



Environmental Visage

**CHIMNEY HEIGHT ASSESSMENT AND
DETAILED AIR QUALITY ASSESSMENT FOR A
JUSTSEN 4.39 MW_{th} SWIP BIOMASS BOILER**

FRAMPTONS LIMITED

**CHARLTON ROAD, SHEPTON MALLET,
SOMERSET, BA4 5PD**

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Executive Summary

A detailed air quality assessment has been undertaken for a Justsen 4.39 MW_{th} SWIP biomass boiler that is to be installed to provide steam for process use and Clean-In-Place systems Framptons Limited, located on Charlton Road, Shepton Mallet. The 4.39 MW_{th} boiler (3.9 MW_{th(output)}) will burn non-hazardous waste wood chip fuel, to create up to 6 tonnes per hour of steam. The boiler may also receive small quantities of waste packaging from the site operations. The SWIP biomass boiler will be installed within a new building designed specifically for the purpose, and will be supplied by Novalux Energy Limited. Additionally, a separate gas-fired, Combined Heat and Power (CHP) unit will be installed and operated at the site by a third-party (Pure World Energy). The CHP will be capable of producing up to 2 tonnes per hour of steam, and has been considered completely in combination with the SWIP, as both units are being installed within the same area of the site at a similar time, and both will operate largely continuously. Therefore, although the activities are operated independently of one another and only the SWIP is associated with the Framptons Limited Environmental Permit, this assessment considers that both plant will operate concurrently and continually and has modelled them as such.

It is important to note that the new SWIP and CHP plant will be installed to replace the existing, gas fired plant at the site. These comprise three gas fired boilers, two of which will remain in-situ as back-up plant, but will only be operated in place of the SWIP and / or CHP units. As such, contributions to atmospheric pollutants from the new energy plant will replace those already released, although no quantification of the existing emissions has been possible.

The version of this report produced in April 2021 updated earlier versions in order to incorporate the final design data submitted and consented at planning, and to increase the emissions concentrations from the SWIP, which will fire less than 3 tonnes per hour waste fuel, to the maximum permitted emissions anticipated to be incorporated into the Environmental Permit. Emission limits are now expected to be specified to the Annex VI IED levels, rather than the more stringent BAT-Conclusion levels as previously modelled, and hence have been incorporated into this latest assessment.

The assessment includes a chimney height calculation based upon the procedures in HMIP Guidance Note D1, subsequently verified by detailed atmospheric dispersion modelling using the ADMS Version 5.2 model. Emissions data and chimney discharge conditions for the SWIP were provided by Justsen via Novalux Energy Limited, and building dimensions were taken from site plans and process drawings. Pure World Energy confirmed the anticipated releases from the CHP plant that they will install.

The results from the D1 calculation are appended to this report and show that the theoretical height of the discharge stacks should be approximately 18 m, or about 9 m above the height of the building roof. As the site is sloped, the energy centre is positioned at a lower ground level than the neighbouring factory building, and this clearly impacts on the stack height required. The planning consent permits the release points to extend to 18.445 m above ground level, and this final stack height was applied to the model.

The detailed air quality assessment was undertaken using the ADMS Version 5.2 atmospheric dispersion model in order to determine the likely impact of the releases. The model applied hourly average meteorological data sets from the Bristol Airport measurement station, which is approximately 25 km to the north, north-west of the site. Detailed terrain and surface roughness data was also applied to the model.

The results from detailed atmospheric dispersion modelling confirmed that chimney heights of 18.445 metres for both the SWIP and CHP units will provide adequate dispersion of emissions from the SWIP biomass boiler to be installed at Framptons Limited. Resulting increases in background pollutant concentrations under normal operating conditions will be low and can be screened out as insignificant at both ecological receptors and in areas where members of the general public may be present for relevant periods of time.

Additionally, when modelling higher than usual, short-term emissions which account for allowable emissions over a 30-minute averaging period, and emissions which may be experienced during abnormal operating conditions, the short-term Process Contributions and Predicted Environmental Concentrations generally remain within the stated Environmental Quality Standards, and the longer-term annual average Predicted Environmental Concentrations remain within 70 % of the relevant standards, thereby screening their impact as insignificant.

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Issue and Revision Record

Issue	Date	Author	Review / Authorise	Description
DRAFT	30/09/2020	Amanda Owen	ENVISAGE	Initial draft
1	18/10/2020	Amanda Owen	ENVISAGE	Issue 1
2	30/10/2020	Amanda Owen	ENVISAGE	Issue 2 Updated metals assessment
3	02/11/2020	Amanda Owen	ENVISAGE	Issue 3 Editorial amendment
4	06/04/2021	Amanda Owen	ENVISAGE	Issue 4 Incorporation of final design and IED Annex VI ELVs

1. Introduction

Environmental Visage Limited (Envisage) was commissioned by Novalux Energy Limited, to undertake a chimney height and air quality assessment for a proposed biomass boiler installation to be installed at Framptons Limited, Shepton Mallet, Somerset. The purpose of the study was to confirm the required discharge stack height to provide effective dispersion of pollutant emissions from a Justsen 4.39 MW_{th(input)} biomass boiler (3.9 MW_{th(output)}), to be installed within a new building, located adjacent to the main site building. The boiler will be used to provide steam to the site food treatment and packaging processes and to the Clean-In-Place (CIP) systems.

The biomass boiler will burn non-hazardous, waste wood chip fuel which will be fed through a screw feed stoker, moving through the combustion chamber on a pusher grate system. Pollutant emissions from the boiler will be minimised through good process control and will be abated using Urea and Sodium Bicarbonate dosing, before flue gases discharge to atmosphere via a high efficiency ceramic filter and dedicated chimney. The exhaust gases from the biomass boiler will meet all relevant UK and EU emissions standards, as specified by the Industrial Emissions Directive (IED), that apply to the combustion of waste-derived fuels.

For regulatory purposes, the biomass boiler is regarded as a Small Waste Incineration Plant, a SWIP biomass boiler, and will require an Environmental Permit to operate. Although more usually regulated by the Local Authority, in this instance Mendip District Council, the Framptons site already has a Part A(1) Environmental Permit (reference EPR/BN9551IT) and is therefore regulated by the Environment Agency for their site processes. As such, the SWIP will be scoped into the existing site Permit by way of a Permit Variation.

Technical information relating to the operation of the SWIP biomass boiler was provided by Novalux Energy Limited, the suppliers of the plant.

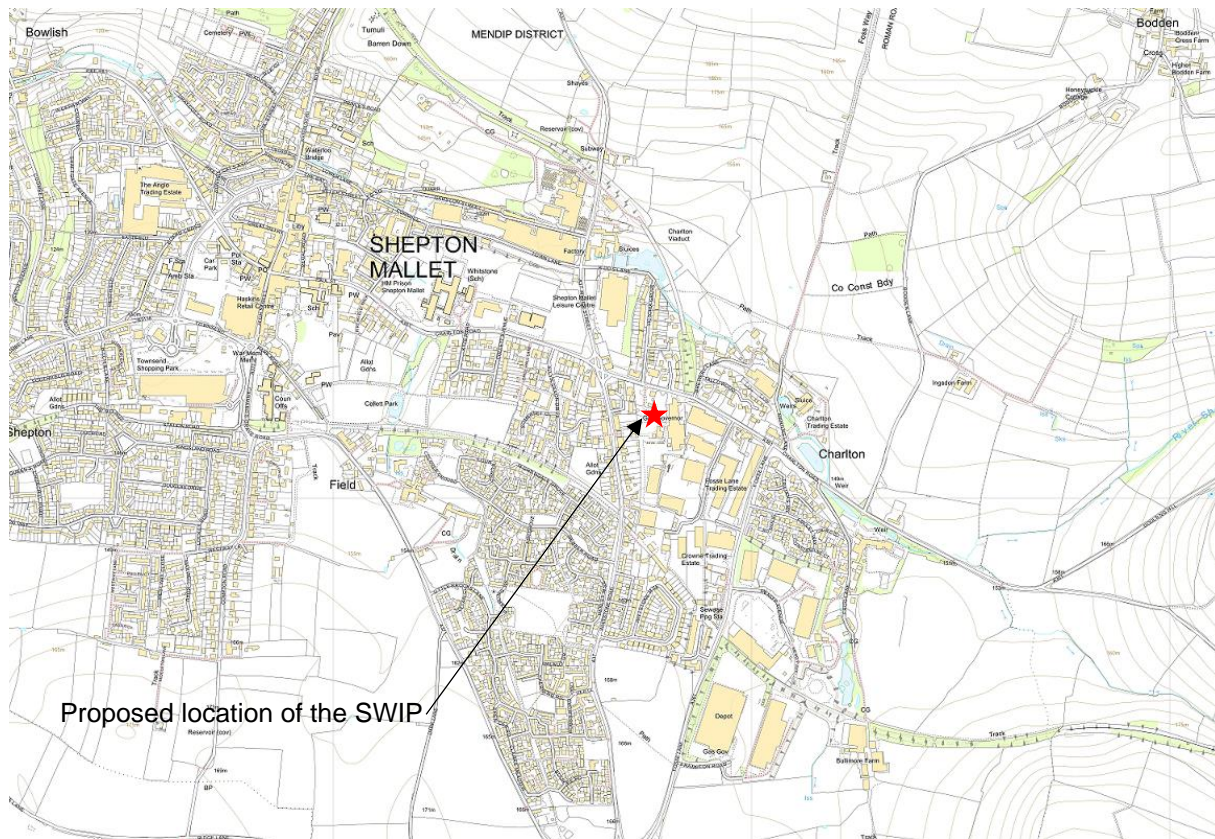
In addition to the proposed SWIP, and located within the same energy centre building, a third-party CHP plant comprising an 800 kW_e CHP and an additional steam boiler with an associated 65 kW_e generation unit will also be installed. This will be installed and operated by a third-party, Pure World Energy, and hence will be required to apply for and maintain its own Environmental Permit. However, as all of the units within the energy centre are anticipated to discharge on a continuous basis, the anticipated emissions from the CHP unit have been incorporated into this study in order to provide a realistic, worst-case assessment of emissions from the new plant. Technical information relating to the operation of and emissions from the CHP plant were provided by Pure World Energy.

An initial chimney height assessment has been carried out in accordance with the procedures outlined in Her Majesty's Inspectorate of Pollution, Technical Guidance Note (Dispersion) D1 (1993). The calculation method assumes that the chimney (discharge stack) height is governed by the need to limit local ground level pollutant concentrations below a maximum level that might occur for short periods, and that, as per best practice, stacks which release emissions very close to one another should generally be the same height. Therefore, and with the benefit of the final design data for the plant, the emissions from all of the energy plant were considered as a combined release in the D1 assessment.

1.1 Site Location and Local Setting

The SWIP will be installed in a new building which has been designed by Pure World Energy and which essentially incorporates both the SWIP and the CHP, although the units are completely separated by a solid wall. Figure 1 over page shows the location of the Framptons Limited site and the setting of the proposed SWIP, with the approximate location of the new boiler house building and chimney highlighted by the red star.

Figure 1 The Location of the Proposed SWIP



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2. D1 Calculation Procedure

A D1 chimney height assessment¹ has been undertaken based on the detailed design of the SWIP and CHP plant, including the small additional steam boiler. As per the D1 methodology, the emissions from these local discharges were combined within the assessment.

2.1 Calculation Procedure

The first step in the D1 calculation procedure is to calculate the pollution index for the chimney. The pollution index is then used to calculate the final discharge stack height, correcting for the presence of nearby tall buildings if necessary. Finally, attention is given to subsidiary matters such as absolute minimum stack heights, discharge conditions etc.

2.2 Calculating the Pollution Index

The pollution index is defined as;

$$\text{Pollution Index, } P_i = \frac{D}{(G_d - B_c)} \times 1000$$

Where:

D is the discharge rate of the pollutant in g s⁻¹;

G_d is the guideline concentration of the pollutant in mg m⁻³, and,

B_c is the background concentration of the pollutant for a particular district in mg m⁻³.

The major pollutant, or group of pollutants, is that which produces the highest pollution index, and this value is then used to calculate the chimney height. For the purpose of this study, the calculations were based on discharge characteristics provided by Novalux Energy Limited and Pure World Energy Limited². The pollutant discharge from each of the release points was combined, resulting in a single pollution index figure for each pollutant.

Emissions from the SWIP were assumed to discharge at the anticipated emission limit values, which are in line with those stipulated in Annex VI of the IED, and emissions from the CHP and its ancillary plant were as specified by Pure World Energy. The calculation procedure assumes that all of the particulate releases are as PM₁₀, which may overestimate the significance of the particulate release to a certain extent, as the emission of total suspended particulates may include particles with sizes greater than 10 µm.

2.3 Determining the Guideline Concentration for the Pollutant

The guideline concentration is one to which the general population may be safely exposed for continuous periods of up to one hour, and which may be repeated intermittently in the longer-term. There is little formal advice on guideline concentrations of this sort and it is common practice, where short-term air quality standards are not available, to use modified values of, for example, occupational exposure limits such as those issued by the HSE³. The value commonly used is one fortieth of the Short-Term Exposure Limit (STEL). If only a Time Weighted Average (TWA) is given, then a value of one fortieth of the TWA is used. If the pollutant is scheduled under COSHH regulation and has a Maximum Exposure Limit (MEL), then a value of one hundredth of the MEL is used.

2.4 Correcting for Background Pollutant Concentrations

Account is taken of the background concentration of a particular pollutant in the vicinity of the process. Guidance Note D1 gives a range of suggested values for common pollutants for situations ranging from rural areas with little development to major city centres / heavy industrial areas.

The calculation procedure requires a judgement to be made on the type of district in which the process is situated. Alternatively, background concentrations specific to the local area can be applied. For the current study, estimated background pollutant concentrations for 2021 were taken from the DEFRA 2018 Background Maps website⁴ for a location close to the Framptons site, situated within an area under the jurisdiction of Mendip District Council. As a worst-case, a local measured roadside NO₂ figure was also applied to the D1 calculation.

2.5 Combinations of Pollutants

Technical Guidance Note D1 recommends that for groups of pollutants of similar type, e.g. acidic gases, their pollution indices (P_i) are added together to produce a combined pollution index.

$$P_i(\text{Combined}) = P_i(1) + P_i(2) + P_i(3), \text{ etc}$$

For certain substances, e.g. acidic gases, it is necessary to correct for the background concentrations of similar pollutant types by calculating the polluting equivalent of the individual components. This is accomplished by scaling the concentration of the background pollutant by the ratio of the guideline concentrations of the discharged pollutant to that of the background pollutant.

$$B_e = B_c \times \left(\frac{G_d}{G_b} \right)$$

Where:

B_c is the actual concentration of the background pollutant;

G_d is the guideline concentration of the discharged pollutant, and

G_b is the guideline concentration of the background pollutant.

2.6 Calculation of Discharge Stack Height

Uncorrected discharge stack heights are calculated on the basis of the buoyancy and momentum of the discharge respectively. If necessary, the final stack height is then calculated, corrected for the downwash due to adjacent buildings.

2.7 Calculation of Uncorrected Chimney Height for Buoyancy (U_b)

The first stage is the calculation of the heat release rate (Q) using the formula;

$$Q(MW_{th}) = \frac{V \left(1 - \frac{283}{T_d} \right)}{2.9}$$

Where:

V is the volumetric flowrate of the discharge from the stack in $m^3 s^{-1}$, at the discharge conditions, and, T_d (K) is the temperature of the discharge.

Note: The ambient temperature is assumed to be 283K.

The uncorrected chimney height (U_b) is then calculated from the pollution index as follows:

$$U_b = 10^a - P_i^b$$

Where:

For $Q \leq 1$ MW: $a = -1.11 - 0.19 \log_{10} Q$;
 $b = 0.49 + 0.005 \log_{10} Q$.

For $Q \geq 1$ MW: $a = -0.84 - 0.1 \exp(Q^{0.31})$;
 $b = 0.46 - 0.011 \exp(Q^{0.32})$;

The limits of application for the calculation of U_b are:

U_b , minimum 1m, maximum 200 m;
 Q, minimum 0.03 MW, maximum 100 MW, and
 P_i , minimum 50, maximum 10^7 .

In this case the heat release, Q, was found by summing the respective values for the individual discharges in order to determine the combined heat release from all of the discharge points.

2.8 Calculation of Uncorrected Chimney Height for Momentum (U_m)

The first stage in the calculation of uncorrected chimney height is the estimation of the discharge momentum. Provided that the discharge is of combustion products, the discharge momentum (M) is calculated as follows:

$$M = \frac{283}{T_d} \cdot V \cdot w$$

Where:

T_d is the discharge temperature,
 V is the volumetric flowrate, in $m^3 s^{-1}$, at the discharge temperature, and,
 w is the discharge velocity in $m s^{-1}$.

As for Q, the discharge momentum, M, of the combined emission is also found by summing the respective values for the individual discharges.

Knowing M and P_i , the discharge stack height for momentum can then be calculated from,

$$\log_{10} U_m = x + (y \cdot \log_{10} P_i + z)^{0.5}$$

Where:

$$x = -3.7 + (\log_{10} M)^{0.9},$$

$$y = 5.9 - 0.624 \cdot \log_{10} M,$$

$$z = 4.24 - 9.7 \cdot \log_{10} M + 1.47(\log_{10} M)^2 - 0.07(\log_{10} M)^3$$

The limits of application for the calculation of U_m are:

U_m , minimum 1 m, maximum 200 m,

M , minimum 1, maximum 2×10^4 , and

P_i , minimum 50, maximum 10^7 .

There are minimum values of U_m for particular values of M , irrespective of the values of P_i . These override lower calculated values of U_m . Minimum discharge stack heights for momentum can be calculated from;

$$\text{Minimum } U_m = 0.82 M^{0.32}$$

The lowest value of U_m for any value of M is 1 metre.

2.9 Calculation of Final Discharge Stack Height, Corrected for Nearby Buildings

The presence of large structures in the vicinity of discharge stacks can adversely affect the dispersion of pollutants emitted. It is necessary, therefore, to correct the calculated chimney height to take account of the downwash created by adjacent buildings. Buildings within $5U_m$ of the chimney of the SWIP biomass boiler were considered in the analysis. If the lesser of U_b or U_m (U) is greater than $2\frac{1}{2}$ times the tallest building, then no building correction is required. If U is less than $2\frac{1}{2}$ times the tallest building, then the following procedure is adopted.

For the commonly occurring case where there is a single, dominant building that is wider than it is high, the final discharge stack height is given by;

$$C = H + 0.6 [U + (2.5H - U)(1 - A^{-\frac{U}{H}})]$$

Where:

H = Building Height,

U = lesser of U_m or U_b ,

If there is no value of U_b , or if $U_b > U_m$, then $A = 1$ and the equation reduces to;

$$C = H + 0.6U$$

Which is the same correction as in the 1981 Chimney Heights Memorandum⁵.

