Environmental Statement Addendum – Additional Air Quality Assessment

Calder Valley Skip Hire Small Waste Incineration Plant

Rochdale Road, Sowerby Bridge, Calderdale HX6 3LL

For Calder Valley Skip Hire Ltd

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Quality Management

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Executive Summary

The proposed Small Waste Incineration Plant (SWIP) at Calder Valley Skip Hire, Belmont Industrial Estate is located within the administrative area of Calderdale Metropolitan Borough Council (CMBC). CMBC has designated seven Air Quality Management Areas (AQMAs) due to high levels of nitrogen dioxide (NO_2) pollution associated with road traffic emissions. One of these AQMAs (AQMA No. 2) encompasses Sowerby Bridge and is located approximately 680 m north-east of the proposed SWIP.

This Air Quality Assessment considers the air quality impacts from the operational phase of the SWIP.

In undertaking this assessment, RPS experts have exercised professional skills and judgement to the best of their abilities and have given professional opinions that are objective, reliable and backed with scientific rigour. These professional responsibilities are in accordance with the code of professional conduct set by the Institution of Environmental Sciences for members of the Institute of Air Quality Management (IAQM).

Detailed atmospheric dispersion modelling has been undertaken. The operational impact of the Proposed Development on existing receptors is predicted to be 'negligible'. Using the criteria adopted for this assessment together with professional judgement, the operational air quality effects are considered to be 'not significant' overall.

The proposed SWIP does not, in air quality terms, conflict with national or local policies, or with measures set out in CMBC's Air Quality Action Plan. There are no constraints to the development in the context of air quality.

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1 Introduction

1.1 This report details the air quality assessment undertaken for the proposed Small Waste Incineration Plant (SWIP) at Calder Valley Skip Hire, Belmont Industrial Estate.

1.2 The local authority, Calderdale Metropolitan Borough Council (CMBC), has designated seven Air Quality Management Areas (AQMAs) due to high levels of nitrogen dioxide (NO_2) pollution associated with road traffic emissions. One of these AQMAs (AQMA No. 2) encompasses Sowerby Bridge and is located approximately 680 m north-east of the proposed SWIP.

1.3 This air quality assessment covers the operational phase of the proposed SWIP, focusing on the impacts of emissions from the SWIP on the local area.

1.4 This report begins by setting out the policy and legislative context for the assessment. The methods and criteria used to assess potential air quality effects have then been described. The baseline air quality conditions have been established taking into account Defra estimates, local authority documents and the results of any local monitoring. The results of the assessment of air quality impacts have been presented. A conclusion has been drawn on the significance of the residual operational-phase effects.

2 Policy and Legislative Context

Emission Limits

Industrial Emissions Directive Limits

2.1 The plant would be designed and operated in accordance with the requirements of the Industrial Emissions Directive (2010/75/EU) [1], known hereafter as the IED, which requires adherence to emission limits for a range of pollutants.

2.2 Emission limits in the IED are specified in the form of half-hourly mean concentrations; daily-mean concentrations; mean concentrations over a period of between 30 minutes and 8 hours; or, for dioxins and furans, mean concentrations evaluated over a period of between six and eight hours.

2.3 For the purposes of this assessment for those pollutants having only one emission limit (for a single averaging period), the facility has been assumed to operate at that limit (with the exception of arsenic and Chromium VI, as discussed later). Where more than one limit exists for a pollutant, the half-hourly mean emission limit value has been used to calculate short-term (≤ 24-hour average) peak ground-level concentrations (Scenario 1) (again, with the exception of arsenic and Chromium VI, as discussed later). The daily mean emission limit value has been used for these pollutants to calculate long-term (greater than 24-hour average) mean ground-level concentrations (Scenario 2). The IED emission limit values are provided in Table 2.1.

Table 2.1 Relevant Industrial Emissions Directive Limit Values

Pollutant	Scenario 1 Short-Term Emission Limits ($mg.Nm^{-3}$)	Scenario 2 Daily-Mean Emission Limits ($mg.Nm^{-3}$)
Particles	30	10
Hydrogen Chloride (HCl)	60	10
Hydrogen Fluoride (HF)	4	1
Sulphur Dioxide (SO_2)	200	50
Nitrogen Oxides (NO_X)	400	200
Carbon Monoxide (CO)	-	50
Group 1 metals (a)	-	0.05 (d)
Group 2 metals (b)	-	0.05 (d)
Group 3 metals (c)	-	0.5 (d)
Dioxins and furans	-	0.0000001 (e)

Notes: All concentrations referenced to temperature 273 K, pressure 101.3 kPa, 11% oxygen, dry gas.
(a) Cadmium (Cd) and thallium (Tl).
(b) Mercury (Hg).
(c) Antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), and vanadium (V).
(d) All average values over a sample period of a minimum of 30 minutes and a maximum of 8 hours.
(e) Average values over a sample period of a minimum of 6 hours and a maximum of 8 hours. The emission limit value refers to the total concentration of dioxins and furans calculated using the concept of toxic equivalence (TEQ).

2.4 Ammonia (NH_3), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are not specifically regulated under the IED. For the purposes of this assessment, the emission concentrations in Table 2.2 have been used for these pollutants to calculate long-term (greater than 24-hour average) mean ground-level concentrations (Scenario 2).

Table 2.2 Modelled Emission Concentrations for non-IED-Regulated Pollutants

Pollutant	Scenario 2 Emission Limits ($mg.Nm^{-3}$)
NH_3	5
PCBs	0.005
PAHs (as B[a]P equivalent)	0.001

Notes: All concentrations referenced to temperature 273 K, pressure 101.3 kPa, 11% oxygen, dry gas.
Emission limits obtained from the IPPC Reference Document on the Best Available Techniques for Waste Incineration (August 2006)

Waste Framework Directive

2.5 Directive 2008/98/EC [2] of the European Parliament and Council on Waste requires member states to ensure that waste is recovered or disposed of without harm to human health and the environment. It requires member states to impose certain obligations on all those dealing with waste at various stages. Operators of waste disposal and recovery facilities are required to obtain a permit, or register a permit exemption. Retention of the permit requires periodic inspections and documented evidence of the activities in respect of waste.

2.6 The Waste Framework Directive (WFD) requires member states to take appropriate measures to establish an integrated and adequate network of disposal installations. The WFD also promotes environmental protection by optimising the use of resources, promoting the recovery of waste over its disposal (the “waste hierarchy”).

2.7 Annex II A and B of the WFD provide lists of the operations which are deemed to be “disposal” and “recovery”, respectively. The terms are mutually exclusive and an operation cannot be a disposal and recovery operation simultaneously. Where the operation is deemed to be a disposal operation, the permit will contain more extensive conditions than for a recovery operation.

2.8 The principal objective of a recovery operation is to ensure that the waste serves a useful purpose, replacing other substances which would have been used for that purpose. Where the combustion of waste is used to provide a source of energy, the operation is deemed to be a recovery operation.

2.9 The EPR 2016 implements the WFD in the UK. As such, the Environment Agency is responsible for implementing the obligations set out in the WFD for most activities and waste operations but local authorities are responsible for implementing the WFD obligations in respect of generally smaller scale facilities including SWIPs..

Ambient Air Quality Legislation and National Policy

Ambient Air Quality Criteria

2.10 There are several European Union (EU) Air Quality Directives and UK Air Quality Regulations that will apply to the operation of the proposed facility. These provide a series of statutory air quality limit values, target values and objectives for pollutants, emissions of which are regulated through the IED.

2.11 There are some pollutants regulated by the IED which do not have statutory air quality standards prescribed under current legislation. For these pollutants, a number of non-statutory air quality objectives and guidelines exist which have been applied within this assessment. The Environment Agency website provides further assessment criteria in its online guidance.

The Ambient Air Quality Directive and Air Quality Standards Regulations

2.12 The 2008 Ambient Air Quality Directive (2008/50/EC) [3] aims to protect human health and the environment by avoiding, reducing or preventing harmful concentrations of air pollutants; it sets legally binding concentration-based limit values, as well as target values. There are also information and alert thresholds for reporting purposes. These are to be achieved for the main air pollutants: particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene. This Directive replaced most of the previous EU air quality legislation and in Wales was transposed into domestic law by the Air Quality Standards (Wales) Regulations 2010 [4], which in addition incorporates the 4th Air Quality Daughter Directive (2004/107/EC) that sets targets for ambient air concentrations of certain toxic heavy metals (arsenic, cadmium and nickel) and polycyclic aromatic hydrocarbons (PAHs). Member states must comply with the limit values (which are legally binding on the Secretary of State) and the Government and devolved administrations operate various national ambient air quality monitoring networks to measure compliance and develop plans to meet the limit values. The statutory air quality limit values are listed in Table 2.3.

Table 2.3 Summary of Relevant Statutory Air Quality Limit Values and Air Quality Objectives

Pollutant	Averaging Period	Objectives/ Limit Values	Not to be Exceeded More Than	Target Date
Nitrogen Dioxide (NO_2)	1 hour	200 µg.m^{-3}	18 times per calendar year	-
	Annual	40 µg.m^{-3}	-	-
Particulate Matter (PM_{10})	24 Hour	50 µg.m^{-3}	35 times per calendar year	-
	Annual	40 µg.m^{-3}	-	-
Particulate Matter ($PM_{2.5}$)	Annual	25 µg.m^{-3}	-	01.01.2020 (a) 01.01.2015 (b)
Carbon Monoxide	Maximum daily running 8 hour mean	10,000 µg.m^{-3}	-	-
Sulphur Dioxide (SO_2)	15 minute	266 µg.m^{-3}	> 35 times per calendar year	-
	1 hour	350 µg.m^{-3}	> 24 times per calendar year	-
	24 hour	125 µg.m^{-3}	> 3 times per calendar year	-
Lead	Annual	0.25 µg.m^{-3}	-	-
Arsenic (As)	Annual (b)	0.006 µg.m^{-3}	-	-
Cadmium (Cd)	Annual (b)	0.005 µg.m^{-3}	-	-
Nickel (Ni)	Annual (b)	0.02 µg.m^{-3}	-	-

(a) Target date set in UK Air Quality Strategy 2007
(b) Target date set in Air Quality Standards Regulations 2010

2.13 In July 2017, Defra published the *'UK plan for tackling roadside nitrogen dioxide concentrations'.* This describes the Government's plan for bringing roads with NO_2 concentrations above the EU Limit Value back into compliance within the shortest possible time, covering five cities, the GLA and 23 other local authorities. A Supplement to the plan was published in October 2018, which sets out measures to bring forward compliance in a further 33 local authorities that had not been covered by actions in the July 2017 plan because they had been projected to comply with the EU Limit Value by 2021.

2.14 On 14 January 2019, Defra published the *'Clean Air Strategy 2019'.* The report sets out actions that the Government intends to take to reduce emissions from transport, in the home, from farming and from industry.

Non-Statutory Air Quality Objectives and Guidelines

2.15 The Environment Act 1995 established the requirement for the Government and the devolved administrations to produce a National Air Quality Strategy (AQS) for improving ambient air quality, the first being published in 1997 and having been revised several times since, with the latest published in 2007 [5]. The Strategy sets UK air quality standards and objectives for the pollutants in the Air Quality Standards Regulations plus 1,3-butadiene and recognises that action at national, regional and local level may be needed, depending on the scale and nature of the air quality problem.

2.16 Non-statutory air quality objectives and guidelines also exist within the World Health Organisation Guidelines [6] and the Expert Panel on Air Quality Standards Guidelines (EPAQS) [7]. The non-statutory objectives and guidelines are presented in Table 2.4.

Table 2.4 Non-Statutory Air Quality Objectives and Guidelines

Pollutant	Averaging Period	Guideline	Target Date
Particulate Matter ($PM_{2.5}$)	Annual	Target of 15% reduction in concentrations at urban background locations	Between 2010 and 2020 (a)
	Annual	25 µg.m^{-3}	2020 (a)
PAHs (as B[a]P equivalent)	Annual (a)	0.00025 µg.m^{-3}	-
Sulphur Dioxide (SO_2)	Annual (b)	50 µg.m^{-3}	-
Hydrogen Chloride	1 hour (c)	750 µg.m^{-3}	-
Hydrogen Fluoride	1 hour (c)	160 µg.m^{-3}	-

Notes:
(a) Target date set in UK Air Quality Strategy 2007
(b) World Health Organisation Guidelines
(c) EPAQS recommended guideline values

Environmental Assessment Levels

2.17 The Environment Agency's on-line guidance entitled '*Environmental management – guidance, Air emissions risk assessment for your environmental permit'* [**xvi**] provides further assessment criteria in the form of Environmental Assessment Levels (EALs).

2.18 Table 2.5 presents all available EALs for the pollutants relevant to this assessment.

Table 2.5 Environmental Assessment Levels (EALs)

Pollutant	Long-Term EAL (µg.m^{-3})	Short-Term EAL (µg.m^{-3})
Nitrogen Dioxide (NO_2)	40	200
Carbon Monoxide (CO)	-	10,000
Sulphur Dioxide (SO_2)	50	266
Particulates (PM_{10})	40	50
Particulates ($PM_{2.5}$)	25	-
Hydrogen chloride (HCl)	-	750
Hydrogen fluoride (HF)	16 (monthly average)	160
Arsenic (As)	0.003	-
Antimony (Sb)	5	150
Cadmium (Cd)	0.005	-
Chromium (Cr)	5	150
Chromium VI ((oxidation state in the PM_{10} fraction)	0.0002	-
Cobalt (Co)	0.2 (a)	6 (a)
Copper (Cu)	10	200
Lead (Pb)	0.25	-
Manganese (Mn)	0.15	1500
Mercury (Hg)	0.25	7.5
Nickel (Ni)	0.02	-
Thallium (Tl)	1 (a)	30 (a)
Vanadium (V)	5	1
PAHs (as B[a]P equivalent)	0.00025	-

Notes: (a) EALs have been obtained from the EA's earlier Horizontal Guidance Note EPR H1 guidance note as no levels are provided in the current guidance.

2.19 Within the assessment, the statutory air quality limit and target values are assumed to take precedence over objectives, guidelines and the EALs, where appropriate. In addition, for those pollutants which do not have any statutory air quality standards, the assessment assumes the lower of either the EAL or the non-statutory air quality objective or guideline where they exist.

National Planning Policy

National Planning Policy Framework

2.20 The National Planning Policy Framework (NPPF) [8] is a material consideration for local planning authorities and decision-takers in determining applications. At the heart of the NPPF, is a presumption in favour of sustainable development, subject to caveats where a plan or project affects a habitats site. For determining planning applications, this means approving development proposals if they accord with an up-to-date local development plan, unless material considerations indicate otherwise. If the development plan does not contain relevant policies, or the policies are out of date, then planning permission should be granted unless the application of policies in the NPPF that protect areas or assets of particular importance provides a clear reason for refusing the development, or any adverse impacts would significantly outweigh the benefits.

2.21 The NPPF sets out three overarching objectives to achieve sustainable development which are stated to be interdependent and need to be pursued in mutually supportive ways. The three objectives comprise an economic objective, a social objective and an environmental objective. Of particular relevance in the context of this air quality assessment is the environmental objective which is as follows:

“**an environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution and adapting to climate change, including moving to a low carbon economy” (Paragraph 8c)

2.22 Under the heading ‘Promoting sustainable transport’, the NPPF states:

“The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help to reduce congestion and emissions, and improve air quality and public health. However, opportunities to maximise sustainable transport solutions will vary between urban and rural areas, and this should be taken into account in both plan-making and decision-making.” (Paragraph 103)

2.23 Under the heading ‘Conserving and enhancing the natural environment’, the NPPF states:

“Planning policies and decisions should contribute to and enhance the natural and local environment by:

…

Preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; …" (Paragraph 170)

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan." (Paragraph 181)

National Planning Practice Guidance

2.24 The National Planning Practice Guidance (NPPG) was issued on-line in March 2014 and is updated periodically by government as a live document. The Air Quality section of the NPPG describes the circumstances when air quality, odour and dust can be a planning concern, requiring assessment.

2.25 The NPPG advises that whether or not air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to generate air quality impact in an area where air quality is known to be poor. They could also arise where the development is likely to adversely impact upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife).

2.26 The NPPG states that when deciding whether air quality is relevant to a planning application, considerations could include whether the development would:

"Significantly affect traffic in the immediate vicinity of the proposed development site or further afield. This could be by generating or increasing traffic congestion; significantly changing traffic volumes, vehicle speed or both; or significantly altering the traffic composition on local roads. Other matters to consider include whether the proposal involves the development of a bus station, coach or lorry park; adds to turnover in a large car park; or result in construction sites that would generate large Heavy Goods Vehicle flows over a period of a year or more.

Introduce new point sources of air pollution. This could include furnaces which require prior notification to local authorities; or extraction systems (including chimneys) which require approval under pollution control legislation or biomass boilers or biomass-fuelled CHP plant; centralised boilers or CHP plant burning other fuels within or close to an air quality management area or introduce relevant combustion within a Smoke Control Area;

Expose people to existing sources of air pollutants. This could be by building new homes, workplaces or other development in places with poor air quality.

Give rise to potentially unacceptable impact (such as dust) during construction for nearby sensitive locations.

Affect biodiversity. In particular, is it likely to result in deposition or concentration of pollutants that significantly affect a European-designated wildlife site, and is not directly connected with or necessary to the management of the site, or does it otherwise affect biodiversity, particularly designated wildlife sites."

2.27 The NPPG provides advice on how air quality impacts can be mitigated and notes "Mitigation options where necessary will be locationally specific, will depend on the proposed development and should be proportionate to the likely impact. It is important therefore that local planning authorities work with applicants to consider appropriate mitigation so as to ensure the new development is appropriate for its location and unacceptable risks are prevented. Planning conditions and obligations can be used to secure mitigation where the relevant tests are met."

Local Planning Policy

2.28 Planning decisions in Calderdale are currently based on the Replacement Calderdale Unitary Development Plan (RCUDP) and the NPPF. The following policies contained within the RCUDP are of relevance to air quality:

"*Policy EP 1*

Protection of Air Quality

Development which might cause air pollution (including that from modes of transport) will only be permitted if:-

i. it would not harm the health and safety of users of the site and surrounding area; and

ii. it would not harm the quality and enjoyment of the environment.

Where permission is granted, appropriate conditions and/or planning obligations will be attached to ensure that the air quality is maintained."

"*Policy WM9*

Incineration

Proposals for incinerators will only be permitted where they meet the following criteria:-

i. *the development creates no unacceptable environmental, amenity, traffic, safety, or other problems;*

ii. *…*

vi. *appropriate provision is made for the control of odour, visual impact, noise, dust and emissions to the air; …*"

3 Assessment Methodology

3.1 Neither the NPPF nor the NPPG is prescriptive on the methodology for assessing air quality effects or describing significance; practitioners continue to use guidance provided by Defra and non-governmental organisations, including Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM). However, the NPPG does advise that "*Assessments should be proportionate to the nature and scale of development proposed and the level of concern about air quality, and because of this are likely to be locationally specific. The scope and content of supporting information is therefore best discussed and agreed between the local planning authority and applicant before it is commissioned.*" It lists a number of areas that might be usefully agreed at the outset.

3.2 This air quality assessment covers the elements recommended in the NPPG. The approach is consistent with Defra's Local Air Quality Management Technical Guidance: LAQM.TG16 [9]. It includes the key elements listed below:

- assessment of the existing air quality in the study area (existing baseline) and prediction of the future air quality without the development in place (future baseline), using official government estimates from Defra, publically available air quality monitoring data for the area, and relevant Air Quality Review and Assessment (R&A) documents;
- a quantitative prediction of the future operational-phase air quality impact with the development in place (with any necessary mitigation), focusing on the impacts of the stack emissions on the local area, including Sowerby Bridge AQMA.

3.3 In line with the guidance set out in the NPPG, the Environmental Health Department at CMBC was consulted to agree the scope and methodology for this assessment. The Pollution Control Officer, Tommy Moorhouse, agreed that the approach to the assessment was reasonable [10].

