Surrey Waste Local Plan 2018-2033

SURREY

Appendix C to the Habitat Regulations Assessment Report

Thermal Treatment Facility Proxies for use in Air Quality Modelling to inform the HRA process

Wind Roses for Airports & Airfields relevant to wind conditions in the county of Surrey

Draft for Consultation

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C-1 Introduction

1. The purpose of this appendix to the HRA report is to identify a small number of thermal treatment plant developments that have been either proposed or permitted, that have been used as proxies for the types of waste related development that could be brought forward on any of the sites that are proposed for allocation in the emerging Surrey Waste Local Plan (2018-2033).

2. To date the emerging Surrey WLP has offered no guidance as to the type and scale of development that would be considered appropriate for each of the prospective allocated sites. In order to be found sound, and to proceed ultimately to adoption, the Surrey WLP will need to be assessed with reference to the requirements of Article 6(3) of the EU Habitats Directive (92/43/EEC). The question of the impact of major thermal treatment plants on air quality, with particular reference to the deposition of nutrients and acids, across the Special Protection Areas (SPAs) and Special Areas of Conservation (SACs) that are situated both within Surrey and in the surrounding area, is one that has to be addressed as part of the Habitat Regulations Assessment.

3. This paper provides details of the following four thermal treatment plants that have been identified by the CPA as suitable proxies for use in the Surrey WLP HRA process.

   3.1 Beddington Energy Recovery Facility (ERF), Beddington Lane, Sutton – a 275,000 tonne per annum (tpa) energy recovery facility. Details of the air quality assessment work undertaken as part of the EIA submitted with the planning application are given in part B of this paper.

   3.2 Hooton Park Gasification Facility, land off North Road, Hooton Park Industrial Estate, Eastham, Wirral – a 284,000 tpa gasification facility. Details of the air quality assessment work undertaken as part of the EIA submitted with the planning application are given in part C of this paper.

   3.3 Wealden Brickworks Energy from Waste (EfW) Plant, Langhurstwood Road, Horsham, West Sussex – a proposed 180,000 tpa energy from waste facility. Details of the air quality assessment work undertaken as part of the EIA submitted with the planning application are given in part D of this paper.

   3.4 Charlton Lane 'Eco Park' Gasification Facility, Charlton Lane, Shepperton, Surrey – a permitted 44,710 tpa fluidised bed gasification facility. Details of the air quality assessment work undertaken as part of the EIA submitted with the planning application are given in part E of this paper.

C-2 Beddington Energy Recovery Facility (ERF), Beddington Lane, Sutton

4. The following design and dispersion modelling parameters are taken from Technical Annex (Air Quality & Human Health Effects Assessment) to Chapter 6 (Air Quality) of the Environmental Statement submitted in support of Planning Application D2012/66220/FUL. The report was prepared by RWDI Anemos Ltd, and dated November 2012.

5.3 Stack Emissions

The largest source of emissions to atmosphere will be the gases emitted to atmosphere through the two main chimney stacks. These gases will leave the chimney in a plume that subsequently disperses in the atmosphere and dilutes the concentrations of the pollutants it contains. The physical processes that govern this dispersion process can be simulated with a dispersion model, leading to the quantification of impacts in terms of airborne concentrations at ground level and deposition rates to the underlying surface.

The primary dispersion model used in this assessment was ADMS 4 (version4.2), a well-known model and one whose use is recognised by the Environment Agency, amongst others.

The model requires inputs for:

- meteorological conditions hour by hour;
- terrain;
- significant building dimensions; and
- physical properties of the plume and pollutant release rates.

The model utilises a meteorological dataset that contains hourly values for wind speed, wind direction and certain meteorological variables that allow it to compute the stability of the atmospheric boundary layer. These data allow the model to compute the ground level concentration at every point on the grid used to define the modelling domain and at every defined receptor point. This simulation is carried out for every hour for each of five years, thereby enabling each location to be assigned over 43,000 values of the estimated ground concentration. This ensures that the full range of meteorological conditions is accounted for and the statistics for mean and peak concentrations are robust.

This assessment has used input data derived from observations at Gatwick Airport (2007-2011) and also Heathrow Airport (2008) for comparison purposes.

A digital terrain dataset was obtained from the Ordnance Survey and used as an input to the model.

In circumstances where the plume is released into the atmosphere close to a building that is more than one third the height of the release, or where the building is very wide, the potential exists for the building to affect the airflow sufficiently for the plume trajectory to be influenced and the ground level concentrations increased, relative to the case of there being no building. In the case of the ERF, the main building is large and has to be considered as an input to the model.

The emissions data comprise the physical properties of the flue gases, which determine the plume rise, and the mass release rates for the individual pollutants. (These values are set out in Section 6.3)

Various choices are made by the model user with regard to the model set up. A summary of the various selections made in this case is provided below.

