DETAILED AIR QUALITY ASSESSMENT FOR THE DRY ANAEROBIC DIGESTION FACILITY AT MELTON ENERGY TECH

MELTON ENERGY TECH LIMITED
GIBSON LANE, MELTON

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Executive Summary

Environmental Visage Limtied was commissioned by Melton Energy Tech Limited (MET) to prepare a dispersion modelling and air quality assessment that considered emissions from their proposed dry anaerobic digestion facility (dry AD Facility) to be installed on a site within the Melton Waste Park, off Gibson Lane in Melton.

The modelling was undertaken using ADMS Version 6, and applied hourly average meteorological data from the Leconfield measurement station for the years 2018 to 2022. Results presented include the maximum process contributions across a 4 km x 4 km receptor grid with 20-metre grid spacing, as well as those at nearby specified receptor locations.

The model predicted that process contributions for all modelled pollutants would be well below the objective limits defined within the UK Air Quality Standards Regulations, or relevant environmental assessment levels recommended by the Environment Agency, with all impacts from the MET Facility either screening as insignificant or being deemed to be not significant at the secondary assessment stage.

Impacts at the modelled human health receptors almost consistently screened as insignificant, with the four pollutant and averaging periods that could not immediately be screened, being confirmed as not significant at the secondary assessment stage. Contributions of Nitrogen Dioxide at local air quality monitoring sites all immediately screened as insignificant.

At key local ecological receptors, the majority of contributions were deemed to be insignificant, or were confirmed as not significant where not initially screened. Consideration of nutrient Nitrogen deposition at the Humber Estuary assumed a salt marsh sensitivity associated with some areas of the SSSI. Process contributions remain small although were not insignificant and, with a high existing background level that already exceeds the lower critical load and equates to more the 90 % of the higher critical load, the incremental increase in Nitrogen deposition attributable to emissions of NO_x and NH_3 from the Facility is unlikely to have a measurable effect on the integrity of the ecological habitat site.

The process contribution to odour levels in the area was also modelled and remained well within the assessment level of 3 OU_E m^{-3} as a 98th percentile hourly average, at the point of maximum impact across all five years of modelled data. As such, no issues of odour nuisance are anticipated from the Facility.

The overall conclusion from detailed modelling of emissions from the MET dry AD Facility to be located at the Melton Waste Park was that the potential impact on local air quality is likely to be small, generally being screened as insignificant and will not therefore have any significant impact on the health of people living and working nearby, or on the surrounding environment.

Contents

Issue and Revision Record

Issue	Date	Author	Review / Authorise	Description
DRAFT	01/12/2023	A. Owen		DRAFT
1	02/12/2023	A. Owen	ENVISAGE	Issue 1

1. Introduction

Environmental Visage Limited (Envisage) was commissioned by Melton Energy Tech Limited (MET) to prepare a detailed air quality assessment in support of an application for an Environmental Permit for their dry anaerobic digestion facility (dry AD Facility) located within the Melton Waste Park, off Gibson Lane, Melton, near Hull.

The Environmental Permit application considers the entire MET process, including the anaerobic digestion plant, gas up-grade processes, digestate handling and processing operations, and the production of heat and energy to support the processes.

This dispersion modelling assessment considered the impact of emissions from the Facility that are associated with the process, specifically the discharge from the air ventilation abatement system, emissions from a small natural gas fired boiler, and the Carbon Dioxide release from the gas upgrade system. Emergency releases including the flare and the emergency generator have not been included in the assessment.

The assessment also considers the impact of other, local processes that might not otherwise be included in the current background, in an assessment of the cumulative impact with other operations.

The objective of the modelling exercise was to assess the potential impact of the process emissions from the Facility on local air quality, in terms of ground level concentrations of pollutants designated by air quality standard objective values and other relevant environmental assessment levels recommended by the Environment Agency. Modelling was based upon emissions and process data, and site drawings supplied by MET and their technology providers, Thoni and Amzco.

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

1.1 ADMS Model

The main modelling software used was ADMS Version 6, one of a range of atmospheric dispersion models available for assessing the impact on local air quality of pollutant emissions to atmosphere. The ADMS model uses two parameters to describe the atmospheric boundary layer, namely the boundary layer height (*h*) and the Monin-Obukhov Length (L_{MO}), and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions. Models used routinely in the UK for this sort of application include United States Environmental Protection Agency (US-EPA) models such as AERMOD, and the ADMS models developed in the UK by Cambridge Environmental Research Consultants (CERC)[1].

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

1.2 Modelling Uncertainty

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

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

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

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

- Selection of the dispersion model - ADMS 6 is a commonly used atmospheric dispersion model and results have been verified through a number of inter-comparison studies to ensure that model predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using hourly average meteorological data from the nearby Leconfield measurement station which is considered to be the most representative of local conditions;
- Plant operating conditions – Data on the likely discharge conditions from the installation were provided by the technology providers to the project. As the Facility is not yet operational, all of the information provided regarding the discharge conditions is naturally theoretical;
- Receptor locations - A 4 km x 4 km Cartesian Grid (with 20-metre grid spacing) was utilised in the model in order to calculate maximum predicted concentrations in the vicinity of the Facility. Specific receptor locations were also included in the model to provide detailed assessment at these sensitive locations; and,
- Variability - All model inputs are as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

The application of the above measures to reduce uncertainty and the use of a series of worst-case assumptions relating to the operational performance of the process should result in model accuracy of an acceptable level.

1.3 Air Quality Standards and Environmental Assessment Levels

In the UK, limit values, targets, and air quality standards (AQS) and objectives for major pollutants are described in The Air Quality Strategy. In addition, the Environment Agency provide environmental assessment levels (EALs) for other pollutants. The results of the modelling were considered in the context of these limits, targets, objectives and assessment levels, as summarised in Table 1 over page.

Table 1 Air Quality Standards and Environmental Assessment Levels

Substance	Assessment Level	Averaging time	Specific Receptors	Regulatory Source
Ammonia	2,500 µg m^{-3}	1 hour mean	Human health / AQ	EAL
Ammonia	180 µg m^{-3}	Annual mean	Human health / AQ	EAL
Ammonia	1 µg m^{-3} where lichens or bryophytes (including mosses, liverworts and hornworts) are present, 3 µg m^{-3} where they're not	Annual mean	Conservation / Habitats	Critical Level
Hydrogen Sulphide	150 µg m^{-3}	Daily mean	Human health / AQ	WHO AQ guidelines for Europe
Hydrogen Sulphide	140 µg m^{-3}	Annual mean	Human health / AQ	EAL
1,3-butadiene	2.25 µg m^{-3}	Running annual mean	Human health / AQ	AQ Regulations
Benzene	5 µg m^{-3}	Annual mean	Human health / AQ	AQ Regulations
Benzene	30 µg m^{-3}	24-hour mean	Human health / AQ	EAL
Particulates (PM_{10})	50 µg m^{-3} with up to 35 exceedances (90.41st %)	24-hour mean	Human health / AQ	AQ and AQS Regulations
Particulates (PM_{10})	40 µg m^{-3}	Annual mean	Human health / AQ	AQ and AQS Regulations
Particulates ($PM_{2.5}$)	20 µg m^{-3}	Annual	Human health / AQ	AQS Regulations
Particulates ($PM_{2.5}$)	10 µg m^{-3}	Annual from 2040	Human health / AQ	Env. Target 2040
Nitrogen Dioxide	200 µg m^{-3} with up to 18 exceedances (99.79th %)	1 hour mean	Human health / AQ	AQ and AQS Regulations
Nitrogen Dioxide	40 µg m^{-3}	Annual mean	Human health / AQ	AQ and AQS Regulations
Oxides of Nitrogen (as Nitrogen Dioxide)	75 µg m^{-3}	Daily mean	Conservation / Habitats	Critical Level
Oxides of Nitrogen (as Nitrogen Dioxide)	30 µg m^{-3}	Annual mean	Conservation / Habitats	Critical Level
Carbon Dioxide	27,400 mg m^{-3}	15-minute	Human Health	Workplace exposure limit
Carbon Dioxide	9,150 mg m^{-3}	8-hour	Human Health	Workplace exposure limit

Key to Table 1:

AQ Regulations	Air Quality (England) Regulations 2000 (as amended)[2]
AQS Regulations	Air Quality Standards Regulations 2010 Limit or Target Values and UK Air Quality Strategy Objectives[3]
Critical Level	Not habitat specific but cover broad vegetation types
EAL	Environmental Assessment Levels[4]
Env. Target 2040	The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023[5]
Workplace Exposure Limit	EH40[6]

2. Modelling Input Data

2.1 The Facility

MET intends to install a high solids anaerobic digester, or a ‘dry’ anaerobic digestion (dry AD) Facility within the wider Melton Waste Park, located off Gibson Lane in Melton, East Yorkshire. The location of the Facility within the wider Melton Waste Park is shown in Figure 1.

The process feedstock will comprise organic materials that would otherwise be transferred from the neighbouring waste operations undertaken at the Melton Waste Park by Transwaste Recycling and Aggregates Limited (Transwaste). MET will receive up to 52,000 tonnes of organic fraction material from Transwaste’s treatment of municipal solid waste, and up to 5,200 tonnes per year of green waste, also from the Transwaste operations.

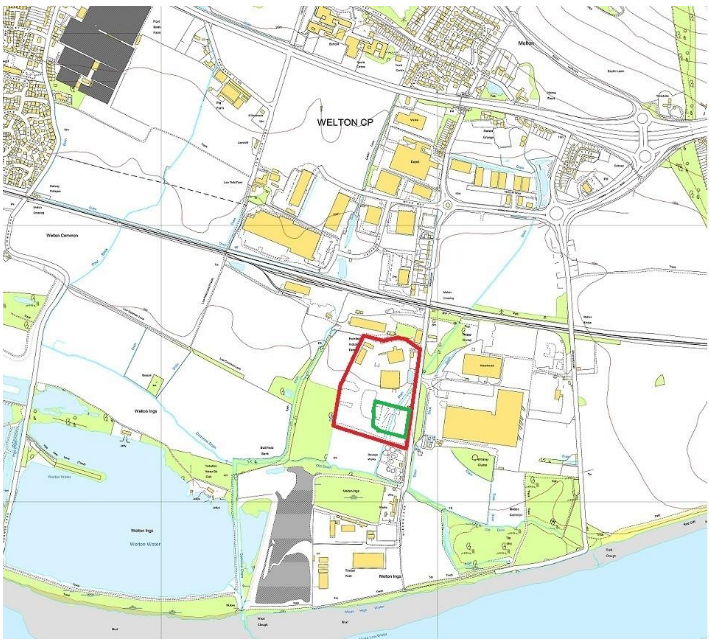
All waste handling and storage operations will be undertaken within the confines of the process building that will be served by an abated ventilation system. The system is sufficiently sized and specified to receive both ventilation and process air, passing potentially contaminated and odorous air through a sulphuric acid scrubber for initial treatment as necessary, before discharging through a Carbon filter.

Transwaste will also provide water, electricity and heat to the dry AD plant, with the heat sourced from three small (0.95 kW_{th} output) virgin wood fuel boilers. In return, MET is contracted to provide solid digestate to Transwaste for use as a fuel to be burned in conjunction with waste wood, in three small waste incineration plants also installed at the Melton Energy Park.

The digestion of the organic feedstock produces up to 7,900,000 Nm^3 biogas per annum and up to 60,000 tonnes per annum solid digestate. The biogas passes through a pressure swing adsorption (PSA) gas upgrade system before being transferred to the National Gas Networks (NGN), and the PSA releases the Carbon Dioxide stripped from the biogas, to atmosphere.

In addition to the materials and utilities supplied by Transwaste, MET will operate their own, gas-fired package boiler to serve the PSA. The Facility also includes numerous pressure release valves, a flare and an emergency generator. However, as any of these release points would only activate in the event of an emergency, they have not been included in the modelling exercise.

Figure 1 The MET Boundary (Outlined in Green) Within the Melton Waste Park (Outlined in Red)



2.2 Emissions Data

The operation of the Facility will be regulated by the Environment Agency in line with the conditions of an Environmental Permit. This modelling study has been prepared to inform the application for a new, bespoke Environmental Permit for the site.

Details of the release characteristics to be considered have been advised by the technology provider or represent the maximum allowable emission limits which will likely be imposed on the site operations when considering Best Available Techniques (BAT). The Industrial Emissions Directive[7] (IED) upon which the Environmental Permitting Regulations[8] are based is supported by Best Available Techniques Reference notes (BREFs) and BAT-Conclusions documents, and these specify the allowable emission limits from each regulated process. MET is committed to employing best available techniques at the site and meeting the relevant emission limits specified. As such, this air quality assessment has been undertaken considering the relevant emission limit values (ELVs) specified for new plant, where available, or the anticipated release concentration where lower emissions are expected or where no limit is anticipated.

The modelled source and emissions data applied to the model are summarised in Tables 2 and 3 respectively.

Table 2 Emission Source Parameters

Parameter	Abated Air Ventilation Stack	Gas Fired Boiler Stack	Pressure Swing Adsorption Release
Stack Height (m)	15	6.25	9.8
Stack Diameter (m)	1.2	0.3	0.775
Efflux Temperature (° C)	Ambient	202	30
Oxygen Content (% dry)	Ambient	2.1	N/A
Moisture Content (%)	Ambient	Not specified	N/A
Flue-gas Volumetric Flowrate (Am^3/hr)	62,350	3,374*	450
Flue-gas Volumetric Flowrate (Nm^3/hr)	N/A	1,498*	N/A
Efflux Velocity ($m\ s^{-1}$)	15.31	13.26	0.265
Location (x, y)	496777, 425290	496868, 425237	496863, 425251

* Actual and normalised volumetric flowrates provided in the boiler specification.

Table 3 Modelled Emissions Data

Substance	Emission Limit Value ($mg\ Nm^{-3}$)	Maximum Long-Term Mass Emission Rate ($g\ s^{-1}$)
Abated Ventilation Air Stack Releases		
Ammonia (NH_3)	3.8 (5 ppm)	0.066
Hydrogen Sulphide (H_2S)	7.6 (5 ppm)	0.132
Volatile Organic Compounds (VOCs)	40	0.6928
Particulate (modelled as PM_{10} and $PM_{2.5}$)	5	0.087
Odour (Odour Units)	1,000 $OuE\ m^{-3}$	17,320 $OuE\ s^{-1}$
Natural Gas Fired Boiler		
Nitrogen Oxides (NO_x as NO_2)	100	0.042
Pressure Swing Adsorption Column		
Carbon Dioxide (CO_2)	1,683,000	210.375

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

2.3 Atmospheric Chemistry

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

Emissions of Oxides of Nitrogen should be recorded as Nitrogen Dioxide because Nitrogen Oxide converts to Nitrogen Dioxide over time:

- For short-term process contributions (PC) and predicted environmental concentrations (PEC), assume only 50 % of emissions of Oxides of Nitrogen convert to Nitrogen Dioxide in the environment;
- For long-term PCs and PECs, assume all Oxides of Nitrogen convert to Nitrogen Dioxide.

Further guidance[9] from the Air Quality Monitoring and Assessment Unit regarding the preparation of dispersion models for Environmental Permitting specifically, goes on to clarify that:

For combustion processes where no more than 10 % of Nitrogen Oxides are emitted as Nitrogen Dioxide, you can assume worst case conversion ratios to Nitrogen Dioxide of:

- 35 % for short-term average concentrations
- 70 % for long-term average concentrations

This assessment follows a step-wise approach to the modelling of Nitrogen Dioxide.

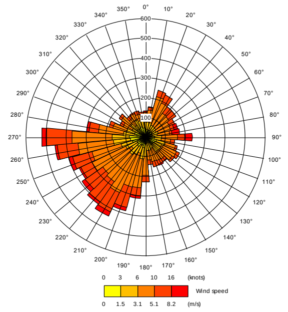
Despite the recognition that only a portion of the discharge comprises NO_2, this method may still overestimate concentrations of NO_2 in close proximity to the site as the conversion of NO_x to NO_2 is unlikely to be instantaneous, requiring the mixing of the plume with ambient air and its associated oxidant species such as Ozone (O_3) etc.

In addition to the influence of atmospheric chemistry on some pollutants, it is possible to run the model such that the effects of deposition on the modelled concentrations are discounted from the vapour phase process contributions. In running a model with ‘no plume depletion’, levels of deposited pollutants can be calculated at the same time as the vapour phase contributions, with the latter being identical to those that would be predicted when deposition is not considered. Without this additional aspect to the modelling files, concentrations in the plume are depleted by the regular deposition of pollutant across the grid, and lower vapour concentrations are therefore predicted. As such, modelling with no plume depletion represents a conservative case, and was applied to the MET Facility model.

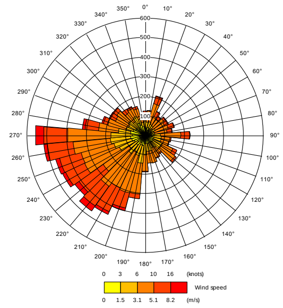
2.4 Meteorological Data

Hourly averaged meteorological data from the Leconfield measurement station, located approximately 17.2 km to the north, north-east of the MET site was applied to the models. The Leconfield site is non-coastal and has a difference in elevation of 10 – 12 m lower than the location of MET. Five-years’ of data for 2018 to 2022 were used in the detailed modelling assessment and the wind roses from the data applied are shown in Figure 2.

