AIR QUALITY ASSESSMENT TO SUPPORT A PROPOSAL TO INSTALL A THIRD CHP UNIT AT BRYN POWER LIMITED

GELLIARGWELLT FARM, GELLIGAER, HENGOED, CF82 8FY

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Executive Summary

Bryn Power Limited operates an anaerobic digestion (AD) facility at their site on Gelliargwellt Farm in Hengoed. The AD plant currently includes two 0.5 MW combined heat and power (CHP) engines which receive the biogas from the process in order to create energy. Bryn Power Limited are now considering the installation of a third CHP unit with a capacity of 1 MW, in order to efficiently and effectively utilise the digestion process to its maximum potential. The unit will be located adjacent the two existing engines with its discharge stack to the north, and a third process tank also required to service the new system.

Other combustion processes are also operational within the site boundary, including two small waste incineration plant (SWIPs).

Environmental Visage Limited has been requested to provide an air quality assessment to ensure that, anticipated contributions of combustion gases from the new CHP discharge in such a way as to result in an acceptable process contribution to the local environment. The assessment has assumed that the three CHP units and the two SWIPS discharge continually throughout the year, at the maximum permitted emissions concentrations, as regulated by the site Environmental Permits. This report details the assessment undertaken and the results obtained.

Detailed dispersion modelling demonstrated that, when discharging at maximum emission levels and applying the accepted methodology for screening insignificant impacts, none of the contributions to pollutant levels or the Predicted Environmental Concentrations exceeded their relevant assessment levels outside of the site boundary. At one location within the site boundary, calculated contributions of Benzene to the 24-hour assessment level could not be screened, and exceeded the assessment level marginally. However, occurring for one 24-hour period at a single location on a site roadway, there is no potential for any relevant exposure of members of the general public, or of site workers to the calculated levels of Benzene from total VOCs. All other pollutants remain within their relevant assessment levels at all locations and across all referencing periods.

When considering the impact of emissions at local sensitive receptors, most pollutants could be screened as insignificant at either the primary or secondary stage. The one exception to this was when considering the contribution of acid deposition to the Critical Load at the Nelson Bog SSSI, where contributions ranged from approximately 2.1 to 3.7 % of the Critical Load.

It is therefore concluded that, based on the releases to atmosphere from the existing and proposed plant at Bryn Power Limited, modelled in combination and at maximum permitted emission levels, the Process Contributions from the proposed future operations can be screened as being not significant in relation to human health, and insignificant or very small at local sensitive ecological sites.

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Issue and Revision Record

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1	07/03/2022	Amanda Owen	ENVISAGE	Issue 1 to Client
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1. Introduction

Bryn Power Limited operates an anaerobic digestion (AD) facility at their site on Gelliargwellt Farm in Hengoed, located in the County Borough of Caerphilly, South Wales. The AD plant includes two combined heat and power (CHP) engines which receive the biogas from the process in order to create energy and a third, larger CHP is now proposed in order to optimise the use of the facility and the biogas created.

Environmental Visage Limited (Envisage) has therefore been commissioned to undertake a detailed air quality assessment to determine the likely impact of emissions from the new CHP in combination with the existing site processes. Previous modelling and air quality assessments undertaken by Envisage for Bryn Power Limited have considered emissions from the two existing CHP engines and two 'small waste incineration plant' (SWIPs) also located on the site. This report details the latest assessment undertaken, which accounts for these existing processes plus the new CHP, and presents the results obtained.

2. Principal Objectives and Scope of Work

The principal aim of the work undertaken was to determine the nature of the dispersion of airborne pollutants from the existing site processes in combination with a proposed new CHP engine. The new, 1 MW engine will support the two existing 0.5 MW engines already located that the site, which serve the Bryn Power AD facility. However, modelling also considered the emissions from other operational plant at the site, comprising two SWIPs for the combustion of Grade B and Grade C recycled wood chip fuel.

Each of the CHP units will operate almost continuously in order to optimise the use of the biogas produced by the AD plant. It is assumed that the SWIP units also operate continuously, and all discharges have been modelled at their maximum permitted emission limit values (ELVs). Therefore, this study provides a worst-case assessment in relation to the emissions from the operational plant at the site.

The operations are located at Gelliargwellt Farm, Hengoed, with the nearest off-site residents situated to the east in Gelligaer. The aerial imagery below shows the location of the site and the surrounding villages. The main Gelliargwellt Farm waste recycling operations are marked on the plan with a red star, although the Bryn Group operations continue to utilise a much wider area for their additional aggregates and dairy operations.

Figure 1 Aerial View of the Bryn Group Waste Recycling Operations

Aerial imagery attributable to Google 2022.

The only definitive means of quantifying the impact of process emissions on air quality and the surrounding area is to undertake a comprehensive programme of environmental monitoring around the site in question. As an alternative, atmospheric dispersion modelling provides a means of estimating the potential impacts of emissions with a reasonable degree of confidence, by modelling the dispersion of a plume or plumes exiting a chimney in relation to a number of key parameters. This enables the calculation of an estimated contribution to ground level pollutant concentrations arising from the releases, prior to the development or authorisation of new or modified plant.

For the purpose of this study, the latest version of the UK Atmospheric Dispersion Modelling System was used (ADMS 5.2). The ADMS model is one of the leading atmospheric dispersion models available in the UK and can be used to assess ambient pollutant concentrations from a wide variety of emissions sources associated with an industrial installation.

3. Study Parameters

3.1 ADMS Model

The ADMS Version 5.2 modelling software is one of a range of atmospheric dispersion models available for assessing the impact on local air quality of pollutant emissions to atmosphere. The ADMS model uses two parameters to describe the atmospheric boundary layer, namely the boundary layer height (h) and the Monin-Obukhov Length (L_{MO}), and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions. 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).[1]

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).

3.2 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. This included the following:

- Selection of the dispersion model - ADMS 5.2 is a commonly used atmospheric dispersion model and results have 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 calculated through numerical weather predictions (NWP). This data is produced by computer models which process weather observations to forecast the weather in a particular area and is especially useful where no local or relevant measured data is available. Although there is a local weather station (approximately 10 km distant) at Cwmbargoed, the data capture from this site is severely limited. The next most local monitoring stations are at St Athan or Cardiff, both of which are located on the Bristol Channel. Therefore, in order to apply local, inland data to the modelling, the use of NWP data is considered to be the most representative of local conditions;
- Plant operating conditions – Operating conditions were based upon process information provided by Bryn Power Limited and assume continuous discharges;
- Receptor locations - A 4 km x 4 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 site. Specific receptor locations were also included in the model to provide detailed assessment at these sensitive locations; 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 the releases.

Results were considered in the context of Air Quality Standard (AQS) objective values and relevant Environmental Assessment Levels (EALs) recommended by the Environment Agency and Natural Resources Wales. 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.

The location and dimensions of the chimneys associated with the combustion units at the Bryn Power site, along with those of adjacent buildings and structures were obtained from drawings provided by Bryn Power Limited.

Details of the release characteristics from each of the combustion units at the site have their base in the current Permit emission limit values, and either maximum capacity or extractive testing data provided for each of the existing plant. The model assumes that all units operate concurrently and continuously at the specified discharge volume flow rates and velocities, emitting pollutants at the maximum permitted levels.

3.3 Emission Parameters

Emissions to atmosphere are vented through individual chimney stacks, one per plant. The two original CHP units are located close together and their stacks discharge through the roof of the engine enclosure at heights of 10 m above ground level. The two SWIPs are located further afield with one associated with the In-Vessel Composting (IVC) building, and the other associated with the Materials Recycling Facility (MRF). The new CHP engine will be located adjacent the original CHP units, with its stack situated to the north.

Figure 2 presents the layout of the site buildings and the locations of the stacks modelled, highlighted by red spots. The detailed discharge point, emission and building parameters are presented in Tables 1 – 3.

Due to the need to locate the three engines in close proximity to one another, an initial assessment of the stack height requirement was undertaken for the new unit and suggested a required stack height of 19 m in order to adequately disperse the cumulative emissions. This discharge height was therefore applied to the new unit, in the detailed modelling.

It is noted that the SWIPs have the potential to release pollutants in addition to those listed here. However, only those which might impact on the assessment of the CHP units are included in this study. It is also noted that the anaerobic digestion facilities include a flare for emergency releases. However, as this will only operate in emergencies and at that point emissions from the engines would be reduced or would stop, it is not considered further in this study.

Figure 2 Building and Discharge Point Layout

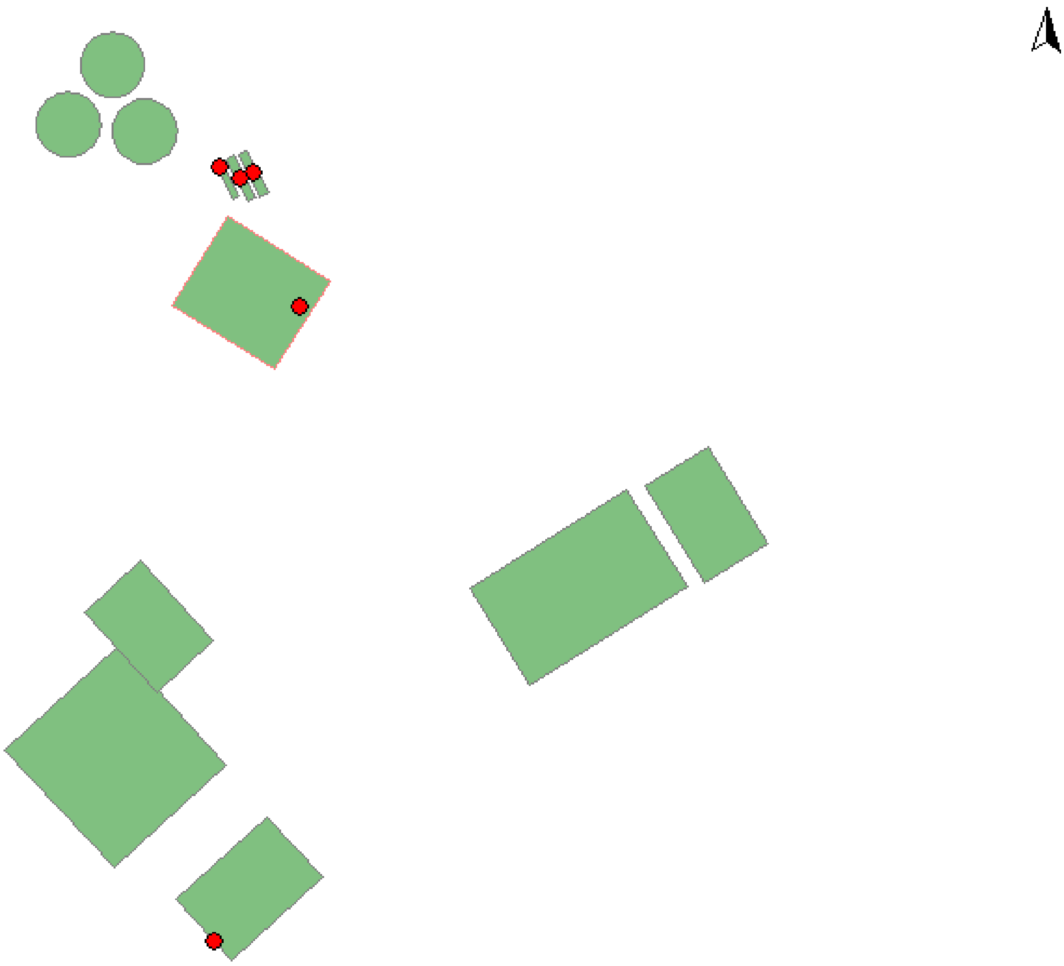


Table 1 Discharge Point Parameters

Parameter	CHP 1	CHP 2	New CHP	SWIP 1	SWIP 2
Description	Clarke Jenbacher	Edina	Clarke Jenbacher	Boiler 1 (MRF wood)	Boiler 2 (IVC)
Grid Reference of Flue	312450 196700.9	312445 196699.1	312436.47 196703.67	312434.6 196390.7	312468.9 196647.2
Internal Flue Diameter (m)	0.35	0.25	0.35	0.5	0.5
Stack Height - current or proposed (m)	10	10	19	14	14
Temperature of Release (°C)	201	205	180	161.6	118
Oxygen Content of Release (%)	8.1	7.6	8.1	9.6	7
Moisture Content of Release (%)	11.9	12	11.9	14.1	13
Actual Flow Rate ($Am^3 s^{-1}$)	1.37	1.82	2.0	1.033	1.08
Emission Velocity at Stack Exit ($Am s^{-1}$)	14.3	37	21.2	5.3	5.5

