Halewood Manufacturing Plant

Air Emissions Risk Assessment

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Making Sustainability Happen

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1.0 Introduction

SLR Consulting Limited (SLR) has been commissioned by Jaguar Land Rover Limited to undertake an Air Emissions Risk Assessment (AERA) to support their Environmental Permit (EP) Variation application for Halewood Manufacturing Plant, located off Speke Boulevard, Halewood, Liverpool ('the Site').

1.1 Background

The Site comprises of four existing operational boilers, whilst the EP variation application seeks to add the operation of a further three boilers. Full details of the application are contained within the Non-Technical Summary (NTS) and accompanying EP application. The following details are of direct relevance to the AERA:

- All seven (7 No.) boilers (i.e. 4 No. existing and 3 No. new) are fired on natural gas. Each of the existing boilers have a rated thermal input of 28 mega watts (MW), whilst the new boilers will have a rated thermal input of 1.52 MW;
- Combustion emissions are discharged via individual 30.5 m (existing boilers) and 8.5 m (new boilers) high exhaust stacks;
- The existing boilers are permitted to comply with a nitrogen oxides (NO_x) exhaust emission limit value (ELV) of 140 mg/Nm^3 at 3% O_2;
- The new boilers will comply with a NO_x exhaust ELV of 100 mg/Nm^3 at 3% O_2.

1.2 Scope and Objective

The scope of the AERA is limited to point source combustion emissions to air from the seven natural gas fired boilers at the Site. Consistent with EA guidance for gas fired boilers, the principal release of NO_x has been assessed.

The objective of the study is to assess, using atmospheric dispersion modelling, the impact of NO_x emissions against the relevant Air Quality Standards for nitrogen dioxide (NO_2) for the protection of human health and the relevant Critical Levels (for NO_x) and Critical Loads (for N and acid deposition) for the protection of designated ecological receptors, where present within the relevant screening distances.

This report presents the approach, detailed methodology and findings of the AERA.

2.0 Legislation and Relevant Guidance

2.1 Environmental Permitting Regulations

The Environmental Permitting (England and Wales) Amendment Regulations 2018 (EPR) implements European Union Directive 2015/2193/EU (the Medium Combustion Plant Directive, MCPD) in Schedule 25A.

Although each of the new boilers have a rated thermal input greater than 1MWth but less than 50MWth (i.e. aligning with the description of a Medium Combustion Plant (MCP) - as defined by Schedule 25A of the EPR 2018), they are exempt from the MCPD on the basis that the Site is currently a Chapter III IED regulated site (i.e. large combustion plant). The aggregation rules Chapter III IED regulated site stipulate that all onsite combustion plant should be covered by the same permit (i.e. the existing permit will need to be varied in order to include the new boilers).

However, as discussed further within the accompanying EP application, the new boilers will be subject to the standards required as part of the MCPD.

2.1.1 Permitting Guidance

The EA have produced guidance for the assessment of emissions for permitted processes - '*Air emissions risk assessment for your environmental permit*'[1] (the AERA guidance). The purpose of the AERA guidance is to assist operators for all types of permitted facilities to assess risks to the environment and human health when applying for a permit under the EPR.

2.2 Air Quality Legislation and Guidance

2.2.1 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010[2] (AQSR) transpose both the EU Ambient Air Quality Directive (2008/50/EC), and the Fourth Daughter Directive (2004/107/EC) within UK legislation, in order to align and mirror European obligations. The regulations set Limit Values, Target Values, and Objectives for the protection of human health and the environment. Following the UK's withdrawal from the EU, the Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020[3] was introduced to mirror revisions to supporting EU legislation.

2.2.2 Air Quality Strategy

The latest AQS for England was published in 2023[4]. The AQS provides the delivery framework for air quality management across England for local authorities and summarises the air quality standards and objectives operable within England for the protection of public health and the environment.

The ambient air quality objectives (hereafter referred to as Air Quality Assessment Levels – AQALs) of relevance to human receptors in this assessment are provided in Table 2-1. The

[1] Air emissions risk assessment for your environmental permit. https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

[2] The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.

[3] The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020, Statutory Instrument No. 1313, The Stationary Office Limited.

[4] Air Quality Strategy: Framework for Local Authority Delivery, Defra. April 2023.

AQALs apply at locations where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period (defined as 'relevant exposure'). Table 2-2 provides an indication of those locations.

Table 2-1: Applied AQALs

Pollutant	AQAL (µg/m^3)	Averaging Period
Nitrogen Dioxide (NO_2)	40	Annual mean
	200	1-hour mean (not to be exceeded on more than 18 occasions per year)

Table 2-2: Human Health Relevant Exposure

Averaging Period	AQALs Should Apply At:	AQALs Should Not Apply At:
Annual mean	Building facades of residential properties, schools, hospitals etc.	Facades of offices or other places of work Hotels Gardens of residences Kerbside sites
1-hour mean	As above together with hotels, gardens of residential properties, kerbside sites of regular access, car parks, bus stations etc.	Kerbside sites where public would not be expected to have regular access

2.2.3 Local Air Quality Management

Part IV of the Environment Act 1995 requires local authorities to undergo a process of Local Air Quality Management (LAQM). This requires local authorities to Review and Assess air quality within their boundaries to determine the likeliness of compliance, regularly and systematically.

Where any of the prescribed AQS objectives are not likely to be achieved, the authority must designate an Air Quality Management Area (AQMA). For each AQMA, the local authority is required to prepare an Air Quality Action Plan (AQAP), which details measures the authority intends to introduce to deliver improvements in local air quality in pursuit of the objective. Local authorities therefore have formal powers to control air quality through a combination of LAQM and through application of wider planning policies.

Defra has published technical guidance for use by local authorities in their LAQM review and assessment work[5] – referred to as LAQM.TG(22) throughout this report.

2.3 Protection of Nature Conservation Sites

Sites of nature conservation importance are provided environmental protection from developments, including from atmospheric emissions. AQALs for the protection of ecological receptors are known as Critical Levels (CLe) for airborne concentrations and Critical Loads (CLo) for deposition to land from air.

The AERA guidance provides screening distances for the assessment of habitat sites. For Sites of Special Scientific Interest (SSSIs) and local nature sites, the distances extend to

[5] Local Air Quality Management Technical Guidance 22, Published by Defra in partnership with the Scottish Government, Welsh Government and Department of Agriculture, Environment and Rural Affairs Northern Ireland. August 2022.

2km. Whilst, for Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites, the distances extend to 10km.

It is noted that the screening distances extend to 15km for some habitat site designations (i.e. SSSIs, SACs, SPAs and Ramsar sites) for larger emitters. For natural gas-fired combustion plants, the 15km screening distance should be applied for installations with an aggregated thermal input of more than 500 MW. As the aggregated thermal input for the Site is less than 500MW, the 15km screening distance has not been applied in this AERA.

2.3.1 Critical Levels (CLe)

CLe 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. The relevant CLe for the protection of vegetation and ecosystems are presented in Table 2-3.

Table 2-3: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	CLe (μg/m^3)	Averaging Period and Habitat
NO_x	30	Annual mean (all ecosystems)
	75 / 200	Daily mean (all ecosystems)

2.3.2 Critical Loads (CLo)

CLo 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.

