PROPOSED WASTE TYRE FACILITY
PORT OF SUNDERLAND

Schedule 5 Response

Air Emissions Risk Assessment

Dispersion Modelling Assessment: Normal Operation

Prepared for: Wastefront AS

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1.0 INTRODUCTION

SLR Consulting Ltd (SLR) has been commissioned by Wastefront AS to undertake an Air Emissions Risk Assessment (AERA) for a proposed waste tyre facility ('Proposed Development') at the Port of Sunderland (the 'Site'). The Site lies within the administrative area of Sunderland City Council (SCC).

The Proposed Development comprises a series of regulated Emission Points (A1 – A19), including a 30m flue stack (A1 – 'Proposed Installation'). Exhaust gases associated with pyrolysis process (which do not meet the end of waste protocol) are released at A1 during normal operation.

1.1 Scope of Assessment

Following submission of the original AERA, the Environment Agency (EA) issued a Schedule 5 notice (Notice of Requirement for More Information) – seeking clarification and/or further assessment of air emissions. Furthermore, in the interim the design of the process has also evolved.

The AERA has been revised to account for these design changes and Schedule 5 comments, where relevant. Of relevance to this assessment is the dispersion modelling assessment of emissions to air associated with normal operation of the Proposed Installation (A1), and other on-site cumulative sources (that emit the same pollutants). This includes three dust filters (A5, A6 and A7). The objective of the assessment is to determine the extent of potential air quality effects, by comparison to relevant guidelines for the protection of human health and sensitive habitats.

The dispersion modelling methodology applied in this assessment has remained consistent with the original AERA for any item not raised by the EA in their Schedule 5 notice.

The following assessments will be issued separately:

- screening of emissions to air (under normal conditions) for those pollutants which do not require detailed assessment; and
- dispersion modelling assessment of abnormal conditions.

Consideration of these task elements are excluded from this assessment and not referred to herein – as agreed with the EA.

2.0 LEGISLATIVE CONTEXT AND GUIDANCE

In the interim period the UK has formally left the EU, however, despite this the EU law and regulations referred to throughout this report have subsequently been ratified into UK law and thus are still of relevance.

2.1 National Air Quality Legislation

2.1.1 Air Quality Standards Regulations

The Air Quality Standards Regulations 2010[1] (AQSR) transpose both the EU Ambient Air Quality Directive (2008/50/EC)[2], and the Fourth Daughter Directive (2004/107/EC)[3] within UK legislation, in order to align and bring together in one statutory instrument the Government's obligations. The AQSR includes Limit Values, Target Values, Objectives, Critical Levels and Exposure Reduction Targets for the protection of human health and the environment. Limit values are legally binding and are considered to apply everywhere with the exception of the carriageway and central reservation of roads and any location where the public do not have access (e.g. industrial sites).

2.1.2 Air Quality Strategy

The UK Air Quality Strategy (AQS) 2007 for England, Scotland, Wales and Northern Ireland[4] provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the UK Government and Devolved Administrations for the protection of public health and the environment.

The AQS objectives are only applicable at locations:

- which are situated outside of buildings or other natural or man-made structures above or below ground; and
- where members of the public are regularly present.

As such, compliance with the objectives should focus on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant objective.

2.1.3 Local Air Quality Management

As reinforced within the AQS, Part IV of the Environment Act 1995 induces a statutory duty for 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. AQMAs can give rise to potential constraints to development, or at least a higher degree of scrutiny to air quality assessment work.

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

[1] The Air Quality Standards Regulations (England) 2010, Statutory Instrument No 1001, The Stationary Office Limited.
[2] Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.
[3] Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004.
[4] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, Defra. July 2007.

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 (the 'Habitats Regulations')[5] 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 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 EU[6].

Other sites of international significance are Ramsar sites, which are wetlands protected under the 1971 Ramsar Convention[7]. Many of these sites in the UK were initially selected on the basis of their importance to waterbirds, and are therefore also classified as SPAs.

The Countryside and Rights of Way (CRoW) Act (2000) provides protection to Sites of Special Scientific Interest (SSSI) to ensure that developments are not likely to cause damage.

Locally important sites (such as National Nature Reserves (NNR), Local Nature Reserves (LNR), Local Wildlife Sites (LWS) or Sites of Importance for Nature Conservation (SINCs) and Ancient Woodland (AW)) are also protected by legislation to ensure that developments do not cause significant pollution.

2.2 Regulation of Industrial Emissions

2.2.1 Industrial Emissions Directive

The Industrial Emissions Directive[8] (IED) recast seven existing directives including the Waste Incineration Directive (WID)[9]. Chapter IV of the IED applies to incineration and co-incineration plants (which accept waste and other fuels such as biomass) which thermally treat waste as defined in the Waste Framework Directive.

The IED defines requirements for facilities classified as waste incinerators under the IED definition, including:

- operating conditions, including gas temperatures and residence times, such as 850°C / 2 seconds;
- emission limit values (ELVs) for a range of substances to air and water; and
- emissions monitoring requirements.

2.2.2 Emission Limit Values to Air

The IED defines ELVs for emissions to air from installations as described above. These ELVs are detailed in Table 2-1.

[5] The Conservation of Habitats and Species Regulations 2017 Statutory Instrument 490.

[6] The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

[7] Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

[8] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

[9] Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste.

Table 2-1
IED Chapter IV Emission Limit Values

Pollutant	Emission Limits (mg/Nm^3) [(a)]		
	Daily average values	Half hourly averages	
		100th Percentile	97th Percentile
Continuous Monitoring			
Particulate Matter (PM)	10	30	10
Total Organic Carbon (TOC)	10	20	10
Hydrogen Chloride (HCl)	10	60	10
Hydrogen Fluoride (HF)	1	4	2
Sulphur Dioxide (SO_2)	50	200	50
Oxides of Nitrogen (NO_x)	200	400	200
Carbon Monoxide (CO) [(b)]	50	150	100
Spot Sample Measurements			
Group 1 Metals [(c)]	0.05		
Group 2 Metals [(c)]	0.05		
Group 3 Metals [(c)]	0.5		
Dioxins and Furans [(d)]	1e-7		

Table Notes:
(a) Concentrations referenced to temperature 273.15 K, pressure 101.3 kPa, 11% oxygen, dry gas.
(b) 150mg/Nm^3 of combustion gas for at least 95% of all measurements determined as 10 minute averages or 100mg/Nm^3 of combustion gas of all measurements determined as half-hourly average values taken in any 24 hour period.
(c) Metal groups are as follows:
- Group 1: Cadmium (Cd) and thallium (Tl)
- Group 2: Mercury (Hg)
- Group 3: Antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), and vanadium (V).

(d) The emission limit value refers to the total concentration of dioxins and furans calculated using the concept of toxic equivalence (TEQ).

2.2.3 Environmental Permitting

In England, the Environmental Permitting (England and Wales) Regulations 2016 (SI 2016 No.1154 as amended) transpose the IED into UK legislation. Proposed Emission Points (A1-A19) would be regulated by the EA under the EP Regulations which includes regulating emissions to air.

Of particular relevance to the assessment of air quality impacts is the EA's 'Air Emission Risk Assessment for your Environmental Permit' guidance[10] (herein referred to as the AERA guidance). The purpose of this guidance is to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations. This guidance sets out Environmental Assessment Levels (EALs) which are taken from the AQS and AQSR but also includes EALs for additional pollutants derived from occupational exposure limits (OEL) and maximum exposure levels (MEL). Those relevant to this assessment are presented within Table 2-2 below.

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

2.3 Environmental Standards

The environmental standards for air, taken from 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 Protection of Human Health

The standards applied in this assessment are taken from the EA's AERA guidance (collectively termed Air Quality Assessment Levels (AQAL) throughout this report).

The AERA guidance provides the relative environmental thresholds provided in the AQS and AQSR, as well as EALs provided by the EA, for the protection of health. Table 2-2 sets out those AQALs that are relevant to the assessment with regard to human receptors.

Updates to any AQAL that has occurred in the interim period have been assessed (e.g. Benzene). Where several AQALs are referenced in the EA's AERA guidance, the lowest has been used.

Table 2-2
Relevant AQALs Applied

Pollutant		Standard (µg/m³)		Reference
		Annual	Short Term	
Nitrogen Dioxide	(NO_2)	40	200 (1-hour) not to be exceeded more than 18 times per year	AQSR
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)	EAL
Sulphur Dioxide	(SO_2)	-	266 (15-minute) not to be exceeded more than 35 times per year	AQS
			350 (1-hour) not to be exceeded more than 24 times per year	AQSR
			125 (24-hour) not to be exceeded more than 3 times per year	AQSR
Hydrogen Chloride	(HCl)	-	750 (1-hour)	EAL
Hydrogen Fluoride	(HF)	16 (monthly)	160 (1-hour)	EAL
Benzene	(C_6H_6)	5	30 (24-hour)	AQSR/EAL
Arsenic	(As)	0.006	-	EAL
Antimony	(Sb)	5	150 (1-hour)	EAL
Cadmium	(Cd)	0.005	-	AQSR
Chromium (II and III)	(Cr)	5	150 (1-hour)	EAL
Chromium (VI)		0.00025	-	EAL
Copper	(Cu)	10	200 (1-hour)	EAL
Lead	(Pb)	0.25	-	AQS
Manganese	(Mn)	0.15	1500 (1-hour)	EAL
Mercury	(Hg)	0.25	7.5 (1-hour)	EAL
Nickel	(Ni)	0.02	-	AQSR
Vanadium	(V)	-	1 (24-hour)	EAL

Pollutant		Standard (µg/m³)		Reference
		Annual	Short Term	
Polycyclic Aromatic Hydrocarbons as Benzo(a)Pyrene	(PAH as BaP)	0.00025	-	AQS
Polychlorinated Biphenyls	(PCBs)	0.2	6 (1-hour)	EAL
Dioxins and Furans	(Dioxin)	0.0000003[7]	-	WHO [(a)]

Table Notes:
(a) No assessment criteria defined for dioxins and furans. The World Health Organisation (WHO)[11] provides an indicator for the air concentrations above which it considers it necessary to identify and control local emission sources; this value is 0.3pg/m³ (300fg/m³) and has been adopted as an AQAL in this assessment.

2.3.2 Relevant Exposure

In accordance with Defra's technical guidance on Local Air Quality Management (LAQM.TG(22))[12], the AQALs presented in Table 2-2 should only be assessed at locations of relevant exposure i.e. where members of the public are regularly present and might reasonably be expected to be exposed to pollutant concentrations over the relevant averaging period. These AQALs do not apply to exposure at the workplace.

A summary of the typical relevant locations associated with each applicable AQAL assessed is detailed below in Table 2-3.

Table 2-3
Relevant Public Exposure

Averaging Period	Relevant Locations	Locations AQALs Should Apply At	Locations AQALs Should Not Apply At
Annual mean	Where individuals are exposed for a cumulative period of 6 months in a year	Building facades of residential properties, schools, hospitals etc.	Facades of offices, hotels, gardens of residences and kerbside sites
24-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
8-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure is expected to be short term
1-hour mean	Where individuals might reasonably be expected to spend one hour or longer	As above together with kerbside sites of regular access, car parks, bus stations etc.	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		-

[11] WHO (2000) World Health Organisation, Air quality Guidelines for Europe (Second Edition).
[12] Local Air Quality Management Technical Guidance 22, Published by Defra in partnership with the Scottish Government, Welsh Assembly Government and Department of the Environment Northern Ireland. August 2022.

2.3.3 Standards for the Protection of Ecosystems and Vegetation

Sites of nature conservation importance are provided environmental protection with respect to air quality, through the application of standards known as Critical Levels (CLe) for airborne concentrations and Critical Loads (CLo) for deposition to land from air.

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. CLe for the protection of vegetation and ecosystems are specified within relevant European air quality directives and corresponding UK air quality regulations (see Table 2-4).

To provide a conservative assessment, the CLe for annual mean SO_2 at all ecological designations has assumed to be 10µg/m^3 which is only applicable where lichens or bryophytes are present, otherwise 20µg/m^3 is appropriate.

Table 2-4
Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Habitat and Averaging Period
SO_2	10	Annual mean. Sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity
	20	Annual mean. For all higher plants (all other ecosystems)
NO_x	30	Annual mean (all ecosystems)
	75 (200) [a] [b]	Daily mean (all ecosystems)
HF	5	Daily mean
	0.5	Weekly mean

Table Notes:
(a) Non statutory
(b) 75µg/m^3 CLe only considered appropriate where levels of SO_2 and O_3 are close to their CLe. Where O_3 and SO_2 are not elevated above their CLe (common across the UK) a value of 200µg/m^3 is recommended for assessments (IAQM, 2020).

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 eutrophication and acidification are relevant which can both occur via wet and dry deposition. Wet deposition occurs due to rainout (within cloud) scavenging and washout (below cloud) scavenging, whereas dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. For the assessment of short range emissions, dry deposition is considered the predominant removal mechanism. Wet deposition can therefore be discounted from further assessment[13].

