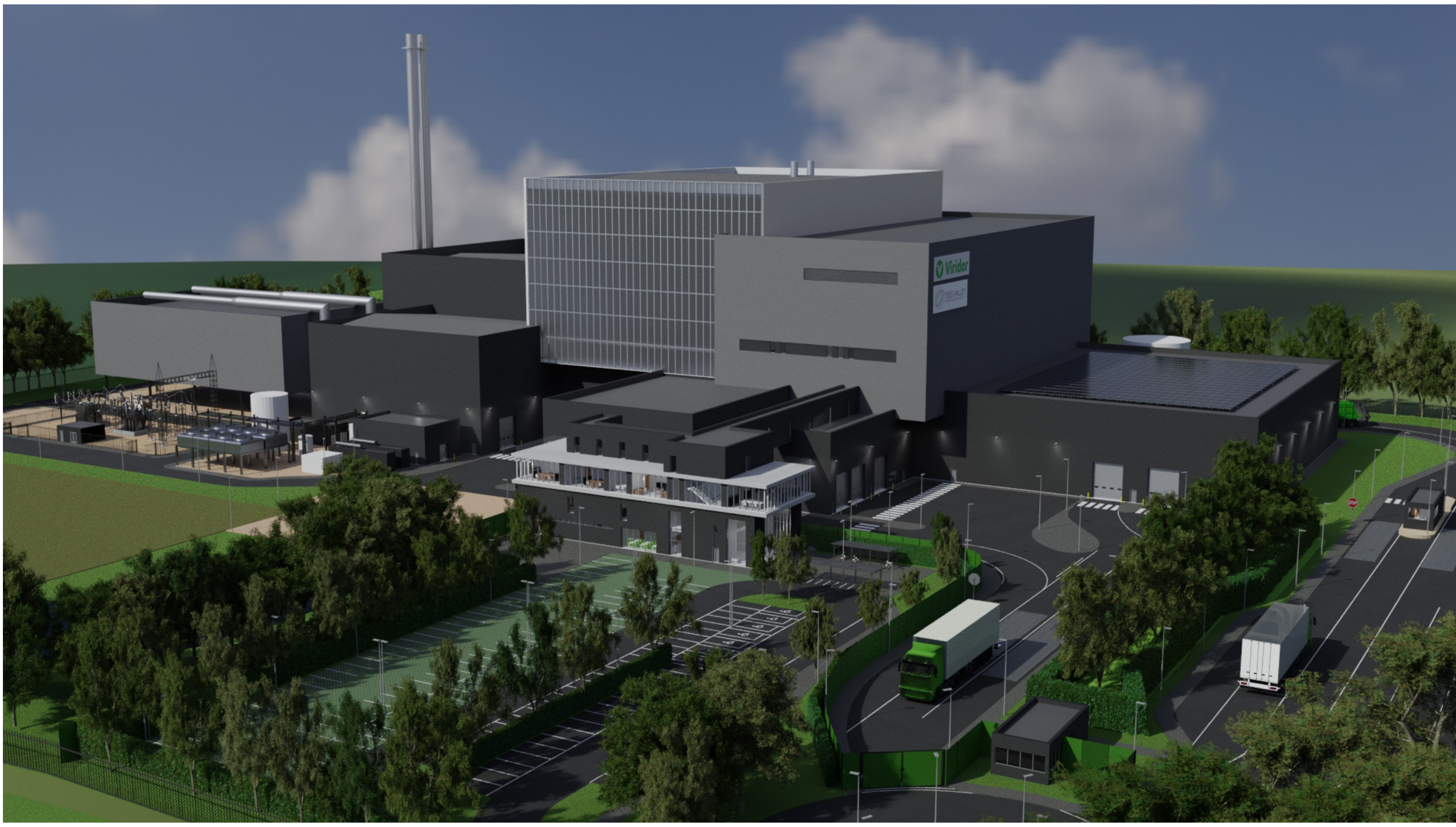


Air Quality: Emissions Modelling Report

Tees Valley Energy Recovery Facility
Grangetown Prairie, Dorman Point
Prepared on behalf of Viridor Tees Valley Limited
March 2023

Document approval

	Name	Signature	Position	Date
Prepared by:	Stuart Nock		Associate Senior Environmental Consultant	21/03/2023
Checked by:	Rosalind Flavell		Senior Consultant	21/03/2023

Document revision record

Revision no	Date	Details of revisions	Prepared by	Checked by
0	27/10/2021	Draft for client review	SMN	RSF
1	04/01/2022	Updated following client comments	SMN	RSF
2	14/02/2022	Updated following final client comments	SMN	RSF
3	08/02/2023	Updated baseline and cumulative schemes	SMN	RSF
4	14/03/2023	Inclusion of additional cumulative scheme	SMN	RSF
5	21/03/2023	Final version	SMN	RSF

Contents

1 Introduction

This report sets out the approach taken to modelling emissions from the stack which forms part of the detailed design of the Tees Valley Energy Recovery Facility (the Proposed ERF). This report includes all model inputs and justifications where appropriate. Finally, this report presents the results of the modelling and indicates where impacts can be screened out as 'negligible' or 'insignificant'. The findings of this report are summarised in Chapter 11 of the Environmental Impact Assessment: Statement of Conformity submitted with the reserved matters application for the Proposed ERF. Where appropriate, reference has been made to the Air Quality Assessment submitted with the outline planning application reference R/2019/0767/OOM (the Outline AQA).

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 (EA) include Environmental Assessment Levels (EALs) for other pollutants in the environmental management guidance 'Air Emissions Risk Assessment for your Environmental Permit'[1] ("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)[2].

The Environment Act 2021, passed in November 2021, will deliver key aspects of the UK's Clean Air Strategy. It has introduced a duty on the government to set a legally binding target for $PM_{2.5}$. Although the Environment Act does not stipulate the level it states that the Secretary of State will lay a draft of the target for annual average levels of $PM_{2.5}$ before Parliament by 31 October 2022. To date, no draft target level has been published.

The World Health Organisation (WHO) set an annual mean $PM_{2.5}$ guideline value of 10 µg/m³ in 2005, which was updated to 5 µg/m³ in 2021. It is possible that the Secretary of State will set targets at either of the WHO recommendations or set an independently determined target. Whilst neither the 2005 nor 2021 WHO guideline values are currently legally binding, the impact of the Proposed ERF against these guideline values has been considered in this assessment.

AAD Target and Limit Values, AQS Objectives, and EALs are collectively referred to as Air Quality Assessment Levels (AQALs) for the remainder of this report. Table 1 to Table 3 summarise the AQALs 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)	AQS Objective
	40	Annual	-	AQS Objective
Sulphur dioxide	266	15 minutes	35 times per year (99.9th percentile)	AQS Objective
	350	1 hour	24 times per year (99.73rd percentile)	AQS Objective
	125	24 hours	3 times per year (99.18th percentile)	AQS Objective
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.41st percentile)	AQS Objective

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

2 www.apis.ac.uk

Pollutant	Limit Value (µg/m³)	Averaging Period	Frequency of Exceedances	Source
	40	Annual	-	AQS Objective
Particulate matter ($PM_{2.5}$)	25	Annual	-	AQS Target Value
	10	Annual	-	WHO 2005 Guideline
	5	Annual	-	WHO 2021 Guideline
Carbon monoxide	10,000	8 hours, running	-	AQS Objective
	30,000	1 hour		Air Emissions Guidance
Hydrogen chloride	750	1 hour	-	Air Emissions Guidance
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 hours	-	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: Air Quality Assessment Levels for Metals

Pollutant	AQAL (ng/m³)	Averaging Period	Source
Cadmium	-	1 hour	-
	5	Annual	AAD Target Value
Mercury	7,500	1 hour	Air Emissions Guidance
	250	Annual	Air Emissions Guidance
Antimony	150,000	1 hour	Air Emissions Guidance
	5,000	Annual	Air Emissions Guidance
Arsenic	-	1 hour	-
	6	Annual	Air Emissions Guidance
Chromium (II & III)	150,000	1 hour	Air Emissions Guidance
	5,000	Annual	Air Emissions Guidance
Chromium (VI)	-	1 hour	-
	0.25	Annual	Air Emissions Guidance
Copper	200,000	1 hour	Air Emissions Guidance

Pollutant	AQAL (ng/m³)	Averaging Period	Source
	10,000	Annual	Air Emissions Guidance
Lead	-	1 hour	-
	250	Annual	AQS Target
Manganese	1,500,000	1 hour	Air Emissions Guidance
	150	Annual	Air Emissions Guidance
Nickel	-	1 hour	-
	20	Annual	AAD Limit
Vanadium	1,000	24 hour	Air Emissions Guidance

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

Pollutant	Concentration (µg/m³)	Measured as	Source
Nitrogen oxides (as nitrogen dioxide)	75	Daily mean	Air Emissions Guidance
	200(1)		
	30	Annual mean	AAD Critical Level
Sulphur dioxide	10	Annual mean For the protection of lichens and bryophytes	Air Emissions Guidance / APIS
	20	Annual mean for all higher plants	AAD Critical Level
Hydrogen fluoride	5	Daily mean	Air Emissions Guidance / APIS
	0.5	Weekly mean	Air Emissions Guidance / APIS
Ammonia	1	Annual mean For the protection of lichens and bryophytes	APIS
	3	Annual mean for all higher plants	APIS

Note:
**only for detailed assessments where the 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 3,000 ppb.h (6,000 µg/m³.h) 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.*

As noted in Table 3, when ozone and sulphur dioxide are below their Critical Levels it appropriate to use 200 µg/m³ as the short-term Critical Level for oxides of nitrogen. When carrying out this assessment the daily Critical Level of 75 µg/m^3 has been used as an initial screening level, and where a potentially significant impact cannot be screened out, consideration has also been given to the impact with reference to the much higher Critical Level of 200 µg/m^3.

In addition to the Critical Levels set out in the table above, 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 (2022) (LAQM.TG(22))[3] 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.
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.	-

3 Department for Environment, Food and Rural Affairs, Local Air Quality Management Technical Guidance (TG22), August 2022, available at: https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf

2.3 Industrial pollution regulation

The Industrial Emissions Directive (IED) (Directive 2010/75/EU), adopted on 7th January 2013, is the key European Directive which covers almost all regulation of industrial processes in the EU. Within the IED, the requirements of the relevant sector Best Available Techniques Reference Document (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 Waste incineration (WI) BREF was adopted by the European IPPC Bureau in December 2019. The EA is required to review and implement conditions within all permits which require operators to comply with the requirements set out in the WI BREF. The WI BREF introduced BAT-Associated Emission Limits (BAT-AELs) which are more stringent than the ELVs set out in the IED. It has been assumed that emissions from the Proposed ERF will comply with the upper end of the BAT-AEL range for each pollutant, except where otherwise stated.

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 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

In this section, we have reviewed the baseline air quality and defined appropriate baseline concentrations to be used within this assessment.

The Outline AQA included a review of baseline pollutant concentrations. The baseline concentrations used in the Outline AQA were chosen as conservative estimates, representative of the likely maximum concentrations in the vicinity of the Proposed ERF and based on representative monitoring data where available. Whilst the baseline concentrations used in the Outline AQA are considered to be appropriate, a review of local and national monitoring and pollution mapping has been undertaken to update the baseline concentrations used in this assessment.

The Proposed ERF is located within the Grangetown Prairie Zone in the south-west corner of the South Tees Development Corporation Regeneration Area. It is located approximately 1.5 km from the River Tees to the north, around 6.5 km to the north-east of Middlesbrough and 5 km south-west of Redcar town centre. It is within the Redcar and Cleveland Borough Council (RCBC) local authority area.

The following sources have been used to determine baseline pollutant concentrations:

- Local and national monitoring networks;
- Published literature; and
- Modelled background maps published by:
  - The Department for the Environment Food and Rural Affairs (Defra); and
  - The Centre for Hydrology and Ecology (CEH).

3.1 Air quality review and assessment

The closest AQMA to the Site is in Staithes, approximately 25 km to the east. Due to the distance from the Proposed ERF, it is considered that the impact of emissions from the Proposed ERF within this AQMA will be negligible. As the impact has been screened out, the AQMA has been excluded from this assessment of baseline pollutant concentrations.

3.2 National modelling – mapped background data

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 Defra 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 within the modelling domain (i.e., within 5 km of the Proposed ERF) has been downloaded along with the concentrations for the grid squares containing the Proposed ERF. A summary is presented in Table 5. The mapped background concentrations of all pollutants are well below the relevant AQALs.

Table 5: Mapped Background Data

Pollutant	Annual Mean AQAL ($\mu g/m^3$)	Concentration ($\mu g/m^3$)		Dataset
		At Facility	Max Within 5 km of Facility	
Nitrogen dioxide	40	13.87	28.68	Defra 2018 Dataset
Particulate matter (PM_{10})	40	10.52	14.19	Defra 2018 Dataset
Particulate matter ($PM_{2.5}$)	20	7.06	8.82	Defra 2018 Dataset
Carbon monoxide	-	295	375	Defra 2001 Dataset
Sulphur dioxide	-	10.70	34.30	Defra 2001 Dataset
Benzene	5	0.62	0.73	Defra 2001 Dataset
1,3-butadiene	2.25	0.28	0.32	Defra 2001 Dataset
Ammonia	180	1.55	2.09	CEH 2014 Dataset

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).

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 measure the 2001 mapped background concentrations have been presented; however, due to a decline in local industry and shipping, 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

Monitoring locations are broadly classified into 'roadside' and 'background' locations. 'Background' locations, which may be urban, suburban, rural or industrial, are typically sited so that no single pollutant source is dominant and are intended to be representative of background concentrations over several square kilometres. 'Roadside' sites are dominated by road traffic emissions and only representative of concentrations in the immediate vicinity of the analyser. This analysis has considered background sites within 5 km and roadside sites within 2 km of the Proposed ERF.

The UK Automatic Urban and Rural Network (AURN) is a country-wide network of air quality monitoring stations operated on behalf of Defra. A review of the AURN interactive map has shown that the closest site to the Proposed ERF is the Middlesbrough urban industrial site, located approximately 4.4 km to the west. This site monitors nitrogen dioxide, sulphur dioxide, and particulate matter as PM_{10} and $PM_{2.5}$. In addition, automatic monitoring of polycyclic aromatic hydrocarbons (PAHs) and non-automatic (diffusion tube) monitoring of benzene is co-located with the Middlesbrough AURN site. For the assessment of baseline concentrations of PAHs, only monitored concentrations of benzo-[a]-pyrene (BaP) have been considered as this is the only PAH of which there is an AQAL which is monitored at this site. No other AURN monitoring sites lie within 5 km of the Proposed ERF. Monitoring results from the last five years from the Middlesbrough site are presented in Table 6.

Table 6: Monitoring – Middlesbrough AURN and co-located passive benzene and BaP monitoring

Pollutant	Annual Mean Concentration (µg/m³)						
	AQAL	Mapped Bg(1)	2017	2018	2019	2020	2021
Nitrogen dioxide	40	18.4	13	14	16	12	13
PM_{10}	40	12.5	13	16	18	15	14
$PM_{2.5}$	20	8.3	7	9	10	8	7
Sulphur dioxide	-	5.1	2	2	1	1	1
Benzene	5	0.72	0.65	1.10	0.64	0.55	0.59
Annual Mean Concentration (ng/m³)							
BaP	0.25	-	0.14	0.17	0.18	0.13	0.18

Note:
(1) Mapped background concentration taken from 2018-based background maps for nitrogen dioxide and particulate matter, and 2001-based background maps for sulphur dioxide and benzene. No mapped background data is available for B[a]P.

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

In addition to the national AURN, local authorities undertake monitoring of a range of pollutants as part of the LAQM review process. Monitoring is undertaken in the local area by Redcar and Cleveland Borough Council (RCBC), Middlesbrough Borough Council (MBC) and Stockton-on-Tees Borough Council (STBC). Data from the most recent Annual Status Reports (ASRs), published by RCBC, and MBC, and STBC in 2022, shows that roadside monitoring is undertaken at 2 locations within 2 km of the Proposed ERF, both operated by RCBC, and 4 background type monitoring locations within 5 km of the Proposed ERF, 3 of which are operated by RCBC and the remaining 1 by MBC. Little weight is given to monitoring undertaken in 2020 and 2021 in this report due to the effect of the Covid-19 pandemic which artificially reduced pollutant concentrations.

The most recent 5 years of monitoring results are provided in Table 7.

Table 7: Local Authority Monitoring Data

Ref	Local Authority	Distance from stack (km)	Annual Mean Concentration (µg/m³)					
			2018 Mapped Bg	2017	2018	2019	2020	2021
Roadside monitoring – nitrogen dioxide								
R26	RCBC	1.5	15.9	19.8	24.7	19.5	17.7	19.6
R27	RCBC	0.6	14.5	25.5	29.8	24.8	21.0	23.1
Background monitoring – nitrogen dioxide								
RD(1)	RCBC	4.4	14.7	12.0	10.0	9.0	9.0	11.0
R17-19(2)	RCBC	4.4	14.7	14.8	17.5	15.2	13.2	11.5
R46	RCBC	2.0	17.3	-	-	16.1	14.0	-
M20-22(2)	MBC	4.4	18.4	16.6	19.2	16.2	12.0	13.6
Background monitoring – PM_{10}								
RD(1)	RCBC	4.4	11.4	12.0	12.0	14.0	13.0	14.0

Ref	Local Authority	Distance from stack (km)	Annual Mean Concentration (µg/m³)					
			2018 Mapped Bg	2017	2018	2019	2020	2021
Background monitoring – $PM_{2.5}$								
RD(1)	RCBC	4.4	7.4	8.4	8.4	9.8	9.1	7.0
Note: *(1) RD = Redcar Dormanstown, an automatic monitoring site.* *(2) R17 – R19 and M20-22 are co-located in triplicate with the Redcar Dormanstown and Middlesbrough AURN automatic sites respectively. The average of the three diffusion tubes has been reported.*								

Source: RCBC 2022 and MBC 2022 Air Quality Annual Status Reports, and © Crown 2023 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL

As shown, no exceedance of any AQAL has been measured. The monitored concentrations at background sites (i.e., away from significant road sources) are generally in line with the mapped background concentrations, although concentrations in excess of the mapped background have been measured in at least one of the last five years at several sites, indicating that the mapped background may underestimate actual concentrations. The same is true of the roadside sites, although this is expected as they are affected by traffic emissions.

As there is a large quantity of monitoring data available, it is considered appropriate to use monitored data rather than mapped background data to obtain the baseline concentrations for the assessment. Therefore, the maximum monitored background concentrations of nitrogen dioxide, PM_{10}, $PM_{2.5}$, sulphur dioxide, benzene and BaP have been used as the baseline background concentrations for the assessment. These are summarised in Table 12.

3.4 National monitoring data

3.4.1 Hydrogen chloride

Hydrogen chloride is measured 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). There are no monitoring locations within 10 km of the Proposed ERF. A summary of data from all UK monitoring sites is presented in Table 8. The UK ceased monitoring of hydrogen chloride at the end of 2015.

Table 8:National Monitoring – Hydrogen Chloride

Site Type	Quantity	AQAL	Annual Mean Concentration (µg/m³)				
			2012	2013	2014	2015	2016
All	Min	-	0.11	0.15	0.10	0.12	-
	Max		0.49	0.50	0.54	0.71	-
	Average		0.27	0.31	0.26	0.24	-

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL)

In lieu of any local monitoring, the UK maximum from the national monitoring network will be used as the baseline concentration for the assessment.

3.4.2 Hydrogen fluoride

Baseline concentrations of hydrogen fluoride are not measured locally or nationally since this pollutant is 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 µg/m^3 to 2.35 µg/m^3.

In lieu of any local monitoring, the maximum measured baseline hydrogen fluoride concentration (2.35 µg/m^3) will be used as the baseline concentration for the assessment as a conservative estimate.

3.4.3 Ammonia

Ammonia is also measured as part of the UKEAP project. There are no UKEAP monitoring locations within 10 km of the Proposed ERF. In lieu of any representative monitoring data, the maximum mapped background concentrations within the modelling domain presented in Table 5 (2.09 µg/m^3) has been used as the baseline concentration for the assessment.

3.4.4 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 automatic 1,3-butadiene monitors within 10 km of the Proposed ERF.

Non-automatic monitoring of benzene is undertaken at the Middlesbrough AURN site. The maximum concentration monitored in the last 5 years (1.1 µg/m^3, as presented in Table 6) has been used as the baseline concentrations for the assessment.

In lieu of any local monitoring of 1,3-butadiene, the maximum mapped background concentrations within the modelling domain (0.32 µg/m^3 for 1,3-butadiene as presented in Table 5) has been used as the baseline concentration for the assessment.

3.4.5 Metals

Metals are measured as part of the Rural Metals and UK Urban/Industrial Networks (previously the Lead, Multi-Element and Industrial Metals Networks). Monitoring of metals was undertaken at the Redcar Normanby site, an urban background site located approximately 4.4 km south of the Proposed ERF, until the end of 2013. No other monitoring sites lie within 100 km of the Proposed ERF. Therefore, it is considered that the historical monitoring data from Redcar Normanby is most representative of the conditions in the vicinity of the Proposed ERF. The most recent monitoring data from Redcar Normanby is presented in Table 9.

Table 9: Metals Monitoring – Redcar Normanby

Substance	AQAL (ng/m^3)	Annual Mean Concentration (ng/m^3) - 2013	as % of AQAL
Arsenic	6	0.39	6.50%
Cadmium	5	0.12	2.40%

Substance	AQAL (ng/m^3)	Annual Mean Concentration (ng/m^3) - 2013	as % of AQAL
Chromium	5,000	1.60	0.03%
Cobalt	-	0.03	-
Copper	10,000	2.20	0.02%
Lead	250	4.30	1.72%
Manganese	150	4.10	2.73%
Nickel	20	0.51	2.55%
Vanadium	5,000	0.65	0.01%

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL)

As shown, the monitored concentrations are well below the respective AQALs.

There are also AQALs for antimony and mercury. However, these metals were not monitored at Redcar Normanby. Monitoring of antimony across the UK ceased at the end of 2013. The maximum monitored at any background site in 2013 across the UK was 1.30 ng/m^3 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/m^3.

Mercury was widely monitored across the UK until the end of 2013 (and was monitored in the PM_{10} fraction at Redcar Normanby, although this excludes gaseous mercury). The maximum monitored at any urban or rural background site in 2013 was 2.10 ng/m^3 at Cockley Beck, which has been used as the baseline concentration for the assessment. This value is only 0.84% of the annual mean AQAL of 250 ng/m^3.

3.4.6 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 Proposed ERF.

A summary of dioxin and furan and PCB concentrations from all monitoring sites across the UK is presented in Table 10 and Table 11. Monitoring data is only available up to the end of 2016 for dioxins and the end of 2018 for PCBs.

Table 10: TOMPS – Dioxin and Furans Monitoring

Site	Annual Mean Concentration ($fgTEQ/m^3$)				
	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	0.60	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	9.30	2.34	1.61	1.42	16.32

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL)

Table 11: 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	92.60	97.27	40.10
Weybourne	17.00	20.95	38.61	32.26	11.23

Source: © Crown 2021 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL)

As shown, the concentrations vary significantly between sites and years. As no site is located in close proximity to the Proposed ERF, the maximum monitored concentrations (32.99 fg/TEQ/m^3 for dioxins and furans and 128.93 pg/m^3 for PCBs) have been used as the baseline concentrations for the assessment.

3.5 Summary

The preceding sections have provided a review of the baseline local and national monitoring data and national modelled background concentrations. Table 12 presents the values for the annual baseline concentrations that will be used to evaluate the impact of the Proposed ERF. Further consideration will be given to the baseline concentrations at specific receptor locations if the predicted impact of emissions of a given pollutant from the Proposed ERF cannot be screened out as 'insignificant'.

Table 12: Summary of Baseline Concentrations

Pollutant	Annual Mean Concentration	Units	Source
Nitrogen dioxide	19.2	µg/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at M20-22, 2018).
Sulphur dioxide	2.0	µg/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at Middlesbrough AURN, 2017).
Particulate matter (as PM_{10})	18.0	µg/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at Middlesbrough AURN, 2018).
Particulate matter (as $PM_{2.5}$)	9.8	µg/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at Redcar Dormanstown, 2019).
Carbon monoxide	375	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
Benzene	1.10	µg/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at Middlesbrough AURN, 2018).

Pollutant	Annual Mean Concentration	Units	Source
1,3-butadiene	0.32	µg/m³	Maximum mapped background concentration from across the modelling grid – Defra 2001 dataset
Ammonia	2.09	µg/m³	Maximum mapped background concentration from across the modelling grid – CEH 2014 dataset
Hydrogen chloride	0.71	µg/m³	Maximum monitored concentration across the UK 2011 to 2015
Hydrogen fluoride	2.35	µg/m³	Maximum measured concentration from EPAQS report
Mercury	2.10	ng/m³	Maximum monitored at a UK background site in 2013
Antimony	1.30	ng/m³	Maximum monitored at a UK background site in 2013
Arsenic	0.39	ng/m³	Maximum monitored at Redcar Normanby in 2013
Cadmium	0.12	ng/m³	
Chromium	1.60	ng/m³	
Cobalt	0.03	ng/m³	
Copper	2.20	ng/m³	
Lead	4.30	ng/m³	
Manganese	4.10	ng/m³	
Nickel	0.51	ng/m³	
Vanadium	0.65	ng/m³	
PaHs	0.18	ng/m³	Maximum background concentration monitored within 5 km of the Proposed ERF (at Middlesbrough AURN, 2021).
Dioxins and Furans	32.99	fg ITEQ /m³	Maximum monitored across the UK 2012 to 2016
PCBs	128.93	pg/m³	Maximum monitored across the UK 2014 to 2018

4 Sensitive Receptors

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

4.1 Human sensitive receptors

The Air Quality Assessment submitted with the outline planning application (the Outline AQA) included a descriptive location for groups of receptors but did not provide coordinates. Most of these were selected to capture the impact of vehicle emissions. The assessment of vehicle emissions in the Outline AQA was comprehensive and a qualitative analysis (presented in Chapter 11 of the Environmental Impact Assessment Statement of Conformity) has concluded that the results would not be significantly different for the reserved matters application. Therefore, modelling of vehicle emissions has not been repeated for this reserved matters application, and a set of discrete receptors has been selected to capture the maximum impact of stack emissions at areas of relevant exposure.

