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Permit Variation

Permali, Gloucester

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Quality Management			
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1 Introduction

1.1 This report details the air quality assessment undertaken to accompany the application to vary the Environmental Permit for the Permali, Gloucester site.

1.2 The assessment covers an evaluation of the impacts on the local area of emissions from the proposed sources and existing stacks operated on the site. The proposed sources comprise:

- 1 No. Regenerative Thermal Oxidiser which emits Volatile Organic Compounds (VOCs)
- 1 No. Scrubber which emits VOCs, phenol and formaldehyde
- 3 No. Dust Arrestment which emits particulate matter (PM)
- 2 No. Gas-fired Boiler which emits nitrogen dioxide (NO_2)

1.3 The assessment also considers the effects of the proposed sources on the surrounding area in the context of odour. The odour assessment has been undertaken in accordance with the Institute of Air Quality Management (IAQM) *Guidance on the Assessment of Odour for Planning* (2018) methodology [1], drawing on the evidence of multiple best-practice investigative tools. The IAQM odour guidance states that using different assessment tools in combination can *"minimise individual limitations and increase confidence in the overall conclusion. Best practice is to use a multi-tool approach where practicable."* The proposed sources are not yet in operation; therefore, a combination of predictive assessment tools (qualitative risk-based assessment and odour modelling) has been used to evaluate the operational effects of the proposed sources.

1.4 This report begins by setting out the policy and legislative context for the assessment. The methods and criteria used to assess potential air quality effects have then been described. The baseline air quality conditions have been established taking into account Defra estimates. The results of the assessment of air quality impacts have been presented. A conclusion has been drawn on the significance of the residual effects.

2 Policy and Legislative Context

Environmental Permitting Regulations

2.1 EU Directive 96/61/EC concerning Integrated Pollution Prevention and Control ("the IPPC Directive") [2] applies an integrated environmental approach to the regulation of certain industrial activities. The Environmental Permitting Regulations (EPR) 2016 [3] implement the IPPC Directive relating to installations in England and Wales. The Regulations define activities that require an Environmental Permit from the Environment Agency (EA).

2.2 EPR is a regulatory system that employs an integrated approach to control the environmental impacts of certain listed industrial activities. The intention of the regulatory system is to ensure that Best Available Techniques (BAT), required by the IPPC Directive, are used to prevent or minimise the effects of an activity on the environment, having regard to the effects of emissions to air, land and water via a single permitting process.

2.3 To gain a permit, Operators have to demonstrate in their applications, in a systematic way, that the techniques they are using or are proposing to use are the BAT for their installation and meet certain other requirements taking account of relevant local factors. The permitting process also places a duty on the regulating body to ensure that the requirements of the Industrial Emissions Directive (IED) are included for permitted sites to which these apply.

2.4 The essence of BAT is that the techniques selected to protect the environment should achieve a high degree of protection of people and the environment taken as a whole. Indicative BAT standards are laid out in national guidance and where relevant, should be applied unless a different standard can be justified for a particular installation. The EA is legally obliged to go beyond BAT requirements where EU Air Quality Limit Values may be exceeded by an existing operator.

2.5 The EA's on-line guidance entitled '*Environmental management – guidance, Air emissions risk assessment for your environmental permit*' [4] provides guidelines for air dispersion modelling. The assessment of air quality effects for the proposed development is consistent with this guidance.

Nuisance Provisions

2.6 Part III of the Environmental Protection Act 1990 defines a number of statutory nuisances and includes: *"any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance"*. The Act places a duty on local authorities to investigate the likely occurrence of statutory nuisance and to take reasonable steps to investigate local complaints. Where a local authority is satisfied of the existence or recurrence of statutory nuisance it must generally serve an abatement notice requiring the execution of such works and other steps necessary to rectify the nuisance. If ignored, this can result in proceedings in the Magistrates Court and imposition of an order to prevent the nuisance and a fine. The Act provides a defence for the operator to demonstrate that the Best Practicable Means (BPM) have been used to control potential nuisance. For a nuisance action to succeed the offence also has to be a cause of material harm or to be persistent or likely to recur.

2.7 The above statutory nuisance controls apply mainly to odour from premises not regulated under other specific environmental regulations, such as the EPR. Indeed, a local authority requires the consent of the Secretary of State to institute statutory nuisance proceedings arising from operation of a "regulated facility" (including a waste operation, a Part A(1), Part A(2) or Part B EPR installation, mobile plant or mining operation); or an "exempt waste operation". This is designed to avoid the operators of such regulated facilities or exempt waste operations being exposed to action by both the Environment Agency and the local authority for the same incident (i.e. to avoid "double jeopardy") [5].

2.8 It is important to note that there is no numerical odour concentration limit that can indicate unequivocally whether a statutory (or other) nuisance is being caused and it is ultimately only the Court that can decide at what point it becomes "prejudicial to health or a nuisance" and whether a statutory nuisance is occurring.

The Ambient Air Quality Directive and Air Quality Standards Regulations

2.9 The Air Quality Standards Regulations 2010 [6], amended by The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020 [7], sets limit values for ambient air concentrations for the main air pollutants: particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene, certain toxic heavy metals (arsenic, cadmium and nickel) and polycyclic aromatic hydrocarbons (PAHs).

2.10 These limit values are legally binding on the Secretary of State. The Government and devolved administrations operate various national ambient air quality monitoring networks to measure compliance and develop plans to meet the limit values.

2.11 The statutory air quality limit value relevant to this assessment is summarised in Table 2.1.

Table 2.1 Statutory Air Quality Limit Values

Pollutant	Averaging Period	Limit Values	Not to be Exceeded More Than
Nitrogen	1 hour	200 $\mu g.m^{-3}$	18 times pcy

Pollutant	Averaging Period	Limit Values	Not to be Exceeded More Than
Dioxide (NO_2)	Annual	40 µg.m^{-3}	-
Particulate Matter (PM_{10})	24 hour	50 µg.m^{-3}	35 times pcy
	Annual	40 µg.m^{-3}	-
Particulate Matter (PM_{10})	Annual	20 µg.m^{-3}	-
Benzene	Annual	5 µg.m^{-3}	-

Non-Statutory Air Quality Objectives and Guidelines

2.12 The Environment Act 1995 established the requirement for the Government and the devolved administrations to produce a National Air Quality Strategy (AQS) for improving ambient air quality, the first being published in 1997 and having been revised several times since, with the latest published in 2007 [8]. The Strategy sets UK air quality standards• and objectives# for the pollutants in the Air Quality Standards Regulations plus 1,3-butadiene and recognises that action at national, regional and local level may be needed, depending on the scale and nature of the air quality problem. There is no legal requirement to meet objectives set within the UK AQS except where equivalent limit values are set within the EU Directives.

2.13 Non-statutory air quality objectives and guidelines also exist within the World Health Organisation Guidelines [9] and the Expert Panel on Air Quality Standards Guidelines (EPAQS) [10]. There are no non-statutory objectives and guidelines relevant to this assessment.

Environmental Assessment Levels

2.14 The Environment Agency's on-line guidance entitled 'Environmental management – guidance, Air emissions risk assessment for your environmental permit' [4] provides further assessment criteria in the form of EALs. The on-line guidance states "*If you release volatile organic compounds into the air and do not know what all the substances in them are, treat them all as 100% benzene in your risk assessment. If you want to treat them as something else, you'll need to explain why".*

2.15 Table 2.2 presents all available EALs for the pollutants relevant to this assessment.

Table 2.2 Environmental Assessment Levels (EALs)

Pollutant	Long-term EAL, µg.m^{-3}	Short-term EAL, µg.m^{-3}
Nitrogen dioxide (NO_2)	40	200
Particulates (PM_{10})	40	50
Particulates ($PM_{2.5}$)	20	-

Pollutant	Long-term EAL, $\mu g.m^{-3}$	Short-term EAL, $\mu g.m^{-3}$
VOCs (assuming 100% Benzene)	5	30
Formaldehyde	5	100
Phenol	200	3900

2.16 Within the assessment, the statutory air quality limit and target values (as presented in Table 2.1) are assumed to take precedent over objectives, guidelines and the EALs. In addition, for those pollutants which do not have any statutory air quality standards, the assessment assumes the lower of either the EAL or the non-statutory air quality objective or guideline where they exist.

3 Assessment Methodology

Approach

3.1 The approach for the air quality assessment includes the key elements listed below:

- Establishing the background Ambient Concentration (AC) from consideration of Air Quality Review & Assessment findings and assessment of existing local air quality through a review of Defra background map data in the vicinity of the proposed site.
- Quantitative assessment of the operational effects on local air quality from stack emissions utilising a "new generation" Gaussian dispersion model, ADMS 5. Assessment of Process Contributions (PC) from the facility in isolation, and assessment of resultant Predicted Environmental Concentrations (PEC).

3.2 The odour assessment has used a multi-tool approach in accordance with the IAQM *Guidance on the Assessment of Odour for Planning (2018)* and incorporated multiple predictive assessment tools.

Dispersion Model Selection

3.3 A number of commercially available dispersion models are able to predict ground level concentrations arising from emissions to atmosphere from elevated point sources. Modelling for this study has been undertaken using ADMS 5, a version of the ADMS (Atmospheric Dispersion Modelling System) developed by Cambridge Environmental Research Consultants (CERC) that models a wide range of buoyant and passive releases to atmosphere either individually or in combination. The model calculates the mean concentration over flat terrain and also allows for the effect of plume rise, complex terrain, buildings and deposition. Dispersion models predict atmospheric concentrations within a set level of confidence and there can be variations in results between models under certain conditions; the ADMS 5 model has been formally validated and is widely used in the UK and internationally for regulatory purposes.

3.4 ADMS comprises a number of individual modules each representing one of the processes contributing to dispersion or an aspect of data input and output. Amongst the features of ADMS are:

- An up-to-date dispersion model in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This approach allows the vertical structure of the boundary layer, and hence concentrations, to be calculated more accurately than does the use of Pasquill-Gifford stability categories, which were used in many previous models (e.g. ISCST3). The restriction implied by the Pasquill-Gifford approach that the dispersion parameters are independent of height is avoided. In ADMS the concentration distribution is Gaussian in stable and neutral conditions, but the vertical distribution is non-Gaussian in convective conditions, to take account of the skewed structure of the vertical component of turbulence;

- A number of complex modules including the effects of plume rise, complex terrain, coastlines, concentration fluctuations and buildings; and
- A facility to calculate long-term averages of hourly mean concentration, dry and wet deposition fluxes and radioactivity, and percentiles of hourly mean concentrations, from either statistical meteorological data or hourly average data.

Model Inputs

Meteorological Data

3.5 The most important meteorological parameters governing the atmospheric dispersion of pollutants are wind direction, wind speed and atmospheric stability as described below:

- Wind direction determines the sector of the compass into which the plume is dispersed;
- Wind speed affects the distance that the plume travels over time and can affect plume dispersion by increasing the initial dilution of pollutants and inhibiting plume rise; and
- Atmospheric stability is a measure of the turbulence of the air, and particularly of its vertical motion. It therefore affects the spread of the plume as it travels away from the source. New generation dispersion models, including ADMS, use a parameter known as the Monin-Obukhov length that, together with the wind speed, describes the stability of the atmosphere.

3.6 For meteorological data to be suitable for dispersion modelling purposes, a number of meteorological parameters need to be measured on an hourly basis. These parameters include wind speed, wind direction, cloud cover and temperature. There are only a limited number of sites where the required meteorological measurements are made.

3.7 The year of meteorological data that is used for a modelling assessment can have a significant effect on source contribution concentrations. Dispersion model simulations have been performed using five years of numerical weather prediction (NWP) data centred on 382376, 217160 between 2017 and 2021.

3.8 Wind roses have been produced for each of the years of meteorological data used in this assessment and are presented in Figure 1.

Stack Parameters and Emissions Rates used in the Model

3.9 The emissions characteristics for the proposed stacks are provided in Table 3.1. Stack height calculations have been performed for each type of plant proposed and are included in Appendix A.

