ES Appendix VI

Emissions Modelling Assessment

MEDICAL WASTE INCINERATION PLANT, STOPGATE LANE - DISPERSION MODELLING ASSESSMENT

Culzean W2E Limited

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1.2	21/12/2020	DY		Updated to include in-combination with biomass boilers on adjacent waste site
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1 Introduction

1.1 Background and Context of Assessment

1.1.1 An emissions modelling assessment has been undertaken in support of a Schedule 13 Environmental Permit application being submitted for the operation of a medical waste incineration plant at Stopgate Lane, Simonswood. The assessment has been undertaken to predict the potential air quality impacts at sensitive receptor locations as a result of residual emissions associated with the proposed process.

1.2 Site Location

1.2.1 Reference should be made to Appendix I for a site location plan. The site is located off Stopgate Lane, Simonswood.

1.3 Proposed Activities and Environmental Context

1.3.1 The proposals are for the installation of a Medical Waste Incineration Plant. This will have a waste throughout of up to approximately 400kg/hour, less than 10 tonnes hazardous waste per day. As such, the process will be regulated as a Small Waste Incineration Plant under Schedule 13 of the Environmental Permitting (England and Wales) Regulations 2016 ("the regulations"). Operations under the permit will be regulated by the Local Authority (West Lancashire Borough Council [WLBC]). Therefore, this assessment has been undertaken in accordance with relevant permitting guidance. However, the assessment will also be submitted to the Lancashire County Council as part of the planning application for the proposals.

1.3.2 The operation of the process will have the potential to create airborne emissions and subsequent impacts upon the surrounding environment. Potential air quality impacts have been quantified within this report through prediction of resulting ground level pollutant concentrations which have been compared to the relevant Air Quality Limit Values (AQLVs), Air Quality Standards (AQS), Environmental Assessment Levels (EALs), critical levels and loads.

2 Air Quality Legislation and Guidance

2.1 Air Quality Standards, Limits and Objectives

2.1.1 Table 2.1 and Table 2.2 contain the AQLVs and AQS which are relevant to this assessment. These have been obtained from the Air Quality Standards Regulations 2010 and government permitting risk assessment website.

Table 2.1 - Air Quality Limit Values

Pollutant	Measured As	Purpose	Air Quality Limit Values
Nitrogen dioxide (NO_2)	1-hour mean	Protection of human health	200µg.m^{-3} (not to be exceeded more than 18 times per calendar year)
	Annual mean	Protection of human health	40µg.m^{-3}
Particulate matter less than 10µm in aerodynamic diameter (PM_{10})	24-hour mean	Protection of human health	50µg.m^{-3} (not to be exceeded more than 35 times per calendar year)
	Annual mean	Protection of human health	40µg.m^{-3}
$PM_{2.5}$	Annual mean	Protection of human health	20µg.m^{-3}
Sulphur dioxide SO_2)	1-hour mean	Protection of human health	350µg.m^{-3} (not to be exceeded more than 24 times per calendar year)
	24-hour mean	Protection of human health	125µg.m^{-3} (not to be exceeded more than 3 times per calendar year)
Carbon monoxide (CO)	Maximum daily running 8-hour mean	Protection of human health	10mg.m^{-3}
Benzene	Annual mean	Protection of human health	5µg.m^{-3}
Lead	Annual mean	Protection of human health	0.5 µg.m^{-3}

Table 2.2 - Ambient Air Directive Target Values and UK Air Quality Strategy Objectives

Pollutant	Measured As	Purpose	Ambient Air Directive Target Values and UK Air Quality Strategy Objectives
Arsenic (total content in PM_{10} fraction)	Annual mean	Protection of human health	$6ng.m^{-3}$
Cadmium (total content in PM_{10} fraction)	Annual mean	Protection of human health	$5ng.m^{-3}$
Nickel (total content in PM_{10} fraction)	Annual mean	Protection of human health	$20ng.m^{-3}$
Lead	Annual mean	Protection of human health	$0.25\mu g.m^{-3}$
SO_2	15-minute mean	Protection of human health	$266\mu g.m^{-3}$ (not to be exceeded more than 35 times per calendar year)

2.2 Environmental Assessment Levels

2.2.1 A list of short and long-term EALs relevant to this assessment are presented in the table below. These have been obtained from the government website[1].

Table 2.3 - Environmental Assessment Levels

Substance	EALs			
	Long Term Annual Limit ($\mu g.m^{-3}$)	Short Term Hourly Limit ($\mu g.m^{-3}$)	24-Hour Mean ($\mu g.m^{-3}$)	Monthly Mean Limit ($\mu g.m^{-3}$)
Mercury	0.25	7.5	-	-
Vanadium	5	1	-	-
Manganese	0.15	1500	-	-
Arsenic	0.006	-	-	-
Antimony	5	150	-	-
Copper	10	200	-	-
Benzene	5	-	30	-
Chromium III	5	150	-	-
Chromium (VI)	0.00025	-	-	-
Hydrogen Chloride (HCL)	-	750	-	-

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

Substance	EALs			
	Long Term Annual Limit ($\mu g.m^{-3}$)	Short Term Hourly Limit ($\mu g.m^{-3}$)	24-Hour Mean ($\mu g.m^{-3}$)	Monthly Mean Limit ($\mu g.m^{-3}$)
Hydrogen Fluoride (HF)	-	160	-	16

2.3 Critical Levels for Protection of Vegetation and Ecosystems

2.3.1 Table 2.1 contains critical levels for the protection of vegetation at nature conservation sites, obtained from permitting risk assessment guidance on the government website.

Table 2.4 - Critical Levels for the Protection of Vegetation

Pollutant	EALs	
	Concentration (µg.m-3)	Measured As
Nitrogen oxide (NO_x, expressed as NO_2	30	Annual mean
	75	Daily mean
SO_2	20 (10µg.m^{-3} where lichens or bryophytes are present)	Annual mean
HF	5	Daily mean
	0.5	Weekly mean

2.4 Critical Loads for Protection of Vegetation and Ecosystems

2.4.1 Critical loads are assigned for nitrogen and acid deposition at sensitive ecological sites, above which it is suggested harmful effects on vegetation may occur. There are no Sites of Special Scientific Interest (SSSI) within 2km of the site and no Special Areas of Conservation (SAC), Special Protection Areas (SPAs) or Ramsar sites within 10km of the site. There are no ancient woodland areas or Local Nature Reserves within 2km of the site. There are some Local Wildlife Sites (LWS) within 2km of the site. However, no site specific information is available on critical loads. Therefore, the table below contains worst case critical loads to ensure a precautionary assessment.

Table 2.5 - Site Specific Critical Loads for Nitrogen Deposition

Site	Worst Case Critical Load for Nitrogen Deposition (Kg N.ha^{-1}.$Year^{-1}$)
All LWS within 2km	3

Table 2.6 - Site Specific Critical Loads for Acid Deposition

Site	Worst Case Critical Load for Acid Deposition (keq.ha^{-1}.$Year^{-1}$)

	Nitrogen	Sulphur
All LWS within 2km	0.1	0.1

3 Baseline Position

3.1 Air Quality Across West Lancashire

3.1.1 WLBC are required to undertake a review and assessment of air quality within their area of jurisdiction under Section 82 part IV of the Environment Act (1995). Local Authorities (LAs) are obligated to prepare an Annual Status Report (ASR) each year. For areas where AQLVs are not expected to be achieved, the LA will undertake further assessment. Subsequently, if AQLVs are not predicted to be met following detailed assessment, the LA must declare an Air Quality Management Area (AQMA).

3.1.2 The latest ASR report available on the WLBC website is the 2019 Air Quality ASR[2]. No continuous monitoring is undertaken by WLBC at present. Monitoring is limited to the deployment of NO_2 diffusion tubes which are located within the AQMA. The AQMA is declared as follow:

- Ormskirk AQMA – declared for annual mean NO_2. An area encompassing properties in Moor Street and Stanley Street in Ormskirk

3.1.3 The declared AQMA is not in close proximity to the proposed site, being located approximately 7.5km to the North-North-West. Therefore, it has not been considered further within this assessment.

[2] Air Quality ASR, WLBC, 2019.

3.2 Air Quality Monitoring Data

3.2.1 Continuous Monitoring

3.2.1.1 The Automatic Urban and Rural Network (AURN) is a network of air pollution monitoring stations across the UK, managed by Bureau Veritas on behalf of DEFRA. The main purpose of the network is to enable the government to assess air quality at different locations to aid with the implementation of suitable policy measures for protection of human health.

3.2.1.2 The closest AURN monitoring station to the proposed site is St Helens Linkway. This is an urban traffic monitoring location situated approximately 10km to the South-East of the proposed site. Given the proximity to the proposed site and nature of the monitoring location, which is a major urban environment, adjacent to arterial roads, it was not considered that it would provide a suitable source of background data for use in this assessment.

3.2.1.3 WLBC do not maintain any continuous monitoring sites within their area of jurisdiction.

3.2.2 Nitrogen Dioxide Diffusion Tube Monitoring

3.2.2.1 WLBC undertake NO_2 diffusion tube monitoring at several locations across their area of jurisdiction. However, these are all located within the AQMA, several kilometres from the site. As such, it was not considered that these would provide a suitable source of background data for use in this assessment.

3.2.3 Heavy Metals Monitoring

3.2.3.1 Heavy metals monitoring is undertaken at a number of locations around the country as part of the DEFRA Heavy Metals Network and Rural Heavy Metals Network, which is managed and operated on behalf of DEFRA by the National Physical Laboratory (NPL).

3.2.3.2 The closest heavy metals monitoring site to the proposed site is Runcorn Weston Point, which is an urban industrial monitoring location situated approximately 20km to the

South-South-East. Given the nature of this monitoring location, it was considered that it may provide a suitable source of background data for use in this assessment, In lieu of any available metals monitoring data in the vicinity of the site. Annual average metals concentrations were calculated for the most recent five years of available data. It should be noted that no monitoring data is available for chromium(VI). However, a previous Expert Panel on Air Quality Standards (EPAQS) Report[3] indicated that it is likely that less than 20% of chromium emissions are present as chromium (VI) and that the proportion of chromium (VI) in ambient air may be lower than measured in emissions, citing data from Canada which has suggested that between 3% and 8% of total airborne chromium consists of chromium(VI). Therefore, the background chromium (VI) concentration has been assumed to be 20% of the background chromium concentration reported in the table below.

Table 3.1 – Maximum Calculated Annual Mean Metal Concentrations Across Urban Industrial Monitoring Locations Between 2015 and 2019

Metal	Maximum Annual Mean Concentration at Runcorn Weston Point Between 2015 and 2019 ($ng.m^{-3}$)
Cadmium	0.128
Vanadium	1.258
Manganese	3.715
Chromium	1.729
Lead	6.189
Nickel	1.411
Copper	6.054
Arsenic	0.708
Mercury	20.064
Chromium (VI)	0.785

[3] Metals and Metalloids, Expert Panel on Air Quality Standards, 2009.

3.2.4 Non-Automatic Hydrocarbon Network

3.2.4.1 The Non-Automatic Hydrocarbon Network includes sites which measure ambient benzene concentrations at various locations around the United Kingdom. The closest monitoring location to the proposed site is Liverpool Speke, which is an urban industrial monitoring location, situated approximately 17km to the South of the site. Given the nature of this monitoring location, it was considered that it may provide a suitable source of background data for use in this assessment, In lieu of any available monitoring data in the vicinity of the site. Annual average benzene concentrations were calculated for the most recent five years of available data.

Table 3.2 – Annual Mean Benzene Concentrations at Liverpool Speke

Site	Annual Mean Benzene Concentration ($\mu g.m^{-3}$)				
	2015	2016	2017	2018	2019
Liverpool Speke	0.73	0.77	0.79	0.67	0.69

3.2.5 Dioxin and Furan Monitoring

3.2.5.1 Polychlorinated dibenzo dioxins (PCDD) and Polychlorinated dibenzo furans (PCDF) ‘dioxins’ and ‘furans’ are monitored at 6 locations throughout the UK as part of the Toxic Organic Micropollutants (TOMPS) network. The nearest of these monitoring locations to the proposed site is located within Manchester Law Courts, which is classified as an urban monitoring location, situated 40km to the East. Data from all 6 monitoring locations from the most recent 5 years of available data is presented in the table below. The proposed site is in a semi-rural location, with significant industrial process within 1km of the site. In lieu of any monitoring stations in close proximity to the site, the average PCDD/PCDF concentration across all 6 monitoring locations from the most recent 5 years of available data was used to provide an estimate of potential background concentration at the site.

Table 3.3 - Annual Mean PCCD/PCDF Concentrations at Manchester Law Courts

Monitoring Site	Annual Mean PCCD/PCDF Concentration – SUM TEQ ($fg.m^{-3}$)				
	2012	2013	2014	2015	2016

Monitoring Site	Annual Mean PCCD/PCDF Concentration – SUM TEQ ($fg.m^{-3}$)				
	2012	2013	2014	2015	2016
Manchester Law Courts	33	10.2	16.95	5.95	12.25
London Nobel House	15.45	3.5	2.87	5.48	24.33
Weybourne	9.25	2.33	1.62	11.93	5.7
Hazlerigg	8.75	2.03	2.59	5.29	4.58
High Muffles	4.33	0.6	1.09	0.54	2.78
Auchencorth Moss	0.13	0.85	0.01	0.01	0.15
Average concentration across all sites from most recent years of available data	**6.48$fg.m^{-3}$**				

3.2.6 Acid Gas Monitoring

3.2.6.1 Ambient measurements of HF are limited in the UK. The EPAQS previously issued a report[4] which presented long term (monthly) HF ambient concentrations monitored in the vicinity of three industrial plants. This reported long term average HF concentrations of up to 2.35$\mu g.m^{-3}$ as the highest value[4]. In lieu of site specific data, this was considered to provide a highly conservative worst case long term background concentration for HF to use within this assessment.

3.2.6.2 The UK Acid Gases and Aerosols Monitoring Network is maintained in the UK by DEFRA and has been in operation since 1999. The network includes several sites around the UK in rural monitoring locations and includes monitoring of HCL. There are no monitoring stations in close proximity to the proposed plant, the closest monitoring station being Plas Y Brenin, which is a rural monitoring site located approximately 82km to the West-South-West. The EPAQS report on halogens and halides in ambient air[4], reported a range in annual mean background HCL concentrations across 12 monitoring locations in the UK of

[4] Guidelines for Halogens and Hydrogen Halides in Ambient Air for Protecting Human Health Against Acute Irritancy Effects, Expert Panel on Air Quality Standards, 2005.

between 0.12µg.m^{-3} and 0.41µg.m^{-3} during 2002. In lieu of site specific data, the upper end of this range was used as a source of background HCL data to use within this assessment, which was considered to provide a conservative scenario.

3.3 Background Pollutant Mapping

3.3.1 The DEFRA website contains background pollutant mapping data for NO_x, NO_2, PM_{10}, $PM_{2.5}$, SO_2, benzene and CO on a 1km by 1km grid square basis across the UK. This data is routinely used for assessing background pollutant concentrations where no suitably representative air pollution monitoring data exists. The archive is maintained by AEA on behalf of DEFRA. NO_x, NO_2, PM_{10} and $PM_{2.5}$ data is available for each grid square for the years 2018 to 2030. Background mapping of CO, SO_2 and benzene is only available for 2001. Future year predictions of CO and benzene have been calculated using the appropriate year adjustment factors contained on the DEFRA website. The annual mean concentration for SO_2 has been calculated as 75% of the 2001 mapped concentration, in accordance with previous LAQM guidance. Table 3.4 contains background pollutant concentrations for the grid square containing the site.

Table 3.4 - Background Pollutant Mapping Data for Grid Square 343500, 400500

Pollutant	2020 Annual Mean Concentration (µg.m^{-3}) within Grid Square Containing Site
NO_x	13.3
NO_2	10.13
PM_{10}	11.83
$PM_{2.5}$	7.37
CO	154.6
SO_2	2.67
Benzene	0.41

3.4 Summary of Background Data Used in Assessment

3.4.1 The table below summarises the background data used within this assessment.

Table 3.5 - Summary of Background Data Used in Assessment

Pollutant	Annual Mean Background Concentration ($\mu g.m^{-3}$)	1-Hour Mean ($\mu g.m^{-3}$)[(a)]	24-Hour Mean ($\mu g.m^{-3}$)[(b)]	8-Hour Mean ($\mu g.m^{-3}$)[(c)]	15-Minute Mean ($\mu g.m^{-3}$)[(d)]	Source of Annual Mean Background Data
NO_x	13.3	N/A	15.69	N/A	N/A	DEFRA Mapped Background Data
NO_2	10.13	20.26	N/A	N/A	N/A	DEFRA Mapped Background Data
PM_{10}	11.83	N/A	13.96	N/A	N/A	DEFRA Mapped Background Data
$PM_{2.5}$	7.37	N/A	N/A	N/A	N.A	DEFRA Mapped Background Data
SO_2	2.67	5.34	3.15	N/A	7.16	DEFRA Mapped Background Data
CO	N/A	414.33	N/A	290.03	N/A	DEFRA Mapped Background Concentrations
Benzene	0.79	1.58	N/A	N/A	N/A	Non-Automatic Hydrocarbon Network – Maximum reported concentration at Liverpool Speke
HCL	N/A	0.82	N/A	N/A	N/A	UK Acid Gases and Aerosols Monitoring Network – maximum reported concentrations within EPAQS report.
HF	2.35	4.7	2.77	N/A	N/A	Long term background concentrations reported by EPAQS report
Cadmium	0.000128	N/A	N/A	N/A	N/A	DEFRA heavy metals monitoring network – worst case annual mean concentration across 5 years of data at Runcorn Weston Point
Vanadium	0.001258	0.002516	N/A	N/A	N/A	
Manganese	0.003715	0.00743	N/A	N/A	N/A	
Chromium (III)	0.001729	0.003457	N/A	N/A	N/A	
Chromium (VI)	0.000346	N/A	N/A	N/A	N/A	
Lead	0.006189	N/A	N/A	N/A	N/A	
Nickel	0.001411	N/A	N/A	N/A	N/A	
Copper	0.006054	0.012108	N/A	N/A	N/A	
Arsenic	0.000708	N/A	N/A	N/A	N/A	

Pollutant	Annual Mean Background Concentration (µg.m^{-3})	1-Hour Mean (µg.m^{-3})[(a)]	24-Hour Mean (µg.m^{-3})[(b)]	8-Hour Mean (µg.m^{-3})[(c)]	15-Minute Mean (µg.m^{-3})[(d)]	Source of Annual Mean Background Data
Mercury	0.020064	0.040128	N/A	N/A	N/A	
PCDD and PCDF	6.48 x 10^{-9}	N/A	N/A	N/A	N/A	TOMPS Network – average long term concentrations across all six sites within TOMPS network

N.B (a) 1-hour mean concentration assume to be twice annual mean background concentration in accordance with relevant guidance
(b) 24-hour mean concentration provided by multiplying 1-hour mean concentration by factor of 0.59 in accordance with relevant guidance
(c) 8-hour mean concentration provided by multiplying 1-hour mean concentration by factor of 0.7 in accordance with relevant guidance
(d) 15-minute mean concentration provided by multiplying 1-hour mean concentration by factor of 1.34 in accordance with relevant guidance

3.5 Sensitive Receptors

3.5.1 The tables below outline the nearest receptors. The locations identified are the closest receptors to the proposed site and therefore represent worst case long term exposure locations. Reference should be made to Appendix II for a graphical representation of receptor locations.

Table 3.6 - Sensitive Receptors

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R1	Wood House Farm	342860	401189
R2	High Barn Farm	343225	401159.9
R3	Voces Farm	343464	401666.9
R4	Residential property off Siding Lane	343455.6	401032.8
R5	Residential property off Stopgate Lane	343527.3	401115.1
R6	Abram's Farm	343623.3	401154.1
R7	Newbridge Farm	344207.8	401333.5
R8	Peartree Cottage	344090.7	401551.9
R9	The Coach House	344454.7	401442.2
R10	Wild Goose Slack	344834.6	400855.5

Receptor Identifier	Receptor Description	National Grid Reference (m)	
R11	Moss Cottage	345274	400414
R12	Spencer's House Farm	343914	399950.3
R13	Bullens Farm	343630.7	399956.1
R14	Keeper's House	343349	400214.6
R15	South Head Farm	343183.3	400047.3
R16	Woods Farm	342780.3	400272.1
R17	Residential property off Dale Lane	342465.9	400031.5
R18	Residential property off Dorchester Drive	342226.4	400216.2
R19	Residential property off Freckleton Drive	342207.4	400267.9
R20	Residential property off Anders Drive	342195.8	400331.2
R21	Residential property off Anders Drive	342179.9	400410.3
R22	Residential property off Epsom Grange	342153.6	400557
R23	Residential property off Calder Close	342083.9	400759.5
R24	Simonswood Hall Barn	341737.9	401145.2
R25	Residential property off Hall Lane	341916.7	401304
R26	Grayson's Farm	342363	401510.8
R27	LWS	343277.9	400523.2
R28	LWS	343805.8	401736.7
R29	LWS	342635.7	399830.5
R30	LWS	342649.2	399312.5

4 Modelling Methodology

4.1 Model Description

4.1.1 The potential air quality impacts associated with residual emissions arising from the process have been quantified using AERMOD, which is a steady state, next generation, dispersion model. AERMOD was developed jointly by the American Meteorological Society (AMS) and the United States (US) Environmental Protection Agency (EPA) Regulatory Model Improvement Committee. AERMOD is a development from the Industrial Source Complex (ISC) 3 dispersion model and incorporates improved dispersion algorithms and pre-processors to integrate the impact of meteorology and topography within the modelling output, and is approved for use in the UK by the EA. The version of AERMOD that has been used for this current assessment is Lakes Environmental ISC-AERMOD View Version 9.9.0. The model has been run using the most recent version of the AERMOD executable file, 19191. In order to improve model run times, Lakes Environmental have produced an equivalent source code to 19191, known as AERMOD parallel which enables the model to be run over multiple processors. The model was run using Lakes Environmental AERMOD MPI 19191.

4.2 Model Inputs

4.2.1 Emission Source Process Parameters

4.2.1.1 Reference should be made to Appendix I for a graphical representation of the site layout showing the proposed air emission point source location. Table 4.1 contains expected stack process parameters for the proposed plant. Parameters for stack internal diameter, exhaust flow rate, temperature, oxygen and moisture content were provided by the plant manufacturer.

Table 4.1 - Expected Emission Source Process Parameters

Process Parameter	Value
Exhaust Flue (A1)	343239.29, 400693.02
Stack internal diameter (m)	0.5

Process Parameter	Value
Stack height (m)	14
Expected stack efflux velocity ($m.s^{-1}$)	14.92
Expected actual stack volumetric flowrate ($m^3.s^{-1}$)	2.93
Flow rate expressed at reference conditions of 273.15K, 11% oxygen, dry gas, 101.3kPa ($Nm^3.s^{-1}$)	1.36
Expected stack efflux temperature (K)	393
Expected oxygen content of exhaust gas, (v/v, %)	13.5
Expected moisture content of exhaust gas (v/v, %)	4
Expected absolute stack pressure (KPa)	Assumed to be Standard Atmospheric Pressure (101.3kPa)

4.2.2 Pollutant Emissions

4.2.2.1 There will be a number of potential pollutant emissions as a result of operation of the proposed plant. Residual emissions arising from the plant will need to comply with the Emission Limit Values (ELVs) in Annex VI of the Industrial Emissions Directive[5]. The emission limits are presented in the table below. Compliance with these ELVs will need to be demonstrated through continuous and periodic emissions monitoring during operation of the plant, which will be a condition within the Environmental Permit.

- IED Annex VI Emission Limit Values

Pollutant	Daily Average ELV ($mg.m^{-3}$)[(a)]	Half Hourly Average ELV (97%) ($mg.m^{-3}$) [(a)]	Half Hourly Average ELV (100%) ($mg.m^{-3}$) [(a)]	Average Over Minimum of 30 Minutes to Maximum of 8 Hours ELV ($mg.m^{-3}$)[(a)]	Average Over Minimum of 6 Hours and Maximum of 8 Hours ELV ($mg.m^{-3}$)[(a)]
NO_x	200	200	400	-	-
SO_2	50	50	200	-	-

5 Directive 2010/75/EU on Industrial Emissions (Integrated Pollution Prevention and Control)

Pollutant	Daily Average ELV (mg.m^{-3})[(a)]	Half Hourly Average ELV (97%) (mg.m^{-3}) [(a)]	Half Hourly Average ELV (100%) (mg.m^{-3}) [(a)]	Average Over Minimum of 30 Minutes to Maximum of 8 Hours ELV (mg.m^{-3})[(a)]	Average Over Minimum of 6 Hours and Maximum of 8 Hours ELV (mg.m^{-3})[(a)]
CO	50	-	100	-	-
Total dust	10	10	30	-	-
Gaseous and vaporous organic substances, expressed as Total organic carbon (TOC)	10	10	20	-	-
HCL	10	10	60	-	-
HF	1	2	4	-	-
Mercury and it's compounds	-	-	-	0.05	-
Group 1 Metals (cadmium and thallium and their compounds (total))	-	-	-	0.05	-
Group 3 Metals (antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium)	-	-	-	0.5	-
Polychlorinated dibenzo-dioxins and polychlorinated dibenzo furans (Dioxins and furans)	-	-	-	-	1×10^{-7}

N.B (a) Based upon the following reference conditions: 11% oxygen, dry gas, 273.15K, 101.3KPa

4.2.2.2 Daily, weekly, monthly and annual mean pollutant concentrations have been assessed based upon pollutants being emitted at daily average ELVs, whilst short term air impacts (15 minute, 1 and 8 hour means/maximums) have been assessed based upon pollutants being emitted at the worst case half-hourly ELV levels contained in the table above. The exception to this is for metals, PCDDs and PCDFs, for which only one emission limit is in place.

4.2.2.3 For Group 1 and 3 metals, the ELVs above will be applicable to the combined emission of all metals within the group. The Group 1 metals consist of cadmium and thallium. In order to provide a worst case assessment, it has been assumed that each individual metal is emitted at the combined ELV level. For Group 3 metals, the Environment Agency (EA) has produced guidance on assessing group 3 metal stack emissions from incinerators[6]. This guidance is stated to be for applicants of environmental permits for Municipal Waste Incinerators (MSW) and Waste Wood Incinerators and that metals assessments from other plant may only use the method within this guidance if it can be shown that the data is representative. Although the proposals are for a medical waste incinerator, it is argued that the MSW and waste wood incinerators encompass a much larger range of wastes than is proposed to be accepted at the proposed site. It is therefore considered that such data is suitable for use within this assessment and may indeed be conservative.

4.2.2.4 The EA guidance states the following:

"Step 1 – Worst Case Screening for Group 3 Metals

Make predictions based on assuming each metal is being emitted at 100% of the group ELV (i.e. 0.5 mg/m³). Where the PC of any metal exceeds 1% of a long-term or 10% of a short-term environmental standard we consider this a potential for significant pollution. Under these circumstances the predicted environmental concentration (PEC) should be compared against the environmental standard. If the PEC is greater than 100% of the environmental standard proceed to step 2.

Step 2 – Case Specific Screening for Group 3 Metals

Use the maximum emissions data listed in Appendix A to revise your predictions. Where the PC of any metal exceeds 1% of a long-term or 10% of a short-term environmental

6 Releases from Waste Incinerators: Guidance on Assessing Group 3 Metal Stack Emissions from Incinerators, Version 4, EA, 2016.

standard the PEC should be compared against the environmental standard. This can be screened out where the PEC is less than 100% of the environmental standard. We require Applicants to justify their use of any data lower than the maximum emission concentrations listed, i.e. where using the maximum emission concentration cannot be screened out. We also require applicants to provide evidence for any chromium VI background levels of less than 20% of total background chromium."

4.2.2.5 Annex A of the above EA guidance document contains metal monitoring data obtained from 18 incineration plants across the UK between 2007 and 2015. The maximum reported emission levels have been summarised in the table below, expressed in terms of the fraction of the IED Group 3 Metals ELV.

Table 4.2 – Monitoring Data from Municipal Waste Incinerators and Waste Wood Co-Incinerators

Pollutant	Percentage of the IED Group 3 ELV (%)		
	Max	Mean	Min
Antimony	2.3	0.3	0.02
Arsenic	5.0	0.2	0.04
Total Chromium	18.4	1.7	0.04
Chromium (VI)	0.03	0.01	0.0005
Cobalt	1.1	0.2	0.03
Copper	5.8	1.5	0.4
Lead	10.1	2.2	0.1
Manganese	12.0	3.4	0.3
Nickel	44.0	3.0	0.5
Vanadium	1.2	0.1	0.0

4.2.2.6 The ELV for particulate matter is stated as total dust. For the purpose of this assessment, it has been assumed that emissions of dust consist entirely of PM_{10} or $PM_{2.5}$. This enables a worst-case assessment of potential resulting ground level PM_{10} and $PM_{2.5}$ concentrations as it would not be expected that emissions of dust from the process would consist entirely of these particle size fractions.

4.2.2.7 There are no ambient air quality guideline values for TOC. In accordance with the relevant guidance, it has been assumed that TOC emissions consist entirely of benzene and modelled concentrations have subsequently been compared to the annual mean and 1-hour mean AQLV/EAL for benzene. This presents a worst case assessment since it is highly unlikely that TOC emissions would consist entirely of benzene.

4.2.2.8 Table 4.3 contains the pollutant emission rates used as model inputs. These have been based upon the emission concentrations presented and discussed above.

Table 4.3 - Pollutant Emission Rates Used Within Model

Pollutant	Pollutant Emission Rates ($g.s^{-1}$)[(a)]	
	Short Term	Long Term
NO_x	0.543	0.271
SO_2	0.271	0.0678
CO	0.136	N/A
Particulate matter	0.0407	0.0136
TOC (as benzene)	0.0271	0.0136
HCL	0.0814	0.0136
HF	0.00543	0.00136
Group 1 Metals (cadmium and thallium and their compounds (total))	0.0000678	0.0000678
Mercury	0.0000678	0.0000678
Group 3 Metals (antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium)	0.000678	0.000678
Chromium (VI)	N/A	1.76×10^{-7}
PCDDs and PCDFs (TEQ)	N/A	1.36×10^{-10}

4.2.3 Building Downwash

4.2.3.1 Significant on-site buildings and structures were digitised within the model from site layout and elevation information provided by the site operator. As the closest buildings to the emission points, these would be expected to have an influence on pollutant dispersion. Height information for surrounding buildings was provided by the applicant. In accordance with the relevant guidance, buildings/structures included within the model are those within a distance of 5L of the proposed exhaust flue, where L is defined as the lesser of the building/structure height and maximum projected width. Table 4.4 contains information on building heights used within the model. Reference should be made to Appendix I for a plan showing building locations. The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All buildings and structures were input into the BPIP processor.

Table 4.4 - Building Inputs

Structure	Length and Width (m)	Diameter (m)	Max Height (m)
Structure A	40 x 28	N/A	10.63
Structure B	312 x 50	N/A	12
Structure C	N/A – polygon structure	N/A	8
Structure D	12.2 x 2.4	N/A	3.9
Structure E	N/A – polygon structure	N/A	5.9
Structure F	3.7 x 2.4	N/A	6.99
Structure G	3.7 x 2.4	N/A	6.99
Structure H	N/A	1.2	14

4.2.4 Meteorological Data

4.2.4.1 Meteorological data used in this assessment was from Liverpool John Lennon Airport. Liverpool John Lennon Airport is located approximately 18km to the South of the proposed site and it is considered that it provides suitable data for use in this assessment. Previous DEFRA guidance stated met stations within 30km of a study site to be suitable for use in dispersion modelling assessments. Although Crosby meteorological station (14km to West) is marginally closer, it is considered to be in a more exposed coastal location than Liverpool Airport and therefore is not considered to be as representative of the application site, which is much further inland. There are no other observing stations within 30km of the application site with sufficient date capture. As such, Liverpool John Lennon Airport is considered to provide the most appropriate data for use in this assessment. Reference should be made to Appendix III for wind roses showing wind speed and direction frequency at Liverpool between 2013 and 2017.

4.2.4.2 Five years of sequential meteorological data observed between 2013 and 2017 was used within the assessment. Data was previously supplied by ADM Ltd, an established distributor of met data within the UK. The data provided by ADM Ltd was in ADMS format. This was converted to the required format required by AERMET using the ADMS UK to SAMSON converter, which is a tool within the AERMET processor. The AERMET processor within AERMOD was used to process the data to be site specific. US EPA guidance on processing met data for use within AERMOD states that land use up to 1km upwind from a site should be considered when determining surface roughness characteristics, whilst for Bowen ratio and albedo, land use types within a 10km by 10km area centred over the site should be considered[7]. AERMOD guidance states that albedo and Bowen ratio should be calculated as the arithmetic and geometric mean respectively of land use types over the 10km by 10km grid, not weighted by direction or distance. The Land Use Creator and AERSURFACE tool within AERMET was used to calculate the appropriate land-use characteristics, which are contained in the following table.

Table 4.5 - Parameters for Surface Roughness, Albedo and Bowen Ratio

Parameter	Directional Sector	Value
Surface Roughness	0-30°	0.239
	30-60°	0.229
	60-90°	0.251
	90-120°	0.143

7 AERMOD Implementation Guide, USEPA, August 2015.

Parameter	Directional Sector	Value
	120-150°	0.101
	150-180°	0.129
	180-210°	0.113
	210-240°	0.192
	240-270°	0.579
	270-300°	0.194
	300-330°	0.104
	330-360°	0.105
Albedo	All	0.18
Bowen Ratio	All	0.68

4.2.5 Assessment Area

4.2.5.1 Two uniform cartesian receptor grids were used to define the modelling domain. This included a high resolution grid, extended over a 3000m by 3000m area with a spacing of 20m in X and Y direction, centred over the stack location. A further uniform cartesian receptor grid was extended over a 20,000m by 20,000m area with a spacing of 200m in X and Y direction, centred over the stack location. This ensure the maximum point of impact could be captured. In addition, the discrete receptors identified previously were included within the model as cartesian receptors.

4.2.6 Terrain Data

4.2.6.1 Topographical features can have a significant impact on pollutant dispersion. Given that the gradient of the land between the site and receptors exceeds a gradient of 10% in places, terrain data was included in the model, in accordance with the relevant guidance[8]. The terrain data used was Ordnance Survey Terrain 5 data, which is 1:10,000 scale data, contoured at 5m vertical intervals. The digital terrain data was processed in AERMAP, the

8 LAQM.TG(16), DEFRA, 2016.

inbuilt terrain processor within AERMOD. This then applied elevation data to all sources, buildings and receptors within the modelling domain.

4.2.7 NOx to NO_2 Conversion

4.2.7.1 Nitric oxide (NO) and NO_2 are normally measured as oxides of NO_x, but when comparing against health based standards, NO_x is usually expressed as it's individual components. NO is oxidised to NO_2 in the presence of ozone. In order to provide a conservative estimate of resulting NO_2 concentrations, it has been assumed that 35% of modelled NO_x concentrations are present as NO_2 for short-term concentrations, whilst it has been assumed that 70% of modelled NO_x concentrations are present as NO_2 for long term average concentrations. This provides a worst case scenario, in accordance with the relevant guidance.

4.2.8 Model Scenarios

4.2.8.1 The scenarios modelled are contained within Table 4.6. It was assumed that the plant will be operational continuously for 24-hours per day, 365 days per year with no shut down periods which ensured a worst-case scenario.