The human sensitive receptors identified for assessment are displayed in Figure 1 and listed in Table 13. These have been selected as the residential dwellings, schools and health facilities representative of the maximum impact of stack emissions from the Proposed ERF at areas of relevant long-term exposure.

Table 13: Human Sensitive Receptors

ID	Name	Location		Distance from ERF stack (m)
		X (m)	Y (m)	
R1	Elgin Avenue	454542	520552	905
R2	Jones Road	453788	520848	912
R3	Strauss Road	453770	520709	1,022
R4	Low Grange Farm new housing	454191	520590	908
R5	Bolckow Road	455310	520893	1,011
R6	Dimples Day Nursery	453561	520505	1,314
R7	Saint Peter's Catholic College	453793	520150	1,469
R8	South Bank Community Primary School	453638	519852	1,805
R9	Low Grange Health Village	453907	519896	1,656
R10	Tigertots community day nursery	455000	520328	1,245
R11	Grangetown Primary School	455179	520377	1,290

4.2 Ecological sensitive receptors

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

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs), or Ramsar sites within 10 km of the Proposed ERF;
- Sites of Special Scientific Interest (SSSIs) within 2 km of the Proposed ERF; and

- National Nature Reserves (NNR), Local Nature Reserves (LNRs), local wildlife sites and ancient woodlands within 2 km of the Proposed ERF. These are collectively referred to as local nature sites.

The sensitive ecological receptors identified as a result of the study are displayed in Figure 2 and are listed in Table 14. A review of the citation and APIS website for each site has been undertaken to determine if lichens or bryophytes are an important part of the ecosystem's integrity. If lichens or bryophytes are present, the more stringent Critical Level has been applied as part of the assessment.

Table 14: Ecological Sensitive Receptors

ID	Site	Desig-nation[(1)]	Closest point to ERF		Distance from stack at closest point (km)	Lichens / bryo-phytes present
			X (m)	Y (m)		
European and UK Designated Sites						
E1	Teesmouth and Cleveland Coast	Ramsar/ SPA/SSSI	453310	522440	1.5	No
E2	North York Moors	SAC/SPA	458902	513002	9.5	Yes
Note: *No local nature sites have been identified within 2 km of the Proposed ERF.*						

As the Teesmouth and Cleveland Coast site lies close to the Proposed ERF and covers a wide area, the maximum process contribution at ground level within the site has been assessed. The process contribution at the North York Moors site has been assessed using a single ground level receptor at the point shown in Table 14.

5 Process Emissions Dispersion Modelling Methodology

5.1 Selection of model

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

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the EA and local authorities. The maximum predicted concentration for each pollutant and averaging period has been used to determine the significance of any potential impacts.

5.2 Emission limits

As detailed in section 2.3 the Proposed ERF will be designed to meet the requirements of the Waste Incineration BREF for a new ERF. Therefore, this assessment has been undertaken assuming that the emissions from the Proposed ERF will comply with the BAT-AELs set out in the Waste Incineration BREF for new plants, with the exception of oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range will be applied for. For the remainder of this assessment the anticipated emission limits, which are the BAT-AELs, emission limits from the IED, or project-specific lower limits as applicable, are referred to as ELVs.

5.3 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the Proposed ERF were provided by the technology provider for the Proposed ERF and are presented in Table 15 and Table 16. The flue gas data is based on a thermal input of 82.5MW$_{th}$ for each of the two boilers, which is 110% of the design point thermal input and therefore represents a conservative approach.

Table 15: Stack Source Data

Item	Unit	Value
Stack Data		
Height	m	80 - See Stack Height Analysis (section 6.1)
Internal diameter (each flue)(1)	m	2.13
Internal effective diameter (both flues)	m	3.01
Location (centre point of both flues)	m, m	454470.5, 521454.5
Flue Gas Conditions		
Temperature	°C	148
Exit moisture content	% v/v	20.72%
	kg/kg	0.157

Item	Unit	Value
Exit oxygen content	% v/v dry	6.3%
Reference oxygen content	% v/v dry	11%
Volume at reference conditions (dry, ref O_2) – both flues combined	Nm^3/h	341,122
	Nm^3/s	94.76
Volume at actual conditions – both flues combined	Am^3/h	450,576
	Am^3/s	125.16
Flue gas exit velocity	m/s	17.54

Note:
(1) The Proposed ERF will have two flues each in a dedicated stack. The stacks are sufficiently close together to be modelled a single source.

Table 16: Stack Emissions Data – Both Flues Combined

Pollutant	Daily or Periodic	Half-hourly	Daily or Periodic	Half-hourly
	Conc. (mg/Nm^3)		Release Rate (g/s)	
Oxides of nitrogen (as NO_2)	100	400	9.476	37.902
Sulphur dioxide	30	200	2.843	18.951
Carbon monoxide	50	150(1)	4.738	14.213
Fine particulate matter (PM)(2)	5	30	0.473	2.843
Hydrogen chloride	6	60	0.569	5.685
Volatile organic compounds (as TOC)	10	20	0.948	1.895
Hydrogen fluoride	1	4	0.0948	0.379
Ammonia	10	-	0.948	-
Cadmium and thallium	0.02	-	1.895 mg/s	-
Mercury	0.02	-	1.895 mg/s	-
Other metals(3)	0.3	-	28.43 mg/s	-
Benzo(a)pyrene (PAHs)(4)	0.2 µg/Nm^3	-	18.95 µg/s	-
Dioxins, furans and dioxin-like PCBs	0.06 ng/Nm^3	-	5.685 ng/s	-
PCBs(5)	5.0 µg/Nm^3	-	0.474 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 µg/m³ 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 Proposed ERF.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Proposed ERF.

If the Proposed ERF continually operated at the half-hourly limits, the daily limits would be exceeded. The Proposed ERF is designed to achieve the daily limits and as such will only operate at the short term limits for short periods on rare occasions. The impact of the Proposed ERF operating at the short-term limits is presented in section 7.

5.4 Other inputs

5.4.1 Meteorological data and surface characteristics

The impact of meteorological data used in the assessment has been taken from Durham Tees Valley Airport meteorological recording station for the years 2015 – 2019. Durham Tees Valley Airport is located approximately 19 km to the southwest of the Proposed ERF and is the closest and most representative meteorological station available. The data was provided by ADM Limited.

The period 2015 to 2019 was chosen as this was the most recent full set of data available at the time of starting the air quality modelling. The EA recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. Wind roses for each year are presented in Figure 3.

The minimum Monin-Obukhov length can be selected in ADMS for both the dispersion site and the meteorological site. This is a measure of the minimum stability of the atmosphere and can be adjusted to account for urban heat island effects which prevent the atmosphere in urban areas from ever becoming completely stable. The minimum Monin-Obukhov length has been set to 30 m for the dispersion site and 10 m for the meteorological site. The value of 30 m is recommended by CERC for mixed urban/industrial areas such as the dispersion site. The value of 10 m is recommended by CERC for small towns <50,000 inhabitants and is considered appropriate for the surroundings of the meteorological site.

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 0.2 m for the meteorological site, which is appropriate for the relatively open surroundings of Durham Tees Valley Airport. The surface roughness length varies widely across the modelling domain, from very low values over the Tees 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 and used as a model input. 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 17 and a visual representation provided in Figure 4.

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

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

Table 17: Spatially Varying Surface Roughness File Parameters

Parameter	Value
Grid spacing (m)	100
Grid points	134
Grid Start X (m)	447800
Grid Finish X (m)	461100
Grid Start Y (m)	514900
Grid Finish Y (m)	528200

Table 18: Surface Roughness Lengths Used for Different Land Use Classes

Land Use Classification	Corine 2018 Land Use Codes	Surface Roughness Length (m)
Continuous urban fabric	111	1.2
Forest	311,312	0.75
Green urban areas	141	0.6
Discontinuous urban fabric, industrial or commercial units(1), sport and leisure facilities, port areas	112,121,142,123	0.5
Agricultural land with areas of natural vegetation	243	0.3
Non-irrigated arable land, inland marshes	211,411	0.05
Pastures, moors and heathland, natural grasslands	231,322,321	0.03
Salt marshes, sparsely vegetated areas, mineral extraction sites	421,333,131	0.005
Intertidal flats	423	0.0005
Water(2)	523,512,511	0.0001

Notes:

(1) The area between the A1085 and A1053 covered by the British Steel site was misclassified as 'Road and rail networks and associated land'. This area was considered to be industrial or commercial units with a roughness length of 0.5 m.

(2) The 'most likely' value for water is given as zero. ADMS cannot model a surface roughness length of zero, so areas of water have been assigned a roughness length of 0.0001 which is the value recommended by CERC for 'sea'.

A summary of the meteorological parameters used in the dispersion modelling is shown in Table 19

Table 19: Meteorological parameters

Parameter	Dispersion Site Value (m)	Met Site Value (m)
Surface roughness length	Variable	0.2
Minimum Monin-Obukhov length	30	10

The sensitivity of the modelling results to the choice of surface roughness has been considered in Section 6.2.

5.4.2 Modelling domain

Modelling has been undertaken using a nested grid of points; a 2 km x 2 km grid with a spatial resolution of 20 m nested within a 12 km x 12 km grid with a spatial resolution of 120 m. The high resolution of the finest grid has been chosen to ensure that the gridded output accurately captures the highest modelled concentrations. Reference should be made to Figure 5 for a graphical representation of the modelling domain used. The extent of the modelling domain is detailed in Table 20.

Table 20: Modelling Domain

Grid Quantity	Fine Grid	Wide Grid
Grid spacing (m)	20	120
Grid points	101	101
Grid Start X (m)	453460	448500
Grid Finish X (m)	455460	460500
Grid Start Y (m)	520440	515500
Grid Finish Y (m)	522440	527500

5.4.3 Terrain

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

A terrain file large enough to cover the output grid of points was created using Ordnance Survey Terrain 50 data. The North York Moors designated habitat site lies outside of the output grid of points. Due to the distance to this receptor and the very low likelihood of a significant effect, the model has been run without the effect of terrain to assess the impact at the North York Moors.

The parameters of the terrain files used are outlined in Table 21. Reference should be made to Figure 6 for a graphical representation of the terrain file used.

Table 21: Terrain File Parameters

Parameter	Value
Grid spacing (m)	100
Grid points	134
Grid Start X (m)	447800
Grid Finish X (m)	461100
Grid Start Y (m)	514900
Grid Finish Y (m)	528200

5.4.4 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 5.2 user guide also states that buildings less than one third of the stack height will not have any effect on the dispersion calculations in the model.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 22. The buildings have been modelled at the height of the highest point of the structure. A site plan showing which buildings have been included in the model is presented in Figure 7. The administration block and other ancillary buildings have been excluded as they are to short or small to influence dispersion.

Table 22: Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler House [(1)]	454497.9	521368.7	50.0	80.1	51.5	159
Waste Reception	454530.0	521289.3	15.6	71.0	52.1	159
Bunker	454512.6	521331.6	41.1	87.1	40.7	159
Flue Gas Treatment	454481.1	521417.4	32.5	50.0	52.4	159
Turbine Hall	454443.8	521394.7	21.1	35.5	41.0	159
ACCs	454423.8	521451.0	22.0	30.2	56.6	159
Note: *(1) Selected as the main building for the Proposed ERF*						

5.5 Chemistry

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

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

5.6 Baseline concentrations

Background concentrations for the assessment have been derived from monitoring and national mapping as presented in section 3. For short term averaging periods, the background concentration has been assumed to be twice the long term ambient concentration following the Air Emissions Guidance methodology.

5.7 Assessment criteria

5.7.1 Human health

In 2017 the IAQM published the guidance document "Land-Use Planning & Development Control: Planning for Air Quality" (referred to within this report as the IAQM 2017 guidance). This has been developed for professionals operating within the planning system. It provides them with a means of reaching sound decisions, having regard to the air quality implications of development proposals. This is not intended to replace the guidance that exists for industrial developments which require a permit to operate but notes that guidance for permitting has not been developed for conducting an assessment to accompany a planning application.

The IAQM 2017 guidance states that this may be adapted using professional judgement. Therefore, where appropriate EA guidance has been incorporated. This is appropriate as the project is an industrial source which will need an Environmental Permit to operate and will be regulated by the EA.

The IAQM 2017 guidance provides the following matrix which can be used to describe the magnitude of change based on the change in concentration relative to the annual AQAL, and the total predicted concentration with the scheme – i.e. the future baseline plus the process contribution (PC). The total predicted concentration with the scheme is referred to as the predicted environmental concentration (PEC).

Table 23: IAQM Magnitude of Change Descriptors

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

It is intended that the change in concentration relative to the AQAL (the PC) is rounded to the nearest whole number. Therefore, any impact which is between 0.5% and 1.5% will be classified as a 1% change in concentration. For a change in concentration to be described as 'negligible' irrespective of the PEC, the PC needs to be less than 0.5% of the AQAL.

Table 23 is only designed to be used with annual mean concentrations. For short-term concentrations (i.e. those averaged over a period of an hour or less) the IAQM 2017 guidance states that the following descriptors of change should be used to describe the severity of the impact:

- < 10% - negligible;

- 10 – 20% - slight;
- 20 – 50% - moderate; and
- > 50% - substantial.

The approach for assessing the impact of short-term emissions has been carried out in line with the IAQM 2017 guidance and does not take into account the background concentrations as it is noted that background concentrations are less important in determining the severity of impact for short-term concentrations.

For the purpose of this assessment, the IAQM criteria outlined above has been used to define the magnitude of change associated with the Proposed ERF. In accordance with IAQM 2017 guidance, professional judgement has then been used to determine the overall significance of effect of the development at receptor locations (i.e. as either 'significant' or 'not significant'). This judgement has considered:

- the existing air quality in the local area;
- the extent of the predicted impacts from the Proposed ERF; and
- the influence and validity of the assumptions adopted in the dispersion modelling.

The IAQM 2017 guidance states that:

"In most cases, the assessment of impact severity for a proposed development will be governed by the long-term exposure experienced by receptors and it will not be a necessity to define the significance of effects by reference to short-term impacts. The severity of the impact will be substantial when there is a risk that the relevant AQAL for short-term concentrations is approached through the presence of the new source, taking into account the contribution of other prominent local sources."

5.7.2 Ecology

The IAQM has published the guidance document 'A guide to the assessment of air quality impacts on designated nature conservation sites', last updated in May 2020 (the IAQM (2020) guidance). This guidance draws on the EA's Air Emissions Guidance, which states that to screen out impacts as 'insignificant' at European and UK statutory designated sites:

- the long-term process contribution must be less than 1% of the long-term environmental standard (i.e. the Critical Level or Load); and
- the short-term process contribution 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 process contribution 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 process contribution must be less than 100% of the long-term environmental standard; and
- the short-term process contribution must be less than 100% of the short-term environmental standard.

In accordance with the Air Emissions Guidance, calculation of the PEC for local nature sites is not required. However, with regard to locally designated sites, the IAQM (2020) guidance states: *"For local wildlife sites and ancient woodlands, the Environment Agency uses less stringent criteria in its permitting decisions. Environment Agency policy for its permitting process is that if either the short-term or long-term PC is less than 100% of the critical level or load, they do not require further assessment to support a permit application. In ecological impact assessments of projects and plans, it is, however, normal practice to treat such sites in the same manner as SSSIs and European Sites, although the determination of the significance of an effect may be different. It is difficult to understand how the Environment Agency's approach can provide adequate protection."*

As such, it is considered appropriate to apply the screening criteria for SSSIs and European Sites to locally designated sites to screen out the requirement for further consideration of the significance of effect for planning. However, as detailed in section 4.2 no local nature sites have been identified in the study area, so these criteria do not need to be considered.

6 Sensitivity Analysis

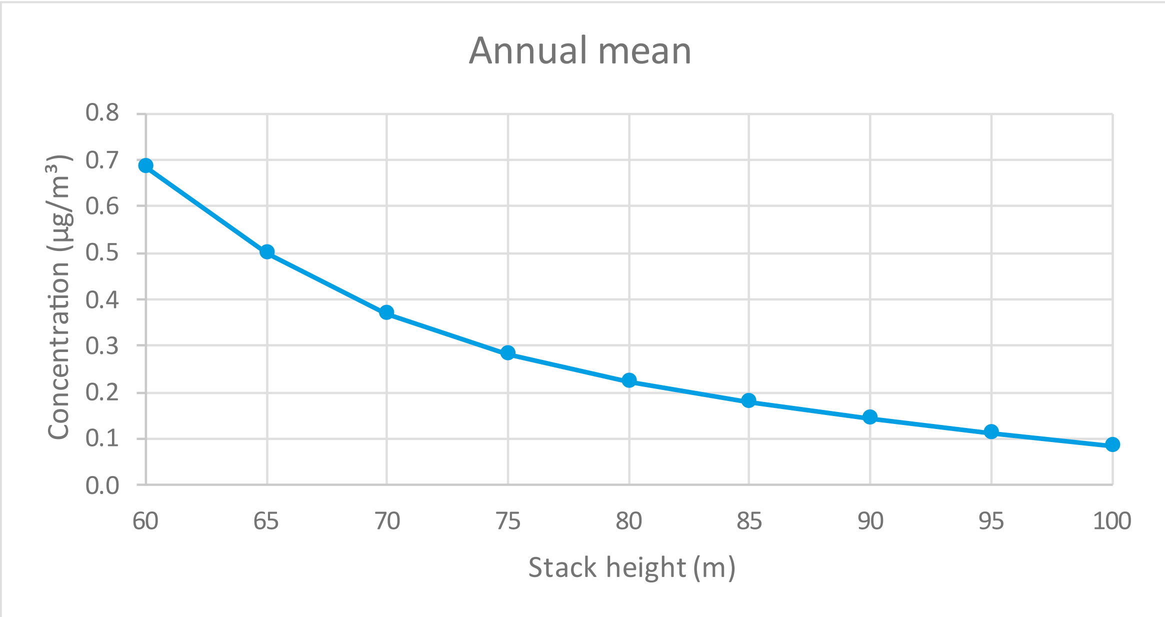
6.1 Stack height assessment

When determining a suitable stack height, it is best practice to identify the stack height where the rate of reduction in maximum ground level concentration with increased height slows down. This can be identified on a graph as a step change in the slope. A range of stack heights from 60 m to 100 m has been considered.

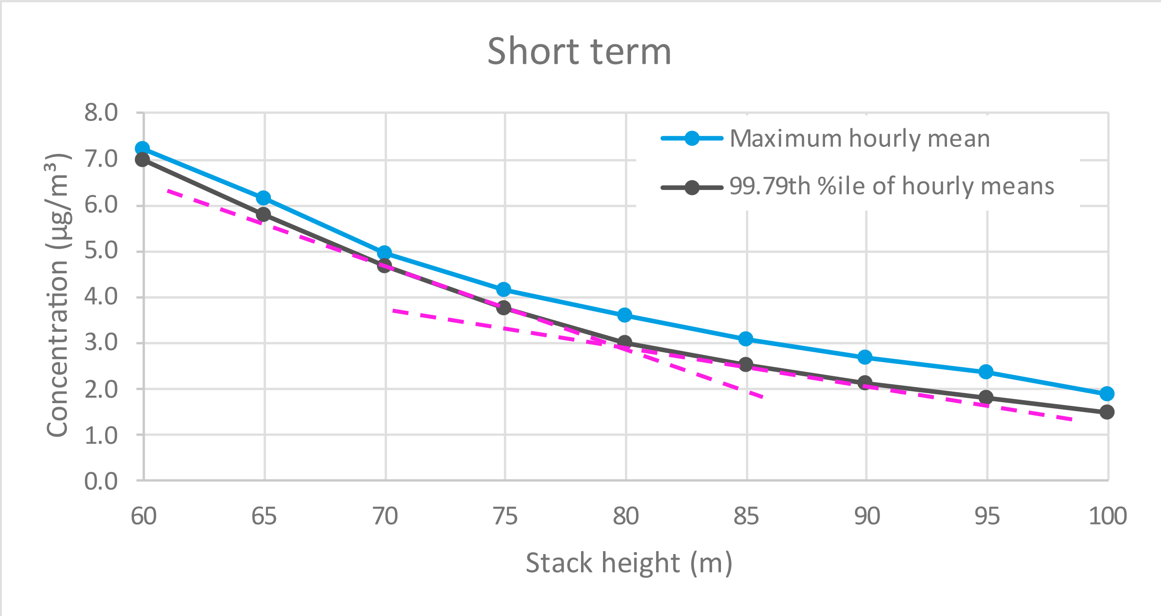
The following parameters were kept constant:

- Buildings – included;
- Dispersion site surface roughness value – variable at 64 x 64 resolution;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 64 x 64 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015 to 2019.

The graphs below show the ground level concentration at the point of maximum impact for a range of stack heights for the Proposed ERF, for a nominal 1 g/s release rate.



Graph 1 – Annual Mean Stack Height Analysis



Graph 2 – Short-Term Stack Height Analysis

Analysis of the graphs shows that for annual mean concentrations there is no clear step change in the angle of the slope, but rather a general flattening of the slope is observed as the stack height is increased. For the 99.79th percentile of hourly mean concentrations (which has been selected for its relevance to the short-term AQAL for nitrogen dioxide), there is a slight change in slope at a stack height of 80 m, as shown by the magenta lines. For maximum hourly concentrations, there is a slight change in the angle of the slope at a stack height of 75 m.

These results show that, particularly for short-term concentrations, the benefit to increasing the stack height is reduced for stack heights above 80 m. With an 80 m high stack, at the point of maximum impact, and assuming operation at the emission limits set out in Table 16:

- all annual mean impacts on human health can be described as 'negligible' when the total concentration (known as the Predicted Environmental Concentration, "PEC") is considered;
- all short-term impacts on human health can be described as 'negligible' or 'insignificant' if it is assumed that the plant operates at the daily BAT-AELs; and
- the short-term impact of sulphur dioxide with regard to human health is described as 'moderate adverse' if it is assumed the plant operates at the half-hourly ELV set in the IED.
- Certain impacts on ecological receptors cannot be screened out as 'insignificant' but increasing the stack height within a reasonable range is not effective in mitigating these impacts.

Although short-term impacts do not screen out as 'negligible' for a stack height of 80 m if it is assumed that both lines of the Proposed ERF operate at the half-hourly ELV from the IED for sulphur dioxide and nitrogen dioxide, non-negligible impacts are only predicted to occur under the highly conservative assumption that both lines of the Proposed ERF operate at the half-hourly ELV during the worst-case weather conditions for dispersion.

Therefore, a stack height of 80 m provides adequate dispersion of pollutants from the Proposed ERF, and the remainder of this assessment has been undertaken for a stack height of 80 m.

6.2 Surface roughness

The sensitivity of the results to using spatially varying surface roughness length has been considered by running the model with a variety of surface roughness lengths for the dispersion site. For all sensitivity 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 were kept constant:

- Stack height – 80 m
- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 64 x 64 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Proposed ERF to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 24.

Table 24: Surface Roughness Sensitivity Analysis

Surface roughness (m)	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Varying	**2.12**	**28.47**	**33.97**
0.1	1.73	29.91	31.47
0.2	1.87	28.64	30.59
0.3	1.95	28.01	33.89
0.5	2.07	27.03	30.59
0.7	2.14	26.53	34.20
Maximum impacted receptor			
Varying	**0.19**	**10.27**	**16.25**
0.1	0.19	10.63	14.91
0.2	0.19	10.65	14.54
0.3	0.20	10.54	14.56
0.5	0.22	10.85	15.66
0.7	0.22	10.53	15.57

As shown, increasing the surface roughness value leads to greater annual mean concentrations at the point of maximum impact and at the maximum impacted receptor. The choice of surface roughness length has little effect on short-term concentrations. The variable surface roughness length file leads to a maximum annual mean concentration similar to that produced by a constant roughness length of between 0.5 m and 0.7 m.

The spatially varying surface roughness length was selected for the model as this was considered the most accurate representation of the different land use types in the modelling domain.

6.3 Building parameters

The sensitivity of the results to the effect of buildings has been considered by running the model with and without the buildings presented in Table 22.

The following parameters were kept constant:

- Stack height – 80 m
- Dispersion site surface roughness – variable at 64 x 64 resolution;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 30 m;
- Meteorological site Monin-Obukhov length – 10 m;
- Terrain – included at 64 x 64 resolution; and
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Proposed ERF to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 25 for each scenario.

Table 25: Effect of Buildings

Scenario used in model	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including buildings	**2.12**	**28.47**	**33.97**
Excluding buildings	0.55	14.41	19.07
Maximum impacted receptor			
Including buildings	**0.19**	**10.27**	**16.25**
Excluding buildings	0.19	9.34	18.12

As shown, modelling the presence of buildings results in higher annual mean and short-term concentrations at the point of maximum impact, but has little effect at the maximum impacted receptor. Buildings have been included in the dispersion model as this represents a realistic approach.

6.4 Terrain

The sensitivity of the results to the effect of terrain has been considered by running the model with and without the terrain presented in Table 21.