CLo are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions CLo for acidification are relevant which can occur via both wet and dry deposition; however, on a local scale only dry (direct deposition) is considered significant. Deposition of nitrogen can cause eutrophication and acidification.

Nutrient nitrogen and acidification Critical Loads are site specific. Critical Loads for the habitats and species of relevance to this assessment have been obtained from the Air Pollution Information System (APIS) website[6]. The most sensitive habitat listed (that is present in the study area) has been used / provided to facilitate a worst-case assessment. The relevant CLo are presented in 4.3.

[6] Air Pollution Information System http://www.apis.ac.uk/

3.0 Assessment Methodology

Detailed atmospheric dispersion modelling has been undertaken with due consideration to the EA's AERA guidance. The modelling approach is based upon the following stages:

- Review of boiler specification and operational envelope to define emission sources, pollutant emission rates and characteristics;
- Identification of sensitive receptors;
- Compilation of the existing air quality baseline and review of LAQM status; and
- Calculation of process contribution to ground level concentrations (GLC) and evaluation against relevant environmental standards for both human and ecological receptors.

3.1 Quantification of Emissions

The emission parameters applied in the modelling are provided in Table 3-1. The boiler emission parameters have been input on the basis of manufacturer's design and specifications / stack emission monitoring reports.

The emission concentrations for the existing boilers are compliant with the existing permit, whereas the emission concentrations for the new boilers are compliant with the ELVs for new medium combustion plant.

Table 3-1: Emission Parameters

Parameter	Existing LaMont Boiler 2	Existing LaMont Boiler 3	Existing LaMont Boiler 4	Existing LaMont Boiler 6	New Hoval Boiler 1	New Hoval Boiler 2	New Hoval Boiler 3
Stack Height (m)	30.5				8.5		
Stack Diameter (m)	1.6				0.4		
Actual Volumetric Flow Rate (Am^3/s)	17.2				0.79		
Velocity (m/s)	8.6				6.0		
Emission Temperature (°C)	145				69		
Oxygen Content (% O2 dry gas)	7.2				6.5		
Moisture content (% H_2O)	12.6				8.0		
Normalised Volumetric Flow Rate (Nm^3/s)	7.5(A)				0.5(A)		

Parameter	Existing LaMont Boiler 2	Existing LaMont Boiler 3	Existing LaMont Boiler 4	Existing LaMont Boiler 6	New Hoval Boiler 1	New Hoval Boiler 2	New Hoval Boiler 3
NO_x Emission Concentration (mg/Nm^3)	140				100		
NO_x Emission Rate (g/s)	1.06				0.05		

Table notes:
(A) Normalised to 273K, dry, 3% O_2.

3.2 Dispersion Model Setup

For this assessment the AERMOD View model[7] (AERMOD) has been applied; this model is widely used and accepted by the EA for undertaking such assessments and its predictions have been validated against real-time monitoring data by the United States (US) Environmental Protection Agency (EPA). It is therefore considered a suitable model for this assessment.

3.2.1 Model Domain / Receptors

The modelling has been undertaken using a receptor grid across a map of the study area. Pollutant exposure isopleths are generated by interpolation between receptor points and superimposed onto the map. This method allows the maximum ground level concentration outside the Site boundary to be assessed.

A nested receptor grid extending 5 km from the Site was applied as follows:

- 200 m x 200 m at 20 m grid resolution;
- 500 m x 500 m at 50 m grid resolution;
- 1000 m x 1000 m at 100 m grid resolution;
- 2,000 m x 2,000 m at 200 m grid resolution; and
- 5,000 m x 5,000 m at 500 m grid resolution.

In addition, the modelling of discrete sensitive receptor locations as described in Section 4.1 was undertaken to assess the impact at relevant exposure locations for annual mean impact and facilitate the discussion of results.

3.2.2 Building Downwash

Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. Building downwash has been considered for buildings that have a maximum height equivalent to at least 40% of the emission height and which are within a distance defined as five times the lesser of the height or maximum projected width of the building.

The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Structures input to the model are represented in Figure 3-1.

[7] Software used: Lakes AERMOD View, (Executable Aermod_22112).

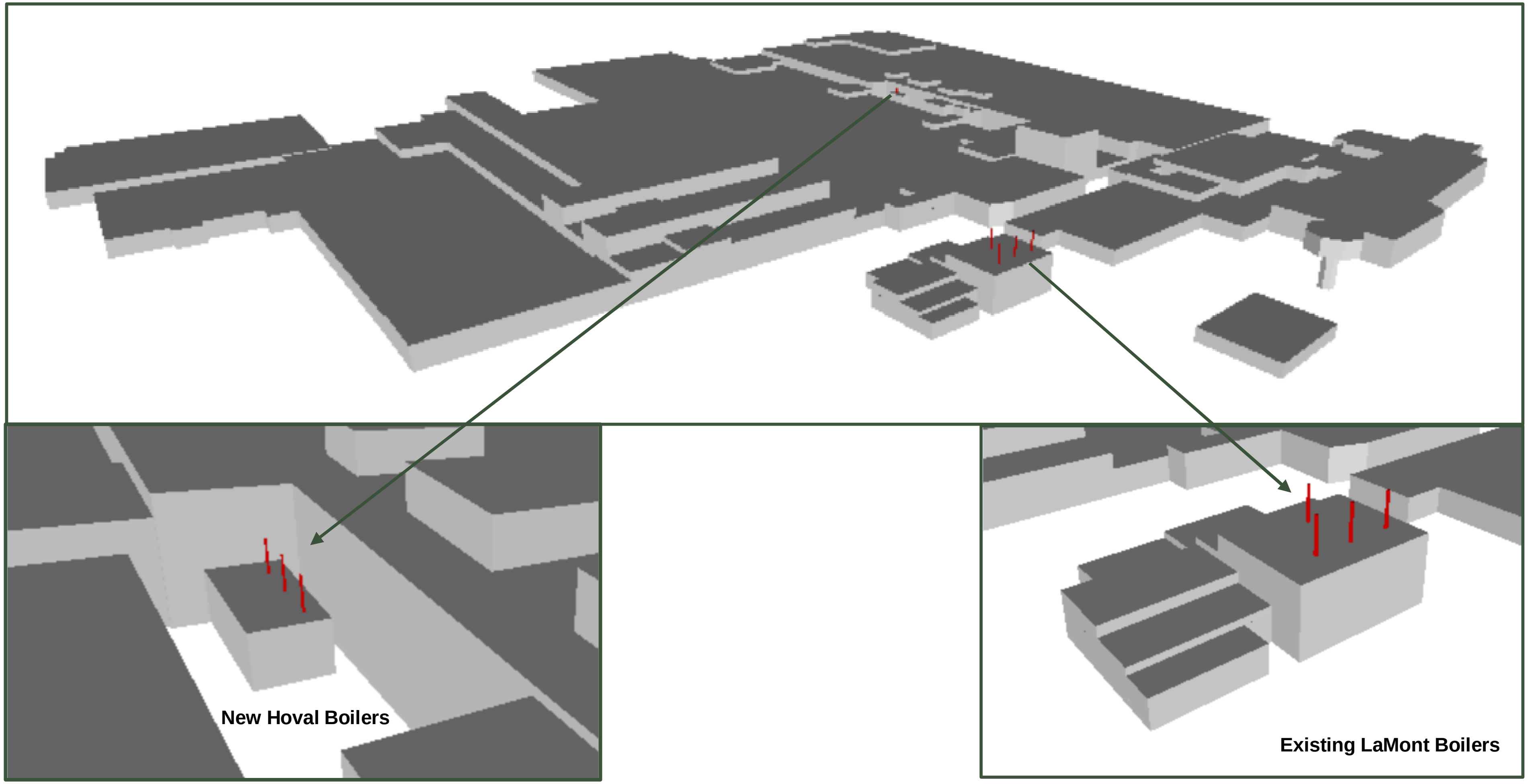

Figure 3-1: Modelled Buildings and Structures

3.2.3 Topography

The presence of elevated terrain can significantly affect the dispersion of pollutants and the resulting ground level concentration in a number of ways. Elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and hence, plume mixing with the effect of increasing concentrations near to a source and reducing concentrations further away.

