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Consulting Engineers Limited

Killoch ERP

Barr Environmental Ltd

Process Emissions Modelling

ENGINEERING ─┼─ CONSULTING

Document approval

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Contents

1 Introduction

This Appendix has been produced to set out the approach taken to modelling emissions from the Energy Recovery Park (ERP) (the Proposed Development) at Killoch, East Ayrshire. The operation of the Proposed Development would include the release of emissions from a single point source, the stack. This appendix refers only to these process emissions.

This Appendix sets out the approach taken to modelling the emissions from the stack. This includes all model inputs and justifications where appropriate. Finally, this Appendix presents the results of the modelling.

When considering the impact of the operation of the Proposed Development on human health, the predicted atmospheric concentrations have been compared to the Air Quality Assessment Levels (AQALs) for the protection of human health. When considering the impact on ecosystems, the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that deposition of emissions over a prolonged period can have nitrification and acidification impacts. An assessment of the long-term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

It should be noted that this assessment does not consider the air quality impacts resulting from the abnormal operation of the Proposed Development; nor does it consider the impact from pollutants accumulating within the environment, both of which are considered separately

2 Air Quality Standards, Objectives and Guidelines

Limits and targets related to ambient air are set in European legislation namely the Air Quality Directive (Directive 2008/50/EC), the fourth daughter Directive (Directive 2004/107/EC). In Scotland these are described in the Air Quality Standards (Scotland) Regulations (2010) and subsequent amendments.

The UK Government and the devolved administrations are required under the Environment Act (1995) to produce a national air quality strategy. This was last reviewed and published in 2007. The Air Quality Strategy (AQS) sets out the UK's air quality objectives and recognises that action at national, regional and local level may be needed, depending on the scale and nature of the air quality problem. This includes additional targets and limits for 15-minute sulphur dioxide and 1,3-butadiene and more stringent requirements for benzene and PAHs, known as AQS Objectives. In 2015 the Scottish Government produced "Cleaner Air for Scotland – the Road to a Healthier Future" (CAFS Strategy). This sets out how the Scottish Government proposed to reduce air pollution further to protect human health and fulfil Scotland's legal responsibilities. This included a commitment to include in legislation World Health Organisation (WHO) guideline values as Scottish objectives for PM_{10} and $PM_{2.5}$. For other pollutants SEPA set Environmental Assessment Levels (EALs) in the IPPC H1 (2003) document. On other projects SEPA has requested that those EALs set out in the Environment Agency's environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[1] ("Air Emissions Guidance") are also considered. The long-term and short-term EALs from these documents have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within IPPC H1, the Air Emissions Guidance and the Air Pollution Information System (APIS).

2.1.1 Regulated pollutants

2.1.2 Nitrogen dioxide

All combustion processes produce nitric oxide and nitrogen dioxide, known by the general term of nitrogen oxides. In general, the majority of the nitrogen oxides released is in the form of NO, which then reacts with ozone in the atmosphere to form nitrogen dioxide. Of the two compounds, nitrogen dioxide is associated with adverse effects on human health, principally relating to respiratory illness. The World Health Organisation has stated that "many chemical species of nitrogen oxides exist, but the air pollutant species of most interest from the point of view of human health is nitrogen dioxide".

The single greatest source of nitrogen oxides in Scotland is road transport. According to the most recent annual report from the National Atmospheric Emissions Inventory (NAIE)[2], in 2018 road transport accounted for 48% of Scottish emissions. High levels of nitrogen oxides in urban areas are almost always associated with high traffic densities.

The AQS includes two objectives, which are also included in the Air Quality Standards (Scotland) Regulations.

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

[2]   NAIE Air Pollution Inventories for England, Scotland, Wales and Northern Ireland: 1990-2018, DEFRA.

- A limit for the one-hour mean of 200 µg/m³, not to be exceeded more than 18 times a year (equivalent to the 99.79th percentile).
- A limit for the annual mean of 40 µg/m³.

The AQS includes objectives for the protection of sensitive vegetation and ecosystems of 30 µg/m³ for the annual mean nitrogen oxides. This is also included in the Air Quality Standards (Scotland) Regulations. The APIS also defines the daily mean Critical Level as 75 µg/m³ for nitrogen oxides.

2.1.3 Sulphur dioxide

Sulphur dioxide is predominantly released by the combustion of fuels containing sulphur. Emissions of sulphur dioxide in Scotland have reduced by 96% since 1990, due to a reduction in the number of coal-fired combustion plants, the installation of flue gas desulphurisation plants on a number of large coal-fired power stations and the reduction in sulphur content of liquid fuels. The AQS contains three objectives for the control of sulphur dioxide:

- A limit for the 15-minute mean of 266 µg/m³, not to be exceeded more than 35 times a year (the 99.9th percentile).
- A limit for the one hour mean of 350 µg/m³, not to be exceeded more than 24 times a year (the 99.73rd percentile).
- A limit for the daily mean of 125 µg/m³, not to be exceeded more than 3 times a year (the 99.2nd percentile).

The hourly and daily objectives are included in the Air Quality Standards (Scotland) Regulations.

The Air Quality Standards (Scotland) Regulations includes a Critical Level for the protection of vegetation and ecosystems of 20 µg/m³ as an annual mean and as a winter average. This is also set out in the AQS. In addition, APIS defines the long-term Critical Level as 10 µg/m³ where lichens or bryophytes are present.

2.1.4 Particulate matter

Concerns over the health impact of solid matter suspended in the atmosphere tend to focus on particles with a diameter of less than 10 µm, known as PM_{10}. These particles have the ability to enter and remain in the lungs. Various epidemiological studies have shown increases in mortality associated with high levels of PM_{10}, although the underlying mechanism for this effect is not yet understood. According to the NAIE, significant sources of PM_{10} include industrial processes (28%), residential, commercial and public sector combustion (25%), agriculture (17% and transport (15%). The most significant sources of $PM_{2.5}$s differs slightly with residential, commercial and public sector combustion the greatest (44%).

The AQS includes two objectives for PM_{10} specific to Scotland which go beyond those set out in European legislation and are transposed into Scottish legislation in the Air Quality (Scotland) Amendment Regulations (2002).

- A limit for the annual mean of 18 µg/m³.
- A daily limit of 50 µg/m³, not to be exceeded more than 7 times a year (the 98.1st percentile) in Scotland.

The annual mean objective set in the Air Quality (Scotland) Amendment Regulations (2002) is more stringent than the WHO guideline value. Therefore, there was no reason to further amend the objective to comply with the commitment set out in the CAFS Strategy.

The AQS included some provisional objectives for particulate matter with a diameter less than 2.5 µm (PM$_{2.5}$). These have been replaced by an objective based on the WHO guideline values for PM$_{2.5}$ of 10 µg/m³ as an annual mean.

2.1.5 Carbon monoxide

Carbon monoxide is produced by the incomplete combustion of fuels containing carbon. By far the most significant sources are residential, commercial public sector combustion (43%), industrial combustion (27%) and transport (23%). Carbon monoxide can interfere with the processes that transport oxygen around the body, which can prove fatal at very high levels.

Concentrations in the Scotland and indeed the UK are well below levels at which health effects can occur. The AQS includes the following objective for the control of carbon monoxide, which is also included in the Air Quality Standards (Scotland) Regulations:

- A limit for the 8-hour running mean of 10 mg/m³.

The Environment Agency's Air Emissions Guidance also defines the hourly EAL as 30 mg/m³.

2.1.6 Hydrogen chloride

There are no objectives for hydrogen chloride contained within the AQS or Air Quality Standards (Scotland) Regulations. However, IPPC H1 (2003) defines the long-term EAL of 20 µg/m³ and the short-term EAL of 800 µg/m³. The Environment Agency's Air Emissions Guidance also defines the short-term EAL as 750 µg/m³, but provides no long-term EAL. For the purpose of this analysis the most conservative of the IPPC H1 (2003) or Air Emissions Guidance limit has been applied.

2.1.7 Hydrogen fluoride

There are no objectives for hydrogen fluoride contained within the AQS or Air Quality Standards (Scotland) Regulations. However, IPPC H1 (2003) defines the short term EAL of 250 µg/m³. No long term EAL is provided in IPPC H1.

The Environment Agency's Air Emissions Guidance defines the short-term EAL as 160 µg/m³ and the long-term EAL as 16 µg/m³. In addition, Critical Levels for the protection of vegetation and ecosystems of 5 µg/m³ as a daily mean and 0.5 µg/m³ as a weekly mean concentration are set for hydrogen fluoride, these have not been derived from a European Directive and are not contained in IPPC H1 (2003).

For the purpose of this analysis the most conservative of the IPPC H1 (2003) or Air Emissions Guidance limit has been applied.

2.1.8 Ammonia

There are no objectives for ammonia contained within the AQS or Air Quality Standards (Scotland) Regulations. However, IPPC H1 (2003) defines the short term EAL as 2,500 µg/m³ and the long term EAL as 180 µg/m³. These are the same as those set in the Environment Agency's Air Emissions Guidance.

APIS also provides Critical Levels for the protection of vegetation and ecosystems. This level is 3 µg/m³ as an annual mean, reduced to 1 µg/m³ where lichens or bryophytes are present.

For the purpose of this analysis the most conservative of the IPPC H1 (2003) or Air Emissions Guidance limit has been applied.

2.1.9 Volatile Organic Compounds (VOCs)

A variety of VOCs could be released from the stacks, of which benzene and 1,3-butadiene are included in the AQS and monitored at various stations around the UK. The AQS includes the following objectives for Scotland for the running annual mean:

- Benzene – 3.25 µg/m³; and
- 1,3-butadiene – 2.25 µg/m³.

The Environment Agency's Air Emissions Guidance includes a short-term EAL for benzene, calculated from occupational exposure. This is a limit of 195 µg/m³ for an hourly mean. There are no short-term EALs for 1,3-butadiene.

2.1.10 Metals

Lead is the only metal included in the AQS or Air Quality Standards (Scotland) Regulations. Lead can have many health effects, including effects on the synthesis of haemoglobin, the nervous system and the kidneys. Emissions of lead in the UK have declined by 97% since 1990, due principally to the virtual elimination of leaded petrol.

The AQS includes objectives to limit the annual mean to 0.5 µg/m³ by the end of 2004 and to 0.25 µg/m³ by the end of 2008. Only the first objective is included in the Air Quality Standards (Scotland) Regulations.

The fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes target values for arsenic, cadmium and nickel. However, the preamble to the Directive makes it clear that the use of these target values is relatively limited. Paragraph (5) states:

"The target values would not require any measures entailing disproportionate costs. Regarding industrial installations, they would not involve measures beyond the application of best available techniques (BAT) as required by Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (5) and in particular would not lead to the closure of installations. However, they would require Member States to take all cost-effective abatement measures in the relevant sectors."

And paragraph (6) states:

"In particular, the target values of this Directive are not to be considered as environmental quality standards as defined in Article 2(7) of Directive 96/61/EC and which, according to Article 10 of that Directive, require stricter conditions than those achievable by the use of BAT."

Although these target values have been included in the assessment, it is important to note that the application of the target values would not have an effect on the design or operation of the Proposed Development. The Proposed Development will be designed in accordance with BAT and will include cost effective methods for the abatement of arsenic, cadmium and nickel, including the injection of activated carbon and a fabric filter.

Emissions limits have been set in permits for similar facilities for a number of heavy metals which do not have air quality standards associated with them. The EALs for these metals, and lead, are summarised in Table 1. The Environment Agency published updated EALs in its Air Emissions Guidance. These take into account the guidelines for metals and metalloids in ambient air for the

protection of human health produced by EPAQS in 2009, after the publication of IPPC H1. Some metals included in this assessment do not have EALs.

Table 1: Environmental Assessment Levels (EALs) for Metals

Metal	AAD Limit / Target (ng/m³)	EALs (ng/m³) – IPPC H1 (2003)		EALs (ng/m³) – EA 2016	
		Long-term	Short-term	Long-term	Short-term
Arsenic	6	200	15,000	3	-
Antimony	-	5,000	150,000	5,000	150,000
Cadmium	5	5	1,500	5	-
Chromium (II & III)	-	5,000	150,000	5,000	150
Chromium (VI)	-	100	3,000	0.0002	-
Cobalt	-	200	6,000	-	-
Copper	-	10,000	200,000	10,000	200
Lead	500 (250 AQS Target)	-	-	250	-
Manganese	-	1,000	1,500,000	150	1500
Mercury	-	250	7,500	250	7.5
Nickel (total nickel compounds in the PM$_{10}$ fraction)	20	-	-	20	-
Nickel and inorganic compounds (as Ni)	-	1,000	30,000	-	-
Nickel, organic compounds (as Ni)		10,000	300,000	-	-
Thallium	-	1,000	30,000	-	-
Vanadium	-	5,000	1,000	5	1

2.1.11 Dioxins and furans

Dioxins and furans are a group of organic compounds with similar structures, which are formed as a result of combustion in the presence of chlorine. Principal sources include steel production, power generation, coal combustion and uncontrolled combustion, such as bonfires. The Municipal Waste Incineration Directive and UK legislation imposed strict limits on dioxin emissions in 1995, with the result that current emissions from incineration of municipal solid waste in the UK in 1999 were less than 1% of the emissions from waste incinerators in 1995. The Waste Incineration Directive, now

included in the IED, imposed even lower limits, reducing the limit to one tenth of the previously permitted level and the BAT-AELs in the Waste Incineration BREF reduce the limits even more.

One dioxin, 2,3,7,8-TCDD, is a definite carcinogen and a number of other dioxins and furans and dioxin-like PCBs are considered to be possible carcinogens. A tolerable daily intake for dioxins, furans and dioxin-like PCBs of 2 pg I-TEQ per kg bodyweight per day has been recommended by the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment. This is expressed as the total intake from inhalation and ingestion. The Human Health Risk Assessment (Appendix 8.5 of the EIAR) considers the intake from inhalation and ingestion and compares this to the tolerable daily intake.

2.1.12 Polychlorinated biphenyl (PCBs)

PCBs have high thermal, chemical and electrical stability and were manufactured in large quantities in the UK between the 1950s and mid 1970s. Commercial PCB mixtures, which contained a range of dioxin-like and non-dioxin like congeners, were sold under a variety of trade names, the most common in the UK being the Aroclor mixtures. UK legislative restrictions on the use of PCBs were first introduced in the early 1970s.

Although now banned from production current atmospheric levels of PCBs are due to the ongoing primary anthropogenic emissions (e.g. accidental release of products or materials containing PCBs), volatilisation from environmental reservoirs which have previously received PCBs (e.g. sea and soil) or incidental formation of some congeners during the combustion process.

There are no objectives for PCBs contained within the AQS. However, IPPC H1 (2003) defines the short-term EAL as 6 µg/m³ and the long-term EAL as 0.2 µg/m³. These are the same as those set in the Environment Agency's Air Emissions Guidance.