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

CLo for the habitats and species of relevance to this assessment have been obtained from the Air Pollution Information System (APIS) website[14], whereby the most sensitive habitat listed has been used/provided to facilitate a worst-case assessment. These are presented in Section 4.3.

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

3.0 ASSESSMENT METHODOLOGY

3.1 Dispersion Model

ADMS 5 Version 5.2.0 modelling software was used for this for the assessment of operational emissions to air released from the proposed stack. ADMS 5 is an advanced atmospheric dispersion model that has been developed and validated by Cambridge Environmental Research Consultants (CERC). The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by the EA and local authorities.

3.2 Receptors

The modelling has been undertaken using a receptor grid for receptors outside of the Site boundary. This method allows the maximum ground level concentration outside the Site boundary to be assessed.

A nested receptor grid of 5km by 5km centred upon the Site was applied as follows:

- 200m x 200m at 5m grid resolution;
- 400m x 400m at 25m grid resolution;
- 1,000m x 1,000m at 50m grid resolution;
- 2,000m x 2,000m at 250m grid resolution; and
- 5,000m x 5,000m at 500m grid resolution.

3.2.1 Human Receptors

Human receptors considered in the assessment are shown in Table 3-1 and their locations are illustrated in Figure 3-1 (titled discrete receptors). These receptor locations are considered to capture worst-case relevant exposure relative to the Site, in accordance with LAQM.TG(22) presented in Table 2-3 and excludes workplace locations. Consideration has also been given to land uses with sensitive populations for inclusion within the model (e.g. elderly care home, schools etc.).

Table 3-1
Modelled Discrete Human Receptor Locations

Receptor	Details	Relevant Exposure	NGR		Height (m)
			X	Y	
R1	Allotment	Short Term	440748	555679	1.5
R2	School	Short and Long Term	440577	555907	1.5
R3	Orphanage	Short and Long Term	440751	557056	1.5
R4	Residential	Short and Long Term	440698	556951	1.5
R5	Residential	Short and Long Term	440704	556288	1.5
R6	Residential	Short and Long Term	440735	556136	1.5
R7	Residential	Short and Long Term	440744	556034	1.5
R8	School	Short and Long Term	440625	555875	1.5
R9	Residential	Short and Long Term	440638	555589	1.5
R10	Care Home	Short and Long Term	440675	557343	1.5
R11	Residential	Short and Long Term	440836	557524	1.5
R12	Residential	Short and Long Term	440756	557420	1.5
R13	Residential	Short and Long Term	440470	557845	1.5
R14	Residential	Short and Long Term	440703	557209	1.5

Receptor	Details	Relevant Exposure	NGR		Height (m)
			X	Y	
R15	Residential	Short and Long Term	440765	555413	1.5
R16	Residential	Short and Long Term	440590	555730	1.5
R17	Residential	Short and Long Term	440459	556644	1.5
R18	Residential	Short and Long Term	440620	556397	1.5
R19	Residential	Short and Long Term	440867	558344	1.5
R20	Residential	Short and Long Term	440582	558201	1.5
R21	Nursing Home	Short and Long Term	440596	556077	1.5

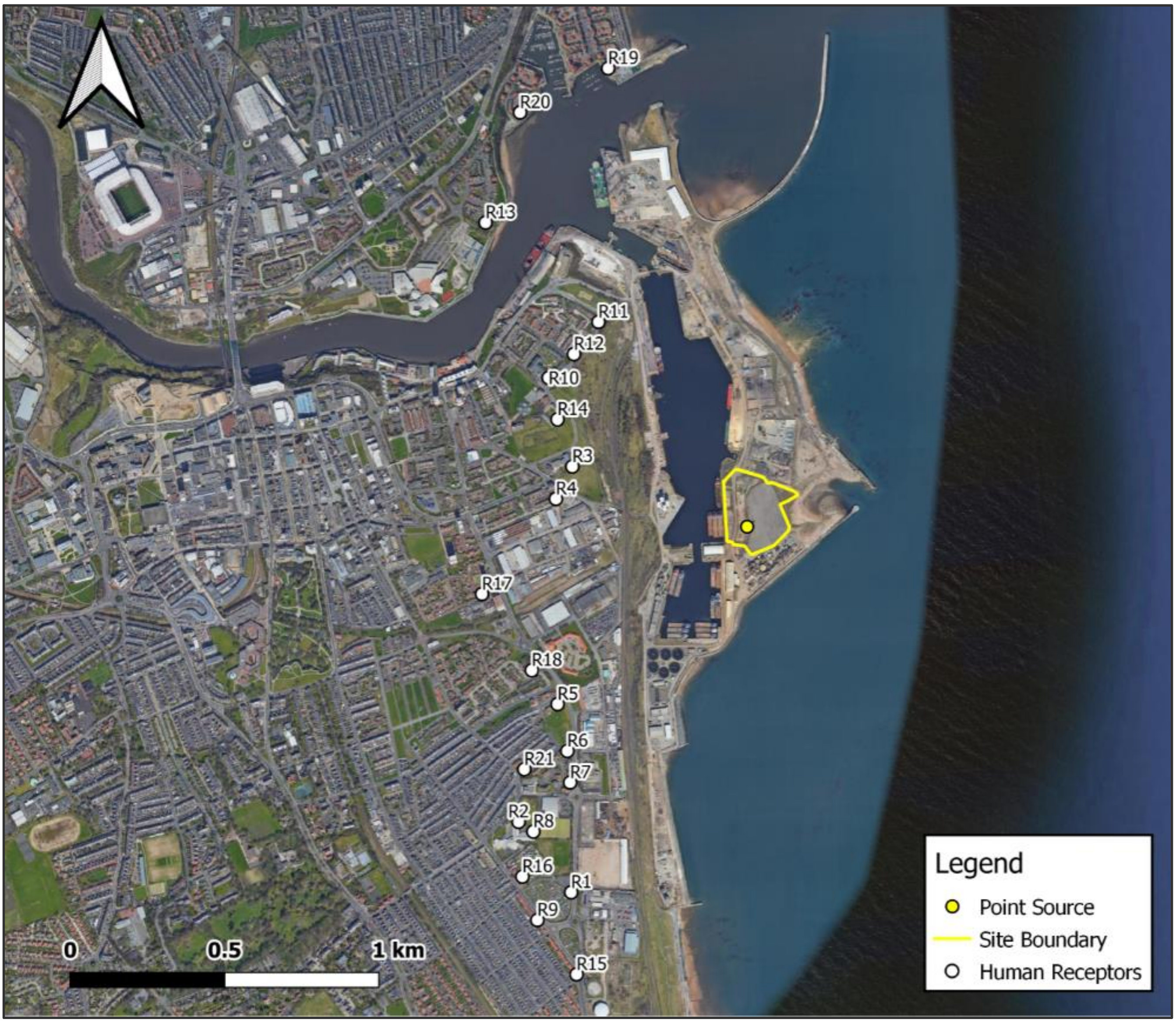

Figure 3-1
Discrete Human Receptors

3.2.2 Ecological Receptors

The EA's AERA Guidance states that the following ecological sites need to be considered:

- SPAs, SACs and Ramsar Sites (protected wetlands) within 10km of the Site; and

- SSSIs and local nature sites (AW, LWS, NNR and LNR) within 2km of the Site.

Following application of these distance thresholds, Table 3-1 provides details of ecological receptors considered within this assessment, and are illustrated in Figure 3-2. All receptors have assumed a height of 0m and represented in the model using gridded and polygon boundary receptors.

LWSs were provided by the EA following a pre-application conservation screening request[15].

Table 3-2
Designated Ecological Sites of Relevance

Receptor ID	Site Name	Designation	Distance to Site
ER1	Mowbray Park	LWS	1.3
ER2	Wearmouth Riverside Park/Wearmouth Colliery	LWS	1.5
ER3 (a)	Sunderland South Dock	LWS	1.0
ER4	Dock Tufa	LWS	1.6
ER5	Sunderland South Docks Hendon Railway	LWS	1.9
ER6	Hendon Colliery	LWS	1.8
ER7	Northumbria Coast	SPA/Ramsar	2.0
ER8	Durham Coast	SAC	2.0
Table Notes: (a) Unidentifiable designation. Site name based upon local topography.			

[15] Environment Agency. Pre-Application Conservation Screening Report and Maps. Reference EPR/JP3407LQ/A001. 25/03/2020.

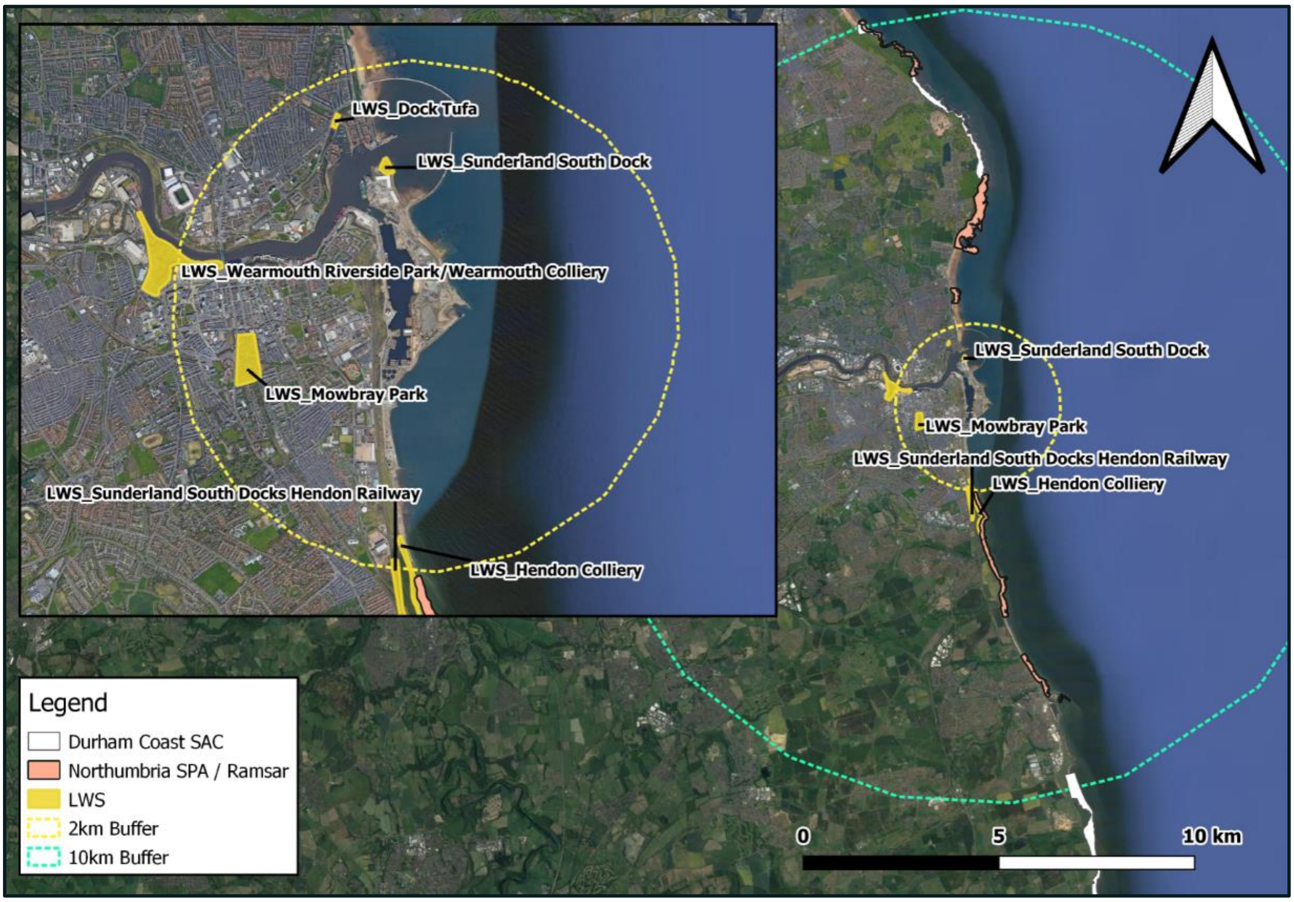

Figure 3-2
Ecological Designations of Relevance

3.3 Terrain

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. The ADMS modelling guidance indicates it is generally unnecessary to include terrain where gradient in slopes is less than 10%.

An evaluation of the terrain covering the extent of the model domain suggests that the area is generally flat with little to no significant terrain features. Therefore, terrain has not been included within the dispersion model.

3.4 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, which can result in elevated ground level concentrations.

The Buildings Module within the ADMS model has been used to incorporate buildings within the model, in line with EA guidance, where:

- the maximum height of the building is equivalent to at least 40% of the emission height (i.e. 12m); and
- are within a distance defined as five times the lesser of the height or maximum projected width of the building (referred to as 5L)).