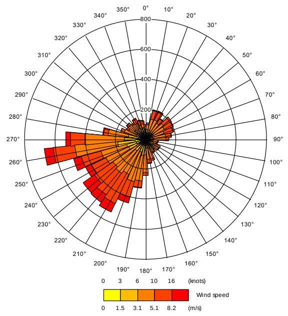
Figure 2 Wind Roses for the Leconfield Measurement Station



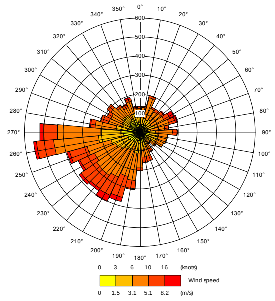
2018 Wind Rose



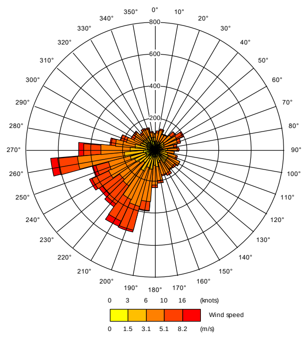
2019 Wind Rose



2020 Wind Rose



2021 Wind Rose



2022 Wind Rose

All meteorological data used in the assessment were provided by Atmospheric Dispersion Modelling (ADM) Limited, which is an accredited distributor of meteorological data within the UK. The data indicate the prevailing wind being from the south-west quadrant, and the application of multiple years' of data enables the effects of inter-annual variations to be taken into account.

The meteorological data included within the model incorporated the nine parameters defined below:

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

2.5 Local Environmental Conditions

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

Surface Roughness

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

Land use along Gibson Lane in the immediate vicinity of the development is predominantly industrial and commercial, with open, agricultural fields to the west, and a mixture of agricultural areas, villages and small towns in the wider area. The Humber Estuary is to the south of the site, and the presence of mixed land uses and the river estuary in relatively close proximity to the site and within the modelled grid, prompted the use of a spatially variable surface roughness file to accurately detail the surface roughness across the area.

Additionally, a surface roughness of 0.2 m was applied to describe the Leconfield meteorological monitoring location, which is a roughness relevant to areas akin to open agricultural areas similar to the area surrounding Leconfield.

Nearby Buildings and Structures

The proximity of solid structures, such as buildings, to an emission source can affect the dispersion of a plume emitted from an adjacent stack, particularly in the vicinity of that structure. The effects of this were included into the model based on the data presented in Table 4, and graphically in Figure 3.

Table 4 Modelled Building Data

Building	Height (m)	Width (m)	Length / Diameter (m)	Orientation (Degrees N)
ERF Building	24	12	44	116
SWIP Building	12.5	63.9	68.5	93
ERF Building 1	24	15	54	26
ERF Building 2	24	12	44	116
SWIP Building 1	12.5	25.7	63.9	3
Transwaste Boiler Building	6.7	31.8	40.11	10
SWIP Building 2	6.7	13	19.5	93
SWIP Building 3	8.3	15	30	93
SWIP Building 4	9.5	64.7	22	93
Gas Dome	15.02	---	20	---
AD Units	11	28	46.91	94
Gas Boiler 1	2.9	2.44	8.29	94
Gas Boiler 2	5.4	2.44	4.2	94
MET Waste Reception	10.45	26	52	94
Dewatering / Press Building	13.5	52.5	10	94
Dryer Building	9.05	20	38	94
Ammonia Scrubber Unit	9.2	---	4	---
Sulphuric Acid Tank	6.5	---	3.4	---

Figure 3 Site Layout as Modelled

Sensitivity of Building Inputs

Although considered wholly appropriate to include the site buildings such that any down-wash effects would be appropriately modelled, a sensitivity analysis was prepared to determine the impact of modelling without the site buildings included. The impact of removing the buildings from the model is detailed below considering the MET process contributions of Nitrogen Dioxide in 2022 as an example.

NO_x as NO_2	Buildings Included	No Buildings
Maximum Annual Average (NO_2 = 100 % NO_x)	3.20	2.64
Maximum Hourly Average (NO_2 = 50 % NO_x)	20.92	10.01

As would be expected, removing the detail of the buildings from the assessment, thereby naturally removing the potential for any negative effects of building down-wash, is beneficial to the dispersion of the plume and thereby results in lower process contributions. However, the site does include some relatively significant structures and in order to present the most comprehensive and conservative case the model should include these. Data on the site buildings were therefore included in each of the detailed modelling runs.

Wind Turbines

Two, Enercon E82 (2.3 MW_e) wind turbines, both with a hub height of 78 m and a rotor diameter of 82 m, giving a total turbine height of 119 m, are located at the Transwaste Limited site, at grid references 496859, 425371 and 496569, 425237, located approximately 55 metres to the north, and 303 m to the west, south-west of the dry AD Facility respectively.

The disturbance of air flow caused by a wind turbine can significantly impact the dispersion of emissions from process plant and as such, the ADMS model has the capability to model the effects of wind turbines on dispersion. The model calculates changes in the flow field due to the rotation of a wind turbine, and then calculates how this modified flow field affects dispersion of emissions from nearby sources. An "Additional Input" *"AAI"* wind turbine data file was therefore created for inclusion within the model, specifying the location of each of the turbines and the wind velocity / thrust coefficient data of the turbines.

Due to the location of the turbines in the immediate vicinity of the MET Facility, wind turbine data was included as a standard feature in each of the model runs and scenarios, as the presence of the turbines could be expected to generally impact on the process discharges.

Local Terrain

Local terrain can affect wind flow patterns and, consequently, can affect the dispersion of atmospheric pollutants. The effects of terrain are not normally noticeable where the gradient is less than 10 % (otherwise described as a 1:10 slope). Ordnance Survey mapping for the area generally shows the absence of significant terrain in the immediate vicinity of the Facility although the land does rise from approximately 1.5 km north of the site, on the northern side of the A63.

As such, an initial sensitivity check was run to confirm the effects of incorporating terrain data into the modelling exercise.

Sensitivity of Local Terrain

Although considered wholly appropriate to include detailed information on the local terrain in order that the effects of the undulating landscape would be incorporated into the model, a sensitivity analysis was prepared to determine the impact of modelling without terrain effects included. The impact of modelling without any information on the local terrain is detailed below, using the resultant process contributions of NO_x as NO_2 in 2022, as an example.

NO_x as NO_2	Terrain Included	No Terrain
Maximum Annual Average (NO_2 = 100 % NO_x)	3.20	2.61
99.79th % Hourly Average (NO_2 = 50 % NO_x)	20.92	16.62

A difference was reported when modelling with and without the terrain data, with the inclusion of terrain influencing the modelling results and resulting in slightly higher process contributions. Hence, a spatially variable terrain file was included within the assessment in order to ensure the most accurate representation of local conditions.

Similar differences were reported for all other modelled pollutants and averaging periods.

Coastal Effects

The effect of a coastline on the dispersion of emissions will generally only be significant for discharges from elevated point sources that are within a few kilometres (up to a maximum of 5 km) of the coast. ADMS 6 has the ability to model the effects of a coastline, although additional data such as terrain and surface roughness files, and information on local buildings and other infrastructure such as wind turbines cannot be modelled at the same time.

Although located less than 600 m from the banks of the Humber Estuary, the MET Facility is over 30 km from the coastline at its nearest point, and approximately 45 km from the mouth of the Humber. As such, it was considered not appropriate to model coastal effects.

Output Grid

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

Fifteen specific receptors, representing nearby residential properties or locations where people may congregate for significant periods of time, were entered into the model, in addition to data on four nearby sensitive ecological receptors and eleven nearby locations where East Riding of Yorkshire Council undertakes NO_2 diffusion tube monitoring, as shown in the following table.

Receptors 16 – 18, identified as E1 to E3, represent nearby locations within the Humber Estuary, a National Site Network ecological habitat, which is situated within 10 km of the MET site. The Humber Estuary is classified as a Ramsar Site, Special Protection Area (SPA), Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI). Receptor 19 (E4) is the nearest point within the Melton Bottom Chalk Pit SSSI, less than 2 km from the MET site and which is designated for its geological significance.

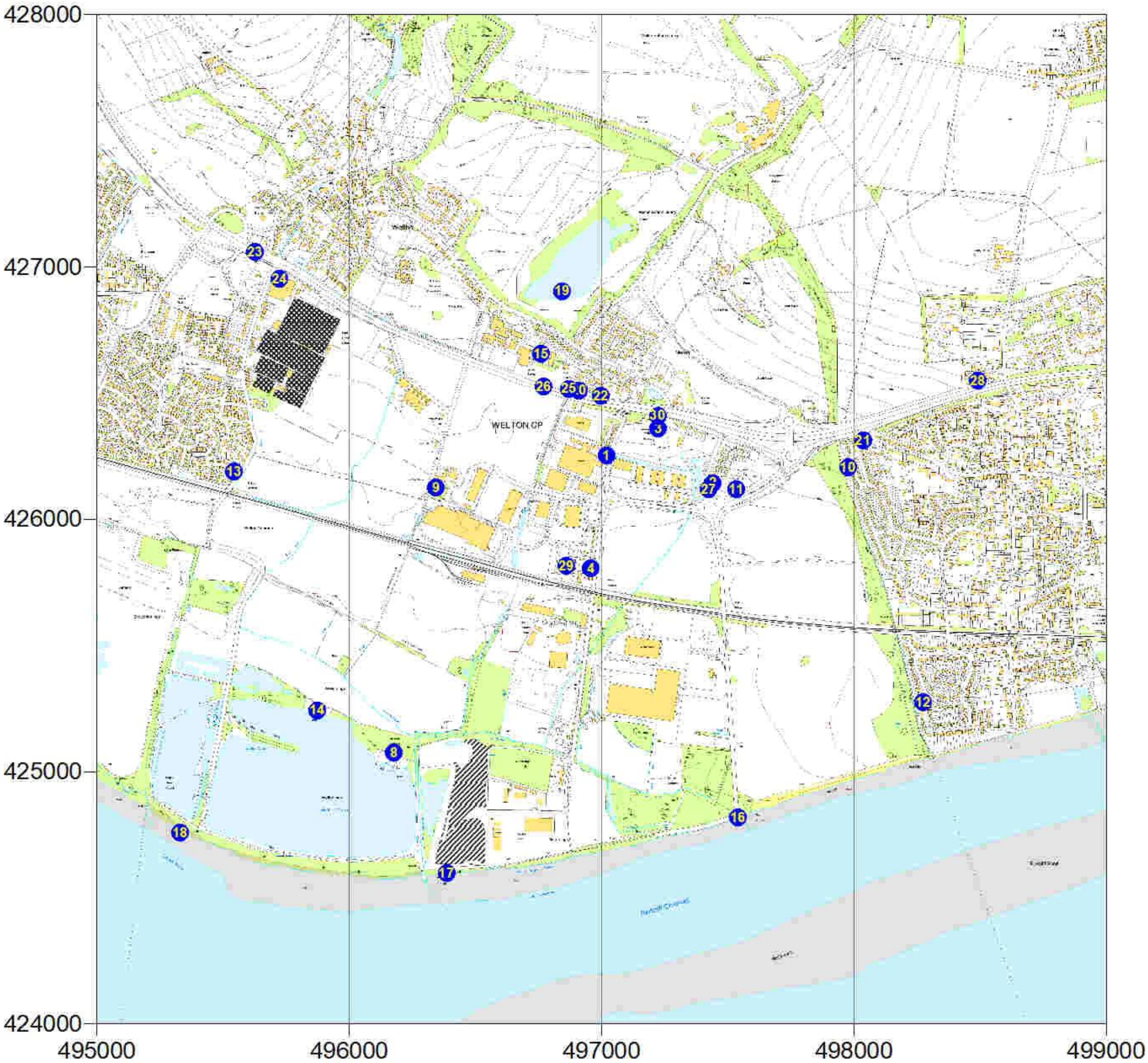
Discrete receptors Auto 1 and 2, and those with the “S” prefix represent locations where East Riding of Yorkshire Council undertakes air quality monitoring.

Details of the sensitive receptor locations are presented in the following table.

Table 5 Specific Receptors Included in Detailed Modelling

Receptor	X	Y	Distance from Site (m)	Receptor Name
1	497020	426254	872	52, Gibson Lane South, Welton, Melton
2	497441	426144	974	21, Brickyard Lane, Welton, Melton
3	497224	426360	1,040	A63, Welton, Melton
4	496958	425806	426	100, Gibson Lane South, Welton, Melton
5	497541	424818	948	Brickyard Lane, Welton, Melton
6	496385	424598	912	Welton Water Sailing Club, Common Lane, Welton
7	495330	424758	1,608	Welton, Melton
8	496177	425075	707	Welton Water Sailing Club, Common Lane, Welton
9	496344	426126	849	Heron Foods, Lowfield Lane, Welton, Melton
10	497976	426205	1,420	79, Plantation Drive, North Ferriby
11	497534	426120	1,021	The Sandpiper, Grange Close, Welton, Melton
12	498274	425275	1,480	75, Southfield Drive, North Ferriby
13	495543	426190	1,479	Kingscroft Drive, Welton
14	495873	425243	942	Welton Water Adventure Centre, Common Lane, Welton
15	496759	426657	1,248	South Hunsley School, East Dale Road, Welton, Melton
16 (E1)	497541	424818	948	Humber Estuary SPA, SAC, Ramsar, SSSI
17 (E2)	496385	424598	912	Humber Estuary SPA, SAC, Ramsar, SSSI
18 (E3)	495330	424758	1,608	Humber Estuary SPA, SAC, Ramsar, SSSI
19 (E4)	496844	426905	1,496	Melton Bottom Chalk Pit SSSI
20 (Auto 1)	496909	426511	1,106	21 Reynolds Close, Melton
21 (Auto 2)	498036	426313	1,531	Melton Road, North Ferriby
22 (S28)	496997	426490	1,098	A63/Gibson Lane North, Welton
23 (S35)	495626	427060	2,025	A63 East (The Old Foundry), Welton
24 (S45)	495723	426954	1,883	A63 West (Pool Bank Farm), Welton
25 (S55)	496871	426518	1,110	Reynolds Close (No.17), Melton
26 (A56)	496771	426527	1,117	A63 East (Shell Grand Dale)
27 (S63)	497423	426118	943	23 Brickyard Lane, Melton
28 (S67)	498492	426550	2,040	Woodgates Lane (No.35), North Ferriby
29 (S71)	496860	425815	409	100 Gibson Lane, Melton
30 (S72)	497222	426411	1,086	A63 West (Melton Grange), Melton

Figure 4 Receptor Locations



Background Air Quality

Estimates of background concentrations for NO_2, PM_{10}, $PM_{2.5}$, Benzene and 1,3-Butadiene are provided on the UK-AIR[10] website hosted by DEFRA at a resolution of 1 km x 1 km grid spacing. The MET Facility is located within an area under the jurisdiction of East Riding of Yorkshire Council, and data were obtained for 2024 for the locality around the Facility, representing the proposed start date for the operations.

The data show that future estimates of background concentrations for the pollutants included within the model and without any process contribution from the Facility, are well below their respective air quality standards.

Data in the upwind and downwind grid squares closest to the site were considered and, being similar in their reported concentrations, the marginally higher values were applied to provide an assessment of background air quality in the area around the site.

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

Pollutant	Annual Average Concentration (µg m^{-3})
Nitrogen Dioxide (NO_2)	7.821
Particulate Matter as PM_{10}	13.448
Particulate Matter as $PM_{2.5}$	7.582
Benzene (for VOC)	0.180
1,3-Butadiene (for VOC)	0.078
Estimated concentrations at grid reference 497500, 425500	

East Riding of Yorkshire Council also undertakes air quality monitoring across the area in connection with its Local Air Quality Management obligations. Annual data from nearby monitoring stations and NO_2 diffusion tube monitoring locations for 2019 to 2022 (where available) showed the following trends in annual average NO_2 concentrations[11].

Table 7 Annual Average NO_2 Concentrations at Nearby Diffusion Tube Monitoring Locations (µg m^{-3})

Receptor	2019	2020	2021	2022
20 (Auto 1)			18.3	16.3
21 (Auto 2)				12.6
22 (S28)	41	31.5	33.1	32.9
23 (S35)	40	30	33.4	32.4
24 (S45)	29	21.8	25.3	23.7
25 (S55)	21	16.7	18.3	16.8
26 (A56)	35	24.4	30.7	27.3
27 (S63)			15.7	16.3
28 (S67)	29	21.8	23.2	22.3
29 (S71)	17	19.2	22.8	20.6
30 (S72)	31	25.1	27	23.9

Although the background levels measured are seen to be elevated and representative of the urban environment that they are located in, levels are seen to generally be reducing over time at the majority of the diffusion tube monitoring locations detailed. Located within the modelled grid, the monitoring locations were included as specific receptors in the model and, in order to discount any impact of Covid lockdown periods, the measured 2019 data was applied where available. Data from 2022 was applied for locations where monitoring was not being undertaken in 2019.

Background levels for Ammonia were obtained from the national monitoring network site at Caenby, which recorded a background concentration of 1.394 µg m^{-3} gaseous Ammonia in 2022. The Caenby monitoring site is located approximately 36 km to the south of the MET Facility and was identified as the nearest Ammonia monitoring station to the site.

There are no readily available background concentration data for either Hydrogen Sulphide or Carbon Dioxide.

2.6 Model Default Values Applied

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

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

Priestley-Taylor Parameter; 1 representing moist grassland.

Minimum Monin-Obukhov Length; 1 m.

3. Detailed Modelling – Results and Discussion

3.1 Modelled Parameters

Detailed atmospheric dispersion modelling of emissions from the Facility was undertaken on the basis of the assumptions made and conclusions of the sensitivity analyses detailed in Sections 2.5 – 2.6, summarised as follows:

Building downwash module: active
Terrain effects: active, with a spatially variable file
Wind turbine effects: active
Surface roughness (grid): spatially variable surface roughness file
Surface roughness (meteorological site): 0.2 metre

Emissions of Ammonia (NH_3), Hydrogen Sulphide (H_2S), particulate (as PM_{10} and $PM_{2.5}$), VOCs, Oxides of Nitrogen (NOx as NO_2), and Carbon Dioxide were assessed in line with the air quality standards and their objective values (where applicable), against specific pollutant EALs detailed in EA guidance, or against workplace exposure limits (CO_2) where no other assessment level was available.

