3 ES ADDENDUM TO 2017 ES CHAPTER 7: AIR QUALITY

3.1 An Addendum to the 2017 ES Chapter 7: Air Quality is provided in this section of the ES Addendum. As set out in Section 1, this addendum to 2017 ES Chapter 7 provides an updated operational phase assessment which is intended to replace the Chapter 7 of the 2017 ES in terms of the operational-phase assessment on human health. The 2017 ES remains unchanged in terms of construction phase AQ impacts albeit this phase is reduced by the deletion of the previously proposed extension to the thermal treatment building; traffic impacts; CO2 savings; and, impacts on ecological receptors. The ES Addendum should therefore be read alongside the 2017 ES.

3.2 The ES Addendum to the 2017 ES Chapter 7: Air Quality is found over the page. Its appendices are found in ES Addendum Volume 2.

Introduction

3.3 The primary purpose of this ES update is to re-assess impacts on air quality due to the operation of the Small Waste Incineration Plant (SWIP) taking into account up-to-date baseline information, higher-resolution terrain data and recent meteorological data. Terrain data for dispersion modelling must be obtained in a specific format, so the higher resolution data obtained have been compared with on-site topographical information to confirm their accuracy for this purpose. In addition, detailed modelling of road traffic emissions has now been undertaken to predict baseline nitrogen dioxide (NO_2) concentrations at sensitive receptor locations.

3.4 The 2017 Environmental Statement (2017 ES) included an assessment of construction phase air quality impacts, concluding that the risk of impacts was negligible. Given that the 2017 ES took into account the then proposed vertical extension of the SWIP building which no longer forms part of the proposed development, the construction phase effects are expected to be even less significant than those predicted previously and have not been reassessed.

3.5 The 2017 ES concluded that the "*process impacts are of negligible significance at all receptor locations*". The results of the updated assessment have been compared with the original conclusions to identify and discuss any differences.

policy and guidance

3.6 This section sets out the up-to-date policy and guidance and supersedes the air quality policy and guidance set out in the 2017 ES.

Emission Limits

Industrial Emissions Directive Limits

3.7 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.

3.8 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.

3.9 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 3.1.

Table 3.1 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).

3.10 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 3.2 have been used for these pollutants to calculate long-term (greater than 24-hour average) mean ground-level concentrations (Scenario 2).

Table 3.2 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

3.11 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.

3.12 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”).

3.13 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.

3.14 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.

3.15 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

3.16 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.

3.17 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

3.18 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 3.3.

Table 3.3 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 $\mu g.m^{-3}$	18 times per calendar year	-
	Annual	40 $\mu g.m^{-3}$	-	-
Particulate Matter (PM_{10})	24 Hour	50 $\mu g.m^{-3}$	35 times per calendar year	-
	Annual	40 $\mu g.m^{-3}$	-	-
Particulate Matter ($PM_{2.5}$)	Annual	25 $\mu g.m^{-3}$	-	01.01.2020 (a)
				01.01.2015 (b)
Carbon Monoxide	Maximum daily running 8 hour mean	10,000 $\mu g.m^{-3}$	-	-
Sulphur Dioxide (SO_2)	15 minute	266 $\mu g.m^{-3}$	> 35 times per calendar year	-
	1 hour	350 $\mu g.m^{-3}$	> 24 times per calendar year	-
	24 hour	125 $\mu g.m^{-3}$	> 3 times per calendar year	-
Lead	Annual	0.25 $\mu g.m^{-3}$	-	-
Arsenic (As)	Annual (b)	0.006 $\mu g.m^{-3}$	-	-
Cadmium (Cd)	Annual (b)	0.005 $\mu g.m^{-3}$	-	-
Nickel (Ni)	Annual (b)	0.02 $\mu g.m^{-3}$	-	-

(a) Target date set in UK Air Quality Strategy 2007

(b) Target date set in Air Quality Standards Regulations 2010

3.19 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.`

3.20 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

3.21 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.

3.22 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 3.4.

Table 3.4 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 $\mu g.m^{-3}$	2020 (a)
PAHs (as B[a]P equivalent)	Annual (a)	0.00025 $\mu g.m^{-3}$	-
Sulphur Dioxide (SO_2)	Annual (b)	50 $\mu g.m^{-3}$	-
Hydrogen Chloride	1 hour (c)	750 $\mu g.m^{-3}$	-
Hydrogen Fluoride	1 hour (c)	160 $\mu g.m^{-3}$	-

Notes:

(a) Target date set in UK Air Quality Strategy 2007

(b) World Health Organisation Guidelines

(c) EPAQS recommended guideline values

Environmental Assessment Levels

3.23 The Environment Agency's on-line guidance entitled '*Environmental management – guidance, Air emissions risk assessment for your environmental permit'* [8] provides further assessment criteria in the form of Environmental Assessment Levels (EALs).

3.24 Table 3.5 presents all available EALs for the pollutants relevant to this assessment. The EALs are

Table 3.5 Environmental Assessment Levels (EALs)

Pollutant	Long-Term EAL ($\mu g.m^{-3}$)	Short-Term EAL ($\mu g.m^{-3}$)
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)

Pollutant	Long-Term EAL (μg.m^{-3})	Short-Term EAL (μg.m^{-3})
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.

3.25 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

3.26 The National Planning Policy Framework (NPPF) [9] 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.

3.27 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)*

3.28 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)

3.29 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

3.30 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.

3.31 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).

3.32 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."

3.33 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

3.34 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. …

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

Approach to Assessment

3.35 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.

3.36 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 [10]. 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.

3.37 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 the detailed assessment contained within the 2019 Air Quality Assessment Report referred to below. The Pollution Control Officer, Tommy Moorhouse, agreed that the approach to the assessment was reasonable [11].

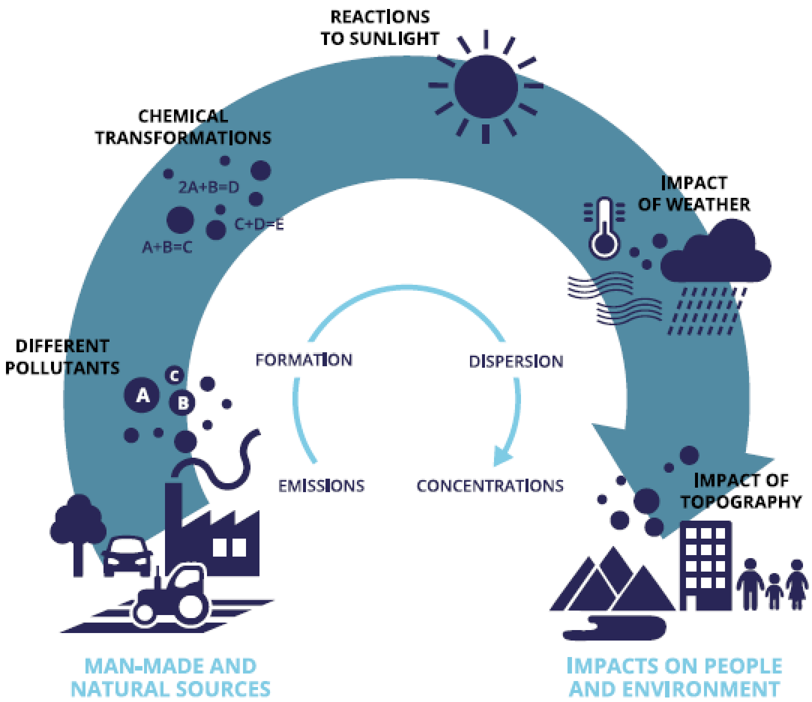
3.38 Air quality guidance advises that the organisation engaged in assessing the overall risks should hold relevant qualifications and/or extensive experience in undertaking air quality assessments. The RPS air quality team members involved at various stages of this assessment have professional affiliations 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

3.39 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

3.40 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 5.

