Air Quality Assessment of Emissions to Atmosphere from the Proposed Back-Up Generator at the Hickleton Energy Park

P1715

A Report Prepared for
Alkane Energy UK Ltd
by

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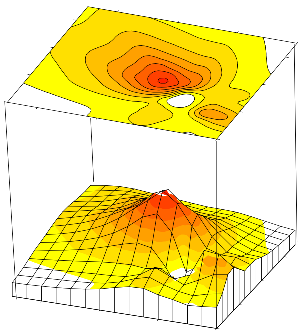

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1 INTRODUCTION

Alkane Energy UK Ltd (Alkane) commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality assessment of the impacts on human health occurring due to emissions to atmosphere from the proposed containerised standby gas fuelled generator to be located on the Hickleton Energy Park, off Barrowfield Road, Thurnscoe, Rotherham, S63 0BH

The proposal is for a single 2.5 MWe unit fuelled by natural gas. This additional unit will operate alongside the four existing Deutz mine-gas engines and only when required by the national grid. The proposed generator will operate for no more than 1,000 hours per year.

The exhausts from the four existing generators only extend 0.2 m to 0.3 m above the roof and therefore the emissions to atmosphere from these generators are subject to poor dispersion resulting elevated ground level pollutant concentrations. As part of the proposal for the additional generator the heights of the four existing generator exhausts will be increased by 3 m leading to a substantial improvement in dispersion and corresponding reduction in pollutant ground level concentrations. The effect of this increase in stack height is presented in this assessment. Also presented is the assessment of the impact on air quality of the incremental increase due to the proposed generator.

The purpose of this technical report is to present the air quality impact assessment as required by the Local Authority which have stated

'An operational phase air quality assessment will be required to assess the impact of emissions from the proposed development on local air quality and associated air quality objectives / limit values. The methodology of the assessment shall be agreed with the Local Planning Authority and will consider the cumulative impact of emissions for the existing facility along with emissions from the proposed development. (1)'

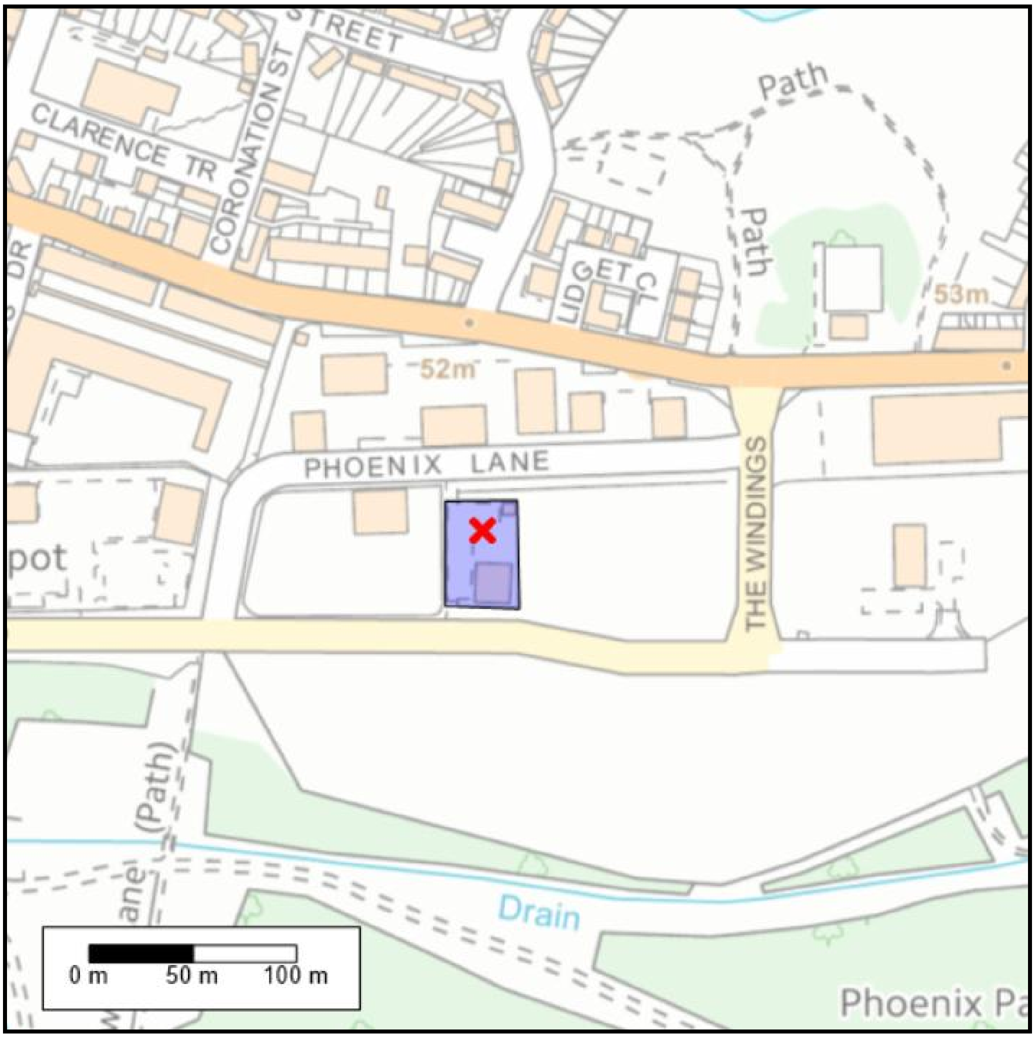
The ADMS 5.2 dispersion model has been used to make predictions of ground level concentrations of the oxides of nitrogen (NO_x) which is the principal pollutant released to atmosphere from the generators. Emissions of carbon monoxide (CO) will have a negligible impact on air quality and are not considered further. Emissions of any other pollutants have been screened out as being negligible and are not considered further.

Predictions of nitrogen dioxide (NO_2) are made for actual emissions from the existing four generators.

Figure 1.1 shows the location of the Hickleton Energy Park and the proposed generator stack.

(1) Email (18 October 2017) from Chris Shields, Technical Officer, Barnsley Council.

Figure 1.1 Location of Hickleton Energy Park and Proposed Generator Stack



The remainder of the report is structured as follows:

- Section 2 - description of the assessment and significance criteria
- Section 3 - presents and assesses the existing air quality
- Section 4 - describes the modelling methodology
- Section 5 - presents the predicted concentrations
- Section 6 - provides a summary and conclusions

2 PLANNING CONTEXT, ASSESSMENT AND SIGNIFICANCE CRITERIA

2.1 INTRODUCTION

This section presents the planning context with regard to air quality, together with relevant air quality legislation and guidance.

2.2 PLANNING CONTEXT

2.2.1 EUROPEAN LEGISLATION

Local authorities currently have no statutory obligation to assess air quality against European limit values but are encouraged to do so. In order to assist with longer-term planning and the assessment of development proposals in their local areas, Defra's Technical Guidance LAQM TG16 for Local Authorities provides guidance on how to assess against the time-frame of the European limit values (1).

The Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment) Regulations 2002 (SI 2002 No. 3043) include national air quality objectives which, in most cases, are numerically synonymous with the European limit values although they may have different compliance target dates and can apply to different locations. The air quality objectives are for specific use by local authorities when undertaking their Local Air Quality Management (LAQM) duties in pursuit of Part IV of the Environment Act 1995. Of principal concern to this assessment is nitrogen dioxide (NO_2).

2.2.2 MEDIUM COMBUSTION PLANT DIRECTIVE (MCPD)

The Department for Environment Food and Rural Affaires (Defra) has published draft legislation to transpose Medium Combustion Plant Directive (MCPD) into UK law by 19 December 2017 (2). MCPD provides regulation and emission controls for combustion plants in the 1-50 MWth range, it will apply to new plants from December 2018 and for existing plants from 2024 or 2029 depending on their size. The proposed generator will comply with the requirements of the MCPD and will meet the emission limits.

2.2.3 NATIONAL LEGISLATION AND GUIDANCE

The Government's policy on air quality within the UK is set out in the Air Quality Strategy for England, Scotland, Wales & Northern Ireland Strategy (AQS), published in July 2007 in accordance with the requirements of Part IV of the Environment Act 1995. The Air Quality Strategy (AQS) sets out a framework to reduce adverse health effects from air pollution and ensures that international commitments are met. The AQS sets standards and objectives for pollutants to protect human health, vegetation and ecosystems.

(1) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.
(2) Draft Statutory Instruments (2017 No. 0000) The Environmental Permitting (England and Wales) Miscellaneous Amendments Regulations 2017.

Many of the objectives in the Air Quality Strategy (AQS) were made statutory in England with the Air Quality (England) (Amendment) Regulations 2002 for the purpose of Local Air Quality Management (LAQM).

2.2.4 REVIEW AND ASSESSMENT

Under Part IV of the Environment Act, local planning authorities must review and assess the air quality within their area by way of staged appraisals; with the aim of meeting the objectives by target dates defined in the Air Quality (England) (Amendment) Regulations. Where the air quality objectives have not been achieved a local planning authority is required to designate an AQMA and to draw up an air quality action plan (AQAP) towards achieving air quality objectives in the future.

The Department for Environment, Food and Rural Affairs (Defra) has published technical guidance for use by local planning authorities in their review and assessment work (1).

