



Five Fords,
Wrexham

Air Quality Assessment

July 2020



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1. INTRODUCTION	5
Background.....	5
Site Location and Context	5
2. LEGISLATION AND POLICY	6
Legislation.....	6
Local Air Quality Management.....	7
Critical Loads and Levels	7
National Planning Policy	8
Local Planning Policy	9
3. BASELINE.....	11
Local Air Quality Management.....	11
Air Quality Monitoring	11
Background Pollutant Concentrations	11
Sensitive Receptors	12
Sensitive Human Receptors	12
Sensitive Ecological Receptors.....	12
4. METHODOLOGY.....	19
Introduction.....	19
Dispersion Model	19
Modelling Scenarios	19
Assessment Area	20
Process Conditions and Emissions	20
NO _x to NO ₂ Conversion	21
Building Effects	21
Meteorological Data.....	22
Roughness Length	22
Monin-Obukhov Length.....	22
Terrain Data.....	23
Nitrogen Deposition	23
Acid Deposition.....	23
Background Concentrations.....	24
Assessment Criteria.....	24
Human Receptors.....	24

Ecological Receptors	25
Model Uncertainty	25
5. ASSESSMENT	27
Introduction.....	27
Maximum Pollutant Concentrations	27
Predicted Impacts	27
Human Receptors	27
Ecological Receptors.....	29
6. CONCLUSION	39

1. Introduction

Background

This report has been prepared to support the installation of an energy centre at Five Fords, Wrexham.

It is proposed to install four gas-fired Combined Heat and Power (CHP) units at the site. These have the potential to cause air quality impacts as a result of emissions associated with heat generation. As such, an Air Quality Assessment was required in order to determine baseline conditions and assess potential effects during operation.

Site Location and Context

The site is situated at Five Fords, Wrexham, at approximate National Grid Reference (NGR): 336975, 348090. Reference should be made to Figure 1 for a map of the site and surrounding area.

The proposals include installation of four gas-fired Combined Heat and Power (CHP) units. One CHP unit will have a thermal input of 2.9MW. Three of the CHP units will have a thermal input of 6.1MW. All CHP units are to be housed within a building situated within the northern part of the site. Combustion emissions will be released via dedicated stacks.

It is also proposed to install two gas-fired boilers alongside the CHP units. These will operate as emergency plant for when the CHP units are out of service.

The operation of the energy plant may result in atmospheric emissions from the combustion of natural gas. These have the potential to cause air quality impacts at sensitive locations within the vicinity of the site and have therefore been quantified within this report.

2. Legislation and Policy

Legislation

The Air Quality Standards (Wales) Regulations (2010) came into force on 11th June 2010 and include Air Quality Limit Values (AQLVs) for the following pollutants:

- Nitrogen dioxide (NO₂);
- Sulphur dioxide;
- Lead;
- Particulate matter with an aerodynamic diameter of less than 10µm;
- Particulate matter with an aerodynamic diameter of less than 2.5µm;
- Benzene; and,
- Carbon monoxide.

Target Values were also provided for an additional 5 pollutants. There include:

- Ozone;
- Arsenic;
- Cadmium;
- Nickel; and,
- Benzo(a)pyrene.

Part IV of the Environment Act (1995) requires UK government to produce a national Air Quality Strategy (AQS) which contains standards, objectives and measures for improving ambient air quality. The most recent AQS was produced by the Department for Environment, Food and Rural Affairs (DEFRA) and published in July 2007¹. The AQS sets out Air Quality Objectives (AQOs) that are maximum ambient pollutant concentrations that are not to be exceeded either without exception or with a permitted number of exceedences over a specified timescale. These are generally in line with the AQLVs, although the requirements for the determination of compliance vary.

Table 1 presents the AQOs for pollutants considered within this assessment.

Table 1 Air Quality Objectives

Pollutant	Air Quality Objective	
	Concentration (µg/m ³)	Averaging Period
NO ₂	40	Annual mean
	200	1-hour mean; not to be exceeded on more than 18 occasions per annum

¹ The AQS for England, Scotland, Wales and Northern Ireland, DEFRA, 2007.

Table 2 summarises the advice provided in the DEFRA guidance² on where the AQOs for pollutants considered within this report apply.

Table 2 Examples of Where the Air Quality Objectives Apply

Averaging Period	Objective Should Apply At	Objective Should Not Apply At
Annual mean	All locations where members of the public might be regularly exposed Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access Hotels, unless people live there as their permanent residence Gardens of residential properties Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
1-hour mean	All locations where the annual mean and 24 mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets) Those parts of car parks, bus stations and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more Any outdoor locations where members of the public might reasonably be expected to spend one hour or longer	Kerbside sites where the public would not be expected to have regular access

Local Air Quality Management

Under Section 82 of the Environment Act (1995) (Part IV) Local Authorities are required to periodically review and assess air quality within their area of jurisdiction under the system of Local Air Quality Management (LAQM). This review and assessment of air quality involves comparing present and likely future pollutant concentrations against the AQOs. If it is predicted that levels at locations of relevant exposure are likely to be exceeded, the Local Authority is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan, the objective of which is to reduce pollutant concentrations in pursuit of the AQOs.

Critical Loads and Levels

A critical load is defined by the UK Air Pollution Information System (APIS)³ as:

"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

² Local Air Quality Management Technical Guidance (TG16), DEFRA, 2018.

³ UK Air Pollution Information System, www.apis.ac.uk.

occur, according to present knowledge. The exceedance of a critical load is defined as the atmospheric deposition of the pollutant above the critical load."

A critical level is defined as:

"Threshold for direct effects of pollutant concentrations according to current knowledge. Exceedance of a critical level is defined as the atmospheric concentration of the pollutant above the critical level."

A critical load refers to deposition of a pollutant, while a critical level refers to pollutant concentrations in the atmosphere (which usually have direct effects on vegetation or human health).

When pollutant loads (or concentrations) exceed the critical load or level it is considered that there is a risk of harmful effects. The excess over the critical load or level is termed the exceedance. A larger exceedance is often considered to represent a greater risk of damage.

Maps of critical loads and levels and their exceedances have been used to show the potential extent of pollution damage and aid in developing strategies for reducing pollution. Decreasing deposition below the critical load is seen as means for preventing the risk of damage. However, even a decrease in the exceedance may infer that less damage will occur.

Critical loads have been designated within the UK based on the sensitivity of the receiving habitat and have been reviewed for the purpose of this assessment.

Table 3 presents the critical levels for the protection of vegetation for pollutants considered within this assessment.

Table 3 Critical Levels for the Protection of Vegetation

Pollutant	Critical Level	
	Concentration ($\mu\text{g}/\text{m}^3$)	Averaging Period
Oxides of nitrogen (NO_x)	30	Annual mean
	75	24-hour mean

Critical loads have been designated within the UK based on the sensitivity of the receiving habitat and have been reviewed for the purpose of this assessment.

National Planning Policy

Planning Policy Wales⁴ was published in December 2018 and sets out the land use planning policies of the Welsh Government, including air quality. Chapter 6, Section 6.7 - Air Quality and Soundscape provides a framework for addressing air quality and states that:

"The planning system should maximise its contribution to achieving the well-being goals, and in particular a healthier Wales, by aiming to reduce average population

⁴ Planning Policy Wales Edition 10, Welsh Government, 2018.

exposure to air and noise pollution alongside action to tackle high pollution hotspots. In doing so, it should consider the long-term effects of current and predicted levels of air and noise pollution on individuals, society and the environment and identify and pursue any opportunities to reduce, or at least, minimise population exposure to air and noise pollution, and improve soundscapes, where it is practical and feasible to do so.

[...]

In proposing new development, planning authorities and developers must, therefore:

- *address any implication arising as a result of its association with, or location within, air quality management areas, noise action planning priority areas or areas where there are sensitive receptors;*
- *not create areas of poor air quality or inappropriate soundscapes; and,*
- *seek to incorporate measures which reduce overall exposure to air and noise pollution and create appropriate soundscapes."*

This has been considered within this report through the assessment of potential air quality impacts associated with the development.

Local Planning Policy

The Wrexham Unitary Development Plan⁵ (WUDP) was adopted by Wrexham County Borough Council (WCBC) in 2005. The WUDP sets out WCBC's vision for the area and identifies specific policies for housing, employment and transport.

A review of the WUDP indicated the following policy in relation to air quality which is relevant to this assessment:

"Policy GDP1 - General Design Principles

All new developments should:-

[...]

f) Ensure the safety and amenity of the public and safeguard the environment from the adverse effects of pollution of water, land or air, hazards from industry and quarrying, and associated noise, odour or vibration arising from development.

[...]

h) Safeguard sites and areas of nature conservation and wildlife interest, and to provide new habitats where there is an unavoidable loss of existing habitats and areas of wildlife interest.

[...]

⁵ WUDP 1996 - 2011, WCBC, 2005.

k) Secure the development of sustainable communities, through the promotion of the economic, social and environmental well-being of the area."

The above policy was taken into consideration throughout the undertaking of the assessment.

3. Baseline

Existing air quality conditions in the vicinity of the site were identified in order to provide a baseline for assessment. These are detailed in the following Sections.

Local Air Quality Management

As required by the Environment Act (1995), WCBC has undertaken Review and Assessment of air quality within their area of jurisdiction. This process has indicated that concentrations of all pollutants considered within the AQS are currently below the relevant AQOs. As such, no AQMAs have been designated within the county.

Air Quality Monitoring

Monitoring of pollutant concentrations is undertaken by WCBC throughout their area of jurisdiction. Recent NO₂ results recorded in the vicinity of the site are shown in Table 4.

Table 4 Monitoring Results

Monitoring Site		Site Classification	Annual Mean NO ₂ Concentration (µg/m ³)		
			2016	2017	2018
WBC-041	Marchwiell	Roadside	15.2	15.0	15.4

As shown in Table 4, annual mean NO₂ concentrations were below the AQO at the WBC-041 - Marchwiell monitor in recent years. Reference should be made to Figure 2 for a map of the survey position.