AERMOD utilises digital elevation data to determine the impact of topography on dispersion from a source. Topography was incorporated within the modelling using 30m resolution Shuttle Radar Topography Mission (SRTM) terrain data files. Data was processed by the AERMAP function within AERMOD to calculate terrain heights (see Figure 4-2).

3.2.4 Meteorological Data and Preparation

The meteorological data provider was consulted for the closest and most representative dataset appropriate to the study area recording all the parameters necessary for dispersion modelling. The observation site selected for use in this assessment was Liverpool Airport, located approximately 2km to the south / southwest of the Site. A 5-year windrose is presented in Figure 4-1.

The meteorological data (5 years of hourly sequential data for the period 2018 to 2022) was obtained in .met format from the data supplier and converted to the required surface and profile formats for use in AERMOD using AERMET View meteorological pre-processor. Details specific to the station location were used to define the surface characteristics; albedo, bowen ratio and surface roughness, applied in the conversion (Table 3-2).

Table 3-2: Applied Surface Characteristics

Zone (Start)	Zone (End)	Albedo	Bowen Ratio	Surface Roughness (m)
0	30	0.16	0.31	0.052
30	60			0.066
60	90			0.075
90	120			0.051
120	150			0.035
150	180			0.058
180	210			0.066
210	240			0.054
240	270			0.061
270	300			0.075
300	330			0.075
330	0			0.058

3.2.5 Dispersion Model Uncertainty

Model validation studies[8] for AERMOD generally suggest that these dispersion models are for the vast majority of cases able to predict maximum short term high percentiles concentrations well within a factor of two and the latest evaluation studies for AERMOD show the composite (geometric mean) ratio of predicted to observed short-term averages from 'test sites' (where real-time monitoring data is available to validate model performance), to be between 0.96 and 1.2.

3.3 Assessment of Impacts on Air Quality

3.3.1 Operational Envelope

The new and existing boilers will be used only when required. However, to present a precautionary assessment it has been assumed that the boilers operate at a maximum output of 8,760 hours per year.

3.3.2 Treatment of Model Output

Predicted pollutant concentrations are summarised in the following formats:

- Process contribution (PC) – the predicted contributions from the existing source alone; and
- Predicted environmental concentration (PEC) – the resultant predicted concentration (i.e. PC + ambient background concentration value).

Table 3-3 presents the treatment of averaging periods of relevance to this assessment.

Table 3-3: Model Outputs

Averaging Period	Model Output – Process Contribution (PC)	Predicted Environmental Concentration (PEC)
1 hour mean (not to be exceeded more than 18 times a calendar year)	99.79%ile of 1-hour means for NO_2	PC + 2 x annual mean background
24-hour maximum	24-hour average from 5 met. years	PC + 2 x annual mean background
Calendar year	Annual mean from 5 met. years	PC + annual mean background

3.3.3 Conversion of NO_x to NO_2

With respect to NO_x emissions, the EA Air Quality Modelling and Assessment Unit (AQMAU) guidance[9] on conversion ratio for NO_x and NO_2 has been adopted (i.e. that 70% of NO_x is present as NO_2 in relation to long term impacts and 35% of NO_x is present as NO_2 in relation to short-term impacts).

[8] AERMOD: Latest Features and Evaluation Results, EPA-454/R-03-003, June 2003 (United States Environmental Protection Agency).

[9] Environment Agency, Air Quality Modelling and Assessment Unit, 'Conversion Ratios for NO_x and NO_2' (no date).

3.3.4 Assessment of Impact and Significance

To assess the potential impact on air quality, the predicted exposure is compared to the AQALs, and the results of the dispersion modelling have been presented in the form of:

- Tabulated concentrations at discrete receptor locations to facilitate the discussion of results; and
- Illustrations of the impact as isopleths (contours of concentration) for the criteria selected enabling determination of impact at any locations within the study area.

In accordance with the EA's AERA guidance, the impact is considered to be insignificant or negligible if:

- The long-term process contribution is <1% of the long term AQAL; and
- The short-term process contribution is <10% of the short term AQAL.

For PCs that cannot be considered insignificant, further assessment has been undertaken and the PEC has been determined for comparison as a percentage of the relevant AQAL.

3.4 Assessment of Impacts on Vegetation and Ecosystems

3.4.1 Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA AQTAG06[10]. Dry deposition flux was calculated using the following equation:

Dry deposition flux (µg/m^2/s) = ground level concentration (µg/m^3) x 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 (AQTAG06) compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered. The applied deposition velocities are as shown in Table 3-4.

Table 3-4: Applied Deposition Velocities

Chemical Species	Recommended Deposition Velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.0030

3.4.1.1 Critical Loads – Eutrophication

The CLo 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.

3.4.1.2 Critical Loads – Acidification

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

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

3.4.1.3 Calculation of PC as a percentage of Acid Critical Load Function

The calculation of the process contribution of N to the acid CLo function has been carried out according to the guidance on the Air Pollution Information System (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 affects 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*"

3.4.2 Significance of Effect on Ecological Receptors

In addition to the AERA guidance, the EA's Operational Instruction 66_12[11] 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 international sites, 'no likely damage' for Sites of Special Scientific Interest (SSSI) and 'no significant pollution' for other sites, as follows:

- PC does not exceed 1% long-term CLe and/or CLo or that the PEC does not exceed 70% long-term CLe and/or CLo for International sites and SSSIs;
- PC does not exceed 10% short-term CLe for NOx for International sites and SSSIs;
- PC does not exceed 100% long-term CLe and/or CLo other conservation sites; and
- PC does not exceed 100% short-term CLe for NO_x 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 the EA's Operational Instruction 67_12[12]. 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;

[11] 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.

[12] EA Working Instruction 67_12 – Detailed assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation.

- 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.

4.0 Baseline Environment

4.1 Site Setting and Sensitive Receptors

The Site is located off Speke Boulevard, Halewood, Liverpool at the approximate National Grid Reference (NGR) x344579, y383964. The Site setting and assessed receptor locations are described in the following sections.

4.1.1 Human Receptors

According to LAQM.TG(22), the AQALs should only apply to locations where members of the public may be reasonably likely to be exposed to air pollution for the duration of the relevant AQAL. As such, several locations surrounding the Site have been selected to inform the risk assessment in terms of relevant annual mean exposure (presented in Table 4-1 and displayed in Figure 4-3). All the selected receptor locations have been modelled at a height of 1.5m.

