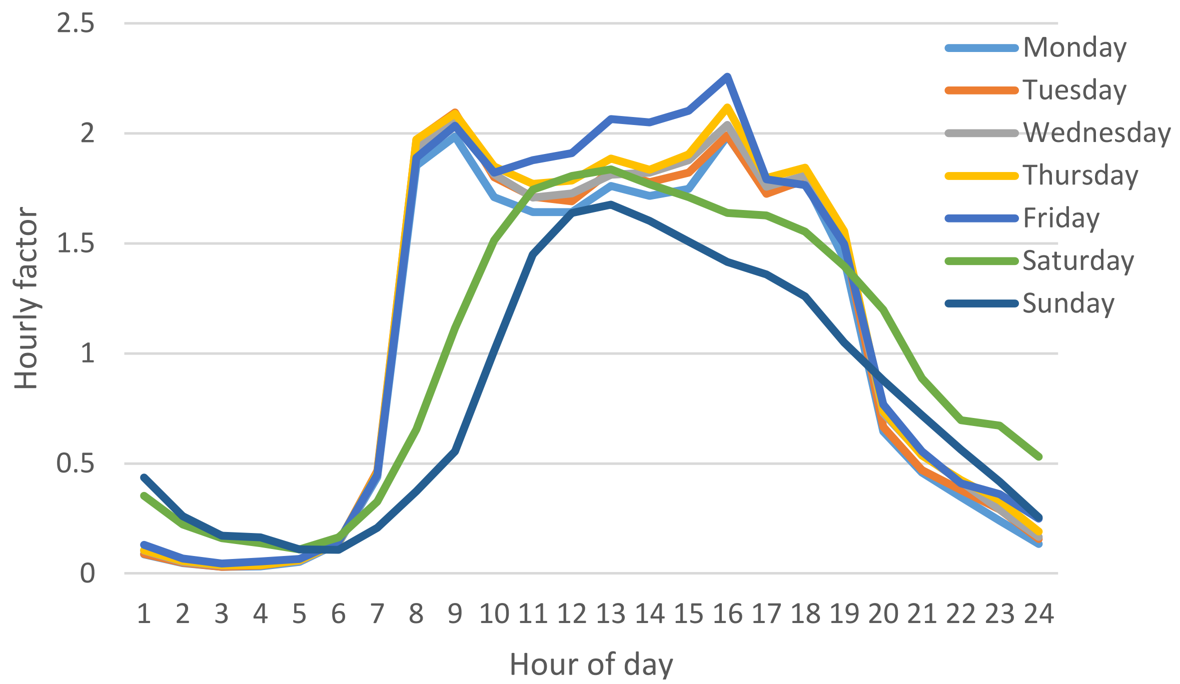

Figure A6.1.1 Diurnal profiles for Cambridge

Industrial sources

6.1.10 Large point sources were taken from national atmospheric emissions inventory (NAEI)[1] data and data provided for Addenbrookes site by the Council. All other industrial emissions were included in the NAEI gridded emissions as described under other sources.

NAEI point sources

6.1.11 Emissions parameters for large point sources were taken from NAEI data. Where data were available, source-specific stack height, diameter, velocity and temperature data were used; for other sources, default parameters were used. Emissions parameters in the NAEI data were assumed constant until 2026.

Cambridge Biomedical Campus point sources

6.1.12 Emissions parameters for the modelled industrial sources at the Cambridge Biomedical Campus (CBC) sites are presented in Table A6.1.2.

Table A6.1.2 Emissions from industrial sources g/s

Site Name	Location	NOx	PM10
Papworth	546245, 254947	0.080	0.001
AZ	545920, 254967	0.262	0.000
Forum	546287, 254981	0.107	0.000
Bellatrix	545929, 254594	0.116	0.000
Capella	546195, 255321	0.002	0.000
Plot 9	545940, 254694	0.010	0.000
Atria	546023, 254908	0.015	0.000
LTHW	546176, 254609	0.000	0.000
2040	546280, 254643	0.045	0.000

Other sources

6.1.13 Spatially-diffuse emissions from sources other than those explicitly modelled were represented by a set of 1-km square grid sources with a depth of 10 m. Gridded emissions data for 2019 from the NAEI were used to represent these sources. For 2026, minor road emissions were adjusted at the same rate as the calculated major road emissions, and in all other sectors the 2019 emissions were used.

