Porter, Karen

From: Peter White <peter.white@watsonbatty.com>
Sent: 20 May 2015 09:07
To: Porter, Karen
Cc: Branson, Steve
Subject: WMS Spalding- Fuel Oil to Energy
Attachments: 150306 406 01490 00020_Morrison Spalding_Air Quality Assessment_v2.pdf; B3995 20150420 R.PDF

Good morning Karen,
Please find attached an air quality report and noise report in relation to the above recent application.
For your information.

Site contact details: James Hutchinson (07720) 805172

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For and on behalf of
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SLR
global environmental solutions

Spalding Fuel Oil to Energy Project

Wm Morrison Supermarkets PLC

Air Quality Assessment

SLR Ref : 406-01490-00020

May 2015

MORRISONS

Version: Rev 1

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1.0 INTRODUCTION

SLR Consulting Ltd has been commissioned to prepare an Air Quality Assessment on behalf of Wm Morrison Supermarkets PLC. This Air Quality Assessment presents the atmospheric dispersion assessment undertaken in support of the planning application for a proposed energy plant at the Spalding site in Lincolnshire.

1.1 Brief Project Description

The proposed plant will be located to the north of the existing main building on Enterprise Way approximately 2 km north of Spalding. The proposals for the development comprise two 1.5 MW engines and one 1 MW engine, all contained within purpose built containers. The exhausts from the engines will pass through a waste heat boiler which will use the excess heat to provide hot water and compressed air for the site.

The main fuel for the engines will be tallow oil derived on site from animal processing, with fuel oil used during the start up.

1.2 Scope and Objectives

The scope of this assessment is specifically concerned with combustion emissions to air from the proposed energy plant. The scope of the assessment incorporates:

- a review of relevant legislation and guidance;
- a review of baseline conditions at the site; and
- assessment using atmospheric dispersion modelling of emissions associated with the energy plant.

The objective of the assessment is to determine the potential impact of emissions from the proposed facility on the air quality environment by comparison to Air Quality Standards for the protection of human health and the environment.

1.3 Report Structure

The remainder of the report is structured as follows:

- Section 2 details the relevant guidance and environmental quality standards;
- Section 3 describes the baseline environment with regard to sensitive receptors and prevailing meteorological conditions;
- Section 4 summarises the emissions to air and describes the overall assessment methodology;
- Section 5 details the results of the dispersion modelling; and
- Section 6 concludes the assessment.

2.0 POLICY, LEGISLATION AND GUIDANCE

2.1 The Air Quality Strategy

The UK Air Quality Strategy[1] (UK AQS) sets out a comprehensive strategic framework within which air quality policy will be taken forward in the short to medium term, and the roles that Government, industry, the Environment Agency (EA), local government, business, individuals and transport have in protecting and improving air quality.

The UK AQS contains air quality objectives based on the protection of both human health and vegetation (ecosystems) and have been set taking into account the air quality standards defined in the Air Quality Standards Regulations[2].

The UK AQS includes more exacting objectives for some pollutants than those required by EC legislation. This air quality assessment refers only to UK Air Quality Standards, as compliance with these standards will also ensure that the less demanding European Air Quality limit values would also be met.

The AQS objectives and standards relevant to this assessment are presented in Table 2-1.

Table 2-1
Relevant Air Quality Strategy Standards and Objectives

Pollutant	Standard ($\mu g/m^3$)[A]	Measured as	Equivalent percentile
Nitrogen dioxide (NO_2)	40	Annual mean	-
	200	1-hour mean	99.79th percentile of 1-hour means (equivalent to 18 1-hour exceedences)
Carbon monoxide (CO)	10,000	8-hour mean	100th percentile of 8-hour running means
Particulate matter with an aerodynamic diameter of less than 10µm (PM_{10}) (gravimetric)	40	Annual mean	-
	50	24-hour mean	90.41st percentile of 24-hour means (equivalent to 35 24-hour exceedences)
Particulate matter with an aerodynamic diameter of less than 2.5µm ($PM_{2.5}$) (gravimetric)	25	Annual mean	-
Sulphur dioxide (SO_2)	266	15-minute mean	99.9th percentile of 15-minute means (equivalent to 35 15-minute exceedences)
	350	1-hour mean	99.73th percentile of 1-hour means (equivalent to 24 1-hour exceedences)
	125	24-hour mean	99.18th percentile of 24-hour means (equivalent to 3 24-hour exceedences)

Note A: $\mu g/m^3$ – micrograms per cubic meter

1 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, DEFRA. July 2007.
2 Statutory Instrument 2010 No. 1001, The Air Quality Standards Regulations, 11th June 2010.

In accordance with the Department for Environment, Food and Rural Affairs (DEFRA) technical guidance on Local Air Quality Management (LAQM.TG(09)), the air quality objectives should be assessed at locations where members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. A summary of relevant exposure for the objectives presented in Table 2-1 are shown below in Table 2-2.

Table 2-2
Relevant Public Exposure

Objective Averaging Period	Relevant Locations	Objectives Should Apply At:	Objectives Should Not Apply At:
Annual mean	Where individuals are exposed for a cumulative period of 6 months in a year	Building facades of residential properties, schools, hospitals etc	Facades of offices Hotels Gardens of residences Kerbside sites
24-hour and 8-hour mean	Where individuals may be exposed for eight hours or more in a day	As above together with hotels and gardens of residential properties	Kerbside sites where public exposure if expected to be short-term
1-hour mean	Where individuals might reasonably expected to spend one hour or longer	As above together with kerbside sites of regular access, car parks, bus stations etc	Kerbside sites where public would not be expected to have regular access

2.2 Environmental Permitting Regulations and Guidance

Emissions to air from the installation will be controlled under the Environmental Permitting (EP) (England and Wales) Regulations by the EA. Guidance has been produced by the EA to assist operators to assess risks to the environment and human health when applying for a permit under the EP Regulations; these include both over arching 'horizontal' guidance and sector specific guidance. Horizontal Guidance Note H1 - Environmental risk assessment for permits[3] has been consulted in undertaking this assessment.

Annex F[4] of the H1 Guidance Note is specifically concerned with emissions to air and the process of carrying out a bespoke risk assessment. Included in Annex F of the H1 Guidance Note are Environmental Assessment Levels (EALs) for protection of human health and the environment and screening distances for habitat sites.

2.3 Critical Levels and Critical Loads

There are many areas in the UK which have been designated by a variety of UK and International bodies as being worthy of protection. These sites will contain species, communities or other receptors which will be sensitive to pollution for which indicative exposure thresholds for their protection have been defined. These thresholds are known as Critical Levels (for airborne concentrations) and Critical Loads (for deposition rates).

2.3.1 Critical Levels

Critical levels are a quantitative estimate of exposure to one or more airborne pollutants in gaseous form, below which significant harmful effects on sensitive elements of the

[3] Environment Agency, Horizontal Guidance Note H1 - Environmental risk assessment for permits v2.1 (April 2010).
[4] Environment Agency H1 Environmental Risk Assessment – annex f v2.2, December 2011.

environment do not occur, according to present knowledge. Critical levels for the protection of vegetation and ecosystems are specified within relevant European air quality directives and corresponding UK air quality regulations (see Table 2-3).

Table 2-3
Critical Levels for the Protection of Vegetation and Ecosystems

Pollutant	Concentration (µg/m^3)	Measured as
Nitrogen oxides	30	Annual mean
	75	Daily mean
Sulphur dioxide	20	Annual mean

2.3.2 Critical Loads

Critical loads are a quantitative estimate of exposure to deposition of one or more pollutants, below which significant harmful effects on sensitive elements of the environment do not occur, according to present knowledge. Critical loads are set for the deposition of various substances to sensitive ecosystems. In relation to combustion emissions critical loads for eutrophication and acidification are relevant which can occur via both wet and dry deposition; however on a local scale only dry (direct deposition) is considered significant[5].

Empirical critical loads for eutrophication (derived from a range of experimental studies) are assigned based for different habitats, including grassland ecosystems, mire, bog and fen habitats, freshwaters, heathland ecosystems, coastal and marine habitats, and forest habitats and can be obtained from the UK Air Pollution Information System (APIS) website (www.apis.ac.uk/). The critical loads for nitrogen and acid deposition are presented in Section 3.4.

2.4 Local Air Quality Management

Part IV of the Environment Act 1995 requires local authorities to periodically review and assess the quality of air within their administrative area. The reviews have to consider the present and future air quality and whether any air quality objectives prescribed in regulations are being achieved or are likely to be achieved in the future.

Where any of the prescribed air quality objectives are not likely to be achieved the authority concerned must designate an Air Quality Management Area (AQMA). For each AQMA the local authority has a duty to draw up an Air Quality Action Plan (AQAP) setting out the measures the authority intends to introduce to deliver improvements in local air quality in pursuit of the air quality objectives.

Defra has published technical guidance for use by local authorities in their review and assessment work[6]. This guidance, referred to in this report as LAQM.TG(09), has been used where appropriate in the assessment presented here.

5 Environment Agency, AQTAG 06, Technical Guidance on detailed modelling approach for an appropriate assessment for emissions to air, updated version, March 2014.