Table 4.6 - Model Scenarios

Pollutant	Modelled Scenarios
NO_x	Annual mean, maximum 24-hour mean
NO_2	Annual mean, 99.8th percentile 1-hour mean
PM_{10}	Annual mean, 90.4th percentile 24-hour mean
$PM_{2.5}$	Annual mean
SO_2	Annual mean, 99.2nd percentile 24-hour mean, 99.7th percentile 1-hour mean, 99.9th percentile 15-minute mean
CO	Rolling 8-hour maximum
HCL	1-hour maximum mean
HF	Monthly maximum mean, 24-hour maximum mean, 1-hour maximum mean

Pollutant	Modelled Scenarios
TOC (as benzene)	Annual mean, 1-hour maximum mean
Metals	Annual mean, 1-hour maximum mean
Dioxins and Furans	Annual mean

4.3 In-Combination Assessment

4.3.1 This modelling has been undertaken as part of an Environmental Impact Assessment (EIA) for the proposals. The Town and County Planning (Environmental Impact Assessment) Regulations 2017 require an assessment of cumulative impacts with other developments. This should include developments for which applications have been submitted or consented and which are not yet in operation. This is since processes which are already operational will have been taken account of within background pollutant concentrations.

4.3.2 A search was undertaken on the LCC and WLBC planning public access websites to identify other significant processes with point source emissions within the vicinity of the proposed site. This search was extended up to 1km from the proposed site. Examples of other relevant processes would include other combustion or incineration operations, which have not yet been brought into operation. This has identified that planning consent was issued in 2017 for the operation of four biomass boilers, fuelled by clean waste wood, located on the adjacent waste site at City Centre Commercials Waste Limited (ref: LCC/2017/0007). As a precautionary assessment, it has been assumed that these boilers have not yet been brought into full operation and therefore will not have been accounted for within the baseline assessment of existing background pollutant concentrations. These have therefore been included within an in-combination assessment with the proposals.

4.3.3 It is understood that the boilers qualify for Renewable Heat Incentive (RHI). Under the RHI Scheme, the biomass boilers must comply with emission limits for particulate matter and NO_x of $30g.GJ^{-1}$ and $150g.GJ^{-1}$ respectively. These would be anticipated to be the primary pollutants of concern from boilers operated on clean waste wood. The boilers installed at the adjacent site are understood to be 990KW capacity Heizomat GmBH boilers (RHK-AK-

1000). The RHI Certificate for the boilers includes emissions data to demonstrate compliance with the RHI limits. The test data states emission values of 13.7g.GJ^{-1} for particulate matter and 54.1g.GJ^{-1} for NO_x. These values have been used to determine appropriate emission rates for use within the assessment. Reference should be made to the table below for exhaust process parameters assumed for the biomass boilers. This is based on the data outlined above, information submitted to WLBC as part of the application for a Part B Environmental Permit and planning application documents contained on the LCC planning website.

Table 4.7 - Expected Emission Source Process Parameters for Biomass Boilers at CCC Waste

Process Parameter	Value
Exhaust Flue NGR (x4)	343769.51, 400861.59 343770.99, 400862.22 343781.74, 400866.96 343783.22, 400867.60
Stack internal diameter (m) of each flue	0.5
Stack height (m) for each flue	7.3
Expected stack efflux velocity (m.s^{-1}) for each flue	5.704
Expected actual stack volumetric flowrate (m^3.s^{-1}) for each flue	1.21
Expected stack efflux temperature (K) for each flue	422
Particulate matter emission rate (g.s^{-1}) for each flue	0.0151
NO_x emission rate (g.s^{-1}) for each flue	0.0595

4.3.4 The biomass boilers are housed within a building 40m by 25m in length and width, which is also understood to be 7.3m in height to the ridge. This was included within the BPIP processor to account for building downwash effects.

4.3.5 Elevation details for the building and sources were calculated using the AERMOD terrain processor (AERMAP) and used as model inputs.

4.3.6 It was assumed that the boilers would be operational for 100% of each year with no shut downs, which provided a conservative assessment.

4.3.7 Reference should be made to Appendix I for graphical illustration of building and flues used as a model input.

4.4 Methodology for Assessment of Potential Impacts at Human Receptors

4.4.1 In order to assess potential impacts at human receptor locations, reference has been made to the permitting air emissions risk assessment guidance on the government website.[9]

4.4.2 The government guidance indicates that potential impacts from a process can be considered insignificant if the following screening criteria are met for human and statutory ecological receptors:

- The long term process contribution (PC) is <1% of the long term environmental standard; and/or,
- The short term PC is <10% of the short term environmental standard.

4.4.3 The guidance also indicates that more detailed assessment of emissions (modelling) for a process may be required if the following criteria are met:

- The long term PC + background concentration is >70% of the long term environmental standard; and/or
- The short term process contribution is >20% (Short term environmental standard minus twice annual mean background concentration).

4.4.4 If any of the criteria above are met for both short and long term modelled concentrations, it can be concluded that potential impacts will be acceptable and there is no requirement for further assessment, in accordance with the relevant guidance. If the above criteria are

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

exceeded, the Predicted Environmental Concentration (PEC) is then compared to the relevant environmental standard. If the modelling shows that the relevant standard will be met at receptor locations confidence will be high that a breach of the standard will be unlikely, especially given the conservative assumptions which have been used throughout the assessment.

4.5 Methodology for Assessment of Potential Impacts at Ecological Receptors

4.5.1 In accordance with government permitting risk assessment guidance, potential impacts on non-statutory ecological receptors can be screened out as insignificant if the PC is <100% of the critical level for relevant pollutants.

4.6 Model Verification and Uncertainty

4.6.1 It was not possible to verify model results as the plant is not yet operational.

4.6.2 There can be a significant degree in uncertainty in predications made by any atmospheric dispersion model, which needs to be considered when assessing results. Such uncertainty can arise as a result of model limitations, uncertainty in input data, including emissions estimates, meteorological data used and background pollutant concentrations used in the assessment.

4.6.3 AERMOD is a commonly used model produced by the US EPA and is approved for use in the UK by the EA. The model is well validated and the US EPA present the results of the model validation exercises undertaken on their website. These verify the output of the model in comparison to observed data for a number of scenarios, to ensure predictions are as accurate as possible. The model input code is periodically updated by the US EPA to resolve bugs and errors and to improve the output to take account of latest knowledge. The latest AERMOD model executable file has been used to run the model for the purpose of this assessment.

4.6.4 In addition to the choice of model, the following methods used in the assessment ensures that confidence can be high that potential impacts have not been underestimated:

- Worst case modelled concentrations across 5 years of meteorological data used in assessment;
- Assumption that the plant will emit continuously at maximum permitted levels and be operational for 100% of each year with no shut down;
- Where possible, estimation of existing background pollutant concentrations have been conservative;
- Worst case assumption made for NO_x to NO_2 conversion;
- Worst case assumption that dust emissions consist entirely of PM_{10} or $PM_{2.5}$; and,
- Worst case assumption that TOC emissions consist entirely of benzene.

5 Model Results

5.1 Modelled Pollutant Concentrations

5.1.1 The tables below contain the maximum modelled ground level pollutant concentrations within the modelling domain and at sensitive receptors, with comparison to the relevant AQS, EALs and critical levels for each pollutant and scenario. Maximum modelled concentrations from the five years of sequential data have been used to undertake assessment of potential impacts.

5.1.2 In accordance with previous guidance[10], annual mean AQS/EALs are considered relevant at receptors where cumulative occupancy exceeds 6 months of the year, eg residential properties. However, this should also include schools, hospitals and care homes. The annual mean AQLVs/EALs are not relevant at building facades of offices and other places of work where members of the public do not have regular access. 15-minute mean, 1-hour mean, 8 hour mean and 24-hour mean AQLVs/EALs are considered relevant at places where annual mean AQLVs apply, in addition to places where exposure would be expected to be more short term. For example, 24-hour mean AQLVs are relevant at places where exposure may last for 8 hours or more per day and 1-hour mean AQLVs relevant at places where exposure may be for 1 hour or more per day, for example offices and recreational areas.

5.1.3 In order to ensure a worst case assessment of potential short term impacts on human receptors (24-hour mean, 8-hour mean, 1-hour mean and 15-minute mean concentrations), the maximum point of impact within the modelling domain has been considered in the assessment, in addition to discrete human receptor locations. This is considered to provide a conservative assessment of potential short term impacts since

[10] LAQM.TG(09), DEFRA, 2009.

the maximum point of impact does not necessarily correspond to relevant points of short term exposure.

Table 5.1 – Modelled Annual Mean NO_2 Concentrations

Receptor	Modelled PC to Annual Mean NO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.264383	0.323316	0.270032	0.313775	0.352352	0.88	10.48	26.21
R2	0.378812	0.447685	0.407939	0.381472	0.409682	1.12	10.58	26.44
R3	0.107415	0.121814	0.129612	0.135534	0.142275	0.36	10.27	25.68
R4	0.342762	0.436723	0.418551	0.430591	0.472626	1.18	10.60	26.51
R5	0.240513	0.311703	0.292572	0.300993	0.325843	0.81	10.46	26.14
R6	0.188888	0.252154	0.23611	0.237419	0.249879	0.63	10.38	25.96
R7	0.063336	0.068145	0.071659	0.068145	0.07042	0.18	10.20	25.50
R8	0.070903	0.088837	0.089075	0.090076	0.093485	0.23	10.22	25.56
R9	0.040145	0.043169	0.045976	0.04312	0.044758	0.11	10.18	25.44
R10	0.026257	0.029211	0.027538	0.028665	0.035826	0.09	10.17	25.41
R11	0.027762	0.02751	0.030786	0.031262	0.039634	0.10	10.17	25.42
R12	0.122444	0.070959	0.095984	0.092295	0.108423	0.31	10.25	25.63
R13	0.129892	0.07196	0.086534	0.097279	0.084714	0.32	10.26	25.65
R14	0.178899	0.123109	0.126679	0.163674	0.1323	0.45	10.31	25.77
R15	0.083363	0.052164	0.055664	0.064337	0.048202	0.21	10.21	25.53
R16	0.084812	0.099288	0.081368	0.151956	0.075992	0.38	10.28	25.70
R17	0.046368	0.05523	0.050246	0.087297	0.045059	0.22	10.22	25.54
R18	0.04193	0.050862	0.041181	0.065891	0.031927	0.16	10.20	25.49
R19	0.043925	0.051961	0.042875	0.065107	0.032417	0.16	10.20	25.49
R20	0.04844	0.052717	0.044765	0.066472	0.031808	0.17	10.20	25.49
R21	0.055517	0.053263	0.046221	0.064855	0.032886	0.16	10.19	25.49
R22	0.058863	0.057841	0.047894	0.056455	0.036589	0.15	10.19	25.47
R23	0.068698	0.061901	0.059437	0.065394	0.050652	0.17	10.20	25.50
R24	0.061516	0.047768	0.050834	0.06356	0.043505	0.16	10.19	25.48
R25	0.068537	0.055111	0.064106	0.081095	0.057043	0.20	10.21	25.53
R26	0.110908	0.102767	0.090482	0.11963	0.115017	0.30	10.25	25.62

Table 5.2 – Modelled 99.8th Percentile 1-Hour Mean NO_2 Concentrations

Receptor	Modelled PC to 99.8th Percentile 1-Hour Mean NO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	13.62933	14.3951115	14.66937	15.00505	14.456603	7.50	35.27	17.63
R2	15.33514	14.5263335	14.03694	15.13634	15.937705	7.97	36.20	18.10
R3	9.945544	9.1832055	9.789493	11.27346	10.2315535	5.64	31.53	15.77
R4	15.89891	14.4852995	14.75681	15.31937	15.4645155	7.95	36.16	18.08
R5	13.41619	11.629499	11.41549	12.95751	12.07563	6.71	33.68	16.84
R6	8.594401	10.4077295	8.953469	11.28217	11.2404285	5.64	31.54	15.77
R7	3.037888	3.1368225	2.889282	3.20165	3.127747	1.60	23.46	11.73
R8	4.37884	4.878692	5.205554	5.882895	6.238792	3.12	26.50	13.25
R9	2.12373	2.0581155	1.976891	2.083648	1.9765165	1.06	22.38	11.19
R10	1.33903	1.378629	1.082802	1.325863	1.3608455	0.69	21.64	10.82
R11	1.845421	1.450666	1.505739	1.667743	2.0106415	1.01	22.27	11.14
R12	7.571491	5.503918	7.497361	6.3483	6.3973175	3.79	27.83	13.92
R13	6.709325	5.7173375	6.200737	6.186653	5.6150325	3.35	26.97	13.48
R14	9.126985	10.585666	9.301289	9.491927	8.4798105	5.29	30.85	15.42
R15	4.648921	5.3870845	3.984341	4.974589	4.0105835	2.69	25.65	12.82
R16	5.145956	5.1435265	6.555458	6.796125	7.2435965	3.62	27.50	13.75
R17	3.439086	3.194359	3.98047	4.81145	5.5061965	2.75	25.77	12.88
R18	2.451435	2.6763555	2.469856	2.661467	2.3676835	1.34	22.94	11.47
R19	2.454053	2.4650255	2.411469	2.702322	2.340282	1.35	22.96	11.48
R20	2.525649	2.317322	2.466762	2.747553	2.3465785	1.37	23.01	11.50
R21	2.634058	2.3854005	2.474399	2.912487	2.3792685	1.46	23.17	11.59
R22	2.255176	2.4881815	2.475582	2.455768	2.4806565	1.24	22.75	11.37
R23	2.642476	2.6310795	3.272224	3.887681	4.8047055	2.40	25.06	12.53
R24	3.64958	3.579548	4.430909	5.451086	4.468177	2.73	25.71	12.86
R25	5.513599	3.9755345	6.170224	6.52049	5.5286875	3.26	26.78	13.39
R26	8.567612	7.7843185	7.618786	9.076438	8.607655	4.54	29.34	14.67
Maximum Point of Impact	79.77503	85.518426	81.83747	83.74088	83.0548985	42.76	105.78	52.89

Table 5.3 – Modelled Annual Mean NO_x Concentrations

Receptor	Modelled PC to Annual Mean NO_x Concentrations ($\mu g.m^{-3}$)					Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
	2013	2014	2015	2016	2017			
R27	0.6098	0.35568	0.41884	0.55276	0.44014	2.03	13.91	46.37
R28	0.10749	0.13774	0.13122	0.13988	0.1608	0.54	13.46	44.87
R29	0.05273	0.05322	0.04686	0.07708	0.0437	0.26	13.38	44.59
R30	0.03103	0.02555	0.02824	0.0355	0.02615	0.12	13.34	44.45

Table 5.4 – Modelled 24-Hour Mean NO_x Concentrations

Receptor	Modelled PC to 24-Hour Mean NO_x Concentrations ($\mu g.m^{-3}$)	Maximum PC to Critical Level (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
R27	9.40732	12.54	25.10	33.46
R28	1.81242	2.42	17.50	23.34
R29	1.30184	1.74	16.99	22.66
R30	1.03276	1.38	16.72	22.30

Table 5.5 – Modelled Annual Mean PM_{10} Concentrations

Receptor	Modelled PC to Annual Mean PM_{10} Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.01895	0.02318	0.01936	0.0225	0.02526	0.06	11.86	29.64
R2	0.02716	0.0321	0.02925	0.02735	0.02937	0.08	11.86	29.66
R3	0.0077	0.00873	0.00929	0.00972	0.0102	0.03	11.84	29.60
R4	0.02457	0.03131	0.03001	0.03087	0.03388	0.08	11.86	29.66
R5	0.01724	0.02235	0.02098	0.02158	0.02336	0.06	11.85	29.63
R6	0.01354	0.01808	0.01693	0.01702	0.01791	0.05	11.85	29.62
R7	0.00454	0.00489	0.00514	0.00489	0.00505	0.01	11.84	29.59
R8	0.00508	0.00637	0.00639	0.00646	0.0067	0.02	11.84	29.59
R9	0.00288	0.00309	0.0033	0.00309	0.00321	0.01	11.83	29.58
R10	0.00188	0.00209	0.00197	0.00206	0.00257	0.01	11.83	29.58
R11	0.00199	0.00197	0.00221	0.00224	0.00284	0.01	11.83	29.58
R12	0.00878	0.00509	0.00688	0.00662	0.00777	0.02	11.84	29.60
R13	0.00931	0.00516	0.0062	0.00697	0.00607	0.02	11.84	29.60
R14	0.01283	0.00883	0.00908	0.01173	0.00949	0.03	11.84	29.61
R15	0.00598	0.00374	0.00399	0.00461	0.00346	0.01	11.84	29.59
R16	0.00608	0.00712	0.00583	0.01089	0.00545	0.03	11.84	29.60
R17	0.00332	0.00396	0.0036	0.00626	0.00323	0.02	11.84	29.59
R18	0.00301	0.00365	0.00295	0.00472	0.00229	0.01	11.83	29.59
R19	0.00315	0.00373	0.00307	0.00467	0.00232	0.01	11.83	29.59
R20	0.00347	0.00378	0.00321	0.00477	0.00228	0.01	11.83	29.59
R21	0.00398	0.00382	0.00331	0.00465	0.00236	0.01	11.83	29.59
R22	0.00422	0.00415	0.00343	0.00405	0.00262	0.01	11.83	29.59
R23	0.00493	0.00444	0.00426	0.00469	0.00363	0.01	11.83	29.59
R24	0.00441	0.00342	0.00364	0.00456	0.00312	0.01	11.83	29.59
R25	0.00491	0.00395	0.0046	0.00581	0.00409	0.01	11.84	29.59
R26	0.00795	0.00737	0.00649	0.00858	0.00825	0.02	11.84	29.60

Table 5.6 – Modelled 90.4th Percentile 24-Hour Mean PM_{10} Concentrations

Receptor	Modelled PC to 90.4th Percentile 24-Hour Mean PM_{10} Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.062072	0.071185	0.064225	0.076899	0.085054	0.17	14.05	28.09
R2	0.089546	0.099655	0.088183	0.090192	0.091069	0.20	14.06	28.12
R3	0.023739	0.029235	0.028439	0.032832	0.031479	0.07	13.99	27.99
R4	0.077181	0.089711	0.07641	0.092564	0.09672	0.19	14.06	28.11
R5	0.054932	0.065224	0.055158	0.064141	0.066407	0.13	14.03	28.05
R6	0.04283	0.055209	0.043621	0.050631	0.047667	0.11	14.02	28.03
R7	0.014305	0.015592	0.01298	0.015257	0.013851	0.03	13.98	27.95
R8	0.014501	0.019186	0.019018	0.020924	0.019897	0.04	13.98	27.96
R9	0.009657	0.0098227	0.00835	0.009256	0.0088324	0.02	13.97	27.94
R10	0.005367	0.0060536	0.005592	0.005702	0.0070446	0.01	13.97	27.93
R11	0.006436	0.0062265	0.006108	0.00733	0.0080801	0.02	13.97	27.94
R12	0.029395	0.018768	0.025157	0.022263	0.025981	0.06	13.99	27.98
R13	0.033637	0.019264	0.021445	0.023479	0.018872	0.07	13.99	27.99
R14	0.041856	0.035269	0.027734	0.041793	0.027425	0.08	14.00	28.00
R15	0.017489	0.0092355	0.011577	0.01472	0.010151	0.03	13.98	27.95
R16	0.022983	0.027845	0.020984	0.036977	0.021359	0.07	14.00	27.99
R17	0.011476	0.014142	0.014166	0.02186	0.01354	0.04	13.98	27.96
R18	0.011225	0.01424	0.010193	0.020179	0.0074629	0.04	13.98	27.96
R19	0.011566	0.013471	0.010883	0.018802	0.007263	0.04	13.98	27.96
R20	0.012112	0.013396	0.012027	0.018698	0.0070275	0.04	13.98	27.96
R21	0.015289	0.014196	0.012895	0.016457	0.0079072	0.03	13.98	27.95
R22	0.017271	0.01598	0.012653	0.014584	0.0090914	0.03	13.98	27.95
R23	0.019844	0.016639	0.015155	0.018345	0.014071	0.04	13.98	27.96
R24	0.014954	0.013143	0.013468	0.018659	0.010129	0.04	13.98	27.96
R25	0.017455	0.015511	0.018483	0.02087	0.012926	0.04	13.98	27.96
R26	0.027507	0.023909	0.024792	0.030262	0.026041	0.06	13.99	27.98
Maximum Point of Impact	1.59638	2.05783	1.71819	1.65834	1.81919	4.12	16.02	32.04

Table 5.7 – Modelled Annual Mean $PM_{2.5}$ Concentrations

Receptor	Modelled PC to Annual Mean $PM_{2.5}$ Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.01895	0.02318	0.01936	0.0225	0.02526	0.13	7.40	36.98
R2	0.02716	0.0321	0.02925	0.02735	0.02937	0.16	7.40	37.01
R3	0.0077	0.00873	0.00929	0.00972	0.0102	0.05	7.38	36.90
R4	0.02457	0.03131	0.03001	0.03087	0.03388	0.17	7.40	37.02
R5	0.01724	0.02235	0.02098	0.02158	0.02336	0.12	7.39	36.97
R6	0.01354	0.01808	0.01693	0.01702	0.01791	0.09	7.39	36.94
R7	0.00454	0.00489	0.00514	0.00489	0.00505	0.03	7.38	36.88
R8	0.00508	0.00637	0.00639	0.00646	0.0067	0.03	7.38	36.88
R9	0.00288	0.00309	0.0033	0.00309	0.00321	0.02	7.37	36.87
R10	0.00188	0.00209	0.00197	0.00206	0.00257	0.01	7.37	36.86
R11	0.00199	0.00197	0.00221	0.00224	0.00284	0.01	7.37	36.86
R12	0.00878	0.00509	0.00688	0.00662	0.00777	0.04	7.38	36.89
R13	0.00931	0.00516	0.0062	0.00697	0.00607	0.05	7.38	36.90
R14	0.01283	0.00883	0.00908	0.01173	0.00949	0.06	7.38	36.91
R15	0.00598	0.00374	0.00399	0.00461	0.00346	0.03	7.38	36.88
R16	0.00608	0.00712	0.00583	0.01089	0.00545	0.05	7.38	36.90
R17	0.00332	0.00396	0.0036	0.00626	0.00323	0.03	7.38	36.88
R18	0.00301	0.00365	0.00295	0.00472	0.00229	0.02	7.37	36.87
R19	0.00315	0.00373	0.00307	0.00467	0.00232	0.02	7.37	36.87
R20	0.00347	0.00378	0.00321	0.00477	0.00228	0.02	7.37	36.87
R21	0.00398	0.00382	0.00331	0.00465	0.00236	0.02	7.37	36.87
R22	0.00422	0.00415	0.00343	0.00405	0.00262	0.02	7.37	36.87
R23	0.00493	0.00444	0.00426	0.00469	0.00363	0.02	7.37	36.87
R24	0.00441	0.00342	0.00364	0.00456	0.00312	0.02	7.37	36.87
R25	0.00491	0.00395	0.0046	0.00581	0.00409	0.03	7.38	36.88
R26	0.00795	0.00737	0.00649	0.00858	0.00825	0.04	7.38	36.89

Table 5.8 – Modelled Annual Mean Benzene Concentrations

Receptor	Modelled PC to Annual Mean Benzene Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.01895	0.02318	0.01936	0.0225	0.02526	0.51	0.82	16.31
R2	0.02716	0.0321	0.02925	0.02735	0.02937	0.64	0.82	16.44
R3	0.0077	0.00873	0.00929	0.00972	0.0102	0.20	0.80	16.00
R4	0.02457	0.03131	0.03001	0.03087	0.03388	0.68	0.82	16.48
R5	0.01724	0.02235	0.02098	0.02158	0.02336	0.47	0.81	16.27
R6	0.01354	0.01808	0.01693	0.01702	0.01791	0.36	0.81	16.16
R7	0.00454	0.00489	0.00514	0.00489	0.00505	0.10	0.80	15.90
R8	0.00508	0.00637	0.00639	0.00646	0.0067	0.13	0.80	15.93
R9	0.00288	0.00309	0.0033	0.00309	0.00321	0.07	0.79	15.87
R10	0.00188	0.00209	0.00197	0.00206	0.00257	0.05	0.79	15.85
R11	0.00199	0.00197	0.00221	0.00224	0.00284	0.06	0.79	15.86
R12	0.00878	0.00509	0.00688	0.00662	0.00777	0.18	0.80	15.98
R13	0.00931	0.00516	0.0062	0.00697	0.00607	0.19	0.80	15.99
R14	0.01283	0.00883	0.00908	0.01173	0.00949	0.26	0.80	16.06
R15	0.00598	0.00374	0.00399	0.00461	0.00346	0.12	0.80	15.92
R16	0.00608	0.00712	0.00583	0.01089	0.00545	0.22	0.80	16.02
R17	0.00332	0.00396	0.0036	0.00626	0.00323	0.13	0.80	15.93
R18	0.00301	0.00365	0.00295	0.00472	0.00229	0.09	0.79	15.89
R19	0.00315	0.00373	0.00307	0.00467	0.00232	0.09	0.79	15.89
R20	0.00347	0.00378	0.00321	0.00477	0.00228	0.10	0.79	15.90
R21	0.00398	0.00382	0.00331	0.00465	0.00236	0.09	0.79	15.89
R22	0.00422	0.00415	0.00343	0.00405	0.00262	0.08	0.79	15.88
R23	0.00493	0.00444	0.00426	0.00469	0.00363	0.10	0.79	15.90
R24	0.00441	0.00342	0.00364	0.00456	0.00312	0.09	0.79	15.89
R25	0.00491	0.00395	0.0046	0.00581	0.00409	0.12	0.80	15.92
R26	0.00795	0.00737	0.00649	0.00858	0.00825	0.17	0.80	15.97

Table 5.9 – Maximum Modelled 1-Hour Mean Benzene Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Benzene Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.54661	1.82	2.13	7.09
R2	0.51813	1.73	2.10	6.99
R3	0.28448	0.95	1.86	6.21
R4	0.54615	1.82	2.13	7.09
R5	0.381	1.27	1.96	6.54
R6	0.31989	1.07	1.90	6.33
R7	0.11714	0.39	1.70	5.66
R8	0.14608	0.49	1.73	5.75
R9	0.07033	0.23	1.65	5.50
R10	0.04696	0.16	1.63	5.42
R11	0.06264	0.21	1.64	5.48
R12	0.31313	1.04	1.89	6.31
R13	0.25306	0.84	1.83	6.11
R14	0.43811	1.46	2.02	6.73
R15	0.24807	0.83	1.83	6.09
R16	0.37163	1.24	1.95	6.51
R17	0.2177	0.73	1.80	5.99
R18	0.12722	0.42	1.71	5.69
R19	0.10356	0.35	1.68	5.61
R20	0.09991	0.33	1.68	5.60
R21	0.11936	0.40	1.70	5.66
R22	0.08555	0.29	1.67	5.55
R23	0.15599	0.52	1.74	5.79
R24	0.18678	0.62	1.77	5.89
R25	0.18436	0.61	1.76	5.88
R26	0.25767	0.86	1.84	6.13
Maximum Point of Impact	7.4707	24.90	9.05	30.17

Table 5.10 – Modelled 99.2nd Percentile 24-Hour Mean SO_2 Concentrations

Receptor	Modelled PC to 99.2nd Percentile 24-Hour Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.76549	0.83792	0.82079	0.81624	0.96077	0.77	4.11	3.29
R2	0.94268	0.85757	0.9929	0.80468	0.79197	0.79	4.14	3.31
R3	0.33287	0.38336	0.38854	0.46182	0.48104	0.38	3.63	2.90
R4	0.67855	0.85394	0.81127	1.00609	0.96601	0.80	4.16	3.32
R5	0.53681	0.65566	0.57462	0.72672	0.73205	0.59	3.88	3.11
R6	0.51137	0.59008	0.50655	0.60852	0.52209	0.49	3.76	3.01
R7	0.1597	0.2365	0.14795	0.20574	0.13543	0.19	3.39	2.71
R8	0.25864	0.25563	0.2439	0.25434	0.24933	0.21	3.41	2.73
R9	0.10065	0.13084	0.11377	0.12057	0.096401	0.10	3.28	2.62
R10	0.088718	0.086448	0.052311	0.062717	0.068342	0.07	3.24	2.59
R11	0.079717	0.08664	0.09198	0.08139	0.12797	0.10	3.28	2.62
R12	0.36097	0.25662	0.3054	0.32706	0.39914	0.32	3.55	2.84
R13	0.36649	0.2925	0.3086	0.53321	0.41382	0.43	3.68	2.95
R14	0.67256	0.49948	0.49916	0.76349	0.77386	0.62	3.92	3.14
R15	0.46718	0.24935	0.25249	0.32971	0.19362	0.37	3.62	2.89
R16	0.3654	0.38417	0.36076	0.57594	0.32281	0.46	3.73	2.98
R17	0.20354	0.24102	0.21545	0.38318	0.22169	0.31	3.53	2.83
R18	0.14104	0.18098	0.22585	0.19541	0.15572	0.18	3.38	2.70
R19	0.16056	0.20164	0.18766	0.1978	0.15362	0.16	3.35	2.68
R20	0.16907	0.1907	0.15479	0.21526	0.17547	0.17	3.37	2.69
R21	0.16722	0.1798	0.14981	0.23826	0.15552	0.19	3.39	2.71
R22	0.18402	0.16892	0.16342	0.19758	0.15176	0.16	3.35	2.68
R23	0.22065	0.18805	0.19503	0.22783	0.18785	0.18	3.38	2.70
R24	0.19409	0.17063	0.15765	0.23089	0.19431	0.18	3.38	2.70
R25	0.22494	0.19364	0.24973	0.32414	0.26754	0.26	3.47	2.78
R26	0.3824	0.40144	0.32014	0.40389	0.45581	0.36	3.61	2.88
Maximum Point of Impact	14.38445	15.74413	14.74882	17.15915	16.44273	13.73	20.31	16.25

Table 5.11 – Modelled 99.7th Percentile 1-Hour Mean SO_2 Concentrations

Receptor	Modelled PC to 99.7th Percentile 1-Hour Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	15.30397	17.87111	20.03214	20.21824	19.3197	5.78	25.56	7.30
R2	19.19534	20.00969	18.40283	20.03802	20.16487	5.76	25.50	7.29
R3	11.47651	9.61446	10.62764	13.63213	13.30553	3.89	18.97	5.42
R4	19.73351	18.41875	18.39843	20.44093	18.79222	5.84	25.78	7.37
R5	14.77582	15.25192	13.88565	17.77539	15.43679	5.08	23.12	6.60
R6	10.89074	12.24879	11.18148	15.03063	14.8135	4.29	20.37	5.82
R7	3.72584	3.92102	3.4592	4.03058	4.00028	1.15	9.37	2.68
R8	4.74558	5.74256	5.76386	6.90941	6.82578	1.97	12.25	3.50
R9	2.25254	2.42767	2.27838	2.35049	2.18491	0.69	7.77	2.22
R10	1.67646	1.78282	1.34066	1.52701	1.70484	0.51	7.12	2.04
R11	2.20246	1.62664	1.75631	2.01202	2.27314	0.65	7.61	2.18
R12	9.7902	5.81238	7.8792	7.52916	7.67318	2.80	15.13	4.32
R13	7.89311	6.85358	7.88426	6.97604	6.53835	2.26	13.23	3.78
R14	11.31175	12.57153	10.12714	10.75347	9.88813	3.59	17.91	5.12
R15	5.93638	4.98306	4.94449	6.36611	4.38003	1.82	11.71	3.34
R16	5.58202	5.99394	6.62014	7.38227	7.42919	2.12	12.77	3.65
R17	3.6119	4.11942	4.31862	4.86444	5.41204	1.55	10.75	3.07
R18	2.80584	3.22056	2.87888	3.54025	2.78634	1.01	8.88	2.54
R19	3.09256	3.2479	3.05674	3.54395	2.84962	1.01	8.88	2.54
R20	3.1195	3.01948	3.10318	3.60768	2.57156	1.03	8.95	2.56
R21	3.38648	3.18665	3.21173	3.58011	2.80949	1.02	8.92	2.55
R22	2.84907	3.294	3.26678	3.24469	2.86881	0.94	8.63	2.47
R23	3.19252	3.48301	3.72639	4.01951	4.53278	1.30	9.87	2.82
R24	4.7097	4.0152	5.04328	6.49364	4.98349	1.86	11.83	3.38
R25	5.8067	4.1519	7.46526	8.5562	7.00393	2.44	13.90	3.97
R26	11.17862	8.26106	8.55977	11.10907	11.00863	3.19	16.52	4.72
Maximum Point of Impact	112.1826	115.57166	113.9107	114.5346	115.77435	33.08	121.11	34.60

Table 5.12 – Modelled 99.9th Percentile 15-Minute Mean SO_2 Concentrations

Receptor	Modelled PC to 99.9th Percentile 15-Minute Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	28.03575	31.0651798	30.89512	30.81585	29.0286076	11.68	38.23	14.37
R2	30.96372	30.6382156	30.61207	31.59392	33.4241426	12.57	40.58	15.26
R3	22.11036	20.1593888	23.80896	24.02727	24.6025742	9.25	31.76	11.94
R4	32.52161	31.7903476	32.35726	31.25349	33.082188	12.44	40.24	15.13
R5	27.41132	27.4273344	25.85596	26.98936	26.1654162	10.31	34.59	13.00
R6	21.87562	22.5065864	21.92862	24.24103	23.290138	9.11	31.40	11.80
R7	8.807525	9.4840242	8.427019	8.266808	7.188966	3.57	16.64	6.26
R8	11.65816	14.5282264	14.55397	15.79639	15.613077	5.94	22.96	8.63
R9	4.74088	5.0347016	4.863155	4.746025	4.648192	1.89	12.19	4.58
R10	3.287261	3.1182604	2.583091	2.885918	2.8874052	1.24	10.45	3.93
R11	4.642283	4.1384828	4.368655	4.330304	5.8173018	2.19	12.98	4.88
R12	15.71797	14.6640488	15.62428	14.39432	14.3430652	5.91	22.88	8.60
R13	16.11869	14.1496764	16.69478	15.71776	12.5832164	6.28	23.85	8.97
R14	21.11155	23.1040254	20.232	20.92383	20.4027998	8.69	30.26	11.38
R15	13.34375	14.2998368	10.83497	12.65405	10.8247076	5.38	21.46	8.07
R16	15.36849	14.128625	14.32224	16.2829	16.5474322	6.22	23.71	8.91
R17	11.3822	10.941703	12.04367	12.69943	12.5482022	4.77	19.86	7.47
R18	5.123651	5.7162122	5.40213	5.46724	5.374472	2.15	12.88	4.84
R19	5.478845	5.5827214	5.221069	5.598493	5.2083254	2.10	12.76	4.80
R20	5.377876	5.1567086	5.572189	6.379981	5.2483244	2.40	13.54	5.09
R21	6.692831	5.011801	5.210175	6.394802	5.2040642	2.52	13.85	5.21
R22	4.963253	5.8344806	5.48265	5.651115	7.9888254	3.00	15.15	5.70
R23	8.536162	7.3744488	8.713162	11.42708	10.8506768	4.30	18.59	6.99
R24	9.28754	9.6346	10.73818	11.87461	11.1659788	4.46	19.03	7.16
R25	12.24303	11.4963826	13.20778	14.09973	12.1760306	5.30	21.26	7.99
R26	17.92774	17.5055992	17.83851	19.40817	20.2646324	7.62	27.42	10.31
Maximum Point of Impact	163.2652	168.75692	166.4041	167.5418	166.357074	63.44	175.92	66.13

