FICHTNER

Consulting Engineers Limited

Avonmouth Energy Recovery Facility

Viridor Avonmouth Waste Services Limited

Dispersion Modelling Assessment

ENGINEERING – CONSULTING

Document approval

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Management Summary

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged by Viridor Avonmouth Waste Services Limited to undertake a Dispersion Modelling Assessment to support the application for a variation to the Environmental Permit (EP) for the Avonmouth Energy Recovery Facility (the Facility). The proposed change to the EP is to increase the processing capacity of the Facility from 376,500 tonnes per annum to 427,050 tonnes per annum of waste, based on continuous operation at the 110% MCR point on the firing diagram.

This assessment has considered the following scenarios:

- the "Operational Facility" – the model has been set up with data from the operational plant and this has been used to evaluate the impact of the Facility as it is currently operated; and
- the "Proposed Facility" – operational data factored to represent operation at 110% of the design load.

Dispersion Modelling of Emissions

The ADMS dispersion model is routinely used for air quality assessments to the satisfaction of the Environment Agency (EA). The model uses weather data from the local area to predict the spread and movement of the exhaust gases from the stack for each hour over a five-year period. The model takes account of wind speed, wind direction, temperature, humidity and the amount of cloud cover, as all of these factors influence the dispersion of emissions. The model also takes account of the effects of buildings and terrain on the movement of air. To set up the model, it has been assumed that the Facility operates for the whole year and continuously releases emissions at the emission limits set in the existing EP for operation after 3 December 2023, i.e. after the implementation of the BREF. The model has been used to predict concentration of pollutants on a long-term and short-term basis across a grid of points. In addition, concentrations have been predicted at the identified sensitive receptors.

Approach and Assessment of Impact on Air Quality – Protection of Human Health

The air quality impact on human health has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the AQALs set for the protection of human health the following can be concluded from the assessment.

1. Emissions from the operation of the Proposed Facility will not cause a breach of any AQAL.
2. There is predicted to be a slight increase in the impacts, but a slight reduction in the peak 1-hour impacts as a result of the proposed EP variation.
3. For all pollutants the change in impact as a result of the EP variation can be screened out as 'insignificant'.
4. For all pollutants the overall impact of the Proposed Facility can either be screened out as 'insignificant' or is 'not significant' when the total concentration is taken into consideration.

Approach and Assessment of Impact on Air Quality – Protection of Ecosystems

The impact of air quality on ecology has been assessed using a standard approach based on guidance provided by the EA. Using this approach, in relation to the Critical Level and Critical Loads set for the protection of ecology the following can be concluded from the assessment.

1. At all identified European and UK designated ecological receptors, the change in impact can be screened out as 'insignificant' as it is less than 1% of the long term Critical Levels and Critical Loads and less than 10% of the short term Critical Levels.
2. The impact of the Proposed Facility cannot be screened out as 'insignificant' at the Severn Estuary and River Wye designated sites. However, as the change in impact from the Operational Facility is extremely small and would be imperceptible, it is considered that there would be no significant effects on the integrity of these designated sites as a result of the proposed EP variation.
3. As a screening assessment it has been assumes that a local nature site is present at the overall point of maximum impact. The change in impact and the overall impact of the Proposed Facility at the point of maximum impact are both less than 100% of the Critical Levels and Loads and can be screened out as 'insignificant'.

Summary and Conclusions

In summary, the assessment has shown that the change in air quality impact associated with the proposed EP variation is marginal and emissions would not have a significant impact on local air quality, the general population or the local community. As such there should be no air quality constraint in granting a variation to the existing EP for the increased throughput as proposed.

Contents

1 Introduction

1.1 Background

Fichtner Consulting Engineers Ltd ("Fichtner") has been engaged by Viridor Avonmouth Waste Services Limited to undertake a Dispersion Modelling Assessment to support the application for a variation to the Environmental Permit (EP) for the Avonmouth Energy Recovery Facility (the Facility). The proposed change to the EP is to increase the processing capacity of the Facility from 376,500 tonnes per annum to 427,050 tonnes per annum of waste, based on continuous operation at the 110% MCR point on the firing diagram.

This assessment has considered the following scenarios:

- the "Operational Facility" – the model has been set up with data from the operational plant and this is used to evaluate the impact of the Facility as it is currently operated; and
- the "Proposed Facility" – operational data factored to represent operation at 110% of the design load.

The existing EP (Ref: EPR/GP3834HY) includes emission limits for emissions to air based on the Industrial Emissions Directive (IED) (Directive 2010/75/EU) and the Waste Incineration BREF[1]. The Facility will be required to comply a more stringent set of emission limits on emission to air to align with the BREF from 3 December 2023. As the variation to the EP is likely to be granted after 3 December 2023, it has been assumed that both the Operational Facility and the Proposed Facility comply with the ELVs prescribed in the EP from 3 December 2023, to allow a direct comparison between the impact of emissions in the two scenarios.

When considering the impact on human health, the predicted atmospheric concentrations have been compared to the Air Quality Assessment Levels (AQALs) for the protection of human health. It is noted that for dioxins the AQAL is a Tolerable Daily Intake (TDI) which considered the combination of the intake from inhalation and ingestion. As such it is not possible to demonstrate compliance with the assessment level with just reference to the air concentration. As such, a separate Dioxin Pathway Intake Assessment has been undertaken to assess the pathway intake of these pollutants and impacts compared to the TDI.

When considering the impact on ecosystems the predicted atmospheric concentrations have been compared to the Critical Levels for the protection of ecosystems. It is noted that deposition of emissions over a prolonged period can have nutrification and acidification impacts. An assessment of the long-term deposition of pollutants has been undertaken and the results compared to the habitat specific Critical Loads.

1.2 Structure of the report

This report has the following structure.

- National and international air quality legislation and guidance are considered in section 2.
- The background levels of ambient air quality are described in section 3.
- The residential properties and ecological receptors which are sensitive to changes in air quality associated with the Facility and identified in section 4.
- The inputs used for the dispersion model are contained in section 5.

[1] Best Available Techniques (BAT) Reference Document for Waste Incineration - 2019

- Details of the sensitivity analysis carried out is presented in section 6
- The assessment methodology and results of the assessment of the impact of emissions on human health is presented in section 7.
- The assessment methodology and results of the assessment of the impact of emissions at ecological sites is presented in section 8.
- The conclusions of the assessment are set out in section 9.
- The Appendices include illustrative figures and detailed results tables.

2 Legislation Framework and Policy

2.1 Air quality assessment levels

In the UK, Ambient Air Directive (AAD) Limit Values, Targets, and air quality standards and objectives for major pollutants are described in The Air Quality Strategy (AQS). In addition, the Environment Agency include Environmental Assessment Levels (EALs) for other pollutants in the environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[2] ("Air Emissions Guidance"), which are also considered. The long-term and short-term EALs from these documents have been used when the AQS does not contain relevant objectives. Standards and objectives for the protection of sensitive ecosystems and habitats are also contained within the Air Emissions Guidance and the Air Pollution Information System (APIS).

AAD Target and Limit Values, AQS Objectives, and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups. For the remainder of this report these are collectively referred to as AQALs. Table 1 to Table 3 summarise the air quality objectives and guidelines used in this assessment.

Table 1: Air Quality Assessment Levels (AQALs)

Pollutant	Limit value (µg/m³)	Averaging period	Frequency of exceedances	Source
Nitrogen dioxide	200	1 hour	18 times per year (99.79th percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AAD Limit Value
	125	24 hours	3 times per year (99.18th percentile)	AAD Limit Value
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AAD Limit Value
	40	Annual	-	AAD Limit Value
Particulate matter ($PM_{2.5}$)	20	Annual	-	AAD Limit Value
	10	Annual	-	Environmental Targets (fine particulate matter) (England) Regulations 2023
Carbon monoxide	10,000	8 hours, running	-	AAD Limit Value
	30,000	1 hour		Air Emissions Guidance
Hydrogen chloride	750	1 hour	-	Air Emissions Guidance

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

Pollutant	Limit value (µg/m³)	Averaging period	Frequency of exceedances	Source
Hydrogen fluoride	160	1 hour	-	Air Emissions Guidance
	16	Annual	-	Air Emissions Guidance
Ammonia	2,500	1 hour	-	Air Emissions Guidance
	180	Annual	-	Air Emissions Guidance
Lead	0.25	Annual	-	AQS Objective
Benzene	5.00	Annual	-	AQS Objective
	30	24 hour	-	Air Emissions Guidance
1,3-butadiene	2.25	Annual, running	-	AQS Objective
PCBs	6	1-hour	-	Air Emissions Guidance
	0.2	Annual	-	Air Emissions Guidance
PAHs	0.00025	Annual	-	AQS Objective

Table 2: Environmental Assessment Levels (EALs) for Metals

Metal	Daughter Directive target level (µg/m³)	EALs (µg/m³)	
		Long-term	Short-term
Arsenic	0.006	0.006	-
Antimony	-	5	150
Cadmium	0.005	0.005	-
Chromium (II & III)	-	5	150
Chromium (VI)	-	0.00025	-
Cobalt	-	-	-
Copper	-	10	200
Lead	-	0.25	-
Manganese	-	0.15	1500
Mercury	-	0.25	7.5
Nickel	0.020	0.020	-
Thallium	-	-	-
Vanadium	-	-	1 (daily average)

Table 3: Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75 / 200*	Daily mean	Air Emissions Guidance
	30	Annual mean	AQS Objective

Pollutant	Concentration (μg/m³)	Measured as	Source
Sulphur dioxide	10	Annual mean, for the protection of lichens and bryophytes	Air Emissions Guidance
	20	Annual mean for all higher plants	AQS Objective
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance
	0.5	Weekly mean	Air Emissions Guidance
Ammonia	1	Annual mean, for the protection of lichens and bryophytes	Air Emissions Guidance
	3	Annual mean For all higher plants	Air Emissions Guidance
Note: **The higher Critical Level of 200 μg/m³ is only for detailed assessments where ozone is below the AOT40 critical level and sulphur dioxide is below the lower Critical Level of 10 μg/m³* The *AOT40 for ozone is 6,000 μg/m³ calculated from accumulated hourly ozone concentrations – AOT40 means the sum of the difference between each hourly daytime (08:00 to 20:00 Central European Time (CET))) ozone concentration greater than 80 μg/m³ (40 ppb) and 80 μg/m³, for the period between 01 May and 31 July.*			

In addition to the Critical Levels set out in Table 3, provides habitat specific Critical Loads for nitrogen and acid deposition. Full details of the habitat specific Critical Loads can be found in Appendix B.

2.2 Areas of relevant exposure

The AQALs apply only at areas of exposure relevant to the assessment level. The following table extracted from Local Authority Air Quality Technical Guidance (LAQM.TG(22)) explains where the AQALs apply.

Table 4: Guidance on Where AQALs Apply

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

Averaging period	AQALs should apply at:	AQALs should generally not apply at:
24-hour mean and 8-hour mean	All locations where the annual mean AQAL would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
1-hour mean	All locations where the annual mean and 24 and 8-hour mean AQALs apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
15-minute mean	All locations where members of the public might reasonably be exposed for a period of 15-minutes or longer.	

Source: Box 1.1 LAQM.TG(22)

2.3 Industrial pollution regulation

Atmospheric emissions from industrial processes are controlled in England through the Environmental Permitting Regulations (2016) (and subsequent amendments). The Facility currently has an EP to operate. The EP includes conditions to ensure that the environmental impact of the operations is minimised. This includes conditions to prevent fugitive emissions of dust and odour beyond the boundary of the permitted activity, and limits on emissions to air.

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), was adopted on 07 January 2013, and is the key European Directive which covers almost all regulation of industrial processes in the European Union (EU). Within the IED, the requirements of the relevant sector BREF become binding as BAT guidance, as follows.

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

The EA explain that 'BAT' means the available techniques which are the best for preventing or minimising emissions and impacts on the environment where 'techniques' include both the technology used and the way the installation is designed, built, maintained, operated and decommissioned.

The Waste Incineration BREF was published by the European Integrated Pollution Prevention and Control (IPPC) Bureau in December 2019. The Waste Incineration BREF has introduced BAT-AELs which the Facility must comply with from 3 December 2023 and the existing EP has been varied to include these requirements. As noted in section 1.1 it has been assumed that emissions from the Facility are at the ELVs which apply from 3 December 2023, to allow a direct comparison between the impact of emissions from the Operational Facility and the Proposed Facility.

2.4 Local air quality management

In accordance with Section 82 of the Environment Act (1995) (Part IV), local authorities are required to periodically review and assess air quality within their area of jurisdiction, under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves assessing present and likely future ambient pollutant concentrations against AQALs. If it is predicted that levels at the façade of buildings where members of the public are regularly present (normally residential properties) are likely to be exceeded, then the local authority is required to declare an Air Quality Management Area (AQMA). For each AQMA, the local authority is required to produce an Air Quality Action Plan (AQAP), the objective of which is to reduce pollutant levels in pursuit of the relevant AQALs.

3 Baseline Air Quality

The Facility is located in Avonmouth, a predominantly industrial area within the administrative area of Bristol City Council (BCC) approximately 10 km northwest of Bristol city centre. The boundary with South Gloucestershire District Council (SGDC) lies immediately to the east of the Facility. The location of the Facility is shown on Figure 1 of Appendix A.

3.1 Air quality review and assessment

Under Section 82 of the Environment Act (1995) (Part IV), local authorities are required to undertake an ongoing exercise to review air quality within their area of jurisdiction.

The closest AQMA to the Facility is the Bristol AQMA, declared by BCC due to concern over concentrations of nitrogen dioxide and particulate matter. The Bristol AQMA lies approximately 7 km southeast of the Facility at the closest point. Due to the distance from the Facility the impact in this and all other AQMAs will be insignificant and the impact at AQMAs has not been considered further.

3.2 National modelling – mapped background data

In order to assist local authorities with their responsibilities under LAQM, Defra provides modelled background concentrations of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements and is used by local authorities in lieu of suitable monitoring data. In addition, mapped atmospheric concentrations of ammonia are available from CEH throughout the UK on a 5 km by 5 km grid. Concentrations will vary over the modelling domain area. Therefore, the maximum mapped background concentration data within the modelling domain (i.e. within 5 km) have been downloaded along with the concentrations for the grid squares containing the Facility. A summary is presented in Table 5.

Table 5: Mapped Background Data

Pollutant	Annual mean concentration (µg/m³)		Dataset
	At Facility	Max within 5 km of Facility	
Nitrogen dioxide	12.27	23.63	2018 Defra dataset
Sulphur dioxide	5.85	15.60	2001 Defra dataset
Particulate matter (as PM_{10})	13.96	15.91	2018 Defra dataset
Particulate matter (as $PM_{2.5}$)	8.58	10.17	2018 Defra dataset
Carbon monoxide	274	449	2001 Defra dataset
Benzene	0.39	0.88	2001 Defra dataset
1,3-butadiene	0.17	0.34	2001 Defra dataset
Ammonia	0.75	2.09	2014 CEH dataset

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Defra has not updated the mapped background datasets for carbon monoxide, sulphur dioxide, benzene and 1,3-butadeine since those produced for a base year of 2001. 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 assumption the 2001 mapped background concentrations have been presented. However, it is anticipated that concentrations of pollutants in the area, in particular sulphur dioxide, have decreased substantially since 2001.

3.3 AURN and LAQM monitoring data

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of the Defra. This includes automatic monitoring of oxides of nitrogen, nitrogen dioxide, sulphur dioxide, ozone, carbon monoxide and particulates.

Monitoring sites are broadly categorised into 'background' sites and 'roadside' sites. Background sites are positioned that they are not influenced significantly by any single source or street but rather by the contribution from all sources upwind of the station and are considered broadly representative for several square kilometres. Roadside sites are predominately determined by emissions from nearby traffic and are only representative of air quality for the immediate area of the analyser. As such, background sites within 5 km of the Facility and roadside sites within 3 km of the Facility have been considered in this analysis.

The closest AURN monitoring stations to the Facility are in Bristol city centre, approximately 10 km south-east. Due to the distance from the Facility and the city centre setting, these monitoring sites are not considered to be representative of the areas close to the Facility and AURN monitoring data has not been considered further.

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. A review of the most recent Air Quality Annual Status Reports (ASRs) published by BCC and SGDC shows that there is only one background site within 5 km of the Facility and no roadside sites within 3 km of the Facility. This is a diffusion tube monitoring nitrogen dioxide at an urban background location in Severn Beach approximately 3 km north of the Facility. A summary of monitoring data from this site is shown in Table 6.

Table 6: Diffusion Tube Monitoring within 10 km of the Facility

Diffusion Tube	Location		Nitrogen dioxide annual mean concentration (μg/m³)					
	X	Y	2018 mapped bg	2017	2018	2019	2020	2021
38 Severn Beach	354282	184653	11.94	13.8	13.6	12.3	9.8	10.8

Source: SGDC Annual Status Report 2022

As shown, the diffusion tube monitoring data from the background site is comparable to the mapped background for the grid square containing the diffusion tube, demonstrating that the mapped background is a reasonable estimation of concentrations at background locations away from local road sources.

3.4 Summary of mapped background, AURN and LAQM data

In summary, there is very little local monitoring available. However, where background monitoring is available it is similar to the 2018 Defra mapped background dataset. Therefore, in the first instance the maximum mapped background concentrations within the modelling domain, as presented in Table 5, have been used as the baseline concentrations for this assessment. Further consideration has been given to the choice of baseline concentration for any impacts that cannot be screened out as 'insignificant'.

3.5 Other national monitoring networks data

Neither the Defra mapped background dataset, AURN or LAQM include monitoring of other pollutants released from the Facility such as hydrogen chloride, hydrogen fluoride, VOCs, metals or dioxins. As such reference has been made to national modelling to determine a suitable baseline concentration.

3.5.1 Hydrogen chloride

Hydrogen chloride was measured until the end of 2015 on behalf of Defra as part of the UK Eutrophying and Acidifying Atmospheric Pollutants (UKEAP) project. This consolidates the previous Acid Deposition Monitoring Network (ADMN), and National Ammonia Monitoring Network (NAMN). Monitoring of hydrogen chloride ceased at the end of 2015 and none of the historic sites were located within 10 km of the site. Prior to the cessation of the monitoring concentrations were fairly constant.

The maximum annual average monitored within the UK between 2011 and 2015 was 0.71 $\mu g/m^3$. In lieu of any recent representative monitoring this has been used as the baseline concentration for this assessment as a conservative estimate. No other significant sources of hydrogen chloride emissions have been identified in the local area.

3.5.2 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are neither measured locally nor nationally, since these are not generally of concern in terms of local air quality. However, the EPAQS report 'Guidelines for halogens and hydrogen halides in ambient air for protecting human health against acute irritancy effects' contains some estimates of baseline levels, reporting that measured concentrations have been in the range of 0.036 $\mu g/m^3$ to 2.35 $\mu g/m^3$.

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration has been used for the purpose of this assessment as a conservative estimate. No other significant sources of hydrogen fluoride emissions have been identified in the local area.

3.5.3 Ammonia

Ammonia is also measured as part of the UKEAP project at rural background locations. There are no UKEAP monitoring locations within 10 km of the Facility. The nearest monitoring site is at Castle Cary, approximately 50 km to the south. In lieu of any local UKEAP monitoring, the maximum CEH mapped background value from within 5 km of the Facility (2.09 $\mu g/m^3$) has been used for the purpose of the assessment of impacts on human health. For the assessment of any impacts on ecological features that cannot be screened out as 'insignificant', site-specific baseline data has been obtained from APIS.

3.5.4 Volatile Organic Compounds

As part of the Automatic and Non-Automatic Hydrocarbon Network, benzene concentrations are measured at sites co-located with the AURN across the UK. In 2007, due to low monitored concentrations of 1,3-butadiene at non-automatic sites, Defra took the decision to cease non-automatic monitoring of 1,3-butadiene.

There are no benzene monitoring sites within 10 km of the Facility. The closest sites are at Bath and Newport, both approximately 25 km from the Facility. Therefore, the maximum mapped background values within 5 km of the Facility shown in Table 5, 0.88 µg/m³ and 0.34 µg/m³ for benzene and 1,3-butadiene respectively, have been used as the baseline concentrations for this assessment.