The following parameters were kept constant:

- Stack height – 80 m
- Dispersion site surface roughness – variable at 64 x 64 resolution;
- Buildings – included;
- Meteorological site surface roughness – 0.2 m;
- Dispersion site Monin-Obukhov length – 30 m;

- Meteorological site Monin-Obukhov length – 10 m;
- Meteorological data used – Durham Tees Valley Airport 2015.

The contribution of the Proposed ERF to the ground level concentration of oxides of nitrogen at the point of maximum impact and at the maximum impacted human receptor is presented in Table 25 for each scenario.

Table 26: Effect of Terrain

Scenario used in model	Oxides of Nitrogen PC (µg/m³)		
	Annual Mean	99.79%ile of 1-hour mean	Max 1-hour mean
Point of maximum impact			
Including terrain	**2.12**	**28.47**	**33.97**
Excluding terrain	1.53	24.14	29.50
Maximum impacted receptor			
Including terrain	**0.19**	**10.27**	**16.25**
Excluding terrain	0.19	10.27	13.42

As shown, modelling the effects of terrain results in higher annual mean and short-term concentrations at the point of maximum impact, but has little effect at the maximum impacted receptor, except for maximum hourly concentrations which are significantly higher when terrain is included. Terrain effects have been included in the dispersion model as this represents a realistic approach.

6.5 Sensitivity analysis – operating below the design point

Dispersion modelling has been undertaken using the emission parameters based on the design point for the Proposed ERF. The Proposed ERF will be operated as a commercial plant, so it is beneficial to operate at full capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect 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 amount of pollutants being emitted, so that the impact of the plant when running below the design point would be reduced.

7 Impact on Human Health – Stack Emissions

7.1 At the point of maximum impact

Table 27 and Table 28 present the results of the dispersion modelling of process emissions from the Proposed ERF at the point of maximum impact. This is the maximum predicted concentration based on the following:

- Modelling domain size – a nested grid of points; a 2 km x 2 km grid with a spatial resolution of 20 m nested within a 12 km x 12 km grid with a spatial resolution of 120 m;
- Buildings – included;
- Stack height – 80 m;
- 5 years of weather data 2015 to 2019 from Durham Tees Valley Airport meteorological recording station;
- Operation at the long term ELVs for 100% of the year;
- Operation at the short term ELVs during the worst-case conditions for dispersion of emissions (
- only);
- EA's worst case 70% long-term and 35% short-term conversion of NOx to nitrogen dioxide;
- The entire VOC emissions are assumed to consist of either benzene or 1,3-butadiene; and
- Cadmium is released at the combined emission limit for cadmium and thallium.

The baseline concentration is taken from the review of baseline monitoring presented in section 3.

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

Table 27: Dispersion Modelling Results – Point of Maximum Impact – Operation at Daily ELVs

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC (PC) at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
Nitrogen dioxide	Annual mean	µg/m³	40	19.2	1.48	1.35	1.28	1.29	1.20	1.48	**3.70%**	20.68	51.70%
	99.79th%ile of hourly means	µg/m³	200	38.4	9.96	9.94	9.72	9.71	9.76	9.96	4.98%	48.36	24.18%
Sulphur dioxide	99.18th%ile of daily means	µg/m³	125	4.0	4.90	4.70	4.20	4.48	4.36	4.90	3.92%	8.90	7.12%
	99.73rd%ile of hourly means	µg/m³	350	4.0	8.49	8.48	8.11	8.17	8.30	8.49	2.43%	12.49	3.57%
	99.9th%ile of 15 min. means	µg/m³	266	4.0	9.32	9.24	9.13	9.24	9.34	9.34	3.51%	13.34	5.02%
PM_{10}	Annual mean	µg/m³	40	18.0	0.11	0.10	0.09	0.09	0.09	0.11	0.26%	18.11	45.26%
	90.41st%ile of daily means	µg/m³	50	36.0	0.37	0.35	0.31	0.33	0.28	0.37	0.73%	36.37	72.73%
$PM_{2.5}$	Annual mean	µg/m³	20	9.8	0.11	0.10	0.09	0.09	0.09	0.11	**0.53%**	9.91	49.53%
Carbon monoxide	8 hour running mean	µg/m³	10,000	750	14.50	13.51	13.64	13.11	13.84	14.50	0.14%	764.50	7.64%
	Hourly mean	µg/m³	30,000	750	16.99	15.27	15.36	15.98	15.10	16.99	0.06%	766.99	2.56%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	2.04	1.83	1.84	1.92	1.81	2.04	0.27%	3.46	0.46%
Hydrogen fluoride	Annual mean	µg/m³	16	2.35	0.02	0.02	0.02	0.02	0.02	0.02	0.13%	2.37	14.82%
	Hourly mean	µg/m³	160	4.70	0.34	0.31	0.31	0.32	0.30	0.34	0.21%	5.04	3.15%
Ammonia	Annual mean	µg/m³	180	2.09	0.21	0.19	0.18	0.18	0.17	0.21	0.12%	2.30	1.28%
	Hourly mean	µg/m³	2,500	4.18	3.40	3.05	3.07	3.20	3.02	3.40	0.14%	7.58	0.30%
VOCs (as benzene)	Annual mean	µg/m³	5	1.10	0.21	0.19	0.18	0.18	0.17	0.21	**4.23%**	1.31	26.23%
	Daily mean	µg/m³	30	2.20	1.86	2.67	2.25	2.08	1.76	2.67	8.91%	4.87	16.24%
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.32	0.21	0.19	0.18	0.18	0.17	0.21	**9.40%**	0.53	23.63%
Mercury	Annual mean	ng/m³	250	2.10	0.42	0.39	0.36	0.37	0.34	0.42	0.17%	2.52	1.01%

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC (PC) at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
	Hourly mean	ng/m³	7,500	4.20	6.79	6.11	6.14	6.39	6.04	6.79	0.09%	10.99	0.15%
Cadmium	Annual mean	ng/m³	5	0.12	0.42	0.39	0.36	0.37	0.34	0.423	**8.46%**	0.54	10.86%
PAHs	Annual mean	pg/m³	250	180	4.23	3.85	3.64	3.69	3.42	4.23	**1.69%**	184.23	73.69%
Dioxins	Annual mean	fg/m³	-	33.0	1.27	1.16	1.09	1.11	1.03	1.27	-	34.26	-
PCBs	Annual mean	ng/m³	200	0.129	0.11	0.10	0.09	0.09	0.09	0.11	0.05%	0.23	0.12%
	Hourly mean	ng/m³	6000	0.258	1.70	1.53	1.54	1.60	1.51	1.70	0.03%	1.96	0.03%
Other metals	Annual mean	ng/m³	-	-	-	-	-	-	-	-	See metals assessment – Section 7.2.7		
	Hourly mean	ng/m³	-	-	-	-	-	-	-	-			

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

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

Pollutant	Quantity	Units	AQAL	Bg Conc.	PC (PC) at Point of Maximum Impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2015	2016	2017	2018	2019	Max			
Nitrogen dioxide	99.79th%ile of hourly means	µg/m³	200	38.4	39.85	39.76	38.89	38.83	39.05	39.85	**19.93%**	78.25	39.13%
Sulphur dioxide	99.73rd%ile of hourly means	µg/m³	350	4.0	56.59	56.51	54.10	54.47	55.32	56.59	**16.17%**	60.59	17.31%
	99.9th%ile of 15 min. means	µg/m³	266	4.0	62.12	61.61	60.89	61.58	62.28	62.28	**23.41%**	66.28	24.92%
Carbon monoxide	8 hour running mean	µg/m³	10,000	750	43.50	40.53	40.92	39.34	41.53	43.50	0.43%	793.50	7.93%
	Hourly mean	µg/m³	30,000	750	50.96	45.82	46.09	47.94	45.29	50.96	0.17%	800.96	2.67%
Hydrogen chloride	Hourly mean	µg/m³	750	1.42	20.38	18.33	18.43	19.17	18.11	20.38	2.72%	21.80	2.91%
Hydrogen fluoride	Hourly mean	µg/m³	160	4.70	1.36	1.22	1.23	1.28	1.21	1.36	0.85%	6.06	3.79%

Note:
All assessment is based on the maximum PC using all 5 years of weather data and operation at the short-term ELVs.

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

- Annual mean nitrogen dioxide;
- Annual mean $PM_{2.5}$;
- Annual mean VOCs as benzene and 1,3-butadiene;
- Annual mean cadmium;
- Annual mean PAHs;
- 99.79th percentile of hourly mean nitrogen dioxide;
- 99.9th percentile of 15-minute mean sulphur dioxide; and
- 99.73rd percentile of hourly mean sulphur dioxide.

Further analysis of impacts at specific receptor locations has been undertaken to define the magnitude of change for annual mean impacts, and the impact at areas of relevant exposure has been analysed using plot files to determine the magnitude of change for short-term impacts.

7.2 Further assessment

7.2.1 Annual mean nitrogen dioxide

The annual mean nitrogen dioxide PC from the Proposed ERF is predicted to be 3.70% of the AQAL at the point of maximum impact. Table 29 details the impact of annual mean nitrogen dioxide contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 8 shows the spatial distribution of emissions.

Table 29: Annual Mean Nitrogen Dioxide Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.18	0.46%	19.38	48.46%
R2	0.18	0.45%	19.38	48.45%
R3	0.19	0.49%	19.39	48.49%
R4	0.19	0.47%	19.39	48.47%
R5	0.12	0.29%	19.32	48.29%
R6	0.17	0.43%	19.37	48.43%
R7	0.16	0.40%	19.36	48.40%
R8	0.13	0.34%	19.33	48.34%
R9	0.14	0.35%	19.34	48.35%
R10	0.14	0.36%	19.34	48.36%
R11	0.13	0.33%	19.33	48.33%

The PC at all identified sensitive receptors is less than 0.5% of the AQAL and can be screened out as 'negligible' irrespective of the total concentration. As shown in Figure 8, the PC is predicted to slightly exceed 0.5% of the AQAL at a small number of residential dwellings on Passfield Crescent. However, there are no significant sources of nitrogen dioxide close to this area, so the baseline concentration is applicable, and the PEC will remain well below 75% of the AQAL. The maximum PC at an area of relevant exposure rounds to 1% of the AQAL and the PEC is less than 75% of the AQAL, therefore, the impact is described as 'negligible'.

7.2.2 Annual mean $PM_{2.5}$

The annual mean $PM_{2.5}$ PC from the Proposed ERF is predicted to be 0.53% of the AQAL at the point of maximum impact. Table 29 details the impact of annual mean $PM_{2.5}$ contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 9 shows the spatial distribution of emissions.

Table 30: Annual Mean $PM_{2.5}$ Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.013	0.07%	9.81	49.07%
R2	0.013	0.06%	9.81	49.06%
R3	0.014	0.07%	9.81	49.07%
R4	0.013	0.07%	9.81	49.07%
R5	0.008	0.04%	9.81	49.04%
R6	0.012	0.06%	9.81	49.06%
R7	0.012	0.06%	9.81	49.06%
R8	0.010	0.05%	9.81	49.05%
R9	0.010	0.05%	9.81	49.05%
R10	0.010	0.05%	9.81	49.05%
R11	0.009	0.05%	9.81	49.05%

7.2.2.1 Annual mean $PM_{2.5}$ - effect of Environment Act

As detailed in section2.1, the Environment Act has introduced a requirement for a new legally-binding limit on annual mean concentrations of $PM_{2.5}$. The recommended value during the various committee stages of the Environment Act was 10 µg/m³, which is the WHO 2005 guideline value. An updated recommendation of 5 µg/m³ was published by the WHO in September 2021. Although these guideline values are not currently legally binding in the UK, the impact of the Proposed ERF has been assessed against the WHO guideline values for completeness.

The PC from the Proposed ERF at the point of maximum impact is predicted to be 1.03% of the WHO 2005 guideline value and 2.06% of the WHO 2021 guideline value. This conservatively assumes that the entire PM emissions consists of only $PM_{2.5}$. PM2.5 could consist of up to 48% of the total PM ELV and the impact would be less than 1% of the WHO 2021 guideline value. Viridor existing ERFs have needed to monitor the speciation of PM_{10} to $PM_{2.5}$ and report this to the EA. This data has shown that the PM_{10} emissions are 0.25 mg/Nm³ (or 5% of the ELV for the Proposed ERF) and $PM_{2.5}$ emissions are 0.17 mg/Nm³ (or 3% of the ELV for the Proposed ERF). Assuming emissions of $PM_{2.5}$ of 3% of the ELV, as is typical for Viridor's operational ERFs, the PC would be 0.004 µg/m³, which is only 0.07% WHO 2021 guideline value.

The PC at receptor locations (assuming emissions at the ELV, and that the entire PM emissions consist of only $PM_{2.5}$) is presented in Table 31. Figure 9 shows the spatial distribution of emissions.

Table 31: Annual Mean $PM_{2.5}$ Impact at Identified Sensitive Receptors – WHO Guideline Values

Receptor	PC as µg/m³	PC as % of WHO 2005 Guideline Value	PC as % of WHO 2021 Guideline Value
R1	0.013	0.13%	0.26%
R2	0.013	0.13%	0.26%
R3	0.014	0.14%	0.28%
R4	0.013	0.13%	0.27%
R5	0.008	0.08%	0.17%
R6	0.012	0.12%	0.25%
R7	0.012	0.12%	0.23%
R8	0.010	0.10%	0.19%
R9	0.010	0.10%	0.20%
R10	0.010	0.10%	0.21%
R11	0.009	0.09%	0.19%

As shown, the impact at all receptor locations is less than 0.5% of the AQAL and of the 2005 and 2021 WHO guideline values, and is therefore 'negligible' irrespective of the total concentration.

7.2.3 Annual mean VOCs

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

The PC from the Proposed ERF is predicted to be 4.23% of the AQAL for benzene and 9.40% of the AQAL for 1,3-butadiene at the point of maximum impact. Table 32 and Table 33 detail the impact of annual mean benzene and 1,3-butadiene contributions from process emissions at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 10 and Figure 11 show the spatial distribution of emissions.

Table 32: Annual Mean VOCs (as Benzene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.026	**0.53%**	1.13	22.53%
R2	0.026	**0.52%**	1.13	22.52%
R3	0.028	**0.56%**	1.13	22.56%
R4	0.027	**0.53%**	1.13	22.53%
R5	0.017	0.33%	1.12	22.33%
R6	0.025	0.49%	1.12	22.49%

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R7	0.023	0.46%	1.12	22.46%
R8	0.019	0.38%	1.12	22.38%
R9	0.020	0.41%	1.12	22.41%
R10	0.021	0.41%	1.12	22.41%
R11	0.019	0.37%	1.12	22.37%

Table 33: Annual Mean VOCs (as 1,3-Butadiene) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R1	0.026	**1.17%**	0.35	15.39%
R2	0.026	**1.15%**	0.35	15.37%
R3	0.028	**1.24%**	0.35	15.46%
R4	0.027	**1.18%**	0.35	15.40%
R5	0.017	**0.74%**	0.34	14.96%
R6	0.025	**1.09%**	0.34	15.32%
R7	0.023	**1.03%**	0.34	15.25%
R8	0.019	**0.85%**	0.34	15.08%
R9	0.020	**0.90%**	0.34	15.12%
R10	0.021	**0.92%**	0.34	15.14%
R11	0.019	**0.83%**	0.34	15.05%

As shown, the benzene PC rounds to 1% of the AQAL at 4 receptors (and is less than 0.5% of the AQAL at the remainder) and the 1,3-butadiene PC rounds to 1% of the AQAL at all identified receptors. However, the PEC for both pollutants is much less than 75% of the AQAL. As the maximum PC at an area of relevant exposure rounds to 1% of the AQAL and the PEC is less than 75% of the AQAL, the impact is described as 'negligible'.

7.2.4 Annual mean cadmium

The annual mean cadmium PC from the Proposed ERF is predicted to be 8.46% of the AQAL at the point of maximum impact. However, this assumes that the entire cadmium and thallium emissions consist of only cadmium. The Waste Incineration BREF shows that the average concentration recorded from UK plants equipped with bag filters was 1.6 µg/Nm^3 (or 8% of the ELV of 0.02 mg/Nm^3), the highest recorded concentration of cadmium and thallium was 14 µg/Nm^3 (or 70% of the ELV of 0.02 mg/Nm^3) and only three lines recorded concentrations higher than 10 µg/Nm^3 (or 50% of the ELV of 0.02 mg/Nm^3).

Table 34 shows the annual mean cadmium PC at the identified sensitive human receptor locations, for cadmium emitted at 100%, 50% and 8% of the ELV, referred to as the 'screening', 'worst case' and 'typical' scenarios. PCs greater than 0.5% of the AQAL are highlighted. Figure 12 the spatial distribution of emissions assuming cadmium is emitted at 100% of the combined cadmium and thallium emission limit.

Table 34: Annual Mean Cadmium Impact at Identified Sensitive Receptors

Receptor	PC					
	Screening		Worst-case		Typical	
	ng/m³	% AQAL	ng/m³	% AQAL	ng/m³	% AQAL
Pt of max impact	0.423	**8.46%**	0.212	**4.23%**	0.034	**0.68%**
R1	0.053	**1.05%**	0.026	**0.53%**	0.004	0.08%
R2	0.052	**1.03%**	0.026	**0.52%**	0.004	0.08%
R3	0.056	**1.11%**	0.028	**0.56%**	0.004	0.09%
R4	0.053	**1.06%**	0.027	**0.53%**	0.004	0.09%
R5	0.033	**0.66%**	0.017	0.33%	0.003	0.05%
R6	0.049	**0.98%**	0.025	0.49%	0.004	0.08%
R7	0.046	**0.92%**	0.023	0.46%	0.004	0.07%
R8	0.038	**0.77%**	0.019	0.38%	0.003	0.06%
R9	0.041	**0.81%**	0.020	0.41%	0.003	0.06%
R10	0.041	**0.83%**	0.021	0.41%	0.003	0.07%
R11	0.037	**0.75%**	0.019	0.37%	0.003	0.06%

Even under the screening scenario, the maximum impact at a receptor rounds to 1% of the AQAL. As the baseline concentration is 0.12 µg/m³, the maximum PEC at a receptor is 0.176 µg/m³ which is 3.51% of the AQAL. Under the screening assumption, the maximum PC at an area of relevant exposure rounds to 1% of the AQAL and the PEC is less than 75% of the AQAL. Therefore, the impact is described as 'negligible'.

Under the more realistic assumption that cadmium emissions are typical for an ERF operating in the UK, the impact at all receptor locations is well below 0.5% of the AQAL and can be screened out as 'negligible' irrespective of the total concentration.

7.2.5 Annual mean PAHs

The annual mean PAHs (as BaP) PC from the Proposed ERF is predicted to be 1.67% of the AQAL at the point of maximum impact. However, this assumes that BaP is emitted at the highest concentration recorded at a UK plant, as reported in the Waste Incineration BREF, which is a highly conservative assumption.

Table 35 shows the annual mean PAH PC at the identified sensitive human receptor locations. PCs greater than 0.5% of the AQAL are highlighted. Figure 13 shows the spatial distribution of emissions.

Table 35: Annual Mean PAHs (as BaP) Impact at Identified Sensitive Receptors

Receptor	PC		PEC	
	pg/m³	as % of AQAL	pg/m³	as % of AQAL
R1	0.53	0.21%	180.53	72.21%
R2	0.52	0.21%	180.52	72.21%

Receptor	PC		PEC	
	pg/m³	as % of AQAL	pg/m³	as % of AQAL
R3	0.56	0.22%	180.56	72.22%
R4	0.53	0.21%	180.53	72.21%
R5	0.33	0.13%	180.33	72.13%
R6	0.49	0.20%	180.49	72.20%
R7	0.46	0.18%	180.46	72.18%
R8	0.38	0.15%	180.38	72.15%
R9	0.41	0.16%	180.41	72.16%
R10	0.41	0.17%	180.41	72.16%
R11	0.37	0.15%	180.37	72.15%

As shown, the impact at all receptor locations is less than 0.5% of the AQAL and is described as 'negligible' irrespective of the total concentration.

7.2.6 Short-term impacts

The following plot files have been produced to assist with the assessment of short term impacts on concentrations of nitrogen dioxide and sulphur dioxide:

- Figure 14 [99.79%ile of Hourly Mean Nitrogen Dioxide];
- Figure 15 [99.73%ile of Hourly Mean Sulphur Dioxide]; and
- Figure 16 [99.9%ile of 15-Minute Mean Sulphur Dioxide].

Impacts greater than 10% of the AQAL which occur in areas of relevant exposure (see Table 4) cannot be screened out as 'negligible'. In accordance with the guidance set out in section 5.7.1, the magnitude of short-term impacts is assessed without reference to background concentrations (and therefore without reference to the short-term PEC). Table 28 shows that the PEC remains well below the relevant AQAL for all pollutants where the short-term impact of the Proposed ERF cannot be screened out as 'insignificant'.

For hourly mean sulphur dioxide, impacts which are greater than 10% of the AQAL are limited to an area to the north of the Proposed ERF across a landfill site where it is not expected that members of the public would regularly be exposed for an hour or more. In accordance with the guidance detailed in Table 4, the AQALs do not apply at places of work such as landfills, unless members of the public (i.e., not employees) will be exposed. Based on this guidance, the landfill does not qualify as an area of relevant exposure. However, as a conservative measure the impact in this area has been assessed. As the impact is between 10-20% of the AQAL, the impact is described as 'slight adverse'. The England Coast Path lies to the north of the Proposed ERF, but the area of impacts >10% of the AQAL does not cover any part of the footpath so the impact at the footpath is 'negligible'.

For hourly mean nitrogen dioxide, impacts of 10-20% of the AQAL occur over the landfill, and also over the industrial estate north of the A66. As for hourly mean sulphur dioxide, the impact is described as 'slight adverse'.

For 15-minute mean sulphur dioxide, the maximum impact exceed 20% of the AQAL. The impact greater than 20% is predicted to occur only across a very small area of the landfill to the north of the Proposed ERF. This impact is described as 'moderate adverse'. Impacts of 10-20% of the AQAL occur in the same area as for hourly mean impacts described above, but also over a small area between housing on Bolckow Road and the A66, and a very small section of the England Coast Path. The impact at these areas of relevant exposure where the contribution is 10-20% of the AQAL is described as 'slight adverse'.

Short-term impacts that cannot be described as 'negligible' at areas of relevant exposure are only predicted under the assumption that both lines of the Proposed ERF operate at the half-hourly ELVs concurrently during the worst-case meteorological conditions for dispersion. This is a highly conservative and unlikely scenario. If just one line were to operate at the half-hourly ELVs while the other operated at the daily ELV during the worst-case meteorological conditions for dispersion, the maximum impact at any location would be 13.5% of the AQAL for 15-minute mean sulphur dioxide, 9.3% of the AQAL for hourly mean sulphur dioxide, and 12.5% of the AQAL for hourly mean nitrogen dioxide. In this case, the impact at areas of relevant exposure (except the landfill to the north) would be well below 10% of the AQAL and would be described as 'negligible'.

In addition, if it is assumed that both lines of the Proposed ERF operate at the daily ELV, the maximum impact is predicted to be 3.51% of the AQAL for 15-minute mean sulphur dioxide, 2.43% of the AQAL for hourly mean sulphur dioxide, and 4.98% of the AQAL for hourly mean nitrogen dioxide. These impacts are described as 'negligible'.

7.2.7 Heavy metals – at the point of maximum impact

Table 36 and Table 37 detail the PC and PEC assuming that each metal is released at the combined long-term metal ELVs set out in the Waste Incineration BREF. If the PC is greater than 1% of the long-term or 10% of the short-term AQAL and the PEC exceeds the AQAL when it is assumed that each metal is emitted at the total metal ELV, further analysis has been undertaken. The EA metals guidance[6] details the maximum monitored concentrations of group 3 metals emitted by municipal waste incinerators and waste wood co-incinerators as a percentage of the group ELV. It has been assumed that emissions of metals from the Proposed ERF are no greater than the maximum monitored emission presented in the EA's analysis for this further analysis.

[6] Guidance on Assessing group 3 metal stack emissions from incinerators, Environment Agency, 2016

Table 36: Long-Term Metals Results – Point of Maximum 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			
			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	0.39	6.35	**105.79%**	6.74	**112.29%**	8.3%	0.53	**8.82%**	0.92	15.32%
Antimony	5,000	1.30	6.35	0.13%	7.65	0.15%	3.8%	0.24	0.005%	1.54	0.03%
Chromium	5,000	1.60	6.35	0.13%	7.95	0.16%	30.7%	1.95	0.04%	3.55	0.07%
Chromium (VI)	0.25	0.32	6.35	**2538.9%**	6.67	**2666.9%**	0.043%	0.003	**1.10%**	0.32	**129.10%**
Cobalt	-	0.03	6.35	-	6.38	-	1.9%	0.12	-	0.15	-
Copper	10,000	2.20	6.35	0.06%	8.55	0.09%	9.7%	0.61	0.006%	2.81	0.03%
Lead	250	4.30	6.35	**2.54%**	10.65	4.26%	16.8%	1.06	0.43%	5.36	2.15%
Manganese	150	4.10	6.35	**4.23%**	10.45	6.96%	20.0%	1.27	0.85%	5.37	3.58%
Nickel	20	0.51	6.35	**31.74%**	6.86	34.29%	73.3%	4.65	**23.27%**	5.16	25.82%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, recalculated from the data presented in EA metals guidance document (V.4) Table A1.