Details of the buildings are provided in Table 3-3, whilst their locations are illustrated in Figure 3-3.

Table 3-3
Modelled Buildings

Name	Centre Easting (m)	Centre Northing (m)	Height (m)	Length / Diameter (m)	Width (m)	Angle (°)
rCB Process_1	441390.1	556924.7	26.5	26.0	39.6	90.0
Tyre Shredding Area	441319.8	556986.9	11.5	70.5	48.2	89.9
Pyrolysis Building	441338.9	556921.2	13.0	56.8	74.8	179.5
Distillation Unit	441409.3	556858.4	18.0	6.9	10.1	88.8

Figure 3-3
Modelled Buildings

3.5 Meteorological Data

Hourly sequential meteorological data is required as input into the ADMS dispersion model. Wind direction, wind speed, temperature, cloud cover and stability all exert significant influence over atmospheric dispersion, therefore due consideration needs to be given to the use of representative meteorological data within the dispersion model, to ensure real-world application.

Details of the five nearest meteorological stations in proximity to the Site are presented in Table 3-4. The Site is located immediately on the coast, in an urban/industrial setting. It was determined that there is no clear representative meteorological station in close proximity to the Site. The nearest coastal meteorological station is 49.1km away (Loftus), and is situated within a predominately rural setting, not reflective of Site dispersion conditions.

Numerical Weather Prediction (NWP) meteorological data was consequently utilised for the assessment, for the grid square centred at the Site. This is consistent with advice prescribed within LAQM.TG(22) for coastal areas.

Table 3-4
Details of Meteorological Stations in Proximity to the Site

Recording Station Name	Station Elevation (m)	Distance from Site (km)	Summary of Location
Site	*7*	-	*Coastal, Urban/Industrial*
Newcastle Airport	81	26.0	Inland, Rural
Albemarle	146	34.9	Inland, Rural
Durham Tees Valley Airport	37	44.3	Inland, Rural
Loftus	159	49.1	Coastal, Rural
Boulmer	21	59.9	Coastal, Rural
Details of the Site are provided for comparison purposes			

Five consecutive years of hourly-sequential NWP data was acquired based on the Site location and applied in the assessment (2016-2020 inclusive). A wind rose for the period 2016-2020 is presented in Figure 3-4 – showing south-westerlies as the predominate wind in the area. Sensitive land uses are therefore upwind of potential emission releases from the Proposed Installation.

The NWP meteorological data was obtained in .met format from a registered UK vendor. 2016-2020 data was used following recommendations of the vendor, as data pre 2016 relates to a different grid square resolution, not consistent with latter years. Therefore, preference was to ensure consistency and limit potential uncertainty associated with courser data.

A surface roughness value of 0.5m was applied to the meteorological site (i.e. the Site). All other variables refer to those used for the dispersion Site, given the nature of NWP data (section 3.6).

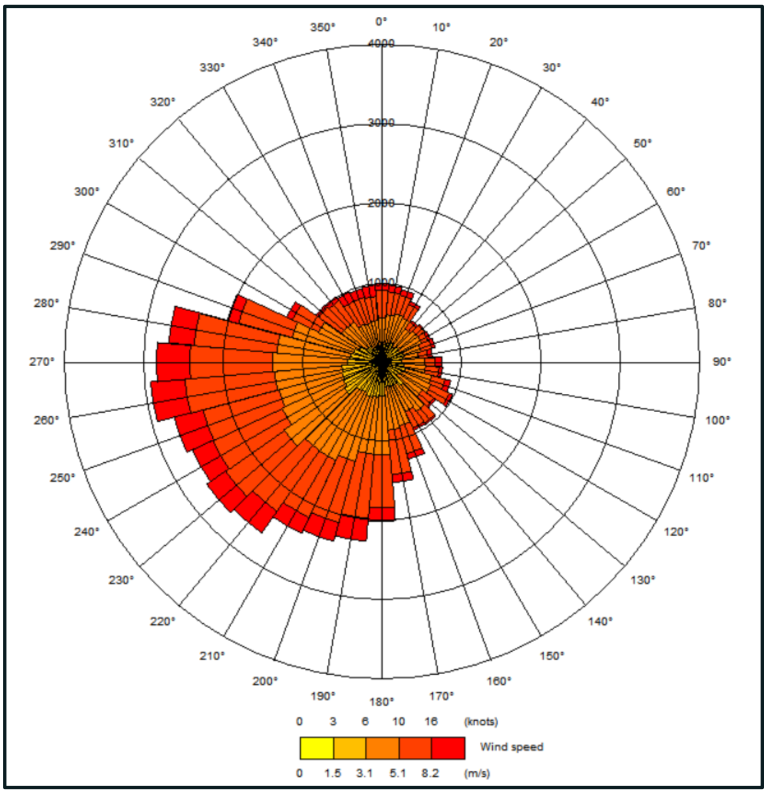

Figure 3-4
2016-2020 NWP Meteorological Data - Sunderland

3.6 Advanced Dispersion Parameters

3.6.1 Surface Roughness

Roughness length, z0, represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

Increasing surface roughness increases turbulent mixing in the lower boundary layer. This can often have conflicting impacts in terms of ground level concentrations:

- the increased mixing can bring portions of an elevated plume down towards ground level, resulting in increased ground level concentrations closer to the emission source; however; and
- the increased mixing increases entrainment of ambient air into the plume and dilutes plume concentrations, resulting in reduced ground level concentrations further downwind from an emission source.

The overall impact on ground level concentration is, therefore, strongly correlated to the distance and orientation of a receptor from the emission source.

Given the coastal nature of the Site, and variance in surrounding topographies across the modelled domain (e.g. urban, rural and sea), a variable surface roughness file has been used. A visualisation of the surface roughness file used in the modelling is presented in Figure 3-5.

A variable surface roughness file spanning 26km x 40km at a 250m grid square resolution centred on the Site was used. Values are interpolated by ADMS v5 between points. Assignment of surface roughness values derive from the 2018 European Commission CORINE (Co-Ordinated Information on the Environment) GIS dataset.

3.6.2 Minimum Monin-Obukhov Length

Urban locations are prone to higher temperatures, specifically during night-time periods, in comparison to surrounding rural areas. This phenonium is known as the ‘urban heat island effect’ and is largely attributed to the enhanced thermal heating capacities of urban surfaces, alongside anthropogenic sources of heat emissions prevalent in urban areas. As such, rural areas often experience stable conditions in comparison to urban locations which experience convective turbulence during night-time conditions. This can ultimately impact dispersion and subsequent ground level concentrations.

In recognition of this, ADMS v5 allows for the minimum Monin-Obukhov length to be defined in order to inform the extent of heat produced in urban areas. A minimum Monin-Obukhov length of 30m has been used which relates to ‘mixed urban/industrial’ and ‘cities and large towns’ – reflective of the study area. The population of Sunderland District is also believed to be <1 million.

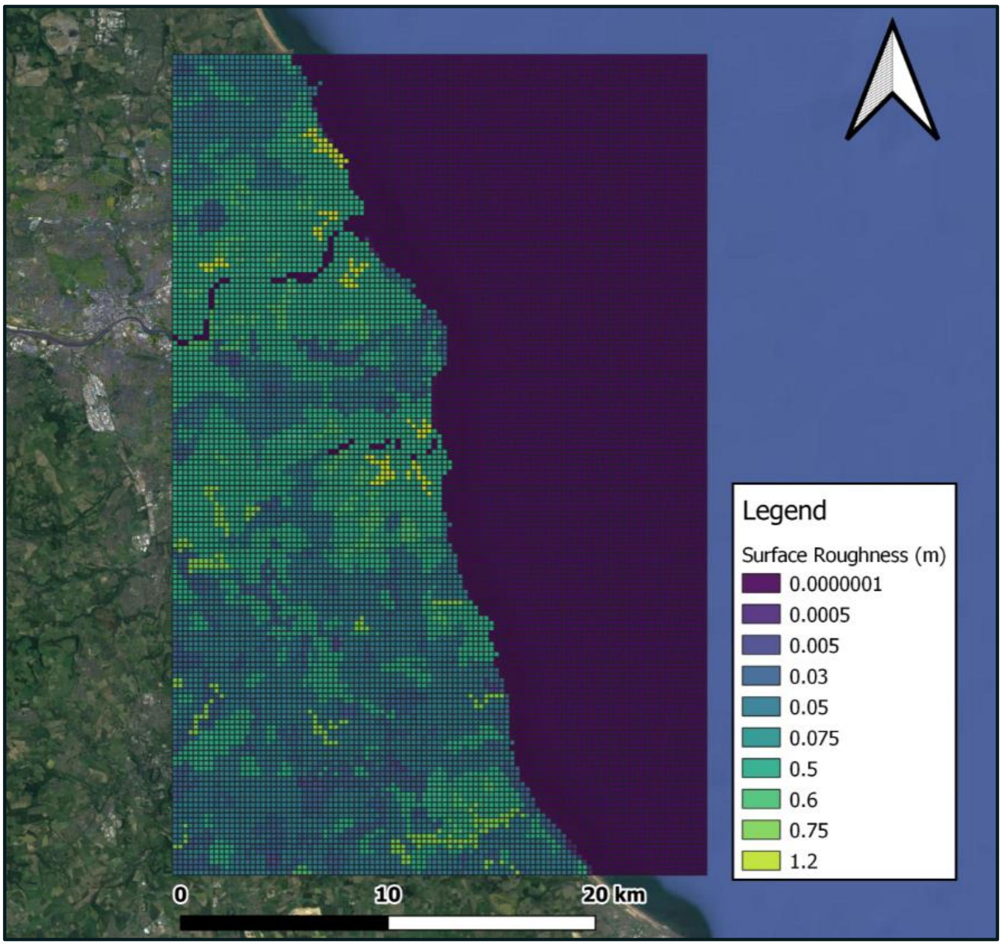

Figure 3-5
Variable Surface Roughness File Visualisation

3.7 Special Treatments

3.7.1 Coastlines

The Site is situated on the North Sea coastline. ADMS v5 includes a Coastline module to account for the effects of the coast on emissions from elevated point sources. This module however has not been validated with reference to monitoring data. The Coastline module has been considered as part of a sensitivity scenario (Section 7.0).

3.8 Model Outputs

Predicted pollutant concentrations are summarised in the following formats:

- process contribution (PC) – the predicted contributions from the installation alone, as output from ADMS v5; and
- predicted environmental concentration (PEC) – the resultant predicted concentration (i.e. PC + ambient background concentration value).

Table 3-5 presents the treatment of averaging periods of relevance to this assessment to arrive at the PEC.

Table 3-5
Model Outputs

Averaging Period	PC	PEC
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
15 minute mean. Not to be exceeded more than 35 times a calendar year	99.9%ile of 15 minute means	PC + 2 x Annual mean background
1 hour mean. Not to be exceeded more than 24 times a calendar year	99.73%ile of 1 hour means	PC + 2 x Annual mean background
24 hour mean. Not to be exceeded more than 3 times a calendar year	99.18%ile of 24 hour means	PC + 2 x Annual mean background
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 daily)	8-hour rolling mean (maximum daily)	PC + 2 x Annual mean background
1 week mean maximum	Maximum 1-week mean	PC + 2 x Annual mean background
Monthly mean maximum	Maximum 1-week mean [(a)]	PC + annual mean background
Calendar year	Annual mean	PC + annual mean background

Table Notes:
(a) 1-week mean in lieu of monthly means, given current limited functionality within ADMS v5. Believed to be conservative on reflection.

3.8.1 Operational Envelope

The assessment has assumed that all proposed plant equipment will be operational for 8760 hours per year (i.e. continuously), whereby no adjustment has been made to the model output. This is precautionary, as the plant will undergo downtime/maintenance on occasions throughout the year resulting in lower output than has been modelled.

3.8.2 Conversion of NO_x to NO_2

In line with EA Air Quality Modelling and Assessment Unit (AQMAU) guidance[16], the assessment has used a NO_x to NO_2 ratio of:

- 70% for long-term average concentrations; and
- 35% for short-term average concentrations.

It should be noted that the use of these conversion ratios is highlighted to be 'worst-case' by the EA.

3.8.3 Calculation of PC to Deposition Rates

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

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

Dry deposition flux (µg/m²/s) = ground level concentration (µg/m³) x deposition velocity (m/s)

The applied deposition velocities for the relevant chemical species are as shown in Table 3-6.

Table 3-6
Applied Deposition Velocities

Chemical Species	Recommended deposition velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.003
SO_2	Grassland	0.012
	Woodland	0.024
HCl	Grassland	0.025
	Woodland	0.06

Critical Loads – Eutrophication

The critical loads for N deposition are recorded in units of kgN/ha/yr. The units are converted from µg/m²/s to units of kgN/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 3-7. These values are then compared to the habitat specific CLo.