3.5.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). The closest metals monitoring site is located at Port Talbot, over 75 km to the west. As no representative local monitoring is available, a review of the metals monitoring across the UK has been carried out and the maximum annual mean concentration from urban background sites has been determined as shown in Table 7. This is considered appropriate for the setting of the Facility; although the Avonmouth area is industrial, it does not contain any significant sources of metals such as steelworks.

Table 7: Metals Monitoring – Maximum Annual Mean Concentrations at Urban Background Sites

Substance	Annual mean concentration (ng/m³)						Max (as % of AQAL)
	AQAL	2018	2019	2020	2021	2022	
Cadmium	5	0.43	0.35	0.42	0.35	0.29	8.6%
Mercury	250	2.80	-	-	-	-	1.1%
Arsenic	6	1.00	1.00	1.00	0.98	0.90	16.7%
Chromium	5,000	5.80	4.20	3.70	4.80	4.60	0.12%
Cobalt	-	0.92	0.56	0.84	0.65	1.50	-
Copper	10,000	26.00	22.00	18.00	16.00	18.00	0.26%
Lead	250	20.00	11.00	7.80	15.00	8.00	8.0%
Manganese	150	9.70	7.80	10.00	7.60	8.50	6.7%
Nickel	20	2.20	1.80	1.70	2.20	2.50	12.5%
Vanadium	-	1.70	1.50	3.00	3.00	1.90	-

Notes:

Excludes data from Sheffield Tinsley and Swansea for chromium, lead, manganese and nickel – although these are background sites they are located close to significant industrial sources of metals and as such have high levels of these pollutants far greater than that monitored at other background sites.

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There is also an AQAL for antimony. However, monitoring of antimony across the UK ceased at the end of 2013. The maximum monitored at any background site in 2013 was 1.30 ng/m³ at Detling, which has been used as the baseline concentration for the assessment. This value is only 0.026% of the annual mean AQAL of 5,000 ng/m³.

As shown, the concentrations monitored were significantly lower than the AQALs. As a conservative assumption the maximum monitored annual mean concentration of each metal from an urban background monitor between 2018 and 2022 as presented in Table 7 has been used as the baseline concentration within this assessment.

3.5.6 Dioxins, furans and polychlorinated biphenyl (PCBs)

Dioxins, furans and PBCs are monitored on a quarterly basis at a number of urban and rural stations in the UK as part of the Toxic Organic Micro Pollutants (TOMPs) network. There are no monitoring locations within 10 km of the Facility. The closest monitoring site is located in Cardiff, approximately 35 km to the west.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 8 and Table 9. Note that monitoring data for dioxins and furans is only available up to the end of 2016 from the UK-Air website. For PCBs, data is only available up to the end of 2018 from the UK-Air website.

Table 8: TOMPS – Dioxin and Furans Monitoring

Site	Annual mean concentration (fgTEQ/m³)				
	2012	2013	2014	2015	2016
Auchencorth Moss	0.13	0.86	0.01	0.01	0.13
Hazelrigg	8.75	2.02	2.61	5.27	4.59
High Muffles	4.32	0.6	1.07	0.54	2.73
London Nobel House	15.42	3.47	2.89	4.34	21.27
Manchester Law Courts	32.99	10.19	16.52	5.94	12.23
Weybourne	9.3	2.34	1.61	1.42	16.32

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Table 9:TOMPS – PCB Monitoring

Site	Annual mean concentration (pg/m³)				
	2014	2015	2016	2017	2018
Auchencorth Moss	23.23	24.27	25.32	19.09	12.31
Hazelrigg	25.84	41.68	52.58	33.15	22.22
High Muffles	26.11	33.43	37.76	31.63	8.86
London Nobel House	107.49	121.39	110.46	121.87	46.63
Manchester Law Courts	128.93	97.99	92.6	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

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As shown, the concentrations vary significantly between sites and years. As there are no monitoring sites located within close proximity of the Facility, or any mapped background datasets, the maximum monitored concentrations from the most recent 5 years of monitoring have been used as the background concentrations within this assessment. These values are 32.99 fg/TEQ/m³ for dioxins and furans and 128.93 pg/m³ for PCBs.

3.5.7 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic Aromatic Hydrocarbons (PAHs) are monitored at a number of stations in the UK as part of the PAH network. For the purpose of this assessment, benzo(a)pyrene is considered as this is the only PAH which an AQAL has been set. The closest PAH analysers to the Facility is Bristol St Pauls, 9.5 km to the southeast. This is unlikely to be representative of the concentrations in the vicinity of the Facility.

A summary of benzo(a)pyrene concentrations from all urban background sites in the UK is presented in Table 10.

Table 10: National Monitoring - Benzo(a)pyrene

Site Type	Quantity	AQAL (ng/m^3)	Annual mean concentration (ng/m^3)				
			2018	2019	2020	2021	2022
All urban background sites	Min	0.25	0.08	0.05	0.06	0.06	0.04
	Max		1.30	0.86	0.74	0.83	0.55
	Average		0.33	0.24	0.21	0.26	0.19

Source: © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

As shown the maximum monitored concentration exceeds the AQAL of 0.25 ng/m^3. However, the AQAL goes beyond the requirement of the European Directive (Commission Decision 2004/107/EC) which sets a target value of 1 ng/m^3. In lieu of any local monitoring of PAHs or any mapped background datasets, the maximum concentration from any urban background site has been used (1.30 ng/m^3 – 2016) as a screening assumption, noting that this exceeds the AQAL.

3.6 Summary

Table 11 outlines the values for the annual average baseline concentrations that have been used to evaluate the impact of the Facility. The choice of baseline concentration will be considered further if the impact of the Facility cannot be screened out as 'insignificant'.

Table 11: Summary of Baseline Concentrations

Pollutant	Annual mean concentration	Units	Justification
Nitrogen dioxide	23.63	$\mu g/m^3$	Maximum mapped background concentration within modelling domain (2018 Defra dataset)
Sulphur dioxide	15.60	$\mu g/m^3$	Maximum mapped background concentration within modelling domain (2001 Defra dataset)
Particulate matter (as PM_{10})	15.91	$\mu g/m^3$	Maximum mapped background concentration within modelling domain (2018 Defra dataset)
Particulate matter (as $PM_{2.5}$)	10.17	$\mu g/m^3$	Maximum mapped background concentration within modelling domain (2018 Defra dataset)
Carbon monoxide	449	$\mu g/m^3$	Maximum mapped background concentration within modelling domain (2001 Defra dataset)
Hydrogen chloride	0.71	$\mu g/m^3$	Maximum monitored concentration across the UK 2011 to 2015
Hydrogen fluoride	2.35	$\mu g/m^3$	Maximum measured concentration from EPAQS report

Pollutant	Annual mean concentration	Units	Justification
Ammonia	2.09	µg/m³	Maximum mapped background concentration within modelling domain (2014 CEH dataset)
Benzene	0.88	µg/m³	Maximum mapped background concentration within modelling domain (2001 Defra dataset)
1,3-butadiene	0.34	µg/m³	
Cadmium	0.43	ng/m³	Maximum monitored 2018 to 2022 at any UK urban background site. Chromium VI assumed to be 20% of total chromium.
Mercury	2.80	ng/m³	
Arsenic	1.00	ng/m³	
Chromium	5.80	ng/m³	
Chromium VI	1.16	ng/m³	
Cobalt	1.50	ng/m³	
Copper	26.00	ng/m³	
Lead	20.00	ng/m³	
Manganese	10.00	ng/m³	
Nickel	2.50	ng/m³	
Vanadium	3.00	ng/m³	
Antimony	1.30	ng/m³	The maximum monitored at any background site from the last year this was monitored (2013)
Dioxins and furans	32.99	fg/m³	Maximum UK monitored concentration between 2012 and 2016
Polychlorinated biphenyl (PCBs)	128.93	pg/m³	Maximum UK monitored concentration between 2014 and 2018
Benzo(a)pyrene (PAHs)	1.30	ng/m³	Maximum monitored 2018 to 2022 at any urban background site

4 Sensitive Receptors

4.1 Human sensitive receptors

The general approach to the assessment is to evaluate the highest predicted process contribution to concentrations at a height of 1.5m, to represent typical breathing height. In addition, the predicted process contribution at a number of sensitive receptors has been evaluated. These sensitive receptors have been selected to represent the residential dwellings and schools most likely to be impacted by emissions from the Facility. The receptors are displayed in Figure 2 of Appendix A and listed in Table 12.

Table 12: Sensitive Receptors

ID	Receptor name	Location			Distance from the stack (km)
		X (m)	Y (m)	Z (m)	
R1	Oasis Academy Bank Leaze Primary School	354968	178939	1.5	2.91
R2	Berwick Lodge	356047	180752	1.5	2.35
R3	Elmington Manor Farm	355666	181552	1.5	1.81
R4	Berwick Farm	355558	180980	1.5	1.82
R5	Hallen Farm	354654	180371	1.5	1.48
R6	Brook Farm	356177	182237	1.5	2.39

4.2 Ecological sensitive receptors

The EA has provided a nature and heritage conservation screening report to identify the following sites of ecological importance in accordance with Air Emissions Guidance criteria:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the Facility;
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Facility; and
- Local Nature Sites[3] within 2 km of the Facility.

The sensitive ecological receptors identified are presented by distance from the stack in Table 13 and are displayed in Figure 3 of Appendix A.

Table 13: Sensitive Ecological Receptors

ID	Name	Location (closest point)		Distance from stack at closest point (km)
		X (m)	Y (m)	
European and UK Designated Sites				
E1	Severn Estuary SAC, SPA, Ramsar, SSSI	353100	182250	0.98
E2	Avon Gorge Woodlands SAC	354800	175640	6.06
E3	River Wye SAC	354450	191110	9.50

[3] National Nature Reserves (NNR), Local Nature Reserves (LNRs), Local Wildlife Sites and ancient woodlands.

ID	Name	Location (closest point)		Distance from stack at closest point (km)
		X (m)	Y (m)	
Local Nature Sites				
E4[(1)]	Point of maximum impact	-	-	-

Note:
[(1)] A total of ten local nature sites have been identified in the nature and conservation screening report. As a screening assumption it has been assumed that the maximum impact of emissions from the Facility occurs at a local nature site.

The Severn Estuary covers a large area in close proximity to the Facility. For the assessment of impacts at the Severn Estuary, the maximum impact across the designated site has been calculated. For the Avon Gorge Woodlands and River Wye SACs the impact has been assessed using a single receptor point at the closest point of each SAC to the Facility.

5 Modelling Methodology

5.1 Selection of model

Detailed dispersion modelling was undertaking using the model ADMS 6, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the atmospheric stability and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the EA and local authorities.

5.2 Source and emissions data

The source and emissions input data utilised within the modelling are presented in Table 14 to Table 16. The data for the Operational Facility has been taken from data recorded by the continuous emissions monitoring system (CEMS) from 11 January 2021 – 11 January 2022.

The data on the waste throughput and NCV recorded at the Facility shows that during the period 11 January 2021 – 11 January 2022 the average thermal input was 56.7 MWth, which is 99% of the design thermal input (100% maximum continuous rating, MCR) of 57.3 MWth. This shows that the Facility has been operating very close to its design point on average. To represent the Proposed Facility operating at 110% MCR, the average flue gas flow rate recorded by the CEMS has been increased by a factor of 11%.

Table 14: Source Data

Item	Unit	Operational Facility	Proposed Facility
Stack data			
Height	m	90	
Effective internal diameter	m	2.404	
Location	m, m	353862, 181627	
Flue gas conditions			
Temperature	°C	147.2	
Exit moisture content	% v/v	17.66%	
Exit oxygen content	% v/v dry	7.36%	
Reference oxygen content	% v/v dry	11%	
Volume at reference conditions (dry, ref O_2)	Nm^3/h	272,339	302,794
	Nm^3/s	75.65	84.11
Volume at actual conditions	Am^3/h	372,673	414,349
	Am^3/s	103.52	115.10
Flue gas exit velocity	m/s	22.81	25.36

The effective internal diameter of 2.404 m is representative of the two individual flues of diameter 1.7 m combined. These have been entered into the model as a single combined source.

Table 15: Stack Emissions Data – Daily or Periodic ELV

Pollutant	Daily or periodic	Operational Facility	Proposed Facility
	Conc. (mg/Nm^3)	Release rate (g/s)	
Oxides of nitrogen (as NO_2)	180	13.617	15.140
Sulphur dioxide	40	3.026	3.364
Carbon monoxide(1)	50	3.782	4.205
Fine particulate matter (PM)(2)	5	0.378	0.421
Hydrogen chloride	8	0.605	0.673
Volatile organic compounds (as TOC)	10	0.756	0.841
Hydrogen fluoride	1	0.076	0.084
Ammonia	15	1.135	1.262
Cadmium and thallium	0.02	1.513 mg/s	1.682 mg/s
Mercury	0.02	1.513 mg/s	1.682 mg/s
Other metals(3)	0.3	22.695 mg/s	25.233 mg/s
Benzo(a)pyrene (PAHs)(4)	0.2 $\mu g/Nm^3$	15.130 µg/s	16.822 µg/s
Dioxins and furans(5)	0.06 ng/Nm^3	4.539 ng/s	5.047 ng/s
PCBs(6)	5 $\mu g/Nm^3$	0.378 mg/s	0.421 mg/s

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

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

(4) 0.2 $\mu g/m^3$ is the maximum recorded at a UK plant (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the Facility.

(5) The EP includes a limit of 0.06 ng I-TEQ/Nm^3 as an average over a minimum of 6 hours, and a limit of 0.08 ng I-TEQ/Nm^3 as a long-term average over a minimum of 2 weeks. The long-term average sampling is only required if it cannot be demonstrated that emissions are low and stable. It has been assumed that the long-term average monitoring will not be required and an emission limit of 0.06 ng I-TEQ/Nm^3 is representative of the maximum annual mean emission concentration from the Facility.

(6) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

As shown in Table 14, the volumetric flow rate on a normalised and actual basis is greater for the Proposed Facility than the Operational Facility. As a result, a greater quantity of pollutants would be released on a g/s basis from the Proposed Facility due to the increase volume of flue gas through the stack. However, these would be released at a greater velocity.

Table 16: Stack Emissions Data – Short Term

Pollutant	Half-hourly ELV	Operational Facility	Proposed Facility
	mg/Nm³	Release rate (g/s)	
Oxides of nitrogen (as NO_2)	400	30.260	33.644
Sulphur dioxide	200	15.130	16.822
Carbon monoxide(1)	150	11.347	12.616
Fine particulate matter (PM)(2)	30	2.269	2.523
Hydrogen chloride	60	4.539	5.047
Volatile organic compounds (as TOC)	20	1.513	1.682
Hydrogen fluoride	4	0.303	0.336

Notes:
All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.
(1) Averaging period for carbon monoxide is 95%ile of all 10-minute averages in any 24-hour period.
(2) As a worst-case it has been assumed that the entire PM emissions consist of PM_{10} for comparison with the relevant short term AQAL.

5.3 Other inputs

5.3.1 Modelling domain

Modelling has been undertaken over a grid of 9 x 9 km with grid spacing of 90 m, with a nested grid of 3 x 3 km with a grid spacing of 30 m. The nested grid option has been used to ensure that the variations in concentrations around the point of maximum impact can be accurately accounted for, while also covering a wider area to consider the more distant receptors. Reference should be made to Figure 4 of Appendix A for a graphical representation of the modelling domain.

Table 17: Modelling Domain

Nested grid	Nested grid	Wider area
Grid Spacing (m)	30	90
Grid Start X	352500	349500
Grid Finish X	355500	358500
Grid Start Y	180200	177200
Grid Finish Y	180200	186200

5.3.2 Meteorological data and surface characteristics

The impact of meteorological data has been taken into account by using meteorological data from the Avonmouth meteorological recording station for the years 2016 – 2020 sourced from Air Pollution Services (APS) Limited. The Avonmouth recording station is located approximately 4.5 km southwest of the Facility and is the closest meteorological station available. 5 years of recent (i.e.

within the last 10 years) data has been used to allow for inter-annual variability in meteorological conditions (as recommended by the EA). Wind roses for each year of meteorological data can be found in Figure 5 of Appendix A.

The minimum Monin-Obukhov length utilised in ADMS can be selected for both the dispersion site and 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. Surface conditions at the Facility are mixed industrial uses whilst conditions at Avonmouth are influenced by its coastal location. As such, the minimum Monin-Obukhov length has been set to 30 m at the dispersion site as recommended by CERC for 'mixed urban/industrial', whilst the meteorological site has been set to 1 m due to its coastal location as the immediate proximity of the sea can result in stable conditions if the sea is cooler than the air.

The surface roughness length can be selected in ADMS for both the dispersion site and the meteorological site. The surface roughness has been set to 0.061 m for the meteorological site, which was recommended by APS as a weighted average of the land uses around the meteorological site.

The surface roughness length varies widely across the modelling domain, from very low values over the Severn estuary to much higher values over built-up areas. To account for the varying surface roughness length a spatially-varying surface roughness file has been generated. The land-use class for each point in the file has been extracted from the CORINE Land Cover database[4] and cross-referenced with the most likely surface roughness length value[5].

The parameters for the spatially-varying surface roughness file are shown in Table 18 and a visual representation shown in Figure 6.

Table 18: Spatially Varying Surface Roughness File Parameters

Parameter	Value
Grid spacing (m)	150
Grid points	67 x 67
Modelled resolution	64 x 64
Grid Start X (m)	348975
Grid Finish X (m)	359025
Grid Start Y (m)	176700
Grid Finish Y (m)	186750

Table 19: Surface Roughness Lengths Used for Different Land Use Classes

Land use classification	Corine 2018 land use codes	Surface roughness length (m)
Broad-leaved forest Coniferous forest	311 312	0.75
Green urban areas Transitional woodland/shrub	141 324	0.6

4 https://land.copernicus.eu/pan-european/corine-land-cover

5 Taken from "Roughness length classification of Corine Land Cover classes", Megajoule Consultants, 2007.

Land use classification	Corine 2018 land use codes	Surface roughness length (m)
Discontinuous urban fabric Construction sites Industrial or commercial units Sport and leisure facilities Port areas	112 133 121 142 123	0.5
Road and rail networks and associated land	122	0.075
Non-irrigated arable land Inland marshes Salt marshes	211 411 421	0.05
Pastures	231	0.03
Airports Mineral extraction sites Sparsely vegetated areas	124 132 333	0.005
Intertidal flats	423	0.001
Water*	511	0.0001
**CLC roughness classification for water is 0, but this is not a valid input for ADMS. The value has been set to 0.0001m, which is the value recommended by CERC for 'sea'.*		

The closest points of ecological receptors E2 and E3 lie outside of the surface roughness file extent (and terrain file extent, see section 5.3.3). Therefore, the impact at these receptors has been assessed without the effect of terrain and spatially varying surface roughness length. The effect of wind turbines (see section 5.3.5) has also been excluded, as the wind turbines wakes will not interact with the plume from the Facility when it is blowing towards receptors E2 and E3. A constant surface roughness length of 0.3 m has been used for this model run. It is noted that the sensitivity analyses presented in section 6 show that the results away from the point of maximum impact are not highly sensitive to the choice of surface roughness length or the inclusion of terrain effects.

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 20.

Table 20: Meteorological parameters

Parameter	Dispersion site value (m)	Met site value (m)
Surface roughness length	Variable	0.061
Minimum Monin-Obukhov length	30	1

5.3.3 Terrain

CERC recommends that, where gradients within 500 m of the modelling domain are greater than 1 in 10, the complex terrain module within ADMS (FLOWSTAR) should be used. A review of the local area has deemed that the effect of terrain should be taken into account in the modelling, although gradients greater than 1 in 10 are located in the southeast of the modelling domain and are unlikely to have a large effect on concentrations at the point of maximum impact.

A terrain file large enough to cover the output grid of points was created using Ordnance Survey Terrain 50 data. The parameters of the terrain file used the same as for the surface roughness file detailed in Table 18, and a graphical representation of the file provided in Figure 7.

