Tradebe Solvent Recycling Limited

Air quality impact assessment of releases from three steam boilers serving a solvent recovery process

Hendon Dock, Sunderland

Carried out for:

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SUMMARY

A dispersion modelling assessment was undertaken to predict the impact on local air quality of releases of volatile organic compounds from the operation of three boilers serving a solvent recovery process at Tradebe Solvent Recycling Limited's Hendon Dock site in Sunderland. Three boilers, burning solvent distillate fuel, generate steam for site use. In addition, two of the three boilers are used to dispose of a stream of process off gas containing volatile materials. The air quality impact of boiler operation was assessed to determine acceptability in relation to applicable air quality standards and workplace exposure limits.

The assessment was undertaken using the UK ADMS 6.0 modelling system, and was based on continuous year round operation of all three boilers at volatile organic compound discharge rates consistent with operation at the maximum best available technique associated emission limit level.

Maximum process contributions occur around the site boundaries and to the west within the adjacent Dock. At the location of maximum, short term process contributions of volatile organic compounds exceed screening criteria, although predicted environmental concentrations on both long term and short averaging bases are around a third of the environmental benchmarks for benzene. It is considered unlikely that air quality standards for human health would be applicable at or around the location of maximum impact due to the industrial nature of the area and the lack of general public access.

At neighbouring residential locations, where both short and long term air quality standards apply, process contributions of volatile organic compounds were considered insignificant based on Environment Agency assessment criteria. The air quality impact significance of process contributions, based on Institute of Air Quality Management descriptors, was assessed as 'negligible when considered at the most affected residential location. It is concluded that volatile organic compound releases from boiler operations are unlikely to have any significant influence on, or pose any risk to, continued attainment of applicable air quality standards in the vicinity of the Tradebe site at Hendon Dock.

In terms of workplace exposure, maximum process contributions are less than 1% of the long term and short term limits applicable to toluene. It is concluded that releases of volatile organic compounds from boiler operations are unlikely to pose any significant risk to continued attainment of applicable workplace exposure limits on or near Tradebe Solvent Recovery Limited's Hendon Dock site.

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

1 INTRODUCTION

Tradebe Solvent Recycling Limited (Tradebe) placed a contract with SOCOTEC UK Limited (SOCOTEC) to undertake an assessment of the impact on local air quality of volatile organic compound releases to atmosphere from three steam raising boilers serving a solvent recovery process at their Hendon Dock site in Sunderland.

1.1 Scope of study

Tradebe operate a solvent recovery process involving distillation of a range of mixed solvents that would otherwise be disposed of to landfill. Releases of off gas from the process, which contain organic compounds, are abated by treatment within the site steam raising boilers. Tradebe requested that the dispersion of releases to atmosphere from the three boilers be investigated. The assessment is confined to consideration of releases of volatile organic compounds. A previous assessment in 2001 considered releases of nitrogen oxides and carbon monoxide. The purpose of this study is to determine whether releases of volatile organic compounds from the site boilers are likely to be dispersed adequately in the context of applicable air quality standards and workplace exposure limits.

1.2 General approach

The approach taken comprised the following main stages:

- Determine a suitable modelling tool for the assessment.
- Collect appropriate representative process release and operational data for input to the model.
- Establish the location of the exhaust flues serving the three boilers relative to nearby buildings and structures (including nearby public buildings and residential properties).
- Obtain information on local background concentrations of volatile organic compounds.
- Obtain 5 years' recent meteorological data from a measurement station representative of the site location.
- Model the dispersion of releases from the boiler exhaust stacks to determine the maximum process contributions to ground level pollutant concentrations within the site boundary and at sensitive locations in the local area, with particular attention to locations of human exposure.
- Assess the predicted process contributions and established background concentrations with reference to the applicable air quality standards and workplace exposure limits to determine compliance.
- Undertake a sensitivity analysis on the results for important variable parameters (e.g. meteorological conditions) and assess compliance with applicable air quality standards.
- Comment on the suitability of the operational arrangement with regard to meeting applicable air quality standard and workplace exposure limit requirements.

Further details of the approach taken and model input information are provided in the following sections.

1.3 Structure of the report

This report provides an assessment of the impact of volatile organic compounds releases from three steam raising boilers serving a solvent recovery process on local air quality near Tradebe's Hendon Dock site, Sunderland. The approach to the assessment has been described above. The following sections provide a detailed commentary on the assessment and conclusions:

Section 2 Air quality standards and assessment criteria
Section 3 The model methodology employed and important input data
Section 4 The results of the assessment including sensitivity analysis
Section 5 Conclusions of the assessment

2 POLICY CONTEXT AND ASSESSMENT CRITERIA

Tradebe Solvent Recycling Limited operate a solvent recovery process at their Hendon Dock site in Sunderland. This involves the distillation of a range of mixed solvents that would otherwise be disposed of to landfill. The process results in an off-gas stream containing a mix of organic compounds. Normal practice is for the off gas stream be treated within the site boilers. As part of the original site permitting process the air quality impact associated with the operation of the three site boilers was assessed and found to be satisfactory with regard to releases of nitrogen oxides and carbon monoxide. The assessment did not, however, include releases of volatile organic compounds. As part of their requirement to demonstrate Best Available Technique (BAT), Tradebe have requested that an assessment of volatile organic compounds releases to atmosphere be undertaken to demonstrate compliance with statutory obligations regarding air quality on and near the site.

2.1 Context of assessment

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. Sunderland City Council[2] have not declared any AQMAs in the local area that are designated for volatile organic compounds. The nearest AQMA is around 17km north west of Hendon Dock in Gateshead (Gateshead AQMA No.1) and is designated for nitrogen dioxide. It is not considered that pollutant releases from Tradebe's operations at Hendon Dock will have any meaningful impact at the nearest AQMAs. Recent planning applications to Sunderland City Council do not indicate any developments in the vicinity of the Hendon Dock that are likely to substantially influence background concentrations of the pollutants of interest in this case.

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. It is in this context that, as part of the environmental permitting process operated by the Environment Agency, it is necessary to demonstrate the impact of site operations on local air quality in accordance with the Environment Agency's published guidance[1].

2.2 Pollutants from solvent recovery

Organic compounds are the predominant pollutants of interest from the recovery of solvents by distillation, with releases reflecting the solvents processed. At their Hendon Dock site, Tradebe process mixed solvents. The permit to operate (BV4673IM, version 6, 16 February 2015) does not specify limits for releases to atmosphere of volatile organic compounds or any requirement for routine monitoring of process off gases.

The Hendon Dock site operates three boilers (denoted boilers 1, 2 and 3) firing solvent distillate fuel for the generation of steam for process operations. The three boiler boilers can also use gas oil as a standby fuel. Each boiler is served by a dedicated exhaust flue (denoted A4, A5 and A21 respectively). Volatile materials, venting from storage and process areas, are collected and normally disposed of by combustion in boilers 2 and 3.

The air quality impact of boiler operation with respect to releases of nitrogen oxides and carbon monoxide was assessed in 2001 as part of the permitting process, although volatile organic compounds were not formally assessed as their release was considered insignificant.

As part of a routine assessment of boiler operation, Tradebe commissioned measurements of releases from Boiler 3. This monitoring was undertaken by SOCOTEC on the 26 and 27 October 2020[3] and included measurement of total volatile organic compounds.

This assessment is confined to consideration of releases of total volatile organic compounds (VOC), from flues A4, A5 and A21 serving Boilers 1, 2 and 3 respectively.

The convention when assessing a volatile organic compound release, where the composition is unknown, is to adopt a worst case approach and assume the entire release is benzene and assess air quality impact against the corresponding air quality standards.

2.3 Environmental Standards

The UK's air quality strategy is set out in The Air Quality (Standards) Regulations 2010[4]. These Regulations specify legally binding limit 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. 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 2023.

The limit value in Table 2.1 is expressed as a concentration recorded over a specified period which is considered acceptable in terms of current knowledge of the impact on health and the environment. Limit values are legally binding time averaged limits that must not be exceeded.

Table 2.1 Air Quality Standards Limit Values

Substance	Basis	Concentration
Benzene	annual mean	5 µg/m^3

a. Annual mean refers to a calendar year.

There are currently no statutory ambient air quality standards specified in England for volatile organic compounds other than benzene.

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 EAL relevant to this study is summarised in Table 2.2.

Table 2.2 Environmental Assessment Levels

Substance	Basis	Concentration
Benzene	24 hour mean	30 µg/m^3

2.3.1 Application of environmental standards

The Air Quality Standards Regulations 2010[4] specify legally binding concentrations of pollutants in the atmosphere that 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 value (1 hour or 1 day means) applies at these locations and other areas where exposure is likely to be of one hour or more on a regular basis.

In this context the assessment of compliance with environmental benchmarks in respect of protection of human health in this study is confined to the nearby residential locations considered likely to be most affected by process releases. Nearby commercial premises are considered likely to be subject to workplace exposure guidelines rather than air quality standards, (see section 2.3.2), and as such are not considered specifically within the assessment with regard to ambient air quality. There are no public footpaths in the area considered close enough to the release point such that air quality might be materially influenced by releases from Tradebe's Hendon Dock operations. As such, exposure along public footpaths has not been considered further.

2.3.2 Workplace exposure limits

Workplace exposure limits are occupational exposure limits set in order to help protect the health of workers. Workplace exposure limit are concentrations of hazardous substances in the air, averaged over a specified period, referred to as a time-weighted average (TWA). Two time periods are generally used: long-term (8 hours); and short-term (15 minutes).

Short-term exposure limits (STELs) are set to help prevent effects such as eye irritation, which may occur following exposure for a few minutes.

The Health and Safety Executive's (HSE) document EH40[5], provides and legally binding list of workplace exposure limits for a range of important substances. Previous assessments of off gas releases[6] have indicated that of the materials normally considered to be present in significant concentrations, toluene has the most stringent workplace exposure limit. The assessment of workplace impact is based on the exposure limits for toluene. This is considered a precautionary approach. The applicable limits for toluene are summarised in Table 2.3.

Table 2.3 Workplace exposure limits

Substance	Exposure limit, mg/m^3	
	Short term (15 minute)	Long term (8 hour time weighted average)
Toluene[a]	384	191

a. Reported values from EH40[5].

Within the assessment, compliance with workplace exposure limits is restricted to locations within and immediately around the site boundary. The Hendon Dock area is generally an industrial location and as such it would be expected that workplace exposure limits would apply within the vicinity of the site boundary, where exposure is likely to be as a result of workplace activities.