2.2.5 NATIONAL PLANNING POLICY FRAMEWORK

In March 2012 the Department of Communities and Local Government published the National Planning Policy Framework (NPPF) (2). The purpose of the framework is to help achieve sustainable development. Section 11 of the policy makes the following references to air quality.

- The planning system should contribute to and enhance the natural and local environment by preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability.

- Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with the local air quality action plan.

The National Planning Practice Guidance (NPPG) for air quality is available on the NPPG web site (3). The NPPG states that '*air quality concerns can be relevant to neighbourhood planning*'.

2.2.6 DEVELOPMENT CONTROL: PLANNING FOR AIR QUALITY

In May 2015 the Institute for Air Quality Management (IAQM) and Environmental Protection UK published an update to its guidance document that contains a framework for air quality consideration to be accounted for in

(1) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.
(2) Department of Communities and Local Government (March 2012) National Planning Policy Framework.
(3) http:\\planningguidance.planningportal.gov.uk.

local development control [1]. The IAQM guidance has been taken into account when undertaking this assessment.

2.2.7 LOCAL AUTHORITY GUIDANCE

In September 2014 the Barnsley Metropolitan Borough Council (MBC) published an Air Quality and Emission Good Practice Guidance which focused on reducing the impacts of traffic emissions on air quality. The general principles of this guidance have been followed as part of this assessment [2].

2.3 ASSESSMENT CRITERIA

2.3.1 AIR QUALITY

This section describes the criteria used to assess the impacts on air quality of emissions to atmosphere from the proposed development.

The Environment Agency's (EA) Environmental Assessment Levels (EALs) published in their risk assessment guidance are used in this assessment where assessment criteria are not available from EU Directives or the Air Quality Strategy (AQS) [3].

Table 2.1 shows the criteria used to assess the impacts on human health.

Table 2.1 Assessment Criteria

Substance	Averaging time	Assessment Criteria ($\mu g\ m^{-3}$)
Nitrogen dioxide (NO_2)	Annual mean	40
	99.79th percentile of hourly means	200

2.3.2 SIGNIFICANCE CRITERIA

The impact refers to the change that is predicted to take place to the prevailing environment as a result of the proposed development (ie the incremental increase or decrease in pollutant concentration).

The significance of an impact is generally determined by the combination of the 'sensitivity' and/or 'value' of the affected environmental receptor and the predicted "extent" and/or "magnitude" of the impact or change. The impact descriptors used in this assessment are taken from the IAQM/EPUK guidance for planning and air quality [4]. The assessment of significance ultimately relies on professional judgement, although comparing the extent of the impact with criteria and standards specific to each environmental topic can guide this judgement.

(1) IAQM (2015) Land-Use Planning & Development Control: Planning for Air Quality.
(2) Barnsley MBC (September 2014) Air Quality and Emissions, Good Practice Planning Guidance.
(3) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit .
(4) Environmental Protection UK/IAQM (May 2015) Land-Use Planning& Development Control: Planning for Air Quality.

Details of impact descriptors used in this assessment are shown in **Table 2.2** It should be noted that the IAQM/EPUK impact descriptors refer to permanent changes in air quality brought about by a development and not short term or temporary changes. They also refer to locations where there is relevant exposure and not therefore necessarily the location of the maximum impact. The criteria therefore are only appropriate for changes to annual average concentrations at locations where there is relevant exposure; ie not generally the point of maximum impact.

Table 2.2 IAQM/EPUK Air Quality Impact Descriptors for Individual Receptors

Long Term Average Concentration at Receptor in Assessment Year	% Change in Concentration Relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
102%-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial
Note: Changes less than 0.5% are Negligible.				

The IAQM guidance on significance shown in **Table 2.2** is only applicable to long term/annual average impacts.

IAQM provides the following guidance for peak short-term concentrations from an elevated source, as shown below.

Magnitude of Impact (percentage of relevant Air Quality Assessment Level, AQAL):

- 10-20% Small
- 20-50% Medium
- >50% Large

The corresponding severity of these impacts can be described as slight, moderate and substantial without the need to make reference to background or baseline concentration.

The Environment Agency's (EA) risk assessment guidance includes a test for insignificance of short term impacts (1). The guidance states that the process contribution (PC) can be considered as insignificant if:

- the long term PC is <1% of the assessment criteria
- the short term PC is < 10% of the assessment criteria

This is not to say that if these thresholds are exceeded the process

(1) https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit .

contribution (PC) is significant, just that it cannot be ruled out as being insignificant.

For the assessment of significance, this assessment uses the IAQM guidance.

3 AMBIENT AIR QUALITY DATA

3.1 INTRODUCTION

This section presents a description of the ambient air quality in the region of the proposed development. Given the large degree of variation in pollutant concentrations, both with time and location, it is desirable to have measurements over a period of time that is long enough to ensure that a complete range of meteorological conditions and emissions have been experienced.

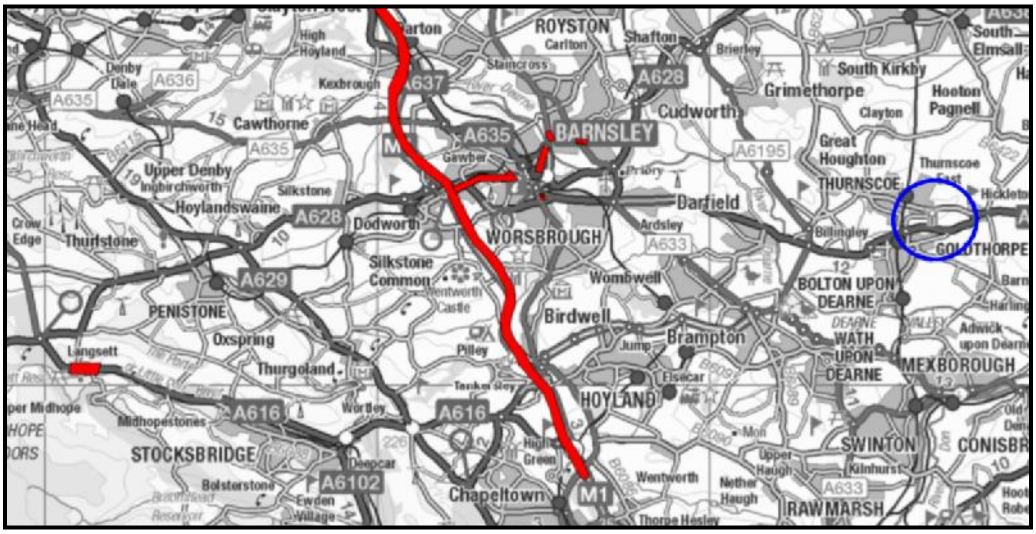
The criteria used throughout this assessment are compared to the incremental increase occurring due to emissions to atmosphere from the proposed development and therefore an accurate determination of the prevailing concentration is not necessary. However, estimates of the prevailing background concentrations are presented where impacts cannot be screened out as being insignificant.

3.2 AIR QUALITY MANAGEMENT AREAS (AQMA)

As part of the requirement of the Environment Act 1995, Barnsley MBC undertake regular reviews to determine if there are any areas that are not meeting the Air Quality Strategy (AQS) objectives. Barnsley MBC have identified a number of locations close to busy/congested roads where AQS objectives are being exceeded and have therefore declared a number of Air Quality Management Areas (AQMA).

Figure 3.1 shows that there are no AQMAs close to the proposed site.

Figure 3.1 Location of the Proposed Site (Blue Circle) and Air Quality Management Areas (AQMA)



Source: Barnsley MBC

3.3 MEASURED CONCENTRATION OF NITROGEN DIOXIDE (NO_2)

As part of on-going requirements to continually review and assess air quality Barnsley MBC operates an extensive monitoring network that includes both passive and continuous sampling. Monitoring sites are usually located where pollutant concentrations are expected to be at their highest and where there is relevant exposure. Monitoring sites therefore tend to get located at road side locations in urban areas.

There is only one air quality monitoring site in the region of the proposed generator which is site number DT45, Mexborough Road, Bolton upon Dearne OS grid reference 445699,402140. This monitoring site is located about 3 km south of the application site and classified as *urban background.* Given its location and classification it is considered to be representative of the prevailing concentration in the region of the development site at any location more than about 50 m from the B6411 and the A635. These two roads will give rise to elevated concentrations within a distance of about 50 m and therefore the use of background concentration would not be representative. Therefore, for receptors that are within 50 m of these two roads, this assessment very conservatively, assumes that the background annual average concentration of nitrogen dioxide (NO_2) is 5 μg m^{-3} higher than the prevailing background (urban background) away from the immediate influence of the road.

Table 3.1 shows the measured annual concentration of nitrogen dioxide (NO_2) at the *urban background* monitoring location DT45,

Table 3.1 Measured Annual Average Background Concentrations of Nitrogen Dioxide (NO_2) in Bolton upon Dearne (μg m^{-3})

Year	Measured Concentration
2012	22.6
2013	22.2
2014	23.9
2015	23.7
2016	24.1
Assessment Criteria	**40**

Source: Barnsley (June 2017) Air Quality Annual Status Report

The measured annual average concentrations of nitrogen dioxide (NO_2) are less than the Air Quality Strategy (AQS) objective of 40 μg m^{-3}.