Table 37: Short-Term Metals Results – Point of Maximum 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			
			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	-	0.78	101.91	-	102.69	-	8.3%	8.49	-	9.27	-
Antimony	150,000	2.60	101.91	0.07%	104.51	0.07%	3.8%	3.91	0.003%	6.51	0.004%
Chromium	150,000	3.20	101.91	0.07%	105.11	0.07%	30.7%	31.25	0.02%	34.45	0.02%
Chromium (VI)	-	0.64	101.91	-	102.55	-	0.043%	0.04	-	0.68	-
Cobalt	-	0.06	101.91	-	101.97	-	1.9%	1.90	-	1.96	-
Copper	200,000	4.40	101.91	0.05%	106.31	0.05%	9.7%	9.85	0.005%	14.25	0.01%
Lead	-	8.60	101.91	-	110.51	-	16.8%	17.09	-	25.69	-
Manganese	1,500,000	8.20	101.91	0.01%	110.11	0.01%	20.0%	20.38	0.001%	28.58	0.002%
Nickel	-	1.02	101.91	-	102.93	-	73.3%	74.73	-	75.75	-
Vanadium (24 hour mean)	1,000	1.30	80.19	**8.02%**	81.49	8.15%	2.0%	1.60	0.160%	2.90	0.29%

Notes:
(1) Metal as maximum percentage of the group 3 BAT-AEL, recalculated from the data as presented in EA metals guidance document (V.4) Table A1.

As shown in Table 36 and Table 37, if it is assumed that the entire emissions of metals consist of only one metal, the impact 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. The PEC is only predicted to exceed the AQALs for annual mean arsenic and chromium (VI) using this worst-case screening assumption. If it is assumed that the Proposed ERF would emit metals at the maximum concentration from the EA 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, chromium (VI) 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 ‘negligible’.

The impact of chromium (VI) at the point of maximum impact slightly exceeds the 1% annual mean screening criterion, and the PEC exceeds the AQAL. The point of maximum impact is uninhabited. Nonetheless, further analysis of the chromium (VI) impact has been undertaken.

Concentrations of chromium (VI) are not widely monitored across the UK and monitoring is not undertaken in the vicinity of the Proposed ERF. Therefore, background chromium (VI) has conservatively been assumed to be 20% of total chromium, in accordance with the EA’s metals guidance. Furthermore, the PC has been assessed assuming that the Proposed ERF operates at the maximum monitored concentration of chromium (VI) reported in the metals guidance. If it is assumed that the Proposed ERF operates at the mean concentration from the metals guidance rather than the maximum, the impact would be 0.30% of the AQAL and would be screened out as ‘negligible’. Under these more realistic scenarios the impact of the Proposed ERF on concentrations of chromium (VI) is well below 1% of the AQAL. Therefore, it is considered that the impact on concentrations of chromium (VI) is ‘negligible’.

8. Impact at Ecological Receptors

This section provides an assessment of the impact of emissions at the ecological receptors identified in Section 4.2.

8.1 Methodology

8.1.1 Atmospheric emissions - Critical Levels

The impact of emissions from the Proposed ERF has been compared to the Critical Levels listed in Table 3 and the results are presented in Section 8.2.

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

8.1.2 Deposition of emissions - Critical Loads

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

An assessment has been made for the relevant habitat features identified in APIS for the specific site. The site-specific features tool has been used to identify the feature habitats.

The lowest Critical Loads listed anywhere in each designated site would typically be used to ensure a robust screening assessment. As there are only two designated sites within the relevant screening distances from the Proposed ERF, the screening stage has been omitted and the relevant Critical Loads have been determined as follows:

- The most sensitive habitat present within the Teesmouth and Cleveland Coast SSSI/SPA/Ramsar is the coastal sand dune habitat. Terrence O'Rourke (TOR), who prepared the Habitats Regulations Assessment (HRA), has advised that a nitrogen Critical Load range of 10-15 kgN/ha/yr for calcareous dunes is appropriate for this habitat type. The bird species for which the site has been designated are not sensitive to the effect of acid deposition on the habitats present. Further details are provided in the HRA and the Environmental Impact Assessment Statement of Conformity prepared by TOR.
- Saltmarsh habitats within the Teesmouth and Cleveland Coast SSSI/SPA/Ramsar are also sensitive to nitrogen deposition, so the impact on saltmarsh habitats has also been assessed. The Priority Habitat Inventory provided by the UK government under the Open Government Licence shows that the closest area of saltmarsh lies over 4 km north of the Proposed ERF. The maximum impact in areas of saltmarsh has been assessed.
- A number of other estuarine habitat types may be present but are not the reason for designation of the SSSI/SPA/Ramsar, as detailed in the HRA. These habitats have a nitrogen Critical Load range of 20 – 30 kgN/ha/yr. As a conservative measure it has been assumed that habitats with this Critical Load range are present at the point of maximum impact within the SSSI/SPA/Ramsar.
- The most sensitive habitat present within the North York Moors SAC is bog. The Priority Habitat Inventory provided by the UK government under the Open Government Licence, shows that the closest part of the SAC comprises upland heath, with the closest bog habitats being more than 18 km from the Proposed ERF; this is outside of the 10 km screening distance from the Proposed

ERF and at this distance the impact of emissions would be very small. Therefore, only the impact of the Proposed ERF on heathland habitats has been assessed.

The relevant Critical Loads and background levels of deposition are presented in Appendix B [APIS Critical Loads]. If the impact of process emissions from the Proposed ERF is greater than 1% of the Critical Load, further assessment has been undertaken.

8.1.3 Nitrogen deposition – eutrophication

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

8.1.4 Acidification

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

A search has been undertaken for each of the ecological receptors identified. Each site contains a number of habitat types, each with different Critical Loads. Appendix B summarises the Critical Loads for acidification and background deposition rates as detailed in APIS for each identified habitat. The lowest Critical Loads for each designated site have been used to ensure a robust assessment, except where stated. The impact has been assessed against these Critical Load functions. Where a Critical Load function for acid deposition is not available but the habitat is listed as sensitive to acid deposition, the total nitrogen and sulphur deposition has been presented and compared with the background concentration.

8.1.5 Calculation methodology – nitrogen deposition

The impact of deposition has been assessed using the methodology detailed within the Habitats Directive AQTAG06[7] (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 38.
3. Convert the dry deposition flux into units of kgN/ha/yr using the conversion factors presented in Table 38.
4. Compare this result to the nitrogen deposition Critical Load.

Table 38: 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

7 Air Quality Advisory Group, AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air, March 2014

Pollutant	Deposition Velocity (m/s)		Conversion Factor ($\mu g/m^2/s$ to kg/ha/year)
	Grassland	Woodland	
Ammonia	0.0200	0.030	259.7
Hydrogen chloride	0.0250	0.060	306.7

8.1.5.1 Acidification

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

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

1. Determine the dry deposition rate in kg/ha/yr of nitrogen, sulphur, hydrogen chloride and ammonia using the methodology outlined in Section 8.1.5.
2. Apply the conversion factor for N outlined in Table 38 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 hydrogen chloride to determine the dry deposition keq/ha/year from hydrogen chloride.
5. Add the contribution from S to wet deposition from hydrogen chloride and treat this sum as the total contribution from S.
6. Plot the results against the Critical Load functions.

Table 39: 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 emissions of hydrogen chloride, the PC of hydrogen chloride , in addition to S and N, should be considered in the acidity Critical Load assessment. The H+ from hydrogen chloride should be added to the S contribution (and treated as S in APIS tool). This should include the contribution of hydrogen chloride from wet deposition.

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

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

Where PEC N Deposition < CLminN:

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

Where PEC N Deposition > CLminN:

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

8.2 Results – atmospheric emissions - Critical Levels

The impact of emissions from the operation of the Proposed ERF has been compared to the Critical Levels and the results are presented in Table 40. If the emissions of a particular pollutant are greater than 1% of the long-term or 10% of the short-term Critical Level, further assessment has been undertaken. 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 16.

Table 40: Process Contribution at Designated Ecological Sites

Site	NOx		SO_2	HF		NH_3
	Annual Mean	Daily Mean	Annual Mean	Weekly Mean	Daily Mean	Annual Mean
Process Contribution as µg/m³						
Teesmouth and Cleveland Coast	0.55	4.51	0.17	0.021	0.05	0.055
North York Moors	0.04	0.66	0.01	0.002	0.01	0.004
Process Contribution as % of Critical Level						
Teesmouth and Cleveland Coast	**1.85%**	6.01%	0.83%	4.30%	0.90%	**1.85%**
North York Moors(1)	0.13%	0.88%	0.12%	0.41%	0.13%	0.41%
Note: *(1) The lower annual mean Critical Levels of 10 µg/m³ for sulphur dioxide and 1 µg/m³ for ammonia for the protection of lichens and bryophytes have been applied at the North York Moors SAC.*						

At all designated sites the PC is less than 1% of the long-term or 10% of the short-term Critical Level and can be screened out as 'insignificant' for all pollutants considered, with the exception of annual mean oxides of nitrogen and annual mean ammonia at the Teesmouth and Cleveland Coast SPA/Ramsar.

Exceedances of the screening criteria do not automatically mean that the impact is significant but do require further analysis to determine the significance of effect.

The background concentration of oxides of nitrogen and ammonia have been extracted from APIS across the area of the Teesmouth and Cleveland Coast SPA/Ramsar where the PC cannot be screened out as 'insignificant'.

The maximum background concentration of oxides of nitrogen in this area is 44.2 µg/m³ (near the mouth of the River Tees, with industrial and shipping sources contributing). As the maximum background exceeds the Critical Level, the PEC also exceeds the Critical Level and cannot be screened out. Therefore, consideration has been given to the habitats present. The only priority habitat present in the area where the PC of oxides of nitrogen exceeds 1% of the Critical Load is mudflats, which is not sensitive to additional loading of oxides of nitrogen. Therefore, there is no potential for a significant effect.

The maximum background concentration of ammonia in the area where the PC cannot be screened out is 2.0 µg/m³, or 66.7% of the Critical Level of 3 µg/m³ set for the protection of higher plants. When the PC is included, the PEC remains below 70% of the Critical Level, so the PEC is screened out as 'not significant'.

8.3 Results - deposition of emissions - Critical Loads

Appendix C [Deposition Analysis at Ecological Sites] presents the results at each of the identified statutory designated ecological receptors.

As shown in Appendix C, at all designated sites the PC is less than 1% of the Critical Load and can be screened out as 'insignificant' for all pollutants considered, with the exception of nitrogen deposition on coastal sand dune and estuary habitats within the Teesmouth and Cleveland Coast SPA/Ramsar. Figure 17 shows the distribution of nitrogen deposition resulting from emissions from the Proposed ERF.

Estuary habitats are included for completeness as recommended by TOR, as the habitat type is a designated features in other estuarine SPAs. However, this is not a designated habitat in the Teesmouth and Cleveland Coast SPA/Ramsar. Nitrogen deposition on coastal sand dunes only slightly exceeds 1% of the Critical Load at 1.21%. The significance of effect of nitrogen deposition has been assessed by TOR as part of the HRA.

9 Cumulative Assessment

This section details the inputs used for the dispersion modelling of emissions from cumulative point sources, and the results of this modelling. A discussion of potential cumulative effects, including sources not included in the dispersion model, is contained within Chapter 13 of the Environmental Impact Assessment: Statement of Conformity.

The following plans and projects which include point source emissions were identified for inclusion in the cumulative assessment in consultation with RCBC:

- TeesREP Biomass Plant (ref: R/2008/0671/EA);
- Teesside Combined Cycle Power Plant (CCPP) (R/2017/0119/DCO);
- Grangetown Peaking Plant (R/2018/0098/FF);
- Peak African Minerals Resources Refinery (R/2017/0876/FFM);
- Redcar Energy Centre (ref: R/2020/0411/FFM).

In addition to the above, a planning application (ref: R/2023/0080/ESM) has been submitted by Circular Fuels Arboretum Ltd (CFA) for a renewable gas production facility to be located on Plot 6, Dorman Point, Teesworks, approximately 200 m east of the Proposed Development. The renewable gas production process involves the gasification of refuse-derived fuel, which is regulated under the same legislation as the Proposed Development, i.e., the IED and Waste Incineration BREF. Unlike the projects listed above, the CFA application does not yet have planning consent. Therefore, when considering the cumulative effects, the following scenarios have been considered:

1. The cumulative effect of Proposed Development and the consented schemes; and
2. As Scenario 1, with the effect of CFA development included.

The location of each cumulative point source is shown on Figure 18.

Only emissions with the potential for significant cumulative effects with the Proposed ERF have been included in the cumulative dispersion modelling. As shown in section 7.2.6, short-term impacts from the Proposed ERF that cannot be described as 'negligible' are limited to areas in close proximity to the Proposed ERF. Short-term impacts from the cumulative point sources above will likewise be limited to close proximity to each source. Therefore, it is considered that there is no potential for significant cumulative short-term effects and the cumulative assessment has been limited to annual mean impacts. The exception is the CFA development, which is located close to the Proposed ERF. An assessment of the potential short-term cumulative effects is presented in section 9.1.4

For pollutants for which the annual mean impact of the Proposed ERF cannot be screened out as 'negligible' irrespective of the total concentration at areas of relevant exposure, the inclusion of emissions from the cumulative schemes may change the conclusions of the assessment. The pollutants considered in the cumulative assessment are:

- For the assessment of impacts on human health:
  - Annual mean nitrogen dioxide (noting that Figure 8 shows that the impact is predicted to exceed 0.5% of the AQAL across a small section of Passfield Crescent);
  - Annual mean VOCs as benzene and 1,3-butadiene;
  - Annual mean cadmium; and
  - Short-term nitrogen dioxide and sulphur dioxide (cumulative scenario 2 only).
- For the assessment of impacts on ecosystems:
  - Annual mean oxides of nitrogen;

- Annual mean sulphur dioxide;
- Annual mean ammonia; and
- Annual mean nitrogen and acid deposition.

Not all of the cumulative point sources include emissions of all of these pollutants. The data for input into the cumulative dispersion modelling has been taken from the AQAs submitted with the planning application for each cumulative scheme and is presented in Appendix D.

9.1 Human health

As this cumulative assessment is only concerned with annual mean impacts, the assessment has been limited to the receptors identified in section 4.1 for the pollutants listed in section 9.

For all other pollutants, the annual mean impact of the Proposed ERF can be screened out as 'negligible' irrespective of the total concentration and therefore the inclusion of any other developments would not change this conclusion.

9.1.1 Annual mean nitrogen dioxide

Table 41 details the impact of annual mean nitrogen dioxide contributions from process emissions from the Proposed ERF and from all other modelled consented cumulative schemes at the point of maximum impact of the Proposed ERF, and at the identified sensitive human receptor locations.

Table 41: Annual Mean Nitrogen Dioxide Cumulative Impact - Cumulative Scenario 1

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	1.48	3.70%	0.43	1.08%	21.11	52.78%
R1	0.18	0.46%	0.41	1.04%	19.80	49.50%
R2	0.18	0.45%	0.36	0.91%	19.74	49.36%
R3	0.19	0.49%	0.36	0.89%	19.75	49.38%
R4	0.19	0.47%	0.37	0.93%	19.76	49.39%
R5	0.12	0.29%	1.18	2.94%	20.49	51.23%
R6	0.17	0.43%	0.35	0.87%	19.72	49.30%
R7	0.16	0.40%	0.36	0.91%	19.73	49.32%
R8	0.13	0.34%	0.37	0.93%	19.71	49.27%
R9	0.14	0.35%	0.39	0.98%	19.73	49.33%
R10	0.14	0.36%	0.50	1.26%	19.85	49.62%
R11	0.13	0.33%	0.51	1.28%	19.84	49.61%

As shown, the cumulative schemes add a maximum of 2.94% of the AQAL at any receptor location. Figure 8 shows that the Proposed ERF PC is predicted to exceed 0.5% of the AQAL across a small section of Passfield Crescent, less than 50 m from R3. The contribution from the cumulative schemes in this area will not be significantly different to R3 where the cumulative PEC is 49.5% of the AQAL. Therefore, the cumulative PEC will remain well below 75% of the AQAL across the small area where the Proposed ERF PC exceeds 0.5% of the AQAL. As the impact of the Proposed ERF rounds to 1% of the AQAL and the cumulative PEC is less than 75% of the AQAL, the impact remains 'negligible'.

Table 42 shows the same results for cumulative scenario 2, including the CFA Development.

Table 42: Annual Mean Nitrogen Dioxide Cumulative Impact - Cumulative Scenario 2

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	1.48	3.70%	0.90	2.25%	21.58	53.96%
R1	0.18	0.46%	0.47	1.19%	19.86	49.65%
R2	0.18	0.45%	0.40	1.00%	19.78	49.45%
R3	0.19	0.49%	0.39	0.99%	19.79	49.47%
R4	0.19	0.47%	0.43	1.06%	19.81	49.53%
R5	0.12	0.29%	1.23	3.07%	20.54	51.36%
R6	0.17	0.43%	0.38	0.94%	19.75	49.37%
R7	0.16	0.40%	0.40	0.99%	19.76	49.39%
R8	0.13	0.34%	0.40	0.99%	19.73	49.33%
R9	0.14	0.35%	0.42	1.05%	19.76	49.40%
R10	0.14	0.36%	0.54	1.36%	19.89	49.72%
R11	0.13	0.33%	0.55	1.38%	19.88	49.71%

As shown, when the CFA development is included, the cumulative PEC remains below 75% of the AQAL and the conclusions are unchanged from cumulative scenario 1.

9.1.2 Annual mean VOCs

Table 43 and Table 44 detail the impact of annual mean benzene and 1,3-butadiene contributions from process emissions from the Proposed ERF and from all other modelled consented cumulative schemes at the point of maximum impact of the Proposed ERF, and at the identified sensitive human receptor locations. This assumes that all VOCs from all modelled sources are emitted as either benzene or 1,3-butadiene for comparison with the relevant AQALs.

Table 43: Annual Mean VOCs (as Benzene) Cumulative Impact - Cumulative Scenario 1

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	0.212	4.23%	0.013	0.27%	1.32	26.50%
R1	0.026	**0.53%**	0.011	0.21%	1.14	22.74%
R2	0.026	**0.52%**	0.010	0.20%	1.14	22.72%
R3	0.028	**0.56%**	0.010	0.20%	1.14	22.75%

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
R4	0.027	**0.53%**	0.010	0.21%	1.14	22.74%
R5	0.017	0.33%	0.011	0.22%	1.13	22.55%
R6	0.025	0.49%	0.009	0.18%	1.13	22.68%
R7	0.023	0.46%	0.009	0.18%	1.13	22.65%
R8	0.019	0.38%	0.009	0.17%	1.13	22.56%
R9	0.020	0.41%	0.009	0.18%	1.13	22.59%
R10	0.021	0.41%	0.010	0.20%	1.13	22.62%
R11	0.019	0.37%	0.010	0.20%	1.13	22.58%

Table 44: Annual Mean VOCs (as 1,3-Butadiene) Cumulative Impact - Cumulative Scenario 1

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	0.212	9.40%	0.013	0.60%	0.54	24.22%
R1	0.026	**1.17%**	0.011	0.47%	0.36	15.86%
R2	0.026	**1.15%**	0.010	0.45%	0.36	15.81%
R3	0.028	**1.24%**	0.010	0.44%	0.36	15.90%
R4	0.027	**1.18%**	0.010	0.46%	0.36	15.86%
R5	0.017	**0.74%**	0.011	0.48%	0.35	15.45%
R6	0.025	**1.09%**	0.009	0.41%	0.35	15.73%
R7	0.023	**1.03%**	0.009	0.41%	0.35	15.66%
R8	0.019	**0.85%**	0.009	0.39%	0.35	15.46%
R9	0.020	**0.90%**	0.009	0.40%	0.35	15.52%
R10	0.021	**0.92%**	0.010	0.45%	0.35	15.59%
R11	0.019	**0.83%**	0.010	0.45%	0.35	15.50%

As shown, the cumulative PEC remains well below 75% of the AQAL across the areas where the Proposed ERF PC exceeds 0.5% of the AQAL. As the impact of the Proposed ERF rounds to 1% of the AQAL and the cumulative PEC is less than 75% of the AQAL, the impact remains ‘negligible’.

Table 45 and Table 46 show the same results for cumulative scenario 2, including the CFA Development.

Table 45: Annual Mean VOCs (as Benzene) Cumulative Impact - Cumulative Scenario 2

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	0.212	4.23%	0.72	14.37%	2.03	40.60%
R1	0.026	**0.53%**	0.37	7.31%	1.49	29.84%
R2	0.026	**0.52%**	0.26	5.18%	1.38	27.69%
R3	0.028	**0.56%**	0.25	5.04%	1.38	27.60%
R4	0.027	**0.53%**	0.35	6.98%	1.48	29.51%
R5	0.017	0.33%	0.26	5.14%	1.37	27.47%
R6	0.025	0.49%	0.19	3.90%	1.32	26.39%
R7	0.023	0.46%	0.20	4.10%	1.33	26.56%
R8	0.019	0.38%	0.16	3.27%	1.28	25.65%
R9	0.020	0.41%	0.19	3.74%	1.31	26.14%
R10	0.021	0.41%	0.21	4.11%	1.33	26.52%
R11	0.019	0.37%	0.20	4.08%	1.32	26.46%

Table 46: Annual Mean VOCs (as 1,3-Butadiene) Cumulative Impact - Cumulative Scenario 2

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	µg/m³	as % of AQAL	µg/m³	as % of AQAL	µg/m³	as % of AQAL
Point of maximum impact of ERF	0.212	9.40%	0.72	31.92%	1.25	55.55%
R1	0.026	**1.17%**	0.37	16.25%	0.71	31.64%
R2	0.026	**1.15%**	0.26	11.51%	0.60	26.87%
R3	0.028	**1.24%**	0.25	11.21%	0.60	26.67%
R4	0.027	**1.18%**	0.35	15.51%	0.70	30.91%
R5	0.017	**0.74%**	0.26	11.43%	0.59	26.39%
R6	0.025	**1.09%**	0.19	8.66%	0.54	23.97%
R7	0.023	**1.03%**	0.20	9.11%	0.55	24.36%
R8	0.019	**0.85%**	0.16	7.26%	0.50	22.34%
R9	0.020	**0.90%**	0.19	8.30%	0.53	23.43%
R10	0.021	**0.92%**	0.21	9.13%	0.55	24.27%
R11	0.019	**0.83%**	0.20	9.07%	0.54	24.13%

As shown, when the CFA development is included, the cumulative PC increases considerably from 0.013 µg/m³ to 0.72 µg/m³ at the point of maximum impact of the Proposed ERF. This is mainly due to VOC emissions from the dryer of the CFA development; with an emission rate of 2.3 g/s, VOCs are released from the dryer of the CFA development at more than twice the rate as from the Proposed ERF stack, from a considerably lower release point. Nonetheless, the PECs for both benzene and 1,3-butadiene remain below 75% of the AQAL and the conclusions are unchanged from cumulative scenario 1.

9.1.3 Annual mean cadmium

Table 47 details the impact of annual mean cadmium contributions from process emissions from the Proposed ERF and from all other modelled consented cumulative schemes at the point of maximum impact of the Proposed ERF, and at the identified sensitive human receptor locations.

This analysis assumes that cadmium from all modelled sources is emitted at 100% of the combined cadmium and thallium emission limit i.e., the most conservative screening scenario detailed in section 7.2.4.

Table 47: Annual Mean Cadmium Cumulative Impact - Cumulative Scenario 1

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL	ng/m³	as % of AQAL
Point of maximum impact of ERF	0.423	8.46%	0.027	0.54%	0.57	11.40%
R1	0.053	**1.05%**	0.021	0.43%	0.19	3.88%
R2	0.052	**1.03%**	0.020	0.40%	0.19	3.83%
R3	0.056	**1.11%**	0.020	0.39%	0.20	3.91%
R4	0.053	**1.06%**	0.021	0.41%	0.19	3.88%
R5	0.033	**0.66%**	0.022	0.44%	0.18	3.50%
R6	0.049	**0.98%**	0.018	0.37%	0.19	3.75%
R7	0.046	**0.92%**	0.018	0.37%	0.18	3.69%
R8	0.038	**0.77%**	0.017	0.35%	0.18	3.52%
R9	0.041	**0.81%**	0.018	0.36%	0.18	3.57%
R10	0.041	**0.83%**	0.020	0.41%	0.18	3.63%
R11	0.037	**0.75%**	0.020	0.40%	0.18	3.55%

As shown, the cumulative PEC remains well below 75% of the AQAL across the areas where the Proposed ERF PC exceeds 0.5% of the AQAL. As the impact of the Proposed ERF rounds to 1% of the AQAL and the cumulative PEC is less than 75% of the AQAL, the impact remains 'negligible'.

Table 48 shows the same results for cumulative scenario 2, including the CFA Development.

Table 48: Annual Mean Cadmium Cumulative Impact - Cumulative Scenario 2

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL	ng/m³	as % of AQAL
Point of maximum impact of ERF	0.423	8.46%	0.139	2.79%	0.68	13.65%
R1	0.053	**1.05%**	0.080	1.59%	0.25	5.04%

Receptor	ERF PC		Cumulative Schemes PC		Cumulative PEC	
	ng/m³	as % of AQAL	ng/m³	as % of AQAL	ng/m³	as % of AQAL
R2	0.052	**1.03%**	0.054	1.07%	0.23	4.51%
R3	0.056	**1.11%**	0.055	1.09%	0.23	4.61%
R4	0.053	**1.06%**	0.073	1.46%	0.25	4.93%
R5	0.033	**0.66%**	0.071	1.42%	0.22	4.49%
R6	0.049	**0.98%**	0.046	0.93%	0.22	4.31%
R7	0.046	**0.92%**	0.048	0.97%	0.21	4.29%
R8	0.038	**0.77%**	0.042	0.83%	0.20	4.00%
R9	0.041	**0.81%**	0.045	0.91%	0.21	4.12%
R10	0.041	**0.83%**	0.058	1.16%	0.22	4.39%
R11	0.037	**0.75%**	0.058	1.17%	0.22	4.32%

As shown, when the CFA development is included, the cumulative PEC remains well below 75% of the AQAL and the conclusions are unchanged from cumulative scenario 1.

