Report for:

Pegasus Group

Residential Development on Land at Newgate Lane (South), Fareham

Detailed Odour Constraints Assessment

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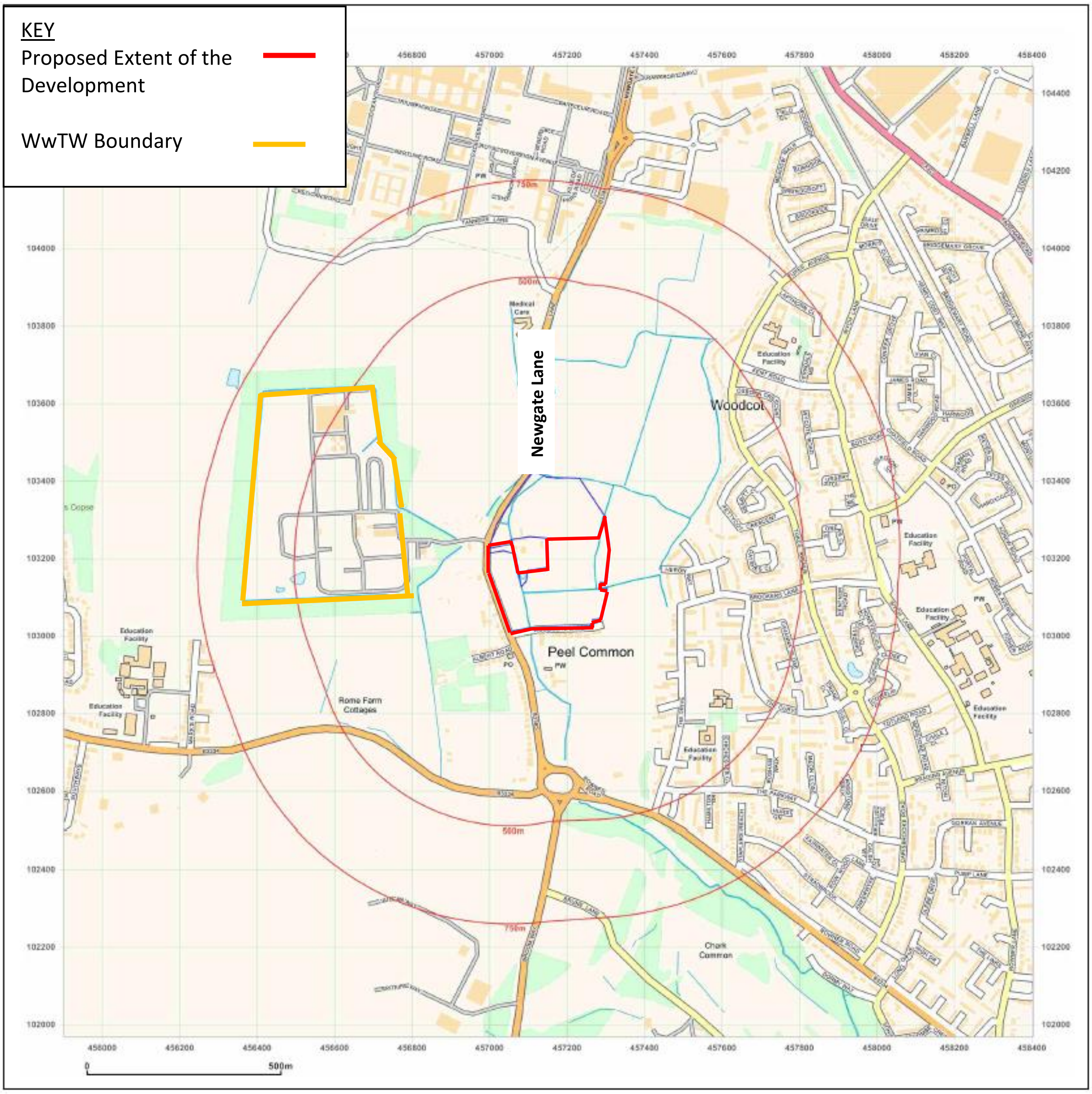
1. INTRODUCTION

ACCON UK Limited (ACCON) has been commissioned by Pegasus Group to carry out an odour assessment for the potential impacts of an existing Wastewater Treatment Works (WwTW) on a proposed residential development on land adjacent to Newgate Lane (North), Fareham. The location of the site is identified in **Figure 1** in relation to the Wastewater Treatment Works (WwTW).

Figure 1.1: Proposed Development Location



The site is bounded by existing residential properties to the south and on the opposite side of Newgate Lane; the new Newgate Lane Bypass to the east and north and Woodcote Lane (which includes residential properties and a care home).

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Potential odour as a result of the WwTW could result in complaints and potentially statutory nuisance at the proposed residential properties due to their proximity to the treatment plant. However, there are existing properties between the WwTW and the proposed development site.

Consultation with the Environmental Health Department of FBC, with respect to odour, on 14th March 2018 states:

> *"The location is not ideal for residential development. The proposed development is likely to be impacted by odour from Peel Common Sewage Works…*
>
> *The developer must demonstrate the suitability of the site by way of assessment.*
>
> *Odour*
>
> *The developer should provide a predictive assessment that demonstrates that the development will not be adversely affected by odour from Peel Common Sewage Works.*
>
> *I strongly advise that the standard to achieve is that contained within the Guidance produced in 2012 by the Chartered Institution of Water and Environmental management (CIWEM) for application to waste water treatment site:*
>
> *"C98, 1-hour <3ouE/m^3" complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature."*

ACCON have therefore undertaken the following tasks:

- Carried out two site visits and each time a qualitative odour assessment was undertaken in the vicinity of the WwTW;
- Carried out an odour impact assessment in accordance with published guidance from DEFRA[1], the Environment Agency (EA)[2], the Institute of Air Quality Management (IAQM)[3] and statements from bodies such as CIWEM and UKWIR to determine the potential odour impact of the wastewater treatment works on the proposed development; and
- Carried out detailed dispersion modelling in accordance with guidance and legislation outlined in **Section 2**.

[1] '*Odour Guidance for Local Authorities'*, DEFRA (2010)
[2] IPPC H4 *'Odour Management',* Environment Agency (2011)
[3] 'Guidance on the assessment of odour for planning' IAQM (2014)

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2. ODOUR BACKGROUND, POLICY, LEGISLATION AND GUIDANCE

2.1. Odour Legislation and Guidance Used in this Assessment

The following legislation and guidance was utilised as part of this assessment:

- Odour Guidance for Local Authorities', DEFRA (2010);
- IPPC H4 *'Odour Management',* Environment Agency (2011);
- 'Guidance on the assessment of odour for planning' IAQM (2018);
- Chartered Institute for Water and Environmental Management (CIWEM) Policy Statement (2011);
- Odour Control in Wastewater Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001); and
- Planning Precedent Decisions

2.2. Odour Background

2.2.1. Odour Definition

The DEFRA guidance defines odour as:

"An odour is the organoleptic attribute perceptible by the olfactory organ on sniffing certain volatile substances. It is a property of odorous substances that make them perceptible to our sense of smell. The term odour refers to the stimuli from a chemical compound that is volatilised in air. Odour is our perception of that sensation and we interpret what the odour means. Odours may be perceived as pleasant or unpleasant. The main concern with odour is its ability to cause a response in individuals that is considered to be objectionable or offensive.

Odours have the potential to trigger strong reactions for good reason. Pleasant odours can provide enjoyment and prompt responses such as those associated with appetite. Equally, unpleasant odours can be useful indicators to protect us from harm such as the ingestion of rotten food. These protective mechanisms are learnt throughout our lives. Whilst there is often agreement about what constitutes pleasant and unpleasant odours, there is a wide variation between individuals as to what is deemed unacceptable and what affects our quality of life."

Odour is perceived by our brains in response to chemicals present in the air we breathe. Odour is the effect that those chemicals have upon us. Humans have a particularly developed sense of smell and they can detect odour even when chemicals are present in very low concentrations. Most odours are a mixture of many chemicals that interact to produce what we detect as an odour.