6 Department for Environment, Food and Rural Affairs (DEFRA): Local Air Quality Management Review and Assessment Technical Guidance LAQM.TG(09), 2009.

2.5 Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM) Guidance

EPUK and the IAQM have together published guidance[7] to help ensure that air quality is properly accounted for in the development control process. It clarifies when an air quality assessment should be undertaken, what it should contain, and how impacts should be described and assessed. Importantly, it sets out a recommended approach to assess the significance of impacts.

The guidance also states that best-practice design and operational measures should be recommended and applied to all developments that require an Air Quality Assessment, to reduce emissions and human exposure to poor air quality. This guidance has been used to provide a description of the impacts of the development on local air quality.

2.6 Planning Policy

2.6.1 National Policy

The National Planning Policy Framework (NPPF) was formally adopted on 27th March 2012 and describes the policy context in relation to pollutants, including atmospheric pollution:

> *"The Government's objective is that planning should help to deliver a healthy natural environment for the benefit of everyone and safe places which promote wellbeing.*
>
> *To achieve this objective, the planning system should aim to conserve 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 land, air, water or noise pollution or land instability."*

Where pollution is defined as:

> *"Any consideration of the quality of land, air, water, soils, which might lead to an adverse impact on human health, the natural environment or general amenity. Pollution can arise from a range of emissions, including smoke, fumes, gases, dust, steam and odour."*

The policies within the NPPF in relation to air pollution are considered within this Air Quality Assessment.

2.6.2 Local Policy

The South Holland Local Plan was adopted in July 2006. The plan sets out the SHDC planning policies for the development and use of land in the District until the year 2021.

One of the general policies, SG13 – Pollution and Contamination, sets out to protect occupiers and neighbours of proposed developments from the harmful effects of pollution. The policy states

> *"Planning permission will only be permitted for development proposals which:*

[7] Environmental Protection UK and Institute of Air Quality Management, '*Land-Use Planning and Development Control: Planning for Air Quality*, Final draft April 2015.

1) do not cause unacceptable levels of pollution of the surrounding area by noise, light, toxic or offensive odour, airborne pollutants or by the release of waste products."

3.0 BASELINE ENVIRONMENT

3.1 Site Setting and Sensitive Receptors

The proposed energy plant will be situated at the existing Spalding site, located adjacent to the existing buildings. The Spalding site is situated within Enterprise Park and is surrounded by a mixture of commercial and industrial facilities. The closest residential property is located approximately 400 m to the north of the site. The site is approximately 2 km north of the centre of Spalding at National Grid Reference (NGR) x525230 y324620.

3.1.1 Human Receptor Locations

Human receptor locations have been characterised with reference to LAQM.TG(09) Box 1.4. According to LAQM.TG(09) air quality standards should only apply to locations where *'members of the public are likely to be regularly present and are likely to be exposed for a period of time appropriate to the averaging period of the objective. Authorities should not consider exceedences of the objectives at any location where relevant public exposure would not be realistic'*.

On this basis the receptors in Table 3-1 (illustrated in Figure 3-1) have been assessed against relevant averaging periods, based upon appropriate exposure locations outlined within Table 2-2. As a precautionary approach all land surrounding the boundary (whether footpaths are present or not) has been considered as short term receptors only (i.e. for 1-hour and 15-minute means).

Table 3-1
Sensitive Human Receptor Locations

Reference	Description	NGR-X (m)	NGR-Y (m)	Approximate Distance from Stack (m)	Direction from site
1	Johnson Community Hospital	524840	324339	489	South-west
2	Residential property on Spalding Road	524655	324190	727	South-west
3	Residential property on St Helena Road	524707	324134	726	South-west
4	Residential property on Sherwood Drive	524764	324127	693	South-west
5		524802	324116	678	South-west
6	Residential property on Chiltern Drive	525111	323912	752	South
7	The Yews Farm	524599	324257	732	South-west
8	Residential property off Spalding Road	524685	324435	572	West
9	Residential property on Chiltern Drive	524628	324448	620	West
10		524533	324716	681	West
11		524470	324823	760	West
12		524439	324921	817	North-west
13	Residential property on Red Mile Lane	524518	324915	741	North-west
14	Residential property on Wardentree Lane	524732	324978	578	North
15		524939	324961	409	North

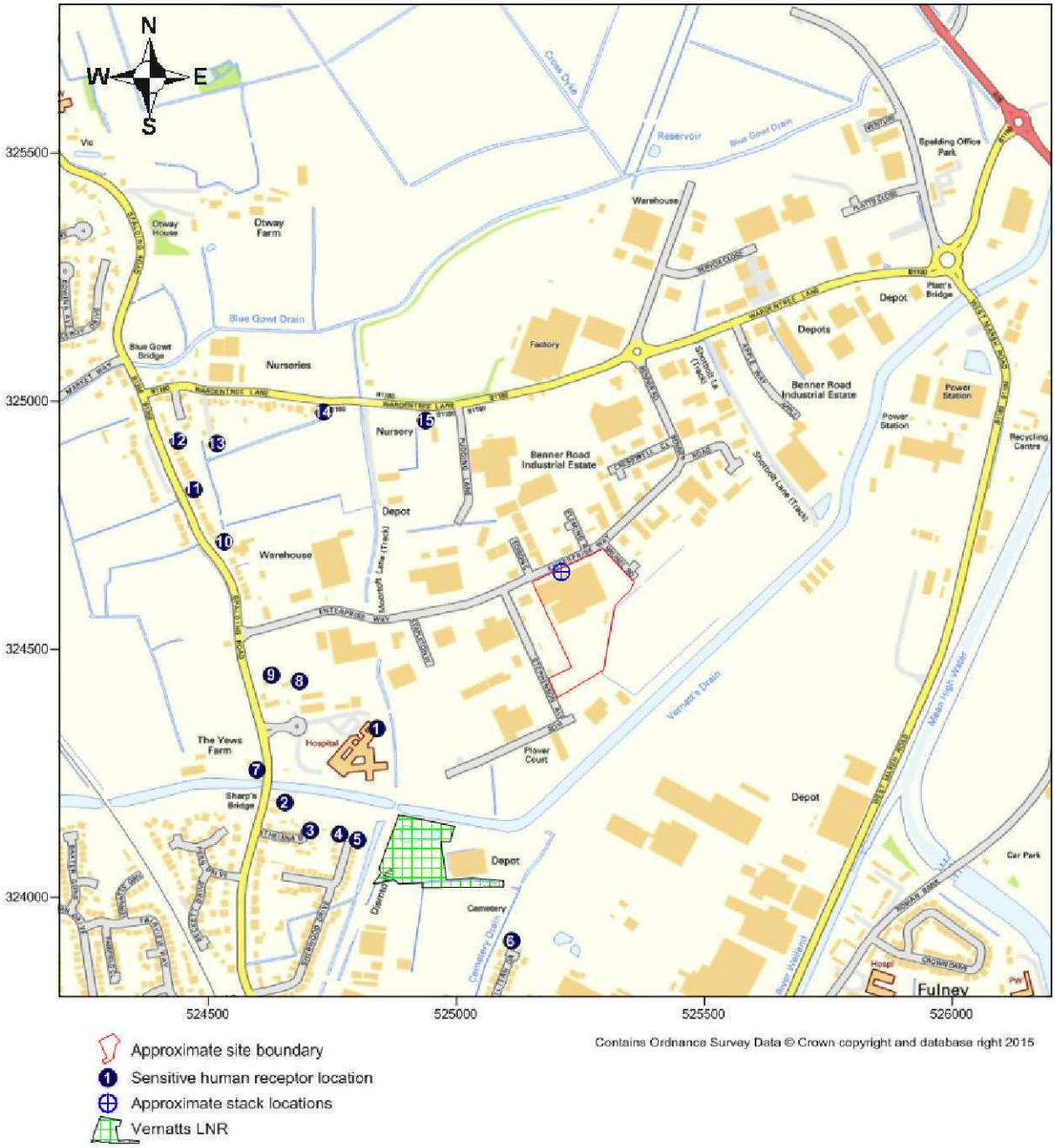


Figure 3-1
Site Surroundings and Receptor Locations

3.1.2 Ecological Receptors

Environment Agency H1 Guidance Note[4] states that ecological habitats should be screened against relevant standards if they are located within the following set distances from the site:

- Special Protection Areas (SPAs), Special Areas of Conservation (SACs) or Ramsar sites within 10 km of the installation; and
- Sites of Special Scientific Interest (SSSIs), National Nature Reserves (NNR), Local Nature Reserves (LNR), local wildlife sites (LWS) and ancient woodland (AW) within 2 km of the installation.

Designated nature conservation sites within the screening distances from the energy plant are presented in Table 3-2. For this assessment, there are no European designated habitat sites within 10 km of the proposed installation and one LNR within 2 km, also shown on Figure 3-1.

Table 3-2
Nature Conservation Sites

Receptor Name	Type of Receptor	NGR-X (m)	NGR-Y (m)	Approximate distance from stack (km)	Direction from Site Boundary
European / International Designated ecological Receptors within 10km					
None					
Ecological Receptors within 2km					
Vernatts Drain	LNR	524888	324162	0.58	South-west
		524989	324137	0.55	South-west
		525088	324027	0.63	South

The dispersion modelling has specifically included the ecological receptors in Table 3-2. In accordance with AQTAG06[5], either discrete or array receptor grids at 15m resolution have been used to represent sensitive ecological receptors.

