Air Quality Risk Assessment of Emissions to Atmosphere Shredder Celsa Manufacturing (UK) Ltd, Rover Way, Cardiff

P2209

A Report Prepared for
Earth & Marine Environmental
Consultants Ltd

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1 INTRODUCTION

Earth & Marine Environmental Consultants Ltd (EAME) has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality risk assessment of emissions to atmosphere from the proposed shredder. The shredder will be located on land to the south of Rover Way, Cardiff and will be operated by Celsa Manufacturing (UK) Ltd.

The air quality assessment is required to support an application for an Environmental Permit (EP) under the Environmental Permitting (England and Wales) Regulations.

The principal emission point to the atmosphere is Stack A11, associated with emissions of particulate matter (PM), including fine particulate matter (PM_{10} and $PM_{2.5}$).

The proposed installation will undertake the following activities (as defined in the EU Waste Framework Directive 2008/98):

- R13 (storage of waste pending any of the operations numbered R1 to R12); and
- R4 (recycling/reclamation of metals and metal compounds) activities.

The proposed shredder will shred 320,000 tonnes per year of waste and operate 10 hours per day, seven days a week. Operating hours will be 6 am to 6 pm, including 2 hours of maintenance per day.

Figure 1.1 shows the location of the proposed installation.

Figure 1.1 Location of Proposed Installation

The ADMS 5.2 dispersion model has been used to make predictions of ground-level concentrations of the following pollutants released into the atmosphere from the proposed installation:

- particulate matter (<10 μm, PM_{10}) and
- particulate matter (<2.5 μm, $PM_{2.5}$)

The remainder of this report is structured as follows:

- Section 2: describes the assessment criteria
- Section 3: presents and assesses the existing air quality
- Section 4: describes the modelling methodology
- Section 5: assessment of impacts
- Section 6: provides a summary and conclusions

About the Author

This air quality assessment and report was prepared by David Harvey MBA BSc FIAQM, who has 30 years of experience in air quality. Mr Harvey is a Director of ADM Ltd, a company he founded in 1997 and is a Fellow of the Institute of Air Quality Management (FIAQM). Fellowship is for '*professionals who have had a distinguished career in the field of air quality'*. Mr Harvey has given expert evidence at Public Inquiries on air quality, dust and odour. He has prepared evidence for a House of Commons Select Committee on three occasions and the High Court on odour nuisance.

2 ASSESSMENT AND SIGNIFICANCE CRITERIA

2.1 INTRODUCTION

This section presents the relevant air quality legislation and guidance. Also presented is a description of the pollutants assessed together with the assessment and significance levels.

2.2 LEGAL CONTEXT AND GUIDANCE

2.2.1 EUROPEAN LEGISLATION

Local authorities currently have no statutory obligation to assess air quality against European limit values, which have been transposed into UK law but are encouraged to do so. To assist with longer-term planning and the assessment of development proposals in their local areas, Defra's Technical Guidance LAQM TG16 for Local Authorities provides guidance on assessing against the time-frame of the European limit values [(1)].

Air Quality (Wales) Regulations 2000, as amended by the Air Quality (Wales) (Amendment) Regulations 2002 air quality objectives which, in most cases, are numerically synonymous with the European limit values.

Of principal concern to this assessment is particulate matter (PM_{10}).

2.2.2 NATIONAL LEGISLATION AND GUIDANCE

The Government's policy on air quality within the UK is set out in the Air Quality Strategy for England, Scotland, Wales & Northern Ireland Strategy (AQS), published in July 2007, following the requirements of Part IV of the Environment Act 1995. The Air Quality Strategy (AQS) sets out a framework to reduce adverse health effects from air pollution and ensures that international commitments are met. The AQS sets standards and objectives for pollutants to protect human health, vegetation and ecosystems.

2.2.3 DEVELOPMENT CONTROL: PLANNING FOR AIR QUALITY

In January 2017, the Institute for Air Quality Management (IAQM) and Environmental Protection UK (EPUK) published an update to its guidance document that contains a framework for air quality consideration to be accounted for in local development control [(2)]. The EPUK/IAQM guidance has been considered when undertaking this assessment.

This guidance has been included given that it can be useful, in addition to the guidance for assessment provided by the Environment Agency (EA) and Natural Resource Wales (NRW).

(1) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.

(2) IAQM (2017) Land-Use Planning & Development Control: Planning for Air Quality.

2.3 DESCRIPTION OF POLLUTANTS

2.3.1 PARTICULATE MATTER (PM)

Particulate matter (PM) is a term used to describe all suspended matter, sometimes referred to as total suspended particulate matter (TSP). Sources of particles matter in the air include road transport. Chemical processes in the air can also lead to the formation of particles. Both $PM_{2.5}$.(<2.5 μm) and PM_{10} (<10 μm) are of health concern because of their ability to penetrate and remain deep within the lungs due to their small size.

2.4 AIR QUALITY ASSESSMENT LEVELS (AQAL)

Table 2.1 shows the Air Quality Assessment Level (AQAL) used in this assessment to assess the impacts on human health.

Table 2.1 Air Quality Assessment Levels (AQAL)

Substance	Averaging time	Assessment Criteria (μg m^{-3})
Particulate matter (PM_{10})	Annual mean	40
	90.4th %ile of 24-hour means	50
Particulate matter ($PM_{2.5}$)	Annual mean	25 [a]

(a) Defra is currently consulting on a target annual mean concentration for $PM_{2.5}$ of 10 μg m^{-3} to be met across England by 2040. The Welsh Government published a White Paper on 13 January 2021, which included powers to set a target for $PM_{2.5}$.

2.5 SIGNIFICANCE CRITERIA

The impact refers to the change predicted to occur to the prevailing environment due to the proposed installation, often referred to as the process contribution (PC).

The significance of an impact is generally determined by the combination of the sensitivity and/or 'value' of the affected environmental receptor and the predicted 'extent' and/or 'magnitude' of the impact or change. The impact descriptors used in this assessment are taken from the IAQM/EPUK guidance for planning and air quality [(1)]. The assessment of significance ultimately relies on professional judgement, although comparing the extent of the impact with criteria and standards specific to each environmental topic can guide this judgement.

Details of impact descriptors used in this assessment are shown in **Table 2.2.** It should be noted that the IAQM/EPUK impact descriptors refer to permanent changes in air quality brought about by a development and not short-term or temporary changes. They also refer to locations where there is relevant

(1) IAQM (May 2017) Land-Use Planning & Development Control: Planning for Air Quality.

exposure and not necessarily the location of the maximum impact. The criteria, therefore, are only appropriate for changes to annual average concentrations at locations where there is relevant exposure, ie not generally the point of maximum impact.

Table 2.2 IAQM/EPUK Air Quality Impact Descriptors for Individual Receptors

Long-term Average Concentration at Receptor in Assessment Year	% Change in Concentration Relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL [a]	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
102%-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Note: Changes less than 0.5% are Negligible.
(a) Air Quality Assessment Level (AQAL).

The IAQM guidance on significance shown in **Table 2.2** is only applicable to long-term/annual average impacts where there is relevant exposure.

For short-term impacts, the IAQM guidance states:

'Where such peak short-term concentrations from an elevated source are in the range 11-20% of the relevant AQAL, then their magnitude can be described as small, those in the range 21-50% medium and those above 51% 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.'