Different life experiences and natural variation in the population can result in different sensations and emotional responses by individuals to the same odorous compounds. Because the response to odour is synthesised in our brains, other senses such as sight and taste, and even our upbringing, can influence our perception of odour and whether we find it acceptable, objectionable or offensive

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2.2.2. Odour Units

The concentration at which an odour is just detectable to a 'typical' human nose is referred to as the 'threshold' concentration. At the detectability threshold, the concentration of an odour is so low that it is not recognisable as any specific odour at all, but the presence of some very faint, odour can be sensed when the 'sample' odour is compared to a clean, odour-free sample of air.

Odours are a complex mixture of compounds and the concentration of the mixture is expressed in European odour units per cubic metre ($ouEm^{-3}$ or ouE/m^{3}) as defined by European standard BSEN 13725:2003 'Air quality. Determination of odour concentration by dynamic olfactometry'.

An odour at strength of 1 $ouEm^{-3}$ would only be detectable within the confines of an odour laboratory by the majority of the population. As odour concentrations increase they become more noticeable. The following published guideline values4 provide context to odour concentrations;

- $1ou_Em^{-3}$ = the point of detection;
- $5ou_Em^{-3}$ = is a faint odour;
- $10ou_Em^{-3}$ = is a distinct odour.

In the general environment however, the population are exposed to levels of 'background' odours from road traffic, vegetation and numerous other activities which can produce background odour concentrations between 5 to $60ou_Em^{-3}$.

The units for exposure to odour is given in terms of a percentile of averages over the course of a year. The current accepted method of assessing the impact of odour concentration in the UK at present is a 98_{th} percentile (C_{98}) of hourly averages. This allows for 2% (175 hours) of the year to be above the limit criterion.

2.2.3. Odour Exposure

Before an adverse effect (such as disamenity, annoyance, nuisance or complaints) can occur, there must be odour exposure. For odour exposure to occur all three links in the source-pathway-receptor chain must be present:

i. An emission source - a means for the odour to get into the atmosphere.

ii. 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.
   - increasing the length of the pathway (e.g. by releasing the emissions from a high stack or at a distance) will – all other things being equal – increase the dilution and dispersion.

iii. The presence of receptors (people) that could experience an adverse effect, noting that people vary in their sensitivities to odour.

[4] IPPC H4 *'Odour Management',* Environment Agency (2011)

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The scale of exposure (the impact) is determined by the parameters collectively known as the FIDO factors (Frequency, Intensity, Duration and Offensiveness; these are described in **Table 2.1**. The magnitude of the effect experienced is determined by the scale of exposure (**FIDOL**) and the sensitivity of the receptor (**L**, denoting the location, which is often taken to be a surrogate for the sensitivity and incorporates the social and psychological factors that can be expected for a given community.) **Figure 2.1** depicts how the human appraisal of the **FIDOL** factors and social and psychological factors determines whether an odour has an adverse odour impact and an objectionable effect. Different combinations of the **FIDO** factors can result in different exposures at a location. For example, odours may occur as a one-off, as frequent short bursts, or for longer, less-frequent periods, and may be said to give 'acute' or 'chronic' exposures respectively.

Table 2.1: Description of the FIDOL factors

Frequency	How often an individual is exposed to odour
Intensity	The individual's perception of the strength of the odour
Duration	The overall duration that individuals are exposed to an odour over time.
Odour unpleasantness	Odour unpleasantness describes the character of an odour as it relates to the 'hedonic tone' (which may be pleasant, neutral or unpleasant) at a given odour concentration/intensity. 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.
Location	The type of land use and nature of human activities in the vicinity of an odour source. Tolerance and expectation of the receptor. The 'Location' factor can be considered to encompass the receptor characteristics, receptor sensitivity, and socio-economic factors.

Source: IAQM, 2014

2.2.4. Adverse Effects of Odour

The odour effect to be concerned with is 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 adverse effects such as loss of amenity, annoyance, nuisance and possibly complaints. It is important to emphasise the technical differences* between annoyance and nuisance:

- Annoyance – the adverse effect occurring from an immediate exposure; and
- Nuisance – the adverse effect caused cumulatively, by repeated events of annoyance.

Accordingly, in determining whether a site is suitable for development it is important to understand the scale of the potential odour, over what period it may occur and importantly whether it will migrate from the source to the receptor on a regular basis such as to cause a loss of amenity or nuisance.

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Table 2.2: Receptor sensitivity to odours

High sensitivity receptor	Surrounding land where: •Users can reasonably expect enjoyment of a high level of amenity; and •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 be expected 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/recreation 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.

Source: IAQM, 2014

2.2.5. Odour from Wastewater Treatment Works

There are many chemical species that have been detected in wastewater treatment works odours. In addition to hydrogen sulphide and other pollutants such as ammonia, there are a wide variety of organic sulphides and organic nitrogen-based compounds along with some oxygenated organic compounds and organic acids.

In addition to these compounds, there are many potential substances which may be released depending upon the quality of the influent, for example if it includes industrial effluent. The range of contaminants potentially present in industrial effluent is extensive but those which are likely to be of concern are already odorous liquids (such as wastewater from food production), warm effluent which may accelerate anaerobic conditions and volatile organic compounds such as solvents and petroleum derivatives. The primary odours from wastewater treatment works are biogenic due to the degradation of organic matter by microorganisms under anaerobic conditions. The development of anaerobic conditions in sewage is often referred to as 'septicity'. Septicity can be onset by elevated temperature, high biological oxygen demand, high sulphate levels and the presence of reducing chemicals. Anaerobic activity leads to the production of methane, hydrogen sulphide (H_2S), ammonia (NH_3), organic sulphur, thiols (mercaptans), amines, indole and skatole. During the fermentation phase of anaerobicity, volatile fatty acids, alcohols, aldehydes and ketones can be produced.

However, odour which is not typical of anaerobic conditions can also be generated by other mechanisms in a treatment works including:

- Volatile substances in the influent such as petroleum derivatives, solvents;
- Air stripping of volatile compounds and odours particularly from industrial effluent often at inlet works or during aeration;

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- Aerobic odours – which are often described as a 'musty' odour; and
- Ammonia odour from reactions after liming of sludges or when sludges become re-wetted.

Hydrogen sulphide is often referred to as the cause of odour from sewage treatment works. Whilst hydrogen sulphide may be a principal component of the odour cocktail, there are other compounds which cannot be ignored. Because it is relatively easy to measure, H_2S is often used as a target indicator for odour but there are important limitations to this technique.

2.3. Odour Standards and Benchmarks

There are a number of sources of 'standards' for odour unit concentrations and the assessment of impacts. Malodours from WwTW (particularly where sludge is used and processed) are considered to be potentially highly offensive and therefore careful consideration should be given to the placement of potential receptors.

2.3.1. Planning Precedents

There are a number of planning precedents that are able to inform this assessment. The first of these is the Newbiggin-by-the-Sea[5] Planning Inspectorate decision in 1993. The appeal addressed what was an appropriate odour exposure limit at a sensitive receptor and the appeal concluded that: "Whilst a particularly sensitive person could detect an emission level as low as $2ou_Em^{-3}$, it seems to be that adoption of a level of $5ou_Em^{-3}$ for the appeal site is both reasonable and cautious."

The decision in this Planning Inspectorate case was the origin of the now well-established empirical standard of $5ou_Em^{-3}$ (98_{th} percentile - $C_{98,\ 1\text{-hour}}$), which has been widely used in the wastewater sectors in the UK to assess the likelihood of community annoyance. This impact criteria has been successfully applied within similar assessments, where odour from WwTW has been assessed at adjacent residential receptors[6,7,8].

2.3.2. IAQM Guidance (2018)

The 2018 IAQM document (Version 1.1) provides guidance on the odour impacts for planning purposes. As such, it gives details of relevant descriptors of effects and impacts, so that modelled odour concentrations can be quantified. **Table 2.3** compares the receptor sensitivity and relative odour exposure and provides a magnitude of effect.

[5] Department of the Environment (July 1993) Appeal by Northumbrian Water Ltd: *Land Adjacent to Spital Burn, Newbiggin-by-the-sea, Northumberland. Case* ref: APP/F2930/A/92 206240.
[6] Planning Inspectorate – Appeal Reference: APP/P0240/A/09/2110667
[7] Planning Inspectorate – Appeal Reference: APP/E3525/A/11/2145235.
[8] High Court of Justice (2011). EWHC 3253 (TCC).