2.4 Background air quality in Sunderland

In considering the overall impact of a process, 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 Hendon Dock are available from DEFRA's air quality archive (http://uk-air.defra.gov.uk/data/pcm-data). The archive provides modelled background concentrations of important pollutants for 1km^2 areas for the UK. The latest available background levels for an area within a 2 km radius of the site (centre 441360 556740) were used for this assessment. Table 2.4 summarises the background concentrations for benzene obtained from the air quality archive. The values 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
Benzene (2020)	annual mean	0.26	0.22

Sunderland City Council[2] undertake automatic and non-automatic monitoring for range of substances around the Sunderland area, although currently there is no monitoring for organic compounds within the area that is likely to be influenced by releases from Tradebe's Hendon Dock operations.

The DEFRA archive does not consider background concentrations of toluene, although ambient concentrations are expected to be low and largely insignificant outside of the immediate area around a source. As such, it might be expected that the current background concentrations of toluene around the Hendon Dock area would be predominantly influenced by releases from Tradebe's operations. As such, where the process contribution from Tradebe's operations is being assessed in the context of a total environmental concentration, an assumption of negligible background concentrations is considered representative (i.e. in the absence of Tradebe's operations the background concentration of toluene would be negligible as there are no other significant sources in the immediate vicinity).

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 mean) and twice the background concentration (annual mean). This methodology has been employed in this assessment.

When considering the impact of a process contribution, the existing background concentration and the headroom that this allows are significant. Table 2.5 summarises the adopted background concentrations in the area around the Hendon Dock area in the context of the applicable environmental standards.

Table 2.5 Background concentrations adopted in the assessment

Substance	Averaging basis	Background concentration	
		μg/m^3	% of standard
Air Quality Standard Limit Values			
Benzene	annual mean[b]	0.26	5.2
Environmental assessment levels			
Benzene	24 hour mean[a,b]	0.31	1.0
Workplace exposure limits			
Toluene[c]	hourly mean	0	0
	annual mean	0	0

a. 24 hour mean is determined from annual mean value using a conversion factor of 1.18[1].
b. Volatile organic compounds are assessed against the limit values for benzene in accordance with Environment Agency guidance[1].
c. In the absence of Tradebe's operations it is considered that the background concentration is negligible.

2.5 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 nature conservation areas 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.

2.5.1 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.

2.5.2 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

2.5.3 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 none of the above substances are the subject of this assessment and as such effects on local conservation sites are not considered further.

2.5.4 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[7] (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 are exposures that 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 volatile organic compounds from Tradebe's operation of three steam raising boilers at their Hendon Dock site in Sunderland have been modelled using the Atmospheric Dispersion Modelling System (ADMS) version 6.0. The use of this modelling tool is accepted by UK Local Authorities and the Environment Agency.

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 summarised in Annex B.

All modelling files containing relevant input information (see Annex B) are available to the Regulatory Authorities 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 2000 m x 2000 m area with Tradebe's Hendon Dock site (441360 556740) located approximately at the centre. Figure 3.1 illustrates the location of the site within Hendon Dock. Figure 3.2 details the site arrangement and immediate surrounding area. Figure 3.3 shows the area over which the assessment was undertaken and extends to include the nearest residential areas.

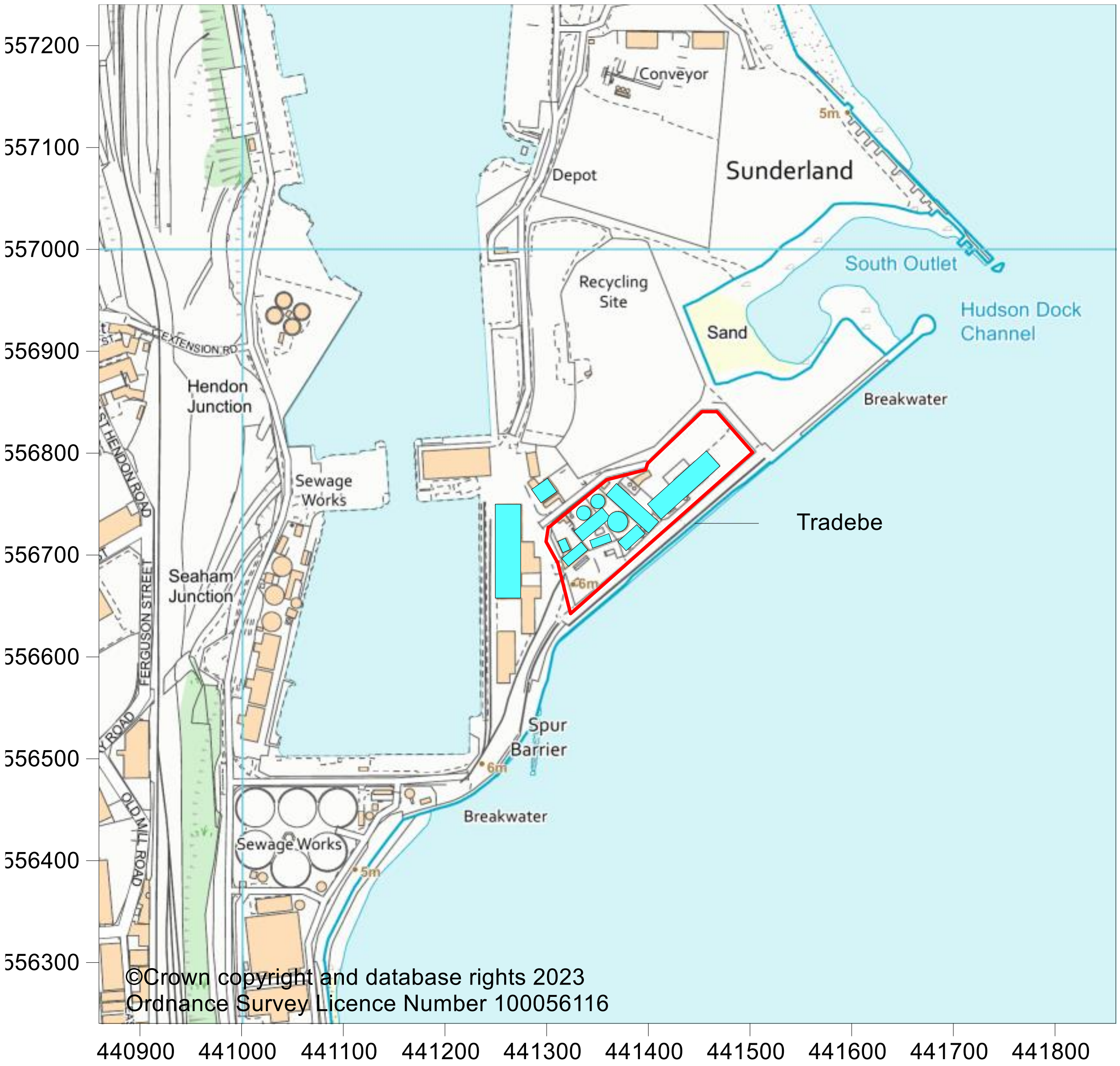
A general grid with receptors spaced at 20m intervals (i.e. 10201 points for a 101 x 101 grid) was used to assess the process contribution to ground level concentrations over the assessment area. The grid was considered at an elevation of 1.5m.

In addition to the receptor grid, 24 receptors were positioned at the neighbouring residential locations (numbered 1 to 24). These receptors are illustrated in Figure 3.3 and were considered at an elevation of 1.5m corresponding to approximately ground floor level. These are intended to correspond to the locations of most frequent long term human exposure near the site.

In order to determine the likely maximum process contribution beyond the Tradebe site, 25 receptors were located on the site boundary, again at an elevation of 1.5m (as shown by the red line in Figure 3.1).

A single receptor was also located on the boundary of the Northumbria Coast Special Protection Area (SPA) and Durham Coast Site of Special Scientific Interest (SSSI) at a position closest to the Tradebe site. These sites overlap and are the only sites near Tradebe's Hendon Dock site which would require consideration based on Environment Agency screening criteria if any relevant substances were released to atmosphere. As mentioned earlier, there is no requirement to consider impacts at local conservation sites, although process contributions at this location are provided in Annex D for completeness.

Figure 3.1 Location of the Tradebe Hendon Dock site



There are some commercial/industrial premises around Hendon Dock. It might be expected that workplace standards, rather than air quality standards for human health, would apply at these locations (see section 2.3.2) and as such no assessment is undertaken at these locations specifically.

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

1 to 24	Residential locations (see Table D.1 and Figure 3.3)
25 to 49	Site boundary (see Table D.1 and Figure 3.1)
50	Conservation sites (see Table D.1)

These receptors are described in Annex D.

