Knauf Insulation Limited

PERMIT APPLICATION FOR KNAUF SHOTTON

Air Emission Risk Assessment



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1 INTRODUCTION

1.1 BACKGROUND, AIMS AND OBJECTIVES

1.1.1. Knauf Insulation Limited (hereinafter referred to as 'Knauf') are submitting an application for an Environmental Permit for a new facility in Deeside Industrial Park (hereinafter referred to as the 'Site') that will be used for the manufacture of rock mineral wool products, comprising the storage and handling of raw materials, a main production building for bath preparation, electric furnace melting, forming, curing, cooling, and cutting and packaging of final product (hereinafter referred to as the 'Proposed Development').

1.1.2. Emissions associated with the Proposed Development will be discharged via stacks installed at the Site. An assessment of the impact of emissions to air associated with the installation is required to determine the anticipated pollutant releases to air from the Site.

1.2 SITE DESCRIPTION

1.2.1. The Site is located on the brownfield land within the eastern part of the TATA Steel complex, forming part of the wider Deeside Industrial Park. The Site itself extends to approximately 30.50 acres (2.34 hectares (ha)). As shown in Figure 1-1 the Site boundaries are defined by two existing ponds to the south, existing TATA buildings and infrastructure to the west, the Flintshire Bridge HVDC Convertor Station to the north and railway lines to the north-east and east (with Hawarden Train Station immediately south).



Figure 1-1 - Site location

1.3 SOURCES OF INFORMATION

1.3.1. The information used in this report is shown in **Table 1-1**.

Table 1-1 – Sources of information

Item	Source
Process and emissions data	Knauf Insulation Process handbook Prince RMW (Ref.: 20251219)
Site layout	4208-A-M-05-00-00011-SHOTTON ACCESS
Baseline air quality	Government bodies, local authorities and third parties
Ordnance survey maps	Open Street Maps (OSM)
Meteorological data	Historic meteorological data obtained from Hawarden meteorological station

1.4 REPORT CHECKLIST

EA and NRW guidance list out the information that needs to be included in an AERA report, which demonstrates an understanding of the environmental implications of the emissions based on the best available science at the time of submission.

Table 1-2 - AERAChecklist

Item	Included in assessment?	Relevant section of the report
Purpose of the study	Yes	Section 1.1
Location map	Yes	Figure 1-1
Site plan	Yes	Figure 4-1
List of pollutants modelled and relevant air quality guidelines	Yes	Section 1.4
Details of modelled scenarios	Yes	Section 4.3
Details of relevant ambient concentrations used	Yes	Section 3 and Section 4.10
Model description and justification	Yes	Section 4.1
Special model treatments used	Yes	Section 4.12
Table of emission parameters used	Yes	Table 4-1
Details of modelled domain and receptors	Yes	Section 4.8
Details of meteorological data used, including origin and justification	Yes	Section 4.4
Details of terrain treatment	Yes	Section 4.7
Details of building treatment	Yes	Section 4.6
Details of modelling wet/dry deposition	Yes	Section 4.11
Sensitivity analysis	Yes	Section 4.15
Assessment of impacts	Yes	Section 6
Model input files	Yes	Under separate cover

2 ASSESSMENT CRITERIA

2.1 CRITERIA APPROPRIATE TO THE ASSESSMENT

2.1.1. There are a large number of sources of standards against which air quality should be assessed and these often use different terms for the assessment levels, including limit value, air quality standard (AQS), air quality objective (AQO), environmental assessment level (EAL), critical level (CLe), critical load (CLo) and target. For simplicity, this report follows the IAQM/ EPUK[1] guidance in using the term air quality assessment level (AQAL) to refer to any of these.

2.1.2. **Table 2-1** and **Table 2-2** set out the AQALs that are relevant to this assessment.

Table 2-1 – Air Quality Assessment Levels (pollutants)

Pollutant	Receptor affected	AQAL type	Averaging period	Value (µg/m^3)
Nitrogen Dioxide (NO_2)	Human	AQS	Annual mean	40
	Human	AQS	1-hour mean, not to be exceeded more than 18 times a year (equivalent to 99.79th percentile)	75
Nitrogen Oxide (NO_X)	Ecological	AQS	Annual mean	30
	Ecological	AQO	Daily mean	75-200[(a)]
Particulate Matter (microns under 10 micrograms) (PM_{10})	Human	AQS	Annual mean	40
	Human	AQS	24-hour mean, not to be exceeded more than 7 times a year (equivalent to 98.08 percentile)	50
Particulate Matter (microns under 2.5 micrograms) ($PM_{2.5}$)	Human	AQO	Annual mean	20
Sulphur Dioxide (SO_2)	Human	AQS	24-hour mean, not to be exceeded more than 3 times a year (equivalent to 99.18 percentile)	125
	Human	AQS	1-hour mean, not to be exceeded more than 24 times a year (equivalent to 99.73 percentile)	350
	Human	EAL	15-minute mean, not to be exceeded more than 35 times a year (equivalent to 99.99 percentile)	266
	Ecological	AQS	Annual mean	10[(b)]-20

[1] Institute of Air Quality Management, (2020). *Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites (version 1.1*). Available at: http://www.iaqm.co.uk/text/guidance/air-quality-impacts-on-nature-sites-2020.pdf (Accessed August 2025).

Pollutant	Receptor affected	AQAL type	Averaging period	Value (µg/m^3)
Ammonia (NH_3)	Human	EAL	Annual mean	180
	Human	EAL	1-hour mean	2,500
	Ecological	EAL	Annual mean	1[(b)]-3
Diethylamine (DiEA)	Human	EAL	1-hour mean	330
	Human	EAL	24-hour long term	33
Mono-ethanolamine (MEA)	Human	EAL	1-hour mean	400
	Human	EAL	24-hour (long term) mean	100
N-nitrosodimethylamine (NDMA)	Human	EAL	Annual mean	0.0002
Phenol	Human	EAL	1-hour mean	3,900
	Human	EAL	Annual mean	200
VOCs (as benzene)	Human	EAL	24-hour mean	30
	Human	AQO	Annual mean	5
Hydrogen Fluoride (HF)	Human	EAL	Monthly mean	16
	Human	EAL	1-hour mean	160
	Ecological	AQO	24-hour mean	5
	Ecological	AQO	Weekly mean	0.5
Hydrogen Chloride (HCl)	Human	EAL	1-hour mean	750
Formaldehyde	Human	EAL	30-minute mean	100
	Human	EAL	Annual mean	5
Nitrogen deposition	Ecological	Critical load	Annual mean	Site-specific
Acid deposition	Ecological	Critical load	Annual mean	Site-specific

Table notes:

(a) Lower level applied where O_3 and SO_2 are present above their critical levels. Higher level applied where O_3 and SO_2 are present below their critical levels.

(b) Lower level applies where lichens or bryophytes are present

Table 2-2 – Air Quality Assessment Levels (metals)

Pollutant	Receptor affected	AQAL type	Averaging period	Value (µg/m^3)
Arsenic	Human	AQO	Annual mean	6 (ng/m^3)
Antimony	Human	EAL	Annual mean	5
	Human	EAL	1-hour mean	150
Cadmium	Human	AQO	Annual mean	5
	Human	EAL	24-hour	0.03
Chromium III	Human	EAL	24-hour	2
Chromium VI	Human	EAL	Annual mean	0.25 (ng/m^3)
Copper	Human	EAL	24-hour mean	0.5
Lead	Human	EAL	Annual mean	0.25
Manganese	Human	EAL	Annual mean	0.15
	Human	EAL	1-hour mean	1,500
Selenium	Human	EAL	24-hour mean	2
Nickel	Human	AQO	Annual mean	20 (ng/m^3)
	Human	EAL	1-hour mean	0.7
Vanadium	Human	EAL	24-hour mean	1

2.2 CRITICAL LOADS RELEVANT TO THE ASSESSMENT

2.2.1. Air Pollution Information Services (APIS) contains information on applicable CLo's for various habitats and species.

2.2.2. Eutrophication critical loads are given as a range and have units of kg N/ha/y. Generally, the lower end of the range should be used as a conservative assessment. The CLo's for acidification are more complicated, in that both the nitrogen and sulphur deposition fluxes must be considered at the same time. Therefore, a critical load function is specified for acidification, via the use of three critical load parameters:

- $CL_{max}S$ – the maximum CLo of sulphur, above which the deposition of sulphur alone would be considered to lead to an exceedance;
- $CL_{min}N$ – a measure of the ability of a system to "consume" deposited nitrogen (e.g., via immobilisation and uptake of the deposited nitrogen); and
- $CL_{max}N$ – the maximum CLo of acidifying nitrogen, above which the deposition of nitrogen alone would be considered to lead to an exceedance.

2.2.3. These three quantities define the critical load function shown in **Figure 2-1**. The CLo's applied to this assessment are presented in the **Table 2-3**. The CLo's were sent to the Project Ecologist for their input and confirmation that they were suitable for the habitats assessed.

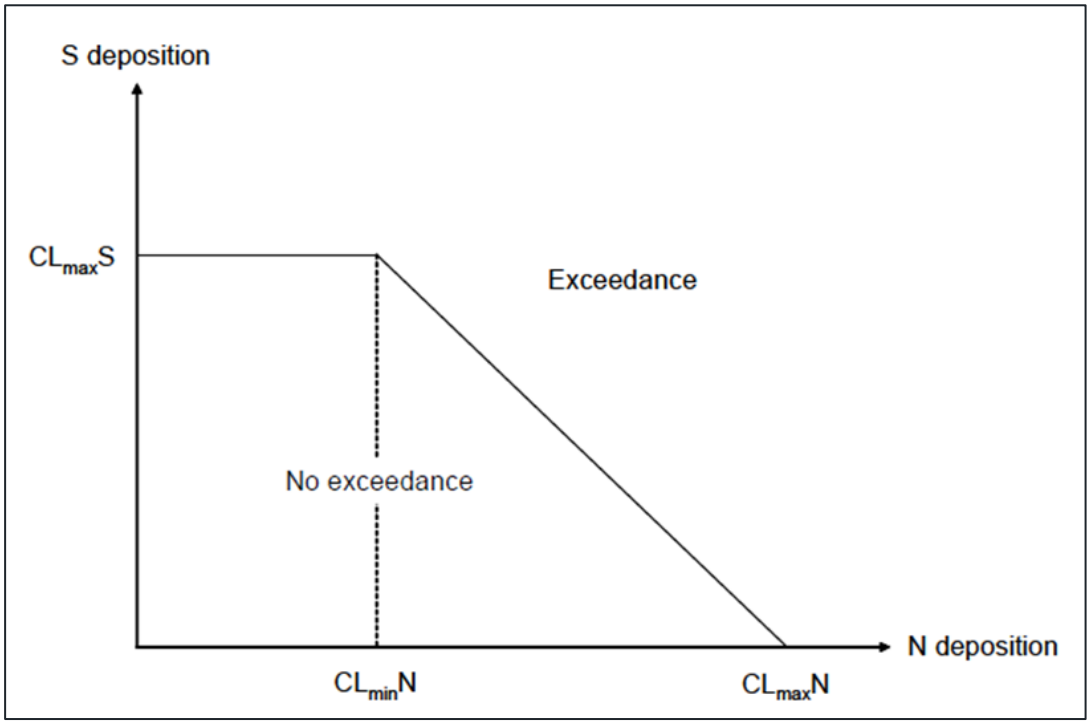


Figure 2-1 - Schematic critical load function for acidity

Table 2-3 – Critical loads

Site		Designation	Acid deposition critical load function (keg/ha/yr)			Nitrogen deposition critical load (kgN/ha/yr)
			$CL_{min}N$	$CL_{max}N$	$CL_{max}S$	
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0.856	4.856	4.000	5-30[(a)]
E02	Ancient Semi Natural Woodland	AW	N/A	N/A	N/A	5
E03	River Dee (Afon Dyfrdwy)	SSSI	N/A	N/A	N/A	Not sensitive
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.714	1.564	0.830	5-30[(a)]
E05	Shotton Lagoons and Reedbeds	SSSI	1.071	5.071	4.000	10
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.856	4.856	4.000	5-30[(a)]

Site		Designation	Acid deposition critical load function (keg/ha/yr)			Nitrogen deposition critical load (kgN/ha/yr)
			$CL_{min}N$	$CL_{max}N$	$CL_{max}S$	
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	N/A	N/A	N/A	2 -20[(b)]
E08	Deeside and Buckley Newt sites	SAC	0.142	1.720	1.448	10 – 30[(c)]
E09	Halkyn Mountain (Mynydd Helygain)	SAC	0.856	4.856	4.000	5 – 20[(d)]
E10	Shotton Steelworks	LWS	N/A	N/A	N/A	5
E11	River Dee	LWS	N/A	N/A	N/A	10
E12	Shotton Banks	LWS	N/A	N/A	N/A	5

Notes

(a) 10 kgN/ha/yr selected for use in the assessment in consultation with Project Ecologist to represent the minimum CLo of Atlantic salt meadow, estuaries and mudflats which are present in areas close to the Project

(b) 10 kgN/ha/yr selected for use in the assessment in consultation with Project Ecologist to represent the minimum CLo of Old Sessile Oak Woods which are present close to the Project

(c) 10 kgN/ha/yr selected for use in the assessment as it represents the minimum Clo

(d) 5 kgN/ha/yr selected for use in the assessment as it represents the minimum CLo

2.3 SIGNIFICANCE CRITERIA

2.3.1. The NRW air quality guidance[2] and EA air emission risk assessment guidance[3] set out a series of criteria that can be used to screen out insignificant impacts. It should be noted that exceedances of the criteria do not equate to a significant impact.

2.3.2. The EA air emission risk assessment guidance provides criteria for screening out-source contributions in the context of environmental permit applications. This guidance suggests applicants first perform a screening assessment and, if the results of that do not meet the screening-out criteria, then perform a detailed modelling assessment.

2.3.3. This guidance also introduces the terms ‘process contribution’ (PC), meaning the concentration or deposition rate resulting from the development activities only, excluding other sources, and ‘predicted environmental concentration’ (PEC), meaning the total modelled concentration, equal to

[2] Natural Resources Wales (2025). *Assessing air quality impacts as part of your planning application. Available at: https://naturalresources.wales/guidance-and-advice/business-sectors/planning-and-development/advice-for-developers/assessing-air-quality-impacts-as-part-of-your-planning-application/?lang=en* (Accessed July 2026)

[3] Environment Agency and Department for Environment, Food and Rural Affairs (2016). *Air emissions risk assessment for your environmental permit* (online). Available at: Air emissions risk assessment for your environmental permit - GOV.UK (www.gov.uk) (Accessed July 2026).

the PC plus the background contribution from all other sources. These terms are commonly used in air quality assessments, even where the term 'process' is not strictly accurate and so are used in this assessment with 'process' referring to the installation. The term PEC is also used to describe total deposition rates.

2.3.4. For human receptors and for SPAs, SACs, Ramsar sites and SSSIs, there is no need for further assessment if the screening calculation finds that:

If both the following are met:

- the short term Process Contribution (PC) is less than 10% of the short term Critical Level (CLe) or Critical Load (CLo); and
- the long term PC is less than 1% of the long term CLe or CLo;

If the above criteria are exceeded, then no further assessment is required if:

- the short term PC is less than 20% of the short term CLe or CLo minus twice the long term background; and
- the long term Predicted Environmental Concentration (PEC) (i.e. PC + background) is less than 70% of the long term AQAL.

2.3.5. For local nature sites (ancient woodland, local wildlife sites and national and local nature reserves, county wildlife sites), emissions are insignificant if:

- The short term PC is less than 100% of the short term CLe or CLo; and
- The long term PC is less than 100% of the long term CLe or CLo.

2.3.6. The IAQM guidance provides further suggestions on circumstances where there is definitely an insignificant effect on a site in relation to the Habitats Directive. This guidance notes that the EA criteria above are commonly used in air quality assessments, but notes that:

"*In the IAQM's opinion, the 1% and 10% screening criteria should not be used rigidly and not to a numerical precision greater than the expression of the criteria themselves. Whilst it is straightforward to generate model results for the PC to any level of precision required, the accuracy of the result is much less certain, and it is unwise to place too much emphasis on whether the PC is 0.9% or 1.1% for example. In practice, because the magnitude of impacts attributable to new sources is often around 1% of the criterion, a regulator may require the results to be presented at greater resolution, i.e. having one (or more) decimal places. The distinction here is between the presentation of the model results and the weight given to find differences around the criterion itself in making a judgement.*

It is important to remember that a change of more than 1% does not necessarily indicate that a significant effect (or adverse effect on integrity) will occur; it simply means that the change in concentration or deposition rate cannot in itself be described as numerically inconsequential or imperceptible and therefore requires further consideration".

2.3.7. Therefore, this assessment identifies in Section 6.3 where impacts have been screened out. This report should be read in conjunction with the Habitats Regulation Assessment submitted as part of the permitting application, where a detailed discussion is presented.

3 AMBIENT AIR QUALITY

3.1 EXISTING BASELINE CONDITIONS

MAPPED BACKGROUND CONCENTRATIONS

3.1.1. Defra maintains a nationwide model (the Pollution Climate Mapping (PCM) model)[4] of existing and future background air quality concentrations on a 1km-by-1km grid square resolution. The datasets include annual average concentration estimates for NO_X, NO_2, PM_{10}, $PM_{2.5}$, CO, SO_2 and benzene. The PCM model is semi-empirical in nature: it uses data from the national atmosphere emissions inventory (NAEI)[5] to model the concentrations of pollutants at the centroid of each 1km grid square but then calibrates these concentrations in relation to actual monitoring data. The concentrations represent background locations, excluding roadside locations or those significantly influenced by point sources.

3.1.2. The dataset was updated in 2024 for a reference year of 2021 for NO_X, NO_2, PM_{10} and $PM_{2.5}$. Data is available for years covering 2021 to 2040, with modelled concentrations generally showing a downward trend over this period.

3.1.3. Annual mean background data for NO_X and NO_2 for 2025 was obtained from the PCM model. Background concentration of CO, SO_2 and benzene was extracted from the 2001 Defra background map. Using the 2001 data is considered appropriate by Defra and in line with the LAQM.TG(22) guidance[6].

3.1.4. Defra has not updated the mapped background datasets for CO, SO_2 and benzene since those produced for the 2001 base year. Defra provides factors for adjusting these pollutants to later years. The factors were published in 2003 and result in reduced concentrations in later years. As a conservative measure, the 2001 mapped background concentrations have been presented and used in this assessment. However, due to a decline in local industry and shipping, it is anticipated that concentrations of pollutants in the area, in particular SO_2, have decreased substantially since 2001.

3.1.5. Mapped atmospheric concentrations of NH_3 are available from the Centre for Ecology and Hydrology (CEH) throughout the UK on a 1km-by-1km grid[7].

3.1.6. A summary is presented in **Table 3-1** showing the mapped annual mean background concentration expected at the Site. The concentrations shown in the table are the maximum predicted background concentrations over the installation boundary.

[4] DEFRA (2020). Background Mapping data for local authorities. (Online). Available at: https://uk-air.DEFRA.gov.uk/data/laqm-background-home (Accessed May 2026).
[5] National Atmospheric Emission Inventory (2023). (Online). Available at: https://naei.energysecurity.gov.uk/ (Accessed May 2026).
[6] DEFRA (2022). Local Air Quality Management Technical Guidance (TG22). (Online). Available at LAQM-TG22-August-22-v1.0.pdf (DEFRA.gov.uk) (Accessed May 2026).
[7] Centre for Ecology and Hydrology (CEH) (2024). Air Pollution Information System. (Online). Available at: https://www.apis.ac.uk/app. (Accessed May 2026).

Table 3-1 – Mapped annual mean background concentrations (µg/m^3)

Pollutant	Concentration	Dataset
NO_X	12.0	Defra 2025 dataset
NO_2	9.2	Defra 2025 dataset
PM_{10}	11.2	Defra 2025 dataset
$PM_{2.5}$	7.1	Defra 2025 dataset
CO	0.3	Defra 2001 dataset
SO_2	4.3	Defra 2001 dataset
VOCs (as benzene)	0.3	Defra 2001 dataset
NH_3	2.1	CEH (2022-2024 average)

Table notes:

Backgrounds presented are the maximum predicted over the installation boundary and were doubled for the assessment of short-term impacts. Location specific backgrounds were applied to individual receptors within each site.

3.1.7. BACKGROUND DEPOSITION LEVELS FOR ECOLOGICAL RECEPTORS

3.1.8. In regard to baseline ambient concentrations and deposition levels, over the identified ecological receptors, data were extracted from the Air Pollution Information Service (APIS) website[7] and the Defra background maps[8]. The pollutants of concern were NO_x, SO_2 and their contribution to nitrogen and acid deposition. Data is provided for both 'long' and 'short' vegetation. The maximum deposition data for each site is presented in **Table 3-2** although location specific backgrounds were applied to individual receptors within each site.

Table 3-2 – Background deposition data for ecological receptors

Nitrogen deposition (kgN/ha/yr)		Designation	Nitrogen deposition (kgN/ha/yr)		Acidification load (keg/ha/yr)	
			'Short'	'Long'	'Short	'Long'
E1	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	17.6	31.5	1.45	2.50
E2	Ancient Semi Natural Woodland	Ancient Woodlands	18.1	32.6	1.50	2.60

[8] DEFRA (2020). Background Mapping data for local authorities. (Online). Available at: https://uk-air.DEFRA.gov.uk/data/laqm-background-home (Accessed May 2026).

Nitrogen deposition (kgN/ha/yr)		Designation	Nitrogen deposition (kgN/ha/yr)		Acidification load (keg/ha/yr)	
			'Short'	'Long'	'Short	'Long'
E3	River Dee (Afon Dyfrdwy)	SSSI	18.1	32.5	Assessed within SAC (E7)	
E4	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	17.6	31.5	1.45	2.49
E5	Shotton Lagoons and Reedbeds	SSSI	16.8	30	1.42	2.44
E6	Dee Estuary (Aber Afon Dyfrdwy)	SAC	17.6	31.5	1.45	2.49
E7	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	22.0	40.1	1.59	2.78
E8	Deeside and Buckley Newt sites	SAC	18.5	32.2	1.46	2.49
E9	Halkyn Mountain (Mynydd Helygain)	SAC	16.7	28.7	1.32	2.22
E10	Shotton Steelworks	LWS	17	30.5	N/A	N/A
E11	River Dee	LWS	17.9	32.1	N/A	N/A
E12	Shotton Banks	LWS	18.1	32.5	N/A	N/A

Table notes:

'N/A' implies no relevant information is listed in APIS.

Maximum data for each site although location specific backgrounds were applied to individual receptors within each site.

LOCAL AUTHORITY REVIEW AND ASSESSMENT

3.1.11. As required by the Environment Act (1995), Flintshire County Council (FCC) has undertaken Review and Assessment of air quality within their area of jurisdiction. This process identified that there are no Air Quality Management Area's located within FCC boundary.

3.1.12. The nearest AQMA is located approximately 9.2km east of the Site in Cheshire West and Chester Council (Chester City Centre AQMA (No.5): "*Incorporating the entire area within the inner ring road and the adjoining sections of Liverpool Road, Parkgate Road, Hoole Way, Boughton gyratory and Watergate Street)*". Owing to the distance, this AQMA is not considered relevant to this air quality study.

NATIONAL MONITORING DATA

Hydrogen Chloride

3.1.13. Hydrogen chloride is measured on behalf of Defra as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project[9]. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). There are no monitoring locations within 10km of the Facility. The UK ceased monitoring of hydrogen chloride at the end of 2015. In lieu of any local monitoring, the HCl measured at Harwell Monitoring site for 2015 has been used (0.06 µg/m^3).

Hydrogen Fluoride

3.1.14. Ambient measurements of hydrogen fluoride (HF) are limited in the UK. In 2005, the Environment Agency issued a report entitled "*A review of the Toxicity and Environmental Behaviour of Hydrogen Fluoride in Air*"[10]. This report identifies that any monitoring of HF in the UK has historically been short-term fenceline campaigns at industrial facilities with the main sources of HF in the UK identified as coal fired power plants and aluminium smelters. The report also presents long term (monthly) HF ambient concentrations monitored in the vicinity of three industrial plants of up to 1.17 µg/m³, with an average of 0.17 µg/m³. Given the age of this data and the subsequent disconnection of the last UK coal fired power plant in 2024, as well as the subsequent decommissioning of all aluminium smelters in the UK since this report was written, background concentrations of HF are expected to have decreased. In the absence of any other data, the average HF concentration of 0.17µg/m³ has been used.

Ammonia (NH_3)

3.1.15. Ammonia is measured as part of the UKEAP project. There are no UKEAP monitoring locations within 10km of the Facility. In lieu of any representative monitoring data, background concentrations background concentrations were taken from the CEH 2022-2024 averaged dataset for the UK[11].

Volatile Organic Compounds (VOCs)

3.1.16. In the absence of VOC speciation data, all emissions from the Proposed Development have been assumed to be comprised of benzene, in line with EA guidance. Benzene concentrations are measured as part of the automatic and non-automatic hydrocarbon networks. There are no monitoring locations within 10km of the Facility. In lieu of any representative monitoring data,

[9] DEFRA (2020). UK Eutrophying and Acidifying Atmospheric Pollutants Project (Online). Available at: https://uk-air.defra.gov.uk/networks/network-info?view=ukeap (Accessed January 2026).
[10] Environment Agency (2005). A review of the Toxicity and Environmental Behaviour of Hydrogen Fluoride in Air. (Online). Available at: https://assets.publishing.service.gov.uk/media/5a7cbee740f0b6629523b8c5/scho0105bimy-e-e.pdf (Accessed May 2026).

relevant background concentrations predicted by the Defra 2001 maps[8] have been used as the baseline concentration without being factored to recent years.