Further, the dispersion modelling has been completed using a receptor grid to allow potential short-term exposure to be assessed at all locations surrounding the Site.

Table 4-1: Modelled Human Receptor Locations

ID	Description	NGR-X	NGR-Y
HR1	Residential Estate	Multiple grid coordinates	
HR2	Residential Estate (Liverpool AQMA)	Multiple grid coordinates	
HR3	Residential	346278	382879
HR4	Residential	343561	384890

4.1.2 Ecological Receptors

The details of the designated ecological sites present within the relevant screening distances from the Site are presented in Table 4-2 and displayed in Figure 4-4.

Table 4-2: Assessed Designated Ecological Sites

ID	Site and Designation	Approx. Distance to Sources (km)
ER1	Hop Yard Wood and Mill Wood AW	1.0
ER2	Millwood and Alder Wood LNR	0.9
ER3	Mersey Estuary Ramsar / SPA	2.0
ER4	Liverpool Bay / Bae Lerpwl SPA	10.0

4.2 Baseline Conditions at Human Receptors

Monitoring data collected during the COVID-19 pandemic (i.e. 2020 and 2021) has not been used to characterise the baseline environment, as pollutant concentrations monitored during 2020 and 2021 are expected to be atypical and not representative of the local environment.

4.2.1 Local Air Quality Management

The Site is located within the administrative area of Knowsley Metropolitan Borough Council (KMBC). However, the administrative area of Liverpool City Council (LCC) is located within 100m from the Site.

KMBC and LLC, in fulfilment of statutory requirements, have conducted on-going exercises to review and assess air quality within their administrative areas. There is one AQMA, declared for exceedance of the annual mean NO_2 AQAL, within proximity to the Site (i.e. within 2km). At the closest point, this AQMA (the Liverpool City AQMA) is located less than 100m to the south of the Site. Residential properties within the Liverpool City AQMA, in proximity to the Site, have been considered in the AERA.

4.2.2 Local Monitoring Data

A review of LAQM monitoring data (collected outside of the COVID-19 pandemic), undertaken by KMBC and LCC, has been undertaken. Moreover, a review has been undertaken of Defra's automatic monitoring network: the Automatic Urban and Rural Network[13] (AURN).

4.2.2.1 Automatic Air Quality Monitoring

The details and results from the automatic monitors relevant to the AERA study area are presented in Table 4-3 and Table 4-4 respectively.

Table 4-3: Automatic Monitors: Details

Site ID	Site Type	NGR (m)		Approx. Distance to Site (m)
		X	Y	
Liverpool - Speke	Urban Industrial	343887	383603	350
Halewood	Roadside	345213	384691	330

Table 4-4: Automatic Monitors: NO_2 Results

ID	Year	Annual Mean NO_2 Concentration (µg/m^3)
Liverpool - Speke	2016	23.0
	2017	17.5
	2018	17.6
	2019	19.5
	2022	14.9
Halewood	2016	32.3
	2017	27.8
	2018	30.3
	2019	24.3
	2022	-
Table Notes: - Data unavailable from the latest LAQM report (2022 KMBC Air Quality Annual Status Report).		

As presented in Table 4-4, annual mean NO_2 concentrations at the two relevant automatic monitors have remained below the AQAL across the considered period (i.e. 2016-2019 and 2022).

[13] Automatic Urban and Rural Network (AURN) - Defra, UK.

4.2.2.2 Passive Diffusion Tube Monitoring

The details and results of the monitoring locations of relevance to the AERA study area are presented in Table 4-5 and Table 4-6, respectively.

Table 4-5: LAQM Monitoring Sites: Details

Site ID	Site Type	NGR (m)		Approx. Distance to Site (m)
		X	Y	
HW1a / HW1b	Roadside	344843	385022	650
HW2a / HW2b	Roadside	344827	385202	820
HW3Aa / HW3Ab	Roadside	344927	385128	790

Table 4-6: LAQM Monitoring Sites: Results

Site ID	2022 Data Capture (%)	Annual Mean NO_2 Concentration (µg/m^3)				
		2016	2017	2018	2019	2022
HW1a / HW1b	92%	-	-	-	-	15.7
HW2a / HW2b	92%	-	-	-	-	20.5
HW3Aa / HW3Ab	67%	-	-	-	-	36.1

Table Notes:
- Data unavailable from KMBC LAQM reports.

Local KMBC monitoring in the vicinity of the Site commenced in 2022. During 2022, monitored annual mean NO_2 concentrations were below the AQAL at all considered locations. It is important to note that monitor HW3Aa / HW3Ab is located within close proximity to a bus stop where elevated NO_2 concentrations can be expected.

The empirical relationship given in LAQM.TG(22) states that exceedances of the 1-hour mean AQAL for NO_2 is unlikely to occur where annual mean concentrations are <60µg/m^3. This indicates that an exceedance of the 1-hour mean AQAL was unlikely to have occurred at the above locations for the period assessed.

4.2.3 Defra Mapped Background Concentrations

Defra maintains a nationwide model of existing and future background air quality concentrations at a 1km grid square resolution which is routinely used to support LAQM requirements and air quality assessments. The data sets include annual average concentration estimates for NO_2 using a reference year of 2018 (the year in which comparisons between modelled and monitored concentrations are made).

The Defra mapped annual mean background concentrations for a base year of 2022 for the grid squares containing the modelled receptors are presented in Table 4-7.

All of the mapped background concentrations presented are well below the respective annual mean AQALs.

Table 4-7: Defra Mapped Background Pollutant Concentrations

Grid Square (X, Y)	Year	Annual Mean Background Concentration (µg/m^3)
		NO_2
344500, 384500	2022	15.9
344500, 385500		13.9
345500, 384500		14.8
343500, 383500		17.2
344500, 383500		16.9
345500, 383500		17.2
343500, 384500		16.3
346500, 382500		10.3

4.2.4 Application of Baseline Data in the Assessment

For HR1, the most recent annual mean NO_2 concentration for the Halewood roadside automatic monitor has been applied as the background concentration (2019 - 24.3µg/m^3). This monitor is located immediately adjacent to the modelled HR1 residential estate and, therefore, is considered to be representative. The monitored concentration is greater than the 2022 mapped Defra background levels for the HR1 grid squares, as well as the 2022 monitored concentrations recorded at HW1a / HW1b and HW2a / HW2b (both being located within close proximity to the HR1 residential estate). Data from HW3Aa / HW3Ab has not been considered due to the proximity of the monitor to a bus stop and, therefore, is not considered representative of the modelled locations which comprise HR1.

For HR2 (Liverpool City AQMA), the 2019 annual mean NO_2 concentration for the Liverpool - Speke Urban Industrial automatic monitor has been applied as the background concentration (19.5µg/m^3). This is considered a conservative approach as the most recent (2022) annual mean NO_2 concentration measured at this monitoring location was 14.9µg/m^3. The monitor is located within the modelled HR2 residential estate and, therefore, is considered representative. The 2019 monitored concentration is greater than the 2022 mapped Defra background levels for the HR2 grid squares.

For HR3 and HR4, the corresponding mapped Defra background annual mean NO_2 concentrations for the relevant grid squares have been applied (2022 - 10.3µg/m^3 and 16.3µg/m^3 respectively).