Table 5.13 – Modelled Annual Mean SO_2 Concentrations

Receptor	Modelled PC to Annual Mean SO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
	2013	2014	2015	2016	2017			
R27	0.15256	0.08899	0.10479	0.13829	0.11012	1.53	2.82	28.23
R28	0.02689	0.03446	0.03283	0.035	0.04023	0.40	2.71	27.10
R29	0.01319	0.01331	0.01172	0.01928	0.01093	0.19	2.69	26.89
R30	0.00776	0.00639	0.00707	0.00888	0.00654	0.09	2.68	26.79

Table 5.14 – Modelled Daily Mean HF Concentrations

Receptor	Maximum Modelled PC to Daily Mean HF Concentrations ($\mu g.m^{-3}$)	Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
R27	0.04721	0.94	2.82	56.34
R28	0.0091	0.18	2.78	55.58
R29	0.00653	0.13	2.78	55.53
R30	0.00518	0.10	2.78	55.50

Table 5.15 – Modelled Weekly Mean HF Concentrations

Receptor	Maximum Modelled PC to Weekly Mean HF Concentrations ($\mu g.m^{-3}$)	Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
R27	0.04721	9.44	2.82	563.44
R28	0.0091	1.82	2.78	555.82
R29	0.00653	1.31	2.78	555.31
R30	0.00518	1.04	2.78	555.04

Table 5.16 – Maximum Modelled Monthly Mean HF Concentrations

Receptor	Maximum Modelled PC to Monthly Mean HF Concentrations (µg.m^{-3})	Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL(%)
R1	0.00702	0.044	2.777	17.356
R2	0.00589	0.037	2.776	17.349
R3	0.00163	0.010	2.772	17.323
R4	0.00503	0.031	2.775	17.344
R5	0.00357	0.022	2.774	17.335
R6	0.00329	0.021	2.773	17.333
R7	0.00111	0.007	2.771	17.319
R8	0.00152	0.010	2.772	17.322
R9	0.00072	0.005	2.771	17.317
R10	0.00045	0.003	2.770	17.315
R11	0.0005	0.003	2.771	17.316
R12	0.00185	0.012	2.772	17.324
R13	0.00211	0.013	2.772	17.326
R14	0.00319	0.020	2.773	17.332
R15	0.0014	0.009	2.771	17.321
R16	0.00338	0.021	2.773	17.334
R17	0.00198	0.012	2.772	17.325
R18	0.00131	0.008	2.771	17.321
R19	0.00122	0.008	2.771	17.320
R20	0.00132	0.008	2.771	17.321
R21	0.00143	0.009	2.771	17.321
R22	0.0014	0.009	2.771	17.321
R23	0.0013	0.008	2.771	17.321
R24	0.00119	0.007	2.771	17.320
R25	0.00136	0.009	2.771	17.321
R26	0.00276	0.017	2.773	17.330

Table 5.17 – Maximum Modelled 1-Hour Mean HF Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean HF Concentrations (µg.m^{-3})	Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL(%)
R1	0.67784	0.42	5.38	3.36
R2	0.73077	0.46	5.43	3.39
R3	0.49039	0.31	5.19	3.24
R4	0.6296	0.39	5.33	3.33
R5	0.51479	0.32	5.21	3.26
R6	0.4503	0.28	5.15	3.22
R7	0.25093	0.16	4.95	3.09
R8	0.30159	0.19	5.00	3.13
R9	0.13035	0.08	4.83	3.02
R10	0.07923	0.05	4.78	2.99
R11	0.14509	0.09	4.85	3.03
R12	0.28666	0.18	4.99	3.12
R13	0.3094	0.19	5.01	3.13
R14	0.39503	0.25	5.10	3.18
R15	0.30335	0.19	5.00	3.13
R16	0.39865	0.25	5.10	3.19
R17	0.26462	0.17	4.96	3.10
R18	0.13713	0.09	4.84	3.02
R19	0.13366	0.08	4.83	3.02
R20	0.14896	0.09	4.85	3.03
R21	0.19388	0.12	4.89	3.06
R22	0.18688	0.12	4.89	3.05
R23	0.22326	0.14	4.92	3.08
R24	0.22555	0.14	4.93	3.08
R25	0.25444	0.16	4.95	3.10
R26	0.38222	0.24	5.08	3.18
Maximum Point of Impact	2.86809	1.79	7.57	4.73

Table 5.18 – Maximum Modelled 1-Hour Mean HCL Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean HCL Concentrations (µg.m^{-3})	Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL(%)
R1	10.16141	1.35	10.98	1.46
R2	10.95488	1.46	11.77	1.57
R3	7.35129	0.98	8.17	1.09
R4	9.43826	1.26	10.26	1.37
R5	7.71716	1.03	8.54	1.14
R6	6.75029	0.90	7.57	1.01
R7	3.76168	0.50	4.58	0.61
R8	4.52113	0.60	5.34	0.71
R9	1.95402	0.26	2.77	0.37
R10	1.18774	0.16	2.01	0.27
R11	2.17498	0.29	2.99	0.40
R12	4.29724	0.57	5.12	0.68
R13	4.63817	0.62	5.46	0.73
R14	5.92178	0.79	6.74	0.90
R15	4.54742	0.61	5.37	0.72
R16	5.97614	0.80	6.80	0.91
R17	3.96681	0.53	4.79	0.64
R18	2.05571	0.27	2.88	0.38
R19	2.00362	0.27	2.82	0.38
R20	2.23296	0.30	3.05	0.41
R21	2.90637	0.39	3.73	0.50
R22	2.80145	0.37	3.62	0.48
R23	3.34687	0.45	4.17	0.56
R24	3.38113	0.45	4.20	0.56
R25	3.81425	0.51	4.63	0.62
R26	5.72982	0.76	6.55	0.87
Maximum Point of Impact	42.99493	5.73	43.81	5.84

Table 5.19 – Modelled Annual Mean Mercury Concentrations

Receptor	Modelled Annual Mean Mercury Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00009449	0.00011555	9.65E-05	0.000112	0.00012593	0.05	0.02019	8.08
R2	0.00013539	0.00016001	0.000146	0.000136	0.00014642	0.06	0.02022	8.09
R3	0.00003839	0.00004354	4.63E-05	4.84E-05	0.00005085	0.02	0.02011	8.05
R4	0.0001225	0.00015609	0.00015	0.000154	0.00016892	0.07	0.02023	8.09
R5	0.00008596	0.00011141	0.000105	0.000108	0.00011646	0.05	0.02018	8.07
R6	0.00006751	0.00009012	8.44E-05	8.49E-05	0.00008931	0.04	0.02015	8.06
R7	0.00002264	0.00002435	2.56E-05	2.44E-05	0.00002517	0.01	0.02009	8.04
R8	0.00002534	0.00003175	3.18E-05	3.22E-05	0.00003341	0.01	0.02010	8.04
R9	0.00001435	0.00001543	1.64E-05	1.54E-05	0.000016	0.01	0.02008	8.03
R10	0.00000938	0.00001044	9.84E-06	1.03E-05	0.0000128	0.01	0.02008	8.03
R11	0.00000992	0.00000983	0.000011	1.12E-05	0.00001417	0.01	0.02008	8.03
R12	0.00004376	0.00002536	3.43E-05	3.3E-05	0.00003875	0.02	0.02011	8.04
R13	0.00004642	0.00002572	3.09E-05	3.48E-05	0.00003028	0.02	0.02011	8.04
R14	0.00006394	0.000044	4.53E-05	5.85E-05	0.00004729	0.03	0.02013	8.05
R15	0.00002979	0.00001864	1.99E-05	2.3E-05	0.00001723	0.01	0.02009	8.04
R16	0.00003031	0.00003549	2.91E-05	5.43E-05	0.00002716	0.02	0.02012	8.05
R17	0.00001657	0.00001974	1.8E-05	3.12E-05	0.0000161	0.01	0.02010	8.04
R18	0.00001499	0.00001818	1.47E-05	2.36E-05	0.00001141	0.01	0.02009	8.04
R19	0.0000157	0.00001857	1.53E-05	2.33E-05	0.00001159	0.01	0.02009	8.03
R20	0.00001731	0.00001884	0.000016	2.38E-05	0.00001137	0.01	0.02009	8.04
R21	0.00001984	0.00001904	1.65E-05	2.32E-05	0.00001175	0.01	0.02009	8.03
R22	0.00002104	0.00002067	1.71E-05	2.02E-05	0.00001308	0.01	0.02009	8.03
R23	0.00002455	0.00002212	2.12E-05	2.34E-05	0.0000181	0.01	0.02009	8.04
R24	0.00002199	0.00001707	1.82E-05	2.27E-05	0.00001555	0.01	0.02009	8.03
R25	0.0000245	0.0000197	2.29E-05	2.9E-05	0.00002039	0.01	0.02009	8.04
R26	0.00003964	0.00003673	3.23E-05	4.28E-05	0.00004111	0.02	0.02011	8.04

Table 5.20 – Maximum Modelled 1-Hour Mean Mercury Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Mercury Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.00846368	0.11	0.05	0.65
R2	0.00912458	0.12	0.05	0.66
R3	0.00612306	0.08	0.05	0.62
R4	0.00786135	0.10	0.05	0.64
R5	0.00642781	0.09	0.05	0.62
R6	0.00562248	0.07	0.05	0.61
R7	0.0031332	0.04	0.04	0.58
R8	0.00376575	0.05	0.04	0.59
R9	0.00162755	0.02	0.04	0.56
R10	0.0009893	0.01	0.04	0.55
R11	0.00181159	0.02	0.04	0.56
R12	0.00357927	0.05	0.04	0.58
R13	0.00386324	0.05	0.04	0.59
R14	0.00493239	0.07	0.05	0.60
R15	0.00378765	0.05	0.04	0.59
R16	0.00497767	0.07	0.05	0.60
R17	0.00330405	0.04	0.04	0.58
R18	0.00171225	0.02	0.04	0.56
R19	0.00166886	0.02	0.04	0.56
R20	0.00185989	0.02	0.04	0.56
R21	0.00242078	0.03	0.04	0.57
R22	0.00233339	0.03	0.04	0.57
R23	0.00278769	0.04	0.04	0.57
R24	0.00281622	0.04	0.04	0.57
R25	0.00317698	0.04	0.04	0.58
R26	0.00477251	0.06	0.04	0.60
Maximum Point of Impact	0.0358115	0.48	0.08	1.01

Table 5.21 – Modelled Annual Mean Cadmium Concentrations

Receptor	Modelled Annual Mean Cadmium Concentrations ($\mu g.m^{-3}$)					Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	9.45E-05	0.00011555	9.65E-05	0.000112	0.00012593	2.52	0.00025	5.08
R2	0.000135	0.00016001	0.000146	0.000136	0.00014642	3.20	0.00029	5.76
R3	3.84E-05	0.00004354	4.63E-05	4.84E-05	0.00005085	1.02	0.00018	3.58
R4	0.000123	0.00015609	0.00015	0.000154	0.00016892	3.38	0.00030	5.94
R5	8.6E-05	0.00011141	0.000105	0.000108	0.00011646	2.33	0.00024	4.89
R6	6.75E-05	0.00009012	8.44E-05	8.49E-05	0.00008931	1.80	0.00022	4.36
R7	2.26E-05	0.00002435	2.56E-05	2.44E-05	0.00002517	0.51	0.00015	3.07
R8	2.53E-05	0.00003175	3.18E-05	3.22E-05	0.00003341	0.67	0.00016	3.23
R9	1.44E-05	0.00001543	1.64E-05	1.54E-05	0.000016	0.33	0.00014	2.89
R10	9.38E-06	0.00001044	9.84E-06	1.03E-05	0.0000128	0.26	0.00014	2.82
R11	9.92E-06	0.00000983	0.000011	1.12E-05	0.00001417	0.28	0.00014	2.84
R12	4.38E-05	0.00002536	3.43E-05	3.3E-05	0.00003875	0.88	0.00017	3.44
R13	4.64E-05	0.00002572	3.09E-05	3.48E-05	0.00003028	0.93	0.00017	3.49
R14	6.39E-05	0.000044	4.53E-05	5.85E-05	0.00004729	1.28	0.00019	3.84
R15	2.98E-05	0.00001864	1.99E-05	2.3E-05	0.00001723	0.60	0.00016	3.16
R16	3.03E-05	0.00003549	2.91E-05	5.43E-05	0.00002716	1.09	0.00018	3.65
R17	1.66E-05	0.00001974	1.8E-05	3.12E-05	0.0000161	0.62	0.00016	3.18
R18	1.5E-05	0.00001818	1.47E-05	2.36E-05	0.00001141	0.47	0.00015	3.03
R19	1.57E-05	0.00001857	1.53E-05	2.33E-05	0.00001159	0.47	0.00015	3.03
R20	1.73E-05	0.00001884	0.000016	2.38E-05	0.00001137	0.48	0.00015	3.04
R21	1.98E-05	0.00001904	1.65E-05	2.32E-05	0.00001175	0.46	0.00015	3.02
R22	2.1E-05	0.00002067	1.71E-05	2.02E-05	0.00001308	0.42	0.00015	2.98
R23	2.46E-05	0.00002212	2.12E-05	2.34E-05	0.0000181	0.49	0.00015	3.05
R24	2.2E-05	0.00001707	1.82E-05	2.27E-05	0.00001555	0.45	0.00015	3.01
R25	2.45E-05	0.0000197	2.29E-05	2.9E-05	0.00002039	0.58	0.00016	3.14
R26	3.96E-05	0.00003673	3.23E-05	4.28E-05	0.00004111	0.86	0.00017	3.42

Table 5.22 – Modelled Annual Mean Vanadium Concentrations

Receptor	Modelled Annual Mean Vanadium Concentrations ($\mu g.m^{-3}$)					Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.03	0.00252	0.05
R2	0.00135	0.0016	0.00146	0.00136	0.00146	0.03	0.00286	0.06
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.01	0.00177	0.04
R4	0.00123	0.00156	0.0015	0.00154	0.00169	0.03	0.00295	0.06
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.02	0.00242	0.05
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.02	0.00216	0.04
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.01	0.00152	0.03
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.01	0.00159	0.03
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.00	0.00142	0.03
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.00	0.00139	0.03
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.00	0.00140	0.03
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.01	0.00170	0.03
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.01	0.00172	0.03
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.01	0.00190	0.04
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.01	0.00156	0.03
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.01	0.00180	0.04
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.01	0.00157	0.03
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.00	0.00150	0.03
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.00	0.00149	0.03
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.00	0.00150	0.03
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.00	0.00149	0.03
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.00	0.00147	0.03
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.01	0.00151	0.03
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.00	0.00149	0.03
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.01	0.00155	0.03
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.01	0.00169	0.03

Table 5.23 – Maximum Modelled 1-Hour Mean Vanadium Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Vanadium Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.08464	8.46	0.09	8.72
R2	0.09125	9.13	0.09	9.38
R3	0.06123	6.12	0.06	6.37
R4	0.07861	7.86	0.08	8.11
R5	0.06428	6.43	0.07	6.68
R6	0.05622	5.62	0.06	5.87
R7	0.03133	3.13	0.03	3.38
R8	0.03766	3.77	0.04	4.02
R9	0.01628	1.63	0.02	1.88
R10	0.00989	0.99	0.01	1.24
R11	0.01812	1.81	0.02	2.06
R12	0.03579	3.58	0.04	3.83
R13	0.03863	3.86	0.04	4.11
R14	0.04932	4.93	0.05	5.18
R15	0.03788	3.79	0.04	4.04
R16	0.04978	4.98	0.05	5.23
R17	0.03304	3.30	0.04	3.56
R18	0.01712	1.71	0.02	1.96
R19	0.01669	1.67	0.02	1.92
R20	0.0186	1.86	0.02	2.11
R21	0.02421	2.42	0.03	2.67
R22	0.02333	2.33	0.03	2.58
R23	0.02788	2.79	0.03	3.04
R24	0.02816	2.82	0.03	3.07
R25	0.03177	3.18	0.03	3.43
R26	0.04773	4.77	0.05	5.02
Maximum Point of Impact	0.35811	35.81	0.36	36.06

Table 5.24 – Modelled Annual Mean Manganese Concentrations

Receptor	Modelled Annual Mean Manganese Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.84	0.00498	3.32
R2	0.00135	0.0016	0.00146	0.00136	0.00146	1.07	0.00532	3.54
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.34	0.00423	2.82
R4	0.00123	0.00156	0.0015	0.00154	0.00169	1.13	0.00541	3.60
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.77	0.00488	3.25
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.60	0.00462	3.08
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.17	0.00398	2.65
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.22	0.00405	2.70
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.11	0.00388	2.58
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.09	0.00385	2.56
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.09	0.00386	2.57
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.29	0.00416	2.77
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.31	0.00418	2.78
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.43	0.00436	2.90
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.20	0.00402	2.68
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.36	0.00426	2.84
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.21	0.00403	2.68
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.16	0.00396	2.64
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.15	0.00395	2.63
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.16	0.00396	2.64
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.15	0.00395	2.63
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.14	0.00393	2.62
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.17	0.00397	2.64
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.15	0.00395	2.63
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.19	0.00401	2.67
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.29	0.00415	2.76

Table 5.25 – Maximum Modelled 1-Hour Mean Manganese Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Manganese Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.08464	0.006	0.09	0.006
R2	0.09125	0.006	0.10	0.007
R3	0.06123	0.004	0.07	0.005
R4	0.07861	0.005	0.09	0.006
R5	0.06428	0.004	0.07	0.005
R6	0.05622	0.004	0.06	0.004
R7	0.03133	0.002	0.04	0.003
R8	0.03766	0.003	0.05	0.003
R9	0.01628	0.001	0.02	0.002
R10	0.00989	0.001	0.02	0.001
R11	0.01812	0.001	0.03	0.002
R12	0.03579	0.002	0.04	0.003
R13	0.03863	0.003	0.05	0.003
R14	0.04932	0.003	0.06	0.004
R15	0.03788	0.003	0.05	0.003
R16	0.04978	0.003	0.06	0.004
R17	0.03304	0.002	0.04	0.003
R18	0.01712	0.001	0.02	0.002
R19	0.01669	0.001	0.02	0.002
R20	0.0186	0.001	0.03	0.002
R21	0.02421	0.002	0.03	0.002
R22	0.02333	0.002	0.03	0.002
R23	0.02788	0.002	0.04	0.002
R24	0.02816	0.002	0.04	0.002
R25	0.03177	0.002	0.04	0.003
R26	0.04773	0.003	0.06	0.004
Maximum Point of Impact	0.35811	0.024	0.37	0.024

Table 5.26 – Modelled Annual Mean Copper Concentrations

Receptor	Modelled Annual Mean Copper Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.013	0.00731	0.07
R2	0.00135	0.0016	0.00146	0.00136	0.00146	0.016	0.00765	0.08
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.005	0.00656	0.07
R4	0.00123	0.00156	0.0015	0.00154	0.00169	0.017	0.00774	0.08
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.012	0.00721	0.07
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.009	0.00695	0.07
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.003	0.00631	0.06
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.003	0.00638	0.06
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.002	0.00621	0.06
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.001	0.00618	0.06
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.001	0.00619	0.06
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.004	0.00649	0.06
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.005	0.00651	0.07
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.006	0.00669	0.07
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.003	0.00635	0.06
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.005	0.00659	0.07
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.003	0.00636	0.06
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.002	0.00629	0.06
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.002	0.00628	0.06
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.002	0.00629	0.06
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.002	0.00628	0.06
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.002	0.00626	0.06
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.003	0.00630	0.06
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.002	0.00628	0.06
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.003	0.00634	0.06
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.004	0.00648	0.06

Table 5.27 – Maximum Modelled 1-Hour Mean Copper Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Copper Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.08464	0.04	0.10	0.05
R2	0.09125	0.05	0.10	0.05
R3	0.06123	0.03	0.07	0.04
R4	0.07861	0.04	0.09	0.05
R5	0.06428	0.03	0.08	0.04
R6	0.05622	0.03	0.07	0.03
R7	0.03133	0.02	0.04	0.02
R8	0.03766	0.02	0.05	0.02
R9	0.01628	0.01	0.03	0.01
R10	0.00989	0.00	0.02	0.01
R11	0.01812	0.01	0.03	0.02
R12	0.03579	0.02	0.05	0.02
R13	0.03863	0.02	0.05	0.03
R14	0.04932	0.02	0.06	0.03
R15	0.03788	0.02	0.05	0.02
R16	0.04978	0.02	0.06	0.03
R17	0.03304	0.02	0.05	0.02
R18	0.01712	0.01	0.03	0.01
R19	0.01669	0.01	0.03	0.01
R20	0.0186	0.01	0.03	0.02
R21	0.02421	0.01	0.04	0.02
R22	0.02333	0.01	0.04	0.02
R23	0.02788	0.01	0.04	0.02
R24	0.02816	0.01	0.04	0.02
R25	0.03177	0.02	0.04	0.02
R26	0.04773	0.02	0.06	0.03
Maximum Point of Impact	0.35811	0.18	0.37	0.19

Table 5.28 – Modelled Annual Mean Chromium Concentrations

Receptor	Modelled Annual Mean Chromium Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.025	0.00299	0.06
R2	0.00135	0.0016	0.00146	0.00136	0.00146	0.032	0.00333	0.07
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.010	0.00224	0.04
R4	0.00123	0.00156	0.0015	0.00154	0.00169	0.034	0.00342	0.07
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.023	0.00289	0.06
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.018	0.00263	0.05
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.005	0.00199	0.04
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.007	0.00206	0.04
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.003	0.00189	0.04
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.003	0.00186	0.04
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.003	0.00187	0.04
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.009	0.00217	0.04
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.009	0.00219	0.04
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.013	0.00237	0.05
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.006	0.00203	0.04
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.011	0.00227	0.05
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.006	0.00204	0.04
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.005	0.00197	0.04
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.005	0.00196	0.04
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.005	0.00197	0.04
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.005	0.00196	0.04
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.004	0.00194	0.04
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.005	0.00198	0.04
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.005	0.00196	0.04
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.006	0.00202	0.04
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.009	0.00216	0.04

Table 5.29 – Maximum Modelled 1-Hour Mean Chromium Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Chromium Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL(%)
R1	0.08464	0.06	0.09	0.06
R2	0.09125	0.06	0.09	0.06
R3	0.06123	0.04	0.06	0.04
R4	0.07861	0.05	0.08	0.05
R5	0.06428	0.04	0.07	0.05
R6	0.05622	0.04	0.06	0.04
R7	0.03133	0.02	0.03	0.02
R8	0.03766	0.03	0.04	0.03
R9	0.01628	0.01	0.02	0.01
R10	0.00989	0.01	0.01	0.01
R11	0.01812	0.01	0.02	0.01
R12	0.03579	0.02	0.04	0.03
R13	0.03863	0.03	0.04	0.03
R14	0.04932	0.03	0.05	0.04
R15	0.03788	0.03	0.04	0.03
R16	0.04978	0.03	0.05	0.04
R17	0.03304	0.02	0.04	0.02
R18	0.01712	0.01	0.02	0.01
R19	0.01669	0.01	0.02	0.01
R20	0.0186	0.01	0.02	0.01
R21	0.02421	0.02	0.03	0.02
R22	0.02333	0.02	0.03	0.02
R23	0.02788	0.02	0.03	0.02
R24	0.02816	0.02	0.03	0.02
R25	0.03177	0.02	0.04	0.02
R26	0.04773	0.03	0.05	0.03
Maximum Point of Impact	0.35811	0.24	0.36	0.24

Table 5.30 – Modelled Annual Mean Lead Concentrations

Receptor	Modelled Annual Mean Lead Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.50	0.00745	2.98
R2	0.00135	0.0016	0.00146	0.00136	0.00146	0.64	0.00779	3.12
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.20	0.00670	2.68
R4	0.00123	0.00156	0.0015	0.00154	0.00169	0.68	0.00788	3.15
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.46	0.00735	2.94
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.36	0.00709	2.84
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.10	0.00645	2.58
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.13	0.00652	2.61
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.06	0.00635	2.54
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.05	0.00632	2.53
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.06	0.00633	2.53
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.18	0.00663	2.65
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.18	0.00665	2.66
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.26	0.00683	2.73
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.12	0.00649	2.60
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.22	0.00673	2.69
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.12	0.00650	2.60
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.10	0.00643	2.57
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.09	0.00642	2.57
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.10	0.00643	2.57
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.09	0.00642	2.57
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.08	0.00640	2.56
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.10	0.00644	2.58
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.09	0.00642	2.57
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.12	0.00648	2.59
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.17	0.00662	2.65

Table 5.31 – Modelled Annual Mean Antimony Concentrations

Receptor	Modelled Annual Mean Antimony Concentrations ($\mu g.m^{-3}$)					Maximum PC to EAL (%)
	2013	2014	2015	2016	2017	
R1	0.00094	0.00116	0.00097	0.00112	0.00126	0.025
R2	0.00135	0.0016	0.00146	0.00136	0.00146	0.032
R3	0.00038	0.00044	0.00046	0.00048	0.00051	0.010
R4	0.00123	0.00156	0.0015	0.00154	0.00169	0.034
R5	0.00086	0.00111	0.00105	0.00108	0.00116	0.023
R6	0.00068	0.0009	0.00084	0.00085	0.00089	0.018
R7	0.00023	0.00024	0.00026	0.00024	0.00025	0.005
R8	0.00025	0.00032	0.00032	0.00032	0.00033	0.007
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.003
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.003
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.003
R12	0.00044	0.00025	0.00034	0.00033	0.00039	0.009
R13	0.00046	0.00026	0.00031	0.00035	0.0003	0.009
R14	0.00064	0.00044	0.00045	0.00058	0.00047	0.013
R15	0.0003	0.00019	0.0002	0.00023	0.00017	0.006
R16	0.0003	0.00035	0.00029	0.00054	0.00027	0.011
R17	0.00017	0.0002	0.00018	0.00031	0.00016	0.006
R18	0.00015	0.00018	0.00015	0.00024	0.00011	0.005
R19	0.00016	0.00019	0.00015	0.00023	0.00012	0.005
R20	0.00017	0.00019	0.00016	0.00024	0.00011	0.005
R21	0.0002	0.00019	0.00017	0.00023	0.00012	0.005
R22	0.00021	0.00021	0.00017	0.0002	0.00013	0.004
R23	0.00025	0.00022	0.00021	0.00023	0.00018	0.005
R24	0.00022	0.00017	0.00018	0.00023	0.00016	0.005
R25	0.00024	0.0002	0.00023	0.00029	0.0002	0.006
R26	0.0004	0.00037	0.00032	0.00043	0.00041	0.009

Table 5.32 – Maximum Modelled 1-Hour Mean Antimony Concentrations

Receptor	Maximum Modelled PC to 1-Hour Mean Antimony Concentrations ($\mu g.m^{-3}$)	Maximum PC to EAL (%)
R1	0.08464	0.06
R2	0.09125	0.06
R3	0.06123	0.04
R4	0.07861	0.05
R5	0.06428	0.04
R6	0.05622	0.04
R7	0.03133	0.02
R8	0.03766	0.03
R9	0.01628	0.01
R10	0.00989	0.01
R11	0.01812	0.01
R12	0.03579	0.02
R13	0.03863	0.03
R14	0.04932	0.03
R15	0.03788	0.03
R16	0.04978	0.03
R17	0.03304	0.02
R18	0.01712	0.01
R19	0.01669	0.01
R20	0.0186	0.01
R21	0.02421	0.02
R22	0.02333	0.02
R23	0.02788	0.02
R24	0.02816	0.02
R25	0.03177	0.02
R26	0.04773	0.03
Maximum Point of Impact	0.35811	0.24

Table 5.33 – Modelled Annual Mean Arsenic Concentrations

Receptor	Modelled Annual Mean Arsenic Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	21.00	0.00197	32.80
R2	0.00135	0.0016	0.00146	0.00136	0.00146	26.67	0.00231	38.47
R3	0.00038	0.00044	0.00046	0.00048	0.00051	8.50	0.00122	20.30
R4	0.00123	0.00156	0.0015	0.00154	0.00169	28.17	0.00240	39.97
R5	0.00086	0.00111	0.00105	0.00108	0.00116	19.33	0.00187	31.13
R6	0.00068	0.0009	0.00084	0.00085	0.00089	15.00	0.00161	26.80
R7	0.00023	0.00024	0.00026	0.00024	0.00025	4.33	0.00097	16.13
R8	0.00025	0.00032	0.00032	0.00032	0.00033	5.50	0.00104	17.30
R9	0.00014	0.00015	0.00016	0.00015	0.00016	2.67	0.00087	14.47
R10	0.00009	0.0001	0.0001	0.0001	0.00013	2.17	0.00084	13.97
R11	0.0001	0.0001	0.00011	0.00011	0.00014	2.33	0.00085	14.13
R12	0.00044	0.00025	0.00034	0.00033	0.00039	7.33	0.00115	19.13
R13	0.00046	0.00026	0.00031	0.00035	0.0003	7.67	0.00117	19.47
R14	0.00064	0.00044	0.00045	0.00058	0.00047	10.67	0.00135	22.47
R15	0.0003	0.00019	0.0002	0.00023	0.00017	5.00	0.00101	16.80
R16	0.0003	0.00035	0.00029	0.00054	0.00027	9.00	0.00125	20.80
R17	0.00017	0.0002	0.00018	0.00031	0.00016	5.17	0.00102	16.97
R18	0.00015	0.00018	0.00015	0.00024	0.00011	4.00	0.00095	15.80
R19	0.00016	0.00019	0.00015	0.00023	0.00012	3.83	0.00094	15.63
R20	0.00017	0.00019	0.00016	0.00024	0.00011	4.00	0.00095	15.80
R21	0.0002	0.00019	0.00017	0.00023	0.00012	3.83	0.00094	15.63
R22	0.00021	0.00021	0.00017	0.0002	0.00013	3.50	0.00092	15.30
R23	0.00025	0.00022	0.00021	0.00023	0.00018	4.17	0.00096	15.97
R24	0.00022	0.00017	0.00018	0.00023	0.00016	3.83	0.00094	15.63
R25	0.00024	0.0002	0.00023	0.00029	0.0002	4.83	0.00100	16.63
R26	0.0004	0.00037	0.00032	0.00043	0.00041	7.17	0.00114	18.97

Table 5.34 – Modelled Annual Mean Nickel Concentrations

Receptor	Modelled Annual Mean Nickel Concentrations (µg.m^{-3})					Maximum PC to EAL (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	6.30	0.00267	13.36
R2	0.00135	0.0016	0.00146	0.00136	0.00146	8.00	0.00301	15.06
R3	0.00038	0.00044	0.00046	0.00048	0.00051	2.55	0.00192	9.61
R4	0.00123	0.00156	0.0015	0.00154	0.00169	8.45	0.00310	15.51
R5	0.00086	0.00111	0.00105	0.00108	0.00116	5.80	0.00257	12.86
R6	0.00068	0.0009	0.00084	0.00085	0.00089	4.50	0.00231	11.56
R7	0.00023	0.00024	0.00026	0.00024	0.00025	1.30	0.00167	8.36
R8	0.00025	0.00032	0.00032	0.00032	0.00033	1.65	0.00174	8.71
R9	0.00014	0.00015	0.00016	0.00015	0.00016	0.80	0.00157	7.86
R10	0.00009	0.0001	0.0001	0.0001	0.00013	0.65	0.00154	7.71
R11	0.0001	0.0001	0.00011	0.00011	0.00014	0.70	0.00155	7.76
R12	0.00044	0.00025	0.00034	0.00033	0.00039	2.20	0.00185	9.26
R13	0.00046	0.00026	0.00031	0.00035	0.0003	2.30	0.00187	9.36
R14	0.00064	0.00044	0.00045	0.00058	0.00047	3.20	0.00205	10.26
R15	0.0003	0.00019	0.0002	0.00023	0.00017	1.50	0.00171	8.56
R16	0.0003	0.00035	0.00029	0.00054	0.00027	2.70	0.00195	9.76
R17	0.00017	0.0002	0.00018	0.00031	0.00016	1.55	0.00172	8.61
R18	0.00015	0.00018	0.00015	0.00024	0.00011	1.20	0.00165	8.26
R19	0.00016	0.00019	0.00015	0.00023	0.00012	1.15	0.00164	8.21
R20	0.00017	0.00019	0.00016	0.00024	0.00011	1.20	0.00165	8.26
R21	0.0002	0.00019	0.00017	0.00023	0.00012	1.15	0.00164	8.21
R22	0.00021	0.00021	0.00017	0.0002	0.00013	1.05	0.00162	8.11
R23	0.00025	0.00022	0.00021	0.00023	0.00018	1.25	0.00166	8.31
R24	0.00022	0.00017	0.00018	0.00023	0.00016	1.15	0.00164	8.21
R25	0.00024	0.0002	0.00023	0.00029	0.0002	1.45	0.00170	8.51
R26	0.0004	0.00037	0.00032	0.00043	0.00041	2.15	0.00184	9.21

Table 5.35 – Modelled Annual Mean Chromium (VI) Concentrations

Receptor	Modelled Annual Mean Chromium (VI) Concentrations ($\mu g.m^{-3}$)					Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00094	0.00116	0.00097	0.00112	0.00126	504.00	0.00161	642.40
R2	0.00135	0.0016	0.00146	0.00136	0.00146	640.00	0.00195	778.40
R3	0.00038	0.00044	0.00046	0.00048	0.00051	204.00	0.00086	342.40
R4	0.00123	0.00156	0.0015	0.00154	0.00169	676.00	0.00204	814.40
R5	0.00086	0.00111	0.00105	0.00108	0.00116	464.00	0.00151	602.40
R6	0.00068	0.0009	0.00084	0.00085	0.00089	360.00	0.00125	498.40
R7	0.00023	0.00024	0.00026	0.00024	0.00025	104.00	0.00061	242.40
R8	0.00025	0.00032	0.00032	0.00032	0.00033	132.00	0.00068	270.40
R9	0.00014	0.00015	0.00016	0.00015	0.00016	64.00	0.00051	202.40
R10	0.00009	0.0001	0.0001	0.0001	0.00013	52.00	0.00048	190.40
R11	0.0001	0.0001	0.00011	0.00011	0.00014	56.00	0.00049	194.40
R12	0.00044	0.00025	0.00034	0.00033	0.00039	176.00	0.00079	314.40
R13	0.00046	0.00026	0.00031	0.00035	0.0003	184.00	0.00081	322.40
R14	0.00064	0.00044	0.00045	0.00058	0.00047	256.00	0.00099	394.40
R15	0.0003	0.00019	0.0002	0.00023	0.00017	120.00	0.00065	258.40
R16	0.0003	0.00035	0.00029	0.00054	0.00027	216.00	0.00089	354.40
R17	0.00017	0.0002	0.00018	0.00031	0.00016	124.00	0.00066	262.40
R18	0.00015	0.00018	0.00015	0.00024	0.00011	96.00	0.00059	234.40
R19	0.00016	0.00019	0.00015	0.00023	0.00012	92.00	0.00058	230.40
R20	0.00017	0.00019	0.00016	0.00024	0.00011	96.00	0.00059	234.40
R21	0.0002	0.00019	0.00017	0.00023	0.00012	92.00	0.00058	230.40
R22	0.00021	0.00021	0.00017	0.0002	0.00013	84.00	0.00056	222.40
R23	0.00025	0.00022	0.00021	0.00023	0.00018	100.00	0.00060	238.40
R24	0.00022	0.00017	0.00018	0.00023	0.00016	92.00	0.00058	230.40
R25	0.00024	0.0002	0.00023	0.00029	0.0002	116.00	0.00064	254.40
R26	0.0004	0.00037	0.00032	0.00043	0.00041	172.00	0.00078	310.40

