APPENDIX 9-6

Operational Phase Traffic and Stack Emissions Assessment

Introduction

Following the initial submission of the Environmental Statement for the proposed development, comments were received from Natural Resource Wales planning department. The comments contained the following requirement: "*Requirement 1: Designated Sites – further information is required to determine if changes in air quality will avoid significant and adverse effects on the integrity of the Severn Estuary SAC/SSSI*". In addition, the Cardiff Council (CC) Environment Health Officer(EHO) also identified the need for a detailed assessment of potential air quality impacts on the Estuary.

In addition, further comments from Natural Resources Wales indicated that there is a need to consider NO_x emissions from stack A5 of the proposed development. As such, a detailed assessment of the air quality impacts on the Severn Estuary Special Area of Conservation (SAC)/ Special Protection Area (SPA)/ Site of Special Scientific Interest (SSSI) habitats, including the Atlantic Salt meadow feature, has been undertaken, after consultation with the CC EHO (a copy of the e-mail communication can be found in Appendix 9-4).

The assessment of traffic emission on the Seven Estuary Ramsar/SAC/SPA/SSSI has been undertaken with reference to the following documents:

- Local Air Quality Management Technical Guidance (LAQM.TG(16));
- DMRB Volume 11, Section 3, Part 1 HA207/07- Air Quality (an Interim Advice Note); and
- A guide to the assessment of air quality impacts on designated nature conservation sites (v1.0, 2019) – IAQM.

Vehicle movements associated with the proposed development will generate additional emissions, including NO_x on the local and regional road networks with the potential to impact upon the nearby Severn Estuary nature conservation site (Ramsar/SAC/SPA/SSSI). Information on operational phase road traffic movements was provided by the SLR Highways & Transportation team, transport consultants to the Applicant based upon a 2023 opening year of the Application Site. In 2023, 5-years after the opening year of 2019, there would be +88 HDV and +20 LDV AADT movements associated solely with the proposed development. For this assessment it has been assumed all development traffic will travel through Rover Way (north), the road closest to the Severn Estuary ecological designation. In accordance with the criterion presented within DMRB (i.e. +1000 LDV and +200 HDV), additional road vehicle trips during the operational phase of the proposed development, when assessed in isolation, "*can be considered to have insignificant effects*" on air quality.

In-combination impacts associated with operational phase road traffic movements from the proposed development and other relevant plans and projects were also provided for the 2023 Application Site opening year. This assessment included standard TEMPro growth in traffic movements, local plan allocations and road traffic movements associated with the consented Biomass plant on Rover Way (committed development). It has been assumed that all traffic from the neighbouring Biomass plant (committed development) will travel through Rover Way (north). In-combination road traffic movements on Rover Way (north) are predicted to be +269 HDV and +1,557 LDV AADT. This exceeds the criterion presented within the DMRB guidance (i.e. +1000 LDV and +200 HDV) and therefore 'triggers' the need for a detailed, quantitative assessment of road vehicle emissions.

Rover Way (north) is therefore classified as an 'affected' road during the assessment of in-combination impacts. The Severn Estuary designated nature conservation site (Ramsar/SAC/SPA/SSSI) lies within 200m of Rover Way (north) and therefore in line with the IAQM guidance[1] a detailed assessment of the air quality impacts associated with road vehicle emissions is required for the Severn Estuary. For the purposes of this assessment detailed air dispersion modelling has been undertaken using the Cambridge Environmental Research Consultants (CERC)

[1] IAQM (2019) A guide to the assessment of air quality impacts on designated nature conservation sites, Version 1.0, June 2019.

ADMS Roads v4.1 air dispersion model, following guidance provided in LAQM.TG(16) to predict annual mean and 24 hour concentrations of NO_x for the various scenarios. The model requires various input data, including emissions from each section of road (based upon vehicle flows and vehicle type), and the road characteristic (including road width and street canyon height, where applicable).

The following scenarios have been modelled:

- *'Do Minimum' scenario (DM): situation if the scheme is not taken forward (opening year 2023 and inclusive of anticipated traffic from local plan allocations);*
- *'Do Something' scenario (DS): situation if the proposed development is taken forward (opening year 2023 and inclusive of anticipated traffic from local plan allocations); and*
- *'Do Something' scenario (DS): situation if the Application Site is taken forward and including cumulative developments (opening year 2023 and inclusive of anticipated traffic from local plan allocations).*

In addition to the above scenarios the modelled traffic exhaust concentrations of NO_x have been subject to verification in accordance with LAQM.TG(16).

The ADMS 5.2 air dispersion model was used to predict annual mean and 24 hour concentrations of NO_x as a result of emissions of from stack A5. The predicted concentrations were combined with the outputs of the traffic emission assessment described above to calculate the total process contribution of the proposed development on NOx concentrations.

Assessment Criteria

Critical Levels and Critical Loads

There are many areas in the UK which have been designated by a variety of UK and International bodies as being worthy of protection. These sites will contain species, habitats or other receptors which are potentially sensitive to atmospheric pollution for which indicative exposure thresholds for their protection have been defined. These thresholds are known as Critical Levels (C_{Le}) (for airborne concentrations) and Critical Loads (C_{Lo}) (for deposition rates).

Critical Levels are a quantitative estimate of exposure to one or more airborne pollutants in gaseous form, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Critical Levels for the protection of vegetation and ecosystems are specified within the Air Quality Standards Regulations as presented within Chapter 9 (Air Quality).
Critical Loads are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Critical loads are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions critical loads for eutrophication and acidification are relevant which can occur via both wet and dry deposition; however on a local scale only dry (direct deposition) is considered significant.

Empirical critical loads for eutrophication (derived from a range of experimental studies) are assigned based for different habitats, including grassland ecosystems, mire, bog and fen habitats, freshwaters, heathland ecosystems, coastal and marine habitats, and forest habitats and can be obtained from the UK Air Pollution Information System (APIS) website (www.apis.ac.uk/).

Assessment of Impact and Significance

The assessment has utilised the screening criteria detailed in the EA's AERA guidance. It also makes reference to the EA's Operational Instruction 66_12[2] details how the air quality impacts on ecological sites should be assessed. This guidance provides risk based screening criteria to determine whether impacts will have 'no likely significant effects (alone and in-combination)' for European sites, 'no likely damage' for SSSI's and 'no significant pollution' for other sites, as follows:

- PC does not exceed 1% long-term C_{Le} and/or C_{Lo} or that the PEC does not exceed 70% long-term C_{Le} and/or C_{Lo} for European sites and SSSIs;
- PC does not exceed 10% short-term C_{Le} for NOx for European sites and SSSIs;
- PC does not exceed 100% long-term C_{Le} and/or C_{Lo} other conservation sites; and
- PC does not exceed 100% short-term C_{Le} for NOx (if applicable) for other conservation sites.

Where impacts cannot be classified as resulting in 'no likely significant effect', more detailed assessment may be required depending on the sensitivity of the feature in accordance with EAs Operational Instruction 67_12 ('*Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation'*). This can require the consideration of the potential for in-combination effects, the actual distribution of sensitive features within the site, and local factors (such as the water table).

The guidance provides the following further criteria:

- if the PEC does not exceed 100% of the appropriate limit it can be assumed there will be no adverse effect;
- if the background is below the limit, but a small PC leads to an exceedance – decision based on local considerations;
- if the background is currently above the limit and the additional PC will cause a small increase – decision based on local considerations;
- if the background is below the limit, but a significant PC leads to an exceedance – cannot conclude no adverse effect; and
- if the background is currently above the limit and the additional PC is large - cannot conclude no adverse effect.

Methodology

Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA AQTAG06[3]. Dry deposition flux was calculated using the following equation:

$$\text{Dry deposition flux } (\mu g/m^2/s) = \text{ground level concentration } (\mu g/m^3) \times \text{deposition velocity } (m/s)$$

Wet deposition occurs via the incorporation of the pollutant into water droplets which are then removed in rain or snow, and is not considered significant over short distances compared with dry deposition and therefore for the purposes of this assessment (in accordance with AQTAG06), wet deposition has not been considered.
The applied deposition velocities for the relevant chemical species are as shown in Table 9-6-1.

[2] EA Working Instruction 66_12 - Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.

[3] AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air. Environment Agency, March 2014 version.

Table 9-6-1: Applied Deposition Velocities

Chemical Species	Recommended deposition velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.003

Critical Loads - Eutrophication

The critical loads for nitrogen deposition (N) are recorded in units of kgN/ha/yr. The deposition PC is converted from µg/m^2/s to units of kgN/ha/year by multiplying the dry deposition flux by the standard conversion factor of 95.9.