3.4 ESTIMATED BACKGROUND CONCENTRATIONS

Defra provides estimates of the background concentration for a number of pollutants for a number of years on a 1 km grid resolution for the whole of the UK.

Table 3.2 shows the Defra estimated background concentration at the closest grid point to the location of the proposed generator in 2017 and 2020 for OS grid reference 446500,405500 which is the closest to the site.

Table 3.2 Estimated Annual Average Background Concentrations of Nitrogen Dioxide (NO_2) for 2017 and 2020 ($\mu g\ m^{-3}$)

Year	Nitrogen Dioxide (NO_2)
2017	12.2
2020	10.7
Assessment Criteria	**40**

The Defra estimate of background annual average concentration of nitrogen dioxide (NO_2) in 2017 of 12.2 μg m^{-3} is less than the Air Quality Strategy (AQS) objective of 40 μg m^{-3}. Although it is considered that the background concentration shown in **Table 3.2** provide a reasonable estimate of current concentrations in the region of the proposed generator, the concentration measured in Bolton upon Dearne during 2016 of 24.1 μg m^{-3} is conservatively used in the assessment as the prevailing background. This value is used when assessing the impact of the generators at locations more than 50 m from main roads. A value of 29.1 μg m^{-3} is used for locations within 50 m of the roads.

The impacts of emission from the four existing generators is added to the prevailing background concentration before an assessment of the incremental impact of the proposed generator is made.

It is considered that this is a very conservative approach to the prevailing background concentration in the region of the proposed generator.

4 METHODOLOGY

4.1 INTRODUCTION

This section describes the methodology and assumptions made for the air quality assessment. Also described are the emissions data used.

Four operating scenarios are modelled and assessed:

- Emissions from the existing four Deutz mine-gas engines.
- Emissions from the existing four Deutz mine-gas engines following a 3 m increase in their stack heights.
- The proposed single natural gas fuelled 2.5 MWe engine operating in isolation for a maximum of 1,000 hours per year.
- Proposed operation of the Hickleton Energy Park facility. This comprises of the operation of the four existing Deutz mine-gas engines with exhaust stack heights increased by 3 m and the proposed single natural gas fuelled 2.5 MWe operating for a maximum of 1,000 hours per year.

Actual half-hourly load data from the existing facility are available for 2015 and 2016. These have conservatively been converted to hourly data assuming that if there is any operation during either half-hour period then it is modelled as all four units are operating at full load for the whole hour. These actual emission data are then used with each of five years of meteorological data as detailed in **Table 4.1**.

Table 4.1 Emissions and Meteorological Data

Year from which Emissions Data Used	Meteorological Data Year
2016	2012
2015	2013
2016	2014
2015	2015
2016	2016

It is considered that the use of two years of actual emissions data together with five years of meteorological data will provide a realistic range of the impact of the current and proposed facility.

4.2 EMISSIONS DATA

The emissions data presented here are for the four existing Deutz mine gas engines and the single proposed 2.5 MWe natural gas fuelled engine.

Table 4.2 shows the parameters which describe the physical properties of emissions from the four existing Deutz gas engines, as required for definition of the emissions in dispersion modelling terms.

Table 4.3 shows the parameters which describe the physical properties of emissions from the proposed single natural gas fuelled engine.

Traditionally, the emissions concentrations for gas engines has been referenced to 5% O_2 (dry). However, because the emissions limits in the draft Medium Combustion Plant Directive (MCPD) are referenced to 15% O_2 (dry) **Table 4.1** and **Table 4.2** gives the emission concentration and normalised flow rates referenced to both 5% O_2 (dry) and 15% O_2 (dry).

Table 4.2 Deutz Mine-Gas Engines (1.5 MWe) Emissions and Physical Properties

Parameter	Value
Number of stacks	4
Number of Units	4
OS Grid Reference (m)	
Stack 1	446391.0, 405324.6
Stack 2	446390.8, 405320.1
Stack 3	446390.7, 405315.7
Stack 4	446390.5, 405311.4
Number of Flues per Stack	1
Existing Release Height above ground level (m)	5.4
Proposed Release Height above ground level (m)	8.4
Exit Diameter (m)	0.4
Exit Velocity (m s^{-1})	30.3
Flue Gas Emission Temperature (deg C)	525
Actual Volumetric Flow Rate (Am^3 s^{-1}) – per unit	3.8
Percentage O_2 (% v/v dry)	9.0
Percentage H_2O (% v/v)	11.3
Normalised Volumetric Flow Rate (Nm^3 s^{-1}) [(a)]	0.88
Normalised Volumetric Flow Rate (Nm^3 s^{-1}) [(b)]	2.33
Emission Concentration (mg Nm^{-3})	
Oxides of Nitrogen (NO_x as NO_2, 5% O_2)	500 [(a)]
Oxides of Nitrogen (NO_x as NO_2, 15% O_2)	189 [(b)]
Pollutant Emission Rate Per Unit (g s^{-1})	
Oxides of Nitrogen (NO_x as NO_2)	0.44
(a) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 5% v/v O_2.	
(b) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 15% v/v O_2.	

Because exact engine details are not available, the emissions data shown in **Table 4.3** are for a 2.7 MWe Jenbacher which will have similar but slightly higher emissions to the proposed 2.5 MWe engine.

Table 4.3 Natural gas Engine (2.7 MWe) Emissions and Physical Properties

Parameter	Value
Number of stacks	1
Number of Units	1
Number of Flues per Stack	1
OS Grid Reference (m)	446382.5,405344.6
Stack Height (m)	8.0
Exit Diameter (m)	0.62
Exit Velocity ($m\ s^{-1}$)	30.3
Flue Gas Emission Temperature (deg C)	400
Actual Volumetric Flow Rate ($Am^3\ s^{-1}$)	9.15
Percentage O_2 (% v/v dry)	9.0
Percentage H_2O (% v/v)	10
Normalised Volumetric Flow Rate ($Nm^3\ s^{-1}$) (a)	2.50
Normalised Volumetric Flow Rate ($Nm^3\ s^{-1}$) (b)	6.74
Emission Concentration (mg Nm^{-3}) (a)	
Oxides of Nitrogen (NO_x as NO_2, 5% O_2)	500 **(a)**
Oxides of Nitrogen (NO_x as NO_2, 15% O_2)	185 **(b)**
Pollutant Emission Rate (g s^{-1}, per unit)	
Oxides of Nitrogen (NO_x as NO_2)	1.25

(a) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 5% v/v O2.
(b) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 15% v/v O2.

4.3 RECEPTORS

Predictions are made of ground level concentrations resulting from emission to atmosphere from the facility for both a grid of receptors and at specific sensitive receptors. The grid of receptors is 500 m by 500 m with 5 m spacing.

In addition to predictions at the grid of receptors, predictions are made at 12 specific receptors which are selected to be representative of maximum impacts at residential properties. Also included are receptors at business units where exposure is likely during the working day.

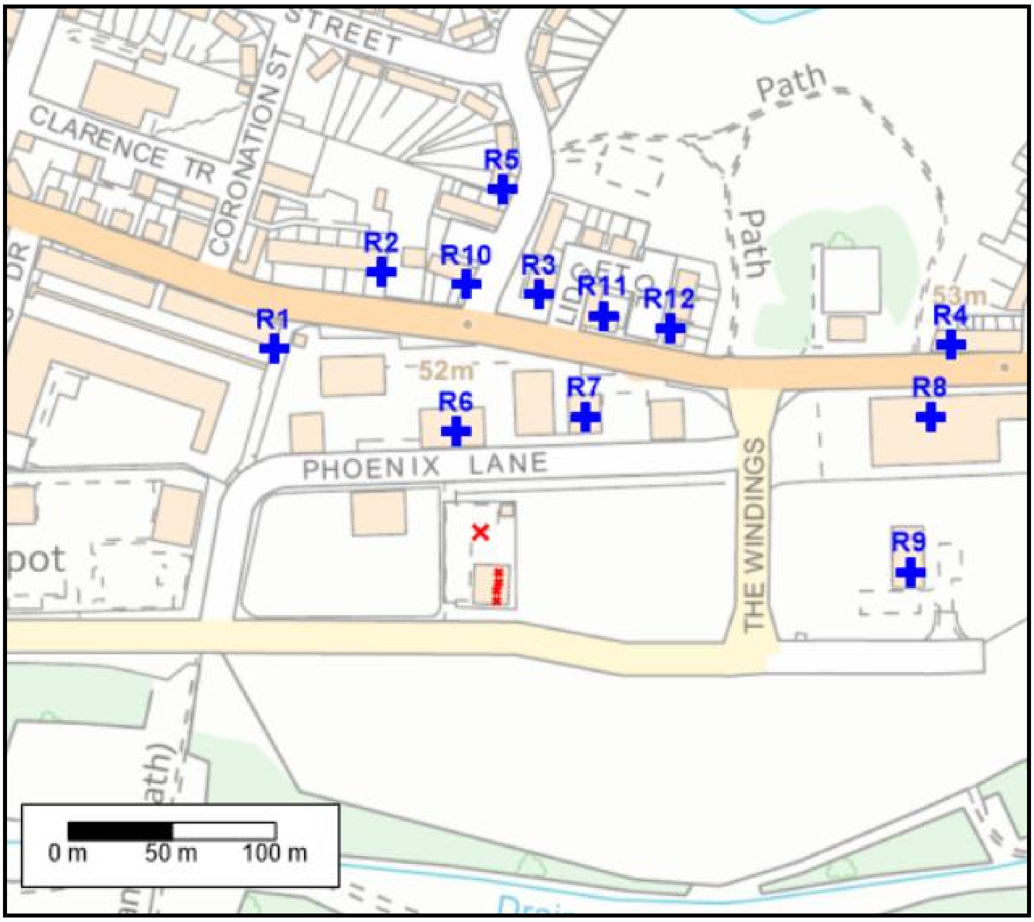
This assessment considers the effects on air quality at the closest sensitive receptors, which are presented in **Table 4.4**.