Dispersion Model

3.41 The UK detailed dispersion model, ADMS 5, has a facility to run the US detailed dispersion model, AERMOD. This has been undertaken, to ensure consistency with the Air Quality Assessment forming part of the 2017 Environmental Statement (ES) which utilised AERMOD.

3.42 Additional modelling has been undertaken using ADMS 5, detailed within an additional Air Quality Assessment Report which is presented as an integral part of the Environmental Statement Addendum (ES Addendum) at Appendix 3.1, Volume 2. This additional Air Quality Assessment Report is hereafter referred to as the 2019 Air Quality Assessment Report. The 2019 Air Quality Assessment Report is intended to be read alongside this ES Addendum chapter, elements of it are referred to and incorporated into this ES Addendum chapter and it is intended to add further assurance to the overall air quality assessment, results and conclusions.

Model Input Data

Meteorological Data

3.43 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

3.44 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.

3.45 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. Leeds-Bradford Airport meteorological data (2009 – 2013) were utilised in the 2017 ES.

3.46 A sensitivity test has been undertaken in ADMS 5 using five years of meteorological data collated at Bingley between 2013 and 2017. The results of this sensitivity test are provided in Appendix F of the 2019 Air Quality Assessment Report.

3.47 Wind roses have been produced for each of the years of meteorological data used in this assessment and are presented in Figure 1 of the 2019 Air Quality Assessment Report.

3.48 The surface roughness and albedo/Bowen Ratio input data of the AERMOD meteorology files are identical to those used in the 2017 ES.

Stack Parameters and Emissions Rates used in the Model

3.49 Stack emissions characteristics modelled are provided in Table 3.6 and the mass emissions are provided in Table 3.7. The stack characteristics and mass emissions are consistent with those used in the 2017 ES, with the exception of short-term CO (a daily-average emission limit value was used in the 2017 ES and a more conservative half-hourly average value has been used within this update). It is noted that the annual-mean mass emission rate values provided in Table 7.1 of the 2017 ES are the long-term mass emission rates with the 5/7 operational hours scaling factor applied.

Table 3.6 Stack Characteristics

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

Table 3.7 Mass Emissions of Released Pollutants

Pollutant	Short-Term Mass Emission Rate ($g.s^{-1}$)	Long-Term (a) Mass Emission Rate ($g.s^{-1}$)	Annual-Mean Mass Emission Rate (Scaled for Operational Hours) (e) ($g.s^{-1}$)
Particulates	0.04	0.01	0.009
HCl	0.08	0.01	0.009
HF	5.11E-03	1.28-03	0.001
SO2	0.26	0.06	0.046
NOX	0.51	0.26	0.182
CO	0.13	0.06	0.046
Group 1 Metals Total (b)	-	6.38E-05	4.56E-05

Pollutant	Short-Term Mass Emission Rate ($g.s^{-1}$)	Long-Term (a) Mass Emission Rate ($g.s^{-1}$)	Annual-Mean Mass Emission Rate (Scaled for Operational Hours) (e) ($g.s^{-1}$)
Group 2 Metals (c)	-	6.38E-05	4.56E-05
Group 3 Metals Total (d)	-	6.38E-04	4.56E-04
Dioxins and furans	-	1.28E-10	9.12E-10
NH3	-	6.38E-3	0.005
PCBs	-	6.38E-06	4.56E-06
PAHs – B[a]P	-	1.28E-06	9.12E-7

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)

e. The annual-mean mass emission rates are scaled down by a factor of 5/7 to reflect a 24-hours-a-day, 5-days-per-week working pattern.

3.50 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.

3.51 An Organic Rankine Cycle (ORC) unit is proposed, to generate electricity. The ORC unit would be self-contained, would not have a flue or any emissions to air. It would therefore not affect emissions from the SWIP.