Critical Loads - Acidification

The deposition PC is converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by multiplying the µg/m^2/s by standard conversion factor of 6.84.

Calculation of PC as a percentage of Acid Critical Load Function

The calculation of the process contribution of N to the critical load function has been carried out according to the guidance on APIS, which is as follows:

> *'The potential impacts of additional sulphur and/or nitrogen deposition from a source are partly determined by PEC, because only if PEC of nitrogen deposition is greater than CLminN will the additional nitrogen deposition from the source contribute to acidity. Consequently, if PEC is less that CLminN only the acidifying effects of sulphur from the process need to be considered:*
> *Where PEC N Deposition < CLminN*
> *PC as % CL function = (PC S deposition/CLmaxS)*100*
> *Where PEC is greater than CLminN (the majority of cases), the combined inputs of sulphur and nitrogen need to be considered. In such cases, the total acidity input should be calculated as a proportion of the CLmaxN.*
> *Where PEC N Deposition > CLminN*
> *PC as %CL function = ((PC of S+N deposition)/CLmaxN)*100'*

ADMS Roads Model Inputs

The 2023 development opening year was considered with appropriate 'do-minimum' and 'do-something' scenarios. The 'do-minimum' scenario included predicted traffic data should the development not occur. The 'do-something' scenario included predicted traffic data should the development be completed.

Speeds entered into the dispersion modelling assessment were assumed to accord with the national speed limit for each link. It is noted that paragraph 7.247 of LAQM.TG(16) recommends that to represent speeds within dispersion modelling for non-congested and motorway junctions and roundabouts, a speed reduction of 10kph slower than the average free-flowing speed should be applied, when local information with regards to congestion and associated speeds is not available. As emission factors are speed related slower speeds would be associated with higher emission factors and would therefore represent a worst-case assessment in terms of overall emissions and concentrations.

Emission factors for NO_X were determined for each scenario using the Emission Factor Toolkit (EFT) v.9.0 as produced by DEFRA and incorporated within ADMS Roads. Emissions factors for 2023 have been used to represent the proposed opening year. A sensitivity assessment was also undertaken, detailed at the end of this Appendix, using 2018 emission factors matching that year of the verification year, as a worst-case assessment.

These modelling assumptions and sensitivity on the dispersion modelling inputs, are in accordance with principles of the IAQM's *Position Statement on Dealing with Uncertainty in Vehicle NOx Emissions within Air Quality Assessments*[4].

Meteorological Data

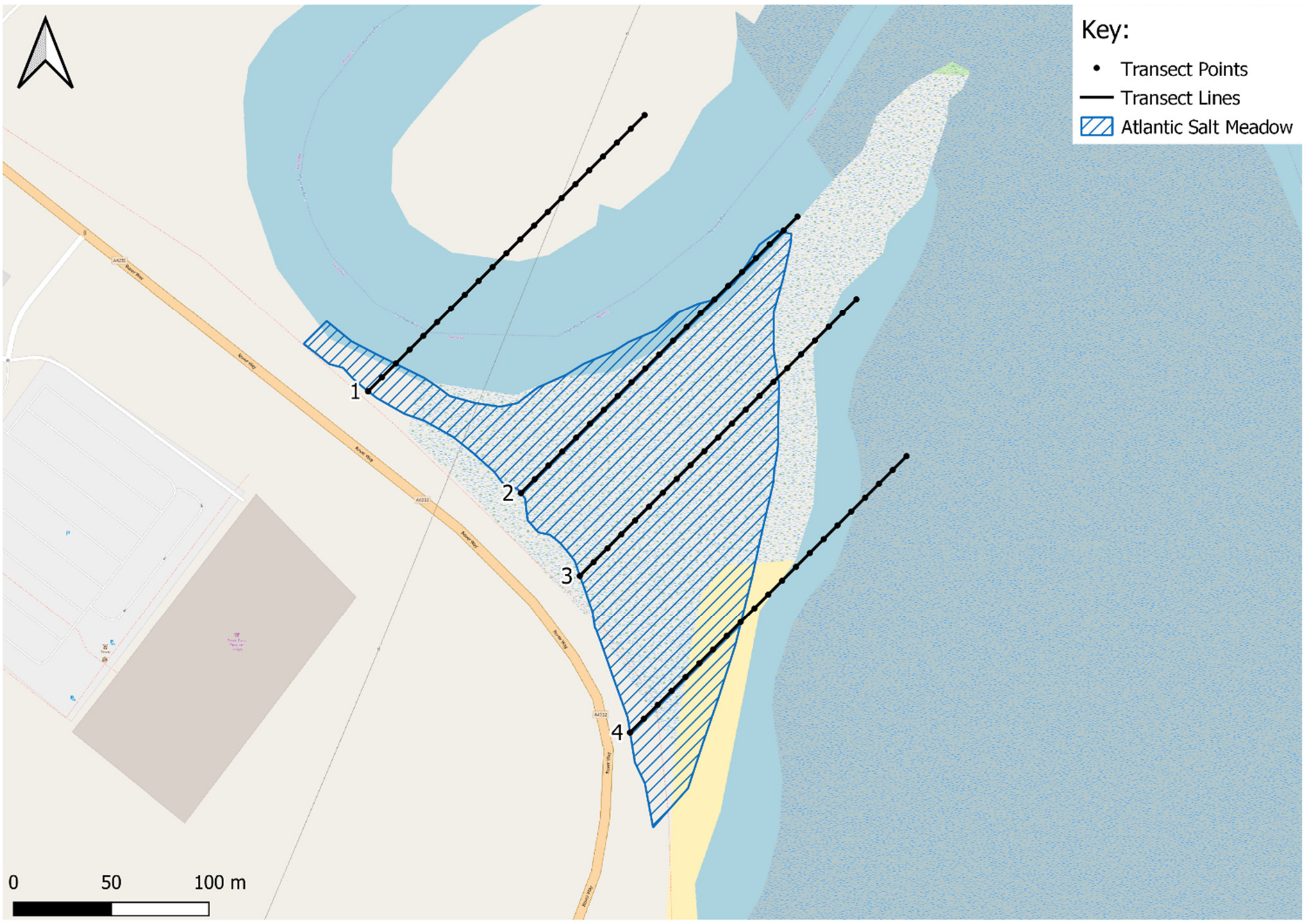
To calculate pollutant concentrations at identified receptor locations the model uses sequential hourly meteorological data, including wind direction, wind speed, temperature, cloud cover and stability, which exert significant influence over atmospheric dispersion. Dispersion modelling has been undertaken using 2018 Cardiff Airport meteorological data to match the model verification year of 2018.

Assessment Area

Discrete receptors were identified across the area of Atlantic Salt Meadow within the Severn Estuary SAC. An output grid was drawn across the area and four transects from the edge of the area nearest to Rover Way also. The transects were selected at 10m intervals across the section of Atlantic Salt Meadow habitat nearest to Rover Way in order to calculate concentration drop-off from road traffic exhaust emissions within the Severn Estuary SAC.

The four transects (Figure 9-6-1) were selected at differing points along the habitat to assess the potential impacts of the modelled road link. These multiple transects corresponding to the Severn Estuary receptor are referred to as E1_1, E1_2, E1_3 and E1_4 within the reporting text.

Figure 9-6-1: Modelled transects



An output grid was modelled covering the identified area of Atlantic Salt Meadow habitat nearest to Rover Way

[4] http://www.iaqm.co.uk/text/position_statements/vehicle_NOx_emission_factors.pdf - accessed September 2019.

at ground level (z = 0m).

Surface Roughness Length

A roughness length z_0 of 0.3m was used within the assessment area of this dispersion modelling study. This value of z_0 is comparable to 'agricultural areas (max)' and therefore considered appropriate for the morphology of the dispersion modelling assessment area. It is also represents a worst case assumption, considering that the surface roughness for open water is significantly lower. In addition it matches the surface roughness used at the meteorological station that is also located at a coastal area.

Monin-Obukhov Length

The minimum Monin-Obukhov (MO) length is an important variable for dispersion models. The minimum MO length allows for the effect of heat production from the surrounding area. The larger the city, the larger the heat production (from buildings and traffic etc.) and the less stable the atmosphere. This effect is not taken into account within the meteorological data and therefore is input separately in to the model.

A minimum MO length of 10m was used within the assessment area of this dispersion modelling study. This value is considered to be appropriate for 'small towns <50,000 [population]' and considered to be representative of the immediate locale surrounding the considered ecological designations.

