Weaverthorpe-1

Planning Application for an exploration well

Weaverthorpe Wellsite, Land off Butt Lane, Foxholes, Driffield YO25 3HY

Air quality assessment of hydrocarbon exploration operations

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SUMMARY

Egdon Resources UK Limited proposes to undertake hydrocarbon exploration operations at a new site off Butt Lane near Foxholes, known as the Weaverthorpe wellsite. The proposed operation involves drilling a single exploratory borehole and then testing to determine viability. This includes preliminary construction of the wellsite and subsequent decommissioning and site restoration following the test phase. Site electricity requirements will be fully met from on-site generation using diesel fuelled generators. Natural gas produced during a short testing phase will be disposed of by incineration. The expected project duration is around 21-23 weeks in total although there may be periods of dormant activity between phases.

As part of the planning and permitting process, Egdon Resources UK Limited have asked that the dispersion of releases to atmosphere associated with the proposed operations be assessed to determine their impact on ambient concentrations of important pollutants around the local area. Impact at locations of permanent human habitation and designated and local ecological sites, in the context of attainment of applicable environmental standards, requires assessment.

The predominant source of pollutant releases during site operations will be from the use of diesel fuel in mobile plant and stationary engines and from the incineration of produced natural gas. This is largely undertaken during the drilling and testing phases which cover a 12 week period. Releases of nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter and sulphur dioxide were therefore considered. The assessment was undertaken using the UK ADMS 6.0 modelling system, with an operating regime considered to provide unlikely worst case conditions for pollutant releases and air quality impact.

Maximum pollutant process contributions from site operations occur within the wellsite boundary. Beyond this location, process contributions reduce significantly with distance. It is not considered that statutory air quality standards would be applicable around the area of maximum impact, or around and just beyond the site boundary, due to the infrequency of human exposure and limited access.

At neighbouring locations of residential occupation, where long term human exposure might be expected, it is considered that pollutant process contributions from the proposed site operations are insignificant. In all cases the predicted environmental concentration of all pollutants is less than, and in some cases substantially less than, a third of the applicable standard. Bearing in mind the precautionary assumptions made in the assessment, it is considered unlikely that pollutant process contributions from the proposed exploratory operations at the Weaverthorpe wellsite will pose any risk to, or have any meaningful influence on, the continued attainment of air quality standards at the nearest locations of human exposure.

At the nearest designated and local ecological sites requiring assessment, which are sensitive to nitrogen oxides, sulphur dioxide and nitrogen and acid deposition, process contributions are considered unlikely to pose any threat to, or have any substantial influence on, the attainment of critical levels and critical loads.

Necessary assumptions made to undertake the modelling are considered to have the effect of substantially overestimating the process contribution to ambient concentrations. It is considered that the predicted process impact reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort despite the inevitable uncertainty of such modelling studies.

It is likely that the construction activities associated with the development of the wellsite will give rise to dust emissions. It is expected, based on Institute of Air Quality Management methodology, that with adequate mitigation measures in place the risk of dust impact from all proposed development operations will be 'negligible'.

Increases in road traffic brought about by the construction activities and subsequent site operation are assessed to have a neutral impact on air quality based on the guidance within National Highways' Design Manual for Roads and Bridges.

1 INTRODUCTION

Egdon Resources UK Limited (Egdon) placed a contract with SOCOTEC UK Limited (SOCOTEC) to undertake an assessment of the impact on local air quality of proposed hydrocarbon exploration operations at a new wellsite near Foxholes, Driffield.

1.1 Scope of study

Egdon proposes to undertake hydrocarbon exploration operations at a new site off Butt Lane near Foxholes, known as the Weaverthorpe wellsite. The proposed operation involves drilling a single exploratory borehole and then testing to determine viability. The operations include preliminary construction of the wellsite and subsequent decommissioning and site restoration following the test phase. Site electricity requirements will be fully met from on-site generation using diesel fuelled generators. Natural gas produced during a short testing phase will be disposed of by incineration. The expected project duration is around 21-23 weeks in total although there may be periods of dormant activity between phases.

As part of the planning and permitting process, Egdon have asked that the dispersion of releases to atmosphere associated with wellsite operations be assessed to determine their impact on ambient concentrations of important pollutants around the local area.

The main sources of pollutant releases during site development will be from the use of diesel fuel in on-site stationary engines and construction and transport vehicles. There will also be a requirement for incineration of produced natural gas during the well testing phase.

Releases of nitrogen oxides, carbon monoxide, volatile organic compounds, sulphur dioxide and particulate matter were considered. The assessment was undertaken using the UK ADMS 6.0 modelling system with operating scenarios considered to provide worst case conditions for pollutant releases and air quality impact across the proposed operations.

The purpose of this study is to determine whether, under what is considered a worst case operating regime, releases to atmosphere are likely to be dispersed adequately in the context of applicable environmental standard attainment.

1.2 General approach

The approach taken comprised the following main stages:

- Determine a suitable modelling tool for the assessment.
- Collect appropriate representative operational data for the plant and vehicles intended for use for input to the model.
- Establish the proposed timeline for operations and their duration and frequency to determine the amount of discharges from each source and the likely timeline for discharge.
- Establish the location of the points of discharge for each source relative to proposed temporary buildings and structures on the wellsite.
- Establish the locations of any sensitive areas that might be impacted by releases from the wellsite including residential properties, public footpaths and designated and local ecological sites.
- Obtain information on local background concentrations of important pollutants.
- Obtain 5 years' recent meteorological data from a measurement station representative of the wellsite location.

- Model the dispersion of releases from the site operations to determine the process contribution to ambient concentrations of selected pollutants over the local area with particular attention to locations of human exposure and designated and local ecological sites.
- Assess the predicted process contributions and established background concentrations with reference to applicable environmental standards to determine compliance.
- Undertake a sensitivity analysis on the results for other important variable parameters and assess compliance with applicable environmental standards.

1.3 Structure of the report

This report provides an assessment of the impact of releases from proposed exploratory hydrocarbon operations on local air quality near the Weaverthorpe wellsite. The approach to the assessment has been described above. The following sections provide a detailed commentary on the assessment and conclusions:

Section 2 Policy context and assessment criteria
Section 3 Modelling methodology
Section 4 Modelling results
Section 5 Conclusions

2 POLICY CONTEXT AND ASSESSMENT CRITERIA

Egdon proposes to undertake hydrocarbon exploration operations at a new site off Butt Lane near Foxholes, known as the Weaverthorpe wellsite. The proposed operation involves drilling a single exploratory borehole and then testing to determine viability. The operations include preliminary construction of the wellsite and subsequent decommissioning and site restoration following the test phase. Site electricity requirements will be fully met from on-site generation using diesel fuelled generators. Natural gas produced during a short testing phase will be disposed of by incineration. The expected project duration is around 21-23 weeks.

The planned site is located on agricultural land to the north of Butt Lane, near Foxholes and is currently in arable use. The site is located within the administrative boundary of North Yorkshire Council, although the boundary with the East Riding of Yorkshire is just 350m to the east. The village of Foxholes is around 850m to the west. The nearest site with an ecological designation is the Gypsy Race local wildlife site, around 500m to the south. This and the West Dale, Fordon local wildlife site are the only areas with ecological designations within 2km of the proposed wellsite. The nearest residential property is West Field House, which lies around 640m to the east of the proposed wellsite.

2.1 Context of assessment

As part of the planning and permitting application, it is necessary to demonstrate the likely impact of the proposed exploration operations on local ambient concentrations of important pollutants. It is in this context that the operations are being examined to determine their additional contribution to the existing concentrations of pollutants and therefore determine compliance with applicable air quality standards and environmental benchmarks.

Local Authorities are required to assess compliance with applicable air quality objectives. Where the objectives are unlikely to be met, the Local Authority is required to declare an Air Quality Management Area (AQMA) and prepare proposals for remedial action to achieve the required objective. The nearest AQMA is the Hull AQMA, designated for annual mean nitrogen, which is around 44km to the south and unlikely to be influenced by releases from the proposed wellsite.

A survey of planning and permitting applications did not indicate any recently approved, or proposed future developments, with the potential to influence background concentrations of pollutants of interest in the area near the wellsite.

The Environment Agency play an important role in relation to local air quality management by ensuring that processes under their regulatory control do not contribute any significant threat to the attainment of air quality standards. As part of the planning and permitting process it is necessary to demonstrate the impact of site operations on local air quality in the context of the published guidance provided by the Environment Agency[1].

2.2 Local policies

The following policies are most relevant to the preparation of an Air Quality Assessment in North Yorkshire. These have been taken into account in preparing this Assessment.

Minerals and Waste Joint Plan (2022)

D02 Local amenity and cumulative impacts

1) Proposals for minerals and waste development, including ancillary development and minerals and waste transport infrastructure, will be permitted where it can be demonstrated that there will be no unacceptable

impacts on the amenity of local communities and residents, local businesses and users of the public rights of way network and public open space including as a result of: …
• dust,
• odour,
• emissions to air, land or water …

D14 Air quality

Proposals for mineral and waste development will be permitted provided that:

(a) there are no unacceptable impacts on the intrinsic quality of air;
and
(b) there are no unacceptable impacts on the management and protection of air quality, including any unacceptable impacts on Air Quality Management Areas.

M17 Other spatial and locational criteria applying to hydrocarbon development

Cumulative impact

2(i) Hydrocarbon development will be permitted in locations where it would not give rise to unacceptable cumulative impact, as a result of a combination of individual impacts from the same development and/or through combinations of impacts in conjunction with other existing, planned or unrestored hydrocarbons development.

Specific local amenity considerations relevant to hydrocarbon development

4(i) Hydrocarbon development will be permitted in locations where it would not give rise to unacceptable impact on local communities or public health. Adequate separation distances should be maintained between hydrocarbon development and residential buildings and other sensitive receptors in order to protect against unacceptable adverse individual and cumulative impacts on amenity and public health….

4(II) Proposals should refer to any relevant data from baseline monitoring and other available information to ensure that a robust assessment of potential impacts is undertaken…

4(iii) Proposals involving hydraulic fracturing should be accompanied by an air quality monitoring plan and Health Impact Assessment.

Ryedale Local Plan Strategy (2013)

Policy SP17 Managing Air Quality, Land and Water Resources

Air Quality will be protected and improved by:
• Locating and managing development to reduce traffic congestion and air pollution and promote the use of alternative forms of travel to the private car
• Supporting measures to encourage non-car based means of travel or the use of low emission vehicles
• Reducing air quality emissions from buildings through renewable energy provision and sustainable building standards in line with Policy SP18
• Requiring development proposals within or adjoining the Malton Air Quality Management Area to demonstrate how effects on air quality will be mitigated and further human exposure to poor air quality reduced. All development proposals within or near to the Air Quality Management Area which are likely to impact upon air quality; which are sensitive to poor air quality or which would conflict with any Air Quality Action Plan will be accompanied by an Air Quality Assessment
• Only permitting development if the individual or cumulative impact on air quality is acceptable and appropriate mitigation measures are secured

The assessment herein considers the above policies. It may be noted that in the pre-application advice from NYC, no requirement for an air quality monitoring plan was identified.

A screening opinion was received from NYC on 5th February 2025. It stated that there is potential for an impact in relation to air quality from the proposed development but this is unlikely to have a significant effect.

2.3 Pollutants from wellsite operations

The principal source of pollutant releases to atmosphere will be the operation of stationary and mobile plant and vehicles:

- Stationary diesel engines and generators providing power for site operations
- Non-road mobile plant brought to site for construction and site restoration operations
- The movement of heavy duty vehicles (HDV) for transport throughout the proposed operations

All plant will be diesel fuelled and as such pollutant releases will be characteristic of the combustion of diesel fuel. The main pollutants from the combustion of diesel fuel are oxides of nitrogen, carbon monoxide and fine particulate matter.

In addition to the combustion of diesel fuel, the natural gas produced during well testing will be disposed of by incineration. Combustion of natural gas will give rise to the same pollutants as combustion of diesel fuel, although it is not expected that there will be any significant releases of particulate matter.

Operations will also include venting of produced gas entrained in the drilling fluids from the drilling rig degasser. This will give rise to a steady release of volatile organic compounds during the drilling phase of operations.

Oxides of nitrogen are generally considered to comprise primarily of nitrogen monoxide and nitrogen dioxide. While nitrogen oxides from road transport is a major contributor to ground level concentrations, emissions from combustion processes are also significant. Oxides of nitrogen are associated with lung damage and enhanced sensitivity to allergens. Emissions from combustion primarily consist of nitrogen monoxide, although reaction in the atmosphere results in conversion to nitrogen dioxide, which is the primary nitrogen oxide of interest with respect to ambient pollution. The emission of nitrogen oxides and their transformation products can cause a wide range of environmental effects including acidification and eutrophication

Combustion of diesel fuel will generally release some form of particulate matter. Particle size will determine the potential impact. Generally, the finer the particulate, the further it can travel into the human respiratory system. Particle size is defined by effective aerodynamic diameter. Material termed PM_{10} (i.e. all particles with an effective aerodynamic diameter up to 10μm) is seen as significant in this regard. Lower particle sizes (e.g. $PM_{2.5}$) are also considered in some air quality legislation and are the subject of monitoring.

Carbon monoxide is a product of incomplete combustion of the fuel and is therefore related to combustion efficiency. It reacts with other pollutants to form ground level ozone and has implications for neurological health. With incomplete combustion there is also the risk of elevated levels of volatile organic compounds which can give rise to odours and influence ground level ozone formation.

There will also be a release of sulphur dioxide which will be dependent on the sulphur content of the diesel fuel and the produced natural gas.

This assessment considers the air quality impact of the following substances resulting from the proposed exploration operations:

Nitrogen oxides (NO_x, consisting of nitrogen monoxide (NO) and nitrogen dioxide (NO_2))
Sulphur dioxide (SO_2)
Carbon monoxide (CO)
Particulate matter (considered as both $PM_{2.5}$ and PM_{10})
Volatile organic compounds (VOCs – assessed as benzene)

2.4 Environmental Standards

The UK's air quality strategy is based on the European Union (EU) Ambient Air Quality Directive (2008/50/EC, 21 May 2008)[2] and the Fourth Daughter Directive (2004/107/EC, relating to metals and hydrocarbons[3]. These directives specify limit values and target values. Limit values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedances allowed per year, if any, and a date by which it must be achieved. Some pollutants have more than one limit value covering different endpoints or averaging times. Target values are set out in the same way as limit values and are to be attained where possible by taking all necessary measures not entailing disproportionate costs.

The Air Quality (Standards) Regulations 2010[4] transpose into English law the requirements of Directives 2008/50/EC and 2004/107/EC on ambient air quality. Equivalent regulations have been made by the devolved administrations in Scotland, Wales and Northern Ireland. Schedules 2 and 3 of the Regulations specify limit and target values respectively.

Table 2.1 summarises the applicable limit values for the substances considered in this assessment as at 2025.

The limit values below are expressed as concentrations recorded over a specified time period which are considered acceptable in terms of current knowledge of the impact on health and the environment. Limit values are legally binding time averaged limits which must not be exceeded. In the case of target values these are values which are expected to be met by a specified date.

Table 2.1 Air Quality Standard Limit Values and Target Values

Substance	Basis	Concentration
Carbon monoxide	running 8 hour mean across a 24 hour period[c]	10 mg/m^3
Nitrogen dioxide	1 hour mean (99.79 percentile – 18 exceedances per year)	200 µg/m^3
	annual mean	40 µg/m^3
Sulphur dioxide	*15 minute mean (99.90 percentile – 35 exceedances per year[a]*	*266 µg/m^3*
	1 hour mean (99.72 percentile – 24 exceedances per year)	350 µg/m^3
	24 hour mean (99.18 percentile – 3 exceedances per year)	125 µg/m^3
PM_{10}	24 hour mean (90.41 percentile – 35 exceedances per year)	50 µg/m^3
	annual mean	40 µg/m^3
$PM_{2.5}$	annual mean	20 µg/m^3
Benzene	annual mean	5 µg/m^3

a. Target value included in Environment Agency guidance[1].
b. Annual means refer to a calendar year.
c. Running 8 hour mean for each daily period commences at 1700 on the previous day and is updated every hour for the following 24 hours.

Critical levels are specified for sulphur dioxide and nitrogen oxides in relation to the protection of ecological conservation areas as shown in Table 2.2.

Table 2.2 Critical levels for the protection of ecological conservation areas

Substance	Basis	Concentration
Nitrogen oxides (as NO_2)	annual mean	30 µg/m^3
	daily mean[b]	75 µg/m^3
Sulphur dioxide	annual mean[a]	10 µg/m^3

a. refers to the lower limit for sensitive lichen communities & bryophytes and ecosystems where lichens & bryophytes are an important part of the ecosystem's integrity. The upper limit where lichens are not present is 20 µg/m^3.
b. The daily critical level for nitrogen oxides is 75 µg/m^3, although this may be increased[1] to 200 µg/m^3 in the case of detailed assessments where the ozone concentration is below the AOT40 critical level (6000 µg/m^3) and the sulphur dioxide concentration is below the lower critical level of 10 µg/m^3. In this case the AOT 40 for ozone is 6064 µg/m^3 (see Annex C), while the sulphur dioxide concentration is less than 10 µg/m^3 (see Table F.2) across both sites considered. As such a daily critical level of 75µg/m^3 is adopted.

In addition, for the purposes of assessing the significance of pollutants in the ambient atmosphere, the Environment Agency also publish Environmental Assessment Levels (EALs) for the protection of human health[1].

The EALs relevant to this study are summarised in Table 2.3.

Table 2.3 Environmental Assessment Levels

Substance	Basis	Concentration
Carbon monoxide	hourly mean	30000 µg/m^3
Benzene	24 hour mean	30 µg/m^3
Nitrogen monoxide	hourly mean	4400 µg/m^3
	annual mean	310 µg/m^3

2.4.1 Application of environmental standards

The Air Quality Standards Regulations 2010[4] specify legally binding concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The Regulations define ambient air as;

"…outdoor air in the troposphere, excluding workplaces where members of the public do not have regular access."

Compliance with limit values for the protection of human health does not need to be assessed (Schedule 1, Part 1) at the following locations:

a) any location situated within areas where members of the public do not have access and there is no fixed habitation;
b) on factory premises or at industrial locations to which all relevant provisions concerning health and safety at work apply;
c) on the carriageway of roads and on the central reservation of roads except where there is normally pedestrian access to the central reservation.

It is therefore considered that compliance with environmental benchmarks should concentrate on areas where members of the general public are present over the entire duration of the concentration averaging period specific to the relevant standard. For the longer averaging periods the standards are considered to apply around the frontage of premises such as residential properties, schools and hospitals. The shorter term limit values (1 hour or 1 day means) apply at these locations and other areas where exposure is likely to be of one hour or more on a regular basis.

In this context this assessment of compliance with environmental benchmarks, in respect of protection of human health, is considered at the residential locations near the proposed Weaverthorpe wellsite. The assessment of compliance with critical loads and critical levels with respect to ecological impact is assessed at the designated and local ecological sites required for assessment within Environment Agency guidance[1] (see section 2.6.3).

2.5 Background air quality around Foxholes

In considering the overall impact of a proposed development, such as this herein, on local air quality and compliance with environmental benchmarks, it is necessary not only to consider the contribution from the proposed source but also the existing levels of pollutants of interest. Background air quality data for the area around the wellsite are available from Department for Environment Food and Rural Affairs (DEFRA) air quality archive[5]. The archive provides modelled background concentrations of important pollutants for 1km^2 areas for the UK. The latest available background levels for the area within an approximate 2 km radius of the proposed Weaverthorpe wellsite (502300 473160) were used for this assessment. Within this area there were 22 points at which background concentrations were available. Table 2.4 summarises the background pollutant concentrations obtained from the air quality archive for the assessment area. The values reported are the mean and maximum of the 22 points for which data were available.

Table 2.4 Modelled background pollutant concentrations from the DEFRA archive

Substance	Averaging basis	Concentration (μg/m^3)	
		Maximum	Mean
Nitrogen dioxide (2023)	annual mean	3.48	3.42
Total nitrogen oxides (2023)	annual mean (as NO_2)	4.35	4.28
Nitrogen monoxide (2023)[a]	annual mean	0.57	0.56
PM_{10} (2023)	annual mean	11.96	11.90
$PM_{2.5}$ (2023)	annual mean	5.14	5.12
Carbon monoxide (2010)	maximum 8 hour rolling mean	1440	1430
Sulphur dioxide (2023)	annual mean	0.66	0.61
Benzene (2023)	annual mean	0.20	0.20

a. calculated based on the difference between total nitrogen oxides and nitrogen dioxide assuming total nitrogen oxides is the sum of nitrogen monoxide and nitrogen dioxide.

Neither North Yorkshire Council[6] or the East Riding of Yorkshire Council[7] undertake automatic monitoring for any of the substances of interest in this case. Both undertake non-automatic monitoring for nitrogen dioxide, although there are no monitoring stations within the area considered to be influenced by the proposed releases from the Weaverthorpe wellsite.

For the purposes of this assessment background concentrations are assumed to be the maximum values from the DEFRA archive across the assessment area. This is considered a precautionary approach which will most likely overestimate the existing background concentrations in some areas of human exposure.

When considering the combination of estimated process contributions and background concentrations it should be noted that background concentrations are generally available as annual mean values and as such simple addition when considering short term air quality standards may not be appropriate. Guidance from the Environment Agency[1] suggests a simplified method for combining estimated process contributions and background concentrations. For comparison with long term standards the overall concentration is the sum of the process contribution (annual mean) and background concentration (annual mean). For comparison with short term standards the Environment Agency suggest the sum of the process contribution (hourly or daily mean) and twice the background concentration (annual mean). This methodology has been employed in this assessment.

Table 2.5 summarises the pollutant background concentrations adopted for this assessment.