Table 5.2 Dispersion Model Set Up

Input/Parameter	Value
Building dimension	90 m x 50 m x 39 m (h), angle 154 degrees At 529233, 166848
Roughness length	0.7 m
Grid spacing	100 m
Model domain	8 km x 8 km

One important aspect of the modelling is the treatment of the oxidation of nitric oxide (NO) to nitrogen dioxide (NO_2). Guidance issued by the Environment Agency's Air Quality Assessment and Modelling Unit (AQMAU) indicates that an initial screening approach would be to assume that 100% of annual average concentrations of NOx are in the form of NO_2 and 50% of peak hourly average concentrations. For a worst case approach, i.e. the next level of consideration, the amounts recommended are 70% and 35% respectively. Given that the maximum concentrations occur relatively close to the source, it is these numbers that have been adopted for this assessment.

6.3 ERF Stack Emissions

6.3.1 Dispersion Model Inputs

The model inputs with regard to meteorological data, terrain and building heights are described in Section 5.3, along with the selections made with regard to the model set up.

The physical properties of the gases exiting the chimney stacks were defined by Viridor's engineering contractors, CNIM. The relevant data for modeling purposes are summarised in Table 6.5.

Table 6.5 Physical Properties of the Flue Gases and Chimney Stack

Item	Unit	Single flue	Combined Flues
Stack height	m	85	85
Internal stack diameter	m	1.9	2.69(b)
Stack location			529220, 166822
Flue gas velocity	m s-1	15.8	15.8
Volume flow rate (actual)	Am3 s-1	45	89
Volume flow rate (reference)(a)	Nm3 s-1	28.6	57.2
Temperature	Celsius	140	140
Oxygen (wet)	% v/v	8.1	8.1
Moisture content	%v/v	15.3	15.3
Moisture content	%w/w	10	10
Moisture content	kg kg-1	0.1	0.1
(a) Reference conditions are dry flue gas, with 11% O_2 (b) the plume is modelled as one single source, in line with conventional practice for two adjacent flues.			

These input data are based on the assumed maximum annual waste throughput of 302,500 tonnes of waste with a calorific value of 8.7 MJ kg-1. This represents the worst case with regard to the volume of gas emitted.

The volume of gas emitted from the chimney stacks determines the amount of individual pollutants released, as entered into the dispersion model, because the assumption is made that the ERF emits each of the pollutants at concentrations at the limit value, as defined in the Waste

Incineration Directive. This is a clear overestimate of the true situation, since it would be impossible to operate the ERF such that each pollutant was precisely at the limit value and it would not be permissible to operate the ERF with concentrations of pollutants above the limit values. Data on real emission concentrations in flue gases at energy from waste plants operating the UK shows that, for most pollutants, the actual emissions are substantially below the limit values. Values for the mass release rates used in the dispersion modelling are given below in Table 6.6.

Table 6.6 Mass Release Rates of Pollutants Used for Dispersion Modelling

Pollutant	WID limit value (24 hour) (mg Nm-3)	Mass Release rate used for modeling (g s-1)
Oxides of Nitrogen (NO_x)	200	11.44
Sulphur dioxide (SO_2)	50	2.861
Carbon monoxide (CO)	50	2.861
Particulate matter (PM_{10} or $PM_{2.5}$)	10	0.572
Hydrogen chloride (HCl)	10	0.572
Hydrogen fluoride	1	0.057
Volatile organic compounds (VOCs)	10	0.572
Ammonia	(not regulated)	0.572
Mercury (Hg)	0.05	0.003
Cadmium + Thallium	0.05	0.003
Sum of other metals	0.5	0.029
Dioxins and furans	0.0000001	5.72 x 10-9
Benzo-a-pyrene	(not regulated)	0.00014

Notes: - Ammonia emissions arise as excess reagent in the flue gas treatment of NOx and a value of 10 mg Nm-3 is assumed. Operating practice at existing Energy from Waste plant suggests that 5 mg Nm-3 is a more likely estimate in practice.
'Other metals' consist of antimony, arsenic, chromium, cobalt, lead, manganese, nickel and vanadium. The initial assessment carried out assumes that the 0.029 g s-1 mass release rate is distributed equally amongst all 9 metals.
The emission of benzo-a-pyrene is based on typical emissions from measurements at existing EfW plants. Total PAHs will be greater than this individual PAH.

A modeling exercise was completed using preliminary emission data in order to derive a suitable stack height. (These emission data were based on a higher calorific value and were not, therefore, identical to those set out in Tables 6.1 and 6.2. They were, however, very similar and the desired result for this purpose depends on the relative difference between concentrations at each stack height and not the absolute vales.)

Model runs were carried out using stack heights in the range 60 m to 100 m, at 5 m intervals. The results are expressed in terms of the annual mean concentrations of NOx, at the point of maximum impact. These results were obtained using meteorological data form Gatwick airport for one year (2011), shown to produce the highest value of the five years investigated initially. All other aspects of the model set up were as described elsewhere.

The professional judgment made was that a stack height of 85 m was more than sufficient to meet requirements regarding the significance of the additional contribution to air quality is a height beyond which the additional benefits would be insufficiently large to warrant the additional cost of raising the height further.