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Table 2.3: IAQM suggested descriptors for magnitudes of odour effects

Relative Odour Exposure (Impact)	Receptor Sensitivity: Low	Receptor Sensitivity: Medium	Receptor Sensitivity: High
Very Large	Moderate adverse	Substantial adverse	Substantial adverse
Large	Slight adverse	Moderate adverse	Substantial adverse
Medium	Negligible	Slight adverse	Moderate adverse
Small	Negligible	Negligible	Slight adverse
Negligible	Negligible	Negligible	Negligible

Applicable to odours at the "most offensive" end of the relative-unpleasantness spectrum

2.3.3. Assessment of Community Response to Odorous Emissions

Environment Agency (EA) Research and Development Technical Report P4-095/TR (2002) provides a scientific background to assist in identifying defensible numerical limits for regulating exposure to odours in the UK. This report recognises that the $C_{98,\ 1\text{-hour}} < 5\ ou_E m^{-3}$ exposure level is currently applied in the UK with the legal objective of avoiding nuisance. Not all aspects of wastewater treatment have the potential to generate odour which is likely to be offensive and therefore have the potential to generate complaints. However, in this assessment, all sources of potential odour have been assessed in the dispersion modelling.

2.3.4. UKWIR Research[9]

The UK Water Industry Research (UKWIR) organisation undertook research into the correlation between modelled odour impacts and the spatial distribution of odour complaints in the areas surrounding nine WwTW in the UK. The report includes the likely amount of complaints for a given odour concentration and concludes:

"The main source of research into odour impacts in the UK has been the wastewater industry and the most in-depth study published study in the UK of the correlation between modelled odour impacts and human response (dose-effect) was published by UK Water Industry Research (UKWIR) in 2001. This was based on a review of the correlation between reported odour complaints and modelled odour impacts in relation to 9 wastewater treatment works in the UK with ongoing odour complaints. The findings of this research (and subsequent UKWIR research) indicated the following:

- *At modelled exposures of below $C_{98,\ 1\text{-hour}}\ 5ou_E m^{-3,}$ complaints are relatively rare, at only 3% of the total registered;*
- *At modelled exposures between $C_{98,\ 1\text{-hour}}\ 5ou_E m^{-3}$ and $C_{98,\ 1\text{-hour}}\ 10ou_E m^{-3}$, a significant proportion of total registered complaints occur; 38% of the total;*
- *The majority of complaints occur in area of modelled exposure greater than $C_{98,\ 1\text{-hour}}\ 10ou_E{}^{-3,}$ 59% of the total."*

[9] Odour Control in Wastewater Treatment (Technical Reference Document 01/WW/13/3) UK Water Industry Research (UKWIR) (2001)

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Therefore, the UKWIR research findings are consistent with the 'Newbiggin' standard and other planning precedents (**Section 2.3.1**) as any potential odour impact and annoyance is effectively controlled for the vast majority of the population at a 98_{th} percentile hourly mean odour impacts of $5ou_Em^{-3}$ or less.

2.3.5. Environment Agency H4 Odour Guidance

The EA published guidelines on odour regulation, assessment and control (H4: Odour Management) in March 2011. In Appendix 3 (of H4), modelled odour concentration benchmark levels are presented for odours of varying degrees of offensiveness.

The guidance recommends that preferably five years (and a minimum of three), should be used to calculate the 98^{th} percentile of the hourly mean odour concentrations, to assess varying meteorological conditions.

2.3.6. Chartered Institute for Water and Environmental Management (CIWEM)

CIWEM released a Policy Position Statement regarding odour in February 2011. The statement provides appropriate assessment criteria and benchmarks to determine the potential for odour nuisance and was as follows:

"Given the differing odour impact criteria available, the selection of the most appropriate criterion should be determined by the objective of the assessment (whether this be against a standard of avoidance of nuisance or 'significant pollution') and the nature of the odour under assessment. It is, therefore, the view of CIWEM that these and other odour impact criteria should be regarded as indicative guidelines and cannot be applied as over-arching statutory numerical standards. CIWEM considers that the following framework is the most reliable that can be defined on the basis of the limited research undertaken in the UK at the time of writing:

- $C_{98,\ 1\text{-hour}} > 10ou_E/m^3$ *– complaints are highly likely and odour exposure at these levels represents an actionable nuisance;*
- $C_{98,\ 1\text{-hour}} > 5ou_E/m^3$*, – complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and*
- $C_{98,\ 1\text{-hour}} < 3ou_E/m^3$*, – complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature."*

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3. ASSESSMENT METHODOLOGY

3.1. Sniff Testing Methodology

The potential odours were assessed against a fixed framework as detailed in **Appendix 3**, which covers weather conditions, odour intensity, strength, frequency and characteristics. A number of locations were identified for assessment to account for typical odour exposure depending on the wind speed and direction. Each location was assessed for a fixed period of time (10 minutes) to enable the assessment of frequency.

3.1.1. Assessment Quality Assurance

To ensure that the odour assessment was carried out to a satisfactory standard the following quality assurance steps were taken:

- A suitably qualified and trained odour assessor (assessed against EN13725);
- An objective method of describing and measuring odours
- A standardised monitoring process and data reporting

In addition, the quality of the assessment was managed by utilising the following guidelines as detailed in 'Guidance on the assessment of odour for planning' IAQM, (2014):

- The odour assessor should not carry out the assessment if they have a cold, sore throat, sinus trouble, etc;
- The odour assessor should not be hungry or thirsty;
- The odour assessor should not work within half an hour of the end of their last meal;
- The odour assessor should not smoke or consume strongly flavoured food or drink, including coffee, for at least half an hour before the field odour survey is carried out, or during the survey;
- The odour assessor should not consume confectionery or soft drinks for at least half an hour before the field odour survey is carried out, or during the survey;
- Scented toiletries, such as perfume/aftershave should not be used on the day of the field odour survey;
- The vehicle used during the field odour survey should not contain any deodorisers;
- If the odour assessor has had to travel a long distance, then a rest period should be taken before starting the survey; and
- To reduce the likelihood of odour fatigue, assessors should always carry out the field odour survey before making any works site visit, inspection or walk-through survey.

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3.2. Dispersion Modelling Methodology

The dispersion model used in this assessment is Breeze AERMOD. AERMOD is a steady-state Gaussian dispersion model that represents the current state-of-science and promulgated dispersion model

The model calculates downwind pollutant concentration in the surrounding area for each hour of the day over the period of meteorological data. Statistics on the frequency and concentration of pollutants at the receptor sites are based upon the hourly calculations.

The detailed dispersion modelling has been used to predict the ground level concentration of odour and has been undertaken in accordance with the Environment Agency's best practice methodology for dispersion modelling[10]. This includes the use of 5-years of hourly sequential consecutive meteorological data from a representative meteorological station. Modelled odour concentrations are presented graphically so that the inter-year variability can be visualised. In addition, the results from individual meteorological years have been determined by the maximum concentrations (as outlined in the IAQM guidance) to produce a worst-case assessment. **Appendix 1** details the meteorological data used in this assessment.

3.3. Model Uncertainty and Limitations

This assessment has utilised a range of precautionary measures and assumptions that aim to provide a worst-case assessment so as not to under-predict ground level concentrations. This has been achieved by assuming the WwTW is operational for all hours and utilising 5-years of meteorological data. This is likely to result in an overestimation of the likely odour concentrations and therefore the concentrations presented within this assessment are worst-case.

The dispersion model cannot take into account fugitive odours such as non-consented discharges or plant maintenance. However, any odours produced within these times would probably be of short duration and would only be likely to impact the development under adverse meteorological conditions. Although all care has been taken to verify the odour emission data provided by Anglian Water, it has been assumed that the data is correct and representative of the reactors at the WwTW.

3.4. Odour Benchmarks

As outlined in **Section 2.2.4**, receptor sensitivity and possible exposure to potential odours will vary depending on the land-use of the site. The land use will change the expectation of users of the land depending on the level of amenity and the time spent at the location.

As such, this assessment has considered the following criteria when assessing the impacts of the WwTW on the proposed development. This will enable the quantification of a 'stand-off' distance from the WwTW depending on the land-use and sensitivity of the proposed receptor. The criteria have been determined by the recommendations of the CIWEM, IAQM guidance and planning precedents outline in **Section 2.3**.

