LAING O'ROURKE

BRIGHTON 3Ts

Document Information Cover Sheet

Asite/Document Reference Number: LOR-CO-EC-PCD-0019

Document Title: Planning Condition Discharge Condition 19 – Energy Centre Emissions

Revision: P01

Purpose of Issue: For Planning Condition Approval

Publisher: LO'R

Published: 14/05/2021

Document Information Cover Sheet
Asite/Document Reference Number: A1F-ME-EC-RP-5901
Document Title: Dispersion Modelling Assessment (Energy Centre)
Revision: P01
Publisher: Laing O'Rourke on behalf of A1 Flue Systems
Published: 26/05/2020
Outline Description/Comments on Content: This assessment will seek to address the requirements of Planning Condition 19. Reference: BH2011/02886 dated 28 March 2012

DISPERSION MODELLING ASSESSMENT
BRIGHTON 3T'S PROJECT
ROYAL SUSSEX COUNTY HOSPITAL
A1 FLUE SYSTEMS
DMA-21888A-19-157
SEPTEMBER 2019

DISPERSION MODELLING ASSESSMENT
BRIGHTON 3T'S PROJECT
ROYAL SUSSEX COUNTY HOSPITAL
A1 FLUE SYSTEMS
DMA-21888A-19-157
SEPTEMBER 2019

Current Document Details

Authors

Elizabeth Whittall

Approved by

[redacted]
……………………………………………
Kat Johnson

Issued by

[redacted]
……………………………………………
Elizabeth Whittall

M:\Jobs 21000-22000\21888 A1 Flue Dispersion Studies\a Brighton 3T's\4.0 Project Documents\4.6 Merebrook report\DMA-21888a-19-157.docx

Document Revisions

Rev	Date	Author	Approved	Issued	Remarks
0	13/09/19	ECW	KRJ	ECW	-

Report issued from

DERBYSHIRE   Cromford Mills, Mill Lane, Matlock, Derbyshire. DE4 3RQ   Tel: 01773 829988

TABLE OF CONTENTS

SECTION 1 INTRODUCTION 1
SECTION 2 SITE SETTING AND PROPOSALS 2
SECTION 3 LEGISLATION AND ASSESSMENT STANDARDS 2
3.1 AIR QUALITY REGULATIONS 2
3.2 CLEAN AIR ACT 3
3.3 ENVIRONMENTAL PERMITTING REGULATIONS 3
SECTION 4 BASELINE AIR QUALITY 4
4.1 INTRODUCTION 4
4.2 LOCAL AUTHORITY MONITORING DATA 5
4.3 DEFRA BACKGROUND MAPS 7
4.4 INDUSTRIAL INSTALLATIONS 7
4.5 SUMMARY 8
SECTION 5 ASSESSMENT METHODLOGY 8
SECTION 6 INPUT PARAMETERS 8
6.1 GENERAL 8
6.2 BUILDINGS 9
6.3 PLANT PARAMETERS 9
6.4 METEOROLOGICAL DATA 10
6.5 MODELLED RECEPTORS 10
6.6 GRIDDED OUTPUT 12
SECTION 7 RESULTS & IMPACT ASSESSMENT 12
SECTION 8 CONCLUSIONS 18

APPENDIX 1 ....
Drawings

APPENDIX 2 ....
Input parameters

APPENDIX 3 ....
Predicted concentrations at proposed receptors

APPENDIX 4 ....
Contour plots

SECTION 1 INTRODUCTION

1.1 A1 Flue Systems has commissioned IDOM Merebrook Limited (IDOM) on behalf of Laing O'Rourke to undertake dispersion modelling for the proposed new energy centre to be installed within the Thomas-Kemp Tower (TKT) at the Royal Sussex County Hospital (RSCH) as part of the Brighton Trauma, Tertiary and Teaching (3T's) project.

1.2 This assessment will seek to address the requirements of Condition 19 of planning consent reference BH2011/02886 dated 28 March 2012 which reads as follows:

'*The Energy Centre shall not be brought into use until the Applicant has demonstrated that the emissions produced would result in an NO_2 concentration at all heights of the Thomas Kemp Tower which is less than 40µg/m^3 as an annual mean and is less than 200µg/m^3 for the 19th highest hour in the year. This evidence is to be submitted to and approved in writing by the Local Planning Authority. This final evidence will include the results of further dispersion modelling and nitrogen dioxide monitoring which will be used to inform the scope of any Computation Fluid Dynamic (CFD) study (if required) and details of any Mitigation Scheme proposed to reduce emissions from the Energy Centre. The Mitigation Scheme shall also include details of mechanical ventilation systems and the specification and maintenance of NOx filters for the Thomas Kemp Tower where appropriate. The scheme shall be implemented fully in accordance with the approved details and retained as such thereafter'*.

1.3 The objectives of the investigation are to:

i. *Establish baseline air quality at the subject site;*

ii. *Undertake dispersion modelling of emissions from the proposed energy centre;*

iii. *Assess whether predicted concentrations are likely to result in a breach of the Air Quality Objectives (AQO) in areas of relevant exposure within the site.*

iv. *If necessary, recommend mitigation measures to address any unacceptable risks to human health.*

1.4 This report has been prepared for A1 Flue Systems for the sole purpose described above and no extended duty of care to any third party is implied or offered. Third parties making reference to the report should consult A1 Flue Systems and IDOM as to the extent to which the findings may be appropriate for their use.

SECTION 2 SITE SETTING AND PROPOSALS

2.1 The RSCH is located to the north of Eastern Road in Brighton at approximate National Grid Reference ^{5}32776, ^{1}03911 as indicated on drawing reference 21888a-001-001 in Appendix 1.

2.2 The Brighton 3T's project involves the partial redevelopment of the RSCH including the addition of a three-storey helideck on top of the existing TKT, replacement of existing hospital buildings to the north of Eastern Road and site-wide infrastructure including energy centre and flues. The replacement hospital buildings are referred to as Section 02 (to the south of TKT) and Section 03 (to the southwest of TKT), as shown in Figure 1 in Appendix 2.

2.3 It is understood that 4 No. 1,540 kW boilers currently operate on the site and that the new energy centre will phase out these boilers in two stages (as described in Section 6.3 of this report). This assessment considers the impact of the completed energy centre once fully operational (i.e. upon completion of Stage 2). The proposed replacement energy centre is to be installed within the TKT which is located centrally on site.

2.4 The Brighton 3T's project is currently under construction in the south of the hospital site. The hospital is bounded as follows:

i. *To the north by residential apartment blocks;*

ii. *To the east by Bristol Gate (road) beyond which are residential properties, the Macmillan Horizon Centre, Brighton College Nursery & Pre-Prep School;*

iii. *To the south by Eastern Road with Sussex Eye Hospital, The Audrey Emerton Building (a conference centre) and the hospital Outpatients Department beyond; and,*

iv. *To the west by Upper Abbey Road with residential apartments and housing beyond.*

SECTION 3 LEGISLATION AND ASSESSMENT STANDARDS

3.1 AIR QUALITY REGULATIONS

3.1.1 European air quality legislation is contained within directive 2008/50/EC, which came into force on 11th June 2008. This directive consolidates previous legislation designed to deal with specific pollutants in a consistent manner including directive 99/30/EC – the first air quality 'daughter' directive which sets limit values for NO_x and NO_2.

3.1.2 Directive 2008/50/EC is transposed under UK law into the Air Quality Standards Regulations 2010. Air quality standards and objectives (AQOs) for major pollutants are outline in the Air Quality Strategy 2007 (AQS).

3.1.3 The AQS defines ‘standards’ and ‘objectives’ in paragraph 17:

3.1.4 *‘For the purposes of the strategy:*

i. standards are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups or on ecosystems

ii. objectives are policy targets often expressed as a maximum ambient concentration not to be exceeded, either without exception or with a permitted number of exceedances, within a specified timescale.’

3.1.5 The status of the objectives is clarified in paragraph 22, which also emphasises the importance of European Directives:

i. ‘The air quality objectives in the Air Quality Strategy are a statement of policy intentions or policy targets. As such, there is no legal requirement to meet these objectives except in as far as these mirror any equivalent legally binding limit values in EU legislation’.

3.1.6 The relevant AQO for human exposure to NO_2 are an annual mean concentration of 40 $\mu g.m^{-3}$ and an hourly mean concentration of 200 $\mu g.m^{-3}$ not to be exceeded more than 18 times per year. The AQOs were to have been achieved by 2005 and continue to apply in all years thereafter.

3.1.7 The regulations state that likely exceedances of the AQO should be assessed in relation to *‘the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present’*.

3.1.8 The focus is therefore on those 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.

3.2 CLEAN AIR ACT

3.2.1 The Clean Air Act 1993 sets out, in Section 14 of Chapter 11, the statutory requirement for chimney stacks to disperse polluting emissions before they reach ground level. It applies to all boilers or industrial plant equipped with a furnace which burns fuel above a certain rate. The chimney height of such appliances is required to be approved by the local authority, which must be satisfied that the emissions will not be prejudicial to health or a nuisance.

3.3 ENVIRONMENTAL PERMITTING REGULATIONS

3.3.1 The Environmental Permitting Regulations (England and Wales) 2016 require regulators to control certain activities which could harm the environment or human health including combustion activities.

3.3.2 The Environmental Permitting (England and Wales) (Amendment) Regulations 2018 were made on 29 January and came into force on 30 January. These Regulations amend the 2016 Regulations to add provisions relating to medium combustion plants (MCP), defined as combustion plant with a rated thermal input between 1 and 50 MW. The 2018 Regulations transpose the Medium Combustion Plant Directive (MCPD) which lays down rules to control emissions of sulphur dioxide, nitrogen oxides and dust from MCPs.

SECTION 4 BASELINE AIR QUALITY

4.1 INTRODUCTION

4.1.1 Oxides of nitrogen (NO_x) are emitted by combustion processes, mostly in the form of the less harmful nitrogen oxide (NO). This is converted in the atmosphere to the Air Quality Strategy pollutant nitrogen dioxide (NO_2). The amount of NO_2 produced depends on a number of factors, including the presence of other pollutants (particularly ozone) and meteorological conditions. It therefore varies considerably over time and geographical area. However, the relative contribution of various sources to the resulting ambient concentrations of NO_2 can generally be assumed to be in proportion to their emissions of NO_x.

4.1.2 PM_{10} comprises the proportion of airborne particulate matter that is less than 10 µm in diameter. This includes fine particles of less than 2.5 µm diameter ($PM_{2.5}$), which can penetrate deeper into the lungs than coarser particles and are becoming increasingly associated with the health effects of particulate pollution. Fine particles are emitted by combustion processes, non-exhaust traffic-related emissions (tyre and brake wear) and also include secondary particles, which are formed in the atmosphere by chemical reactions between other pollutants. The sources of secondary particles can be very distant and include areas outside the UK. The coarser fraction of PM_{10} originates primarily from non-combustion sources.

4.1.3 As all proposed plant is to be fired using natural gas under normal operational conditions, the key air pollutant of concern for the purpose of this assessment is NO_2. Under emergency conditions (interruption of the gas-supply to the site), the boilers will be capable of temporary operation using light fuel-oil. The potential for PM_{10} emissions exists during firing of the boilers using light fuel oil, primarily during start-up and shut down (emissions during steady-state operation are typically negligible). However, as this emergency situation is unlikely to occur, and testing of the boilers using light fuel oil will be restricted to around 12 hours per year, PM_{10} emissions are not considered to warrant detailed consideration in this assessment.

4.1.4 The significance of emissions from the proposed combustion plant must be considered alongside ambient concentrations of air pollutants which are summarised in the following section.