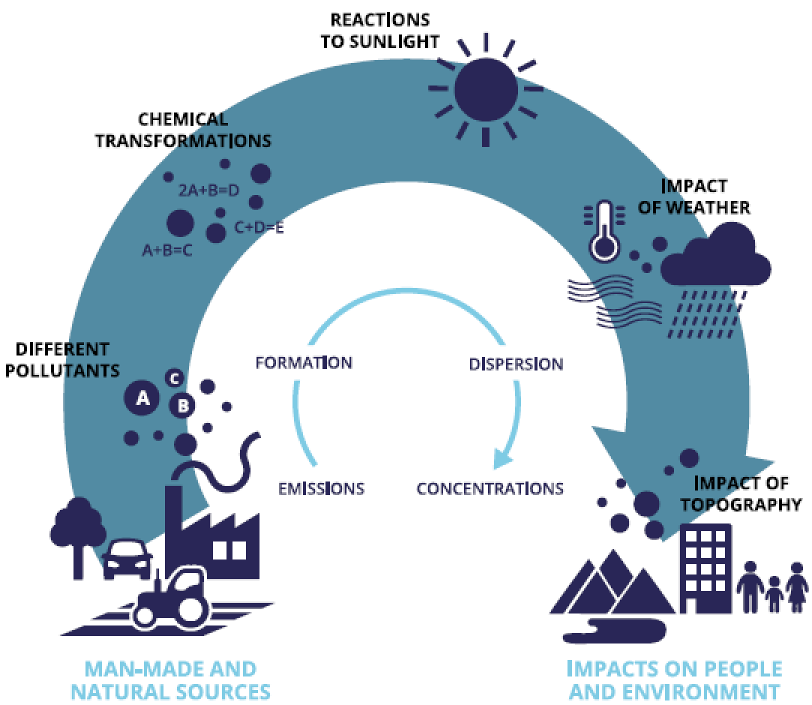
3.4 Air quality guidance advises that the organisation engaged in assessing the overall risks should hold relevant qualifications and/or extensive experience in undertaking air quality assessments. The RPS air quality team members involved at various stages of this assessment have professional affiliations that include Fellow and Member of the Institute of Air Quality Management, Chartered Chemist, Chartered Scientist, Chartered Environmentalist and Member of the Royal Society of Chemistry and have the required academic qualifications for these professional bodies. In addition, the Director responsible for authorising all deliverables has over 25 years' experience.

Operational Phase - Methodology

Atmospheric Dispersion Modelling of Pollutant Concentrations

3.5 In urban areas, pollutant concentrations are primarily determined by the balance between pollutant emissions that increase concentrations, and the ability of the atmosphere to reduce and remove pollutants by dispersion, advection, reaction and deposition. An atmospheric dispersion model is used as a practical way to simulate these complex processes; such a model requires a range of input data, which can include emissions rates, meteorological data and local topographical information. The model used and the input data relevant to this assessment are described in the following sub-sections.

Figure 3.1 Air Pollution: From Emissions to Exposure



Source: European Environment Agency (2016) Explaining Road Transport Emissions: A Non-technical Guide

3.6 The atmospheric pollutant concentrations in an urban area depend not only on local sources at a street scale, but also on the background pollutant level made up of the local urban-wide background, together with regional pollution and pollution from more remote sources brought in on the incoming air mass. This background contribution needs to be added to the fraction from the modelled sources, and is usually obtained from measurements or estimates of urban background concentrations for the area in locations that are not directly affected by local emissions sources. Background pollution levels are described in detail in Section 4.

Dispersion Model Selection

3.7 A number of commercially available dispersion models are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources. Modelling for this study has been undertaken using ADMS 5, a version of the ADMS (Atmospheric Dispersion Modelling System) developed by Cambridge Environmental Research Consultants (CERC) that models a wide range of buoyant and passive releases to atmosphere either individually or in combination. The model calculates the mean concentration over flat terrain and also allows for the effect of plume rise, complex terrain, buildings and deposition. Dispersion models predict atmospheric concentrations within a set level of confidence and there can be variations in results between models under certain conditions; the ADMS 5 model has been formally validated and is widely used in the UK and internationally for regulatory purposes.

3.8 ADMS comprises a number of individual modules each representing one of the processes contributing to dispersion or an aspect of data input and output. Amongst the features of ADMS are:

- An up-to-date dispersion model in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This approach allows the vertical structure of the boundary layer, and hence concentrations, to be calculated more accurately than does the use of Pasquill-Gifford stability categories, which were used in many previous models (e.g. ISCST3). The restriction implied by the Pasquill-Gifford approach that the dispersion parameters are independent of height is avoided. In ADMS the concentration distribution is Gaussian in stable and neutral conditions, but the vertical distribution is non-Gaussian in convective conditions, to take account of the skewed structure of the vertical component of turbulence;
- A number of complex modules including the effects of plume rise, complex terrain, coastlines, concentration fluctuations and buildings;
- A facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes and radioactivity, and percentiles of hourly mean concentrations, from either statistical meteorological data or hourly average data; and
- A facility to run the main model options of the US EPA-approved dispersion model, AERMOD, using ADMS meteorological data from the ADMS 5 interface.

Model Input Data

Meteorological Data

3.9 The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

- Wind direction determines the sector of the compass into which the plume is dispersed;
- Wind speed affects the distance that the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise; and
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. New generation dispersion models, including ADMS, use a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere.

3.10 For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made.

3.11 The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. Dispersion model simulations have been performed using five years of data from Leeds-Bradford Airport between 2013 and 2017.

3.12 A sensitivity test has been undertaken using five years of meteorological data collated at Bingley between 2013 and 2017. The results of this sensitivity test are provided in Appendix F.

3.13 Wind roses have been produced for each of the years of meteorological data used in this assessment and are presented in Figure 1.

Stack Parameters and Emissions Rates used in the Model

3.14 Flue gases are emitted from an elevated stack to allow dispersion and dilution of the residual combustion emissions. The stack needs to be of sufficient height to ensure that pollutant concentrations are acceptable by the time they reach ground level. The stack also needs to be high enough to ensure that releases are not within the aerodynamic influence of nearby buildings, or else wake effects can quickly bring the undiluted plume down to the ground.

3.15 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the stack. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1 [**xvi**], for undertaking risk assessments on 1 February 2016; however, the approach used here by RPS is consistent with that EA guidance which required the identification of "*an option that gives acceptable environmental performance but balances costs and benefits of implementing it*."

3.16 The stack height determination has focused on identifying the stack height required to overcome the wake effects of nearby buildings. This involved running a series of atmospheric dispersion modelling simulations to predict the ground-level concentrations with the stack at different heights: starting at 12 metres and extending up in 1 metre increments, until a height of 18 metres was reached. The results of the stack height determination are provided in Appendix D. The stack height determination indicated a 12 m stack height was appropriate.

3.17 Stack emissions characteristics modelled are provided in Table 3.1 and the mass emissions are provided in Table 3.2.

Table 3.1 Stack Characteristics

Parameter	Unit	Value
Stack height	m	12
Internal diameter	m	0.4
Efflux velocity	$m.s^{-1}$	21.3
Efflux temperature	^{o}C	300
Normalised volumetric flow (Dry, 0°C, 11% O_2)	$m^3.s^{-1}$	1.28

Table 3.2 Mass Emissions of Released Pollutants

Pollutant	Short-Term Mass Emission Rate ($g.s^{-1}$)	Long-Term (a) Mass Emission Rate ($g.s^{-1}$)
Particulates	0.04	0.01
HCl	0.08	0.01
HF	5.11E-03	1.28-03
SO_2	0.26	0.06
NO_X	0.51	0.26
CO	0.13	0.06
Group 1 Metals Total (b)	-	6.38E-05
Group 2 Metals (c)	-	6.38E-05
Group 3 Metals Total (d)	-	6.38E-04
Dioxins and furans	-	1.28E-10
NH_3	-	6.38E-3
PCBs	-	6.38E-06
PAHs – B[a]P	-	1.28E-06

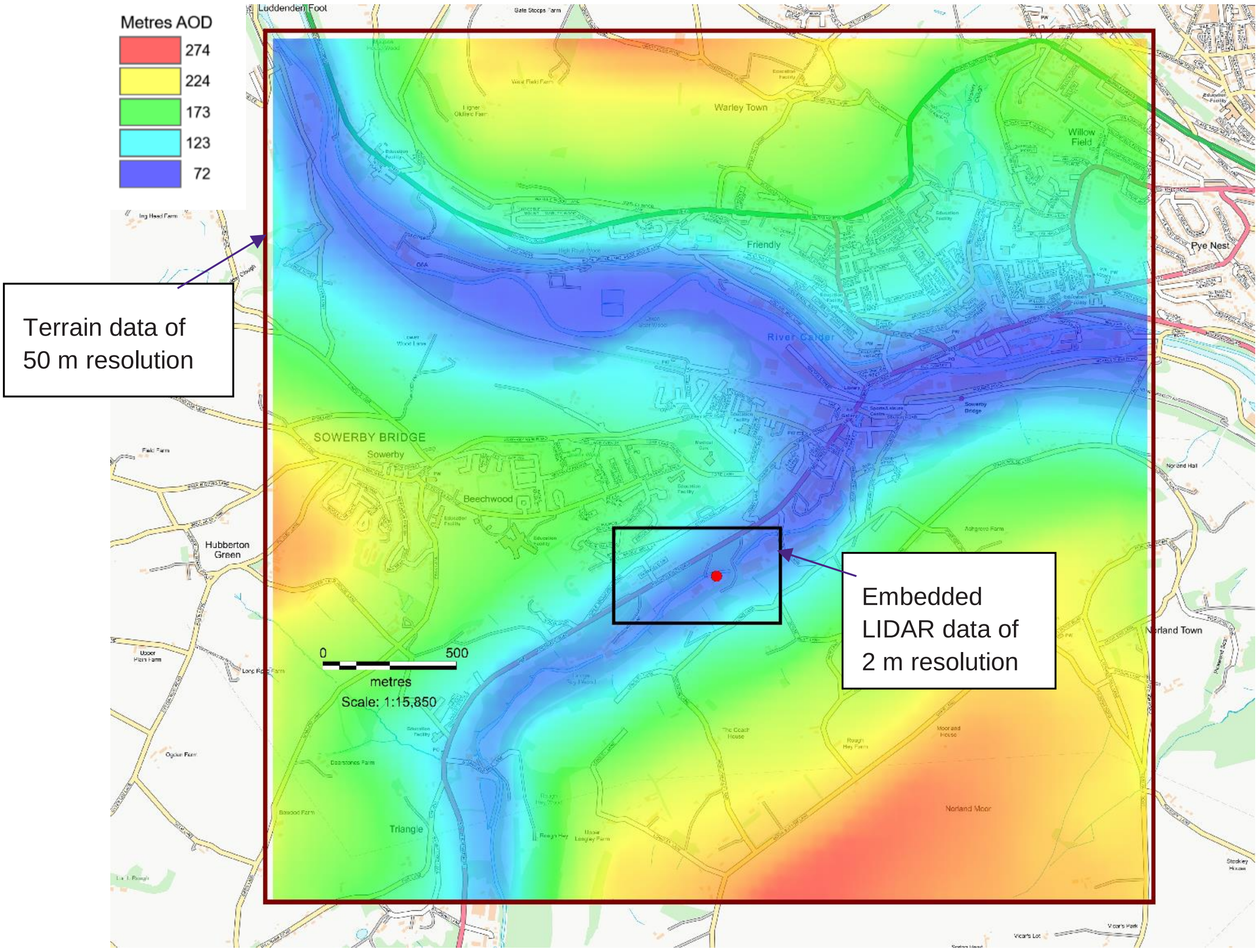
Notes:
(a) For averaging periods of 24 hours or greater.
(b) Cadmium (Cd) and thallium (Tl)
(c) Mercury (Hg)
(d) Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), and Vanadium (V)

3.18 Emission limits in the IED are provided for total particles. For the purposes of this assessment, all particles are assumed to be less than 10 µm in diameter (i.e. PM_{10}). Furthermore, all particles are also assumed to be less than 2.5 µm in diameter (i.e. $PM_{2.5}$). In reality, the PM_{10} and $PM_{2.5}$ concentrations will be a smaller proportion of the total particulate emissions and the $PM_{2.5}$ concentration will be a smaller proportion of the PM_{10} concentration. Therefore, this can be considered a conservative estimate of the likely particulate emissions in each size fraction.

Terrain

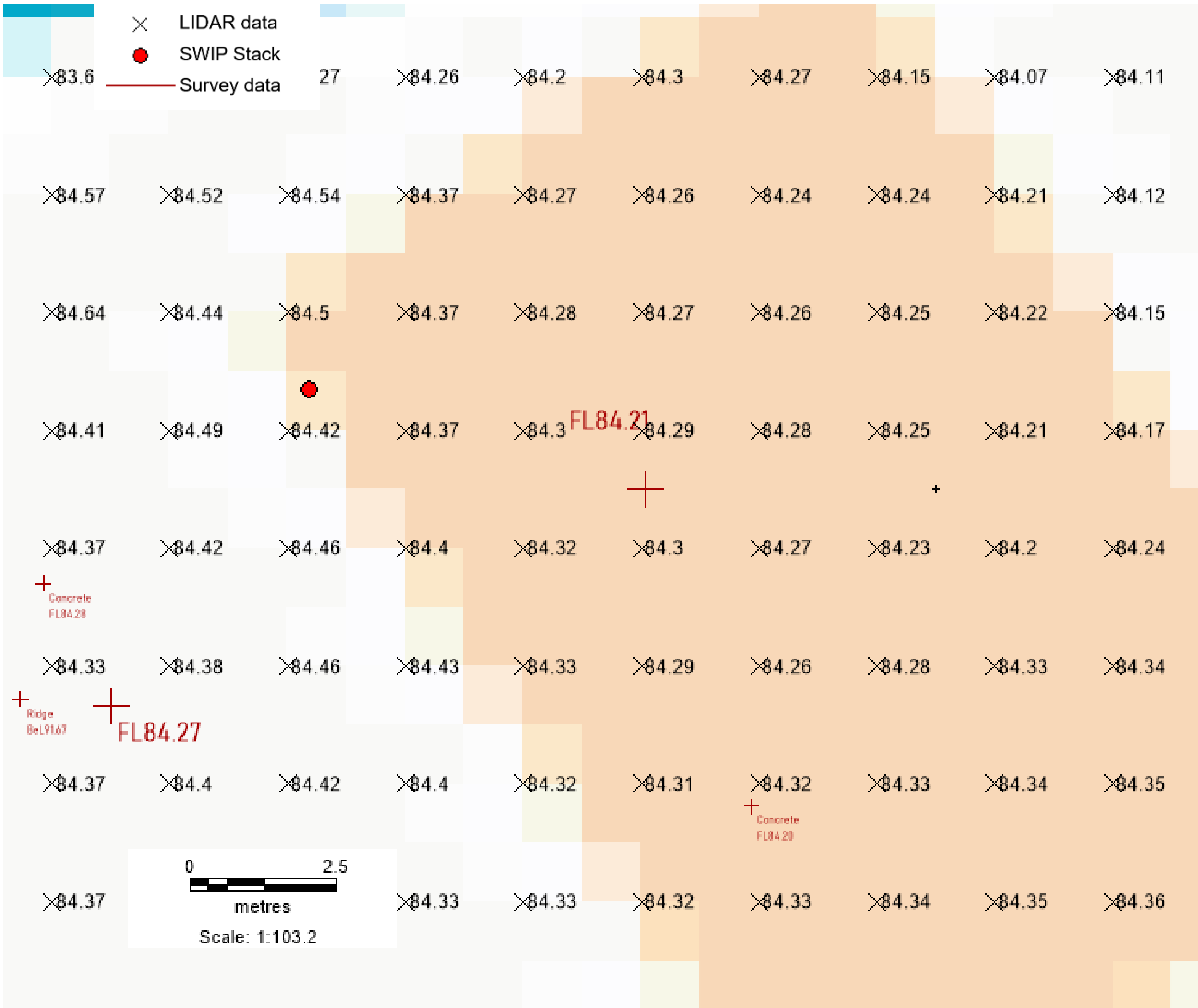
3.19 The presence of elevated terrain can significantly affect (usually increase) ground level concentrations of pollutants emitted from elevated sources such as stacks, by reducing the distance between the plume centre line and ground level and by increasing turbulence and, hence, plume mixing. A complex terrain file was used within the model. The terrain data used in the model comprises terrain data of 50 m resolution for the whole study area, supplemented with 2 m resolution government-published LIDAR data [[11]] for a smaller area encompassing the Application Site. This is shown graphically in Figure 3.2 below.

Figure 3.2 Complex Terrain Data Used in Model



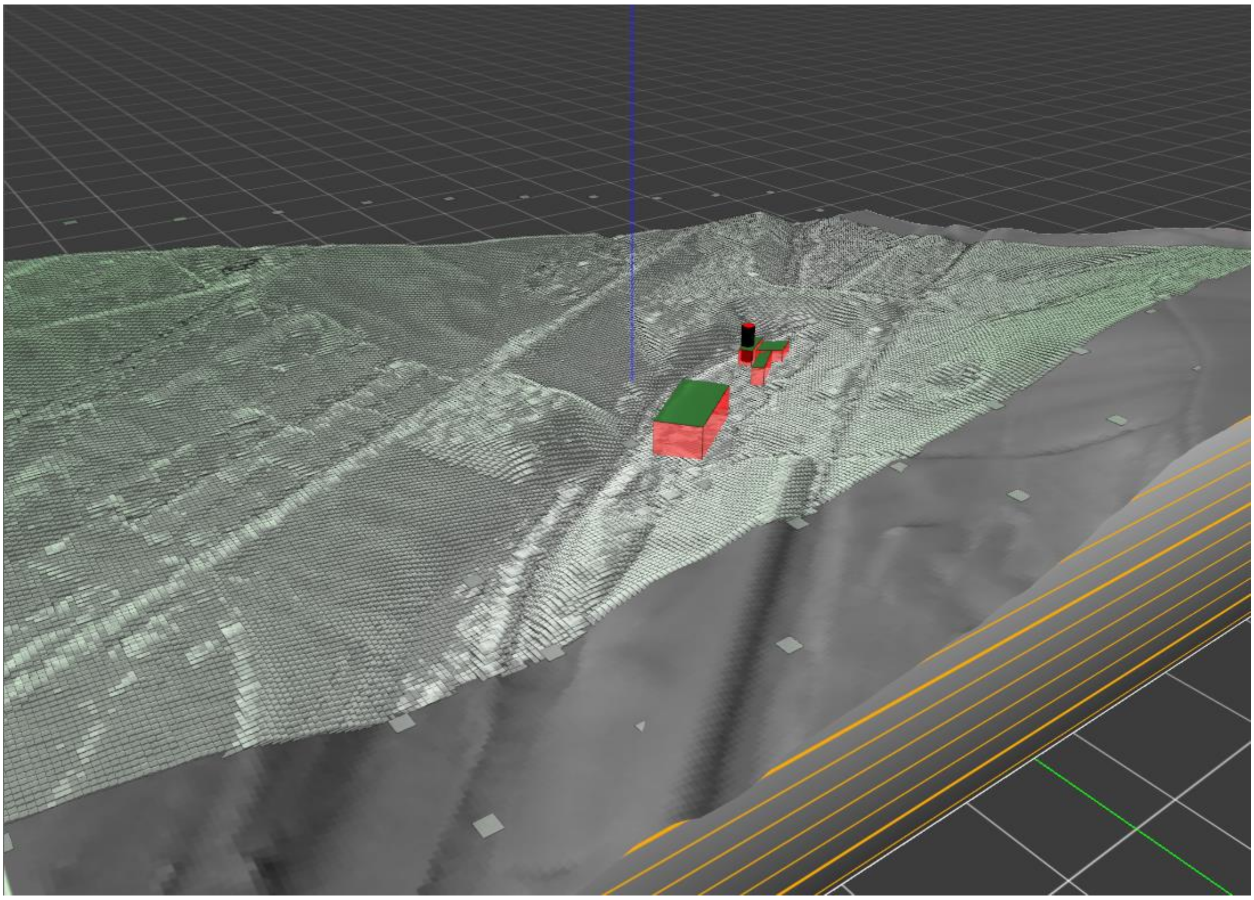
3.20 Figure 3.3 below shows the LIDAR data values and topographical survey values closest to the SWIP stack. This figure shows close agreement between the LIDAR data and the surveyed data. The LIDAR data value closest to the SWIP stack is 84.42 m AOD. This indicates that the stack height would be approximately 96.4 m AOD (i.e., 12 m above ground level).

Figure 3.3 LIDAR Data and Topographical Survey Data Close to SWIP Stack



3.21 Figure 3.4 is a 3D view of the complex terrain file, stack and buildings modelled (note that the stack is not to scale). This figure demonstrates that the high-resolution of the terrain data used represents well the features of the valley in the vicinity of the Application Site.

Figure 3.4 3D View of Complex Terrain Data Used in Model



Surface Roughness

3.22 The roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. This is accounted for by a parameter called the surface roughness length.

3.23 A surface roughness length of 1 m, which the software developer recommends for use in woodland, was used within the ADMS model to represent the average surface characteristics across the study area.

3.24 A sensitivity test has been undertaken using a variable surface roughness file. This is detailed within Appendix F.

Building Wake Effects

3.25 The dominant building structures (i.e. with the greatest dimensions likely to promote turbulence) were confirmed with Paul Nutton at Ryley and are listed in Table 3.3. These were included in the model.