Table 3.1: Proposed Stack and Emissions Characteristics

Parameter	P1	P2	P3	P4	P5	P6	P7
Type of Plant	Thermal Oxidiser	Scrubber	Dust Arrestment	Dust Arrestment	Dust Arrestment	Gas fired boiler	Gas fired boiler
Grid coordinates	382295, 217222	382377, 217173	382262, 217088	382264, 217096	382266, 217103	382273, 217127	382272, 217216
Stack height (m)	15	14.3	14.9	7.72	7.78	5	5
Efflux temperature (° C)	280	17	20	20	20	101	101
Internal diameter (m)	1.7	1.1	0.8	0.8	0.8	0.3	0.3
Actual efflux velocity ($m.s^{-1}$)	12.4	4.6	12.6	12.6	12.6	2.8	2.8
Actual volumetric flow ($Am^3.s^{-1}$)	20	4.4	6.3	6.3	6.3	0.2	0.2
NO_x mass emissions ($g.s^{-1}$)	-	-	-	-	-	0.023	0.023
VOC mass emissions ($g.s^{-1}$)	0.274	0.010	-	-	-	-	-
PM mass emissions ($g.s^{-1}$)	-	-	0.003	0.003	0.003	-	-
Phenol mass emissions ($g.s^{-1}$)	-	0.025	-	-	-	-	-
Formaldehyde mass emissions ($g.s^{-1}$)	-	0.0002	-	-	-	-	-
Data source	Provided by Permali		September 2020 stack emissions monitoring report		Provided by Permali		

3.10 The stack parameters for the existing stacks are shown in

3.11 Table **3.2**. Emissions from existing stacks have only been included in this assessment for those pollutants emitted from the proposed stacks, i.e. NOx, VOC and PM. No phenol or formaldehyde is emitted from the existing stacks.

Table 3.2: Stack and Emissions Characteristics – Existing Stacks

Parameter	E1	E2	E3	E4
Type of Plant	1 x Spray Booth routed through two stacks		2 x Gas fired boiler routed through two stacks	
Grid coordinates	382376, 217160	382378, 217168	382353, 217171	382353, 217172

Parameter	E1	E2	E3	E4
Stack height (m)	10.9	10.9	10.3	10.3
Efflux temperature (° C)	19.2	19.2	87.9	87.9
Internal diameter (m)	0.64	0.64	0.43	0.43
Actual efflux velocity ($m.s^{-1}$)	9.6	9.6	6.0	6.0
Actual volumetric flow ($Am^3.s^{-1}$)	3.1	3.1	0.9	0.9
NO_x mass emissions ($g.s^{-1}$)	-	-	0.01	0.01
VOC mass emissions ($g.s^{-1}$)	0.197	0.197	0.028	0.028
PM mass emissions ($g.s^{-1}$)	0.005	0.005	-	-

Operating Hours

3.12 To ensure the assessment is conservative, the model has been run assuming that all proposed stacks will operate continuously throughout the year.

3.13 The existing E1 and E2 stacks are assumed to operate 5 days a week for 15 hours a day.

3.14 The actual operating conditions will be lower with most plant only running during the weekdays. Some processes are batch process so would be operational for a few hours or days at a time.

Surface Roughness

3.15 The roughness of the terrain over which a plume passes can have a significant effect on dispersion by altering the velocity profile with height, and the degree of atmospheric turbulence. This is accounted for by a parameter called the surface roughness length.

3.16 A surface roughness length of 0.5 m has been used within the model to represent the average surface characteristics across the study area.

Building Wake Effects

3.17 The movement of air over and around buildings generates areas of flow circulation, which can lead to increased ground level concentrations in the building wakes. Where building heights are greater than about 30 - 40% of the stack height, downwash effects can be significant. The building dimensions are listed in Table 3.3 and shown in Figure 2.

Table 3.3: Dimensions of Buildings Included Within the Dispersion Model

Building number	Location X(m)	Location Y(m)	Height (m)	Length(m)	Width(m)	Angle from North
1	382317	217108	8.6	151	93	195
2	382321	217223	8.6	17	23	199
3	382372	217203	8.6	28	75	196

Model Outputs

Receptors

3.18 The air quality assessment predicts the impacts at locations that could be sensitive to any changes. Such sensitive receptors should be selected where the public is regularly present and likely to be exposed over the averaging period of the objective. LAQM.TG22 [11] provides examples of exposure locations and these are summarised in Table 3.4.

Table 3.4: Example of Where Air Quality Objectives Apply

Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual-mean	All locations where members of the public might be regularly exposed. Building façades of residential properties, schools, hospitals, care homes.	Building façades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties. Kerbside sites (as opposed to locations at the buildings façades), or any other location where public exposure is expected to be short-term.
Daily-mean	All locations where the annual-mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short-term.
Hourly-mean	All locations where the annual and 24 hour mean would apply. Kerbside sites (e.g. pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or more. Any outdoor locations to which the public might reasonably be expected to spend 1-hour or longer.	Kerbside sites where the public would not be expected to have regular access.

3.19 The effects of the proposed development have been assessed at the façades of local receptors. All human receptors have been modelled at a height of 1.5 m, representative of typical head height. The locations of these discrete receptors are listed in Table 3.5 and illustrated in Figure 2.

Table 3.5: Modelled Sensitive Receptors

Receptor	National Grid Reference	
	X (m)	Y (m)
Residential 1	382150	216948
Residential 2	382185	217055
Residential 3	382190	217147
Residential 4	382217	217213
Residential 5	382245	217239
Residential 6	382254	217266
Residential 7	382531	217246
Residential 8	382482	217179
Residential 9	382414	217097
Residential 10	382390	217050
Residential 11	382362	217001
Industrial 1	382330	217240
Industrial 2	382401	217222
Industrial 3	382335	217212
Industrial 4	382330	217197
Industrial 5	382382	217183
Industrial 6	382269	217020
Industrial 7	382315	217006

Note: Receptors have been modelled at 1.5m above ground level, representative of typical head height

3.20 The long and short-term standards apply at residential receptors. Only the short-term standards apply at the industrial receptors.

Significance Criteria

3.21 As discussed in Section 2, the on-line EA guidance is for risk assessments and provides details for screening out substances for detailed assessment. In particular, it states that:

"To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

- *the short-term PC is less than 10% of the short-term environmental standard*
- *the long-term PC is less than 1% of the long-term environmental standard*

If you meet both of these criteria you don't need to do any further assessment of the substance.

If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

3.22 It continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

3.23 It then states that further action may be required where:

- *"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributors – if you think this is the case contact the Environment Agency)*
- *the PEC is already exceeding an environmental standard"*

3.24 On that basis, the results of the detailed modelling presented in this report have been used as follows:

- The effects are not considered significant if the short-term PC is less than 10% of the short-term Air Quality Assessment Level (AQAL); and
- The effects are not considered significant if the PEC is below the AQAL.

3.25 The Air Quality Assessment Level refers to the AQS air quality objective and the EU limit value.

Overview of Odour Assessment Tools Used

3.26 Most odours are mixtures of many chemicals that interact to produce what we detect as a smell. Odour-free air contains no odorous chemicals, whilst fresh air is usually perceived as being air that contains no chemicals or contaminants that are unpleasant (i.e. air that smells 'clean'). Fresh air may contain odorous chemicals, but these odours will usually be pleasant in character, such as freshly-mown grass or sea spray. Perceptions of an odour - whether we find it acceptable, objectionable or offensive - are partly innate and hard-wired, and partly determined through life experiences and hence can be subjective to the individual.

3.27 Before annoyance or nuisance can occur, there must be odour exposure. For odour exposure to occur, all three links in the source-pathway-receptor chain must be present:

- an emission **source** - a means for the odour to get into the atmosphere.

- a **pathway** - for the odour to travel through the air to locations off site, noting that:
  - anything that increases dilution and dispersion of an odorous pollutant plume as it travels from source to receptor will reduce the concentration at the receptor, and hence reduce exposure.
  - dilution and dispersion increase as the length of the pathway increases.
  - increasing the length of the pathway (e.g. by releasing the emissions from a high stack) will – all other things being equal – increase the dilution and dispersion.
- The presence of **receptors** (people) that could experience an adverse effect, noting that different people vary in their sensitivities to odour.

3.28 By convention, the term odour impact is restricted to the negative appraisal by a human receptor of the odour exposure. This appraisal, occurring over a matter of seconds or minutes, involves many complex psychological and socio-economic factors. Once exposure to odour has occurred, the process can lead to annoyance, nuisance and possibly complaints.

3.29 Both, or either, annoyance and nuisance can lead to loss of amenity and complaint action. However, a lack of complaints does not necessarily prove there is no loss of amenity, annoyance or nuisance. On the other hand, there needs to be an underlying level of annoyance before complaints are generated. The responses of annoyance and nuisance can change over time.

3.30 Several methods have been used as part of the assessment of the odour impact at the proposed development:

- The first tool used was a qualitative predictive assessment of the potential for odour impact, carried out using the source-pathway-receptor concept and following the method in the 2018 IAQM odour guidance. This assessment tool considers: the emission source; the presence of odour controls (both engineering controls and odour management procedures and with the assumption that regulators will properly and effectively enforce these); the prevailing wind direction relative to the locations and distances of the proposed receptors, and their sensitivity to the type of odour in question.
- Quantitative assessment of the odour impacts on the surrounding area from the stack emissions, by atmospheric dispersion modelling. A “new generation” Gaussian dispersion model, ADMS 5, was used. This predicts the odour impacts under the full range of meteorological conditions likely to be experienced over a year.

Methodology - Qualitative Predictive Odour Impact Assessment

3.31 A qualitative prediction of the odour impact of emissions from the proposed scrubber on the surrounding area was carried out using the risk-based assessment method in the IAQM Guidance

Appendix 1, which provides examples of risk factors for odour source potential, pathway effectiveness and receptor sensitivity (set out in Table 3.6).

Table 3.6: IAQM Examples of Risk Factors for Odour Source, Pathway and Receptor

Source Odour Potential	Pathway Effectiveness	Receptor
Factors affecting the source odour potential include: ▪ the magnitude of the odour release (taking into account odour-control measures) ▪ how inherently odorous the compounds are ▪ the unpleasantness of the odour	Factors affecting the odour flux to the receptor are: ▪ distance from source to receptor the frequency (%) of winds from the source to receptor (or, qualitatively, the direction of receptors from source with respect to prevailing wind) ▪ the effectiveness of any mitigation/control in reducing flux to the receptor ▪ the effectiveness of dispersion/ dilution in reducing the odour flux to the receptor ▪ topography and terrain	For the sensitivity of people to odour, the IAQM recommends that the air quality practitioner uses professional judgement to identify where on the spectrum between high and low sensitivity a receptor lies, taking into account the following general principles:
Large Source Odour Potential Magnitude - Larger Permitted processes of odorous nature or large STWs; materials usage hundreds of thousands of tonnes/m^3 per year; area sources of thousands of m^2. The compounds involved are very odorous (e.g. mercaptans), having very low Odour Detection Thresholds (ODTs) where known. Unpleasantness - processes classed as "Most offensive" in H4; or (where known) compounds/odours having unpleasant (-2) to very unpleasant (-4) hedonic score. Mitigation/control - open air operation with no containment, reliance solely on good management techniques and best practice.	**Highly Effective Pathway for Odour Flux to Receptor** Distance - receptor is adjacent to the source/site; distance well below any official set-back distances [a]. Direction - high frequency (%) of winds from source to receptor (or, qualitatively, receptors downwind of source with respect to prevailing wind). Effectiveness of dispersion/dilution - open processes with low-level releases, e.g. lagoons, uncovered effluent treatment plant, landfilling of putrescible wastes.	**High Sensitivity Receptor** - surrounding land where: ▪ users` can reasonably expect enjoyment of a high level of amenity; and ▪ the people would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium Source Odour Potential Magnitude - smaller Permitted processes or small Sewage Treatment Works (STWs); materials usage thousands of tonnes/m^3 per year; area sources of hundreds of m^2. The compounds involved are moderately odorous. Unpleasantness - processes classed in H4 as "Moderately offensive"; or (where known) odours having neutral (0) to unpleasant (-2) hedonic score.	**Moderately Effective Pathway for Odour Flux to Receptor** Distance - receptor is local to the source. Where mitigation relies on dispersion/dilution - releases are elevated, but compromised by building effects.	**Medium Sensitivity Receptor** - surrounding land where: ▪ users' would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or ▪ people wouldn't reasonably be expected to be present here continuously or regularly

Source Odour Potential	Pathway Effectiveness	Receptor
Mitigation/control - some mitigation measures in place, but significant residual odour remains.		for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreation fields.
Small Source Odour Potential Magnitude - falls below Part B threshold; materials usage hundreds of tonnes/m^3 per year; area sources of tens m^2. The compounds involved are only mildly odorous, having relatively high ODTs where known. Unpleasantness - processes classed as "Less offensive" in H4; or (where known) compounds/odours having neutral (0) to very pleasant (+4) hedonic score. Mitigation/control - effective, tangible mitigation measures in place (e.g. BAT, BPM) leading to little or no residual odour.	**Ineffective Pathway for Odour Flux to Receptor** Distance - receptor is remote from the source; distance exceeds any official set-back distances. Direction - low frequency (%) of winds from source to receptor (or, qualitatively, receptors upwind of source with respect to prevailing wind). Where mitigation relies on dispersion/ dilution - releases are from high level (e.g. stacks, or roof vents > 3 m above ridge height) and are not compromised by surrounding buildings	**Low Sensitivity Receptor** - surrounding land where: ▪ the enjoyment of amenity would not reasonably be expected; or ▪ there is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial, farms, footpaths and roads.

