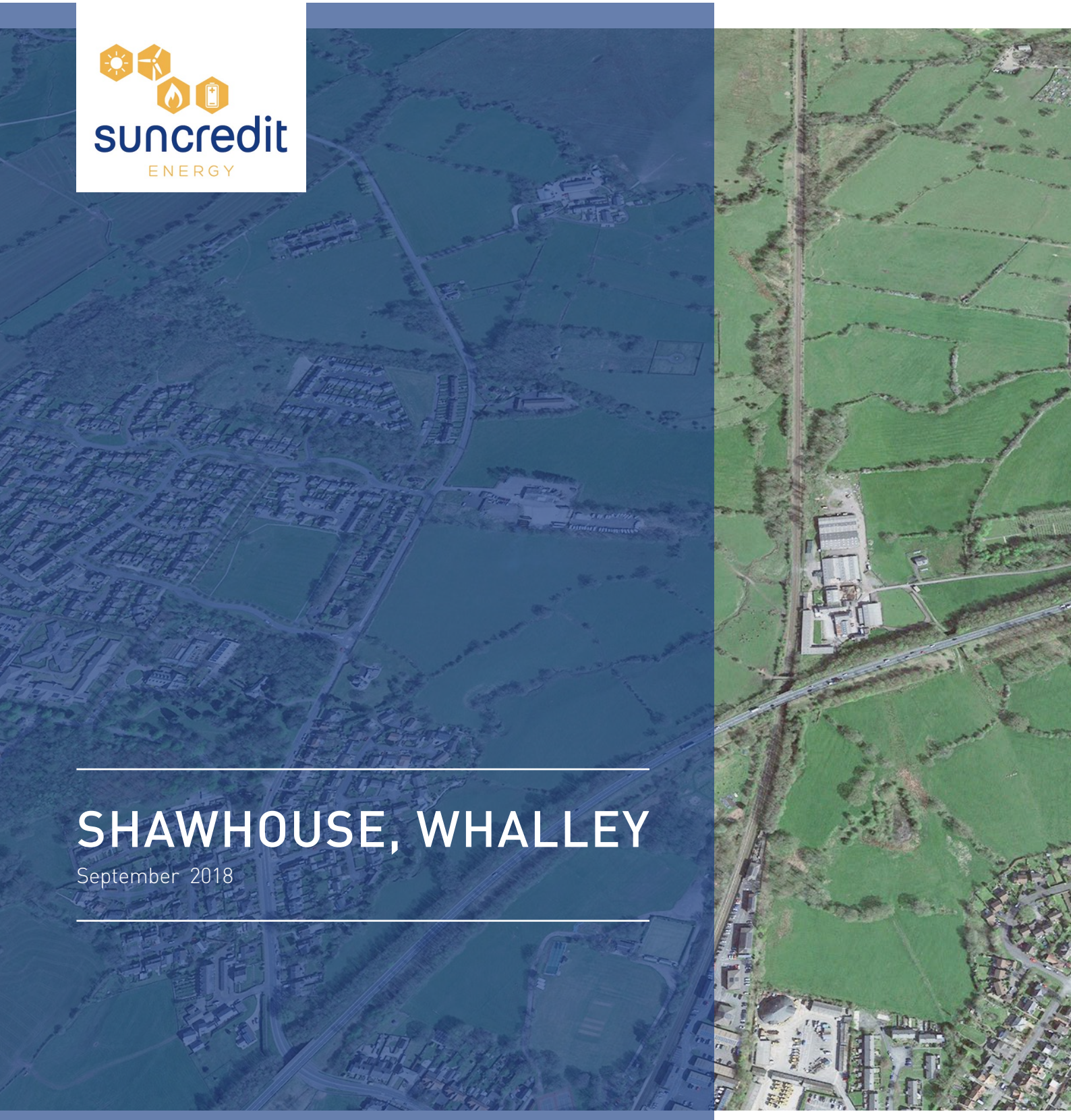

SHAWHOUSE, WHALLEY

September 2018

Air Quality Assessment

On behalf of Suncredit Energy

Air Quality Assessment:
Gas Power Generation Facility, Shawhouse Farm, Ribble Valley

October 2018

Experts in air quality management & assessment

Document Control

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Job Number	J3443

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Contents

1 Introduction

1.1 This report assesses the potential for air quality impacts associated with the proposed natural-gas power-generation facility at Shawhouse Farm in Nethertown, Ribble Valley. The assessment has been carried out by Air Quality Consultants Ltd. on behalf of Suncredit Solutions Ltd.

1.2 The proposed development will involve the installation of 12 natural-gas generators housed within individual containers along with some associated infrastructure, such as transformers. The facility will provide up to ~24 MW_e of reserve electricity to the national grid via two separate connections and will operate for short periods of time when there is demand; the exact operation schedule is therefore unknown. In line with the planning application, it has been assumed that the generators will operate for 2,000 hours per year.

1.3 Emissions from the natural gas generators could impact on local air quality. The main air pollutant of concern with respect to human health is nitrogen dioxide.

1.4 There are also several designated ecological sites in the study area (Mitton Wood Ancient Woodland (AW), Planes Wood AW and Spring Wood AW), and potential air quality impacts on these sites have also been considered. List Clough Site of Special Scientific Interest (SSSI) is also within the study area, however, it has been designated for geological features; it is, therefore, not sensitive to air quality impacts. The main pollutants of concern with respect to ecology are nitrogen oxides concentrations, nitrogen deposition and acid deposition.

1.5 Fuel will be piped to the site and vehicular access limited to site maintenance, as such the impacts of traffic generated by the proposed development can be screened out as *insignificant* and they are not considered further.

1.6 This report has been prepared taking into account relevant national and local guidance and regulations. Where appropriate the assessment has followed a worst-case approach, so as not to underestimate the impacts of the proposed facility.

2 Policy Context and Assessment Criteria

Air Quality Strategy

2.1 The Air Quality Strategy (Defra, 2007) published by the Department for Environment, Food, and Rural Affairs (Defra) and Devolved Administrations, provides the policy framework for air quality management and assessment in the UK. It provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. It also sets out how the different sectors: industry, transport and local government, can contribute to achieving the air quality objectives. Local authorities are seen to play a particularly important role. The strategy describes the Local Air Quality Management (LAQM) regime that has been established, whereby every authority has to carry out regular reviews and assessments of air quality in its area to identify whether the objectives have been, or will be, achieved at relevant locations, by the applicable date. If this is not the case, the authority must declare an Air Quality Management Area (AQMA), and prepare an action plan which identifies appropriate measures that will be introduced in pursuit of the objectives.

Industrial Emissions Directive (IED)

2.2 The Industrial Emissions Directive (2010/75/EU) integrates seven separate directives into one, including the Large Combustion Plant Directive, which has been transposed by the UK Government into the Environmental Permitting Regulations 2010. IED is applicable to large combustion plants with a total rated thermal input equal to or greater than 50 MW, irrespective of the type of fuel used.

2.3 The IED aims to achieve a high level of protection of human health and the environment taken as a whole by reducing harmful industrial emissions across the EU, in particular through better application of Best Available Techniques (BAT).

Medium Combustion Plant Directive (MCPD)

2.4 Pollutant emissions from combustion plant with a rated input between 1 and 50 megawatts (MW_{th}) are regulated through the MCPD (Directive 2015/2193/EU of the European Parliament and of the Council, 2015). The MCPD was transposed into UK law in January 2018 through an amendment to the Environmental Permitting Regulations (2018).

The Environmental Permitting (England and Wales) (Amendment) Regulations 2018

2.5 The legislation sets emission limits to be applied from December 2018 for new plant and from 2025 or 2030 for existing plant (depending on the rated input). In addition to addressing emissions from plant with a rated input of 1 to 50 MW_{th}, as required by the MCPD, the amendment also introduces

emission limits on all generator plant <1 MW_{th}. Generators whose sole purpose is maintaining power supply at a site during an on-site emergency, that are operated for the purpose of testing/maintenance for no more than 50 hours per year, will be exempt from the emission limits, but will be required to apply for an exemption with the regulating authority.

Clean Air Act 1993 & Environmental Protection Act

2.6 Small combustion plant of less than 20 MW net rated thermal input are currently controlled under the Clean Air Act 1993 (1993). This requires the local authority to approve the chimney height. Plant which are smaller than 366 kW have no such requirement.

2.7 Measures to ensure adequate dispersion of emissions from discharging stacks and vents are included in Technical Guidance Note D1 (Dispersion) (Technical Guidance Note D1 (Dispersion), 1993), issued in support of the Environmental Protection Act (HMSO, 1990).

Draft Clean Air Strategy 2018

2.8 Defra launched a consultation on a new Clean Air Strategy (Defra, 2018) in May 2018. The draft strategy sets out a wide range of actions by which the UK Government, will seek to reduce pollutant emissions and improve air quality. Actions are targeted at four main sources of emissions: Transport, Domestic, Farming and Industry. Responses to the consultation will be used to inform the final UK Clean Air Strategy and detailed National Air Pollution Control Programme to be published by March 2019.