A number of PCBs are considered to possess dioxin like toxicity and are known as dioxin-like PCBs. The effect of emissions of dioxins, furans and dioxin-like PCBs has been assessed within the Human Health Risk Assessment (Appendix 8.5 of the EIAR). .

2.1.13 Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The best known PAH is benzo[a]pyrene (B[a]P). The AQS included an objective to limit the annual mean of B[a]P to 0.25 ng/m³. This goes beyond the requirements of European Directives, since the fourth Daughter Directive on air quality (Commission Decision 2004/107/EC) includes a target value for B[a]P of 1 ng/m³ as an annual mean which was transposed in to Scottish legislation via the Air Quality Standards (Scotland) Regulations .

2.1.14 Summary

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as AQALs. Table 2 to Table 4 summarise the air quality objectives and guidelines used in this assessment. The sources for each of the values can be found in the preceding sections.

Table 2:   Air Quality Assessment Levels (AQALs)

Pollutant	AQAL (μg/m³)	Averaging period	Frequency of exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AAD Limit Value
	125	24 hours	3 times per year (99.18th percentile)	AAD Limit Value
Particulate matter (PM10)	50	24 hours	7 times per year (98.1stpercentile)	AQS Objective (Scotland)
	18	Annual	-	AQS Objective (Scotland)
Particulate matter (PM2.5)	10	Annual	-	AQS Objective (Scotland)
Carbon monoxide	10,000	8 hours, running	-	AAD Limit Value
	30,000	1 hour	-	EA (2016)
Hydrogen chloride	750	1 hour		EA (2016)
	20	Annual	-	IPPC H1 (2003)
Hydrogen fluoride	160	1 hour	-	EA (2016)
	16	Annual	-	EA (2016)
Ammonia	2,500	1 hour	-	IPPC H1 (2003)
	180	Annual	-	IPPC H1 (2003)
Benzene	3.25	Annual	-	EA (2016)
	195	1 hour	-	IPPC H1 (2003)
1,3-butadiene	2.25	Annual, running	-	AQS Objective
PCBs	6	1-hour	-	IPPC H1 (2003)
	0.2	Annual	-	IPPC H1 (2003)
PAHs	0.00025	Annual	-	AQS Objective

Table 3:   Air Quality Assessment Levels for Metals

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Cadmium	1,500	1 hour	IPPC H1 (2003)
	5	Annual	AAD Target Value
Thallium	30,000	1 hour	IPPC H1 (2003)

Pollutant	AQAL (ng/m³)	Averaging Period	Source
	1,000	Annual	IPPC H1 (2003)
Mercury	7,500	1 hour	IPPC H1 (2003)
	250	Annual	IPPC H1 (2003)
Antimony	150,000	1 hour	IPPC H1 (2003)
	5,000	Annual	IPPC H1 (2003)
Arsenic	15,000	1 hour	IPPC H1 (2003)
	3	Annual	EA (2016)
Cadmium	1,500	1 hour	IPPC H1 (2003)
	5	Annual	IPPC H1 (2003)
Chromium (II & III)	150,000	1 hour	IPPC H1 (2003)
	5,000	Annual	IPPC H1 (2003)
Chromium (VI)	3,000	1 hour	IPPC H1 (2003)
	0.2	Annual	EA (2016)
Cobalt	6,000	1 hour	IPPC H1 (2003)
	200	Annual	IPPC H1 (2003)
Copper	200,000	1 hour	IPPC H1 (2003)
	10,000	Annual	IPPC H1 (2003)
Lead	-	1 hour	-
	250	Annual	AQS Target
Manganese	1,500,000	1 hour	IPPC H1 (2003)
	150	Annual	EA (2016)
Nickel	30,000	1 hour	IPPC H1 (2003)
	20	Annual	AAD Limit
Vanadium	1,000	1 hour	IPPC H1 (2003)
	5,000	Annual	IPPC H1 (2003)

Table 4:   Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75	Daily mean	APIS
	30	Annual mean	AAD Critical Level
Sulphur dioxide	10	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity	IPPC H1 / APIS
	20	Annual mean	AAD Critical Level

Pollutant	Concentration (µg/m³)	Measured as	Source
		for all higher plants	
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance / APIS
	0.5	Weekly mean	Air Emissions Guidance / APIS
Ammonia	1	Annual mean for sensitive lichen communities and bryophytes and ecosystems where lichens and bryophytes are an important part of the ecosystems integrity	APIS
	3	Annual mean for all higher plants	APIS

2.2 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance (2016) (LAQM.TG(16))[3] explains where the AQALs apply.

Table 5: Guidance on Where AQALs Apply

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
Annual mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
24-hour mean and 8-hour mean	All locations where the annual mean AQAL would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.

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[3] Department for Environment, Food and Rural Affairs, Local Air Quality Management Technical Guidance (TG16), February 2018, available at: https://laqm.defra.gov.uk/documents/LAQM-TG16-February-18-v1.pdf

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
1-hour mean	All locations where the annual mean and 24 and 8-hour mean AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Source: Box 1.1 LAQM.TG(16)

3 Sensitive Receptors

As part of this assessment, the predicted Process Contribution (PC) at the point of maximum impact and a number of sensitive receptors has been evaluated.

3.1 Human sensitive receptors

The human sensitive receptors identified for assessment are displayed in Figure 1 of Annex E and listed in Table 6. These have been identified to represent residential properties, farms and schools within 3 km of the application site.

Table 6:   Human Sensitive Receptors

ID	Name	Location		Distance from the stack (m)
		X (m)	**Y (m)**	
R1	Pennymore	248884	621862	1,986
R2	Findlayston	250156	620463	2,447
R3	Holehouse	249570	619960	1,876
R4	Bardarroch Farm	247095	618531	1,833
R5	Hunterston	246279	621583	1,958
R6	Creoch House	247623	620969	720
R7	Ardmhor	247622	621096	847
R8	The Bungalow	248878	621553	1,741
R9	Knowe View	249895	620966	2,290
R10	Gallowlee Avenue	250241	620991	2,628
R11	Torview	248903	620814	1,311
R12	Mote Toll	249057	620619	1,388
R13	Netherton	250498	620708	2,817
R14	North Palmerston	250712	620043	3,002
R15	The Bungalow	250697	619775	3,018
R16	Hilltop	249337	619489	1,791
R17	Auchness Cottage	248554	619646	1,034
R18	Lessnessock Bungalows	248306	619658	838
R19	Provost Mount	247711	619866	389
R20	Clydenoch	247290	619272	1,072
R21	Oakmount	246933	618100	2,293
R22	The Cottage	246426	619844	1,355
R23	Shield	245279	619923	2,461
R24	Briardene Cottage	245108	621159	2,762
R25	Alpbach	245396	621344	2,564
R26	House Fox Hollow	246050	621589	2,136

ID	Name	Location		Distance from the stack (m)
		X (m)	Y (m)	
R27	Gowanpark House	247977	622321	2,082
R28	Gargowan	247489	622329	2,087
R29	Steelpark	248503	622454	2,335
R30	Corselet	248450	621650	1,576
R31	Cawhillan	249237	621552	1,998
R32	Slatehole	249078	623077	3,133
R33	Barturk	249516	622088	2,568
R34	Low Carston	249945	621752	2,684
R35	Hill of Ochiltree	250016	621331	2,538
R36	High Tarbeg	248610	620713	1,003
R37	Back o'Hill	250217	619821	2,537
R38	South Palmerston	250786	619544	3,150
R39	Glenconner	249470	619350	1,972
R40	Barquharrie	250259	619079	2,800
R41	Burnockstone	250123	618685	2,872
R42	Lessnessock	248181	619633	776
R43	Barlosh Court	248066	618199	2,085
R44	High Plyde	248906	617702	2,816
R45	Burnton	249367	617985	2,806
R46	Bardarroch	247373	618715	1,578
R47	Killochside	247386	620184	339
R48	Treesmax	246082	618570	2,348
R49	East Tarelgin	246665	619857	1,125
R50	Macquittiston	246068	619250	1,932
R51	Lochmark Farm	245065	619639	2,723
R52	West Tarelgin	246137	620014	1,599
R53	Chipperlaigan	245629	620735	2,143
R54	Hoodston	245937	620972	1,920
R55	Speirston	246330	621261	1,714
R56	Braehead	246828	621708	1,704
R57	Trabbochburn	246676	621872	1,924
R58	Laigh Tarbeg	248730	620437	1,029
R59	Tarelgin Smokehouse	246115	619720	1,690
R60	Gemmell's Garden Centre	245656	621496	2,406
R61	Ochiltree Primary School	250523	621047	2,915
R62	Watson	249647	621013	2,073

ID	Name	Location		Distance from the stack (m)
		X (m)	Y (m)	
R63	Ochiltree Corner - Ayr Road	250682	621117	3,087
R64	Ochiltree Corner - Main Street 1	250727.5	621184	3,150
R65	Ochiltree Corner - Main Street 2	250744	621172.7	3,162
R66	Ochiltree Corner - Main Street 3	250768	621191	3,191
R67	Ochiltree Corner - Main Street 4	250795	621180	3,213
R68	Ochiltree Corner - Mill Street	250797.5	621197.5	3,221
R69	Ochiltree Corner - Burnock Street 1	250829	621179	3,246
R70	Ochiltree Corner - Burnock Street 2	250839	621151	3,247

3.2 Ecological sensitive receptors

A study was undertaken to identify the following sites of ecological importance in accordance with the following screening distances laid out in IPPC H1:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 15 km of the site;
- Sites of Special Scientific Interest (SSSIs) within 15 km of the site; and
- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the site.

Where habitats are found to cover a large area, multiple receptor points have been selected along the boundary of the ecological site closest to the Proposed Development. The sensitive ecological receptors identified as a result of the study are displayed in Figure 2 of Annex E and are listed in Table 7.

There are multiple sites which have been designated for geological reasons, rather than ecological reasons. These sites are included within Table 7 but do not require further assessment because they are not home to any sensitive habitats or species which could potentially be impacted by emissions from the Proposed Development.

A review of the citation, APIS website and discussions with the project ecologist has been undertaken to determine if lichens or bryophytes are an important part of the ecosystem's integrity at each site. If lichens or bryophytes are present, the more stringent Critical Level has been applied as part of the assessment.

Table 7: Ecological Sensitive Receptors

ID	Site	Design ation	Closest point to site		Distance from stack at closest point (km)	Lichens/ bryo-phytes present
			X (m)	Y (m)		
European designated sites						
E1	Airds Moss (A)	SAC	257461	624709	10.7	Yes
E2	Airds Moss (B)		259302	622825	11.9	Yes
E3	Muirkirk and North Lowther Uplands (A)	SPA	257418	624779	10.7	Yes

ID	Site	Designation	Closest point to site		Distance from stack at closest point (km)	Lichens/ bryo-phytes present
			X (m)	Y (m)		
E4	Muirkirk and North Lowther Uplands (B)		258148	623668	11.0	Yes
E5	Muirkirk and North Lowther Uplands (C)		254645	633055	14.6	Yes
E6	Muirkirk and North Lowther Uplands (D)		256052	628981	12.1	Yes
E7	Muirkirk and North Lowther Uplands (E)		263344	620377	15.6	Yes
UK designated sites						
E8	River Ayr Gorge	SSSI	245808	624721	4.9	Yes[1]
E9	Muirkirk Uplands (A)	SSSI	256110	628851	12.0	Yes
E10	Muirkirk Uplands (B)	SSSI	255179	631719	13.7	Yes
E11	Barlosh Moss (A)	SSSI	248300	618674	1.7	Yes
E12	Barlosh Moss (B)	SSSI	249141	618711	2.1	Yes
E13	Dalmellington Moss	SSSI	246342	606588	13.7	Yes
E14	Bogton Loch	SSSI	246565	605778	14.5	Yes
E15	Martnaham Loch and Wood	SSSI	240321	617764	7.8	Yes
Locally designated sites						
E16	Burnock Water	LWS	249957	620139	2.2	No
E17	Ancient woodland 1	AW	247689	620602	0.3	Yes*
E18	Ancient woodland 2	AW	248241	620679	0.7	Yes*
E19	Ancient woodland 3	AW	248648	620755	1.1	Yes*
E20	Ancient woodland 4	AW	248260	621326	1.2	Yes*
E21	Ancient woodland 5	AW	245905	620304	1.8	Yes*
UK designated sites – geological reasons						
E22	Afton Lodge	SSSI	241591	625802	8.3	No
E23	Stairhill	SSSI	245153	624132	4.6	No
E24	Howford Bridge	SSSI	251274	625107	6.0	No
E25	Greenock Mains	SSSI	263280	627653	17.2	No
E26	Lugar Sill	SSSI	259823	621527	12.2	No
E27	Nith Bridge	SSSI	259294	614130	13.1	No
E28	Benbeoch	SSSI	248945	608874	11.4	No
E29	Dunaskin Glen	SSSI	245597	609165	11.3	No
Notes: AW = ancient woodland						

ID	Site	Design ation	Closest point to site		Distance from stack at closest point (km)	Lichens/ bryo-phytes present
			X (m)	**Y (m)**		

(1) Lichens not listed as a site feature but considered likely- conservatively have assumed 'yes'.

(*) For the ancient woodland sites, there is no botanical data available. It is likely that there are some lichen and bryophyte species present, but they are unlikely to be a key part of the system integrity. To be conservative, their presence has been assumed and this has been further assessed by the ecologist if necessary.

4 Dispersion Modelling Methodology

4.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.2, developed and supplied by Cambridge Environmental Research Consultants (CERC) This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and permitting purposes to the satisfaction of the SEPA and local authorities. In line with the SEPA's requirements, a sensitivity study has also been undertaken using the USEPA AERMOD model. AERMOD has been run through ADMS 5.2 to ensure that the model inputs are consistent. This prevents variances between model inputs as a result of using the two different models.

4.2 Emission limits

The IED (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector BREF become binding as BAT guidance, as follows.

- Article 15, paragraph 2, of the IED requires that Emission Limit Values (ELVs) are based on best available techniques, referred to as BAT.
- Article 13 of the IED, requires that 'the Commission' develops BAT guidance documents (referred to as BREFs).
- Article 21, paragraph 3, of the IED, requires that when updated BAT conclusions are published, the Competent Authority (in England this is the Environment Agency) has up to four years to revise permits for facilities covered by that activity to comply with the requirements of the sector specific BREF.

The Waste incineration BREF was adopted by the European IPPC Bureau in December 2019. The BREF introduces BAT-Associated Emission Limits (BAT-AELs) which are more stringent than the ELVs currently set out in the IED. It has been assumed that stack emissions from the Proposed Development will comply with the BAT-AELs, or the emission limits from Annex VI Part 3 of the IED for waste incineration plants where BAT-AELs are not applicable.

