

AIR QUALITY IMPACT ASSESSMENT

Boiler heat recovery project

Report for: Princes Group

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Ricardo, Gemini Building, Fermi Avenue, Harwell, Oxfordshire, OX11 0QR, UK | +44(0)1235 75 3000 | www.ricardo.com
Registered company no. 08229264 | VAT no. GB 212 8365 24

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Ricardo reference:
ED19193135

Contact:
Dr Nigel Gibson, Gemini Building, Fermi Avenue, Harwell, Didcot, OX11 0QR, UK

T: +44 (0) 1235 753 609
E: nigel.gibson@ricardo.com

Author:
James Southgate, Nigel Gibson

Approved by:
Mark Roberts



Date:
09 August 2024

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1. INTRODUCTION

1.1 PURPOSE OF STUDY

The Princes Group (Princes) facility, located on Bridge Rd, Long Sutton, Spalding PE12 9EQ, produces a range of canned goods. Princes have submitted a permit variation to optimise heat recovery from the site boilers. It is intended that the flue gas from its boilers pass through a new heat recovery system and the gas discharge from the boilers will be discharged through a common discharge stack at a reduced temperature of 20°C.

The main air pollutant associated with the boilers will be oxides of nitrogen (NOx).

Preliminary discussions with the Environment Agency as part of scoping for the permit variation indicated that the consequences of the process changes linked to this proposal needed to be evaluated using the H1 risk assessment tool. On completion of the H1 risk assessment, the analysis indicated a likelihood of an exceedance of the air quality objective for nitrogen dioxide due to the proposed changes. The H1 tool used for that risk assessment generally provides a worst-case impact assessment.

The objective of this study is to describe and assess the air quality impacts from the Princes' facility following the installation of the heat recovery system serving the site boilers. This study considers the impacts from the emission of NOx relative to current UK health-based and habitat air quality standards and objectives.

1.2 GENERAL APPROACH TAKEN

The approach taken in this study was:

- Collection and interpretation of emissions data from Princes for input to an atmospheric dispersion model for the existing boiler configuration and for the proposed changes.
- Collection of local background pollutant concentrations from national mapping and air quality monitoring data.
- Use of five consecutive years of relevant meteorological data to model concentrations of nitrogen dioxide (NO_2) around the study area, concentrating on the locations (receptors) where relevant human and sensitive habitat exposure may occur.
- Determination of the predicted worst-case annual mean pollutant concentrations at nearby receptor locations; and the predicted spatial variation in concentrations across the study area using contour plots.
- Comparison of the predicted magnitude of change in pollutant concentrations with current UK best practice guidance impact descriptors.

1.3 MAPPING

The mapping used for the study area was all sourced from the OS OpenData™ resource[1]. This enabled accurate OS grid references to be obtained for the study area as a whole, and specific features such as stack location and local receptors to be accurately identified.

All maps within this report: Contain Ordnance Survey data © Crown copyright and database right 2024.

1.4 UNITS OF CONCENTRATION

The units of pollutant concentration used throughout this report are micrograms per cubic metre (µg/m^3), consistent with the presentation of the Air Quality Strategy objective.

[1] https://www.ordnancesurvey.co.uk/opendatadownload/products.html

2. AIR QUALITY STANDARDS AND GUIDANCE

This assessment is concerned with the potential impacts on local ambient air quality from the proposed heat exchanger variation on the boiler facility for those pollutants commonly known to be a concern for air quality under the Local Air Quality Management system invoked by the Environment Act 1995. This study considers the impact from the emission of NO_2.

2.1 AIR QUALITY STRATEGY AND OBJECTIVES

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland was published in July 2007. The objectives specified in the strategy mirror limit values required by the EU Framework on Air Quality and air quality daughter directives. These were transposed into UK and Welsh law through the Air Quality Standards Regulations 2007 and The Air Quality Standards (Wales) Regulations 2010. Since then, further relevant EU Directives have been published: (2008/50/EC) consolidating the Framework and first three Daughter Directives; and 2004/107/EC, the fourth air quality daughter directive. These were subsequently transposed into UK Regulations in the Air Quality Standards Regulations 2010.

The current site operations use an on-site gas-fired boiler producing indirect heat for use in the canning process. The natural gas combustion process emits NOx, made up of nitric oxide (NO) and smaller quantities of nitrogen dioxide (NO_2). Nitric oxide is converted to nitrogen dioxide NO_2 in the atmosphere. An outline of the current UK Air Quality Objectives that are relevant to this study are presented in Table 1. The table also includes environmental assessment levels (EALs) for the protection of ecosystems and vegetation set in the Environment Agency's H1 guidance[2].

UK Local Authorities are required under the Environment Act 1995 to assess air quality in their areas on an annual basis against the air quality objectives; and are required to declare an Air Quality Management Area (AQMA) where they have identified that the air quality objectives are not being achieved. There are no AQMAs in the South Holland District Council area.

Table 1: Relevant Air Quality Objectives for human health and ecology

Pollutant	Air Quality Objective Concentration	Measured as
Nitrogen dioxide (NO_2) – human health	200 µg/m^3 not to be exceeded more than 18 times a year	1 hour mean
	40 µg/m^3	Annual mean
Nitrogen oxides (NOx) - ecology	75 µg/m^3	Daily mean
	30 µg/m^3	Annual mean

2.2 SENSITIVE RECEPTOR LOCATIONS

The locations where the air quality objectives apply are defined in the Air Quality Strategy as locations outside buildings or other natural or man-made structures above or below ground where members of the public are regularly present and might reasonably be expected to be exposed over the relevant averaging period of the objectives. Typically, these include residential properties, hospitals and schools for the longer averaging periods (i.e. annual mean) pollutant objectives and the above locations plus workplaces, shopping areas etc. for short-term (i.e. 1-hour) pollutant objectives.

In addition, sensitive receptor locations also include:

- Any special protection areas (SPAs), special areas of conservation (SACs) or Ramsar site (protected Wetlands) within 10km of the site; and
- Any sites of specific scientific interest (SSSIs) and local nature sites (e.g. local wildlife sites) within 2 km of the site.

[2] https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

3. THE STUDY AREA

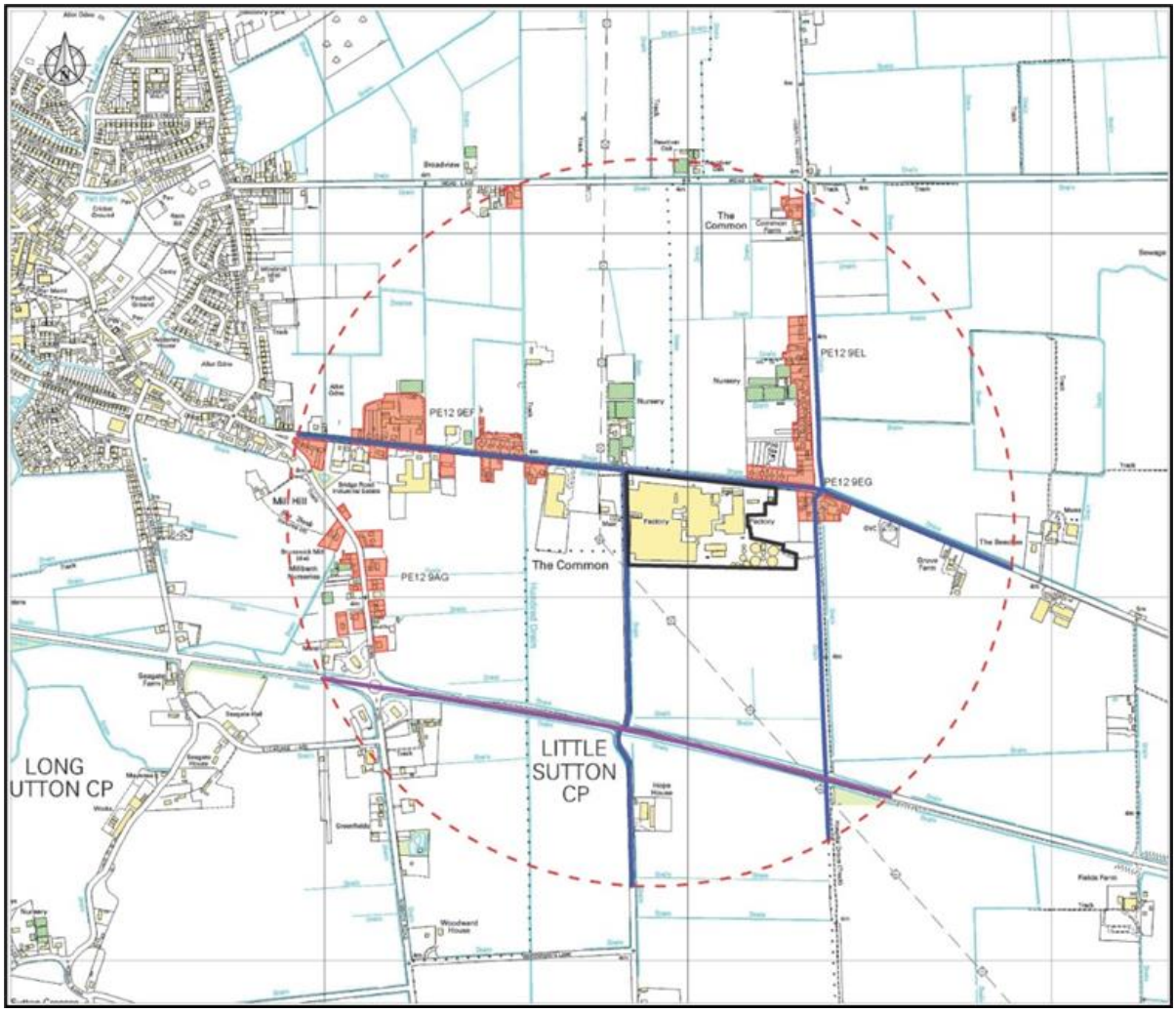
3.1 SITE DESCRIPTION AND LOCATION

The Long Sutton is located in Lincolnshire. The land around the Princes' site in Long Sutton is predominantly used for agriculture.

The Princes' facility is located off Bridge Road to the east of Long Sutton. There are several commercial concerns linked to the agriculture or the food industry.

The nearest residential properties to the princes' site are located approximately 250m northwest and 325m east of the site boilers.

Figure 1: Site location and sensitive receptors[3]



[3] Map used in Site management plans

Table 2: Summary of Sensitive Receptors

Receptor	Minimum distance to site boundary	Direction	Receptor Type
Properties on Bridge Road PE12 9EG	30 m	Northeast and East	Residential Property
Properties on Hospital Drove PE12 9EG	100 m	Northeast	Residential Property
Properties on Bridge Road PE12 9EF	30 m	West	Residential Property

3.2 BACKGROUND POLLUTANT CONCENTRATIONS

Background pollutant concentrations for a dispersion modelling study can be derived from the background maps provided by the Defra website[4]. The background mapping data provides estimates of annual mean background concentrations of key pollutants at a resolution of 1 x 1 km for the United Kingdom projected from a base year of 2018 adjusted to 2024. For the purpose of this study the representative baseline air quality levels for each substance of potential concern were identified, as set out in Table 3.

Table 3: Background air pollutant concentrations

Substance	Long-term background concentration (µg/m^3)	Basis
Nitrogen dioxide (NO_2) (annual mean)	7.4	Interpolated map value for 2024 projected from a base year of 2018 for 545000,322500.
Nitrogen dioxide (NO_2) (99.79th percentile of hourly means)	14.8	
Oxides of nitrogen	9.5	

[4] https://uk-air.defra.gov.uk/data/laqm-background-home, accessed August 2024.