Figure 3.2 Tradebe Hendon Dock site arrangement

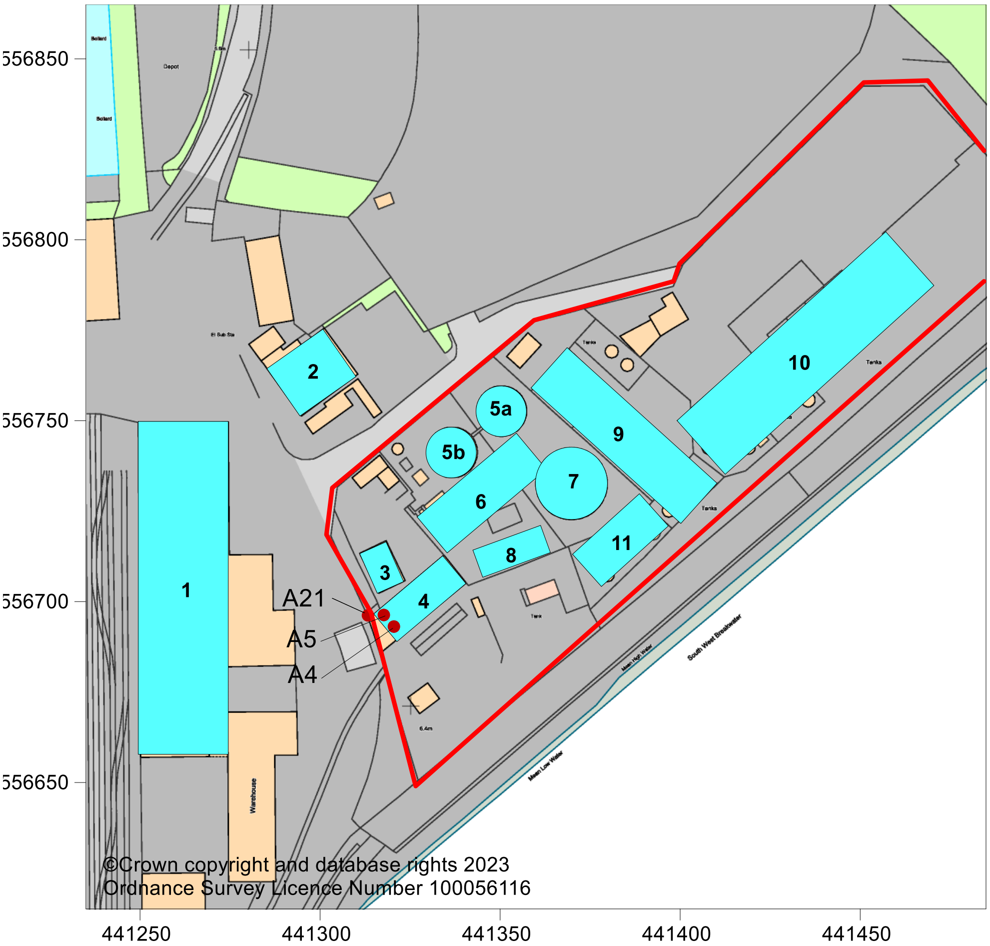
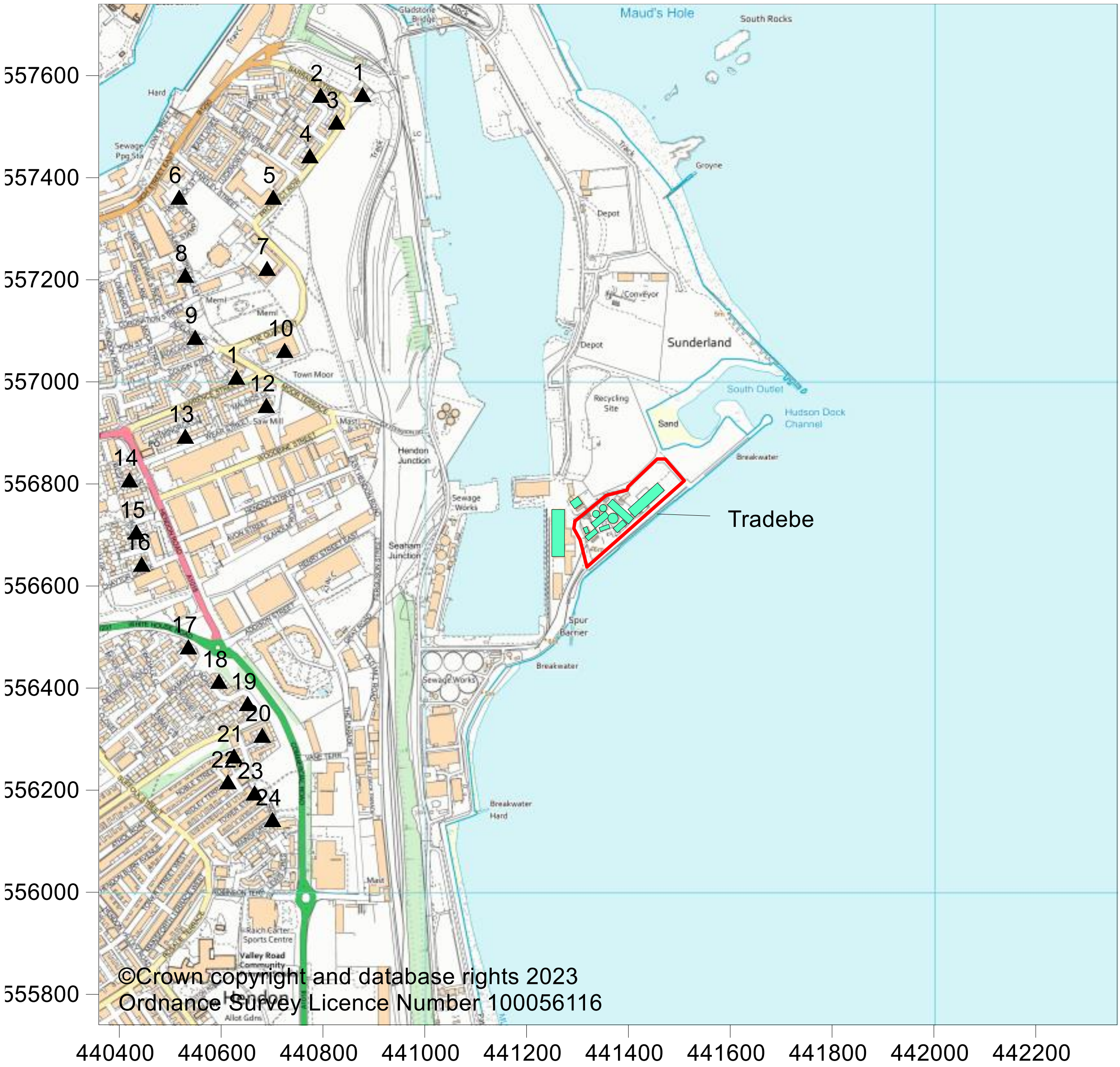


Figure 3.3 Tradebe Hendon Dock site and assessment area



3.2 Buildings

The presence of buildings close to a discharge flue can have an important influence 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 should be considered in any modelling.

ADMS 6.0 models buildings as either rectangular or circular structures. As shown in Figure 3.2, for the purposes of this assessment, eleven buildings or structures, some containing multiple elements, within and adjacent to the Hendon Dock site boundary, were considered. Each is simplified as a rectangular block. Based on the information provided by Tradebe[8], the defining parameters for these structures, as summarised in Table 3.1, were estimated and used within the modelling.

Table 3.1 Building parameters

Building (see Figure 3.2)	Building centre grid reference (m)		Height[a] (m)	Angle (° from north)	Length (m)	Width (m)
	Easting	Northing				
1	441262	556704	10	90	25	92
2	441298	556763	7	55	19	16
3	441317	556709	7	66	8	12
4	441328	556701	4	50	25	10
5a	441350	556753	9	-	14 diameter	
5b	441336	556741	9	-	14 diameter	
6	441345	556731	23	50	36	13
7	441369	556733	9	-	20 diameter	
8	441352	556714	4	70	20	8
9	441384	556750	14	42	16	56
10	441435	556769	14	48	78	20
11	441383	556717	9	48	25	12

a. Height is referenced to the south west corner of Building 4.

The sensitivity of predicted maximum process contributions of total volatile organic compounds at the residential locations to the consideration of a main building was examined as below.

Main building	Change (%) in predicted total VOC concentration from base case with Building 6 as the main building (residential receptors 1 to 24)			
	Annual mean		24 hour mean	
	Maximum	Average	Maximum	Average
1	0.0	0.0	0.0	-2.9
2	0.0	0.1	0.0	0.4
3	0.0	0.1	0.0	0.4
4	0.0	0.1	0.0	0.4
5a	0.0	0.1	0.0	0.4
7	0.0	-0.1	0.0	-2.2
8	0.0	0.1	0.0	0.4
9	0.0	0.3	6.4	8.4
10	0.0	0.2	5.5	8.0
11	0.0	0.0	0.0	0.4
No building	3.4	2.3	2.7	-2.2

It is noted that the selection of the main building in this case does not have a significant influence on maximum predicted process contributions. It is considered that the selection of Building 9 as the main building influencing dispersion tends towards a precautionary approach, providing marginally higher predicted process contributions. It is not thought that any uncertainty introduced due to this selection will have a meaningful influence on the conclusions reached in section 4.

Tradebe[9] have identified the location of the three flues serving the boiler plant as illustrated in Figure 3.2 and summarised in Table 3.2.

Table 3.2 Boiler flue locations

Flue	Boiler	Easting (m)	Northing (m)	Height (m)	Diameter (m)
A4	1	441321	556693	18.0	0.450
A5	2	441318	556696	18.0	0.450
A21	3	441313	556696	20.0	0.984

3.3 Meteorology

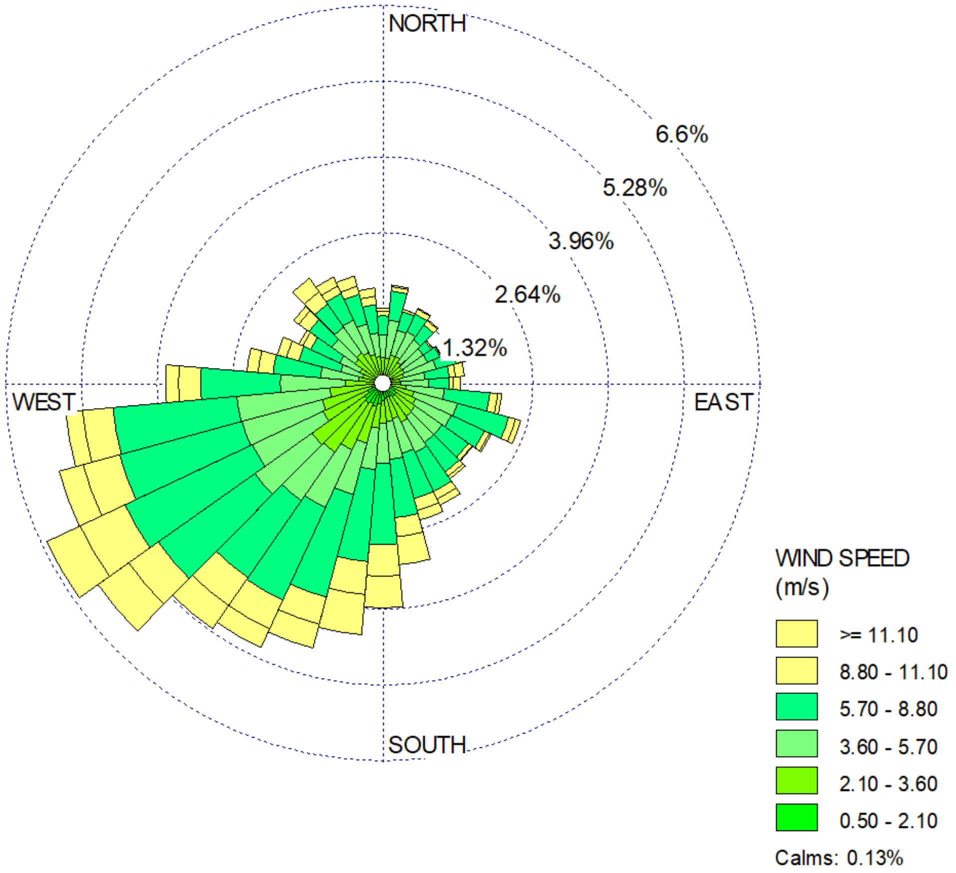
For this modelling assessment hourly sequential meteorological data from the nearest suitable measurement station to the area was obtained. The data, provided by the UK Met Office, was from the Loftus station and covered the 5 year period 2017 to 2021. The Loftus station is around 49 km south east of Hendon Dock at an elevation of 158m, compared with the site elevation of around 1m. It is also has the characteristics of a coastal station (within 10km of the coast). There are two other stations in the area which were also considered as possible sources of meteorological data:

Station	Position	Elevation	Data coverage
Durham	21km SW (not coastal)	117m	Missing cloud and wind data
Albemarle	35km NW (not coastal)	147	Complete

On the basis of the general location, elevation, coastal characteristics and data coverage, the Loftus station was considered to provide measurements most representative of the conditions in Hendon Dock.