[10] Environment Agency – Air Quality Modelling and Assessment Unit (AQMAU). *Air dispersion modelling report requirements (for detailed air dispersion modelling)*

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- High sensitivity receptors – considered suitable for any development, including residential: Applied benchmark of less than $C_{98,\ 1\text{-hour}}$ 3ou_E/m^3;
- Medium sensitivity receptors – considered suitable for places of work, commercial/retail premises and playing/recreation fields: Applied benchmark of greater than $C_{98,\ 1\text{-hour}}$ 3ou_E/m^3 but less than $C_{98,\ 1\text{-hour}}$ 5ou_E/m^3; and
- Low sensitivity receptors – considered suitable for non-sensitive uses where exposure would be only transient, e.g. industrial use, farms, footpaths, car-parks and roads: Applied benchmark of greater than $C_{98,\ 1\text{-hour}}$ 5ou_E/m^3.

3.5. IAQM – Significance Criteria

The impact significance has been determined based upon the IAQM matrix and descriptors as presented within **Table 2.3**. **Table 3.1** outlines the relationship between the modelled odour exposure level and the relevant receptor sensitivity. It should be noted that **Table 3.1** below is a conservative estimate of the impacts based on highly offensive odours. Therefore, less offensive odours may require a higher level of exposure to elicit the same response.

Table 3.1: IAQM odour effect descriptors for impacts predicted by modelling

Odour Exposure Level ou_E/m^3	Receptor Sensitivity		
	Low	Medium	High
>10	Moderate	Substantial	Substantial
5 - <10	Moderate	Moderate	Substantial
3 - <5	Slight	Moderate	Moderate
1.5 - <3	Negligible	Slight	Moderate
0.5 - <1.5	Negligible	Negligible	Slight
<0.5	Negligible	Negligible	Negligible

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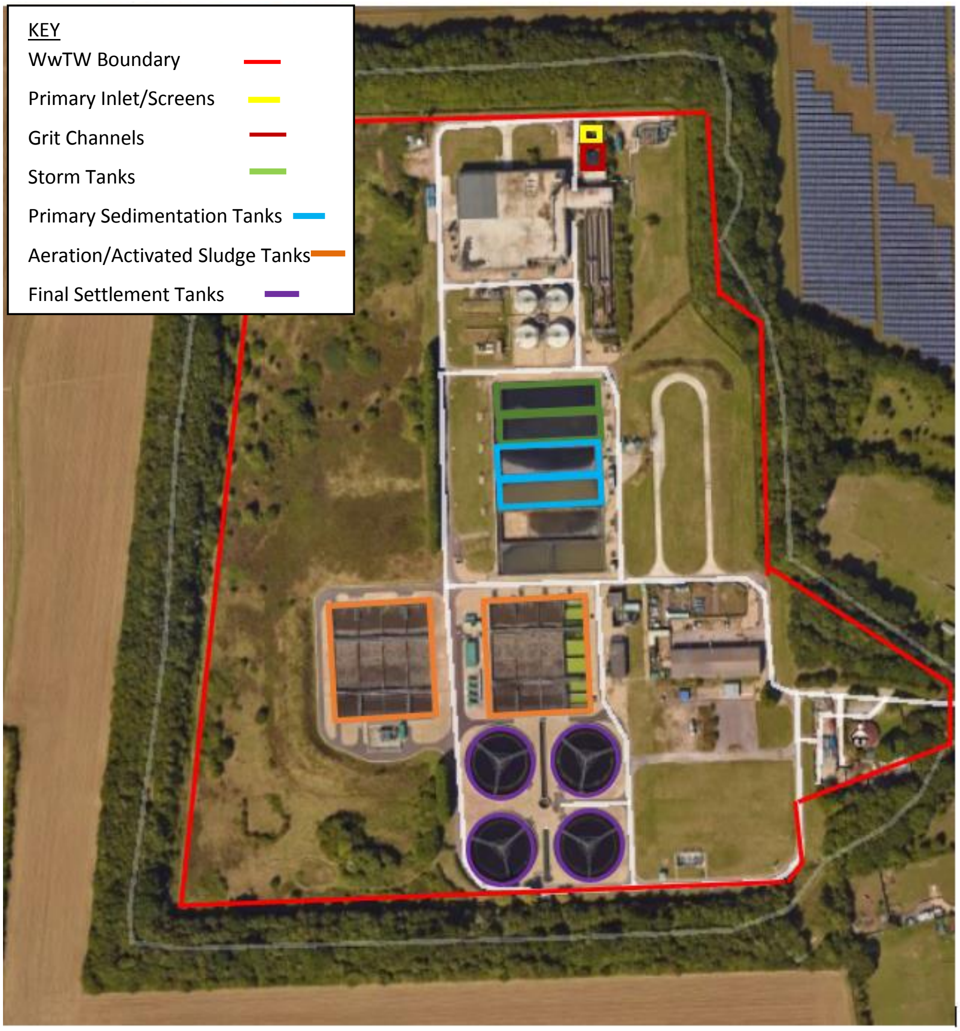
4. QUANTIFICATION OF ODOUR EMISSIONS

4.1. WwTW Process Overview

The proposed development is located to the south of Fareham and west of Bridgemary in Hampshire. The current proposals (outlined in **Appendix 3.1**) are for residential dwellings located on the site of open agricultural/grassland field. A wastewater treatment works is located 175m to the west of the proposed development.

Figure 4.1: WwTW Site Layout



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As identified in **Figure 4.1,** the WwTW contains varied reactor types throughout the treatment/recycling process. All of the reactors are open to the atmosphere (except for the primary inlet and the grit channel) and are considered to be operational at all times to create a worst-case scenario.

There are 6 No. processes within the WwTW that have the potential to generate odours and they are as follows:

- Primary Inlet chamber with screens – High malodour potential;
- Grit Channels – High malodour potential;
- Storm Tanks – Low malodour potential;
- Primary Sedimentation Tanks– High malodour potential;
- Aeration/Activation Sludge Tanks – High malodour potential; and
- Final Settlement Tanks– Low malodour potential.

4.2. Odour Emission Rates

Odour emission rates were derived from the following source:

- UKWIR[11] published emission rates.

Due to the high level of odour control which has been implemented on the site in recent years the model has utilised of UKWIR 'Low' values for the reactors within the WwTW. The use of 'Low' emission values is in line with observations made during the on-site 'sniff testing'.

This assessment considers the reactors listed below to be operating constantly which will contribute to a worst-case scenario and will take into account seasonal variations in demand. Dispersion Model Input Data

4.3. Modelling Scenarios

This assessment considers the number of exceedances of the 1-hour mean. The 98th percentile will be applied to the 1-hour concentrations which assess if the 1-hour mean is exceeded for more than 2% of the year (175 hours). Five years of meteorological data have been used in the assessment to enable the assessment of odours under a range of likely meteorological conditions.

4.4. Assumptions

It has been assumed that the WwTW is operational 24-hours per day, 365-days per year in order to create a reasonable worst-case scenario with respect to odour emissions. All reasonable care has been taken to assess the validity and suitability of data from external sources.

[11] UK Water Industry Research (UKWIR) (2001), Odour Control in Wastewater Treatment – *Technical Reference Document 01/WW13/3*

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4.5. Meteorological Data

Atmospheric Dispersion Modelling (ADM) Ltd were consulted in order to determine the most appropriate meteorological station for the proposed development. The meteorological data controls the direction of dispersion through the wind direction; the dilution and subsequent spread of odours through the wind speed; and the turbulence and atmospheric stability.

The data was sourced from Thorney Island Airfield meteorological station, which is approximately 19km east of the proposed development and the WwTW. Five consecutive years of hourly-sequential observation data from the meteorological station, covering the period 2013 – 2017, inclusive, were obtained. The use of 5-years of meteorological data prevents results being skewed by infrequent meteorological conditions that would give a false indication of 'average conditions'.

The prevailing wind (as identified in **Appendix 1**) is typically from the south-west, with the majority of the wind occurring between the south and west sectors.

The terrain around the WwTW is relatively flat and therefore no terrain data has been added to the model.