Background Pollutant Concentrations

Predictions of background pollutant concentrations on a 1km by 1km grid basis have been produced by DEFRA for the entire of the UK to assist LAs in their Review and Assessment of air quality. The facility is located in grid square NGR: 336500, 348500. Data for this location was downloaded from the DEFRA website⁶ for the purpose of this assessment and is summarised in Table 5.

Table 5 Background Pollutant Concentrations

Pollutant	Predicted 2020 Background Concentration (µg/m ³)
NO ₂	7.15

As shown in Table 5, the predicted background NO₂ concentration is below the relevant AQO at the site.

⁶ <https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2017>.

Sensitive Receptors

A sensitive receptor is defined as any location which may be affected by changes in air quality. These have been defined for human and ecological receptors in the following Sections.

Sensitive Human Receptors

A desk-top study was undertaken in order to identify any sensitive human receptor locations in the vicinity of the facility that required specific consideration during the assessment. These are summarised in Table 6.

Table 6 Sensitive Human Receptor Locations

Receptor		NGR (m)	
		X	Y
R1	Residential - Mulberry House	337063.8	347472.2
R2	Residential - Bangor Road	336339.5	347613.2
R3	Residential - Glenrafon Cottage	336582.1	348494.6
R4	Residential - Bedwell Road	337187.2	348374.6
R5	Residential - Bedwell Road	337452.5	348099.6
R6	Industrial - Bedwell Road	337309.0	347923.4

Reference should be made to Figure 3 for a map showing the sensitive human receptor locations.

Sensitive Ecological Receptors

Atmospheric emissions from the facility have the potential to impact on receptors of ecological sensitivity within the vicinity of the site. The Conservation of Habitats and Species Regulations (2010) and subsequent amendments require competent authorities to review applications and consents that have the potential to impact on ecological designations. A study was therefore undertaken to identify the following sites of ecological or nature conservation importance:

- Special Areas of Conservation (SAC), Special Protection Areas or Ramsar sites within 10km of the facility; and,
- Sites of Special Scientific Interest, National Nature Reserves, Ancient Woodland (AW) and Local Nature Reserves within 2km of the facility.

The study was completed using the Multi-Agency Geographic Information for the Countryside (MAGIC)⁷ web-based interactive mapping service which draws together information on key

⁷ <https://magic.defra.gov.uk/MagicMap.aspx>

environmental schemes and designations, as well as publicly available information. This indicated the following ecological designation within the relevant distances:

- River Dee and Bala Lake SAC;
- Johnstown Newt Site SAC;
- Berwyn and South Clwyd Mountains SAC;
- Marchwiel AW;
- Black Dog AW;
- Mill Wood AW;
- Cottage Wood AW;
- Erilas Black Wood AW; and,
- Several unnamed AWs.

For the purpose of the modelling assessment, discrete receptors were placed at the closest points of each designation to the facility to ensure the maximum potential impact was predicted. These are summarised in Table 7.

Table 7 Sensitive Ecological Receptor Locations

Receptor		NGR (m)	
		X	Y
ER1	River Dee and Bala Lake SAC	341302.6	352753.2
ER2	River Dee and Bala Lake SAC	341995.7	349963.1
ER3	River Dee and Bala Lake SAC	341341.2	347901.6
ER4	River Dee and Bala Lake SAC	338777.0	346557.7
ER5	River Dee and Bala Lake SAC	336202.4	344292.1
ER6	Johnstown Newt Sites SAC	330802.0	345279.3
ER7	Johnstown Newt Sites SAC	331396.6	346923.3
ER8	Berwyn and South Clwyd Mountains SAC	327341.8	349680.6
ER9	Marchwiel Covert AW	336386.1	347947.3
ER10	Black Dog AW	336381.1	348403.3
ER11	Black Dog AW	336497.6	348522.3
ER12	Mill Wood AW	335751.4	348650.4
ER13	Unnamed AW	335229.8	348715.7
ER14	Cefn Park AW	335770.9	349567.1
ER15	Cottage Wood AW	335762.8	350041.1

Receptor		NGR (m)	
		X	Y
ER16	Unnamed AW	336351.2	349894.3
ER17	Big Wood AW	336683.1	349802.7
ER18	Erlas Black Wood AW	337742.8	349929.0
ER19	Unnamed AW	337423.9	349270.1
ER20	Unnamed AW	338213.6	347891.1
ER21	Unnamed AW	337751.8	347511.4
ER22	Unnamed AW	337313.2	346842.3
ER23	Unnamed AW	336938.1	346482.3

Reference should be made to Figure 4 for a map of the ecological receptor locations.

Critical loads have been designated within the UK based on the sensitivity and relevant features of the receiving habitat. Review of the APIS website⁸ was undertaken to identify the features most sensitive to nitrogen deposition. The relevant critical loads are presented in Table 8.

Table 8 Critical Loads - Nitrogen Deposition

Receptor	Feature	APIS Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
ER1	Luronium natans - Floating water-plantain	Permanent oligotrophic waters: Softwater lakes	3	10
ER2	Luronium natans - Floating water-plantain	Permanent oligotrophic waters: Softwater lakes	3	10
ER3	Luronium natans - Floating water-plantain	Permanent oligotrophic waters: Softwater lakes	3	10
ER4	Luronium natans - Floating water-plantain	Permanent oligotrophic waters: Softwater lakes	3	10
ER5	Luronium natans - Floating water-plantain	Permanent oligotrophic waters: Softwater lakes	3	10
ER6	Triturus cristatus - Great crested newt	_(a)	-	-
ER7	Triturus cristatus - Great crested newt	_(a)	-	-

⁸ <http://www.apis.ac.uk/>.

Receptor	Feature	APIS Critical Load Class	Nitrogen Critical Load (kgN/ha/yr)	
			Low	High
ER8	Blanket bogs	Raised and blanket bogs	5	10
ER9	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER10	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER11	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER12	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER13	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER14	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER15	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER16	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER17	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER18	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER19	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER20	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER21	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER22	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20
ER23	Broadleaved, Mixed and Yew Woodland	Broadleaved deciduous woodland	10	20

NOTE: (a) No comparable habitat with established critical load estimate available.

The site features were also reviewed to identify the habitat types most sensitive to acid deposition. These are summarised in Table 9.

Table 9 Critical Loads - Acid Deposition

Receptor	Feature	APIS Acidity Class	Acid Critical Load (keq/ha/yr)		
			CLMaxS	CLMinN	CLMaxN
ER1	Water courses of plain to montane levels with the Ranunculus fluitantis and Callitriche-Batrachion vegetation	Freshwater	_(a)	_(a)	_(a)
ER2	Water courses of plain to montane levels with the Ranunculus fluitantis and Callitriche-Batrachion vegetation	Freshwater	_(a)	_(a)	_(a)
ER3	Water courses of plain to montane levels with the Ranunculus fluitantis and Callitriche-Batrachion vegetation	Freshwater	_(a)	_(a)	_(a)
ER4	Water courses of plain to montane levels with the Ranunculus fluitantis and Callitriche-Batrachion vegetation	Freshwater	_(a)	_(a)	_(a)
ER5	Water courses of plain to montane levels with the Ranunculus fluitantis and Callitriche-Batrachion vegetation	Freshwater	_(a)	_(a)	_(a)
ER6	Triturus cristatus - Great crested newt	Freshwater	_(a)	_(a)	_(a)
ER7	Triturus cristatus - Great crested newt	Freshwater	_(a)	_(a)	_(a)
ER8	Calcareous and calcshist screes of the montane to alpine levels	Montane	0.23	0.178	0.551
ER9	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.407	0.357	1.764
ER10	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.403	0.357	1.76

Receptor	Feature	APIS Acidity Class	Acid Critical Load (keq/ha/yr)		
			CLMaxS	CLMinN	CLMaxN
ER11	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.403	0.357	1.76
ER12	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.528	0.142	1.67
ER13	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.528	0.142	1.67
ER14	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.997	0.142	1.139
ER15	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	0.978	0.142	1.12
ER16	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.402	0.357	1.759
ER17	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.402	0.357	1.759
ER18	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.4	0.357	1.757
ER19	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.4	0.357	1.757
ER20	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.401	0.357	1.758
ER21	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.404	0.357	1.761
ER22	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.405	0.357	1.762
ER23	Broadleaved, Mixed and Yew Woodland	Broadleaved/Coniferous unmanaged woodland	1.408	0.357	1.765

NOTE: (a) Critical load not defined.

Background pollutant concentrations and deposition rates at each ecological receptor location were obtained from the APIS website⁹. These are summarised in Table 10.

⁹ <http://www.apis.ac.uk/>.

Table 10 Baseline Pollution Levels

Receptor	Annual Mean NO _x Concentration (µg/m ³)	Annual Nitrogen Deposition (kgN/ha/yr)	Annual Acid Deposition (keq/ha/yr)	
			Nitrogen	Sulphur
ER1	8.47	23.10	1.7	0.1
ER2	7.91	23.40	1.7	0.1
ER3	7.28	23.40	1.7	0.1
ER4	8.39	23.90	1.7	0.2
ER5	7.29	23.00	1.6	0.2
ER6	11.50	22.10	1.6	0.2
ER7	12.49	22.10	1.6	0.2
ER8	6.49	19.90	1.4	0.2
ER9	8.90	41.30	2.95	0.19
ER10	10.93	41.30	2.95	0.19
ER11	10.93	41.30	2.95	0.19
ER12	9.29	41.30	2.95	0.19
ER13	9.29	41.30	2.95	0.19
ER14	10.95	41.30	2.95	0.19
ER15	11.79	42.56	3.04	0.2
ER16	10.22	41.30	2.95	0.19
ER17	10.22	41.30	2.95	0.19
ER18	16.00	41.30	2.95	0.19
ER19	16.00	41.30	2.95	0.19
ER20	8.23	41.30	2.95	0.19
ER21	8.81	41.30	2.95	0.19
ER22	7.99	41.30	2.95	0.19
ER23	8.02	41.30	2.95	0.19

4. Methodology

Introduction

Emissions from the energy plant have the potential to contribute to elevated pollutant concentrations in the vicinity of the site. These have been quantified through dispersion modelling in accordance with the methodology outlined in the following Sections. The following Environment Agency (EA) guidance, which is endorsed by Natural Resources Wales (NRW), was utilised as necessary throughout the assessment:

- Air emissions risk assessment for your environmental permit¹⁰; and,
- Environmental permitting: air dispersion modelling reports¹¹.