Notes: [a] Minimum setback distances may be defined for some odorous activities

3.32 The first step of this qualitative assessment is to estimate the odour-generating potential of the site activities, termed the "Source Odour Potential". This takes into account three factors:

- The scale (magnitude) of the release from the odour source, taking into account the effectiveness of any odour control or mitigation measures that are already in place. This involves judging the relative size of the release rate after mitigation and taking account of any pattern of release (e.g. intermittency). The assumption has been made, as required by the NPPF, that any pollution-control regimes applying to potentially-odorous sites will operate effectively and that the appropriate BAT standards of odour control will be enforced.
- How inherently odorous the emission is. In some cases it may be known whether the release has a low, medium or high odour detection threshold (ODT); this is the concentration at which an odour becomes detectable to the human nose. In most instances the odours released by a source will be a complex mixture of compounds and the detectability will not be known. However, for some industrial processes the odour will be due to one or a small number of known compounds and the detection thresholds will be a good indication of whether the release is highly odorous or mildly odorous.

- The relative pleasantness/unpleasantness* of the odour. Lists of relative pleasantness of different substances are given in the Environment Agency guidance H4 Odour Management [12].

3.33 Using the example risk ranking in Table 3.6, the Source Odour Potential can be categorised as small, medium or large.

Table 3.7: H4 Offensiveness of Odour Emission Sources

Offensiveness	Odour Emission Sources
Most Offensive	Processes involving decaying animal or fish remains Processes involving septic effluent or sludge Biological landfill odours
Moderately Offensive	Intensive livestock rearing Fat frying (food processing) Sugar beet processing Well aerated green waste composting
Less Offensive	Brewery Confectionary Coffee

3.34 Next, the effectiveness of the pollutant pathway as the transport mechanism for odour through the air to the receptor, versus the dilution/dispersion in the atmosphere, needs to be estimated. Anything that increases dilution and dispersion of the odorous pollutant plume as it travels from source (e.g. processes and plant) to receptor will reduce the concentration at the receptor, and hence reduce exposure. Important factors to consider here are:

- The distance of sensitive receptors from the odour source.
- Whether these receptors are downwind (with respect to the predominant prevailing wind direction). Odour episodes often tend to occur during stable atmospheric conditions with low wind speed, which gives poor dispersion and dilution; receptors close to the source in all directions around it can be affected under these conditions. When conditions are not calm, it will be the downwind receptors that are affected. Overall, therefore, receptors that are downwind with respect to the prevailing wind direction tend to be at higher risk of odour impact.
- The effectiveness of the point of release in promoting good dispersion, e.g. releasing the emissions from a high stack will - all other things being equal - increase the pathway, dilution and dispersion.

* This can be measured in the laboratory as the hedonic tone, and when measured by the standard method and expressed on a standard nine-point scale it is termed the hedonic score.

- The topography and terrain between the source and the receptor. The presence of topographical features such as hills and valleys, or urban terrain features such as buildings can affect air flow and therefore increase, or inhibit dispersion and dilution.

3.35 Using the example risk ranking in Table 3.6, the pollutant pathway from source to receptor can be categorised as ineffective, moderately effective, or highly effective.

3.36 In the third step, the estimates of Source Odour Potential and the Pathway Effectiveness are considered together to predict the risk of odour exposure (impact) at the receptor location, as shown by the example matrix in Table 3.8.

Table 3.8: Risk of Odour Exposure (Impact) at the Specific Receptor Location

		Source Odour Potential		
		Small	**Medium**	**Large**
Pathway Effectiveness	**Highly effective**	Low Risk	Medium Risk	High Risk
	Moderately effective	Negligible Risk	Low Risk	Medium Risk
	Ineffective	Negligible Risk	Negligible Risk	Low Risk

3.37 The next step is to estimate the effect of that odour impact on the exposed receptor, taking into account its sensitivity, as shown by the example matrix in Table 3.9. The odour effects may range from negligible, through slight adverse and moderate adverse, up to substantial adverse.

Table 3.9: Likely Magnitude of Odour Effect at the Specific Receptor Location

Risk of Odour Exposure	Receptor Sensitivity		
	Low	**Medium**	**High**
High	Slight Adverse Effect	Moderate Adverse Effect	Substantial Adverse Effect
Medium	Negligible Effect	Slight Adverse Effect	Moderate Adverse Effect
Low	Negligible Effect	Negligible Effect	Slight Adverse Effect
Negligible	Negligible Effect	Negligible Effect	Negligible Effect

3.38 This procedure results in a prediction of the likely odour effect at each sensitive receptor. The next step is to estimate the overall odour effect on the surrounding area, taking into account the different magnitude of effects at different receptors, and the number of receptors that experience these different effects*. This requires the competent and suitably experienced Air Quality Practitioner to apply professional judgement.

* Unless there is only a small number of local receptors, then a representative selection of receptors will have been used in the assessment. This final stage of considering the overall effect needs to take into account how many receptors these selected ones represent.

Methodology - Odour Dispersion Modelling

Stack Parameters used in the Model

3.39 The values of the stack emissions characteristics that were modelled are provided in

3.40 Table **3.2**. These are based on information provided by Permali.

Table 3.10 Stack Characteristics

Parameter	Unit	P2
Location (x, y)	-	382377, 217173
Stack height	m	14.3
Internal diameter	m	1.1
Efflux velocity	$m.s^{-1}$	4.6
Efflux temperature	°C	17
Odour emission rate	$ou_E.s^{-1}$	1137

Emissions Rates used in the Model

3.41 For the Scrubber (P2), the phenol and formaldehyde emissions rates were provided, and an odour emission rate of 1137 $ou_E.s^{-1}$ was calculated. The calculations are shown in Table 3.11. The odour detection threshold (ODT) have been taken from Table 9.4 of the Environment Agency, 2007, *Review of odour character and thresholds* report.

Table 3.11 Odour Emission Rates

Species	Emission Rate ($g.s^{-1}$)	Emission Rate ($mg.s^{-1}$)	Volumetric Flow ($m^3.s^{-1}$)	Emission Concentration ($mg.m^3$)	ODT (ppm) at 293k	ODT ($mg.m^{-3}$) at 293k	Odour Emission Concentration ($Oue.m^{-3}$)	Odour emission rate ($Ou.s^{-1}$) for 1 flue
Phenol	0.025	25.000	4.4	5.682	0.0056	0.022	258.26	1136
Formaldehyde	0.0002	0.200		0.045	0.50	0.614	0.07	0.326
							Total	1137

Model Outputs

Receptors

3.42 The odour assessment predicts the impacts at relevant sensitive receptors. The IAQM *Guidance on the Assessment of Odour for Planning* provides examples of receptor sensitivity to odour which are summarised in Table 3.12.

Table 3.12 Receptor sensitivity to odours

For the sensitivity of people to odour, the IAQM recommends that the Air Quality Practitioner uses professional judgement to identify where on the spectrum between high and low sensitivity a receptor lies, taking into account the following general principles:	
High sensitivity receptor	Surrounding land where: • Users can reasonably expect enjoyment of a high level of amenity; • People would reasonably be expected to be present here continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land. Examples may include residential dwellings, hospitals, schools/education and tourist/cultural.
Medium sensitivity receptor	Surrounding land where: • Users would expect to enjoy a reasonable level of amenity, but wouldn't reasonably expect to enjoy the same level of amenity as in their home; or • People wouldn't reasonably expect to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. Examples may include places of work, commercial/retail premises and playing/recreational fields.
Low sensitivity receptor	Surrounding land where: • The enjoyment of amenity would not reasonably be expected; or • There is transient exposure, where the people would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. Examples may include industrial use, farms, footpaths and roads.

3.43 The modelling assessment predicted the odour impacts across the modelled domain: a grid of 3 km by 3 km with a grid spacing of 30 m.

3.44 In addition, the odour impacts of the facility have been predicted at the façades of representative discrete local existing receptors. All human receptors have been modelled at a height of 1.5 m, representative of typical head height. The locations of these discrete receptors are listed in Table 3.5.

Significance Criteria - Odour Stack Impacts

3.45 In accordance with convention, odour levels across the project site have been predicted by the model as the 98th percentiles of the 1-hour average concentrations. Formaldehyde and phenol odours would not be expected to be at the 'most offensive' end of the spectrum and can be considered 'moderately offensive' odours.

3.46 The 2018 IAQM odour guidance for planning categorises the odour effects likely to result from various 98 percentile 1-hour average odour exposure levels, as reproduced in Table 3.13.

Table 3.13 IAQM Proposed Odour Effect Descriptors for Impacts Predicted by Modelling (Moderately Offensive Odours)

Odour Exposure Level C_{98}, ou_E /m^3	Receptor Sensitivity		
	Low	Medium	High
≥10	Moderate	Substantial	Substantial
5- <10	Slight	Moderate	Moderate
3- <5	Negligible	Slight	Moderate
1.5- <3	Negligible	Negligible	Slight
0.5- <1.5	Negligible	Negligible	Negligible
<0.5	Negligible	Negligible	Negligible

Uncertainty

3.47 All air quality assessment tools, whether models or monitoring measurements, have a degree of uncertainty associated with the results. The choices that the practitioner makes in setting-up the model, choosing the input data, and selecting the baseline monitoring data will decide whether the final predicted impact should be considered a central estimate, or an estimate tending towards the upper bounds of the uncertainty range (i.e. tending towards worst-case).

3.48 The atmospheric dispersion model itself contributes some of this uncertainty, due to it being a simplified version of the real situation: it uses a sophisticated set of mathematical equations to approximate the complex physical and chemical atmospheric processes taking place as a pollutant is released and as it travels to a receptor. The predictive ability of even the best model is limited by how well the turbulent nature of the atmosphere can be represented.

3.49 Each of the data inputs for the model, listed earlier, will also have some uncertainty associated with them. Where it has been necessary to make assumptions, these have mainly been made towards the upper end of the range informed by an analysis of relevant, available data.

3.50 The main components of uncertainty in the total predicted concentrations include those summarised in Table 3.14.

Table 3.14 Approaches to Dealing with Uncertainty used Within the Modelling Assessment

Source of Uncertainty	Approach to Dealing with Uncertainty	Comments
Emissions and stack characteristics	Emission rates have been derived using a number of conservative assumptions. This is likely to be a central estimate, with associated uncertainty attached.	The predicted concentration is likely to be between a central estimate and the top of the uncertainty range.
Meteorological Data	Uncertainties arise from any differences between the conditions at the met station and the development site, and between the historical met years and the future years. These have been minimised by using meteorological data collated at a representative measuring site. The model has been run for five full years of meteorological conditions. This means that the conditions in 43,800 hours have been considered in the assessment.	
Receptors	Receptor locations have been identified where concentrations are expected to be the highest or where the greatest changes are expected.	

3.51 The analysis of the component uncertainties indicates that, overall, the predicted total concentration is likely fall between a central estimate and the top of the uncertainty range (i.e. tending towards worst-case).

4 Baseline Air Quality Conditions

Overview

4.1 The background concentration often represents a large proportion of the total pollution concentration, so it is important that the background concentration selected for the assessment is realistic. EPUK/IAQM guidance highlight public information from Defra and local monitoring studies as potential sources of information on background air quality.

4.2 For this assessment, the background air quality has been characterised by drawing on information from the following public sources:

- Defra maps [13], which show estimated pollutant concentrations across the UK in 1 km grid squares;
- published results of local authority Review and Assessment (R&A) studies of air quality, including local monitoring and modelling studies; and
- results published by national monitoring networks.

4.3 There is no urban background monitoring NO_2 or PM_{10} in the vicinity of the site so the background concentrations have been derived from the Defra mapped background concentration estimate at the site. The background concentrations used in the assessment are set out in Table 4.1.

Table 4.1 Summary of Assumed Background Concentrations

Pollutant	Averaging Period	Concentration ($\mu g.m^{-3}$)	Data Source
NO_2	1 hour (99.79th percentile)	35.4(a)	Defra mapped (2018)
	1 hour (annual mean)	17.7	
PM_{10}	24 hour (90.41st percentile)	15.5	
	24 hour (annual mean)	15.5	
Benzene (b)	1 hour (annual mean)	0.75	Average of data collected at Bath Roadside, Newport, Oxford Centre Roadside and Oxford St Ebbes (2014-2019)
	24 hour (daily mean)	1.5 (a)	

Note:
(a) Short-term background data approximately equate to the 90th percentile, which is approximately equivalent to 2 x the annual mean.
(b) Benzene has been used as a proxy for background VOCs

5 Assessment of Air Quality Impacts

Results of Stack Emissions Modelling

Table 5.1 to *includes the 73.03 and 39.40 µg.m^{-3} from P7.