Table 4.4 Sensitive Receptors

Description		OS Grid Reference (m)	
R1	Lockwood Lane (Residential)	446283	405433
R2	Lidget Lane (Residential)	446335	405470
R3	Hall (Social)	446411	405459
R4	Vincent Terrace (Residential)	446610	405435
R5	Tudor Street (Residential)	446393	405510
R6	Thumscoa (Business Park)	446371	405393
R7	Thumscoe (Business Park)	446433	405400
R8	Thumscoa (Business Park)	446600	405400
R9	Business Park	446590	405325
R10	Lidget Lane (Residential)	446376	405464
R11	Lidget Lane (Residential)	446442	405449
R12	Lidget Lane (Residential)	446474	405443

Figure 4.1 shows the location of the selected receptors together with the location of the Hickleton Energy Park.

Figure 4.1 Location of Stacks (Red Crosses) and Specific Receptors



4.4 FACTORS AFFECTING DISPERSION

There are a number of factors that will affect how emissions disperse once released to atmosphere. The four factors having the greatest effect on dispersion are:

- physical characteristics of the emissions
- climate
- terrain
- building downwash

4.4.1 Physical Characteristics of the Emissions

Provided that exhaust gases have sufficient velocity at stack exit to overcome the effects of stack tip downwash, which is almost certainly the case for velocities of 15 m s^{-1} or more, the physical characteristics of the flue gases will determine the amount of plume rise and hence the affect on ground level pollutant concentrations. The degree of plume rise usually depends on the greater of the thermal buoyancy or momentum effects.

4.4.2 Climate

The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind speed, wind direction and atmospheric stability.

- **Wind direction** determines the broad transport of the plume and the sector of the compass into which the plume is dispersed.

- **Wind speed** can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise.

- **Atmospheric stability** is a measure of the turbulence of the air, particularly of the vertical motions present. For dispersion modelling purposes, one method of classifying stability is by the use of Pasquill Stability categories, A to F. Another is by reference to the surface heat flux present at the ground.

New generation dispersion models, such as ADMS and AERMOD PRIME, do not allocate the degree of atmospheric turbulence into six discrete categories. These models use a parameter known as the Monin-Obukhov length which, together with the wind speed, describes the stability of the atmosphere.

4.4.3 Building Downwash

The presence of buildings can significantly affect the dispersion of the atmospheric emissions. Wind blowing around a building distorts the flow and creates zones of turbulence that are greater than if the building were absent. Increased turbulence causes greater plume mixing; the rise and trajectory of the plume may be depressed generally by the flow distortion. Downwash leads to higher ground level concentrations closer to the stack than those present if the building were not there.

The building that houses the four existing Deutz engines has a sloping roof with a height that ranges from 4.1 m to 6.5 m. Because it is not possible to model a sloping roof, the building has been divided into two separate buildings of different heights. In addition to the existing building the 5.0 m high proposed generator container has also been included in the modelling.

Table 4.5 shows the details of the buildings that have been included in this assessment.

Table 4.5 Dimensions of Buildings Included in the Modelling

Building	Centre (m)		Height (m) [a]	Length (m)	Width (m)	Angle (deg) [b]
Existing	446383	405318	6.5	8.6	19.3	92.0
Existing	446392	405318	4.1	8.6	19.3	92.0
Proposed Generator Container	446388	405344	5.0	17.5	4.9	90.5

(a) Height above ground level.
(b) Angle building length makes to north.

4.4.4 NATURE OF THE SURFACE

Terrain

The effects of terrain have been included in the modelling.

Roughness

The nature of the surface of the terrain can have a significant influence on dispersion by affecting the velocity profile with height and the amount of atmospheric turbulence. To account for the surrounding nature of the proposed site, a surface roughness length of 0.4 m has been assumed for the dispersion modelling. Also, it is assumed that this roughness length for the meteorological data used in this assessment from Robin Hood Airport is 0.2 m.

4.5 SELECTION OF SUITABLE DISPERSION MODEL

The dispersion models which are widely used to predict ground level pollutant concentrations are based on the concept of the time averaged lateral and vertical concentration of pollutants in a plume being characterised by a Gaussian [(1)] distribution and the atmosphere is characterised by a number of discrete stability classes. So called 'new generation' dispersion models have been developed which replace the description of the atmospheric boundary layer as being composed of discrete stability classes with an infinitely variable

(1) A Gaussian distribution has the appearance of a bell-shaped curve. The maximum concentration occurs on the centre line.

measure of the surface heat flux, which in turn influences the turbulent structure of the atmosphere and hence the dispersion of a plume.

There are two commercially available dispersion models that are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources (ie stacks), and are described by the Environment Agency as being 'new generation'.

- AERMOD: The US **A**merican Meteorological Society and **E**nvironmental Protection Agency **R**egulatory Model Improvement Committee developed the dispersion **MOD**del called AERMOD which incorporates the latest understanding of the atmospheric boundary layer.

- Atmospheric Dispersion Modelling System (ADMS): This dispersion model was developed by the UK consultancy CERC. The model allows for the skewed nature of turbulence within the atmospheric boundary layer.

In many respects the models are quite similar and in some situations, generate similar predictions of ground level concentrations.

ADMS 5.2 was selected as the model for use in this assessment because it has been extensively used for assessment work of this nature.

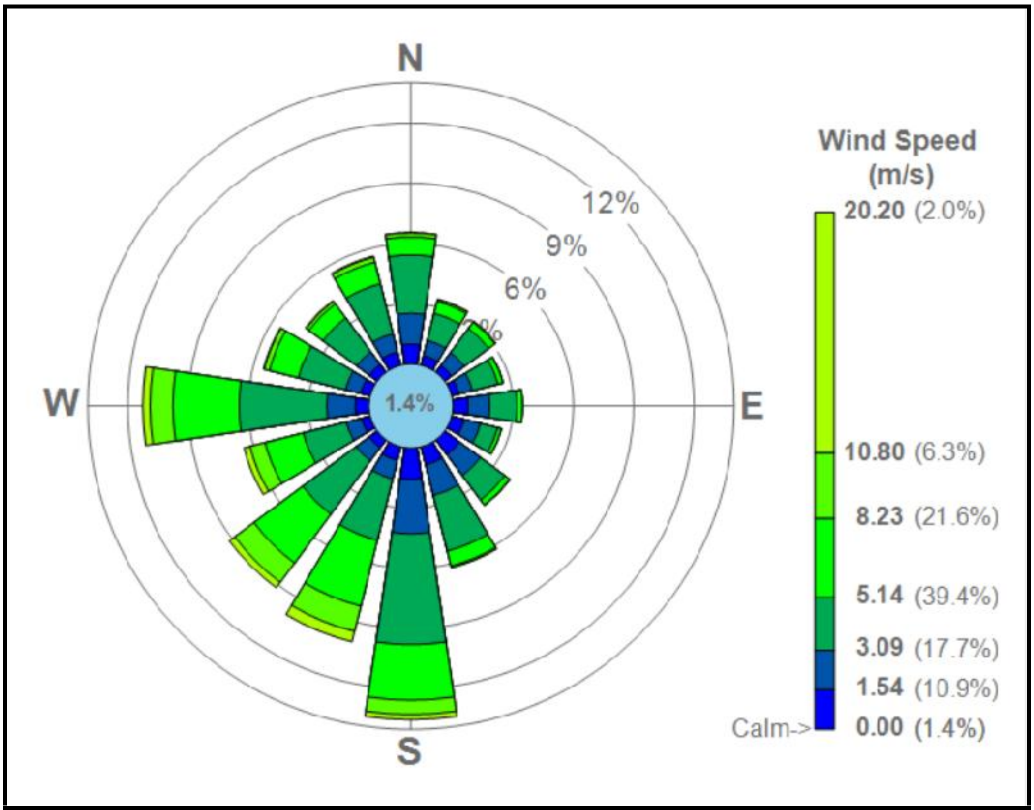
4.6 METEOROLOGICAL DATA

An important input to the dispersion model is the meteorological data. These data are important in determining the location of the maximum concentrations and their magnitude.

The closest observing station where data is available is Doncaster-Sheffield/Robin Hood airport which is 21 km away and considered to be representative of the location of the proposed development.

Figure 4.2 shows the windrose for Rostherne for 2012-2016, used in this assessment which shows that the prevailing wind direction is from the south-west.

Figure 4.2 Wind Rose from Robin Hood Airport (2012-2016)



4.7 PERCENTAGE OXIDATION OF NITRIC OXIDE (NO) TO NITROGEN DIOXIDE (NO_2)

Oxides of nitrogen (NO_x) emitted to atmosphere as a result of gas combustion will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, nitric oxide is oxidised to nitrogen dioxide (NO_2), which is of concern with respect to health and other impacts. The proportion of nitric oxide oxidised to nitrogen dioxide depends on a number of factors and the oxidation is limited by the availability of oxidants, such as ozone (O_3).

