Environmental Visage

DETAILED AIR QUALITY ASSESSMENT FOR A PROPOSED ENERGY RECOVERY FACILITY, IRVINE, SCOTLAND

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Executive Summary

WEP Partners Limited proposes to develop an Energy Recovery Facility (ERF) on a brownfield site within the Oldhall West Industrial Estate, Irvine. Detailed atmospheric dispersion modelling has been undertaken to consider the potential impact of the emissions to atmosphere from the proposed facility Modelling has considered normal operating conditions at maximum output and discharging emissions to atmosphere via a 60-metre high chimney, as well as short-term and abnormal releases. Emissions were based upon the achievable limits for new plant, as specified in the European BAT-Conclusions document.

The assessment began with a ‘D1’ chimney height calculation and iterative modelling assessment, followed by a detailed dispersion model. Modelling was undertaken using ADMS Version 5.2 and incorporated a sensitivity analysis to assess the results against a second modelling platform, AERMOD.

Modelling predicted that, under normal operating conditions the maximum annual average Process Contribution for NO_2 would be about 2 µg m^{-3}, or approximately 6 % of the 40 µg m^{-3} annual objective value. The location of the maximum Process Contribution was predicted to be about 290 metres to the north-east of the chimney serving the ERF, with values considerably lower farther afield. The Process Contributions for the other prescribed pollutants indicated that there would be no exceedance of their respective Air Quality Standard objective values and relevant environmental assessment levels, and contributions could be screened as insignificant at the initial or secondary assessment stages.

Short-term Process Contributions and Predicted Environmental Concentrations also remained within their stated Environmental Quality Standards when discharging at the allowable half-hourly limit values and were therefore screened as insignificant, although the impact of half-hourly emissions of NO_2 does exceed 20 % of the hourly average assessment level. This exceedance does not occur at any sensitive human health receptors.

An assessment of the cumulative impact of emissions from the proposed ERF with those from a STOR facility that recently received planning permission from North Ayrshire Council showed that, assuming that both facilities are developed in due course, there would generally be a small increase in NO_x Process Contributions and deposition impacts in the vicinity of the two facilities, but the resulting increases would not have a significant adverse impact on local air quality.

The overall conclusion from detailed modelling of emissions from the proposed ERF to be developed by WEP Partners, near Irvine, is that the potential impact on local air quality is likely to be small and is unlikely to have a significant impact on the health of people living and working nearby, or the surrounding environment as a whole.

Contents

Issue and Revision Record

Issue	Date	Author	Review / Authorise	Description
1	09/01/2019	[redacted]		Initial Draft
2	04/04/2019			Initial Draft
3	24/04/2019			Version 1
4	08/05/2019			Version 2
5	10/06/2019			Version 3
6	10/09/2020			Version 4
7	12/10/2020			Version 5
8	14/10/2020			Version 6 - Formatting only
9	25/10/2020			Version 7 – Final amendments

1. Introduction

WEP Partners Limited proposes to develop an Energy Recovery Facility (ERF) to process up to 180,000 tonnes per annum of residual commercial and industrial (C&I) waste and residual municipal solid waste (MSW).

The processing of waste by the proposed development will generate an estimated 15 MW_e of electricity per annum, of which approximately 12 MW_e would be available for export to the National Grid, with the remainder used by the facility itself. The proposed development would also be capable of supplying electricity and heat directly to local businesses or residential areas. The amount of electricity and heat distributed would be determined by potential customers' energy requirements and commercial terms.

The principal components of the proposed development are as follows:

- A series of buildings incorporating a fuel reception hall, bunker and control room, boiler and turbine halls and a flue-gas treatment hall. The heights of each of these buildings vary, ranging from 20 m to 40 m metres.

- A chimney will be located to the north of the boiler hall to disperse emissions from the waste incineration process. The 60 m height of the chimney has been confirmed by detailed modelling of the emissions to atmosphere to ensure that there are no unacceptable impacts to human health and the environment.

Detailed atmospheric dispersion modelling of process emissions from the ERF chimney has been undertaken in support of planning and PPC Permit applications for the facility. The objective of the modelling exercise was to assess the potential impact of the process emissions from the ERF on local air quality, in terms of ground level concentrations of pollutants designated by Scottish Air Quality Regulations and other relevant Environmental Assessment Levels (EALs) recommended by the Scottish Environment Protection Agency (SEPA). Modelling was based upon emissions and process data, and site drawings supplied by Castellum Consulting Limited, planning advisors to WEP Partners, and Fichtner Consulting Engineers Limited who are preparing the PPC Permit application.

This report describes the data used, the methodology adopted, assumptions made, and the results generated by the model.

1.1 ADMS Model

The main modelling software used was ADMS Version 5.2, one of a range of atmospheric dispersion models available for assessing the impact on local air quality of pollutant emissions to atmosphere. The ADMS model uses two parameters to describe the atmospheric boundary layer, namely the boundary layer height (*h*) and the Monin-Obukhov Length (L_{MO}), and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions. Models used routinely in the UK for this sort of application include United States Environmental Protection Agency (US-EPA) models such as AERMOD, and the ADMS models developed in the UK by Cambridge Environmental Research Consultants (CERC)[1]. As requested by SEPA, a sensitivity analysis of the results obtained through the use of ADMS has been undertaken with the AERMOD model, and is reported in Section 4.18.

The ADMS model can be used to assess ambient pollutant concentrations arising from a wide variety of emissions sources associated with an industrial process. It can be used for initial screening or more refined determination of ground level pollutant concentrations on either a short-term basis (up to 24-hour averages) or longer term (monthly, quarterly or annual averages).

Modelling Uncertainty

Atmospheric dispersion modelling is not a precise science and results can be impacted by a variety of factors such as:

- Model uncertainty - due to limitations in the dispersion algorithms incorporated into the model and their ability to replicate “real life” situations;
- Data uncertainty - due to potential errors associated with emission estimates, discharge characteristics, land use characteristics and the relevance of the meteorological data to a particular location; and,
- Variability - randomness of measurements used.

CERC models are continually validated against available measured data obtained from real world situations, field campaigns and wind tunnel experiments. Validation of the ADMS dispersion models has been performed using many experimental datasets that test different aspects of the models, for instance: ground / high level sources, passive and buoyant releases, buildings, complex terrain, chemistry, deposition and plume visibility. These studies are both short-term as well as annual, and involve tracer gases or specific pollutants of interest.

Potential uncertainties in model results derived from the current study have been minimised as far as practicable, and a series of worst-case assumptions have been applied to the input data in order to provide a robust assessment. This included the following:

- Selection of the dispersion model - ADMS 5.2 is a commonly used atmospheric dispersion model and results have been verified through a number of inter-comparison studies to ensure that model predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using hourly average meteorological data from the nearby Prestwick Airport measurement station which is considered to be the most representative of local conditions;
- ERF operating conditions – Data on the likely discharges from the development were provided by Fichtner Consulting Engineers Limited, who are preparing the PPC Permit application on behalf of WEP Partners. As the proposed ERF is not yet operational, all of the information provided regarding the discharge conditions is naturally theoretical;
- Receptor locations - A 4 km x 4 km Cartesian Grid (20-metre grid spacing) was utilised in the model in order to calculate maximum predicted concentrations in the vicinity of the ERF. Specific receptor locations were also included in the model to provide detailed assessment at these sensitive locations; and,
- Variability - All model inputs are as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

Results were considered in the context of Scottish Air Quality Standard (AQS) objective values and relevant environmental assessment levels recommended by SEPA. The application of the above measures to reduce uncertainty and the use of a series of worst-case assumptions relating to the operational performance of the process should result in model accuracy of an acceptable level.

2. Modelling Input Data

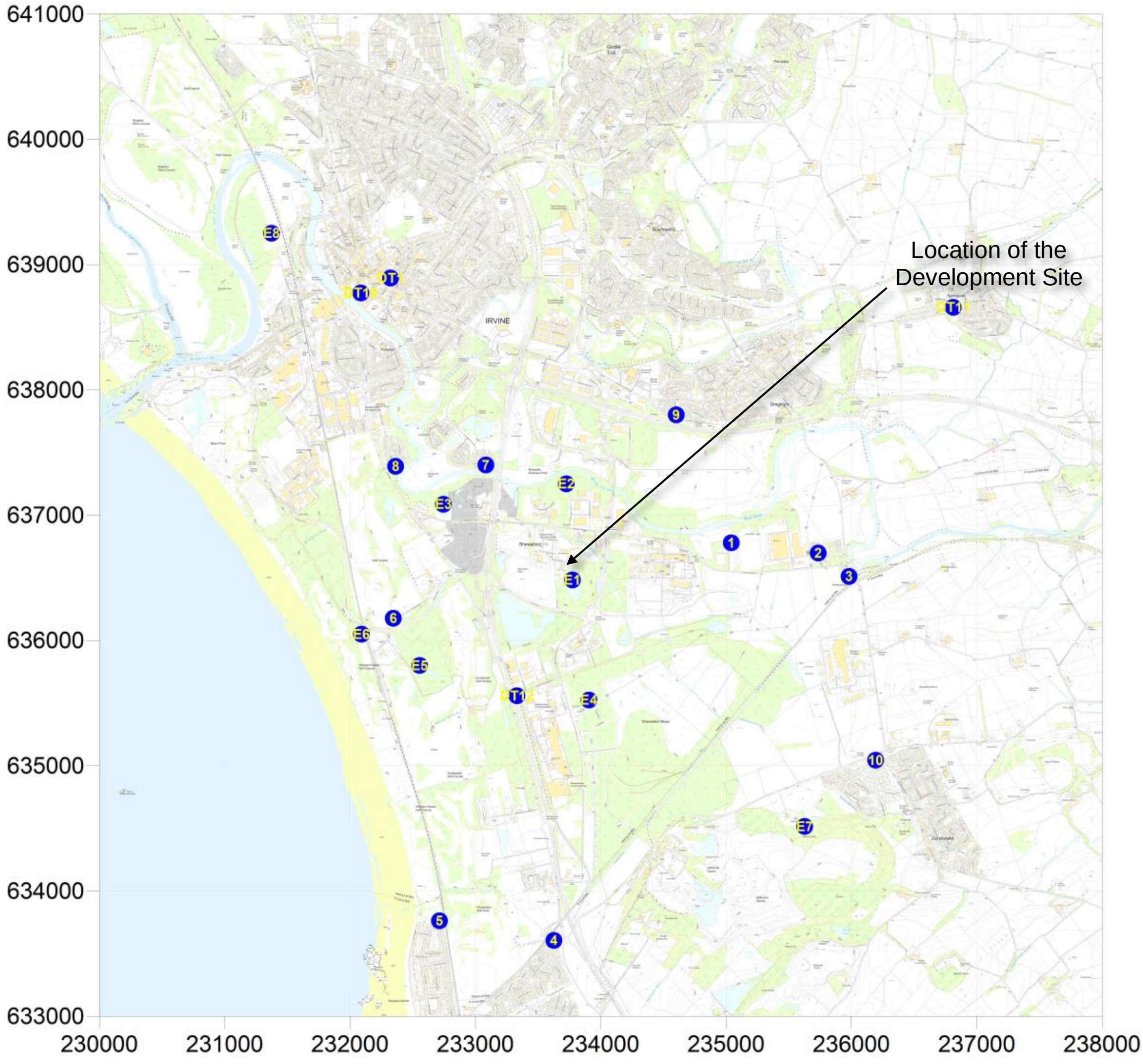
2.1 Introduction

This section provides a summary of the input data used in the model.

2.2 Site Location and Local Setting

The site of the proposed development is located to the south of Murdoch Place within the Oldhall West Industrial Estate, Irvine – Ordnance Survey Co-ordinates NS 33627 36643. Land use in the vicinity of the development site is predominantly industrial / commercial, interspersed with scrubland, and with the nearest residential properties approximately 1 km to the north-west of the chimney of the ERF. Some of the specific receptors included in the model are shown by the blue circles on the plan. Those numbered 1 - 10 represent locations where members of the general public may be present for significant periods of time, either through residence or occupation. Additional receptors, representing nearby ecological habitats (prefixed with E), are also shown, as are receptors where North Ayrshire Council undertakes NO_2 diffusion tube monitoring (prefixed with DT). Figure 1 shows the local setting of the facility.

Figure 1 The Local Setting Showing the Location of the Proposed ERF Development Site



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2.3 Plant Details

The ADMS model requires emission sources to be defined in terms of dimensions, location and physical characteristics of temperature and velocity. This modelling study has been carried out to assess the potential impact on local air quality due to releases of atmospheric pollutants from the single chimney associated with the proposed ERF. Modelling was based upon emissions and process data, and site drawings supplied by Castellum Consulting Limited, planning advisors to WEP Partners, and Fichtner Consulting Engineers Limited who are preparing the PPC Permit application. The ERF will consist of purpose-built process buildings that will incorporate the fuel reception, storage and handling area, the waste incineration line and associated power generation equipment.

There will be vehicle movements associated with the operation of the ERF, including delivery of waste to the site, transfer of materials within the site, and removal of solid residues from the site. Air quality impacts associated with vehicular movements into and out of the development site are dealt with in a separate report and should be referred to separately.

The ERF will be operational for approximately 8,000 hours (about 91 %) a year. The remainder of the time, the ERF will be offline for routine maintenance. However, the model was run to calculate annual average Process Contributions for all 8,760 or 8,784 hours of the year, therefore representing a worst-case condition.

2.4 Emissions Data

The operation of the ERF will be regulated by SEPA in line with the conditions of a PPC Permit that will be required to operate the ERF. The process will be regulated under the Pollution Prevention and Control (Scotland) Regulations 2012 (as amended) and will be operated in accordance with conditions for waste incineration plant as defined by the Industrial Emissions Directive (European Community – Directive 2010/75/EU) (IED).

Details of the release characteristics to be considered have their base in the maximum allowable emission limits which will likely be imposed on the site operations. The IED is supported by Best Available Techniques Reference notes (BREFs) and BAT-Conclusions documents, and these specify the allowable emission limits from each regulated process. The Waste Incineration BREF Note[2] and BAT-Conclusions documents[3] specify more stringent emission limits than those originally detailed in the IED, and WEP Partners is committed to employing best available techniques at the site and meeting the relevant emission limits specified. As such, this air quality assessment has been undertaken considering the relevant emission limit values (ELVs) specified for new plant.

The modelled source and emissions data applied to the model are summarised in Tables 1 and 2 respectively. The data apply to the single waste incineration line and its dedicated chimney.

Table 1 Emission Source Parameters

Parameter	Value
Stack Height (m)	60
Stack Diameter (m)	1.84
Efflux Temperature (° C)	140
Oxygen Content (% dry)	8.5
Moisture Content (%)	14.86
Flue-gas Volumetric Flowrate (Am^3/s)	52.99
Flue-gas Volumetric Flowrate (Nm^3/s)	37.35
Efflux Velocity ($m\ s^{-1}$)	19.93
Location (x y)	233703 636609

Table 2 Modelled Emissions Data

Substance	Emission Limit Value (mg Nm^{-3})	Maximum Long-Term Mass Emission Rate (g/s)
Nitrogen Oxides (as NO_2)	120	4.48
Sulphur Dioxide	30	1.12
Carbon Monoxide	50	1.87
Particulates (PM_{10})	5	0.187
VOCs	10	0.374
HCl	6	0.224
HF	1	0.0374
Cadmium / Thallium and Mercury	0.02	0.000747
Other Metals – Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.3	0.0112
Ammonia	10	0.374
Dioxins and Furans	4×10^{-08}	1.49×10^{-09}
Dioxins, Furans and PCBs	6×10^{-08}	2.24×10^{-09}
PAH (as B[a]P only)	0.001	3.74×10^{-05}

Although no limit is specified for PAH within the IED, or the BREF Note[2] or BAT-Conclusions[3] documents which support it, the BREF does suggest an achievable range of PAH emission from incineration plant of 0.00000001 - 0.05 mg m^{-3} as total PAH or 0.000000004 - 0.001 mg m^{-3} as B[a]P. The upper end of this latter range was applied in the modelling, and results are compared with the air quality objective value of 0.25 ng m^{-3} B[a]P.

The pollutant emission rates calculated for the initial modelling exercise represent a worst-case scenario under normal operating conditions with emissions throughout the year at the maximum levels that are expected to be included as conditions in the PPC Permit for the ERF.

2.5 Atmospheric Chemistry

Emissions of NO_x will comprise contributions of Nitric Oxide (NO) and Nitrogen Dioxide (NO_2). Air quality assessments are made against the concentration of NO_2, although assessments for the impact on vegetation are made against the concentrations of NO_x as NO_2. As emissions of NO_2 are only ever a proportion of the total emissions of NO_x, an allowance for the quantity of NO_2 in NO_x has to be made. The following procedure recommended by SEPA[4] was used to calculate annual average and hourly average NO_2 ground-level concentrations from the reported annual average NO_x concentrations:

In time, emissions of NO will oxidise to NO_2 and so the following guidelines are recommended unless justification for an alternative assumption can be provided:

- *short-term emissions: convert all measured or estimated nitrogen oxide emissions to NO_2 and assume 50 % of this value as the short term NO_2 emission.*
- *long-term emissions: convert all measured or estimated nitrogen oxide emissions to NO_2 and use this value as the long-term emission.*

Predicted Environmental Concentrations for NO_2 were calculated using the following formulae:

Equation 1 Calculation of Annual Average NO_2 Predicted Environmental Concentration (PEC)

(Annual NO_x Modelled + Annual NO_2 Monitored)

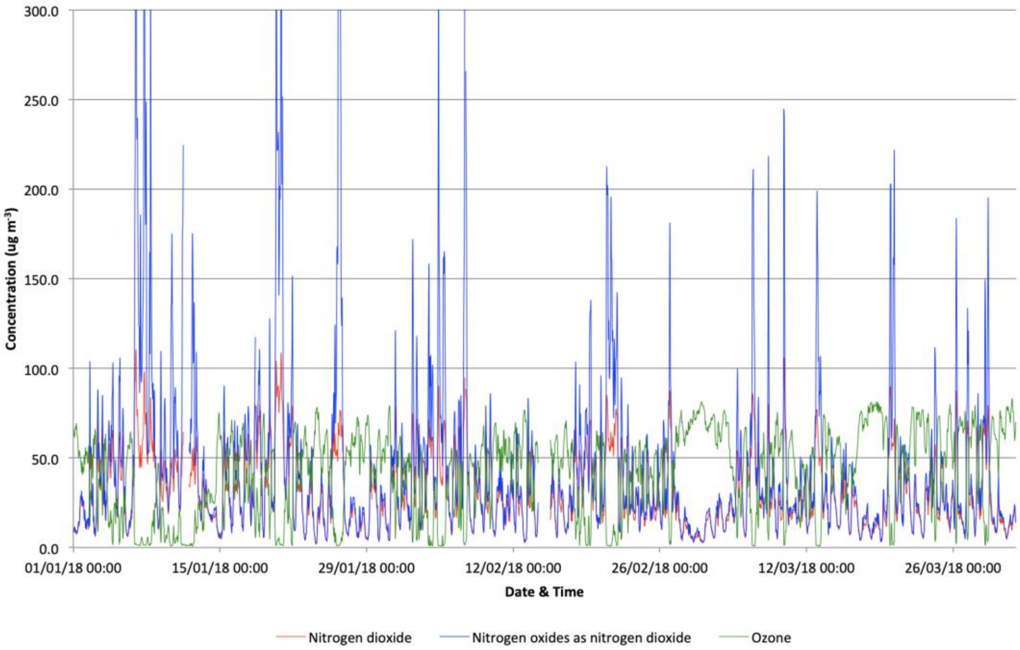
Equation 2 Calculation of Hourly Average NO_2 Predicted Environmental Concentration (PEC)

(Hourly NO_x Modelled x 0.5) + (Annual NO_2 Monitored x 2)

This method may overestimate concentrations of NO_2 in close proximity to the site as the conversion of NO_x to NO_2 is unlikely to be instantaneous, requiring the mixing of the plume with ambient air and its associated oxidant species such as Ozone (O_3) etc.

Atmospheric chemistry in the vicinity of the ERF development site is not constant, as shown by data recorded at the Glasgow Townhead AURN monitoring station, which is located approximately 40 km to the north-east of the development site. This is an urban background monitoring site and provides a reasonable indication of the variability of the atmospheric chemistry in the vicinity of the development site. Data for February to April 2018, plotted below, show the variability of hourly average NO_x, NO_2 and Ozone concentrations, and indicate that the availability of atmospheric oxidants such as Ozone may be much lower at certain times, and varies significantly on a daily basis.

Figure 2 Variation in Hourly Average NO_X, NO_2 and Ozone Concentrations at the Glasgow Townhead Urban Background AURN Site – February to April 2018



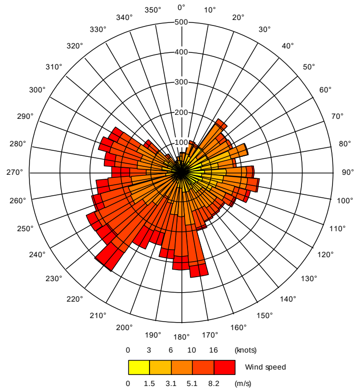
As can be seen, the NO_x and Ozone curves tend to mirror one another, with NO_2 comprising the majority of the NO_x for much of the time when Ozone concentrations are higher. Similar patterns are exhibited for other months throughout the year.

The NO_x / NO_2 concentrations are markedly higher when Ozone concentrations are lower, with NO_x being the dominant species (due to the higher levels of nitric oxide). Under these variable conditions, the atmospheric transformation of NO_x to NO_2, associated with emissions from the proposed ERF will be affected to a varying degree. Accordingly, there is likely to be a proportion of the year when the atmospheric chemistry in the vicinity of the ERF development site may be restricted in its capacity to convert NO_x to NO_2 and the model predictions may therefore over-estimate the significance of annual average NO_2 predictions at receptors in the vicinity of the ERF development site.

2.6 Meteorological Data

Hourly averaged meteorological data from the Prestwick Airport measurement station, located approximately 9 km to the south of the ERF development site was applied to the models. Five years' of data for 2015 to 2019 were used in the detailed modelling assessment. The 2019 wind rose for the Prestwick Airport measurement station is shown in Figure 3.

Figure 3 2019 Wind Rose for the Prestwick Airport Measurement Station



All meteorological data used in the assessment were provided by Atmospheric Dispersion Modelling (ADM) Limited, which is an accredited distributor of meteorological data within the UK. The data indicate winds being prevalent from most directions, the exception being the north-west to north-east quadrant. The meteorological data included the nine parameters defined in Table 3.