5.1 Table 5.7 summarise the maximum predicted PCs across the modelled grid for each of the proposed stacks and for all of the meteorological years modelled. Where the PCs are greater than 1% of the long-term EAL or greater than 10% of the short-term EAL, the Predicted Environmental Concentration (PEC) has been shown. The PEC is calculated as the PC from the proposed stacks added to the PC from the existing stacks plus the ambient concentration (AC) derived in Table 4.1.

5.2 Figure 4 to Figure 6 show contour plots for NO_2 and VOC concentrations from proposed stacks. The 2018 meteorological year has been used for the annual-mean NO_2 contour and the 2017 meteorological year has been used for the annual-mean and 30-minute mean VOC contours. The meteorological year selected for each contour has been determined using the year in which the maximum concentration across the grid for each pollutant is predicted.

5.3 There may be some discrepancies between the contours and the concentrations predicted at the discrete sensitive receptors. This is because the location of the maximum predicted impact varies with each year of meteorological data and the maximum concentration at each sensitive receptor is often predicted in a different meteorological year to the maximum predicted concentration across the grid.

Table 5.1 Maximum Predicted Contributions at across the grid – P1

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	PEC as % of EAL	PEC is Potentially Significant ?
VOCs (assumed to be 100% Benzene)	24 hour (daily mean)	**30**	15.91	53	10	Yes	69.25*	85.16	284	Yes
	1 hour (annual mean)	**5**	1.33	27	1	Yes	16.10*	17.43	349	Yes

*includes the 2.96 and 0.91 $\mu g.m^{-3}$ from P2.

Table 5.2 Maximum Predicted Contributions at across the grid – P2

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	PEC as % of EAL	PEC is Potentially Significant ?
VOCs (assumed to be 100% Benzene)	24 hour (daily mean)	**30**	2.96	10	10	No	-	-	-	-
	1 hour (annual mean)	**5**	0.91	18	1	Yes	16.72*	17.63	353	Yes
Formaldehyde	1 hour (annual mean)	**5**	0.02	0	1	No	-	-	-	-
	30 minute (maximum)	**100**	0.38	0	10	No	-	-	-	-
Phenol	1 hour (annual mean)	**200**	47.47	1	1	No	-	-	-	-
	1 hour (annual mean)	**3900**	2.27	1	10	No	-	-	-	-

*includes the 1.33 $\mu g.m^{-3}$ from P1.

Table 5.3 Maximum Predicted Contributions at across the grid – P3

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	PEC as % of EAL	PEC is Potentially Significant ?
PM_{10}	24 hour (90.41st percentile)	**50**	0.15	0	10	No	-	-	-	-
	24 hour (annual mean)	**40**	0.08	0	1	No	-	-	-	-

Table 5.4 Maximum Predicted Contributions at across the grid – P4

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	PEC as % of EAL	PEC is Potentially Significant ?
PM_{10}	24 hour (90.41st percentile)	**50**	0.83	2	10	No	-	-	-	-
	24 hour (annual mean)	**40**	0.31	1	1	No	-	-	-	-

Table 5.5 Maximum Predicted Contributions at across the grid – P5

Pollutant	Averaging Period	EAL ($\mu g.m^{-3}$)	Max PC ($\mu g.m^{-3}$)	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks ($\mu g.m^{-3}$)	PEC ($\mu g.m^{-3}$)	PEC as % of EAL	PEC is Potentially Significant ?
PM_{10}	24 hour (90.41st percentile)	**50**	0.85	2	10	No	-	-	-	-
	24 hour (annual mean)	**40**	0.32	1	1	No	-	-	-	-

Table 5.6 Maximum Predicted Contributions at across the grid – P6

Pollutant	Averaging Period	EAL (µg.m^{-3})	Max PC (µg.m^{-3})	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks (µg.m^{-3})	PEC (µg.m^{-3})	PEC as % of EAL	PEC is Potentially Significant ?
NO_2	1 hour (99.79th percentile)	**200**	73.03	37	10	Yes	111.28*	184.31	92	No
	1 hour (annual mean)	**40**	43.62	109	1	Yes	59.02*	102.64	257	Yes

*includes the 73.03 and 39.40 µg.m^{-3} from P7.

Table 5.7 Maximum Predicted Contributions at across the grid – P7

Pollutant	Averaging Period	EAL (µg.m^{-3})	Max PC (µg.m^{-3})	Max PC as % of EAL	Criteria (%)	PC is Potentially Significant?	AC including existing stacks (µg.m^{-3})	PEC (µg.m^{-3})	PEC as % of EAL	PEC is Potentially Significant ?
NO_2	1 hour (99.79th percentile)	**200**	73.03	37	10	Yes	111.28	184.31	92	No
	1 hour (annual mean)	**40**	39.40	98	1	Yes	63.24	102.64	257	Yes

*includes the 73.03 and 43.62 µg.m^{-3} from P6.

5.4 The maximum PCs across the modelled grid does not exceed 1% of the EAL for long-term and 10% of the EAL for short-term averaging periods for all pollutants except VOCs for P1 and P2 and NO_2 for P6 and P7 and the impacts for those other pollutants are not considered to cause a significant effect.

5.5 Based on the PC alone, the VOC and NO_2 impacts are potentially significant however, when the PCs are added to the background concentrations, the resulting maximum PEC is below the relevant EAL for 99.79th percentile NO_2. On that basis, the effects are not considered to be significant for short-term NO_2. For VOCs and long-term NO_2, the PCs at the nearest sensitive receptors have been considered and are presented in Table 5.8 and Table 5.9.

Table 5.8 Maximum Predicted Contributions at Sensitive Receptors - VOCs

	Annual Mean								30 Minute Mean		
Receptor	PC Proposed (P1 and P2) (μg.m-3)	Existing sources (μg.m-3)	AC (μg.m-3)	Proposed PC as %EAL (assumed to be 100% formaldehyde)	Proposed PC is Potentially Significant?	PEC	PEC as %EAL (assumed to be 100% formaldehyde)	PEC is Potentially Significant?	PC Proposed (P1 and P2) (μg.m-3)	Proposed PC as %EAL (assumed to be 100% formaldehyde)	Proposed PC is Potentially Significant?
R1	0.2	**0.6**	-	4	Yes	0.8	16	No	0.2	0	No
R2	0.3	**0.9**		6		1.2	25		0.3	0	
R3	0.5	**0.7**		11		1.3	26		0.6	1	
R4	0.5	**0.7**		10		1.2	24		0.5	1	
R5	0.4	**0.8**		7		1.1	22		0.4	0	
R6	0.4	**0.7**		8		1.1	22		0.4	0	
R7	0.5	**2.2**		11		2.8	56		0.5	1	
R8	0.5	**2.9**		10		3.5	69		0.5	1	
R9	0.4	**2.6**		8		3.1	61		0.4	0	
R10	0.3	**1.8**		6		2.1	43		0.3	0	
R11	0.2	**1.2**		5		1.5	29		0.2	0	
I1	N/A								0.6	1	
I2									0.9	1	
I3									1.1	1	
I4									0.3	0	

Receptor	Annual Mean: PC Proposed (P1 and P2) (µg.m^{-3})	Annual Mean: Existing sources (µg.m^{-3})	Annual Mean: AC (µg.m^{-3})	Annual Mean: Proposed PC as %EAL (assumed to be 100% formaldehyde)	Annual Mean: Proposed PC is Potentially Significant?	Annual Mean: PEC	Annual Mean: PEC as %EAL (assumed to be 100% formaldehyde)	Annual Mean: PEC is Potentially Significant?	30 Minute Mean: PC Proposed (P1 and P2) (µg.m^{-3})	30 Minute Mean: Proposed PC as %EAL (assumed to be 100% formaldehyde)	30 Minute Mean: Proposed PC is Potentially Significant?
I5									1.4	1	
I6									0.3	0	
I7									0.3	0	

Usually as recommended by the EAs on-line guidance, where the exact substances that make up the VOCs are unknown it is assumed to be 100% benzene and is compared with the EAL for benzene. In this case, benzene is not being emitted by P1, so it has been assumed to be 100% formaldehyde and compared to the EAL for formaldehyde.

PCs/PECs as a % of the EAL that exceed the relevant criteria are shaded in grey.

Table 5.9 Maximum Predicted Contributions at Sensitive Receptors – NO_2

Receptor	Annual Mean: PC Proposed (P6 & P7) (µg.m^{-3})	Annual Mean: Existing sources (µg.m^{-3})	Annual Mean: AC (µg.m^{-3})	Annual Mean: PC as %EAL	Annual Mean: PC is Potentially Significant?	Annual Mean: PEC	Annual Mean: PEC as %EAL	Annual Mean: PEC is Potentially Significant?
R1	0.30	0.05	17.7	1	No	-	-	-
R2	0.96	0.09		2	Yes	18.8	47	No
R3	0.57	0.08		1	No	-	-	-
R4	0.49	0.07		1	No	-	-	-
R5	0.60	0.08		2	Yes	18.4	46	No
R6	0.42	0.07		1	No	-	-	-
R7	0.38	0.15		1	No	-	-	-
R8	0.60	0.20		1	No	-	-	-
R9	0.60	0.21		2	Yes	18.5	46	No

Receptor	Annual Mean							
	PC Proposed (P6 & P7) (µg.m^{-3})	Existing sources (µg.m^{-3})	AC (µg.m^{-3})	PC as %EAL	PC is Potentially Significant?	PEC	PEC as %EAL	PEC is Potentially Significant?
R10	0.54	0.11		1	No	-	-	-
R11	0.47	0.09		1	No	-	-	-
I1	N/A							
I2								
I3								
I4								
I5								
I6								
I7								

5.6 Based on the PC alone, the NO_2 impacts are potentially significant however, when the PCs are added to the background concentrations, the resulting PECs are all below the relevant EALs. On that basis the effects are not considered to be significant.

5.7 Based on the PC alone, the VOC impacts are potentially significant however, when the PCs are added to the background concentrations, the resulting PECs are all below the relevant EALs. On that basis the effects are not considered to be significant. This is a conservative assessment as it assumes that all VOCs are formaldehyde which has the lowest (most stringent) EAL of the VOCs emitted.

Significance of Effects

5.8 As set out in Section 3, it is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively. Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts.

5.9 The impacts at existing receptors are shown to be not significant even for this conservative scenario. Consequently, further sensitivity analysis has not been undertaken and, in practice, the impacts at sensitive receptors are likely to be lower than those reported in this conservative assessment.

6 Assessment of Odour Impacts

Qualitative Predictive Odour Impact

Source Odour Potential

6.1 The first step in the qualitative assessment of odour impact is to estimate the odour source potential which has been determined based on the guidance set out in Table 3.6. The factors affecting the Source Odour Potential are the magnitude of the odour release, how inherently odorous the compounds are, and the unpleasantness of the odour.

6.2 The total scrubber emission rate is 1137 $ou_E.s^{-1}$, a relatively small scale of release.

6.3 The compounds involved are likely to be moderately odorous, with the compounds having moderate Odour Detection Thresholds.

6.4 Regarding the unpleasantness of the odours and how inherently odorous the constituent compounds are the Environment Agency odour guidance H4 gives paint a hedonic score of -0.75. As this is towards the middle of the typical range of -4 to +4, the unpleasantness can be expected to fall into the “moderately offensive” category shown in Table 3.7.

6.5 Based on the above factors, RPS has conservatively categorised the Source Odour Potential as ‘medium’.

Pathway Effectiveness

6.6 The odour flux from the odour sources is dependent on the effectiveness of odour transport to the receptors, versus the mitigating effect of dilution/dispersion in the atmosphere.

6.7 The locations of the proposed development site and the nearest sensitive receptors are shown in Figure 3. The nearest residential receptors are approximately 85 m to the southeast and 105 m to the east of the scrubber stack. The nearest industrial receptors are approximately 10 m north of the stack.

6.8 The average wind directions centred on the site are shown in Figure 1. This data indicates that the prevailing wind direction is south-westerly.

6.9 The guidance examples in Table 3.6 suggest that releases from the stack to receptors adjacent to the site would be ‘highly effective’. The nearest industrial receptor is 10 m north of the stack which is mostly downwind. The nearest residential receptor downwind of the stack is further away at a distance of 105 m east from the stack. On that basis the pathway effectiveness is categorised as “moderately effective”.

Receptor Sensitivity

6.10 The residential receptors are deemed to be "high sensitivity".

6.11 The industrial receptors are deemed to be "medium sensitivity".

Risk of Odour Exposure (Impact)

6.12 When the small source odour potential (ignoring mitigation) is considered in the context of the pathway effectiveness (Table 3.8), the risk of odour exposure (impact) is "low risk".

Likely Magnitude of Odour Effect

6.13 When the above risk of odour exposure impact is considered in the context of the sensitivity of the receptors using the matrix in Table 3.9, the likely resulting odour effect is predicted to be "slightly adverse" at residential receptors and "negligible" at industrial receptors.