6.3.2 Modelling Results and Significance

The concentrations at the maximum point of impact have been extracted an presented in Table 6.7 for the pollutants with air quality objectives and which might exert an effect over the short term and long term.

Table 6.7 ERF Contribution to Airborne Concentrations at the point of maximum impact.

Pollutant	ERF contribution (PC) (µg m-3)							
	Annual Mean	99.79th %tile hourly mean	90.41st %ile daily mean	99.18th %ile daily mean	99.18th %ile hourly mean	99.90th %ile 15 min mean	8 hour running mean	Max 1 hour mean
Nitrogen dioxide (NO_2)	1.5	7.5	-	-	-	-	-	-
PM_{10}	0.11	-	0.37	-	-	-	-	-
$PM_{2.5}$	0.11	-	-	-	-	-	-	-
Sulphur dioxide (SO_2)	-	-	-	3.8	5.2	5.7	-	-
Carbon monoxide (CO)	-	-	-	-	-	-	4.9	-
Hydrogen chloride (HCl)	-	-	-	-	-	-	-	1.4
Hydrogen fluoride (HF)	0.1	-	-	-	-	-	-	0.14
Ammonia (NH3)	0.11	-	-	-	-	-	-	1.4
VOCs (as benzene)	0.11	-	-	-	-	-	-	-
PAH (as benzo-a-pyrene)	9.7×10^{-7}	-	-	-	-	-	-	-

6.3.4 Sensitivity of Modelling results to Meteorological Data and Model Choice

In line with good practice, a comparison of model results was obtained for different meteorological data (Heathrow) and a different dispersion model. The results are summarised below, using the annual mean concentration of NO2 as the indicator result.

Table 6.11 Summary of Sensitivity Results

Model Choice	Met Data	Annual mean NO_2	99.79th percentile NO_2
ADMS	Gatwick 2011	1.5	7.0
ADMS	Gatwick 2008	1.4	6.9
ADMS	Heathrow 2008	1.3	6.9
AERMOD	Gatwick 2011	0.92	4.6

The primary assessment has made use of ADMS with meteorological data for the year 2011. As Table 6.5 demonstrates, this is the worst case of the various options.

C-3 Hooton Park Gasification Facility, land off North Road, Hooton Park Industrial Estate, Eastham, Wirral

5. The following design and dispersion modelling parameters are taken from Appendix 11-2 (Air Quality Assessment) to the Environmental Statement submitted in support of Planning Application 14/00314 (Walsall Borough Council). The report was prepared by Fichtner Consulting Engineers, and dated 6 November 2013.

7.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the Monin-Obukhov length and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the Environment Agency.

7.2 Model inputs

7.2.1 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the HOPSEF gasification facility are presented in Table 7.1

Table 7.1: Source Data		
Item	**Unit**	
Stack Data		
Height	m	80
Internal diameter	m	2.20
Location (E�something"ings,N"ings)	m, m	337420, 380021
Flue Gas Conditions		
Temperature	°C	135
Exit moisture content	% v/v	18.6
Exit oxygen content	% v/v dry	3.44
Reference oxygen content	% v/v dry	11.0
Volume at reference conditions (dry, ref O2)	Nm3/s	86.09
	Nm3/h	309,934
Volume at actual conditions	Am3/s	89.82
	Am3/h	323,351
Flue gas exit velocity	m/s	23.63

As the facility will be fuelled by municipal solid waste (MSW) and commercial and industrial (C&I) waste, emissions from the facility have been assumed to comply with the limits prescribed in Chapter VI of the Industrial Emissions Directive as summarised in Table 7.2, with the exception of NOx. A more stringent limit of 100 mg/Nm^3 is being applied for as part of the Environmental Permit application, this is 50% of the IED limit.

Table 7.2: Emissions Data		
Pollutant	**Conc. (mg/Nm3)**	**Release Rate (g/s)**
Oxides of nitrogen (as NO_2)	100	8.609
Sulphur dioxide	50	4.305
Carbon monoxide	50	4.305
Particulates	10	0.861
Hydrogen chloride	10	0.861
Volatile organic compounds (as TOC)	10	0.861
Hydrogen fluoride	1	0.086
Ammonia	10	0.861
Cadmium and thallium	0.05	4.305 mg/s
Mercury	0.05	4.305 mg/s
Other metals	0.5	43.305 mg/s
Benzo(a)pyrene	0.2 µg/Nm^3	17.219 µg/s
Dioxins and furans	0.1 ng/Nm^3	8.609 ng/s
Dioxin like PCBs	0.005	0.431 mg/s

NOTES:
All emissions are expressed at reference conditions dry, 11% oxygen, 273K.
There have been limited measurements of PM2.5s emissions from waste incineration facilities. From information available on the Environment Agency"s public registers for waste incineration plants at Bolton, Stoke and Lewisham it is indicated that the PM2.5 fraction makes up around 33% of the PM10 fraction. However as a worst-case it has been assumed that the entire PM emissions consist of either PM10 or PM2.5 for comparison with the relevant AQOs.
The highest recorded emission concentration of B[a]P from the Environment Agencys public register was 0.105 ug/m^3, or 0.000105 mg/m^3 (dry, 11% oxygen, 273K).
Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).
BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). in lieu of other available data, this has been assumed to be the emission concentration for the facility.