The data included, among other parameters, hourly measurements of wind speed and direction. Figure 3.4 illustrates a composite wind rose for Loftus station for the period considered within this modelling. It may be seen that the wind is predominantly from the west/south west. Annex C provides a more detailed analysis of the meteorological data used

Figure 3.4 Composite windrose for the Loftus station (2017-2021)



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 that 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 approximately 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

Tradebe's site in Hendon Dock is located in an industrial setting and is adjacent to a number of warehouses. The seafront is immediately to the east with industrial and Docks operations and warehousing in all other directions. The nearest residential neighbours are around 800m to the west, just beyond the A1018, to the north west, adjacent to the Hendon Industrial Estate and to the north along the River Wear. A sensitivity analysis has been undertaken considering variations in surface roughness of between 0.1 and 1.5 m. This resulted in the following variations in predicted maximum process contributions of total VOCs over the residential receptors (1 to 24, see Figure 3.3):

Surface roughness (m)	Change (%) in predicted PC of total VOCs over the residential receptors (1 to 24) compared with base case of a surface roughness of 0.5m			
	Annual mean		24 hour mean	
	Maximum	Average	Maximum	Average
0.1	22.9	24.9	67.9	35.6
0.3	9.0	8.4	20.1	11.9
0.7	-4.3	-4.8	-11.6	-2.3
0.9	-9.4	-10.1	-12.5	-6.0
1.0	-11.8	-12.7	-15.3	-8.6
1.5	-22.8	-23.0	-23.4	-19.0

It is considered that the variations in the value of surface roughness, over the range considered representative of the area, are unlikely to introduce uncertainties which are significant in the context of the conclusions reached in section 4. A precautionary approach is adopted and a surface roughness of 0.3m was selected for the assessment. This provides somewhat higher predicted process contributions compared with surface roughness lengths towards the upper end of the representative range for the ambient air quality averaging bases.

This is considered as precautionary approach, although unlikely to introduce uncertainties which compromise the conclusions of this assessment.

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 200m 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 has the characteristics of a mixed urban and industrial area. A sensitivity analysis has been undertaken considering variations in minimum Monin Obukhov length of between 1m and 50m. This resulted in the following variations in predicted maximum process contributions of total VOCs over the residential receptors (1 to 24 see Figure 3.3):

Minimum Monin Obukhov length (m)	Change (%) in predicted PC of total VOCs over the residential receptors (1 to 24) compared with base case of a minimum Monin Obukhov length of 10m			
	Annual mean		24 hour mean	
	Maximum	Average	Maximum	Average
1	-1.0	-0.4	0.0	1.9
5	0.7	1.8	0.0	4.2
20	0.7	0.4	0.0	-2.0
40	6.2	3.3	0.0	-0.7
50	3.6	1.7	0.0	-5.7

Variations in predicted process contributions over the length range considered are largely insignificant in the context of the conclusions of this assessment. A length of 10m was selected for the assessment. This is considered to be representative of the range typical for the land use around Hendon Dock.

AERMOD does not 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

A sensitivity analysis has been undertaken considering Priestley Taylor parameters in the range 0 to 1.5. This resulted in the following variations in predicted maximum process contributions of total VOCs over the residential receptors (1 to 24, see Figure 3.3).

Priestley Taylor parameter	Change (%) in predicted PC of total VOCs over the residential receptors (1 to 24) compared with base case of a Priestley Taylor parameter of 1			
	Annual mean		24 hour mean	
	Maximum	Average	Maximum	Average
1.5	6.8	3.8	52.9	17.5
0.5	-4.1	-4.0	0.0	-2.7
0	-7.7	-6.7	-2.6	-4.8

Variations in predicted process contributions with the value of the Priestley Taylor parameter are largely insignificant in the context of 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

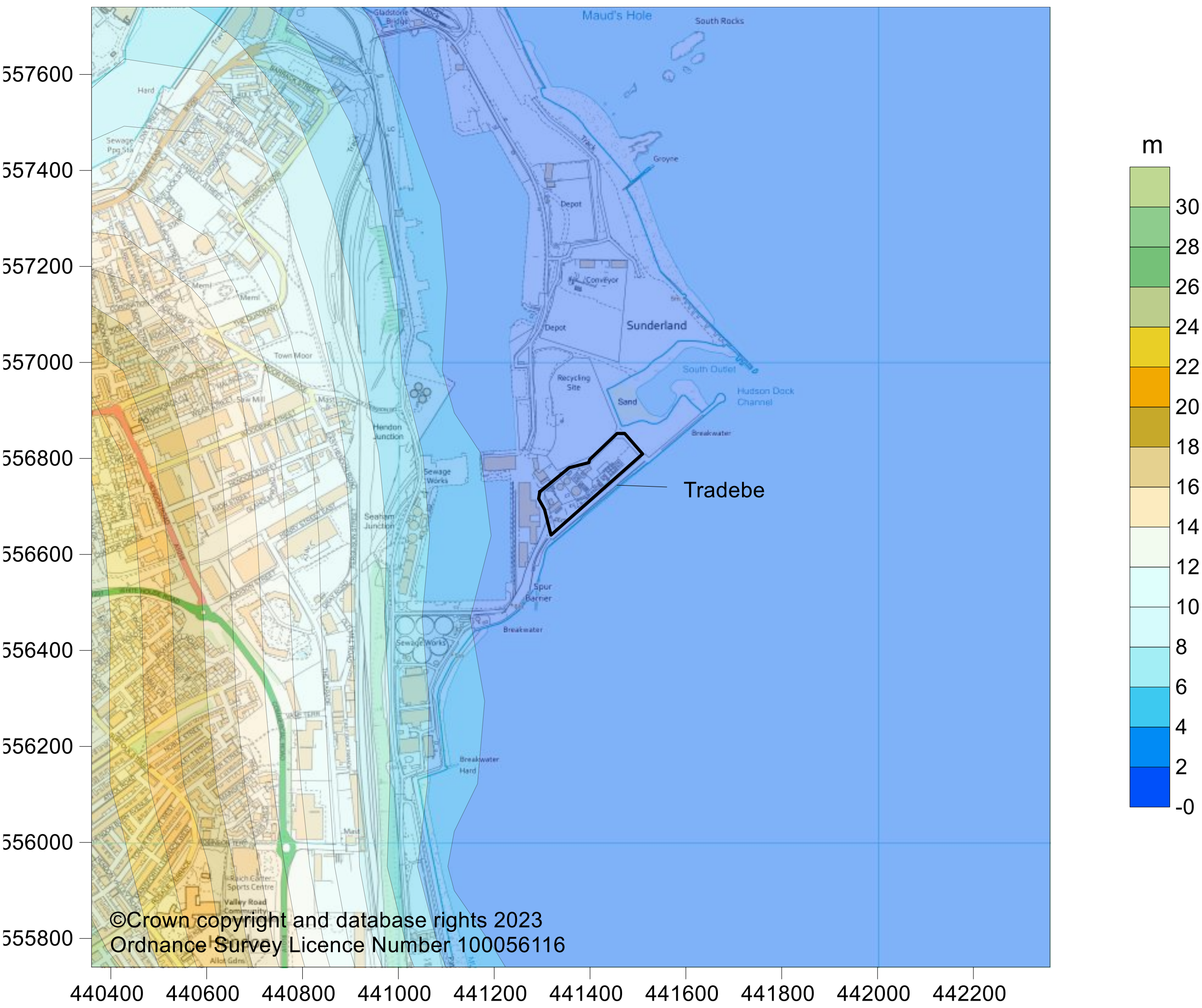
Urban	2.0-4.0
Desert shrubland	5.0-10.0

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 is some change in general elevation with the ground rising from the seafront to the west an average gradient of around 2%, although the area in the immediate vicinity of Hendon Dock is largely flat. The terrain over the assessment area is illustrated in Figure 3.5.

Figure 3.5 Ground elevation within assessment area



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 maximum process contributions of total VOCs across the residential receptors (1 to 24, see Figure 3.3) to consideration of terrain was examined as below.

Terrain	Change (%) in predicted PC of total VOCs over the residential receptors (1 to 24) compared with base case of an elevated assessment area			
	Annual mean		24 hour mean	
	Maximum	Average	Maximum	Average
Flat	-3.4	-7.8	-0.3	-6.3

Guidance suggests that consideration of terrain is not necessary at gradients of less than 5%. In this case the differences between a flat and elevated assessment area are unlikely to significantly influence the assessment outcome. For avoidance of doubt, an elevated assessment area has been considered in the overall air quality assessment as this generally provides marginally higher maximum predicted process contributions.

3.5 Pollutant releases and conditions

Measurements of releases from Boiler 3 were undertaken by SOCOTEC on the 26 and 27 October 2020[3] with the unit operating at typical conditions. Tradebe[9] have confirmed that the measurements undertaken are representative of boiler operation, although without the additional off gas releases. It is not expected that the relatively small amount of off gas (c. 15 kg/h) would add significantly to the flue gas volume flow or characteristics from this boiler bearing in mind the fuel consumption rate of around 1000 kg/h. It is therefore considered, for the purposes of this assessment, that the measured boiler flue gas characteristics are representative of operation with off gas disposal.