Results of Stack Emissions Modelling

6.14 Table 6.1 presents the 98th percentile hourly-mean odour concentrations predicted at the nearest sensitive receptors.

Table 6.1 98th Percentile of Hourly Odour Concentrations ($ou_E.m^{-3}$)

Receptor ID	Receptor Sensitivity	98th Percentile Hourly-mean Odour Concentration ($ou_E.m^{-3}$)	Odour Effect Descriptor
Residential 1	High	0.03	Negligible
Residential 2		0.06	Negligible
Residential 3		0.06	Negligible
Residential 4		0.06	Negligible
Residential 5		0.07	Negligible
Residential 6		0.07	Negligible
Residential 7		0.08	Negligible
Residential 8		0.12	Negligible
Residential 9		0.14	Negligible
Residential 10		0.13	Negligible
Residential 11		0.08	Negligible
Industrial 1	Medium	0.14	Negligible
Industrial 2		0.15	Negligible
Industrial 3		0.16	Negligible

Receptor ID	Receptor Sensitivity	98th Percentile Hourly-mean Odour Concentration ($ou_E.m^{-3}$)	Odour Effect Descriptor
Industrial 4		0.12	Negligible
Industrial 5		0.20	Negligible
Industrial 6		0.06	Negligible
Industrial 7		0.07	Negligible

6.15 Table 6.1 shows that the predicted 98th percentile hourly odour concentrations at the nearest sensitive receptor locations are all well below the 1.5 $ou_E.m^{-3}$ benchmark at residential receptors and the 3 $ou_E.m^{-3}$ benchmark at industrial receptors and the resulting odour effect descriptor at all receptors is negligible.

Significance of Effects

6.16 It is generally considered good practice that, where possible, an assessment should communicate effects both numerically and descriptively. Professional judgement by a competent, suitably qualified professional is required to establish the significance associated with the consequence of the impacts.

6.17 The impacts predicted at individual receptors and the geographical extent over which such impacts occur, can be used to inform the judgement on the impact on the surrounding area as a whole, and whether the resulting overall effect is significant or not.

6.18 Using professional judgement, the resulting odour effect is considered to be 'not significant' overall.

7 Conclusions

7.1 This report details the air quality assessment undertaken to accompany the application to vary the permit for the Permali, Gloucester site.

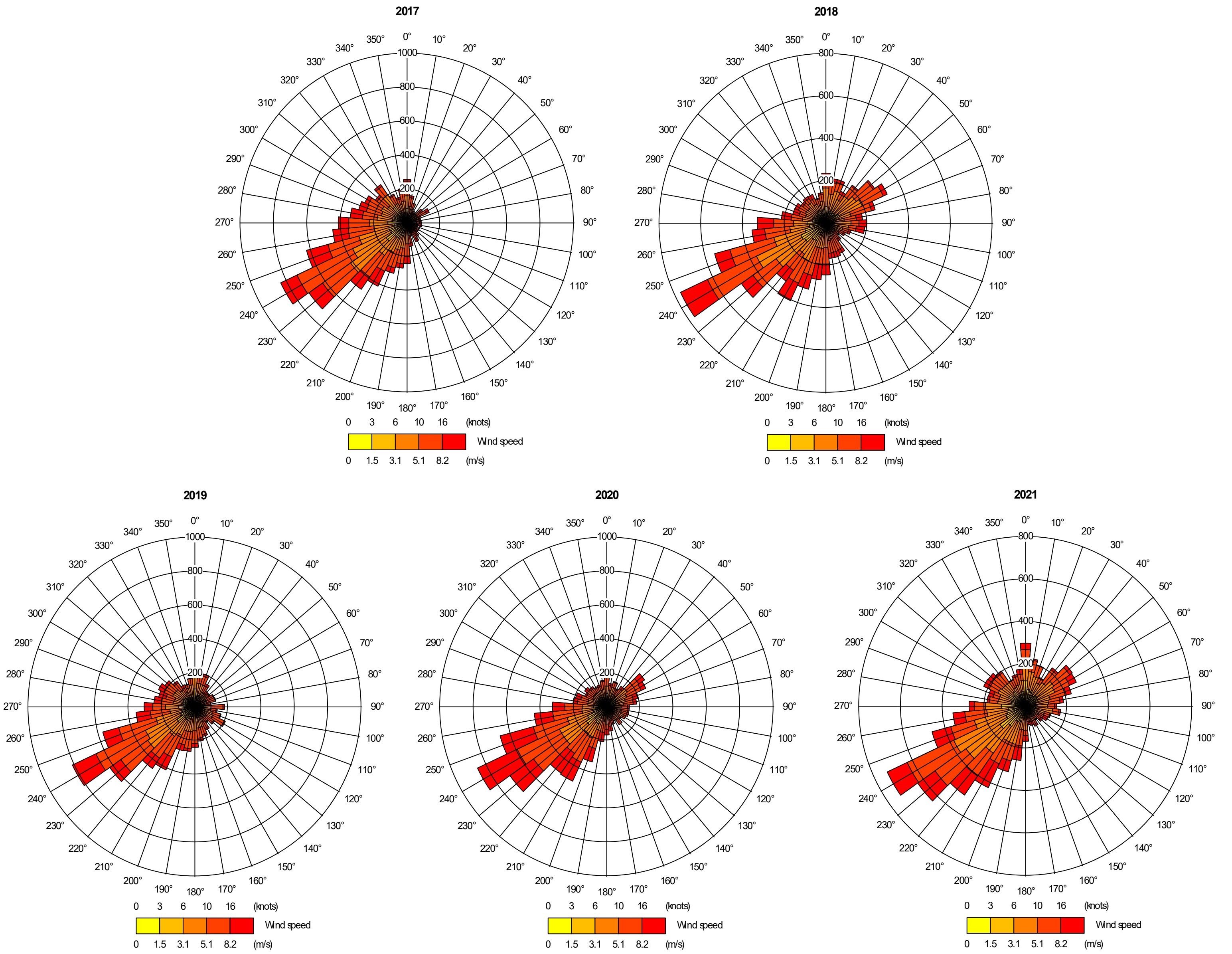
7.2 The assessment covers an evaluation of the impacts on the local area of NO_2, PM_{10}, VOC, formaldehyde, phenol, and odour emissions from the proposed and existing stacks operated on the site.

7.3 Detailed atmospheric dispersion modelling has been undertaken to predict contributions from the varied operations. Modelling has been undertaken using five years of hourly sequential meteorological data. Concentrations have been predicted across a grid and at selected, representative receptors and compared with the relevant air quality standards.

7.4 The results show that, with the new stacks, the predicted concentrations associated with operations at the site are below the relevant air quality standards at sensitive receptors and the effects of the impacts are not considered to be significant.

7.5 Using professional judgement and experience of similar projects, the resulting air quality effect of the proposed variation is considered to be ‘not significant’ overall.

Figures



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Project: Permali, Gloucester

Job Ref: JAR02788

File location:

Date: 16/01/2023	**Rev: 0**
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Figure 1: Wind Roses – NWP Data centred on 382376, 217160 (2017 – 2022)

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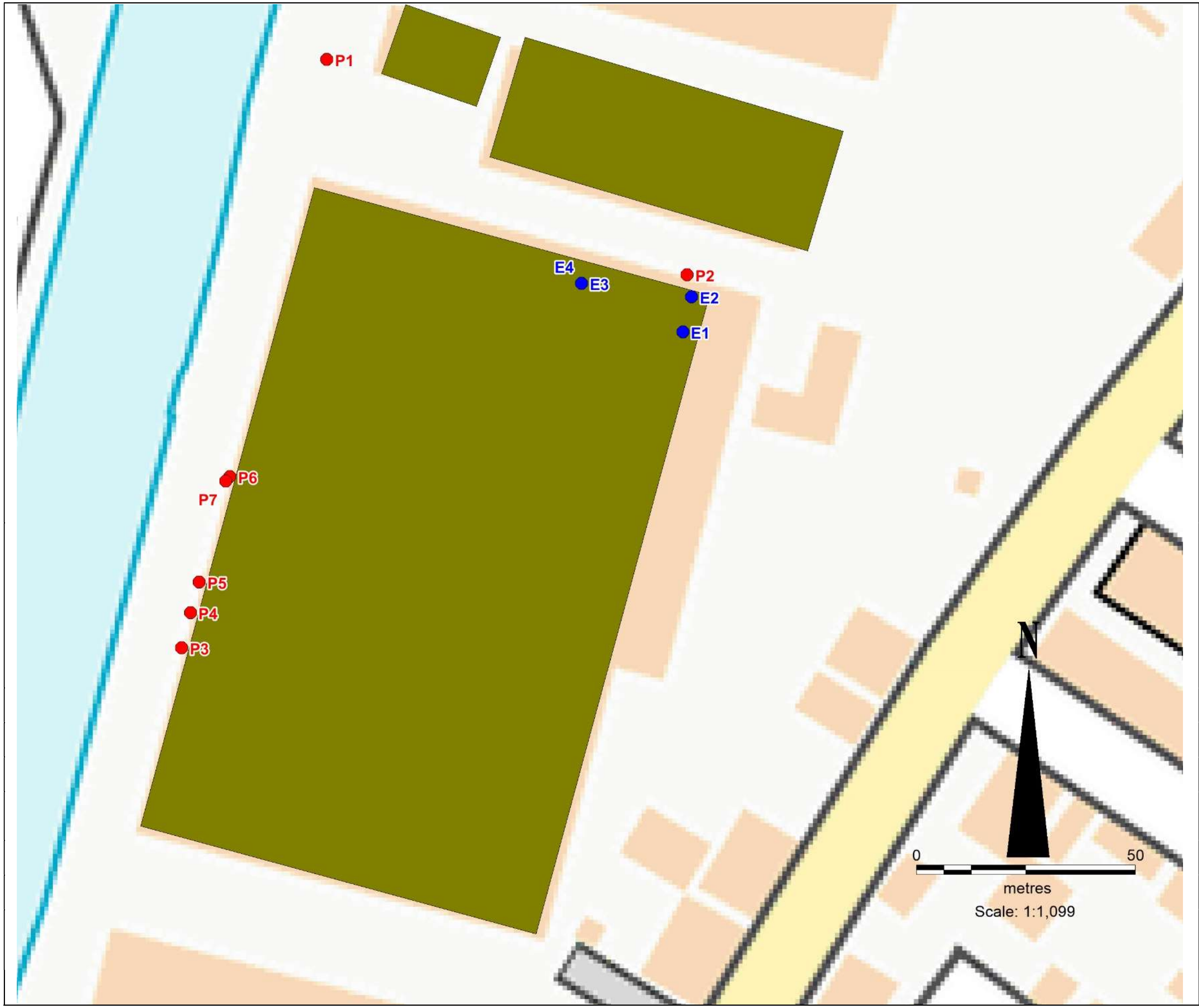

Legend

Buildings Modelled

Proposed Sources

Existing Sources

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Figure 2: Stacks and Buildings Modelled

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Legend

Buildings Modelled

Proposed Sources

Existing Sources

Residential Sensitive Receptors

Industrial Sensitive Receptors

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Figure 3: Modelled Sensitive Receptors