Traffic Data

A summary of the traffic data for Rover Way (north) used in this assessment are presented in Table 9-6-2. Note that the traffic data used for the verification of the model where extracted from the Department for Transport website[5].

Table 9-6-2: Traffic Data for Rover Way (north)

Scenario	AADT	% HGVs	Speed (km/h)
2023 Base (including local plan)	22,874	9.7	48
2023 + Application Site (including local plan)	22,982	10.0	48
2023 + Application Site + Committed Development	23,342	10.1	48

Model Inputs: Overview

The modelling parameters are summarised in Table 9-6-3.

[5] https://roadtraffic.dft.gov.uk/#6/55.254/-6.053/basemap-regions-countpoints

Table 9-6-3: Summary of ADMS Roads Modelling Inputs

Parameter	Description	Input Variable
Surface Roughness	Surface roughness of the modelling domain as a function of land use	z_0 = 0.3m
Minimum MO length	Minimum MO length of the modelling domain as a function of land use	MO length = 10m
Road Source Emissions	Source of the emission factors used	EFT v.9.0
Emission Year	Modelling year used to factor the traffic emissions	2023 for the opening year of the development (A)
Road Type	Road type within the EFT emission database	Wales (Urban)
Elevation of Road	Height of the road link above ground level	0m for all road links.
Road Width	Width of the road link	Road width used depended on data obtained from OS map data for the specific road link
Road Speed	Road speed in km/h	Table 9-6-2
Time Varied Emissions	Daily, weekly or monthly variations in emissions applied to road sources	None
Meteorology	Representative hourly sequential meteorological data	2018 Cardiff Airport
Background	Background pollutant concentration considered during the modelling	2023 NOx backgrounds presented within Chapter 9 (Air Quality)**Error! Reference source not found.**
Output	Output as gridded or specified points	Specific points Gridded Area
Pollutant Output	Pollutants modelled and averaging time	NO_x annual mean
Note: (A) Scenario modelled as an assumed 2023 development opening year, with corresponding 2023 emission factors. An alternative scenario has also been modelled using 2018 emission factors. .		

ADMS 5.2 Model Inputs

The ADMS 5.2 dispersion model utilised the same model inputs as the ADMS Roads model (detailed above) for the following:

- Assessment area;
- Surface Roughness Length; and
- Monin-Obukhov Length.

The model was run using 5 years of meteorological data from Cardiff Airport to establish the worst year in terms of dispersion. A sensitivity test was also undertaking using the model's coastline option. Coastline effects can be significant from elevated point sources, such as stack A5, within a few kilometres (up to a maximum of 5km) from the coast. The results of the sensitivity tests are presented at the end of this Appendix.

The emission parameters applied in the modelling are provided in Table 9-6-4 below and are based on stack monitoring undertaken at the Rotherham plant in November 2019[6].

Table 9-6-4: Emission Parameters

Parameter / Source	Stack A5
Stack Location (NGR x,y)	321483, 176275
Stack Height (m)	22
Stack diameter (m)	1.5
Velocity (m/s)	12.7
Emission temperature (C)	102
NOx emission (g/s)	0.09

The processing of the model outputs assumed that the plant operates 82% of the year. Considering that there are no significant structures in the vicinity of the stack and the fact that the Severn Estuary is over 1 km away, no buildings were included in the model.

Results

Operational Phase Impact Assessment – Ecological Receptors

Modelling of impacts over the Severn Estuary has been undertaken to determine impacts on Critical Loads and Critical Levels, as presented within the following subsections. Paragraph 7.508 of LAQM.TG(16) states that: '*The model used should have some form of published validation assessment available and/or should be recognised as being fit for purpose by the regulatory authorities*'. An adjustment factor has been calculated and applied to the modelling results for the assessment scenarios in line with this guidance. The calculated factor from an average of all considered monitoring locations is **2.10** (see end of this Appendix for full details).

Two separate scenarios were modelled for the 2023 development opening year. Scenario 1 (2023 DS - 2023 DM) incorporated the change in AADT from the proposed development alone. Scenario 2 ((2023 DS + Cumulative development) - 2023 DM) incorporated the change in AADT from the proposed development and surrounding developments and plans (i.e. in-combination impacts).

Note that all 2023 sub scenarios are inclusive of local plan allocation contribution to traffic flows.

[6] Socotec (2019). Stack Emissions Monitoring Report. Harco Metals Group Limited, Steelphalt Slag Reduction Co, The Ickles, Sheffield Road, Rotherham.

The output of the traffic and stack dispersion modelling were combined and the total process contribution of NOx from the site was calculated. The assessment of impacts over the Atlantic Salt Meadow habitat detailed below is also representative of potential impacts of the Severn Estuary SSSI.

Critical Levels

The contributions from additional development trips and from the stack A5 to the annual mean and 24-hour NOx Critical Levels at the roadside boundary of the Severn Estuary Atlantic Salt Meadow habitat is presented in Table 9-6-5 to Table 9-6-8. Note that annual mean background NO_x concentrations are based on 2023 Defra background maps, as presented Chapter 9 (Air Quality). The 24-hour mean background NO_x concentrations are 2 x the annual mean. The DS scenario under Verified Modelled NOx Contribution is inclusive of the contribution of emission of NO_x from stack A5.

It is noted that the concentration stated within Table 9-6-5 to Table 9-6-8 for the 'grid' receptor is the maximum concentration modelled over the considered grid, and for the 'ER1_1', 'ER1_2', 'ER1_3' and 'ER1_4' is the maximum concentration modelled over each transect.

Table 9-6-5: Maximum Impacts on Annual Mean NOx Critical Levels –Scenario 1

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		Annual Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)	DS Concentration as a % of Critical Level (%)
		DM	DS	DM	DS			
Grid	17.1	20.7	20.9	37.9	38.1	+0.19	0.63	127
E1_1	19.2	11.5	11.6	30.7	30.8	+0.11	0.36	103
E1_2	19.2	7.63	7.70	26.8	26.9	+0.08	0.25	90
E1_3	17.2	9.08	9.17	26.2	26.3	+0.09	0.29	88
E1_4	17.2	21.1	21.3	38.2	38.4	+0.19	0.64	128

Table 9-6-6: Maximum Impacts on Annual Mean NOx Critical Levels –Scenario 2

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		Annual Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)	DS Concentration as a % of Critical Level (%)
		DM	DS	DM	DS			
Grid	17.1	20.7	21.3	37.9	38.4	+0.54	1.81	139
E1_1	19.2	11.5	11.8	30.7	31.0	+0.31	1.02	118
E1_2	19.2	7.63	7.84	26.8	27.0	+0.21	0.69	105
E1_3	17.2	9.08	9.32	26.2	26.5	+0.24	0.81	99.5
E1_4	17.2	21.1	21.6	38.2	38.8	+0.55	1.83	140

Table 9-6-7: Maximum Impacts on 24-Hour Mean NOx Critical Levels –Scenario 1

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		24 Hour Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)	DS Concentration as a % of Critical Level (%)
		DM	DS	DM	DS			
Grid	34.3	91.1	91.9	125	126	+0.86	1.14	168
E1_1	38.3	57.3	57.9	95.6	96.2	+0.58	0.77	128
E1_2	38.3	36.8	37.2	75.2	75.6	+0.42	0.56	101
E1_3	34.3	42.6	43.1	76.9	77.4	+0.47	0.62	103
E1_4	34.3	92.4	93.2	127	128	+0.87	1.15	170

Table 9-6-8: Maximum Impacts on 24-Hour Mean NOx Critical Levels –Scenario 2

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		24 Hour Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)	DS Concentration as a % of Critical Level (%)
		DM	DS	DM	DS			
Grid	34.3	91.1	93.4	125	128	+2.30	3.07	170
E1_1	38.3	57.3	58.8	95.6	97.1	+1.49	1.98	129
E1_2	38.3	36.8	37.9	75.2	76.2	+1.03	1.38	102
E1_3	34.3	42.6	43.8	76.9	78.1	+1.17	1.56	104
E1_4	34.3	92.4	94.7	127	129	+2.33	3.11	172

Under Scenario 1, which considers the development alone, Table 9-6-5 illustrates that the modelled contribution to annual mean NOx concentrations is very low, at less than 1% increase of the annual mean NOx Critical Level of 30µg/m³ at all considered receptors, based upon the 2023 development opening year. Table 9-6-7 illustrates that the contribution to 24-hour mean NOx concentrations is very low, at less than 10% increase of the annual mean NOx Critical Level of 75µg/m³ at all considered receptors, based upon the 2023 development opening year.

