CC014

Cambridge
Environmental
Research
Consultants

Review of the Chelmsford Local Plan – Air Quality Impact Assessment

Final report

Prepared for
Chelmsford City Council

12th December 2024

CERC

Report Information

CERC Job Number:	FM1484
Job Title:	Review of the Chelmsford Local Plan - Air Quality Impact Assessment
Prepared for:	Chelmsford City Council
Report Status:	Final report
Report Reference:	FM1484/R2/24
Issue Date:	12th December 2024
Author(s):	Matthew Williams
Reviewer(s):	Sarah Strickland

Issue	Date	Comments
1	06/12/24	Draft
2	12/12/24	Final

Main File(s):	FM1484_CERC_Chelmsford_R2_12Dec24.pdf

Contents

1 Summary

Chelmsford City Council is carrying out a five-yearly review of its Local Plan, which was adopted in 2020. The Council commissioned Cambridge Environmental Research Consultants (CERC) to carry out dispersion modelling to determine the impact of the Review of the Local Plan (Local Plan for short) on air quality.

Pollutant emissions from vehicles were calculated using traffic model data provided by the council, together with emission factors taken from the Department for the Environment, Food and Rural Affairs (Defra) Emission Factor Toolkit. To take account of the uncertainty of emission rates from diesel vehicles, these emission factors were adjusted based on real-world remote sensing data.

Emissions data from other sources were taken from the National Atmospheric Emissions Inventory (NAEI).

Modelling was carried out using the ADMS-Urban model (version 5.0.1.3) using meteorological data from Andrewsfield, the nearest Met Office weather station with suitable data, and background pollutant data from rural monitoring sites.

The modelling was carried out in line with relevant guidance including Defra's Air Quality Management Technical Guidance, TG(22), and the Institute of Air Quality Management's Land Use Planning and Development Control: Planning for Air Quality guidance.

Model verification was carried out, comparing modelled concentrations with measured data for 2023. The modelling showed generally good agreement with the measured data, with the majority of modelled concentrations within 25% of the measured data and no systematic under or overprediction of concentrations.

In the modelling for the year 2023, there were no modelled exceedences of any of the air quality limit values.

By 2041, vehicle exhaust emissions of NO_x, PM_{10} and $PM_{2.5}$ are predicted to decrease significantly. However, PM_{10} and $PM_{2.5}$ emissions also include contributions from non-exhaust emissions, i.e. road, brake and tyre wear, which are expected to increase in proportion to traffic levels.

Using the IAQM significance criteria, the impact of the Local Plan on air quality is considered ***Negligible***.

2 Introduction

Chelmsford City Council is carrying out a five-yearly review of its Local Plan, which was adopted in 2020. The Council commissioned Cambridge Environmental Research Consultants (CERC) to carry out dispersion modelling to determine the impact of the Local Plan on air quality.

The air quality standards, with which the calculated concentrations are compared, are presented in Section 3. An overview of the area and details of local monitoring data are given in Section 4. The emissions data are summarised in Section 5, and the detailed model set-up is summarised in Section 6.

The model verification for 2023 is presented in Section 7, and the results of detailed modelling for 2023 are presented in Section 8. The results of the modelling for the 2041 scenarios are given in Section 9. As assessment of the significance of air quality impacts due to the Local Plan is provided in Section 10, and a discussion of the results in Section 11.

A glossary is provided in Appendix A and a description of the ADMS-Urban model is given in Appendix B.

3 Air quality standards

In the UK, the *Air Quality Standards Regulations 2010* [1] set legally binding limits for outdoor concentrations of air pollutants which take into account the effects of each pollutant on the health of those who are most sensitive to air quality. *The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020*[2] updated the 2010 regulations to set a new limit value for $PM_{2.5}$ of 20 µg/m³. Local authorities are required to review and assess air quality and to take action to improve air quality when the limit values are not met. The limit values are presented in Table 3.1.

Table 3.1: Air quality limit values

	Value (µg/m³)	Description of standard
NO_2	200	Hourly mean not to be exceeded more than 18 times a calendar year (modelled as 99.79th percentile)
	40	Annual average
PM_{10}	50	24-hour mean not to be exceeded more than 35 times a calendar year (modelled as 90.41st percentile)
	40	Annual average
$PM_{2.5}$	20	Annual average

The *Environment Act 2021* [3] set an annual mean concentration target for $PM_{2.5}$ of 10 µg/m³, however the responsibility for meeting this target sits with the national government not with local authorities.

The short-term objectives, i.e. those measured hourly or over 24 hours, are specified in terms of the number of times during a year that a concentration measured over a short period of time is permitted to exceed a specified value. For example, the concentration of NO_2 measured as the average value recorded over a one-hour period is permitted to exceed the concentration of 200 µg/m³ up to 18 times per year. Any more exceedences than this during a one-year period would represent a breach of the objective.

It is convenient to model objectives of this form in terms of the equivalent percentile concentration value. A percentile is the concentration below which lie a specified percentage of concentration measurements. For example, taking the NO_2 objective considered above, allowing 18 exceedences per year is equivalent to not exceeding for 8742 hours or for 99.79% of the year. This is therefore equivalent to the 99.79th percentile value. It is important to note that modelling exceedences of short-term averages is generally not as accurate as modelling annual averages.

[1] http://www.legislation.gov.uk/uksi/2010/1001/contents/made
[2] https://www.legislation.gov.uk/uksi/2020/1313/contents/made
[3] https://www.legislation.gov.uk/ukpga/2021/30/contents

3.1 Public exposure

The regulations state that exceedences of the air quality objectives should be assessed in relation to "the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present". Table 3.2 gives examples from the Defra TG(22) guidance of where the air quality objectives should apply.

Table 3.2: Examples of where the air quality objectives should apply

Averaging period	**Objectives should apply at:**	**Objectives should generally not apply at:**
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless used as a permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
24-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties (where relevant for public exposure e.g. seating or play areas).	Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be shorter than 24-hours.
1-hour mean	All locations where the annual mean and 24-hour mean objectives apply and: Kerbside sites (for example pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or longer. Any outdoor locations where members of the public might reasonably expect to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

3.2 Significance assessment

The Institute of Air Quality Management (IAQM) guidance *Land-Use Planning & Development Control: Planning for Air Quality*[4] sets out a methodology for assessing the significance of the air quality impact of planned developments. Table 3.3 sets out descriptors for air quality impacts based on the modelled concentration and the change in concentration relative to the air quality standard.

Table 3.3: IAQM impact descriptors

Long-term average concentration at receptor in assessment year	**% change in concentration relative to Air Quality Assessment Level (AQAL)**			
	1	**2-5**	**6-10**	**>10**
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

[4] https://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

4 Site information

4.1 Site location

Chelmsford is located approximately 45 km to the northeast of central London, with the north-eastern segment of the M25 lying 15 km to the southwest of the city. The administrative area of Chelmsford covers an area of 350 km^2, centred on the city.

Chelmsford City Council previously had two Air Quality Management Areas (AQMA) for annual average nitrogen dioxide (NO_2) concentrations, but these were revoked in 2024 following improvements in air quality.

4.2 Air quality monitoring

NO_2 and particulate ($PM_{2.5}$ and PM_{10}) concentrations in Chelmsford are measured at four sites using automatic monitors. NO_2 concentrations are also measured using diffusion tubes at 30 active sites, with a further 9 sites with historic measurement data. Automatic monitors provide high-quality measurements on an hourly basis, while diffusion tubes provide monthly measurements.

4.2.1 Nitrogen dioxide

Table 4.1 shows the measured annual average NO_2 concentrations measured by the automatic monitors. There were no exceedences of the hourly limit value of 200 µg/m^3 at any of the monitoring sites.

Table 4.1: Annual average NO_2 concentrations at automatic monitors (µg/m^3)

ID	Location	2019	2020	2021	2022	2023
CM1	Chignal St James	11.9	9.3	8.9	12.9	12.8
CM2	Springfield Road (Prison)	34.5	31.4	28.2	28.4	23.6[5]
CM3	Rainsford Land (Fire Station)	19.9	18.8	19.7	20.3	18.7
CM4	Baddow Road	27.0	20.7	20.1	22.0	19.4

Table 4.2 shows the measured annual average NO_2 concentrations measured using diffusion tubes. Note that not all sites were operational for all years. There were no recorded exceedences of the air quality standards in 2021, 2022 or 2023.

[5] Measured NO_2 concentrations at the CM2 monitor showed significantly increased concentrations from September to December, not reflected in measurements from the co-located diffusion tube. The average from January to August has therefore been used in this assessment.

Table 4.2: Annual average NO_2 concentrations at diffusion tube sites

ID	Location	2019	2020	2021	2022	2023
CB01	12 Van Diemans Road	30.2	24.4	25.6	26.4	22.8
CB13	60 Roxwell Road	17.7	14.5	14.7	13.7	N/A
CB22/B/C	95 Baddow Road	29.6	23.6	26.1	24.6	23.6
CB26	214 Baddow Road	28.0	24.8	24.0	21.8	22.0
CB27	Howe Green Interchange	31.8	26.2	26.3	27.2	N/A
CB32	2 Abbots Place	29.3	25.9	24.8	23.9	N/A
CB36	2 Rainsford Lane	28.4	22.8	21.9	20.4	N/A
CB38/39/40	Prison 1, Springfield Road	28.0	23.6	22.0	21.5	20.7
CB46	32 Rochford Road	24.9	19.4	22.0	21.8	N/A
CB49	26 Rochford Road	24.2	20.1	17.3	16.8	17.4
CB57	Goldlay House, Parkway	27.6	24.0	23.1	23.1	N/A
CB58	148 Baddow Road	35.1	31.3	31.7	31.0	29.9
CB61	10 Fraser Close	15.2	13.7	12.6	12.3	N/A
CB62/63/64	Chignal 1/2/3	11.6	9.2	9.0	9.0	7.3
CB65/66/67	Fire Station 1/2/3, Rainsford Lane	21.4	19.2	18.7	18.0	16.9
CB68/B/C	Goldlay Avenue 1/2/3	29.4	24.6	25.0	24.8	N/A
CB76	Maldon Road, Danbury	36.3	27.6	31.5	31.0	28.0
CB79	10 Waterhouse Lane	39.0	32.5	32.4	32.2	29.4
CB82	122 Springfield Road	31.5	23.9	25.6	25.9	24.1
CB83	134/136 Springfield Road	35.8	30.9	31.9	30.4	30.7
CB84/5/6	Baddow Road AQMS 1/2/3	26.4	22.0	21.0	21.0	19.3
CB87	Bus Station, Duke Street	39.6	30.6	30.4	32.8	30.7
CB89	135 Springfield Road	37.4	31.8	31.3	33.1	28.7
CB90	144 Springfield Road	26.1	23.1	21.9	21.1	22.7
CB91/2/3	26 Maldon Road, Danbury	**42.8**	33.9	34.6	34.8	29.5
CB94	Copt Hill, Danbury	25.0	19.7	21.6	22.3	19.9
CB95	Eves Corner, Danbury	27.5	20.3	23.4	23.0	19.4
CB96	Heathcote School, Main Road	29.8	23.8	22.7	22.4	20.0
CB98/B/C	Rear if 66 Baddow Road (Dentists)	**45.8**	38.3	36.8	35.9	34.5
CB99/B/C	Rear of 74 Baddow Road (Aga shop)	**45.4**	**40.2**	37.5	37.8	33.5
CB102	Maldon Road Junction w/ The Avenue	39.4	28.9	31.1	30.8	N/A
CB103	Opposite Myra, Cottage, Maldon Road	36.9	29.6	30.7	30.8	28.1
CB108	Blacksmiths Cottage, Maldon Road	17.8	14.8	14.4	14.5	13.2
CB109	Adj to Anytime Fitness, Viaduct Road	33.7	24.8	24.4	25.0	24.2
CB110	Adj to 25 Wood Street	25.4	24.3	21.6	23.0	20.1
CB111	Wood Street adj to Bruce Grove	N/A	25.9	29.2	33.1	27.1
CB112	Burnham Road / Greenwood Surgery	N/A	N/A	26.3	28.4	25.8
CB113	Broomfield Road	N/A	N/A	25.1	23.6	21.8
CB117	White Hart Lane adj to Centenary Way	N/A	N/A	29.9	33.0	28.8

4.2.2 $PM_{2.5}$

Table 4.3 shows the measured annual average $PM_{2.5}$ concentrations. There were no measured exceedences of the air quality standard for the years 2019 to 2023.