Table 4-8: Applied Long Term Background Concentrations

ID	Applied Annual Mean Background NO_2 Concentration (µg/m^3)
HR1	24.3
HR2	19.5
HR3	10.3
HR4	16.3

4.3 Baseline Conditions at Ecological Receptors

The APIS website[14], a support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology, has been used to provide information on NO_x concentrations, current deposition rates and CLo for nutrient nitrogen (Table 4-9) and CLo functions for acidity (Table 4-10) at the ecological receptors.

Table 4-9: NO_x Backgrounds, Nitrogen Critical Loads and Current Loads

Site	APIS CLo Class	NO_x Annual Mean ($\mu g/m^3$)	CLo Range (kg N/ha/yr)	CLo Applied in Assessment (kg N/ha/yr)	Current Load (kg N/ha/yr)
ER1 (AW)	Broadleaved deciduous woodland	23.7	10 – 20	10	35.2
ER2 (LNR)	Broadleaved deciduous woodland	23.7	10 – 20	10	35.2
ER3 (Ramsar / SPA)	*Anas acuta* (North-western Europe) - Atlantic upper-mid & mid-low salt marshes	28.5	10 – 20	10	24.3
ER4 (SPA)	*Sterna albifrons* (Eastern Atlantic - breeding) - Coastal dune grasslands (grey dunes) - acid type	20.2	5 – 20	5	18.4

Table 4-10: Acid Critical Load Functions and Current Loads

Site	APIS CLo Class	CLo Function (keq/ha/yr)		Current Load (keq/ha/yr)
		CLminN	CLmaxN	N
ER1 (AW)	Broadleaved Woodland	0.36	1.76	2.5
ER2 (LNR)	Broadleaved Woodland	0.36	1.76	2.5
ER3 (Ramsar / SPA)	*Numenius arquata* (Europe - breeding) - Calcareous grassland (using base cation)	1.07	5.07	1.9
ER4 (SPA)	*Sterna albifrons* (Eastern Atlantic - breeding) - Calcareous grassland (using base cation)	1.07	5.07	1.3

[14] http://www.apis.ac.uk/ accessed September 2023.

4.4 Meteorological Conditions

Windroses from the Liverpool Airport meteorological station, located approximately 2km to the south / southwest of the Site, is presented in Figure 4-1 and shows the frequency of wind speed and direction used in the assessment. It is evident that the majority of winds are from the south and west sectors with winds from the north sector occurring least frequently. On this basis, it is receptors to the north and east which have the highest potential for impacts from emissions originating from the Site.

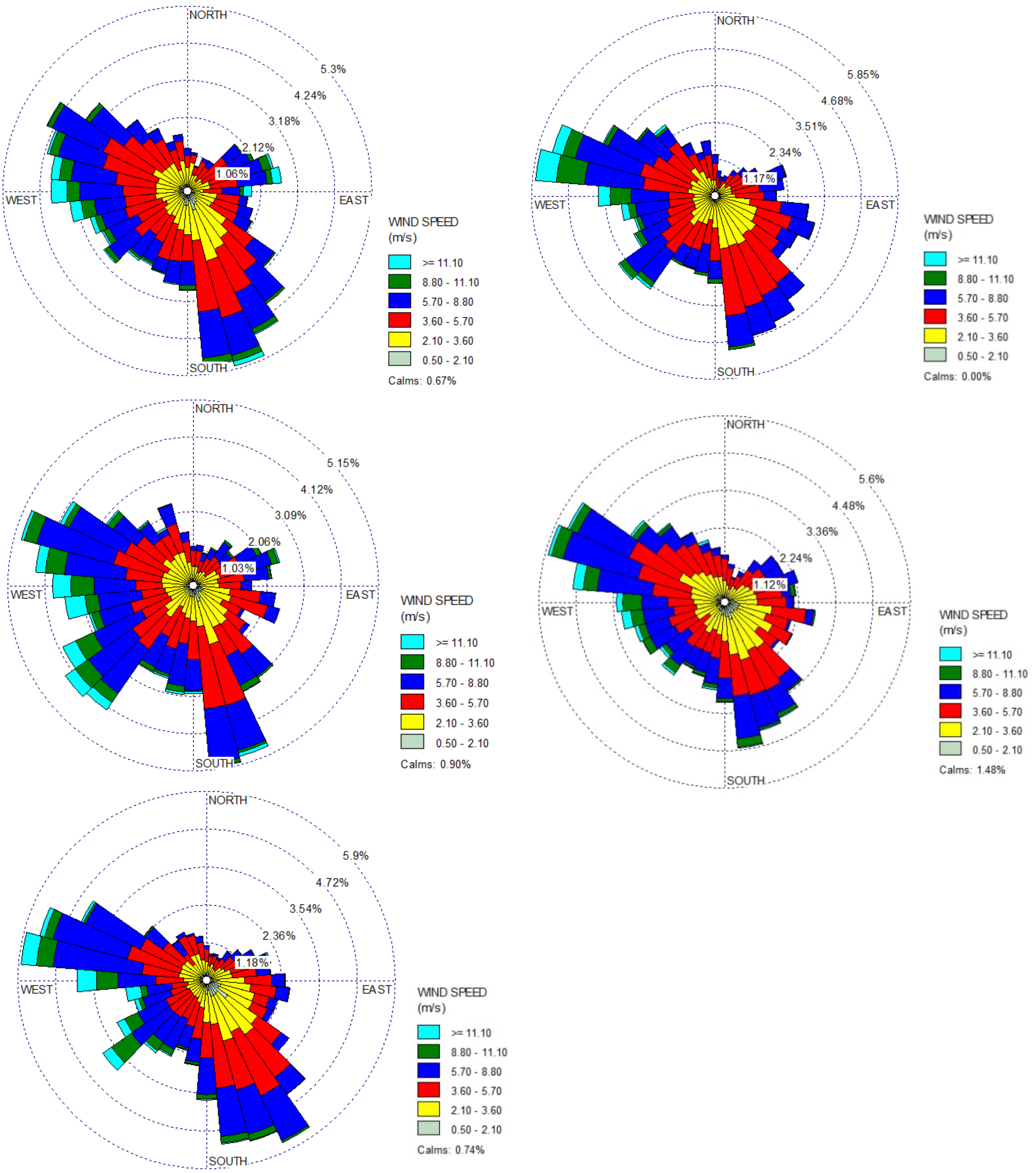

Figure 4-1: Windroses from Liverpool Airport (2018 – 2022)

4.5 Topography

The Site lies at approximately 24m above ordnance datum (AOD). Local topography has been incorporated into the model and is illustrated in Figure 4-2.