Table 2 Emission Levels from Each Flue

Plant and Parameter	Carbon Monoxide	Nitrogen Dioxide	Sulphur Dioxide	VOCs	Hydrogen Chloride	Hydrogen Fluoride
CHP 1 Clarke Jenbacher Engine						
Concentration (mg m^{-3})	1400	500	350	2000	-	-
Mass Release (g s^{-1})	0.77	0.275	0.19	1.1	-	-
CHP 2 Edina Engine						
Concentration (mg m^{-3})	1400	500	350	2000	-	-
Mass Release (g s^{-1})	1.045	0.373	0.26	1.49	-	-
New CHP Clarke Jenbacher Engine						
Concentration (mg m^{-3})	1400	500	350	2000	-	-
Mass Release (g s^{-1})	1.22	0.436	0.31	1.74	-	-
SWIP 1 MRF Wood						
Concentration (mg m^{-3})	50	200	50	10	10	1
Mass Release (g s^{-1})	0.032	0.128	0.032	0.006	0.006	0.0006
SWIP 2 IVC						
Concentration (mg m^{-3})	50	200	50	10	10	1
Mass Release (g s^{-1})	0.04	0.18	0.04	0.01	0.01	0.001

The discharges from CHPs 1 and 2 have been combined within the models, to account for the fact that emissions from chimneys in very close proximity to one another will effectively act as a single plume with combined source characteristics. Data of the individual sources and emissions were entered into the model, which was then set to calculate the combined source parameters and model the two CHP flues together as a single source.

Table 3 Associated Building Dimensions

Building	Height (m)	Length (m)	Width (m)
IVC building housing the biomass boiler	10.5	48.9	42.4
Engine Enclosure 1 (CHP 1)	3.5	12.2	3
Engine Enclosure 2 (CHP 2)	3.5	12.2	3
Engine Enclosure 3 (New CHP)	5.5	12.2	3
Tank 1	12	26	-
Tank 2	12	26	-
Tank 3 (New Tank)	12	26	-
Farm buildings 1 and 2	8.6	110.0	46.0
MRF 1	9.2	49.9	32.9
MRF 2	12.6	64.9	61.9
MRF 3	9.2	43.4	31.0

For processes which have a stack or stacks located on top of a building, or adjacent to a tall building, the effect of surrounding structures may need to be taken into account. As a general guide, building downwash problems (where emissions are caught in the turbulent wake of the wind blowing around a building), may occur if the stack height is less than 2.5 times the height of the building upon which it sits. Buildings which sit adjacent to stacks may need to be considered if they are within 5 stack heights of the point of release. The most significant buildings and structures around the site were therefore included in the model to ensure a robust approach. Building shapes must be simplified for incorporation into the ADMS model, and hence a series of shapes denote the more complex site buildings.

3.4 Detailed Consideration of Pollutants

Atmospheric Chemistry

Emissions of Oxides of Nitrogen will comprise contributions of Nitric Oxide (NO) and Nitrogen Dioxide (NO_2). Air quality assessments are made against the concentration of NO_2, which is a more toxic gas than Nitric Oxide, however combustion flue gases mainly comprise NO which requires time in the atmosphere to oxidise to NO_2. As emissions of NO_2 are only one constituent of the total emissions of NO_x from combustion sources, an allowance for the NO_2 proportion of NO_x has to be made.

In current Environment Agency risk assessment guidance[2] which is also applied by Natural Resources Wales, consideration of short-term Process Contributions (PC) and Predicted Environmental Concentrations (PEC), assume only 50 % of emissions of NO_x convert to NO_2 in the environment, whilst long-term Process Contributions and Predicted Environmental Concentrations assume all NO_x convert to NO_2. Hence in the modelling work undertaken, it has been assumed that 50 % of the NO_x emission is converted to NO_2 in the short-term (up to 1 hour).

This method may overestimate concentrations of NO_2 in close proximity to the emission points, as the conversion of NO_X to NO_2 is unlikely to be instantaneous, requiring the mixing of the plume with the ambient air and its associated oxidant species such as Ozone (O_3) etc.

The combination of emissions, atmospheric chemistry, and meteorology can drive substantial variation in the distributions of hourly pollutant concentrations across the year and across each day that underpin any given annual average pollutant concentration. The Air Quality Standards account for this by establishing both a long-term (annual mean) and a short-term (one hour mean) to reflect the varying impacts on health of differing exposure to pollutants. For example, the long-term standard for NO_2 (40 µg m^{-3}) is lower than the short-term standard (200 µg m^{-3}) owing to the chronic health effects associated with exposure to low concentrations of pollutants for prolonged periods.

Deposition Factors

The deposition velocity of pollutants is employed to determine the rate of nutrient Nitrogen and acid deposition at sensitive ecological sites such as Sites of Special Scientific Interest (SSSIs). Rates of dry deposition were included within the model where available and were based on the following parameters, specified by the Regulator for habitat Appropriate Assessment modelling[3].

Table 4 Recommended Deposition Factors

Pollutant	Recommended Deposition Velocity (m s^{-1})	
	Grassland	Woodland
Nitrogen Dioxide	0.0015	0.003
Sulphur Dioxide	0.012	0.024
Hydrogen Chloride	0.025	0.06

Where a dry deposition velocity cannot be specified, pollutants are identified as reactive or un-reactive depending on whether or not the gas will undergo a significant chemical reaction with the surface of the ground. Hydrogen Fluoride was assumed to be reactive, whereas all other pollutants were assumed to be unreactive. Although some volatile organic compounds (VOCs) would generally be considered to be reactive, Benzene, which is the specific VOC referred to by the Air Quality Standard, has a low solubility and hence was assumed to be a less reactive compound.

Information from CERC, the company which developed the ADMS model, specifies that for SO_2, NO_2, and NH_3, 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. This is supported by the Regulators guidance[3] which states that "It is considered that the wet deposition of SO_2, NO_2 and NH_3 is not significant within a short range. However, wet deposition for HCl and HNO_3 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.

3.5 Local Environmental Conditions

Background Pollutant Levels

Estimates of background concentrations for NO_X, NO_2, PM_{10} and $PM_{2.5}$ are provided on DEFRA's Background Mapping Data website[4], which provides estimates of background levels of pollution across the country. Data have been drawn from a location in the vicinity of the site (Grid Reference 312500 196500) and have been extrapolated from base data to 2022.

Table 5 Background Pollution Levels Close to Bryn Power

Pollutant	Year of Base Data	Estimated Annual Average Background Concentrations µg m^{-3}
Carbon Monoxide	2001	0.12*
Oxides of Nitrogen	2018	7.82
Nitrogen Dioxide	2018	6.18
Sulphur Dioxide	2001	3.24#
Benzene (for VOCs)	2010	0.23

* Background concentrations of Carbon Monoxide are presented in mg m^{-3}.
# Background SO_2 concentrations are reported at the base data (2001) values.

Surface Roughness

For the purpose of running the ADMS model, it is necessary to assign a surface roughness figure to the area to be modelled. This describes the degree of ground turbulence caused by the passage of winds across surface structures. The degree of ground turbulence is much greater in urban areas than in rural areas due to the presence of tall buildings increasing the level of turbulence. ADMS requires the selection of a surface roughness factor to be input into the model, or for a complex surface roughness file to be produced to identify different areas of ground turbulence. A sensitivity analysis confirmed that, in this case, the application of a complex spatially variable surface roughness file resulted in slightly lower Process Contributions than were reported when applying a single surface roughness factor across the entire modelled grid. As such, a single surface roughness factor of 0.3 was chosen to represent the site and its local area, which is characteristic of agricultural areas.

Terrain Data

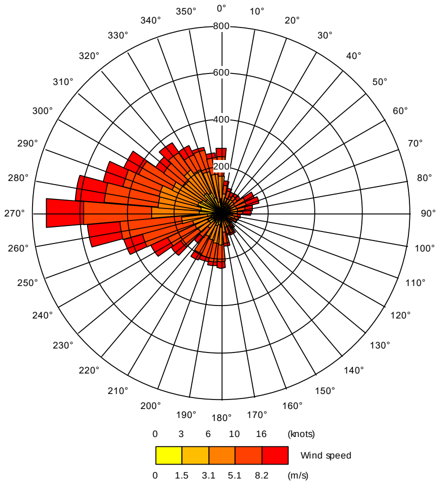
The use of terrain data was considered prior to running the model. A sensitivity assessment provided in previous modelling for the site confirmed that terrain effects, which are only included if the local gradient exceeds 1:10, appeared to have limited impact on the emissions from the SWIP units, which were the primary focus of that study[5]. However, a new sensitivity assessment was also undertaken for a model primarily focusing on the CHP systems[6], and noted a distinct increase in the process contributions when terrain data was included. This is as would be expected due to the location of the AD plant and CHP engines at the foot of a hill.

Therefore, Terrain 50 digital data were used to map the terrain local to the Bryn Power Limited site, and all models were run with the terrain module activated.

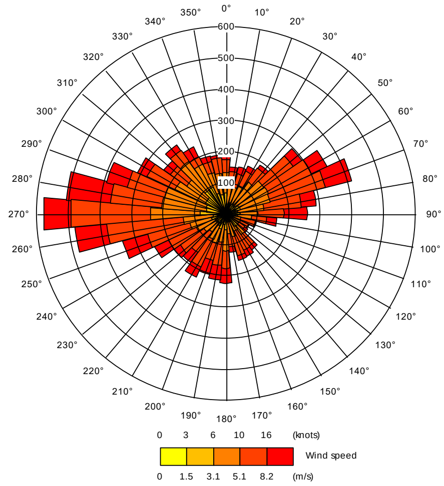
3.6 Meteorological Data

One of the key factors affecting the dispersion characteristics of a plume is the height it can gain above the release point, as a result of momentum and buoyancy. The higher the plume rises, the greater the volume of the atmosphere in which it can disperse, and the lower the potential contribution to ground level concentrations of pollutants. This in turn results in a lower potential impact on the environment. Additionally, meteorological conditions affect the dispersion of a plume, and thus the ADMS model uses comprehensive data to determine the impact of the weather on emissions. As a minimum requirement for modelling plume dispersion, details of wind speed, direction, stability conditions and mixing height are required. A total of five years' worth of numerical weather prediction meteorological data were employed in this modelling exercise (2017 – 2021). The wind-roses from the data are presented over page and report westerly and easterly prevailing wind directions for the local area.