Table 4.3: Annual average $PM_{2.5}$ concentrations at automatic monitors

ID	Location	2019	2020	2021	2022	2023
CM1	Chignal St James	-	-	-	-	10.5
CM2	Springfield Road (Prison)	11.4	10.2	10.9	10.5	9.0

4.2.3 PM_{10}

Table 4.4 shows the measured annual average PM_{10} concentrations and Table 4.5 shows the number of measured daily average PM_{10} concentrations which exceeded 50 µg/m³. There were no measured exceedences of the air quality standards for the years 2019 to 2023.

Table 4.4: Annual average PM_{10} concentrations at automatic monitors

ID	Location	2019	2020	2021	2022	2023
CM1	Chignal St James	15.9	12.4	10.9	16.0	-
CM2	Springfield Road (Prison)	25.3	21.9	24.7	19.3	20.6
CM3	Rainsford Lane (Fire Station)	18.7	21.4	24.0	25.0	23.5

Table 4.5: Number of days with PM_{10} > 50 µg/m³ at automatic monitors

ID	Location	2019	2020	2021	2022	2023
CM1	Chignal St James	3	0	0	0	-
CM2	Springfield Road (Prison)	13	2	5	3	5
CM3	Rainsford Lane (Fire Station)	2	2	3	3	4

5 Emissions data

An emissions inventory was compiled for Chelmsford and the surrounding area for 2023 and for two 2041 scenarios: Do-Minimum (DM) without the Local Plan developments in place; and Do-Something (DS)[6] with the Local Plan developments in place. The inventories were compiled using CERC's emissions inventory toolkit (EMIT), version 3.9.1.

5.1 Major road traffic emissions

The air quality modelling included representation of emissions from all roads across Chelmsford City Council's area. A detailed representation of emissions from major roads was included. Emissions from road transport were calculated using modelled traffic flows and speeds, together with road traffic emission factors for NO_x, PM_{10} and $PM_{2.5}$.

5.1.1 Traffic flows

Traffic model flow and speed data from Chelmsford's Strategic (VISUM) Traffic Model were provided by Ringway Jacobs/Essex Highways, comprising annual average daily total (AADT), AM peak, PM peak, inter-peak (IP) and off-peak (OP) car, LGV and HGV flows for 2019 and for the 2041 DM and DS scenarios.

The 2019 data traffic flows for each vehicle type were projected to the 2023 base year by comparing all the Department for Transport traffic count data for Chelmsford for 2019 and 2023 and deriving a growth factor.

The 2041 traffic data includes changes to the Army & Navy junction, North East Chelmsford, the A12 widening proposals and capacity improvements at the Boreham Interchange.

5.1.2 Traffic speeds

The traffic data included average speeds for each road and time period. As part of the model verification process, the speed data were compared with measured data previously obtained for air quality modelling carried out for Danbury on behalf of Chelmsford City Council. The measured average speeds for 2019 were approximately 40% lower than the model data provided and consequently the calculated emissions were underestimated. To avoid underestimating emissions and improve agreement between measured and modelled pollutant concentrations, all speed for the base year and future scenarios were reduced by 40%.

[6] The DS scenario considers the emerging Pre-Submission Local Plan including the proposed new allocation Andrews Place, Chelmsford

5.1.3 Emission factors

Traffic emissions of NO_x, NO_2, PM_{10}, and $PM_{2.5}$ were calculated from traffic flows using the Emission Factor Toolkit (version 12). The EfT emission factors include speed-emissions data for NO_x based on the COPERT 5 software tool[7]. 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.

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 published Remote Sensing Data (RSD)[8] for vehicle NO_x emissions. Scaling factors were applied to each vehicle category and Euro standard.

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.

5.1.4 Vehicle fleet

The EFT uses vehicle fleet data, which take into account the types and ages of the vehicles in the modelled area, to calculate road traffic emission rates relevant to the area. For the base year, the emissions calculations used the standard EFT *England Urban* vehicle fleet supplemented with local bus fleet data provided by the Council, as shown in Table 5.1.

Table 5.1: Bus fleet data for Chelmsford

	2019/20		2023/24	
Euro I/II	11	2%	0	0%
Euro III	166	24%	62	6%
Euro IV	169	24%	141	13%
Euro V	212	31%	509	47%
Euro VI	135	19%	184	17%
Euro VI retrofit	0	0%	171	16%
Other	0	0%	18	2%
Unknown	0	0%	3	0%
Total	**693**		**1088**	

As it is not clear how the local bus fleet will change by 2041, the standard *England Urban* fleet was used for all vehicles for the future scenarios.

7 http://copert.emisia.com/

8 Davison, Jack, et al. "Distance-based emission factors from vehicle emission remote sensing measurements." Science of the Total Environment 739 (2020): 139688. https://doi.org/10.1016/j.scitotenv.2020.139688.

5.2 Minor Roads

Emissions from minor roads were modelled on a 1-km resolution grid, with emissions data taken from the National Atmospheric Emissions Inventory (NAEI). For 2041, the change in minor road emissions was assumed to be proportional to the change in emissions on the major road network.

5.3 Non-road emissions

5.3.1 Industrial sources

All industrial stacks emitting NO_x or particulates were identified from the NAEI within 5 km of the Chelmsford City Council area. Emissions parameters for these sources were obtained from the NAEI, and are presented in Table 5.2. All other exit characteristics were assumed to have representative values as presented in Table 5.3.

Table 5.2: Emissions from industrial sources, tonnes/year

Site Name	Location	NO_x	PM_{10}	$PM_{2.5}$
Hunt Graphics Europe Ltd, Basildon	574696, 190325	0.00	0.15	0.04
Norman Knights Ltd, Wickford	575652, 193032	0.00	0.02	0.01
Chelmsford Crematorium, Chelmsford	569653, 205873	1.64	0.07	0.07
United Utilities Green Energy Ltd, Roxwell Landfill Gas Project	565597, 208762	10.29	0.42	0.42
National Grid Gas Plc, Chelmsford Compressor Station	566110, 208350	0.16	0.00	0.00
Novera Energy Generation No2 Ltd, Brittons Hall Farm, Roxwell	565400, 208500	12.3	0.89	0.89

Table 5.3: Emission parameters used for industrial sources

Parameter	Value
Height (m)	30
Diameter (m)	0.5
Exit velocity (m/s)	15
Temperature (°C)	100

All other industrial emissions were included in the NAEI gridded emissions, as described in Section 5.3.1.

5.3.2 Other emissions

Spatially-diffuse emissions from sources other than those explicitly modelled, such as emissions from domestic combustion, were represented by a set of 1-km square grid sources with a depth of 10 m. Gridded emissions data for 2022 from the NAEI were used to represent these sources. Apart from the minor roads, all other emissions were assumed to remain the same between 2023 and 2041. Planning Policy DM31 in the Preferred Options Local Plan Consultation Document 2024 states that all new buildings must be designed and built to be Net Zero Carbon and fossil fuel free. It was therefore assumed that there would be no additional pollutant emissions generated by the proposed new developments.

5.4 Time varying profiles

The variation of traffic flow during the day was taken into account by applying a set of hourly profiles to the road emissions. These profiles were calculated from local traffic count data provided by the Council and area shown in Figure 5.1.

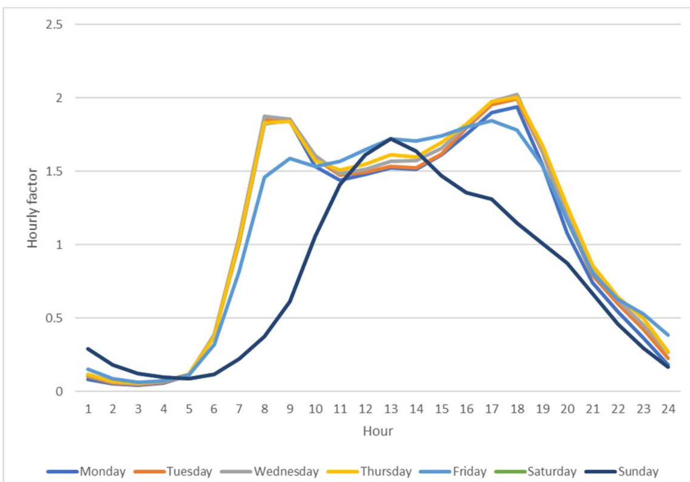

Figure 5.1: Hourly profiles used for other roads and grid sources

Profiles for grid sources were derived from European Monitoring and Evaluation Programme (EMEP) emissions data, and are shown in Figure 5.2.

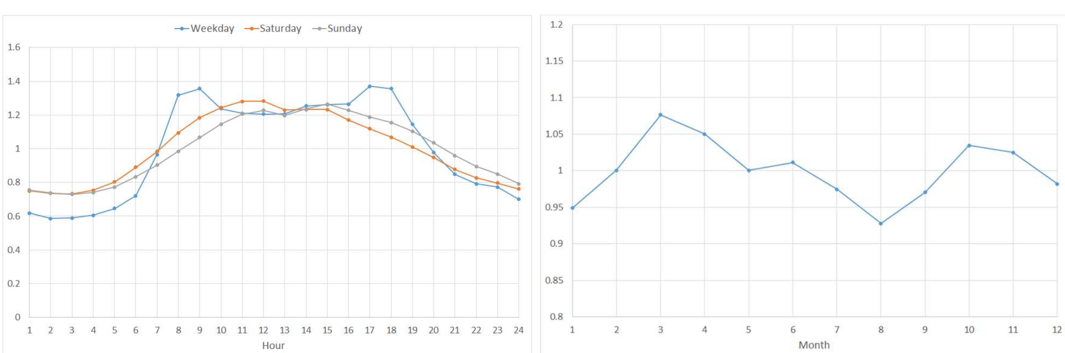

Figure 5.2: Diurnal (left) and monthly profiles (right) for grid source emissions

6 Model set-up

Modelling was carried out using the ADMS-Urban[9] model (version 5.0.1.3). The model uses the detailed emissions inventory described in Section 5, together with a range of other input data to calculate the dispersion of pollutants. This section summarises the data and assumptions used in the modelling.

6.1 Surface roughness

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 0.75 m was used to represent Chelmsford, representing the built-up nature of the area.

6.2 Monin-Obukhov length

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.

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.

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 metres was used in the modelling.

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

6.3 Meteorological data

The modelling used meteorological data from the Andrewsfield weather station for the year 2023. Andrewsfield is the nearest Met Office weather station with suitable data and is situated approximately 18 km north of the centre of Chelmsford. The data measured at Andrewsfield are considered to be representative of meteorological conditions at Chelmsford. A summary of the data is given in Table 6.1. Figure 6.1 shows a wind rose giving the frequency of occurrence of wind from different directions for a number of wind speed ranges.

A value of 0.1 m was used for the surface roughness for the meteorological station, representing the rural nature of the site.