4. MODELLING STUDY

4.1 MODEL DESCRIPTION

The air quality impacts of the existing and proposed scenarios were calculated using the Atmospheric Dispersion Modelling System ADMS 6.

ADMS 6 is the latest version of a new generation dispersion model developed by Cambridge Environmental Research Consultants Ltd (CERC) which has been extensively validated to international dispersion modelling standards. New generation dispersion models describe the atmospheric boundary layer in terms of the boundary layer depth and the Monin-Obukhov length and allow for the use of a skewed Gaussian distribution under convective meteorological conditions. These facilities allow for accurate predictions of emission concentrations under different meteorological conditions.

4.2 MODEL INPUT DATA

4.2.1 Model domain

The dispersion modelling study aimed to assess the impact of atmospheric pollutant emissions from the existing and proposed scenarios at the Princes' installation. Pollutant dispersion was calculated over a regular Cartesian grid pattern and at specified receptor points as detailed in Section 4.2.2. The modelled domain consisted of a 2 km x 2 km grid which predicted pollutant concentrations at a resolution of 10 m. A grid height of 1.5 m was modelled to represent a realistic level of human exposure.

4.2.2 Specified receptor locations

Sensitive receptor locations (Table 2 and Table 3) have been specified within the model domain to represent locations outside of the facility grounds where humans may be exposed to atmospheric pollutant emissions from the emission sources. A notional radius of 3 km was used for this assessment.

Figure 2: Locations of sensitive receptors



Table 4: Locations of sensitive receptors

Name	Type	Easting	Northing	Approx. distance from discharge (m)
Bridge Road 1	Residential	545175	322339	221
Bridge Road 2	Residential	545202	322338	243
Bridge Road 3	Residential	545231	322333	266
Bridge Road 4	Residential	545258	322331	289
Bridge Road 5	Residential	545333	322270	344
Bridge Road 6	Residential	545308	322269	319
Bridge Road 7	Residential	544824	322393	250
Hospital Drive 1	Residential	545312	322343	343
Hospital Drive 2	Residential	545311	322355	348
Hospital Drive 3	Residential	545311	322369	354

4.2.3 Ecological habitats – designated sites

The Wash is designated as SPA, SAC's or Ramsar sites within 10km of the application site, this was verified using the Multi-Agency Geographic Information for the Countryside (MAGIC) website.

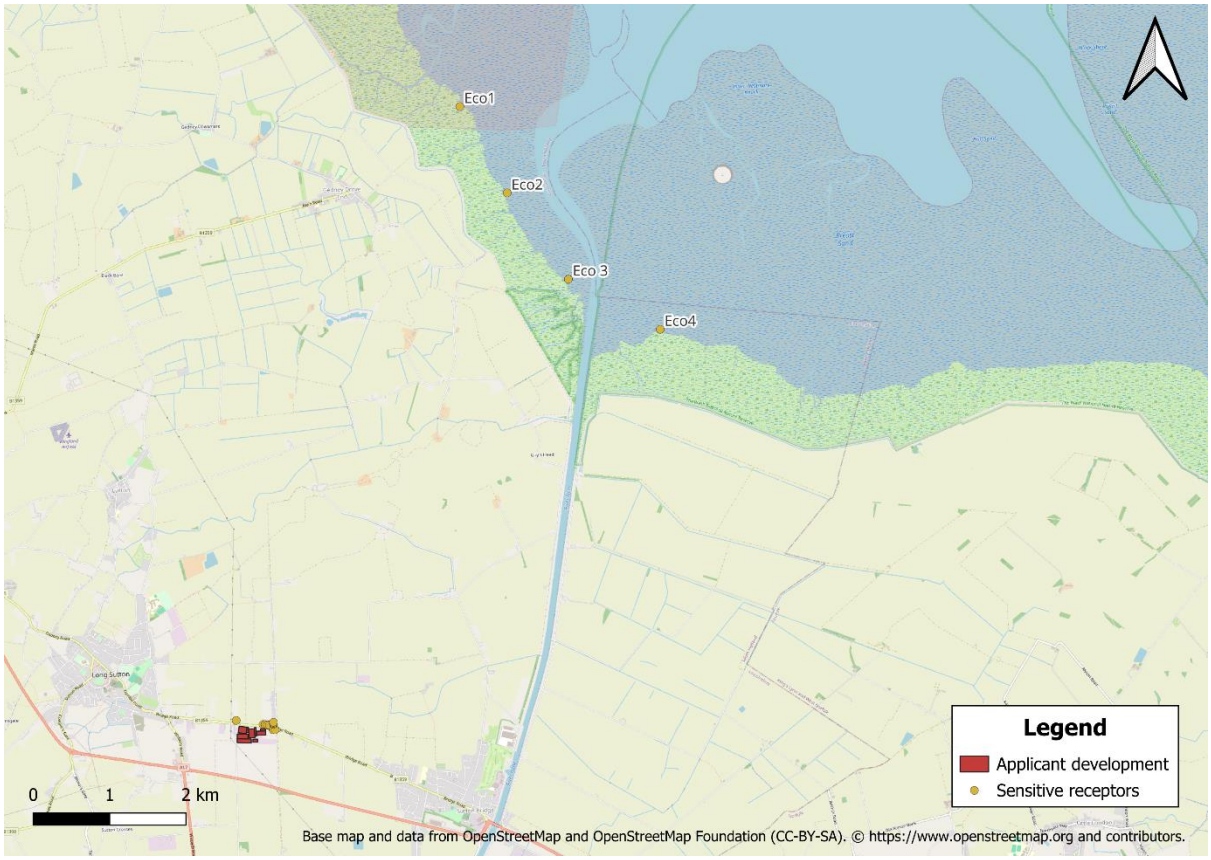
There are no sites of local ecological importance within 2km of the application site, this was verified using the Multi-Agency Geographic Information for the Countryside (MAGIC) website.

Table 5 lists the locations used to assess air quality on the Wash.

Table 5: Ecological sites

ID	Easting	Northing	Designated site
Eco 1	547751	330420	Wash
Eco 2	548370	329292	
Eco 3	549171	328163	
Eco 4	550372	327507	

Figure 3: Location of nearby ecological receptors



4.3 METEOROLOGY

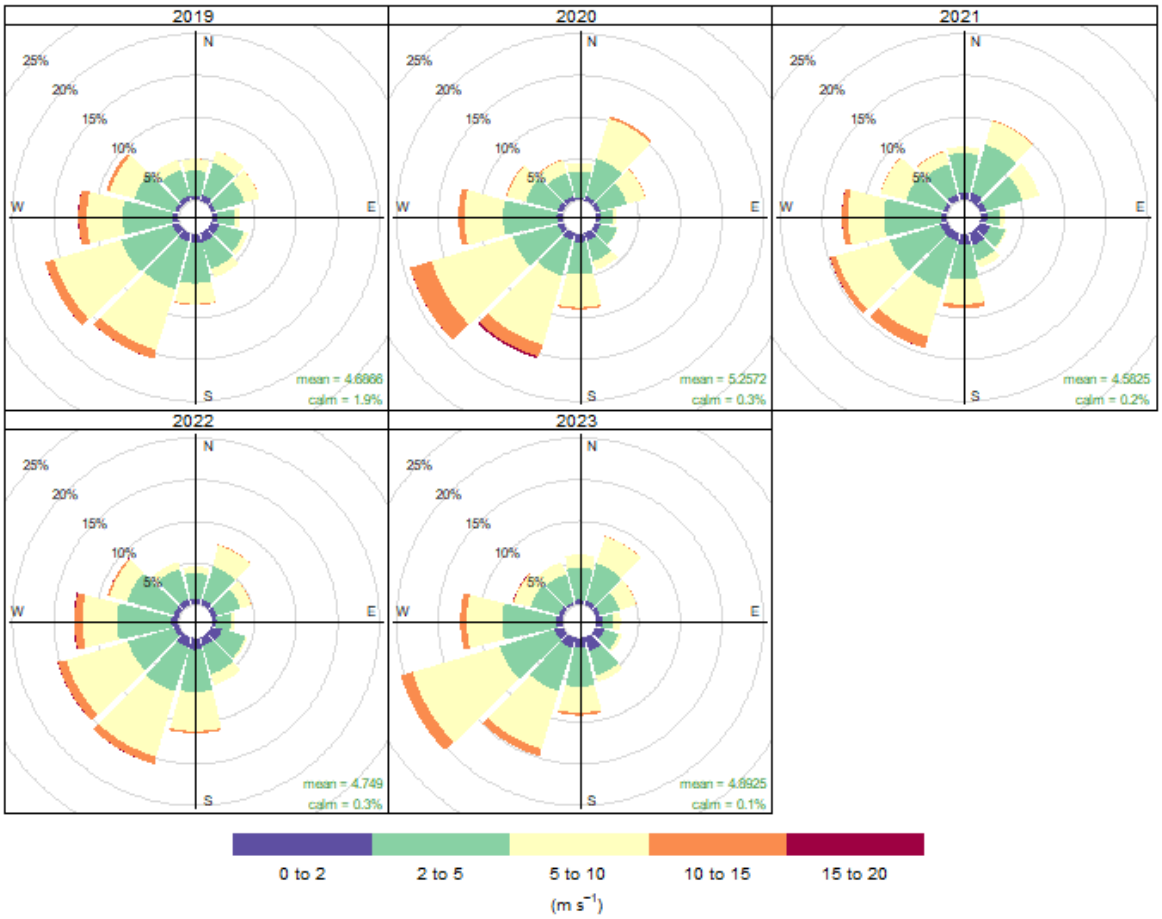
ADMS 6 uses a range of hourly sequential meteorological data to calculate atmospheric dispersion. Meteorological data from 2019 to 2023 was obtained from a nearby, representative meteorological station. The closest weather station to the proposed site is the RAF Wittering weather station, located near Peterborough, approximately 46 km southwest of the proposed site. Measurements at this station are representative of the weather conditions likely to be experienced at the proposed development site.

The data capture for wind direction and wind speed at the RAF Wittering weather station was found to be good (>90%). Missing cloud cover data is quite common in meteorological data sets, and where necessary, data filling was carried out for cloud cover data according to the methodology provided by the USEPA in their "Meteorological Monitoring Guidance for Regulatory Modelling Applications" guidance document[5]. The recommended filling procedure is based on the persistence method, where a missing value is replaced by the use of data from the previous hour(s). After gap-filling the data capture is good, i.e. ≥90% for all meteorological parameters.

Examination of the wind roses (see Figure 4) shows that the winds measured at RAF Wittering are predominantly from the south-west. This is typical of the conditions experienced generally in the UK.

[5] United States Environmental Protection Agency, "Meteorological Monitoring Guidance for Regulatory Modelling Applications" available via https://www3.epa.gov/scram001/guidance/met/mmgrma.pdf [accessed June 2017]

Figure 4: Wind rose for RAF Wittering (2019-2024)



4.4 TERRAIN AND LAND USE

The topographical features surrounding a site will have an influence on the dispersion of pollution in that area. This is accounted for in the surface roughness length specified in the model input; and an optional module which model the effects of complex terrain if required.

A surface roughness value of 0.3 m, which represents agricultural land, was considered appropriate for the Princes' site.

Wind flows can be altered by the terrain of an area which can affect the dispersion of a plume. The general area around Long Sutton is relatively flat. Consequently, the effects of terrain on dispersion of emissions from the Princes facility have not been taken into account.

4.5 BUILDING PARAMETERS

ADMS contains an option to use algorithms that account for building downwash effects. Nearby buildings (within five stack heights from the stack; and with a height of more than one third of the stack height) can affect the dispersion of emissions from a stack. The main effect can be to increase concentrations in the immediate vicinity of the building, while reducing concentrations further away.