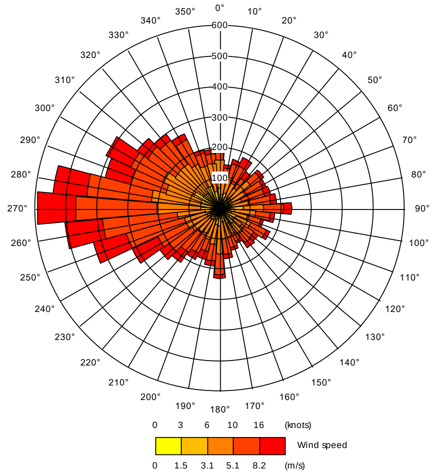
Figure 3 Wind-Roses from Numerical Weather Predictions for the Area Local to Bryn Power Limited at Gelliargwellt Farm, Hengoed



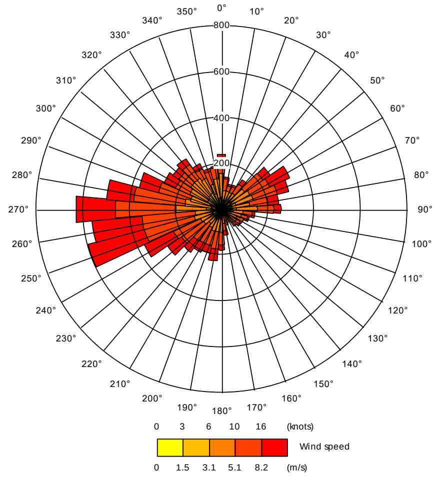
Wind-Rose for 2017



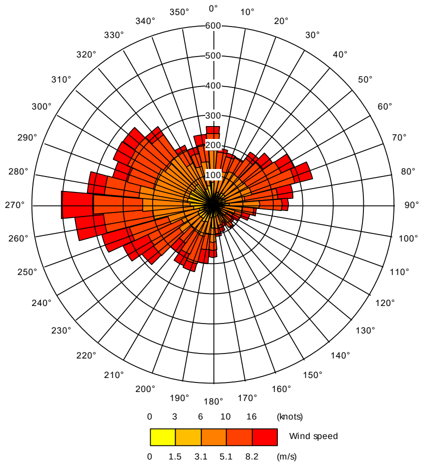
Wind-Rose for 2018



Wind-Rose for 2019



Wind-Rose for 2020



Wind-Rose for 2021

3.7 Model Output Parameters

The ADMS 5.2 model calculates the likely contribution to ground level concentrations within a definable grid system, which is pre-determined by the user. For the purpose of this study a Cartesian co-ordinate grid system was chosen, to cover an area of 4 km x 4 km with the location of the proposed emission points identified at the approximate centre of the grid. The Cartesian style grid has regular, pre-defined increments, 20 m apart in both northerly and easterly directions. Ground level concentrations are specified at the intersections of these grid lines.

A selection of points were also included in the model to represent sensitive receptors in the area, and consideration of the requirements of the Part IV of the Environment Act 1995: Local Air Quality Management Technical Guidance LAQM.TG(16)[7], was made in choosing these receptors. With regards to air quality for human health, this states that an assessment of the quality of the air should be made at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present. Hence, receptor points 1 – 16 incorporated within the model represent local residential properties and areas close to the Bryn Power site and include points 1 - 3 which are the nearest downwind residential receptors to the site, and receptor number 16, which represents the location of a farmhouse situated within the confines of the Bryn Power Limited site. Details of the sensitive receptors are included in Table 6 over page.

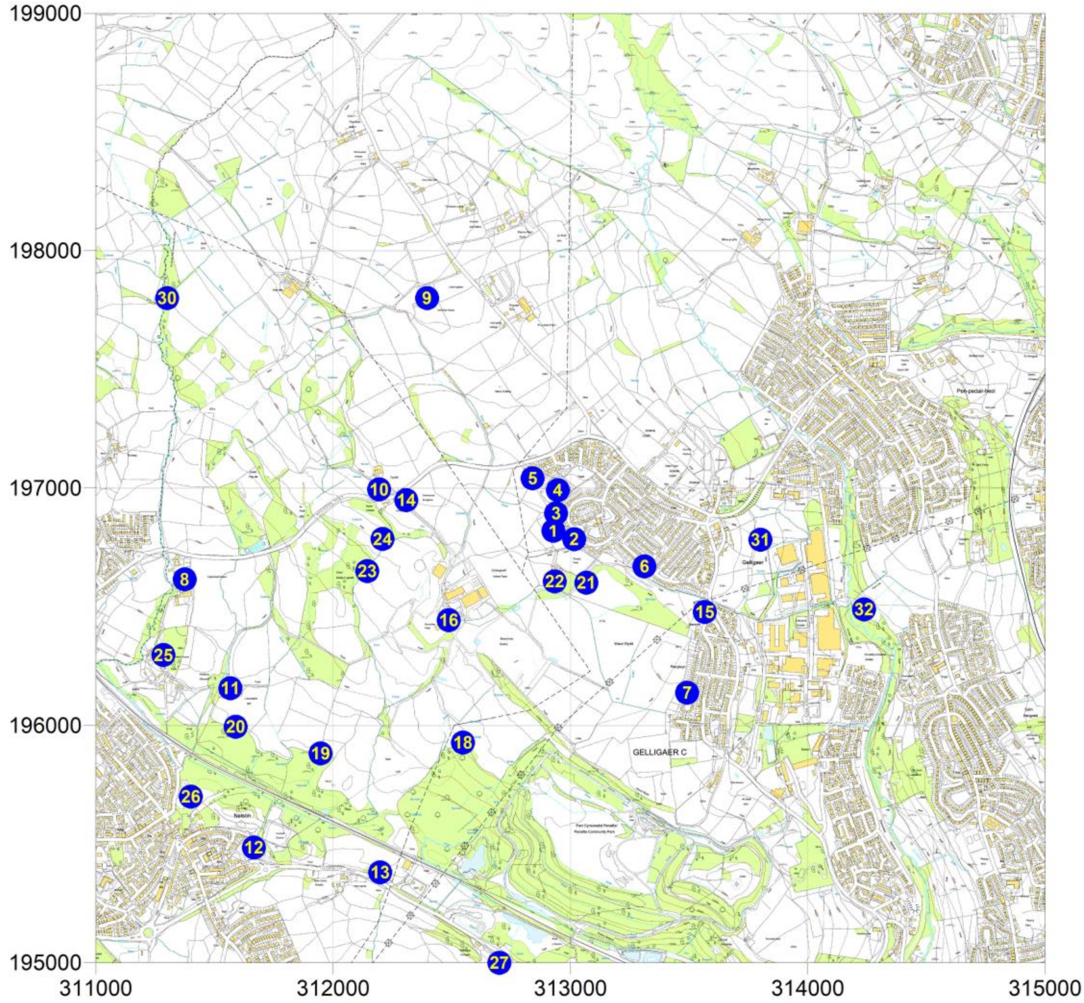
Additionally, other key sites have been included, such as sensitive ecological receptors including a local Site of Special Scientific Interest (SSSI - the Nelson Bog) and two Sites of Importance for Nature Conservation (SINCs), both of which are located close to the site with one to the east and the other to the west. Local wildlife sites have also been included. Figure 4 shows the location of the nearest sensitive receptors to the site.

It should be noted, that although only a selection of receptors has been chosen, such as key residential sites, or a number of grid references to represent a large sensitive ecological area, the purpose of the Cartesian grid is to comprehensively model the pollutant dispersion across a designated area. Thus, other residential properties or sensitive ecological habitats within the 4 km x 4 km modelled grid are considered by the model. The concentration isopleth diagrams presented in the Figures throughout this report demonstrate the Process Contribution of pollutants to the local area.

Table 6 Sensitive Receptor Points Included Within the Modelling Exercise

Receptor Number	Description	X (m)	Y (m)
1	Residential property or area	312927	196820
2	Residential property or area	313015	196784
3	Residential property or area	312939	196893
4	Residential property or area	312946	196991
5	Residential property or area	312840	197041
6	Residential property or area	313311	196670
7	Residential property or area	313491	196138
8	Residential property or area	311374	196615
9	Residential property or area	312395	197800
10	Residential property or area	312193	196994
11	Residential property or area	311566	196157
12	Residential property or area	311665	195485
13	Residential property or area	312198	195381
14	Residential property or area	312307	196949
15	Residential property or area	313565	196478
16	Farmhouse within Bryn Power Limited site	312486	196443
17	Aberbargoed Grassland	316130	198576
18	Location within the Nelson Bog SSSI	312546	195928
19	Location within the Nelson Bog SSSI	311946	195882
20	Location within the Nelson Bog SSSI	311589	195994
21	Location 1 within SINC to the east	313067	196601
22	Location 2 within SINC to the east	312933	196607
23	Location 1 within SINC to the west	312143	196650
24	Location 2 within SINC to the west	312207	196785
25	Llancaiach-Fawr Meadows,	311284	196296
26	Wern Woodland, Nelson	311400	195700
27	Tredomen Tip Ponds, Nelson	312700	195000
28	Coed Penallta and Railway Line	313585	194890
29	Brooklands Marsh, North of Nelson	310800	196200
30	Nant Caeach, North of Llancaiach	311300	197800
31	Land South of Gelligaer Infants School	313800	196782
32	Pottery Road Slopes, East of Gelligaer	314237	196489

Figure 4 Location of Local Sensitive Receptors Included in the Model



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The output for the model was set as 'long-term', which provides a single concentration averaged over all of the lines of meteorological data, for each point on the grid, that is, providing an annual average concentration for each pollutant at each grid point or receptor. Pollutants were modelled over 15-minute, 1 hour, 8-hour (rolling), or 24-hour averaging periods, in line with their respective Air Quality Standards (AQS). Additionally, percentile concentrations were calculated to demonstrate the worst predicted contribution to ground level concentrations (the 100th percentile), minus any allowable exceedances (other percentile values).

In running the model this way, all lines of meteorological data are considered in the calculations, and any allowable number of exceedances can be taken into account. Where the model output is set as 'short-term', only the first 24 lines of the meteorological file are considered (that is, data for 1st January on any given year), and the model cannot give consideration to any relevant percentile values.

Part IV of The Environment Act 1995 sets provisions for protecting air quality in the UK and for local air quality management. The Air Quality Standards (Wales) Regulations 2010[8] which came into force on 11th June 2010, transpose into Welsh law the requirements of Directives 2008/50/EC on ambient air quality and cleaner air for Europe, amongst others. The Regulations specify a number of limit values, target values, and objectives for key pollutants, which must be adhered to or aimed at, and where these pollutants are considered by this modelling exercise, the relevant limit, target or objective is summarised in Table 7 over page.

Air Quality Standards are considered to be the relevant Environmental Assessment Level (EAL) when considering the protection of human health and the environment as a whole and are used to define the upper bound concentration of a substance in the environment that is considered to be tolerable.

There are no assessment levels for total emissions of Volatile Organic Compounds (VOCs), although there is an AQS for Benzene. However, there is no information available regarding the proportion of Benzene that may be present in the VOC emission discharged from the CHP and SWIP plants, and as such, there is no directly comparable assessment criterion for the emission of VOCs. Benzene is however, considered likely to be a very small percentage of the total emission from each of the plant, modelled and referred to hereafter as VOC. As such, the assessment assumes that Benzene accounts for up to 5 % of the total VOC release, and results are assessed on that basis.

Table 7 Air Quality Standards (AQS) and Environmental Assessment Levels (EAL)

Pollutant	Objective Concentration	Averaging Period
Carbon Monoxide (Limit Value)	10 mg m^{-3}	Maximum Daily 8 Hour Mean
Nitrogen Dioxide (Limit Value)	200 µg m^{-3} not to be exceeded more than 18 times a year (99.79th percentile)	1 Hour Mean
Nitrogen Dioxide (Limit Value)	40 µg m^{-3}	Annual Average
Oxides of Nitrogen (Critical level for the protection of vegetation)	30 µg m^{-3}	Annual Average
Sulphur Dioxide (Target Value)	266 µg m^{-3} not to be exceeded more than 35 times a year (99.9th percentile)	15 Minute Mean
Sulphur Dioxide (Limit Value)	350 µg m^{-3} not to be exceeded more than 24 times a year (99.73rd percentile)	1 Hour Mean
Sulphur Dioxide (Limit Value)	125 µg m^{-3} not to be exceeded more than 3 times a year (99.18th percentile)	24 Hour Mean
Sulphur Dioxide (Critical level for the protection of vegetation)	20 µg m^{-3}	Annual Average
Benzene (Limit Value)	5 µg m^{-3}	Annual Average
Benzene (EAL)	30 µg m^{-3}	24 Hour Mean

3.8 Determining Significance

The UK Government, via the Environment Agency, provides guidance[2] for screening the significance of air quality impacts associated with the operation of industrial processes.

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 not significant.