Under Scenario 2, which considers in-combination impacts, Table 9-6-6 illustrates that the modelled contribution to annual mean NOx concentrations varies across the receptors. The maximum impacts identified on the receptor grid and transect E1_4 exceed 1% of the annual mean NOx Critical Level of 30µg/m³. The grid location and transect E1_3 and E1_4 receptors that are exceeding 1% represent a point where the grid and transect overlap. Table 9-6-8 illustrates that the contribution to 24-hour mean NOx concentrations is low, at less than 10% increase of the annual mean NOx Critical Level of 75µg/m³ at all considered receptors, based upon the 2023 development opening year.

The annual mean NOx Critical Level of 30µg/m^3 is predicted to be exceeded under both 'do-minimum' and 'do-something' of Scenario 1 and 2 at several of the maximum impact receptors; Grid, E1_1 and E1_4. This is considered to be a function of the proximity of the Severn Estuary designation to the kerbside of the road. In addition the 24-hour mean NOx Critical Level of 75µg/m^3 is predicted to be exceeded under both 'do-minimum' and 'do-something' of Scenario 1 and 2.

It is noted that the predicted annual mean NOx road traffic contribution associated with additional development trips will reduce (below those presented within Table 9-6-5 to Table 9-6-8) at increasing distances from the roadside. Reference should be made to Figures 9-6-2 and Figure 9-6-3 for a presentation of the modelled annual mean NOx concentration drop-off for Transect 4 (considered worst-case), as concentration change associated with additional development trips, within the Severn Estuary ecological designation. Figure 9-6-3 illustrates the geographical area where the process contribution for Scenario 2 is over 1% of the AQO. This area corresponds to 1,327 m^2 (0.13 ha), corresponding to less than 0.01 % of the total area of the Severn Estuary classed as Atlantic Salt meadow (1,400 ha).

Figure 9-6-2: Annual Mean NO_x Concentration Change - Transect 4 (Scenario 1)

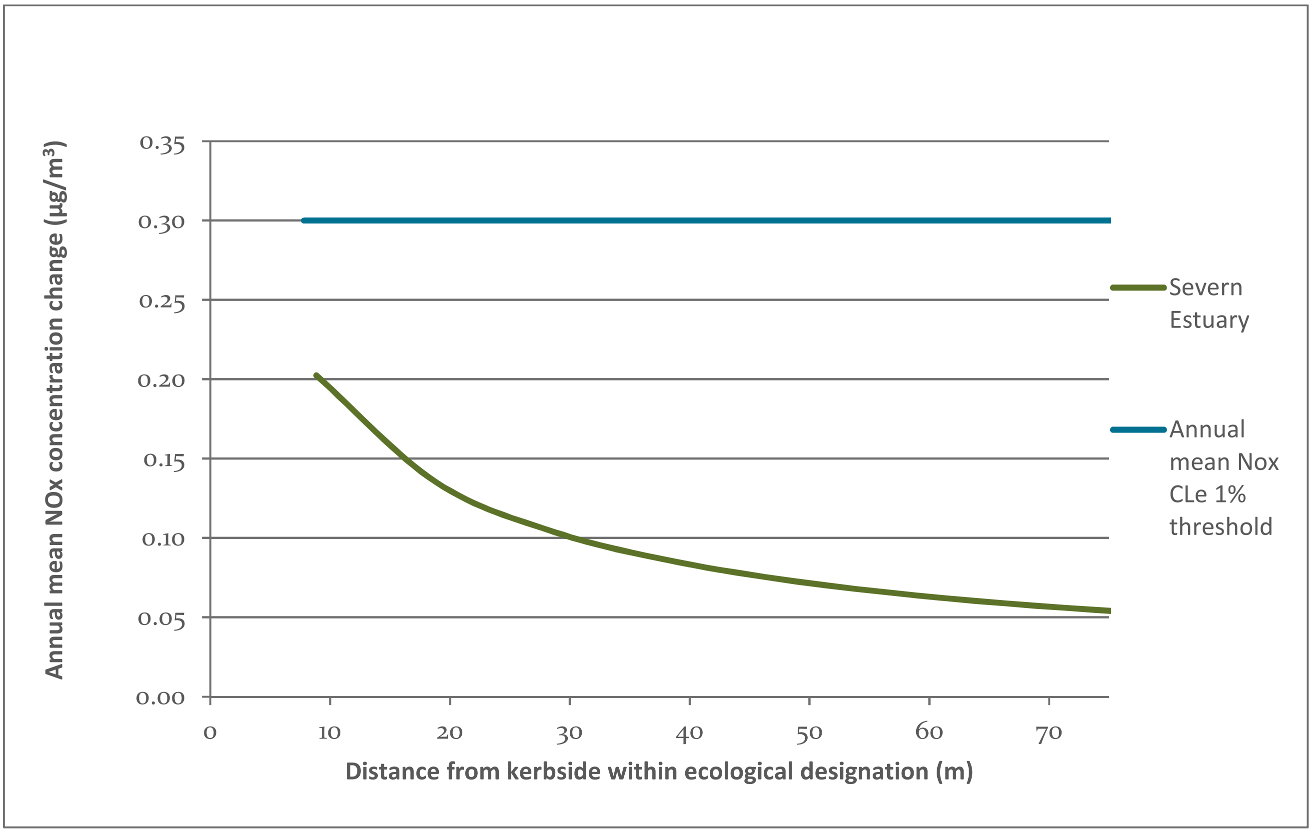


Figure 9-6-3: Annual Mean NO_x Concentration Change - Transect 4 (Scenario 2)