Table 3 Modelled Meteorological Parameters

Parameter	Description
YEAR	Year of observation
TDAY	Julian Day (1 to 366) of observation
THOUR	Hour of Observation
T0C	Temperature (^{o} C)
U	Wind speed (m s^{-1})
PHI	Wind Direction (nearest 10 degrees)
P	Precipitation (mm)
CL	Cloud cover (Oktas)
RHUM	Relative Humidity (%)

2.7 Local Environmental Conditions

Local environmental conditions describe the factors that might influence the dispersion process (such as nearby structures, sharply rising terrain, etc.) and also describe the locations at which pollutant concentrations are to be predicted. These include:

Surface Roughness

Surface roughness defines the amount of near-ground turbulence that occurs as a consequence of surface features, such as land use (i.e. agriculture, water bodies, urbanisation, open parkland, woodland, etc.). Agricultural areas may have a surface roughness of approximately 0.2m to 0.3m whereas large cities and woodlands may have a roughness of 1 to 1.5m.

Land use in the immediate vicinity of the development site is predominantly industrial and commercial, interspersed with scrubland. However, the additional presence of other features such as sand dunes and coastline, prompted the use of a spatially variable surface roughness file to accurately detail the surface roughness across the modelled grid. Where it was not appropriate to apply the variable roughness file to model runs, such as when considering more distant receptors and when modelling the more extensive gridded area for the cumulative assessment, a surface roughness factor of 0.3 metres was considered appropriate to provide a generic description of the local area. This figure is appropriate for describing agricultural areas, including fields, trees, building and infrastructure, and the same roughness figure (0.3 m) was applied to describe the surface roughness at the Prestwick Airport meteorological monitoring location.

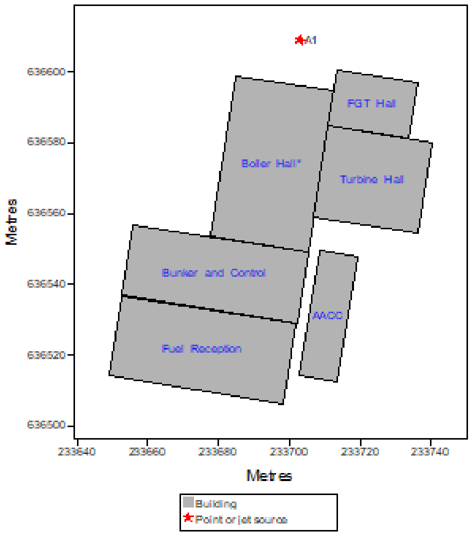
Nearby Buildings and Structures

The proximity of solid structures, such as buildings, to an emission source can affect the dispersion of a plume emitted from an adjacent chimney, particularly in the vicinity of that structure. The effects of this were included into the model based on the data presented in Table 4, and graphically in Figure 4.

Table 4 Modelled Building Data

Building	Height (m)	Length (m)	Width (m)	Angle (Degrees)
Boiler Hall	40	28	46	99
Bunker and Control Room	35	50	20	99
Fuel Reception	22	50	23	99
ACC	22	11	36	99
FGT Hall	25	23	16	99
Turbine Hall	20	30	26	99

Figure 4 Site Layout as Modelled



Local Terrain

Local terrain can affect wind flow patterns and, consequently, can affect the dispersion of atmospheric pollutants. The effects of terrain are not normally noticeable where the gradient is less than 10 %. Ordnance Survey mapping for the area shows the absence of significant terrain in the vicinity of the ERF development site, and a sensitivity analysis undertaken during the initial modelling exercises confirmed that the impact of terrain data within the models had a negligible effect on the results. Accordingly, terrain effects were excluded from the detailed modelling runs, reported here.

Output Grid

When setting up a receptor grid it is important to ensure that there are sufficient receptor points to be able to accurately predict the magnitude and location of the maximum Process Contribution. If the grid of receptor points is too widely spaced, the maximum concentration may be missed. Modelling of the ERF was undertaken using a 4 km x 4 km grid with 20-metre grid spacing.

Ten specific receptors, representing nearby residential properties or locations where people may congregate for significant periods of time, were entered into the model, as were four key air quality sites. Additionally, sixteen sensitive ecological receptors were modelled, and these represent national or European designated sites within 15 km of the site. Details of the sensitive receptor locations are presented in the following table.

Table 5 Specific Receptors Included in Detailed Modelling

Receptor	X	Y	Distance from Site (m)	Receptor Name
1	235041	636779	1,329	Residence - Drybridge, KA11 5BX
2	235734	636697	2,013	Residence - Shewalton Moss, KA11 5BW,
3	235981	636511	2,260	Residence - Main Street, Drybridge, KA11 5BX
4	233626	633605	3,004	Residence - Lochgreen Avenue, Loans, KA10 6UP
5	232713	633762	3,019	Residence - Firth Road, Troon, KA10 6TF
6	232345	636177	1,443	Glasgow Golf Club / Gailes Links, Irvine
7	233083	637400	1,018	Residence - Muirfield Court, Irvine, KA11 4DG
8	232364	637390	1,568	Residence - Carson Drive, Irvine, KA12 8HR
9	234602	637800	1,482	Residence - Monarch Gardens, Dreghorn, KA11 4EB
10	236193	635043	2,924	Residence - Kilnford Drive, Dundonald, KA2 9ET
DT1	232323	638892	2,679	Diffusion Tube – 35 East Road, Irvine
DT10	232085	638774	2,716	Diffusion Tube – 34 Kirkgate, Irvine
DT11	236813	638659	3,709	Diffusion Tube – 25 Main Road, Springside
DT12	233332	635558	1,120	Diffusion Tube – Auchengate (Bridge)
E1	233773	636482	135	Oldhall Ponds Wildlife Site
E2	233725	637250	642	Dundonald Burn SSSI
E3	232745	637087	1,089	Shewalton Wood Nature Reserve
E4	233905	635524	1,099	Shewalton Sandpits Nature Reserve
E5	232555	635800	1,420	Gailes Marsh Nature Reserve
E6	232091	636049	1,725	Western Gailes SSSI
E7	235627	634515	2,829	Dundonald Wood SSSI
E8	231374	639251	3,536	Bogside Flats SSSI
E9	233375	629177	7,439	Ardrossan to Saltcoates Coast SSSI
E10	224619	641003	10,109	Troon Golf Links and Foreshore SSSI
E11	227654	644041	9,583	Ashgrove Loch SSSI
E12	241629	625913	13,313	Afton Lodge SSSI
E13	228199	648234	12,862	Lynn Spout SSSI
E14	234761	646727	10,173	Dykeneuk Moss SAC / SSSI
E15	235504	648529	12,055	Cockinhead Moss SAC / SSSI
E16	234643	650371	13,794	Bankhead Moss, Beith SAC / SSSI

Specific receptors with the “DT” prefix represent locations where North Ayrshire Council undertakes air quality monitoring, and Receptors E1 to E16 represent nearby designated ecological habitats.

Although located within the area assessed for the presence of ecological receptors, and indeed being very local to the site, E2, the Dundonald Burn SSSI is designated for its geological and geomorphological significance, specifically for the evidence it provides on relative sea-level change on the Ayrshire coast during the Flandrian. Changes in air pollution will not therefore significantly affect the site and as such, the results of the modelling are not reported here.

Similarly, there are no site specific data for receptors E8, Bogside Flats SSSI; E9, Androssan to Saltcoates Coast SSSI; E12, Afton Lodge SSSI; and E13 Lynn Spout SSSI, and these receptors are also therefore excluded from the reported data.

Background Air Quality

Estimates of background concentrations for NO_x, NO_2 and PM_{10} are provided on the Scottish Air Quality website[5] at a resolution of 1 km x 1 km grid spacing. The development site is located within an area under the jurisdiction of North Ayrshire Council, and data were obtained for 2024 for the locality around the proposed ERF. The data show that future estimates of background concentrations for the pollutants included within the model and without any Process Contribution from the proposed ERF development, are well below their respective Air Quality Standards.

Where information on specific pollutants was not available on the Scottish Air Quality Website, data was instead drawn from the UK-AIR[6] website hosted by DEFRA, which includes information on estimated background concentrations in Scotland.

Data for the grid square immediately adjacent to the ERF development site (233500 636500) were used to provide the basis for assessment for the general area around the site, relative to existing background concentrations. The air quality assessment for the ERF was based upon the estimated background concentrations for 2024, when the background concentration for Nitrogen Dioxide was estimated to be 7.12 µg m^{-3}, and this value was used to determine the Predicted Environmental Concentration from the model predictions for NO_2.

Table 6 Background Air Quality Data in the Vicinity of the Development Site (2024)

Pollutant	Annual Average Concentration (µg m^{-3})	
NO_2	7.12	(Scottish Air Quality Website)
NO_X	10.13	(Scottish Air Quality Website)
PM_{10}	7.9	(Scottish Air Quality Website)
$PM_{2.5}$	4.97	(DEFRA UK-AIR)
SO_2 (2001)	2.22	(DEFRA UK-AIR)
CO	0.099	(DEFRA UK-AIR)
Benzene (for VOC)	0.141	(DEFRA UK-AIR)
Average of concentrations at grid point 233500 636500		

The “Air Quality in Scotland” website indicates that ambient pollutant concentrations in the vicinity of the ERF development site are typical of what might be expected for a rural background location.

North Ayrshire Council has not declared any Air Quality Management Area (AQMA) within its area, however, the Council does undertake air quality monitoring in connection with its Local Air Quality Management obligations and data from nearby diffusion tube monitoring locations for 2014 to 2018 showed the following trends in annual average NO_2 concentrations.

Table 7 Annual Average NO_2 Concentrations at Nearby Diffusion Tube Monitoring Locations

	2014	2015	2016	2017	2018
DT1	23	22	22	22	18
DT10	11	8	9	8	11
DT11	15	15	14	14	13
DT12	11	10	12	12	12

The above diffusion tube monitoring locations were included as specific receptors in the model.

2.8 Model Default Values Applied

The following values were retained as the default inputs defined by the model, in the absence of any site-specific data for the ERF location or the meteorological measurement station:

Surface Albedo; 0.23 representing an area of non-snow covered land.

Priestley-Taylor Parameter; 1 representing moist grassland.

Minimum Monin-Obukhov Length; 1 m

3. Chimney Height Assessment

Two approaches were adopted with regard to determining the most appropriate chimney height for the ERF, as follows:

1. Calculating stack height using the D1 calculation procedure; and,
2. Iterative modelling of stack height using the ADMS model.

The results are discussed in the following sections.

3.1 D1 Chimney Height Calculation

The methodology defined in Her Majesty's Inspectorate of Pollution (HMIP, now the Environment Agency) guidance note D1[7] was used to calculate the appropriate height of the chimney of the ERF. As a minimum, the guidance recommends that a stack is at least 3 metres taller than the height of the building on which the emission stack is located, or near to. In this instance the minimum height for the chimneys would be 43 metres as the nearest structure is the boiler hall, which is 40 metres at its highest point.

The D1 chimney height methodology was followed based on discharge conditions and emission rates defined in Table 1 and Table 2, and incorporating all of the sections of the buildings associated with the facility as a whole, of which the boiler hall is the highest at 40 metres.

The D1 calculation estimated that the stack height for the single chimney associated with the ERF should be approximately 45 metres, based upon the assumption that 50 % of the NO_x emitted from the chimney of the ERF is converted to NO_2 in the short-term, as per the recommended basis for assessment of NO_x emissions in SEPA Guidance.

The printout from the D1 calculation is appended to this document.

3.2 Iterative Modelling of Chimney Height

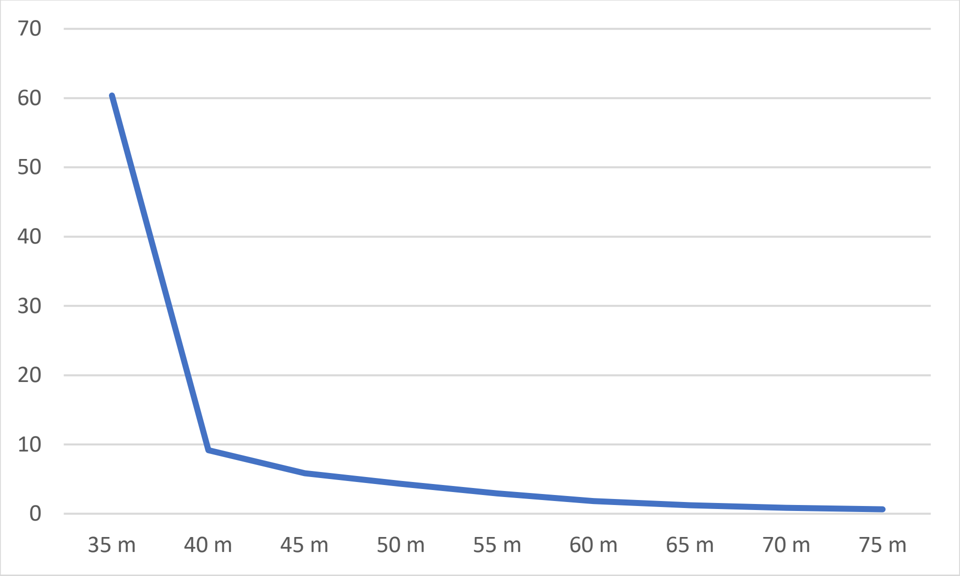
An iterative assessment of stack height was then undertaken using the ADMS model to determine what the appropriate stack height should be to facilitate effective dispersion of atmospheric pollutants from the single chimney of the ERF. The results of the modelling are presented in Table 8, and, Figure 5 and Figure 6, and are based upon the maximum NO_2 Process Contribution across the 4 km x 4 km receptor grid.

Table 8 Results from Iterative Chimney Height Assessment – Annual and Hourly Average NO_2 Process Contributions

Stack Height (m)*	Maximum Annual Average PC (µg m^{-3})	Percentage of AQS Objective Value	Maximum Hourly Average PC (µg m^{-3})	Percentage of AQS Objective Value
35	60.38	151 %	108.07	54 %
40	9.18	23 %	41.85	21 %
45	5.83	15 %	29.26	15 %
50	4.30	11 %	24.19	12 %
55	2.93	7 %	18.84	9 %
60	1.85	5 %	13.81	7 %
65	1.23	3 %	9.36	5 %
70	0.85	2 %	6.93	3 %
75	0.64	2 %	5.93	3 %
* Note modelling was undertaken with a spatially variable surface roughness file; Building Effects Module – Active; Terrain Module – Inactive; Release Height – Variable; Meteorological Data – Prestwick Airport 2019; NO_X ELV of 120 mg Nm^{-3}.				

When the results are plotted on a graph, the pattern for the maximum annual average NO_2 Process Contribution is as shown in the following figure.

Figure 5 Variation in Maximum Annual Average Process Contribution of NO_2 (µg m^{-3}) with Different Chimney Heights



The corresponding graph for the maximum hourly average NO_2 Process Contribution is shown in the following figure.

Figure 6 Variation in Maximum Hourly Average Process Contribution of NO_2 (µg m^{-3}) with Different Chimney Heights

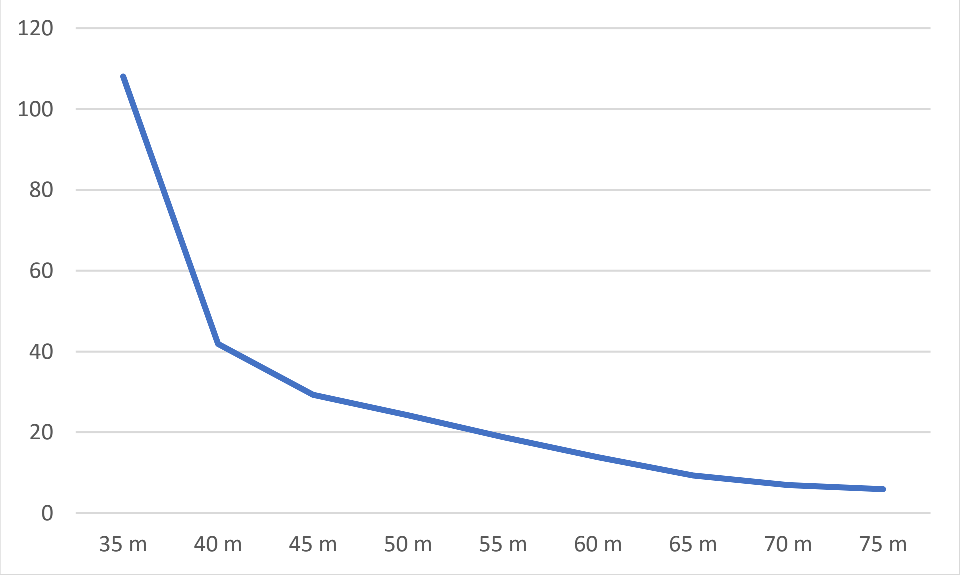


Figure 6 above plots short-term NO_2, equating to 50 % of the modelled NO_x result.

The results from the iterative height assessment for the chimney of the ERF indicate that the maximum annual average and hourly average NO_2 Process Contributions would be approximately 6 µg m^{-3} and 30 µg m^{-3} respectively, for the D1-calculated stack height of 45 metres. Significant changes occur in the gradient of the line below that height, and a further change is noticeable at 70 m. The change in gradient is generally considered to be indicative of the height when emissions from a chimney escape from the effects of downwash, associated with the passage of the winds over adjacent buildings and structures, and in this case confirm that the most significant effects are observed at heights of less than 45 m, with a steady reduction in the influence of local infrastructure from that point.

For chimney heights greater than 45 metres there is a more gradual reduction in ground level Process Contribution resulting from the increasing effectiveness of dispersion from taller chimneys. Despite the fact that the D1 calculation indicated that a 45-metre high chimney would provide effective dispersion of emissions from the ERF, WEP Partners Limited propose to install a 60-metre high chimney to provide additional confidence that there will be no significant impact on local air quality. Compared to the D1-calculated value of 45 metres, increasing the height of the chimney to 60 metres results in a more than three-fold reduction in the maximum annual average Process Contribution, and more than two-fold reduction in the maximum hourly average Process Contribution.

Subsequent detailed modelling was undertaken on the basis of a 60-metre high chimney.

4. Detailed Modelling – Air Quality Assessment

4.1 Modelled Parameters

Detailed atmospheric dispersion modelling of emissions from the ERF was undertaken on the basis of the conclusions of the original sensitivity analyses as follows:

Release height: 60 metres
Building downwash module: active
Terrain effects: inactive
Surface roughness: variable surface roughness file or 0.3 metres
Meteorological data: Prestwick Airport 2015 to 2019

Emissions of NO_x, SO_2, CO, Particles (PM_{10}), VOCs, HCl, HF, Ammonia, Mercury, Cadmium, Other Metals, Dioxins and Furans, PCBs and PAH (as Benzo[a]Pyrene), were assessed in line with the Air Quality Regulations (Scotland) and their objective limits (where applicable), or against specific pollutant Environmental Assessment Limits (EALs) detailed in SEPA guidance[3].

The modelled emissions data were as summarised in Tables 1 and 2. The results from detailed modelling of the normal operational case are presented in Sections 4.3 to 4.17. Results are presented in terms of the maximum Process Contribution (PC) and, where the PC cannot immediately be screened as insignificant are also reported as the Predicted Environmental Concentration (PEC) taking into account the PC and the estimated background concentration for the area.

4.2 Determining Significance

SEPA provides guidance[4] for screening the significance of air quality impacts associated with the operation of industrial processes. For long-term impacts, the guidance recommends a 1 % insignificance threshold of Process Contributions relative to a long-term AQS or environmental assessment level, with a corresponding 10 % insignificance threshold for the assessment of short-term Process Contributions.

SEPA goes on to note that modelling of long-term effects may be appropriate if the long-term PEC is above 70 % of the relevant environmental benchmark (EQS or EAL), and the modelling of short-term effects may be appropriate if the short-term PC is more than 20 % of the difference between the (long-term) background concentration and the relevant short term environmental benchmark. However, the guidance goes on to note that, the detailed assessment of short-term effects is often complex and the error in estimating short-term releases can be a factor of 4 to 5. Therefore, a pragmatic approach is suggested that unless the short-term PC exceeds 30 % of the short term EAL then the emissions may be considered to be tolerable and detailed modelling may not be needed.

This report details the assessment of comprehensive modelling undertaken for the proposed Oldhall ERF development. The significance or otherwise of the results are therefore assessed using a two-stage approach, whereby:

- a long-term PC of less than 1 % of the assessment level, or a PEC of less than 70 % of the assessment level is screened as insignificant; and
- a short-term PC of less than 10 % of the assessment level, or a PC of less than 20 % of the assessment level minus the long-term background is screened as insignificant.

Descriptive terms for the impact significance of NO_2 and PM_{10} are also provided and are based on those published in Land Use Planning and Development Control: Planning for Air Quality (2017 Update) prepared by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[8]. Impact description involves expressing the "*magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion*". The EPUK / IAQM descriptor matrix is shown in the Table over page:

Table 9 Definition of Impact Magnitude for Changes in Annual Mean Nitrogen Dioxide and PM_{10} Concentration

Long term average Concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

The EPUK / IAQM guidance states that impacts on air quality, whether adverse or beneficial, will have an effect on human health that can be judged as "significant" or "not significant". The EPUK / IAQM guidance was followed for determining the impact descriptor for the maximum increase in annual average NO_2 and PM_{10} concentrations across the modelled grid and at sensitive receptors in the vicinity of the development site, due to the operation of the ERF.

4.3 Nitrogen Dioxide (NO_2)

The results of the NO_2 modelling are presented in Table 10. The data presented are for both the maximum Process Contribution (PC) and the Predicted Environmental Concentration (PEC) for NO_2 and are based upon the maximum values for the 2015 to 2019 meteorological data. The PEC values take into account the background NO_2 concentration for 2024 of 7.12 µg m^{-3} and conversion of the NO_x released from the process, based upon empirical formulae recommended by SEPA; 50 % conversion for short-term assessment and 100 % conversion for long-term assessment.

The maximum reported values (annual average Process Contributions) are predicted by modelling to occur at a location about 290 metres to the north-east of the chimney of the ERF and reduce significantly with distance from the site.