For the proposed scenarios, buildings located at the Princes' site has been included in the study. Building heights for the Princes' building was provided by Princes. The same heights have been assumed for the other buildings on site. Building locations were sourced from OS map data and aerial/street photography to ensure correct location and orientation for existing buildings.

The dispersion model requires the height, length, width and orientation of the buildings as input data. The buildings included in the model and the relevant input data are provided in Table 6 and Figure 3.

Table 6: Buildings parameters

Building	Easting	Northing	Height (m)	Width (m)	Length (m)	Angle (º)
Building 1	544907	322184	6	64.0	141.3	91.5
Building 2	544929	322127	6	52.8	186.6	91.4
Building 3	545073	322129	6	37.7	61.8	88.5
Building 4	544908	322268	6	86.1	106.2	97.0
Building 5	545027	322224	6	77.4	119.8	175.2
Building 6	544972	322270	6	28.7	68.0	178.7
Building 7	545076	322243	6	22.8	115.0	176.9
Building 8	545150	322227	6	53.9	121.6	87.5
Building 9	545173	322270	6	28.8	66.8	87.4

Figure 5: Source and building locations



4.6 EMISSIONS DATA

The routine monitoring carried out on site has not been able to measure the air flow due to the nature of the sample port used. For this study we have estimated the air flow from each boiler based on fuel

use and boiler rating. Actual and normal flow rate estimates are given in Table 7. Table 7 also sets out the emission characteristics of the proposed variation.

This study has assumed that the discharge is at the emission limit value of 300 mg/Nm^3. The routine monitoring has been carried out on the boiler emission. The measured emission data[6] are presented in Table 8Table 8. The measured concentrations are about 36% of the emission limit value.

Table 7: Emission parameters

Source	Easting	Northing	Height (m)	Effective diameter (m)	Velocity (m/s)	Actual flow (Am^3/s)	Normal flow (Nm^3/s)	Flue temperature (^{o}C)
Boiler 1	544982	322210	10	1.1	5.6	5.4	2.5	208
Boiler 2	544982	322206			4.5	4.3	2.1	214
Boiler 3	544982	322202			6.0	5.7	2.3	217
Boiler 4	544982	322199			5.6	5.4	2.5	196
Boiler 5	544982	322194			6.6	6.2	3.0	196
Boiler 6	544982	322192			2.9	2.7	1.3	210
Variation Proposal with 3 boilers	544990	322218	10, 13, 16 & 19	0.9	15.0	9.2	6.8	20
Variation Proposal with 6 boilers	544990	322218	10, 13, 16 & 19	1.2	15.0	18.1	13.8	20

Table 8: Emission rates

	Normal flow (Nm^3/s)	NOx conc (mg/m^3)	Emission rate (g/s)	NOx conc (mg/m^3) [1]
Boiler 1	2.473	300	0.742	98.9
Boiler 2	2.092		0.628	100.8
Boiler 3	2.266		0.680	161.0
Boiler 4	2.473		0.742	86.0
Boiler 5	3.028		0.908	91.9
Boiler 6	1.259		0.378	120.0
Variation Proposal with 3 boilers	6.831	300	2.049	
Variation Proposal with 6 boilers	6.831	300	4.077	

note, 1 – measure data included to show then likely emission concentration that occurs.

[6] Extracted from Element reports for 2023 monitoring5.6

4.7 SPECIAL TREATMENT OF RESULTS: NITRIC OXIDE TO NO2 CONVERSION

Oxides of nitrogen (NOx) emitted to atmosphere as a result of combustion 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 Air Quality Modelling and Assessments Unit (AQMAU) guidance[7] on a conversion ratio for NOx and NO_2 a worse-case scenario has been applied in that 35% of NOx is presented as NO_2 in relation to short term impacts and 70% of NOx is present as NO_2 in relation to long term impacts.

4.8 RESULTS INTERPRETATION

Modelled levels of released substances were assessed against the air quality standards and guidelines set out in Table 9.

The modelled annual mean concentrations of emitted substances were also evaluated using the approach developed by Environmental Protection UK[8]. This enables the scale of potential impacts on air quality to be described in planning terms on a consistent and independent basis (see Table 9).

Table 9: IAQM impact descriptors

Maximum annual mean concentration	% change in concentration relative to Air Quality Standard / Guideline			
	1	2 - 5	6 - 10	>10
75% or less of AQSG	Negligible	Negligible	Slight	Moderate
76 – 94% of AQSG	Negligible	Slight	Moderate	Moderate
95 – 102% of AQSG	Slight	Moderate	Moderate	Substantial
103 – 109% of AQSG	Moderate	Moderate	Substantial	Substantial
110% or more of AQSG	Moderate	Substantial	Substantial	Substantial

The modelled annual mean concentrations of emitted substances were also evaluated using the significance criteria adopted by the Environment Agency. This evaluation comprises:

Step 1 – A process contribution is deemed insignificant, i.e. further assessment is not required, if:

- The short-term process contribution is less than 10% of the short-term environmental standard.
- The long-term process contribution is less than 1% of the long-term environmental standard.

Step 2 – The predicted environmental concentration is deemed acceptable if:

- [Maximum Process Contribution (long term) + background concentration] is less than 70% of the Environmental Assessment Level.
- [Maximum Process Contribution (short term) + 2 * background concentration] less than 20% Environmental Assessment Level.

[7] https://consult.defra.gov.uk/airquality/medium-combustion-plant-and-controls-on-generators/supporting_documents/Generator%20EA%20air%20dispersion%20modelling%20report.pdf

[8] Environmental Protection UK and Institute of Air Quality Management, "Guidance on land-use planning and development control: Planning for air quality 2015 via http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

4.9 CONSERVATIVE APPROACH

This study was carried out on a conservative basis, to ensure that modelled concentrations and impacts are more likely to be over-estimated than under-estimated. The conservative assumptions adopted in this study are listed below:

- The maximum NOx emission concentration specified by the permit have been applied to all boilers.
- It is assumed that all sources have continuous emissions.
- The highest modelled concentrations for any of the five years of meteorological data was used in the study.

5. RESULTS

5.1 IMPACT AT HUMAN RECEPTORS

5.1.1 Stack height selection

Following on from an initial risk assessment carried out using the H1 tool an initial assessment has been carried out to evaluate the stack that should be used for the proposed condition. This analysis has been carried out using:

- The current discharge for the three and six individual boilers.
- The future situation has been modelled based on the discharge characteristics for three boilers passing through the heat exchanger and stack. This is considered to be 'normal operation. The six-boiler situation has also been considered.
- The analysis has assumed that the permitted emission limit of 300 mg/m^3 applies. Recent measurements show that emissions are about 36% of the permitted emission limit.

The results of this analysis are presented in Table 10, which shows the predicted concentration at the point of maximum impact Figure 6 shows the annual average concentration and Figure 7 shows the 99.79% 1-hour concentration at the point of maximum impact expressed as a percentage of the relevant air quality objective.

In actual operation the site is likely to be about 36% of the AQO contribution set out in figure for the three-boiler condition.

Table 10: Maximum annual average and 99.79% 1-hour NO_2 concentration for the current and varied operation (using various stack heights

	Annual average (µg/m^3)	99.97% 1 hour mean (µg/m^3)
Baseline – 3 boilers	164	449
Baseline – 6 boiler	284	761
Variation 10m – 3 boilers	95	138
Variation 10m – 6 boilers	146	207
Variation 13m – 3 boilers	67	101
Variation 13m – 6 boilers	105	160
Variation 16m – 3 boilers	47	81
Variation 16m – 6 boilers	74	123
Variation 19m – 3 boilers	4.6	35
Variation 19m – 6 boilers	7.5	56
AQO	40	200

It is likely that the difference between the baseline and the variation proposal is linked to:

- Estimating concentrations within the building wake, and/or
- Increased momentum offered by the variation affecting the plume rise.

Figure 6: stack height evaluation based on annual average NO_2 impact at the point of maximum impact

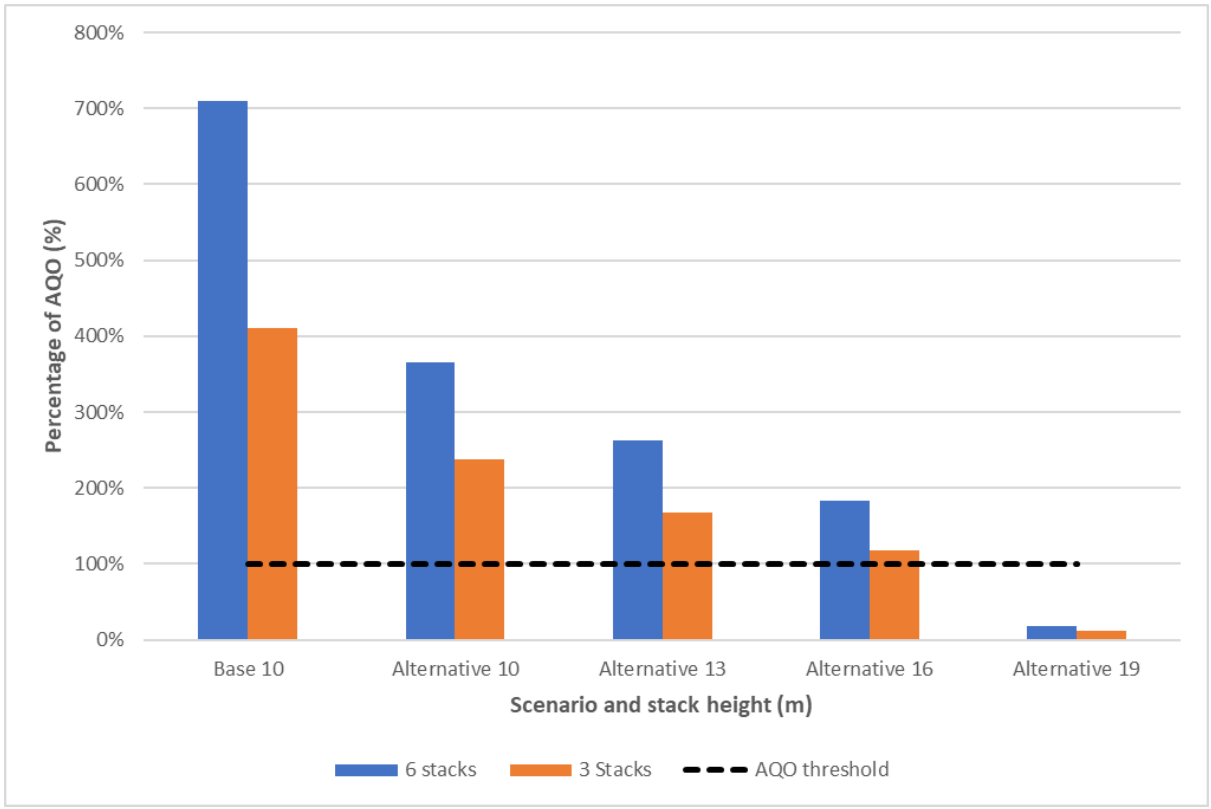
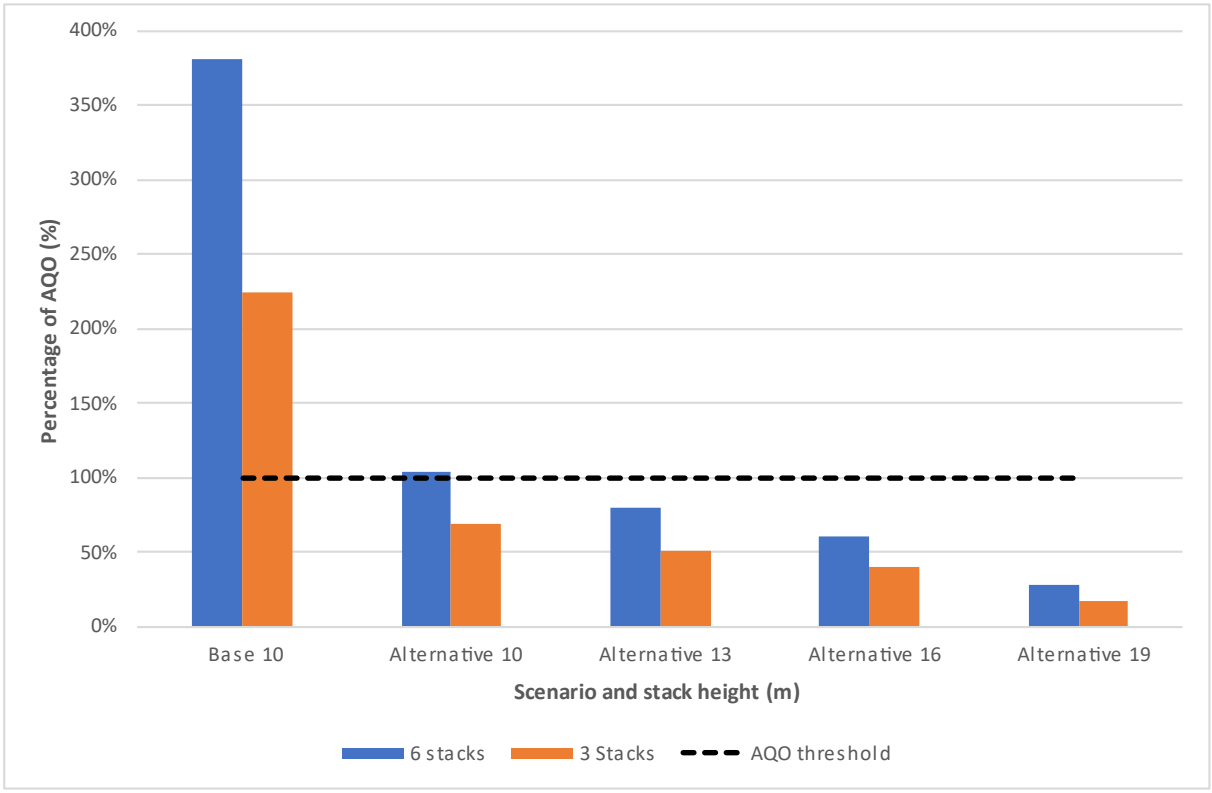