Dispersion Model

Dispersion modelling was undertaken using ADMS-5.2 (v5.2.4.0), which is developed by Cambridge Environmental Research Consultants (CERC) Ltd. ADMS-5 is a short-range dispersion modelling software package that simulates a wide range of buoyant and passive releases to atmosphere. It is a new generation model utilising boundary layer height and Monin-Obukhov length to describe the atmospheric boundary layer and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions.

The model utilises hourly meteorological data to define conditions for plume rise, transport and diffusion. It estimates the concentration for each source and receptor combination for each hour of input meteorology and calculates user-selected long-term and short-term averages.

Modelling Scenarios

The pollutants considered for human receptors in the modelling assessment are summarised in Table 11.

Table 11 Human Receptor Modelled Pollutants

Pollutant	Modelled As	
	Short Term	Long Term
NO ₂	99.8 th percentile (%ile) 1-hour mean	Annual mean

Some short-term air quality criteria are framed in terms of the number of occasions in a calendar year on which the concentration should not be exceeded. The %ile shown in Table 11 was selected to represent the relationship between the permitted number of exceedences of short-period concentrations and the number of periods within a calendar year.

The pollutants considered for ecological receptors in the modelling assessment are summarised in Table 12.

¹⁰ Air emissions risk assessment for your environmental permit, EA, 2016.

¹¹ Environmental permitting: air dispersion modelling reports, EA, 2019.

Table 12 Ecological Receptor Modelled Pollutants

Pollutant	Modelled As	
	Short Term	Long Term
NO _x	24-hour mean	Annual mean
Nitrogen deposition	-	Annual deposition
Acid deposition	-	Annual deposition

Predicted pollutant concentrations were summarised in the following formats:

- Process contribution (PC) - Predicted pollutant concentration as a result of emissions from plant; and
- Predicted environmental concentration (PEC) - Total predicted pollutant concentration as a result of emissions from the plant and existing baseline levels.

Predicted ground level pollutant concentrations and deposition rates were compared with the relevant AQOs, critical loads and critical levels. These criteria are collectively referred to as Environmental Quality Standards (EQSs).

Assessment Area

The assessment area was defined based on the site location, anticipated pollutant dispersion patterns and the positioning of sensitive receptors. Ambient concentrations were predicted over NGR: 336050, 347450 to 337550, 348950. One Cartesian grid with a resolution of 10m was used within the model to produce data suitable for contour plotting using the Surfer software package.

Reference should be made to Figure 5 for a graphical representation of the assessment grid extents.

Process Conditions and Emissions

Process conditions were provided by Low Carbon Farming Ltd to define inputs to the dispersion model. A summary of the inputs is provided in Table 13 and include installation of NO_x abatement to control emissions from the site. It should be noted that the gas boilers are provided for back-up only and will not operate concurrently with the CHP units. As such, they were not included in the model setup.

Table 13 Process Conditions and Emissions

Parameter	Unit	CHP 1	CHP 2	CHP 3	CHP 4
Stack location	NGR	336817.7, 348214.3	336820.1, 348214.3	336835.7, 348214.3	336838.1, 348214.3
Stack height	m	12	12	12	12
Stack diameter	m	0.5	0.6	0.6	0.6
Exhaust gas temperature	°C	60	60	60	60

Parameter	Unit	CHP 1	CHP 2	CHP 3	CHP 4
Exhaust gas flow rate	Nm ³ /hr	4,835 ^(a)	11,095 ^(a)	11,095 ^(a)	11,095 ^(a)
Exhaust gas flow rate	m ³ /hr	7,337	16,476	16,476	16,476
Stack moisture content	%	10.35	9.37	9.37	9.37
Exhaust gas efflux velocity	m/s	10.38	16.19	16.19	16.19
NO _x emission concentration	ppmv	15	15	15	15
NO _x emission rate	g/s	0.0462	0.1048	0.1048	0.1048

NOTE: ^(a) Stated dry at 273K.

Emissions from the CHP units were assumed to be constant, with the plant in operation 24-hours per day, 365-days per year. This is considered to be a worst-case assessment scenario as plant shutdown or periods of reduced work load are not reflected in the modelled emissions.

NO_x to NO₂ Conversion

Emissions of NO_x from combustion processes are predominantly in the form of NO. Excess oxygen in the combustion gases and further atmospheric reactions cause the oxidation of NO to NO₂. Comparisons of ambient NO and NO₂ concentrations in the vicinity of point sources in recent years has indicated that it is unlikely that more than 30% of the NO_x is present at ground level as NO₂.

Ground level NO_x concentrations were predicted through dispersion modelling. NO₂ concentrations reported in the results section assume 70% conversion from NO_x to NO₂ for annual means and 35% conversion for 1-hour concentrations, based upon EA guidance¹².

Building Effects

The dispersion of substances released from elevated sources can be influenced by the presence of buildings close to the emission point. Structures can interrupt the wind flows and cause significantly higher ground-level concentrations close to the source than would arise in the absence of the buildings.

Analysis of the site layout indicated that a number of buildings should be included within the model in order to take account of effects on pollutant dispersion. Input geometries are shown in Table 14.

Table 14 Building Geometries

Building	NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (°)
	X	Y				
Greenhouse	336935.5	347957.6	8.0	468.0	344.0	180.0
Energy Centre Building	336816.8	348211.2	8.0	37.9	84.0	180.0

¹² Environmental permitting: air dispersion modelling reports, EA, 2019.

Building	NGR (m)		Height (m)	Length/ Diameter (m)	Width (m)	Angle (°)
	X	Y				
Packing House	336925.1	348219.0	8.0	55.0	112.0	180.0
Silo 1	336810.3	348251.1	12.5	25.0	-	-
Silo 2	336836.2	348251.7	12.5	25.0	-	-

Reference should be made to Figure 5 for a graphical representation of the site layout.

Meteorological Data

Meteorological data used in the assessment was taken from Hawarden meteorological station over the period 1st January 2014 to 31st December 2018 (inclusive). Hawarden meteorological station is located at NGR: 334586, 364102, which is approximately 16.9km north of the facility. It is anticipated that conditions would be reasonably similar over a distance of this magnitude. The data was therefore considered suitable for an assessment of this nature.

All meteorological records used in the assessment were provided by Atmospheric Dispersion Modelling (ADM) Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 6 for wind roses of the utilised meteorological data.

Roughness Length

Roughness length (z_0) is a modelling parameter applied to allow consideration of surface height roughness elements. A z_0 of 0.3m was used within the model to describe the dispersion extents. This value is considered appropriate for the morphology of the area and is suggested within ADMS-5 as being suitable for 'agricultural areas (max)'.

A z_0 of 0.5m was used within the model to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'parkland, open suburbia'.

Monin-Obukhov Length

The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 10m was used to describe the dispersion extents. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'small towns < 50,000'.

A minimum Monin-Obukhov length of 30m was used to describe the meteorological site. This value is considered appropriate for the nature of the area and is suggested within ADMS-5 as being suitable for 'mixed urban/industrial'.

Terrain Data

Ordnance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC¹³.

Nitrogen Deposition

Nitrogen deposition rates were calculated using the conversion factors provided within EA document 'Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06'¹⁴. Predicted pollutant concentrations were multiplied by the relevant deposition velocity and conversion factor to calculate the speciated dry deposition flux. The conversion factors used for the determination of nitrogen deposition are presented within Table 15.

Table 15 Conversion Factors to Determine Dry Deposition Flux for Nitrogen Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor ($\mu\text{g}/\text{m}^2/\text{s}$ to $\text{kg}/\text{ha}/\text{yr}$ of pollutant species)
	Grassland	Forest	
NO ₂	0.0015	0.003	95.9

Acid Deposition

Predicted ground level NO₂ concentrations were converted to kilo-equivalent ion depositions ($\text{keq}/\text{ha}/\text{yr}$) for comparison with the critical load for acid deposition at each of the identified ecological designations. The conversion to units of equivalents, a measure of the potential acidifying effect of a species, was undertaken using the standard conversion factors shown in Table 16.

Table 16 Conversion Factors to Determine Dry Deposition Flux for Acid Deposition

Pollutant	Deposition Velocity (m/s)		Conversion Factor ($\mu\text{g}/\text{m}^2/\text{s}$ to $\text{keq}/\text{ha}/\text{yr}$ of pollutant species)
	Grassland	Forest	
NO ₂	0.0015	0.003	6.84

The PC proportion of the EQS was calculated using the following formula obtained from the APIS website¹⁵:

$$PC \text{ as } \%CL \text{ function} = ((PC \text{ of } N \text{ deposition})/CL_{\text{max}N}) \times 100$$

¹³ Note 105: Setting up Terrain Data for Input to CERC Models, CERC, 2016.

¹⁴ Technical Guidance on Detailed Modelling approach for an Appropriate Assessment for Emissions to Air AQTAG 06, EA, 2014.

¹⁵ <http://www.apis.ac.uk/>.

Background Concentrations

Review of existing data in the vicinity of the facility was undertaken in Section 3 in order to identify suitable background values for use in the assessment. Monitoring of pollutant concentrations is undertaken by WCBC throughout their area of jurisdiction. The closest survey position is approximately 1.5km from the installation. Whilst similar concentrations may occur over a distance of this magnitude, the survey position is situated adjacent to an A-road which is not representative of the site or surrounding receptors. As such, this source of data was not considered further in the context of the assessment. The background concentration predicted by DEFRA, as shown in Table 5, was therefore utilised to represent baseline levels in the vicinity of the installation.