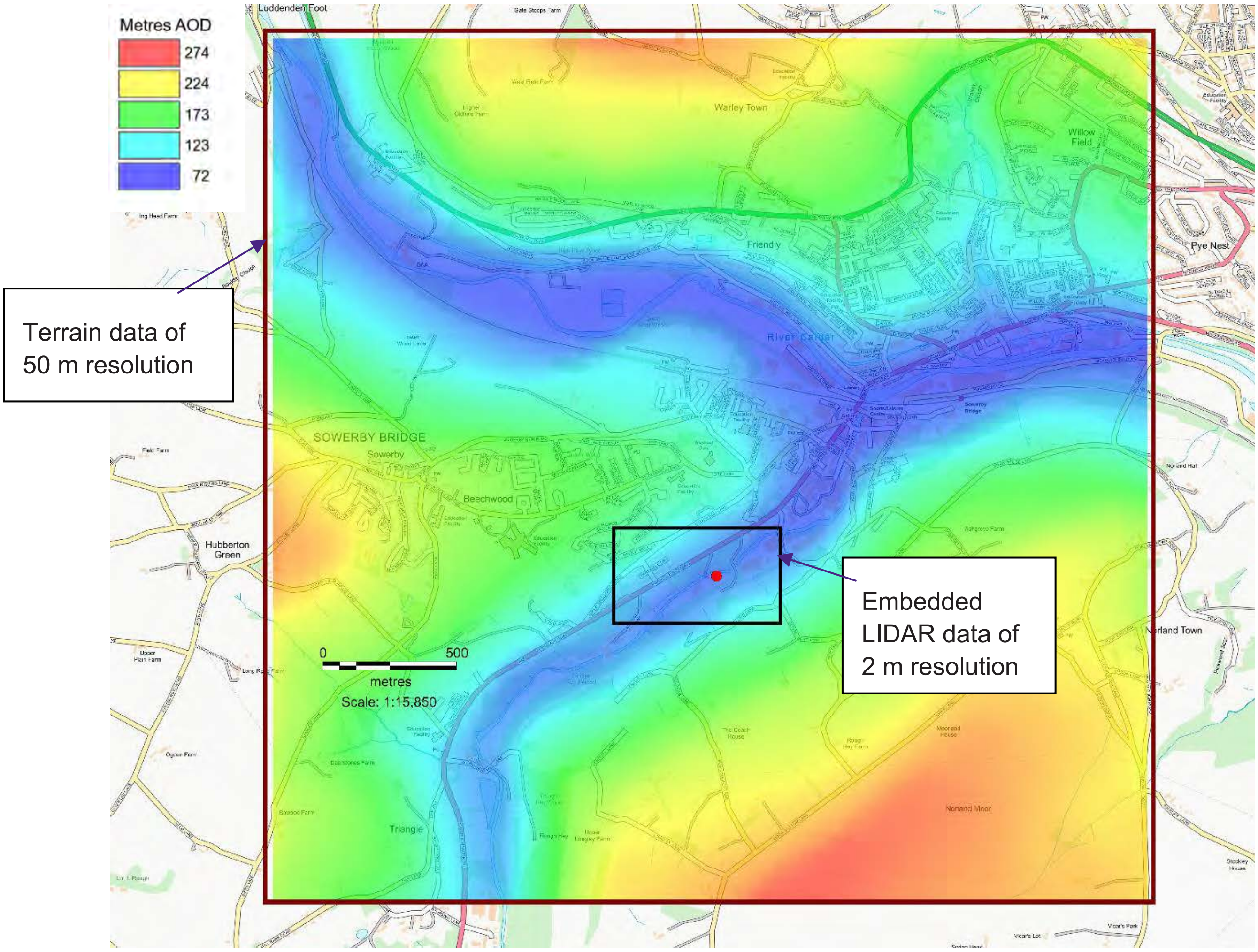
Terrain

3.52 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. As with the 2017 ES, a complex terrain file has been used within the model. In this assessment, a more refined complex terrain file has been utilised than the one used in the 2017 ES. This is to ensure the elevations on the Appeal Site and nearby sensitive receptors are accurately represented.

3.53 In paragraph 7.29 of the Air Quality chapter of the 2017 ES it is stated that the proposed stack height of 12 m will result in a release height of 105 m AOD. As a result of the topographical survey carried out in April 2019 and presented in Drawing UAM3131_A dated 16.04.2019 this statement (together with other references to levels in metres AOD) in the 2017 ES was found to be inaccurate. The true release height of the proposed 12 m stack will be at approximately 96.4 m AOD, as discussed below. However, this has been fully taken into account in the reassessment contained in this ES Addendum chapter by using the more refined complex terrain file in the model as referred to in this section. Consequently, the elevations, including the stack and its release height, at the Appeal Site and nearby sensitive receptors have been accurately represented. This includes an accurate representation of the release height of the stack relative to the surrounding terrain.

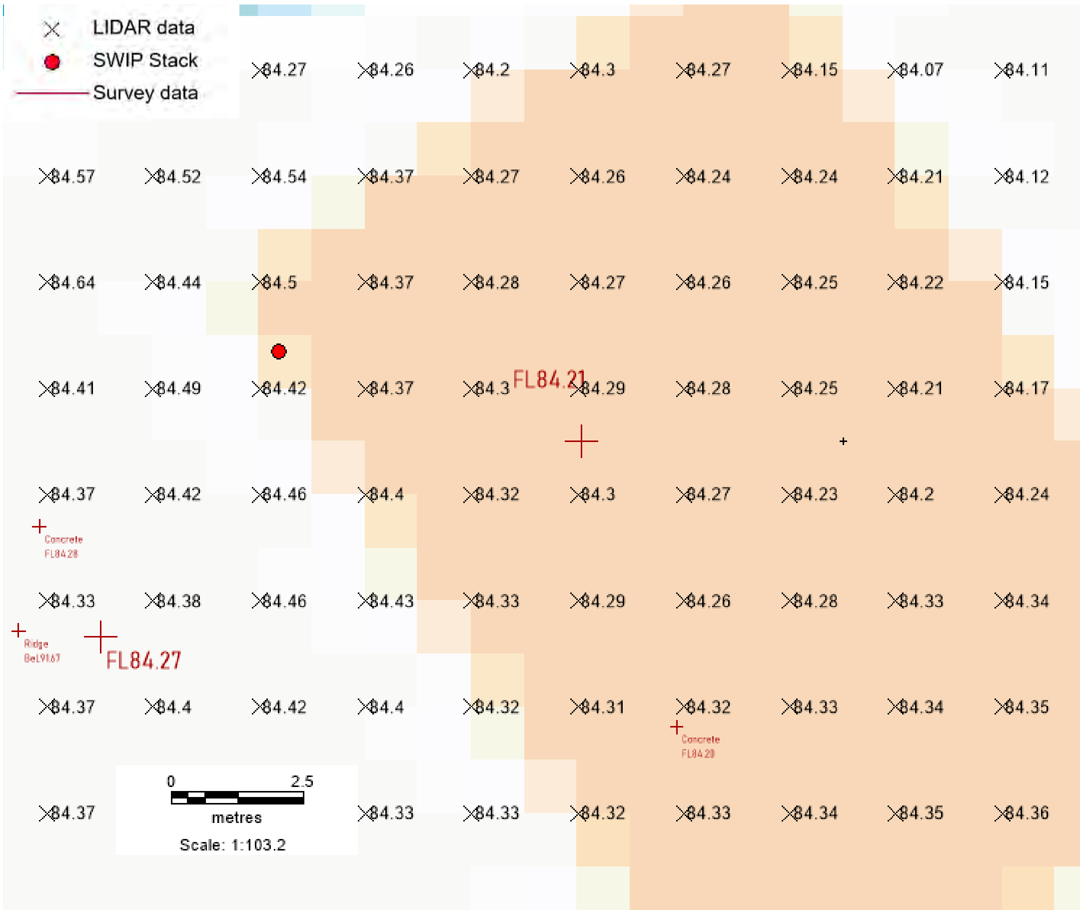
3.54 The terrain data used in the model comprises terrain data of 50 m resolution for the whole study area, supplemented with 2 m resolution (i.e. spot heights on a regular grid every 2 m) government-published LIDAR data [12] for a smaller area encompassing the Application Site. This is shown graphically in Figure 4.2 below.