Table 3.3 Dimensions of Buildings Included Within the Dispersion Model

Name	Building Centre (x, y)	Height (m)	Length (m)	Width (m)	Angle (Degrees)
SWIP Process Building	405352, 422842	8	18.5	6.5	57
Feed Storage	405360, 422836	6	13.2	12.2	148
Office	405340, 422821	9	5.9	18.9	142
Recycling Building	405279, 42295	15	20.7	42.8	144

Receptors

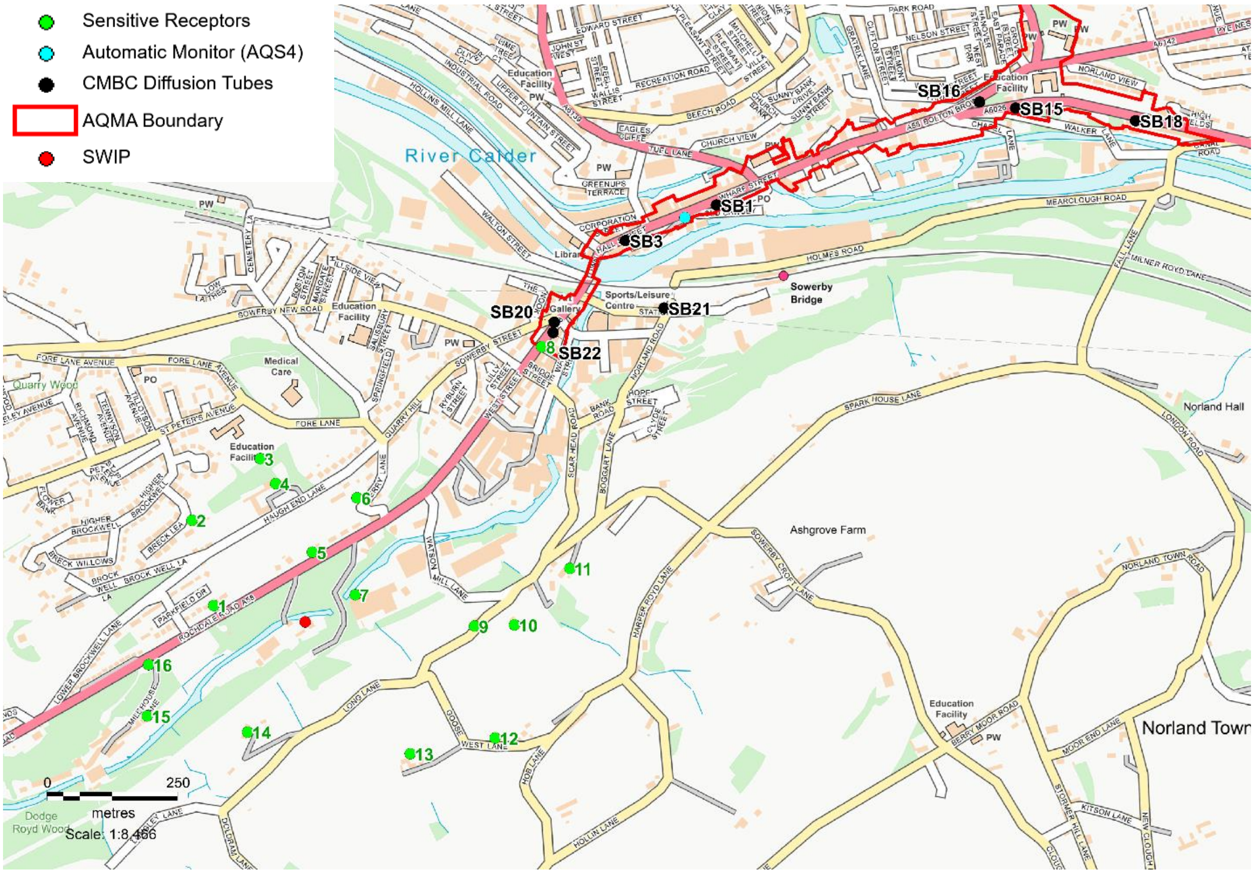
3.26 Concentrations have been modelled across a 1 km by 1 km grid, with a spacing of 20 m, at a height of 1.5 m, centred on the proposed development.

3.27 In addition, concentrations have been modelled at the 16 selected sensitive receptors modelled in the 2017 Environmental Statement. These receptors are listed in Table 3.4 and shown in Figure 2.

Table 3.4 Modelled Sensitive Receptors

ID	Description	x	y
1	28 Rochdale Road	405174	422873
2	9 Breck Lea	405133	423036
3	Sacred Heart Catholic Primary School	405263	423154
4	Haugh End House	405293	423106
5	84 Rochdale Road	405363	422975
6	Highfield Jerry Lane	405448	423079
7	Spring Bank Industrial Estate	405445	422894
8	Mill West (AQMA)	405801	423368
9	Ivy Cottage	405673	422834
10	Cottage	405749	422836
11	Black Sowerby Croft	405855	422944
12	Prospect Terrace	405712	422620
13	Hullen Edge	405550	422590
14	Bank House	405239	422631
15	Mill House Farm	405047	422662
16	Mill House Lodge	405050	422760

Figure 3.5 Modelled Sensiitve Receptors and Local Air Quality Monitors



3.28 The annual, daily and hourly-mean AQS objectives apply at the front and rear façades of all residential properties and at Sacred Heart Catholic Primary School. The daily and hourly-mean AQS objectives only, apply at Spring Bank Industrial Estate. The approaches used to predict the concentrations for these different averaging periods are described below.

NO_X to NO_2 Relationship

3.29 The NOx emissions will typically comprise approximately 90-95% nitrogen monoxide (NO) and 5-10% nitrogen dioxide (NO_2) at the point of release. The NO oxidises in the atmosphere in the presence of sunlight, ozone and volatile organic compounds to form NO_2, which is the principal concern in terms of environmental health effects.

3.30 There are various techniques available for estimating the proportion of NOx converted to NO_2 by the time it has reached receptors. The methods used in this assessment are discussed below.

NO_X to NO_2 Assumptions for Annual-Mean Calculations

3.31 Total conversion (i.e. 100%) of NO to NO_2 is sometimes used for the estimation of the absolute upper limit of the annual mean NO_2. This technique is based on the assumption that all NO emitted is converted to NO_2 before it reaches ground level. However, in reality the conversion is an equilibrium reaction and even at ambient concentrations a proportion of NOx remains in the form of NO. Total conversion is, therefore, an unrealistic assumption, particularly in the near field [12]. While this approach is useful for screening assessments, it is not appropriate for detailed assessments.

3.32 Historically, the Environment Agency has recommended that for a 'worse case scenario', a 70% conversion of NO to NO_2 should be considered for calculation of annual average concentrations. If a breach of the annual average NO_2 objective/limit value occurs, the Environment Agency requires a more detailed assessment to be carried out with operators asked to justify the use of percentages lower than 70%.

3.33 Following the withdrawal of the Environment Agency's H1 guidance document, there is no longer an explicit recommendation; however, for the purposes of this detailed assessment, a 70% conversion of NO to NO_2 has been assumed for annual average NO_2 concentrations in line with the Environment Agency's historic recommendations.

NO_X to NO_2 Assumptions for Hourly-Mean Calculations

3.34 An assumed conversion of 35% follows the Environment Agency's recommendations [13] for the calculation of 'worse case scenario' short-term NO_2 concentrations.

Modelling of Long-Term and Short-Term Emissions

3.35 Long-term (annual-mean) NO_2 has been modelled for comparison with the relevant annual mean objectives.

3.36 For short-term NO_2, the objective is for the hourly-mean concentration not to exceed 200 $\mu g.m^{-3}$ more than 18 times per calendar year. As there are 8,760 hours in a non-leap year, the hourly-mean concentration would need to be below 200 $\mu g.m^{-3}$ in 8,742 hours, i.e. 99.79% of the time. Therefore, the 99.79th percentile of hourly NO_2 has been modelled.

Planning Significance Criteria for Development Impacts on the Local Area

3.37 The Environmental Protection UK (EPUK)/ Institute of Air Quality Management (IAQM) Land-Use Planning & Development Control: Planning For Air Quality document has been used for assessing the impacts of NO_2, and long-term PM_{10} and $PM_{2.5}$, as the pollutants most commonly associated with assessment by that method. (For assessing the significance of other pollutants, the Environment Agency's approach has been used, as discussed later on.)

3.38 The EPUK & IAQM Land-Use Planning & Development Control: Planning For Air Quality document advises that:

"The significance of the effects arising from the impacts on air quality will depend on a number of factors and will need to be considered alongside the benefits of the development in question. Development under current planning policy is required to be sustainable and the definition of this includes social and economic dimensions, as well as environmental. Development brings opportunities for reducing emissions at a wider level through the use of more efficient technologies and better designed buildings, which could well displace emissions elsewhere, even if they increase at the development site. Conversely, development can also have adverse consequences for air quality at a wider level through its effects on trip generation."

3.39 When describing the air quality impact at a sensitive receptor, the change in magnitude of the concentration should be considered in the context of the absolute concentration at the sensitive receptor. Table 3.5 provides the EPUK & IAQM approach for describing the long-term air quality impacts at sensitive human-health receptors in the surrounding area.

Table 3.5 Impact Descriptors for Individual Sensitive Receptors

Long term average concentration at receptor in assessment year	% Change in concentration relative to Air Quality Assessment Level			
	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 than AQAL	Moderate	Substantial	Substantial	Substantial

1. AQAL = Air Quality Assessment Level, which may be an air quality objective, EU limit or target value, or an Environment Agency 'Environmental Assessment Level (EAL)'.
2. The table is intended to be used by rounding the change in percentage pollutant concentration to whole numbers, which then makes it clearer which cell the impact falls within. The user is encouraged to treat the numbers with recognition of their likely accuracy and not assume a false level of precision. Changes of 0%, i.e. less than 0.5% will be described as negligible.
3. The table is only designed to be used with annual mean concentrations.
4. Descriptors for individual receptors only; the overall significance is determined using professional judgement. For example, a 'moderate' adverse impact at one receptor may not mean that the overall impact has a significant effect. Other factors need to be considered.
5. When defining the concentration as a percentage of the AQAL, use the 'without scheme' concentration where there is a decrease in pollutant concentration and the 'with scheme;' concentration for an increase.

6. The total concentration categories reflect the degree of potential harm by reference to the AQAL value. At exposure less than 75% of this value, i.e. well below, the degree of harm is likely to be small. As the exposure approaches and exceeds the AQAL, the degree of harm increases. This change naturally becomes more important when the result is an exposure that is approximately equal to, or greater than the AQAL.
7. It is unwise to ascribe too much accuracy to incremental changes or background concentrations, and this is especially important when total concentrations are close to the AQAL. For a given year in the future, it is impossible to define the new total concentration without recognising the inherent uncertainty, which is why there is a category that has a range around the AQAL, rather than being exactly equal to it.

3.40 The human-health impact descriptors above apply at individual receptors. The EPUK & IAQM guidance states that the impact descriptors *"are not, of themselves, a clear and unambiguous guide to reaching a conclusion on significance. These impact descriptors are intended for application at a series of individual receptors. Whilst it maybe that there are 'slight', 'moderate' or 'substantial' impacts at one or more receptors, the overall effect may not necessarily be judged as being significant in some circumstances."*

3.41 The above criteria and matrix are for assessing the long-term impacts; for short term impacts the EPUK/IAQM guidance states that:

"*The Environment Agency uses a threshold criterion of 10% of the short term AQAL as a screening criterion for the maximum short term impact. This is a reasonable value to take and this guidance also adopts this as a basis for defining an impact that is sufficiently small in magnitude to be regarded as having an insignificant effect. Background concentrations are less important in determining the severity of impact for short-term concentrations, not least because the peak concentrations attributable to the source and the background are not additive.*

Where such peak short term concentrations from an elevated source are in the range 10-20% of the relevant AQAL, 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. That is not to say that background concentrations are 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. This approach is intended to be a streamlined and pragmatic assessment procedure that avoids undue complexity."

3.42 Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts. This judgement is likely to take into account the extent of the current and future population exposure to the impacts and the influence and/or validity of any assumptions adopted during the assessment process.

Environment Agency Significance Criteria

3.43 For assessing the significance of other pollutants, the on-line Environment Agency (EA) guidance entitled 'Environmental management – guidance, Air emissions risk assessment for your environmental permit' [xvi] has been used. This guidance provides details for screening out substances for detailed assessment. In particular, it states that:

"To *screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:*

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

If you meet both of these criteria you don't need to do any further assessment of the substance. If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

3.44 It continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

3.45 It then states that further action may be required where:

- *"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributions – if you think this is the case contact the Environment Agency)*
- *The PEC is already exceeding an environmental standard"*

3.46 On that basis, the results of the detailed modelling presented in this report have been used as follows:

- The effects are not considered significant if the short-term PC is less than 10 % of the short-term Air Quality Assessment Level (AQAL) or the PEC is below the AQAL; and
- The effects are not considered significant if the long-term PC is less than 1 % of the long-term AQAL or the PEC is below the AQAL.

3.47 The Air Quality Assessment Level refers to the AQS air quality objective and the EU limit value.

Uncertainty

3.48 All air quality assessment tools, whether models or monitoring measurements, have a degree of uncertainty associated with the results. The choices that the practitioner makes in setting-up the model, choosing the input data, and selecting the baseline monitoring data will decide whether the final predicted impact should be considered a central estimate, or an estimate tending towards the upper bounds of the uncertainty range (i.e. tending towards worst-case).

3.49 The atmospheric dispersion model itself contributes some of this uncertainty, due to it being a simplified version of the real situation: it uses a sophisticated set of mathematical equations to approximate the complex physical and chemical atmospheric processes taking place as a pollutant is released and as it travels to a receptor. The predictive ability of even the best model is limited by how well the turbulent nature of the atmosphere can be represented.

3.50 Each of the data inputs for the model, listed earlier, will also have some uncertainty associated with them. Where it has been necessary to make assumptions, these have mainly been made towards the upper end of the uncertainty range informed by an analysis of relevant, available data.

3.51 The atmospheric dispersion models used for this assessment, ADMS 5 and ADMS Roads, have been validated by their supplier and are widely used by professionals in the UK and overseas. A site-specific verification (calibration) provides additional certainty and is particularly important when air quality levels are close to exceeding the objectives/limit values.

3.52 LAQM.TG16 requires that local authorities verify the results of any detailed modelling undertaken for the purposes of fulfilling their R&A duties. Model verification refers to the checks that are carried out on model performance at a local level. Modelled concentrations are compared with the results of monitoring. Where there is a disparity between modelled and monitored concentrations, the first step is to review the appropriateness of the data inputs to determine whether the performance of the model can be improved. Once reasonable efforts have been made to reduce the uncertainties in the data inputs, an adjustment may be established and applied to reduce any remaining disparity between modelled and monitored concentrations. No adjustment factor is deemed necessary where the modelled concentrations are within 25% of the monitored concentrations.

3.53 For the verification and adjustment of NOx/NO_2 concentrations for R&A purposes, it is recommended that the comparison involves a combination of automatic and diffusion monitoring, rather than a single automatic monitor. This is to ensure any adjustment factor derived is representative of all locations modelled and not unduly weighted towards the characteristics at a single site. Where only diffusion tubes are used for the model verification, the study should consider a broad spread of monitoring locations across the study area to provide sufficient information relating to the spatial variation in pollutant concentrations.

3.54 Local Authorities generally implement a broad spread of monitoring, particularly in areas that are known to be sensitive to changes in air quality. Consequently, Local Authorities are usually able to verify the models they use for R&A purposes. However, for individual developments, there is less likely to be a broad range of monitoring locations within the relevant study area. Notwithstanding this, a number of monitoring locations have been identified within the study area and an ADMS-Roads model verification study has been undertaken for the proposed development and is included at Appendix B.

3.55 The main components of uncertainty in the total predicted concentrations, made up of the background concentration and the modelled fraction (in this case, for NO_2, the modelled road contribution, and for all pollutants, the modelled stack emissions), include those summarised in Table 3.6.

Table 3.6 Approaches to Dealing with Uncertainty used Within the Assessment

Concentration	Source of Uncertainty	Approach to Dealing with Uncertainty	Comments
Background Concentration	Characterisation of future background air quality	The future background concentrations used in the assessment are the same as the current baseline concentration and no reduction has been assumed. This is a conservative assumption as, in reality, background concentrations are likely to reduce over time as cleaner vehicle technologies form an increasing proportion of the fleet.	The background concentration is the major proportion of the total predicted concentration. The conservative assumptions adopted ensure that the background concentration used within the model contributes to the result being towards the top of the uncertainty range tending towards worst case, rather than a central estimate.
Fraction from Modelled Sources	Traffic flow estimates	Growth assumptions have been used to develop the traffic dataset used within the model.	The modelled fraction is a minor proportion of the total predicted concentration. The modelled fraction is likely to contribute to the result being between a central estimate and the top of the uncertainty range.
	Traffic speed estimates	The average speed has been reduced in congested areas to take account of slow-moving and queuing traffic.	
	Roads Modelling	The model predictions have been compared with monitored concentrations. The model has been found to be performing well without the need of a correction factor. However, to ensure a conservative assessment, the model outputs have been adjusted using a correction factor of 1.0704.	
	Road-related emission factors – projection to future years	The most recently published emission factors have been used within the modelling and these are based on the current and best understanding of the variation in emission factors in future years.	

Concentration	Source of Uncertainty	Approach to Dealing with Uncertainty	Comments
	Stack emissions and characteristics	Pollutant emissions were assumed to be at the maximum levels allowed by the current Industrial Emissions Directive (IED) limits, with the exception of arsenic and hexavalent chromium, where the results of EA monitoring studies were used to inform likely emission rates.	
	Meteorological Data	Uncertainties arise from any differences between the conditions at the met station and the development site, and between the historical met years and the future years. These have been minimised by using meteorological data collated at a representative measuring site. The model has been run for five full years of meteorological conditions. This means that the conditions in 5 x 8,760 hours have been considered in the assessment. Furthermore, a sensitivity test has been undertaken using five years of meteorological data collated at an alternative station. The maximum concentrations from the five modelled datasets have been reported.	
	Receptors	Various discrete receptor locations have been modelled, including Receptor 8, on the AQMA boundary closest to the SWIP. In addition, gridded receptors have been modelled in order to produce contour plots showing the geographical extent of impacts.	

3.56 The analysis of the component uncertainties indicates that, overall, the predicted total concentration is likely to be towards the top of the uncertainty range, and, therefore, tending towards worst case, rather than being a central estimate. The actual concentrations that will be found when the development is operational are unlikely to be higher than those presented within this report and are more likely to be lower.

3.57 As an additional quality assurance measure, sensitivity testing has been carried out (Appendix F) to check the changes in the results and conclusions (if any) that are accounted for by using different data and modelling input assumptions.

4 Baseline Air Quality Conditions

4.1 A detailed description of how the baseline air quality has been derived is provided in Appendix A. The baseline concentrations used in the assessment are set out in Table 4.1.

4.2 The results of recent monitoring across the UK suggest that background annual-mean NO_2 concentrations have not decreased in line with expectations. To ensure that the assessment presents conservative results, no reduction in the background has been applied for future years.

Table 4.1 Summary of Baseline Concentrations used in the Assessment

Pollutant	Where Applies	Long-Term Concentration	Short-Term Concentration*	Data Source
NO_2	Receptor 1	29.7 µg.m^{-3}	59.4 µg.m^{-3}	Roads modelling exercise (detailed in Appendix C)
	Receptor 2	28.2 µg.m^{-3}	56.3 µg.m^{-3}	
	Receptor 3	28.1 µg.m^{-3}	56.3 µg.m^{-3}	
	Receptor 4	28.2 µg.m^{-3}	56.4 µg.m^{-3}	
	Receptor 5	30.4 µg.m^{-3}	60.8 µg.m^{-3}	
	Receptor 6	28.8 µg.m^{-3}	57.6 µg.m^{-3}	
	Receptor 7	28.4 µg.m^{-3}	56.8 µg.m^{-3}	
	Receptor 8 in AQMA	35.5 µg.m^{-3} *	71.1 µg.m^{-3} **	
	Receptor 9	28.1 µg.m^{-3}	56.3 µg.m^{-3}	
	Receptor 10	28.1 µg.m^{-3}	56.2 µg.m^{-3}	
	Receptor 11	28.1 µg.m^{-3}	56.2 µg.m^{-3}	
	Receptor 12	28.0 µg.m^{-3}	56.1 µg.m^{-3}	
	Receptor 13	28.0 µg.m^{-3}	56.1 µg.m^{-3}	
	Receptor 14	28.1 µg.m^{-3}	56.2 µg.m^{-3}	
	Receptor 15	28.3 µg.m^{-3}	56.7 µg.m^{-3}	
	Receptor 16	30.0 µg.m^{-3}	59.9 µg.m^{-3}	
PM_{10}	All receptors	25 µg.m^{-3}	-	2016 monitored concentration at AQS4 Sowerby Bridge

Pollutant	Where Applies	Long-Term Concentration	Short-Term Concentration*	Data Source
$PM_{2.5}$	All receptors	13 μg.m^{-3}	-	2016 monitored concentration at AQS2 Huddersfield Road
Sulphur dioxide (SO_2)	All receptors	4.4 μg.m^{-3}	8.9 μg.m^{-3}	Defra 2001
Hydrogen Chloride (HCl)	All receptors	-	0.35 μg.m^{-3}	Average monitored concentration (2012-2015) at Ladybower (UK Eutrophying and Acidifying Network)
Arsenic (As)	All receptors	0.71 ng.m^{-3}	-	Average monitored concentration (2014-2017) at Sheffield Devonshire Green
Cadmium (Cd)	All receptors	0.16 ng.m^{-3}	-	
Chromium (Cr)	All receptors	4.72 ng.m^{-3}	-	
Cobalt (Co)	All receptors	0.18 ng.m^{-3}		
Nickel (Ni)	All receptors	2.22 ng.m^{-3}	-	
Lead (Pb)	All receptors	8.76 ng.m^{-3}	-	
Manganese (Mn)	All receptors	32.75 ng.m^{-3}	-	Average monitored concentration (2014-2017) at Sheffield Tinsley
Mercury (Hg)	All receptors	17.55 ng.m^{-3}	-	Average monitored concentration (2014-2017) at Runcorn Weston Point

*Short-term background data approximately equate to the 90th percentile, which is approximately equivalent to 2 x the annual mean.
**Maximum of modelled concentrations at the facades aligning the road (further detail provided in Appendix C)

4.3 The assessment does not assume a reduction in roadside pollution levels in future years but, in reality, roadside pollution levels will reduce over time, as a consequence of tighter emissions controls, changing vehicle fleet and air quality action plans. The focus of the government's UK plan for tackling roadside nitrogen dioxide concentrations is to reduce concentrations of NO_2 around roads where levels are above legal limits.