3.2 Meteorological Conditions

The most important meteorological parameters governing the atmospheric dispersion of pollutants are as follows:

- wind direction determines the broad transport of the emission and the sector of the compass into which the emission is dispersed;
- wind speed will affect ground level concentrations of emissions by increasing the initial dilution of pollutants in the emission; and
- atmospheric stability; a measure of the turbulence, particularly of the vertical motions present.

To calculate pollutant concentrations at identified receptor locations the model uses sequential hourly meteorological data, including wind direction, wind speed, temperature, cloud cover and stability, which exert significant influence over atmospheric dispersion.

Due to the closet meteorological station being greater than 20 km from the site, dispersion modelling has been undertaken using Global Forecasting System (GFS) Numerical Weather Prediction (NWP) meteorological dataset 2010 - 2014, based upon the coordinates for the site. The GFS is a spectral model and data are archived at a horizontal resolution of 0.5 degrees (approximately 50 km over the UK). The GFS resolution adequately captures major topographical features and the broad-scale characteristics of the weather over the UK. This meteorological data is accepted for use in dispersion modelling assessments in the UK and provides the advantage of a more site-focussed data set than would be the case for data collected by the Met Office in the UK.

A wind rose of the meteorological dataset used within this assessment is presented within Figure 3-2.

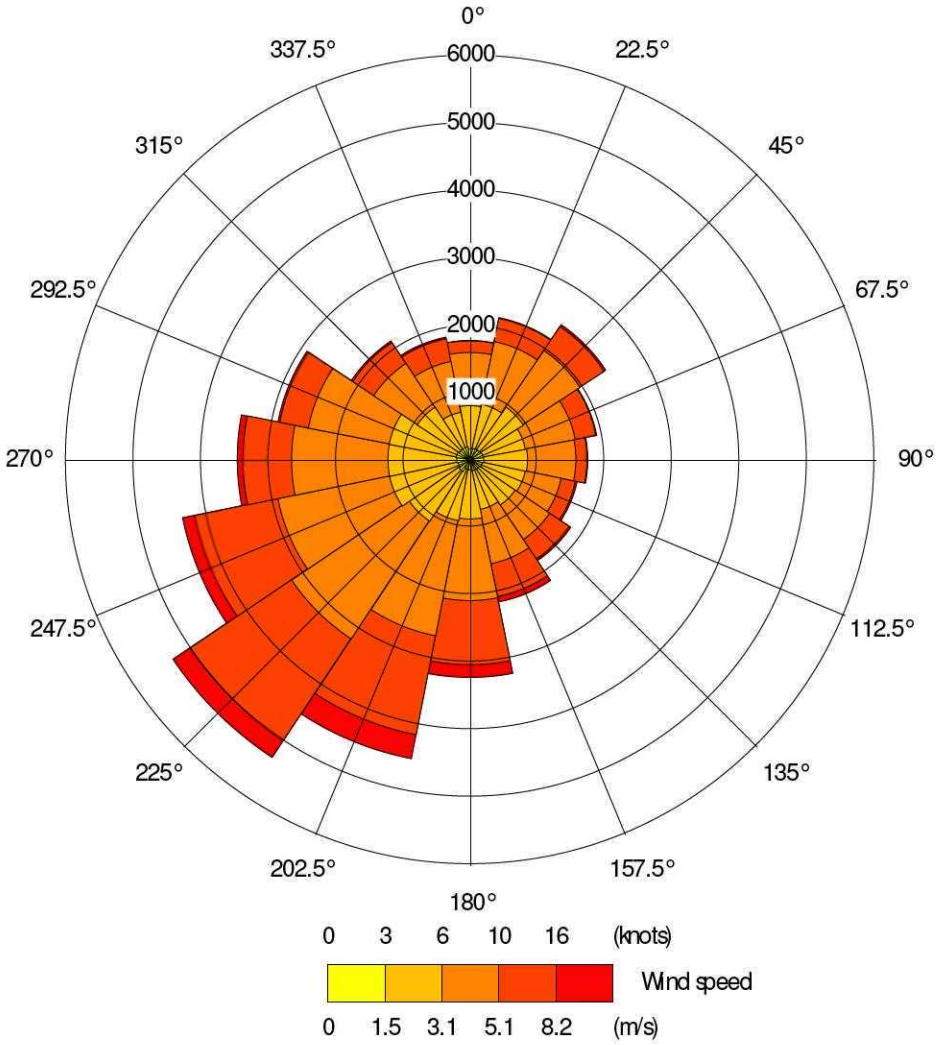


Figure 3-2
Wind-rose for GFS NWP Site Specific Wind Rose (2010 – 2014)

It can be seen that there is a strong westerly component (190° – 270°) with winds from this sector accounting for approximately 40% of hours in the five year period. Winds from the north (320° – 30°) and east (70 ° – 150°) occur least frequently, both at approximately 16% of total winds.

3.3 Topography

The presence of elevated terrain can significantly affect the dispersion of pollutants and the resulting ground level concentration in a number of ways. Elevated terrain reduces the distance between the plume centre line and the ground level, thereby increasing ground level concentrations. Elevated terrain can also increase turbulence and, hence, plume mixing with the effect of increasing concentrations near to a source and reducing concentrations further away.

The installation is located at an elevation of approximately 5 m above ordnance datum (AoD). The area around the site is relatively flat gradually with gradients less than 1:10. On this basis elevation is not likely to have a significant effect on the dispersion of emissions. Notwithstanding this, elevation has been incorporated into the dispersion modelling.

3.4 Baseline Air Quality Conditions

This section reviews the existing baseline air quality in the vicinity of the site according to monitoring and / or modelling from SHDC and the UK AIR website[8].

3.4.1 Local Authority Review and Assessment

As required under Section 82 of the Environment Act (1995) (Part IV), SHDC has conducted an on-going exercise to review and assess air quality within its administrative area.

All air quality monitoring carried out by SHDC with its administrative area indicates compliance with the relevant Air Quality Objectives (AQO).

3.4.2 Automatic Air Quality Monitoring

SHDC operate two automatic monitoring stations within its administrative area. One of these automatic monitoring stations is an urban background monitoring location approximately 3 km south-east of the site the proposed development at Monkhouse School. This station measures the concentrations of NO_2 and PM_{10}. The other station is located over 20 km from the site is not considered to be representative of the assessment location. The recent monitoring results are presented in Table 3-3 and Table 3-4, respectively.

3.4.3 Passive Diffusion Tube Monitoring

SHDC maintains a network of 15 NO_2 passive diffusion tubes as part of their commitment to LAQM. Five of these tubes are located within 3 km of site. A summary of recent NO_2 monitoring results is presented within Table 3-3.

8 Defra, UK Air Information Resource (UK-AIR) website, http://uk-air.defra.gov.uk/, accessed March 2015.

Table 3-3
NO_2 Monitoring Results

Monitoring Location	Type	Site Classification	NGR (m)		Annual Mean Concentration (µg/m^3)		
			X	Y	2012	2013	2014
Monkhouse School	AM (A)	Urban Background (B)	523168	322454	15.3	11.3	-
Priory Rd	Diffusion Tube	Kerbside (C)	524734	322403	13.9	19.4	18.3
Pinchbeck Road		Kerbside (C)	524595	323793	26.9	32.3	30.4
Springfields Roundabout		Roadside (D)	526309	323820	24.1	27.3	26.0
Church Street, Pinchbeck		Roadside (D)	524182	325804	27.2	31.6	25.3
High Street, Spalding		Roadside (D)	524892	322571	25.0	28.3	27.3

Notes:
(A) Automatic monitoring station.
(B) A monitoring location distanced from sources (such as major roads and industrial sources) broadly representative of city wide background conditions.
(C) A site sampling within one metre of the kerb of a busy road.
(D) Defined as, 'a site sampling between 1m of the kerbside of a busy road and the back of the pavement. Typically this will be within 5m of the road, but could be up to 15m'.

Table 3-4
PM_{10} Monitoring Results

Monitoring Location	Type	Site Classification	NGR (m)		Annual Mean Concentration (µg/m^3))	
			X	Y	2012	2013
Monkhouse School	AM (A)	Urban Background (B)	523168	322454	16.9	12.7

Notes:
(A) Automatic monitoring station.
(B) A monitoring location distanced from sources (such as major roads and industrial sources) broadly representative of city wide background conditions.

3.4.4 Background Estimations

Background pollutant concentration data on a 1 km x 1 km spatial resolution is provided by Defra and is routinely used to support LAQM and Air Quality Assessments.

Mapped background concentrations of oxides of nitrogen (NO_X), NO_2 and PM_{10} were downloaded for grid square representing the site x525500, y324500 which contains the proposed development, and the grid spares containing the sensitive receptors as presented in Table 3-5. These mapped background concentrations are based upon the 2011 base year Defra update[8] apart from CO, which is based upon the 2001 background maps factored forward to 2015.