Planning Policy

National Policies

2.9 The National Planning Policy Framework (NPPF) (2018) sets out planning policy for England. It states that the purpose of the planning system is to contribute to the achievement of sustainable development, and that the planning system has three overarching objectives, one of which is an environmental objective:

"to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy".

2.10 To prevent unacceptable risks from air pollution, the NPPF states that:

"Planning policies and decisions should contribute to and enhance the natural and local environment by…preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or

noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air quality".

and

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

2.11 More specifically on air quality, the NPPF makes clear that:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan".

2.12 The NPPF is supported by Planning Practice Guidance (PPG) (DCLG, 2018), which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states that *"Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with EU Limit Values"* and *"It is important that the potential impact of new development on air quality is taken into account … where the national assessment indicates that relevant limits have been exceeded or are near the limit".* The role of the local authorities is covered by the LAQM regime, with the PPG stating that local authority Air Quality Action Plans "*identify measures that will be introduced in pursuit of the objectives*". The PPG makes clear that *"Air quality can also affect biodiversity and may therefore impact on our international obligation under the Habitats Directive".*

2.13 The PPG states that:

"Whether or not air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to generate air quality impact in an area where air quality is known to be poor. They could also arise where the development is likely to adversely impact upon the implementation of air quality strategies and action plans and/or, in particular, lead to a breach of EU legislation (including that applicable to wildlife)".

2.14 The PPG sets out the information that may be required in an air quality assessment, making clear that *"Assessments should be proportionate to the nature and scale of development proposed and the level of concern about air quality"*. It also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear that *"Mitigation options where necessary, will depend on the proposed development and should be proportionate to the likely impact".*

Local Policies

2.15 Whilst the development site falls within Ribble Valley, the study area also crosses Hyndburn District. The local policies from both local authorities that are relevant to air quality are provided below.

Ribble Valley

2.16 The Ribble Valley Core Strategy (Ribble Valley Borough Council, 2014) was adopted in December 2014, within which there is only one policy pertaining to air quality. Policy DMG1, 'General Considerations' states that:

"In determining planning applications, all development must:…consider air quality and mitigate adverse impacts where possible."

Hyndburn

2.17 The Hyndburn Local Plan comprises four documents, two of which: the Core Strategy Development Plan Document (DPD) (Hyndburn Borough Council, 2012) (adopted in 2012) and the Development Management DPD (Hyndburn Borough Council, 2018) (adopted in 2018), contain policies relating to air quality.

2.18 Policy Env 7 'Environmental Amenity' within the Core Strategy DPD states:

"Proposals for new development will be permitted only if it is demonstrated that the material impacts arising by reason of traffic, visual impact, noise, dust, emissions, pollution, odour, over-looking or loss of light, or other nuisances will not give rise to unacceptable adverse impacts or loss of local amenity and can be properly controlled in accordance with best practice and recognised standards."

2.19 Policy DM25 'Pollution Control' within the Development Management DPD states:

"1. Potentially polluting industrial and waste development will not be permitted:

A. where they are within, or in close proximity to, existing or proposed residential, educational, institutional, recreational or major retail developments;

B. where they would have an unacceptable adverse impact on the viability of existing neighbouring businesses; or

C. where the emissions from the development would have an unacceptable adverse impact on existing or proposed development.

2. Where proposals satisfy the criteria above, the Council will consider whether any potential impacts on the natural environment (including water quality and wildlife habitats) are acceptable in line with Policy DM18: Protection and Enhancement of the Natural Environment…"

National Air Quality Action Plan

2.20 Defra has produced an Air Quality Plan to tackle roadside nitrogen dioxide concentrations in the UK (Defra, 2017a). Alongside a package of national measures, the Plan requires those English Local Authorities (or the GLA in the case of London Authorities) that are predicted to have exceedances of the limit values beyond 2020 to produce local action plans by December 2018. These plans are undertaken in stages (the initial Stage of which was to be completed by the end of March 2018) and must have measures to achieve the statutory limit values within the shortest possible time, which may include the implementation of a Clean Air Zone (CAZ). There is currently no practical way to take account of the effects of the national Plan in the modelling undertaken for this assessment; however, consideration has been given to whether there is currently, or is likely to be in the future, a limit value exceedance in the vicinity of the proposed development. This assessment has principally been carried out in relation to the air quality objectives, rather than the EU limit values that are the focus of the Air Quality Plan.

Policy for the Protection of Sensitive Ecosystems

European Policies

2.21 The "Habitats Directive" (The Council of European Communities, 1992) requires member states to introduce a range of measures for the protection of habitats and species. The Regulations (2010) transpose the Directive into law in England and Wales. They require the Secretary of State to provide the European Commission with a list of sites which are important for the habitats or species listed in the Directive. The Commission then designates worthy sites as Special Areas of Conservation (SACs). The Regulations also require the compilation and maintenance of a register of European sites, to include SACs and Special Protection Areas (SPAs), with these classified under the "Birds Directive" (The European Parliament and the Council of the European Union, 2009). These sites form a network termed "Natura 2000".

2.22 The Regulations primarily provide measures for the protection of European Sites and European Protected Species, but also require local planning authorities to encourage the management of other features that are of major importance for wild flora and fauna.

2.23 In addition to SACs and SPAs, some internationally important UK sites are designated under the Ramsar Convention. Originally intended to protect waterfowl habitat, the Convention has broadened its scope to cover all aspects of wetland conservation.

2.24 The Habitats Directive (as implemented by the Regulations) requires the competent authority, which in this case will be the planning authority, to firstly evaluate whether the development is likely to give rise to a significant effect on the European site. Where this is the case, it has to carry out an 'appropriate assessment' in order to determine whether the development will adversely affect the integrity of the site.

National Policies

2.25 Sites of national importance may be designated as Sites of Special Scientific Interest (SSSIs). Originally notified under the National Parks and Access to the Countryside Act (1949), SSSIs have been re-notified under the Wildlife and Countryside Act (1981). Improved provisions for the protection and management of SSSIs (in England and Wales) were introduced by the Countryside and Rights of Way Act (2000) (the "CROW" act). If a development is "*likely to damage*" a SSSI, the CROW act requires that a relevant conservation body (i.e. Natural England) is consulted. The CROW act also provides protection to local nature conservation sites, which can be particularly important in providing 'stepping stones' or 'buffers' to SSSIs and European sites. In addition, the Environment Act (1995) and the Natural Environment and Rural Communities Act (2006) both require the conservation of biodiversity.

2.26 National planning policy on biodiversity and conservation is set out in the NPPF (2018). This emphasises that the planning system should seek to minimise impacts on biodiversity and provide net gains in biodiversity wherever possible as part of the Government's commitment to halting declines in biodiversity and establishing coherent and resilient ecological networks.

2.27 Local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife sites will be judged, making distinctions between different levels of site designation. If significant harm from a development cannot be prevented, adequately mitigated against, or compensated for, then planning permission should be refused.

Assessment Criteria

Human Health

2.28 The Government has established a set of air quality standards and objectives to protect human health. The 'standards' are set as concentrations below which effects are unlikely even in sensitive population groups, or below which risks to public health would be exceedingly small. They are based purely upon the scientific and medical evidence of the effects of an individual pollutant. The 'objectives' set out the extent to which the Government expects the standards to be

achieved by a certain date. They take account of economic efficiency, practicability, technical feasibility and timescale. The objectives for use by local authorities are prescribed within the Air Quality (England) Regulations, 2000, Statutory Instrument 928 (2000) and the Air Quality (England) (Amendment) Regulations 2002, Statutory Instrument 3043 (2002). The objectives for nitrogen dioxide were to have been achieved by 2005, and continue to apply in all future years thereafter.

2.29 The objectives apply at locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Defra explains where these objectives will apply in its Local Air Quality Management Technical Guidance (Defra, 2016). The annual mean objective for nitrogen dioxide is considered to apply at the façades of residential properties, schools, hospitals etc.; they do not apply at hotels. The 1-hour mean objective for nitrogen dioxide applies wherever members of the public might regularly spend 1-hour or more, including outdoor eating locations, gardens and fishing areas. Further details on relevant locations for members of the public can be found in the note published by Air Quality Consultants (AQC, 2016).

2.30 The European Union has also set limit values for nitrogen dioxide. The limit values for nitrogen dioxide are the same numerical concentrations as the UK objectives, but achievement of these values is a national obligation rather than a local one (Directive 2008/50/EC of the European Parliament and of the Council, 2008). In the UK, only monitoring and modelling carried out by UK Central Government meets the specification required to assess compliance with the limit values. Central Government does not recognise local authority monitoring or local modelling studies when determining the likelihood of the limit values being exceeded.