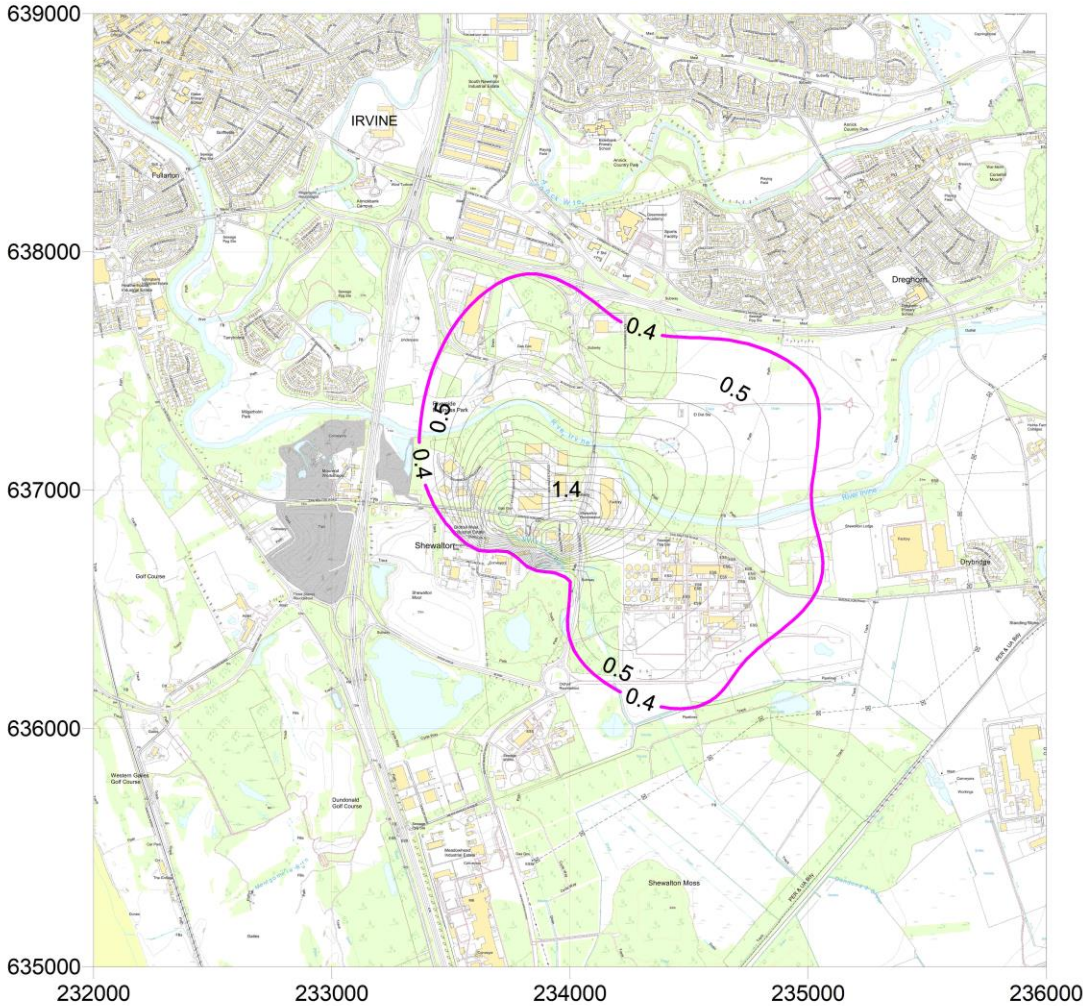
Table 10 Results from Detailed Assessment for Nitrogen Dioxide and Oxides of Nitrogen

Pollutant	Statistic	Exceedance Threshold	Averaging Period	Concentration (µg m^{-3})	Percentage of the AQS
Oxides of Nitrogen (NO_x) –	Annual PC Protection of Ecosystems	30	Annual	2.22	**7.4 %**
Nitrogen Dioxide (NO_2)	Annual PC	40	Annual	2.22	**5.6 %**
	Annual PEC			9.34	23 %
	Short-term 99.79% PC	200	1hr	13.88	6.9 %
	Short-term 99.79% PEC			28.11	14.1 %

The results from modelling predict that the Process Contribution from the ERF will equate to approximately 7 % of the annual average for the protection of ecosystems and approximately 6 % of the annual average for the protection of human health when the ERF is operational. Although not immediately screened as insignificant, when the existing background concentration is added to the PC, the NO_2 PEC would be approximately 9.3 µg m^{-3}, or approximately 23 % of the 40 µg m^{-3} annual objective value. As such, the impact of Nitrogen Dioxide levels remains within 70 % of the assessment level and can be screened as insignificant.

The Process Contribution plot for NO_x as NO_2 is presented in Figure 7 over page.

Figure 7 Annual Average Process Contribution of NO_x as NO_2 (µg m^{-3}); 2015 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (1 % of the AQS)



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In terms of the EPUK / IAQM impact descriptors, a Process Contribution of 5.6 % and a PEC of less than 75% represents a **negligible** impact on local air quality at the location of the maximum Process Contribution, which is about 290 metres to the north-east of the chimney of the ERF. Process Contributions at nearby residential receptors are significantly lower in relation to their distance from the site.

The maximum hourly average NO_2 PC was predicted to be almost 14 µg m^{-3}, expressed as the 99.79th percentile value, or about 7 % of the 200 µg m^{-3} objective limit value, and can therefore be automatically screened as insignificant in relation to SEPA guidance.

The above results are based upon a NO_x emission concentration of 120 mg Nm^{-3}, as specified by BAT-Conclusions document, which is expected to be the emission limit value (ELV) specified in the PPC Permit that will be obtained prior to the operation of the ERF. The results are based upon worst-case emissions, and an estimated background NO_2 concentration of approximately 7.12 µg m^{-3}. It should also be noted that the data above relate to the point of maximum Process Contribution, which is greater than the PC across the remainder of the modelled output grid.

4.4 Sulphur Dioxide (SO_2)

The results from detailed modelling of Sulphur Dioxide associated with emissions from the ERF are presented in the following table.

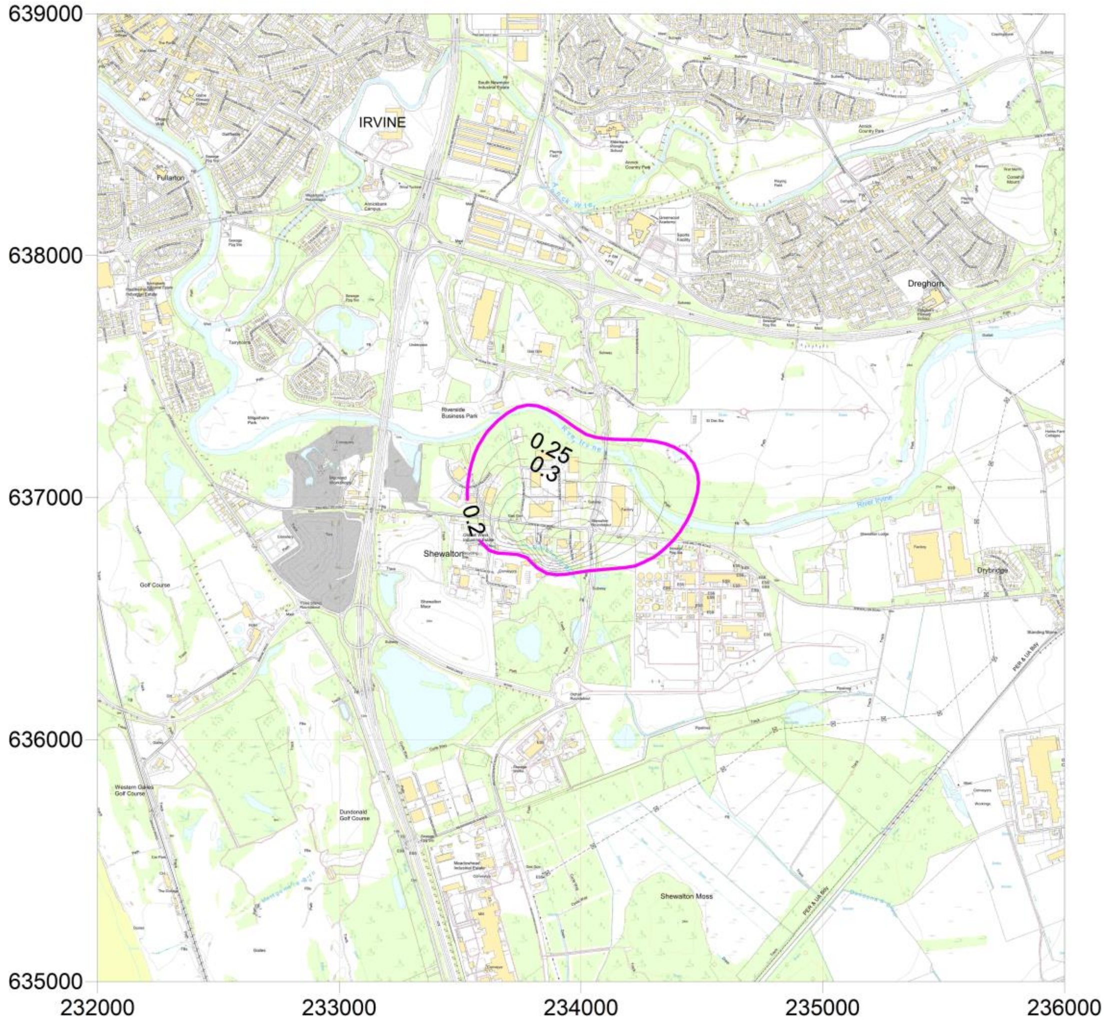
Table 11 Results for Sulphur Dioxide

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	20	1hr	**0.55**	**2.8 %**
Annual PEC			2.77	13.9 %
Short-term PC 99.9% Average	266	15min	7.44	2.8 %
Short-term PC 99.73% Average	350	1hr	6.9	2 %
Short-term PC 99.18% Average	125	24hr	4.97	4 %

The annual average SO_2 Process Contribution was predicted to be approximately 0.6 µg m^{-3}, which is 2.8 % of the Annual Limit Value of 20 µg m^{-3} for the protection of ecosystems, and cannot automatically be screened out as insignificant in relation to SEPA guidance. However, when considered in relation to the current estimated background concentration of about 2.2 µg m^{-3}, the resulting Predicted Environmental Concentration of about 2.77 µg m^{-3}, represents a value that is about 14 % of the annual average Limit Value and, in accordance with SEPA guidance does not require further consideration. The results indicate that emissions of SO_2 from the ERF are unlikely to have a significant impact on long-term local air quality in the vicinity of the site.

The results from detailed modelling of emissions of SO_2 from the ERF, based upon an emission limit value of 30 mg Nm^{-3} predicted that the maximum 15-minute Process Contribution would be approximately 2.8 % of the 266 µg m^{-3} objective value. The model predicted that there would be no exceedances of the assessment level. The maximum 1-hour average PC was predicted to be approximately 7 µg m^{-3} (approximately 2 % of the objective limit of 350 µg m^{-3}), and the maximum daily average PC was predicted to be approximately 5 µg m^{-3} (4 % of the objective limit of 125 µg m^{-3}). The short-term Process Contributions are all less than 10 % of their respective AQS objective values and can therefore be screened as insignificant in relation to SEPA guidance.

Figure 8 Annual Average Process Contribution of SO_2 (µg m^{-3}); 2015 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance for Ecological Receptors (1 % of the AQS)



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4.5 Carbon Monoxide (CO)

The results from detailed modelling of Carbon Monoxide are presented in Table 12.

Table 12 Modelling Predictions for Carbon Monoxide

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	-	8hrs Max. Rolling	0.8	-
Short-term PC 100%	10,000		25	0.25 %

Detailed modelling predicted that the maximum 8-hour rolling average ground-level Process Contribution for CO associated with emissions from the ERF would equate to approximately 0.25 % of the AQS objective value of 10,000 µg m^{-3}. The predicted PC is considerably lower than SEPA's 10 % insignificance threshold, and the results indicate that emissions of CO from the ERF are unlikely to have a significant impact on local air quality in the vicinity of the site.

4.6 Particulates (PM_{10})

The results from detailed modelling of Particulates (PM_{10}) are included in Table 13 and are presented in the context of the Process Contribution and the resultant Predicted Environmental Concentration, taking into account the annual average background concentration of 7.9 µg m^{-3}.

Table 13 Maximum Process Contribution for Particulates (PM_{10})

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	18	-	0.093	0.5 %
Annual PEC			7.99	44.4 %
Short-term PC 98.08%	50	24hr	0.516	1.03 %
Short-term PEC 98.08%			16.31	32.6 %

Detailed modelling predicted that the maximum annual average PC for particulates (PM_{10}) due to emissions from the ERF was likely to be less than 0.1 µg m^{-3}, which is 0.5 % of the 18 µg m^{-3} AQS objective value, and can be screened as insignificant. The maximum daily average PC under normal operating conditions was predicted to be approximately 0.5 µg m^{-3}, expressed as the 98.08 percentile value, equivalent to a value that is approximately 1.0 % of the 50 µg m^{-3} daily average objective value, and can therefore also be screened as insignificant.

The maximum annual average Process Contribution of 0.1 µg m^{-3} represents a **negligible** change in ambient concentrations, as specified by the EPUK / IAQM assessment criteria.

Taking the background into consideration with the Process Contribution predicted by modelling, the maximum annual average Predicted Environmental Concentration for PM_{10} for the ERF was estimated to be approximately 8 µg m^{-3}, or about 44 % of the annual objective value of 18 µg m^{-3}, and continues to be screened out as insignificant.

The results from detailed modelling indicate that emissions of Particulates from the ERF, expressed as PM_{10}, are likely to have a negligible impact on local air quality in the vicinity of the development site. No exceedances of the AQS for Particulates (PM_{10}) were predicted as a result of the operation of the ERF. Accordingly, emissions of Particulates (PM_{10}) were screened out as insignificant and do not require further assessment.

4.7 Particulates ($PM_{2.5}$)

The implementation of EC Directive 2008/50/EC introduced two new objective values for Particulates ($PM_{2.5}$) with a Stage 1 Target Value of 25 µg m^{-3} across the UK, expressed as an annual average which was to be met by 2020, and a Scottish Limit Value of 10 µg m^{-3}, expressed as an annual average, also to be met by 2020.

Modelling was undertaken assuming that all of the particulate matter released from the ERF was $PM_{2.5}$, and so represents an absolute worst-case scenario. The assessment was based upon a worst-case assumption for emissions of particulates at a value of 5 mg Nm^{-3}.

The results from the detailed modelling of Particulates as $PM_{2.5}$ are reported in Table 14 and are presented in the context of the annual average PC and PEC Concentration, taking into account DEFRA's estimated background concentration for 2024 of 4.97 µg m^{-3}.

Table 14 Modelling Predictions for Particulates ($PM_{2.5}$)

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	10	Annual	0.093	0.93 %
Annual PEC			5.06	50.6 %

The results from modelling for Particulates ($PM_{2.5}$), assuming that the total emission is $PM_{2.5}$, predicted that the maximum annual average PC associated with emissions from the ERF was likely to equate to 0.93 % of the 10 µg m^{-3} limit value, and is therefore insignificant in relation to SEPA guidance.

Taking the background into consideration with the Process Contribution predicted by modelling, the maximum annual average Predicted Environmental Concentration for $PM_{2.5}$ for the ERF was estimated to be approximately 5 µg m^{-3}, or about 51 % of the limit value.

In terms of the EPUK / IAQM impact descriptors, based upon those for PM_{10}, the increase in $PM_{2.5}$ concentrations arising from emissions from the ERF, assuming that all of the particulate emission is $PM_{2.5}$, is likely to have a **negligible** impact on local air quality.

4.8 Volatile Organic Compounds (VOCs)

The results from detailed modelling of VOCs are presented in Table 15.

Table 15 Maximum Process Contribution for VOCs

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	3.25	1hr	0.185	**5.7 %**
Annual PEC			0.327	10.1 %
Short-term PC 100%	195		8.07	4.1 %

There are no assessment levels for total VOC emissions as they comprise a mixture of organic compounds, although Benzene, a VOC, does have an Air Quality Standard. There is no information available about the proportion of Benzene that may be present in the VOC emission from the ERF, although, it is likely to be a very small percentage of the total.

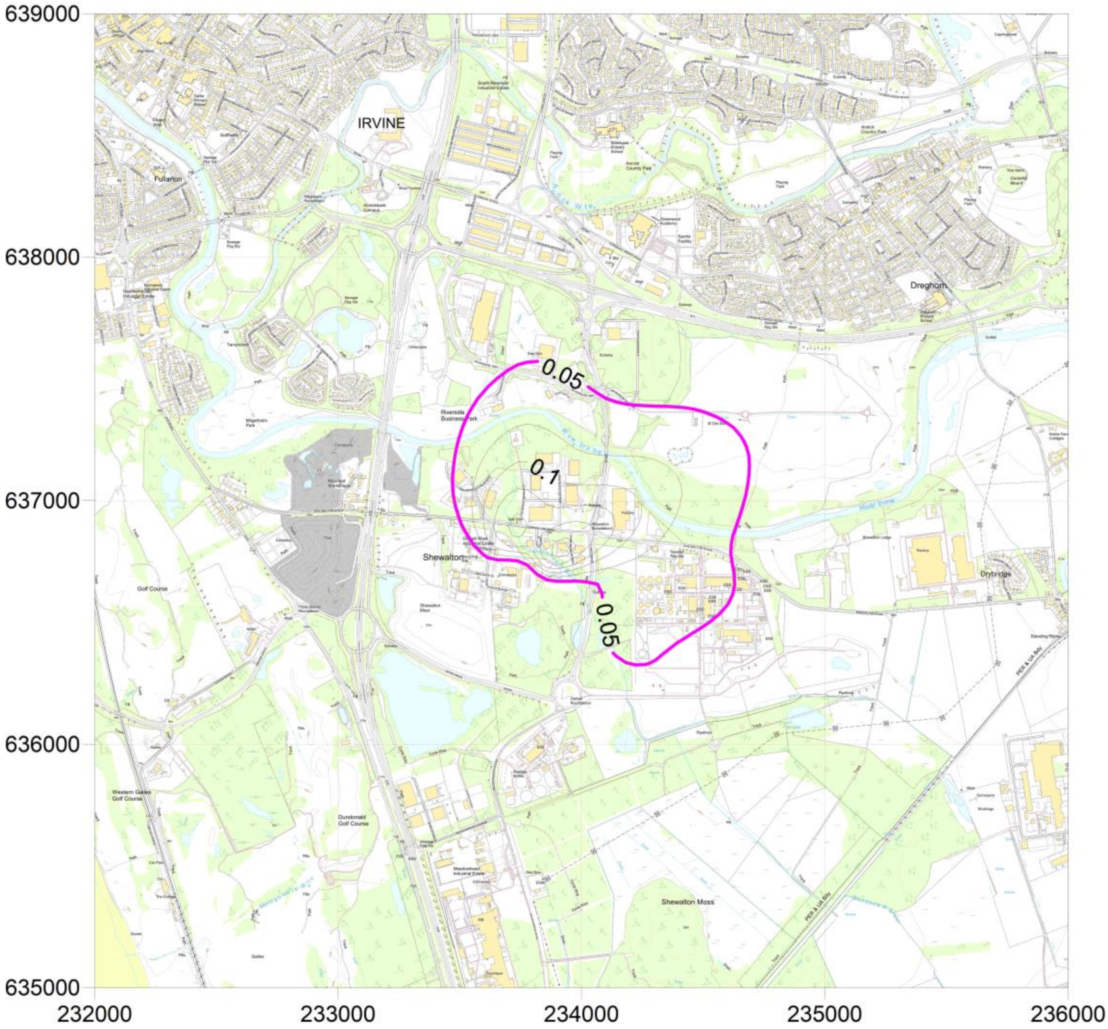
In order to provide a worst-case assessment, the annual average Process Contribution for VOCs was compared against the annual AQS objective value for 2010 for Benzene of 3.25 µg m^{-3}, expressed as a running annual mean.

The model predicted a maximum annual average Process Contribution of approximately 0.19 µg m^{-3} for total VOC emissions from the ERF, which equates to approximately 5.7 % of the Benzene AQS. Bearing in mind that Benzene will comprise only a very small percentage of the total VOC, and that the assessment is based upon a worst-case assumption for VOC emissions, the results can likely be screened out as insignificant at this initial assessment stage.
However, applying the DEFRA background for Benzene of 0.1414 µg m^{-3} to the modelled VOC result to calculate a PEC of approximately 0.33 µg m^{-3} confirms that the overall PEC can be screened as insignificant at the second assessment stage, despite the overly conservative assumption that the total VOC emission comprises Benzene only.

The short-term, hourly average PC of total VOCs equates to 4.1 % of the hourly assessment level for Benzene and is therefore immediately screened as insignificant. On the basis of the above results, the impact on local air quality of emissions of VOCs from the ERF require no further assessment.

Figure 9 over page presents the Process Contribution plot for total VOC, with the point of insignificance shown as 1 % of the Benzene AQS.

Figure 9 Annual Average Process Contribution of VOC (µg m^{-3}); 2015 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance for Benzene (1 % of the AQS)



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4.9 Hydrogen Chloride (HCl)

The results from detailed modelling of HCl are presented in Table 16.

Table 16 Maximum Process Contribution for Hydrogen Chloride

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the EAL
Annual	20	1hr	0.111	0.6 %
Short-term PC 100%	750		4.834	0.6 %

There is no Air Quality Standard for HCl and the assessment level was therefore based upon SEPA guidance for long-term (annual) and short-term (1 hour) assessments. Detailed modelling predicts a maximum annual average concentration of 0.111 µg m^{-3} equating to approximately 0.6 % of the assessment level. The maximum hourly average PC for HCl was approximately 4.8 µg m^{-3} (0.6 % of the EAL of 750 µg m^{-3}). As such, both the long and the short-term PCs are immediately screened as insignificant and require no further assessment.

4.10 Hydrogen Fluoride (HF)

The results from detailed modelling of Hydrogen Fluoride are presented in Table 17.

Table 17 Maximum Process Contribution for Hydrogen Fluoride

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the EAL
Annual	16	1hr	0.019	0.12 %
Short-term PC 100%	160		0.807	0.5 %

Detailed modelling predicted that the maximum hourly average Process Contribution for HF associated with the emissions from the ERF would be approximately 0.81 µg m^{-3}, or 0.5 % of the 160 µg m^{-3} EAL, and is therefore insignificant in relation to SEPA guidance. The corresponding annual average PC for HF was predicted to be 0.02 µg m^{-3}, or 0.12 % of the long-term average EAL of 16 µg m^{-3}, and is also therefore insignificant in relation to SEPA guidance.