4.6. Building Effects

Dispersion models are not capable of modelling the effects of buildings upon area source emissions, which are the only source of emissions at the Peel Common WwTW. As such, effects such as building downwash have not been considered or applied in this assessment.

In addition, barriers to dispersion such as the trees surrounding the WwTW and any potential objects on the boundary of the proposed development are not able to be modelled and therefore contribute to maintaining a worst-case scenario.

4.7. Receptor Locations

For the modelling a cartesian grid was utilised to model the dispersion of the odour in order to incorporate contours into the results. Additionally, sensitive receptors have been modelled both at existing receptors in close proximity to the proposed development and on the western boundary of the proposed development site.

The contour results from the dispersion modelling are included in **Appendix 4**.

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5. RESULTS

5.1. Qualitative Assessment

Two qualitative odour assessments were carried out on the 9th and 11th April 2018. Whilst, each qualitative assessment can only ever represent a 'snapshot in time' of the operational and meteorological conditions on the day, it does provide useful observations in respect of how odorous the WWTW is and the extent to which odour could migrate offsite. The assessments cover a range of meteorological conditions (temperature in particular).

The two people carrying out the sniff testing on all three occasions have previously had their detection threshold tested by Spectrum Environmental Limited and Silsoe Odours Limited. Their detection threshold was determined at 80.2ppb and 29.9ppb respectively for n-butanol (EN13725). What this means in practice is that both assessors have a range of odour sensitivity that covers the general population. Therefore, their judgements can be relied upon to determine the extent to which odour might be considered offensive such as to result in a nuisance or a loss of amenity to potential occupiers of the proposed property.

As access to the wastewater treatment works was not possible, sniff testing was carried out at the boundaries of the wastewater treatment works. **Appendix 2.2** outlines each of the locations where sniff testing was carried out. **Table 5.1** outlines meteorological conditions on the days of each site visit and they were typically warm, partly cloudy and a light west to south-westerly wind. These conditions are typical of this area as identified by the wind roses in **Appendix 1**.

Table 5.1: Meterological Conditions on Assessment Days

Date	Average Temperature	Average Wind Speed	Average Wind Direction	General Conditions
9th April	10°C	Negligible	N/A	Light to heavy persistent rain. No wind
11th April	14°C	2-3m/s	SW	Partially cloudy day with long spells of bright sunshine

During both of the site visits, there was no discernible odour at any of the locations, around the northern, eastern or western boundary of the WwTW. There was one location where there was a faint odour of bleach/chlorine.

As such, it is highly unlikely that odours will reach the proposed development (at least 175m west of the boundary of the WwTW and 320m west of the nearest odour source). Even with the dominant wind direction to the south-west, only faint, intermittent odours on the site may be detectable on days with unfavourable weather conditions.

A detailed breakdown of the tests, conditions and subsequent findings is provided in **Appendix 2**.

5.2. Dispersion Modelling

Table 5.2 identifies the highest annual 98th percentile concentration at each sensitive receptor location for the worst case year (2013). There are no exceedances of the $C_{98,\,1\text{-hour}}$ 3ou$_E$/m^3 benchmark at any proposed residential receptor. The south-western boundary of the site (DR6 and DR7) has the

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highest potential for odour (as identified in **Table 5.2**) and the worst-case $C_{98, 1\text{-hour}}$ value of 2.6 ou_E/m^3 is below the 3ou_E/m^3 benchmark.

When the concentrations below in **Table 5.2** are compared against the IAQM impact matrix (**Table 3.1**), the impacts at the proposed residential dwellings are considered to be *moderate.* However, given that the IAQM impact descriptors are conservative and that there are various objects that will limit the dispersion of odours (such as the trees surrounding the WwTW and the natural hedgerows that are likely to form the development boundary), the odour concentrations and resultant impacts are likely to be significantly lower.

It is apparent that the highest concentrations are found at ground level (modelled in this assessment at 1.5m) and concentrations typically decrease slightly with height.

Table 5.2: Highest Annual 98th Percentile Hourly Mean Odour Concentrations (2013)

Receptor	Floor (Height)	Receptor Description and Potential Sensitivity	Highest 98th Percentile Hourly Mean Concentration (ou_E/m^3) (worst case year)	Impact Descriptor
DR5			2.4	Moderate
DR6			2.6	Moderate
DR7			2.6	Moderate
ER1		Existing Sensitive Receptors (High Sensitivity)	8.9	Substantial
ER2			4.4	Moderate
ER3			3.5	Moderate
ER4			4.1	Moderate
ER5			2.1	Moderate

Appendix 4 identifies the 98th Percentile 1-hour odour concentration contours for the worst case modelled year (2013) and visually displays the variability in meteorological conditions as identified in **Table 5.2** above. The 3ou_E/m^3 contour encroaches marginally on the south-west corner of the proposed development site, but this is predicted to only impact a very small part of the site, which could easily be utilised for non-residential uses.

Given the worst-case modelling and assessment, it is likely that the modelled concentrations will not be realised. The research carried out by UKWIR states that "At modelled exposures of below $C_{98, 1\text{-hour}}$ 5$ou_E m^{-3,}$ complaints are relatively rare, at only 3% of the total registered". Given that all modelled receptor locations on the proposed development are predicted to be below 3$ou_E m^{-3}$, it is highly unlikely that the WwTW will be a nuisance or prove to be a detriment to amenity for future residents.

Additionally, CIWEM state that at $C_{98, 1\text{-hour}}$ <3ou_E/m^3 "complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature". As such, the proposed development (and the proposed residential properties) is considered to be suitable and should not be constrained by odour.

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6. Conclusions

The WwTW is located to the west of the proposed development site. In addition, the presence of a significant buffer (175m) between the proposed development site boundary and the WwTW boundary, and 300m between the site boundary and the nearest odour source, ensures that there is significant dilution between source and receptor even under adverse meteorological conditions.

A qualitative assessment of odour from the existing wastewater treatment works has been carried out over two separate visits (covering a variety of meteorological conditions) to determine whether the proximity of the proposed residential development could result in nuisance occurring to occupiers of the proposed properties. It should be noted that the pleasantness/unpleasantness of an odour and the ability to detect an odour is very subjective and can change from person to person. That assessment concluded that odours were only considered to be distinctive on the boundary of the WwTW when assessed under 'summer conditions'.

The detailed dispersion modelling concluded that at all of the proposed residential receptor locations (high sensitivity receptors), the 98th percentile hourly mean odour concentrations are below the $3ou_E/m^3$ benchmark and as such the WwTW is not anticipated to have an adverse impact on the proposed residential development. The odour contours (**Appendix 4**) identify that the $3ou_E/m^3$ contour does slightly encroach on the south-west corner of the proposed development site. Research by UKWIR and the policy position statement by CIWEM suggest that below $C_{98,\ 1\text{-hour}}$ $3ou_E/m^3$, odours are highly unlikely be a nuisance or prove to be a detriment to amenity for future residents.

The dispersion modelling has considered multiple years of meteorological data and has used worst-case assumptions where possible. This includes various objects that are not possible to be modelled and which are likely to reduce the dispersion of odours towards the proposed development (i.e. the trees surrounding the WwTW).

The combination of sniff testing and dispersion modelling has created a broad assessment of the potential odour from the WwTW and the potential impact on the proposed development. As such, it is not considered that the WwTW would cause a loss of amenity, annoyance, nuisance or complaints for future occupiers of the residential development on the proposed site. Accordingly, there is no requirement for mitigation measures to be implemented.