In cases other than for single, wide buildings, the procedure is slightly different;

$$C = H_m \left(1 - \frac{H_m}{T_m} \right) \left[U + (T_m - U) \left(1 - A_m^{-\frac{U}{H}} \right) \right]$$

Where:

H_m = Maximum H considering all relevant buildings,

T_m = Maximum disturbed height ($H + 1.5K$) considering all relevant buildings,

H = Building Height, and

U = lesser of U_m or U_b ,

If there is no value of U_b , or if $U_b > U_m$, then $A = 1$ and the equation reduces to;

$$C = H + U \left(1 - \frac{H_m}{T_m} \right)$$

Which is the same as the correction in the 1981 Memorandum⁵.

3. Assessment Input Data

The location and dimensions of energy centre and adjacent buildings and structures were obtained from planning drawings and measurements taken from Google Earth. The SWIP biomass boiler is to be installed within a new building located adjacent to the main operational building on the site.

Process information for the SWIP biomass boiler was provided from the SWIP manufacturers, Justsen, via Novalux Energy Limited. The following parameters were used in the D1 calculation:

Table 1 Stack Dimensions and Discharge Conditions

Reference	4.39 MW _{th} SWIP Biomass Boiler	800 kW _e CHP	Steam Boiler	65 kW _e Generator
Stack Diameter (m)	0.8	0.8	0.4	0.25
Efflux Temperature (°C)	170	178	110	139.7
Flue Gas Volumetric Flowrate (As Measured m ³ hr ⁻¹)	13,630	24,228	5,328	2,484
Flue Gas Volumetric Flowrate (As Measured m ³ s ⁻¹)	3.79	6.73	1.48	0.69
Efflux Velocity (m s ⁻¹)	7.5	13.4	11.8	14.01
Flue Gas Volumetric Flowrate Nm ³ hr ⁻¹ (11 % O ₂ , dry, STP)	8,373	-	-	-

Table 2 Associated Building Dimensions

Building / Structure	Height (m)	Length (m)	Width (m)
New SWIP Boiler House	9.085	20	36.5
Main Process Building	9.965 Input into D1 as 11.965 to account for differences in ground-level	27	110

Although only the two nearest and most significant buildings were incorporated into the D1 assessment, the comprehensive dispersion model also included details of the site reception building at 5 m high and with dimensions of 15 m x 15 m, in order to ensure that no additional disturbance of the flow-field might be prompted by the presence of this building in the lee of the main factory.

Background air quality data for 2021 in the locality of the development site were taken from the 2018 DEFRA Background Maps website⁴.

Table 3 Background Levels of Pollution

Pollutant	Annual Concentration ($\mu\text{g}/\text{m}^3$)	Short-Term Concentration ($\mu\text{g}/\text{m}^3$)
Oxides of Nitrogen (NO_x)	8.04	15.44
Nitrogen Dioxide (NO_2)	6.37	11.96
NO_2 as measured at Paul Street 2019	22.56	45.12
Particulate Matter (PM_{10})	12.81	25.16
Particulate Matter ($\text{PM}_{2.5}$)	7.97	15.96
Carbon Monoxide (CO)	0.0946	0.1892
Sulphur Dioxide (SO_2)	2.25	4.5
Benzene (for VOC)	0.129	0.259
Concentrations at grid point 362500 142500		

Note: Background concentrations were included in the D1 assessment where available. The short-term concentration is twice the annual average.

The chosen location for the background concentration represents the nearest, upwind location to the proposed development, situated to the south west of the site. Consideration of multiple locations around the site confirmed that this upwind location generally returned the second highest background level. Where monitored data for Shepton Mallet was incorporated, the highest roadside location result was employed and was drawn from the 2020 Air Quality Annual Status Report (2019 monitoring results) which is the most recent, available report.

It is important to note that the new SWIP and CHP plant will be installed to replace the existing, gas fired plant at the site. These comprise three gas fired boilers, two of which will remain in-situ as back-up plant but will only be operated in place of the SWIP and / or CHP units. As such, contributions to atmospheric pollutants will replace those already released which will be accounted for by the background concentrations detailed in Table 3. No further quantification of the current emissions has been possible, and therefore the application of the DEFRA estimated background emissions will result in some level of double-counting.

3.1 Pollutant Emissions

As the SWIP biomass boiler burns non-hazardous, waste wood chip fuel, the chimney height assessment was based upon emissions data for the following pollutants, prescribed for regulation by the Industrial Emissions Directive (IED) for waste incineration processes; Oxides of Nitrogen (NO_x), Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), Particulates, Carbon Monoxide (CO), Hydrogen Chloride (HCl), Hydrogen Fluoride (HF) and Volatile Organic Compounds (VOCs). These pollutants are associated with short-term, acute, health effects, which is the basis for the D1 calculation procedure. Pollutant discharge rates were calculated by multiplying the respective IED emission limit value by the normalised flue gas volumetric flowrate ($8,373 \text{ Nm}^3/\text{hr} - 11\% \text{ O}_2$, dry and STP).

Discharge conditions applied in the chimney height and dispersion modelling assessment were based upon information provided by the SWIP manufacturers, Justsen, via Novalux Energy Limited, and represent the condition for maximum output while burning waste wood chip fuel.

Table 4 Pollutant Release Rates Applied to the D1 Assessment

Pollutant Release (g s^{-1})	SWIP	C800	Steam	C65	Total
Oxides of Nitrogen (NO_x)	0.465	0.064	0.087	0.0072	0.6232
Nitrogen Dioxide (NO_2)*	0.2325	0.032	0.0435	0.0036	0.3116
Particulates (PM_{10})	0.0233	-	-	-	0.0233
Carbon Monoxide (CO)	0.116	0.214	-	0.022	0.352
Sulphur Dioxide (SO_2)	0.116	-	-	-	0.116
Hydrogen Chloride (HCl)	0.0233	-	-	-	0.0233
Hydrogen Fluoride (HF)	0.00233	-	-	-	0.00233
Volatile Organic Compounds (VOC)	0.0233	0.015	-	0.001	0.0393

Note: * Assumes 50 % conversion of NO_x to NO_2 in the short-term, in line with Environment Agency guidance⁶.

3.2 Assumptions

Environment Agency guidance for air quality assessments suggests that short-term modelling of NO₂ where atmospheric chemistry is not incorporated, as is the case in the D1 calculations, should assume that, as a worst-case basis for assessment, 50 % of the NO_x is converted to NO₂.

Particulate emissions were also assumed to be totally as PM₁₀, which may overestimate the significance of the particulate release and provides a worst-case basis for assessment.

3.3 Results from the D1 Calculations

The results from the D1 calculation are appended to this report. Emissions of Nitrogen Dioxide (NO₂) were shown to be the most significant pollutant, with the highest Pollution Index (2,012) of the individual pollutants.

When considered in relation to the energy centre and the main site building, the results show that the theoretical height of the chimney of the SWIP biomass boiler should be approximately 17.2 metres, rounded up to 18 m as per the D1 convention. Planning has been consented with stack heights of 18.445 m and Framptons Limited agreed that this stack height should continue to be employed for the four discharge points and comprehensive modelling should progress on that basis.

It should be noted, that the D1 calculation procedure is a screening technique, and the D1 guidance makes the following statement with regard to accuracy:

“It lays out a relatively simple, non-specific method of approximately determining the heights of discharge stacks for polluting emissions, which should be adequate in normal circumstances.”

Accordingly, the results from the D1 calculations should be taken as indicative of the discharge height required to ensure adequate dispersion of pollutant emissions from the chimney of the SWIP biomass boiler. The subsequent assessment using the ADMS Version 5.2 atmospheric dispersion modelling software, was therefore used to confirm the suitability of the proposed stack height.

4. Input and Methodology of the Detailed ADMS Dispersion Model Assessment

4.1 ADMS Model

The Atmospheric Dispersion Modelling System (ADMS) Version 5.2 modelling software was applied and is one of a range of models available for assessing the impact of pollutant emissions to atmosphere on local air quality. Those used routinely in the UK for this sort of application include United States Environmental Protection Agency (US-EPA) models such as AERMOD, and the ADMS models developed in the UK by Cambridge Environmental Research Consultants (CERC).

The ADMS model can be used to assess ambient pollutant concentrations arising from a wide variety of emissions sources associated with an industrial process. It can be used for initial screening or more refined determination of ground level pollutant concentrations on either a short-term basis (up to 24-hour averages) or longer-term (monthly, quarterly or annual averages).

4.2 Modelling Uncertainty

Atmospheric dispersion modelling is not a precise science and results can be impacted by a variety of factors such as:

- Model uncertainty - due to limitations in the dispersion algorithms incorporated into the model and their ability to replicate “real life” situations;
- Data uncertainty - due to potential errors associated with emission estimates, discharge characteristics, land use characteristics and the relevance of the meteorological data to a particular location; and,
- Variability - randomness of measurements used.

CERC models are continually validated against available measured data obtained from real world situations, field campaigns and wind tunnel experiments. Validation of the ADMS dispersion models has been performed using many experimental datasets that test different aspects of the models, for instance: ground / high level sources, passive and buoyant releases, buildings, complex terrain, chemistry, deposition and plume visibility. These studies are both short-term as well as annual, and involve tracer gases or specific pollutants of interest.

Potential uncertainties in model results derived from the current study have been minimised as far as practicable, and a series of worst-case assumptions have been applied to the input data in order to provide a robust assessment. These included the following:

- Selection of the dispersion model - ADMS 5.2 is a commonly used atmospheric dispersion model which has been verified through a number of inter-comparison studies to ensure that model predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using hourly average meteorological data from the nearby Bristol Airport measurement station which is considered to be the most representative of local conditions;
- Operating conditions – Operating conditions are assumed to be continual for both the SWIP and the new CHP, and apply the anticipated emission limit values for the SWIP, and the guaranteed emission levels of the CHP. They are therefore considered to be representative of worst-case process operations;
- Receptor locations - A 5 km x 5 km Cartesian Grid (with 20-metre grid spacing) was utilised in the model in order to calculate maximum predicted concentrations in the vicinity of the proposed SWIP. Specific receptor locations were also included in the model to provide detailed assessment in local sensitive areas; and,
- Variability - All model inputs are as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential ground level pollutant concentrations.

Results were considered in the context of Air Quality Standards (AQS) objective values and relevant Environmental Assessment Levels (EALs) recommended by the Environment Agency, as well as the joint guidance of Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM). The application of the above measures to reduce uncertainty and the use of a series of worst-case assumptions relating to the operational performance of the process should result in model accuracy of an acceptable level.

4.3 Full Layout and Pollutant Data

Figure 2 below shows the final layout of the proposed energy centre in relation to the main factory building and reception block. The emission points are denoted by the red stars.

Figure 2 Building Layout and Stack Locations



The detailed dispersion model considered additional pollutants to those incorporated in the D1 assessment, and the full list of modelled emissions from the SWIP are presented below. There are no additional emissions from the CHP or associated plant from those already incorporated into the D1 assessment.

Table 5 Emission Concentrations and Release Rates from the SWIP Applied to the Detailed Modelling Assessment

Pollutant	Emission Concentration (mg Nm ⁻³)	Discharge rate (g s ⁻¹)
Oxides of Nitrogen (NO _x)	200	0.465
Nitrogen Dioxide (NO ₂)*	100	0.2325
Particulates (PM ₁₀)	10	0.0233
Carbon Monoxide (CO)	50	0.116
Sulphur Dioxide (SO ₂)	50	0.116
Hydrogen Chloride (HCl)	10	0.0233
Hydrogen Fluoride (HF)	1	0.00233
Volatile Organic Compounds (VOC)	10	0.0233
Ammonia (NH ₃)#	10	0.0233
Cadmium and Thallium (Cd and Tl)	0.05	0.000116
Mercury and its compounds (Hg)	0.05	0.000116
Group 3 metals (Pb, Ab, As, Cr, Co, Cu, Mn, Ni, V)	0.5	0.00116
Dioxin and Furans	0.0000001	0.00000000233
Benzo[a]Pyrene (for PAH)	0.001	0.0000233

Notes:

* Assumes 50 % conversion of NO_x to NO₂ in the short-term, in line with Environment Agency guidance⁶.

Although no maximum emission limit value is specified for Ammonia in the IED, a level of Ammonia slip equivalent to 10 mg Nm⁻³ is generally considered to be achievable and has been included in the model.

For the purpose of the detailed air quality assessment it has been assumed that both the SWIP and the CHP operate continually and at full output throughout the year and the assessment considers the potential impact of the SWIP whilst taking full account of the cumulative effect of the CHP. The models were therefore run to calculate annual average Process Contributions from both plant for all 8,760 hours of the year, and hence provide a worst-case assessment.

The ADMS model can combine discharges which are in close proximity to one another and which discharge at the same height. Although it is anticipated that all of the emission points will discharge on a continuous basis, this cannot be guaranteed and as such, the majority of the modelling has combined the three CHP releases but has modelled the SWIP separately, albeit with a constant operation.

4.4 Local Environmental Conditions

Local environmental conditions describe the factors that might influence the dispersion process such as sharply rising terrain, etc. and also describe the locations at which pollutant concentrations are to be predicted. These include:

Local Terrain

Local terrain can affect wind flow patterns and, consequently, can affect the dispersion of atmospheric pollutants. The effects of terrain are not normally noticeable where the gradient is less than 10 %. Ordnance Survey mapping for the area shows the presence of hills in the vicinity of the Framptons site, especially to the north and east, including Ingsdons Hill. Accordingly, terrain effects were included within the detailed modelling exercise using OS Terrain 50 digital data to map the terrain local to the Framptons site. This was also important for the accurate modelling of the building layouts as the topography across the Framptons site varies.

Terrain data was only applied to gridded and local receptor data. Receptors more than approximately 2.5 km away from the site were outside of the terrain mapping applied, and therefore no terrain data was considered when modelling these points.

Surface Roughness

Surface roughness defines the amount of near-ground turbulence that occurs as a consequence of surface features, such as land use (i.e. agriculture, water bodies, urbanisation, open parkland, woodland, etc.). Agricultural areas may have a surface roughness of approximately 0.2m to 0.3m whereas large cities and woodlands may have a roughness of 1 to 1.5m.

The Framptons site is located in the Charlton area of Shepton Mallet to the east of the town. Although located within the urban area, open countryside is present within one kilometre in most directions from the site. In order to account for the variations in surface roughness that may be present in the area, a spatially variable surface roughness file was created to ensure the appropriate consideration of turbulence impacts across the modelled area. Similarly to the terrain file, the spatially variable surface roughness file was only applied to gridded and local receptor data. Receptors more than approximately 2.5 km away from the site were outside of the surface roughness data applied, and when modelling these points, an individual surface roughness figure of 0.2 was applied to represent the open countryside local to the site, and the Bristol Airport measurement station from which the meteorological conditions were drawn.

Dry Deposition

As well as considering the potential contribution of pollution to air from the SWIP biomass boiler, pollutants can also be deposited onto the land in the vicinity of an emission source. Both dry and wet deposition remove material from a plume, depositing it onto the ground and altering the plume concentration. Dry deposition occurs when pollutants are brought to the surface by gravitational settling and turbulence, thereby depositing on the ground surface or on vegetation. Wet deposition occurs due to the scavenging of material from the plume either within cloud formations, where pollutants are absorbed into the rain, or below the cloud where they can be washed out of the plume by rainfall. These processes lead to a variation in the plume strength with distance, as well as potential changes in the vertical concentration profile.

Information from CERC, the company which developed the ADMS model, specifies that for Nitrogen Dioxide, Sulphur Dioxide and Ammonia, wet deposition from a short-range plume is much less significant compared with dry deposition, and therefore does not usually need to be considered. Wet deposition due to a primary release of Sulphur Trioxide or Sulphuric Acid would need to be considered if the release were significant, however this does not apply in this instance. CERC's advice is supported by the Regulators guidance⁷ which states that *"It is considered that the wet deposition of SO₂, NO₂ and NH₃ is not significant within a short range. However, wet deposition for HCl and HNO₃ should be considered where a process emits these species."* In the absence of any additional data, it is generally considered acceptable that total deposition (wet and dry) comprises 3 x dry deposition, where it is required to be included.

The detailed modelling exercise undertaken and reported here considered the effects of dry deposition only for Nitrogen Dioxide, Sulphur Dioxide and Ammonia, as the stack height will result in a short-range plume. Deposition rates of Hydrogen Chloride and Hydrogen Fluoride are multiplied by 3 to represent total deposition for these highly soluble pollutants.

Output Grid

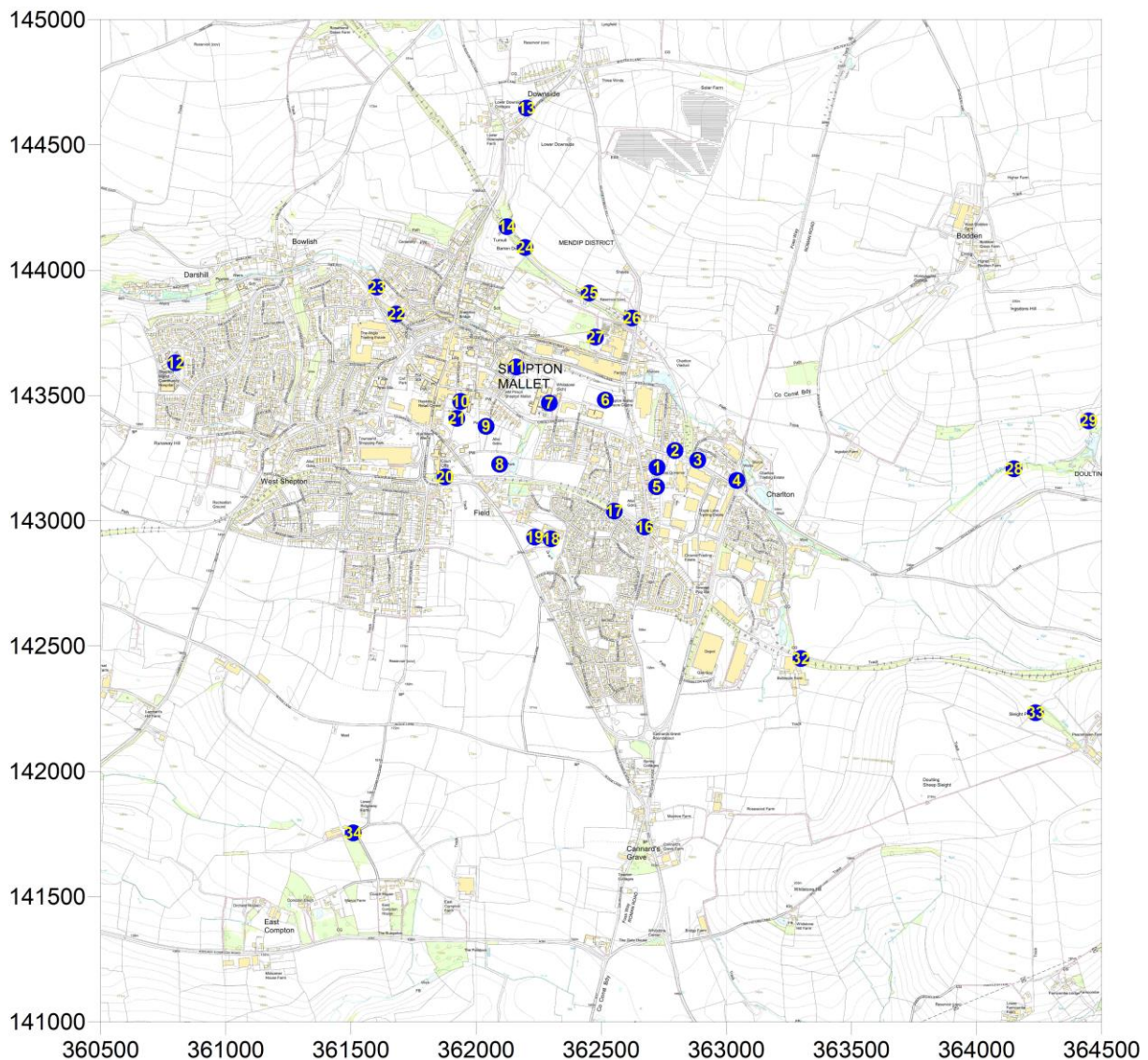
When setting up a receptor grid it is important to ensure that there are sufficient receptor points to be able to accurately predict the magnitude and location of the maximum Process Contribution. If the grid is too widely spaced, the maximum concentration may be missed. Modelling was undertaken using a 5 km x 5 km grid with 20-metre spacing. The site is located approximately centrally within the grid.