Figure 3.2 Complex Terrain Data Used in Model



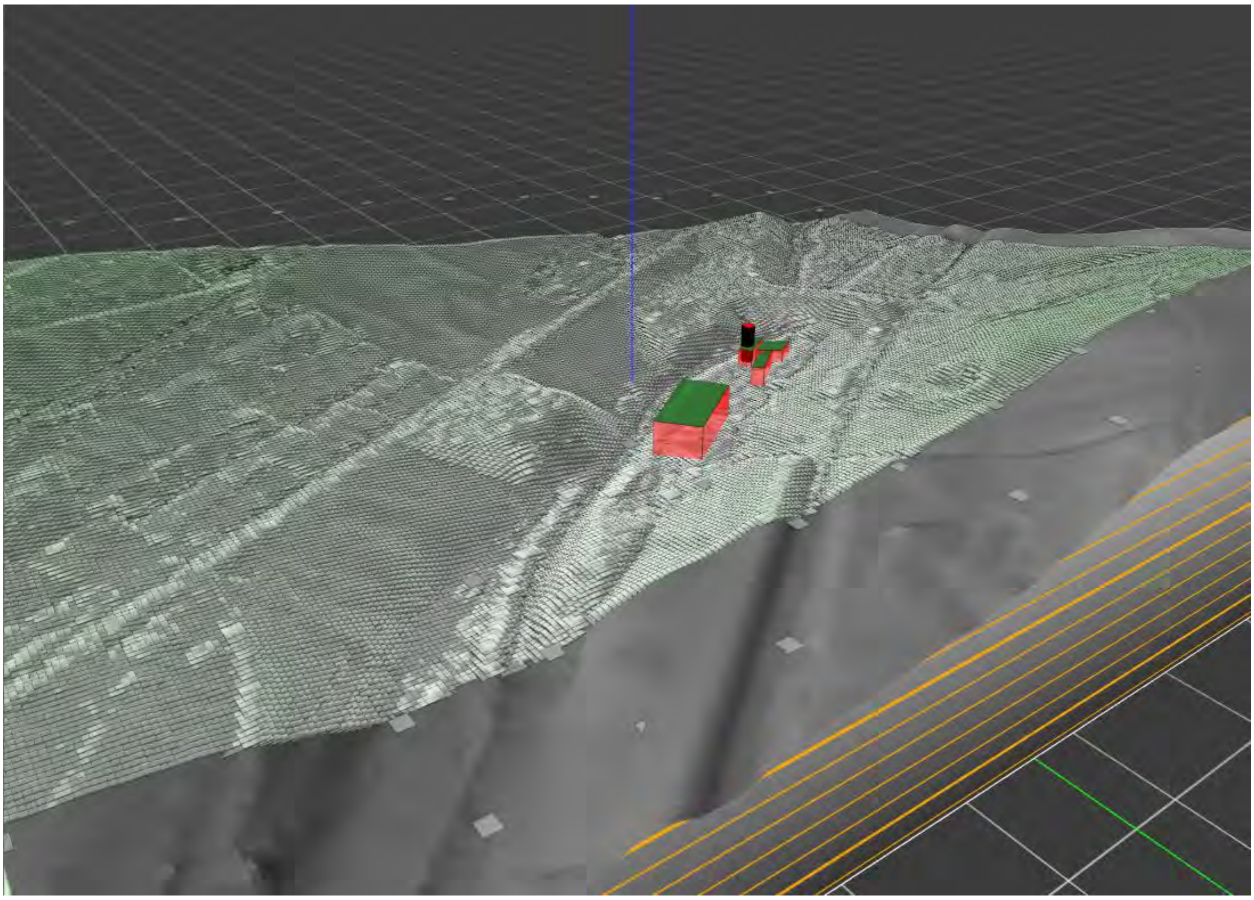
3.55 The figure in Appendix 2.3, Volume 2 shows the LIDAR data values across the application site and the recently surveyed elevations. That figure shows close agreement between the LIDAR data and the surveyed data. Figure 3.3 below shows the LIDAR data values and topographical survey values closest to the SWIP stack. 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



3.56 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 graphically 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



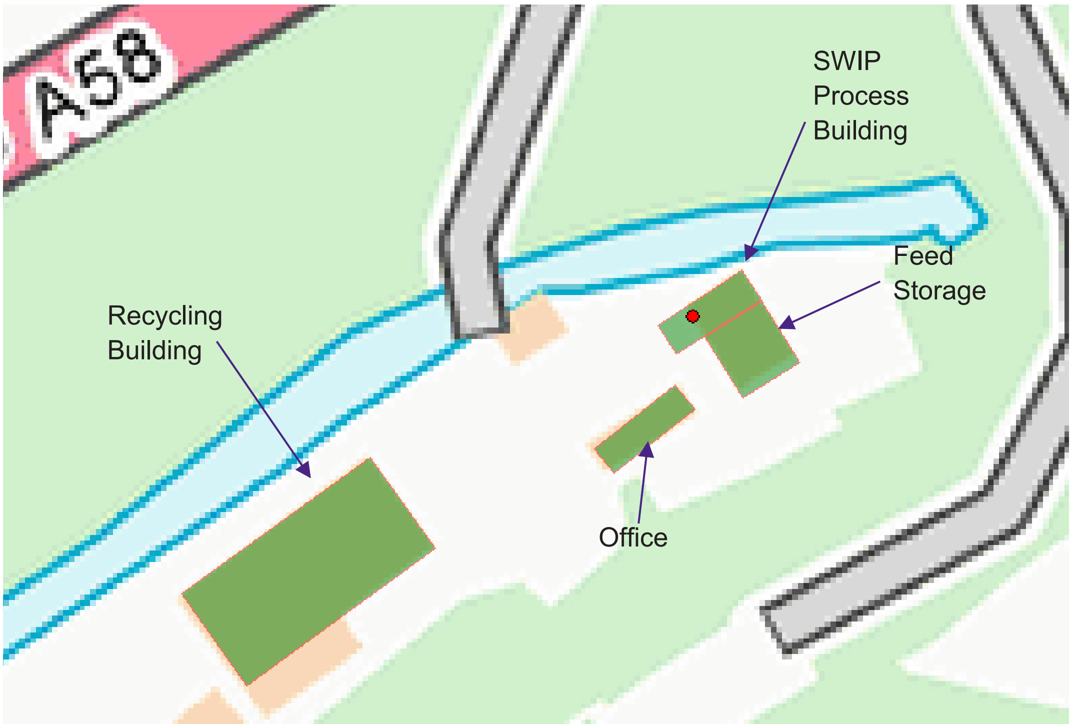
Building Wake Effects

3.57 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 3.8 and shown in Figure 3.5. These were included in the model.

Table 3.8 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

Figure 3.5 Buildings Included Within the Dispersion Model



3.58 Paragraph 7.32 of the 2017 ES states that "the main process building associated with the development is 9 m high and has been included in the model as a potential downwash structure". The revised air quality assessment therefore includes greater detail in terms of building structures than the previous air quality assessment.

Receptors

3.59 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. This is slightly more refined than the grids modelled as part of the 2017 ES. As stated at paragraph 7.38 of the 2017 ES, "*pollutant concentrations have been predicted at both discrete receptor locations and over a 1 km by 1 km Cartesian grid of 25 m resolution and a 3 km by 4 km Cartesian grid of 50 m resolution*".