The modelled emissions data were as summarised in Tables 2 and 3. The results from detailed modelling of the normal operational case are discussed in Sections 3.3 to 3.9. Results are presented in terms of the maximum process contribution and are also reported as the predicted environmental concentration taking into account the PC and the estimated background concentration for the area.

3.2 Determining Significance

This report details the assessment of comprehensive modelling undertaken for the Facility. The significance or otherwise of the results regarding the potential impact on human health or national ecological sites are assessed using a two-stage approach, aligned with the Environment Agency (EA) requirements.

The EA provides guidance[4] for screening the significance of air quality impacts associated with the operation of industrial processes. For long-term impacts, the guidance recommends a 1 % insignificance threshold of process contributions relative to a long-term AQS or EAL, with a corresponding 10 % insignificance threshold for the assessment of short-term PCs.

Where the long-term PC is greater than 1 % but the PEC remains within 70 % of the long-term assessment level, the emissions do not screen as insignificant, but are not considered to be significant. Similarly, where the short-term PC is more than 10 % of the assessment level, but is less than 20 % of the assessment level minus twice the long-term background concentration, emissions are confirmed as not significant.

Contour plots are provided for pollutants assessed against air quality objectives, and where the process contribution cannot be screened as insignificant.

3.3 Ammonia

Ammonia may be released from the stack discharging the abated ventilation air, and therefore this emission point has been considered. The results from detailed modelling of Ammonia are presented in Table 8 below.

Table 8 Modelling Predictions for Ammonia

<table>
<tr><th>Statistic</th><th>Assessment Level</th><th>Averaging Period</th><th>Process Contribution ($\mu g\ m^{-3}$)</th><th>Percentage of the EAL</th></tr>
<tr><td>Annual PC</td><td rowspan="2">180</td><td rowspan="3">1-hr</td><td>1.06</td><td>0.59 %</td></tr>
<tr><td>Annual PEC</td><td>2.46</td><td>1.37 %</td></tr>
<tr><td>Short-term PC 100%</td><td>2,500</td><td>24.69</td><td>0.99 %</td></tr>
</table>

The reported, worst-case process contributions from modelling five-years' worth of meteorological conditions, predicted that both the long (annual average) and short-term (maximum hourly average) process contribution of Ammonia to ground level concentrations would equate to less than 1 % of the assessment levels.

The addition of the background concentration of gaseous Ammonia measured at Caenby in 2022 (1.394 µg m^{-3}) results in a predicted environmental concentration of 2.46 µg m^{-3}, or a PEC that is approximately 1.4 % of the assessment level. As such contributions of Ammonia to local air quality and any resultant impact on human health are immediately discounted as insignificant.

Figures 5 and 6 that follow, plot the maximum process contribution of Ammonia across the area in relation to the annual and hourly average human health assessment levels. Contributions are insignificant at all points of the grid.

Figure 5 Annual Average Process Contribution of Ammonia (µg m^{-3}) 2020 Meteorological Conditions.

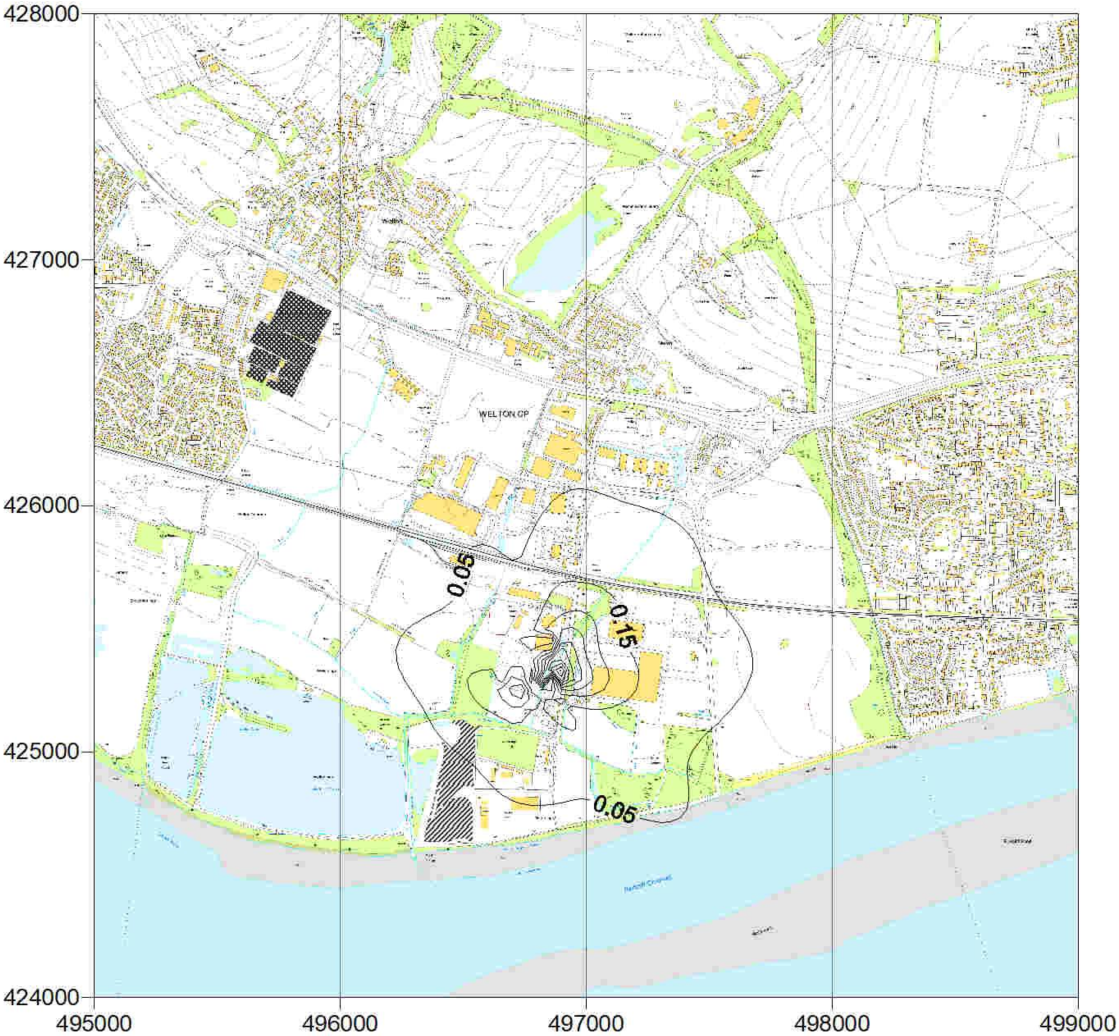
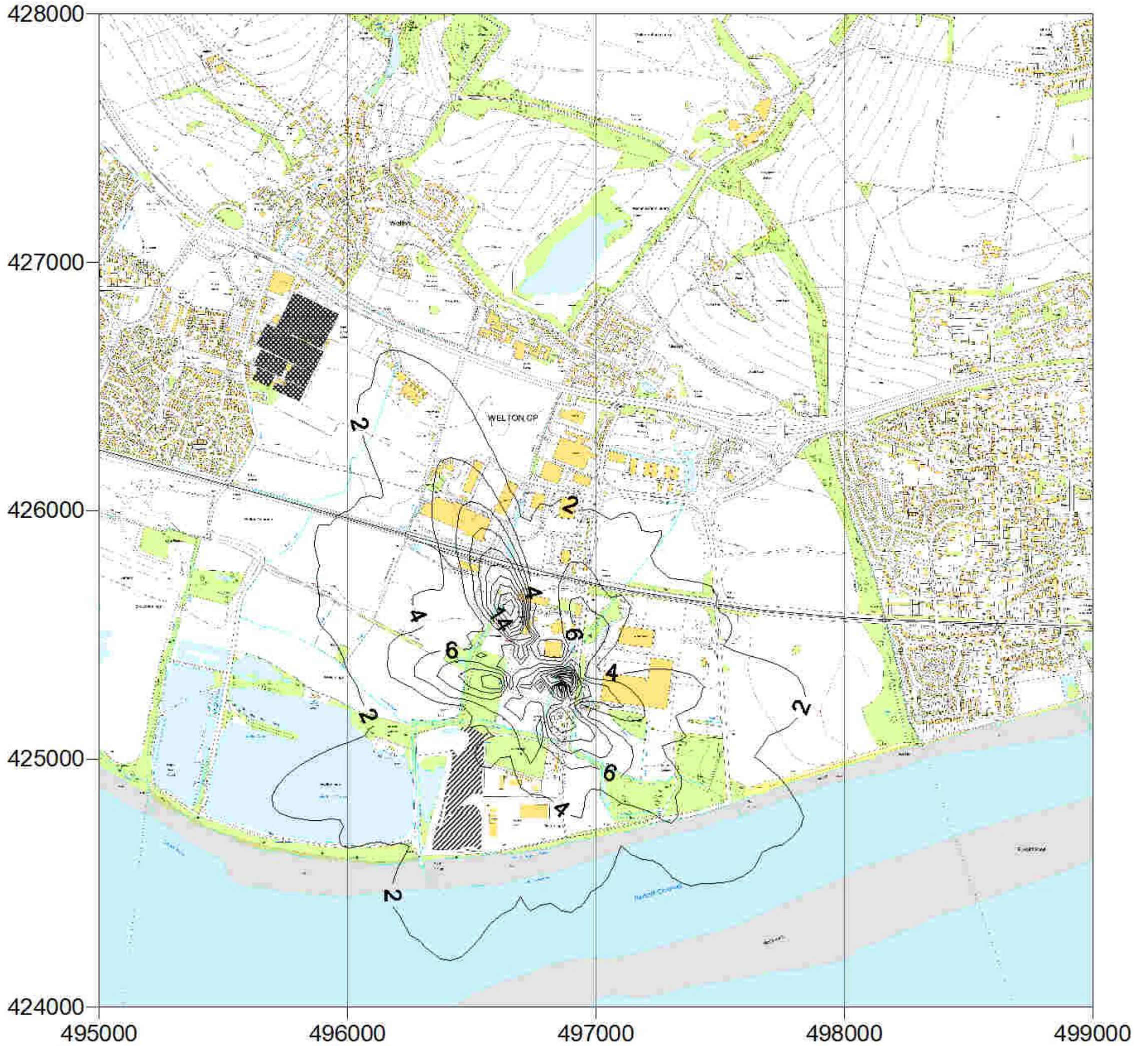


Figure 6 Hourly Average Process Contribution of Ammonia (µg m^{-3}) 2018 Meteorological Conditions.



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3.4 Hydrogen Sulphide

Hydrogen Sulphide may also be released from the stack discharging the abated ventilation air. The maximum results from modelling emissions of H_2S applying five-years' of meteorological data are presented in the following table.

Table 9 Modelling Predictions for Hydrogen Sulphide

Statistic	Assessment Level	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the EAL
Annual PC	140	1-hr	2.13	**1.52 %**
Short-term PC 100%	150	24-hr	15.57	**10.38 %**

The reported, worst-case process contributions from modelling five years' worth of meteorological conditions, predicted that both the long (annual average) and short-term (maximum hourly average) process contribution of Hydrogen Sulphide are marginally above the point at which they would be screened as insignificant (1 % of the long-term assessment level and 10 % of the short-term assessment level).

As such, the contributions cannot immediately be screened as insignificant and, with no measured or estimated background concentration available, it is not possible to quantify the predicted environmental concentration of H_2S.

However, the PCs are only marginally above the insignificance threshold and with the location of the maximum concentrations being either within (annual average) or at the eastern boundary (24-hour average) of the site, the potential impacts of emissions of H_2S are not considered to be significant. Neither the long nor short-term maximum process contribution occurs at an ecological or a specific human health receptor, occurring instead within the site boundary where access by the general public is not anticipated. In addition, as a workplace, MET staff will not be present at the site for either the annual or 24-hourly averaging period, and as such, assessment of this point of maximum represents an overly conservative approach.

Figures 7 and 8 plot the maximum annual and 24-hour process contributions of Hydrogen Sulphide in the locality and demonstrate the small area where PCs are not screened as insignificant. These all occur within the MET site boundary, and the point at which contributions become insignificant is marked by the magenta isopleth. No magenta contour line is shown on the 24-hour plot as only a single, 24-hourly average result, of the 40,401 modelled concentrations returned equates to more than 10 % of the EAL.

Figure 7 Annual Average Process Contribution of Hydrogen Sulphide (µg m^{-3}) 2020 Meteorological Conditions.

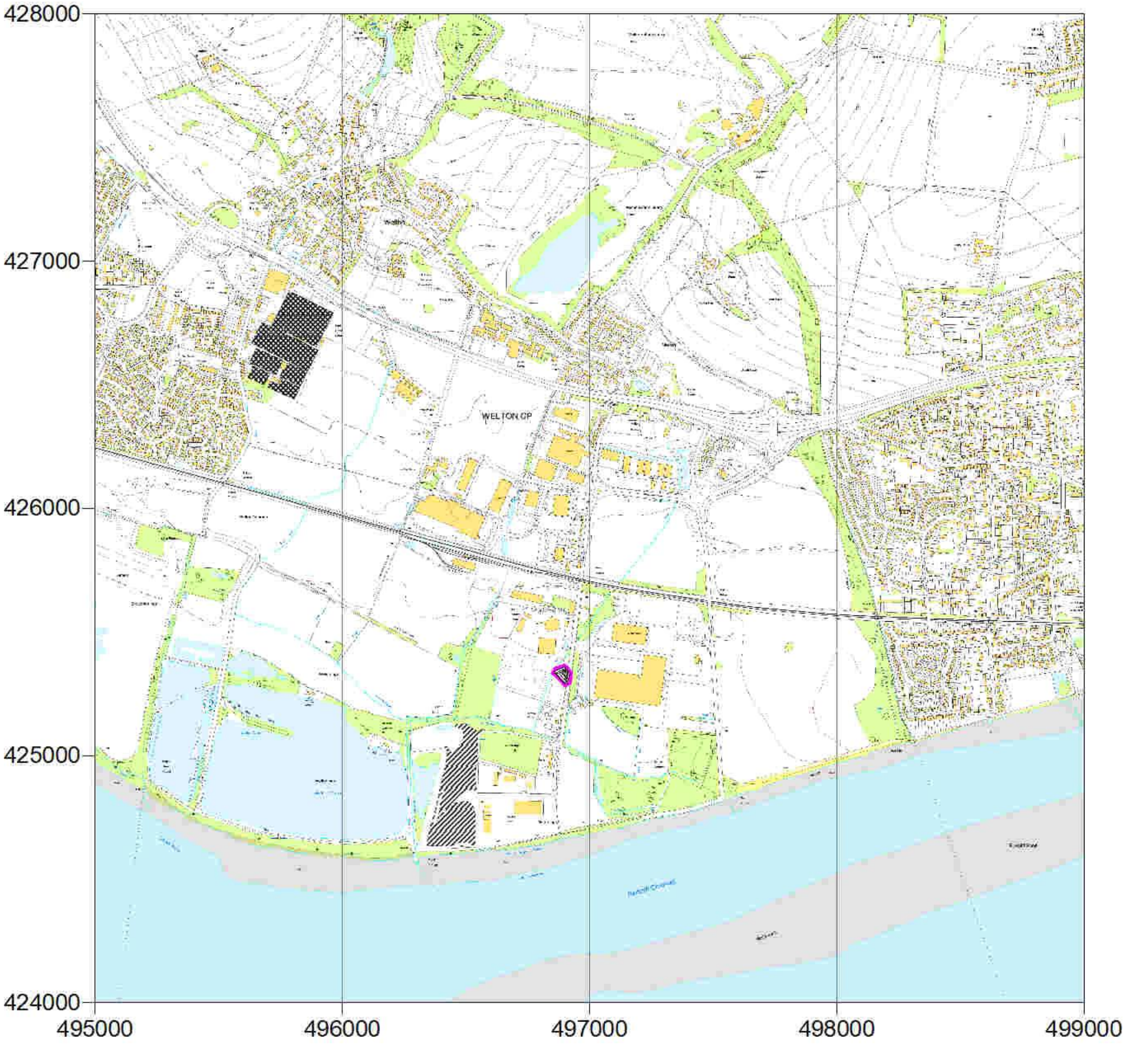
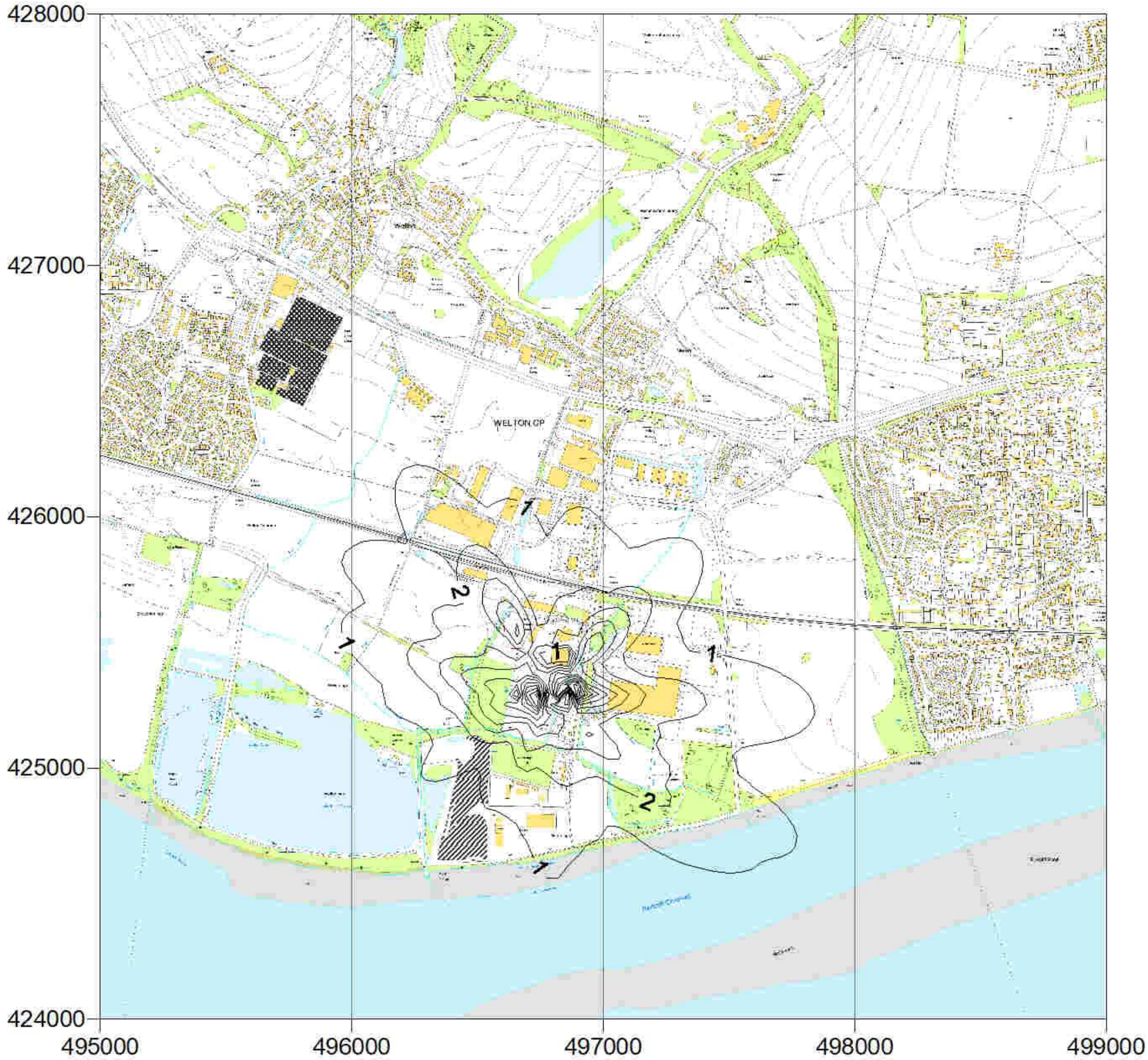