Table 5.36 – Modelled Annual Mean Chromium (VI) Concentrations – Based on Emissions Data in EA Guidance Document

Receptor	Modelled Annual Mean Chromium (VI) Concentrations ($\mu g.m^{-3}$)					Maximum PC to EAL (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to EAL (%)
	2013	2014	2015	2016	2017			
R1	0.00000025	0.0000003	2.5E-07	2.9E-07	0.00000033	0.13	0.00035	138.53
R2	0.00000035	0.00000042	3.8E-07	3.5E-07	0.00000038	0.17	0.00035	138.57
R3	0.0000001	0.00000011	1.2E-07	1.3E-07	0.00000013	0.05	0.00035	138.45
R4	0.00000032	0.00000041	3.9E-07	4E-07	0.00000044	0.18	0.00035	138.58
R5	0.00000022	0.00000029	2.7E-07	2.8E-07	0.0000003	0.12	0.00035	138.52
R6	0.00000018	0.00000023	2.2E-07	2.2E-07	0.00000023	0.09	0.00035	138.49
R7	0.00000006	0.00000006	7E-08	6E-08	0.00000007	0.03	0.00035	138.43
R8	0.00000007	0.00000008	8E-08	8E-08	0.00000009	0.04	0.00035	138.44
R9	0.00000004	0.00000004	4E-08	4E-08	0.00000004	0.02	0.00035	138.42
R10	0.00000002	0.00000003	3E-08	3E-08	0.00000003	0.01	0.00035	138.41
R11	0.00000003	0.00000003	3E-08	3E-08	0.00000004	0.02	0.00035	138.42
R12	0.00000011	0.00000007	9E-08	9E-08	0.0000001	0.04	0.00035	138.44
R13	0.00000012	0.00000007	8E-08	9E-08	0.00000008	0.05	0.00035	138.45
R14	0.00000017	0.00000011	1.2E-07	1.5E-07	0.00000012	0.07	0.00035	138.47
R15	0.00000008	0.00000005	5E-08	6E-08	0.00000004	0.03	0.00035	138.43
R16	0.00000008	0.00000009	8E-08	1.4E-07	0.00000007	0.06	0.00035	138.46
R17	0.00000004	0.00000005	5E-08	8E-08	0.00000004	0.03	0.00035	138.43
R18	0.00000004	0.00000005	4E-08	6E-08	0.00000003	0.02	0.00035	138.42
R19	0.00000004	0.00000005	4E-08	6E-08	0.00000003	0.02	0.00035	138.42
R20	0.00000004	0.00000005	4E-08	6E-08	0.00000003	0.02	0.00035	138.42
R21	0.00000005	0.00000005	4E-08	6E-08	0.00000003	0.02	0.00035	138.42
R22	0.00000005	0.00000005	4E-08	5E-08	0.00000003	0.02	0.00035	138.42
R23	0.00000006	0.00000006	6E-08	6E-08	0.00000005	0.02	0.00035	138.42
R24	0.00000006	0.00000004	5E-08	6E-08	0.00000004	0.02	0.00035	138.42
R25	0.00000006	0.00000005	6E-08	8E-08	0.00000005	0.03	0.00035	138.43
R26	0.0000001	0.0000001	8E-08	1.1E-07	0.00000011	0.04	0.00035	138.44

Table 5.37 – Modelled Annual Mean PCDD/DF Concentrations

Receptor	Modelled Annual Mean PCDD/DF Concentrations (fg.m^{-3})					Maximum PC (As Percentage of Background Level) (%)
	2013	2014	2015	2016	2017	
R1	0.18954212	0.2317906	0.193592	0.224953	0.2526089	3.90
R2	0.2715788	0.32095629	0.29246	0.273488	0.29370846	4.95
R3	0.07700977	0.08733229	0.092923	0.097167	0.10199884	1.57
R4	0.24573265	0.31309633	0.30007	0.308698	0.33883421	5.23
R5	0.17242735	0.22346843	0.20975	0.215787	0.23360427	3.61
R6	0.13541663	0.18077545	0.16927	0.170212	0.17914584	2.79
R7	0.04540796	0.04885293	0.051372	0.048856	0.05048592	0.79
R8	0.05083107	0.06368869	0.063857	0.064576	0.06702083	1.03
R9	0.02877965	0.03094822	0.03296	0.030913	0.03208812	0.51
R10	0.01882506	0.02093991	0.019741	0.020552	0.02568202	0.40
R11	0.01990499	0.01972044	0.022071	0.02241	0.02841592	0.44
R12	0.08778284	0.05087062	0.068813	0.066166	0.07773168	1.35
R13	0.09312287	0.05159048	0.062038	0.069741	0.06073391	1.44
R14	0.12825874	0.08825838	0.090821	0.117343	0.09485047	1.98
R15	0.05976513	0.03739841	0.039905	0.046125	0.03455691	0.92
R16	0.0608034	0.07118186	0.058334	0.108939	0.05448278	1.68
R17	0.03324292	0.03959764	0.036021	0.062585	0.03230483	0.97
R18	0.03005863	0.03646463	0.029525	0.047241	0.02289007	0.73
R19	0.0314899	0.03725349	0.030738	0.046677	0.02324257	0.72
R20	0.03472559	0.03779352	0.032091	0.047658	0.02280398	0.74
R21	0.03980056	0.03818317	0.033137	0.046497	0.02357862	0.72
R22	0.04220092	0.04146832	0.034336	0.040475	0.02623324	0.65
R23	0.04925099	0.04437679	0.042609	0.046884	0.0363135	0.76
R24	0.04410054	0.03424659	0.036443	0.045566	0.031192	0.70
R25	0.04913786	0.03950849	0.045959	0.058141	0.04089616	0.90
R26	0.07951479	0.07367452	0.064869	0.085767	0.08245982	1.32

5.2 Assessment of Potential Impacts at Sensitive Human Receptors

5.2.1 Nitrogen Dioxide

5.2.1.1 The PEC for NO_2 has been modelled to be <70% of the annual mean AQLV at all relevant receptor locations (R1 to R26). Therefore, potential long term impacts are not predicted to be significant. The PC to 99.8th percentile 1-hour mean NO_2 concentrations is predicted to be <20% of the AQLV minus twice the annual mean background NO_2 concentration at receptors R1 to R26. Although this criteria is exceeded at the maximum point of impact, the PEC is significantly below the 1-hour mean AQLV for NO_2 (52.89% of the AQLV). Therefore, a breach of the short term AQLV is highly unlikely at any location surrounding the plant. Therefore, potential short term impacts are not predicted to be significant. Reference should be made to Appendix IV for NO2 pollutant contour profiles.

5.2.2 Particulate Matter

5.2.2.1 The modelled PC to the annual mean AQLV for PM_{10} and $PM_{2.5}$ is predicted to be <1% at receptors R1 to R26. As such, potential long term impacts have been screened out as insignificant. The modelled to PC to the 90.4th percentile 24-hour mean PM_{10} concentration is <10% of the AQLV at all locations surrounding the plant. As such, potential short term impacts are not predicted to be significant.

5.2.3 Sulphur Dioxide

5.2.3.1 The modelled PC to 99.2nd percentile 24-hour mean SO_2 concentrations is predicted to be <10% of the AQLV at receptors R1 to R26. The modelled PC to the 99.2nd percentile 24-hour mean SO_2 concentration is predicted to be <20% of the AQLV minus twice the annual mean background SO_2 concentration at the maximum point of impact surrounding the plant. As such, potential impacts on the 24-hour mean AQLV for SO_2 have been screened out as insignificant.

5.2.3.2 The PC to 99.7th percentile 1-hour mean SO_2 concentrations is predicted to be <10% of the AQLV at receptors R1 to R26. Although the screening criteria is exceeded at the maximum point of the impact, the PEC is significantly below the AQLV at this location (34.60% of the AQLV). Therefore, a breach of the AQLV is highly unlikely and impacts are not therefore predicted to be significant.

5.2.3.3 The PC to 99.9th percentile 15-minute mean SO_2 concentrations, is predicted to be <20% of the AQS minus twice the annual mean background SO_2 concentration at receptors R1 to R26. Although the screening criteria is exceeded at the maximum point of impact, the PEC is significantly below the 15-minute mean AQS for SO_2 at the maximum point of impact surrounding the plant (66.13% of the AQS). Given the above, confidence is high that the proposals will not lead to a breach of the 15-minute SO_2 AQLV at any location surrounding the plant and therefore, impacts are not predicted to be significant.

5.2.4 Benzene

5.2.4.1 The PEC is <70% of the annual mean AQLV for benzene at receptors R1 to R26. As such, potential impacts on the long term AQLV for benzene are not predicted to be significant. The modelled PC to 24-hour mean benzene concentrations is <10% of the EAL at receptors R1 to R26. Although the screening criteria are exceeded at the maximum point of impact, the PEC is significantly below the 24-hour mean EAL at this location (30.17% of the EAL). As such, a breach of the short term EAL is highly unlikely and impacts are not predicted to be significant.

5.2.5 Carbon Monoxide

5.2.5.1 The modelled PC is less than 10% of both 8-hour mean AQLV and 1-hour mean EAL at all locations surrounding the proposed plant for CO. As such, impacts have been screened out as insignificant.

5.2.6 Hydrogen Chloride

5.2.6.1 The modelled PC is <10% of the 1-hour mean EAL for HCL at all locations surrounding the plant. As such, potential impacts have been screened out as insignificant.

5.2.7 Hydrogen Fluoride

5.2.7.1 The modelled PC to monthly mean HF concentrations is less than 1% of the EAL at receptors R1 to R26. The modelled PC is <10% of the 1-hour mean EAL for HF at all locations surrounding the proposed plant. As such, potential impacts have been screened out as insignificant.

5.2.8 Mercury and Cadmium

5.2.8.1 The modelled PC to annual mean mercury concentrations is less than 1% of the EAL at receptors R1 to R26. The PEC is <70% of the EAL for annual mean cadmium concentrations at receptors R1 to R26. As such, potential long term impacts have been screened out as insignificant. The modelled PC to 1-hour mean mercury concentration is <10% of the EAL at the maximum point of impact. As such, potential short term impacts have been screened out as insignificant.

5.2.9 IED Group 3 Metals

5.2.9.1 In accordance with EA guidance, assessment was initially undertaken on the basis that each IED Group 3 metal is emitted at 100% of the group ELV (worst case screening). For lead, antimony, vanadium, manganese, copper, total chromium, arsenic and nickel, potential impacts have been screened out as insignificant since the PEC is <100% of the short and long term EALs for these compounds at relevant receptor locations. The modelled PC exceeds the EAL for annual mean chromium (VI) concentrations. As such, emissions were remodelled based on maximum reported incinerator emission concentration outlined within the EA guidance chromium (VI) (Case specific screening). The revised model predictions demonstrate that the PC to annual mean chromium (VI) concentrations will be less than 1% of the EAL at receptors R1 to R26. As such, impacts are not predicted to be significant, in accordance with the relevant guidance.

5.2.10 Dioxins and Furans

5.2.10.1 There are no AQS for PCDDs and PCDFs. In this instance, the modelled PC to annual mean PCDD/PCDF concentrations at relevant receptors has been compared to existing background PCDD/DF concentrations. The model results show that the PC to annual mean concentrations will be <10% of the estimated background PCDD/DF concentration. Therefore, PCDD and PCDF concentrations are considered to be relatively insignificant in comparison to existing background levels.

5.3 Assessment of Potential Impacts at Sensitive Ecological Receptors

5.3.1 Critical Levels

5.3.1.1 The modelled PC is less than 100% of the critical level for all relevant pollutants and scenarios at receptors R27 to R30, including annual mean and 24-hour mean NO_x, annual mean SO_2, daily and weekly mean HF concentrations. As such, potential impacts on non-statutory ecological receptors are not predicted to be significant, in accordance with the relevant guidance.

5.3.2 Nitrogen Deposition

5.3.2.1 The maximum PC to nitrogen deposition has been calculated from predicted annual mean NO_x at sensitive ecological receptors, in accordance with the relevant guidance. Nitrogen deposition arising as a result of resulting annual mean NO_x concentrations has been calculated using the following formula. In order to ensure a worst case scenario, it has been assumed that modelled concentrations comprise 100% NO_2. This provides a precautionary assessment, since the deposition velocity for NO is extremely small.

5.3.2.2 It should be noted that wet deposition has not been considered within this assessment. This is in accordance with the relevant guidance[11], which states the following:

"Wet deposition is not normally assessed by air quality practitioners because the impacts of a project or local development plan typically occur over short distances and over timescales that are too short for wet deposition to be significant. One exception to this is hydrogen chloride (HCl), which is readily 'washed out' of plumes at short range and can, therefore, be required for some industrial permit applications"

$$F = \left(\frac{Vd \times C \times 10000}{1000000000}\right) \times 0.3 \times 31536000$$

Where: F = deposition flux (Kg N $ha^{-1}Year^{-1}$)

V_d = nitrogen dry deposition velocity, assumed to be $0.003m.s^{-1}$ (worst case based on assumption that deposition is to woodland)

C = predicted annual mean NO_x concentration ($\mu g.m^{-3}$)

10000 = conversion from m^2 to hectares (ha)

1000000000 = conversion from µg to Kg

0.30 = correcting NO_2 to N

31536000 = conversion from seconds to year

5.3.2.3 Calculated annual nitrogen deposition at sensitive ecological receptors is presented in the table below, based on worst case modelled annual mean NO_x concentrations. As the PC is <100% of the worst case critical load, impacts are predicted to be insignificant and there is

[11] A Guide to the Assessment of Air Quality Impacts on Designated Nature Conservation Sites, IAQM, June 2019

no requirement for further assessment in accordance with government permitting risk assessment guidance.

Table 5.38 - Calculated Annual Nitrogen Deposition at Ecological Receptors

Receptor	Maximum Modelled Annual Mean NO_x Concentration ($\mu g.m^{-3}$)	Calculated PC to Annual Nitrogen Deposition (Kg $N.ha^{-1}.Year^{-1}$) Based on Modelled Annual Mean NO_2 Concentration	Percentage Contribution to Worst Case Critical Load for Annual Nitrogen Deposition (%)
R27	0.6098	0.173075875	5.77
R28	0.1608	0.045638899	1.52
R29	0.07708	0.021877154	0.73
R30	0.0355	0.010075752	0.34

5.3.3 Acid Deposition

5.3.3.1 The potential PC to acid deposition across non-statutory ecological sites can be calculated by converting nitrogen and sulphur deposition predictions to kiloequivalents ($keq.ha^{-1}.Year^{-1}$) using the following assumptions, obtained from the APIS website:

- 1 keq N $ha^{-1}.Year^{-1}$ is equal to 14kg N $ha^{-1}.Year^{-1}$; and,
- 1keq S $ha^{-1}.Year^{-1}$ is equal to 16kg S $ha^{-1}.Year^{-1}$

5.3.3.2 The critical loads for acid deposition due to sulphur are based on the assumption that nitrogen deposition is zero. Likewise, the critical loads for acid deposition due to nitrogen are based on the assumption that sulphur deposition is zero. Therefore, a worst case assessment is to compare the total acid deposition (sulphur + nitrogen) against the lower of the site specific critical loads for nitrogen and sulphur.

5.3.3.3 Potential sulphur deposition across non statutory ecological sites was calculated in a similar fashion to nitrogen deposition, using the following equation and assumptions:

Where: F = deposition flux (Kg S $ha^{-1}Year^{-1}$)

V_d = sulphur dry deposition velocity, assumed to be $0.012m.s^{-1}$

C = predicted annual mean SO_2 concentration ($\mu g.m^{-3}$)

10000 = conversion from m^2 to hectares (ha)

1000000000 = conversion from µg to Kg

0.5 = correcting SO_2 to S

31536000 = conversion from seconds to year

5.3.3.4 Based upon the above, the following table summarises annual nitrogen and sulphur deposition and calculated acid deposition. As is shown, the PC to acid deposition is predicted to be less than 100% of the worst case critical load at all relevant ecological receptors. As such, potential impacts are not predicted to be significant.

Table 5.39 - Calculated Acid Deposition at Ecological Receptors

Receptor	Calculated PC to Annual Nitrogen Deposition (Kg $N.ha^{-1}.Year^{-1}$) Based on Modelled Annual Mean NO_x Concentration	Calculated PC to Annual Sulphur Deposition (Kg $N.ha^{-1}.Year^{-1}$) Based on Modelled Annual Mean SO_2 Concentration	Calculated PC to Annual Acid Deposition ($keq.ha^{-1}.Year^{-1}$)	Percentage Contribution of Annual Acid Deposition to Critical Load (%)
R27	0.012362563	0.018041746	0.030404308	0.30
R28	0.003259921	0.0047576	0.008017521	0.08
R29	0.001562654	0.002280053	0.003842707	0.04
R30	0.000719697	0.001050149	0.001769845	0.02

5.4 In-Combination Modelling Assessment Results

5.4.1 The tables below contain the maximum modelled ground level pollutant concentrations within the modelling domain and at sensitive receptors, with comparison to the relevant AQS, EALs and critical levels for each pollutant and scenario, based on the in-combination assessment. Maximum modelled concentrations from the five years of sequential data have been used to undertake assessment of potential impacts.

5.4.2 As is indicated, the PEC is <70% of the AQLV for annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations at all relevant sensitive receptor locations. As such, potential impacts are insignificant, in accordance with the relevant guidance. The PC to annual mean and 24-hour mean NO_x concentrations at relevant ecological receptors is predicted to be <100% of the critical level. As such, potential impacts will not be significant on ecological receptors.

5.4.3 The PC to 99.8th percentile 1-hour mean NO_2 concentrations is predicted to be <20% of the AQLV minus twice the annual mean background NO_2 concentration at receptors R1 to R26. Although this criteria is exceeded at the maximum point of impact, the PEC is significantly below the 1-hour mean AQLV for NO_2 (59.41% of the AQLV). Therefore, a breach of the short term AQLV is highly unlikely at any location surrounding the plant. Therefore, potential short term in-combination impacts are not predicted to be significant.

5.4.4 The modelled to PC to the 90.4th percentile 24-hour mean PM_{10} concentration is <10% of the AQLV at all discrete receptor locations surrounding the plant (R1 to R26). As such, potential short term in-combination impacts are not predicted to be significant at discrete receptor locations. Although this criteria is exceeded at the maximum point of impact, the PEC is significantly below the 24-hour mean AQLV for PM_{10} (79.33% of the AQLV). Therefore, a breach of the short term AQLV for PM_{10} is highly unlikely at any location surrounding the plant. Therefore, potential short term in-combination impacts are not predicted to be significant.

Receptor	Modelled PC to Annual Mean NO_2 Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.407855	0.44485	0.405993	0.486906	0.458052	1.22	10.62	26.54
R2	0.708197	0.764841	0.714119	0.762419	0.731976	1.91	10.89	27.24
R3	0.298144	0.396515	0.344274	0.383418	0.356349	0.99	10.53	26.32
R4	1.11447	1.149631	1.124585	1.260679	1.138599	3.15	11.39	28.48
R5	1.090068	1.206716	1.052009	1.270976	1.28996	3.22	11.42	28.55
R6	1.131473	1.650628	1.299599	1.498098	1.497153	4.13	11.78	29.45
R7	0.252224	0.316232	0.313586	0.314104	0.33033	0.83	10.46	26.15
R8	0.228585	0.284186	0.27125	0.291774	0.328958	0.82	10.46	26.15
R9	0.152068	0.165025	0.172585	0.162736	0.176232	0.44	10.31	25.77
R10	0.098203	0.108549	0.104111	0.111769	0.141176	0.35	10.27	25.68
R11	0.074487	0.075593	0.086282	0.086149	0.102242	0.26	10.23	25.58
R12	0.218729	0.149954	0.168952	0.174636	0.18158	0.55	10.35	25.87
R13	0.19019	0.118972	0.129549	0.149429	0.124404	0.48	10.32	25.80
R14	0.252273	0.189665	0.191394	0.261177	0.194474	0.65	10.39	25.98
R15	0.126721	0.0994	0.095851	0.132265	0.084763	0.33	10.26	25.66
R16	0.126588	0.153293	0.130788	0.231077	0.114688	0.58	10.36	25.90
R17	0.073836	0.090881	0.085974	0.143332	0.073311	0.36	10.27	25.68
R18	0.070973	0.087101	0.073815	0.11221	0.057666	0.28	10.24	25.61
R19	0.073717	0.087864	0.075866	0.110719	0.057008	0.28	10.24	25.60
R20	0.079555	0.088298	0.078036	0.111657	0.055391	0.28	10.24	25.60
R21	0.088263	0.088256	0.078939	0.10864	0.055419	0.27	10.24	25.60
R22	0.093289	0.093142	0.080206	0.096831	0.057778	0.24	10.23	25.57
R23	0.104083	0.098602	0.091924	0.102137	0.076629	0.26	10.23	25.59
R24	0.099589	0.082516	0.085428	0.101269	0.069076	0.25	10.23	25.58
R25	0.114863	0.094164	0.102452	0.125062	0.087612	0.31	10.26	25.64
R26	0.170541	0.151613	0.142989	0.183792	0.159033	0.46	10.31	25.78

Table 5.40 – Modelled 99.8th Percentile 1-Hour Mean NO_2 Concentrations

Receptor	Modelled PC to 99.8th Percentile 1-Hour Mean NO_2 Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	7.137235	7.615321	7.688181	8.179448	7.510916	4.09	28.44	14.22
R2	13.78742	14.9047115	13.06304	15.13593	16.594445	8.30	36.85	18.43
R3	7.043306	7.9911125	6.925982	8.752009	6.55907	4.38	29.01	14.51
R4	19.65346	21.7186025	21.20951	22.64024	23.295314	11.65	43.56	21.78
R5	20.56835	20.663727	20.24417	23.4551	22.0625545	11.73	43.72	21.86
R6	20.83329	23.5638305	23.13404	24.27412	24.588522	12.29	44.85	22.42
R7	4.192444	5.4588695	5.549478	6.86938	6.5456965	3.43	27.13	13.56
R8	5.243417	5.9149755	4.952231	6.529817	6.7302655	3.37	26.99	13.50
R9	3.68521	3.048493	3.726279	3.531749	3.6513645	1.86	23.99	11.99
R10	2.642784	3.4877955	2.577456	2.865912	3.1383415	1.74	23.75	11.87
R11	1.89672	1.9173385	2.02818	2.009998	2.117724	1.06	22.38	11.19
R12	4.216478	4.388097	4.10074	3.746418	3.9705505	2.19	24.65	12.32
R13	3.787651	3.723153	3.308396	4.082208	2.9796585	2.04	24.34	12.17
R14	5.515517	5.3928875	5.26252	5.181127	4.970455	2.76	25.78	12.89
R15	2.906362	3.1546305	2.897836	3.135832	2.827356	1.58	23.41	11.71
R16	3.252603	3.183411	3.369072	3.530335	3.744706	1.87	24.00	12.00
R17	2.686509	2.699592	3.225502	3.337005	3.390842	1.70	23.65	11.83
R18	2.121074	2.530864	2.408403	2.619449	2.4944395	1.31	22.88	11.44
R19	2.286781	2.618224	2.592839	2.769536	2.2583295	1.38	23.03	11.51
R20	2.274871	2.196565	2.760863	2.805355	2.1017045	1.40	23.07	11.53
R21	2.483936	2.101218	2.408718	2.765371	2.012262	1.38	23.03	11.51
R22	2.172884	2.5716215	2.535726	2.662065	2.0523195	1.33	22.92	11.46
R23	2.215518	2.207702	2.383385	2.607287	2.7823985	1.39	23.04	11.52
R24	2.269908	2.31245	2.454414	2.803525	2.464903	1.40	23.06	11.53
R25	2.816044	2.3867235	3.08545	3.266785	2.761857	1.63	23.53	11.76
R26	4.277732	3.8861725	3.804392	4.531149	4.295914	2.27	24.79	12.40
Maximum Point of Impact	89.80072	95.5414775	96.8033	96.16758	98.554246	49.28	118.81	59.41

Table 5.41 – Modelled Annual Mean NO_x Concentrations

Receptor	Modelled PC to Annual Mean NO_x Concentrations ($\mu g.m^{-3}$)					Maximum PC to Critical Level (%)	Maximum Predicted Environmental Concentration (PEC) ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
	2013	2014	2015	2016	2017			
R27	0.80659	0.59344	0.63313	0.91427	0.62727	3.05	14.21	47.38
R28	0.36229	0.41511	0.40569	0.40296	0.42898	1.43	13.73	45.76
R29	0.08619	0.09648	0.08939	0.14793	0.08132	0.49	13.45	44.83
R30	0.05247	0.05319	0.04918	0.06994	0.04535	0.23	13.37	44.57

Table 5.42 – Modelled 24-Hour Mean NO_x Concentrations

Receptor	Modelled PC to 24-Hour Mean NO_x Concentrations ($\mu g.m^{-3}$)	Maximum PC to Critical Level (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to Critical Level (%)
R27	9.42799	12.57	25.12	33.49
R28	3.31915	4.43	19.01	25.35
R29	2.26661	3.02	17.96	23.94
R30	1.46836	1.96	17.16	22.88

Table 5.43 – Modelled Annual Mean PM_{10} Concentrations

Receptor	Modelled PC to Annual Mean PM_{10} Concentrations (µg.m^{-3})					Maximum PC to AQLV (%)	Maximum PEC (µg.m^{-3})	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.07097	0.06724	0.06865	0.08526	0.06358	0.21	11.92	29.79
R2	0.14657	0.14708	0.14025	0.16546	0.14622	0.41	12.00	29.99
R3	0.07685	0.10832	0.08712	0.09959	0.08781	0.27	11.94	29.85
R4	0.30435	0.28977	0.28597	0.33182	0.27533	0.83	12.16	30.40
R5	0.32524	0.34683	0.29631	0.37324	0.3729	0.93	12.20	30.51
R6	0.35527	0.52509	0.40249	0.47407	0.47011	1.31	12.36	30.89
R7	0.07302	0.09483	0.09285	0.09406	0.09928	0.25	11.93	29.82
R8	0.06225	0.07719	0.07243	0.07958	0.09207	0.23	11.92	29.81
R9	0.04346	0.04727	0.0492	0.04646	0.05087	0.13	11.88	29.70
R10	0.02797	0.03086	0.02974	0.03218	0.04076	0.10	11.87	29.68
R11	0.01893	0.0194	0.02233	0.02214	0.02554	0.06	11.86	29.64
R12	0.04369	0.03373	0.03334	0.03647	0.0343	0.11	11.87	29.68
R13	0.03117	0.0222	0.0218	0.02588	0.02046	0.08	11.86	29.65
R14	0.03943	0.03296	0.03254	0.04708	0.03202	0.12	11.88	29.69
R15	0.02169	0.02086	0.01856	0.02924	0.01671	0.07	11.86	29.65
R16	0.02123	0.0267	0.02375	0.03958	0.01948	0.10	11.87	29.67
R17	0.01328	0.01688	0.01656	0.02657	0.01347	0.07	11.86	29.64
R18	0.01354	0.01678	0.01478	0.02152	0.01162	0.05	11.85	29.63
R19	0.01395	0.01674	0.01503	0.0212	0.01124	0.05	11.85	29.63
R20	0.01475	0.01668	0.01527	0.02115	0.01083	0.05	11.85	29.63
R21	0.01585	0.01651	0.01517	0.02052	0.01053	0.05	11.85	29.63
R22	0.0167	0.01694	0.01515	0.01869	0.0103	0.05	11.85	29.62
R23	0.01775	0.01774	0.01604	0.01801	0.01305	0.05	11.85	29.62
R24	0.01821	0.01602	0.01619	0.01823	0.01239	0.05	11.85	29.62
R25	0.02171	0.01811	0.0185	0.02175	0.01517	0.05	11.85	29.63
R26	0.02957	0.02508	0.02552	0.03184	0.0242	0.08	11.86	29.65

Table 5.44 – Modelled 90.4th Percentile 24-Hour Mean PM_{10} Concentrations

Receptor	Modelled PC to 90.4th Percentile 24-Hour Mean PM_{10} Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.31289	0.31857	0.33808	0.40395	0.36706	0.81	14.36	28.73
R2	0.54851	0.50709	0.51299	0.54638	0.51434	1.10	14.51	29.02
R3	0.27787	0.33633	0.32934	0.32675	0.31834	0.67	14.30	28.59
R4	1.03885	0.89577	1.02429	1.07847	0.89112	2.16	15.04	30.08
R5	1.11503	1.03504	0.91961	1.18904	1.1956	2.39	15.16	30.31
R6	1.16421	1.54762	1.27224	1.47489	1.40129	3.10	15.51	31.02
R7	0.23357	0.29547	0.27513	0.32645	0.30066	0.65	14.29	28.57
R8	0.24433	0.25092	0.21972	0.27365	0.2813	0.56	14.24	28.48
R9	0.15168	0.16106	0.14862	0.17705	0.15219	0.35	14.14	28.27
R10	0.09144	0.10959	0.093356	0.097439	0.12311	0.25	14.08	28.17
R11	0.068826	0.075033	0.076921	0.077645	0.091484	0.18	14.05	28.10
R12	0.20699	0.14218	0.14262	0.17591	0.13628	0.41	14.17	28.33
R13	0.17059	0.10275	0.10984	0.14986	0.093079	0.34	14.13	28.26
R14	0.23181	0.15133	0.1759	0.24036	0.18577	0.48	14.20	28.40
R15	0.11449	0.096897	0.088232	0.13879	0.082808	0.28	14.10	28.20
R16	0.10876	0.16157	0.11429	0.21414	0.098989	0.43	14.17	28.35
R17	0.077201	0.09312	0.080702	0.14105	0.069801	0.28	14.10	28.20
R18	0.072473	0.087235	0.069965	0.12423	0.052375	0.25	14.08	28.17
R19	0.07309	0.087379	0.071398	0.12177	0.049433	0.24	14.08	28.16
R20	0.071303	0.085366	0.081062	0.123	0.049948	0.25	14.08	28.17
R21	0.084632	0.091914	0.088553	0.1034	0.049834	0.21	14.06	28.13
R22	0.10177	0.087396	0.084471	0.092789	0.052042	0.20	14.06	28.12
R23	0.10985	0.1017	0.080326	0.11136	0.068005	0.22	14.07	28.14
R24	0.095635	0.086025	0.089	0.10629	0.068303	0.21	14.07	28.13
R25	0.11072	0.090886	0.094536	0.11494	0.07574	0.23	14.07	28.15
R26	0.15104	0.12174	0.12963	0.15771	0.12874	0.32	14.12	28.24
Maximum Point of Impact	21.07593	25.7044	21.77715	23.54172	25.44337	51.41	39.66	79.33

Table 5.45 – Modelled Annual Mean $PM_{2.5}$ Concentrations

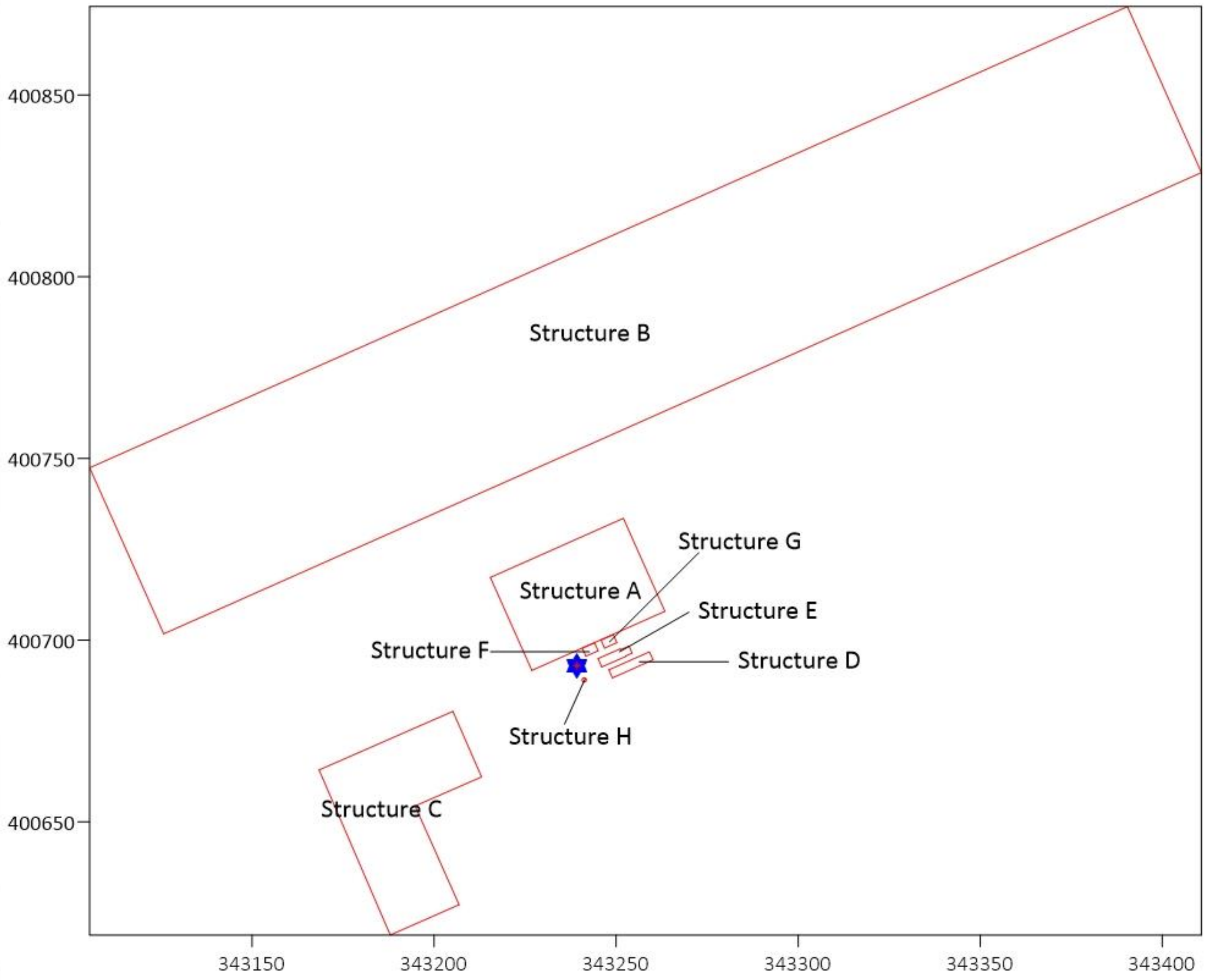
Receptor	Modelled PC to Annual Mean $PM_{2.5}$ Concentrations ($\mu g.m^{-3}$)					Maximum PC to AQLV (%)	Maximum PEC ($\mu g.m^{-3}$)	Contribution of PEC to AQLV (%)
	2013	2014	2015	2016	2017			
R1	0.07097	0.06724	0.06865	0.08526	0.06358	0.43	7.46	37.28
R2	0.14657	0.14708	0.14025	0.16546	0.14622	0.83	7.54	37.68
R3	0.07685	0.10832	0.08712	0.09959	0.08781	0.54	7.48	37.39
R4	0.30435	0.28977	0.28597	0.33182	0.27533	1.66	7.70	38.51
R5	0.32524	0.34683	0.29631	0.37324	0.3729	1.87	7.74	38.72
R6	0.35527	0.52509	0.40249	0.47407	0.47011	2.63	7.90	39.48
R7	0.07302	0.09483	0.09285	0.09406	0.09928	0.50	7.47	37.35
R8	0.06225	0.07719	0.07243	0.07958	0.09207	0.46	7.46	37.31
R9	0.04346	0.04727	0.0492	0.04646	0.05087	0.25	7.42	37.10
R10	0.02797	0.03086	0.02974	0.03218	0.04076	0.20	7.41	37.05
R11	0.01893	0.0194	0.02233	0.02214	0.02554	0.13	7.40	36.98
R12	0.04369	0.03373	0.03334	0.03647	0.0343	0.22	7.41	37.07
R13	0.03117	0.0222	0.0218	0.02588	0.02046	0.16	7.40	37.01
R14	0.03943	0.03296	0.03254	0.04708	0.03202	0.24	7.42	37.09
R15	0.02169	0.02086	0.01856	0.02924	0.01671	0.15	7.40	37.00
R16	0.02123	0.0267	0.02375	0.03958	0.01948	0.20	7.41	37.05
R17	0.01328	0.01688	0.01656	0.02657	0.01347	0.13	7.40	36.98
R18	0.01354	0.01678	0.01478	0.02152	0.01162	0.11	7.39	36.96
R19	0.01395	0.01674	0.01503	0.0212	0.01124	0.11	7.39	36.96
R20	0.01475	0.01668	0.01527	0.02115	0.01083	0.11	7.39	36.96
R21	0.01585	0.01651	0.01517	0.02052	0.01053	0.10	7.39	36.95
R22	0.0167	0.01694	0.01515	0.01869	0.0103	0.09	7.39	36.94
R23	0.01775	0.01774	0.01604	0.01801	0.01305	0.09	7.39	36.94
R24	0.01821	0.01602	0.01619	0.01823	0.01239	0.09	7.39	36.94
R25	0.02171	0.01811	0.0185	0.02175	0.01517	0.11	7.39	36.96
R26	0.02957	0.02508	0.02552	0.03184	0.0242	0.16	7.40	37.01

6 Conclusions

6.1 An assessment of potential air quality impacts has been undertaken for the proposed operation of a Medical Waste Incineration Plant at Stopgate Lane, Simonswood. Modelling has been undertaken using AERMOD to quantify resulting pollutant concentrations at surrounding ground level locations and an assessment undertaken of potential impacts, as a result of residual emissions from the stack serving the process. The model results have indicated that the proposals will not generate any significant adverse impacts on local air quality, with impacts predicted to be insignificant at all human and ecological receptors surrounding the plant.