Specific receptors, representing locations where members of the general public may be present for significant periods of time, as well as nearby ecological habitat receptors, were entered into the model, as shown in the following table and figure. A total of 38 receptors were included although some of these are outside of the area mapped in Figure 3 and hence do not appear.

Table 6 Specific Receptors Included in Detailed Modelling

Receptor	X	Y	Distance from Stack (m)	Receptor Name
1	362723	143213	58	Residence - Whitstone Place
2	362795	143280	81	Residence - Charlton Close
3	362886	143242	114	Residence - Charlton Road
4	363042	143161	265	The Thatched Cottage Inn
5	362721	143136	87	Residence - Whitstone Road
6	362516	143482	386	Leisure Centre Sports Pitch
7	362293	143470	557	Whitstone School
8	362094	143225	686	Collett Park Bandstand
9	362040	143377	761	Shepton Bowls
10	361938	143476	886	St Pauls Junior School
11	362161	143614	745	Shepton Mallet Prison
12	360799	143630	2,027	Shepton Mallet Community Hospital
13	362202	144647	1,558	Hobb's Quarry SSSI
14	362123	144174	1,175	Viaduct Quarry SSSI
15	364656	142467	2,014	Doultling Railway Cutting SSSI
16	362673	142975	249	Priority Habitat - Woodland
17	362552	143039	279	Priority Habitat - Woodland
18	362300	142928	552	Priority Habitat - Woodland
19	362234	142935	607	Priority Habitat - Woodland
20	361876	143175	904	Priority Habitat - Woodland
21	361923	143409	882	Priority Habitat - Woodland
22	361681	143825	1,264	Priority Habitat - Woodland
23	361603	143932	1,386	Priority Habitat - Woodland
24	362196	144091	1,065	Priority Habitat - Woodland
25	362452	143909	781	Priority Habitat - Woodland
26	362623	143809	629	Priority Habitat - Woodland
27	362477	143733	613	Priority Habitat - Woodland
28	364149	143207	1,369	Priority Habitat - Woodland
29	364448	143399	1,680	Priority Habitat - Woodland
30	364555	143751	1,859	Priority Habitat - Woodland
31	364671	143556	1,924	Priority Habitat - Woodland
32	363298	142450	911	Priority Habitat - Woodland
33	364236	142234	1,747	Priority Habitat - Woodland
34	361509	141754	1,925	Priority Habitat - Woodland
35	365434	147223	4,820	Mells Valley SAC 1
36	366864	147428	5,878	Mells Valley SAC 2
37	369974	144448	7,301	Mendip Woodlands 1
38	370109	145805	7,778	Mendip Woodlands 2

Figure 3 Location of Specific Receptors in Relation to the Chimney of the SWIP Biomass Boiler



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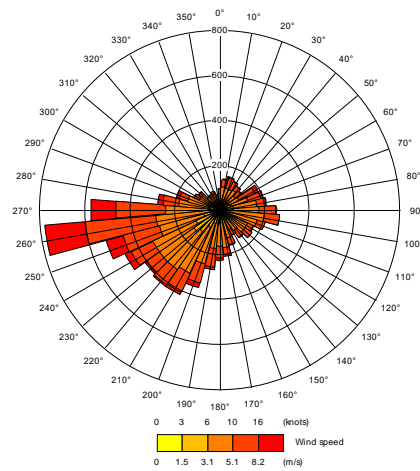
Note: All mapped figures within this report present a 4 km x 4 km area, despite the modelling having been undertaken over a 5 km x 5 km grid. Results are set to the same scale as the background maps.

4.5 Meteorological Data

The detailed air quality assessment was undertaken using the ADMS Version 5.2 atmospheric dispersion model, applying the hourly average meteorological data set for the Bristol Airport measurement station, between 2015 and 2019. The Bristol Airport meteorological measurement station is located approximately 25 km to the north, north-west of the proposed SWIP biomass boiler. The 2019 wind rose from the site is presented over page and shows the prevailing winds from the west and south-west.

Bristol Airport is an international airport located in a rural location to the south-west of Bristol. Aside from the airport infrastructure, the local area is largely open countryside and farmland, and a surface roughness of 0.2 metres was therefore included within the model, representative of agricultural land.

Figure 4 2019 Windrose for the Bristol Airport Meteorological Data Measurement Station



4.6 Background Air Quality

Background air quality data for 2021 were largely taken from the DEFRA Background Maps website⁴ as detailed in Table 3, although background levels of other pollutants, such as Ammonia and metal species were drawn from the measured concentrations at the Chilbolton Observatory, located approximately 76.5 km to the east of the site.

There is no readily available background data for levels of Hydrogen Chloride or Hydrogen Fluoride in the UK generally, and hence, where these are required for inclusion in the assessment, estimated data was drawn from the 2006 EPAQS report on Halogens and Hydrogen Halides in Ambient Air⁸.

Mendip District Council also undertakes ambient monitoring across the District although has declared no Air Quality Management Areas (AQMAs) in their area. The 2020 Air Quality Annual Status Report was obtained from the Mendip District Council website⁹ and the following background concentrations were reported for the roadside locations in 2019, where monitoring is undertaken:

Table 7 Summary of Ambient Air Quality Monitoring Results for Shepton Mallet in 2019

Site	Monitoring Method	NO ₂ (µg m ⁻³)	Applied to Receptor Numbers
Paul Street	Diffusion Tube	22.56	6 and 7
West	Diffusion Tube	20.61	None
Whitstone	Diffusion Tube	21.80	1 – 5

The results measured in these key areas are significantly higher than the estimated background of NO₂ in the wider area (approximately 6.4 µg m⁻³) and reflect the roadside location of the monitoring points. As receptor locations 1 – 7 are situated in the immediate vicinity of the Paul Street and Whitstone monitoring locations, where the background data for these sensitive receptors is required, the 2019 monitoring results have been applied.

4.7 Determining Significance

The UK Government, via the Environment Agency, provides guidance for screening the significance of air quality impacts associated with the operation of industrial processes⁶.

For long-term impacts, the guidance recommends a 1 % insignificance threshold relative to a long-term Air Quality Standard (AQS) or Environmental Assessment Level (EAL) of the substance being studied, with a corresponding 10 % insignificance threshold for the assessment of short-term impacts.

If both of these criteria are met, there is no requirement to do any further assessment of the substance and its impact is screened as insignificant.

If the initial criteria are not met, a second stage screening assessment is undertaken to determine the impact of the Predicted Environmental Concentration (PEC). The PEC is the sum of the Process Contribution (PC) plus the appropriate background concentration. The second stage screening assessment states that if:

- the short-term PC is less than 20 % of the short-term environmental standard minus twice the long-term background concentration; and
- the long-term PEC is less than 70 % of the long-term environmental standard,

there is no requirement to do any further assessment of the substance and its impact is screened as insignificant.

4.8 Other Assessment Criteria

Within this report, and in addition to applying the Environment Agency's screening methodology, descriptive terms for the impact significance of long-term contributions of NO₂ and PM₁₀ are based on those published in Land Use Planning and Development Control: Planning for Air Quality (2017 Update) prepared by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)¹⁰. Impact description involves expressing the "*magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion*". The EPUK / IAQM descriptor matrix is shown in the Table below:

Table 8 Definition of Impact Magnitude for Changes in Annual Mean Nitrogen Dioxide and Particulates (PM₁₀) Concentration

LT Average Concentration	Percentage Increase on Air Quality Assessment Level (AQAL)			
	1	2 - 5	6 – 10	> 10
75 % or less of AQAL	Negligible	Negligible	Slight	Moderate
76 – 94 % of AQAL	Negligible	Slight	Moderate	Moderate
95 – 102 % of AQAL	Slight	Moderate	Moderate	Substantial
103 – 109 % of AQAL	Moderate	Moderate	Substantial	Substantial
110 % or more of AQAL	Moderate	Substantial	Substantial	Substantial

The EPUK / IAQM guidance states that impacts on air quality, whether adverse or beneficial, will have an effect on human health that can be judged as "significant" or "not significant". The above assessment criteria were applied to the modelled increases in annual average NO₂ and PM₁₀ concentrations due to the operation of the proposed SWIP biomass boiler.

5. Results of the Detailed ADMS Dispersion Model Assessment

The results of the detailed modelling are presented in this section. Only emissions of Nitrogen Dioxide have been modelled from the CHP, and hence all other pollutants consider emissions from the SWIP biomass boiler only.

5.1 Results of Modelling Nitrogen Dioxide (NO₂)

The results from detailed modelling of Nitrogen Dioxide associated with emissions from both the SWIP biomass boiler and the CHP are presented in the following table.

Table 9 Maximum Process Contribution of Nitrogen Dioxide (NO₂)

Statistic	Exceedance Threshold	Averaging Period	Concentration ($\mu\text{g m}^{-3}$)	Percentage of the AQS
Annual Average (PC)	30 - 40	Annual	8.75	22 – 29 %
Annual Average (PEC)			15.12	38 - 50 %
Short-Term 99.79% (PC)	200	1 hr	37.26	18.6 %
Short-Term 99.79% (PEC)			50.00	25 %
AQS – (2 * Background)	187.26	1 hr	37.26	19.9 %

Figures in bold represent results which cannot immediately be screened as insignificant.

Data in Table 9 are based upon the maximum annual and 99.79th percentile hourly average NO₂ Process Contributions (PC), due to emissions from the SWIP biomass boiler and the CHP operating at full output. The maximum result from modelling five-years' worth of meteorological conditions are presented and are compared against the Air Quality Standards or Environmental Assessment Levels for NO₂ in ambient air, assuming continuous operations for the entire year. The data presented are for both the maximum Process Contribution (PC) and the Predicted Environmental Concentration (PEC) for NO₂. The PEC values take account of the DEFRA-estimated annual average background NO₂ concentration for 2021 of 6.37 $\mu\text{g m}^{-3}$, which is doubled to 12.74 $\mu\text{g m}^{-3}$ when considering the short-term concentrations.

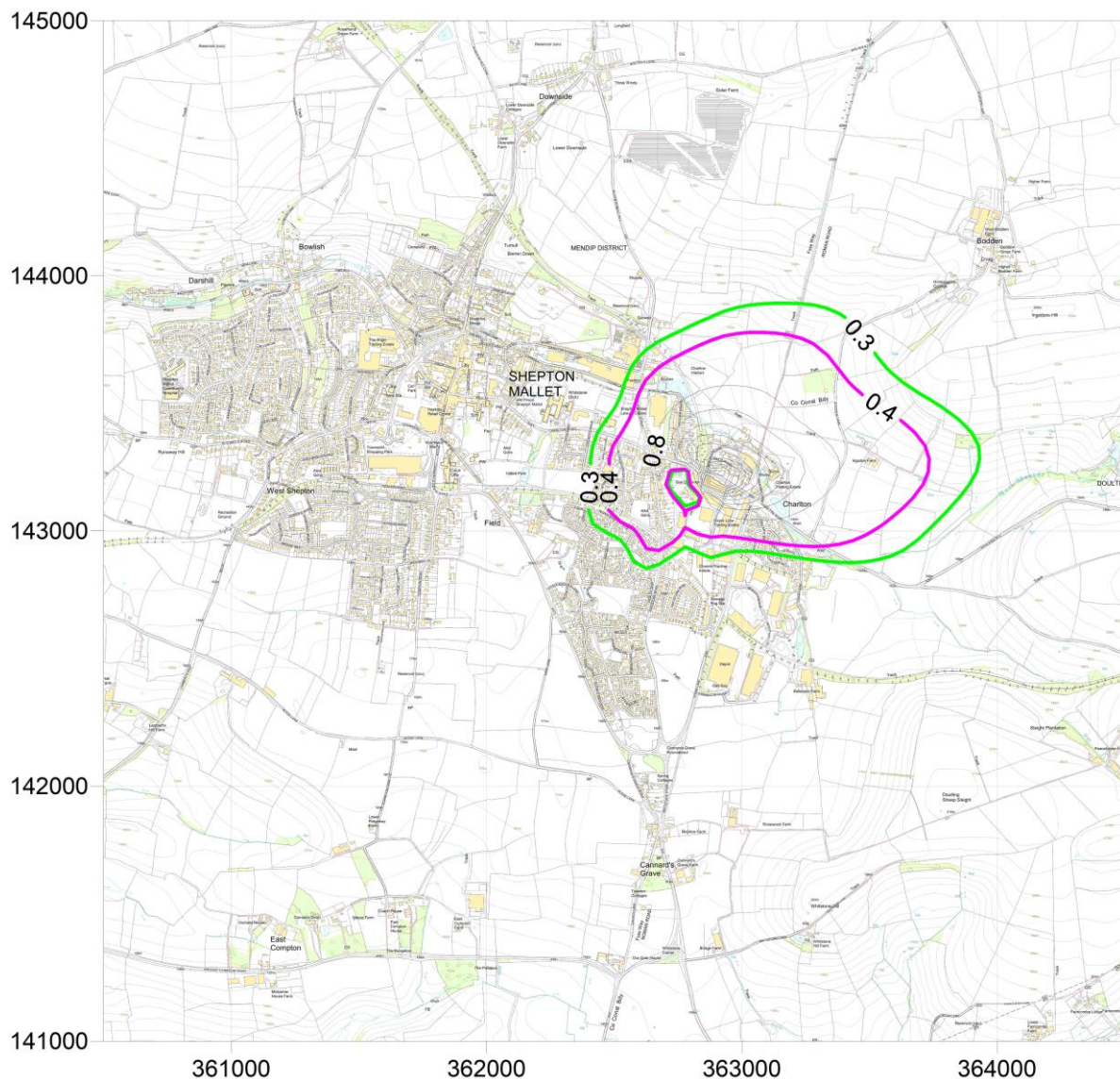
The results show that, although not immediately screened as insignificant, with the annual average PC equating to more than 1 % of the assessment level and the short-term PC equating to more than 10 % of the Air Quality Standard, both are screened at the second stage assessment.

The total annual average PEC of between 38 % of the assessment level for human health receptors and 50 % of the Critical Level for sensitive ecological sites remains within the 70 % threshold and hence can be screened as insignificant. In reality, the point of maximum contribution occurs in the immediate vicinity of the building housing the proposed new SWIP and CHP at the Framptons Limited site and hence is not relevant to any sensitive receptors outside of the site boundary. It is also noted that, in replacing the three existing gas-fired boilers, the existing contributions and therefore the background concentration will reduce, thereby resulting in an overly conservative assessment of several pollutants, but especially of Nitrogen Dioxide.

In relation to the EPUK / IAQM guidance, the impact descriptor for an annual average contribution of more than 10 % against a long-term average concentration of less than 75 % would equate to a **moderate** impact at this point of maximum contribution.

The short-term 99.79th percentile hourly average Process Contribution remains within 20 % of the short-term environmental standard minus twice the long-term background concentration (187.26 $\mu\text{g m}^{-3}$) and hence can also be screened as insignificant.

It must also be remembered that, when considering the Process Contributions of Nitrogen Dioxide, the model has assumed that both the SWIP and the CHP are operating cumulatively and consistently. When the results from modelling the impact of emissions from the SWIP and the CHP are plotted, the following patterns of dispersion are seen.

Figure 5 Maximum Annual Average NO₂ Process Contribution ($\mu\text{g m}^{-3}$)

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Figure 5, and all of similar isopleth diagrams presented in this report apply meteorological conditions from 2017, which represent the worst-case conditions for most releases.

The coloured isopleths depict the point at which the contributions from the SWIP and the CHP operations reduce to 1 % of the Air Quality Standard ($0.4 \mu\text{g m}^{-3}$) and the Environmental Assessment Level ($0.3 \mu\text{g m}^{-3}$). Therefore, in all areas outside these contours, the annual average NO₂ Process Contribution can be regarded as insignificant in relation to Environment Agency guidance when assessing human health impacts and potential effects on ecological receptors respectively. The area where the contributions cannot be screened as insignificant, is restricted to a relatively local area.

Irrespective of the fact that some locations may be exposed to concentrations of Nitrogen Dioxide that cannot immediately be screened as insignificant, the Predicted Environmental Concentration remains within 70 % of the assessment levels, and hence contributions are screened at all locations across the modelled grid at the secondary assessment stage.

The corresponding contour plot for the maximum hourly average NO₂ Process Contribution is shown in the figure over page, assuming that 50 % of the NO_x emission from the SWIP biomass boiler and CHP is released as NO₂.

Figure 6 Maximum 99.79th Percentile Hourly Average NO₂ Process Contribution ($\mu\text{g m}^{-3}$)



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The coloured isopleth depicts the point at which the contributions from the SWIP and the CHP operations reduce to 10 % of the Air Quality Standard for short-term NO₂ ($20 \mu\text{g m}^{-3}$). Therefore, in all areas outside of this contour, the hourly average NO₂ Process Contribution can be regarded as insignificant in relation to Environment Agency guidance when assessing human health impacts. The area where the contribution cannot be screened as insignificant, is restricted to an area very local to the plant and, as the impact of the short-term Process Contribution across the grid is screened as insignificant at the second stage of the assessment, the short-term contributions of NO₂ are unlikely to have any significant effect on the health of people living and working nearby.