Other Assessment Criteria

Descriptive terms for the impact significance of pollutants 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)[9]. 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 Pollutant Concentrations

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 EPUK / IAQM guidance was followed for determining the impact descriptor for increases in annual average pollutant concentrations in the vicinity of the Bryn Power site, due to the operation of the AD CHPs and the site SWIPs.

3.9 Modelling Assumptions

In addition to the parameters described in the sections above, some assumptions have had to be made for the modelling study and these are listed below:

- All emissions are assumed to be continuous although operations may not necessarily be running constantly, with for example time for scheduled and un-planned shut-downs. Thus, the model can be seen to represent a worst-case as emissions are considered to occur on a 24 hour, 365 days per year basis.

4. Results and Discussion

The results below report the predicted Process Contributions of the modelled pollutants discharged from the three CHP units and the two SWIPs. The modelling assumes the continuous operation of all plant, and the maximum results predicted when modelling five years' of meteorological conditions are reported. The annual average background concentrations reported previously in Table 5 are added to the annual average PC to calculate the PEC of each pollutant. The short-term background is assumed to be twice the annual, which is therefore doubled when calculating the short-term PEC.

4.1 Nitrogen Dioxide

The Process Contributions (PC) and resultant Predicted Environmental Concentrations (PEC) of Nitrogen Dioxide at the point of maximum contribution are reported below:

Table 9 Nitrogen Dioxide (µg m^{-3}) at the Point of Maximum Contribution

Statistic	Exceedance Threshold	Averaging Period	Concentration (µg m^{-3})	Percentage of the AQS
Annual (PC)	40	Annual	21.83	**54.6 %**
Annual (PEC)			28.01	**70.0 %**
Short-term 99.79% (PC)	200	1 hr	114.91	**57.5 %**
Short-term 99.79% (PEC)			127.27	**63.6 %**
Short-term 99.79% AQS minus twice background (PC)	187.64	1 hr	114.91	**61.2 %**

Figures in bold cannot be screened as insignificant.

The results in Table 9 detail the annual average Process Contribution of NO_2 as 100 % of the NO_X release, with short-term NO_2 equating to 50 % total NO_X.

Neither the long, nor the short-term PCs nor the PECs of NO_2 can be screened as insignificant when considering the point of maximum contribution. However, this point of maximum contribution occurs within the Bryn Power Limited site boundary at grid reference 312480 196680, on the entrance road close to the in-vessel composting building and would therefore not impact on a sensitive receptor to the same extent.

Although not screened as insignificant, neither the long nor the short-term Air Quality Standards are exceeded at this point and, as the point of maximum contribution is not a location where relevant exposure may occur, the contributions are deemed acceptable. In relation to the EPUK / IAQM descriptor matrix, an annual average PC of more than 10 %, resulting in a PEC equating to less than 75 % of the AQS would be considered to have a **moderate** impact at this point. Sections 4.6 and 4.7 detail the contributions of pollutants at the modelled sensitive receptor locations.

Detailed analysis of the contribution of the various combustion plant to concentrations of Nitrogen Dioxide are presented in Table 10 and suggest that the most significant contributors at this point of maximum impact are the two existing CHP units.

Table 10 Contribution of Combustion Units to Annual Average Total

Modelled Unit(s)	Process Contribution (µg m^{-3})	Percent of Total Contribution
All Sources	21.83	100 %
All CHPs (3 units)	20.08	92 %
New CHP only	4.21	19 %
New CHP as percentage of All CHPs		21 %

When considering the short-term Process Contributions, the three CHP units effectively contribute 100 % of the total at the point of maximum impact.

Figures 5 and 6 which follow demonstrate the modelled dispersion characteristics of the plume when considering the long-term, annual average impact (Figure 5) and the short-term 99.79th percentile of the hourly average contribution of NO_2 (Figure 6). The maximum contributions over the five years of modelled meteorological conditions are displayed.

Figure 5 Annual Average Process Contribution of NO_X as NO_2 (µg m^{-3}) 2017 Meteorological Conditions

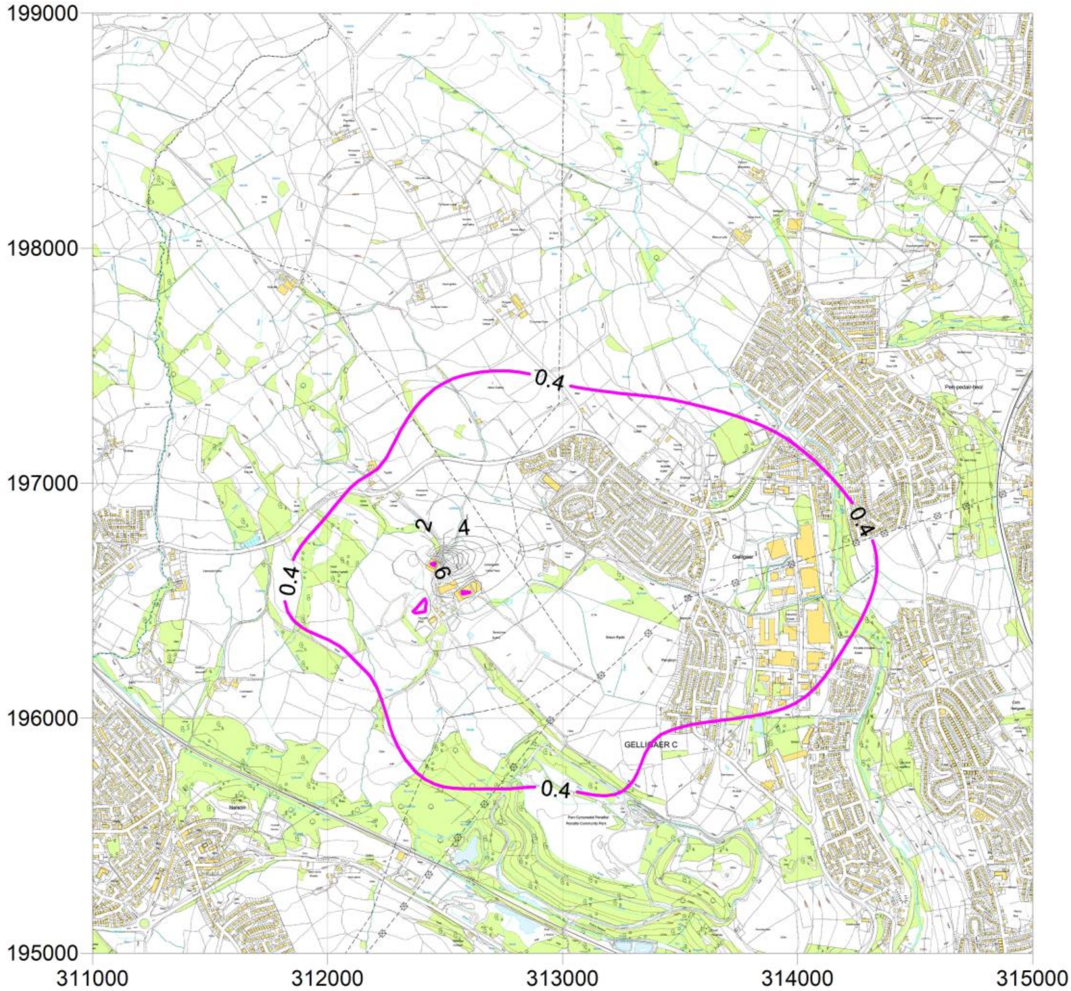

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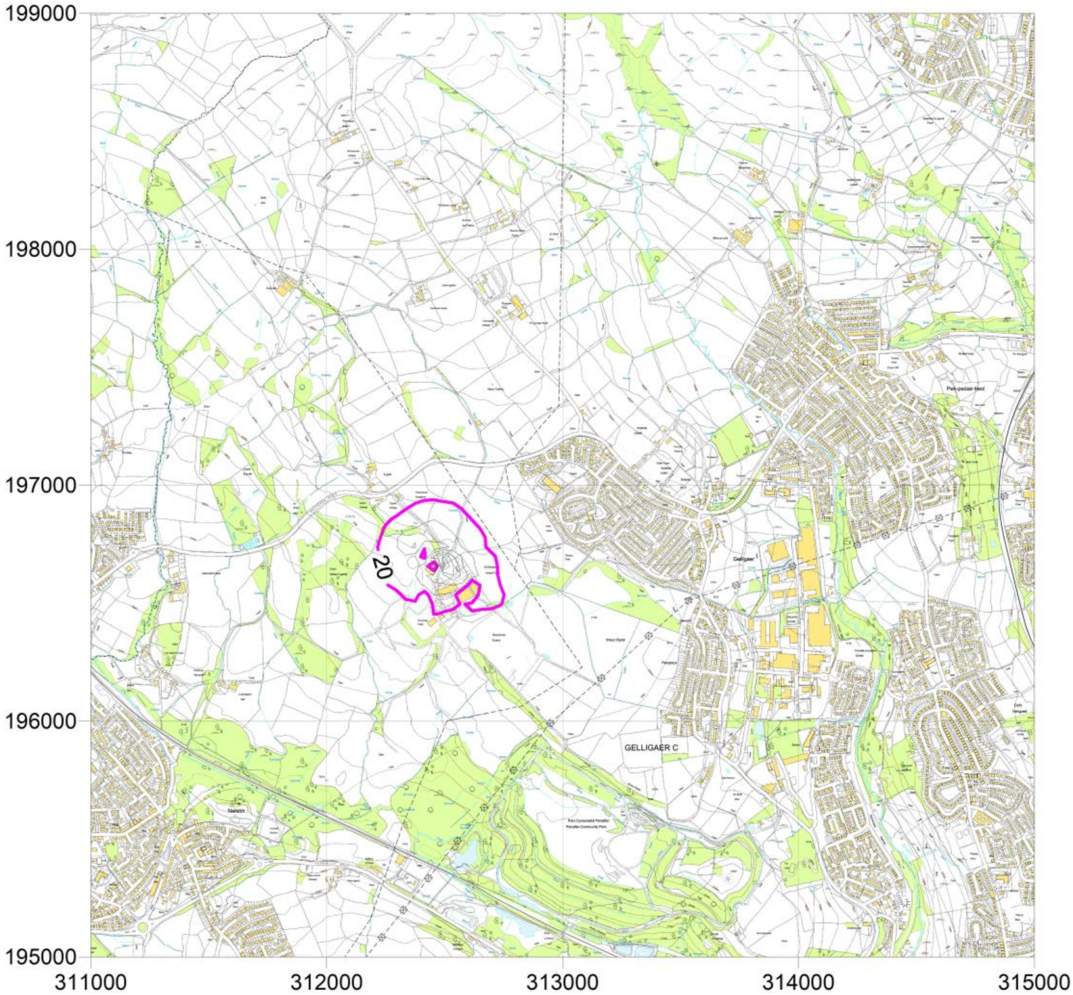
Figure 6 99.79th Percentile Hourly Average Process Contribution of NO_2 (µg m^{-3}); 2020 Meteorological Conditions



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The magenta isopleths in Figures 5 and 6 denote the point at which the long and short-term Process Contributions equate to 1 % and 10 % of the AQS respectively and therefore, at all locations outside of these contours, the Process Contribution can be considered to have an insignificant impact.

Figures 5 and 6 demonstrate that although not all areas across the modelled grid are screened as insignificant, the extent of the areas which cannot immediately be screened is relatively limited and elevated concentrations reduce rapidly from the point of maximum impact within the Bryn Power site. Detailed consideration of the annual average gridded data confirms that only at this single point of maximum contribution, of the 40,401 modelled points across the grid and across 5-years' worth of meteorological data, would the PEC not go on to screen as insignificant, equating to marginally more than 70 % of the AQS, with all other modelled data resulting in a PEC of less than 70 % of the AQS. At no point across the grid are either then long or the short-term AQS exceeded.

4.2 Sulphur Dioxide

The Process Contributions (PC) and resultant Predicted Environmental Concentrations (PEC) of Sulphur Dioxide at the point of maximum contribution are reported in Table 11 below.