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APPENDICES

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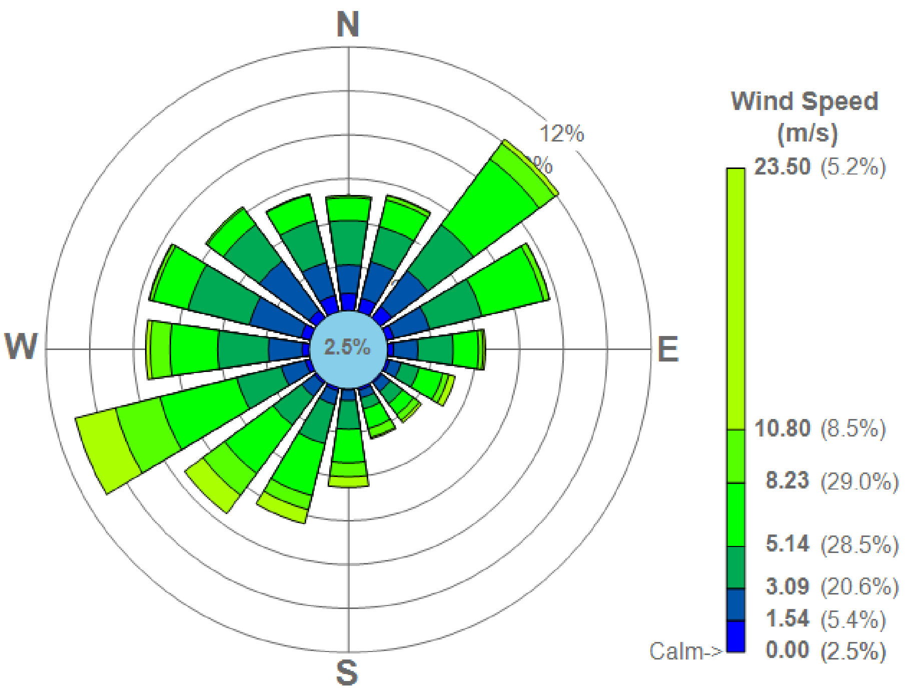
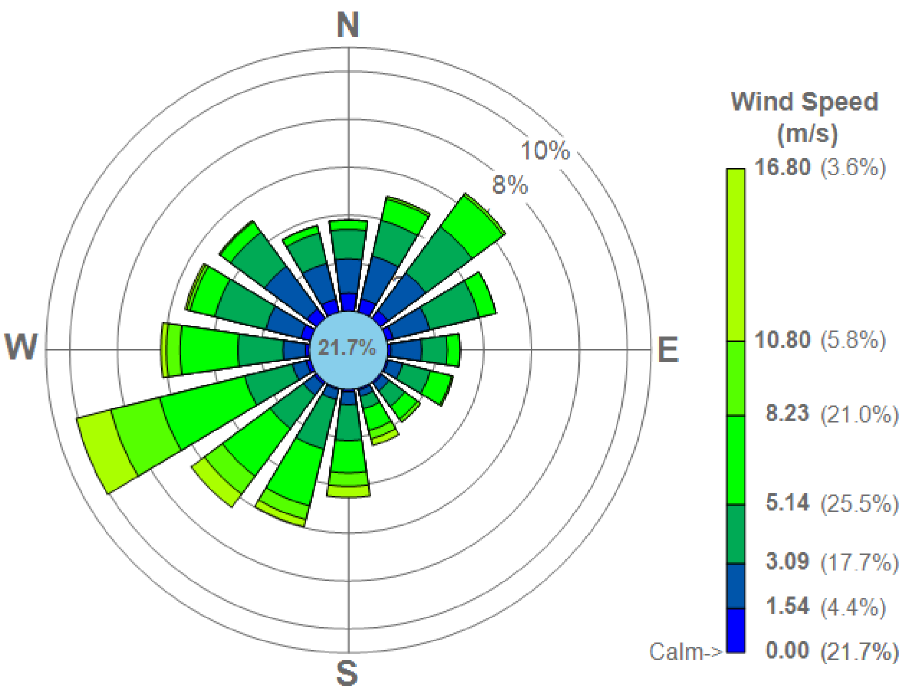
Appendix 1: Meteorological Data – 2013 to 2017 Wind Roses

2013



2014



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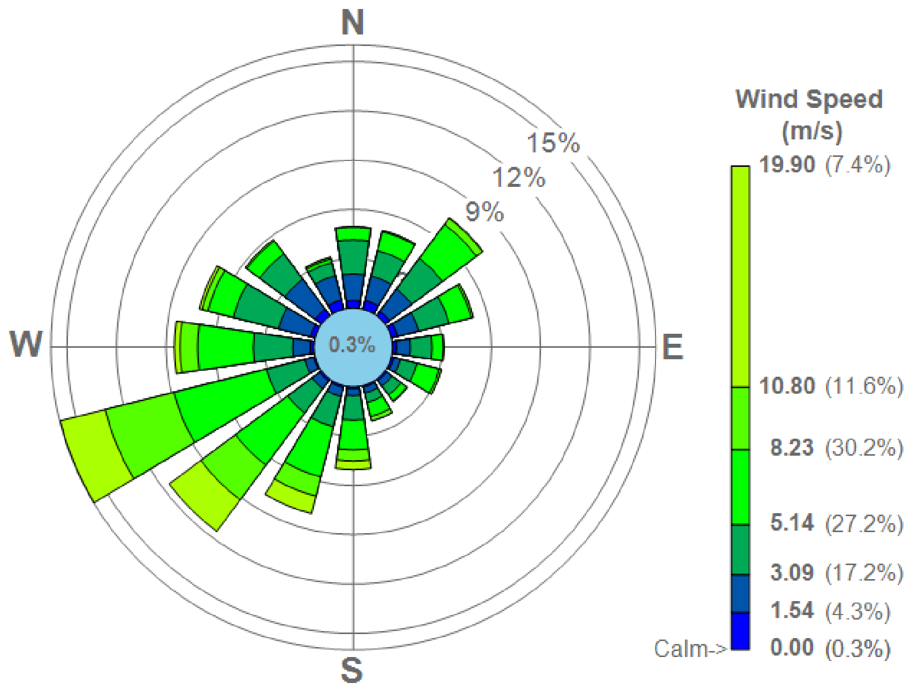
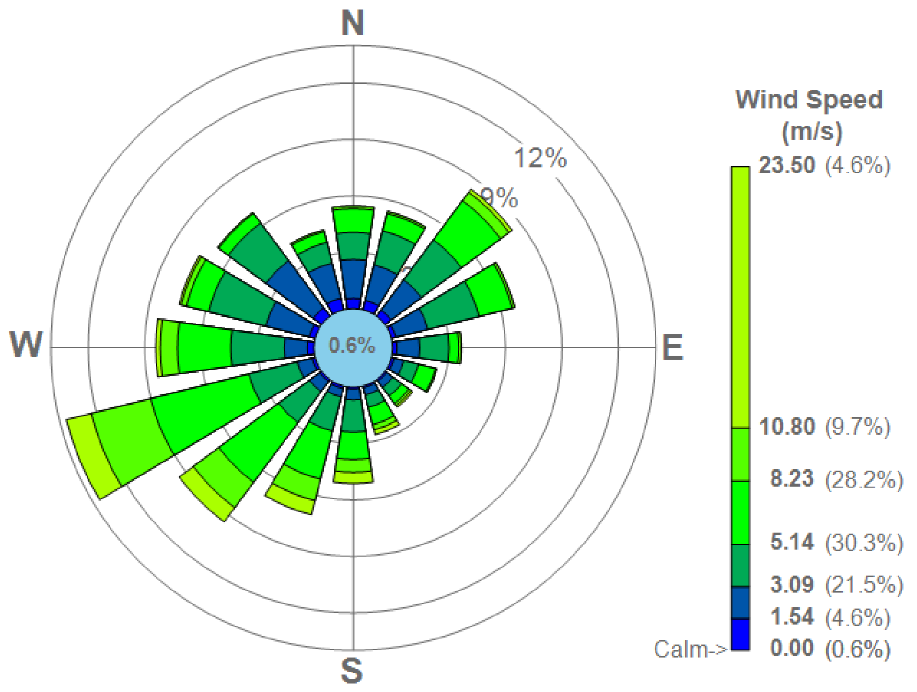
2015



