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Gleeson Developments Ltd

Proposed Residential Development - Land to the south of Lowfield
Road

Odour Constraints Assessment - Bolton on Dearne Wastewater
Treatment Works

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CONTENTS

1.0	INTRODUCTION	1
1.1	Context	1
1.2	Site Location	1
1.3	Report Structure	1
1.4	Documents Consulted.....	2
2.0	RELEVANT LEGISLATION AND GUIDANCE	3
2.1	Planning Policy	3
2.1.1	National Policy	3
2.1.2	Local Policy.....	3
2.2	Water Companies' Obligations in respect to Odour Control at WwTWs.....	4
2.3	Assessment of Predicted Odour Impact	4
3.0	ASSESSMENT METHODOLOGY	8
3.1	Basis for Odour Quantification.....	8
3.2	Odour Sampling.....	8
3.3	Detailed Dispersion Modelling	9
3.4	Acceptability of Predicted Odour Impacts	9
4.0	QUANTIFICATION OF ODOUR EMISSIONS	11
4.1	Potential Sources of Odour.....	11
4.2	Bolton on Dearne WwTW – Operational Issues.....	12
4.3	Area Sources - Odour Monitoring Results	12
4.4	Estimated Emission Rates	13
5.0	MODEL INPUT DATA	15
5.1	Modelling Scenarios	15
5.2	Process Conditions	15
5.3	Assessment Area.....	16
5.4	Meteorological Data.....	16
5.5	Terrain Data.....	17
5.6	Building Downwash.....	17
6.0	RESULTS	18
6.1	Model Validation	18
6.2	Odour Constraints Assessment	18
7.0	DISCUSSION AND CONCLUSION	20
8.0	CLOSURE	21

TABLES

Table 4-1 Measured Odour Concentrations	12
Table 4-2 Process Conditions – Area Sources: Specific Odour Emission Rates	13
Table 4-3 Modelled Process Conditions – Storm Tanks.....	13
Table 5-1 Odour Constraints Assessment – Modelling Scenarios	15
Table 5-2 Robin Hood Airport Meteorological Data Statistics	16
Table 5-3 Meteorological Data Preparation – Applied Surface Characteristics	17

APPENDICES

Appendix AQ1 – Drawings

Appendix AQ2 – Figures

Appendix AQ3 – Hydrogen Sulphide Monitoring Results and Analysis

Appendix AQ4 – Raw Olfactometry Laboratory Results

DRAWINGS

Drawing AQ1-1 Average modelled odour impact of the Bolton on Dearne WwTW, average of 2007 – 2011 meteorology, Geomean Odour Concentrations

Drawing AQ1-2 Maximum modelled odour impact of the Bolton on Dearne WwTW, 2011 meteorology, Geomean Odour Concentrations

FIGURES

Figure 1 Robin Hood Airport Meteorological Station – 2007 Wind Rose

Figure 2 Robin Hood Airport Meteorological Station – 2008 Wind Rose

Figure 3 Robin Hood Airport Meteorological Station – 2009 Wind Rose

Figure 4 Robin Hood Airport Meteorological Station – 2010 Wind Rose

Figure 5 Robin Hood Airport Meteorological Station – 2011 Wind Rose

1.0 INTRODUCTION

SLR Consulting Limited (SLR) has been commissioned by Gleeson Developments Ltd (Gleeson) to undertake a detailed Odour Constraints Assessment of the Bolton on Dearne Wastewater Treatment Works (WwTW), Bolton on Dearne.

This assessment is provided in order to:

- ascertain whether odour issues may be expected on the site of a proposed housing development upon land immediately to the north and north-east of the WwTW, and
- provide a quantification of potential odour impact of the WwTW and inform a buffer zone, thus safeguarding the amenity of the development.

This report has been produced solely for Gleeson Developments Ltd.

1.1 Context

Gleeson submitted a planning application to Barnsley Council (BC) for the development of 60-residential units to the south of Lowfield Road, Bolton on Dearne (planning application reference: 2011/0963) which achieved planning consent on 8th December 2012. The consented development is located at a stand-off of approximately 200m from the northern boundary of the WwTW.

It is understood that Yorkshire Water Services (YWS), the operators of the Bolton on Dearne WwTW, did not object to the consented development on the grounds that no historical odour complaints had been received from residents on Lowfield Meadows, located to the north, parallel with the southern boundary of units to be built out. On this basis, YWS considered that there were no reasonable grounds for refusal.

Gleeson is seeking to submit a further planning application to develop an additional area of land located immediately to the north and north-east to the Bolton on Dearne WwTW, into residential housing. This planning application would introduce receptors in closer stand-off distance to the boundary of the Bolton on Dearne WwTW.