Table 6.1: Hours of meteorological data used in the modelling

Year	Percentage used	Parameter	Minimum	Maximum	Mean
2023	99.8	Temperature (°C)	-5.1	31.6	11.1
		Wind speed (m/s)	0	16.5	4.2
		Cloud cover (oktas)	0	8	4.8

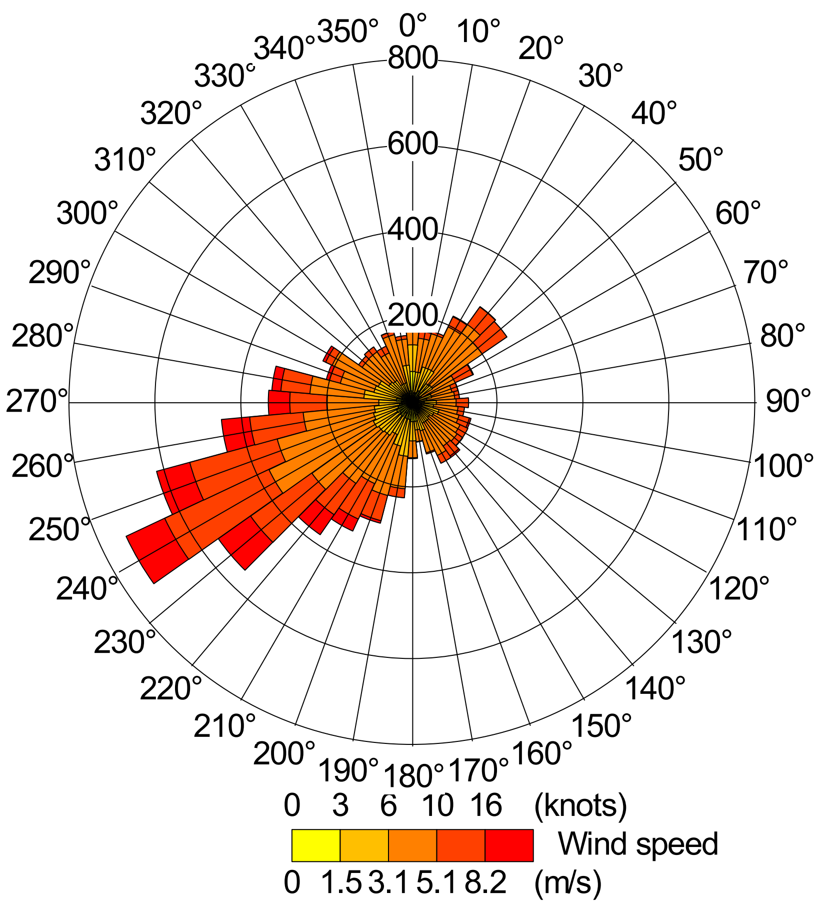

Figure 6.1: Wind rose for Andrewsfield, 2023

6.4 Background concentrations

Nitrogen dioxide (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).

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.

Hourly background data for these pollutants were input to the model to represent the concentrations in the air being blown into Chelmsford.

6.4.1 Background data for 2023

Hourly measured NO_x, NO_2, O_3, PM_{10} and $PM_{2.5}$ concentrations were obtained from the Rochester Stoke, Wicken Fen, and St. Osyth rural monitoring sites which are part of the Automatic Urban and Rural Monitoring Network managed by the Environment Agency on behalf of Defra. The monitored concentration used for each hour depended upon the wind direction for that hour, as shown in Figure 6.2. As SO_2 is not monitored at St. Osyth, background data from Rochester Stoke and Wicken Fen were used, split at 85°.

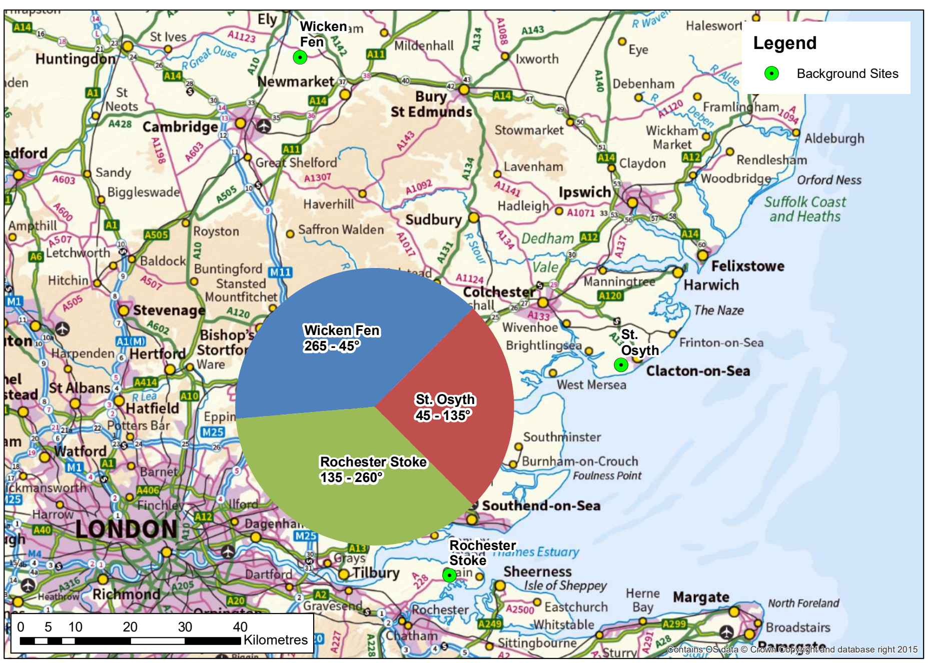

Figure 6.2: Wind direction segments used to calculate background concentrations for NO_x, NO_2, O_3, PM_{10} and $PM_{2.5}$

Table 6.2 summarises the annual statistics of the resulting background concentrations used in the modelling for 2023.

Table 6.2: Background concentrations for 2023 (µg/m^3)

	NO_x	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
Annual average	7.2	8.8	57.8	12.8	8.0	0.6
99.79th percentile of hourly average	45.8	72.5	153.6	67.1	50.6	3.2
90.41st percentile of 24-hour averages	-	-	-	21.5	15.1	0.9

6.4.2 Background data for 2041

Background concentrations show a flat or very slight downward trend over recent years. In order to avoid underestimating concentrations in 2041, the background data for 2023 was used unchanged, i.e. it was assumed that there will be no reduction in background concentrations over this period.

6.5 Street canyons

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. The Advanced Street Canyon option can model asymmetric canyons, e.g. with different building heights on each side of the road or with buildings at different distances from the road on each side, and can take into account discontinuous canyons, i.e. buildings with gaps in between. Street canyon parameters were calculated from OS MasterMap buildings data. Street canyon data were processed for all modelled roads.

7 Model verification

The first stage of a modelling assessment is to verify that the input data and model setup are representative for the area. This was carried out by calculating annual average concentrations of NO_2 and PM_{10} at the monitoring sites at which they are measured. Note that the monitoring site in the bus station was not included in the analysis due to uncertainties in bus emissions in the bus station.

***Table* 7.**1 and Figure 7.1 show the measured and modelled annual average NO_2 concentrations for 2023. Table 7.2 and Table 7.3 show the measured and modelled annual average PM_{10} and $PM_{2.5}$ concentrations, respectively.

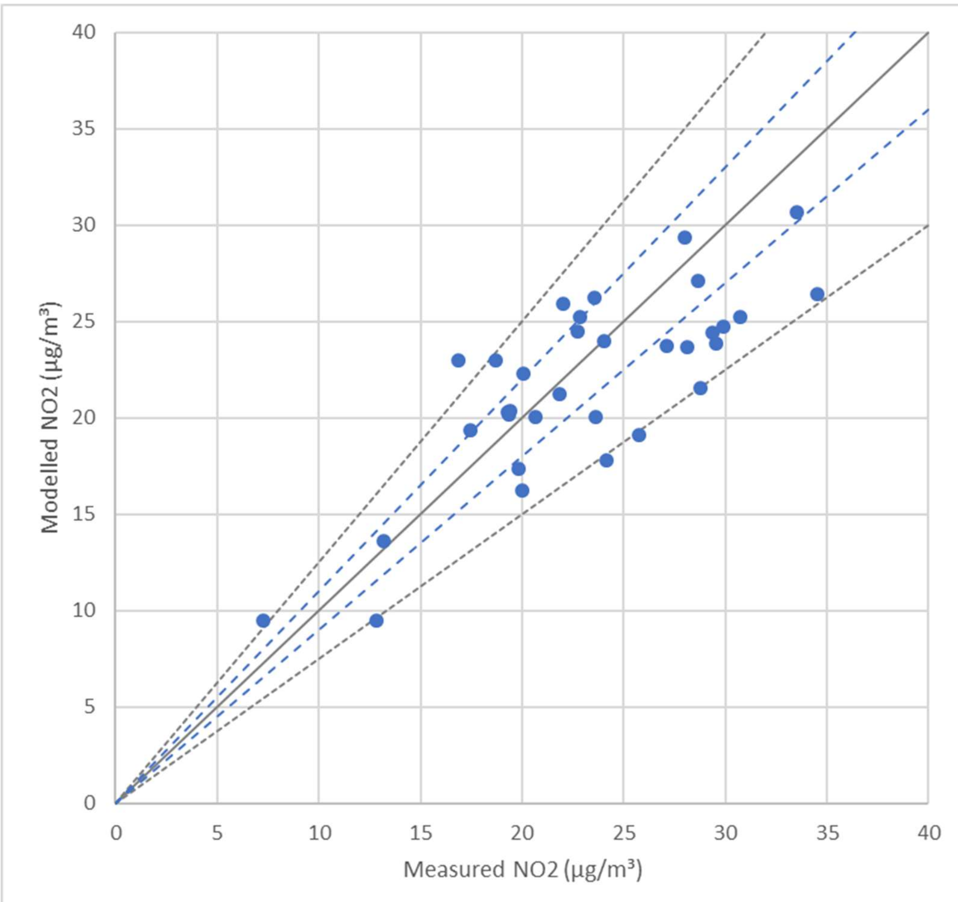

Figure 7.1: Measured and modelled annual average NO_2 concentrations

The modelled concentrations show generally good agreement with the measured data, with no consistent under or over-prediction. The modelled concentrations are within 25% of the measured data at 85% of the sites considered; 33% are within 10% of the measured data.

Table 7.1: Measured and modelled annual average NO_2 concentrations (μg/m³)

ID	Location	Measured	Modelled	
		μg/m³	μg/m³	%
CM1	Chignal St James	11.1	9.5	85%
CM2	Springfield Road (Prison)	23.6	20.1	85%
CM3	Rainsford Lane (Fire Station)	18.7	23.0	123%
CM4	Baddow Road	18.9	20.3	108%
CB01	12 Van Diemans Road	22.8	25.2	111%
CB22	95 Baddow Road	23.6	26.2	111%
CB26	214 Baddow Road	22.0	25.9	118%
CB38-40	Prison 3	20.7	20.1	97%
CB49	26 Rochford Road	17.4	19.4	111%
CB58	148 Baddow Road	29.9	24.7	83%
CB62-64	Chignal 3	7.3	9.5	130%
CB65-67	Fire Station 3	16.9	23.0	136%
CB76	5/7 Maldon Road, Danbury	28.0	29.4	105%
CB79	10 Waterhouse Lane	29.4	24.4	83%
CB82	122 Springfield Road	24.1	24.0	100%
CB83	134/136 Springfield Road	30.7	25.2	82%
CB84-86	Baddow Road AQMS 3	19.3	20.3	105%
CB89	135 Springfield Road	28.7	27.1	95%
CB90	144 Springfield Road	22.7	24.5	108%
CB91-93	26 Maldon Road, Danbury	29.5	23.8	81%
CB94	Copt Hill, Danbury	19.9	17.3	87%
CB95	Eves Corner, Danbury	19.4	20.2	104%
CB96	Heathcote School, Main Road, Danbury	20.0	16.2	81%
CB98	Rear of 66 Baddow Road (Dentists)	34.5	26.4	76%
CB99	Rear of 74 Baddow Road (Aga Shop)	33.5	30.7	91%
CB103	Opposite Myra Cottage Maldon Road, Danbury	28.1	23.7	84%
CB108	Blacksmiths Cottage, Maldon Road, Danbury	13.2	13.6	103%
CB109	Adjacent to Anytime Fitness, Viaduct Road	24.2	17.8	74%
CB110	Adjacent to 25 Wood Street	20.1	22.3	111%
CB111	Wood Street adjacent to Bruce Grove	27.1	23.8	88%
CB112	Burnham Road / Greenwood Surgery	25.8	19.1	74%
CB113	Broomfield Road	21.8	21.2	97%
CB117	White Hart Lane adjacent to Centenary Way	28.8	21.5	74.9%

Table 7.2: Measured and modelled annual average PM_{10} concentrations (μg/m³)

Code	Address	Measured	Modelled	Modelled %
CM2	Springfield Road	20.6	18.8	91%
CM3	Rainsford Lane	23.5	20.1	85%

Table 7.3: Measured and modelled annual average $PM_{2.5}$ concentrations (μg/m³)

Code	Address	Measured	Modelled	Modelled %
CM1	Chignal St James	10.5	8.5	81%
CM2	Springfield Road	9.9	10.6	107%

8 2023 baseline concentrations

Ground level concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated on a regular grid of receptor points, with additional points added in the vicinity of major roads, in order to more accurately capture roadside concentrations. Concentrations were calculated to allow comparison against the air quality standards presented in Section 3, and presented in the form of 10 m resolution coloured contour maps.