Figure 8 24-Hour Average Process Contribution of Hydrogen Sulphide (µg m^{-3}) 2021 Meteorological Conditions.



3.5 Volatile Organic Compounds (VOCs)

The results from detailed modelling of VOCs are presented as both Benzene and 1,3-Butadiene below.

There are no assessment levels for total VOC emissions as they comprise a mixture of organic compounds, although Benzene and 1,3 Butadiene, which are both VOC species, do have air quality objective values associated with them. There is no information available about the proportion of Benzene or 1,3-Butadiene that may be present in the VOC emission from the Facility, although, each is likely to be a very small percentage of the total, and is assumed here to comprise 5 % of the total discharge. Therefore, 5 % of the maximum annual average process contribution for total VOCs is compared against individual objective values for Benzene (5 µg m^{-3}) and 1,3-Butadiene (2.25 µg m^{-3}) in Table 10.

Table 10 Maximum Process Contribution for VOCs as Either Benzene or 1,3-Butadiene

Pollutant	Statistic	Assessment Level	Averaging Period	5 % of Total Process Contribution (µg m^{-3})	Percentage of the AQS
Benzene	Annual PC	5	Annual	0.56	**11.2 %**
	Annual PEC			0.74	14.8 %
	Short-term PC 100%	30	24-hr	4.09	**13.6 %**
	Short-term PEC 100%			4.45	14.8 %
	Revised ST Assessment Level (AQS – background x 2)	29.64	24-hr	4.09	13.8%
1,3-Butadiene	Annual PC	2.25	Annual	0.56	**24.8 %**
	Annual PEC			0.64	28.3 %

The model predicted a maximum annual average process contribution of approximately 0.56 µg m^{-3} for Benzene, which is assumed to constitute 5 % of the total VOC emissions from the Facility. This equates to approximately 11.2 % of the Benzene assessment level and, when the same proportion of 1,3-Butadiene is assumed, equates to almost 25 % of the EAL for 1,3-Butadiene. Although not immediately screened as insignificant, the application of the relevant estimated background concentrations in the area (0.18 µg m^{-3} Benzene and 0.078 µg m^{-3} 1,3-Butadiene) results in the PEC of both volatile species remaining within 70 % of their assessment levels and, as such are not considered to be significant.

The short-term PC of Benzene, again when assuming 5 % of the total VOC release, equates to approximately 13.6 % of the 24-hour average assessment level for Benzene but remains within 20 % of the EAL when considering either the PEC or the assessment of the PC against the revised short-term assessment level. As such the short-term impacts are also deemed not to be significant.

Plots of the predicted long and short-term distribution of VOCs are presented in Figures 9 and 10 that follow and show the point at which the annual average contribution to Benzene (magenta isopleth) and 1,3-Butadiene (green isopleth) would become insignificant.

Figure 9 Annual Average Process Contribution of VOC (µg m-3); 2020 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance for Benzene Whilst Green Isopleth Denotes the Point of Insignificance for 1,3-Butadiene

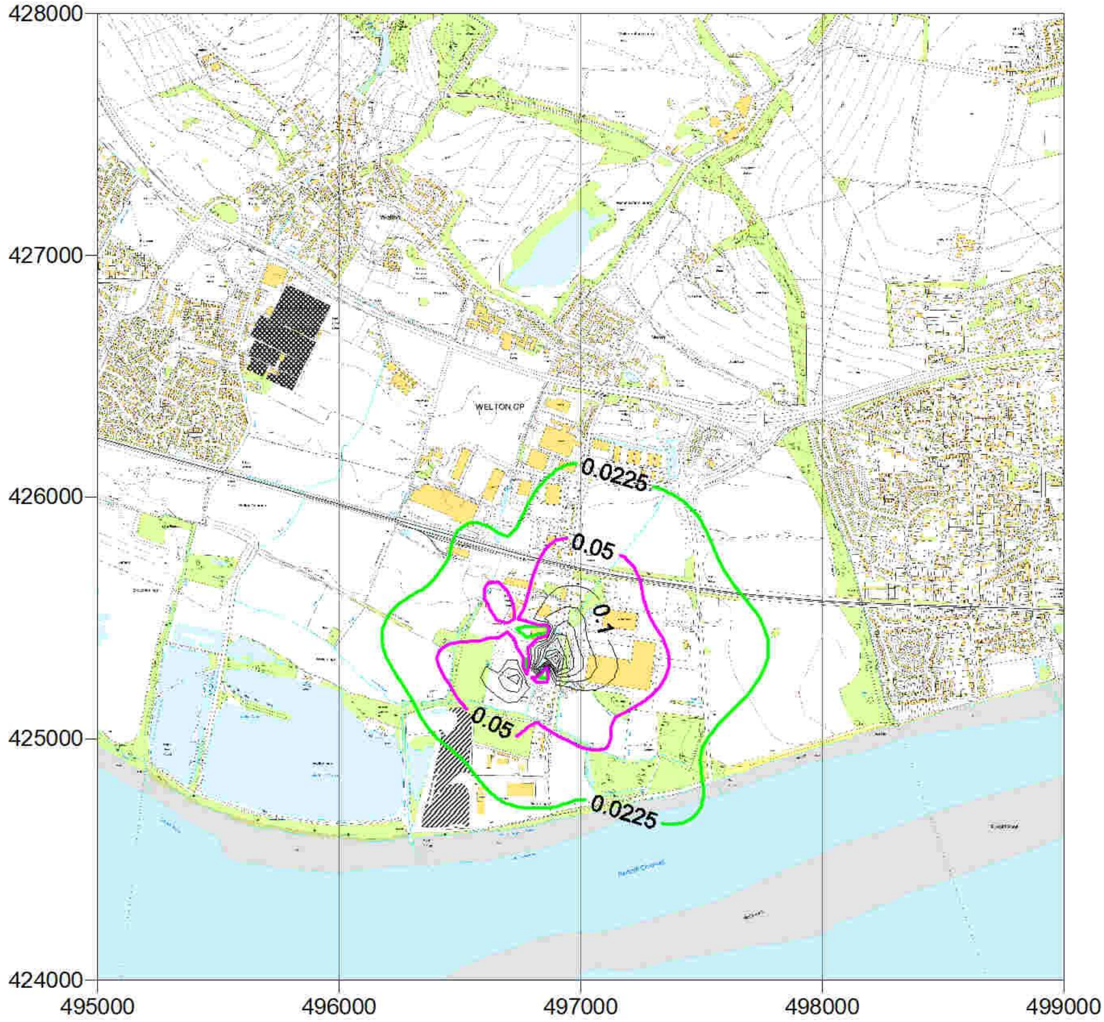
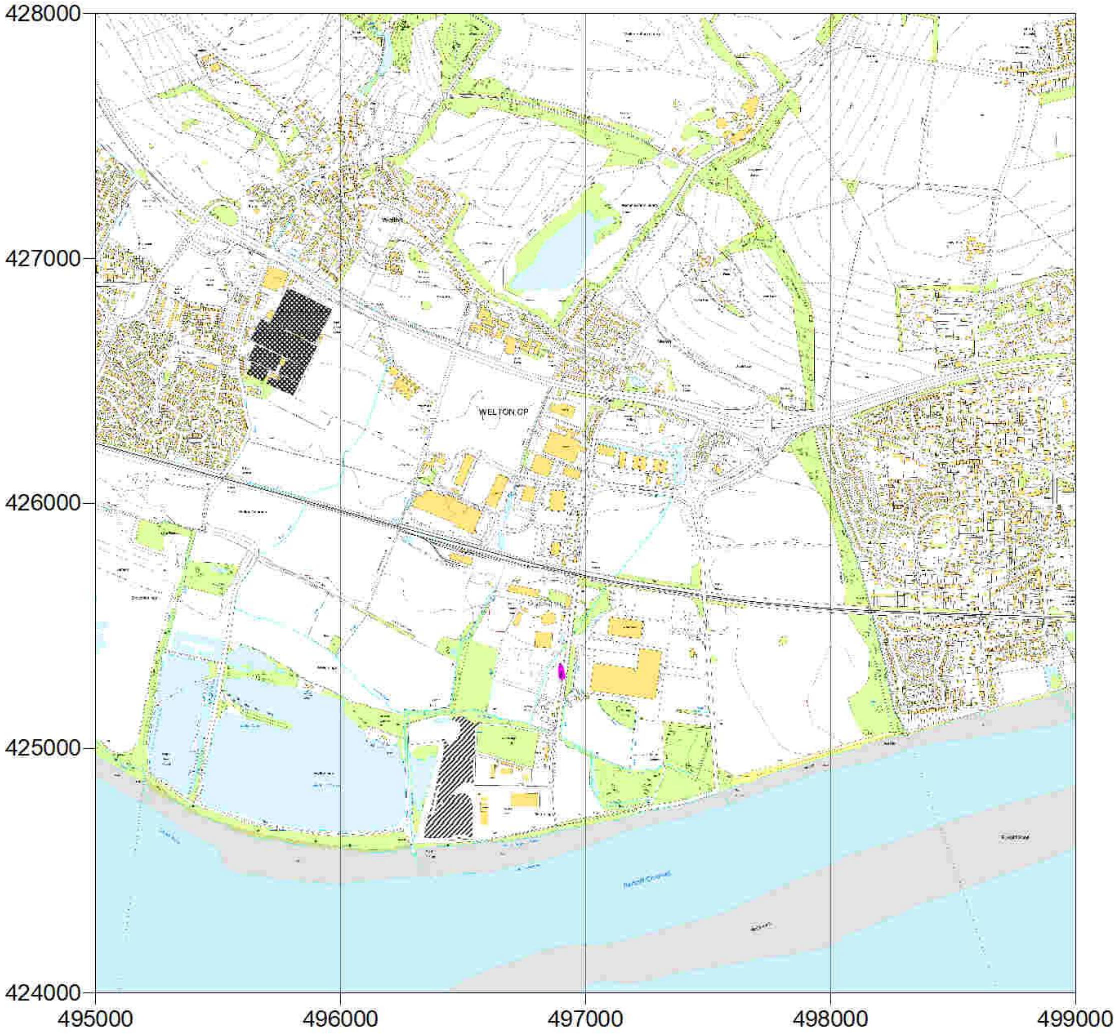


Figure 10 24-Hour Average Process Contribution of Benzene (µg m^{-3}); 2021 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance



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3.6 Particulates (PM_{10})

The results from detailed modelling of particulates (as PM_{10}) are provided in Table 11 and are presented in the context of the process contribution and the resultant predicted environmental concentration, taking into account the DEFRA estimated annual average background concentration for 2024 of 13.45 µg m^{-3}.

Table 11 Maximum Process Contribution for Particulates (PM_{10})

Statistic	Assessment Level	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Annual PC	40	Annual	1.43	**3.6 %**
Annual PEC			14.87	37 %
Short-term PC 90.41%	50	24-hr	4.42	**9 %**
Short-term PEC 90.41%			31.31	63 %
Revised ST Assessment Level (AQS – background x 2)	23.1	24-hr	4.42	19 %

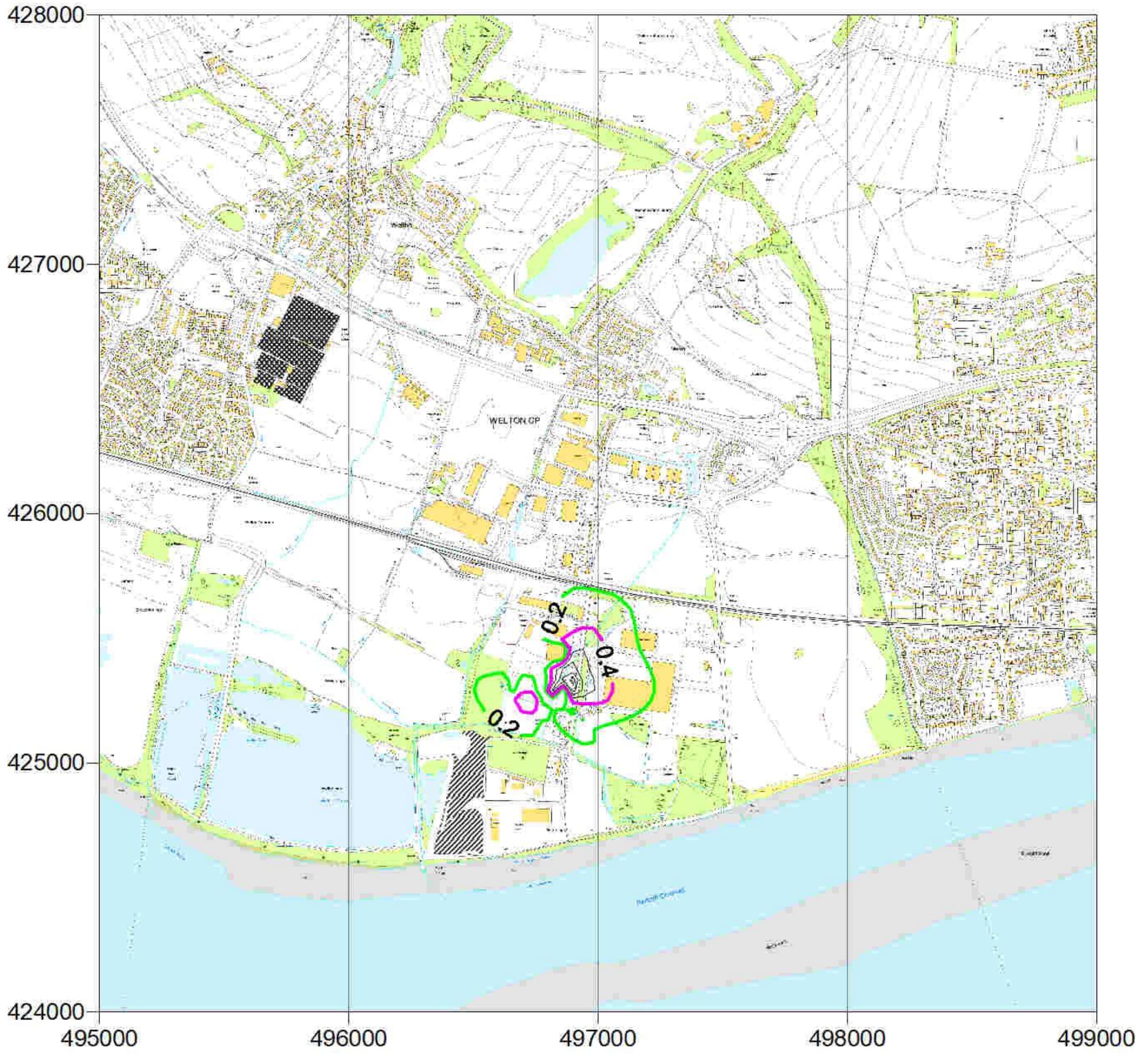
Detailed modelling predicted that the maximum annual average PC for particulates (PM_{10}) due to emissions from the Facility was likely to be 1.43 µg m^{-3}, or approximately 3.6 % of the AQS objective value. Although not screened as insignificant, the addition of the local estimated background PM_{10} level (13.45 µg m^{-3}) results in a PEC of less than 15 µg m^{-3}, or 37 % of the assessment level. As such, the annual average PEC is not considered to be significant.