The Environment Agency's (EA)/NRW risk assessment guidance, includes a two stage test for insignificance of impacts [1].

Stage 1:

The EANRW guidance states that the process contribution (PC) can be considered as insignificant if both of the following are achieved:

- The long-term PC is <1% of the long-term Environmental Assessment Level (EAL)
- The short-term PC is < 10% of the short-term Environmental Assessment Level (EAL)

The EA/NRW guidance states:

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.

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

Stage 2:

The EA/NRW guidance states that detailed modelling of emissions is needed for emissions that do not meet both of the following requirements:

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

This is not to say that if these thresholds are exceeded, the process contribution (PC) is significant, just that it cannot be ruled out as being insignificant.

2.6 WORLD HEALTH ORGANIZATION (WHO) GUIDELINES

In September 2021, the World Health Organization (WHO) updated its 2005 Air Quality Guidelines (1). The WHO's 2021 Air Quality guidelines (AQG) for PM_{10} and $PM_{2.5}$ are shown below.

Fine particulate matter ($PM_{2.5}$):

- 5 μg m^{-3} annual mean
- 15 μg m^{-3} 24-hour mean

Coarse particulate matter (PM_{10}):

- 15 μg m^{-3} annual mean
- 45 μg m^{-3} 24-hour mean

A spokesperson for the Department for Environment, Food and Rural Affairs (Defra) said in response to the publication of the WHO guidelines (2).

'Air pollution has reduced significantly since 2010 – at a national level emissions of fine particulate matter have fallen by 11%, while emissions of nitrogen oxides are at their lowest level since records began.

To continue to drive forward tangible and long-lasting improvements to the air we breathe, we will set stretching and ambitious targets on air quality through our Environment Bill. We will consider the updated WHO guidelines on PM2.5 to inform the development of air quality targets but we must not underestimate the challenges these would bring particularly in large cities and for people's daily lives.

We must all understand the impact of the choices we need to make, which is why we will be running a public consultation on the proposed targets early next year which will inform the target setting process alongside independent expert advice and analysis on a range of factors.'

(1) World Health Organization (2021) WHO global air quality guidelines.
(2) https://deframedia.blog.gov.uk/2021/09/23/who-updates-guideline-levels-for-air-pollutants/.

2.7 NATURE CONSERVATION SITES

The only mechanism whereby emissions to the atmosphere of particulate matter from the proposed stack A11 of the shredder might affect a nature conservation site is through dust soiling (ie direct deposition of particulate matter onto vegetation).

In May 2020, the IAQM published guidance on the assessment of air quality impacts on designated nature conservation sites (1). The IAQM guidance does not include consideration of the effects of soiling. It does, however, make reference to the methodology for the qualitative risk assessment of construction dust on ecological sites (2).

(1) IAQM (May 2020) A guide to the assessment of air quality impacts on designated nature conservation sites.
(2) IAQM (February 2014) Guidance on the assessment of dust from demolition and construction.

3 AMBIENT AIR QUALITY DATA

3.1 INTRODUCTION

This section describes the ambient air quality in the region of the proposed installation.

Cardiff Council (CC) has designated four Air Quality Management Areas (AQMAs) within their administrative. The closest AQMAs are Stephenson Court and Cardiff City Centre, located approximately 3 km northeast of the proposed installation. These AQMAs were designated due to exceedences of the annual mean AQS objective for nitrogen dioxide (NO_2) and are therefore not relevant to this assessment.

3.2 MEASURED DATA

Cardiff Council measures ambient PM_{10} concentrations at three locations within 5 km of the proposed installation.

Table 3.1 shows the measured annual average concentration of PM_{10} for 2016 to 2020, together with the OS grid reference and distance from the proposed installation.

Table 3.1 Measured Annual Average Concentrations of PM_{10} (μg m^{-3}) for 2016 to 2020

Station Name/OS Grid Reference, Distance from Site (km)	Cardiff Centre AURN 1 (318416,176525), 3.1 km	Cardiff Newport Road AURN 2 (320095,177520), 1.9 km	Cardiff Castle Street (318055, 176459) 3.5 km
2016	15	-	-
2017	16	-	-
2018	17	20	-
2019	22	19	-
2020 [(a)]	14	17	16
Air Quality Assessment Level (AQAL)		**40**	
(a) Due to lower traffic levels during the Covid 19 pandemic lock-down, concentrations are reduced.			

Source: Cardiff Council (November 2021) 2021 Air Quality Progress Report for Cardiff Council

Table 3.1 shows that the measured annual average concentration of PM_{10} is in the range of 15 to 22 μg m^{-3}, significantly below the Air Quality Assessment Level (AQAL) of 40 μg m^{-3}.

3.3 ESTIMATED BACKGROUND CONCENTRATIONS

The Department for Environment, Food and Rural Affairs (Defra) provides estimates of the background concentrations for several pollutants for many years on a 1 km grid resolution for the whole of the UK. The OS grid reference closest to the proposed installation's location is 321500,176500.

Table 3.2 summarises all the relevant annual average background pollutant concentrations used in this assessment and the data source.

Table 3.2 Estimated Annual Average Background Pollutant Concentrations for 2022 ($\mu g\ m^{-3}$)

Pollutant	Background Concentration	Air Quality Assessment Level (AQAL)	Percentage of AQAL (%)
Particulate matter (PM_{10})	12.8	40	32
Particulate matter ($PM_{2.5}$)	8.0	25	32

Table 3.2 shows that all the estimated background annual average concentrations of PM_{10} and $PM_{2.5}$ are less than the Air Quality Assessment Level (AQAL).

4 METHODOLOGY

4.1 INTRODUCTION

This section describes the methodology and assumptions made for the air quality assessment. Also described are the emissions data used.

4.2 EMISSIONS DATA

Table 4.1 and Table 4.2 show the parameters which describe the physical properties of emissions from the proposed A11 stack, as required for the definition of the emissions in dispersion modelling terms.

Table 4.1 Emissions and Physical Properties

Parameter	Value
Number of stacks	1
Number of flues in each stack	1
Stack A11:OS Grid Reference (m)	321509 176296
Release height above ground level (m)	18.0
Actual volumetric flow rate per flue ($Am^3\ hr^{-1}$)	30,000
Actual volumetric flow rate per flue ($Am^3\ s^{-1}$)	8.3
Exhaust gas water content (% v/v)	1.1
Flue diameter (m)	1.0
Exit velocity ($m\ s^{-1}$)	10.6
Flue gas emission temperature (deg C)	28
Normalised volumetric flow per flue ($Nm^3\ s^{-1}$) [(a)]	7.5
(a) Corrected for: dry at 273 k; pressure; 101.3kPa (1 atmosphere).	

Table 4.2 shows both the pollutant emission concentrations and emission rates.

Table 4.2 Pollutant Emission Concentrations and Emission Rates

	Emission Concentration ($mg\ Nm^{-3}$) [(a)]	Emission Rate ($g\ s^{-1}$)
BAT-associated emission level (BAT-AEL)		
Dust (particulate matter, PM)	5	0.037
PM_{10}	5	0.037
$PM_{2.5}$	5	0.037
Expected (actual) [(b)]		
Dust (particulate matter, PM)	0.73	0.0055
PM_{10}	0.04	0.00030
$PM_{2.5}$	0.04	0.00030
(a) Corrected for: dry at 273 k; pressure; 101.3kPa (1 atmosphere).. (b) ESG (3 September 2015) Stack emissions monitoring report, A1 – Metal Shredder.		