4.4 CMBC collaborates with the four other West Yorkshire Local Authorities to create and implement the West Yorkshire Low Emission Strategy (WYLES). The main focus of the WYLES which CMBC adopted in December 2016 is tackling transport emissions. In addition, CMBC adopted in May 2019 its Air Quality Action Plan which replaced the previous Action Plan. The primary focus of the Action Plan is also to reduce traffic related emissions. It recognises in section 3.3 that road traffic is the main source of emissions in all seven AQMAs within CMBC's district. As a result of the actions which CMBC is taking alongside technological improvements, NO_2 concentrations within Sowerby Bridge and the surrounding area are expected to reduce in future years.

4.5 As stated at Section 3.2.1.3 of CMBC's 2018 Annual Status Report, *"the trends in nitrogen dioxide concentrations are generally decreasing, particularly at AQS3 (Figure 2) and AQS4 (Figure 3)".*

5 Assessment of Operational-Phase Air Quality Impacts

Nitrogen Dioxide (NO_2) Impacts

5.1 Table 5.1 presents the annual-mean NO_2 concentrations predicted at the façades of receptors, i.e. at locations where there is relevant human exposure.

Table 5.1 Maximum Predicted Annual-Mean NO_2 Impacts at Receptor Locations

Receptor ID	Receptor Name	Max Annual-Mean NO_2 PC ($\mu g.m^{-3}$)	PC as % of the EAL*	AC ($\mu g.m^{-3}$)**	PEC ($\mu g.m^{-3}$)	Impact Descriptor
1	28 Rochdale Road	0.17	0 (0.42)	29.7	29.9	Negligible
2	9 Breck Lea	0.08	0 (0.21)	28.2	28.3	Negligible
3	Sacred Heart Catholic Primary	0.08	0 (0.2)	28.1	28.2	Negligible
4	Haugh End House	0.10	0 (0.25)	28.2	28.3	Negligible
5	84 Rochdale Road	0.24	1 (0.6)	30.4	30.6	Negligible
6	Highfield Jerry Lane	0.20	1 (0.51)	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	3.18	8 (7.94)	28.4	31.6	N/A***
8	Mill West (AQMA)	0.19	0 (0.46)	35.5	35.7	Negligible
9	Ivy Cottage	0.23	1 (0.56)	28.1	28.4	Negligible
10	Cottage	0.16	0 (0.4)	28.1	28.3	Negligible
11	Black Sowerby Croft	0.18	0 (0.44)	28.1	28.3	Negligible
12	Prospect Terrace	0.03	0 (0.09)	28.0	28.1	Negligible
13	Hullen Edge	0.03	0 (0.09)	28.0	28.1	Negligible
14	Bank House	0.18	0 (0.45)	28.1	28.3	Negligible
15	Mill House Farm	0.23	1 (0.58)	28.3	28.6	Negligible
16	Mill House Lodge	0.17	0 (0.43)	30.0	30.1	Negligible

*The PC as a percentage of the EAL is rounded to the nearest whole number, in line with the EPUK/IAQM guidance. PCs of <0.5% round down to 0%.
**Established by detailed roads modelling
***Annual-mean EALs do not apply at workplaces

5.2 The long-term NO_2 impact descriptor is 'negligible' at all relevant discrete receptors modelled, and the resulting effects are not considered to be significant.

5.3 Normal operation of the plant will require its operation to be within the long-term emission limit in order to meet the daily average emission limit. Table 5.2 summarises the maximum short-term NO_2 PCs at the long-term IED emission limit values, predicted at the façades of receptors, i.e. at locations where there is relevant human exposure. As the predicted PCs are less than 10% of the EAL, the short-term impacts are considered to be negligible at all these receptors.

Table 5.2 Predicted Short-Term NO_2 Impacts at Receptor Locations (at Long-Term Emission Limit Values)

Receptor ID	Receptor Name	Max 1 hour (99.79th Percentile) NO_2 PC ($\mu g.m^{-3}$)	PC as % of the EAL	Impact Descriptor
1	28 Rochdale Road	2.7	1	Negligible
2	9 Breck Lea	1.8	1	Negligible
3	Sacred Heart Catholic Primary	1.7	1	Negligible
4	Haugh End House	2.0	1	Negligible
5	84 Rochdale Road	3.7	2	Negligible
6	Highfield Jerry Lane	1.9	1	Negligible
7	Spring Bank Industrial Estate	6.4	3	Negligible
8	Mill West (AQMA)	1.7	1	Negligible
9	Ivy Cottage	1.0	1	Negligible
10	Cottage	0.8	0	Negligible
11	Black Sowerby Croft	0.7	0	Negligible
12	Prospect Terrace	0.6	0	Negligible
13	Hullen Edge	0.7	0	Negligible
14	Bank House	1.5	1	Negligible
15	Mill House Farm	1.4	1	Negligible
16	Mill House Lodge	1.5	1	Negligible

5.4 Figure 3 and Figure 4 show the predicted annual-mean and predicted 99.79th percentile of hourly-mean NO_2 concentrations (at long-term IED emission rates) as contour plots, respectively. These show the geographical extent of impacts on the surrounding area.

5.5 As shown in the contour plots, the maximum concentration is predicted to occur just north-east of the site, i.e. not at a location where the public would be exposed.

Impacts – Other Pollutants

5.6 For each of the five years of meteorological data, the maximum predicted concentration across the modelled domain was identified and are reported below.

Scenario 1: Short-Term IED Emission Limit Values

5.7 Table 5.3 summarises the maximum predicted Process Contribution (PC) to ground-level concentrations for all relevant pollutants with short-term emission limit values set out in the IED. The resulting Predicted Environmental Concentrations (PECs) have been calculated by adding the PC to the background Ambient Concentration (AC). The maximum PC and PEC for all points over the modelled grid are shown. The PEC for each pollutant has then compared with the relevant Environmental Assessment Levels (EALs). Where the PC is considered potentially significant, the PEC has been considered.

Scenario 2: Long-Term IED Emission Limit Values

5.8 Table 5.4 summarises the PCs and the resulting PECs for all pollutants assuming that the proposed development is operating at long-term emission limit values.

Table 5.3 Predicted Maximum Process Contribution at Short-Term Emission Limit Values – Results Across the Modelled Grid

Pollutant	Averaging Period	EAL (µg.m^{-3})	Max PC (µg.m^{-3})	Max PC as % of EAL	Criteria (%)	AC (µg.m^{-3})	PEC (µg.m^{-3})	Is PC Potentially Significant?	Is PEC Potentially Significant?
HCl	1 hour (maximum)	750	132.0	18	10	0.35	132.4	Yes	No
HF	1 hour (maximum)	160	8.8	6	10	-	-	No	-
SO_2	15 minute (99.90th percentile)	266	66.6	25	10	8.9	75.5	Yes	No
	1 hour (99.73th percentile)	350	53.5	15	10	8.9	62.3	Yes	No
	24 hour (99.18th percentile)	125	25.2	20	10	8.9	34.0	Yes	No
PM_{10}	24 hour (90.41st percentile)	50	2.6	5	10	-	-	No	-
CO	8 hour (maximum daily running)	10000	220.1	2	10	-	-	No	-

Table 5.4 Predicted Maximum Process Contributions (µg.m^{-3}) at Long-Term Emission Limit Values – Results Across the Modelled Grid

Pollutant	Averaging Period	EAL (µg.m^{-3})	Max PC (µg.m^{-3})	Max PC as % of EAL	Criteria (%)	AC (µg.m^{-3})	PEC (µg.m^{-3})	Is PC Potentially Significant?	Is PEC Potentially Significant?	EPUK/IAQM Impact Descriptor*
PM_{10}	24 hour (90.41st percentile)	50	0.9	2	10	25.0	25.9	No	-	-
	24 hour (annual mean)	40	0.3	1	1	25.0	25.3	No	-	Negligible
$PM_{2.5}$	24 hour (annual mean)	25	0.3	1	1	13.0	13.3	No	-	Negligible
HCl	1 hour (maximum)	750	22.0	3	10	-	-	No	-	-

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	AC ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	Is PC Potentially Significant?	Is PEC Potentially Significant?	EPUK/IAQM Impact Descriptor*
HF	1 hour (maximum)	160	2.2	1	10	-	-	No	-	-
SO_2	15 minute (99.90th percentile)	266	16.7	6	10	-	-	No	-	-
	1 hour (99.73th percentile)	350	13.4	4	10	-	-	No	-	-
	24 hour (99.18th percentile)	125	6.3	5	10	-	-	No	-	-
	1 hour (annual mean)	50	1.1	2	1	4.4	5.5	Yes	No	-
CO	8 hour (maximum daily running)	10,000	110.0	1	10	-	-	No	-	-
Cd	1 hour (annual mean)	0.005	1.11E-03	22	1	1.59E-04	0.0013	Yes	No	-
Tl	1 hour (maximum)	30	0.11	0	10	-	-	No	-	-
	1 hour (annual mean)	1	1.11E-03	0	1	-	-	No	-	-
Hg	1 hour (maximum)	7.5	0.11	1	10	-	-	No	-	-
	1 hour (annual mean)	0.25	1.11E-03	0	1	-	-	No	-	-
Sb	1 hour (maximum)	150	1.10	1	10	-	-	No	-	-
	1 hour (annual mean)	5	0.01	0	1	-	-	No	-	-
As	1 hour (annual mean)	0.003	0.01	368	1	7.13E-04	0.0118	Yes	Yes	-
Cr	1 hour (maximum)	150	1.10	1	10	-	-	No	-	-
	1 hour (annual mean)	5	0.01	0	1	4.72E-03	0.0158	No	-	-
Co	1 hour (maximum)	6	1.10	18	10	-	-	Yes	-	-
	1 hour (annual mean)	0.2	0.01	6	1	1.77E-04	0.0112	Yes	No	-
Cu	1 hour (maximum)	200	1.10	1	10	-	-	No	-	-

Pollutant	Averaging Period	EAL (µg.m-3)	Max PC (µg.m-3)	Max PC as % of EAL	Criteria (%)	AC (µg.m-3)	PEC (µg.m-3)	Is PC Potentially Significant?	Is PEC Potentially Significant?	EPUK/IAQM Impact Descriptor*
	1 hour (annual mean)	10	0.01	0	1	-	-	No	-	-
Pb	1 hour (annual mean)	0.25	0.01	4	1	8.76E-03	0.0198	Yes	No	-
Mn	1 hour (maximum)	1500	1.10	0	10	-	-	No	-	-
	1 hour (annual mean)	0.15	0.01	7	1	3.27E-02	0.0438	Yes	No	-
Ni	1 hour (annual mean)	0.02	0.01	55	1	2.22E-03	0.0133	Yes	No	-
V	1 hour (maximum)	5	1.10	22	10	-	-	Yes	-	-
	1 hour (annual mean)	1	0.01	1	1	-	-	No	-	-
Dioxins & Furans	1 hour (annual mean)	-	2.21E-09	-	1	-	-	-	-	-
PAHs	1 hour (annual mean)	0.00025	2.21E-05	9	1	2.24E-04	2.46E-04	Yes	No	-
PCB	1 hour (annual mean)	0.2	1.11E-04	0	1	-	-	No	-	-

Cells are shaded grey where impacts cannot be screened out as insignificant.
* For assessing the impacts of long-term PM_{10} and $PM_{2.5}$, the Environmental Protection UK (EPUK)/ Institute of Air Quality Management (IAQM) Land-Use Planning & Development Control: Planning For Air Quality document has been used.

5.9 The results presented in Table 5.3 show that the predicted PC is below 10% of the relevant EAL for HF, PM_{10}, and CO and the impacts are screened out as being insignificant. For 1-hour HCl, 1-hour SO_2, and 15-minute and 24-hour SO_2, the PC exceeds 10% of the EAL but the PEC is below 100% of the EAL and the impacts are therefore not considered significant.

5.10 The results presented in Table 5.5 show that the predicted PC is below 10% of the relevant short-term EAL and below 1% of the long-term EAL or the PEC is below 100% for all pollutants with the exception of As (arsenic).

5.11 For As, the predicted PC is more than 1% of the EAL and the PEC is above the EAL. These predictions are based on the assumption that arsenic comprises the total of the group 3 metals emissions. In reality, the IED emission limit applies to all nine of the group 3 metals. The Environment Agency's '*Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators'* version 4 (undated), provides a summary of 34 measured values for each metal recorded at 18 municipal waste and waste wood co-incinerators between 2007 and 2015. For As, the measured concentration varies from 0.04% to 5% of the IED emission concentration limit.

5.12 Table 5.5 shows the predicted PC if the emission limit is assumed to apply equally to each of the nine group 3 metals, i.e. the PC for As has been divided by 9 (11% of the IED emission concentration limit). In this case, the predicted PC remains more than 1% above the EAL; however, the PEC for As is below the EAL. Compared with the Environment Agency findings, use of 11% can be considered highly conservative. At long-term emission limits, the As impacts are therefore not considered significant.

Table 5.5 Maximum Predicted Environmental Concentrations ($\mu g.m^{-3}$) at Long-Term Emission Limit Values – Arsenic

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	AC ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	Is PC Potentially Significant?	Is PEC Potentially Significant?
As	1 hour (annual mean)	0.003	0.00123	41	1	0.0007	0.0019	Yes	No

5.13 For hexavalent chromium (Cr VI), the mean measured concentration in the Environment Agency's *'Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators*' version 4 (undated) is 3.5 x 10^{-5} $mg.Nm^{-3}$. Table 5.6 shows the predicted PC at average operational emission rates.

Table 5.6 Predicted Maximum Cr VI Process Contributions (µg.m^{-3}) at Average Operational Emission Rates

Pollutant	Averaging Period	EAL	Max PC (µg.m^{-3})	Max PC as % of EAL	Is PC Potentially Significant?
Cr VI	1 hour (annual-mean)	0.0002	7.74E-07	0.4	No

5.14 The PC does not exceed 1% of the EAL and the impacts are therefore screened out as being insignificant.

Significance of Effects

5.15 It is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively. Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts.

5.16 Based on the predicted concentrations, the effects are deemed to be not significant, with no predicted exceedences of any objectives or standards at the modelled discrete receptors.

Sensitivity and Uncertainty

5.17 Section 3 provided an analysis of the sources of uncertainty in the results of the assessment. The conclusion of that analysis was that, overall, the predicted total concentration is likely to be towards the top of the uncertainty range and, therefore, tending towards worst case, rather than being a central estimate. The actual concentrations that will be found when the development is operational are unlikely to be higher than those presented within this report and are more likely to be lower.

5.18 The impacts at existing receptors are shown to be not significant even for this conservative scenario. In practice, the impacts at sensitive receptors are likely to be lower than those reported in this conservative assessment. Nevertheless, for robustness, further sensitivity analysis has been undertaken, as detailed within Appendix F.

6 Mitigation

6.1 The overall air quality impact on the surrounding area as a whole is considered to be "negligible" and the resulting effect is considered to be "not significant". On that basis, no mitigation measures are considered necessary.

7 Conclusions

7.1 This assessment has considered the air quality impacts during the operational phase of the proposed Small Waste Incineration Plant (SWIP) at Calder Valley Skip Hire, Belmont Industrial Estate.

7.2 Detailed atmospheric dispersion modelling has been undertaken. The operational impact of the SWIP on existing receptors in the local area is predicted to be ‘negligible’. Using the criteria adopted for this assessment together with professional judgement, the overall impact on the area as a whole is described as ‘negligible’.

7.3 Using professional judgement, the resulting air quality effect of the SWIP is considered to be ‘not significant’ overall.

7.4 At the heart of the NPPF is a presumption in favour of sustainable development, subject to caveats where a plan or project affects a habitats site. For determining planning applications, this means approving development proposals if they accord with the local development plan, unless material considerations indicate otherwise. If the development plan is absent, silent or the policies are out of date, then planning permission should be granted unless any adverse impacts would significantly outweigh the benefits, or specific policies in the NPPF indicate development should be restricted.

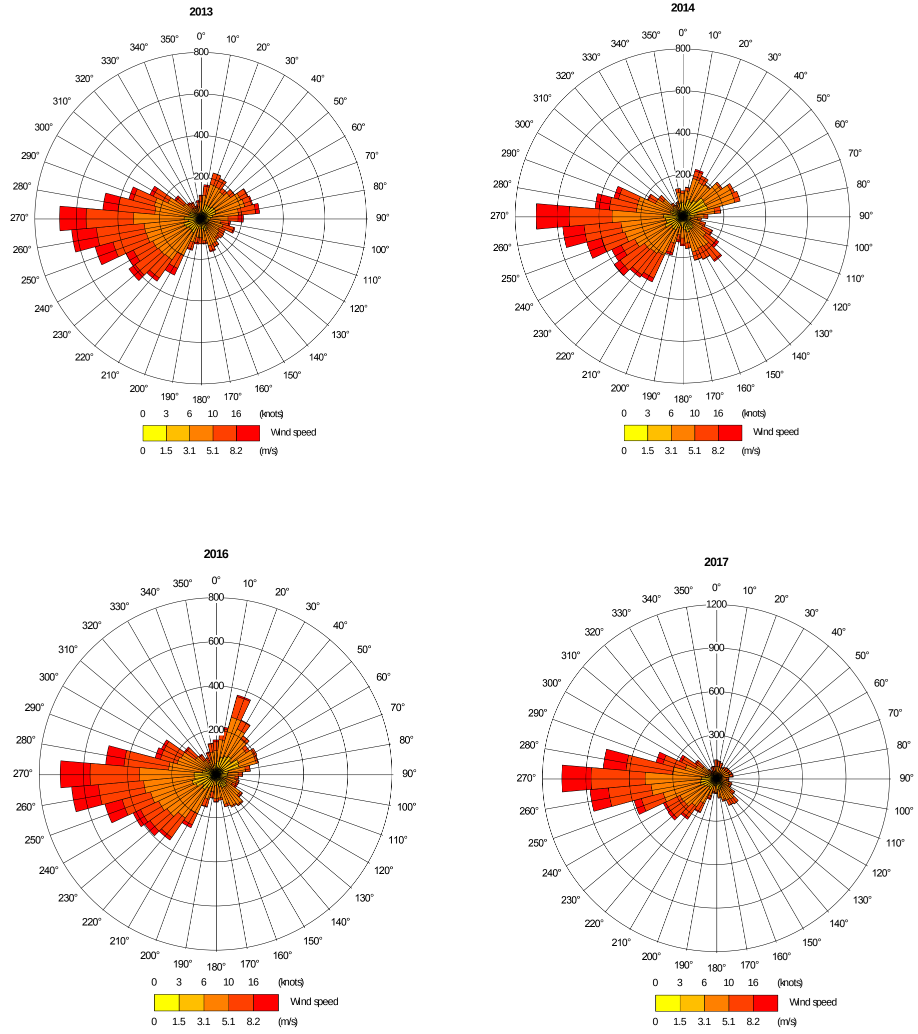
7.5 The NPPG advises that in considering planning permission, the relevant question for air quality is “will the proposed development (including mitigation) lead to an unacceptable risk from air pollution, prevent sustained compliance with EU limit values or national objectives for pollutants or fail to comply with the requirements of the Habitats Regulations?” The proposed development will not do any of these things.

7.6 The proposed SWIP does not, in air quality terms, conflict with national or local policies, or with measures set out in CMBC’s Air Quality Action Plan. There are therefore no constraints to the development in the context of air quality.