2.31 The relevant air quality criteria for this assessment are provided in Table 1.

Table 1: Air Quality Criteria for Nitrogen Dioxide

Pollutant	Time Period	Objective
Nitrogen Dioxide	1-hour Mean	200 $\mu g/m^3$ not to be exceeded more than 18 times a year
	Annual Mean	40 $\mu g/m^3$

Long Term (Annual Mean)

2.32 The approach developed jointly by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[1] (Moorcroft and Barrowcliffe et al, 2017) provides a method for describing the impacts on local air quality arising from the development. Impact description involves expressing the magnitude of incremental change as a proportion of a relevant

[1] The IAQM is the professional body for air quality practitioners in the UK.

assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion. Table 2 sets out the matrix for determining the impact descriptor for annual mean concentrations at individual receptors, having been adapted from the table presented in the guidance document.

2.33 From this it can be inferred that:

- any change in concentration smaller than 0.5% (0.2 µg/m^3) of the long-term (annual mean) environmental standard will be *negligible*, regardless of the existing air quality conditions;
- any change smaller than 1.5% (0.6 µg/m^3) of the long-term environmental standard will be *negligible* so long as the total (with-scheme) concentration is less than 94% (37.8 µg/m^3) of the standard; and
- any change smaller than 5.5% (2.2 µg/m^3) of the long-term environmental standard will be *negligible* so long as the total (with-scheme) concentration is less than 75% (30.2 µg/m^3) of the standard.

Table 2: Air Quality Impact Descriptors for Individual Receptors for Annual Mean Nitrogen Dioxide Concentrations

Annual Mean Concentration At Receptor In Assessment Year (µg/m^3)	Change in Concentration (µg/m^3)				
	<0.2	0.2 - 0.6	0.6 - 2.2	2.2 - 4.2	>4.2
<30.2	Negligible	Negligible	Negligible	Slight	Moderate
30.2-37.8	Negligible	Negligible	Slight	Moderate	Moderate
37.8-41.0	Negligible	Slight	Moderate	Moderate	Substantial
41.0-43.8	Negligible	Moderate	Moderate	Substantial	Substantial
>43.8	Negligible	Moderate	Substantial	Substantial	Substantial

2.34 Where the impacts are *negligible* the overall significance is 'not significant'.

Short-term (1-hour mean) Concentrations

2.35 Given that the short-term objective considers the number of hours exceeding a standard rather than being a single concentration not to be exceeded, it is not possible to usefully assign a magnitude of change. The objective and limit value allow 18 hours a year to exceed the standard of 200 µg/m^3, which can also be expressed as a 99.79th percentile of hourly concentrations. Where the total concentrations are below 200 µg/m^3, based on worst-case modelling assumptions for NOx to NO_2 ratios and baseline concentrations, the impacts in relation to the short-term objective are considered to be negligible.

Vegetation and Ecosystem Criteria

2.36 Objectives for the protection of vegetation and ecosystems have been set by the UK Government. They are the same as the EU limit values. The limit values and objectives only apply a) more than 20 km from an agglomeration (about 250,000 people), and b) more than 5 km from Part A industrial sources, motorways and built up areas of more than 5,000 people. Critical levels and critical loads are the ambient concentrations and deposition fluxes below which significant harmful effects to sensitive ecosystems are unlikely to occur. Some of the critical levels are set at the same concentrations as the objectives, but do not have the same legal standing. Typically, the potential for exceedances of the critical levels and critical loads is considered in the context of the level of protection afforded to the ecological site as a whole. For example, the level of protection afforded to an internationally-designated site (such as a SAC) is significantly greater than that afforded to a local level designation such as an ancient woodland; reflecting the relative sensitivity of the sites as well as their perceived ecological value. The critical levels relevant to this assessment are set out in Table 3, while the critical loads, for the ecological sites identified in Section 3.8, are provided in Table 4.

Table 3: Vegetation and Ecosystem Critical Levels [a]

Pollutant	Time Period	Critical Level
Nitrogen Oxides (expressed as NO_2)	Annual Mean [b]	30 µg/m^3
	24-hour Mean [c]	75 µg/m^3

[a] The critical levels are defined by the World Health Organisation (WHO, 2000).

[b] Away from major sources (see Paragraph 2.36), this critical level is set as an objective (Defra, 2007) and a limit value (Directive 2008/50/EC of the European Parliament and of the Council, 2008).

[c] This critical level is not an objective and thus does not have the same legal standing.

Table 4: Vegetation and Ecosystem Critical Loads

Ecological Site	Habitat Type	Nutrient Nitrogen	Acid Deposition
		kgN/ha/yr [a]	'N_{max}' (keq/ha/yr) [b]
Mitton Wood Ancient Woodland	Broadleaved, mixed and yew woodland	10	3.139
Planes Wood Ancient Woodland	Broadleaved, mixed and yew woodland	10	3.139
Spring Wood Ancient Woodland	Broadleaved, mixed and yew woodland	10	3.139

[a] Critical loads for nutrient nitrogen taken from APIS (APIS, 2018). Broadleaved, mixed and yew woodland habitats have been assumed for ancient woodland sites.

[b] Critical loads for acid deposition have been taken from (APIS, 2018). N_{max} is the value above which additional nitrogen deposition will lead to an exceedance. The value of N_{max} used is the most stringent across the entire designation and is not specific to the receptors assessed.

2.37 In terms of the potential for ecological impacts on local (as opposed to national or European) wildlife sites, the Environment Agency's Air Emissions Risk Assessment guidance discounts as insignificant any impacts where the PC is less than 100% of the long-term or short-term environmental standard.

2.38 It should be noted that the previously mentioned EPUK and IAQM guidance does not apply to nature conservation sites, thus the use of the Environment Agency guidance is most appropriate for assessing impacts on ecosystems in relation to the proposed facility.

3 Assessment Approach

Existing Conditions

3.1 Information on existing air quality has been obtained by collating the results of monitoring carried out by the local authority. Background concentrations have been defined using the national pollution maps published by Defra (2018a). These cover the whole country on a 1x1 km grid.

3.2 Exceedances of the annual mean EU limit value for nitrogen dioxide in the study area have been identified using the maps of roadside concentrations published by Defra (2017) as part of its 2017 Air Quality Plan for the baseline year 2015 and for the future years 2017 to 2030. These are the maps used by the UK Government to report exceedances of the limit value to the EU.

Modelling Methodology

3.3 The impacts of emissions from the proposed facility have been modelled using the ADMS-5.2 dispersion model. ADMS-5.2 is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer. The model input parameters are set out in Appendix A2.

Operating Hours

3.4 Operation of the proposed generators is expected to be limited to when there is demand. There will, however, be some flexibility around this. The scheme will be subdivided into two compounds, whereby 12 engines will connect to the local 33 kV power line, and two engines will connect to the 11 kV power line. The compounds are not interdependent, and would generate either individually or at the same time. The planning application seeks permission to operate each compound for up to 2,000 hours per annum. Thus, the annual operational scenario considered within this assessment is 2,000 hours.

3.5 Since the precise hours when the plant will operate are not known, and in order to provide a worst-case assessment, it has been assumed that all the generators will operate continuously throughout the year. The predicted annual mean concentrations assuming continuous operation have been adjusted to account for the 2,000 hours of operation, by applying a factor of 0.228 (which is 2,000/8,760).

3.6 For the assessment of short-term impacts, it has been assumed that the generators will operate continuously throughout the year to ensure that potential impacts under all meteorological conditions are considered. As a result, the assessment is worst-case and is likely to have over-predicted the actual impacts of the scheme in terms of concentrations in relation to the hourly mean objective.

Receptor Grid

3.7 Concentrations have been predicted across nested Cartesian grids. These grids have a spacing of 5 m x 5 m within 200 m of the facility, 25 m x 25 m within 400 m of the facility, 50 m x 50 m within 1 km of the facility, 250 m x 250 m within 2 km of the facility, and 500 m x 500 m within 5 km of the facility. The receptor grid has been modelled at a height of 1.5 m above ground level. The extent of this modelled receptor grid defines the 'Study Area'.

Ecological Sites

3.8 A search of ecological sites has identified four locally designated sites within 2 km of the proposed development as shown in Figure 1. No European designated ecological sites have been identified within 10 km of the development. List Clough SSSI has been designated for geological features, and will not be sensitive to air quality impacts, thus no assessment is necessary for this site.