Similarly, although the maximum daily average PC was predicted to be 4.42 µg m^{-3}, expressed as the 90.41 percentile value, equivalent to approximately 9 % of the 50 µg m^{-3} daily average objective value, and is not therefore immediately screened as insignificant, re-assessment of the PC against the assessment level minus twice the background concentration calculates that the PC equates to 19 % of the revised short-term assessment level and contributions will not therefore have any significant impact.

The long and short-term process contribution isopleths are presented as Figures 11 and 12 and show the rapid reduction and therefore limited spatial extent of process contributions that are not immediately screened as insignificant.

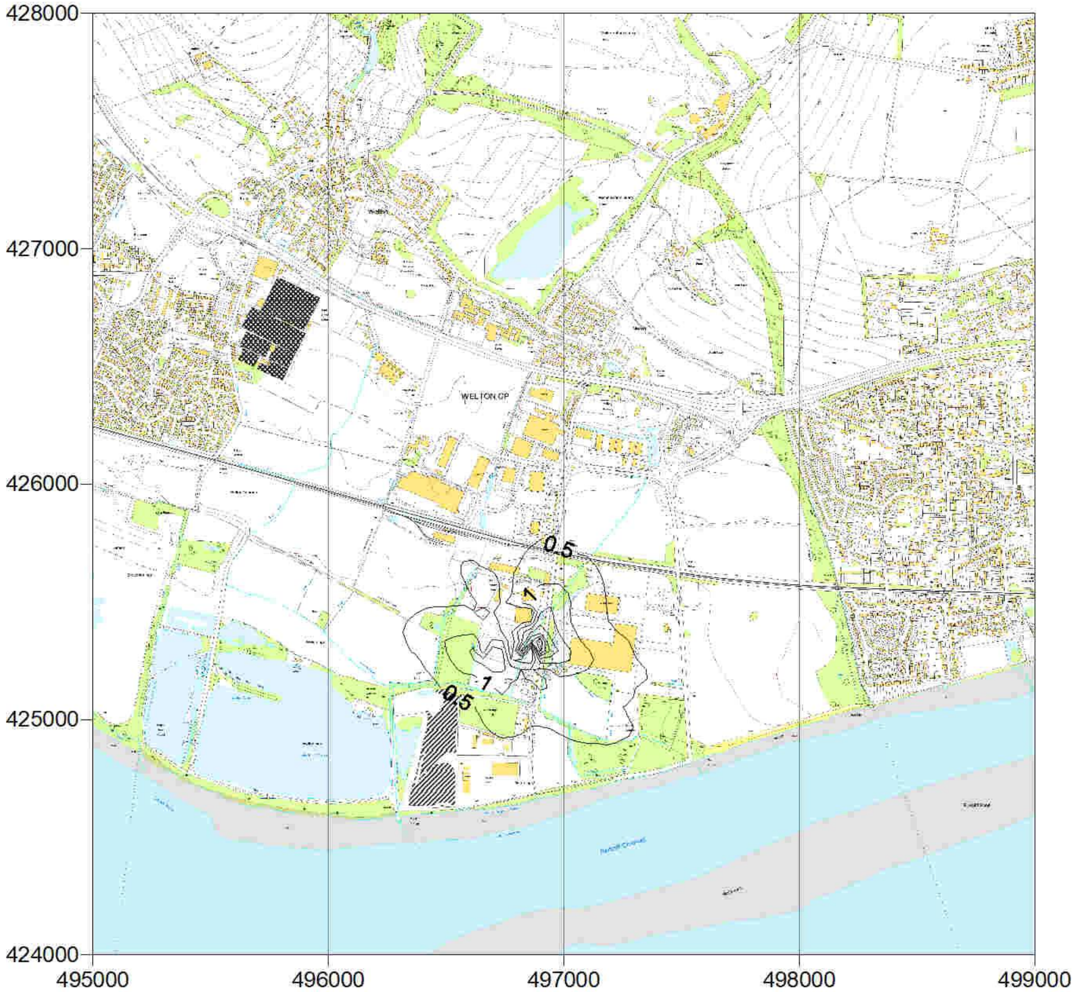
The annual average isopleths in Figure 11 mark the point at which the PC of PM_{10} becomes insignificant with a magenta contour line. The green contour line denotes the point at which contributions of $PM_{2.5}$ would also become insignificant.

Figure 11 Annual Average Process Contribution of Particulate Matter (µg m^{-3}); 2020 Meteorological Conditions



Similar to Figure 8 which plotted the short-term assessment of process contributions of H_2S, no magenta contour line is shown on the 90.41st percentile 24-hourly average plot as only a single result, of the 40,401 modelled concentrations returned, equates to more than 10 % of the EAL.

Figure 12 90.41st Percentile Daily Average Process Contribution of Particulate Matter as PM_{10} ($\mu g\ m^{-3}$); 2021 Meteorological Conditions



3.7 Particulates ($PM_{2.5}$)

The Air Quality Standards Regulations 2010 (as amended) set a target of 20 µg m^{-3} $PM_{2.5}$ to be met by 2020. A new target[5] has recently been issued and ultimately requires a background level of 10 µg m^{-3} $PM_{2.5}$ to be met by 2040. Hence, both assessment levels, current and future are considered here.

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

The results from the detailed modelling of particulates as $PM_{2.5}$ are reported in Table 12 and are presented in the context of the annual average PC and PEC Concentration, taking into account DEFRA's current estimated annual average background concentration for 2024 of 7.58 µg m^{-3}.

Table 12 Modelling Predictions for Particulates ($PM_{2.5}$)

Statistic	Assessment Level	Averaging Period	Process Contribution ($\mu g\ m^{-3}$)	Percentage of the AQS
Annual PC	20 (current)	Annual	1.42	**7.1 %**
Annual PEC			9.00	45 %
Annual PC	10 (by 2040)	Annual	1.42	**14.2 %**
Annual PEC			9.00	**90 %**

The results from modelling particulates, assuming that the total particulate emission is of $PM_{2.5}$, predicted that the maximum annual average PC associated with emissions from the Facility was likely to equate to 7.1 % of the current 20 µg m^{-3} target value, and 14.2 % of the future 10 µg m^{-3} target value. Contributions of $PM_{2.5}$ from the process cannot therefore immediately be screened as insignificant in relation to Environment Agency guidance.

The annual average distribution of dispersed $PM_{2.5}$ would be similar to that of PM_{10}, depicted in Figure 11, which therefore also includes the point of insignificance for $PM_{2.5}$.

Taking the background into consideration with the process contribution predicted by modelling, the maximum annual average predicted environmental concentration for $PM_{2.5}$ for the Facility was estimated to be approximately 9 µg m^{-3}. Whilst a PEC equating to 45 % of the current assessment level can be deemed to not be significant, when compared against the future target value for $PM_{2.5}$, the PEC is approximately 90 % of the target value.

However, in addition to the target value for background concentrations, the Environmental Targets (Fine Particulate Matter) (England) Regulations 2023[5] also sets a population exposure reduction target, requiring a 35 % reduction in population exposure by 2040, compared to a base year of 2018. The DEFRA estimated background level for the local area in 2018 was 8.4 µg m^{-3}, and therefore, the 2040 background, at which the reduced background target level is effective, is expected to be approximately 5.46 µg m^{-3}. The resultant PEC anticipated in 2040 would be 6.88 µg m^{-3}, or approximately 69 % of the target value, and hence, even at the point of maximum impact, levels of $PM_{2.5}$ will not be significant when assessing at either the current or the target (2040) value.

3.8 Oxides of Nitrogen (NO_x as NO_2)

Oxides of Nitrogen are emitted from the gas fired boiler, and the results of NO_x modelling are presented in Table 8 over page. The data presented are for both the maximum process contribution (PC) and the predicted environmental concentration (PEC) for NO_2 and are based upon the maximum values for the 2018 to 2022 meteorological data. The PEC values take into account the average estimated background concentration of NO_2 around the Facility in 2024 (7.82 µg m^{-3}) and conversion of the NO_x released from the process, based upon empirical formulae recommended by the Environment Agency; 50 % conversion for short-term assessment and 100 % conversion for long-term assessment.

The maximum reported values (annual average process contributions) are predicted by the modelling to occur along the eastern boundary of the site, and reduce significantly with distance from the site.

Table 13 Results from Detailed Assessment for Nitrogen Dioxide and Oxides of Nitrogen

Pollutant	Statistic	Assessment Level	Averaging Period	Process Contribution (µg m^{-3})	Percentage of the AQS
Oxides of Nitrogen (NO_X) –	Annual PC Protection of Ecosystems	30	Annual	3.54	**12 %**
Nitrogen Dioxide (NO_2)	Annual PC	40	Annual	3.54	**9 %**
	Annual PEC			11.36	28 %
	Short-term 99.79% PC	200	1hr	21.79	**11 %**
	Short-term 99.79% PEC			37.44	19 %
	Revised ST Assessment Level (AQS – background x 2)	184.36		21.79	12 %

The results from modelling predict that the process contribution (PC) from the Facility will equate to approximately 12 % of the annual average for the protection of ecosystems, or approximately 9 % of the annual average for the protection of human health at the point of maximum process contribution, when the Facility is operational. These contributions cannot immediately be screened as insignificant although this point of maximum impact is not located at either an ecological receptor, or a specific human health receptor, occurring instead at the eastern site boundary where long periods of access by the general public are not anticipated.

Receptors of annual average duration exposure would usually include locations where members of the public might be regularly exposed, such as building façades of residential properties, schools, hospitals, care homes etc. The air quality objectives do not usually apply at the building façades of offices or other places of work where members of the public do not have regular access and thus annual average contributions will not generally be of concern at such locations.

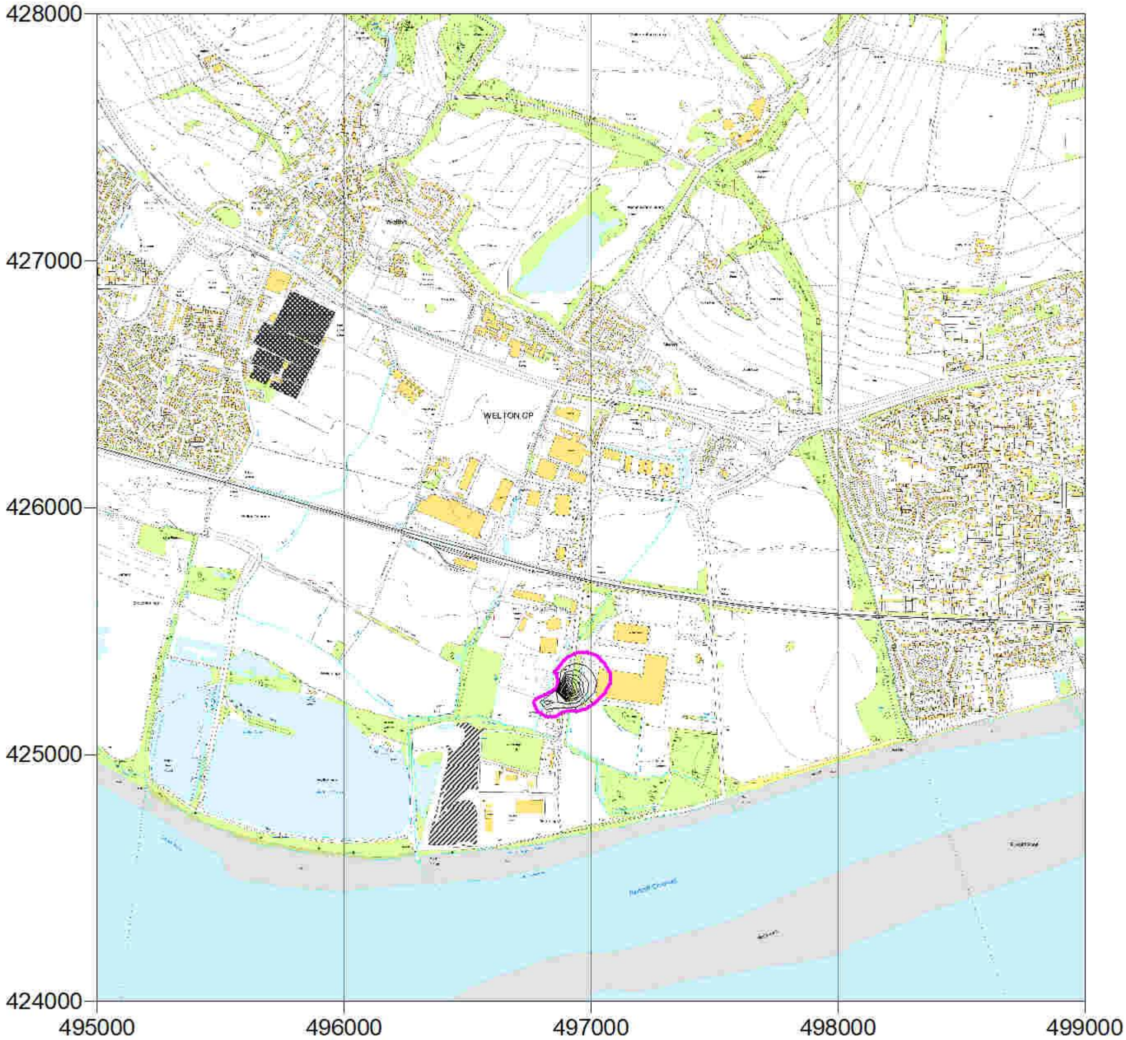
The assessment was made assuming that 100 % of the long-term NO_x converts fully to Nitrogen Dioxide (NO_2) which is a worst-case estimate. Applying the more conservative assumption, that only 70 % of the NO_x will actually convert to NO_2 in the long-term, results in a process contribution of 2.48 µg m^{-3}, or 6 % of the annual average Air Quality Standard (AQS).

Applying the estimated background concentration of NO_2 around the Facility in 2024 (7.82 µg m^{-3}) in order to calculate the predicted environmental concentration (PEC) results in a PEC of 11.36 µg m^{-3} (when modelling 100 % NO_x as NO_2) or 28 % of the AQS, reducing to 26 % when the process contribution of NO_2 is assumed to be 70 % of the total NO_x.

Therefore, although the annual average PC does not screen as insignificant at the initial assessment stage, the maximum PEC remains well within 70 % of the AQS and will therefore not have any significant effect on air quality.

The annual average process contribution plot for Nitrogen Dioxide, where NO_2 is modelled as total NO_x, is presented in Figure 13.

Figure 13 Annual Average Process Contribution of NO_x as NO_2 (µg m^{-3}); 2020 Meteorological Conditions. Magenta Isopleth Denotes the Point of Insignificance

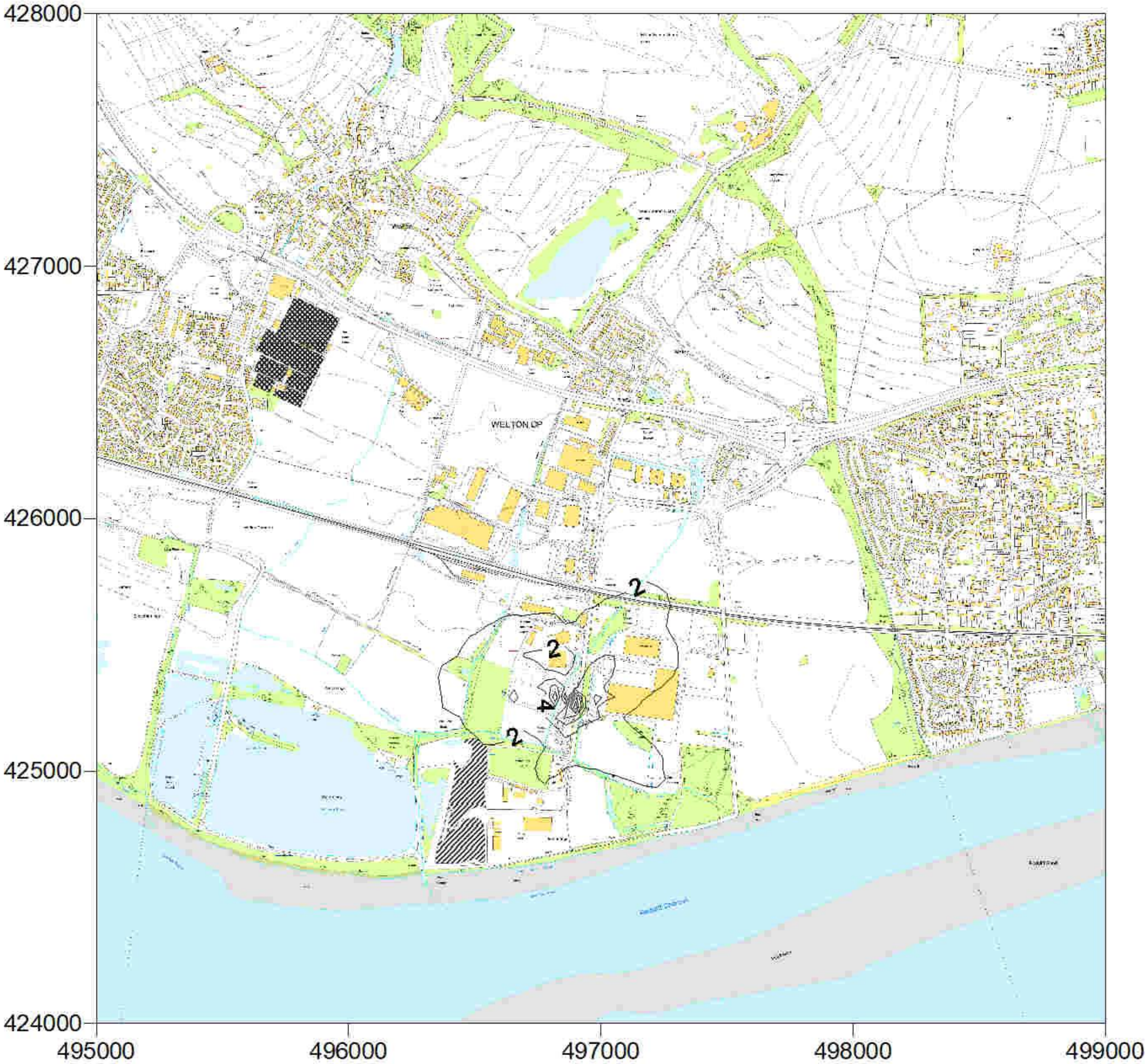


The maximum hourly average NO_2 PC was predicted to be approximately 21.79 µg m^{-3}, expressed as the 99.79th percentile value, equating to approximately 11 % of the 200 µg m^{-3} objective value. However, this assumes that up to 50 % of the NO_x released converts to NO_2 in the short-term, whereas the Environment Agency confirms that, for combustion processes where no more than 10 % of Nitrogen Oxides are emitted as Nitrogen Dioxide, a conservative conversion ratio of 35 % can be applied to the short-term averaging period.