Glossary

AADT	Annual Average Daily Traffic Flow
ADMS	Atmospheric Dispersion Modelling System
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
Deposited Dust	Dust that has settled out onto a surface after having been suspended in air
Dust	Solid particles suspended in air or settled out onto a surface after having been suspended in air
Effect	The consequences of an impact, experienced by a receptor
EPUK	Environmental Protection UK
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
IAQM	Institute of Air Quality Management
Impact	The change in atmospheric pollutant concentration and/or dust deposition. A scheme can have an ‘impact’ on atmospheric pollutant concentration but no effect, for instance if there are no receptors to experience the impact
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
R&A	Review and Assessment
Receptor	A person, their land or property and ecologically sensitive sites that may be affected by air quality
Risk	The likelihood of an adverse event occurring

Figures



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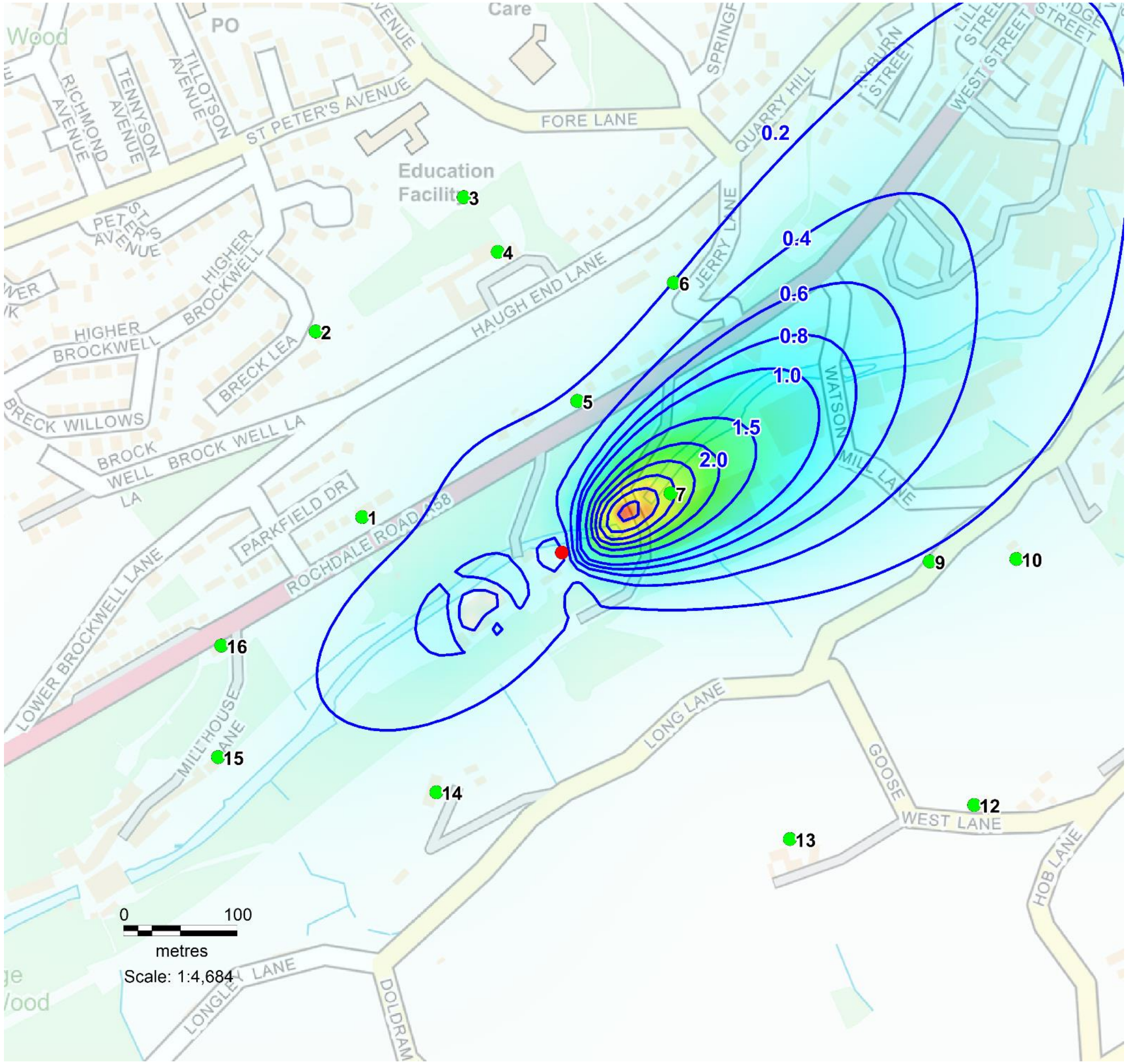
Job Ref: JAP10294	
File location:	
Date: 17/06/19	Rev: 0
Drawn: RC	Checked: KB

Figure 1: Wind Roses – Leeds-Bradford, 2013-2017



Receptors

SWIP

Annual-Mean NO2 PC Contour

Annual-Mean NO2 PC

	4
	3
	2
	1
	0

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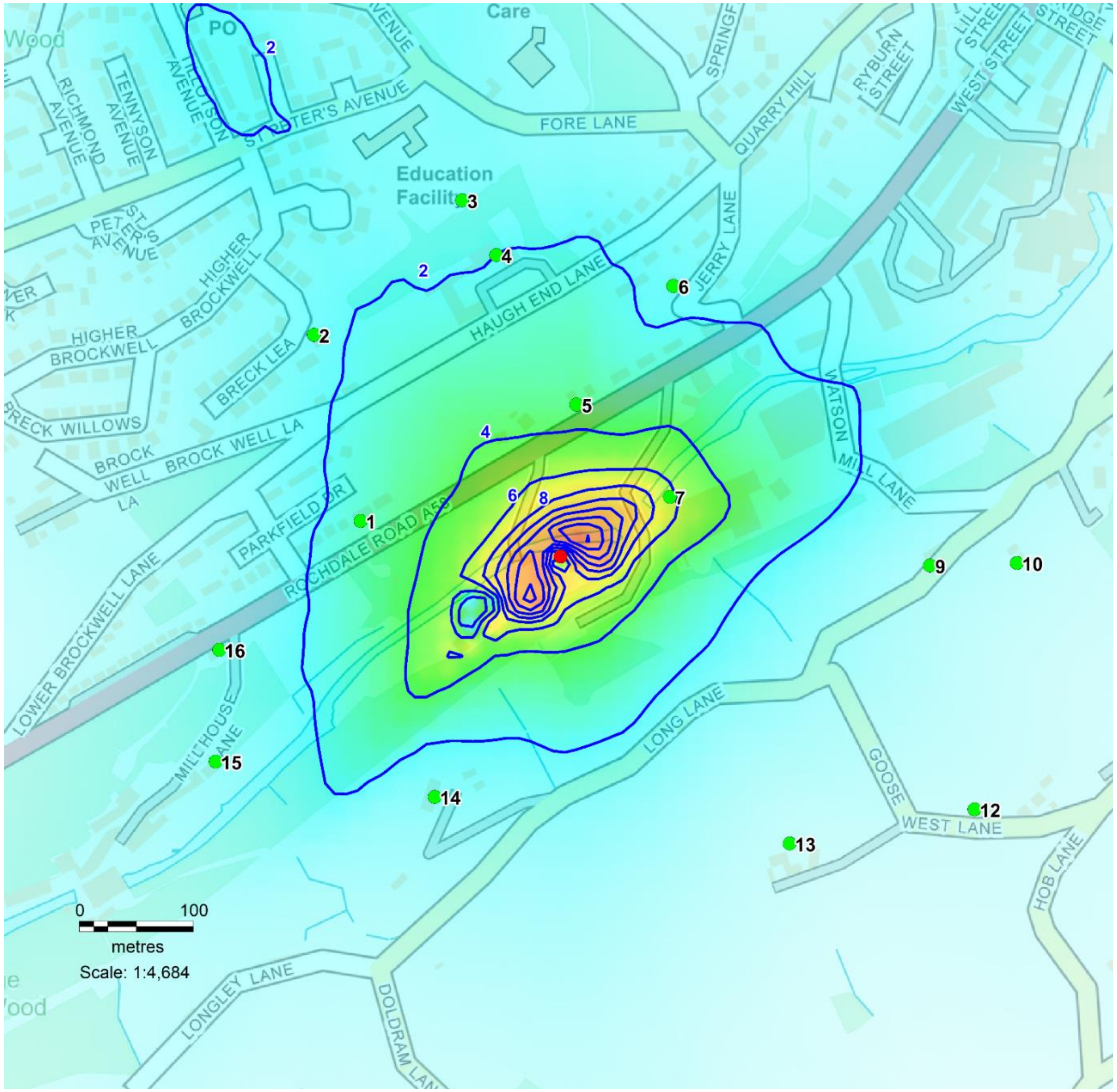
Figure 2: Annual-Mean NO_2 Process Contributions ($\mu g.m^{-3}$)



Receptors

SWIP

Short-Term NO2 PC Contour

Short-Term NO2 PC

20
18
16
13
11
9
7
4
2
0

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Figure 3: Short-Term NO_2 Process Contributions ($\mu g.m^{-3}$)

Appendices

Appendix A: Baseline Conditions

A.1 CMBC has designated seven Air Quality Management Areas (AQMAs) due to high levels of nitrogen dioxide (NO_2) pollution associated with road traffic emissions. One of these AQMAs (AQMA No. 2) encompasses Sowerby Bridge and is located approximately 680 m north-east of the SWIP.

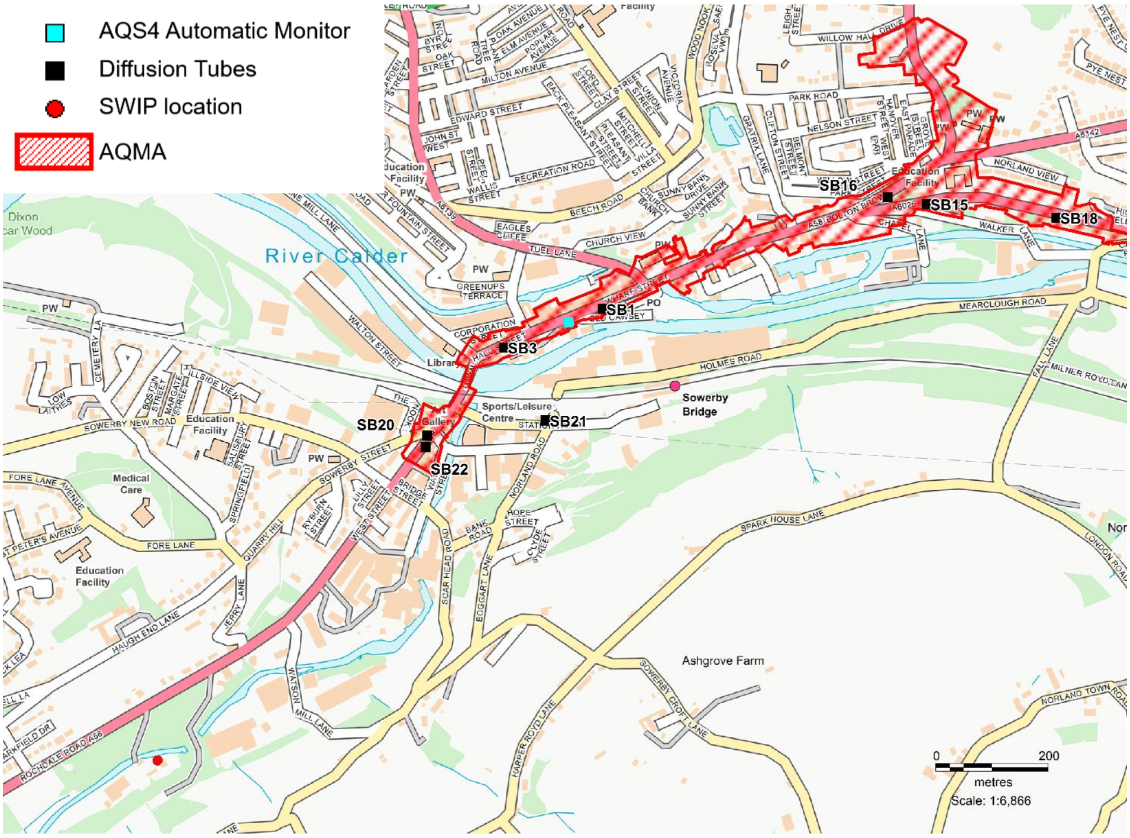
A.2 The Calderdale Air Quality Action Plan (AQAP) 2019 contains several measures proposed to improve air quality in Calderdale, specifically including Sowerby Bridge AQMA. In particular, Section 5.2.2 of the AQAP discusses the transport infrastructure measures proposed to improve air quality within Sowerby Bridge AQMA.

Nitrogen Dioxide

Local Monitoring Data

A.3 CMBC monitor levels of NO_2 at several locations within Sowerby Bridge as shown in Figure A.1.

Figure A.1 CMBC Monitored Annual-Mean NO_2 Concentrations



A.4 The most recently measured annual-mean concentrations are presented in Table A.1.

Table A.1 CMBC Monitored Annual-Mean NO_2 Concentrations

Monitoring Method	Monitor ID	Monitor Name/ Description	Site Type	Concentration (µg.m^{-3})						
				2012	2013	2014	2015	2016	2017	Average
Automatic	AQS4	Sowerby Bridge	Roadside	43	42	43	-	41	36	41.0
Passive	LF1	Burnley Road, Luddendenfoot	Roadside	48	48	45	46	46	39	45.3
Passive	SB15	Street furniture, Wakefield Rd, Copley	Roadside	43	42	41	45	42	37	41.7
Passive	SB3	24 Town Hall St (drainpipe)	Roadside	47	47	45	44	46	40	44.8
Passive	SB16	former CV4	Roadside	41	41	41	43	42	38	41.0
Passive	SB1	former CD07	Roadside	53	54	51	53	50	45	51.0
Passive	LF2	Tillotson Buildings Lfoot	Roadside	37	38	36	38	38	35	37.0
Passive	SB18	drainpipe 52 Wakefield Road	Roadside	35	34	34	36	35	-	34.8
Passive	SB20	2 West Street	Roadside	-	-	-	47	46	-	46.5
Passive	SB22	Sign adjacent to 34-45 Mill West	Roadside	-	-	-	45	48	42	45.0
Passive	SB21	Sign opposite Police Station, Station Road	Urban Background*	-	-	-	24	28	-	26.0

*Stated to be 'Roadside' in Review and Assessment documents with the exception of CMBC's 2018 Annual Status Report which states it to be an 'Urban Background' location

Defra Mapped Concentration Baseline Estimates

A.5 Defra's total annual-mean background NO_2 concentration estimates have been collected for the 1 km grid squares of the urban background monitoring site (SB21) and the Application Site and are summarised in Table A.2.

Table A.2 Defra Mapped Annual-Mean Background NO_2 Concentration Estimates

Location	Concentration (µg.m^{-3})	
	Range of Monitored	Estimated Defra Mapped
SB21	24 - 28	12.8
Application Site	-	10.0

A.6 The Defra mapped concentration estimate is below the range of monitoring and the use of these data would not be considered conservative. To ensure the assessment is conservative, the background annual-mean NO_2 concentration has been derived from the 28 µg.m^{-3}, monitored at SB21 in 2016.

A.7 Detailed modelling, using ADMS-Roads, has been undertaken to predict baseline NO_2 concentrations at discrete sensitive receptors.

A.8 The methodology and results of this detailed modelling are provided in Appendix C and the predicted baseline NO_2 concentrations at sensitive receptors are summarised in Table A.3.

Table A.3 Predicted Baseline NO_2 Concentrations at Sensitive Receptors.

Receptor ID	Receptor Name	Annual-Mean NO_2 Baseline Concentration (µg.m^{-3})	Short-Term NO_2 Baseline Concentration (µg.m^{-3}) *
1	28 Rochdale Road	29.7	59.4
2	9 Breck Lea	28.2	56.3
3	Sacred Heart Catholic Primary School	28.1	56.3
4	Haugh End House	28.2	56.4
5	84 Rochdale Road	30.4	60.8
6	Highfield Jerry Lane	28.8	57.6
7	Spring Bank Industrial Estate	28.4	56.8
8	Mill West (AQMA)	35.5	71.1
9	Ivy Cottage	28.1	56.3
10	Cottage	28.1	56.2
11	Black Sowerby Croft	28.1	56.2
12	Prospect Terrace	28.0	56.1
13	Hullen Edge	28.0	56.1

Receptor ID	Receptor Name	Annual-Mean NO_2 Baseline Concentration ($\mu g.m^{-3}$)	Short-Term NO_2 Baseline Concentration ($\mu g.m^{-3}$) *
14	Bank House	28.1	56.2
15	Mill House Farm	28.3	56.7
16	Mill House Lodge	30.0	59.9

*To ensure a conservative approach, the short-term AC is assumed to be twice the long-term AC

Particulate Matter

Local Monitoring Data

A.9 CMBC undertakes PM_{10} monitoring at a roadside location within Sowerby Bridge. The most recent monitored annual-mean PM_{10} concentrations are presented in Table A.4.

Table A.4 Monitored Annual-Mean PM_{10} Concentrations

Monitor Code	Monitor Name	Concentration ($\mu g.m^{-3}$)		
		2015	2016	2017
AQS4	Sowerby Bridge	25	25	23

Defra Mapped Concentration Baseline Estimates

A.10 Defra's total annual-mean PM_{10} concentration estimates have been collected for the 1 km grid squares of the monitoring site and the Application Site and are summarised in Table A.5.

Table A.5 Defra Mapped Annual-Mean Baseline PM_{10} Concentration Estimates

Location	Concentration ($\mu g.m^{-3}$)	
	Range of Monitored	Estimated Defra Mapped
AQS4	23 - 25	10.3
Application Site	-	9.2

A.11 The Defra mapped concentration estimate is lower than the range of monitoring and the use of these data would not be conservative. The baseline annual-mean PM_{10} concentration has been derived from the 25 $\mu g.m^{-3}$ monitored in 2015 and 2016 at AQS4.

Carbon Monoxide

A.12 In the absence of CO monitoring at this site, the baseline annual-mean concentration has been derived from the 2001 Defra mapped concentration estimate of 293 $\mu g.m^{-3}$.

Sulphur Dioxide

A.13 In the absence of SO_2 monitoring at this site, the baseline annual-mean concentration has been derived from the 2001 Defra mapped concentration estimate of 4.4 µg.m^{-3}.

Hydrogen Chloride

A.14 HCl is monitored as part of the UK Eutrophying and Acidifying Network, which forms part of the Acid Gas and Aerosol Network. The closest monitoring site to the Proposed Development is Ladybower. The most recently measured concentrations at Ladybower are provided in Table A.6.

A.6 Measured HCl Concentrations (µg.m^{-3})

Location	Concentration (µg.m^{-3})				
	2012	2013	2014	2015	Average
Ladybower	0.27	0.47	0.44	0.23	0.35

A.15 The average HCl concentration monitored between 2012 and 2015 has been used within the assessment.

Heavy Metals

A.16 The Heavy Metals Network monitors the concentrations in air, and the deposition rates of a range of metallic elements at urban, industrial and rural sites.

A.17 The nearest urban background site to the Application Site is Sheffield Devonshire Green, approximately 46 km away. The average monitored concentrations of heavy metals at this site have been used within the assessment, with the exception of Hg (total) and Mn, which have been derived from the average monitored concentrations at Runcorn Weston Point and Sheffield Tinsley sites respectively. The monitored concentrations are summarised in Table A.7.

Table A.7 Measured Metals Concentrations (ng.m^{-3})

Monitoring Site	Metal	Concentration (ng.m^{-3})				
		2014	2015	2016	2017	Average
Sheffield Devonshire Green	As	0.79	0.70	0.68	0.69	0.71
	Cd	0.22	0.14	0.13	0.13	0.16
	Co	0.15	0.14	0.22	0.20	0.18
	Cr	3.45	4.88	5.77	4.78	4.72
	Ni	2.51	1.97	2.57	1.82	2.22
	Pb	11.26	9.37	7.68	6.73	8.76
Runcorn Weston Point	Hg [total gaseous]	15.79	20.06	15.64	18.71	17.55
Sheffield Tinsley	Mn	36.08	27.73	27.40	39.77	32.75

Polycyclic Aromatic Hydrocarbons

A.18 The polycyclic aromatic hydrocarbon (PAH) network monitors ambient concentrations of PAHs at 31 sites in the UK. At the majority of sites, only solid PAHs are monitored; both gaseous and solid PAHs are only monitored at two locations.

A.19 The nearest site monitoring PAHs is Leeds Millshaw. The most recently monitored annual-mean PAHs concentrations are summarised in Table A.8.

Table A.8 Annual-Mean PAHs Concentrations (ng.m^{-3})

Monitoring Site	Concentration (ng.m^{-3})				
	2014	2015	2016	2017	Average
Leeds Millshaw	0.26	0.20	0.25	0.19	0.22

7.7 The average monitored PAHs concentration of 0.22 ng.m^{-3} has been used within the assessment.

Appendix B: Roads Model Verification

B.1 The approach to model verification that LAQM.TG16 recommends for local authorities when they carry out their LAQM duties is summarised in Section 3. For the verification and adjustment of NO_x /NO_2 concentrations, the guidance recommends that the comparison considers a broad spread of automatic and diffusion-tube monitoring. CMBC undertakes passive roadside NO_2 monitoring using diffusion tubes at three locations and at one location using automatic monitoring techniques in the vicinity of the Application Site.