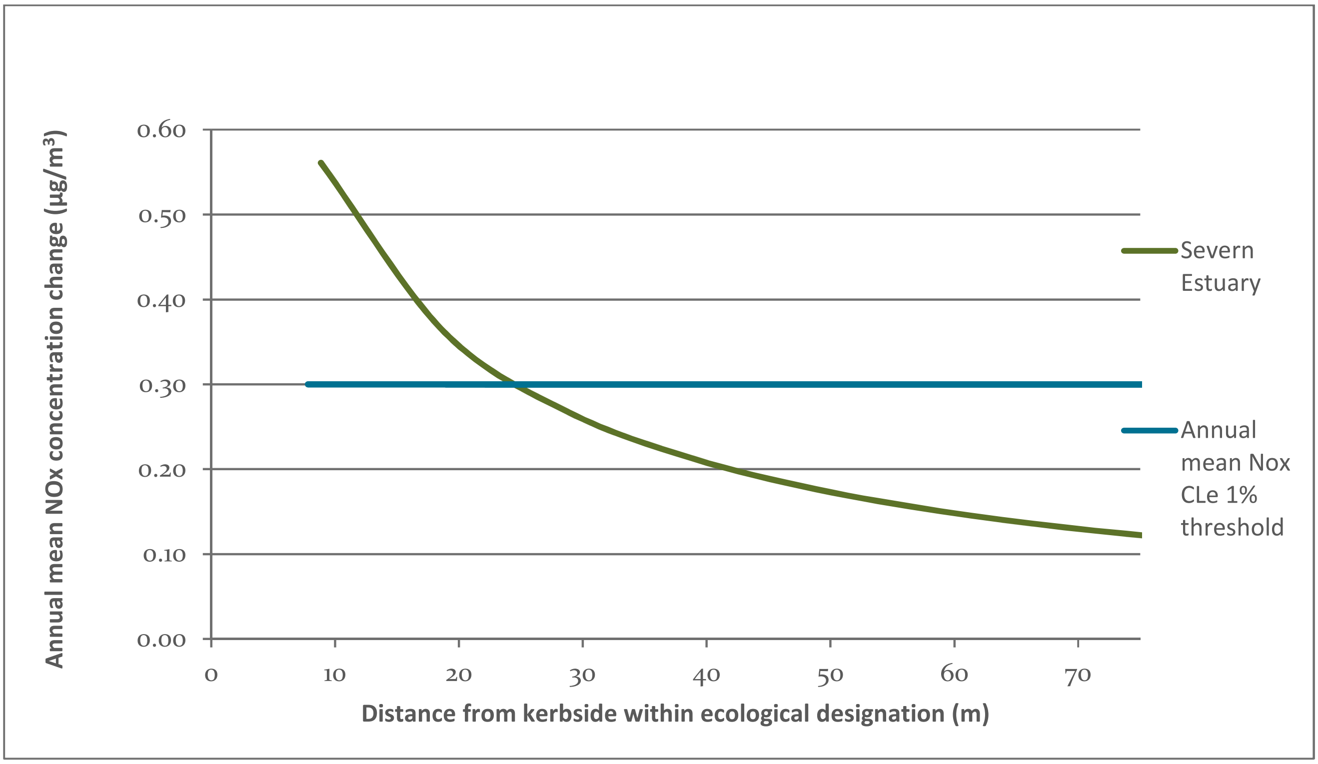
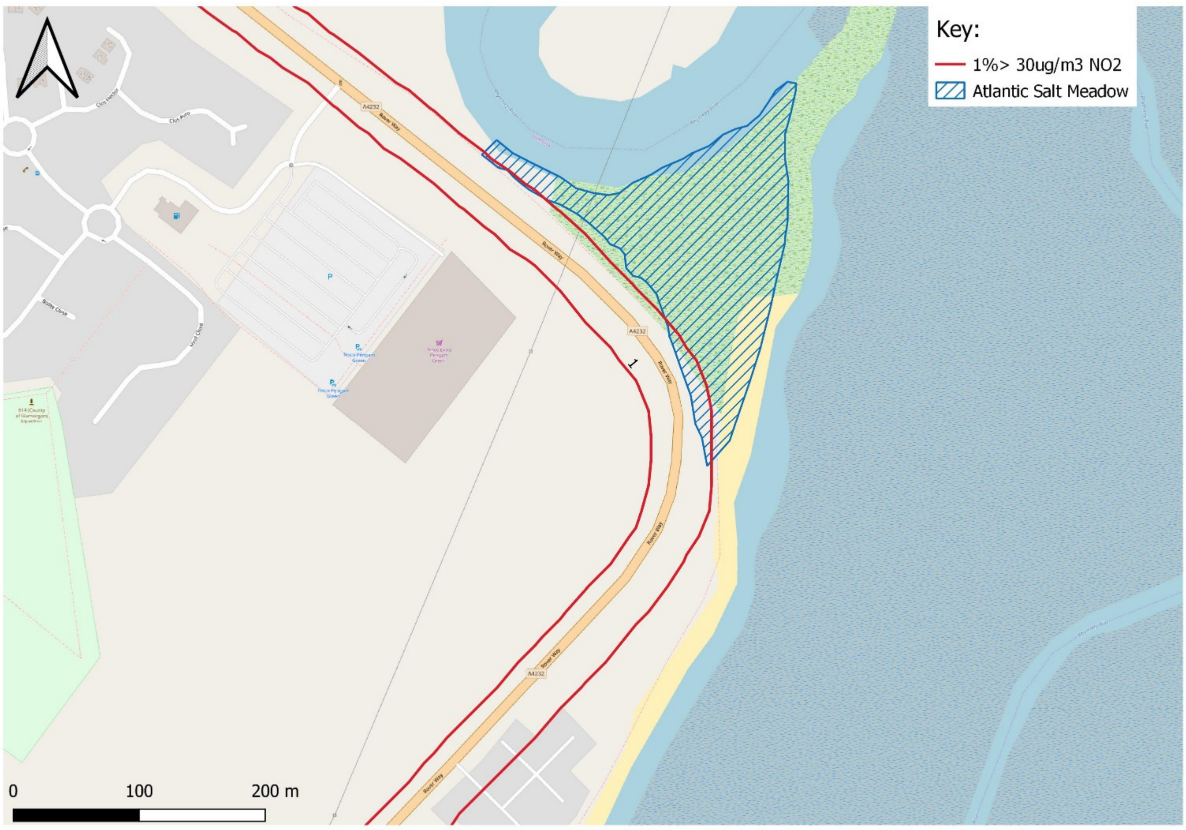


Figure 9-6-4: Annual mean NO_x concentration >1% of the AQO (Scenario 2)



Critical Loads – Nutrient Nitrogen

The contributions from development to the Critical Loads for nutrient nitrogen deposition at the Severn Estuary SAC Atlantic Salt Meadow habitat is presented in Table 9-6-9 and Table 9-6-10 for Scenarios 1 and 2, respectively.

It is noted that the contribution change presented is the maximum modelled concentration from each of the four considered transects and receptor grid.

Table 9-6-9: Maximum Impact on Critical Load for Nutrient Nitrogen Deposition –Scenario 1

Receptor	Relevant Nitrogen Critical Load Class	Lower Load (kg N/ha/yr)	Current deposition (kg N/ha/yr)	Process contribution change (kg N/ha/yr)	PC as a % of Lower CL (%)
E1 Max	Atlantic Salt meadows	20	13.7	+0.02	0.09

Table 9-6-10: Maximum Impact on Critical Load for Nutrient Nitrogen Deposition –Scenario 2

Receptor	Relevant Nitrogen Critical Load Class	Lower Load (kg N/ha/yr)	Current deposition (kg N/ha/yr)	Processcontribution change (kg N/ha/yr)	PC as a % of Lower CL (%)
E1 Max	Atlantic Salt meadows	20	13.7	+0.05	0.27

The modelled and verified road traffic contribution to the Critical Loads for nutrient nitrogen is very low, at less than 1% increase of the nutrient nitrogen lower Critical Load at all considered receptors and ecological designations, based upon the 2023 development opening year scenarios (both Scenario 1 and Scenario 2). In addition when considering current deposition and the contribution from the proposed development, committed development and local plan allocations, the lower Critical Load of 20kg N/ha/yr is not exceeded.

It is noted that the predicted road traffic contribution to the Critical Loads for nutrient nitrogen deposition associated with additional development trips will reduce (below those presented within Table 9-6-9 and Table 9-6-10) at increasing distances from the roadside.

Critical Loads – Acidity

The contributions from additional development trips to the Critical Loads for nitrogen contribution to acid deposition at the roadside boundary of the Severn Estuary designation is presented in Table 9-6-11 and Table 9-6-12 for Scenarios 1 and 2 respectively.

It is noted that the contribution change presented is the maximum modelled concentration from each of the four considered transects and receptor grid.

The Atlantic Salt Meadows habitat defined under the Severn Estuary SAC designation is not sensitive to acid deposition and therefore the habitat most sensitive to acid deposition and defined under the Severn Estuary SSSI designation ‘Neutral grassland’ has been considered instead[7].

[7] http://www.apis.ac.uk/

Table 9-6-11: Maximum Impacts on Critical Loads for Acidity Deposition –Scenario 1

Receptor	Terrestrial Habitat Information	CLmaxN (keq/ha/yr)	Current Load (keq/ha/yr)	Process contribution change (keq/ha/yr)	Change as a % of CLmaxN (%)
E1 Max	Neutral grassland	1.063	0.9	+0.001	0.13

Table 9-6-12: Maximum Impacts on Critical Loads for Acidity Deposition –Scenario 2

Receptor	Terrestrial Habitat Information	CLmaxN (keq/ha/yr)	Current Load (keq/ha/yr)	Process contribution change (keq/ha/yr)	Change as a % of CLmaxN (%)
E1 Max	Neutral grassland	1.063	0.9	+0.004	0.36

The modelled contribution to the Critical Loads for nitrogen contribution to acid deposition is very low, at less than 1% increase of the acid Critical Load at all considered receptors and ecological designations, based upon the 2023 development opening year scenarios (both Scenario 1 and Scenario 2). In addition, when considering current deposition and the contribution from the proposed development, committed development and local plan allocations, the Critical Load of 1.06keq/ha/yr is not exceeded.

It is noted that the predicted contribution to the Critical Loads for nitrogen contribution to acid deposition associated with additional development trips will reduce (below those presented within Table 9-6-11 and Table 9-6-12) at increasing distances from the roadside.

Significance of Air Quality Impacts

The unmitigated impact associated with the proposed development has been predicted in accordance with the stated assessment methodology. It is noted that the overall determination of the significance of effect has been undertaken based upon the modelling 2023 development opening year. The following factors have been taken into account:

- increases in annual mean NOx are less than 1% of the Critical Level across all of the Severn Estuary SAC when the impacts of the development are considered alone;
- increases in annual mean NOx are seen above 1% of the Critical Level at parts of the Severn Estuary SAC nearest to Rover Way when in-combination impacts are considered. The exceedances are limited to an area of 1,327 m^2 (<0.01 % of the Atlantic Salt designation). However, under both 'do-minimum' and 'do-something' scenarios the annual mean NOx concentrations at these receptors exceeds the annual mean Critical Level of 30µg/m^3;
- increases in 24-hour mean NOx are less than 10% of the Critical Level across all of the Severn Estuary SAC when the impacts of the development are considered alone and in combination with the committed development;
- increases in nutrient nitrogen are less than 1% of the lower Critical Load across all of the Severn Estuary SAC when the impacts of the development are considered alone and in combination with the committed development;
- increases in nitrogen contribution to acidity are less than 1% of the acid Critical Load across all of the Severn Estuary SAC when the impacts of the development are considered alone and in combination with the committed development; and

- the total load (i.e. road traffic contribution change plus the current load) is not in excess of the nitrogen and acid Critical Load at any considered ecological receptors.