Metals

3.1.17. Metals are monitored monthly by Defra as part of the Heavy Metals Network[11]. There are no monitoring locations within 10km of the Site. Background concentrations were taken from the closest rural background monitoring location is Cwmystwyth. Monitoring of antimony was not carried out at Cwmystwyth, therefore monitored background concentrations from Chilbolton Observatory were used for antimony. 2024 background data for metals used for the assessment for human health is presented in **Table 3-3**. The average measured concentration was used for annual averaging periods and the maximum measured data was used for all shorter averaging.

3.1.18. No data was available for hexavalent chromium. In the UK, ambient chromium is typically comprised of chromium in the trivalent form. Given the industrial location of the Proposed Development, it has been conservatively assumed that 15% of the background chromium concentration is in the hexavalent form.

Table 3-3 – National metals monitoring data used in assessment

Substance	Maximum concentration (ng/m^3)	Annual Average Concentration (ng/m^3)
Arsenic	0.27	0.17
Antimony	225	54.25
Cadmium	0.089	0.033
Chromium	2 (assumed 15% is CrVI)	0.72 (assumed 15% is CrVI)
Copper	2.97	0.88
Lead	1.84	0.94
Manganese	2.42	1.07
Nickel	0.75	0.31
Selenium	1.00	0.38
Vanadium	0.58	0.29

3.2 FUTURE BASELINE CONDITIONS

3.2.1. It is expected there will be a gradual decline in pollutant concentrations in the atmosphere as a result of measures such as the implementation of the Government's Clean Air Strategy, improvements in real world emissions performance of road vehicles, and more stringent emission limits for industrial sources as environmental permits for operators covering the various industrial

[11] DEFRA (2020). Heavy Metals Network (Online). Available at: https://uk-air.defra.gov.uk/networks/network-info?view=metals (Accessed May 2026).

sectors are updated in a phased manner to bring them in line with the requirements of the Industrial Emissions Inventory.

3.2.2. With regard to the potential effects of climate change on the future air quality baseline, the 2007 report produced by the Air Quality Expert Group (AQEG)[12] indicated that the winter season may become windier with fewer, less stable weather conditions by the end of the century, whilst summer seasons are anticipated to become hotter and sunnier, with an increase in unstable weather conditions by the 2040s. The new effect of these anticipated changes on the baseline air quality is difficult to establish but is unlikely to significantly alter the baseline air quality to an extent that it would affect the outcome of any assessment. Other factors such as changes in technology and the move away from combusting fossil fuels, driven by climate change abatement would potentially lead to decreases in emissions of the key pollutants considered in this assessment, and a corresponding decrease in background concentrations of air pollutants into the future.

[12] Air Quality Expert Group (2007). Air Quality and Climate Change: A UK Perspective (Online). Available at: https://uk-air.defra.gov.uk/library/assets/documents/reports/aqeg/fullreport.pdf (Accessed May 2026).

4 ASSESSMENT METHODOLOGY

4.1 DISPERSION MODEL SETUP

4.1.1. The model used in this assessment is the latest version of the ADMS 6 (v6.0.0.1)[13] atmospheric dispersion model developed by Cambridge Environmental Research Consultants (CERC). The model was used to predict the ground level concentration of pollutants emitted to atmosphere from the Proposed Development. ADMS 6 is an advanced dispersion model used to model the air quality impact of industrial installations. The model has been used extensively throughout the UK for regulatory compliance purposes and is accepted as an appropriate air quality modelling tool by NRW, the EA and local authorities.

4.1.2. ADMS 6 parameterises stability and turbulence in the atmospheric boundary layer by the Monin-Obukhov length and the boundary layer depth. This approach allows the vertical structure of the boundary layer to be more accurately defined than by the stability classification methods of earlier dispersion models. In ADMS, the concentration distribution follows a symmetrical Gaussian profile in the vertical and crosswind directions in neutral and stable conditions. However, the vertical profile in convective conditions follows a skewed Gaussian distribution to take account of the inhomogeneous nature of the vertical velocity distribution in the convective boundary layer.

4.1.3. A number of complex modules, including the effects of complex terrain, percentile concentrations and the calculation of long-term averages of hourly mean concentrations are include in the model.

4.1.4. A range of input parameters is required including, among others, data describing the local area, meteorological measurements and emissions data.

4.2 PROCESS EMISSIONS

4.2.1. The principal inputs to the model with respect to the emissions to air has been derived from the Knauf Insulation Process handbook Prince RMW (Ref.: 20251219) and the emissions are compliant with BAT.

4.2.2. The pollutants assessed are:

- Oxides of nitrogen (NO_X as NO_2);
- Particulate matter (PM_{10} and $PM_{2.5}$);
- Carbon monoxide (CO);
- Sulphur dioxide (SO_2);
- Hydrogen fluoride (HF);
- Hydrogen chloride (HCl);
- Amines;
- Metals;
- Volatile organic compounds (VOCs); and
- Ammonia (NH_3).

[13] Cambridge Environmental Research Consultants (CERC) ADMS 6. Available at: https://www.cerc.co.uk/environmental-software/ADMS-model.html (Accessed May 2026).

4.2.3. Given that the speciation of VOCs is not known, it is assumed that VOCs are emitted as benzene and compared against the benzene AQAL in line with Environment Agency guidance. Similarly, it is assumed that all particles are emitted in the PM_{10} and $PM_{2.5}$ fractions for comparison against the PM_{10} and $PM_{2.5}$ AQAL.

4.2.4. To assess emissions of metals from P1 (Melter), that has ELVs presented as a total for different metal groupings, the group ELV was used to estimate the emissions of each metal within the relevant grouping. To produce a conservative assessment, the model output represents the total metal predicted concentrations and no factor has been applied for speciation percentages, with the exception of hexavalent chromium, for which a 1% speciation has been assumed, as indicated by Knauf.

4.2.5. It is understood that the installation operating period is up to 8000 hours per yearfor normal operations. Therefore, to calculate predicted concentrations over an annual averaging period, the maximum annual concentrations were multiplied by a factor of 91.3% (8000/8760) to account for this. Stack P3 only operates in the event of equipment failure when hot fumes from the melter need to be exhausted quickly and therefore was only assessed against short term limits.

4.2.6. Model input parameters are given in **Table 4-1.** The location of the sources is shown in **Figure 4-1**.

4.2.7. Amines are organic derivatives of ammonia (NH_3), wherein one or more of the hydrogen (H) atoms are replaced by a substituent organic group I. The type of amine can be defined as primary, secondary, or tertiary, based on the number of H atoms that are replaced:

- Primary amine (R-NH2) where 1 H-atom is replaced; − e.g. Monoethanolamine, MEA.
- Secondary amine (R2-NH) where 2 H-atoms are replaced; and − e.g. Dimethylamine, DMA.
- Tertiary amine (R3-N) where 3 H-atoms are replaced. − e.g. Trimethylamine, TMA.

4.2.8. The composition of amines emitted from the stack will depend on the composition of amines in the binder used in the process (if any). Emissions from the downstream stack are anticipated to be substantially below the Emission Limit of 3 mg/Nm^3, however this has been used for conservatism. Furthermore, since the specific details of the binders are confidential, the assessment has been undertaken on the basis that 100% of the amine releases are either Monoethanolamine, (MEA, a primary amine), Diethylamine (DiEA) or Dimethylamine (DMA) (secondary amines). MEA, DiEA and DMA represent three of the most studied amine compounds and for which EALs are available, thus resulting in greater data availability relating to their respective reaction schemes. Specifically, DMA is a secondary amine from which the nitrosamine, NDMA, is formed. The assumption that all modelled direct and indirect nitrosamine and nitramine parameters associated with the Proposed Development will be equivalent to NDMA represents a worst case approach in terms of assessment versus the EAL, given that NDMA is one of the most toxic nitrosamines.

4.2.9. This represents a very conservative assessment as not all of the binders used will contain amines.

4.2.10. The amine compounds included within the binder can react with substances to create new, potentially harmful compounds (e.g. nitrosamines and nitramines). These reactions can occur both within the manufacturing process itself and in the atmosphere following release of the treated post-combustion flue gases. Therefore, it is important that emissions to atmosphere, associated chemical transformations, and dispersion and deposition within the Study Area are represented within the air quality model.

Table 4-1 – Model input parameters

Parameter		P1 Melter	P2 Downstream	P3 Emergency	P4 De-dusting	P5 Fibre	P6 Batch	V1 SO_X vent (fresh lime)	V2 SO_X vent (reaction product)
Stack characteristics									
Stack location	X (m)	331020	331017	331046	331197	331059	331037	331014	331010
	Y (m)	370435	370362	370398	370380	370378	370424	370440	370437
Stack height	m	60.00	120.00	40.00	12.40	19.50	32.00	16.27	20.39
Stack diameter	m	0.65	2.85	0.65	1.70	0.60	0.90	0.15	0.15
Stack area	m^2	0.33	11.34	0.33	2.27	0.28	0.64	0.02	0.02
Temperature	°C	180.00	35.00	500.00	25.00	25.00	25.00	25.00	25.00
Velocity	m/s	19.20	20.00	11.37	17.00	16.00	18.00	20.00	20.00
Volume flow rate	Am^3/s	6.37	127.58	3.77	38.59	4.52	11.45	0.35	0.35
Volume flow rate	Nm^3/s_{wet}	3.87	113.09	1.33	36.11	4.17	18.06	0.33	0.33
Volume flow rate	Nm^3/s_{dry}	3.39	106.67	1.03	—	—	—	—	—
Emission concentration									
PM	mg/Nm^3	20.0	20.0	2230.0	20.0	20.0	20.0	20.0	20.0
NO_X	mg/Nm^3	259.0	-	-	-	-	-	-	-

Parameter		P1 Melter	P2 Downstream	P3 Emergency	P4 De-dusting	P5 Fibre	P6 Batch	V1 SO_x vent (fresh lime)	V2 SO_x vent (reaction product)
SO_x	mg/Nm^3	350.0	-	-	-	-	-	-	-
HCl	mg/Nm^3	30.0	-	-	-	-	-	-	-
HF	mg/Nm^3	5.0	-	-	-	-	-	-	-
H_2S	mg/Nm^3	2.0	-	-	-	-	-	-	-
Metals 1[(a)]	mg/Nm^3	1.0	-	-	-	-	-	-	-
Metals 2[(b)]	mg/Nm^3	2.0	-	-	-	-	-	-	-
CO	mg/Nm^3	100.0	-	-	-	-	-	-	-
NH_3	mg/Nm^3	10.0	5.0	-	-	-	-	-	-
Phenol	mg/Nm^3	-	10.0	-	-	-	-	-	-
Formaldehyde	mg/Nm^3	-	5.0	-	-	-	-	-	-
Amines [(c)]	mg/Nm^3	-	3.0	-	-	-	-	-	-
Total VOCs	mg/Nm^3	-	30.0	-	-	-	-	-	-
Emission rate (g/s)									
PM	g/s	0.068	2.133	2.292	0.021	0.722	0.083	0.361	0.007
NO_x	g/s	0.879	-	-	-	-	-	-	-

Parameter		P1 Melter	P2 Downstream	P3 Emergency	P4 De-dusting	P5 Fibre	P6 Batch	V1 SO_x vent (fresh lime)	V2 SO_x vent (reaction product)
SO_x	g/s	1.188	-	-	-	-	-	-	-
HCl	g/s	0.102	-	-	-	-	-	-	-
HF	g/s	0.017	-	-	-	-	-	-	-
H_2S	g/s	0.007	-	-	-	-	-	-	-
Metals 1	g/s	0.003	-	-	-	-	-	-	-
Metals 2	g/s	0.007	-	-	-	-	-	-	-
CO	g/s	0.339	-	-	-	-	-	-	-
NH_3	g/s	0.034	0.533	-	-	-	-	-	-
Phenol	g/s	-	1.067	-	-	-	-	-	-
Formaldehyde	g/s	-	0.533	-	-	-	-	-	-
Amines	g/s	-	0.320	-	-	-	-	-	-
Total VOCs	g/s	-	3.200	-	-	-	-	-	-

Notes: (a) Metals 1 represents the sum of arsenic, cobalt, nickel, cadmium, selenium and hexavalent chromium

(b) Metals 2 represents the sum of arsenic, cobalt, nickel, cadmium, selenium, hexavalent chromium, antimony, lead, trivalent chromium, copper, manganese and tin.

(c) Amine emission rates are provided as a total for all amines, which includes: Methylamine (MMA), Dimethylamine (DMA), Diethylamine (DiEA), Monoethanolamine (MEA) and trimethylamine (TMA).

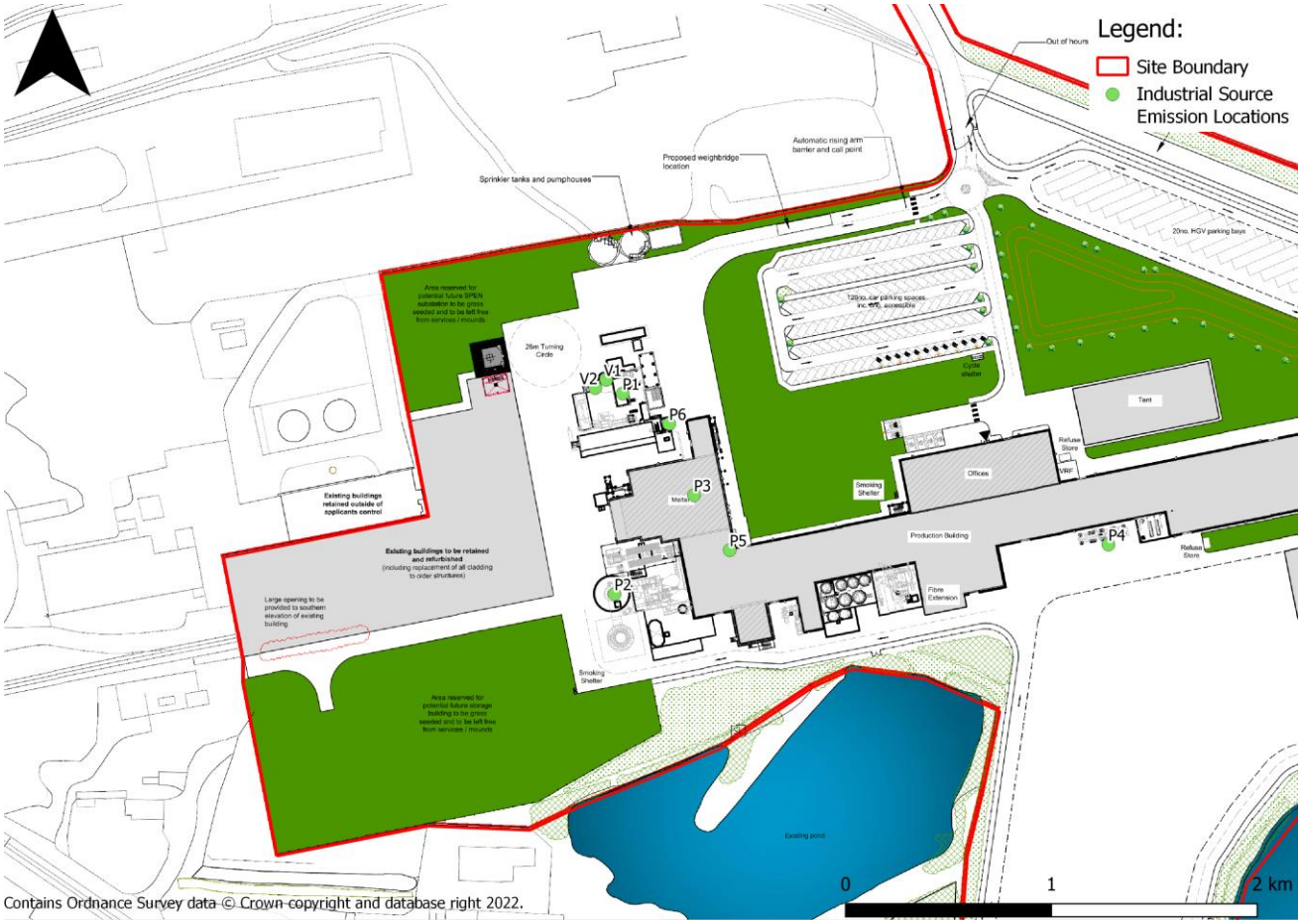


Figure 4-1 - Source location

4.3 MODELLED SCENARIOS

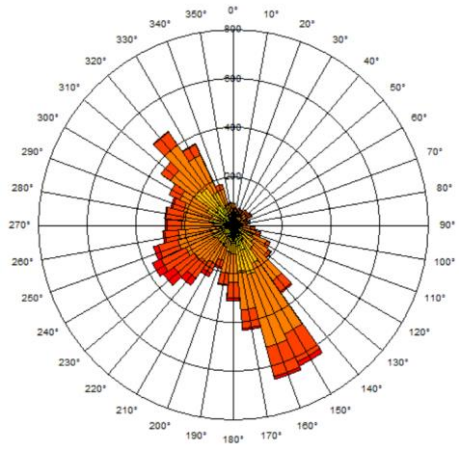
4.3.1. Two modelled scenarios were included in this assessment:

- 'Normal' operation: P1 (Melter), P2 (Downstream), P4 (De-dusting), P5 (Fibre), P6 (Batch), V1 (Fresh Lime SO_X Vent) and V2 (Reaction Product SO_X Vent); and
- 'Emergency' operation: P3 (Emergency).

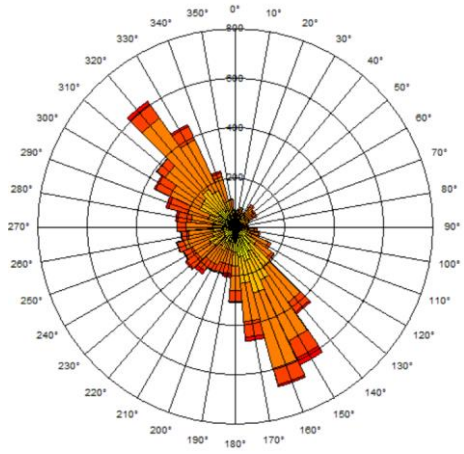
4.4 METEOROLOGY

4.4.1. This assessment has used meteorological data recorded at Hawarden meteorological station from 2020 to 2024.The meteorological station is located approximately 7.5km south-east with a difference in elevation of 3.1m, offering data in a suitable format for the model and can be considered representative of local meteorological conditions. **Figure 4-2** shows the wind roses for the modelled years used in this assessment.

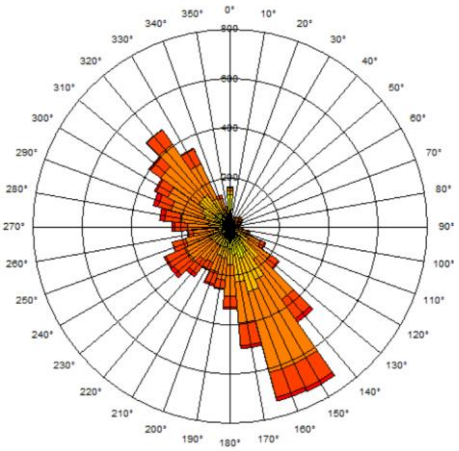
2020



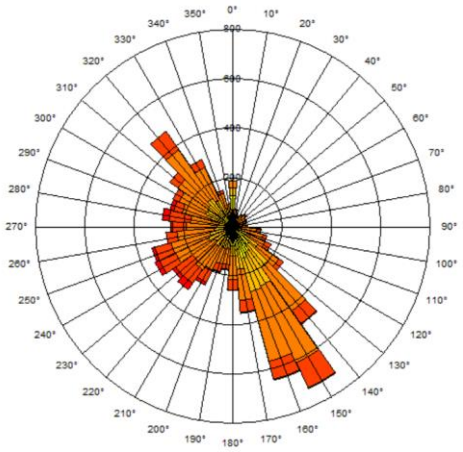
2021



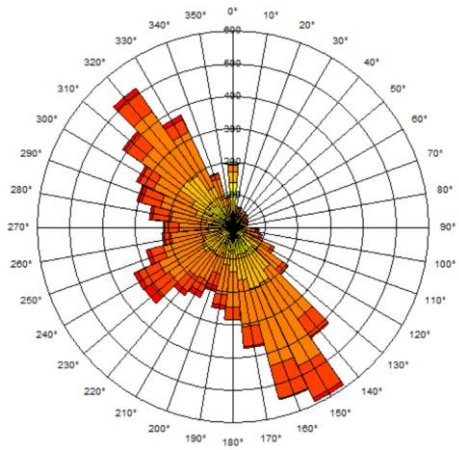
2022



2023



2024



Legend

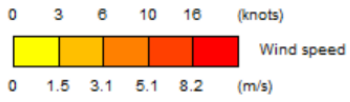


Figure 4-2 - Meteorological wind roses for Hawarden station 2020 to 2024

4.5 SURFACE ROUGHNESS

4.5.1. The area around the site is a mix of industry rural with the Dee Estuary in close proximity. Owing to the change in roughness extending out to 10km from the Site boundary, a variable surface roughness file was used.

MONIN-OBUKHOV LENGTH

4.5.2. The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 30m for the dispersion site and 10m for the meteorological site.

SURFACE ENERGY BUDGET

4.5.3. A model default value of 1.0m has been retained for the Priestly-Taylor parameter and annual averaged values have been adopted throughout the model domain for this assessment.

4.6 BUILDINGS

4.6.1. Any large object has an impact on atmospheric flow and air turbulence within the locality of the object. This can result in maximum ground level concentrations that are significantly different (generally higher) from those encountered in the absence of buildings. The building 'zone of influence' is generally regarded as extending a distance of 5L (where L is the lesser of the building height or width) from the foot of the building in the horizontal place and three times the height of the building in the vertical plane. **Table 4-2** presents the parameters of each building included in the model and **Figure 4-3** shows the location of the buildings in relation to the sources.

Table 4-2 – Modelled buildings

ID	X (m)	Y (m)	Z (m)	Length (m)	Width (m)	Angle (ºC)
Building001	330965	370416	13.7	41.2	45.4	78.0
Building002	330936	370368	29.1	116.9	37.5	78.0
Building004	331069	370349	4.2	13.0	11.9	78.0
Building005	331049	370418	6.2	10.0	13.6	78.0
Building006	331037	370394	37.2	42.3	27.8	78.0
Building007	331054	370368	15.8	19.7	30.4	78.0
Building008	331078	370369	12.8	26.7	22.0	78.0
Building009	331154	370387	11.2	128.5	17.7	78.0
Building010	331151	370406	12.3	56.0	19.1	78.0
Building011	331122	370363	12.8	16.4	15.9	78.0

ID	X (m)	Y (m)	Z (m)	Length (m)	Width (m)	Angle (ºC)
Building012	331144	370368	16.1	30.1	14.8	78.0
Building013	331279	370409	11.2	126.7	26.9	78.0
Building014	331304	370371	10.5	80.4	25.3	78.0
Building015	331212	370430	10.5	51.8	23.2	78.0
Building016	331282	370449	4.6	14.3	6.9	110.0
Building017	330923	370394	29.1	50.0	18.0	78.0
Building018	331139	370358	16.1	15.3	3.5	78.0
Building019	331214	370386	11.2	11.5	9.7	78.0
Building020	331090	370354	12.8	8.7	12.3	78.0

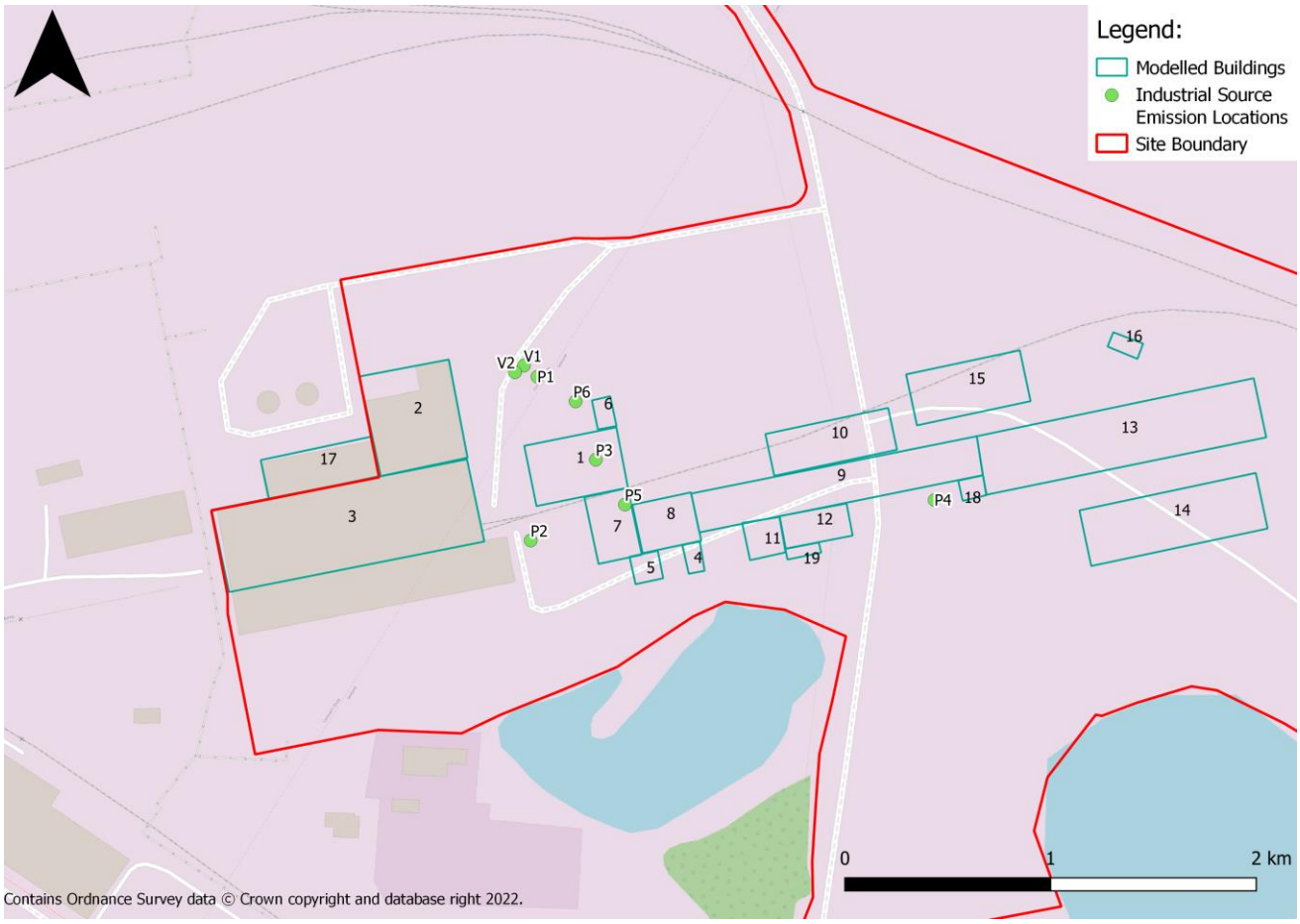


Figure 4-3 - Buildings included in the model

4.7 TERRAIN

4.7.1. As the area immediately surrounding the Site does not have a gradient change of more than 10m, a variable terrain was not required. However, given the height of the stacks and the overall change in landscape across the 10km modelled domain, a variable terrain file was included in the modelling.