Figure 7: Stack height evaluation based on 99.79% 1-hour average NO_2 impact at the point of maximum impact



5.1.2 Predications across the model domain

Predicted NO_2 process contribution (based on the 300 mg/m^3 emission limit value) across the model domain and at the receptor locations for the existing and proposal situations are presented as follows:

- For the baseline: Annual average is shown in Figure 8 and Table 11, 99.79% is shown in Figure 9 and Table 12.
- For the variation proposal with a 10m stack : Annual average is shown in Figure 8 and Table 13, 99.79% is shown in Figure 11and Table 14.
- For the variation proposal with a 13m stack : Annual average is shown in Figure 8 and Table 15, 99.79% is shown in Figure 13 and Table 16.
- For the variation proposal with a 16m stack : Annual average is shown in Figure 14 and Table 17, 99.79% is shown in Figure 15 and Table 18.
- For the variation proposal with a 19m stack : Annual average is shown in Figure 16 and Table 11, 99.79% is shown in Figure 17 and Table 20.

The contours shown in the various figures present the impact concentrations as a percentage of the air quality objective (AQO) set at 40µg/m^3 for the annual average and 200µg/m^3 for the 99.79% 1 hour mean.

Based on the emission limit value the annual average NO_2 objective is complied at all of the receptor locations considered. Based on the 2023 emission monitoring the NO_2 concentration could be 36% of the predicted concentrations shown.

Based on the emission limit value the 99.79% 1 hour average NO_2 objective is predicted to be exceeded in the current situation were all 6 boilers to be used. No exceedances are predicted for any of the stack height scenarios for the proposed variation. Based on the 2023 emission monitoring the NO_2 concentration could be 36% of the predicted concentrations shown.

The analysis has shown that by combining the boiler emissions there is a reduction in the impact concentration, the magnitude of which increases with the height of the stack considered. In planning terms this results in a reduction in the annual average NO_2 at the receptors considered. This improvement would result in a benefit in planning terms.

Based on the predicted results, the variation proposal would make a detectable but not excessive contribution at nearby sensitive receptor locations with the new heat exchanger in operation. The study finds that based on the discharge at the emission limit:

- All predicted long-term and short-term concentrations comply with the relevant environmental quality standards at all receptor locations.
- Use of the EPUK criteria set out in Table 9 indicates that the effect of the facility operating the new heat exchanger on annual concentrations of NO2 can be considered ‘beneficial’ at all of the residential receptor locations where the annual average objective applies.
- Use of the Environment Agency’s significance criteria applied to the closest receptor locations the process contribution indicates that the annual average PC would exceed the 1% insignificance threshold and PEC would not exceed 70% of the AQO. Compliance with the threshold is demonstrated at all residential sensitive locations.
- Use of the Environment Agency’s significance criteria applied to process contribution at sensitive receptors indicates that the short-term PC would exceed with the 10% insignificance threshold. The PEC would exceed the 20% of the AQO insignificance criteria but the AQO would not be exceeded.

The analysis indicates that using a stack height of 10m.

Figure 8: Annual average process contributions – existing situation

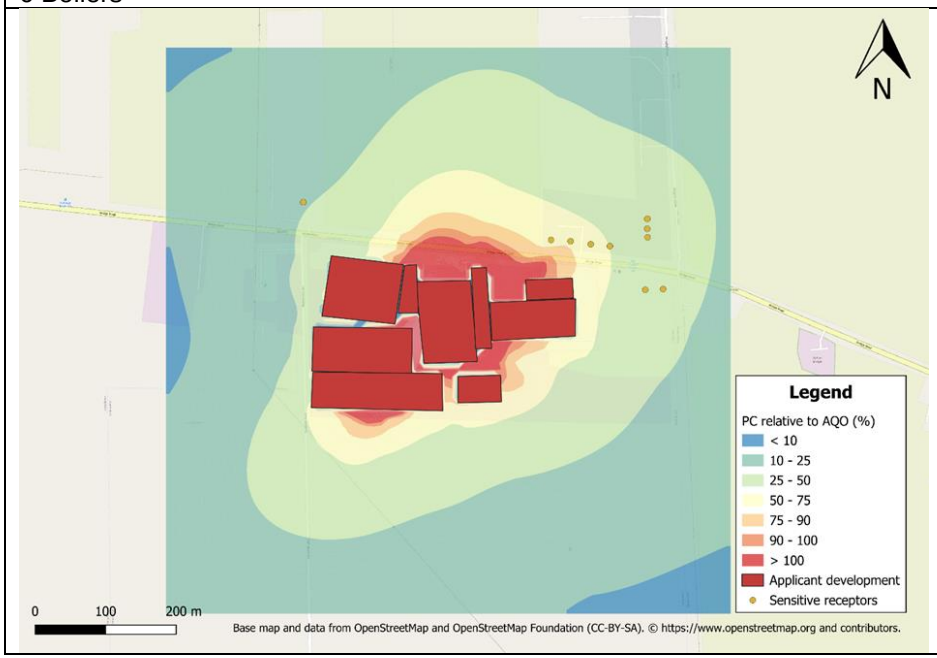
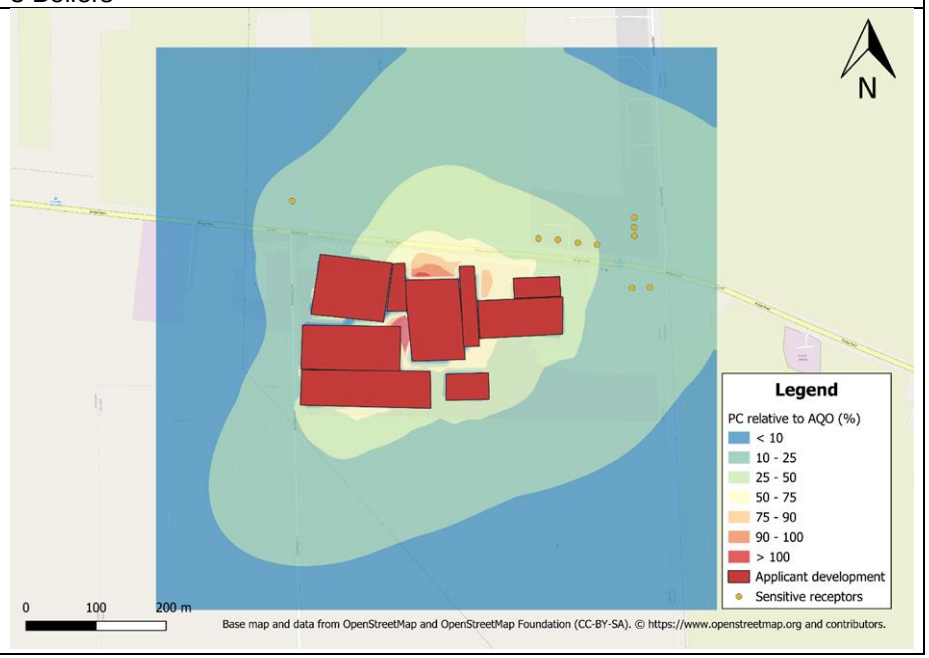
6 Boilers	3 Boilers
	

Table 11: Annual average impact assessment – existing situation

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	7.4	27.0	67.4%	34.4	85.9%	13.9	34.8%	21.3	53.3%
Bridge Road 2	7.4	27.3	68.3%	34.7	86.8%	14.1	35.2%	21.5	53.7%
Bridge Road 3	7.4	23.2	58.1%	30.6	76.6%	11.8	29.5%	19.2	48.0%
Bridge Road 4	7.4	20.2	50.5%	27.6	69.0%	10.2	25.5%	17.6	44.0%
Bridge Road 5	7.4	13.4	33.4%	20.8	51.9%	6.7	16.7%	14.1	35.2%
Bridge Road 6	7.4	15.1	37.8%	22.5	56.3%	7.5	18.9%	14.9	37.4%
Bridge Road 7	7.4	9.7	24.2%	17.1	42.7%	4.9	12.3%	12.3	30.8%
Hospital Drive 1	7.4	15.3	38.3%	22.7	56.8%	7.7	19.3%	15.1	37.8%
Hospital Drive 2	7.4	15.2	37.9%	22.6	56.4%	7.7	19.1%	15.1	37.6%
Hospital Drive 3	7.4	14.8	37.0%	22.2	55.5%	7.5	18.7%	14.9	37.2%