Furthermore, the IAQM's Position Statement on the Use of a Criterion for the Determination of an Insignificant Effect of Air Quality Impacts on Sensitive Habitats[8], states the following:

> *[…] it is the position of the IAQM that the use of a criterion of 1% of an assessment level in the context of habitats should be used only to screen out impacts that will have an insignificant effect.*

Therefore, on the basis of the above, the overall effect on air quality and impacts at the considered ecological designation as a result of the additional development trips is considered to be 'insignificant'. The impacts from the cumulative assessment indicate that there are limited exceedences of the annual mean NOx objective over an area 1,327m^2 of the Atlantic Salt Meadow designation of the Severn Estuary. The assessment is considered conservative as it has assumed that all traffic from the proposed development and committed development travels on Rover Way (north). In addition a single model verification factor was applied across the modelled grid and transects, irrespective of their distance from the road. Although the extend of the exceedance is very limited (<0.01% of the area of Atlantic Salt Meadow habitat), annual mean NOx concentrations from traffic generated by the propose scheme will result in further exceedance of the threshold breached by the committed development (however negligibly). The impact of this is considered further in Chapter 11 (Ecology).

[8] http://www.iaqm.co.uk/text/position_statements/aq_impacts_sensitive_habitats.pdf - accessed June 2017.

ADMS Roads Model Verification

The comparison of modelled concentrations with local monitored concentrations is a process termed 'verification'. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and / or uncertainties in model input data, modelling and monitoring data assumptions.

The following are examples of potential causes of such discrepancy:

a) estimates of background pollutant concentrations;
b) meteorological data uncertainties;
c) traffic data uncertainties;
d) model input parameters, such as 'roughness length'; and
e) overall limitations of the dispersion model.

Most nitrogen dioxide is produced in the atmosphere by the reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of the primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2), in line with the guidance provided within LAQM.TG16.

The model has been run to predict the 2018 annual mean road-NOx contribution at three roadside diffusion tubes within the modelled road network. The model outputs of road-NOx have been compared with the 'measured' road-NOx, which was determined from the NO_2 concentrations measured using diffusion tubes at the monitoring locations, utilising the NOx from NO_2 calculator provided by Defra and the NO_2 background concentration (from the Defra background map). The most recent suitable data available for model verification purposes are the Cardiff Council diffusion tubes data. The approach followed was agreed with the CCC EHO.

The Table 9-6-13 and Figure 9-6-4 below present the data used in the verification process.

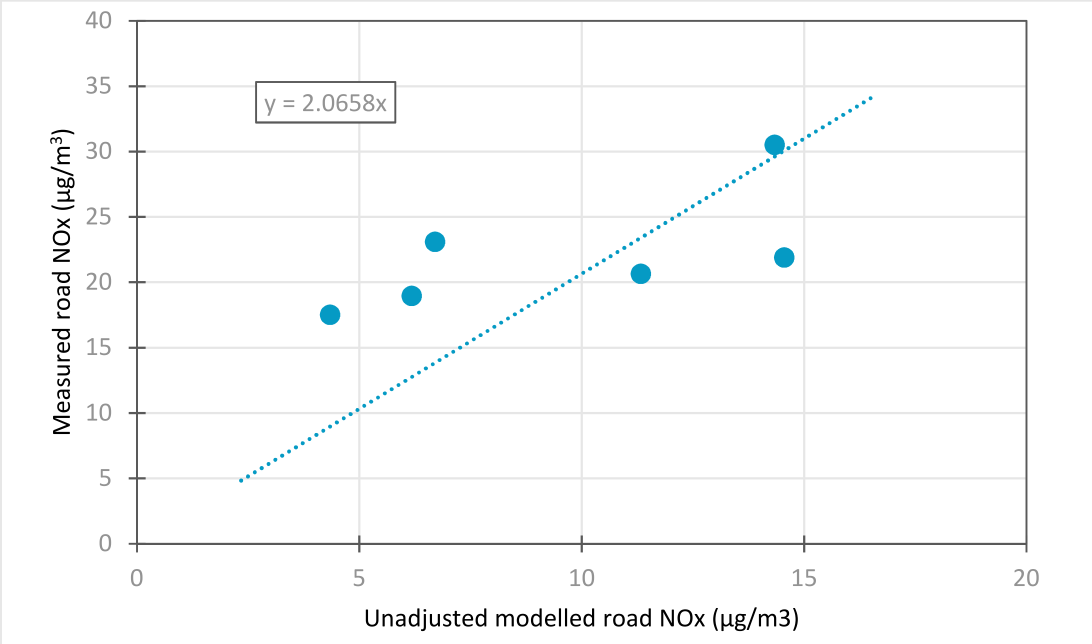
Table 9-6-13: Data Used in model verification

Monitoring Site	Measured Annual Mean NO_2 Concentration (μg/m^3)	Background NO_2 (μg/m^3)	Measured Road-NOx (μg/m^3) (from NO_x:NO_2 calculator)	Modelled Road-NOx (μg/m^3)	Ratio
49	27.3	17.7	19.0	6.2	3.1
147	29.3	17.7	23.1	6.7	3.4
148	26.6	17.7	17.5	4.3	4.0
159	35.6	20.7	30.5	14.3	2.1
195	31.6	20.7	21.9	14.6	1.5
197	31.0	20.7	20.6	11.3	1.8

The road-NOx adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure 9-6-4).

This factor indicates that the model is under predicting concentrations and therefore no adjustment to the predicted NO_X was applied. This approach ensured that the worst case predicted results were considered in the assessment.

Figure 9-6-4: Comparison of Measured Road-NOx with Unadjusted Modelled Road-NOx



Model Uncertainty

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG16 identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. These include:

f) root mean square error (RMSE);
g) fractional bias (FB); and
h) correlation coefficient (CC).

These parameters estimate how the model results agree or diverge from the observations. These calculations can be carried out prior to, and after adjustment, or based on different options for adjustment, and can provide useful information on model improvement. A brief for explanation of each statistic is provided in Table 9-6-14, and further details can be found in Box 7.17 of LAQM.TG16.

Table 9-6-14: Methods for describing model uncertainty

Statistical Parameter	Comments
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared. If the RMSE values are higher than 25% of the objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements.
Fractional Bias	It is used to identify if the model shows a systematic tendency to over or under predict.
Correlation Coefficient	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship.

To assess the uncertainty of a model, the RMSE is the simplest parameter to calculate providing an estimate of the average error of the model in the same units as the modelled predictions. It is also often easier to interpret the RMSE than the other statistical parameters and therefore it has been calculated in this assessment to understand the model uncertainty.

The RMSE value calculated after verification was 3.3 which is below the recommended value of 4, indicating that it would be appropriate to correct modelled predictions by the calculated verification factor.

Traffic Emissions Assessment Sensitivity

The section presents the results of the assessment utilising 2018 vehicle emission factors and 2018 Defra background maps to match the 2018 verification year.

Critical Levels

The contributions from additional development trips to the annual mean and 24-hour NOx Critical Levels at the roadside boundary of the Severn Estuary SAC Atlantic Salt Meadow habitat is presented in Table 9-6-15 to Table 9-6-18.

It is noted that the concentration stated for the ‘grid’ receptor is the maximum concentration modelled over the considered grid, and for the ‘ER1_1’, ‘ER1_2’, ‘ER1_3’ and ‘ER1_4’ is the maximum concentration modelled over each transect.