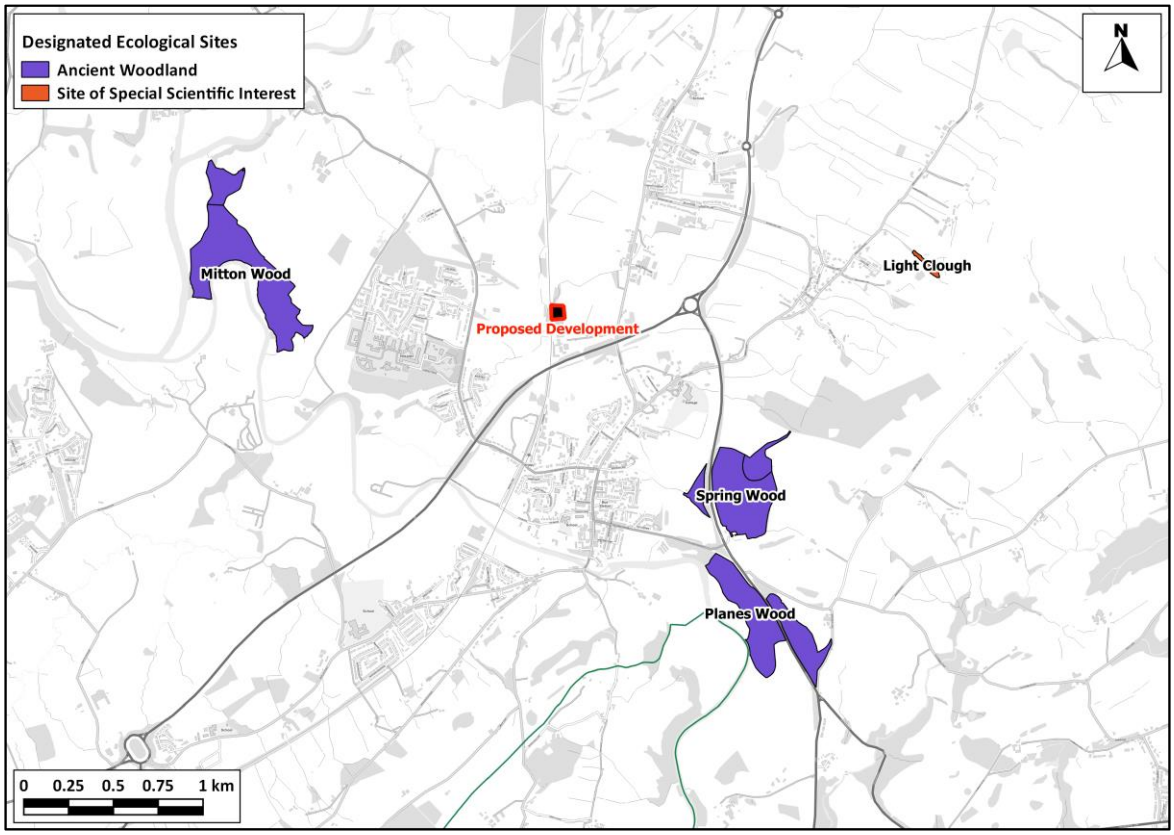

Figure 1: Ecological Receptor Locations

Meteorological Data

3.9 In order to allow for uncertainties in local and future-year meteorological conditions, the dispersion model has been run five times, with each run using a different full year of hour-by-hour meteorological data from an appropriate meteorological station. For each individual receptor point on the nested Cartesian grids, the maximum predicted concentration across any of the five meteorological datasets has then been determined. It is these maxima which are presented in this report. This approach provides a degree of conservatism and will tend to over-predict the impacts of the facility. Further details of this approach, as well as the meteorological datasets used, are provided in Appendix A2.

Model Result Processing

3.10 Details on how the model outputs have been processed, including the NOx to NO_2 relationship are set out in Appendix A2.

Additional Sources of Uncertainty

3.11 The point source dispersion model used in the assessment is dependent upon emission rates, flow rates, exhaust temperatures and other parameters for each source, all of which in reality are variable. There are then additional uncertainties, as models are required to simplify real-world conditions into a series of algorithms. These uncertainties cannot be easily quantified and it is not possible to verify the point-source model outputs. Where these parameters have been estimated the approach has been to use reasonable worst-case assumptions.

3.12 On balance, when taking into account the assumed number of operating hours, the approach taken to meteorological conditions and the assumed NOx to NO_2 relationship, the assessment can be expected to over-predict the impacts of the facility. The approach used thus provides a robust assessment.

4 Site Description and Baseline Conditions

4.1 The proposed development is located on land at Shawhouse Farm, to the east of the town of Nethertown in Ribble Valley. The site is currently derelict land, and surrounded by agricultural land, and farm buildings directly to the south of the development boundary. The closest residential receptor to the facility is Shawhouse Farm House, 110 m from the site boundary.

Air Quality Review and Assessment

4.2 Ribble Valley Borough Council has investigated air quality within its area as part of its responsibilities under the LAQM regime. The Council has declared a single AQMA for exceedances of the annual mean nitrogen dioxide objective, located in Clitheroe, 4 km north of the proposed development. The AQMA is sufficiently far away that it is unlikely to be impacted by the proposed development. The location of this AQMA is shown in Figure 2.

4.3 Hyndburn Borough Council has not declared any AQMAs for exceedances of the nitrogen dioxide objectives.

Local Air Quality Monitoring

4.4 Ribble Valley Borough Council operates seven nitrogen dioxide monitoring sites using diffusion tubes prepared and analysed by Gradko Environmental Ltd (using the 50% TEA in acetone method). Five sites are located within the study area, principally located within the AQMA. None of Hyndburn Borough Council's monitoring sites are within the study area. Results for the years 2012 to 2016 (latest available year) are summarised in Table 5 and the monitoring locations are shown in Figure 2.

Table 5: Summary of Nitrogen Dioxide Diffusion Tube Monitoring (2012-2016) [a, b]

Site Type	Location	2012	2013	2014	2015	2016
Urban Background	Whittle Close	14.2	12.7	12.5	11.8	12.9
Roadside	Royal British Legion [c]	**47.0**	36.2	36.9	33.3	39.9
Roadside	Greenacre Street	34.4	24.2	26.9	24.3	28.7
Roadside	57 Whalley Road	**43.4**	37.4	36.7	32.8	36.6
Roadside	85 Whalley Road	-	-	24.6	26.3	32.1
Objective		**40**				

[a] Exceedances of the objective are shown in bold.

[b] Data have been taken from the 2017 Ribble Valley Air Quality Annual Status Report (ASR) (Ribble Valley Borough Council, 2017).

[c] Average of triplicate site.

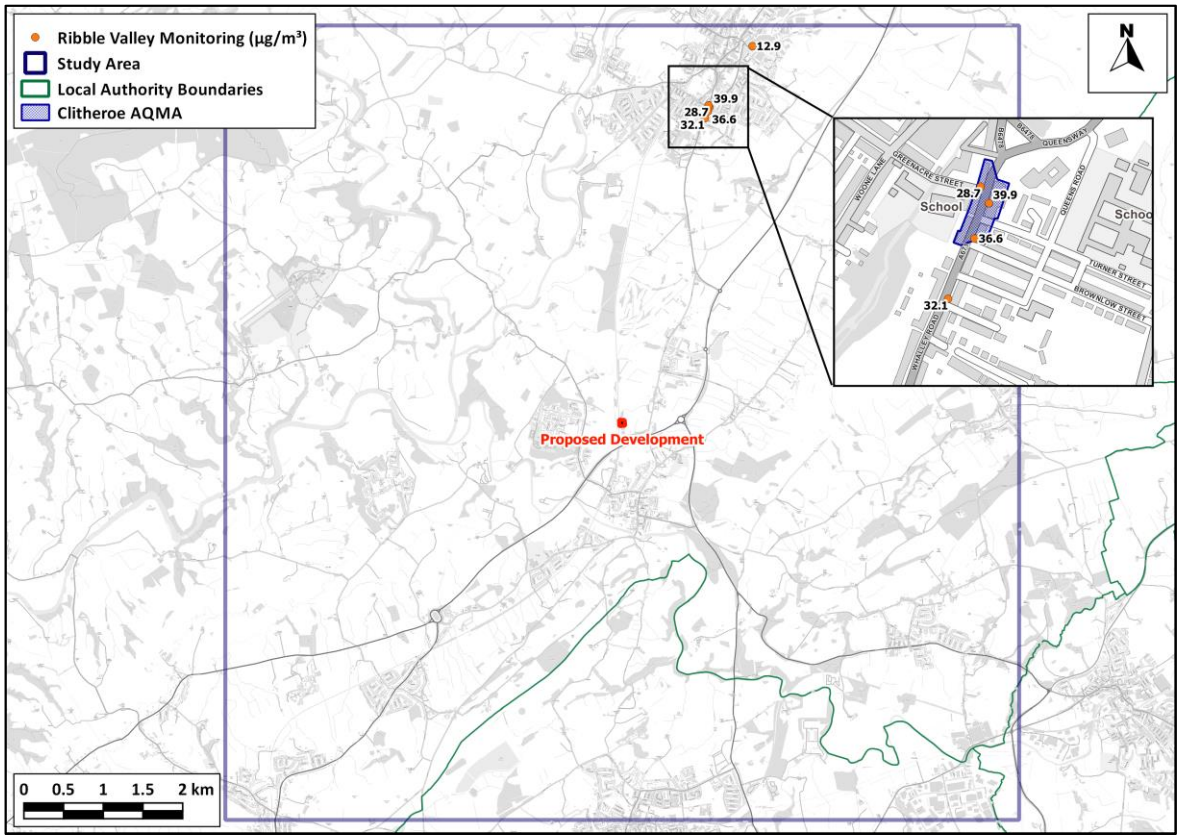

Figure 2: Monitoring Locations and AQMAs within the Study Area, and Nitrogen Dioxide Concentrations in 2016 (µg/m^3)

4.5 There have been no exceedances of the annual mean objective since 2012. Whalley Road, adjacent to which the majority of the presented diffusion tubes are located, is a particularly canyon-like environment and on approach to a congested junction, likely resulting in the poor dispersion of pollutants. This is in contrast to near the development site, which is open countryside with free-flowing roads.