5.3.4 Buildings

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

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

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

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

The ADMS 6 user guide also states that buildings less than one third of the stack height will not have any effect on dispersion.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 21. A site plan showing which buildings have been included in the model is presented in Figure 8 of Appendix A.

Table 21: Building Details

Buildings	Centre point		Height (m)	Length (m)	Width (m)	Angle (°)
	X (m)	Y (m)				
A	353738	181758	25	80.4	153.7	33
B (main building)	353848	181687	50	78.6	108.8	33
C	353927	181636	30	63.8	78.2	33

5.3.5 Wind turbines

Wind turbine wakes have the potential to interfere with dispersion of pollutants when the stack is within 12 – 15 rotor diameters of the turbine, with the wind turbine effects becoming more noticeable when the stack is within a few rotor diameters of the turbine.

There are three wind turbines located within close proximity to the Facility. Due to the proximity of the turbines it is considered that they should be included in the dispersion modelling. The details of the turbines are presented in Table 22 and their locations shown on Figure 9.

Table 22: Wind Turbines Included in Dispersion Modelling

Ref	Turbine type	Hub height (m)	Rotor diameter (m)	X (m)	Y (m)	Distance from stack (m)
A	Nordex N100	80	100	353135	181967	803
B	Nordex N100	80	100	353395	181825	507

Ref	Turbine type	Hub height (m)	Rotor diameter (m)	X (m)	Y (m)	Distance from stack (m)
C	Enercon E115	92	115	353352	182327	866

As shown, these turbines are all well within 12 rotor diameters of the stack. The sensitivity of the model results to the inclusion or exclusion of wind turbine effects is considered in section 6.4.

5.4 Chemistry

The Facility will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are collectively referred to as oxides of nitrogen (NOx). In the atmosphere, NO will be converted to NO_2 in a reaction with ozone (O_3) which is influenced by solar radiation. Since the AQALs are expressed in terms of NO_2, it is important to be able to assess the conversion rate of NO to NO_2.

Ground level NOx concentrations have been predicted through dispersion modelling. NO_2 concentrations reported in the results section assume 70% conversion from NOx to NO_2 for annual means and a 35% conversion for short term (hourly) concentrations, based upon the worst-case scenario specified in the EA's guidance for dispersion modelling[6] which is appropriate where the primary NO_2 to NOx ratio is less than 10%. Given the short travel time to the areas of maximum concentrations, this approach is considered conservative.

5.5 Baseline concentrations

Baseline concentrations for the assessment have been derived from monitoring and national mapping as summarised in Table 11. For short term averaging periods, the baseline concentration has been assumed to be twice the long-term ambient concentration following the EA recommendation within the Air Emission Guidance.

The Facility became operational in 2020, so the contribution it makes to baseline concentrations is not captured in the 2018-based Defra background maps. As such, the background maps provide an appropriate baseline as this avoids double-counting the contribution from the Facility.

Other local point sources may contribute to the baseline concentrations, in particular the Severnside Energy Recovery Centre, an energy from waste plant, and the Seabank combined cycle gas turbine (CCGT) power station, both located approximately 1 km to the north. As both of these sources have been operational for several years, their contribution to baseline concentrations is captured in the latest Defra background maps. The maximum 2018-based mapped background concentrations from within 5 km of the Facility have been used to determine baseline concentrations for some pollutants; for others, conservative baseline values have been taken from older mapped background data or national monitoring datasets. Therefore, these local point sources are highly unlikely to increase baseline concentrations to above the conservative values presented in Table 11 and these sources have not been explicitly modelled.

6 https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

6 Sensitivity Analysis

The sensitivity of the dispersion modelling results to various input parameters has been tested in accordance with EA guidance on dispersion modelling reports[7]. This has been undertaken using meteorological data for 2016, which is the year which results in the maximum annual mean impact.

6.1 Surface roughness

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

The following parameters have been kept constant:

- Scenario – Proposed Facility;
- Grid – nested 3 km x 3 km at 30 m resolution within wider 9 km x 9 km at 90 m resolution;
- Buildings – included;
- Wind turbines – included;
- Terrain file – included at 64 x 64 resolution;
- Meteorological site surface roughness – 0.061 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Avonmouth 2016.

The contribution of the Facility to the ground level concentrations of oxides of nitrogen at the point of maximum impact and at the maximum impacted receptor are presented in Table 23.

Table 23: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Variable	**2.15**	**47.32**	**0.80**	**22.99**
0.1	2.77	40.07	0.84	29.00
0.2	3.01	40.43	0.80	28.34
0.3	3.14	40.88	0.80	26.20
0.5	3.33	41.66	0.80	25.86
0.7	3.46	42.27	0.80	24.51
% Change from Variable				
0.1	29.2%	-15.3%	5.0%	26.1%
0.2	40.1%	-14.6%	-0.2%	23.3%
0.3	46.3%	-13.6%	-0.4%	14.0%

[7] https://www.gov.uk/guidance/environmental-permitting-air-dispersion-modelling-reports

Surface roughness (m)	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
0.5	55.0%	-12.0%	0.3%	12.5%
0.7	60.9%	-10.7%	0.4%	6.6%

As shown, higher surface roughness lengths result in higher annual mean concentrations but lower short-term concentrations. The use of a spatially varying surface roughness file results in a lower maximum annual mean concentration and higher short-term concentration than any of the constant surface roughness lengths modelled.

In contrast to the point of maximum impact, at the maximum impacted receptor the spatially varying surface roughness file results in high annual mean concentrations and lower short-term concentrations than any constant surface roughness length modelled. However, there is little difference in the annual mean concentration between scenarios.

Due to the sensitivity of the maximum results to the choice of surface roughness length it is considered appropriate to use the spatially varying surface roughness file in the main model runs as this most accurately represents the variations in land use and surface roughness around the Facility.

6.2 Building parameters

ADMS 6 has a buildings effects module to account for the impact of buildings when it calculates the air flow and dispersion of pollutants from a source. The sensitivity of the results to the effect of buildings has been considered by running the model with the building presented in Table 21 and with no buildings at all.

The following parameters have been kept constant:

- Scenario – Proposed Facility;
- Grid – nested 3 km x 3 km at 30 m resolution within wider 9 km x 9 km at 90 m resolution;
- Wind turbines – included;
- Terrain file – included at 64 x 64 resolution;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.061 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Avonmouth 2016.

The contribution of the Facility to the ground level concentrations of oxides of nitrogen at the point of maximum predicted concentration and maximum impacted receptor are presented in Table 24 for each scenario.

Table 24: Effect of Buildings

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual Mean	Max 1-hour mean	Annual Mean	Max 1-hour mean
Including buildings	**2.15**	**47.32**	**0.80**	**22.99**
Excluding buildings	0.64	30.46	0.49	21.40
% Change	-70.0%	-35.6%	-38.3%	-6.9%

As shown, modelling the presence of buildings results in much higher annual mean and short-term concentrations at the point of maximum impact and the maximum impacted receptor. Building effects have been included in the dispersion model as this is the most realistic scenario.

6.3 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without the terrain file.

The following parameters have been kept constant:

- Scenario – Proposed Facility;
- Grid – nested 3 km x 3 km at 30 m resolution within wider 9 km x 9 km at 90 m resolution;
- Buildings – included;
- Wind turbines – included;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.061 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Avonmouth 2016.

The contribution of the Proposed Facility to the ground level concentrations of oxides of nitrogen at the point of maximum predicted concentration and maximum impacted receptor are presented in Table 25 for each scenario.

Table 25: Effect of Terrain

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Including terrain	**2.15**	**47.32**	**0.80**	**22.99**
Excluding terrain	2.13	46.95	0.82	22.30
% Change	-1.0%	-0.8%	2.1%	-3.0%

As shown, modelling the effect of terrain has a small effect on the annual mean and maximum 1-hour concentrations. The main model runs have included the effect of complex terrain as this is the most realistic scenario.

6.4 Wind turbines

The sensitivity of the results to the effect of nearby wind turbines has been considered by running the model with and without the wind turbines.

The following parameters have been kept constant:

- Scenario – Proposed Facility;
- Grid – nested 3 km x 3 km at 30 m resolution within wider 9 km x 9 km at 90 m resolution;
- Buildings – included;
- Terrain file – included at 64 x 64 resolution;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.061 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Avonmouth 2016.

The contribution of the Proposed Facility to the ground level concentrations of oxides of nitrogen at the point of maximum predicted concentration and maximum impacted receptor are presented in Table 25 for each scenario.

Table 26: Effect of Wind Turbines

Scenario	Oxides of nitrogen PC (µg/m³)			
	Point of maximum impact		Maximum impacted receptor	
	Annual mean	Max 1-hour mean	Annual mean	Max 1-hour mean
Including wind turbines	**2.15**	**47.32**	**0.80**	**22.99**
Excluding wind turbines	2.10	47.39	0.76	22.69
% Change	-2.1%	0.1%	-5.6%	-1.3%

As shown, modelling the effect of wind turbines has a small effect on the annual mean and maximum 1-hour concentrations at the point of maximum impact and at the maximum impacted receptor. The greatest effect would occur downwind of the turbines. The main model runs have included the effect of wind turbines as this is the most realistic scenario.

6.5 Grid resolution

The sensitivity of the results to the grid resolution used has been considered by comparing the results with the nested grid (which has the finest resolution of 30 m close to the stack, in the vicinity of the point of maximum impact) with a finer grid resolution of 10 m.

The following parameters were kept constant:

- Scenario – Proposed Facility;

- Buildings – included;
- Wind turbines – included;
- Terrain file – included at 64 x 64 resolution;
- Dispersion site surface roughness – spatially varying at 64 x 64 resolution;
- Meteorological site surface roughness – 0.061 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 1 m; and
- Meteorological data used – Avonmouth 2016.

The contribution of the Facility to the ground level concentration of NOx at the point of maximum impact is presented in Table 27 for each scenario.

Table 27: Effect of Grid Resolution

Grid resolution used in model (m)	Oxides of nitrogen PC (µg/m³)	
	Annual mean	Max 1-hour mean
30 m	**2.13**	**47.32**
10 m	2.15	48.13
% change	0.2%	1.7%

As shown, the choice of grid resolution has a negligible effect on the maximum annual mean concentrations and short-term concentrations. The output grid resolution of 30 m is considered sufficiently fine to accurately capture the maximum predicted concentrations. The choice of grid resolution does not affect the impacts at the specific receptor points.

6.6 Operating below the design point

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

7 Impact on Human Health

7.1 Screening criteria

The Air Emissions Guidance states that to screen out 'insignificant' process contributions:

- the long-term process contribution must be less than 1% of the long-term environmental standard; and
- the short-term process contribution must be less than 10% of the short-term environmental standard.

Consultation with the EA has confirmed that if the above criteria are achieved, it can be concluded that "it is not likely that emissions would lead to significant environmental impacts" and the process contributions can be screened out. These screening criteria have been applied to the change in process contribution as a result of the EP variation.

The long-term 1% process contribution threshold is based on the judgement that:

- it is unlikely that an emission at this level will make a significant contribution to air quality; and
- the threshold provides a substantial safety margin to protect health and the environment.

The short-term 10% process contribution threshold is based on the judgement that:

- spatial and temporal conditions mean that short-term process contributions are transient and limited in comparison with long-term process contributions; and
- the threshold provides a substantial safety margin to protect health and the environment.

If the change in process contributions cannot be screened out, assessment of the following should be undertaken:

- the predicted environmental concentration (PEC) at the point of maximum impact – defined as the process contribution plus the baseline concentration; and
- the- change in process contribution and PEC at areas of public exposure.

In these cases, consultation with the EA has confirmed that if the long-term PEC is below 70% of the AQAL, or the change in short-term process contribution is less than 20% of the headroom[8] it can be concluded that "there is little risk of the PEC exceeding the AQAL", and the impact can be considered to be 'not significant'.

The EA guidance document 'Guidance on assessing group 3 metals stack emissions from incinerators – V.4 June 2016' ('EA metals guidance') states that where the process contribution for any metal exceeds 1% of the long term or 10% of the short-term environmental standard (in this case the AQAL), this is considered to have potential for significant pollution. Where the process contribution exceeds these criteria, the PEC should be compared to the AQAL. The PEC can be screened out if is less than the AQAL. Where the impact is within these parameters it can be concluded that there is no risk of exceeding the AQAL.

7.2 Results

Table 28 and Table 29 present the results of the dispersion modelling of process emissions from the Operational Facility and the Proposed Facility at the point of maximum impact. This is a summary of the maximum predicted impact using 5 years of weather data. Detailed results tables for each

[8] Calculated as the AQAL minus twice the long-term background concentration.

year of weather data are provided in Appendix D. Results are presented as the maximum predicted concentration based on the following:

- Grid – nested 3 x 3 km at 30 m resolution within wider 9 x 9 km at 90 m resolution;
- Buildings – included;
- Stack height – 90 m;
- Spatially varying terrain and surface roughness – included;
- 5 years of weather data 2016 to 2020 from the Avonmouth meteorological recording station;
- Operation at the long term ELVs for the entire year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions (Table 29 only);
- EA's worst case conversion of NOx to nitrogen dioxide;
- The entire dust emissions consist of either PM_{10} of $PM_{2.5}$;
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

Process contributions that cannot be screened out as 'insignificant' are highlighted. Where the process contribution cannot be screened out as 'insignificant', further analysis has been undertaken.

Table 28: Dispersion Modelling Results – Point of Maximum Impact - Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg conc.	Operational Facility		Proposed Facility				Change in PC		
					Max PC	Max PC as % of AQAL	Max PC	Max PC as % of AQAL	Max PEC	Max PEC as % of AQAL	Conc.	as % of AQAL	As % of Operational Facility
Nitrogen dioxide	Annual mean	µg/m³	40	23.63	1.47	**3.67%**	1.50	**3.76%**	25.13	62.83%	0.03	0.09%	2.32%
	99.79th %ile of hourly means	µg/m³	200	47.26	9.20	4.60%	9.54	4.77%	56.80	28.40%	0.35	0.17%	3.77%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	31.20	3.70	2.96%	3.83	3.07%	35.03	28.03%	0.13	0.11%	3.57%
	99.73rd %ile of hourly means	µg/m³	350	31.20	5.59	1.60%	5.86	1.67%	37.06	10.59%	0.27	0.08%	4.79%
	99.9th %ile of 15 min. means	µg/m³	266	31.20	6.84	2.57%	7.04	2.65%	38.24	14.38%	0.21	0.08%	3.06%
PM_{10}	Annual mean	µg/m³	40	15.91	0.06	0.15%	0.06	0.15%	15.97	39.92%	0.00	<0.01%	2.31%
	90.41st %ile of daily means	µg/m³	50	31.82	0.21	0.41%	0.21	0.42%	32.03	64.06%	0.01	0.01%	2.73%
$PM_{2.5}$	Annual mean	µg/m³	20	10.17	0.06	0.29%	0.06	0.30%	10.23	51.15%	0.00	0.01%	2.31%
			10*	10.17	0.06	0.58%	0.06	0.60%	10.23	102.30%	0.00	0.01%	2.31%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	7.48	0.07%	7.70	0.08%	905.70	9.06%	0.23	<0.01%	3.02%
	Hourly mean	µg/m³	30,000	898	13.62	0.05%	13.14	0.04%	911.14	3.04%	-0.48	<0.01%	-3.50%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	2.18	0.29%	2.10	0.28%	3.52	0.47%	-0.08	-0.01%	-3.50%
	Annual mean	µg/m³	16	2.35	0.01	0.07%	0.01	0.07%	2.36	14.76%	0.00	<0.01%	2.31%

Pollutant	Quantity	Units	AQAL	Bg conc.	Operational Facility		Proposed Facility				Change in PC		
					Max PC	Max PC as % of AQAL	Max PC	Max PC as % of AQAL	Max PEC	Max PEC as % of AQAL	Conc.	as % of AQAL	As % of Oper-ational Facility
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	0.27	0.17%	0.26	0.16%	4.96	3.10%	-0.01	-0.01%	-3.50%
Ammonia	Annual mean	µg/m³	180	2.09	0.17	0.10%	0.18	0.10%	2.27	1.26%	0.00	<0.01%	2.31%
	Hourly mean	µg/m³	2,500	4.18	4.09	0.16%	3.94	0.16%	8.12	0.32%	-0.14	-0.01%	-3.50%
VOCs (as benzene)	Annual mean	µg/m³	5	0.88	0.12	**2.33%**	0.12	**2.39%**	1.00	19.99%	0.00	0.05%	2.31%
	Daily mean	µg/m³	30	1.76	1.02	3.41%	1.07	3.58%	2.83	9.45%	0.05	0.17%	5.05%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.34	0.12	**5.18%**	0.12	**5.30%**	0.46	20.41%	0.00	0.12%	2.31%
Mercury	Annual mean	ng/m³	250	2.80	0.23	0.09%	0.24	0.10%	3.04	1.22%	0.01	<0.01%	2.31%
	Hourly mean	ng/m³	7,500	5.60	5.45	0.07%	5.26	0.07%	10.86	0.14%	-0.19	<0.01%	-3.50%
Cadmium	Annual mean	ng/m³	5	0.43	0.23	**4.66%**	0.24	**4.77%**	0.67	13.37%	0.01	0.11%	2.31%
PAHs	Annual mean	pg/m³	250	1,300	2.33	0.93%	2.39	0.95%	1302.39	520.95%	0.05	0.02%	2.31%
Dioxins	Annual mean	fg/m³	-	32.99	0.70	-	0.72	-	33.71	-	0.02	-	2.31%
PCBs	Annual mean	ng/m³	200	1.29	0.06	0.03%	0.06	0.03%	1.35	0.67%	0.00	<0.01%	2.31%
	Hourly mean	ng/m³	6,000	2.58	1.36	0.02%	1.31	0.02%	3.89	0.06%	-0.05	<0.01%	-3.50%

Notes:

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

Assumes the Operational Facility and Proposed Facility operate for 100% of the time at the daily ELVs.

**Annual mean AQAL of 10 µg/m³ for $PM_{2.5}$ is the target value to be achieved by 2040.*

Table 29: Dispersion Modelling Results – Point of Maximum Impact - Short-Term ELVs

Pollutant	Quantity	Units	AQAL	Bg conc.	Operational Facility		Proposed Facility				Change in PC		
					Max PC	Max PC as % of AQAL	Max PC	Max PC as % of AQAL	Max PEC	Max PEC as % of AQAL	Conc.	as % of AQAL	As % of Perm-itted Facility
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	47.26	20.44	**10.22%**	21.21	**10.60%**	68.47	34.23%	0.77	0.39%	3.77%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	31.20	27.96	7.99%	29.30	8.37%	60.50	17.28%	1.34	0.38%	4.79%
	99.9th%ile of 15 min. means	µg/m³	266	31.20	34.18	**12.85%**	35.22	**13.24%**	66.42	24.97%	1.04	0.39%	3.06%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	22.43	0.22%	23.11	0.23%	921.11	9.21%	0.68	0.01%	3.02%
	Hourly mean	µg/m³	30,000	898	40.86	0.14%	39.43	0.13%	937.43	3.12%	-1.43	<0.01%	-3.50%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	16.35	2.18%	15.78	2.10%	17.20	2.29%	-0.57	-0.08%	-3.50%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	1.09	0.68%	1.05	0.66%	5.75	3.59%	-0.04	-0.02%	-3.50%

Notes:
All assessment is based on the maximum PC using all 5 years of weather data.
Assumes the Permitted and Proposed Facility operates for 100% of the time at the half-hourly ELVs.

As shown, the change in impact is less than 10% of the short-term AQAL and less than 1% of the annual mean AQAL and can be screened out as 'insignificant' for all pollutants and averaging periods. The EP variation results in a slight increase in pollutant concentrations for all averaging periods except for the maximum hourly concentrations, for which there is a slight decrease.

The total impact of the Proposed Facility is less than 10% of the short-term AQAL and less than 1% of the annual mean AQAL for all pollutants considered, and can be screened out as 'insignificant', with the exception of the of the following:

- Annual mean nitrogen dioxide;
- Annual mean VOCs as benzene and as 1,3-butadiene;
- Annual mean cadmium;
- Hourly mean nitrogen dioxide; and
- 15-minute mean sulphur dioxide.