Figure 8.1 and Figure 8.2 show the modelled annual average and the modelled 99.79th percentile of hourly average NO_2 concentrations for 2023. There are no modelled exceedences of the annual average NO_2 limit value of 40 µg/m³ or the hourly average NO_2 limit value of 200 µg/m³.

Figure 8.3 and Figure 8.4 show the modelled annual average and 90.41st percentile of daily average PM_{10} concentrations for 2023. Figure 8.5 shows the modelled annual average $PM_{2.5}$ concentrations for 2023. The modelling does not show any exceedences of the limit values for PM_{10} or $PM_{2.5}$.

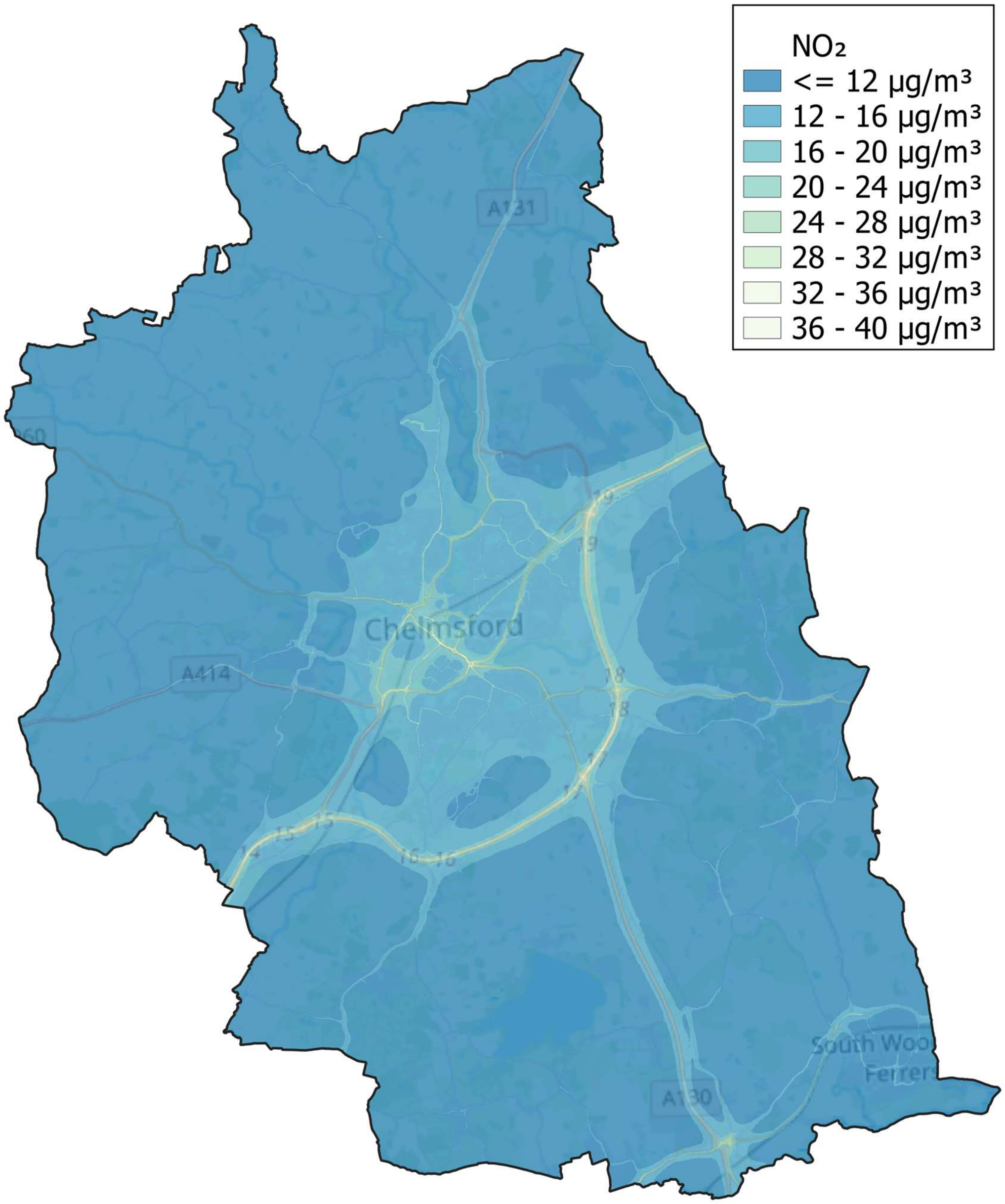

Figure 8.1: Annual average NO_2 concentration 2023 (µg/m³)

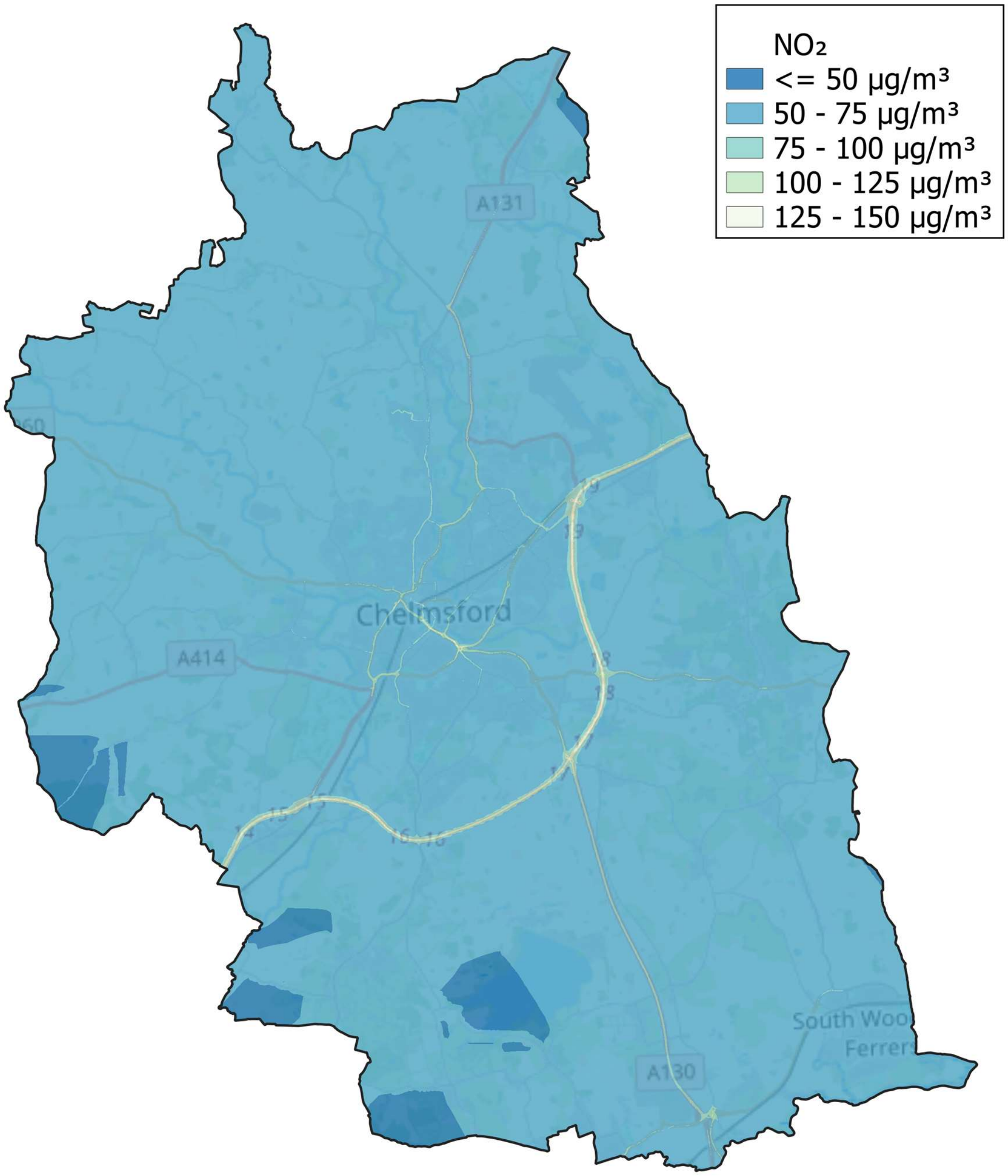

Figure 8.2: 99.79th percentile of hourly average NO_2 concentrations 2023 (µg/m³)