Exceedances of EU Limit Value

4.6 There are no AURN monitoring sites within 1 km of the development site with which to identify exceedances of the annual mean nitrogen dioxide limit value.

4.7 Defra's roadside annual mean nitrogen dioxide concentrations (Defra, 2017), used to report exceedances of the limit value to the EU and which have been updated to support the 2017 Air Quality Plan, do not identify any exceedances within the study area in 2015.

Background Concentrations

4.8 The estimated background concentrations in the study area have been determined for 2018 (Table 6). Nitrogen dioxide and nitrogen oxide background concentrations have been derived using Defra's background maps (Defra, 2018a), whilst those for deposition have been determined from APIS (APIS, 2018). The background concentrations are well below the objective for nitrogen dioxide, nitrogen oxide and acid deposition. The background nutrient nitrogen deposition rate is above the critical load at the ecological sites.

Table 6: Estimated Annual Mean Background Pollutant Concentrations in 2018 [a]

Year	NO_2 ($\mu g/m^3$)	NOx ($\mu g/m^3$)	Nutrient-Nitrogen (kgN/ha/yr)	Acid Deposition (k_{eq}/ha/yr)
2018	5.3 – 14.0 [b]	6.8 – 19.4 [b]	**26.0** [c]	2.07 [c]
Objective	**40**	**30**	**10**	**3.14**

[a] Exceedances of the objective / critical load are shown in bold.

[b] The range covers all the 1 km x 1 km grid squares within the study area.

[c] This is the baseline deposition rate for the 5 x 5 km grid square covering the ecological areas described in Table 4.

5 Impact Assessment

Human Health

Nitrogen Dioxide Annual Mean Concentrations

5.1 Figure 3 shows concentration contours which define the area over which emissions are predicted to add more than 0.2, 0.6, 2.2 and 4.0 µg/m^3 to annual mean nitrogen dioxide concentrations. The Figure also sets out Defra's predicted 'background' concentrations[2] over the relevant 1 km grid squares, which represent conditions well away from any emission sources.

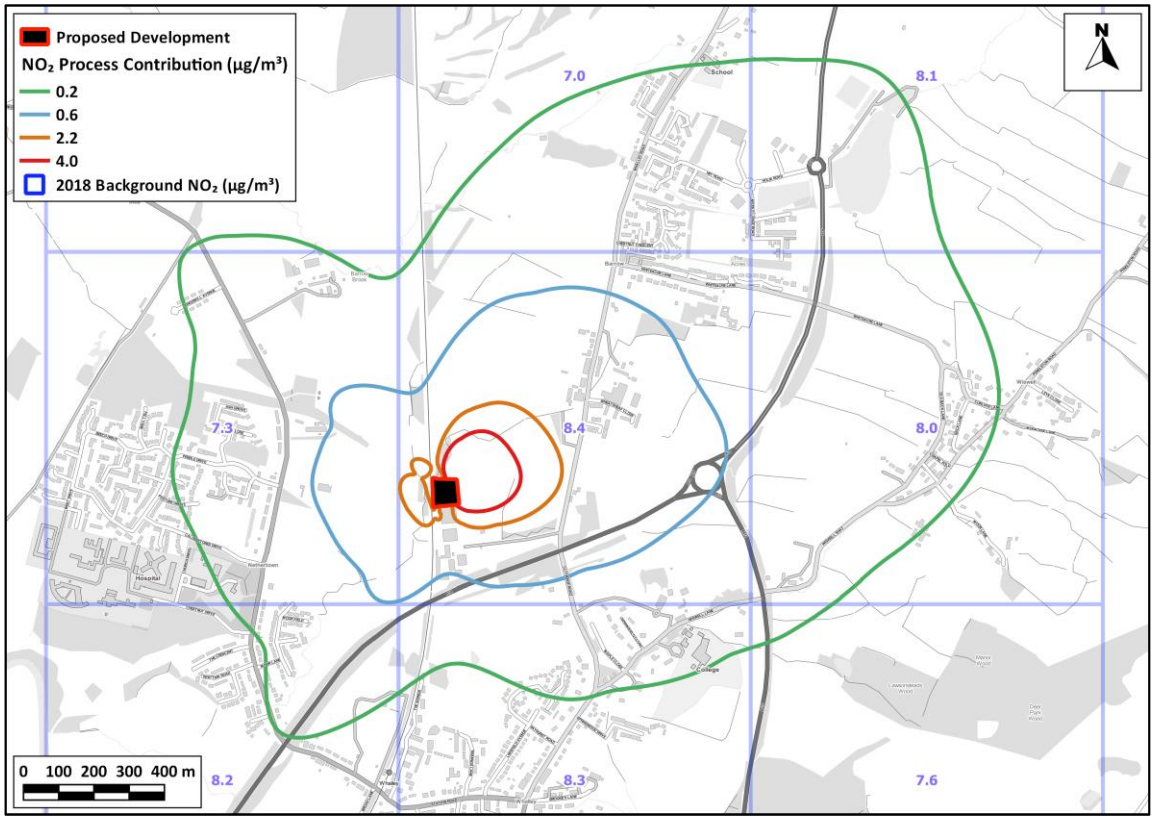

Figure 3: Annual Mean Nitrogen Concentration Contours (µg/m^3) for Maximum Process Contributions for 2,000 Hours of Operation.

5.2 Table 7 sets out the exposure that occurs within each of the four concentration range bands, which are based on the impact descriptors in Table 2.

[2] Background concentrations for 2018 have been used in this assessment.

Table 7: Relevant Exposure within Concentrations Bands [a]

	Red Contour (>4.0 µg/m^3)	Orange Contour (2.2 - 4.0 µg/m^3)	Blue Contour (0.6 - 2.2 µg/m^3)	Green Contour (0.2-0.6 µg/m^3)
Relevant Exposure	No relevant exposure	No relevant exposure	Large number of properties	Large number of properties

[a] This is based on examination of OS open data maps and may exclude some isolated properties. The exposure is based on the number between each of the contours.

5.3 Using the descriptive terminology developed jointly by EPUK and the IAQM, as described in Paragraph 2.33, the annual mean impacts can be described as follows:

- outside the area defined by the 0.2 µg/m^3 (green) contour the impacts will be negligible, regardless of the receptor-specific total concentrations (process contribution plus baseline concentration);
- the impacts will also be negligible between the 0.2 and 0.6 µg/m^3 (green and blue) contours, as long as the baseline concentration is below 37.2 µg/m^3 (the band threshold of 37.8 µg/m^3 minus the maximum process contribution within the area of 0.6 µg/m^3);
- between the 0.6 and 2.2 µg/m^3 contours (blue and orange), the impacts will be negligible with a baseline concentration below 28.0 µg/m^3 (the band threshold of 30.2 µg/m^3 minus the maximum process contribution within the area of 2.2 µg/m^3). Impacts will be slight adverse with a baseline concentration between 28.0 and 35.6 µg/m^3 (the band threshold of 37.8 µg/m^3 minus the maximum process contribution of 2.2 µg/m^3); and
- non-negligible impacts will occur in the area between the 2.2 µg/m^3 (orange) and 4.0 µg/m^3 (red) contours wherever there are locations with relevant exposure to the annual mean objective as described in Paragraph 2.29.

5.4 In order to apply the above approach, it is necessary to define the baseline concentrations at the receptors within the relevant contours. There are no monitoring sites within any of the contours, with the nearest monitoring sites located within Clitheroe. The monitoring sites on Whalley Road (see Figure 2) are not considered representative of relevant sensitive receptors within the contours since they are in a canyon-like environment close to a busy junction. Measured concentrations at the urban background monitoring site on Whittle Close are similar to Defra's background maps, and representative of relevant receptors set back from major roads.