Table 11 Sulphur Dioxide (µg m^{-3}) at the Point of Maximum Contribution

Statistic	Exceedance Threshold	Averaging Period	Concentration (µg m^{-3})	Percentage of the AQS
Short-term 99.90% (PC)	266	15-minute	179.47	**67.5 %**
Short-term 99.9% (PEC)			185.95	**69.9 %**
Short-term 99.9% AQS minus twice background (PC)	259.5	15-minute	179.47	**69.2 %**
Short-term 99.73% (PC)	350	1 hr	155.55	**44.4 %**
Short-term 99.73% (PEC)			162.03	**46.3 %**
Short-term 99.73% AQS minus twice background (PC)	343.5	1 hr	155.55	**45.3 %**
Short-term 99.18% (PC)	125	24 hrs	83.02	**66.4 %**
Short-term 99.18% (PEC)			89.5	**71.6 %**
Short-term 99.18% AQS minus twice background (PC)	118.5	24 hrs	83.02	**70.0 %**

Figures in bold cannot be screened as insignificant.

When considering the impact of emissions of Sulphur Dioxide, none of the short-term human health assessment levels can be screened as insignificant. That said and similarly to the impact of NO_2 releases, no exceedance of the AQS is predicted and the extent of any elevated concentrations is limited. Figures 7 – 9 demonstrate the dispersion characteristics of the discharge, with the most significant contributions occurring within the site boundary.

The magenta isopleths denote the point at which the short-term Process Contributions equate to 10 % of the relevant assessment level and therefore, at all locations outside of these contours, the Process Contribution can be considered to have an insignificant impact.

Figure 7 99.9th Percentile 15-Minute Average Process Contribution of SO_2 (µg m^{-3}); 2017 Meteorological Conditions

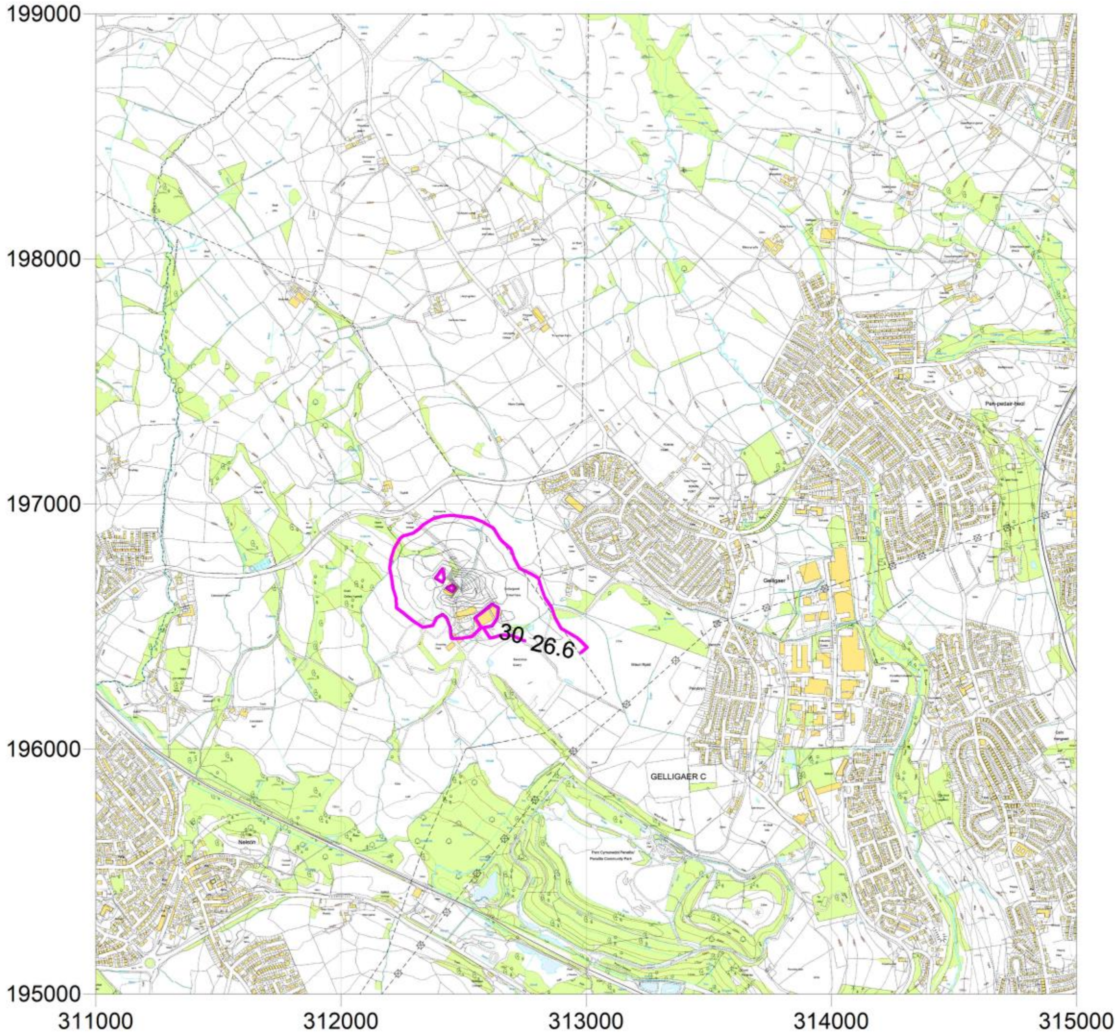

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Figure 8 99.73rd Percentile Hourly Average Process Contribution of SO_2 (µg m^{-3}); 2017 Meteorological Conditions

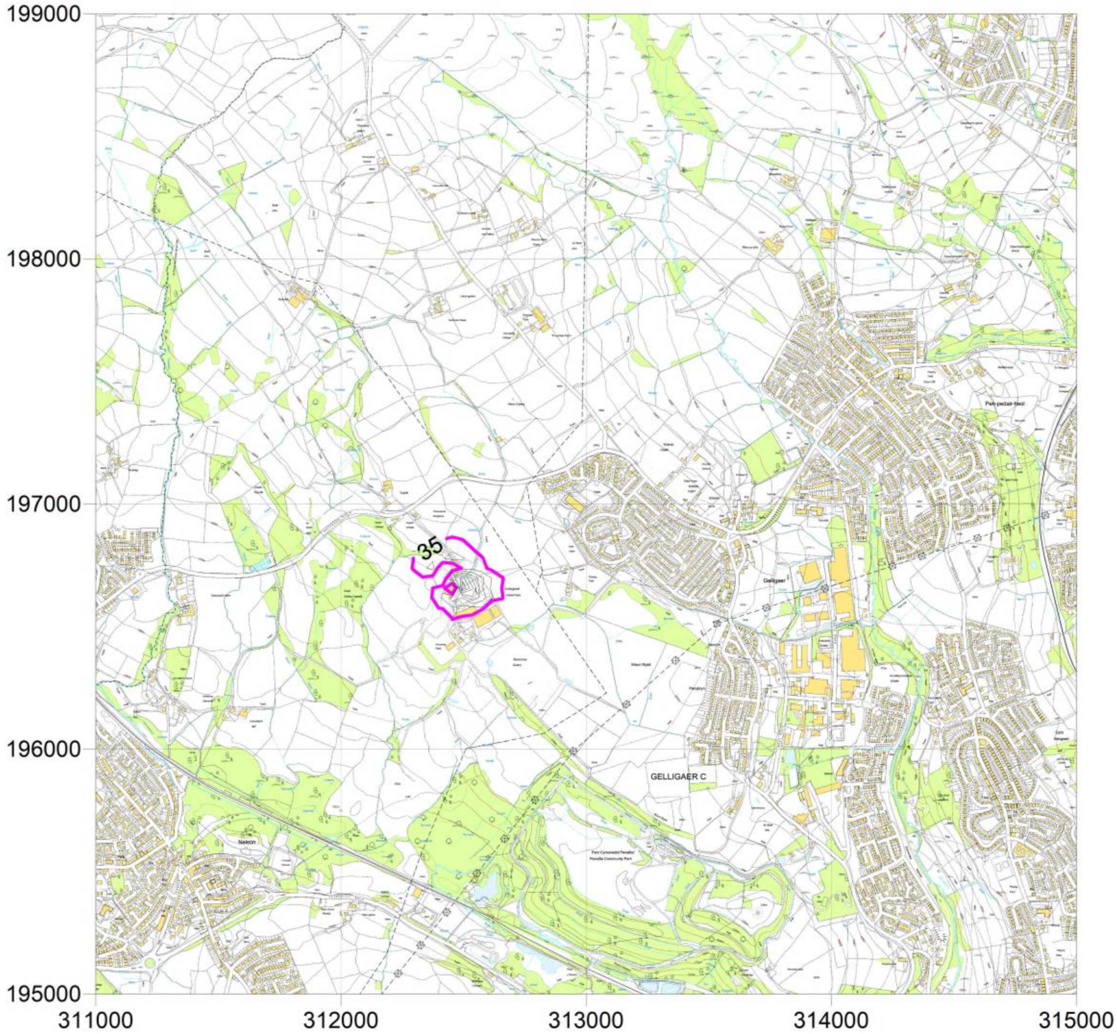

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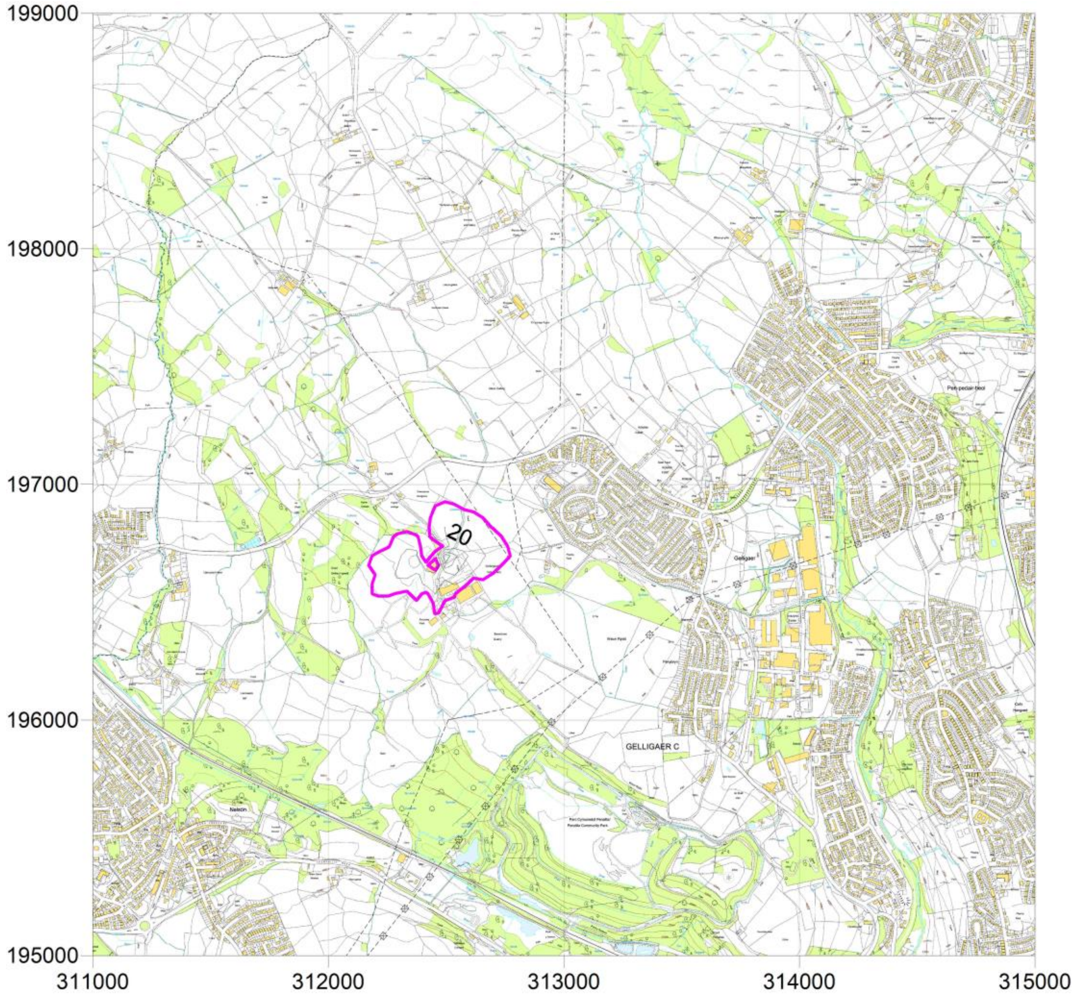
Figure 9 99.18th Percentile 24-Hourly Average Process Contribution of SO_2 (µg m^{-3}); 2020 Meteorological Conditions



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4.3 Volatile Organic Compounds (as Benzene)

The Process Contributions (PC) and resultant Predicted Environmental Concentrations (PEC) at the point of maximum contribution for Volatile Organic Compounds (VOC) modelled as Benzene, are reported below. The reported figures assume that only 5 % of the total VOC contribution is released as Benzene.