Table 2.5 Background concentrations adopted in the assessment

Substance	Averaging basis	Background concentration	
		μg/m³	% of standard
Air Quality Standard Limit Values and Target Values			
Carbon monoxide	8 hour mean	1440	14.4
Nitrogen dioxide	1 hour mean	6.96[a]	3.5
	annual mean	3.48	8.7
Sulphur dioxide	15 minute mean	1.77[b]	0.7
	1 hour mean	1.32[a]	0.4
	24 hour mean	9.78[c]	0.6
PM_{10}	24 hour mean	14.11[d]	28.2
	annual mean	11.96	29.9
$PM_{2.5}$	annual mean	5.14	25.7
Benzene[e]	annual mean	0.20	4.0
Environmental assessment levels			
Carbon monoxide	hourly mean	2059[f]	6.9
Benzene[e]	24 hour mean	0.24[d]	0.8
Nitrogen monoxide	hourly mean	1.14[a]	<0.1
	annual mean	0.57	0.2

a. One hour mean is determined from annual mean value using a conversion factor of 2.0[1].
b. 15 minute mean is determined from the hourly mean using a conversion factor of 1.34[1].
c. 24 hour mean is determined from the hourly mean using a conversion factor of 0.59[1].
d. 24 hour mean is determined from annual mean value using a conversion factor of 1.18 (a and c above).
e. Volatile organic compounds are assessed against the limit value for benzene in accordance with Environment Agency guidance[1] for situations where the composition of the organic compound release is unknown.
f. One hour mean is determined from 8 hour mean using a conversion factor of 1.43[1].

Background levels specific to the designated and local ecological sites considered are obtained from the Air Pollution Information System (APIS)[8] and are discussed later.

2.6 Assessment criteria

The Environment Agency[1] provides a methodology for assessing the impact and determining the acceptability of emissions to atmosphere on ambient air quality for human health and ecology and for deposition to ground. Two stages of assessment are recommended.

Screening assessment – based on standard dispersion factors the ambient impact of releases to atmosphere may be estimated. The estimates tend to be very conservative since no account is taken of plume rise, meteorological conditions or the locations of the sensitive receptors where impact is to be assessed. The estimates are compared with the assessment criteria discussed in sections 2.5.1 to 2.5.3. Where a release can be demonstrated to be 'insignificant' it may be screened out. Where this is not possible a further detailed assessment is required.

Detailed assessment – based on atmospheric dispersion modelling taking into account the factors which influence dispersion and ambient impact (e.g. meteorology, release conditions, locations of sensitive receptors, etc.). Process contributions and predicted environmental concentrations are compared with the same assessment criteria. Where conditions for excluding the release from further consideration cannot be made, a detailed cost benefit assessment will be necessary.

In this assessment all releases have been assessed using detailed modelling approach only.

The criteria considered in this assessment are described below.

2.6.1 Criteria relevant to human health

The contribution of the process (PC) to the ambient concentration of a given pollutant is considered insignificant and requiring no further assessment, if both of the following conditions are met:

- the long term PC is less than 1% of the long term environmental standard
- the short term PC is less than 10% of the short term environmental standard

If these conditions are not met then the corresponding predicted environmental concentration (PEC, PC + background concentration) should be assessed. The process contribution is considered insignificant and requiring no further assessment, if both of the following conditions are met:

- the short term PC is less than 20% of the short term standard minus twice the long term background concentration
- the long term PEC is less than 70% of the long-term environmental standard

If these conditions are not met then the compliance of the process with Best Available Technique (BAT) will need to be assessed. No further action is necessary if it can be demonstrated that both of the following apply:

- proposed emissions comply with BAT associated emission levels (AELs) or the equivalent requirements where there is no BAT AEL
- the resulting PECs won't exceed environmental standards

Failure to meet these criteria requires that a cost-benefit analysis be undertaken for consideration by the Environment Agency.

2.6.2 Criteria for deposition to ground

Where any of the substances in Table 2.6 are released it is required that the impact they have when absorbed by soil and leaves (termed 'deposition') is assessed.

If the PC to ground for any of these substances is below 1% of the limit it is insignificant and requires no further assessment. Where the PC to ground is 1% of the limit or greater a further assessment will be necessary.

In this case none of the substances in Table 2.6 are considered to be released in a quantity sufficient to merit an assessment for deposition to ground.

Table 2.6 Limits for deposition to ground

Substance	Deposition limit (PC to ground) µg/m^2/day
Arsenic	0.02
Cadmium	0.009
Chromium	1.5
Copper	0.25
Fluoride	2.1
Lead	1.1
Mercury	0.004
Molybdenum	0.016
Nickel	0.11
Selenium	0.012
Zinc	0.48

2.6.3 Criteria relevant to protected conservation areas

Where there are protected conservation areas near the release it is necessary to consider the impact of following pollutants:

- nitrogen oxides (long and short term bases)
- sulphur dioxide (long term basis)
- ammonia (long term basis)
- hydrogen fluoride (long and short term bases)
- nutrient nitrogen and acid deposition

In this case releases of nitrogen oxides and sulphur dioxide are considered, together with their impact in relation to the deposition of nutrient nitrogen and acid.

An assessment is required where the release is within 10 km (15 km if the site is a large electric power station or refinery) of any of the following designated sites:

- special protection area (SPA)
- special area of conservation (SAC)
- Ramsar site (protected wetland of international importance)

or within 2 km of a:

- site of special scientific interest (SSSI)
- local nature site (ancient wood, local wildlife site (LWS) and national or local nature reserve (NNR, LNR))

For some larger (greater than 50 MW) emitters there may be a requirement to extend the assessment to:

- 15km for European sites
- 10km or 15km for SSSIs

The impact of air emissions on protected conservation areas at a distance of 15km should be considered for both:

- natural gas (or fuels with a similarly low sulphur content) fired combustion plants, with more than 500 MW thermal input
- some larger combustion plants using more sulphurous fuels with more than 50 MW thermal input

If the PC at a SPA, SAC, Ramsar or SSSI meets both of the following criteria, it is insignificant and no further assessment is required:

- the short term PC is less than 10% of the short-term environmental standard for protected conservation areas
- the long term PC is less than 1% of the long-term environmental standard for protected conservation areas

If these criteria are not met then the corresponding PEC should be assessed. The emission is considered insignificant if:

- the long term PC is greater than 1% and the corresponding PEC is less than 70% of the long term environmental standard,

If either of the following criteria are met, a more detailed consideration of ecological impact is required:

- the long term PC is greater than 1% and the long term PEC is greater than 70% of the long term environmental standard

- the short term PC is greater than 10% of the short term environmental standard

For local conservation areas releases are considered insignificant where both of the following criteria are met:

- the short term PC is less than 100% of the short term environmental standard
- the long term PC is less than 100% of the long term environmental standard

A failure to meet the above criteria requires a more detailed consideration of ecological impact.

Environmental standards for conservation areas such as critical levels for ambient air and critical loads for nitrogen and acid deposition are considered specific to the habitat types associated with each conservation site. APIS[8] provides acidity and nitrogen deposition critical loads for designated features within every SAC, SPA or A/SSSI in the UK.

2.6.4 Significance of impact

Environmental Protection UK (EP UK) and the Institute of Air Quality Management (IAQM) have published guidance on the impact of pollutant releases in the context of existing air quality assessment levels[9] (i.e. AQS limit and target values etc.). Their categorisation is shown in Table 2.7.

Table 2.7 Impact descriptor for individual receptors

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

In this case impact is considered as the change in the concentration of an air pollutant, as experienced by a receptor. This may have an effect on the health of a human receptor, depending on the severity of the impact and a range of other contributing factors. The descriptor in itself is not considered a measure of effect.

IAQM guidance indicates that for any point source some consideration must also be given to the impacts resulting from short term, peak concentrations of those pollutants that can affect health through inhalation. Background concentrations are considered less important in determining the severity of impact for short term concentrations. Short term concentrations in this context are those averaged over periods of an hour or less. These exposures would be regarded as acute and will occur when a plume from an elevated source affects airborne concentrations experienced by a receptor over an hour or less.

Where such peak short term concentrations from an elevated source are in the range 10-20% of the relevant AQA_L, then their magnitude can be described as small, those in the range 20-50% medium and those above 50% as large. These are the maximum concentrations experienced in any year and the severity of this impact can be described as slight, moderate and substantial respectively, without the need to reference background or baseline concentrations. Table 2.8 summarises these descriptors.

Table 2.8 Impact descriptors for short term process contributions

Short term process contribution (% AQA_L)	Magnitude	Severity
11-20	Small	Slight
21-50	Medium	Moderate
>51	Large	Substantial

Background concentrations are not unimportant, but they will, on an annual average basis, be a much smaller quantity than the peak concentration caused by a substantial plume and it is the contribution that is used as a measure of the impact, not the overall concentration at a receptor.

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

3 MODELLING METHODOLOGY

The contributions to ambient concentrations of the selected pollutant releases from wellsite exploration operations have been modelled using the Atmospheric Dispersion Modelling System (ADMS) version 6.0. The use of this modelling tool is accepted by the Environment Agency and UK Local Authorities for regulatory purposes.

ADMS and the United States Environmental Protection Agency's (US EPA) AERMOD modelling systems are the two most widely used air dispersion models for regulatory purposes worldwide. Both are based on broadly similar principles. In this case ADMS 6.0 has been employed for the assessment, although the results have been compared with those obtained from the same modelling using the AERMOD system in order to provide confidence in the assessment findings.

ADMS 6.0 requires a range of information in order to perform the modelling. The primary information required is discussed below and is summarised in Annex B.

All modelling files containing relevant input information (see Annex B) are provided to the Regulatory Authorities, on request, to assist in any required confirmatory assessment of the modelling undertaken herein.

3.1 Assessment area

The area over which the assessment was undertaken is a 2km x 2km area with the proposed Weaverthorpe wellsite (502300 473160) located around the centre. Figure 3.1 illustrates the assessment area, location of the site, the surrounding area and nearest residential locations.

Figure 3.2 illustrates a larger area which covers the nearby village of Foxholes and all residential locations within 2km of the proposed wellsite.

A general grid with receptors spaced at 20 m intervals (i.e. 10201 points for a 101 x 101 grid) was used to assess the process contribution to ground level concentrations over the assessment area illustrated in Figure 3.1. The grid was considered at an elevation of 1.5 m. This is intended to represent the typical height of human exposure.

In addition to the receptor grid, 31 receptors (1 to 31 in Figure 3.2) were positioned at residential locations near the proposed wellsite. These receptors were placed at an elevation of 1.5 m, as described in Table E.1, and are intended to correspond to locations of long term human exposure near the wellsite.

16 receptors (34 to 49) were located around the proposed wellsite boundary to give an indication of the maximum off site process contributions. These receptors are also described in Table E.1.

There are a number of tracks in the area which are generally used for farm access and which are not considered to be locations of frequent human exposure where air quality standards for human health would be expected to apply, (as defined in section 2.4.1). These locations are not considered in this assessment.

Figure 3.1 Location of the proposed Weaverthorpe wellsite and assessment area

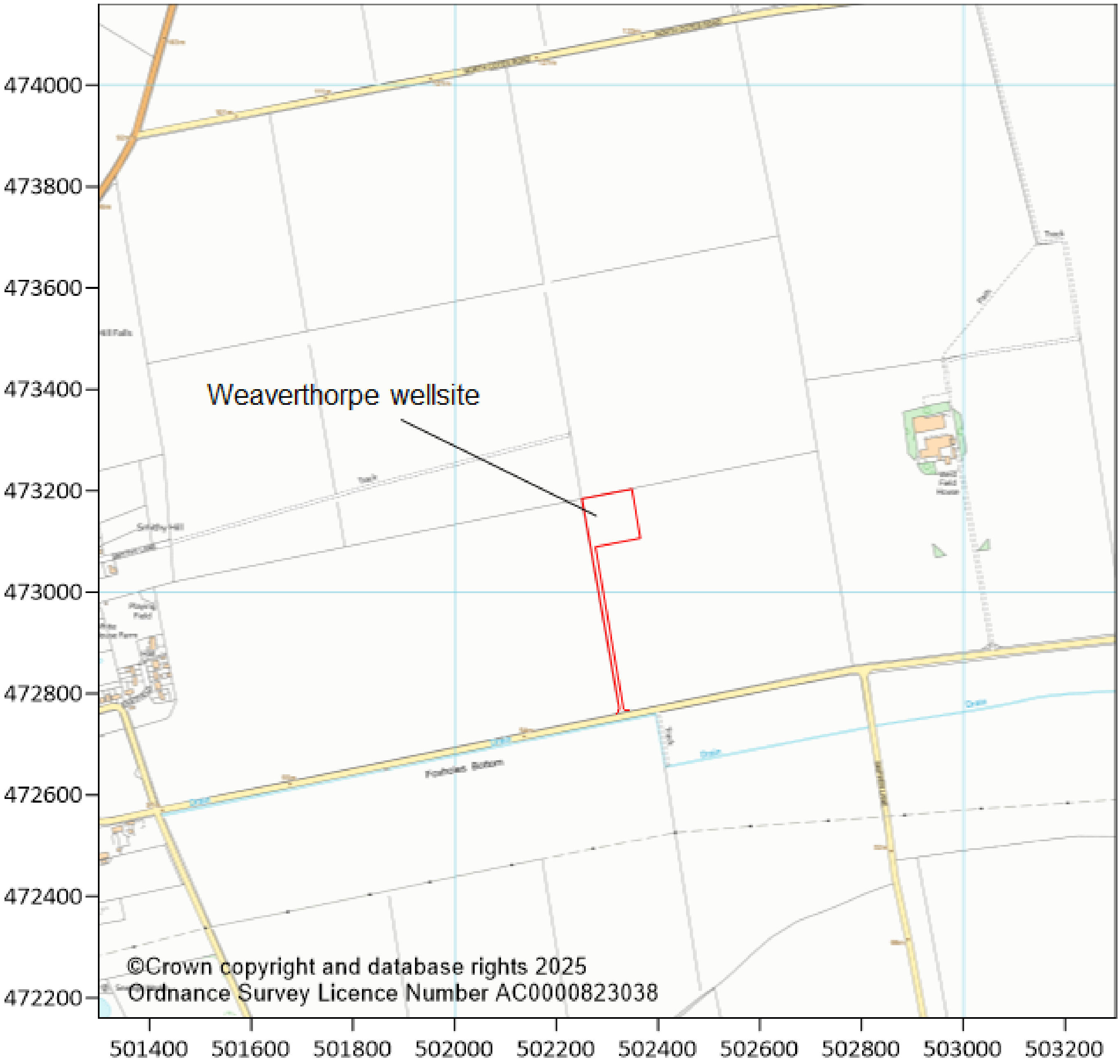
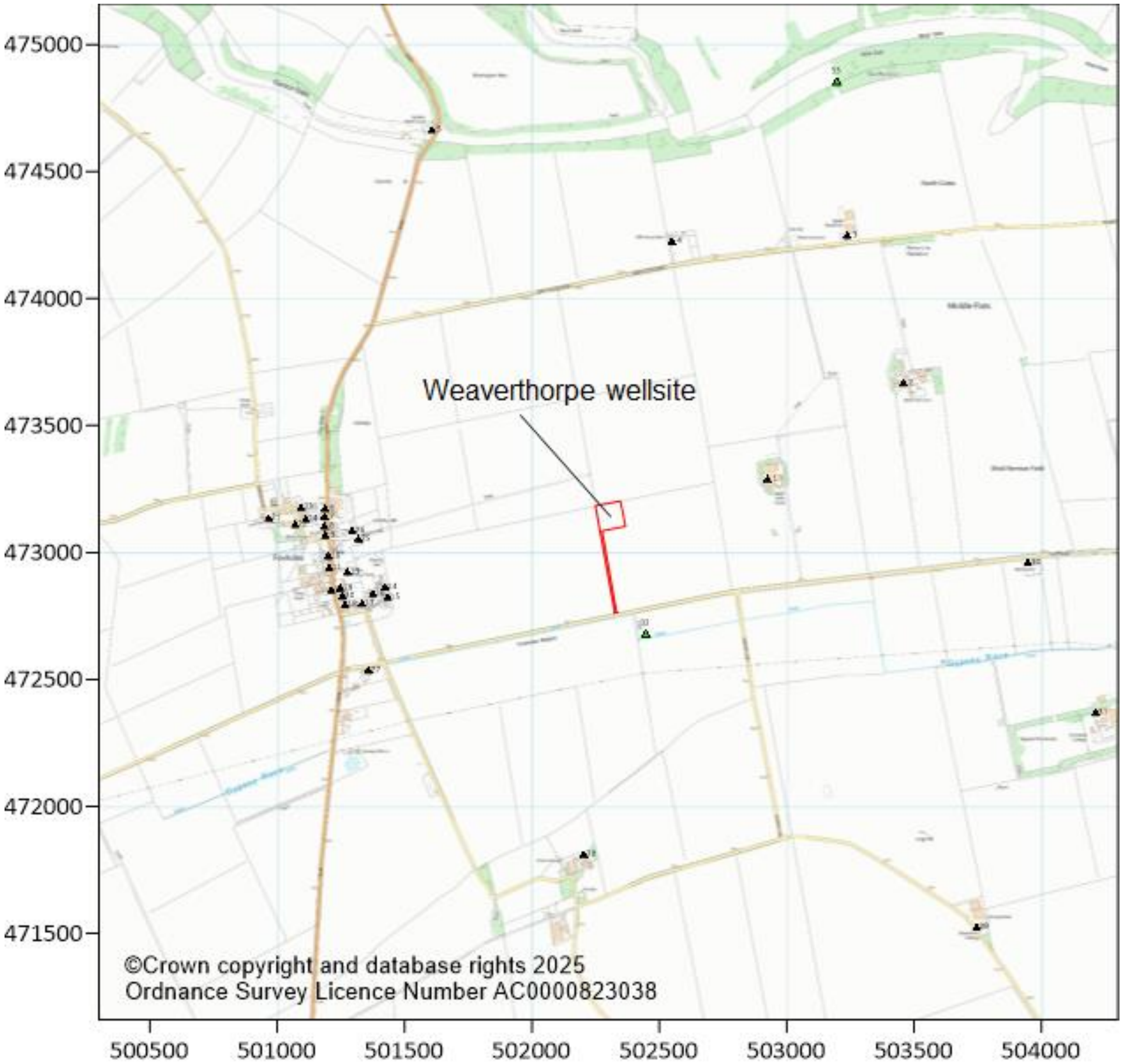


Figure 3.2 Foxholes and the surrounding area

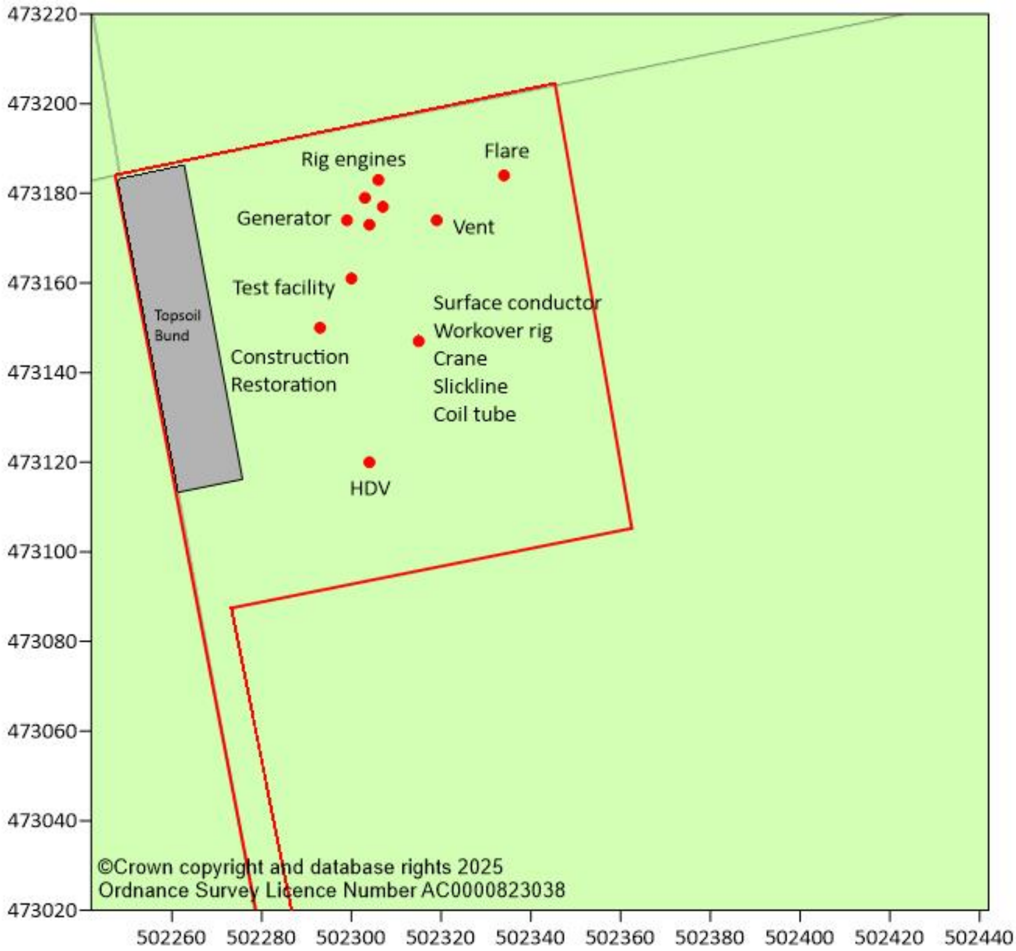


For the purposes of the assessment, the receptors were considered in groups as described below:

1 to 31	Residential locations (see Table E.1 and Figure 3.2)
32 and 33	Designated and local ecological sites (see Tables 3.2 and E.1 and Figure 3.2)
34 to 49	Site boundary (see Table E.1 and Figure 3.3)

Annex E describes the location of these discrete receptors.

Figure 3.3 Layout of the proposed Weaverthorpe wellsite during exploration operations



It is also necessary to consider the impact of releases on any local statutory designated sites. Following a review of all sites in the local area, two local ecological sites, met the criteria for assessment (see 2.6.3). The location of each of these sites is described by a single discrete receptor as summarised in Table 3.1.

Table 3.1 Location of receptors at the designated and local ecological sites

Receptor		Position[a]	Easting (m)	Northing (m)
32	Gypsy Race LWS	501 m S	502448	472681
33	West Dale, Fordon LWS	1919 m NE	503197	474856

a. Location of the edge of the habitat closest to the centre of the proposed Weaverthorpe wellsite.

3.2 Buildings

The presence of buildings close to a discharge flue can have a significant impact on the dispersion of releases. The most significant impact can be the downwash of a plume around a building causing increased concentrations in the immediate area around the building. Buildings can also disturb the wind flow causing a turbulent wake downwind which can also affect dispersion. It is normally considered that buildings within 5 times the height of release or within 5 times the height of the building should be considered in any modelling.