9.1.4 Short term impacts

As detailed in section 5.7.1, the magnitude of short-term impacts is to be assessed without reference to baseline concentrations, although the IAQM 2017 guidance goes on to state that an impact should be assessed as ‘substantial’ when there is a risk of exceedance of a short-term AQAL, taking into account the contribution of other prominent local sources.

The only cumulative source with the potential for a significant short-term impact is the CFA development. The model has been run with the Proposed ERF and CFA development, with all parameters otherwise unchanged from those detailed in section 5. The results are presented in Table 49.

Table 49: Short Term Cumulative Assessment – ERF and CFA Development Only

Pollutant	ERF PC		CFA PC		Cumulative PC		Cumulative PEC	
	µg/m³	% of AQAL	µg/m³	% of AQAL	µg/m³	% of AQAL	µg/m³	% of AQAL
99.79%ile hourly mean nitrogen dioxide	39.85	19.93%	63.52	31.76%	63.52	31.76%	101.92	50.96%
99.9%ile 15-min mean sulphur dioxide	62.28	23.41%	104.25	39.19%	104.25	39.19%	108.25	40.70%
99.73%ile hourly mean sulphur dioxide	56.59	16.17%	87.82	25.09%	87.82	25.09%	91.82	26.23%

Notes:

Assumes both lines of the Proposed ERF and the char combustor of the CFA development operate concurrently at the short-term ELVs during the worst case weather conditions for dispersion as a worst-case.

The PC presented is the maximum for each source, while the cumulative PC is the maximum at any location from all sources.

The results show that the maximum PC from the CFA is the same as the maximum cumulative PC. This means that, during the periods of highest modelled concentrations, the concentrations at the point of maximum cumulative impact are entirely due to emissions from the CFA; the emissions from the CFA and ERF do not overlap. Furthermore, the PEC is predicted to be no more than 51% of the short-term AQAL for any pollutant. As there is no risk of exceeding the AQAL, it is concluded that no significant cumulative short-term effects will occur.

9.2 Ecological receptors

The two ecological receptors identified for inclusion in the assessment are both European designated sites. The Air Emissions guidance for the assessment of impacts at European Designated sites states that:

> *"For SPAs, SACs and Ramsar sites, you need to consider the 'in combination' (combined) impact of all permissions, plans or projects that affect the site."*

An assessment of the impact of the Proposed ERF in-combination with the other relevant plans and projects has been undertaken to inform the HRA for the Proposed ERF, which has been prepared by TOR. As reported in the HRA, TOR has found that:

> *"Previous in-combination assessment work undertaken for the approved Redcar Energy Centre (R/2020/0411/FFM) considered the in-combination air quality impacts of the approved scheme along with the Tees Renewable Energy Plant (R/2008/0671/EA), the Teesside Combined Cycle Power Plant (R/2017/0119/DCO) and the current scheme (as per the outline application).*
>
> *Although these schemes result in a PEC above the lower end of the critical load range for sand dune habitats it was concluded (and accepted by Natural England in September 2020) that this would not result in adverse impacts on the integrity of the Teesmouth and Cleveland Coast SPA/Ramsar."*

Therefore, the assessment of cumulative effects on the Teesmouth and Cleveland Coast SPA/Ramsar has considered how the total in-combination impact of all modelled point source emissions compares to the in-combination impact presented in the approved in-combination assessment for the Redcar Energy Centre. The North York Moors designated site was not considered in the in-combination assessment for the Redcar Energy Centre due to the significant distance but requires consideration in the in-combination assessment for the Proposed ERF. Therefore, the total in-combination impact at the North York Moors has been included as a standalone assessment in the HRA for the Proposed ERF, without reference to the in-combination assessment for the Redcar Energy Centre.

9.2.1 Atmospheric emissions - Critical Levels

The impact of emissions from the operation of the Proposed ERF for the pollutants listed in section 9 has been compared to the annual mean Critical Levels and the results are presented in Table 50 and Table 51. If the emissions of a particular pollutant are greater than 1% of the long-term Critical Level, further assessment has been undertaken.

Table 50: Process Contribution at Designated Ecological Sites – Point of Maximum Impact of ERF

Site	NOx			SO_2			NH_3		
	ERF	Total In-Combination		ERF	Total In-Combination		ERF	Total In-Combination	
		Scenario 1	Scenario 2		Scenario 1	Scenario 2		Scenario 1	Scenario 2
Process Contribution as µg/m³									
Teesmouth and Cleveland Coast	0.55	2.39	2.79	0.17	1.22	1.32	0.055	0.074	0.108
North York Moors	0.04	0.31	0.33	0.01	0.10	0.11	0.004	0.008	0.010
Process Contribution as % of Critical Level									
Teesmouth and Cleveland Coast	**1.85%**	**7.95%**	**9.29%**	0.83%	**6.10%**	**6.60%**	**1.85%**	**2.46%**	**3.58%**
North York Moors(1)	0.14%	**1.04%**	**1.11%**	0.12%	**1.03%**	**1.08%**	0.41%	0.79%	0.97%
Note: (1) The lower Critical Levels of 10 µg/m³ for sulphur dioxide and 1 µg/m³ for ammonia have been applied at the North York Moors SAC.									

Table 51: Process Contribution at Designated Ecological Sites – Point of Maximum In-Combination Impact

Site	NOx			SO_2			NH_3		
	ERF	Total In-Combination		ERF	Total In-Combination		ERF	Total In-Combination	
		Scenario 1	Scenario 2		Scenario 1	Scenario 2		Scenario 1	Scenario 2
Process Contribution as µg/m³									
Teesmouth and Cleveland Coast	0.16	3.58	3.70	0.05	1.27	1.37	0.016	0.225	0.235
Process Contribution as % of Critical Level									
Teesmouth and Cleveland Coast	0.55%	**11.93%**	**12.34%**	0.25%	**6.34%**	**6.84%**	0.55%	**7.49%**	**7.83%**
Note: The impact at the North York Moors SAC has been assessed at a single receptor point, so the PCs are the same as presented in Table 50.									

The in-combination impact at the point of maximum impact of the Proposed ERF in each designated site (Table 50) exceeds the screening criteria for all pollutants at all designated sites, except for ammonia at the North York Moors SAC. The in-combination impact at the point of maximum in-combination impact (Table 51) exceeds the screening criteria for all pollutants.

For the North York Moors SAC, the in-combination PCs for oxides of nitrogen and sulphur dioxide only slightly exceed the 1% screening criterion. According to APIS, the baseline concentration of oxides of nitrogen at the closest point of the SAC to the Proposed ERF is 7.9 µg/m³, which is 26.3% of the Critical Level. When the worst-case in-combination PC (including the CFA development) is added, the PEC is 8.23 µg/m³ which is 27.4% of the Critical Level. For sulphur dioxide the baseline concentration is 0.8 µg/m³, or 8.0% of the Critical Level, and the PEC is 9.1% of the Critical Level. Therefore, the in-combination PECs for oxides of nitrogen and sulphur dioxide at the North York Moors SAC are less than 70% of the Critical Level and can be screened out as 'not significant'.

At the Teesmouth and Cleveland Coast SPA/Ramsar, the maximum baseline concentration of sulphur dioxide is 4.10 µg/m³, or 20.5% of the Critical Level. In the first instance it has been assumed that this is the baseline concentration at the point of maximum in-combination impact. When the maximum in-combination PC of 1.37 µg/m³ is added, the PEC is 5.47µg/m³ which is 27.3% of the Critical Level and can be screened out as 'not significant'.

According to APIS, the highest baseline concentration of ammonia in the area of interest for in-combination impacts is 2.0 µg/m³. Conservatively assuming this to be the baseline concentration at the point of maximum in-combination impact and adding the worst-case in combination PC of 0.225 µg/m³, the PEC is 2.235 µg/m³ which is 74.5% of the Critical Level. Although this is slightly above 70% of the Critical Level and cannot be screened out as 'not significant', the detailed modelling has shown that there is no risk of exceedance of the Critical Level, so no significant effects are anticipated.

Therefore, the in-combination PECs for sulphur dioxide and ammonia at the Teesmouth and Cleveland Coast SPA/Ramsar are well below the relevant Critical Levels and no significant effects on the integrity of the designated site are likely.

For oxides of nitrogen, the baseline concentration exceeds the Critical Level across large parts of the Teesmouth and Cleveland Coast SPA/Ramsar, so the PEC will exceed the Critical Level where the in-combination PC cannot be screened out as 'insignificant'. The assessment of the significance of effect of this impact, in particular regarding the associated nitrogen deposition, is presented in the HRA prepared by TOR.

9.2.2 Deposition of emissions - Critical Loads

Appendix C [Deposition Analysis at Ecological Sites] presents the in-combination results at each of the identified statutory designated ecological receptors. As shown in Appendix C, the in-combination impact in each habitat in each designated site can be screened out as 'insignificant', except for nitrogen deposition on coastal sand dune, saltmarsh and estuary-type habitats at the Teesmouth and Cleveland Coast SPA/Ramsar.

Regarding nitrogen deposition at the Teesmouth and Cleveland Coast SPA/Ramsar, the maximum worst-case in-combination impact (including the contribution from the CFA development) is 15.93% of the Critical Load for coastal sand dune habitats. The contribution from the Proposed ERF at this in-combination point of maximum impact is a small proportion of the total, at only 1.02% of the Critical Load. A majority of the in-combination impact is due to emissions from the Redcar Energy Centre which is located within a few hundred metres of the sand dune habitats.

The significance of effect of in-combination impacts that cannot be screened out as ‘insignificant’ has been assessed by TOR as part of the HRA for the Proposed ERF. The conclusion of the HRA is that no significant effects on the integrity of the Teesmouth and Cleveland Coast and North York Moors designated sites are predicted as a result of the construction and operation of the Proposed ERF, either alone or in-combination with other relevant plans and projects.

10 Conclusions

This Emissions Modelling Report has been undertaken to support the reserved matters application for the Proposed ERF. This has been undertaken based on the assumption that the Proposed ERF will operate continually at the emission limits, compliant with the BAT-AELs set out in the Waste Incineration BREF for new plants, except for oxides of nitrogen for which an emission limit lower than the upper end of the BAT-AEL range will be applied for.

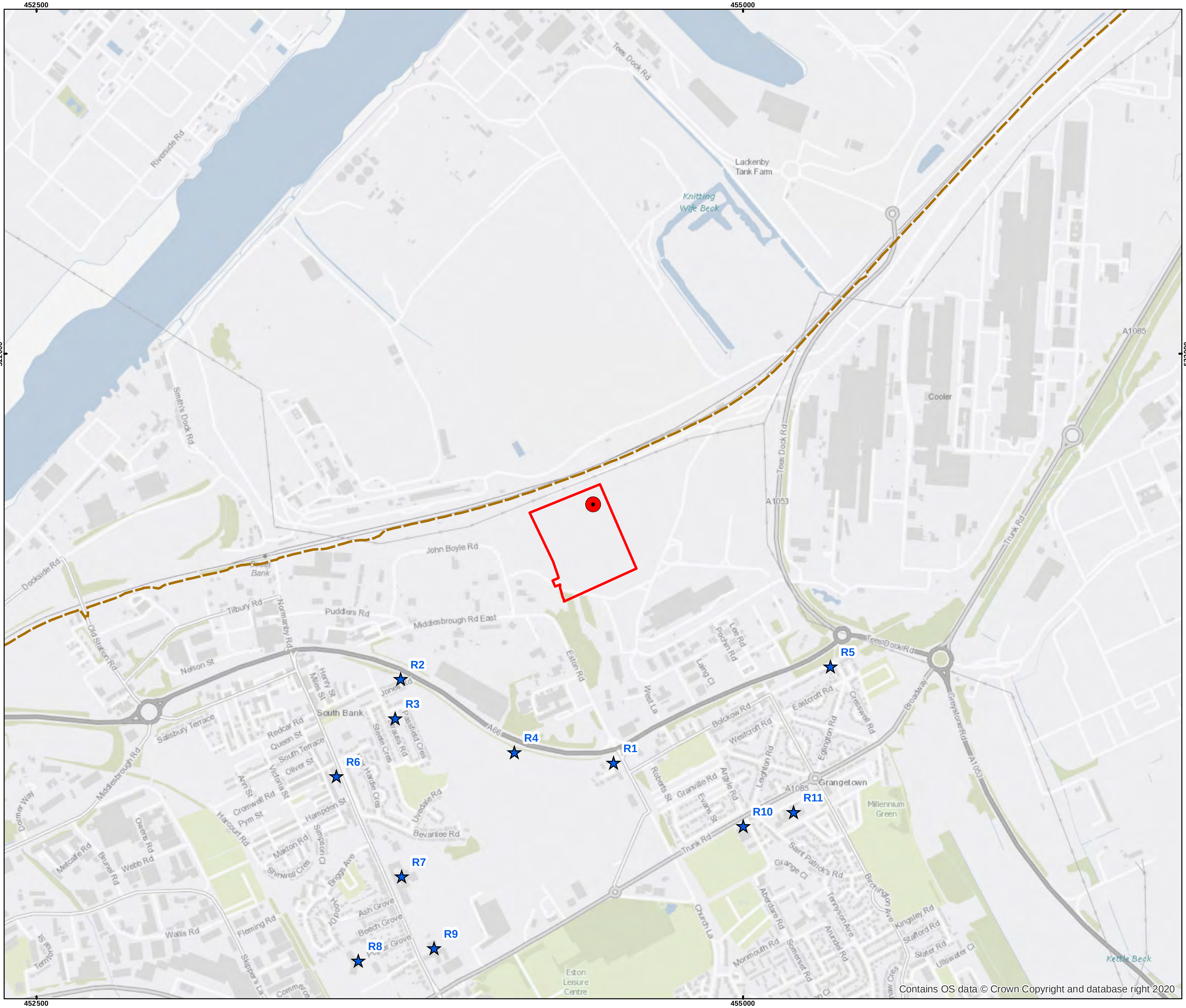
This assessment has included a review of baseline pollution levels, dispersion modelling of emissions and quantification of the impact of these emissions on local air quality.

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 ERF will not cause a breach of any AQAL.
    b. The overall impact of long-term process emissions due to the operation of the Proposed ERF can be described as 'negligible' in accordance with IAQM criteria at all areas of relevant exposure.
    c. The overall impact of short-term process emissions associated with the operation of the Proposed ERF can be described as 'negligible' in accordance with IAQM screening criteria at all areas of relevant exposure and at all identified human sensitive receptors, except for short-term sulphur dioxide and nitrogen dioxide, for which there are small areas where the impact is described as 'slight adverse' or 'moderate adverse' under a set of worst-case assumptions. This does not constitute a significant effect.
    d. The EA's approach to assessing the impact of metals has been used which considers the risk of exceeding the AQAL based on the existing background levels and contribution from the Proposed ERF. Using this approach, it has been determined that where the PEC exceeds the AQAL for heavy metals, it is due to the assumed high background concentration rather than contributions from the Proposed ERF.
    e. A cumulative assessment including other consented point source emissions has been undertaken. The inclusion of these cumulative sources does not change any of the conclusions regarding human health.
2. In relation to the impact on ecologically sensitive sites:
    a. All of the impacts at ecological features can be screened out as 'insignificant' except for nitrogen deposition at coastal sand dune habitats in the Teesmouth and Cleveland Coast SPA/Ramsar.
    b. When the 'in-combination' impact with the other identified plans and projects is considered, the in-combination impact on saltmarsh and estuary-type habitats at the Teesmouth and Cleveland Coast SPA/Ramsar also cannot be screened out as 'insignificant'.
    c. The significance of effect of impacts that cannot be screened out as 'insignificant' has been considered in the HRA, which concludes that the effect of the operation of the Proposed ERF is 'not significant', either alone or in-combination with other plans and projects.
3. In summary, the assessment has shown that the operation of the Proposed ERF will not cause a breach of any AQAL, and no significant effects on human health or ecology are predicted to occur due to process emissions from the Proposed ERF. As such, there should be no air quality constraint in granting planning consent for the detailed design for the Proposed ERF.

Appendices

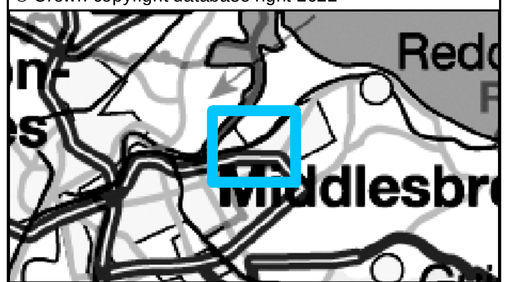
A Figures



Legend

- Area of proposed development
- Stack
- Human receptors
- England Coast Path

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 1 - Human Receptors
Drawn by: HKL	Date: 04/01/2022



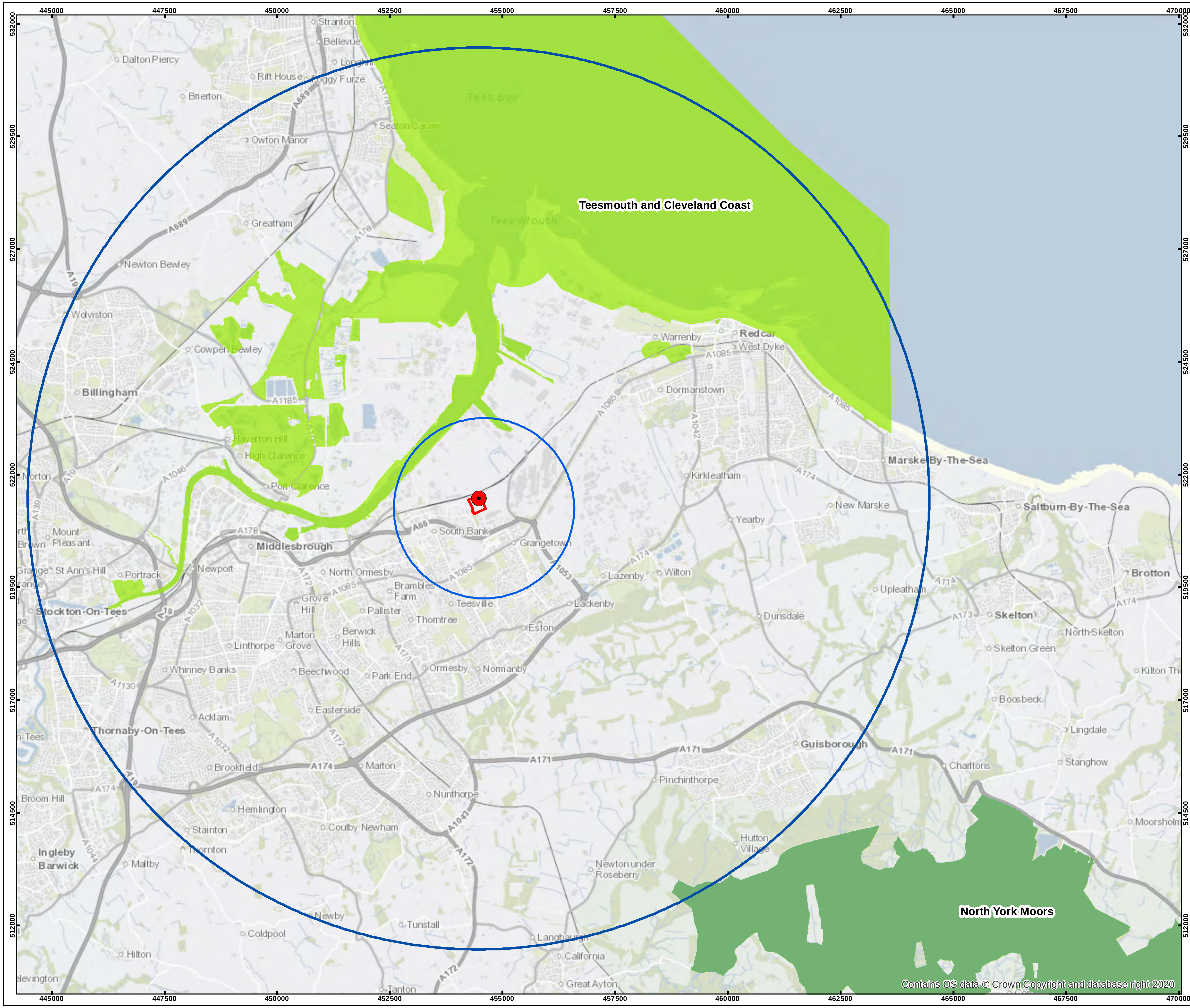
0 0.125 0.25 0.5 km

Scale: 1:12,500

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack
- Area of proposed development
- 2 km from Site
- 10km from Site
- North York Moors
- Teesmouth and Cleveland Coast

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 2 - Ecological Sensitive Receptors
Drawn by: HKL	Date: 04/01/2022

0 0.75 1.5 3 km

Scale: 1:77,500

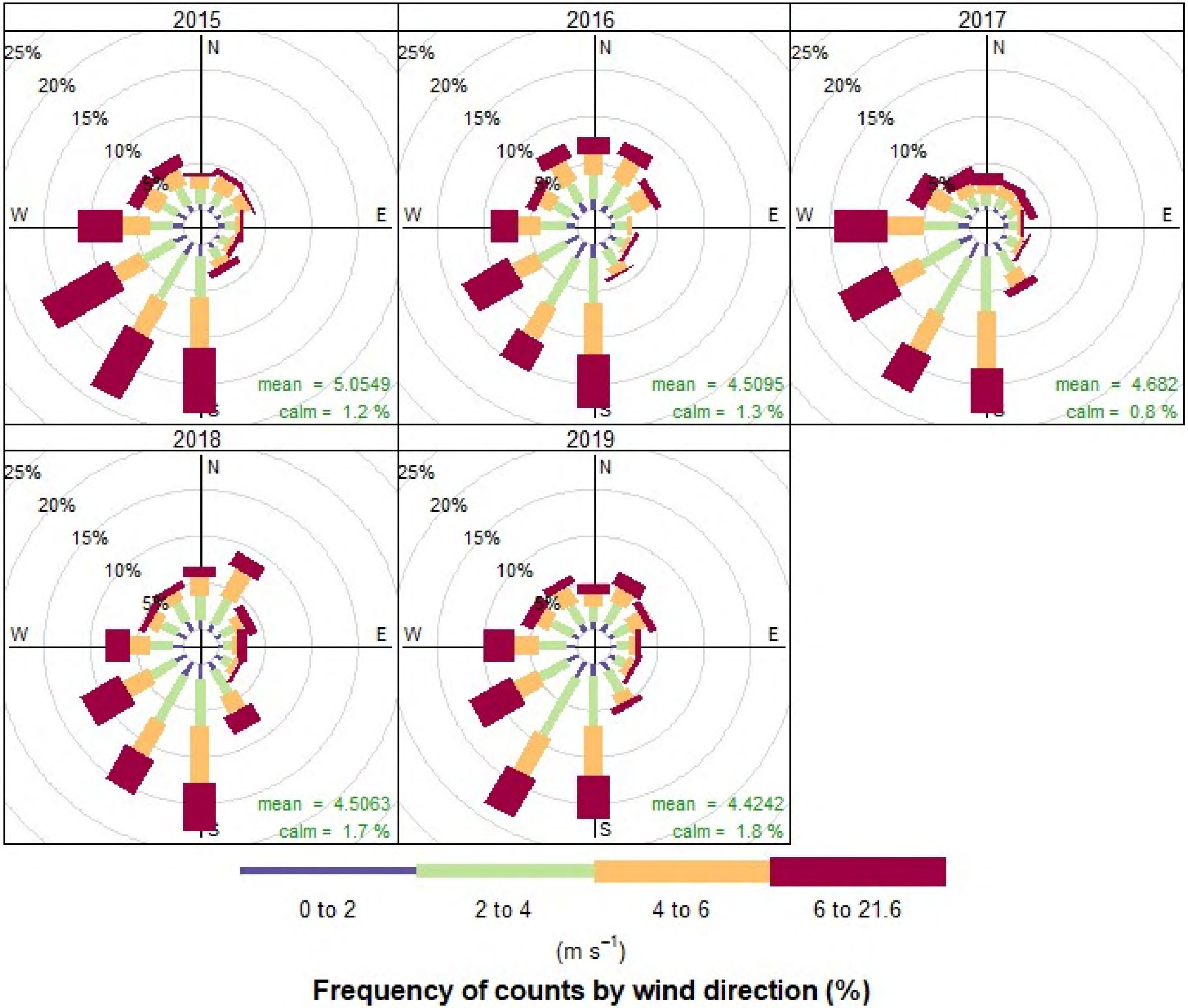
FICHTNER

Consulting Engineers Limited

Kingsgate, Wellington Road North, Stockport, Cheshire, SK4 1LW

Tel: 0161 476 0032

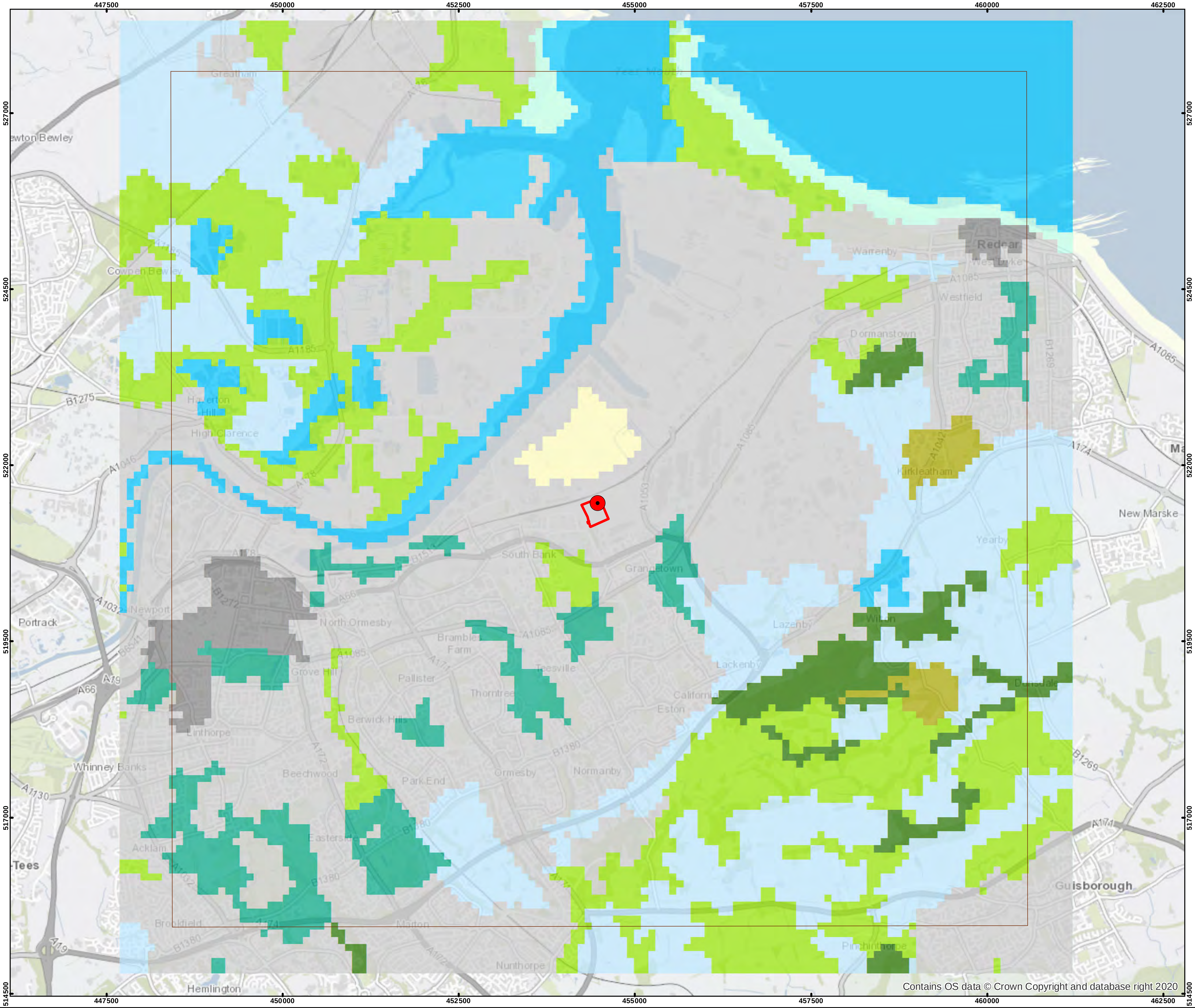
Fax: 0161 474 0618



Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 3 - Durham Tees Valley Wind Roses 2015 - 2019
Drawn by: HKL	Date: 04/01/2022