1.2 Site Location

The Bolton on Dearne WwTW is located off A6098 Angel Street, Bolton on Dearne at the approximate National Grid Reference (NGR) 445895, 402195. The Bolton on Dearne WwTW is bordered and defined by:

- an open area of open pasture land and brownfield land, including the proposed development site directly to the north;
- Lowfield Lakes fishing venue directly to the east, beyond which is an area of arable farmland;
- the River Dearne immediately to the south, beyond which is an area of open pasture and farmland; and
- the Wakefield Line rail line located immediately to the west on a raised embankment, beyond which is an area of existing residential housing.
- 221No. residential properties, of which 79No. properties are affordable units.

1.3 Report Structure

The remainder of this report is structured as follows:

- section 2 presents an overview of the relevant legislation and guidance;
- section 3 details the assessment methodology;
- section 4 presents the a quantification of odour emissions;
- section 5 presents the dispersion model input parameters
- section 6 presents the results of the Odour Constraints Assessment; and
- section 7 concludes the study.

1.4 Documents Consulted

The following documents were consulted during the undertaking of this assessment:

- Horizontal Guidance H4: Odour Management – How to comply with your Environmental Permit, Environment Agency, 2011;
- National Planning Policy Framework (NPPF), 2012;
- Code of Practice on Odour Nuisance from Sewage Treatment Works, DEFRA, 2006;
- Odour Control in Wastewater Treatment – A Technical Reference Document 01/WW13/3, UK Water Industry Research (UKWIR), 2001;
- Environmental Protection Act, 1990;
- Assessment of Community Response to Odorous Emissions, R&D Technical Report P4-095/TR, Environment Agency, 2002;
- Odour Control Best Practice, Yorkshire Water Services: Waste Water Business Unit, 2001;
- Environmental Permitting (England and Wales) Regulations, 2010; and
- Odour Guidance for Local Authorities, DEFRA, March 2010.

2.0 RELEVANT LEGISLATION AND GUIDANCE

This section details the assessment criteria and background information used in this dispersion modelling study.

2.1 Planning Policy

2.1.1 National Policy

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

'The Government's objective is that planning should help to deliver a healthy natural environment for the benefit of everyone and safe places which promote wellbeing.'

To achieve this objective, the planning system should aim to conserve and enhance the natural and local environment by:

[...] preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of land, air, water or noise pollution or land instability.'

Where pollution is defined as:

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

The policies within the NPPF in relation to air pollution are considered within this Odour Constraints Assessment.

2.1.2 Local Policy

BC adopted the Core Strategy on Development Plan Document on 8th September 2011. The Core Strategy forms a part of the Local Development Framework (LDF) documents, in line with the Planning and Compulsory Purchases Act (2004). The Core Strategy sets out the key elements of the planning framework for Barnsley to shape development within the council's area to the period 2026.

The following consideration in relation to odour is contained within the Barnsley Core Strategy:

'CSP 40 Pollution Control and Protection

Development will be expected to demonstrate that it is not likely to result, directly or indirectly, in an increase in air, surface water and groundwater, noise, smell, dust, vibration, light or other pollution which would unacceptably affect or cause a nuisance to the natural and built environment or to people.

We will not allow development of new housing or other environmentally sensitive development where existing air pollution, noise, smell, dust, vibration, light or other pollution levels are unacceptable and there is no reasonable prospect that these can be mitigated against.

Developers will be expected to minimise the effects of any possible pollution and provide mitigation measures where appropriate.'

The policy contained within the Barnsley Core Strategy relating to odour is addressed within this Odour Constraints Assessment.

2.2 Water Companies' Obligations in respect to Odour Control at WwTWs

The DEFRA Code of Practice (COP)¹ states that:

"[...] sewage treatment operators have the responsibility to put in place measures to control or abate odour problems from their plant using "Best Practicable Means".

The guidance is also intended to provide an aid to Environmental Services in assessing the seriousness of an odour nuisance and to enable the Environmental Health Officer (EHO) to decide on what measures are in place to deal with such an issue and also take a view on whether Best Practicable Measures (BPM) have been taken.

Whilst voluntary, the COP applies to all operating facilities and makes no distinction between older works and recently built works. Simple routine operational changes made to mitigate odour are considered as 'Baseline Measures' in the COP whilst process modifications and installation of appropriate odour control equipment (Enhanced Measures) will offer additional benefits in odour reduction, containment and control.

The main philosophy behind the COP is that sewage treatment works operators should use appropriate means to prevent odour nuisance, and to abate odour emissions with the aim of ensuring that nuisance is minimised. This is described as a specific stepwise procedure and is referred to as the Good Practice Approach.

Some odour control measures should be put in place by the sewage treatment works operator as a matter of course in order to reduce the risk of nuisance occurring in the first place. These are essentially preventative measures and should be thought of as minimum day-to-day operating standards as part of good management practice and to meet their statutory obligations. Examples of such an approach would be planned and routine maintenance of plant and equipment and (where possible) locating or re-locating sources of odour as far as is practicable from the site boundary and sensitive receptors.