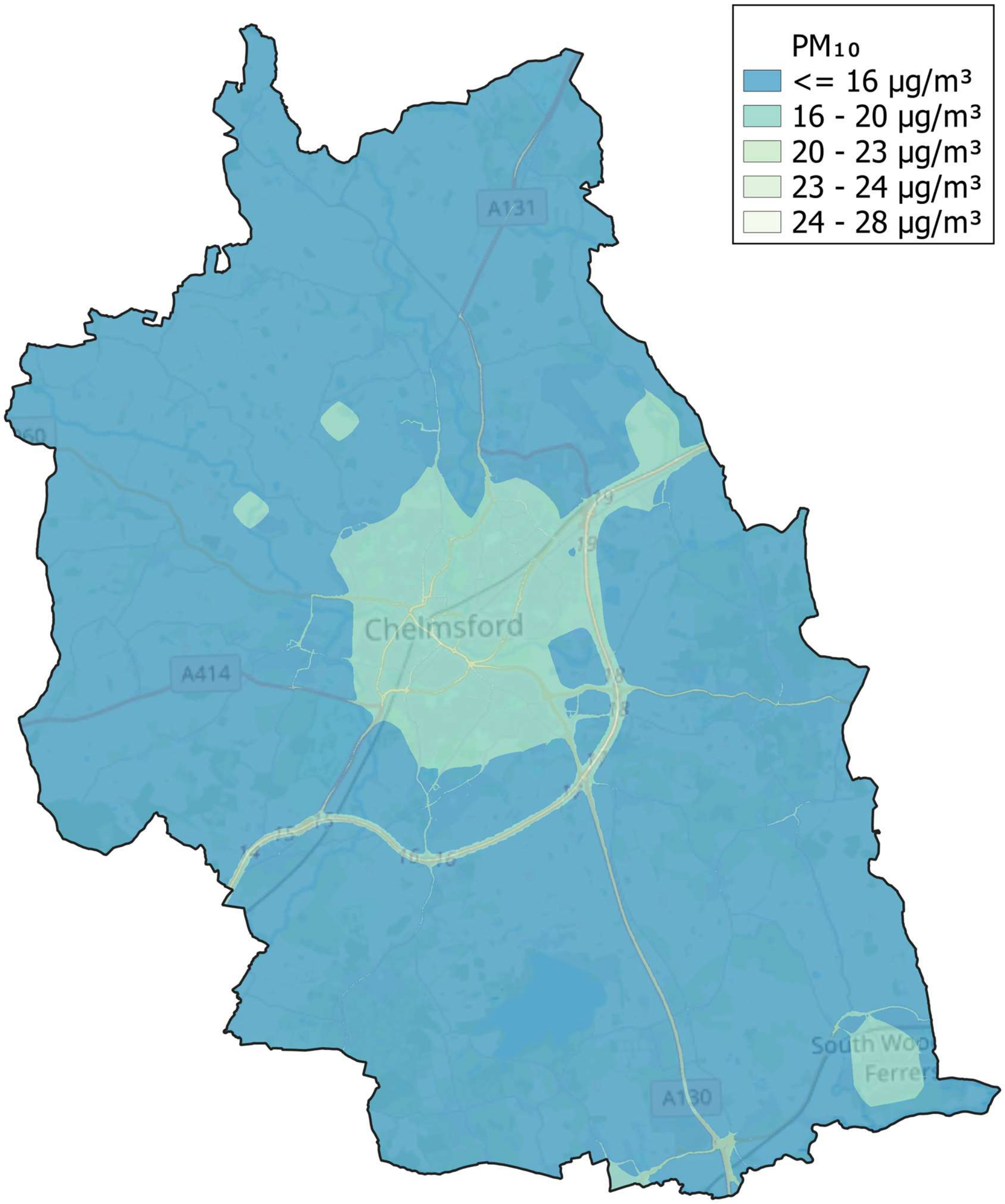

Figure 8.3: Modelled annual average PM_{10} concentration 2023 (µg/m³)

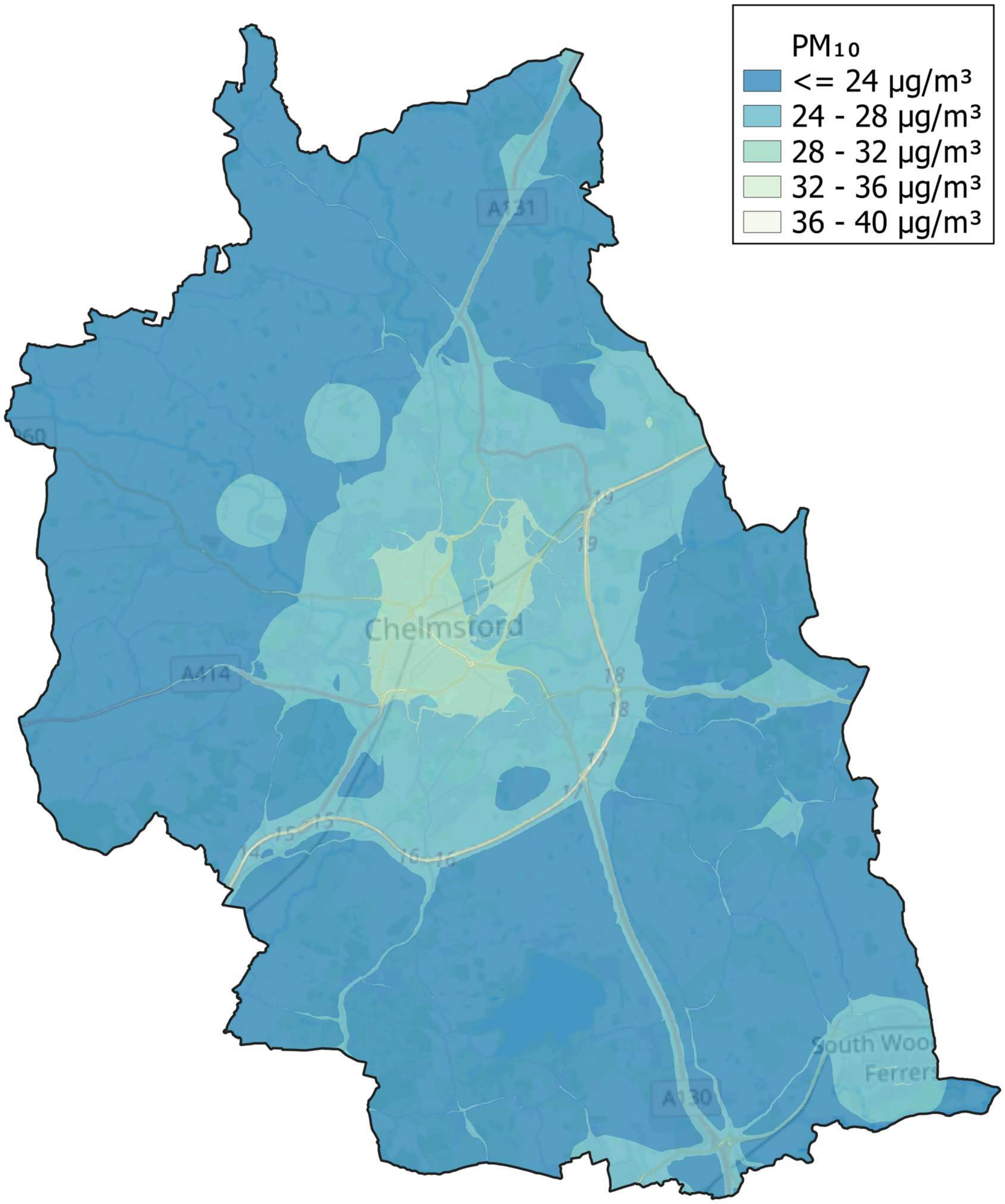

Figure 8.4: Modelled 90.41st percentile of 24-hour average PM_{10} concentrations 2023 (µg/m³)

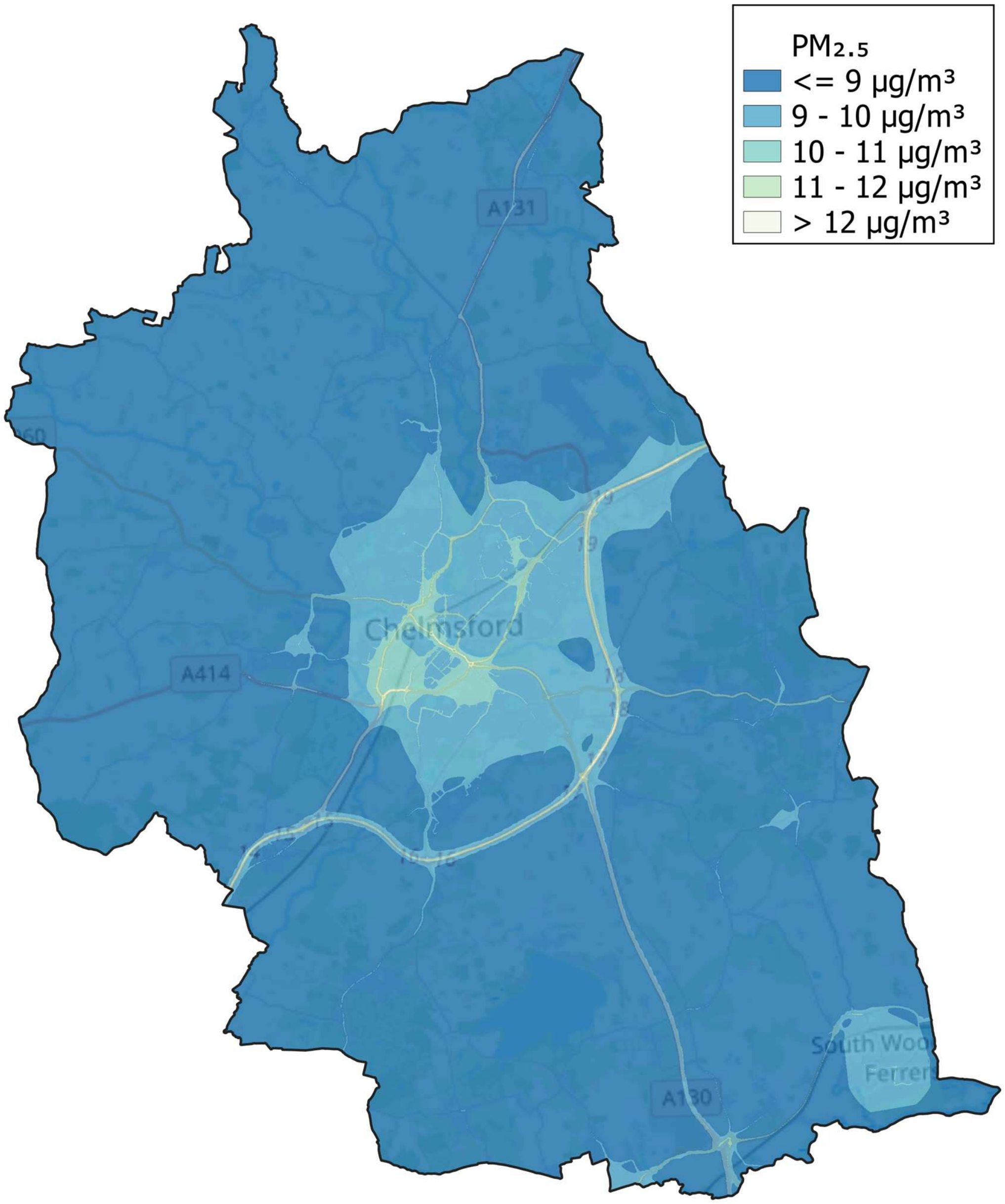

Figure 8.5: Modelled annual average $PM_{2.5}$ concentration 2023 (µg/m³)

9 2041 concentrations

Ground level concentrations of NO_2, PM_{10} and $PM_{2.5}$ were calculated at the same set of output points for the 2041 DM and DS scenarios.

Figure 9.1 shows the modelled annual average NO_2 concentrations for the 2041 DM and DS scenarios[10]. No exceedences of the limit value are predicted with or without the Local Plan. By 2041, vehicle NO_x emissions are predicted to decrease significantly from current levels due to improvements in vehicle technology, uptake of electric vehicles and progressively tighter emissions standards.

Figure 9.2 shows the modelled 99.79th percentiles of hourly average NO_2 concentrations for the 2014 DM and DS scenarios. No exceedences of the limit value are predicted with or without the Local Plan.

Figure 9.3 shows the modelled annual average PM_{10} concentrations for the 2041 DM and DS scenarios. No exceedences of the limit value are predicted with or without the Local Plan. The 2041 concentrations are very similar to the 2023 values. This is because emissions of PM_{10} are made up of exhaust and non-exhaust emissions; only exhaust emissions are predicted to decrease in future years, with non-exhaust emissions likely to increase proportionally to traffic levels.

Figure 9.4 shows the modelled 90.41st percentiles of 24-hour average PM_{10} concentrations for the 2041 DM and DS scenarios. No exceedences of the limit value are predicted with or without the Local Plan.

Figure 9.5 shows the modelled annual average $PM_{2.5}$ concentrations for the 2041 DM and DS scenarios. No exceedences of the limit value are predicted, with or without the Local Plan.