FICHTNER
Consulting Engineers Limited

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



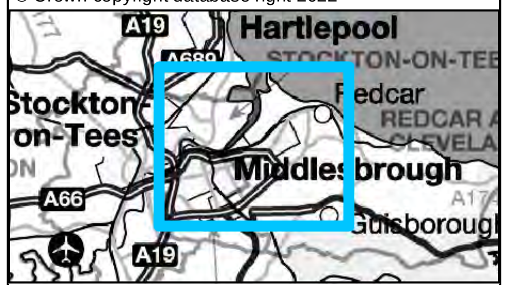
Legend

- Stack
- Area of proposed development
- Modelling domain

Variable roughness file values

- Water courses
- Intertidal Flats
- Sparsely vegetated areas
- Pastures/moors/grassland
- Arable land/salt marshes
- Agricultural land/natural vegetation
- Discontinuous urban fabric
- Green urban areas/transitional woodland
- Forest
- Continuous urban fabric

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 4 - Spatially-varying roughness file
Drawn by: HKL	Date: 04/01/2022

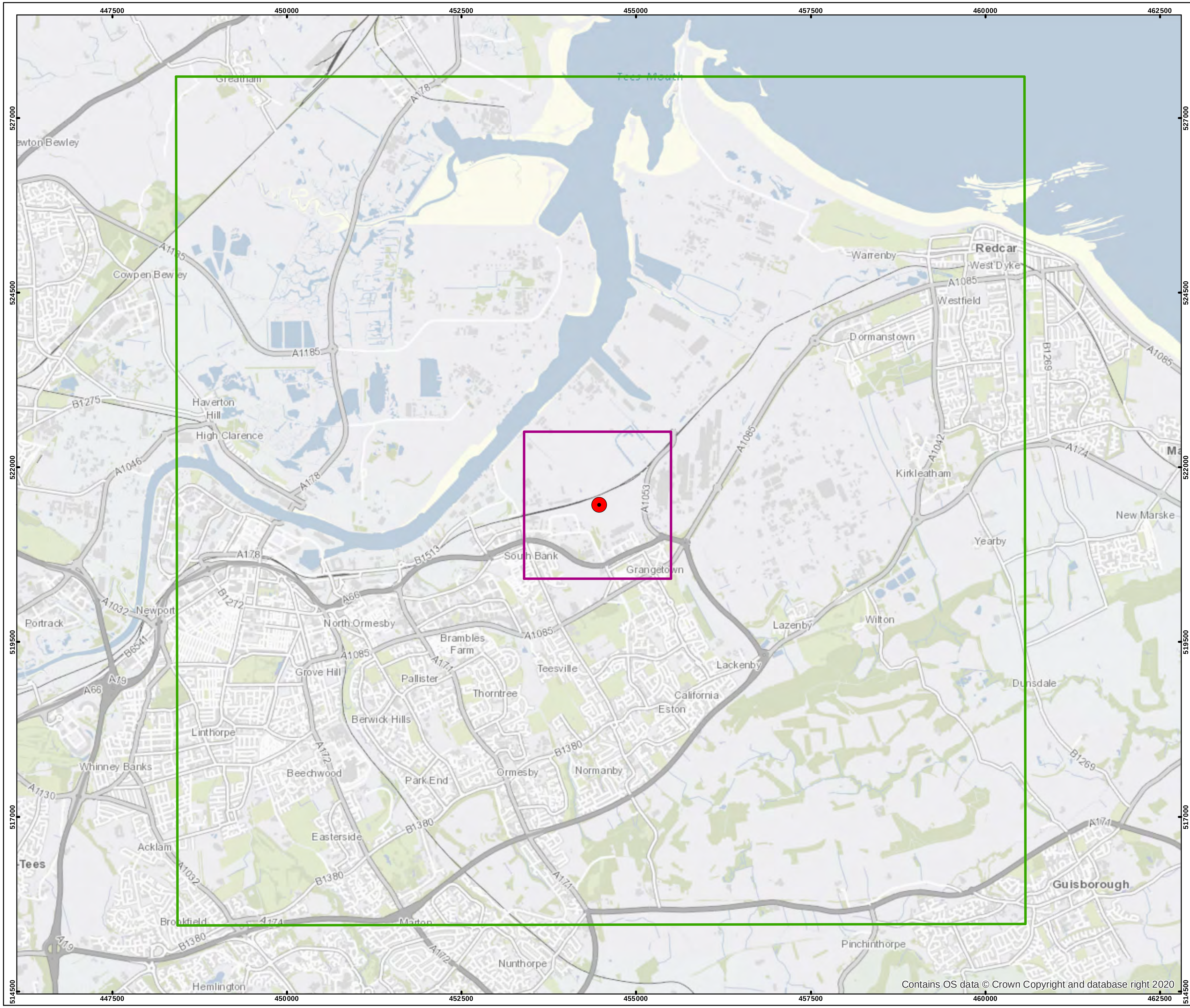


0 0.5 1 2 km

N

Scale: 1:50,000

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



Legend

- Stack
- Fine grid extent
- Wide grid extent

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 5 - Modelling Domain
Drawn by: HKL	Date: 04/01/2022

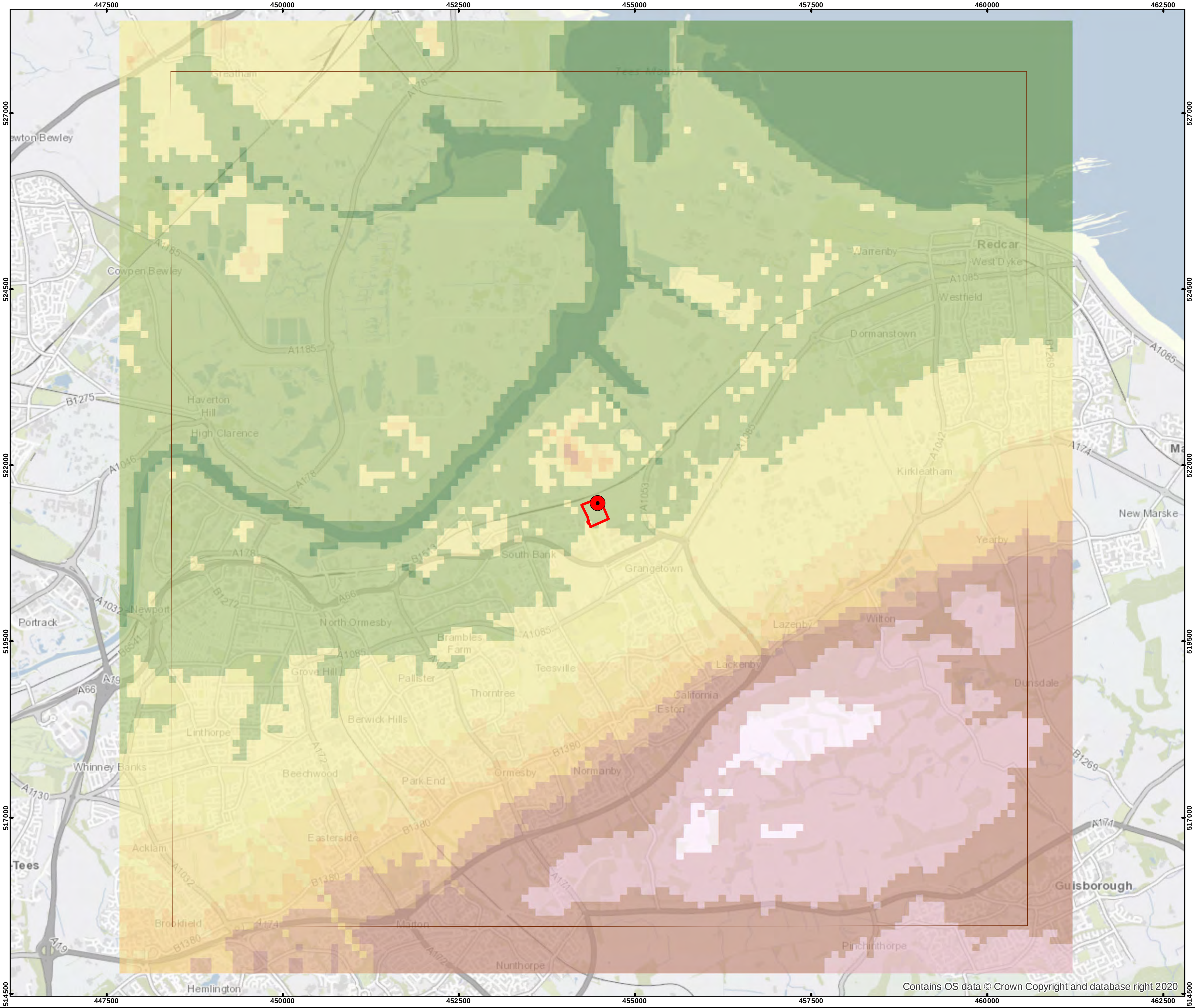
0 0.5 1 2 km

N

Scale: 1:50,000

FICHTNER
Consulting Engineers Limited

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



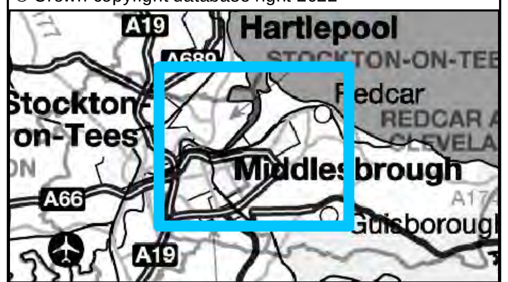
Legend

- Stack
- Area of proposed development
- Modelling domain

Terrain file

- 0 m
- 0-10 m
- 10 - 20 m
- 20 - 30 m
- 30- 40 m
- 40 - 50 m
- 50 - 100 m
- 100 - 200 m
- >200 m

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 6 - Terrain file
Drawn by: HKL	Date: 04/01/2022



0 0.5 1 2 km

N

Scale: 1:50,000

FICHTNER
Consulting Engineers Limited

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

Legend

- Area of proposed development
- Stack
- Buildings

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 7 - Buildings Modelled
Drawn by: HKL	Date: 04/01/2022

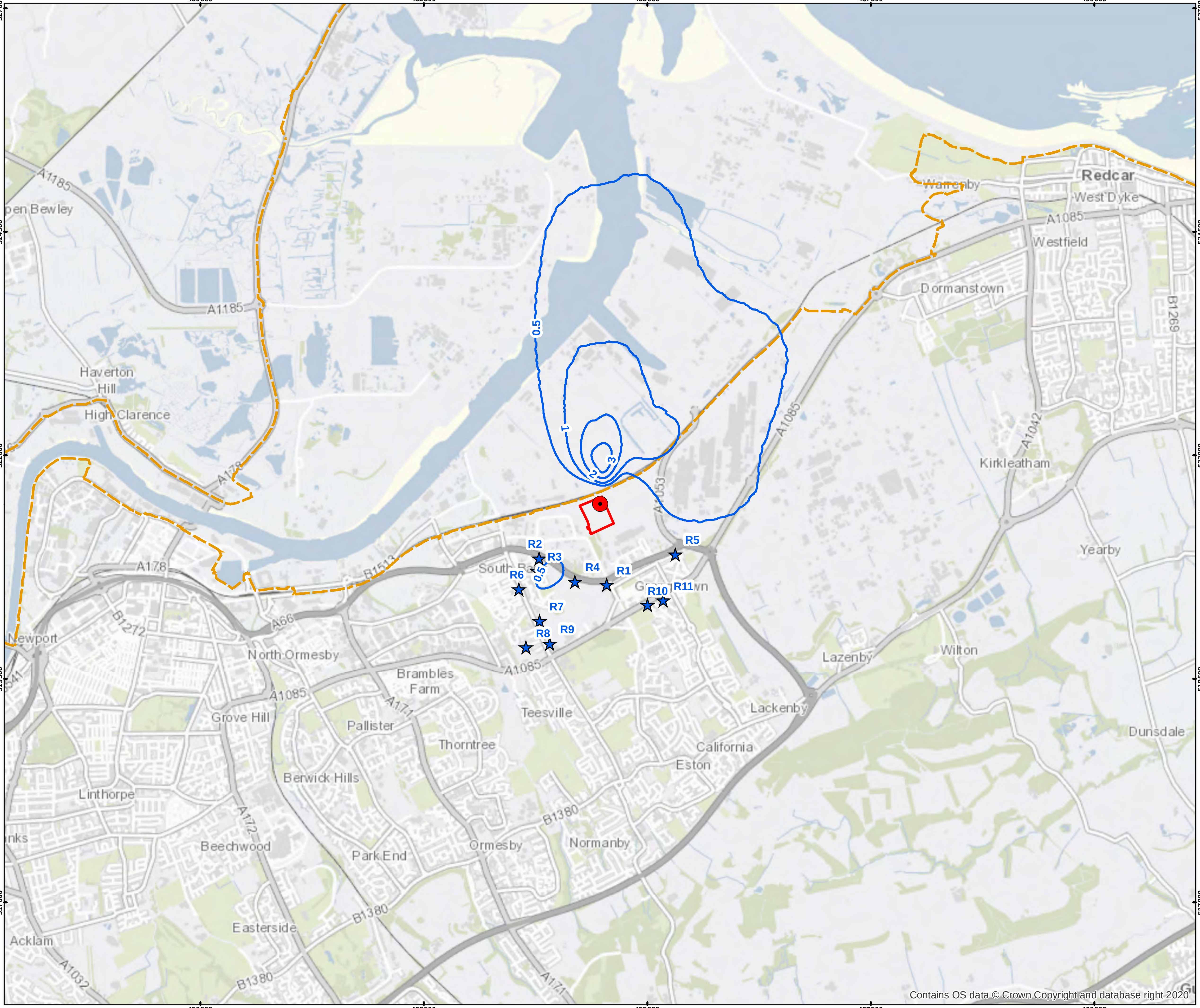
0 0.025 0.05 0.1 km

Scale: 1:2,500

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Human receptors
- England Coast Path route
- Annual mean nitrogen dioxide as % of AQAL

Note: Assumes 70% NOx to NO2 conversion

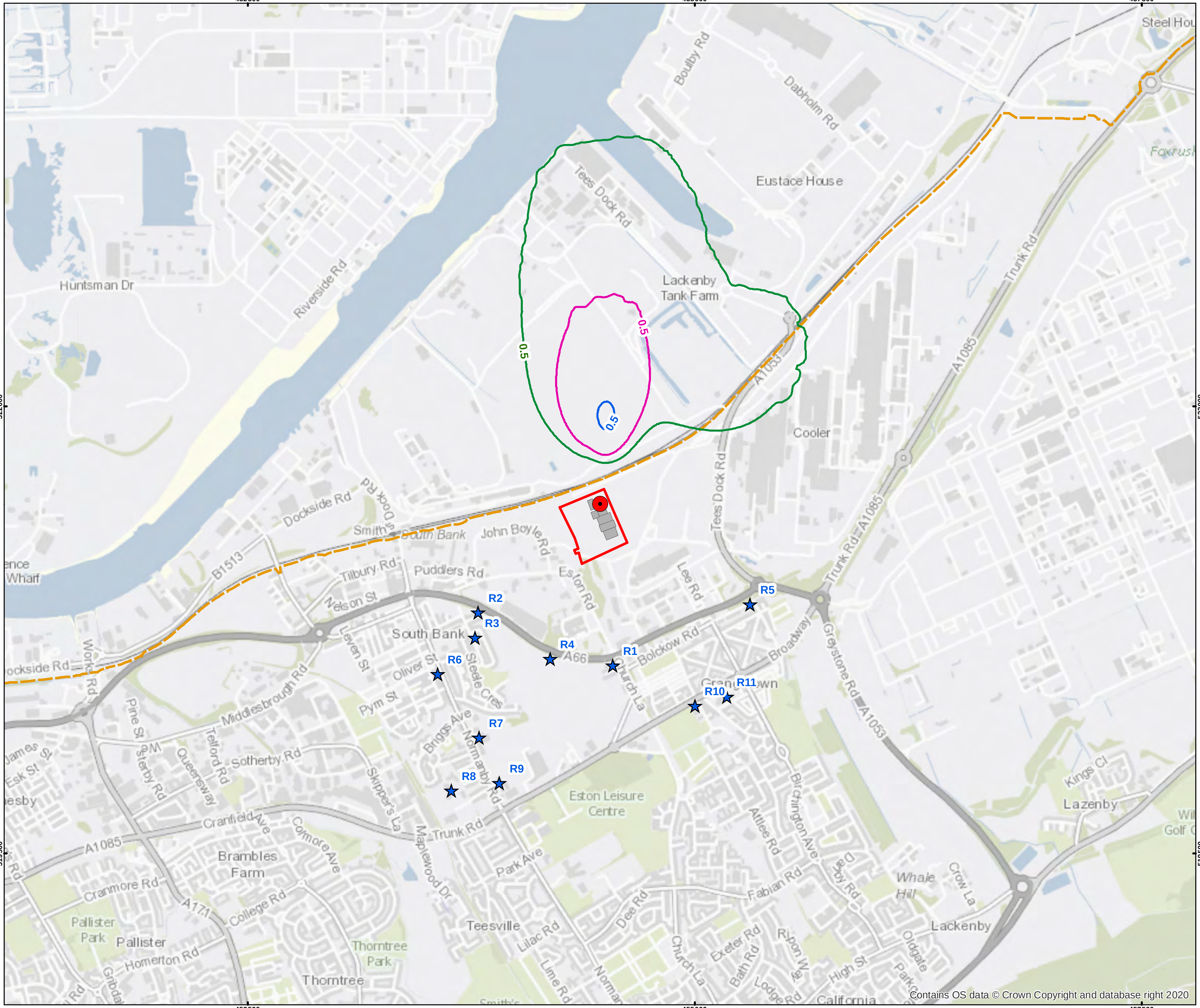
Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 8 - Annual Mean Nitrogen Dioxide

Drawn by: HKL | Date: 04/01/2022

Scale: 1:40,000 (0 0.4 0.8 1.6 km)

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- Annual mean PM2.5 as % of WHO 2021 guideline value
- Annual mean PM2.5 as % of WHO 2005 guideline value
- Annual mean PM2.5 as % of AQAL

Note: Assumes all PM emissions are PM2.5

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 9 - Annual Mean PM2.5

Drawn by: HKL	Date: 04/01/2022

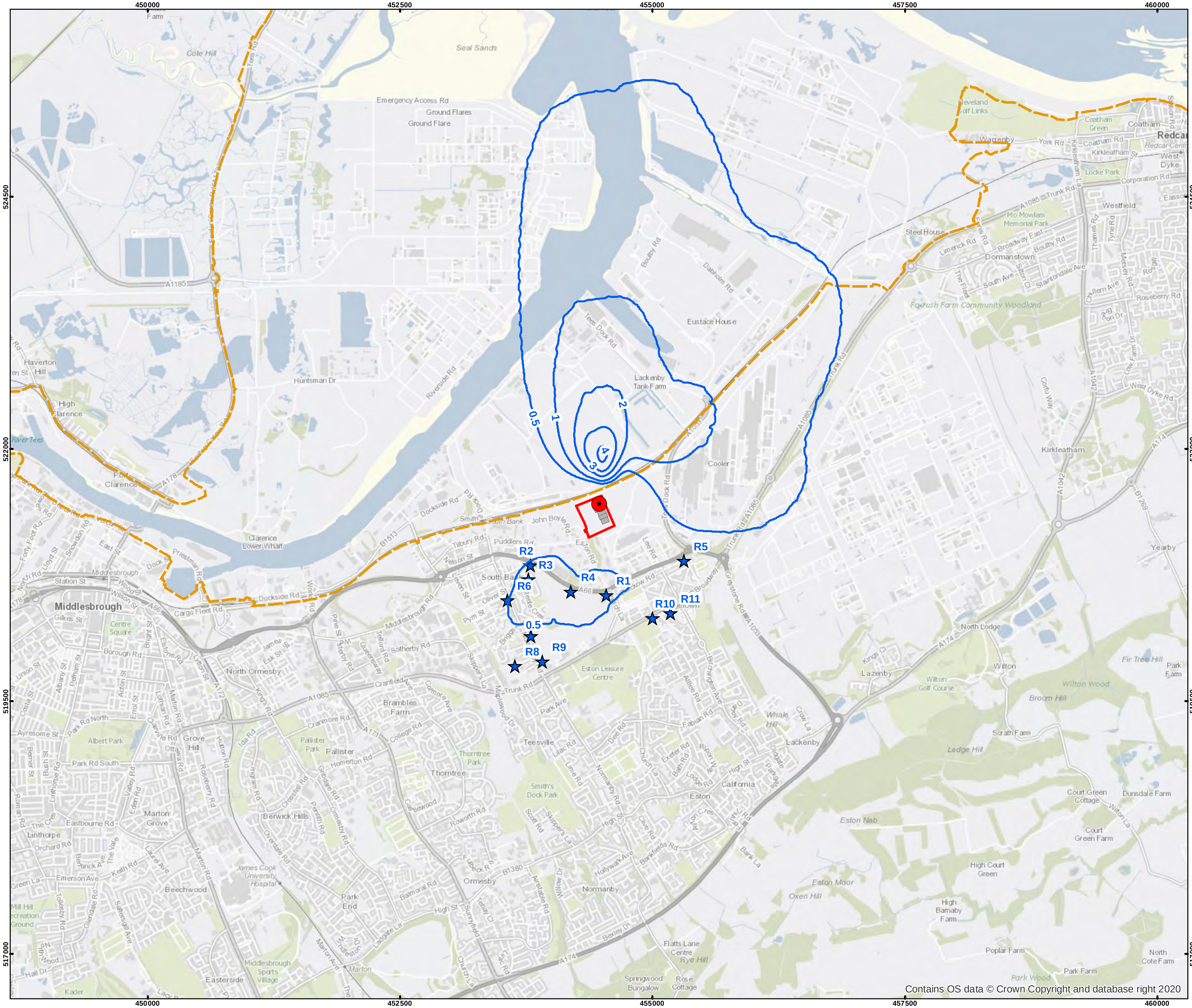
0 0.2 0.4 0.8 km

Scale: 1:20,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Stack
- Area of proposed development
- Buildings
- Human receptors
- England Coast Path route
- Annual mean benzene as % of AQAL