Table 3-7
Applied Deposition Conversion Factors

Chemical Species	Conversion factor [µg/m²/s to kgN/ha/year]	
NO_2	of N:	95.9

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/m²/s) by standard conversion factors as presented in Table 3-8.

Table 3-8
Applied Acidification Conversion Factors

Chemical Species	Conversion factor [µg/m²/s to k_{eq}/ha/year]
NO_2	6.84
SO_2	9.84
HCl	8.63

Calculation of PC as a percentage of Acid Critical Load Function

The calculation of the process contribution of N, S and HCL 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 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'*

Where a proposed installation emits HCl emissions, corresponding contributions should be treated as S.

3.9 Assessment of Impact and Significance

3.9.1 Human Receptors

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

- the long-term PC <1% of the long-term AQAL; and
- the short-term PC <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.

3.9.2 Vegetation and Ecosystems

In addition to the AERA guidance, the EA's Operational Instruction 66_12[17] 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 summarised in Table 3-9.

Table 3-9
Vegetation and Ecosystems PC Assessment Screening

Ecological Designation	Short Term	Long Term
European Sites and SSSIs	PC <10% CLe	PC <1% CLe and/or CLo
		PEC <70% CLe and/or CLo [(a)]
Other Conservation Sites	PC <100% CLe	PC <100% CLe and/or CLo
Table Notes: (a) Only assessed if the PC is >1% of CLe and/or CLo		

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[18]. 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;

[17] 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
[18] 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.

3.10 Uncertainty

It is recognised that dispersion modelling is inherently uncertain, particularly in circumstances where verification of modelled predictions relative to real-world condition is not possible. The accuracy of modelled predictions is intrinsically reliant on assessment inputs (i.e. emission rates, exhaust temperatures etc.), and the ability of the dispersion model to replicate real-world conditions.

The model is well validated with observed concentrations for a number of scenarios by the model developers CERC and the EA. Notwithstanding, a sensitivity assessment has been provided in Section 7.0, which explores potential impacts associated with differential input configurations, in accordance with EA guidance.

4.0 BASELINE ENVIRONMENT

4.1 Ambient Air Quality

4.1.1 Local Air Quality Management

SCC, in fulfilment of statutory requirements, has conducted an on-going exercise to review and assess air quality within their administrative area (Review and Assessment). The latest publicly available LAQM report for SCC at the time of writing is the 2019 Annual Status Report[19] (ASR).

SCC do not presently have any declared AQMAs. The nearest AQMA in relation to the Site is situated approximately 16km north west of the Site, titled, Gateshead AQMA No.1, declared by South Tyneside Metropolitan Borough Council. Given the separation distance relative to the Proposed Installation, no further consideration has been given to this AQMA within this assessment.

4.1.2 Nitrogen Dioxide

Monitoring of NO_2 is undertaken at within SCC's jurisdiction via automatic and non-automatic methodologies.

The details and latest set of results (2018) from NO_2 monitoring undertaken within 2km of the Site are presented in Table 4-1 and Table 4-2 respectively, whilst their locations are illustrated in Figure 4-1.

Table 4-1
Local NO_2 Monitoring: Details

Site ID	Method	Site Type	NGR (m)		Distance to Site (km)
			X	Y	
57	Diffusion Tube	Kerbside	439664	557829	1.9
94	Diffusion Tube	Kerbside	439423	556738	1.9
117	Diffusion Tube	Roadside	439901	558514	2.0
119	Diffusion Tube	Roadside	439792	556921	1.6
120	Diffusion Tube	Roadside	439806	557063	1.6
128	Diffusion Tube	Roadside	439707	557312	1.7
129	Diffusion Tube	Roadside	439938	557089	1.4
130	Diffusion Tube	Roadside	439538	557292	1.9
132	Diffusion Tube	Roadside	439661	557901	2.0

Table 4-2
Local NO_2 Monitoring: 2014-2018 Results

Site ID	2018 Data Capture (%)	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
		2014	2015	2016	2017	2018
57	83	35.4	29.0	32.4	26.9	27.1
94	58	35.1	31.7	31.2	29.9	29.6
117	100	35.7	33.9	33.8	29.2	29.1
119	92	26.1	26.6	27.1	23.0	23.7
120	50	29.9	22.1	27.0	27.0	23.0

[19] Sunderland City Council, 2019 Air Quality Annual Status Report, 2019.

Site ID	2018 Data Capture (%)	Annual Mean NO_2 Concentration ($\mu g/m^3$)				
		2014	2015	2016	2017	2018
128	100	30.8	28.3	21.3	29.9	22.3
129	100	20.2	21.1	23.5	19.6	19.4
130	92	24.0	21.4	32.3	23.3	25.0
132	75	39.1	36.2	40.3	40.0	34.2

Annual mean NO_2 concentrations recorded within 2km of the Site were observed to be below the AQAL for the period assessed, with the exception of Site 132 during 2016 and 2017. All sites occupy roadside/kerbside locations, which therefore reflect localised elevated conditions relative to the wider area, whereby concentrations are expected to reduce with distance from road to lower (background) conditions. There appears to be a long-term reduction in NO_2 annual mean concentrations recorded at the majority of the sites assessed, demonstrating local improvements at key locations.

4.1.3 Particulate Matter

PM_{10} concentrations are recorded at two automatic monitoring locations within SCC's jurisdiction, however one only records $PM_{2.5}$.

The details and latest set of results from PM_{10}/$PM_{2.5}$ monitoring undertaken within SCC's jurisdiction are presented in Table 4-3 to Table 4-6, whilst their locations are illustrated in Figure 4-1.

Table 4-3
Local PM_{10}/$PM_{2.5}$ Automatic Monitors: Details

Site ID	Site Type	NGR (m)		PM_{10}/$PM_{2.5}$ Monitored	Distance to Site (km)
		X	Y		
CM1	Kerbside	438928	557151	PM_{10}	2.3
CM2	Urban Background	438149	554478	PM_{10}/$PM_{2.5}$	3.8

Table 4-4
Automatic Monitors: 2014-2018 Annual Mean PM_{10} Results

Site ID	2018 Data Capture %	Annual Mean PM_{10} Concentration ($\mu g/m^3$)				
		2014	2015	2016	2017	2018
CM1	84.5	21.3	20.9	18.0	16.0	19.0
CM2	96.4	13.9	14.6	13.0	12.0	15.0

Table 4-5
Automatic Monitors: 2014-2018 Number of PM_{10} Daily Mean Exceedences

Site ID	2018 Data Capture %	Daily PM_{10} Means in Excess of $50\mu g/m^3$				
		2014	2015	2016	2017	2018
CM1	92.0	3	6	1	2	2
CM2	99.0	3	2	1	0	2

Table 4-6
Automatic Monitors: 2014-2018 Annual Mean $PM_{2.5}$ Results

Site ID	2018 Data Capture %	Annual Mean PM_{10} Concentration ($\mu g/m^3$)

		2014	2015	2016	2017	2018
CM2	85.0	10.0	7.0	6.0	7.0	8.0

For the period assessed (2014-2018), all pollutant concentrations monitored were below the relevant annual mean and short term PM_{10}/$PM_{2.5}$ AQALs.

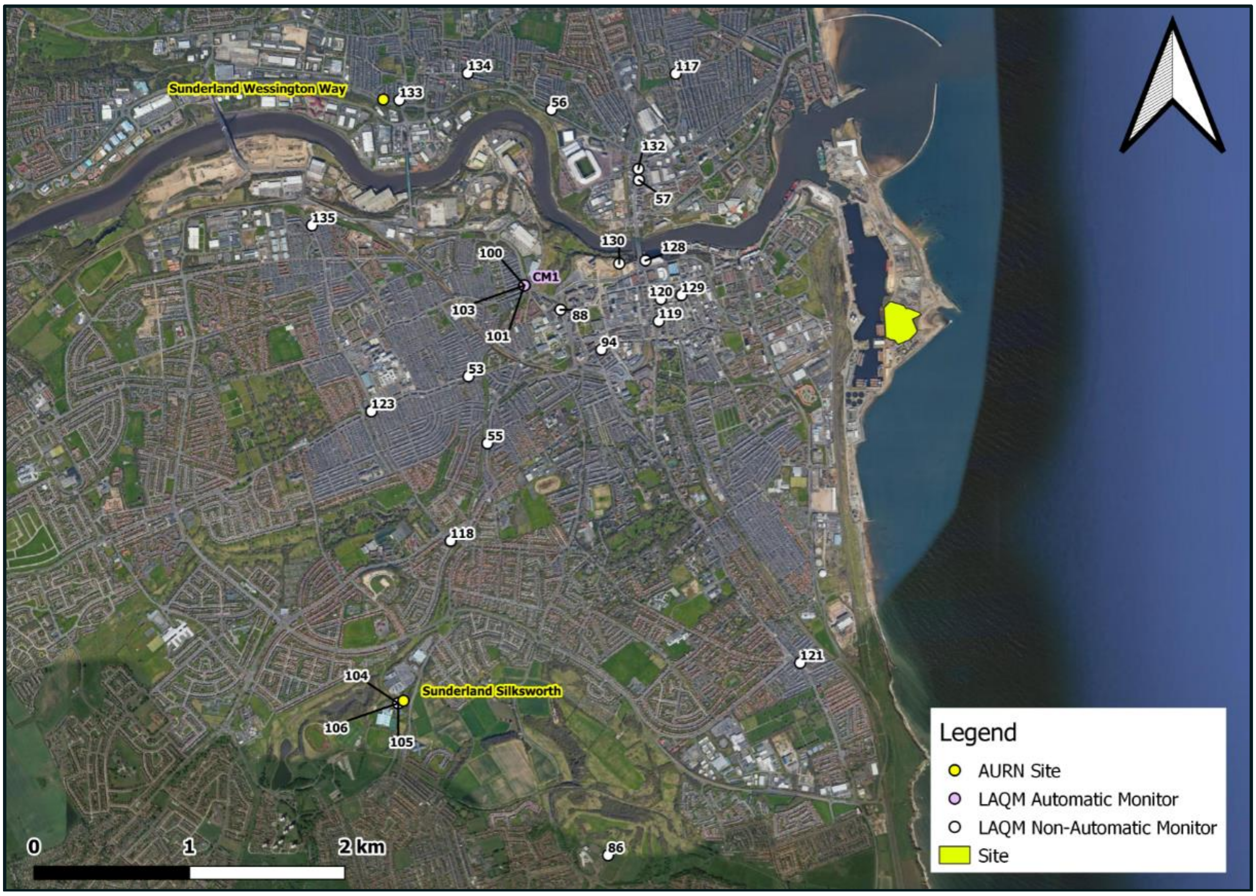

Figure 4-1
Local Monitoring Sites

4.1.4 UK AIR Modelled Data

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 datasets include annual average concentration estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$ using a reference year of 2018 (the year in which comparisons between modelled and monitoring are made). Background pollutant concentrations of CO, Benzene and SO_2 are based upon a 2001 reference year, therefore these values are likely to be overly conservative upon application.

Annual mean background concentrations of NO_2, PM_{10}, $PM_{2.5,}$ CO and SO_2 for the 1km grid squares which cover the modelled domain are presented in Table 4-7. Values refer to reference concentrations (i.e. the year in which comparisons between modelled and monitoring are made), to represent the latest year of ratified data.

Table 4-7
Relevant Defra Mapped Annual Mean Background Concentrations

Pollutant	Reference Year	Annual Mean Concentration (µg/m^3)
NO_2	2018	8.0 – 21.3
PM_{10}	2018	9.3 – 13.4
$PM_{2.5}$	2018	6.0 - 7.5
SO_2	2001	2.2 – 3.9
CO	2001	289 – 393

4.1.5 Benzene

Benzene is monitored at Newcastle Centre AURN, an urban background site located approximately 17km north west of the Site. Preference was therefore to utilise background benzene concentrations recorded at Newcastle Centre AURN over 2001 modelled estimates provided by Defra.

The 2019 annual mean concentration of benzene was 0.42µg/m^3 and has subsequently been used to define background concentrations across the study area.

4.1.6 Metals

Monitoring of metals is currently carried out on behalf of Defra at 25 sites around the UK (termed the Heavy Metals Monitoring Network (HMMN)). The closest location to the Site is Eskdalemuir, a rural background site, located approximately 130km to the north west within Scotland. Given the rural nature of Eskdalemuir, concentrations may not be representative of those experienced in the modelled domain. The closest monitoring site (that also shares similar characteristics of the modelling domain) is Redcar Normanby, located approximately 45km from the Site, whereby the last full data recorded was 2010., as presented in Table 4-8.

Mercury was not monitored at Redcar Normanby, baseline concentrations derive from 2013 concentrations recorded at Sheffield Tinsley, the next closest monitoring site.