Table 3-5
Relevant Estimated Annual Mean Background Concentrations

Pollutant	Predicted 2015 (µg/m^3)		
	x525500, y324500	x524500, y324500	x525500, y323500
NO_2	19.9	11.9	14.0
NO_x	29.4	16.4	19.5
PM_{10}	18.9	17.5	16.4
$PM_{2.5}$	12.0	10.8	10.8
CO	111	111	112
SO_2	3.31	2.99	3.90

3.4.5 Selected Background Concentrations

The background mapped concentrations have been used as appropriate baseline air quality concentrations within this assessment apart from at receptors located on Spalding Road. At these receptors the measured annual mean NO_2 concentration at the Pinchbeck Road diffusion tube has been used.

3.4.6 Critical Levels and Critical Loads

The Air Pollution Information System (APIS)[9] is a support tool for assessment of potential effects of air pollutants on habitats and species developed in partnership by the UK conservation agencies and regulatory agencies and the Centre for Ecology and Hydrology. APIS has been used to provide information on:

- identification of whether the habitats present are sensitive to effects caused by potential emissions;
- critical levels (Table 2-3) and current baseline concentrations (Table 3-6); and
- critical loads and current deposition rates (Table 3-7 and Table 3-8).

Table 3-6
Background Concentrations

Name / Type	NO_x	SO_2
Vernatts Drain (LNR)	11.9	1.87

Table 3-7
Nitrogen Critical Loads and Current Loads (kg N/ha/yr)

Name / Type	Terrestrial Habitat Information	Critical Load Range	Current Load
Vernatts Drain (LNR)	Fens, Marsh, Swamp	10-30	19.2
	Wood pasture and parkland	10-20	35.7

[9] Centre for Ecology and Hydrology, Air Pollution Information System (APIS), accessed May 2015

Table 3-8
Acid Critical Load Functions and Current Loads (kg_{eq}/ha/yr)

Name / Type	Terrestrial Habitat Information	Critical Load Function	N Dep	S Dep
Vernatts Drain (LNR)	Fens, Marsh, Swamp	Not Sensitive	1.37	0.2
	Wood pasture and parkland	CLmaxS:10.6 CLminN: 0.36 CLmaxN: 10.92	2.55	0.25

4.0 ASSESSMENT METHODOLOGY AND INPUT DATA

For this assessment the AERMOD model[10] has been applied with due consideration to relevant guidance[11]. This model is widely used and accepted by the EA and UK planning authorities for undertaking such assessments and its predictions have been validated against real-time monitoring data by the United States Environmental Protection Agency (US EPA)[12]. It is therefore considered a suitable model for this assessment.

4.1 Emission Parameters

Given the use of Tallow Oil as a fuel is not commonly used there is limited information available on emissions. A study carried out by the University of Birmingham[13] showed than tallow oil consumption is up to 15% higher than using diesel (fuel oil). Therefore, this assessment is based on the assumption that emissions from the combustion of Tallow Oil is similar to those from the combustion of heavy fuel oil but with a 15% increase in the volumetric flow rate[13].

In addition, the University of Birmingham study and other studies[14,15] show that as a result of higher oxygen content of tallow oil, at higher loads, results in more complete combustion and emissions of soot, carbon monoxide (CO) and hydrocarbons (HC) are significantly lower than from fuel oil.

The emission concentration for NOx has been taken from the concentration used in the University of Birmingham study. Emissions for CO and particulates have been taken from the Secretary of State Guidance note PG1/5 95[16]. The SO_2 release rate has been calculated based on the sulphur content of tallow oil being less than 0.1% by weight.

The inputs used in the assessment are presented in Table 4-1.

[10] Software used: Lakes AERMOD Pro, v8.8.9.
[11] USEPA, Aermod Implementation Workgroup, Aermod Implementation Guide, (Jan 9th, 2008).
[12] AERMOD: Latest Features and Evaluation Results. USEPA Report: EPA-454/R-03-003 June 2003, (http://www.epa.gov/scram001/dispersion_prefrec.htm#aermod).
[13] Jakub Piaszyk, University of Birmingham, Animal Fat (Tallow) as Fuel For Stationary Combustion Engines, March 2012.
[14] Sehmus ALTUN, Department of Machine Eductaion, Batman University, Performance and exhaust emissions of a DI diesel engine fuelled with waste cooking oil and inedible animal tallow methyl esters, April 2010.
[15] International Conference on Modelling Optimization and Computing-(ICMOC-2012), Performance and emission analysis of DI diesel engine fuelled with methyl esters of beef tallow and diesel blends, Procedia Enginerringing 38 (2012) 342 – 358, 2012.
16 Department of Environment (now Defra), Secretary of State's Guidance, Compression Ignition Engines, 20-50 MW Net Rated Thermal Input, PG1/5 95, December 1995.

Table 4-1
Emission Parameters

Parameter	Unit	Engine
Total Thermal Input	MW	4
Stack Location	NGR (m)	525212, 324656
Stack Height	m	30
Stack Diameter	m	0.6
Temperature	°C	213
Volumetric Flow Rate	Am^3/s	8.87
Volumetric Flow Rate [A]	Nm^3/s	4.33
Actual Efflux Velocity	m/s	15
NOx Emission Concentration [A]	mg/Nm^3	450
CO Emission Concentration [A]	mg/Nm^3	150
PM Emission Concentration [A]	mg/Nm^3	50
SO_2 Emission Concentration [A]	mg/Nm^3	45.6
NOx Release Rate	g/s	1.948
CO Release Rate	g/s	0.649
PM Release Rate	g/s	0.216
SO_2 Release Rate	g/s	0.198

Note: Reference conditions: 0°C (273k), 101.3 kPa, dry and 15% oxygen content.

4.2 Operational Hours

The energy plant will operate Monday to Friday between the hours of 7am and 10pm. To allow for a degree of flexibility this assessment has been carried out based on all of the boilers operating simultaneously continually at full load between the hours of 6am and 11pm. This is likely to represent a worst case approach because the boilers are not all likely to operate simultaneously and maximum full load.

4.3 Model Domain / Receptors

In addition to the assessment of discrete locations for human receptors listed in Table 3-1, the modelling has been undertaken using a receptor grid across an OS map of the study area. This grid extends 2.1 km by 2.1 km with a 15 m resolution, which is less than 1.5 times the stack height as identified from Environment Agency (EA) guidance on dispersion modelling.

4.4 Meteorological Data and Pre-processing

The meteorological data was obtained in '*.met*' format from the data supplier and converted to the required surface and profile formats for use in AERMOD using AERMET View (v8.8.9) meteorological pre-processor. Details of the meteorological data used in this assessment are provided in Section 3.1.2.

Details specific to the exact site location were used for the conversion, such as latitude, longitude and surface characteristics in accordance with the latest guidance[17]. Given the

[17] AERMOD Implementation guide. AERMOD implementation workgroup, USEPA. Last revised March 19, 2009.

sub-urban nature of the surface features around the site, the surface characteristics were based upon land use characteristics 1km from the main stack. The values applied are shown in Table 4-2.

Table 4-2
Met Data Preparation – Applied Surface Characteristics

Zone (Start)	Zone (end)	Landscape Character	Albedo	Bowen[a]	Surface Roughness
0	120	Cultivated land	0.28	0.75	0.0725
120	240	Urban	0.2075	1.625	1
240	360	Cultivated land	0.28	0.75	0.0725

4.5 Topography

The model was run with Shuttle Radar Topography Mission (SRTM) elevation data imported from the integrated WebGIS feature within Lakes AERMOD. Data was processed by the AERMAP function within AERMOD to calculate terrain heights and interpolate data to calculate terrain heights for sources and receptors.

4.6 Building Downwash

Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. Building downwash should always be considered for buildings that have a maximum height equivalent to at least 40% of the emission height and which within a distance defined as five times the lesser of the height or maximum projected width of the building.

The integrated Building Profile Input Programme (BPIP) module within AERMOD was used to assess the potential impact of building downwash upon predicted dispersion characteristics.

Simplified buildings have been input to the model based on the site layout plan and are illustrated in Figure 4-1.