4.3 Source and emissions data

The principal inputs to the model with respect to the process emissions to air from the Proposed Development are presented in Table 8 and Table 9. This data is based a thermal input capacity of approximately 54.7 MWth, assuming the combustion of 18.2 tonnes per hour of residual waste with a net calorific value of 10.5 MJ/kg

Table 8: Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	75

Item	Unit	Value
Internal diameter	m	1.8
Location	m, m	247717.7, 620254.9
Flue Gas Conditions		
Temperature	°C	130
Exit moisture content	% v/v	16.22%
	kg/kg	0.116
Exit oxygen content	% v/v dry	7.39%
Reference oxygen content	% v/v dry	11%
Volume at reference conditions (dry, ref O_2)	Nm³/s	30.53
Volume at actual conditions	Am³/s	39.46
Exit velocity	m/s	15.51

Table 9: Stack Emissions Data

Pollutant	Conc. (mg/Nm³)		Release rate (g/s)	
	Daily or periodic	Half-hourly	Daily or periodic	Half-hourly
Oxides of nitrogen (as NO_2)	120	400	3.663	12.210
Sulphur dioxide	30	200	0.916	6.105
Carbon monoxide	50	100(1)	1.526	3.053
Fine Particulate Matter (PM)[2]	5	30	0.153	0.916
Hydrogen chloride	6	60	0.183	1.832
Volatile organic compounds (as TOC)	10	20	0.305	0.611
Hydrogen fluoride	1	4	0.031	0.122
Ammonia	10	-	0.305	-
Cadmium and thallium	0.02	-	0. 611 (mg/s)	-
Mercury	0.02	0.035	0. 611 mg/s	1.068 (mg/s)
Other metals[3]	0.3	-	9.158 (mg/s)	-
Dioxins and furans	0.06 ngITEQ/Nm3	-	1.831 (ng/s	-
Benzo(a)pyrene (PaHs) [4]	0.0002	-	6.1051 µg/s	-
PCBs[5]	0.005	-	0.153 (mg/s)	-
Notes:				
All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.				
(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.				

Pollutant	Conc. (mg/Nm³)		Release rate (g/s)	
	Daily or periodic	**Half-hourly**	**Daily or periodic**	**Half-hourly**

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM10 or PM2.5 for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) Figure 8.121 of the Waste Incineration BREF shows that the maximum B[a]P concentration from an ERF was 0.4 µg/Nm3 (dry, 11% oxygen, 273K). However, this was an outliner, being twice as high as the next highest concentration, and was recorded at a German plant. The maximum monitored concentration of B[a]P for a UK plant was 0.2 µg/m³. In lieu of any specific limit, this has been assumed to be the emission concentration for the ERP.

(5) The 2006 Waste Incineration BREF provided a range of values for PCB emissions to air from European municipal waste incineration plants. This stated that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). The latest version of the BREF (2019) does not include any data on the emissions of total PCBs. In lieu of any specific limit, the data from 2006 Waste Incineration BREF has been assumed to be the emission concentration for the Proposed Development.

The Proposed Development will be designed to operate at full capacity and is not anticipated to have significant changes in loading. Therefore, it is appropriate to base the assessment on the design point of the system. If the Proposed Development continually operated at the half-hourly limits, the daily limits would be exceeded. The Proposed Development is designed to achieve the daily limits and as such will only operate at the short-term limits for short periods on rare occasions.

4.4   Other Inputs

4.4.1   Modelling domain

Various model runs have been undertaken at various grid sizes and spatial resolutions. To assess the impact at human receptors, a grid size of 7.5 km x 7.5 km has been used with a spatial resolution of 75 m. This covers the extent of all chosen human receptors and uses a spatial resolution of less than 1.5 times the stack height, which is the widely accepted method. To improve accuracy of emissions closer to the stack, and surrounding the point of maximum impact, a nested grid approach has been used for the smaller area of 2 km x 2 km at a spatial resolution of 20 m.

Reference should be made to Figure 3 of Annex E for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 10.

Table 10: Modelling Domain

Grid Quantity	Value
Human receptor grid	
Grid spacing (m)	75
Grid points	101
Grid Start X (m)	243950
Grid Finish X (m)	251450

Grid Quantity	Value
Grid Start Y (m)	616550
Grid Finish Y (m)	624050
Human receptor nested grid	
Grid spacing (m)	20
Grid points	101
Grid Start X (m)	246700
Grid Finish X (m)	248700
Grid Start Y (m)	619300
Grid Finish Y (m)	621300

4.4.2 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Prestwick meteorological station for the years 2015 – 2019. The data was obtained from ADM Limited. Prestwick airport is approximately 13 km to the north west of the Proposed Development and is the closest and most representative meteorological recording station available. Prestwick meteorological station is located at an elevation of 20 metres above sea level, compared to approximately 156 m at the Proposed Development. However, this is not expected to significantly affect the meteorological parameters used for dispersion modelling. Five years of data have been used to take into account inter-annual fluctuations in weather conditions. Wind roses from Prestwick Airport for each year can be found in

Figure 4 of Annex E.

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 1 m, the model default, for the dispersion site. This is deemed most representative of the surrounding rural area of the site. The meteorological site uses a minimum Monin-Obukhov length of 10 m, appropriate for 'small towns' due to the business park and residential areas of Prestwick to the south and west but predominantly rural landscapes to the north and east.

The surface roughness length can be selected in ADMS for both the dispersion site and the meteorological site. The surface roughness has been set to 0.3 m (agricultural areas max) for both the dispersion site and meteorological site. This is deemed most appropriate for the open fields and rural surroundings of the dispersion site and the large areas of open space to the north and east of the meteorological site. The sensitivity of the modelling to the choice of surface roughness has been considered in Section 6.1.

Table 11: Meteorological parameters summary

Parameter	Dispersion site	Meteorological site
Minimum Monin-Obukhov length	1 m	10 m
Surface roughness	0.3 m	0.3 m

4.4.3 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The IPPC H1 recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS 5.2 user guide also states that buildings less than one third of the stack height will not have any effect on dispersion.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 12. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 5 of Annex E. The main building has been selected as the boiler hall.

Table 12: Building Details

Buildings	Centre point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler Hall	247799.2	620290.5	45	28	55	68
ACC, Turbine hall and technical building	247765	620301	21	16.7	110.5	68
Bunker	247836	620309.4	33.5	53.8	27.6	68
Tipping hall	247870.6	620313	16	35.5	40	68
FGT	247747.5	620270.5	30	27.5	55	68
Visitor centre	247806	620273.5	12	9	55	68

4.4.4 Terrain

CERC recommends that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has deemed that the effect of terrain should be taken into account in the modelling.

A terrain file large enough to cover the output grid of points was created using Ordnance Survey Terrain 50 data. Due to the use of two modelling domains for human receptors and to cover all of the ecological receptors, three sizes of terrain files have been used. The parameters of the terrain files used are outlined in Table 13. Reference should be made to Figure 3 of Annex E for a graphical representation of the modelling domain and terrain files used. The sensitivity of the modelling to the use of terrain has been considered in Section 6.1

Table 13: Terrain File Parameters

Parameter	Value
Terrain file used with human receptor grid	
Grid Start X	243400
Grid Finish X	252000
Grid Start Y	616000
Grid Finish Y	624600
Resolution	64 x 64
Terrain file used with human receptor nested grid	
Grid Start X	246000
Grid Finish X	249500
Grid Start Y	618400
Grid Finish Y	621900
Resolution	64 x 64
Terrain file used with ecological receptor grid	
Grid Start X	230000
Grid Finish X	268000
Grid Start Y	600000
Grid Finish Y	638000
Resolution	64 x 64

4.5 Chemistry

The Proposed Development will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as NOx. In the atmosphere, nitric oxide will be converted to nitrogen dioxide in a reaction with ozone which is influenced by solar radiation. Since the AQALs are expressed in terms of nitrogen dioxide, it is important to be able to assess the conversion rate of nitric oxide to nitrogen dioxide.

Ground level NOx concentrations have been predicted through dispersion modelling. Nitrogen dioxide concentrations reported in the results section assume 70% conversion from NOx to nitrogen dioxide for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario in the Environment Agency methodology, which is accepted for use by SEPA. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

4.6 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in Appendix 8.1 - Baseline Analysis. For short term averaging periods, the background concentration has been assumed to be twice the long-term ambient concentration following the methodology set out in IPPC H1.

5 Stack Height Assessment

When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope. This analysis has been carried out for the emissions from the stack of the Proposed Development.

The following parameters were kept constant:

- model – ADMS 5.2
- buildings – included;
- dispersion site surface roughness value – 0.3 m;
- meteorological site surface roughness – 0.3 m;
- dispersion site Monin-Obukhov length – model default;
- meteorological site Monin-Obukhov length – 10 m;
- terrain – included at 64 x 64 resolution; and
- meteorological data used – Prestwick 2015 to 2019.

The stack height modelling has been analysed to take into consideration the following key pollutants and averaging periods which align with the AQALs for the protection of human health:

- Annual mean nitrogen dioxide impacts;
- Annual mean particulate matter (as PM_{10}) impacts;
- Annual mean particulate matter (as $PM_{2.5}$) impacts;
- Annual mean chromium VI impacts;
- 99.79[th] percentile of 1-hour nitrogen dioxide impacts;
- 99.9[th] percentile of 15-minute mean sulphur dioxide impacts.

5.1 Analysis

The following graphs show the annual mean (Graph 1) and short term mean (Graph 2) ground level concentration based on an emission rate of 1 g/s from the Proposed Development.

Graph 1: Stack height analysis – annual mean at 1 g/s emission rate
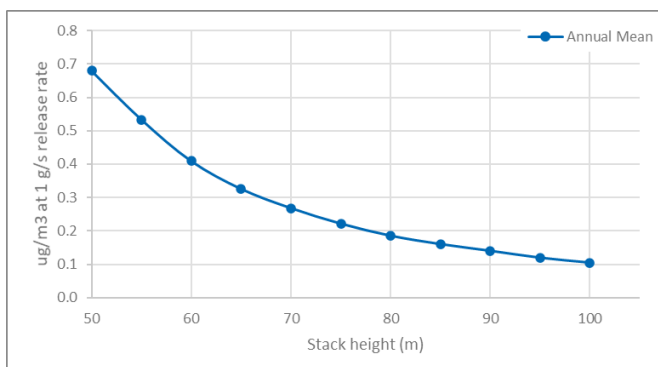
Graph 2: Stack height analysis – short term at 1 g/s emission rate
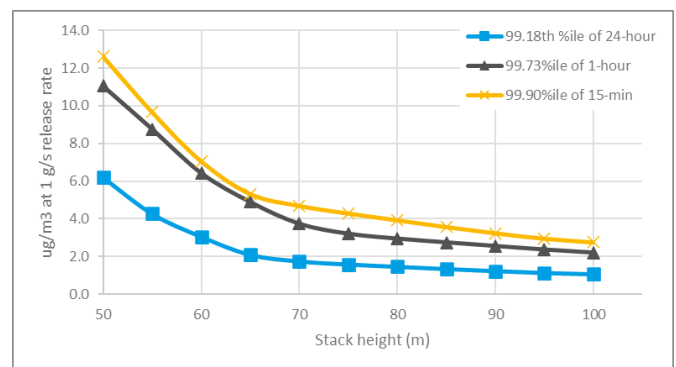
As shown, for annual mean results the change is gradual with height and there is not an obvious step change in slope. However, the results of the short term percentiles clearly show that the rate of reduction in concentration with increased stack height slow down at 65 m. This would therefore be the minimum suggested stack height. However, further assessment of the impacts of pollutants in comparison to the relevant AQALs is required, as follows.

The following graphs shows the predicted impact of the Proposed Development at the point of maximum impact for the range of stack heights considered.

Graph 3: Annual mean at daily ELV - nitrogen dioxide
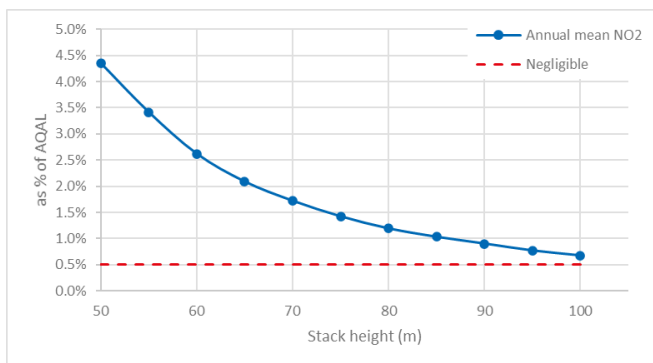
Graph 4: Annual means at daily ELVs – other pollutants
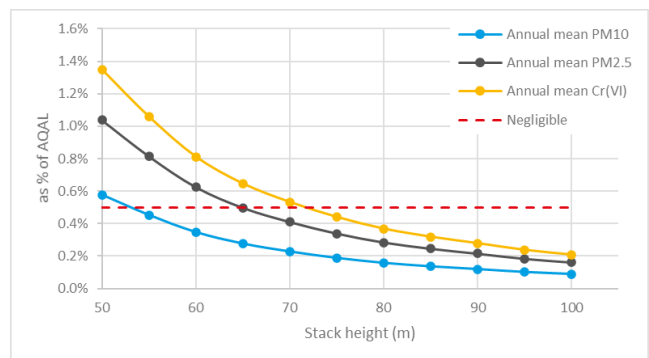
Graph 5: Short term means at daily ELVs
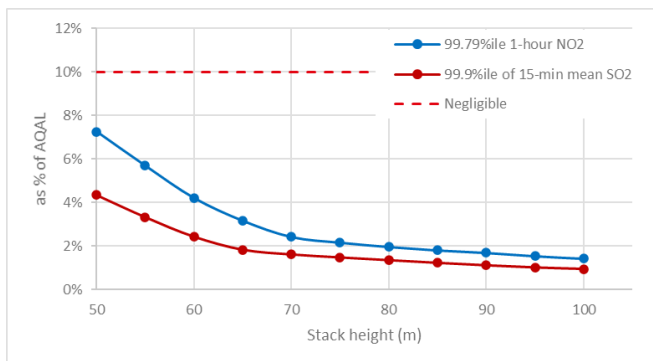
Graph 6: Short term means at half hourly ELVs
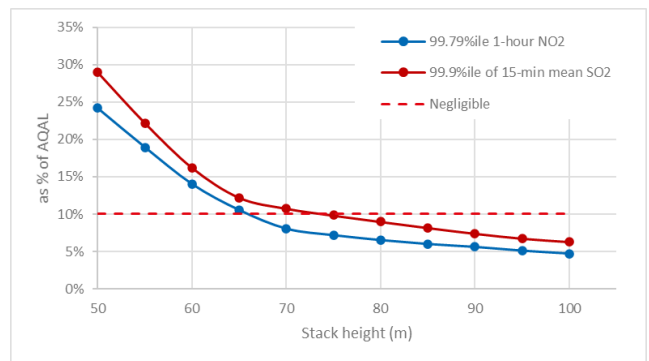
Graphs 4 to 6 show that at a stack height of 75 m, at the point of maximum impact:

- all annual mean impacts of particulate matter and chromium VI are less than 0.5% of the AQAL and can be described as 'negligible', 'insignificant' or 'not significant' irrespective of background conditions; and

- all short term impacts are less than 10% of the AQAL and can be described as 'negligible' or 'insignificant' if it is assumed that the plant operates at the daily BAT-AELs.