An oxidation of 35% has been assumed for oxidation of nitric oxide (NO) to nitrogen dioxide (NO_2) for short-term concentrations. For predictions of annual averages, it is assumed that 70% of the oxides of nitrogen (NO_x) are in the form of nitrogen dioxide (NO_2). These assumptions are recommended by the Environment Agency (EA) [(1)].

(1) Environment Agency (AQMAU): Conversion Ratios for NO_x and NO_2.

5 PREDICTIONS AND ASSESSMENT OF IMPACTS

5.1 INTRODUCTION

This section presents the predicted ground level concentrations of nitrogen dioxide (NO_2) occuring as a result of the existing and proposed operation of the Hickleton Energy Park.

The assessment is undertaken using two years of actual emissions data and five years of meteorological data.

5.2 PREDICTED IMPACT

Modelling was undertaken assuming full load operation for each of the three years of meteorological data. This showed that the use of 2015 meteorological data gives rise to the highest impact and this has therefore been used for this assessment.

The principal pollutant released to atmosphere from the proposed development is the oxides of nitrogen (NO_x) which will progressively oxidise to nitrogen dioxide (NO_2) in the atmosphere. **Table 5.1** shows the predicted annual average ground level concentration of nitrogen dioxide (NO_2) occurring as a consequence of emissions to atmosphere from the existing generators, both with and without the proposed 3 m increase in exhaust height, together with the proposed generator in isolation and the total impact. Predictions are presented for the year of meteorological data that gives rise to the maximum impact.

Table 5.1 ADMS 5.2 Predicted Annual Average Ground Level Concentration of Nitrogen Dioxide, Maximum for Five Years of Meteorological Data (NO_2, $\mu g\ m^{-3}$)

Receptor		Existing (Four Units)	Existing with Increase in Height of 3 m	Proposed 2.5 MW Generator (in Isolation)	Existing (+ 3m) + Proposed	Change
R1	Lockwood Lane	0.9	0.7	0.3	1.1	0.1
R2	Lidget Lane	1.1	1.0	0.5	1.5	0.3
R3	Hall	1.6	1.4	0.8	2.2	0.5
R4	Vincent Terrace	0.7	0.6	0.3	0.9	0.2
R5	Tudor Street	1.0	0.9	0.5	1.4	0.4
R6	Thumscoa	3.2	2.0	0.8	2.8	-0.5
R7	Thumscoe	3.6	2.8	1.3	4.1	0.5
R8	Thumscoa	0.7	0.7	0.3	1.0	0.2
R9	Business Park	0.9	0.8	0.4	1.2	0.3
R10	Lidget Lane	1.4	1.1	0.7	1.8	0.4
R11	Lidget Lane	1.8	1.5	0.9	2.4	0.6
R12	Lidget Lane	1.7	1.5	0.8	2.3	0.6
Grid Maximum		**31.9**	**4.9**	**1.5**	**5.5**	**-26.4**
Assessment Criteria				**40**		

Table 5.1 shows the following:

- At the point of maximum impact, increasing the stack height of the four existing generators by 3 m substantially reduces the predicted annual average ground level concentration nitrogen dioxide (NO_2). The reduction at the specific receptors is less marked.

- The contribution to annual average ground level concentrations due to emissions from the proposed generator at the specific receptors is in the range of 0.3 μg m^{-3} to 1.3 μg m^{-3}. This reduces to an increase in the range of -0.5 μg m^{-3} to 0.6 μg m^{-3} when the cumulative beneficial effects of the increase in the stack heights is included. These predictions can be compared to the Air Quality Strategy (AQS) objective of 40 μg m^{-3}

It should be noted that these predictions are for the year of meteorological data that gives rise to the highest impact.

Table 5.2 shows the predicted 99.8th percentile of hourly average ground level concentration of nitrogen dioxide (NO_2) occurring as a consequence of emissions to atmosphere from the existing generators, both with and without the proposed 3 m increase in exhaust height. Predictions are presented for the year that gives rise to the maximum impact out of five years of meteorological data

Table 5.2 ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Ground Level Concentration of Nitrogen Dioxide, Maximum for Five Years of Meteorological Data (NO_2, μg m^{-3})

Receptor		Existing (Four Units)	Existing with Increase in Height of 3 m	Proposed 2.5 MW Generator (in Isolation)	Existing (+ 3m) + Proposed	Change
R1	Lockwood Lane	40.8	36.2	17.9	51.7	10.9
R2	Lidget Lane	35.9	31.2	21.0	49.7	13.8
R3	Hall	41.2	35.1	24.3	57.1	15.9
R4	Vincent Terrace	20.1	18.4	10.3	27.3	7.2
R5	Tudor Street	27.5	23.7	16.0	38.9	11.4
R6	Thumscoa	96.7	72.3	45.0	112.6	15.9
R7	Thumscoe	77.4	62.0	41.3	90.2	12.8
R8	Thumscoa	23.3	20.6	10.8	30.1	6.7
R9	Business Park	27.1	24.7	12.4	35.0	7.9
R10	Lidget Lane	40.2	32.9	23.1	53.4	13.3
R11	Lidget Lane	42.5	37.0	24.4	55.9	13.3
R12	Lidget Lane	41.2	36.2	21.9	51.7	10.6
Grid Maximum		**387.6**	**132.4**	**68.8**	**158.3**	**-229.3**
Assessment Criteria				**200**		

Table 5.2 shows the following:

- At the point of maximum impact, increasing the stack height of the four existing generators by 3 m substantially reduces the predicted 99.8th percentile of hourly average ground level concentration nitrogen dioxide (NO_2). The reduction at the specific receptors is less marked.

- The predicted 99.8th percentile of hourly average due to emissions from the proposed generator at the specific receptors is in the range of 10.3 μg m^{-3} to 45.0 μg m^{-3}. This reduces to an increase in the range of 6.7 μg m^{-3} to 15.9 μg m^{-3} when the cumulative beneficial effects of the increase in the stack heights of the existing generators is included. These predictions can be compared to the Air Quality Strategy (AQS) objective of 200 μg m^{-3}

The predictions presented in **Table 5.1** and **Table 5.2** show that emissions of the oxide of nitrogen (NO_x) from the proposed generator do not give rise to exceedence of the Air Quality Strategy (AQS) objectives and are therefore not of concern to human health. The predictions also show that at the point of maximum impacts the proposed development, which includes an increase in the existing stack heights by 3 m gives rise to a substantial reduction in ground level concentrations of nitrogen dioxide (NO_2).

To determine the significance of emissions from the proposed development (ie new generator and increase in existing stack heights) the IAQM guidance on significance is used (1).

The IAQM significance criteria are applicable to locations where there is relevant exposure and are only applicable to annual average concentrations. Defra TG16 guidance gives the following examples of where there is relevant exposure to annual average objectives (2).

- Building facades of residential properties
- Schools
- Hospitals
- Care homes

Examples given of where there is not relevant exposure to annual average objectives include; gardens of residential properties, hotels, offices and kerbside sites.

Table 5.3 shows the IAQM significance criteria applied to the 7 locations where there is relevant exposure to annual average objectives.

(1) Environmental Protection UK/IAQM (May 2015) Land-Use Planning& Development Control: Planning for Air Quality.
(2) DEFRA (April 2016) Local Air Quality Management, Technical Guidance LAQM TG16.

Table 5.3 IAQM Significance Criteria; Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$)

No.	Description	Predicted Increment[a]	Increase %age of Objective	Process Contribut-ion [b]	Back-ground [c]	PEC [d]	PEC %age of Objective [e]	Impact Descriptor
R1	Lockwood	0.14	0%	1.06	29.1	30.2	75.4%	Negligible
R2	Lidget Lane	0.33	1%	1.48	29.1	30.6	76.4%	Negligible
R3	Hall	0.53	1%	2.16	29.1	31.3	78.2%	N/A
R4	Vincent Ter	0.23	1%	0.90	29.1	30.0	75.0%	Negligible
R5	Tudor Street	0.42	1%	1.40	24.1	25.5	63.7%	Negligible
R6	Thumscoa	-0.48	-1%	2.75	24.1	26.9	67.1%	N/A
R7	Thumscoe	0.48	1%	4.10	29.1	33.2	83.0%	N/A
R8	Thumscoa	0.24	1%	0.99	29.1	30.1	75.2%	N/A
R9	Business Pk	0.28	1%	1.18	24.1	25.3	63.2%	N/A
R10	Lidget Lane	0.40	1%	1.80	29.1	30.9	77.3%	Negligible
R11	Lidget Lane	0.59	1%	2.42	29.1	31.5	78.8%	Negligible
R12	Lidget Lane	0.60	1%	2.35	29.1	31.4	78.6%	Negligible

(a) Increase due to new generator plus four existing units with 3 m increase in stack height.
(b) New generator plus four existing units with 3 m increase in stack height (ie no background).
(c) Background (ie with no contribution from the Energy Park).
(d) Predicted Environmental Concentration (PEC); predicted increment from whole facility, PC + background
(e) Air Quality Strategy (AQS) Objective, 40 $\mu g\ m^{-3}$.