Assuming that only 35 % of the NO_x converts to NO_2 in the short-term, the resultant maximum 99.79th percentile hourly average process contribution equates to 15.26 µg m^{-3} or approximately 8 % of the short-term air quality objective, and would therefore immediately be screened as insignificant.

Figure 14 over page plots the short-term NO_2 PC, with NO_2 equating to 50 % of total NO_x. No magenta contour line is shown on the 99.79th percentile hourly average plot as only a single result, of the 40,401 modelled concentrations returned, equates to more than 10 % of the EAL.

Figure 14 99.79th Percentile Hourly Average Process Contribution of NO_x as NO_2 (µg m^{-3}); 2019 Meteorological Conditions



3.9 Carbon Monoxide (CO)

The results from detailed modelling of Carbon Dioxide emitted from the gas upgrade system are presented in Table 14 and were assessed against workplace exposure limits in the absence of any air quality standards or environmental assessment levels.

Table 14 Modelling Predictions for Carbon Dioxide

Statistic	Assessment Level (mg m^{-3})	Averaging Period	Process Contribution (mg m^{-3})	Percentage of the AQS
Short-term PC 100%	27,400	15-minute	3,369	**12.3 %**
Short-term PC 100%	9,150	8-hr	1,824	**19.9 %**

Detailed modelling predicted that both the maximum 15-minute and 8-hour average ground-level process contribution for CO_2 associated with emissions from the Facility equate to more than 10 % of the workplace exposure limits. There is no background level available in order to consider the PEC.

However, as the assessment is based on workplace exposure limits which are set in order to help protect the health of workers and to aid in demonstrating control of exposure, control is defined as adequate if the principles of good control practice are applied, and the exposure limit is not exceeded. As such, although exceeding the Environment Agency's insignificance threshold for environmental assessment levels, exposure at the point of maximum remains well within the short-term exposure limits and will not therefore have any significant effect.

4. Air Quality Impact at Specific Receptors

The ADMS model was set up to calculate the impact of emissions at thirty specific receptors in the vicinity of the Facility. The locations of these receptors were shown in Figure 4 and fifteen of these represent locations where members of the general public may be present for extended periods of time, either through residence in a particular area, or as a result of their employment. The results have been assessed and, are summarised in Tables 15A – 15C. Process contribution percentages in bold type denote locations where the maximum pollutant contribution, predicted when modelling five-years' worth of meteorological data, could not immediately be screened as insignificant.

As process contributions of CO_2 were compared against workplace exposure limits rather than environmental assessment levels in Section 3.9, and contributions at the point of maximum impact remained well within the exposure limits, contributions of CO_2 at sensitive receptors are not considered, as these will naturally be less than these highest concentrations.

Of the remaining pollutants which were assessed, only four results do not immediately screen as insignificant (see Table 15 B). These were, the contribution to $PM_{2.5}$ when compared against the future target level, the annual average Benzene and 1,3-Butadiene contributions at Receptor Number 4, and the annual average 1,3 Butadiene contribution at Receptor Number 5.

At each of the receptor points, these higher contributions are all approximately an order of magnitude lower than the results already assessed at the point of maximum impact across the modelled grid. With each of the maximum contributions having already been deemed to have no significant effect on air quality and therefore human health, when the predicted environmental concentrations are assessed, the same will naturally be true at the modelled receptor points, where a similar background concentration could be expected.

Therefore, although contributions of $PM_{2.5}$ (when assessed against the future target), Benzene and 1,3 Butadiene do not screen as insignificant at Receptor Number 4, and nor does the contribution of 1,3-Butadiene at Receptor Number 5, they all screen at the second stage assessment and hence will have no significant impact at these locations.

Table 15A Results from Detailed Assessment for Specific Human Health Receptors (PC in µg m^{-3})

Receptor Number	NO_x as NO_2 (ST NO_2 = 50 % NO_x)				Particulate Matter as PM_{10}			
	Annual PC	% of AQS	99.79th % Hourly PC	% AQS	Annual PC	% of AQS	90.41st % Daily PC	% of AQS
1	0.0233	0.06 %	0.4125	0.21 %	0.0539	0.13 %	0.1668	0.33 %
2	0.0411	0.10 %	0.8706	0.44 %	0.0499	0.12 %	0.1268	0.25 %
3	0.0241	0.06 %	0.3840	0.19 %	0.0426	0.11 %	0.1191	0.24 %
4	0.0711	0.18 %	1.1727	0.59 %	0.1616	0.40 %	0.4631	0.93 %
5	0.0540	0.13 %	1.1048	0.55 %	0.0890	0.22 %	0.3164	0.63 %
6	0.0208	0.05 %	0.7708	0.39 %	0.0359	0.09 %	0.1392	0.28 %
7	0.0074	0.02 %	0.1975	0.10 %	0.0127	0.03 %	0.0470	0.09 %
8	0.0362	0.09 %	0.8805	0.44 %	0.0456	0.11 %	0.1891	0.38 %
9	0.0154	0.04 %	0.4216	0.21 %	0.0449	0.11 %	0.1577	0.32 %
10	0.0221	0.06 %	0.3269	0.16 %	0.0273	0.07 %	0.0703	0.14 %
11	0.0417	0.10 %	0.9185	0.46 %	0.0468	0.12 %	0.1244	0.25 %
12	0.0221	0.06 %	0.3006	0.15 %	0.0366	0.09 %	0.1017	0.20 %
13	0.0120	0.03 %	0.3027	0.15 %	0.0243	0.06 %	0.0829	0.17 %
14	0.0200	0.05 %	0.4129	0.21 %	0.0304	0.08 %	0.1173	0.23 %
15	0.0087	0.02 %	0.1927	0.10 %	0.0231	0.06 %	0.0744	0.15 %

Table 15B Results from Detailed Assessment for Specific Human Health Receptors (PC in μg m^{-3})

Receptor Number	Particulate Matter as $PM_{2.5}$			Volatile Organic Compounds (as 5 % of Total)				
	Annual PC	% of Current AQS	% of Future Target	Annual PC	% of Benzene EAL	% of 1,3-Butadiene EAL	Daily PC	% of Benzene EAL
1	0.0525	0.26 %	0.52 %	0.0211	0.42 %	0.94 %	0.2667	0.89 %
2	0.0487	0.24 %	0.49 %	0.0196	0.39 %	0.87 %	0.1553	0.52 %
3	0.0420	0.21 %	0.42 %	0.0170	0.34 %	0.75 %	0.1494	0.50 %
4	0.1574	0.79 %	**1.57 %**	0.0623	**1.25 %**	**2.77 %**	0.5266	1.76 %
5	0.0832	0.42 %	0.83 %	0.0331	0.66 %	**1.47 %**	0.3832	1.28 %
6	0.0344	0.17 %	0.34 %	0.0139	0.28 %	0.62 %	0.2027	0.68 %
7	0.0122	0.06 %	0.12 %	0.0049	0.10 %	0.22 %	0.0696	0.23 %
8	0.0441	0.22 %	0.44 %	0.0174	0.35 %	0.77 %	0.2368	0.79 %
9	0.0417	0.21 %	0.42 %	0.0169	0.34 %	0.75 %	0.2986	1.00 %
10	0.0264	0.13 %	0.26 %	0.0106	0.21 %	0.47%	0.0887	0.30 %
11	0.0455	0.23 %	0.45 %	0.0182	0.36 %	0.81 %	0.1608	0.54 %
12	0.0351	0.18 %	0.35 %	0.0146	0.29 %	0.65 %	0.1595	0.53 %
13	0.0230	0.11 %	0.23 %	0.0095	0.19 %	0.42 %	0.1730	0.58 %
14	0.0297	0.15 %	0.30 %	0.0121	0.24 %	0.54 %	0.1548	0.52 %
15	0.0219	0.11 %	0.22 %	0.0088	0.18 %	0.39 %	0.1114	0.37 %

Table 15C Results from Detailed Assessment for Specific Human Health Receptors (PC in µg m^{-3})

Receptor Number	Ammonia				Hydrogen Sulphide			
	Annual PC	% of AQS	Hourly PC	% AQS	Annual PC	% of AQS	Daily PC	% of AQS
1	0.0401	0.022 %	1.611	0.06 %	0.0803	0.06 %	1.016	0.68 %
2	0.0373	0.021 %	1.964	0.08 %	0.0746	0.05 %	0.592	0.39 %
3	0.0323	0.018 %	1.612	0.06 %	0.0646	0.05 %	0.569	0.38 %
4	0.1188	0.066 %	3.727	0.15 %	0.2376	0.17 %	2.007	1.34 %
5	0.0631	0.035 %	3.346	0.13 %	0.1262	0.09 %	1.460	0.97 %
6	0.0265	0.015 %	2.603	0.10 %	0.0529	0.04 %	0.772	0.51 %
7	0.0093	0.005 %	1.336	0.05 %	0.0186	0.01 %	0.265	0.18 %
8	0.0331	0.018 %	2.832	0.11 %	0.0661	0.05 %	0.902	0.60 %
9	0.0322	0.018 %	3.891	0.16 %	0.0644	0.05 %	1.138	0.76 %
10	0.0202	0.011 %	1.582	0.06 %	0.0405	0.03 %	0.338	0.23 %
11	0.0347	0.019 %	1.518	0.06 %	0.0695	0.05 %	0.613	0.41 %
12	0.0278	0.015 %	1.115	0.04 %	0.0557	0.04 %	0.608	0.41 %
13	0.0181	0.010 %	1.284	0.05 %	0.0362	0.03 %	0.659	0.44 %
14	0.0231	0.013 %	1.618	0.06 %	0.0463	0.03 %	0.590	0.39 %
15	0.0167	0.009 %	1.224	0.05 %	0.0335	0.02 %	0.424	0.28 %

5. Air Quality Impact at Air Quality Monitoring Receptors

The ADMS model was also set up to calculate the impact of emissions at eleven nearby specific receptors where East Riding of Yorkshire Council undertakes air quality monitoring. The location of these receptors was shown in Figure 4 as Receptor Numbers 20 to 30, and the results of the maximum annual average process contribution to background concentrations of NO_2 at each of these locations are presented in Table 16 below.

Table 16 Results from Detailed Assessment for Nitrogen Dioxide at Nearby Air Quality Monitoring Locations

Receptor Number	Annual Average NO_2 PC (µg m^{-3})	Percentage of the AQS	Background Concentration (µg m^{-3})*	PEC (µg m^{-3})	Percentage of the AQS/EAL
20	0.0128	0.03 %	16.3#	16.31	40.8 %
21	0.0187	0.05 %	12.6#	12.62	31.5 %
22	0.0152	0.04 %	**41**	41.02	**102.5 %**
23	0.0043	0.01 %	**40**	40.00	**100.0 %**
24	0.0047	0.01 %	29	29.00	72.5 %
25	0.012	0.03 %	21	21.01	52.5 %
26	0.0103	0.03 %	35	35.01	87.5 %
27	0.0433	0.11 %	16.3#	16.34	40.9 %
28	0.0098	0.02 %	29	29.01	72.5 %
29	0.0517	0.13 %	17	17.05	42.6 %
30	0.0221	0.06 %	31	31.02	77.6 %

* Measured background concentrations from 2019 are applied in the assessment where available, in order to negate any influence from the Covid lock-down periods.
# Measured data from 2022.

The results show that the increase in annual average NO_2 concentrations due to the operation of the dry AD Facility at each of the nearby monitoring sites is a fraction than 1 % of the AQS objective value, and is therefore immediately screened as insignificant. When considered in relation to the existing background, annual average NO_2 process contributions attributable to the operation of the Facility do not trigger any exceedance of the AQS objective value, where one does not already exist and nor do the contributions result in an overall predicted environmental concentration equating to more than 70 % of the AQS, where this is not already the case at these monitoring points.

6. Impact of Emissions on Nearby Ecological Receptors

Four ecological receptor locations were incorporated into the ADMS model representing designated ecological habitats within a 10 km radius of the development site, and Sites of Special Scientific Interest (SSSI) within 2 km of the site. Receptor Numbers 16 – 18 represent locations on the bank of the River Humber, a National Site Network receptor, being a Ramsar, SAC, SPA and SSSI, and Receptor Number 19 represent the Melton Bottom Chalk Pit, a SSSI site of geological interest.

6.1 Assessment Relative to Critical Level Values

Annual average process contributions of NO_x and Ammonia were calculated for each of the ecological receptors using the ADMS model, and the predicted increases were compared against their respective critical level values as specified by the Environment Agency[4]. The critical levels are summarised in the following table.

Table 17 Critical Levels for NO_x and NH_3

Pollutant	Averaging Period	Critical Level ($\mu g\ m^{-3}$)
Oxides of Nitrogen (NO_x as NO_2)	Annual	30
Oxides of Nitrogen (NO_x as NO_2)	24-hr	75
Ammonia (Other Vegetation)	Annual	1 - 3

The critical level (CL) for Ammonia is stated as a range and this accounts for a more stringent (lowest) level for areas where lichen or bryophytes may be present, with the less stringent (higher) level applied elsewhere. As the ecological receptors under consideration are the Humber Estuary and a site of geological interest, whereas lichens and bryophytes are more generally associated with woodland, it is appropriate to assign a critical level of 3 to the local ecological receptors.

The results from the critical levels assessment are presented in the tables below. As the environmental assessment level for ecological receptors considers NO_x as NO_2, the results provided are of total NO_x.

Table 18 Critical Levels Assessment for NO_x and SO_2

Ecological Receptor Name	Annual NO_x PC ($\mu g\ m^{-3}$)	Percentage of Critical Level	Daily NO_x PC ($\mu g\ m^{-3}$)	Percentage of Critical Level	Annual NH_3 PC ($\mu g\ m^{-3}$)	Percentage of Critical Level
16 – Humber Estuary 1	0.0540	0.18 %	0.7087	0.94 %	0.0631	**2.10 %**
17 – Humber Estuary 2	0.0208	0.07 %	0.3432	0.46 %	0.0265	0.88 %
18 – Humber Estuary 3	0.0074	0.02 %	0.1203	0.16 %	0.0093	0.31 %
19 Melton Bottom Chalk Pit	0.0075	0.03 %	0.1020	0.14 %	0.0138	0.46 %

As can be seen in Table 18 above, and with the exception of annual average contributions of Ammonia to one of the three locations on the Humber Estuary, the annual average process contributions of NO_x and NH_3 at each of the receptors considered are less than 1 % of the relevant critical levels.

Where the process contribution of Ammonia is not immediately screened as insignificant the addition of the existing background concentration (2 $\mu g\ m^{-3}$, obtained for the Humber Estuary from the APIS website[12]) results in a PEC of 2.063 $\mu g\ m^{-3}$ which equates to 68.8 % of the critical level and, being less than 70 % of the assessment value, can be considered to be not significant.

6.2 Assessment Relative to Site-Specific Critical Load Values

Sensitive ecological receptors may also be sensitive to nutrient Nitrogen and acid deposition, and where relevant, an assessment has been made of the potential for deposition to occur. Information on site specific critical loads and background levels of nutrient Nitrogen and acid deposition were obtained from the APIS website[12]. The Humber Estuary is specified on the APIS website as not being sensitive to nutrient Nitrogen nor acid deposition, although dunes and salt marshes associated with the estuary may be. The Melton Bottom Chalk Pit is also not sensitive to nutrient Nitrogen or acid deposition.

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

Dry deposition of:	**Grassland Velocity (m s^{-1})**
NO_2	0.0015
NH_3	0.02

Wet deposition was also modelled and applied default washout coefficients: A = 0.0001 and B = 0.64.

Although there are no dunes situated on the banks of the River Humber close to the MET dry AD Facility location, it was assumed for the purpose of this study that the river bank may include salt marsh areas. As such, a nutrient Nitrogen critical load range of 10 – 20 kg N ha^{-1} $year^{-1}$ was assigned to the local area.

The following methods were applied when calculating total nutrient Nitrogen and acid deposition rates.