Appendix I

Site Plans



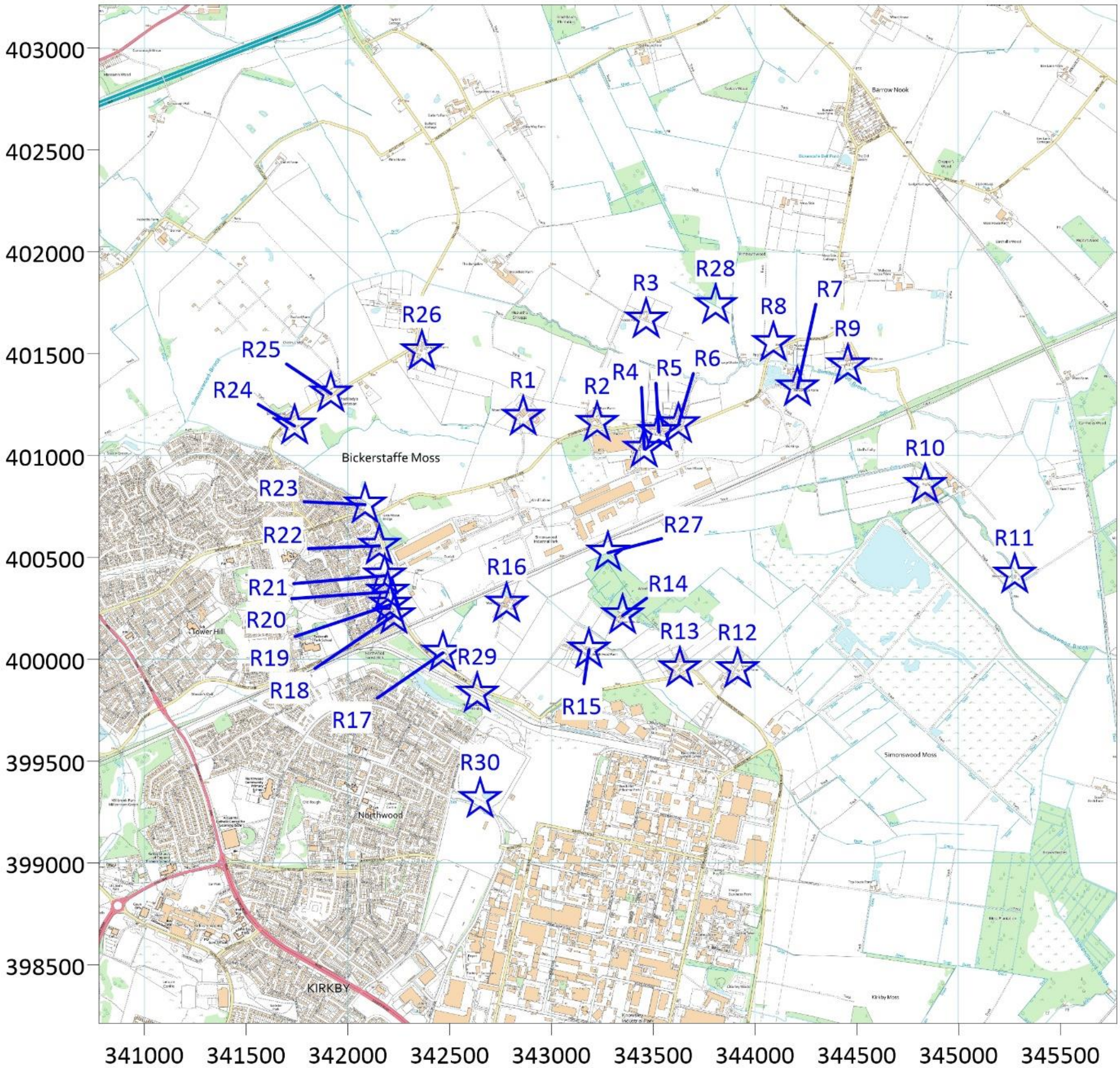
Buildings and Stacks Digitised Within Model

Stack Location

Oaktree Environmental Ltd
Lime House
2 Road Two
Winsford
Cheshire
CW7 3QZ

Appendix II

Sensitive Receptor Locations



Appendix II Figure 1 - Sensitive Receptors

☆ Receptor Location

R1 Receptor Identifier

Oaktree Environmental Ltd
Lime House
2 Road Two
Winsford
Cheshire
CW7 3QZ

N.B - Map contains Ordnance Survey data

Appendix III

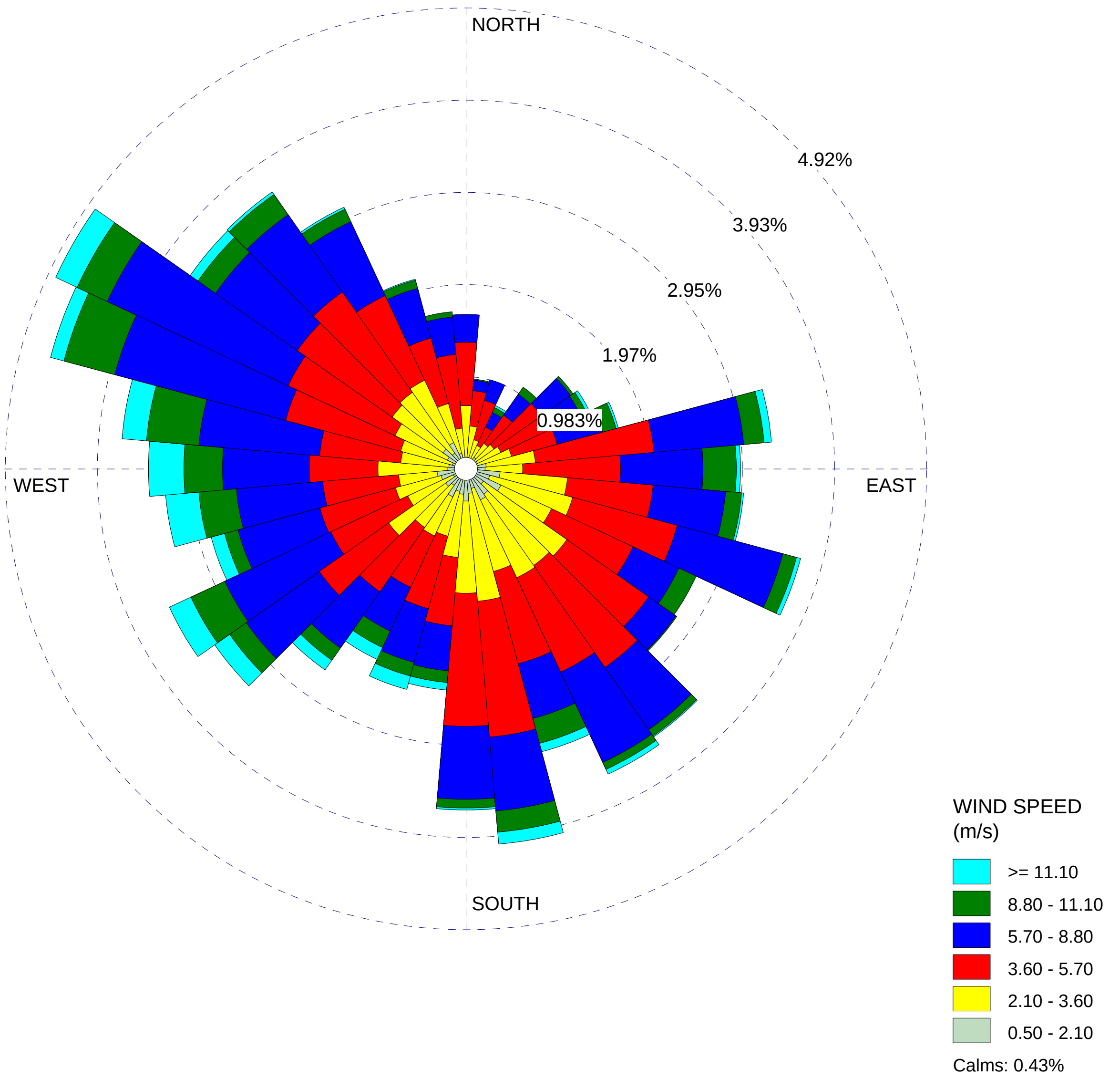
Liverpool Wind Roses

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 01/01/2013 - 00:00** **End Date: 31/12/2013 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.43%**	TOTAL COUNT: **8701 hrs.**	
	AVG. WIND SPEED: **5.02 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

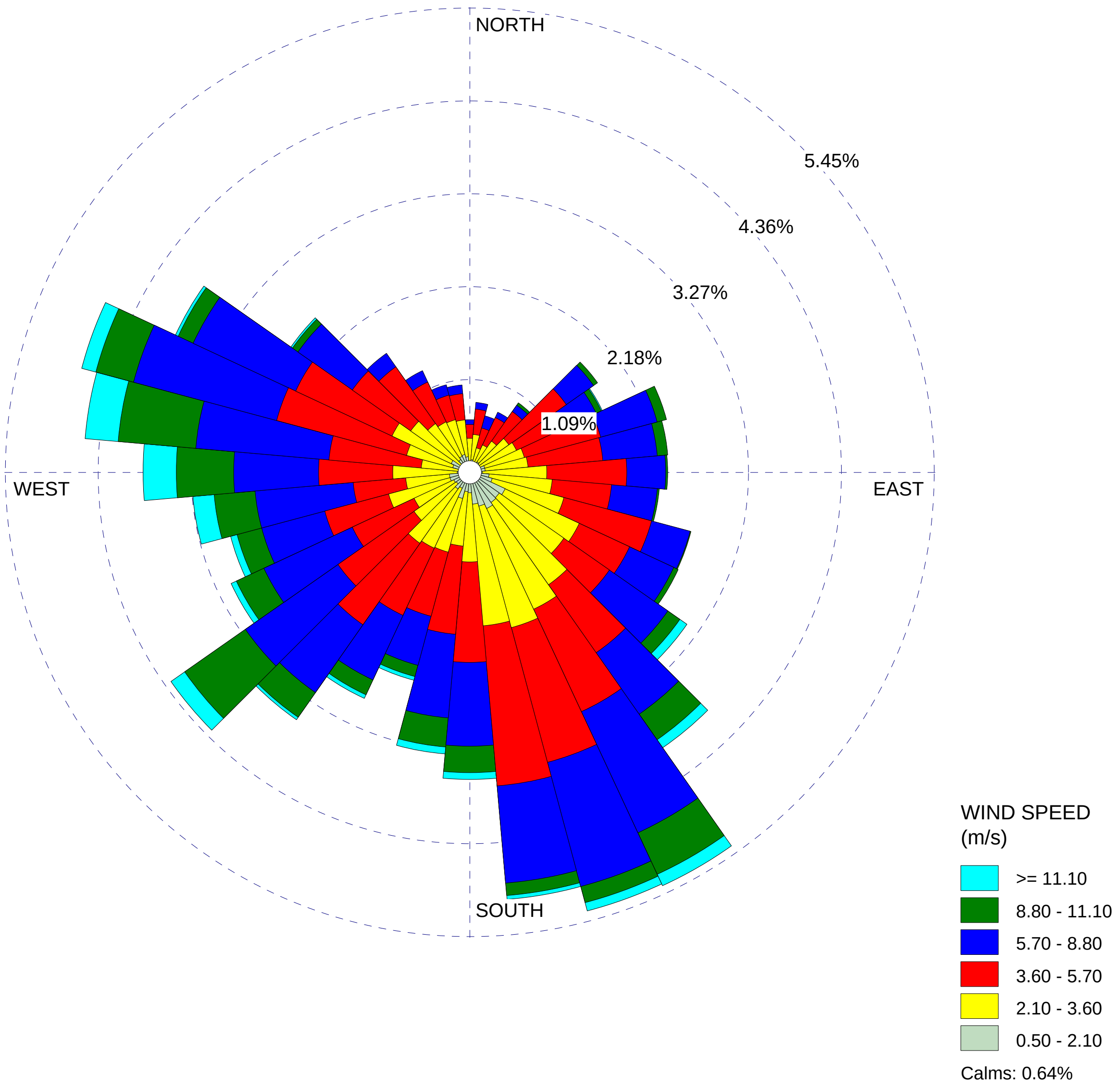
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2014 - 00:00
End Date: 31/12/2014 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

0.64%

TOTAL COUNT:

8702 hrs.

AVG. WIND SPEED:

4.86 m/s

DATE:

15/01/2019

PROJECT NO.:

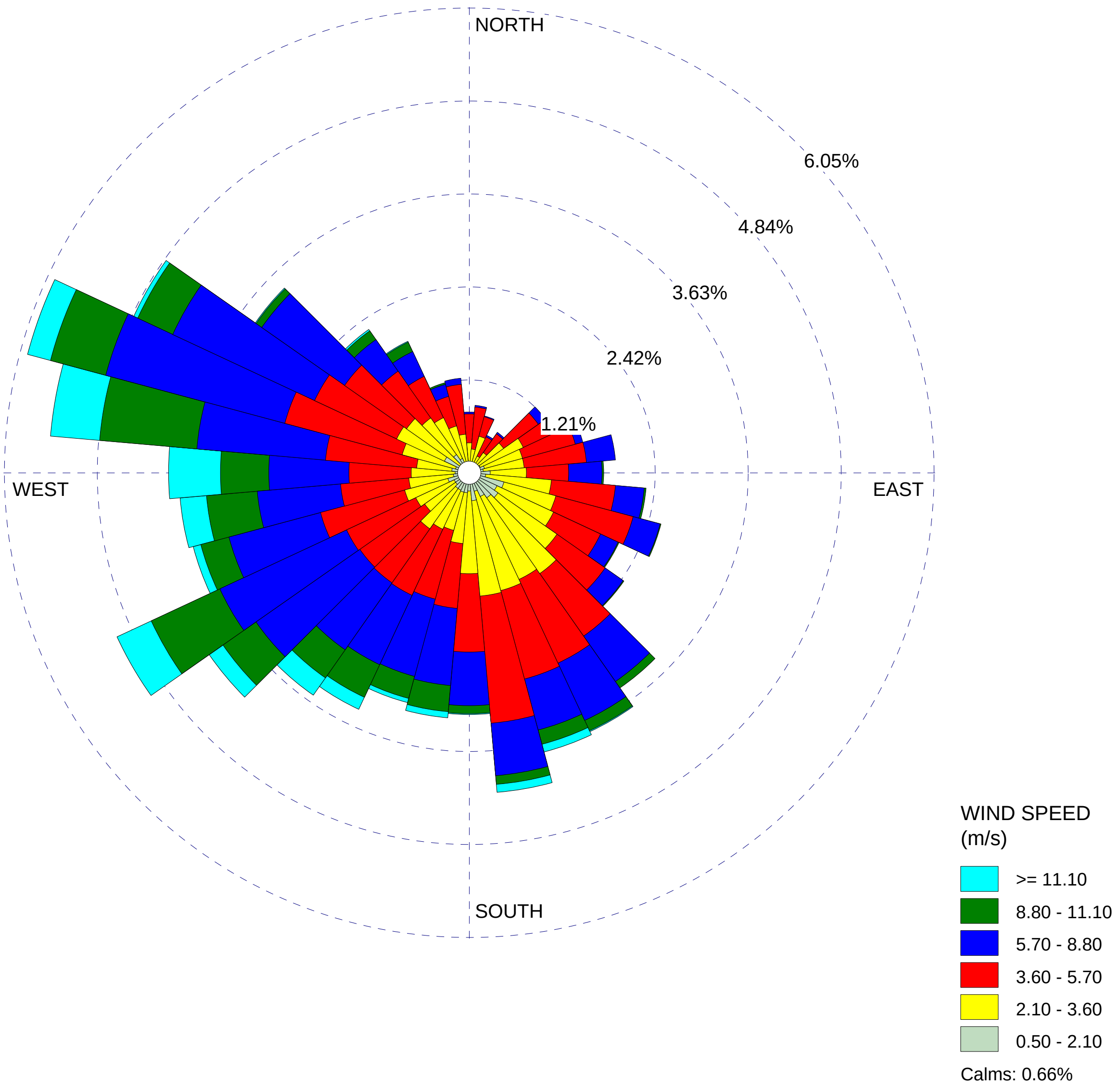
4013

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



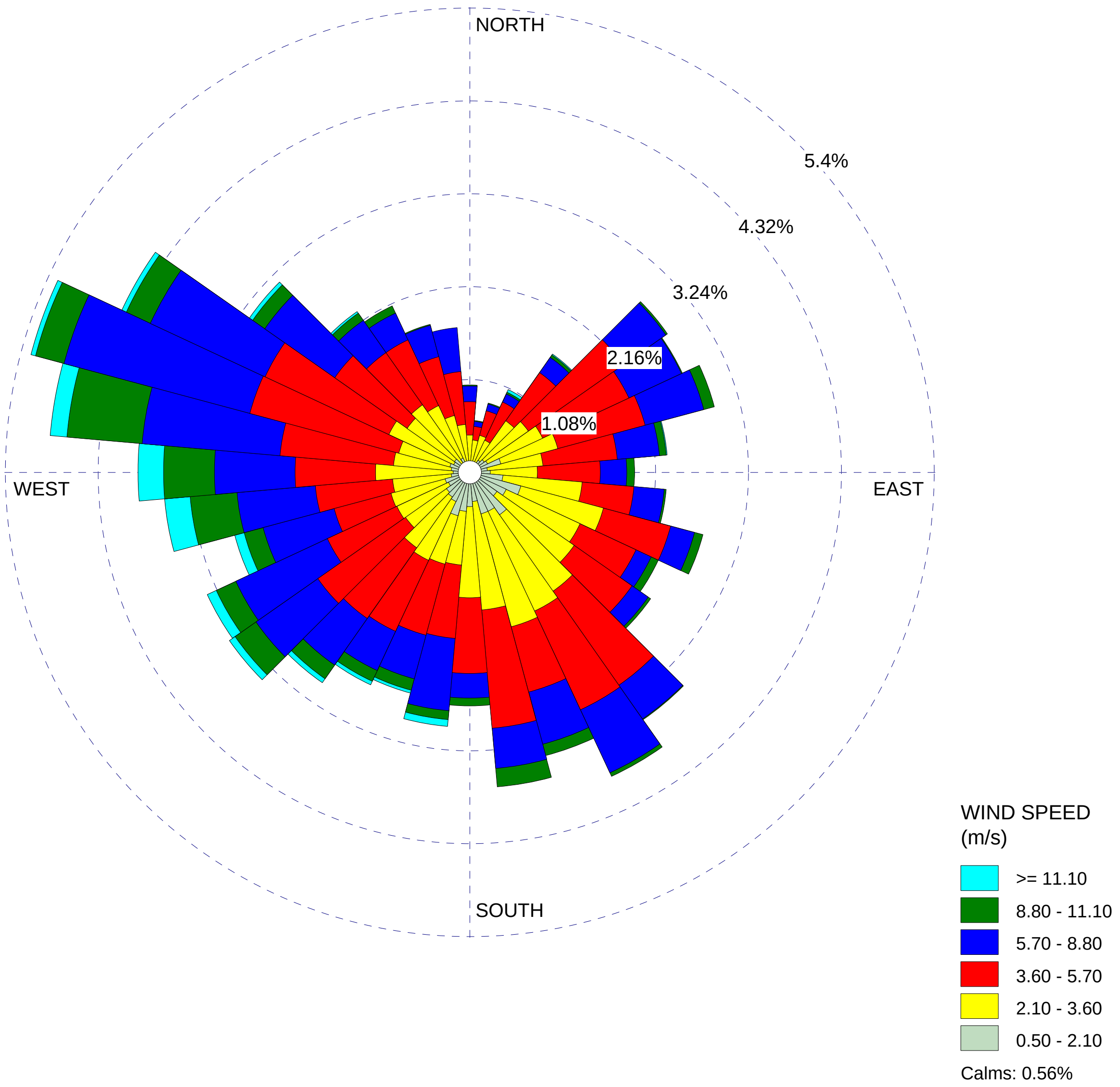
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 01/01/2015 - 00:00 **End Date: 31/12/2015 - 23:00**		
		MODELER:	
	CALM WINDS: **0.66%**	TOTAL COUNT: **8727 hrs.**	
	AVG. WIND SPEED: **5.02 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



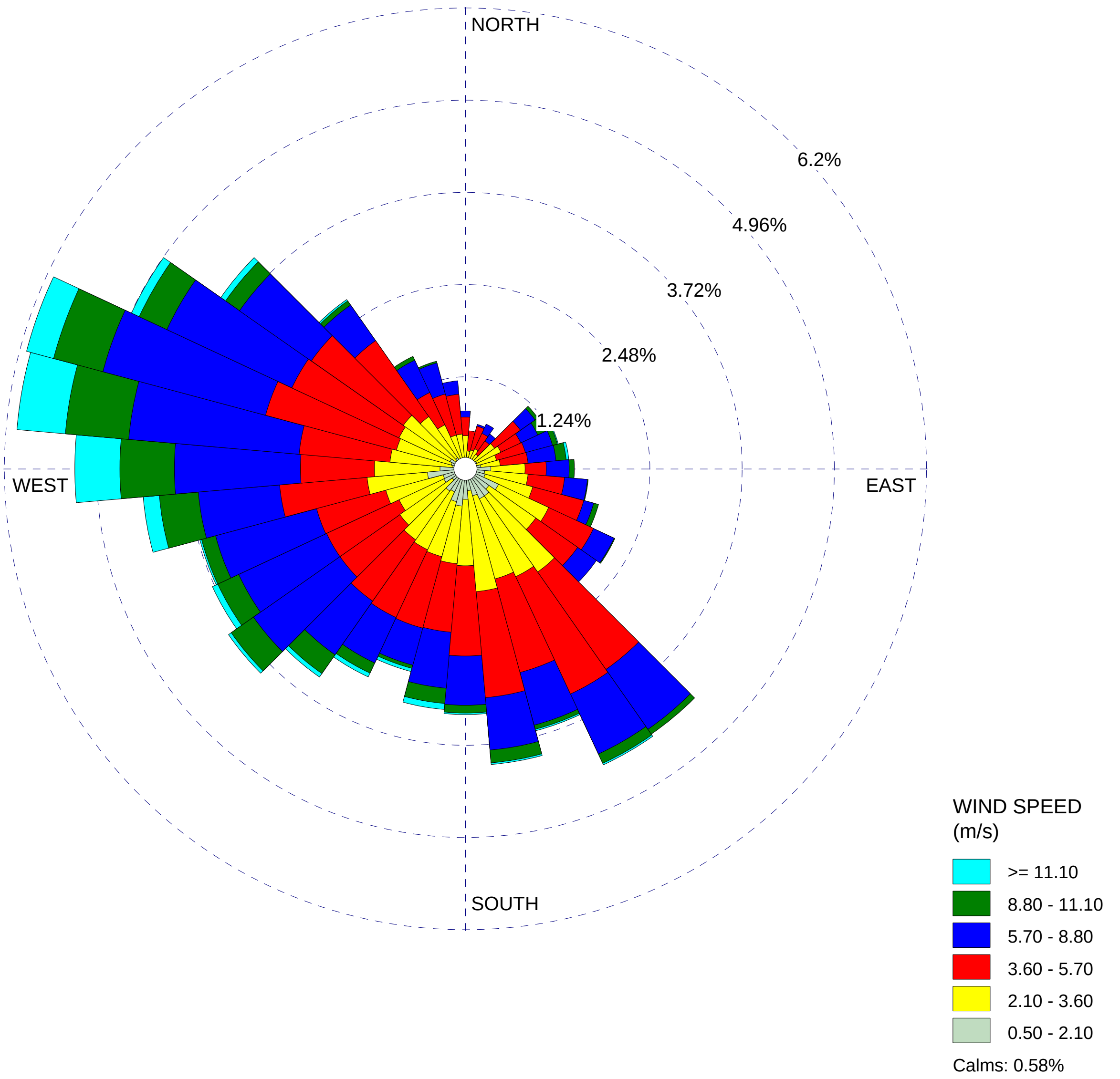
COMMENTS:	DATA PERIOD: **Start Date: 01/01/2016 - 00:00** **End Date: 31/12/2016 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.56%**	TOTAL COUNT: **8744 hrs.**	
	AVG. WIND SPEED: **4.46 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 01/01/2017 - 00:00** **End Date: 31/12/2017 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.58%**	TOTAL COUNT: **8708 hrs.**	
	AVG. WIND SPEED: **4.77 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

WRPLOT View - Lakes Environmental Software

ES Appendix VII

Human Health Risk Assessment

MEDICAL WASTE INCINERATION PLANT, STOPGATE LANE - HUMAN HEALTH RISK ASSESSMENT

Culzean W2E Limited

Version:	1.1	**Date:**	2 November 2021		
Doc. Ref:	2776-005-C	**Author(s):**	DY	**Checked:**	
Client No:	005	**Job No:**	2776		

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1.0	27/11/2020	DY		Internal draft
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1 Introduction

1.1 A Human Health Risk Assessment (HHRA) has been undertaken in support of a permit and planning application for a proposed Medical Waste Incinerator at Stopgate Lane, Simonswood. The purpose of this HHRA is to quantify potential risk to population exposed to residual emissions of polychlorinated dibenzo-dibenzo-dioxins (PCDD) ("dioxins) and polychlorinated dibenzofurans (PCDF) ("furans) from the proposed plant.

1.2 Risk to the population from inhalation of gaseous pollutants, particulate matter and metals has been addressed through undertaking dispersion modelling of emissions and comparing the resulting ground level pollutant concentrations with the various health based Air Quality Limit Values and Environmental Assessment Levels (EALs). These standards have been set based on known intake mechanisms, such as inhalation and ingestion. There are no ambient Air Quality Standards for dioxins and furans and health effects from these compounds can occur at very low inhalation and ingestion levels. Inhalation presents a direct exposure pathway, whilst ingestion can arise via indirect pathways, following the deposition of dioxins and furans from air to various media, including land and water, with subsequent uptake by humans via consumption of produce, drinking water and livestock which is subsequently consumed. In order to evaluate the potential health impacts from intake of dioxins/furans, a human health risk assessment model needs to be used, which takes account of exposure via all potential forms of intake.

1.3 The approach used by the Environment Agency (EA) when assessing potential health impacts from incinerators, is to use the H1 assessment methodology to assess impacts from most pollutants (including metals) against established Air Quality Standards and EALs and established dioxin intake models to assess potential health impacts from dioxins and furans. The principal models that can be used to assess dioxin intake are discussed later in this document.

2 Background on Dioxin and Furans, Exposure Routes and Tolerable Daily Intake

2.1 Description of Dioxins and Furans

2.1.1 The term 'dioxin' is normally used to refer to the family of 210 compounds known as PCDDs and PCDFs. There are 75 PCDDs and 135 PCDFs which make up the 'dioxin' family of compounds. Each dioxin compound comprises two benzene rings, interconnected by oxygen atoms and the various compounds have differing toxicity and physical properties. It is therefore important when assessing atmospheric transport and exposure to these toxic compounds to consider them on a congener specific basis. Out of the 210 dioxin compounds, there are 17 dioxin congeners which are thought to be the most toxic to human health, due to them possessing a specific structure of chlorines. These 17 congeners are presented in Table 2.1. Dioxins and furans are formed as by-products from combustion and incineration processes at low to mid temperatures (<850C). Dioxins and furans can be destroyed when incinerated at sufficiently high temperature, with adequate residence time and sufficient mixing during the combustion process. Therefore, legislation requires incineration processes to operate at a minimum temperature of 850C for at least 2 seconds before the last intake of combustion air, to destroy dioxins and furans. In the case of incineration of hazardous wastes, this required temperature rises to 1,100C.

2.1.2 The Industrial Emissions Directive (IED) requires dioxins and furans to be reported using the International Toxic Equivalence Quotient (I-TEQ) reporting convention in order to assess compliance against an Emission Limit Value (ELV) of 0.1ng I-TEQ.Nm^{-3}. The relative contribution of individual dioxin and furan congeners to the overall toxicity of a mixture is calculated by multiplying the individual congener emission concentration by the TEF. The most potent and widely studied congener is 2,3,7,8-TCDD, which is assigned a TEF of 1. Other congeners are assigned TEFs which define the relative toxicity of each congener, compared to 2,3,7,8-TCDD. The overall TEQ emission concentration is calculated by summing individual TEQ quotient concentrations. As the proposed plant is not yet operational, it is not possible to present a site specific emission profile for the 17 dioxin and furan congeners. However, reference has been made to a previous United States (US)

Environmental Protection Agency (EPA) inventory report on dioxin and furan releases in the United States for the years 1987, 1995 and 2000. The table below contains the average dioxin emissions concentrations reported across 104 Municipal Waste Incinerators. It is considered that in the absence of site specific information, this data will provide a suitable estimation of potential dioxin emission profile, given the large dataset used. The dioxin concentrations have been multiplied by the World Health Organisation (WHO) Toxic Equivalency Factors to determine TEQ emission concentrations, and then subsequently factored relative to the IED ELV to estimate a TEQ dioxin emission profile for the proposed plant.

Table 2.1 – Typical Dioxin Congener Emission Profile for Incineration Plants

Congener	Average Dioxin and Furan Emission Concentrations Across 104 MWI in the United States During Year 2000 (ng.Nm^{-3})	WHO TEQ Factors	Emission Concentrations Factored to WHO TEQ (ng.Nm^{-3})	TEQ Emission Concentrations Factored Relative to IED ELV (ng.Nm^{-3})
2,3,7,8-TCDD	0.005	1	0.005	0.005881
1,2,3,7,8-PeCDD	0.016	1	0.016	0.018819
1,2,3,4,7,8-HxCDD	0.016	0.1	0.0016	0.001882
1,2,3,6,7,8-HxCDD	0.037	0.1	0.0037	0.004352
1,2,3,7,8,9-HxCDD	0.032	0.1	0.0032	0.003764
1,2,3,4,6,7,8-HpCDD	0.219	0.01	0.00219	0.002576
OCDD	0.345	0.0003	0.000104	0.000122
2,3,7,8-TCDF	0.072	0.1	0.0072	0.008469
1,2,3,7,8-PeCDF	0.05	0.03	0.0015	0.001764
2,3,4,7,8-PeCDF	0.069	0.3	0.0207	0.024347
1,2,3,4,7,8-HxCDF	0.082	0.1	0.0082	0.009645
1,2,3,6,7,8-HxCDF	0.059	0.1	0.0059	0.00694
2,3,4,6,7,8-HxCDF	0.066	0.1	0.0066	0.007763
1,2,3,7,8,9-HxCDF	0.013	0.1	0.0013	0.001529

Congener	Average Dioxin and Furan Emission Concentrations Across 104 MWI in the United States During Year 2000 ($ng.Nm^{-3}$)	WHO TEQ Factors	Emission Concentrations Factored to WHO TEQ ($ng.Nm^{-3}$)	TEQ Emission Concentrations Factored Relative to IED ELV ($ng.Nm^{-3}$)
1,2,3,4,6,7,8-HpCDF	0.156	0.01	0.00156	0.001835
1,2,3,4,7,8,9-HpCDF	0.024	0.01	0.00024	0.000282
OCDF	0.090	0.0003	0.000027	3.18E-05
			TOTAL	**0.1ng.Nm^{-3}**

2.2 Dioxin and Furan Exposure Routes

2.2.1 In general, levels of dioxins and furans in air are very low, except in the vicinity of inefficient incinerators and since these compounds are poorly soluble, concentrations are also very low in drinking water and surface water[1]. Dioxins and furans released from processes, such as combustion and incineration, are deposited to land, leading to bioaccumulation and bioconcentration through food chains. Therefore, the principal human exposure route for dioxins and furans is through ingestion of contaminated food products, such as meat, fish, eggs and dairy products. However, other parts of the human diet, can also contribute significantly to the total dioxin and furan intake, such as cereals, fats and oils.[1,2] Indeed, the WHO have estimated that 90% of human exposure to dioxins is through the food chain.[3]

1 Exposure to Dioxins and Dioxin-Like Substances: A Major Public Health Concern, WHO, 2010
2 Statement on the Tolerable Daily Intake for Dioxins and Dioxin-Like Polychlorinated Biphenyls, Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment, 2001.
3 Dioxins and Their Effects on Human Health, Fact Sheet No 225, WHO, June 1999.