In addition to the limits shown in Table 7.2, the IED also details half hourly average limits for a number of pollutants. It should be noted that if the facility continually operated at these limits the daily limits would be exceeded. The plant will be designed to achieve the limits shown in Table 7.2 and as such will only operate at the shorter term limits for short periods on rare occasions.

Dispersion modelling has been undertaken based on the emission parameters presented in the above tables. These are based on the design point for the facility. The facility would be operated as a commercial facility producing power for export to the national grid. Therefore it Is beneficial for the facility to operate at capacity. If loading does fall below the design point the volumetric flow rate and the exit velocity of the exhaust gases would reduce. The effect on this would be to decrease the quantity of pollutants emitted but also to reduce the buoyancy of the plume due to momentum. The reduction in buoyancy, which would lead to reduced dispersion would be more than offset by the decrease in the amount of pollutants being emitted, to that the impact of the plant when running below the design point would be reduced.

The plant is designed to operate at capacity and it is not anticipated to have significant changes in loading. Therefore it is appropriate to base the assessment on the design point of the facility.

Table 7.3: Emissions Data – Half Hourly Averages		
Pollutant	**Conc. (mg/Nm3)**	**Release Rate (g/s)**
Oxides of nitrogen (as NO_2)	400	34.437
Sulphur dioxide	200	17.219
Carbon monoxide	100	8.609
Particulates	30	2.583
Hydrogen chloride	60	5.166
Volatile organic compounds (as TOC)	20	1.722
Hydrogen fluoride	4	0.344

7.2.2 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Liverpool Speke for the years 2008 - 2012. The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions.

Wind roses for each year can be found in Figure A.3 of Appendix A.

The surface roughness length can be selected in ADMS. The sensitivity to this is considered within the sensitivity analysis. [see section 8.2 below]

The Monin-Obukov length for the site can be specified in ADMS. This provides a measure of the stability of the atmosphere and indicates the height above which convective turbulence (i.e. thermal) is more important than mechanical (i.e. friction). This allows for the effect of the urban heat island, to prevent the atmosphere from ever becoming very stable, to be simulated within the model. The Monin-Obukov length of the modelling domain was taken to be 30 m which is the value appropriate for cities and towns and mixed urban and industrial areas.

7.2.3 Modelling domain

Modelling has been undertaken over a 5.9 km x 5.9 km grid with a spatial resolution of 60 m. The maximum grid spacing is less than 1.5 times the stack height in accordance with the Environment Agency modelling rule of thumb.

Table 7.4: Modelling Domain	
Grid	**Values**
Grid Spacing (m)	60
Grid Points	99
Grid Start X	334460
Grid Finish X	340340
Grid Start Y	377060
Grid Finish Y	382940

7.2.4 Terrain

It is recommended that, where gradients within 500 m of the modelling domain are greater than 1 in 10 the complex terrain module within ADMS (FLOWSTAR) should be used.

A review of the area surrounding area has deemed that consideration is not required of complex terrain within the modelling.

7.2.5 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The Environment Agency recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 7.5. The height limitation has been taken as one third of the stack height. A site plan showing which buildings have been contained in the model is presented in Figure A.4 of Appendix A. The main building has been selected as the boiler, as this is the highest building onsite.

Table 7.5: Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Boiler	337391	380067	33	28	19.6	41
Waste reception #1	337280.6	380093.7	10	15.6	24.9	41
Waste reception #2	337289.4	380107.2	10	16.4	20.8	41
Waste treatment	337310.6	380120.5	13.5	16.617	12.08	41
Processed fuel #1	337298.8	380152.3	38.5	27	-	-
Processed fuel #2	337328.8	380162	38.5	27	-	-
Gasifier	337375	380115	44	35	23	41
Bed materials silos	337362	380122	17	13	6.6	41
Nitrogen	337371	380132	10	13	6.3	41
Ash containers	337359	380100	19	8.7	21.1	41
Liquid nitrogen station	337360	380132	12	13.5	7	41
Fly ash	337400	380123	36	8	-	-
Hot gas filters	337395	380093	26	25	42	41
Flue gas cleansing	337406	380033	25	15	37	41
Turbine building	337406	380048	30	21	27.7	41
EL building	337422	380058	30	14.3	26	41
Fly ash silo	337409	380017	33	4.8	-	-
Firewater tank	337433	380071	10	12	-	-
Ammonium tank	337381	380074	5	3.8	-	-
Effluent plant	337446	380064	3	8	-	-
Turbine condenser	337457.8	380016.1	35	55.5	41	41
MRF building	337322.6	380034.6	20	50	120	41

8.2 Surface Roughness

The sensitivity of the results to surface roughness length has been considered by running the model with a range of surface roughness lengths.

The following parameters were kept constant:

- Stack height – 80m;

- Buildings – included;
- Terrain – excluded; and
- Met data year - 2008

Table 8.5 presents the contribution to the ground level concentration of the emissions of nitrogen dioxide at the point of maximum impact.