5.2 Sulphur Dioxide (SO₂)

The results from detailed modelling of Sulphur Dioxide associated with emissions from the SWIP biomass boiler are presented in the following table.

Table 10 Maximum Process Contribution of Sulphur Dioxide (SO₂)

Statistic	Exceedance Threshold (µg m ⁻³)	Averaging Period	Approximate Concentration (µg m ⁻³)	PC as an Approximate % of AQS / EAL Value
Annual Average (PC)	20	Annual	1.93	9.6 %
Annual Average (PEC)			4.18	21 %
Short-Term 99.9 % (PC)	266	15 min	29.53	11.1 %
Short-Term 99.9 % (PEC)			34.03	13 %
AQS – (2 * Background)	261.5	15 min	29.53	11.3 %
Short-Term 99.73 % (PC)	350	1 hr	16.14	5 %
Short-Term 99.18 % (PC)	125	24 hr	5.52	4 %

Figures in bold represent results which cannot immediately be screened as insignificant.

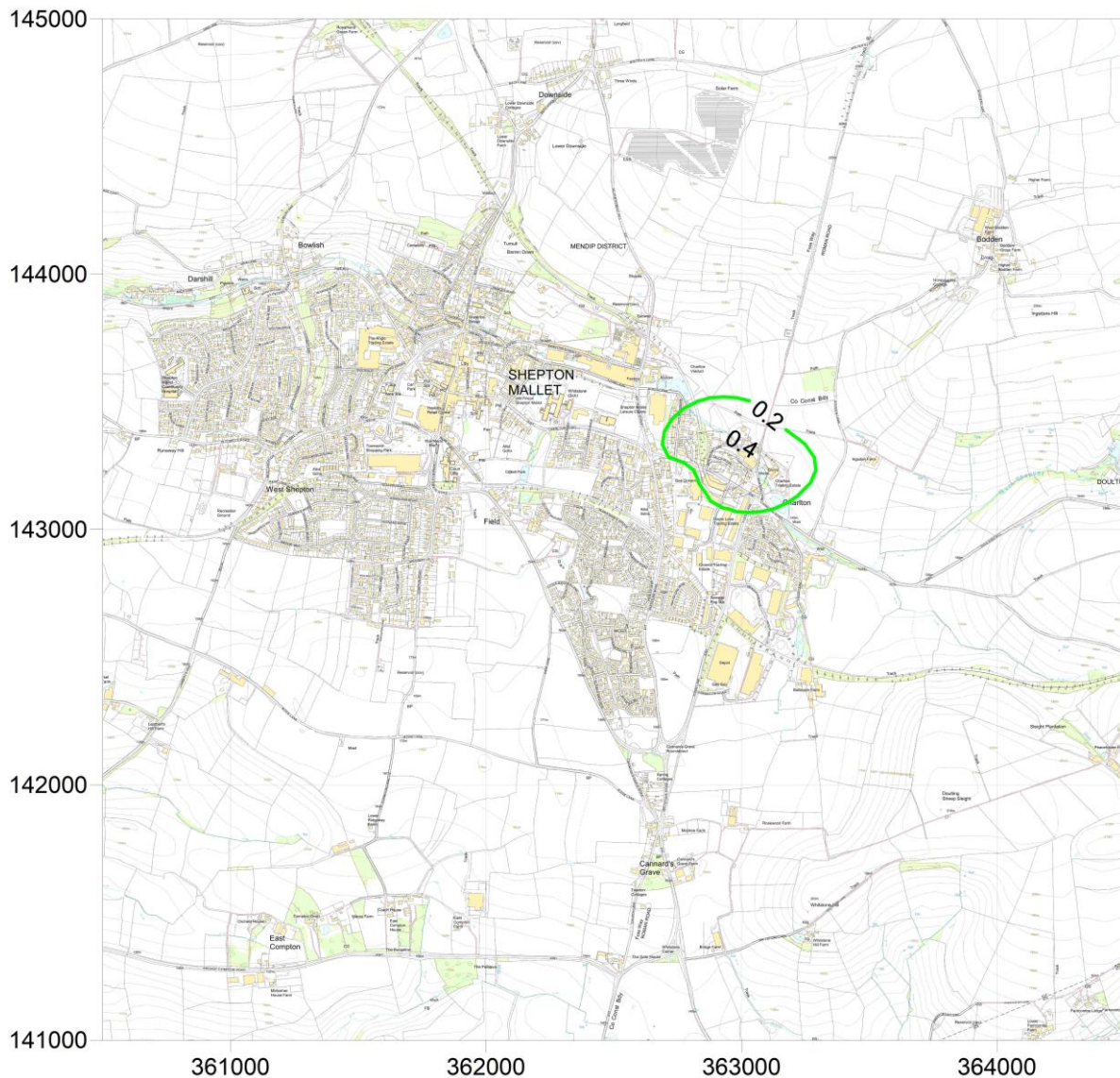
The results from detailed modelling of emissions of SO₂ from the SWIP biomass boiler, based upon an emission concentration of 50 mg Nm⁻³, predicted that both the hourly and 24-hour short-term Process Contributions equate to less than 10 % of their respective AQS objective values and can immediately be screened out as insignificant in accordance with Environment Agency guidance. Although slightly above 10 % of the 99.99th percentile 15-minute average assessment level, the 15-minute average PC goes on to screen at the secondary assessment stage.

The annual average was predicted to be approximately 1.9 µg m⁻³ which is well below the annual Critical Level of 20 µg m⁻³ for the protection of ecosystems, although is not immediately screened as insignificant. With an estimated annual average background concentration for the locality of approximately 2.25 µg m⁻³, the resulting maximum SO₂ PEC of about 4.2 µg m⁻³ represents approximately 21 % of the limit value, and hence the PEC can be screened as insignificant in relation to Environment Agency guidance. It is noted that this point of maximum contribution of the annual average occurs within the Framptons factory boundary and is therefore not at the location of any sensitive ecological receptor that the EAL is designed to protect.

No exceedances of the SO₂ objective limit values were predicted, and the results indicate that emissions of SO₂ from the SWIP biomass boiler will not have a significant impact on local air quality in the local area.

The isopleth diagram presented over page shows the annual average Process Contribution of Sulphur Dioxide, with the green isopleth denoting the point at which the contributions become insignificant when assessed against the Environmental Assessment Level for the protection of sensitive ecological habitats. The 1 % contour marked in green denotes the extent of a contribution equal to or greater than 0.2 µg m⁻³. The contour is local to the Framptons Limited site and does not extend across any ecologically sensitive area. However, even were there to be sensitive ecological receptors in the immediate vicinity of the site, the Predicted Environmental Concentration of Sulphur Dioxide equates to approximately 20 % of the EAL and therefore, any potential impact would be screened as insignificant at the secondary assessment stage.

Figure 7 Maximum Annual Average SO₂ Process Contribution (µg m⁻³)



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5.3 Particulates (PM₁₀)

The following results relate to emissions of particulates from the SWIP biomass boiler, assuming that all of the particles released are less than 10 µm in diameter; PM₁₀.

Table 11 Maximum Process Contribution for Particulates

Statistic	Exceedance Threshold (µg m ⁻³)	Averaging Period	Approximate Concentration (µg m ⁻³)	PC as an Approximate % of AQS Objective Value
Annual Average (PC)	40	Annual	0.388	0.97 %
Annual Average (PEC)			13.2	33 %
Daily average 90.41 % (PC)	50	24 hr	0.873	1.7 %
Daily average 90.41% (PEC)			26.49	53 %
AQS – (2 * Background)	24.38	24 hr	0.873	4 %

Data in Table 11 are based upon the maximum annual and 90.41st percentile 24-hourly average PM₁₀ Process Contributions (PC), due to emissions from the SWIP biomass boiler operating at full output. The maximum result from modelling five-years' worth of meteorological conditions are presented for each statistic and are compared against the Air Quality Standards for PM₁₀, assuming continuous operations for the entire year. The data presented are for both the maximum Process Contribution (PC) and the Predicted Environmental Concentration (PEC) for particulate, with the PEC values taking account of the DEFRA-estimated annual average background of 12.81 $\mu\text{g m}^{-3}$, which is doubled to 25.62 $\mu\text{g m}^{-3}$ when considering the short-term concentrations.

The results show that whether considering the annual average or short-term Process Contributions, the impact of emissions of PM₁₀ from the SWIP biomass boiler can immediately be screened as insignificant. In relation to the EPUK / IAQM guidance, the impact descriptor of an annual average contribution of less than 1 % resulting in a long-term average concentration of less than 75 % would equate to a **negligible** impact at this point of maximum contribution.

When the results from modelling the impact of emissions from the SWIP are plotted, the following patterns of dispersion are seen.

Figure 8 Maximum Annual Average Particulate Matter Process Contribution as PM₁₀ ($\mu\text{g m}^{-3}$)



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The lack of a coloured isopleth in Figure 8 above confirms that the annual average Process Contribution of PM₁₀ remains within 1 % (0.4 µg m⁻³) of the annual average Air Quality Standard and will not have a significant impact on the health of people living and working nearby.

Similar conclusions can be drawn for emissions of fine particles (PM_{2.5}), as their dispersion characteristics are virtually identical to those of the overall PM₁₀ fraction. That said, the assessment level for PM_{2.5} is lower than that of PM₁₀, with an annual average assessment level of 20 µg m⁻³. A Process Contribution of approximately 0.39 µg m⁻³ would therefore equate to 1.9 % of the Air Quality Standard and could not categorically be screened as insignificant at the initial assessment stage. However, with an existing background of 7.97 µg m⁻³, the resultant long-term average concentration equates to 8.36 µg m⁻³, or approximately 42 % of the target level, and can therefore be screened as insignificant at the secondary assessment stage. Additionally, as the overall PEC remains within 75 % of the AQS a contribution of 1.5 % equates to a **negligible** impact at this point of maximum contribution when considering the EPUK / IAQM impact descriptors.

On the basis of the above results, the impact on local air quality of emissions of particulates from the SWIP biomass boiler can be screened as insignificant and requires no further assessment.

5.4 Carbon Monoxide (CO)

The results from detailed modelling of Carbon Monoxide from the SWIP and CHP plant are presented in the table below.

Table 12 Maximum Process Contribution for Carbon Monoxide (CO)

Statistic	Exceedance Threshold (mg m ⁻³)	Averaging Period	Approximate Concentration (mg m ⁻³)	PC as an Approximate % of AQS Value
Short-Term 100 % (PC)	10	Maximum Rolling 8 hr Average	0.101	1.01 %

Detailed modelling predicted that the maximum rolling 8 hour average ground-level Process Contribution for CO associated with emissions from the SWIP biomass boiler would be approximately 1 % of the AQS objective value of 10 mg m⁻³. The predicted PC is considerably below the 10 % insignificance threshold recommended by the Environment Agency for short-term impacts and can therefore be screened as insignificant.

5.5 Volatile Organic Compounds (VOCs)

The results from detailed modelling of VOCs are presented in the Table below.

Table 13 Maximum Process Contribution for VOCs

Statistic	Exceedance Threshold (µg m ⁻³)	Averaging Period	Process Contribution (µg m ⁻³)	Percentage of the AQS
Annual Average (PC)	5	Annual	0.498	10 %
Annual Average (PEC)			0.63	13 %

Figures in bold represent results which cannot immediately be screened as insignificant.

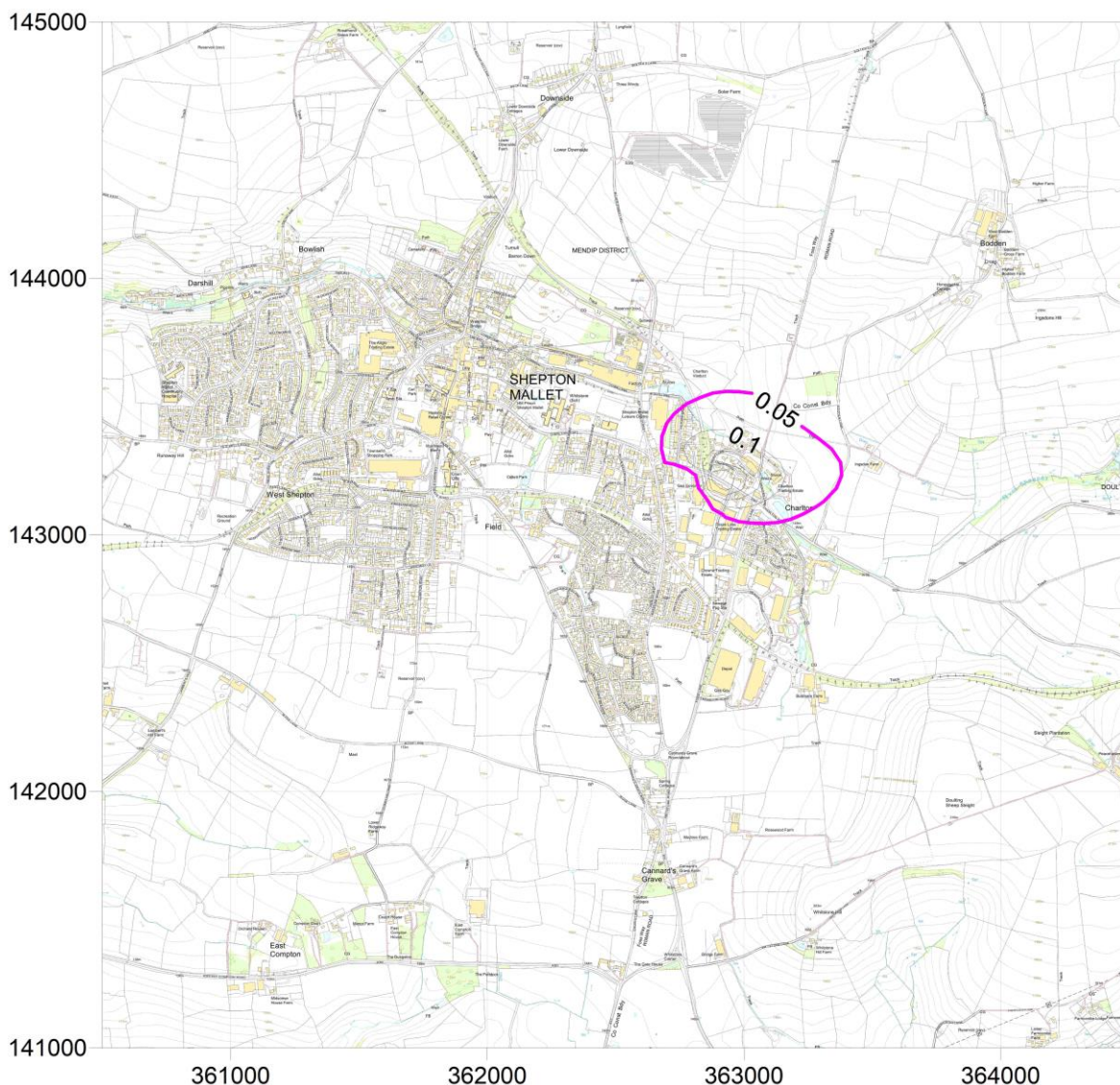
There are no assessment levels for combined VOC emissions as they comprise a mixture of organic compounds, although Benzene, a VOC, does have an Air Quality Standard. There is no information available about the proportion of Benzene that may be present in the VOC emission from the SWIP biomass boiler or the CHP releases, although, it is likely to be a very small percentage of the total. However, in order to provide a worst-case assessment, the annual average Process Contribution for total VOCs was compared against the annual AQS objective value for Benzene of 5 µg m⁻³.

The model predicted a maximum annual average Process Contribution of approximately 0.5 µg m⁻³ for total VOC emissions, which represents a value that is about 10 % of the Benzene AQS.

The estimated local background concentration for Benzene from the DEFRA 2001 Background Maps⁴ (extrapolated to 2021) is $0.1294 \mu\text{g m}^{-3}$, so the resulting Predicted Environmental Concentration will be approximately $0.63 \mu\text{g m}^{-3}$, or 13 % of the AQS objective value, and screens as insignificant in relation to Environment Agency guidance. Bearing in mind that Benzene will comprise only a very small percentage of the total VOC emissions, and that the assessment is based upon worst-case assumptions, the results can be screened as insignificant, and the overall impact on local air quality may be described as **negligible**. On the basis of the above, the impact on local air quality of VOC emissions from the proposed new plant at the Framptons Limited site can be screened as insignificant and require no further assessment.

The isopleth diagram presented below shows the annual average Process Contribution of Volatile Organic Compounds, with the magenta isopleth denoting the point at which the contributions become insignificant when assessed against the Air Quality Standard for Benzene. The coloured 1 % contour denotes the extent of a contribution equal to or greater than $0.05 \mu\text{g m}^{-3}$. Despite the significant worst-case assessment of emissions of total VOCs, the Predicted Environmental Concentration across the small area where the PC does not immediately screen, equates to approximately 13 % of the AQS for Benzene. Therefore, any potential impact can be screened as insignificant at the secondary assessment stage.

Figure 9 Maximum Annual Average Process Contribution of VOC ($\mu\text{g m}^{-3}$)



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5.6 Ammonia

The results from detailed modelling of Ammonia are presented in the Table below.

Table 14 Maximum Process Contribution for Ammonia ($\mu\text{g m}^{-3}$)

Statistic - for the protection of human health	Exceedance Threshold ($\mu\text{g m}^{-3}$)	Averaging Period	Process Contribution ($\mu\text{g m}^{-3}$)	Percentage of the EAL
Annual Average (PC)	180	Annual	0.388	0.02 %
Short-Term 100 % (PC)	2,500	1 hr	17.13	0.69 %

Different Environmental Assessment Levels exist for Ammonia depending on whether the protection of human health or the environment is the driving factor. The data in Table 14 is assessed against the EALs for the protection of human health and, with Process Contributions equating to a fraction of 1 % of both the long and short-term EALs, can immediately be screened as insignificant.

Further consideration is given to the impacts of Ammonia on sensitive ecological receptors, some of which are located in the immediate vicinity of the proposed SWIP biomass boiler, in Section 6.

5.7 Hydrogen Chloride (HCl)

The results from detailed modelling of HCl are presented in the following Table.

Table 15 Maximum Process Contribution for Hydrogen Chloride ($\mu\text{g m}^{-3}$)

Statistic	Exceedance Threshold ($\mu\text{g m}^{-3}$)	Averaging Period	Process Contribution ($\mu\text{g m}^{-3}$)	Percentage of the EAL
Short-Term 100 % (PC)	750	1 hr	17.13	2.3 %

There is no Air Quality Standard for HCl and the assessment level was therefore based upon Environment Agency guidance for short-term (1 hour) assessments. The Environment Agency guidance does not recommend a long-term EAL for HCl, therefore the results relate solely to the hourly average Process Contribution.