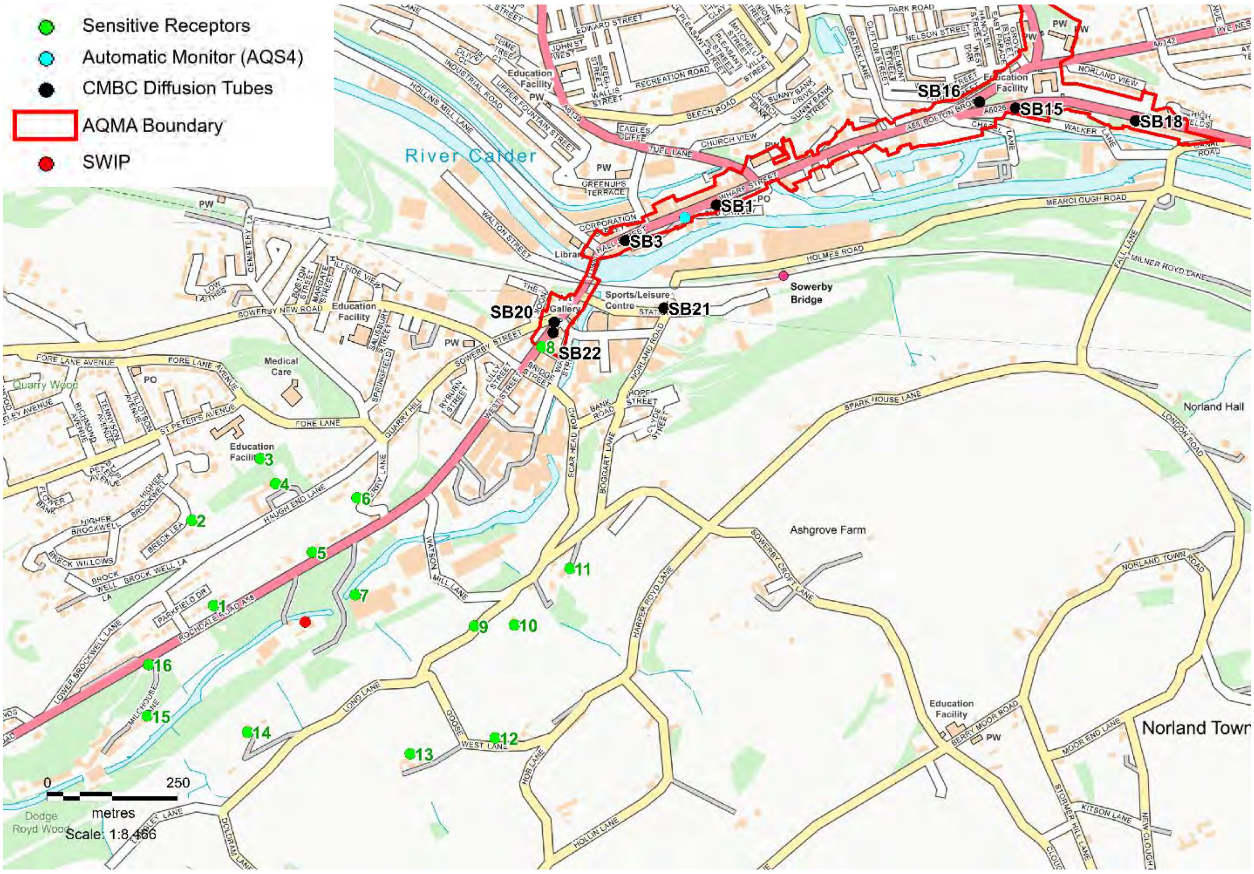
3.60 Concentrations have also been modelled at the 16 selected sensitive receptors modelled in the 2017 ES. These receptors are listed in Table 3.9 and shown in Figure 3.6. The nearby CMBC air quality monitors and the AQMA are also depicted.

Table 3.9 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

ID	Description	x	y
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 3.6 Modelled Sensiitve Receptors and Local Air Quality Monitors



3.61 The annual, daily and hourly-mean AQS objectives apply at the front, side 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.

3.62 Sensitive habitat receptors within 2 km of the Application Site were modelled as part of the 2017 ES Air Quality Assessment. The impacts were predicted to be negligible at all receptors. Detailed modelling using ADMS 5 has been undertaken to predict air quality impacts at nature designations within 10 km that were not considered in the 2017 ES. This is detailed within Appendix E of the 2019 Air Quality Assessment Report.

NO_X to NO_2 Relationship

3.63 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.

3.64 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

3.65 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 [13]. While this approach is useful for screening assessments, it is not appropriate for detailed assessments.

3.66 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%.

3.67 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

3.68 An assumed conversion of 35% follows the Environment Agency's recommendations [14] for the calculation of 'worse case scenario' short-term NO_2 concentrations.

Modelling of Long-Term and Short-Term Emissions

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

3.70 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

3.71 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.)

3.72 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."

3.73 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 3.10 provides the EPUK & IAQM approach for describing the long-term air quality impacts at sensitive human-health receptors in the surrounding area.

Table 3.10 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.

3.74 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."*

3.75 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."

3.76 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

3.77 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' [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."

3.78 It continues by stating that:

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

3.79 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"*

3.80 On that basis, the results of the detailed modelling presented in this ES Addendum chapter 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.

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

Uncertainty

3.82 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).

3.83 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.

3.84 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.

3.85 The atmospheric dispersion models used for this assessment 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.

3.86 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.

3.87 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 in the 2019 Air Quality Assessment Report.

3.88 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 3.11.

Table 3.11 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.	
	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	

Concentration	Source of Uncertainty	Approach to Dealing with Uncertainty	Comments
		means that the conditions in 5 x 8,760 hours have been considered in the assessment. Furthermore, a sensitivity test has been undertaken using ADMS, utilising five years of meteorological data collated at an alternative station (see 2019 Air Quality Assessment Report). 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.	

3.89 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 ES Addendum chapter and are more likely to be lower.

3.90 Additional quality assurance measures have been carried out. Dispersion modelling using ADMS 5 has been undertaken, as detailed within the 2019 Air Quality Assessment Report, and sensitivity testing has been carried out (Appendix F of the 2019 Air Quality Assessment Report) to check the changes in the results and conclusions (if any) that are accounted for by using different data and modelling input assumptions.

Baseline Environment

3.91 The baseline air quality conditions have been re-established since the 2017 ES, drawing upon the most-recent published monitoring data and Defra mapped concentration estimates. In contrast to the Air Quality Assessment forming part of the 2017 ES, detailed roads modelling has been undertaken to establish the baseline NO_2 concentrations at discrete receptor locations.

3.92 A detailed description of how the baseline air quality has been derived is provided in Appendix A of the 2019 Air Quality Assessment Report. The baseline concentrations used in the assessment are set out in Table 3.12.

3.93 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 3.12 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 $\mu g.m^{-3}$	59.4 $\mu g.m^{-3}$	Roads modelling exercise (detailed in Appendix C of the

Pollutant	Where Applies	Long-Term Concentration	Short-Term Concentration*	Data Source
	Receptor 2	28.2 µg.m^{-3}	56.3 µg.m^{-3}	2019 Air Quality Assessment Report)
	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
$PM_{2.5}$	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 of the 2019 Air Quality Assessment Report)

3.94 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.

3.95 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.

3.96 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)".

Mitigation Measures adopted as part of the development

3.97 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.

Assessment of Effects

3.98 This section details the air quality effects on sensitive human health receptors. These results supersede the results at human health receptors presented in the 2017 ES. In contrast to the 2017 ES, results at sensitive receptor locations are only presented for NO_2; for all other pollutants, the maximum results across the grid are presented. This is a robust approach, as the maximum concentrations predicted across the grid would be greater than concentrations predicted at sensitive receptor locations.

3.99 As the main concern is NO_2 impacts on human health, these results are presented first. The impacts of other pollutants are discussed subsequently.

Nitrogen Dioxide (NO_2) Impacts

3.100 Table 3.13 presents the annual-mean NO_2 concentrations predicted at the façades of receptors, i.e. at locations where there is relevant human exposure. To allow for a direct comparison, the corresponding results from the 2017 ES (Table 7.12 of the 2017 ES) are also shown.