[10] The DS scenario considers the emerging Pre-Submission Local Plan including the proposed new allocation Andrews Place, Chelmsford

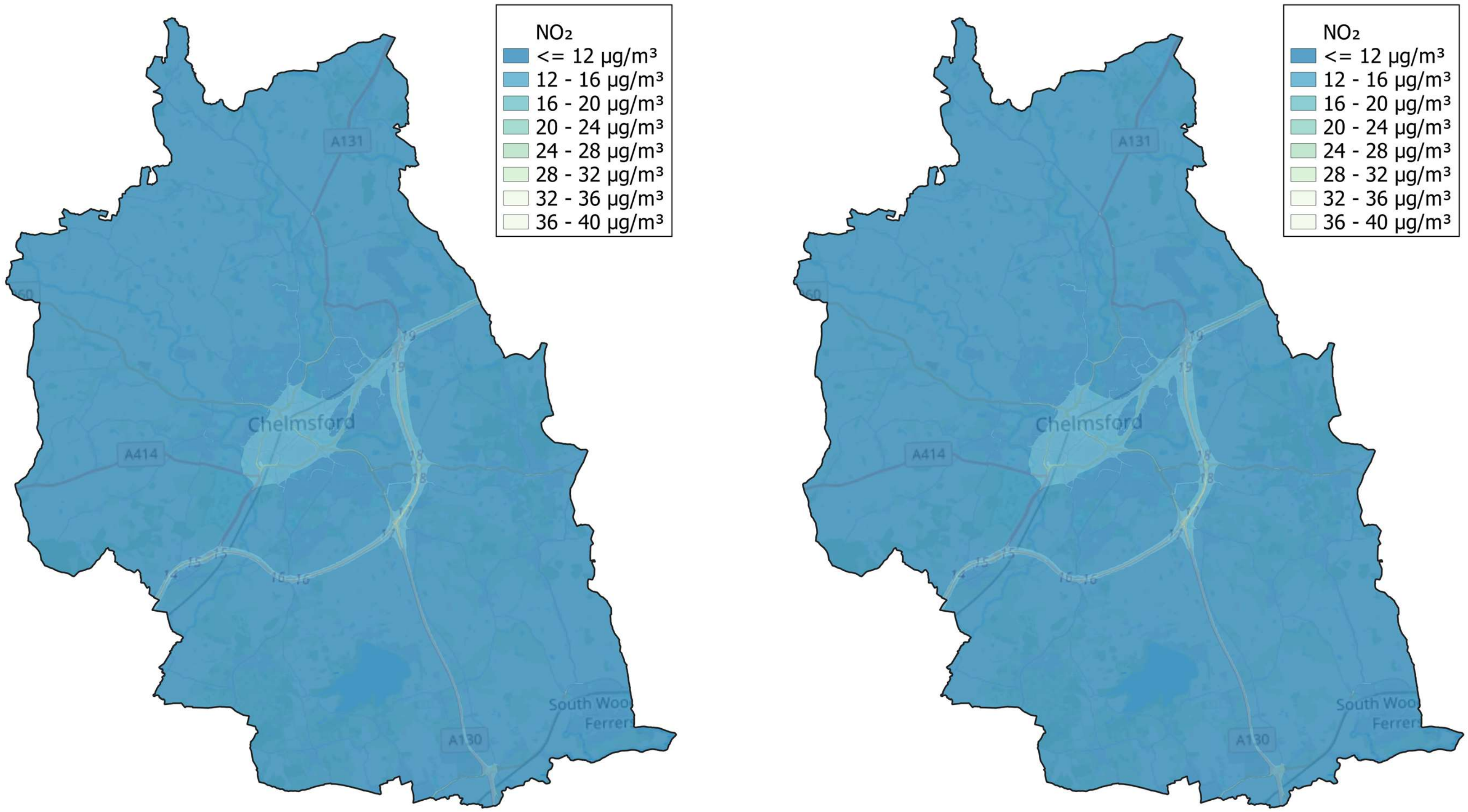

Figure 9.1: Modelled annual average NO_2 concentration, 2041 DM (left) and DS (right) (µg/m³)

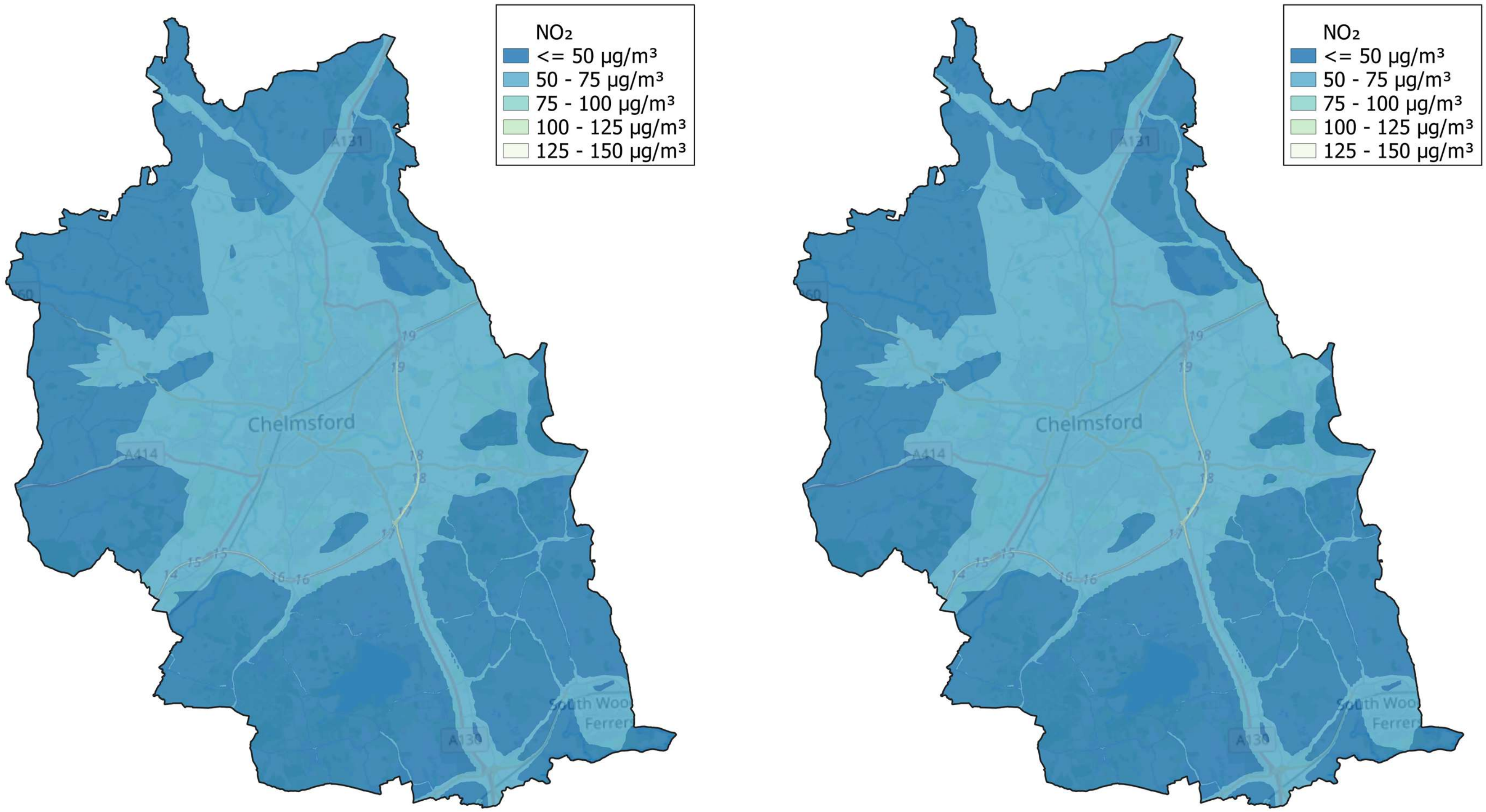

Figure 9.2: Modelled 99.79th percentile of hourly average NO_2 concentrations 2041 DM (left) and DS (right) (µg/m³)

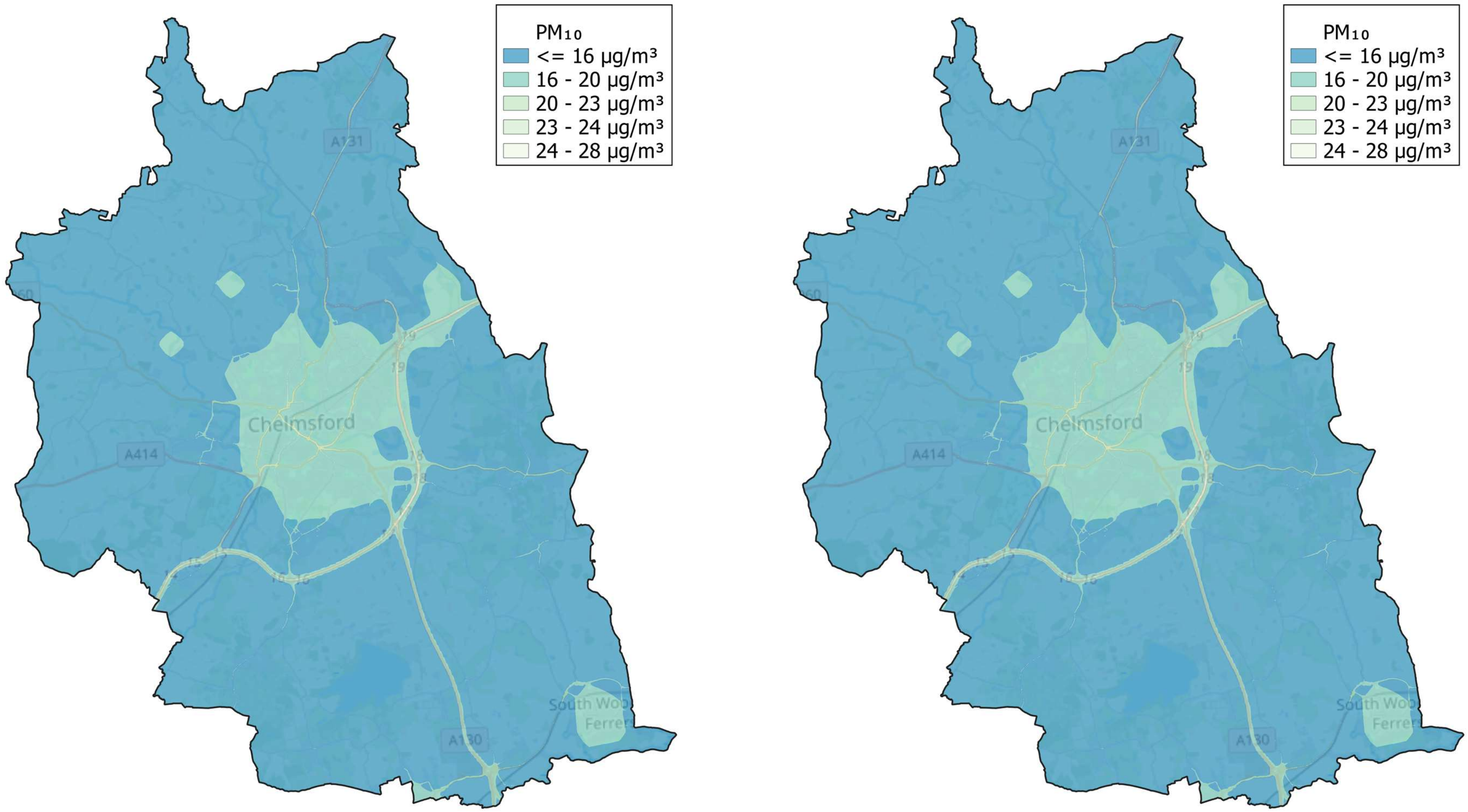

Figure 9.3: Modelled annual average PM_{10} concentration 2041 DM (left) and DS (right) (µg/m³)