2.3 Potential Dioxin and Furan Health Impacts and Tolerable Daily Intake

2.3.1 The WHO report that long term exposure to dioxins is linked to impairment of the immune system, the developing nervous system, the endoxrine system and reproductive functions. Chronic exposure of animals to dioxins has resulted in several types of cancer.[3]

2.3.2 The Tolerable Daily Intake (TDI) is the amount of a substance that can be ingested daily over a human lifetime without causing appreciable health risk, and is expressed in relation to bodyweight. The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) previously recommended a TDI level for dioxins, furans and dioxin like PCBs of 2 picograms (pg) I-TEQ/Kg body weight/day.[2] They considered this to protect against effects on the male reproductive system and other possible effects such as cancer and cardiovascular effects. However, the COT have recently revised advice, resulting in a change from a TDI to a Tolerable Weekly Intake (TWI) of 2pg I-TEQ/Kg body weight/day, equivalent to approximately 0.29 pg I-TEQ/Kg body weight/day . As such exposure levels from the proposed plant have been compared to the lower TDI level to provide a worst case assessment.

2.3.3 For infant exposure via breast milk, there are no target levels for exposure. In order to evaluate potential health impacts as a result of exposure of infants to dioxins via breast milk, calculated exposure levels have been compared to national average background levels. The previous COT report[2] estimated an average consumer intake of 1.8pg.kg^{-1}.day^{-1} for dioxins/furans and 3.1 pg.kg^{-1}.day^{-1} for the 97.5 percentile consumer. As such, exposure levels via breast milk have been compared to the estimated background exposure level of 1.8 pg.kg^{-1}.day^{-1}.

2.4 Dioxin and Furan Intake Models

2.4.1 Two models have been recommended by COT to predict dioxin and furan uptake for comparison with the TDI, either of which the EA accept can be used when undertaking health impact assessments in support of permit applications. One of these models is the

Human Health Risk Assessment Protocol (HHRAP)[4] developed by the USEPA, the other being a model previously developed by HMIP[5]. Whilst the HMIP model is restricted to assessment of dioxins and furans only, the USEPA model contains algorithms which can also be applied to metals. However, the potential health impacts from metal emissions can be assessed through comparison with heath based Air Quality Standards/Environmental Assessment Levels and the EA position, based on the approach taken in recent permit decision documents, is that it is not therefore necessary to model the human body intake of metals. For the purpose of this assessment, the HHRAP has been used.

3 Assessment Methodology

3.1 HHRAP Model

3.1.1 In order to assess potential human health impacts from residual dioxins and furans arising from the proposed plant, the USEPA HHRAP model[4] has been used. The HHRAP comprises a multitude of equations to predict the concentration of dioxins and furans in soil, water and air and subsequent uptake by animals and humans. The HHRAP is freely available on the USEPA website. However, in order to simplify the process, Lakes Environmental have developed software, known as IRAP-h View, which is an interface which automatically undertakes the multitude of calculations within the HHRAP, based on defined input values by the user, which greatly simplifies the risk assessment process. IRAP-h View version 5.1.0 has been used to undertake this assessment.

3.1.2 The HHRAP model incorporates the following stages:

- Facility Characterisation;
- Air Dispersion and Deposition Modelling;
- Exposure Scenario Identification;

4 Human Health Risk Assessment protocol for Hazardous Waste Combustion Facilities, USEPA, 2005.
5 Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes, HMIP, 1996.

- Estimation of Media Concentrations; and,
- Quantifying Exposure.

3.1.3 The following sections discuss the above stages in more detail and outlines the methodology used to undertake the assessment.

3.2 Facility Characterisation

3.2.1 The first stage in the HHRAP is to characterise the facility, in terms of the nature and magnitude of emissions. As outlined previously, this assessment has been undertaken to assess potential health impacts from dioxins and furans. The following table outlines expected stack process parameters. Parameters for stack internal diameter, exhaust flow rate, temperature, oxygen and moisture content were provided by the plant manufacturer.

Table 3.1 - Expected Emission Source Process Parameters

Process Parameter	Value
Exhaust Flue (A1)	343239.29, 400693.02
Stack internal diameter (m)	0.5
Stack height (m)	14
Expected stack efflux velocity ($m.s^{-1}$)	14.92
Expected actual stack volumetric flowrate ($m^3.s^{-1}$)	2.93
Flow rate expressed at reference conditions of 273.15K, 11% oxygen, dry gas, 101.3kPa ($Nm^3.s^{-1}$)	1.36
Expected stack efflux temperature (K)	393
Expected oxygen content of exhaust gas, (v/v, %)	13.5
Expected moisture content of exhaust gas (v/v, %)	4
Expected absolute stack pressure (KPa)	Assumed to be Standard Atmospheric Pressure (101.3kPa)

3.2.2 The following table outlines dioxin and furan congener emission rates assigned within the assessment. Emission concentrations for each dioxin congener were calculated based on a maximum dioxin emission concentration of $0.1ng.Nm^{-3}$, which was then split across the 17 dioxin and furan congeners, based on the expected relative contribution of each to the total dioxin and furan emission concentration, based on the HMIP emission profile for waste incineration plants, as described previously. Equivalent emission rates were then subsequently determined.

Table 3.2 – Dioxin and Furan Congener Emission Rates

Congener	Dioxin Congener Emission Concentrations I-TEQ ($ng.Nm^{-3}$)[(a)]	Dioxin Congener Emission Rates (TEQ $ng.s^{-1}$)
2,3,7,8-TCDD	0.005881	0.007979178
1,2,3,7,8-PeCDD	0.018819	0.025533098
1,2,3,4,7,8-HxCDD	0.001882	0.002553446
1,2,3,6,7,8-HxCDD	0.004352	0.005904673
1,2,3,7,8,9-HxCDD	0.003764	0.005106891
1,2,3,4,6,7,8-HpCDD	0.002576	0.003495046
OCDD	0.000122	0.000165526
2,3,7,8-TCDF	0.008469	0.011490505
1,2,3,7,8-PeCDF	0.001764	0.002393346
2,3,4,7,8-PeCDF	0.024347	0.033033336
1,2,3,4,7,8-HxCDF	0.009645	0.013086069
1,2,3,6,7,8-HxCDF	0.00694	0.009416
2,3,4,6,7,8-HxCDF	0.007763	0.010532624
1,2,3,7,8,9-HxCDF	0.001529	0.002074505
1,2,3,4,6,7,8-HpCDF	0.001835	0.002489677
1,2,3,4,7,8,9-HpCDF	0.000282	0.00038261
OCDF	3.18E-05	4.31454E-05

3.3 Modelling of Dioxin and Furan Deposition

3.3.1 Emission Rates

3.3.1.1 Dispersion modelling was undertaken to determine dioxin and furan deposition surrounding the plant. This was undertaken using AERMOD and was in accordance with USEPA guidance.[4] The AERMOD model output is directly proportional to the emission rate for any given compound. As such, the HHRAP recommends calculation of deposition rates based on a unitised emission rate of 1.0 $g.s^{-1}$. The unitised air concentrations and deposition values are then adjusted to the individual dioxin congener specific air concentrations and deposition rates in IRAP-h. This provides a significant time saving as otherwise the model would have to be run multiple times.

3.3.2 Dioxin Deposition

3.3.2.1 Dioxins have a low volatility and dispersion in the atmosphere is likely to be via particulate aerosols[6]. As such, dioxins were assumed to particle phase/bound within the assessment.

3.3.2.2 In order to model deposition rates for particle bound congeners, AERMOD provides two options as follows, as stated within the AERMOD View guidance:

- Method 1 – This method is used when a significant fraction (greater than 10 percent) of the total particulate mass has a diameter of 10 microns or larger. The particle size distribution must be known reasonably well in order to use Method 1; and,
- Method 2 – This method is used when the particle size fraction is not well known and a small fraction (less than 10 percent) of the total particulate mass ha a diameter of 10 microns or larger

6 WHO Air Quality Guidelines for Europe, 2nd Edition, 2000.

3.3.2.3 Given that the plant is not yet operational, there is no data on particle size distribution. Furthermore, the plant will be using ceramic filtration for particulate matter control and therefore it is reasonable to assume that the majority of particulate matter exiting the system will be less than 10 microns. In order to use Method 2, the user must provide values for mean particle diameter and fine particle fraction. For the purpose of this assessment, a fine particle fraction of 0.9 was assumed, given that the majority of particulate matter is expected to be less than 10 microns in diameter. A mean particle diameter of 0.1µm was assumed based on the value previously recommended by the USEPA[7].

3.3.3 Meteorological Data

3.3.3.1 Meteorological data used in this assessment was from Liverpool John Lennon Airport. Liverpool John Lennon Airport is located approximately 18km to the South of the proposed site and it is considered that it provides suitable data for use in this assessment. Previous DEFRA guidance stated met stations within 30km of a study site to be suitable for use in dispersion modelling assessments. Although Crosby meteorological station (14km to West) is marginally closer, it is considered to be in a more exposed coastal location than Liverpool Airport and therefore is not considered to be as representative of the application site, which is much further inland. There are no other observing stations within 30km of the application site with sufficient date capture. As such, Liverpool John Lennon Airport is considered to provide the most appropriate data for use in this assessment. Reference should be made to Appendix III for wind roses showing wind speed and direction frequency at Liverpool between 2013 and 2017.

3.3.3.2 Five years of sequential meteorological data observed between 2013 and 2017 was used within the assessment. Data was previously supplied by ADM Ltd, an established distributor of met data within the UK. The data provided by ADM Ltd was in ADMS format. This was

[7] Deposition Parameterizations for the Industrial Source Complex (ISC3) Model. Environmental Research Division, Argonne National Laboratory on behalf of US Department of Energy, June 2002

converted to the required format required by AERMET using the ADMS UK to SAMSON converter, which is a tool within the AERMET processor. The AERMET processor within AERMOD was used to process the data to be site specific. US EPA guidance on processing met data for use within AERMOD states that land use up to 1km upwind from a site should be considered when determining surface roughness characteristics, whilst for Bowen ratio and albedo, land use types within a 10km by 10km area centred over the site should be considered[8]. AERMOD guidance states that albedo and Bowen ratio should be calculated as the arithmetic and geometric mean respectively of land use types over the 10km by 10km grid, not weighted by direction or distance. The Land Use Creator and AERSURFACE tool within AERMET was used to calculate the appropriate land-use characteristics, which are contained in the following table.

Table 3.3 - Parameters for Surface Roughness, Albedo and Bowen Ratio

Parameter	Directional Sector	Value
Surface Roughness	0-30°	0.239
	30-60°	0.229
	60-90°	0.251
	90-120°	0.143
	120-150°	0.101
	150-180°	0.129
	180-210°	0.113
	210-240°	0.192
	240-270°	0.579
	270-300°	0.194
	300-330°	0.104
	330-360°	0.105
Albedo	All	0.18
Bowen Ratio	All	0.68

8 AERMOD Implementation Guide, USEPA, August 2015.

3.3.4 Assessment Area

3.3.4.1 Two uniform cartesian receptor grids were used to define the modelling domain. This included a high resolution grid, extended over a 3000m by 3000m area with a spacing of 20m in X and Y direction, centred over the stack location. A further uniform cartesian receptor grid was extended over a 20,000m by 20,000m area with a spacing of 200m in X and Y direction, centred over the stack location. This ensured the maximum point of impact could be captured.

3.3.5 Terrain Data

3.3.5.1 Topographical features can have a significant impact on pollutant dispersion. Given that the gradient of the land between the site and receptors exceeds a gradient of 10% in places, terrain data was included in the model, in accordance with the relevant guidance[9]. The terrain data used was Ordnance Survey Terrain 5 data, which is 1:10,000 scale data, contoured at 5m vertical intervals. The digital terrain data was processed in AERMAP, the inbuilt terrain processor within AERMOD. This then applied elevation data to all sources, buildings and receptors within the modelling domain.

3.3.6 Building Downwash

3.3.6.1 Significant on-site buildings and structures were digitised within the model from site layout and elevation information provided by the site operator. As the closest buildings to the emission points, these would be expected to have an influence on pollutant dispersion. Height information for surrounding buildings was provided by the applicant. In accordance with the relevant guidance, buildings/structures included within the model are those within a distance of 5L of the proposed exhaust flue, where L is defined as the lesser of the

[9] LAQM.TG(16), DEFRA, 2016.

building/structure height and maximum projected width. The table below contains information on building heights used within the model. Reference should be made to Appendix I for a plan showing building locations. The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics. Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. All buildings and structures were input into the BPIP processor.

Table 3.4 - Building Inputs

Structure	Length and Width (m)	Diameter (m)	Max Height (m)
Structure A	40 x 28	N/A	10.63
Structure B	312 x 50	N/A	12
Structure C	N/A – polygon structure	N/A	8
Structure D	12.2 x 2.4	N/A	3.9
Structure E	N/A – polygon structure	N/A	5.9
Structure F	3.7 x 2.4	N/A	6.99
Structure G	3.7 x 2.4	N/A	6.99
Structure H	N/A	1.2	14

3.4 Exposure Scenarios

3.4.1 The HHRAP recommends assessing the following exposure scenarios, when they are consistent with site specific exposure settings:

- Farmer;
- Farmer Child;
- Resident;
- Resident Child;
- Fisher:

- Fisher Child;
- Acute Receptor; and,
- Nursing Infant

3.4.2 In order to provide a conservative worst case assessment, the farmer and farmer child scenario has been included in the assessment and potential impacts have been assessed at the maximum point of impact surrounding the plant in addition to the worst case discrete receptor location. Therefore, this assumes that each person will be exposed via inhalation and that their diet consists of ingesting products grown at these locations, which is highly unlikely to be the case in reality.

3.4.3 A search of the site and surrounding has not identified any significant surface water bodies. Furthermore, the local population will predominantly obtain their drinking water from treated water provided by local water companies. As such, exposure via drinking water consumption has not been considered.

3.4.4 Although there are likely to be various places where fishing is undertaken as a recreational activity, it is highly unlikely that locally caught fish will contribute significantly to diet within the local population. As such, exposure via consumption of locally caught fish has not been included in the assessment.

3.4.5 The table below contain the exposure scenarios included within the risk assessment. The risk assessment has included the following principal exposure scenarios:

- Inhalation;
- Ingestion of homegrown produce and meat; and
- Ingestion of breast milk.

Table 3.5 – Exposure Scenarios Included in Risk Assessment

Exposure Pathways	Farmer	Farmer Child	Farmer Infant
Inhalation of vapours and particulates	✓	✓	X
Incidental ingestion of soil	✓	✓	X
Ingestion of drinking water from surface water sources	X	X	X
Ingestion of homegrown produce	✓	✓	X
Ingestion of homegrown beef	✓	✓	X
Ingestion of milk from homegrown cows	✓	✓	X
Ingestion of homegrown chicken	✓	✓	X
Ingestion of eggs from homegrown chickens	✓	✓	X
Ingestion of homegrown pork	✓	✓	X
Ingestion of fish	X	X	X
Ingestion of breast milk	X	X	✓

3.5 Sensitive Receptors

3.5.1 The following table outlines the sensitive receptors considered within this assessment. These are representative of the locations of worst case long term exposure. In addition, impacts have been assessed at the maximum point of impact surrounding the plant.

Table 1.1 - Sensitive Receptors

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R1	Wood House Farm	342860	401189
R2	High Barn Farm	343225	401159.9
R3	Voces Farm	343464	401666.9
R4	Residential property off Siding Lane	343455.6	401032.8
R5	Residential property off Stopgate Lane	343527.3	401115.1

Receptor Identifier	Receptor Description	National Grid Reference (m)	
		X	Y
R6	Abram's Farm	343623.3	401154.1
R7	Newbridge Farm	344207.8	401333.5
R8	Peartree Cottage	344090.7	401551.9
R9	The Coach House	344454.7	401442.2
R10	Wild Goose Slack	344834.6	400855.5
R11	Moss Cottage	345274	400414
R12	Spencer's House Farm	343914	399950.3
R13	Bullens Farm	343630.7	399956.1
R14	Keeper's House	343349	400214.6
R15	South Head Farm	343183.3	400047.3
R16	Woods Farm	342780.3	400272.1
R17	Residential property off Dale Lane	342465.9	400031.5
R18	Residential property off Dorchester Drive	342226.4	400216.2
R19	Residential property off Freckleton Drive	342207.4	400267.9
R20	Residential property off Anders Drive	342195.8	400331.2
R21	Residential property off Anders Drive	342179.9	400410.3
R22	Residential property off Epsom Grange	342153.6	400557
R23	Residential property off Calder Close	342083.9	400759.5
R24	Simonswood Hall Barn	341737.9	401145.2
R25	Residential property off Hall Lane	341916.7	401304
R26	Grayson's Farm	342363	401510.8

3.6 Site Specific Parameters for Estimation of Media Concentrations

3.6.1 Annual Average Precipitation

3.6.1.1 The UK metoffice website was consulted to determine an appropriate value to assign for average annual precipitation. The nearest met station is Crosby, which was considered to provide a suitably representative figure for rainfall at the site. The metoffice website states an annual average rainfall amount of 836.6mm per annum at Crosby, which was used an input for the HHRAP.

3.6.2 Annual Average Evapo-Transpiration Rate

3.6.2.1 The annual average evapo-transpiration rate (E_v) was assumed to be 70% of the annual average precipitation level. Therefore, a value of 585.62mm/annum was assumed.

3.6.3 Annual Average Irrigation

3.6.3.1 Annual average irrigation (I) was assumed to be insignificant (0mm/year)

3.6.4 Annual Average Runoff

3.6.4.1 Annual average runoff (RO) was calculated based on a water mass balance, in accordance with the following formula.

$$P + I = E_v + RO$$

3.6.4.2 Therefore, a value of 250.98mm/annum was used as an input value for RO.

3.6.5 Annual Average Wind Velocity

3.6.5.1 Data from Liverpool John Lennon between 2013 and 2017 was used to determine annual average wind speed (W). A value of $4.83 m.s^{-1}$ was used as a model input.

3.6.6 Soil Zone Mixing Depth

3.6.6.1 A soil zone mixing depth of 2cm was assumed in the assessment, appropriate for untilled land. It should be noted that assuming untilled land results in a higher soil concentration value and therefore conservative assessment of potential impacts.

3.6.7 Exposure Duration

3.6.7.1 In accordance with the HHRAP, an exposure duration of 40 years was assumed for the farmer scenario and 6 years for farmer child.

3.6.8 Other Parameters

3.6.8.1 All other parameters used for estimation of media concentrations were the default parameters within the IRAP-h View model.

3.7 Calculation of Average Daily Dose

3.7.1 Ingestion

3.7.1.1 The Average Daily Dose (ADD) from ingestion of dioxins and furans via indirect exposure routes (including via soil, produce and milk) for each exposure scenario was calculated by IRAP-h View for each dioxin and furan congener. The ADD from each congener was summed to determine the total intake across all dioxin and furan congeners for each exposure scenario.

3.7.2 Inhalation

3.7.2.1 The ADD via inhalation was calculated using the following formula, based on the HHRAP guidance:

$$ADD\ from\ inhlation = \left(\frac{Ca\ \times IR \times ET\ \times EF \times ED}{BW\ \times AT}\right)$$

Where: Ca = Concentration of dioxins (pg.m^{-3}) (total)

IR = inhalation rate (m^{3}.hour.$^{-1}$)

ET = Exposure time (24 hours.day^{-1})

EF = Exposure frequency (350 days.year^{-1})

ED = Exposure duration (years)

BW = Body weight (kg)

AT = Average Time (years)

3.7.2.2 For the farmer scenario, an IR of 0.83m^3.hour^{-1} was assumed in accordance with the HHRAP guidance. For the farmer child scenario, an inhalation rate of 0.45m^3.hour^{-1} was assumed, based on HMIP guidance. A BW of 70kg was assumed for adults and 15kg for child. An AT and ED of 40 years was assumed for farmer scenario and 6 years for farmer child scenario.

3.7.2 The ADD from each congener was summed to determine the total intake across all dioxin and furan congeners for each exposure scenario.

3.7.1 Total Daily Intake

3.7.1.1 Total intake was calculated by summing total intake via ingestion and inhalation routes for both the farmer and farmer child scenarios.

4 Results

4.1 Dispersion Modelling Results

4.1.1 The following tables present the maximum modelled dioxin/furan concentrations and dry and wet deposition values, based on a unitised emission rate of $1g.s^{-1}$. The maximum reported values for each have been used as inputs with IRAP-h View, in order to provide a conservative assessment. The assessment has been based on the maximum point of impact surrounding the plant and at the worst case long term receptor location, which is receptor R4.

Table 4.1 – Maximum Predicted Unitised Annual Mean Dioxin Concentrations

Receptor	Predicted Unitised Annual Mean Concentration ($\mu g.m^{-3}$)				
	2013	2014	2015	2016	2017
Maximum Point of Exposure	51.31725	59.1961	54.12153	53.33068	55.74799
R4	1.81641	2.31152	2.2179	2.27943	2.50187

Table 4.2 – Maximum Predicted Unitised Annual Dry Deposition

Receptor	Predicted Unitised Annual Dry Deposition ($g.m^2.Year^{-1}$)				
	2013	2014	2015	2016	2017
Maximum Point of Exposure	3.25967	3.83221	3.46094	3.34185	3.30258
R4	0.09875	0.10986	0.11252	0.10759	0.11393

Table 4.3 – Maximum Predicted Unitised Annual Wet Deposition

Receptor	Predicted Unitised Annual Wet Deposition (g.m^{2}.Year^{-1})				
	2013	2014	2015	2016	2017
Maximum Point of Exposure	0.02942	0.02389	0.02961	0.03751	0.032
R4	0.00172	0.00281	0.00438	0.00406	0.00573

4.2 Dioxin and Furan Daily Intake Results

4.2.1 The table below presents the total daily intake for farmer and farmer child scenarios with comparison to the relevant TDI. The results show that at the maximum point of impact the predicted daily intake of dioxins/furans is significantly below the TDI for both the farmer and farmer child Scenarios, a 24.99% and 37.34% contribution to TDI respectively. However, this assumes that receptors would be permanently present at this location and consuming locally grown produce, which will not be the case in reality. At the worst case point of relevant long term exposure (receptor R4), the total daily intake of dioxins is predicted to be significantly lower, a 0.77% and 1.16% contribution to the TDI for the farmer and farmer child scenario respectively, again assuming that the receptors are present at this location throughout the whole year and consuming locally grown produce. As such, impacts from exposure to dioxins and furans as a result of plant emissions are not predicted to be significant.

Table 4.4 – Daily Intake Results – Farmer Adult and Farmer Child

Receptor	Farmer		Farmer Child	
	Total Daily Intake of Dioxins and Furans (I-TEQ/Kg body weight/day)	Total Daily Intake As Percentage of TDI (%)	Total Daily Intake of Dioxins and Furans (I-TEQ/Kg body weight/day)	Total Daily Intake As Percentage of TDI (%)
Maximum Point of Impact	0.0725	24.99	0.108	37.34
R4	0.00222	0.77	0.00336	1.16

4.2.2 The table below presents the total daily intake of dioxins and furans for breast fed farmer infant scenario, via ingestion from breast milk, with comparison to background exposure levels. As is indicated, the predicted daily intake is significantly less than background exposure levels, 56.75% at the point of maximum impact, falling to 1.74% of background exposure levels at the point of worst case relevant long term exposure. As such, impacts are not predicted to be significant.

Table 4.5 – Daily Intake Results – Breast Fed Farmer Infant

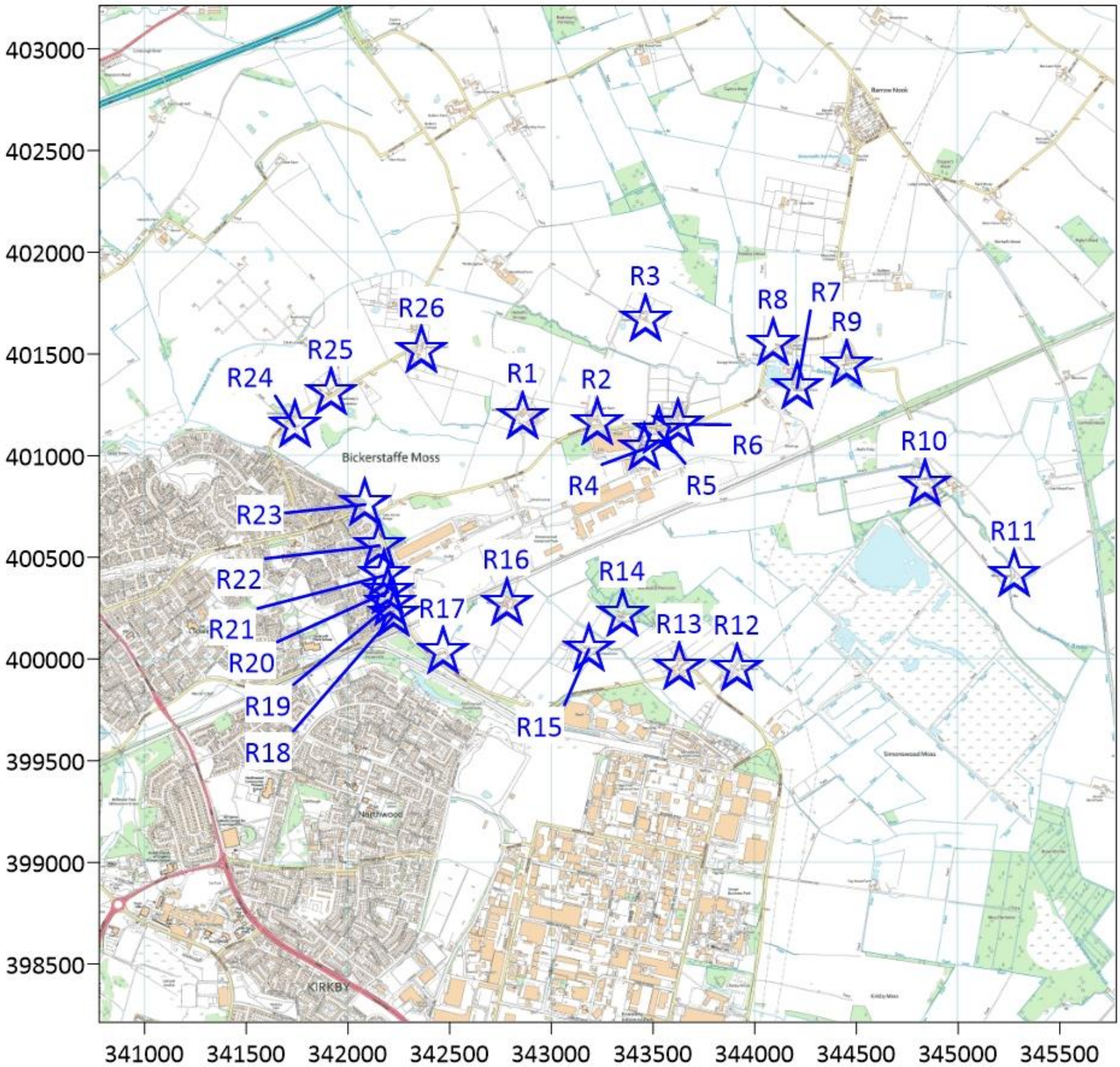
Receptor	Farmer Infant	
	Total Daily Intake of Dioxins and Furans (I-TEQ/Kg body weight/day)	Total Daily Intake As Percentage of Background Levels (%)
Maximum Point of Impact	1.02	56.74
R4	0.0313	1.74

5 Conclusions

5.1 A HHRA has been undertaken to assess potential health impacts as a result of exposure to emissions of dioxins and furans from the proposed medical waste incinerator at Stopgate Lane, Simonswood. The predicted total daily intake of dioxins and furans is significantly less than the TDI for farmer and farmer child scenarios at the worst case point of relevant long term exposure. Furthermore, predicted exposure of infants to dioxins via breast milk is not predicted to be significant, with exposure levels significantly lower than to existing background concentrations at the worst case point of relevant long term exposure. Given the above, potential health impacts as a result of potential dioxin and furan emissions from the proposed plant are not predicted to be significant.

Appendix I

Sensitive Receptors



Sensitive Receptors

Receptor Location

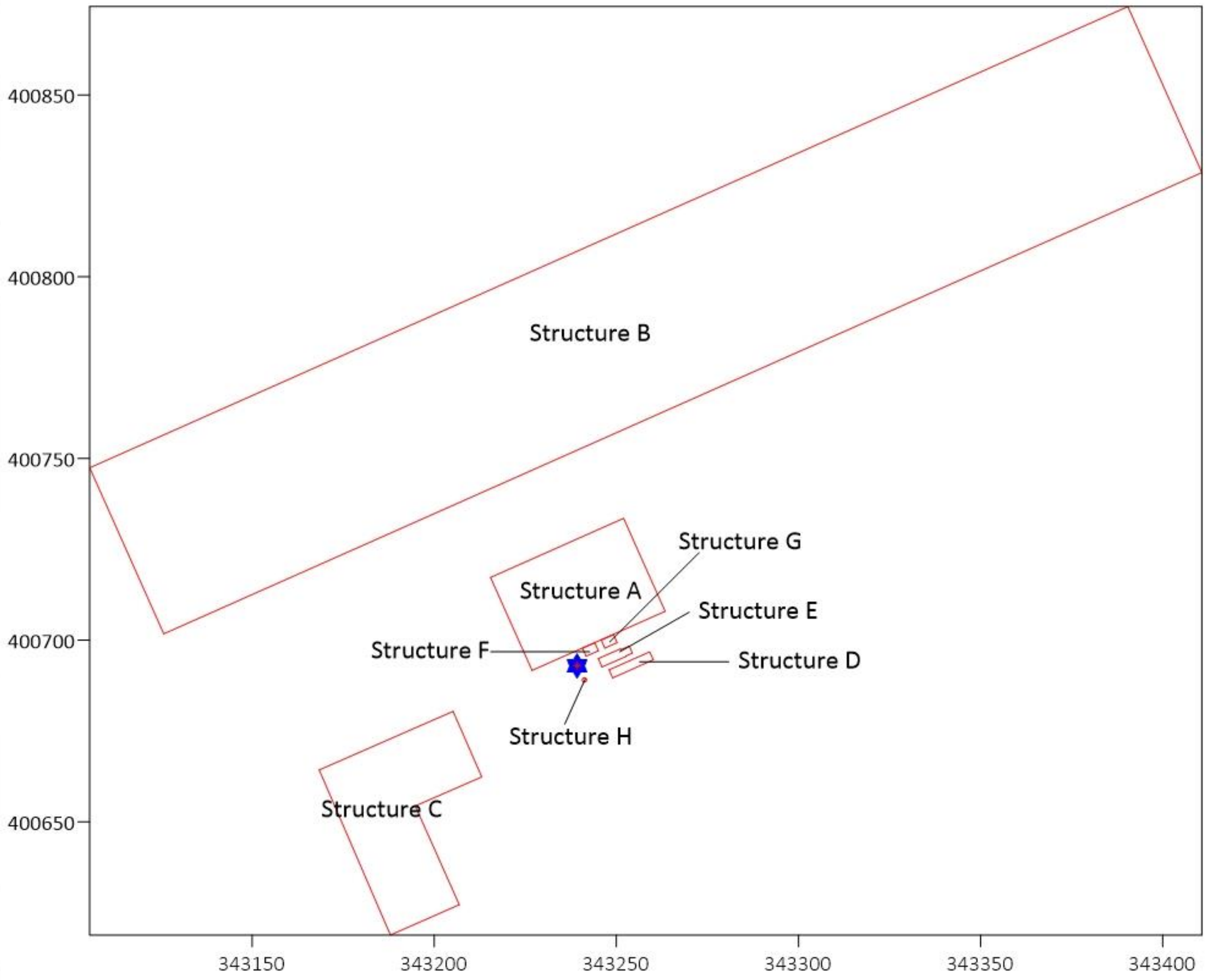
R1 Receptor Identifier

Oaktree Environmental Ltd
Lime House
2 Road Two
Winsford
Cheshire
CW7 3QZ

N.B - Map contains Ordnance Survey data

Appendix II

Buildings and Structures Digitised Within Model



Buildings and Stacks Digitised Within Model

Stack Location

Oaktree Environmental Ltd
Lime House
2 Road Two
Winsford
Cheshire
CW7 3QZ

Appendix III

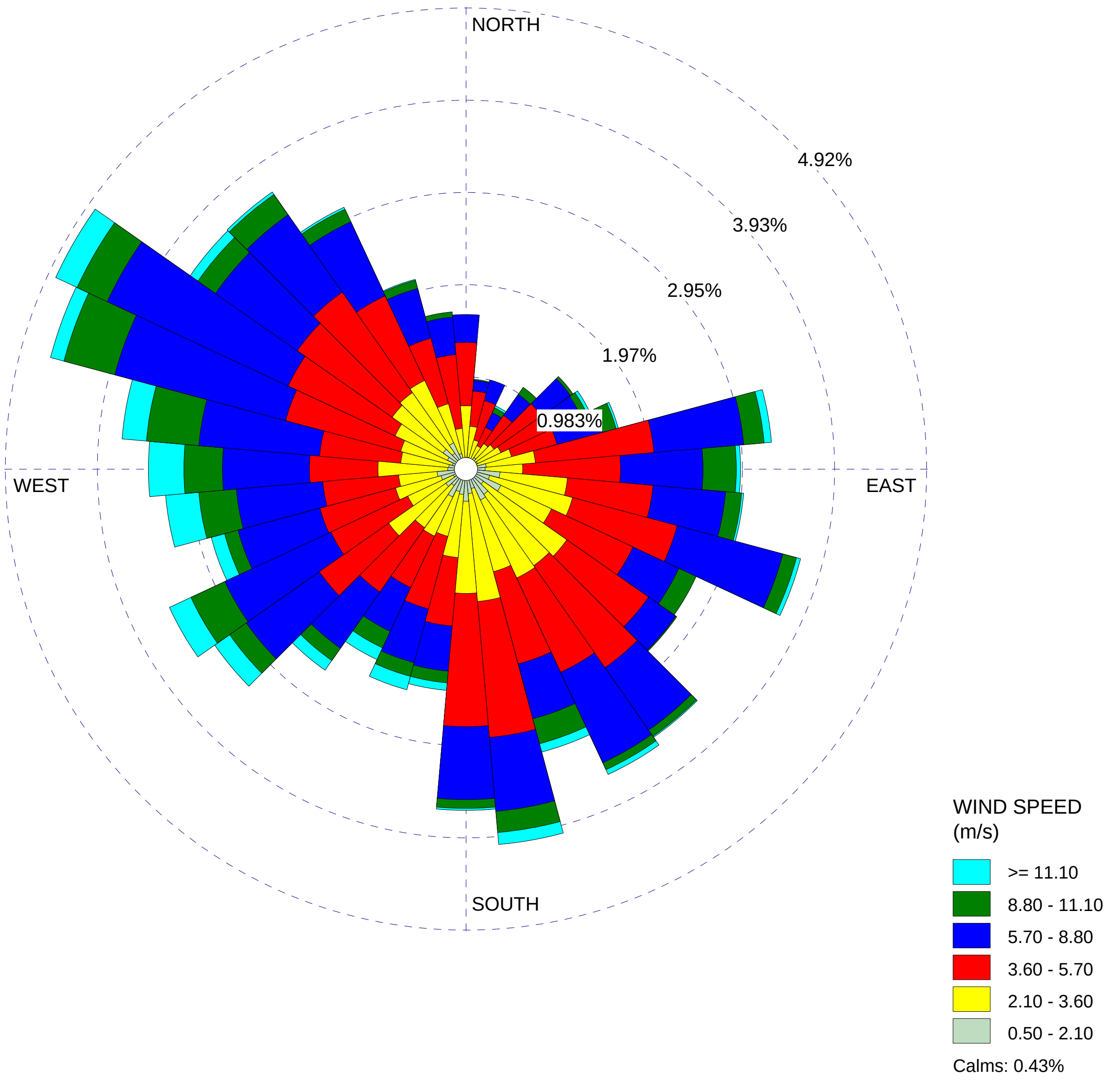
Wind Roses for Liverpool Airport

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2013 - 00:00
End Date: 31/12/2013 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

0.43%

TOTAL COUNT:

8701 hrs.