2.3 Assessment of Predicted Odour Impact

There is neither European nor United Kingdom (UK) specific regulatory standards for the assessment of the impact of odours. However, it may be reasonably argued that complaints are likely to occur when odours become detectable and recognisable. The longer the odour detection persists for an individual, the greater the level of complaints may be expected, particularly if the odours are unpleasant.

The potential for odorous compounds to cause nuisance is dependant upon a wide range of factors, including:

- the rate of emission of the compound(s);
- the duration and frequency of exposure;
- the time of the day that this emission occurs;
- the prevailing meteorology;

¹ DEFRA (2006) Code of Practice on Odour Nuisance from Sewage Treatment Works.

- the sensitivity of the 'receptors' to the emission, i.e. whether the odorous compound is more likely to cause nuisance, such as the sick or elderly, who may be more sensitive;
- the odour detection capacity of individuals to the various compound(s); and
- the individual perception of the odour, (i.e. whether the odour is regarded as unpleasant). This is greatly subjective, and may vary significantly from individual to individual. For example, some individuals may consider some odours as pleasant, such as petrol, paint and creosote.

2.3.1 Chartered Institute for Water and Environmental Management

The Chartered Institute for Water and Environmental Management (CIWEM) released a Policy Position Statement regarding odour in February 2011. In consideration of an appropriate assessment criterion to determine potential odour impacts, CIWEM stated that:

“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:

- $C_{98, 1-hour} > 10 \text{ou}_E/\text{m}^3$ – complaints are highly likely and odour exposure at these levels represents an actionable nuisance;
- $C_{98, 1-hour} > 5 \text{ou}_E/\text{m}^3$, – complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance
- $C_{98, 1-hour} < 3 \text{ou}_E/\text{m}^3$, – 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.”

2.3.2 Precedent Planning Decision

A planning inspectorate's decision on a public inquiry in 1993 for an application for a residential development adjacent to a Northumbrian Water Ltd operated WwTW sited at Newbiggin-by-the-Sea, Northumberland² addressed the issue of what constituted an appropriate exposure limit at a sensitive receptor. The presiding inspector concluded that:

“Whilst a particularly sensitive person could detect an emission level as low as $2 \text{ou}_E/\text{m}^3$, it seems to be that adoption of a level of $5 \text{ou}_E/\text{m}^3$ for the appeal site is both reasonable and cautious.”

As a result of this case, an impact criteria of $5.0 \text{ou}_E/\text{m}^3$ as a 98th percentile of 1-hour average concentrations has been frequently quoted and accepted and is applied as being sufficient to prevent nuisance for a number of industry sectors. This impact criteria has more recently

² Department of the Environment (15th July 1993) Appeal by Northumbrian Water Ltd: Land Adjacent to Spital Burn, Newbiggin-by-the-sea, Northumberland. Case ref: APP/F2930/A/92 206240.

been applied within the context of odour assessment from WwTW related odour adjacent to existing and proposed residential receptors^{3,4,5}

2.3.3 Assessment of Community Response to Odorous Emissions

Environment Agency (EA) Research and Development Technical Report P4-095/TR was released in 2002. This report provides a scientific background to assist in identifying defensible numerical limits for regulating exposure to odours in the UK, and identify further supporting research work as required to underpin such limits.

This report recognises that the $C_{98, 1\text{-hour}} < 5 \text{ ou}_E/\text{m}^3$ exposure level (refer to Section 3.1 for description of notation) is currently applied in the UK with the legal objective of avoiding nuisance.

The EA R&D document recognises that not all aspects of wastewater treatment have the potential to generate odour which is likely to be offensive and, thus, has the potential to generate complaints. It is considered, within the context of this Odour Constraints Assessment that raw sewage, primary treatment odours and raw sludge would be considered to have a relatively high annoyance potential, however secondary and final treatment units would be considered as having a low annoyance potential. However, in order to undertake a worst-case assessment, this Odour Constraints Assessment has considered odour generated by all aspects of treatment at the Bolton on Dearne WwTW.

2.3.4 UKWIR – Odour Control in Wastewater Treatment

In 1999, UK Water Industry Research (UKWIR) commissioned a study into wastewater treatment odour control. In 2001, Technical Reference Document 01/WW/13/3 'Odour Control in Wastewater Treatment' was published. This document consists of two parts. Part 1 outlines the principles of odour formation, measurement and management. Part 2 describes in detail the practical methods available to control odours in wastewater treatment. Importantly, Table 5.1 of this document provides emission rate estimates from wastewater and sludge treatment processes; these emission rate estimates have been considered in this assessment.

UKWIR Technical Reference Document 01/WW/13/3 is relevant to this assessment as it provides specific odour emission data against which the values used in this assessment may be compared.