There are no similar measurements for Boilers 1 or 2. As these boilers are similar to Boiler 3 and use the same fuel, it was agreed with Tradebe that the flue gas characteristics for these boilers would be based on the measured properties from Boiler 3, adjusted in proportion to the relative boiler thermal inputs.

Table 3.3 summarises the determination of flue gas conditions.

Table 3.3 Boiler flue gas exhaust conditions

Boiler		1	2	3[a]
Flue		A4	A5	A21
Boiler maximum thermal input	MW	4.53	5.33	8.12
Volume flow rate (actual)	m^3/s	2.85[b]	3.57[b]	5.11[a]
Exhaust gas velocity	m/s	17.9	22.4	6.7
Exhaust temperature	°C	218[c]	218[c]	218[a]
Oxygen content	%, dry	8.0[c]	8.0[c]	8.0[a]
Water vapour content	%	11.1[c]	11.1[c]	11.1[a]
Volume flow rate (reference conditions)[d]	Nm^3/s	1.02	1.27	1.82

a. Measured conditions[3].
b. Based on the measured conditions on Boiler 3 and the relative boiler maximum thermal inputs.
c. Boiler operating conditions assumed to be identical to those measured on Boiler 3[3].
d. Reference conditions are based on a dry gas containing 3% by volume oxygen at a temperature of 273K and pressure of 101.3kPa (Standard temperature and pressure (STP)).

Tradebe indicate that the boiler manufacturer[9] generally expects a volatile organic compound release concentration of 2-3 mg/m^3 at measured conditions, with a design objective of less than 20 mg/m^3 at reference conditions, when operating with off gas disposal. The best available technique associated emission level (BAT-AEL) for total volatile organic compounds to air for the sector (re-refining of waste oil, physio-chemical treatment of waste with calorific value and the regeneration of spent solvents[10]) is 5-30 mg/Nm^3.

For the purposes of this assessment it is assumed that all boilers operate at the upper BAT-AEL of 30 mg/Nm^3. This is considered a conservative, worst case approach which will most likely over estimate the release of volatile organic compounds in practice. Table 3.4 summarises the determination of volatile organic compound discharge rates from the boilers.

Table 3.4 Boiler discharge rates

Boiler		1	2	3
Flue		A4	A5	A21
Volume flow rate (reference conditions)	Nm^3/s	1.02	1.27	1.82
Volatile organic compound concentration	mg/Nm^3	30	30	30
Volatile organic compound discharge rate	g/s	0.0305	0.0381	0.0547

Tradebe[9] indicate that only Boilers 2 and 3 are used to dispose of process off gas and that generally Boiler 3 is operated in conjunction with either Boilers 1 or 2. For the purposes of this assessment an operational worst case is assumed where all three boilers are operational continuously at their maximum thermal input with discharge conditions and volatile organic compounds discharge rates consistent with those in Tables 3.3 and 3.4. This is considered a highly unlikely worst case, which will substantially over estimate the discharges of volatile organic compounds and their subsequent ambient impact, particularly on a long term basis.

This assessment considers the air quality impact and workplace exposure on the basis of the standards for benzene and toluene respectively. This will most likely provide an overestimate of the significance of air quality impact and workplace exposure, as it might be expected that most of the compounds present will have air quality and workplace exposure benchmarks which are significantly less stringent.

It is considered that these assumptions in the modelling will result in an overestimate of the ambient impact of releases 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.

3.6 Modelling scenarios

ADMS 6.0 has been employed to estimate process contributions to ambient and workplace concentrations of volatile organic based on the general conditions specified above. The model has been run using meteorological data for each of five years (2017 to 2021). In order to ensure the worst case combination of releases and meteorological conditions was captured, the modelling considered continuous year round operation of all three boilers.

In addition, sensitivity analyses have then been undertaken to assessment the impact 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 influence of process releases on ambient concentrations over the entire assessment area in the context of the applicable environmental standards.

The initial discussion considers the maximum impact of process releases on local air quality. The subsequent sections discuss the impact at sensitive locations where human exposure is most likely (see section 3.1).

4.1 Impact of process releases beyond the site boundary

Table 4.1 details the estimated maximum process contributions and corresponding overall predicted environmental concentration at the location of maximum concentration in the context of the applicable environmental standards. Figures A.1 and A.2 present contour plots of the process contribution of total volatile organic compounds (expressed as benzene) for the short term (24 hours) and long term (annual) averaging bases respectively. Table D.2 presents the process contributions of total volatile organic compounds (expressed as benzene) at each of the discrete receptors considered.

On a long term basis the maximum process contribution occurs on the site boundary, while on the short term basis the maximum is around 50m beyond the site boundary within the Dock area between the site and the sewage works. Process contributions decline rapidly with distance from the location of maximum

Table 4.1 Maximum process contributions and predicted environmental concentrations

Substance	Averaging basis	Process contribution		Background	Predicted environmental concentration	
		µg/m^3	% standard	µg/m^3	µg/m^3	% standard
Total volatile organic compounds[a]	annual	1.38	27.5	0.26	1.64	32.7
	24 hours	9.18	30.6	0.31	9.49	31.6

a. Total volatile organic compounds are assessed on the basis of the environmental standards applicable to benzene.

It should be considered that these concentrations are the maxima determined across the assessment area for each of five years. Process contributions at other locations of interest, and at other times, will be lower and often considerably lower, as shown in Figures A.1 and A.2.

The maximum process contribution of benzene on a short term basis exceeds the screening criteria (i.e. the short term process contribution is less than 20% of the short term environmental standard less the corresponding background concentration) within limited areas on site and on the south eastern boundary and within the dock area to the west of the site (see Figure A.1). At the location of maximum process contribution the short term predicted environmental concentration is around a third of the corresponding benchmark.

On a long term basis all process contributions are within screening criteria (i.e. the predicted environmental concentration is less than 70% of the long term environmental standard), with predicted environmental concentrations also around a third of the benchmark.

It is noted also that the locations of screening criteria exceedance (see Figure A.1) are in areas where public exposure would not be of the duration and frequency consistent with the application of either the short term (24 hours) or long term (annual) air quality benchmarks applicable to benzene (see section 2.3.1). These would be expected to apply at residential locations where there is prolonged and frequent occupancy. The areas affected by an exceedance of the screening criteria are within a largely industrial setting which is expected to be subject to workplace exposure limits (see section 4.3).

Bearing in mind the headroom for compliance and the expected substantial over estimate of ambient impact, It is not considered that process contributions from boiler operations are likely to compromise the attainment of the relevant air quality standards at any location within the assessment area or beyond.

In the following section process contributions at sensitive locations, where short term and long term air quality standards would be expected to apply, are assessed.

4.2 Impact of process releases at locations of human exposure

In order to determine the impact of boiler releases at locations of frequent human exposure, discrete receptors were positioned at residential locations in the vicinity of Tradebe's Hendon Dock site (see Figure 3.1 and Table D.1). These are considered the only locations in the vicinity of the Hendon Dock site to which the public normally have access and where human exposure for some or all the environmental standard averaging periods is likely.

Table 4.2 summarises the maximum process contributions arising from process releases and the resulting predicted environmental concentrations at these locations.

The maximum process contributions at residential locations are determined to be insignificant and requiring no further assessment on the basis of Environment Agency assessment criteria (i.e. the short term process contribution is less than 20% of the short term less the corresponding background concentration and the long term predicted environmental concentration is less than 70% of the long term environmental standard). It is not considered that process contributions from the operation of the three boilers at Tradebe's Hendon Dock site will have any meaningful influence on, or pose any substantial risk to, continued compliance with environmental standards at the nearest residential locations.

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

Substance	Averaging basis	Process contribution		Background	Predicted environmental concentration	
		μg/m^3	% standard	μg/m^3	μg/m^3	% standard
Total volatile organic compounds[a]	annual	0.06	1.2	0.26	0.32	6.4
	24 hours	0.83	2.8	0.31	1.14	3.8

a. Total volatile organic compounds are assessed on the basis of the environmental standards applicable to benzene.

Environmental Protection UK (EP UK) and the Institute of Air Quality Management (IAQM) provide guidance on the significance of pollutant releases in the context of existing air quality assessment levels (section 2.5)[7].

Table 4.3 summarises the significance of long term impact on air quality at the most affected residential location (The Quadrant, about 650m to the north west of the Tradebe site). The impact significance is classified as 'negligible'.

Table 4.3 Impact significance of process contributions (long term)

Substance	Process contribution	Predicted environmental concentration	EPUK impact class
	%AQAL		
Total volatile organic compounds[a]	1.2	6.4	Negligible

a. Total volatile organic compounds are assessed on the basis of the environmental standards applicable to benzene.

While volatile organic compounds do not require assessment in terms of ecological impact, a discrete receptor was located at the site boundary of the nearest nature conservation sites discussed in section 3.1. This is not discussed here, but process contributions at this location (Table D.1) are presented in Table D.2 for information.

4.3 Impact of process releases on the Tradebe site

Table 4.4 summarises the maximum process contributions and compliance with the applicable workplace standards for toluene.

Table 4.4 Maximum workplace process contributions

Substance	Averaging basis	Process contribution	
		μg/m^3	% standard
Total volatile organic compounds[a]	15 minutes	50.7	0.013
	8 hours	14.2	0.007

a. Total volatile organic compounds are assessed on the basis of the workplace exposure limits applicable to toluene.

It may be seen that the maximum process contributions are comfortably within the applicable workplace exposure limits. The assumptions made in the assessment are likely to substantially over estimate releases and their significance and as such it is concluded that process contributions during the operation of the three site boilers are unlikely to have any meaningful influence on workplace exposure limit attainment.

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.

Sensitivity analyses were 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 4.5 summarises the influence of meteorological conditions on maximum process contributions over the assessment area.

Table 4.5 Influence of meteorological conditions on maximum process contribution

Averaging basis	Maximum process contribution	
	Mean ratio of maximum to minimum (2017 to 2021)	
	Residential receptors	Site boundary receptors
Annual mean	1.8	1.4
24 hour mean	1.6	1.5

The annual variations in meteorological conditions generally exhibit around a 50% variation in predicted process contributions and in some cases higher. It should be noted that this assessment is based on the maximum process contribution for all the years considered at each location and as such is likely to be an overestimate 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 maximum process contributions at 2017 meteorological conditions. Table 4.6 summarises the comparison between the ADMS and AERMOD model predictions of maximum process contributions over the averaging bases considered.