4.8 MODELLED DOMAIN AND RECEPTORS

MODELLED DOMAIN

4.8.1. A 10km x 10km cartesian grid centred on the site was modelled, with a receptor resolution of 100m, to assess the impact of atmospheric emissions from the site on local air quality. This resolution is considered suitable for capturing the maximum process contribution from site emissions and complies with EA guidance as it is less than the 1.5 times the height of the two main stacks through which the majority of pollutants are emitted (melter and downstream).

HUMAN RECEPTORS

4.8.2. Guidance from the UK Government and Devolved Administrations makes clear that exceedances of the health-based objectives should be assessed at outdoor locations where members of the general public are regularly present over the averaging time of the objective, and it excludes workplace exposure. **Table 4-3** provides an indication of those locations that may or may not be relevant for each averaging period. This table has been reproduced from the LAQM.TG(22).[6]

Table 4-3 – Examples of where AQALs should apply for human receptors

Averaging period	Objectives should apply at	Objectives should generally not apply at
Annual mean	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties.
24-hour mean and 8-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties[(a)].	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean objectives would apply. Kerbside sites (e.g., pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend one hour or more. Any outdoor locations at which the public may be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

Averaging period	Objectives should apply at	Objectives should generally not apply at
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer	

Table notes:
(a) For gardens, such locations should represent parts of the garden where relevant public exposure is likely, for example where there is a seating or play areas. It is unlikely that relevant public exposure would occur at the extremities of the garden boundary, or in front gardens, although local judgement should always be applied.

4.8.3. Discrete receptors considered were chosen based on locations where people may be located and judged in terms of the likely duration of their exposure to pollutants and proximity to the Site, following the guidance given above in **Table 4-3**. Details of the locations of human receptors are given in **Table 4-4**, and graphical representation is shown in **Figure 4-4**.

4.8.4. For the purposes of assessing air quality impacts, workplace locations have been excluded from the assessment in accordance with Schedule 1, Part 1, Paragraph 2 of the Air Quality Standards Regulations 2010. These Regulations does not differentiate between whether this a workplace location under the control of the operator, or an off-site workplace location.

Table 4-4 – Details of modelled human receptors

ID	Address	Type	X (m)	Y (m)	Z (m)
H01	Green Lane Way	Residential	333625	370877	1.5
H02	Green Lane Estate	Residential	333882	369938	1.5
H03	Rollason Grove	Residential	332586	369772	1.5
H04	Sealand Avenue	Residential	332542	369378	1.5
H05	Ashberry Homes Jubilee Place	Residential	331992	369377	1.5
H06	Fairfield Road	Residential	331733	368383	1.5
H07	Park Avenue	Residential	331138	368660	1.5
H08	Ashfield Road	Residential	330936	368930	1.5
H09	Manley Court	Residential	330538	369155	1.5
H10	Chandlers Court	Residential	329692	369605	1.5
H11	Dee View Road	Residential	329022	370028	1.5
H12	Kelsterton Road	Residential	328516	370378	1.5
H13	Toybox Day Nursery	Educational	328169	370457	1.5
H14	College	Educational	328038	370435	1.5

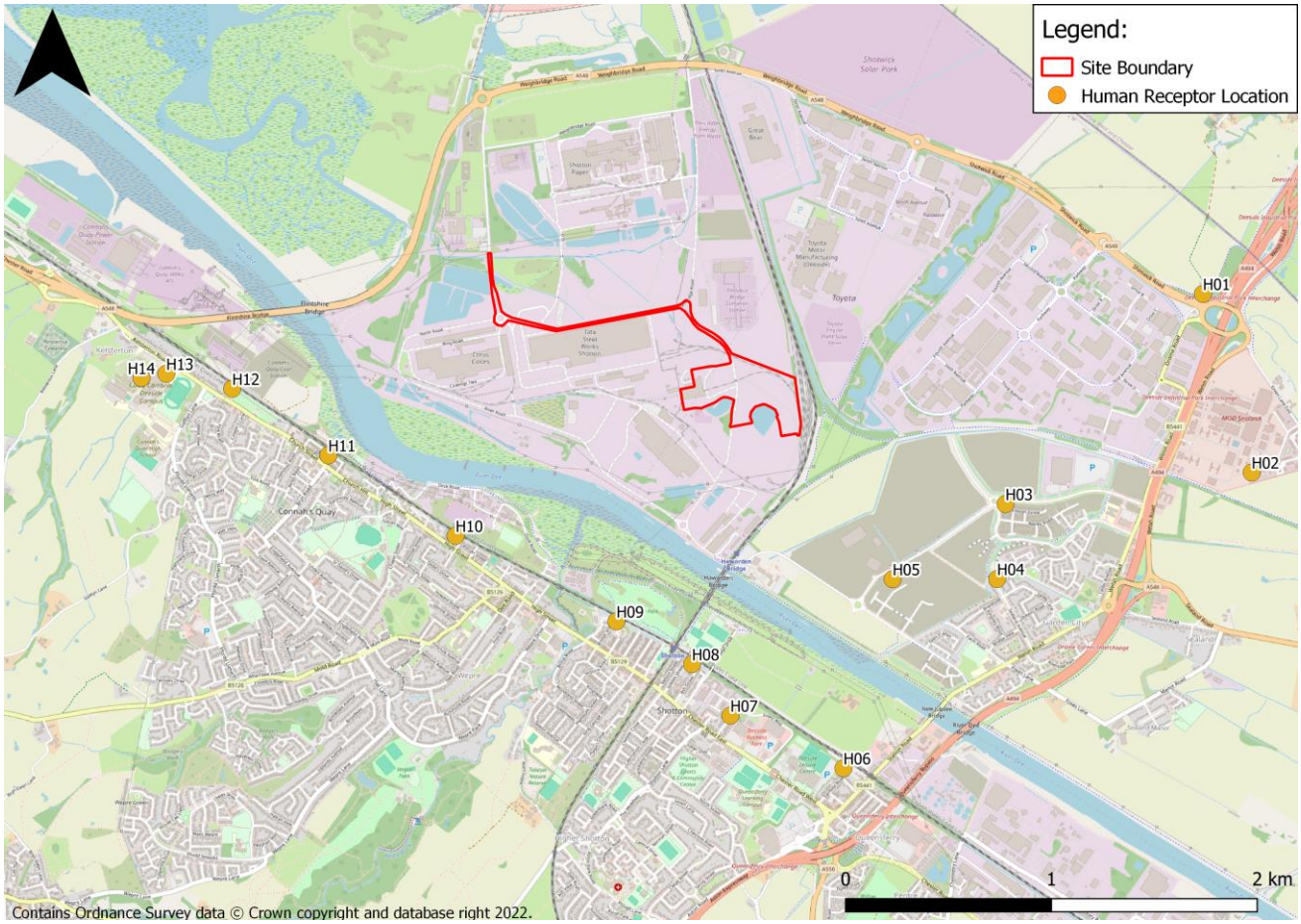


Figure 4-4 - Location of modelled human receptors

4.9 ECOLOGICAL RECEPTORS

4.9.1. NRW Guidance[2] provides a series of zones of influence (ZoIs) based on fuel and MW(th) input, which is primarily targeted at Medium Combustion Plants and Specified Generators. The energy for the melter is supplied by electricity, as such the screening distances listed in this document are not applicable. As a result, the ZoIs identified in the EA Risk Assessment Guidance have been used:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Ramsar Sites (protected wetlands) within 10km of the Site boundary; and
- Sites of Special Scientific Interest (SSSIs) and local nature sites (ancient woods, local wildlife sites and national and local nature reserves) within 2km of the Site boundary.

4.9.2. The Environment Agency's "Specified generators: dispersion modelling assessment" guidance (part of the "Risk assessments for specific activities: environmental permits")[3] requires detailed dispersion modelling to be carried out based on local sensitive receptors. To align with the ecological receptors needing to be modelled as per the above guidance for the operational industrial stack assessment, the following ecological receptors have been included in the assessment as shown **Table 4-5**. Each ecological site was modelled using a grid of receptors placed at 100m intervals.

Table 4-5 – Details of modelled ecological receptors

ID		Habitat classification	Z (m)	Distance to nearest source (km)
E1	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0	0.75
E2	Ancient Semi Natural Woodland	Ancient Woodlands	0	2.20
E3	River Dee (Afon Dyfrdwy)	SSSI	0	0.71
E4	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0	0.76
E5	Shotton Lagoons and Reedbeds	SSSI	0	1.12
E6	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0	0.76
E7	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	0	0.71
E8	Deeside and Buckley Newt sites	SAC	0	2.34
E9	Halkyn Mountain (Mynydd Helygain)	SAC	0	9.49
E10	Shotton Steelworks	LWS	0	0.44
E11	River Dee	LWS	0	0.96
E12	Shotton Banks	LWS	0	1.93

4.10 BACKGROUND CONCENTRATIONS

4.10.1. The annual mean background concentrations for the receptors considered in this assessment are the maximum predicted concentration for the site and have been taken from a range of sources as shown in **Table 4-6**. Further details are provided in **Section 3**.

Table 4-6 – Source of background concentrations

Pollutant	Source of background concentration
NO_X	Defra 2025 dataset[4]
NO_2	Defra 2025 dataset[4]
PM	Defra 2025 dataset[4]
SO_2	Defra 2001 dataset[8]
HF	UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP)[9]
CO	Defra 2001 dataset[8]
HCl	Environment Agency[10]

Pollutant	Source of background concentration
Metals	Defra Heavy metals network[11]
NH_3	CEH (2022-2024 average) [7]
VOCs (as benzene)	Defra 2001 dataset[8]
Phenol	n/a
Formaldehyde	n/a
Amines	n/a
Nitrogen Deposition	APIS[7]
Acid Deposition	APIS[7]

4.10.2. The maximum annual process contribution is added to the maximum annual background concentration to give a total concentration at each receptor location. This total concentration can then be compared against the relevant AQAL and the likelihood of an exceedance determined.

4.10.3. It is not technically rigorous to add predicted short-term or percentile concentrations to ambient background concentrations since peak contributions from different sources would not necessarily coincide at the same time or at the same location. Without hourly ambient background monitoring data available, it is difficult to make an assessment against the short-term assessment criteria. For this assessment, conservative short-term ambient levels will be derived by applying a factor of two to the annual mean background data as per the recommendation in EA Guidance[3].

4.10.4. For metals, the 2024 annual average measured concentration was used for annual averaging periods, and the 2024 maximum measured monthly data was used for all shorter averaging.

4.10.5. Modelled background concentrations and nitrogen/ acid deposition for the ecological receptors were extracted from the APIS portal.

4.10.6. Further details on background concentrations used in this assessment are provided in **Section 3**.

NEARBY INDUSTRIAL PROJECTS

4.10.7. There are a number of planned/ proposed industrial projects within 10 km of the Proposed Development which would not be captured under existing monitoring data or mapped background concentrations. To account for the contribution of these projects to ambient air quality, emissions of common pollutants were modelled using publicly available information and added to the background to estimate the PEC. The projects considered include the following:

- Connah Quay Carbon Capture;
- Shotton Paper Mill;
- ICT Paper Mill;
- Parc Adfer ERF;
- Padeswood Carbon Capture Project;
- Deeside Power Station Upgrade; and
- Arrow Biowaste Recycling Facility.

4.10.8. It should be noted that some of the above projects above are 'improvements' to existing facilities and therefore may result in a decrease in predicted air quality concentrations. For these projects, emissions were modelled for both the current permitted emissions and the proposed project, with the difference between existing and proposed emissions added to the concentrations from the Proposed Development plus ambient background. Further details of these projects is provided in Appendix D.

4.11 DEPOSITION

4.11.1. The predominant route by which emissions will affect land in the vicinity of a process is by deposition of atmospheric emissions. Ecological receptors can potentially be sensitive to the deposition of pollutants, particularly nitrogen and sulphur compounds, which can affect the character of the habitat through eutrophication and acidification.

4.11.2. Deposition processes in the form of dry and wet deposition remove material from a plume and alter the plume concentration. Dry deposition occurs when particles are brought to the surface by gravitational settling and turbulence. They are then removed from the atmosphere by deposition on the land surface. Wet deposition occurs due to rainout scavenging (within clouds) and washout scavenging (below clouds) of the material in the plume. These processes lead to a variation with downwind distance of the plume strength and may alter the shape of the vertical concentration profile as dry deposition only occurring at the surface.

4.11.3. EA guidance AQTA06 recommends deposition velocities for various pollutants dependent upon the habitat type, shown in **Table 4-7**. For nitrogen-containing pollutants not included within this guidance (i.e. amines, nitrosamines, nitramines), a deposition velocity equivalent to that for ammonia was used, which is considered to be conservative

Table 4-7 – Recommended dry deposition velocities

Pollutant	Deposition velocities (ms^{-1})	
	Grassland	Forest
NO_2	0.0015	0.003
SO_2	0.012	0.024
HCl	0.025	0.06
NH_3	0.02	0.03
Amines	0.02	0.03

4.11.4. In order to assess the impacts of deposition, habitat-specific critical loads and critical levels have been created. These are generally defined as: "*a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge".*

4.11.5. It is important to distinguish between a critical load and a critical level. The critical load relates to the quantity of a material deposited from air to the ground, whilst critical levels refer to the concentration

of a material in air. APIS provides critical load data for ecological sites in the UK (relevant critical loads for this assessment are shown in **Table 2-3**).

4.11.6. The critical loads used to assess the impact of compounds deposited to land which result in eutrophication and acidification are expressed in terms of kilograms of nitrogen deposited per hectare per year (Kg N ha^{-1} yr^{-1}) and kilo-equivalents deposited per hectare per year (keg ha^{-1} yr^{-1}). The units of 'equivalents' (eq) is used for the purposes of assessing acidification, rather than a unit of mass. The unit eq (1 keq =1,000 eq) refers to molar equivalent of potential acidity resulting from e.g. sulphur, oxidised and reduced nitrogen, as well as base cations. Essentially, it means 'moles of charge' and is a measure of how acidifying a particular chemical species can be.

4.11.7. To convert the predicted concentration in air of NO_2, the following algorithm is used:

$$DR_i = C_i v_{d_i} f_i$$

Where:

DR_i= annual deposition of N or S (kg N ha^{-1} hr^{-1} or kg S ha^{-1} hr^{-1})

C_i= annual mean concentration of the ith chemical species (µg/m^3)

v_{d_i}= deposition velocity of ith species

f_i= factor to convert from µg m^{-2} s^{-1} to kg ha^{-1} yr^{-1} for the ith species

4.11.8. **Table 4-8** and **Table 4-9** provides the relevant conversion factors as derived from EA guidance AQTA06.

Table 4-8 – Dry deposition flux conversion factors for nutrient nitrogen deposition

Pollutant	Conversion factor (µg m^{-2} s^{-1} to kg ha^{-1} yr^{-1} for the ith species)	
	Of	f_i
NO_2	N	95.9
NH_3	N	259.7
Amines (assumed to be all MEA)	N	72.3

4.11.9. In order to convert deposition of N to acid equivalents, the following relationship can be used:

$$1\ keg\ ha^{-1}yr^{-1} = 14kg\ N\ ha^{-1}yr^{-1}$$

4.11.10. To account for acidification of other species, the following dry deposition flux conversion factors were used for SO_2 and HCl and added to the acid equivalents from nitrogen deposition.

Table 4-9 – Dry deposition flux conversion factors for converting modelled deposition rates to acid

Pollutant	Conversion factor from µg m^{-2} s^{-1} to keq $ha^{-1}year^{-1}$
SO_2	9.84

Pollutant	Conversion factor from µg m^{-2} s^{-1} to keq $ha^{-1}year^{-1}$
HCl	8.63

4.11.11. With respect to wet deposition, the EA states: "*it is considered that wet deposition of SO_2, NO_2 and NH_3 is not significant within a short range".* Therefore, the assessment only considers dry deposition of nutrifying and acidifying N and S compounds. The effects of plume depletion are also not considered, as a conservative approach.

4.11.12. Wet deposition of hydrogen chloride (HCl) was also not included in the acid deposition assessment. Instead, predicted concentrations of HCl (with no plume depletion) were modelled and dry deposition of HCl was calculated from the predicted HCl concentrations in post-processing with no effects of plume depletion considered, as described above. While it is anticipated that simulating the effects of wet deposition will reduce the mass of HCl in the airborne plume available for dry deposition, thus reducing the amount of dry deposition, sensitivity tests were completed to confirm the impacts on total HCl deposition. Further details are provided in Section 4.15.

4.12 SPECIAL TREATMENT

4.12.1. Specialised model treatments, for short-term (puff) releases, coastal models, fluctuations or photochemistry were not used this assessment, with the exception of the amine modelling, which is discussed in the following section.

4.13 AMINE MODELLING

4.13.1. Direct emissions of amines and nitrosamines associated with degradation within the manufacturing process and entrainment within the flue gas, are expected to be low. Nevertheless, the ADMS amine chemistry module[14] has been used to model the chemical reactions associated with the release of amine compounds and the formation of associated nitrosamines and nitramines in the atmosphere.

4.13.2. Whilst the Environment Agency acknowledges that the uncertainty associated with modelling of amines is likely to be very high, its latest draft guidance[15] on the assessment of impacts to air quality from amine-based post-combustion carbon capture plants states "…the only commercially available modelling software to evaluate the potential impacts from amines and amine degradation products releases is the amines module within ADMS. The amines chemistry module is based on established science considering published research on mechanisms of formation of toxic compounds. Although the validation of the module is not possible at the moment, the ADMS air dispersion modelling algorithms are continually validated against real world situations, field campaigns and wind tunnel experiments".

4.13.3. The mechanisms for the formation of nitrosamines and nitramines in the atmosphere are complex. However, the main initial reaction of amines in the atmosphere is with hydroxyl (OH) radicals and it is this reaction on which the ADMS amine chemistry module is based (CERC). As described above,

[14] CERC (2023). ADMS 6 Amine Chemistry User Guide Supplement (Online). Available at: https://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS_6_Amine_chemistry_supplement.pdf (Accessed May 2026).
[15] Environment Agency. (2021). 'AQMAU recommendations for the assessment and regulation of impacts to air quality from amine based post-combustion carbon capture plants' https://ukccsrc.ac.uk/wp-content/uploads/2021/11/AQMAU-C2025-RP01.pdf (Accessed May 2026).

the subsequent formation of nitrosamines and nitramines are attributed to reactions with NO and NO_2, however, they can further degrade in the atmosphere (e.g. through photo-oxidation and subsequent reaction with oxygen molecules to form imines, which are relatively stable and non-toxic compounds[16] .

4.13.4. Primary amines do not form stable nitrosamines, meaning that any such nitrosamines would be rapidly isomerised to the respective imine. However, secondary and tertiary amines do form stable nitrosamines. The ADMS amine chemistry module includes an option to allow only unstable nitrosamines to be created (i.e. assuming emissions of primary amines only) which, if selected by the model user, sets all nitrosamine outputs to zero and only nitramines will form. This option was not selected for this assessment to ensure that the degradation of amines (primary, secondary or tertiary) is taken into account, and, as a worst case, nitrosamines formed from the degradation of primary amines were considered in the assessment[17].

4.13.5. The general reaction scheme simulated by the ADMS amine chemistry module is as follows:

AMINE + hydroxyl radical (•OH)	→ amino RADICAL + H2O (1a)
	→ non-amine radical (RN(H)C•H2) + H2O (1b)
amino RADICAL + O2	→ imine + hydroperoxyl (HO_2) (2)
amino RADICAL + NO	→ NITROSAMINE (3)
amino RADICAL + NO_2	→ NITRAMINE (4a)
	→ imine + nitrous acid (HONO) (4b)
	hυ
NITROSAMINE	→ amino RADICAL (5)

Notes:

- R represents an alkyl group.
- Terms in capitals are the generic names given to the respective compounds for which input data are required for modelling in ADMS.

4.13.6. The amount of nitrosamine and nitramine formed in the atmosphere is dependent on the initial reaction of the amine with the OH radical – specifically the branching ratio of the abstraction of an H atom from the amino group (N-H) (i.e. forming the amino radical) to the abstraction from the methyl group (C-H) (i.e. forming the non-amine radical) – where a lower branching ratio will result in fewer amino radicals being made available and thus fewer nitrosamine/nitramine compounds being formed. However, other variables play an essential role in the potential formation of nitrosamines and nitramines in the atmosphere and are required for the ADMS amine chemistry module to run, including:

[16] Manzoor, S., A. Simplerer and A korre. (2015). 'A theoretical study of the reaction kinetics of amines released into the atmosphere from CO_2 capture' International Journal of Greenhouse Gas Control, 41, 219-228. Available at: https://doi.org/10.1016/j.ijggc.2015.05.012 (Accessed May 2026).
[17] CERC (2012). 'Atmospheric Chemistry Modelling – Activity 1: Gaseous Phase Chemistry Modelling (Initiated by hydroxyl radical) Final Report' Available at: https://gassnova.no/app/uploads/sites/6/2019/10/GaseousphaseOHchemistrymodelling_CERC-1.pdf (Accessed May 2026).

4.13.7. Ambient concentrations of the OH radical:

- A representative annual average OH radical concentration for the Study Area was sourced from published research[18] , based on modelling prepared by UK Centre for Ecology and Hydrology using the atmospheric chemistry model EMEP4UK.
- An OH concentration of 11x 10^5 molecules cm^3 is reported for the Site location.
- This is the value used to feed into the amine chemistry modelling and is likely to be conservative (skewed high) as an annual average (i.e. if more OH radicals are available in the atmosphere, daytime amine degradation increases, resulting in increased production of nitrosamine/nitramine compounds).

4.13.8. Photolysis rates applicable to the region of study:

- The ADMS meteorological pre-processor provides hourly information with respect to incoming solar radiation (K) specific to the met year data and latitude. A subsequent calculation is completed using the K values to derive hourly photolysis rates, which are then used to calculate an annual average rate constant for NO_2 (jNO_2).
- The meteorological data used in the amines chemistry module aligns with that used for modelling of all other non-amine related pollutants, comprising hourly data for years 2020-2024 inclusive from Hawarden meteorological station.

4.13.9. Ambient concentrations of ozone (O_3) and NOx (i.e. NO and NO_2):

- The amine reaction scheme requires hourly background levels of NOx and O_3 equivalent to the year of meteorological data. Hourly data for these species were sourced from Defra's Liverpool AURN monitoring site, representing urban background levels, for the years 2020-2024 inclusive.
- Background NO_X concentrations are used to dictate the availability of NO and NO_2 in the formation of nitrosamines and nitramines, respectively, on an hourly basis.
- The hydroxyl radical concentration varies based on a number of factors, including solar radiation, latitude, and background levels of O_3. The ADMS amine module requires a constant, 'c', which is used to calculate hourly varying OH radical concentrations for the region of study. The value for c is derived based on the relationship between annual average values for jNO_2, O_3 and OH radical concentrations as described above.

4.13.10. The reaction rates and associated kinetic parameters input to ADMS v6.0 need to be defined by the model user.

4.13.11. The binder used in the Rockwool manufacture process will vary, as a result there may be fluctuations in the amine content of the binder used. Emissions from the downstream stack are anticipated to be substantially below the Emission Limit of 3mg/Nm^3, however this has been used for conservatism. Furthermore, since the specific details of the binders are confidential, the assessment has been undertaken on the basis that all of the amine releases are either MEA (primary amine), DiEA or DMA (secondary amines). Reaction rate data for these species are available, albeit with some variability, in publicly available literature. Details of the references used are provided in **Appendix B** .The values used are provided in **Table 4-10.** Acknowledging the uncertainty

[18] CERC. 2024. Improving Post-combustion carbon capture air quality risk assessment techniques. https://ukccsrc.ac.uk/wp-content/uploads/2024/05/CERC_2024_Improving_Post-Combustion_Carbon_Capture_Air_Quality_Risk_Assessment_Techniques.pdf (Accessed May 2026).

associated with modelling amines and their degradation, sensitivity testing has been undertaken and is reported in **Section 4.15**.

Table 4-10 - ADMS Amine Chemistry Module Reaction Rate Coefficients and Chemistry Module Inputs

Parameter	Units	Notes	Input	Sensitivity Testing
Amine Emission Rates	g/s	Emission rate for amine compounds. Annual mean rate based on the AEL provided by Knauf. For modelling, emissions are assumed to be either all MEA, all DiEA or all DMA	As per **Table 4-1**	N/A
NOx Emission Rate	g/s	Emission rate for NOx based on the in-stack emission rate provided by Knauf for Melter Stack	As per **Table 4-1**	N/A
% NOx emission as NO_2 in flue gas	%	Proportion of NOx assumed to be NO_2 in flue gas from Melter stack.	5%	10%
Amine/OH reaction rate constant, k1	/ppb/s	Relating to the reaction of the emitted amine with the OH radical.	MEA:2.02 DiEA: 2.10 DMA:1.54	Min DMA: 1.30 Max DMA: 1.78
Amino radical/O2 reaction rate constant, k2	/ppb/s	Relating to the reaction of the amino radical with oxygen (forming imine).	MEA: 5.22×10^{-8} DiEA: 5.65×10^{-9} DMA: 9.29×10^{-10}	

Parameter	Units	Notes	Input	Sensitivity Testing
Rate constant for formation of nitrosamine, k3	/ppb/s	Relating to the formation of nitrosamine from the reaction of the amino radical with NO.	MEA: 0.018 DiEA:0.226 DMA: 0.020	Min DMA: 0.002 Max DMA: 0.056
Rate constant for formation of nitramine, k4a	/ppb/s	Relating to the formation of nitramine from the reaction of the amino radical with NO_2.	MEA: 0.0002 DiEA: 0.0079 DMA: 0.0079	
Amino radical / NO_2 reaction rate constant, k4	/ppb/s	Relating to the reaction of the amino radical with NO_2 (forming imine or nitramine)	MEA: 0.0003 DiEA: 0.0082 DMA: 0.0082	
Branching ratio for amine / OH reaction	Dimensionless	The ratio of H atom abstraction from amino group (N-H) to the methyl group (C-H)	MEA: 0.11 DiEA: 0.6 DMA: 0.38	
Ratio of j(nitrosamine) / jNO_2	Dimensionless	Ratio of photolysis rate constants for the nitrosamine and NO_2	MEA: 0.32 DiEA: 0.32 DMA: 0.32	
Constant, c, for OH concentration calculations	s	Constant for calculating hourly varying OH concentrations, based on relationship between annual average jNO2, O3 and OH concentrations. Specifically derived for each year following CERC guidance[14]	2020: 0.0012 2021: 0.0016 2022: 0.0012 2023: 0.0011 2024: 0.0017	N/A - 2021: 0.0017

Parameter	Units	Notes	Input	Sensitivity Testing
Background NOx / NO_2 concentrations	µg/m³	Ambient hourly concentrations for each species sourced from representative monitoring location.	Hourly data obtained from Liverpool AURN for 2020 - 2024	
Background O3 concentrations	µg/m³	Ambient hourly concentrations for each species sourced from representative monitoring location.	Hourly data obtained from Liverpool AURN for 2020 - 2024	

Notes: MEA, DiEA and DMA represent three of the most studied amine compounds and for which EALs are available, thus resulting in greater data availability relating to their respective reaction schemes. Specifically, DMA is a secondary amine from which the nitrosamine, NDMA, is formed. The assumption that all modelled direct and indirect nitrosamine and nitramine parameters associated with the Proposed Scheme will be equivalent to NDMA represents a worst case approach in terms of assessment versus the EAL, given that NDMA is one of the most toxic nitrosamines.

4.13.12. The general description of the ADMS amine chemistry module scheme can be summarised in five steps:

1. On an hourly basis, ADMS uses the above input parameters to model concentrations of the species of interest as well as the age of the primary pollutants (e.g. amines) at each receptor/grid point using the standard ADMS dispersion algorithms.
2. Using the ‘dilution and entrainment’ scheme within the ADMS amine chemistry module, the primary pollutant concentrations are adjusted to removed dilution effects (i.e. becoming increasingly conservative with distance from stack exit).
3. The chemistry reaction scheme requires consideration of timescales, so that after each hourly dispersion calculation, the 'age' of the pollutants is calculated based on the plume travel time. The chemical reaction equations are applied to all pollutants from the source.
4. At this point, the ‘dilution and entrainment’ scheme is used to dilute all pollutants as ambient air, containing the background pollutants, is entrained into the plume.
5. Steps 3 and 4 are repeated for each time step until time becomes equal to the pollutant ‘age’. Modelling Deposition of Amines in ADMS.

4.14 MODELLING DEPOSITION OF AMINES IN ADMS

4.14.1. CERC[14] recommend the following method for calculating deposition of amines and associated products (nitrosamines, nitramines) in ADMS is undertaken based on the following approach:

1. Run the respective ADMS amine chemistry model runs with amine chemistry switched on and deposition switched off (i.e. as detailed above).
2. Run the same model set up as in Step 1, but with the ADMS amine chemistry module switched off and deposition switched on.
3. Run the same model set up as in Steps 1 and 2, but with both ADMS amine chemistry module and deposition switched off.

4.14.2. Based on the outputs from Step 2 (deposition switched on) and Step 3 (deposition switched off), the ratio of the concentration to deposition flux was calculated for each amine and at each receptor/grid location. This ratio is then multiplied by the concentration output from Step 1 (ADMS amine chemistry module switched on) to derive the amine deposition fluxes at all receptor and grid locations.

4.14.3. This approach has not been followed in this assessment since, as for other pollutants, deposition will be limited within the Study Area due to the predominance of man-made rather than vegetated surfaces. This has no material impact on the assessment but, if anything, it ensures a degree of conservatism in the output as pollutant concentrations will not drop-off as quickly.

4.14.4. Research published by Karl et al (2009)[19], which reports on worst case studies for assessing deposition of amines from the carbon capture process, adopted a deposition velocity of 10mm/s for amines and 30mm/s for nitrosamines and nitramines. This reflects that the solubility of amines is relatively lower than that of nitrosamines and nitramines. However, in the absence of recommended deposition velocities for these compounds, a conservative approach has been adopted for the assessment of the Proposed Scheme, whereby the deposition velocity for all amine, nitrosamine, and nitramine compounds is assumed to be equivalent to that for ammonia (20mm/s or 30mm/s depending on vegetation type) (i.e. all gaseous amine compounds assumed to be highly soluble).

4.15 SENSITVITY ANALYSIS

4.15.1. Wherever possible, this assessment has used worst-case scenarios, which will exaggerate the impact of the emissions on the surrounding area, including emissions, operational profile, ambient concentrations, meteorology and surface roughness. This assessment has considered five years of meteorological data, with data reported from the year(s) predicting the highest ground-level concentrations at the nearest sensitive receptor for comparison with the AQAL. Table 4-11 presents a comparison of the impact on annual and 24-hour PM_{10} with the model runs including buildings and without buildings. PM_{10} is a critical output for this assessment, and therefore two scenarios have been included in this sensitivity analysis: 'normal' operation and 'emergency' operation. Overall, the results indicate that there are no significant changes in predicted concentrations with the absence of buildings in the model for the 'normal' operation. The table below shows that that for the 'emergency' scenario, the model underpredicts PM_{10} concentrations when the buildings are removed from the model. Therefore, the assessment included in the above report can be considered conservative.

Table 4-11- Model sensitivity analysis – with buildings vs without buildings

Pollutant	With buildings	Without buildings
Annual PM_{10}	1.00	0.95
24-hour PM_{10} (normal)	1.00	1.14
24-hour PM_{10} (emergency)	1.00	0.75

AMINE DEGRADATION SENSITIVITY TESTING

4.15.10. This section presents the results of the sensitivity testing of the amine chemistry module in the dispersion modelling. The parameters tested were set out in Table 4-10 and testing was undertaken using meteorological data for 2021. The results are shown in **Table 4-12** below.

4.15.11. To recap, the modelling of amine degradation has been based on MEA, DiEA and DMA as compounds representative of the degradation of primary and secondary amines. Primary amines do not form stable nitrosamines.

[19] Karl, M., Wright, R.F., Berglen, T.F. and Denby, B. (2009). 'Worst Case Study Method to assess the environmental impact of amine emissions from a CO2 capture plant' Available at: https://www.sciencedirect.com/science/article/abs/pii/S1750583610001581?via%3Dihub (Accessed May 2026).

Table 4-12- Model sensitivity analysis – Nitrosamines

Pollutant	'Base Case'	Lower Limit of Reaction Co-efficients	Upper Limit of Reaction Co-efficients	Increased Primary NO_2	Increased Background OH
Annual NDMA	1.00	0.89	1.13	1.00	1.06

4.15.12. In general, the sensitivity of the modelled nitrosamines and nitramines to varying input parameters to the amine chemistry module lies within +/-15% of the base case. This level of uncertainty has been taken into account in the assessment of the significance of the effects arising from emissions of amines with the Proposed Development.

WET DEPOSITION SENSITIVITY TESTING

4.15.13. Wet deposition of hydrogen chloride (HCl) was not included in the acid deposition assessment. Instead, predicted concentrations of HCl (with no plume depletion) were modelled and dry deposition of HCl was calculated from the predicted HCl concentrations in post-processing with no effects of plume depletion considered. While it is anticipated that simulating the effects of wet deposition will reduce the mass of HCl in the airborne plume available for dry deposition, thus reducing the amount of dry deposition, the model has been re-run to confirm this.

4.15.14. Specifically, the model was re-run to simulate the impacts of both wet and dry deposition but with plume depletion enabled. The resulting 'total deposition' was then incorporated into updated acid deposition calculations.

4.15.15. Dry deposition was modelled using the parameters described in **Table 4-7**. Wet deposition was modelled using two different methods:

1. Using the Washout coefficients for HCl, taken from the ADMS 6 User Guide[20] (CERC, 2023):
    a. Washout Co-efficient A: 0.0003
    b. Washout Co-efficient B: 0.66
2. Using the Falling drop methodology, based on an initial pH of 5.6 for droplets above plume.

The total HCl deposition simulated by the model was then converted to acid deposition equivalent and combined with acid deposition resulting from other pollutants using the methodology described in Section **4.11**. The results are compared to the base case in **Table 4-13**, below.

Table 4-13- Model sensitivity analysis –Total Acid Deposition

Site	'Base Case'	Wet Deposition modelled using washout co-efficient and Plume Depletion	Wet Deposition modelled using Falling Drop methodology and Plume Depletion

[20] Cambridge Environmental Research Consultants Limited (CERC). ADMS 6 User Guide (2023) Available online at https://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS_6_User_Guide.pdf (Accessed June 2026)

E01	Dee Estuary (Aber Afon Dyfrdwy) RAMSAR, SPA	1.00	0.98	0.98
E04	Dee Estuary (Aber Afon Dyfrdwy) SSSI	1.00	0.98	0.98
E05	Shotton Lagoons and Reedbeds SSSI	1.00	1.00	1.00
E06	Dee Estuary (Aber Afon Dyfrdwy) SAC	1.00	0.98	0.98
E08	Deeside and Buckley Newt sites SAC	1.00	0.94	0.94
E09	Halkyn Mountain (Mynydd Helygain) SAC	1.00	0.96	0.96

The results of both wet deposition methodologies resulted in no change to the maximum acid deposition at Shotton Lagoons and Reedbeds SSSI and a slight decrease in acid deposition at all other sites. As a result, the acid deposition results presented in this assessment (i.e. base case) are considered to be conservative and the inclusion of wet deposition in the modelling would not change the conclusions of the assessment.

4.16 MODEL UNCERTAINTY

4.16.1. Process emissions have been modelled under expected operation using the standard steady-state algorithms in ADMS to determine the impact on local human receptors. In order to model atmospheric dispersion using standards Gaussian methods, the following assumptions have to be made and limitations accepted:

- Conservation of mass – the entire mass of emitted pollutant remains in the atmosphere, and with the exception of amines, no allowance is made for loss due to chemical reactions or deposition processes (Although the standard Gaussian model can be modified to include such processes, as is the case with ADMS). Portions of the plume reaching the ground are assumed to be dispersed back away from the ground by turbulent eddies (eddy reflection);
- Steady-state emissions – emission rates are assumed to be constant and continuous over the time averaging period of interest; and
- Steady-state meteorology – no variations in wind speed, direction or turbulent profiles occur during transport from the sources to the receptor. This assumption is reasonable within a few kilometres of a source but may be valid for receptor distances in the order of tens of kilometres. For example, for a receptor 50km from a source and with a wind speed of 5m s-1 will take nearly three hours for the plume to travel this distance during which time many

different processes may change (e.g. the sun may rise or set and clouds may form or dissipate affecting the turbulent profiles). For this reason, Gaussian models are practically limited to predicting concentrations within ~20km of a source.

4.16.2. As a result of the above, and in combination with other factors, not least attempting to replicate stochastic processes (e.g. turbulence) by deterministic methods, dispersion modelling is inherently uncertain but is nonetheless a useful tool in plume footprint visualisation and prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

4.16.3. This assessment has incorporated a number of worst-case assumptions, as described above, which will result in an overestimation of the predicted ground level concentrations from the process. As a result of these worst-case assumptions, the predicted results should be considered the upper limit of model uncertainty for a scenario where the actual site impact is determined. Therefore, the actual predicted ground level concentrations would be expected to be lower than those reported in this assessment and, in some cases, significantly lower.

5 EMBEDDED MITIGATION

5.1.1. The Proposed Development has been designed with embedded mitigation to minimise impacts on air quality, where practicable. In particular, the melting process will be electric fired, which results in less process combustion emissions than a traditional melter.

5.1.2. The Proposed Development has been designed to comply with BAT- AEL Emission limit values and must obtain an Environmental Permit to operate, which will mandate compliance with emission limits for stack emissions. These limits are established by regulations or specified by the regulator in the permit.

5.1.3. Emissions of ammonia from the Proposed Development will go above and beyond those prescribed by BAT. Specifically, acid scrubbing is proposed to be installed to mitigate ammonia emissions from the downstream stack, reducing the emissions from 60 mg/Nm^3 to 5 mg/Nm^3.

5.1.4. The stack heights were identified to reduce the impacts of ground level air quality impacts with consideration to visual impacts.

6 ASSESSMENT OF IMPACT

6.1.1. As described in Section 4.3, results were calculated separately for five consecutive years of meteorological data. For each specific receptor and for each pollutant measured, the meteorological year giving the highest concentration was determined, and the corresponding concentration is the one presented in this assessment. In other words, each of the individual results are the worst case for that measure. For plotting the concentration isopleths, a single meteorological year was chosen, namely the year producing the highest mean concentration at any point in the model domain. This means that some results in the tables of specific receptors will not accord exactly with the contour bandings on the figure (they will be higher in the tables).

6.2 HUMAN RECEPTORS

6.2.1. **Table 6-1** presents a summary of the maximum predicted PC at any gridded receptor point for all pollutants modelled and **Table 6-2** presents a summary of the maximum predicted PC of metals.

6.2.2. **Table 6-1** shows that the maximum long term PC for all pollutants is less than 1% of the relevant long term AQAL and can therefore be classified as 'insignificant' in accordance with AERA guidance. This is with the exception of NO_2, particulate matter, VOCs and NDMA. For NO_2, particulate matter and VOCs, the PEC is less than 70% of the long term AQAL, therefore the second screening criteria is met and potential long term impacts are therefore not expected to be significant.

6.2.3. For long term NDMA, the maximum PC is 86% of the relevant long term standard and the PEC is 94% of the relevant long term standard. The maximum predicted concentration at a discrete receptor is 73% of the relevant long term standard and an isopleth plot is provided in Appendix E. This is considered to be a conservative assessment as it assumes all amines released from the Proposed Development are DMA and the concentration of NDMA was calculated by summing the relevant nitrosamine and nitramine concentrations. In reality, there will be day to day fluctuation in the binders used, depending on market requirements, not all of which will contain amines or DMA. Furthermore, primary amines (such as MEA) do not form stable amines. Therefore, if any of the amines released to air are primary amines, then the modelled impacts (with stable nitrosamines assumed for all proxy compounds, including MEA) will be conservative. As a result, this represents a very conservative assessment and the actual NDMA concentrations as a result of industrial process emissions from the facility are expected to be lower than those included in **Table 6-1.** Given the conservatism of the assessment and the fact that the PEC is below the AQAL, no predicted exceedances of the AQAL are predicted within the study area and the effect of the development is judged as not significant. An isopleth plot is provided in **Appendix E**.

6.2.4. For short term impacts, the PC is less than 10% of the AQAL for all assessed pollutants, with the exception of particulate matter as illustrated in **Table 6-1,** although the PC at discrete receptor locations is below 10% of the AQAL and the short term impacts are therefore classed as 'insignificant' in accordance with AERA guidance.

6.2.5. **Table 6-2** shows that for the majority of metals, the maximum long term PC is less than 1% of the relevant AQAL and long term impacts can therefore be classed as 'insignificant' in accordance with AERA guidance. The exception to this is long term concentrations of arsenic, chromium VI and nickel for which the PC is greater than 1% of the AQAL but the PEC is less than 70% of the relevant AQAL. Therefore the second screening criteria is met and potential long term impacts are not expected to be significant. This is also considered to be a conservative assessment as metal

speciation is not available for either group 1 or group 2 metals. As a result, the emission rate of each metal was conservatively assumed to be equal to the total emission rate of the respective metal group it is part of, with the exception of chromium VI, which was assumed to be 1% of the total group 1 metal emissions, as agreed with Knauf. It can therefore be assumed that the actual metals emitted from the installation are expected to be lower than those included in **Table 6-2**.

6.2.6. For short term impacts, the short term PC is less than 10% of the relevant AQAL for all metals with the exception of 24 hour averaged copper and cadmium. However, the PEC is still significantly less less than the AQAL for both metals and the maximum PC at discrete receptors is less than 20% of the AQAL for both metals.

6.2.7. The results described above are the maximum predicted concentrations for all gridded receptors. Full results at individual human receptors are included in **Appendix C.1**

Table 6-1 – Impact to air at gridded human receptor locations – pollutants (maximum PC)

Pollutant	Averaging period	AQAL	PC	PC as a % of AQAL	PEC(µg/m³)	PEC as a % of AQAL
Nitrogen Dioxide	Annual	40	0.55	1.39%	11.35	28.38%
	1-hour	200	5.99	2.99%	33.98	16.99%
Particulate Matter (<10)	Annual	40	1.97	4.93%	12.53	31.33%
	24-hour [a]	50	8.96	17.92%	30.08	60.16%
	24-hour [b]	50	20.86	41.72%	41.98	83.96%
Particulate Matter (<2.5)	Annual	20	0.65	3.25%	6.62	33.10%
Sulphur Dioxide	1-hour	350	20.52	5.86%	30.85	8.82%
	24-hour	125	5.56	4.45%	13.88	11.11%
	15-minute	266	29.68	11.16%	37.82	14.22%
Hydrogen Fluoride	1-hour	160	0.59	0.37%	0.93	0.58%
	Monthly	16	0.02	0.10%	0.19	1.16%
Carbon Monoxide	8-hour rolling	10,000	0.31	<0.01%	598.31	5.98%
	1-hour	30,000	11.84	0.04%	609.84	2.03%
Hydrogen Chloride	1-hour	750	3.56	0.48%	4.77	0.64%
Phenol	Annual	200	0.05	0.02%	0.05	0.03%

Pollutant	Averaging period	AQAL	PC	PC as a % of AQAL	PEC(µg/m³)	PEC as a % of AQAL
	1-hour	3900	5.50	0.14%	5.50	0.14%
Formaldehyde	Annual	5	0.02	0.47%	0.03	0.52%
	30-minute	100	2.90	2.90%	2.90	2.90%
Ammonia	Annual	180	0.03	0.02%	2.11	1.17%
	1-hour	2500	3.05	0.12%	7.20	0.29%
VOCs	Annual	5	0.14	2.84%	0.52	10.33%
	24-hour	30	1.83	6.10%	2.55	8.51%
Diethylamine (DiEA)	1-hour	330	0.48	1.19%	1.44	0.44%
	24-hour	33	1.53	4.65%	1.53	4.65%
Mono-ethanolamine (MEA)	1-hour	400	1.44	0.36%	1.44	0.36%
	24-hour	100	1.53	1.53%	1.53	1.53%
N-nitrosodimethylamine (NDMA)	Annual	0.0002	0.00017	85.54%	0.00019	94.54%

Table 6-2 - Impact to air at gridded human receptor locations – metals (maximum PC)

Metal	Averaging period	AQAL	PC	PC as a % of AQAL	PEC (µg/m³)	PEC as a % of AQAL
Arsenic	Annual	0.006	0.00247	41.15%	0.00286	47.74%

Metal	Averaging period	AQAL	PC	PC as a % of AQAL	PEC (µg/m³)	PEC as a % of AQAL
Antimony	Annual	5	0.006	0.12%	0.06	1.21%
	1-hour	150	0.24	0.16%	0.44	0.29%
Cadmium	Annual	5	0.00247	0.05%	0.00273	0.05%
	24-hour	0.03	0.0166552	55.52%	0.016	54.54%
Chromium III	24-hour	2	0.039	1.94%	0.037	1.85%
Chromium VI	Annual	0.00025	0.00002	9.88%	0.00014	54.01%
Copper	24-hour	0.05	0.0389	77.72%	0.0379	75.86%
Lead	Annual	0.25	0.006	2.30%	0.007	2.82%
Manganese	Annual	0.15	0.006	3.84%	0.007	4.79%
	1-hour	1500	0.24	0.02%	0.21	0.01%
Selenium	24-hour	2	0.039	1.94%	0.036	1.80%
Nickel	Annual	0.02	0.0025	12.35%	0.0030	15.02%
	1-hour	0.7	0.105	14.97%	0.102	14.63%
Vanadium	24-hour	1	0.04	3.89%	0.04	3.55%

6.3 ECOLOGICAL RECEPTORS

CRITICAL LEVELS

Oxides of Nitrogen (NO_X)

6.3.1. **Table 6-3** summarises the modelled annual PC NO_X concentrations at the designated ecological sites as a result of the impact from the Proposed Development.

6.3.2. The maximum PC concentrations at local sites (Local Wildlife Sites and Ancient Woodland) are below 100% of the Critical Levels and therefore considered 'insignificant', according to the NRW criteria[2].

6.3.3. The maximum long term PC concentrations at all national and international designated sites are below 1% of the relevant Critical Levels and therefore considered 'insignificant', according to the NRW criteria[2].

6.3.4. **Table 6-4** summarises the maximum modelled 24-hour PC NO_X concentrations at the designated ecological sites as a result of the impact from the Proposed Development.

6.3.5. The maximum 24-hour PC concentrations at all national and international designated sites are below 10% of the relevant Critical Levels and therefore considered 'insignificant', according to the NRW criteria[2].

Table 6-3 - Maximum Annual NO_X total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0.23	0.77%	13.10	43.7%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	0.05	0.15%	12.50	41.7%
E03	River Dee (Afon Dyfrdwy)	SSSI	0.11	0.36%	12.28	40.9%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.23	0.77%	13.10	43.7%
E05	Shotton Lagoons and Reedbeds	SSSI	0.06	0.20%	12.64	42.1%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.23	0.77%	13.10	43.7%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	0.11	0.36%	11.01	36.7%
E08	Deeside and Buckley Newt sites	SAC	0.02	0.06%	7.92	26.4%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	0.00	0.01%	4.39	14.6%
E10	Shotton Steelworks	LWS	0.61	2.04%	12.09	40.3%
E11	River Dee	LWS	0.08	0.25%	10.73	35.8%

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E12	Shotton Banks	LWS	0.09	0.31%	11.88	39.6%

Table 6-4 - Maximum 24 – hour NO_X total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	1.74	0.87%	57.54	28.77%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	0.42	0.21%	27.82	13.91%
E03	River Dee (Afon Dyfrdwy)	SSSI	1.37	0.69%	24.15	12.08%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	1.74	0.87%	57.54	28.77%
E05	Shotton Lagoons and Reedbeds	SSSI	1.02	0.51%	25.98	12.99%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	1.74	0.87%	57.54	28.77%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	1.37	0.69%	35.83	17.92%
E08	Deeside and Buckley Newt sites	SAC	0.45	0.23%	18.65	9.33%

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E09	Halkyn Mountain (Mynydd Helygain)	SAC	0.08	0.04%	10.14	5.07%
E10	Shotton Steelworks	LWS	3.86	1.93%	29.71	14.86%
E11	River Dee	LWS	1.16	0.58%	21.03	10.52%
E12	Shotton Banks	LWS	0.79	0.40%	26.52	13.26%

Sulphur Dioxide

6.3.6. Assessment of direct SO_2 toxicity upon each designated site has been completed using the SO_2 CLe of 10µg/m^3.

6.3.7. **Table 6-5** summarises the modelled annual PC SO_2 concentrations at the designated ecological sites as a result of operational emissions associated with the Proposed Development.

6.3.8. The maximum PCs at local ecological sites are below 100% of the Critical Levels and therefore insignificant, according to the NRW criteria[2].

6.3.9. The maximum PC at Shotton Lagoons and Reedbeds, Deeside and Buckley Newt Sites SSSI and Halkyn Mountain SAC are below 1% of the CLe and can therefore be classified as 'insignificant' in accordance with the NRW criteria[2].

6.3.10. At all other designated sites with national or international importance, the maximum PC is greater than 1% but the maximum PEC is less than 70% of the CLe. Therefore, the impact is classed as negligible in accordance with the NRW Criteria[2].

Table 6-5 - Maximum SO_2 total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0.31	3.1%	3.75	37.5%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	0.06	0.6%	4.35	43.5%
E03	River Dee (Afon Dyfrdwy)	SSSI	0.14	1.4%	4.49	44.9%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.31	3.1%	3.75	37.5%
E05	Shotton Lagoons and Reedbeds	SSSI	0.08	0.8%	3.62	36.2%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.31	3.1%	3.75	37.5%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	0.14	1.4%	4.49	44.9%
E08	Deeside and Buckley Newt sites	SAC	0.02	0.2%	4.67	46.7%

Receptor ID		Designation type	Maximum PC (µg/m³)	% PC of CLe	PEC (µg/m³)	% PEC of CLe
E09	Halkyn Mountain (Mynydd Helygain)	SAC	<0.01	<0.01%	2.47	24.7%
E10	Shotton Steelworks	LWS	0.83	8.3%	4.45	44.5%
E11	River Dee	LWS	0.10	1.0%	4.74	47.4%
E12	Shotton Banks	LWS	0.13	1.3%	4.46	44.6%

Ammonia

6.3.11. Assessment of direct NH_3 toxicity upon each designated site has been completed using the site-specific critical levels.

6.3.12. Table 6-6 summarises the modelled annual PC NH_3 concentrations at the designated ecological sites to assess the impact from the Proposed Development.

6.3.13. The maximum PCs at local ecological sites are below 100% of the Critical Levels and therefore considered 'insignificant', according to the NRW criteria[2].

6.3.14. The maximum PC at River Dee (Afon Dyfrdwy) SSSI, Shotton Lagoons and Reedbeds SSSI, Deeside and Buckley Newt Sites SSSI and Halkyn Mountain SAC are below 1% of the CLe and can therefore be classified as 'insignificant' in accordance with the NRW criteria. The maximum PC at the Dee Estuary Ramsar/SPA/SAC and SSSI is greater than 1% of the CLe but the PEC is less than 70% of the CLe, as a result the second screening criteria is met and potential long term impacts are therefore not expected to be significant.

6.3.15. At River Dee and Bala Lake SAC, the maximum PC is greater than 1% and the maximum PEC is greater than 70% of the CLe and therefore cannot be screened out as negligible. Furthermore, process emissions from the facility go above and beyond the BAT AEL-ELVs. The maximum PEC of ammonia at River Dee and Bala Lake SAC is greater than the CLe of 1 µg/m³ but less than the CLe of 3 µg/m³. Further assessment on the significance of the impacts at relevant habitats is considered further in the **Habitats Risk Assessment**.

6.3.16. A contour plot for ammonia is provided in **Appendix E**.

Table 6-6 – Maximum NH_3 total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Critical Level (µg/m³)	Maximum PC (µg/m³)	% PC of CLe	PEC (µg/m³)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	3	0.03	1.16%	1.96	65.36%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	3	0.01	0.34%	2.16	71.90%
E03	River Dee (Afon Dyfrdwy)	SSSI	3	0.03	0.86%	2.16	72.04%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	3	0.03	1.16%	1.96	65.36%
E05	Shotton Lagoons and Reedbeds	SSSI	3	0.01	0.46%	1.94	64.57%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	3	0.03	1.16%	1.96	65.36%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	1	0.03	2.57%	2.16	216.12%
E08	Deeside and Buckley Newt sites	SAC	3	<0.01	0.16%	1.94	64.82%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	1	<0.01	0.10%	1.53	153.46%
E10	Shotton Steelworks	LWS	3	0.04	1.17%	2.06	68.51%

Receptor ID		Designation type	Critical Level (µg/m³)	Maximum PC (µg/m³)	% PC of CLe	PEC (µg/m³)	% PEC of CLe
E11	River Dee	LWS	3	0.02	0.66%	2.10	69.89%
E12	Shotton Banks	LWS	3	0.02	0.78%	2.16	71.97%

Hydrogen Fluoride

Assessment of Hydrogen Fluoride concentrations at each designated site has been completed using the weekly HF CLe of 0.5µg/m^3 and the 24-hour HF CLe of 5µg/m^3.

6.3.17. **Table 6-7** and **Table 6-8** summarise the modelled weekly and 24-hour HF concentrations, respectively at the designated ecological sites resulting from operational emissions associated with the Proposed Development.

6.3.18. The maximum long-term weekly PCs at local ecological sites are below 100% of the Critical Levels and therefore insignificant, according to the NRW criteria[2].

6.3.19. The maximum PC at Deeside and Buckley Newt SAC and Halkyn Mountain SAC are below 1% of the CLe and can therefore be classified as 'insignificant' in accordance with the NRW criteria[2]. At all other sites of national or international significance, the maximum long-term PC is greater than 1% of the CLe but the PEC is less than 70% of the CLe, as a result the second screening criteria is met and potential long term impacts are therefore not expected to be significant.

6.3.20. The maximum short term (24-hour) PC at all receptors are less than 10% of the Short term CLe and therefore insignificant, according to the NRW criteria[2].

Table 6-7 - Maximum Weekly HF total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0.020	3.96%	0.19	37.96%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	0.004	0.70%	0.17	34.70%
E03	River Dee (Afon Dyfrdwy)	SSSI	0.015	2.90%	0.18	36.90%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.020	3.96%	0.19	37.96%
E05	Shotton Lagoons and Reedbeds	SSSI	0.010	1.90%	0.18	35.90%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.020	3.96%	0.19	37.96%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	0.015	2.90%	0.18	36.90%

Receptor ID		Designation type	Maximum PC (µg/m³)	% PC of CLe	PEC (µg/m³)	% PEC of CLe
E08	Deeside and Buckley Newt sites	SAC	0.004	0.87%	0.17	34.87%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	<0.001	0.06%	0.17	34.06%
E10	Shotton Steelworks	LWS	0.047	9.33%	0.22	43.33%
E11	River Dee	LWS	0.013	2.54%	0.18	36.54%
E12	Shotton Banks	LWS	0.009	1.90%	0.18	35.90%

Table 6-8 - Maximum 24-hour HF total Knauf concentration for each ecological habitat site

Receptor ID		Designation type	Maximum PC (µg/m³)	% PC of CLe	PEC (µg/m³)	% PEC of CLe
E01	Dee Estuary (Aber Afon Dyfrdwy)	Ramsar, SPA	0.03	0.67%	0.37	7.47%
E02	Ancient Semi Natural Woodland	Ancient Woodlands	0.01	0.16%	0.35	6.96%
E03	River Dee (Afon Dyfrdwy)	SSSI	0.03	0.53%	0.37	7.33%
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.03	0.67%	0.37	7.47%
E05	Shotton Lagoons and Reedbeds	SSSI	0.02	0.39%	0.36	7.19%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.03	0.67%	0.37	7.47%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	0.03	0.53%	0.37	7.33%

Receptor ID		Designation type	Maximum PC (µg/m^3)	% PC of CLe	PEC (µg/m^3)	% PEC of CLe
E08	Deeside and Buckley Newt sites	SAC	0.01	0.17%	0.35	6.97%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	<0.01	0.03%	0.34	6.83%
E10	Shotton Steelworks	LWS	0.07	1.49%	0.41	8.29%
E11	River Dee	LWS	0.02	0.45%	0.36	7.25%
E12	Shotton Banks	LWS	0.02	0.31%	0.36	7.11%

CRITICAL LOADS

Nitrogen deposition

6.3.21. Predicted nitrogen deposition is given in **Table 6-9**. The CLo's were extracted from the APIS website and are based on the designation type of each ecological site.

6.3.22. The maximum PCs at all local ecological sites are below 100% of the CLo and therefore considered 'insignificant', according to the NRW criteria[2].

6.3.23. The maximum PC at Shotton Lagoons and Reedbeds SSSI, Halkyn Mountain SAC and Deeside and Buckley Newt sites SAC are below 1% of the CLe and can therefore be classified as 'insignificant' in accordance with the NRW criteria[2].

6.3.24. At all other designated sites of national or international importance, the maximum PC is greater than 1% and the maximum PEC is greater than 70% of the CLe and therefore cannot be screened out as negligible. Background nitrogen deposition is already high at all locations before any contribution from the Proposed Development. It is worth noting that although the PC is above 1% of the CLo, current and future trends in nitrogen deposition indicate a gradual reduction, with ambient NOx emissions (a key contributor to nitrogen deposition) estimated to reduce by over 20% in the next 10 years.

6.3.25. The results of this assessment present the maximum concentration at any gridded receptor within each designated site. Further assessment on the significance of the impacts at relevant habitats is considered further in the **Habitats Risk Assessment.**

Table 6-9 – Nitrogen deposition impacts

Receptor		Designation type	Critical load (kg/N/ha/yr)	PC (kgN/ha/yr)	PC as a % of AQAL	PEC (kgN/ha/yr)	PEC as a % of CLo
E01	Dee Estuary (Aber Afon Dyfrdwy)	RAMSAR/SPA	10	0.23	2.28%	16.89	169%
E02	Ancient Semi Natural Woodland	Ancient Woodland	5	0.10	1.98%	32.94	659%
E03	River Dee (Afon Dyfrdwy)	SSSI	Not sensitive				
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	10	0.23	2.28%	16.89	169%
E05	Shotton Lagoons and Reedbeds	SSSI	10	0.09	0.90%	17.00	170%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	10	0.23	2.28%	16.89	169%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	10	0.25	2.52%	32.93	329%
E08	Deeside and Buckley Newt sites	SAC	10	0.05	0.47%	31.10	311%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	5	0.01	0.13%	16.69	334%
E10	Shotton Steelworks	LWS	5	0.24	4.81%	17.49	349%
E11	River Dee	LWS	10	0.12	2.50%	18.08	181%
E12	Shotton Banks	LWS	5	0.15	2.96%	18.31	366%

Acid deposition

6.3.26. **Table 6-10** presents the assessment of predicted acid deposition using the critical load function on the ecological receptors considered in this study that are sensitive to acid deposition. The CLo's were extracted from the APIS website and are based on the designation type of each ecological site.

6.3.27. The maximum PC deposition occurs at Ecological Receptors E01, E04 and E06, which represent Dee Estuary Ramsar/SPA, SSSI and SAC respectively.

6.3.28. The maximum PC depositions at local ecological receptors are below 100% of the Critical Loads and therefore considered insignificant, according to NRW guidance.

6.3.29. The maximum PC depositions at Deeside and Buckley Newt Sites SAC, Shotton Lagoon and Reedbeds SAC and Halkyn Mountain SAC are less than 1% of the CLo and therefore negligible, according to the EA criteria.

6.3.30. At all other designated sites of national or international importance (except Dee Estuary SSSI) that are sensitive to acid deposition, the maximum PC is greater than 1% but the maximum PEC is less than 70% of the CLo. Therefore, the impact is classed as negligible in accordance with the NRW Criteria[2].

6.3.31. At Dee Estuary SSSI, the maximum PC is greater than 1% and the maximum PEC is greater than 70% of the CLo. There are high background concentrations of acid deposition and the PEC is less than 100% of the CLo. Furthermore, process emissions from the facility go above and beyond the BAT AEL-ELVs.

Table 6-10 – Acid deposition impacts

Receptor		Designation Type	$CL_{min}N$ (keq/ha/yr)	$CL_{max}N$ (keq/ha/yr)	$CL_{max}S$ (keq/ha/yr)	PC (keq/ha/yr)	PC as a % of CLo	PEC (keq/ha/yr)	% PEC
E01	Dee Estuary (Aber Afon Dyfrdwy)	RAMSAR/SPA	0.856	4.856	4	0.06	1.29%	1.54	31.7%
E02	Ancient Semi Natural Woodland	Ancient Woodland	Not Sensitive						
E03	River Dee (Afon Dyfrdwy)	SSSI	Not Sensitive						
E04	Dee Estuary (Aber Afon Dyfrdwy)	SSSI	0.714	1.564	0.83	0.06	4.02%	1.54	98.3%
E05	Shotton Lagoons and Reedbeds	SSSI	1.071	5.071	4	0.02	0.35%	1.45	28.7%
E06	Dee Estuary (Aber Afon Dyfrdwy)	SAC	0.856	4.856	4	0.06	1.29%	1.54	31.7%
E07	River Dee and Bala Lake (Afon Dyfrdwy a Llyn Tegid)	SAC	Not Sensitive						

Receptor		Designation Type	$CL_{min}N$ (keq/ha/yr)	$CL_{max}N$ (keq/ha/yr)	$CL_{max}S$ (keq/ha/yr)	PC (keq/ha/yr)	PC as a % of CLo	PEC (keq/ha/yr)	% PEC
E08	Deeside and Buckley Newt sites	SAC	0.142	1.72	1.448	0.01	0.65%	1.44	83.7%
E09	Halkyn Mountain (Mynydd Helygain)	SAC	0.856	4.856	4	<0.01	0.02%	1.31	26.9%
E10	Shotton Steelworks	LWS	Not Sensitive						
E11	River Dee	LWS	Not Sensitive						
E12	Shotton Banks	LWS	Not Sensitive						

6.4 ASSUMPTIONS

6.4.1. The ADMS model has been validated against numerous case studies. However, in the absence of monitored concentrations, it is not possible to undertake a local validation of the model for point sources.

6.4.2. Therefore, potential uncertainty in the model outputs has been considered in this assessment by using conservative assumptions including:

- Assessing impacts based on the worst-case impact over 5 years of meteorological data.
- Assuming emissions always occur at the guaranteed emissions limit.
- Assuming all amine emissions could comprise entirely of MEA, DiEA or DMA.
- Assuming worst-case stack exhaust characteristics; and
- Basing tabulated PEC concentrations on assumption of:
    - no improvement over time
    - impacts from proposed developments proceed as planned

6.4.3. Assuming that background contributions of NDMA are dominated by other amine emitting processes and as such, background concentrations of NDMA were estimated through modelling of proposed developments assuming all nitramines and nitrosamines could be NDMA. Primary amines do not form stable amines. Therefore, if any of the amines released to air are primary amines, then the modelled impacts (with stable nitrosamines assumed for all proxy compounds, including MEA) will be conservative. No observations are available.Where parameters have been assumed/estimated in the models, such as surface roughness and building height, sensitivity testing has been carried out to demonstrate the impact that these parameters have on the model.

6.4.4. The model outputs are, therefore, precautionary and tending to over-estimate impacts.

7 SUMMARY AND CONCLUSION

7.1.1. This AERA uses detailed dispersion modelling to predict the impact of the installation of a new facility for the manufacture of rock mineral wool products at the Knauf Shotton Site. The process includes the storage and handling of raw materials, a main production building for bath preparation, electric furnace melting, forming, curing, cooling, and cutting and packaging of final product.

7.1.2. The Proposed Development has been designed with embedded mitigation to minimise impacts on air quality, where practicable. In particular, the melting process will be electric fired, which results in less process combustion emissions than a traditional melter. Furthermore, the Proposed Development has been designed to comply with BAT- AEL Emission limit values with emissions of ammonia that go above and beyond those prescribed by BAT. Specifically, acid scrubbing is proposed to be installed to mitigate ammonia emissions from the downstream stack, reducing the emissions from 60 mg/Nm³ to 5 mg/Nm³.

7.1.3. Predicted impacts have been screened using the following NRW/EA criteria for the long term and short-term PCs:

- the long-term process contribution is >1% of the long-term air quality standards or guidelines, and
- the short-term process contribution is >10% of the short-term air quality standards or guidelines.

7.1.4. In the second stage screening, the NRW/EA state that no further assessment is required:

- if the long-term PEC <70% of the Air Quality Standard, CLo or CLe; and
- if the short-term PC is <20% of the short-term environmental standard minus twice the long-term background concentration i.e. less than 20% of the headroom between background concentration and the standard.

7.1.5. For local nature sites (ancient woodland, local wildlife sites and national and local nature reserves, county wildlife sites), emissions are insignificant if:

- The short term PC is less than 100% of the short term CLe or CLo; and
- The long term PC is less than 100% of the long term CLe or CLo.

7.1.6. For human health, the first stage criteria are met for all pollutants with the exception of NO_2, PM_{10}, VOCs, DMA and some metals but the second stage screening criteria are met for all pollutants except NDMA and short term concentrations of copper and cadmium, however the PEC is below the AQAL and there are a number of embedded conservatisms in the modelling. In reality, there will be day to day fluctuation in the binders used, depending on market requirements, not all of which will contain amines or DMA. Furthermore, the emission rate of each metal was conservatively assumed to be equal to the total emission rate of the respective metal group it is part of. Emission rates for both metals and amines are therefore expected to be lower than those presented in this report. As a result, at all human health receptors in the study area, the impact of the operation of the Proposed Development is **expected to be not significant**.

7.1.7. For ecological receptors, the first or second stage criteria are met for all impacts, with the exception of impacts of ammonia, nitrogen deposition and acid deposition at some sites of national or international importance. This is further assessed in the Habitats Risk Assessment which concludes

that the Project will result in no adverse effects on integrity for NH_3, nitrogen deposition and acid deposition on all European sites.

At all ecological receptors in the study area, the impact of the operation of the Proposed Development is therefore **not expected to be significant.**

Appendix A

GLOSSARY OF TERMS

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Term	
ADMN	Acid Deposition Monitoring Network
ADMS	Atmospheric Dispersion Modelling System
AERA	Air Emissions Risk Assessment
APIS	Air Pollution Information System
AQAL	Air Quality Assessment Level
AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
AQO	Air Quality Objective
AQS	Air Quality Standard
As	Arsenic
Cd	Cadmium
CEH	Centre for Ecology and Hydrology
CERC	Cambridge Environmental Research Consultants
CLe	Critical Level
CLo	Critical Load
CO	Carbon Monoxide
CoCP	Code of Construction Practice
Cr	Chromium
Cr III	Chromium III
CR VI	Chromium VI
Cu	Copper
CWS	County Wildlife Site
Defra	Department for Environment, Food and Rural Affairs
Dust	Dust comprises particles typically in the size range 1-75 micrometres (µm) in aerodynamic diameter and is created through the action of crushing and abrasive forces on material
EA	Environment Agency
EALs	Environmental Assessment Levels

Term	
EPR	Environmental Permitting Regulations
eq	Equivalents
EQS	Environmental Quality Standards
ER	Emission Rate
EU	European Union
FCC	Flintshire County Council
g/s	Grams per second
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
IED	Industrial Emissions Directive
keg ha^{-1} yr^{-1}	Kilo-equivalents deposited per hectare per year
kg	Kilogram
Kg N ha^{-1} yr^{-1}	Kilograms of nitrogen deposited per hectare per year
LAQM	Local Air Quality Management
LAQM.TG(22)	Local Air Quality Management Technical Guidance 2022
LWS	Local Wildlife Site
m	Metre
Mn	Manganese
NAMN	National Ammonia Monitoring Network
NCEI	National Centres for Environmental Information
NH_3	Ammonia
Ni	Nickel
NOAA	National Oceanic and Atmospheric Administration
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Oxides of nitrogen (NO_X = NO +NO_2)
NPPF	National Planning Policy Framework

Term	
NPPG	National Planning Practice Guidance
O_2	Oxygen
O_3	Ozone
OS	Ordnance Survey
OSM	Open Street Maps
Pb	Lead
PC	Process Contribution
PCM	Pollution Climate Mapping
PEC	Predicted Environmental Contribution
PM_{10}	Particulate Matter (smaller than 10 microns)
$PM_{2.5}$	Particulate Matter (smaller than 2.5 microns)
SAC	Special Area of Conservation
Sb	Antimony
Se	Selenium
SO_2	Sulphur Dioxide
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom
V	Vanadium
VOC	Volatile Organic Compound
WHO	World Health Organisation

Appendix B

AMINE MODELLING PARAMETER REFERENCES

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Table B-1 – Amine Chemistry Kinetic Parameters -Diethylamine (DiEA)

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
Amine/OH reaction rate constant, k1	da Silva et al., 2010[21]	8.07E-11	Average of all references 8.40 E-11	2.101
	Nielsen et al, 2012[22]	7.40E-11		
	Tuazon et al., 2011[23]	1.19E-10		
	Borduas et al., 2016[24]	7.29E-11		
	Barnes et al., 2016[25]	7.36E-11		
Amino radical/O2 reaction rate constant, k2	Liu et al., 2019[26]	2.26E-19	2.26E-19	5.65E-9
Rate constant for formation of nitrosamine, k3	Liu et al., 2019[26]	9.04E-12	9.04E-12	0.226
Rate constant for formation of nitramine, k4a	N/A – no data found, assumed to be equal to DMA	3.17E-13	3.17E-13	0.0079
Amino radical / NO2 reaction rate constant, k4	N/A – no data found, assumed to be equal to DMA	1.10E-14	1.10E-14	0.0082
Branching ratio for amine / OH reaction	Nielsen, 2012[22]	0.6 (dimensionless)	0.6 (dimensionless)	0.6 (dimensionless)

[21] da Silva et al, 2010. Protocol for evaluation of solvents – process and atmospheric chemistry. SINTEF Project No. 801572.
[22] Nielsen et al., 2012a. Atmospheric Degradation of Amines (ADA). Summary report from atmospheric chemistry studies of amines, nitrosamines, nitramines and amides. CLIMIT project no. 208122. ISBN 978-82-992954-7-5
[23] Tuazon et al., 1984. Atmospheric reactions of N-nitrosodimethylamine and dimethylnitramine. Environ. Sci. Technol., 18, 1, p49 – 54.
[24] Borduas et al., 2016. Gas-Phase Mechanisms of the Reactions of Reduced Organic Nitrogen Compounds with OH Radicals. Environ. Sci. Technol., 50, 21, p11723 – 11734.
[25] Barnes et al., 2016. Rate Coefficients for the Reactions of OH Radicals with a Series of Alkyl Substituted Amines. J. Phys. Chem. A, 120, 44, p8823 – 8829.
[26] Liu et al., 2019. Mechanism and predictive model development of reaction rate constants for N center radicals with O2. Chemosphere, 237, 124411.

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
Ratio of j(nitrosamine) / jNO_2	CERC[27]	0.32 (dimensionless)	0.32 (dimensionless)	0.32 (dimensionless)

Table B-2 – Amine Chemistry Kinetic Parameters - Dimethylamine (DMA)

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
Amine/OH reaction rate constant, k1	Atkinson, 1978[28]	6.54E-11	Average of all references 6.17 E-11	1.543
	Carl and Crowley, 1998[29]	6.49E-11		
	Galano and Alvarez- Idaboy, 2008[30]	5.20E-11		
	da Silva et al., 2010[21]	6.55E -11		
	Nielsen et al, 2011[31]	7.10E-11		
	Onel et al., 2013[32]	6.27E-11		
	Manzoor et al., 2014[33], 2015[34]	6.26E-11		

[27] CERC. (2023). ADMS 6 Amine Chemistry User Guide Supplement (Online). Available at: https://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS_6_Amine_chemistry_supplement.pdf
[28] Atkinson et al., 1977. Rate constants for the reaction of the OH radical with CH3SH and CH3NH2 over the temperature range 299–426 K. J. Chem. Phys., 66, p1578 – 1581.
[29] Carl and Crowley, 1998. Sequential two (blue) photon absorption by NO2 in the presence of H2 as a source of OH in pulsed photolysis kinetic studies: rate constants for reactions of OH with CH3NH2, (CH3)2NH, (CH3)3N, and C2H5NH2 at 295 K. J. Phys. Chem. A, 102, 42, p8131 – 8141.
[30] Gallano and Alvarez-Idaboy, 2008. Branching Ratios of Aliphatic Amines + OH Gas-Phase Reactions: A Variational Transition-State Theory Study. J. Chem. Theory Comput., 4, 2, p322 – 327.
[31] Nielsen et al., 2011. Atmospheric degradation of amines. Summary report: Photo-oxidation of methylamine, dimethylamine and trimethylamine. CLIMIT project no. 201604
[32] Onel et al., 2013. Gas-phase reactions of OH with methyl amines in the presence or absence of molecular oxygen. An experimental and theoretical Study. Environ. Sci. Technol. 2014, 48, 16, 9935–9942.
[33] Manzoor et al., 2014. Atmospheric chemistry modelling of amine emissions from post combustion CO2 capture technology. Energy Procedia, 63, p822 – 829.
[34] Manzoor et al., 2015. A theoretical study of the reaction kinetics of amines released into the atmosphere from CO2 capture. Int. J. Greenh. Gas Control, 41, p219 – 228.