Table 8.5: Surface Roughness Sensitivity		
Surface roughness (m)	**Max annual mean NOx process contribution**	**Max 1-hour mean NOx process contribution**
0.0001 – Sea	0.56	46.05
0.2 – Agricultural areas min	0.92	50.93
0.3 – Agricultural areas max	1.00	50.80
0.5 – Parklands & open suburbia	1.13	51.24
1.0 – Cities & large towns	1.40	52.45

As shown increasing the surface roughness the predicted concentration at the point of maximum impact also increases. The surface roughness of 0.5 m is most representative of the wider area, therefore, has been used within this assessment.

C-4 Wealden Brickworks Energy from Waste (EfW) Plant, Langhurstwood Road, Horsham, West Sussex

6. The following design and dispersion modelling parameters are taken from Chapter 7 (Air Quality & Odour) to the Environmental Statement submitted in support of Planning Application WSCC/062/16/NH. The report was prepared by RPS, and dated 5 December 2016.

Dispersion Model Selection

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

Model Inputs – Meteorological Data

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

7.3.20 The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. Dispersion model simulations have been performed using five years of data from Charlwood, near Gatwick between 2011 and 2015.

7.3.21 Wind roses have been produced for each of the years of meteorological data used in this assessment and are presented in Figure 7.1.

Model Inputs – Stack Parameters and Emissions

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

7.3.23 A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the stack. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1 [16], for undertaking risk assessments on 1 February 2016; however, the approach used here by RPS is consistent with that EA guidance which required the identification of *"an option that gives acceptable environmental performance but balances costs and benefits of implementing it."*

7.3.24 The stack height determination has focused on identifying the stack height required to overcome the wake effects of nearby buildings. This involved running a series of atmospheric dispersion modelling simulations to predict the ground-level concentrations with the stack at different heights: starting at 50 metres and extending up in 5 metre increments, until a height of 100 metres was reached. The results of the stack height determination are provided in Appendix 7.2. The stack height determination indicated a 95 m stack height was appropriate.

7.3.25 Stack emissions characteristics modelled are provided in Table 7.7 and the mass emissions are provided in Table 7.8.

Table 7.7: Stack Characteristics

Parameter	Unit	Value
Stack height	m	95
Stack location	x, y	517183,134331
Internal diameter	m	2.4
Efflux velocity	$m.s^{-1}$	16.1
Efflux temperature	°C	120
Actual volumetric flow	$Am^3.s^{-1}$	73.0
Moisture content	%	15
Oxygen content (dry)	%	9.4
Normalised volumetric flow (11% O2, 00C, dry)	$Am^3.s^{-1}$	50.0

Table 7.8: Mass Emissions

Substance	Short-Term Mass Emission (g.s-1)	Long-Term(a) Mass Emission (g.s-1)
Particles	1.5	0.5
HCl	3.0	0.5
HF	0.2	0.05
SO2	10.0	2.5
NOx	20.0	10.0
CO	5.0	2.5
Group 1 Metals Total (b)	-	0.002
Group 2 Metals (c)	-	0.001
Group 3 Metals Total (d)	-	0.025
Dioxins and furans	-	5.0 E-09
PCBs	-	2.5 E-04
PAHs – B[a]P	-	5.0 E-04

Notes:
(a) For averaging periods of 24 hours or greater.
(b) Cadmium (Cd) and thallium (Tl).
(c) Mercury (Hg)

7.3.26 Emission limits in the IED are provided for total particles. For the purposes of this assessment, all particles are assumed to be less than 10 µm in diameter (i.e. PM10). Furthermore, all particles are also assumed to be less than 2.5 µm in diameter (i.e. PM2.5). In reality, the PM10 and PM2.5 concentrations will be a smaller proportion of the total particulate emissions and the PM2.5 concentration will be a smaller proportion of the PM10 concentration. Therefore, this can be considered a conservative estimate of the likely particulate emissions in each size fraction.

Model Inputs – Terrain

7.3.27 The presence of elevated terrain can significantly affect (usually increase) ground level concentrations of pollutants emitted from elevated sources such as stacks, by reducing the distance between the plume centre line and ground level and by increasing turbulence and, hence, plume mixing. A complex terrain file has been used within the model.

Model Inputs – Surface Roughness

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

7.3.29 A surface roughness length of 0.5 m has been used within the model to represent the average surface characteristics across the study area.

Model Inputs – Building Wake Effects

7.3.30 The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. The dominant structure (i.e. with the greatest dimensions likely to promote turbulence) included within the model are listed in Table 7.9.