Table 3.13 Maximum Predicted Annual-Mean NO_2 Impacts at Receptor Locations

Receptor ID	Receptor Name	2017 ES Max Annual-Mean NO_2 PC ($\mu g.m^{-3}$)	Updated Assessment 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	0.33	0.20	0	29.7	29.9	Negligible
2	9 Breck Lea	0.24	0.16	0	28.2	28.3	Negligible
3	Sacred Heart Catholic Primary	0.23	0.12	0	28.1	28.3	Negligible
4	Haugh End House	0.33	0.18	0	28.2	28.4	Negligible
5	84 Rochdale Road	0.53	0.16	0	30.4	30.5	Negligible
6	Highfield Jerry Lane	0.32	0.19	0	28.8	29.0	Negligible
7	Spring Bank Industrial Estate	0.56	0.15	0	28.4	28.6	N/A***
8	Mill West (AQMA)	0.11	0.09	0	35.5	35.6	Negligible
9	Ivy Cottage	0.78	0.62	2	28.1	28.8	Negligible
10	Cottage	0.50	0.40	1	28.1	28.5	Negligible
11	Black Sowerby Croft	0.23	0.19	0	28.1	28.3	Negligible
12	Prospect Terrace	0.09	0.05	0	28.0	28.1	Negligible
13	Hullen Edge	0.11	0.06	0	28.0	28.1	Negligible
14	Bank House	0.37	0.21	1	28.1	28.3	Negligible
15	Mill House Farm	0.15	0.10	0	28.3	28.4	Negligible
16	Mill House Lodge	0.19	0.12	0	30.0	30.1	Negligible

AC = Ambient Concentration; PC = Process Contribution; PEC = Predicted Environmental Concentration

*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

3.101 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. The differences between the PCs predicted in the updated assessment and the predicted PCs in the 2017 ES are likely to be due to the differences in the complex terrain files used. In each case the predicted PC is less than in the 2017 ES. The predicted impacts are consistent with those predicted in the 2017 ES, i.e. 'negligible' at all discrete receptors.

3.102 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 3.14 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. The short-term NO_2 impact descriptor is 'negligible' at all relevant discrete receptors modelled, and the resulting effects are not considered to be significant.

Table 3.14 Predicted Short-Term NO_2 Impacts at Receptor Locations (at Long-Term Emission Limit Values)

		2017 ES	Updated Assessment				
Receptor ID	Receptor Name	Max 1 hour (99.79th Percentile) NO_2 PC ($\mu g.m^{-3}$)	Max 1 hour (99.79th Percentile) 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	6.2	5.1	3	59.4	65	Negligible
2	9 Breck Lea	8.1	8.6	4	56.3	65	Negligible
3	Sacred Heart Catholic Primary	7.6	7.3	4	56.3	64	Negligible
4	Haugh End House	10.5	12.2	6	56.4	69	Negligible
5	84 Rochdale Road	10.2	4.6	2	60.8	65	Negligible
6	Highfield Jerry Lane	10.9	6.2	3	57.6	64	Negligible
7	Spring Bank Industrial Estate	4.7	1.3	1	56.8	58	Negligible
8	Mill West (AQMA)	1.3	1.0	0	71.1	72	Negligible
9	Ivy Cottage	11.4	10.9	5	56.3	67	Negligible
10	Cottage	9.7	10.7	5	56.2	67	Negligible
11	Black Sowerby Croft	6.4	6.0	3	56.2	62	Negligible
12	Prospect Terrace	1.3	0.8	0	56.1	57	Negligible
13	Hullen Edge	2.1	1.1	1	56.1	57	Negligible
14	Bank House	5.4	2.7	1	56.2	59	Negligible
15	Mill House Farm	1.9	1.8	1	56.7	58	Negligible
16	Mill House Lodge	3.1	2.4	1	59.9	62	Negligible

3.103 The differences between the short-term NO_2 PCs predicted in the updated assessment and the predicted PCs in the 2017 ES are likely to be due to the differences in the complex terrain files used. In the majority of receptors the short-term NO_2 PCs is predicted to be less than in the 2017 ES with a slight but inconsequential increase in a minority of them. The predicted impacts are, generally, consistent with those predicted in the 2017 ES. The impact descriptor is 'negligible' at all discrete receptors modelled, and the resulting effects are not considered to be significant.

3.104 Figure 7.1 and Figure 7.2 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.

Figure 7.1 Predicted Annual-Mean NO_2 Process Contributions ($\mu g.m^{-3}$)