4.2 LOCAL AUTHORITY MONITORING DATA

4.2.1 Reference has been made to the following information sources:

i. *BHCC Air Quality Annual Status Reports 2015 to 2018; and,*

ii. *DEFRA UK AIR website.*

4.2.2 The site itself is not located within an Air Quality Management Area (AQMA). However, Eastern Road which bounds the site to the south has been declared an AQMA by BHCC in respect of the 1-hour mean and annual mean AQO for NO_2.

4.2.3 There were five active continuous monitoring station (CMS) sites operating within the BHCC area in 2017. The closest CMS sites to the proposed flue location are North Street (BH10), Lewes Road (BH6) and Preston Park (BH0). The table below summaries the site details and annual mean concentrations of NO_2 recorded at these CMS sites in recent years.

Table 1: Annual mean concentrations of NO_2 at nearby CMS sites

Site Name	Site type	Distance to flue location	Annual Mean Concentration ($\mu g.m^{-3}$)					
			2013	2014	2015	2016	2017	2018
BH10	R	1.8 km W	**59.7**	**56.4**	**52.5**	**47.1**	**50.3**	-[A]
BH6	R	1.9 km NW	**48.4**	**48.7**	39	**46.2**	**51.1***	-[A]
BH0	SUB	3.2 km NW	16.7	16	14.8	16.5*	16.9	16[B]
AQO			**40**					

Notes:
Bold values represent an exceedance of the AQO
* Data capture is below 90 %
[A] Data not yet available
[B] AURN site- data obtained from UK-AIR (DEFRA) website

Key:
SUB – Suburban background
R – Roadside

4.2.4 Annual mean concentrations of NO_2 at the roadside CMS sites BH10 and BH6 have exceeded, or been close to exceeding, the AQO of 40 $\mu g.m^{-3}$ for all years reviewed. Concentrations of NO_2 at the suburban background site BH0 are consistently well below (less than half of) the AQO.

4.2.5 There have been no exceedances of the hourly mean AQO for NO_2 at BH6 and BH10. However, the roadside BH10 CMS exceeded the short-term AQO in 2013 (19 exceedances), 2014 (33 exceedances) and 2017 (69 exceedances).

4.2.6 As concentrations of NO_2 decrease with distance from the road, it is anticipated that NO_2 concentrations at the façade of TKT (which is situated over 50 m from the nearest road) will be lower than those recorded at the roadside CMS sites (BH10 and BH6). However, they are likely to be higher than those recorded at the background CMS (BH0) which is situated approximately 200 m from the closest road.

4.2.7 Non-automatic (passive) monitoring of NO_2 is also undertaken in the vicinity of the site using diffusion tubes. Table 2 provides details of the closest monitoring locations to the proposed flue location. Bias-adjusted monitoring data from these sites in recent years is presented in Table 3.

Table 2: Diffusion tubes in the vicinity of the energy centre.

Site ID	Description	Type	Distance to kerb (m)	Approximate distance to flue locations (km)	Direction relative to flues
E18	Eastern Road	R	3.5	0.1	S
C3 - 2015	St James Street Lamp	K	3	1.3	W
C03	St James Street	R	3.8	1.3	W
E17-2015	174 Edwards Street	R	2.9	1.4	NW
C05 - 2012	Pavilion Gardens	UB	102	1.6	NW

Key:
R – Roadside
K - Kerbside
UB- Urban Background

Table 3: Annual mean concentrations of NO_2 at nearby diffusion tube sites

Site Name	Annual Mean Concentration ($\mu g.m^{-3}$)					
	2013[D]	2014	2015	2016	2017	**AQO**
E18	**42.2**	**40.5****	35.4	**43.6**	**42.2**	**40**
C3 - 2015	-	-	37.3**	**40.2***	**40.5****	
C03	39.9	36.3*	33	35.3*	34.1*	
E17 - 2015	-	-	36.5**	37.8	37**	
C05 - 2012	26.1	22.6	22.5**	26.1**	23.6	

Notes: **Bold** values represent an exceedance of the AQO
* Data capture is below 90 %
** Data capture is below 75 %
[D] Data capture is not available

4.2.8 With reference to the table above, concentrations at the roadside diffusion tube sites C03 and E17–2015 have been elevated but below the annual mean AQO for all years reviewed. Annual mean concentrations at the kerbside site C3–2015, located in close proximity to monitoring site C03, have been above the AQO since 2016 (data capture rates for 2015 and 2017 were below 75 % and should therefore be treated with caution).

4.2.9 Annual mean concentrations of NO_2 recorded at the roadside monitor E18, located closest to the study area, have been above the AQO in recent years with the exception of 2015 when they were marginally below.

4.2.10 Annual mean concentrations of NO_2 at the urban background diffusion tube site C05 – 2012 have been well below the AQO since at least 2013.

4.3 DEFRA BACKGROUND MAPS

4.3.1 Reference has been made to the DEFRA background air pollutant concentration maps available on the UK-AIR website. The background maps are presented in 1 km x 1 km grid squares across England, Wales, Scotland and Northern Ireland. The current version of the background maps (reference year 2017) contains estimates for NO_x, NO_2, PM_{10} and $PM_{2.5}$ for the period 2017 through to 2030.

4.3.2 The 2017 reference year background maps are based on monitoring and meteorological data for 2017. The predicted background concentrations of for the grid square in which the site is situated are presented in the table below for the reference year (2017) and current year (2019).

Table 4: Predicted annual mean background map concentrations for grid square centred at ^{5}32500, ^{1}03500.

Pollutant	Annual Mean Concentration (µg.m^{-3})		AQO
	2017	2019	
NO_2	13.86	12.69	**40**

4.3.3 The predicted DEFRA background concentration for NO_2 in the vicinity of the site is well below the annual mean AQO.

4.3.4 To verify the reliability of the predicted DEFRA background map concentrations for predicting background concentrations at the site, a comparison was made between the 2015 monitored NO_2 concentration at the C05–2012 urban background diffusion tube monitoring site and the predicted DEFRA background map concentration for the corresponding grid square. Comparison of the monitored concentration of 22.5 µg.m^{-3} and the predicted background map concentration of 20.73 µg.m^{-3} indicates that the DEFRA background maps are slightly underpredicting background concentrations in the local area.

4.4 INDUSTRIAL INSTALLATIONS

4.4.1 With reference to the Environment Agency (EA) online public register there are no permitted Part A processes within 1 km of the proposed development site.

4.4.2 With reference to the Environmental Permitting Regulations 2017 public register accessed via the BHCC website, there are no relevant Part B process registered within 500 m of the energy centre.

4.5 **SUMMARY**

4.5.1 The closest monitoring site to the study area is the roadside diffusion tube ‘E18’ which is located adjacent to Eastern Road to the south of the site. However, as the flues are to be located approximately 90 m north of Eastern Road, baseline concentrations are expected to be closer to urban background levels. The closest urban background monitoring location to the proposed flues is diffusion tube C05–2012. This monitoring site is considered to be adequately representative of baseline concentrations in the vicinity of the flues.

4.5.2 The baseline concentration of NO_2 is therefore assumed to be 23.6 $\mu g.m^{-3}$ for the purpose of this assessment based on the most recent monitoring data from C05–2012 site.

SECTION 5 ASSESSMENT METHODLOGY

5.1 This assessment has been carried out using Atmospheric Dispersion Modelling System 5 (ADMS5). This is commercially available software in the form of a “new generation” Gaussian plume dispersion model, produced by Cambridge Environmental Research Consultants (CERC). It can model the three-dimensional dispersion of pollutants released to atmosphere from multiple chimney stacks simultaneously and calculates predicted concentrations of designated pollutants at ground level or at other designated points. The ADMS family of models are recognised, and in some cases used, by UK regulatory authorities including the Environment Agency (EA) and many Local Authorities.

5.2 Upon completion of the project, the energy demand will be addressed by one of the following combinations:

i. *Scenario A - Operation of 3 No. 3000 kW boilers and 1 No. 2000 kW boiler; or,*

ii. *Scenario B - Operation of 3 No. 3000 kW boilers and 1 No. CHP unit.*

5.3 Modelling has been undertaken on the basis of continuous (24/7) operation of all items of plant (four items in total for each scenario) at full load in order to assess worst-case impacts.

SECTION 6 INPUT PARAMETERS

6.1 **GENERAL**

6.1.1 A surface roughness of 0.5 m was selected to represent the dispersion site which is representative of ‘Parkland, open suburbia’. Dimensions of key buildings were input specifically as detailed in Section 6.2.

6.1.2 RSCH is located on a hill sloping downwards from north to south. To represent this change in gradient, a terrain file has been included in the model.

6.2 BUILDINGS

6.2.1 ADMS 5 requires buildings to be inputted as regular cuboids. For the purpose of this assessment all surrounding buildings greater than 40 % of the modelled stack height have been included in the model which accords with EA guidance for environmental permitting applications. When a building is an irregular shape, its dimensions are averaged out manually for use in the model.

6.2.2 The proposed energy centre is to be installed within TKT, which is also the tallest building on site. Therefore, TKT has been input specifically along with the existing Royal Alexandra Children's Hospital and the proposed Section 02 buildings, as shown in Figure 2 in Appendix 2. The dimensions of the modelled buildings are provided in Tables A7- A9 in Appendix 2.

6.3 PLANT PARAMETERS

6.3.1 ADMS5 simulates the dispersion of plumes of exhaust gases emitted by one or more sources.

6.3.2 It is understood that the site is currently served by 4 No. 1540 kW boilers. The replacement energy centre will serve the existing site as well as the two new clinical buildings which are currently under construction (Section 02 and Section 03).

6.3.3 The emission sources within the completed energy centre will comprise:

i. *3 No. Hoval pressure jet SRH-plus 3000 kW boilers;*

ii. *1 No. Hoval pressure jet SRH-plus 2000 kW boiler; and,*

iii. *1 No. Cogeneration Unit JMS 612 GS-N.L Combined Heat and Power (CHP) unit.*

6.3.4 The energy centre will be commissioned in two stages. Stage 1 will involve the commissioning of 2 No. 3000 kW boilers which will be operated alongside 3 No. existing 1540 kW boilers (which will continue to serve the existing site). Stage 2 will involve the replacement of the remaining 3 No. 1540 kW boilers with a further 3000 kW boiler, a 2000 kW boiler and a CHP unit. This assessment considers the impact of the completed energy centre once fully operational (i.e. upon completion of Stage 2).

6.3.5 Each item of plant will be individually flued giving a total of five flues upon completion of Stage 2.

6.3.6 All items of plant will be fuelled by natural gas under normal operation. The boilers are dual-fuel type (gas and oil) to allow for emergency operation using light fuel oil in the event of an interruption to the gas supply (highly unlikely).

6.3.7 IDOM has been advised that the burners are expected to be fired using light fuel oil on a monthly basis, for an approximate duration of one-hour, for testing purposes.

The annual mean AQO is not applicable to the oil-fired scenario due to the limited hours of operation. Additionally, as the burners are anticipated to be fired using oil for only 12 hours per year (for testing purposes), it will not be possible to exceed the short-term AQO which allows for NO_2 emissions to exceed 200 µg.m^{-3} on 18 occasions over the course of a calendar year.

6.3.8 As neither of the AQO's are strictly applicable to oil-fired operations, this assessment considers the impact of the energy centre under normal operation (gas-fired) only.

6.3.1 Plant parameters including diameter of flue, temperature of emissions, volume flow rates and NO_x emissions rates have been supplied by A1 Flue Systems and Laing O'Rourke. A full list of the input parameters used is provided in Appendix 2. These plant parameters are based on data provided and have been used in good faith. However, independent verification of these parameters or the base data has not formed part of IDOM's appointment.