Table 4-8
Baseline Metals Monitoring Data

Metal		2019 Annual average (ng/m^3)
Arsenic	As	0.33
Cadmium	Cd	0.09
Chromium (total)	Cr	0.71
Copper	Cu	2.30
Manganese	Mn	4.20
Nickel	Ni	0.47
Lead	Pb	4.50
Vanadium	V	0.68
Antimony	Sb	Not measured
Chromium (VI)	CrVI	0.14 (estimated as 20% of total Cr)
Mercury	Hg	0.003 (2013 data as measurements ceased)

Monitoring is not routinely undertaken for antimony or hexavalent chromium (Cr(VI)) in the UK and therefore no background data for these pollutants is available. The adopted approach of the EA for estimating Cr(VI) is to assume it is a fraction of total Cr, and guidance[20] states that a value of 20% should be applied unless otherwise justified.

4.1.7 Hydrogen Halides

Hydrogen Chloride

Hydrogen chloride is monitored as part of the UK Acid Gases & Aerosol Network (AGANET), which predominately form a collection of rural background monitors. The nearest in relation monitor is Moorhouse located 70km south west to the Site. The annual mean concentration of HCl from the most recent ratified data, i.e. 2015, is 0.19µg/m^3.

Hydrogen Fluoride

In 2005, The Expert Panel on Air Quality Standards (EPAQS) published a draft report entitled '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/m^3 as approximate monthly averages. Therefore 3.5µg/m^3 has been assumed as an appropriate monthly mean background concentration for HF.

4.1.8 Dioxins and PCBs

The Toxic Organic Micro-Pollutants (TOMPs) network measures ambient air concentrations for a range of persistent organic pollutants (POPs) across the UK, including polychlorinated biphenyls (PCBs), polychlorinated-p-dioxins (PCDDs – dioxins), polychlorinated dibenzofurans (PCDFs – furans).

The closest urban monitoring site is the Manchester Law Courts, located 170km to the south-west of the Site. Other sites are located within closer proximity of the Site, however, situated in rural background locations, not consistent with the study area.

The most recent data available from the Manchester Law Courts site is from 2016, as follows:

- sum of dioxins and furans (Toxic Equivalent Quotient): 12fgTEQ/m^3; and
- sum of seven indicator PCB congeners (PCBs 28,52,101,118,138,153,180): 105pg/m^3.

4.1.9 Polycyclic Aromatic Hydrocarbon (PAH)

The measurement of polycyclic aromatic hydrocarbon (PAH) in the Network began in 1991. The closest urban monitoring site is Newcastle Centre located approximately 17km north west of the Site. The 2019 annual mean concentration recorded at this site was 0.15ng/m^3 of benzo(a)pyrene.

4.2 Applied Background Concentrations

The applied annual mean backgrounds in relation to the assessment of human health are provided in Table 4-9 below. Baseline concentrations for short-term averaging periods have assumed to be twice the long-term mean concentration, in accordance with AERA guidance (except for PM_{10} 24-hour mean, as per LAQM.TG(22). This method is considered to derive conservative short-term ambient background concentrations.

[20] Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators. Version 4. Environment Agency, June 2016.

Table 4-9
Applied Long Term Background Concentrations

Pollutant	Unit	Annual Background Concentration	Data Source
NO_2	µg/m³	21.3	Maximum value from the relevant 2018 Defra background maps for the 1km x 1km grid squares covering the modelled domain
PM_{10}	µg/m³	15.0	2019 annual mean concentration recorded at CM2
$PM_{2.5}$	µg/m³	8.0	
SO_2	µg/m³	3.9	Maximum value from the relevant 2001 Defra background maps for the 1km x 1km grid squares covering the modelled domain
CO	µg/m³	393	
HCl	µg/m³	0.19	UK AGNET Moorhouse 2015
HF	µg/m³	3.5 (a)	EPAQS
Benzene	µg/m³	0.42	2019 Newcastle Centre
Mercury	ηg/m³	0.003	2013 Sheffield Tinsley
Antimony	ηg/m³	-	2010 Redcar Normanby HMMN
Cadmium	ηg/m³	0.09	
Arsenic	ηg/m³	0.33	
Chromium (total)	ηg/m³	0.71	
Copper	ηg/m³	2.30	
Lead	ηg/m³	4.50	
Manganese	ηg/m³	4.20	
Nickel	ηg/m³	0.47	
Vanadium	ηg/m³	0.68	
Chromium VI	ηg/m³	0.14	20% of total Cr
PCB	pg/m³	105	TOMPS (Manchester Law Courts 2016)
Dioxins furans	fgTEQ/m³	12	TOMPS (Manchester Law Courts 2016)
B(a)P	ηg/m³	0.15	PAH Network (Newcastle Centre 2019)
Tables Notes: (a) Monthly mean			

4.3 Baseline Conditions at Ecological Receptors

APIS is a support tool for the 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. APIS has been used to provide information on:

- identification of whether the habitats present are sensitive;
- current ambient baseline concentrations (Table 4-10); and

- CLo and current deposition rates for nutrient N and for acidity (Table 4-11 and Table 4-12).

Background concentrations and deposition rates are provided at a 5km grid square resolution across the UK, calculated via a Concentration Based Estimated Deposition (CBED) approach based upon measured-interpolated data for a three-year rolling mean average (presently 2017 – 2019).

APIS provides details of habitats and corresponding CLo/deposition rates for SSSIs, SPAs and SACs via the or 'search by location' function'. For the assessment of locally important designations, appropriate CLo/deposition rates were obtained via the 'site relevant critical load search' using the NGR for the location of maximum PC relative to the assessed habitat. Assumptions regarding the primary habitat type present at each LWS were made based upon online literature and satellite imagery.

The most sensitive habitat listed on APIS has been used to provide a worst case assessment, documented below.

4.3.1 Critical Levels

The baseline concentrations of NO_x and SO_2 are summarised in Table 4-10 below. Values relates to the maximum reported concentration across the habitat.

Table 4-10
Baseline Maximum Annual Mean Concentrations at Ecological Receptors

Site	Habitat	Maximum Annual Mean Concentration (µg/m³)	
		NO_x	SO_2
ER1 (LWS)	Broadleaved, Mixed and Yew Woodland	23.58	1.69
ER2 (LWS)	Broadleaved, Mixed and Yew Woodland	26.17	1.69
ER3 (LWS)	Calcareous grassland	18.74	Null
ER4 (LWS)	Broadleaved, Mixed and Yew Woodland	25.18	Null
ER5 (LWS)	Calcareous grassland	14.26	Null
ER6 (LWS)	Calcareous grassland	14.30	Null
ER7 (SPA/Ramsar)	Acid grassland	26.19	1.32
ER8 (SAC)	Vegetated sea cliffs of the Atlantic and Baltic Coasts	16.31	1.45
Table Notes: Null background values reported on APIS			

4.3.2 Critical Loads

Nutrient N

CLo and baseline deposition rates in relation to nutrient N are provided in Table 4-11.

Nutrient N CLo are habitat/species specific (derived from a range of experimental studies) available via APIS[21]. Given that CLo are often reported in ranges in relation to eutrophication, representing the upper and lower bounds where impacts are perceptible, those values which facilitate a worst-case assessment have been used (i.e. min CLo for nutrient N deposition).

Table 4-11
Relevant N Critical Loads and Baseline Deposition Rates

Site	Habitat/N Class (Most Sensitive)	CLo Range (Min – Max)	CLo Adopted	Current N Load (Max)
		(kgN/ha/yr)		
ER1 (LWS)	Broadleaved woodland	10 – 20	10	25.6
ER2 (LWS)	Broadleaved woodland	10 – 20	10	25.6
ER3 (LWS)	Sub-atlantic semi-dry calcareous grassland	15 – 25	15	Null
ER4 (LWS)	Broadleaved woodland	10 – 20	10	Null
ER5 (LWS)	Sub-atlantic semi-dry calcareous grassland	15 – 25	15	11.6
ER6 (LWS)	Sub-atlantic semi-dry calcareous grassland	15 – 25	15	Null
ER7 (SPA/Ramsar)	Coastal stable dune grasslands – acid type	8 – 10	8	15.0
ER8 (SAC) [(a)]	Coastal stable dune grasslands	8 – 15	8	16.3

Table Notes:
Null background values reported on APIS
(a) No comparable habitat with established critical load estimate available for ER8 (Durham Coast SAC). Underlying Durham Coast SSSI habitats adopted.

According to APIS, the Durham Coast SAC has no comparable habitat with established critical load estimate available. To provide a complete assessment, the most sensitive habitat provided in relation to the underlying Durham Coast SSSI has been adopted.

Acidification

CLo and baseline deposition rates in relation to acidification are provided in Table 4-12.

Acidification CLo are dependent on soil chemistry, as well as habitat type. In the UK, empirical CLo have been assigned at a 1km grid square resolution based upon the mineralogy and chemistry of the dominant soil series present in the grid square, as provided on APIS. These values have been utilised to determine the CLo for each ecological designation of interest to this assessment.

For the assessment of SSSIs, SPAs and SACs, minimum CLo values have been adopted for conservatism, as APIS provides the range of CLo for these designations (i.e. where they span over multiple 1km CLo grid squares). Receptor specific CLo (location of maximum impact) have been used in relation to other ecological sites, where otherwise not provided on APIS (i.e. via the 'site relevant critical load search').

Table 4-12
Relevant Acid Critical Load Functions and Baseline Deposition Rates

Site	Habitat/Acidity Class (Most Sensitive)	Critical Load			Baseline Deposition		Sensitivity
		CLminN	CLmaxS	CLmaxN	N	S	
		(keq/ha/yr)					
ER1 (LWS)	Broadleaved, Mixed and Yew Woodland	0.357	2.127	2.484	1.83	0.18	N
ER2 (LWS)	Broadleaved, Mixed and Yew Woodland	0.357	2.127	2.484	1.83	0.18	N
ER3 (LWS)	Calcareous grassland	N/A	N/A	N/A	Null	0.14	-
ER4 (LWS)	Broadleaved, Mixed and Yew Woodland	0.357	2.366	2.723	Null	0.17	S

Site	Habitat/Acidity Class (Most Sensitive)	Critical Load			Baseline Deposition		Sensitivity
		CLminN	CLmaxS	CLmaxN	N	S	
		(keq/ha/yr)					
ER5 (LWS)	Calcareous grassland	N/A	N/A	N/A	0.83	0.14	-
ER6 (LWS)	Calcareous grassland	N/A	N/A	N/A	Null	0.14	-
ER7 (SPA/Ramsar)	Acid grassland	0.438	1.57	2.008	Null	0.14	S
ER8 (SAC) [(a)]	Acid grassland	0.223	0.81	1.033	1.2	0.2	N

Table Notes:
Null background values reported on APIS
N/A = No comparable habitat with established critical load estimate available
(a) Habitats present at ER8 (Durham Coast SAC) are not sensitive to acidification. Underlying Durham Coast SSSI habitats adopted.

Habitats present on the Durham Coast SAC are not sensitive to acidification, as reported on APIS. To provide a complete assessment, the most sensitive habitat provided in relation to the underlying Durham Coast SSSI has been adopted. Furthermore, assessment of acidification has been scoped out for ER3, ER5 and ER6 (all LWS), as corresponding CLo were not available.

5.0 EMISSIONS TO ATMOSPHERE

Table 5-1 details the extent of emissions sources considered within the dispersion modelling assessment (normal conditions).

Table 5-1
Emission Sources Considered Within the Modelling Assessment (Normal Conditions)

Emission Point	Name	Digitised Source	NGR	
			X	Y
A1	Main Emissions Stack	Point	441363.1	556875.2
A5	Jet Mill Dust Filter	Point	441402.4	556920.0
A6	Tyre Shredding Dust Filter	Point	441300.0	556963.3
A7	Tyre Shredding Dust Filter	Point	441300.1	557009.9

The Proposed Installation (A1) has been considered in-combination with other proposed Emission Points that emit the same pollutants. This includes three dust filters (A5, A6 and A7) – as release particulate matter. All other Emission Points have been excluded as will not influence cumulative modelled predictions. All other Emission Points have been assessed separately – as discussed in Section 1.1.

The Waste Treatment BAT Reference Document (BREF)[22] and associated BAT Conclusion (BATc)[23] documents are considered relevant for the regulation of the three dust filters.

5.1 Emission Release Parameters

Table 5-2 details the emission release input parameters for all sources considered in the assessment. The reference conditions are based upon the principles provided within the relevant documentation governing these emission releases.

Table 5-2
Emission Characteristics (Normal Operation)

Parameter		A1	A5	A6	A7
Stack Internal Diameter (m)		0.97	0.20	0.20	0.20
Stack Exhaust Height (m)		30.0	26.6	11.6	11.6
Volumetric Flow Rate	Normalised (Nm^3/s)	9.741	0.439	0.439	0.439
	Actual (Am^3/s)	11.000	0.471	0.471	0.471
Emission Temperature (°C)		73.0	20.0	20.0	20.0
Oxygen Content (% O_2 dry gas)		6.99	-	-	-
Moisture content (% H_2O)		19.9	0.0	0.0	0.0
Emission Velocity (m/s)		14.9	15.0	15.0	15.0

[22] European Commission. BAT Reference Document for Waste Treatment. 2018.
[23] European Commission. Commission Implementing Decision (EU) 2018/1147 of 10 August 2018. Establishing BAT Conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for Waste Treatment.