Figure 9: 99.79% process contributions – existing situation

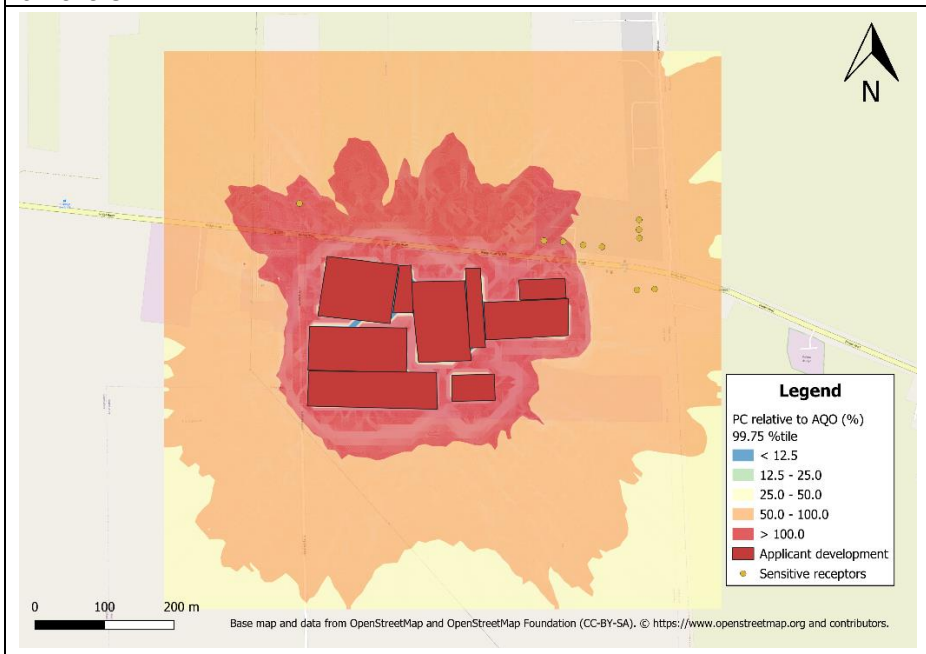
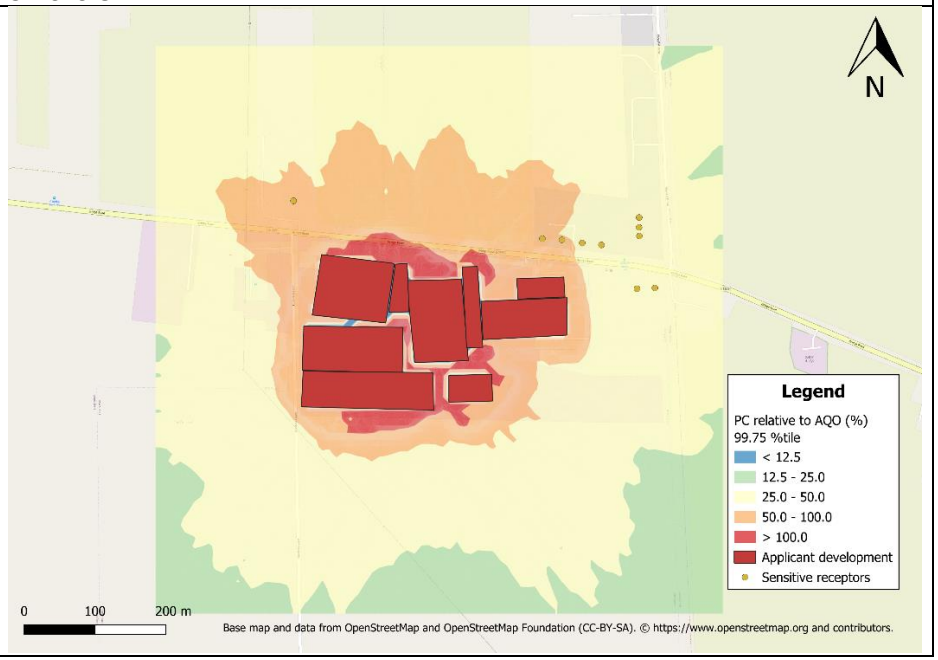
6 Boilers	3 Boilers
	

Table 12: 99.79% impact assessment – existing situation

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	14.8	204.1	102.0%	218.9	109.4%	107.9	53.9%	122.7	61.3%
Bridge Road 2	14.8	214.5	107.3%	229.3	114.7%	122.6	61.3%	137.4	68.7%
Bridge Road 3	14.8	180.7	90.4%	195.5	97.8%	92.1	46.1%	106.9	53.5%
Bridge Road 4	14.8	152.8	76.4%	167.6	83.8%	74.0	37.0%	88.8	44.4%
Bridge Road 5	14.8	141.6	70.8%	156.4	78.2%	69.6	34.8%	84.4	42.2%
Bridge Road 6	14.8	151.5	75.8%	166.3	83.2%	73.2	36.6%	88.0	44.0%
Bridge Road 7	14.8	228.7	114.3%	243.5	121.7%	116.5	58.3%	131.3	65.7%
Hospital Drive 1	14.8	129.6	64.8%	144.4	72.2%	67.2	33.6%	82.0	41.0%
Hospital Drive 2	14.8	131.5	65.8%	146.3	73.2%	66.2	33.1%	81.0	40.5%
Hospital Drive 3	14.8	129.8	64.9%	144.6	72.3%	65.8	32.9%	80.6	40.3%

Figure 10: Annual average process contributions – variation with a 10m stack

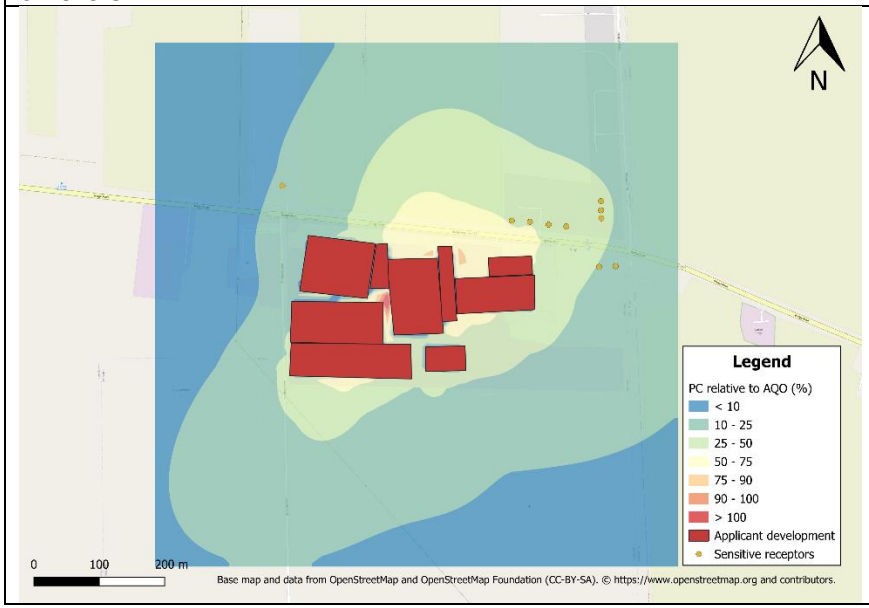
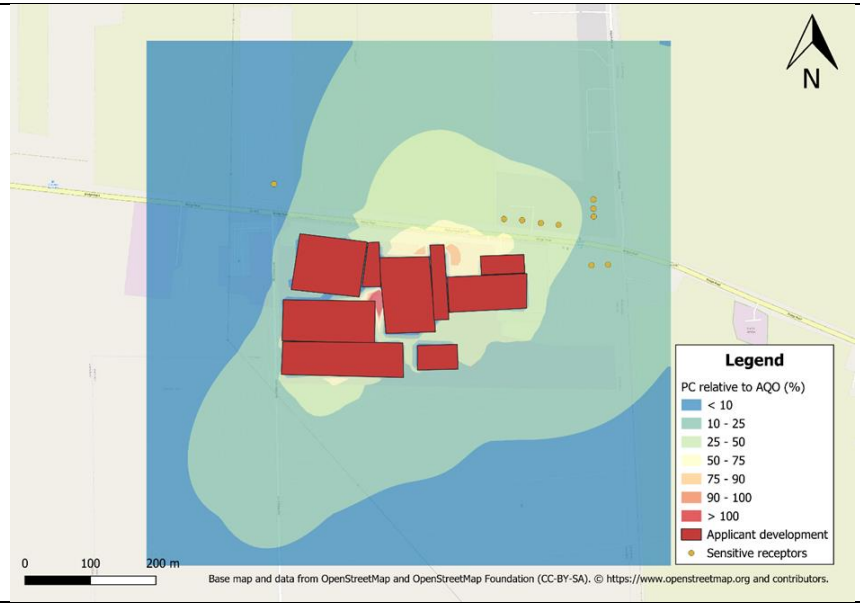
6 Boilers	3 Boilers
	

Table 13: Annual average impact assessment – variation with a 10m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	7.4	16.3	40.7%	23.7	59.2%	9.8	24.5%	17.2	43.0%
Bridge Road 2	7.4	15.1	37.8%	22.5	56.3%	9.1	22.6%	16.5	41.1%
Bridge Road 3	7.4	14.0	34.9%	21.4	53.4%	8.3	20.8%	15.7	39.3%
Bridge Road 4	7.4	12.1	30.2%	19.5	48.7%	7.2	18.0%	14.6	36.5%
Bridge Road 5	7.4	7.3	18.3%	14.7	36.8%	4.4	11.1%	11.8	29.6%
Bridge Road 6	7.4	8.2	20.5%	15.6	39.0%	5.0	12.4%	12.4	30.9%
Bridge Road 7	7.4	3.4	8.6%	10.8	27.1%	2.2	5.5%	9.6	24.0%
Hospital Drive 1	7.4	9.4	23.5%	16.8	42.0%	5.5	13.8%	12.9	32.3%
Hospital Drive 2	7.4	9.4	23.5%	16.8	42.0%	5.5	13.8%	12.9	32.3%
Hospital Drive 3	7.4	9.3	23.3%	16.7	41.8%	5.4	13.6%	12.8	32.1%

Figure 11: 99.79% process contributions – variation with a 10m stack

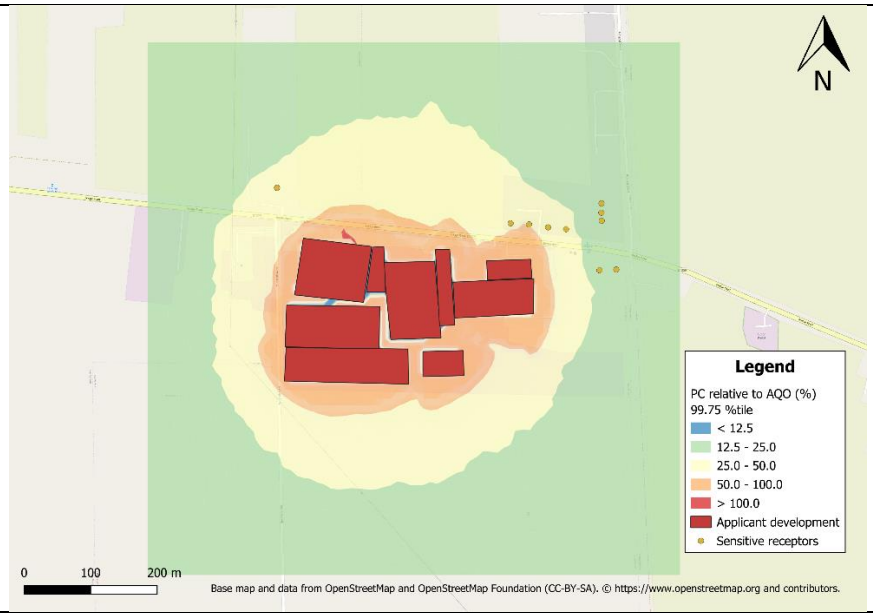
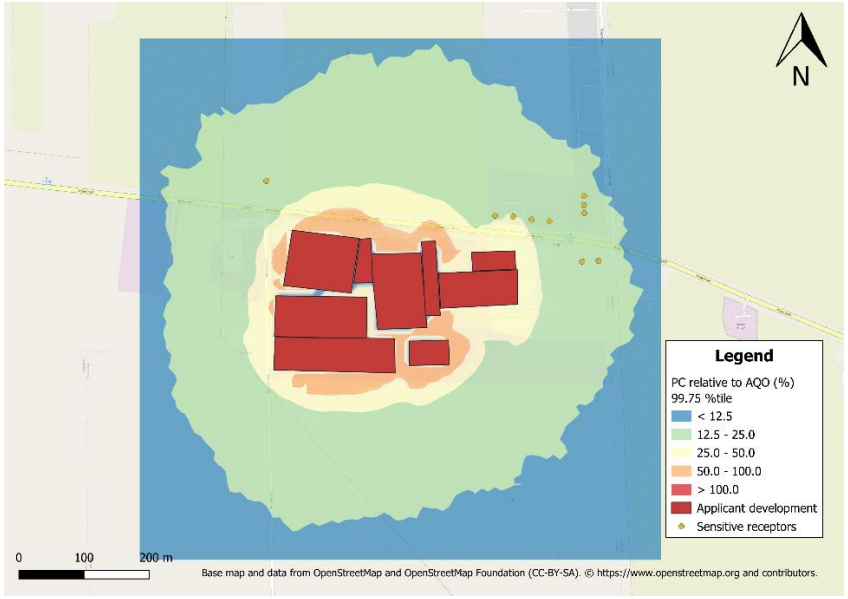
6 Boilers	3 Boilers
	