The main structure present on the wellsite is the topsoil storage bund, which will be formed during the construction phase and will be present throughout the drilling and testing phases and into the restoration phase. While there are other temporary structures on the site from time to time, the bund is the only major structure present throughout the energy intensive phases. It is also the only structure considered likely to have an influence dispersion due to its dimensions and similarity in height to the main release points.

ADMS 6.0 models buildings as either rectangular or circular structures. In this case the bund is modelled as a single rectangular block. Based on the drawings provided by Egdon[10], the main parameters describing the bund were estimated as summarised in Table 3.2.

Table 3.2 Parameters describing the Topsoil Bund

Structure	Structure centre grid reference		Height (m)	Angle (º from north)	Length (m)	Width (m)
	Easting	Northing				
Topsoil storage bund	502262	473150	3	80	70	15

It is assumed, for the purposes of the assessment, that this is the only structure with the potential to influence dispersion of site releases. A sensitivity analysis was undertaken to determine whether the bund has any significant impact on dispersion as summarised in Table 3.3.

Table 3.3 Sensitivity analysis - Buildings

Main structure (see Table 3.2 and Figure 3.3)	Change (%) in predicted PC of nitrogen dioxide over the residential receptors (1 to 31) compared with base case of the bund as the main structure			
	Long term average		Short term average	
	Maximum	Mean	Maximum	Mean
No structure	-16.4	-7.1	-18.1	-13.5

The differences associated with the consideration of building effects are not significant in terms of the overall conclusions of this assessment which are based on maximum impact. It is apparent from the sensitivity analysis that no assessment of building effects provides marginally lower predicted process contributions than inclusion of the bund in the modelling. As such, for the purposes of the assessment, the bund is considered as the main building influencing dispersion. This is considered a precautionary approach.

Egdon[10] provided details of the wellsite arrangement for each phase of the proposed operations, and in particular the locations of the main items of plant proposed for use, as illustrated in Figure 3.3. Table 3.4 describes the release point locations for the discharges considered in this assessment.

Table 3.4 Location of release points

Plant		Easting (m)	Northing (m)	Height of release (m)[a]	Diameter (m)[a]
A	Construction plant	502293	473150	3.0	0.30
B	Surface conductor	502315	473147	4.0	0.20
C	Generator	502299	473174	4.0	0.30
D1	Rig engine 1	502304	473173	4.0	0.40
D2	Rig engine 2	502303	473179	4.0	0.40
D3	Rig engine 3	502307	473177	4.0	0.40
D4	Rig engine 4	502306	473183	4.0	0.40
E	Workover rig	502315	473147	4.0	0.30
F	Flare	502334	473184	4.0	0.30
G	Crane	502315	473147	3.0	0.20
H	Coil tube unit	502315	473147	4.0	0.30
I	Slickline	502315	473147	4.0	0.30
J	Test facilities	502300	473161	3.0	0.20
K	Restoration plant	502293	473150	3.0	0.30
Vent gas		502319	473174	3.0	0.10
HDV		502319	473174	3.0	0.05

a. The release height and exhaust flue diameter are either assumed, based on experience, or taken from the equipment specification (see Table G.1). In the case of the HDVs and construction and restoration plant, where there are multiple smaller sources, the release is combined into an assumed single point which represents the average location of operation (see section 3.5).

3.3 Meteorology

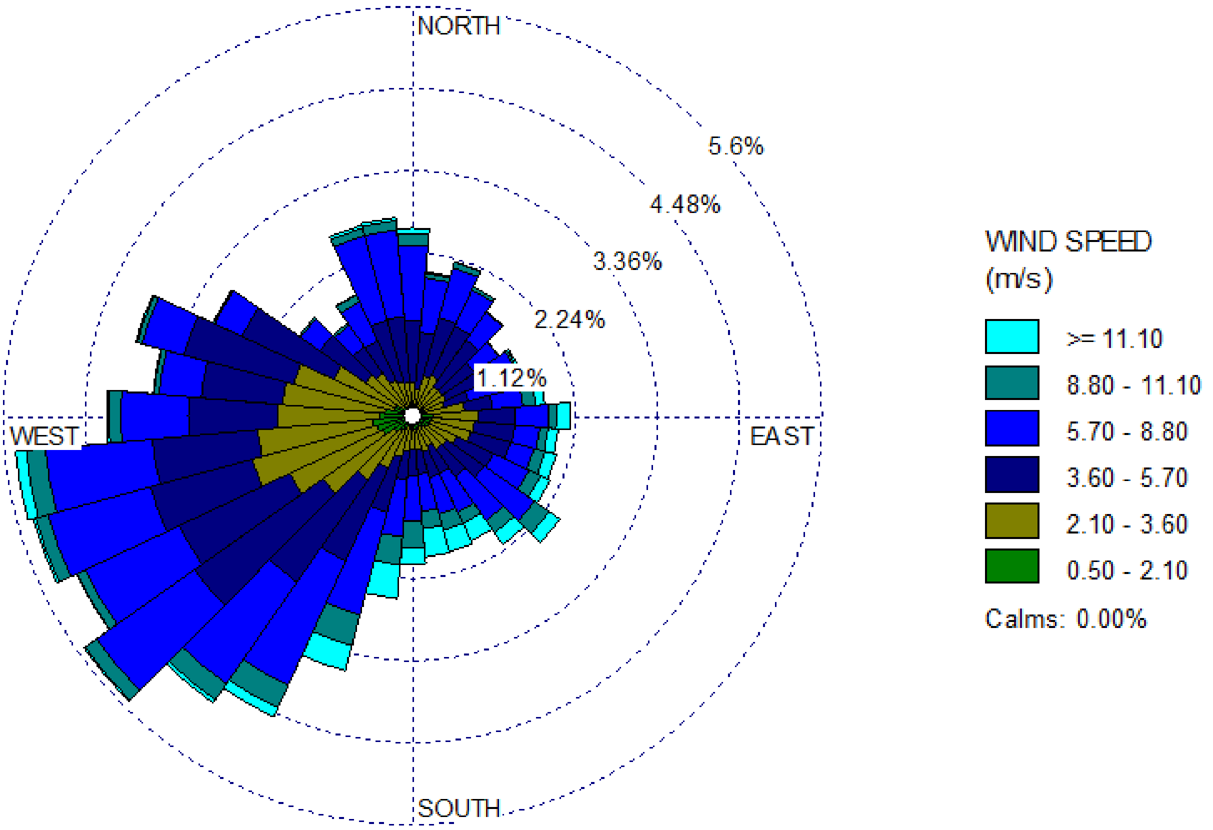
For this modelling assessment hourly sequential meteorological data from the nearest suitable meteorological station to the area was obtained. The data, provided by the UK Met Office, was from the Bridlington Marine Rescue Sub Centre (Mrsc) station and covered the 5 year period 2020 to 2024. The Bridlington Mrsc station is around 17km south east of the proposed Weaverthorpe wellsite at an elevation of 15m, compared with the site elevation of around 75m. It lies around 1km from the coast. Three other measurement stations were also considered as possible sources of meteorological data:

Station	Position	Elevation	Distance to coast	Data coverage
High Mowthorpe	15km SW	175m	26km	Complete
Fylingdales	29km NW	262m	3km	Missing cloud
Scarborough	14km N	110m	1km	Missing cloud and wind

Based on advice provided by the Met Office, the proximity of the station, elevation, coastal location and data coverage, it was considered that data from the Bridlington Mrsc station provided measurements most representative of the conditions around the proposed Weaverthorpe wellsite.

The data included, among other parameters, hourly measurements of wind speed and direction. Figure 3.4 illustrates a composite wind rose for the Bridlington Mrsc station. It may be seen that the wind has significant a south westerly component. Annex D provides a more detailed analysis of the meteorological data used.

Figure 3.4 Composite windrose for the Bridlington Mrsc station (2020 to 2024)



3.4 Surface characteristics

The characteristics of the surrounding surfaces and the land use within the assessment area have an important influence in determining turbulent fluxes and hence the stability of the boundary layer and atmospheric dispersion. In ADMS it is necessary to consider the following parameters which describe land use and surface properties:

Surface roughness
Surface albedo
Minimum Monin Obukhov length
Priestley Taylor parameter

3.4.1 Surface roughness

The roughness length represents the aerodynamic effects of surface friction and is physically defined as the height at which the extrapolated surface layer wind profile tends to zero. This value is an important parameter used by meteorological pre-processors to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and, consequently, the degree of turbulent mixing.

The surface roughness length is related to the height of surface elements. Typically, the surface roughness length is around 10% of the height of the main surface features. Surface roughness is higher in built up areas than in rural locations.

A range of typical roughness values for common land use types are provided within ADMS:

Land use	Surface roughness (m)
Ice	0.00001
Snow	0.00005
Sea	0.0001
Short grass	0.005
Open grassland	0.02
Root crops	0.1
Agricultural areas	0.2-0.3
Parkland, open suburbia	0.5
Cities, woodland	1.0
Large urban areas	1.5

The proposed Weaverthorpe wellsite is located in a rural area on relatively flat agricultural land with little woodland in the immediate area. The nearest residential location is around 640m to the east. A surface roughness of 0.5m has been selected based on a sensitivity analysis, which considered variations in surface roughness between 0.1 and 1.0m. This resulted in variations in predicted hourly and annual process contributions of nitrogen dioxide over the residential receptors (1 to 31, see Figure 3.2) as summarised in Table 3.5.

Table 3.5 Sensitivity analysis – Surface roughness

Surface roughness (m)	Change (%) in predicted PC of nitrogen dioxide over the residential receptors (1 to 31) compared with base case of a surface roughness of 0.5m			
	Long term average		Short term average	
	Maximum	Mean	Maximum	Mean
0.1	2.2	-9.9	31.0	8.8
0.3	-4.8	-19.8	11.5	-9.9
0.7	-14.1	-27.0	-4.0	-21.0
0.9	-17.6	-30.3	-11.3	-24.9
1.0	-19.2	-31.9	-13.8	-26.5

It is considered that a surface roughness of 0.5m is reasonably representative of the area of influence and tends towards a more conservative estimate of the range likely to be most descriptive of the general assessment area (i.e. relatively flat agricultural land). This selection does not introduce uncertainties which are significant in the context of the conclusions reached in section 4.

3.4.2 Surface albedo

The surface albedo is the ratio of reflected to incident shortwave solar radiation at the surface of the earth and lies in the range 0 to 1. This parameter is dependent upon surface characteristics and varies throughout the year. Surface albedo is higher (higher proportion of reflected radiation) when the ground is snow covered. Based on the recommendations of Oke (1987), ADMS provides default values of 0.6 for snow-covered ground and 0.23 for non-snow covered ground, respectively. In this case a value for surface albedo of 0.23 has been employed.

3.4.3 Monin Obukhov length

The Monin Obukhov length provides a measure of the stability of the atmosphere and allows for the effect of heat production in cities which may not be represented by the meteorological data. In urban areas heat generated from buildings and traffic warms the air above which has the effect of preventing the atmosphere from becoming very stable. Generally the larger the area the greater the effect. In stable conditions the Monin Obukhov length will not fall below a minimum value with the value becoming larger depending on the size of the city. The minimum value of the

Monin Obukhov length generally lies between 1 and 200 m, with 1m corresponding to a rural area. ADMS provides the following guidance on minimum Obukhov length:

Population size	Minimum Obukhov length (m)
Large conurbations (>1 million)	100
Cities and large towns	30
Mixed urban/industrial	30
Small towns	10
Rural area	1

In this case the area is considered typical of a rural area with a nearby small town. A minimum Monin Obukhov length of 10m has been employed. A sensitivity analysis has been undertaken considering minimum Monin Obukhov lengths in the range 1 to 30m. This resulted in variations in predicted hourly and annual process contributions of nitrogen dioxide over the residential receptors (1 to 31, see Figure 3.2) as shown in Table 3.6.

Table 3.6 Sensitivity analysis – Minimum Monin Obukhov length

Minimum Monin Obukhov length (m)	Change (%) in predicted PC of nitrogen dioxide over the residential receptors (1 to 31) compared with base case of a minimum Monin Obukhov length of 10m			
	Long term average		Short term average	
	Maximum	Mean	Maximum	Mean
1	-10.8	-25.6	4.0	-20.0
5	-10.5	-25.1	4.0	-19.0
15	-10.2	-23.4	4.0	-14.3
20	-9.3	-19.6	4.0	-7.0
30	-5.9	-12.6	4.5	0.5

The variations are largely insignificant over the length range considered descriptive of the assessment area and not likely to influence the conclusions reached in section 4. The selected length tends towards a more conservative assessment than might be expected with the use of a smaller length. AERMOD does require that the minimum Monin Obukhov length be specified.

3.4.4 Priestley Taylor parameter

The Priestley Taylor parameter represents the surface moisture available for evaporation. Areas where moisture availability is greater will experience a greater proportion of incoming solar radiation released back to atmosphere in the form of latent heat, leaving less available in the form of sensible heat and, thus, decreasing convective turbulence. The Priestley Taylor parameter lies between 0 and 3. Based on suggestions by Holstag and van Ulden, ADMS provides default values of:

Land type	Priestley Taylor parameter
Dry bare earth	0
Dry grassland	0.45
Moist grassland	1

In this case the area is considered representative of moist grassland and a value of 1.0 for the Priestley Taylor parameter has been employed. A sensitivity analysis has been undertaken considering Priestley Taylor parameters in the range 0 to 1.5. This resulted in variations in predicted hourly and annual process contributions of nitrogen dioxide averaged over the residential receptors (1 to 31, see Figure 3.2) as summarised in Table 3.7.

Table 3.7 Sensitivity analysis – Priestley Taylor parameter

Priestley Taylor parameter	Change (%) in predicted PC of nitrogen dioxide over the residential receptors (1 to 31) compared with base case of a Priestley Taylor parameter of 1			
	Long term average		Short term average	
	Maximum	Mean	Maximum	Mean
1.5	-11.2	-21.6	6.9	-16.4
0.5	-10.8	-26.3	2.6	-18.2
0	-12.6	-28.1	1.5	-19.3

The variations are not significant over the range considered most likely to be descriptive of the area and not likely to influence the conclusions reached in section 4. It is considered that the use of the model default value (for moist grassland) is likely to be most representative of the area.

It may be noted that AERMOD uses the Bowen ratio to describe available surface moisture rather than the Priestley Taylor parameter. The following default values are provided from Paine (1987).

Land use	Bowen ratio (-variation with season)
Water	0.1
Deciduous forest	0.6-2.0
Coniferous forest	0.6-2.0
Swamp	0.2-2.0
Cultivated land	1.0-2.0
Grassland	1.0-2.0
Urban	2.0-4.0
Desert shrubland	5.0-10.0

For the modelling herein, a value of 1.0 was employed for the Bowen ratio.

3.4.5 Terrain

Terrain data was obtained for the assessment area from the Ordnance Survey Land-form Panorama DTM database. There are slight variations in elevation across the main assessment area with the ground rising to the north and falling to the south at maximum gradient of around 5% (towards the north east) as shown in Figure 3.5.

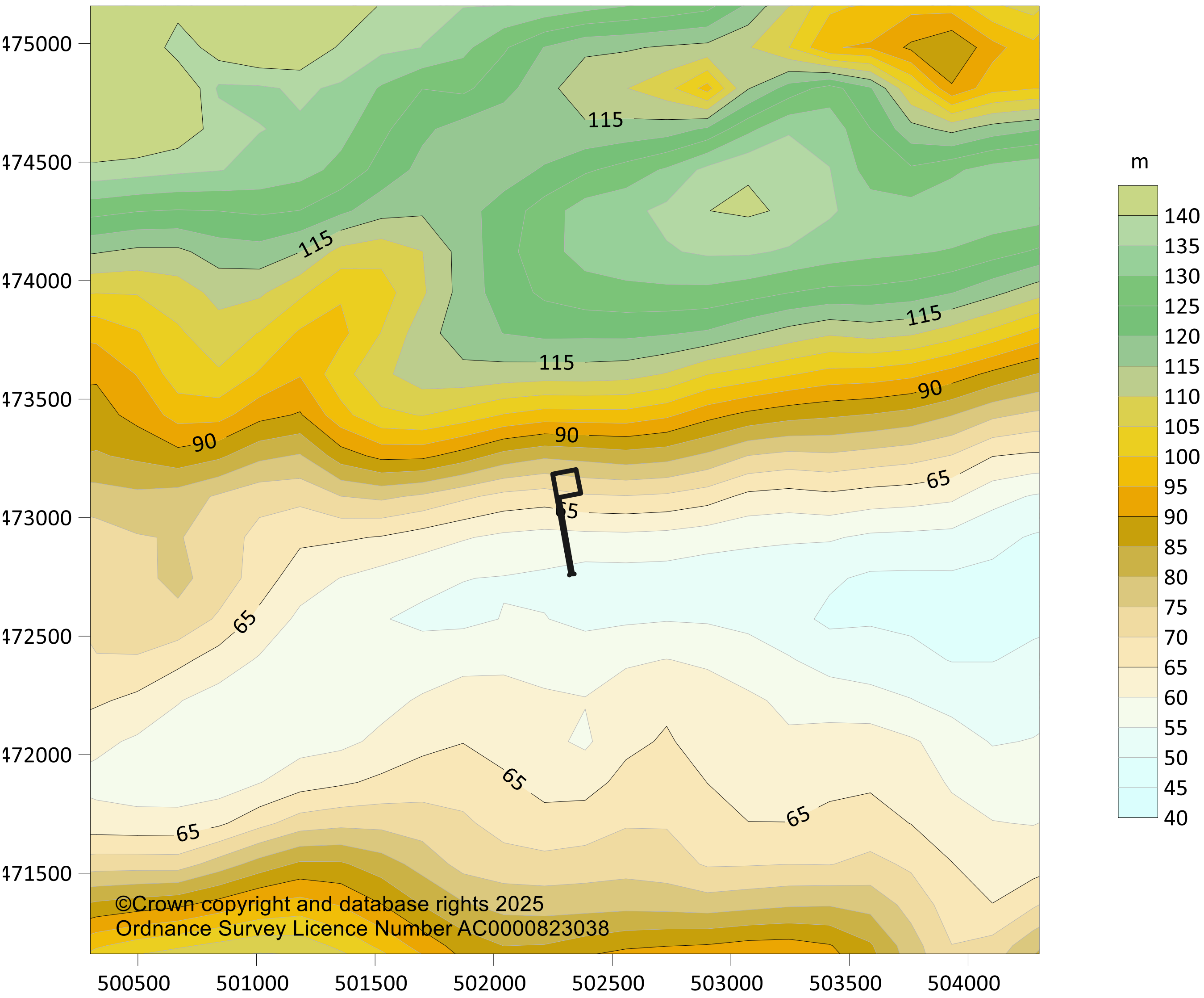
A sensitivity analysis was undertaken to determine the impact of consideration of terrain in the assessment, in contrast to the assumption of a flat assessment area. The sensitivity of the predicted annual and hourly process contributions of nitrogen dioxide across the residential receptors (1 to 31, see Figure 3.2) to consideration of terrain was examined as summarised in Table 3.8.

Table 3.8 Sensitivity analysis – Terrain

Terrain	Change (%) in predicted PC of nitrogen dioxide over the residential receptors (1 to 31) compared with base case of an elevated assessment area			
	Long term average		Short term average	
	Maximum	Mean	Maximum	Mean
Flat	-6.0	-23.0	10.0	-16.2

General guidance suggests that consideration of terrain is not necessary at gradients of less than 5%. In this case, the higher process contributions generally occur when an elevated assessment area is considered, although the differences are unlikely to influence the main conclusions of this assessment. For avoidance of doubt, the assessment is based on an elevated assessment area. This is considered a precautionary approach.

Figure 3.5 Ground elevation within assessment area



3.5 Pollutant releases and conditions

Five sources of pollutant releases are considered in this assessment:

Flare for the incineration of produced natural gas
Diesel fired generators and stationary engines associated with temporary mobile plant.
Diesel fuelled construction vehicles used on site
Diesel fuelled HDV vehicle movements on site
Drilling rig degasser vent gases

Egdon[11] provided details of the incinerator, stationary engines, generators, construction vehicles and HDV movements intended over the various phases of the proposed operations. A full listing of the equipment employed and references for the specifications used are provided in Annex G.

3.5.1 Flare

Disposal of produced natural gas by incineration during flow testing will employ a Uniflare UF10 flare stack[12,13]. The actual flow test, although set at a duration of 96 hours, will involve ramping up and down flow rates, and shut-in periods to gather downhole pressure, temperature and flow data. Egdon[11] estimate a maximum produced gas disposal requirement of 2.5 MMscfd (2790 Nm^3/h) during this period. For the purposes of this assessment, it is assumed that the flare operates at this maximum disposal rate continuously throughout the 96 hour period. This represents an unlikely worst case scenario, which will substantially overestimate the total gas disposal volume and the corresponding pollutant releases in practice.

The UF10 flare stack range has a maximum capacity of 10000 Nm^3/h and is specified to operate at a temperature of 1000°C and an excess air level of 200%. Egdon[12] have confirmed that these operating conditions are maintained at the lower throughput considered in this assessment.

The release conditions for the flare have been assessed in Table 3.10, based on the natural gas composition provided by Egdon[10] in Table 3.9.

Table 3.9 Natural gas composition

Parameter		Value
Methane	% v/v	88.4
C_2	% v/v	3.2
C_3	% v/v	1.1
C_4	% v/v	0.7
C_5	% v/v	0.9
C_6+	% v/v	0.4
Inerts	% v/v	5.2
Hydrogen sulphide	% v/v	0.1

Table 3.10 Exhaust gas conditions

Property		Value
Disposal rate	MMscfd	2.5
	Nm^3/s	0.775
Exhaust gas temperature[a]	°C	1000[a]
Exhaust gas flow rate (actual)[b]	m^3/s	113.9
Flue diameter[a]	m	2.91
Velocity	m/s	17.1

a. Based on flare specification[13].

Unit pollutant release factors are estimated in Table 3.11. Releases are based on the emission factors for industrial flares published by the US EPA in their AP42 document[15] and emission factors from the EMEP-EEA for flaring in oil and gas extraction operations[14].