Table 4.6 Maximum process contributions (variation with model) - 2017

Averaging basis	Maximum process contribution (mean ratio of ADMS to AERMOD)	
	Annual mean	24 hour mean
Maximum across assessment area	1.3	1.5
Residential receptors	1.3	1.3
Site boundary receptors	1.8	1.3

The ADMS model predictions over both averaging bases are generally higher than those provided by AERMOD. Bearing in mind the margins available in the assessment of compliance in sections 4.2 and 4.3 and the conservative approach to the modelling, it is considered that the differences exhibited due to model selection are unlikely to have any meaningful impact on the 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 assessment is based on continuous year round operation of all three boilers. Tradebe indicate that this is an unlikely operating scenario with normal operation likely to balance boiler operation to site steam needs. The assessment will therefore overestimate the release of volatile organic compounds and their ambient impact, particularly on the long term averaging basis.

- The mass release rate of volatile organic compounds is consistent with meeting the upper range of the BAT-AEL (i.e. 30 mg/Nm^3). The boiler manufacturer indicates design levels of below 20 mg/Nm^3. It is considered likely that, in practice, mass release rates of volatile organic compounds will be substantially less than those employed in this assessment, which will result in an overestimate the corresponding ambient impact.

- For the purposes of the assessment, the ambient impact of the total organic compound release is compared with the environmental and workplace benchmarks for benzene and toluene respectively. In practice, it is considered most likely that the volatile organic compound release will comprise a range of compounds with most having substantially less stringent environmental and workplace benchmarks than benzene and toluene respectively. This will tend towards an overestimation of the significance of air quality impact and workplace exposure.

- 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 meteorological year providing the maximum impact and as such is likely to be an overestimate for most meteorological years.

- 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 significantly dependent on the selection of model. ADMS generally provides a higher predicted impact than the AERMOD model for most averaging bases and most receptor groups.

- 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 which are considered representative of the assessment area with a tendency towards a precautionary approach.

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 therefore incorporate a reasonable margin of comfort in spite of the inevitable uncertainty of such modelling studies.

5 CONCLUSIONS

organic compounds from the operation of three boilers serving a solvent recovery process at Tradebe Solvent Recycling Limited's Hendon Dock site in Sunderland. Three boilers, burning solvent distillate fuel, generate steam for site use. In addition, two of the three boilers are used to dispose of a stream of process off gas containing volatile materials. The air quality impact of boiler operation was assessed to determine acceptability in relation to applicable air quality standards and workplace exposure limits.

The assessment was undertaken using the UK ADMS 6.0 modelling system, and was based on continuous year round operation of all three boilers at volatile organic compound discharge rates consistent with operation at the maximum best available technique associated emission limit level.

Maximum process contributions occur around the site boundaries and to the west within the adjacent Dock. At the location of maximum, short term process contributions of volatile organic compounds exceed screening criteria, although predicted environmental concentrations on both long term and short averaging bases are around a third of the environmental benchmarks for benzene. It is considered unlikely that air quality standards for human health would be applicable at or around the location of maximum impact due to the industrial nature of the area and the lack of general public access.

At neighbouring residential locations, where both short and long term air quality standards apply, process contributions of volatile organic compounds were considered insignificant based on Environment Agency assessment criteria. The air quality impact significance of process contributions, based on Institute of Air Quality Management descriptors, was assessed as 'negligible when considered at the most affected residential location. It is concluded that volatile organic compound releases from boiler operations are unlikely to have any significant influence on, or pose any risk to, continued attainment of applicable air quality standards in the vicinity of the Tradebe site at Hendon Dock.

In terms of workplace exposure, maximum process contributions are less than 1% of the long term and short term limits applicable to toluene. It is concluded that releases of volatile organic compounds from boiler operations are unlikely to pose any significant risk to continued attainment of applicable workplace exposure limits on or near Tradebe Solvent Recovery Limited's Hendon Dock site.

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

6 REFERENCES

1. Environment Agency and Department for Environment Food and Rural Affairs, Risk assessment for specific activities, environmental permits, Environmental Management guidance: Air emissions risk assessment for your environmental permit, 22 March 2023 (www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air).

2. Sunderland City Council, 2019 air quality annual status report, June 2019.

3. SOCOTEC UK Limited, Stack emission monitoring report, LNO16047 version 2, 8 December 2020 (Tradebe, Sunderland, Boiler 3).

4. SI 2010:1001, Environmental Protection, The Air Quality Standards Regulations 2010.

5. Health and safety Executive, EH40/2005 Workplace Exposure Limits, 2020.

6. SOCOTEC UK Limited, Air quality impact of releases from an emergency stack serving a solvent recovery process, LSW230530, 30 June 2023.

7. EP UK & IAQM, Land use planning development and control: planning for air quality, January 2017

8. Private communication, C Wright (Tradebe) to N Ford (SOCOTEC), email, 19 May 2022.

9. Private communication, C Wright (Tradebe) to N Ford (SOCOTEC), email, 11 August 2023.

10. BAT reference document for waste treatment, JRC Science for Policy Report, 2018.

Annex A Dispersion modelling contour plots

The results of the modelling of the impact of boiler flue gas releases on local ambient ground level concentrations are presented in tabular form in Section 4. In Annex A the results for total organic compounds (assessed as benzene) are presented as contour plots of the process contribution to ambient concentrations (excluding any existing background concentration). All results are expressed as a percentage of the applicable environmental standard for the year providing the maximum contribution across the assessment area in each case.

Figures A.1 and A.2 consider the ambient impact in terms of the Environmental Assessment Level and Air Quality Standard for human health for benzene (24 hour and annual means respectively). These benchmarks are applicable in locations where there is frequent and prolonged human exposure, such as residential locations. The contour plots are presented for an area of 2km x 2km (see Figure 3.3) which includes the Tradebe Hendon Dock site and the immediate commercial and industrial neighbours and the nearest residential areas.

For presentational purposes minimum contours of 1% and 10% of the long term and short term environmental standards respectively are provided. Generally, values below 1% and 10% of the long term and short term environmental standards respectively, are considered to be insignificant in terms of air quality impact.

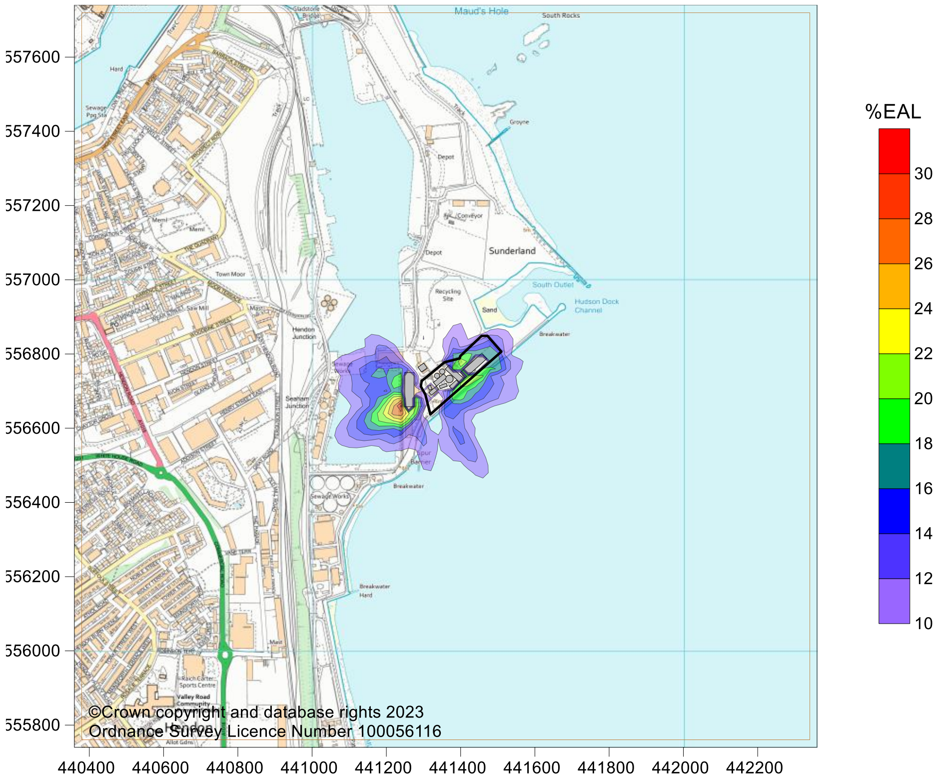
In addition, Figure A.1 includes a further contour plot over a reduced area of 1km x 1km to provide some clarity on the small area around the site where ambient process contributions exceed the screening criteria. It may be noted that for the long term ambient impact there is no exceedance of screening criteria over the assessment area.

The following figures are presented:

Figure 1 Predicted process contribution of total volatile organic compounds (maximum 24 hour mean)

Figure 2 Predicted process contribution of total volatile organic compounds (maximum annual mean)

Figure A.1 Predicted process contribution of total volatile organic compounds (maximum 24 hour mean)