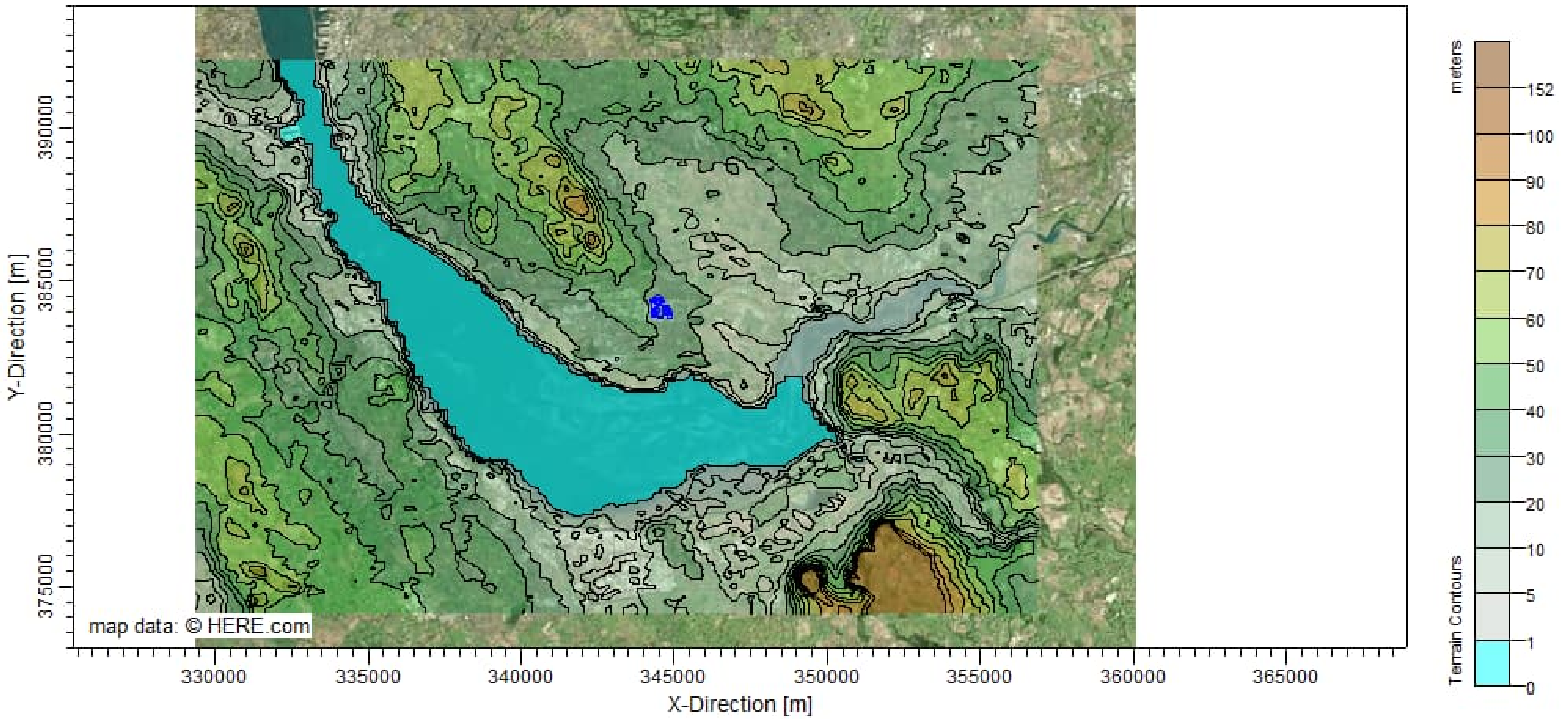

Figure 4-2: Surrounding Topography

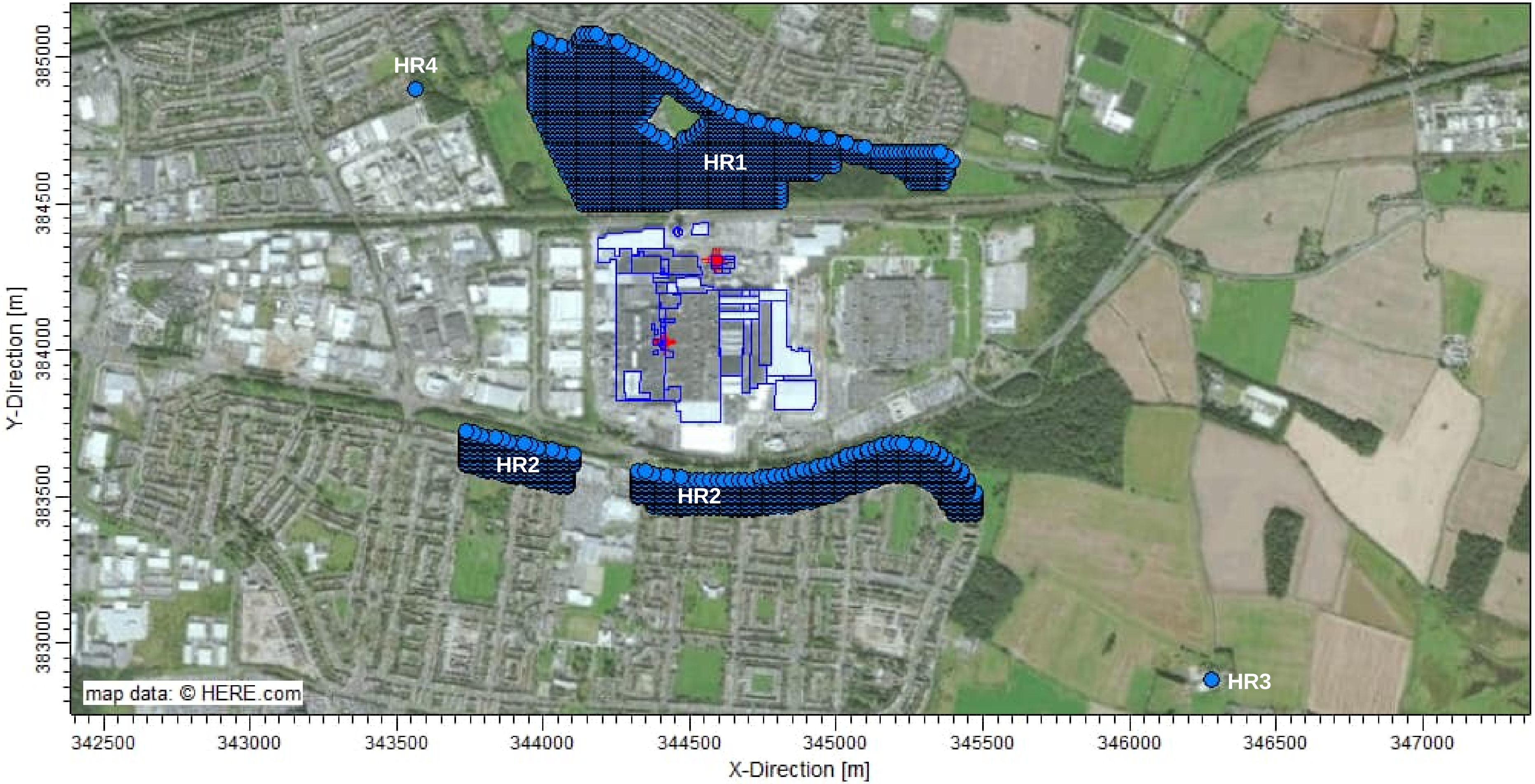

Figure 4-3: Modelled Human Receptor Locations

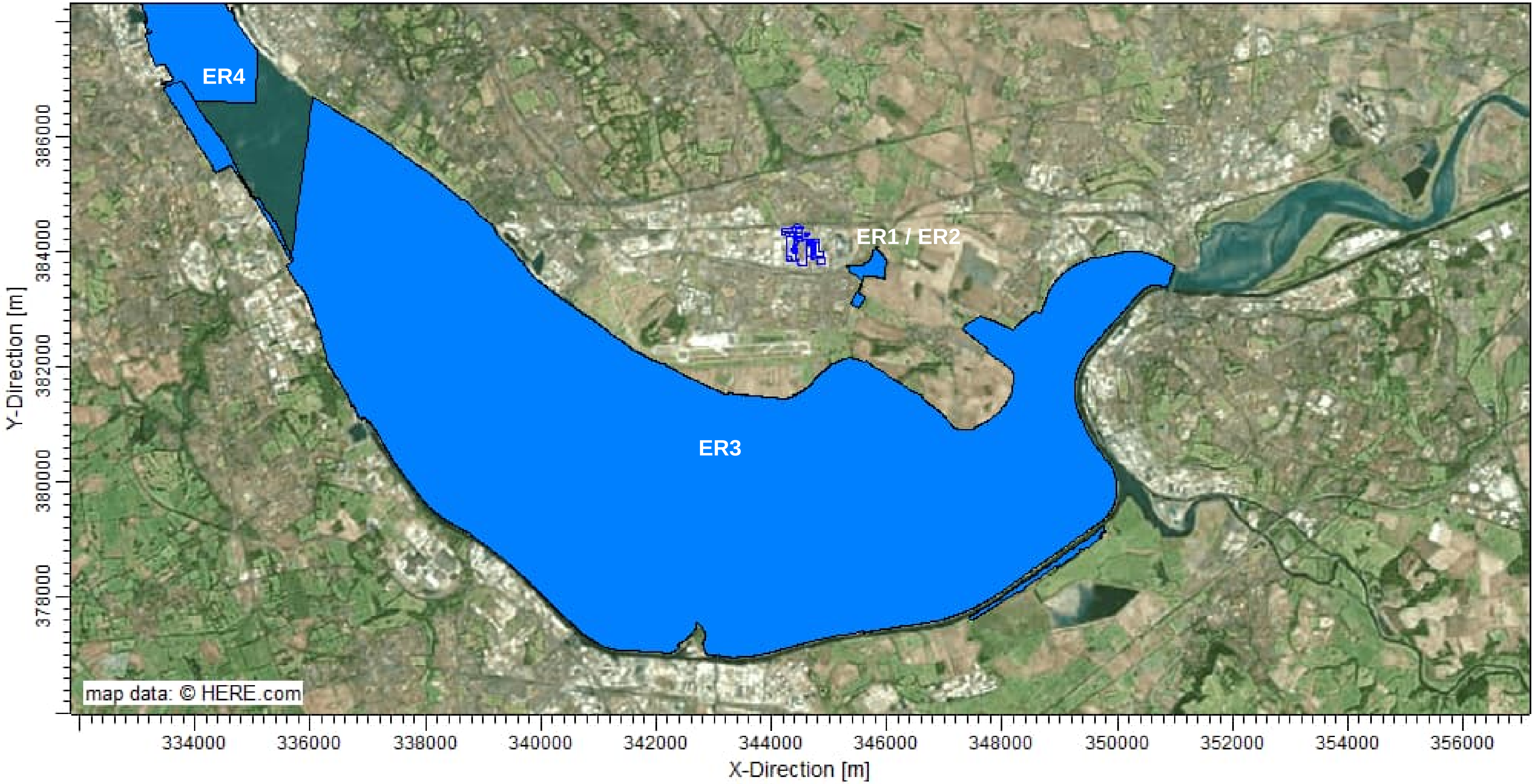

Figure 4-4: Modelled Designated Ecological Sites

5.0 Assessment Results

5.1 Impacts on Human Receptors

5.1.1 Annual Mean NO_2 Impacts

Predicted annual mean NO_2 impacts at the modelled receptor locations are summarised in Table 5-1 (an isopleth plot is presented in Appendix B) for a maximum operational envelope of 8,760 hours per year.

The impact is described as insignificant at receptor HR3 as the predicted PC is less than 1% of the AQAL. The PC cannot be classified as insignificant at the remaining receptor locations; however, the calculated PECs are not predicted to exceed the annual mean AQAL at any considered location.

Table 5-1: Predicted Annual Mean NO_2 Impacts

ID	PC (µg/m^3)	PC as % of AQAL	PEC (µg/m^3)	PEC as % of AQAL
HR1[(A)]	3.1	7.8%	27.4	68.6%
HR2[(A)]	0.8	1.9%	20.3	50.6%
HR3	0.3	0.7%	N.A.	
HR4	0.4	1.0%	16.7	41.8%

Table notes:
PEC not presented where the PC is insignificant (i.e. <1% of the AQAL).
[(A)] Maximum PC obtained from the modelled grid points which comprise the receptor.

5.1.2 1-hour Mean (99.79%ile) NO_2 Impacts

The maximum predicted short-term NO_2 impacts at the modelled receptor locations are summarised in Table 5-2 (an isopleth plot is presented in Appendix B).

The short-term PC impacts are considered insignificant at HR2 – HR4 as the predicted PCs are less than 10% of the AQAL. The PC cannot be classified as insignificant at HR1; however, the calculated PEC is not predicted to exceed the AQAL.

Table 5-2: Predicted 1-hour Mean (99.79%ile) NO_2 Impacts

ID	PC (µg/m^3)	PC as % of AQAL	PEC (µg/m^3)	PEC as % of AQAL