Table 14: 99.79% impact assessment – variation with a 10m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	14.8	63.6	31.8%	78.4	39.2%	41.1	20.5%	55.9	27.9%
Bridge Road 2	14.8	110.4	55.2%	125.2	62.6%	66.7	33.4%	81.5	40.8%
Bridge Road 3	14.8	65.9	32.9%	80.7	40.3%	41.1	20.5%	55.9	27.9%
Bridge Road 4	14.8	54.6	27.3%	69.4	34.7%	34.3	17.1%	49.1	24.5%
Bridge Road 5	14.8	44.1	22.1%	58.9	29.5%	28.2	14.1%	43.0	21.5%
Bridge Road 6	14.8	47.1	23.5%	61.9	30.9%	30.6	15.3%	45.4	22.7%
Bridge Road 7	14.8	59.5	29.7%	74.3	37.1%	36.4	18.2%	51.2	25.6%
Hospital Drive 1	14.8	43.9	21.9%	58.7	29.3%	27.8	13.9%	42.6	21.3%
Hospital Drive 2	14.8	43.7	21.8%	58.5	29.2%	27.6	13.8%	42.4	21.2%
Hospital Drive 3	14.8	42.9	21.4%	57.7	28.8%	27.0	13.5%	41.8	20.9%

Figure 12: Annual average process contributions – variation with a 13m stack

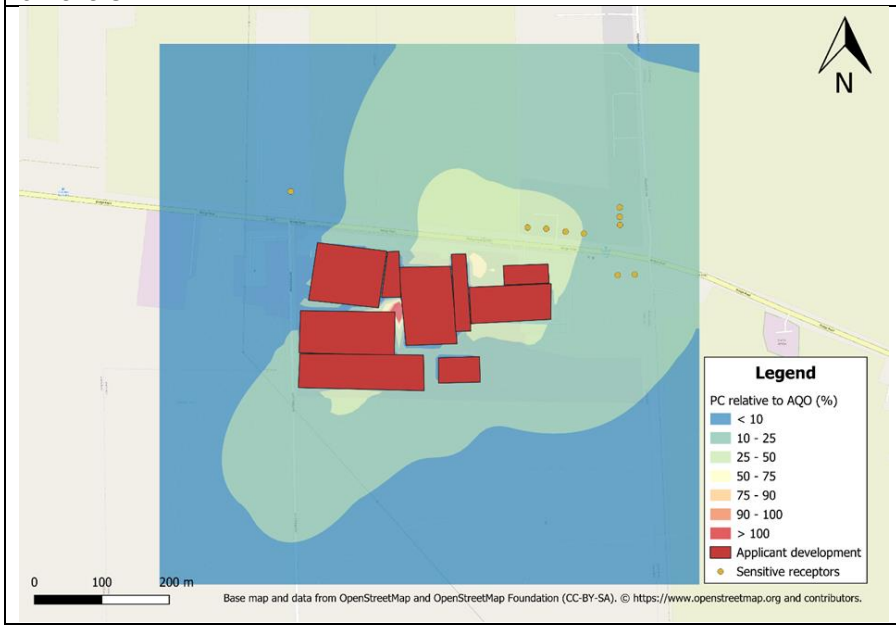
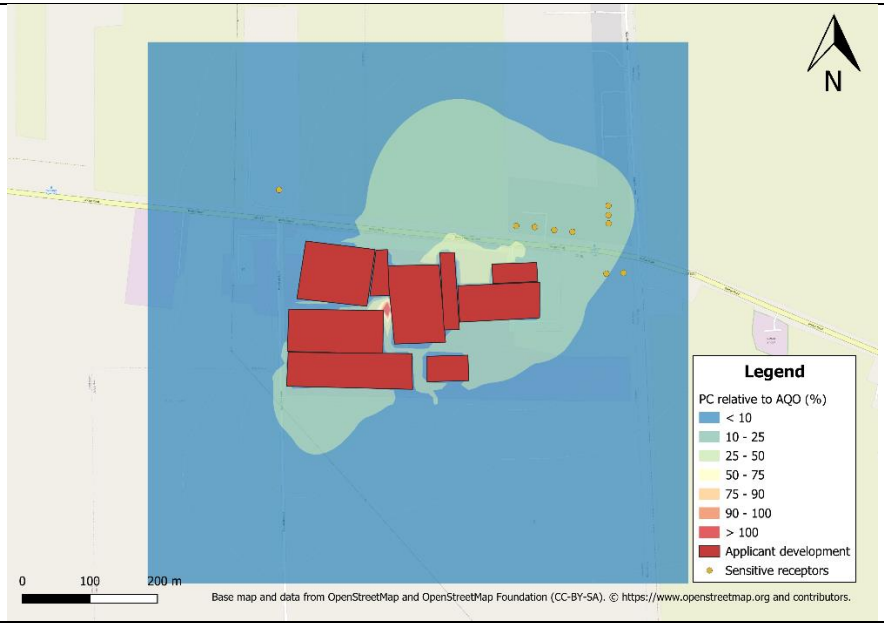
6 Boilers	3 Boilers
	

Table 15: Annual average impact assessment – variation with a 13m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	7.4	16.3	40.7%	23.7	59.2%	7.8	19.6%	15.2	38.1%
Bridge Road 2	7.4	15.1	37.8%	22.5	56.3%	7.4	18.4%	14.8	36.9%
Bridge Road 3	7.4	14.0	34.9%	21.4	53.4%	6.9	17.2%	14.3	35.7%
Bridge Road 4	7.4	12.1	30.2%	19.5	48.7%	6.0	15.0%	13.4	33.5%
Bridge Road 5	7.4	7.3	18.3%	14.7	36.8%	3.7	9.3%	11.1	27.8%
Bridge Road 6	7.4	8.2	20.5%	15.6	39.0%	4.1	10.3%	11.5	28.8%
Bridge Road 7	7.4	3.4	8.6%	10.8	27.1%	1.8	4.5%	9.2	23.0%
Hospital Drive 1	7.4	9.4	23.5%	16.8	42.0%	4.7	11.8%	12.1	30.3%
Hospital Drive 2	7.4	9.4	23.5%	16.8	42.0%	4.7	11.8%	12.1	30.3%
Hospital Drive 3	7.4	9.3	23.3%	16.7	41.8%	4.7	11.7%	12.1	30.2%

Figure 13: 99.79% process contributions – variation with a 13m stack

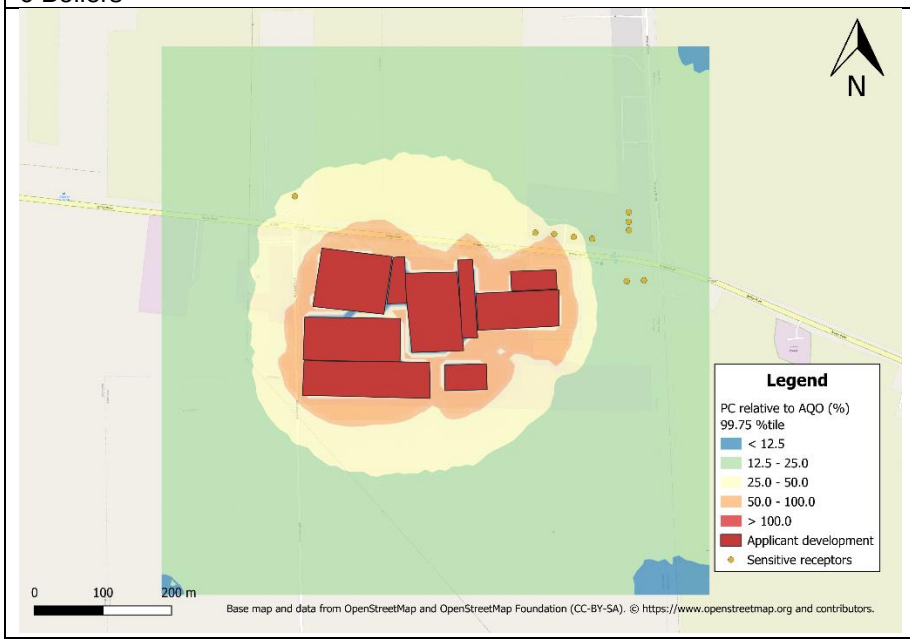
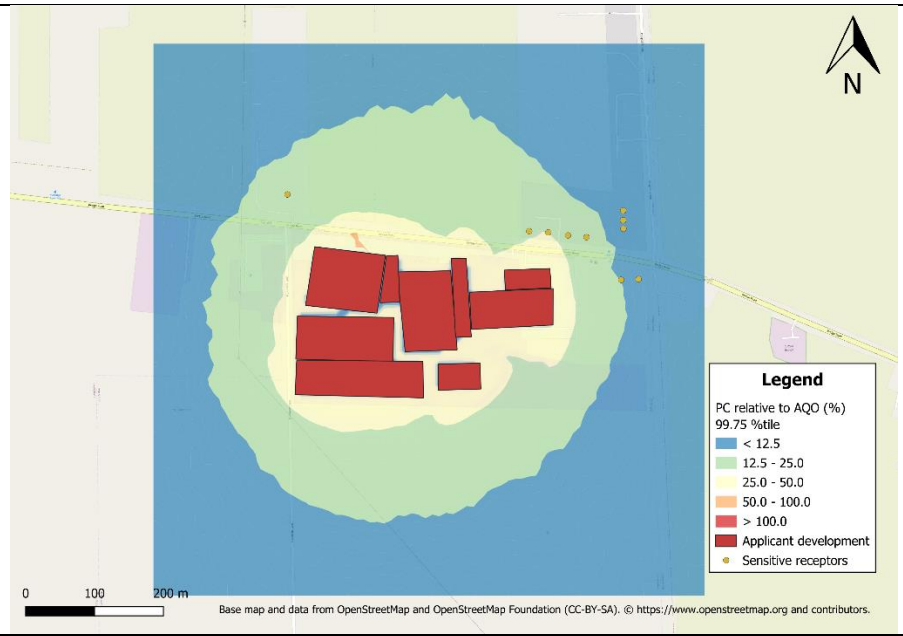
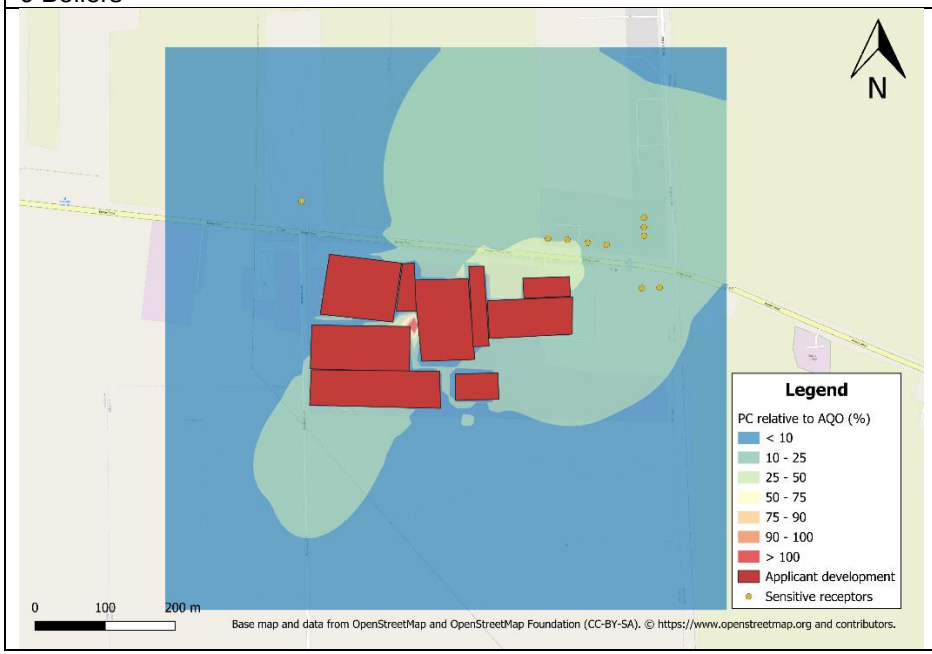
6 Boilers	3 Boilers
	