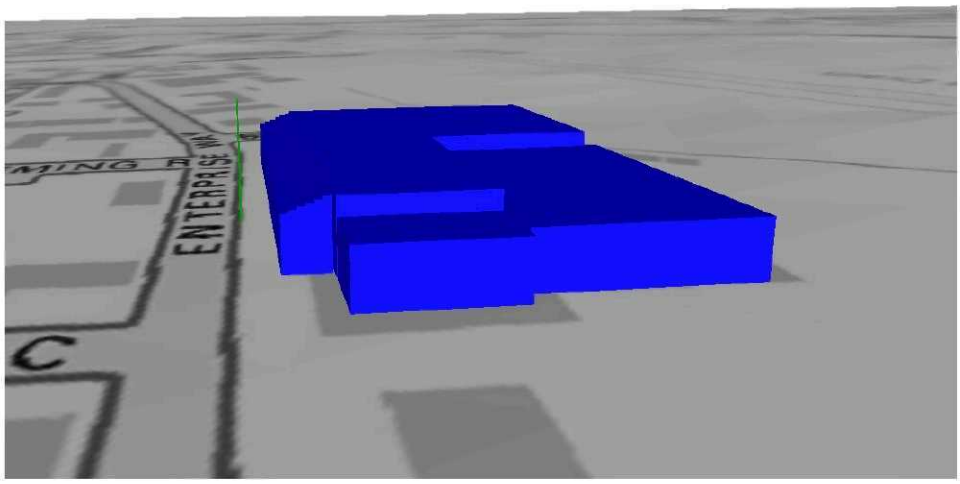


Figure 4-1
Modelled Buildings

4.7 Approach to Specific Air Emissions

4.7.1 Nitric Oxide to NO_2 Conversion

NO_x emitted to atmosphere as a result of combustion sources will consist largely of nitric oxide (NO), a relatively innocuous substance. Once released into the atmosphere, NO is oxidised to NO_2. The proportion of NO converted to NO_2 depends on a number of factors including wind speed, distance from the source, solar radiation and the availability of oxidants, such as ozone (O_3).

Following the Environment Agency AQMAU guidance[18] on conversion ratio for NO_x and NO_2 a conservative assumption has been applied that 35% of NO_x is presented as NO_2 in relation to short term impacts (1-hour mean) and 70% of NO_x is present as NO_2 in relation to long term impacts (annual mean).

4.7.2 Particulate Matter

It was assumed that 100% of the particulate matter emitted from the plant is in the PM_{10} size fraction and also the $PM_{2.5}$ fraction. The actual proportion will be less than 100%, and therefore actual PM_{10} and $PM_{2.5}$ impacts will be lower than those presented.

4.7.3 Sulphur dioxide

The 15-minute mean sulphur dioxide concentrations were derived using the maximum concentration from the modelled 99.9th percentile of 1-hour means multiplied by 1.34.

4.8 Assessment of Impacts on Habitats

4.8.1 Assessment for LNR

The EA's Operational Instruction 66_12 '*Simple assessment of the impact of aerial emissions from new or expanding IPPC regulated industry for impacts on nature conservation*' has been used for sites with designations such as National Nature Reserve (NNR), Local Nature Reserve (LNR), Local Wildlife Sites (LWS) and Ancient Woodlands (AW). This guidance provides risk based screening criteria to determine whether emissions are likely to result in 'significant pollution', for NNR, LNR, LWS and AW if the process contribution is less than 100% of the relevant critical level or load then it can be concluded there is 'no significant pollution'.

4.8.2 Calculation of Contribution to Critical Loads

Deposition rates were calculated using empirical methods recommended by the EA (AQTAG06). Dry deposition flux was calculated using the following equation:

> Dry deposition flux ($\mu g/m^2/s$) = ground level concentration ($\mu g/m^3$) x deposition velocity (m/s)

The applied deposition velocities for the relevant chemical species are as shown in Table 4-3.

[18] Environment Agency, NO_x to NO_2 conversion, undated.

Table 4-3
Applied Deposition Velocities

Chemical Species	Recommended deposition velocity (m/s)	
NO_2	Grassland	0.0015
	Woodland	0.003

The units are then converted from µg/m^2/s to units of kg/ha/year by multiplying the dry deposition flux by standard conversion factors as summarised in Table 4-4.

Table 4-4
Applied Deposition Conversion Factors

Chemical Species	Conversion factor [µg/m^2/s to kg/ha/year]	
NO_2	of N:	96

Wet deposition occurs via the incorporation of the pollutant into water droplets which are then removed in rain or snow, and is not considered significant over short distances (AQTAG06) compared with dry deposition and therefore for the purposes of this assessment, wet deposition has not been considered.

Critical Loads - Eutrophication

The contribution to critical loads for nitrogen deposition are recorded as KgN/ha/yr.

Critical Loads - Acidification

The predicted deposition rates are converted to units of equivalents (keq/ha/year), which is a measure of how acidifying the chemical species can be, by dividing the dry deposition flux (kg/ha/year) by standard conversion factors as presented in Table 4-5.

Table 4-5
Applied Acidification Conversion Factors

Chemical Species	Conversion factor [kg/ha/year to keq/ha/year]
of N:	multiply by 96

4.8.3 Calculation of PC as a percentage of Acid Critical Load Function

The calculation of the process contribution of N to the critical load function has been carried out according to the guidance on APIS, which is as follows:

> *"The potential impacts of additional sulphur and/or nitrogen deposition from a source are partly determined by PEC, because only if PEC of nitrogen deposition is greater than CLminN will the additional nitrogen deposition from the source contribute to acidity. Consequently, if PEC is less that CLminN only the acidifying affects of sulphur from the process need to be considered:*
>
> *Where PEC N Deposition < CLminN*
>
> *PC as % CL function = (PC S deposition/CLmaxS)*100*

Where PEC is greater than CLminN (the majority of cases), the combined inputs of sulphur and nitrogen need to be considered. In such cases, the total acidity input should be calculated as a proportion of the CLmaxN.

Where PEC N Deposition > CLminN

*PC as %CL function = (PC of S+N deposition)/CLmaxN)*100"*

5.0 RESULTS

This section below presents the results of the dispersion modelling with comparison to AQO at the point of maximum ground level concentration and relevant exposure locations. Full tables of results are presented in Appendix A. The tables provide the following information:

- AQO for each substance under consideration;
- Estimated annual mean baseline concentrations of the substance;
- Process Contribution (PC), the maximum modelled concentration of the substance due to process emissions alone;
- Predicted Environmental Concentration (PEC), the maximum modelled concentration due to process emissions combined with estimated baseline concentrations; and
- PC and PEC as a percentage of the AQO.

5.1 Maximum Concentration

The summary of maximum predicted PC at any of the assessed locations included in the assessment are presented in Table 5-1. The location of maximum potential exposure occurs at a residential property on Wardentree Lane (R15). The maximum short-term concentrations (hourly and 15-minute means) occur adjacent to the northern site boundary along Enterprise Way.

Table 5-1
Maximum Concentration at a Sensitive Receptor Location

Substance	Averaging Period	AQO (µg/m^3)	Background (µg/m^3)	PC (µg/m^3)	PC as % of AQO (%)	PEC (µg/m^3)	PEC as % AQO (%)
NO_2	Annual mean	40	11.9	0.49	1.22%	12.39	30.98%
	1-hour 99.79%ile	200	23.8	10.67	5.33%	34.47	17.24%
	1-hour 99.79%ile[(a)]	200	23.8	46.09	23.05%	69.90	34.95%
PM_{10}	Annual mean	40	17.5	0.08	0.19%	17.54	43.85%
	24-hour 90.41%ile	50	26.6	0.25	0.49%	26.89	53.79%
$PM_{2.5}$	Annual mean	25	10.8	0.08	0.31%	10.84	43.34%
CO	8-hour Maximum	10,000	222	8.98	0.09%	230.86	2.31%
SO_2	15-minute 99.9%ile	266	6.0	5.62	2.11%	11.60	4.36%
	15-minute 99.9%ile[(a)]	266	6.6	18.99	7.14%	25.61	9.63%
	1-hour 99.79%ile	350	6.0	2.96	0.84%	8.94	2.55%
	1-hour 99.79%ile[(a)]	350	6.6	13.36	3.82%	19.98	5.71%
	24-hour 99.18%ile	125	6.0	0.99	0.79%	6.97	5.58%

Note A: Maximum concentration at any off-site location

The results show that the maximum annual mean NO_2 at any of the assessed locations PC is 0.49 µg/m^3, which is equivalent to 1.22% of the AQO with a PEC equivalent to 31.0% of the AQO. Based on the IAQM guidance[7] an increase of between 1% (after rounding) with a PEC less than 75% of the AQO is described as a '*negligible' change.*

The results show that the maximum annual mean PM_{10} PC is 0.078 µg/m^3, which is equivalent to less than 1% of the AQO with a PEC equivalent to 43.9% of the AQO. Based on the IAQM guidance[7] an increase of between 1% (after rounding) with a PEC less than 75% of the AQO is described as a '*negligible' change.*

Similarly the results for the annual mean $PM_{2.5}$ is 0.31% of the AQO with a PEC equivalent to 43.3% of the AQO, which is described as a *'negligible'*.

In addition, the maximum PEC is 34.9% and 53.8% of the relevant AQOs for the 99.79th 1-hour mean NO_2 and 90.41st 24-hour mean AQOs, respectively. Similarly for CO and SO_2, the maximum PEC is less than 10% of the relevant AQOs. Therefore, the overall impact of the proposed energy plant is not considered to be significant.

Contour plots have been produced of the model results for key substances where either the long-term process contribution is greater than 1% of the relevant air AQO or short-term process contribution is greater than 10% of the relevant air AQO. In this assessment, contour plots have been produced for both the long-term and short-term process contribution in Appendix B (note these plots have been produced for illustrative purposes only).

5.2 Exposure at Receptors

The predicted PC and PEC at the individual receptor locations are presented in Table 5-2 and Table 5-3, respectively. The PEC remains well below the relevant AQOs at all receptor locations. On the basis of these results the guidance states that the overall impact is '*negligible*' at receptor locations.