Table 9-6-15: Maximum Impacts on Annual Mean NOx Critical Levels –Scenario 1, 2018 Sensitivity

Receptor	Background NOx Concentration (μg/m^3)*	Verified Modelled NOx Contribution (μg/m^3)		Annual Mean NOx Concentration (μg/m^3)		Absolute Concentration Change (μg/m^3)	Concentration Change as a % of Critical Level (%)
		DM	DS	DM	DS		
Grid	20.5	35.2	35.7	55.8	56.2	+0.47	1.57
E1_1	23.5	19.7	19.9	43.2	43.5	+0.27	0.89
E1_2	23.5	13.0	13.2	36.6	36.8	+0.18	0.60
E1_3	20.5	15.5	15.7	36.0	36.2	+0.21	0.71
E1_4	20.5	35.80	36.27	56.3	56.8	+0.48	1.59

Table 9-6-16: Maximum Impacts on Annual Mean NOx Critical Levels –Scenario 2, 2018 Sensitivity

Receptor	Background NOx Concentration (μg/m^3)	Verified Modelled NOx Contribution (μg/m^3)		Annual Mean NOx Concentration (μg/m^3)		Absolute Concentration Change (μg/m^3)	Concentration Change as a % of Critical Level (%)
		DM	DS	DM	DS		
Grid	20.5	35.2	36.3	55.8	56.9	+1.12	3.72
E1_1	23.5	19.7	20.3	43.2	43.8	+0.63	2.10
E1_2	23.5	13.0	13.5	36.6	37.0	+0.42	1.41
E1_3	20.5	15.5	16.0	36.0	36.5	+0.50	1.67
E1_4	20.5	35.80	36.93	56.3	57.4	+1.13	3.78

Table 9-6-17: Maximum Impacts on 24-Hour Mean NOx Critical Levels –Scenario 1, 2018 Sensitivity

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		24-Hour Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)
		DM	DS	DM	DS		
Grid	41.0	148.6	150.5	189.6	191.5	+1.89	2.52
E1_1	47.1	94.1	95.4	141.2	142.4	+1.26	1.68
E1_2	47.1	61.7	62.6	108.8	109.7	+0.89	1.19
E1_3	41.0	71.2	72.2	112.3	113.3	+1.01	1.35
E1_4	41.0	150.65	152.56	191.7	193.6	+1.91	2.55

Table 9-6-18: Maximum Impacts on 24-Hour Mean NOx Critical Levels –Scenario 2, 2018 Sensitivity

Receptor	Background NOx Concentration (µg/m³)	Verified Modelled NOx Contribution (µg/m³)		24-Hour Mean NOx Concentration (µg/m³)		Absolute Concentration Change (µg/m³)	Concentration Change as a % of Critical Level (%)
		DM	DS	DM	DS		
Grid	41.0	149	153	190	194	+4.37	5.82
E1_1	47.1	94.1	97.0	141	144	+2.88	3.83
E1_2	47.1	61.7	63.7	109	111	+1.99	2.65
E1_3	41.0	71.2	73.5	112	115	+2.27	3.03
E1_4	41.0	151	155	192	196	+4.42	5.89

Under Scenario 1, which considers the development alone, Table 9-6-15 illustrates that the modelled contribution to annual mean NOx concentrations varies across the receptors. The maximum impacts identified on the receptor grid and transect E1_4 exceed 1% of the annual mean NOx Critical Level of 30µg/m³. Table 9-6-17 illustrates that the contribution to 24 hour mean NOx concentrations is low, at less than 10% increase of the annual mean NOx Critical Level of 75µg/m³ at all considered receptors, based upon the 2023 development opening year.

Under Scenario 2, which considers in-combination impacts, Table 9-6-16 illustrates that the modelled contribution to annual mean NOx concentrations varies across the receptors. The maximum impacts identified on the receptor grid and transect E1_4 exceed 1% of the annual mean NOx Critical Level of 30µg/m³. The national grid reference of the exceeding grid and transect E1_4 receptors is x322045, y177084 and therefore represents a point where the grid and transect overlap. Table 9-6-18 illustrates that the contribution to 24 hour mean NOx concentrations is low, at less than 10% increase of the annual mean NOx Critical Level of 75µg/m³ at all considered receptors, based upon the 2023 development opening year.

The annual mean NOx Critical Level of 30µg/m³ is predicted to be exceeded under both 'do-minimum' and 'do-something' of Scenario 1 and 2 at several of the maximum impact receptors; Grid, E1_1 and E1_4. This is considered to be a function of the proximity of the Severn Estuary designation to the kerbside of the road. In addition the 24 hour mean NOx Critical Level of 75µg/m³ is predicted to be exceeded under both 'do-minimum' and 'do-something' of Scenario 1 and 2.

It is noted that the predicted annual mean NOx road traffic contribution associated with additional development trips will reduce (below those presented within Table 9-6-15 to Table 9-6-18) at increasing distances from the roadside. Reference should be made to Figures 9-6-6 and Figure 9-6-7 for a presentation of the modelled annual mean NOx concentration drop-off for Transect 4, as concentration change associated with additional development trips, within the Severn Estuary ecological designation.

Figure 9-6-6: Annual Mean NO_x Concentration Change - Transect 4 (Scenario 1), 2018 Sensitivity

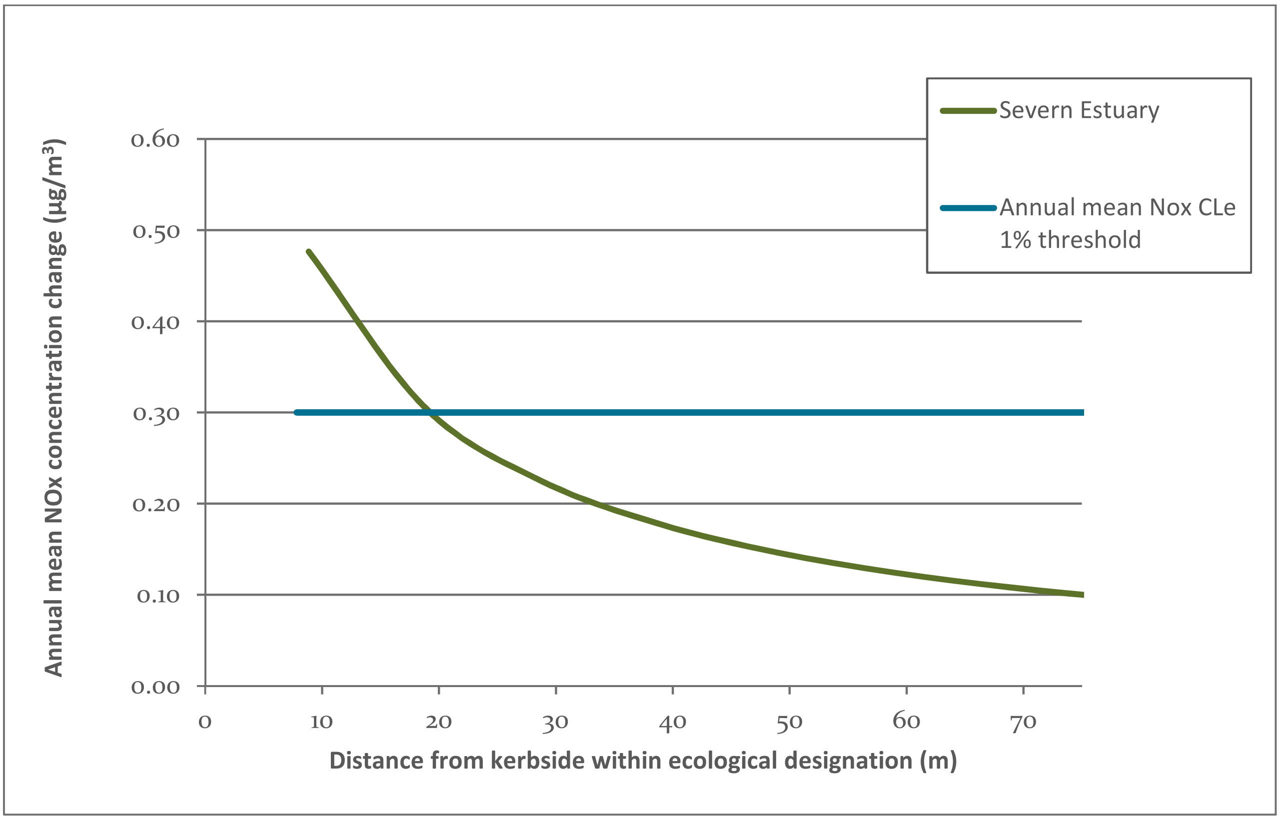
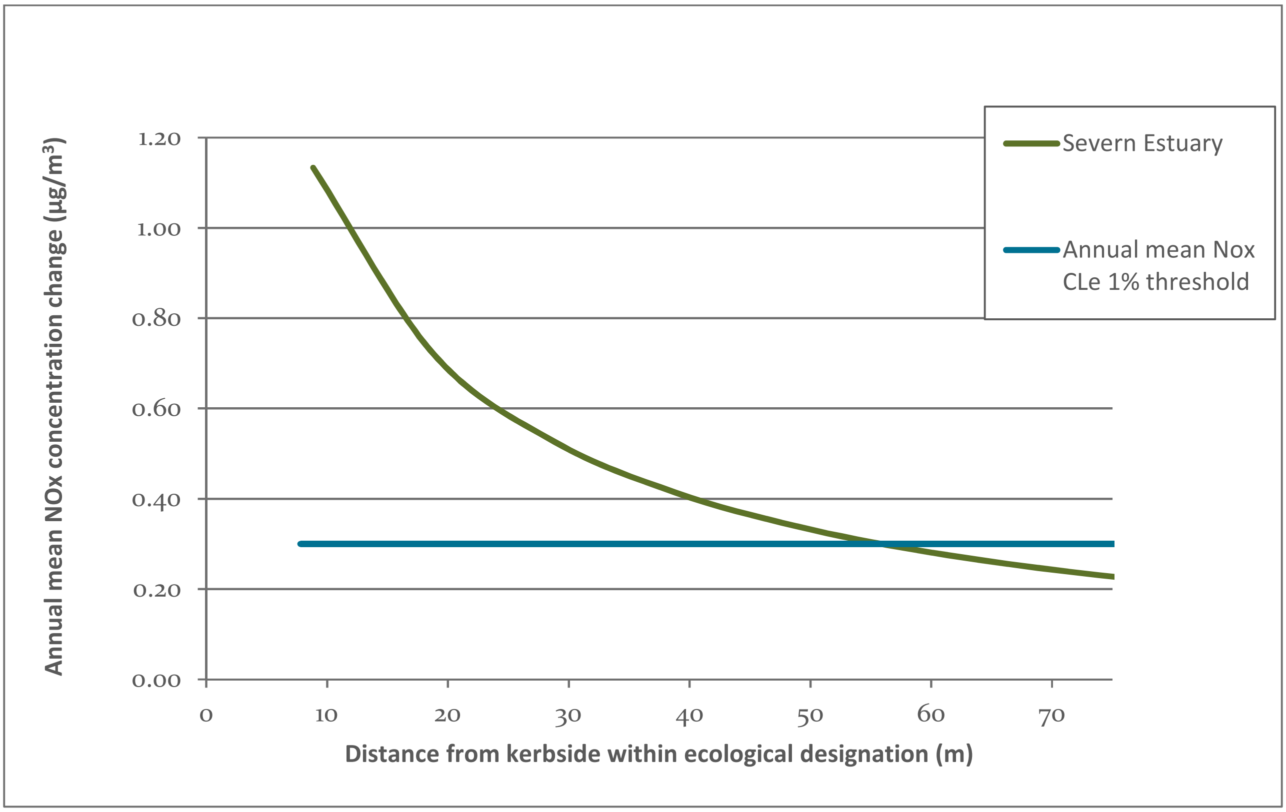