Further analysis of these impacts at areas of relevant exposure has been undertaken to define the significance of annual mean impacts.

7.2.1 Further analysis – annual mean nitrogen dioxide

As shown in Table 28, the change in annual mean nitrogen dioxide impact is only 0.09% of the AQAL at the point of maximum impact. Therefore, the change in impact can be screened out as insignificant as the change is less than 1% of the AQAL.

The PC from the Operational Facility and the Proposed Facility at receptor locations is presented in Table 30, along with the PEC for the Proposed Facility.

Table 30: Annual Mean Nitrogen Dioxide at Receptor Locations

Receptor	Operational Facility PC		Proposed Facility PC		Proposed Facility PEC		Change	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.09	0.24%	0.10	0.25%	23.73	59.32%	0.0049	0.01%
R2	0.30	0.75%	0.32	0.80%	23.95	59.88%	0.0224	0.06%
R3	0.62	**1.55%**	0.66	**1.66%**	24.29	60.74%	0.0433	0.11%
R4	0.37	0.91%	0.39	0.97%	24.02	60.04%	0.0215	0.05%
R5	0.22	0.56%	0.23	0.57%	23.86	59.65%	0.0056	0.01%
R6	0.48	**1.21%**	0.52	**1.30%**	24.15	60.37%	0.0348	0.09%

Figure 10 of Appendix A shows the contour plot of impacts. As shown, the area of impact greater than 1% of the AQAL for the Proposed Facility is marginally larger than the Operational Facility. This shows that spatially there is a marginal difference in impact associated with the proposed EP variation. In addition, there are no sensitive receptors within the 1% contour for the Proposed Facility that are close to busy roads which may result in a locally-elevated PEC. Therefore, the PEC is less than 70% of the AQAL at all areas of relevant exposure where the PC from the Proposed Facility is predicted to exceed 1% of the AQAL, so the absolute impact of the Proposed Facility is 'not significant'.

7.2.2 Further analysis – annual mean VOCs

As shown in Table 28, the change in annual mean VOC impacts is only 0.05% of the AQAL for benzene, and 0.11% of the AQAL for 1,3-butadiene at the point of maximum impact. Therefore, the change in impact can be screened out as insignificant as the change in impact is less than 1% of the AQAL.

The PCs of benzene and 1,3-butadiene from the Operational Facility and the Proposed Facility at receptor locations are presented in Table 31 and Table 32, along with the PECs for the Proposed Facility.

Table 31: Annual Mean Benzene at Receptor Locations

Receptor	Operational Facility PC		Proposed Facility PC		Proposed Facility PEC		Change	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.007	0.15%	0.008	0.16%	0.89	17.76%	0.0004	0.01%
R2	0.024	0.47%	0.025	0.51%	0.91	18.11%	0.0018	0.04%
R3	0.049	0.99%	0.053	**1.05%**	0.93	18.65%	0.0034	0.07%
R4	0.029	0.58%	0.031	0.61%	0.91	18.21%	0.0017	0.03%
R5	0.018	0.35%	0.018	0.36%	0.90	17.96%	0.0004	0.01%
R6	0.038	0.77%	0.041	0.82%	0.92	18.42%	0.0028	0.06%

Table 32: Annual Mean 1,3-Butadiene at Receptor Locations

Receptor	Operational Facility PC		Proposed Facility PC		Proposed Facility PEC		Change	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.007	0.33%	0.008	0.35%	0.35	15.46%	0.0004	0.02%
R2	0.024	**1.05%**	0.025	**1.13%**	0.37	16.24%	0.0018	0.08%
R3	0.049	**2.19%**	0.053	**2.34%**	0.39	17.45%	0.0034	0.15%
R4	0.029	**1.29%**	0.031	**1.36%**	0.37	16.48%	0.0017	0.08%
R5	0.018	0.79%	0.018	0.81%	0.36	15.92%	0.0004	0.02%
R6	0.038	**1.71%**	0.041	**1.83%**	0.38	16.94%	0.0028	0.12%

The PEC is less than 70% of the AQAL at all areas of relevant exposure where the PC from the Proposed Facility is predicted to exceed 1% of the AQAL, so the absolute impact of the Proposed Facility is 'not significant'.

Figure 11 and of Figure 12 show the contour plot of impacts of VOCs compared to the AQALs for benzene and 1,3-butadiene respectively. As shown, the area of impact greater than 1% of the AQAL for the Proposed Facility is marginally larger than the Operational Facility. This shows that spatially there is a marginal difference in impact from the Proposed Facility compared to the Operational Facility.

7.2.3 Further analysis – annual mean cadmium

As shown in Table 28, the change in annual mean cadmium impacts is only 0.11% of the AQAL at the point of maximum impact. This conservatively assumes that the Operational Facility and Proposed Facility operate at the combined ELV for cadmium and thallium and the entire emissions consist only of cadmium. Under this assumption, the maximum annual mean impact from the Proposed Facility is 4.77% of the AQAL. Figure 13 of Appendix A shows the contour plot of impacts. As shown, the area of impact greater than 1% of the AQAL for the Proposed Facility is marginally larger than the Operational Facility.

Emissions of cadmium and thallium from the Operational Facility are periodically monitored and these results reported to the EA. A review of this periodic monitoring data is provided in Table 33.

Table 33: Summary of Cadmium and Thallium Monitoring from Existing Facility

Monitoring period	Monitored combined concentration of cadmium and thallium			
	µg/m³		As % of ELV	
	Line 1	Line 2	Line 1	Line 2
2021 - H1	0.7	0.8	3.5%	4.0%
2021 - H2	0.7	0.9	3.5%	4.5%
2022 – H1	-	0.7	-	3.5%
2022 - H2	1.1	0.9	5.5%	4.5%
Max	1.1		5.5%	
Average	0.8		4.1%	

Note:

All measured concentrations were below the limit of detection (LOD). Therefore, the LOD (i.e. the maximum possible emission concentration) has been reported.

As % of ELV applicable from 3 December 2023.

Source: Viridor Avonmouth Extractive Monitoring Reports 2021 and 2022, Element

As shown the combined emissions of cadmium and thallium are well below the ELV. The maximum monitored concentration in 2021 and 2022 was only 5.5% of the ELV and the average 4.1% of the ELV. If it is assumed that emissions Facility are at the maximum from the monitoring detailed in Table 33 (i.e. 5.5% of the ELV) and this only consists of cadmium, the maximum PC of cadmium from the Operational is only 0.26% of the AQAL at the point of maximum impact and can be screened out as 'insignificant'.

7.2.4 Further analysis – short-term impacts

As shown in Table 29, when the Proposed Facility operates at the half-hourly ELV during the worst-case weather conditions for dispersion, the PC at the point of maximum impact is predicted to be 10.60% of the AQAL for the 99.79th percentile of hourly mean nitrogen dioxide, and 13.24% of the AQAL for the 99.9th percentile of 15-minute mean sulphur dioxide. The change in impact between the Operational Facility and the Proposed Facility is less than 1% of the AQAL for both pollutants and is 'insignificant'.

Figure 14 and Figure 15 of Appendix A show the contour plot of short term impacts for nitrogen dioxide and sulphur dioxide. These illustrate that the areas where the PC from the Operational

Facility and the Proposed Facility cannot be screened out as 'insignificant'. Spatially there is a marginal difference in impact from the Proposed Facility compared to the Operational Facility.

Consideration has also been given to the headroom for each pollutant for the Operational Facility and the results presented in Table 34.

Table 34: Short-Term PC as % of Headroom

Pollutant	Quantity	Headroom (µg/m³)	Proposed Facility PC	
			µg/m³	% of Headroom
Nitrogen dioxide	99.79th%ile of hourly means	152.74	21.21	13.89%
Sulphur dioxide	99.9th %ile of 15 min. means	234.80	35.22	15.00%

As shown, the PC from the Proposed Facility is less than 20% of the headroom so the absolute impact of the Proposed Facility is considered to be 'not significant'.

7.2.5 Heavy metals – at the point of maximum impact

The assessment of the impact of heavy metals has been undertaken for the Operational Facility; the Proposed Facility; and also the change in impact as a result of the EP variation.

The results tables below (Table 35 to Table 40) detail the following:

1. The PC and PEC for each metal, assuming that each metal is released at the combined long-term metal ELV set out in EP (stage 1 screening); and
2. The PC and PEC for metal, assuming that each metal is released at the maximum monitored concentration presented in the EA's metals guidance[9].

[9] Environment Agency, June 2016, Guidance on assessing group 3 metal stack emissions from incinerators (V.4)

Table 35: Long-Term Metals Results at Point of Maximum Impact – Operational Facility

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	1.00	3.50	**58.30%**	4.50	74.96%	8.3%	0.29	**4.86%**	1.29	21.52%
Antimony	5,000	1.30	3.50	0.07%	4.80	0.10%	3.8%	0.13	0.003%	1.43	0.03%
Chromium	5,000	5.80	3.50	0.07%	9.30	0.19%	30.7%	1.07	0.02%	6.87	0.14%
Chromium (VI)	0.25	1.16	3.50	**1,399.1%**	4.66	**1,863.1%**	0.043%	0.002	0.61%	1.16	**464.61%**
Cobalt	-	1.50	3.50	-	5.00	-	1.9%	0.07	-	1.57	-
Copper	10,000	26.00	3.50	0.03%	29.50	0.29%	9.7%	0.34	0.003%	26.34	0.26%
Lead	250	20.00	3.50	**1.40%**	23.50	9.40%	16.8%	0.59	0.23%	20.59	8.23%
Manganese	150	10.00	3.50	**2.33%**	13.50	9.00%	20.0%	0.70	0.47%	10.70	7.13%
Nickel	20	2.50	3.50	**17.49%**	6.00	29.99%	73.3%	2.56	**12.82%**	5.06	25.32%
Vanadium	-	3.00	3.50	-	6.50	-	2.0%	0.07	-	3.07	-

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm³, recalculated from the data presented in EA's metals guidance document (V.4) Table A1.

Table 36: Long-Term Metals Results at Point of Maximum Impact – Proposed Facility

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV [1]	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	1.00	3.58	**59.64%**	4.58	76.31%	8.3%	0.30	**4.97%**	1.30	21.64%
Antimony	5,000	1.30	3.58	0.07%	4.88	0.10%	3.8%	0.14	0.003%	1.44	0.03%
Chromium	5,000	5.80	3.58	0.07%	9.38	0.19%	30.7%	1.10	0.02%	6.90	0.14%
Chromium (VI)	0.25	1.16	3.58	**1,431.5%**	4.74	**1,895.5%**	0.043%	0.002	0.62%	1.16	**464.62%**
Cobalt	-	1.50	3.58	-	5.08	-	1.9%	0.07	-	1.57	-
Copper	10,000	26.00	3.58	0.04%	29.58	0.30%	9.7%	0.35	0.003%	26.35	0.26%
Lead	250	20.00	3.58	**1.43%**	23.58	9.43%	16.8%	0.60	0.24%	20.60	8.24%
Manganese	150	10.00	3.58	**2.39%**	13.58	9.05%	20.0%	0.72	0.48%	10.72	7.14%
Nickel	20	2.50	3.58	**17.89%**	6.08	30.39%	73.3%	2.62	**13.12%**	5.12	25.62%
Vanadium	-	3.00	3.58	-	6.58	-	2.0%	0.07	-	3.07	-

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm³, recalculated from the data presented in EA's metals guidance document (V.4) Table A1.

Table 37: Long-Term Metals Results at Point of Maximum Impact – Change in Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			Change in PC		PEC			Change in PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	6	1.00	0.08	**1.35%**	1.08	18.02%	8.3%	0.007	0.112%	1.01	16.78%
Antimony	5,000	1.30	0.08	0.002%	1.38	0.03%	3.8%	0.003	0.0001%	1.30	0.03%
Chromium	5,000	5.80	0.08	0.002%	5.88	0.12%	30.7%	0.025	0.000%	5.82	0.12%
Chromium (VI)	0.25	1.16	0.08	**32.4%**	1.24	**496**.4%	0.043%	0.00004	0.014%	1.16	**464.01%**
Cobalt	-	1.50	0.08	-	1.58	-	1.9%	0.002	-	1.50	-
Copper	10,000	26.00	0.08	0.001%	26.08	0.26%	9.7%	0.008	0.0001%	26.01	0.26%
Lead	250	20.00	0.08	0.03%	20.08	8.03%	16.8%	0.014	0.005%	20.01	8.01%
Manganese	150	10.00	0.08	0.05%	10.08	6.72%	20.0%	0.016	0.011%	10.02	6.68%
Nickel	20	2.50	0.08	0.40%	2.58	12.90%	73.3%	0.059	0.297%	2.56	12.80%
Vanadium	-	3.00	0.08	-	3.08	-	2.0%	0.002	-	3.00	-

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm³, recalculated from the data presented in EA's metals guidance document (V.4) Table A1.

Table 38: Short-Term Metals Results at Point of Maximum Impact – Operational Facility

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	2.00	81.73	-	83.73	-	8.3%	6.81	-	8.81	-
Antimony	150,000	2.60	81.73	0.05%	84.33	0.06%	3.8%	3.13	0.002%	5.73	0.004%
Chromium	150,000	11.60	81.73	0.05%	93.33	0.06%	30.7%	25.06	0.02%	36.66	0.02%
Chromium (VI)	-	2.32	81.73	-	84.05	-	0.043%	0.04	-	2.36	-
Cobalt	-	3.00	81.73	-	84.73	-	1.9%	1.53	-	4.53	-
Copper	200,000	52.00	81.73	0.04%	133.73	0.07%	9.7%	7.90	0.004%	59.90	0.03%
Lead	-	40.00	81.73	-	121.73	-	16.8%	13.70	-	53.70	-
Manganese	1,500,000	20.00	81.73	0.01%	101.73	0.01%	20.0%	16.35	0.001%	36.35	0.002%
Nickel	-	5.00	81.73	-	86.73	-	73.3%	59.93	-	64.93	-
Vanadium (daily mean)	1,000	6.00	30.68	3.07%	36.68	3.67%	2.0%	0.61	0.061%	6.61	0.66%

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm^3, recalculated from the data as presented in EA's metals guidance document (V.4) Table A1.

Table 39: Short-Term Metals Results at Point of Maximum Impact – Proposed Facility

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			PC		PEC			PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	2.00	78.86	-	80.86	-	8.3%	6.57	-	8.57	-
Antimony	150,000	2.60	78.86	0.05%	81.46	0.05%	3.8%	3.02	0.002%	5.62	0.004%
Chromium	150,000	11.60	78.86	0.05%	90.46	0.06%	30.7%	24.18	0.02%	35.78	0.02%
Chromium (VI)	-	2.32	78.86	-	81.18	-	0.043%	0.03	-	2.35	-
Cobalt	-	3.00	78.86	-	81.86	-	1.9%	1.47	-	4.47	-
Copper	200,000	52.00	78.86	0.04%	130.86	0.07%	9.7%	7.62	0.004%	59.62	0.03%
Lead	-	40.00	78.86	-	118.86	-	16.8%	13.22	-	53.22	-
Manganese	1,500,000	20.00	78.86	0.01%	98.86	0.01%	20.0%	15.77	0.001%	35.77	0.002%
Nickel	-	5.00	78.86	-	83.86	-	73.3%	57.83	-	62.83	-
Vanadium (daily mean)	1,000	6.00	32.23	3.22%	38.23	3.82%	2.0%	0.64	0.064%	6.64	0.66%

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm³, recalculated from the data as presented in EA's metals guidance document (V.4) Table A1.

Table 40: Short-Term Metals Results at Point of Maximum Impact – Change in Impact

Metal	AQAL	Baseline conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Each metal emitted at the maximum concentration from the EA metals guidance document			
			Change in PC		PEC			Change in PC		PEC	
	ng/m³	ng/m³	ng/m³	as % AQAL	ng/m³	as % AQAL		ng/m³	as % AQAL	ng/m³	as % AQAL
Arsenic	-	2.00	-2.86	-	80.86	-	8.3%	-0.24	-	8.57	-
Antimony	150,000	2.60	-2.86	-0.002%	81.46	0.05%	3.8%	-0.11	-0.0001%	5.62	0.004%
Chromium	150,000	11.60	-2.86	-0.002%	90.46	0.06%	30.7%	-0.88	-0.0006%	35.78	0.02%
Chromium (VI)	-	2.32	-2.86	-	81.18	-	0.043%	0.00	-	2.35	-
Cobalt	-	3.00	-2.86	-	81.86	-	1.9%	-0.05	-	4.47	-
Copper	200,000	52.00	-2.86	-0.001%	130.86	0.07%	9.7%	-0.28	-0.0001%	59.62	0.03%
Lead	-	40.00	-2.86	-	118.86	-	16.8%	-0.48	-	53.22	-
Manganese	1,500,000	20.00	-2.86	-0.0002%	98.86	0.01%	20.0%	-0.57	-0.00004%	35.77	0.002%
Nickel	-	5.00	-2.86	-	83.86	-	73.3%	-2.10	-	62.83	-
Vanadium (daily mean)	1,000	6.00	1.55	0.15%	38.23	3.82%	2.0%	0.03	0.003%	6.64	0.66%

Notes:
(1) Metal as maximum percentage of the group 3 ELV of 0.3 mg/Nm^3, recalculated from the data as presented in EA's metals guidance document (V.4) Table A1.

If it is assumed that the entire emissions of metals consist of only one metal, the impact of the Proposed Facility is less than 1% of the long-term and less than 10% of the short-term AQAL, with the exception of annual mean impacts of arsenic, chromium (VI), lead, manganese, and nickel, which have been highlighted. The PEC is only predicted to exceed the AQALs for annual mean chromium (VI) using this worst-case screening assumption.

If it is assumed that the Proposed Facility would emit metals at the maximum concentration from the EA's metals guidance document, the PC is below 1% of the long term and 10% of the short term AQAL for all pollutants with the exception of annual mean arsenic and nickel. However, the annual mean PEC is well below the AQAL for both arsenic and nickel. Therefore, the impact of emissions of these metals can be screened out and is considered to be not significant. In addition, the PEC of chromium (VI) exceeds the AQAL but this due to the high assumed baseline concentration (20% of total chromium, in lieu of any direct monitoring of chromium (VI)). The contribution from the Proposed Facility is less than 1% of the AQAL and can be screened out as 'insignificant'.

Consideration has also been given to the change in impact. Table 40 shows that, if it is assumed that the Proposed Facility would emit metals at the maximum concentration from the EA's metals guidance document, the change in long-term PC is less than 1% and the change in short-term PC is less than 10% for all pollutants. Therefore, the change in impact of emissions of metals can be screened out as 'insignificant'.

This analysis has shown that the change in impact associated with the increase in throughput is insignificant and it can be concluded that there is no risk of the proposed variation to the EP resulting in an exceedance of an AQAL for any metal on either a long or short-term basis.

8 Impact at Ecological Receptors

8.1 Screening

The Air Emissions Guidance states that to screen out impacts as 'insignificant' at European and UK statutory designated sites:

- the long-term PC must be less than 1% of the long-term environmental standard (i.e. the Critical Level or Load); and
- the short-term PC must be less than 10% of the short-term environmental standard.

If the above criteria are met, no further assessment is required. If the long-term PC exceeds 1% of the long-term environmental standard, the PEC must be calculated and compared to the standard. If the resulting PEC is less than 70% of the long-term environmental standard, the Air Emissions Guidance states that the emissions are 'insignificant' and further assessment is not required. In accordance with the guidance, calculation of the PEC for short-term standards is not required.

The Air Emissions Guidance states further that to screen out impacts as 'insignificant' at local nature sites:

- the long-term PC must be less than 100% of the long-term environmental standard; and
- the short-term PC must be less than 100% of the short-term environmental standard.

In accordance with the guidance, calculation of the PEC for local nature sites is not required. However, this has been calculated for completeness.

8.2 Methodology

8.2.1 Atmospheric emissions – Critical Levels

The impact of emissions has been compared to the Critical Levels listed in Table 3. Further assessment would be undertaken where the process contribution of a particular pollutant is greater than 1% of the long term or 10% of the short-term Critical Level for European and UK designated sites, and where the process contribution of a particular pollutant is greater than 100% of the Critical Level for local nature sites.