Table 5.3 shows that at all the locations where the is relevant exposure the significance of the annual average impact is Negligible.

For determining the total annual average concentration it is correct to add the predicted increment to the prevailing background, this is not the case for the 99.8th percentile.

The Environment Agency's H1 Technical Guidance states:

PEC short term = PC short term + (2 x Background long term)

where PC is the Process Contribution and PEC is the Predicted Environmental Concentration.

Table 5.4 shows the predicted 99.8th percentile concentration at the specific receptors for the predicted increase due to the proposed development (which includes the increase in stack heights for the existing generators) together with the total short-term impact (emissions from the whole energy park plus background) and with the significance criteria. The reason for the inclusion of the grid maximum in **Table 5.4** and not in **Table 5.3** is that impacts at the location of maximum impact is relevant exposure for short term impacts but not long term impacts.

Table 5.4 **ADMS 5.2 Predicted 99.8th Percentile Concentration of Nitrogen Dioxide (NO_2, $\mu g\ m^{-3}$) (a)**

No.	Description	Predicted Increment (a)	Increase %age of Objective	Process Contribut-ion (b)	PEC (c)	Impact Descriptor
R1	Lockwood Ln	10.9	5.5%	51.7	109.9	Negligible
R2	Lidget Lane	13.8	6.9%	49.7	107.9	Negligible
R3	Hall	15.9	7.9%	57.1	115.3	Negligible
R4	Vincent Ter	7.2	3.6%	27.3	85.5	Negligible
R5	Tudor Street	11.4	5.7%	38.9	87.1	Negligible
R6	Thumscoa	15.9	8.0%	112.6	160.8	Negligible
R7	Thumscoe	12.8	6.4%	90.2	148.4	Negligible
R8	Thumscoa	6.7	3.4%	30.1	88.3	Negligible
R9	Business Park	7.9	4.0%	35.0	83.2	Negligible
R10	Lidget Lane	13.3	6.6%	53.4	111.6	Negligible
R11	Lidget Lane	13.3	6.7%	55.9	114.1	Negligible
R12	Lidget Lane	10.6	5.3%	51.7	109.9	Negligible
Grid Maximum		-229.3	-114.6%	158.3	158.3	Substantial (beneficial)

(a) Increase due to new generator plus four existing units with 3 m increase in stack height.
(b) New generator plus four existing units with 3 m increase in stack height.
(c) Predicted Environmental Concentration (PEC); predicted increment from whole facility, PC + background.
(d) Air Quality Strategy (AQS) Objective, 200 $\mu g\ m^{-3}$.

Table 5.4 shows that the maximum increase in predicted 99.8th percentile of hourly average nitrogen dioxide (NO_2) concentration as a result of the proposed development (new generator plus 3 m extension to existing stacks) is at the most 15.9 $\mu g\ m^{-3}$, 8% of the objective which is negligible impact.

At the point of maximum impact (and at locations close to it) the modelling predicts that there will be a substantial improvement in the short-term impacts of emissions from the Hickleton Energy Park as a consequence of the proposed development. This improvement is a direct consequence of the proposed increase in the stack heights of the four existing generators.

Tables 5.1 to 5.4 show that at the specific receptors, the predicted increase in the concentration of nitrogen dioxide (NO_2) occurring due to emissions from the proposed generator are negligible compared to the assessment criteria and are not of concern to human health. In addition, there is a substantial beneficial impact for short term concentrations at and close to the point of maximum impact.

The following figures are presented to illustrate the distribution of concentrations of the nitrogen dioxide (NO_2). Predictions are presented for 2014 meteorological data as this is the year that gives rise to the highest predicted concentration.

- **Figure 5.1;** Annual Average, Existing Facility
- **Figure 5.2;** Annual Average, Existing Facility with 3 m Stack Extensions

- **Figure 5.3;** Annual Average, Proposed Generator (in isolation)
- **Figure 5.4**; Annual Average, Proposed Generator + Existing Facility with 3 m Stack Extension
- **Figure 5.5;** 99.8th percentile of hourly averages, Existing Facility
- **Figure 5.6;** 99.8^{th} percentile of hourly averages, Existing Facility with 3 m Stack extensions
- **Figure 5.7;** 99.8^{th} percentile of hourly averages, Proposed Generator (in isolation)
- **Figure 5.8**; 99.8^{th} percentile of hourly averages, Proposed Generator + Existing Facility with 3 m Stack Extension

The figures show the maximum predicted increments/contribution to ground level concentrations occur within about 100 m of the Energy Park and is very localised.

Figure 5.1 ADMS 5.2 Predicted Annual Average Ground Level Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Existing Facility

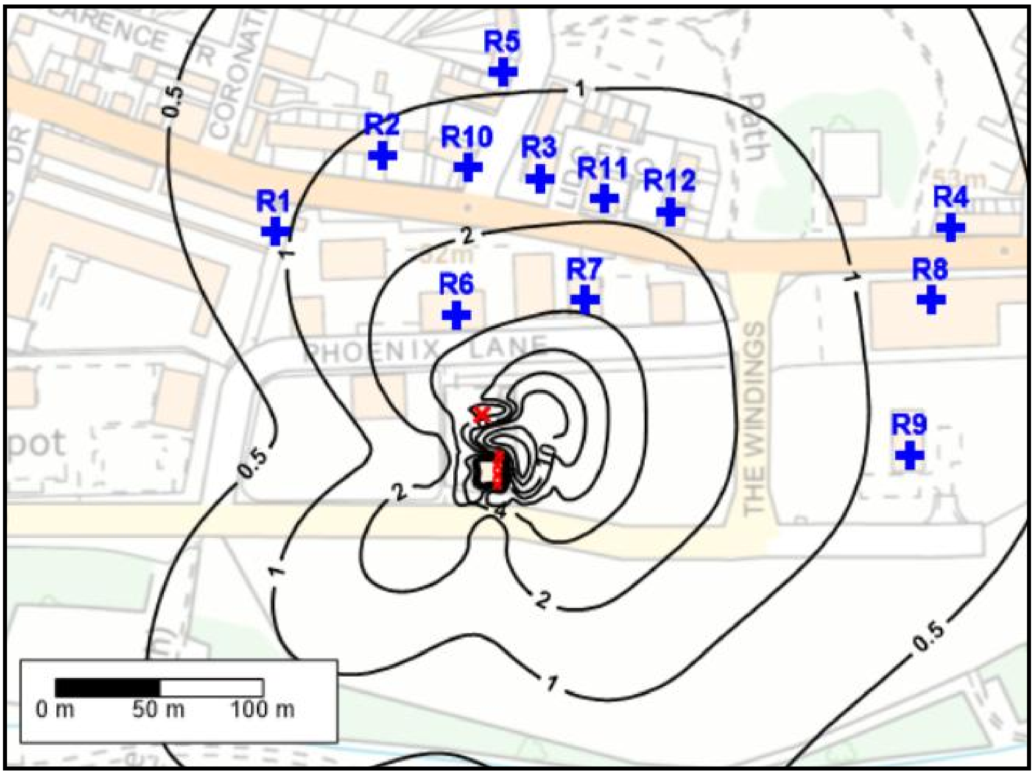


Figure 5.2 ADMS 5.2 Predicted Annual Average Ground Level Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Existing Facility with 3 m Stack Extensions

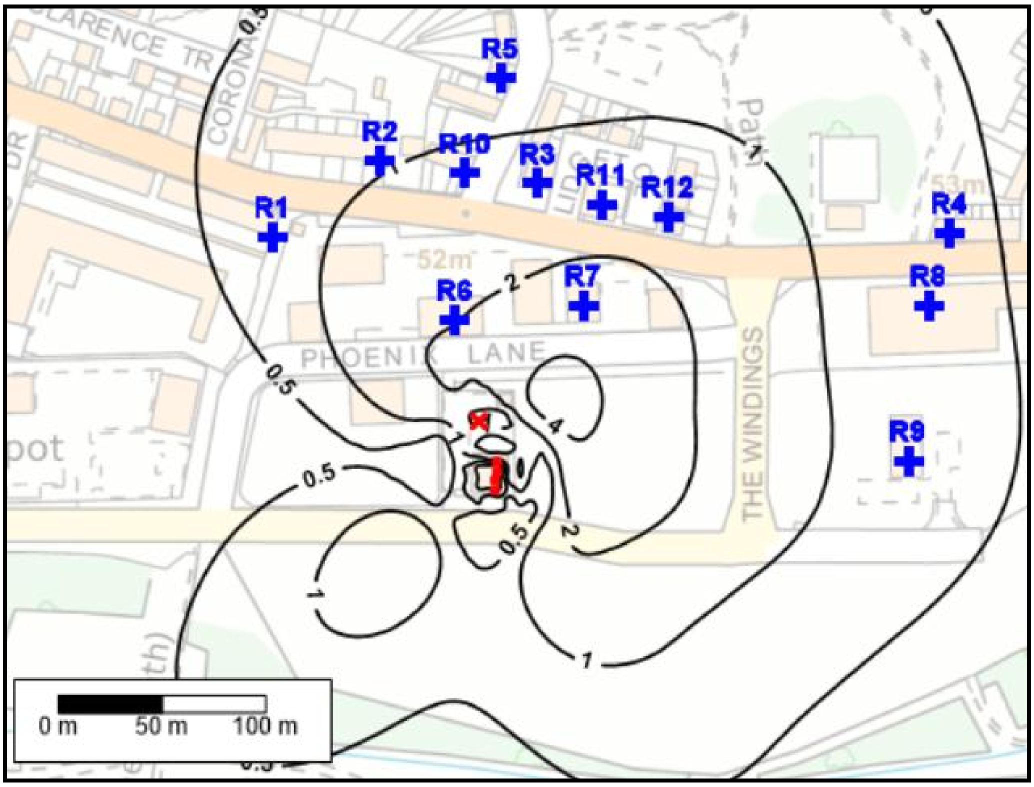


Figure 5.3 **ADMS 5.2 Predicted Annual Average Ground Level Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Proposed Generator (In Isolation)**