Note: Assumes entire VOC emissions are as benzene

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	

Figure 10 - Annual Mean VOCs (as benzene)

Drawn by: HKL	Date: 04/01/2022

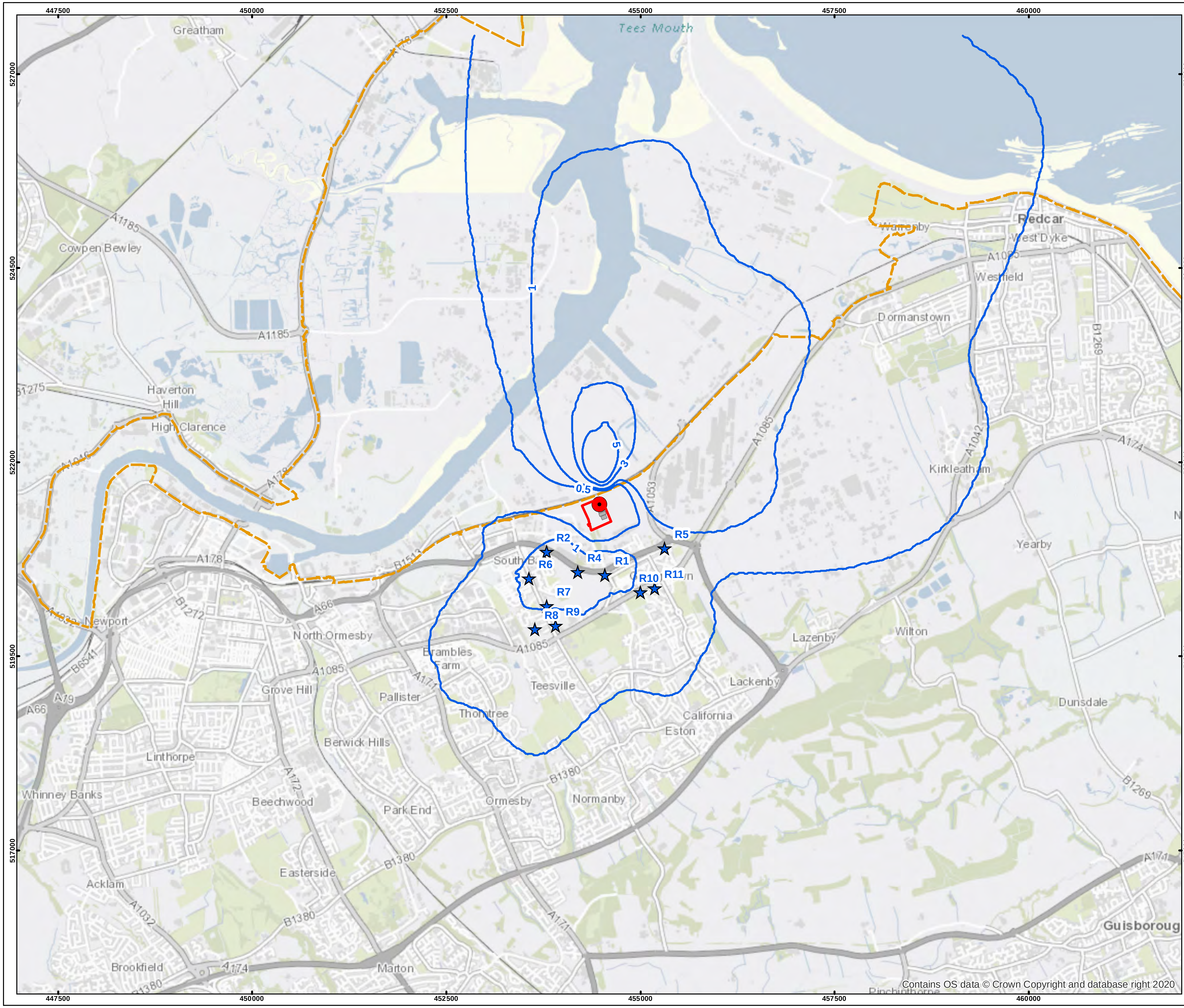
0 0.35 0.7 1.4 km

Scale: 1:35,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- Annual mean 1,3-butadiene as % of AQAL

Note: Assumes entire VOC emissions are as 1,3-butadiene

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 11 - Annual Mean VOCs (as 1,3-butadiene)

Drawn by: HKL | Date: 04/01/2022

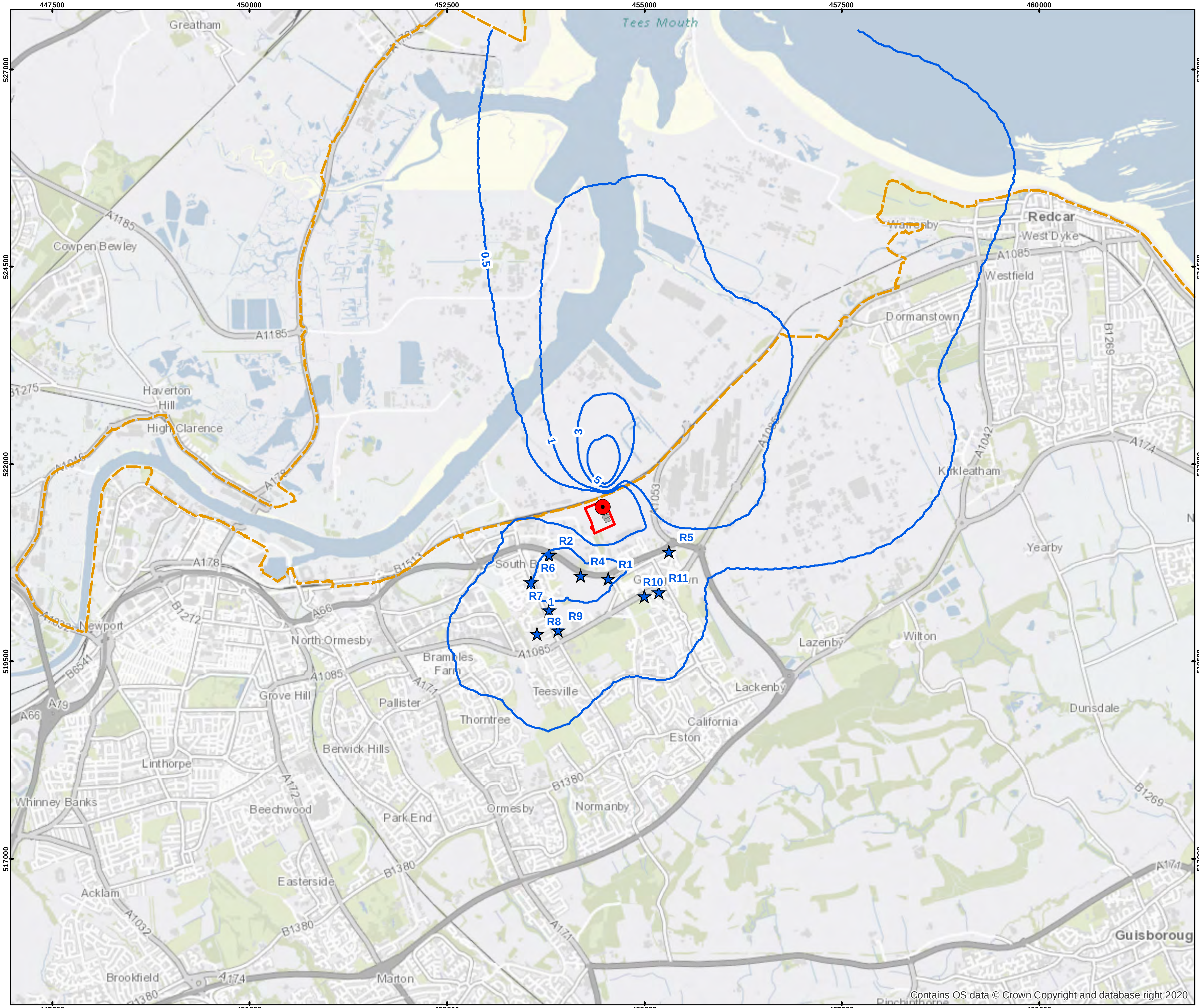
0 0.475 0.95 1.9 km

Scale: 1:45,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- Annual mean cadmium as a % of AQAL (screening)

Note: Assumes cadmium emitted at 100% of the combined cadmium and thallium emission limit

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 12 - Annual Mean Cadmium

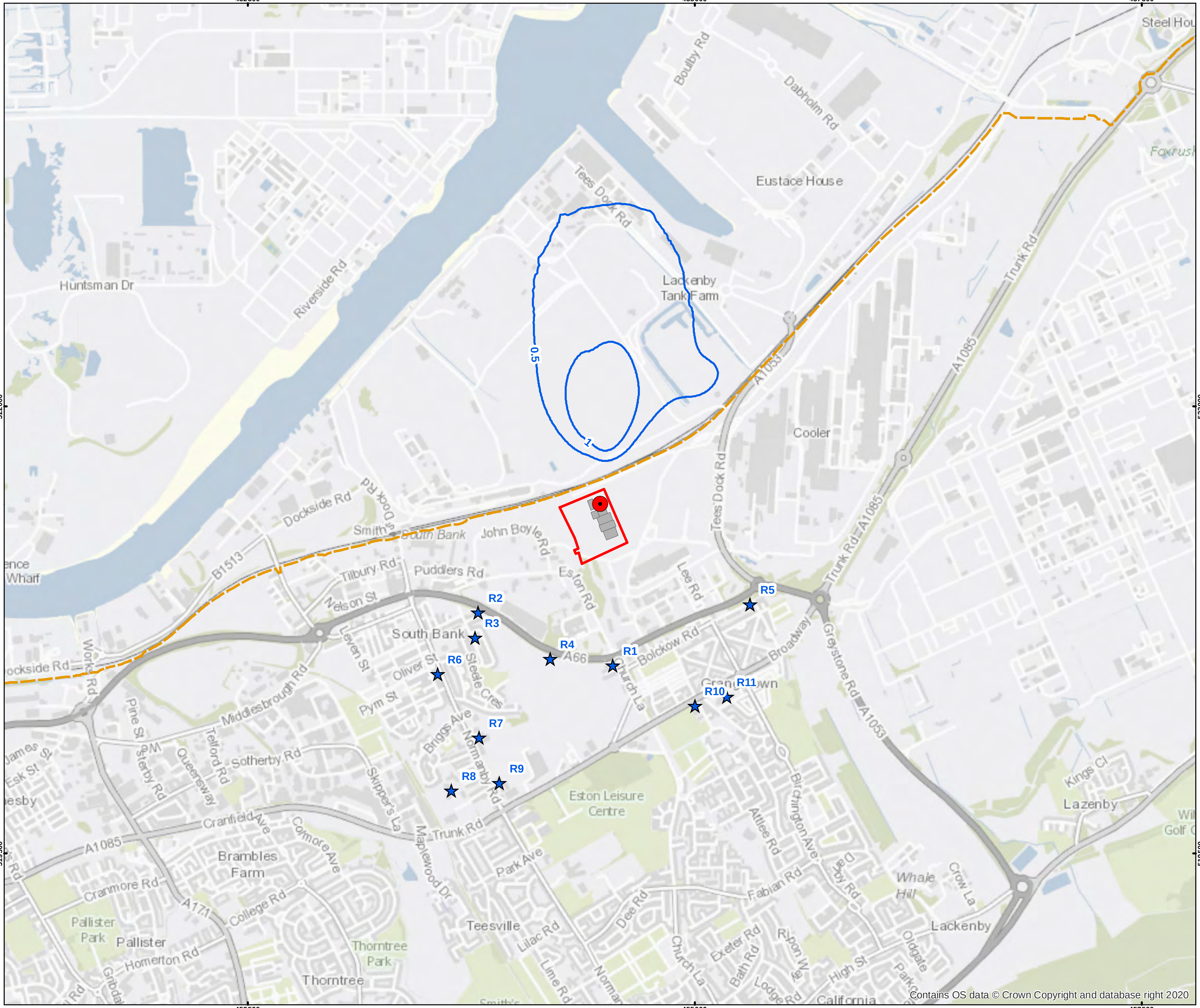
Drawn by: HKL | Date: 04/01/2022

0 0.475 0.95 1.9 km

Scale: 1:45,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- Annual Mean PAHs (as BaP) as % of AQAL

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 13 - Annual Mean PAHs

Drawn by: HKL | Date: 04/01/2022

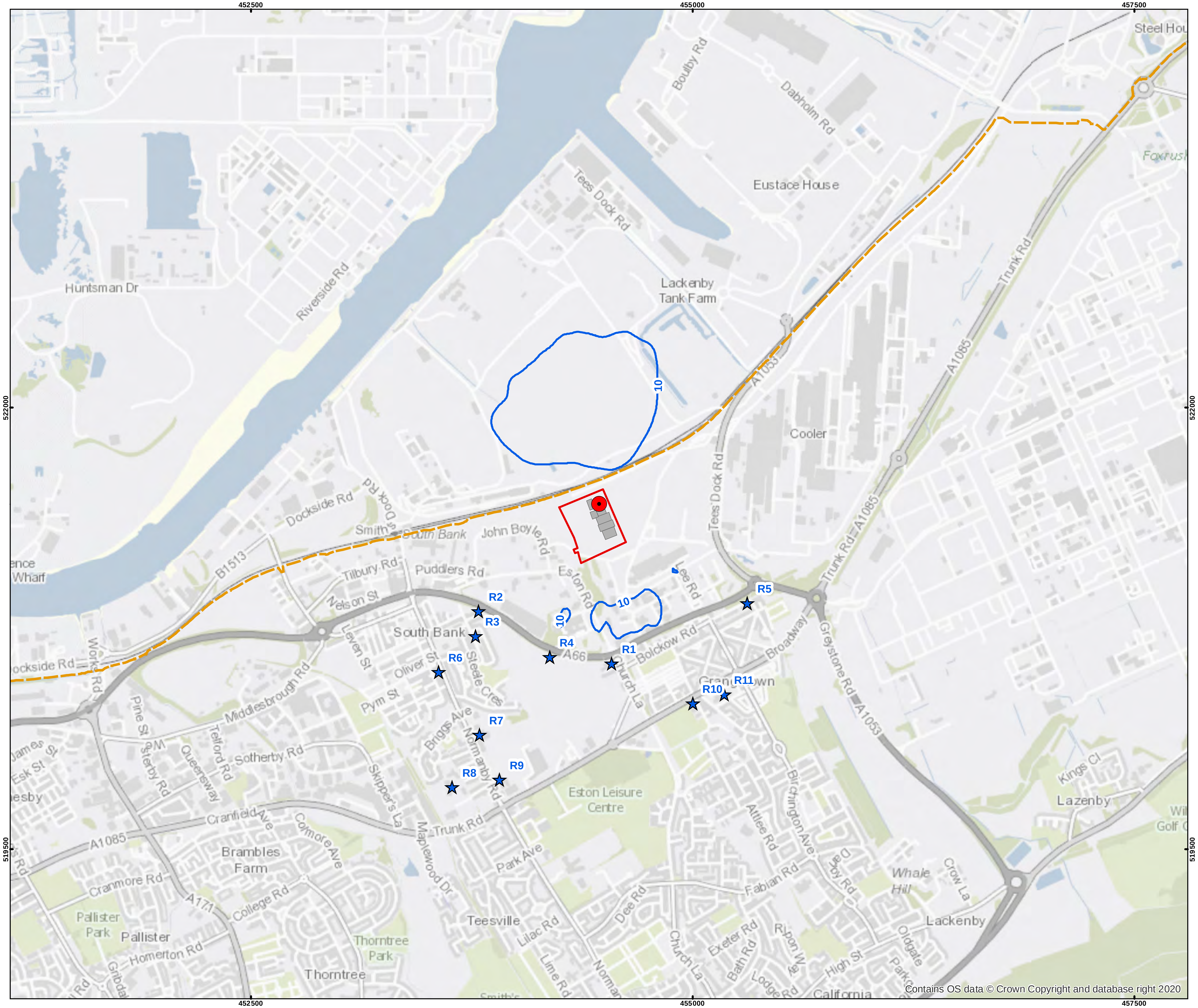
0 0.2 0.4 0.8 km

Scale: 1:20,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- 99.79%ile of hourly mean nitrogen dioxide as % of AQAL

Note: Assumes 35% conversion from NOx to NO2

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 14 - 99.79%ile of Hourly Mean Nitrogen Dioxide

Drawn by: HKL | Date: 04/01/2022

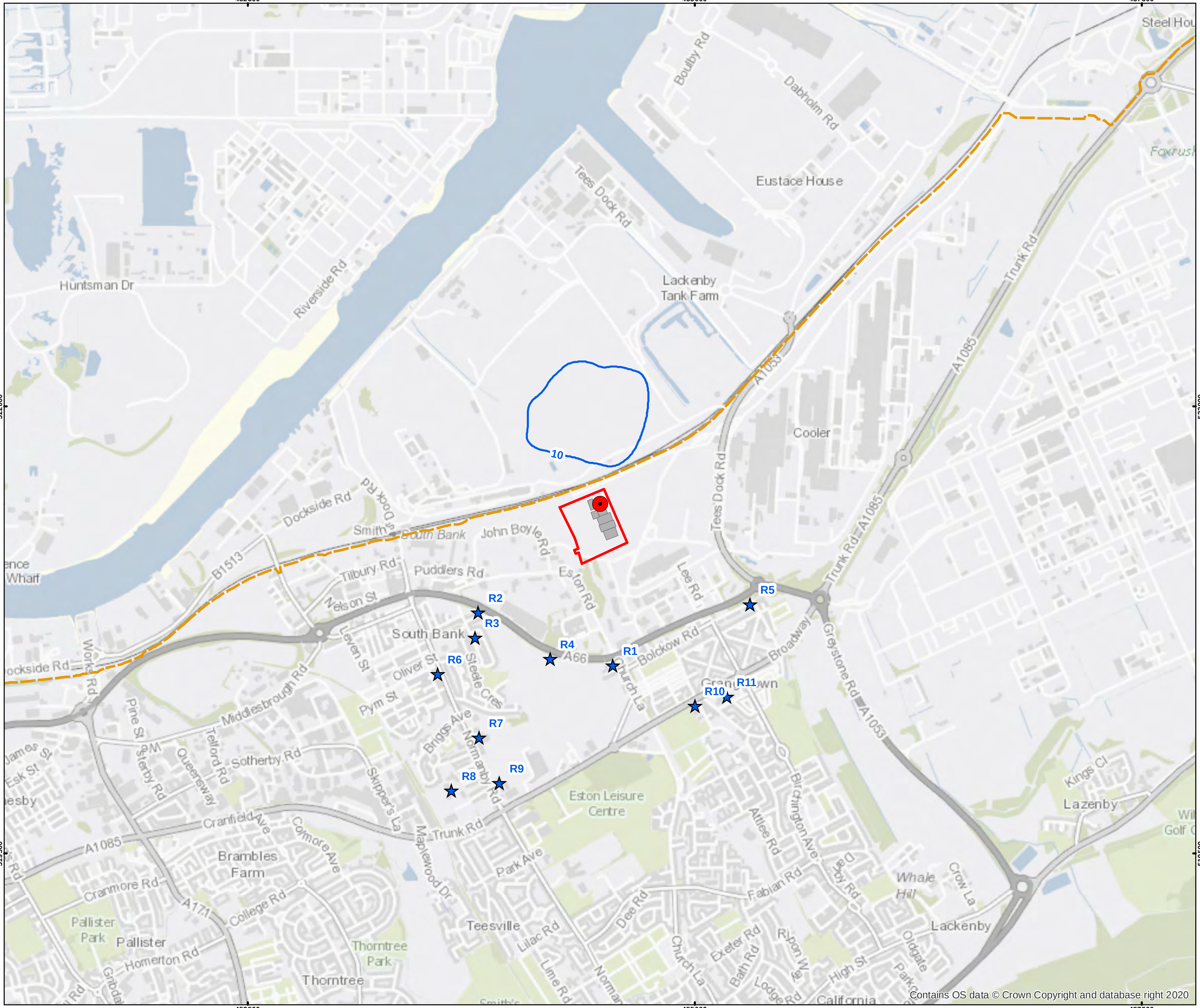
0 0.2 0.4 0.8 km

Scale: 1:20,000

N

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- 99.73%ile of hourly mean sulphur dioxide as % of AQAL

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 15 - 99.73%ile of Hourly Mean Sulphur Dioxide
Drawn by: HKL	Date: 04/01/2022

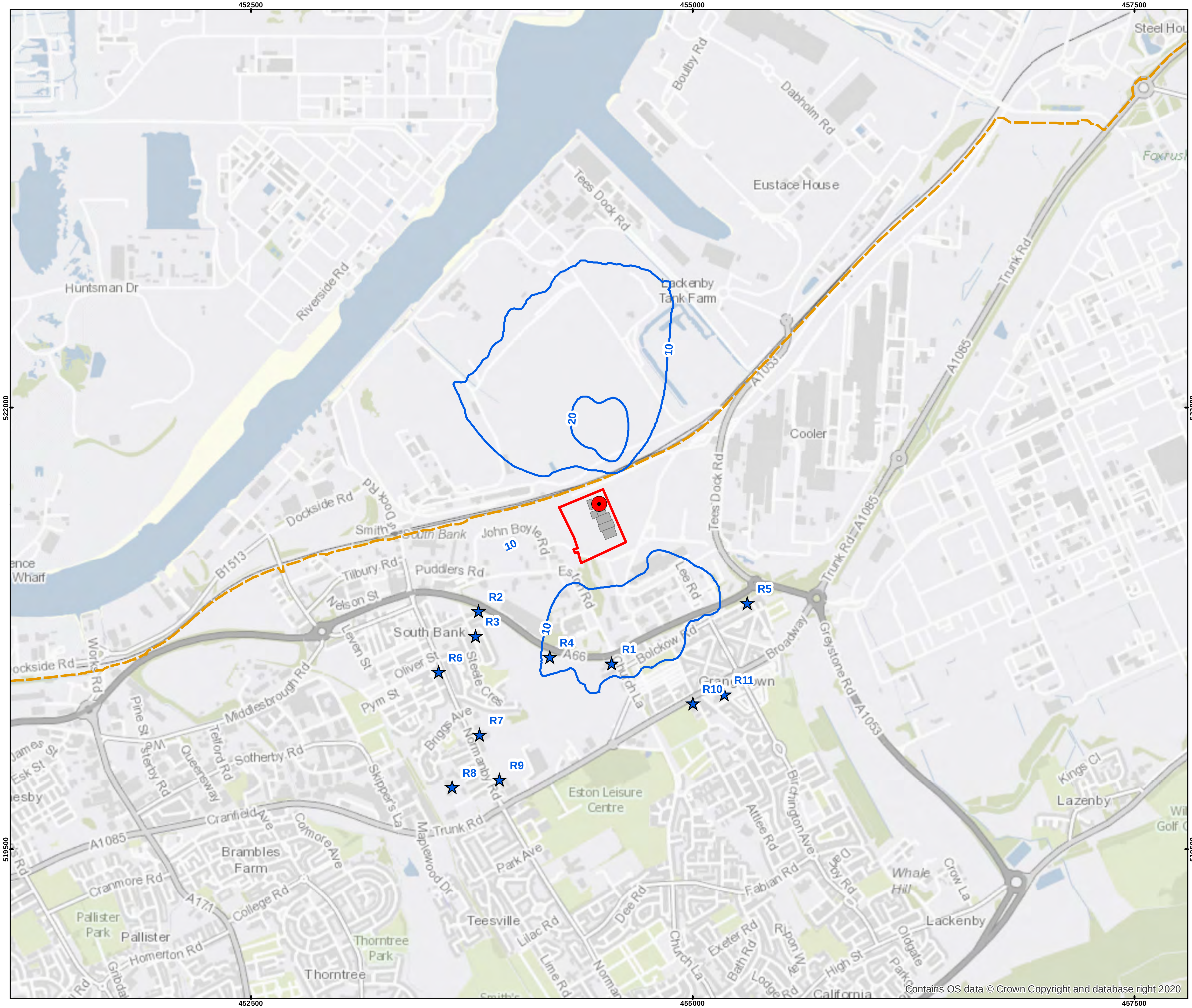
0 0.2 0.4 0.8 km

N

Scale: 1:20,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Human receptors
- England Coast Path route
- 99.9%ile of 15-min mean sulphur dioxide as % of AQAL

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 16 - 99.9%ile of 15-minute Mean Sulphur Dioxide