However, at a 75 m stack height annual mean nitrogen dioxide is greater than 0.5% of the AQAL and cannot screen out as negligible irrespective of background levels. This would be the case even at higher stack heights up to 100 m, higher than which was not considered in this assessment. Further analysis shows that when the low background conditions are considered, the PC at the point of maximum impact is well below 5% of the AQAL and the PEC is well below 75%. Therefore, for planning purposes, the impact would still be described as negligible. For permitting, the PEC at the

point of maximum impact is well below 70% of the AQAL and so the impact can be described as not significant.

At a stack height of 75 m, 99.9%ile of 15 minute means sulphur dioxide just exceeds the 10% of the AQAL screening criteria when it is assumed the Proposed Development operates at half-hourly ELVs as set out in the IED (i.e. 200 mg/Nm^3). This is four times the daily ELV set in the IED (50 mg/Nm^3). The Waste Incineration BREF introduces a more stringent limit of 30 mg/Nm^3. If the same ratio is applied the maximum process contribution is predicted to be 7% of the AQAL. It is unlikely that the plant would operate at the half-hourly ELV during the worst-case weather conditions for dispersion. Therefore, there is little risk that the impact would exceed 10% of the AQAL.

Therefore, a stack height of 75 m provides adequate dispersion of pollutants from the Proposed Development, and the remainder of this assessment has been undertaken for a stack height of 75 m.

6 Sensitivity Analysis

6.1 Choice of model

Within ADMS, the FLOWSTAR module is used to generate a new flow and turbulence field based on the terrain. This simulates the changes to the movement of air in the horizontal and vertical direction as a result of the terrain features in that the air flow is simulated flowing above and around raised ground. This modified flow field is then used by the model to predict the dispersion of the pollutants.

Within AERMOD, the effect of terrain is modelled by scaling the sum of two possible extreme plume states as shown in the following figure.
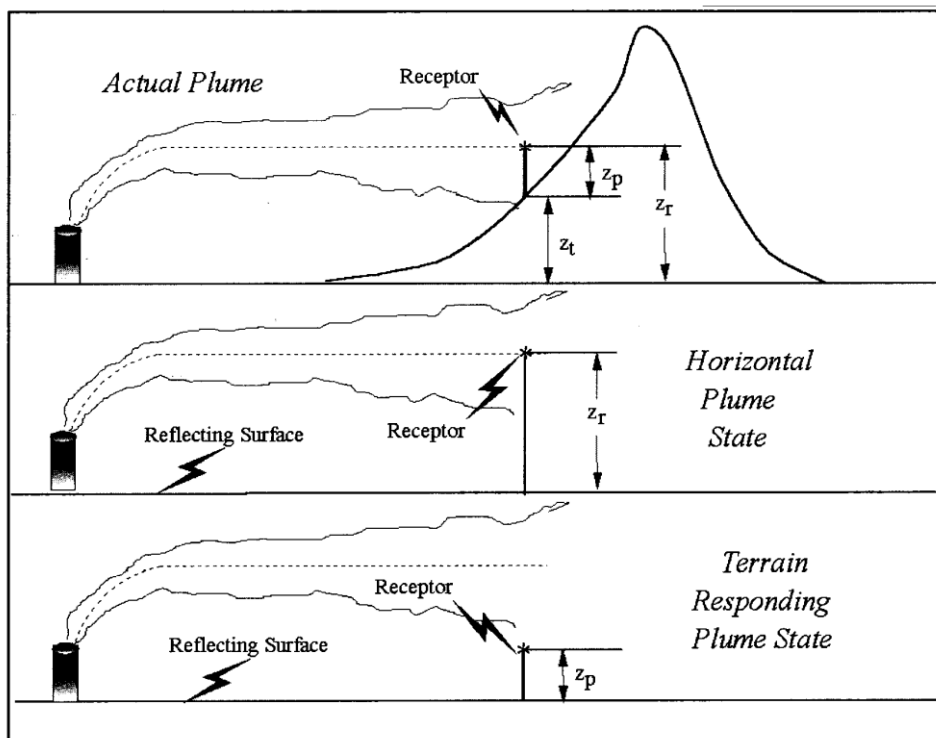
The terrain data is used by the AERMAP processor to determine the hill height scale for each receptor. This is then used to calculate the dividing streamline height and consequently the fraction of the plume mass which is below this height. This is used as the basis of the scaling of the two extreme plume states. AERMOD therefore does not take into account changes in wind flow patterns as a result of presence of terrain features. As such, in areas of complex terrain, ADMS is considered to be the most suitable model and so it has been used as the main model for this application.

To investigate whether the models (including and excluding) are simulating the dispersion of pollutants in a similar way, we have compared the ADMS and AERMOD model outputs. The latest release of the ADMS model, ADMS 5.2, allows the user to run the model with the US EPA developed AERMOD executable. The standard ADMS conversion tool has been used to generate and run the AERMOD version of the model.

The following parameters were kept constant:

- buildings – included;
- dispersion site surface roughness value – 0.3 m;

- meteorological site surface roughness – 0.3 m;
- dispersion site Monin-Obukhov length – model default;
- meteorological site Monin-Obukhov length – 10 m;
- meteorological data used – Prestwick 2019.

The following table outlines the results at the point of maximum impact for nitrogen dioxide using both ADMS and AERMOD assuming a 75 m stack for the Proposed Development.

Table 14: Sensitivity - Choice of Model

Model	Nitrogen dioxide process contribution (µg/m³)		
	Excluding terrain	**Including terrain**	**% Difference**
Annual Mean			
ADMS 5.2	0.65	0.54	17%
AERMOD	0.30	0.30	2%
% Difference	53%	45%	
Max 1-hour			
ADMS 5.2	41.04	40.36	2%
AERMOD	7.57	9.38	-24%
% Difference	82%	77%	
99.79%ile 1-hour			
ADMS 5.2	10.98	10.61	3.3%
AERMOD	5.75	5.53	3.7%
% Difference	48%	48%	

As shown in Table 22 and presented in Figure 6 of **Annex E**, the greatest annual mean and short-term impacts are predicted using ADMS 5.2, regardless of whether the effect of terrain is considered or not. The impact of terrain is minimal at the point of maximum impact, but due to the topography of the area terrain effects are considered likely to affect concentrations at receptor locations. As explained previously, in areas of complex terrain, ADMS is considered to be the most suitable model. In addition, ADMS predicts a higher maximum ground-level concentration than AERMOD. Therefore, as a conservative approach, ADMS has been used as the model for this application.

As shown, for both long term and short term nitrogen dioxide impacts, AERMOD predicts lower impacts. The results excluding terrain are more similar, demonstrating the different ways which ADMS and AERMOD process terrain; AERMOD does not take into account changes in wind flow patterns as a result of presence of terrain features, and therefore can underestimate ground level concentrations and is not considered to be representative of the likely ground level concentrations.

6.2 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site. For all sensitivity analysis the impact of changing model parameters on the maximum annual mean and short-term concentrations of oxides of nitrogen have been considered.

The following parameters were kept constant:

- Stack height – 75 m
- Buildings – included;
- Terrain file – included at 64 x 64 resolution;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Prestwick 2019.

The contribution of the Proposed Development to the ground level concentration of the emissions of oxides of nitrogen at the point of maximum predicted concentration is presented in Table 15.

Table 15: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
0.1	0.51	22.94	0.42	14.75
0.2	0.54	42.89	0.42	14.31
0.3	0.54	40.36	0.42	14.01
0.5	0.60	37.25	0.43	13.58
0.7	0.63	35.27	0.44	13.46

As shown, increasing the surface roughness value leads to greater annual mean concentrations but generally lower short-term concentrations. A surface roughness value of 0.3 m was selected for the model as this was deemed the most appropriate for the surrounding landscape which mainly comprises open fields, copses and isolated buildings.

6.3 Building parameters

ADMS 5.2 has a buildings effects module to account for the impact of buildings when it calculates the air flow and dispersion of pollutants from a source. The model works by combining the inputted individual buildings into a single effective building for each wind direction.

The sensitivity of the results to the effect of buildings has been considered by running the model with the buildings presented in Table 12 and with no buildings at all.

The following parameters were kept constant:

- Stack height – 75 m;
- Terrain file – included at 64 x 64 resolution;
- Dispersion site surface roughness value – 0.3 m;
- Meteorological site surface roughness value – 0.3 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Prestwick 2019.

Table 16 presents the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration for each building scenario.

Table 16: Effect of Buildings

Scenario used in model	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Including buildings presented in Table 12	0.54	40.36	0.42	14.01
Excluding buildings	0.35	17.99	0.32	13.35

As shown, modelling the presence of buildings results in higher annual mean and short-term concentrations. Buildings have been included in the dispersion model as this represents a realistic approach.

6.4   Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without the main human receptor terrain file (at 64 x 64 resolution).

The following parameters were kept constant:

- Stack height – 75 m
- Buildings – included
- Dispersion site surface roughness value – 0.3 m;
- Meteorological site surface roughness – 0.3 m;
- Dispersion site Monin-Obukhov length – model default;
- Meteorological site Monin-Obukhov length – 10 m; and
- Meteorological data used – Prestwick 2019.

Table 16 presents the ground level concentration of oxides of nitrogen at the point of maximum predicted concentration for each terrain scenario.

Table 17: Effect of Terrain

Scenario used in model	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Including terrain	0.54	40.36	0.42	14.01
Excluding terrain	0.65	41.04	0.46	14.27

As shown, including modelling the effect of terrain has minimal effect on the annual mean and maximum 1-hour concentrations. The terrain file has been included in the dispersion model as this represents a realistic approach.

6.5 Sensitivity analysis – operating below the design point

Dispersion modelling has been undertaken based on the emission parameters based on the design point for the Proposed Development. The Proposed Development is to be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect on this would decrease the quantity of pollutants emitted but also reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion, would be more than offset by the decrease in the amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

7 Impact on Human Health

7.1 At the point of maximum impact

Table 18 and Table 19 present the results of the dispersion modelling of process emissions from the Proposed Development at the point of maximum impact. This is the maximum predicted concentration based on the following:

- The smaller modelling domain size – 2 km by 2 km at 20 m resolution;
- Buildings – included;
- Terrain – included at 64 x 64 resolution;
- Stack height – 75 m;
- 5 years of weather data 2015 to 2019 from Prestwick meteorological recording station;
- Operation at the long term ELVs for 100% of the year;
- Operation at the short term ELVs (Table 19 only);
- Environment Agency's worst case conversion of NOx to nitrogen dioxide;
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline monitoring contained in Appendix 8.3 of the EIAR.

Impacts that cannot be described as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 criteria are highlighted. Where the impact cannot be screened out 'as 'negligible' irrespective of the total concentration, further analysis has been undertaken.

Table 18: Dispersion Modelling Results – Point of Maximum Impact - Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	4.79	0.60	0.55	0.63	0.62	0.45	0.63	1.57%	5.42	13.54%
	99.79th%ile of hourly means	µg/m³	200	9.58	4.03	4.12	3.59	4.46	3.97	4.46	2.23%	14.04	7.02%
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	6.76	1.08	1.19	1.26	1.50	1.01	1.50	1.20%	8.26	6.61%
	99.73rd%ile of hourly means	µg/m³	350	6.76	2.69	2.85	2.49	3.05	2.62	3.05	0.87%	9.81	2.80%
	99.9th%ile of 15 min. means	µg/m³	266	6.76	3.26	3.57	3.15	4.52	4.28	4.52	1.70%	11.28	4.24%
PM$_{10}$	Annual mean	µg/m³	18	11.08	0.04	0.03	0.04	0.04	0.03	0.04	0.21%	11.12	61.76%
	98.1st %ile of daily means	µg/m³	50	22.16	0.16	0.17	0.18	0.20	0.14	0.20	0.40%	22.36	44.72%
PM$_{2.5}$	Annual mean	µg/m³	10	5.81	0.04	0.03	0.04	0.04	0.03	0.04	0.37%	5.85	58.47%
Carbon monoxide	8 hour running mean	µg/m³	10000	354	13.62	7.28	11.17	9.23	5.92	13.62	0.14%	367.62	3.68%
	Hourly mean	µg/m³	30000	354	13.62	7.28	11.17	9.23	5.92	13.62	0.05%	367.62	1.23%
Hydrogen chloride	Annual mean	µg/m³	20	0.71	0.04	0.04	0.04	0.04	0.03	0.04	0.22%	0.75	3.77%
	Hourly mean	µg/m³	750	1.42	1.63	2.15	1.49	1.78	1.91	2.15	0.29%	3.57	0.48%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.01	0.01	0.01	0.01	0.01	0.01	0.05%	2.36	14.73%
	Hourly mean	µg/m³	160	4.7	0.27	0.36	0.25	0.30	0.32	0.36	0.22%	5.06	3.16%
Ammonia	Annual mean	µg/m³	180	3.18	0.07	0.07	0.07	0.07	0.05	0.07	0.04%	3.25	1.81%
	Hourly mean	µg/m³	2500	6.36	2.72	3.59	2.48	2.97	3.18	3.59	0.14%	9.95	0.40%

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
VOCs (as benzene)	Annual mean	µg/m³	3.25	0.23	0.07	0.07	0.07	0.07	0.05	0.07	2.30%	0.30	9.38%
	Hourly mean	µg/m³	195	0.46	2.73	3.60	2.49	2.98	3.19	3.60	1.85%	4.06	2.08%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.08	0.07	0.07	0.07	0.07	0.05	0.07	3.33%	0.15	6.88%
Mercury	Annual mean	ng/m³	250	2.8	0.14	0.13	0.15	0.15	0.11	0.15	0.06%	2.95	1.18%
	Hourly mean	ng/m³	7500	5.6	5.46	7.20	4.97	5.96	6.38	7.20	0.10%	12.80	0.17%
Cadmium	Annual mean	ng/m³	5	0.57	0.14	0.13	0.15	0.15	0.11	0.15	2.99%	0.72	14.39%
	Hourly mean	ng/m³	1500	1.14	5.46	7.20	4.97	5.96	6.38	7.20	0.48%	8.34	0.56%
Thallium	Annual mean	ng/m³	1000	-	0.14	0.13	0.15	0.15	0.11	0.15	0.01%	-	-
	Hourly mean	ng/m³	30000	-	5.46	7.20	4.97	5.96	6.38	7.20	0.02%	-	-
PAHs	Annual mean	pg/m³	250	980	1.44	1.32	1.50	1.48	1.07	1.50	0.60%	981.50	392.60%
Dioxins	Annual mean	fg/m³	-	32.99	0.43	0.40	0.45	0.44	0.32	0.45	-	33.44	-
PCBs	Annual mean	ng/m³	200	0.12893	0.04	0.03	0.04	0.04	0.03	0.04	0.02%	0.17	0.08%
	Hourly mean	ng/m³	6000	0.25786	1.37	1.80	1.24	1.49	1.60	1.80	0.03%	2.06	0.03%
Other metals	Annual mean	ng/m³	-	-	2.16	1.99	2.25	2.22	1.61	2.25	See metals assessment – Section 7.2.4		
	Hourly mean	ng/m³	-	-	81.93	107.97	74.58	89.35	95.72	107.97			

Note:

All assessment is based on the maximum PC using all 5 years of weather data.