6.4 METEOROLOGICAL DATA

6.4.1 ADMS5 requires meteorological data, which it uses to simulate the behaviour of exhaust emission plumes in different weather conditions. Data was acquired from ADM Ltd for the weather station at Shoreham situated approximately 13 km to the west. The data was in the form of an hourly sequential dataset for 2018 (the most recent dataset available).

6.4.2 A wind rose illustrating the meteorological data is presented in Figure 3 in Appendix 2. This clearly shows that the most frequent winds are from the north however the strongest winds are from the southwest.

6.4.3 The dataset for 2018 contains 8522 usable lines of meteorological data (met lines) which equates to over 97.2 % usable data. The site has 52.1% missing cloud data for 2018 which has been supplemented from Gatwick (10 %) and Southampton (42.1 %) as recommended by the supplier.

6.5 MODELLED RECEPTORS

6.5.1 Introduction

6.5.1.1 Modelled receptor heights have been taken as 1.5 m above finished floor level to correspond with exposure (breathing) height at each floor. Where building/floor height information is not available, satellite imagery has been used to estimate the number of floors and each floor has been assumed to be approximately 3 m in height.

6.5.2 Existing receptors

6.5.2.1 A number of receptors have been selected surrounding the proposed flue locations to represent existing exposure. These are located within the RSCH site, as well as nearby off-site locations.

6.5.2.2 For buildings on-site, a receptor has been selected on each façade and at each floor height of TKT in order to satisfy the requirements of planning condition 19. In addition, a number of receptors have been modelled to represent the existing hospital buildings surrounding the flues. Receptor locations for these buildings have been selected on the façades closest to the flues and have been modelled at ground and roof level to demonstrate the range of concentrations which are predicted to be experienced in these locations.

6.5.2.3 The off-site existing receptors are predominantly located northeast and south of the proposed flue location due to the dominant wind direction being from the north and southwest. Concentrations have been predicted at the highest storey of these off-site buildings to represent worst-case exposure (i.e. closest to the modelled flue termination height).

6.5.2.4 The increase in NO_2 concentrations has been used to predict the impact of the proposed energy centre on existing, off-site, sensitive receptors and inform the assessment of the overall effect on local air quality. The existing modelled receptors are shown on Figure 4 in Appendix 2 and are detailed in the table below.

Table 5: Modelled existing sensitive receptor locations

On / off-site	Ref	Type	x	y	Floor(s)
Off-site	EX1	Residential	532805.2	103994.2	6
	EX2	Residential	532828	103991.8	2
	EX3	Residential	532828	103991.8	2
	EX4	Residential	532828	103991.8	2
	EX5	Brighton College Nursery & Pre-Prep School	532870.9	103958.9	3
	EX6	Residential	532870.9	103958.9	3
	EX7	Residential	532870.9	103958.9	2
	EX8	Residential	532885.5	103888.7	2
On-site	H2	Royal Sussex Children's Hospital	532732.4	103941.9	0 & Roof level
	H3	Millennium Wing	532801.6	103952.7	0 & Roof level
	H4	Sussex Kidney Unit & Multi-storey Car Park	532748	103968.1	0 & Roof level
	H5	A&E	532794.7	103904.7	0 & Roof level

On / off-site	Ref	Type	x	y	Floor(s)
	H7	TKT east	532789	103923.1	0-11
	H8	TKT west	532757.5	103932.7	0-11
	H9	TKT north	532782.5	103949.4	0-11
	H10	TKT south	532768.2	103905.1	0-11

6.5.3 Proposed receptors

6.5.3.1 Receptors have also been selected on the façades of the Section 02 and Section 03 buildings currently under construction as part of the Brighton 3T's project to represent future exposure. Future receptors have been selected on the façade closest to the proposed flue locations and have been modelled at ground and roof level.

6.5.3.2 The future modelled receptor locations are shown on Figure 5 in Appendix 2 and details are provided in Table 6 below.

Table 6: Modelled future sensitive receptors locations

Proposed building	Ref	x	y	z
Section 02	H1.0	532777.9	103896	1.5
	H1.1	532777.9	103896	50.67
	H11.0	532734.3	103911.6	1.5
	H11.1	532734.3	103911.6	50.67
Section 03	H6.0	532693.5	103920.7	1.5
	H6.1	532693.5	103920.7	25.52

6.6 GRIDDED OUTPUT

6.6.1 The model has also been used to predict ground level concentrations on a regular grid across the modelled domain. The modelled domain extends over an area of 365 x 315 m and covers the site and closest surrounding sensitive receptors. The receptor grid resolution that has been selected results in a spacing of 5 m between output points.

SECTION 7 RESULTS & IMPACT ASSESSMENT

7.1 INTRODUCTION

7.1.1 In dispersion modelling NO_x emission rates are input as 'NO_x as NO_2' values in order to account for uncertainties in the proportions of NO and NO_2 present in the exhaust gas. EA guidance recommends a phased approach for dispersion modelling of combustion sources where NOx is expressed as NO_2. The results reported in the following sections summarise the results for the 'worst case' scenario as defined by the EA guidance (i.e. 70 % for the long term and 35% for the short term mean concentrations).

7.2 CONTOUR PLOTS

7.2.1 Contour plots showing the spatial distribution of long term (annual mean) and short-term (99.79th percentile of hourly mean) NO_2 concentrations are provided in Appendix 4.

7.2.2 The maximum NO_2 concentrations predicted within the modelled domain are summarised in the table below.

Table 7: Maximum predicted ground level NO_2 concentrations within modelled domain

Scenario	Averaging period	x	y	NO_2 concentration ($\mu g.m^{-3}$)
A	Long term (annual mean)	532745	103915	3.44
	Short term (hourly mean)	532645	104065	6.49
B	Long term (annual mean)	532745	103915	1.64
	Short term (hourly mean)	532645	104065	2.69

7.2.3 The model result for the 99.79th percentile of hourly mean concentrations is used for comparison with the hourly mean AQO (200 $\mu g.m^{-3}$). Concentrations higher than this percentile value would typically occur on only 18 hours per year. Therefore, if the 99.79th percentile is lower than the hourly mean AQO (when background concentrations are taken into account) it can be assumed that the AQO will not be exceeded more often than the permitted 18 times per year.

7.2.4 With reference to the contour plots in Appendix 4 (Figures 6 - 9), the maximum ground level annual mean NO_2 concentrations for Scenario A and Scenario B are predicted to occur the along the western façade of TKT to the west of the flues. The highest 99.79th percentile of hourly mean concentrations for both scenarios are predicted to occur northwest of RSCH site (northeast of the flues).

7.2.5 With reference to Section 4.5.2, the baseline concentration of NO_2 in the study area is assumed to be 23.6 $\mu g.m^{-3}$ for the purpose of this assessment.

7.2.6 When considering short term impacts EA guidance suggests that it is appropriate to combine 2 x the assumed annual mean background concentration with the process contribution for comparison against the AQO. When combined with the assumed background, the predicted ground-level concentrations summarised in Table 7 above are below both the long-term and short-term AQO.

7.3 MODELLED RECEPTORS

7.3.1 Existing Receptors

Off-site

7.3.1.1 The Air Quality Regulations state that likely exceedances of the AQO should be assessed in relation to *'the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present'*.

7.3.1.2 The focus is therefore on those 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. For annual mean concentrations this might be where people are exposed for a cumulative period of six months in a year e.g. residential dwellings. Hospitals, schools, hospitals and care homes are considered to be of comparable sensitivity to residential dwellings therefore annual mean AQOs also apply at the façades of such buildings.

7.3.1.3 Guidance produced jointly by the IAQM and Environmental Protection UK (EPUK)[1] outlines a methodology for determining the significance of impacts.

7.3.1.4 An impact descriptor is determined for each receptor based on the change in annual mean pollutant concentration with the combustion plant in operation and the total resulting pollutant concentrations relative to the AQO. Where the change in concentration is less than 0.5 % of the AQO the impact can be described as 'negligible'.

7.3.1.5 The magnitude of impact at the modelled existing off-site receptor locations is summarised in the Table 8 below.

Table 8: Predicted annual mean NO_2 concentrations at sensitive existing receptors for Scenario A.

Scenario	Receptor ID	Annual mean NO_2 contribution ($\mu g.m^{-3}$)	% change relative to AQO	Total annual mean concentration ($\mu g.m^{-3}$)	Total annual mean as % of AQO	Impact
A	EX1.0	1.39	3	24.99	62	Negligible
	EX1.1	1.39	3	24.99	62	Negligible
	EX1.2	1.39	3	24.99	62	Negligible
	EX1.3	1.39	3	24.99	62	Negligible

[1] Moorcroft and Barrowcliffe. et. al. (2017) 'Land-Use Planning & Development Control: Planning for Air Quality. v1.2', IAQM

Scenario	Receptor ID	Annual mean NO_2 contribution (µg.m^{-3})	% change relative to AQO	Total annual mean concentration (µg.m^{-3})	Total annual mean as % of AQO	Impact
	EX1.4	1.39	3	24.99	62	Negligible
	EX1.5	1.39	3	24.99	62	Negligible
	EX1.6	1.39	3	24.99	62	Negligible
	EX2.0	1.11	3	24.71	62	Negligible
	EX2.1	1.11	3	24.71	62	Negligible
	EX2.2	1.11	3	24.71	62	Negligible
	EX3.0	0.62	2	24.22	61	Negligible
	EX3.1	0.62	2	24.22	61	Negligible
	EX3.2	0.62	2	24.22	61	Negligible
	EX4.1	0.16	0	23.76	59	Negligible
	EX5.1	0.08	0	23.68	59	Negligible
	EX6.1	0.28	1	23.88	60	Negligible
	EX7.1	0.42	1	24.02	60	Negligible
	EX8.1	0.86	2	24.46	61	Negligible
B	EX1.0	0.63	2	24.23	61	Negligible
	EX1.1	0.63	2	24.23	61	Negligible
	EX1.2	0.63	2	24.23	61	Negligible
	EX1.3	0.63	2	24.23	61	Negligible
	EX1.4	0.63	2	24.23	61	Negligible
	EX1.5	0.63	2	24.23	61	Negligible
	EX1.6	0.63	2	24.23	61	Negligible
	EX2.0	0.52	1	24.12	60	Negligible
	EX2.1	0.52	1	24.12	60	Negligible
	EX2.2	0.52	1	24.12	60	Negligible
	EX3.0	0.34	1	23.94	60	Negligible
	EX3.1	0.34	1	23.94	60	Negligible
	EX3.2	0.34	1	23.94	60	Negligible
	EX4.1	0.11	0	23.71	59	Negligible
	EX5.1	0.05	0	23.65	59	Negligible
	EX6.1	0.16	0	23.76	59	Negligible
	EX7.1	0.24	1	23.84	60	Negligible
	EX8.1	0.46	1	24.06	60	Negligible

7.3.1.6 The guidance states that judgement of the overall significance of effect for a proposal will rely on professional judgement based on a number of factors including the degree of impact at individual receptors. For example, a ‘moderate’ adverse impact at one receptor may not mean that the overall impact has a significant effect.

7.3.1.7 For Scenario A and B, the predicted impact at all of the modelled receptors is ‘negligible’. The combination of combustion plant emissions and assumed baseline is below the annual mean AQO at all modelled receptors.

7.3.1.8 The predicted 99.8th percentile of hourly mean NO_2 concentrations at the modelled receptors (including assumed baseline concentrations) is summarised in the table below. The energy centre contribution is indicated in parentheses.

Table 9: Predicted 99.8th percentile of hourly mean NO_2 concentrations at existing off-site receptors.