The results indicate that emissions of HF are unlikely to have a significant impact on local air quality in the vicinity of the site. Accordingly, emissions of HF were screened out as insignificant and do not require further assessment.

4.11 Ammonia

The results from detailed modelling of Ammonia are presented in Table 18.

Table 18 Modelling Predictions for Ammonia

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the EAL
Annual PC	180	1hr	0.19	0.1 %
Short-term PC 100%	2,500		8.07	0.32 %

Detailed modelling predicted that the maximum annual average PC for Ammonia was 0.2 µg m^{-3}, or approximately 0.1 % of the long-term average EAL of 180 µg m^{-3}, and is therefore screened as insignificant in accordance with SEPA guidance. The corresponding hourly average Process Contribution for Ammonia associated with the emissions from the ERF would be approximately 8 µg m^{-3}, or 0.3 % of the 2,500 µg m^{-3} EAL, and is also therefore insignificant in relation to SEPA guidance.

The results indicate that emissions of Ammonia are unlikely to have a significant impact on local air quality in the vicinity of the site. Accordingly, emissions of Ammonia were screened out as insignificant and do not require further assessment.

4.12 Cadmium and Thallium (Cd & Tl)

The results from detailed modelling of Cadmium and Thallium are presented in the following table and are presented on the basis that all of the emissions occur as the individual species.

Table 19 Maximum Process Contribution for Cadmium and Thallium

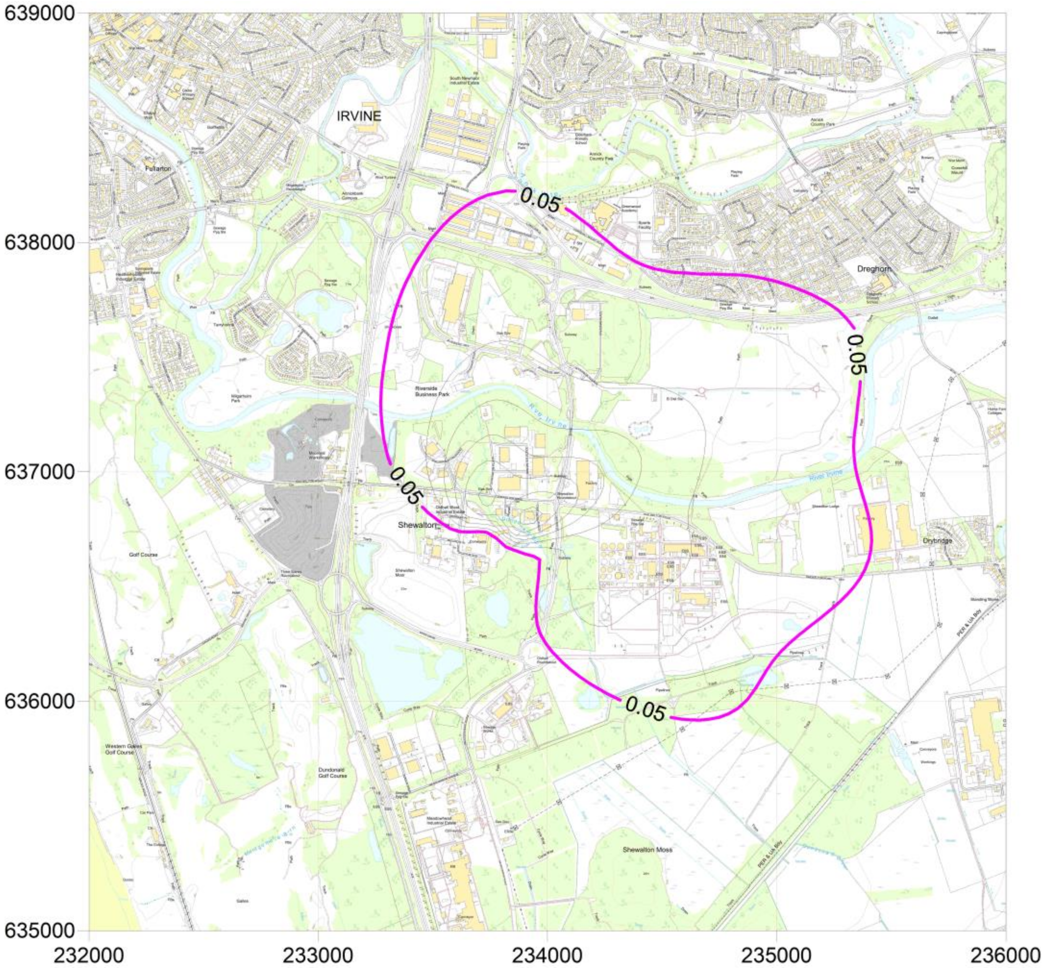
<table>
<tr><th>Pollutant</th><th>Statistic</th><th>Exceedance Threshold</th><th>Averaging Period</th><th>Process Contribution (µg m^{-3})</th><th>Percentage of the EAL</th></tr>
<tr><td rowspan="3">Cadmium</td><td>Annual PC</td><td rowspan="2">0.005</td><td rowspan="3">1hr</td><td>0.00037</td><td>7.4 %</td></tr>
<tr><td>Annual PEC</td><td>0.00042</td><td>8 %</td></tr>
<tr><td>Short-term PC 100%</td><td>1.5</td><td>0.0161</td><td>1.07 %</td></tr>
<tr><td rowspan="2">Thallium</td><td>Annual PC</td><td>1</td><td rowspan="2">1hr</td><td>0.00037</td><td>0.037 %</td></tr>
<tr><td>Short-term PC 100%</td><td>30</td><td>0.0161</td><td>0.054 %</td></tr>
</table>

The Air Quality Standards (Scotland) Regulations 2010 specify a standard of 5 ng m^{-3} for Cadmium (0.005 µg m^{-3}) as an annual average in the PM_{10} fraction of particulate emissions. This value had to be met by 31st December 2012. As a worst-case assessment it was assumed that all of the Cadmium and Thallium emissions were associated with the PM_{10} release, and that emissions were totally as Cadmium, or as Thallium.

Detailed modelling predicts an annual average Process Contribution for Cadmium of approximately 0.0004 µg m^{-3} (or about 7 % of the AQS objective). When a background measured concentration of Cadmium is added to the PC, the resultant PEC is approximately 8 % of the EAL and is therefore screened as insignificant. The background concentration was measured as 3.2 x 10^{-5} µg m^{-3} at Auchencorth Moss[9] in 2019. Auchencorth Moss is located approximately 92 km to the east, north-east of the proposed ERF site and is the nearest and most representative heavy metals measurement station to the development. The corresponding value for the hourly average PC for Cadmium was predicted to be approximately 0.016 µg m^{-3}, equating to a little over 1 % of the EAL. As a result, both the long and the short-term impacts of contributions of Cadmium from the proposed development are screened as insignificant.

When considering the potential discharge of Thallium, both the long and the short-term Process Contributions equate to a fraction of 1 % of the EAL and thus are immediately screened as insignificant. Figure 10 below presents the Process Contribution plot for Cadmium, in ng m^{-3}, with the 1 % point of insignificance (0.05 ng m^{-3}) shown.

Figure 10 Annual Average Process Contribution of Cadmium (ng m^{-3}); 2015 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (1 % of the AQS)



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4.13 Mercury and its Compounds (Hg)

The results from detailed modelling of Mercury and its compounds are presented in the following table.

Table 20 Maximum Process Contribution for Mercury and its Compounds

Statistic	Exceedance Threshold	Averaging Period	Process Contribution ($\mu g\ m^{-3}$)	Percentage of the EAL
Annual PC	0.25	1hr	0.00037	0.15 %
Short-term PC 100%	7.5		0.0161	0.22 %

There is no Air Quality Standard for Mercury and assessment levels were therefore based upon SEPA guidance for long-term (annual) and short-term assessment levels.

Detailed modelling predicted that the maximum annual average PC for Mercury is likely to be approximately 0.0004 $\mu g\ m^{-3}$, or about 0.15 % of the long-term EAL. The corresponding hourly average PC for Mercury was predicted to be approximately 0.016 $\mu g\ m^{-3}$, equating to approximately 0.2 % of the short-term EAL. Accordingly, the impact on local air quality of emissions of Mercury from the ERF can be considered to be insignificant based on SEPA guidance, and do not require further assessment.

4.14 Group 3 Metals

The IED and associated BREF and BAT-Conclusions documents stipulate emission limits on Group 3 metals including Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), and Vanadium (V). The emission limit requires that the total emission (i.e. the sum) for all of these metals is below 0.3 mg Nm^{-3}, and this is the basis for the assessment.

The Environment Agency has issued guidance on metals impact assessment[10], which recommends a stepwise approach to assessment of emissions of Group 3 metals. It is presumed that the Environment Agency guidance is acceptable to SEPA, and is appropriate for the assessment of emissions of Group 3 metals from the ERF. The guidance is based upon the presumption that the assessment is applicable for Municipal Waste Incineration (MSW) and waste wood co-incineration facilities, and is therefore appropriate for the ERF.

The first step is based upon the assumption that each of the nine metal species is emitted at the IED emission limit value of 0.3 mg Nm^{-3} for Group 3 metals. The results from this initial screening assessment are presented below.

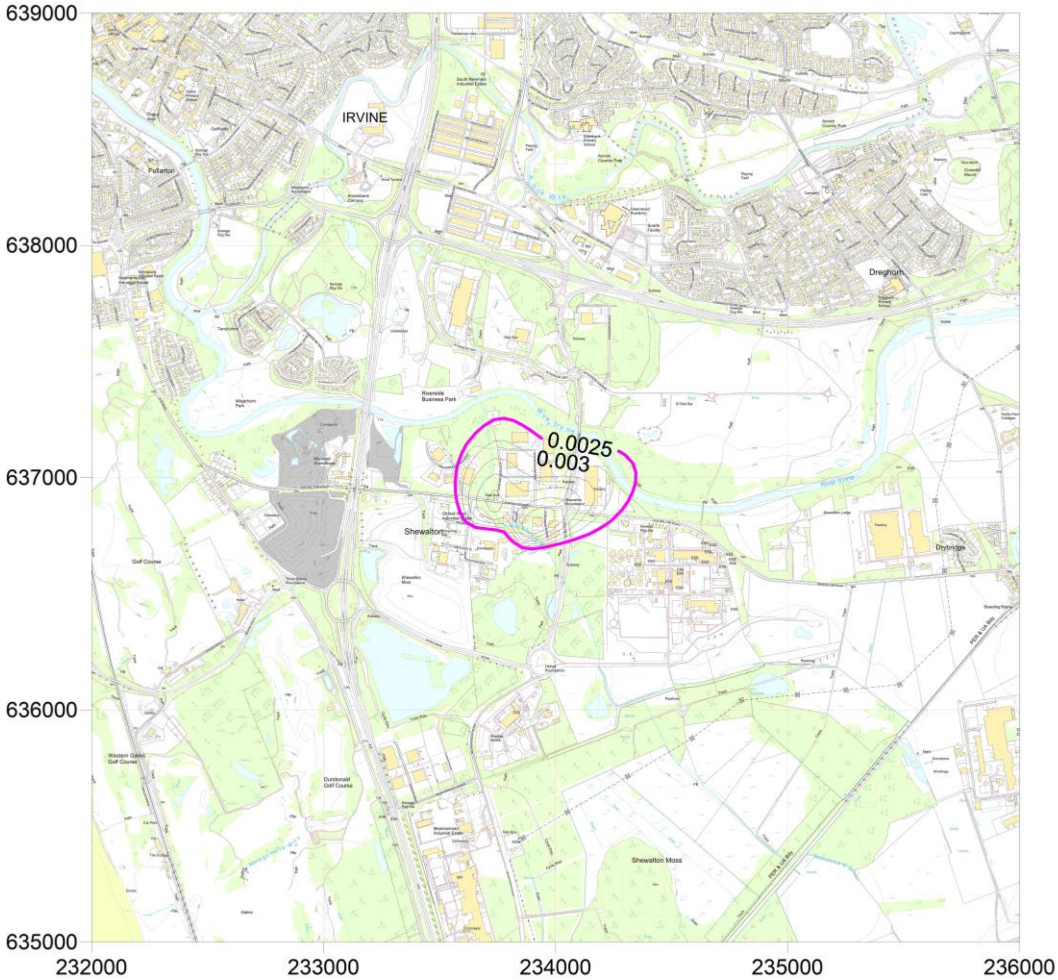
Table 21 Maximum Annual Average Process Contribution for Group 3 Metals – Step 1 Screening

Metal	Exceedance Threshold ($\mu g\ m^{-3}$)	Approximate Concentration ($\mu g\ m^{-3}$)	Percentage of the AQS/EAL
Antimony	5	0.0055	0.11 %
Arsenic	0.003	0.0055	**185 %**
Chromium$^{(VI)}$	0.0002	0.0055	**2,774 %**
Cobalt	0.2	0.0055	**2.77 %**
Copper	10	0.0055	0.06 %
Lead	0.25	0.0055	**2.22 %**
Manganese	0.15	0.0055	**3.70 %**
Nickel	0.02	0.0055	**27.74 %**
Vanadium	5	0.0055	0.11 %

As can be seen, emissions of Arsenic, Chromium$^{(VI)}$, Cobalt, Lead, Manganese and Nickel are identified as being potentially significant by this initial screening assessment (values in bold text). It should be noted that the assessment assumes that all of the Chromium present in the emissions to atmosphere is present as Chromium$^{(VI)}$, therefore representing an absolute worst-case basis for the assessment.

Figure 11 below presents the Process Contribution plot for the sum of the Group 3 metals, with the point of insignificance shown as 1 % of the AQS for Lead.

Figure 11 Annual Average Process Contribution of Group 3 Metals (µg m^{-3}); 2015 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance for Lead (1 % of the AQS)



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Short-term process contributions are assessed using the same methodology, where short-term EALs are available, and results are presented in Table 22 below:

Table 22 Maximum Annual Average Process Contribution for Group 3 Metals – Step 1 Screening

Metal	Exceedance Threshold (µg m^{-3})	Approximate Concentration (µg m^{-3})	Percentage of the AQS/EAL
Antimony	150	0.2417	0.16 %
Arsenic	15	0.2417	1.6 %
Chromium$^{(VI)}$	3	0.2417	8.1 %
Cobalt	6	0.2417	4.0 %
Copper	200	0.2417	0.12 %
Manganese	1,500	0.2417	0.02 %
Nickel	30	0.2417	0.81 %
Vanadium	1	0.2417	**24.17 %**

Where not initially screened as insignificant, the Predicted Environmental Concentration of the metal species are calculated, applying measured background data from the nearest Heavy Metals Monitoring Network site, in this case at Auchencorth Moss. The Environment Agency guidance note specifies that, where the PEC is less than 100 % of the environmental standard, no further assessment is required. Where it is above 100 %, the assessment should proceed to Step 2. Table 23 presents the calculated PEC values for both long and short-term emissions where required.

Table 23 Predicted Environmental Concentrations of Group 3 Metals Where Long-Term PC is Greater Than 1 % and Short-Term PC is Greater Than 10 % of the EAL

Metal	Measured background ($\mu g\ m^{-3}$)	Predicted Environmental Concentration ($\mu g\ m^{-3}$)	Percentage of the AQS/EAL
Arsenic	0.0002211	0.00577	**192 %**
Chromium$^{(VI)}$	0.00083	0.00638	**3,189 %**
Cobalt	0.0000269	0.00557	2.79 %
Lead	0.001144	0.00669	2.68 %
Manganese	0.00126	0.00681	5 %
Nickel	0.00022	0.00577	28.84 %
Vanadium (ST)	ST = (0.000346) x 2 = 0.000692	0.2424	24.2 %

The results in Table 23 demonstrate that, despite the worst-case PC not being immediately screened for the majority of the Group 3 metals, the PEC does go on to screen for Cobalt, Lead, Manganese, Nickel, and short-term contributions of Vanadium, leaving only Arsenic and Chromium$^{(VI)}$ which cannot be screened as insignificant in Step 1.

Environment Agency guidance then recommends that a second stage screening assessment should be carried out for those metals with a PC greater than 1 % and PEC greater than 100 % of the long-term assessment level, and this should be based on measured emissions data from currently operational MSW incineration and waste wood co-incineration plant. The Environment Agency has published a summary of measurements undertaken at facilities between 2007 and 2015, enabling the percentage contribution that each individual metal species makes to the total Group 3 metals contribution, to be used in calculating the likely release of each species from the modelled result. The calculated percentages specified in the guidance note are representative of the original BAT-AEL specified for Group 3 metals in the IED (0.5 mg Nm^{-3}). Due to the reduction in the BAT-AEL as specified in the BREF and BAT-Conclusions documents of 2019[2&3], the percentage contribution of the measured value has been recalculated in relation to the revised BAT-AEL. As the overall emission of Group 3 metals will reduce with the application of BAT, this likely represents a significant over-estimate of the contribution of each species, and would suggest an exceedance of the BAT-AEL if the Group 3 metals were to be summed. However, with no firm knowledge that individual metal species would be reduced proportionately through the application of best available techniques, the use of this conservative approach is considered to be reasonable.

Table 24 Percentage Contribution of Species for the Step 2 Assessment of Group 3 Metals

Measurement	Maximum (mg Nm^{-3})	Percentage Contribution to 0.5 mg Nm^{-3} ELV	Percentage Contribution to 0.3 mg Nm^{-3} ELV
Antimony	0.0115	2.3 %	3.8 %
Arsenic	0.025	5 %	8.3 %
Chromium$^{(VI)}$	0.00013	0.03 %	0.043 %
Cobalt	0.0056	1.1 %	1.9 %
Copper	0.029	5.8 %	9.7 %
Lead	0.0503	10.1 %	16.8 %
Manganese	0.060	12 %	20 %
Nickel	0.220	44 %	73.3 %
Vanadium	0.006	1.2 %	2 %

In the first instance, the Step 2 screening assessment should be based upon the maximum emissions and resultant percentage contributions as specified in the above table, and the measured data from the nearest Heavy Metals Monitoring Network site, in this case at Auchencorth Moss. A similar assessment of PC and PEC values should be applied as in Step 1. Therefore, the calculated maximum percentage contributions were applied to the total Process Contribution of 0.0055 µg m^{-3} for Arsenic and Chromium$^{(VI)}$, and Table 25 below reports both the PC and the resultant Predicted Environmental Concentration.

Table 25 Maximum Annual Average Predicted Environmental Concentrations for Arsenic and Chromium^{VI} – Step 2 Screening

Metal	Exceedance Threshold (µg m^{-3})	PC (µg m^{-3})	Percentage of the AQS/EAL	Background Concentration (µg m^{-3})	PEC (µg m^{-3})	Percentage of the AQS/EAL
Arsenic	0.003	0.000462	**15 %**	0.000221	0.000683	23 %
Chromium$^{(VI)}$	0.0002	2.4×10^{-06}	**1.2 %**	0.000166*	0.000168	84 %

** Note: The background concentration of Chromium$^{(VI)}$ is assumed to equate to 20 % of the total Chromium background as measured at Auchencorth Moss in 2019 (0.00083 µg m^{-3}).*

As can be seen, although the PC of Arsenic is greater than 1 % of the EAL, the PEC is significantly within the AQS, equating to 23 % of the total. The PC of Chromium$^{(VI)}$ also remains above 1 % of the EAL, albeit only marginally, and the resultant PEC which includes a background concentration estimated from total Chromium measured in 2019 at Auchencorth Moss remains within 100 % of the EAL. Therefore, and in accordance with the Environment Agency guidance note, the contributions of both Arsenic and Chromium$^{(VI)}$ screen as insignificant when applying the Step 2 screening methodology.

4.15 Dioxins and Furans

The results from detailed modelling of Dioxins and Furans are presented in the following table.

Table 26 Maximum Process Contribution for Dioxins and Furans

Statistic	Averaging Period	Approximate Concentration (µg m^{-3})
Annual	1hr	7.38×10^{-10}
Short-term PC 100%		3.22×10^{-08}
Short-term PC 100%	24hr	9.14×10^{-09}

There is a general concern within the population at large about the potential health effects associated with exposure to Dioxins and Furans in the emissions from industrial processes. However, there are no air quality standards or environmental assessment levels for Dioxins.

The maximum annual PC for Dioxins associated with emissions from the ERF, assuming a constant discharge at the permitted emission limit value of 0.04 ng Nm^{-3} was approximately 0.7 fg m^{-3}, at the point of maximum Process Contribution, which is about 290 metres to the north-east of the chimney of the ERF. At such low levels, emissions of Dioxins from the ERF are not expected to significantly increase the airborne concentration or deposition rate of Dioxins and Furans over what may be currently experienced in the locality. The maximum hourly average PC for Dioxins was predicted to be approximately 32 fg m^{-3}, and the maximum daily contribution was reported as approximately 9 fg m^{-3}.

4.16 PCBs and Dioxins and Furans

The maximum ELV for PCBs specified in the BAT-Conclusions document for Poly Chlorinated Biphenyls (PCBs) is for a combined and total emission of PCBs and Dioxins and Furans, and is limited to 0.06 ng Nm^{-3}, or 1.5 times the Dioxin and Furan ELV. The assessment here assumes that the total permitted concentration is emitted as PCBs.

Table 27 Maximum Process Contribution of PCBs

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (μg m^{-3})	Percentage of the EAL
Annual	0.2	1hr	1.11 x 10^{-09}	0.0000006 %
Short-term PC 100%	6		4.83 x 10^{-08}	0.0000008 %

The results in Table 27 demonstrate that, even when assuming that the total permitted release of PCBs, Dioxins and Furans is emitted as PCBs only, the Process Contribution is a very small fraction of 1 % of the Environmental Assessment Level and hence can be screened as insignificant.

By way of an additional assessment, specific to emissions of PCBs alone, reference is made to the original (August 2006) Waste Incineration BREF[11] which includes a table of measured emissions from some European municipal solid waste incineration plant, suggesting potentially higher releases of PCBs, although confirming that measured emissions of total PCBs are less than 0.005 mg Nm^{-3}. Modelling on this basis results in the Process Contributions reported in Table 28 below.

Table 28 Process Contribution of PCBs Emitted at 0.005 mg Nm^{-3}

Statistic	Exceedance Threshold	Averaging Period	Process Contribution (μg m^{-3})	Percentage of the EAL
Annual	0.2	1hr	9.26 x 10^{-05}	0.05%
Short-term PC 100%	6		4.04 x 10^{-03}	0.07%

Despite the significant increase in the modelled PCB emission when considering the historical data reported in the 2006 BREF[11], the Process Contribution remains a fraction of 1 % of the EAL for PCBs and is immediately screened as insignificant. As such, no further assessment is required.