Table 3.11 Pollutant releases from flare operations

Emission factor source	US EPA AP42[a]	EMEP/EEA 2019[b]
Emission factors		
Total hydrocarbons	0.14 lb/MMBtu	-
Nitrogen oxides (as NO_2)	0.068 lb/MMBtu	1.4 g/kg gas
Carbon monoxide	0.31 lb/MMBtu	6.3 g/kg gas
Non methane volatile organic compounds	-	1.8 g/kg gas
Release rates (g/s per Nm^3/s of gas consumed)		
Non methane volatile organic compounds (as carbon)		1.48
Nitrogen oxides	1.21	1.15
Carbon monoxide	5.51	5.17
Sulphur dioxide[c]	0.70	
Total hydrocarbons (as carbon)	2.49	-

a. AP-42 factors are based on thermal input at the higher heating value.
b. EMEP/EEA factors are based on kg of natural gas burned and a gas density of 0.82 kg/Nm^3.
c. Sulphur dioxide release is based on total oxidation of the sulphur in a gas containing 700mgS/Nm^3 (i.e. 0.1%H_2S by volume)

The Environment Agency require that, in the case of a volatile organic compound release of unknown composition, the release is assessed on the basis of the assessment criteria for benzene. Experience suggests that a significant proportion of the volatile organic compounds emission from incineration will be methane and lower hydrocarbons, which have substantially higher environmental benchmarks compared with benzene. In addition, the concentration of higher hydrocarbons (C_6 and above) present in the flue gas will generally be representative of the proportion of higher hydrocarbons in the natural gas[16]. For this assessment the volatile organic compound discharge from the flare is based on the non-methane volatile organic compound release This is considered a significant overestimate of higher hydrocarbons in practice based on the above experience. The non-methane volatile organic compound content of the produced natural gas is 14.7% by weight, compared with the higher hydrocarbon (C_{6+}) content of 2.0% by weight (see Table 3.9).

Where there are corresponding emission factors from the USEPA and EMEP/EEA, the factor providing the greatest release rate is employed. Table 3.12 summarises the pollutant release rates adopted for this assessment.

Table 3.12 Flare stack pollutant release rates adopted for assessment

Property		Value
Natural gas disposal rate	Nm^3/s	0.775
Pollutant release rate		
Nitrogen oxides	gNO_2/s	0.936
Carbon monoxide	gCO/s	4.266
Sulphur dioxide	gSO_2/s	1.087
Volatile organic compounds (C_6+)[a]	gbenzene/s	1.143

a. The fraction of non-methane volatile organic compounds is based on natural gas analysis provided by Egdon[10] -see Table 3.9.

It may be noted that the flare manufacturer[14] indicates significantly lower releases of nitrogen oxides, carbon monoxide and hydrocarbons than determined from the standard emission factors in Table 3.14.

3.5.2 Stationary engines

Table 3.13 summarises the diesel fuelled stationary engines specified for use by Egdon[11] during the proposed operations.

Table 3.13 Stationary engines and performance

Equipment		Power output full load	Emission standard
		kWh	
B	Surface conductor rig	179	EU Stage 3A
C	Generator	350	EU Stage 3A
D	Rig engine[b]	1420	Measured releases[a]
E	Workover rig	354	US Tier 2
G	Crane	400	EU Stage 4
H	Coiled tubing unit	354	US Tier 2
I	Slickline	354	US Tier 2
J	Test facility generator	128	EU Stage 3B

a. The engine is not certified to an emission standard and the manufacturer's claimed maximum exhaust gas emission concentrations are assumed within the assessment. The emissions relate to operation in low emission mode.
b. The main drilling rig has four identical engines.

The engine specifications generally indicate compliance with either European Union or United States emission standards. The engines are assumed to operate at the emission standards. In addition, it is assumed that the engines will use ultra-low sulphur diesel with a sulphur content of 10 mg/kg (10 ppm).

Based on the claimed emission standards and full load operation, pollutant release rates for each stationary engine have been determined as summarised in Table 3.14.

Table 3.14 Pollutant release rates for stationary engines

Equipment	Pollutant release rate per unit (g/s)				
	CO	THC[a,b]	NO_x[a,b]	PM	SO_2
Surface conductor rig	0.174	0.015	0.184	0.010	0.000209
Generator	0.340	0.029	0.360	0.019	0.000408
Rig engine	0.188	0.026	1.442	0.028	0.00167
Workover rig	0.344	0.047	0.583	0.020	0.000413
Crane	0.389	0.021	0.044	0.003	0.000467
Coiled tubing unit	0.344	0.047	0.583	0.020	0.000413
Slickline	0.344	0.047	0.583	0.020	0.000413
Test facility generator	0.187	0.007	0.124	0.001	0.000177

a. Total hydrocarbons (THC) are expressed as benzene and nitrogen oxides are expressed as nitrogen dioxide.
b. Where the emission standard quotes a combined value for hydrocarbons and nitrogen oxides, it is assumed that nitrogen oxides comprise 92.6% of the total with the remainder being hydrocarbons[15].
c. A load of 100% is assumed for all engines.

The exhaust gas conditions in Table 3.15 have been estimated and used in the assessment.

Table 3.15 Exhaust gas conditions for stationary engines

Equipment	Height of release (m)	Internal flue diameter (m)	Temperature[a] (°C)	Velocity[b] (m/s)
Surface conductor rig	4.0	0.20	550	21.4
Generator	4.0	0.30	550	18.6
Rig engine	4.0	0.40	455	39.5
Workover rig	4.0	0.30	550	18.8
Crane	3.0	0.20	150	22.0
Coiled tubing unit	4.0	0.30	550	18.8
Slickline	4.0	0.30	550	18.8
Test facility generator	3.0	0.20	550	18.2

a. Based on engine specification with allowance for heat loss.
b. Based on combustion calculations assuming diesel lower heating value of 42.78 MJ/kg.

It is assumed that all stationary engines operate at full load continuously when operational (see Table G.2).

3.5.3 Construction vehicles

Egdon[11] specified the principal mobile plant that are intended to be employed for the construction and restoration phases of the proposed development as shown in Table 3.16.

It is assumed that all vehicles will operate at the specified emission standard at full load when operational. On this basis the pollutant emission rates for the construction vehicle fleet are estimated in Table 3.17.

Table 3.16 Specification of main construction and restoration vehicles

Type		Gross power output (kW)	Emission standard
A1 K1	20 t excavator (JCB)	129	EU Stage 5
A2 K4	Dozer	120	EU Stage 4
A3 K2	9t dumper	55.4	EU Stage 3B
A4 K3	13t sheeps roller	115	EU Stage 5
A5	Concrete pump truck	240	EURO 6

Table 3.17 Pollutant release rates for construction vehicles

Type	Pollutant release rate per unit (g/s)				
	CO	THC[a]	NO_x[a]	PM	SO_2[c]
20 t excavators (2)	0.358	0.014	0.029	0.001	0.00030
Dozer	0.167	0.006	0.013	0.001	0.00014
9t dumpers (2)	0.154	0.011	0.134	0.001	0.00013
13t sheeps roller	0.160	0.006	0.013	0.000	0.00013
Concrete pump truck	0.100	0.009	0.027	0.001	0.00028
Total construction phase	0.939	0.045	0.215	0.004	0.00094
Total restoration phase	0.839	0.037	0.189	0.003	0.00070

a. Total hydrocarbons are expressed as benzene and nitrogen oxides are expressed as nitrogen dioxide. Where the emission standard quotes a combined value for hydrocarbons and nitrogen oxides it is assumed that nitrogen oxides comprise 92.6% of the total with the remainder being hydrocarbons (based on US EPA AP42 emission factors for uncontrolled emissions from diesel engines -Table 3.3-1)[15].
b. A load of 100% is assumed for all plant.

c. Assumes a diesel sulphur content of 10 mg/kg.
d. The fleet contains two 20t excavators and two 9t dumpers.

It is assumed that releases from the vehicles used in the construction phase can be considered as a single point release (diameter 0.3m) for the purposes of the assessment at a height of 3.0m with a velocity of 20.7 m/s and exhaust temperature of 150^{o}C. For the smaller fleet of vehicles used in the restoration phase a single point release (diameter 0.3m) is considered at a height of 3.0m with a velocity of 14.8m/s and exhaust temperature of 150^{o}C. In addition, for the purposes of this assessment it is assumed that all construction and restoration vehicles operate on a continuous basis for the duration of each of phases 1 and 4 respectively. This is a significant overestimate in all phases and will allow sufficient margin should minor changes to the above schedule become necessary.

3.5.4 Heavy duty vehicles

Heavy duty vehicles will enter the site and then generally off load, load and leave site. For the purposes of the assessment of releases from these vehicles while on site, it is assumed that the vehicle enters the wellsite and then idles for a period of one hour before leaving. This is considered a conservative estimate of releases and it is noted that in practice vehicles will be switched off when not in use.

The emission factors for idling in Table 3.18 have been assumed based on an evaluation of four studies of heavy duty vehicle idling emissions[17,18,19,20]. These are considered conservative estimates. A factor of 45 gNO_2/h for nitrogen oxides during HDV idling has been used as a guideline by the Greater London Authority[21].

Table 3.18 Emission factors for HDV idling

Parameter		Rahman[17]	DIESELNET[18]	Christopher Frey[19]	Khan[20]	Selected
Nitrogen oxides	g/h	56.9	70.9	89.5		70.9
Carbon monoxide	g/h	95.0	27.8	17.8		27.8
Particulate matter	g/h	2.6	2.5	1.3		2.6
Total hydrocarbons	g/h		13.6			13.6
Higher hydrocarbons	g/h	13.0		3.5		13.0
Sulphur dioxide	g/h	5.8		0.037	0.029	0.033[a]

a. Mean of values from Christopher Frey and Khan.

Egdon[10] have provided details of maximum daily HDV movements for the various phases of the proposed operations (see Table G.3). It is assumed, as a worst case scenario, that HDV movements are maximised based on a 7 day working week to give a pessimistic scenario of HDV movements during each year. The average number of HDVs idling on each working day of each phase is determined in Table 3.19.

Table 3.19 Frequency of HDV idling

Phase	HDV 2 way movements /phase	Maximum HDVs idling/working hour in phase
1	102	0.28
2	214	0.32
3	48	0.15
4	148	0.50

a. In the determination of idling rate HDVs are assumed to operate for 12 hours on each working day (see Table G.2).

Based on the average frequency of HDV idling (Table 3.19) and the selected pollutant emission rates (Table 3.18) the average release rates for HDV idling were estimated for each phase of the proposed operations.

Table 3.20 Pollutant releases from HDV idling

Phase	Pollutant release rate in each working hour (g/s)				
	NO_x	CO	PM	VOC	SO_2
1	0.0056	0.0022	0.00020	0.0011	0.0000026
2	0.0063	0.0025	0.00023	0.0012	0.0000029
3	0.0029	0.0011	0.00011	0.0006	0.0000014
4	0.0099	0.0039	0.00036	0.0019	0.0000046
Maximum in phase	0.0099	0.0039	0.00036	0.0019	0.0000046

It is assumed that releases from the HDVs during idling can be considered as a single point release (diameter 0.05m) for the purposes of the assessment at a height of 3.0m with a velocity of 3.5m/s and exhaust temperature of 150°C.

For the purposes of this assessment, the maximum hourly HDV pollutant rates in Table 3.20 (based on a 12 hour operational day and the maximum average HDV movements in any individual phase) have been adopted for all phases of the proposed operations and applied as a continuous release over 24 hours per day, 7 days per week operation. This is a significant overestimate in all phases and will allow sufficient margin should minor changes to the above schedule become necessary.

3.5.5 Vent gas releases

Egdon[11] have provided estimates of the gas release from the drilling rig degasser during the drilling phase of the proposed operations.

Similar to the treatment of volatile organic compound releases from the flare, the volatile organic compound release is based on the non-methane fraction of the release only and is assessed as benzene. It is considered that this provides a more representative approach, albeit most likely to provide an overestimate of the significance of releases.

Table 3.21 summarises the volatile organic compounds release from the drilling rig degasser during phase 2 of the proposed operations based on information provided by Egdon[11].

Table 3.21 Volatile organic compounds releases in vented gas

Property		Value
Vent gas release	tCH4/day	0.0458
Total produced gas release[a]	t/day	0.0592
Non-methane volatile organic compound content	%w/w	14.7
Non-methane volatile organic compound release	t/day	0.0087
	g/s	0.101[b]

a. Based on produced gas composition in Table 3.9.
b. Release rate assumes a uniform release across each day.

The above release rate has been employed in the assessment. The vented gas release is assumed to have a temperature of 50°C and to be released from a 0.1m diameter vent at a velocity of 0.1m/s as a continuous release during the drilling phase (Phase 2) of the proposed operations.

3.6 Modelling scenarios

ADMS 6.0 has been employed to estimate process contributions to ambient pollutant concentrations based on the general conditions specified above. For the assessment the model has been run using meteorological data for each of five years (2020 to 2024).

The expected programme of work is listed in Table G.2.

Table 3.22 summarises the equipment usage for the individual phases. The specification for each item of equipment is presented in Table G.1.

Table 3.22 Equipment usage

Equipment		Phase			
		1	2	3	4
		Days used during proposed programme			
A	Construction plant	1-35			
B	Surface conductor		36-45		
C	Generator	1-35	36-91	92-119	
D	Drilling rig		43-84		
E	Workover rig				120-133
F	Flare			103-106	
G	Crane			92-95	120-123
H	Coiled tubing unit			96-98	
I	Slickline unit				124-127
J	Test facilities			92-119	
K	Restoration plant				120-147
HDV		1-35	36-91	92-119	120-147
Vent			43-84		

a. See Tables G.1 and G.2 for equipment description and daily operational hours respectively.

It may be noted that long term air quality benchmarks are expressed as a mean over a calendar year. For the purposes of this assessment, it is assumed that the proposed operations will start at the beginning of the year and, once commenced, will run continuously with no breaks between phases or within phases and that phases will be of the full duration assumed. These assumptions would be expected to ensure that the proposed activities which provide the maximum pollutant releases and hence have the maximum air quality impact, are captured and accommodated within a calendar year. As such the assessment represents a worst case for the proposed operations both in terms of long term and short term air quality impact.

In practice, it would be expected that there will be breaks between and within various phases of the proposed operations and there is the potential for the operations to span more than one calendar year depending on breaks and the start date. It is considered that the proposed schedule in Table G.2 represents an unlikely worst case which will provide estimates of air quality impact substantially greater than those in practice, particularly in the case of impacts assessed over the long term. Any departures in practice, from the proposed schedule should not result in changes to air quality impacts which would be any worse than those determined in this assessment. There is, therefore, a reasonable margin of headroom inherent in the conclusions of this assessment.

Sensitivity analyses have been undertaken to look at the impact on air quality of model selection. The US EPA's AERMOD modelling system is a widely used model for determining the dispersion of releases to air and their subsequent ambient impact and is accepted by the Environment Agency and UK Local Authorities for regulatory purposes. To determine the influence of the model selection, part of the assessment was repeated using the AERMOD model.

4 MODELLING RESULTS

ADMS 6.0 has been run for the operating scenarios described in Section 3.6. The results of the modelling are discussed below. In this section results are presented in tabular form, while in Annex A contour plots are provided which illustrate the estimated process contribution to selected ambient pollutant concentrations over the entire assessment area.

The initial part of this assessment is used to determine the air quality impact at the location of maximum concentration in order to identify those pollutants which are clearly insignificant in terms of air quality impact and those which may require further assessment. The second part of the assessment then considers the impact of process contributions of selected pollutants at sensitive locations to determine their significance in the context of applicable air quality standards and critical levels and loads.

4.1 Impact of process releases

Figures A.1 and A.2 illustrate the dispersion of nitrogen dioxide on short term and long term bases respectively,. Figures A.3 and A.4 provide the corresponding illustrations for total volatile organic compounds (assessed as benzene). The dispersion patterns are reasonably typical of all pollutants considered. On both long and short term averaging bases, the location of maximum process contribution is within the wellsite boundary. This pattern is typical of low level releases. The maximum off site process contribution occurs at the wellsite's north eastern boundary in the general direction of the prevailing wind. Table 4.1 summarises the maximum process contributions and predicted environmental concentrations at the wellsite boundary, representing the maximum off-site air quality impact.

Table 4.1 Maximum process contributions and predicted environmental concentrations – Site boundary

Substance	Averaging basis	Process contribution		Background	Predicted environmental concentration	
		µg/m^3	% standard	µg/m^3	µg/m^3	% standard
Carbon monoxide	8 hours	1015	10.1	1440	2455	24.5
	1 hour	1594	5.3	2059	3653	12.2
Nitrogen dioxide	1 hour	649	325	6.96	656	328
	annual	43.80	110	3.48	47.3	118
Sulphur dioxide	15 min	18.82	7.1	1.77	20.6	7.7
	1 hour	10.50	3.0	1.32	11.8	3.4
	24 hours	1.47	1.2	0.78	2.2	1.8
PM_{10}	24 hours	5.23	10.5	14.11	19.3	38.7
	annual	1.61	4.0	11.96	13.6	33.9
$PM_{2.5}$	annual	1.61	8.1	5.14	6.8	33.8
VOC (as benzene)	24 hours	263	875	0.24	263	876
	annual	8.37	167	0.20	8.6	171
Nitrogen monoxide	1 hour	1835	41.7	1.14	1836	41.7
	annual	40.90	13.2	0.57	41.5	13.4

For all substances, with the exception of nitrogen dioxide, nitrogen monoxide and volatile organic compounds (as benzene), maximum process contributions are within the Environment Agency screening criteria (short term process contributions are less than 20% of the short term environmental standard less the corresponding background and/or the maximum long term predicted environmental concentration is less than 70% of the long term environmental standard) and as such are considered insignificant and requiring no further investigation.

Maximum process contributions of nitrogen dioxide, nitrogen monoxide and volatile organic compounds exceed Environment Agency screening criteria and in some cases exceed the applicable air quality benchmarks.

Air quality standards with respect to human health are not considered to be applicable on the wellsite or around the wellsite boundary and beyond in the areas most affected by site process contributions. Frequent human exposure, over the periods of the standards, is unlikely in these areas (see section 2.3.1) due to the absence of any residential locations or designated footpaths. Figures A.1 to A.4 include identification of the area within which screening criteria are exceeded. Process contributions beyond this area are not considered significant.

The air quality impacts of these substances are considered in more detail in the following sections at sensitive locations where air quality standards would be expected to apply. These locations include the nearest residential properties. Nitrogen dioxide, nitrogen oxides and sulphur dioxide are also considered at designated and local ecological sites where critical levels and loads are applicable.

4.2 Impact of process releases at locations of human exposure

In order to determine the impact of wellsite releases at locations of frequent human exposure, discrete receptors were located at the residential locations in the vicinity of the proposed Weaverthorpe wellsite (see Figure 3.2 and Table E.1). These are considered to be the only locations in the vicinity of the wellsite to which the public normally have access and where human exposure for some or all of the air quality standard averaging periods is likely.

Table 4.2 summarises the maximum process contributions and predicted environmental concentrations at residential locations near the proposed wellsite.

Table 4.2 Maximum process contributions and predicted environmental concentrations – Residential locations

Substance	Averaging basis	Process contribution		Background	Predicted environmental concentration	
		µg/m³	% standard	µg/m³	µg/m³	% standard
Carbon monoxide	8 hours	23.2	0.2	1440	1463	14.6
	1 hour	54.0	0.2	2059	2113	7.0
Nitrogen dioxide	1 hour	20.9	10.5	6.96	27.9	14.0
	annual	0.9	2.2	3.48	4.4	10.9
Sulphur dioxide	15 min	1.8	0.7	1.77	3.6	1.4
	1 hour	0.7	0.2	1.32	2.0	0.6
	24 hours	0.4	0.3	0.78	1.2	1.0
PM_{10}	24 hours	0.1	0.2	14.11	14.2	28.4
	annual	0.03	0.1	11.96	12.0	30.0
$PM_{2.5}$	annual	0.03	0.2	5.14	5.2	25.9
VOC (as benzene)	24 hours	2.5	8.2	0.24	2.7	9.0
	annual	0.1	1.8	0.20	0.3	5.8
Nitrogen monoxide	1 hour	96.7	2.2	1.14	97.9	2.2
	annual	0.8	0.3	0.57	1.4	0.5

For all substances considered maximum process contributions at residential locations are less than 20% of their short term environmental standard less the corresponding background and/or the maximum long term predicted environmental concentration is less than 70% of the long term environmental standard. Process contributions of these substances are therefore considered insignificant.

The predicted environmental concentration of all pollutants is less than, and in some cases substantially less than, a third of the applicable standard. Bearing in mind the precautionary assumptions made in the assessment, it is considered unlikely that pollutant process contributions from exploration operations at the proposed Weaverthorpe wellsite will pose any risk to, or have any meaningful influence on, continued attainment of air quality standards at the nearest locations of human exposure.

Table E.2 provides detailed process contribution data for nitrogen dioxide and volatile organic compounds, the two most predominant substances, for all discrete receptors

Based on Environmental Protection UK and the Institute of Air Quality Management classification (section 2.6.4) the maximum impact significance of releases of all substances at the most affected sensitive location (West Field House) is considered to be 'negligible'. Table 4.3 summarises the assessment of significance.

Table 4.3 Assessment of impact significance based on IAQM classification

Substance	Maximum process contribution[a]	Predicted environmental concentration[a]	IAQM classification (see Table 2.7)
	% environmental standard		
Nitrogen dioxide	2.2	11	Negligible
VOC (as benzene)	1.8	6	Negligible
Nitrogen monoxide	0.3	<1	Negligible
PM_{10}	0.1	30	Negligible
$PM_{2.5}$	0.2	26	Negligible

a. Process contributions and predicted environmental concentrations are expressed as a percentage of the applicable long term environmental standard (see Table 4.4) for the most affected residential location.

4.3 Impact of process releases at designated and local ecological sites

Two local ecological sites, requiring assessment based on Environment Agency criteria (see section 2.5.3), were identified near the proposed Weaverthorpe wellsite as discussed in section 3.1.

The main substances of interest at these sites are nitrogen oxides, nitrogen dioxide and sulphur dioxide. For the purposes of the assessment of process contributions at these sites, a discrete receptor was placed at the boundary of each site closest to the proposed wellsite as described in Table 3.1.

The critical loads and levels adopted for use in this assessment have been obtained from the APIS and are summarised in Table F.1 In the absence of site specific information, a neutral grassland habitat is assumed or each site for the purposes of selecting critical loads. The nitrogen critical load is provided as a range and the minimum in that range has been adopted for the assessment. This represents a worse case precautionary approach to the assessment and will most likely result in an overestimate of impact.