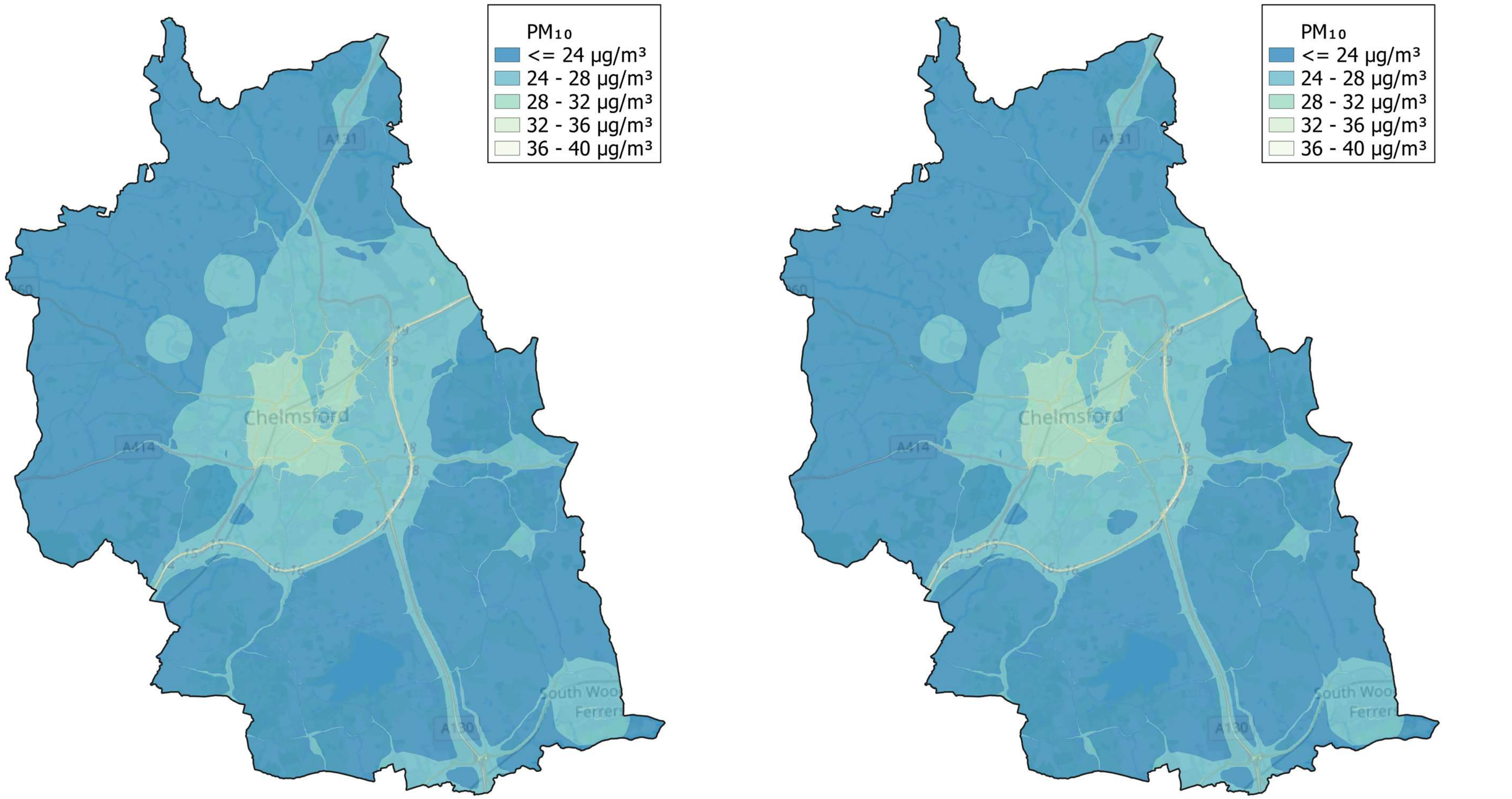

Figure 9.4: Modelled 90.41st percentile of daily average PM_{10} concentrations 2041 DM (left) and DS (right) ($\mu g/m^3$)

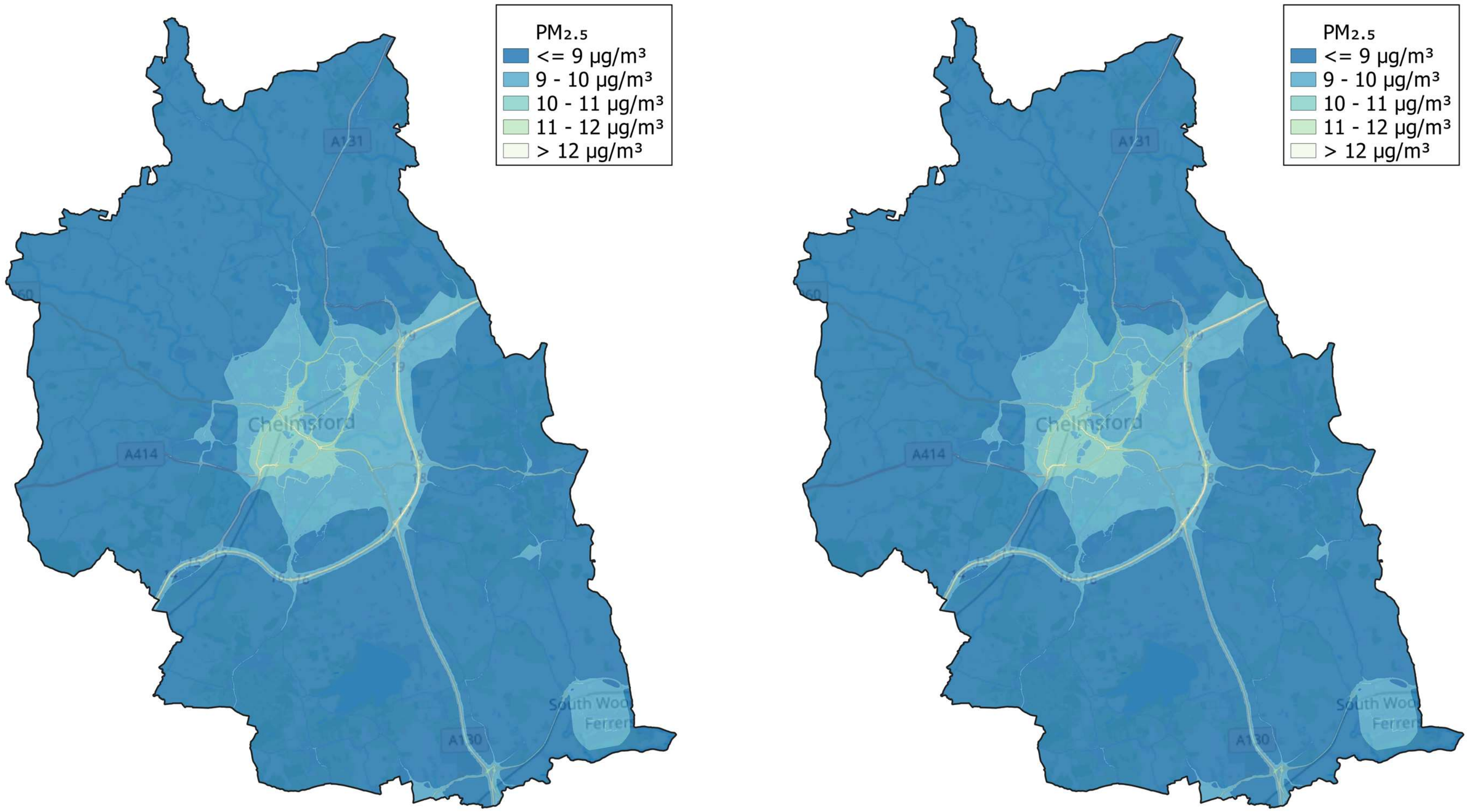

Figure 9.5: Modelled annual average $PM_{2.5}$ concentrations 2041 DM (left) and DS (right) (µg/m³)

10 Significance assessment

The IAQM significance criteria shown in Section 3.2 are based on the modelled total and change in annual average concentrations relative to the air quality standards. Any change in concentration of less than 0.5% of the limit value is considered ***Negligible***. Where the change is greater than 0.5% of the limit value, the descriptor depends both on the total concentration and the change in concentration.

Difference plots were calculated by subtracting the modelled annual average concentrations for the 2041 DM scenario from the 2041 DS scenario. The resulting concentrations are shown as maps, where areas coloured red show an increase in concentrations and areas in blue show a decrease in concentrations; areas with no colour show no significant change in concentrations. The concentration change bands were set to +/- 1 % of the relevant air quality limit, in line with the IAQM impact descriptors.

Figure 10.1 shows the modelled change in annual average NO_2 concentration with the Local Plan in place. In the majority of the modelled area, NO_2 concentrations change by less than 0.2 µg/m³, or 0.5% of the limit value. Along some of the major roads, there are modelled changes in concentrations of up to 1%. These roads include Chelmer Road, Springfield Road, High Bridge Road, the Chelmsford Bypass (A12) and some small areas at major road junctions.

The modelled concentrations in 2041 are less than 30 µg/m³, or 75% of the limit value, throughout Chelmsford, and the maximum change in concentration is less than 0.6 µg/m³, or 1.5% of the limit value. The change in NO_2 concentrations can therefore be considered ***Negligible***.

The calculated change in concentrations for both annual average PM_{10} and $PM_{2.5}$ concentration was less than 1% of the relevant air quality limit values throughout Chelmsford, and therefore can be considered ***Negligible***. Difference plots for PM_{10} and $PM_{2.5}$ would not show any areas with changes in concentrations of more than 0.5% so are not presented.

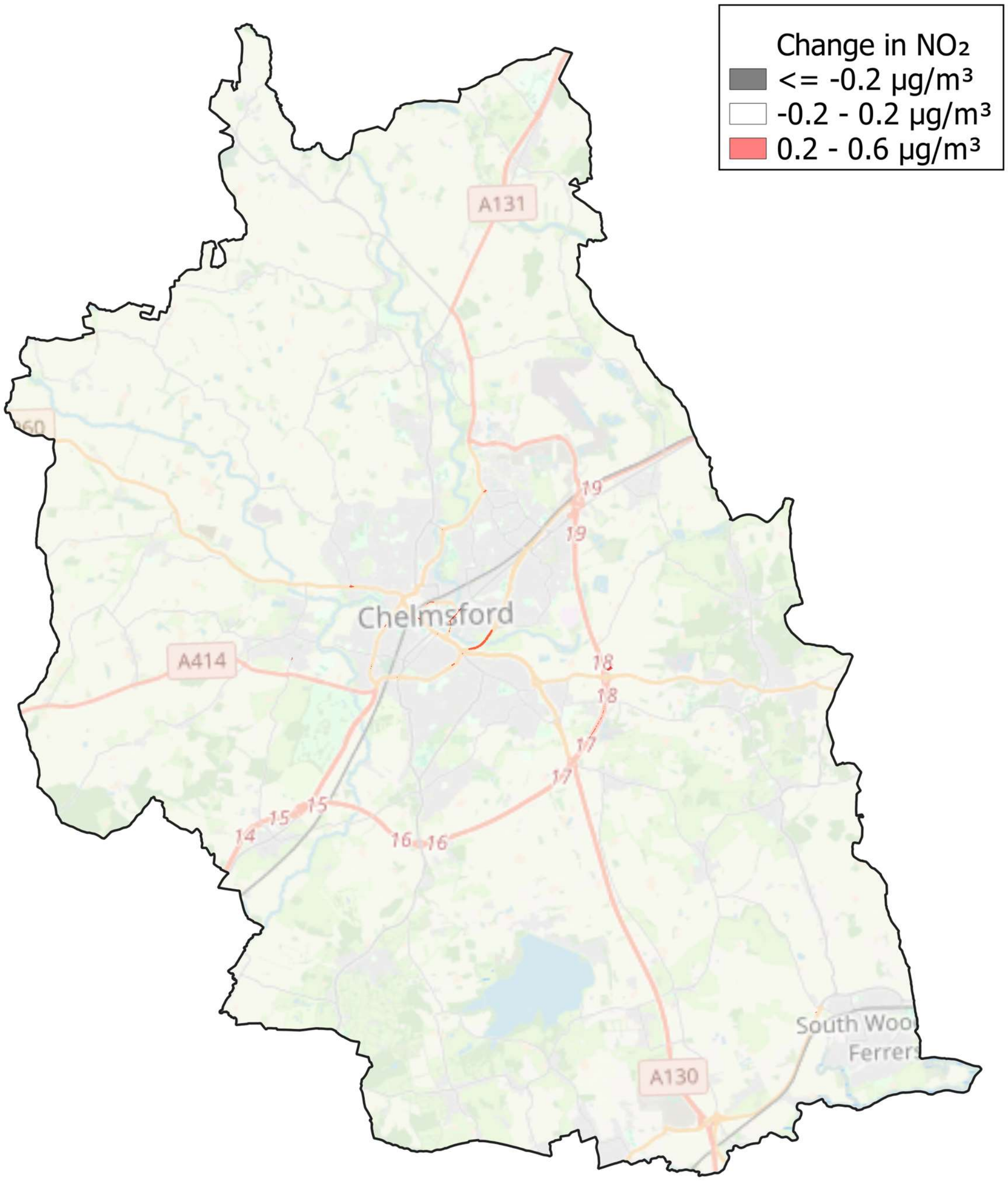

Figure 10.1: Modelled change in annual average NO_2 concentration with Local Plan ($\mu g/m^3$)