8.2.2 Deposition of emissions – Critical Loads

In addition to the Critical Levels for the protection of ecosystems, habitat specific Critical Loads for nature conservation sites at risk from acidification and nitrogen deposition (eutrophication) are outlined in APIS. In terms of acid deposition, the APIS Database contains a maximum critical load for sulphur (CLmaxS), a minimum Critical Load for nitrogen (CLminN) and a maximum Critical Load for nitrogen (CLmaxN). These components define the Critical Load function for acid deposition. Where the acid deposition flux falls within the area under the Critical Load function, no exceedances are predicted.

An assessment has been made for the most sensitive habitat features identified in APIS for the specific sites. The site-specific features tool in the APIS app has been used to identify the feature habitats and the habitat specific Critical Load for the specific points assessed within the designated sites. The relevant Critical Loads are presented in Appendix B. The lowest Critical Loads for each designated site have been used to ensure a robust assessment.

8.2.3 Calculation methodology

8.2.3.1 Nitrogen deposition

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

1. Determine the annual mean ground level concentrations of nitrogen dioxide and ammonia at each site.
2. Calculate the dry deposition flux (µg/m^2/s) at each site by multiplying the annual mean ground level concentration by the relevant deposition velocity presented in Table 41.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 41.
4. Compare this result to the nitrogen deposition Critical Load.

Table 41: Deposition Factors

Pollutant	Deposition velocity (m/s)		Conversion factor (µg/m^2/s to kg/ha/year)
	Grassland	Woodland	
Nitrogen dioxide	0.0015	0.003	96.0
Sulphur dioxide	0.0120	0.024	157.7
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

Source: AQTAG 6 (March 2014)

8.2.3.2 Acidification

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

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

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in section 8.2.3.1.
2. Apply the conversion factor for N outlined in Table 41 to the nitrogen and ammonia deposition rate in kg/ha/year to determine the total keq N/ha/year.
3. Apply the conversion factor for S to the sulphur deposition rate in kg/ha/year to determine the total keq S/ha/year.
4. Apply the conversion factor for HCl to the hydrogen chloride deposition rate in kg/ha/year to determine the dry keq Cl/ha/year.
5. Add the contribution from S to HCl and treat this sum as the total contribution from S.
6. Plot the results against the Critical Load functions.

Table 42: Conversion Factors

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

The March 2014 version of the AQTAG06 document states that, for installations with an HCl emission, the PC of HCl, in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from HCl should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of HCl from wet deposition.

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

The contribution from the proposed development has been calculated using APIS formula:

Where PEC N Deposition < CLminN:

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

Where PEC N Deposition > CLminN:

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

8.3 Results - atmospheric emissions - Critical Levels

The impact of emissions from the operation of the Operational Facility, the Proposed Facility, and the change in impact have been compared to the Critical Levels, refer to Table 43 and Table 44.

The maximum impact at any point in the Severn Estuary SAC/SPA/ Ramsar/SSSI has been presented, while the impact at the other UK and European designated sites has been assessed at the closest point in each site to the Facility. A screening approach has been used to determine the impacts at the local nature sites where the point of maximum impact has been compared to the relevant Critical Levels. The PC has been calculated based on the maximum predicted using all five years of weather data. This assumes operation at the daily ELVs as set out in Table 15. PCs that cannot be screened out in accordance with the screening criteria detailed in section 8.1 have been highlighted.

Table 43: Assessment Against Annual Mean Critical Levels

Site	NOx			SO_2 [(1)]			NH_3 [(1)]		
	Operational	Proposed	Change	Operational	Proposed	Change	Operational	Proposed	Change
Process Contribution as µg/m³									
E1 - Severn Estuary SAC, SPA, Ramsar, SSSI	0.54	0.54	0.004	0.12	0.12	0.001	0.05	0.05	0.0003
E2 - Avon Gorge Woodlands SAC	0.06	0.07	0.004	0.01	0.01	0.001	0.005	0.005	0.0003
E3 - River Wye SAC	0.06	0.06	0.004	0.01	0.01	0.001	0.005	0.005	0.0003
E4 – Local nature sites (pt of max impact)	2.10	2.15	0.049	0.47	0.48	0.010	0.17	0.18	0.0040
Process Contribution as % of Critical Level									
E1 - Severn Estuary SAC, SPA, Ramsar, SSSI	**1.80%**	**1.81%**	0.01%	0.60%	0.60%	0.01%	**1.50%**	**1.51%**	0.01%
E2 - Avon Gorge Woodlands SAC	0.20%	0.22%	0.01%	0.14%	0.14%	0.01%	0.51%	0.54%	0.03%
E3 - River Wye SAC	0.19%	0.21%	0.01%	0.13%	0.14%	0.01%	0.48%	0.51%	0.03%
E4 – Local nature sites (pt of max impact)	7.00%	7.16%	0.16%	4.66%	4.77%	0.11%	17.49%	17.89%	0.40%

Note:
(1) PCs of sulphur dioxide and ammonia have been assessed against the lower Critical Levels of 10 µg/m³ and 1 µg/m³ respectively, except for at E1 where lichens and bryophytes are not an important part of the ecosystem.

Table 44: Assessment Against Short-Term Critical Levels

Site	Daily mean NOx			Daily mean HF			Weekly mean HF		
	Operational	Proposed	Change	Operational	Proposed	Change	Operational	Proposed	Change
Process Contribution as µg/m³									
E1 - Severn Estuary SAC, SPA, Ramsar, SSSI	10.23	10.71	0.48	0.06	0.06	0.003	0.02	0.02	0.001
E2 - Avon Gorge Woodlands SAC	1.60	1.70	0.10	0.01	0.01	0.001	0.002	0.002	0.0001
E3 - River Wye SAC	0.94	0.99	0.05	0.01	0.01	0.0003	0.001	0.002	0.0001
E4 – Local nature sites (pt of max impact)	18.41	19.34	0.93	0.10	0.11	0.005	0.04	0.04	0.0003
Process Contribution as % of Critical Level									
E1 - Severn Estuary SAC, SPA, Ramsar, SSSI	**13.64%**	**14.28%**	0.64%	1.14%	1.19%	0.05%	4.65%	4.88%	0.22%
E2 - Avon Gorge Woodlands SAC	2.14%	2.27%	0.14%	0.18%	0.19%	0.01%	0.35%	0.37%	0.02%
E3 - River Wye SAC	1.25%	1.32%	0.07%	0.10%	0.11%	0.01%	0.28%	0.30%	0.02%
E4 – Local nature sites (pt of max impact)	24.55%	25.79%	1.24%	2.05%	2.15%	0.10%	8.28%	8.34%	0.05%

As shown, the change in impact at all European and UK sites for all pollutants is less than 1% of the long-term and 10% of the short-term Critical Levels and is screened out as 'insignificant'. The change in impact at the point of maximum impact, used as a screening assessment for local nature sites, is less than 100% of the long-term and short-term Critical Levels and is also screened out as 'insignificant'.

The impact of the Proposed Facility at all European and UK sites is less than 1% of the long-term and 10% of the short-term Critical Levels and is screened out as 'insignificant', except for annual mean and short-term NOx and annual mean ammonia at the Severn Estuary. The impact at the point of maximum impact is less than 100% of the long-term and short-term Critical Levels. It follows that the impact at all local nature sites can be screened out as 'insignificant'.

Further assessment has been undertaken to determine if there is a risk of exceeding the Critical Levels for NOx and ammonia at the Severn Estuary. Figure 16 and Figure 17 show the annual mean and short-term impact of the Facility on NOx concentrations and Figure 18 shows the annual mean impact on ammonia concentrations. As shown, the area of the Severn Estuary designated site where the annual mean PC from the Proposed Facility cannot be screened out as 'insignificant' extends southwest from the Facility.

APIS provides background concentrations of NOx and ammonia for the coastal grid squares in this area. The maximum NOx and ammonia PEC using these concentrations is presented in Table 45.

Table 45: Further Assessment Against Critical Levels

Pollutant	Baseline (µg/m³)	PC (µg/m³)	PEC	
			µg/m³	% of Critical Level
NOx – annual mean	18.80	0.54	19.34	64.48%
NOx – daily mean	37.60(1)	10.71	48.31	64.41%
Ammonia – annual mean	1.40	0.05	1.45	48.18%

Note:
(1) Short-term baseline concentration assumed to be twice the annual mean concentration.

All PECs are less than 70% of the Critical Level, so the impacts are 'not significant'.

8.4 Results - deposition - Critical Loads

The results of the deposition analysis are presented in Appendix C. This shows that the change in PC as a result of the EP variation is less than 1% of the Critical Loads for all habitats identified at all European and UK designated sites, and less than 100% of the Critical Loads for the assessment at Local Nature Sites. Therefore, the change in PC can be screened out as 'insignificant'.

The PC from the Proposed Facility exceeds 1% of the Critical Load for nitrogen deposition at the Severn Estuary designated site and for nitrogen and acid deposition at the River Wye SAC. However, this is highly conservative assessment as it has been assumed that the most sensitive habitat is present at the point of maximum impact within the designated site, which is particularly conservative for the River Wye SAC as the most sensitive habitat (bog woodland) is highly unlikely to be present near the point of maximum within the site, which is at the tidal section of the River Wye where it enters the Severn Estuary. The following Illustrative plot files of nitrogen and acid deposition have been produced:

- Figure 19 – Nitrogen deposition to grassland habitats;
- Figure 20 – Nitrogen deposition to woodland habitats;
- Figure 21 – Acid deposition to grassland habitats; and
- Figure 22 – Acid deposition to woodland habitats.

At both the Severn Estuary and River Wye designated sites the change as a result of the EP variation is extremely small at a maximum of 0.13% of the Critical Load. Such a change would be imperceptible and will not have a significant effect on the integrity of the designated sites.

9 Conclusions

This Dispersion Modelling Assessment has been undertaken to support an application for a variation to the EP for the Facility. As the Facility is already operational a comparison has been made to the impact of the Operational Facility. To ensure that a direct comparison is being made between the Proposed Facility and Operational Facility dispersion modelling has been carried out for both. This has been undertaken based on the assumption that for both scenarios the Facility will operate continually at the emission limits prescribed in the existing EP for operation after 3 December 2023, i.e. following the implementation of the BREF.

This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and quantification of the impact of these emissions on local air quality.

The primary conclusions of the assessment are presented below.

1. In relation to the impact on human health:
    a. Emissions from the operation of the Proposed Facility will not cause a breach of any AQAL.
    b. For all pollutants the change in impact as a result of the EP variation can be screened out as 'insignificant'.
    c. For all pollutants the overall impact of the Proposed Facility can either be screened out as 'insignificant' or is 'not significant' when the total concentration is taken into consideration.
2. In relation to the impact on ecologically sensitive sites:
    a. At all identified European and UK designated ecological receptors, the change in impact can be screened out as 'insignificant' as it is less than 1% of the long term Critical Levels and Critical Loads and less than 10% of the short term Critical Levels.
    b. The impact of the Proposed Facility cannot be screened out as 'insignificant' at the Severn Estuary and River Wye designated sites. However, as the change in impact from the Operational Facility is extremely small and would be imperceptible, it is considered that there would be no significant effects on the integrity of these designated sites.
    c. As a screening assessment it has been assumed that a local nature site is present at the overall point of maximum impact. The change in impact and the overall impact of the Proposed Facility at the point of maximum impact are both less than 100% of the Critical Levels and Loads and can be screened out as 'insignificant'.

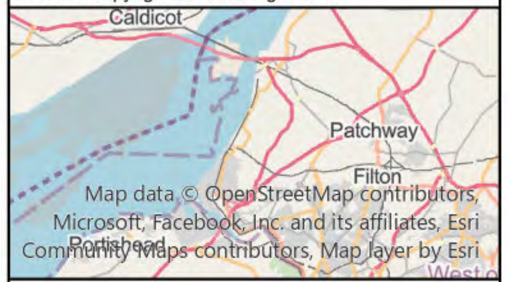
In summary, the assessment has shown that the change in air quality impact associated with the proposed EP variation is marginal and emissions would not have a significant impact on local air quality, the general population or the local community. As such there should be no air quality constraint in granting a variation to the existing EP for the increased throughput as proposed.

Appendices

A Figures

Client: Viridor
Site: Avonmouth ERF
Project: Dispersion Modelling Assessment
Title:
Figure 1. Site Location

Drawn by: SMN
Date: 05/09/2023



0 0.3 0.6 1.2 km
N
Scale: 1:30,000

FICHTNER
Consulting Engineers Limited

Kingsgate, Wellington Road North,
Stockport, Cheshire, SK4 1LW
Tel: 0161 476 0032
Fax: 0161 474 0618

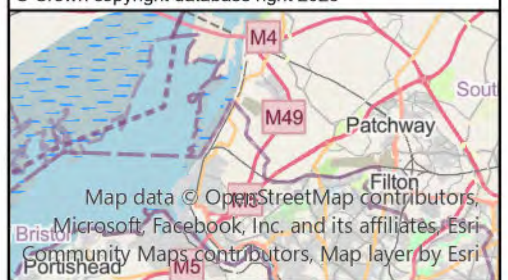
Legend

- Stack
- Human Receptors

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 2. Human Sensitive Receptors

Drawn by: SMN	Date: 05/09/2023



0 0.2 0.4 0.8 km

N

Scale: 1:20,000

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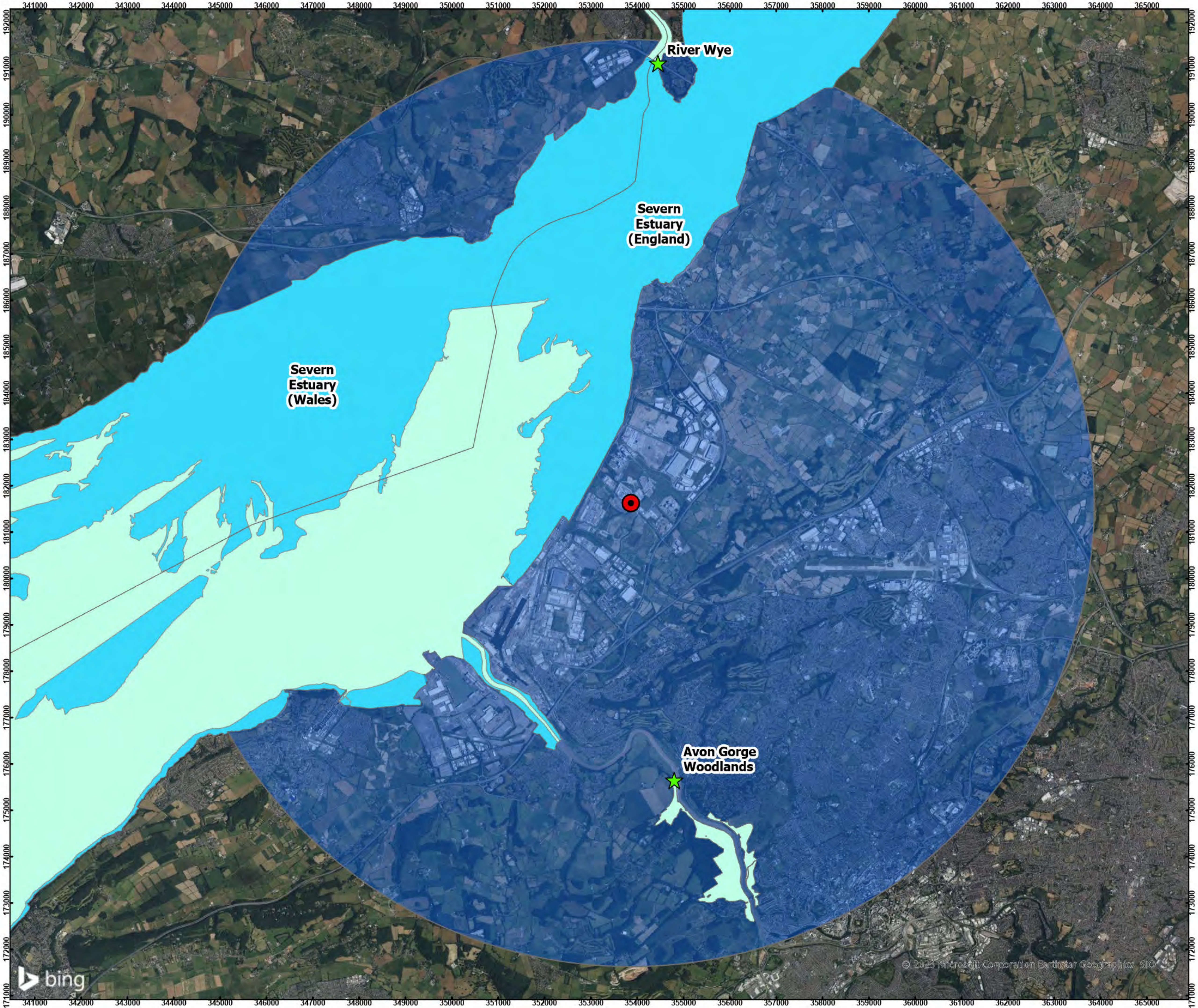


Legend

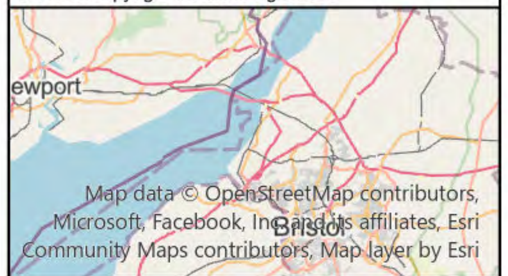
- Stack
- Discrete Ecological Receptor Points
- Ramsars
- SACs
- 10 km Stack Buffer

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 3. Ecological Sensitive Receptors

Drawn by: SMN | Date: 05/09/2023



0 0.75 1.5 3 km

Scale: 1:76,294

N

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Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	Figure 4. Modelling Domain

Drawn by: SMN | Date: 06/09/2023

0 0.35 0.7 1.4 km

Scale: 1:35,000

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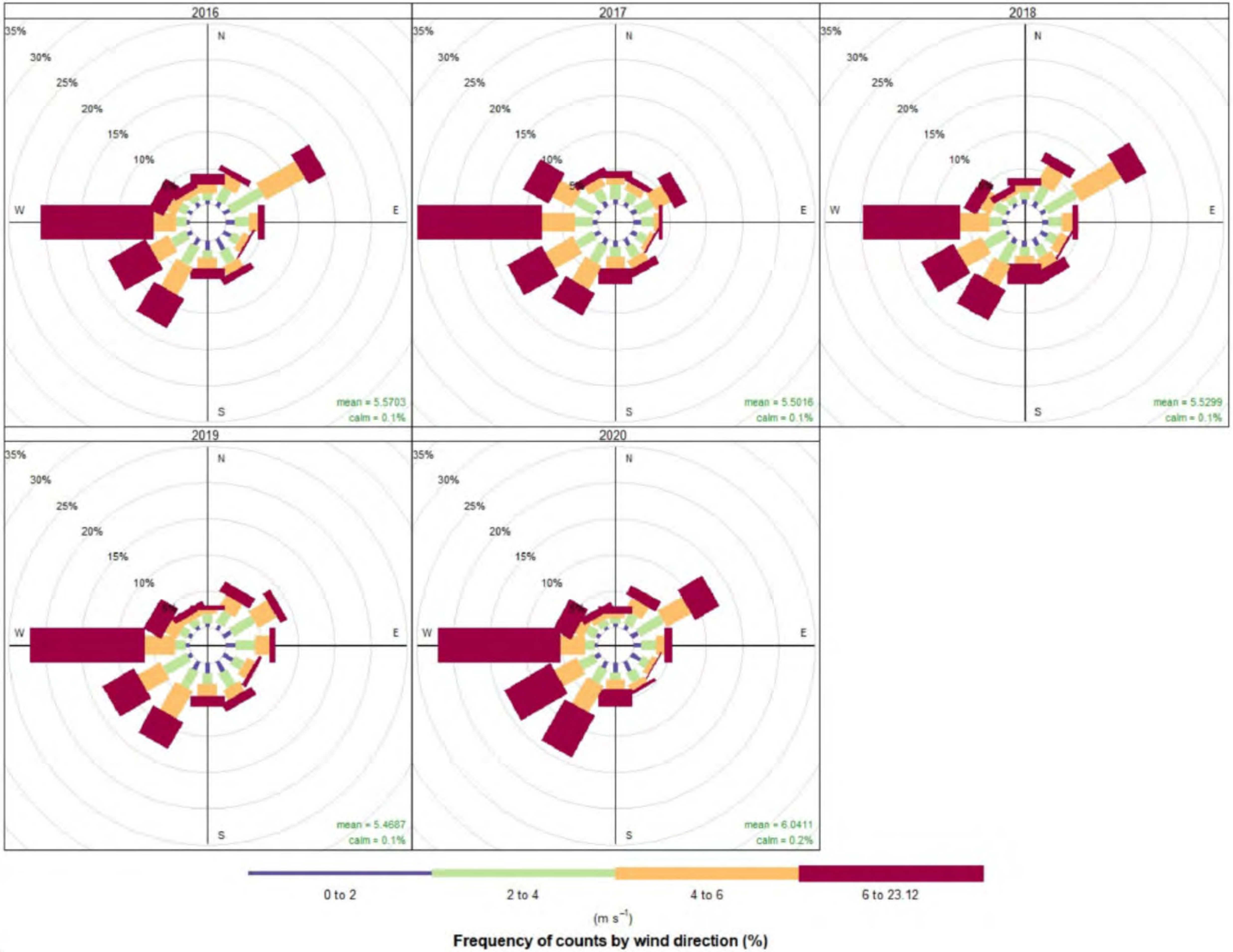