Operating hours will be seven days per week, 6 am to 6 pm, including 2 hours of maintenance per day.

4.3 RECEPTORS

Predictions are made of ground-level concentrations using a grid of receptors. The receptor grid is 1,000 m by 1,000 m with a grid spacing of 10 m. Making predictions using a grid of receptors allows the maximum impact to be determined, and also the predicted ground-level concentrations can be presented as contour plots.

In addition to predictions made using a grid of receptors, predictions are made at 7 specific receptors selected to represent locations where there is relevant exposure, such as residential properties.

For Local Air Quality Management (LAQM), the Air Quality Strategy Objectives (AQS) only apply where there is ‘relevant exposure’. This is defined as being where members of the public are regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. For the annual average objective, locations of relevant exposure include residential properties, schools and hospitals.

Table 4.3 presents details of the specific receptors included in the modelling selected because of their potential for ‘relevant exposure’.

Table 4.3 Human Health Receptor Locations

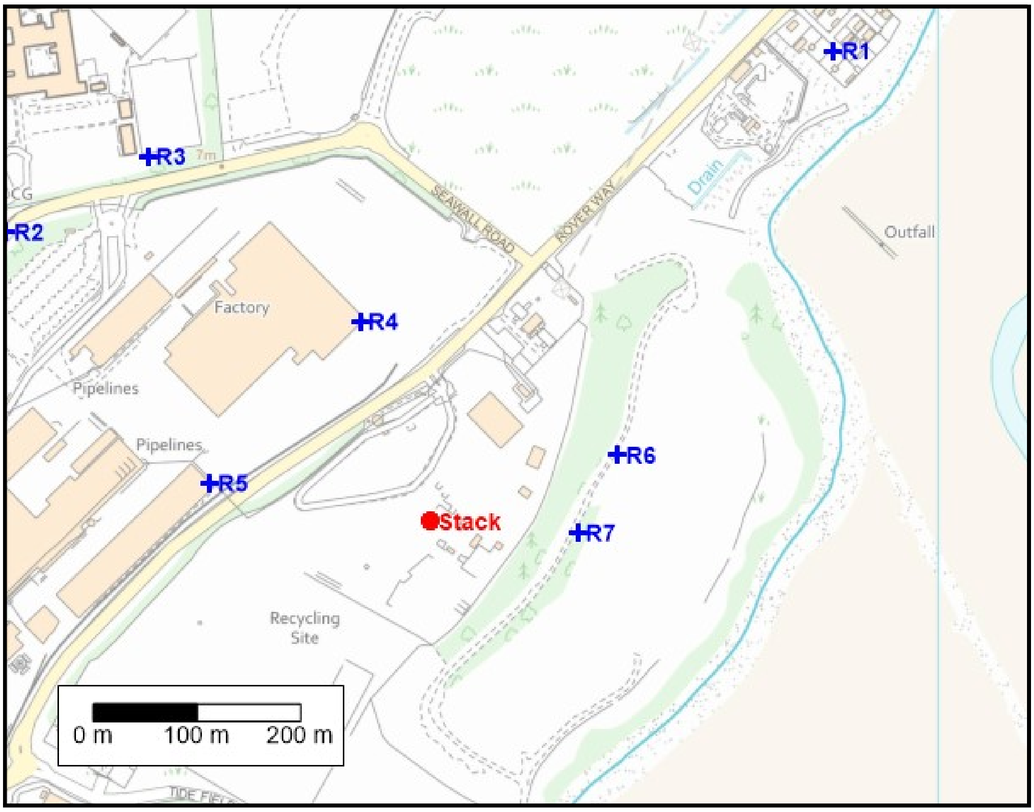
No.	Description	Distance from Stack (km)	OS Grid Reference (m)	
R1	Caravan Site	0.6	321899	176750
R2	Residential – Willows Avenue	0.5	321069	176556
R3	Willows High School	0.4	321237	176648
R4	Industrial	0.2	321442	176489
R5	Industrial	0.2	321297	176333
R6	Proposed Industrial	0.2	321691	176360
R7	Proposed Industrial	0.2	321652	176285

In addition to the human health receptors, three designated ecological sites require consideration:

- Severn Estuary Ramsar/SAC/SPA/SSSI, 300 m to the south-east
- Gwent Levels SSSI, 2 km north-east
- Cardiff Beech Woods SAC, 10 km to the north-west

Figure 4.1 shows the locations of the human receptors.

Figure 4.1 Location of Human Health Receptors and Stack (A11)



4.4 FACTORS AFFECTING DISPERSION

Several factors will affect how emissions disperse once released into the atmosphere. The four factors having the most significant effect on dispersion are:

- Physical characteristics of the emissions
- Climate
- Terrain
- Building downwash/Tree downwash

4.4.1 PHYSICAL CHARACTERISTICS OF THE EMISSIONS

Provided that the exhaust gases have sufficient velocity to overcome the effects of stack tip downwash, which is almost certainly the case for velocities of 15 m s^{-1} or more, the physical characteristics of the flue gases will determine the amount of plume rise and hence the effect on ground level pollutant concentrations. The degree of plume rise depends on the greater of the thermal buoyancy or momentum effects and not necessarily a combination of the two effects.

4.4.2 CLIMATE

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind speed, wind direction and atmospheric stability.

- **Wind direction** determines the broad transport of the plume and the sector of the compass into which the plume is dispersed.

- **Wind speed** can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

- **Atmospheric stability** is a measure of the turbulence of the air, particularly of the vertical motions present. For dispersion modelling purposes, one method of classifying stability is by using Pasquill Stability categories, A to F. Dispersion models, such as ADMS and AERMOD, do not allocate the degree of atmospheric turbulence into six discrete categories (A-F). These models use a parameter known as the Monin-Obukhov length, which, together with the wind speed, describes the atmosphere's stability.

4.4.3 BUILDING DOWNWASH

The presence of buildings can significantly affect the dispersion of atmospheric emissions. Wind blowing around a building distorts the flow and creates greater turbulence zones than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. For elevated releases such as from stacks, building downwash leads to higher ground level concentrations closer to the stack than those present if a building was not there. The effects of building downwash are usually only significant where the buildings are more than about 40% of the stack height.

The acoustic housing around the proposed shredding equipment will affect dispersion and has been included in the model as solid buildings.

Table 4.4 shows the dimensions of the buildings included in the modelling.