The site background concentrations, as obtained from APIS, are summarised in Table F.2.

The maximum process contributions to concentrations of nitrogen oxides and sulphur dioxide at the sites are summarised in Table 4.4. Table F.3 presents the detailed determination of process contributions at each site.

Table 4.4 Maximum process contributions of nitrogen oxides and sulphur dioxide at local ecological sites

Site	Nitrogen oxides[a]				Sulphur dioxide	
	Annual mean		Daily mean		Annual mean	
	PC	PEC	PC	PEC	PC	PEC
	% of critical level					
Gypsy Race LWS	1.6	18	36.2	50	0.01	7
West dale, Fordon LWS	0.5	18	7.0	21	0.01	7

a. Total nitrogen oxides are expressed as NO_2.

The maximum long term and short term process contributions of nitrogen oxides and sulphur dioxide are equivalent to less than 100% of the critical levels for both sites. As such process contributions are considered insignificant.

The determination of nitrogen and acid deposition at the two sites is summarised in Table 4.5. Tables F.4 and F.5 present the detailed determination of nitrogen and acid deposition respectively. The determination was undertaken in accordance with the guidance in AQTAG 06[22] and considered dry deposition only. Guidance indicates that wet deposition over relatively short distances is unlikely to be significant.

Table 4.5 Nitrogen and acid deposition at local ecological sites

Site	Nitrogen deposition		Acid deposition	
	PC	PEC	PC	PEC
	% of critical load			
Gypsy Race LWS	1.0	178	0.2	29
West dale, Fordon LWS	0.3	177	0.1	29

a. Determination of deposition is based on the deposition velocity for forest terrain[22].
b. The nitrogen critical load selected is the minimum of the range specified for a neutral grassland habitat.

The maximum process contributions to nitrogen and acid deposition are equivalent to less than 100% of the applicable critical loads at both sites and as such are not considered significant. While there is exceedance of the nitrogen critical load at both sites, this is due to existing large background depositions. It is not considered that the process contributions from the proposed operations at the Weaverthorpe wellsite will have any significant influence on critical load compliance at these sites.

It is considered that process contributions from the proposed exploratory operations at the Weaverthorpe wellsite will be unlikely to pose any threat to, or have any meaningful influence on, the attainment of critical levels and critical loads at the nearest sites with ecological designations.

4.4 Sensitivity analyses

In the assessment of the impact of process contributions the worst case results have been reported. For the assessment, process contributions were modelled for each of 5 years' meteorological data using the ADMS modelling system. A sensitivity analysis was undertaken to determine the influence of meteorological conditions and model selection on the findings of the assessment and hence provide some measure of their robustness.

4.4.1 Meteorological conditions

Table 4.6 summarises the influence of meteorological conditions on maximum process contributions for the discrete receptor groups describing the neighbouring residential locations, sites with ecological designations and wellsite boundary (see Annex E).

Table 4.6 Influence of meteorological conditions on maximum process contribution

Substance	Averaging basis	Residential	Ecological sites	Site boundary
	Maximum process contribution (ratio of maximum to minimum year)			
Carbon monoxide	8 hours	2.0	1.9	1.5
	1 hour	1.7	1.9	1.3
Nitrogen dioxide	1 hour	2.6	2.7	1.8
	annual	2.4	2.8	2.4
Sulphur dioxide	15 min	21.7	21.2	7.5
	1 hour	6.5	9.0	6.2
	24 hours	12.0	18.6	2.7
PM_{10}	24 hours	5.7	5.2	2.9
	annual	2.1	2.7	2.1
$PM_{2.5}$	annual	2.1	2.7	2.1
VOC (as benzene)	24 hours	4.5	3.5	2.4
	annual	2.0	2.8	1.9
Nitrogen monoxide	1 hour	2.4	2.1	1.2
	annual	2.4	2.8	2.4

Annual variations in meteorological conditions, on average, show up to a threefold difference between maximum and minimum process contributions, with some substances having more substantial differences due to their release profiles. This assessment is based on the maximum process contribution for all the years considered at each location, and as such will be an over estimation for most years.

4.4.2 Model selection

The main assessment has been undertaken using the ADMS modelling system. The US EPA's AERMOD model is also widely used for regulatory purposes worldwide. To determine how the model used may have influenced the findings of the assessment, the AERMOD model was employed to predict process contributions over the important averaging bases at 2024 meteorological conditions. Table 4.7 presents the comparison between the ADMS and AERMOD model predictions averaged over receptor groups describing the neighbouring residential locations, sites with ecological designations and wellsite boundary (see Annex E).

Table 4.7 Maximum process contributions (variation with model)

Averaging basis	Maximum process contribution (ratio of ADMS to AERMOD - 2024)		
	Residential	Ecological sites	Site boundary
annual	1.8	2.3	1.5
1 hour	1.3	1.3	2.7
24 hour	1.9	2.9	2.3

In general, the AERMOD and ADMS models provide predicted ambient process contributions which are in reasonable agreement for all averaging bases at the receptors considered. There are slight differences between the receptor groups, although on average ADMS provides, a higher predicted process contribution across the receptor groups for all averaging bases. Bearing in mind the margin available in the assessment of air quality standard compliance and the maximum impact relative to critical loads and levels at the ecological receptors, it is not considered that the differences exhibited due to model selection will have any substantial impact on the overall conclusions of this assessment.

4.5 Modelling uncertainty

The use of models to predict the dispersion of releases has associated uncertainties. The main uncertainties in this assessment result from:

- The operational load in practice is likely to be lower on most occasions than that modelled in this assessment. The proposed development is modelled based on full load operation of all plant on a continuous 24 hour per day basis for the entire duration of the proposed four phases, except where specifically limited Egdon's operations schedule. This provides what is considered to be a significant overestimate of process releases in practice. It is expected that the duration, frequency and intensity of equipment operation will be substantially lower than that considered in the assessment. As such the process contributions and subsequent ambient impact for all pollutants are likely to be an overestimate of those in practice, providing some margin should there be any changes to the expected schedule.

- The release rates upon which the assessment is based are consistent with the operation of engines, incinerator and construction vehicles at the regulation or benchmark limits. In addition, heavy duty vehicle idling emissions are considered conservative estimates. In practice, it is likely that pollutant release rates will be somewhat lower, and in some cases substantially lower, than the levels assumed in this assessment. This will result in an overestimate of ambient impact.

- Conversion rates for nitrogen monoxide to nitrogen dioxide of 35% and 70% have been employed as recommended by the Environment Agency[1] for short and long term air quality impacts respectively. These are generally considered quite conservative estimates. Conversion rates over the relatively short distances considered in this assessment are likely to be substantially lower than those assumed. Estimates based on the Janssen relationship[23] indicate a likely overestimate of the significance of process releases (see Annex C and Table E.1) of nitrogen dioxide and associated nitrogen and acid deposition at the designated and local ecological sites.

- In the assessment of particulate matter releases the environmental standards used are those for $PM_{2.5}$ and PM_{10}. A precautionary approach is adopted and it is assumed that when comparing the release with the corresponding standards, all particulate matter is present as either PM_{10} or $PM_{2.5}$ as appropriate.

- Volatile organic compounds releases are assessed as benzene as required within guidance[1] for situations where the composition of the release is not known. In practice, it is expected that a large proportion of the total volatile organic compounds release will be methane or other lower hydrocarbons. This is particularly relevant to volatile organic releases from the drilling rig degasser, incineration and site equipment such as diesel-powered stationary engines. Methane and lower hydrocarbons have significantly higher environmental benchmarks compared with benzene. In this case the release is based on the non-methane fraction. This is considered to represent a substantial overestimate of the significance of impact on air quality on human health in practice.

- The meteorological conditions upon which the assessment was based vary from year to year and influence ambient impact. A sensitivity analysis has shown the differences expected due to changes in meteorological conditions for a five year period. This assessment is based on the year providing the maximum impact for each location and pollutant and as such is likely to be an overestimate for most meteorological years.

- Air quality standards are based on assessment over a calendar year and as such long term process contributions will be dependent on the commencement date of the proposed operations and the execution of the schedule. This assessment is based on an worst case where the proposed schedule runs continuously without breaks from the beginning of the year, such that the entire operation is accommodated within a single calendar year. As such the assessment most likely represents an overestimate of air quality impact in practice, particularly for process contributions determined on a long term (annual) basis. Departures from the modelled schedule will, in practice, most likely result in a lower air quality impact than that determined herein.

- The model used can influence predictions of ambient impact. In this case a sensitivity analysis of the two most widely used models for regulatory purposes indicated that the conclusions of the assessment were not dependent on the selection of model. The ADMS and AERMOD show generally reasonable agreement and it is not considered that model selection has any significant impact on assessment conclusions, although the ADMS model does tend to provide higher predicted process contributions at sensitive locations compared with AERMOD.

- The necessary assumptions made regarding surface characteristics (section 3.4) can have either a negative or positive impact on modelling outcomes. A sensitivity analysis indicates that variations due to the assumed surface characteristics are unlikely to be significant in terms of the conclusions of the assessment as the potential for any impact is mitigated by the selection of descriptive parameters considered representative of the assessment area.

There are inherent uncertainties associated with the use of air dispersion models to predict the ambient impact of releases. With this in mind the assessment herein has been undertaken using conservative assumptions which tend towards an over estimation of the ambient impact. It is considered that the assessment has taken a precautionary approach and the conclusions reached incorporate a reasonable margin of comfort despite the inevitable uncertainty of such modelling studies.

4.6 Photochemical ozone creation potential

Some of the pollutants released have the potential to react to form ozone. Ground level ozone is a highly reactive pollutant with a potential to damage human health and vegetation. It is produced by the action of sunlight on volatile organic compounds and oxides of nitrogen. Environment Agency guidance, provides a standardised methodology for determination of the photochemical ozone creation potential (POCP) of a release. In the case of the proposed operations it is considered that releases of volatile organic compounds, nitrogen dioxide, sulphur dioxide and carbon monoxide have implications for ozone formation. The total release of each of these over the duration of the proposed development is assessed in Table 4.8 based on operating conditions in section 3.5.

The assumptions made in relation to releases are considered to represent the worst case for the proposed operations. The determination indicates a POCP for the entire proposed development of 174 tonnes.

Table 4.8 Calculation of POCP related releases

Substance	Release over proposed development (t)				POCP	
	NO_2	CO	SO_2	VOCs		
POCP factor	2.8	2.7	4.8	21.8	tonnes	% of total project releases
Phase						
1	1.4	2.2	0.003	0.1	13	7.6
2	22.8	4.5	0.026	2.4	129	74.4
3	1.5	2.8	0.377	0.5	24	14.1
4	0.7	1.2	0.001	0.1	7	4.0
Total	26	11	0.4	3	174	100.0

4.7 Construction dust

It is likely that the construction activities associated with the proposed operations will give rise to dust emissions, albeit temporary in nature and largely restricted the areas close to the wellsite.

The potential for fugitive dust is most likely to arise from the movement of vehicles over the earth, the stripping of soil, excavations and the subsequent storage of excavated materials and transfer of materials to and from lorries. This may be exacerbated by spillages during transportation and handling and also by periods of dry weather and high wind speeds. This is considered in Annex H in accordance with the methodology described in the IAQM's guidance[24]on the assessment of dust from demolition and construction.

It is expected that, with adequate mitigation measures in place, the risk of dust impact from all operations will be 'negligible'.

4.8 Operations traffic

The proposed operations will have the effect of increasing traffic flow, albeit temporarily, in the area, which in turn will result in additional releases of certain pollutants to air. It is necessary to understand the likely ambient impact of this increase in traffic flow. This is assessed in Annex I using methodology provided by National Highways[25] and the IAQM[9].

Increases in road traffic brought about by the construction activities and subsequent wellsite operations are assessed to have a neutral impact on air quality based the guidance within National Highways' Design Manual for Roads and Bridges. The additional contributions to ambient pollutant concentrations from associated road traffic have no influence on the findings of the main air quality assessment for plant releases to air.

5 CONCLUSIONS

Egdon proposes to undertake hydrocarbon exploration operations at a new site off Butt Lane near Foxholes, known as the Weaverthorpe wellsite. The proposed operation involves drilling a single exploratory borehole and then testing to determine viability. This includes preliminary construction of the wellsite and subsequent decommissioning and site restoration following the test phase. Site electricity requirements will be fully met from on-site generation using diesel fuelled generators. Natural gas produced during a short testing phase will be disposed of by incineration. The expected project duration is around 21-23 weeks in total although there may be periods of dormant activity between phases.

As part of the planning and permitting process, Egdon have asked that the dispersion of releases to atmosphere associated with the proposed operations be assessed to determine their impact on ambient concentrations of important pollutants around the local area. Impact at locations of permanent human habitation and designated and local ecological sites, in the context of attainment of applicable environmental standards, requires assessment.

The predominant source of pollutant releases during site operations will be from the use of diesel fuel in mobile plant and stationary engines and from the incineration of produced natural gas. This is largely undertaken during the drilling and testing phases which cover a 12 week period. Releases of nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter and sulphur dioxide were therefore considered. The assessment was undertaken using the UK ADMS 6.0 modelling system, with an operating regime considered to provide unlikely worst case conditions for pollutant releases and air quality impact.

Maximum pollutant process contributions from site operations occur within the wellsite boundary. Beyond this location, process contributions reduce significantly with distance. It is not considered that statutory air quality standards would be applicable around the area of maximum impact, or around and just beyond the site boundary, due to the infrequency of human exposure and limited access.

At neighbouring locations of residential occupation, where long term human exposure might be expected, it is considered that pollutant process contributions from the proposed site operations are insignificant. In all cases the predicted environmental concentration of all pollutants is less than, and in some cases substantially less than, a third of the applicable standard. Bearing in mind the precautionary assumptions made in the assessment, it is considered unlikely that pollutant process contributions from the proposed exploratory operations at the Weaverthorpe wellsite will pose any risk to, or have any meaningful influence on, the continued attainment of air quality standards at the nearest locations of human exposure.

At the nearest designated and local ecological sites requiring assessment, which are sensitive to nitrogen oxides, sulphur dioxide and nitrogen and acid deposition, process contributions are considered unlikely to pose any threat to, or have any substantial influence on, the attainment of critical levels and critical loads.

Necessary assumptions made to undertake the modelling are considered to have the effect of substantially overestimating the process contribution to ambient concentrations. It is considered that the predicted process impact reported herein is a conservative assessment and the conclusions reached therefore incorporate a reasonable margin of comfort despite the inevitable uncertainty of such modelling studies.

It is likely that the construction activities associated with the development of the wellsite will give rise to dust emissions. It is expected, based on Institute of Air Quality Management methodology, that with adequate mitigation measures in place the risk of dust impact from all proposed development operations will be 'negligible'.

Increases in road traffic brought about by the construction activities and subsequent site operation are assessed to have a neutral impact on air quality based on the guidance within National Highways' Design Manual for Roads and Bridges.

Given the above, the Proposed Development is considered to accord with the relevant development plan policies that cover air quality, namely policies M17, D02 and D14 of the Minerals and Waste Joint Plan 2022 and policy SP17 of the Ryedale Local Plan Strategy 2013. It also accords with paragraph 199 of the NPPF.

6 REFERENCES

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Annex A Dispersion modelling contour plots

The results of the modelling of the impact of pollutant releases from wellsite exploration operations on local ambient ground level concentrations are presented in tabular form in Section 4. In Annex A typical examples of the long term and short term dispersion patterns for nitrogen dioxide and volatile organic compounds (assessed as benzene), the most significant pollutants, are presented. Contour plots illustrating the process contribution to ground level concentrations of each are provided. The results relate to modelling wellsite operations and meteorological conditions which are considered to provide the maximum process contributions over the assessment area. All results are presented as the maximum contribution of the process (excluding existing background concentrations), expressed as a percentage of the applicable air quality benchmark.

The plots are considered over an area of 2km x 2km, which comprises the assessment area, immediate area around the wellsite and the nearest residential neighbours.

For presentational purposes contour plots are limited to minimum values of 1% and 10% of the long and short term environmental standards respectively. Process contribution of less than 1% and 10% of the long term and short term standards respectively, are generally considered insignificant in terms of air quality impact.

The plots also identify the area within which Environment Agency screening criteria are exceeded (black dotted lines). Any process contribution beyond this area does not require further consideration with regard to human health effects.

The following figures are presented:

Figure 1 Predicted maximum process contributions of nitrogen dioxide
(AQS limit 99.8 percentile of 1 hour means – 2023)

Figure 2 Predicted maximum process contributions of nitrogen dioxide
(AQS limit annual mean - 2020)

Figure 3 Predicted maximum process contributions of volatile organic compounds
(EAL for benzene 24 hour means – 2024)

Figure 4 Predicted maximum process contributions of volatile organic compounds
(AQS limit for benzene annual mean - 2024)

Figure A.1 Predicted maximum process contributions of nitrogen dioxide (AQS limit 99.8 percentile of 1 hour means – 2023)

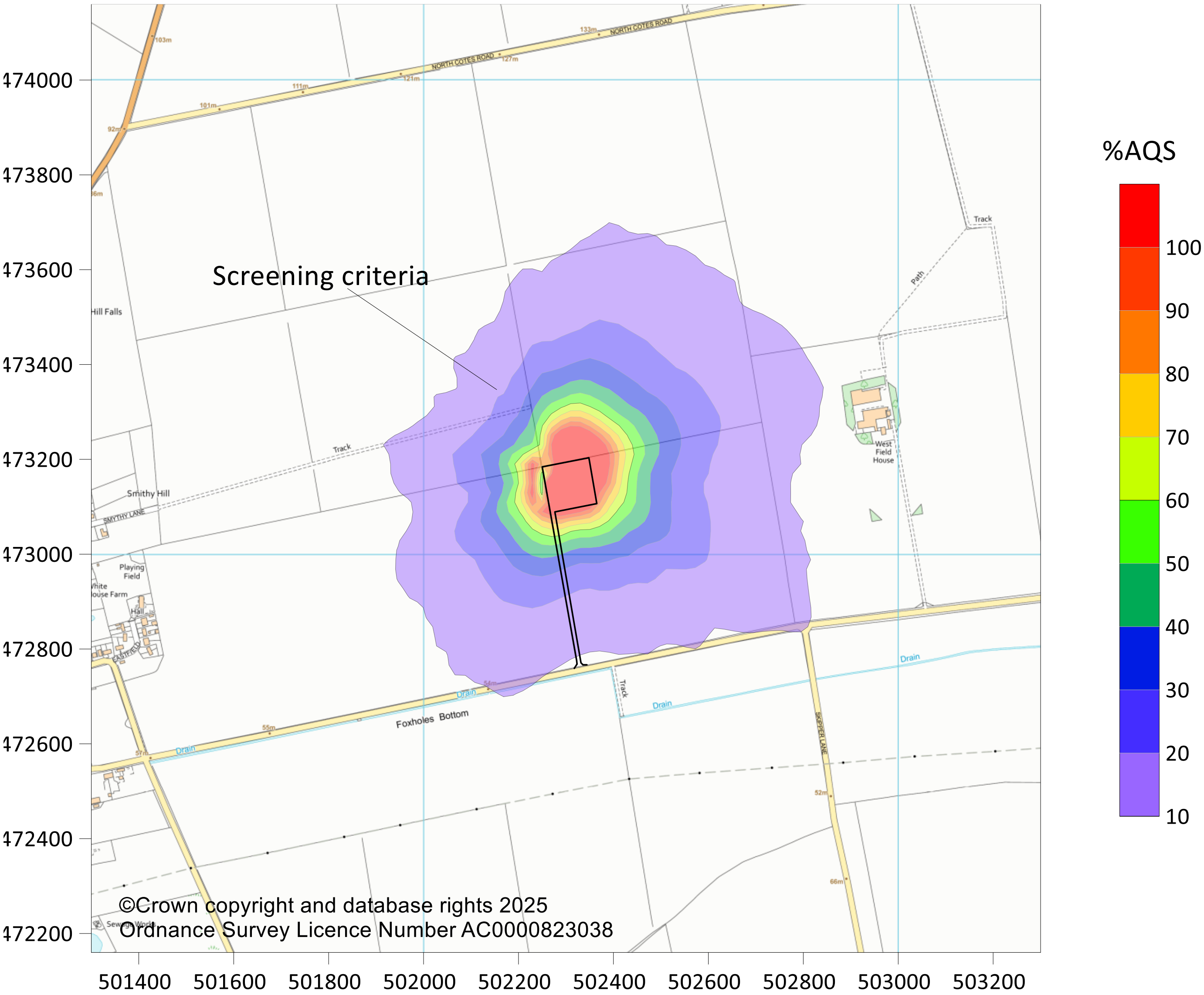


Figure A.2 Predicted maximum process contributions of nitrogen dioxide (AQS limit annual mean - 2020)