Table 7.9: Dimensions of Buildings Included Within the Dispersion Model

Name	Approx Centre Location		Height (m)	Length (m) / Diameter (m)	Width (m)	Angle (Degrees)
	X (m)	Y (m)				
Boiler Hall	517112	134330	48.75	60	30	90
Bottom Ash Area	517124	134355	10	9.5	19.5	90
Air Cooled Condenser	517166	134302	23	22	34	180
Transformer Sub-station	517188	134310	6.14	8	16	180
Turbine Hall	517129	134306	23.25	20	25	180
Tipping Hall	517041	134329	24.71	52	36	90
Bunker	517069	134331	45	23	49	90
Workshop	517048	134294	13	17	21	180
Waste Processing Hall	517055	134371	18.305	30	66	180
Offices	517074	134291	13	9	30	180
Flue Gas Cleaning 1	517158	134328	31.5	13	10	90
Flue Gas Cleaning 2	517180	134326	13.9	6	17	90

C-5 Charlton Lane 'Eco Park' Gasification Facility, Charlton Lane, Shepperton, Surrey

7. The following design and dispersion modelling parameters are taken from Appendix 13.1 (Air Quality Assessment) to the Environmental Statement submitted in support of Planning Application SP13/01335/SCC (granted 25/09/14). The report was prepared by Fichtner Consulting Engineers Ltd, and dated 19 September 2013.

7.1 Selection of model

Detailed dispersion modelling was undertaken using the model ADMS 5.0, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the Monin-Obukhov length and the boundary layer height. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. The model also includes modules to take account of the effect of buildings and complex terrain.

ADMS is routinely used for modelling of emissions for planning and Environmental Permitting purposes to the satisfaction of the Environment Agency.

7.2 Model inputs

7.2.1 Source and emissions data

The principal inputs to the model with respect to the emissions to air from the facility are presented in Table 7.1

Table 7.1: Source Data

Item	Unit	Gasification Plant	Gas Engines (x2 per gas engine)
Stack Data			
Height	m	49	49
Internal diameter	m	1.20	0.347
Location (E‟ings,N‟ings)	m, m	508484, 168646.8	508482, 168648.8 508486, 168648.8
Flue Gas Conditions			
Temperature	°C	138	250
Exit moisture content	% v/v	16.80%	9.00%
Exit oxygen content	% v/v dry	11.80%	5%
Reference oxygen content	% v/v dry	11%	5%
Volume at reference conditions (dry, ref O2)	Nm3/s	9.28	0.95
	Nm3/h	33,407	3,427
Volume at actual conditions	Am3/s	18.26	2.00
	Am3/h	65,752	7,213
Flue gas exit velocity	m/s	16.15	21.19
Moisture content	kg/kg	0.121	0.059

Emissions from the gasification plant have been assumed to comply with the limits prescribed within the Industrial Emissions Directive (IED), except for oxides of nitrogen where it is recommended that the previously permitted lower limit (100 mg/Nm3) is maintained.

Emissions from the gas engines have been assumed to be those outlined within the standard rules permit for an anaerobic digestion facility including the use of resultant biogas (SR2012No12). As an exception, the limit for nitrogen dioxide from the gas engines in the standard rules permit is 500 mg/Nm3. As with the gasification plant a lower limit is being applied for to ensure the impact of the environment is minimised.

The updated standard rules permit does not differentiate between total VOCs and non-methane VOCs. This is important because both benzene and 1,3-butadiene are non-methane VOCs. As no speciation of the VOC emissions is available, it has been assumed that the gas engines will be able to achieve the limit for non-methane VOCs in the Landfill Gas Technical Guidance Note 6, which is the same as the emission limit for non-methane VOCs as stated in the previous standard rules permit, SR2010No15. In lieu of any speciation for the gasification plant it has been assumed that all VOCs are non-methane VOCs, to allow for a comparison with the AQOs.

Table 7.2: Emissions Data

Pollutant	Gasification Plant		Gas Engines (x2)	
	Conc. (mg/Nm3)	Release Rate (g/s)	Conc. (mg/Nm3)	Release Rate (g/s)
Oxides of nitrogen (as NO_2)	100	0.928	300	0.286
Sulphur dioxide	50	0.464	350	0.333
Particulates	10	0.093	-	-
Carbon monoxide	50	0.464	1,400	1.333
Hydrogen chloride	10	0.093	-	-
Hydrogen fluoride	1	0.009	-	-
Volatile organic compounds (as TOC)	10	0.093	1,000 (75 as non-methane)	0.952 (0.071)
Ammonia	10	0.093	-	-
Cadmium and thallium	0.05	0.464 µg/s	-	-
Mercury	0.05	0.464 µg/s	-	-
Other metals	0.5	4.640 µg/s	-	-
Benzo(a)pyrene	0.0001	1.856 ng/s	-	-
Dioxins and furans	0.1 ng/m3	0.928 pg/s	-	-
Dioxin like PCBs	0.005		0.0464 µg/s	

NOTES:
There have been limited measurements of PM2.5s emissions from waste incineration facilities. From information available on the Environment Agency�even‟s public registers for waste incineration plants at Bolton, Stoke and Lewisham it is indicated that the PM2.5 faction makes up around 33% of the PM10 fraction. However as a worst-case it has been assumed that the entire PM emissions consist of either PM10 or PM2.5 for comparison with the relevant AQOs.
The highest recorded emission concentration of B[a]P from the Environment Agency‟s public register was 0.105 ug/m³, or 0.000105 mg/m³.
Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co),copper Cu), manganese (Mn), nickel (Ni) and vanadium (V).
BREF provides a range of values for emissions to air from European municipal waste incineration plants for dioxin like PCBs. This states that the annual average total PCBs is less than 0.005 mg/Nm3 (dry, 11% oxygen, 273K) and so this has been used in lieu of any other data on emissions of PCBs from similar facilities.