HR1[(A)]	38.7	19.3%	87.3	43.6%
HR2[(A)]	13.7	6.8%	N.A.	
HR3	4.8	2.4%	N.A.	
HR4	5.3	2.6%	N.A.	

Table notes:
PEC not presented where the PC is insignificant (i.e. <10% of the AQAL).
[(A)] Maximum PC obtained from the modelled grid points which comprise the receptor.

5.2 Impacts on Ecological Receptors

5.2.1 Critical Levels

The results of the assessment of impacts on CLe are presented in Table 5-3. The findings are as follows:

- The maximum predicted long-term (annual) PC is <100% of the long-term CLe at ER1 and ER2
- The maximum predicted long-term (annual) PC is <1% of the long-term CLe at ER3 and ER4;
- The maximum predicted short-term (24-hour) PC is <100% of the short-term CLe at ER1 and ER2; and
- The maximum predicted short-term (24-hour) PC is <10% of the short-term CLe at ER3 and ER4.

On this basis, the impacts are considered to cause ‘no significant pollution’ to ER1 and ER2 (i.e. Hop Yard Wood and Mill Wood AW and Millwood and Alder Wood LNR, respectively) and ‘no likely significant effects‘ to ER3 and ER4 (i.e. Mersey Estuary Ramsar / SPA and Liverpool Bay / Bae Lerpwl SPA, respectively).

Table 5-3: Impacts on Critical Levels

Site	CLe	PC (µg/m^3)	PC as % of CLe
ER1 (AW)	NO_x Annual Mean	1.0	3.3%
	NO_x 24-hour Mean	7.5	10.0%
ER2 (LNR)	NO_x Annual Mean	1.1	3.5%
	NO_x 24-hour Mean	8.2	10.9%
ER3 (Ramsar / SPA)	NO_x Annual Mean	0.2	0.8%
	NO_x 24-hour Mean	3.6	4.8%
ER4 (SPA)	NO_x Annual Mean	0.1	0.2%
	NO_x 24-hour Mean	0.7	1.0%

5.2.2 Critical Loads

The results of the assessment of impacts on CLo are presented in Table 5-4 and Table 5-5. The findings are as follows:

- The maximum predicted nitrogen and acidic N PC is <100% of the applied CLo at ER1 and ER2; and
- The maximum predicted nitrogen and acidic N PC is <1% of the applied CLo at ER3 and ER4.