Table 16: 99.79% impact assessment – variation with a 13m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	14.8	54.5	27.3%	69.3	34.7%	33.1	16.6%	47.9	24.0%
Bridge Road 2	14.8	93.0	46.5%	107.8	53.9%	54.6	27.3%	69.4	34.7%
Bridge Road 3	14.8	57.5	28.8%	72.3	36.2%	34.2	17.1%	49.0	24.5%
Bridge Road 4	14.8	47.4	23.7%	62.2	31.1%	28.2	14.1%	43.0	21.5%
Bridge Road 5	14.8	37.0	18.5%	51.8	25.9%	23.5	11.8%	38.3	19.2%
Bridge Road 6	14.8	39.9	20.0%	54.7	27.4%	25.2	12.6%	40.0	20.0%
Bridge Road 7	14.8	53.6	26.8%	68.4	34.2%	31.6	15.8%	46.4	23.2%
Hospital Drive 1	14.8	37.7	18.9%	52.5	26.3%	23.4	11.7%	38.2	19.1%
Hospital Drive 2	14.8	37.7	18.9%	52.5	26.3%	23.1	11.6%	37.9	19.0%
Hospital Drive 3	14.8	37.3	18.7%	52.1	26.1%	22.5	11.2%	37.3	18.6%

Figure 14: Annual average process contributions – variation with a 16m stack

6 Boilers



3 Boilers

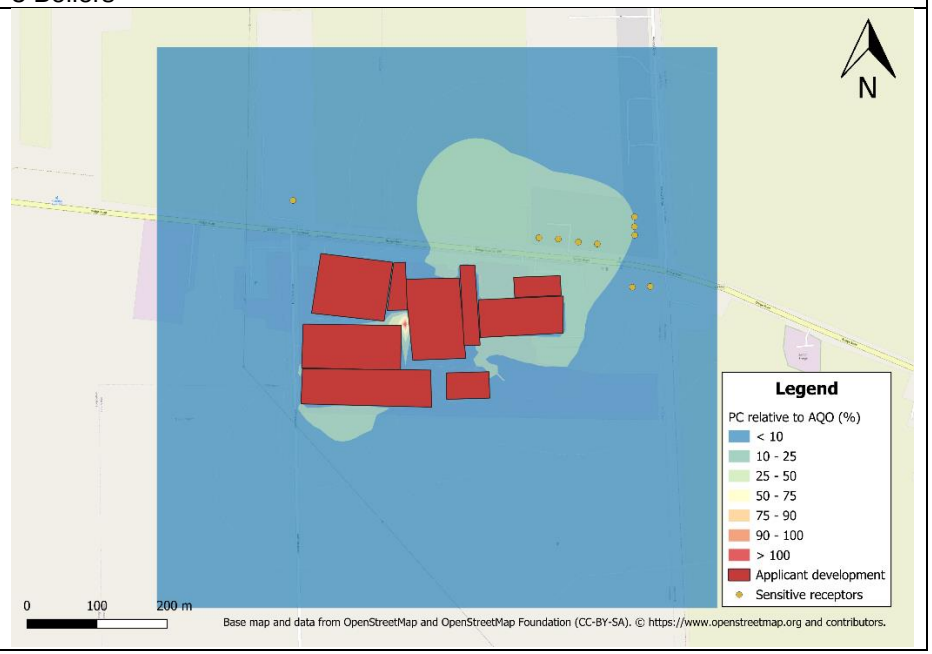


Table 17: Annual average impact assessment – variation with a 16m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	7.4	10.0	25.1%	17.4	43.6%	6.1	15.1%	13.5	33.6%
Bridge Road 2	7.4	9.8	24.6%	17.2	43.1%	5.9	14.7%	13.3	33.2%
Bridge Road 3	7.4	9.5	23.6%	16.9	42.1%	5.6	14.0%	13.0	32.5%
Bridge Road 4	7.4	8.4	20.9%	15.8	39.4%	4.9	12.4%	12.3	30.9%
Bridge Road 5	7.4	5.3	13.4%	12.7	31.9%	3.2	7.9%	10.6	26.4%
Bridge Road 6	7.4	5.8	14.6%	13.2	33.1%	3.5	8.6%	10.9	27.1%
Bridge Road 7	7.4	2.3	5.8%	9.7	24.3%	1.5	3.6%	8.9	22.1%
Hospital Drive 1	7.4	6.9	17.2%	14.3	35.7%	4.0	10.0%	11.4	28.5%
Hospital Drive 2	7.4	7.0	17.4%	14.4	35.9%	4.0	10.1%	11.4	28.6%
Hospital Drive 3	7.4	7.0	17.5%	14.4	36.0%	4.0	10.1%	11.4	28.6%

Figure 15: 99.79% process contributions – variation with a 16m stack

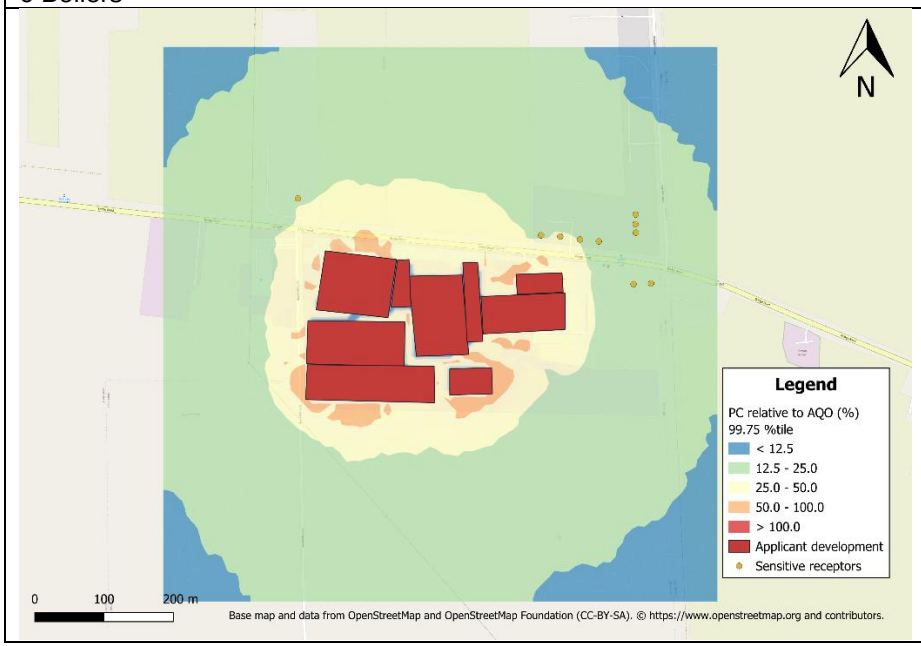
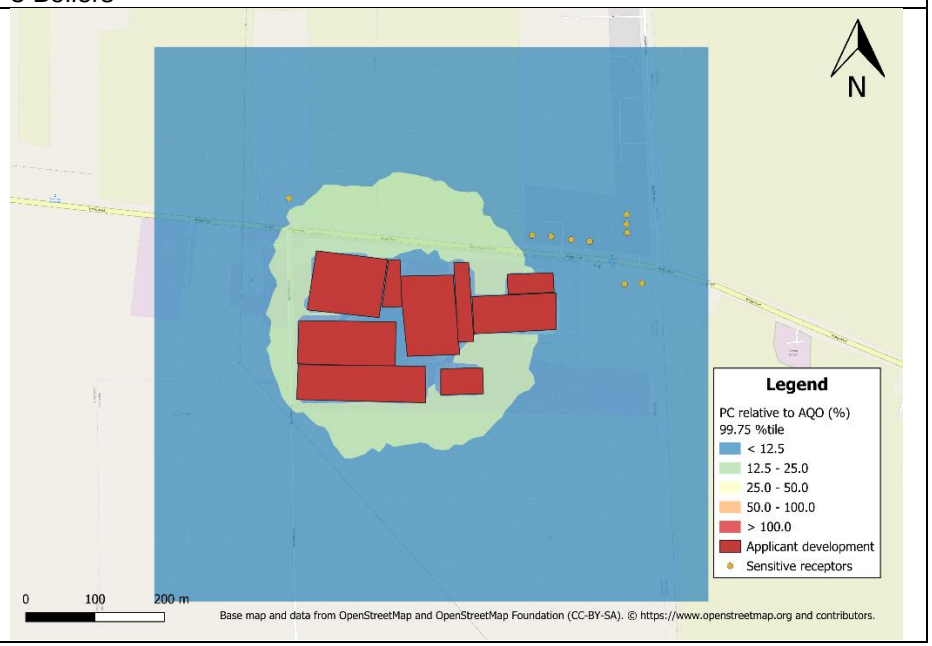
6 Boilers	3 Boilers
	

Table 18: 99.79% impact assessment – variation with a 16m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	14.8	46.8	23.4%	61.6	30.8%	28.0	14.0%	42.8	21.4%
Bridge Road 2	14.8	84.9	42.5%	99.7	49.9%	48.0	24.0%	62.8	31.4%
Bridge Road 3	14.8	49.7	24.9%	64.5	32.3%	29.9	15.0%	44.7	22.4%
Bridge Road 4	14.8	41.6	20.8%	56.4	28.2%	24.4	12.2%	39.2	19.6%
Bridge Road 5	14.8	32.4	16.2%	47.2	23.6%	19.4	9.7%	34.2	17.1%
Bridge Road 6	14.8	35.4	17.7%	50.2	25.1%	20.8	10.4%	35.6	17.8%
Bridge Road 7	14.8	48.3	24.1%	63.1	31.5%	28.5	14.2%	43.3	21.6%
Hospital Drive 1	14.8	33.0	16.5%	47.8	23.9%	19.8	9.9%	34.6	17.3%
Hospital Drive 2	14.8	32.9	16.5%	47.7	23.9%	19.6	9.8%	34.4	17.2%
Hospital Drive 3	14.8	32.8	16.4%	47.6	23.8%	19.5	9.7%	34.3	17.1%