Hourly grid source profile

6.1.14 An hourly profile for grid sources, which are described in Section 0, was derived from typical variations by source type taken from European Monitoring and Evaluation Programme (EMEP) data and the total local emissions for each source type. This profile is shown in Figure A6.1.2.

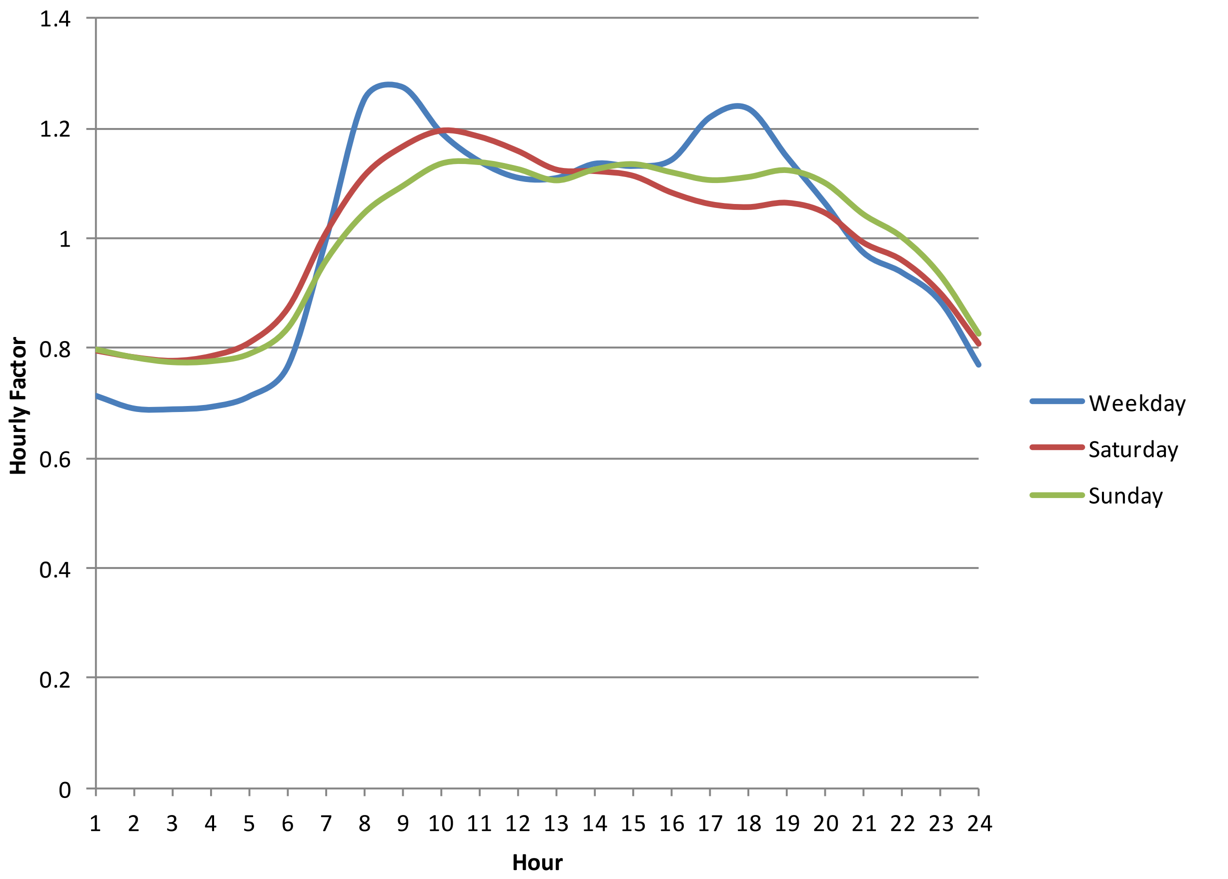

Figure A6.1.2 Diurnal profiles for grid sources

Model set-up

Choice of model

6.1.15 Modelling was carried out using the ADMS-Urban[2] model (version 5.0.1.1). The ADMS models, including ADMS-Urban and ADMS-Roads, have been used extensively for many years in local air quality management and for the assessment of air quality impacts from proposed transport schemes and emission reduction schemes. The models are used by local authorities, government agencies and consultancies in the UK and overseas. The baseline modelling was carried out using ADMS-Urban.