Detailed modelling predicts a maximum hourly average PC for HCl of approximately $17 \mu\text{g m}^{-3}$, equating to 2.3 % of the EAL of $750 \mu\text{g m}^{-3}$, which is insignificant in relation to Environment Agency guidance. The results indicate that emissions of HCl are unlikely to have a significant impact on air quality in the vicinity of the site and the overall impact on local human health and the environment may be described as negligible. Accordingly, emissions of HCl do not require further assessment, although deposition impacts on ecological receptors are considered further in Section 6.

5.8 Hydrogen Fluoride (HF)

The results from detailed modelling of Hydrogen Fluoride are presented in the following Table.

Table 16 Maximum Process Contribution for Hydrogen Fluoride ($\mu\text{g m}^{-3}$)

Statistic	Exceedance Threshold ($\mu\text{g m}^{-3}$)	Averaging Period	Process Contribution ($\mu\text{g m}^{-3}$)	Percentage of the EAL
Annual (PC)	16	Monthly	0.039 (Annual)	0.24 %
Short-Term 100 % (PC)	160	1 hr	1.71	1.07 %

Detailed modelling predicted that both the annual average (assessed against the monthly average EAL) and the maximum hourly average Process Contributions for HF associated with emissions from the SWIP biomass boiler would be a fraction of 1 % and 10 % of the long and short-term EAL respectively and are therefore screened as insignificant in relation to Environment Agency guidance.

No exceedances of the EALs for HF were predicted for the operation of the SWIP biomass boiler, and the results indicate that emissions of HF are unlikely to have a significant impact on air quality in the vicinity of the site. The overall potential impact on human health receptors may therefore be described as negligible. Accordingly, emissions of HF do not require further assessment for their potential effects on human health, although they are considered further in relation to their potential impact on ecological receptors in Section 6.

5.9 Cadmium and Thallium (Cd and Tl)

The results from detailed modelling of Cadmium and Thallium are presented in the following table and are reported on the basis that all of the emissions occur as Cadmium.

Table 17 Maximum Process Contribution for Cadmium and Thallium (ng m⁻³)

Statistic	Exceedance Threshold (ng m ⁻³)	Averaging Period	Approximate Concentration (ng m ⁻³)	Percentage of the AQS
Annual (PC)	5	Annual	1.93	39 %
Annual (PEC)			2.03	40.6 %

Figures in bold represent results which cannot immediately be screened as insignificant.

The Air Quality Standards Regulations (England) 2010 specify a target value of 5 ng m⁻³ for Cadmium as an annual average in the PM₁₀ fraction of particulate emissions. However, no information is available on the Cadmium content of any PM₁₀ emissions that may be emitted from the SWIP biomass boiler. Therefore, as a worst-case assessment it was assumed that all of the Cadmium and Thallium emissions were associated with the PM₁₀ release, and that emissions were totally as Cadmium.

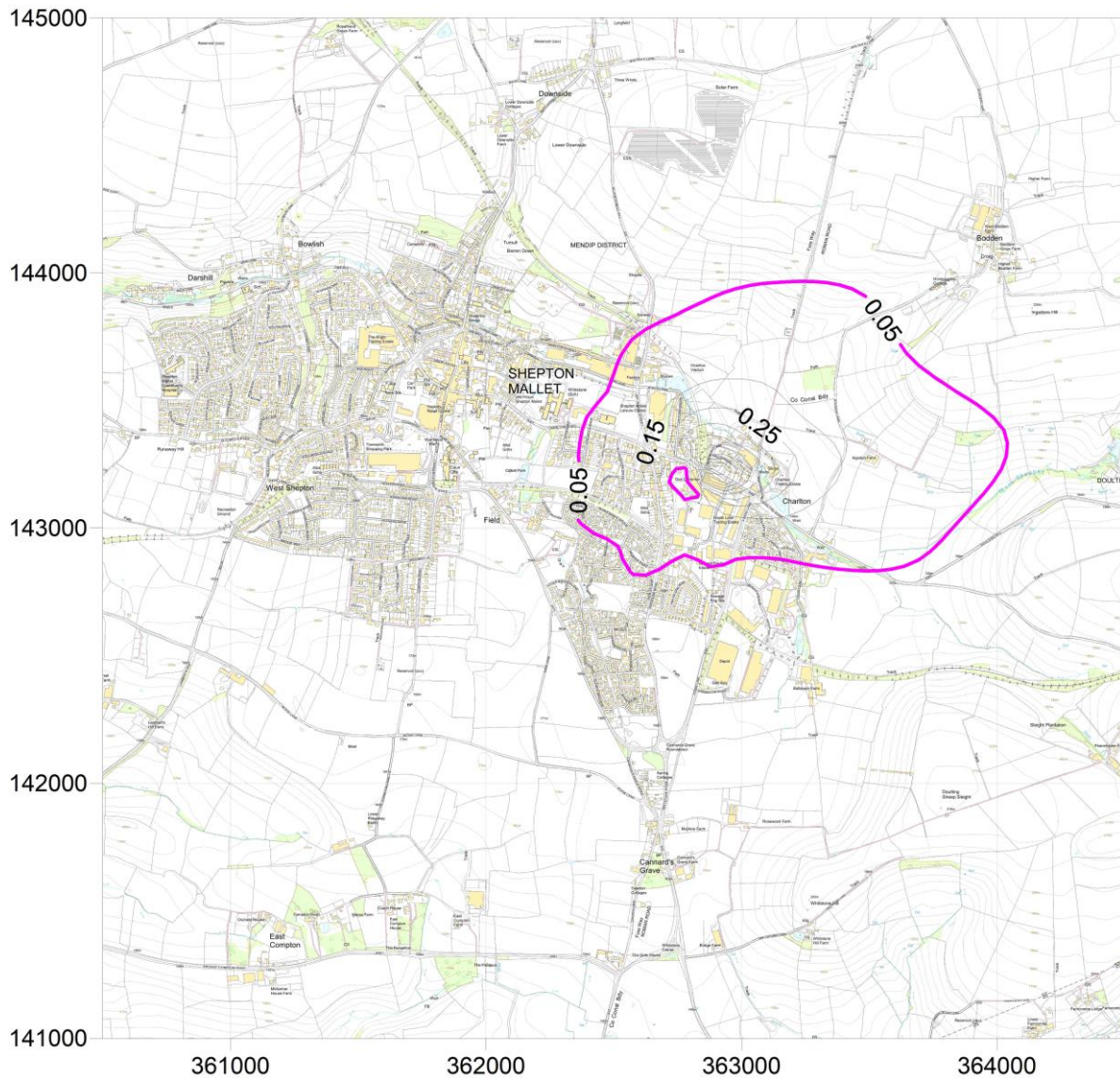
Detailed modelling predicts an annual average Process Contribution for Cadmium of approximately 1.9 ng m⁻³ (or about 39 % of the AQS objective). No exceedances of the annual average AQS for Cadmium were predicted for the operation of the SWIP biomass boiler, although the value for the annual average Process Contribution was in excess of the Environment Agency's 1 % insignificance threshold. Data from the Heavy Metals Monitoring Network rural background measurement station at Chilbolton Observatory¹¹, show that the annual average Cadmium concentration in 2019 was 0.098 ng m⁻³. This measurement station is located approximately 76.5 km to the east of the site but is the nearest monitoring point which would be considered representative of conditions around the Framptons Limited site.

The resulting maximum Predicted Environmental Concentration value for Cadmium associated with the operation of the SWIP biomass boiler is therefore approximately 2.03 ng m⁻³, or about 41 % of the AQS objective value, and in line with Environment Agency guidance does not require further assessment.

It should be noted that the emissions data for Cadmium used in modelling were derived from the IED emission limit value for the combined emissions of both Cadmium and Thallium (0.05 mg Nm⁻³), and it is assumed that all of the emission was as Cadmium. Therefore, the value used in the assessment overestimates the situation for Cadmium significantly. Furthermore, it is highly unlikely that there will be significant quantities of Cadmium in the fuel to be utilised by the SWIP biomass boiler.

Despite this, the isopleth diagram shown in Figure 10 depicts the anticipated pattern of dispersion when the emissions from the SWIP biomass boiler are plotted over a map of the local area. The magenta isopleth denotes the 1 % point of insignificance, and therefore, in all areas outside of this contour line, the impact of emissions of Cadmium and Thallium can immediately be screened as insignificant. Within the coloured contour, the overall PEC is screened at the secondary assessment stage.

Figure 10 Maximum Annual Average Process Contribution of Cadmium (ng m⁻³)



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5.10 Mercury and its Compounds (Hg)

The results from detailed modelling of Mercury and its compounds are presented in the following table.

Table 18 Maximum Process Contribution for Mercury and its Compounds (µg m⁻³)

Statistic	Exceedance Threshold (µg m ⁻³)	Averaging Period	Approximate Concentration (µg m ⁻³)	Percentage of the EAL
Annual (PC)	0.25	Annual	0.00193	0.8 %
Short-Term 100 % (PC)	7.5	1 hr	0.085	1.1 %

Detailed modelling predicted that both the annual average and the maximum hourly average Process Contributions for Mercury associated with the emissions from the SWIP biomass boiler would be a fraction of 1 % and 10 % of the long and short-term EAL respectively and are therefore screened as insignificant in relation to Environment Agency guidance.

No exceedances of the EALs for Mercury were predicted for the operation of the SWIP biomass boiler, and the results indicate that emissions of Mercury are unlikely to have a significant impact on local air quality in the vicinity of the site. As such, the overall potential impact on human health receptors may be described as negligible and emissions of Mercury do not require further assessment.

5.11 Group 3 Metals

The IED stipulates emission limits for Group 3 metals including Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), and Vanadium (V). The emission limit requires that the total emission for all of these metals is below 0.5 mg Nm⁻³.

The Environment Agency has issued guidance on metals impact assessment¹² and recommends a stepwise approach to the assessment of Group 3 metals. The guidance is applicable for use when assessing the impact of Municipal Waste Incineration (MSW) and waste wood co-incineration facilities and is therefore appropriate for the SWIP biomass boiler. The first step is based upon the assumption that each of the nine metal species is emitted at the IED emission limit value of 0.5 mg Nm⁻³ for Group 3 metals. The results from this initial screening assessment are presented below.

Table 19 Maximum Annual Average Process Contribution for Group 3 Metals – Step 1 Screening

Metal	Exceedance Threshold (µg m⁻³)	Approximate Concentration (µg m⁻³)	Percentage of the EAL
Antimony	5	0.019	0.39 %
Arsenic	0.003	0.019	643 %
Chromium ^(VI)	0.0002	0.019	9,648 %
Cobalt	0.2*	0.019	9.65 %
Copper	10	0.019	0.19 %
Lead	0.25	0.019	7.72 %
Manganese	0.15	0.019	12.86 %
Nickel	0.02	0.019	96.48 %
Vanadium	5	0.019	0.39 %

As previously, figures in bold represent results which cannot immediately be screened as insignificant. It is noted * that in the absence of current guidance, and to provide an indicative assessment for Cobalt, the exceedance threshold is based on guidance, now withdrawn, provided by the Environment Agency in IPPC H1.

The Environment Agency guidance on metals assessment requires that where the PC of any metal exceeds 1 % of a long-term or 10 % of a short-term environmental standard, the PEC should be compared against the environmental standard. Table 20 therefore provides this assessment with background data for Arsenic, Chromium (total), Cobalt, Lead, Manganese and Nickel being drawn from the Chilbolton Laboratory monitoring data for heavy metals in 2019.

The Environment Agency guidance on metals assessment requires that where the PEC is greater than 100 % of the environmental standard, further consideration is required, and the results in Table 20 (over page) demonstrate that the contributions of Arsenic and Chromium^(VI) therefore continue to require further assessment.

Table 20 Calculation and Screening of the Predicted Environmental Concentration of Metals

Metal	Background Concentration ($\mu\text{g m}^{-3}$)	PEC ($\mu\text{g m}^{-3}$)	Percentage of the EAL
Arsenic	0.00061	0.019906	664 %
Chromium ^(VI)	0.00096	0.020256	10,128 %
Cobalt	0.000039	0.019335	9.67 %
Lead	0.0036	0.022896	9.2 %
Manganese	0.0025	0.021796	15 %
Nickel	0.00045	0.019746	98.7 %

The final, 'case specific' screening recommended by the Environment Agency uses measured emissions data from operational MSW incineration and waste wood co-incineration plant to assess the likely contributions of individual metal species to the total. On the basis of measurements undertaken at facilities between 2007 and 2015, the Environment Agency published the percentage contributions of each metal species to the limit value, for use in calculating the likely release of species whose PC were greater than 1 % of the long-term assessment level in Step 1. The calculated percentages specified in the guidance note are representative of the BAT-AEL specified for Group 3 metals in Annex VI of the IED (0.5 mg Nm^{-3}), which is in line with the concentration applied in this assessment of the emissions from the SWIP biomass boiler to be installed at the Framptons Limited site.

Table 21 Percentage Contribution of Species for the Step 2 Assessment of Group 3 Metals

Metal	Maximum Measured Concentration (mg Nm^{-3})	Percentage Contribution to 0.5 mg Nm^{-3} ELV
Antimony	0.0115	2.3 %
Arsenic	0.025	5 %
Chromium ^(VI)	0.00013	0.03 %
Cobalt	0.0056	1.1 %
Copper	0.029	5.8 %
Lead	0.0503	10.1 %
Manganese	0.060	12 %
Nickel	0.220	44 %
Vanadium	0.006	1.2 %

In the first instance, the Step 2 screening assessment should be based upon the maximum emissions and resultant percentage contributions as specified in the above table, and the measured data from the nearest Heavy Metals Monitoring Network site, in this case at Chilbolton Observatory. A similar assessment of PC and PEC values should be applied as in Step 1. Therefore, the calculated maximum percentage contributions were applied to the total Process Contribution of $0.019 \mu\text{g m}^{-3}$ for Arsenic and Chromium^(VI), and the results for the Predicted Environmental Concentrations are presented in the following table.

Table 22 Maximum Annual Average Predicted Environmental Concentrations for Arsenic and Chromium^(VI) – Step 2 Screening

Metal	Exceedance Threshold ($\mu\text{g m}^{-3}$)	PC ($\mu\text{g m}^{-3}$)	Percentage of the AQS/EAL	Background Concentration ($\mu\text{g m}^{-3}$)	PEC ($\mu\text{g m}^{-3}$)	Percentage of the AQS/EAL
Arsenic	0.003	0.00096	32 %	0.00061	0.00157	52 %
Chromium ^(VI)	0.0002	5.79×10^{-06}	2.9 %	0.000192*	0.000198	98.89 %

* Note: The background concentration of Chromium^(VI) is assumed to equate to 20 % of the total Chromium background as measured at Chilbolton Observatory in 2019 ($0.00096 \mu\text{g m}^{-3}$).

As can be seen, although the PC of both Arsenic and Chromium^(VI) are greater than 1 % of the EAL, the PECs for both metal species remain within the AQS, equating to 52 % and almost 99 % of the EALs respectively. Contributions of both Arsenic and Chromium can therefore be screened as insignificant.

5.12 Polycyclic Aromatic Hydrocarbons (PAH as B[a]P)

Although measured discharges of total PAH identified in the 2019 Best Available Techniques Reference Note reported concentrations of up to 0.05 mg Nm⁻³ (50,000 ng Nm⁻³) from incineration processes, emissions of Benzo[a]Pyrene (B[a]P) were reported to a maximum of 0.001 mg Nm⁻³ (1,000 ng Nm⁻³). The Air Quality Standards Regulations (England) 2010 specify a target value of 0.25 ng m⁻³ for B[a]P and there is an additional European obligation to limit total ambient PAH to 1 ng m⁻³ as an annual average in the PM₁₀ fraction.

However, no information is available on the PAH content of any PM₁₀ emissions that may be emitted from the SWIP biomass boiler or that which is already present in the environment. Within this assessment therefore, the lower of the two target values has been applied and considers emissions of B[a]P, at 0.001 mg Nm⁻³, rather than total PAH discharges.

The results from detailed modelling of Benzo[a]Pyrene (for PAH) are presented in the following table.

Table 23 Maximum Process Contribution for Benzo[a]Pyrene (ng m⁻³)

Statistic	Exceedance Threshold (ng m ⁻³)	Averaging Period	Approximate Concentration (ng m ⁻³)	Percentage of the EAL
Annual (PC)	0.25	Annual	0.0388	16 %
Annual (PEC)			0.12	46 %

Figures in bold represent results which cannot immediately be screened as insignificant.

Detailed modelling predicts a maximum annual average Process Contribution for B[a]P of approximately 0.04 ng m⁻³ (or about 16 % of the AQS objective). No exceedances of the annual average AQS for B[a]P were predicted for the operation of the SWIP biomass boiler, although the value for the annual average Process Contribution was in excess of the Environment Agency's 1 % insignificance threshold. Measured data from the Chilbolton Observatory reported a background concentration of B[a]P in 2019 of 0.077 ng m⁻³.

The resulting maximum Predicted Environmental Concentration value for B[a]P associated with the operation of the SWIP biomass boiler is therefore 0.12 ng m⁻³, or about 46 % of the AQS objective value, and in line with Environment Agency guidance is screened as insignificant and does not require further assessment.

5.13 Dioxins and Furans, and Poly Chlorinated Biphenyls

The results from detailed modelling of Dioxins and Furans are presented in the following table.

Table 24 Maximum Process Contribution for Dioxins and Furans (µg m⁻³)

Statistic	Averaging Period	Approximate Concentration (µg m ⁻³)
Annual (PC)	Annual	3.88 x 10 ⁻⁹
Short-Term 100 % (PC)	1 hr	1.71 x 10 ⁻⁷

There is a general concern within the population at large about the potential health effects associated with exposure to Dioxins and Furans in the emissions from industrial processes. However, there are no Air Quality Standards or Environmental Assessment Levels for Dioxins.

The maximum annual PC for Dioxins associated with emissions from the SWIP biomass boiler at the IED ELV of 0.1 ng Nm⁻³ was approximately 3.9 fg m⁻³, at the point of maximum Process Contribution, which occurs approximately 20 metres to the east of the SWIP chimney. This location is immediately adjacent the boiler house and does not occur at a point of long-term human exposure. The maximum hourly average PC for Dioxins was predicted to be approximately 171 fg m⁻³, occurring approximately 65 metres to the east, north-east of the chimney and, similar to the annual average contribution, is not a location of any sensitive human health receptor, occurring within the Framptons site boundary.

Emissions of Dioxins from the SWIP biomass boiler are not expected to significantly increase the airborne concentration or deposition rate of Dioxins and Furans over what may be currently experienced in the locality.