Background levels at the ecological receptors were obtained from the APIS¹⁶ website, as summarised in Table 10.

It is not possible to add short-term peak baseline and process concentrations. This is because the conditions which give rise to peak ground-level concentrations of substances emitted from an elevated source at a particular location and time are likely to be different to the conditions which give rise to peak concentrations due to emissions from other sources. This point is addressed in EA guidance 'Air emissions risk assessment for your environmental permit'¹⁷, which advises that an estimate of the maximum combined pollutant concentration can be obtained by adding the maximum predicted short-term concentration due to emissions from the source to twice the annual mean baseline concentration. This approach was adopted throughout the assessment.

Assessment Criteria

Human Receptors

EA guidance 'Air emissions risk assessment for your environmental permit'¹⁸, states that PCs can be screened as insignificant if they meet the following criteria:

- The short-term PC is less than 10% of the short-term environmental standard; and,
- The long-term PC is less than 1% of the long-term environmental standard.

If these criteria are exceeded the following guidance is provided on when whether PECs can be screened as insignificant:

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

Should the above criteria be exceeded then additional consideration to potential impacts should be provided.

¹⁶ <http://www.apis.ac.uk/>.

¹⁷ Air emissions risk assessment for your environmental permit, EA, 2016.

¹⁸ Air emissions risk assessment for your environmental permit, EA, 2016.

Ecological Receptors

EA guidance 'Air emissions risk assessment for your environmental permit'¹⁹ states that PCs at SACs can be screened as insignificant if they meet the following criteria:

- The short-term PC is less than 10% of the short-term environmental standard for protected conservation areas; and,
- The long-term PC is less than 1% of the long-term environmental standard for protected conservation areas.

If the long-term PC is greater than 1% and the PEC is less than 70% of the long-term environmental standard for protected conservation areas, then potential impacts can be screened as insignificant.

For AWs PCs can be screened as insignificant if they meet the following criteria:

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

Predicted PCs have been compared to the relevant EQs and the criteria stated above. Where the impact is within these parameters, it is concluded that impacts associated with an installation are acceptable.

Model Uncertainty

Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - due to errors in input data, including emission estimates, operational procedures, land use characteristics and meteorology; and,
- Variability - randomness of measurements used.

Potential uncertainties in the model results were minimised as far as practicable and worst-case inputs used in order to provide a robust assessment. This included the following:

- Choice of model - ADMS-5 is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible;
- Meteorological data - Modelling was undertaken using five meteorological data sets from the closest observation site to the facility to take account of local conditions. The assessment was based on the worst-case year for each averaging period to ensure maximum concentrations were considered;
- Surface characteristics - The z_0 and Monin-Obukhov length were determined for both the dispersion and meteorological sites based on the surrounding land uses and guidance provided by CERC;
- Plant operating conditions - Operational parameters for the plant were supplied by Low Carbon Farming Ltd. These are considered to be representative of likely operating conditions;
- Emission rates - Emission rates for the plant were supplied by Low Carbon Farming Ltd based on the proposed energy plant specification. Emissions were assumed to be constant

¹⁹ Air emissions risk assessment for your environmental permit, EA, 2016.

throughout the modelling period, which does not allow for operational shut down. These assumptions are likely to overestimate actual emissions and therefore result in a worst-case assessment;

- Background concentrations - Background pollutant levels were obtained from DEFRA and the APIS websites. As such, they are considered to be representative of baseline conditions within the vicinity of the installation;
- Receptor locations - A Cartesian Grid was included in the model in order to provide suitable data for contour plotting. Receptor points were also included at sensitive locations to provide additional consideration of these areas; and,
- Variability - All model inputs were as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

Results were considered in the context of the relevant EQSs. It is considered that the use of the stated measures to reduce uncertainty and the use of worst-case assumptions when necessary has resulted in model accuracy of an acceptable level.

5. Assessment

Introduction

Dispersion modelling was undertaken with the inputs described in Section 4. The results are provided in the following Sections.

Maximum Pollutant Concentrations

Maximum predicted pollutant concentrations at any point within the assessment extents for any meteorological data set are summarised in Table 17.

Table 17 Maximum Predicted Pollutant Concentrations

Pollutant	Averaging Period	EQS ($\mu\text{g}/\text{m}^3$)	PC ($\mu\text{g}/\text{m}^3$)	PC Proportion of EQS (%)	PEC ($\mu\text{g}/\text{m}^3$)	PEC Proportion of EQS (%)
NO ₂	Annual	40	5.92	14.80	13.07	32.67
	99.8 th %ile 1-hour	200	35.49	17.75	49.79	24.90

As shown in Table 17, there are no predicted exceedences of any EQS at any location for any pollutant or averaging period of interest within the modelling extents.

Reference should be made to Figure 7 and 8 for graphical representations of predicted pollutant concentrations, inclusive of background levels, throughout the assessment extents.

It should be noted that the data shown in the Figures are predictions from the meteorological data set which resulted in the maximum pollutant concentration for that species. For example, the maximum annual mean NO₂ concentration was predicted using the 2018 meteorological data set. As such, the contours shown in Figure 7 were produced from the 2018 model outputs.

Predicted Impacts

Human Receptors

Predicted annual mean NO₂ PECs at sensitive human receptors, inclusive of background levels, are summarised in Table 18.

Table 18 Predicted Annual Mean NO₂ Concentrations

Receptor	Predicted Annual Mean NO ₂ PEC ($\mu\text{g}/\text{m}^3$)				
	2014	2015	2016	2017	2018
R1	7.23	7.24	7.27	7.25	7.27
R2	7.19	7.18	7.21	7.18	7.20

Receptor	Predicted Annual Mean NO ₂ PEC (µg/m ³)				
	2014	2015	2016	2017	2018
R3	7.83	7.71	7.64	7.67	7.70
R4	7.57	7.66	7.58	7.65	7.53
R5	7.31	7.33	7.32	7.36	7.29
R6	7.38	7.45	7.42	7.46	7.39

As indicated in Table 18, predicted NO₂ concentrations were below the annual mean EQS of 40µg/m³ at all sensitive receptor locations for all meteorological data sets.

Maximum predicted annual mean NO₂ concentrations at the receptor locations are summarised in Table 19. Reference should be made to Figure 7 for a graphical representation of predicted concentrations throughout the assessment extents.

Table 19 Maximum Predicted Annual Mean NO₂ Concentrations

Receptor		Predicted Annual Mean NO ₂ Concentration (µg/m ³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
R1	Residential - Mulberry House	0.12	7.27	0.29	18.17
R2	Residential - Bangor Road	0.06	7.21	0.15	18.02
R3	Residential - Glenrafon Cottage	0.68	7.83	1.69	19.56
R4	Residential - Bedwell Road	0.51	7.66	1.26	19.14
R5	Residential - Bedwell Road	0.21	7.36	0.53	18.41
R6	Industrial - Bedwell Road	0.31	7.46	0.77	18.64

As indicated in Table 19, all PECs were below 70% of the EQS. As such, predicted effects on annual mean NO₂ concentrations are not considered to be significant, in accordance with the stated criteria.

Predicted 99.8th %ile 1-hour mean NO₂ PECs, inclusive of background levels, are summarised in Table 20.

Table 20 Predicted 99.8th %ile 1-hour Mean NO₂ Concentrations

Receptor	Predicted 99.8 th %ile 1-hour Mean NO ₂ PEC (µg/m ³)				
	2014	2015	2016	2017	2018
R1	15.74	15.79	16.00	15.74	15.91
R2	15.79	15.56	16.00	15.61	15.75

Receptor	Predicted 99.8 th %ile 1-hour Mean NO ₂ PEC (µg/m ³)				
	2014	2015	2016	2017	2018
R3	17.85	17.96	17.69	18.01	17.90
R4	17.35	17.47	17.44	17.49	17.38
R5	16.54	16.22	16.39	16.47	16.29
R6	16.90	16.75	16.96	16.90	16.88

As indicated in Table 20, predicted NO₂ concentrations were below the 1-hour mean EQS of 200µg/m³ at all sensitive receptor locations for all meteorological data sets.

Maximum predicted 1-hour mean NO₂ concentrations at the receptor locations are summarised in Table 21. Reference should be made to Figure 8 for a graphical representation of predicted concentrations throughout the assessment extents.

Table 21 Maximum Predicted 99.8th %ile 1-hour Mean NO₂ Concentrations

Receptor		Predicted 99.8 th %ile 1-hour Mean NO ₂ Concentration (µg/m ³)		PC Proportion of EQS (%)	PC Proportion of EQS Headroom (%) ^(a)
		PC	PEC		
R1	Residential - Mulberry House	1.70	16.00	0.85	0.92
R2	Residential - Bangor Road	1.70	16.00	0.85	0.92
R3	Residential - Glenrafon Cottage	3.71	18.01	1.85	2.00
R4	Residential - Bedwell Road	3.19	17.49	1.60	1.72
R5	Residential - Bedwell Road	2.24	16.54	1.12	1.21
R6	Industrial - Bedwell Road	2.66	16.96	1.33	1.43

NOTE: (a) PC proportion of EQS minus twice the long-term background concentration.

As indicated in Table 21, the PC proportion of the EQS was below 10% at all locations. As such, predicted effects on 1-hour mean NO₂ concentrations are not considered to be significant, in accordance with the stated criteria.

Ecological Receptors

Oxides of Nitrogen

Predicted annual mean NO_x PECs at the ecological receptors are summarised in Table 22.