Table 5-2
Process Contribution at Receptor Locations

ID	NO_2				PM_{10}				$PM_{2.5}$		CO		SO_2					
	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO	PC (µg/m³)	% of AQO
Statistic	***Annual***		***1-hour 99.79 %ile***		***Annual***		***24-hour 90.41 %ile***		***Annual***		***Maximum 8 hour***		***15-min 99.9 %ile***		***1-hour 99.73 %ile***		***24-hour 99.18 %ile***	
AQO (µg/m³)	*40*		*200*		*40*		*50*		*25*		*10,000*		*266*		*350*		*125*	
R1	0.39	0.98%	9.87	4.94%	0.062	0.16%	0.087	0.17%	0.062	0.25%	7.42	0.07%	5.09	1.92%	2.63	0.75%	0.94	0.75%
R2	0.20	0.50%	4.94	2.47%	0.032	0.08%	0.095	0.19%	0.032	0.13%	4.62	0.05%	2.99	1.13%	1.29	0.37%	0.48	0.39%
R3	0.24	0.59%	6.50	3.25%	0.038	0.09%	0.11	0.23%	0.038	0.15%	5.19	0.05%	3.93	1.48%	1.70	0.49%	0.61	0.49%
R4	0.28	0.69%	8.16	4.08%	0.044	0.11%	0.12	0.24%	0.044	0.18%	7.24	0.07%	5.21	1.96%	2.04	0.58%	0.76	0.61%
R5	0.29	0.73%	8.85	4.43%	0.047	0.12%	0.065	0.13%	0.047	0.19%	8.52	0.09%	5.62	2.11%	2.27	0.65%	0.80	0.64%
R6	0.18	0.44%	7.93	3.97%	0.028	0.07%	0.075	0.15%	0.028	0.11%	6.86	0.07%	4.24	1.59%	1.82	0.52%	0.49	0.39%
R7	0.16	0.39%	3.38	1.69%	0.025	0.06%	0.12	0.24%	0.025	0.10%	2.61	0.03%	1.59	0.60%	0.89	0.26%	0.34	0.27%
R8	0.29	0.72%	9.80	4.90%	0.046	0.11%	0.11	0.21%	0.046	0.18%	8.98	0.09%	5.48	2.06%	2.54	0.72%	0.81	0.65%
R9	0.27	0.68%	9.73	4.86%	0.043	0.11%	0.084	0.17%	0.043	0.17%	8.81	0.09%	5.26	1.98%	2.56	0.73%	0.76	0.61%
R10	0.24	0.60%	8.35	4.18%	0.038	0.10%	0.081	0.16%	0.038	0.15%	6.42	0.06%	4.74	1.78%	2.11	0.60%	0.64	0.51%
R11	0.21	0.52%	7.17	3.59%	0.033	0.08%	0.074	0.15%	0.033	0.13%	5.22	0.05%	4.43	1.67%	1.84	0.53%	0.53	0.42%
R12	0.20	0.49%	6.93	3.46%	0.031	0.08%	0.086	0.17%	0.031	0.12%	4.69	0.05%	4.03	1.52%	1.72	0.49%	0.52	0.42%
R13	0.23	0.58%	8.07	4.04%	0.037	0.09%	0.14	0.28%	0.037	0.15%	5.71	0.06%	4.66	1.75%	2.12	0.61%	0.63	0.50%
R14	0.29	0.72%	8.22	4.11%	0.046	0.11%	0.25	0.49%	0.046	0.18%	5.76	0.06%	3.99	1.50%	2.20	0.63%	0.65	0.52%
R15	0.49	1.22%	10.7	5.33%	0.078	0.19%	0.16	0.31%	0.078	0.31%	7.36	0.07%	5.31	2.00%	2.96	0.84%	0.99	0.79%

Table 5-3
PEC at Receptor Locations

ID	NO_2				PM_{10}				$PM_{2.5}$		CO		SO_2					
	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO	PEC (µg/m³)	% of AQO
Statistic	***Annual***		***1-hour 99.79 %ile***		***Annual***		***24-hour 90.41 %ile***		***Annual***		***Maximum 8 hour***		***15-min 99.9 %ile***		***1-hour 99.73 %ile***		***24-hour 99.18 %ile***	
AQO (µg/m³)	*40*		*200*		*40*		*50*		*25*		*10,000*		*266*		*350*		*125*	
R1	12.29	30.73%	33.67	16.84%	17.53	43.81%	26.74	53.47%	10.82	43.28%	229.3	2.29%	11.07	4.16%	8.61	2.46%	6.92	5.54%
R2	30.57	76.42%	65.68	32.84%	17.50	43.74%	26.74	53.49%	10.79	43.16%	226.5	2.26%	8.97	3.37%	7.27	2.08%	6.46	5.17%
R3	12.14	30.35%	30.30	15.15%	17.50	43.75%	26.76	53.53%	10.80	43.18%	227.1	2.27%	9.91	3.72%	7.68	2.20%	6.59	5.27%
R4	12.18	30.44%	31.96	15.98%	17.51	43.77%	26.77	53.54%	10.80	43.21%	229.1	2.29%	11.19	4.21%	8.02	2.29%	6.74	5.39%
R5	12.20	30.49%	32.65	16.33%	17.51	43.77%	26.71	53.43%	10.80	43.22%	230.4	2.30%	11.60	4.36%	8.25	2.36%	6.78	5.42%
R6	14.13	35.32%	35.84	17.92%	16.40	40.99%	25.05	50.10%	10.79	43.15%	230.5	2.30%	12.04	4.52%	9.62	2.75%	8.29	6.63%
R7	30.53	76.32%	64.11	32.06%	17.49	43.72%	26.77	53.54%	10.78	43.13%	224.5	2.24%	7.57	2.85%	6.87	1.96%	6.32	5.06%
R8	12.19	30.48%	33.61	16.80%	17.51	43.77%	26.76	53.51%	10.80	43.21%	230.9	2.31%	11.46	4.31%	8.52	2.43%	6.79	5.43%
R9	30.64	76.60%	70.46	35.23%	17.51	43.77%	26.73	53.47%	10.80	43.20%	230.7	2.31%	11.24	4.23%	8.54	2.44%	6.74	5.40%
R10	30.61	76.52%	69.09	34.54%	17.50	43.75%	26.73	53.46%	10.80	43.18%	228.3	2.28%	10.72	4.03%	8.09	2.31%	6.62	5.30%
R11	30.58	76.45%	67.91	33.95%	17.50	43.74%	26.72	53.45%	10.79	43.16%	227.1	2.27%	10.41	3.91%	7.82	2.23%	6.51	5.21%
R12	30.56	76.41%	67.67	33.83%	17.49	43.74%	26.74	53.47%	10.79	43.15%	226.6	2.27%	10.01	3.76%	7.70	2.20%	6.50	5.20%
R13	12.14	30.34%	31.87	15.94%	17.50	43.75%	26.79	53.57%	10.79	43.18%	227.6	2.28%	10.64	4.00%	8.10	2.32%	6.61	5.29%
R14	12.19	30.47%	32.02	16.01%	17.51	43.77%	26.89	53.79%	10.80	43.21%	227.6	2.28%	9.97	3.75%	8.18	2.34%	6.63	5.31%
R15	12.39	30.98%	34.47	17.24%	17.54	43.85%	26.81	53.61%	10.84	43.34%	229.2	2.29%	11.29	4.24%	8.94	2.55%	6.97	5.58%

5.3 Nitrogen and Acid Deposition at Ecological Receptors

The process contribution to critical loads for nitrogen deposition is presented in Table 5-4.

Table 5-4
Contribution to Nitrogen Critical Loads (kg N/ha/yr)

Name / Type	Terrestrial Habitat Information	Lower CLO	PC	PC as % of Lower CLO
Vernatts Drain (LNR)	Fens, Marsh, Swamp	10	0.056	0.56
	Wood pasture and parkland	10	0.056	0.56

The contribution remains below 100% at Vernatts Drain LNR and can therefore be considered insignificant and not likely to cause significant pollution respectively.

The process contribution for nitrogen and sulphur deposition to acid critical load functions is presented using the APIS Critical Load Function Tool in Figure 5-1. The contribution remains below 100% at Vernatts Drain LNR and can therefore be considered insignificant.

Critical Load Function Deposition data

CLmaxS:	10.57
CLminN:	0.36
CLmaxN:	10.92

Source	keq/ha/yr		
	Sulphur Deposition	Nitrogen Deposition	Total Acid Deposition (S+N)
Process Contribution (PC)	0.0065	0.004	0.01
Background	0.25	2.55	2.8
Predicted Environmental Concentration (PEC)	0.26	2.55	2.81

exceedance and deposition as a proportion of the CL function

Source	Exceedance (keq/ha/yr)	% of CL function*
Process Contribution (PC)	no exceedance of CL function	0.1
Background	no exceedance of CL function	25.6
Predicted Environmental Concentration (PEC)	no exceedance of CL function	25.7

* % of CL function is calculated after the value of PEC relative to CLminN is taken into account. See detailed explanation for further information and justification.