B.2 The concentrations monitored over recent years are provided in Table B.1.

Table B.1 Measured Annual-mean NO_2 Concentrations ($\mu g.m^{-3}$)

Site Type	Monitor ID	Measured Annual-mean NO_2 Concentrations ($\mu g.m^{-3}$)			
		2014	2015	2016	2017
Passive	SB22	-	45	48	42
Passive	SB20	-	47	46	-
Passive	SB3	45	44	46	40
Automatic	AQS4	43	-	41	36

B.3 The most complete dataset is 2016. Ideally, any model verification study should use background concentrations, emissions factors and meteorological data relating to the same year. On that basis, the model verification study has been undertaken using measured NO_2 data collated in 2016, traffic flow data available from the Department for Transport for 2016, and meteorological data collated at Leeds-Bradford in 2016. The NO_2 concentration monitored at SB21 in 2016 has been used as the background annual-mean NO_2 concentration.

B.4 The modelled road links and monitoring locations used in the model verification exercise are shown in Figure B.1 below.

Figure B.1 Modelled Roads and Monitoring Locations

B.5 A comparison of the modelled and monitored total NO_2 concentrations is provided in Table B.2.

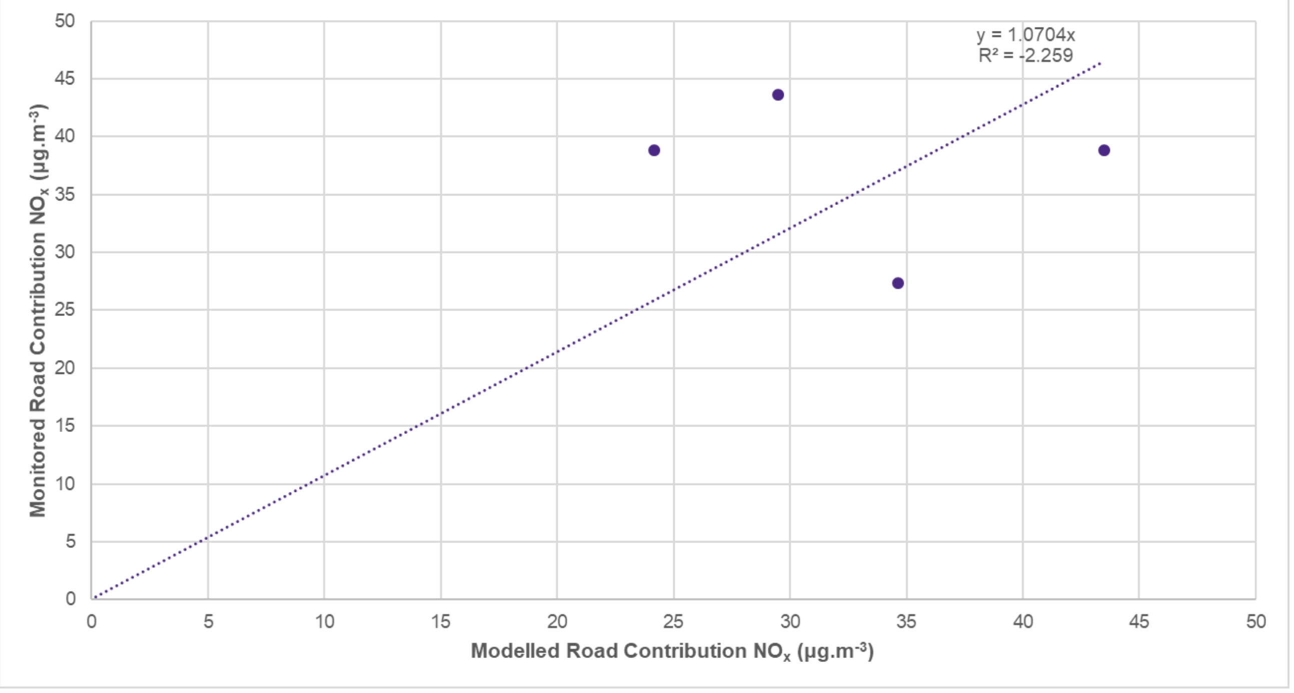
Table B.2 Comparison of Monitored and Modelled NO_2 Concentrations ($\mu g.m^{-3}$)

Monitoring Site	Annual-mean Total NO_2 Concentration ($\mu g.m^{-3}$)		% Difference [(Modelled – Monitored)/Monitored)]
	Monitored	Modelled	
SB22	48	42	-12.6
SB20	46	40	-14.0
SB3	46	48	4.2
AQS4	41	44	7.8

B.6 The above comparison indicates that the model is performing well, with the difference between modelled and monitored concentrations being well within 25% of each other. Furthermore, the model is showing no overall tendency to over or under-predict. In accordance with LAQM.TG16, model verification would not be considered necessary. Nevertheless, to ensure a conservative approach, a correction factor has been derived as discussed below.

B.7 The monitored annual-mean NO_x road contributions have been derived from the monitored annual-mean NO_2 concentrations using the LAQM.TG16 calculator. The modelled annual-mean NO_x road contributions for the four 2016 concentrations have been plotted against the monitored annual-mean NO_x road contributions in Graph B.1.

Graph B.1 Comparison of Monitored and Modelled Annual-mean Road NO_x Contribution ($\mu g.m^{-3}$)



B.8 The modelled NO_x contributions have been multiplied by the gradient of the trend line (1.0704) to determine the corrected NO_x contributions.

B.9 The fractional bias can be used to determine whether the corrected model has a tendency to over or under-predict. The fractional bias is calculated as:

(Average Monitored NO_X Concentration – Average Predicted NO_x Concentration) / 0.5 x (Average Monitored NO_X + Average Predicted NOx Concentration)

B.10 Fractional bias values vary between +2 and -2 and has an ideal value of zero. A negative value suggests a model over-prediction and a positive value suggests a model under-prediction.

B.11 Table B.3 sets out the average monitored concentration and the average predicted concentration.

Table B.3 Comparison of Monitored and Adjusted Modelled Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)

Monitoring Site	Annual-mean Road NO_X Contribution ($\mu g.m^{-3}$)	
	Monitored	Corrected Modelled
SB22	43.6	31.6
SB20	38.9	25.9
SB3	38.9	46.5
AQS4	27.4	37.1
Average	**37.2**	**35.3**

B.12 The fractional bias for this study is therefore (37.2 – 35.3) / (0.5 x (37.2 + 35.3)) = 0.05. The fractional bias is very close to zero, indicating that the model is neither systematically over-predicting nor under-predicting road NO_X contributions.

B.13 The corrected total NO_2 concentrations are compared with the monitored NO_2 concentrations in Table B.4.

Table B.4 Comparison of Monitored and Adjusted Modelled Total NO_2 Concentrations

Monitoring Site	Annual-mean NO_2 Concentration ($\mu g.m^{-3}$)		% Difference [(Modelled – Monitored)/Monitored)]
	Monitored	Corrected Modelled	
SB22	48	43	-10.7
SB20	46	40	-12.3
SB3	46	49	7.0
AQS4	41	45	10.3

B.14 Table B.4 shows that the model is performing well, with the difference between modelled and monitored concentrations being well within 25% of each other.

Appendix C: Detailed Roads Modelling

Overview

C.1 The ADMS-Roads model has been used to predict the baseline nitrogen dioxide (NO_2) concentrations at sensitive receptors in 2020.

C.2 ADMS-Roads is a version of the Atmospheric Dispersion Modelling System (ADMS), a formally validated model developed in the UK by Cambridge Environmental Research Consultants Ltd (CERC) and widely used in the UK and internationally for regulatory purposes.

Model Input Data

Traffic Flow Data

C.3 The traffic flow data used in this assessment have been obtained by applying a growth factor[1] to the traffic flows publically available from the Department for Transport (DfT). The traffic flow data are summarised in Table C.1. The modelled road links are illustrated in Figure C.1.

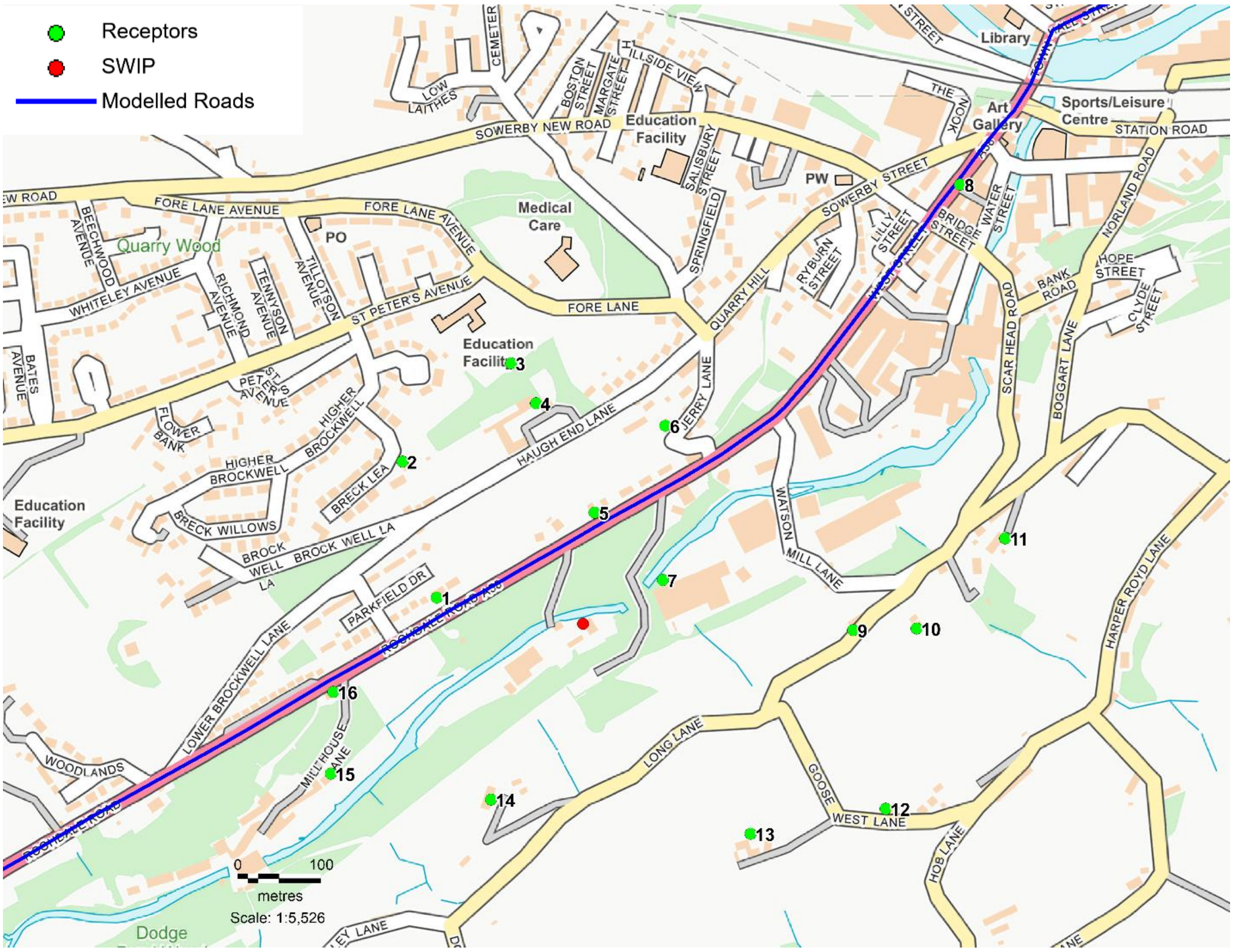
Table C.1 Traffic Data Used Within the Assessment

ADMS-Roads Link ID	Road Name	DfT Count Point ID	Speed ($km.hr^{-1}$)	Daily Two-Way Vehicle Flow (2020)	
				Total Vehicles	% HDV
1	A58 (East of Jerry Lane)	77654	48 / 32*	18496	6
2	A6139	47905	32	10235	3
3	A58 Rochdale Road (West of Jerry Lane)	6576	48	10360	4

Notes: $km.hr^{-1}$ = kilometres per hour
HDV = Heavy Duty Vehicle - vehicles greater than 3.5 t gross vehicle weight including buses
LDV = Light Duty Vehicle
*Speed reduces to 32 $km.hr^{-1}$ within the AQMA

[1] A yearly growth factor of 1.005 was obtained by averaging the year-on-year growth for DfT Count Point 77654 between 2000 and 2016. (The average traffic growth factor between 2000 and 2017 was 0.992458.)

Figure C.1 Modelled Road Links



C.4 The average speed on each road has been reduced by 10 km.hr^{-1} to take into account the possibility of slow-moving traffic near junctions and at roundabouts in accordance with LAQM.TG16.

Vehicle Emission Factors

C.5 The modelling has been undertaken using Defra's 2019 emission factor toolkit (version 9.0) which draws on emissions generated by the European Environment Agency (EEA) COPERT 5 emission calculation tool.

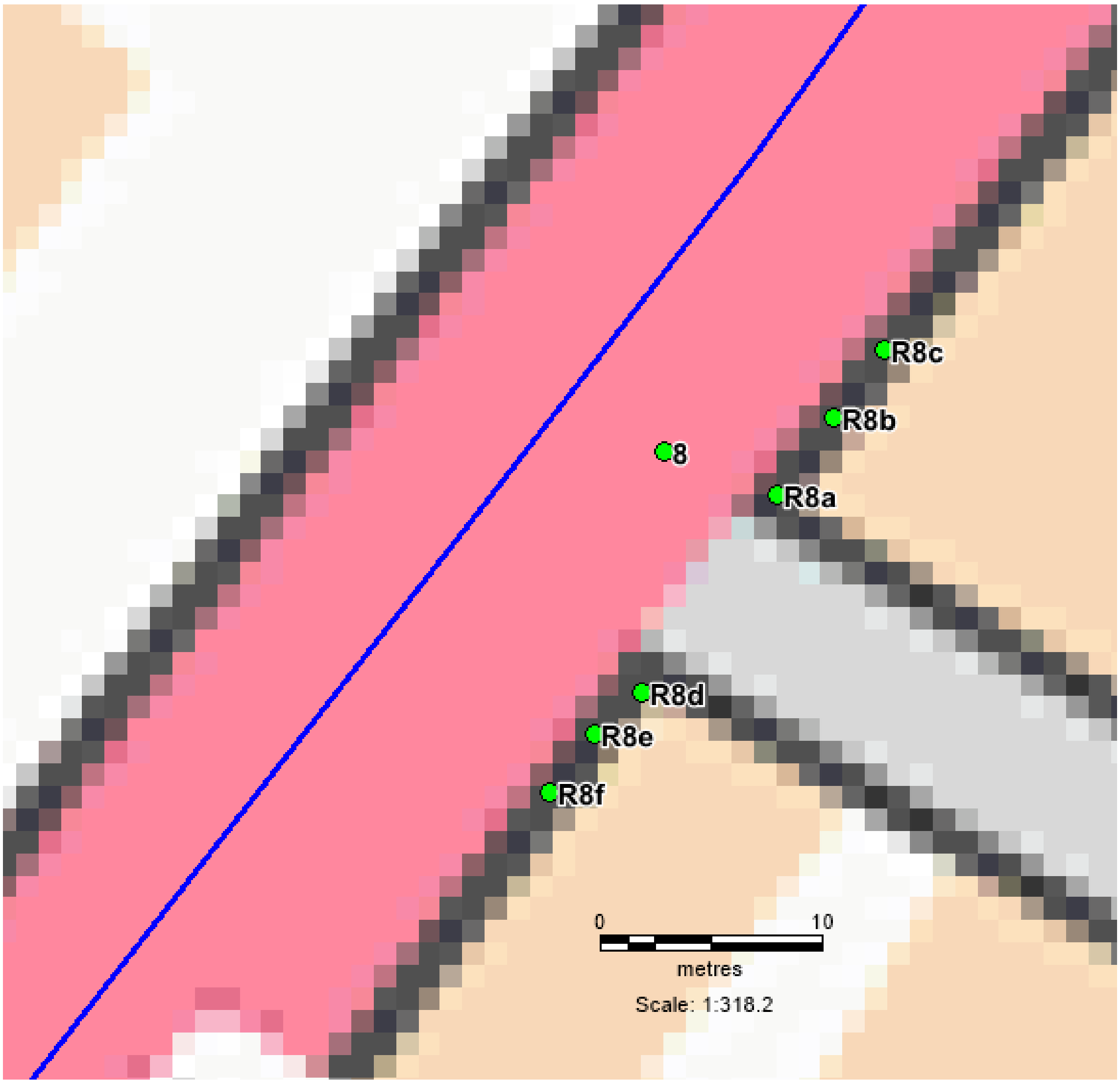
Meteorological Data

C.6 Meteorological data from Leeds-Bradford station for 2017 have been used within the dispersion model.

Receptors

C.7 Receptor 8 is located at the boundary of the AQMA, and was selected and modelled for the 2017 ES. This receptor location is a theoretical location placed on the edge of the AQMA closest to the SWIP and was originally only designed to provide a prediction of the maximum process contribution from the SWIP on the AQMA. It is not a suitable receptor location for a roads modelling exercise, as it lies within the road. The roads modelling exercise has therefore utilised alternative receptors to Receptor 8, located along the façades aligning the road, as shown in Figure C.2 below.

Figure C.2 Receptor 8 and Roads Receptors within AQMA



C.8 All other sensitive receptors are the same as those modelled for the main assessment.

Long-Term Pollutant Predictions

C.9 Annual-mean NO_x concentrations have been predicted at representative sensitive receptors using ADMS-Roads, then added to relevant background concentration (in this case, a background concentration of 28 µg.m^{-3} has been used, taken from the monitored concentration at SB21 in 2016). Primary NO in the NO_x emissions is converted to NO_2 to a degree determined by the availability of atmospheric oxidants locally and the strength of sunlight. For road traffic sources, annual-mean NO_2 concentrations have been derived from the modelled road-related annual-mean NO_x concentration using Defra's calculator [xiv].

Results

C.10 The predicted annual-mean NO_2 concentrations at sensitive receptors in 2020 are provided in Table C.2 below.

C.2 Predicted Annual-Mean NO_2 Concentrations ($\mu g.m^{-3}$) at Receptors

Receptor ID	Receptor Name	NO_2
1	28 Rochdale Road	29.7
2	9 Breck Lea	28.2
3	Sacred Heart Catholic Primary School	28.1
4	Haugh End House	28.2
5	84 Rochdale Road	30.4
6	Highfield Jerry Lane	28.8
7	Spring Bank Industrial Estate	28.4
8	Mill West (AQMA)	35.5*
9	Ivy Cottage	28.1
10	Cottage	28.1
11	Black Sowerby Croft	28.1
12	Prospect Terrace	28.0
13	Hullen Edge	28.0
14	Bank House	28.1
15	Mill House Farm	28.3
16	Mill House Lodge	30.0

*The maximum predicted concentration at receptors R8a – R8f

C.11 The NO_2 concentrations above have been used as the baseline NO_2 concentrations within the main assessment.

Appendix D: Stack Height Determination

Overview

D.1 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the height of the stack. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1 [xv], for undertaking risk assessments on 1 February 2016; however, the approach used here is consistent with that EA guidance which required the identification of "*an option that gives acceptable environmental performance but balances costs and benefits of implementing it*."

Methodology

D.2 Model simulations have been run using ADMS 5 to determine what stack height is required to provide adequate dispersion/dilution and to overcome local building wake effects.

D.3 The stack height determination considers ground level concentrations over the averaging periods relevant to the air quality assessment, together with the full range of all likely meteorological conditions through the use of five years (2013 to 2017) of hourly sequential meteorological data from Leeds Bradford Airport. A complex terrain file was also used within the model. The model was run for a range of stack heights between 12 m and 18 m, in 1 m increments.

D.4 The modelled domain was 1 km by 1 km centred on the proposed development and with a grid spacing of 20 m. Results have been reported for the location where the highest concentration is predicted and for the worst-case meteorological conditions.