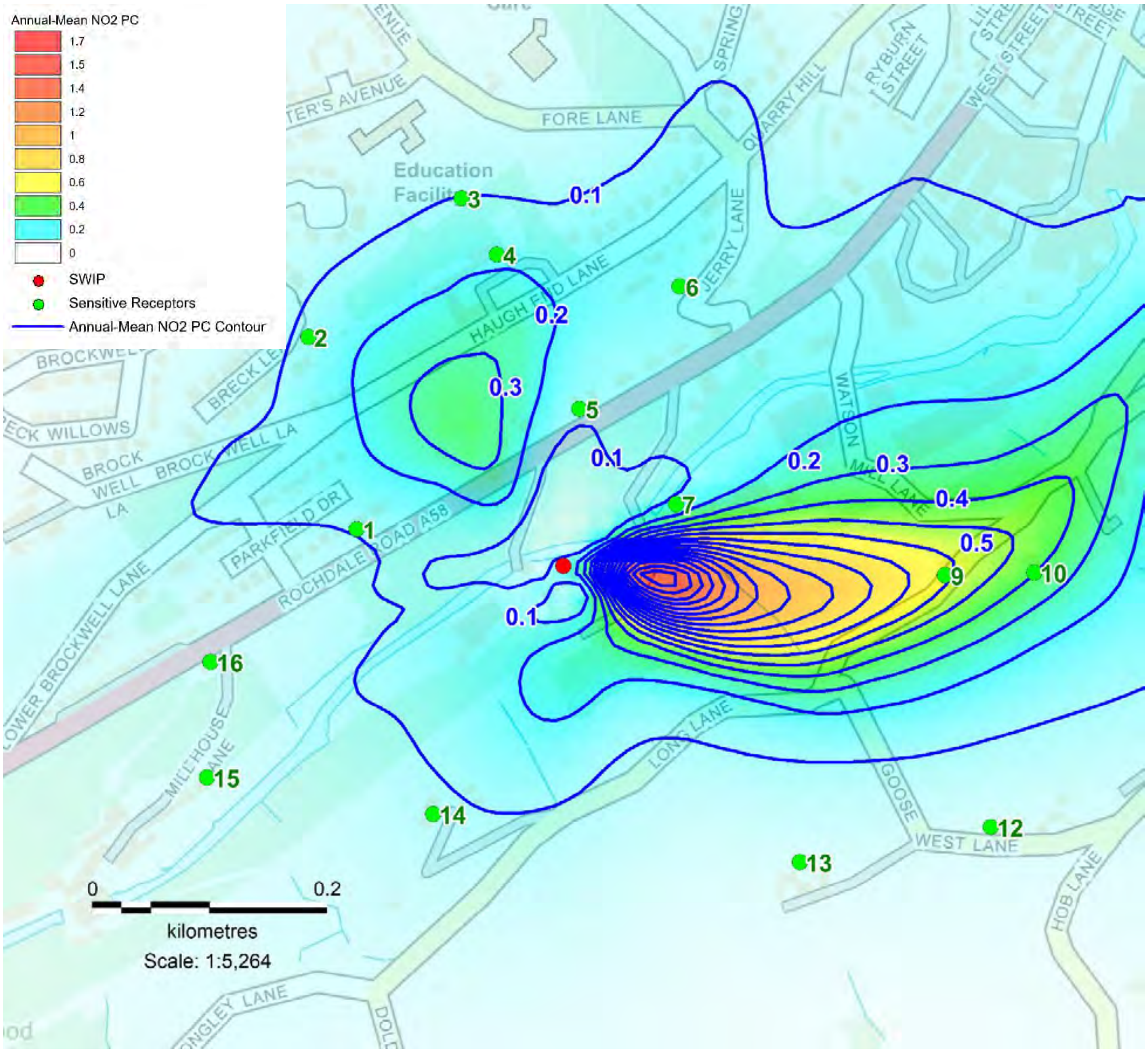
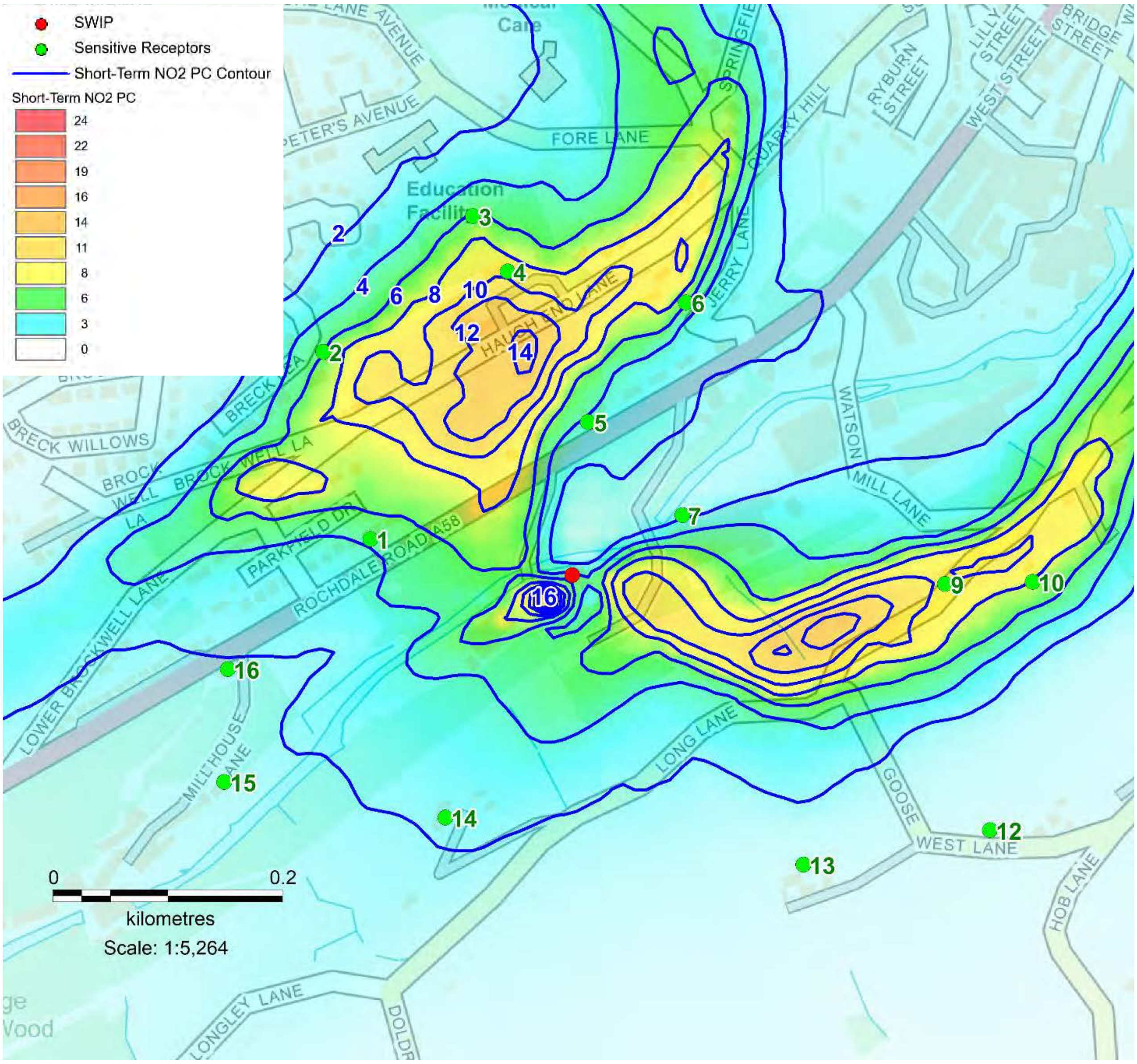


Figure 7.2 Predicted 99.79th Percentile NO_2 Process Contributions (µg.m^{-3})



3.105 As shown in Figure 7.1, the maximum annual-mean process contribution is predicted to occur just east of the site, i.e. not at a location where the public would be exposed for a year.

3.106 As shown in Figure 7.2, the maximum short-term process contribution is predicted to occur just south-west of the SWIP, i.e. not at a location where the public would be exposed for an hour. As indicated by the key in Figure 7.2, the maximum predicted process contribution across the grid is 24 µg.m^{-3}, which is 12% of the relevant EAL of 200 µg.m^{-3}. Given that the maximum short-term baseline NO_2 concentration at the sensitive receptor locations is 71 µg.m^{-3}, the PEC is predicted to be well below the EAL across the surrounding area.

Impacts – Other Pollutants

3.107 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

3.108 Table 3.15 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

3.109 Table 3.16 summarises the PCs and the resulting PECs for all pollutants assuming that the proposed development is operating at long-term emission limit values.