2016



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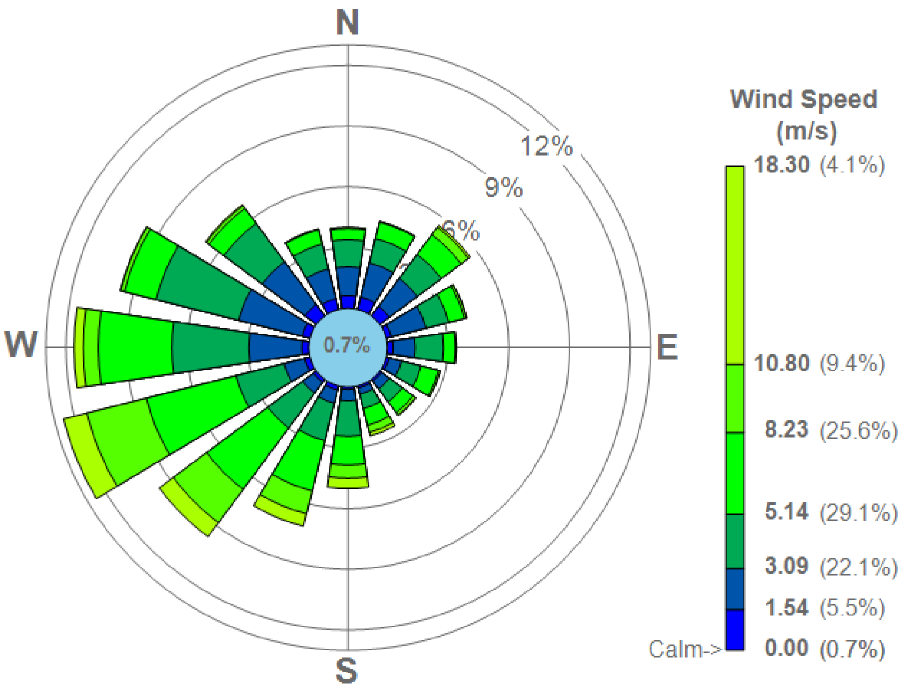
2017



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Appendix 2.1: Indicative Development Proposals and Dispersion Modelling Receptor Locations

Legend

Proposed Receptor Location

Existing Receptor Location

DR1 Receptor Location Number

N

Client: Pegasus Group		Description: Indicative Development Proposals	Design	CP	06.09.2018	ACCON UK Environmental Consultants
			Drawn	CP	06.09.2018	
Rev: A	Description: FINAL	Project: Land at Newgate Lane (South), Fareham	Checked	GP	17.04.2019	*Appendix 3.1*
			Approved	GP	17.04.2019	Scale Not to Scale

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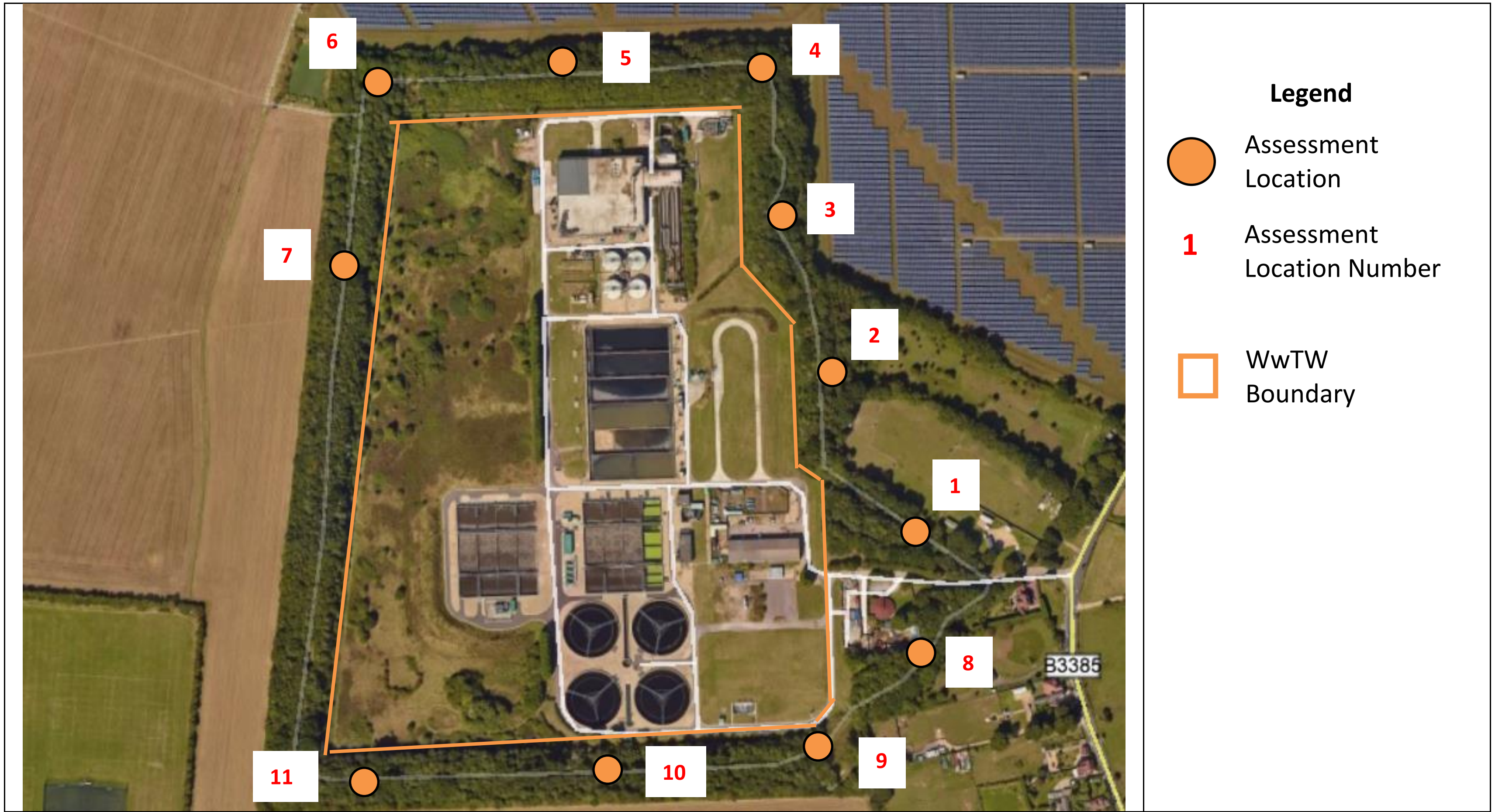
Appendix 2.2: Sniff Testing Locations



Client: Pegasus Group		Description: Odour Assessment Locations	Design	CP	06.09.2018	ACCON UK ENVIRONMENTAL CONSULTANTS
			Drawn	CP	06.09.2018	
Rev: A	Description: FINAL	Project: Land at Newgate Lane (South), Fareham	Checked	GP	17.04.2019	*Appendix 2.2*
			Approved	GP	17.04.2019	Scale Not to Scale

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Appendix 3:
Odour Report Forms – 'Sniff Tests'

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Odour Report Form – *Adapted from IPPC H4 'Odour Management', Environment Agency (2011)*

Odour Report Form		Date: 9/4/2018	Project: FAREHAM			
Test Location	1.	2.	3.	4.	5.	6.
Grid Reference	—	—	—	—	—	—
Time	1000	1010	1020	1030	1040	1050
Weather Conditions	OCC LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN
Temperature	10°	10°	10°	10°	10°	10°
Wind Speed/Direction	NIL	NIL	NIL	NIL	NIL	NIL
Distance to Source	—	—	—	—	—	—
Plant Operational?	YES	YES	YES	YES	YES	YES
Intensity (*VDI 3882, Part 14*)	0	0	0	0	0	0
Duration	10 min	10 min	10 min	10 min	10 mins	10 mins
Frequency	—	—	—	—	—	—
Notes and Odour Characteristics	—	—	—	—	—	—
Current Receptor Sensitivity	N/A	N/A	N/A	N/A	N/A	N/A
Future Receptor Sensitivity	—	—	—	—	—	—

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour **4**, Strong odour, **5** Very strong odour, **6** Extremely strong odour

Quality Control

Assessor 1
Name: C PARK
Position: SEN. CONSULTANT
N-butanol detection threshold: 50.2 ppb
Signed: C Park

Assessor 2
Name: G PARRY
Position: MD
N-butanol detection threshold: 29.9 ppb
Signed: [signature]

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Odour Report Form – *Adapted from IPPC H4 'Odour Management', Environment Agency (2011)*