Receptor ID	Total 99.8th percentile of hourly mean concentrations of NO_2 ($\mu g.m^{-3}$)	
	Scenario A	Scenario B
EX1.0	52.36 (5.16)	49.56 (2.36)
EX1.1	52.36 (5.16)	49.56 (2.36)
EX1.2	52.36 (5.16)	49.56 (2.36)
EX1.3	52.36 (5.16)	49.56 (2.36)
EX1.4	52.36 (5.16)	49.56 (2.36)
EX1.5	52.36 (5.16)	49.56 (2.36)
EX1.6	52.36 (5.16)	49.56 (2.36)
EX2.0	52.34 (5.14)	49.51 (2.31)
EX2.1	52.34 (5.14)	49.51 (2.31)
EX2.2	52.34 (5.14)	49.51 (2.31)
EX3.0	51.71 (4.51)	49.46 (2.26)
EX3.1	51.71 (4.51)	49.46 (2.26)
EX3.2	51.71 (4.51)	49.46 (2.26)
EX4.1	50.6 (3.4)	49.1 (1.9)
EX5.1	49.64 (2.44)	48.71 (1.51)
EX6.1	50.66 (3.46)	48.92 (1.72)
EX7.1	50.69 (3.49)	48.92 (1.72)
EX8.1	51.31 (4.11)	49.2 (2)

7.3.1.9 With reference to the table above, the predicted total concentrations are well below the short-term AQO at all modelled existing receptors.

7.3.1.10 The overall effect of both Scenario A and Scenario B on local air quality is judged to be ‘not significant’.

On-site

7.3.1.11 Concentrations of NO_2 have also been predicted at selected on-site existing receptors.

7.3.1.12 The full results for long-term (annual mean) and short-term (1-hour mean) averaging periods for Scenario A and Scenario B are presented in Tables A10 – A11 in Appendix 3.

7.3.1.13 For Scenario A and B, predicted concentrations are well below the relevant AQO at all modelled receptors at all floor heights.

7.3.2 Proposed Receptors

7.3.2.1 Concentrations of NO_2 have been predicted at selected proposed receptors on the façade of the Section 02 and Section 03 buildings closest to the proposed energy centre flues as detailed in Section 6.5.3. Receptors have been modelled at ground and roof level. The results for long-term (annual mean) and short-term (hourly mean) averaging periods for Scenario A and B are presented in Table 10 below. The energy centre contribution is indicated in parentheses after the total figure (which includes assumed baseline concentrations).

Table 10: Total predicted NO_2 concentrations at proposed receptors

Scenario	Receptor ID	Total predicted NO_2 concentration (µg.m^{-3})	
		Annual mean	99.8th percentile of hourly mean
A	H1.0	26.88 (3.28)	52.39 (5.19)
	H1.1	26.88 (3.28)	52.39 (5.19)
	H6.0	25.06 (1.46)	52.21 (5.01)
	H6.1	25.06 (1.46)	52.21 (5.01)
	H11.0	27 (3.4)	52.39 (5.19)
	H11.1	27 (3.4)	52.39 (5.19)
B	H1.0	25.18 (1.58)	49.64 (2.44)
	H1.1	25.18 (1.58)	49.64 (2.44)
	H6.0	24.31 (0.71)	49.47 (2.27)
	H6.1	24.31 (0.71)	49.47 (2.27)
	H11.0	25.22 (1.62)	49.64 (2.44)
	H11.1	25.22 (1.62)	49.64 (2.44)

7.3.2.2 For Scenarios A and B, predicted concentrations are below the relevant AQO at all modelled future receptors at all floor heights. The highest energy centre contributions (and therefore total annual mean concentrations) for both scenarios are predicted to occur at receptor H11 with concentrations of 27 µg.m^{-3} and 25.22 µg.m^{-3} predicted for Scenario A and Scenario B respectively.

7.3.2.3 The highest hourly mean energy centre contributions for both scenarios are predicted to occur at receptors H1 and H11 with concentrations of 5.19 µg.m^{-3} and 2.44 µg.m^{-3} for Scenario A and Scenario B respectively.

SECTION 8 CONCLUSIONS

8.1 Dispersion modelling has been undertaken using ADMS 5 for emissions from the proposed energy centre to be installed as a part of the Brighton 3T's project at RSCH. The modelling has been used to assess the predicted impact of combustion plant emissions on existing and proposed sensitive receptors.

8.2 As combustion plant is to be fired using natural gas under normal operation the pollutant of concern for the purpose of this assessment was identified as NO_2.

8.3 The site itself is not located within an AQMA and baseline concentrations of NO_2 in the vicinity of the proposed energy centre are expected to be well below the annual mean AQO.

8.4 Modelling has been undertaken to represent two potential operating scenarios upon completion of Stage 2 of the energy centre and following construction of all new buildings associated with the 3T's project.

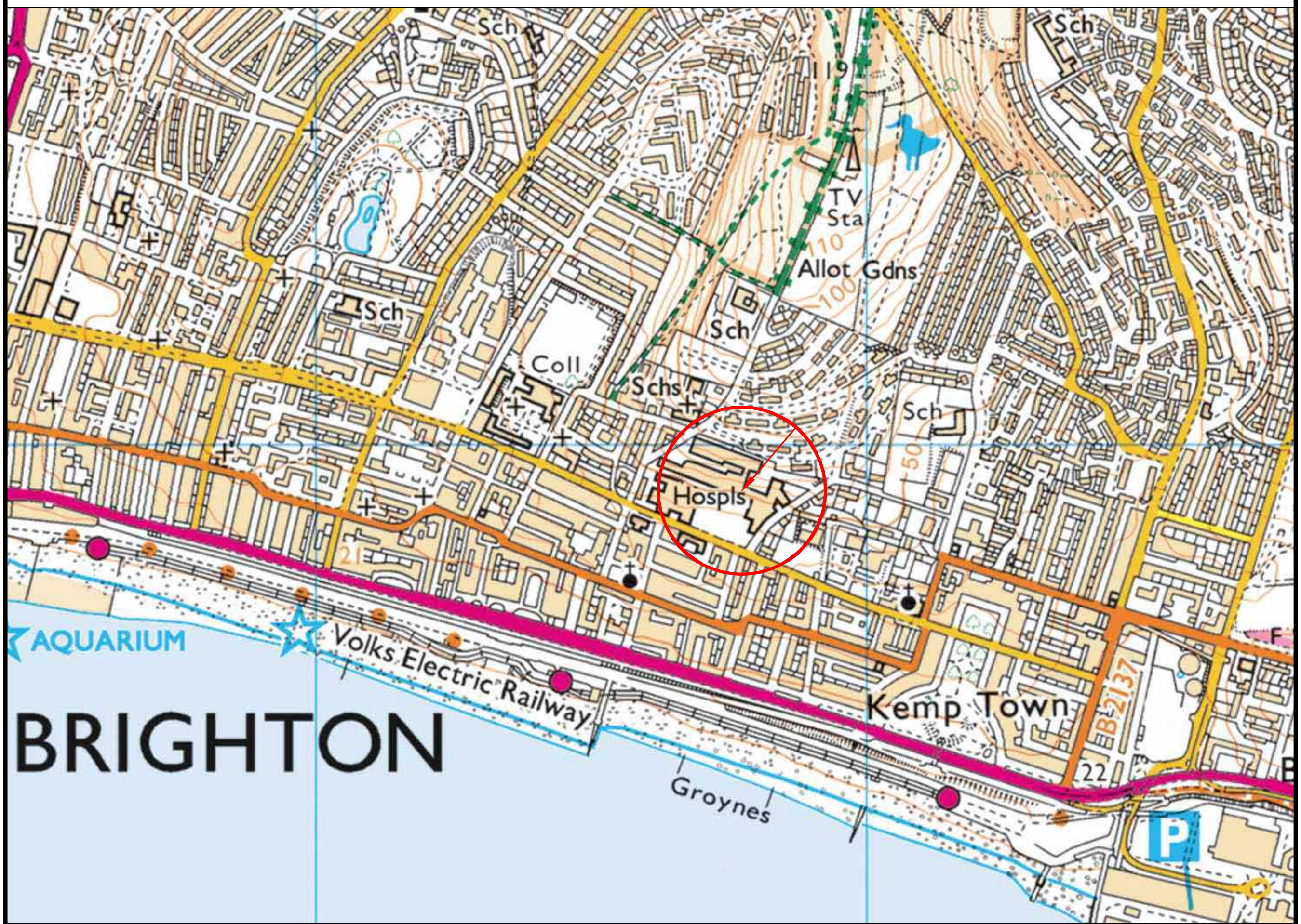
8.5 For each scenario, all items of plant have been assumed to operate continuously (24/7) at full load in order to produce a robust assessment.

8.6 Modelling was undertaken based on a stack termination height of 71.9 m agl which corresponds to 3 m above the highest part of TKT through which the proposed energy centre flues will discharge.

8.7 For both operating scenarios, the relevant AQO are achieved at all modelled receptors. Specifically, energy centre emissions at all floors of the TKT are predicted to result in NO_2 concentrations which are less than 40 $\mu g.m^{-3}$ as an annual mean and less than 200 $\mu g.m^{-3}$ for the 19th highest hour in the year. As the proposed flue termination height enables the relevant AQO to be achieved, the requirements of planning condition 19 are considered to be satisfied.

8.8 It is understood that 4 No. large boilers are currently operating on the RSCH site. The net increase in emissions will therefore be significantly lower than presented in this assessment. There may even be an improvement compared to the current situation. However, modelling of existing combustion plant for comparison with the proposed energy centre is not within the remit of this assessment.

APPENDIX 1 Drawings



Issue Details			
First Issue		26-06-2019	REV
	SNC	ECW	ECW
Issue Details	Dwn	Chd	App'd

IDOM

A1 Flue Systems, Brighton 3T's Project, Royal Sussex County Hospital

Site Location Plan

Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
t: +44(0)1773 829 988 f: +44(0)1773 829 393 e: info.derbyshire@idom.com

Job No.	Dwg No.	Revision
21888a	001-001	-
Scale	**Date**	**Frame Dimensions mm**
N.T.S	June 2019	(A4) 250x181
Drawn	**Checked**	**Approved**
SNC	ECW	ECW