Parameter	A1	A5	A6	A7
Actual Conditions: • **A1**: At stack conditions (wet). • **A5, A6 and A7**: At stack conditions (assumed dry). **Reference Conditions:** • **A1**: Temperature: 237.15K, Moisture Content: Dry (0%), Oxygen Content: 11%. • **A5, A6 and A7**: Temperature: 237.15K, Moisture Content: Dry (0%), Oxygen Content: No Correction.				

Emission release characteristics have been sourced from the manufacturer's design and specifications. The emission temperature for all dust filters has assumed to be 20°C (and dry). These emission release characteristics have been applied in all scenarios assessed (excluding the sensitivity assessment).

Sensitivity testing of model inputs parameters used in relation to the Proposed Installation (A1) has been investigated (Section 7.0). As this sensitivity test relates to NO_2 modelled concentration, A1 has only been considered.

5.2 Scenarios

For the purposes of the dispersion modelling assessment, it has been assumed that the Proposed Installation will operate at maximum throughput, 24-hours per day for 365 days per year (i.e. 8,760 hours per year), with emission concentrations at the IED prescribed ELVs. This is likely to represent a precautionary (worst case) approach, as in reality operational hours are likely to be less to account for maintenance and plant downtime. In addition, all other Emission Points considered have assumed to be operational continuously.

Furthermore, the Proposed Installation will be expected to meet, or will already operate under the BAT-C prescribed BAT-AELs via controls, which are lower than those presented in the IED. Use of these IED ELVs is therefore precautionary.

Based upon the IED requirements, the following scenarios have been assessed:

- normal 'daily average' emission limits; and
- half-hourly emission limits.

As discussed in Section 1.1, plausible abnormal emissions have been assessed separately and are excluded from this assessment.

Table 5-3 details the extent of sources considered for each scenario.

Table 5-3
Modelled Scenarios

Emission Point	Name	Scenario	
		Daily Average	Half Hourly
A1	Main Emissions Stack	Section 5.2.1	Section 5.2.2
A5	Jet Mill Dust Filter	Waste Treatment BAT-AELs (Table 5-4)	
A6	Tyre Shredding Dust Filter	Waste Treatment BAT-AELs (Table 5-4)	
A7	Tyre Shredding Dust Filter	Waste Treatment BAT-AELs (Table 5-4)	

The pollutant emission releases for the three dust filters remain unchanged for both scenarios assessed (Daily Average and Half Hourly), as these scenarios relate to the Proposed Installation (A1).

Table 5-4 details the emission concentration and mass emission rates applied within the assessment for the three dust filers. These are based on the emission release characteristics outlined in Table 5-2. As the emission release characteristics are the same for all three dust filters, the emission rate applied for each emission point is the same.

These emission rates are based on the maximum BAT-AELs for dust prescribed within the Waste Treatment BATc. Furthermore, in the absence of any specific BAT-AELs for $PM_{2.5}$ and/or PM_{10}, 100% of the maximum dust BAT-AEL ELV has been assumed to be PM_{10} and $PM_{2.5}$. Application of these assumptions (in-combination) are likely to result in conservative modelled predictions.

Table 5-4
Dust Filter (A5, A6 and A7) Emission Rates

Pollutant	BAT-AEL (mg/Nm^3)	Daily Average Emission Rate	
		Value	Unit
Particulate Matter	5	0.002195	g/s

Detail with regards to the Daily Average and Half-Hourly Emission Limits applied for the Proposed Installation (A1) are discussed below.

5.2.1 Daily Average Pollutant Emission Scenario

Emission rates for the daily average pollutant emission scenario have been calculated from the process conditions detailed above, in conjunction with the ELVs (detailed in Table 2-1). Other pollutant specific issues are discussed in the sections below.

Table 5-5
Daily Average Pollutant Emission Rates

Pollutant	IED ELV (mg/Nm^3)	Daily Average Emission Rate	
		Value	Unit
Nitrogen Dioxide	200	1.94819	g/s
Particulate Matter	10	0.09741	g/s
Sulphur Dioxide	50	0.48705	g/s
Carbon Monoxide	50	0.48705	g/s
Hydrogen Chloride	10	0.09741	g/s
Hydrogen Fluoride	1	0.00974	g/s
Organics (TOC)	10	0.09741	g/s
Group 1 metals (total)	0.05	0.48705	mg/s
Group 2 metals	0.05	0.48705	mg/s
Group 3 metals (total)	0.5	4.87046	mg/s
Dioxins and furans	0.0000001	0.97409	ng/s
PAH (BaP)	0.001	0.00974	mg/s
PCBs	0.005	0.04870	mg/s

Particle Size

Particulate matter (PM) is classified in terms of its aerodynamic diameter; with PM_{10} 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 PM_{10} fraction i.e. PM_{10} includes $PM_{2.5}$.

ELVs prescribed within the IED relate to total PM. To facilitate a conservative assessment, 100% of the ELV has been assumed to be PM_{10} and $PM_{2.5}$.

Total Organic Carbon (TOC)

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 100% of TOCs would be benzene, in line with the AERA guidance.

B(a)P

There is no ELV for PAHs (or B(a)P specifically) provided in the IED. The current Waste Incineration BREF Note (2019) states *"emission levels range … from 0.004 ng/Nm^3 to 1 µg/Nm^3 for BaP".* A value of 0.001mg/Nm^3 (1µg/Nm^3) has been adopted as an ELV in this assessment and is considered to represent a precautionary approach.

Polychlorinated Biphenyl (PCBs)

There is no ELV for PCBs provided in the IED. The current Waste Incineration BREF Note does not contain data on total PCBs, however the 2006 Waste Incineration BREF Note[24], indicates potential PCB emissions of <0.005mg/Nm^3. This value has been applied in the assessment.

Metals

As shown in Table 2-1, the IED emission limits for metals are based on the total aggregated emission rates for three different groups. The following conservative assumptions have been applied:

- the aggregated ELV for Group 1 has been assumed to be Cadmium; and
- the aggregated ELV for Group 2 has been assumed to be Mercury.

Group 3 comprises nine individuals metals[25]. Analysis sponsored by the European Commission in 2004 characterises the elemental metal content of tyre rubber[26]. This data represents a summary of several studies (Malmqvist, 1983; Hewitt and Rashed, 1990; Brewer, 1997; VROM, 1997; Legret and Pagotto, 1999a). The maximum compositional dataset for each metal (mg/kg) has been applied in the assessment (Table 5-6).

Table 5-6
Elemental Metal Content of Tyres: Group 3 Metal Emission Apportionment

Metal	Maximum Concentration (mg/kg)	Maximum % of Group 3	Modelled Emission Rate (mg/s)
Arsenic	0.8	0.3	0.01547
Antimony	2	0.8	0.03868
Copper	29.3	11.6	0.56667
Lead	160	63.5	3.09444
Manganese	2	0.8	0.03868
Nickel	50	19.9	0.96701
Vanadium	1	0.4	0.01934
Total Chromium	6.73	2.7	0.13016

[24] European Commission, Integrated Pollution Prevention and Control Reference Document on the Best Available Techniques for Waste Incineration, August 2006.
[25] Group 3: Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), and Vanadium (V).
[26] European Commission, 2004. Particulates: Measurement of Non-Exhaust Particulate Matter Version 2.0. https://www.groundsmartrubbermulch.com/docs/resources/Measurement-of-non-exhaust-particulate-matter.pdf

The European Commission analysis literature review did not find data for speciated chromium to identify hexavalent chromium; similar studies on use of waste tyre rubber reached the same conclusions[27 28]. However a review by the European Chemicals Agency[29] found that:

> *"In one study Cr VI was specifically reported but the concentration was below LOD … (specified as <0.004 mg/kg)."*

In the absence of other data this maximum value has been adopted. Total Chromium (assumed to be chromium trioxide to be worst case) is also reported by the European Chemicals Agency.

In consideration of all potential scenarios which could be explored to inform the Cr(VI) apportionment with use of these datasets, the following methodology has been applied to result in the maximum Cr(VI) emission rate:

- calculate the % proportion of Cr(VI) (0.004mg/kg) relative to Total Chromium (weighted average - 5.3mg/kg). Use of the weighted average Total Chromium value will result in a greater Cr(VI) apportionment; and
- this % proportion has then been applied to the Total Chromium emission rate derived from use of the European Commission data (Table 5-6) to ensure consistency with the apportionment of the remaining Group 3 metals.

This process is detailed in Table 5-7.

Table 5-7
Elemental Metal Content of Tyres: Cr(VI) Emission Apportionment

European Chemicals Agency			European Commission	Output
Maximum Concentration (mg/kg)		% Cr(VI) vs. Cr	Modelled Emission Rate (mg/s)	
Cr(VI)	Cr		Cr	Cr(VI)
0.004	5.3	0.08	0.13016 (Table 5-6)	0.000098

An alternative approach to apportion Cr(VI) would be to calculate the % proportion of Cr(VI) (0.004mg/kg) relative to all Group 3 metals (Table 5-6), however this results in a lower emission rate in comparison.

5.2.2 Half Hourly Emission Limits Scenario

In addition to the daily average ELVs assessed, the IED also stipulates half-hourly ELVs with the 97th percentile at levels that mirror the daily average levels (with the exception of HF and CO), but with 100th percentile values that are elevated. As such the modelled scenarios include an assessment of elevated emissions that could occur for 3% of half hourly averages as detailed in Table 2-1.

Table 5-8
Half Hourly Pollutant Emission Rates

Pollutant	Emission Concentration (mg/Nm^3)	Half Hourly Emission Rate	
		Value	Units
NO_2	400	3.89637	g/s
PM	30	0.29223	g/s

[27] United States Consumer Product Safety Commission "Final Report on Technical Support Activities for a Screening-Level Risk Assessment of Playground Surfaces (March 2022).
[28] Tests of rubber granules used as artificial turf for football fields in terms of toxicity to human health and the environment Beata Grynkiewicz-Bylina1, Bożena Rakwic1 & Barbara Słomka-Słupik.
[29] European Chemicals Agency, ANNEX XV INVESTIGATION REPORT Investigation into whether substances in infill material cause risks to the environment and human health that are not adequately controlled – prioritisation and preliminary risk assessment (May, 2021).

Pollutant	Emission Concentration (mg/Nm^3)	Half Hourly Emission Rate	
		Value	Units
SO_2	200	1.94819	g/s
CO	150 [(a)]	1.46114	g/s
HCl	60	0.58446	g/s
HF	4	0.03896	g/s

Table Notes:
(a) The half–hourly Limit Value is 100mg/Nm^3, the 10 minute average value is 150mg/Nm^3 which has been assessed.

6.0 PREDICTED AIR QUALITY IMPACTS

6.1 Human Health

Results presented herein relate to the maximum ground level PC predicted across the entirety of the gridded receptors irrespective of relevant exposure, and as such, represents a conservative outlook. PCs predicted at all other locations, including human receptor locations would be lower. Therefore, if impacts can be screened out at the location of maximum ground level PC, impacts at other areas can also be screened out.

6.1.1 Long-Term Impacts

Predicted long-term impacts are summarised in Table 6-1.

Isopleth plots are presented in Appendix C for those PCs that are >1%. For those PCs that cannot be considered insignificant, the PEC is below the AQAL.

Table 6-1
Predicted Maximum Ground Level Long-Term Impacts

AQAL			PC (µg/m^3)	PC % of AQAL	PEC (µg/m^3)	PEC % of AQAL
Pollutant	Period	µg/m^3				
NO_2	Annual	40	5.6	14.1	26.9	67.3
PM_{10}	Annual	40	0.50	1.3	15.5	38.8
$PM_{2.5}$	Annual	20	0.50	2.5	8.5	42.5
Benzene	Annual	5	0.40	8.0	0.82	16.5
Cadmium	Annual	0.005	0.0020	40.2	0.0021	42.0
Mercury	Annual	0.25	0.0020	0.8	n/c	n/c
Antimony	Annual	5	0.00016	<0.1	n/c	n/c
Arsenic	Annual	0.006	0.00006	1.1	0.00039	6.6
Chromium (III)	Annual	5	0.00054	<0.1	n/c	n/c
Chromium (VI)	Annual	0.00025	0.00000040	0.2	n/c	n/c
Copper	Annual	10	0.0023	<0.1	n/c	n/c
Lead	Annual	0.25	0.013	5.1	0.017	6.9
Manganese	Annual	0.15	0.00016	0.1	n/c	n/c
Nickel	Annual	0.02	0.0040	19.9	0.0045	22.3
HF	Monthly	16	0.13	0.8	n/c	n/c
PCB	Annual	0.2	0.00020	0.1	n/c	n/c
PAH (BaP)	Annual	0.00025	0.000040	16.1	0.00019	75.3
Dioxins	Annual	0.0000003	0.0000000040	1.3	0.000000016	5.3

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

6.1.2 Short-Term Impacts

Predicted short-term impacts are summarised in Table 6-2.