5.5 There are no relevant receptors within the red or orange contours, there will, therefore, be no impacts in these areas. Within the blue contour there are many relevant receptors which will experience elevated concentrations as a direct result of the proposed facility. Baseline concentrations at residential properties, such as Shawhouse Farm House, which are set back from the adjacent road network, are expected to be within a few microgrammes of Defra's predicted background maps (7.3 – 8.4 µg/m^3 as presented in Figure 3). This is well below the threshold

concentration of 28.0 µg/m^3 discussed in Paragraph 5.3 for *negligible* impacts; total nitrogen dioxide concentrations will also remain well below the annual mean objective.

5.6 There are also several residential properties (~20) within the blue contour that are adjacent to Clitheroe Road, within 5 m of the kerb. At these properties baseline concentrations may exceed 28.0 µg/m^3, however there is no local monitoring to verify this. It is considered highly unlikely that concentrations at these properties would exceed 35.6 µg/m^3 by the time that the proposed development is operational. Impacts may, therefore, be described as *slight adverse* here, but are highly unlikely to be *moderate adverse*, and are perhaps more likely to be *negligible*. Total concentrations will be below the annual mean objective.

5.7 The green contour covers many residential properties in Nethertown, Barrow and Wiswell. The majority of these properties are located on quiet residential no-through roads, where baseline concentrations are expected to be similar to Defra's background concentrations. There are roadside properties adjacent to Mitton Road (B6246); the maximum measured concentration in 2016 in Clitheroe was 39.9 µg/m^3 however, Mitton Road is more open and free-flowing than Whalley Road. Baseline concentrations are unlikely to exceed 37.2 µg/m^3 (the threshold for non-negligible impacts). There are no receptors adjacent to the A59 and A671, busy 'A' roads which bisect the contour. Since baseline concentrations are unlikely to exceed the threshold of 37.2 µg/m^3 at any location within the green contour, impacts at all locations will be described as *negligible*.

5.8 Table 8summarises the impacts within each of the contours from Figure 3.

Table 8: Impacts at Receptors within Different Process Contribution Bands

Process Contribution Band	Likely Impact
Green to Blue (0.2 to 0.6 µg/m^3)	Negligible
Blue to Orange (0.6 to 2.2 µg/m^3)	Negligible with a risk of some Slight Adverse
Orange to Red (2.2 to 4.0 µg/m^3)	No Exposure
Red (>4.0 µg/m^3)	No Exposure

Short-term Impact Assessment

5.9 Relevant locations for the short-term objectives are locations where members of the public are likely to regularly spend 1 hour or more.

5.10 Figure 4 shows contour areas representing the 99.79th percentile of 1-hour mean nitrogen dioxide process contributions from the generator emissions. The modelling has assumed continuous operation of the generators when considering the short-term impacts, when in reality they will only operate for 2,000 hours per year. Therefore, these impacts are very much worst-case.

5.11 Common practice when calculating the total 99.79th percentile of 1-hour mean nitrogen dioxide concentrations is to add the process contribution to twice the local annual mean baseline concentration.

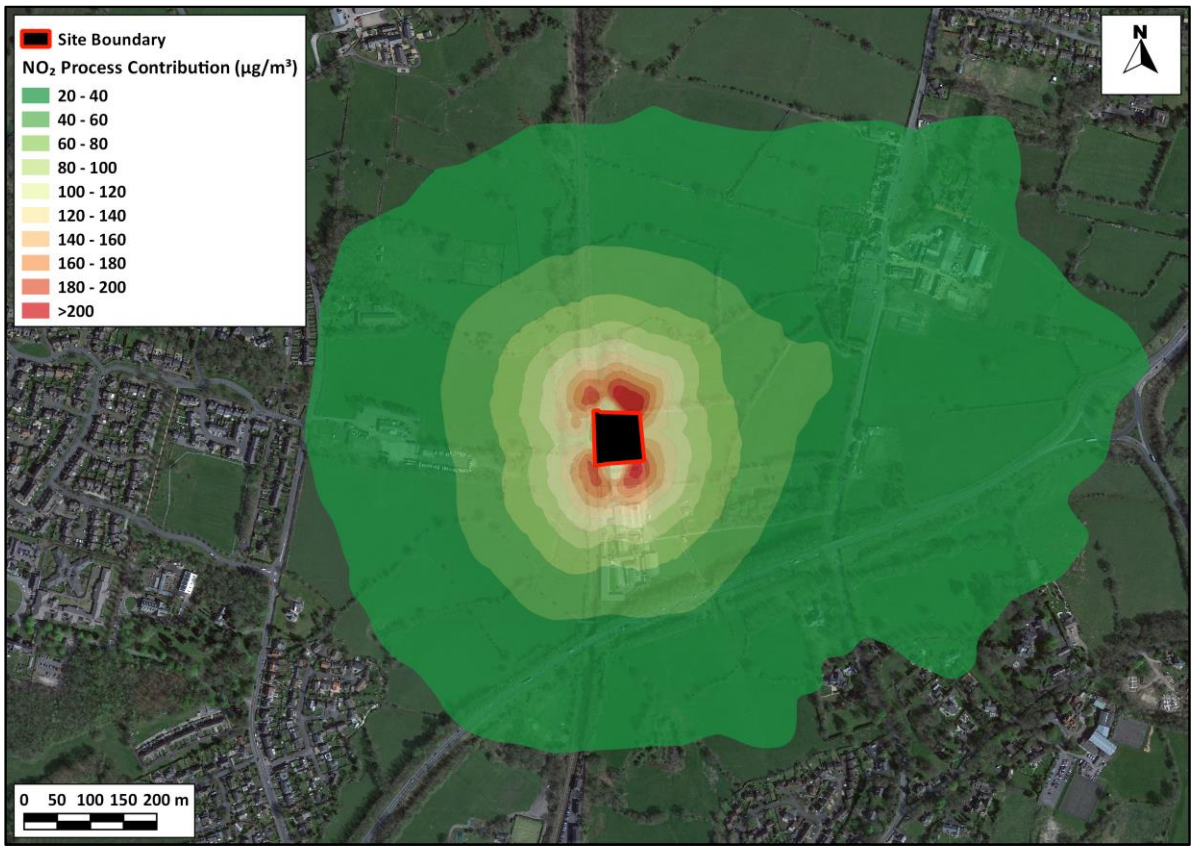

Figure 4: Maximum Short-term 99.79th Percentile Nitrogen Dioxide Process Contribution Contours (µg/m3)

Contains Google imagery. Imagery ©2018 Google

5.12 Assuming that, away from the local road network, the annual mean baseline is similar to Defra's predicted background concentrations (7 – 8 µg/m3), twice this maximum value would be 16 µg/m3; the process contribution from the generators would, therefore, need to be greater than 184 µg/m3 in order for the short-term objective to be exceeded (i.e. the 19th highest hour would have a concentration above 200 µg/m3). There are no relevant receptors within the orange or red contours (representing process contributions greater than 180 µg/m3), and therefore, there is no risk of an exceedance of the short-term objective at any location set back from the local highway.

5.13 Given that it has been assumed that no location within the green contour will experience baseline concentrations greater than 37.2 µg/m3, assuming this worst-case value as a baseline concentration for roadside locations of relevant exposure, process contributions would need to be greater than 120 µg/m3 for there to be a risk of an exceedance of the 1-hour objective. There are no roadside locations within the yellow contours (representing process contributions greater than

120 µg/m^3); therefore there is no risk of an exceedance of the short-term objective at roadside locations.

5.14 Whalley, Wiswell and Barrow Cemetery is located within the green contours where process contributions from the generators are between 20 and 60 µg/m^3. Since the local baseline is not predicted to be greater than 37.2 µg/m^3 at any location within any contour, there will not be any risk of an exceedance of the 1-hour objective at the cemetery.

5.15 Overall, the impacts of the scheme in relation to short-term concentrations are judged to be 'not significant'.

Ecological Impact Assessment

5.16 The maximum predicted nitrogen oxides concentrations and rates of nutrient deposition at any location within the designated ancient woodland sites associated with emissions from the proposed facility are shown in Table 9 and Table 10. The maximum predicted concentrations from each of the five meteorological years are considered and from any building scenario. The annual mean process contributions have been scaled to represent the proposed 2,000 hours of annual operation. The 24-hour mean process contributions are based on continuous operation of the development.

Table 9: Predicted Maximum Pollutant Concentrations in Relation to Critical Levels

Location	Annual Mean Nitrogen Oxides (µg/m^3)			24-hour Mean Nitrogen Oxides (µg/m^3)		
	PC	% of EAL	Screening Criterion (% of EAL)	PC	% of EAL	Screening Criterion (% of EAL)
Maximum Process Contribution	0.16	0.5	100	9.1	12	100%

5.17 These predicted maximum concentrations can be compared with the screening criteria recommended by the Environment Agency, as previously described in Section 2, and the following conclusions can be drawn:

- the predicted maximum annual mean nitrogen oxides process contributions at any nationally designated ancient woodland site is well below the screening criterion (100%); and
- the predicted maximum 24-hour mean nitrogen oxides process contributions at any nationally designated ancient woodland site is well below the screening criterion (100%).