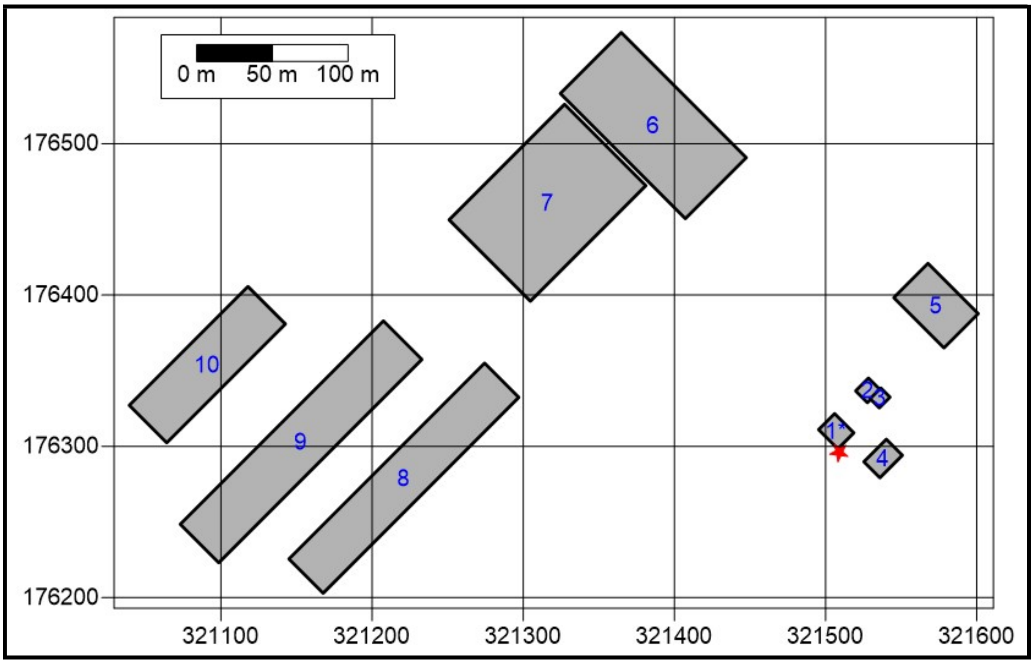
Table 4.4 Dimensions of Buildings Included in the Modelling

Building	Centre (m)		Height (m) [(a)]	Length (m)	Width (m)	Angle (deg) [(b)]
1	321507	176310	11.5	18	15	135
2	321528	176337	11.5	11	12	135
3	321536	176331	11.5	8.6	10	135
4	321538	176292	14.0	15	21	135
5	321573	176393	13.8	47	32	135
6	321386	176512	38.5	117	57	135
7	321316	176461	16.5	76	108	135
8	321221	176279	24.0	32	183	135
9	321153	176303	42.0	36	190	135
10	321091	176354	22.0	35	111	135

(a) Height above ground level.
(b) Angle building length makes to the north.

Figure 4.2 shows the buildings included in the modelling and the stack location**.**

Figure 4.2 Buildings included in the Model (Stack is Red Star)



4.4.4 NATURE OF THE SURFACE

Terrain

The effects of elevated terrain can affect dispersion and have been included in the modelling.

Roughness

The nature of the surface can have a significant influence on dispersion by affecting the vertical velocity profile (ie the rate of increase in wind speed for increasing heights above ground level). The amount of atmospheric turbulence also affects dispersion.

The site is located close to the coast, which will result in lower roughness lengths for onshore winds. Considering the site's surrounding nature, the dispersion modelling has assumed a surface roughness length of 0.3 m. A surface roughness length of 0.2 m is assumed for the Cardiff Airport, which is the source of the meteorological data used in this assessment.

Coastline

For the following conditions, emissions from elevated sources close to a coast (less than 5 km) can be drawn into an internal boundary layer that forms along the coast.

- Winds blowing onshore
- The land is warmer than the sea
- Meteorological conditions over the land are unstable (convective)

The effects can be simulated in ADMS's coastline module, but the effects tend only to be significant for stacks that are significantly taller than the proposed 18 m stack. Also, it is not possible to combine the effects of the coastline and building downwash. Given that, in this case, building downwash effects will be much greater than coastline effects, the coastline module has not been selected.

4.5 SELECTION OF SUITABLE DISPERSION MODEL

The dispersion models widely used to predict ground-level pollutant concentrations are based on the concept of the time-averaged lateral and vertical concentration of pollutants in a plume being characterised by a Gaussian [1] distribution. Older models such as ISC characterise the atmosphere into several discrete stability classes. So called 'new generation' dispersion models such as ADMS and AERMOD have been developed, which replace the description of the atmospheric boundary layer as being composed of discrete stability classes with an infinitely variable measure of the surface heat flux, which in turn influences the turbulent structure of the atmosphere and hence the dispersion of a plume.

Two commercially available dispersion models described by the Environment Agency (EA) as being 'new generation' are:

- AERMOD: The US **A**merican Meteorological Society and **E**nvironmental Protection Agency **R**egulatory Model Improvement Committee developed

(1) A Gaussian distribution has the appearance of a bell-shaped curve. The maximum concentration occurs on the centre line.

the dispersion **MOD**del called AERMOD, which incorporates the latest understanding of the atmospheric boundary layer.

- Atmospheric Dispersion Modelling System (ADMS): This dispersion model was developed by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer.

In many respects, the models are quite similar and generate comparable predictions of ground-level concentrations in many situations.

The ADMS 5.2 dispersion model was selected for use in this assessment because it has been extensively validated and widely used for assessment work of this nature.

4.6 METEOROLOGICAL DATA

An essential input to the dispersion model is the meteorological data.

Cardiff Airport is the closest observing station where complete data are available. Five years of hourly meteorological data used for this assessment are from 2017 to 2021.

Figure 4.3 shows the windrose for the Cardiff Airport for 2017-2021.

Figure 4.3 Wind Rose from the Cardiff Airport (2017-2021)

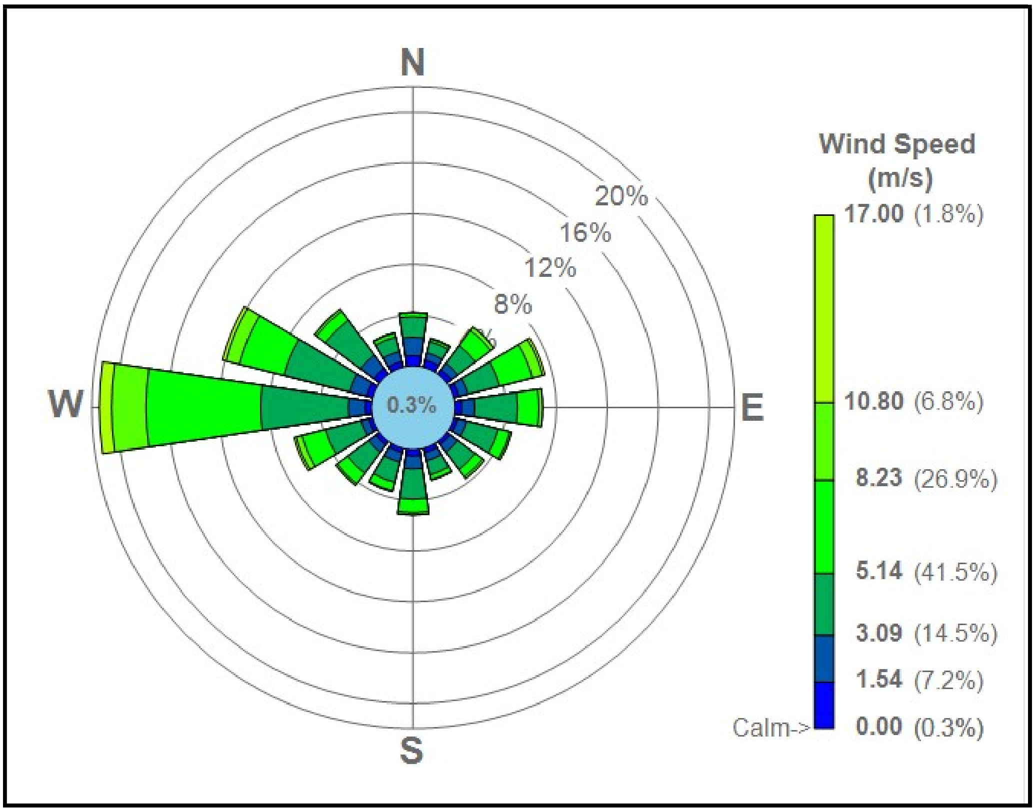


Figure 4.3 shows that the prevailing wind direction is from the west, which will transport emissions to the east.