Nitrogen Based Species

Levels of dry NO_x deposition were multiplied by 0.7 in order to represent the deposited level of NO_2, as NO does not deposit in any significant quantity. The resultant µg m^{-2} s^{-1} figures were multiplied by 95.9 to calculate the contributions to nutrient Nitrogen deposition. Levels of nutrient Nitrogen from Ammonia releases were calculated by multiplying the dry deposited Ammonia level reported from the modelling exercise by 260, before the contributions from NO_2 and NH_3 releases were summed to provide a total kg N ha^{-1} $year^{-1}$ nutrient Nitrogen deposition loading.

Table 19 Results from Detailed Modelling of Nitrogen Deposition in Relation to the Site-Specific Critical Load

Ecological Receptor Name	N Deposition (kgN/ha/yr)	% Lower Critical Load (10 kgN/ha/yr)	% Higher Critical Load (20 kgN/ha/yr)
16 – Humber Estuary 1	0.334	**3.3 %**	**1.7 %**
17 – Humber Estuary 2	0.140	**1.4 %**	0.7 %
18 – Humber Estuary 3	0.049	0.5 %	0.2 %

The results in Table 19 confirm that the contributions of nutrient Nitrogen to areas of salt marsh that may occur along the banks of the Humber Estuary in areas close to the MET dry AD Facility may equate to more than 1 % of the critical levels assigned to that habitat in some areas. Coupled with a level of background deposition that is already quite high (18.2 kg N ha^{-1} $year^{-1}$ in the areas closest to the riverbank in this area[12]), the PEC of nutrient Nitrogen across all three receptor locations would range from 91 – 93 % of the critical load, with the most substantial contribution from the existing background. This existing pressure is recognised in the status of the SSSI in the vicinity of the MET dry AD Facility, with both units 26 (within which Receptor Number 18 is located) and 27 (within which Receptor Numbers 16 and 17 are located) being assigned an ‘Unfavourable – Recovering’ status when they were last assessed in August 2010[13].

The description of the habitats for the two units are:

- Fen, marsh and swamp (lowland) for unit 26, and
- Littoral sediment for unit 27

Although not specifically designated as salt marsh, the critical load assigned is therefore assumed to apply to Receptor Number 18 only of the three locations modelled and, as process contributions at this receptor remain within 1 % when considering either the lower or the higher critical load assigned, the potential impact screens as insignificant. In each case, the PEC remains within the higher critical load of 20 kg N ha^{-1} $year^{-1}$.

Significantly, it should be noted that exceedance of a critical load is not a quantitative estimate of damage to a particular habitat but instead represents the potential for damage to occur. Accordingly, and noting that the incremental increase in Nitrogen deposition attributable to emissions of NO_x and NH_3 from the Facility is low at all receptors, it is unlikely to have a measurable effect on the integrity of the any of the ecological habitat sites considered.

7. Odour Potential

7.1 Introduction

As a biological treatment process, the MET Facility activities include the handling and storage of biodegradable wastes. Although the nature of the operation promotes just-in-time delivery, limited storage and controlled handling of the waste materials, the site does have the potential to create odours if not correctly managed. The air ventilation system that serves all internal process areas and potentially odorous process emissions includes an abatement system that is guaranteed to limit the concentration of odour in the discharged air to 1,000 OU_E m^{-3}, although in reality it is expected to discharge at approximately half that concentration.

7.2 Detailed Atmospheric Dispersion Modelling of Odour

Detailed atmospheric dispersion modelling was undertaken to assess the potential impact on ground level odour concentrations of emissions from the abated ventilation air.

Details of the discharge conditions and anticipated odour levels were presented in Tables 2 and 3 in Section 2.2 and were incorporated into the model as per other releases, with similar building layouts, meteorological and environmental conditions applied as previously.

Determining Significance

The perception of odour requires three inputs: a source; a pathway and the presence of receptors. The scale of the impact is determined by parameters collectively referred to as FIDOL (Frequency, Intensity, Duration, Offensiveness and Location), which are described in more detail in the table below, and are taken from guidance provided by the Institute for Air Quality Management (IAQM)[14].

Frequency	How often an individual is exposed to odour
Intensity	The individual's perception of the strength of the odour
Duration	The overall duration that individuals are exposed to an odour over time.
Odour unpleasantness	Odour unpleasantness describes the character of an odour as it relates to the 'hedonic tone' (which may be pleasant, neutral or unpleasant) at a given odour concentration/intensity. This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

Based on the FIDOL factors, IAQM defines three levels of sensitivity for nearby receptors that can be applied when defining the odour impact risk using atmospheric dispersion modelling techniques. These assessment criteria are defined in terms of a minimum concentration of odour (reflecting the intensity / strength) that occurs for a minimum period of time (reflecting duration and frequency) over a typical meteorological year. The concentration element of these criteria can be increased or lowered to reflect variations in the offensiveness of the odours released from a specific type of facility, and the sensitivity of nearby locations.

High sensitivity receptor	Surrounding land where: • users can reasonably expect enjoyment of a high level of amenity; and • people would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium sensitivity receptor	Surrounding land where: • users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or • people wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Low sensitivity receptor	Surrounding land where: • the enjoyment of amenity would not reasonably be expected; or • there is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

In terms of the above sensitivity criteria, residential properties in the vicinity of the MET site would be classified as "high sensitivity receptors", although commercial and industrial land in the immediate vicinity of the MET site would be classified as a "low sensitivity receptor".

IAQM guidance states that:

"a high sensitivity receptor subject to a large odour exposure will experience a substantial adverse effect, and a low sensitivity receptor subject to a small odour exposure will experience a negligible effect; however, between these extremes the various combinations will give rise to a gradation of effects for which no descriptor terms have been universally agreed."

The IQMA guidance proposes the following general framework of descriptors for the magnitude of effects for receptors of different sensitivities.

Relative Odour Exposure (Impact)	Receptor Sensitivity: Low	Receptor Sensitivity: Medium	Receptor Sensitivity: High
Very Large	Moderate adverse	Substantial adverse	Substantial adverse
Large	Slight adverse	Moderate adverse	Substantial adverse
Medium	Negligible	Slight adverse	Moderate adverse
Small	Negligible	Negligible	Slight adverse
Negligible	Negligible	Negligible	Negligible

Applicable to odours at the "most offensive" end of the relative-unpleasantness spectrum

In terms of defining the magnitude and significance of the impact, the IAQM guidance proposes the following assessment matrix when considering the most offensive odours:

Odour Exposure Level C_{98}, ou_E/m^3	Receptor Sensitivity: Low	Receptor Sensitivity: Medium	Receptor Sensitivity: High
≥10	Moderate	Substantial	Substantial
5-<10	Moderate	Moderate	Substantial
3-<5	Slight	Moderate	Moderate
1.5-<3	Negligible	Slight	Moderate
0.5-<1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible

It should be noted that the Table applies equally to cases where there are increases and decreases in odour exposure as a result of this development, in which case the appropriate terms "adverse" or "beneficial "should be added to the descriptors.

The Odour Exposure Level is expressed as the 98th percentile of the modelled hourly averages. The IAQM states within their guidance that:

"Odour assessment methodology, as it has developed in Europe and UK over the last 35 years, has become well-established. The predictive, quantitative approach involves obtaining estimates of the odour source emission rate, use of the emissions in a dispersion model to predict 98th percentile concentration at sensitive receptors and comparison of these with criteria that have evolved from research and survey work. At the present time, this remains an accepted technique and the IAQM supports this."

However, the level of offensiveness of any odour must also be taken into account as some process odours may of course be pleasant. Within their 'H4' odour management guidance[15], the Environment Agency suggests the following criterion for differing odour sources:

Criterion, C_{98} ou_E/m^3	Offensiveness	Odour Emission Sources
1.5	Most Offensive	Processes involving decaying animal or fish remains Processes involving septic effluent or sludge Biological landfill odours
3.0	Moderately Offensive	Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting
6.0	Less Offensive	Brewery Confectionery Coffee

Accordingly, an EAL of 3 OU_E m^{-3}, appropriate for the assessment of moderately offensive odours, was used as the basis for the assessment of odour releases from the MET dry AD Facility. It is noted that both of the preceding odour exposure tables above detail the impact of the 'most offensive' odours and hence, for a 'moderately offensive' odour, a level of judgement must be applied to the assessment.

For the purpose of this assessment therefore, the magnitude and significance matrix for the impact of moderately offensive odours is applied as follows:

Odour Exposure Level C_{98}, ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
≥10	Moderate	Substantial	Substantial
5-<10	Slight	Moderate	Moderate
3-<5	Negligible	Slight	Moderate
1.5-<3	Negligible	Negligible	Slight
0.5-<1.5	Negligible	Negligible	Negligible
<0.5	Negligible	Negligible	Negligible

It should be noted that the Table applies equally to cases where there are increases and decreases in odour exposure as a result of this development, in which case the appropriate terms "adverse" or "beneficial "should be added to the descriptors.

7.3 Results from Detailed Modelling of Odour Release

The results from detailed odour modelling are presented in Table 20 over page and reflect the maximum hourly average process contribution (PC) for odour, expressed as the 100th percentile (maximum hour and therefore, worst-case) and the 98th percentile value at the point of maximum impact, over five years of meteorological conditions. The number of hours in each year that reported concentrations above 3 are also listed, as is a description of the location where the maximum impact occurs.

Table 20 Results of Detailed Modelling – Maximum Process Contribution to Ground Level Odour Concentration

Odour Concentrations $OU_E\ m^{-3}$	2018	2019	2020	2021	2022
Maximum Hour (100th Percentile)	6.48	6.358	6.454	6.454	6.36
Location of Occurrence	All occur within the wider Melton Waste Park				
98th Percentile	2.52	2.646	2.629	2.764	2.689
Location of Occurrence	All occur within the wider Melton Waste Park				
Results > 3 $OU_E\ m^{-3}$	83	103	95	149	90
Percentage of Results > 3	0.95%	1.18%	1.08%	1.70%	1.03%

The detailed modelling predicted that during the five years' worth of meteorological conditions assessed, odour concentrations would not exceed 3 $OU_E\ m^{-3}$ expressed as the 98th percentile of the hourly average, at any location across the modelled grid. While the 100th percentile, maximum hourly average concentration did exceed 6 $OU_E\ m^{-3}$, it remained within 6.5 $OU_E\ m^{-3}$ at all times, and the points of maximum impact occur within the Melton Waste Park whether considering the 100th or 98th percentile values. Concentrations were above 3 $OU_E\ m^{-3}$ for between 0.95 % and 1.7 % of the year, with the 98th percentile representing up to 175 exceedances of the appropriate assessment level, in any given year.

With such low levels of odour predicted to occur within the boundary of the wider Melton Waste Park, it is considered that there is negligible potential for odour emissions from the MET Facility have a negative impact on local sensitive receptors.

In summary the;

Frequency of any exposure at or beyond the Melton Waste Park boundary will be small (< 2 %) during the course of any year. Although higher concentrations can occur within the Melton Waste Park, these are infrequent and the site would be considered to be a low sensitive receptor;
Intensity of the odour to be experienced may be heightened in the local area by historical incidents, although the overall odour release from the MET dry AD Facility and the wider Melton Waste Park is expected to be minimal;
Duration of the odour exposure period is limited, with modelling reporting hourly average results;
Odour from biological treatment facilities is considered to have a medium offensiveness;
Location is largely commercial / industrial, but includes a mixture of high and low sensitivity receptors in the vicinity of the site.

The overall impact of odour emissions from the MET site is however, expected to be of negligible significance due to the appropriate process operation and control which include short storage times, the internal storage and handling of waste materials, and the discharge of ventilation air that has first passed through a purpose designed, dedicated abatement system.

8. Cumulative Impact with Other Recent Developments and Proposals

Although the potential impacts of the Facility are effectively screened as insignificant or are deemed not to be significant at the secondary assessment stage, it is recognised here that the wider Melton Waste Park includes other emission sources that might also impact on air quality locally. Although existing facilities are naturally considered through the incorporation of a background level, which will include contributions from those sites which are already operational, where plant are new, are under construction or have only recently been commissioned, it is likely that the contributions from those plant will not be included in the existing background data, and thus a cumulative impact assessment must consider the likely overall impact of the future operations.

The following processes are operational or planned within the Melton Waste Park, and hence have been included within the cumulative assessment:

- Three 0.95 MW_{th} biomass boilers (existing Transwaste operation);
- Three 1 MW_{th} Small waste incineration plants (existing Transwaste plant but not yet fully operational);
- Proposed energy from waste plant. The plans for this are uncertain at this stage but have been based on the most recent, fully available data for the site. It is anticipated that this process will require a number of years to be permitted, constructed and commissioned. However, it has been included here in order to consider a worst, though anticipated case.

The discharge characteristics and mass emission rates from each stack are as follows:

Table 21 Cumulative Assessment Input Data

Parameter	3 x biomass plant	3 x SWIPs	Energy from Waste
Height of Release (m)	11	22	55
Diameter (m)	0.48	0.3	1
Location (x,y)	496652.5, 425324.3 496650.6, 425317.9 496661.4, 425316.9	496831, 425402.5 496842, 425402.5 496854, 425402.25	496710, 425461
Flue-Gas Temperature (°C)	182.6	160	150
Flue-Gas Moisture Content (%)	15	12	18.11
Flue-Gas Oxygen Content (% dry)	8.43	7	4.97
Volumetric Flowrate (Actual) ($m^3\ s^{-1}$)	0.974	0.815	61.14
Reference Conditions; STP, dry and O_2 %	6	11	11
Volumetric Flowrate ($m^3\ s^{-1}$)	0.415	0.635	52
Flue-Gas Velocity ($m\ s^{-1}$)	5.4	11.53	19.86
Mass Releases ($g\ s^{-1}$)	**3 x biomass plant**	**3 x SWIPs**	**Energy from Waste**
Ammonia (NH_3)	-	0.00635	0.52
Volatile Organic Compounds (VOCs)	-	0.00635	0.52
Particulate (modelled as PM_{10} and $PM_{2.5}$)	-	0.00635	0.26
Nitrogen Oxides (NO_x as NO_2)	0.249	0.127	6.24

Emissions of Hydrogen Sulphide, Carbon Dioxide and odour have not been modelled cumulatively as they are not expected to be released from the other processes now modelled.

Previously at the Melton Waste Park, Eco-Power operated a large number of small wood-fired boilers. However, this installation is currently not operational and is not expected to operate again in its current form. As such, it has been discounted from the assessment. A review of the East Riding of Yorkshire planning portal has not identified any other potential and significant facilities in the local area that may require scoping into the assessment.

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

Table 22 Human Health Assessment of Maximum Cumulative Process Contributions

Pollutant	Averaging Period and Units	Maximum Cumulative Contribution	Assessment Level	Percentage of Assessment Level	PEC (PC plus Local Background)	Percentage of Assessment Level	Revised ST Assessment Level*	PC as Percentage of Revised EAL
Ammonia	Annual µg m^{-3}	1.09	180	0.61 %	2.48	1.38 %	-	-
	Hourly µg m^{-3}	24.69	2500	0.99 %	27.47	1.1 %	2,497.2	1 %
Benzene#	Annual µg m^{-3}	0.57	5	**11.4 %**	0.75	15 %	-	-
	Daily µg m^{-3}	4.13	30	**13.8 %**	4.49	15 %	29.64	13.9 %
1,3-Butadiene#	Annual µg m^{-3}	0.57	2.25	**25.3 %**	0.65	28.8 %	-	-
Particulate (as PM_{10})	Annual µg m^{-3}	3.24	40	**8.1 %**	16.69	42 %	-	-
	90.41^{st} % Daily µg m^{-3}	9.02	50	**18 %**	35.91	**72 %**	23.10	**39 %**
Particulate (as $PM_{2.5}$)	Annual µg m^{-3}	3.24	20	**16.2 %**	10.82	54 %	-	-
Nitrogen Dioxide	Annual µg m^{-3} (NO_2 = 100 % NO_x)	21.1.	40	**53 %**	28.92	**72 %**	-	-
	Annual µg m^{-3} (NO_2 = 70 % NO_x)	14.77	40	**37 %**	22.59	56 %	-	-
	99.79 % Hourly µg m^{-3} (NO_2 = 50 % NO_x)	120.1	200	**60 %**	135.74	68 %	184.36	**65 %**
	99.79 % Hourly µg m^{-3} (NO_2 = 35 % NO_x)	84.07	200	**42 %**	99.71	50 %	184.36	**46 %**

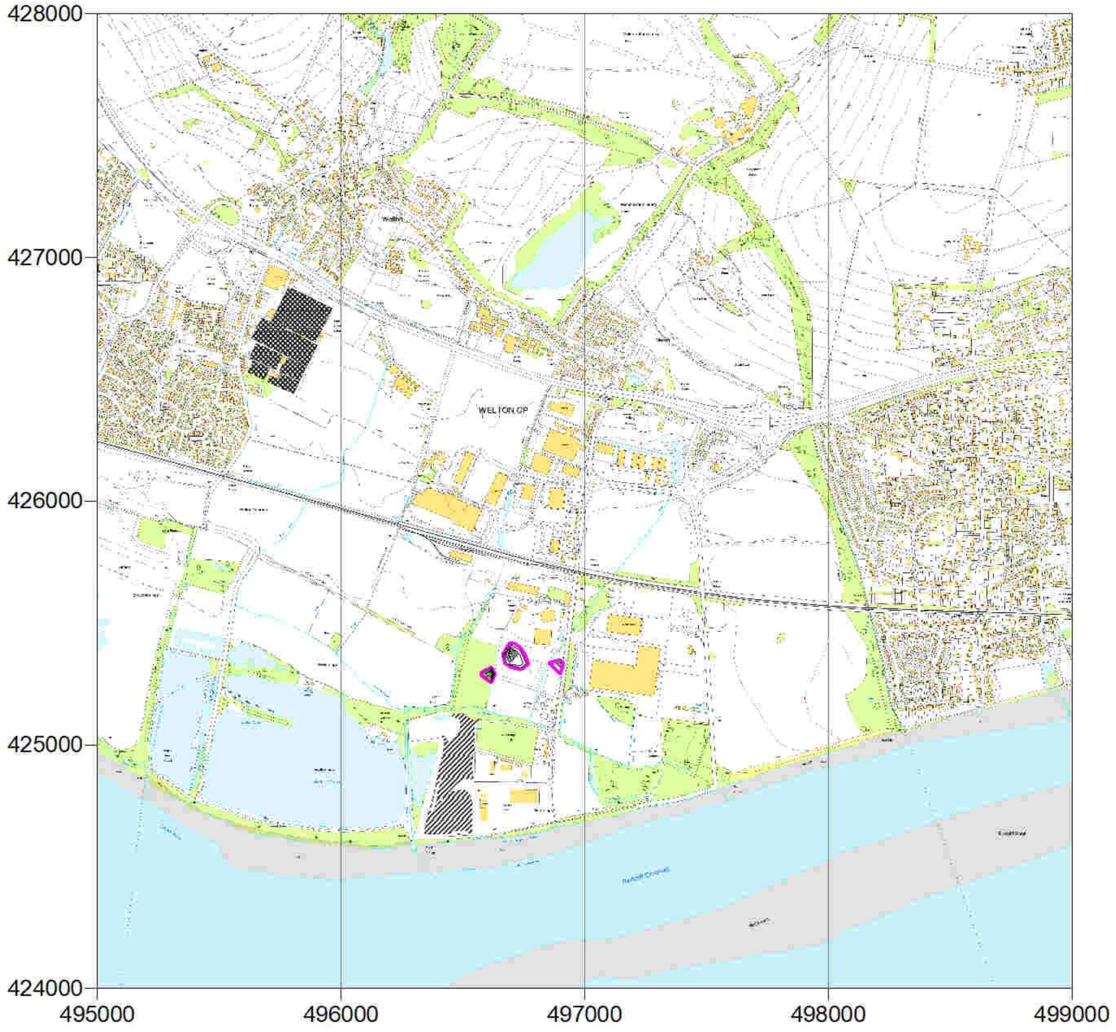
* As previously, the revised short-term assessment level for the second stage assessment is calculated as the air quality standard objective value or environmental assessment level, minus twice the long-term background concentration.
# Benzene and 1,3-Butadiene are each assumed to comprise 5 % of the total VOC discharge.