Table 19: *Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs*

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2014	2015	2016	2017	2018	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	9.58	13.43	13.73	11.95	14.87	13.23	14.87	7.44%	24.45	12.23%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	6.76	17.94	18.98	16.58	20.33	17.45	20.33	5.81%	27.09	7.74%
	99.9th%ile of 15 min. means	µg/m³	266	6.76	21.71	23.81	21.02	30.16	28.56	30.16	11.34%	36.92	13.88%
Carbon monoxide	8 hour running mean	µg/m³	10000	354	27.24	14.56	22.34	18.45	11.84	27.24	0.27%	381.24	3.81%
	Hourly mean	µg/m³	30000	354	27.24	14.56	22.34	18.45	11.84	27.24	0.09%	381.24	1.27%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	16.33	21.52	14.87	17.81	19.08	21.52	2.87%	22.94	3.06%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.7	1.09	1.43	0.99	1.19	1.27	1.43	0.90%	6.13	3.83%
VOCs (as benzene)	Hourly mean	µg/m³	195	0.46	5.46	7.20	4.97	5.96	6.38	7.20	3.69%	7.66	3.93%
Mercury	Hourly mean	ng/m³	7500	5.6	9.56	12.60	8.70	10.42	11.17	12.60	0.17%	18.20	0.24%
Note: *All assessment is based on the maximum PC using all 5 years of weather data and operation at the short-term ELVs.*													

As shown, at the point of maximum impact all of the PCs are less than 10% of the short-term AQAL when operating at the daily ELVs and less than 0.5% of the annual mean AQAL and can be screened out as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 guidance, with the exception of the following :

- annual mean nitrogen dioxide impacts;
- annual mean VOCs impacts;
- annual mean cadmium impacts; and
- annual mean PAHs impact.

At the point of maximum impact all of the PCs are less than 10% of the short-term AQAL when operating at the half-hourly ELVs and can be screened out as 'negligible' irrespective of the total concentration in accordance with the IAQM 2017 guidance, with the exception of short term (99.9th%ile of 15 min. means) sulphur dioxide impacts.

Further analysis of the likely future baseline concentrations has been undertaken to define the magnitude of change for annual mean impacts for, and the extent of relevant exposure has been undertaken to determine the magnitude of change for short-term impacts.

7.2   Further assessment

7.2.1   Annual mean nitrogen dioxide

The annual mean nitrogen dioxide PC from the Proposed Development is predicted to be 1.57% of the AQAL at the point of maximum impact. Table 20 details the impact of annual mean nitrogen dioxide contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 7 of Annex E shows the spatial distribution of emissions.

Table 20: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.12	0.29%	4.91	12.26%
R2	0.12	0.30%	4.91	12.28%
R3	0.17	0.42%	4.96	12.39%
R4	0.03	0.06%	4.82	12.04%
R5	0.05	0.13%	4.84	12.11%
R6	0.16	0.41%	4.95	12.38%
R7	0.17	0.42%	4.96	12.40%
R8	0.15	0.38%	4.94	12.36%
R9	0.14	0.35%	4.93	12.32%
R10	0.11	0.29%	4.90	12.26%
R11	0.30	0.75%	5.09	12.72%
R12	0.27	0.68%	5.06	12.66%
R13	0.10	0.25%	4.89	12.23%
R14	0.09	0.23%	4.88	12.20%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R15	0.09	0.21%	4.88	12.19%
R16	0.12	0.31%	4.91	12.28%
R17	0.22	0.54%	5.01	12.52%
R18	0.19	0.48%	4.98	12.46%
R19	0.03	0.08%	4.82	12.05%
R20	0.05	0.13%	4.84	12.10%
R21	0.02	0.05%	4.81	12.03%
R22	0.08	0.21%	4.87	12.18%
R23	0.04	0.11%	4.83	12.09%
R24	0.04	0.11%	4.83	12.08%
R25	0.04	0.11%	4.83	12.08%
R26	0.05	0.12%	4.84	12.09%
R27	0.11	0.28%	4.90	12.25%
R28	0.09	0.22%	4.88	12.19%
R29	0.09	0.22%	4.88	12.19%
R30	0.14	0.35%	4.93	12.32%
R31	0.14	0.36%	4.93	12.33%
R32	0.06	0.14%	4.85	12.12%
R33	0.09	0.23%	4.88	12.21%
R34	0.11	0.27%	4.90	12.25%
R35	0.13	0.32%	4.92	12.29%
R36	0.40	1.00%	5.19	12.98%
R37	0.11	0.27%	4.90	12.25%
R38	0.07	0.19%	4.86	12.16%
R39	0.11	0.26%	4.90	12.24%
R40	0.07	0.16%	4.86	12.14%
R41	0.06	0.16%	4.85	12.13%
R42	0.13	0.32%	4.92	12.30%
R43	0.01	0.03%	4.80	12.01%
R44	0.02	0.06%	4.81	12.04%
R45	0.05	0.13%	4.84	12.10%
R46	0.02	0.06%	4.81	12.04%
R47	0.10	0.26%	4.89	12.23%
R48	0.05	0.13%	4.84	12.11%
R49	0.11	0.28%	4.90	12.26%
R50	0.08	0.21%	4.87	12.18%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R51	0.04	0.10%	4.83	12.07%
R52	0.06	0.15%	4.85	12.13%
R53	0.06	0.14%	4.85	12.11%
R54	0.06	0.14%	4.85	12.12%
R55	0.06	0.14%	4.85	12.11%
R56	0.06	0.16%	4.85	12.14%
R57	0.06	0.14%	4.85	12.12%
R58	0.37	0.92%	5.16	12.90%
R59	0.07	0.18%	4.86	12.15%
R60	0.04	0.11%	4.83	12.08%
R61	0.10	0.25%	4.89	12.22%
R62	0.16	0.41%	4.95	12.39%
R63	0.09	0.23%	4.88	12.21%
R64	0.09	0.23%	4.88	12.20%
R65	0.09	0.22%	4.88	12.20%
R66	0.09	0.22%	4.88	12.20%
R67	0.09	0.22%	4.88	12.19%
R68	0.09	0.22%	4.88	12.19%
R69	0.09	0.22%	4.88	12.19%
R70	0.09	0.21%	4.88	12.19%

7.2.2 Annual mean VOCs

There are two VOCs for which an AQAL has been set: benzene and 1,3-butadiene. For the purpose of this analysis it has been assumed that the entire VOC emissions consist of only benzene or 1,3-butadiene. This is a highly conservative assumption as it does not take into account the speciation of VOCs in the emissions and the modelling does not take into account the volatile nature of the compounds.

The PC from the Proposed Development is predicted to be 2.30% of the AQAL for benzene and 3.33% of the AQAL for 1,3-butadiene at the point of maximum impact. Table 21 and Table 22 detail the impact of annual mean benzene and 1,3-butadiene contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 8 and Figure 9 of Annex E show the spatial distribution of emissions.

Table 21: Annual Mean VOCs (as Benzene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R1	13.74	0.42%	243.74	7.50%
R2	14.42	0.44%	244.42	7.52%
R3	19.91	0.61%	249.91	7.69%

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R4	3.08	0.09%	233.08	7.17%
R5	6.27	0.19%	236.27	7.27%
R6	19.52	0.60%	249.52	7.68%
R7	20.25	0.62%	250.25	7.70%
R8	18.15	0.56%	248.15	7.64%
R9	16.68	0.51%	246.68	7.59%
R10	13.68	0.42%	243.68	7.50%
R11	35.70	1.10%	265.70	8.18%
R12	32.61	1.00%	262.61	8.08%
R13	12.01	0.37%	242.01	7.45%
R14	10.75	0.33%	240.75	7.41%
R15	10.21	0.31%	240.21	7.39%
R16	14.70	0.45%	244.70	7.53%
R17	26.00	0.80%	256.00	7.88%
R18	23.04	0.71%	253.04	7.79%
R19	3.80	0.12%	233.80	7.19%
R20	6.08	0.19%	236.08	7.26%
R21	2.49	0.08%	232.49	7.15%
R22	9.99	0.31%	239.99	7.38%
R23	5.33	0.16%	235.33	7.24%
R24	5.14	0.16%	235.14	7.24%
R25	5.09	0.16%	235.09	7.23%
R26	5.70	0.18%	235.70	7.25%
R27	13.22	0.41%	243.22	7.48%
R28	10.34	0.32%	240.34	7.40%
R29	10.44	0.32%	240.44	7.40%
R30	16.62	0.51%	246.62	7.59%
R31	17.14	0.53%	247.14	7.60%
R32	6.70	0.21%	236.70	7.28%
R33	11.22	0.35%	241.22	7.42%
R34	13.05	0.40%	243.05	7.48%
R35	15.24	0.47%	245.24	7.55%
R36	47.78	1.47%	277.78	8.55%
R37	12.97	0.40%	242.97	7.48%
R38	8.86	0.27%	238.86	7.35%
R39	12.63	0.39%	242.63	7.47%

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R40	7.82	0.24%	237.82	7.32%
R41	7.61	0.23%	237.61	7.31%
R42	15.32	0.47%	245.32	7.55%
R43	1.46	0.04%	231.46	7.12%
R44	2.88	0.09%	232.88	7.17%
R45	6.04	0.19%	236.04	7.26%
R46	2.92	0.09%	232.92	7.17%
R47	12.27	0.38%	242.27	7.45%
R48	6.25	0.19%	236.25	7.27%
R49	13.37	0.41%	243.37	7.49%
R50	9.95	0.31%	239.95	7.38%
R51	4.77	0.15%	234.77	7.22%
R52	7.29	0.22%	237.29	7.30%
R53	6.59	0.20%	236.59	7.28%
R54	6.89	0.21%	236.89	7.29%
R55	6.58	0.20%	236.58	7.28%
R56	7.68	0.24%	237.68	7.31%
R57	6.73	0.21%	236.73	7.28%
R58	44.09	1.36%	274.09	8.43%
R59	8.43	0.26%	238.43	7.34%
R60	5.13	0.16%	235.13	7.23%
R61	11.88	0.37%	241.88	7.44%
R62	19.67	0.61%	249.67	7.68%
R63	11.01	0.34%	241.01	7.42%
R64	10.80	0.33%	240.80	7.41%
R65	10.71	0.33%	240.71	7.41%
R66	10.60	0.33%	240.60	7.40%
R67	10.47	0.32%	240.47	7.40%
R68	10.47	0.32%	240.47	7.40%
R69	10.32	0.32%	240.32	7.39%
R70	10.26	0.32%	240.26	7.39%

Table 22: Annual Mean VOCs (as 1,3-Butadiene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R1	13.74	0.61%	93.74	4.17%

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R2	14.42	0.64%	94.42	4.20%
R3	19.91	0.89%	99.91	4.44%
R4	3.08	0.14%	83.08	3.69%
R5	6.27	0.28%	86.27	3.83%
R6	19.52	0.87%	99.52	4.42%
R7	20.25	0.90%	100.25	4.46%
R8	18.15	0.81%	98.15	4.36%
R9	16.68	0.74%	96.68	4.30%
R10	13.68	0.61%	93.68	4.16%
R11	35.70	1.59%	115.70	5.14%
R12	32.61	1.45%	112.61	5.00%
R13	12.01	0.53%	92.01	4.09%
R14	10.75	0.48%	90.75	4.03%
R15	10.21	0.45%	90.21	4.01%
R16	14.70	0.65%	94.70	4.21%
R17	26.00	1.16%	106.00	4.71%
R18	23.04	1.02%	103.04	4.58%
R19	3.80	0.17%	83.80	3.72%
R20	6.08	0.27%	86.08	3.83%
R21	2.49	0.11%	82.49	3.67%
R22	9.99	0.44%	89.99	4.00%
R23	5.33	0.24%	85.33	3.79%
R24	5.14	0.23%	85.14	3.78%
R25	5.09	0.23%	85.09	3.78%
R26	5.70	0.25%	85.70	3.81%
R27	13.22	0.59%	93.22	4.14%
R28	10.34	0.46%	90.34	4.02%
R29	10.44	0.46%	90.44	4.02%
R30	16.62	0.74%	96.62	4.29%
R31	17.14	0.76%	97.14	4.32%
R32	6.70	0.30%	86.70	3.85%
R33	11.22	0.50%	91.22	4.05%
R34	13.05	0.58%	93.05	4.14%
R35	15.24	0.68%	95.24	4.23%
R36	47.78	2.12%	127.78	5.68%
R37	12.97	0.58%	92.97	4.13%

Receptor	PC		PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R38	8.86	0.39%	88.86	3.95%
R39	12.63	0.56%	92.63	4.12%
R40	7.82	0.35%	87.82	3.90%
R41	7.61	0.34%	87.61	3.89%
R42	15.32	0.68%	95.32	4.24%
R43	1.46	0.06%	81.46	3.62%
R44	2.88	0.13%	82.88	3.68%
R45	6.04	0.27%	86.04	3.82%
R46	2.92	0.13%	82.92	3.69%
R47	12.27	0.55%	92.27	4.10%
R48	6.25	0.28%	86.25	3.83%
R49	13.37	0.59%	93.37	4.15%
R50	9.95	0.44%	89.95	4.00%
R51	4.77	0.21%	84.77	3.77%
R52	7.29	0.32%	87.29	3.88%
R53	6.59	0.29%	86.59	3.85%
R54	6.89	0.31%	86.89	3.86%
R55	6.58	0.29%	86.58	3.85%
R56	7.68	0.34%	87.68	3.90%
R57	6.73	0.30%	86.73	3.85%
R58	44.09	1.96%	124.09	5.51%
R59	8.43	0.37%	88.43	3.93%
R60	5.13	0.23%	85.13	3.78%
R61	11.88	0.53%	91.88	4.08%
R62	19.67	0.87%	99.67	4.43%
R63	11.01	0.49%	91.01	4.05%
R64	10.80	0.48%	90.80	4.04%
R65	10.71	0.48%	90.71	4.03%
R66	10.60	0.47%	90.60	4.03%
R67	10.47	0.47%	90.47	4.02%
R68	10.47	0.47%	90.47	4.02%
R69	10.32	0.46%	90.32	4.01%
R70	10.26	0.46%	90.26	4.01%

7.2.3   Annual mean cadmium

The annual mean cadmium PC from the Proposed Development is predicted to be 3.07% of the AQAL. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. The Waste Incineration BREF shows that the average concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm³ (or 8% of the ELV of 0.02 mg/Nm³), the highest recorded concentration of cadmium and thallium was 14 µg/Nm³ (or 70% of the ELV of 0.02 mg/Nm³) and only three lines recorded concentrations higher than 10 µg/Nm³ (or 50% of the ELV of 0.02 mg/Nm³).