AVG. WIND SPEED:

5.02 m/s

DATE:

15/01/2019

PROJECT NO.:

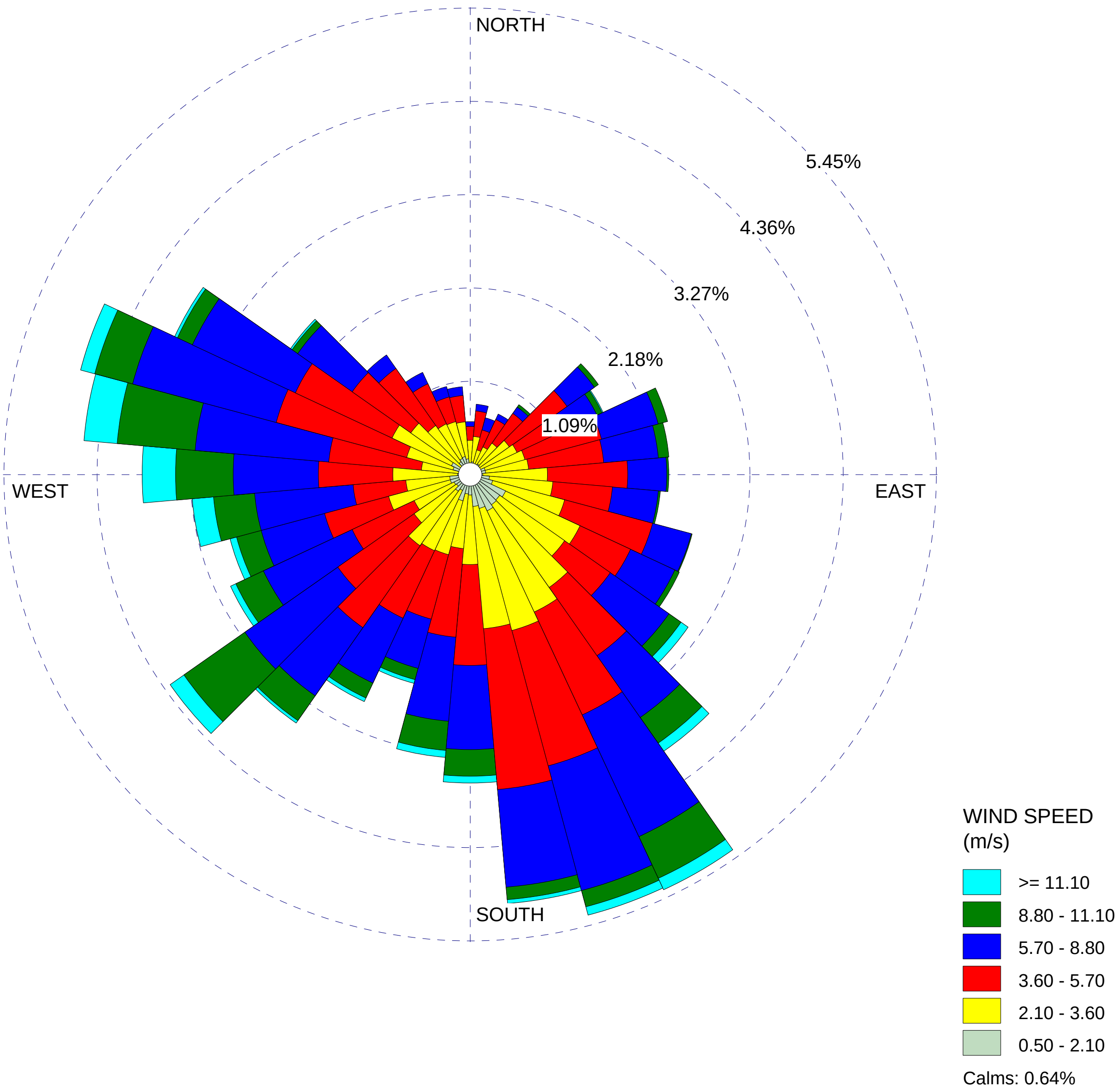
4013

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



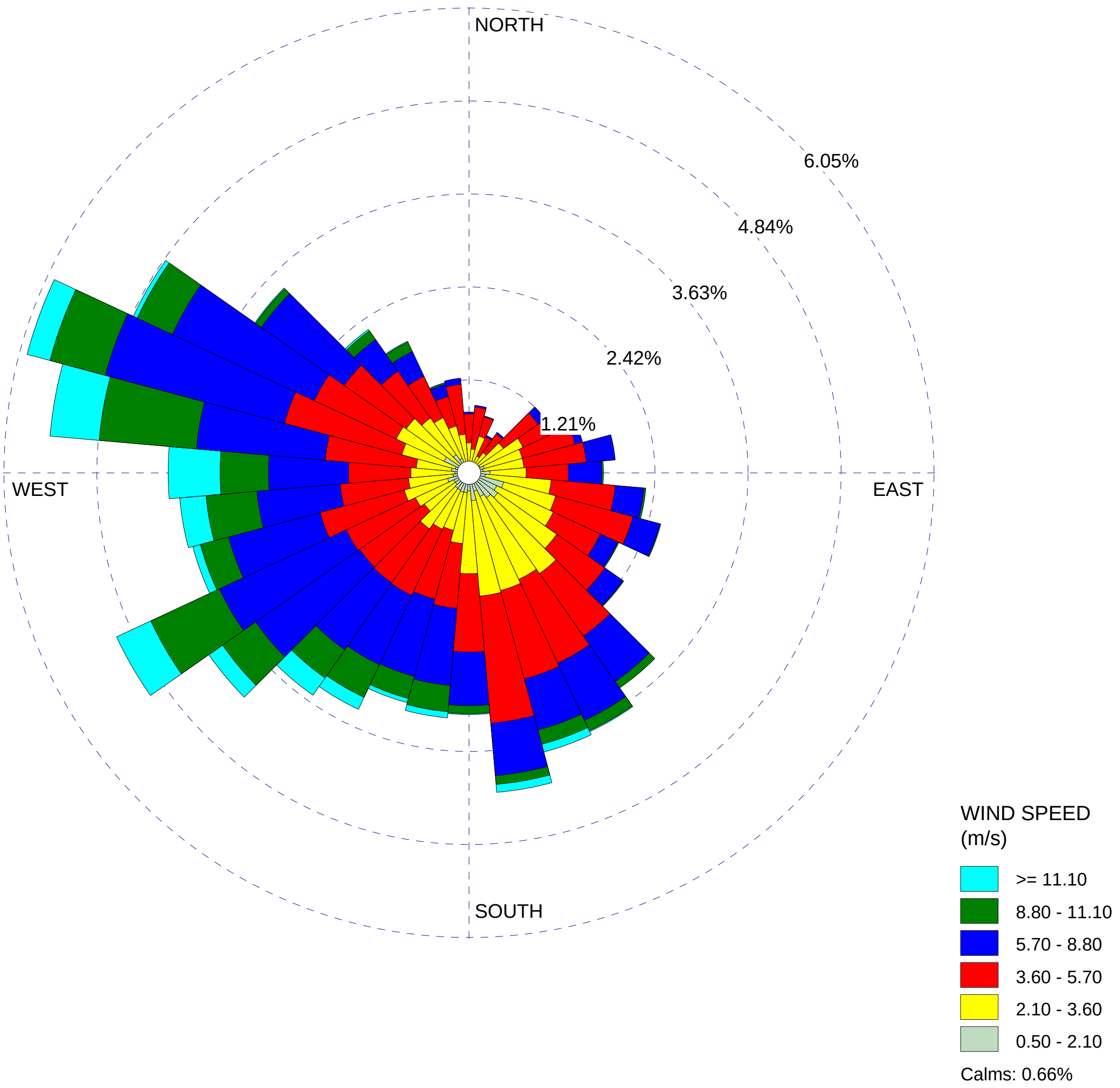
COMMENTS:	DATA PERIOD: **Start Date: 01/01/2014 - 00:00** **End Date: 31/12/2014 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.64%**	TOTAL COUNT: **8702 hrs.**	
	AVG. WIND SPEED: **4.86 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD: **Start Date: 01/01/2015 - 00:00** **End Date: 31/12/2015 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.66%**	TOTAL COUNT: **8727 hrs.**	
	AVG. WIND SPEED: **5.02 m/s**	DATE: **15/01/2019**	PROJECT NO.: **4013**

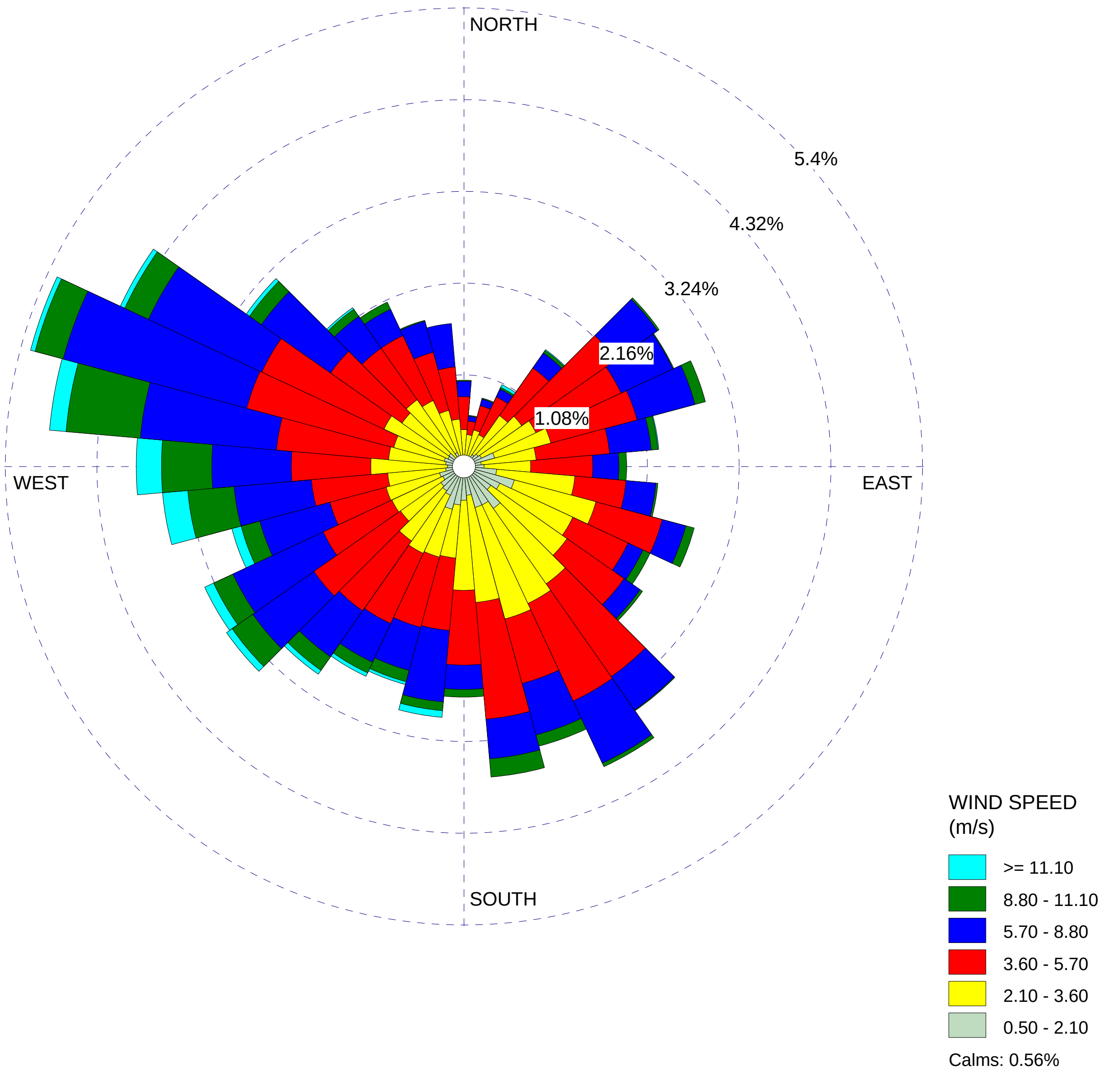
WRPLOT View - Lakes Environmental Software

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2016 - 00:00
End Date: 31/12/2016 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

0.56%

TOTAL COUNT:

8744 hrs.

AVG. WIND SPEED:

4.46 m/s

DATE:

15/01/2019

PROJECT NO.:

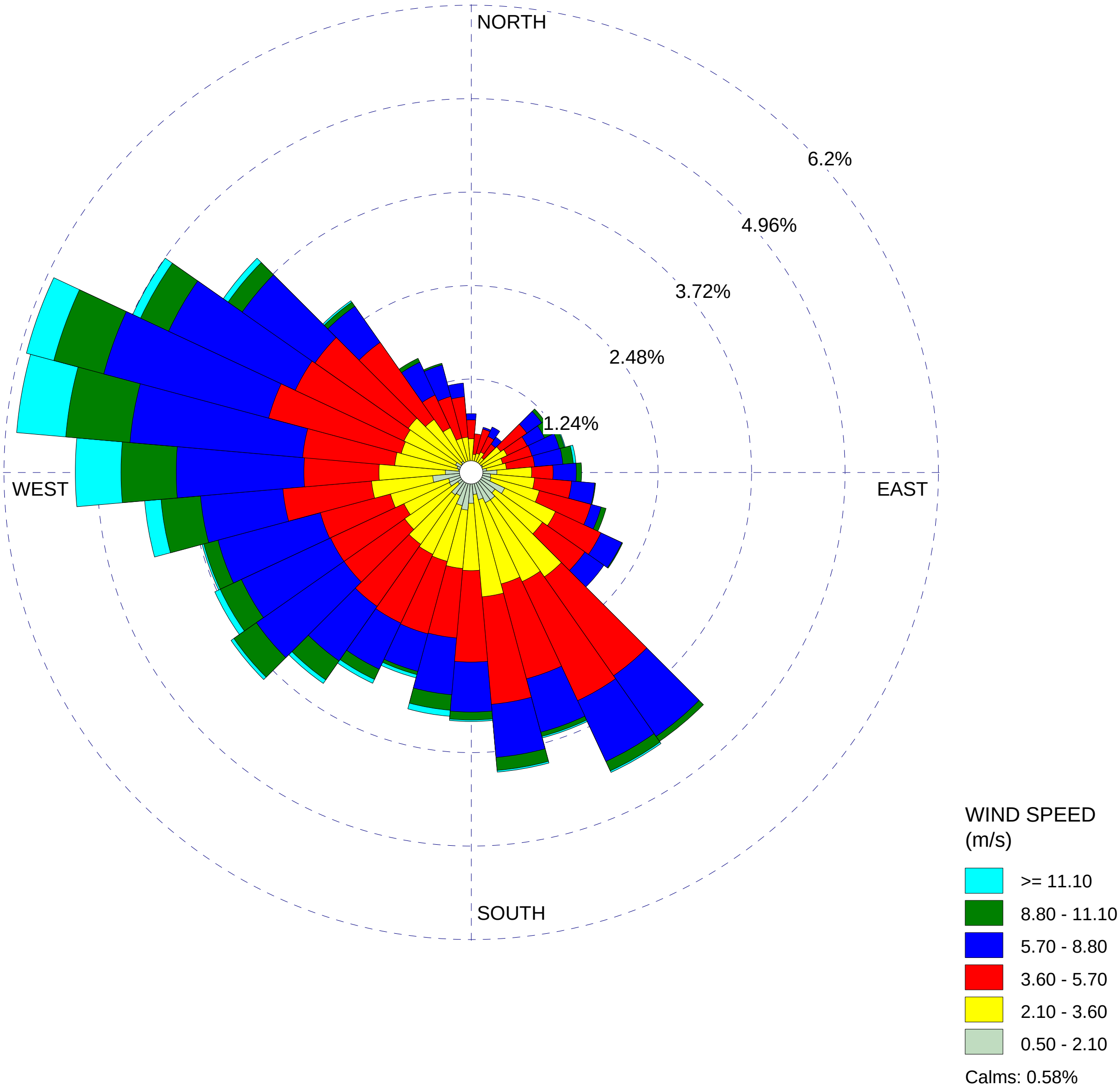
4013

WIND ROSE PLOT:

Liverpool - Wind Speed and Direction Frequency

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

DATA PERIOD:

Start Date: 01/01/2017 - 00:00
End Date: 31/12/2017 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:

0.58%

TOTAL COUNT:

8708 hrs.

AVG. WIND SPEED:

4.77 m/s

DATE:

15/01/2019

PROJECT NO.:

4013

ES Appendix VIII

Noise Impact Assessment

ENVIRONMENTAL NOISE ASSESSMENT

Stopgate Lane, Simonswood

Culzean W2E Limited

Version:	1.0	**Date:**	30 November 2021		
Doc. Ref:	005-2776-F	**Author(s):**	TB	**Checked:**	
Client No:	2776	**Job No:**	005		

Oaktree Environmental Ltd

Waste, Planning & Environmental Consultants

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REGISTERED IN THE UK | COMPANY NO. 4850754

Document History:

Version	Issue date	Author	Checked	Description
1.0	30/11/2021	TB	DY	Application submission version

CONTENTS

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List of Appendices:

1 Introduction

1.1 Background to Report

1.1.1 Oaktree Environmental have been commissioned by Culzean W2E Limited to undertake an environmental noise assessment for a site at Stopgate Lane, Simonswood.

1.1.2 This report is to be submitted in support of a planning application for the:

"Demolition of Existing Building and Erection of Purpose Built Building (and Ancillary Structures) to House High Temperature Treatment Facility for the Management of Medical Waste"

1.1.3 Given that the proposals include the disposal of hazardous wastes, they fall under Schedule 1 of the Town and Country Planning (Environmental Impact Assessment) Regulations 2017. As such, the proposals are Environmental Impact Assessment (EIA) development and an Environmental Statement (ES) has therefore been submitted as part of the application. An EIA scoping opinion has previously been received from Lancashire County Council whom have advised that "*It is therefore considered that noise impacts during the daytime period are unlikely to be a significant environmental effect given the distance to the nearest properties and the existing day time noise levels. However, it is noted that the plant would operate at night and therefore noise impacts during those times are likely to be more significant. The ES should therefore contain an assessment of night time noise impacts at the nearest residential properties on Sidings Lane. The assessment should be based upon a survey of existing background night time noise levels at these properties and should assess the likely noise impact during the proposed hours of operation. The noise assessment should be undertaken in accordance with recognised guidance (BS4142:2014 and the Noise Policy Statement for England)".*

1.2 Site Location

1.2.1 The application site is located at Stopgate Lane, Simonswood, within an existing industrial estate, which contains a number of existing industrial processes, including waste recycling facilities and other industrial processes.

1.2.2 The site is located within an industrial estate and therefore suitable for this type of development. There are a number of existing waste and other industrial operations in the vicinity with several large-scale structures. The existing site is permitted for waste management related use. As such, the proposals are in keeping with the location, both in terms of scale and proposed processes.

1.2.3 The site is accessed via Stopate Lane, via an existing purpose-built access point.

1.2.4 Reference should be made to Drawing No. 2776-008-01 and 2776-008-02 within Appendix I for the general location of the site and indicative red-line planning application boundary. All references to 'the site' in this statement shall mean this area. A site layout plan is also provided (2776-008-04).

1.2.5 The nearest noise sensitive receptors comprise the residential dwelling off Siding Lane approximately 300m to the northeast and the farmhouses to the south, ranging from 600-750m from the site boundary.

1.3 Hours of operation

1.3.1 The process will be operated on a continual basis, 24 hours per day, 7 days per week, except for periods of maintenance/shut down. However, the site will be open for the limited number of HGV movements for the delivery and export of materials between the hours of 06:00 and 20:00.

2 Planning Policy

2.1 Noise Policy Statement for England

1.1.1 The Noise Policy Statement for England (NPSE), March 2010, sets out the Governments long-term noise policy, the aims of which are:

1.1.2 "Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- Avoid significant adverse effects on health and quality of life:
- Mitigate and minimise adverse effects on health and quality of life;
- Where possible, contribute to the improvement of health and quality of life."

1.1.3 The first aim of the NPSE is to avoid significant adverse effects, considering the shared UK principles of sustainable development.

1.1.4 The second aim provides guidance on the scenario when the potential noise impact falls between the LOAEL (Lowest Observed Adverse Effect Level) and the SOAEL (Significant Observed Adverse Effect Level), in which case it is stated; "all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development". However, it is also stated "This does not mean that such adverse effects cannot occur".

1.1.5 With regards to the SOAEL, the document states "It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations", acknowledging that this is very much dependent on the noise source, the receptor and the time of day. Therefore, the NPSE provides the necessary policy flexibility until further guidance / evidence is available.

1.1.6 Other guidance will need to be taken into account when applying the principles of the NPSE, as well the nature of the proposed development and its specific circumstances.

2.2 National Planning Policy Framework

1.2.1 The NPPF, revised in 2021, replaces the Planning Policy Guidance Note 24 (PPG 24) and does not make reference to any other relevant noise guidance, other than the NPSE.

1.2.2 With regards to noise, the NPPF states the planning process should "contribute and enhance the natural and local environment", with regards to noise this means "preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affect by unacceptable levels" of, amongst other things, noise.

1.2.3 The NPPF states that Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life,

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

2.3 Planning Practice Guidance – Noise

1.3.1 It is important to set out the appropriate guidance set out in the NPPF which advises that the Local Authority should consider the following when decision making:

- Whether or not a significant adverse effect is occurring or likely to occur.
- Whether or not an adverse effect is occurring or likely to occur.
- Whether or not a good standard of amenity can be achieved.

1.3.2 As previously discussed within the NPSE, the guidance discusses the LOAEL and SOAEL and provides scenarios that could be expected for the perception level of noise, plus the associated activities that may be required to bring about the desired outcome. Again, as with the NPSE, no objective noise levels are provided for LOAEL or SOAEL.

1.3.3 It is stated that “the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation”. These factors include:

- The absolute noise level of the source and the time of day it occurs.
- Where the noise is non-continuous (intermittent), the number of noise events along with any patterns of occurrence.
- The frequency of content and acoustic characteristics (tonality etc.) of the noise.
- The effects of noise on the surrounding wildlife.
- The acoustic environment of external amenity areas provided as an intrinsic part of the overall design.
- The impact of noise from certain commercial developments such as night clubs and pubs where activities are often at their peak during the evening and night.

3 Noise Assessment Criteria

3.1 Overview

3.1.1 In order to assess the impacts of existing road traffic and industrial noise on the proposed development, the following documents have been used:

- BS8233:2014
- BS4142:2014
- World Health Organisation (WHO) Guidelines on Community Noise

3.2 BS8233:2014

3.2.1 This document provides guidance on the relevant level of sound insulation required by a variety of building types affected by general environmental noise and provides recommendations for appropriate internal ambient noise level criteria for a variety of different situations including residential dwellings. The table below includes the proposed noise criteria within BS8283:2014 with regards to residential properties:

Table 3.1 - BS8233:2014 Internal Criteria

Activity	Location	07:00 – 23:00	23:00 – 7:00
Resting	Living rooms	35 $L_{Aeq, 16hour}$	-
Dining	Dining room	40 $L_{Aeq, 16hour}$	-
Sleeping	Bedroom	35 $L_{Aeq, 16hour}$	30 $L_{Aeq, 16hour}$

3.3 BS4142:2014

3.3.1 BS4142:2014 provides a method for assessing and rating sound of an industrial / commercial nature. The method described in the standard uses the rating level from a noise source and the existing background noise level to assess the potential effects of sound on the residential premises upon which sound is incident.

3.3.2 Using this method the background sound level is subtracted from the rating level. The resulting figure is assessed using the following guidance from the document:

- The greater the difference between the background sound level and the rating level, the greater the impact on the receptor.
- An exceedence of the background level of around 10dB or more is likely to be an indication of a significant adverse impact, dependent on the context.
- An exceedence of the background level of around 5dB is likely to be an indication of an adverse impact, dependent on the context.
- The lower the rating level compared to the existing background level, the less likely an adverse impact or a significant adverse impact. Where the rating level does not exceed the background level, this is indicative of a low impact, dependent on context.

3.3.3 The document introduces a requirement to consider and report the uncertainty in the data as well as also including guidance for applying a correction/penalty for certain adverse acoustic features such as tonality, impulsivity or intermittency. The following table summarises the corrections based on the subjective assessment of the noise.

Table 3.2 - BS4142:2014 Corrections and Penalties

	Tonality	**Impulsivity**	**Other characteristics**
Just perceptible	+ 2dB	+ 3dB	
Clearly perceptible	+ 4dB	+ 6dB	
Highly perceptible	+ 6dB	+ 9dB	
Readily Distinctive against Residual Environment			+ 3dB

3.4 WHO Guidelines for Community Noise

3.4.1 The WHO Guidelines (1999) recommends indoor night-time guidelines in order to avoid sleep disturbance, the document states these to be 30 dB (LAeq)and 45 dB (LA_{fmax})for continuous and individual noise events respectively.

3.4.2 The document states that the number of noise events should also be considered and that individual noise events should not exceed 45 dB (LA_{fmax})more than 10 – 15 times per night.

3.4.3 The WHO document also recommends that steady, continuous noise levels should not exceed 55 dB (LAeq) on outdoor living areas (balconies, terraces etc.). However, in order protect the majority of individuals from moderate annoyance, external noise levels should not exceed 50 dB (LAeq).

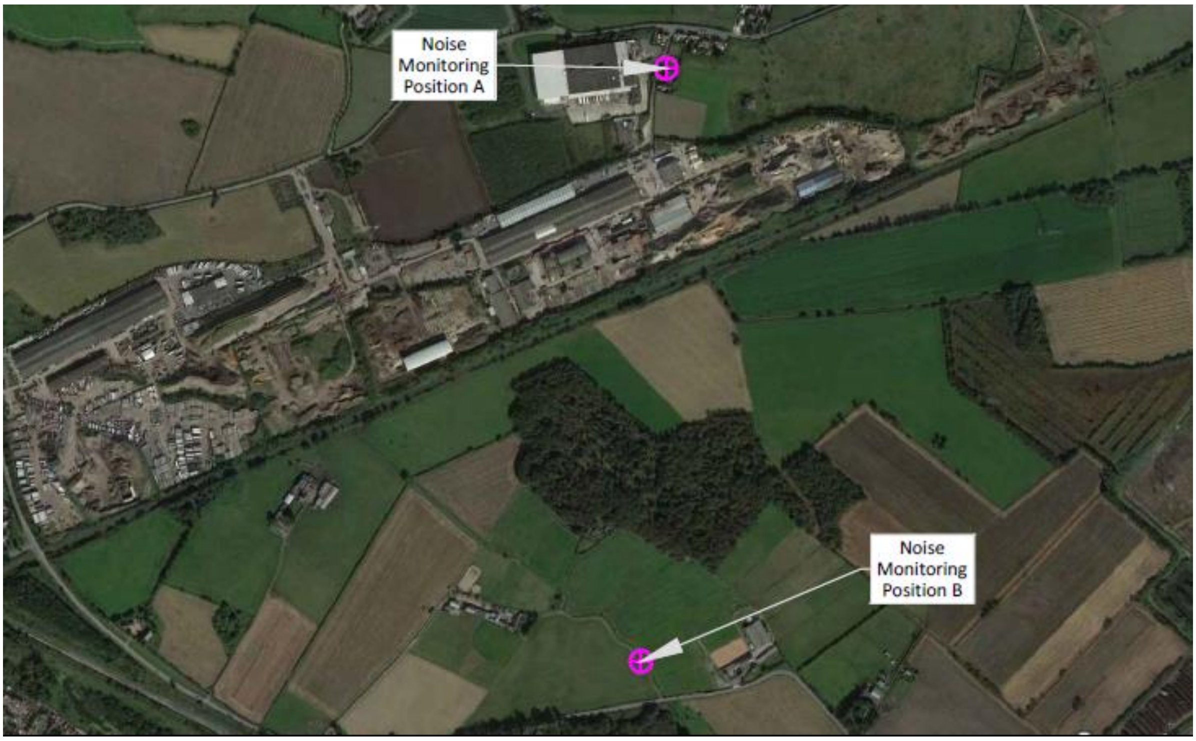
4 Existing Noise Climate and Background Levels

4.1 Procedure and Monitoring Locations

2.1.1 An initial noise survey was completed on the 14-15th December 2020 in accordance with BS 7445-1: 2003 by Thomas Benson of Oaktree Environmental Ltd. Attended background level measurements were taken at locations representative of the nearest noise sensitive receptors within the vicinity of the site.

2.1.2 The measurement locations are presented within the Noise Monitoring Plan within Figure 4.1 below:

Figure 3.1 - Site location and noise monitoring position



4.2 Weather conditions

2.2.1 The weather during the background surveys is summarised in the table below, this was recorded via a mixture of an anemometer and ongoing onsite observations:

Table 4.1 – Weather conditions

Date	Wind Speed (max)	Cloud Cover	Temperature	Precipitation
14/12/2020 - 15/12/2020	Mainly still with gusts up to 3.1 m/s	30-50%	9oC falling to 6.5oC	None recorded whilst onsite

4.3 Equipment Used During the Survey

2.3.1 Details of the equipment used during the survey are shown in the table below:

Table 4.2 - Survey Equipment

Description	Model	Manufacturer	Serial No.	Calibration Date
Class 1 Sound Analyser	NOR 150	Norsonic	15030504	02/10/2020
Microphone	Norsonic Type 1225	Norosnic	305208	02/10/2020
Field Calibrator	NOR 1251	Norsonic	35205	03/03/2020

4.4 Results

2.3.2 The results of the background noise monitoring survey are tabulated overleaf in tables 4.3-4.6.

Table 4.3 - Measurement Results for Noise Monitoring Position A (Siding Lane)

Measurement Time	LA_{eq}	LA_{90}	LA_{10}	LA_{max}
14/12/2020 23:00-00:00	42.3	40.5	43.6	61.3
15/12/2020 01:20-02:20	43.8	42.3	44.9	66.5
15/12/2020 03:45-04:45	43.7	42.3	44.7	66.9

Table 4.4 - Measurement Results for Noise Monitoring Position B (to the north of North Perimeter Road)

Measurement Time	LA_{eq}	LA_{90}	LA_{10}	LA_{max}
15/12/2020 00:10-01:10	47.7	41.5	45.3	70.4
15/12/2020 02:35-03:35	46.6	41.5	46.4	68.5
15/12/2020 04:55-05:55	56.0	45.6	60.4	70.8

Table 4.5 – 15-minute LA_{90} values for Noise Monitoring Position A (Siding Lane)

Measurement Time	LA_{90}	Measurement Time	LA_{90}
14/12/2020 23:00-23:15	40.0	14/12/2020 23:15-23:30	40.5
14/12/2020 23:30-23:45	41.2	14/12/2020 23:045-00:00	42.2
15/12/2020 01:20-01:35	42.1	15/12/2020 01:35-01:50	42.2
15/12/2020 01:50-02:05	42.1	15/12/2020 02:05-02:20	42.7
15/12/2020 03:45-04:00	42.1	15/12/2020 04:00-04:15	42.3
15/12/2020 04:15-04:30	42.5	15/12/2020 04:30-04:45	42.7

Table 4.6 – 15-minute LA90 values for Noise Monitoring Position B (to the north of North Perimeter Road)

Measurement Time	LA_{90}	Measurement Time	LA_{90}
15/12/2020 00:10-00:25	41.3	15/12/2020 00:25-00:40	41.9
15/12/2020 00:40-00:55	41.7	14/12/2020 00:55-01:10	41.9
15/12/2020 02:35-02:50	41.7	15/12/2020 02:50-03:05	40.9
15/12/2020 03:05-03:20	42.3	15/12/2020 03:20-03:35	41.9
15/12/2020 04:55-05:10	44.9	15/12/2020 05:10-05:25	45.2
15/12/2020 05:25-05:40	47.2	15/12/2020 05:40-05:55	47.9

4.5 Existing Noise Climate – NMP A

4.5.1 During the attended background measurements, it was evident that the existing noise climate at the closest residential receptors on Siding Lane is dominated by fixed external plant (ventilation, extraction etc.) at the large manufacturing unit to the west. Noise from this source comprises a constant tonal hum whilst occasionally internal processes may be audible.

4.5.2 Sporadic noise from the industrial estate to the south was also audible, however this was at a level similar to or below that of the noise sources previously discussed.

4.5.3 Contribution from road traffic throughout the night time monitoring was very occasional and generally lower than that of the sources mentioned previously.

4.6 Existing Noise Climate - NMP B

4.6.1 During the attended background measurements, it was evident that the existing noise climate at this location is more variable than that of NMP A. Noise sources included ventilation/extraction from the industrial estate to the south as well as occasional crashes/bangs from moving plant and associated processes to the south. In addition, passing road traffic along North Perimeter Road was audible, vehicle movements were observed to range from 6-64 movements per hour (the 03:45-04:45 monitoring period was substantially more busy) with a large portion of movements including large HGVs.

5 Noise Impact Assessment

5.1 Introduction

5.1.1 Table 5.1 below includes the noise sources associated with the proposed operation of the site.

Table 5.1 - Noise levels Associated with Proposed Operations

Activity	Noise Level (LAeq)	Sound Power Level	Source	Location
In-feed system	80.0dB (A) at 1m	91	Provided by the manufacturer	Internal
Pyrolysis Unit	80.0dB (A) at 1m	91	Provided by the manufacturer	Internal
Thermal oxidiser	80.0dB (A) at 1m	91	Provided by the manufacturer	Internal
Screw conveyor	80dB (A) at 1m	91	Provided by the manufacturer	Internal
Air filtration	72dB (A) at 1m	83	Provided by the manufacturer	Internal
Air compressor	85dB (A) at 1m	96	Provided by the manufacturer	Internal
Induced draft fan	80.0dB (A) at 1m	88	Provided by the manufacturer	External
Air blast cooler	65dB (A) at 10m	93	Provided by the manufacturer	External
Flue gas abatement	83.0dB (A) at 1m	94	Provided by the manufacturer	External
Flare	80.0dB (A) at 1m	91	Provided by the manufacturer	External

5.1.2 To assess the potential noise impacts associated with the installation of the facility on the on the nearby noise sensitive receptors, noise models have been created using CadnaA. The software package utilises standardised noise prediction methodologies and algorithms in order to predict the propagation of noise from source to receiver.

5.1.3 The CadnaA noise model was constructed using OS mapping Opendata and Google Earth satellite imagery.

5.1.4 The following assumptions/parameters are made within the model:

- The intervening land between the site boundary and residential properties was modelled with G = 0.8 as it was considered that the land is predominantly acoustically absorbent.
- Noise sources are assumed to be constant with no significant variation,
- Buildings were set as acoustically reflective, with a reflection loss of 1 dB.
- Noise levels were determined on a grid and at residential properties representing the nearest residential facades. The height of each receiver was 2.0 m, consistent with the height of a typical first storey window.
- The predicted noise levels were free-field, A-weighted, sound pressure levels. The noise contours generated within the model are also at a height of 2.0 m, assumed to be the worst-case scenario.
- Surrounding building heights have been taken from observations and information provided from the Local Authority public access where available.
- The main treatment building height was modelled at 10m to the eaves, whilst the internal surface area (walls and ceiling) was assumed to be 1,360m^2 .
- The roller shutters on the northern and southern façade are assumed to be closed, consistent with the proposed operation throughout the hours of 23:00-07:00,
- As per the proposed elevations drawings submitted in support of the planning application, external noise sources were modelled as a point source with a height of 14m for the flare, 5.8m for the air blast coolers, 3.8m for the flue gas abatement and 2.5m for the induced draft fan.