The cumulative process contributions of Ammonia immediately screen as insignificant when considering potential impacts on air quality and human health. Cumulative process contributions of other pollutants do not screen immediately, but go on to be confirmed as not significant in all cases except for short term contributions of particulate matter as PM_{10} and of Nitrogen Dioxide, and annual average Nitrogen Dioxide contributions when NO_2 is modelled as 100 % NO_x. However, as per the AQMAU modelling guidance[9], long-term averaging period contributions of NO_2 from combustion sources such as those operated around the Melton Waste Park, will conservatively comprise only 70 % NO_2 and, when correcting the contribution on that basis, the cumulative annual average PEC is confirmed as being not significant.

When considering the short-term PM_{10} contributions, the cumulative PEC remains well within the assessment level, equating to 39 % of 90.41st percentile daily average air quality standard objective value. The spatial area with predicted environmental concentrations between 20 and 39 % of the assessment level is small, as depicted in Figure 15 below, where the magenta contour denotes a process contribution of 4.62 µg m^{-3} or 20 % of the revised short-term assessment level (23.1 µg m^{-3}).

The majority of the area that experiences contributions between 20 and 39 % of the assessment level occur within the Melton Waste Park boundary. However, even where this is not the case, the process contribution remains well within the assessment level and is not an area where members of the public might reasonably be present for 24-hour periods. As such, there is no significant impact predicted from the cumulative emissions of particulate from the Melton Waste Park processes.

Figure 15 90.41st Percentile Daily Average Process Contribution of Particulate Matter as PM_{10} (µg m^{-3}); 2020 Meteorological Conditions



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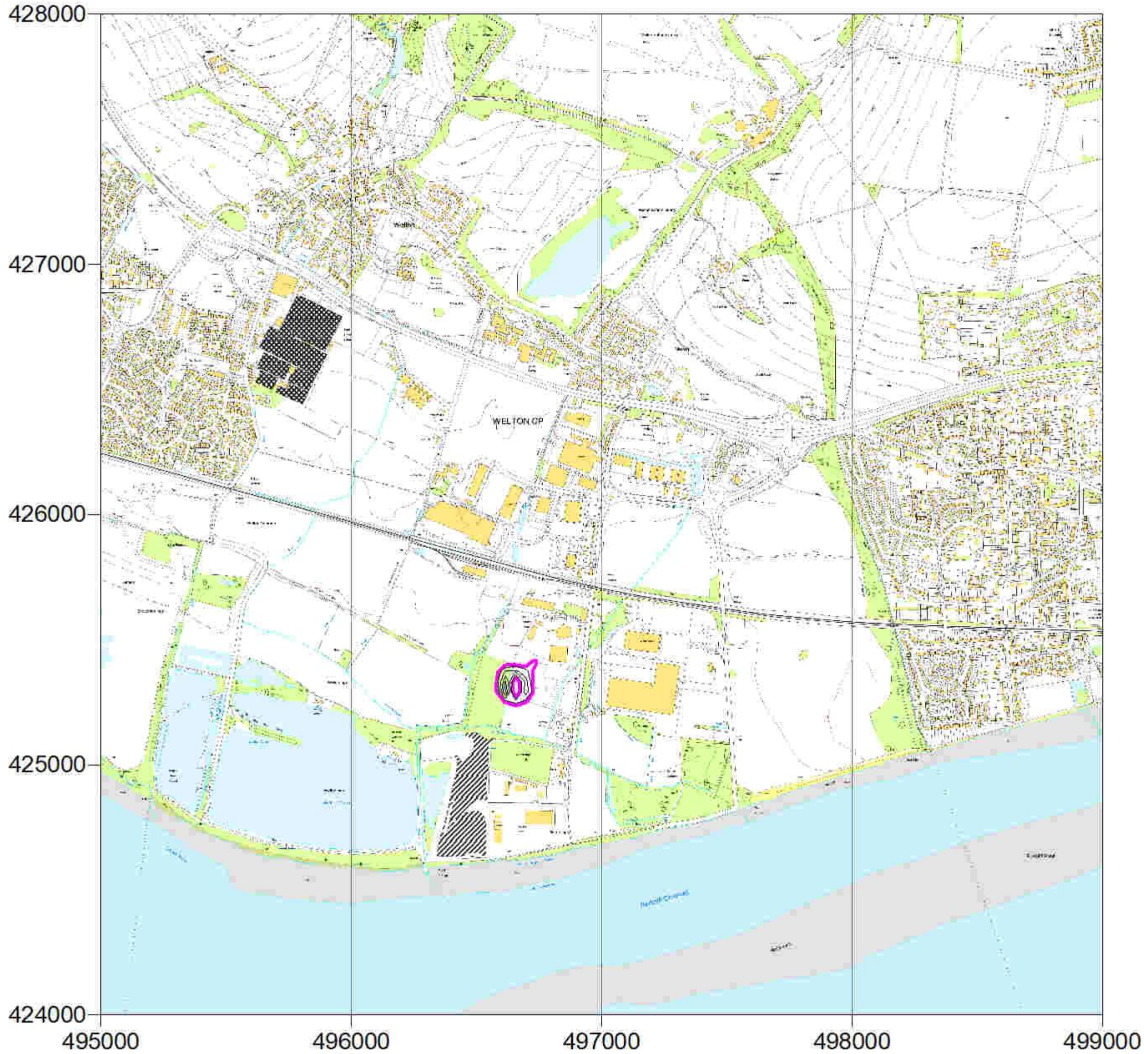
Similar conclusions can be drawn when assessing the short-term contributions of NO_2 which equate to approximately 46 % of the revised short-term assessment level at the point of maximum impact, but which screen as insignificant before reaching any sensitive receptor. Figure 16 shows the contribution of NO_2 modelled as 35 % NO_x with the magenta isopleth denoting the point at which the PC equals 20 % of the air quality standard objective value, minus twice the long-term background concentration.

Figure 16 99.79th Percentile Hourly Average Process Contribution of NO_x as NO_2 (µg m^{-3}); 2019 Meteorological Conditions



The majority of the area that experiences contributions between 20 and 46 % of the assessment level occurs within the Melton Waste Park boundary. However, even where this is not the case, the process contribution remains well within the assessment level and is not an area where members of the public would usually be present. As such, there is no significant impact predicted from the cumulative emissions of Nitrogen Dioxide from the Melton Waste Park processes.

It is noted that although each of the combustion sources across the Melton Waste Park have been included in the cumulative assessment, some of these, specifically the three biomass boilers have been in-situ and operational for several years and therefore contributions from these sources will naturally already be included in the existing background. Additionally, although the proposed energy from waste facility has been modelled as per the project information most recently available, it is understood that this will change substantially going forward, resulting in a reduction in the proposed emissions. Thus, the cumulative emissions modelled and results presented are assumed to represent a significantly conservative assessment.

When considering the potential impact on the national site network area of the Humber Estuary and the Melton Bottom Chalk Pit SSSI, the following cumulative contributions to the site critical levels are predicted.

Table 23 Critical Levels Assessment of Cumulative Impact

Ecological Receptor Name	Annual NO_X PC ($\mu g\ m^{-3}$)	Percentage of Critical Level	Daily NO_X PC ($\mu g\ m^{-3}$)	Percentage of Critical Level	Annual NH_3 PC ($\mu g\ m^{-3}$)	Percentage of Critical Level
16 - Humber Estuary 1	0.848	**2.8 %**	7.592	**10.1 %**	0.0933	**3.11 %**
17 - Humber Estuary 2	0.895	**3.0 %**	10.352	**13.8 %**	0.0650	**2.17 %**
18 - Humber Estuary 3	0.362	**1.2 %**	6.363	8.5 %	0.0294	0.98 %
19 - Melton Bottom Chalk Pit	0.457	**1.5 %**	4.719	6.3 %	0.0350	0.02 %

Although cumulative contributions are not immediately screened as insignificant at all of the modelled points, the addition of background concentrations of NO_x (10.5 $\mu g\ m^{-3}$) and Ammonia (2 $\mu g\ m^{-3}$) confirm that the predicted environmental concentrations of all pollutants remain within 70 % of their critical level, being 38 % (annual average NO_x), 45 % (daily average NO_x) and 69.8 % (Ammonia). As such, the potential cumulative contributions to the sensitive ecological receptor site are considered not to be significant.

The Humber Estuary is specified on the APIS website as not being sensitive to nutrient Nitrogen nor acid deposition, although dunes and salt marshes associated with the estuary may be. The Melton Bottom Chalk Pit is also not sensitive to nutrient Nitrogen or acid deposition.

Although there are no dunes situated on the banks of the River Humber close to the MET dry AD Facility location, it was assumed for the purpose of this study that the river bank may include salt marsh areas. As such, a nutrient Nitrogen critical load range of 10 – 20 kg N ha^{-1} $year^{-1}$ was assigned to the local area. When considering the potential contribution to nutrient Nitrogen critical loads, cumulative contributions were not generally screened as insignificant at the modelled points representing the Humber Estuary.

Table 24 Results from Detailed Modelling of Nitrogen Deposition in Relation to the Site-Specific Critical Load

Ecological Receptor Name	N Deposition (kgN/ha/yr)	% Lower Critical Load (10 kgN/ha/yr)	% Higher Critical Load (20 kgN/ha/yr)
16 - Humber Estuary 1	0.571	**5.7 %**	**2.9 %**
17 - Humber Estuary 2	0.428	**4.3 %**	**2.1 %**
18 - Humber Estuary 3	0.189	**1.9 %**	0.9 %

The results suggest that the cumulative emissions from the site might contribute up to 5.7 % of the nutrient Nitrogen critical load. When coupled with an existing background rate of deposition that already exceeds the lower critical load and equates to 91 % of the higher critical load, the PEC across the three receptor range from 92 – 94 % of the critical load for salt marshes. However, the critical load is not exceeded, and the critical load represents the point from which potential damage might occur.

It should also be remembered that, although each of the combustion sources across the Melton Waste Park have been included in the cumulative assessment, some of these, specifically the three biomass boilers have been in-situ and operational for several years and therefore contributions from these sources will naturally already be included in the existing background. Additionally, although the proposed energy from waste facility has been modelled as per the project information most recently available, it is understood that this will change substantially going forward, resulting in a reduction in the proposed emissions. Coupled with the likelihood that salt marsh is only likely to be relevant at Receptor Number 18 of those locations modelled, and that the PC at this point is insignificant when assessed against the higher critical load, and the cumulative deposition plus the existing background at this point remains within the critical load (equating to approximately 92 % of the higher critical load), it is considered that the nutrient Nitrogen deposition critical load across relevant areas of the Humber is unlikely to be exceeded as a result of the cumulative emissions from the Melton Waste Park.

9. Conclusions

Detailed atmospheric dispersion modelling has been undertaken of emissions to atmosphere from a dry anaerobic digestion plant to be operated by Melton Energy Tech Limited, within the Melton Waste Park, situated off Gibson Lane in Melton. Emissions from the Facility will comprise discharges from the ventilation air abatement process, a gas fired medium combustion plant and the release of CO_2 from the biogas upgrade plant. Modelling of the emissions from the Facility was undertaken for a scenario that represents normal operating conditions while operating at maximum output.

Additionally, consideration of the potential impact of odour emissions and a cumulative assessment that considers other operational or proposed discharges across the Melton Waste Park was also undertaken.

The modelling was undertaken using ADMS Version 6 and incorporated various sensitivity analyses in order to ensure that the model presented a reasonable worst-case assessment. Hourly average meteorological data for the Leconfield measurement station for the years 2018 to 2022 were used to determine maximum process contributions across a 4 km x 4 km receptor grid with 20-metre grid spacing, as well as specified nearby receptor locations.

The model predicted that process contributions for all modelled pollutants would be well below the objective limits defined within the UK Air Quality Standards Regulations, or relevant environmental assessment levels recommended by the Environment Agency, with all impacts from the MET Facility either screening as insignificant or being deemed to be not significant at the secondary assessment stage.

Impacts at the modelled human health receptors almost consistently screened as insignificant, with the four pollutant and averaging periods that could not immediately be screened, being confirmed as not significant at the secondary assessment stage. Contributions of Nitrogen Dioxide at local air quality monitoring sites all immediately screened as insignificant.

At key local ecological receptors, the majority of contributions were deemed to be insignificant, or were confirmed as not significant where not initially screened. Consideration of nutrient Nitrogen deposition at the Humber Estuary assumed a salt marsh sensitivity, associated with areas of the SSSI. Process contributions remain small although were not insignificant and, with a high existing background level that already exceeds the lower critical load and equates to more the 90 % of the higher critical load, the incremental increase in Nitrogen deposition attributable to emissions of NO_x and NH_3 from the Facility is unlikely to have a measurable effect on the integrity of the ecological habitat site.

The process contribution to odour levels in the area remained well within the assessment level of 3 OU_E m^{-3} as a 98th percentile hourly average, at the point of maximum impact across all five-years' of modelled data. As such, no issues of odour nuisance are anticipated from the Facility.

Finally, and by way of presenting an overly conservative, cumulative assessment, contributions from the other existing or proposed relevant emission points across the Melton Waste Park were included in the assessment. It is noted that Transwaste has operated their three small biomass boilers for several years at the site and hence it could be considered that these are already incorporated into any background concentrations. Three 1 MW SWIP plant are also installed although are not yet fully operational, and a proposed energy from waste facility at the Melton Waste Park has not yet been commissioned and its scope will almost certainly be amended prior to detailed design, with an expectation that the capacity of the plant originally proposed will be reduced. As such, the cumulative study provides a best estimate, albeit is expected to represent an overly conservative assessment of the actual cumulative contributions from the waste park. On this basis, and considering the limited spatial extent of the contributions that could not be screened, which do not impact significantly on sensitive receptors, and recognising that contributions of the MET Facility to the total were not significant even at their point of maximum impact, it is considered unlikely that the cumulative process contributions, once all plant are operational, will result in any exceedance of the relevant environmental assessment level.

The overall conclusion from detailed modelling of emissions from the MET dry AD Facility to be located at the Melton Waste Park was that the potential impact on local air quality is likely to be small, generally being screened as insignificant and will not therefore have any significant impact on the health of people living and working nearby, or on the surrounding environment.

10. References

[1] https://www.cerc.co.uk/environmental-software/ADMS-model/data.html

[2] The Air Quality (England) Regulations 2000 SI 2000 No. 928 (as amended)

[3] Air Quality Standards (England) Regulations 2010 SI 2010 No. 1001 (as amended)

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

[5] The Environmental Targets (Fine Particulate Matter) (England) Regulations 2023

[6] https://www.hse.gov.uk/pubns/priced/eh40.pdf

[7] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)

[8] The Environmental Permitting (England and Wales) Regulations 2016. UK Statutory Instrument 2016 No. 1154 (as amended)

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

[10] https://uk-air.defra.gov.uk/data/laqm-background-home

[11] East Riding of Yorkshire 2023 Air Quality Annual Status Report (ASR). June 2023

[12] http://www.apis.ac.uk/

[13] https://magic.defra.gov.uk/magicmap.aspx

[14] Guidance on the assessment of odour for planning. Version 1.1, Institute of Air Quality Management. July 2018

[15] Additional guidance for H4 Odour Management. How to comply with your environmental permit. Environment Agency. March 2011. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296737/geho0411btqm-e-e.pdf