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 5. Wind Roses Avonmouth 2016 - 2020

Drawn by: SMN	Date: 06/09/2023

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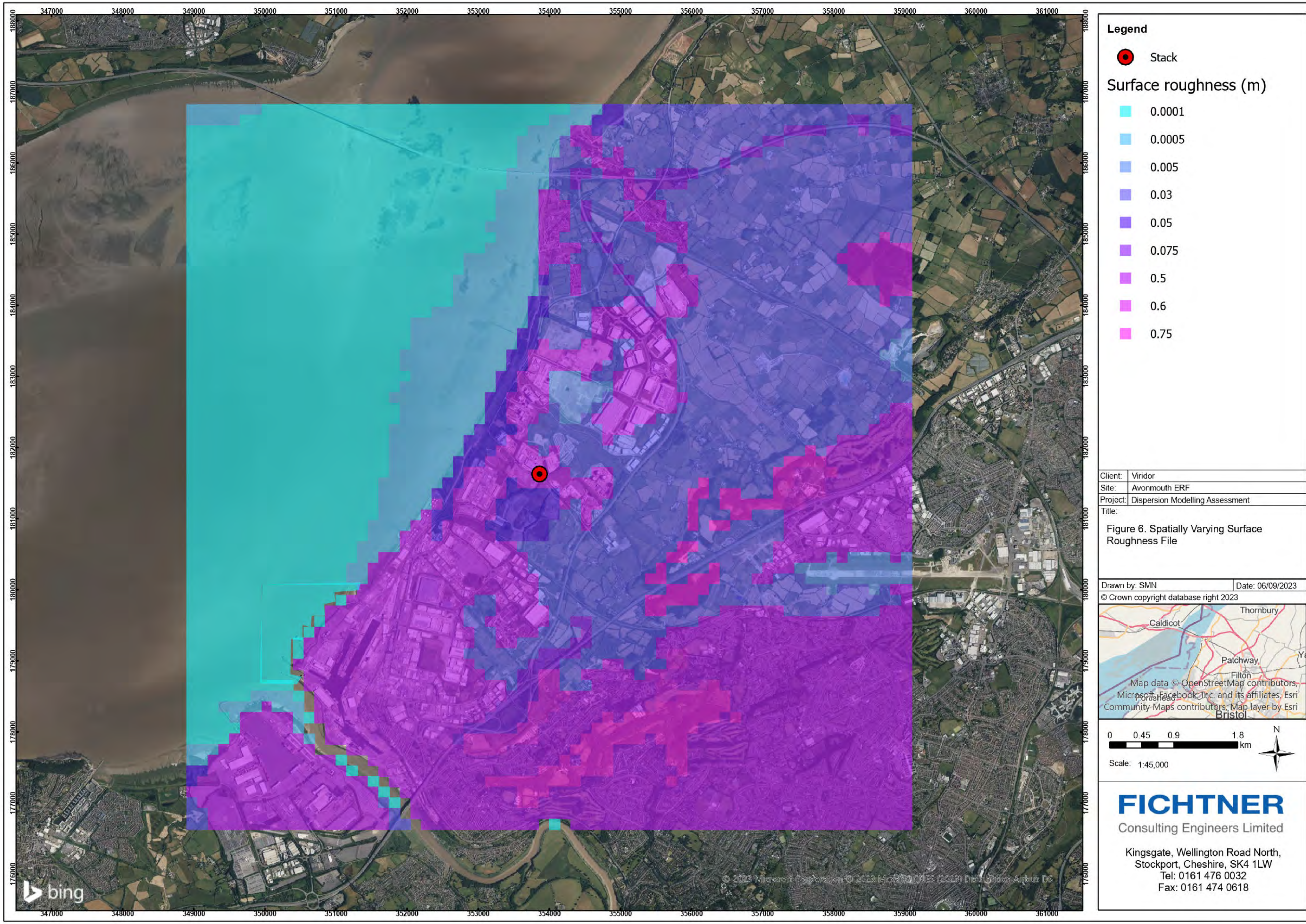

Client: Viridor
Site: Avonmouth ERF
Project: Dispersion Modelling Assessment
Title:

Figure 6. Spatially Varying Surface Roughness File

Drawn by: SMN | Date: 06/09/2023

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Legend

Stack

Elevation

0 - 15 m

15 - 30 m

30 - 50 m

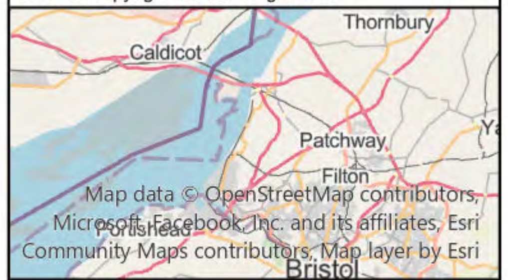
50 - 70 m

>70 m

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 7. Terrain File

Drawn by: SMN | Date: 06/09/2023



0 0.45 0.9 1.8 km

N

Scale: 1:45,000

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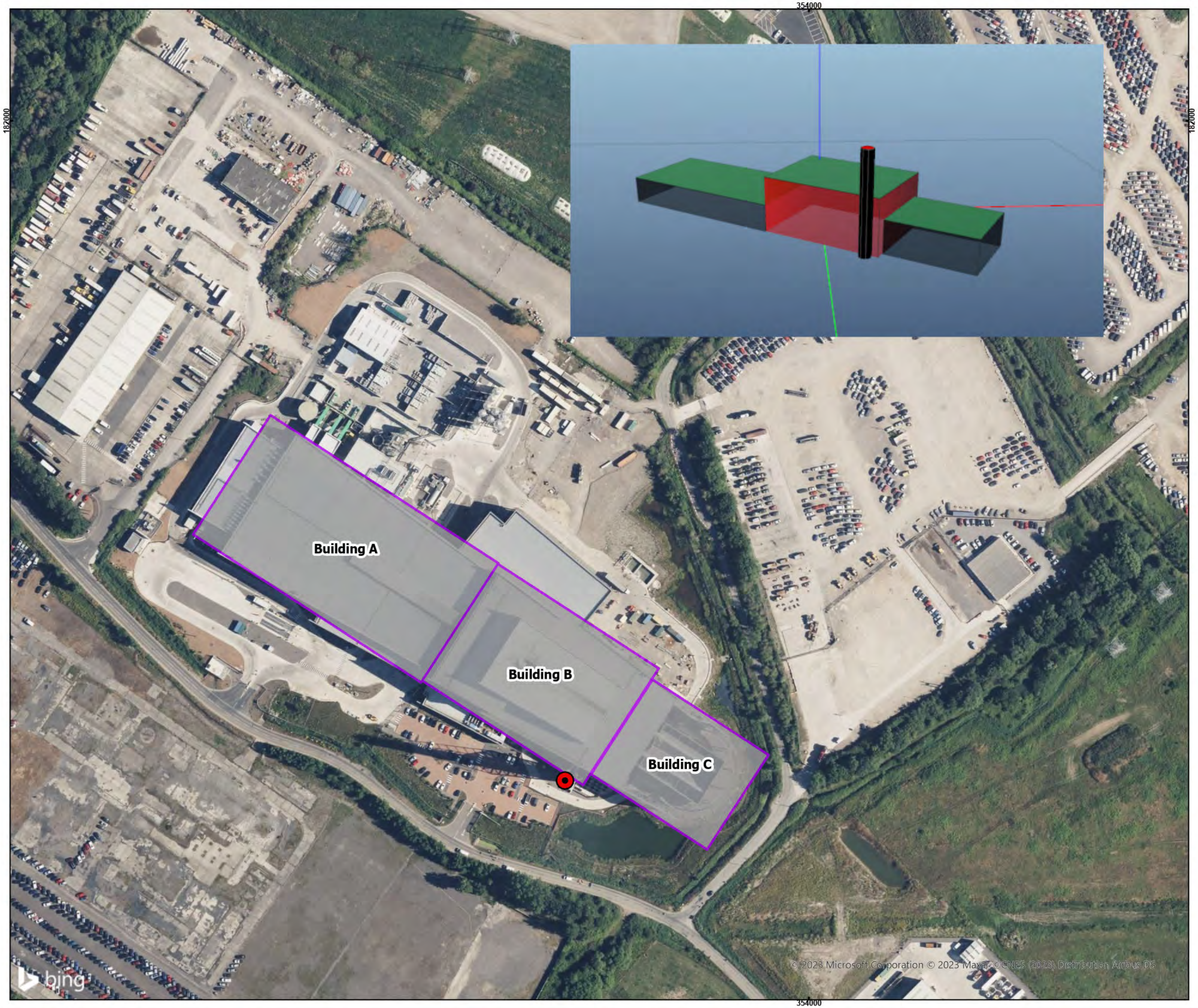

Legend

Stack

Buildings

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 8. Buildings Modelled

Drawn by: SMN	Date: 08/09/2023

0 0.02 0.04 0.08 km

Scale: 1:2,000

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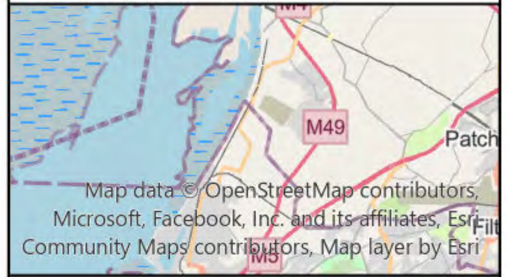
Legend

- Stack
- Wind Turbines

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	Figure 9. Wind Turbines

Drawn by: SMN | Date: 08/09/2023



0 0.05 0.1 0.2 km

Scale: 1:5,000

N

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Legend

Stack

Human Receptors

Annual mean NO2 as % of AQAL - Operational Facility

Annual mean NO2 as % of AQAL - Proposed Facility

Notes:

Assumes 70% NOx to NO2 conversion rate

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 10. Annual Mean Nitrogen Dioxide

Drawn by: SMN	Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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Legend

Stack

Human Receptors

Annual mean benzene as % of AQAL - Operational Facility

Annual mean benzene as % of AQAL - Proposed Facility

Notes:

Assumes all VOCs are emitted as benzene

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 11. Annual Mean VOCs as Benzene

Drawn by: SMN | Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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Legend

- Stack
- Human Receptors
- Annual mean 1,3-butadiene as % of AQAL - Operational Facility
- Annual mean 1,3-butadiene as % of AQAL - Proposed Facility

Notes:
Assumes all VOCs are emitted as 1,3-butadiene

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	Figure 12. Annual Mean VOCs as 1,3-Butadiene

Drawn by: SMN | Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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Legend

Stack

Human Receptors

Annual mean cadmium as % of AQAL - Operational Facility

Annual mean cadmium as % of AQAL - Proposed Facility

Notes:
Assumes cadmium emitted at the combined ELV for cadmium and thallium

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 13. Annual Mean Cadmium

Drawn by: SMN	Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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Legend

- Stack
- Human Receptors
- Hourly NO2 as % of AQAL - Operational Facility
- Hourly NO2 as % of AQAL - Proposed Facility

Notes:

Assumes 35% NOx to NO2 conversion rate

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 14. Hourly Mean Nitrogen Dioxide

Drawn by: SMN	Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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Legend

- Stack
- Human Receptors
- 15-min SO2 as % of AQAL - Operational Facility
- 15-min SO2 as % of AQAL - Proposed Facility

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 15. 15-Minute Mean Sulphur Dioxide

Drawn by: SMN | Date: 13/09/2023

0 0.25 0.5 1 km

N

Scale: 1:25,000

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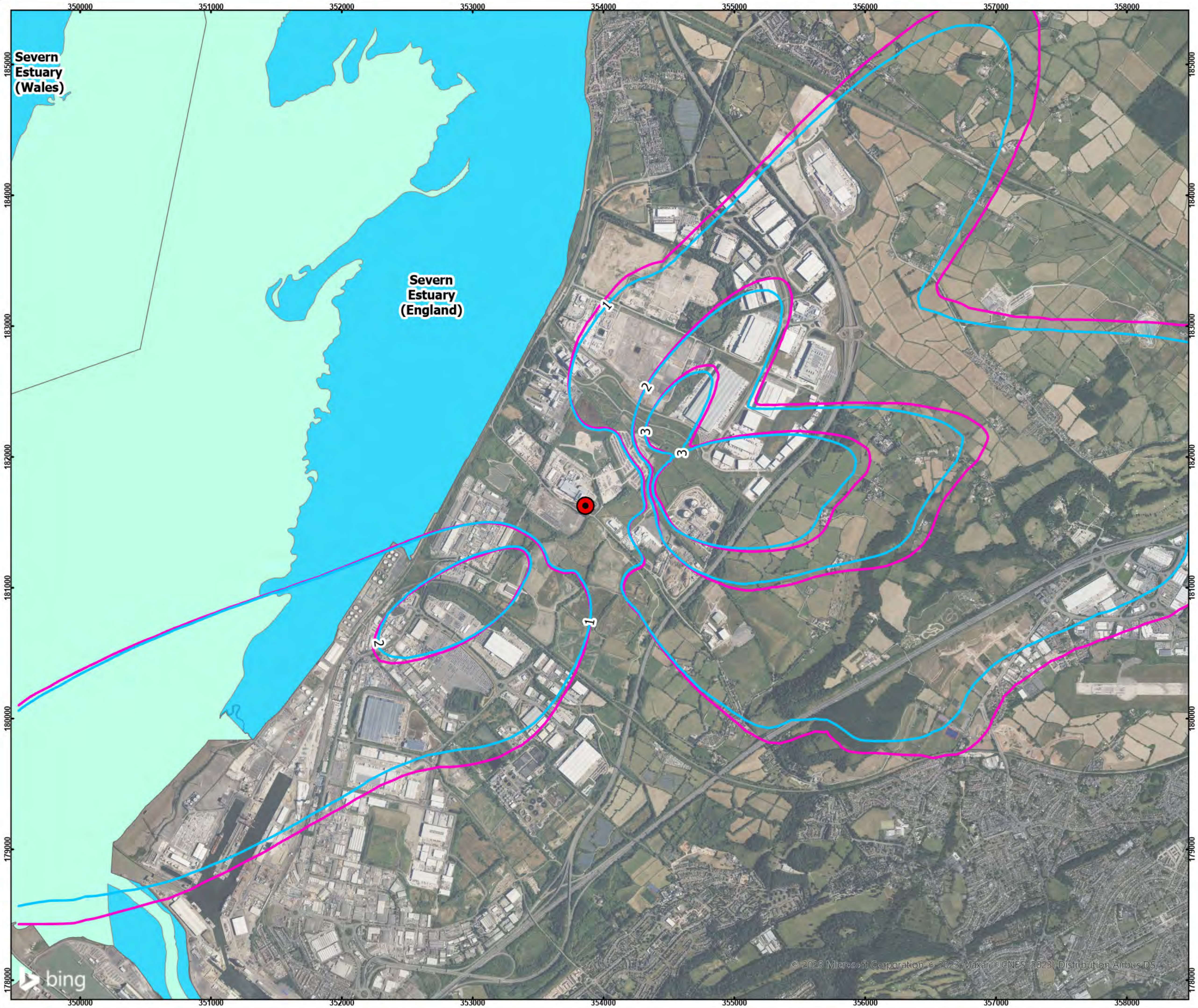

Legend

- Stack
- Annual Mean NOx as % of Critical Level - Operational Facility
- Annual Mean NOx as % of Critical Level - Proposed Facility
- Ramsars
- SACs

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 16. Annual Mean Oxides of Nitrogen

Drawn by: SMN | Date: 13/09/2023

0 0.28 0.55 1.1 km

Scale: 1:27,000

N

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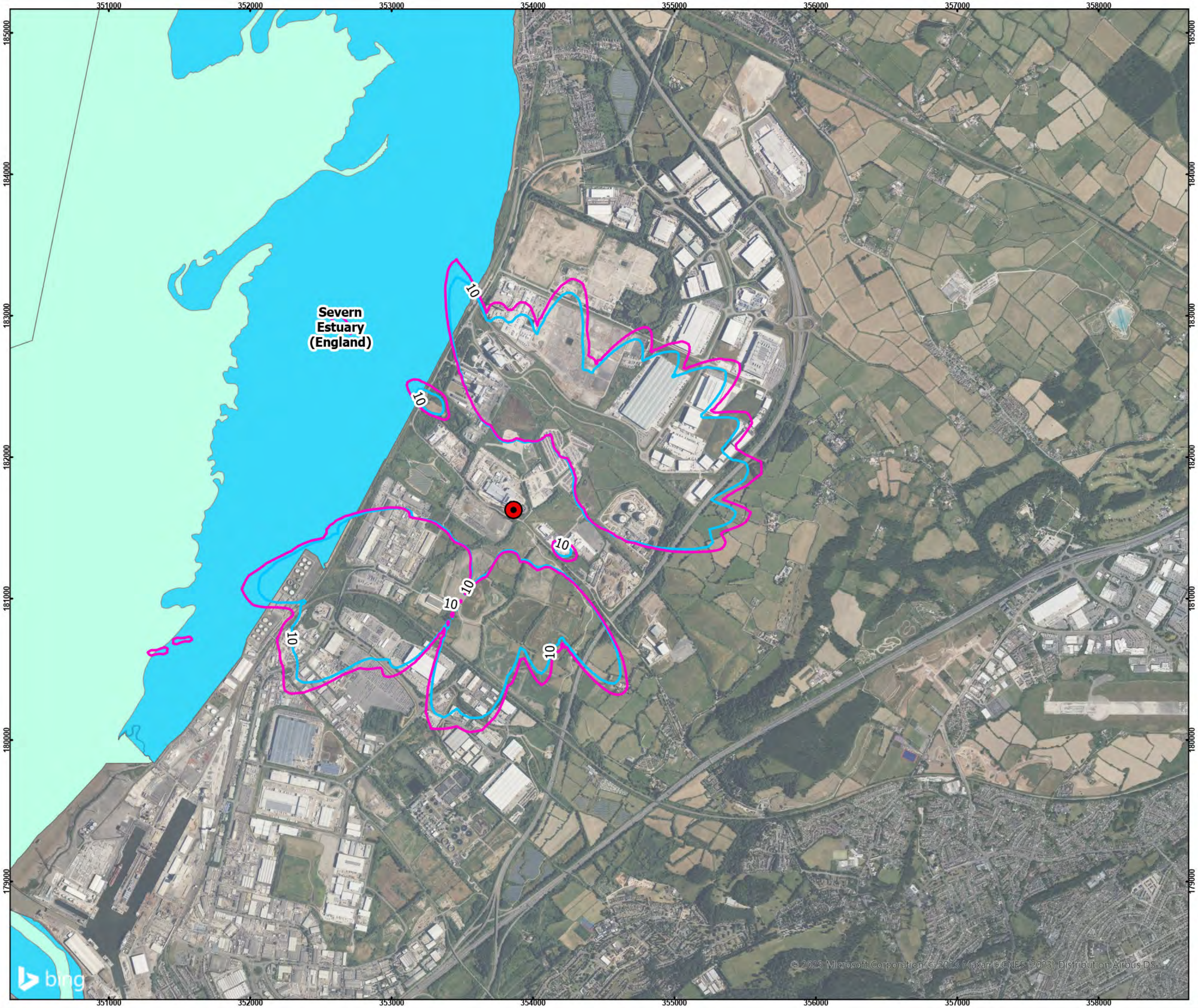