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
	Butkovskaya and Setser, 2016[35]	5.20E-11		
	Borduas et al., 2016[24]	6.32E-11		
Amino radical/O2 reaction rate constant, k2	Manzoor et al., 2014[33], 2015[34]	1.89E-20	Average of all references 3.72E-20	9.29E-10
	Liu et al., 2019[26]	5.54E-20		
Rate constant for formation of nitrosamine, k3	Lazarou et al., 1994[36]	8.53E-14	Average of all references 7.96E-13	0.020
	Manzoor et al., 2015[34]	8.37E-14		
	Liu et al., 2019[26]	2.22E-12		
Rate constant for formation of nitramine, k4a	Lazarou et al., 1994[36]	3.18E-13	Average of all references 3.17E-13	0.0079
	Manzoor et al., 2014[33], 2015[34]	3.15E-13		
Amino radical / NO2 reaction rate constant, k4	Manzoor et al., 2014[33], 2015[34]	1.10E-14	1.10E-14	0.0082
Branching ratio for amine / OH reaction	Lindley et al., 1979[37]	0.37(dimensionless)	0.384 (dimensionless)	0.384 (dimensionless)
	Nielsen et al., 2011[31]	0.42(dimensionless)		
	Onel et al., 2014[38]	0.41(dimensionless)		
	Manzoor et al., 2014[33], 2015[34]	0.38(dimensionless)		

[35] Butkovskaya and Setser, 2016. Branching Ratios and Vibrational Distributions in Water-Forming Reactions of OH and OD Radicals with Methylamines. J. Phys. Chem. A, 120, 34, p6698 – 6711.
[36] Lazarou et al., 1994. Gas-phase reactions of (CH3)2N radicals with NO and NO2. J. Phys. Chem., 98, 8, p2110 – 2115.
[37] Lindley et al., 1979. Rate studies of the reactions of the (CH3)2N radical with O2, NO, and NO2. Chem. Phys. Lett., 67, 1, p57 – 62.
[38] Onel et al., 2014. Branching ratios in reactions of OH radicals with methylamine, dimethylamine, and ethylamine. Environ. Sci. Technol., 48, 16, p9935 – 9942.

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
	Butkovskaya and Setser, 2016[35]	0.34(dimensionless)		
Ratio of j(nitrosamine) / jNO_2	CERC[39]	0.32 (dimensionless)	0.32 (dimensionless)	0.32 (dimensionless)

Table B-3 – Amine Chemistry Kinetic Parameters -Monoethanolamine (MEA)

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
Amine/OH reaction rate constant, k1	Karl, 2012a[40]	9.2E-11	Average of all references 8.06E-11	2.015
	Onel et al., 2013[38]	7.61E-11		
	Borduas et al., 2016[24]	7.02E-11		
	Xie, 2014[41]	7.27E-11		
	Manzoor et al., 2014[33], 2015[34]	9.2E-11		
Amino radical/O2 reaction rate constant, k2	Nielsen et al, 2010[42]	1.2E-19	Average of all references 2.09E-18	5.22E-8
	Manzoor et al., 2015[34]	3.86E-18		
	Xie et al., 2015[43]	2.9E-18		
	Liu et al., 2019**Error! Bookmark not defined.**	1.47E-18		

[39] CERC. (2023). ADMS 6 Amine Chemistry User Guide Supplement (Online). Available at: https://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS_6_Amine_chemistry_supplement.pdf

[40] Karl et al., 2012a. Study of OH-initiated degradation of 2-aminoethanol. Atmos. Chem. Phys., 12, 4, p1881 – 1901.

[41] Xie et al., 2014. Atmospheric Chemical Reactions of Monoethanolamine Initiated by OH Radical: Mechanistic and Kinetic Study. Environ. Sci. Technol., 48, 3, p1700 – 1706.

[42] Nielsen et al., 2010. Atmospheric degradation of amines. Summary report: gas-phase photo oxidation of 2-aminoethanol (MEA). CLIMIT project no. 193438

[43] Xie et al., 2015. Quantum Chemical Study on ·Cl-Initiated Atmospheric Degradation of Monoethanolamine. Environ. Sci. Technol., 49, 22, p13246 – 13255.

Parameter	Reference	Value (cm^3/molecule/s)	Value Used (cm^3/molecule/s)	Value Used ($pbb^{-1}s^{-1}$)
Rate constant for formation of nitrosamine, k3	Nielsen et al, 2010[44]	8.53E-14	Average of all references 7.07E-14	0.0017
	Manzoor et al., 2015[34]	5.62E-14		
Rate constant for formation of nitramine, k4a	Manzoor et al., 2015[34]	8.40E-15	8.40E-15	0.0002
Amino radical / NO2 reaction rate constant, k4	Manzoor et al., 2015[34]	4.14E-15	4.14E-15	0.0003
Branching ratio for amine / OH reaction	Nielsen et al, 2010[45]	0.08 (dimensionless)	0113 (dimensionless)	0.113 (dimensionless)
	Karl et al., 2012[40]	0.15 (dimensionless)		
	Xie et al., 2014[41]	0.17 (dimensionless)		
	Manzoor et al., 2014[33], 2015[34]	0.05 (dimensionless)		
Ratio of j(nitrosamine) / jNO_2	CERC[46]	0.32 (dimensionless)	0.32 (dimensionless)	0.32 (dimensionless)

[44] Nielsen et al., 2010. Atmospheric degradation of amines. Summary report: gas-phase photo oxidation of 2-aminoethanol (MEA). CLIMIT project no. 193438

[45] Nielsen et al., 2010. Atmospheric degradation of amines. Summary report: gas-phase photo oxidation of 2-aminoethanol (MEA). CLIMIT project no. 193438

[46] CERC. (2023). ADMS 6 Amine Chemistry User Guide Supplement (Online). Available at: https://www.cerc.co.uk/environmental-software/assets/data/doc_userguides/CERC_ADMS_6_Amine_chemistry_supplement.pdf

Table B-4 – Amine Conversion Factors

Substance		Conversion Factor	Reference
Diethylamine	Amine	0.329	Based on a molar mass of 73.1 g/mol and molar volume of 247.06 at 293.15K and 101.3kPa
	Nitramine	0.204	ADMS Amine Chemistry tool (relative molecular mass of 118.1 g/mol)
	Nitrosamine	0.236	CERC guidance (relative molecular mass of 102.1 g/mol)
Dimethylamine	Amine	0.534	Based on a molar mass of 45.1 g/mol and molar volume of 247.06 at 293.15K and 101.3kPa
	Nitramine	0.267	ADMS Amine Chemistry tool (relative molecular mass of 90.1 g/mol)
	Nitrosamine	0.325	CERC guidance (relative molecular mass of 74.1 g/mol)
Monoethanolamine	Amine	0.394	Based on a molar mass of 61.1 g/mol and molar volume of 247.06 at 293.15K and 101.3kPa
	Nitramine	0.227	ADMS Amine Chemistry tool (relative molecular mass of 106.1 g/mol)
	Nitrosamine	0.267	CERC guidance (relative molecular mass of 90.1 g/mol)

Appendix C

FULL RESULTS

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Appendix C.1

HUMAN

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Table C-1 – Annual mean NO_2 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	12.16	0.03	0.07%	12.51	31.28%
H02	8.74	0.03	0.07%	9.12	22.80%
H03	7.69	0.05	0.14%	9.12	22.81%
H04	7.69	0.09	0.22%	9.26	23.16%
H05	7.20	0.13	0.33%	8.13	20.32%
H06	7.96	0.03	0.08%	8.05	20.13%
H07	7.96	0.03	0.08%	8.00	20.00%
H08	7.54	0.04	0.09%	7.61	19.04%
H09	7.16	0.02	0.06%	7.17	17.92%
H10	7.26	0.02	0.06%	7.09	17.73%
H11	8.92	0.01	0.03%	8.69	21.72%
H12	6.84	0.01	0.02%	6.77	16.93%
H13	6.84	0.01	0.02%	6.99	17.47%
H14	6.84	0.01	0.02%	7.01	17.51%

Table C-2 – 1-hour mean NO_2 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	24.33	0.41	0.21%	25.86	12.93%
H02	17.49	0.50	0.25%	20.39	10.20%
H03	15.39	0.60	0.30%	20.16	10.08%
H04	15.39	0.79	0.39%	20.81	10.40%
H05	14.40	0.78	0.39%	18.47	9.24%
H06	15.93	0.62	0.31%	19.32	9.66%
H07	15.93	0.75	0.37%	19.22	9.61%
H08	15.09	0.91	0.46%	19.06	9.53%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H09	14.31	0.79	0.39%	17.68	8.84%
H10	14.51	0.84	0.42%	17.82	8.91%
H11	17.84	0.54	0.27%	18.57	9.28%
H12	13.68	0.42	0.21%	17.26	8.63%
H13	13.68	0.35	0.18%	20.00	10.00%
H14	13.68	0.34	0.17%	19.38	9.69%

Table C-3 – Annual mean PM_{10} impacts (normal operation)

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	12.55	0.14	0.36%	12.70	31.75%
H02	11.71	0.11	0.27%	11.81	29.54%
H03	10.29	0.28	0.70%	10.58	26.46%
H04	10.29	0.39	0.97%	10.70	26.75%
H05	10.56	0.64	1.61%	11.25	28.14%
H06	10.62	0.14	0.34%	10.76	26.91%
H07	10.62	0.13	0.33%	10.76	26.90%
H08	10.96	0.17	0.43%	11.14	27.85%
H09	10.16	0.11	0.28%	10.28	25.70%
H10	10.69	0.10	0.24%	10.79	26.97%
H11	11.16	0.06	0.14%	11.22	28.05%
H12	10.30	0.04	0.10%	10.35	25.87%
H13	10.30	0.04	0.09%	10.34	25.86%
H14	10.30	0.03	0.09%	10.34	25.86%

Table C-4 – 24-hour mean PM_{10} impacts (normal operation)

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	25.11	0.49	0.98%	25.53	51.07%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H02	23.41	0.37	0.75%	23.74	47.47%
H03	20.58	0.97	1.94%	21.48	42.95%
H04	20.58	1.25	2.49%	21.76	43.51%
H05	21.12	2.05	4.10%	23.12	46.23%
H06	21.23	0.54	1.07%	21.75	43.50%
H07	21.23	0.46	0.93%	21.67	43.35%
H08	21.91	0.60	1.19%	22.48	44.96%
H09	20.32	0.42	0.84%	20.69	41.39%
H10	21.37	0.37	0.74%	21.70	43.40%
H11	22.32	0.21	0.42%	22.48	44.96%
H12	20.61	0.19	0.37%	20.78	41.55%
H13	20.61	0.16	0.31%	20.76	41.53%
H14	20.61	0.15	0.30%	20.76	41.52%

Table C-5 – 24-hour mean PM_{10} impacts (emergency operation)

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	25.11	0.53	1.06%	25.58	51.15%
H02	23.41	0.46	0.92%	23.82	47.65%
H03	20.58	1.21	2.42%	21.70	43.40%
H04	20.58	1.63	3.26%	22.13	44.26%
H05	21.12	2.46	4.91%	23.52	47.04%
H06	21.23	0.48	0.96%	21.70	43.39%
H07	21.23	0.53	1.06%	21.74	43.48%
H08	21.91	0.70	1.40%	22.58	45.16%
H09	20.32	0.50	1.01%	20.78	41.55%
H10	21.37	0.46	0.91%	21.77	43.54%
H11	22.32	0.24	0.47%	22.50	45.01%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H12	20.61	0.16	0.32%	20.76	41.53%
H13	20.61	0.13	0.26%	20.74	41.48%
H14	20.61	0.12	0.24%	20.73	41.46%

Table C-6 – Annual mean $PM_{2.5}$ impacts (normal operation)

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	6.69	0.14	0.71%	6.83	34.17%
H02	6.38	0.11	0.53%	6.51	32.53%
H03	6.19	0.28	1.41%	6.54	32.70%
H04	6.19	0.39	1.93%	6.69	33.47%
H05	5.97	0.64	3.21%	6.73	33.67%
H06	6.29	0.14	0.68%	6.43	32.15%
H07	6.29	0.13	0.66%	6.45	32.24%
H08	6.78	0.17	0.85%	6.98	34.90%
H09	6.10	0.11	0.56%	6.24	31.19%
H10	6.54	0.10	0.48%	6.64	33.22%
H11	7.09	0.06	0.28%	7.14	35.71%
H12	6.03	0.04	0.21%	6.07	30.34%
H13	6.03	0.04	0.18%	6.06	30.31%
H14	6.03	0.03	0.17%	6.06	30.30%

Table C-7 – 24-hour mean SO_2 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	9.48	0.36	0.28%	10.02	8.02%
H02	8.48	0.34	0.27%	9.11	7.29%
H03	8.58	0.66	0.53%	9.73	7.78%
H04	8.58	0.91	0.73%	10.05	8.04%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H05	7.78	1.31	1.05%	9.56	7.65%
H06	9.32	0.48	0.38%	9.83	7.86%
H07	9.32	0.51	0.40%	9.87	7.89%
H08	9.14	0.74	0.59%	9.94	7.95%
H09	8.14	0.70	0.56%	8.98	7.19%
H10	7.72	0.85	0.68%	8.88	7.11%
H11	7.08	0.33	0.26%	7.64	6.12%
H12	7.50	0.27	0.21%	8.10	6.48%
H13	7.50	0.23	0.19%	7.94	6.35%
H14	7.50	0.22	0.17%	7.85	6.28%

Table C-8 – 1-hour mean SO_2 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	9.48	1.57	0.45%	11.62	3.32%
H02	8.48	1.63	0.47%	11.01	3.15%
H03	8.58	2.31	0.66%	12.52	3.58%
H04	8.58	3.02	0.86%	13.07	3.73%
H05	7.78	2.94	0.84%	12.01	3.43%
H06	9.32	2.26	0.64%	12.23	3.49%
H07	9.32	2.87	0.82%	13.23	3.78%
H08	9.14	3.50	1.00%	13.87	3.96%
H09	8.14	2.86	0.82%	12.07	3.45%
H10	7.72	3.06	0.87%	12.22	3.49%
H11	7.08	1.91	0.55%	10.13	2.89%
H12	7.50	1.57	0.45%	10.15	2.90%
H13	7.50	1.29	0.37%	9.49	2.71%
H14	7.50	1.23	0.35%	9.42	2.69%

Table C-9 – 15-min mean SO_2 impacts

Receptor	Background (µg/m³)	PC (µg/m³)	PC as a % of AQAL	PEC (µg/m³)	PEC as a % of AQAL
H01	9.48	2.32	0.87%	15.41	5.79%
H02	8.48	2.83	1.06%	15.32	5.76%
H03	8.58	3.09	1.16%	14.46	5.44%
H04	8.58	4.47	1.68%	16.90	6.36%
H05	7.78	4.33	1.63%	16.16	6.07%
H06	9.32	3.13	1.18%	13.74	5.17%
H07	9.32	4.20	1.58%	16.84	6.33%
H08	9.14	4.59	1.73%	17.96	6.75%
H09	8.14	4.32	1.63%	20.23	7.60%
H10	7.72	4.17	1.57%	15.70	5.90%
H11	7.08	2.88	1.08%	15.21	5.72%
H12	7.50	2.32	0.87%	11.87	4.46%
H13	7.50	2.15	0.81%	10.91	4.10%
H14	7.50	1.96	0.74%	10.06	3.78%

Table C-10 – Monthly mean HF impacts

Receptor	Background (µg/m³)	PC (µg/m³)	PC as a % of AQAL	PEC (µg/m³)	PEC as a % of AQAL
H01	0.17	0.002	0.01%	0.17	1.07%
H02	0.17	0.002	0.01%	0.17	1.07%
H03	0.17	0.003	0.02%	0.17	1.08%
H04	0.17	0.005	0.03%	0.17	1.09%
H05	0.17	0.007	0.04%	0.18	1.10%
H06	0.17	0.002	0.01%	0.17	1.08%
H07	0.17	0.001	0.01%	0.17	1.07%
H08	0.17	0.002	0.01%	0.17	1.07%
H09	0.17	0.001	0.01%	0.17	1.07%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H10	0.17	0.002	0.01%	0.17	1.08%
H11	0.17	0.001	0.01%	0.17	1.07%
H12	0.17	0.001	<0.01%	0.17	1.07%
H13	0.17	0.001	<0.01%	0.17	1.07%
H14	0.17	0.001	<0.01%	0.17	1.07%

Table C-11 – 1-hour mean HF impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.34	0.05	0.03%	0.39	0.24%
H02	0.34	0.04	0.02%	0.38	0.24%
H03	0.34	0.06	0.04%	0.40	0.25%
H04	0.34	0.06	0.04%	0.40	0.25%
H05	0.34	0.09	0.05%	0.43	0.27%
H06	0.34	0.07	0.04%	0.41	0.26%
H07	0.34	0.08	0.05%	0.42	0.26%
H08	0.34	0.07	0.05%	0.41	0.26%
H09	0.34	0.07	0.05%	0.41	0.26%
H10	0.34	0.06	0.04%	0.40	0.25%
H11	0.34	0.05	0.03%	0.39	0.24%
H12	0.34	0.04	0.03%	0.38	0.24%
H13	0.34	0.04	0.03%	0.38	0.24%
H14	0.34	0.04	0.02%	0.38	0.24%

Table C-12 – 8-hour rolling mean CO impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	588.00	0.016	<0.01%	588.02	5.88%
H02	596.00	0.014	<0.01%	596.01	5.96%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H03	602.00	0.030	<0.01%	602.03	6.02%
H04	602.00	0.048	<0.01%	602.05	6.02%
H05	598.00	0.071	<0.01%	598.07	5.98%
H06	606.00	0.017	<0.01%	606.02	6.06%
H07	606.00	0.017	<0.01%	606.02	6.06%
H08	590.00	0.019	<0.01%	590.02	5.90%
H09	576.00	0.012	<0.01%	576.01	5.76%
H10	552.00	0.012	<0.01%	552.01	5.52%
H11	540.00	0.006	<0.01%	540.01	5.40%
H12	522.00	0.005	<0.01%	522.00	5.22%
H13	522.00	0.004	<0.01%	522.00	5.22%
H14	522.00	0.004	<0.01%	522.00	5.22%

Table C-13 – 1-hour mean CO impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	588.00	0.94	<0.01%	588.94	1.96%
H02	596.00	0.76	<0.01%	596.76	1.99%
H03	602.00	1.24	<0.01%	603.24	2.01%
H04	602.00	1.26	<0.01%	603.26	2.01%
H05	598.00	1.72	<0.01%	599.72	2.00%
H06	606.00	1.38	<0.01%	607.38	2.02%
H07	606.00	1.67	<0.01%	607.67	2.03%
H08	590.00	1.47	<0.01%	591.47	1.97%
H09	576.00	1.45	<0.01%	577.45	1.92%
H10	552.00	1.25	<0.01%	553.25	1.84%
H11	540.00	0.96	<0.01%	540.96	1.80%
H12	522.00	0.87	<0.01%	522.87	1.74%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H13	522.00	0.80	<0.01%	522.80	1.74%
H14	522.00	0.77	<0.01%	522.77	1.74%

Table C-14 – 1-hour mean HCl impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.12	0.28	0.04%	0.88	0.12%
H02	0.12	0.23	0.03%	0.85	0.11%
H03	0.12	0.37	0.05%	0.86	0.11%
H04	0.12	0.38	0.05%	0.99	0.13%
H05	0.12	0.52	0.07%	1.24	0.17%
H06	0.12	0.42	0.06%	0.95	0.13%
H07	0.12	0.50	0.07%	1.07	0.14%
H08	0.12	0.44	0.06%	1.46	0.19%
H09	0.12	0.44	0.06%	1.90	0.25%
H10	0.12	0.38	0.05%	1.33	0.18%
H11	0.12	0.29	0.04%	1.27	0.17%
H12	0.12	0.26	0.03%	1.12	0.15%
H13	0.12	0.24	0.03%	0.92	0.12%
H14	0.12	0.23	0.03%	0.90	0.12%

Table C-15 – Annual mean Phenol impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.01	0.01%	0.03	0.01%
H02	—	0.01	0.01%	0.03	0.01%
H03	—	0.02	0.02%	0.04	0.02%
H04	—	0.03	0.02%	0.05	0.03%
H05	—	0.05	0.04%	0.09	0.05%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H06	—	0.02	0.02%	0.04	0.02%
H07	—	0.01	0.01%	0.03	0.01%
H08	—	0.01	0.01%	0.02	0.01%
H09	—	0.01	0.01%	0.03	0.01%
H10	—	0.01	0.01%	0.03	0.01%
H11	—	0.01	0.01%	0.02	0.01%
H12	—	0.01	0.01%	0.01	0.01%
H13	—	0.01	0.01%	0.01	0.01%
H14	—	0.01	0.01%	0.01	0.01%

Table C-16 – 1-hour mean Phenol impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	1.43	0.04%	1.43	0.04%
H02	—	1.43	0.03%	1.31	0.03%
H03	—	2.22	0.06%	2.22	0.06%
H04	—	2.23	0.05%	2.08	0.05%
H05	—	2.59	0.06%	2.35	0.06%
H06	—	2.07	0.05%	1.97	0.05%
H07	—	2.51	0.06%	2.34	0.06%
H08	—	2.85	0.07%	2.68	0.07%
H09	—	3.27	0.08%	2.96	0.08%
H10	—	2.79	0.07%	2.67	0.07%
H11	—	2.40	0.06%	2.39	0.06%
H12	—	1.57	0.04%	1.56	0.04%
H13	—	1.38	0.04%	1.38	0.04%
H14	—	1.35	0.03%	1.34	0.03%

Table C-17 – Annual mean Formaldehyde impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.006	0.13%	0.007	0.14%
H02	—	0.006	0.12%	0.007	0.14%
H03	—	0.009	0.18%	0.010	0.20%
H04	—	0.012	0.24%	0.013	0.26%
H05	—	0.021	0.42%	0.023	0.46%
H06	—	0.009	0.18%	0.010	0.20%
H07	—	0.006	0.12%	0.007	0.13%
H08	—	0.006	0.11%	0.006	0.12%
H09	—	0.006	0.12%	0.006	0.13%
H10	—	0.006	0.12%	0.006	0.13%
H11	—	0.004	0.07%	0.004	0.08%
H12	—	0.003	0.06%	0.003	0.07%
H13	—	0.003	0.05%	0.003	0.06%
H14	—	0.003	0.05%	0.003	0.06%

Table C-18 – 30-minute mean Formaldehyde impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.86	0.86%	0.86	0.86%
H02	—	0.83	0.83%	0.83	0.83%
H03	—	1.23	1.23%	1.23	1.23%
H04	—	1.22	1.22%	1.22	1.22%
H05	—	1.38	1.38%	1.38	1.38%
H06	—	1.15	1.15%	1.15	1.15%
H07	—	1.39	1.39%	1.39	1.39%
H08	—	1.48	1.48%	1.48	1.48%
H09	—	1.62	1.62%	1.62	1.62%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H10	—	1.52	1.52%	1.52	1.52%
H11	—	1.42	1.42%	1.42	1.42%
H12	—	0.93	0.93%	0.93	0.93%
H13	—	0.80	0.80%	0.80	0.80%
H14	—	0.77	0.77%	0.77	0.77%

Table C-19 – Annual mean NH_3 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	2.11	0.008	<0.01%	2.12	1.18%
H02	2.15	0.007	<0.01%	2.15	1.20%
H03	2.11	0.012	0.01%	2.12	1.18%
H04	2.11	0.017	0.01%	2.13	1.18%
H05	2.07	0.027	0.02%	2.10	1.17%
H06	2.08	0.011	0.01%	2.09	1.16%
H07	2.08	0.007	<0.01%	2.08	1.16%
H08	2.02	0.007	<0.01%	2.03	1.13%
H09	2.02	0.007	<0.01%	2.03	1.13%
H10	1.95	0.007	<0.01%	1.96	1.09%
H11	1.92	0.004	<0.01%	1.92	1.07%
H12	1.73	0.004	<0.01%	1.74	0.96%
H13	1.73	0.003	<0.01%	1.73	0.96%
H14	1.73	0.003	<0.01%	1.73	0.96%

Table C-20 – 1-hour mean NH_3 impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	4.23	0.76	0.03%	4.83	0.19%
H02	4.29	0.71	0.03%	4.60	0.18%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H03	4.22	1.19	0.05%	5.41	0.22%
H04	4.22	1.12	0.04%	5.33	0.21%
H05	4.15	1.30	0.05%	5.45	0.22%
H06	4.15	1.05	0.04%	4.82	0.19%
H07	4.15	1.27	0.05%	5.09	0.20%
H08	4.04	1.44	0.06%	5.26	0.21%
H09	4.04	1.61	0.06%	5.19	0.21%
H10	3.90	1.45	0.06%	4.85	0.19%
H11	3.84	1.27	0.05%	4.63	0.19%
H12	3.46	0.83	0.03%	3.77	0.15%
H13	3.46	0.72	0.03%	3.72	0.15%
H14	3.46	0.71	0.03%	3.63	0.15%

Table C-21 – Annual mean VOCs impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.33	0.04	0.76%	0.37	7.42%
H02	0.35	0.04	0.74%	0.39	7.70%
H03	0.36	0.06	1.10%	0.41	8.22%
H04	0.36	0.07	1.45%	0.43	8.57%
H05	0.36	0.13	2.51%	0.49	9.73%
H06	0.37	0.05	1.08%	0.42	8.44%
H07	0.37	0.04	0.73%	0.40	8.09%
H08	0.36	0.03	0.68%	0.39	7.84%
H09	0.35	0.04	0.71%	0.38	7.69%
H10	0.31	0.03	0.69%	0.34	6.89%
H11	0.30	0.02	0.44%	0.32	6.50%
H12	0.29	0.02	0.37%	0.30	6.09%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H13	0.29	0.02	0.33%	0.30	6.05%
H14	0.29	0.02	0.31%	0.30	6.03%