- The value of R (sound reduction index offered by the building) was based upon trapezoidal 45mm steel sheeting whilst roller shutters were assumed to comprise 1mm steel sheeting,

5.1.5 Figure 6.2 overleaf details the predicted noise levels (in dB A) associated with the proposed operations at the relevant receptors.

Figure 6.2 – Noise modelling of noise associated with the proposed operations

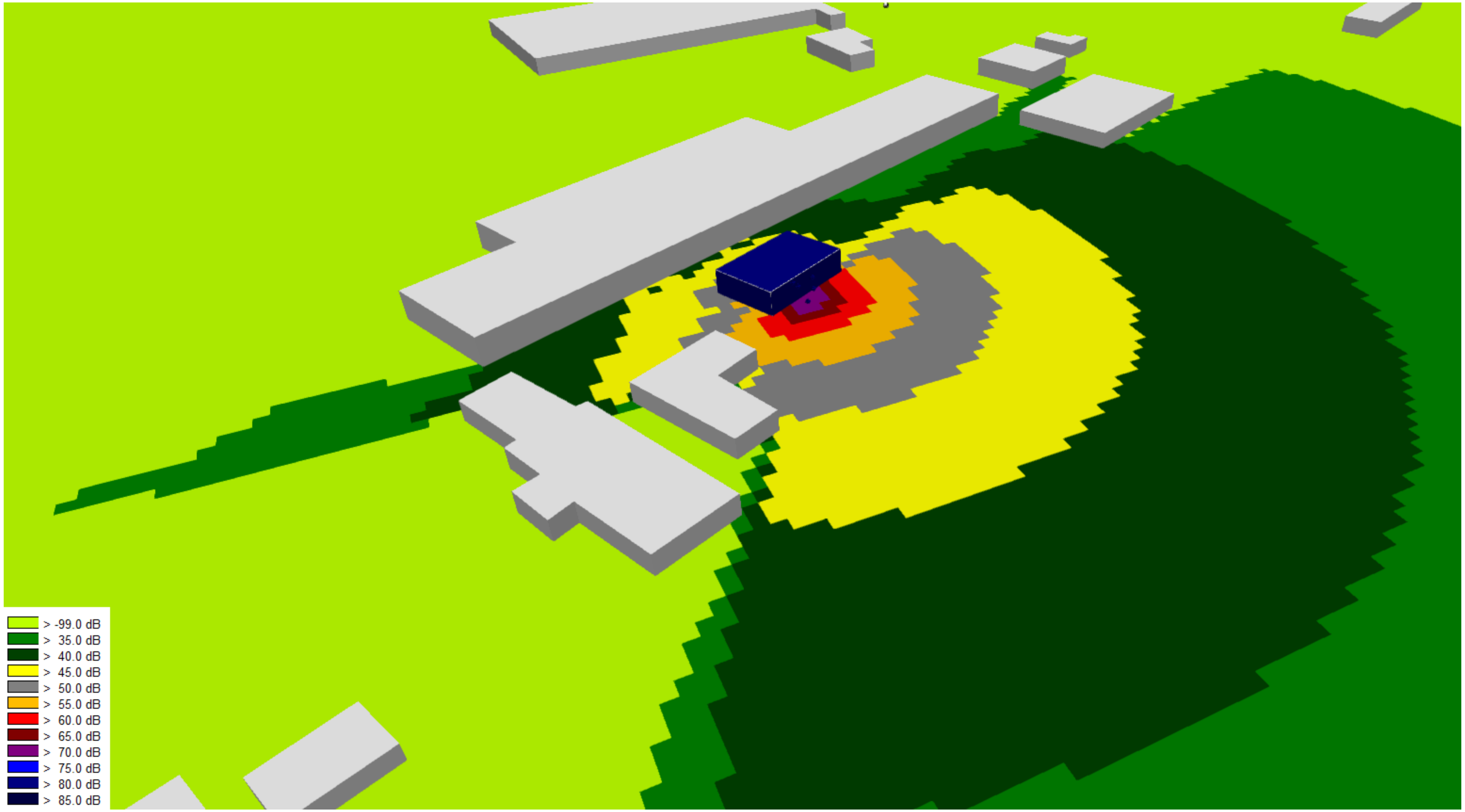
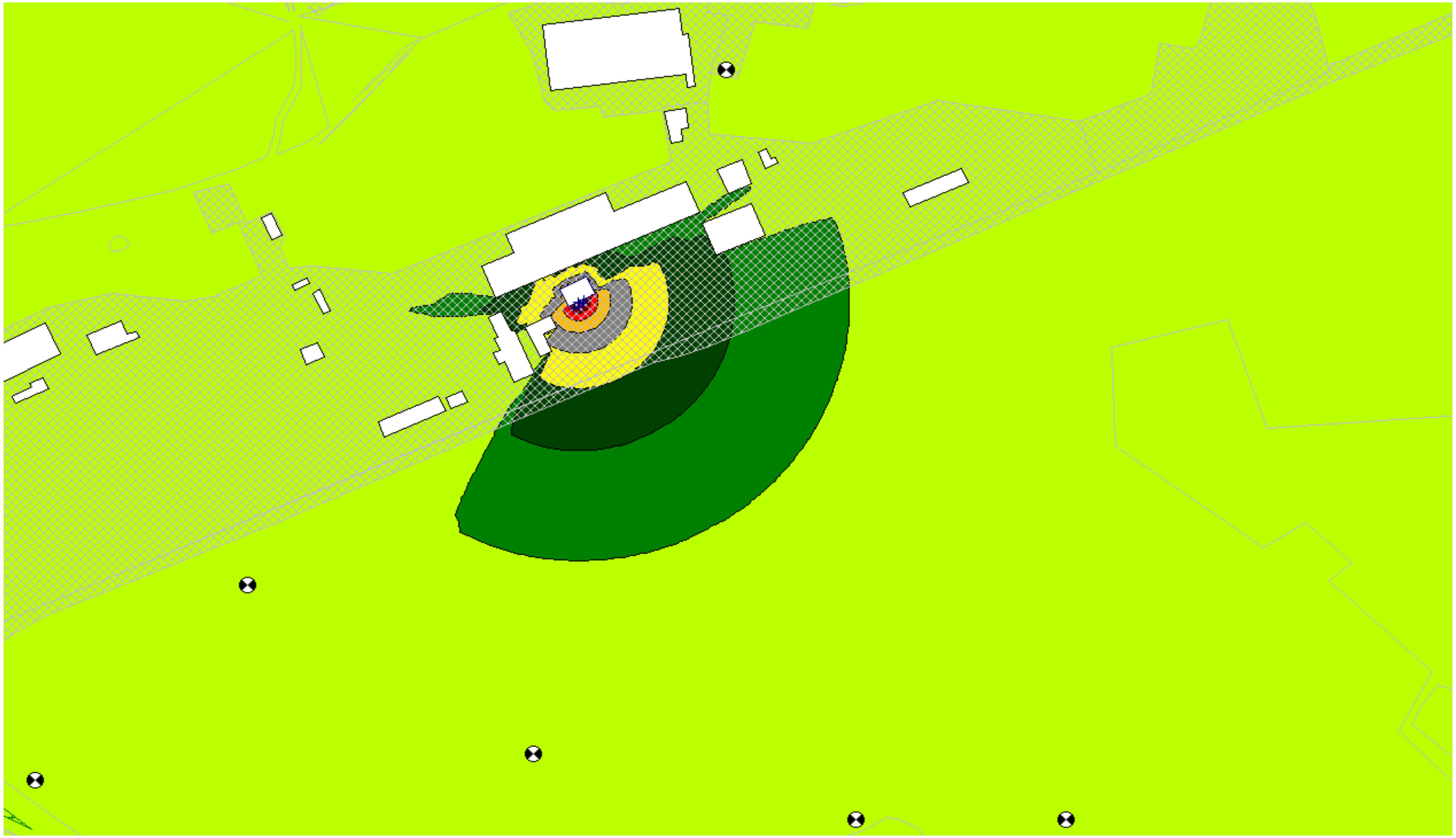


Figure 6.3 – Noise modelling of noise associated with the proposed operations



5.2 Discussion

5.2.1 With regards to impulsive penalties, the system is free from any impulsive crashes or bangs due to the nature of the noise sources. However, there is a tonal element to the plant that may be just perceptible at the nearest dwellings. Therefore, a 2dB penalty has been applied to the operation of the site between the hours of 23:00-07:00.

5.2.2 With regards to background levels, BS4142:2014 states the importance of ascertaining the representative background level rather than the lowest: *it is important to ensure that results are reliable and suitably represent both the particular circumstances and periods of interest. For this purpose, the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods* (paragraph 8.1, page 11). With this in mind, the median value of the 15 minute LA90 values provided in Table 4.5 and Table 4.6 has been utilised.

Table 5.3 – Preliminary BS4142:2014 assessment with regards to operation between 23:00-07:00

	Calculated noise level at Siding Lane	**Calculated noise level at 5no. dwellings to the south**	**Comments**
Calculated noise level as per figure 6.2-6.3	23.4	22.5 to 31.4	
Addition of relevant penalties as per bs4142:2014	+2 = 25.4	+2 = 24.5 to 33.4	As per Section 5.2.1
Comparison to median background level – 23:00-07:00	25.4-42.2 = 16.8dB (A) below	24.5 to 33.4-41.9 = 17.4 to 8.5dB (A) below	Negligible/low impact as per BS4142:2014

5.2.3 Therefore, the preliminary assessment shows that with regards to the proposed operations during the night time, the rating level is considerably below the measured background level at these times and therefore the impacts associated with noise as a result of the proposed operation of the site at these times are negligible/low.

5.2.4 It may also be observed that BS4142:2014 gives an indication with regards to external noise levels and is not intended to be applied to the derivation of indoor sound levels arising from external noise sources or the assessment of indoor sound levels. However, it is reasonable to assume that residents would not expect to be utilising external amenity areas between 23:00 and 07:00 and therefore, in some instances it may be more appropriate to assess night time noise levels using the internal criteria within BS8233:2014 in order to give an indication of the likelihood of noise complaints given the context of the other standards. Whilst, BS8233:2014 is not intended for the assessment of noise generating activities, it does serve to give an additional layer indication of the likelihood of noise complaints.

5.2.5 The WHO Guidelines for Community Noise consider that a typical window left open for ventilation provides 15 dB attenuation from external noise sources. The table below calculates a worst-case scenario internal noise level at these properties as a result of the activities between the hours of 23:00-07:00. Tonal/impulsive penalties have not been applied as these would only be relevant with regards to BS4142:2014.

Table 5.4 – BS8233:2014 assessment with regards internal noise levels

Operation	**Predicted façade level**	**Predicted internal noise level**	**Guideline limit (daytime bedroom/ living room value)**
Siding Lane	23.4	-15 = 8.4	30
5no. dwellings to the south	22.5 to 31.4	-15 = 7.5 to 16.4	30

5.2.6 As can be seen from Table 5.4, the internal levels fall in well within those quoted within BS8233:2014. As discussed previously, the noise source is also free from impulsive crashes and bangs which may cause undue disturbance during the evening.

5.3 Uncertainty

5.3.1 Uncertainty in this assessment was controlled via the following precautions/procedures:

- Both the sound level meter and calibrator have a traceable laboratory calibration and the meter was field-calibrated both before and after the measurements.
- Background monitoring undertaken during a time of national restrictions taking place in late 2020 as a result of the ongoing COVID-19 pandemic. At this time people are asked to stay at home, except for specific purposes and to avoid meeting people with whom you do not live (including working from home where possible). The closure of certain business and venues was taking place. It would therefore be reasonable to assume that measured LA90 values may be lower than would normally be the case, thus providing a robust, worst-case scenario assessment.
- Weather during the background sound monitoring was ideal for outdoor noise monitoring (dry, wind speed under 5m/s).
- As per Section 4.5-4.6, tonal noise arising from ventilation/extraction systems within the vicinity of the receptors both to the north and south form part of the existing noise climate. It could therefore be reasoned that the tonal nature of the noise from the proposed operations may not be distinguishable from the existing sources and that the 2dB penalty applied within the assessment need not be included. However, this has been applied in order to provide a robust assessment.

6 Conclusion

6.1 Summary & Recommendations

6.1.1 Oaktree Environmental have undertaken a noise impact assessment for a site at Stopgate Lane, Simonswood.

6.1.2 This report is to be submitted in support of a planning application for the:

"Demolition of Existing Building and Erection of Purpose Built Building (and Ancillary Structures) to House High Temperature Treatment Facility for the Disposal of Medical Waste."

6.1.3 The local authority has also provided comment on the nature of the assessment, confirming that they do not expect daytime noise levels to warrant consideration.

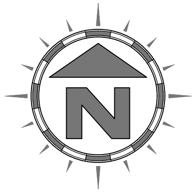
6.1.4 The primary receptors are considered to be the residential dwellings to the residential dwelling off Siding Lane approximately 300m to the northeast and the farmhouses to the south, ranging from 600-750m from the site boundary.

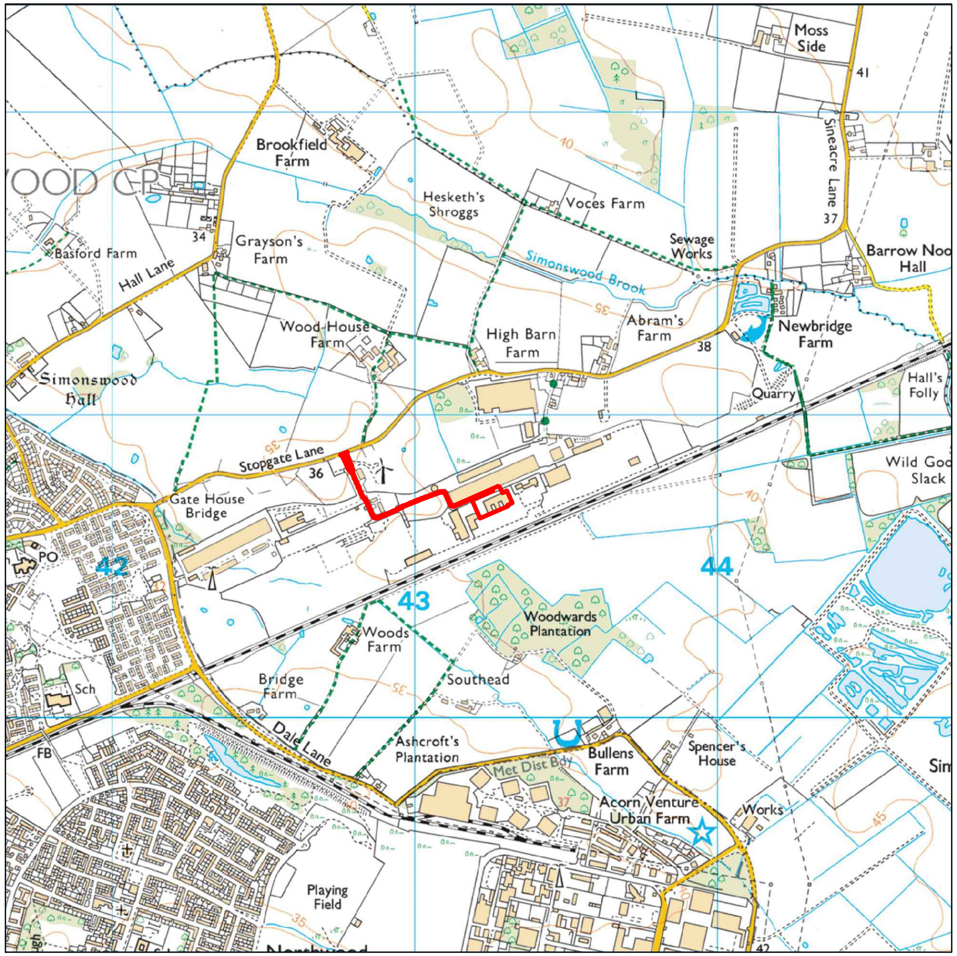
6.1.5 The rating level of the proposed operations at the nearest residential receptors are considerably below that of the background levels measured previously and therefore a negligible/low impact is derived as per the guidance within BS4142:2014. In addition, it has been confirmed that the noise levels associated with the operation of the plant will not breach internal criterion as per BS8233:2014.

6.1.6 It should therefore be considered that noise need not be an impediment to the grant of planning consent. Indeed in order to ensure ongoing compliance, a Schedule 13 EP will be required to be in place for the operations, which will be regulated on a continual basis by West Lancashire Borough Council, who will undertake regular compliance inspections to ensure the site operator is complying with stringent permit conditions so designed to protect air, land and water and human health/amenity.

Appendix I

Drawings





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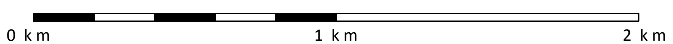

NOTES

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REVISION HISTORY

Rev:	Date:	Init:	Description:
-	30.11.21	RS	Initial drawing
A	01.12.21	RS	Boundary amended
B	08.12.21	RS	Minor amendment

KEY:

Site location (planning boundary)

Oaktree Environmental Ltd
Waste, Planning and Environmental Consultants

DRAWING TITLE
SITE LOCATION MAP

CLIENT
Culzean W2E Limited

PROJECT/SITE
Proposed High Temperature Treatment Facility, Stopgate Lane, Simonswood

SCALE @ A4	CLIENT NO	JOB NO
1:25,000	2776	008

DRAWING NUMBER	REV	STATUS
2776-008-01	B	Issued

DRAWN BY	CHECKED	DATE
RS	RS	08.12.21

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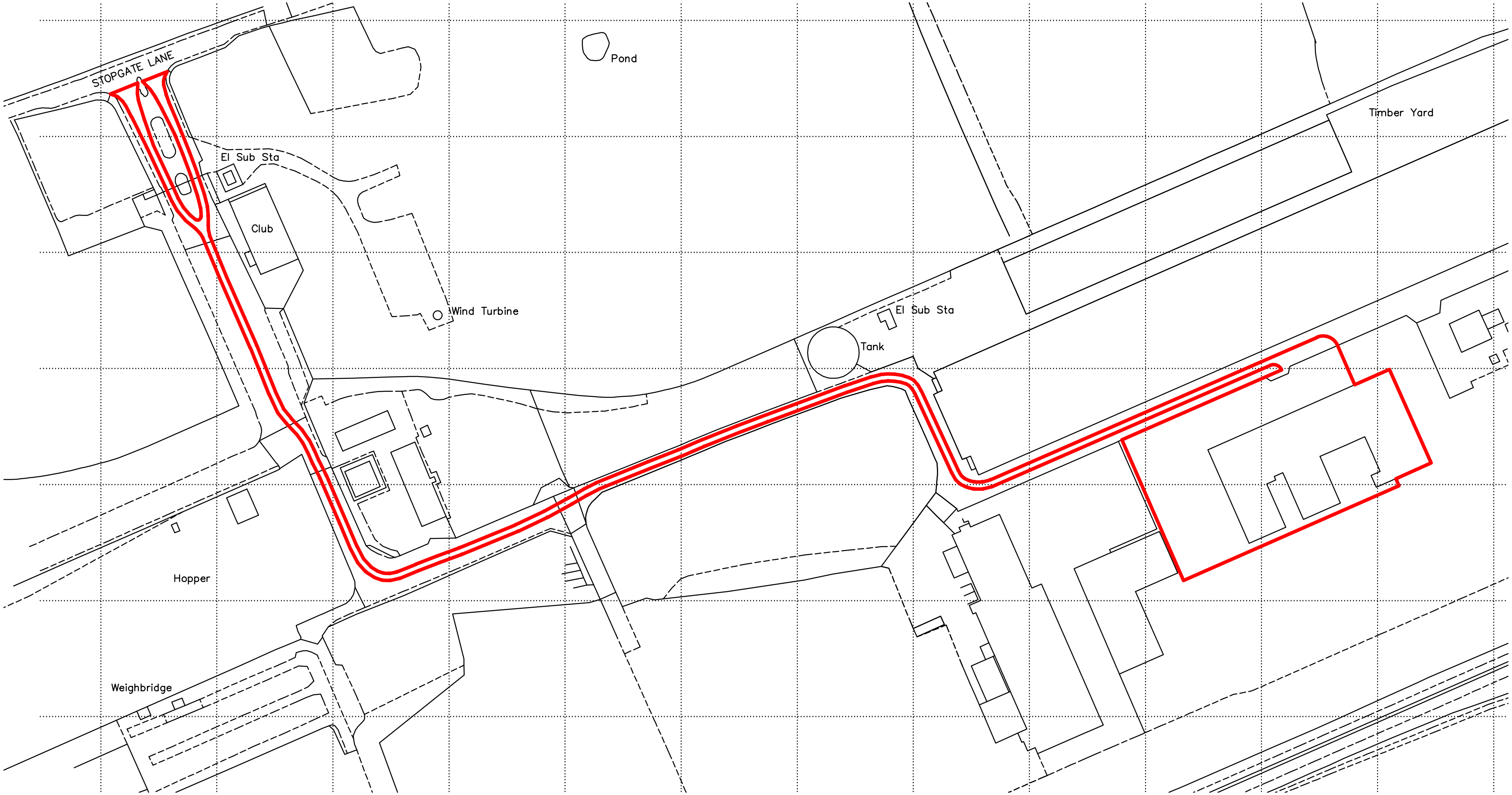

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Waste, Planning and Environmental Consultants

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DRAWING TITLE
SITE LOCATION MAP

CLIENT
Culzean W2E Limited

PROJECT/SITE
Proposed High Temperature Treatment Facility, Stopgate Lane, Simonswood

SCALE @ A4	CLIENT NO	JOB NO
1:2,500	2776	008

DRAWING NUMBER	REV	STATUS
2776-008-02	B	Issued

DRAWN BY	CHECKED	DATE
RS	RS	08.12.21

KEY

Planning application boundary

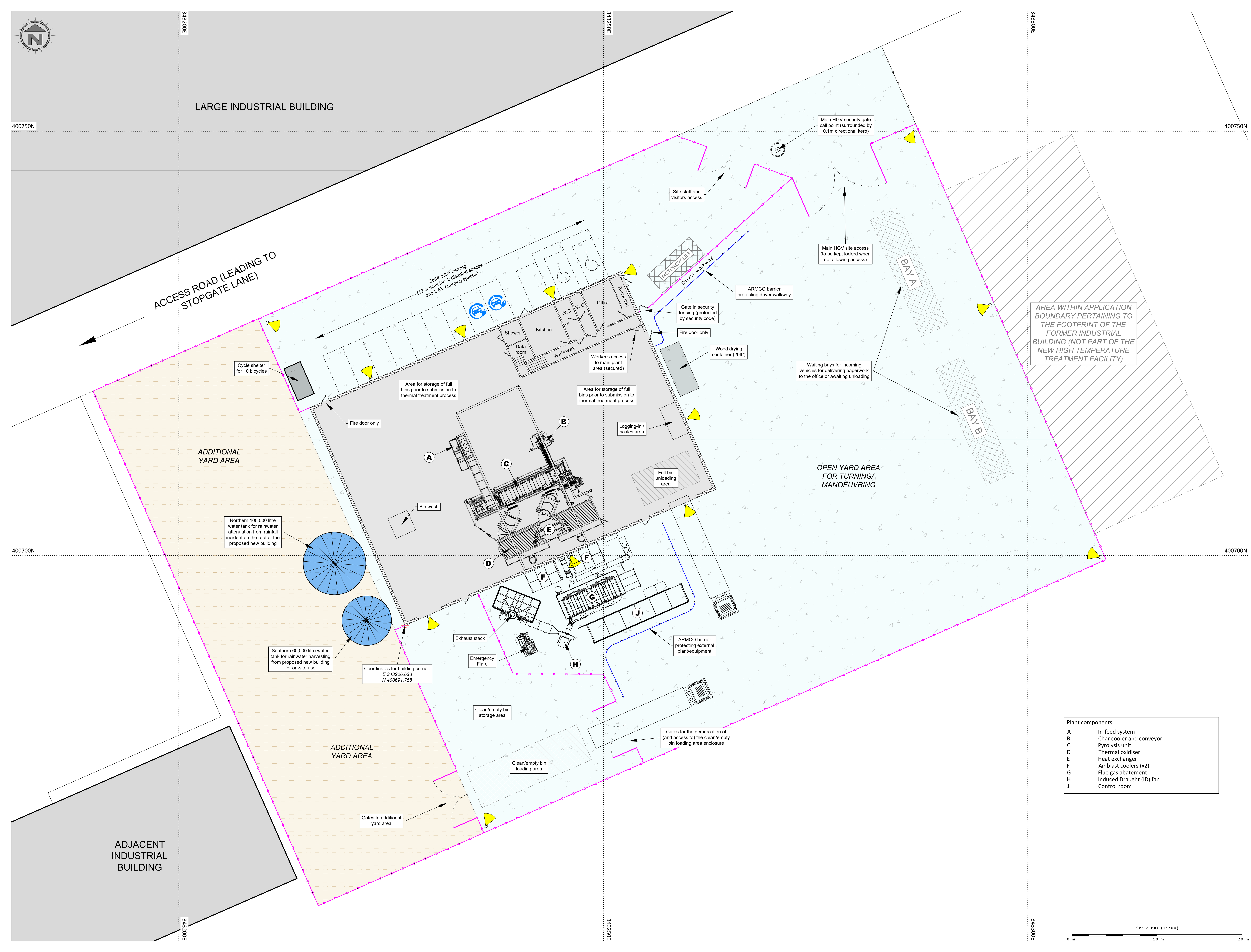
Scale Bar (1:2,500)

0 m 20 40 60 80 100 m

NOTES

REVISION HISTORY

Rev:	Date:	Init:	Description:
-	30.11.21	RS	Initial drawing
A	01.12.21	RS	Boundary amended
B	08.12.21	RS	Minor amendment



Plant components

A	In-feed system
B	Char cooler and conveyor
C	Pyrolysis unit
D	Thermal oxidiser
E	Heat exchanger
F	Air blast coolers (x2)
G	Flue gas abatement
H	Induced Draught (ID) fan
J	Control room

NOTES

REVISION HISTORY

Rev	Date	Init:	Description:
-	03.12.20	RS	Initial drawing
A	05.08.21	RS	Layout amended
B	11.08.21	RS	Wood drying container added
C	08.10.21	RS	Amended plant configuration
D	23.11.21	RS	Client comments
E	28.11.21	RS	Amendments; surfacing added
F	30.11.21	CG	Water tanks
G	01.12.21	RS	Amendment to water tanks
H	07.12.21	RS	Client comments (submission)

KEY:

- Fixed lighting
- Electrical vehicle (EV) charging point
- Perimeter security fencing (minimum 2.0m high)
- Main site area (surfaced with concrete)
- Additional yard area (surfaced with stone overlying existing concrete)

Oaktree Environmental Ltd
Waste, Planning and Environmental Consultants

DRAWING TITLE
PROPOSED LAYOUT PLAN

CLIENT
Culzean W2E Limited

PROJECT/SITE
Proposed High Temperature Treatment Facility, Stopgate Lane, Simonswood

SCALE @ A1	JOB NO	CLIENT NO
1:200	3285	1452

DRAWING NUMBER	REV	STATUS
2776-008-04	H	Issued

DRAWN	CHECKED	DATE
RS	RS	07.12.21

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ES Appendix IX

Sustainable Drainage Strategy

DRAINAGE STRATEGY

Stopgate Lane, Simonswood

Culzean W2E Limited

Version:	1.0	**Date:**	30 November 2021		
Doc. Ref:	2776-008-DRAINAGE	**Author(s):**	CG	**Checked:**	
Client No:	2776	**Job No:**	008		

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REGISTERED IN THE UK | COMPANY NO. 4850754

Document History:

Version	Issue date	Author	Checked	Description
1.0	30/11/21	CG		Document issue

CONTENTS

List of Support Drawings:

Appendix I - Drawings

Drawing No. 2776-008-04 – Proposed Layout Plan

1 General Considerations

1.1 Development site and location

1.1.1 Oaktree Environmental was commissioned by Culzean W2E Limited to prepare a Drainage Strategy in support of a planning application for the construction of a purpose built building, 28m by 40m in length and width and 10.635m in height to the ridge. This will be located as shown on the site layout plan. The proposals also include the demolition of an existing ageing building on-site, to make way for the footprint of the new development/building.

1.1.2 The site hydrological setting has been reviewed in the context of the Lancashire County Council Planning Application Validation Checklist and associated guidance. The site is in flood zone 1 which comprises land having less than a 1 in 1,000 annual probability of flooding from rivers or the sea. A significant proportion of the site area comprises the access from Stopgate Lane to the north. The Applicant will have sole control only of the area within the footprint of the building and surrounding surface as shown on Drawing No. 2776-008-04 which comprises less than 1 Ha. The site location with respect to the surrounding flood zone designations is shown at Appendix I. It is therefore concluded that the preparation of a formal SFRA is not necessary in order to validate the application.

1.1.3 Notwithstanding the above the drainage proposals included within the application are set out in further detail in this drainage assessment.

2 General principles

2.1.1 The site is already developed for industrial use. No changes to the area comprising impermeable surfaces at the site are proposed as part of the planning application.

2.1.2 The proposals include the demolition and reconstruction of a currently dilapidated building. As part of the development proposals, it will be necessary to provide a significant quantity of water for non-potable use, as well as to minimise the volume of runoff draining to the existing surrounding over which the Applicant does not have sole control.

2.1.3 The site generally falls gently towards the north west. The site is in the catchment of the Simonswood Brook. Surface water incident to the site discharges generally towards the site access at the north western corner of the site and thence northwards towards an unnamed tributary of the Simonswood Brook approximately 105m north of the site at its closes point. The unnamed tributary discharges northwards, is culverted beneath Stopgate Lane and discharges to Simonswood Brook approximately 1.3km north west of the site.

2.1.4 Sustainable drainage principles will be built into the scheme, including the harvesting of rainwater from the roof of the new building, which will be used for operations on site, such as bin and vehicle washdown.

2.1.5 It is proposed that water incident to the roof of the proposed building is conveyed first to a rainwater harvesting but then an attenuation tank. The rainwater harvesting butt will overflow via a non-return valve to the larger above ground attenuation tank. The attenuation tank will discharge to the surrounding site surface at a rate significantly reduced compared to the rainfall volume incident to the building footprint as part of the current situation.

2.1.6 Consistent with the current situation, the replaced concrete surface will drain towards the site access road. Runoff from the proposed building roof will discharge to the site surface consistent with the current situation, nevertheless at a significantly reduced rate compared with the current situation.

2.1.7 The specifications for the drainage system components are provided in Section 3.

3 Drainage system component specifications

3.1.1 The Flood Estimation Handbook (FEH) data is provided with this assessment. The Standard Average Annual Rainfall is 873mm. The area of the building roof will comprise 40m x 28m which is equal to 1,120m^2. The annual volume of rainfall is therefore calculated as 977.76m^3, which is the equivalent to a monthly rainfall of 81.48m^3. On this basis, it is recommended that the rainwater harvesting butt comprises a volume of 60m^3, and that any excess rainfall discharges via a non-return valve to the larger attenuation tank.

3.1.2 The capacity of the attenuation tank is calculated at Appendix II. It is calculated that a tank with 100m^3 capacity and a discharge rate of 0.5l/s will have sufficient capacity to attenuate the 1 in 100 year rainfall event and still have fully discharged at the end of the 96 hour duration event. It is therefore proposed that 100m^3 capacity attenuation tank is installed with an outlet to the site drainage system fitted with a suitable flow restriction device for the purposes of limiting the discharge to 0.5l/s.

3.1.3 It is therefore considered that the harvesting and attenuation proposals will result in a significant betterment with respect to runoff generation in the catchment of the Simonswood Brook compared with the current situation.

4 Conclusion

4.1.1 Based on the information presented in and appended to this strategy there is adequate information in respect of the proposed drainage arrangements to determine this planning application in accordance with Lancashire County Council Policy and the National Planning Policy Framework.

4.1.2 The proposed harvesting and drainage proposals will result in a significant betterment compared with the current situation with respect to runoff generation in the catchment of the Simonswood Brook and the sustainable harvesting of rainwater for non-potable uses.

Appendix I

Drawings

Environment Agency

Flood map for planning

Your reference	Location (easting/northing)	Created
Simonswood	**343282/400724**	**30 Nov 2021 17:00**

Your selected location is in flood zone 1, an area with a low probability of flooding.

This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn’t include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Environment Agency

Flood map for planning

Your reference
Simonswood

Location (easting/northing)
343282/400724

Scale
1:2500

Created
30 Nov 2021 17:00

Selected point

Flood zone 3

Flood zone 3: areas benefitting from flood defences

Flood zone 2

Flood zone 1

Flood defence

Main river

Flood storage area

0 20 40 60m

Appendix II

Attenuation calculations

Flood risk assessment

Calculation of storm water containment for a 1 in 100 year storm event plus an allowance for climate change

Parameter	Value	Units	
Positively drained area	0.11	ha	Building area
Specified discharge rate	0.5	l/s	Lowest discharge rate considered achievable in order to maximise storage
Assumed runoff coefficient for current site	1	unitless	No evaporative loss assumed conservatively
Climate change factor	0.4	unitless	Precautionary allowance for rainfall intensity increase due to climate change for the 2080s

Storm Duration (hr)	Rainfall for the site derived from reference 1 (mm)	Rainfall Intensity corrected for climate change (mm/hr)	Volume of runoff generated during 1 in 100 year plus 40% rainfall event (m^3)	Storage required at specified discharge rate (m)
0.25	25.44	142.46	39.89	39.44
0.5	33.69	94.33	52.83	51.93
0.75	38.71	72.26	60.70	59.35
1	42.37	59.32	66.44	64.64
1.25	44.9	50.29	70.40	68.15
1.5	46.9	43.77	73.54	70.84
1.75	48.6	38.88	76.20	73.05
2	50.07	35.05	78.51	74.91
4	58.7	20.55	92.04	84.84
6	64.1	14.96	100.51	89.71
8	67.88	11.88	106.44	92.04
10	70.79	9.91	111.00	93.00
10.25	71.11	9.71	111.50	93.05
10.5	71.43	9.52	112.00	93.10
10.75	71.73	9.34	112.47	93.12
11	72.03	9.17	112.94	93.14
11.25	72.33	9.00	113.41	93.16
11.5	72.61	8.84	113.85	93.15
11.75	72.89	8.68	114.29	93.14
12	73.17	8.54	114.73	93.13
12.25	73.43	8.39	115.14	93.09
24	82.32	4.80	129.08	85.88
48	92.96	2.71	145.76	59.36
72	101.14	1.97	158.59	28.99
93	107.5	1.62	168.56	1.16
93.25	107.57	1.61	168.67	0.82
93.5	107.64	1.61	168.78	0.48
93.75	107.72	1.61	168.90	0.15
94	107.79	1.61	169.01	-0.19
94.25	107.86	1.60	169.12	-0.53
96	108.37	1.58	169.92	-2.88

Maximum storage volume	93.16	m^3
Critical Storm Period	11.25	hr

References

Reference 1. Flood Estimation Handbook 2013 data. https://fehweb.ceh.ac.uk/