Table 23 shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100%, 50% and 8% of the ELV, referred to as the 'screening', 'worst case' and 'typical' scenarios. PCs greater than 0.5% of the AQAL are highlighted. Figure 10 of Annex E shows the spatial distribution of emissions for all three scenarios.

Table 23:   Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor					PC (as % of AQAL)	
		Screening		Worst-case		Typical
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
R1	27.49	0.55%	13.74	0.27%	2.20	0.04%
R2	28.83	0.58%	14.42	0.29%	2.31	0.05%
R3	39.83	0.80%	19.91	0.40%	3.19	0.06%
R4	6.16	0.12%	3.08	0.06%	0.49	0.01%
R5	12.54	0.25%	6.27	0.13%	1.00	0.02%
R6	39.03	0.78%	19.52	0.39%	3.12	0.06%
R7	40.49	0.81%	20.25	0.40%	3.24	0.06%
R8	36.31	0.73%	18.15	0.36%	2.90	0.06%
R9	33.36	0.67%	16.68	0.33%	2.67	0.05%
R10	27.35	0.55%	13.68	0.27%	2.19	0.04%
R11	71.41	1.43%	35.70	0.71%	5.71	0.11%
R12	65.21	1.30%	32.61	0.65%	5.22	0.10%
R13	24.03	0.48%	12.01	0.24%	1.92	0.04%
R14	21.50	0.43%	10.75	0.21%	1.72	0.03%
R15	20.43	0.41%	10.21	0.20%	1.63	0.03%
R16	29.40	0.59%	14.70	0.29%	2.35	0.05%
R17	52.00	1.04%	26.00	0.52%	4.16	0.08%
R18	46.08	0.92%	23.04	0.46%	3.69	0.07%
R19	7.60	0.15%	3.80	0.08%	0.61	0.01%
R20	12.16	0.24%	6.08	0.12%	0.97	0.02%
R21	4.97	0.10%	2.49	0.05%	0.40	0.01%
R22	19.98	0.40%	9.99	0.20%	1.60	0.03%
R23	10.65	0.21%	5.33	0.11%	0.85	0.02%
R24	10.28	0.21%	5.14	0.10%	0.82	0.02%

Receptor	PC (as % of AQAL)					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
R25	10.17	0.20%	5.09	0.10%	0.81	0.02%
R26	11.39	0.23%	5.70	0.11%	0.91	0.02%
R27	26.43	0.53%	13.22	0.26%	2.11	0.04%
R28	20.68	0.41%	10.34	0.21%	1.65	0.03%
R29	20.88	0.42%	10.44	0.21%	1.67	0.03%
R30	33.25	0.66%	16.62	0.33%	2.66	0.05%
R31	34.28	0.69%	17.14	0.34%	2.74	0.05%
R32	13.40	0.27%	6.70	0.13%	1.07	0.02%
R33	22.43	0.45%	11.22	0.22%	1.79	0.04%
R34	26.10	0.52%	13.05	0.26%	2.09	0.04%
R35	30.48	0.61%	15.24	0.30%	2.44	0.05%
R36	95.57	1.91%	47.78	0.96%	7.65	0.15%
R37	25.95	0.52%	12.97	0.26%	2.08	0.04%
R38	17.73	0.35%	8.86	0.18%	1.42	0.03%
R39	25.26	0.51%	12.63	0.25%	2.02	0.04%
R40	15.65	0.31%	7.82	0.16%	1.25	0.03%
R41	15.22	0.30%	7.61	0.15%	1.22	0.02%
R42	30.63	0.61%	15.32	0.31%	2.45	0.05%
R43	2.92	0.06%	1.46	0.03%	0.23	0.00%
R44	5.75	0.12%	2.88	0.06%	0.46	0.01%
R45	12.09	0.24%	6.04	0.12%	0.97	0.02%
R46	5.84	0.12%	2.92	0.06%	0.47	0.01%
R47	24.54	0.49%	12.27	0.25%	1.96	0.04%
R48	12.50	0.25%	6.25	0.12%	1.00	0.02%
R49	26.74	0.53%	13.37	0.27%	2.14	0.04%
R50	19.90	0.40%	9.95	0.20%	1.59	0.03%
R51	9.53	0.19%	4.77	0.10%	0.76	0.02%
R52	14.58	0.29%	7.29	0.15%	1.17	0.02%
R53	13.18	0.26%	6.59	0.13%	1.05	0.02%
R54	13.77	0.28%	6.89	0.14%	1.10	0.02%
R55	13.16	0.26%	6.58	0.13%	1.05	0.02%
R56	15.37	0.31%	7.68	0.15%	1.23	0.02%
R57	13.47	0.27%	6.73	0.13%	1.08	0.02%
R58	88.17	1.76%	44.09	0.88%	7.05	0.14%
R59	16.86	0.34%	8.43	0.17%	1.35	0.03%

Receptor	PC (as % of AQAL)					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
R60	10.27	0.21%	5.13	0.10%	0.82	0.02%
R61	23.75	0.48%	11.88	0.24%	1.90	0.04%
R62	39.35	0.79%	19.67	0.39%	3.15	0.06%
R63	22.03	0.44%	11.01	0.22%	1.76	0.04%
R64	21.61	0.43%	10.80	0.22%	1.73	0.03%
R65	21.43	0.43%	10.71	0.21%	1.71	0.03%
R66	21.20	0.42%	10.60	0.21%	1.70	0.03%
R67	20.94	0.42%	10.47	0.21%	1.68	0.03%
R68	20.94	0.42%	10.47	0.21%	1.67	0.03%
R69	20.64	0.41%	10.32	0.21%	1.65	0.03%
R70	20.53	0.41%	10.26	0.21%	1.64	0.03%

7.2.4 Annual mean PAHs

The annual mean cadmium PC from the Proposed Development is predicted to be 0.60% of the AQAL. Figure 11 of Annex E shows the spatial distribution of emissions as shown the area where impacts are predicted to exceed 0.5% of the AQAL is restricted to a small area to the north-east of the Proposed Development where there is no area of relevant exposure.

7.2.5 15-minute sulphur dioxide

The 99.9[th] percentile of 15-minute sulphur dioxide process emissions is predicted to be 11.34% of the AQAL at the point of maximum impact if it assumed that the plant continually operates at the half-hourly ELV as set out in the IED (i.e. 200 mg/Nm^3) and this coincides with the worst-case weather conditions for dispersion. Figure 12 shows the distribution of emissions and the areas where the impact is greater than 10% of the AQAL.

The half-hourly ELV assumed is four times the daily ELV set in the IED (50 mg/Nm^3). The Waste Incineration BREF introduces a more stringent limit of 30 mg/Nm^3 as a daily average. If the same ratio of daily to half-hourly ELV is applied the maximum process contribution is predicted to be 7% of the AQAL. It is unlikely that the plant would operate at the half-hourly ELV during the worst-case weather conditions for dispersion. Therefore, there is little risk that the impact would exceed 10% of the AQAL at any area of relevant exposure.

7.2.6 Heavy metals – at the point of maximum impact

Table 24 and Table 25 detail the PC and PEC assuming that each metal is released at the combined long and short term metal ELVs respectively. If the PC is greater than 0.5% of the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken assuming the release is no greater than the maximum monitored at an existing waste facility. The Environment Agency's metals guidance details the maximum monitored concentrations of group 3 metals emitted by Municipal Waste Incinerators and Waste Wood Co-Incinerators as a percentage

of the group ELV. The maximum monitored emission presented in the Environment Agency's analysis has been used as a conservative assumption.

Table 24: Long-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Metals emitted no worse than a currently permitted facility			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	3	1.10	2.25	74.87%	3.35	111.53%	8.3%	0.19	6.24%	1.29	42.91%
Antimony	5,000	-	2.25	0.04%	-	-	3.8%	0.09	0.00%	-	-
Chromium	5,000	39.00	2.25	0.04%	41.25	0.82%	30.7%	0.69	0.01%	39.69	0.79%
Chromium (VI)	0.2	7.80	2.25	1123.0%	10.05	5023.0%	0.043%	0.00	0.49%	7.80	3900.49%
Cobalt	200	0.92	2.25	1.12%	3.17	1.58%	1.9%	0.04	0.02%	0.96	0.48%
Copper	10,000	33.00	2.25	0.02%	35.25	0.35%	9.7%	0.22	0.002%	33.22	0.33%
Lead	250	20.00	2.25	0.90%	22.25	8.90%	16.8%	0.38	0.15%	20.38	8.15%
Manganese	150	36.00	2.25	1.50%	38.25	25.50%	20.0%	0.45	0.30%	36.45	24.30%
Nickel	20	2.70	2.25	11.23%	4.95	24.73%	73.3%	1.65	8.24%	4.35	21.74%
Vanadium	5,000	1.70	2.25	0.04%	3.95	0.08%	2.0%	0.04	0.001%	1.74	0.03%
Notes: (1) Metal as maximum percentage of the group 3 BAT-AEL, calculated from the data presented in Environment Agency metals guidance document (V.4) Table A1.											

Table 25: Short-Term Metals Results – Point of Maximum Impact

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Metals emitted no worse than a currently permitted facility			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	1,500	2.20	107.97	7.20%	110.17	7.34%	8.3%	9.00	0.60%	11.20	0.75%
Antimony	150,000	-	107.97	0.07%	-	-	3.8%	4.14	0.003%	-	-
Chromium	150,000	78.00	107.97	0.07%	185.97	0.12%	30.7%	33.11	0.02%	111.11	0.07%
Chromium (VI)	3,000	15.60	107.97	3.6%	123.57	4.1%	0.043%	0.05	0.00%	15.65	0.52%
Cobalt	6,000	1.84	107.97	1.80%	109.81	1.83%	1.9%	2.02	0.03%	3.86	0.06%
Copper	200,000	66.00	107.97	0.05%	173.97	0.09%	9.7%	10.44	0.005%	76.44	0.04%
Lead	-	40.00	107.97	-	147.97	-	16.8%	18.10	-	58.10	-
Manganese	1,500,000	72.00	107.97	0.01%	179.97	0.01%	20.0%	21.59	0.001%	93.59	0.006%
Nickel	30,000	5.40	107.97	0.36%	113.37	0.38%	73.3%	79.17	0.26%	84.57	0.28%
Vanadium	1,000	3.40	107.97	10.80%	111.37	11.14%	2.0%	2.16	0.216%	5.56	0.56%
Notes:											
(1) Metal as maximum percentage of the group 3 BAT-AEL, calculated from the data presented in Environment Agency metals guidance document (V.4) Table A1.											

As shown in Table 24 the PCs exceed 1% for many of the long term pollutants. However, the PEC is only predicted to exceed the long term AQAL for arsenic using this worst-case screening assumption, and this is due to the high background concentration used.

As shown in Table 25, if it is assumed that the entire emissions of metals consist of only one metal, the impact is less than 10% of the short term AQAL for all pollutants excluding manganese. However, the PECs are not predicted to exceed the short term AQAL.

If it is assumed that the Proposed Development would perform no worse than a currently operating facility, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of annual mean arsenic and nickel. The PEC is not predicted to exceed the long term AQAL for either pollutant.

8. Impact at Ecological Receptors

This section provides an assessment of the impact of emissions at the ecological receptors identified in Section 3.2.

8.1 Methodology

8.1.1 Atmospheric emissions - Critical Levels

The impact of emissions from the Proposed Development has been compared to the Critical Levels listed in Table 4 and the results are presented in Section 8.2.

For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the PC is greater than 1% of the long-term or 10% of the short-term Critical Level further consideration will be made to the baseline concentrations.

8.1.2 Deposition of emissions - Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS.

An assessment has been made for each habitat feature identified in APIS for the specific site. The site specific features tool has been used to identify the feature habitats. The lowest Critical Loads for each designated site have been used to ensure a robust assessment.

APIS does not include site specific Critical Loads for locally designated sites. In lieu of this, the search by location function of APIS has been used to obtain Critical Loads based on the broad habitat type and location. The relevant Critical Loads are presented in Annex A [APIS Critical Loads].

If the impact of process emissions from the Proposed Development upon nitrogen or acid deposition is greater than 1% of the Critical Load, further assessment has been undertaken by the project ecologist.

8.1.3 Nitrogen deposition – eutrophication

Annex A summarises the Critical Loads for nitrogen deposition and background deposition rates as detailed in APIS for each identified receptor. The impact has been assessed against these Critical Loads for nitrogen deposition.

8.1.4 Acidification

The APIS Database contains a maximum Critical Load for sulphur (CLmaxS), a minimum Critical Load for nitrogen (CLminN) and a maximum Critical Load for nitrogen (CLmaxN). These components define the Critical Load function. Where the acid deposition flux falls within the area under the Critical Load function, no exceedances are predicted.

A search has been undertaken for each of the ecological receptors identified. Each site contains a number of habitat types, each with different Critical Loads. Annex A summaries the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat. The lowest Critical Loads for each designated site have been used to ensure a robust assessment, except where stated. The impact has been assessed against these Critical Load functions. Where a Critical

Load function for acid deposition is not available, the total nitrogen and sulphur deposition has been presented and compared with the background concentration.

8.1.5 Calculation methodology – nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG 6 (March 2014). The steps to this method are as follows.

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux ($\mu g/m^2/s$) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 26.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 26.
4. Compare this result to the nitrogen deposition Critical Load.

Table 26: Deposition Factors

Pollutant	Deposition velocity (m/s)		Conversion factor (µg/m2/s to kg/ha/year)
	Grassland	**Woodland**	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

Source: AQTAG 6 (March 2014)

8.1.5.1 Acidification

Deposition of nitrogen, sulphur, hydrogen chloride and ammonia can cause acidification and should be taken into consideration when assessing the impact of the Proposed Development.