Table 12 Benzene (µg m^{-3}) at the Point of Maximum Contribution

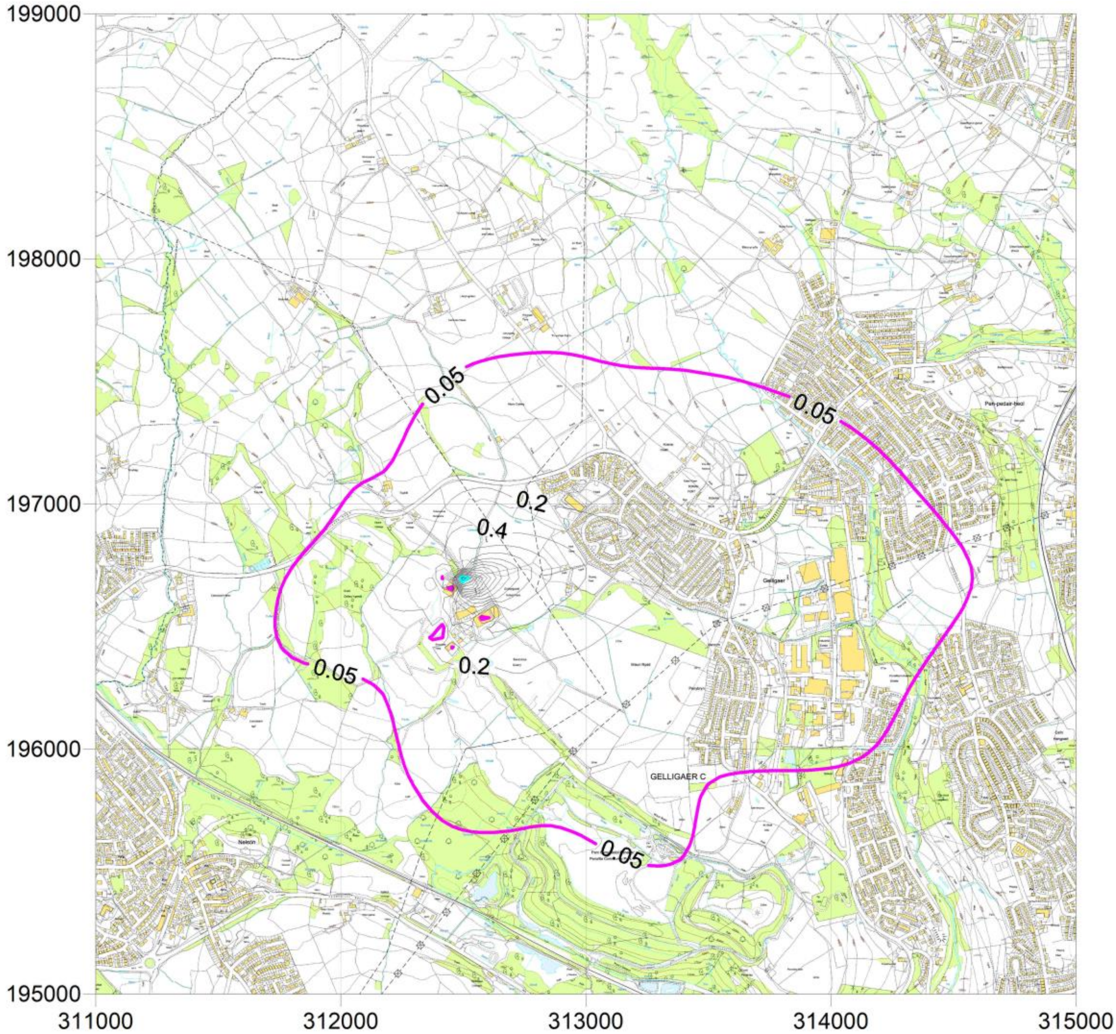
Statistic	Exceedance Threshold	Averaging Period	Concentration (µg m^{-3})	Percentage of the AQS
Annual (PC)	5	Annual	4.01	**80.3 %**
Annual (PEC)			4.24	**84.9 %**
Short-term 100% (PC)	30	24 hrs	30.45	**101.5 %**
Short-term 100% (PEC)			30.91	**103 %**
Short-term 100% AQS minus twice background (PC)	29.54	24 hrs	30.45	**103 %**

Figures in bold cannot be screened as insignificant.

Assuming that Benzene comprises up to 5 % of the VOC release, and although neither the Process Contribution nor the Predicted Environmental Concentration can be screened as insignificant, the majority of the results do remain within both the long and short-term assessment levels for Benzene. The one exception is the worst-case point of maximum contribution where, at one location within the site boundary (grid reference 312480 196680) and for one 24-hour period over the five-years' worth of modelled meteorological conditions, the 24-hour average exceeds the Environmental Assessment Level, being 30.45 µg m^{-3}, compared to the EAL of 30. As this location occurs on the entrance road close to the in-vessel composting building it is highly unlikely that a person might be exposed to Benzene for any 24-hour period, and contributions at all of the sensitive local receptors, including residential areas where people may potentially spend extended periods, are significantly lower than at this point of maximum.

Figures 10 and 11 demonstrate the long and short-term dispersion characteristics of the discharge, with the most significant contributions occurring within the site boundary. The magenta isopleths denote the point at which the long and short-term Process Contributions equate to 1 % and 10 % of the AQS respectively and therefore, at all locations outside of these contours, the Process Contribution can be considered to have an insignificant impact.

Figure 10 Annual Average Process Contribution of Benzene (5 % total VOC) (µg m^{-3}); 2017 Meteorological Conditions



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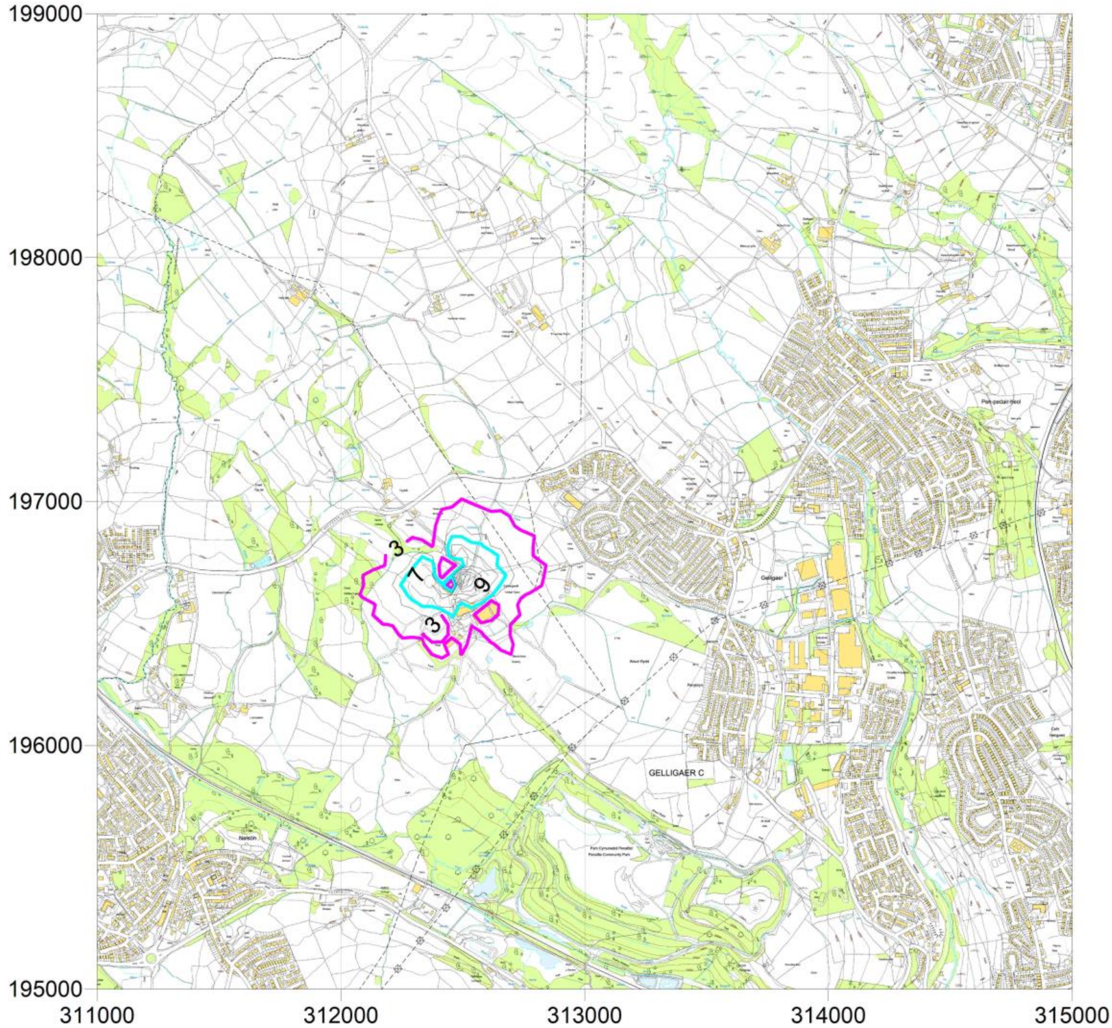
Although not completely screened as insignificant at either the initial or secondary assessment stages, the turquoise isopleth in Figure 10 marks the 3.2 µg m^{-3} contour, and at all points outside of this area, which occurs within the site boundary, the PEC would remain within 70 % of the AQS, thereby screening at the secondary assessment stage.

Figure 11 24-Hour Process Contribution of Benzene (5 % total VOC) (µg m^{-3}); 2020 Meteorological Conditions



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The area of the modelled grid which does not screen as insignificant over the shorter-term (24-hour) averaging period for Benzene is much smaller in its extent than the annual average, although the area where the PEC cannot be screened at the secondary assessment stage is larger. The impacted area is however, within or around the Bryn Power site and the contributions reduce rapidly and substantially from the point of maximum concentration.

4.4 Carbon Monoxide

The Process Contributions (PC) and resultant Predicted Environmental Concentrations (PEC) of Carbon Monoxide at the point of maximum contribution are reported in Table 13 below.

Table 13 Carbon Monoxide (mg m^{-3}) at the Point of Maximum Contribution

Statistic	Exceedance Threshold	Averaging Period	Concentration (mg m^{-3})	Percentage of the AQS
Short-term 100% (PC)	10	8 hr rolling	0.614	6.1 %
Short-term 100% (PEC)			0.73	7.3 %

The Process Contribution of Carbon Monoxide at the point of maximum impact remains within 10 % of the short-term AQS (10 mg m^{-3}) and is therefore immediately screened as insignificant. The PEC also remains well within 20 % of the AQS.