APPENDIX 2 Input parameters

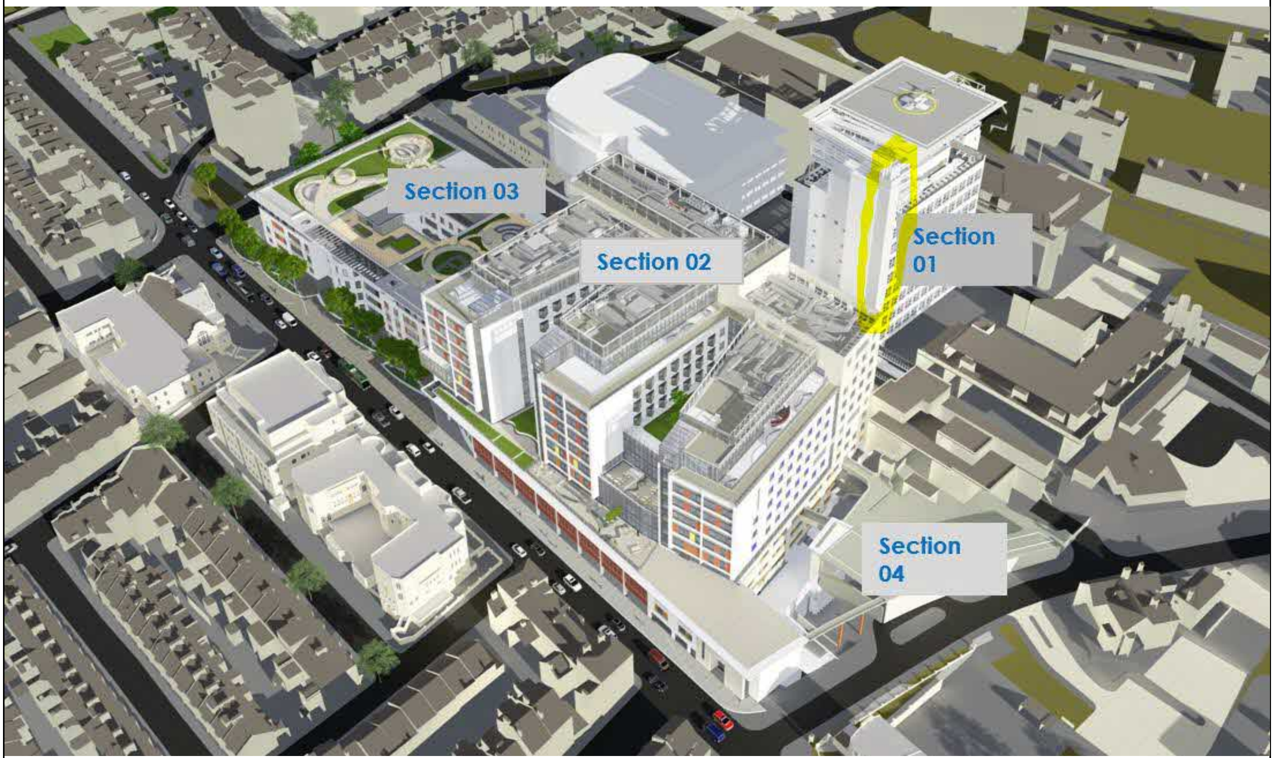


Figure 1: Proposed Site layout (received from Laing O'Rourke 24.06.19)

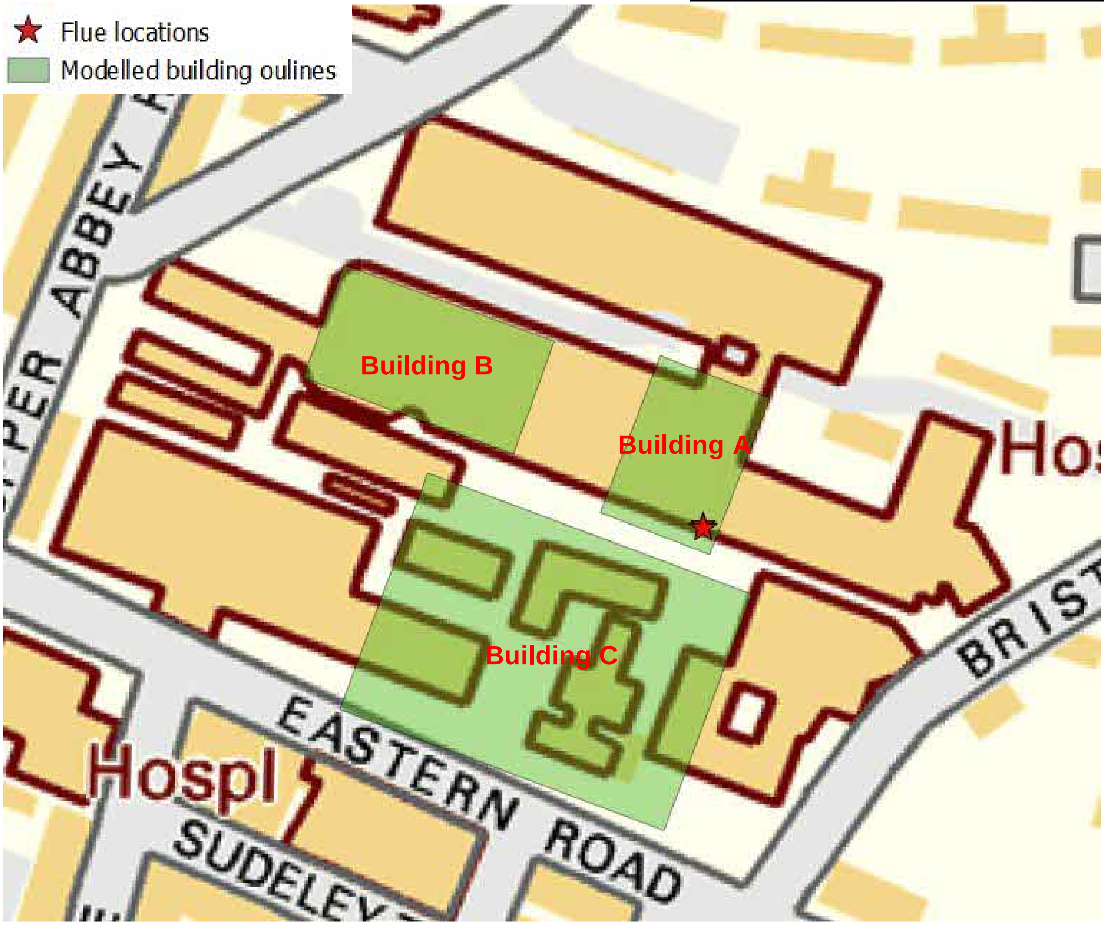


Figure 2: Modelled buildings

(Contains OS data © Crown copyright and database right (2019))

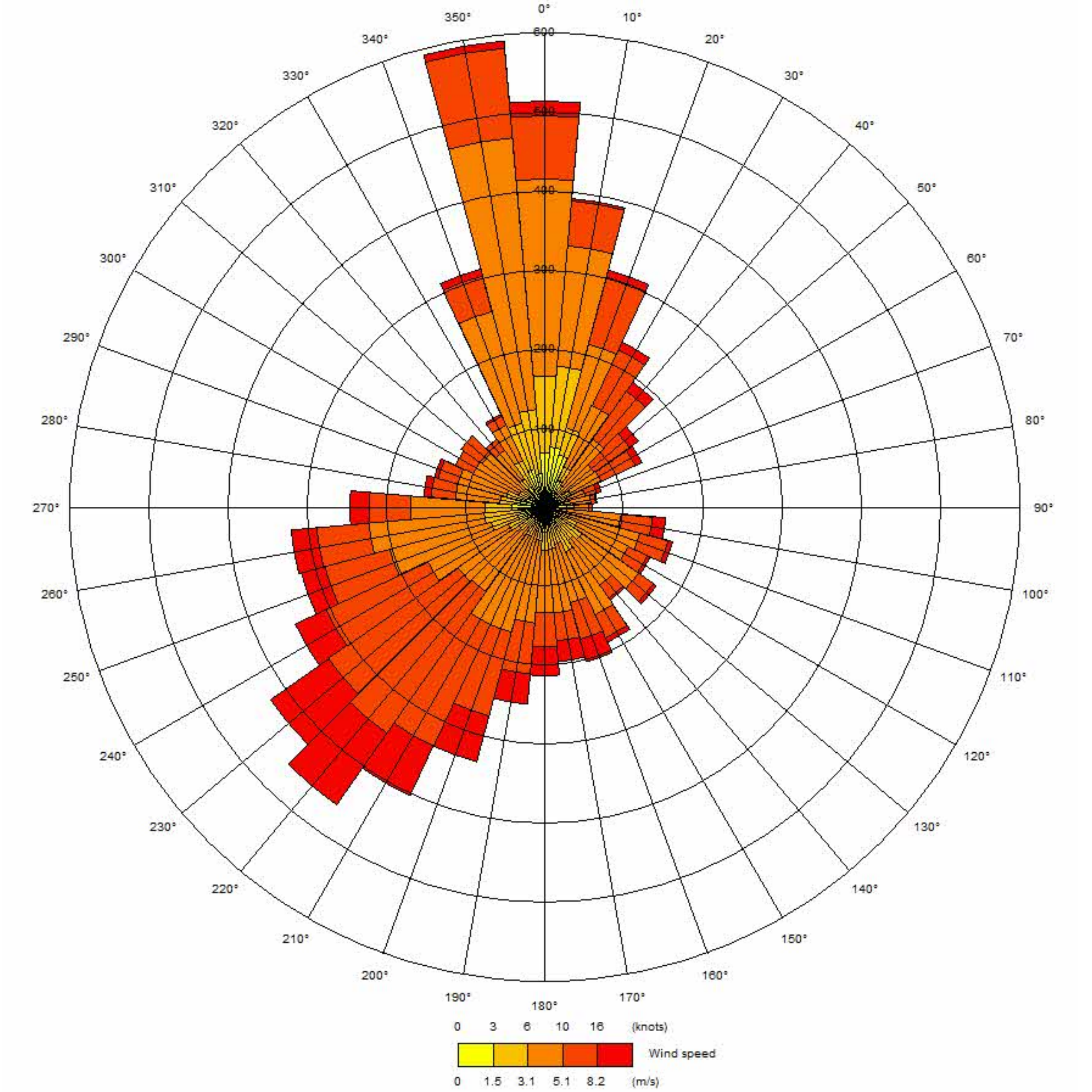


Figure 3: Wind rose showing meteorological dataset for Shoreham (2018)

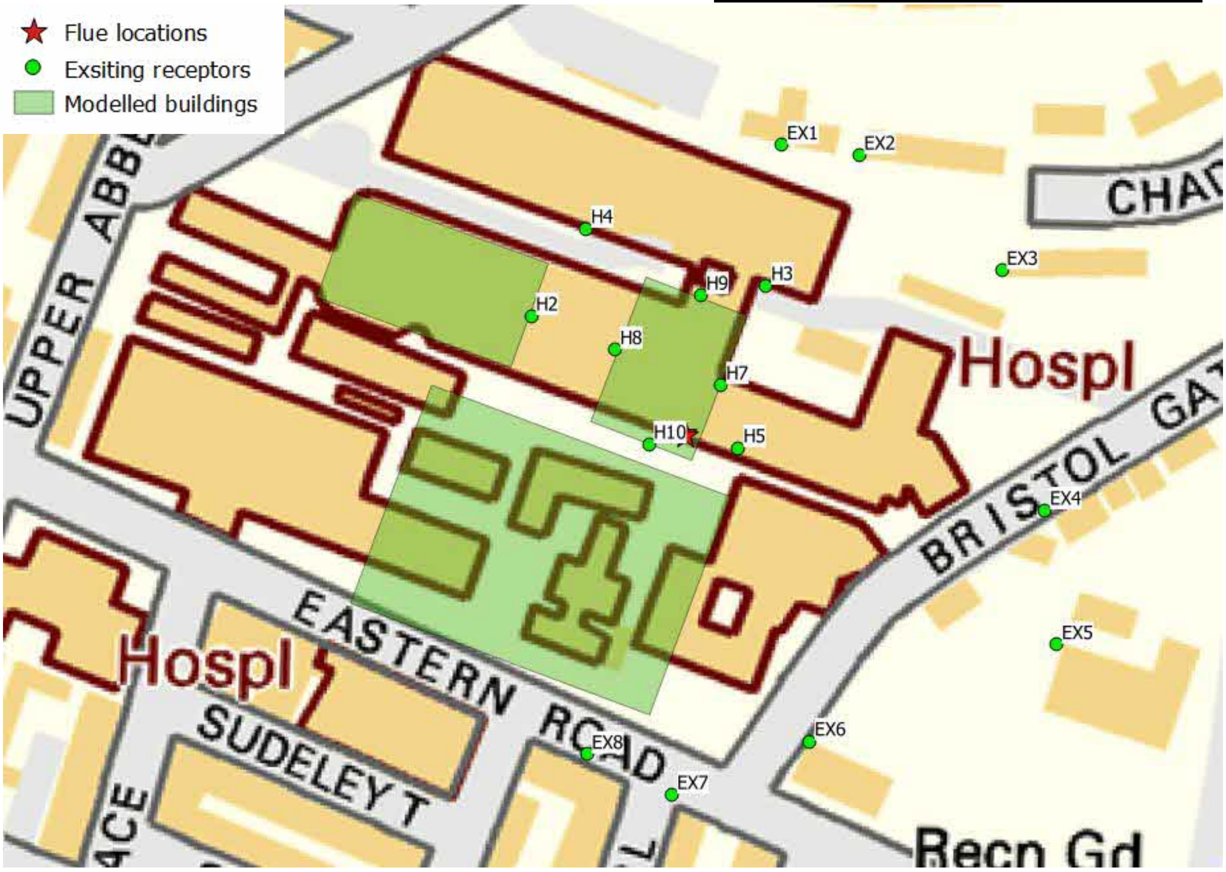


Figure 4: Modelled existing receptor locations

(Contains OS data © Crown copyright and database right (2019))