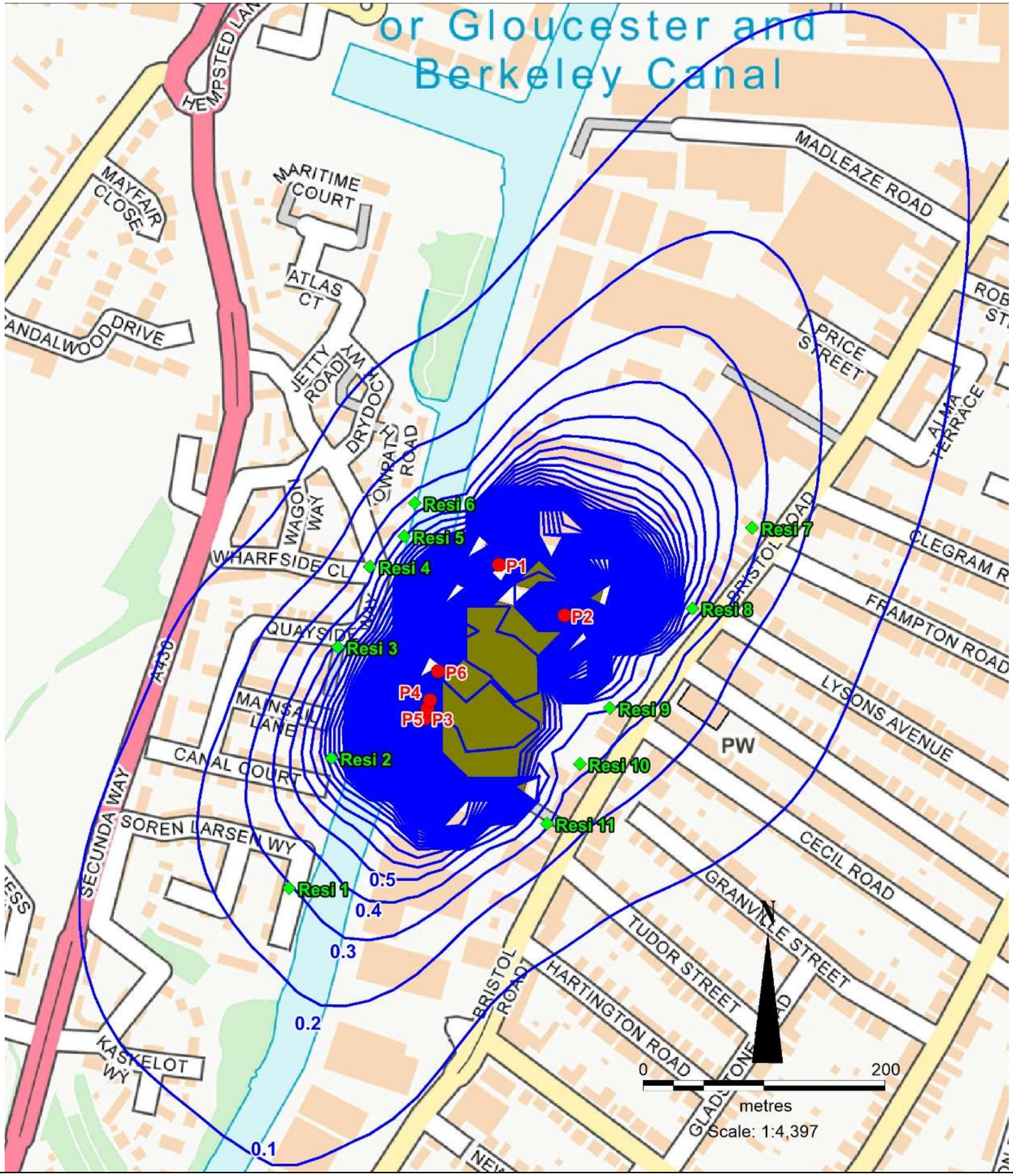

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Figure 4: Annual Mean NO_2 PCs (ug/m^3)

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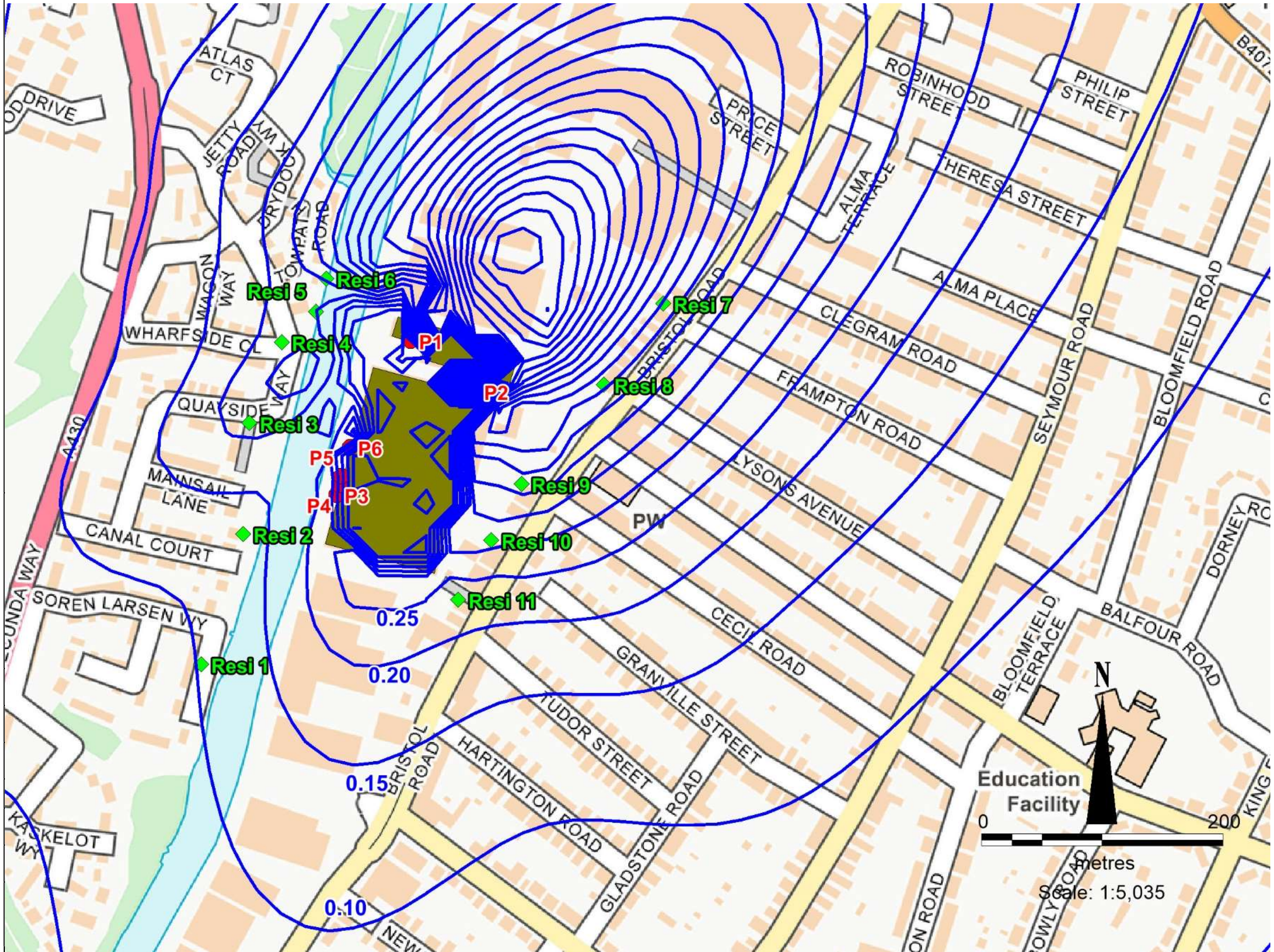

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Figure 5: Annual Mean VOC PCs (ug/m^3)

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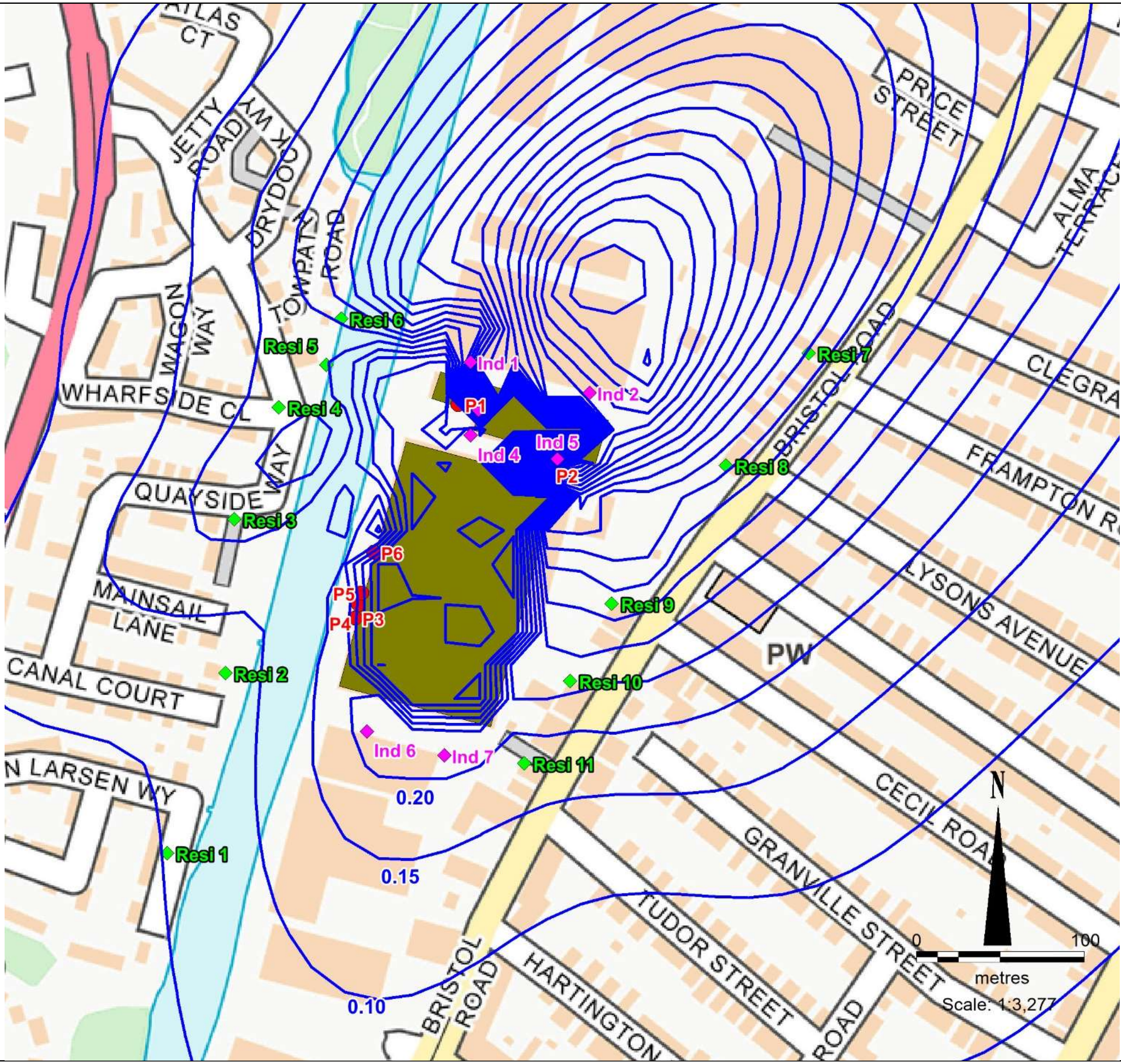

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Figure 6: 30 Minute Mean VOCs (Formaldehyde) PCs (ug/m^3)

Appendices

Appendix A: Stack Height Determination

A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the generator stacks. The Environment Agency removed their detailed guidance, Horizontal Guidance Note EPR H1 (EA, 2010), for undertaking risk assessments on 1 February 2016; however, the approach used here by RPS is consistent with that EA guidance which required the identification of *"an option that gives acceptable environmental performance but balances costs and benefits of implementing it."*

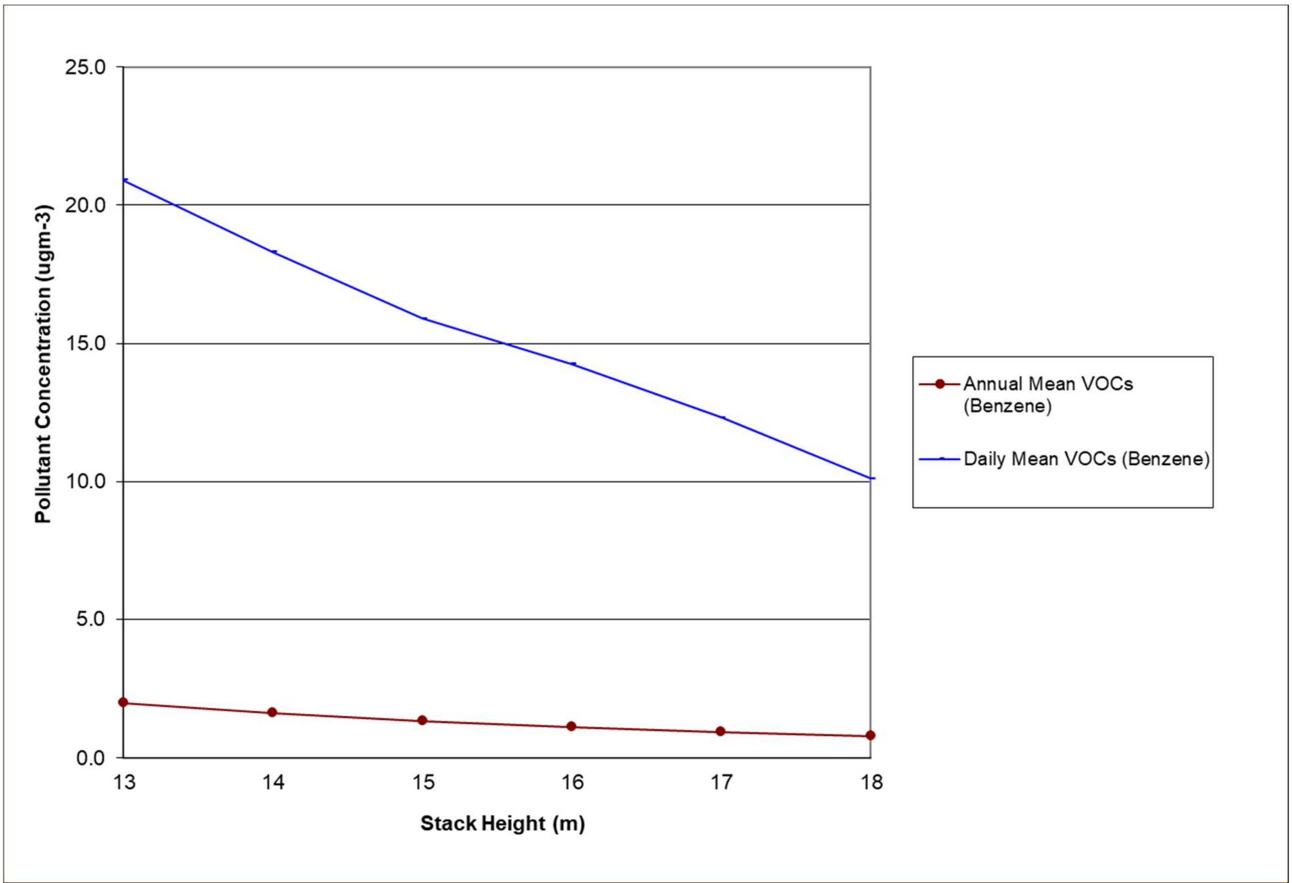
The emissions data used in the stack height determination are summarised in Section 3 of the report. Simulations have been run using ADMS 5 to determine what stack height is required to provide adequate dispersion/dilution and to overcome local building wake effects.