Table 22 Predicted Annual Mean NO_x Concentrations

Receptor	Predicted Annual Mean NO _x PEC (µg/m ³)				
	2014	2015	2016	2017	2018
ER1	8.48	8.48	8.48	8.48	8.48
ER2	7.92	7.92	7.92	7.92	7.92
ER3	7.30	7.29	7.30	7.30	7.30
ER4	8.45	8.45	8.46	8.45	8.46
ER5	7.30	7.29	7.30	7.29	7.30
ER6	11.50	11.50	11.50	11.50	11.50
ER7	12.49	12.49	12.49	12.49	12.49
ER8	6.49	6.49	6.49	6.49	6.49
ER9	8.98	8.96	9.02	8.96	9.01
ER10	11.18	11.12	11.13	11.07	11.12
ER11	11.54	11.43	11.37	11.37	11.41
ER12	9.35	9.33	9.34	9.33	9.34
ER13	9.32	9.31	9.31	9.31	9.31
ER14	11.08	11.05	11.04	11.05	11.05
ER15	11.92	11.89	11.89	11.89	11.89
ER16	10.39	10.36	10.38	10.36	10.38
ER17	10.36	10.34	10.37	10.35	10.37
ER18	16.05	16.05	16.04	16.05	16.05
ER19	16.09	16.09	16.08	16.09	16.09
ER20	8.31	8.31	8.32	8.33	8.30
ER21	8.96	8.98	8.98	8.98	8.97
ER22	8.04	8.05	8.07	8.05	8.07
ER23	8.04	8.04	8.05	8.04	8.05

As shown in Table 22, annual mean NO_x PECs were below the EQS of 30µg/m³ at all ecological receptor locations for all meteorological data sets.

Maximum predicted annual mean NO_x concentrations at the receptor locations are summarised in Table 23.

Table 23 Maximum Predicted Annual Mean NO_x Concentrations

Receptor		Predicted Annual Mean NO _x Concentration (µg/m ³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
ER1	River Dee and Bala Lake SAC	0.01	8.48	0.05	28.28
ER2	River Dee and Bala Lake SAC	0.01	7.92	0.04	26.41
ER3	River Dee and Bala Lake SAC	0.02	7.30	0.07	24.33
ER4	River Dee and Bala Lake SAC	0.07	8.46	0.22	28.19
ER5	River Dee and Bala Lake SAC	0.01	7.30	0.03	24.33
ER6	Johnstown Newt Sites SAC	0.00	11.50	0.01	38.34
ER7	Johnstown Newt Sites SAC	0.00	12.49	0.01	41.64
ER8	Berwyn and South Clwyd Mountains SAC	0.00	6.49	0.00	21.64
ER9	Marchwiel Covert AW	0.12	9.02	0.39	30.05
ER10	Black Dog AW	0.25	11.18	0.84	37.27
ER11	Black Dog AW	0.61	11.54	2.03	38.46
ER12	Mill Wood AW	0.06	9.35	0.21	31.17
ER13	Unnamed AW	0.03	9.32	0.10	31.07
ER14	Cefn Park AW	0.13	11.08	0.43	36.93
ER15	Cottage Wood AW	0.13	11.92	0.43	39.73
ER16	Unnamed AW	0.17	10.39	0.55	34.62
ER17	Big Wood AW	0.15	10.37	0.52	34.58
ER18	Erlas Black Wood AW	0.05	16.05	0.17	53.50
ER19	Unnamed AW	0.09	16.09	0.29	53.63
ER20	Unnamed AW	0.10	8.33	0.34	27.78
ER21	Unnamed AW	0.17	8.98	0.57	29.94
ER22	Unnamed AW	0.08	8.07	0.26	26.90
ER23	Unnamed AW	0.03	8.05	0.09	26.83

As indicated in Table 23, PCs were below 1% of the EQS at all SACs and 100% of the EQS at all AWs. As such, predicted effects on annual mean NO_x concentrations are not considered to be significant, in accordance with the stated criteria.

Predicted 24-hour mean NO_x PECs at the ecological receptors are summarised in Table 24.

Table 24 Predicted 24-hour Mean NO_x Concentrations

Receptor	Predicted 24-hour Mean NO _x PEC (µg/m ³)				
	2014	2015	2016	2017	2018
ER1	17.04	17.06	17.04	17.03	17.03
ER2	15.90	15.92	15.92	15.95	15.96
ER3	14.79	14.73	14.73	14.72	14.80
ER4	17.70	17.40	17.26	17.28	17.24
ER5	14.71	14.75	14.72	14.78	14.86
ER6	23.04	23.08	23.07	23.05	23.05
ER7	25.04	25.04	25.06	25.07	25.04
ER8	13.01	13.02	13.01	13.01	13.01
ER9	19.88	19.89	20.18	19.77	19.99
ER10	24.20	24.89	24.61	24.65	24.36
ER11	24.70	25.19	24.68	24.91	25.19
ER12	19.28	19.26	19.27	19.31	19.29
ER13	18.99	18.97	18.89	18.93	18.91
ER14	22.69	22.65	22.66	22.91	22.57
ER15	24.43	24.24	24.40	24.46	24.18
ER16	21.42	21.36	21.56	21.29	21.34
ER17	21.38	21.12	21.69	21.25	21.39
ER18	32.27	32.30	32.37	32.31	33.64
ER19	32.48	32.47	32.62	32.50	33.89
ER20	17.22	17.15	17.32	17.39	17.18
ER21	19.26	18.75	18.60	18.79	18.65
ER22	16.57	16.97	16.79	16.73	16.76
ER23	16.39	16.44	16.54	16.69	16.40

As shown in Table 24, 24-hour mean NO_x PECs were below the EQS of 75µg/m³ at all ecological receptor locations.

Maximum predicted 24-hour mean NO_x concentrations at the receptor locations are summarised in Table 25.

Table 25 Maximum Predicted 24-hour Mean NO_x Concentrations

Receptor		Predicted 24-hour Mean NO _x Concentration (µg/m ³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
ER1	River Dee and Bala Lake SAC	0.12	17.06	0.16	22.75
ER2	River Dee and Bala Lake SAC	0.14	15.96	0.19	21.28
ER3	River Dee and Bala Lake SAC	0.24	14.80	0.32	19.74
ER4	River Dee and Bala Lake SAC	0.92	17.70	1.23	23.60
ER5	River Dee and Bala Lake SAC	0.28	14.86	0.38	19.82
ER6	Johnstown Newt Sites SAC	0.08	23.08	0.10	30.77
ER7	Johnstown Newt Sites SAC	0.09	25.07	0.12	33.43
ER8	Berwyn and South Clwyd Mountains SAC	0.04	13.02	0.06	17.37
ER9	Marchwiel Covert AW	2.38	20.18	3.17	26.91
ER10	Black Dog AW	3.03	24.89	4.05	33.19
ER11	Black Dog AW	3.33	25.19	4.44	33.59
ER12	Mill Wood AW	0.73	19.31	0.97	25.74
ER13	Unnamed AW	0.41	18.99	0.54	25.32
ER14	Cefn Park AW	1.01	22.91	1.35	30.55
ER15	Cottage Wood AW	0.88	24.46	1.17	32.61
ER16	Unnamed AW	1.12	21.56	1.50	28.75
ER17	Big Wood AW	1.25	21.69	1.67	28.92
ER18	Erlas Black Wood AW	1.64	33.64	2.18	44.85
ER19	Unnamed AW	1.89	33.89	2.52	45.19
ER20	Unnamed AW	0.93	17.39	1.24	23.19

Receptor		Predicted 24-hour Mean NO _x Concentration (µg/m ³)		Proportion of EQS (%)	
		PC	PEC	PC	PEC
ER21	Unnamed AW	1.64	19.26	2.19	25.68
ER22	Unnamed AW	0.99	16.97	1.32	22.63
ER23	Unnamed AW	0.65	16.69	0.86	22.25

As indicated in Table 25, all PCs were below 10% of the EQS at all SACs and 100% of the EQS at all AWs. As such, predicted effects on 24-hour mean NO_x concentrations are not considered to be significant, in accordance with the stated criteria.

Nitrogen Deposition

Predicted annual nitrogen deposition PCs at the ecological receptors are summarised in Table 26.

Table 26 Predicted Annual Nitrogen Deposition

Receptor	Predicted Annual Nitrogen Deposition PC (kgN/ha/yr)				
	2014	2015	2016	2017	2018
ER1	0.003	0.002	0.002	0.003	0.003
ER2	0.002	0.002	0.002	0.003	0.002
ER3	0.004	0.003	0.003	0.004	0.003
ER4	0.012	0.013	0.013	0.013	0.013
ER5	0.001	0.001	0.002	0.001	0.001
ER6	0.000	0.000	0.001	0.000	0.000
ER7	0.000	0.000	0.001	0.000	0.001
ER8	0.000	0.000	0.000	0.000	0.000
ER9	0.016	0.012	0.023	0.011	0.021
ER10	0.051	0.038	0.041	0.029	0.039
ER11	0.122	0.101	0.088	0.089	0.097
ER12	0.013	0.009	0.010	0.007	0.010
ER13	0.006	0.004	0.005	0.003	0.005

Receptor	Predicted Annual Nitrogen Deposition PC (kgN/ha/yr)				
	2014	2015	2016	2017	2018
ER14	0.026	0.021	0.019	0.020	0.021
ER15	0.026	0.020	0.020	0.020	0.021
ER16	0.033	0.028	0.031	0.028	0.032
ER17	0.028	0.025	0.030	0.026	0.031
ER18	0.010	0.010	0.009	0.010	0.010
ER19	0.018	0.018	0.016	0.017	0.017
ER20	0.017	0.016	0.018	0.021	0.015
ER21	0.030	0.034	0.033	0.034	0.033
ER22	0.011	0.011	0.016	0.012	0.016
ER23	0.004	0.003	0.006	0.004	0.005

Maximum predicted annual nitrogen deposition at the receptor locations are summarised in Table 27.