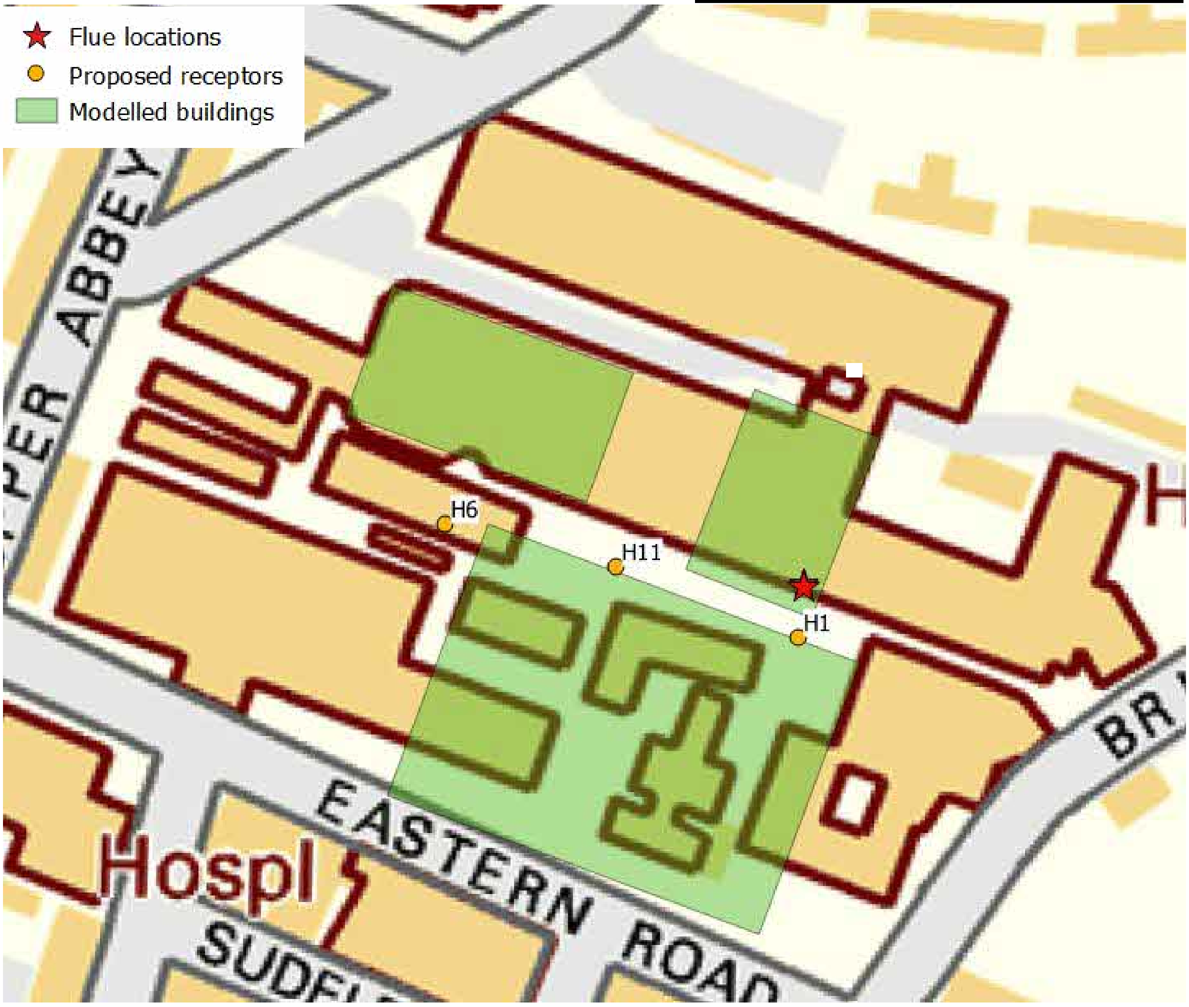


Figure 5: Modelled future receptor locations

(Contains OS data © Crown copyright and database right (2019))

Input parameters for proposed boiler plant - 3 x Hoval pressure jet SRH-plus 3000

Table A1: Calculation of input parameters (1 x boiler)

Ref.	*Parameter*	*Value*	*Units*	*Justification*
y	NOx emission factor @ 0 % O_2	0.0900	g/kWhr	Email from A1 Flue Systems 13.06.19
p	Power	3000	kW	Technical data sheet
D	NOx Discharge rate	0.075	g/s	(y*p)/3600
Td	Discharge temperature	405	K	Email from A1 Flue Systems 10.06.19
V	Vertical Velocity	11.20	m/s	Email from A1 Flue Systems 10.06.19
Vtd	Volume flow rate @ Td	2.97	m^3/s	Email from A1 Flue Systems 10.06.19
A	Xsect area	0.25970594	m^2	

Table A2: Summary of ADMS 5 Input parameters (3 x boilers individually flued)

Parameter	*Value*	*Units*	*Justification*
Height of discharge	71.90	m	Estimated from scale drawing
Discharge stack diameter (ID)	0.575	m	Email from A1 Flue Systems 10.06.19
Discharge temperature	132	°C	Email from A1 Flue Systems 10.06.19
Vertical Velocity	11.20	m/s	Email from A1 Flue Systems 10.06.19
Discharge rate NOx	0.0750	g/s	Calculated

Input parameters for proposed boiler plant - 1 x Hoval pressure jet SRH-plus 2000

Table A3: Calculation of input parameters

Ref.	*Parameter*	*Value*	*Units*	*Justification*
y	NOx emission factor @ 0 % O_2	0.0900	g/kWhr	Email from A1 Flue Systems 13.06.19
p	Power	1866	kW	Technical datasheet
D	NOx Discharge rate	0.0467	g/s	(y*p)/3600
Td	Discharge temperature	419	K	Email from A1 Flue Systems 10.06.19
Vtd	Volume flow rate @ Td	1.675	m^3/s	Email from A1 Flue Systems 10.06.19
A	Xsect area	0.159	m^2	

Table A4: Summary of ADMS 5 Input parameters (1 x boilers)

Parameter	*Value*	*Units*	*Justification*
Height of discharge	71.9	m	Estimated from scale drawing
Discharge stack diameter (ID)	0.450	m	Email from A1 Flue Systems 10.06.19
Discharge temperature	146	°C	Email from A1 Flue Systems 10.06.19
Volume flow rate @ Td	1.675	m^3/s	Email from A1 Flue Systems 10.06.19
Vertical Velocity	10.30	m/s	Email from A1 Flue Systems 10.06.19
Discharge rate NOx	0.0467	g/s	Calculated

Input parameters for proposed CHP plant (Cogeneration Unit JMS 612 GS-N.L)

Table A5: Calculation of input parameters

Ref.	*Parameter*	*Value*	*Units*	*Justification*
y	NOx emission factor @ 5% O2	0.250	g/Nm^3	Technical description
yTd	NOx emission factor	0.109	g/m^3	Adjusted for Td
D	NOx emissions	0.685	g/s	Adjusted for Td
Td	Discharge temperature	624	K	Email from A1 Flue Systems 25.06.19
V	Vertical Velocity	39.2	m/s	Email from A1 Flue Systems 25.06.19
Vd	Volume flow rate @ Td	6.266	m^3/s	Email from A1 Flue Systems 25.06.19

Table A6: Summary of ADMS 5 Input parameters (CHP) (individually flued)

Parameter	*Value*	*Units*	*Justification*
Height of discharge	71.90	m	Estimated from scale drawing
Discharge stack diameter	0.450	m	Email from A1 Flue Systems 10.06.19
Discharge temperature	351	°C	Email from A1 Flue Systems 25.06.19
Vertical Velocity	39.2	m/s	Email from A1 Flue Systems 25.06.19
Discharge rate NO_2	0.685	g/s	Adjusted for Td

Input parameters for buildings

Table A7: Building A (Thomas-Kemp Tower)

Parameter	*Value*	*Units*	*Justification*
x coordinate of building centre	532773.5	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
y coordinate of building centre	103927.5	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Effective height of building	68.9	m	Estimated from scale drawing 'BDP-AR-ST1-A00-EL-00-0201'
Effective length of building	31.9	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Effective width of building	45.6	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Angle made by length to north	109.6	°	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Ground finished floor level	49.3	m AOD	Estimated from scale drawing 'Drawing 1964-1110-01B_3D_withsharedcoordinates'

Table A8: Building B (Royal Alexandra Children's Hospital)

Parameter	*Value*	*Units*	*Justification*
x coordinate of building centre	532703.1	m	Estimated from scale drawing '3TS-BDP-SXX-XX-M3-A-SiteCoordination'
y coordinate of building centre	103951.7	m	Estimated from scale drawing '3TS-BDP-SXX-XX-M3-A-SiteCoordination'
Effective height of building	35.4	m	Estimated from scale drawing 'BDP-AR-HE-A00-EL-00-0221'
Effective length of building	32.6	m	Estimated from scale drawing '3TS-BDP-SXX-XX-M3-A-SiteCoordination'
Effective width of building	60.9	m	Estimated from scale drawing '3TS-BDP-SXX-XX-M3-A-SiteCoordination'
Angle made by length to north	198.4	°	Estimated from scale drawing '3TS-BDP-SXX-XX-M3-A-SiteCoordination'
Ground finished floor level	53.2	m AOD	Estimated from scale drawing 'Drawing 1964-1110-01B_3D_withsharedcoordinates'

Table A9: Building C (Proposed development Section 02)

Parameter	*Value*	*Units*	*Justification*
x coordinate of building centre	532737	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
y coordinate of building centre	103873.2	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Effective height of building	50.7	m	Estimated from scale drawing 'LOR-CO-ST1-Wholescheme-Section1'
Effective length of building	94.1	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Effective width of building	68.5	m	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Angle made by length to north	109.0	°	Estimated from scale drawing 'LOR-CO-ST1-Wholeschemelayout'
Ground finished floor level	41.5	m AOD	Estimated from scale drawing 'LOR-CO-ST1-Wholescheme-Section1'

Building heights measured relative to respective ground finished floor level at each modelled building