2.3.5 EA's H4 Guidance

The EA's H4 Guidance⁶ (which specially only applies to sites covered by the Environmental Permitting Regulations, which does not include the majority of WwTW including the Bolton on Dearne WwTW) proposes installation-specific exposure criteria (benchmarks) on the basis that not all odours are equally offensive, and not all receptors are equally sensitive.

The H4 Guidance proposes the following benchmarks levels for the assessment and indication of unacceptable odour pollution:

³ Planning Inspectorate – Appeal Reference: APP/P0240/A/09/2110667.

⁴ Planning Inspectorate – Appeal Reference: APP/E3525/A/11/2145235.

⁵ High Court of Justice - [2011] EWHC 3253 (TCC).

⁶ Horizontal Guidance H4: Odour Management – How to comply with your Environmental Permit, Environment Agency, 2011.

- $1.5\text{ou}_E/\text{m}^3$ (as a 98th percentile of 1-hour average concentrations) for the most offensive odours;
- $3\text{ou}_E/\text{m}^3$ (as a 98th percentile of 1-hour average concentrations) for moderately offensive odours; and
- $6\text{ou}_E/\text{m}^3$ (as a 98th percentile of 1-hour average concentrations) for less offensive odours;

The H4 Guidance refers to the application of the $1.5\text{ou}_E/\text{m}^3$ criterion against the most offensive odorous sources, such as those processes involving septic effluent or sludge. It is considered that only the sludge storage tank process at the Bolton on Dearne WwTW would be comparable to this assessment criterion. However, the sludge treatment processes undertaken at the Bolton on Dearne WwTW are not covered by the Environmental Permitting Regulations.

It is noted that Water UK, in their consultation response to the EA on the draft Environmental Permitting Regulations H4: Odour Management⁷, stated that an odour assessment criteria of $5\text{ou}_E/\text{m}^3$ as a 98th percentile of 1-hour average concentrations was a more realistic target for the assessment of odour at the nearest receptor.

⁷ Environment Agency Technical Guidance Note: H4 Odour Management Consultation, Water UK Response, 2009.

3.0 ASSESSMENT METHODOLOGY

3.1 Basis for Odour Quantification

The assessment of an odour impact may be undertaken with two differing approaches, by the use of indicator determinands, or total odour. Both approaches are discussed below. In the case where an emission is dominated by one particular odorous gas (such as hydrogen sulphide (H₂S) commonly used in the case of wastewater treatment), the use of an indicator determinand may allow simple validation of an assessment through monitoring at source and receptor. The relationship between concentration of this determinand and odour impact is often difficult to derive for all sources⁸.

A more appropriate approach in the case of complex gas mixture (or a site with multiple sources of differing nature) is that of total odour. Total odour is measured using the concept of the European Odour Unit (ou_E), as defined in British Standard EN 13725(2003). This approach allows impact assessment of any odorous gas as it is independent of chemical constituents and centres instead on human response or detection threshold of the gas in question.

As the odour unit is a Standard Unit in the same way as gram or milligram, the notation used in odour assessment will follow the conventions of any mass emission unit as follows:

- concentration: ou_E/m³;
- emission: ou_E/s; and
- specific emission (emission per unit area): ou_E/m²/s.

Like air quality standards for individual pollutants, exposure to odour is given in terms of a percentile of averages over the course of a year. The exposure criteria accepted in the UK at present is given in terms of (concentration) European Odour Units as a 98th percentile (C₉₈) of hourly averages. This allows 2% of the year when the impact may be above the limit criterion (175 hours). The notation for impact is therefore:

$$C_{98, 1\text{-hour}} \times \text{ou}_E/\text{m}^3$$

For the purposes of this assessment the approach using European Odour Units has been adopted as the most appropriate method.

3.2 Odour Sampling

Site specific Sampling was undertaken on the 2nd August 2012 by SLR Consulting representatives. During odour sampling, a temperature of 20°C was recorded, rising throughout the survey period to a maximum temperature of 23°C.

Area sources were sampled using a Lindvall Sampling Hood. This is a floating cover placed on the liquid surface that is ventilated at a known rate with carbon filtered air in order to ensure that odour samples are not contaminated with additional odorous components. Samples of the outlet odour are then collected and analysed by a UKAS accredited laboratory. The increase in odour concentration between inlet and outlet is caused by the odour emitted from the liquid surface, allowing odour emission rates to be calculated.

⁸ Van Harreveld, A.P & Stoaling, M (2002) Chemicals as odour predictors: what causes the odour deficit? Presented at 'Odours, what a nuisance' – Regulation and Quantification of Environmental Odour. CIWEM, 2002.

Odour samples were collected using inert 40l nalophane sampling bags, in accordance with the principals of BS EN 13725⁹. Samples were extracted by drawn vacuum using the collapsed lung method, negating any issues of contamination from sampling pumps. All sources were sampled in triplicate.