The steps to determine the acid deposition flux are as follows.

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 8.1.5.
2. Apply the conversion factor for N outlined in Table 26 to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
3. Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
4. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
5. Determine the wet deposition rate of HCl in kg/ha/yr by multiplying the model output by the factors presented in Table 27.
6. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the wet keq Cl/ha/year.
7. Add the contribution from S to HCl dry and wet and treat this sum as the total contribution from S.
8. Plot the results against the Critical Load functions.

Table 27: Conversion Factors

Pollutant	Conversion factor (kg/ha/year to keq/ha/year)
Nitrogen	Divide by 14
Sulphur	Divide by 16
Hydrogen chloride	Divide by 35.5

Source: AQTAG (March 2014)

The March 2014 version of the AQTAG 6 document states that, for installations with an HCl emission, the PC of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of HCl from wet deposition.

Consultation with AQMAU confirmed that the maximum of the wet or dry deposition rate for HCl should be included in the calculation. For the purpose of this analysis it has been assumed that wet deposition of HCl is double dry deposition.

The contribution from the Proposed Development has been calculated using APIS formula:

Where PEC N Deposition < CLminN:

PC as % of CL function = PC S deposition / CLmaxS

Where PEC N Deposition > CLminN:

PC as % of CL function = (PC S + N deposition) / CLmaxN

8.2 Results – atmospheric emissions

The impact of emissions from the operation of the Proposed Development has been compared to the Critical Levels. For the purpose of the ecological assessment, the mapped background dataset from APIS has been used. If the emissions of a particular pollutant are greater than 1% of the long-term or 10% of the short-term Critical Level, further assessment would be undertaken. The PC has been calculated based on the maximum predicted using all five years of weather data. These results are presented in Annex C.

As shown in Annex C, for all pollutants considered, the process contribution is less than 1% of the long term and less than 10% of the short term Critical Level at all statutory and non-statutory designated sites with the exception of:

- Barlosh Moss (B) for annual mean ammonia;

- Ancient Woodland 2 for annual mean oxides of nitrogen, annual mean sulphur dioxide and annual mean ammonia;
- Ancient Woodland 3 for annual mean oxides of nitrogen, annual mean sulphur dioxide and annual mean ammonia; and
- Ancient Woodland 4 for annual mean ammonia.

The spatial distribution of atmospheric emissions results are shown in Figures 13 – 15.

8.3 Results - deposition of emissions

Annex D presents the results at each of the identified designated ecological receptors. The contribution from the Proposed Development has been assessed against the most sensitive feature

in each site. As shown in Annex D, for all pollutants considered, the process contribution is less than 1% of the long term and less than 10% of the short term Critical Level at all statutory and non-statutory designated sites with the exception of:

- Barlosh Moss (B) for nitrogen deposition (grassland) and acid deposition (grassland);

- Burnock Water for nitrogen deposition (both woodland and grassland) and acid deposition (woodland); and

- Ancient Woodlands 2,3 and 4 for nitrogen deposition (woodland) and acid deposition (woodland).

The spatial distribution of atmospheric emissions results are shown in Figures 16 – 19.

9 Plume visibility

9.1 Introduction

There is the potential for the plume to be visible under certain circumstances. ADMS 5.2 includes a plume visibility module, which models the dispersion and cooling of water vapour and predicts whether the plume will be visible, based on the liquid water content of the plume. This module has been used to quantify the number of visible plumes likely to occur during the operation of the Proposed Development. These results have been drawn upon in the EAIR Chapter 10 (Landscape and Visual Impact).

9.2 Assessment

The following table sets out the criteria for impact description of plume visibility, in accordance with IPPC H1.

Table 28: Impact descriptors for plume visibility

Impact	Quantitative description
Zero	No visible impacts resulting from operation of process.
Insignificant	Regular small impact from operation of process. Plume length exceeds boundary <5% of daylight hours per year. No local sensitive receptors
Low	Regular small impact from operation of process. Plume length exceeds boundary <5% of daylight hours per year. Sensitive local receptors.
Medium	Regular large impact from operation of process. Plume length exceeds boundary >5% of daylight hours per year. Sensitive local receptors.
High	Continuous large impact from operation of process. Plume length exceeds boundary >25% of daylight hours per year with obscuration. Local sensitive receptors.

9.3 Results

The results of the plume visibility modelling are set out below. The following parameters have been calculated:

- The length of the longest visible plume;
- The number of visible plumes during daylight hours;
- The percentage of modelled daylight hours with any visible plume;
- The number of plumes exceeding the boundary during daylight hours;
- The percentage of modelled daylight hours a visible plume exceeds the site boundary; and
- Percentage of visible plumes with a length of more than; 20m; 50m; 100; and 200m.

The following tables set out the results of the modelling for the five years of meteorological data.

Table 29: Plume visibility summary

	2015	**2016**	**2017**	**2018**	**2019**	**Average**
Length of longest visible plume (m)	195	199	228	264	249	227
Total number of visible plumes in daylight hours	306	271	141	356	241	263
% of modelled daylight hours with any visible plumes	7.7%	6.8%	3.4%	9.0%	6.0%	6.6%
Total number of plumes exceeding site boundary during daylight hours	53	57	33	143	75	72
% of modelled daylight hours a visible plume exceeds site boundary	1.33%	1.44%	0.8%	3.61%	1.86%	1.81%
Number of visible plumes in daylight hours						
>20m from stack	190	155	61	215	147	153.6
>50m from stack	83	53	14	77	57	56.8
>100m from stack	26	10	2	19	16	14.6
>200m from stack	0	0	1	4	1	1.2
Percentage of daylight hours a plume is visible						
>20m from stack	4.8%	3.9%	1.5%	5.4%	3.6%	3.8%
>50m from stack	2.1%	1.3%	0.3%	1.9%	1.4%	1.4%
>100m from stack	0.7%	0.3%	0.0%	0.5%	0.4%	0.4%
>200m from stack	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
Percentage of visible plumes which the length is						
>20m from stack	62.1%	57.2%	43.3%	60.4%	61.0%	56.8%
>50m from stack	27.1%	19.6%	9.9%	21.6%	23.7%	20.4%
>100m from stack	8.5%	3.7%	1.4%	5.3%	6.6%	5.1%
>200m from stack	0.0%	0.0%	0.7%	1.1%	0.4%	0.4%

Annexes

A Glossary

Table 30: Glossary

Acronym	Definition
AAD	Air quality directive (Directive 2008/50/EC) and the fourth daughter Directive (Directive 2004/107/EC)
ADMS	Advanced dispersion modelling system – new generation Gaussian plume air dispersion modell**ing** software developed by CERC
AERMOD	Steady-state dispersion modelling software developed by AERMIC (American meteorological society and US environmental protection agency
APIS	Air Pollution Information System
AQAL	Air quality assessment level
AQS	Air Quality Strategy
BAT	Best available techniques
BAT-AELs	BAT-Associated Emission Limits
BREF	BAT reference document
CAFS	Cleaner Air for Scotland
CERC	Cambridge Environmental Research Consultants
CLmaxN	Maximum Critical Load for nitrogen
CLmaxS	Maximum Critical Load for sulphur
CLminN	Minimum Critical Load for nitrogen
Critical Level	Concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur according to present knowledge *(APIS)*
Critical Load	A quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge *(APIS)*
EA	Environment Agency
EAL	Environmental Assessment Levels

Acronym	Definition
EIAR	Environmental impact assessment report
EPAQS	Expert Panel on Air Quality Standards
ERP	Energy Recovery Park
HCl	Hydrogen chloride
IAQM	Institute of Air Quality Management
IED	Industrial Emissions Directive
IPPC	Integrated pollution prevention and control
LNR	Local Nature Reserve
LWS	Local Wildlife Site
N	Nitrogen
NAIE	National Atmospheric Emissions Inventory
NNR	National Nature Reserve
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen
PAH	Polycyclic aromatic hydrocarbon
PC	Process contribution
PCB	Polychlorinated biphenyl
PEC	Predicted environmental concentration
PM_{10}	Particulate matter with particles with a diameter of less than 10 microns
$PM_{2.5}$	Particulate matter with particles with a diameter of less than 2.5 microns
S	Sulphur
SAC	Special Areas of Conservation

Acronym	Definition
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TOC	Total organic carbon
VOC	Volatile organic compound
WHO	World Health Organisation

B   APIS Critical Loads

Table 31: Nitrogen Deposition Critical Loads

Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
European sites within 15 km					
Airds Moss	Blanket Bog	Raised and blanket bogs	5	10	16.9
Muirkirk and North Lowther Uplands (A)	Montane	Moss and lichen dominated mountain summits	5	10	19.9
UK designated sites within 15 km					
River Ayr Gorge	Upland Oak woodland*	Coniferous woodland*	5	15	34.3
Muirkirk Uplands	Blanket Bog	Raised and Blanket bogs	5	10	14.6
Barlosh Moss	Bogs	Raised and blanket bogs	5	10	20.6
Dalmellington Moss	Bogs	Raised and blanket bogs	5	10	20.6
Bogton Loch	Fen, marsh and swamp	Valley mires, poor fens and transition mires	10	15	16.8
Martnaham Loch and Wood	Upland Oak Woodland*	Coniferous woodland*	5	15	29.5
Locally designated sites within 2 km					
Burnock Water	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3
	Alpine grasslands	Alpine and subalpine grasslands	5	10	21.6
Ancient woodland 1	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3
Ancient woodland 2	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3

Site	Species/Habitat Type	NCL Class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Maximum Background (kgN/ha/yr)
Ancient woodland 3	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3
Ancient woodland 4	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3
Ancient woodland 5	Broadleaved, mixed and yew woodland	Broadleaved deciduous woodland	10	20	34.3
Note: * have used the lowest critical load on APIS to be conservative. Site descriptions actually imply a broadleaved deciduous woodland.					

Table 32: Acid Deposition Critical Loads

Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			CLminN	CLmaxN	CLmaxS	Nitrogen	Sulphur
European designated sites within 15 km							
Airds Moss	Blanket Bogs	Bog	0.321	0.67	0.349	1.2	0.1
Muirkirk and North Lowther Uplands	Montane	Montane	0.178	0.668	0.359	1.4	0.2
UK designated sites within 15 km							
River Ayr Gorge	Broadleafed Woodland	Broadleafed/Coniferous unmanaged woodland	0.357	3.925	3.568	2.45	0.15
Muirkirk Uplands	Blanket Bogs	Bogs	0.321	0.683	0.362	1.04	0.12
Barlosh Moss	Bogs	Bogs	0.321	0.729	0.478	1.47	0.15
Dalmellington Moss	Bogs	Bogs	0.321	0.889	0.568	1.2	0.19
Bogton Loch	Fens	Not sensitive to acidity	-	-	-	1.2	0.19
Martnaham Loch and Wood	Upland Oak woodland	Unmanaged Broadleafed/Coniferous unmanaged woodland	0.357	1.832	1.475	2.11	0.16
Locally designated sites within 2 km							
Burnock Water	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.725	2.368	2.45	0.15
	Acid grassland	Alpine and subalpine grasslands	0.438	2.028	1.59	1.54	0.13
Ancient woodland 1	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.725	2.368	2.45	0.15
Ancient woodland 2	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.725	2.368	2.45	0.15

Site	Species/Habitat Type	Acidity Class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			CLminN	**CLmaxN**	**CLmaxS**	**Nitrogen**	**Sulphur**
Ancient woodland 3	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.725	2.368	2.45	0.15
Ancient woodland 4	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.707	2.35	2.45	0.15
Ancient woodland 5	Broadleaved, mixed and yew woodland	Broadleafed/Coniferous unmanaged woodland	0.357	2.724	2.367	2.45	0.15

C Atmospheric emissions results at ecological sites

Table 33:   Process contributions at ecological sites

Site	Process Contribution – ERC Only											
	Oxides of nitrogen				Sulphur dioxide		Hydrogen fluoride				Ammonia	
	Annual Mean		Daily Mean		Annual Mean		Weekly Mean		Daily Mean		Annual Mean	
	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL
European sites within 15km												
Airds Moss (A)	0.028	0.09%	0.35	0.47%	0.01	0.07%	<0.01	0.15%	<0.01	0.06%	0.002	0.23%
Airds Moss (B)	0.021	0.07%	0.21	0.28%	0.01	0.05%	<0.01	0.10%	<0.01	0.04%	<0.01	0.17%
Muirkirk and North Lowther Uplands (A)	0.028	0.09%	0.37	0.49%	0.01	0.07%	<0.01	0.15%	<0.01	0.06%	<0.01	0.23%
Muirkirk and North Lowther Uplands (B)	0.024	0.08%	0.21	0.28%	0.01	0.06%	<0.01	0.12%	<0.01	0.04%	<0.01	0.20%
Muirkirk and North Lowther Uplands (C)	0.008	0.03%	0.12	0.16%	<0.01	0.02%	<0.01	0.05%	<0.01	0.02%	<0.01	0.07%
Muirkirk and North Lowther Uplands (D)	0.015	0.05%	0.22	0.29%	<0.01	0.04%	<0.01	0.10%	<0.01	0.04%	<0.01	0.12%
Muirkirk and North Lowther Uplands (E)	0.013	0.04%	0.14	0.19%	<0.01	0.03%	<0.01	0.06%	<0.01	0.02%	<0.01	0.11%
UK designated sites within 15 km												
River Ayr Gorge	0.026	0.09%	0.63	0.84%	0.01	0.07%	0.00	0.24%	0.01	0.11%	0.00	0.22%
Muirkirk Uplands (A)	0.015	0.05%	0.21	0.28%	0.00	0.04%	0.00	0.10%	0.00	0.04%	0.00	0.13%
Muirkirk Uplands (B)	0.009	0.03%	0.12	0.16%	0.00	0.02%	0.00	0.06%	0.00	0.02%	0.00	0.08%
Barlosh Moss (A)	0.034	0.11%	1.24	1.65%	0.01	0.09%	0.00	0.68%	0.01	0.21%	0.00	0.28%
Barlosh Moss (B)	0.138	0.46%	1.47	1.96%	0.03	0.35%	0.01	1.04%	0.01	0.24%	0.01	1.15%
Dalmellington Moss	0.004	0.01%	0.19	0.25%	0.00	0.01%	0.00	0.09%	0.00	0.03%	0.00	0.03%
Bogton Loch	0.003	0.01%	0.16	0.21%	0.00	0.01%	0.00	0.10%	0.00	0.03%	0.00	0.03%
Martnaham Loch and Wood	0.021	0.07%	0.43	0.57%	0.01	0.05%	0.00	0.30%	0.00	0.07%	0.00	0.18%