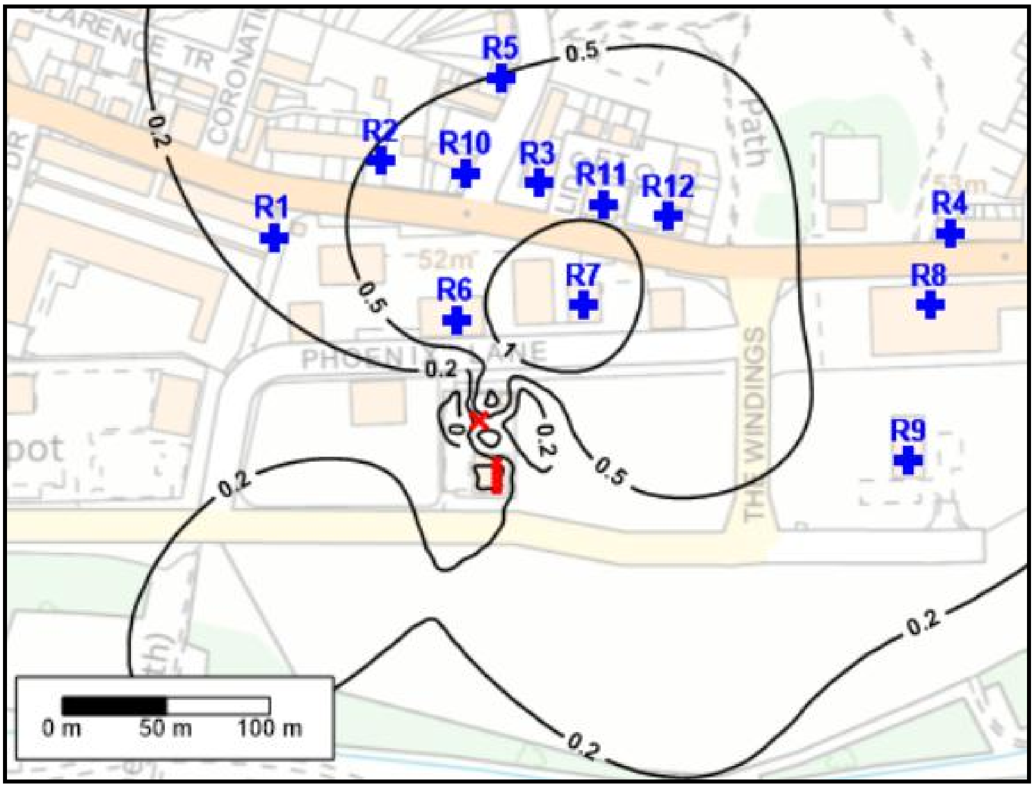


Figure 5.4 **ADMS 5.2 Predicted Annual Average Ground Level Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Existing Facility (3 m Extensions) + Proposed Generator**

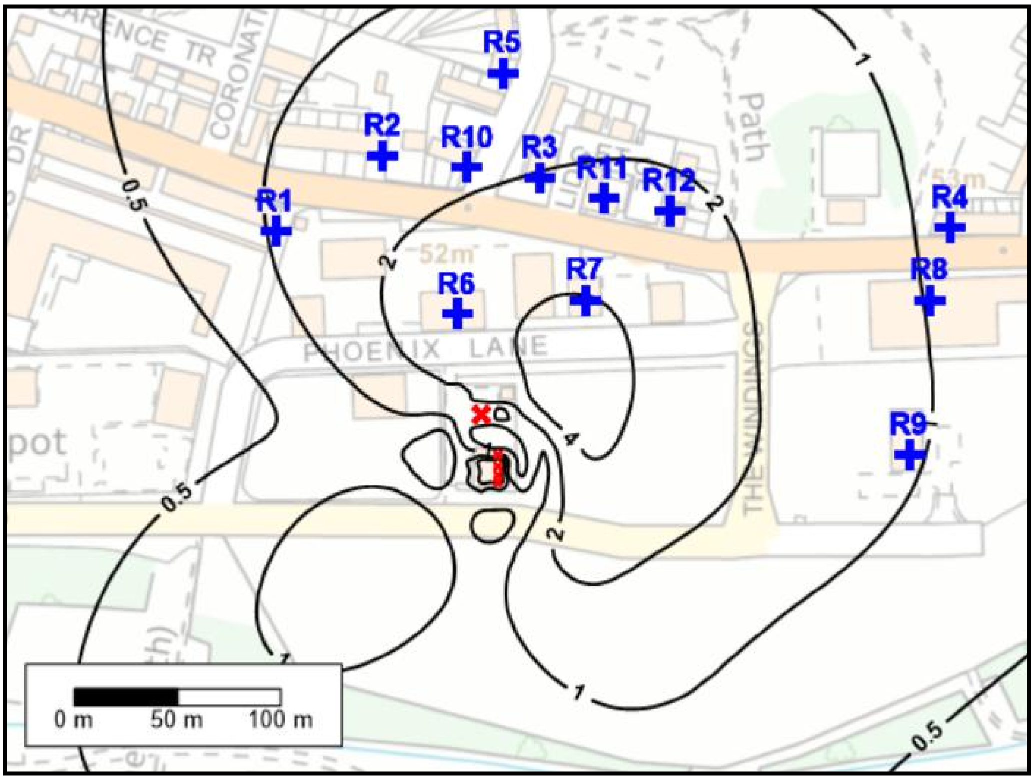


Figure 5.5 **ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data (μg m^{-3}); Assuming 70% Oxidation, Existing Facility**

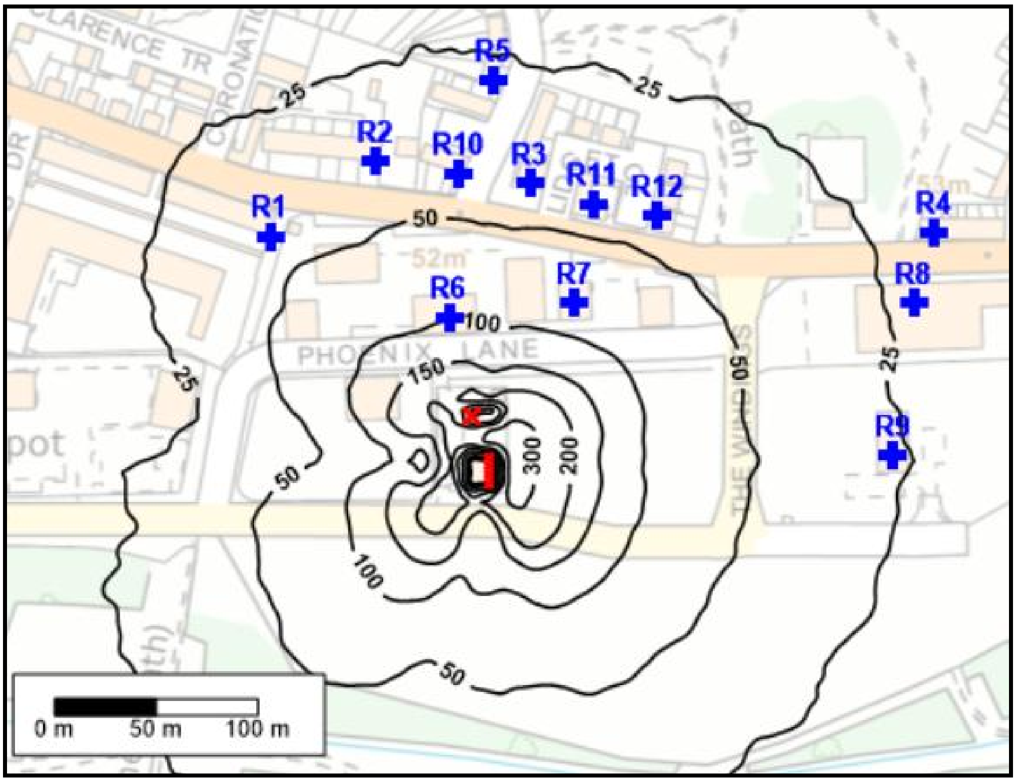


Figure 5.6 **ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data (μg m^{-3}); Assuming 70% Oxidation, Existing Facility with 3 m Stack Extensions**