Odour samples were analysed by Silsoe Odours, a UKAS accredited laboratory, in accordance with British Standard BS EN 13725 (2003) for the determination of odour.

A methodology for odour monitoring is prescribed within EA Technical Guidance Note IPPC H4: Part 2¹⁰, which has since been superseded by the revised H4 Guidance¹¹, however, the odour monitoring methodology was not updated or transposed into the updated guidance. In accordance with IPPC H4: Part 2 methodology, odour source samples were taken from source sections most likely to give rise to high odour emissions, as a worst-case scenario. For example, in the instance of the PSTs, odour samples were taken from a small quantity of scum collecting and building up on the surface of the tank.

Hydrogen sulphide (H₂S) concentrations were analysed directly from the odour bag samples in order to determine concentrations resulting from specific WwTW processes, without any further dilution from ambient air. H₂S concentrations were determined through the use of a hand-held Arizona Instruments Jerome 631-X monitor. H₂S monitoring results from the odour bag samples and an analysis of the results is presented within Appendix AQ3

3.3 Detailed Dispersion Modelling

In order to consider potential odour impacts within the vicinity of the Bolton on Dearne WwTW, a quantitative assessment using the AERMOD dispersion model was undertaken. AERMOD is a regulatory model approved for the United States Environmental Protection Agency (US EPA) and is used extensively for odour impact assessment in the UK. The detailed dispersion modelling has been used to predict the ground level concentration of odour and has been undertaken in accordance with the relevant EA guidance¹². In accordance with the EA best practice methodology for dispersion modelling assessment, 5-years of hourly sequential consecutive meteorological data were used. Modelled odour concentrations are presented for each individual year in order to present inter-year variability, in addition an average of the 5-years of meteorological data is used to present average conditions. Reference should be made to Section 5.4 for further information on the utilised meteorological datasets.

The assessment methodology used in this assessment was agreed with YWS prior to the assessment¹³.

3.4 Acceptability of Predicted Odour Impacts

This Odour Constraints Assessment has considered the following criterion for the determination of odour impacts from the standard operation of the Bolton on Dearne WwTW

⁹ BS EN 13725 (2005) Air Quality – determination and odour concentration by dynamic dilution olfactometry.

¹⁰ Integrated Pollution Prevention and Control (IPPC) Technical Guidance Note H4 (Draft), Horizontal Guidance for Odour Part 2 – Assessment and Control, Environment Agency, 2002.

¹¹ Horizontal Guidance H4: Odour Management – How to comply with your Environmental Permit, Environment Agency, 2011.

¹² Environment Agency – Air dispersion modelling report requirements (for detailed air dispersion modelling), Air Quality Modelling and Assessment Unit.

¹³ E-mail communication between Molly Barton, Project Engineer (Odour) within Yorkshire Water Services and SLR Consulting, dated 2/4/2012.

to quantify an appropriate stand-off distance for the protection of residential amenity at the proposed development site:

- an impact criteria of $C_{98, 1\text{-hour}} < 50 u_E/m^3$ in accordance with the recommendation of the CIWEM; and
- an impact criteria of $C_{98, 1\text{-hour}} < 50 u_E/m^3$ in accordance with the planning inspectorate's decision from the Newbiggin-by-the-Sea public inquiry, and later planning appeals. This additionally accords to the impact criteria applied by YWS for assessments undertaken during their asset management.

3.4.1 Model Uncertainty and Limitations

This assessment has incorporated a number of worst-case assumptions, as described in the following subsections, which would result in an overestimation of the predicted ground level concentrations from the standard operation of the Bolton on Dearne WwTW. Therefore actual predicted ground level concentrations would be expected to be lower than this and in some instances significantly lower.

Some factors cannot be included within the dispersion modelling exercise, including non-standard infrequent abnormal operations such as non-consented discharges to sewer and unabated air displaced during tanker filling from the sludge storage tanks. During these periods, it is expected that the generation of odour would be elevated for a short period of time, but considering the frequency and duration of such operations from the site (circa.1-hour per-fortnight, total of 26-hours per-year) these would not significantly compromise the amenity of the development.

4.0 QUANTIFICATION OF ODOUR EMISSIONS

4.1 Potential Sources of Odour

The generation of odour from sewage is primarily associated with the release of odorous Volatile Organic Compounds (VOCs) that are generated as a result of the anaerobic breakdown of organic matter by micro-organisms. The objective of the treatment process is to remove solid organic matter responsible for generation of odours and other contaminants from the wastewater so that it can be returned back into the environment. Since the main source of odour and VOCs is the solid organic matter, the most intense and offensive odours tend to be generated from the operations involving the handling and treatment of raw sewage, or sludge extracted from the raw sewage. The treatment units that rely on aerobic processes and are at secondary or tertiary stages of the works typically pose a lesser risk of generating offensive odours.