5 PREDICTIONS AND ASSESSMENT OF IMPACTS

5.1 INTRODUCTION

This section presents the incremental increase in ground-level concentrations predicted to occur due to emissions to the atmosphere from the operation of the proposed shredder. The incremental increase is referred to as the Process Contribution (PC). The PC + the prevailing background concentration is the Predicted Environment Concentration (PEC). Predictions are presented, and an assessment is made of the routine emissions to the atmosphere from the proposed installation.

5.2 MODELLING AND ASSESSMENT OF EMISSIONS

5.2.1 PARTICULATE MATTER (PM_{10})

Table 5.1 shows the predicted annual average ground level Process Concentration (PC) of PM_{10} at the specific receptors and at the point of maximum impact for each of the five years of meteorological data. Also shown are the Predicted Environmental Concentrations (PEC).

Table 5.1 ADMS 5.2 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) Annual Average Ground Level Concentrations of PM_{10} (μg m^{-3}) at an Emission Concentration of 5 mg Nm^{-3}

Location	Process Contribution (PC)						Predicted Environmental Concentration (PEC)	Maximum PC as Percentage of AQAL (%)
	2017	2018	2019	2020	2021	Max.		
R1	0.01	0.01	0.01	0.01	0.01	**0.01**	**12.8**	**0.0%**
R2	0.02	0.02	0.01	0.01	0.01	**0.02**	**12.8**	**0.0%**
R3	0.01	0.01	0.01	0.01	0.01	**0.01**	**12.8**	**0.0%**
R4	0.00	0.00	0.00	0.00	0.00	**0.00**	**12.8**	**0.0%**
R5	0.05	0.05	0.06	0.05	0.05	**0.06**	**12.9**	**0.1%**
R6	0.10	0.09	0.09	0.10	0.09	**0.10**	**12.9**	**0.3%**
R7	0.29	0.24	0.25	0.24	0.23	**0.29**	**13.1**	**0.7%**
Grid Maximum	**0.38**	**0.32**	**0.34**	**0.33**	**0.30**	**0.38**	**13.2**	**1.0%**
Air Quality Assessment Level (AQAL)						**40**		

Table 5.1 shows that the maximum predicted annual average ground-level Process Contribution of PM_{10} is 0.38 μg m^{-3} which is 1.0% (0.95%) of the long-term Air Quality Assessment Level (AQAL) of 40 μg m^{-3}.

Given that the grid maximum PC is less than 1% of the AQAL, it is screened out as insignificant using the EA/NRW screening criteria.

The IAQM/EPUK significance criteria apply to locations where there is relevant exposure and are only applicable to annual average concentrations. Defra's TG16 guidance gives the following examples of where there is relevant exposure to annual average objectives

- Building facades of residential properties
- Schools
- Hospitals
- Care homes

Examples of where there is no relevant exposure to annual average objectives include; gardens of residential properties, hotels, and kerbside sites.

The IAQM/EPUK impact description is 'negligible' at all the receptor locations with relevant exposure to annual average concentration (eg residential properties).

Table 5.2 shows the predicted 90.4th percentile of 24 hourly average Process Contribution (PC) at the specific receptors at the point of maximum impact for each of the five years of meteorological data. Also shown are the Predicted Environmental Concentrations (PEC).

Table 5.2 ADMS 5.2 Predicted 90.4th Percentile of 24 Hourly Average Ground Level Process Contribution (PC) of PM_{10} ($\mu g\ m^{-3}$) at an Emission Concentration of 5 mg Nm^{-3}

No.	Process Contribution (PC)						Predicted Environmental Conc. (PEC) a)	Maximum PC as Percentage of AQAL (%)
	2017	2018	2019	2020	2021	Max.		
R1	0.00	0.00	0.00	0.00	0.00	**0.00**	**25.6**	**0.0%**
R2	0.00	0.00	0.00	0.00	0.00	**0.00**	**25.6**	**0.0%**
R3	0.00	0.00	0.00	0.00	0.00	**0.00**	**25.6**	**0.0%**
R4	0.00	0.00	0.00	0.00	0.00	**0.00**	**25.6**	**0.0%**
R5	0.00	0.03	0.02	0.00	0.01	**0.03**	**25.6**	**0.1%**
R6	0.43	0.32	0.34	0.48	0.25	**0.48**	**26.1**	**1.0%**
R7	1.57	1.39	1.42	1.33	1.28	**1.57**	**27.2**	**3.1%**
Grid Maximum	**2.15**	**1.89**	**1.97**	**1.90**	**1.70**	**2.15**	**27.7**	**4.3%**
Air Quality Assessment Level (AQAL)						**50**		
(a) EA/NRW: 'Short-term background concentration of a substance is twice its long-term concentration.'								

Table 5.2 shows that the maximum predicted 90.4th percentile of 24 hourly average PM_{10} Process Contribution (PC) is 2.15 $\mu g\ m^{-3}$ which is 4.3% of the Air Quality Assessment Level (AQAL) of 50 $\mu g\ m^{-3}$.

Given that the grid maximum PC is less than 10% of the short-term AQAL, it is screened out as insignificant using the EA/NRW screening criteria.

The IAQM/EPUK impact description is 'negligible' at all the receptor locations with relevant exposure to short term concentrations.

Table 5.1 and Table 5.2 show that predicted Process Contribution (PC) concentrations of PM_{10} occurring due to emissions from the proposed installation operating at its emissions limit are insignificant and not of concern to human health.

It should be noted that predictions presented in **Table 5.1** and **Table 5.2** conservatively assuming all the particulate matter emissions are PM_{10} and the emissions at the emission limit of 5 mg Nm^{-3}. The actual emission concentration of PM_{10} will be significantly lower.

The following figures are presented to illustrate the distribution of concentrations of PM_{10}. 2017 meteorological data are used as this is the year that gives rise to the highest impact. The predictions are for the Process Contributions (PC).

- **Figure 5.1;** Annual Average
- **Figure 5.2**; 90.4th percentile of 24 hourly averages

The figures show that peak predicted increments to ground level concentrations occur within about 100 m of the installation.