Legend

- Stack
- Daily mean NOx as % of Critical Level - Proposed Facility
- Daily mean NOx as % of Critical Level - Operational Facility
- Ramsars
- SACs

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 17. Daily Mean Oxides of Nitrogen

Drawn by: SMN | Date: 13/09/2023

0 0.25 0.5 1 km

Scale: 1:25,000

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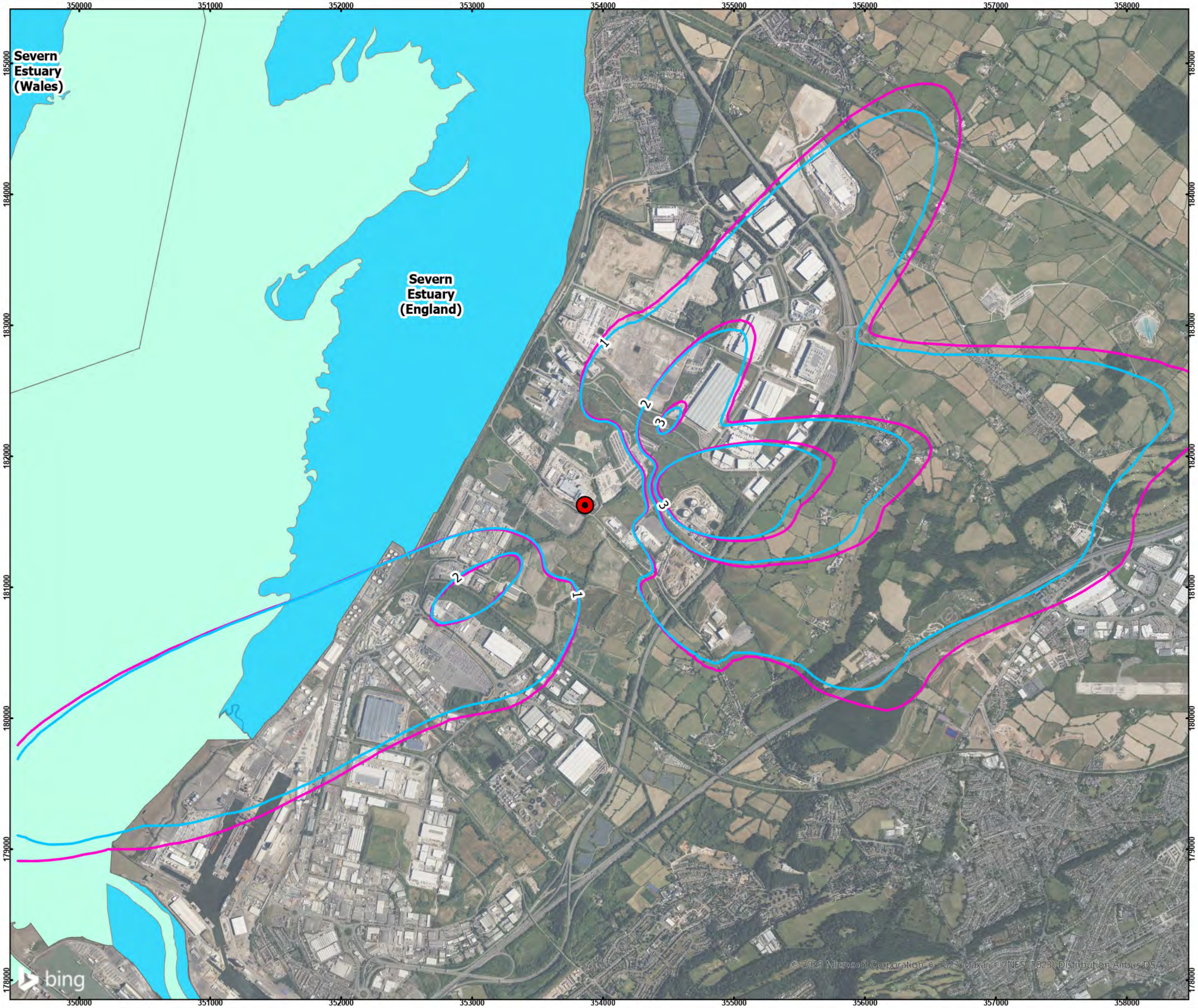

Legend

- Stack
- Annual mean ammonia as % of Critical Level - Operational Facility
- Annual mean ammonia as % of Critical Level - Proposed Facility
- Ramsars
- SACs

Notes:
PC as % of higher Critical Level of 3 µg/m³

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	Figure 18. Annual Mean Ammonia

Drawn by: SMN | Date: 13/09/2023

0 0.28 0.55 1.1 km

N

Scale: 1:27,000

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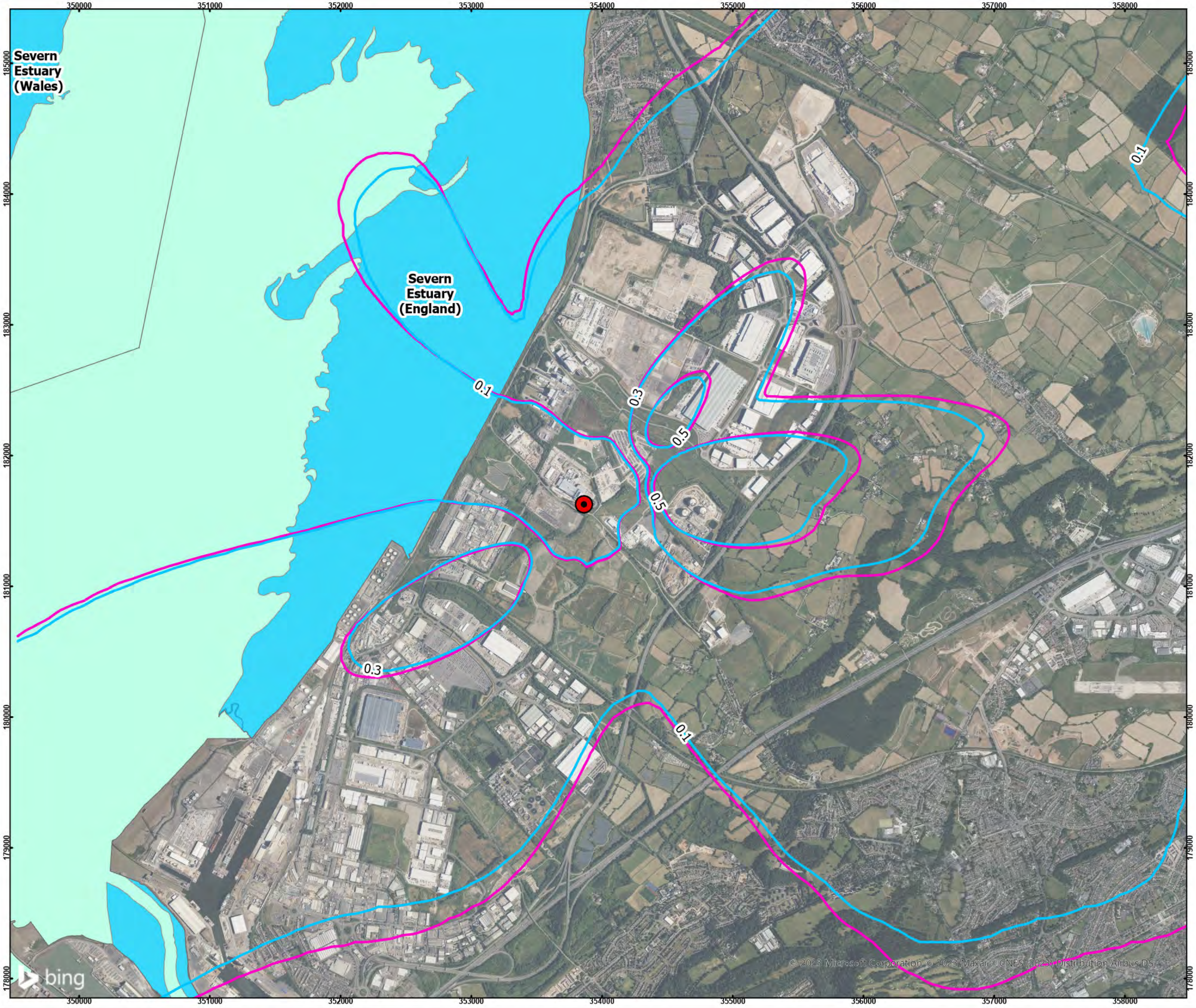

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 19. Nitrogen Deposition to Grassland Habitats

Drawn by: SMN | Date: 13/09/2023

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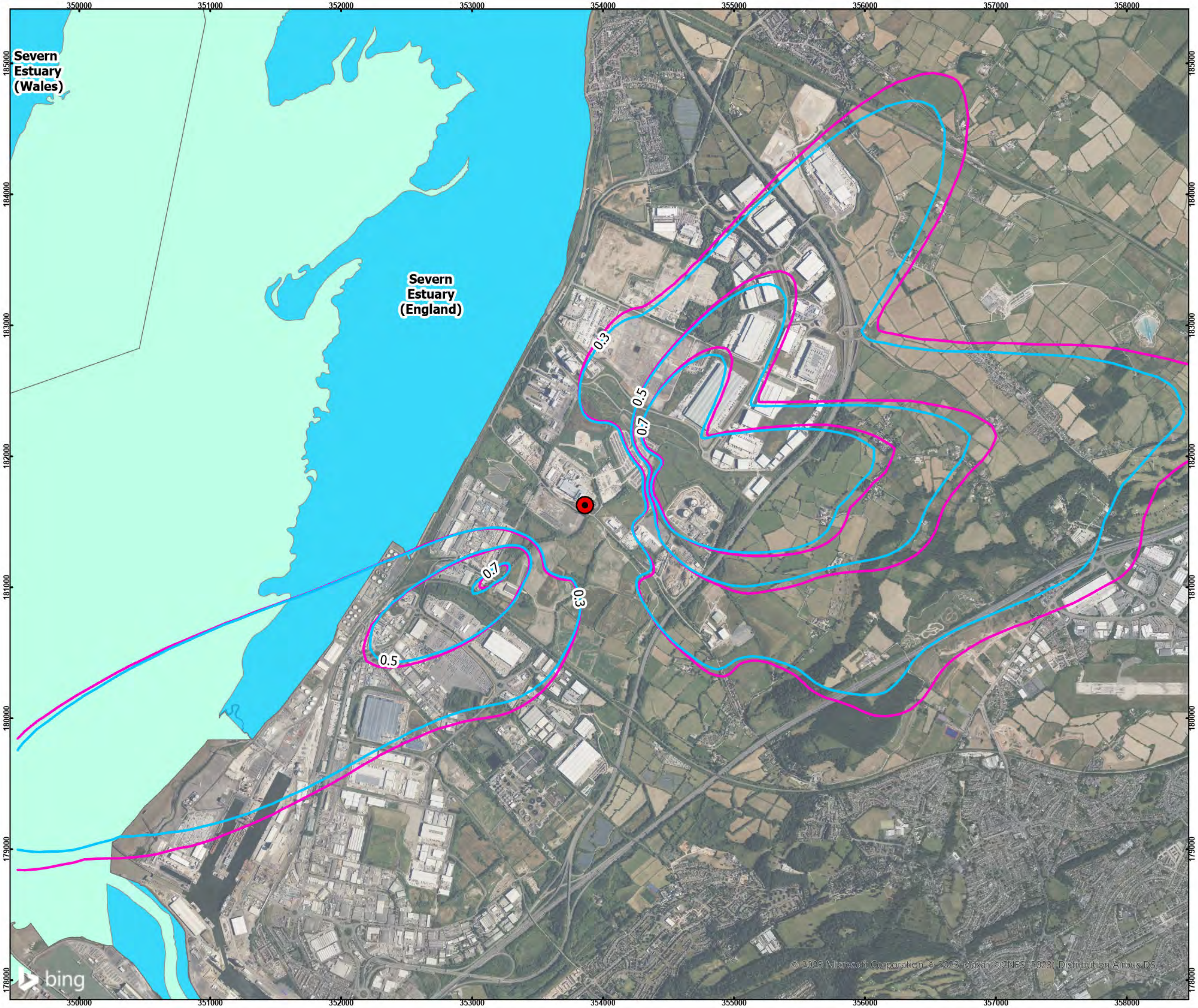

Legend

- Stack
- Nitrogen deposition to woodland - Operational Facility
- Nitrogen deposition to woodland - Proposed Facility
- Ramsars
- SACs

Notes:
PC as kgN/ha/yr

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 20. Nitrogen Deposition to Woodland Habitats

Drawn by: SMN | Date: 13/09/2023

0 0.28 0.55 1.1 km

Scale: 1:27,000

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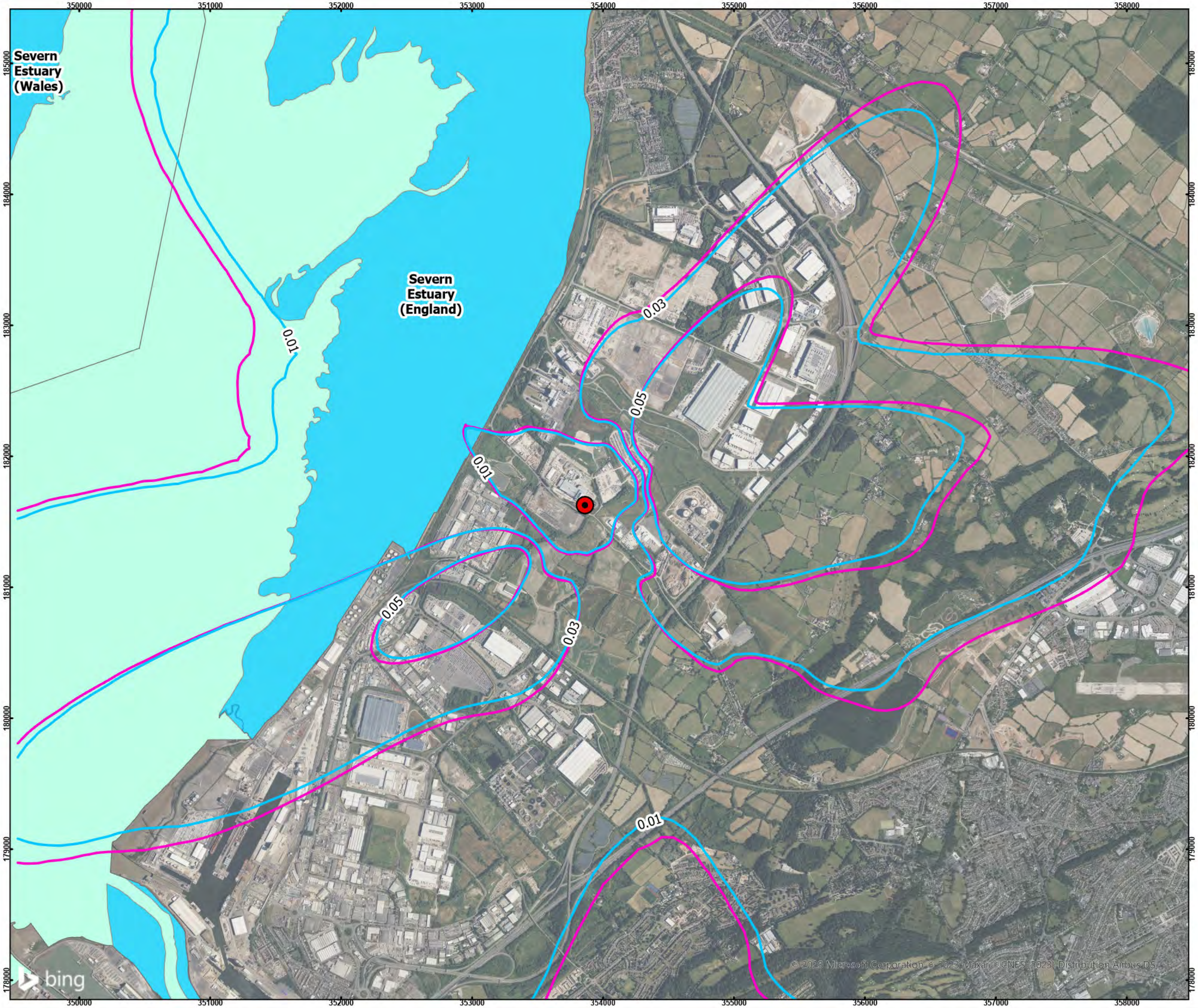

Legend

Stack

Acid deposition to grassland - Operational Facility

Acid deposition to grassland - Proposed Facility

Ramsars

SACs

Notes:
PC as keq/ha/yr

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment
Title:	

Figure 21. Acid Deposition to Grassland Habitats

Drawn by: SMN	Date: 13/09/2023

0 0.28 0.55 1.1 km

N

Scale: 1:27,000

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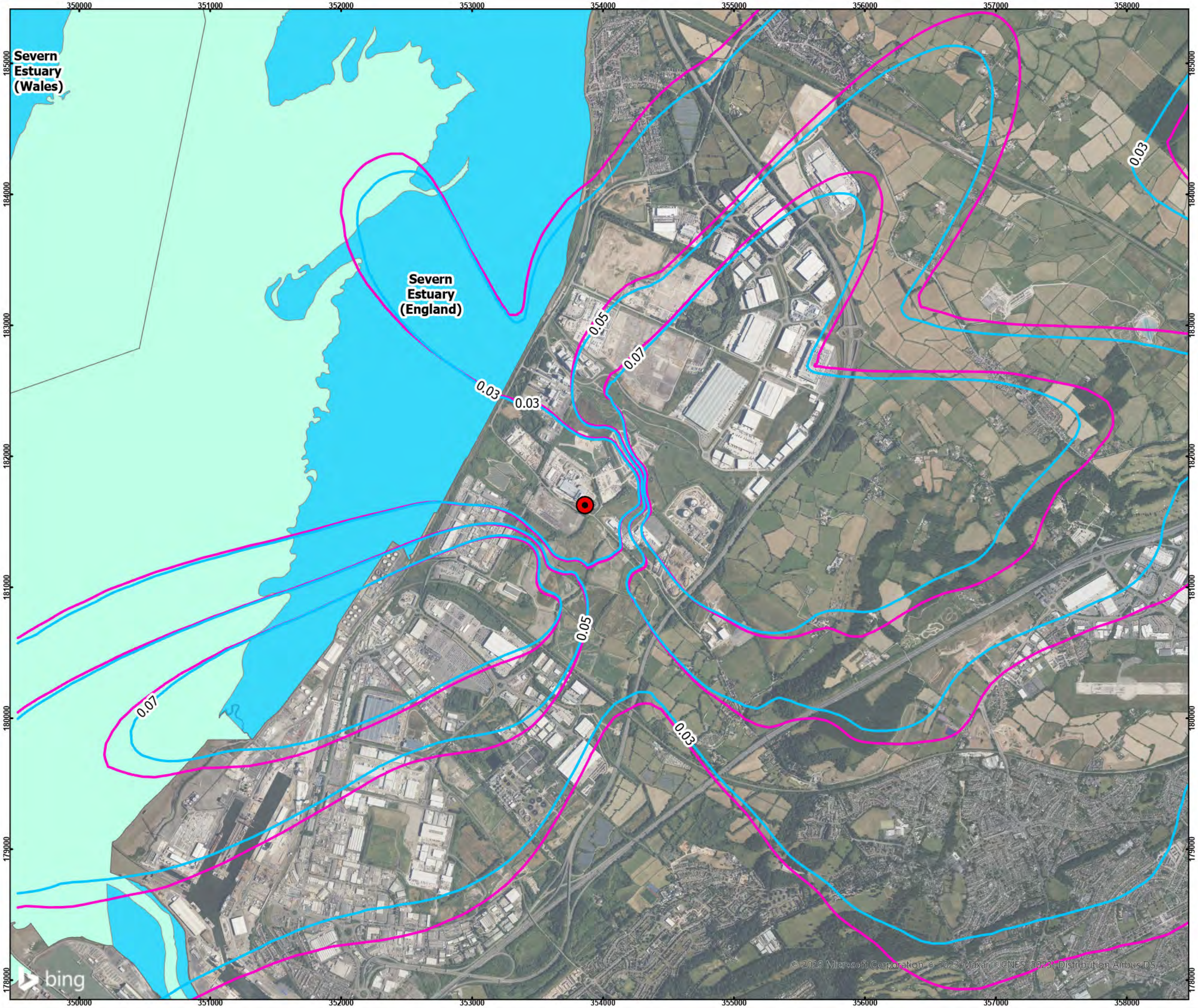