Isopleth plots are presented in Appendix C for those PCs that are >10%. The resultant PECs are below the AQAL.

Table 6-2
Predicted Maximum Ground Level Short-Term Impacts

AQAL			PC (µg/m^3)	PC % of AQAL	PEC (µg/m^3)	PEC % of AQAL
Pollutant	Period	µg/m^3				
NO_2	1-Hour (99.79%ile)	200	39.4	19.7	82.0	41.0
PM_{10}	24-Hour (90.4%ile)	50	1.5	3.0	n/c	n/c
Benzene	24-Hour	30	3.0	10.0 (9.97)	n/c	n/c
CO	Daily 8-Hour	10,000	27.1	0.3	n/c	n/c
CO	1-Hour	30,000	39.2	0.1	n/c	n/c
SO_2	24-Hour (99.18%ile)	125	12.5	10.0 (9.98)	n/c	n/c
SO_2	1-Hour (99.73%ile)	350	27.6	7.9	n/c	n/c
SO_2	15-Min (99.9%ile)	266	34.7	13.0	42.5	16.0
HCI	1-Hour	750	7.8	1.0	n/c	n/c
HF	1-Hour	160	0.78	0.5	n/c	n/c
Mercury	1-Hour	7.5	0.039	0.5	n/c	n/c
Antimony	1-Hour	150	0.0031	<0.1	n/c	n/c
Chromium (III)	1-Hour	150	0.010	<0.1	n/c	n/c
Copper	1-Hour	200	0.046	<0.1	n/c	n/c
Manganese	1-Hour	1,500	0.0031	<0.1	n/c	n/c
Vanadium	24-Hour	1	0.0006	0.1	n/c	n/c
PCB	1-Hour	6	0.0039	0.1	n/c	n/c

Table Notes:
n/c = not calculated: following AERA guidance the PEC has not been calculated as all PCs are less than 10%.

6.1.3 Impacts from Half Hourly Emission Limits

In addition to the daily average emission limits assessed, the IED also stipulates half-hourly ELVs with the 97th percentile at levels above the daily average levels. The significance of the half-hourly ELVs has been investigated for those pollutants which have AQALs at hourly resolution or lesser (e.g. NO_2, SO_2, HCl and HF), as greater averaging periods would not be significantly affected by the half-hourly IED ELV.

Table 6-3
Maximum Short Term Impacts using Half-Hourly IED Chapter IV ELVs

AQAL			PC (µg/m^3)	PC % of AQAL	PEC (µg/m^3)	PEC % of AQAL
Pollutant	Period	µg/m^3				
NO_2	1-Hour (99.79%ile)	200	78.8	39.4	121.4	60.7

AQAL			PC (µg/m³)	PC % of AQAL	PEC (µg/m³)	PEC % of AQAL
Pollutant	Period	µg/m³				
CO	1-Hour	30,000	117.7	0.4	n/c	n/c
SO_2	1-Hour (99.73%ile)	350	110.2	31.5	118.0	33.7
SO_2	15-Min (99.9%ile)	266	138.8	52.2	146.6	55.1
HCl	1-Hour	750	47.1	6.3	n/c	n/c
HF	1-Hour	160	3.1	2.0	n/c	n/c

Table Notes:
n/c = not calculated: following AERA guidance the PEC has not been calculated as all PCs are less than 10%.

Maximum ground level PCs are less than 10% of the corresponding AQALs for all emissions with the exception of NO_2 1-hour mean and SO_2 1-hour and 15-min means. However, resultant PECs are below the AQAL despite application of the highest background concentrations contained within the Defra background maps for the 1km squares covering the entirety of the modelled domain.

6.2 Sensitive Ecosystems

6.2.1 Critical Levels

Table 6-4 and Table 6-5 details the predicted impacts on long term and short term CLe, respectively, at the identified ecological sites. The presented PC relates to the maximum modelled impact at each individual ecological designation requiring assessment.

Table 6-4
Predicted Impacts on Long-Term Critical Levels

Site	NOx Annual Mean		SO_2 Annual Mean [a]	
	PC (µg/m³)	PC as % CLe	PC (µg/m³)	PC as % Cle
ER1 (LWS)	0.1	0.3	<0.1	0.2
ER2 (LWS)	0.1	0.3	<0.1	0.2
ER3 (LWS)	0.3	0.9	0.1	0.7
ER4 (LWS)	0.1	0.4	<0.1	0.3
ER5 (LWS)	0.1	0.3	<0.1	0.2
ER6 (LWS)	0.1	0.3	<0.1	0.2
ER7 (SPA/Ramsar)	0.1	0.3	<0.1	0.2
ER8 (SAC)	0.1	0.3	<0.1	0.2

Table Notes:
(a) To provide a conservative assessment, the Cle for annual mean SO_2 at all ecological designations has assumed to be 10µg/m³ which is only applicable where lichens or bryophytes are present.

Table 6-5
Predicted Impacts on Short-Term Critical Levels

Site	NOx 24-Hour Mean		HF 24-Hour Mean		HF Weekly Mean	
	PC (µg/m³)	PC as % CLe	PC HF Daily	PC as % CLe	PC (µg/m³)	PC as % CLe
ER1 (LWS)	2.6	3.4	0.01	0.3	0.004	0.7

Site	NOx 24-Hour Mean		HF 24-Hour Mean		HF Weekly Mean	
	PC (µg/m³)	PC as % CLe	PC HF Daily	PC as % CLe	PC (µg/m³)	PC as % CLe
ER2 (LWS)	2.3	3.1	0.01	0.2	0.003	0.7
ER3 (LWS)	3.7	4.9	0.02	0.4	0.006	1.3
ER4 (LWS)	1.8	2.4	0.01	0.2	0.003	0.6
ER5 (LWS)	1.7	2.2	0.01	0.2	0.003	0.5
ER6 (LWS)	1.9	2.5	0.01	0.2	0.003	0.6
ER7 (SPA/Ramsar)	1.4	1.9	0.01	0.1	0.002	0.5
ER8 (SAC)	1.4	1.9	0.01	0.1	0.002	0.5

All short and long-term PCs are below the relevant designation-specific assessment criteria. Impacts can therefore be considered insignificant, and will cause:

- 'no likely significant effects (alone and in-combination' to the SAC and SPA/Ramsar; and
- 'no significant pollution' for the LWS.

6.2.2 Critical Loads

The predicted impact on CLo at the identified ecological sites for nitrogen and acid deposition are presented in Table 6-6 and Table 6-7, respectively. The presented PC relates to the maximum modelled impact at each individual ecological designation requiring assessment.

Table 6-6
Maximum Predicted Nutrient Nitrogen Deposition Impacts at Ecological Receptors

Site	PC N	Applied CLo (Min)	PC as % C_{Lo}
	(kg/ha/yr)		
ER1 (LWS)	0.018	10	0.2
ER2 (LWS)	0.017	10	0.2
ER3 (LWS)	0.027	15	0.2
ER4 (LWS)	0.023	10	0.2
ER5 (LWS)	0.008	15	0.1
ER6 (LWS)	0.009	15	0.1
ER7 (SPA/Ramsar)	0.010	8	0.1
ER8 (SAC)	0.008	8	0.1

Table 6-7
Acid Deposition Impacts at Ecological Receptors

Site	Sensitivity [a]	Applied CLo (MaxS/MaxN)	PC	PC as % CLo
		(keq/ha/yr)		
ER1 (LWS)	N	2.484	0.0087	0.4
ER2 (LWS)	N	2.484	0.0086	0.3
ER3 (LWS)	No comparable habitat with established critical load estimate available			
ER4 (LWS)	S	2.366	0.0099	0.4
ER5 (LWS)	No comparable habitat with established critical load estimate available			
ER6 (LWS)	No comparable habitat with established critical load estimate available			

Site	Sensitivity [a]	Applied CLo (MaxS/MaxN) (keq/ha/yr)	PC	PC as % CLo
ER7 (SPA/Ramsar)	S	1.57	0.0039	0.2
ER8 (SAC)	N	1.033	0.0036	0.4

Table Notes:
(a) Whether Nitrogen or Sulphur is the principal constraint in the local setting (Critical Load Function)
No assessment undertaken where 'no comparable habitat with established critical load estimate available'

All long-term PCs are below the relevant designation-specific assessment criteria. Impacts can therefore be considered insignificant, and will cause:

- 'no likely significant effects (alone and in-combination' to the SPA/Ramsar; and
- 'no significant pollution' for the LWS.

7.0 SENSITIVITY ASSESSMENT

Table 7-1 presents details of the scenarios undertaken as part of sensitivity testing of input parameters, developed in accordance with EA guidance.

The meteorological data which results in the maximum GLC (for both annual and 1-hour means (99.79%ile) was first identified (Sensitivity 0). Year 2020 was found to result in the highest annual mean GLC, whereas 2016 was found to result in the highest 1-hour (99.79%ile) mean GLC. These years were then used as input for the residual sensitivity scenarios (Sensitivity 1 - 10).

The results are summarised in Table 7-2 for NO_2 annual and 1-hour (99.79%ile) means.

Table 7-1
Sensitivity Scenarios Modelled

Scenario	Parameter Changed
Sensitivity 0	Year of maximum GLC (2016 ST / 2020 LT)
Sensitivity 1	Increased temperature by 30°C. Normalised flow (and mass emission) remains as baseline
Sensitivity 2	Decreased temperature by 30°C. Normalised flow (and mass emission) remains as baseline
Sensitivity 3	Increased discharge velocity by 15%. Normalised flow (and mass emission) remains as baseline
Sensitivity 4	Decreased discharge velocity by 15%. Normalised flow (and mass emission) remains as baseline
Sensitivity 5	Composite surface roughness (0.5m)
Sensitivity 6	Composite surface roughness (1m)
Sensitivity 7	Composite surface roughness (0.02m)
Sensitivity 8	No buildings
Sensitivity 9	Coastline module
Sensitivity 10	AERMOD dispersion code

Table 7-2
Model Sensitivity Assessment

Scenario	1-Hour Mean NO_2 99.79%ile (200µg/m³)				Annual Mean NO_2 (40µg/m³)			
	Max GLC (µg/m³)	PC as % of AQAL	PEC (µg/m³)	PEC as % of AQAL	Max GLC (µg/m³)	PC as % of AQAL	PEC (µg/m³)	PEC as % of AQAL
0	41.2	20.6	83.8	41.9	6.5	16.2	27.8	69.4
1	40.0	20.0	82.7	41.3	6.0	15.1	27.3	68.4
2	42.9	21.5	85.5	42.8	7.2	18.0	28.5	71.3
3	38.7	19.3	81.3	40.6	6.0	15.1	27.3	68.3
4	43.4	21.7	86.0	43.0	7.0	17.5	28.3	70.7
5	27.6	13.8	70.2	35.1	5.3	13.3	26.6	66.6
6	24.5	12.3	67.1	33.6	5.3	13.4	26.6	66.6
7	54.3	27.2	96.9	48.5	5.2	12.9	26.5	66.2
8	18.5	9.3	61.1	30.6	1.9	4.7	23.2	58.0
9	11.9	5.9	54.5	27.2	1.5	3.8	22.8	57.0
10	22.9	11.5	65.6	32.8	3.4	8.4	24.7	61.7

None of the variations in the dispersion modelling input parameters investigated leads to a breach of the NO_2 AQALs. PECs are still considered to be well below (<75%) despite application of the highest background concentration contained within the 2018 Defra background maps (2018-reference year) for the 1km squares covering the entirety of the modelled domain. The level of variation is broadly applicable to other pollutants, on the basis of which it can be concluded that the level of variation in the parameters investigated would not lead to exceedences of the AQALs.

8.0 CONCLUSIONS

The conclusions of the detailed atmospheric dispersion modelling assessment of emissions to air on sensitive human and ecological receptor locations arising from the Proposed Installation (in-combination with other relevant proposed Emission Points) are as follows:

- there are no predicted exceedances of air quality standards for the protection of human health at the point of maximum ground level impact for any of the scenarios assessed;
- the predicted impact on designated sensitive habitats are considered insignificant according to EA guidance and will cause:
    - 'no likely significant effects (alone and in-combination)' to the SAC and SPA/Ramsar; and
    - 'no significant pollution' for the LWS.