Table 10: Predicted Maximum Deposition Fluxes in Relation to Critical Loads

Location	Nutrient-Nitrogen Deposition (kgN/ha/yr)			Acid-Nitrogen Deposition (k_{eq}/ha/yr)		
	PC	% of EAL	Screening Criterion (% of EAL)	PC	% of EAL	Screening Criterion (% of EAL)
Maximum Process Contribution	0.03	0.3	100	0.002	0.1	100%

5.18 The predicted maximum annual mean nutrient nitrogen and acid-nitrogen deposition fluxes are also well below the screening criterion (100%). The potential for significant impacts on designated sensitive habitats from the operation of the proposed development can thus be discounted.

6 Conclusions

6.1 The impacts associated with the proposed natural-gas power-generation facility at Shawhouse Farm have been assessed in relation to the air quality objectives set to protect human health and critical levels and critical loads set to protect sensitive ecosystems. The assessment has considered an operational scenario of 2,000 hours per year. The impacts have been predicted using the ADMS-5 dispersion model.

Human Health Impacts

Annual Mean Nitrogen Dioxide Concentrations

6.2 There will be no significant effects outside of the contours shown in Figure 3. Within these contours, the impacts are predicted to be negligible at most locations. There will be a small area along Clitheroe Road where impacts may be described as slight adverse. Nonetheless, at all locations, total concentrations will remain well below the annual mean nitrogen dioxide objective. Overall, these impacts are considered to be 'not significant'.

1-hour Mean Nitrogen Dioxide Concentrations

6.3 The assessment has demonstrated that the hourly mean nitrogen dioxide objective will not be exceeded at any relevant receptor, thus the impacts of the scheme in relation to short-term concentrations are judged to be 'not significant'.

Ecological Impacts

6.4 The effects on ecological designated sites have been assessed. The impacts can be screened out as 'not significant'.

Conclusion

6.5 Overall, it is considered that the air quality effects associated with the proposed natural-gas power-generation facility at Shawhouse Farm, with the generators operating for up to 2,000 hours, will be 'not significant'.

7 References

APIS (2018) *Recommended values within nutrient nitrogen critical load ranges for use in air pollution impact assessments. http://www.apis.ac.uk/sites/default/files/downloads/APIS%20critical_load_range_document_0.pdf*.

AQC (2016) *Relationship between the UK Air Quality Objectives and Occupational Air Quality Standards*, [Online].

Clean Air Act 1993 (1993), HMSO, Available: http://www.legislation.gov.uk/ukpga/1993/11/contents.

Countryside and Rights of Way Act 2000 (2000), Available: http://www.legislation.gov.uk/ukpga/2000/37/contents.

DCLG (2018) *Planning Practice Guidance*, [Online], Available: http://planningguidance.planningportal.gov.uk/blog/guidance/.

Defra (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*, Defra.

Defra (2016) *Review & Assessment: Technical Guidance LAQM.TG16*, Defra.

Defra (2017) *2017 NO2 projections data (2015 reference year)*, [Online], Available: https://uk-air.defra.gov.uk/library/no2ten/2017-no2-projections-from-2015-data.

Defra (2017a) *Air quality plan for nitrogen dioxide (NO2) in the UK*, Available: https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017.

Defra (2018) *Clean Air Strategy 2018 (Draft)*, Available: https://consult.defra.gov.uk/environmental-quality/clean-air-strategy-consultation/.

Defra (2018a) *Defra Air Quality Website*, [Online], Available: http://laqm.defra.gov.uk/.

Directive 2008/50/EC of the European Parliament and of the Council (2008).

Directive 2015/2193/EU of the European Parliament and of the Council (2015).

Environment Act (1995), HMSO, Available: http://www.legislation.gov.uk/ukpga/1995/25/contents.

Environment Agency (2005) *Conversion ratios for NOx and NO2*, [Online], Available: http://persona.uk.com/kings_lynn/Core_docs/Q/Q11.pdf.

HMSO (1990) *Environmental Protection Act 1990*.

Hyndburn Borough Council (2012) *The Core Strategy*.

Hyndburn Borough Council (2018) *Hyndburn Borough Council Local Plan: Development Management DPD*.

Ministry of Housing, Communities and Local Government (2018) *National Planning Policy Framework*, Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/607721169 50.pdf.

Moorcroft and Barrowcliffe et al (2017) *Land-Use Planning & Development Control: Planning For Air Quality v1.2*, IAQM, London, Available: http://iaqm.co.uk/guidance/.

National Parks and Access to the Countryside Act (1949), Available: https://www.legislation.gov.uk/ukpga/Geo6/12-13-14/97.

Natural Environment and Rural Communities Act (2006), HMSO, Available: http://www.legislation.gov.uk/ukpga/2006/16/contents.

Ribble Valley Borough Council (2014) *Core Strategy 2008 - 2028*.

Ribble Valley Borough Council (2017) *2017 Air Quality Annual Status Report (ASR)*.

Technical Guidance Note D1 (Dispersion) (1993), HMSO.

The Air Quality (England) (Amendment) Regulations, 2002, Statutory Instrument 3043 (2002), HMSO.

The Air Quality (England) Regulations 2000 Statutory Instrument 928 (2000), HMSO, Available: http://www.legislation.gov.uk/uksi/2000/928/contents/made.

The Conservation of Habitats and Species Regulations 2010 Statutory Instrument 490 (2010), Stationery Office, Available: http://www.legislation.gov.uk/uksi/2010/490/contents/made.

The Council of European Communities (1992) *European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora*.

The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 Statutory Instrument 110 (2018), The Stationery Office Limited, Available: http://www.legislation.gov.uk/uksi/2018/110/pdfs/uksi_20180110_en.pdf.

The European Parliament and the Council of the European Union (2009) *Directive 2009/147/EC of the European Parliament and of the Council*.

WHO (2000) *Air Quality Guidelines for Europe; 2nd Edition. http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf*.

Wildlife and Countryside Act (1981), Available: http://www.legislation.gov.uk/ukpga/1981/69.

8 Glossary

ADMS-5	Atmospheric Dispersion Modelling System model for point sources
APIS	Air Pollution Information System
AQC	Air Quality Consultants
AQMA	Air Quality Management Area
Background	Background concentration representative of a 1x1 km area
Baseline	Baseline concentration representative a specific receptor that may be affected by local sources, such as a road
CROW	Countryside and Rights of Way Act
Defra	Department for Environment, Food and Rural Affairs
EAL	Environmental Assessment Level
EPUK	Environmental Protection UK
Exceedance	A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure
IAQM	Institute of Air Quality Management
µg/m^3	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
Objectives	A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides
PC	Process Contribution
PEC	Predicted Environmental Concentration
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest

9 Appendices

A1 Professional Experience

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is a Technical Director with AQC and has twenty years' experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist. Dr Marner is a member of Defra's Network of Evidence Experts and a member of Defra's Air Quality Expert Group.

Ricky Gellatly, BSc (Hons) MIEnvSc MIAQM

Mr Gellatly is a Principal Consultant with AQC with over six years' relevant experience. He has undertaken air quality assessments for a wide range of projects, assessing many different pollution sources using both qualitative and quantitative methodologies, with most assessments having included dispersion modelling (using a variety of models). He has assessed road schemes, airports, energy from waste facilities, anaerobic digesters, poultry farms, urban extensions, rail freight interchanges, energy centres, waste handling sites, sewage works and shopping and sports centres, amongst others. He also has experience in ambient air quality monitoring, the analysis and interpretation of air quality monitoring data, the monitoring and assessment of nuisance odours and the monitoring and assessment of construction dust. He is a Member of IAQM.

Dr Frances Marshall, MSci PhD AMIEnvSc AMIAQM

Dr Marshall is a Consultant with AQC, having joined the company in September 2016. She is currently gaining experience of undertaking air quality assessments, including the use of dispersion modelling. Prior to joining AQC, Frances spent four years carrying out postgraduate research into atmospheric aerosols at the University of Bristol. She is an Associate Member of both the Institute of Air Quality Management and The Institute of Environmental Sciences.

Full CVs are available at www.aqconsultants.co.uk.

A2 Modelling Methodology

A2.1 The impacts of emissions from the proposed facility have been predicted using the ADMS-5.2 dispersion model. ADMS-5.2 is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer.

Model Inputs

Emissions and Release Conditions

A2.2 The model input parameters for the proposed generators have been derived from the generator datasheets for a MTU 2026 kW generator (MTU 16V4000 GS)

A2.3 The emissions parameters employed in the modelling are given in Table A2.1. These are based on use of natural-gas fuel for 100% of the operation for each of the generators.