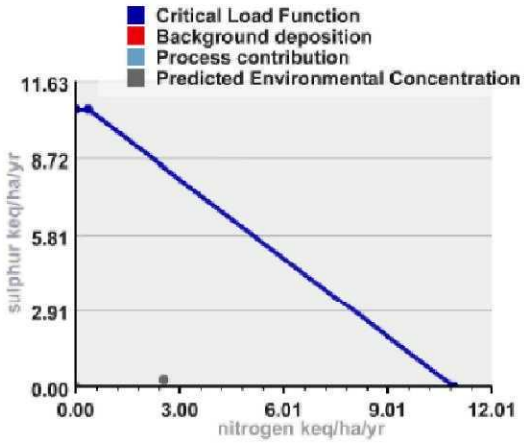


Figure 5-1
Critical Load Function: Vernatts Drain LNR

The process contribution for nitrogen oxides to critical levels is presented in Table 5-5. All process contributions are insignificant.

Table 5-5
Contribution to Critical Levels (µg/m^3)

Name / Type	NO_x Daily PC	PC as % of EAL	NO_x Annual PC	PC as % of EAL	SO_2 Annual PC	PC as % of EAL
Vernatts Drain (LNR)	15.5	20.7	0.55	1.84	0.06	0.28

The process contribution to critical levels and critical loads remains below 100% at Vernatts Drain LNR. Therefore, it can be concluded there is '*no significant pollution*' at Vernatts Drain LNR.

6.0 CONCLUSIONS

This Air Quality Assessment has been carried to determine the potential impact of a proposed energy plant at the Wm Morrison Supermarkets Spalding site in Lincolnshire.

The assessment, undertaken using atmospheric dispersion modelling, concluded that the predicted concentrations associated with emissions from the proposed energy plant are well below the AQOs. In particular:

- the Process Contribution of all pollutants considered (NO_2, PM_{10}, $PM_{2.5}$, CO and SO_2) are not predicted to lead to exceedences of their respective Air Quality Objectives;
- based on the IAQM Guidance, the change in air quality concentrations relative to the Air Quality Objectives is described as '*negligible*';
- the combined process contribution of nitrogen oxides and sulphur dioxide are less than 100% of the relevant Critical Levels and Critical Loads at all locally designated ecological sites. Therefore, according to EA guidance leads to a conclusion of '*no significant pollution'*.

On this basis, the proposed energy plant at the Spalding site will not lead to any significant impact on air quality.

7.0 CLOSURE

This report has been prepared by SLR Consulting Limited with all reasonable skill, care and diligence, and taking account of the manpower and resources devoted to it by agreement with the client. Information reported herein is based on the interpretation of data collected and has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of Wm Morrison Supermarkets PLC; no warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

APPENDIX A – TABULATED RESULTS: PROCESS CONTRIBUTIONS (PC)

Table A-1
NO_2 Annual Mean (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	0.40	0.28	0.31	0.49	0.48
R2	0.21	0.14	0.16	0.26	0.24
R3	0.27	0.17	0.20	0.26	0.28
R4	0.34	0.19	0.22	0.30	0.33
R5	0.39	0.20	0.22	0.32	0.34
R6	0.30	0.12	0.16	0.16	0.14
R7	0.15	0.11	0.13	0.22	0.19
R8	0.31	0.23	0.21	0.34	0.36
R9	0.30	0.21	0.19	0.31	0.34
R10	0.24	0.18	0.21	0.27	0.30
R11	0.22	0.18	0.18	0.23	0.24
R12	0.20	0.19	0.17	0.20	0.22
R13	*0.23*	*0.23*	*0.20*	*0.24*	*0.26*
R14	0.23	0.33	0.32	0.26	0.29
R15	0.45	0.59	0.49	0.41	0.51
H1a	0.78	0.37	0.34	0.59	0.57
H1b	0.87	0.36	0.34	0.61	0.54
H1c	0.66	0.24	0.33	0.35	0.29

Table A-2
NO_2 1-hour Mean 99.79%ile (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	0.40	0.28	0.31	0.49	0.48
R2	0.21	0.14	0.16	0.26	0.24
R3	0.27	0.17	0.20	0.26	0.28
R4	0.34	0.19	0.22	0.30	0.33
R5	0.39	0.20	0.22	0.32	0.34
R6	0.30	0.12	0.16	0.16	0.14
R7	0.15	0.11	0.13	0.22	0.19
R8	0.31	0.23	0.21	0.34	0.36
R9	0.30	0.21	0.19	0.31	0.34
R10	0.24	0.18	0.21	0.27	0.30
R11	0.22	0.18	0.18	0.23	0.24
R12	0.20	0.19	0.17	0.20	0.22
R13	0.23	0.23	0.20	0.24	0.26
R14	0.23	0.33	0.32	0.26	0.29
R15	0.45	0.59	0.49	0.41	0.51

Table A-3
PM_{10} and $PM_{2.5}$ Annual Mean (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	0.06	0.04	0.05	0.08	0.08
R2	0.03	0.02	0.03	0.04	0.04
R3	0.04	0.03	0.03	0.04	0.04
R4	0.05	0.03	0.04	0.05	0.05
R5	0.06	0.03	0.03	0.05	0.05
R6	0.05	0.02	0.03	0.02	0.02
R7	0.02	0.02	0.02	0.04	0.03
R8	0.05	0.04	0.03	0.05	0.06
R9	0.05	0.03	0.03	0.05	0.05
R10	0.04	0.03	0.03	0.04	0.05
R11	0.03	0.03	0.03	0.04	0.04
R12	0.03	0.03	0.03	0.03	0.03
R13	0.04	0.04	0.03	0.04	0.04
R14	0.04	0.05	0.05	0.04	0.05
R15	0.07	0.09	0.08	0.06	0.08

Table A-4
PM_{10} 24-hour Mean 90.41%ile (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	0.10	0.03	0.03	0.15	0.12
R2	0.15	0.03	0.02	0.15	0.13
R3	0.16	0.03	0.02	0.19	0.16
R4	0.22	0.04	0.02	0.17	0.16
R5	0.14	0.03	0.06	0.06	0.05
R6	0.06	0.03	0.03	0.15	0.10
R7	0.11	0.06	0.08	0.17	0.19
R8	0.11	0.04	0.06	0.16	0.16
R9	0.07	0.03	0.07	0.09	0.16
R10	0.09	0.04	0.06	0.06	0.15
R11	0.08	0.06	0.07	0.08	0.09
R12	0.09	0.08	0.07	0.08	0.10
R13	0.13	0.14	0.17	0.11	0.13
R14	0.23	0.30	0.24	0.16	0.30
R15	0.28	0.05	0.04	0.23	0.18

Table A-5
CO maximum 8-hour Mean (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	7.79	6.32	7.84	7.28	7.89
R2	4.05	4.46	3.85	5.28	5.44
R3	7.11	3.75	5.17	4.19	5.70
R4	5.81	3.96	7.87	6.51	12.07
R5	9.09	5.62	7.12	7.37	13.42
R6	9.59	5.38	7.77	5.31	6.27
R7	2.73	2.37	3.07	2.63	2.22
R8	12.21	10.71	6.32	7.39	8.30
R9	10.44	9.76	6.58	7.79	9.49
R10	7.73	3.95	7.78	5.42	7.20
R11	4.96	7.20	3.10	7.20	3.64
R12	5.36	4.44	4.01	4.38	5.25
R13	6.12	4.34	5.12	5.13	7.86
R14	4.65	8.32	6.69	4.22	4.92
R15	8.98	8.26	7.51	6.63	5.44

Table A-6
SO_2 15-minute Mean 99.9%ile (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	5.46	4.01	4.60	5.28	6.11
R2	2.71	2.02	2.32	3.40	4.52
R3	4.66	3.34	3.74	2.81	5.10
R4	5.18	3.67	5.73	4.84	6.65
R5	5.64	4.98	5.02	4.83	7.62
R6	6.50	3.32	3.92	3.53	3.90
R7	1.62	1.20	1.62	1.88	1.63
R8	7.19	5.82	3.76	4.71	5.91
R9	5.66	5.50	4.42	5.04	5.68
R10	5.57	4.23	5.76	3.26	4.91
R11	5.10	4.33	4.14	4.58	4.01
R12	4.84	4.14	3.24	3.86	4.09
R13	4.84	4.66	4.59	4.33	4.91
R14	3.77	3.62	5.06	3.69	3.84
R15	7.63	4.88	4.98	4.72	4.34

Table A-7
SO_2 1-hour Mean 99.73%ile (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	2.74	2.46	2.51	2.57	2.89
R2	1.39	1.00	1.26	1.25	1.57
R3	1.78	1.39	1.77	1.53	2.05
R4	1.90	1.71	1.98	1.71	2.93
R5	2.34	1.80	2.02	2.00	3.20
R6	2.79	1.44	1.90	1.68	1.29
R7	0.94	0.77	0.87	1.07	0.83
R8	2.77	2.93	2.11	2.33	2.54
R9	3.09	2.97	1.89	2.19	2.67
R10	2.69	1.69	1.98	1.93	2.27
R11	2.26	1.77	1.58	1.83	1.76
R12	1.91	1.84	1.30	1.79	1.74
R13	2.26	2.12	1.69	2.24	2.31
R14	2.10	2.27	2.41	2.09	2.11
R15	3.08	3.07	2.84	3.02	2.77