Stack Height Determination Results

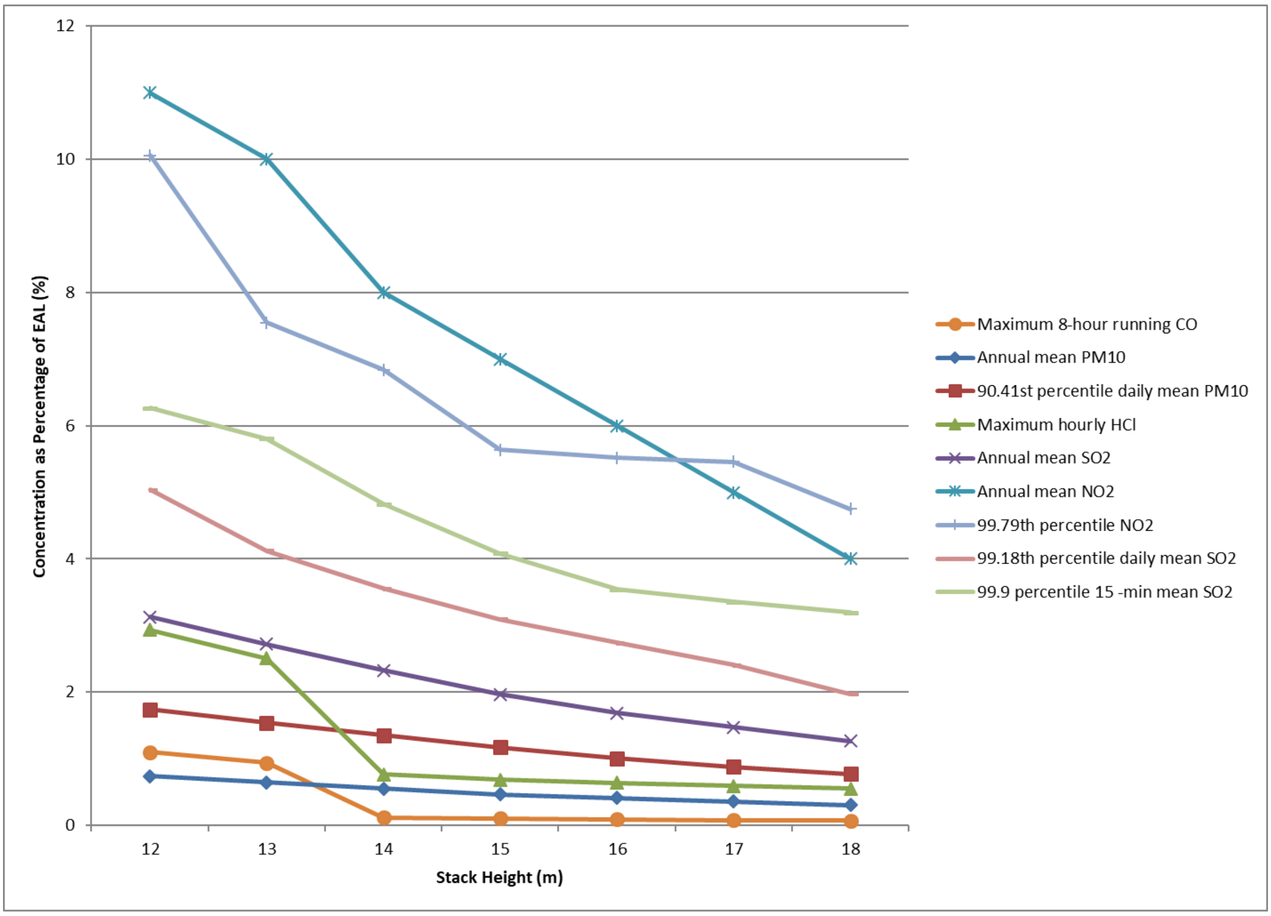
D.5 The stack height modelling results have been analysed in two stages as discussed below.

D.6 **Stage 1 -** The maximum predicted Process Contributions (PCs) have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights.

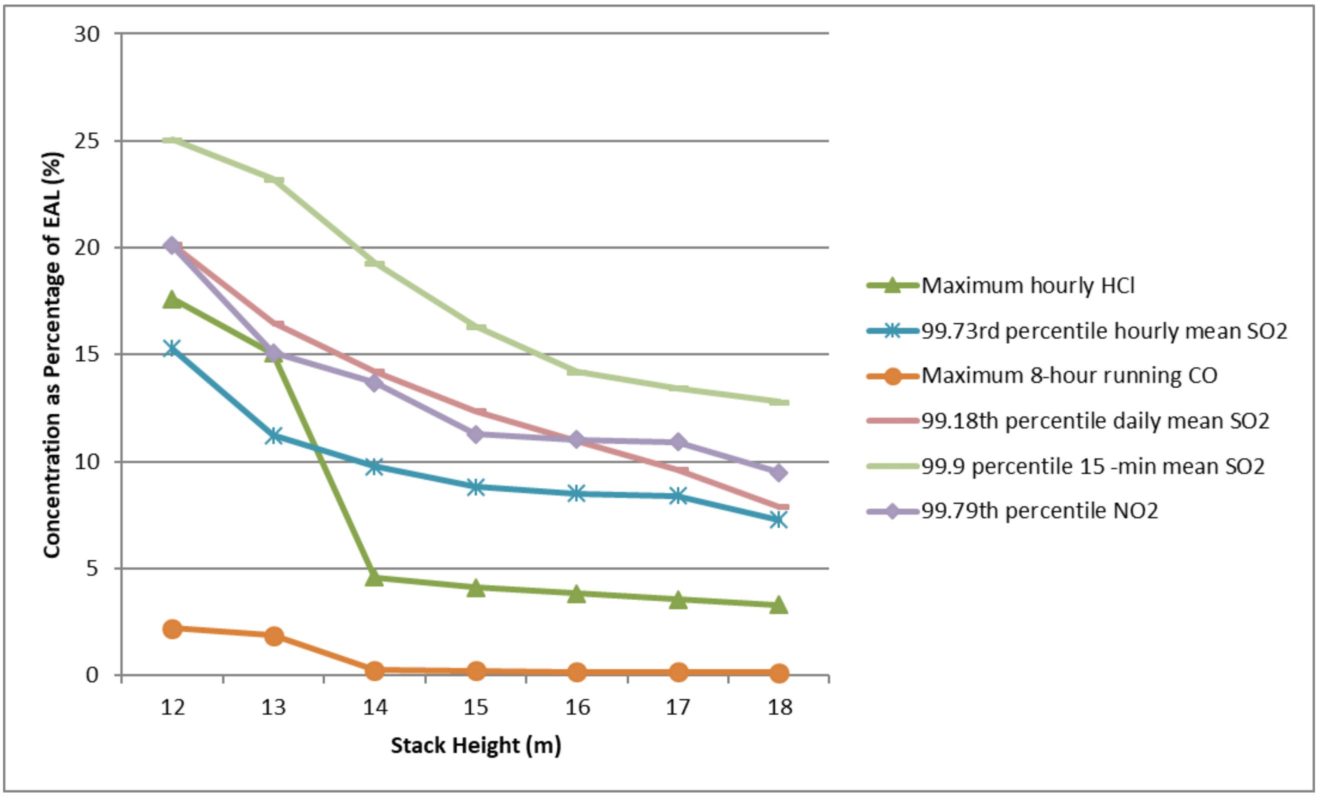
Graph D.1 compares the maximum PCs when the plant is operating at the long-term emission limit values set out in the EU Industrial Emissions Directive (IED) for waste operations.

Graph D.2 compares the maximum PCs when the plant is operating at the short-term emission limit values set out in the IED for waste operations.

Graph D.1 Maximum Predicted Process Contributions vs Stack Height at Long-term IED Limits



Graph D.2 Maximum Predicted Process Contributions vs Stack Height at Short-term IED Limits



D.7 The graphs do not show the ground-level Process Contribution levelling off within the range of heights considered. The graphs indicate that the point at which there are no further potential benefits in increasing the stack height has not been reached by 18 m.

D.8 **Stage 2 –** The on-line EA guidance entitled '*Environmental management – guidance, Air emissions risk assessment for your environmental permit'* [xvi] is for risk assessments and provides details for screening out substances for detailed assessment. In particular, it states that:

"To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

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

If you meet both of these criteria you don't need to do any further assessment of the substance.

If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

The PEC refers to the Predicted Environmental Concentration calculated as the PC added to the Ambient Concentration (AC).

D.9 The on-line EA guidance continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

It then states that further action may be required where:

"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributors – if you think this is the case contact the Environment Agency)

the PEC is already exceeding an environmental standard"

D.10 On that basis, the stack height has been determined as the height at which the effects are not considered significant, i.e. the height at which:

- the short-term PC is less than 10 % of the short-term Environmental Assessment Level (EAL) or the PEC is below the EAL; and
- the long-term PC is less than 1 % of the long-term EAL or the PEC is below the EAL.

D.11 Table D.1 provides the maximum predicted PC when the plant is operating at the long-term emission limit values set out in the IED for waste operations. Table D.2 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the long-term emission limit values set out in the IED for waste operations.

D.12 Table D.3 provides the maximum predicted PC when the plant is operating at the short-term emission limit values set out in the IED for waste operations. Table D.4 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the short-term emission limit values set out in the IED for waste operations.

D.13 Table D.5 and Table D.6 provide the maximum predicted PEC, for relevant pollutants, as a percentage of the EAL when the plant is operating at the long-term and short-term emission limit values set out in the IED for waste operations.

Table D.1 Maximum Predicted Process Contributions (µg.m^{-3}) at each Stack Height Modelled – Long-term IED Emission Limit Values

Height (m)	Concentration (µg.m^{-3})									
	Annual-mean PM_{10}	90.41st percentile daily mean PM_{10}	Maximum hourly HCl	Annual mean SO_2	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	Annual-mean NO_2	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
12	0.3	0.9	22.0	1.6	13.4	110.0	4.4	20.1	6.3	16.7
13	0.3	0.8	18.8	1.4	9.8	94.1	3.8	15.1	5.1	15.4
14	0.2	0.7	5.7	1.2	8.5	12.0	3.3	13.7	4.4	12.8
15	0.2	0.6	5.2	1.0	7.7	10.7	2.8	11.3	3.9	10.9
16	0.2	0.5	4.8	0.8	7.5	9.0	2.4	11.0	3.4	9.4
17	0.1	0.4	4.5	0.7	7.3	7.7	2.1	10.9	3.0	8.9
18	0.1	0.4	4.1	0.6	6.4	7.2	1.8	9.5	2.5	8.5

Table D.2 Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Long-term IED Emission Limit Values

	Percentage of Environmental Assessment Level (%)									
Environmental Assessment Level ($\mu g.m^{-3}$)	40	50	750	50	350	10000	40	200	125	266
Height (m)	Annual-mean PM_{10}	90.41st percentile daily mean PM_{10}	Maximum hourly HCl	Annual mean SO_2	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	Annual mean NO_2	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
12	0.7	1.7	2.9	3.1	3.8	1.1	11.0	10.1	5.0	6.3
13	0.6	1.5	2.5	2.7	2.8	0.9	10.0	7.5	4.1	5.8
14	0.6	1.4	0.8	2.3	2.4	0.1	8.0	6.8	3.6	4.8
15	0.5	1.2	0.7	2.0	2.2	0.1	7.0	5.6	3.1	4.1
16	0.4	1.0	0.6	1.7	2.1	0.1	6.0	5.5	2.7	3.5
17	0.4	0.9	0.6	1.5	2.1	0.1	5.0	5.5	2.4	3.4
18	0.3	0.8	0.5	1.3	1.8	0.1	4.0	4.8	2.0	3.2

Cells are shaded grey where the predicted process contribution is above 1% (for long-term concentrations) or 10% (for short-term concentrations) of the EAL.

Table D.3 Maximum Predicted Process Contributions (µg.m-3) at each Stack Height Modelled – Short-term IED Emission Limit Values

Height (m)	Concentration (µg.m^{-3})					
	Maximum hourly HCl	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
12	132.0	53.5	220.1	40.2	25.2	66.6
13	113.0	39.3	188.3	30.2	20.6	61.8
14	34.4	34.2	24.0	27.4	17.8	51.3
15	30.9	30.9	21.4	22.6	15.5	43.4
16	28.8	29.8	17.9	22.1	13.7	37.7
17	26.7	29.4	15.5	21.8	12.0	35.7
18	24.7	25.5	14.4	19.0	9.9	34.0

Table D.4 Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Short-term IED Emission Limit values

	Percentage of Environmental Assessment Level (%)					
Level Environmental Assessment (µg.m^{-3})	750	350	10000	200	125	266
Height (m)	Maximum hourly HCl	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
12	17.6	15.3	2.2	20.1	20.1	25.1
13	15.1	11.2	1.9	15.1	16.5	23.2
14	4.6	9.8	0.2	13.7	14.2	19.3
15	4.1	8.8	0.2	11.3	12.4	16.3
16	3.8	8.5	0.2	11.0	11.0	14.2
17	3.6	8.4	0.2	10.9	9.6	13.4
18	3.3	7.3	0.1	9.5	7.9	12.8

Cells are shaded grey where the predicted process contribution is above 10% of the EAL.

Table D.5 Maximum Predicted Environmental Concentration (PEC) as a Percentage of the Relevant EAL at each Stack Height Modelled – Long-term IED Emission Limit Values

	Percentage of Environmental Assessment Level (%)		
Environmental Assessment Level ($\mu g.m^{-3}$)	50	40	200
Height (m)	Annual mean SO_2	Annual mean NO_2*	99.79th Percentile NO_2 *
12	12	81	24
13	12	80	22
14	11	78	21
15	11	77	20
16	11	76	20
17	10	75	19
18	10	74	19

*A background annual-mean NO_2 concentration of 28 $\mu g.m^{-3}$ was used to calculate the PEC. This is the monitored concentration at SB21 in 2016 and is considered to be broadly representative of concentrations in the surrounding area.

Table D.6 Maximum Predicted Environmental Concentration as a Percentage of the Relevant EAL at each Stack Height Modelled – Short-term IED Emission Limit Values

	Percentage of Environmental Assessment Level (%)				
Environmental Assessment Level (µg.m^{-3})	200	350	125	266	750
Height (m)	99.79th percentile NO_2	99.73rd percentile hourly mean SO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2	Maximum Hourly HCl
12	48	18	27	28	18
13	43	14	24	27	15
14	42	12	21	23	5
15	39	11	19	20	4
16	39	11	18	18	4
17	39	11	17	17	4
18	38	10	15	16	3

Discussion

D.14 The results in Table D.2 indicate that there are no heights below 18 m at which the impacts can simply be screened-out as insignificant based on the PC alone when the plant is operating at long-term IED emission limit values. The results in Table D.4 indicate that there are no heights below 18 m at which the impacts can simply be screened-out as insignificant based on the PC alone when the plant is operating at short-term IED emission limit values.

D.15 It is necessary, therefore, to examine the impacts in more detail by looking at the PECs. The results in Table D.5 and Table D.6 indicate that the PECs are below the EAL at all heights for both the long-term and short-term IED emission limit values.

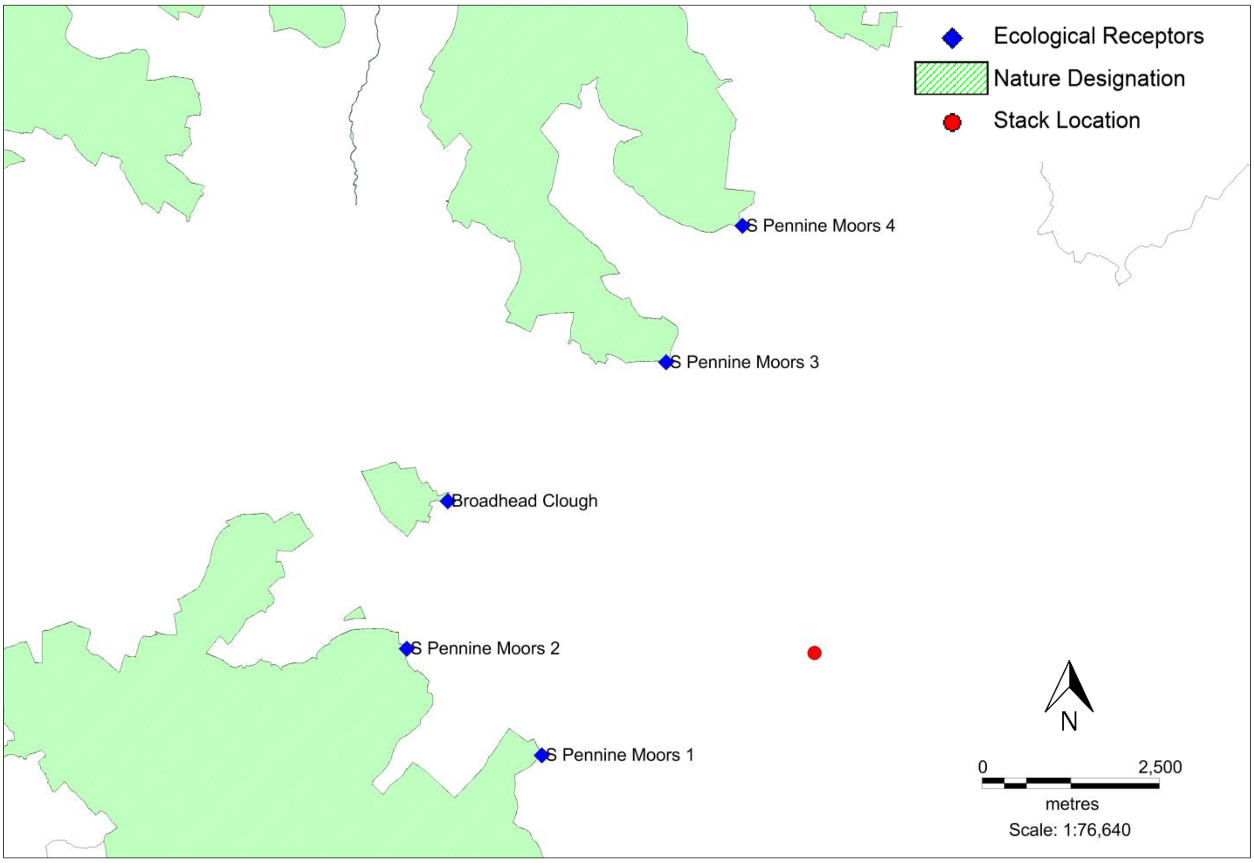
D.16 On that basis, and according to the EA guidance, the impacts would be considered not significant at all heights modelled.

D.17 Taking into account a 3 m clearance[2] between the roof of the tallest nearby building (9 m) and the tip of the stack, an acceptable stack height for the assessment is considered to be 12 m.

[2] The HMIP D1 Technical Guidance Note advises the following: "*No discharge stack should be less than 3 m above the ground or any adjacent area to which there is general access. For example, roof areas and elevated walkways. … A discharge stack should be at least 3 m above any opening windows or ventilation air inlets within a distance of 5U_m.*" (U_m is the uncorrected discharge stack height in metres.)

Appendix E: Impacts on Nature Designations

E.1 Air quality impacts have been predicted at discrete locations within the nature designations closest to the source of emissions, as shown in the figure below.



E.2 Critical Levels are maximum atmospheric concentrations of pollutants for the protection of vegetation and ecosystems and are specified within relevant European air quality directives and corresponding UK air quality regulations. Process Contributions (PCs) of annual-mean nitrogen oxides (NOX), sulphur dioxide (SO2) and ammonia (NH3) have been calculated for comparison with the relevant annual-mean Critical Level.

E.3 The maximum predicted PCs of NOX, SO2 and NH3 (from ADMS modelling utilising Leeds-Bradford 2013 – 2017 meteorological data) are compared with the relevant Critical Levels in the table below.

Habitat Receptor	Annual-Mean NO_X PC ($\mu g.m^{-3}$)	NO_X PC/Critical Level (%)	Annual-Mean SO_2 PC ($\mu g.m^{-3}$)	SO_2 PC/Critical Level (%)	Annual-Mean NH_3 PC ($\mu g.m^{-3}$)	NH_3 PC/Critical Level (%)
S Pennine Moors 1	0.01	0	<0.005	0	<0.005	0
Broadhead Clough	<0.005	0	<0.005	0	<0.005	0
S Pennine Moors 2	<0.005	0	<0.005	0	<0.005	0
S Pennine Moors 3	<0.005	0	<0.005	0	<0.005	0
S Pennine Moors 4	<0.005	0	<0.005	0	<0.005	0
Maximum	**0.01**	**0**	**<0.005**	**0**	**<0.005**	**0**

Annual-Mean NO_X Critical Level = 30 $\mu g.m^{-3}$
Annual-Mean SO_2 Critical Level = 10 $\mu g.m^{-3}$
Annual-Mean NH_3 Critical Level = 1 $\mu g.m^{-3}$

E.4 Critical Loads refer to the quantity of pollutant deposited, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. PCs of nutrient nitrogen (N) deposition and acid deposition have been derived using empirical methods recommended by the Environment Agency.

E.5 The maximum PCs of nutrient nitrogen (N) deposition are compared against the relevant Critical Loads (CLs) in the table below. There are various interest features within the habitat sites that are sensitive to N deposition. Only the results for the most-sensitive interest features are shown. Data on Critical Loads have been obtained from the UK Air Pollution Information System (APIS) database [xvii].

Designation	Habitat Site	N Deposition CL ($kgN.ha^{-1}.yr^{-1}$)	N Deposition PC ($kgN.ha^{-1}.yr^{-1}$)	N Deposition PC/CL (%)
SAC	South Pennine Moors (maximum)	5	0.002	0
SPA	South Pennine Moors (maximum)	3	0.002	0
SSSI	South Pennine Moors (maximum)	5	0.002	0
SSSI	Broadhead Clough	5	0.001	0

CLF = Critical Load Function (info at http://www.apis.ac.uk/clf-guidance)

E.6 The maximum PCs of acid deposition are compared against the relevant Critical Loads (CLs) in the table below. There are various interest features within the habitat sites that are sensitive to acid deposition. Only the results for the most-sensitive interest features are shown. Data on Critical Loads have been obtained from the UK Air Pollution Information System (APIS) database [xviii].