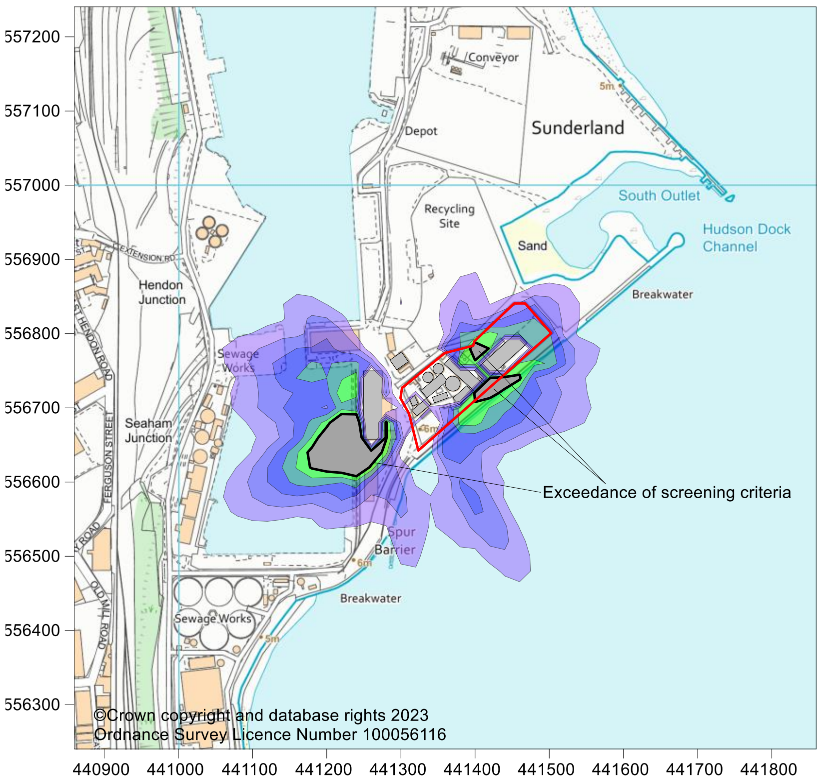
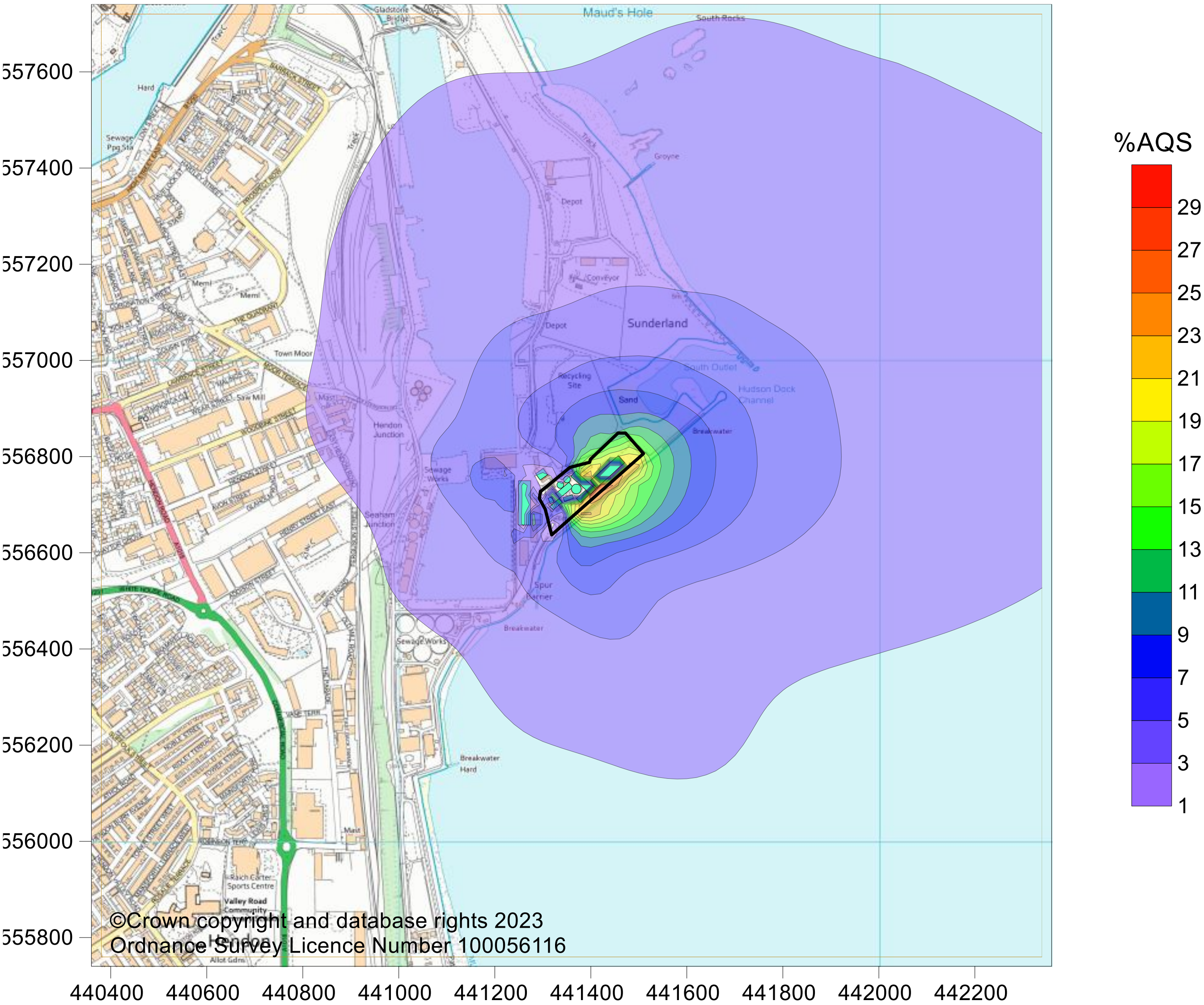


Figure A.2 Predicted process contribution of total volatile organic compounds (maximum annual mean)



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	2000m x 2000m area with centre 441360 556740
Cartesian receptor grid	101 x 101 receptor grid (total 10201) with receptors spaced at 20m intervals
Discrete receptors	50 receptors - see Table D.1 for description
Meteorological data	Hourly sequential data supplied by the UK Meteorological Office from the Loftus station for the 5 year period 2017 to 2021.
Topography	Elevated assessment area Terrain data obtained from the Ordnance Survey Landform Panorama database (NZ 24, 26, 44 & 46)
Surface roughness	0.3m
Minimum Moni Obukhov length	10m
Surface albedo	0.23
Priestley Taylor parameter	1.0

Table B.2 summarises the release characteristics for three boiler flues. These are described in more detail in section 3.5.

Table B.2 Source characteristics

Boiler		1	2	3
Flue		A4	A5	A21
Exhaust flue location and characteristics				
Easting	m	441321	441318	441313
Northing	m	556693	556696	556696
Height	m	18.0	18.0	20.0
Flue diameter	m	0.450	0.450	0.984
Exhaust gas conditions				
Velocity	m/s	17.9	22.4	6.7
Temperature	ºC	218	218	218
Total volatile organic compounds	g/s	0.0305	0.0381	0.0547

B.2 Model input files

Electronic files containing the input data used in the modelling of the maximum process contributions are available upon request as detailed below:

Total volatile organic compounds (24 hours)	TBE3 AB 2019.APL
Total volatile organic compounds (annual)	TBE3 AB 2017.APL

B.3 Models used

ADMS	Cambridge Environmental Research Consultants Limited ADMS 6.0: version 6.0.0.1 License: A01-1347-C-ADMS6-UK (10.10.23)
AERMOD	Lakes Environmental Software AERMOD View: version 11.2.0 (AERMOD version 21112) License: AER0005883 (21.11.23)

ANNEX C Meteorological data

For this modelling assessment hourly sequential meteorological data provided by the UK Met Office from the Loftus station were employed and covered the 5 year period 2017 to 2021. Further details of the data employed are provided in this section.

C.1 Windroses

In section 3.3 a cumulative wind rose for the period 2017 to 2021 is presented. The windroses for each individual year of data used are illustrated below.