Table A2.1: Plant Specifications, Emissions and Release Conditions (per Generator).

Parameter	Value
Power Output (kW_{out})	2,026
Generator Inputs	
Net Input Fuel Rate (kW_{in})	4,748
Gross Input Fuel Rate (kW_{in})	5,259
Gross Fuel Consumption (kg/hr)	367
Combustion Air_{in} (kg/h)	10,402
Excess Air (%) [a]	77
Exhaust Temperature (ºC)	412
Exhaust Flow (kg/h) for Actual Flow	10,831
Molar Flow Rate (mol/s) for Actual Flow	106.7
Molecular Mass (g/mol) for Actual Flow	28.2
Exhaust Flow (Am^3/s) [b, c] **for Actual Flow**	6.0
Flue Internal Diameter (m)	0.5
Exhaust Velocity (Am/s) [b] **for Actual Flow**	30.6
Exhaust Flow (kg/h) for Normalised Flow [d]	5,493
Molar Flow Rate (mol/s) for Normalised Flow [d]	50.8
Exhaust Flow (Nm^3/s) [d, e] **for Normalised Flow**	1.1

Parameter	Value
Condition Specific Emissions	
NOx Emission Rate (mg/m^3) [f]	250.0
NOx Emission Rate (mg/Nm^3) [d]	328.6
NOx Emission Rate (g/s)	0.37396

Note: Orange highlighted cells contain the values entered into the model. The number of significant figures presented should not be taken to represent the accuracy of the information entered into the model.

[a] Derived from combustion air m^3/s.

[b] Actual flow conditions assumed to be 412 ºC, 8.5% O_2, wet (11.8% H_2O).

[c] Calculated from molar flow rate x 8.3145 x (412+273.13) / 101,325.

[d] Normalised to 0 ºC, 101.325 kPa, 0% O_2, dry.

[e] Calculated from normalised molar flow rate x 8.3145 x (273.13) / 101,325.

[f] Standardised to 0 ºC, 101.325 kPa, 5% oxygen, dry.

Spatial Configuration

A2.4 Within the model, the generators have been positioned across the site as shown in Figure A2.1.

A2.5 The flues have been modelled at a height of 8.0 m.

A2.6 Entrainment of the plume into the wake of the generator housings (the so-called building downwash effect) has been taken into account by including the housings themselves as buildings within the model. There are also buildings near to the generators that may have an impact on the dispersion, and these have also been included. Three separate modelling scenarios have therefore been run:

- No on site buildings (generator housings);
- Generator housings at 5.5 m; and
- Generator housings at 5.5 m and additional buildings at heights between 2.4 m and 6.4 m.

A2.7 Local terrain has been included within the model based on OS Terrain 50 data.

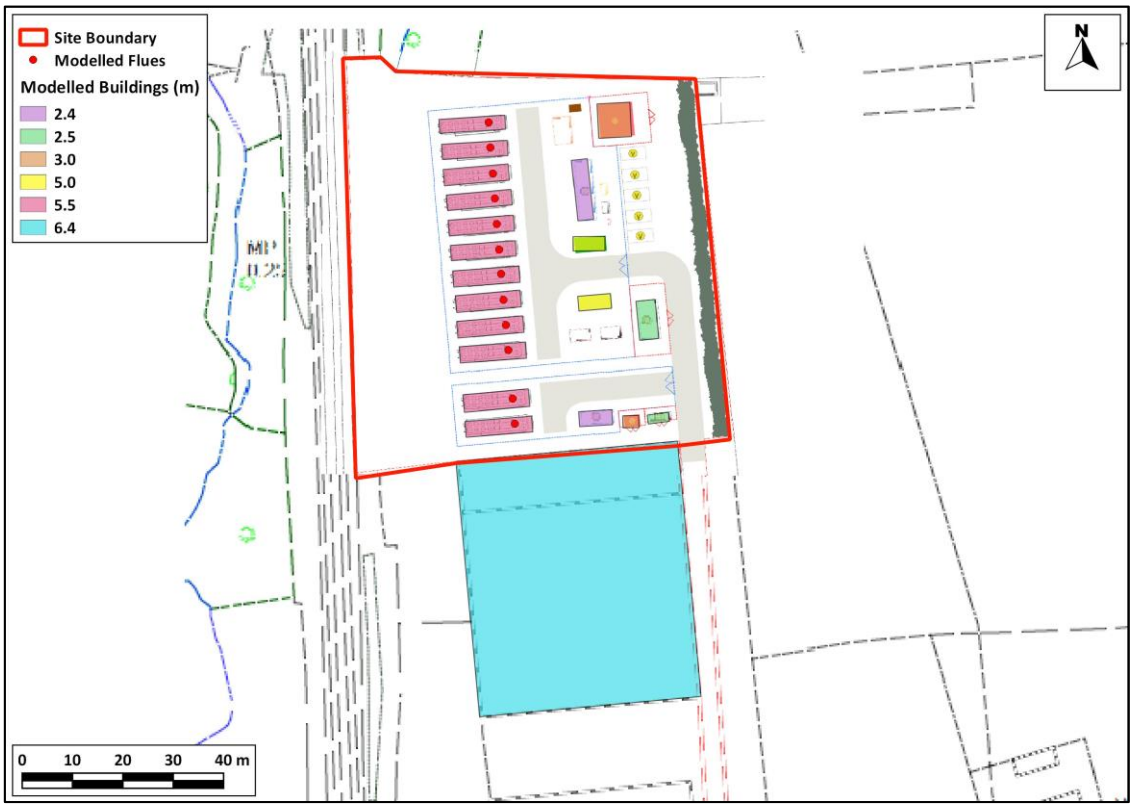

Figure A2.1: Modelled Generator Flue Outlet Layout (red circles) and Modelled Buildings

Contains data provided by Pegasus Design, drawing number P17-2766_03.

Meteorological Inputs

A2.8 Hourly sequential meteorological data for the years 2012 to 2016 from Bingley have been used. The Bingley meteorological monitoring station is located approximately 38 km to the east of the proposed development site. It is deemed to be the nearest monitoring station representative of meteorological conditions at the proposed development site.

A2.9 The maximum concentrations predicted using any of the five years of meteorological data have been used in the preparation of the results set out in Section 5.

Model Post-processing for Nitrogen Dioxide

A2.10 Emissions from the generators will be predominantly in the form of nitrogen oxides (NOx). ADMS-5 has been run to predict the contribution of the generators to annual mean concentrations of nitrogen oxides and a percentile of 1-hour mean nitrogen oxides. The approach recommended by the Environment Agency (Environment Agency, 2005) has been used to predict annual mean nitrogen dioxide concentrations and the percentile of 1-hour mean nitrogen dioxide concentrations. This assumes that:

- annual mean nitrogen dioxide concentrations = annual mean nitrogen oxides x 0.7; and
- percentile of 1-hour mean nitrogen dioxide concentrations = percentile of 1-hour mean nitrogen oxides x 0.35.

A2.11 These NOx to NO_2 ratios are likely to be overly pessimistic within close proximity of the proposed facility. The NOx emissions require time and ozone (O_3) available to react and convert to NO_2, thus 35% NO_X to NO_2 ratio for short-term impacts is considered worst-case for receptors within 500 m of the site.

Deposition Rates

A2.12 Deposition has not been included within the dispersion model because the principal depositing component of concern is nitrogen dioxide and this is calculated from nitrogen oxides outside of the model. Instead, deposition has been calculated from the predicted ambient concentrations using the deposition velocities set out in Table A2.2. Deposition velocities refer to a height above ground, typically 1 or 2 m, although in practice the precise height makes little difference and here they have been applied to concentrations predicted at a height of 1.5 m above ground. The velocities are applied simply by multiplying a concentration (µg/m^3) by the velocity (m/s) to predict a deposition flux (µg/m^2/s). Subsequent calculations required to present the data as kg/ha/yr of nitrogen or sulphur and as keq/ha/yr for acidity follow basic chemical and mathematical rules[3].

Table A2.2: Deposition Velocities Used in This Assessment

Pollutant	Deposition Velocity (m/s)	Reference
Nitrogen Dioxide	0.003 m/s (Forest)	AQTAG06 (Environment Agency, 2011)

A2.13 Wet deposition has been discounted. Wet deposition of the emitted pollutants this close to the emission source will be restricted to wash-out, or below cloud scavenging. For this to occur, rain droplets must come into contact with the gas molecules before they hit the ground. Falling raindrops displace the air around them, effectively pushing gasses away. The low solubility of nitrogen dioxide means that any scavenging of this gas will be a negligible factor. While wash-out of sulphur dioxide might be more significant, the very low sulphur oxide emission rates mean that discounting wet deposition is highly unlikely to affect the outcomes of the assessment.

[3] For example, 1 kg N/ha/yr = 0.071 keq/ha/yr