On this basis, the impacts are considered to cause ‘no significant pollution’ to ER1 and ER2 (i.e. Hop Yard Wood and Mill Wood AW and Millwood and Alder Wood LNR, respectively) and ‘no likely significant effects‘ to ER3 and ER4 (i.e. Mersey Estuary Ramsar / SPA and Liverpool Bay / Bae Lerpwl SPA, respectively).

Table 5-4: Impact on Nitrogen Critical Load

Site	Applied CLo (kg N/ha/yr)	PC (kg N/ha/yr)	PC as % of CLo
ER1 (AW)	10	0.20	2.0%
ER2 (LNR)	10	0.21	2.1%
ER3 (Ramsar / SPA)	10	0.03	0.3%
ER4 (SPA)	5	0.01	0.1%

Table 5-5: Impact on Acid Critical Load

Site	Applied CLo (keq/ha/yr)	PC (keq/ha/yr)	PC as % of CLo
ER1 (AW)	1.76	0.01	0.8%
ER2 (LNR)	1.76	0.02	0.9%
ER3 (Ramsar / SPA)	5.07	<0.01	<0.1%
ER4 (SPA)	5.07	<0.01	<0.1%

6.0 Summary and Conclusions

This AERA has quantified and assessed the potential air quality impacts associated with combustion emissions from the Site using Environment Agency approved techniques against published standards for the protection of human health and designated ecological sites.

The conclusions of the AERA are as follows:

- The process contributions do not lead to any exceedances of the standards (long-term or short-term) for the protection of human health at any location outside of the Site; and
- The emissions from the Site are considered to cause ‘no significant pollution’ to the Hop Yard Wood and Mill Wood AW and the Millwood and Alder Wood LNR and ‘no likely significant effects‘ to the Mersey Estuary Ramsar / SPA and the Liverpool Bay / Bae Lerpwl SPA.

Appendix A EA Modelling Checklist

Halewood Manufacturing Plant

Air Emissions Risk Assessment

Jaguar Land Rover Limited

SLR Project No.: 416.064966.00001

16 November 2023

Table A-1: Modelling Checklist

Item	Yes/No	Details / Reason for Omission
Location map	Yes	Figure 4-3
Site plan	Yes	Figure 3-1
Pollutants modelled and relevant EALs	Yes	Table 2-1, and Section 2.3
Details of modelled scenarios	Yes	Section 3.3.1
Details of relevant ambient concentrations	Yes	Section 4.2 and 4.3
Model description and justification	Yes	Section 3.2
Special model treatment used	Yes	Section 3.3.2 and 3.4.1
Table of emission parameters used	Yes	Table 3-1
Details of modelled domain and receptors	Yes	Section 3.2.1 and 4.1
Details of meteorological data used	Yes	Section 3.2.4
Details of terrain treatment	Yes	Section 3.2.3
Details of building treatment	Yes	Section 3.2.2
Details of modelling deposition	Yes	Section 3.4
Model uncertainty and sensitivity	Yes	Section 3.2.53.2.5
Assessment of impacts	Yes	Section 5.0
Contour plots	Yes	Appendix B
Model input files	Yes	Appendix C

Appendix B Contour Plots

Halewood Manufacturing Plant

Air Emissions Risk Assessment

Jaguar Land Rover Limited

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16 November 2023

Figure B-1: 1-hour Mean (99.79%ile) NO_2 Process Contribution

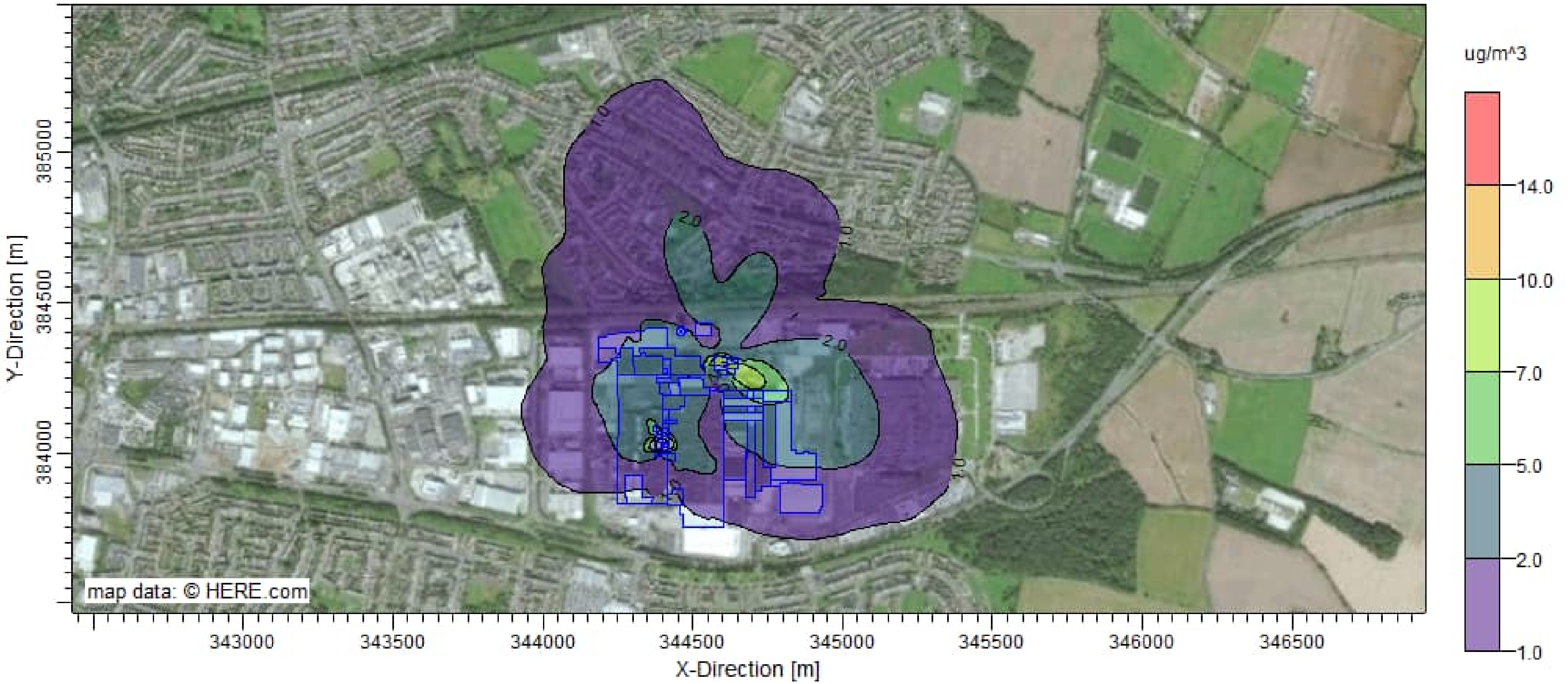

Figure B-2: Annual Mean NO_2 Process Contribution

Appendix C Model Files (electronic only)

Halewood Manufacturing Plant

Air Emissions Risk Assessment

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