APPENDIX 3 Predicted concentrations at proposed receptors

Table A10: Total predicted NO_2 concentration for Scenario A

Receptor ID	Total predicted NO_2 concentration (process contribution) ($\mu g.m^{-3}$)	
	Annual mean	99.79th percentile of hourly mean
H2.0	26.6 (3)	52.39 (5.19)
H2.1	26.6 (3)	52.39 (5.19)
H3.0	25.19 (1.59)	52.36 (5.16)
H3.1	25.19 (1.59)	52.36 (5.16)
H4.0	25.82 (2.22)	52.39 (5.19)
H4.1	25.82 (2.22)	52.39 (5.19)
H5.0	26.61 (3.01)	52.39 (5.19)
H5.1	26.61 (3.01)	52.39 (5.19)
H7.0	26.91 (3.31)	52.39 (5.19)
H7.1	26.91 (3.31)	52.39 (5.19)
H7.2	26.91 (3.31)	52.39 (5.19)
H7.3	26.91 (3.31)	52.39 (5.19)
H7.4	26.91 (3.31)	52.39 (5.19)
H7.5	26.91 (3.31)	52.39 (5.19)
H7.6	26.91 (3.31)	52.39 (5.19)
H7.7	26.91 (3.31)	52.39 (5.19)
H7.8	26.91 (3.31)	52.39 (5.19)
H7.9	26.91 (3.31)	52.39 (5.19)
H7.10	26.91 (3.31)	52.39 (5.19)
H7.11	26.91 (3.31)	52.39 (5.19)
H8.0	27.04 (3.44)	52.39 (5.19)
H8.1	27.04 (3.44)	52.39 (5.19)
H8.2	27.04 (3.44)	52.39 (5.19)
H8.3	27.04 (3.44)	52.39 (5.19)
H8.4	27.04 (3.44)	52.39 (5.19)
H8.5	27.04 (3.44)	52.39 (5.19)
H8.6	27.04 (3.44)	52.39 (5.19)
H8.7	27.04 (3.44)	52.39 (5.19)
H8.8	27.04 (3.44)	52.39 (5.19)
H8.9	27.04 (3.44)	52.39 (5.19)
H8.10	27.04 (3.44)	52.39 (5.19)
H8.11	27.04 (3.44)	52.39 (5.19)
H9.0	26.5 (2.9)	52.39 (5.19)
H9.1	26.5 (2.9)	52.39 (5.19)
H9.2	26.5 (2.9)	52.39 (5.19)
H9.3	26.5 (2.9)	52.39 (5.19)
H9.4	26.5 (2.9)	52.39 (5.19)
H9.5	26.5 (2.9)	52.39 (5.19)
H9.6	26.5 (2.9)	52.39 (5.19)
H9.7	26.5 (2.9)	52.39 (5.19)
H9.8	26.5 (2.9)	52.39 (5.19)
H9.9	26.5 (2.9)	52.39 (5.19)
H9.10	26.5 (2.9)	52.39 (5.19)
H9.11	26.5 (2.9)	52.39 (5.19)

Receptor ID	Total predicted NO_2 concentration (process contribution) ($\mu g.m^{-3}$)	
	Annual mean	99.79th percentile of hourly mean
H10.0	27.04 (3.44)	52.39 (5.19)
H10.1	27.04 (3.44)	52.39 (5.19)
H10.2	27.04 (3.44)	52.39 (5.19)
H10.3	27.04 (3.44)	52.39 (5.19)
H10.4	27.04 (3.44)	52.39 (5.19)
H10.5	27.04 (3.44)	52.39 (5.19)
H10.6	27.04 (3.44)	52.39 (5.19)
H10.7	27.04 (3.44)	52.39 (5.19)
H10.8	27.04 (3.44)	52.39 (5.19)
H10.9	27.04 (3.44)	52.39 (5.19)
H10.10	27.04 (3.44)	52.39 (5.19)
H10.11	27.04 (3.44)	52.39 (5.19)

Table A11: Total predicted NO_2 concentration for Scenario B

Receptor ID	Total predicted NO_2 concentration (process contribution) ($\mu g.m^{-3}$)	
	Annual mean	99.79th percentile of hourly mean
H2.0	24.99 (1.39)	49.59 (2.39)
H2.1	24.99 (1.39)	49.59 (2.39)
H3.0	24.36 (0.76)	49.59 (2.39)
H3.1	24.36 (0.76)	49.59 (2.39)
H4.0	24.58 (0.98)	49.56 (2.36)
H4.1	24.58 (0.98)	49.56 (2.36)
H5.0	25.05 (1.45)	49.6 (2.4)
H5.1	25.05 (1.45)	49.6 (2.4)
H7.0	25.18 (1.58)	49.64 (2.44)
H7.1	25.18 (1.58)	49.64 (2.44)
H7.2	25.18 (1.58)	49.64 (2.44)
H7.3	25.18 (1.58)	49.64 (2.44)
H7.4	25.18 (1.58)	49.64 (2.44)
H7.5	25.18 (1.58)	49.64 (2.44)
H7.6	25.18 (1.58)	49.64 (2.44)
H7.7	25.18 (1.58)	49.64 (2.44)
H7.8	25.18 (1.58)	49.64 (2.44)
H7.9	25.18 (1.58)	49.64 (2.44)
H7.10	25.18 (1.58)	49.64 (2.44)
H7.11	25.18 (1.58)	49.64 (2.44)
H8.0	25.24 (1.64)	49.64 (2.44)
H8.1	25.24 (1.64)	49.64 (2.44)
H8.2	25.24 (1.64)	49.64 (2.44)
H8.3	25.24 (1.64)	49.64 (2.44)
H8.4	25.24 (1.64)	49.64 (2.44)
H8.5	25.24 (1.64)	49.64 (2.44)
H8.6	25.24 (1.64)	49.64 (2.44)
H8.7	25.24 (1.64)	49.64 (2.44)
H8.8	25.24 (1.64)	49.64 (2.44)
H8.9	25.24 (1.64)	49.64 (2.44)
H8.10	25.24 (1.64)	49.64 (2.44)
H8.11	25.24 (1.64)	49.64 (2.44)
H9.0	24.96 (1.36)	49.64 (2.44)
H9.1	24.96 (1.36)	49.64 (2.44)
H9.2	24.96 (1.36)	49.64 (2.44)
H9.3	24.96 (1.36)	49.64 (2.44)
H9.4	24.96 (1.36)	49.64 (2.44)
H9.5	24.96 (1.36)	49.64 (2.44)
H9.6	24.96 (1.36)	49.64 (2.44)
H9.7	24.96 (1.36)	49.64 (2.44)
H9.8	24.96 (1.36)	49.64 (2.44)
H9.9	24.96 (1.36)	49.64 (2.44)
H9.10	24.96 (1.36)	49.64 (2.44)
H9.11	24.96 (1.36)	49.64 (2.44)

Receptor ID	Total predicted NO_2 concentration (process contribution) (µg.m^{-3})	
	Annual mean	99.79th percentile of hourly mean
H10.0	25.24 (1.64)	49.64 (2.44)
H10.1	25.24 (1.64)	49.64 (2.44)
H10.2	25.24 (1.64)	49.64 (2.44)
H10.3	25.24 (1.64)	49.64 (2.44)
H10.4	25.24 (1.64)	49.64 (2.44)
H10.5	25.24 (1.64)	49.64 (2.44)
H10.6	25.24 (1.64)	49.64 (2.44)
H10.7	25.24 (1.64)	49.64 (2.44)
H10.8	25.24 (1.64)	49.64 (2.44)
H10.9	25.24 (1.64)	49.64 (2.44)
H10.10	25.24 (1.64)	49.64 (2.44)
H10.11	25.24 (1.64)	49.64 (2.44)

APPENDIX 4 Contour plots

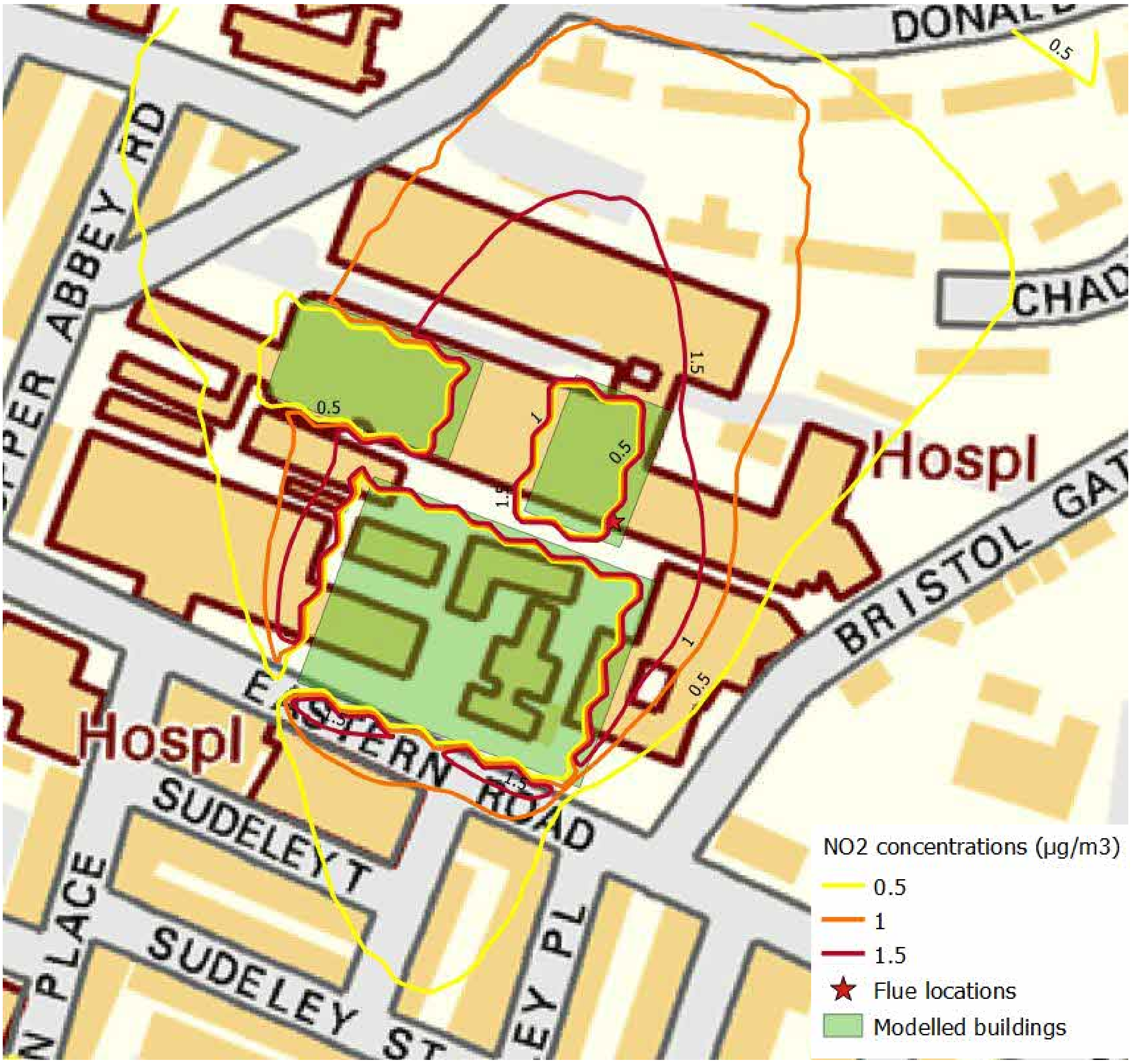


Figure 6: Ground level annual mean concentrations of NO_2 for Scenario A
(Contains OS data © Crown copyright and database right (2019))