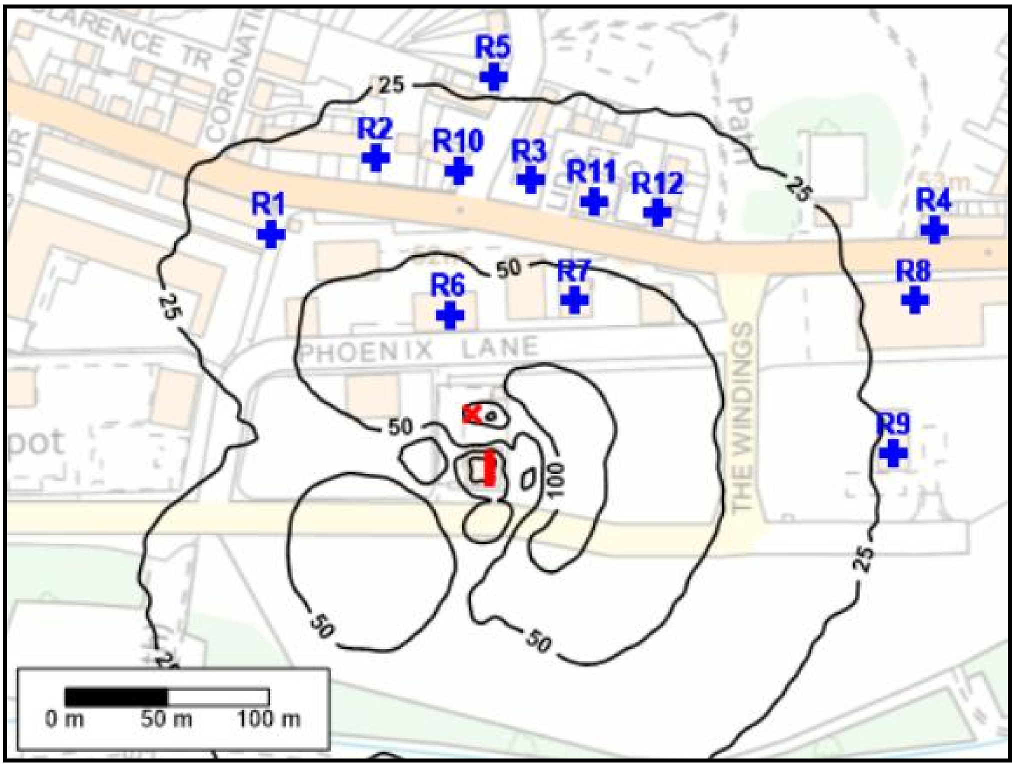


Figure 5.7 **ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Proposed Generator (In Isolation)**

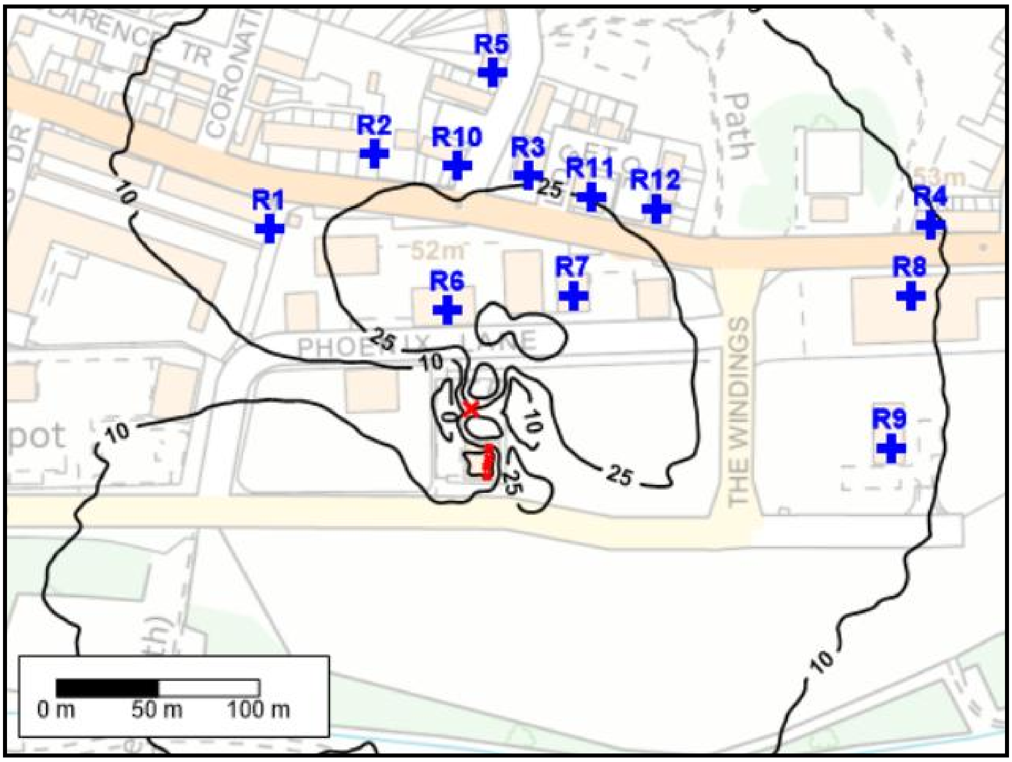
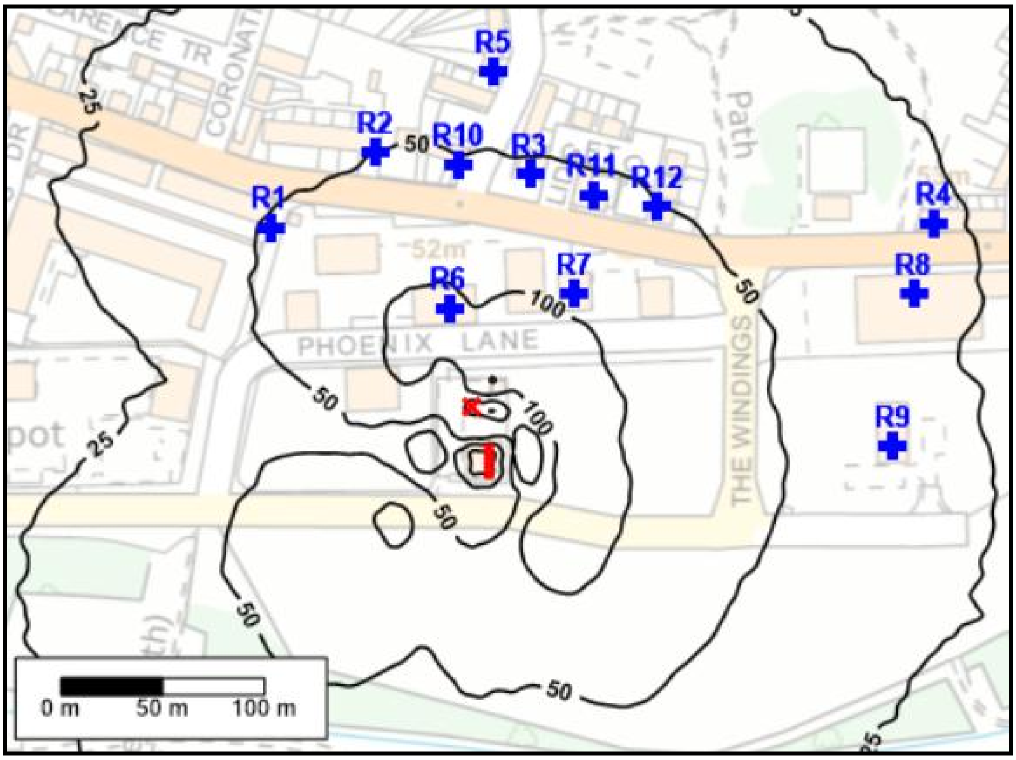


Figure 5.8 **ADMS 5.2 Predicted 99.8th Percentile of Hourly Average Concentration of the Nitrogen Dioxide (NO_2); 2014 Meteorological Data ($\mu g\ m^{-3}$); Assuming 70% Oxidation, Existing Facility (3 m Extensions) + Proposed Generator**



6 SUMMARY AND CONCLUSIONS

Alkane Energy UK Ltd (Alkane) commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an air quality assessment of the impacts on human health occurring due to emissions to atmosphere from the proposed containerised standby gas fuelled generator to be located on the Hickleton Energy Park, off Barrowfield Road, Thurnscoe, Rotherham, S63 0BH

The proposal is for a single 2.5 MWe unit fuelled by natural gas. This additional unit will operate together with the existing four Deutz mine-gas engines and only when required by the national grid and are expected to operate for no more than 1,000 hours per year.

Currently, the exhausts for the four existing generators only extends 0.2 m to 0.3 m above the roof and therefore the emissions to atmosphere from these generators is subject to poor dispersion resulting in elevated ground level pollutant concentrations. As part of the proposal for the additional generator the heights of the four existing generator exhausts will be increased by 3 m.

The following are the principal conclusions that can be drawn from this assessment, which has been undertaken using the emissions data provided and the assumptions specified:

- The increase in the stack height of the existing four generators by 3 m is predicted to lead to a substantial improvement in dispersion and corresponding reduction in pollutant ground level concentrations.

- The proposed generator, together with the increase in stack height of the existing generators, is predicted to rise to an impact of negligible significance at the specific receptors.

- At, and close to the point of the maximum impact, the proposed generator together with the increase in stack height of the existing generators is predicted to give rise to a substantial improvement in air quality.

It is considered that the overall impact on air quality of emissions to atmosphere from the proposed generator and the 3 m increase in stack height for the existing generators is beneficial to air quality.