The stack height determination considers ground level concentrations over the averaging periods relevant to the air quality assessment, together with the full range of all likely meteorological conditions using five years of hourly sequential NWP meteorological data centred on 382376, 217160 between 2017 and 2021.

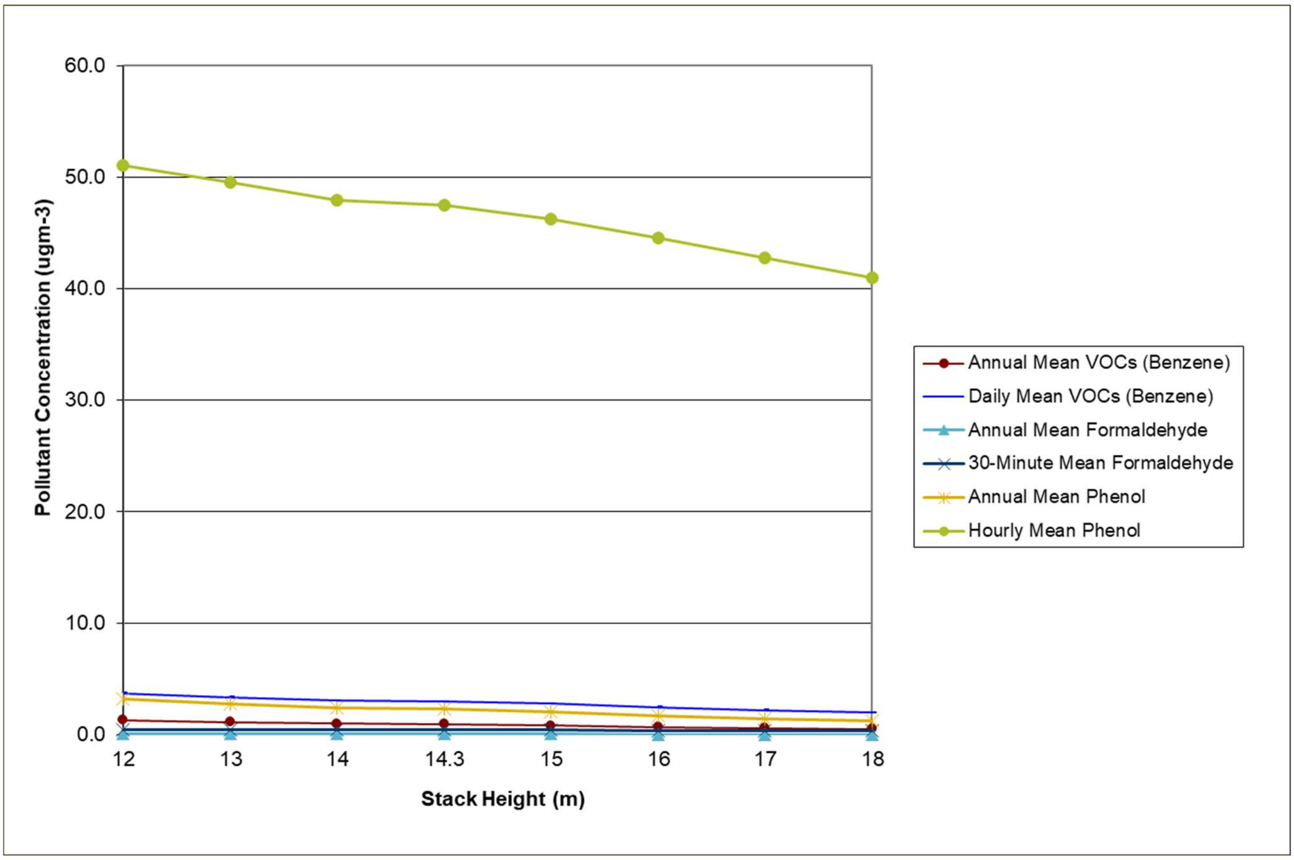
The dispersion modelling for the purposes of stack height determination assumed a domain of 3 km by 3 km centred on the proposed development and with a grid spacing of 30 m.

The maximum predicted contributions have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights for each type of proposed stack in the graphs below.

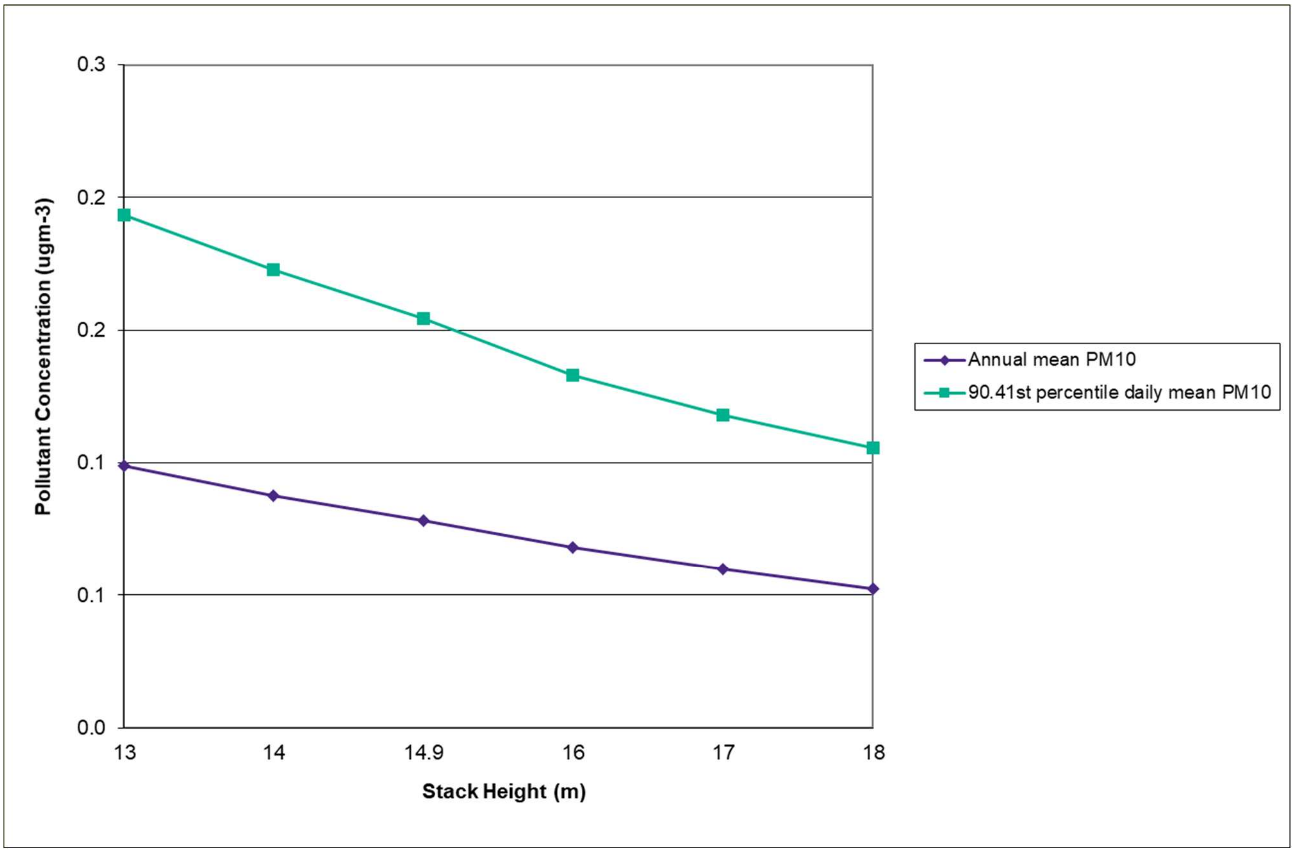
Graph A.1 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P1



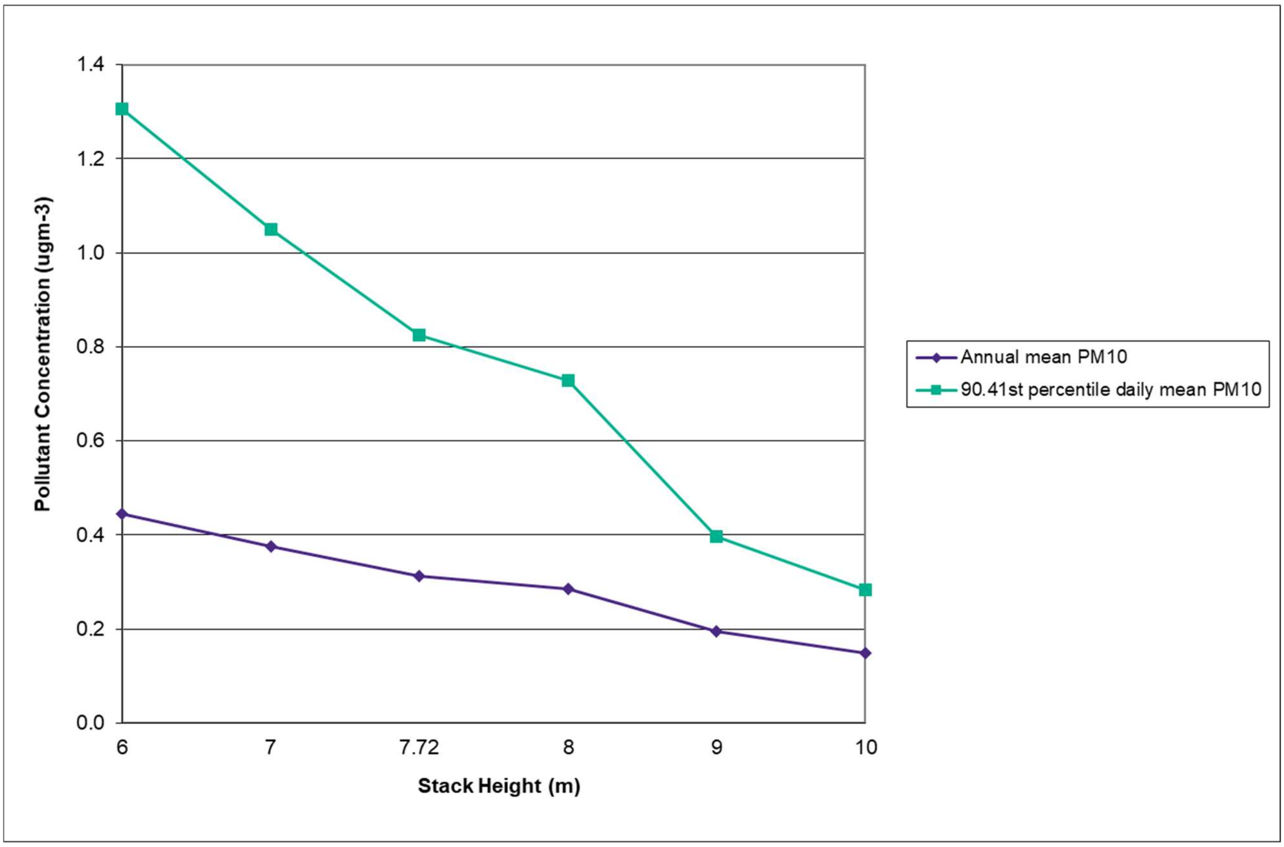
Graph A.2 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P2