Appendix A - Modelling Checklist

Table A-1
Modelling Checklist

Item	Yes / No	Details / Reason for Omission
Location map	Yes	Figure 3-1
Site plan	Yes	Figure 3-1
Pollutants modelled and relevant environmental standards	Yes	Section 2.2 and 2.3
Details of modelled scenarios	Yes	Section 5.2
Details of relevant ambient concentrations	Yes	Section 2.3
Model description and justification	Yes	Section 3.1
Special model treatment used	Yes	Section 3.7 and 3.8
Table of emission parameters used	Yes	Table 2-1 and Table 5-2
Details of modelled domain and receptors	Yes	Section 3.2
Details of meteorological data used	Yes	Section 3.5
Details of terrain treatment	Yes	Section 3.3
Details of building treatment	Yes	Section 3.4
Model uncertainty and sensitivity	Yes	Section 7.0
Assessment of impacts	Yes	Section 6.0
Contour plots	Yes	Appendix C
Model input files	Yes	Appendix B

Appendix B - Model Files (Electronic Only)

Wastefront Sunderland_v2.1 Schedule 5_Normal_16.zip

Appendix C - Process Contribution Isopleths

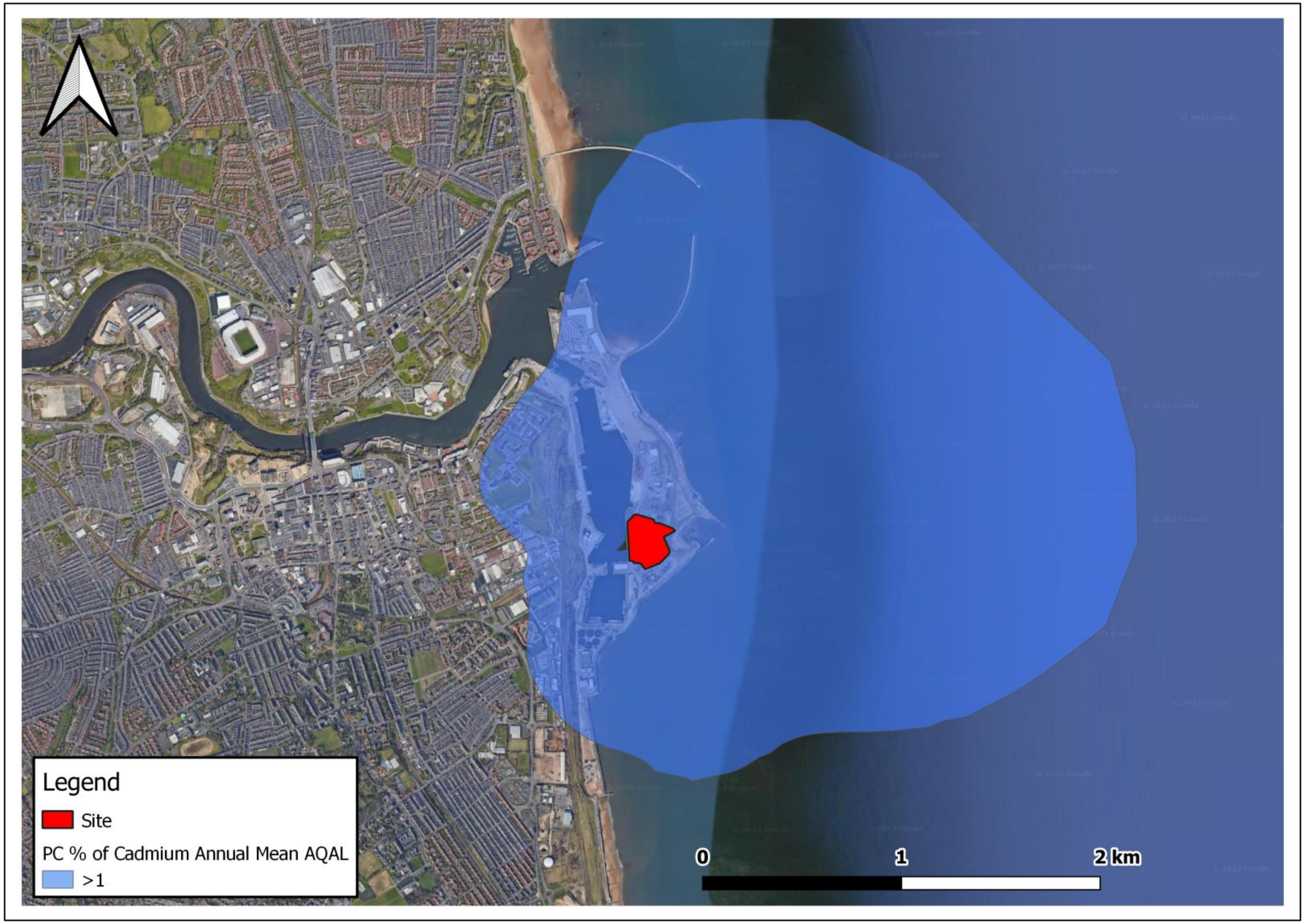

Figure C-1
Cadmium Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-2
NO_2 Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-3
Dioxins Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-4
Benzene PCs as a % of the AQAL: Isopleth

Figure C-5
Arsenic Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-6
$PM_{2.5}$ Annual Mean PCs as a % of the AQAL: Isopleth

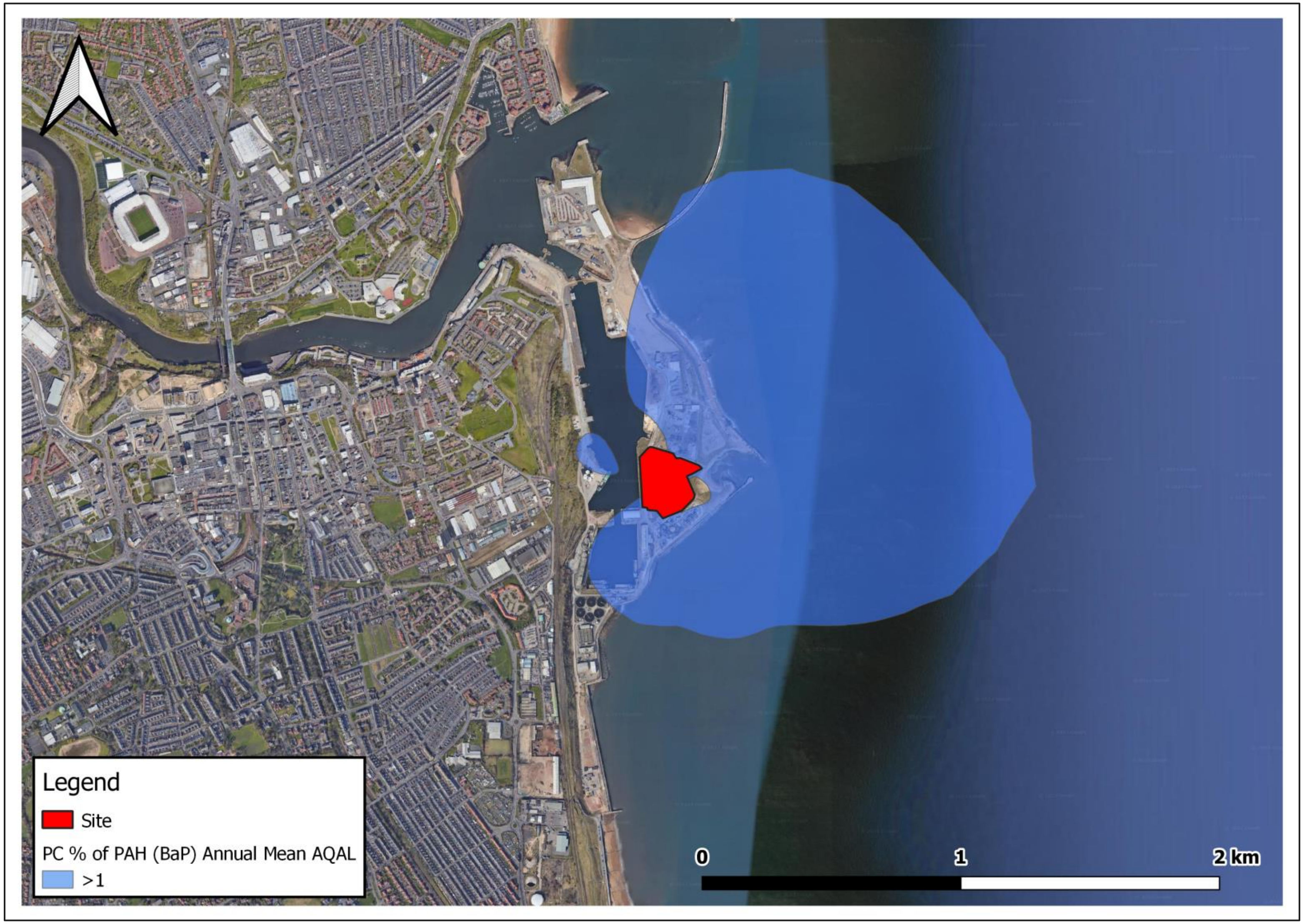

Figure C-7
PAH (BaP) Annual Mean PCs as a % of the AQAL: Isopleth

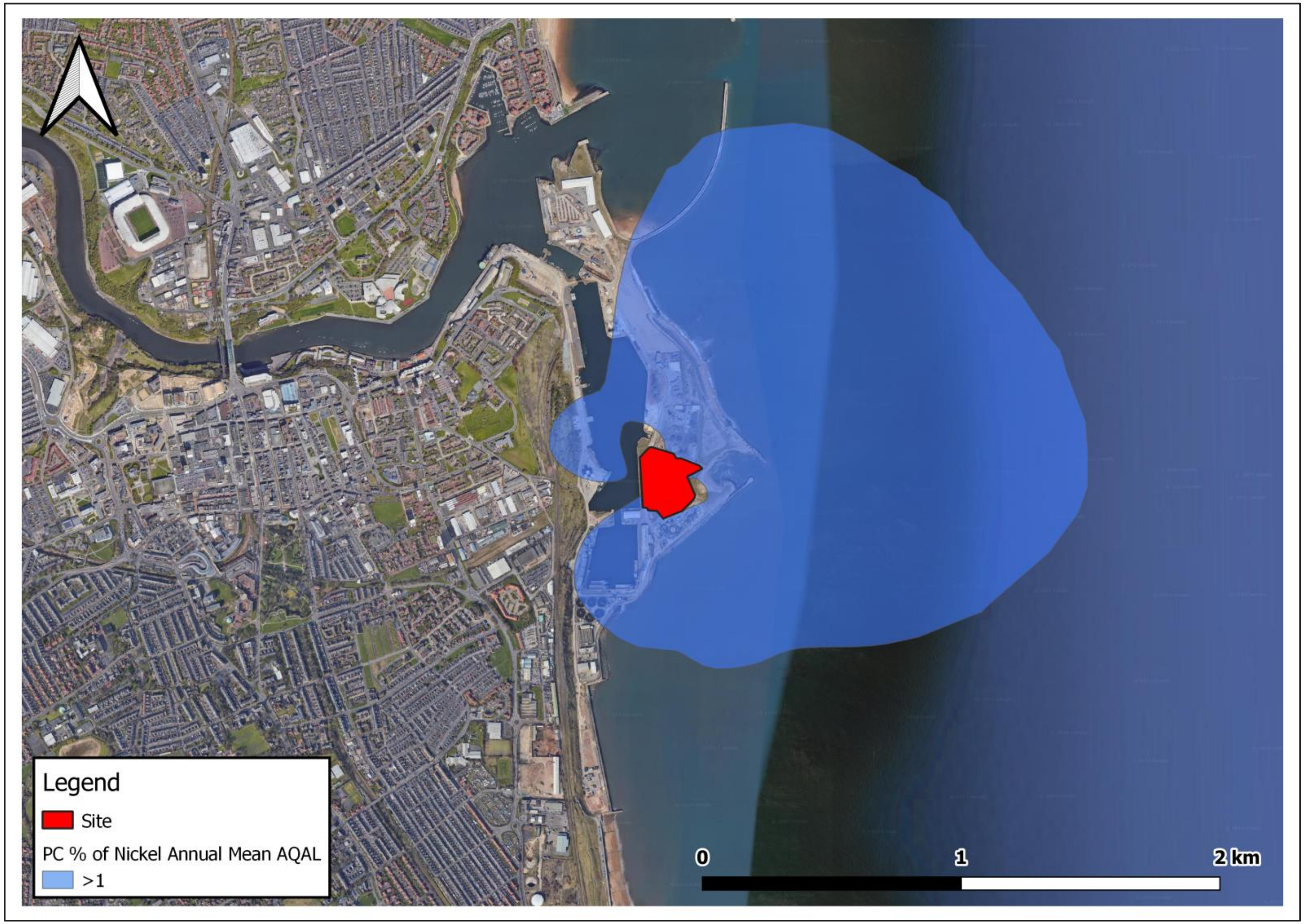

Figure C-8
Nickel Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-9
Lead Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-10
PM_{10} Annual Mean PCs as a % of the AQAL: Isopleth

Figure C-11
NO_2 1-Hour Mean (99.79%ile) PCs as a % of the AQAL: Isopleth

Figure C-12
SO_2 15-Min Mean (99. 9%ile) PCs as a % of the AQAL: Isopleth

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