Table 27 Maximum Predicted Annual Nitrogen Deposition

Receptor		Maximum Predicted Annual PC Nitrogen Deposition (kgN/ha/yr)	Proportion of EQS (%)	
			Low	High
ER1	River Dee and Bala Lake SAC	0.003	0.09	0.03
ER2	River Dee and Bala Lake SAC	0.003	0.09	0.03
ER3	River Dee and Bala Lake SAC	0.004	0.13	0.04
ER4	River Dee and Bala Lake SAC	0.013	0.45	0.13
ER5	River Dee and Bala Lake SAC	0.002	0.06	0.02
ER6	Johnstown Newt Sites SAC	0.001	-	-
ER7	Johnstown Newt Sites SAC	0.001	-	-
ER8	Berwyn and South Clwyd Mountains SAC	0.000	0.01	0.00
ER9	Marchwiel Covert AW	0.023	0.23	0.12
ER10	Black Dog AW	0.051	0.51	0.25

Receptor		Maximum Predicted Annual PC Nitrogen Deposition (kgN/ha/yr)	Proportion of EQS (%)	
			Low	High
ER11	Black Dog AW	0.122	1.22	0.61
ER12	Mill Wood AW	0.013	0.13	0.06
ER13	Unnamed AW	0.006	0.06	0.03
ER14	Cefn Park AW	0.026	0.26	0.13
ER15	Cottage Wood AW	0.026	0.26	0.13
ER16	Unnamed AW	0.033	0.33	0.17
ER17	Big Wood AW	0.031	0.31	0.16
ER18	Erlas Black Wood AW	0.010	0.10	0.05
ER19	Unnamed AW	0.018	0.18	0.09
ER20	Unnamed AW	0.021	0.21	0.10
ER21	Unnamed AW	0.034	0.34	0.17
ER22	Unnamed AW	0.016	0.16	0.08
ER23	Unnamed AW	0.006	0.06	0.03

As indicated in Table 27, PCs were below 1% of the EQS at all SACs and 100% of the EQS at all AWs. As such, predicted effects on nitrogen deposition are not considered to be significant, in accordance with the stated criteria.

Acid Deposition

Predicted annual acid deposition PCs at the ecological receptors are summarised in Table 28.

Table 28 Predicted Annual Acid Deposition

Receptor	Predicted Annual Acid Deposition PC (keq/ha/yr)				
	2014	2015	2016	2017	2018
ER1	0.0002	0.0002	0.0002	0.0002	0.0002
ER2	0.0001	0.0002	0.0002	0.0002	0.0001
ER3	0.0003	0.0002	0.0002	0.0003	0.0002

Receptor	Predicted Annual Acid Deposition PC (keq/ha/yr)				
	2014	2015	2016	2017	2018
ER4	0.0009	0.0009	0.0010	0.0009	0.0010
ER5	0.0001	0.0001	0.0001	0.0001	0.0001
ER6	0.0000	0.0000	0.0000	0.0000	0.0000
ER7	0.0000	0.0000	0.0000	0.0000	0.0000
ER8	0.0000	0.0000	0.0000	0.0000	0.0000
ER9	0.0011	0.0008	0.0017	0.0008	0.0015
ER10	0.0036	0.0027	0.0029	0.0021	0.0028
ER11	0.0087	0.0072	0.0063	0.0063	0.0069
ER12	0.0009	0.0006	0.0007	0.0005	0.0007
ER13	0.0004	0.0003	0.0003	0.0002	0.0003
ER14	0.0019	0.0015	0.0013	0.0014	0.0015
ER15	0.0018	0.0015	0.0014	0.0014	0.0015
ER16	0.0024	0.0020	0.0022	0.0020	0.0023
ER17	0.0020	0.0017	0.0021	0.0019	0.0022
ER18	0.0007	0.0007	0.0006	0.0007	0.0007
ER19	0.0013	0.0013	0.0011	0.0012	0.0012
ER20	0.0012	0.0012	0.0013	0.0015	0.0011
ER21	0.0022	0.0024	0.0024	0.0025	0.0023
ER22	0.0008	0.0008	0.0011	0.0009	0.0011
ER23	0.0003	0.0002	0.0004	0.0003	0.0004

Maximum predicted annual acid deposition at the ecological receptors are summarised in Table 29.

Table 29 Maximum Predicted Annual Acid Deposition

Receptor		Maximum Predicted Annual PC Acid Deposition (keq/ha/yr)	Change as a Proportion of Critical Load (%)
ER1	River Dee and Bala Lake SAC	0.0002	-
ER2	River Dee and Bala Lake SAC	0.0002	-
ER3	River Dee and Bala Lake SAC	0.0003	-
ER4	River Dee and Bala Lake SAC	0.0010	-
ER5	River Dee and Bala Lake SAC	0.0001	-
ER6	Johnstown Newt Sites SAC	0.0000	-
ER7	Johnstown Newt Sites SAC	0.0000	-
ER8	Berwyn and South Clwyd Mountains SAC	0.0000	0.00
ER9	Marchwiel Covert AW	0.0017	0.09
ER10	Black Dog AW	0.0036	0.21
ER11	Black Dog AW	0.0087	0.50
ER12	Mill Wood AW	0.0009	0.05
ER13	Unnamed AW	0.0004	0.03
ER14	Cefn Park AW	0.0019	0.16
ER15	Cottage Wood AW	0.0018	0.16
ER16	Unnamed AW	0.0024	0.13
ER17	Big Wood AW	0.0022	0.13
ER18	Erlas Black Wood AW	0.0007	0.04
ER19	Unnamed AW	0.0013	0.07
ER20	Unnamed AW	0.0015	0.08
ER21	Unnamed AW	0.0025	0.14
ER22	Unnamed AW	0.0011	0.06
ER23	Unnamed AW	0.0004	0.02

As indicated in Table 29, all PCs were below 1% of the EQS at all SACs and 100% of the EQS at all AWs. As such, predicted effects on acid deposition are not considered to be significant, in accordance with the stated criteria.

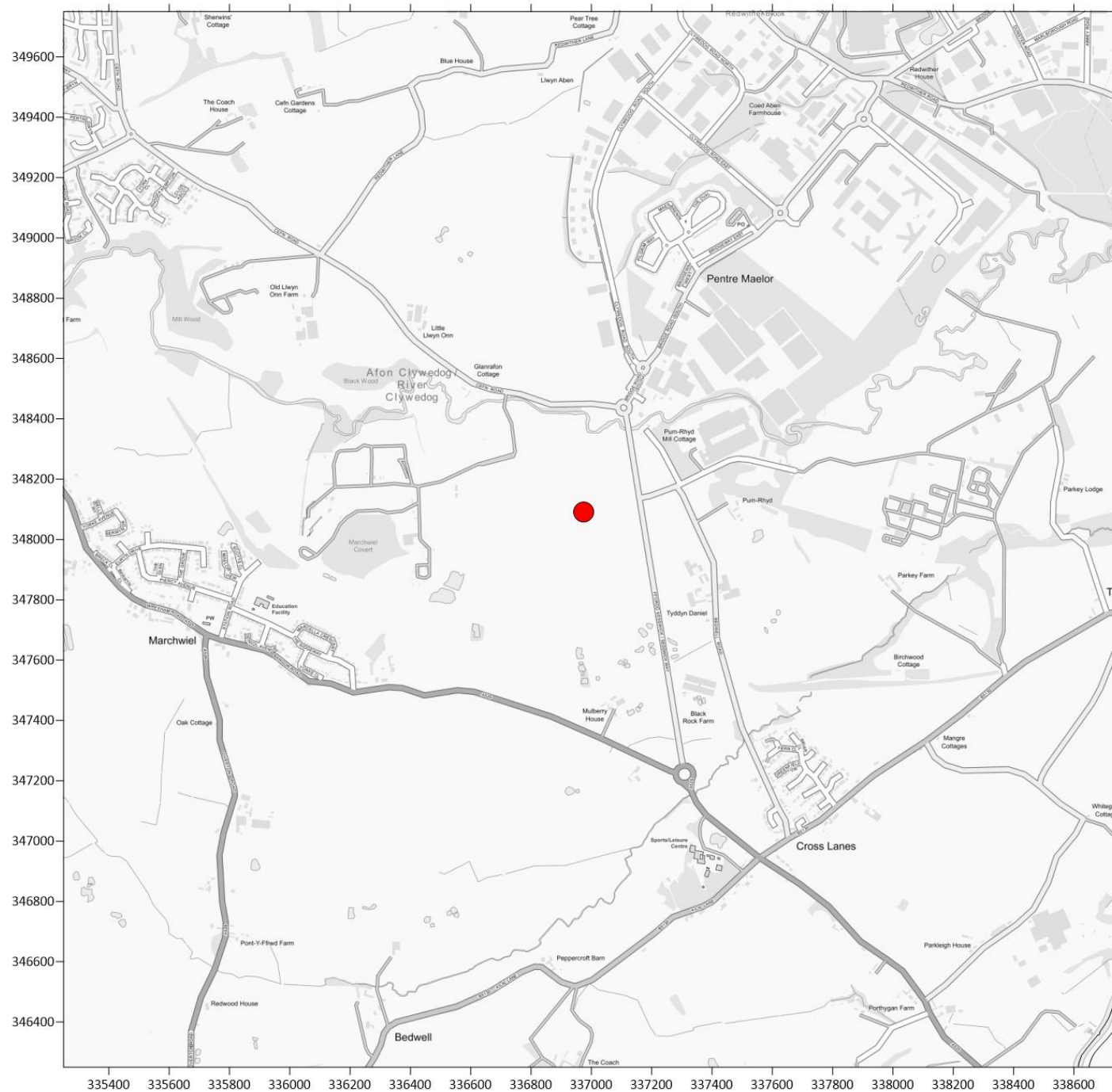
6. Conclusion

This report has been prepared in support of an installation of an energy centre at Five Fords, Wrexham.

The facility has the potential to cause air quality impacts as a result of combustion emissions. As such, an Air Quality Assessment was required in order to determine baseline conditions and assess potential effects during operation.

Dispersion modelling was undertaken in order to predict pollutant concentrations at sensitive locations as a result of emissions from the plant. The results indicated that impacts on pollutant concentrations were not predicted to be significant at any human or ecological receptor location in the vicinity of the site.

Impacts were predicted based on a worst-case assessment scenario of the plant emitting the maximum permitted emission concentration over a period greater than the anticipated operational hours. As such, predicted pollutant levels are likely to overestimate air quality impacts as a result of the facility.