Site	Process Contribution – ERC Only											
	Oxides of nitrogen				Sulphur dioxide		Hydrogen fluoride				Ammonia	
	Annual Mean		Daily Mean		Annual Mean		Weekly Mean		Daily Mean		Annual Mean	
	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL	µg/m³	% of CL
Locally designated sites within 2km												
Burnock Water	0.216	0.72%	1.57	2.09%	0.05	0.54%	0.01	1.09%	0.01	0.26%	0.02	0.60%
Ancient woodland 1	0.058	0.19%	2.07	2.76%	0.01	0.15%	0.00	0.62%	0.02	0.34%	0.00	0.48%
Ancient woodland 2	0.751	2.50%	5.58	7.43%	0.19	1.88%	0.02	4.28%	0.05	0.93%	0.06	6.26%
Ancient woodland 3	0.594	1.98%	3.71	4.94%	0.15	1.49%	0.02	3.10%	0.03	0.62%	0.05	4.95%
Ancient woodland 4	0.264	0.88%	2.39	3.19%	0.07	0.66%	0.01	1.54%	0.02	0.40%	0.02	2.20%
Ancient woodland 5	0.101	0.34%	2.08	2.77%	0.03	0.25%	0.01	1.74%	0.02	0.35%	0.01	0.84%

D Deposition of emissions results at ecological sites

Table 34: Annual mean process contribution used for Deposition analysis

Site	Annual Mean Process Contribution (ng/m³)			
	Nitrogen dioxide	**Sulphur dioxide**	**Hydrogen chloride**	**Ammonia**
European sites within 15km				
Airds Moss (A)	19.37	6.92	1.38	2.30
Airds Moss (B)	14.45	5.16	1.03	1.72
Muirkirk and North Lowther Uplands (A)	19.48	6.96	1.39	2.32
Muirkirk and North Lowther Uplands (B)	16.83	6.01	1.20	2.00
Muirkirk and North Lowther Uplands (C)	5.67	2.02	0.40	0.67
Muirkirk and North Lowther Uplands (D)	10.51	3.75	0.75	1.25
Muirkirk and North Lowther Uplands (E)	9.26	3.31	0.66	1.10
UK designated sites within 15 km				
River Ayr Gorge	18.26	6.52	1.30	2.17
Muirkirk Uplands (A)	10.63	3.80	0.76	1.26
Muirkirk Uplands (B)	6.57	2.35	0.47	0.78
Barlosh Moss (A)	23.86	8.52	1.70	2.84
Barlosh Moss (B)	96.58	34.50	6.89	11.49
Dalmellington Moss	2.66	0.95	0.19	0.32
Bogton Loch	2.39	0.85	0.17	0.28
Martnaham Loch and Wood	14.81	5.29	1.06	1.76
Locally designated sites within 2km				
Burnock Water	150.93	53.92	10.77	17.95

Site	Annual Mean Process Contribution (ng/m³)			
	Nitrogen dioxide	**Sulphur dioxide**	**Hydrogen chloride**	**Ammonia**
Ancient woodland 1	40.63	14.51	2.90	4.83
Ancient woodland 2	526.03	187.92	37.54	62.57
Ancient woodland 3	415.90	148.58	29.68	49.47
Ancient woodland 4	184.88	66.05	13.20	21.99
Ancient woodland 5	70.88	25.32	5.06	8.43

Table 35: Deposition Calculation – Grassland

Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen dioxide	**Sulphur dioxide**	**Hydrogen chloride**	**Ammonia**		**N**	**S**
European sites within 15km							
Airds Moss (A)	0.003	0.013	0.011	0.012	0.015	0.001	0.001
Airds Moss (B)	0.002	0.010	0.008	0.009	0.011	0.001	0.001
Muirkirk and North Lowther Uplands (A)	0.003	0.013	0.011	0.012	0.015	0.001	0.001
Muirkirk and North Lowther Uplands (B)	0.002	0.011	0.009	0.010	0.013	0.001	0.001
Muirkirk and North Lowther Uplands (C)	0.001	0.004	0.003	0.004	0.004	0.000	0.000
Muirkirk and North Lowther Uplands (D)	0.002	0.007	0.006	0.006	0.008	0.001	0.001
Muirkirk and North Lowther Uplands (E)	0.001	0.006	0.005	0.006	0.007	0.001	0.001
UK designated sites within 15 km							
River Ayr Gorge	0.003	0.012	0.010	0.011	0.014	0.001	0.001
Muirkirk Uplands (A)	0.002	0.007	0.006	0.007	0.008	0.001	0.001
Muirkirk Uplands (B)	0.001	0.004	0.004	0.004	0.005	0.000	0.000
Barlosh Moss (A)	0.003	0.016	0.013	0.015	0.018	0.001	0.002

Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
Barlosh Moss (B)	0.014	0.065	0.053	0.060	0.074	0.005	0.007
Dalmellington Moss	0.000	0.002	0.001	0.002	0.002	0.000	0.000
Bogton Loch	0.000	0.002	0.001	0.001	0.002	0.000	0.000
Martnaham Loch and Wood	0.002	0.010	0.008	0.009	0.011	0.001	0.001
Locally designated sites within 2km							
Burnock Water	0.022	0.102	0.083	0.093	0.115	0.008	0.011
Ancient woodland 1	0.006	0.027	0.022	0.025	0.031	0.002	0.003
Ancient woodland 2	0.076	0.356	0.288	0.325	0.401	0.029	0.038
Ancient woodland 3	0.060	0.281	0.228	0.257	0.317	0.023	0.030
Ancient woodland 4	0.027	0.125	0.101	0.114	0.141	0.010	0.014
Ancient woodland 5	0.010	0.048	0.039	0.044	0.054	0.004	0.005

Table 36: : Deposition Calculation – Woodland

Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
European sites within 15km							
Airds Moss (A)	0.006	0.026	0.025	0.018	0.024	0.002	0.003
Airds Moss (B)	0.004	0.020	0.019	0.013	0.018	0.001	0.002
Muirkirk and North Lowther Uplands (A)	0.006	0.026	0.026	0.018	0.024	0.002	0.003
Muirkirk and North Lowther Uplands (B)	0.005	0.023	0.022	0.016	0.020	0.001	0.003

Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
	Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
Muirkirk and North Lowther Uplands (C)	0.002	0.008	0.007	0.005	0.007	0.000	0.001
Muirkirk and North Lowther Uplands (D)	0.003	0.014	0.014	0.010	0.013	0.001	0.002
Muirkirk and North Lowther Uplands (E)	0.003	0.013	0.012	0.009	0.011	0.001	0.001
UK designated sites within 15 km							
River Ayr Gorge	0.005	0.025	0.024	0.017	0.022	0.002	0.003
Muirkirk Uplands (A)	0.003	0.014	0.014	0.010	0.013	0.001	0.002
Muirkirk Uplands (B)	0.002	0.009	0.009	0.006	0.008	0.001	0.001
Barlosh Moss (A)	0.007	0.032	0.031	0.022	0.029	0.002	0.004
Barlosh Moss (B)	0.028	0.131	0.127	0.090	0.117	0.008	0.015
Dalmellington Moss	0.001	0.004	0.003	0.002	0.003	0.000	0.000
Bogton Loch	0.001	0.003	0.003	0.002	0.003	0.000	0.000
Martnaham Loch and Wood	0.004	0.020	0.019	0.014	0.018	0.001	0.002
Locally designated sites within 2km							
Burnock Water	0.043	0.204	0.198	0.140	0.183	0.013	0.024
Ancient woodland 1	0.012	0.055	0.053	0.038	0.049	0.004	0.006
Ancient woodland 2	0.151	0.711	0.691	0.487	0.639	0.046	0.083
Ancient woodland 3	0.120	0.562	0.546	0.385	0.505	0.036	0.066
Ancient woodland 4	0.053	0.250	0.243	0.171	0.225	0.016	0.029
Ancient woodland 5	0.020	0.096	0.093	0.066	0.086	0.006	0.011

Table 37: Detailed Results – Nitrogen Deposition

Site	NCL Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			kgN/ha/yr	% of Lower CL	% of Upper CL	kgN/ha/yr	% of Lower CL	% of Upper CL
European and UK designated sites (within 15km)								
Airds Moss (A)	Raised and blanket bogs	Grassland	0.01	0.30%	0.15%	16.91	338.30%	169.15%
Airds Moss (B)	Raised and blanket bogs	Grassland	0.01	0.22%	0.11%	16.91	338.22%	169.11%
Muirkirk and North Lowther Uplands (A)	Moss and lichen dominated mountain summits	Grassland	0.01	0.30%	0.15%	19.91	398.30%	199.15%
Muirkirk and North Lowther Uplands (B)	Moss and lichen dominated mountain summits	Grassland	0.01	0.26%	0.13%	19.91	398.26%	199.13%
Muirkirk and North Lowther Uplands (C)	Moss and lichen dominated mountain summits	Grassland	<0.01	0.09%	0.04%	19.90	398.09%	199.04%
Muirkirk and North Lowther Uplands (D)	Moss and lichen dominated mountain summits	Grassland	0.01	0.16%	0.08%	19.91	398.16%	199.08%
Muirkirk and North Lowther Uplands (E)	Moss and lichen dominated mountain summits	Grassland	0.01	0.14%	0.07%	19.91	398.14%	199.07%
UK designated sites within 15 km								
River Ayr Gorge	Coniferous	Woodland	0.02	0.44%	0.15%	34.32	686.44%	228.81%
Muirkirk Uplands (A)	Raised and Blanket bogs	Grassland	0.01	0.16%	0.08%	14.57	291.36%	145.68%
Muirkirk Uplands (B)	Raised and Blanket bogs	Grassland	0.01	0.10%	0.05%	14.57	291.30%	145.65%
Barlosh Moss (A)	Raised and blanket bogs	Grassland	0.02	0.36%	0.18%	20.60	411.96%	205.98%
Barlosh Moss (B)	Raised and blanket bogs	Grassland	0.07	**1.47%**	0.74%	20.65	413.07%	206.54%
Dalmellington Moss	Raised and blanket bogs	Grassland	0.00	0.04%	0.02%	16.80	336.04%	168.02%

Site	NCL Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			kgN/ha/yr	% of Lower CL	% of Upper CL	kgN/ha/yr	% of Lower CL	% of Upper CL
Bogton Loch	Valley mires, poor fens and transition mires	Grassland	0.00	0.02%	0.01%	16.80	168.02%	112.01%
Martnaham Loch and Wood	Coniferous woodland	Woodland	0.02	0.36%	0.12%	29.56	591.16%	197.05%
Locally designated sites (within 2km)								
Burnock Water	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.18	**1.83%**	0.92%	34.48	344.83%	172.42%
	Alpine and subalpine grasslands	Alpine and subalpine grasslands	0.11	**2.30%**	1.15%	21.67	433.50%	216.75%
Ancient woodland 1	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.05	0.49%	0.25%	34.35	343.49%	171.75%
Ancient woodland 2	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.64	**6.39%**	3.19%	34.94	349.39%	174.69%
Ancient woodland 3	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.51	**5.05%**	2.53%	34.81	348.05%	174.03%
Ancient woodland 4	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.22	**2.25%**	1.12%	34.52	345.25%	172.62%

Site	NCL Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			kgN/ha/yr	% of Lower CL	% of Upper CL	kgN/ha/yr	% of Lower CL	% of Upper CL
Ancient woodland 5	Broadleaved deciduous woodland	Broadleaved deciduous woodland	0.09	0.86%	0.43%	34.39	343.86%	171.93%

Table 38: Detailed results – Acid deposition

Site	Acidity Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function
European and UK designated sites (within 15km)								
Airds Moss (A)	Bog	Grassland	0.001	0.001	0.37%	1.20	0.10	194.40%
Airds Moss (B)	Bog	Grassland	0.001	0.001	0.27%	1.20	0.10	194.30%
Muirkirk and North Lowther Uplands (A)	Montane	Grassland	0.001	0.001	0.37%	1.40	0.20	239.89%
Muirkirk and North Lowther Uplands (B)	Montane	Grassland	0.001	0.001	0.32%	1.40	0.20	239.84%
Muirkirk and North Lowther Uplands (C)	Montane	Grassland	0.000	0.000	0.11%	1.40	0.20	239.63%
Muirkirk and North Lowther Uplands (D)	Montane	Grassland	0.001	0.001	0.20%	1.40	0.20	239.72%
Muirkirk and North Lowther Uplands (E)	Montane	Grassland	0.001	0.001	0.18%	1.40	0.20	239.70%

Site	Acidity Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function
UK designated sites within 15 km								
River Ayr Gorge	Broadleafed/Coniferous unmanaged woodland	Woodland	0.002	0.003	0.11%	0.002	0.003	0.11%
Muirkirk Uplands (A)	Bogs	Grassland	0.001	0.001	0.20%	0.001	0.001	0.20%
Muirkirk Uplands (B)	Bogs	Grassland	0.000	0.000	0.12%	0.000	0.000	0.12%
Barlosh Moss (A)	Bogs	Grassland	0.001	0.002	0.42%	0.001	0.002	0.42%
Barlosh Moss (B)	Bogs	Grassland	0.005	0.007	**1.69%**	0.005	0.007	1.69%
Dalmellington Moss	Bogs	Grassland	0.000	0.000	0.04%	0.000	0.000	0.04%
Bogton Loch	Not sensitive to acidity	Grassland	0.000	0.000	-	0.000	0.000	-
Martnaham Loch and Wood	Unmanaged Broadleafed/Coniferous unmanaged woodland	Woodland	0.001	0.002	0.20%	0.001	0.002	0.20%
Locally designated sites (within 2km)								
Burnock Water	Broadleafed/Coniferous unmanaged woodland	Woodland	0.013	0.024	**1.36%**	2.46	0.17	96.77%
	Alpine and subalpine grasslands	Grassland	0.008	0.011	0.95%	1.55	0.14	83.30%
Ancient woodland 1	Broadleafed/Coniferous unmanaged woodland	Woodland	0.004	0.006	0.37%	2.45	0.16	95.78%
Ancient woodland 2	Broadleafed/Coniferous unmanaged woodland	Woodland	0.046	0.083	**4.73%**	2.50	0.23	100.15%
Ancient woodland 3	Broadleafed/Coniferous unmanaged woodland	Woodland	0.036	0.066	**3.74%**	2.49	0.22	99.16%

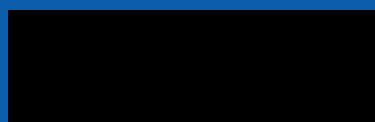| Site	Acidity Class	Deposition Velocity	Process Contribution			Predicted Environmental Concentration		
			N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of Min CL Function
Ancient woodland 4	Broadleafed/Coniferous unmanaged woodland	Woodland	0.016	0.029	**1.68%**	2.47	0.18	97.72%
Ancient woodland 5	Broadleafed/Coniferous unmanaged woodland	Woodland	0.006	0.011	0.64%	2.46	0.16	96.09%

E   Figures

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