It should be noted that the emissions profile was based on the long-term ELV of 0.1 ng Nm⁻³ prescribed for Dioxins and Furans in Annex VI of the Industrial Emissions Directive. The SWIP biomass boiler will operate in compliance with emissions standards specified by the IED, and Dioxin emissions are expected to generally be below the emission limit value. The emissions profile is therefore considered to be overly pessimistic, and to result in higher predicted Process Contributions than are considered likely.

5.14 Combining All Discharges

As discussed in Section 4.3, although it is anticipated that all of the emission points from the new energy centre will discharge on a continuous basis, this cannot be guaranteed. As such and in order to provide a worst-case assessment, the majority of the modelling has combined the three CHP releases but has modelled the SWIP separately, albeit with a constant operation of all plant. Effectively, this results in the four discharge points being modelled as two separate points, one denoting releases from the SWIP biomass boiler and the other for the full CHP operations.

However, due to their close proximity, and recognising the likelihood that all four release points will be discharging for the majority of the time, a model has been run to consider the reduced overall impact when all discharges are operational and can therefore influence one another, for example through improvements in plume buoyancy. The results are presented in Table 25 below and compare the results already detailed in Sections 5.1 – 5.13 with the reduced, combined operation results.

Table 25 Effect of Combining SWIP and CHP Release Points

Pollutant and Statistic	PC CHP Combined Plus SWIP ($\mu\text{g m}^{-3}$)	PC All Discharges Combined ($\mu\text{g m}^{-3}$)	Effect of Combination
Annual Average NO ₂	8.75	4.52	Reduction in PC
99.79 th % Hourly NO ₂	37.26	17.49	Reduction in PC
100 th % 24-Hour NO _x	33.30	20.22	Reduction in PC
Annual Average SO ₂	1.93	0.84	Reduction in PC
99.9 th % 15-Minute SO ₂	29.53	9.37	Reduction in PC
99.73 rd % Hourly SO ₂	16.14	6.11	Reduction in PC
99.18 th % 24-Hour SO ₂	5.52	3.43	Reduction in PC
100 th % Hourly HCl	17.13	6.00	Reduction in PC
Annual Average HF	0.039	0.017	Reduction in PC
100 th % Hourly HF	1.71	0.60	Reduction in PC
100 th % 24-Hour HF	0.161	0.076	Reduction in PC
100 th % Weekly HF	0.094	0.044	Reduction in PC
Annual Average NH ₃	0.388	0.169	Reduction in PC
Annual Average VOC	0.498	0.285	Reduction in PC
Max. 8-Hr Rolling CO (mg m ⁻³)	0.101	0.020	Reduction in PC
90.41 st % 24-Hour PM ₁₀	0.873	0.454	Reduction in PC
Annual Average PM ₁₀	0.388	0.169	Reduction in PC
Annual Average PM _{2.5}	0.388	0.169	Reduction in PC
Annual Average Cd / TI (ng m ⁻³)	1.93	0.84	Reduction in PC
Annual Average Hg	0.0019	0.0008	Reduction in PC
100 th % Hourly Hg	0.085	0.030	Reduction in PC
Annual Average Group 3 Metals	0.019	0.008	Reduction in PC
Annual Average PAH (as B[a]P) (ng m ⁻³)	0.039	0.017	Reduction in PC
Annual Average Dioxin	3.88E-09	1.69E-09	Reduction in PC
100 th % Hourly Average Dioxin	1.71E-07	6.00E-08	Reduction in PC

The results show that combining all four release points consistently reduces the reported process contributions, with the levels of reduction varying with changes in the averaging periods considered. Reductions range from approximately 20 – 62 % of the results originally reported.

Therefore, whilst it is considered that the results presented in Sections 5.1 – 5.13 provide a realistic, albeit conservative assessment of the impact of the discharges from the proposed energy centre, and indeed, even at the levels reported in those earlier Sections process contributions are demonstrated to be screened as insignificant at either the initial or secondary assessment stage, it is likely that the actual impact of the proposed energy centre operations will in fact be lower than those reported, due to the increased buoyancy benefitting the discharges when releasing together. It is considered likely that all four discharges will generally be operational, as this represents normal operating conditions for the plant.

5.15 Deposition of Metals to Land

Some substances can have an impact when absorbed by soil and leaves and thus, Environmental Assessment Levels have been set for deposition rates. Table 26 considers the modelled deposition of metal species, when taking account of dry deposition factors. The data presented has been modelled with discharges from the CHP units combined, and the SWIP discharging on a continuous basis, although not combined with the CHP release.

Table 26 Results of Metals Deposition and Assessment of Impact

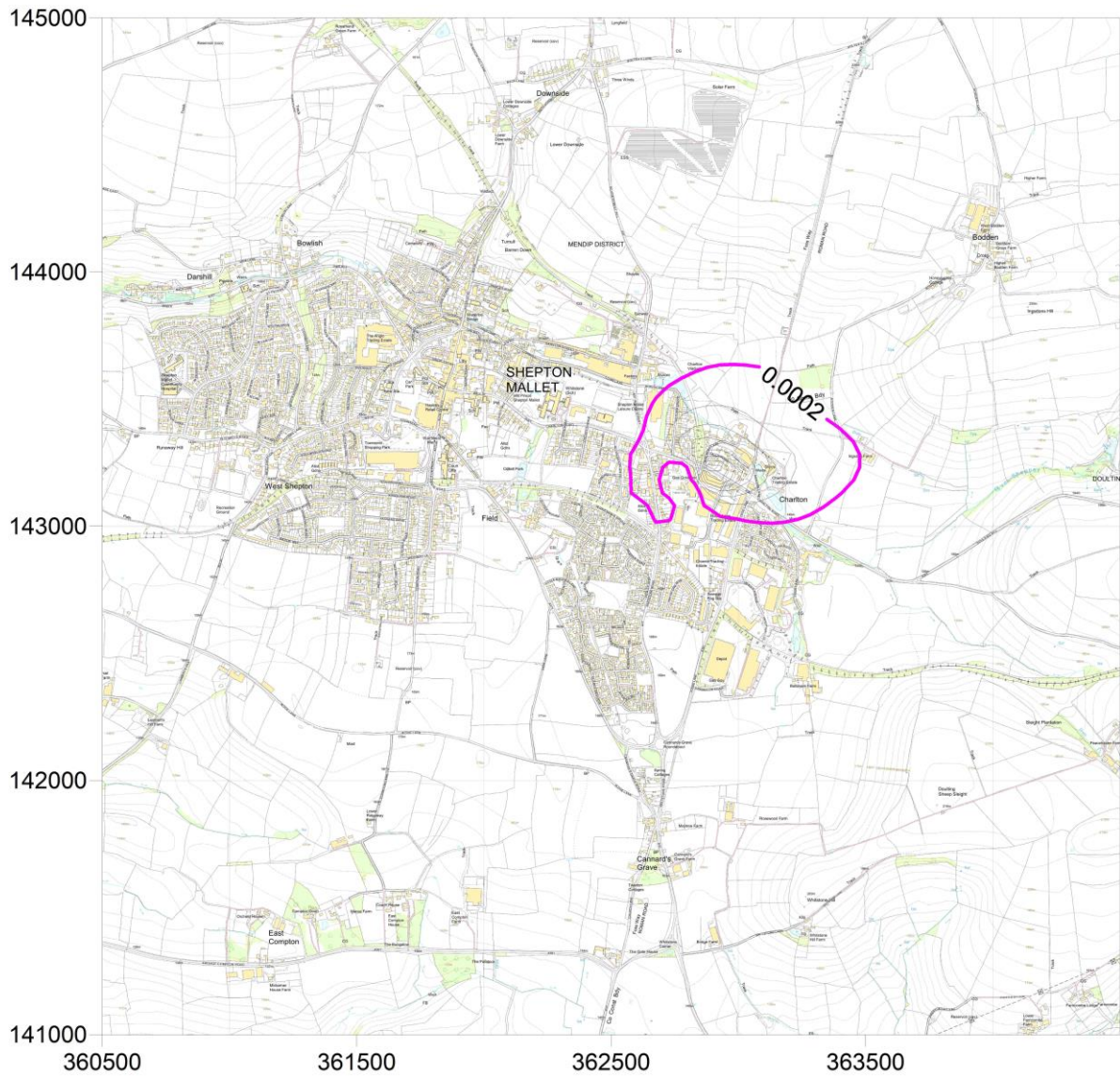
Species	Modelled Deposition ($\mu\text{g m}^{-2} \text{s}^{-1}$)	Modelled Deposition ($\text{mg m}^{-2} \text{day}^{-1}$)	EAL ($\text{mg m}^{-2} \text{day}^{-1}$)	% EAL
Arsenic	0.0000366	0.0032	0.02	15.79 %
Cadmium	0.0000037	0.00032	0.009	3.51 %
Chromium	0.0000366	0.0032	1.5	0.21 %
Copper	0.0000366	0.0032	0.25	1.26 %
Lead	0.0000366	0.0032	1.1	0.29 %
Mercury	0.0000037	0.00032	0.004	7.90 %
Nickel	0.0000366	0.0032	0.11	2.87 %

Of the seven metal species considered, only two are immediately screened as insignificant. Arsenic, Copper and Nickel do not screen immediately but are each assumed to deposit at the total rate for Group 3 metals, a group containing nine individual species. As discussed in Section 5.11, each metal species will only make up a proportion of the total with, for example, Arsenic estimated to equate to 5 % of the sum of the Group 3 metals. As such, the assessment of the total against each EAL can be considered to represent an overly conservative approach, and it is likely that each individual species will in fact remain within 1 % of the EAL. Similarly, Cadmium is modelled in combination with Thallium emissions and therefore, although the reported PC equates to 3.5 % of the EAL, this will overstate the contribution of Cadmium which will likely be less than 2 % of the EAL at this point of maximum contribution.

Mercury, however, is not modelled in combination with other pollutants and its deposition is not immediately screened as insignificant. However, the deposited contributions reduce quickly with distance from the release point and the area that cannot be screened as insignificant includes the area in the immediate vicinity of the proposed new boiler house. Detailed consideration of the model results confirms that the area which is potentially exposed to levels of Mercury deposition in excess of 1 % of the EAL constitutes 341 of the 63,001 gridded points across the 5 km x 5 km grid, which is 0.54 % of the results returned by the model. Additionally, although the modelled Process Contribution is greater than 1 % of the EAL in places, with a maximum contribution equating to approximately 8 % of the assessment level when assuming that the SWIP biomass boiler is discharging continually at the anticipated Emission Limit Value, the level of deposited Mercury remains very small and is unlikely to cause an exceedance of the limit for Mercury contributions to ground, where one does not already exist.

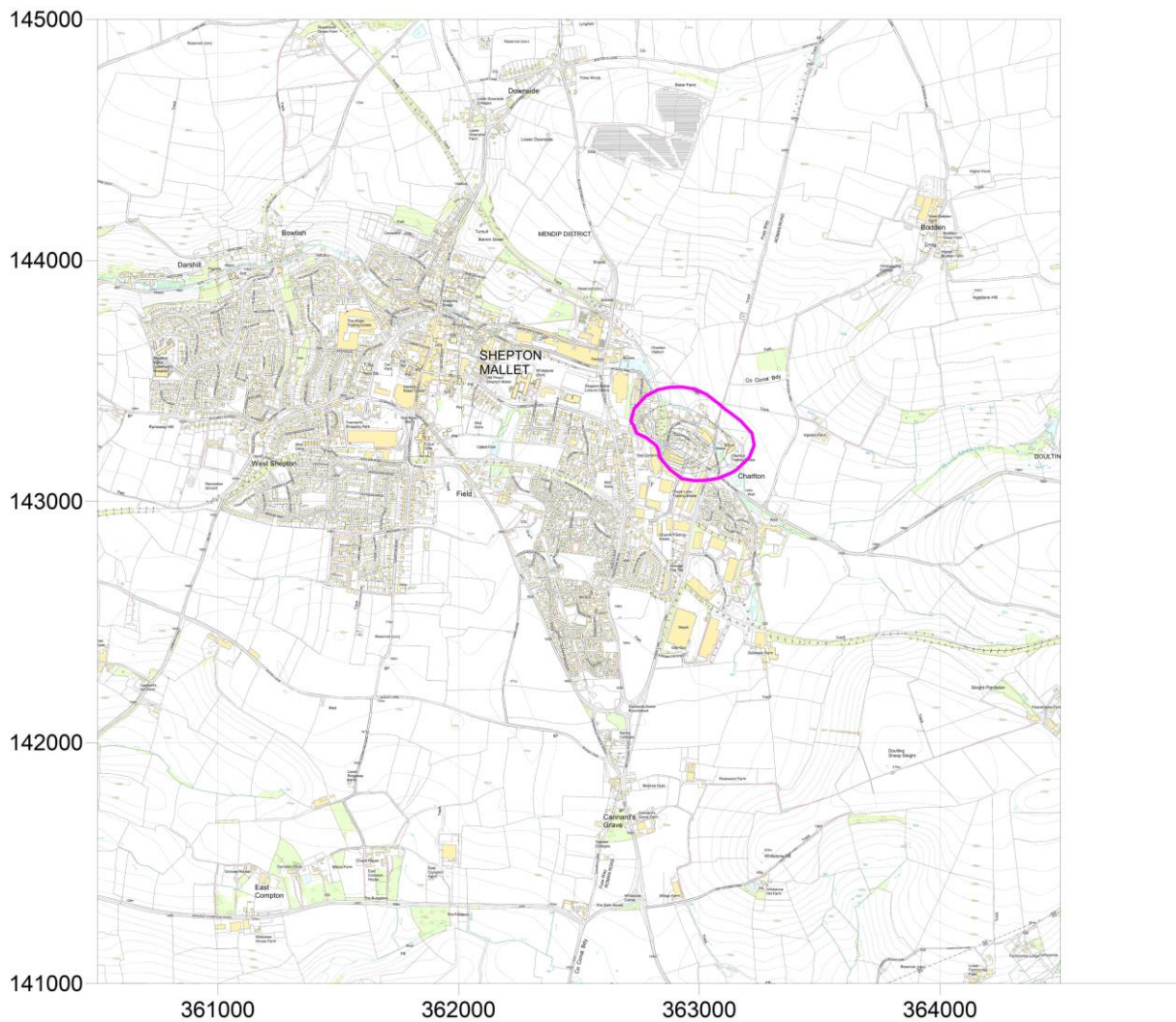
Figures 11 and 12 which follow present the levels of deposition of Group 3 Metals compared to the assessment level for Arsenic and deposited levels of Mercury across the modelled grid. As in previous figures, the plots apply a magenta-coloured isopleth to denote the point at which contributions would immediately be considered to be insignificant.

**Figure 11 Deposition of Group 3 Metals as Arsenic ($\text{mg m}^{-2} \text{day}^{-1}$).
Assessment Level of $0.02 \text{ mg m}^{-2} \text{day}^{-1}$**



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**Figure 12 Process Contributions of Mercury Deposition ($\text{mg m}^{-2} \text{ day}^{-1}$).
Assessment Level of $0.004 \text{ mg m}^{-2} \text{ day}^{-1}$**



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6. Air Quality Impact at Specific Receptors

The model was also set up to calculate the impact of emissions at thirty-eight specific receptors in the vicinity of the site. The locations of many of these receptors were shown in Figure 3, and represent sensitive ecological sites, locations where members of the general public may be present for extended periods of time, either through residence in a particular area, or as a result of their employment, as well as locations for which there are existing concerns regarding air quality. Where Process Contributions at one or more of the sensitive receptors could not immediately be screened as insignificant, they are reported in the following tables, based on the impact of emissions from the SWIP biomass boiler and all CHP plant when reporting emissions of NO_x , NO_2 and VOCs, and are the maximum values reported for the five-years' of meteorological data used in the assessment. The assessment level values used within the calculations vary (as appropriate) by receptor type. All other pollutants and / or averaging periods were immediately screened as insignificant and have not been reported here.

Within the tables, figures in bold represent results which cannot immediately be screened as insignificant.

Table 27 Results from Detailed Assessment for Nitrogen Dioxide at Specific Receptors Impact Due to the Operation of the SWIP and CHP

Receptor	Annual NO ₂ PC (µg m ⁻³)	% AQS	Hourly NO _x as NO ₂ PC (µg m ⁻³)	% AQS	Maximum Daily NO _x as NO ₂ PC (µg m ⁻³)	% AQS
1	0.3432	0.86%	7.66	3.8%	7.43	
2	2.3438	5.86%	16.96	8.5%	28.50	
3	4.6520	11.63%	15.86	7.9%	22.46	
4	2.3109	5.78%	8.83	4.4%	10.76	
5	1.1092	2.77%	12.84	6.4%	16.14	
6	0.3834	0.96%	5.55	2.8%	7.08	
7	0.2639	0.66%	3.76	1.9%	4.78	
8	0.2468	0.62%	2.91	1.5%	3.03	
9	0.2089	0.52%	2.82	1.4%	2.60	
10	0.1592	0.40%	2.42	1.2%	2.17	
11	0.1733	0.43%	2.73	1.4%	2.55	
12	0.0615	0.15%	1.06	0.5%	0.86	
13	0.0652	0.22%	1.43	0.7%	0.70	0.9%
14	0.0702	0.23%	1.62	0.8%	1.68	2.2%
15	0.0718	0.24%	1.39	0.7%	0.69	0.9%
16	1.2174	4.06%	9.72	4.9%	13.15	18%
17	0.9409	3.14%	6.45	3.2%	9.09	12%
18	0.3756	1.25%	3.29	1.6%	4.33	5.8%
19	0.3153	1.05%	2.98	1.5%	4.48	6.0%
20	0.1677	0.56%	2.40	1.2%	2.55	3.4%
21	0.1690	0.56%	2.37	1.2%	2.21	2.9%
22	0.0887	0.30%	1.77	0.9%	1.81	2.4%
23	0.0764	0.25%	1.55	0.8%	1.36	1.8%
24	0.0827	0.28%	1.75	0.9%	1.86	2.5%
25	0.1512	0.50%	2.54	1.3%	1.92	2.6%
26	0.2334	0.78%	2.95	1.5%	3.00	4.0%
27	0.1999	0.67%	3.03	1.5%	3.70	4.9%
28	0.2177	0.73%	1.31	0.7%	1.09	1.4%
29	0.1783	0.59%	1.06	0.5%	0.93	1.2%
30	0.1437	0.48%	1.36	0.7%	2.18	2.9%
31	0.1445	0.48%	1.44	0.7%	2.08	2.78%
32	0.0763	0.25%	2.57	1.3%	2.31	3.08%
33	0.0543	0.18%	1.58	0.8%	0.75	1.00%
34	0.0555	0.19%	1.25	0.6%	0.96	1.28%
35	0.0245	0.08%	0.54	0.3%	0.27	0.36%
36	0.0213	0.07%	0.46	0.2%	0.26	0.35%
37	0.0194	0.06%	0.31	0.2%	0.16	0.21%
38	0.0158	0.05%	0.30	0.1%	0.32	0.43%

Assessment Level is relevant to ecological receptors only.