Legend



Site Location

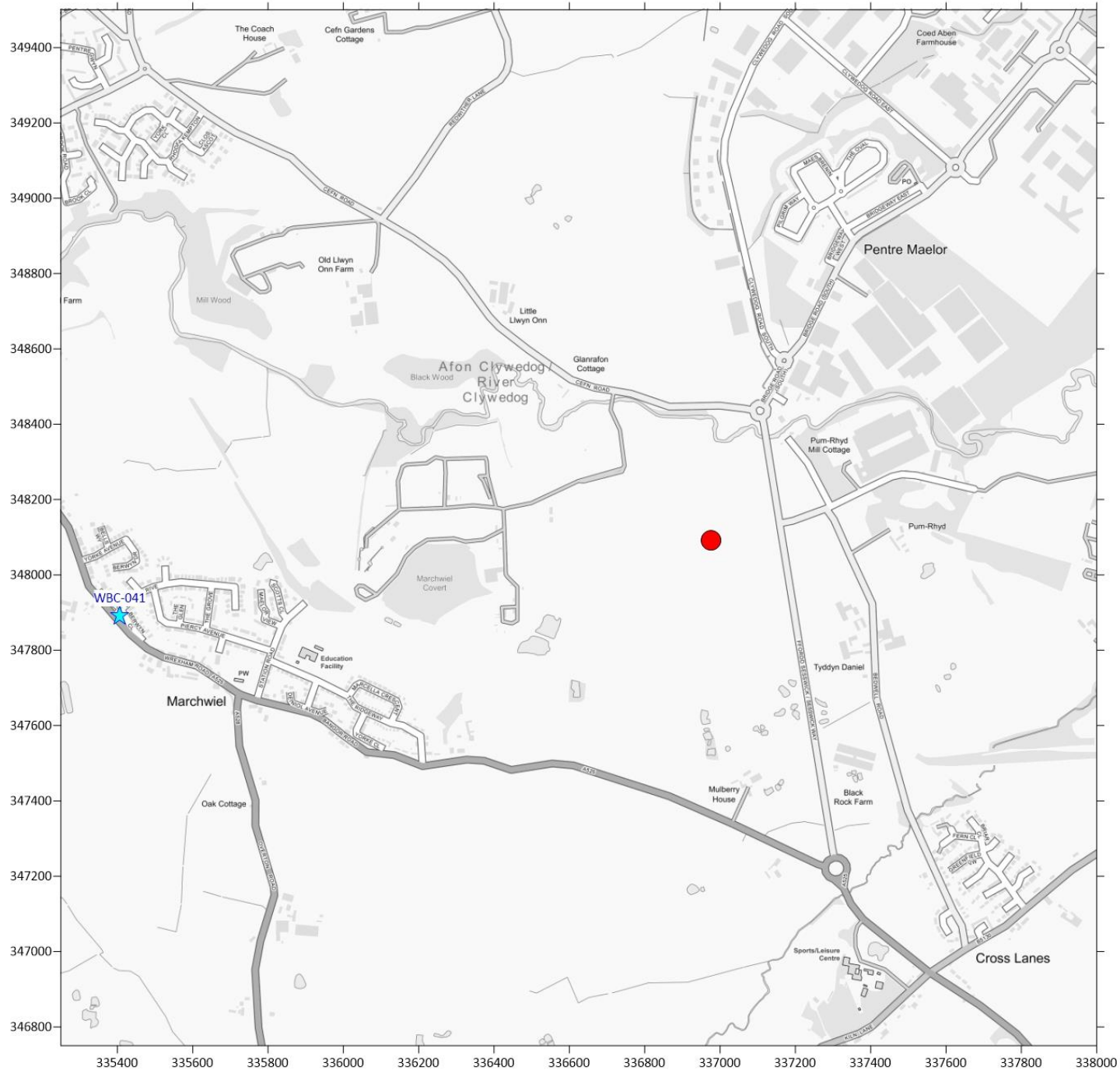
Title

Figure 1 - Site Location Plan

Project

Air Quality Assessment
Five Fords, Wrexham

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Legend

- Site Location
- ★ Monitor

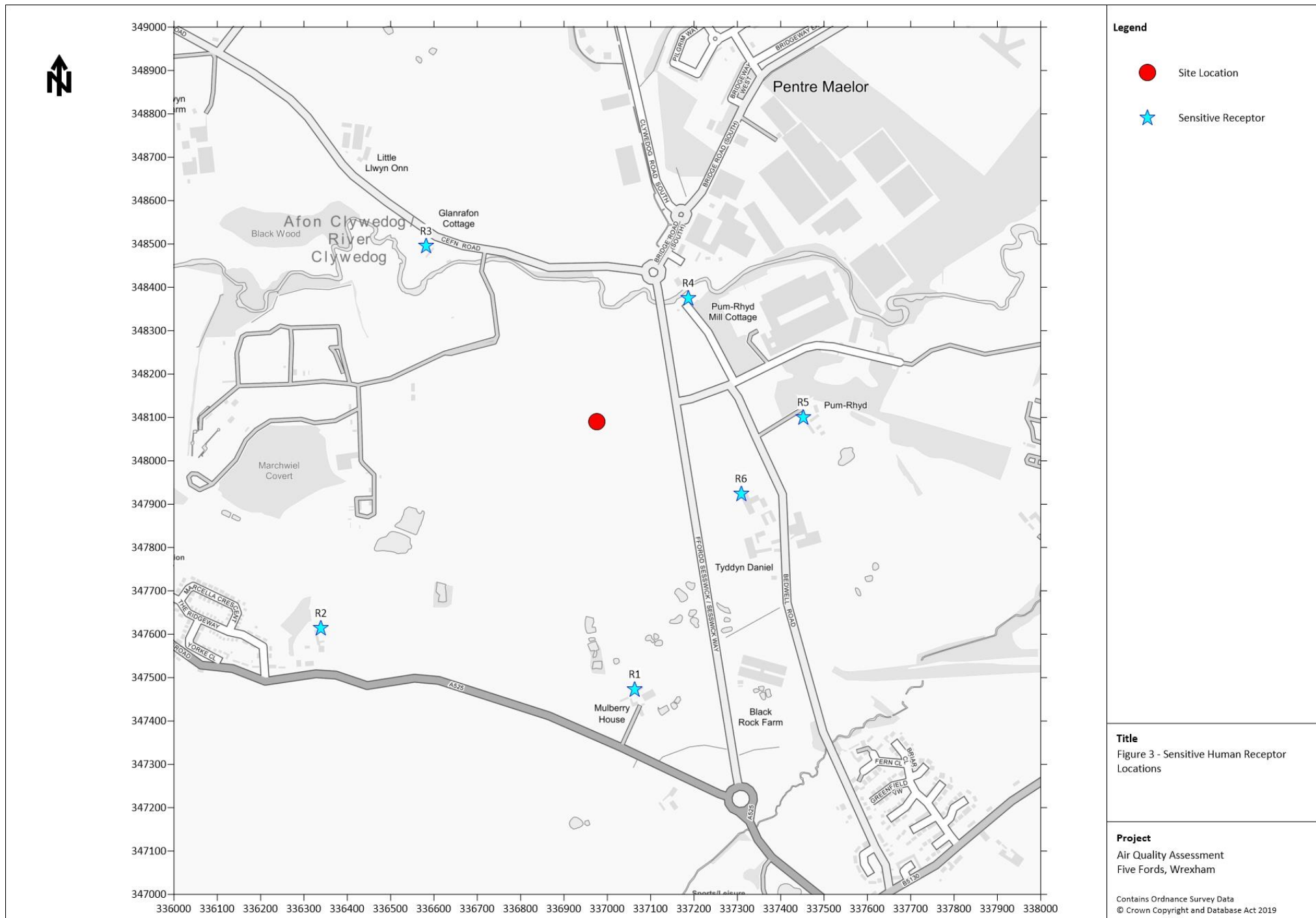
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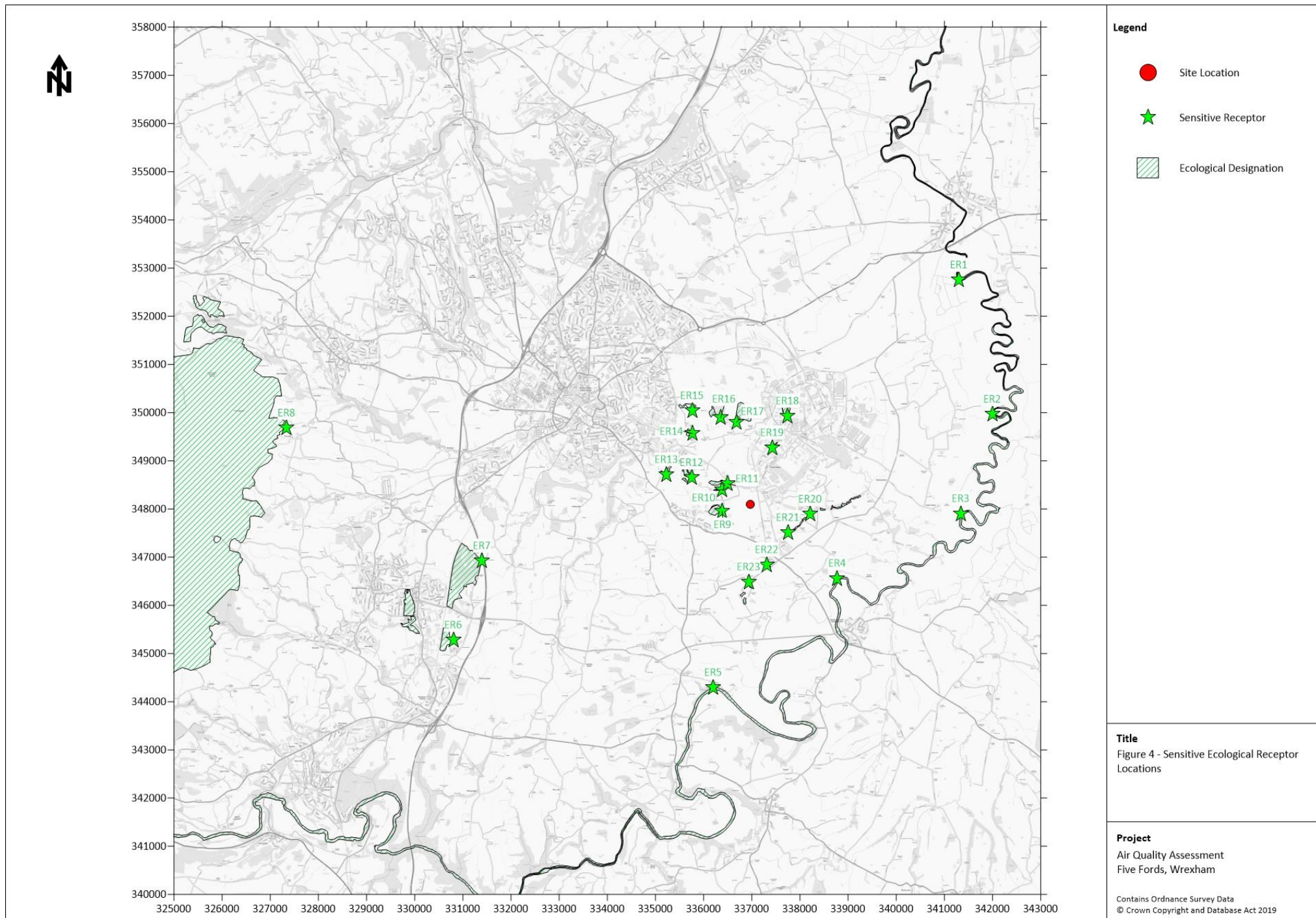
Figure 2 - Monitor Location