Designation	Habitat Site	Critical Loads (keq.ha^{-1}.yr^{-1})			PC (keq.ha^{-1}.yr^{-1})		PC / CLF (%)
		Min N	Max N	Max S	N	S	
SAC	South Pennine Moors (maximum)	0.321	0.569	0.248	1.60E-04	2.87E-04	0
SPA	South Pennine Moors (maximum)	0.178	0.511	0.19	1.60E-04	2.87E-04	0
SSSI	South Pennine Moors (maximum)	0.223	0.556	0.19	1.60E-04	2.87E-04	0
SSSI	Broadhead Clough	0.223	0.660	0.240	7.62E-05	1.37E-04	0

CLF = Critical Load Function (info at http://www.apis.ac.uk/clf-guidance)

E.7 The maximum predicted PCs do not exceed 1% of the relevant Critical Levels / Critical Loads at all habitat sites. In line with current Environment Agency guidelines [xix] and the Institute of Air Quality Management Position Statement [xx], the effects can be screened out as insignificant.

Appendix F: ADMS Model Sensitivity Testing

Alternative Meteorological Data (Bingley 2013-2017)

F.1 The following tables summarise the predicted NO_2 impacts at sensitive receptors based on the maximum predicted concentration using five years of meteorological data for Bingley (2013-2017).

Table F.1. Long-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Long-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	0.2	0	29.7	29.9	Negligible
2	9 Breck Lea	0.1	0	28.2	28.3	Negligible
3	Sacred Heart Catholic Primary	0.1	0	28.1	28.2	Negligible
4	Haugh End House	0.1	0	28.2	28.3	Negligible
5	84 Rochdale Road	0.3	1	30.4	30.6	Negligible
6	Highfield Jerry Lane	0.3	1	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	3.0	8	28.4	31.4	N/A
8	Mill West (AQMA)	0.2	0	35.5	35.7	Negligible
9	Ivy Cottage	0.2	0	28.1	28.3	Negligible
10	Cottage	0.1	0	28.1	28.2	Negligible
11	Black Sowerby Croft	0.2	0	28.1	28.3	Negligible
12	Prospect Terrace	0.0	0	28.0	28.1	Negligible
13	Hullen Edge	0.0	0	28.0	28.1	Negligible
14	Bank House	0.1	0	28.1	28.2	Negligible
15	Mill House Farm	0.2	1	28.3	28.6	Negligible
16	Mill House Lodge	0.2	0	30.0	30.2	Negligible

Table F.2 Short-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Short-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	3.0	2	59	62	Negligible
2	9 Breck Lea	2.0	1	56	58	Negligible

Receptor ID	Receptor	Short-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
3	Sacred Heart Catholic Primary	1.6	1	56	58	Negligible
4	Haugh End House	1.8	1	56	58	Negligible
5	84 Rochdale Road	3.5	2	61	64	Negligible
6	Highfield Jerry Lane	2.0	1	58	60	Negligible
7	Spring Bank Industrial Estate	6.9	3	57	64	Negligible
8	Mill West (AQMA)	1.3	1	71	72	Negligible
9	Ivy Cottage	1.2	1	56	57	Negligible
10	Cottage	0.9	0	56	57	Negligible
11	Black Sowerby Croft	0.8	0	56	57	Negligible
12	Prospect Terrace	0.8	0	56	57	Negligible
13	Hullen Edge	0.9	0	56	57	Negligible
14	Bank House	1.4	1	56	58	Negligible
15	Mill House Farm	1.3	1	57	58	Negligible
16	Mill House Lodge	1.5	1	60	61	Negligible

F.2 The NO_2 impacts remain ‘negligible’ at all receptors.

Calm Conditions

F.3 ADMS 5 includes an option to model ‘calm’ meteorological data (i.e. meteorological data with wind speed at 10 m less than 0.75 m.s^{-1}). By default, such meteorological data are not modelled.

F.4 The following tables summarise the predicted NO_2 impacts at sensitive receptors based on the maximum predicted concentration using five years of meteorological data for Leeds-Bradford (2013-2017) and enabling calm conditions (in this case, wind speeds ≥ 0.3 m.s^{-1}) to be modelled.

Table F.3. Long-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Long-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	0.2	0	29.7	29.9	Negligible
2	9 Breck Lea	0.1	0	28.2	28.2	Negligible
3	Sacred Heart Catholic Primary	0.1	0	28.1	28.2	Negligible

Receptor ID	Receptor	Long-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
4	Haugh End House	0.1	0	28.2	28.3	Negligible
5	84 Rochdale Road	0.2	1	30.4	30.6	Negligible
6	Highfield Jerry Lane	0.2	0	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	3.0	8	28.4	31.5	N/A
8	Mill West (AQMA)	0.2	0	35.5	35.7	Negligible
9	Ivy Cottage	0.2	1	28.1	28.3	Negligible
10	Cottage	0.2	0	28.1	28.3	Negligible
11	Black Sowerby Croft	0.2	0	28.1	28.3	Negligible
12	Prospect Terrace	<0.05	0	28.0	28.1	Negligible
13	Hullen Edge	<0.05	0	28.0	28.1	Negligible
14	Bank House	0.2	0	28.1	28.3	Negligible
15	Mill House Farm	0.2	1	28.3	28.6	Negligible
16	Mill House Lodge	0.2	0	30.0	30.1	Negligible

Table F.4 Short-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Short-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	2.7	1	59	62	Negligible
2	9 Breck Lea	1.8	1	56	58	Negligible
3	Sacred Heart Catholic Primary	1.7	1	56	58	Negligible
4	Haugh End House	2.0	1	56	58	Negligible
5	84 Rochdale Road	3.6	2	61	64	Negligible
6	Highfield Jerry Lane	1.8	1	58	59	Negligible
7	Spring Bank Industrial Estate	6.4	3	57	63	Negligible
8	Mill West (AQMA)	1.7	1	71	73	Negligible
9	Ivy Cottage	1.0	1	56	57	Negligible
10	Cottage	0.8	0	56	57	Negligible
11	Black Sowerby Croft	0.7	0	56	57	Negligible
12	Prospect Terrace	0.6	0	56	57	Negligible
13	Hullen Edge	0.7	0	56	57	Negligible

Receptor ID	Receptor	Short-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
14	Bank House	1.5	1	56	58	Negligible
15	Mill House Farm	1.4	1	57	58	Negligible
16	Mill House Lodge	1.5	1	60	61	Negligible

F.5 The NO_2 impacts remain 'negligible' at all receptors.

Varying Surface Roughness Length (simulating high density of tall trees)

F.6 Additional modelling has been undertaken using a variable surface roughness file. We have created a surface roughness length profile and input this into the model. The surface roughness length around the site has been increased to 1.51 m to represent the high density of tall trees around the site. The surface roughness length for the rest of the modelled domain has been left at 1 m.

Figure F.1 Satellite image of Calder Valley SWIP Site

F.7 The long-term and short-term NO_2 impacts at sensitive receptors predicted using the varied surface roughness are summarised in the tables below, along with the original predicted NO_2 predicted contributions.

Table F.5 Long-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Long-Term NO_2 PC (µg.m^{-3})	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	0.2	0	29.7	29.9	Negligible
2	9 Breck Lea	0.1	0	28.2	28.3	Negligible
3	Sacred Heart Catholic Primary	0.1	0	28.1	28.2	Negligible
4	Haugh End House	0.1	0	28.2	28.3	Negligible
5	84 Rochdale Road	0.2	1	30.4	30.6	Negligible
6	Highfield Jerry Lane	0.2	1	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	3.1	8	28.4	31.5	N/A
8	Mill West (AQMA)	0.2	0	35.5	35.7	Negligible
9	Ivy Cottage	0.2	1	28.1	28.3	Negligible
10	Cottage	0.2	0	28.1	28.3	Negligible
11	Black Sowerby Croft	0.2	0	28.1	28.3	Negligible
12	Prospect Terrace	0.0	0	28.0	28.1	Negligible
13	Hullen Edge	0.0	0	28.0	28.1	Negligible
14	Bank House	0.2	0	28.1	28.3	Negligible
15	Mill House Farm	0.2	1	28.3	28.6	Negligible
16	Mill House Lodge	0.2	0	30.0	30.1	Negligible

Table F.6 Short-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Long-Term NO_2 PC (µg.m^{-3})	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	2.7	1	59	62	Negligible
2	9 Breck Lea	1.8	1	56	58	Negligible
3	Sacred Heart Catholic Primary	1.7	1	56	58	Negligible
4	Haugh End House	2.0	1	56	58	Negligible
5	84 Rochdale Road	4.1	2	61	65	Negligible
6	Highfield Jerry Lane	1.9	1	58	59	Negligible
7	Spring Bank Industrial Estate	6.3	3	57	63	Negligible
8	Mill West (AQMA)	1.8	1	71	73	Negligible
9	Ivy Cottage	1.0	1	56	57	Negligible

Receptor ID	Receptor	Long-Term NO_2 PC ($\mu g.m^{-3}$)	PC as % of EAL	AC	PEC	Impact Descriptor
10	Cottage	0.8	0	56	57	Negligible
11	Black Sowerby Croft	0.7	0	56	57	Negligible
12	Prospect Terrace	0.8	0	56	57	Negligible
13	Hullen Edge	0.8	0	56	57	Negligible
14	Bank House	1.6	1	56	58	Negligible
15	Mill House Farm	1.4	1	57	58	Negligible
16	Mill House Lodge	1.5	1	60	61	Negligible

F.8 The impacts remain 'negligible' at all receptors.

Running AERMOD Through ADMS

F.9 There is a facility in ADMS to run AERMOD. This has been undertaken as a sensitivity test for predicting NO_2 concentrations at sensitive receptors. The ADMS meteorology data processor (as opposed to AERMOD meteorological data files) has been utilised within this sensitivity test.

F.10 Neither model is "better" than the other in terms of their ability to take terrain and topography into account; their algorithms simply provide alternative forecasts. Nevertheless, it could be argued that ADMS has a more sophisticated approach to processing complex terrain, in that it calculates the impacts of terrain on plume spread and allows for the impacts of hill wakes.

F.11 The following tables summarise the predicted NO_2 impacts at sensitive receptors when AERMOD is run through ADMS. The NO_2 impacts are based on the maximum predicted concentration using five years of meteorological data for Leeds-Bradford (2013-2017).

Table F.7. Long-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Long-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	0.19	0	29.7	29.9	Negligible
2	9 Breck Lea	0.13	0	28.2	28.3	Negligible
3	Sacred Heart Catholic Primary	0.09	0	28.1	28.2	Negligible
4	Haugh End House	0.13	0	28.2	28.3	Negligible
5	84 Rochdale Road	0.15	0	30.4	30.5	Negligible
6	Highfield Jerry Lane	0.19	0	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	0.44	1	28.4	28.9	N/A

Receptor ID	Receptor	Long-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
8	Mill West (AQMA)	0.09	0	35.5	35.6	Negligible
9	Ivy Cottage	0.53	1	28.1	28.7	Negligible
10	Cottage	0.37	1	28.1	28.5	Negligible
11	Black Sowerby Croft	0.21	1	28.1	28.3	Negligible
12	Prospect Terrace	0.05	0	28.0	28.1	Negligible
13	Hullen Edge	0.04	0	28.0	28.1	Negligible
14	Bank House	0.20	1	28.1	28.3	Negligible
15	Mill House Farm	0.10	0	28.3	28.4	Negligible
16	Mill House Lodge	0.12	0	30.0	30.1	Negligible

Table F.8 Short-Term NO_2 Impacts at Sensitive Receptors (at long-term IED limits)

Receptor ID	Receptor	Short-Term NO_2 PC	PC as % of EAL	AC	PEC	Impact Descriptor
1	28 Rochdale Road	4.1	2	59	63	Negligible
2	9 Breck Lea	4.2	2	56	61	Negligible
3	Sacred Heart Catholic Primary	3.4	2	56	60	Negligible
4	Haugh End House	6.8	3	56	63	Negligible
5	84 Rochdale Road	3.3	2	61	64	Negligible
6	Highfield Jerry Lane	3.7	2	58	61	Negligible
7	Spring Bank Industrial Estate	3.8	2	57	61	Negligible
8	Mill West (AQMA)	1.0	0	71	72	Negligible
9	Ivy Cottage	7.0	3	56	63	Negligible
10	Cottage	5.6	3	56	62	Negligible
11	Black Sowerby Croft	3.6	2	56	60	Negligible
12	Prospect Terrace	0.9	0	56	57	Negligible
13	Hullen Edge	1.4	1	56	58	Negligible
14	Bank House	3.2	2	56	59	Negligible
15	Mill House Farm	2.3	1	57	59	Negligible
16	Mill House Lodge	2.2	1	60	62	Negligible

F.12 The NO_2 impacts remain 'negligible' at all receptors.

F.13 Contour plots showing the predicted annual-mean and predicted 99.79th percentile of hourly-mean NO_2 concentrations (at long-term IED emission rates) are provided below.

Figure F.2 Predicted Annual-Mean NO_2 Process Contributions ($\mu g.m^{-3}$) – AERMOD run through ADMS

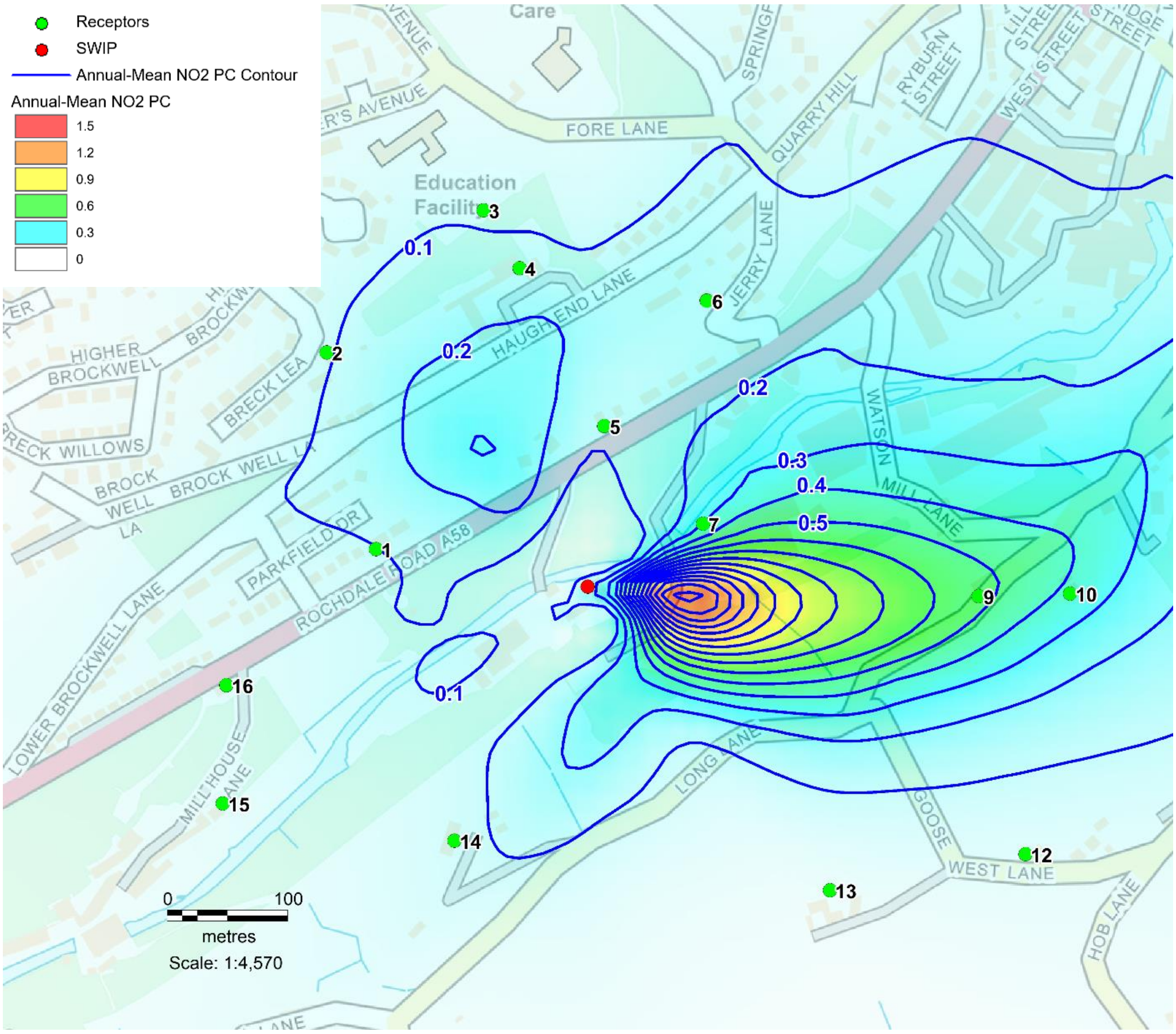


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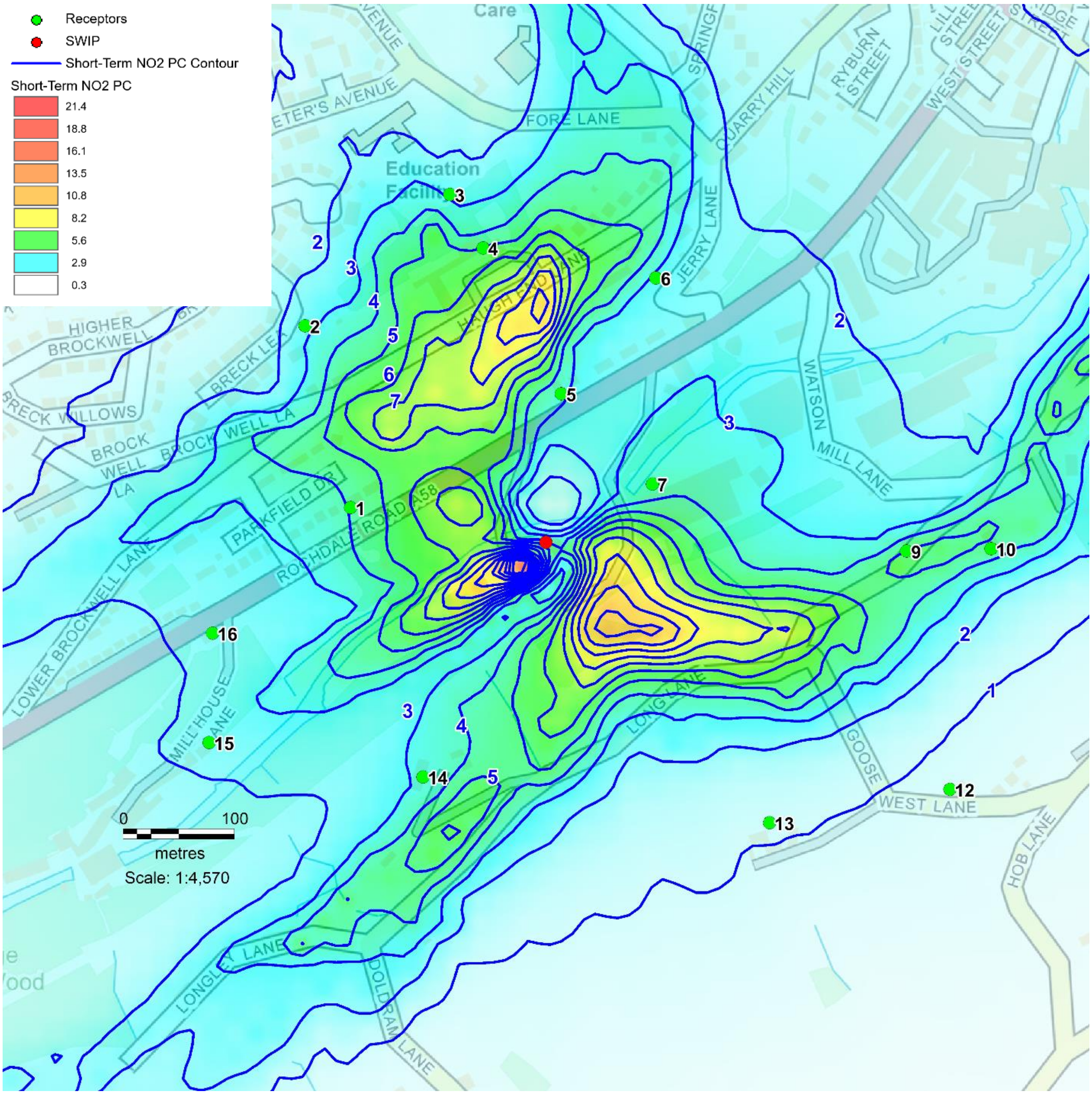
Figure F.3 Predicted 99.79th Percentile NO_2 Process Contributions (µg.m^{-3}) – AERMOD run through ADMS



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