Drawn by: HKL | Date: 04/01/2022

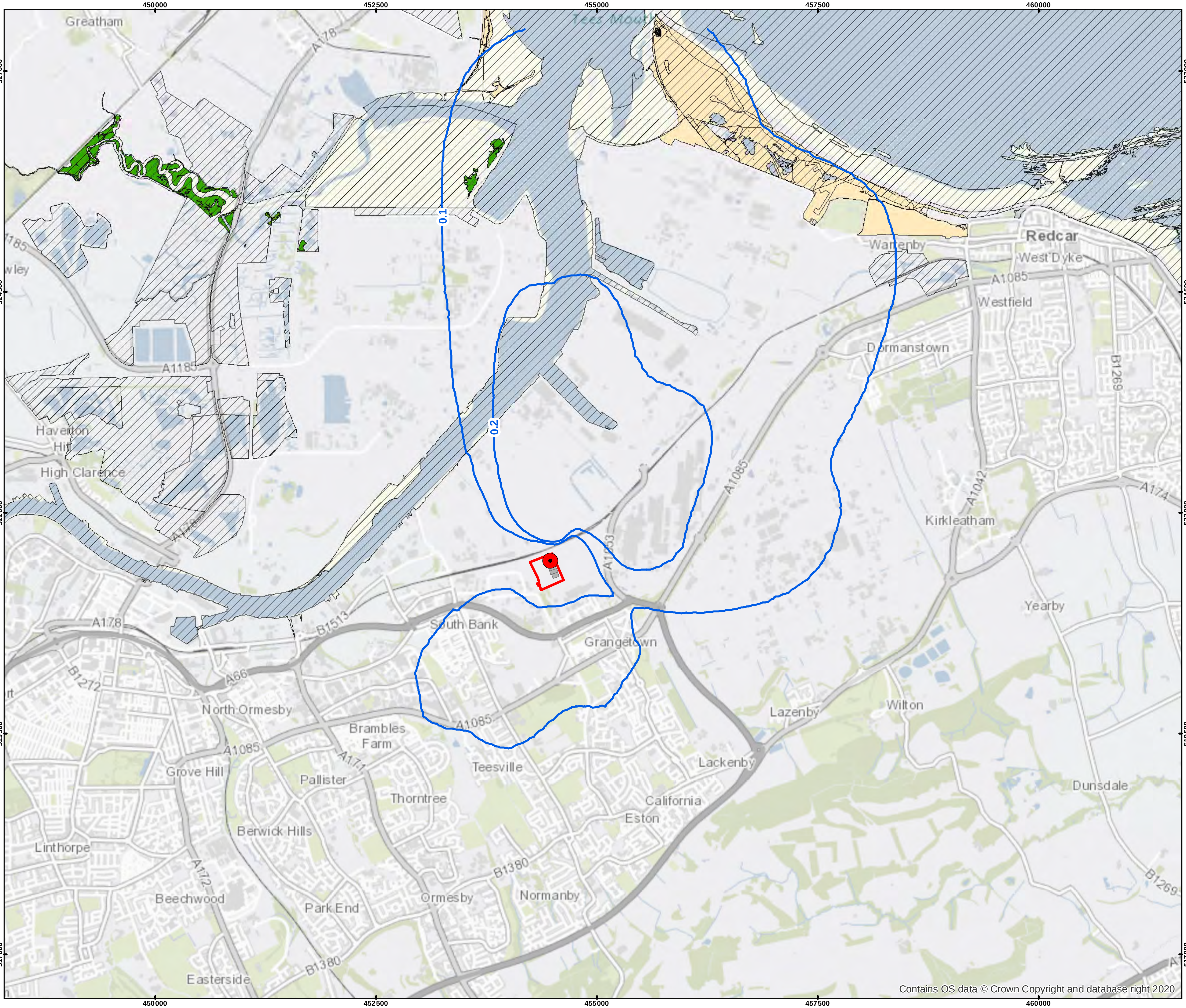
0 0.2 0.4 0.8 km

N

Scale: 1:20,000

FICHTNER
Consulting Engineers Limited

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



Legend

- Area of proposed development
- Stack
- Buildings
- Teesmouth and Cleveland Coast

Habitats

- Coastal saltmarsh
- Coastal sand dunes
- Nitrogen deposition (kgN/ha/yr)

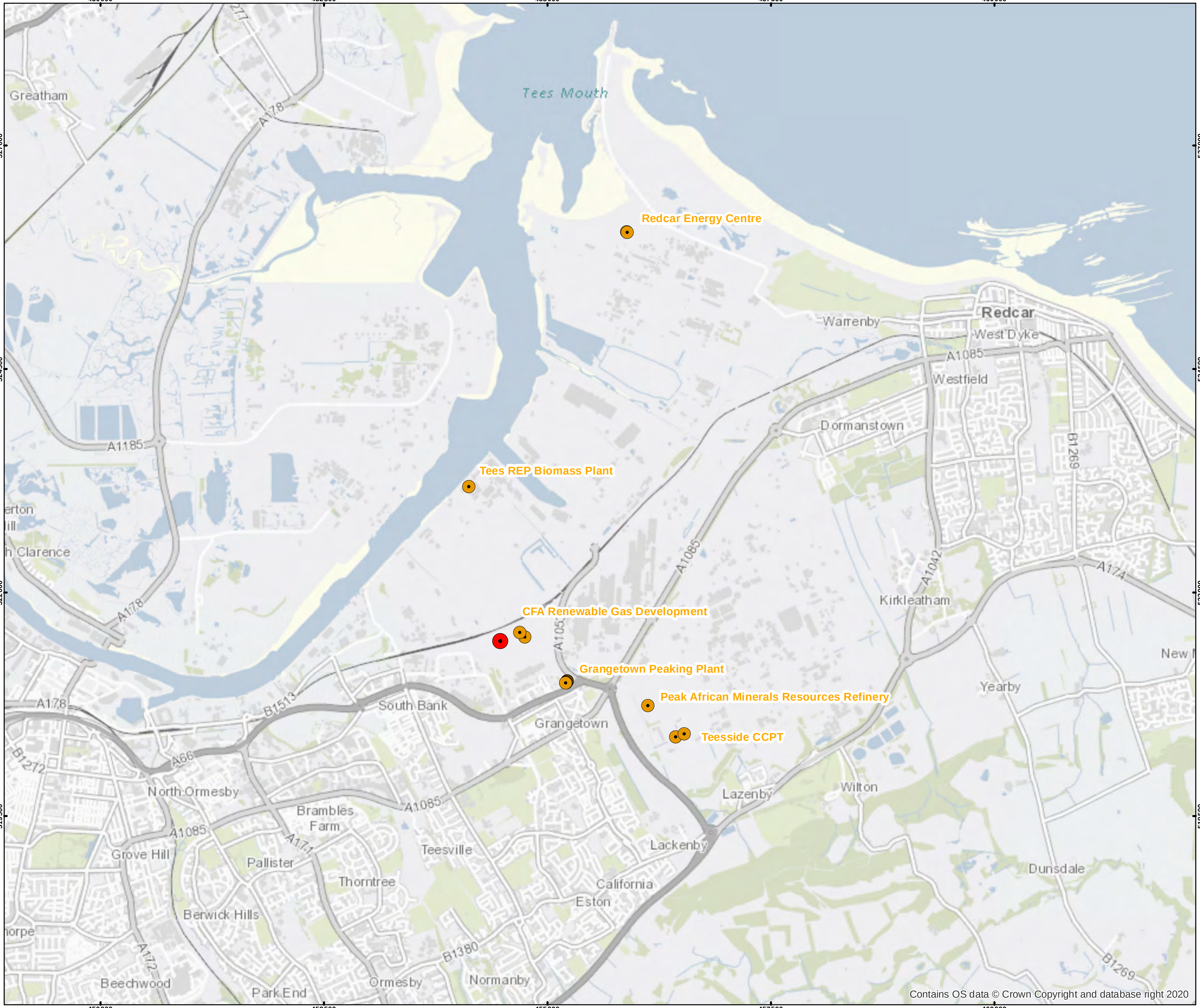
Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 17 - Nitrogen Deposition

Drawn by: HKL | Date: 04/01/2022

Scale: 1:40,000 (0 – 0.4 – 0.8 – 1.6 km)

FICHTNER
Consulting Engineers Limited

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



Legend

- CFA
- ERF Stack
- Cumulative point sources

Client:	Viridor
Site:	Tees Valley ERF
Project:	Air Quality Assessment
Title:	Figure 18 - Modelled Cumulative Sources

Drawn by: HKL | Date: 14/03/2023

0 0.4 0.8 1.6 km

Scale: 1:40,000

FICHTNER
Consulting Engineers Limited

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

B APIS Critical Loads

Table 52: 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)
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Coastal stable dune grasslands - calcareous type	10	15	16.0
	Saltmarsh	Pioneer, low-mid, mid-upper saltmarshes	20	30	16.8
	Estuaries	Estuaries (Critical Load range taken from HRA)	20	30	16.8
North York Moors SAC	European dry heath/ Northern Atlantic wet heaths with Erica tetralix	Dry heaths/ Northern wet heath: Erica tetralix dominated wet heath	10	20	20.3
Note: *(1) Background deposition rates selected for closest part of each designated site to the Proposed ERF at which each habitat is present, as determined using the Priority Habitat Inventory.*					

Table 53: 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
European and UK Statutory Designated Sites							
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	No species sensitive to effects of acid deposition	N/A	-	-	-	-	-
North York Moors SAC	European dry heath/ Northern Atlantic wet heaths with Erica tetralix	Dwarf shrub heath	1.25	4.962	4.07	1.45	0.16

C Deposition Analysis at Ecological Sites

Table 54: Annual Mean ERF PC used for Deposition Analysis – Point of Maximum Impact of ERF

Site	Habitat	Annual Mean PC (ng/m^3)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	136.8	58.6	11.7	19.5
	Saltmarsh	147.9	63.4	12.7	21.1
	Estuaries(1)	388.2	166.4	33.3	55.5
North York Moors SAC	European dry heath/wet heath	29.0	12.4	2.5	4.1
Note: (1) Estuarine habitat types assumed to be present across the entire Teesmouth and Cleveland Coast SSSI/SPA/Ramsar as a conservative measure. Therefore, the PC presented is for the point of maximum impact of the Proposed ERF within the designated site.					

Table 55: Annual Mean PC used for Nitrogen Deposition Analysis – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 1

Site	Habitat	Annual Mean PC (ng/m^3)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	856.2	471.5	95.9	27.4
	Saltmarsh	805.4	495.8	101.2	30.2
	Estuaries(1)	1670.3	1220.3	235.7	73.9
North York Moors SAC	European dry heath/wet heath	217.6	102.8	20.0	7.9

Table 56: Annual Mean PC used for Nitrogen Deposition Analysis – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 2

Site	Habitat	Annual Mean PC (ng/m^3)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	945.7	503.2	102.1	38.2
	Saltmarsh	880.2	522.4	106.4	39.2
	Estuaries(1)	1951.1	1320.0	255.1	107.5
North York Moors SAC	European dry heath/wet heath	232.8	108.2	21.0	9.7

Table 57: Annual Mean PC used for Nitrogen Deposition Analysis – ERF PC at Point of Maximum In-Combination Impact

Site	Habitat	Annual Mean PC (ng/m^3)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	114.8	49.2	9.8	16.4
	Saltmarsh	143.5	61.5	12.3	20.5
	Estuaries(1)	114.8	49.2	9.8	16.4
North York Moors SAC	European dry heath/wet heath	29.0	12.4	2.5	4.1

Note:
(1) Estuarine habitat type is assumed to be present across the entire Teesmouth and Cleveland Coast SSSI/SPA/Ramsar as a conservative measure. Therefore, the PC presented is for the point of maximum in-combination impact within the designated site. Since the point of maximum in-combination impact occurs over land where the priority habitat is 'coastal sand dunes', the PC presented is identical for both habitat types.

Table 58: Annual Mean PC for Nitrogen Deposition Analysis – Total In-Combination PC at Point of Max In-Combination Impact – Cumulative Scenario 1

Site	Habitat	Annual Mean PC (ng/m³)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	2505.1	1059.3	212.8	224.7
	Saltmarsh	737.7	494.0	100.8	29.6
	Estuaries[(1)]	2505.1	1267.3	278.9	224.7
North York Moors SAC	European dry heath/wet heath	217.6	102.8	20.0	7.9

Table 59: Annual Mean PC for Nitrogen Deposition Analysis – Total In-Combination PC at Point of Max In-Combination Impact – Cumulative Scenario 2

Site	Habitat	Annual Mean PC (ng/m³)			
		Nitrogen Dioxide	Sulphur Dioxide	Hydrogen Chloride	Ammonia
European and UK Statutory Designated Sites					
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	2590.4	1089.6	218.7	234.9
	Saltmarsh	812.5	520.5	106.0	38.6
	Estuaries[(1)]	2590.4	1367.5	298.4	234.9
North York Moors SAC	European dry heath/wet heath	232.8	108.2	21.0	9.7

Table 60: Deposition Calculation – ERF

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	19.70	110.98	89.92	101.53	121.23	8.66	12.00
	Saltmarsh	Grassland	30.42	119.94	97.18	109.73	140.15	10.01	12.97
	Estuaries	Grassland	55.89	314.83	255.12	288.03	343.93	24.57	34.05
North York Moors SAC	European dry heath/wet heath	Grassland	4.17	23.50	19.05	21.50	25.68	1.83	2.54

Table 61: Deposition Calculation – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 1

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	123.30	892.25	735.19	142.50	265.80	18.99	97.18
	Saltmarsh	Grassland	115.97	938.33	775.85	156.90	272.88	19.49	102.36
	Estuaries	Grassland	240.52	2309.35	1807.16	383.62	624.14	44.58	246.15
North York Moors SAC	European dry heath/wet heath	Grassland	31.33	194.49	153.11	40.94	72.27	5.16	20.78

Table 62: Deposition Calculation – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 2

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	136.18	952.33	782.61	198.19	334.37	23.88	103.61
	Saltmarsh	Grassland	126.75	988.60	815.52	203.49	330.24	23.59	107.73
	Estuaries	Grassland	280.96	2497.93	1956.00	558.39	839.35	59.95	266.32
North York Moors SAC	European dry heath/wet heath	Grassland	33.53	204.73	161.19	50.43	83.96	6.00	21.88

Table 63: Deposition Calculation – ERF PC at Point of Maximum In-Combination Impact

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	16.53	93.11	74.68	85.18	101.71	7.27	10.03
	Saltmarsh	Grassland	20.67	116.42	74.59	106.51	127.18	9.08	11.48
	Estuaries	Grassland	16.53	93.11	74.68	85.18	101.71	7.27	10.03
North York Moors SAC	European dry heath/wet heath	Grassland	4.17	23.50	19.04	21.50	25.68	1.83	2.54

Table 64: Deposition Calculation – Total In-Combination PC at Point of Maximum In-Combination Impact - Cumulative Scenario 1

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	360.73	2004.58	1631.63	1167.19	1527.92	109.14	217.21
	Saltmarsh	Grassland	106.22	934.81	773.01	153.69	259.92	18.57	101.98
	Estuaries	Grassland	360.73	2398.14	2138.54	1167.19	1527.92	109.14	270.37
North York Moors SAC	European dry heath/wet heath	Grassland	31.33	194.49	153.11	40.94	72.27	5.16	20.78

Table 65: Deposition Calculation – Total In-Combination PC at Point of Maximum In-Combination Impact - Cumulative Scenario 2

Site	Habitat	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
European and UK Statutory Designated Sites									
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	373.02	2061.87	1676.85	1220.29	1593.30	113.81	223.34
	Saltmarsh	Grassland	117.00	985.08	812.69	200.28	317.28	22.66	107.35
	Estuaries	Grassland	373.02	2587.78	2288.22	1220.29	1593.30	113.81	290.65
North York Moors SAC	European dry heath/wet heath	Grassland	33.53	204.73	161.19	50.43	83.96	6.00	21.88

Table 66: Detailed Results – Nitrogen Deposition – ERF

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	0.11	**1.21%**	0.81%	16.11	161.1%	107.4%
	Saltmarsh	Grassland	0.13	0.66%	0.44%	16.93	84.7%	56.4%
	Estuaries	Grassland	0.34	**1.72%**	**1.15%**	17.14	85.7%	57.1%
North York Moors SAC	European dry heath/wet heath	Grassland	0.03	0.26%	0.13%	20.33	203.3%	101.7%

Table 67: Detailed Results – Nitrogen Deposition – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 1

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	0.27	**2.66%**	**1.77%**	16.27	162.7%	108.4%
	Saltmarsh	Grassland	0.27	**1.36%**	0.91%	17.07	85.4%	56.9%
	Estuaries	Grassland	0.62	**3.12%**	**2.08%**	17.42	87.1%	58.1%
North York Moors SAC	European dry heath/wet heath	Grassland	0.07	0.72%	0.36%	20.37	203.7%	101.9%

Table 68: Detailed Results – Nitrogen Deposition – Total In-Combination PC at Point of Maximum Impact of ERF – Cumulative Scenario 2

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	0.33	**3.34%**	**2.23%**	16.33	163.3%	108.9%
	Saltmarsh	Grassland	0.33	**1.65%**	**1.10%**	17.13	85.7%	57.1%
	Estuaries	Grassland	0.84	**4.20%**	**2.80%**	17.64	88.2%	58.8%
North York Moors SAC	European dry heath/wet heath	Grassland	0.08	0.84%	0.42%	20.38	203.8%	101.9%

Table 69: Detailed Results – Nitrogen Deposition – ERF PC at Point of Maximum In-Combination Impact

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	0.10	**1.02%**	0.68%	16.10	161.0%	107.3%
	Saltmarsh	Grassland	0.13	0.64%	0.42%	16.93	84.7%	56.4%
	Estuaries	Grassland	0.10	0.51%	0.34%	16.90	84.5%	56.3%
Note: *The impact at the North York Moors SAC has been assessed at a single receptor point, so the PCs are the same as presented in* Table 66.								

Table 70: Detailed Results – Nitrogen Deposition – Total In-Combination PC at Point of Maximum In-Combination Impact – Cumulative Scenario 1

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	1.53	**15.28%**	**10.19%**	17.53	175.3%	116.9%
	Saltmarsh	Grassland	0.26	**1.30%**	0.87%	17.06	85.3%	56.9%
	Estuaries	Grassland	1.53	**7.64%**	**5.09%**	18.33	91.6%	61.1%

Note:

The impact at the North York Moors SAC has been assessed at a single receptor point, so the PCs are the same as presented in Table 67.

Table 71: Detailed Results – Nitrogen Deposition – Total In-Combination PC at Point of Maximum In-Combination Impact – Cumulative Scenario 2

Site	NCL Class	Deposition Velocity	PC			PEC		
			PC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL	PEC N dep (kgN/ha/yr)	% of Lower CL	% of Upper CL
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	Coastal sand dunes	Grassland	1.59	**15.93%**	**10.62%**	17.59	175.9%	117.3%
	Saltmarsh	Grassland	0.32	**1.59%**	**1.06%**	17.12	85.6%	57.1%
	Estuaries	Grassland	1.59	**7.97%**	**5.31%**	18.39	92.0%	61.3%

Note:

The impact at the North York Moors SAC has been assessed at a single receptor point, so the PCs are the same as presented in Table 68*.*

Table 72: Detailed Results – Acid Deposition – ERF

Site	Acidity Class	Deposition Velocity	PC			PEC		
			N (keq/ha/yr x 1000)	S (keq/ha/yr x 1000	% of CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	No species sensitive to effects of acid deposition	N/A	-	-	-	-	-	-
North York Moors SAC	Dwarf shrub heath	Grassland	1.83	2.54	0.09%	1.45	0.16	32.53%

Table 73: Detailed Results – Acid Deposition – Total In-Combination PC – Cumulative Scenario 1

Site	Acidity Class	Deposition Velocity	PC			PEC		
			N (keq/ha/yr x 1000)	S (keq/ha/yr x 1000	% of CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	No species sensitive to effects of acid deposition	N/A	-	-	-	-	-	-
North York Moors SAC	Dwarf shrub heath	Grassland	5.16	20.78	0.52%	1.46	0.18	32.97%

Table 74: Detailed Results – Acid Deposition – Total In-Combination PC – Cumulative Scenario 2

Site	Acidity Class	Deposition Velocity	PC			PEC		
			N (keq/ha/yr x 1000)	S (keq/ha/yr x 1000	% of CL Function	N (keq/ha/yr)	S (keq/ha/yr)	% of CL Function
European and UK Statutory Designated Sites								
Teesmouth and Cleveland Coast SSSI/SPA/Ramsar	No species sensitive to effects of acid deposition	N/A	-	-	-	-	-	-
North York Moors SAC	Dwarf shrub heath	Grassland	6.00	21.88	0.56%	1.46	0.18	33.01%

D Model Inputs – Cumulative Point Sources

Table 75: Cumulative Schemes Stack Source Data

Item	Unit	TeesREP	Teesside CCPP	Grangetown Peaking Plant	Peak African Minerals Refinery	Redcar Energy Centre	Circular Fuels Arboretum Renewable Gas Plant	
							Char combustor	Dryer
Stack Height	m	95	75	12	18	80	37	35
Internal diameter(1)	m	4.6	8.0 (x 2)	0.5 (x 6)	0.75	2.3 (x 2)	1.71	2.54
Stack location(s)	m, m	454124, 523184	456439, 520384 456530, 520420	See note below table	456128, 520732	455890, 526032 455895, 526030(2)	454747, 521500	454691, 521553
Temperature	°C	154	72.4	400	60	140	141.2	40
Volume at reference conditions(1)	Nm^3/s	250	744	2.0	-	55.4	25.7	75.0
Volume at actual conditions(1)	Am^3/s	386	928	5.5	3.4	79.1	39.2	86.0
Flue gas exit velocity	m/s	23.50	18.50	27.90	7.68	19.06	17.10	17.00

Note:
(1) For each flue, if more than one is present.
(2) The Redcar Energy Centre stacks are close enough together to be modelled as a single source. The 'combine multiple flues' option has been used in the model.

The Grangetown Peaking Plant stacks are located at:

1. 455222.97, 521009.84
2. 521009.84, 521004.69
3. 455216.77, 520999.75
4. 455214.13, 520993.63
5. 455210.77, 520988.69
6. 455208.15, 520984.82

Table 76: Cumulative Schemes Emission Rates

Pollutant	Unit	TeesREP	Teesside CCPP (Each Flue, x 2)	Grangetown Peaking Plant (Each Flue, x 6)	Peak African Minerals Refinery	Redcar Energy Centre (Each Flue, x 2)	Circular Fuels Arboretum Renewable Gas Plant[(2)]	
							Char combustor	Dryer
Oxides of nitrogen	g/s	37.4	22.3	0.11[(1)]	-	6.65	3.10	-
VOCs	g/s	-	-	-	-	0.55	0.26	2.30
Cadmium	mg/s	-	-	-	-	1.11	0.51	-
Sulphur dioxide	g/s	26.4	-	-	1.38	1.66	0.77	-
Hydrogen chloride	g/s	6.5	-	-	-	0.33	0.15	-
Ammonia	g/s	-	-	-	-	0.55	0.26	-

Note:

(1) Assuming the Grangetown Peaking Plant operates for 2,000 hours per year, as per the planning application

(2) The application documents provide emissions for a third point source, the amine unit. The only pollutant of interest from this source for the cumulative assessment is ammonia, which is released at 0.02 g/s. This is around 2% of the release rate for ammonia from the Proposed ERF. As such, ammonia emissions from this source are negligible.

Table 77: Cumulative Schemes Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
TeesREP boiler house	454223.7	523146.2	71.0	82.0	61.0	45.0
TeesREP turbine hall	454271.1	523101.9	32.0	42.0	71.0	45.0
TeesREP fuel silo 1	454312.7	523211.6	65.0	Circular (40 m diameter)		
TeesREP fuel silo 2	454381.3	523202.6	65.0	Circular (40 m diameter)		
TeesREP fuel silo 3	454297.2	523281.9	65.0	Circular (40 m diameter)		
TeesCCPP HRSG west	456444.5	520370.0	45.0	30.0	26.0	68.0
TeesCCPP HRSG east	456535.7	520405.0	45.0	30.0	26.0	68.0
TeesCCPP turbine west	456472.7	520308.7	31.0	64.0	30.0	68.0
TeesCCPP turbine east	456564.0	520346.2	31.0	64.0	30.0	68.0
Grangetown peaking 1	455220.0	521012.0	5.5	3.3	10.5	127.0
Grangetown peaking 2	455217.0	521007.0	5.5	3.3	10.5	127.0
Grangetown peaking 3	455214.0	521002.0	5.5	3.3	10.5	127.0
Grangetown peaking 4	455211.0	520996.0	5.5	3.3	10.5	127.0
Grangetown peaking 5	455208.0	520991.0	5.5	3.3	10.5	127.0
Grangetown peaking 6	455205.0	520987.0	5.5	3.3	10.5	127.0
Refinery Concentrate	456109.8	520743.0	8.0	20.0	77.0	335.0
PMAC REC boiler	455863.0	525961.0	49.0	63.0	25.0	20.0
PMAC REC Bunker 1	455851.0	525933.0	38.0	77.0	37.0	20.0
PMAC REC Bunker 2	455872.0	525980.0	38.0	47.0	15.0	20.0
CFA main bld	454666.0	521533.0	26.5	65.0	24.0	156
CFA Fuel Rec 1	454733.0	521587.0	20.1	44.0	113.0	156
CFA Fuel Rec 2	454786.0	521551.0	20.1	64.0	46.0	156
CFA centre bld	454750.0	521476.0	20.1	57.0	50.0	156

The cumulative model has been run over a large grid to include all cumulative schemes, and with output points representing all receptor locations detailed in section 3. The grid parameters are presented in Table 78.

Table 78: Modelling Domain for Cumulative Model

Grid Quantity	Value
Grid spacing (m)	80
Grid points	151
Grid Start X (m)	449500
Grid Finish X (m)	461500
Grid Start Y (m)	517000
Grid Finish Y (m)	529000

The cumulative model has been run without the spatially varying terrain and surface roughness files to keep model run times to a minimum. The surface roughness has been set to 0.5 m. The sensitivity analysis results in Table 24 show that a constant surface roughness length of 0.5 m results in similar impacts to the variable surface roughness length file at the point of maximum impact and the maximum impacted receptor for the Proposed ERF. Therefore, a constant surface roughness length of 0.5 m is considered appropriate for the cumulative model.

Regarding terrain effects, the sensitivity analysis results in Table 26 show that, away from the point of maximum impact, terrain effects have a negligible effect on annual mean concentrations. Therefore, it also considered appropriate to model the cumulative scenario without terrain effects.

ENGINEERING + CONSULTING

FICHTNER
Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk