



Lincoln Recycling Facility Environmental Permit Application

Air Emissions Risk Assessment

GBCTR Ltd

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SLR Project No.: 416.066578.00002

11 March 2026

Revision: 1.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1.0	11 March 2026	LB	MF	MD

Basis of Report

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1.0 Introduction

GBCTR LtdA Great British Clean Tech Recycling Company Limited (GBCTR) has instructed SLR Consulting Limited (SLR) to prepare an application for an Environmental Permit for the proposed Lincoln Recycling Facility, located at Unit16, Electric Avenue, Witham St Hughs, Lincoln LN6 9BJ (the 'Site').

1.1 Background

This report presents the Air Emissions Risk Assessment (AERA) undertaken in accordance with Environment Agency (EA) guidance '*Air emissions risk assessment for your environmental permit*' (the 'AERA guidance')¹.

The Non-Technical Summary provides a full description of the EP application and the facility. The Site is in the process of being refurbished. Key details of relevance to this AERA are:

- The facility includes 4No. emission points to air:
 - A1: Photovoltaic (PV) panel shredder line 1, fitted with bag filter abatement.
 - A2: Photovoltaic (PV) panel shredder line 2, fitted with bag filter abatement.
 - A3: Battery shredder including gas scrubber and Regenerative Thermal Oxidizer (RTO).
 - A4: Treatment of battery shredder outputs fitted with bag filter abatement.
- Emissions will be discharged via individual stacks at 16.5m above ground level.

1.2 Scope and Objective

An initial screening was undertaken; however, several pollutant PCs could not be considered insignificant and therefore a detailed modelling assessment was required, which has been applied to all pollutants.

The objective of the assessment is to determine the potential effect of emissions on the air quality environment by comparison to relevant guidelines for the protection of human health and protected sensitive habitats.

¹ <https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit>.



2.0 Legislation and Relevant Guidance

2.1 Air Quality Legislation and Guidance

2.1.1 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010² 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 2020³ was introduced to mirror revisions to supporting EU legislation.

2.1.2 Air Quality Strategy

The latest AQS for England was published in 2023⁴. 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 AQS ambient air quality objectives relevance to this assessment are presented in Table 2-1.

2.1.3 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.

The Department for Environment, Food and Rural Affairs (Defra) has published technical guidance for use by local authorities in their LAQM review and assessment work⁵ – referred to as LAQM.TG22 throughout this report.

2.1.4 Protection of Nature Conservation Sites

Ecological habitats vary in terms of their sensitivity, perceived ecological value, geographic importance, and level of protection. Within the UK, there are three types of nature conservation designations: international, national, and local designations, which are all provided environmental protection from developments, including from atmospheric emissions, with a greater level of protection afforded to the former, relative to the latter.

The Conservation of Habitats and Species Regulations 2017 (as amended) (the 'Habitats Regulations')⁶ introduces the precautionary principle for protected European sites, i.e. that projects can only be permitted to proceed having ascertained that there will be no adverse effect on the integrity of the designated site. It requires an assessment to determine if

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.

⁵ Local Air Quality Management Technical Guidance (TG22), Published by Defra in partnership with the Scottish Government, Welsh Government and Department of Agriculture, Environment and Rural Affairs Northern Ireland. May 2025.

⁶ The Conservation of Habitats and Species Regulations 2017 (as amended) Statutory Instrument 490.



significant effects (alone or in-combination) are likely, followed by an 'appropriate assessment' by the competent authority, if necessary. European sites include Special Areas of Conservation (SAC) and Special Protection Areas (SPA). These regulations were subsequently amended in 2019 to make them operable from 1 January 2021 despite the UK's withdrawal from the EU⁷.

The Wildlife and Country Act 1981 (as amended, primarily by The Countryside and Rights of Way Act 2000) provides protection to Sites of Special Scientific Interest (SSSI) to ensure that developments are not likely to cause damage.

Other designations (such as National Nature Reserves (NNR), Local Nature Reserves (LNR), Local Wildlife Sites (LWS) and Ancient Woodland (AW)) are afforded protection under national planning policy and legislation to ensure that developments do not cause significant pollution.

2.2 Environmental Permitting

The Site will be regulated under the Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EPR).

Guidance Notes produced by Defra provide a framework for regulation of installations and additional technical guidance produced by the EA are used to provide the basis for permit conditions.

Of particular relevance to this assessment is the AERA guidance. The purpose of this guidance is to assist operators to assess risks to the environment and human health as a result of emissions to air when applying for a permit under the EPR and has informed the assessment methodology, as set out in Section 3.0.

The waste operations carried out at the Site are required to meet Best Available Techniques (BAT) and appropriate measures, as set out in the EA's guidance notes for the relevant waste activities. The Best Available Techniques - Operating Techniques (BAT-OT) report included with the EP application pack sets out details of the specific processes and BAT for control of emissions to air, and the associated achievable emission limits based on a review of the relevant guidance documents.

2.3 Environmental Standards

The environmental standards for air, taken from the legislation and guidance outlined above, for the protection of human health and sensitive ecological receptors are presented in the sections below.

2.3.1 Standards for the Protection of Human Health

The standards applied in this assessment, taken from the AQSR, AQS and AERA guidance are set out in Table 2-1.

Table 2-1: Relevant Standards

Pollutant		Annual Standard ($\mu\text{g}/\text{m}^3$)	Short Term Standard ($\mu\text{g}/\text{m}^3$)	Ref.
Nitrogen Dioxide	NO ₂	40	200 (1-hour) not to be exceeded more than 18 times per year	AQSR

⁷ The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.



Pollutant		Annual Standard (µg/m ³)	Short Term Standard (µg/m ³)	Ref.
Particulates	PM ₁₀	40	50 (24-hour) not to be exceeded more than 35 times per year	AQSR
Particulates	PM _{2.5}	20	-	AQSR
Carbon Monoxide	CO	-	10,000 (Max 8-hour daily mean)	AQSR
			30,000 (Max 1-hour)	AERA
Hydrogen Chloride	HCl	-	750 (1-hour)	AERA
Hydrogen Fluoride	HF	16 (monthly)	160 (1-hour)	AERA
TOC as Benzene	C ₆ H ₆	5	30 (24-hour)	AQSR / AERA
Sulphuric Acid	H ₂ SO ₄	10	300 (1-hour)	AERA
Arsenic	As	0.006	-	AERA
Cadmium	Cd	0.005	0.03 (24-hour)	AQSR / AERA
Chromium (III)	Cr	2 (24-hour)	-	AERA
Copper	Cu	0.05 (24-hour)	-	AERA
Lead	Pb	0.25	-	AQS
Manganese	Mn	0.15	1,500 (1-hour)	AERA
Mercury	Hg	0.06 (24-hour)	0.6 (1-hour)	AERA
Nickel	Ni	0.02	0.7 (1-hour)	AQSR
Vanadium	V	-	1 (24-hour)	AERA

The objectives 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 (referred to as 'relevant exposure'). Table 2-2 provides an indication of those locations, referenced from LAQM.TG22.

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
24-hour mean	As above together with hotels and gardens of residential properties	Kerbside sites or any other location where public exposure is expected to be shorter than either the 24- or 8-hour relevant mean.
8-hour mean		



Averaging Period	AQALs Should Apply At:	AQALs Should Not Apply At:
1-hour mean	As above together with kerbside sites of regular access, car parks, bus stations etc. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where public would not be expected to have regular access
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	-

2.3.2 Standards for the Protection of Ecosystems and Vegetation

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

The AERA guidance requires that designated ecological sites should be screened against relevant AQALs if they are located within the following set distances from the Site:

- SPAs, SACs and Ramsar sites within 10km; and
- SSSIs, NNR, LNR, LWS, and AW within 2km.

2.3.2.1 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 ($\mu\text{g}/\text{m}^3$)	Averaging Period	Habitat
SO ₂	10	Annual mean	Where lichens or bryophytes are present
	20	Annual mean	All others
NO _x	30	Annual mean	All
	75	Daily mean	All
HF	5	Daily mean	All
	0.5	Weekly mean	All

2.3.2.2 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 sulphur and nitrogen can cause acidification; the relevant CLo are presented in Section 4.3.



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:

- Quantification of emissions from the facility;
- Identification of sensitive receptors;
- Compilation of the existing air quality baseline and review of LAQM status; and
- Atmospheric dispersion modelling to determine process contribution to ground level concentrations and calculate deposition rates; and
- Assessment of impacts by comparison to standards for the protection of human health and ecological receptors.

3.1 Model Setup

For this assessment the AERMOD View model⁸ (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.

3.1.1 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 5km from the Site was applied as follows:

- 100m x 100m at 10m grid resolution;
- 200m x 200m at 20m grid resolution;
- 500m x 500m at 50m grid resolution;
- 1000m x 1000m at 100m grid resolution;
- 2000m x 2000m at 200m grid resolution; and
- 5000m x 5000m at 500m 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.

3.1.2 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.

⁸ Software used: Lakes AERMOD View, (Executable Aermod_24142).



The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Indicative structures input to the model are represented in Figure 3-1, and has included future buildings of St Modwen Park that qualify.



Figure 3-1: Modelled Buildings and Structures

3.1.3 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 3-2).

The Site lies at approximately 17-23m AOD. Within approximately 2km to the southwest of the Site the land rises to approximately 35m AOD. Topography has been incorporated into the model and is illustrated in Figure 3-2.



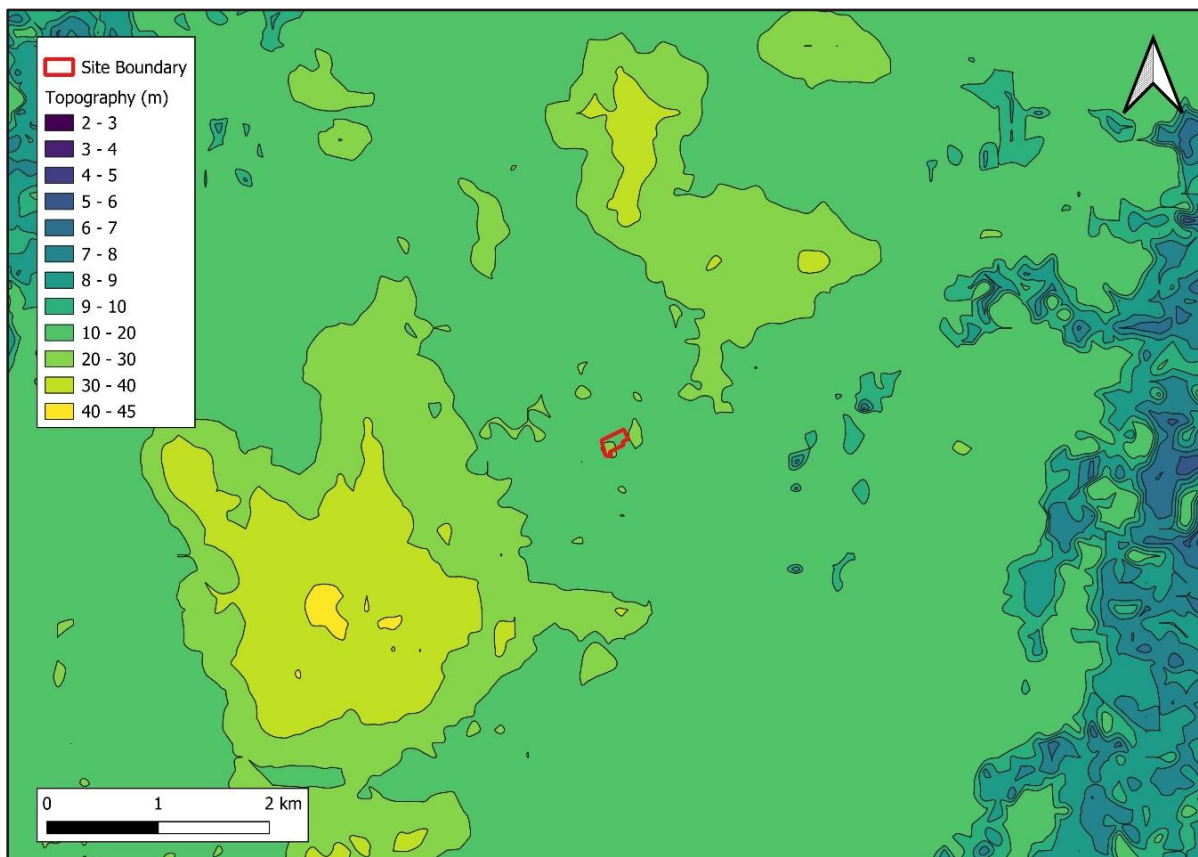


Figure 3-2: Surrounding Topography

3.1.4 Meteorological Data and Preparation

The observation site selected for use in this assessment was Waddington, located approximately 10.5km to the northeast of the Site. A 5-year windrose is presented in Figure 3-3.

The meteorological data (5 years of hourly sequential data for the period 2020 to 2024 inclusive) 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 3-1).

Table 3-1: Applied Surface Characteristics

Zone (Start)	Zone (End)	Albedo	Bowen Ratio	Surface Roughness (m)
220	350	0.18	0.63	0.057
350	220			0.058



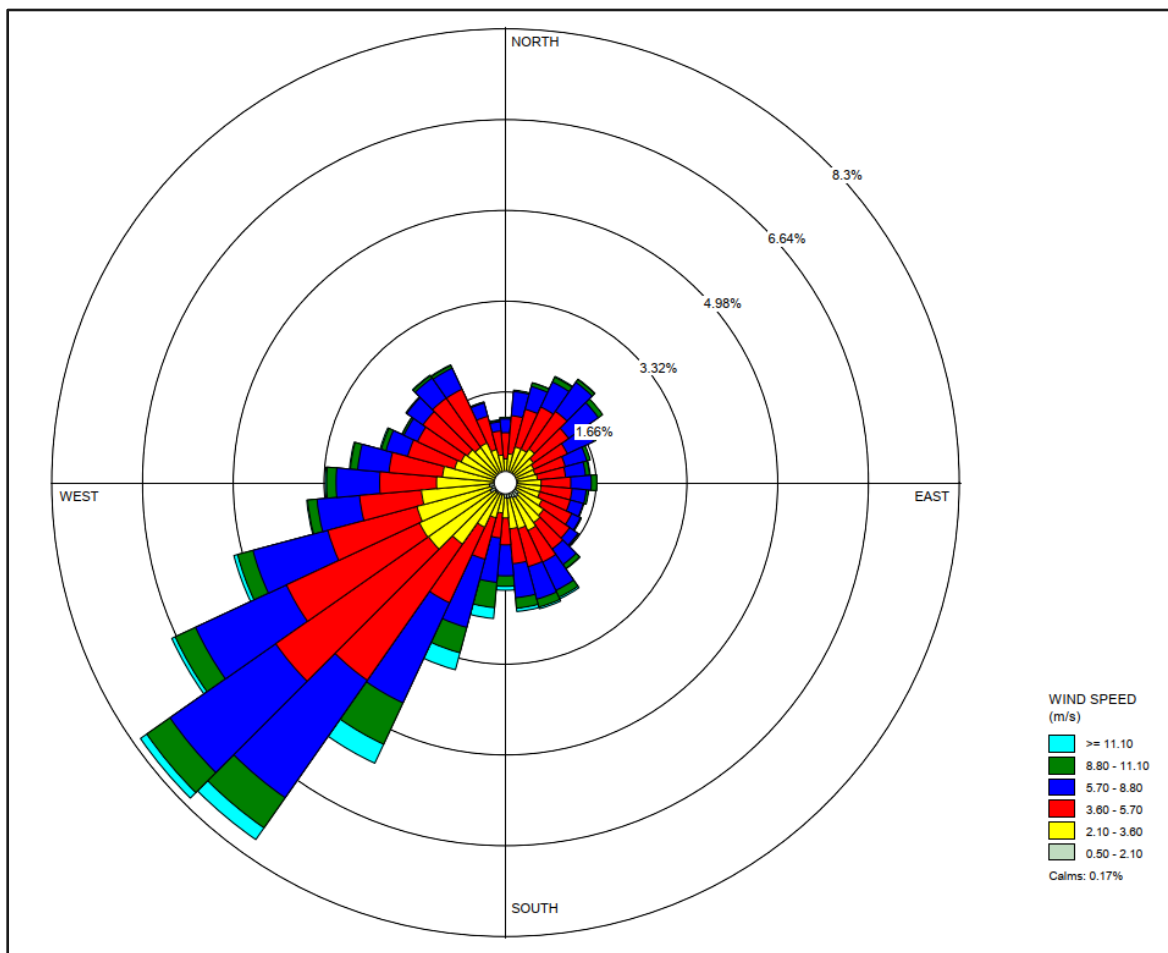


Figure 3-3: Windrose from Waddington (2020-2024)

3.1.5 Dispersion Coefficients

The 'rural' option for dispersion coefficients was selected in accordance with AERMOD guidance⁹.

3.1.6 Dispersion Model Uncertainty

Model validation studies¹⁰ 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.

⁹ EPA, AERMOD Implementation Workgroup, Aermol Implementation Guide (August 3, 2015)

¹⁰ AERMOD: Latest Features and Evaluation Results, EPA-454/R-03-003, June 2003 (United States Environmental Protection Agency).



3.2 Assessment of Impacts on Air Quality

3.2.1 Treatment of Model Output

The assessment of impacts against the AQALs was undertaken using model output as described in Table 3-2.

With respect to NO_x emissions, as per the EA Air Quality Modelling and Assessment Unit (AQMAU) guidance¹¹ on conversion ratio for NO_x and NO₂, it has been assumed that 70% of NO_x is present as NO₂ in relation to annual mean impacts, and 35% of NO_x is present as NO₂ in relation to short-term impacts.

Table 3-2: Model Outputs

Averaging Period	Model Output – Process Contribution (PC)	Predicted Environmental Concentration (PEC)
NO ₂ 1-hour mean. Not to be exceeded more than 18 times a calendar year	99.79%ile of 1-hour means	PC + 2 x annual mean background
PM ₁₀ 24-hour mean. Not to be exceeded more than 35 times a calendar year	90.4%ile of 24-hour means	PC + annual mean background
1-hour maximum	Maximum 1-hour mean	PC + 2 x annual mean background
8-hour rolling mean	Maximum 8-hour mean	PC + 2 x annual mean background
Calendar year	Annual mean	PC + annual mean background

3.2.2 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 process contributions that cannot be considered insignificant further assessment has been undertaken and the Predicted Environmental Concentration (PEC: PC + existing background pollutant concentration) determined for comparison as a percentage of the relevant AQAL.

¹¹ Environment Agency, Air Quality Modelling and Assessment Unit, 'Conversion Ratios for NO_x and NO₂'.



3.3 Assessment of Impacts on Vegetation and Ecosystems

3.3.1 Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA AQTAG06¹². Dry deposition flux was calculated using the following equation:

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

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 (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 3-3.

Table 3-3: Applied Deposition Velocities

Chemical Species	Recommended Deposition Velocity (m/s)	
NO ₂	Grassland	0.0015
	Woodland	0.0030
HCl	Grassland	0.0250
	Woodland	0.0600

3.3.1.1 Critical Loads – Eutrophication

The contribution to critical loads for nitrogen deposition (N) are recorded as kgN/ha/yr. The units are converted from $\mu\text{g}/\text{m}^2/\text{s}$ to units of kgN/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 3-4.

Table 3-4: Applied Deposition Conversion Factors

Chemical Species	Conversion factor [$\mu\text{g}/\text{m}^2/\text{s}$ to kgN/ha/year]	
NO ₂	of N:	95.9

3.3.1.2 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 ($\mu\text{g}/\text{m}^2/\text{s}$) by standard conversion factors as presented in Table 3-5.

Table 3-5: Applied Acidification Conversion Factors

Chemical Species	Conversion factor [kg/ha/year to keq/ha/year]
NO ₂	6.84
HCl	8.63

¹² Environment Agency, AQTAG06 – Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air, March 2014 version.



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

The calculation of the process contribution of N, and Cl 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 than 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”*

The predicted dry N, and Cl deposition (k_{eq} /ha/year) are summed to determine total acid deposition.

3.3.2 Significance of Effect on Ecological Receptors

In addition to the AERA guidance, the EA's Operational Instruction 66_12¹³ 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/European sites, 'no likely damage' for SSSIs, or '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/European sites and SSSIs;
- PC does not exceed 10% short-term CLe for NOx and HF (if applicable) for International/European sites and SSSIs;
- PC does not exceed 100% long-term CLe and/or CLo for other conservation sites; and
- PC does not exceed 100% short-term CLe for NOx and HF (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 the EA's Operational Instruction 67_12¹⁴. 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:

¹³ 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.

¹⁴ 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 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.



4.0 Baseline Environment

4.1 Site Setting and Sensitive Receptors

The Site is located at the approximate National Grid Reference (NGR): x488842, y361940 in Witham St Hughs. The surroundings are illustrated in Figure 4-1 and comprise:

- Other units of St Modwen Park to the north with open green space beyond;
- Small area of woodland with Camp Road and residential areas beyond;
- Open space being developed as part of St Modwen Park Phase 5 (NKDC application reference: 22/0803/RESM) with Swinderby Quarry beyond; and
- Other units of St Modwen Park to the west with open green space beyond.

4.1.1 Human Receptors

Twenty locations surrounding the Site have been selected to inform the risk assessment (presented in Table 4-1 and Figure 4-1 as R1 to R20). All the selected receptor locations were 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	Details	NGR-X	NGR-Y
R1	Residential	488310	362545
R2	Residential	488752	362861
R3	Residential	488862	362935
R4	Residential	489002	363047
R5	Residential	489013	362778
R6	Residential	489032	362667
R7	Residential	489070	362327
R8	Residential	489074	362262
R9	School	489203	362257
R10	Pre-School	489440	362352
R11	Residential	489100	362181
R12	Residential	489194	362141
R13	Residential	489124	362054
R14	Residential	489285	362035
R15	Residential	489127	361966
R16	Residential	489277	361967
R17	Residential	489152	361897
R18	Residential	489287	361863
R19	Residential	489160	361786
R20	Residential	489036	361402



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, whilst their locations are displayed in Figure 4-2.

Table 4-2: Assessed Designated Ecological Sites

ID	Site Name	Designation	Distance to Site (km)
ER1	Hawdin's / Norton Big Wood	AW	1.3
ER2	Butt Lane Pit	LWS	1.1
ER3	Hawdin's Wood	LWS	1.5
ER4	Norton Big Wood	LWS	1.3

4.2 Baseline Air Quality

4.2.1 Local Air Quality Management

The Site is located within North Kesteven District Council's (NKDC) administrative area.

NKDC do not have any declared AQMAs. The closest AQMA to the Site is located ~25km away. Given the separation distance, AQMAs have not been considered further in this assessment.

4.2.2 Local Monitoring Data

NKDC's latest Air Quality Annual Status Report (ASR)¹⁵ has been reviewed for local monitors in proximity to the Site. These are NO₂ diffusion tube monitors.

Monitoring data collected during the COVID-19 pandemic (i.e. 2020/2021) is expected to be atypical and has therefore not been used to characterise the baseline environment.

The details and results from the diffusion tubes within the study are presented in Table 4-3 and Table 4-4, respectively, whilst their locations are displayed in Figure 4-3.

Table 4-3: Local Monitoring Sites: Details

Site ID	Site Type	NGR-X	NGR-Y	Approx. Distance to Site (km)
Aubourn	Kerbside	492360	362640	3.4
Witham St Hughs	Kerbside	489199	361790	0.3

Table 4-4: Local Monitoring Sites: Results

Site ID	2023 % Data Capture	Annual Mean NO ₂ Concentration (µg/m ³)				
		2019	2020	2021	2022	2023
Aubourn	100	13.9	10.9	11.8	11.3	9.4
Witham St Hughs	100	11.2	9.2	9.2	9.3	8.1

As presented in Table 4-4, annual mean NO₂ concentrations have been well below the annual mean AQAL (40µg/m³) across the period considered.

¹⁵ Malvern Hills District Council, 2025 Air Quality Annual Status Report (ASR), June 2025.



The empirical relationship provided in LAQM.TG22 indicates that exceedances of the 1-hour mean NO₂ AQAL were unlikely at the monitors presented.

4.2.3 Mapped Background Concentrations

Defra maintains a nationwide model of existing and future mapped background air quality concentrations at a 1km grid square resolution.

The data sets include annual average concentration estimates of NO₂, PM₁₀ and PM_{2.5} based on the most recent 2021 reference year (the year in which comparisons between modelled and monitored concentrations are made).

For CO and benzene, Defra advises¹⁶ use of the most recent year of Pollution Climate Mapping background concentrations. For benzene these extend to 2024, and to 2010 for CO.

The 2024 (2010 for CO) mapped background pollutant concentrations for the grid squares containing the Site and modelled human receptors are presented in Table 4-5.

Table 4-5: Mapped Background Pollutant Concentrations

Grid Square (X, Y)	Annual Mean Background Concentration (µg/m ³)				
	NO ₂	PM ₁₀	PM _{2.5}	Benzene	CO
488500, 361500	6.2	11.9	6.0	0.3	205
488500, 362500	7.2	13.8	6.2	0.3	206
488500, 363500	6.2	13.9	6.1	0.3	205
489500, 361500	6.2	14.0	6.3	0.3	206
489500, 362500	7.5	13.0	6.3	0.3	208
489500, 363500	7.0	14.8	6.3	0.3	206

4.2.4 Metals

Monitoring of metals is currently carried out on behalf of Defra at 24 sites around the UK, as the Heavy Metals Monitoring Network.

Monitoring data from the closest active rural background monitor, Fenny Compton station, located approximately 119km to the southwest of the Site, was applied in the assessment. The 2024 annual average data is presented in Table 4-6.

Mercury (Hg) is monitored by the UKEAP Automatic Mercury Network at two rural background sites in the UK. Data from the nearest monitor at Chilbolton Observatory is presented in Table 4-6.

4.2.5 Hydrogen Halides

4.2.5.1 Hydrogen Chloride

HCl is monitored as part of the UKEAP Acid Gas and Aerosol Network. At the Caenby station (a rural background site located approximately 26km west of the Site), monitoring of HCl ceased in 2016. The annual mean concentrations from 2014 and 2015 were 0.3µg/m³ and 0.2µg/m³ respectively.

¹⁶ Defra, Background Concentration Maps User Guide, November 2024.



4.2.5.2 Hydrogen Fluoride

In 2005, The Expert Panel on Air Quality Standards (EPAQS) published a draft report titled 'Guidelines for halogen and hydrogen halides in ambient air for protecting human health against acute irritancy effects'. The report noted that only a small number of measurements of ambient concentrations of hydrogen fluoride have been made in the UK. All of these have been made in the vicinity of three industrial plants. Many samples were below the limit of detection. However, measurable values were in the range 0.05 to 3.5µg/m³ as approximate monthly averages.

4.2.6 Sulphuric Acid

There is no available ambient monitoring data for sulphuric acid. Particulate sulphate (SO₄) values were obtained from the Caenby station, part of the Acid Gas and Aerosol Network, and applied as a proxy. The annual mean concentrations in 2023 and 2024 were 1.0µg/m³ and 0.9µg/m³ respectively.

4.2.7 Applied Background Concentrations

The applied background concentrations are provided in Table 4-6. Baseline concentrations for short-term averaging periods have been converted from annual mean in accordance with AERA guidance and LAQM.TG22.

Table 4-6: Applied Background Concentrations

Pollutant	Units	Background Concentration		Data Source
		Short Term	Annual	
NO ₂	µg/m ³	18.8	9.4	Maximum 2023 monitored concentration in the study area of human receptors (Aubourn)
PM ₁₀	µg/m ³	14.8	14.8	Defra 2024 background – highest in study area
PM _{2.5}	µg/m ³	12.6	6.3	Defra 2024 background – highest in study area
CO	µg/m ³	416	208	Defra 2010 background – highest in study area
SO ₂	µg/m ³	3.2	1.6	Defra 2024 background – highest in study area
HCl	µg/m ³	0.6	0.3	Caenby 2014
HF	µg/m ³	7.0	3.5	EPAQS
Benzene	µg/m ³	0.3	0.3	Defra 2024 background – highest in study area
H ₂ SO ₄	µg/m ³	2.0	1.0	Caenby 2023
Mercury	ηg/m ³	2.9	1.5	Chilbolton Observatory 2024
Arsenic	ηg/m ³	1.14	0.57	Fenny Compton (2024)
Cadmium	ηg/m ³	0.15	0.07	Fenny Compton (2024)
Chromium (total)	ηg/m ³	1.42	0.71	Fenny Compton (2024)
Cobalt	ηg/m ³	0.07	0.04	Fenny Compton (2024)
Copper	ηg/m ³	4.05	2.03	Fenny Compton (2024)



Pollutant	Units	Background Concentration		Data Source
		Short Term	Annual	
Lead	ng/m ³	5.41	2.71	Fenny Compton (2024)
Manganese	ng/m ³	4.22	2.11	Fenny Compton (2024)
Nickel	ng/m ³	0.71	0.35	Fenny Compton (2024)
Vanadium	ng/m ³	1.02	0.51	Fenny Compton (2024)

4.3 Baseline Conditions at Ecological Receptors

The APIS website¹⁷, 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 current baseline concentrations (Table 4-7), nitrogen critical loads (Table 4-8) and acid critical loads (Table 4-9).

As all the assessed designated sites are local, the APIS ‘Search by Location’ function has been used. The values from the grid square of maximum impact at each designation have been applied.

Table 4-7: Baseline Concentrations

Site ID	NO _x
ER1	8.6
ER2	8.6
ER3	8.9
ER4	8.6

Table 4-8: Relevant N Critical Loads

Site ID	Critical Load Class	CLo for Assessment (kgN/ha/yr)	Current N Load (kgN/ha/yr)
ER1	Broadleaved deciduous woodland	10	30.7
ER2	Broadleaved deciduous woodland	10	30.7
ER3	Broadleaved deciduous woodland	10	30.7
ER4	Broadleaved deciduous woodland	10	30.7

Table 4-9: Relevant Acid Critical Loads and Baseline Deposition

Site ID	Critical Load Class	Critical Load (k _{eq} /ha/yr)			Current Load (k _{eq} /ha/yr)	
		CLmaxS	CLminN	CLmaxN	N	S
ER1	Broadleaved/Coniferous unmanaged woodland	0.9	0.4	1.3	2.2	0.2
ER2	Broadleaved/Coniferous unmanaged woodland	0.9	0.4	1.3	2.2	0.2

¹⁷ <http://www.apis.ac.uk/> accessed February 2026.



Site ID	Critical Load Class	Critical Load (k _{eq} /ha/yr)			Current Load (k _{eq} /ha/yr)	
		CLmaxS	CLminN	CLmaxN	N	S
ER3	Broadleaved/Coniferous unmanaged woodland	0.9	0.4	1.3	2.2	0.2
ER4	Broadleaved/Coniferous unmanaged woodland	0.9	0.4	1.3	2.2	0.2





Figure 4-1: Modelled Human Receptor Locations



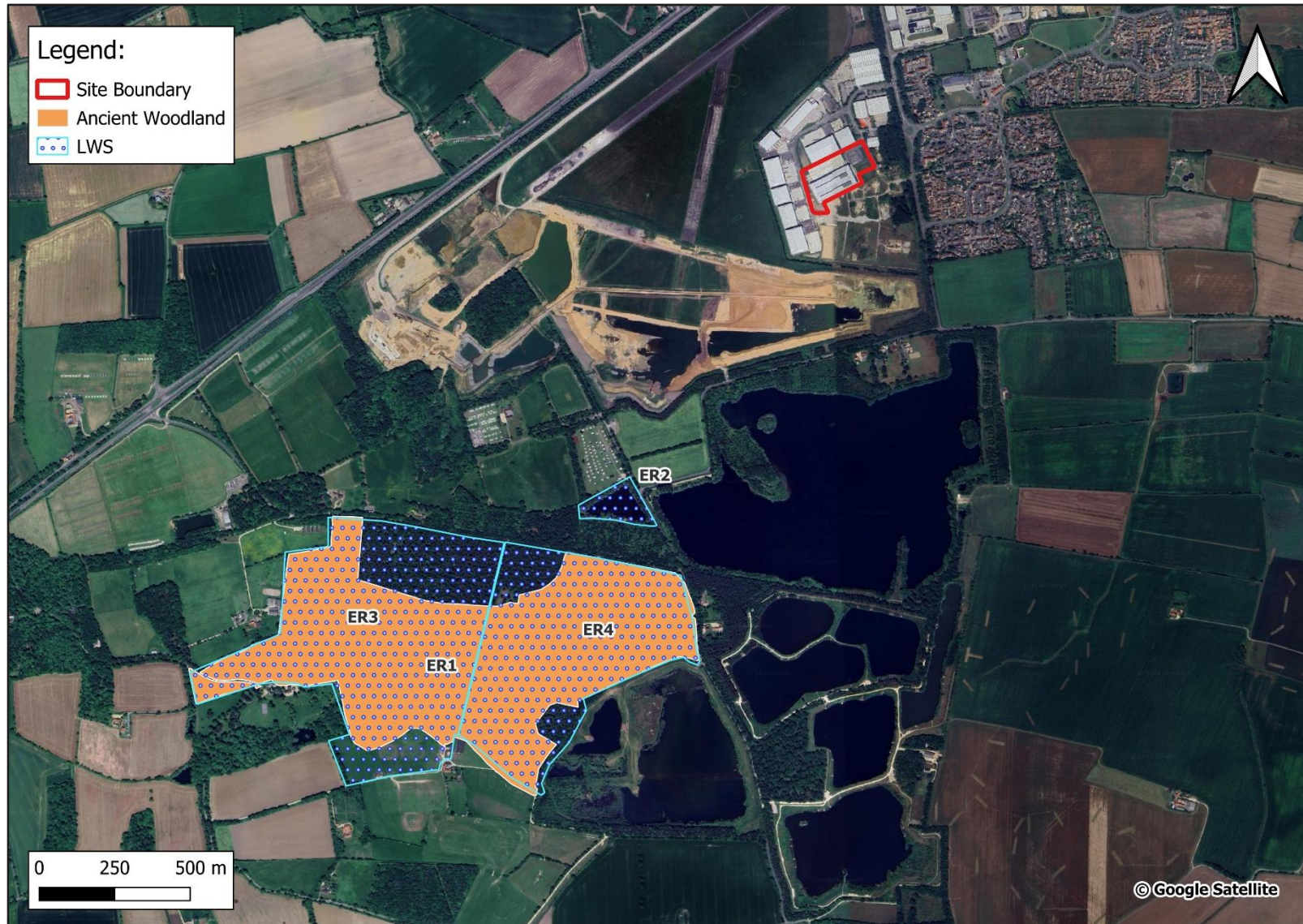


Figure 4-2: Modelled Designated Ecological Sites





Figure 4-3: Local Monitors Relative to Site



5.0 Emissions to Atmosphere

5.1 Operational Envelope

For the purposes of the dispersion modelling assessment, to represent a precautionary (worst case) approach, it has been assumed that the plant operates 24-hours per day for 365 days per year (i.e. 8,760 hours per year).

5.2 Emission Parameters

The emission parameters are summarised in Table 5-1 for the solar panel (A1 and A2) and battery shredder outputs treatment (A4) operations and Table 5-2 for the RTO (A3). For the potential emissions resulting from the operation, as defined in the BAT-OT report, concentrations have been based on the following:

- Best Available Techniques Reference (Bref) Document for Waste Treatment, European IPPC Bureau JRC, published 2018;
- Waste electrical and electronic equipment (WEEE): appropriate measures for permitted facilities, gov.uk, 13 July 2022;
- Measured metal concentrations from the client pilot plant;
- In the absence of either pilot plant data, BAT-AELs or WEEE ELVs, for emitted pollutants as set out in the BAT-OT, the following have been applied:
 - For acid gases – ELVs from the ‘Waste batteries: appropriate measures for permitted facilities, Consultation draft, June 2025’; and
 - Bulk combustion emissions of NO_x and CO from Defra Process Guidance Notes.

Table 5-1: A1, A2, A4 Emission Parameters

Parameter	A1	A2	A4
Stack Location (NGR x, y)	488877, 361918	488885, 361922	488808, 361885
Stack Internal Diameter (m)	0.85	0.85	1.0
Stack Release Height (m AGL)	16.5	16.5	16.5
Actual Flow Rate (Am ³ /s) (wet)	8.3	8.3	9.7
Emission Velocity (m/s)	14.7	14.7	12.4
Emission Temperature (°C)	30	30	90
Volume Flow (Nm ³ /s) (273K, wet, actual O ₂)	7.5	7.5	7.3
PM Concentration (mg/Nm ³) ^(a)	5	5	5
PM Emission Rate (g/s)	0.04	0.04	0.04
Table note: ^(a) Waste Treatment Bref BAT-AEL			

Table 5-2: A3 (RTO) Emission Parameters

Parameter	A3
Stack Location (NGR x, y)	488801, 361880
Stack Internal Diameter (m)	0.5



Parameter	A3
Stack Release Height (m AGL)	16.5
Actual Flow Rate (Am ³ /s) (wet)	2.2
Emission Velocity (m/s)	11.3
Emission Temperature (°C)	90
Volume Flow (Nm ³ /s) (273K, wet, actual O ₂)	1.7
NO _x Concentration (mg/Nm ³) ^(a)	100
CO Concentration (mg/Nm ³) ^(a)	100
TVOC Concentration (mg/Nm ³) ^(e)	15
PM Concentration (mg/Nm ³) ^(e)	5
HCl Concentration (mg/Nm ³) ^(d)	10
HF Concentration (mg/Nm ³) ^(d)	1
H ₂ SO ₄ Concentration (mg/Nm ³) ^(d)	10
As Concentration (mg/Nm ³) ^(b)	0.0003 ^(c)
Cd Concentration (mg/Nm ³) ^(b)	0.0003 ^(c)
Co Concentration (mg/Nm ³) ^(b)	0.0007
Cr Concentration (mg/Nm ³) ^(b)	0.0032
Cu Concentration (mg/Nm ³) ^(b)	0.0072
Mn Concentration (mg/Nm ³) ^(b)	0.0845
Ni Concentration (mg/Nm ³) ^(b)	0.0049
Pb Concentration (mg/Nm ³) ^(b)	0.0036
V Concentration (mg/Nm ³) ^(b)	0.0003
NO _x Emission Rate (g/s)	0.17
CO Emission Rate (g/s)	0.17
TVOC Emission Rate (g/s)	0.0255
PM Emission Rate (g/s)	0.0085
HCl Emission Rate (g/s)	0.017
HF Emission Rate (g/s)	0.0017
H ₂ SO ₄ Emission Rate (g/s)	0.017
As Emission Rate (mg/s)	0.0005
Cd Emission Rate (mg/s)	0.0005
Co Emission Rate (mg/s)	0.0012
Cr Emission Rate (mg/s)	0.0054
Cu Emission Rate (mg/s)	0.0122
Mn Emission Rate (mg/s)	0.1437
Ni Emission Rate (mg/s)	0.0083
Pb Emission Rate (mg/s)	0.0061
V Emission Rate (mg/s)	0.0005



Parameter	A3
Table notes: (a) Emission concentrations applied are consistent with those for thermal oxidisers as defined in Defra Process Guidance Notes 4/02(13) ¹⁸ and 6/23(11) ¹⁹ . (b) Client Pilot Plant monitoring data. (c) Below Limit of Detection, therefore LOD applied. (d) In absence of suitable Bref BAT-AELs 'Waste batteries: appropriate measures for permitted facilities, Consultation draft, June 2025' limits have been applied. (e) Waste Treatment Bref BAT-AEL.	

5.2.1 Particle Size

In air quality terms PM is classified in terms of its aerodynamic diameter; with PM₁₀ relating to particles with an aerodynamic diameter of less than 10µm. Other smaller relevant fractions of particulate matter such as PM_{2.5} (aerodynamic diameter less than 2.5µm) are a sub-fraction of the PM₁₀ fraction i.e. PM₁₀ includes PM_{2.5}.

For the purposes of this assessment 100% of particulate matter has been assumed to be PM₁₀ and 100% to be PM_{2.5}. This approach ensures that a worst-case scenario has been considered for the smallest particles.

5.2.2 Total Organic Carbon

There are no relevant air quality assessment levels or backgrounds for TOC. Whilst it is unlikely that any benzene would be released from the process due to the high temperature of combustion a cautious approach has been adopted by assuming all the organic carbon would be in the form of benzene in line with AERA guidance.

¹⁸ Process Guidance Note 4/02(13) Statutory guidance for polymerisation or copolymerisation of pre-formulated resins or gel coats containing unsaturated hydrocarbons (December 2013).

¹⁹ Process Guidance Note 6/23(11) Statutory guidance for coating of metal and plastic processes (Revised: June 2014).



6.0 Assessment Results

The results from the dispersion modelling are discussed in the following sections. The maximum values from 5-years of modelled meteorological data and all sources which emit each pollutant are presented.

6.1 Impacts at Human Receptors

6.1.1 Predicted Long-term Impacts

Predicted long-term impacts are summarised in Table 6-1. The results presented are the maximum point of predicted long-term impact at any location on the receptor grid and impacts at all other locations will be lower. The PEC does not exceed the standard at any location.

Table 6-1: Maximum Ground Level Long-term Impacts

Pollutant	Standard (µg/m ³)	PC (µg/m ³)	PC as % Standard	PEC (µg/m ³)	PEC as % Standard
NO ₂	40	4.1	10.2%	13.5	33.7%
PM ₁₀	40	3.2	7.9%	18.0	44.9%
PM _{2.5}	20	3.2	15.9%	9.5	47.4%
HF (monthly)	16	0.1	0.7%	n/c	n/c
TOC (as Benzene)	5	0.9	17.4%	1.2	23.4%
H ₂ SO ₄	10	0.6	5.8%	1.6	15.8%
Cadmium	0.005	0.00002	0.3%	n/c	n/c
Mercury	0.06	0.002	3.6%	0.004	6.1%
Arsenic	0.006	0.00002	0.3%	n/c	n/c
Chromium (III)	2	0.001	0.05%	n/c	n/c
Copper	0.05	0.002	4.4%	0.004	8.4%
Lead	0.25	0.0002	0.1%	n/c	n/c
Manganese	0.15	0.005	3.3%	0.01	4.7%
Nickel	0.02	0.0003	1.4%	0.001	3.2%

Table note:

n/c = not calculated: following AERA guidance the PEC has only been calculated where the PC is 1% or above.

6.1.2 Predicted Short-term Impacts

Predicted short-term impacts are summarised in Table 6-2. The results presented are the maximum point of predicted short-term impact at any location on the receptor grid outside the Site boundary and impacts at all other locations, and at all other times, will be lower. The maximum ground level PECs do not exceed the standards.



Table 6-2: Predicted Maximum Ground Level Short-term Impacts

Pollutant	Standard (µg/m ³)	PC (µg/m ³)	PC as % Standard	PEC (µg/m ³)	PEC as % Standard
NO ₂	200	20.0	10.0%	38.8	19.4%
PM ₁₀	50	6.6	13.2%	21.4	42.8%
CO (8-hour)	10,000	47.6	0.5%	n/c	n/c
CO (1-hour)	30,000	100.4	0.3%	n/c	n/c
HCl	750	10.0	1.3%	n/c	n/c
HF	160	1.0	0.6%	n/c	n/c
TOC (as Benzene)	30	4.6	15.2%	5.2	17.2%
H ₂ SO ₄	300	10.0	3.3%	n/c	n/c
Mercury	0.6	0.01	1.2%	n/c	n/c
Cadmium	0.03	0.0001	0.3%	n/c	n/c
Manganese	1,500	0.08	0.01%	n/c	n/c
Nickel	0.7	0.005	0.7%	n/c	n/c
Vanadium	1	0.0001	0.01%	n/c	n/c

Table note:
n/c = not calculated: following AERA guidance the PEC has only been calculated where the PC is 10% or above.

6.2 Impacts at Sensitive Ecosystems

6.2.1 Critical Levels

The predicted impacts on CLe at the identified ecological sites are presented in Table 6-3 and Table 6-4.

The findings are that the PCs are less than 100% of the CLe at the AW and LWS and therefore the impacts are considered insignificant and will cause *'no significant pollution'*.

Table 6-3: Predicted Impacts on Long-term Critical Levels

Site	NO _x		HF Weekly	
	PC (µg/m ³)	PC as % CLe	PC (µg/m ³)	PC as % CLe
ER1	0.1	0.2%	<0.1	5.5%
ER2	0.1	0.2%	<0.1	6.3%
ER3	<0.1	0.2%	<0.1	4.3%
ER4	0.1	0.2%	<0.1	5.4%



Table 6-4: Predicted Impacts on Short-term Critical Levels

Site	NO _x Daily		HF Daily	
	PC (µg/m ³)	PC as % CL _e	PC (µg/m ³)	PC as % CL _e
ER1	1.2	1.6%	0.01	0.2%
ER2	1.3	1.7%	0.01	0.3%
ER3	1.1	1.4%	0.01	0.2%
ER4	1.2	1.6%	0.01	0.2%

6.2.2 Critical Loads

The predicted impact on CL_o at the identified ecological sites for nitrogen and acid deposition are presented in Table 6-5 and Table 6-6.

The findings are that the PCs are less than 100% of the CL_o for the AW and LWS and therefore the impacts are considered insignificant and will cause '*no significant pollution*'.

Table 6-5: Predicted Impacts on Nitrogen Critical Loads

Site	Applied CL _o	PC (kg/ha/yr)	PC as % CL _o
ER1	10	0.01	0.1%
ER2	10	0.01	0.1%
ER3	10	0.01	0.1%
ER4	10	0.01	0.1%

Table 6-6: Predicted Impacts on Acid Critical Loads

Site	Applied CL _o MaxN (k _{eq} /ha/yr)	PC (k _{eq} /ha/yr)	PC as % CL _o
ER1	1.3	<0.01	0.3%
ER2	1.3	<0.01	0.3%
ER3	1.3	<0.01	0.2%
ER4	1.3	<0.01	0.3%



7.0 Conclusions

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

The following summary points are noted:

- There are no predicted exceedances of short-term or long-term standards for the protection of human health at either the point of maximum off-site impact or at the modelled relevant exposure locations.
- The predicted impacts on designated sensitive habitats are considered insignificant and will cause '*no significant pollution*'.





Appendix A EA Modelling Checklist

Lincoln Recycling Facility Environmental Permit Application

Air Emissions Risk Assessment

GBCTR Ltd

SLR Project No.: 416.066578.00002

11 March 2026

Table A-1: Modelling Checklist

Item	Yes/No	Details / Reason for Omission
Location map	Yes	Figure 4-1
Site plan	Yes	Figure 3-1
Pollutants modelled and relevant EALs	Yes	Table 2-1, Table 2-3, Table 5-1, Table 5-2
Details of modelled scenarios	Yes	Section 5.1
Details of relevant ambient concentrations	Yes	Section 4.2
Model description and justification	Yes	Section 3.1
Special model treatment used	Yes	Sections 3.2.1 and 3.3.1
Table of emission parameters used	Yes	Section 5.2
Details of modelled domain and receptors	Yes	Sections 3.1.1 and 4.1
Details of meteorological data used	Yes	Section 3.1.4
Details of terrain treatment	Yes	Section 3.1.3
Details of building treatment	Yes	Section 3.1.2
Details of modelling deposition	Yes	Section 3.3.1
Model uncertainty and sensitivity	Yes	Section 3.1.6
Assessment of impacts	Yes	Section 6.0
Contour plots	Yes	Appendix B
Model input files	Yes	Appendix C





Appendix B Contour Plots

Lincoln Recycling Facility Environmental Permit Application

Air Emissions Risk Assessment

GBCTR Ltd

SLR Project No.: 416.066578.00002

11 March 2026

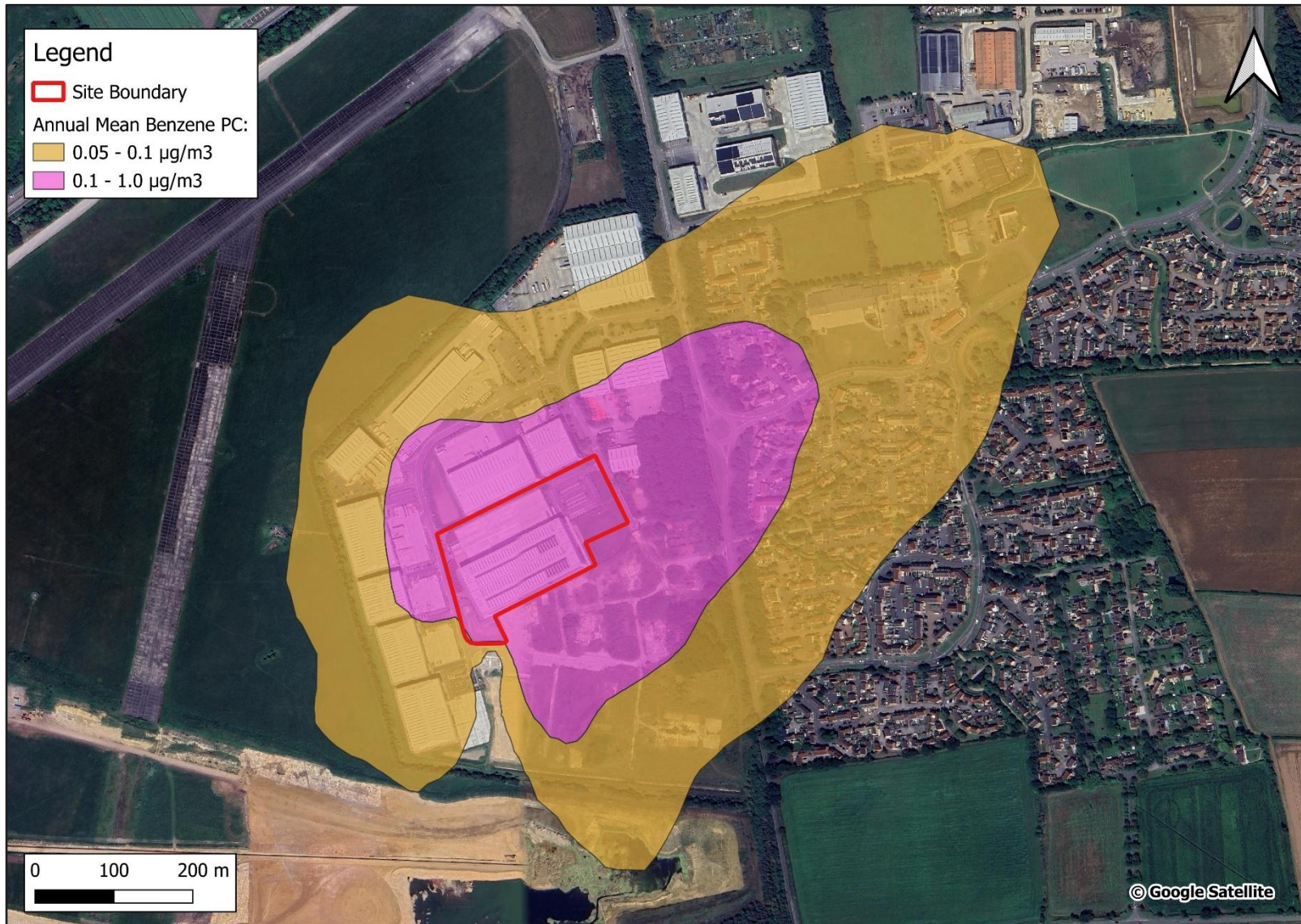


Figure B-1: Annual Mean Benzene PC



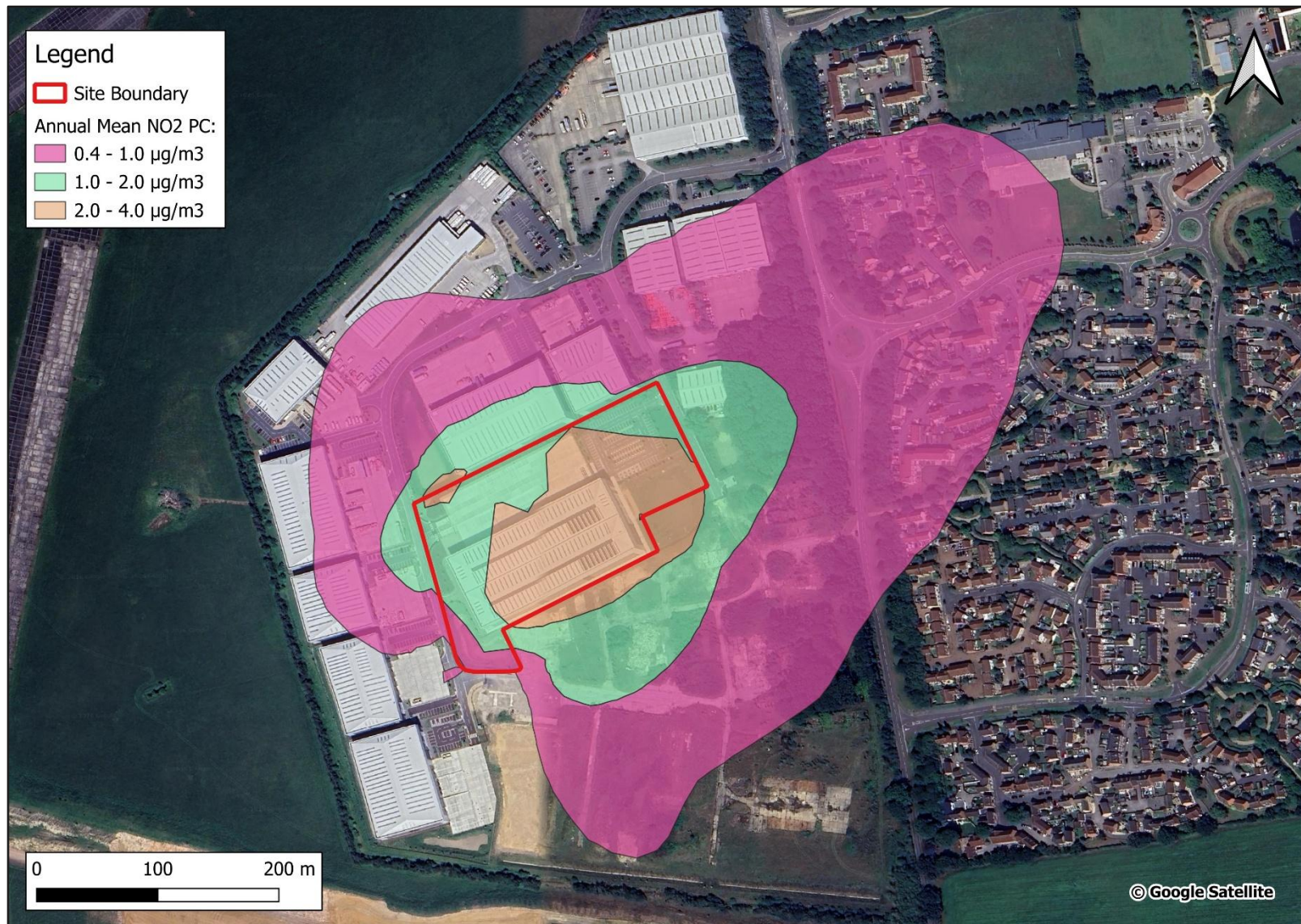


Figure B-2: Annual Mean NO₂ PC





Appendix C Model Files (electronic only)

Lincoln Recycling Facility Environmental Permit Application

Air Emissions Risk Assessment

GBCTR Ltd

SLR Project No.: 416.066578.00002

11 March 2026



Making Sustainability Happen