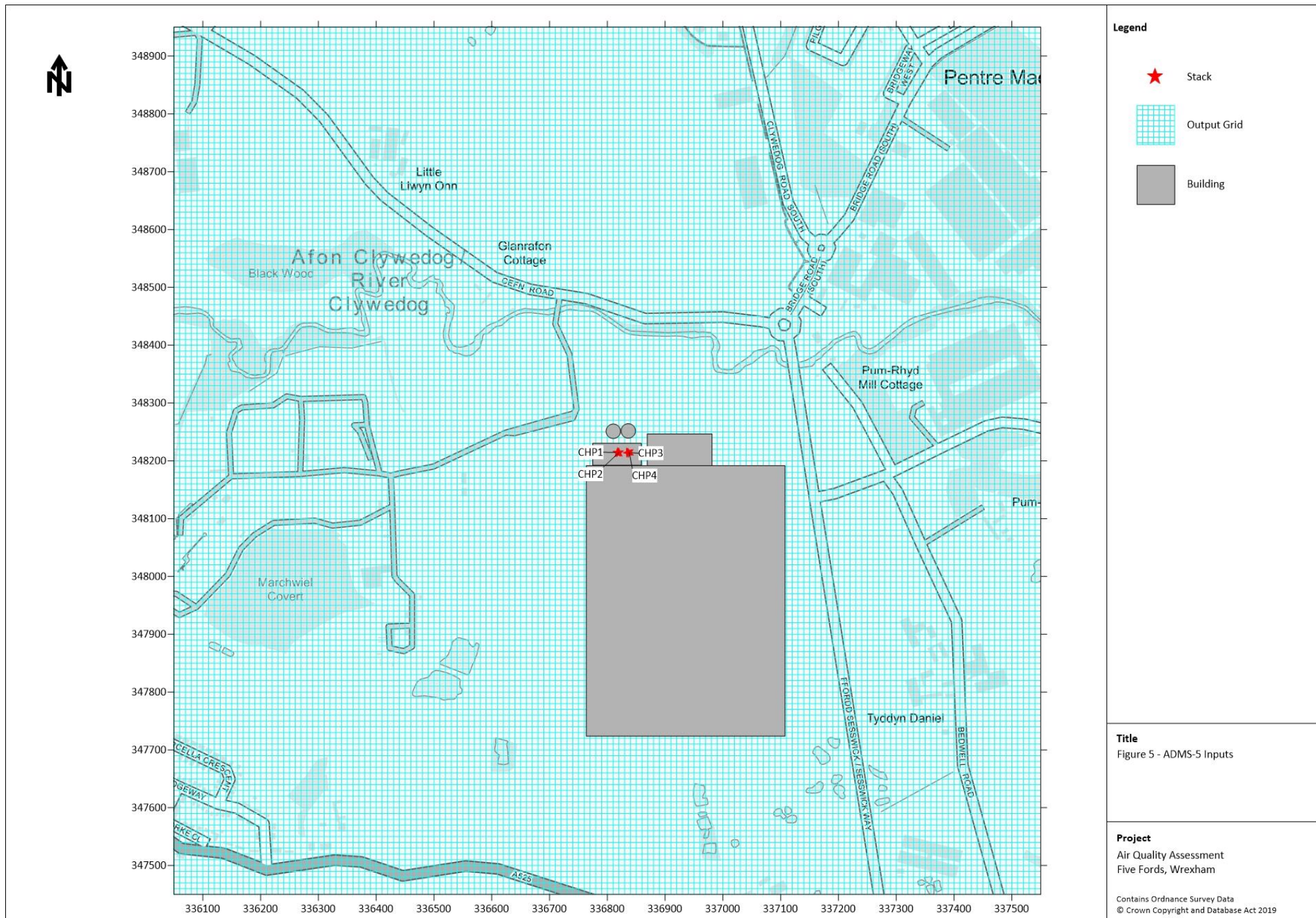
Project

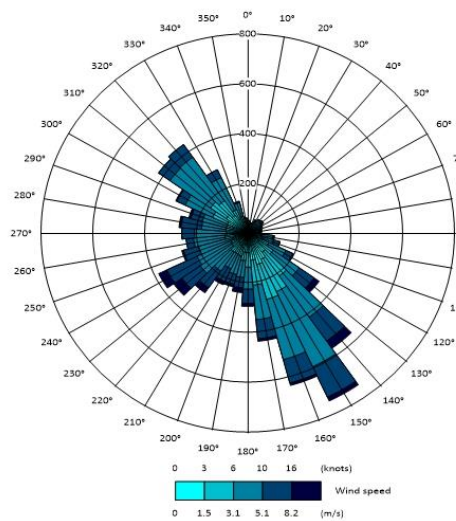
Air Quality Assessment
Five Fords, Wrexham

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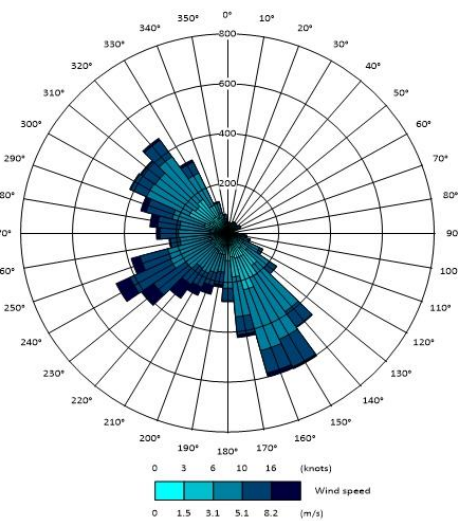




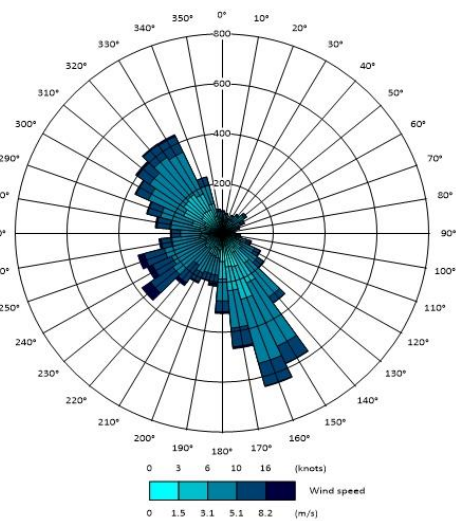




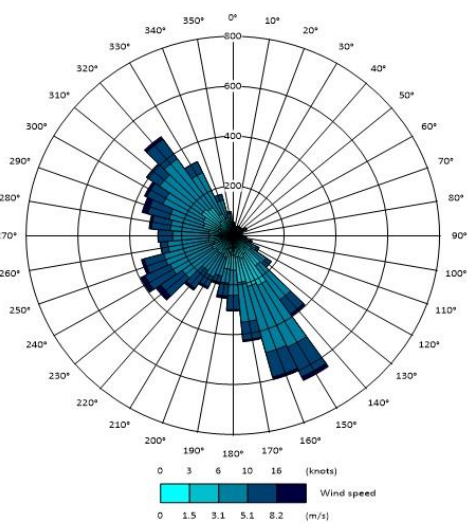
2014 Meteorological Data



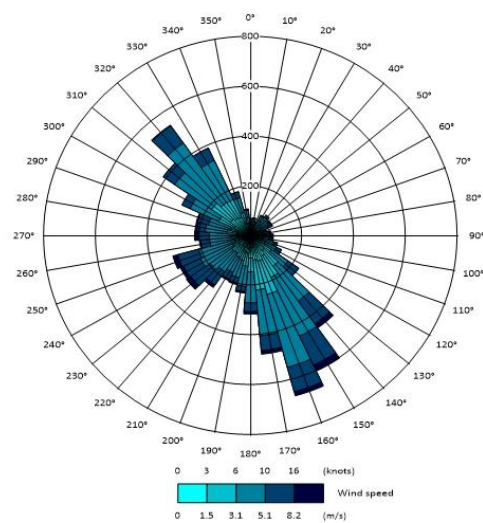
2015 Meteorological Data



2016 Meteorological Data



2017 Meteorological Data



2018 Meteorological Data

Title
Figure 6 - Wind Roses of 2014 - 2018
Hawarden Meteorological Data

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