4.17 Polycyclic Aromatic Hydrocarbons (PAH as B[a]P)

Although measured discharges of total PAH identified in the 2019 BREF[2] reported concentrations of up to 0.05 mg Nm^{-3} (50,000 ng Nm^{-3}) from incineration processes, emissions of Benzo[a]Pyrene (B[a]P) were reported to a maximum of 0.001 mg Nm^{-3} (1,000 ng Nm^{-3}). The Air Quality Standards (Scotland) Regulations 2010 specify a target value of 0.25 ng m^{-3} for B[a]P in ambient air, which had to be met by 31st December 2010. There is an additional European obligation to limit total ambient PAH to 1 ng m^{-3} as an annual average in the PM_{10} fraction. However, no information is available on the PAH content of any PM_{10} emissions that may be emitted from the ERF. Within this assessment therefore, the lower of the two target values has been applied and considers emissions of B[a]P, at 0.001 mg Nm^{-3}, rather than total PAH discharges.

The results from detailed modelling of Polycyclic Aromatic Hydrocarbons (as Benzo[a]Pyrene) are presented in the following table.

Table 29 Maximum Process Contribution for PAH as (B[a]P)

Statistic	Exceedance Threshold (ng m^{-3})	Averaging Period	Approximate Concentration (ng m^{-3})	Percentage of the AQS
Annual (PC)	0.25	Annual	0.0185	**7.4 %**
Annual (PEC)			0.127	50.7 %

Detailed modelling predicts a maximum annual average Process Contribution for B[a]P of approximately 0.019 ng m^{-3} (or about 7 % of the AQS objective). As such, the annual average PC is not immediately screened as insignificant. However, when calculating the PEC using the measured data from the nearby Glasgow Townhead monitoring station, which recorded 0.108 ng m^{-3} in 2019, the PEC equates to approximately 51 % of the AQS and can be screened as insignificant at the secondary assessment stage.

4.18 Comparison of ADMS and AERMOD Results

As requested by SEPA, a sensitivity analysis of the results obtained using the ADMS 5.2 model has been undertaken using the function within the ADMS model which replicates an AERMOD run. Both of the model types are based on broadly similar principles, for example, characterising the boundary layer structure using the Monin-Obuhkov length and boundary height, and a skewed Gaussian profile for convection conditions.

As such, CERC, the developers of ADMS have incorporated a facility within the ADMS model which enables the main model options of AERMOD to be run on the ADMS platform, and this has been employed, along with defined AERMOD meteorological files, including surface and profile data for 2018 and 2019, to compare the results of the two model types. The results are presented in Table 30 below.

Table 30 Results of Sensitivity Analysis – ADMS Vs AERMOD Results

Maximum Hourly Average	2018			2019		
	ADMS	AERMOD	Difference	ADMS	AERMOD	Difference
NO_x	1.77	1.45	0.3230	1.85	1.19	0.6607
SO_2	0.443	0.362	0.0813	0.4614	0.296	0.1654
Ammonia	0.148	0.121	0.0270	0.1541	0.099	0.0552
VOC	0.148	0.121	0.0270	0.1541	0.099	0.0552
Cadmium	0.296	0.240	0.0556	0.3078	0.200	0.1078
Mercury	0.0003	0.0002	0.0001	0.0003	0.0002	0.0001
Lead	0.0044	0.0036	0.0008	0.0046	0.0030	0.0017

The results from the modelling show that for both of the meteorological data years assessed, the ADMS annual average results were consistently higher than the results reported using the AERMOD modelling platform. Modelling 2018 meteorological conditions resulted in Process Contributions reported by AERMOD which were 18 - 19 % lower than those reported by ADMS and, when modelling 2019 weather data the difference was greater still, with AERMOD results being approximately 35 - 36 % lower than the ADMS results. Short-term results were also lower when using AERMOD.

It is noted that, when running AERMOD on the ADMS platform, a limited number of receptor points can be included within the modelled grid. Therefore, although the AERMOD models were run with a 4 km x 4 km grid, only 101 receptor points could be included across each plane, resulting in a gridded point every 40 m, rather than at every 20 m as provided by the ADMS model. This will naturally have an impact on the sensitivity and accuracy of the models run, and goes some way to explain the differences observed in the results.

The sensitivity analysis therefore demonstrates that, in this instance, the application of the ADMS Version 5.2 model results in higher Process Contributions than those predicted by the AERMOD modelling platform, and hence the use of the ADMS modelling system provides a worst-case assessment of the impact of the emissions from the proposed ERF.

5. Impact of Short-Term Releases

In addition to the basic model parameters included in the study, consideration has been given to the potential for higher emission rates, through the modelling of short-term allowable emission levels, specified in the Industrial Emissions Directive. Although the daily emission limit values specified in the Directive are expected to be met for the vast majority of the time, the Directive allows for transient increases in the emitted concentration of some pollutants and as such, a series of half-hourly average limit values are specified which have been modelled to estimate the maximum likely half-hourly average Process Contribution values.

Due to the transient nature of these permissible conditions it is inappropriate to calculate percentile values based upon annual operation at the half-hourly limit values. Accordingly, assessment of these discharges initially considers the maximum, 100th percentile value only, in order to represent the absolute worst-case short-term Process Contribution associated with emissions from plant at the half-hourly Industrial Emissions Directive limit values.

Table 31 Modelled Short-Term Emission Values

Pollutant Species	30-Minute Average Concentration (mg/Nm3)	Release Rate (g/s)
NO_x	400	14.9
SO_2	200	7.47
CO	100	3.74
Particulate Matter (as PM_{10})	30	1.12
HF	4	0.149
HCl	60	2.24
Total / Volatile Organic Compounds (VOC)	20	0.747

Models were run applying meteorological conditions from 2016 only, as the meteorological conditions during that year reported the highest 100th percentile results for most pollutants. The impact of short-term (30-minute) operational releases is considered in Table 32, with the likely Process Contributions from discharges at the maximum half-hourly limit values presented.

Table 32 Maximum Process Contributions During Short-Term (30-Minute ELV) Operating Conditions

Pollutant Parameter	Short-Term 100 % PC (µg m^{-3})	Short-Term AQS / EAL	% AQS / EAL	Short-Term 100 % PEC (µg m^{-3})	% AQS / EAL
Maximum Hourly Average NO_2	160.78	200	**80 %**	175.01	**88 %**
Maximum 15-Minute Average SO_2	163.21	266	**61 %**	167.65	**63 %**
Maximum Hourly Average SO_2	161.21	350	**46 %**	165.65	**47 %**
Maximum 8-Hour Average CO	23	10,000	0.23 %	221.4	2.2 %
Maximum Hourly Average Particulate Matter (as PM_{10})	24.17	50	**48 %**	39.97	**80 %**
Maximum Hourly Average HF	3.22	160	2 %	3.22	2 %
Maximum Hourly Average HCl	48.34	750	6 %	49.16	7 %
Maximum Hourly Average VOC	16.12	195	8 %	16.40	8 %

Although not always screened as insignificant when applying the standard assessment approach, each of the Process Contributions and Predicted Environmental Concentrations remain within the stated Environmental Quality Standard when discharging at the allowable half-hourly limit values and are therefore unlikely to result in an exceedance of the Air Quality Standards or Environmental Assessment Levels.

It is noted that assessment of short-term, transient contributions against standards which have different referencing periods and may include percentile values, is not a strictly relevant comparison, and presents a worst-case approach. As such, Table 33 below considers the Process Contribution of pollutants accounting for allowable exceedances where these are permitted, and demonstrates that, when PCs are considered in line with their comparable assessment levels, the majority screen as insignificant.

Table 33 Process Contributions During Short-Term (30-Minute ELV) Operating Conditions, Accounting for Allowable Exceedances

Pollutant Parameter	Short-Term PC (µg m^{-3})	Short-Term AQS / EAL	% AQS / EAL	Short-Term AQS / EAL – LT Background	% AQS / EAL
99.79th Percentile Hourly Average NO_2	45.84	200	**23 %**	192.88	**23.8 %**
99.9th Percentile 15-Minute Average SO_2	48.54	266	**18 %**	263.78	18.4 %
99.73rd Percentile Hourly Average SO_2	45.53	350	**13 %**	347.78	13.1 %
98.08th Percentile Hourly Average Particulate Matter (as PM_{10})	5.51	50	**11 %**	42.10	13.1 %

Figures 13 – 16 present the Process Contribution plots for short-term emissions of NO_2, SO_2, and PM_{10} when accounting for the allowable exceedances specified by the Air Quality Standards.

Figure 12 99.79th Percentile Hourly Average Process Contribution Due to Short-Term Releases of NO_2 (µg m^{-3}); 2016 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (10 % of the AQS)

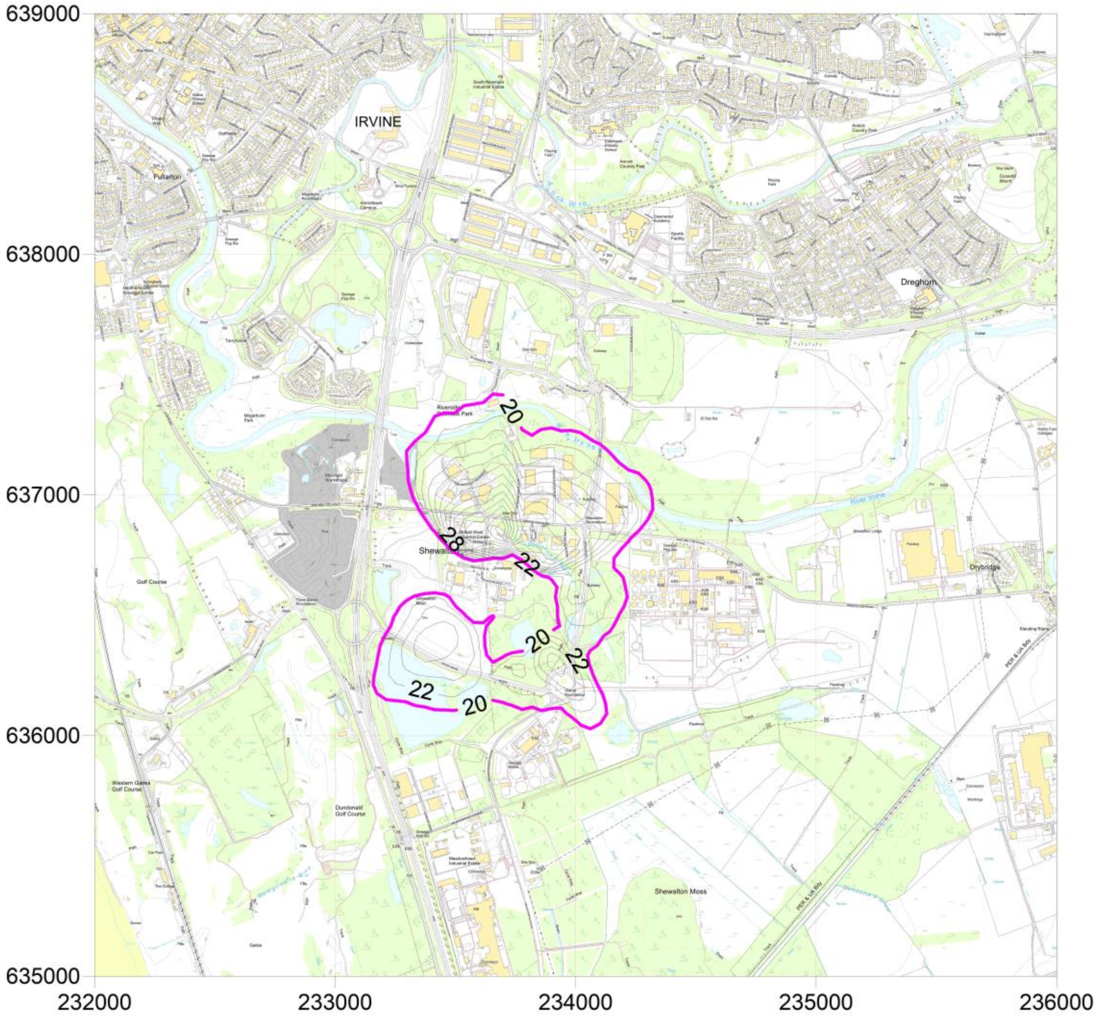

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Figure 13 99.9th Percentile 15-Minute Average Process Contribution Due to Short-Term Releases of SO_2 ($\mu g\ m^{-3}$); 2016 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (10 % of the AQS)

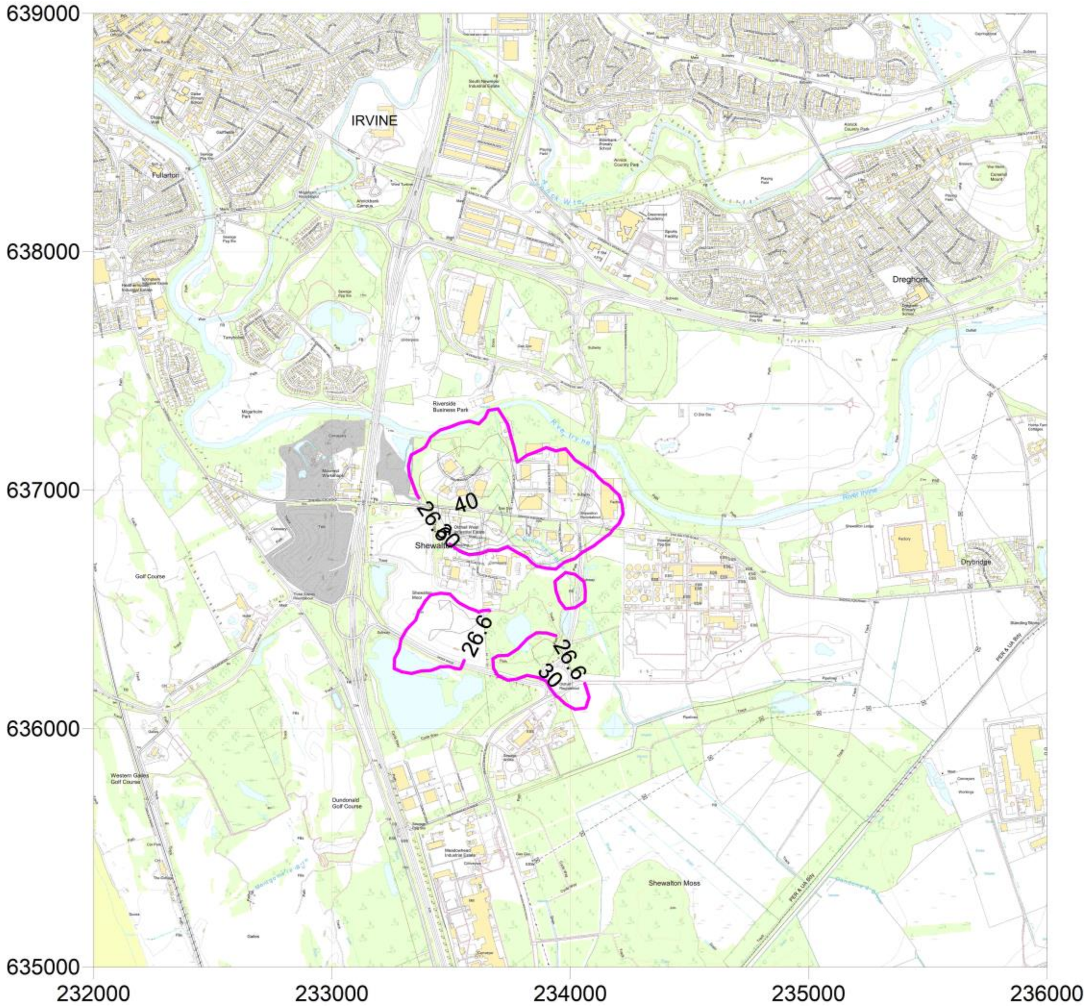

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Figure 14 99.73rd Percentile Hourly Average Process Contribution Due to Short-Term Releases of SO_2 (µg m^{-3}); 2016 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (10 % of the AQS)

Figure 15 98.08th Percentile 24-Hourly Average Process Contribution Due to Short-Term Releases of PM_{10} (µg m^{-3}); 2016 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance (10 % of the AQS)

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The one pollutant which still cannot be screened as insignificant is the short-term release of Nitrogen Dioxide, the PC of which equates to 23 % of the short-term AQS, or approximately 24 % of the short-term AQS minus the existing long-term background concentration. The Predicted Environmental Concentration of short-term NO_2 would equate to approximately 30 % of the AQS, when the short-term background concentration of 14.24 µg m^{-3} (which is twice the long-term background) is added, and confirms that, although not insignificant, the AQS is unlikely to be exceeded in the event of a short-term release. Coupled with the fact that this maximum Process Contribution is predicted to occur approximately 230 m to the north of the proposed discharge stack, and not at a sensitive human health or ecological receptor, the predicted PC is considered to be acceptable, despite not being insignificant.

6. Air Quality Impact at Specific Receptors

The ADMS model was also set up to calculate the impact of emissions at ten specific receptors in the vicinity of the ERF development site. The locations of these receptors were shown in Figure 1, and represent locations where members of the general public may be present for extended periods of time, either through residence in a particular area, or as a result of their employment. The results are summarised in the following table and are based upon the impact of continuous emissions from the ERF, discharging at the anticipated permitted emission limit value.

Table 34 Results from Detailed Assessment for Nitrogen Dioxide and Particulates (PM_{10}) at Specific Receptors – Impact Due to the Operation of the ERF

Receptor	Distance (m)	Annual Average NO_2 PC (µg m^{-3})	Hourly Average NO_2 PC (µg m^{-3})	Annual Average PM_{10} PC (µg m^{-3})	Daily Average PM_{10} PC (µg m^{-3})
1	1,329	**0.46**	2.421	0.019	0.088
2	2,013	0.27	1.752	0.011	0.057
3	2,260	0.24	1.632	0.010	0.050
4	3,004	0.02	1.005	0.001	0.014
5	3,019	0.03	1.381	0.001	0.016
6	1,443	0.14	2.505	0.006	0.082
7	1,018	0.28	4.508	0.012	0.114
8	1,568	0.11	2.198	0.005	0.041
9	1,482	0.34	3.122	0.014	0.082
10	2,924	0.11	1.271	0.005	0.031

Process Contributions due to emissions from the ERF at all of the nearby receptor locations are low and can be considered insignificant in relation to SEPA guidance. The annual average NO_2 Process Contribution at Receptor No.1, the nearest downwind receptor, is marginally above the 1 % insignificance threshold recommended by SEPA. However, the resulting PEC value of 7.58 µg m^{-3} represents a value equivalent to about 19 % of the AQS objective value and can be screened out as insignificant. It is noted that Receptor No. 1 is also located in a relatively rural area with no significant new sources of pollution in the immediate vicinity. As such, the estimated background NO_2 concentration from the Scottish Air Quality website[5] is considered to be appropriate for this receptor, and any other existing industrial contributions in the local area are unlikely to result in an overall exceedance of the Air Quality Standard at this point.

7. Air Quality Impact at Air Quality Monitoring Receptors

The ADMS model was also set up to calculate the impact of emissions at four nearby specific receptors where North Ayrshire Council undertakes air quality monitoring. The location of these receptors was shown in Figure 1 with the prefix 'DT'. The results are summarised in the following table, and detail the impact of emissions from the ERF, based on emissions at the achievable ELV specified in the BAT-Conclusions document.

Table 35 Results from Detailed Assessment for Nitrogen Dioxide at Nearby Air Quality Monitoring Locations – Impact Due to the Operation of the ERF

Receptor	Distance (m)	Annual Average PC ($\mu g\ m^{-3}$)	Percentage of the AQS	Existing Background ($\mu g\ m^{-3}$)	Annual Average PEC ($\mu g\ m^{-3}$)	Percentage of the AQS
DT1	2,679	0.106	0.27%	18	18.106	45%
DT10	2,716	0.099	0.25%	11	11.099	28%
DT11	3,709	0.123	0.31%	13	13.123	33%
DT12	1,120	0.093	0.23%	12	12.093	30%

The results show that the increase in annual average NO_2 concentrations at nearby monitoring sites is less than 1 % of the AQS objective value at each location, and can therefore be screened out insignificant. When considered in relation to the existing background, annual average NO_2 Process Contributions attributable to the operation of the ERF do not result in an exceedance of the AQS objective value where one currently doesn't exist, and at each of these local monitoring points, the overall Predicted Environmental Concentration remains within 70 % of the AQS.

8. Impact of Emissions on Nearby Ecological Receptors

Sixteen ecological receptor locations were incorporated into the ADMS model representing designated ecological habitats within a 15 km radius of the development site, and Local Wildlife Sites within 2 km of the site. The ecological habitats included in the assessment are listed in Table 5. As detailed in Section 2.7, the results in this section consider only 11 of the modelled receptors as the other five sites are designated for their geological importance only and are not therefore likely to be impacted by changes in air quality, or do not have any specified Critical Levels or Loads.

8.1 Assessment Relative to Critical Level Values

Annual average Process Contributions for NO_x and SO_2, HF and NH_3 were calculated for each of the ecological receptors using the ADMS model, and the predicted increases were compared against their respective Critical Level values as specified by SEPA[4] for Oxides of Nitrogen, Sulphur Dioxide and Ammonia, and by the Environment Agency[12] for the assessment of the ecological impact of Hydrogen Fluoride at sensitive habitat sites, which is presumed to also be acceptable to SEPA. The Critical Levels are summarised in the following table.

Table 36 Critical Levels for NO_x, SO_2, NH_3 and HF

Pollutant	Averaging Period	Critical Level (µg m^{-3})
Oxides of Nitrogen (NO_x as NO_2)	Annual	30
Oxides of Nitrogen (NO_x as NO_2)	24 hr	75
Sulphur Dioxide (Forests and Natural Vegetation)	Annual	20
Ammonia (Other Vegetation)	Annual	3
Hydrogen Fluoride	Daily	5
Hydrogen Fluoride	Weekly	0.5

The results from the Critical Levels assessment are presented in the tables below.