4.5 Hydrogen Chloride and Hydrogen Fluoride

The Process Contributions (PC) and resultant Predicted Environmental Concentrations (PEC) of both HCl and HF at the point of maximum contribution are reported below:

Table 14 HCl and HF (µg m^{-3}) at the Point of Maximum Contribution

Statistic	Exceedance Threshold	Averaging Period	Concentration (µg m^{-3})	Percentage of the AQS
HCl 100% short-term (PC)	750	1 hr	38.05	5.1 %
HF long-term (PC)	16	Annual	0.04	0.23 %
HF 100% short-term (PC)	160	1 hr	3.83	2.4 %

The long and short-term Process Contributions of HCl and HF remains within 1 % and 10 % of their relevant assessment levels and are therefore immediately screened as insignificant.

4.6 Impact at Human Health Receptors

The results in Tables 15 to 17 present the maximum predicted Process Contribution of pollutants to the receptors identified as locations where members of the general public may be present for the relevant assessment averaging periods. As in Sections 4.1 – 4.5, the results represent the total combined impact of the modelled operations, including three CHP units and two SWIPs. Five years' worth of meteorological conditions have been considered and the maximum result for each individual receptor is reported.

Where pollutants have been screened as insignificant when considering the point of maximum contribution across the entire gridded area (CO, HCl and HF), the results at each receptor are not detailed here as, by the nature of the gridded assessment, contributions at the sensitive receptors will be lower and will therefore remain insignificant.

The data in Tables 15 – 17 and the narrative associated with each table, confirm that contributions of NO_2, SO_2 and Benzene, when assumed to constitute 5 % of the total VOC release, are screened as insignificant at each of the human health receptor locations, either at the initial or secondary assessment stage.

Table 15 Contributions of Nitrogen Dioxide ($\mu g\ m^{-3}$) at Human Health Receptors

Receptor Number	Annual Average PC NO_2 (100 % NO_X) ($\mu g\ m^{-3}$)	PC as % AQS	Annual Average PEC (Background = 6.18 $\mu g\ m^{-3}$)	PEC as % AQS	99.79th Percentile Hourly Average PC NO_2 ($\mu g\ m^{-3}$)	PC as % AQS
1	2.38	**5.96%**	8.57	21.4%	9.67	4.83%
2	2.19	**5.48%**	8.37	20.9%	8.58	4.29%
3	1.84	**4.60%**	8.02	20.1%	8.74	4.37%
4	1.28	**3.20%**	7.46	18.7%	7.95	3.97%
5	1.17	**2.92%**	7.35	18.4%	10.89	5.45%
6	1.29	**3.24%**	7.48	18.7%	8.05	4.03%
7	0.53	**1.34%**	6.72	16.8%	7.34	3.67%
8	0.32	0.81%	6.50	16.3%	4.23	2.11%
9	0.19	0.48%	6.38	15.9%	4.31	2.16%
10	0.72	**1.80%**	6.90	17.3%	10.72	5.36%
11	0.46	**1.16%**	6.65	16.6%	4.63	2.31%
12	0.18	0.45%	6.36	15.9%	3.61	1.81%
13	0.19	0.49%	6.38	15.9%	3.77	1.88%
14	1.03	**2.58%**	7.22	18.0%	16.17	8.09%
15	0.75	**1.89%**	6.94	17.3%	7.26	3.63%
16	2.92	**7.29%**	9.10	22.7%	19.14	9.57%

Although the annual average Process Contributions (PC) do not immediately screen at a number of the modelled human health receptors, the Predicted Environmental Concentrations (PEC), equating to the PC plus the long-term background value, remain well within 70 % of the AQS and are therefore screened as not significant at the secondary assessment stage. The short-term Process Contributions, the 99.79th percentile of the hourly average contributions, remain within 10 % of the short-term AQS at all receptor locations and are therefore immediately screened as insignificant.

Table 16 Contributions of Sulphur Dioxide (µg m^{-3}) at Human Health Receptors

Receptor Number	99.9th Percentile 15-Min Average PC SO_2 (µg m^{-3})	PC as % AQS	99.73rd Percentile Hourly Average PC SO_2 (µg m^{-3})	PC as % AQS	99.18th Percentile 24-Hour Average PC SO_2 (µg m^{-3})	PC as % AQS
1	15.70	5.90%	12.17	3.48%	7.92	6.33%
2	15.14	5.69%	10.81	3.09%	6.46	5.17%
3	14.60	5.49%	10.89	3.11%	6.11	4.89%
4	14.17	5.33%	9.62	2.75%	4.70	3.76%
5	18.94	7.12%	12.24	3.50%	4.93	3.95%
6	14.83	5.58%	8.79	2.51%	3.82	3.05%
7	17.81	6.69%	7.54	2.15%	2.38	1.90%
8	8.77	3.30%	5.13	1.46%	1.88	1.50%
9	9.27	3.48%	4.45	1.27%	1.24	1.00%
10	16.43	6.18%	13.24	3.78%	6.13	4.90%
11	8.69	3.27%	5.49	1.57%	2.34	1.87%
12	6.41	2.41%	3.87	1.11%	1.22	0.97%
13	6.86	2.58%	4.25	1.22%	1.46	1.17%
14	23.00	8.65%	19.95	5.70%	9.16	7.33%
15	14.73	5.54%	7.63	2.18%	2.56	2.05%
16	25.67	9.65%	22.11	6.32%	13.06	**10.45%**

At almost every human health receptor and considering each averaging period, the Process Contributions (PC) of SO_2 are immediately screened as insignificant. The one exception to this is at receptor number 16, where the 24-hourly average PC only, is marginally over 10 % of the Air Quality Standard.

The estimated background concentration of SO_2 in the local area is 3.24 µg m^{-3} as an annual average, which can be doubled to 6.48 µg m^{-3} as a short-term background. Removing this short-term background from the 24-hour assessment level and considering this highest process contributions against the revised assessment level results in the PC equating to approximately 11 % of the 24-hour average assessment level and, remaining well within the 20 % screening threshold, the contribution to the 99.18th percentile of the 24-hourly average assessment level can be screened as not significant at receptor 16, at the secondary assessment stage.

Table 17 Contributions of Benzene, Modelled as 5 % of Total VOCs (µg m^{-3}) at Human Health Receptors

Receptor Number	Annual Average PC Benzene (µg m^{-3})	PC as % AQS	Annual Average PEC (Background = 0.23 µg m^{-3})	PEC as % AQS	24-Hourly Average PC Benzene (µg m^{-3})	PC as % AQS
1	0.399	**7.98%**	0.629	12.6%	2.426	8.09%
2	0.360	**7.21%**	0.590	11.8%	2.196	7.32%
3	0.307	**6.14%**	0.537	10.7%	2.107	7.02%
4	0.212	**4.25%**	0.442	8.8%	1.421	4.74%
5	0.188	**3.76%**	0.418	8.4%	1.690	5.63%
6	0.199	**3.98%**	0.429	8.6%	1.126	3.75%
7	0.075	**1.51%**	0.305	6.1%	0.940	3.13%
8	0.050	**1.01%**	0.280	5.6%	0.659	2.20%
9	0.031	0.62%	0.261	5.2%	0.451	1.50%
10	0.117	**2.34%**	0.347	6.9%	2.002	6.67%
11	0.068	**1.36%**	0.298	6.0%	0.740	2.47%
12	0.026	0.51%	0.256	5.1%	0.548	1.83%
13	0.028	0.56%	0.258	5.2%	0.527	1.76%
14	0.172	**3.44%**	0.402	8.0%	3.558	**11.86%**
15	0.109	**2.18%**	0.339	6.8%	0.697	2.32%
16	0.292	**5.83%**	0.522	10.4%	4.027	**13.42%**

Although the annual average PC of Benzene, assumed to comprise 5 % of the total VOC emission does not immediately screen at the majority of the modelled human health receptors, the Predicted Environmental Concentrations (PEC), equating to the PC plus the long-term background value, remain well within 70 % of the AQS and can therefore be screened as not significant at the secondary assessment stage.

The short-term,24-hourly average PC remains within 10 % of the short-term Environmental Assessment Level (EAL) at most receptors, the exceptions being receptor numbers 14 (approximately 12 % of the EAL) and 16 (13 % of the EAL). Removing an estimated short-term background concentration of 0.46 µg m^{-3} from the EAL results in a revised assessment level of 29.54 µg m^{-3}, against which the PC at receptor 14 equates to 12.04 %, and at receptor number 16, the PC equates to 13.6 %. As the PC at both of these receptors remain within 20 % of the revised short-term assessment level, the predicted contributions are screened as not significant at the secondary assessment stage.

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4.7 Impact on Sensitive Ecological Habitats

Receptor Numbers 17 to 32 represent local areas which include the presence of sensitive ecological habitats. Similar to the Air Quality Standards for the protection of human health, Critical Levels are specified for the protection of ecological sites, and these are different to those for human health. Tables 18 and 19 detail the assessment of annual average contributions of NO_X as NO_2 and SO_2 when considering the relevant Critical Loads. A similar methodology is applied to the assessment of the significance of the contributions, whereby results can be screened where they remain below 1 % of the long-term assessment level, or where the PEC remains within 70 % of the assessment level for nationally designated sites such as SSSIs. However additionally, when considering locally designated sites such as local nature reserves or Sites of Importance for Nature Conservation, contributions can be screened as insignificant where the PC remains within 100 % of the Critical Level.

Table 18 Process Contributions of NO_X as NO_2 at Sensitive Ecological Receptors When Compared Against Critical Levels

Receptor Number	Annual Average PC NO_2 (100 % NO_X) (µg m^{-3})	PC as % AQS	Background (µg m^{-3})	Annual Average PEC	PEC as % AQS
17	0.05	0.17%	10.97	11.02	36.7%
18	0.57	**1.91%**	10.62	11.19	37.3%
19	0.33	**1.11%**	10.62	10.95	36.5%
20	0.36	**1.21%**	10.62	10.98	36.6%
21	1.90	**6.34%**	10.04	11.94	39.8%
22	2.56	**8.55%**	10.04	12.60	42.0%
23	2.23	**7.45%**	9.75	11.98	39.9%
24	1.76	**5.88%**	9.75	11.51	38.4%
25	0.36	**1.19%**	10.04	10.40	34.7%
26	0.22	0.73%	12.16	12.38	41.3%
27	0.14	0.47%	10.62	10.76	35.9%
28	0.18	0.61%	11.1	11.28	37.6%
29	0.19	0.64%	11.37	11.56	38.5%
30	0.14	0.45%	9.02	9.16	30.5%
31	0.70	**2.32%**	12.62	13.32	44.4%
32	0.43	**1.43%**	11.31	11.74	39.1%

Table 19 Process Contributions of SO_2 at Sensitive Ecological Receptors When Compared Against Critical Levels

Receptor Number	Annual Average PC SO_2 (µg m^{-3})	PC as % AQS	Annual Average PEC (Background = 1.53 µg m^{-3})*	PEC as % AQS
17	0.030	0.15%	2.01	10.05%
18	0.301	**1.50%**	1.83	9.15%
19	0.183	0.91%	1.71	8.56%
20	0.201	**1.01%**	1.73	8.66%
21	1.099	**5.50%**	2.63	13.15%
22	1.480	**7.40%**	3.01	15.05%
23	1.394	**6.97%**	2.92	14.62%
24	1.082	**5.41%**	2.61	13.06%
25	0.213	**1.06%**	1.74	8.71%
26	0.122	0.61%	1.65	8.26%
27	0.081	0.41%	1.61	8.06%
28	0.106	0.53%	1.50	7.48%
29	0.114	0.57%	1.64	8.22%
30	0.082	0.41%	1.61	8.06%
31	0.416	**2.08%**	1.95	9.73%
32	0.249	**1.24%**	1.78	8.89%

* Background at receptor 17 = 1.98 µg m^{-3} and at receptor 28 = 1.39 µg m^{-3}. Background at all other receptors = 1.53 µg m^{-3}.

Similarly to the assessment of the human health receptors, although not all annual average Process Contributions can be screened as insignificant at the initial assessment stage, consideration of the PEC screens the impact of pollution as not being significant at any receptor at the secondary assessment stage when compared against the Critical Levels for sensitive ecological sites.