It is recognised within Odour Guidance for Local Authorities that not all parts of a process are likely to be the cause of significant odours. The potential for odours are greater for some parts of the WwTW treatment process than for others. Those elements of the WwTW that deal with sludges have a far greater propensity for creating malodours than elements such as, for example, the percolating filters where any odour is likely to be inoffensive. This accords to the findings of R&D document P4-095/TR¹⁴ and Water UK's consultation response to DEFRA on the CoP for odour control at WwTW¹⁵.

On this basis the stages of treatment that would typically pose a risk of generating more offensive odours at Bolton on Dearne WwTW are as follows:

- inlet works;
- PST; and
- sludge storage tanks.

However, in order to present a worst-case scenario of potential odour impacts resulting from the standard operation of the Bolton on Dearne WwTW, all odorous sources have been considered within the context of this Odour Constraints Assessment.

The magnitude of emissions from the inlet works will be dictated by the quality of the influent to the works. From discussion with YWS, it is understood that there are no trade discharges or deliveries into the inlet of the works and that septicity is not an issue.

The magnitude of emissions from PSTs can vary markedly based on the quality of the influent to the works and the quantity and length of time settled sludge is retained before desludging. The quality of influent into the PSTs is reported to be good and they are automatically de-sludged, which should reduce peaks in odour emissions. However, even with good quality influent the size of the tanks (measured at approximately 346.36m² each) means that the PSTs will potentially be a significant source of odour.

Due to low rainfall prior to odour sampling at the Bolton on Dearne WwTW, no effluent was present within the storms tanks to sample. Therefore it was agreed as part of the method

¹⁴ Environment Agency (2002) Assessment of Community Response to Odorous Emissions, R&D Technical Report P4-095/TR.

¹⁵ Water UK response to the consultation on the Code of Practice on Odour Nuisance from Sewage Treatment Works and the Accompanying Local Authority Guide, accessed from: <http://www.water.org.uk/home/policy/statements-and-responses/comment-draft-code-of-practice/water-uk-response-to-odour-cop-and-lag-4--apr-05.doc>

statement that in lieu of site-specific samples, an emission rate would be sourced from the UKWIR Technical reference document 01/WW/13/3, corresponding to a 'typical' emission scenario.

4.2 Bolton on Dearne WwTW – Operational Issues

During pre-assessment consultation with YWS, it was confirmed that aspects of the sludge treatment process, including the sludge digesters, belt press and associated odour control unit (OCU) are redundant and non-operational.

Discussion with the site operator determined that the Bolton on Dearne WwTW suffers from a number of vandalism issues resulting in occasional malfunction of individual treatment processes.

Under normal operations, the sludge holding tanks are covered and not associated with the generation of odour. However, on the morning of the period of odour sampling, the 3 sludge holding tanks were overflowing, due to a malfunctioning ball-cock. This resulted in a pool of sludge collecting at the base of the tank, which was cleaned up by YWS representatives during the period of odour monitoring. Consequently, this malfunctioning of the sludge holding tanks resulted in the generation of significant amounts of non-standard malodour as a consequence of raw sludge pooling on the ground, which lead to the release of unabated odour from this source group.

4.3 Area Sources - Odour Monitoring Results

Results of the olfactometric analysis are presented in Appendix AQ4 and Table 4-1. The maximum monitored odour concentration from each source group is presented in bold text.

**Table 4-1
 Measured Odour Concentrations**

Source	Odour Concentration (ou _E /m ³)			Geomean Concentration (ou _E /m ³)
Inlet Works	8330	49995	36764	24831.22
PST	4203	6200	3255	4393.74
Percolating Filters	238	91	117	136.33
Final Tanks	255	112	153	163.49

As presented within Table 4-1, elevated odour concentrations were monitored from the inlet works of the Bolton on Dearne WwTW. Typically, for works which do not have issues with septicity of inlet flows, it would be anticipated that odour concentrations for the inlet work would be no higher than those of the PST. Consultation with YWS has confirmed that inlet flows into the Bolton on Dearne WwTW are not associated with septicity.

It was noted that during the period of odour sampling, representatives of YWS were removing grit build-up from the inlet works channels, for disposal off-site. It was noted by SLR that residue from the grit removal was present on the inlet works channels. Discussion with YWS operators undertaking this grit removal estimated that approximately 12-months had lapsed since grit was previously removed. It is considered that anaerobic conditions had developed within the grit which was removed, leading to elevated odour concentrations from the inlet works. A maximum H₂S concentration of 5.7ppm was measured in the odour samples from this source. However, H₂S concentrations from the PST odour samples are a factor of 10 times lower, with a maximum concentration of 0.48ppm measured.