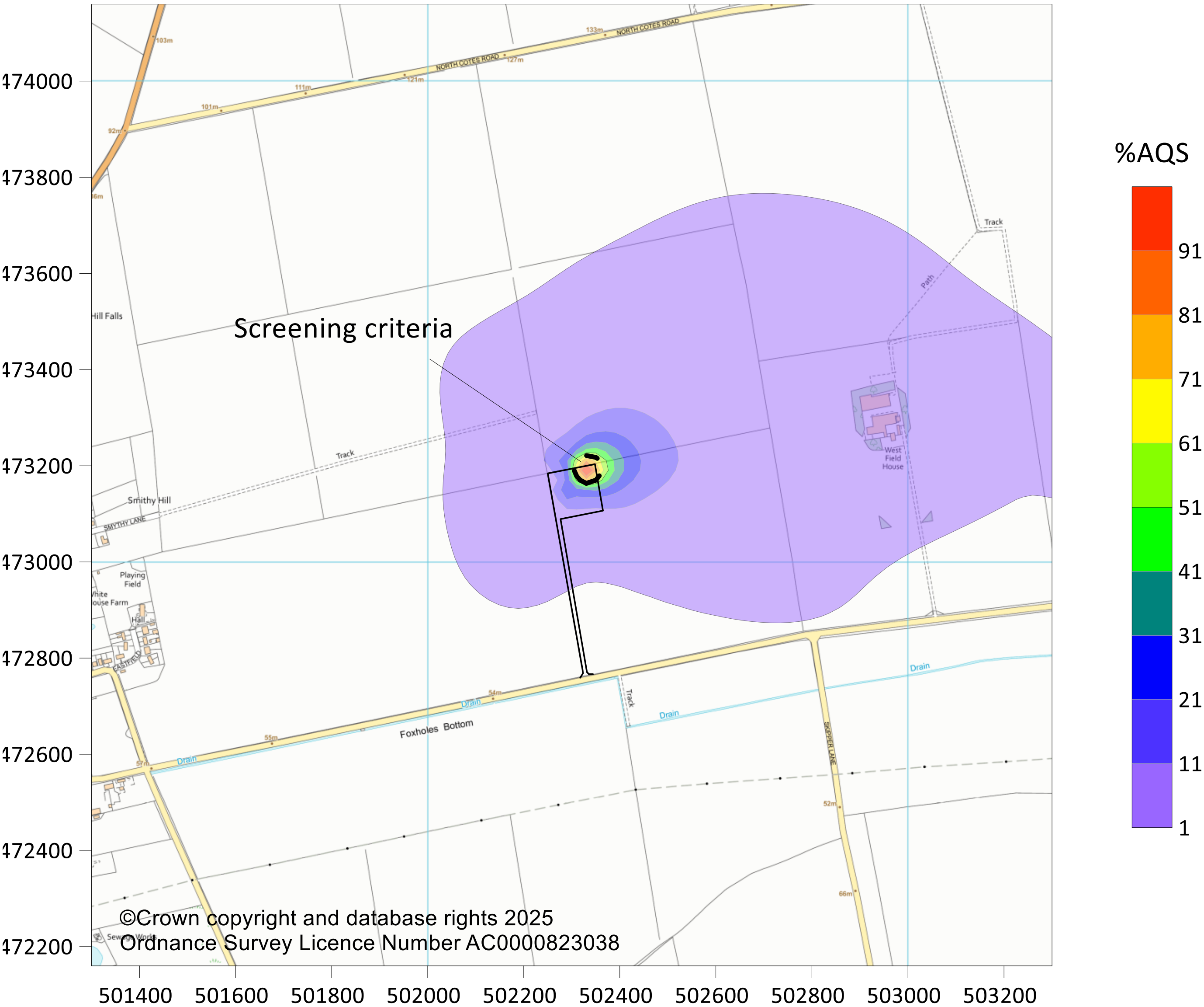


Figure A.3 Predicted maximum process contributions of volatile organic compounds (EAL for benzene 24 hour means – 2024)

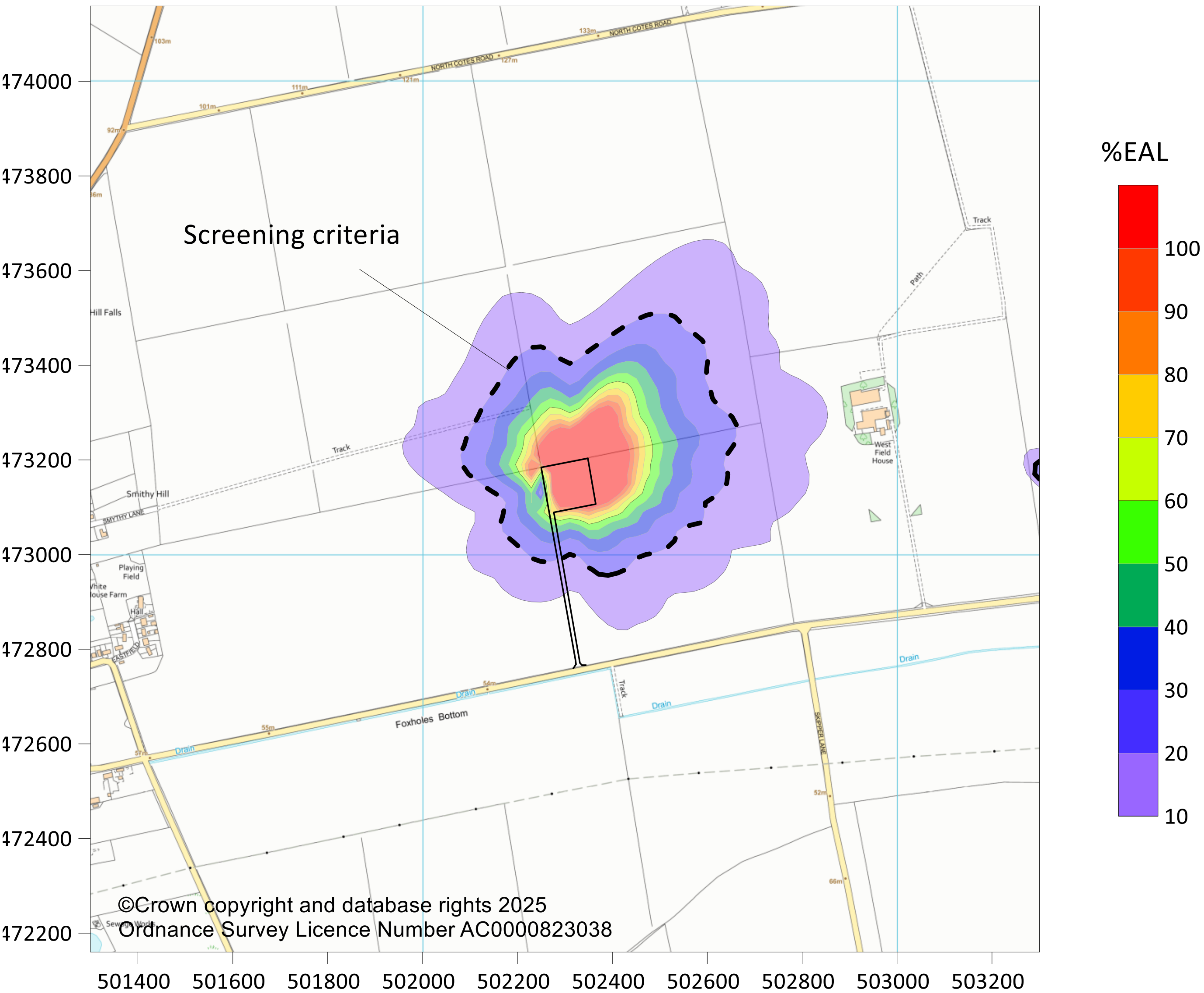
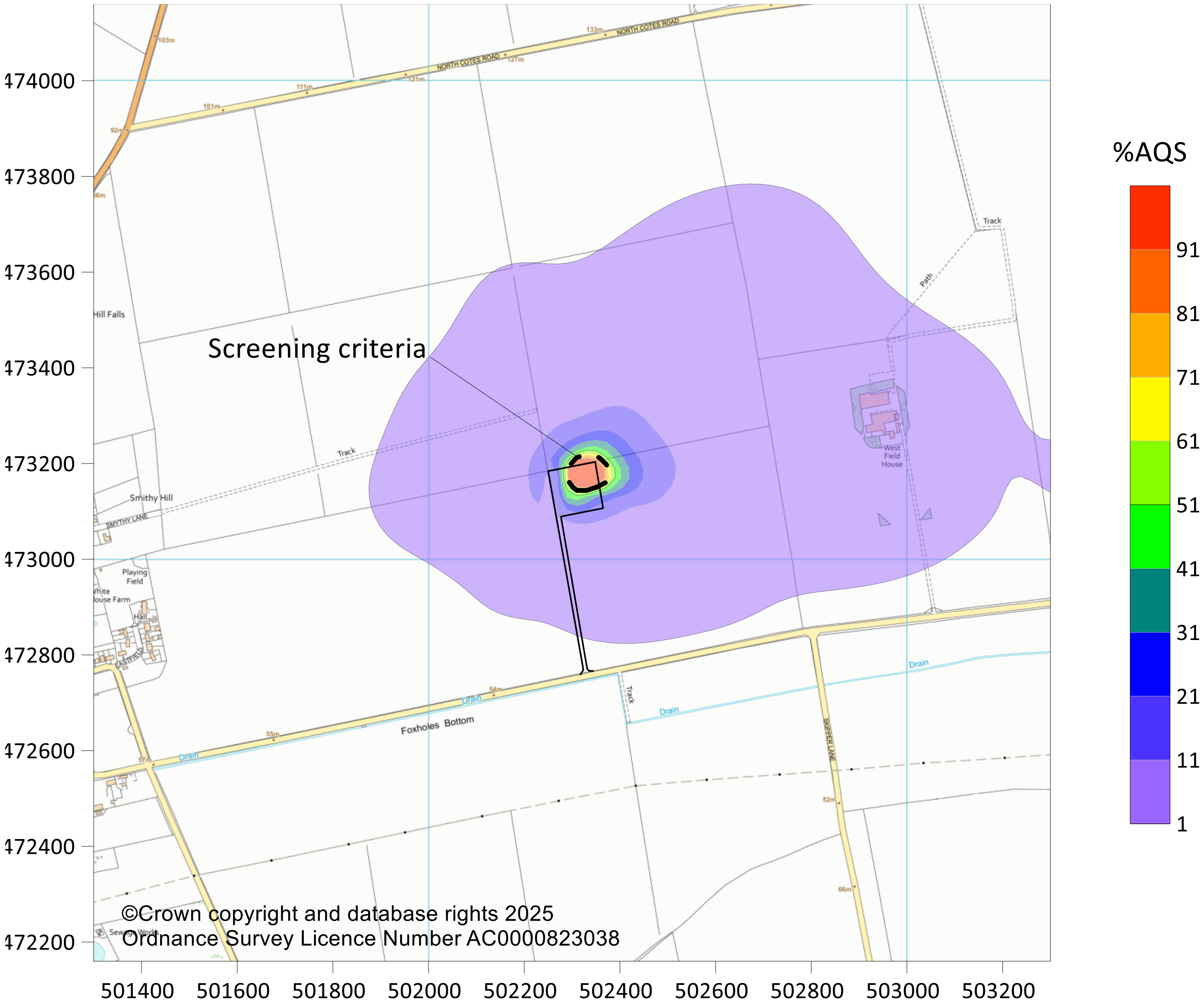


Figure A.4 Predicted maximum process contributions of volatile organic compounds (AQS limit for benzene annual mean - 2024)



ANNEX B Model input data

B.1 Assessment area and surface characteristics

Table B.1 summarises the assessment area considered in the modelling and the values of the parameters describing its surface characteristics. These are described in more detail in sections 3.1 to 3.4.

Table B.1 Assessment area and surface characteristics

Parameter	Value
Assessment area	2000 m x 2000m area with centre 502300 473160
Cartesian receptor grid	101 x 101 receptor grid (total 10201) with receptors spaced at 20m intervals
Discrete receptors	49 receptors - see Table E.1 for description
Meteorological data	Hourly sequential data supplied by the UK Meteorological Office from the Bridlington Marine Rescue Sub Centre (Mrsc) for the 5 year period 2020 to 2024
Topography	Elevated terrain Ordnance Survey Land-form Panorama DTM for area considered (SE86 & 88, TA06 & 08)
Surface roughness	0.5m
Minimum Monin Obukhov length	10m
Surface albedo	0.23
Priestley Taylor parameter	1.0

The release characteristics of the wellsite sources considered in this assessment are detailed in full in Tables 3.9 to 3.21. Tables B.1 and B.2 summarise the main input data to the model.

Table B.1 Exhaust gas conditions

Plant		Easting (m)	Northing (m)	Height of release (m)[a]	Diameter (m)[a]	Temperature (°C)	Velocity (m/s)
A	Construction plant	502293	473150	3.0	0.30	150	20.7
B	Surface conductor	502315	473147	4.0	0.20	550	21.4
C	Generator	502299	473174	4.0	0.30	550	18.6
D1	Rig engine 1	502304	473173	4.0	0.40	455	39.5
D2	Rig engine 2	502303	473179	4.0	0.40	455	39.5
D3	Rig engine 3	502307	473177	4.0	0.40	455	39.5
D4	Rig engine 4	502306	473183	4.0	0.40	455	39.5
E	Workover rig	502315	473147	4.0	0.30	550	18.8
F	Flare	502334	473184	4.0	0.30	550	18.8
G	Crane	502315	473147	3.0	0.20	150	22.0
H	Coil tube unit	502315	473147	4.0	0.30	550	18.8
I	Slickline	502315	473147	4.0	0.30	550	18.8
J	Test facilities	502300	473161	3.0	0.20	550	18.2
K	Restoration plant	502293	473150	3.0	0.30	150	14.8
Vent gas		502319	473174	3.0	0.10	50	0.1
HDV		502319	473174	3.0	0.05	150	3.5

Table B.2 Modelled pollutant releases

Plant		Pollutant release rate (g/s)				
		CO	VOC (as benzene)	NO_2	PM_{10}	SO_2
A	Construction plant	0.939	0.045	0.215	0.004	0.00094
B	Surface conductor	0.174	0.015	0.184	0.010	0.000209
C	Generator	0.340	0.029	0.360	0.019	0.000408
D1	Rig engine 1	0.188	0.026	1.442	0.028	0.00167
D2	Rig engine 2	0.188	0.026	1.442	0.028	0.00167
D3	Rig engine 3	0.188	0.026	1.442	0.028	0.00167
D4	Rig engine 4	0.188	0.026	1.442	0.028	0.00167
E	Workover rig	0.344	0.047	0.583	0.020	0.000413
F	Flare	4.266	1.143	0.936	0	1.087
G	Crane	0.389	0.021	0.044	0.003	0.000467
H	Coil tube unit	0.344	0.047	0.583	0.020	0.000413
I	Slickline	0.344	0.047	0.583	0.020	0.000413
J	Test facilities	0.187	0.007	0.124	0.001	0.000177
K	Restoration plant	0.839	0.037	0.189	0.003	0.000704
Vent gas		0	0.101	0	0	0
HDV		0.004	0.002	0.010	0.0004	0.000005

B.2 Model input files

The input data used in the current assessment have been provided under separate cover. Electronic files containing the input data used in the modelling of the maximum process contributions over the entire assessment area of all pollutants considered have been provided as detailed below:

Carbon monoxide	8 hour mean	WTP 2021.APL
	hourly mean	WTP 2024.APL
Nitrogen dioxide	1 hour mean	WTP 2023.APL
	annual mean	WTP 2020.APL
Sulphur dioxide	15 minute mean	WTP 2020.APL
	1 hour mean	WTP 2020.APL
	24 hour mean	WTP 2024.APL
PM_{10}	24 hour mean	WTP 2020.APL
	annual mean	WTP 2020.APL
$PM_{2.5}$	annual mean	WTP 2020.APL
Benzene	24 hour mean	WTP 2024.APL
	annual mean	WTP 2024.APL
Nitrogen monoxide	hourly mean	WTP 2023.APL
	annual mean	WTP 2020.APL

B.3 Models used

ADMS	Cambridge Environmental Research Consultants Limited ADMS 6.0: version 6.0.0.1 License: A01-1347-C-AD520-UK (10.10.25)
AERMOD	Lakes Environmental Software AERMOD View: version 12.0.0 (AERMOD version 23132) License: AER0005882 (21.11.25)

ANNEX C Conversion of nitrogen monoxide to nitrogen dioxide

The majority of oxides of nitrogen released will be in the form of nitrogen monoxide. While conversion to nitrogen dioxide will occur in the atmosphere it is unlikely that all of the nitrogen oxides in the flue emission will be in the form of nitrogen dioxide at ground level. It may be noted that for this type of assessment the Environment Agency[1] recommend that conversion rates of 35% and 70% be considered for short and long term air quality impacts respectively. These are considered quite conservative estimates. These conversion rates have been used in this assessment and represent a precautionary approach which will, it is considered, significantly over estimate the process contribution to ground level concentrations of nitrogen dioxide at most locations and as such provide a reasonable margin of headroom which should go some way to offsetting the inevitable uncertainties associated with this type of assessment and the necessary modelling assumptions.

There are methodologies available which enable a more representative estimation of conversion rates at specific locations, largely based on distance from the point of release. Based on a study of Dutch power station plumes, Janssen et al[23] determined an approximate relationship between the conversion of NO to NO_2 and the distance from the point of release as below:

$$\frac{NO_2}{NO_x} = A\left(1 - e^{(-\alpha x)}\right)$$

where A is the ozone parameter describing the oxidation of NO to NO_2 in the presence of ozone and the photolysis of NO_2 by sunlight to reform NO.
α is the wind parameter which expresses conversion rates in respect of downwind distance based on wind speed at plume height and ozone concentration.
x is the downwind distance (km)

The values of A and α depend on ozone concentration, incoming solar radiation and wind speed. Janssen developed empirical values for these based on seasonal measurements of conditions in the Netherlands. It is assumed that a similar relationship is applicable in the UK.

Janssen proposed the following seasonal values for A and α:

Winter (December to February)

Background ozone concentration (ppb)	Wind speed at plume height (m/s)					
	0-5		5-15		>15	
	A	α	A	α	A	α
0-10	0.49	0.05	0.49	0.05	0.49	0.05
10-20	0.74	0.07	0.74	0.07	0.74	0.07
20-30	0.83	0.07	0.83	0.07	0.83	0.10
30-40	0.87	0.07	0.87	0.07	0.87	0.15

Spring/Autumn (March to May and September to November)

Background ozone concentration (ppb)	Wind speed at plume height (m/s)					
	0-5		5-15		>15	
	A	α	A	α	A	α
10-20	0.635	0.10	0.635	0.10	0.635	0.10
20-30	0.74	0.10	0.74	0.10	0.74	0.15
30-40	0.80	0.10	0.80	0.10	0.80	0.25
40-60	0.85	0.10	0.85	0.15	0.85	0.30

Summer (June to August)

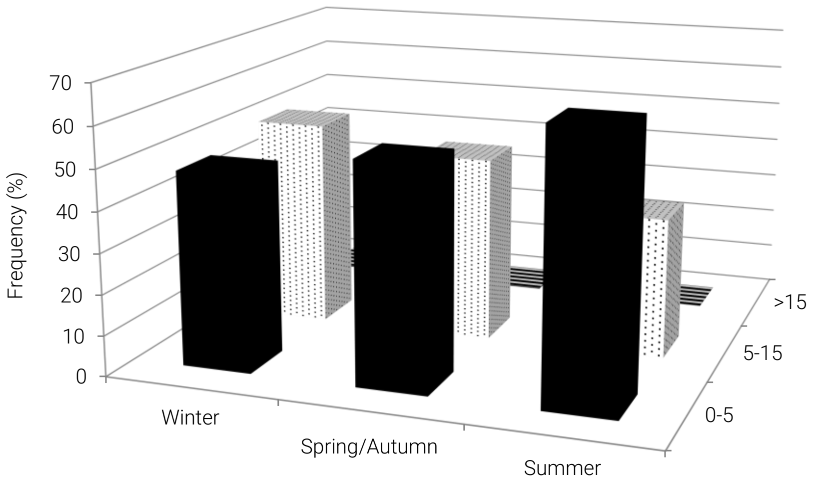
Background ozone concentration (ppb)	Wind speed at plume height (m/s)					
	0-5		5-15		>15	
	A	α	A	α	A	α
20-30	0.67	0.10	0.67	0.10	0.67	0.10
30-40	0.74	0.10	0.74	0.15	0.74	0.25
40-60	0.81	0.15	0.81	0.25	0.81	0.35
60-120	0.88	0.20	0.88	0.35	0.88	0.45
120-200	0.93	0.40	0.93	0.65	0.93	0.80

Janssen indicates that '*the method presented therefore proved to be highly suitable to predict NO_2/NO_x ratios in power plant plumes under widely varying atmospheric conditions*'.

An assessment of the meteorological data for the Bridlington Mrsc station over the period employed in this assessment (2020 to 2024) indicated the following seasonal distribution of wind speed.

Season	Frequency in wind speed category (%)			Mean wind speed (m/s)
	0-5 m/s	5-15 m/s	>15 m/s	
Winter	47.8	51.0	1.2	5.8
Spring/Autumn	54.1	45.5	0.4	5.1
Summer	65.4	34.5	0.1	4.3

Seasonal wind speed

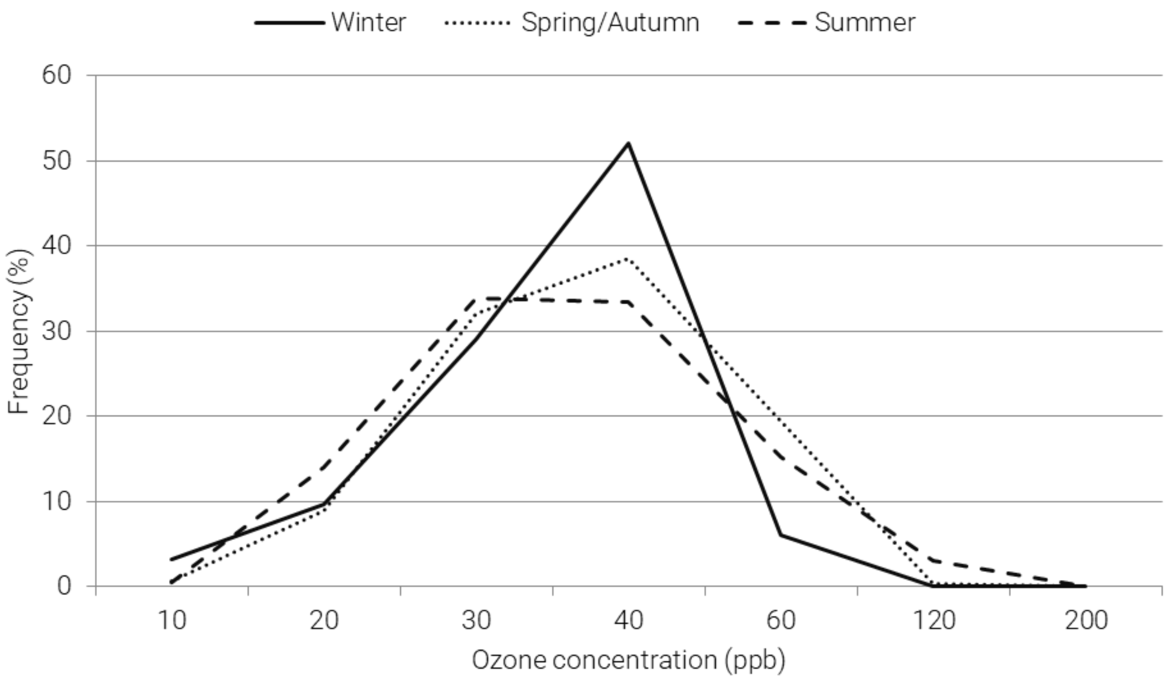


The wind speed is almost exclusively below the 15 m/s category for all seasons, with an overall average of 5.0 m/s.