In addition to the limits shown in Table 7.2, the IED also details half hourly average limits for a number of pollutants. It should be noted that if the gasification plant continually operated at these limits the daily limits would be exceeded. The plant will be designed to achieve the limits shown in Table 7.2 and as such will only operate at the shorter term limits for short periods on rare occasions.

Table 7.3: Emissions Data – Half Hourly Averages

Pollutant	Gasification Plant		Gas Engines (x2)	
	Conc. (mg/Nm3)	Release Rate (g/s)	Conc. (mg/Nm3)	Release Rate (g/s)

Oxides of nitrogen (as NO_2)	400	3.712	-	-
Sulphur dioxide	200	1.856	-	-
Particulates	30	0.278	-	-
Carbon monoxide	100	0.928	-	-
Hydrogen chloride	60	0.557	-	-
Hydrogen fluoride	4	0.037	-	-
Volatile organic compounds (as TOC)	20	0.186	-	-

7.2.2 Modelling domain

Modelling has been undertaken over a 3 km x 3 km grid with a spatial resolution of 40 m. The maximum grid spacing is less than 1.5 times the stack height in accordance with the Environment Agency modelling rule of thumb.

Table 7.4: Modelling Domain	
Grid	**Values**
Grid Spacing (m)	69.8
Grid Points	43
Grid Start X	507000
Grid Finish X	501000
Grid Start Y	167200
Grid Finish Y	170200

7.2.3 Meteorological data and surface characteristics

The impact of meteorological data was taken into account by using weather data from Heathrow Airport for the years 2004 - 2008, for consistency with the original air quality work. The Environment Agency recommends that 5 years of data are used to take into account inter-annual fluctuations in weather conditions. The weather data used for the original planning and permit determination has been used in this assessment so that a direct comparison can be made.

Wind roses for each year can be found in Figure A.3 of Appendix A, showing that the winds are predominantly from the south-west.

The surface roughness length of the modelling domain was taken as 0.5 m, since the land type is typically "parkland / open suburbia" in nature.

The Monin-Obukov length for the site can be specified in ADMS. This provides a measure of the stability of the atmosphere and indicates the height above which convective turbulence (i.e. thermal) is more important than mechanical (i.e. friction). This allows for the effect of the urban heat island, to prevent the atmosphere from ever becoming very stable, to be simulated within the model. The Monin-Obukov length of the modelling domain was taken to be 30 m which is the value appropriate for cities and large towns. The Monin-Obukov length recommended for large cities would be 100 m. As the site is not within the built up area of Greater London it is considered that the 30 m value would be most appropriate.

7.2.4 Terrain

It is recommended that where gradients within 500 m of the modelling domain are greater than 1 in 10 the complex terrain module within ADMS (FLOWSTAR) should be used.

A review of the area surrounding area has deemed that consideration should be made of complex terrain within the modelling. This has been undertaken using Ordnance Survey Digital Terrain Data.

7.2.5 Buildings

The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways:

- Wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing.
- The rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

The Environment Agency recommends that buildings should be included in the modelling if they are both:

- Within 5L of the stack (where L is the smaller of the building height and maximum projected width of the building); and
- Taller than 40% of the stack.

The ADMS user guide also states that buildings less than one third of the stack height will not have any effect on dispersion.

A review of the site layout has been undertaken and the details of the applicable buildings are presented in Table 7.5. The height limitation has been taken as one third of the stack height as recommended in the ADMS user guide. A site plan showing which buildings have been contained in the model is presented in Figure A.4 of Appendix A