Figure 16: Annual average process contributions – variation with a 19m stack

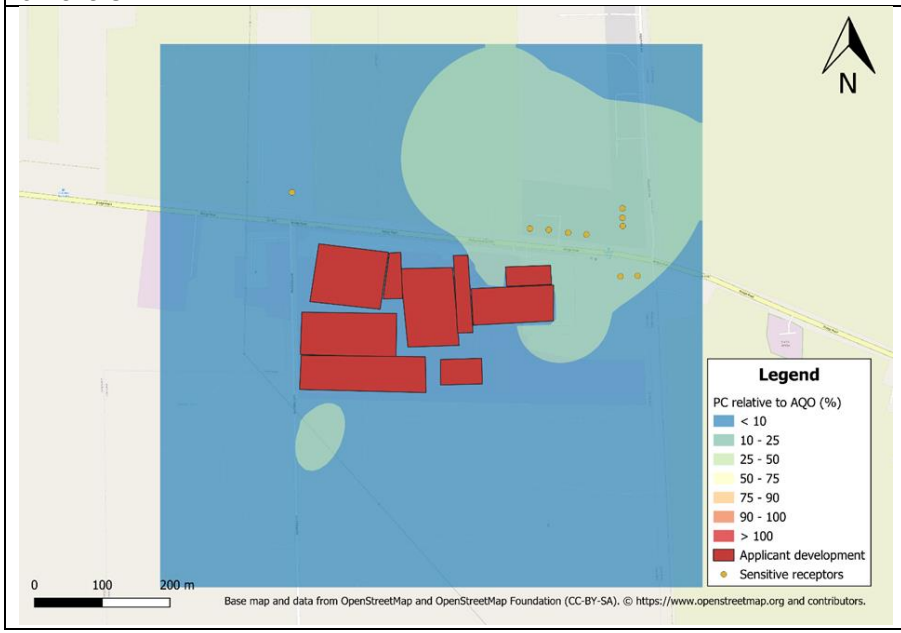
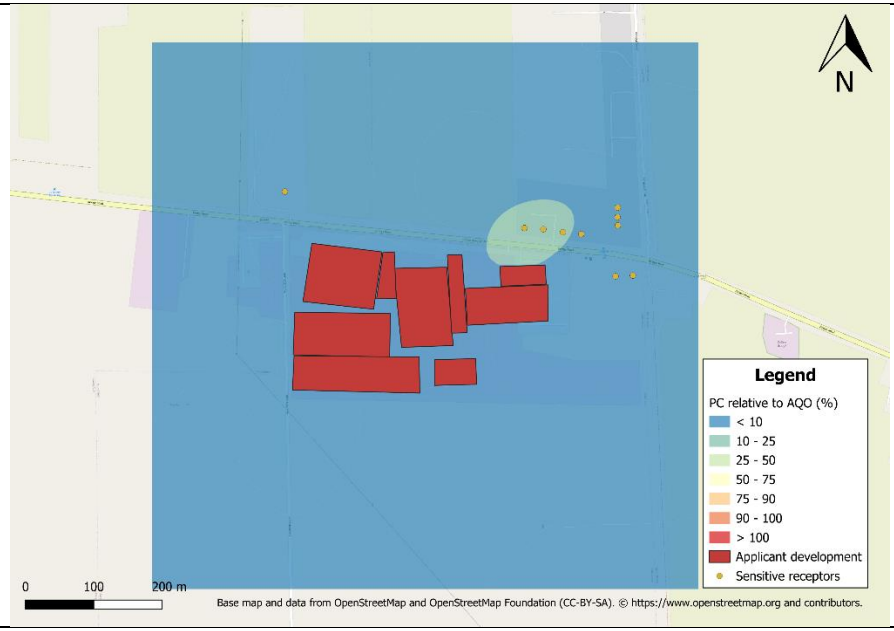
6 Boilers	3 Boilers
	

Table 19: Annual average impact assessment – variation with a 19m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	7.4	10.0	25.1%	17.4	43.6%	4.5	11.3%	11.9	29.8%
Bridge Road 2	7.4	9.8	24.6%	17.2	43.1%	4.4	11.1%	11.8	29.6%
Bridge Road 3	7.4	9.5	23.6%	16.9	42.1%	4.2	10.4%	11.6	28.9%
Bridge Road 4	7.4	8.4	20.9%	15.8	39.4%	3.8	9.6%	11.2	28.1%
Bridge Road 5	7.4	5.3	13.4%	12.7	31.9%	2.6	6.5%	10.0	25.0%
Bridge Road 6	7.4	5.8	14.6%	13.2	33.1%	2.8	7.0%	10.2	25.5%
Bridge Road 7	7.4	2.3	5.8%	9.7	24.3%	1.2	2.9%	8.6	21.4%
Hospital Drive 1	7.4	6.9	17.2%	14.3	35.7%	3.3	8.2%	10.7	26.7%
Hospital Drive 2	7.4	7.0	17.4%	14.4	35.9%	3.3	8.4%	10.7	26.9%
Hospital Drive 3	7.4	7.0	17.5%	14.4	36.0%	3.4	8.4%	10.8	26.9%

Figure 17: 99.79% process contributions – variation with a 19m stack

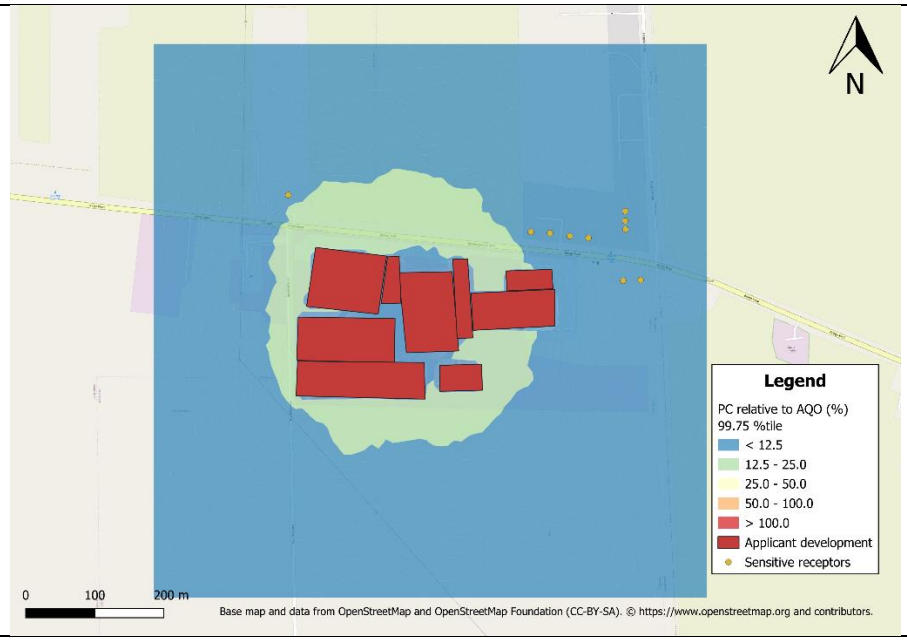
6 Boilers	3 Boilers
	

Table 20: 99.79% impact assessment – variation with a 19m stack

		6 boilers				3 boilers			
Receptor ID	Background (µg/m^3)	PC (µg/m^3)	PC / AQO	PEC (µg/m^3)	PEC / AQO	PC (µg/m3)	PC / AQO	PEC (µg/m^3)	PEC / AQO
Bridge Road 1	14.8	39.2	19.6%	54.0	27.0%	23.0	11.5%	37.8	18.9%
Bridge Road 2	14.8	36.6	18.3%	51.4	25.7%	21.5	10.8%	36.3	18.2%
Bridge Road 3	14.8	34.6	17.3%	49.4	24.7%	20.2	10.1%	35.0	17.5%
Bridge Road 4	14.8	32.7	16.3%	47.5	23.7%	18.7	9.4%	33.5	16.8%
Bridge Road 5	14.8	27.6	13.8%	42.4	21.2%	16.2	8.1%	31.0	15.5%
Bridge Road 6	14.8	29.3	14.7%	44.1	22.1%	17.2	8.6%	32.0	16.0%
Bridge Road 7	14.8	41.2	20.6%	56.0	28.0%	24.0	12.0%	38.8	19.4%
Hospital Drive 1	14.8	28.4	14.2%	43.2	21.6%	16.4	8.2%	31.2	15.6%
Hospital Drive 2	14.8	28.2	14.1%	43.0	21.5%	16.2	8.1%	31.0	15.5%
Hospital Drive 3	14.8	27.8	13.9%	42.6	21.3%	16.1	8.1%	30.9	15.5%

5.2 IMPACT AT ECOLOGICAL LOCATIONS

Table 21: Process contributions to NOx concentrations at the identified sensitive ecological receptor's locations assuming 6 boilers and a 10m stack

Receptor ID	PC annual average NO_x ($\mu g/m^3$)	PC annual average / AQO (%)	PC daily average NO_x ($\mu g/m^3$)	PC daily average / AQO (%)
Eco 1	0.1	< 1	1.7	2.3%
Eco 2	0.1	< 1	1.8	2.4%
Eco 3	0.1	< 1	1.8	2.3%
Eco 4	0.1	< 1	1.8	2.4%

Table 21: Process contributions to NOx concentrations at the identified sensitive ecological receptor's locations assuming 6 boilers and a 10m stack shows that the process contributions to the total concentrations of NO_x at locations where the ecological habitats might be adversely impacted by variation. The table shows that with the worst-case operation the variation development is predicted to contribute less than 1% of the total concentration to the annual NO_x and to less than 10% of the total concentration to the daily NO_x at all locations considered in the study. The contribution would be less than this if fewer boilers were routinely used.

6. CONCLUSION

This report describes an air quality impact assessment study conducted by Ricardo for Princes Group. The study assesses the introduction of a new heat recovery system which will be retrofitted to the existing site boilers.

This detailed dispersion modelling study has been carried out because an initial H1 risk assessment suggested the impact from the new stack may cause an exceedance of air quality objectives for nitrogen dioxide. The study focuses on emissions of nitrogen dioxide and seeks to establish the stack height to ensure compliance with the air quality objectives.

Air quality impacts were calculated using the atmospheric dispersion model ADMS 6 using five years of meteorological data. Some emission parameters used in this study have been estimated because measurements have not been possible from the existing boiler stacks. The study has focused on the emission rates based on the permitted emission limit of 300mg/m^3. It is noted that:

- measurements carried out in 2023 showed that the actual emission concentration was 36% of the emission limit.
- Typical heat requirement of the site is satisfied with only 3 of the 6 boilers operating.

The assessment shows that with the heat exchanger operating with a 10m stack, the proposed facility would make a detectable but not excessive contribution at nearby sensitive receptor locations. The study found that:

- All predicted long-term and short-term concentrations comply with the relevant environmental quality standards at all receptor locations.
- The annual concentrations of NO_2 can be considered ‘beneficial’ at all of the residential receptor locations assessed. The improvement is thought to be due to the increase plume rise offered by the increased discharge momentum as a result of combining the various air flows.
- Use of the Environment Agency’s significance criteria applied to the closest receptor locations the process contribution indicates that the annual average PC would exceed the 1% insignificance threshold and PEC would not exceed 70% of the AQO. Compliance with the threshold is demonstrated at all residential sensitive locations.
- Use of the Environment Agency’s significance criteria applied to process contribution at sensitive receptors indicates that the short-term PC would exceed with the 10% insignificance threshold and 20% of the AQO. The AQO would not be exceeded. Compliance with the threshold is demonstrated at all residential sensitive locations.
- For ecological receptors, the assessment shows that with the heat exchanger the ecological threshold as the long-term PC is less than 1% or the short term PC is less than 10% of the AQO. For ecological receptors, the assessment showed that with the new heat exchanger the of nitrogen deposition to the critical load would be small.

On the basis of this assessment, it was concluded that emissions from the proposed heat exchanger, discharging through a 10m stack will not have a significant effect on local air quality.

T: +44 (0) 1235 75 3000
E: info@ricardo.com
W: www.ricardo.com