Figure 9-6-7: Annual Mean NO_x Concentration Change - Transect 4 (Scenario 2), 2018 Sensitivity



Critical Loads – Nutrient Nitrogen

The contributions from the development to the Critical Loads for nutrient nitrogen deposition at the Severn Estuary SAC Atlantic Salt Meadow habitat is presented in Table 9-6-19 and Table 9-6-20 for Scenarios 1 and 2 respectively. It is noted that the contribution presented is the maximum modelled concentration from each of the four considered transects and receptor grid.

Table 9-6-19: Maximum Impact on Critical Load for Nutrient Nitrogen Deposition –Scenario 1, 2018 Sensitivity

Receptor	Relevant Nitrogen Critical Load Class	Lower Load (kg N/ha/yr)	Current deposition (kg N/ha/yr)	Process contribution change (kg N/ha/yr)	PC as a % of Lower CL (%)
E1 Max	Atlantic Salt meadows	20	13.7	+0.05	0.23

Table 9-6-20: Maximum Impact on Critical Load for Nutrient Nitrogen Deposition –Scenario 2, 2018 Sensitivity

Receptor	Relevant Nitrogen Critical Load Class	Lower Load (kg N/ha/yr)	Current deposition (kg N/ha/yr)	Process contribution change (kg N/ha/yr)	PC as a % of Lower CL (%)
E1 Max	Atlantic Salt meadows	20	13.7	+0.11	0.56

The modelled contribution to the Critical Loads for nutrient nitrogen is low, at less than 1% increase of the nutrient nitrogen lower and upper Critical Loads at all considered receptors and ecological designations, based upon the 2023 development opening year scenarios (both Scenario 1 and Scenario 2). In addition when considering current deposition and the contribution from the proposed development, committed development and local plan allocations, the lower Critical Load of 20kg N/ha/yr is not exceeded.

It is noted that the predicted contribution to the Critical Loads for nutrient nitrogen deposition associated with additional development trips will reduce (below those presented within Table 9-6-19 and Table 9-6-20) at increasing distances from the roadside.

Critical Loads – Acidity

The contributions from the development to the Critical Loads for nitrogen contribution to acid deposition at the roadside boundary of the Severn Estuary designation is presented in Table 9-6-21 and Table 9-6-22 for Scenarios 1 and 2 respectively. It is noted that the road traffic contribution change presented is the maximum modelled concentration from each of the four considered transects and receptor grid.

The Atlantic Salt Meadows habitat defined under the Severn Estuary SAC designation is not sensitive to acid deposition and therefore the habitat most sensitive to acid deposition and defined under the Severn Estuary SSSI designation 'Neutral grassland' has been considered instead[9].

Table 9-6-21: Maximum Impacts on Critical Loads for Acidity Deposition –Scenario 1, 2018 Sensitivity

Receptor	Terrestrial Habitat Information	CLmaxN (keq/ha/yr)	Current Load (keq/ha/yr)	Process contribution change (keq/ha/yr)	Change as a % of CLmaxN (%)
E1 Max	Neutral grassland	1.063	0.9	+0.003	0.31

Table 9-6-22: Maximum Impacts on Critical Loads for Acidity Deposition –Scenario 2, 2018 Sensitivity

Receptor	Terrestrial Habitat Information	CLmaxN (keq/ha/yr)	Current Load (keq/ha/yr)	Process contribution change (keq/ha/yr)	Change as a % of CLmaxN (%)
E1 Max	Neutral grassland	1.063	0.9	+0.008	0.75

The modelled contribution to the Critical Loads for nitrogen contribution to acid deposition is low, at less than 1% increase of the acid Critical Load at all considered receptors and ecological designations, based upon the 2023 development opening year scenarios (both Scenario 1 and Scenario 2). In addition, when considering current deposition and the contribution from the proposed development, committed development and local plan allocations, the Critical Load of 1.06keq/ha/yr is not exceeded.

It is noted that the predicted contribution to the Critical Loads for nitrogen contribution to acid deposition associated with additional development trips will reduce (below those presented within Table 9-6-21 and Table 9-6-22) at increasing distances from the roadside.
The sensitivity assessment indicates that the predicted impacts from the proposed development alone (Scenario 1), using the 2018 vehicle emission factors are in line with the results presented in the main assessment, apart from the process contribution from the proposed development on annual mean NOx Critical Level of 30μg/m^3,

[9] http://www.apis.ac.uk/

which is exceeded up to 20m from the road kerbside (Figure 9-6-7).

Stack Emissions Assessment Sensitivity

The section presents the meteorological data sensitivity assessment as well as the sensitivity test using the coastline option in ADMS 5.2.

Meteorological Analysis

A summary of the annual mean NO_x results corrected assuming the plant operates 82% of the year are summarised in the table below.

Table 9-6-23: Meteorological Analysis to Determine Worst Case Conditions

Receptor name	2018	2016	2015	2014	2013
Grid	0.0082	0.0080	0.0111	0.0114	0.0091
E1_1	0.0070	0.0060	0.0066	0.0082	0.0064
E1_2	0.0072	0.0065	0.0076	0.0089	0.0069
E1_3	0.0074	0.0069	0.0084	0.0095	0.0074
E1_4	0.0079	0.0076	**0.0101**	0.0100	0.0085

For all assessment years the maximum ground level concentration for the annual mean NO_x is predicted at the Grid and E1_4. Table 9-6-23 indicates that the meteorological year 2015 was is the worst-case year.

Coastline Analysis

Table 9-6-24 indicates that there is no change in the outputs of the model when using the coastline option.

Table 9-6-24: Coastline Analysis based in 2015 Meteorological Year

Receptor name	**Without coastline**	**With coastline**
Grid	0.0111	0.0111
E1_1	0.0066	0.0066
E1_2	0.0076	0.0075
E1_3	0.0084	0.0083
E1_4	0.0101	0.0101

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