Figure C.1 Loftus 2017

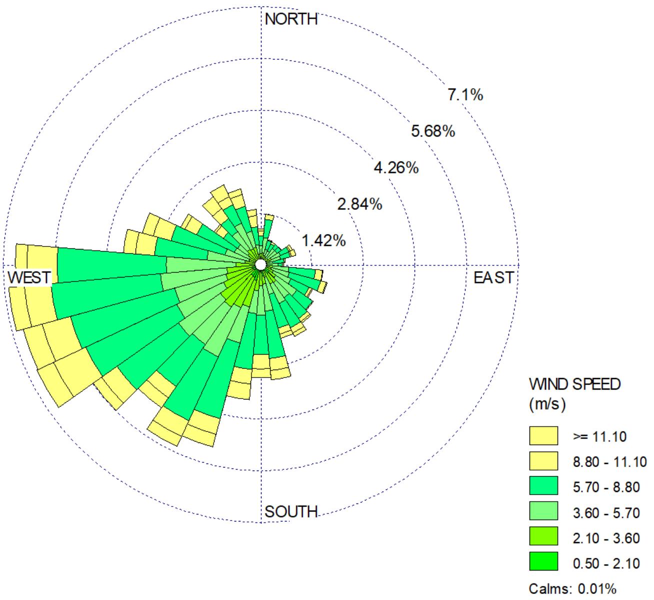


Figure C.2 Loftus 2018

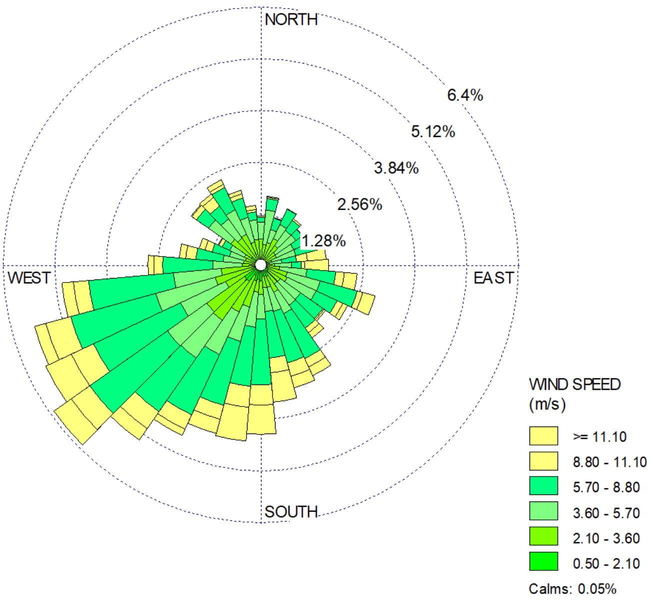


Figure C.3 Loftus 2019

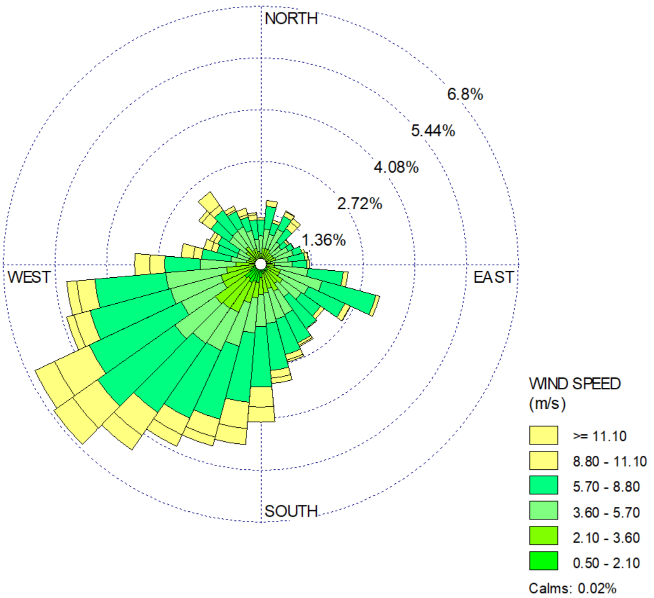


Figure C.4 Loftus 2020

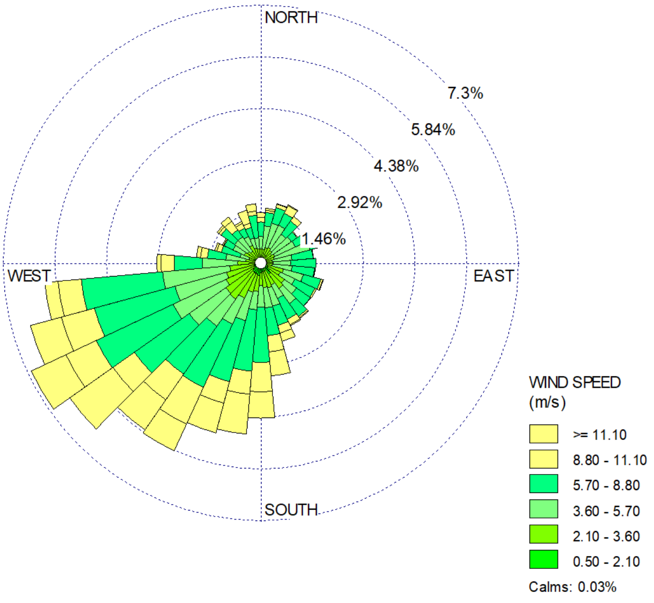
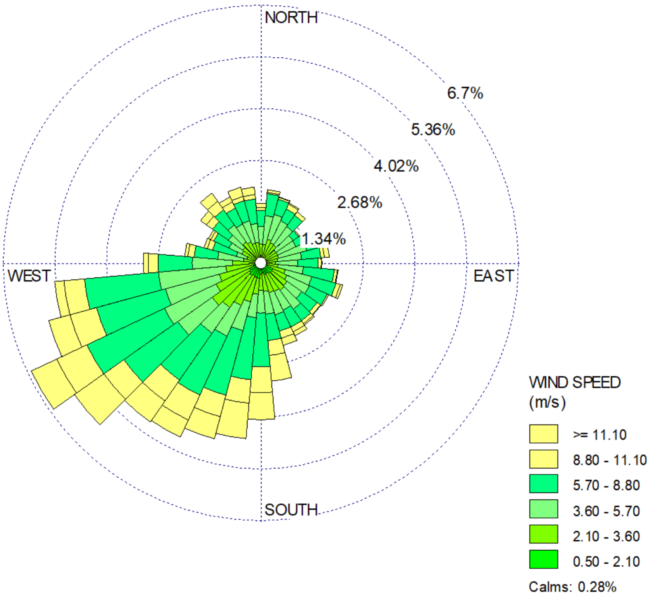


Figure C.5 Loftus 2021



C.2 Data analysis and characteristics

Analyses of the wind direction, wind speed and precipitation are summarised in Tables C.1 and C.2 for the period 2017 to 2021.

Table C.1 Wind speed and direction (2017 to 2021) for Loftus

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	0.5	2.0	2.5	2.3	0.5	0.4	8.2
NE	0.4	1.5	1.9	1.1	0.2	0.1	5.1
E	0.5	1.5	3.0	2.9	0.5	0.5	8.9
SE	1.1	1.7	2.4	2.6	0.4	0.2	8.5
SE	1.7	2.3	3.6	6.7	2.2	2.4	18.8
SW	1.6	3.9	4.7	7.9	2.6	2.2	22.9
W	0.8	2.8	5.3	7.3	2.1	1.3	19.6
NW	0.6	1.7	2.1	2.0	0.8	0.7	7.9
Calm							0.1

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

Table C.2 Rainfall and wind direction (2017 to 2021) for Loftus

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	6.6	0.7	0.4	0.1	0.1	<0.1	0.2
NE	4.3	0.3	0.2	<0.1	0.1	<0.1	0.1
E	7.7	0.4	0.3	0.1	0.1	<0.1	0.2
SE	7.6	0.4	0.2	0.1	0.1	<0.1	0.1
SE	17.2	0.7	0.5	0.1	0.1	<0.1	0.2
SW	21.6	0.6	0.4	0.1	0.1	<0.1	0.1
W	18.4	0.4	0.3	0.1	0.1	<0.1	0.1
NW	6.6	0.5	0.3	0.1	0.1	0.1	0.2
Calm	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total	90.3	4.0	2.6	0.7	0.9	0.3	1.2

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

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

Table C.3 Dataset characteristics (2017 to 2021) for Loftus

No. days data	1826		
No. hours data	43824		
No. calm hours (<0.3 m/s)	57	0.13	%
No. dry hours (<0.1 mm/h)	39560	90.43	%
Mean wind speed (m/s)	5.9		
No. missing records	79	0.18	%
Available records	43745	99.82	%

ANNEX D Discrete receptors

Discrete receptors were used to monitor the process contribution to ambient volatile organic compound concentrations at a range of locations, including the residential areas near to the Tradebe Hendon Dock site, as illustrated in Figure 3.3. Details of their location are provided in Table D.1. All receptors were at an elevation of 1.5m, with the exception of receptor 50 (conservation sites) which had an elevation of 0m.

The receptors fall into the following groups:

1 to 24 Residential locations (see Figure 3.3)
25 to 49 Site boundary (see Figure 3.1)
50 Conservation sites

Table D.1 Discrete receptor locations

Receptor (see Figure 3.3)		Position[a]	Easting (m)	Northing (m)
1	The Welcome Tavern	954 m NW	440878	557563
2	Barrack Street	997 m NW	440795	557562
3	Prospect Row 1	936 m NW	440827	557509
4	Prospect Row 2	915 m NW	440774	557443
5	Prospect Row 3	905 m NW	440702	557362
6	Havelock Street	1047 m NW	440518	557362
7	Trafalgar Square	825 m NW	440690	557222
8	Church Street East	953 m NW	440530	557209
9	Adelaide Place	882 m NW	440549	557087
10	The Quadrant	712 m NW	440725	557062
11	Lawrence Street	778 m W	440630	557009
12	Malings Close	704 m W	440689	556954
13	Minorca Close	844 m W	440530	556894
14	Besford Grove	942 m W	440420	556808
15	Rane Close	927 m W	440434	556706
16	Chaytor Grove	921 m W	440444	556643
17	White House Road	864 m W	440536	556481
18	Bramwell Road 1	831 m SW	440596	556413
19	Bramwell Road 2	799 m SW	440652	556370
20	Primary Gardens	805 m SW	440681	556307
21	Noble Street	874 m SW	440625	556267
22	Ridley Terrace	912 m SW	440613	556216
23	Tower Street	883 m SW	440666	556195
24	Mansforth Terrace	890 m SW	440701	556142

Table D.1 continued

Receptor (see Figure 3.1)		Position[a]	Easting (m)	Northing (m)
25	Site boundary	68 m W	441292	556730
26		69 m SW	441299	556708
27		76 m SW	441309	556683
28		98 m SW	441318	556651
29		95 m S	441331	556649
30		71 m S	441355	556670
31		53 m S	441373	556688
32		44 m SE	441388	556707
33		58 m E	441415	556724
34		74 m E	441434	556744
35		99 m E	441456	556764
36		122 m E	441476	556779
37		149 m E	441498	556796
38		167 m NE	441511	556810
39		162 m NE	441498	556825
40		159 m NE	441484	556838
41		154 m NE	441464	556853
42		126 m NE	441437	556840
43		101 m NE	441422	556820
44		77 m NE	441407	556801
45		59 m NE	441392	556789
46		40 m N	441367	556779
47		34 m NW	441338	556766
48		44 m W	441316	556745
49		61 m W	441299	556735
50	Northumbria Coast SPA, Durham Coast SSSI	1994 m S	441280	554748

a. Position is relative to the area around the three boilers flues (see Figure 3.2).

Table D.2 provides the maximum predicted process contributions of total volatile organic compounds at each of the discrete receptors described above.

Table D.2 Maximum process contributions of total volatile organic compounds

Receptor (see Figures 3.1 & 3.3)		Maximum process contribution of total volatile organic compounds (% of benzene standard)	
		24 hour mean EAL	Annual mean AQS
1	The Welcome Tavern	2.6	1.0
2	Barrack Street	2.2	0.9
3	Prospect Row 1	2.4	1.0
4	Prospect Row 2	1.8	0.9
5	Prospect Row 3	1.7	0.9
6	Havelock Street	1.6	0.7
7	Trafalgar Square	2.2	1.0
8	Church Street East	1.9	0.8
9	Adelaide Place	2.1	0.9
10	The Quadrant	2.8	1.2
11	Lawrence Street	2.4	1.1
12	Malings Close	2.6	1.2
13	Minorca Close	2.3	0.8
14	Besford Grove	1.6	0.6
15	Rane Close	1.6	0.6
16	Chaytor Grove	1.8	0.6
17	White House Road	2.2	0.6
18	Bramwell Road 1	2.1	0.7
19	Bramwell Road 2	2.4	0.7
20	Primary Gardens	2.2	0.7
21	Noble Street	1.9	0.6
22	Ridley Terrace	1.7	0.5
23	Tower Street	1.8	0.6
24	Mansforth Terrace	1.9	0.6
25	Site boundary	10.2	2.5
26		7.3	6.2
27		11.1	8.5
28		3.7	1.5
29		5.7	2.8
30		15.4	11.5
31		20.5	22.9
32		21.4	22.4
33		21.0	26.2
34		20.8	26.9
35		21.1	23.9
36		20.6	22.5
37		19.5	19.8
38		14.4	14.9

Table D.2 Maximum process contributions of total volatile organic compounds

Receptor (see Figure 3.1)		Maximum process contribution of total volatile organic compounds (% of benzene standard)	
		24 hour mean EAL	Annual mean AQS
39	Site boundary	16.0	16.1
40		14.2	14.5
41		11.0	11.0
42		11.7	11.8
43		13.4	13.5
44		18.2	17.7
45		18.9	19.5
46		14.6	13.7
47		7.9	5.1
48		2.9	0.4
49		4.6	0.2
50	Northumbria Coast SPA, Durham Coast SSSI	0.5	0.2

END OF REPORT

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