Odour Report Form		Date: 9/4/2015	Project: FAREHAM			
Test Location	7.	8.	9.	10.	11.	12.
Grid Reference	—	—	—	—	—	
Time	1100	1110	1120	1130	1140	
Weather Conditions	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	OCC. LIGHT RAIN	
Temperature	10°	10°	10°	10°	10°	
Wind Speed/Direction	NIL	NIL	NIL	NIL	NIL	
Distance to Source	—	—	—	—	—	
Plant Operational?	YES	YES	YES	YES	YES	
Intensity (*VDI 3882, Part 14*)	0	0	0	2	0	
Duration	10 min	10 min	10 min	10 min	10 min	
Frequency	—	—	—	10%	—	
Notes and Odour Characteristics	—	—	—	SLIGHT CHLORINE SMELL	—	
Current Receptor Sensitivity	N/A	N/A	N/A	N/A	N/A	
Future Receptor Sensitivity	—	—	—	—	—	

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour **4**, Strong odour, **5** Very strong odour, **6** Extremely strong odour

Quality Control

Assessor 1

Name: C PARRY

Position: SEN CONSULTANT

N-butanol detection threshold: 30.2 ppb

Signed: C Parry

Assessor 2

Name: G PARRY

Position: MD

N-butanol detection threshold: 29.9 ppb

Signed: Graham C Parry

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Odour Report Form – *Adapted from IPPC H4 'Odour Management', Environment Agency (2011)*

Odour Report Form		Date: 11/4/2019	Project: FAREHAM			
Test Location	1.	2.	3.	4.	5.	6.
Grid Reference	—	—	—	—	—	—
Time	1010	1020	1030	1040	1050	1100
Weather Conditions	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY
Temperature	14°C	14°C	14°C	14°C	14°C	14°C
Wind Speed/Direction	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW
Distance to Source	—	—	—	—	—	—
Plant Operational?	YES	YES	YES	YES	YES	YES
Intensity (*VDI 3882, Part 14*)	0	0	0	0	0	0
Duration	10 mins	10 mins	10 mins	10 mins	10 mins	10 mins
Frequency	—	—	—			
Notes and Odour Characteristics						
Current Receptor Sensitivity	N/A	N/A	N/A	N/A	N/A	N/A
Future Receptor Sensitivity	—	—	—	—	—	—

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour **4**, Strong odour, **5** Very strong odour, **6** Extremely strong odour

Quality Control

Assessor 1

Name: C PARK

Position: SEN. CONSULTANT

N-butanol detection threshold: 80.2 ppb

Signed: C Park

Assessor 2

Name: ____________________

Position: ____________________

N-butanol detection threshold: ______ ppb

Signed: ____________________

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Odour Report Form – *Adapted from IPPC H4 'Odour Management', Environment Agency (2011)*

Odour Report Form		**Date:** 11/4/2019	**Project:** FAREHAM			
Test Location	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**
Grid Reference	—	—	—	—	—	
Time	1110	1120	1130	1140	1150	
Weather Conditions	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	PARTLY CLOUDY	
Temperature	14°	14°	14°	14°	14°	
Wind Speed/Direction	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	2-3 m/s SW	
Distance to Source	—	—	—	—	—	
Plant Operational?	YES	YES	YES	YES	YES	
Intensity (*VDI 3882, Part 14*)	0	0	0	0	0	
Duration	10mins	10 mins	10 mins	10 mins	10 m	
Frequency	—	—	—	—	—	
Notes and Odour Characteristics	—	—	—	—	—	
Current Receptor Sensitivity	N/A	N/A	N/A	N/A	N/A	
Future Receptor Sensitivity	—	—	—	—	—	

Intensity Ref: German Standard VDI 3882, Part 14

0 No odour, **1** Very faint odour, **2** Faint odour, **3** Distinct odour **4**, Strong odour, **5** Very strong odour, **6** Extremely strong odour

Quality Control

Assessor 1

Name: C Park

Position: Snr. Consultant

N-butanol detection threshold: 80.2 ppb

Signed: C Park

Assessor 2

Name: __________

Position: __________

N-butanol detection threshold: ______ ppb

Signed: __________

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Appendix 4:

98th Percentile (1-hour) Odour Contours

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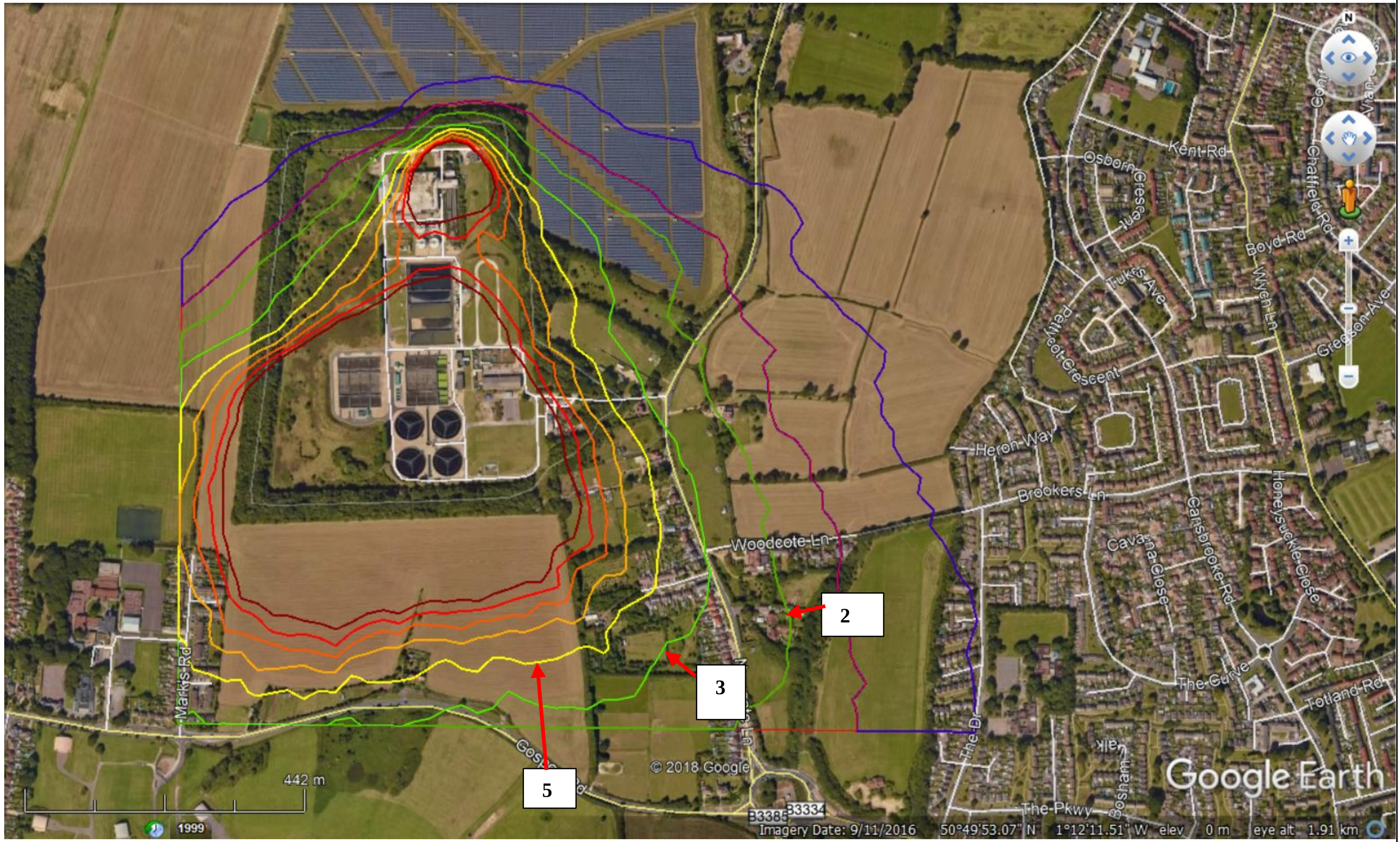
Appendix 4: 98th Percentile 1-hour Mean Odour Concentrations (ou_E/m^3) – 2013 Meteorological Data



Client: Pegasus Group		Description: 2013 Worst Case 98th Percentile Odour Contours	Design	CP	06.09.2018
			Drawn	CP	06.09.2018
Rev: A	Description: FINAL	Project: Land at Newgate Lane, Fareham	Checked	GP	17.04.2019
			Approved	GP	17.04.2019
Scale	Not to Scale				

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