Table 28 Results from Detailed Assessment for SO₂, Ammonia and VOCs at Specific Receptors Impact Due to the Operation of the SWIP

Receptor	Annual SO ₂ PC (µg m ⁻³)	% AQS	Annual NH ₃ PC (µg m ⁻³)	% AQS	Annual VOC PC (µg m ⁻³)	% AQS
1	0.0781734	Assessment Level is relevant to ecological receptors only.	0.0157	0.009%	0.0187	0.37%
2	0.504904		0.1014	0.056%	0.1338	2.68%
3	0.996829		0.2002	0.111%	0.2666	5.33%
4	0.445619		0.0895	0.050%	0.1426	2.85%
5	0.249404		0.0501	0.028%	0.0612	1.22%
6	0.0777813		0.0156	0.009%	0.0229	0.46%
7	0.0529899		0.0106	0.006%	0.0159	0.32%
8	0.0484155		0.0097	0.005%	0.0151	0.30%
9	0.0412466		0.0083	0.005%	0.0127	0.25%
10	0.0315326		0.0063	0.004%	0.0096	0.19%
11	0.0349778		0.0070	0.004%	0.0104	0.21%
12	0.0120201		0.0024	0.001%	0.0038	0.08%
13	0.0127228	0.06%	0.0026	0.085%	0.0040	0.08%
14	0.013851	0.07%	0.0028	0.093%	0.0043	0.09%
15	0.0139754	0.07%	0.0028	0.094%	0.0044	0.09%
16	0.241803	1.2%	0.0486	1.62%	0.0737	1.47%
17	0.180167	0.90%	0.0362	1.21%	0.0583	1.17%
18	0.0724627	0.36%	0.0146	0.485%	0.0232	0.46%
19	0.0612479	0.31%	0.0123	0.410%	0.0194	0.39%
20	0.0328674	0.16%	0.0066	0.220%	0.0102	0.20%
21	0.0333488	0.17%	0.0067	0.223%	0.0103	0.21%
22	0.0177728	0.09%	0.0036	0.119%	0.0053	0.11%
23	0.0153233	0.08%	0.0031	0.103%	0.0046	0.09%
24	0.0163546	0.08%	0.0033	0.110%	0.0050	0.10%
25	0.0299542	0.15%	0.0060	0.201%	0.0092	0.18%
26	0.0461306	0.23%	0.0093	0.309%	0.0142	0.28%
27	0.040081	0.20%	0.0081	0.268%	0.0120	0.24%
28	0.0415898	0.21%	0.0084	0.278%	0.0135	0.27%
29	0.0340079	0.17%	0.0068	0.228%	0.0111	0.22%
30	0.0274983	0.14%	0.0055	0.184%	0.0089	0.18%
31	0.0275551	0.14%	0.0055	0.184%	0.0090	0.18%
32	0.0150937	0.08%	0.0030	0.101%	0.0046	0.09%
33	0.0106303	0.05%	0.0021	0.071%	0.0033	0.07%
34	0.010617	0.05%	0.0021	0.071%	0.0034	0.07%
35	0.00467467	0.02%	0.0009	0.094%	0.0015	0.03%
36	0.00407853	0.02%	0.0008	0.082%	0.0013	0.03%
37	0.0036622	0.02%	0.0007	0.025%	0.0012	0.02%
38	0.0029837	0.01%	0.0006	0.020%	0.0010	0.02%

Table 29 Results from Detailed Assessment for Lead, Cadmium and B[a]P at Specific Receptors Impact Due to the Operation of the SWIP

Receptor	Annual Lead PC ($\mu\text{g m}^{-3}$)	% AQS	Annual Cadmium PC (ng m^{-3})	% AQS	Annual B[a]P PC (ng m^{-3})	% AQS
1	0.00078	0.313%	0.0782	1.56%	0.00157	0.63%
2	0.00505	2.02%	0.5049	10.1%	0.01014	4.06%
3	0.00997	3.99%	0.9968	19.94%	0.02002	8.01%
4	0.00446	1.78%	0.4456	8.91%	0.00895	3.58%
5	0.00249	0.998%	0.2494	4.99%	0.00501	2.00%
6	0.00078	0.311%	0.0778	1.56%	0.00156	0.62%
7	0.00053	0.212%	0.0530	1.06%	0.00106	0.43%
8	0.00048	0.194%	0.0484	0.968%	0.00097	0.39%
9	0.00041	0.165%	0.0412	0.825%	0.00083	0.33%
10	0.00032	0.126%	0.0315	0.631%	0.00063	0.25%
11	0.00035	0.140%	0.0350	0.700%	0.00070	0.28%
12	0.00012	0.048%	0.0120	0.240%	0.00024	0.10%
13	0.00013	0.051%	0.0127	0.254%	0.00026	0.10%
14	0.00014	0.055%	0.0139	0.277%	0.00028	0.11%
15	0.00014	0.056%	0.0140	0.280%	0.00028	0.11%
16	0.00242	0.967%	0.2418	4.84%	0.00486	1.94%
17	0.00180	0.721%	0.1802	3.60%	0.00362	1.45%
18	0.00072	0.290%	0.0725	1.45%	0.00146	0.58%
19	0.00061	0.245%	0.0612	1.23%	0.00123	0.49%
20	0.00033	0.131%	0.0329	0.657%	0.00066	0.26%
21	0.00033	0.133%	0.0333	0.667%	0.00067	0.27%
22	0.00018	0.071%	0.0178	0.355%	0.00036	0.14%
23	0.00015	0.061%	0.0153	0.306%	0.00031	0.12%
24	0.00016	0.065%	0.0164	0.327%	0.00033	0.13%
25	0.00030	0.120%	0.0300	0.599%	0.00060	0.24%
26	0.00046	0.185%	0.0461	0.923%	0.00093	0.37%
27	0.00040	0.160%	0.0401	0.802%	0.00081	0.32%
28	0.00042	0.166%	0.0416	0.832%	0.00084	0.33%
29	0.00034	0.136%	0.0340	0.680%	0.00068	0.27%
30	0.00027	0.110%	0.0275	0.550%	0.00055	0.22%
31	0.00028	0.110%	0.0276	0.551%	0.00055	0.22%
32	0.00015	0.060%	0.0151	0.302%	0.00030	0.12%
33	0.00011	0.043%	0.0106	0.213%	0.00021	0.09%
34	0.00011	0.042%	0.0106	0.212%	0.00021	0.09%
35	0.00005	0.019%	0.0047	0.093%	0.00009	0.04%
36	0.00004	0.016%	0.0041	0.082%	0.00008	0.03%
37	0.00004	0.015%	0.0037	0.073%	0.00007	0.03%
38	0.00003	0.012%	0.0030	0.060%	0.00006	0.02%

Tables 27 to 29 confirm that, when considering the nearest sensitive receptors and assuming the general insignificance thresholds of 1 % of the long-term and 10 % of the short-term Process Contributions, the PC of some pollutants cannot immediately be screened as insignificant. The receptors potentially affected are numbers 1 – 7 and 16 – 19. These receptors represent a mixture of human health and ecological receptors, including local residences, a sports pitch at the Shepton Mallet Leisure Centre, and four areas of priority broadleaved woodland.

As per the assessment of the maximum modelled results reported across the 5 km x 5 km grid, each of the Predicted Environmental Concentrations, which take account of the Process Contribution and the appropriate background, can be screened as insignificant at the secondary assessment stage. It is noted that, when considering the priority woodland habitats, which are ecological sites of local protection and importance, Environment Agency guidance states that where Process Contributions meet both of the following criteria, they are insignificant:

- the short-term PC is less than 100 % of the short-term environmental standard; and
- the long-term PC is less than 100 % of the long-term environmental standard.

6.1 Deposition Assessment

An assessment has also been made of the likely deposition of nutrient Nitrogen and acid to the sensitive ecological receptors, and the potential impact on the receptor Critical Loads.

Critical Loads represent a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Receptor numbers 13 - 15 represent geological Sites of Special Scientific Interest, which are not sensitive to either nutrient Nitrogen or acid deposition and hence have not been included here.

Tables 30 to 32 present the calculated deposition of nutrient Nitrogen and acid to each site. Levels of Nitrogen deposited from NO_x have been reduced to 70 % of the total, as NO does not deposit to any significant extent and as such the reduction accounts for the likely deposited NO₂ fraction.

Similar to the assessment of Critical Levels, contributions to local nature sites (Receptor numbers 16 - 34) can be screened where the PC is less than 100 % of the environmental standard. National and European designated sites (SSSIs, SACs, SPAs, and Ramsar sites) should be assessed against the 1 % insignificance threshold.

The results in the tables demonstrate that, although Process Contributions to nutrient Nitrogen deposition at receptors 16 – 19 and 26, and acid deposition at receptors 16 and 17 equate to more than 1 % of the Critical Loads, they remain well within 100 % of the specified Critical Loads and are therefore screened as insignificant. Contributions of nutrient Nitrogen and acid deposition at all other sites remain well within 1 % of the Critical Loads and are also therefore screened as insignificant.

It should be remembered that the modelling assessment has been undertaken on a worst-case basis, with all discharges assumed to be released at their maximum emission limit value for the entire annual period. This is unlikely to be the case for any plant, which would generally be expected to operate within, albeit up to, an emission limit value for the majority of the time. The reported data are also the maximum modelled results for each receptor, when modelling five-years' worth of meteorological conditions, and assuming a continuous discharge.

Finally, as per the definition, Critical Loads represent an estimate of exposure to deposition below which significant harmful effects do not occur, according to present knowledge. Therefore, remaining within a Critical Load, as the Process Contributions do, would suggest that no significant harm is being caused at a site. The most significant contributions to the Critical Loads come from the existing background contributions, many of which already exceed the environmental standards.

Table 30 Assessment of Contribution to Nutrient Nitrogen and Acid Deposition Critical Loads at Receptor Numbers 16–23

Total Deposited Nutrient Nitrogen and Acid Contributions	Receptor 16	Receptor 17	Receptor 18	Receptor 19	Receptor 20	Receptor 21	Receptor 22	Receptor 23
Rate of Total Deposition as N (kg N/ha/yr)	0.5799	0.4450	0.16646	0.13909	0.07032	0.07149	0.03562	0.03035
Current Maximum Background (kg N/ha/yr)	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76
Low End of Critical Load Range (kg N/ha/yr)	10	10	10	10	10	10	10	10
Deposition as % of Lower Critical Load	5.80%	4.45%	1.66%	1.391%	0.703%	0.715%	0.356%	0.304%
Rate of Total Dry Deposition as N (keq/ha/yr)	0.0413	0.0317	0.011857	0.009907	0.005009	0.005093	0.002538	0.002162
Low End of Critical Load Range N (CLminN keq/ha/yr)	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
Deposition as % of Lower Critical Load	29.09%	22.32%	8.35%	6.98%	3.53%	3.59%	1.79%	1.52%
Current Maximum N Background (keq/ha/yr)	2.45	2.45	2.45	1.79	1.79	1.79	2.45	2.45
PEC N (keq/ha/yr)	2.491	2.482	2.462	1.800	1.795	1.795	2.453	2.452
Is PEC N > CLminN?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rate of Total Dry Deposition as S (keq/ha/yr)	0.0517	0.0392	0.01453	0.01213	0.00594	0.00608	0.00297	0.00252
Rate of Total Deposition as HCl (kg H/ha/yr)	0.0631	0.0479	0.01750	0.01458	0.00717	0.00731	0.00354	0.00299
Rate of Total Deposition as HF (kg H/ha/yr)	0.0042	0.0032	0.00118	0.00098	0.00044	0.00045	0.00021	0.00018
Rate of Total Deposition as S and H (keq/ha/yr)	0.1189	0.0904	0.0332	0.0277	0.0135	0.0138	0.0067	0.0057
Low End of Critical Load Range S (CLmaxS keq/ha/yr)	10.923	10.939	10.923	10.923	10.927	10.927	10.927	10.927
Deposition as % of Lower Critical Load	1.09%	0.83%	0.30%	0.25%	0.12%	0.13%	0.06%	0.05%
Current Maximum S Background (keq/ha/yr)	0.21	0.21	0.21	0.23	0.23	0.23	0.21	0.21
PEC S and H (keq/ha/yr)	0.3289	0.3004	0.2432	0.2577	0.2435	0.2438	0.2167	0.2157
PC Acid (Combined N and S keq/ha/yr)	0.1602	0.1221	0.0451	0.0376	0.0186	0.0189	0.0093	0.0079
Minimum Critical Load (CLmaxN keq/ha/yr)	11.065	11.081	11.065	11.065	11.069	11.069	11.069	11.069
% of Critical Load	1.45%	1.10%	0.41%	0.34%	0.17%	0.17%	0.08%	0.07%
Combined Acid Background (keq/ha/yr)	2.66	2.66	2.66	2.02	2.02	2.02	2.66	2.66
PEC Acid (keq/ha/yr)	2.82	2.78	2.71	2.06	2.04	2.04	2.67	2.67
% of Critical Load	25%	25%	24%	19%	18%	18%	24%	24%

Table 31 Assessment of Contribution to Nutrient Nitrogen and Acid Deposition Critical Loads at Receptor Numbers 24-31

Total Deposited Nutrient Nitrogen and Acid Contributions	Receptor 24	Receptor 25	Receptor 26	Receptor 27	Receptor 28	Receptor 29	Receptor 30	Receptor 31
Rate of Total Deposition as N (kg N/ha/yr)	0.03393	0.06390	0.10175	0.08749	0.09069	0.07323	0.05734	0.0583
Current Maximum Background (kg N/ha/yr)	46.76	46.76	46.76	46.76	46.76	46.76	46.76	46.76
Low End of Critical Load Range (kg N/ha/yr)	10	10	10	10	10	10	10	10
Deposition as % of Lower Critical Load	0.339%	0.639%	1.018%	0.875%	0.907%	0.732%	0.573%	0.58%
Rate of Total Dry Deposition as N (keq/ha/yr)	0.002417	0.004552	0.007248	0.006232	0.006460	0.005216	0.004085	0.0042
Low End of Critical Load Range N (CLminN keq/ha/yr)	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
Deposition as % of Lower Critical Load	1.70%	3.21%	5.10%	4.39%	4.550%	3.67%	2.88%	2.9%
Current Maximum N Background (keq/ha/yr)	1.7	1.7	1.8	1.8	1.3	0.9	1.3	2.45
PEC N (keq/ha/yr)	1.702	1.705	1.807	1.806	1.306	0.905	1.304	2.454
Is PEC N > CLminN?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rate of Total Dry Deposition as S (keq/ha/yr)	0.00285	0.00544	0.00877	0.00756	0.00765	0.00616	0.00482	0.0049
Rate of Total Deposition as HCl (kg H/ha/yr)	0.00339	0.00651	0.01050	0.00908	0.00882	0.00703	0.00552	0.0056
Rate of Total Deposition as HF (kg H/ha/yr)	0.00021	0.00041	0.00069	0.00060	0.00062	0.00050	0.00037	0.0004
Rate of Total Deposition as S and H (keq/ha/yr)	0.0065	0.0124	0.0200	0.0172	0.0171	0.0137	0.0107	0.0108
Low End of Critical Load Range S (CLmaxS keq/ha/yr)	8.483	10.939	10.939	10.939	10.965	10.965	10.965	10.965
Deposition as % of Lower Critical Load	0.08%	0.11%	0.182%	0.158%	0.16%	0.12%	0.10%	0.10%
Current Maximum S Background (keq/ha/yr)	0.2	0.2	0.2	0.2	0.4	0.1	0.4	0.21
PEC S and H (keq/ha/yr)	0.2065	0.2124	0.2200	0.2172	0.4171	0.1137	0.4107	0.2208
PC Acid (Combined N and S keq/ha/yr)	0.0089	0.0169	0.0272	0.0235	0.0235	0.0189	0.0148	0.0150
Minimum Critical Load (CLmaxN keq/ha/yr)	8.625	11.081	11.081	11.081	11.107	11.107	11.107	11.107
% of Critical Load	0.10%	0.15%	0.245%	0.212%	0.21%	0.17%	0.13%	0.14%
Combined Acid Background (keq/ha/yr)	1.90	1.90	2.00	2.00	1.70	1.00	1.70	2.66
PEC Acid (keq/ha/yr)	1.91	1.92	2.03	2.02	1.72	1.02	1.71	2.68
% of Critical Load	22%	17%	18%	18%	16%	9%	15%	24%

Table 32 Assessment of Contribution to Nutrient Nitrogen and Acid Deposition Critical Loads at Receptor Numbers 32-38

Total Deposited Nutrient Nitrogen and Acid Contributions	Receptor 32	Receptor 33	Receptor 34	Receptor 35 Mells Valley 1	Receptor 36 Mells Valley 2	Receptor 37 Woodland SAC1	Receptor 38 Woodland SAC 2
Rate of Total Deposition as N (kg N/ha/yr)	0.0319	0.0198	0.02296	0.0055	0.0042	0.006921121	0.005332744
Current Maximum Background (kg N/ha/yr)	46.76	46.76	46.76	25.5	25.5	39.3	9.3
Low End of Critical Load Range (kg N/ha/yr)	10	10	10	15	15	15	15
Deposition as % of Lower Critical Load	0.32%	0.20%	0.23%	0.04%	0.03%	0.05%	0.04%
Rate of Total Dry Deposition as N (keq/ha/yr)	0.0023	0.0014	0.001635	0.0004	0.0003	0.000493064	0.000379915
Low End of Critical Load Range N (CLminN keq/ha/yr)	0.142	0.142	0.142	0.856	0.856	0.142	0.142
Deposition as % of Lower Critical Load	1.60%	0.99%	1.15%	0.05%	0.04%	0.35%	0.27%
Current Maximum N Background (keq/ha/yr)	2.45	2.45	2.45	1.80	1.80	2.8	2.8
PEC N (keq/ha/yr)	2.452	2.451	2.452	1.800	1.800	2.800	2.800
Is PEC N > CLminN?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rate of Total Dry Deposition as S (keq/ha/yr)	0.0027	0.0016	0.00194	0.0004	0.0003	0.000544226	0.000412342
Rate of Total Deposition as HCl (kg H/ha/yr)	0.0033	0.0019	0.00223	0.0004	0.0003	0.000556521	0.000421694
Rate of Total Deposition as HF (kg H/ha/yr)	0.0002	0.0001	0.00015	0.0001	0.0000	4.44916E-05	3.24992E-05
Rate of Total Deposition as S and H (keq/ha/yr)	0.0061	0.0036	0.0043	0.0008	0.0006	0.0011	0.0009
Low End of Critical Load Range S (CLmaxS keq/ha/yr)	2.619	10.951	10.899	4	4	2.086	2.086
Deposition as % of Lower Critical Load	0.23%	0.03%	0.04%	0.02%	0.02%	0.05%	0.04%
Current Maximum S Background (keq/ha/yr)	0.21	0.21	0.21	0.2	0.2	0.3	0.3
PEC S and H (keq/ha/yr)	0.2161	0.2136	0.2143	0.2008	0.2006	0.3011	0.3009
PC Acid (Combined N and S keq/ha/yr)	0.0084	0.0050	0.0060	0.0012	0.0009	0.0016	0.0012
Minimum Critical Load (CLmaxN keq/ha/yr)	2.761	11.093	11.041	4.856	4.856	2.228	2.228
% of Critical Load	0.31%	0.05%	0.05%	0.03%	0.02%	0.07%	0.06%
Combined Acid Background (keq/ha/yr)	2.66	2.66	2.66	2.00	2.00	3.10	3.10
PEC Acid (keq/ha/yr)	2.67	2.67	2.67	2.00	2.00	3.10	3.10
% of Critical Load	97%	24%	24%	41%	41%	139%	139%

7. Short-Term Releases and Abnormal Operating Conditions

In addition to the basic model parameters included in the study, consideration has been given to the potential for system failures, through the modelling of short-term allowable emission levels, specified in the Industrial Emissions Directive. Although the daily emission limit values specified in the Directive are expected to be met for the vast majority of the time, the Directive also allows for transient increases in the emitted concentration of some pollutants and as such, a series of half-hourly average limit values are specified which have been modelled to estimate the maximum likely short-term contributions.