[1] https://naei.beis.gov.uk/

[2] http://www.cerc.co.uk/environmental-software/ADMS-Urban-model.html

Surface roughness

6.1.16 A length scale parameter called the surface roughness length is used in the model to characterise the assessment area in terms of the effects it will have on wind speed and turbulence, which are key factors in the modelling. A value of 0.5 m was used to represent the modelled area.

Monin-Obukhov length

6.1.17 In urban and suburban areas a significant amount of heat is emitted by buildings and traffic, which warms the air within and above an urban area. This is known as the urban heat island and its effect is to prevent the atmosphere from becoming very stable. In general, the larger the urban area the more heat is generated and the stronger the effect becomes.

6.1.18 In the ADMS-Urban model, the stability of the atmosphere is represented by the Monin-Obukhov parameter, which has the dimension of length. In very stable conditions it has a positive value of between 2 metres and 20 metres. In near neutral conditions its magnitude is very large, and it has either a positive or negative value depending on whether the surface is being heated or cooled by the air above it. In very convective conditions it is negative with a magnitude of typically less than 20 metres.

6.1.19 The effect of the urban heat island is that, in stable conditions, the Monin-Obukhov length will never fall below some minimum value; the larger the urban area, the larger the minimum value. A value of 30 m was used to represent the modelled area.

Meteorological data

6.1.20 Meteorological data from Mildenhall for the year 2019 was used in the modelling. A summary of the data is given in Table A6.1.3. Figure A6.1.3 shows a wind rose giving the frequency of occurrence of wind from different directions for a number of wind speed ranges.

6.1.21 A surface roughness value of 0.1 m and a Monin-Obukhov length of 10 m were used to represent the meteorological site.

Table A6.1.3 Summary of meteorological data

Year	Percentage Used	Parameter	Minimum	Maximum	Mean
2019	97.5%	Temperature (°C)	-5.4	36.9	11.1
		Wind speed (m/s)	0	18.0	4.0
		Cloud cover (oktas)	0	8	4.1