Table A-8
SO_2 24-hour Mean 99.18%ile (µg/m^3)

Receptor ID	2010	2011	2012	2013	2014
R1	0.88	0.73	1.08	1.04	0.98
R2	0.50	0.35	0.53	0.51	0.52
R3	0.63	0.45	0.71	0.56	0.71
R4	0.86	0.53	0.80	0.67	0.92
R5	1.01	0.58	0.82	0.64	0.94
R6	0.66	0.38	0.41	0.52	0.46
R7	0.28	0.25	0.40	0.44	0.33
R8	0.94	0.70	0.81	0.82	0.77
R9	0.91	0.66	0.74	0.80	0.72
R10	0.84	0.53	0.50	0.78	0.57
R11	0.55	0.48	0.49	0.64	0.48
R12	0.55	0.47	0.51	0.48	0.60
R13	0.65	0.57	0.53	0.63	0.77
R14	0.48	0.71	0.65	0.61	0.81
R15	0.98	1.09	1.01	0.92	0.97

APPENDIX B – CONTOUR PLOTS

Figure B-1
Annual Mean NO_2 Process Contribution (µg/m^3)

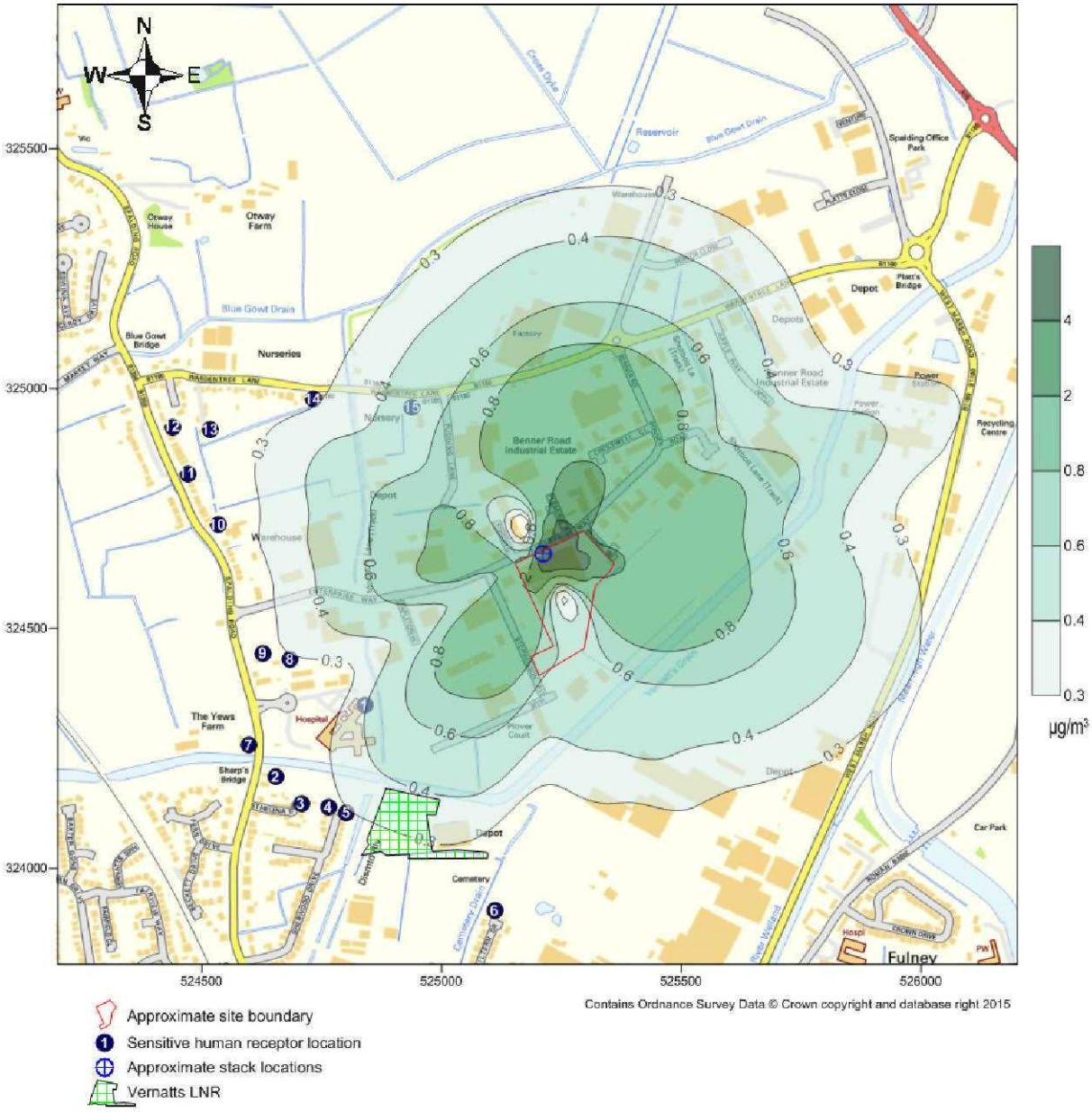
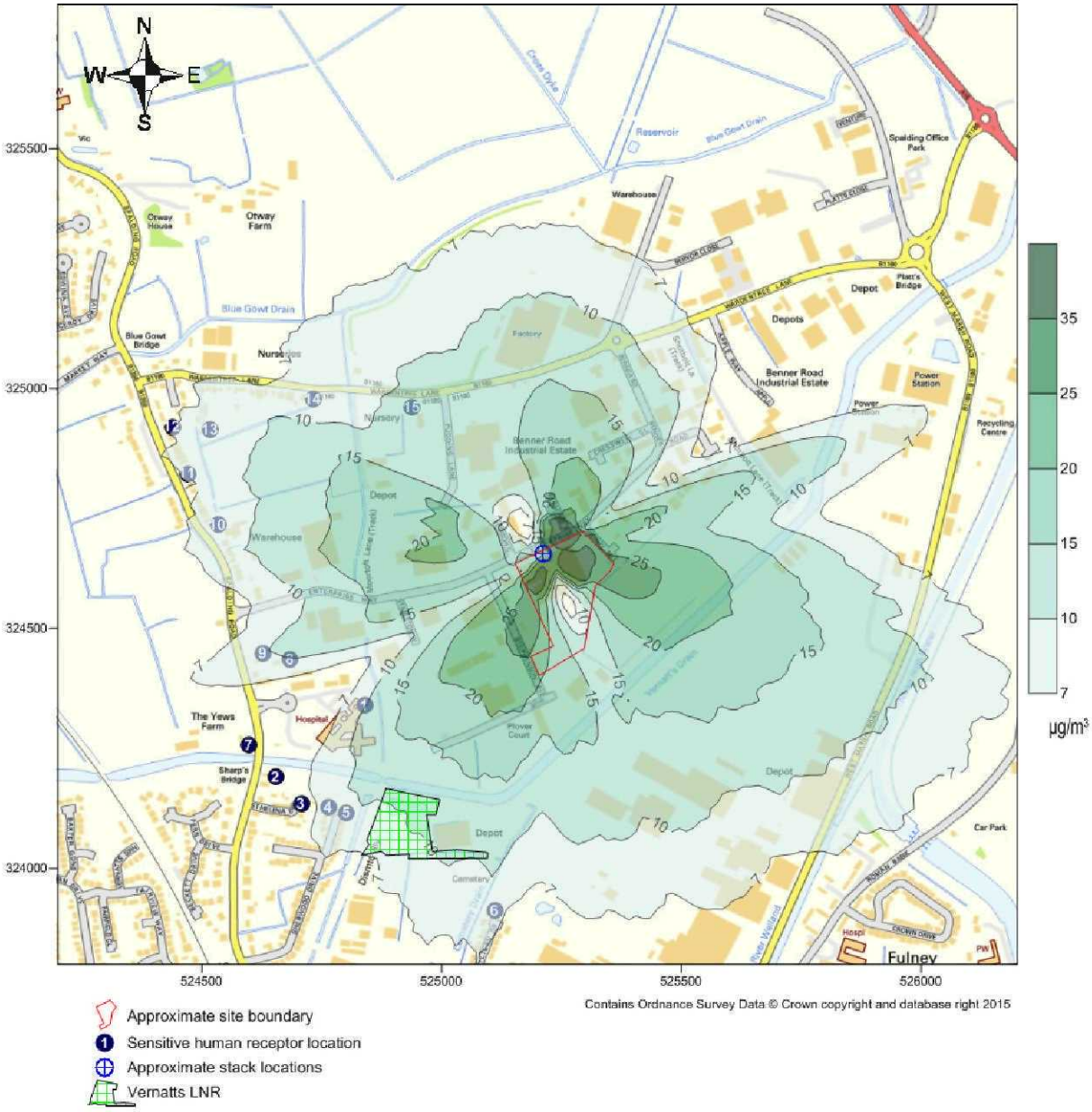


Figure B-2
99.79th Percentile of Hourly Mean NO_2 Process Contribution (µg/m³)



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