Figure 5.1 **ADMS 5.2 Predicted Annual Average Ground Level Process Contribution (PC) of PM_{10}; 2017 Meteorological Data ($\mu g\ m^{-3}$); Assuming an Emissions Concentration of 5 mg Nm^{-3}**

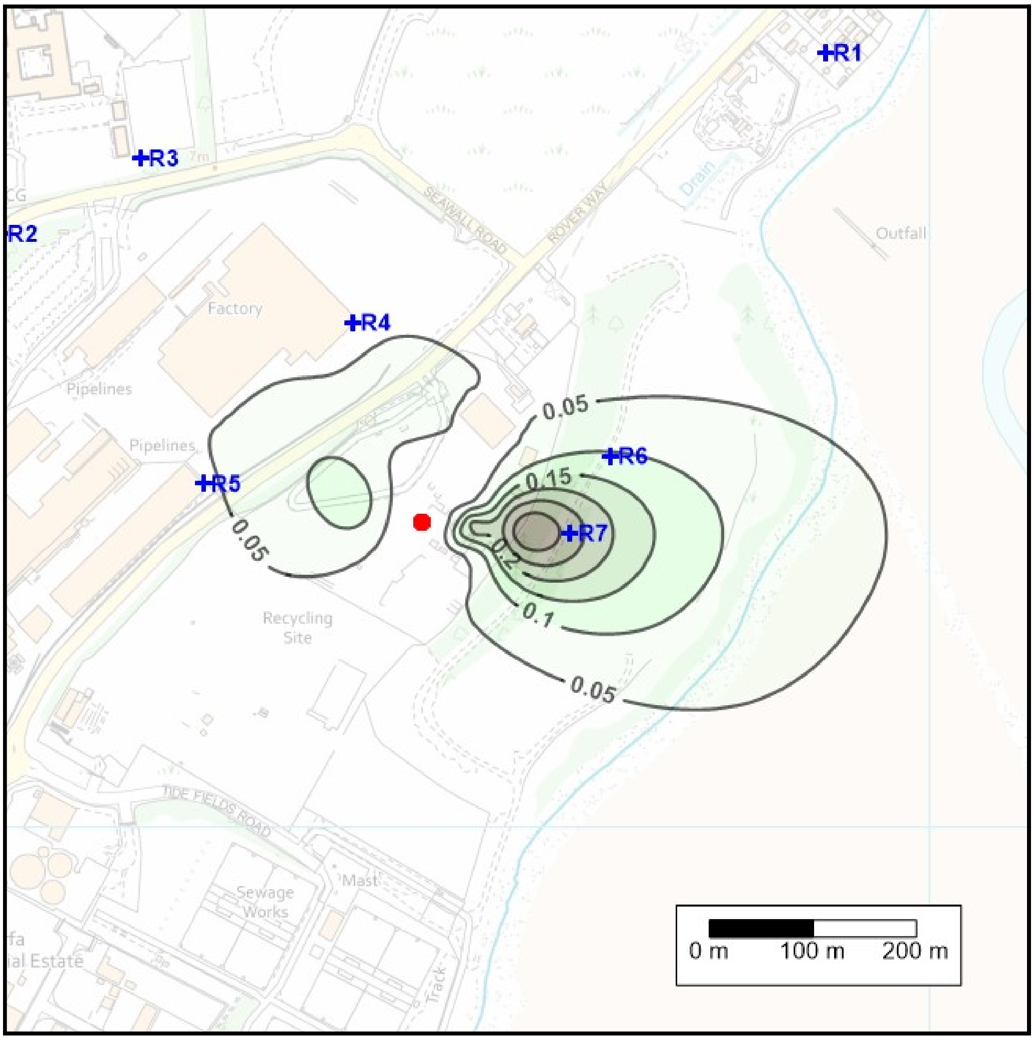
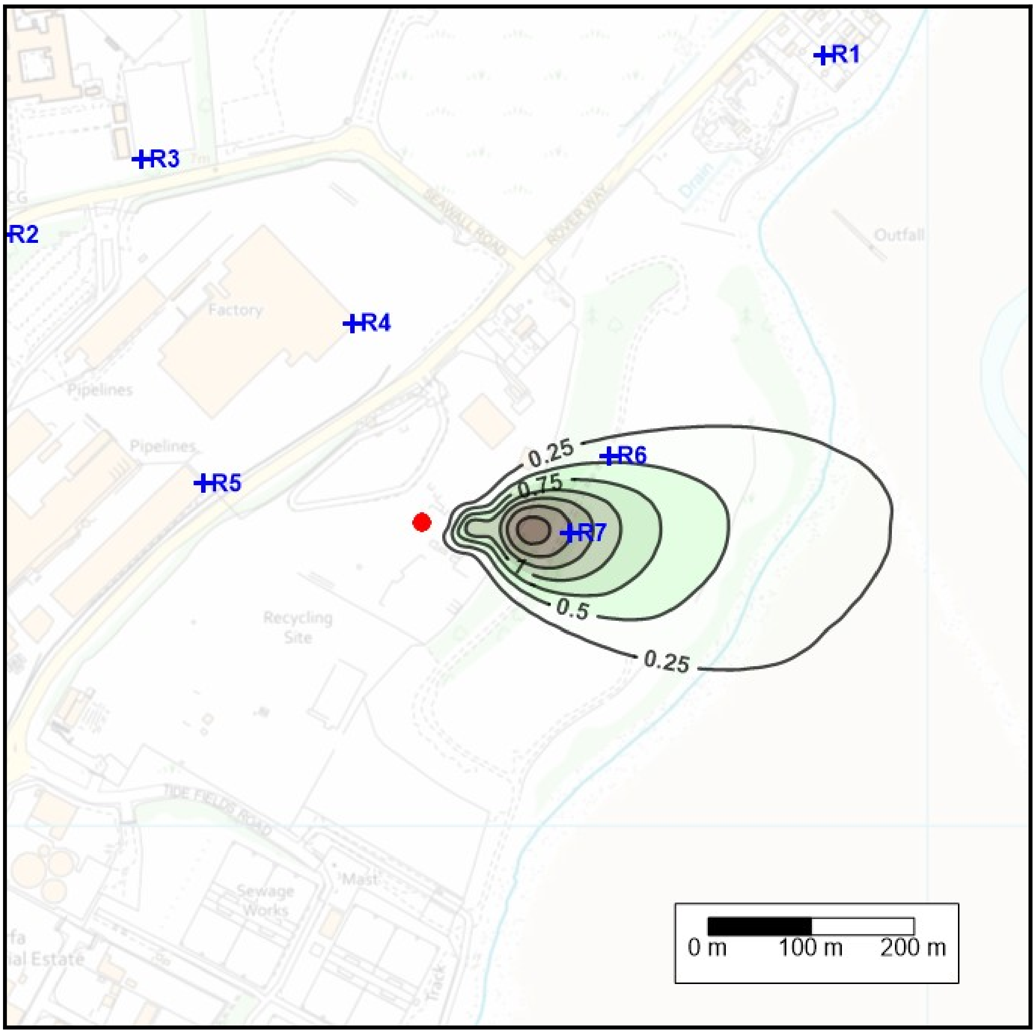


Figure 5.1 shows that the Process Contribution (PC) concentration at the estuary, which is the closest ecological site, is less than 0.05 $\mu g\ m^{-3}$. The deposition rate associated with an annual average concentration of 0.05 $\mu g\ m^{-3}$ will be negligible, and therefore the impact on vegetation and ecosystems of emissions from the proposed A11 stack will be negligible.

Figure 5.2 **ADMS 5.2 Predicted 90.4th Percentile of 24 Hourly Average Ground Level Process Contribution (PC) Concentrations of PM_{10}; 2017 Meteorological (μg m^{-3}); Assuming an Emissions Concentration of 5 mg Nm^{-3}**



5.2.2 PARTICUALTE MATTER ($PM_{2.5}$)

Table 5.3 shows the predicted annual average ground level Process Concentration (PC) of $PM_{2.5}$ at the specific receptors and at the point of maximum impact for each of the five years of meteorological data. Also shown are the Predicted Environmental Concentrations (PEC).

Table 5.3 ADMS 5.2 Predicted Process Contribution (PC) and Predicted Environmental Concentration (PEC) Annual Average Ground Level Concentrations of $PM_{2.5}$ (μg m^{-3}) at an Emission Concentration of 5 mg Nm^{-3}

Location	Process Contribution (PC)						Predicted Environmental Concentration (PEC)	Maximum PC as Percentage of AQAL (%)
	2017	2018	2019	2020	2021	Max.		
R1	0.01	0.01	0.01	0.01	0.01	**0.01**	**8.0**	**0.0%**
R2	0.02	0.02	0.01	0.01	0.01	**0.02**	**8.0**	**0.1%**
R3	0.01	0.01	0.01	0.01	0.01	**0.01**	**8.0**	**0.1%**
R4	0.00	0.00	0.00	0.00	0.00	**0.00**	**8.0**	**0.0%**
R5	0.05	0.05	0.06	0.05	0.05	**0.06**	**8.1**	**0.2%**
R6	0.10	0.09	0.09	0.10	0.09	**0.10**	**8.1**	**0.4%**
R7	0.29	0.24	0.25	0.24	0.23	**0.29**	**8.3**	**1.2%**
Grid Maximum	**0.38**	**0.32**	**0.34**	**0.33**	**0.30**	**0.38**	**8.4**	**1.5%**
Air Quality Assessment Level (AQAL)						**25**		

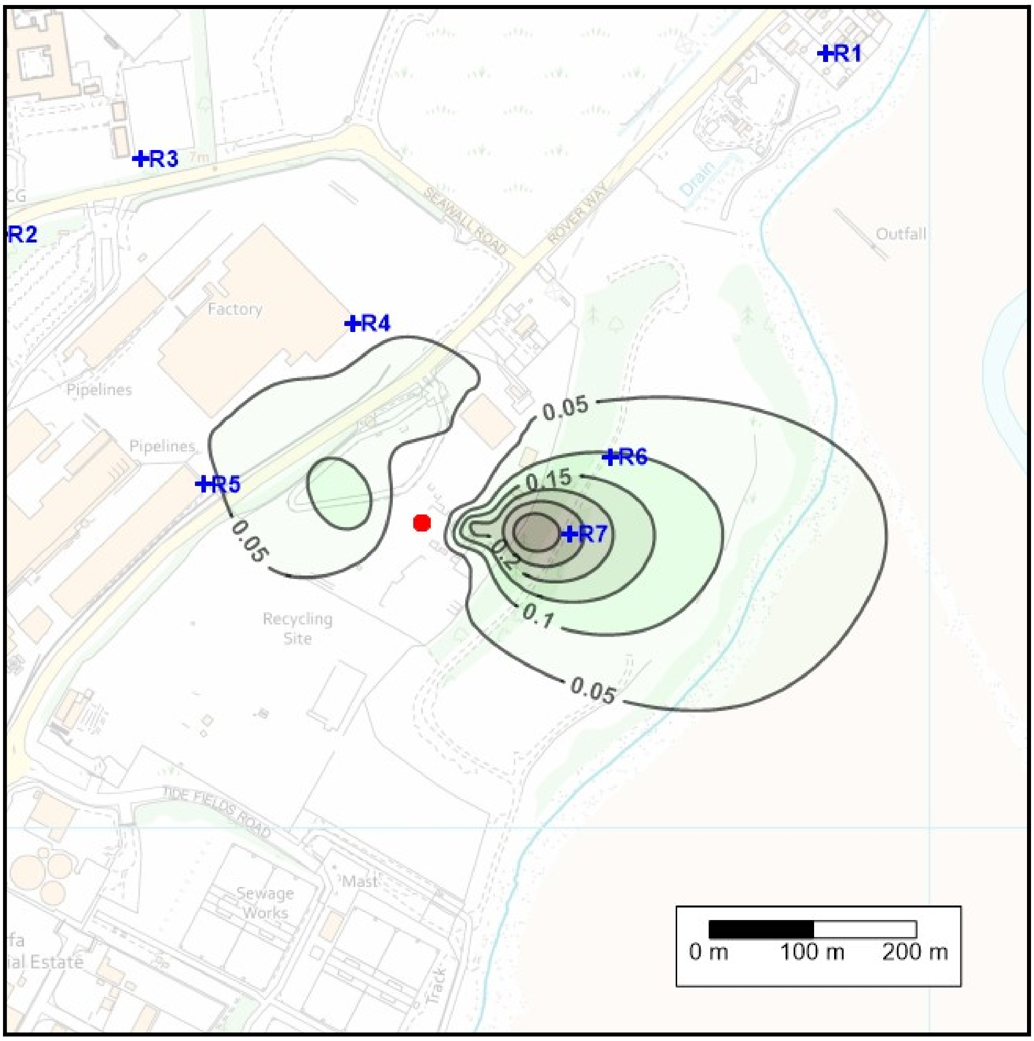
Table 5.3 shows that the maximum predicted annual average ground-level Process Contribution of $PM_{2.5}$ is 0.38 μg m^{-3} which is 1.5% of the long-term Air Quality Assessment Level (AQAL) of 25 μg m^{-3}.

Given that the maximum PEC of 8.4 μg m^{-3} is less than 70% of the AQAL and there is no short term AQAL for $PM_{2.5}$, the impact can be screen as insignificant using Stage 2 of the EA/NRW screening criteria.

It should be noted that predictions presented in **Table 5.3** are conservatively assume all the particulate matter emissions are $PM_{2.5}$ and the emissions at the emission limits of 5 mg Nm^{-3}. The actual emission concentration of $PM_{2.5}$ will be significantly lower.

Figure 5.3 shows the distribution of annual average Process Contribution (PC) concentrations of $PM_{2.5}$ for 2017 meteorological data, which is the year that gives rise to the highest impact.

Figure 5.3 ADMS 5.2 Predicted Annual Average Ground Level Process Contribution (PC) of $PM_{2.5}$; 2017 Meteorological Data ($\mu g\ m^{-3}$); Assuming an Emissions Concentration of 5 mg Nm^{-3}



6 SENSITIVITY ANALYSIS

6.1 INTRODUCTION

This section considers the sensitivity of model-predicted concentrations to the following:

- Meteorological data
- Roughness length
- Grid spacing
- Building downwash
- Terrain
- Stack height

6.2 METEOROLOGICAL DATA

The assessment presented in this report is based on predictions made using five years (2017-2021) of meteorological data from Cardiff Airport.

To illustrate the year-to-year variation in meteorological data, **Table 6.1** shows the maximum predicted ground level concentration of PM_{10} for five years of Cardiff Airport meteorological data and predictions made with 2017 meteorological data from St Athan.

Table 6.1 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\,m^{-3}$)

Year and Source	Annual Average	90.4th Percentile of 24-Hour Averages
Cardiff 2017	0.38	2.15
Cardiff 2018	0.32	1.89
Cardiff 2019	0.34	1.97
Cardiff 2020	0.33	1.90
Cardiff 2021	0.30	1.70
St Athan 2017	0.40	2.13
Assessment Criteria	**40**	**50**

Table 6.1 shows that there is some year to year variation in predicted concentrations, although it is not considered to be significant. The maximum predicted annual average concentration using meteorological data from St Athan is insignificantly higher than using data from Cardiff Airport for 2017; the maximum predicted 90.4th percentiles are similar.

6.3 ROUGHNESS LENGTH

The roughness length of 0.3 m used in this assessment was selected using professional judgement because roughness length is not something that can be directly measured. There is no one unique roughness that fits a given wind speed profile in practice. Roughness length will also vary depending on wind direction and other factors such as the season of the year.

Therefore, it is of interest to see how sensitive the model predictions are to roughness length.

Table 6.2 shows the maximum predicted ground level concentration of PM_{10} for roughness lengths in the range of 0.1 m to 0.5 m using 2017 meteorological data.

Table 6.2 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\ m^{-3}$)

Roughness Length (m)	Annual Average	90.4th Percentile of 24-Hour Averages
0.1	0.39	2.26
0.3	0.38	2.15
0.5	0.38	2.10
Assessment Criteria	**40**	**50**

Table 6.2 shows that increasing roughness length marginally reduces the maximum predicted 90.4th percentile in this modelling situation and has no effect on the annual average concentration.

6.4 GRID SPACING

If the grid spacing is too large, then it is possible that the reported maximum concentrations will not be the actual maxima. This assessment uses a grid spacing of 10 m which is appropriate at less than 1.5 times the stack height. One way to demonstrate this is to model with smaller grid spacing. If the maximum concentration is not significantly different, one can be confident that the grid spacing is adequate.

Table 6.3 shows the maximum predicted ground level concentration of PM_{10} for the grid spacing of 5 m, 10 m (used in this assessment), and 20 m. Predictions are made using 2017 meteorological data.

Table 6.3 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\ m^{-3}$)

Grid Spacing (m)	Annual Average	90.4th Percentile of 24-Hour Averages
5	0.38	2.15
10	0.38	2.15
20	0.36	2.04
Assessment Criteria	**40**	**50**

Table 6.3 shows that halving the grid spacing does not significantly affect the maximum predicted concentrations. It can be concluded from this that the selected receptor spacing of 10 m is adequate to capture the maximum impact.

6.5 BUILDING DOWNWASH AND TERRAIN

The modelling presented in this assessment includes both the effects of building downwash and terrain. **Table 6.4** shows the predicted maximum ground level concentration of PM_{10} both with and without the effects of building downwash and terrain using 2017 meteorological data.

Table 6.4 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\,m^{-3}$)

Building Downwash Effects	Terrain Effects	Annual Average	90.4th Percentile of 24-Hour Averages
Yes	Yes	0.38	2.15
No	Yes	0.13	0.72
Yes	No	0.37	2.07
No	No	0.13	0.71
Assessment Criteria		**40**	**50**

Table 6.4 shows that building downwash effects are predicted to affect dispersion. The effects of terrain on dispersion are not significant; the effects of building downwash are significant.

6.6 STACK HEIGHT

Table 6.5 and **Figure 6.1** show the ADMS 5.2 maximum predicted annual average and 90.4th percentile of 24-hour average concentrations of PM_{10} for stack heights in the range of 14 m to 22 m. Predictions are made for 2017 meteorological data.

Table 6.5 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\,m^{-3}$) Effect of Stack Height

Stack Height (m)	Annual Average	90.4th Percentile
14	0.92	4.43
16	0.59	2.96
18	0.38	2.15
20	0.30	1.69
22	0.23	1.33

Figure 6.1 ADMS 5.2 Maximum Predicted Annual Average and 90.4th Percentile of 24-Hour Average Concentrations of PM_{10} ($\mu g\,m^{-3}$) Effect of Stack Height

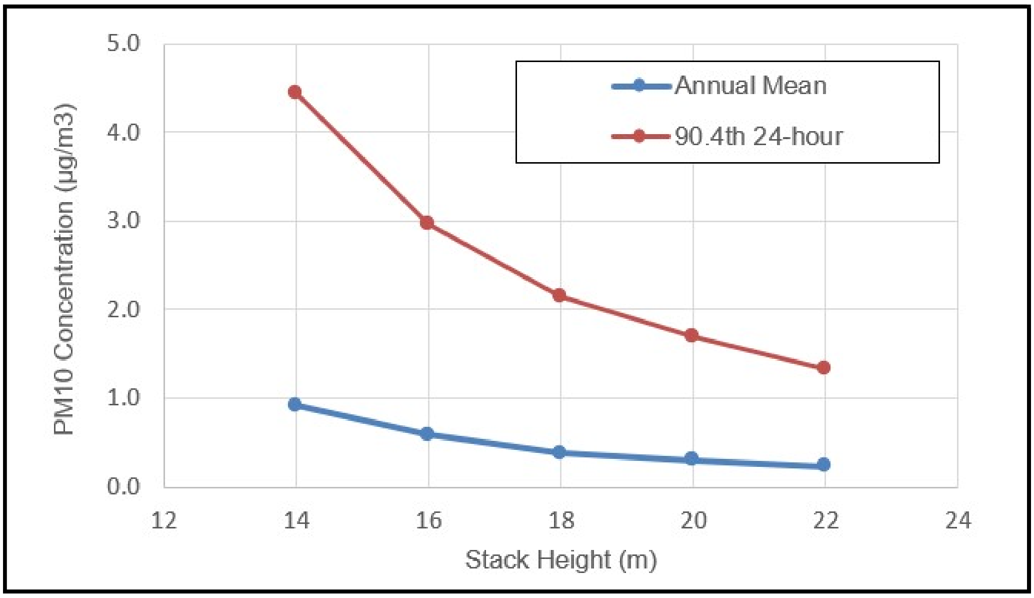


Table 6.5 and Figure 6.1 show that the benefits in terms of reduction in the maximum ground level concentration of PM_{10} for stack heights above the proposed height of 18 m are minimal.

7 SUMMARY AND CONCLUSIONS

Earth & Marine Environmental Consultants Ltd (EAME) has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality risk assessment of emissions to atmosphere from the proposed shredder. The shredder will be located on land to the south of Rover Way, Cardiff and will be operated by Celsa Manufacturing (UK) Ltd.

The air quality assessment is required to support an application for an Environmental Permit (EP) under the Environmental Permitting (England and Wales) Regulations.

The principal emission point to the atmosphere is Stack A11, associated with emissions of particulate matter (PM), including fine particulate matter (PM_{10} and $PM_{2.5}$).

The proposed shredder will shred 320,000 tonnes per year of waste and operate 10 hours per day, seven days a week. Operating hours will be 6 am to 6 pm, including 2 hours of maintenance per day.

The ADMS 5.2 dispersion model has been used to predict ground-level concentrations of particulate matter ($PM_{2.5}$ and PM_{10}) released into the atmosphere from the proposed installation.

The principal conclusion of this assessment is that emissions to the atmosphere at their emission limits from the proposed installation give rise to predicted ground-level pollutant concentrations (process contributions, PC) that are not of concern to human health or ecosystems. The impacts are predicted to be insignificant.