Consequently, it is considered that the removal of grit, which represents a non-standard operation, is skewing the odour concentration from the inlet works. As such, it was agreed with YWS to use the PST odour concentrations to calculate an emission rate for the inlet works¹⁶.

Table 4-2 presents the emission rates used during the modelling process. Emission rates from area sources have been calculated in accordance with British Standard BS EN 13725 (2003).

Table 4-2
Process Conditions – Area Sources: Specific Odour Emission Rates

Source	Emission Rate (ou _E /m ² /s)	
	Geomean of Odour Concentrations	Maximum Odour Concentration
Inlet Works ^(A)	28.87	40.74
PST	28.87	40.74
Percolating Filters	0.90	1.56
Final Tanks	1.07	1.68

Note:
 (A) Emission rates calculated utilising PST odour concentrations.

4.4 Estimated Emission Rates

Emission rates for the storm tanks have been derived from UKWIR Technical reference document 01/WW/13/3, corresponding to fresh storm sewage.

Emission rates from the 4-storm tanks (as presented within Table 4-3) have been calculated in accordance with British Standard BS EN 13725 (2003), based upon the same principles for the site-specific emission rates presented within Table 4-2.

Table 4-3
Modelled Process Conditions – Storm Tanks

Source	Odour Concentration (ou _E /m ³)	Total Effective Emission Rate (ou _E /m ² /s)
Storm Tanks	500	3.29

Inlet flows in excess of the weir threshold are redirected by gravity to the storm tank where effluent is held for later return to the treatment process, returned manually by YWS personnel¹⁷. The maximum volume flow to be treated, prior to redirection to the storm-tanks is unknown.

It was noted during odour monitoring on the 2nd August 2012 that the storm tanks were not in use and inlet flows appeared to be approximately 50% of the maximum volume of incoming flow illustrating sufficient headroom prior to diversion. However, for the purposes of this Odour Constraints Assessment, it has been considered that the storm tanks are being utilised 24-hours per day, 365-days per year. It is considered that the storm tanks would be utilised for a maximum period of 50% of the year during storm-surge periods when incoming

¹⁶ E-mail communication between Molly Barton, Project Engineer (Odour) within Yorkshire Water Services and SLR Consulting, dated 15/08/2012.

¹⁷ Discussion with Darran Howell, Technical Officer in the YWS Operations Team.

flows would be diluted and, therefore, this assumption is considered to overestimate the actual impact of emissions from the storm tanks.

5.0 MODEL INPUT DATA

5.1 Modelling Scenarios

The scenarios considered within this assessment are detailed within Table 5-1.

**Table 5-1
 Odour Constraints Assessment – Modelling Scenarios**

Scenario	Assessment Criteria	Modelling Criteria Applied
Maximum Measured Odour Concentration Emission Rates	1-hour mean not to exceed more than 2% of the time (175 hours)	98 th percentile of 1-hour means
Geomean of Measured Odour Concentration Emission Rates		

The assessment considered odour emissions from all sources during normal operating conditions, as described below.

5.2 Process Conditions

Sources required for site-specific odour sampling were identified through consultation with YWS and reference to aerial photos of the Bolton on Dearne WwTW. This consultation determined that there were 5No. individual sources of potential odour present at the WwTW. These are considered to be:

- Inlet works – high potential malodour production;
- Primary settlement tanks (PST) – high potential malodour production;
- Percolating filters – low potential malodour;
- Final tanks – low potential malodour; and
- Storm tanks – medium potential malodour.

The Bolton on Dearne WwTW is predominantly a combined system conveying both foul sewage flows and surface water by gravity to the plant for treatment. The catchment flows are predominantly from residential areas, with some light industrial and commercial inputs.

5.2.1 Model Assumptions

During the period of odour sampling at the Bolton on Dearne WwTW, it was noted that only one PST was operational, with the second tank empty. From discussion with the site operator, it is understood that the PSTs are operated in series to allow for periods of manual cleaning and maintenance. However, to reflect a worst-case scenario of potential standard operational odour from the Bolton on Dearne WwTW, it has been assumed that both PSTs are operated concurrently.

Three sludge storage tanks are present at the Bolton on Dearne WwTW, which comprise part of the sludge treatment. However, discussion with YWS indicated that the associated belt press and digestors are redundant. The odour control unit (OCU) which abates internal process foul air prior to emission to atmosphere is non-operational. The three sludge storage tanks are covered with no emission point to atmosphere, and, under normal operation are not associated with the release of odour. Therefore, the sludge storage processes of the Bolton on Dearne WwTW have no longer been considered within the context of this assessment.

The treatment sources of the WwTW were assumed to be in operation 24-hours per day, 365-days per year in order to result in a worst-case determination of potential odour impacts.

5.3 Assessment Area

The potential odour impact from the operation of the Bolton on Dearne WwTW has been assessed over an area of 800m x 800m (NGR: 448837.2, 401940.1 to 449637.2, 402740.1) with a Cartesian grid with a resolution of 20m over the entire modelling area.