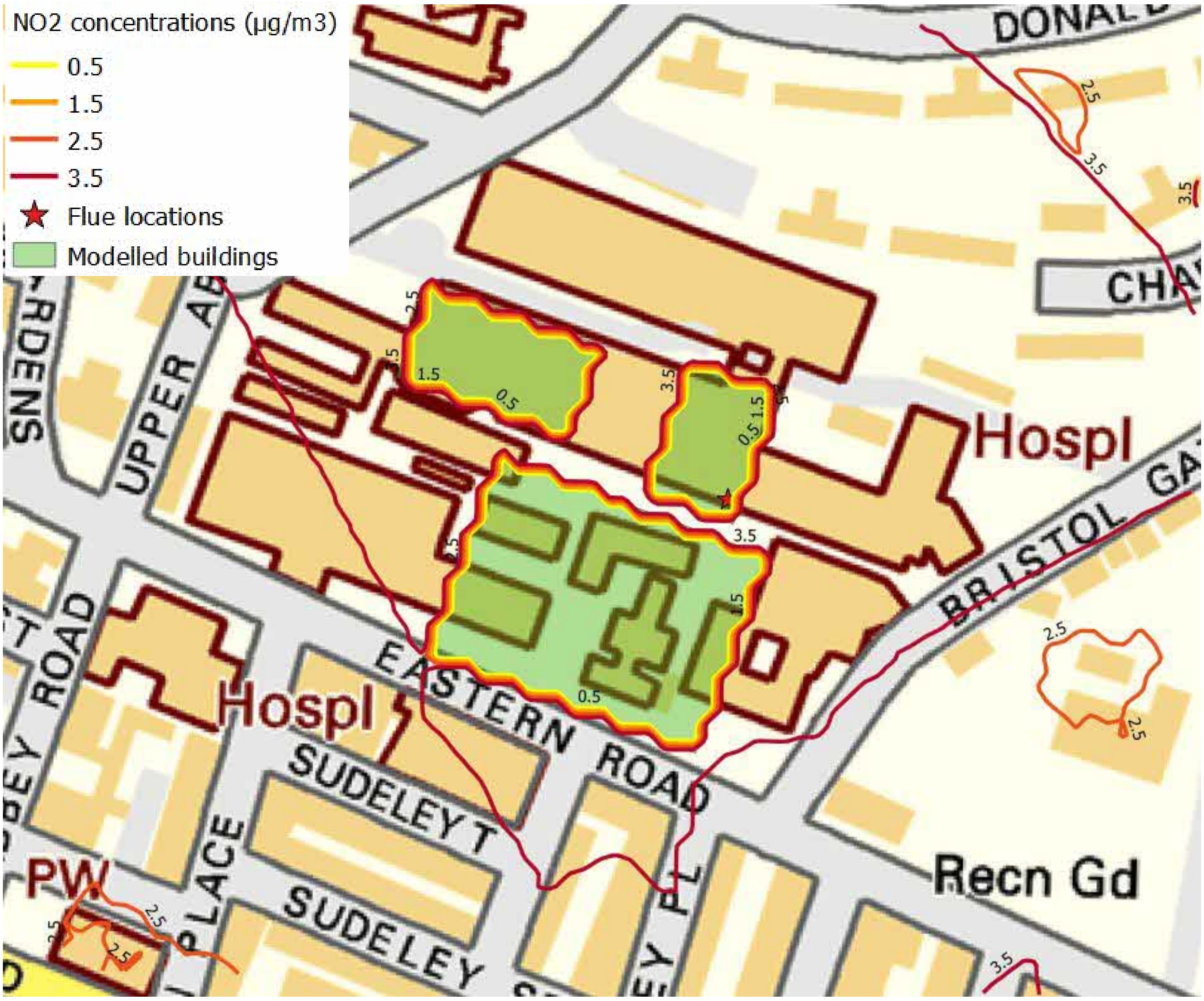


Figure 7: Ground level maximum 99.79th percentile of hourly mean concentrations of NO_2 for Scenario A (Contains OS data © Crown copyright and database right (2019))

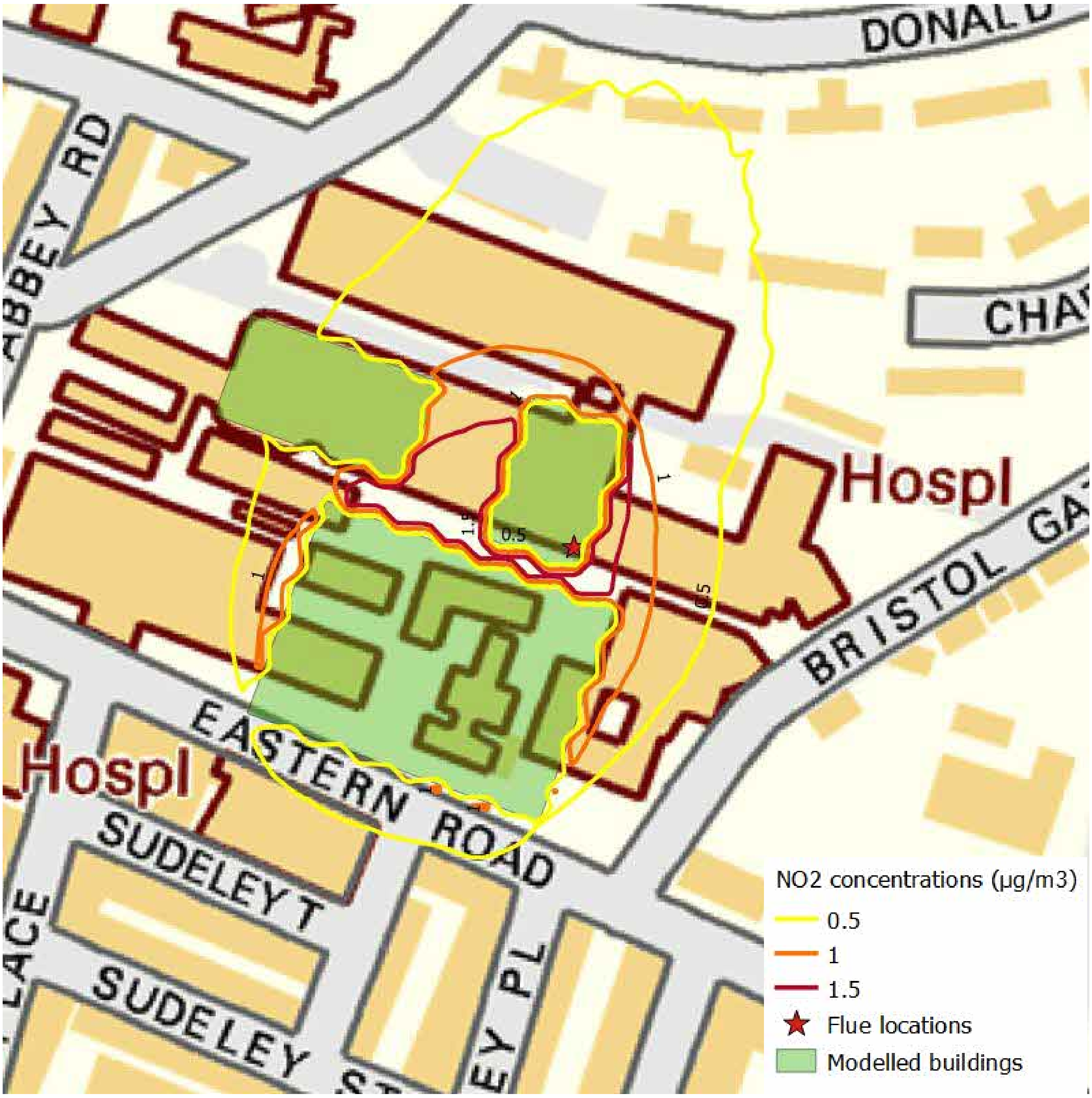


Figure 8: Ground level annual mean concentrations of NO_2 for Scenario B
(Contains OS data © Crown copyright and database right (2019))

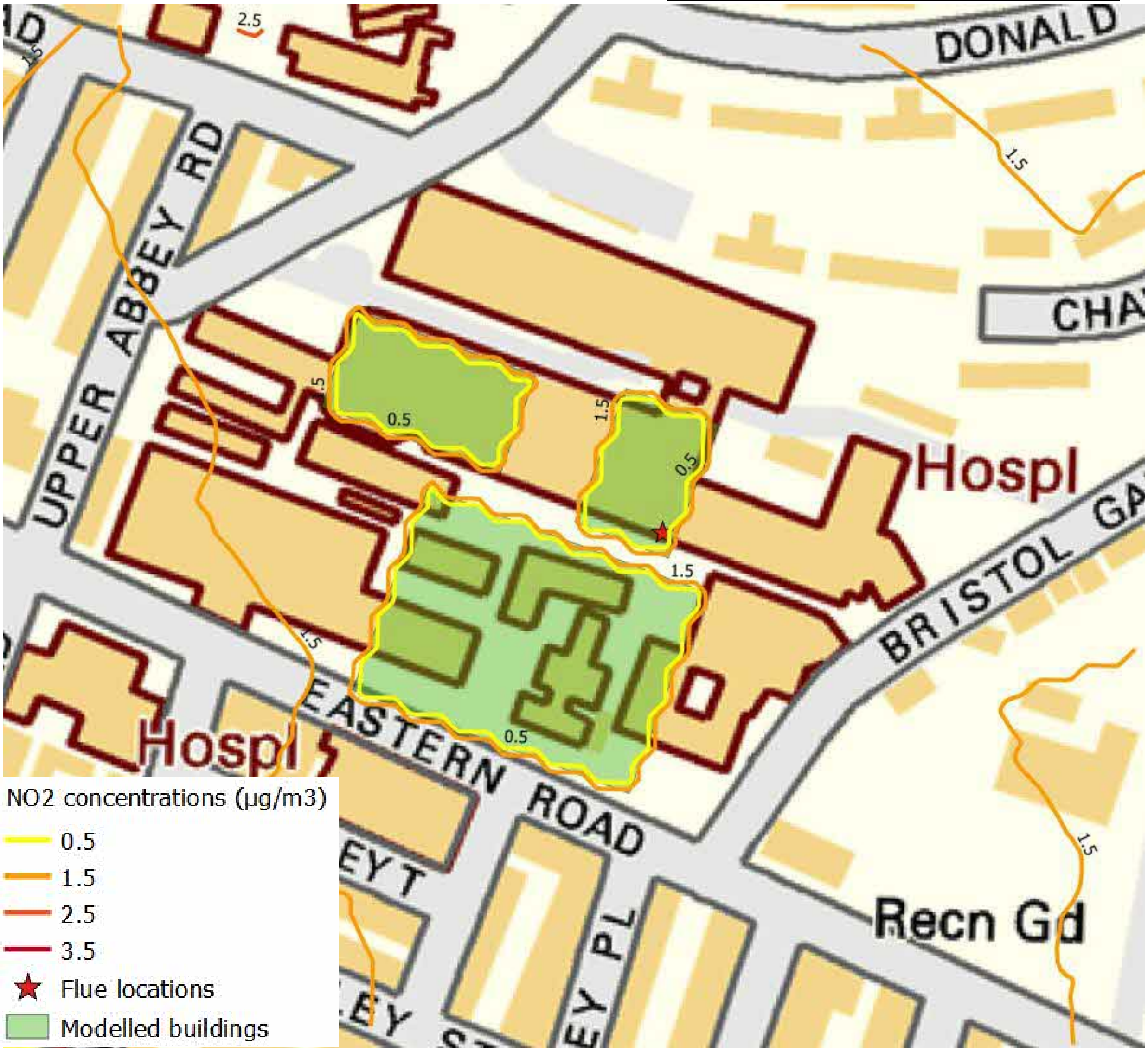


Figure 9: Ground level maximum 99.79th percentile of hourly mean concentrations of NO_2 for Scenario B (Contains OS data © Crown copyright and database right (2019))

IDOM Cromford Mills, Mill Lane, Matlock, Derbyshire DE4 3RQ
t +44 (0)1773 829 988 **f** +44 (0)1773 829 393 **e** info.derbyshire@idom.com **idom.com**

offices Birmingham London Kent Derbyshire Cardiff Manchester Stirling