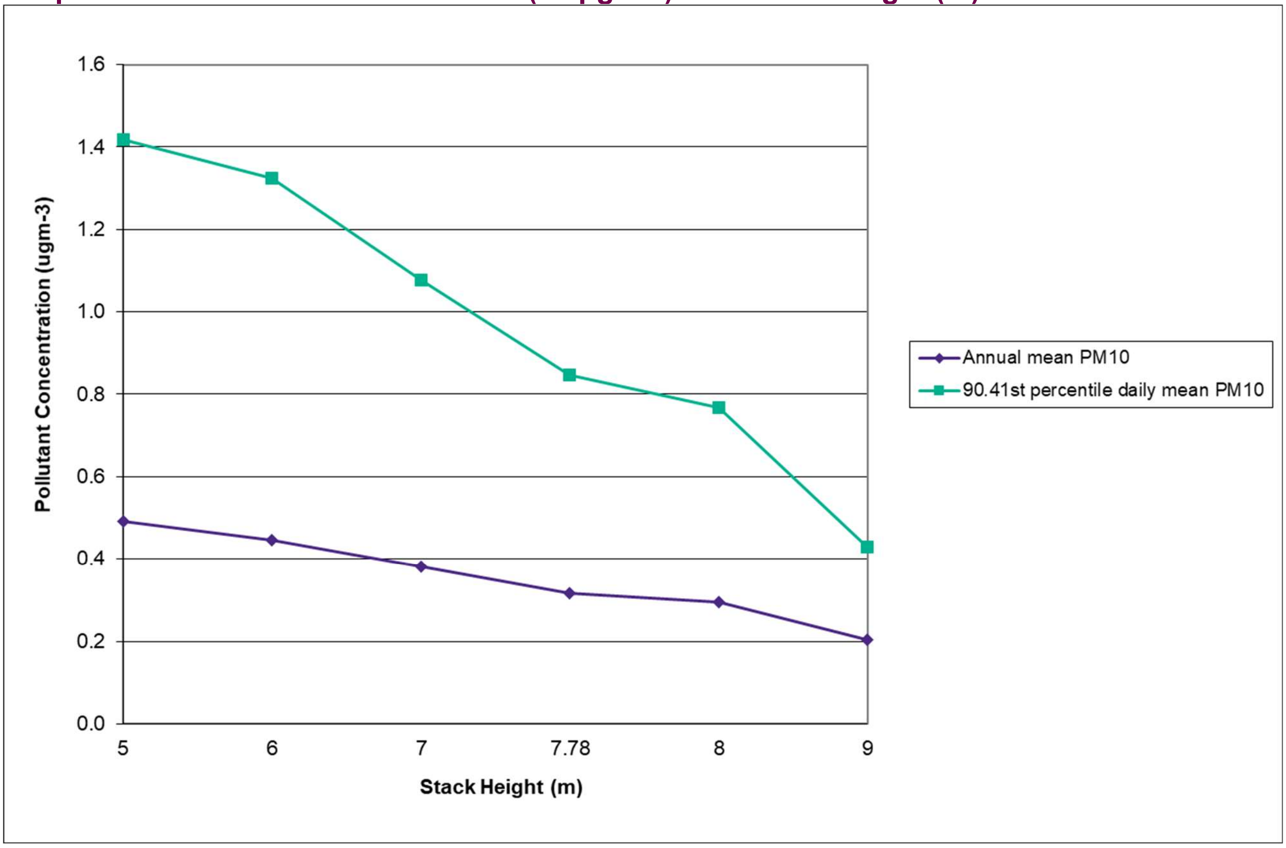
Graph A.3 Variation in Concentration (as $\mu g.m^{-3}$) with Stack Height (m) – Stack P3



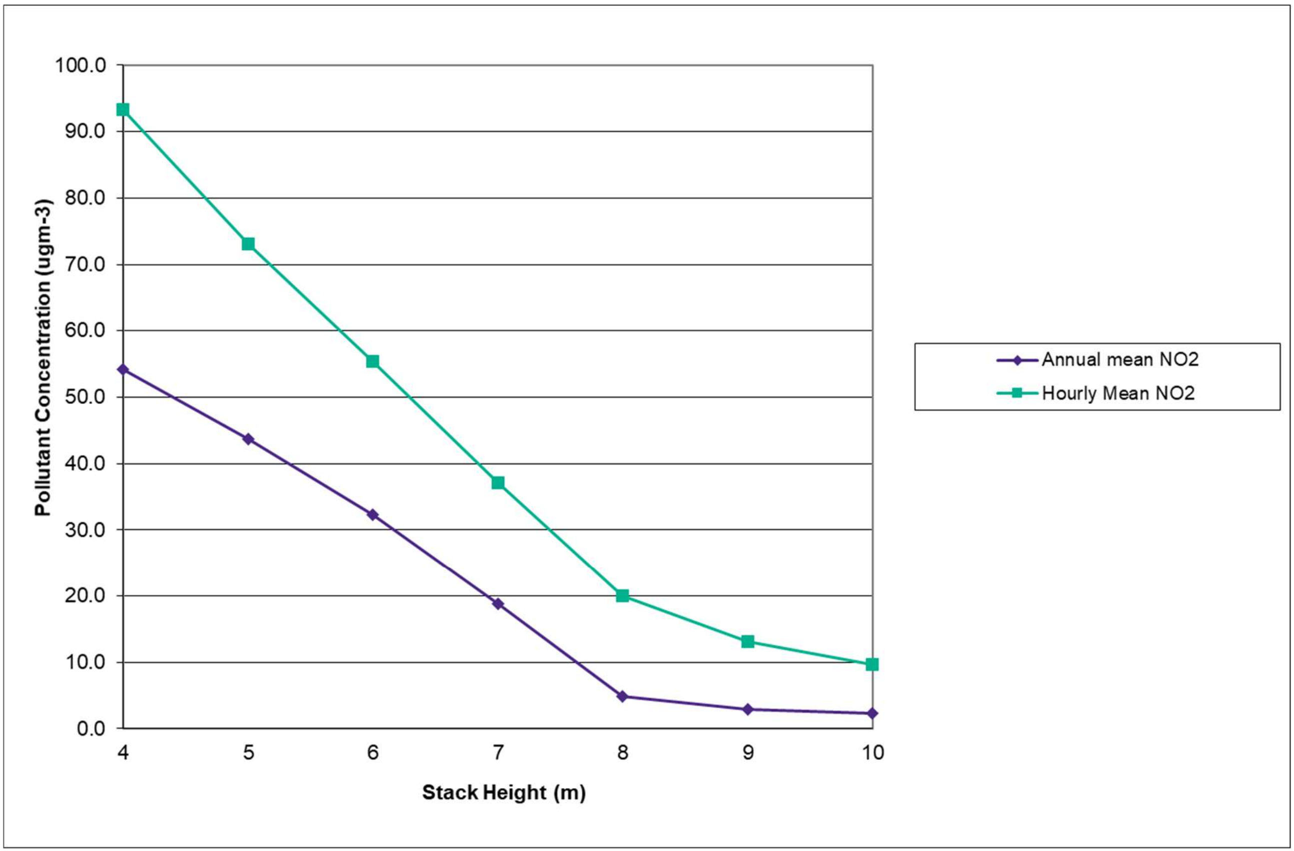
Graph A.4 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P4



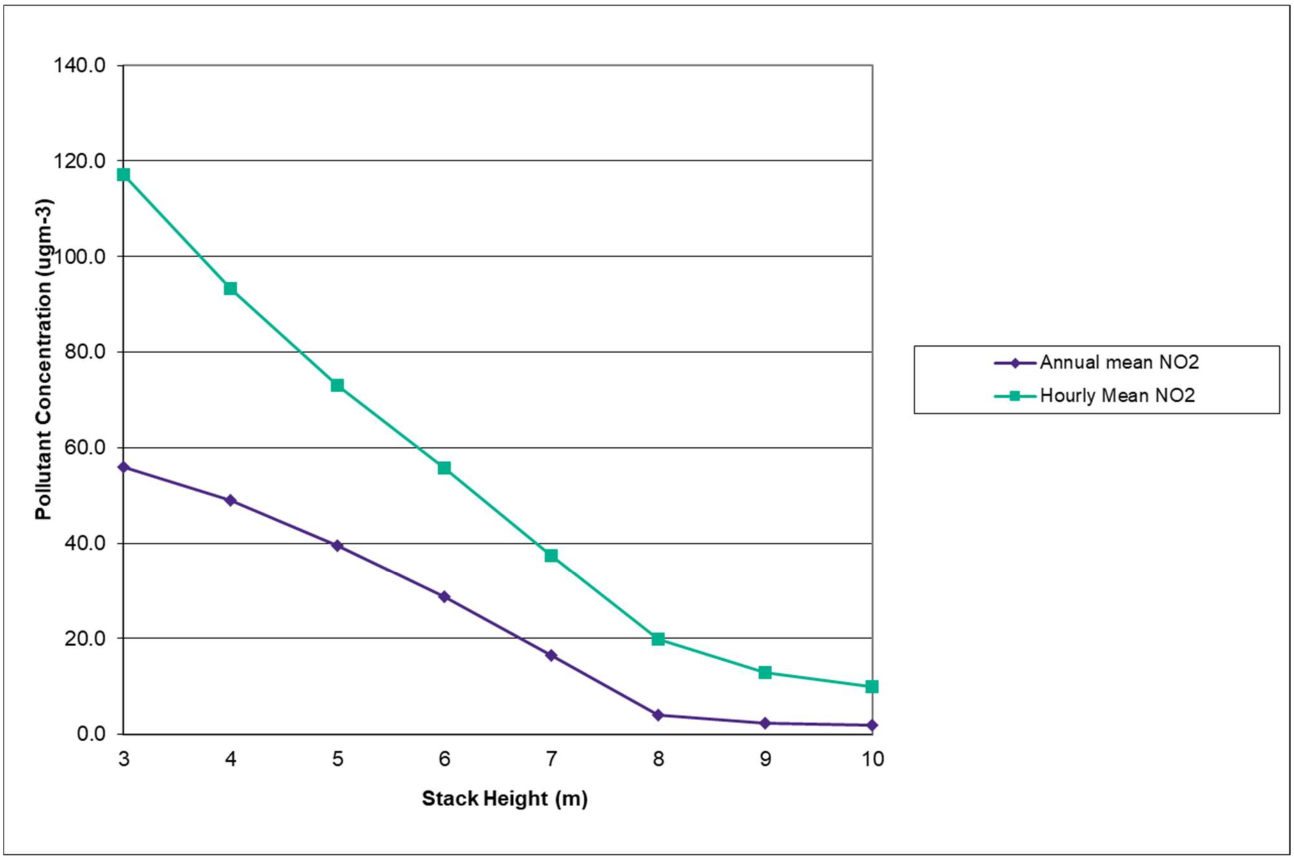
Graph A.5 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P5



Graph A.6 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P6



Graph A.7 Variation in Concentration (as µg.m^{-3}) with Stack Height (m) – Stack P7



7.6 The graph does not indicate that there would be any appreciable improvement in an increase in the stack height above the heights modelled for this assessment for stacks P1 to P5. The graph for P6 and P7 indicates an improvement 8 m and above; however, the results of the assessment undertaken for a 5 m P6 and P7 stack indicate that the NO_2 PCs can be screened-out as not significant at sensitive receptors.

7.7 The stack height used in this assessment is 15.00 m for stack P1, 14.30 m for stack P2, 14.9 m for stack P3, 7.72 m for stack P4, 7.78 m for stack P5, 5 m for stack P6 and 5 m for P7.

References

1 IAQM (2018) Guidance on the assessment of odour for planning

2 Directive 1996/61/EC of 24 September 1996 concerning Integrated Pollution Prevention and Control

3 OPSI (2016) The Environmental Permitting (England and Wales) Regulations 2016

4 Environment Agency 2016, Environmental management – guidance. Air emissions risk assessment for your environmental permit. .gov.uk website: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air-emissions.

5 Defra (2011) Environmental Permitting Guidance – Statutory Nuisance s79 (10) Environmental Protection Act 1990 – for the Environmental Permitting (England and Wales) Regulations 2010.

6 Defra, 2010, The Air Quality Standards Regulations.

7 The Environment (Miscellaneous Amendments) (EU Exit) Regulations 2020

8 Defra, 2007, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Volume 2.

9 World Health Organisation Guidelines (http://www.who.int/en/)

10 Expert Panel on Air Quality Standards (www.defra.gov.uk/environment/airquality/panels/aqs/index.htm)

11 Defra (2016) Local Air Quality Management Technical Guidance 2016

12 Environment Agency: H4 Odour Management. March 2011

13 Drawn from Defra Maps at http://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018