Table 37 Critical Levels Assessment for NO_x and SO_2

Ecological Receptor Name	Annual NO_x PC (µg m^{-3})	Percentage of Critical Level	Daily NO_x PC (µg m^{-3})	Percentage of Critical Level	Annual SO_2 PC (µg m^{-3})	Percentage of Critical Level
Oldhall Ponds Wildlife Site	0.0403	0.13 %	2.89	3.85 %	0.0101	0.05 %
Shewalton Wood Nature Reserve	0.1659	0.55 %	3.63	4.84 %	0.0415	0.21 %
Shewalton Sandpits Nature Reserve	0.0482	0.16 %	2.16	2.88 %	0.0120	0.06 %
Gailes Marsh Nature Reserve	0.2478	0.83 %	3.66	4.88 %	0.0619	0.31 %
Western Gailes SSSI	0.1253	0.42 %	2.59	3.46 %	0.0313	0.16 %
Dundonald Wood SSSI	0.1221	0.41 %	1.33	1.77 %	0.0305	0.15 %
Troon Golf Links and Foreshore SSSI	0.0163	0.05 %	0.26	0.34 %	0.0041	0.02 %
Ashgrove Loch SSSI	0.0197	0.07 %	0.43	0.58 %	0.0049	0.02 %
Dykeneuk Moss SAC / SSSI*	0.0257	0.09 %	0.30	0.39 %	0.0064	0.06 %
Cockinhead Moss SAC / SSSI*	0.0207	0.07 %	0.24	0.32 %	0.0052	0.05 %
Bankhead Moss, Beith SAC / SSSI*	0.0170	0.06 %	0.25	0.34 %	0.0043	0.04 %

** Note: The Critical Level for SO_2 at the SAC sites is 10 µg m^{-3} rather than 20 µg m^{-3}.*

As can be seen in the above table, the annual average Process Contributions of NO_x (as NO_2), and SO_2 at each of the receptors considered are less than 1 % of the 30 µg m^{-3} Critical Level for NO_x and 20 µg m^{-3} for SO_2 (10 µg m^{-3} for SAC sites). Additionally, the daily Process Contribution of NO_x (as NO_2), remains within 10 % of the 75 µg m^{-3} Critical Level for the protection of ecosystems, and as such, all PCs can be screened as insignificant.

The corresponding values for Ammonia and Hydrogen Fluoride are based upon an assumed Ammonia concentration in the emissions to atmosphere of 10 mg Nm^{-3} and emissions of HF at the ELV of 1 mg Nm^{-3}, as specified in the BAT-Conclusions document.

Table 38 Critical Levels Assessment for NH_3 and HF

Ecological Receptor Name	Annual NH_3 PC (µg m^{-3})	Percentage of Critical Level	Daily HF PC (µg m^{-3})	Percentage of Critical Level	Weekly HF PC (µg m^{-3})	Percentage of Critical Level
Oldhall Ponds Wildlife Site	0.00337	0.11 %	0.02409	0.482 %	0.0035	0.696 %
Shewalton Wood Nature Reserve	0.01385	0.46 %	0.03031	0.606 %	0.0104	2.086 %
Shewalton Sandpits Nature Reserve	0.00402	0.13 %	0.01802	0.360 %	0.0047	0.945 %
Gailes Marsh Nature Reserve	0.02069	0.69 %	0.03057	0.611 %	0.0184	3.683 %
Western Gailes SSSI	0.01046	0.35 %	0.02165	0.433 %	0.0128	2.551 %
Dundonald Wood SSSI	0.01019	0.34 %	0.01109	0.222 %	0.0038	0.764 %
Troon Golf Links and Foreshore SSSI	0.00136	0.05 %	0.00213	0.043 %	0.0007	0.147 %
Ashgrove Loch SSSI	0.00165	0.05 %	0.00360	0.072 %	0.0008	0.160 %
Dykeneuk Moss SAC / SSSI *	0.00215	0.21 %	0.00246	0.049 %	0.0007	0.147 %
Cockinhead Moss SAC / SSSI *	0.00172	0.17 %	0.00202	0.040 %	0.0006	0.123 %
Bankhead Moss, Beith SAC / SSSI *	0.00142	0.14 %	0.00210	0.042 %	0.0005	0.108 %

** Note: The Critical Level for NH_3 at the SAC sites is 1 µg m^{-3} rather than 3 µg m^{-3}.*

Annual average NH_3 Process Contributions at each of the reported ecological receptors are less than 1 % of the 3 µg m^{-3} Critical Level for ecological protection (1 µg m^{-3} when considering SAC sites), and can be screened out as insignificant. The daily average and weekly average Process Contributions of Hydrogen Fluoride all remain within 10 % of the short-term Critical Levels and hence are also screened as insignificant.

It should be borne in mind that these results are based upon a series of worst-case assumptions that may overestimate their significance by an appreciable margin, as discussed earlier. Accordingly, the impact of emissions from the ERF on nearby ecological habitats, in relation to Critical Level values, will be very low and will have an insignificant impact on designated species at these locations.

8.2 Assessment Relative to Site-Specific Critical Load Values

Sensitive ecological receptors may also be sensitive to nutrient Nitrogen and acid deposition, and where relevant, an assessment has been made of the potential for deposition to occur. Specified ecological receptors which are reported to be not sensitive to the effects of nutrient Nitrogen or acid deposition and for which no background data could be confirmed from the APIS website[13] were Dundonald Wood SSSI, Bogside Flats SSSI, Ardrossan to Saltcoates Coast SSSI, Afton Lodge SSSI and Lynn Spout SSSI. As such, these sites are not included in the following assessment.

The following deposition velocities were applied to the study to calculate the levels of deposition from the release point:

Dry deposition of:	Grassland Velocity (m s^{-1})	Forest Velocity (m s^{-1})
NO_2	0.0015	0.003
NH_3	0.02	0.03
SO_2	0.012	0.024
HCl	0.025	0.06

In the absence of a stated dry deposition velocity for HF, deposition was modelled and assumes that HF is a reactive gas.

The following methods were applied when calculating deposition rates.

Nitrogen Based Species

The results of annual average concentrations of Oxides of Nitrogen (NO_x as NO_2) and Ammonia were multiplied by the relevant dry deposition factor depending on whether an individual receptor comprises a grassland or woodland site. The resultant µg m^{-2} s^{-1} figures were multiplied by 95.9 (NO_x as NO_2) and 260 (NH_3) to calculate individual contributions to nutrient Nitrogen deposition, before the figures were summed to provide a total kg N ha^{-1} $year^{-1}$ nutrient Nitrogen deposition loading.

When calculating the Nitrogen based component of acid deposition, the µg m^{-2} s^{-1} figures were multiplied by 6.84 (NO_x as NO_2) and 18.5 (NH_3) to calculate individual contributions of Nitrogen based species to acid deposition, before the figures were summed to provide a total keq ha^{-1} $year^{-1}$ Nitrogen based acid loading.

Sulphur and Hydrogen Based Species

Similarly to the calculation of acid deposition from Nitrogen species, the results calculated from the modelled concentrations multiplied by the relevant dry deposition factor to give µg m^{-2} s^{-1} figures, were multiplied by 9.84 (SO_2) and 8.63 (HCl) to calculate those species contributions to acid deposition, although the HCl figure was subsequently also multiplied by 3 to represent total (wet and dry) deposition. Although HF dry deposition levels were modelled, the results were subsequently multiplied by 15.77 and then by 3 in order to report a total acid loading from HF in keq ha^{-1} $year^{-1}$. Finally, the Sulphur and Hydrogen based deposition rates were summed to provide a total S and H keq ha^{-1} $year^{-1}$ acid loading.

The total concentrations of pollutant substances were applied to the deposition calculations and thus results can be considered to represent a worst-case.

The results in Table 39 relate to the maximum annual average nutrient Nitrogen deposition at nearby designated ecological habitats and Local Wildlife Sites, associated with emissions of NO_x and NH_3 from the proposed ERF.

Table 39 Results from Detailed Modelling of Nitrogen Deposition in Relation to the Site-Specific Critical Load

Habitat	N Deposition (kgN/ha/yr)	Critical Load (kgN/ha/yr)	% Critical Load	Background (kgN/ha/yr)	Total N Deposition PEC (kgN/ha/yr)	PEC as % Critical Load
Oldhall Ponds Wildlife Site	0.038	10	0.38 %			
Shewalton Wood Nature Reserve	0.156	10	**1.56 %**	18.06	18.216	182 %
Shewalton Sandpits Nature Reserve	0.045	10	0.45 %			
Gailes Marsh Nature Reserve	0.143	20	0.72 %			
Western Gailes SSSI	0.072	8	0.90 %			
Dundonald Wood SSSI	0.115	10	**1.15 %**	25.62	25.735	257 %
Troon Golf Links and Foreshore SSSI	0.009	8	0.12 %			
Ashgrove Loch SSSI	0.011	10	0.11 %			
Dykeneuk Moss SAC / SSSI	0.015	5	0.30 %			
Cockinhead Moss SAC / SSSI	0.012	5	0.24 %			
Bankhead Moss, Beith SAC / SSSI	0.010	5	0.20 %			

Data is not provided for Dundonald Burn SSSI, Bogside Flats SSSI, Ardrossan to Saltcoates Coast SSSI, Afton Lodge SSSI and Lynn Spout SSSI as these sites are not sensitive to nutrient Nitrogen deposition.

Consideration of the Predicted Environmental Concentration of nutrient Nitrogen deposition is only provided where the Process Contribution does not immediately screen as insignificant.

As can be seen, with the exception of Shewalton Wood Nature Reserve and Dundonald Wood SSSI, annual average deposition of nutrient Nitrogen at all of the above ecological habitat sites are less than 1 % of the site-specific critical load, and can therefore be screened as insignificant in relation to SEPA and Scottish Natural Heritage guidance, irrespective of any existing background concentration.

The annual average nutrient Nitrogen deposition rates at Shewalton Wood Nature Reserve and Dundonald Wood SSSI are both less than 2 % of the critical load, and such a small contribution is probably not measurable to any reasonable degree of accuracy. Additionally, the Process Contribution represents a very small percentage of the current background levels, and the resulting Predicted Environmental Concentrations are dominated by existing deposition.

It should be noted that exceedance of a Critical Load is not a quantitative estimate of damage to a particular habitat but instead represents the potential for damage to occur. There is no evidence in the available literature[14] to indicate that the above ecological habitat sites are suffering as a consequence of Nitrogen deposition from nearby sources. Accordingly, on this basis, the incremental increase in Nitrogen deposition attributable to emissions of NO_x and NH_3 from the proposed ERF is very small and is unlikely to have a measurable effect on the integrity of the above ecological habitat sites.

The results for the associated acid deposition are summarised in the Table 40 over page.

In line with the method for calculating exceedances of the acidity critical load function guidance provided on the APIS website[13], the first stage in the assessment considers the contribution of the Predicted Environmental Concentration of Nitrogen based acid deposition to the CLminN assessment level as, only if the PEC is greater than CLminN will the additional Nitrogen deposition from the source, contribute to acidity. Nitrogen deposition considers contributions from NO_x and Ammonia and where the PEC is more than 100 % of the CLminN, the total acid deposition is subsequently assessed against the CLmaxN assessment level. Where the PEC from Nitrogen based sources is less than 100 %, the assessment of acid deposition considers only contributions from the Sulphur and Hydrogen based species (SO_2, HCl, and HF).

It is noted that contributions from NO_x, Ammonia and SO_2 consider levels of dry deposition only, whereas for contributions of HCl and HF, the dry deposition rates are multiplied by 3 in order to represent total deposition.

Table 40 Results from Detailed Modelling of Acid Deposition in Relation to Site-Specific Critical Loads

Habitat	N Based Acid Deposition	N Based Background	PEC	CLminN	Is PEC < CLminN	S Based Acid Deposition	H Based Acid Deposition (Total)	Total Acid Deposition (N, S and H)	Lowest CLmaxN or S	PC as % CLmaxN / S
	(keq/ha/yr)					(keq/ha/yr)				
Oldhall Ponds Wildlife Site	0.0027	1.29	1.2927	0.142	No	0.00238	0.00334	0.00842	1.44	0.58%
Shewalton Wood Nature Reserve	0.0111	1.29	1.3011	0.142	No	0.00980	0.01407	0.03496	1.438	**2.43%**
Shewalton Sandpits Nature Reserve	0.0032	1.29	1.2932	0.142	No	0.00284	0.00404	0.01011	1.441	0.70%
Gailes Marsh Nature Reserve	0.0102	0.8	0.8102	-	No	0.00731	0.00954	0.02705	4	0.68%
Western Gailes SSSI	0.0052	0.8	0.8052	0.892	Yes	0.00370	0.00478	0.01363	0.8	**1.06%**
Dundonald Wood SSSI	0.0082	1.83	1.8382	0.142	No	0.00721	0.01032	0.02568	3.571	0.72%
Troon Golf Links and Foreshore SSSI	0.0007	0.68	0.6807	0.892	Yes	0.00048	0.00060	0.00175	0.81	0.13%
Ashgrove Loch SSSI	0.0008	1.06	1.0608	1.071	Yes	0.00058	0.00073	0.00213	4	0.03%
Dykeneuk Moss SAC / SSSI	0.0011	1.2	1.2011	0.321	No	0.00076	0.00098	0.00280	0.695	0.40%
Cockinhead Moss SAC / SSSI	0.0008	1.2	1.2008	0.321	No	0.00061	0.00078	0.00224	0.707	0.32%
Bankhead Moss, Beith SAC / SSSI	0.0007	1.5	1.5007	0.321	No	0.00050	0.00064	0.00184	0.753	0.24%

Data is not provided for Dundonald Burn SSSI, Bogside Flats SSSI, Ardrossan to Saltcoates Coast SSSI, Afton Lodge SSSI and Lynn Spout SSSI as these sites are not sensitive to acid deposition.

Annual average Nitrogen based acid deposition rates as Predicted Environmental Concentrations (keq/ha/yr) exceed the CLminN at seven of the eleven sensitive ecological receptors under consideration. Gailes Marsh Nature Reserve does not have a Nitrogen based acid assessment level and is therefore simply assessed against the total.

When considering the relevant total acid deposition rates, either as Sulphur and Hydrogen based species only (Western Gailes SSSI, Troon Golf Links and Foreshore SSSI, and Ashgrove Loch SSSI), or when considering contributions from Nitrogen, Sulphur and Hydrogen based species, the Process Contributions to acid remain within 1 % of the relevant maximum Critical Load at all sites with the exception of Shewalton Wood Nature Reserve, at which the PC is 2.43 %, and at Western Gailes SSSI where the PC is a fraction over 1 %. Equating to less than 3 % of the Critical Load, such small contributions are probably not measurable to any reasonable degree of accuracy. Additionally, and as stated earlier, the exceedance of a Critical Load is not a quantitative estimate of damage to a particular habitat, but represents the potential for damage to occur. Accordingly, on this basis, the incremental increase in acidity deposition attributable to emissions of NO_x, NH_3, SO_2, HCl and HF from the proposed ERF is very small and is unlikely to have a measurable effect on the integrity of the above ecological habitat sites.

9. Cumulative Impact with the Nearby Shewalton Road STOR Facility

9.1 Introduction

Planning permission was granted in 2017 for a Short-Term Operating Reserve (STOR) power generation facility on nearby Shewalton Road. Although the most recent aerial photography shows that the STOR facility has yet to be constructed, a cumulative impact assessment was undertaken to assess the combined effect on local air quality, of emissions from the two installations.

The STOR facility comprises ten MTU 16V4000 GS gas-fired power generation units, and information on the discharge characteristics of the engines was taken from the air quality assessment report prepared by Air Quality Consultants (AQC)[15] in support of the planning application. The dispersion model for the Oldhall ERF was adapted to include the ten gas engines operating for an assumed 2,500 operational hours per annum (the basis for the AQC air quality assessment). The AQC air quality assessment focussed solely on emissions of NO_x from the gas engines, and so this approach was followed for the cumulative impact assessment.

The long-term impact of emissions from the STOR facility was pro-rated to reflect the 2,500 operational hours and added to the annual impact of emissions from the Oldhall ERF, based upon 8,760 hours. In relation to the impact of NO_x emissions on hourly average NO_2 concentrations, AQC considered a worst-case impact for the STOR facility based upon 100 % utilisation. The cumulative hourly average impact of emissions from the two installations was therefore calculated on this basis.

The cumulative impacts assessments applied a single surface roughness value rather than a spatially variable roughness file, due to the larger modelled area.

The modelled source and emissions data used in the cumulative impact assessment are summarised in Table 41.

Table 41 Emission Source Parameters – Preliminary Sensitivity Analysis

Parameter	Oldhall ERF	STOR Facility*
Stack Height (m)	60	2.895
Stack Diameter (m)	1.84	0.6096
Efflux Temperature (° C)	140	412
Flue-gas Volumetric Flowrate ($Am^3 s^{-1}$)	52.99	5.999
Flue-gas Volumetric Flowrate ($Nm^3 s^{-1}$)	37.35	1.138
Efflux Velocity ($m s^{-1}$)	19.93	20.55
Location (x,y)	233703 636609	Various
NO_x Emission Rate ($g s^{-1}$)	4.48	0.374

Note: * Discharge characteristics for each of the ten gas engines

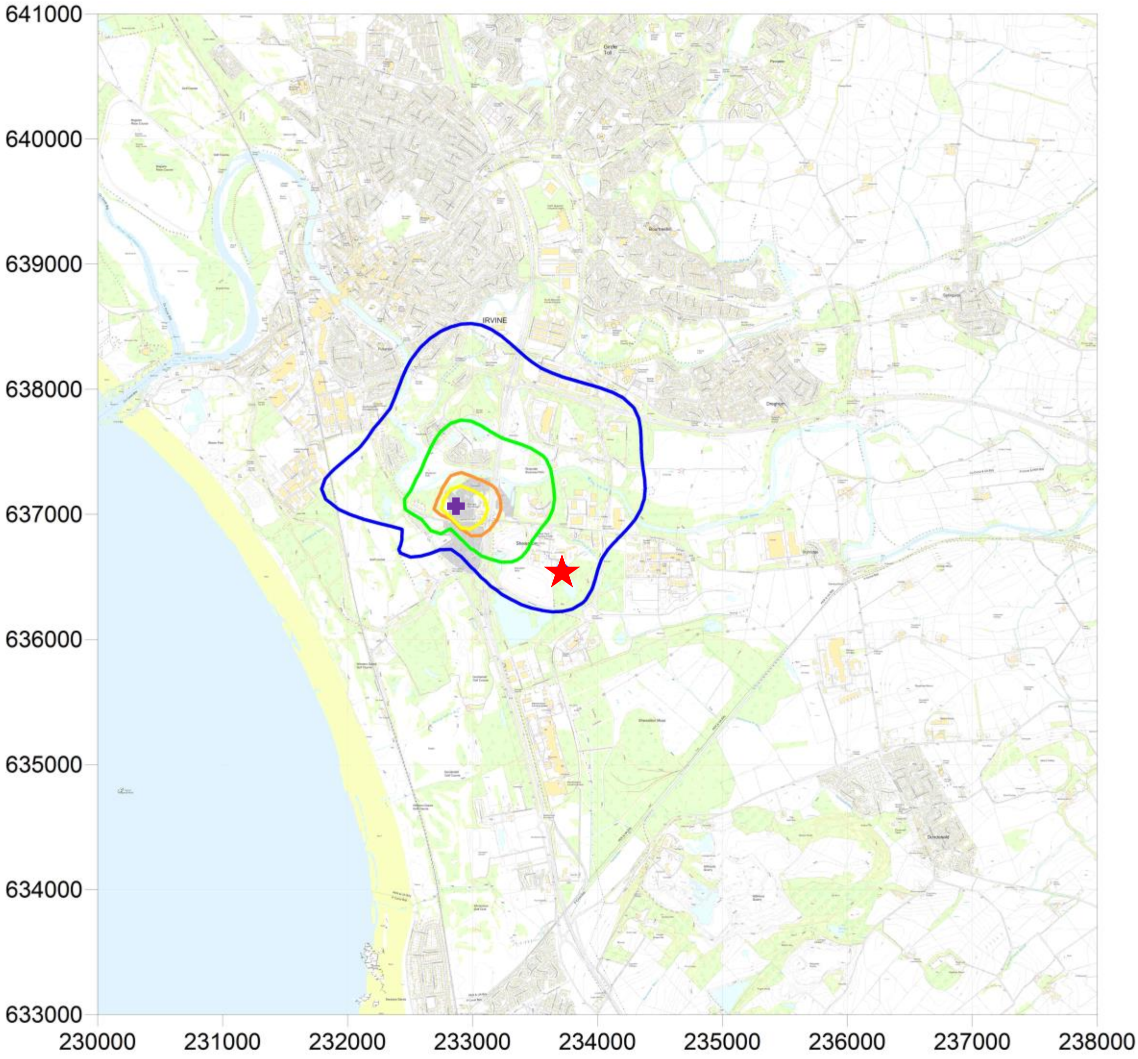
The results of the cumulative impact assessment are presented in the following sections.

9.2 Nitrogen Dioxide (NO_2)

The annual average NO_2 Process Contributions associated with the operation of the Oldhall ERF and the STOR facility occur close to their respective emission points. When originally assessing the STOR facility, AQC applied the EPUK / IAQM impact descriptors to the results from the air quality assessment for the STOR facility and this approach has been followed for the cumulative impact assessment to assist with the interpretation of the results. It is important to note here that the EPUK / IAQM guidance states that *'Changes of 0%, i.e. less than 0.5%, will be described as Negligible.'* As such, AQC includes 0.5 % to each of the lower assessment levels to demonstrate the point at which the impact would still be considered to be negligible.

The following figures show the annual average NO_2 Process Contributions for the STOR facility, the ERF and the cumulative impact of both facilities operating.