Table C-22 – 24-hour mean VOCs impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.67	0.50	1.68%	1.17	3.90%
H02	0.70	0.59	1.98%	1.29	4.30%
H03	0.71	0.79	2.62%	1.50	5.00%
H04	0.71	0.86	2.85%	1.57	5.23%
H05	0.72	1.09	3.64%	1.81	6.04%
H06	0.74	0.65	2.18%	1.39	4.64%
H07	0.74	0.69	2.29%	1.42	4.74%
H08	0.72	0.83	2.78%	1.55	5.16%
H09	0.70	0.80	2.66%	1.49	4.98%
H10	0.62	0.96	3.21%	1.58	5.28%
H11	0.61	0.59	1.97%	1.20	3.99%
H12	0.57	0.49	1.63%	1.06	3.54%
H13	0.57	0.41	1.36%	0.98	3.27%
H14	0.57	0.39	1.31%	0.96	3.21%

Table C-23 – 24-hour mean DiEA impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.05	0.14%	0.07	0.21%
H02	—	0.06	0.17%	0.12	0.35%
H03	—	0.08	0.24%	0.13	0.40%
H04	—	0.08	0.25%	0.10	0.31%
H05	—	0.10	0.30%	0.10	0.30%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H06	—	0.06	0.18%	0.07	0.20%
H07	—	0.06	0.18%	0.08	0.24%
H08	—	0.07	0.22%	0.07	0.22%
H09	—	0.07	0.22%	0.08	0.23%
H10	—	0.09	0.26%	0.09	0.26%
H11	—	0.05	0.15%	0.07	0.22%
H12	—	0.04	0.12%	0.06	0.18%
H13	—	0.04	0.11%	0.04	0.12%
H14	—	0.03	0.10%	0.04	0.11%

Table C-24 – 1-hour mean DiEA impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.38	0.12%	0.38	0.12%
H02	—	0.36	0.11%	0.43	0.13%
H03	—	0.58	0.17%	0.68	0.20%
H04	—	0.51	0.16%	0.59	0.18%
H05	—	0.61	0.19%	0.61	0.19%
H06	—	0.49	0.15%	0.49	0.15%
H07	—	0.60	0.18%	0.60	0.18%
H08	—	0.62	0.19%	0.62	0.19%
H09	—	0.77	0.23%	0.77	0.23%
H10	—	0.75	0.23%	0.75	0.23%
H11	—	0.61	0.18%	0.61	0.18%
H12	—	0.42	0.13%	0.43	0.13%
H13	—	0.35	0.11%	0.40	0.12%
H14	—	0.34	0.10%	0.40	0.12%

Table C-25 – 24-hour mean MEA impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.05	0.05%	0.07	0.07%
H02	—	0.06	0.06%	0.12	0.12%
H03	—	0.08	0.08%	0.13	0.13%
H04	—	0.08	0.08%	0.10	0.10%
H05	—	0.10	0.10%	0.10	0.10%
H06	—	0.06	0.06%	0.07	0.07%
H07	—	0.06	0.06%	0.08	0.08%
H08	—	0.07	0.07%	0.07	0.07%
H09	—	0.07	0.07%	0.08	0.08%
H10	—	0.09	0.09%	0.09	0.09%
H11	—	0.05	0.05%	0.07	0.07%
H12	—	0.04	0.04%	0.06	0.06%
H13	—	0.04	0.04%	0.04	0.04%
H14	—	0.03	0.03%	0.04	0.04%

Table C-26 – 1-hour mean MEA impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	0.38	0.10%	0.38	0.10%
H02	—	0.36	0.09%	0.36	0.09%
H03	—	0.58	0.14%	0.58	0.14%
H04	—	0.52	0.13%	0.52	0.13%
H05	—	0.62	0.15%	0.62	0.15%
H06	—	0.49	0.12%	0.49	0.12%
H07	—	0.60	0.15%	0.60	0.15%
H08	—	0.62	0.16%	0.62	0.16%
H09	—	0.77	0.19%	0.77	0.19%
H10	—	0.76	0.19%	0.76	0.19%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H11	—	0.61	0.15%	0.61	0.15%
H12	—	0.42	0.11%	0.42	0.11%
H13	—	0.36	0.09%	0.36	0.09%
H14	—	0.34	0.08%	0.34	0.08%

Table C-27 – Annual mean HDMA impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	—	4.39E-05	21.95%	8.06E-05	40.28%
H02	—	5.15E-05	25.75%	9.23E-05	46.14%
H03	—	6.54E-05	32.72%	1.19E-04	59.37%
H04	—	9.13E-05	45.67%	1.47E-04	73.46%
H05	—	1.45E-04	72.57%	1.59E-04	79.54%
H06	—	1.02E-04	50.95%	1.79E-04	89.34%
H07	—	1.04E-04	51.99%	1.60E-04	79.98%
H08	—	9.82E-05	49.08%	1.58E-04	78.87%
H09	—	7.82E-05	39.11%	1.61E-04	80.35%
H10	—	8.11E-05	40.55%	1.71E-04	85.59%
H11	—	6.39E-05	31.94%	1.46E-04	73.03%
H12	—	5.41E-05	27.03%	1.10E-04	55.16%
H13	—	5.00E-05	25.00%	9.04E-05	45.19%
H14	—	4.86E-05	24.31%	8.25E-05	41.24%

Table C-28 – Annual mean arsenic impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0002	0.0001	0.0003	2.17%	5.00%
H02	0.0002	0.0001	0.0003	1.94%	4.78%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H03	0.0002	0.0002	0.0004	4.08%	6.91%
H04	0.0002	0.0004	0.0006	6.61%	9.44%
H05	0.0002	0.0006	0.0008	9.67%	12.50%
H06	0.0002	0.0001	0.0003	2.30%	5.14%
H07	0.0002	0.0001	0.0003	2.31%	5.14%
H08	0.0002	0.0002	0.0003	2.72%	5.55%
H09	0.0002	0.0001	0.0003	1.73%	4.56%
H10	0.0002	0.0001	0.0003	1.74%	4.57%
H11	0.0002	0.0001	0.0002	0.91%	3.74%
H12	0.0002	0.0000	0.0002	0.66%	3.49%
H13	0.0002	0.0000	0.0002	0.56%	3.39%
H14	0.0002	0.0000	0.0002	0.53%	3.36%

Table C-29 – Annual mean antimony impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0543	0.0003	0.01%	0.0546	1.09%
H02	0.0543	0.0003	0.01%	0.0545	1.09%
H03	0.0543	0.0006	0.01%	0.0548	1.10%
H04	0.0543	0.0009	0.02%	0.0552	1.10%
H05	0.0543	0.0014	0.03%	0.0556	1.11%
H06	0.0543	0.0003	0.01%	0.0546	1.09%
H07	0.0543	0.0003	0.01%	0.0546	1.09%
H08	0.0543	0.0004	0.01%	0.0546	1.09%
H09	0.0543	0.0002	<0.01%	0.0545	1.09%
H10	0.0543	0.0002	<0.01%	0.0545	1.09%
H11	0.0543	0.0001	<0.01%	0.0544	1.09%
H12	0.0543	0.0001	<0.01%	0.0543	1.09%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H13	0.0543	0.0001	<0.01%	0.0543	1.09%
H14	0.0543	0.0001	<0.01%	0.0543	1.09%

Table C-30 – 1-hour mean antimony impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.23	0.02	0.01%	0.24	0.16%
H02	0.23	0.02	0.01%	0.24	0.16%
H03	0.23	0.03	0.02%	0.25	0.17%
H04	0.23	0.03	0.02%	0.25	0.17%
H05	0.23	0.04	0.02%	0.26	0.17%
H06	0.23	0.03	0.02%	0.25	0.17%
H07	0.23	0.03	0.02%	0.26	0.17%
H08	0.23	0.03	0.02%	0.26	0.17%
H09	0.23	0.03	0.02%	0.25	0.17%
H10	0.23	0.03	0.02%	0.25	0.17%
H11	0.23	0.02	0.01%	0.24	0.16%
H12	0.23	0.02	0.01%	0.24	0.16%
H13	0.23	0.02	0.01%	0.24	0.16%
H14	0.23	0.02	0.01%	0.24	0.16%

Table C-31 – Annual mean cadmium impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00003	0.00014	2.85%	0.00018	3.51%
H02	0.00003	0.00013	2.55%	0.00016	3.21%
H03	0.00003	0.00027	5.36%	0.00030	6.02%
H04	0.00003	0.00043	8.68%	0.00047	9.34%
H05	0.00003	0.00064	12.71%	0.00067	13.37%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H06	0.00003	0.00015	3.03%	0.00018	3.69%
H07	0.00003	0.00015	3.03%	0.00018	3.69%
H08	0.00003	0.00018	3.57%	0.00021	4.23%
H09	0.00003	0.00011	2.27%	0.00015	2.93%
H10	0.00003	0.00011	2.28%	0.00015	2.94%
H11	0.00003	0.00006	1.19%	0.00009	1.85%
H12	0.00003	0.00004	0.86%	0.00008	1.52%
H13	0.00003	0.00004	0.74%	0.00007	1.40%
H14	0.00003	0.00003	0.69%	0.00007	1.35%

Table C-32 – 24-hour mean cadmium impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00009	0.00124	4.14%	0.00133	4.43%
H02	0.00009	0.00119	3.98%	0.00128	4.28%
H03	0.00009	0.00219	7.29%	0.00228	7.59%
H04	0.00009	0.00289	9.64%	0.00298	9.94%
H05	0.00009	0.00426	14.19%	0.00435	14.49%
H06	0.00009	0.00198	6.59%	0.00207	6.89%
H07	0.00009	0.00199	6.64%	0.00208	6.94%
H08	0.00009	0.00234	7.81%	0.00243	8.11%
H09	0.00009	0.00216	7.18%	0.00224	7.48%
H10	0.00009	0.00292	9.72%	0.00300	10.02%
H11	0.00009	0.00162	5.41%	0.00171	5.71%
H12	0.00009	0.00167	5.57%	0.00176	5.86%
H13	0.00009	0.00143	4.76%	0.00152	5.05%
H14	0.00009	0.00136	4.54%	0.00145	4.84%

Table C-33 – 24-hour mean chromium III impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0020	0.0029	0.14%	0.0049	0.24%
H02	0.0020	0.0028	0.14%	0.0048	0.24%
H03	0.0020	0.0051	0.26%	0.0071	0.36%
H04	0.0020	0.0068	0.34%	0.0088	0.44%
H05	0.0020	0.0099	0.50%	0.0119	0.60%
H06	0.0020	0.0046	0.23%	0.0066	0.33%
H07	0.0020	0.0046	0.23%	0.0066	0.33%
H08	0.0020	0.0055	0.27%	0.0075	0.37%
H09	0.0020	0.0050	0.25%	0.0070	0.35%
H10	0.0020	0.0068	0.34%	0.0088	0.44%
H11	0.0020	0.0038	0.19%	0.0058	0.29%
H12	0.0020	0.0039	0.19%	0.0059	0.29%
H13	0.0020	0.0033	0.17%	0.0053	0.27%
H14	0.0020	0.0032	0.16%	0.0052	0.26%

Table C-34 – Annual mean chromium VI impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0001080	0.0000013	0.52%	0.0001093	43.72%
H02	0.0001080	0.0000012	0.47%	0.0001092	43.67%
H03	0.0001080	0.0000024	0.98%	0.0001104	44.18%
H04	0.0001080	0.0000040	1.59%	0.0001120	44.79%
H05	0.0001080	0.0000058	2.32%	0.0001138	45.52%
H06	0.0001080	0.0000014	0.55%	0.0001094	43.75%
H07	0.0001080	0.0000014	0.55%	0.0001094	43.75%
H08	0.0001080	0.0000016	0.65%	0.0001096	43.85%
H09	0.0001080	0.0000010	0.41%	0.0001090	43.61%
H10	0.0001080	0.0000010	0.42%	0.0001090	43.62%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H11	0.0001080	0.0000005	0.22%	0.0001085	43.42%
H12	0.0001080	0.0000004	0.16%	0.0001084	43.36%
H13	0.0001080	0.0000003	0.13%	0.0001083	43.33%
H14	0.0001080	0.0000003	0.13%	0.0001083	43.33%

Table C-35 – 24-hour mean copper impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00297	0.00290	5.79%	0.00587	11.73%
H02	0.00297	0.00279	5.58%	0.00576	11.52%
H03	0.00297	0.00510	10.21%	0.00807	16.15%
H04	0.00297	0.00675	13.50%	0.00972	19.44%
H05	0.00297	0.00993	19.87%	0.01290	25.81%
H06	0.00297	0.00462	9.23%	0.00759	15.17%
H07	0.00297	0.00465	9.29%	0.00762	15.23%
H08	0.00297	0.00547	10.93%	0.00844	16.87%
H09	0.00297	0.00503	10.06%	0.00800	16.00%
H10	0.00297	0.00680	13.61%	0.00977	19.55%
H11	0.00297	0.00379	7.58%	0.00676	13.52%
H12	0.00297	0.00390	7.79%	0.00687	13.73%
H13	0.00297	0.00333	6.66%	0.00630	12.60%
H14	0.00297	0.00318	6.36%	0.00615	12.30%

Table C-36 – Annual mean lead impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00094	0.00030	0.12%	0.00124	0.50%
H02	0.00094	0.00027	0.11%	0.00121	0.48%
H03	0.00094	0.00057	0.23%	0.00151	0.60%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H04	0.00094	0.00092	0.37%	0.00186	0.75%
H05	0.00094	0.00135	0.54%	0.00229	0.92%
H06	0.00094	0.00032	0.13%	0.00126	0.50%
H07	0.00094	0.00032	0.13%	0.00126	0.51%
H08	0.00094	0.00038	0.15%	0.00132	0.53%
H09	0.00094	0.00024	0.10%	0.00118	0.47%
H10	0.00094	0.00024	0.10%	0.00118	0.47%
H11	0.00094	0.00013	0.05%	0.00107	0.43%
H12	0.00094	0.00009	0.04%	0.00103	0.41%
H13	0.00094	0.00008	0.03%	0.00102	0.41%
H14	0.00094	0.00007	0.03%	0.00101	0.41%

Table C-37 – Annual mean manganese impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00107	0.00030	0.20%	0.00137	0.92%
H02	0.00107	0.00027	0.18%	0.00134	0.89%
H03	0.00107	0.00057	0.38%	0.00164	1.09%
H04	0.00107	0.00092	0.62%	0.00199	1.33%
H05	0.00107	0.00135	0.90%	0.00242	1.62%
H06	0.00107	0.00032	0.21%	0.00139	0.93%
H07	0.00107	0.00032	0.22%	0.00139	0.93%
H08	0.00107	0.00038	0.25%	0.00145	0.97%
H09	0.00107	0.00024	0.16%	0.00131	0.87%
H10	0.00107	0.00024	0.16%	0.00131	0.88%
H11	0.00107	0.00013	0.08%	0.00120	0.80%
H12	0.00107	0.00009	0.06%	0.00116	0.77%
H13	0.00107	0.00008	0.05%	0.00115	0.77%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H14	0.00107	0.00007	0.05%	0.00114	0.76%

Table C-38 – 1-hour mean manganese impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0024	0.0194	<0.01%	0.0218	<0.01%
H02	0.0024	0.0157	<0.01%	0.0181	<0.01%
H03	0.0024	0.0257	<0.01%	0.0281	<0.01%
H04	0.0024	0.0261	<0.01%	0.0285	<0.01%
H05	0.0024	0.0354	<0.01%	0.0379	<0.01%
H06	0.0024	0.0286	<0.01%	0.0310	<0.01%
H07	0.0024	0.0344	<0.01%	0.0368	<0.01%
H08	0.0024	0.0303	<0.01%	0.0327	<0.01%
H09	0.0024	0.0299	<0.01%	0.0323	<0.01%
H10	0.0024	0.0258	<0.01%	0.0282	<0.01%
H11	0.0024	0.0197	<0.01%	0.0222	<0.01%
H12	0.0024	0.0179	<0.01%	0.0203	<0.01%
H13	0.0024	0.0166	<0.01%	0.0190	<0.01%
H14	0.0024	0.0160	<0.01%	0.0184	<0.01%

Table C-39 – 24-hour mean selenium impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0010	0.0029	0.14%	0.0039	0.19%
H02	0.0010	0.0028	0.14%	0.0038	0.19%
H03	0.0010	0.0051	0.26%	0.0061	0.31%
H04	0.0010	0.0068	0.34%	0.0078	0.39%
H05	0.0010	0.0099	0.50%	0.0109	0.55%
H06	0.0010	0.0046	0.23%	0.0056	0.28%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H07	0.0010	0.0046	0.23%	0.0056	0.28%
H08	0.0010	0.0055	0.27%	0.0065	0.32%
H09	0.0010	0.0050	0.25%	0.0060	0.30%
H10	0.0010	0.0068	0.34%	0.0078	0.39%
H11	0.0010	0.0038	0.19%	0.0048	0.24%
H12	0.0010	0.0039	0.19%	0.0049	0.24%
H13	0.0010	0.0033	0.17%	0.0043	0.22%
H14	0.0010	0.0032	0.16%	0.0042	0.21%

Table C-40 – Annual mean nickel impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00031	0.00013	0.65%	0.00044	2.20%
H02	0.00031	0.00012	0.58%	0.00043	2.13%
H03	0.00031	0.00024	1.22%	0.00055	2.77%
H04	0.00031	0.00040	1.98%	0.00071	3.53%
H05	0.00031	0.00058	2.90%	0.00089	4.45%
H06	0.00031	0.00014	0.69%	0.00045	2.24%
H07	0.00031	0.00014	0.69%	0.00045	2.24%
H08	0.00031	0.00016	0.82%	0.00047	2.37%
H09	0.00031	0.00010	0.52%	0.00041	2.07%
H10	0.00031	0.00010	0.52%	0.00041	2.07%
H11	0.00031	0.00005	0.27%	0.00036	1.82%
H12	0.00031	0.00004	0.20%	0.00035	1.75%
H13	0.00031	0.00003	0.17%	0.00034	1.72%
H14	0.00031	0.00003	0.16%	0.00034	1.71%

Table C-41 – 1-hour mean nickel impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.0008	0.0083	1.19%	0.0090	1.29%
H02	0.0008	0.0067	0.96%	0.0075	1.07%
H03	0.0008	0.0110	1.57%	0.0118	1.68%
H04	0.0008	0.0112	1.60%	0.0119	1.71%
H05	0.0008	0.0152	2.17%	0.0159	2.28%
H06	0.0008	0.0123	1.75%	0.0130	1.86%
H07	0.0008	0.0147	2.11%	0.0155	2.21%
H08	0.0008	0.0130	1.86%	0.0137	1.96%
H09	0.0008	0.0128	1.83%	0.0136	1.94%
H10	0.0008	0.0111	1.58%	0.0118	1.69%
H11	0.0008	0.0085	1.21%	0.0092	1.32%
H12	0.0008	0.0077	1.09%	0.0084	1.20%
H13	0.0008	0.0071	1.02%	0.0079	1.12%
H14	0.0008	0.0068	0.98%	0.0076	1.08%

Table C-42 – 24-hour mean vanadium impacts

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H01	0.00058	0.00290	0.29%	0.00348	0.35%
H02	0.00058	0.00279	0.28%	0.00337	0.34%
H03	0.00058	0.00510	0.51%	0.00568	0.57%
H04	0.00058	0.00675	0.68%	0.00733	0.73%
H05	0.00058	0.00993	0.99%	0.01051	1.05%
H06	0.00058	0.00462	0.46%	0.00520	0.52%
H07	0.00058	0.00465	0.46%	0.00523	0.52%
H08	0.00058	0.00547	0.55%	0.00605	0.60%
H09	0.00058	0.00503	0.50%	0.00561	0.56%
H10	0.00058	0.00680	0.68%	0.00738	0.74%

Receptor	Background (µg/m^3)	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
H11	0.00058	0.00379	0.38%	0.00437	0.44%
H12	0.00058	0.00390	0.39%	0.00448	0.45%
H13	0.00058	0.00333	0.33%	0.00391	0.39%
H14	0.00058	0.00318	0.32%	0.00376	0.38%

Appendix C.2

ECOLOGICAL

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Table C-43 – Annual mean NO_X impacts

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E01	0.23	0.77%	12.31	41.0%
E02	0.05	0.15%	12.11	40.4%
E03	0.11	0.36%	12.11	40.4%
E04	0.23	0.77%	12.31	41.0%
E05	0.06	0.20%	12.52	41.7%
E06	0.23	0.77%	12.31	41.0%
E07	0.11	0.36%	10.81	36.0%
E08	0.02	0.06%	7.89	26.3%
E09	0.00	0.01%	4.39	14.6%
E10	0.61	2.04%	11.56	38.5%
E11	0.08	0.25%	10.64	35.5%
E12	0.09	0.31%	11.76	39.2%

Table C-44 – 24-hour mean NO_X impacts

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E01	1.74	0.87%	10.86	5.43%
E02	0.42	0.21%	11.71	5.86%
E03	1.37	0.69%	10.49	5.25%
E04	1.74	0.87%	10.86	5.43%
E05	1.02	0.51%	12.57	6.29%
E06	1.74	0.87%	10.86	5.43%
E07	1.37	0.69%	10.49	5.25%
E08	0.45	0.23%	8.71	4.36%
E09	0.08	0.04%	4.98	2.49%
E10	3.86	1.93%	13.03	6.52%
E11	1.16	0.58%	10.28	5.14%

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E12	0.79	0.40%	11.98	5.99%

Table C-45 – Annual mean SO_2 impacts

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E01	0.31	3.1%	3.35	33.5%
E02	0.06	0.6%	4.30	43.0%
E03	0.14	1.4%	4.47	44.7%
E04	0.31	3.1%	3.35	33.5%
E05	0.08	0.8%	3.62	36.2%
E06	0.31	3.1%	3.35	33.5%
E07	0.14	1.4%	4.47	44.7%
E08	0.02	0.2%	4.02	40.2%
E09	<0.01	<0.01%	2.50	25.0%
E10	0.83	8.3%	4.39	43.9%
E11	0.10	1.0%	4.76	47.6%
E12	0.13	1.3%	4.46	44.6%

Table C-46– Weekly mean HF impacts

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E01	0.020	0.19%	3.96	37.96%
E02	0.004	0.17%	0.70	34.70%
E03	0.015	0.18%	2.90	36.90%
E04	0.020	0.19%	3.96	37.96%
E05	0.010	0.18%	1.90	35.90%
E06	0.020	0.19%	3.96	37.96%
E07	0.015	0.18%	2.90	36.90%
E08	0.004	0.17%	0.87	34.87%

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E09	0.000	0.17%	0.06	34.06%
E10	0.047	0.22%	9.33	43.33%
E11	0.013	0.18%	2.54	36.54%
E12	0.009	0.18%	1.90	35.90%

Table C-47 – 24-hour mean HF impacts

Receptor	PC (µg/m^3)	PC as a % of AQAL	PEC (µg/m^3)	PEC as a % of AQAL
E01	0.03	0.20%	0.67	4.07%
E02	0.01	0.18%	0.16	3.56%
E03	0.03	0.20%	0.53	3.93%
E04	0.03	0.20%	0.67	4.07%
E05	0.02	0.19%	0.39	3.79%
E06	0.03	0.20%	0.67	4.07%
E07	0.03	0.20%	0.53	3.93%
E08	0.01	0.18%	0.17	3.57%
E09	<0.01	0.17%	0.03	3.43%
E10	0.07	0.24%	1.49	4.89%
E11	0.02	0.19%	0.45	3.85%
E12	0.02	0.19%	0.31	3.71%

Appendix D

NEARBY PROJECTS

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7.1.8. As part of the cumulative assessment a number committed developments were modelled. Data were extracted from the planning or permit application submission documents.

MODEL INPUTS

7.1.9. The cumulative projects considered are summarized in Table 5.2-48

Table 5.2-48 – Cumulative Projects

Project	Source of data
Connah Quay Low Carbon Power	Environmental Statement, Volume II, Chapter 8: Air Quality (2026)
ICT Paper Mill	Environmental Permit Application, Dispersion Modelling Assessment (2023)
Shotton Paper Mill	Environmental Statement, Chapter 12: Air Quality (2022)
Parc Adfer ERF	Environmental Permit Variation, Air Dispersion Modelling (2022)
Padeswood Carbon Capture	Environmental Permit Variation, Air Dispersion Modelling (2024)
Deeside Power Station Upgrade	Environmental Permit Variation, Air Dispersion Modelling (2025)
Arrow Biowaste Recycling Facility	Air Quality Assessment (2026)

7.1.10. **Table 5.2-49** through 5.2.35 present the model inputs for the cumulative projects. For projects that have two sets of Emission Limit Values (ELVs) for pollutants, the long term (LT) were used to assess long term impacts (i.e. annual, 24 hour averaging period) and short term (ST) were used to assess short term impacts (i.e. 8 hour, 1 hour, 15min averaging periods). Regarding the consideration of amines from the carbon capture projects that contribute to nitrogen deposition they were modelled as Monoethanolamine (MEA), the amine with the highest emission rate.

Table 5.2-49 - Connah Quay Low Carbon Power

Parameter	Unit	Value
Existing		
Stack Diameter (CCGT)	m	7.4
Stack Location (CCGT)	m	327949, 371137 327932, 371112 327914, 371087 327897, 371063
Temp (CCGT)	ºC	105

Parameter	Unit	Value
Velocity (CCGT)	m/s	15.8
Volumetric Flow Rate (CCGT)	Nm³/s	547
Emission Rates (CCGT)	g/s	NO_x (LT): 21.88 NO_x (ST): 54.7 SO_2: 2.133
Proposed		
Stack Height (Absorber)	m	150
Stack Diameter (Absorber)	m	7
Stack Location (Absorber)	m	327355, 371479 327310, 371413
Temp (Absorber)	ºC	50
Velocity (Absorber)	m/s	19.3
Emission Rates (Absorber)	g/s	NO_x (LT): 7.9 NO_x (ST): 31.6 NH_3: 0.7 Amine 1: 0.693 Amine 2: 0.007 Nitrosamine 2: 0.00035 Nitramine 1:0.000035 Nitramine 2:0.00000035

Table 5.2-50 – ICT Papermill

Parameter	Unit	Cogen Stack (E10)	Cogen By-pass (E3)	Gas Boilers
Stack Height	m	28.5	28.5	12.5
Stack Diameter	m	1.8	1.8	0.45
Stack Location	m	349793, 381762	332055, 369786	332377, 369851 332375, 369855
Temp	ºC	220	519	120
Velocity	m/s	19.7	24.0	5.8
Emission Rates	g/s	NO_x : 2.5	NOx (LT): 0.07	NOx: 0.09

Parameter	Unit	Cogen Stack (E10)	Cogen By-pass (E3)	Gas Boilers
			NOx (ST): 3.1	

Table 5.2-51 – Shotton Paper Mill

Parameter	Unit	CHP 1 and 2	CHP 3 and 4	Dryer	Biogas Boiler
Stack Height	m	106	106	35.48	69
Stack Diameter	m	2.1	2	1.57	3.2
Stack Location	m	330395, 371511 330408, 371514	330438 , 371520 330452, 371522	330553,371618	330652, 371480
Temp	ºC	130	130	285	70
Velocity	m/s	19.3	18.2	17	7.8
Emission Rates	g/s	NO_x : 3.28	NO_x : 2.81	NO_x : 0.35	NO_x : 10.38

Table 5.2-52 - Parc Adfer ERF

Parameter	Unit	Value
Existing		
Stack Height	m	85
Stack Diameter	m	1.9
Stack Location	m	331093, 371418
Temp	ºC	140
Velocity	m/s	22.79
Emission Rates	g/s	NO_x (LT): 9.74 PM (LT): 0.487 SO_2 (LT): 2.435 CO: 2.43 HCl: 0.49 HF: 0.049 NH_3: 0.487 VOC:0.49 Cadmium: 0.0012 Mercury:0.0024

Parameter	Unit	Value
		Antimony, Arsenic, lead, Chromium, Copper, Manganese, Nickel, Vanadium:0.0243 CrVI: 0.0063
Proposed		
Stack Height	m	85
Stack Diameter	m	1.9
Stack Location	m	331093, 371418
Temp	ºC	140
Velocity	m/s	22.79
Emission Rates	g/s	NO_x (LT): 8.766 PM (LT): 0.2435 SO_2 (LT): 1.948 CO: 2.43 HCL: 0.39 HF: 0.049 NH_3: 0.487 VOC:0.49 Cadmium: 0.0005 Mercury:0.001 Antimony, Arsenic, lead, Chromium, Copper, Manganese, Nickel, Vanadium:0.0146 CrVI: 0.0063

Table 5.2-53 – Padeswood Carbon Capture

Parameter	Unit	Value
Existing		
Stack Height	m	117.9
Stack Diameter	m	3.35
Stack Location	m	329067, 362058
Temp	ºC	135
Velocity	m/s	15.4
Emission Rates	g/s	NO_x: 29.82

Parameter	Unit	Value
		PM: 0.66 SO_2: 13.25 CO: 79.52 HCl: 0.66 NH_3: 4.64 HF: 0.07 VOC: 3.31 Cadmium: 0.003 Mercury:0.003 Antimony, Arsenic, lead, Chromium, Copper, Manganese, Nickel, Vanadium:0.033
Proposed		
Stack Height	m	117.9
Stack Diameter	m	3.1
Stack Location	m	329067, 362058
Temp	ºC	100
Velocity	m/s	16.8
Emission Rates	g/s	NO_x: 19.22 PM: 0.96 SO_2: 4.81 CO: 38.44 HCl: 0.96 NH_3: 2.88 HF: 0.097 VOC: 2.88 Cadmium: 0.005 Mercury:0.005 Antimony, Arsenic, lead, Chromium, Copper, Manganese, Nickel, Vanadium: 0.05 Amines (Group 1): 0.09731 Amines (Group 2 – Nitrosamines): 0.00006 Amines (Group3 – Nitramines): 0.00002

Table 5.2-54 – Deeside Power

Parameter	Unit	Value
Existing		
		Understood to be mothballed
Proposed		
Stack Height	m	15
Stack Diameter	m	0.8
Stack Location	m	329789, 371579 329789, 371574 329789, 371568 329789, 371562 329789, 371556 329789, 371544 329789, 371538 329789, 371532 329789, 371526 329789, 371520 329789, 371514
Temp	ºC	351
Velocity	m/s	23.79
Emission Rates	g/s	NO_x(LT): 0.18 NOx: 0.79 CO: 0.83

Table 5.2-55 – Arrow Biowaste

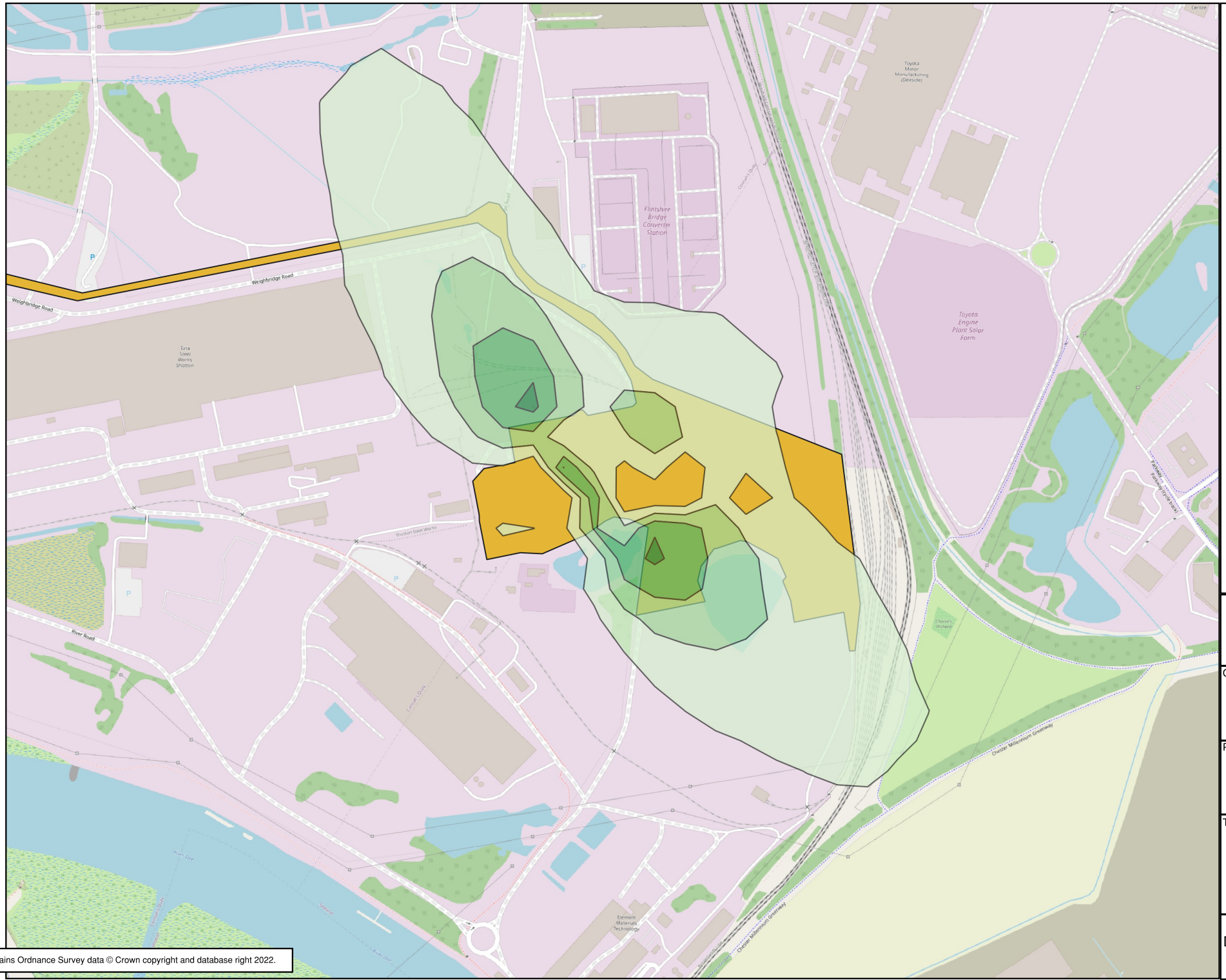
Parameter	Unit	CHP Engine 1 (A1)	CHP Engine 2 (A2)	CHP Engine 3 (A3)
Stack Height	m	10.7	10.7	10.7
Stack Diameter	m	0.51	0.41	0.41
Stack Location	m	331208, 371259	331211, 371249	331217, 371232

Parameter	Unit	CHP Engine 1 (A1)	CHP Engine 2 (A2)	CHP Engine 3 (A3)
Temp	ºC	432	422	422
Velocity	m/s	26.69	34.97	34.97
Emission Rates	g/s	NO_x : 0.79 SO_2: 0.06	NO_x : 0.61 SO_2: 0.05	NO_x : 0.61 SO_2: 0.05

Appendix E

ISOPLETH PLOTS

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Legend

Site boundary

Particulate Matter (µg/m

5

10

15

20

0 100 200 m

Client:

Knauf Insulation Ltd

Project:

Shotton Rock Mineral Wool Facility

Title:

Figure E1: 24 hour PM10 (Upset Conditions - Knauf only)

Date: 19/06/25

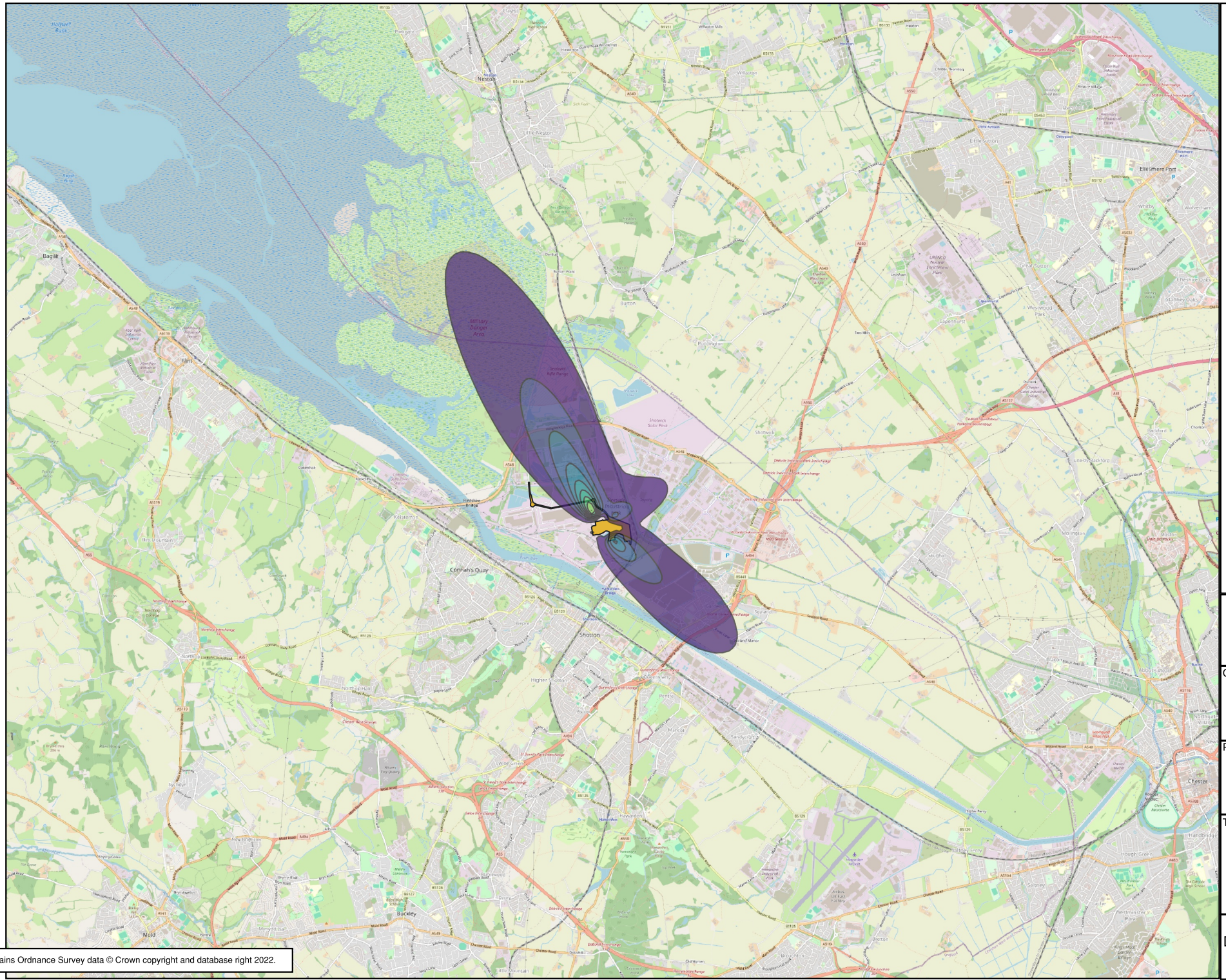
Drawn: MS

Checked: KA

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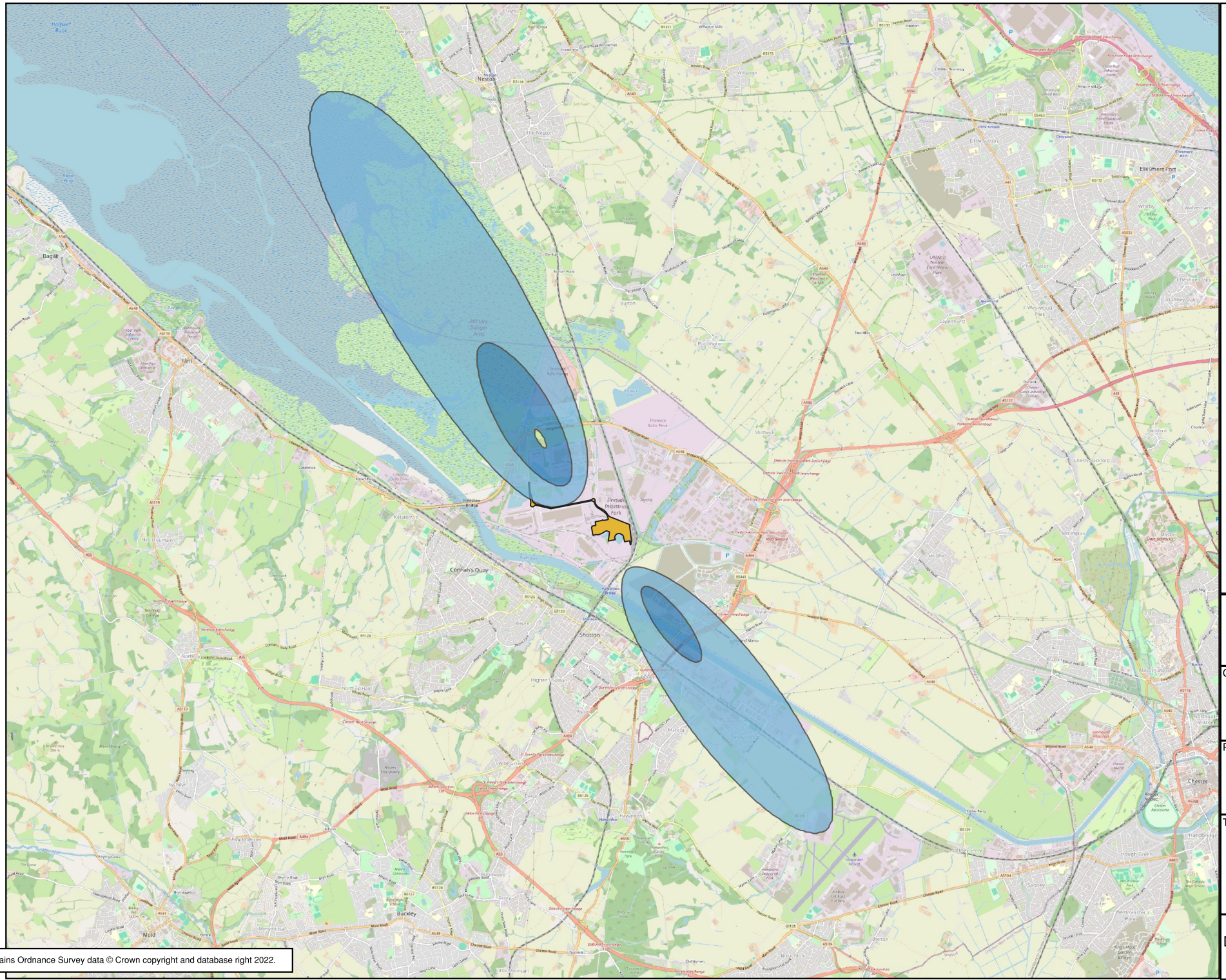
Client:
Knauf Insulation Ltd

Project:
Shotton Rock Mineral Wool Facility

Title:
Figure E2: Annual Mean Arsenic (Knauf Only)

Date: 19/06/25

Drawn: MS
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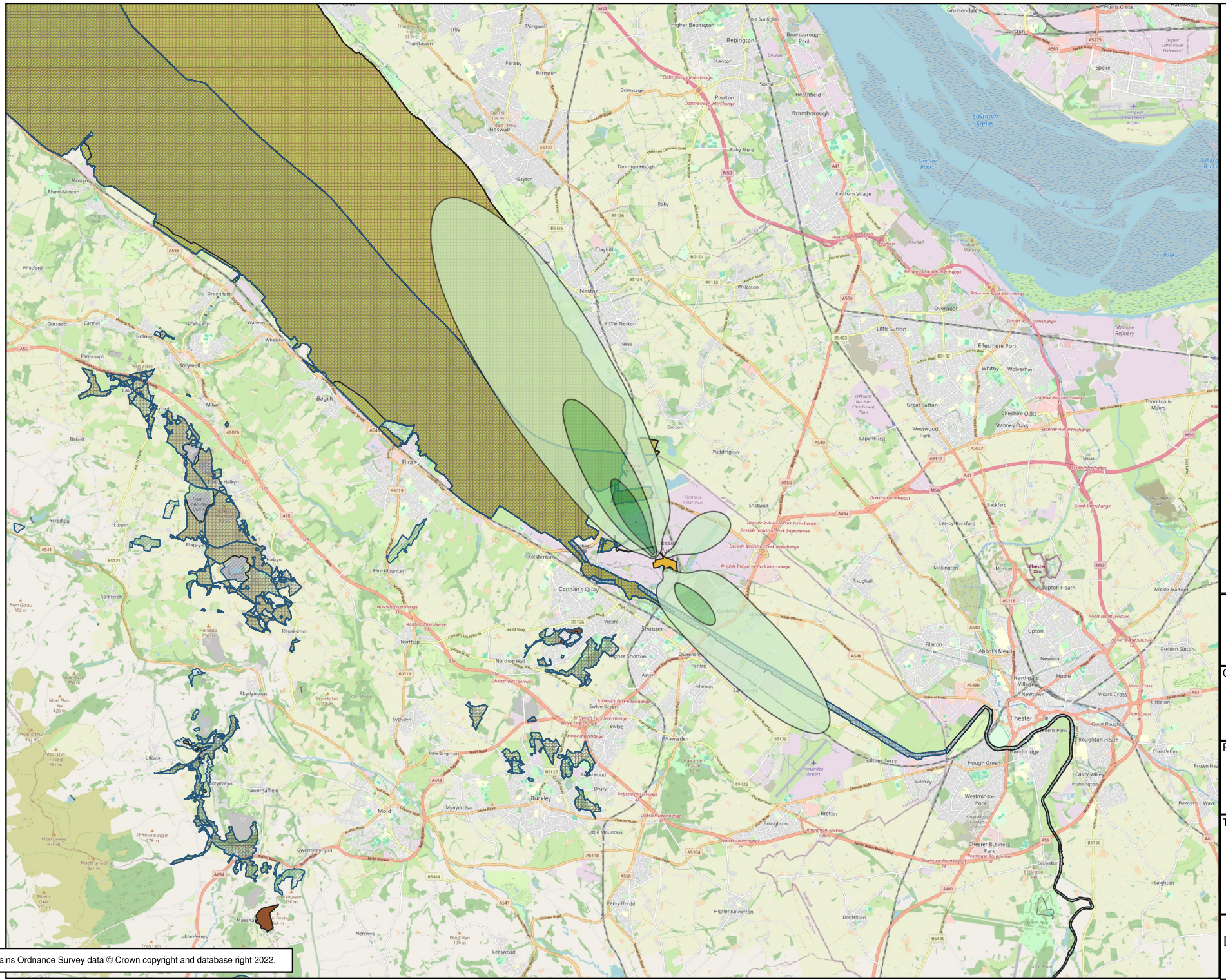
Client:
Knauf Insulation Ltd

Project:
Shotton Rock Mineral Wool Facility

Title:
Figure E3: Annual Mean NDMA (Knauf Only)

Date: 19/06/25

Drawn: MS
Checked: KA
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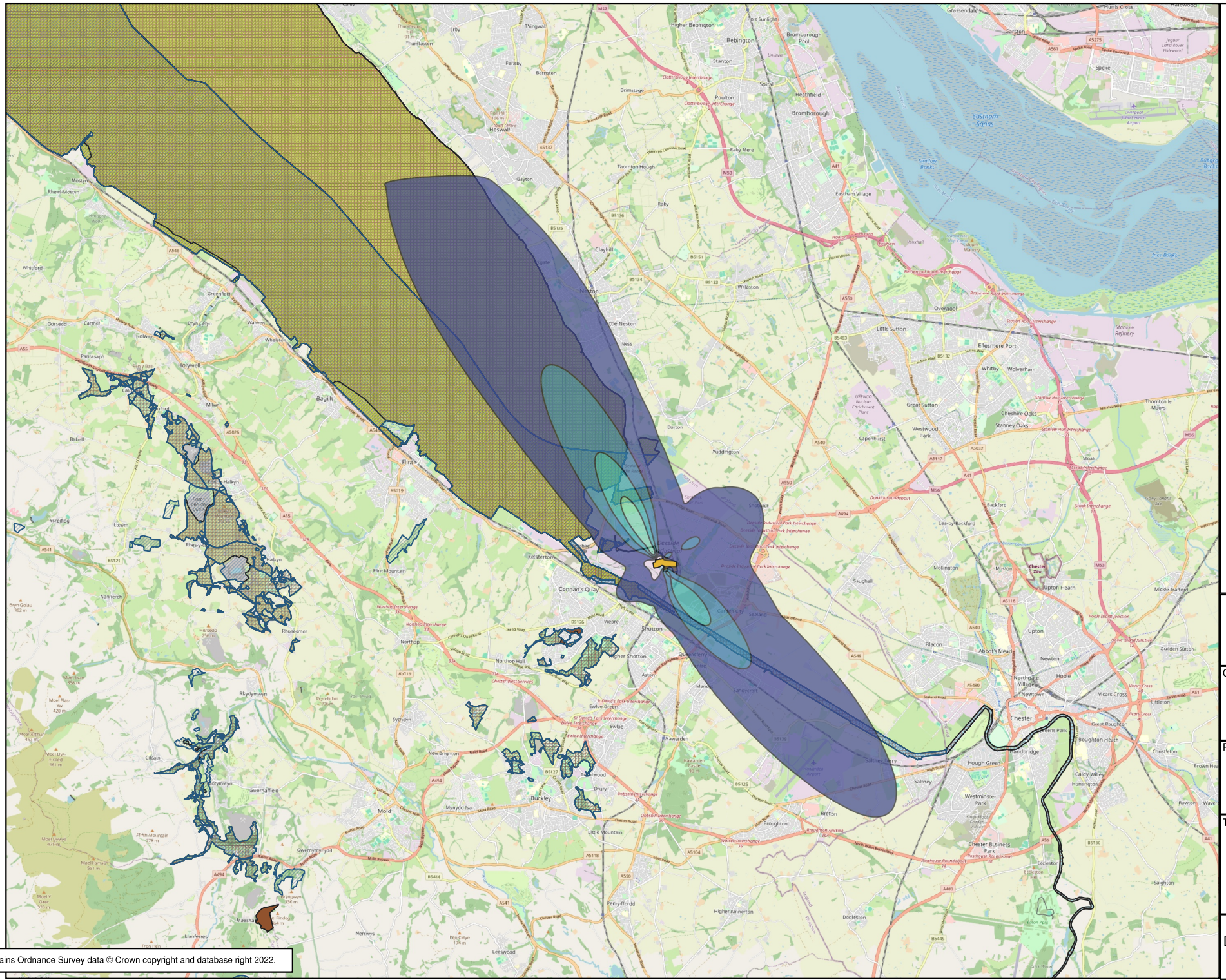
Client:
Knauf Insulation Ltd

Project:
Shotton Rock Mineral Wool Facility

Title:
Figure E4: Annual Mean Ammonia (Knauf Only)

Date: 19/06/25

Drawn: MS
Checked: KA
Approved: KA



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Client:
Knauf Insulation Ltd

Project:
Shotton Rock Mineral Wool Facility

Title:
Figure E5: Annual Mean Nitrogen Deposition (Knauf only)

Date: 19/06/25

Drawn: MS
Checked: KA
Approved: KA

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