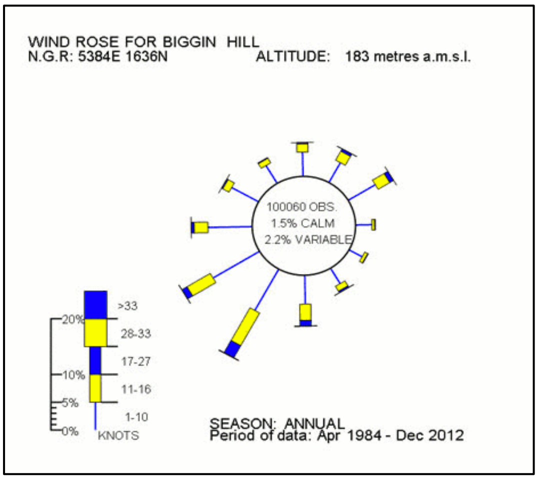
Table 7.5: Building Details

Buildings	Centre Point		Height (m)	Width (m)	Length (m)	Angle (°)
	X (m)	Y (m)				
Main building	508509.6	168567.7	18.5	75.7	115	2.11
Ash collection	508465.3	168585.7	14	14	25.31	2.11
Main building 2	508525.2	168634.3	18.5	50.1	19.01	2.11
Condensers	508490.6	168637.2	13	18.18	9.85	2.11
AD Building 1	508507.5	168689.3	13.5	28.07	30.9	2.11
CHP Engine 1	508507.3	168712.4	4.2	12.19	2.29	2.11
CHP Engine 2	508507.2	168708	4.2	12.19	2.29	2.11
Buffer tank	508545.5	168715.7	16.7	12.6	-	-
AD 1	508542.8	168734.1	15.3	19.6	-	-
AD 2	508521.2	168736.1	15.3	19.6	-	-
PDST	508505.9	168724.7	9.3	8	-	-
SBR	508465.6	168715	9.2	17	-	-
SBR Feed Tank	508483.7	168709.3	9	6.6	-	-
Gas Holder	508476	168731.7	14.1	19	-	-
Chemical Storage	508477.4	168709.5	12.5	4.6	-	-
Odour Control	508528.5	168711.1	6.5	8.3	14	2.11
AD Building 2	508536.5	168680.1	13.5	30.5	47.8	2.11

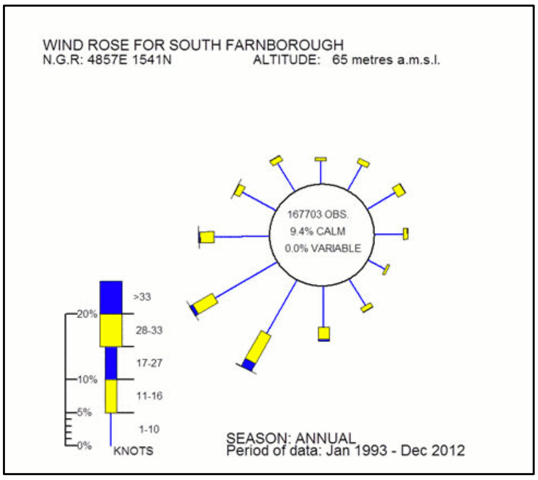
C-6 Wind Rose Data for Airports & Airfields located around Surrey

8. The following are graphical representations showing the relationship between the frequency and speed of wind from compass point directions at six airports or airfields that are located around the county of Surrey. The wind rose data was sourced from the Meteorological Office website (https://www.metoffice.gov.uk/aviation/ga/airfield-climate-stats).

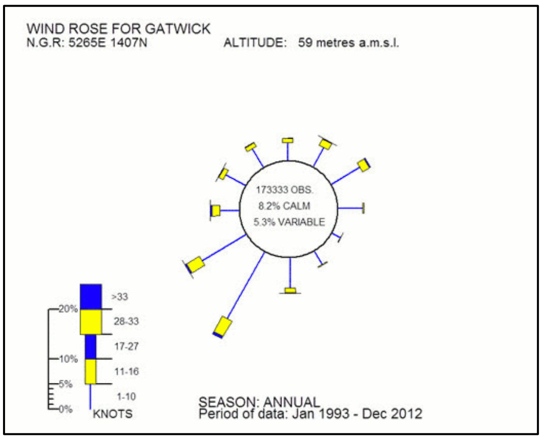
Biggin Hill



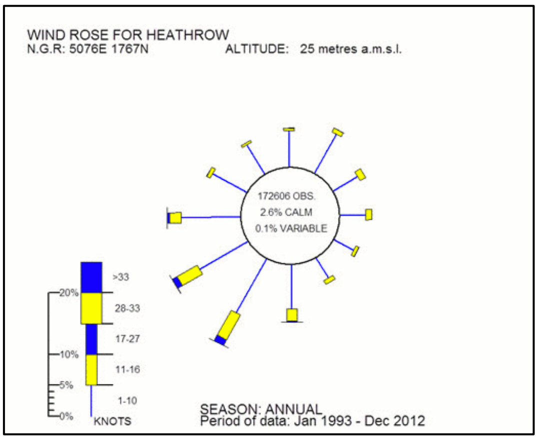
Farnborough



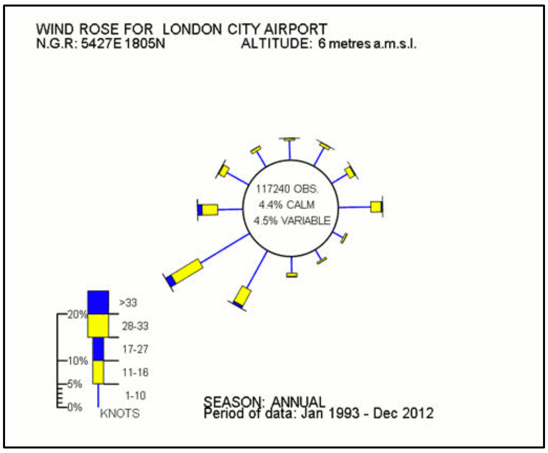
Gatwick



Heathrow



London City Airport



Southampton (Filton)