Figure 16 Maximum Annual Average Process Contribution for NO_2 STOR Facility; 2015 Meteorological Conditions



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Key to Figure 16:

- ✚ Approximate location of Shewalton Road STOR
- Blue line: Concentration > 0.2 µg m^{-3} (0.5 % of EAL)
- Orange line: Concentration > 2.2 µg m^{-3} (5.5 % of EAL)
- ★ Approximate location of Oldhall ERF
- Green line: Concentration > 0.6 µg m^{-3} (1.5 % of EAL)
- Yellow line: Concentration > 4 µg m^{-3} (10 % of EAL)

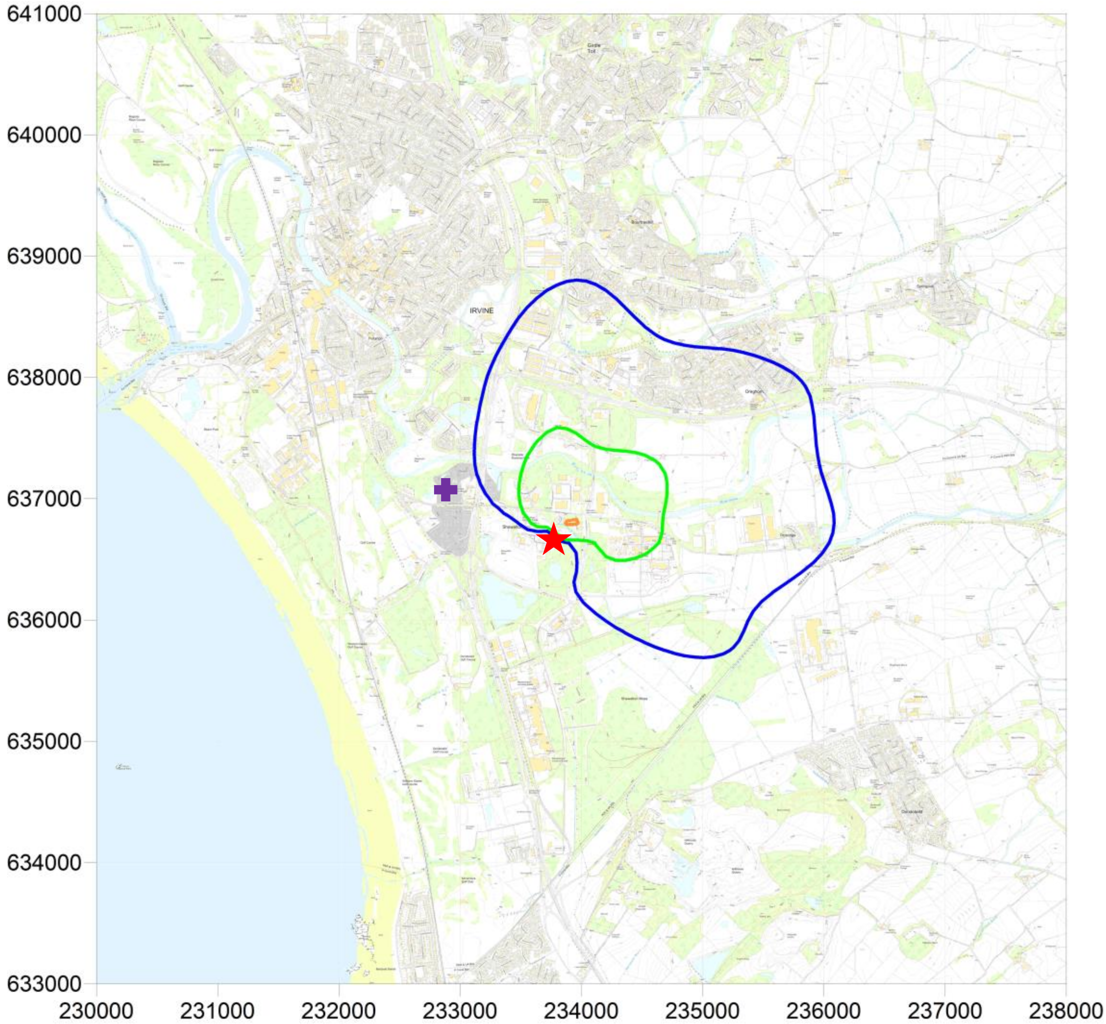
Descriptive terms for the impact significance of Process contributions were provided in Table 9 of this report. Based on the same descriptors, AQC concluded that the impact of the STOR facility on annual mean Nitrogen Dioxide concentrations will be **negligible** everywhere outside of the 2.2 µg m^{-3} (orange) contour. This contour contains two residential properties modelled by AQC at the eastern end of Shewalton Road. The impact at these properties was considered to be *'slight adverse'*. There are no relevant receptors in terms of the annual mean objective inside the yellow (4.0 µg m^{-3}) contour, and thus there will be no moderate adverse impacts.

It is noted that the annual average contribution of the STOR to levels of Nitrogen Dioxide can exceed the specified Air Quality Standard in places within the yellow contour, and the maximum annual average contribution across the gridded area equates to 43.3 µg m^{-3}, or approximately 108 % of the AQS when assuming that the STOR operates for a total of 2,500 hours per year.

However, due to the small spatial extent of these elevated contributions, with only a single gridded point exceeding the AQS before the contributions drop to less than 80 %, their occurrence in the immediate vicinity of the engines, and a lack of sensitive receptors within the impacted area, AQO deemed that the overall impact of the scheme in terms of annual mean Nitrogen Dioxide concentrations was judged to be *'not significant'*.

The following figure illustrates the potential impact of NO_x emissions from the Oldhall ERF on annual average NO_2 Process Contributions.

Figure 17 Maximum Annual Average Process Contribution for NO_2 Oldhall ERF; 2015 Meteorological Conditions



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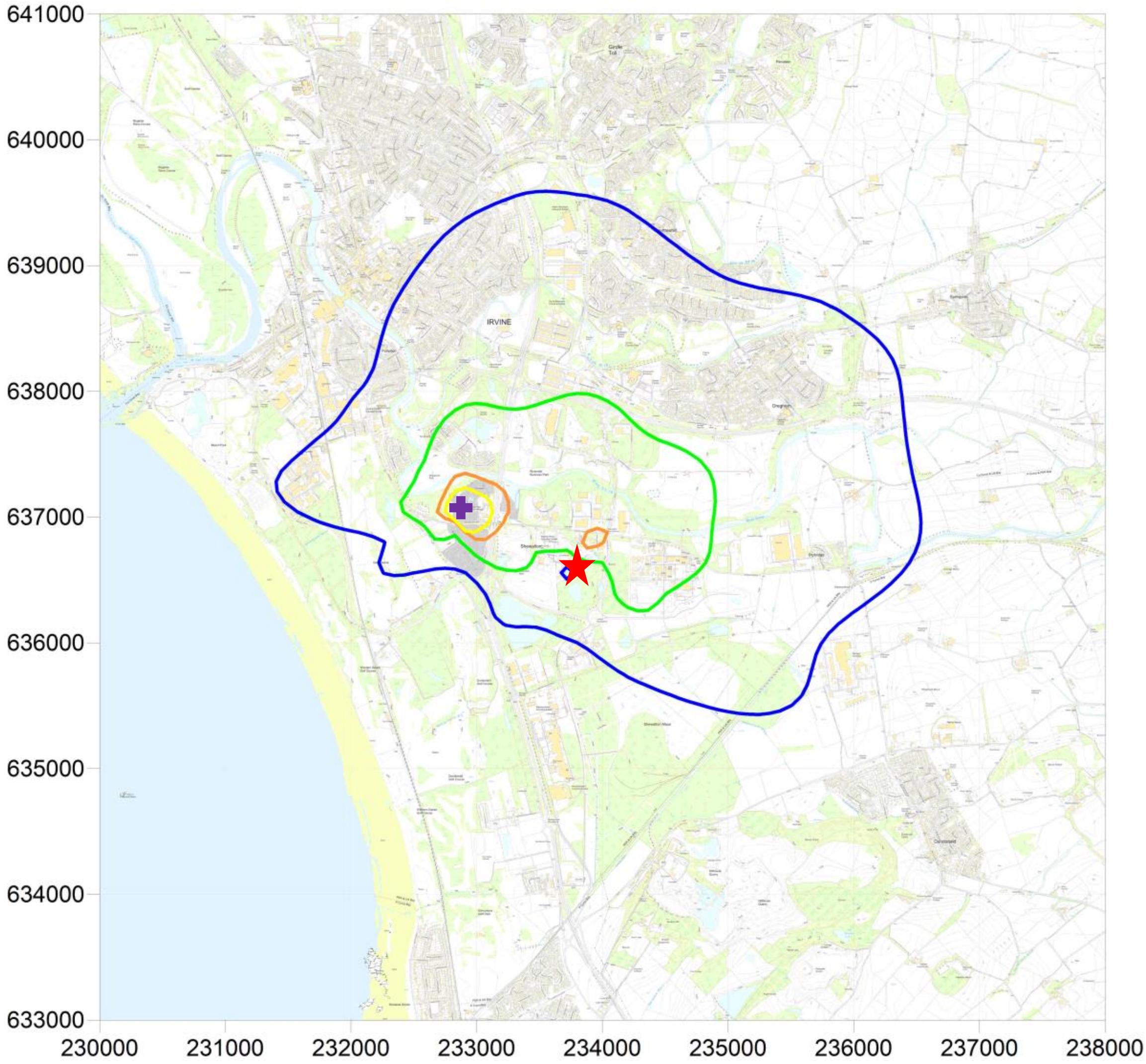
Key to Figure 17:

- Purple cross: Approximate location of Shewalton Road STOR
- Dark blue line: Concentration > 0.2 µg m^{-3} (0.5 % of EAL)
- Yellow line: Concentration > 2.2 µg m^{-3} (5.5 % of EAL)
- Red star: Approximate location of Oldhall ERF
- Green line: Concentration > 0.6 µg m^{-3} (1.5 % of EAL)

When again considering the descriptive terms for impact significance detailed in Table 9, the results for the Oldhall ERF show that the impact of emissions of NO_x on annual average NO_2 Process Contributions will be **negligible** across the modelled grid and at nearby relevant receptors, remaining at less than 6 % of the AQS (2.39 µg m^{-3}). The overall impact of the Oldhall ERF in terms of annual average Nitrogen Dioxide concentrations is therefore considered to be 'not significant'.

The following figure illustrates the potential cumulative impact of NO_x emissions from the Oldhall ERF and the STOR facility on annual average NO_2 Process Contributions.

Figure 18 Maximum Annual Average Process Contribution for NO_2 Cumulative Impact; 2015 Meteorological Conditions



Key to Figure 18:

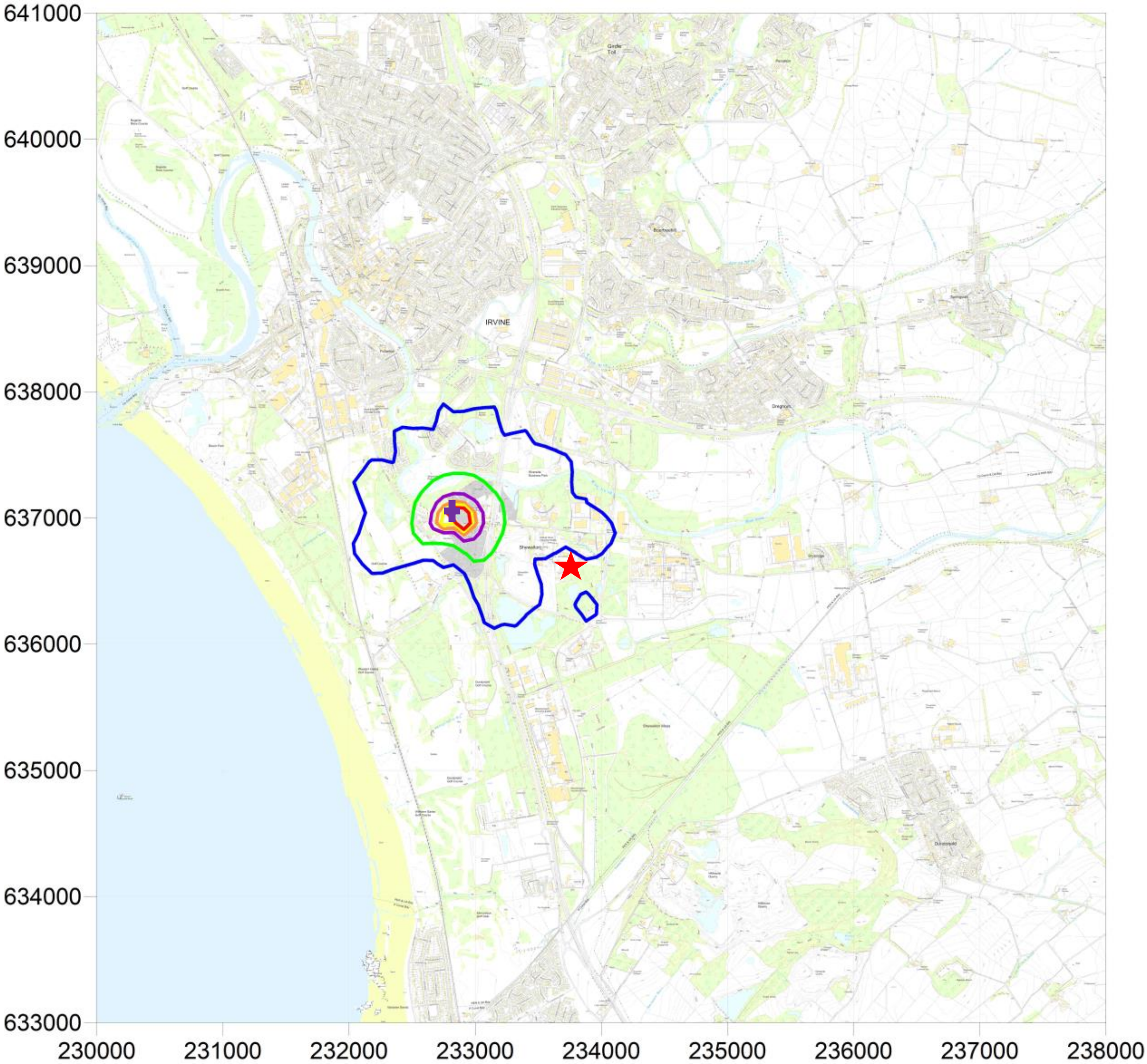
Approximate location of Shewalton Road STOR	Approximate location of Oldhall ERF
Concentration > 0.2 µg m^{-3} (0.5 % of EAL)	Concentration > 0.6 µg m^{-3} (1.5 % of EAL)
Concentration > 2.2 µg m^{-3} (5.5 % of EAL)	Concentration > 4 µg m^{-3} (10 % of EAL)

As can be seen, the extent of the impact of emissions from the two facilities covers a significantly wider area than the two facilities operating in isolation, albeit only for the **negligible** impacts. The extent of the orange and yellow contours where the impacts cannot be considered to be negligible barely change, and as such, the overall conclusions remain unchanged. Only the two residential properties modelled by AQC at the eastern end of Shewalton Road continue to have associated **slight adverse** impacts, from the operation of the STOR.

The maximum Process Contribution across the modelled grid shows a marginal increase on that reported when modelling the STOR alone, equating to 43.4 µg m^{-3}, or 108.5 % of the AQS. However, this exceedance of the AQS occurs at a single point of the 40,401 modelled grid points, and does not occur at the point of any sensitive receptor. The cumulative impact of the Oldhall ERF and the STOR facility operating concurrently, in terms of annual mean Nitrogen Dioxide concentrations, is therefore considered to be not significant.

The maximum cumulative hourly average Process Contribution for NO_2, associated with the operation of the ERF and the STOR facility is presented graphically in the following figure.

Figure 19 99.79th Percentile Hourly Average Process Contribution for NO_2 Cumulative Impact; 2017 Meteorological Conditions



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Key to Figure 19:

✚ (purple)	Approximate location of Shewalton Road STOR	★ (red)	Approximate location of Oldhall ERF
Blue line	Concentration > 20 µg m^{-3} (> 10 % of EAL)	Green line	Concentration > 40 µg m^{-3} (> 20 % of EAL)
Purple line	Concentration > 80 µg m^{-3} (> 40 % of EAL)	Orange line	Concentration > 120 µg m^{-3} (> 60 % of EAL)
Yellow line	Concentration > 160 µg m^{-3} (> 80 % of EAL)	Red line	Concentration > 200 µg m^{-3} (> 100 % of EAL)

The blue contour line represents a Process Contribution of 20 µg m^{-3}, and at locations outside of this contour the impact can be screened as insignificant in relation to SEPA guidance. The assessment for the ERF operating in isolation in Section 3.3 concluded that NO_x emissions from the ERF would not have a significant impact on local air quality. However, as can be seen in Figure 20 when the cumulative impact of the two facilities is taken into account, there is a more significant area of impact which extends into the residential areas to the north, due primarily to localised high hourly average NO_2 Process Contributions arising from the operation of the STOR facility. Nevertheless, with an estimated background concentration of 7.12 µg m^{-3}, there is unlikely to be an exceedance of the hourly average AQS objective value across most areas.

A small area in the vicinity of the STOR facility does experience exceedances of the AQS, even when accounting for allowable exceedances. The 99.79th percentile hourly average Process Contributions are greater than 200 µg m^{-3} at 13 of the gridded receptor points (0.03 % of the reported values) in the immediate vicinity of the engines, and report a maximum contribution of 661 µg m^{-3}, or approximately 331 % of the AQS. However, as previously, the spatial extent of the impacted area is small and there are no sensitive receptors within the impacted area. Additionally, and of specific importance to this study, the increase in the cumulative Process Contributions at these points which exceed the AQS, due to contributions from the ERF are all less than 4 µg m^{-3}, equating to 2 % of the AQS and can therefore be screened as insignificant.

It should be borne in mind that the assessment assumes that the STOR facility will operate for the whole of the year, whereas in practice it is only expected to operate for up to 2,500 hours per annum. Therefore, the assessment for the hourly average NO_2 Process Contribution provides an overly conservative estimate of the significance of the cumulative short-term impact on ambient NO_2 concentrations due to the operation of the ERF and the STOR facility.

9.3 Cumulative Air Quality Impact at Specific Receptors

The ADMS model was also set up to calculate the cumulative impact of NO_x emissions at specific receptors in the vicinity of the ERF and STOR development site. The locations of these receptors represent locations where members of the general public may be present for extended periods of time, either through residence in a particular area, or as a result of their employment, and the cumulative assessment included four additional locations modelled by AQC during the Shewalton Road STOR assessment. The additional receptors included in the cumulative modelling are described in Table 42.

Table 42 Additional Receptors Included in the Cumulative Assessment

Receptor	X	Y	Distance from ERF (m)	Receptor Name
A	232583	637035	1,198	Residential Property on Shewalton Road (W of STOR)
B	232540	636945	1,211	Residential Property on Ayr Road (W of STOR)
C	233182	637003	653	Residential Property on Shewalton Road (E of STOR)
D	233058	636977	743	Residential Property on Shewalton Road (E of STOR)

Examination of the modelling results confirmed that the meteorological conditions recorded in 2017 resulted in the majority of maximum Process Contributions at receptor locations when modelling the STOR facility with five years' worth of data (2015 – 2019). Therefore, 2017 meteorological conditions were applied to the cumulative impact assessment.

The results from modelling emissions as detailed in Table 41 are presented below, and the ERF is assumed to operate continuously, while the STOR facility is expected to operate for a maximum of 2,500 hours per annum.

Table 43 Results from Detailed Assessment for Annual Average Nitrogen Dioxide PCs at Specific Receptors

Receptor	Annual Average NO_2 PC ERF ($\mu g\ m^{-3}$)	% AQS	Annual Average NO_2 PC STOR Facility ($\mu g\ m^{-3}$)	% AQS	Annual Average NO_2 PC Cumulative ($\mu g\ m^{-3}$)	% AQS
1	0.473	**1.18 %**	0.130	0.33 %	0.603	**1.51 %**
2	0.281	0.70 %	0.083	0.21 %	0.363	0.91 %
3	0.242	0.60 %	0.070	0.18 %	0.312	0.78 %
4	0.004	0.01 %	0.014	0.04 %	0.018	0.05 %
5	0.004	0.01 %	0.004	0.01 %	0.008	0.02 %
6	0.107	0.27 %	0.020	0.05 %	0.127	0.32 %
7	0.195	0.49 %	0.945	**2.36 %**	1.140	**2.85 %**
8	0.072	0.18 %	0.324	0.81 %	0.396	0.99 %
9	0.222	0.55 %	0.176	0.44 %	0.398	1.00 %
10	0.114	0.28 %	0.038	0.09 %	0.151	0.38 %
A	0.080	0.20 %	0.880	**2.20 %**	0.960	**2.40 %**
B	0.076	0.19 %	0.862	**2.15 %**	0.938	**2.34 %**
C	0.133	0.33 %	3.219	**8.05 %**	3.352	**8.38 %**
D	0.115	0.29 %	6.596	**16.49 %**	6.710	**16.78 %**

Process Contributions due to emissions from the ERF at all of the nearby receptor locations are low and can be considered insignificant in relation to either first stage or second stage screening according to SEPA guidance.

The corresponding annual average NO_2 Process Contributions due to emissions from the STOR facility are low, apart from those receptors in close proximity to the Shewalton Road STOR site. However, when considered in relation to the existing background value of approximately 7.12 $\mu g\ m^{-3}$ the resulting PEC values are all less than 70 % of the AQS objective value and can be screened out as insignificant.

The cumulative impacts at the above specific receptors result in small increases in the respective values for the ERF and the STOR facility operating in isolation, however, the conclusions regarding the insignificance of the impact on annual average NO_2 concentrations remain valid. The corresponding values for the hourly average NO_2 Process Contributions are presented in the following table.

Table 44 Results from Detailed Assessment for 99.79th Percentile Hourly Average Nitrogen Dioxide PCs at Specific Receptors

Receptor	Hourly Average NO_2 PC ERF ($\mu g\ m^{-3}$)	% AQS	Hourly Average NO_2 PC STOR Facility ($\mu g\ m^{-3}$)	% AQS	Hourly Average NO_2 PC Cumulative ($\mu g\ m^{-3}$)	% AQS
1	2.41	1.21 %	5.88	2.94 %	8.29	4.1 %
2	1.67	0.84 %	4.04	2.02 %	5.71	2.9 %
3	1.55	0.77 %	3.72	1.86 %	5.27	2.6 %
4	0.29	0.15 %	3.92	1.96 %	4.21	2.1 %
5	0.48	0.24 %	0.83	0.42 %	1.31	0.7 %
6	2.25	1.13 %	4.88	2.44 %	7.14	3.6 %
7	4.19	2.10 %	27.03	**13.51 %**	31.22	**15.6 %**
8	2.15	1.07 %	19.88	9.94 %	22.03	**11.0 %**
9	2.80	1.40 %	7.30	3.65 %	10.10	5.0 %
10	1.14	0.57 %	2.47	1.23 %	3.60	1.8 %
A	2.63	1.31 %	51.60	**25.80 %**	54.23	**27.1 %**
B	2.58	1.29 %	43.78	**21.89 %**	46.36	**23.2 %**
C	4.18	2.09 %	41.88	**20.94 %**	46.07	**23.0 %**
D	4.08	2.04 %	78.48	**39.24 %**	82.56	**41.3 %**

Process Contributions due to emissions from the ERF at all of the nearby receptor locations are very low, being less than 10 % of the AQS objective value, and can be considered insignificant in relation to SEPA guidance.