Due to the transient nature of these permissible conditions it is inappropriate to calculate percentile values based upon annual operation at the half-hourly limit values. Accordingly, assessment of these discharges generally considers the maximum, 100th percentile value in order to represent the absolute worst-case short-term Process Contribution associated with emissions from the plant at the half-hourly Industrial Emissions Directive limit values, although percentile results for averaging periods of less than 24-hours, are also included for information.

Table 33 Short-Term Potential Emissions to Atmosphere During the Operation of the SWIP Biomass Boiler

Pollutant Species	30-Minute Average Concentration (mg Nm ⁻³)	Release Rate (g s ⁻¹)
NO _x	400	0.93
SO ₂	200	0.465
CO	100	0.233
Particulate Matter (as PM ₁₀)	30	0.0698
HF	4	0.0093
HCl	60	0.14
Total Volatile Organic Compounds (VOC)	20	0.0465

A worst-case assessment has also been undertaken to determine the likely impact of abatement system failures, based on the maximum allowable period of operation above the emission limit values, as specified in Article 46 (6) of the IED. This states that plant shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded, and the cumulative duration of operation in such conditions over one year shall not exceed 60 hours. As such, the abatement failure assessment assumes that the plant exceeds the normal and half-hourly emission limit values for a total of 60 hours in a year.

In the absence of any other data, and in order to provide a worst-case assessment, emissions during an abatement failure are modelled at double the allowable 30-minute average concentrations with the exception of emissions of Carbon Monoxide which are assumed to quadruple, and particulate matter as PM₁₀ which has a maximum half-hourly average specified in the IED of 150 mg Nm⁻³ during these times. Emissions of metal compounds are also assumed to double from the normal emission limit values, in the event of a failure of the abatement system. These assumptions are based on historic data from other waste to energy plants where emissions from abatement system failures have been monitored or estimated, and demonstrate a maximum percentage increase of 100 % for most species, with most remaining well within that level, although with CO emissions equating to 400 % of the allowable 30-minute release¹³.

The assumption that releases may, for the most part, double in the event of an abatement failure generally represents a significant over-estimate based on the historic data available and it is important to recognise that, due to the monitoring and control requirements of all incineration plant, it is not permissible to operate at elevated emissions levels for prolonged periods. The Industrial Emissions Directive states that:

- Waste gases from waste incineration plants and waste co-incineration plants shall be discharged in a controlled way by means of a stack the height of which is calculated in such a way as to safeguard human health and the environment.

- In the case of a breakdown, the operator shall reduce or close-down operations as soon as practicable until normal operations can be restored.
- Waste incineration plants and waste co-incineration plants shall operate an automatic system to prevent waste feed in the following situations:
 - at start-up, until 850 °C has been reached;
 - whenever the temperature is not maintained at 850 °C;
 - whenever the continuous measurements show that any emission limit value is exceeded due to disturbances or failures of the waste gas cleaning devices.

As such, any increase in emissions to the half-hourly maximum level would be closely monitored, and plant operations would be corrected such that the daily permissible emissions limits are not generally exceeded. Where, for example, abatement failures are observed, plant operations would be corrected or stopped immediately, and hence, any elevated discharge would be for a very limited period.

The impact of short-term (30-minute) operational releases is considered in Table 34, with the likely Process Contributions from discharges at the maximum half-hourly limit values presented.

Table 34 Maximum Process Contributions During SWIP Biomass Boiler Operation at 30-Minute Emission Limit Values

Pollutant Parameter	Short-Term PC ($\mu\text{g m}^{-3}$)	Short-Term AQS / EAL	% AQS / EAL	Short-Term PEC ($\mu\text{g m}^{-3}$)	% AQS / EAL
Maximum Hourly Average NO ₂	347	200	174 %	360	180 %
99.79 th Percentile Hourly Average NO ₂	65.6	200	33 %	78.3	39 %
Maximum 15-Minute Average SO ₂	351	266	132 %	355.6	134 %
99.9 th Percentile 15- Minute Average SO ₂	102	266	38 %	106.6	40 %
Maximum Hourly Average SO ₂	342	350	98 %	346.4	99 %
99.73 rd Percentile Hourly Average SO ₂	57.8	350	17 %	62.3	18 %
Maximum 8-Hour Average CO (mg m^{-3})	0.19	10	1.87 %	0.38	4 %
Maximum Hourly Average Particulate Matter (as PM ₁₀)	51.3	50	103 %	76.9	154 %
Maximum Hourly Average HF	6.8	160	4 %	6.8	14 %
Maximum Hourly Average HCl	103	750	14 %	103	14 %
Maximum Hourly Average VOC	35.2	195	18 %	35.5	18 %

Note: The Environmental Assessment Level stated for VOC is the hourly limit for Benzene.

When applying the usual short-term assessment whereby a short-term PC of less than 10 % can be screened as insignificant, only the short-term emissions of Carbon Monoxide and Hydrogen Fluoride can immediately be screened as insignificant and, with Process Contributions above 20 % at the initial assessment stage, the impact of NO₂, SO₂, and PM₁₀ emissions would clearly not be screened as insignificant during a second stage assessment. However, assessment of short-term, transient contributions against standards which have different referencing periods and may include percentile values, is not a strictly relevant comparison, and presents a worst-case approach. When accounting for allowable exceedances specified for the short-term assessment levels, each of the Process Contributions and the Predicted Environmental Concentrations remain within the stated Environmental Quality Standard when discharging at the allowable half-hourly limit values, and therefore are not predicted to exceed the assessment levels.

When comparing the maximum (100th percentile) hourly PC and PECs for NO₂, short-term (15-minute) SO₂, and PM₁₀ calculated from a maximum half-hour release rate, against the short-term AQS levels, which all incorporate allowable exceedances, then neither the process contributions nor the resultant environmental concentration can be screened. However, as noted above, the averaging periods are not directly comparable and the results therefore present an overly conservative assessment of the process contributions to the assessment levels, with shorter periods generally recognised as having higher emissions and assessment levels. Therefore, it is likely that, should a maximum half-hourly assessment level be available for these three pollutants, the Predicted Environmental Concentration would remain within this assessment level, and these short-term releases are unlikely to pose a threat to the achievement of the longer-term standards.

When considering the potential for abnormal operating conditions to occur and assuming a doubling of the short-term Process Contributions for most species, the quadrupling of contributions of CO, and a maximum PM₁₀ release of 150 mg Nm⁻³ in the event of a failure of the abatement plant, the resultant Process Contributions and Predicted Environmental Concentrations would continue to remain within the relevant Environmental Quality Standard as detailed in Table 35.

Table 35 Annual Contribution to Pollutant Levels Assuming a Maximum of 60-Hours Abnormal Operations

Pollutant	Annual Average PC ($\mu\text{g m}^{-3}$)	PC for 8,700 Hours ($\mu\text{g m}^{-3}$)	Abnormal Annual Average PC ($\mu\text{g m}^{-3}$)	PC for 60 Hours ($\mu\text{g m}^{-3}$)	Total PC ($\mu\text{g m}^{-3}$)	Long-Term Background ($\mu\text{g m}^{-3}$)	PEC ($\mu\text{g m}^{-3}$)	AQS / EAL ($\mu\text{g m}^{-3}$)	PEC as % of AQS / EAL
NO ₂ #	7.74	7.68	30.94	0.2119	7.89	6.37	14.26	40	36%
SO ₂	1.93	1.92	15.47	0.1060	2.02	2.25	4.27	20	21%
HCl	0.388	0.385	4.66	0.0319	0.42	0.41	0.83	750*	0.11%
HF	0.039	0.038	0.31	0.0021	0.041	0.003	0.04	16	0.27%
VOC#	0.388	0.385	1.547	0.0106	0.40	0.1294	0.52	5	10%
CO# (mg m ⁻³)	0.002	0.0019	0.015	0.0001	0.002	0.09455	0.10	10	1.0%
PM ₁₀	0.388	0.385	5.806	0.0398	0.42	12.81	13.23	40	33%
Cd	1.930	1.916	3.859	0.0264	1.94	0.098	2.04	5	41%
Hg	0.0019	0.00192	0.004	0.000026	0.0019	0.001533	0.003	0.25	1%
Pb	0.0388	0.0385	0.078	0.000531	0.039	0.00361	0.04	0.25	17%

#Process Contributions of NO₂, VOC and CO above consider emissions from the SWIP biomass boiler only.

*HCl has a short-term Environmental Assessment Level only.

The results in Table 35 above present the annual contribution to pollution levels, assuming that an abnormal release, due for example to an abatement system failure, occurs for the maximum allowable 60-hour per year period. Normal operational conditions have been assumed for the remainder of the year and the annual average Process Contributions are therefore pro-rated to account for a normal discharge during 8,700 hours in the year, and an elevated discharge for the remaining 60 hours.

Assessing the overall potential longer-term Process Contributions and Predicted Environmental Concentrations in this way provides a robust assessment of pollutant discharges where only longer-term standards are in place. The calculation also presents a realistic, but conservative worst-case assessment as, although the site has the potential to exceed the emission limits specified by the IED for up to 60 hours per year, it will not necessarily do so and additionally, calculating the increase in emissions over the course of the year ensures that all meteorological conditions, including the worst-case conditions for the discharge from the flues, are accounted for in the assessment. Although occasional exceedances of the emission limit values may occur in line with the allowable exceedances identified by the IED, these will not necessarily occur during poor meteorological conditions, will not necessarily be allowed to continue for up to four hours at a time, and will not necessarily occur for a total of 60 hours per year.

Despite the robustness and somewhat conservative nature of this assessment, the results in Table 35 predict that the environmental concentration of all increased pollutants will remain well within 70 % of the AQS or EAL despite the elevated emissions assumed to occur on a temporary basis through abnormal emissions and the potential failure of abatement systems. As such, the pollutant contributions from all allowable operations can be screened as insignificant.

8. Conclusions

A detailed air quality assessment has been undertaken for a Justsen 4.39 MW_{th(input)} SWIP biomass boiler that is to be installed to provide up to 6 tonnes per hour steam for process use at the Framptons Limited site on Charlton Road in Shepton Mallet. The SWIP biomass boiler will be located in a new building adjacent the main site process building and will burn non-hazardous waste wood chip fuel. The boiler will be supplied by Novalux Energy Limited.

Additionally, a separate gas-fired, Combined Heat and Power (CHP) plant will be installed and operated at the site by a third-party (Pure World Energy). The CHP unit comprises a CHP, a steam boiler and a smaller generation unit and will be capable of producing up to 2 tonnes per hour of steam. This plant has been considered in combination with the SWIP, as all units are being installed within the same area of the site at a similar time, and will each operate largely continuously.

The assessment included a chimney height calculation based upon the procedures in HMIP Guidance Note D1, subsequently verified by detailed atmospheric dispersion modelling using the ADMS Version 5.2 model. Emissions data and chimney discharge conditions were provided via Novalux Energy Limited and Pure World Energy Limited, and building dimensions were taken from site plans and process drawings. The chimney height assessment confirmed that a discharge point at 18 m for all flues should result in adequate dispersion of the emissions from the SWIP biomass boiler, and this therefore confirmed the consented stack heights of 18.445 m which were then applied to the modelling exercise.

In line with Environment Agency guidance for modelling of the short-term conversion of NO_x to NO₂, it was assumed that 50 % of the NO_x emission is released as NO₂, with 100 % conversion as the basis for long-term (annual average) assessment. The calculations also assumed that all of the particulate emissions from the SWIP biomass boiler were as PM₁₀, which may overestimate the significance of the particulate release. Estimates of existing background concentrations were taken from publicly available sources including measured emissions from DEFRA and Mendip Borough Council, estimated data from DEFRA, and site-specific data for sensitive ecological receptors from the APIS website. The background data applied related to the locality of the proposed boiler plant where possible, or were specific to identified receptors. Some measured background data is only available from less local sources however, and where this is the case, the most representative data has been applied.

A detailed air quality assessment was undertaken based upon the ADMS Version 5.2 atmospheric dispersion model, utilising hourly average meteorological data sets for the Bristol Airport measurement station, which is located approximately 25 km to the north, north-west of the site. The results confirmed that chimney heights of 18.445 metres will provide effective dispersion of emissions from the SWIP biomass boiler to be installed at Framptons Limited, and similarly for the CHP plant. Resulting increases in background pollutant concentrations under normal operating conditions, will be low and can be screened out as insignificant in accordance with guidance provided by the Environment Agency, either at the initial or secondary assessment stages. The associated risk to the health of members of the general public living and working nearby will therefore be low, and the potential impact on sensitive ecological sites when considering both air quality impacts and the impact of deposition onto sensitive habitats in the vicinity of the plant will similarly be low.

Short-term impacts are less easily defined due to the lack of relevant assessment levels. However, even when applying an overly conservative assessment, considering the worst-case results of shorter-term (half-hourly) emissions against longer-term (hourly) assessment levels the environmental concentration of the majority of pollutants do not exceed the most appropriate assessment level. Exceptions to this are suggested for the maximum hourly NO₂ and PM₁₀ and the maximum 15-minute contributions of SO₂. However, it is likely that, should a 30 minute assessment level be available for these pollutants, the Predicted Environmental Concentration would remain within the assessment level, and the results of the longer-term modelling suggest that these short-term releases are unlikely to pose a threat to the achievement of the longer-term standards. The potential for abnormal operating conditions to occur over the course of a year has also been considered and the impact of such incidents can be screened as insignificant.

Appendix 1 D1 Calculation Output

Summary of D1 Stack Height Calculation

Site: Framptons Limited: Shepton Mallet March 2021.

Pollution Index for each Pollutant

SO₂

D 0.116 g s⁻¹
 Gd 0.35 mg m⁻³
 Bc 0.0045 mg m⁻³
 Pi = 335.7453 m³ s⁻¹

NO

D 0.6232 g s⁻¹
 Gd 4.4 mg m⁻³
 Bc 0.04512 mg m⁻³
 Pi = 143.1038 m³ s⁻¹

NO₂

D 0.3116 g s⁻¹
 Gd 0.2 mg m⁻³
 Bc 0.04512 mg m⁻³
 Pi = 2011.88 m³ s⁻¹

HCl

D 0.0233 g s⁻¹
 Gd 0.75 mg m⁻³
 Bc mg m⁻³
 Pi = 31.06667 m³ s⁻¹

CO

D 0.352 g s⁻¹
 Gd 30 mg m⁻³
 Bc 0.1891 mg m⁻³
 Pi = 11.80776 m³ s⁻¹

VOC (assumed to be Benzene)

D 0.0393 g s⁻¹
 Gd 0.195 mg m⁻³
 Bc 0.000259 mg m⁻³
 Pi = 201.8062 m³ s⁻¹

Suspended Particulate Matter

D 0.0233 g s⁻¹
 Gd 0.05 mg m⁻³
 Bc 0.02562 mg m⁻³
 Pi = 955.6987 m³ s⁻¹

HF

D 0.00233 g s⁻¹
 Gd 0.16 mg m⁻³
 Bc mg m⁻³
 Pi = 14.5625 m³ s⁻¹

Major Pollutant = 2011.88

Final discharge height (C), correcting for nearby buildings

Ub = 3.68 m
 Um = 7.31 m
 U = 3.68 Uncorrected discharge stack height
 A = 1.99 If no value for Ub, or if Ub > Um, then A = 1
 Tm = 29.91 Maximum T when considering all relevant buildings.
 Hm = 11.97 Maximum H when considering all relevant buildings.
 -U/Hm = -0.307

All buildings within a range of 5Um should be considered.

5Um = 36.56237 m

Multiple or Tall Buildings:

$C = Hm + (1 - Hm/Tm)[U + (Tm - U)(1 - A - U/Hm)]$ Therefore, C = 17.17 m calculated stack height
18 m final total stack height

9. References

- ¹ Her Majesty's Inspectorate of Pollution, Technical Guidance Note (Dispersion) D1, "Guidelines on Discharge Stack Heights for Polluting Emissions", HMSO, (1993)
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- ³ <http://www.hse.gov.uk/pubns/priced/eh40.pdf>
- ⁴ <https://uk-air.defra.gov.uk/data/laqm-background-home>
- ⁵ Chimney Heights Memorandum (HMSO,1981)
- ⁶ <https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit>
- ⁷ AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air. Updated version, (Approved March 2014)
- ⁸ Expert Panel on Air Quality Standards. Guidelines for Halogens and Hydrogen Halides in Ambient Air for Protecting Human Health Against Acute Irritancy Effects. DEFRA, The Scottish Executive, The National Assembly for Wales and the Department of the Environment in Northern Ireland. March 2006
- ⁹ 2020 Air Quality Annual Status Report (ASR) In fulfilment of Part IV of the Environment Act 1995. Local Air Quality Management. June 2020. Mendip District Council
- ¹⁰ EPUK and IAQM, Land-Use Planning and Development Control: Planning for Air Quality. January 2017
- ¹¹ https://uk-air.defra.gov.uk/networks/site-info?uka_id=UKA00473
- ¹² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/532474/LIT_7349.pdf
- ¹³ Energy Recovery Facility Kingswood, Cannock. Air Quality – Technical Appendix 6/1 Atmospheric Dispersion Modelling SLR Ref: 402.0034.00320. July 2010