The nearest automatic station monitoring station which includes measurement of ozone is High Muffles (UKA00169) which is located around 32km north west of the Weaverthorpe wellsite (477552 493869). An analysis of hourly average data for 2023 indicated the following seasonal concentrations:

Season	Frequency in ozone concentration category (%)							Mean
	0-10	10-20	20-30	30-40	40-60	60-120	120-200	
	ppb							
Winter	3.2	9.7	29.0	52.0	6.1	<0.1	<0.1	29.8
Spring/Autumn	0.6	8.9	32.1	38.5	19.5	0.4	<0.1	32.1
Summer	0.5	14.0	33.9	33.4	15.2	3.0	<0.1	31.5

Seasonal ozone concentration

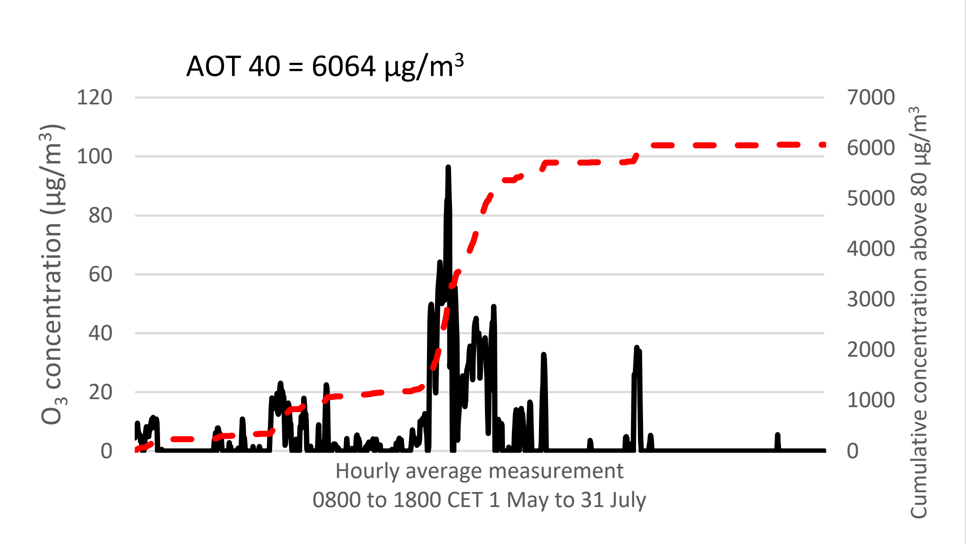


Based the values of wind speed and ozone concentration and Janssen's empirical relationship, it is considered that the following seasonal values for the parameters A and α are appropriate:

Season	Wind speed (m/s)	Ozone concentration (ppb)	A	α
Winter	5-15	30-40	0.87	0.07
Spring/Autumn	0-5	30-40	0.80	0.10
Summer	0-5	20-30	0.67	0.10

The measured ozone concentrations were also examined to determine the AOT 40. This is the sum of the differences of the measured ozone concentrations which are greater than 80μg/m^3 (40 ppb) for the period 0800 to 2000 (Central European Time) over the 1 May to 31 July. The assessment indicated an AOT40 for the data set of 6064μg/m^3 as summarised below.

Ozone AOT 40 assessment (1May to 31 July 2023)



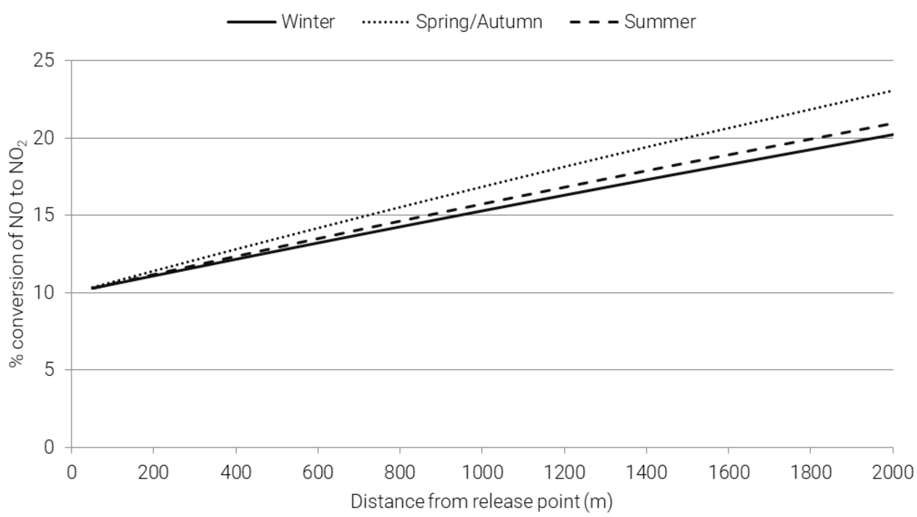
It is likely that a small amount of the nitrogen oxides emitted will be in the form of nitrogen dioxide. For the purposes of this assessment it is assumed that 10% of nitrogen oxides comprise nitrogen dioxide and as such Janssen's relationship for this situation is described by:

$$\frac{NO_2}{NO_x} = y + (1 - y)A\left(1 - e^{(-\alpha x)}\right)$$

where y is the fraction of nitrogen oxides present as nitrogen dioxide at the point of release.

Based on Janssen's relationship the following seasonal conversion rates are estimated with distance from the source.

Estimated seasonal NO to NO_2 conversion rates



The conversion rates expected for locations within 1 km of the source are less, and in some cases significantly less, than those assumed within the assessment.

ANNEX D Meteorological data

For this modelling assessment hourly sequential meteorological data provided by the UK Met Office from the Bridlington Marine Rescue Sub Centre (Mrsc) station covering the 5 year period 2020 to 2024 was used. Further details of these are provided in this section.

D.1 Windroses

In section 3.3 a cumulative wind rose for the period 2020 to 2024 is presented. The windroses for each individual year of data used are illustrated below.

Figure D.1 Bridlington Mrsc 2020

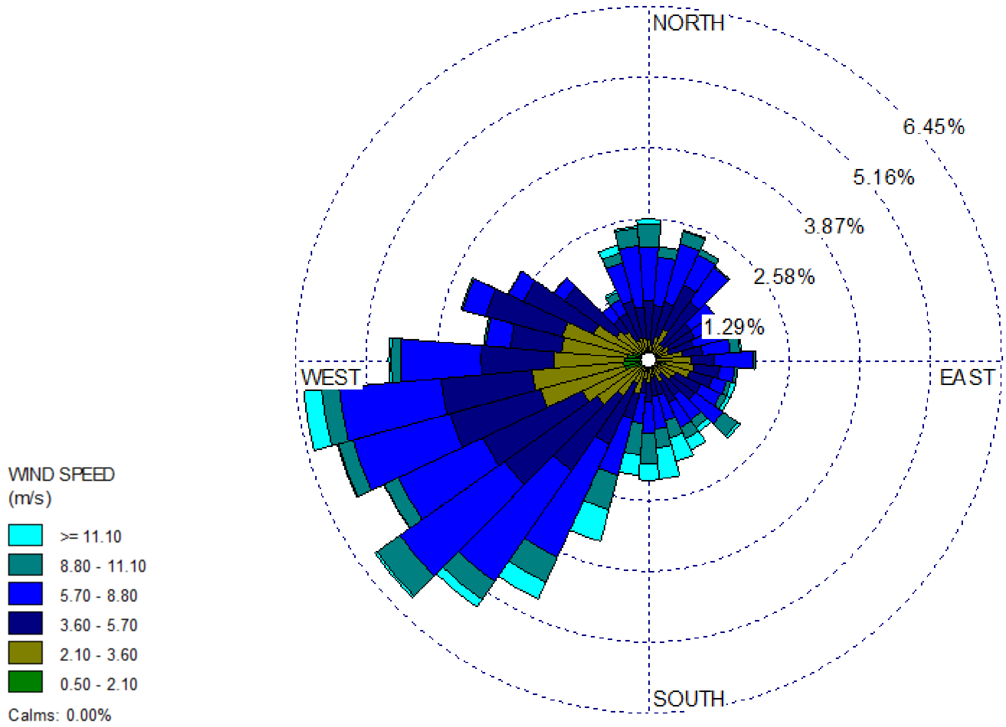


Figure D.2 Bridlington Mrsc 2021

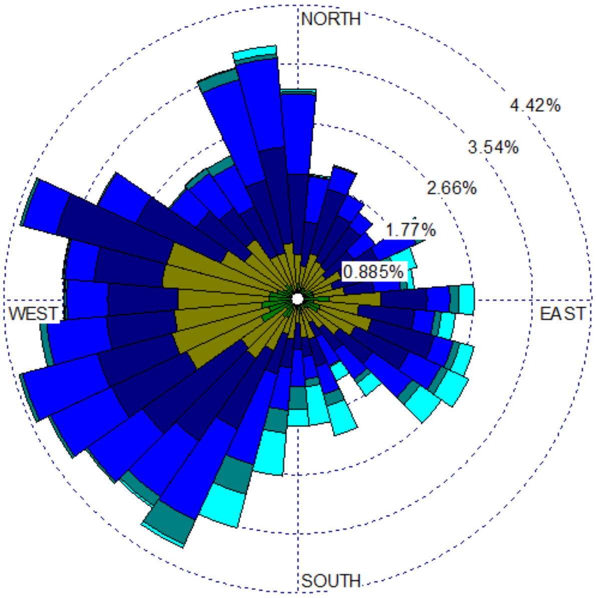


Figure D.3 Bridlington Mrsc 2022

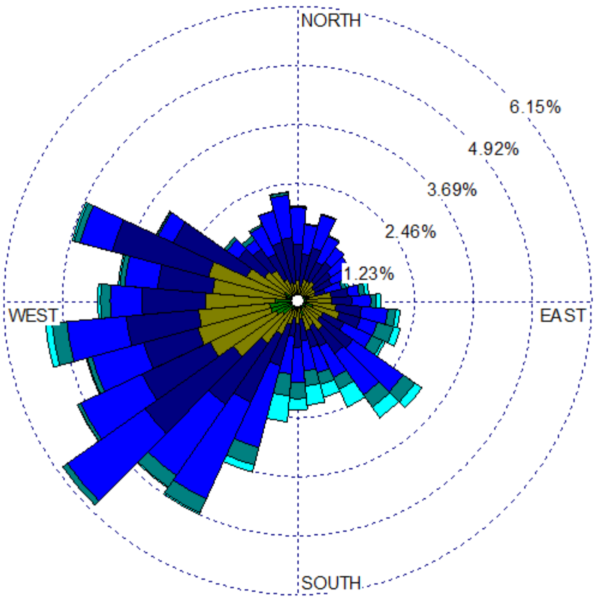


Figure D.4 Bridlington Mrsc 2023

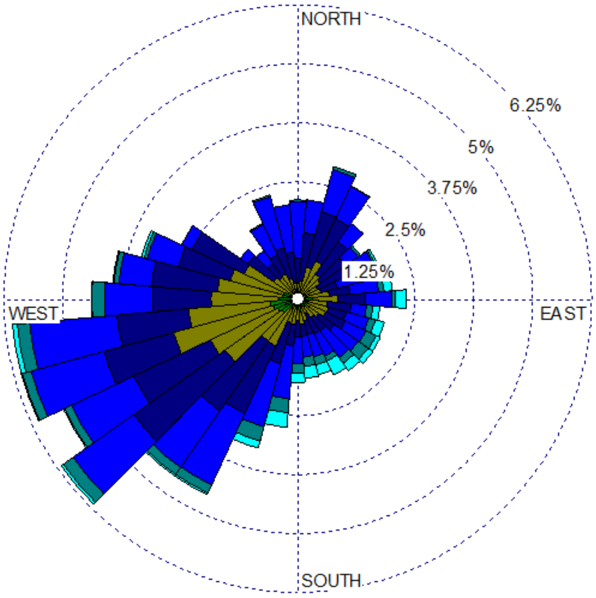
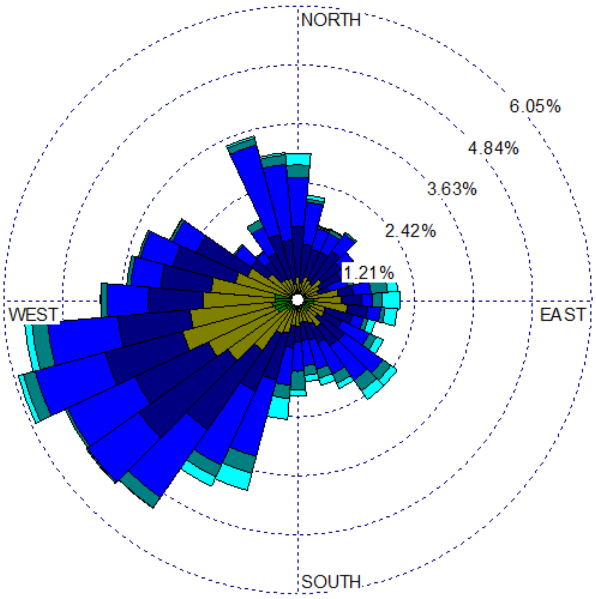


Figure D.5 Bridlington Mrsc 2024



D.2 Data analysis and characteristics

Analyses of the wind direction, wind speed and precipitation are summarised in Tables D.1 and D.2 for the period 2020 to 2024.

Table D.1 Wind speed and direction (2020 to 2024) for Bridlington Mrsc

Wind direction blowing from	Wind speed (m/s)						
	0.3-2.1	2.1-3.6	3.6-5.7	5.7- 8.8	8.8-11.1	> 11.1	Total
	Frequency (% of time)						
N	0.6	1.8	4.2	4.9	0.5	0.2	12.2
NE	0.6	1.6	2.6	1.9	0.1	<0.1	6.8
E	1.3	2.6	2.4	2.0	0.7	0.7	9.5
SE	0.8	1.5	2.0	2.7	0.8	0.8	8.6
SE	0.9	1.6	2.3	3.9	1.6	1.7	12.1
SW	1.3	4.0	6.9	6.6	0.9	0.2	19.9
W	2.2	7.6	6.7	5.0	0.7	0.2	22.5
NW	0.8	2.5	3.2	1.7	0.2	<0.1	8.3
Calm							<0.1

a. Missing data is ignored from the determination of percentage frequency.

Table D.2 Rainfall and wind direction (2020 to 2024) for Bridlington Mrsc

Wind direction Blowing from	Rain fall (mm/h)						
	Dry	0.1-0.3	0.3-0.6	0.6-0.9	0.9-1.2	1.2-1.5	>1.5
	Frequency (% of time)						
N	10.6	0.7	0.4	0.1	0.2	<0.1	0.2
NE	6.1	0.3	0.2	0.1	<0.1	<0.1	0.1
E	8.5	0.4	0.3	0.1	0.1	<0.1	0.2
SE	7.7	0.3	0.2	0.1	0.1	<0.1	0.2
SE	10.3	0.6	0.6	0.1	0.2	0.1	0.2
SW	18.2	0.7	0.4	0.1	0.1	<0.1	0.2
W	21.3	0.5	0.3	0.1	0.1	<0.1	0.1
NW	7.3	0.4	0.3	0.1	0.1	<0.1	0.1
Calm	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total	90.1	3.9	2.8	0.7	1.0	0.3	1.3

a. Missing data is ignored from the determination of percentage frequency.

The main data characteristics are summarised in Table D.3.

Table D.3 Dataset characteristics (2020 to 2024) for Bridlington Mrsc

No. days data	1827		
No. hours data	43848		
No. calm hours (<0.3 m/s)	16	0.04	%
No. dry hours (<0.1 mm/h)	39519	90.32	%
Mean wind speed (m/s)	5.0		
No. missing records	94	0.21	%
Available records	43754	99.79	%

ANNEX E Discrete receptors

Discrete receptors were used to monitor the process contribution to ambient pollutant concentrations at a range of locations, including nearby residential properties as illustrated in Figure 3.2. Details of their location are provided in Table E.1, together with the predicted nitrogen monoxide to nitrogen dioxide conversion rate (see Annex C). All receptors were at an elevation of 1.5m, with the exception of the designated and local ecological sites, which had an elevation of 0m.

The receptors fall into the following groups:

1 to 31 Residential locations (see Figure 3.2)
32 and 33 Designated and local ecological sites (see Figure 3.2 Table 3.2)
34 to 49 Site boundary (see Figure 3.1).

Table E.1 Receptor locations

Receptor		Position[a]	Easting (m)	Northing (m)	NO to NO_2 conversion rate (%)
1	West Field House	639 m E	502925	473290	14.5
2	West Field Farm	1265 m NE	503459	473668	18.6
3	Middle Wold Farm	1438 m NE	503238	474250	19.6
4	Mill House Farm	1095 m N	502550	474226	17.5
5	Ganton Dale House	1658 m NW	501607	474666	21.0
6	The Dale	1113 m W	501188	473173	17.6
7		1115 m W	501185	473142	17.6
8		1115 m W	501186	473104	17.6
9		1116 m W	501188	473069	17.6
10		1113 m W	501201	472987	17.6
11		1117 m W	501205	472940	17.6
12		1129 m W	501213	472853	17.7
13	White House Farm	1051 m W	501276	472925	17.2
14	Eastfield	925 m W	501424	472865	16.4
15		929 m W	501434	472825	16.4
16		978 m W	501376	472839	16.7
17	The Meadows	1031 m W	501334	472801	17.1
18		1096 m W	501266	472795	17.5
19		1093 m W	501249	472860	17.5
20		1096 m W	501255	472829	17.5
21	Church Farm	1334 m W	500966	473136	19.0
22	Manor Farm	1231 m W	501070	473110	18.3
23	Ganton Road	1206 m W	501094	473179	18.2
24		1188 m W	501113	473132	18.1
25	Smithy Lane	987 m W	501319	473054	16.8
26		1008 m W	501295	473087	16.9
27	Gypsy Race	1129 m SW	501358	472538	17.7
28	Octon Grange	1352 m S	502204	471811	19.1
29	Glebe Farm Cottage	2182 m SE	503746	471526	24.1

Table E.1 continued

Receptor		Position[a]	Easting (m)	Northing (m)	NO to NO_2 conversion rate (%)
30	Westholme	1659 m E	503948	472963	21.0
31	The Wold Cottage	2070 m E	504213	472371	23.5
32	Gypsy Race LWS	501 m S	502448	472681	13.5
33	West Dale, Fordon LWS	1919 m NE	503197	474856	22.6
34	Site boundary	81 m SW	502267	473086	10.6
35		70 m S	502289	473090	10.5
36		66 m S	502311	473095	10.5
37		70 m SE	502336	473100	10.5
38		83 m SE	502363	473105	10.6
39		66 m SE	502358	473128	10.5
40		55 m E	502355	473151	10.4
41		52 m E	502350	473176	10.4
42		62 m NE	502345	473202	10.4
43		43 m NE	502319	473198	10.3
44		34 m N	502294	473193	10.2
45		43 m NW	502267	473188	10.3
46		58 m NW	502247	473183	10.4
47		48 m W	502252	473154	10.3
48		53 m SW	502258	473129	10.4
49		66 m SW	502262	473106	10.5

a. Position of receptor relative to the centre of the Weaverthorpe wellsite.

Table E.2 details the results of the assessment for the discrete receptors. The maximum process contributions for nitrogen dioxide and volatile organic compounds (assessed as benzene), identified as the two largest contributors to air quality impact of the pollutants considered, are provided for each discrete receptor expressed as a proportion of the applicable air quality standard.

Table E2 Maximum process contributions at discrete receptors

Receptor		Maximum process contribution (% air quality standard)			
		Nitrogen dioxide		Volatile organic compounds	
		1 hour	annual	24 hour	annual
1	West Field House	10.5	2.2	8.2	1.8
2	West Field Farm	3.8	0.6	2.9	0.5
3	Middle Wold Farm	2.9	0.4	2.0	0.4
4	Mill House Farm	3.7	0.4	1.7	0.3
5	Ganton Dale House	1.8	0.2	1.0	0.1
6	The Dale	3.1	0.3	3.9	0.3
7		3.1	0.3	4.0	0.3
8		3.0	0.3	4.0	0.3
9		2.9	0.3	4.0	0.2
10		2.5	0.2	3.7	0.2
11		1.9	0.2	4.0	0.2
12		1.6	0.2	4.1	0.2

Table E2 continued

Receptor		Maximum process contribution (% air quality standard)			
		Nitrogen dioxide		Volatile organic compounds	
		1 hour	annual	24 hour	annual
13	White House Farm	1.8	0.2	4.5	0.2
14	Eastfield	1.9	0.2	5.6	0.2
15		2.3	0.2	5.2	0.2
16		1.7	0.2	5.0	0.2
17	The Meadows	2.0	0.2	4.5	0.2
18		1.7	0.2	4.2	0.2
19		1.6	0.2	4.4	0.2
20		1.6	0.2	4.3	0.2
21	Church Farm	2.4	0.2	3.1	0.2
22	Manor Farm	2.6	0.3	3.5	0.2
23	Ganton Road	2.8	0.3	3.5	0.2
24		2.8	0.3	3.7	0.2
25	Smithy Lane	3.0	0.3	4.6	0.3
26		3.2	0.3	4.6	0.3
27	Gypsy Race	2.2	0.2	2.9	0.2
28	Octon Grange	1.6	0.2	2.1	0.1
29	Glebe Farm Cottage	1.4	0.1	1.0	0.1
30	Westholme	2.7	0.4	2.2	0.4
31	The Wold Cottage	2.5	0.3	1.4	0.2
32	Gypsy Race LWS	6.9	0.9	6.4	0.8
33	West Dale, Fordon LWS	2.0	0.3	1.3	0.2
34	Site boundary	104.0	17.4	140.3	15.1
35		114.4	20.5	197.0	20.5
36		113.6	20.7	186.0	25.6
37		116.8	21.2	154.6	31.8
38		99.2	19.4	195.5	35.1
39		119.0	24.8	383.6	56.7
40		157.2	32.8	662.7	93.5
41		209.5	69.2	669.1	167.3
42		200.0	83.3	625.0	104.7
43		324.7	109.5	875.3	137.4
44		278.5	63.6	610.9	85.0
45		225.6	33.7	330.5	33.5
46		314.6	36.3	288.7	29.6
47		162.6	21.2	299.7	24.3
48		164.4	25.2	239.5	25.6
49		148.7	22.5	145.7	19.0

ANNEX F Detailed results for designated and local ecological sites

The impact of wellsite process contributions with regard to critical levels for nitrogen oxides and sulphur dioxide and critical loads for nitrogen and acid deposition at designated and local ecological sites is summarised in Section 4.3. Annex F provides the corresponding detailed results.