11 Discussion

Air quality modelling was carried out for Chelmsford using ADMS-Urban to investigate the likely impact of the Chelmsford Local Plan[11] on air quality. The modelling used traffic model data for 2023, 2041 with the Local Plan and 2041 without the Local Plan. The modelling includes changes to the Army & Navy junction, North East Chelmsford, the A12 widening proposals and capacity improvements at the Boreham Interchange.

Model verification was carried out, comparing modelled concentrations with measured data for 2023. The modelling showed generally good agreement with the measured data with the majority of modelled concentrations within 25% of the measured data and no systematic under or overprediction of concentrations.

Modelling for 2023 did not show any exceedences of the limit values for NO_2, PM_{10} or $PM_{2.5}$.

By 2041, vehicle exhaust emissions of NO_x, PM_{10} and $PM_{2.5}$ are predicted to decrease significantly. However, PM_{10} and $PM_{2.5}$ emissions also include contributions from non-exhaust emissions, i.e. road, brake and tyre wear, which are expected to increase proportionally to traffic levels.

Modelled concentrations of NO_2, PM_{10} and $PM_{2.5}$ in 2041 both with and without the Local Plan are all below the relevant limit values. Difference plots show that the introduction of the Local Plan is likely to have a small impact on annual average NO_2 concentrations along some roads, with increases and decreases of up to 1% of the relevant limit values.

The significance of the air quality impact of the Local Plan in 2041 was assessed using IAQM guidance. The impact of the Local Plan in 2041 can be considered ***Negligible*** for all pollutants. The impact in intervening years may vary, depending on when each development is completed and other local factors.

[11] The assessment considers the emerging Pre-Submission Local Plan including the proposed new allocation Andrews Place, Chelmsford

APPENDIX A: Summary of ADMS-Urban

ADMS-Urban is a scientifically advanced but practical air pollution modelling tool, which has been developed to provide high resolution calculations of pollution concentrations for all sizes of study area relevant to the urban environment. The model can be used to look at concentrations near a single road junction or over a region extending across the whole of a major city. ADMS-Urban is used worldwide to assess air quality impact for a wide range of planning and policy studies, incorporating elements such as Low Emission Zones, traffic management, clean vehicle technologies and modal shift. In the UK, it is used extensively for air quality review and assessment carried out by local government.

The following is a summary of the capabilities and validation of ADMS-Urban. More details can be found on the CERC web site[12].

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which has been developed to investigate the impacts of emissions from industrial facilities. ADMS-Urban allows full characterisation of the wide variety of emissions in urban areas, including an extensively validated road traffic emissions model. It also includes a number of other features, which include consideration of:

- the effects of vehicle movement on the dispersion of traffic emissions;
- the behaviour of material released into street-canyons;
- the chemical reactions occurring between nitrogen oxides, ozone and Volatile Organic Compounds (VOCs);
- the pollution entering a study area from beyond its boundaries;
- the effects of complex terrain on the dispersion of pollutants;
- the effects of the urban canopy on the dispersion of pollutants; and
- the effects of a building on the dispersion of pollutants emitted nearby.

Further details of these features are provided below.

Studies of extensive urban areas are necessarily complex, requiring the manipulation of large amounts of data. To allow users to cope effectively with this requirement, ADMS-Urban runs in Windows 10 and Windows 8 environments. The manipulation of data is further facilitated by the ADMS-Urban Mapper, which allows for the visualisation and manipulation of geospatial information, and by the CERC Emissions Inventory Toolkit, EMIT.

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

Dispersion Modelling

ADMS and ADMS-Urban use boundary layer similarity profiles to parameterise the variation of turbulence with height within the boundary layer, and the use of a skewed-Gaussian distribution to determine the vertical variation of pollutant concentrations in the plume under convective conditions.

The main dispersion modelling features of ADMS-Urban are as follows:

- ADMS-Urban is an **advanced dispersion model** in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This method supersedes methods based on Pasquill Stability Categories, as used in, for example, the US models Caline and ISC. Concentrations are calculated hour by hour and are fully dependent on prevailing weather conditions.
- For convective conditions, a **non-Gaussian vertical profile of concentration** allows for the skewed nature of turbulence within the atmospheric boundary layer, which can lead to high concentrations near to the source.
- A **meteorological processor** calculates boundary layer parameters from a variety of input data, typically including date and time, wind speed and direction, surface temperature and cloud cover. Meteorological data may be raw, hourly averaged or statistically analysed data.

Emissions

Emissions into the atmosphere across an urban area typically come from a wide variety of sources. There are likely to be emissions from road traffic, as well as from domestic heating systems and industrial emissions from chimneys. To represent the full range of emissions configurations, the explicit source types available within ADMS-Urban are:

- **Roads**, for which emissions are specified in terms of vehicle flows and the additional initial dispersion caused by moving vehicles is also taken into account.
- **Industrial points**, for which plume rise and stack downwash are included in the modelling.
- **Areas**, where a source or sources is best represented as uniformly spread over an area.
- **Volumes**, where a source or sources is best represented as uniformly spread throughout a volume.

In addition, sources can also be modelled as a regular grid of emissions. This allows the contributions of large numbers of minor sources to be efficiently included in a study while the majority of the modelling effort is used for the relatively few significant sources.

ADMS-Urban can be used in conjunction with CERC's Emissions Inventory Toolkit, EMIT, which facilitates the management and manipulation of large and complex data sets into usable emissions inventories.

Presentation of Results

The results from the model can be based on a wide range of averaging times, and include rolling averages. Maximum concentration values and percentiles can be calculated where appropriate meteorological input data have been input to the model. This allows ADMS-Urban to be used to calculate concentrations for direct comparison with existing air quality limits, guidelines and objectives, in whatever form they are specified.

ADMS-Urban has an integrated Mapper which facilitates both the compilation and manipulation of the emissions information required as input to the model and the interpretation and presentation of the air quality results provided. ADMS-Urban can also be integrated with ArcGIS or MapInfo.

Complex Effects - Street Canyons

ADMS-Urban incorporates two methods for representing the effect of street canyons on the dispersion of road traffic emissions: a basic canyon method based on the *Operational Street Pollution Model (OSPM)*[13], developed by the Danish National Environmental Research Institute (NERI); and an advanced street canyon module, developed by CERC. The basic canyon model was designed for simple symmetric canyons with height similar to width and assumes that road traffic emissions originate throughout the base of the canyon, i.e. that the emissions are spread across both the road and neighbouring pavements.

The advanced canyon model[14] was developed to overcome these limitations and is our model of choice. It represents the effects of channelling flow along and recirculating flow across a street canyon, dispersion out of the canyon through gaps in the walls, over the top of the buildings or out of the end of the canyon. It can take into account canyon asymmetry and restricts the emissions area to the road carriageway.

Complex Effects - Chemistry

ADMS-Urban includes the *Generic Reaction Set (GRS)*[15] atmospheric chemistry scheme. The original scheme has seven reactions, including those occurring between nitrogen oxides and ozone and parameterisations of the large number of reactions involving a wide range of Volatile Organic Compounds (VOCs). In addition, an eighth reaction has been included within ADMS-Urban for the situation when high concentrations of nitric oxide (NO) can convert to nitrogen dioxide (NO_2) using molecular oxygen.

---

[13] Hertel, O., Berkowicz, R. and Larssen, S., 1990, 'The Operational Street Pollution Model (OSPM).' *18th International meeting of NATO/CCMS on Air Pollution Modelling and its Applications.* Vancouver, Canada, pp741-749.

[14] Hood C, Carruthers D, Seaton M, Stocker J and Johnson K, 2014. *Urban canopy flow field and advanced street canyon modelling in ADMS-Urban.* 16th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Varna, Bulgaria, September 2014. http://www.harmo.org/Conferences/Proceedings/_Varna/publishedSections/H16-067-Hood-EA.pdf

[15] Venkatram, A., Karamchandani, P., Pai, P. and Goldstein, R., 1994, 'The Development and Application of a Simplified Ozone Modelling System.' *Atmospheric Environment,* Vol 28, No 22, pp3665-3678.

In addition to the basic GRS scheme, ADMS-Urban also includes a trajectory model[16] for use when modelling large areas. This permits the chemical conversions of the emissions and background concentrations upwind of each location to be properly taken into account.

Complex Effects - Terrain

As well as the effect that complex terrain has on wind direction and, consequently, pollution transport, it can also enhance turbulence and therefore increase dispersion. These effects are taken into account in ADMS-Urban using the FLOWSTAR[17] model developed by CERC.

Complex Effects – Urban Canopy

As wind approaches an urban area of relatively densely packed buildings, the wind profile is vertically displaced. The wind speed and turbulence levels are also reduced within the area of buildings. These effects are taken into account in ADMS-Urban by modifying the wind speed and turbulence profiles based on parameters describing the amount and size of buildings within an urban area.

Data Comparisons – Model Validation

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which is used throughout the UK by industry and the Environment Agency to model emissions from industrial sources. ADMS has been subject to extensive validation, both of individual components (e.g. point source, street canyon, building effects and meteorological pre-processor) and of its overall performance.

ADMS-Urban has been extensively tested and validated against monitoring data for large urban areas in the UK and overseas, including London, Birmingham, Manchester, Glasgow, Riga, Cape Town, Hong Kong and Beijing, as part of projects supported by local governments and research organisations. A summary of model validation studies is available online[18]. CERC have co-authored[19] a number of papers presenting results from ADMS-Urban, and other organisations have published the outcomes of their applications of the model[20].

[16] Singles, R.J., Sutton, M.A. and Weston, K.J., 1997, 'A multi-layer model to describe the atmospheric transport and deposition of ammonia in Great Britain.' In: *International Conference on Atmospheric Ammonia: Emission, Deposition and Environmental Impacts. Atmospheric Environment*, Vol 32, No 3.

[17] Carruthers D.J., Hunt J.C.R. and Weng W-S. 1988. 'A computational model of stratified turbulent airflow over hills – FLOWSTAR I.' Proceedings of Envirosoft. In: *Computer Techniques in Environmental Studies,* P. Zanetti (Ed) pp 481-492. Springer-Verlag.

[18] www.cerc.co.uk/Validation

[19] www.cerc.co.uk/CERCCoAuthorPublications

[20] www.cerc.co.uk/CERCSoftwarePublications