The corresponding hourly average NO_2 Process Contributions due to emissions from the STOR facility are also very low or low, apart from those receptors in close proximity to the Shewalton Road STOR site. Process Contributions at the more distant receptors can go on to be screened as insignificant, while Process Contributions at Receptors A, B, C and D cannot be screened in relation to either first or second stage assessment recommended by SEPA. However, it should be borne in mind that the assessment for the hourly average Process Contribution assumes that the STOR facility operates for the whole of the year, whereas in practice it will only operate for up to 2,500 hours of the year, and may not be operational during the meteorological conditions which result in the higher Process Contributions. Accordingly, the model predictions are likely to provide an overly conservative assessment of the short-term impact of emissions.

The cumulative impacts at the above specific receptors result in small to medium increases in the respective values for the ERF and the STOR facility operating in isolation, and the conclusions regarding the insignificance or significance of the impact on hourly average NO_2 concentrations at the receptors remain largely valid. Despite not necessarily screening as insignificant, the total contributions remain well within the Air Quality Standard, and this remains true of the Predicted Environmental Concentrations. With a maximum combined 99.79th percentile hourly average of 82.56 µg m^{-3} and a short-term background concentration of 14.24 µg m^{-3}, the PEC of 96.8 µg m^{-3} equates to approximately 48 % of the 200 µg m^{-3} AQS, and therefore is unlikely to result in any exceedances of the standard.

9.4 Cumulative Air Quality Impact at Air Quality Monitoring Receptors

The ADMS model was also set up to calculate the impact of emissions at four nearby specific receptors where North Ayrshire Council undertakes air quality monitoring. The location of these receptors was shown in the Figure 1 with the prefix 'DT'. The results are summarised in the following table, and detail the impact of emissions from the ERF operating continuously, and the STOR facility operating for the expected 2,500 hours per annum.

Table 45 Results from Detailed Assessment for Nitrogen Dioxide at Nearby Air Quality Monitoring Locations

Receptor	Distance from ERF (m)	ERF Annual Average PC ($\mu g\ m^{-3}$)	Percentage of the AQS	STOR Annual Average PC 2,500 Hours ($\mu g\ m^{-3}$)	Percentage of the AQS	Total Annual Average PC ($\mu g\ m^{-3}$)	Percentage of the AQS	Existing Background ($\mu g\ m^{-3}$)	Annual Average PEC ($\mu g\ m^{-3}$)	Percentage of the AQS
DT1	2,679	0.085	0.21 %	0.079	0.20%	0.163	0.41 %	18	18.16	45 %
DT10	2,716	0.074	0.18 %	0.086	0.21%	0.160	0.40 %	11	11.16	28 %
DT11	3,709	0.123	0.31 %	0.048	0.12%	0.171	0.43 %	13	13.17	33 %
DT12	1,120	0.011	0.03 %	0.064	0.16%	0.075	0.19 %	12	12.075	30 %

The results show that the increase in annual average NO_2 concentrations at nearby locations where monitoring is undertaken is less than 1 % of the AQS objective value, for either the ERF or the STOR facility operating in isolation or cumulatively, and can be screened out as insignificant. When considered in relation to the existing background, annual average NO_2 Process Contributions attributable to the operation of the ERF do not result in an exceedance of the AQS objective value where one currently does not exist and, based on background concentrations measured in 2018, the Predicted Environmental Concentration at each of the monitoring locations considered would remain within 70 % of the Air Quality Standard.

9.5 Cumulative Impact of Emissions on Nearby Ecological Receptors

Ecological receptor locations were incorporated into the ADMS model representing relevant designated ecological habitats within a 15 km radius of the development site, and Local Wildlife Sites within 2 km of the site. The following section considers the cumulative impact of emissions of NO_x from both facilities.

Assessment Relative to Critical Level Values

Annual average Process Contributions for NO_x were calculated by the ADMS model for each of the ecological receptors applying 2017 meteorological conditions, and the predicted increases were compared against their respective Critical Level values. The assessment was undertaken in relation to Critical Levels specified in the APIS website[13] for Oxides of Nitrogen at the ecological habitat sites incorporated into the model. Again, where sites are not considered to be sensitive to contributions, no assessment has been provided. The results from the Critical Levels assessment are presented in the table below.

Table 46 Annual Average Critical Level Assessment for Oxides of Nitrogen

Ecological Receptor Name	Annual Average NO_x PC ERF ($\mu g\ m^{-3}$)	% AQS	Annual Average NO_x PC STOR Facility ($\mu g\ m^{-3}$)	% AQS	Annual Average NO_x PC Cumulative ($\mu g\ m^{-3}$)	% AQS
Oldhall Ponds Wildlife Site	0.012	0.04%	0.325	**1.08%**	0.337	**1.12%**
Shewalton Wood Nature Reserve	0.092	0.31%	2.580	**8.60%**	2.672	**8.91%**
Shewalton Sandpits Nature Reserve	0.028	0.09%	0.135	0.45%	0.162	0.54%
Gailes Marsh Nature Reserve	0.056	0.19%	0.012	0.04%	0.068	0.23%
Western Gailes SSSI	0.086	0.29%	0.021	0.07%	0.107	0.36%
Dundonald Wood SSSI	0.122	0.41%	0.054	0.18%	0.176	0.59%
Troon Golf Links and Foreshore SSSI	0.014	0.05%	0.018	0.06%	0.033	0.11%
Ashgrove Loch SSSI	0.016	0.05%	0.016	0.05%	0.032	0.11%
Dykeneuk Moss SAC / SSSI*	0.020	0.07%	0.014	0.05%	0.033	0.11%
Cockinhead Moss SAC / SSSI*	0.017	0.06%	0.011	0.04%	0.028	0.09%
Bankhead Moss, Beith SAC / SSSI*	0.013	0.04%	0.009	0.03%	0.022	0.07%

As can be seen in Table 46, at the majority of the ecological receptor locations the annual average NO_x Process Contributions due to emissions from the ERF are less than 1 % of the 30 $\mu g\ m^{-3}$ Critical Level for the protection of ecosystems, and can be screened out as insignificant for contributions from both the ERF and the STOR facilities.

The 1 % insignificance threshold is exceeded at Oldhall Ponds Wildlife Site and at the Shewalton Wood Nature Reserve, where the cumulative NO_x Process Contributions are estimated to be about 1.1 % and 9 % of the Critical Level respectively. However, these are still low or very low contributions and in accordance with current guidance[12] can be screened as insignificant as the long and short-term Process Contribution to local nature sites remains within 100 % of the relevant environmental standard.

Table 47 below presents the results for the maximum cumulative 24-hour average Process Contributions when considering the continuous operation of both the ERF and the STOR. The reported results apply the meteorological conditions from 2017 only, which was the year of meteorological conditions which resulted in the highest number of maximum 24-hour results at the sensitive ecological receptors when modelling the ERF.

Table 47 Maximum 24-Hour Average Critical Level Assessment for Oxides of Nitrogen

Ecological Receptor Name	**Max. Daily Average NO_x PC ERF ($\mu g\ m^{-3}$)**	**% AQS**	**Max. Daily Average NO_x PC STOR Facility ($\mu g\ m^{-3}$)**	**% AQS**	**Max. Daily Average NO_x PC Cumulative ($\mu g\ m^{-3}$)**	**% AQS**
Oldhall Ponds Wildlife Site	1.76	2.3 %	12.99	**17.3 %**	14.75	**19.7 %**
Shewalton Wood Nature Reserve	2.49	3.3 %	115.9	**155 %**	118.41	**158 %**
Shewalton Sandpits Nature Reserve	2.18	2.9 %	7.72	**10.3 %**	9.90	**13.2 %**
Gailes Marsh Nature Reserve	2.83	3.8 %	22.41	**29.9 %**	25.23	**33.6 %**
Western Gailes SSSI	1.95	2.6 %	2.45	3.3 %	4.41	5.9 %
Dundonald Wood SSSI	1.08	1.4 %	2.61	3.5 %	3.69	4.9 %
Troon Golf Links and Foreshore SSSI	0.20	0.3 %	0.90	1.2 %	1.10	1.5 %
Ashgrove Loch SSSI	0.24	0.3 %	0.78	1.0 %	1.01	1.4 %
Dykeneuk Moss SAC / SSSI*	0.22	0.3 %	0.65	0.9 %	0.87	1.2 %
Cockinhead Moss SAC / SSSI*	0.22	0.3 %	0.51	0.7 %	0.73	1.0 %
Bankhead Moss, Beith SAC / SSSI*	0.12	0.2 %	0.41	0.6 %	0.54	0.7 %

The assumption that the STOR will operate for a continuous 24-hour period is likely to be an over-estimate. However, in the absence of any more detailed information on any maximum or likely operating period at any one time, it has been assumed here that the STOR could indeed operate for 24-hours.

Data in Table 47 confirms that the short-term NO_x contribution from the ERF in isolation remains well below 10 % of the Critical Level and can therefore be screened as insignificant.

Although emissions from the ERF can be screened in isolation, the same is not true for the cumulative contributions, with four sites experiencing cumulative Process Contributions of more than 10 % of the Critical Level and three of these, Oldhall Ponds Wildlife Site, the Shewalton Wood Nature Reserve and the Gailes Marsh Nature Reserve suggesting PECs of more than 20 % the EAL minus the long-term background concentration. That said, the vast majority of the PEC at each site is the result of the modelled contributions from the STOR facility, which is unlikely to operate continuously for a 24-hour period. The assessment provided therefore presents a worst-case and a likely over-estimate of the potential for daily NO_x contributions to any of the sensitive ecological sites, and ultimately, only the impact at the Shewalton Wood Nature Reserve cannot be screened as insignificant at any stage of the assessment as the STOR and cumulative PC exceeds 100 % of the EAL.

Assessment Relative to Site-Specific Critical Load Values

The results in Table 48 and 49 relate to the maximum cumulative annual average Nitrogen and acid deposition at nearby designated ecological habitats, and Local Wildlife Sites, associated with emissions from the Oldhall ERF and the STOR facility. The assessment considers the results of meteorological conditions from 2017 only, which was the year that resulted in the highest number of annual average results at the sensitive ecological receptors when modelling the ERF.

As can be seen, with the exception of the Oldhall Ponds Wildlife Site, the Shewalton Wood Local Nature Reserve, and the Dundonald Wood SSSI, annual average deposition rates of nutrient Nitrogen at the modelled ecological habitat sites are less than 1 % of the site-specific critical load, and can therefore be screened out as insignificant in relation to SEPA and Scottish Natural Heritage guidance, despite the fact that the Critical Load is currently exceeded by the existing background concentration. Contributions at the wildlife site and SSSI are only marginally above 1 %, and are well within 2 %, although the cumulative annual average Nitrogen deposition rate at Shewalton Wood Nature Reserve is approximately 9 % of the Critical Load. Process Contributions to the local nature sites remain within 100 % of the relevant environmental standard and can therefore be screened as insignificant. In each case the resulting Predicted Environmental Concentrations are dominated by existing background levels.

It should be noted that exceedance of a Critical Load is not a quantitative estimate of damage to a particular habitat, but represents the potential for damage to occur. There is no evidence in the available literature to indicate that the above ecological habitat sites are currently suffering as a consequence of Nitrogen deposition from nearby sources. Accordingly, the small incremental cumulative increase in Nitrogen deposition attributable to emissions of NO_x from the Oldhall ERF and the STOR facility is unlikely to have a measurable effect on the integrity of the above ecological habitat sites.

The results in Table 49 demonstrate that the annual average acid deposition rate (keq/ha/yr) at most of the ecological habitat sites is less than 1 % of the site-specific critical load, and can therefore be screened out as insignificant in relation to SEPA and Scottish Natural Heritage guidance, despite the fact that the Critical Loads are currently exceeded by existing background acidity deposition (keq/ha/yr). The exceptions are at Oldhall Ponds Wildlife Site, the Shewalton Wood Nature Reserve and Western Gailes SSSI. Both the Wildlife site and the SSSI are predicted to receive a fraction over 1 % of the Critical Load. Cumulative Process Contributions to the Shewalton Wood Nature Reserve are more significant than the contributions from the ERF and equate to approximately 6 % of the Critical Load. As noted earlier, the exceedance of a Critical Load is not a quantitative estimate of damage to a particular habitat, representing instead the potential for damage to occur. There is no evidence in the available literature to indicate that the nature reserve or the SSSI are suffering as a consequence of acid deposition from nearby sources. Accordingly, on this basis, the incremental cumulative increase in acid deposition attributable to emissions of NO_x from the Oldhall ERF and the STOR facility is small and is unlikely to have a measurable effect on the integrity of the above ecological habitat sites.

Table 48 Results from Detailed Modelling of Nitrogen Deposition in Relation to the Site-Specific Critical Load – Cumulative Impact

Habitat	N Deposition (kgN/ha/yr)	Critical Load (kgN/ha/yr)	% Critical Load	Background (kgN/ha/yr)	Total N Deposition PEC (kgN/ha/yr)	PEC as % Critical Load
Oldhall Ponds Wildlife Site	0.123	10	**1.23%**	18.06	18.18	**181%**
Shewalton Wood Nature Reserve	0.877	10	**8.77%**	18.06	18.94	**181%**
Shewalton Sandpits Nature Reserve	0.078	10	0.78%			
Gailes Marsh Nature Reserve	0.117	20	0.59%			
Western Gailes SSSI	0.070	8	0.87%			
Dundonald Wood SSSI	0.130	10	**1.30%**	25.62	25.75	**256%**
Troon Golf Links and Foreshore SSSI	0.012	8	0.15%			
Ashgrove Loch SSSI	0.013	10	0.13%			
Dykeneuk Moss SAC / SSSI	0.016	5	0.32%			
Cockinhead Moss SAC / SSSI	0.013	5	0.26%			
Bankhead Moss, Beith SAC / SSSI	0.011	5	0.21%			

Data is not provided for Dundonald Burn SSSI, Bogside Flats SSSI, Ardrossan to Saltcoates Coast SSSI, Afton Lodge SSSI and Lynn Spout SSSI as these sites are not sensitive to nutrient Nitrogen deposition.

Table 49 Results from Detailed Modelling of Acid Deposition (As Nitrogen) in Relation to Site-Specific Critical Loads

Habitat	N Based Acid Deposition	N Based Background	PEC	CLminN	Is PEC < CLminN	S Based Acid Deposition	H Based Acid Deposition (Total)	Total Acid Deposition (N, S and H)	Lowest CLmaxN or S	PC as % CLmaxN / S
	(keq/ha/yr)					(keq/ha/yr)				
Oldhall Ponds Wildlife Site	0.0088	1.29	1.2988	0.142	No	0.00238	0.00334	0.0145	1.44	**1.01%**
Shewalton Wood Nature Reserve	0.0625	1.29	1.3525	0.142	No	0.00980	0.01407	0.0864	1.438	**6.01%**
Shewalton Sandpits Nature Reserve	0.0056	1.29	1.2956	0.142	No	0.00284	0.00404	0.0125	1.441	0.86%
Gailes Marsh Nature Reserve	0.0084	0.8	0.8084	-	No	0.00731	0.00954	0.0252	4	0.63%
Western Gailes SSSI	0.0050	0.8	0.8050	0.892	Yes	0.00370	0.00478	0.0134	0.8	**1.06 %**
Dundonald Wood SSSI	0.0093	1.83	1.8393	0.142	No	0.00721	0.01032	0.0268	3.571	0.75%
Troon Golf Links and Foreshore SSSI	0.0008	0.68	0.6808	0.892	Yes	0.00048	0.00060	0.0019	0.81	0.13 %
Ashgrove Loch SSSI	0.0009	1.06	1.0609	1.071	Yes	0.00058	0.00073	0.0023	4	0.03 %
Dykeneuk Moss SAC / SSSI	0.0011	1.2	1.2011	0.321	No	0.00076	0.00098	0.0029	0.695	0.41%
Cockinhead Moss SAC / SSSI	0.0009	1.2	1.2009	0.321	No	0.00061	0.00078	0.0023	0.707	0.33%
Bankhead Moss, Beith SAC / SSSI	0.0008	1.5	1.5008	0.321	No	0.00050	0.00064	0.0019	0.753	0.25%

Data is not provided for Dundonald Burn SSSI, Bogside Flats SSSI, Ardrossan to Saltcoates Coast SSSI, Afton Lodge SSSI and Lynn Spout SSSI as these sites are not sensitive to acid deposition.

10. Conclusions

Detailed atmospheric dispersion modelling has been undertaken of emissions to atmosphere from the proposed Energy Recovery Facility (ERF) to be developed by WEP Partners on a brownfield site within the Oldhall West Industrial Estate, Irvine. Modelling of emissions from the ERF was undertaken for a scenario that represents normal operating conditions while operating at maximum output and discharging emissions to atmosphere via a 60-metre high chimney. Short-term (half-hourly) emissions were also modelled and reported. Emissions were based upon the achievable limits for new plant, as specified in the BAT-Conclusions document.

The modelling was undertaken using ADMS Version 5.2 and incorporated a sensitivity analysis to assess the results against a second modelling platform, AERMOD. Hourly average meteorological data for the Prestwick Airport measurement station for the years 2015 to 2019 were used to determine maximum Process Contributions across a 4 km x 4 km receptor grid with 20-metre grid spacing, as well as at nearby specific receptor locations.

The model predicted that Process Contributions for all pollutants prescribed for control by the PPC Regulations and the Industrial Emissions Directive (IED) would be well below objective limits defined within Scottish Air Quality Regulations, or relevant Environmental Assessment Levels recommended by SEPA.

Modelling predicted that, under normal operating conditions the maximum annual average Process Contribution for NO_2 would be about 2 µg m^{-3}, or approximately 6 % of the 40 µg m^{-3} annual objective value. The location of the maximum Process Contribution was predicted to be about 290 metres to the north-east of the chimney serving the ERF, with values considerably lower farther afield. The Process Contributions for the other prescribed pollutants indicated that there would be no exceedance of their respective Air Quality Standard objective values and relevant environmental assessment levels, and contributions could be screened as insignificant at the initial or secondary assessment stages.

The model sensitivity analysis predicted lower Process Contributions when using the AERMOD operating platform in place of the ADMS model. Therefore, the results predicted by ADMS can be considered to present a worst-case assessment.

Short-term Process Contributions and Predicted Environmental Concentrations also remained within their stated Environmental Quality Standards when discharging at the allowable half-hourly limit values and were therefore screened as insignificant, although the impact of half-hourly emissions of NO_2 does exceed 20 % of the hourly average assessment level. This exceedance does not occur at any sensitive human health receptors.

An assessment of the cumulative impact of emissions from the proposed ERF with those from a STOR facility that recently received planning permission from North Ayrshire Council showed that, assuming that both facilities are developed in due course, there would generally be a small increase in the Process Contributions of Nitrogen Dioxide and deposition impacts in the vicinity of the two facilities, but the resulting increases would not have a significant adverse impact on local air quality.

The overall conclusion from detailed modelling of emissions from the proposed ERF to be developed by WEP Partners, near Irvine, is that the potential impact on local air quality is likely to be small and is unlikely to have a significant impact on the health of people living and working nearby, or the surrounding environment as a whole.

Appendix 1 Summary of D1 Chimney Height Calculation

Calculation of Chimney Height Using Method in Technical Guidance Note D1
Oldhall ERF, Irvine, Scotland
October 2020

				Heat Release MWth (1 Boiler)	Heat Release MWth (>1 Boiler)			
Gas Temp C	140							
Gas Temp K	413		**XS Area**	5.752	5.752	**Q<1**	**a**	-1.25
Stack Diameter	1.84	**2.66**	m^2				**b**	0.49
Gas Rate Am3/s	52.99	37.35	Nm3/s (273K, Dry, 11 % O2)	No. of Boilers	**1**	**Q>1**	**a**	-1.40
Gas Velocity m/s	19.9	37.35	Nm3/s (273K, Dry, 11 % O2)	Diameter of 1 Flue (m)	1.8		**b**	0.52
FG O2 (%)	8.5	134,474	Nm3/hr (273K, Dry, 11 % O2)				**x**	-1.13
Building Height m	40.0	190,770	Am3/hr	1 Boiler			**y**	4.12
FG H2O (%)	14.86	52.99	Am3/s	1 Boiler			**z**	-13.11
Std O2 (%)	11	52.99	Am3/s	Multiple Boilers				

	Discharge Conc. (mg/m3)		Discharge Conc. (mg/Nm3)	Discharge Rate (g/s)	Guideline Concentration (mg/m3)	Background Concentration (mg/m3)	Pollution Index (m3/s)	
SO2			30	1.121	0.35	0.004	3243	**SO2**
NOx			120.00	4.482	4.40	0.020	1023	**NOx**
NO2			60.00	2.241	0.2	0.014	12065	**NO2**
HCl			6.00	0.224	0.75	0.001	299	**HCl**
NO			60.00	2.241	1	0.006	2255	**NO**
CO			50.00	1.868	57	0.198	33	**CO**
HF			1.00	0.0374	0.16	6.00E-06	233	**HF**
Lead			0.30	0.01121	0.5	2.29E-06	22	**Lead**
PM_{10}			5.00	0.187	0.05	0.016	5461	**PM10**
Total							**12065**	**Total**

Case for Single Building

Ub (m)	M (m4/s2)		Min Um (m)	Max Um (m)	U Corrected Chimney Height (Metres)	Height Above Building (Metres)
5.46	**723.5**		**6.7**	**6.74**	**44.9**	**4.9**

Case for Multiple Buildings within 5Um

5Um =	**33.7**	**metres**	**CHECK THAT D<5Um**

Building No.	Distance (metres)		Ridge Height (metres)	Height (H)	Projected Width (B)	Length (metres)	K (Min H & B)	T (H+1.5K)
Boiler Hall	10	1	40	40.0	53.9	28	40.0	100.0
Bunker & Control	56	0	35	0.0	53.9	50	0.0	0.0
Fuel Reception	76	0	22	0.0	55.0	50	0.0	0.0
ACC	56	0	22	0.0	37.6	11	0.0	0.0
FGT Hall	11	1	25	25.0	28.0	23	25.0	62.5
Turbine Hall	24	1	20	20.0	39.7	30	20.0	50.0

Hm (Hmax)	Tm (Tmax)		U Min Um&Ub	Is U>Tm? (1=Y, 0=N)	Corr. Disch. Ht. (Metres)
40.0	**100.0**		**5.5**	**0**	**44.9**

11. References

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