The critical loads and levels adopted for use in this assessment have been obtained from the APIS and are summarised in Table F.1. For both sites, a neutral grassland habitat is assumed for the purposes of selecting critical loads and levels.

Table F.1 Site relevant critical loads and levels

Site		32	33
		Gypsy Race LWS	West Dale, Fordon LWS
Critical levels for nitrogen oxides and sulphur dioxide (see Table 2.2)			
Annual mean NO_x	$\mu gNO_2/m^3$	30	
Daily mean NO_x	$\mu gNO_2/m^3$	75	
Annual mean SO_2	$\mu gSO_2/m^3$	10	
Critical load for nitrogen deposition			
Most sensitive habitat		Neutral grassland	Neutral grassland
N deposition CL	kgN/ha/y	10-20	10-20
Critical loads for acid deposition			
Most sensitive habitat		Neutral grassland	Neutral grassland
Minimum CLminN	keq	0.856	0.856
Minimum CLmaxS	keq	4.0	4.0
Minimum CLmaxN	keq	4.856	4.856

The site background concentrations, as obtained from APIS, are summarised in Table F.2. These represent the maximum background concentration across the entire site in each case.

Table F.2 Site relevant background concentrations

Site		32	33
		Gypsy Race LWS	West Dale, Fordon LWS
Nitrogen oxides annual mean	$\mu gNO_2/m^3$	5.20	5.22
Sulphur dioxide annual mean	$\mu gSO_2/m^3$	0.73	0.74
Nitrogen deposition	kgN/ha/y	17.72	17.71
Acid deposition	keq/ha y	1.40	1.39

The maximum process contributions to concentrations of nitrogen oxides and sulphur dioxide at the designated and local ecological sites are detailed in Table F.3 and are correspond to the summary in Table 4.4.

Table F.3 Maximum process contributions of nitrogen oxides and sulphur dioxide at designated and local ecological sites

Site		32 Gypsy Race LWS	33 West Dale, Fordon LWS
Nitrogen oxides[a]			
Maximum annual mean PC	$\mu gNO_2/m^3$	0.49	0.15
	% CL	1.6	0.5
Background concentration	$\mu gNO_2/m^3$	5.20	5.22
Maximum annual mean PEC	$\mu gNO_2/m^3$	5.54	5.33
	% CL	18	18
Maximum daily mean PC	$\mu gNO_2/m^3$	27.13	5.25
	% CL	36.2	7.0
Back ground concentration	$\mu gNO_2/m^3$	10.40	10.44
Maximum daily mean PEC	$\mu gNO_2/m^3$	37.53	15.69
	% CL	50	21
Sulphur dioxide			
Maximum annual mean PC	$\mu gSO_2/m^3$	0.0014	0.0014
	% CL	0.01	0.01
Background concentration	$\mu gSO_2/m^3$	0.73	0.74
Maximum annual mean PEC	µgSO2/m3	0.73	0.74
	% CL	7	7

a. Total nitrogen oxides expressed as NO_2..

The determination of nitrogen deposition at the designated and local ecological sites is summarised in Table 4.5. Table F.4 provides the corresponding detailed determination.

Table F.4 Nitrogen deposition at designated and local ecological sites

Site		32 Gypsy Race LWS	33 West Dale, Fordon LWS
Maximum process N deposition	$\mu gNO_2/m^2/s$[a]	0.0010	0.0003
	kgN/ha/y	0.098	0.030
	% CL[b]	1.0	0.3
Background concentration	kN/ha y	17.72	17.71
Maximum annual mean PEC	kN/ha y	17.82	17.74
	% CL[b]	178	177

a. Determination of deposition is based on the deposition velocity for forest terrain[22].
b. The critical load selected is the minimum of the range specified for the most sensitive habitat over the entire site.

The determination of the process contribution to acid deposition at these sites is summarised in Table 4.5. The detailed determination of acid deposition is presented in Table F.5.

Table F.5 Acid deposition at designated and local ecological sites

Site		32 Gypsy Race LWS	33 West Dale, Fordon LWS
Nitrogen acid deposition	$\mu gNO_2/m^2/s$[a]	0.0010	0.0003
	kgN/ha/y	0.098	0.030
	keq/ha y	0.0070	0.0022
Sulphur acid deposition	$\mu gSO_2/m^2/s$[a]	0.00003	0.00003
	keq/ha y	0.00034	0.00033
Total process acid deposition	keq/ha/y	0.0073	0.0025
	% CL[b,c]	0.15	0.05
Total background acid deposition	keq/ha/y	1.41	1.39
Maximum annual mean PEC	keq/ha y	1.41	1.39
	% CL[b,c]	29	29

a. Determination of deposition is based on the deposition velocity for forest terrain[22].
b. Calculations of process contribution and predicted environmental concentrations were used the APIS critical load tool.

ANNEX G Site equipment specification

Details of the equipment specified for use and its operation during the proposed development are provided in Tables G.1 and G2. Table G.3 provides details of the expected HDV movements during the proposed development.

Table G.1 Site equipment specification

Equipment		Type	Description	Reference
A1	Construction plant	20 t excavator (2)	JCB 220X, 129 kW, EU Stage V	JC Bamford Limited, Tracked Excavators, www.jcb.com/en-gb/products/tracked-excavators.
A2		Dozer	Liebherr PR726 dozer, Liebherr 934 A7, 120 kW, EU Stage 4	Liebherr, PR 726 Litronic, LWT/VM 12227193-0, 5.05.19.
A3		9t dumper (2)	Thwaites MACH 2098 9t dumper, Deutz TD 3.6 L4 engine, 55.4 kW, EU Stage 3B	Thwaites Limited, MACH 2098 9t power swivel, 08/2017
A4		13t sheeps foot roller	Hamm 13i 13t sheeps foot roller, Deutz TCD 4.1 L4, 115 kW, EU Stage 5	Hamm AG, Hamm3i, 12.19, 2737730
A5		Concrete pump	Schwing Stetter concrete pump, engine OM470, R6, 240 kW, EU Stage 6	http://www.schwing-stetter.co.uk/Downloads/S20.pdf?t=637436076063436607
B		Surface Conductor Rig	Junttan PM 20LC surface conductor rig, Cummins QSB6.7 engine, 179 kW, EU stage 3A	Junttan, PM20LC Pile Driving Rig Data sheet, M120LC003, 2 March 2009
C		Generator	Perkins 2206A- E143TAG3 generator, 350 kW, EU Stage 3A	Perkins, PM1880A/12/14.2206A-E13TAG3 engine specification
D		Main drilling rig engines (4)	T-208 WIRTH GH 1500 EG-AC-SV, Caterpillar 3512B, 1360 kWe, manufacturer's emission specification	Caterpillar Electric Power Technical Specification Sheet 3512B, TSS-DM8251-01-GS-EPG-8033726, 7 October 2017
E		Workover rig	Moor 475 workover rig, Detroit Series 60 engine, 354 kW, US Tier 2 compliant.	Detroit Diesel Corp, Detroit engine series 50 and 60 for petroleum applications, 6SA587 304, 2003.
F		Flare	Uniflare UF10 2500	Uniflare Group, Uniflare UF10 range brochure, 2020.
G		100 tonne crane	Liebherr 400kW diesel engine assume EU Stage 4	Liebherr-Werk Ehingen GmbH, Mobile and crawler cranes, LTM1100-5.3, 10/2022.
H		Coiled tubing unit	Price Power Solutions, assume Detroit Series 60 engine, 354 kW, US Tier 2 compliant	Detroit Diesel Corp, Detroit engine series 50 and 60 for petroleum applications, 6SA587 304, 2003.
I		Slickline unit	GOES slickline unit ,assume Detroit Series 60 engine, 354 kW, US Tier 2 compliant.	Detroit Diesel Corp, Detroit engine series 50 and 60 for petroleum applications, 6SA587 304, 2003.
J		Test facilities	Greaves 160kVA generator (128kW), GPWII-PII-160, EU Stage 3B	GMDT Power Solutions, Greaves Power diesel generators, https://www.gmdtpower.com/products/160-kva-greaves-power-diesel-generator.

Table G.1 continued

Equipment		Type	Description	Reference
K1	Restoration plant	20 t excavator (2)	JCB 220X, 129 kW, EU Stage V	JC Bamford Limited, Tracked Excavators, www.jcb.com/en-gb/products/tracked-excavators.
K2		9t dumper (2)	Thwaites MACH 2098 9t dumper, Deutz TD 3.6 L4 engine, 55.4 kW, EU Stage 3B	Thwaites Limited, MACH 2098 9t power swivel, 08/2017
K3		13t sheeps foot roller	Hamm 13i 13t sheeps foot roller, Deutz TCD 4.1 L4, 115 kW, EU Stage 5	Hamm AG, Hamm3i, 12.19, 2737730
K4		Dozer	Liebherr PR726 dozer, Liebherr 934 A7, 120 kW, EU Stage 4	Liebherr, PR 726 Litronic, LWT/VM 12227193-0, 5.05.19.

Table G.2 Equipment usage during proposed exploration phases

Phase	Activity	Duration (days)	Start	End	Days/week	Hours/day	Working days	Equipment in use
1	Construction	35	1	35	6	12	30	A,C
2	Drilling of WV1	56	36	91	7	24	56	B,C,D
3	Testing	28	92	119	7	24	28	C,F,G,H,J
4	Decommission and Restore site	28	120	147	6	12	24	E,G,I,K

Table G.3 HDV movements during proposed exploration phases

Phase	HDVs arriving at site	Total HDV movements (in and out)	AADT
1	102	204	
2	214	428	
3	48	96	
4	148	290	
Total	512	1024	2.8

a. AADT - annual average daily traffic count - based on 365 days per year and the maximum number of two way movements (in and out of site).
b. HDV – a heavy duty vehicle of gross weight greater than 3.5 t.

The highest number of two-way HDV movements over a period of 365 consecutive days is 1024 equivalent to an annual average daily traffic (AADT) count of 3.

ANNEX H Construction dust risk assessment

H.1 Introduction

It is likely that the construction activities associated with the proposed exploration operations at the wellsite will give rise to dust emissions, albeit temporary in nature and largely restricted the areas close to the wellsite.

The potential for fugitive dust is most likely to arise from the movement of vehicles over the earth, the stripping of soil, excavations and the subsequent storage of excavated materials and transfer of materials to and from lorries. This may be exacerbated by spillages during transportation and handling and also by periods of dry weather and high wind speeds.

The potential for dust impact has been assessed based on the guidance provided by the Institute of Air Quality Management[24]. Four activities considered to have the most significant potential for fugitive release of dust are identified; demolition, earthworks, construction, and track-out. In this case there are no demolition activities associated with the proposed development.

The construction of the Weaverthorpe wellsite (phase 1) will last around 56 days. During the subsequent well drilling and testing phases there will be no appreciable construction work likely to give rise to dust emissions. The restoration phase (phase 4) is of 28 days' duration and utilises fewer construction vehicles compared with the construction phase. It is therefore considered that the construction phase is likely to provide the greatest air quality impact with respect to dust and is representative of the worst case.

H.2 Screening assessment

IAQM guidance indicates that an assessment will normally be required where there is:

• a 'human receptor' within 250 m of the boundary of the site or within 50 m of the route(s) used by construction vehicles on the public highway, up to 250 m from the site entrance(s).

• an 'ecological receptor' within 50 m of the boundary of the site or 50 m of the route(s) used by construction vehicles on the public highway, up to 250 m from the site entrance(s).

In this case there are no ecological receptors within 50 m of the wellsite boundary. The nearest site with an ecological designation is a local wildlife site (Gypsy Race) to the north at a distance of 500 m from the main wellsite, although it does run close to the entrance to the wellsite access road where some track construction, albeit minor in comparison, is expected. It is not considered necessary to include ecological receptors within this assessment.

The nearest human receptors are around 580m to the east of the nearest wellsite boundary at West Field House. The wellsite entrance is considered to be at the end of the access road where it joins Butt Lane. All residential properties are in excess of 600m from the access track junction with Butt Lane. On the basis of the screening criteria an assessment of human impact is not required.

Activities likely to give rise to the greatest release of construction related dust are distant from residential locations, such that significant impact is unlikely. Although an assessment of the impact on human receptors is not required, this has been assessed for completeness.

H.3 Risk of dust impact

H3.1 Potential dust emission magnitude

The potential dust emission magnitude for the earthwork, construction and track-out activities, before any mitigation, are assessed in Tables H.1 to H.4. The assessment generally adopts a conservative approach.

Table H.1 Dust emission magnitude for earthworks activities

Criteria	Effect	Classification
Site area	The area of the proposed wellsite is around 11,000 m^2, with around 2500m^2 of access track. The wellsite is only area where major construction activities will take place.	Medium
Soil type	Moderately dusty soil	Medium
Earth moving vehicles operating	Less than 10 vehicles operating at any one time (see Table G.2)	Medium
Material moved	Expected that around 5000 tonnes of top soil will be removed and around 8000 tonnes of aggregate laid down during the construction of the wellsite.	Medium
Presence of bunds	Bunds of less than 4 m height are expected at the wellsite.	Small
Operating times	The major construction phase of the proposed development will last for 56 days and restoration is expected to last for 28 days. The scheduling is as yet unknown.	Small
Overall rating	Conservative estimate of effects.	Medium

The dust emission magnitude for the earthworks associated with the proposed development is considered to be ‘Medium’.

Table H.2 Dust emission magnitude for construction activities

Criteria	Effect	Classification
Building volume	Total building volume is less than 6000 m^3.	Small
Dust potential of construction materials	Largely concrete for drilling pad and MOT type 1 aggregate for site surface (c. 8,000 tonnes).	Small
Concrete batching	Small scale concrete batching is possible	Medium
Sand blasting	No sand blasting is expected.	Small
Overall rating	Conservative estimate of effects.	Medium

Construction activities on the wellsite will involve the levelling of the area including access track, excavation of topsoil, creating a soil storage bund and the laying of aggregate across the wellsite area and access track. These activities will be conducted over a relatively short duration estimated at 56 days. While the dust magnitude is classified as 'Medium' this is considered a precautionary assessment.

Table H.3 Dust emission magnitude for track out

Criteria	Effect	Classification
Number of HDV vehicle movements	Less than 20 HDV outward movements expected in any one day (see Table G.3) during the construction and restoration phases.	Small
Surface material	Moderately dusty.	Medium
Length of unpaved road	The site entrance is at the end of an access track which joins Butt Lane. The access track is around 330m in length. There is minimal unpaved surface.	Small
Overall rating	Conservative estimate of effects.	Medium

Access from the wellsite is from the newly constructed access track which joins Butt Lane. There is minimal unpaved track. While the dust magnitude is conservatively estimated as 'Medium', it is considered that significant impact at the nearest residential locations will be unlikely.

Table H.4 Summary of dust emission magnitude

Activity	Dust emission magnitude
Earthworks	Medium
Construction	Medium
Track-out	Medium

H3.2 Sensitivity of the area

IAQM guidance recommends the assessment of the sensitivity of the area take into account:

- the specific sensitivities of receptors in the area
- the proximity and number of those receptors
- in the case of PM_{10}, the local background concentration
- site specific factors, such as whether there are natural shelters, such as trees, to reduce the risk of wind-blown dust.

It is considered that in terms of both dust soiling and the human health effects of PM_{10} there are a small number of 'high' sensitivity receptors present at around 600m from the nearest location of substantial earthworks associated with the proposed development (i.e. West Field House). All other high sensitivity receptors are beyond 600m from any construction activity associated with the proposed development.

IAQM guidance for trackout sensitivity indicates that receptor distances should be measured from the side of the roads used by construction traffic. Without site specific mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50m from the edge of the road.

As a precautionary approach, the site entrance is assumed to be the access track junction with Butt Lane. The nearest residential location to the main route for HDVs is Gypsy Race, which is around 1km from the access track junction All other residential locations are beyond 1km of the site entrance.

There are no substantial areas of woodland between the wellsite and the nearest residential properties which might provide a natural barrier to wind blown dust emissions.

The sensitivity of the area for the site activities is estimated in Table H.5.

Table H.5 Assessment of sensitivity of area

Potential impact	Condition	Earthworks	Construction	Trackout
Dust soiling	Receptor sensitivity	High	High	High
	Number of receptors	1-10	1-10	1-10
	Distance from site (m)	600	600	950
	Sensitivity of area	Low	Low	Low
Human health	Receptor sensitivity	High	High	High
	Number of receptors	1-10	1-10	1-10
	Distance from site (m)	600	600	950
	PM_{10} background concentration ($\mu g/m^3$)	<24	<24	<24
	Sensitivity of area	Low	Low	Low

3.3 Risk of impact

The risk of impact for human health and dust soiling is estimated by considering the magnitude of the effect (Table H.4) and the sensitivity of the receiving area (Table H.5), as summarised in Table H.6.

Table H.6 Assessment of risk of impact

Potential impact	Earthworks	Construction	Trackout
Dust soiling	Low	Low	Low
Human health	Low	Low	Low
Ecology	Negligible		

H.4 Conclusions and mitigation measures

The impact on human health is considered 'low' based on the distance between the wellsite and access track and the nearest residential locations, the small number of receptors at that distance and the generally low background concentration of PM_{10}.

The risk of dust soiling is considered to be 'low' based on the location of residential properties relative to the site and the small number of receptors.

The assessment indicates that due to the distance between the wellsite and the nearest designated and local ecological sites, the risk of impact on ecological receptors is 'negligible'.

This assessment is made without any mitigation measures being considered.

Mitigation measures, adhering to industry best practice, specific to the control of dust during construction have been incorporated into the design of the development. The following measures will further reduce the dust impact risk determined in this assessment:

- A construction environmental management plan (CEMP), incorporating best practices, will be employed during the construction phase.
- Material deliveries and stock piles on site will be sheeted to prevent windblown dust releases.
- Loads entering and leaving the site will be sheeted, where appropriate, to prevent windblown dust releases.
- In dry periods, a bowser will be available to dampen any dry and dusty road surfaces to minimise entrainment of dust.
- Vehicle wheel washing facilities will be available to minimise the transfer of site dust on to the road network.

It is expected that, with these mitigation measures in place and bearing in mind the conservative approach to the assessment before mitigation, the risk of dust impact from all operations will reduce to 'negligible' for all activities and for all impacts.

ANNEX I Air quality impact of construction and operations traffic

I.1 Introduction

The development of the site and subsequent operation will have the effect of increasing traffic flow in the area, which in turn will result in additional releases of certain pollutants to air. It is necessary to assess the likely ambient impact of this increase in traffic flow.

Assessment methodology, based on the Design Manual for Roads and Bridges (DMRB) published by National Highways[25] has been used to determine significance and impact of additional off-site traffic movements during the main phases of the proposed development. The impact of on-site vehicle movements is considered within the main air quality assessment.

I.2 Expected traffic flows

The wellsite is accessed by an access track off of Butt Lane.

Table I.1 summarises the expected maximum heavy duty vehicle (HDV) movements for the duration of the proposed development.

Table I.1 HDV movements over the proposed development

Phase	HDVs arriving at site	Total HDV movements (in and out)	AADT
1	102	204	
2	214	428	
3	48	96	
4	148	290	
Total	512	1024	2.8

a. AADT - annual average daily traffic count - based on 365 days per year and the maximum number of two way movements (in and out of site).
b. HDV – a heavy duty vehicle of gross weight greater than 3.5 t.

The highest number of two-way HDV movements over a period of 365 consecutive days is 1024 equivalent to an annual average daily traffic (AADT) count of 2.8.

In addition to HDV movements it is expected that there will be no more than 100 movements of passenger cars and light goods vehicles (less than 3.5 t gross weight) during each day of the proposed operations.

I.3 Assessment criteria

The DRMB provides guidance on the screening out of changes with the objective of determining whether a proposed development is likely to have a significant impact in terms of air quality. It is first necessary to identify any affected roads in the vicinity using the criteria in Table I.2.

Table I.2 Screening assessment for affected roads

Criterion	Assessment
Road alignment will change by 5 m or more	Not applicable
Daily traffic flows will change by 1,000 AADT or more	No – see Table I.1
Heavy duty vehicle flows will change by 200 AADT or more	No – see Table I.1
Daily average speed will change by 10 km/h or more	Unlikely
Peak hour speed will change by 20 km/h or more	Unlikely

In this case none of the proposed routes to and from the Weaverthorpe wellsite is classed as an affected road. The DMRB specifies that if none of the roads in the relevant network meet any of the traffic/alignment criteria, then the impact of the scheme can be considered to be neutral in terms of local air quality and no further work is needed.

The IAQM[9] also provide guidance on the need for an air quality assessment based on indicative criteria related to the change in traffic flow brought about by a development as summarised in Table I.3.

Table I.3 IAQM indicative criteria for traffic change significance

The development will	Indicative criteria to proceed to an air quality assessment
Cause a significant change in Light Duty Vehicle (LDV) traffic flows on local roads with relevant receptors. (LDV = cars and small vans of <3.5 t gross weight)	A change of LDV flows of: - more than 100 AADT within or adjacent to an AQMA - more than 500 AADT elsewhere
Cause a significant change in Heavy Duty Vehicle (HDV) flows on local roads with relevant receptors. (HDV = goods vehicles + buses >3.5t gross vehicle weight)	A change of HDV flows of - more than 25 AADT within or adjacent to an AQMA - more than 100 AADT elsewhere

There are no air quality management areas adjacent to any of the proposed routes into or out of the wellsite. Expected increases in average vehicle movements over the duration of the fall well below the IAQM criteria for an air quality assessment, with AADT for HDVs of 2.8.

On this basis, it is determined that an air quality assessment for the change in traffic brought about by the proposed development is not required.

I.4 Conclusions

Increases in road traffic brought about by the construction activities and subsequent site operation are assessed to have a neutral impact on air quality based on National Highways guidance. The additional contributions to ambient pollutant concentrations from associated road traffic have no influence on the findings of the main air quality assessment for plant releases to air.

END OF REPORT

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