Legend

- Stack
- Acid deposition to woodland - Operational Facility
- Acid deposition to woodland - Proposed Facility
- Ramsars
- SACs

Notes:
PC as keq/ha/yr

Client:	Viridor
Site:	Avonmouth ERF
Project:	Dispersion Modelling Assessment

Title:

Figure 22. Acid Deposition to Woodland Habitats

Drawn by: SMN	Date: 13/09/2023

0 0.28 0.55 1.1 km

N

Scale: 1:27,000

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B APIS Critical Loads

Table 46: Nitrogen Deposition Critical Loads

Site	Habitat	NCL class	Lower Critical Load (kgN/ha/yr)	Upper Critical Load (kgN/ha/yr)	Background (kgN/ha/yr)(1)
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	Freshwater	Atlantic upper-mid & mid-low salt marshes	10	20	17.32
E2 Avon Gorge Woodlands SAC	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Shifting coastal dunes	10	20	17.32
	Tilio-Acerion forests of slopes, screes and ravines	Low and medium altitude hay meadows	10	20	17.32
E3 River Wye SAC	European dry heaths	Semi-dry perennial calcareous grassland (basic meadow steppe).	10	20	15.02
	Bog woodland	Carpinus and Quercus mesic deciduous forest	15	20	25.60
E4 Local nature sites (grid max)	Acid grassland	Dry heaths	5	15	23.01
	Woodland	Raised and blanket bogs	5	10	34.21

Table 47: Acid Deposition Critical Loads

Site	Species/habitat type	Acidity class	Critical Load Function (keq/ha/yr)			Maximum Background (keq/ha/yr)	
			CLminN	CLmaxN	CLmaxS	N	S
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	Freshwater	No CL function defined	-	-	-	-	-
E2 Avon Gorge Woodlands SAC	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	Calcareous grassland (using base cation)	0.856	4.854	4	1.178*	-
	Tilio-Acerion forests of slopes, screes and ravines	Unmanaged Broadleafed/Coniferous Woodland	0.142	1.219	1.077	1.961*	-
E3 River Wye SAC	European dry heaths	Dwarf shrub heath	1.107	5.042	4.15	1.713*	-
	Bog woodland	Bogs	0.321	0.487	0.166	2.519*	-
E4 Local nature sites (grid max)	Acid grassland	Acid grassland	0.438	4.548	4.11	0.97	0.14
	Woodland	Broadleafed/Coniferous unmanaged woodland	0.357	11.162	10.805	1.66	0.18

Note:

** For European and UK designated sites APIS provides total acid deposition (N+S) as a single figure, which is reported in this table. The separate individual N and S values for the Local Nature Sites have been obtained using the 'search by location' function in APIS.*

C Deposition Analysis at Ecological Sites

Table 48: Annual Mean PC for Deposition Analysis

Site	Annual mean PC (ng/m^3)							
	Nitrogen dioxide		Sulphur dioxide		Hydrogen chloride		Ammonia	
	Operational	Proposed	Operational	Proposed	Operational	Proposed	Operational	Proposed
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	378.4	381.0	120.1	120.9	24.0	24.2	45.0	45.4
E2 Avon Gorge Woodlands SAC	42.7	45.5	13.5	14.4	2.7	2.9	5.1	5.4
E3 River Wye SAC	40.4	43.2	12.8	13.7	2.6	2.7	4.8	5.1
E4 Local nature sites (grid max)	1,469.2	1,503.2	466.4	477.2	93.3	95.4	174.9	178.9

Table 49: Deposition Calculation – Operational Facility

Site	Deposition velocity	Deposition (g/ha/yr)				N deposition (gN/ha/yr)	Acid deposition (keq/ha/yr x 1000)	
		NO_2	SO_2	HCl	NH_3		N	S
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	Grassland	54.49	227.32	368.41	233.93	288.42	20.60	24.58
E2 Avon Gorge Woodlands SAC	Grassland	6.14	25.63	41.54	26.37	32.52	2.32	2.77
	Woodland	12.29	51.26	99.69	39.56	51.85	3.70	6.01
E3 River Wye SAC	Grassland	5.82	24.29	39.36	24.99	30.82	2.20	2.63
	Woodland	11.64	48.58	94.47	37.49	49.14	3.51	5.70
E4 Local nature sites (grid max)	Grassland	211.57	882.66	1,430.51	908.35	1,119.92	79.99	95.46
	Woodland	423.14	1,765.31	3,433.24	1,362.53	1,785.67	127.55	207.04

Table 50: Deposition Calculation – Proposed Facility

Site	Deposition velocity	Deposition (g/ha/yr)				N deposition (gN/ha/yr)	Acid deposition (keq/ha/yr x 1000)	
		NO_2	SO_2	HCl	NH_3		N	S
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	Grassland	54.87	228.87	370.99	235.57	290.43	20.75	24.75
E2 Avon Gorge Woodlands SAC	Grassland	6.55	27.33	44.31	28.13	34.69	2.48	2.96
	Woodland	13.11	54.67	106.33	42.20	55.30	3.95	6.41
E3 River Wye SAC	Grassland	6.22	25.95	42.06	26.71	32.93	2.35	2.81
	Woodland	12.44	51.90	100.95	40.06	52.51	3.75	6.09
E4 Local nature sites (grid max)	Grassland	216.47	902.97	1,463.66	929.38	1,145.85	81.85	97.67
	Woodland	432.93	1,805.94	3,512.78	1,394.07	1,827.00	130.50	211.82

Table 51: Detailed Results – Nitrogen Deposition

Site	NCL class	Deposition velocity	PC						Proposed Facility PEC	
			Operational Facility		Proposed Facility		Change			
			N dep kgN/ha/yr	% of Lower CL	N dep kgN/ha/yr	% of Lower CL	N dep kgN/ha/yr	% of Lower CL	PEC N dep kgN/ha/yr	% of Lower CL
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	Atlantic upper-mid & mid-low salt marshes	Grassland	0.29	**2.88%**	0.29	**2.90%**	0.002	0.02%	17.6	176.1%
E2 Avon Gorge Woodlands SAC	Semi-dry perennial calcareous grassland (basic meadow steppe)	Grassland	0.03	0.33%	0.03	0.35%	0.002	0.02%	15.1	150.5%
	Carpinus and Quercus mesic deciduous forest	Woodland	0.05	0.35%	0.06	0.37%	0.003	0.02%	25.7	171.0%
River Wye SAC	European dry heaths	Grassland	0.03	0.62%	0.03	0.66%	0.002	0.04%	23.0	460.8%
	Raised and blanket bogs	Woodland	0.05	0.98%	0.05	**1.05%**	0.003	0.07%	34.3	685.2%
E4 Local nature sites (grid max)	Non-mediterranean dry acid and neutral closed grassland	Grassland	1.12	18.67%	1.15	19.10%	0.026	0.43%	14.7	244.8%
	Broadleaved deciduous woodland	Woodland	1.79	17.86%	1.83	18.27%	0.041	0.41%	25.0	250.0%

Table 52: Detailed Results – Acid Deposition

Site	Acidity Class	Deposition velocity	PC									Proposed Facility PEC	
			Operational Facility			Proposed Facility			Change				
			N keq/ ha/yr	S keq/ ha/yr	% CL	N keq/ ha/yr	S keq/ ha/yr	% CL	N keq/ha/ yr	S keq/ha/ yr	% CL	Total keq/ha/ yr	% of CL
E1 Severn Estuary SAC, SPA, Ramsar, SSSI	No CL function defined	Grassland	0.033	0.053	-	0.033	0.054	-	0.0002	0.0004	-	0.09	-
E2 Avon Gorge Woodlands SAC	Calcareous grassland (using base cation)	Grassland	0.002	0.003	0.10%	0.002	0.003	0.11%	0.0002	0.0002	0.01%	1.18	24.4%
	Unmanaged Broadleafed/ Coniferous Woodland	Woodland	0.004	0.006	0.80%	0.004	0.006	0.85%	0.0002	0.0004	0.05%	1.97	161.7%
E3 River Wye SAC	Dwarf shrub heath	Grassland	0.002	0.003	0.10%	0.002	0.003	0.10%	0.0002	0.0002	0.01%	1.72	34.1%
	Bogs	Woodland	0.004	0.006	**1.89%**	0.004	0.006	**2.02%**	0.0002	0.0004	0.13%	2.53	**519.3%**
E4 Local nature sites (grid max)	Acid grassland	Grassland	0.080	0.095	3.86%	0.082	0.098	3.95%	0.0019	0.0022	0.09%	1.29	28.4%
	Unmanaged broadleafed/ coniferous woodland	Woodland	0.128	0.207	3.00%	0.131	0.212	3.07%	0.0030	0.0048	0.07%	2.18	19.6%

D Detailed Results Tables

Table 53: Dispersion Modelling Results – PC at Point of Maximum Impact - Daily ELVs – Operational Facility

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	23.63	1.47	1.45	1.07	1.13	1.23	1.47	3.67%	25.10	62.75%
	99.79th %ile of hourly means	µg/m³	200	47.26	9.20	8.10	8.07	8.36	8.85	9.20	4.60%	56.46	28.23%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	31.20	3.70	3.49	3.18	2.61	3.33	3.70	2.96%	34.90	27.92%
	99.73rd %ile of hourly means	µg/m³	350	31.20	5.59	5.08	4.98	5.03	5.20	5.59	1.60%	36.79	10.51%
	99.9th %ile of 15 min. means	µg/m³	266	31.20	6.84	6.46	6.32	6.49	6.59	6.84	2.57%	38.04	14.30%
Particulates (PM_{10})	Annual mean	µg/m³	40	15.91	0.06	0.06	0.04	0.04	0.05	0.06	0.15%	15.97	39.92%
	90.4th %ile of daily means	µg/m³	50	31.82	0.21	0.20	0.16	0.16	0.17	0.21	0.41%	32.03	64.05%
Particulates ($PM_{2.5}$)	Annual mean	µg/m³	20	10.17	0.06	0.06	0.04	0.04	0.05	0.06	0.29%	10.23	51.14%
		µg/m³	10*	10.17	0.06	0.06	0.04	0.04	0.05	0.06	0.58%	10.23	102.28%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	7.48	6.02	6.10	7.01	6.54	7.48	0.07%	905.48	9.05%
	Hourly mean	µg/m³	30,000	898	13.62	12.49	10.21	9.92	9.75	13.62	0.05%	911.62	3.04%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	2.18	2.00	1.63	1.59	1.56	2.18	0.29%	3.60	0.48%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.01	0.01	0.01	0.01	0.01	0.01	0.07%	2.36	14.76%
	Hourly mean	µg/m³	160	4.70	0.27	0.25	0.20	0.20	0.19	0.27	0.17%	4.97	3.11%
Ammonia	Annual mean	µg/m³	180	2.09	0.17	0.17	0.13	0.13	0.15	0.17	0.10%	2.26	1.26%

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
	Hourly mean	µg/m³	2,500	4.18	4.09	3.75	3.06	2.97	2.92	4.09	0.16%	8.27	0.33%
VOCs (as benzene)	Annual mean	µg/m³	5	0.88	0.12	0.12	0.08	0.09	0.10	0.12	2.33%	1.00	19.93%
	Daily mean	µg/m³	30	1.76	1.02	1.01	0.88	0.80	1.02	1.02	3.41%	2.78	9.28%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.34	0.12	0.12	0.08	0.09	0.10	0.12	5.18%	0.46	20.29%
Mercury	Annual mean	ng/m³	250	2.80	0.23	0.23	0.17	0.18	0.19	0.23	0.09%	3.03	1.21%
	Hourly mean	ng/m³	7,500	5.60	5.45	4.99	4.08	3.97	3.90	5.45	0.07%	11.05	0.15%
Cadmium	Annual mean	ng/m³	5	0.43	0.23	0.23	0.17	0.18	0.19	0.23	4.66%	0.66	13.26%
PaHs	Annual mean	pg/m³	250	130	2.33	2.30	1.69	1.80	1.95	2.33	0.93%	1302.33	520.93%
Dioxins and Furans	Annual mean	fg/m³	-	32.99	0.70	0.69	0.51	0.54	0.58	0.70	-	33.69	-
PCBs	Annual mean	ng/m³	200	1.29	0.06	0.06	0.04	0.04	0.05	0.06	0.03%	1.35	0.67%
	Hourly mean	ng/m³	6,000	2.58	1.36	1.25	1.02	0.99	0.97	1.36	0.02%	3.94	0.07%

Note:

Assumes continuous operation at the daily ELVs.

**Annual mean AQAL of 10 µg/m³ for $PM_{2.5}$ is the target value to be achieved by 2040.*

Table 54: Dispersion Modelling Results – PC at Point of Maximum Impact - Daily ELVs – Proposed Facility

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	Annual mean	µg/m³	40	23.63	1.50	1.48	1.08	1.15	1.25	1.50	3.76%	25.13	62.83%
	99.79th %ile of hourly means	µg/m³	200	47.26	9.54	8.41	8.36	8.87	9.24	9.54	4.77%	56.80	28.40%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	31.2	3.83	3.64	3.23	2.69	3.47	3.83	3.07%	35.03	28.03%
	99.73rd %ile of hourly means	µg/m³	350	31.2	5.86	5.31	5.22	5.25	5.46	5.86	1.67%	37.06	10.59%
	99.9th %ile of 15 min. means	µg/m³	266	31.2	7.04	6.58	6.54	6.78	6.83	7.04	2.65%	38.24	14.38%
Particulates (PM_{10})	Annual mean	µg/m³	40	15.91	0.06	0.06	0.04	0.05	0.05	0.06	0.15%	15.97	39.92%
	90.4th %ile of daily means	µg/m³	50	31.82	0.21	0.21	0.16	0.16	0.17	0.21	0.42%	32.03	64.06%
Particulates ($PM_{2.5}$)	Annual mean	µg/m³	20	10.17	0.06	0.06	0.04	0.05	0.05	0.06	0.30%	10.23	51.15%
		µg/m³	10*	10.17	0.06	0.06	0.04	0.05	0.05	0.06	0.60%	10.23	102.30%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	7.70	6.31	6.42	7.27	6.76	7.70	0.08%	905.70	9.06%
	Hourly mean	µg/m³	30,000	898	13.14	12.94	9.84	10.69	10.10	13.14	0.04%	911.14	3.04%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	2.10	2.07	1.57	1.71	1.62	2.10	0.28%	3.52	0.47%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.01	0.01	0.01	0.01	0.01	0.01	0.07%	2.36	14.76%
	Hourly mean	µg/m³	160	4.70	0.26	0.26	0.20	0.21	0.20	0.26	0.16%	4.96	3.10%
Ammonia	Annual mean	µg/m³	180	2.09	0.18	0.18	0.13	0.14	0.15	0.18	0.10%	2.27	1.26%
	Hourly mean	µg/m³	2,500	4.18	3.94	3.88	2.95	3.21	3.03	3.94	0.16%	8.12	0.32%

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
VOCs (as benzene)	Annual mean	µg/m³	5	0.88	0.12	0.12	0.09	0.09	0.10	0.12	2.39%	1.00	19.99%
	Daily mean	µg/m³	30	1.76	1.06	1.05	0.89	0.83	1.07	1.07	3.58%	2.83	9.45%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.34	0.12	0.12	0.09	0.09	0.10	0.12	5.30%	0.46	20.41%
Mercury	Annual mean	ng/m³	250	2.80	0.24	0.24	0.17	0.18	0.20	0.24	0.10%	3.04	1.22%
	Hourly mean	ng/m³	7,500	5.60	5.26	5.17	3.94	4.28	4.04	5.26	0.07%	10.86	0.14%
Cadmium	Annual mean	ng/m³	5	0.43	0.24	0.24	0.17	0.18	0.20	0.24	4.77%	0.67	13.37%
PaHs	Annual mean	pg/m³	250	1300	2.39	2.35	1.72	1.82	1.98	2.39	0.95%	1302.39	520.95%
Dioxins and Furans	Annual mean	fg/m³	-	32.99	0.72	0.71	0.51	0.55	0.59	0.72	-	33.71	-
PCBs	Annual mean	ng/m³	200	1.29	0.06	0.06	0.04	0.05	0.05	0.06	0.03%	1.35	0.67%
	Hourly mean	ng/m³	6,000	2.58	1.31	1.29	0.98	1.07	1.01	1.31	0.02%	3.89	0.06%

Note:

Assumes continuous operation at the daily ELVs.

**Annual mean AQAL of 10 µg/m³ for $PM_{2.5}$ is the target value to be achieved by 2040.*

Table 55: Dispersion Modelling Results – PC at Point of Maximum Impact - Short-Term ELVs – Operational Facility

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	47.26	20.44	17.99	17.93	18.58	19.66	20.44	10.22%	67.70	33.85%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	31.20	27.96	25.41	24.90	25.15	25.99	27.96	7.99%	59.16	16.90%
	99.9th %ile of 15 min. means	µg/m³	266	31.20	34.18	32.31	31.62	32.44	32.93	34.18	12.85%	65.38	24.58%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	22.43	18.05	18.30	21.03	19.62	22.43	0.22%	920.43	9.20%
	Hourly mean	µg/m³	30,000	898	40.86	37.46	30.63	29.75	29.25	40.86	0.14%	938.86	3.13%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	16.35	14.99	12.25	11.90	11.70	16.35	2.18%	17.77	2.37%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	1.09	1.00	0.82	0.79	0.78	1.09	0.68%	5.79	3.62%

Note:
Assumes continuous operation at the short term ELVs

Table 56: Dispersion Modelling Results – PC at Point of Maximum Impact - Short-Term ELVs – Operational Facility

Pollutant	Quantity	Units	AQAL	Bg conc.	2016	2017	2018	2019	2020	Max	Max as % of AQAL	PEC	PEC as % of AQAL
Nitrogen dioxide	99.79th %ile of hourly means	µg/m³	200	47.26	21.21	18.68	18.59	19.71	20.53	21.21	10.60%	68.47	34.23%
Sulphur dioxide	99.73rd %ile of hourly means	µg/m³	350	31.20	29.30	26.54	26.08	26.26	27.30	29.30	8.37%	60.50	17.28%
	99.9th %ile of 15 min. means	µg/m³	266	31.20	35.22	32.92	32.70	33.88	34.13	35.22	13.24%	66.42	24.97%
Carbon monoxide	8 hour running mean	µg/m³	10,000	898	23.11	18.93	19.26	21.81	20.28	23.11	0.23%	921.11	9.21%
	Hourly mean	µg/m³	30,000	898	39.43	38.81	29.53	32.07	30.31	39.43	0.13%	937.43	3.12%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	15.78	15.53	11.81	12.83	12.13	15.78	2.10%	17.20	2.29%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	1.05	1.03	0.79	0.86	0.81	1.05	0.66%	5.75	3.59%
Note: *Assumes continuous operation at the short term ELVs*													

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