Finally, an assessment was made of the Process Contributions to the Critical Loads relevant to the sensitive ecological habitats. Table 20 below considers the contribution of nutrient Nitrogen from Nitrogen sources (NO_X), whilst Tables 21 to 23 assess the overall contribution of aid deposition against the relevant Critical Load. Receptor numbers 21, 22 and 31 are not sensitive to acid and hence have been omitted from Tables 21 - 23.

Deposition rates for grassland or woodland have been applied as relevant to each habitat type, and the maximum contributions from modelling five years' worth of meteorological conditions have been applied.

The calculations assume dry deposition only for sources of nutrient Nitrogen (NO_2 as 70 % of total NO_x), and Sulphur Dioxide. Deposition of Hydrogen Halides (HCl, and HF from the operation of the SWIPs) was calculated as total deposition, equating to dry deposition x 3. Nitrogen Dioxide rather than total NO_x is assumed, as Nitric Oxide does not deposit at a significant rate and hence has been removed from the calculation, although all sources were initially modelled as releasing total NO_x.

Table 20 Contributions of Nutrient Nitrogen at Sensitive Ecological Receptors When Compared Against Critical Loads

Receptor Number	Dry Deposition of NO_2 ($\mu g\ m^{-2}\ s^{-1}$)	Deposited Nutrient N ($kgN\ ha^{-1}\ yr^{-1}$)	Critical Load ($kgN\ ha^{-1}\ yr^{-1}$)	% Critical Load
17	5.00E-05	0.00480	15	0.03%
18	5.90E-04	0.05662	10	0.57%
19	3.40E-04	0.03257	10	0.33%
20	3.71E-04	0.03562	10	0.36%
21	1.95E-03	0.18673	10	**1.87%**
22	2.63E-03	0.25258	10	**2.53%**
23	4.62E-03	0.44304	10	**4.43%**
24	3.65E-03	0.35025	10	**3.50%**
25	3.67E-04	0.03518	10	0.35%
26	4.34E-04	0.04159	10	0.42%
27	1.45E-04	0.01390	10	0.14%
28	1.83E-04	0.01753	10	0.18%
29	1.95E-04	0.01873	10	0.19%
30	2.40E-04	0.02306	10	0.23%
31	7.02E-04	0.06729	10	0.67%
32	4.29E-04	0.04111	20	0.21%

Although contributions of nutrient Nitrogen to receptor numbers 21 to 24 equate to more than 1 % of the Critical Load value, each of these receptor points represents a location within a locally designated site (a Site of Importance for Nature Conservation) and hence, the requirement is simply for the Process Contributions to remain within 100 % of the Critical Loads in order to be screened as insignificant. All contributions of nutrient Nitrogen are therefore screened.

Table 21 Contributions of Acid from Nitrogen Sources at Sensitive Ecological Receptors When Compared Against Critical Levels

Receptor Number	Acid Deposition from NO_2 (keq ha^{-1} yr^{-1})	Background (keq ha^{-1} yr^{-1})	PEC	Min. Critical Load (keq ha-1 yr-1)	PEC > CL?
17	0.0003	1.5	1.500	0.366	Yes
18	0.0040	1.9	1.904	0.223	Yes
19	0.0023	1.9	1.902	0.223	Yes
20	0.0025	1.9	1.903	0.223	Yes
23	0.0316	2.87	2.902	0.5	Yes
24	0.0250	1.88	1.905	0.581	Yes
25	0.0025	1.88	1.883	0.856	Yes
26	0.0030	2.87	2.873	0.5	Yes
27	0.0010	1.88	1.881	0.581	Yes
28	0.0013	1.47	1.471	0.581	Yes
29	0.0013	2.87	2.871	0.142	Yes
30	0.0016	2.87	2.872	0.5	Yes
32	0.0029	1.88	1.883	1.071	Yes

The calculations in Table 21 present the acid deposition due to sources of Nitrogen, calculate out the site specific Predicted Environmental Concentration, and compare this to the minimum Critical Load for Nitrogen based acid (MinCLminN). Where the PEC is greater than the minimum Critical Load, contributions of Nitrogen and other acid sources should be assessed together against the lower end of the maximum Critical Load (MinCLmaxN). Table 22 calculates the contributions from Sulphur and acid gas sources, before the total acid sources are combined and assessed in Table 23 over page.

Table 22 Contributions of Acid from Sulphur and Acid Gas Sources at Sensitive Ecological Receptors When Compared Against Critical Levels

Receptor Number	S. Dep. (µg m^{-2} s^{-1})	Acid (Dry) (keq ha^{-1} yr^{-1})	HCl. Dep. (µg m^{-2} s^{-1})	Total Acid (keq ha^{-1} yr^{-1})	HF. Dep. (µg m^{-2} s^{-1})	Total Acid (keq ha^{-1} yr^{-1})
17	2.85E-04	2.81E-03	9.71E-06	2.51E-04	1.01E-06	4.79E-05
18	3.21E-03	3.15E-02	2.13E-04	5.51E-03	2.28E-05	1.08E-03
19	1.90E-03	1.86E-02	1.01E-04	2.63E-03	1.06E-05	5.01E-04
20	2.11E-03	2.08E-02	1.10E-04	2.86E-03	1.14E-05	5.42E-04
23	3.01E-02	2.97E-01	9.05E-04	2.34E-02	3.84E-05	1.82E-03
24	2.29E-02	2.26E-01	7.99E-04	2.07E-02	3.10E-05	1.47E-03
25	2.26E-03	2.22E-02	8.21E-05	2.13E-03	8.00E-06	3.79E-04
26	2.22E-03	2.18E-02	1.29E-04	3.33E-03	6.33E-06	3.00E-04
27	8.15E-04	8.02E-03	3.54E-05	9.16E-04	3.57E-06	1.69E-04
28	9.67E-04	9.52E-03	3.83E-05	9.91E-04	3.67E-06	1.74E-04
29	1.18E-03	1.16E-02	4.12E-05	1.07E-03	4.12E-06	1.95E-04
30	1.30E-03	1.28E-02	4.94E-05	1.28E-03	1.81E-06	8.58E-05
32	2.41E-03	2.37E-02	1.00E-04	2.59E-03	9.49E-06	4.49E-04

Table 23 Total Acid Deposition to Sensitive Ecological Receptors When Compared Against Critical Loads

Receptor Number	Total Acid Deposition – N, S, and H Sources (keq ha^{-1} yr^{-1})	Critical Load (keq ha^{-1} yr^{-1})	% Critical Load
17	0.0034	0.646	0.53%
18	0.0422	1.131	**3.73%**
19	0.0241	1.131	**2.13%**
20	0.0267	1.131	**2.36%**
23	0.3533	2.54	**13.91%**
24	0.2727	1.131	**24.11%**
25	0.0272	4.856	0.56%
26	0.0284	2.569	**1.11%**
27	0.0101	1.131	0.89%
28	0.0119	1.111	**1.07%**
29	0.0142	2.353	0.60%
30	0.0158	2.536	0.62%
32	0.0297	5.071	0.58%

The results show that the Process Contributions of acid deposition to six of the sensitive ecological receptors assessed remain within 1 % of the Critical Load and hence can immediately be screened as insignificant. Seven of the receptors report contributions which are above 1 % of the Critical Load, although of these, only receptors 18 – 20 represent a national site, the Nelson Bog SSSI. Acid contributions to the Nelson Bog are calculated to equate to between 2.13 % and 3.73 % of the Critical Load, and are therefore very small, despite not screening as insignificant. Although contributions at other locations range from less than 1 % to approximately 24 % of the Critical Load, the local designation of these sites simply requires that the PC remains within 100 % of the Critical Load, which it does at each receptor.

By definition, Critical Loads represent a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge[10]. Exceedance of a Critical Load is therefore not a quantitative estimate of damage to a particular habitat, but represents the potential for damage to occur. The contribution from the processes within the Bryn Power Limited site do exceed 1 % of the acid deposition Critical Load at the Nelson Bog SSSI, but remain a very small percentage of the overall Critical Load, which is 1.131 keq ha^{-1} $year^{-1}$. According to the APIS website[10], the current background acid deposition loading at the Nelson Bog (2.2 keq ha^{-1} $year^{-1}$) is already almost double the Critical Load.

Overall, the assessment clearly demonstrates that the majority of pollutant contributions from the two CHPs and SWIPs at the Bryn Power Limited site in Hengoed can be screened at either the initial or secondary stage and no further assessment is required. The exceptions to this are when considering the point of maximum contribution which consistently occurs within the site boundary, and the assessment of contributions to acid deposition at the Nelson Bog SSSI which is predicted to receive a maximum contribution of acid equating to less than 4 % of the Critical Load.

The assessments have applied a worst-case approach, modelling all discharges at their emission limit values and assuming continuous operation.

5. Conclusions

Bryn Power Limited operates an anaerobic digestion (AD) facility at their site on Gelliargwellt Farm in Hengoed, located in the County Borough of Caerphilly, South Wales. The AD plant currently includes two combined heat and power (CHP) engines which receive the biogas from the process in order to create energy, and a third engine is now planned for installation. The site also includes two small waste incineration plant.

This assessment has considered the cumulative impact from all four existing processes and the additional 1 MW engine, on local air quality and pollution levels at local sensitive receptors.

Detailed dispersion modelling demonstrated that, when discharging at maximum emission levels and applying the accepted methodology for screening insignificant impacts, none of the contributions to pollutant levels or the Predicted Environmental Concentrations exceeded their relevant assessment levels outside of the site boundary. At one location within the site boundary, calculated contributions of Benzene to the 24-hour assessment level could not be screened, and indeed marginally exceeded the assessment level. However, occurring for one 24-hour period at a single location on a site roadway, there is no potential for any relevant exposure of members of the general public, or of site workers to the calculated levels of Benzene from total VOCs, and hence no further assessment is required. All other pollutants remain within their relevant assessment levels at all locations and across all referencing periods.

When considering the impact of emissions at local sensitive receptors, most pollutants could be screened as insignificant at either the primary or secondary stage. The one exception to this was when considering the contribution of acid deposition to the Critical Load at the Nelson Bog SSSI, where contributions ranged from approximately 2.1 to 3.7 % of the Critical Load. Although these levels cannot be screened as insignificant this contribution equates to a very small percentage of the overall loading, with by far the most significant levels being those already experienced at the site from the current background. However, as the exceedance of a Critical Load is not a quantitative estimate of damage to a particular habitat, it is considered that the potential for a significant negative effect from the Process Contribution of acid deposition to the Nelson Bog is very small.

It is therefore concluded that, based on the releases to atmosphere from the Bryn Power Limited site discharging at 10 m from the two existing CHP units, 19 m from the proposed engine and 14 m from the two SWIP units which have been modelled in combination with the CHPs, the Process Contributions from the proposed future operations can be screened as being not significant in relation to human health, and insignificant or very small at local sensitive ecological sites.

6. References

[1] Cambridge Environmental Research Limited, ADMS Version 5 User Guide, November 2016

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

[3] AQTAG06 Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air. Updated version, (Approved March 2014)

[4] Background data was sourced from the UK Air Quality Archive (https://uk-air.defra.gov.uk)

[5] Chimney Height Assessment and Detailed Air Quality Assessment for Two SWIP Boilers, Bryn Power Ltd, Hengoed. Version 4. September 2018. Environmental Visage Limited

[6] Air Quality Assessment to Accompany an Environmental Permit Variation Application for the Bryn Power Anaerobic Digestion Facility. February 2019. Environmental Visage Limited

[7] Local Air Quality Management Technical Guidance LAQM.TG(16)

[8] The Air Quality Standards (Wales) Regulations 2010. 2010 Welsh Statutory Instrument No. 1443 W.126). Laid before the Welsh Assembly 19th May 2010

[9] EPUK and IAQM, Land-Use Planning and Development Control: Planning for Air Quality. January 2017

[10] Air Pollution Information System - http://www.apis.ac.uk/srcl