Table 3.15 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	27.7	4	10	0.35	28.0	No	No
HF	1 hour (maximum)	160	1.8	1	10	-		No	-
SO_2	15 minute (99.90th percentile)	266	108.6	41	10	8.9	117.5	Yes	No
	1 hour (99.73th percentile)	350	79.4	23	10	8.9	88.3	Yes	No
	24 hour (99.18th percentile)	125	21.5	17	10	8.9	30.3	Yes	No
PM_{10}	24 hour (90.41st percentile)	50	1.5	3	10	-		No	-
CO	8 hour (maximum daily running)	10000	35.9	0	10	-		No	-

Table 3.16 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	0.5	1	10	25.0	25.5	No	-	-
	24 hour (annual mean)	40	0.1	0	1	25.0	25.1	No	-	Negligible
$PM_{2.5}$	24 hour (annual mean)	25	0.1	0	1	13.0	13.1	No	-	Negligible
HCl	1 hour (maximum)	750	4.6	1	10	-	-	No	-	-
HF	1 hour (maximum)	160	0.5	0	10	-	-	No	-	-
SO_2	15 minute (99.90th percentile)	266	27.1	10	10	8.9	36.0	No	-	-
	1 hour (99.73th percentile)	350	19.9	6	10	8.9	28.7	No	-	-
	24 hour (99.18th percentile)	125	5.4	4	10	8.9	14.2	No	-	-
	1 hour (annual mean)	50	1.1	2	1	4.4	5.5	Yes	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*
CO	8 hour (maximum daily running)	10,000	18.0	0	10	-	-	No	-	-
Cd	1 hour (annual mean)	0.005	6.21E-04	12	1	1.59E-04	**0.00078**	Yes	No	-
Tl	1 hour (maximum)	30	0.02	0	10	-	-	No	-	-
	1 hour (annual mean)	1	6.21E-04	0	1	-	-	No	-	-
Hg	1 hour (maximum)	7.5	0.02	0	10	-	-	No	-	-
	1 hour (annual mean)	0.25	6.21E-04	0	1	-	-	No	-	-
Sb	1 hour (maximum)	150	0.23	0	10	-	-	No	-	-
	1 hour (annual mean)	5	0.01	0	1	-	-	No	-	-
As	1 hour (annual mean)	0.003	0.01	207	1	7.13E-04	**0.00693**	Yes	Yes	-
Cr	1 hour (maximum)	150	0.23	0	10	-	-	No	-	-
	1 hour (annual mean)	5	0.01	0	1	4.72E-03	**0.01093**	No	-	-
Co	1 hour (maximum)	6	0.23	4	10	-	-	No	-	-
	1 hour (annual mean)	0.2	0.01	3	1	1.77E-04	**0.00639**	Yes	No	-
Cu	1 hour (maximum)	200	0.23	0	10	-	-	No	-	-
	1 hour (annual mean)	10	0.01	0	1	-	-	No	-	-
Pb	1 hour (annual mean)	0.25	0.01	2	1	8.76E-03	**0.01497**	Yes	No	-
Mn	1 hour (maximum)	1500	0.23	0	10	-	-	No	-	-
	1 hour (annual mean)	0.15	0.01	4	1	3.27E-02	**0.03896**	Yes	No	-
Ni	1 hour (annual mean)	0.02	0.01	31	1	2.22E-03	**0.00843**	Yes	No	-
V	1 hour (maximum)	5	0.23	5	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)	1	0.01	1	1	-	-	No	-	-
Dioxins & Furans	1 hour (annual mean)	-	1.24E-09		1	-	-		-	-
PAHs	1 hour (annual mean)	0.00025	1.24E-05	5.0	1	2.24E-04	**2.37E-04**	Yes	No	-
PCB	1 hour (annual mean)	0.2	6.21E-05	0.0	1	-	-	No	-	-

Cells are shaded grey where impacts cannot be screened out as insignificant.

* For assessing the impacts of long-term PM10 and PM2.5, the Environmental Protection UK (EPUK)/ Institute of Air Quality Management (IAQM) Land-Use Planning & Development Control: Planning For Air Quality document has been used.

3.110 The results presented in Table 3.15 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.

3.111 The results presented in Table 3.16 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).

3.112 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.

3.113 Table 3.17 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. This is consistent with the results of the 2017 ES, which states at paragraph 7.149 that "*the annual mean PC and PEC for As are now well within the relevant EAL*".

Table 3.17: Maximum Predicted Environmental Concentrations (µg.m-3) at Long-Term Emission Limit Values – Arsenic

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?
As	1 hour (annual mean)	0.003	0.00069	23	1	0.0007	0.0014	Yes	No

3.114 For hexavalent chromium (Cr VI), the 2017 ES used the "average effective" emission concentration of 3.5 x 10^{-5} mg.Nm^{-3}. This is the value measured in the Environment Agency's '*Release from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators'* version 4 (undated). Table 3.18 shows the predicted PC at average operational emission rates.

Table 3.18 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	4.35E-07	0.2	No

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

3.116 This is consistent with the results in the 2017 ES. As detailed in Table 7.26 of the ES, using this emission concentration, the maximum predicted PC at any discrete sensitive receptor is well below 1% of the EAL and the effects are therefore not considered significant.

3.117 Paragraph 7.151 of the 2017 ES states that the units of the results in Table 7.26 are presented in nanograms per cubic metre, inconsistent with the table title which states $\mu g.m^{-3}$. The results are believed to be in nanograms per cubic metre ($ng.m^{-3}$), or 10^{-9} or billionths of a gram per cubic metre. The text in Paragraph 7.152 of the 2017 ES is erroneous and irrelevant to the Air Quality Assessment (New Lodge Farm is not a receptor in this project domain).

Significance of Effects

3.118 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.

3.119 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

3.120 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, 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 ES Addendum chapter and are more likely to be lower.

3.121 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, additional modelling has been undertaken using an alternative dispersion model, ADMS 5, and further sensitivity analysis has also been carried out, as detailed within the 2019 Air Quality Assessment Report.

Further Mitigation

3.122 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.

Cumulative Effects

3.123 Cumulative effects have been considered through the use of local monitoring data for nitrogen dioxide. During consultation with CMBC’s Pollution Control Officer, information was requested regarding any cumulative sources requiring consideration. The Pollution Control Officer noted that there is a curing process on Watson Mill Lane, but no other significant existing or committed sources of emissions in the immediate area. Given that the curing process at Watson Mill Lane is operational, it is considered appropriate to assume that any contribution from this process is taken into account within the baseline conditions.

Inter-Related Effects

3.124 No inter-relationships with other topics have been identified.

1 Directive 2010/75/EC Of The European Parliament And Of The Council of 24 November 2010 on industrial emissions

2 Council Directive 2008/98/EC European Parliament and of the Council of 5 April 2006 on Waste

3 Council Directive 2008/50/EC of 21 May 2008 on ambient air quality and cleaner air for Europe.

4 Defra, 2010, The Air Quality Standards (Wales) Regulations.

5 Defra, 2007, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Volume 2.

6 World Health Organisation Guidelines (http://www.who.int/en/)

7 Expert Panel on Air Quality Standards (www.defra.gov.uk/environment/airquality/panels/aqs/index.htm)

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

9 Communities and Local Government, February 2019, National Planning Policy Framework

10 Defra (2016) Local Air Quality Management Technical Guidance, 2016 (LAQM.TG16)

11 Email from Tommy Moorhouse (CMBC) to Rosemary Challen (RPS) dated 07/06/2019

12 Defra Digital Terrain Model (DTM) Lidar Data available from: https://environment.maps.arcgis.com/apps/MapJournal/index.html?appid=c6cef6cc642a48838d38e722ea8ccfee

13 Environment Agency (2007) Review of methods for NO to NO2 conversion in plumes at short ranges

14 Environment Agency (undated) Conversion Ratios for NOx and NO2