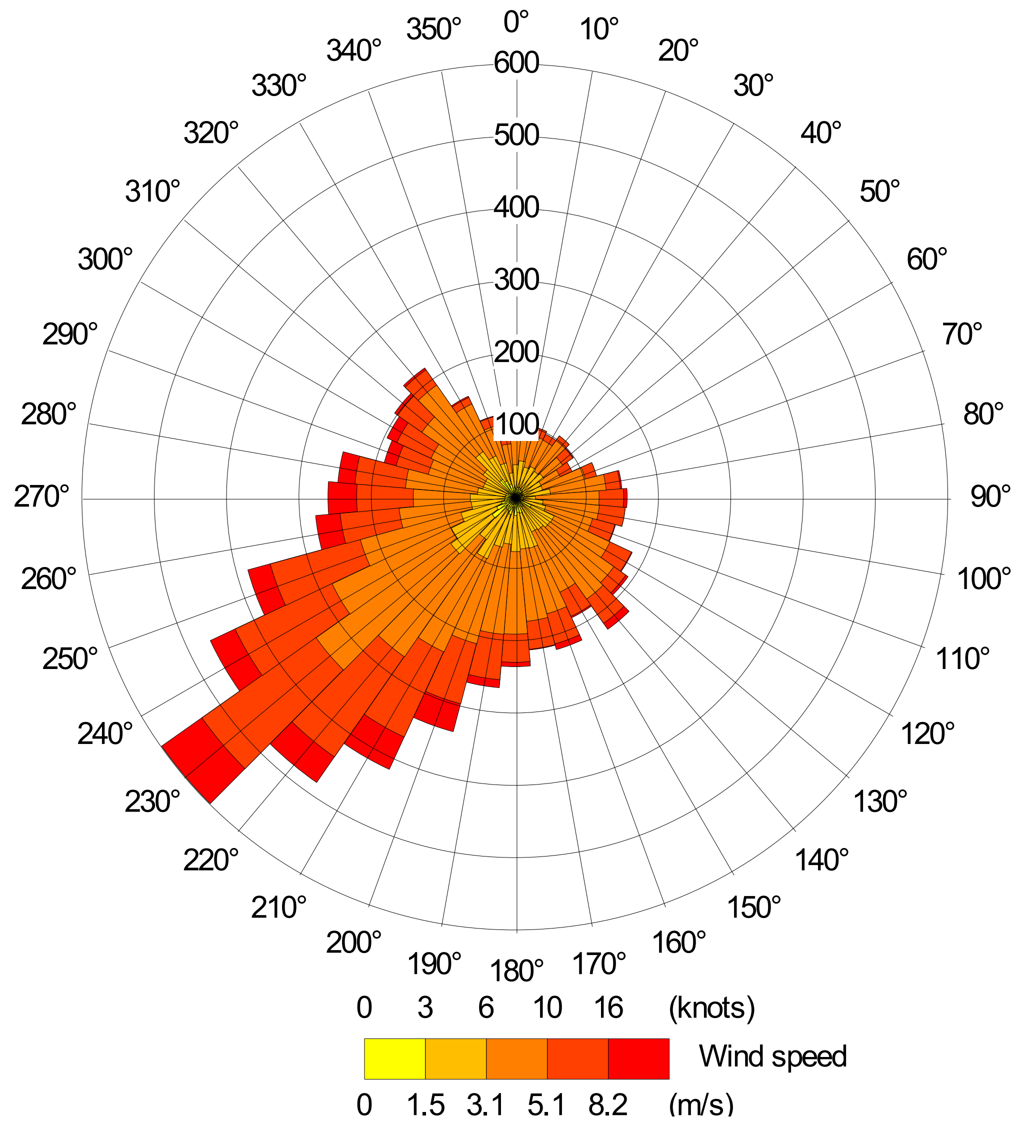

Figure A6.1.3 Wind rose for Mildenhall, 2019

Chemical reactions

6.1.22 NO_2 results from direct emissions from combustion sources together with chemical reactions in the atmosphere involving NO_2, nitric oxide (NO) and ozone (O_3). The combination of NO and NO_2 is referred to as nitrogen oxides (NO_x).

6.1.23 The chemical reactions taking place in the atmosphere were taken into account in the modelling using the Generic Reaction Set (GRS) of equations. These use hourly average background concentrations of NO_x, NO_2 and O_3, together with meteorological and modelled emissions data to calculate the NO_2 concentration at a given point.

Background concentrations

6.1.24 Pollutant concentrations in the air being blown into the modelled area are represented by hourly background data. NO_x, NO_2, and O_3 data were taken from the rural Wicken Fen monitoring site, situated in the north of the modelled area.

6.1.25 PM_{10} and $PM_{2.5}$ concentrations were taken from the rural Rochester Stoke monitoring site in Kent. This is the closest available rural monitoring site to Cambridge.

6.1.26 Table A6.1.4 summarises the annual statistics of the resulting background concentrations used in the modelling for 2019.

Table A6.1.4 Background concentrations for 2019 (µg/m3)

	NO_x	NO_2	O_3	PM_{10}	$PM_{2.5}$
Annual average	9.9	8.4	51.5	15.0	10.8
99.79th percentile of hourly average	66.5	43.7	169.8	-	-
90.41st percentile of 24-hour averages	-	-	-	28.3	22.9

6.1.27 Background concentrations show a flat or very slight downward trend over recent years. In order to avoid underestimating concentrations in 2026, the background data for 2019 was used unchanged, i.e. it was assumed that there will be no reduction in background concentrations over this period.

Street canyons

6.1.28 The presence of buildings either side of a road can introduce street canyon effects that result in pollutants becoming trapped, leading to increased pollutant concentrations. Street canyon effects were taken into account using the ADMS Advanced Canyon option, which makes use of detailed information for roadside buildings. Street canyon parameters were calculated from OS Mastermap buildings data. Estimates of building height data for recent developments close to the busway were also used.