Additional boundary receptors were digitised within the modelling domain with a finer resolution of 2m, in order to determine a maximum odour concentration upon the boundary of the two plots of land Gleeson are seeking to develop.

The land which Gleeson are seeking to develop is referenced within the report as Site A (land to the north of the Bolton on Dearne WwTW) and Site B (land to the north-east of the Bolton on Dearne WwTW).

5.4 Meteorological Data

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

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

Atmospheric Dispersion Modelling (ADM) Ltd was consulted in order to determine the most appropriate meteorological dataset to utilise within the Odour Constraints Assessment. Meteorological data was sourced from Robin Hood Airport located at NGR: 466457, 398940, approximately 20.5km east south-east of the proposed development site. Five consecutive years of hourly-sequential observation data from this location, covering the period 2007 – 2011, inclusive, were obtained. The wind-roses of the meteorological data are provided in the Figures section. The wind-rose indicates that the prevailing wind direction at the Robin Hood Airport observation station is from southern through to western sectors.

Table 5-2 presents statistics on the meteorological dataset illustrating the number of calm hours and the number of missing hours recorded within the 5-year period. Data capture, in terms of the percentage of calm hours and missing hours recorded are less than 10% and therefore, within acceptable limits.

**Table 5-2
 Robin Hood Airport Meteorological Data Statistics**

Year	Calm Hours (%)	Wind Speeds <1.54 m/s (%)	Missing Hours (%)
2007	2.39	11.29	0.54
2008	1.94	9.88	0.26
2009	1.15	10.08	0.08
2010	1.92	13.12	0.00
2011	0.86	10.00	0.00

In order to provide a greater degree of confidence with the modelling results, an average of the odour concentrations modelled with the application of the 2007 – 2011 meteorological data has been presented, this prevents results being skewed by infrequent meteorological conditions that would give a false indication of average conditions. However, in accordance

with EA dispersion modelling best practice guidance¹⁸, modelled results from each individual meteorological year have been presented for an analysis of inter-year variability.

The meteorological data for Robin Hood Airport was obtained from the data supplier and converted to the required surface and profile formats for use in AERMOD using AERMET Pro. Details specific to the exact site location were used for the conversion, such as latitude, longitude and surface characteristics in accordance with the latest guidance¹⁹.

Given the contrasting urban / rural nature of the surface features within a 1km radius of the proposed development site, the surface roughness factor for an urban area was applied to the west and a surface roughness factor for grassland / cultivated land to the east. The Bowen ratio and albedo was assigned based on 50% cultivated land, 35% grassland and 15% urban land-uses within the 10km grid surrounding the site . The applied values are shown in Table 5-3.

**Table 5-3
 Meteorological Data Preparation – Applied Surface Characteristics**

Zone (Start and End Sectors)	Albedo	Bowen	Roughness
0 – 230	0.2726	0.943	0.2
230 – 360	0.2726	0.943	0.8

5.5 Terrain Data

The model was run with OS 1:50,000 scale digital height contour data at 50m horizontal intervals. Data was processed by the AERMAP function within AERMOD to calculate terrain heights and interpolate data to calculate terrain heights for sources and receptors.

5.6 Building Downwash

Building downwash occurs when turbulence, induced by nearby structures, causes pollutants emitted from an elevated source to be displaced and dispersed rapidly towards the ground, resulting in elevated ground level concentrations. However, AERMOD is not capable of processing the influence of building upon area source emission releases, such as those emission sources which constitute the Bolton on Dearne WwTW. Therefore, building downwash has not been considered further within the context of this modelling.

¹⁸ Environment Agency – Air dispersion modelling report requirements (for detailed air dispersion modelling), Air Quality Modelling and Assessment Unit.

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

6.0 RESULTS

The modelled odour impacts corresponding to the standard operation of the Bolton on Dearne WwTW are presented within Appendix AQ1 illustrating:

- Drawing AQ1-1 Average modelled odour impact of the Bolton on Dearne WwTW, average of 2007 – 2011 meteorology, geomean odour emission profile; and
- Drawing AQ1-2 Maximum modelled odour impact of the Bolton on Dearne WwTW, 2007 meteorology, geomean odour emission profile;

6.1 Model Validation

The drawings illustrated in Appendix AQ1 illustrate that the $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ criterion extend beyond the WwTW site boundary, predicting impacts at a number of existing residential properties to the west of the WwTW. Enquiries were made to the Environmental Health department of EC in order to ascertain whether any odour complaints had been made from the residential properties surrounding the Bolton on Dearne WwTW. These enquiries indicated that there were no records of odour complaints which had been attributed to the operation of the WwTW²⁰. Therefore, as no complaints regarding WwTW related odour have been received from any of these residents where predicted exposure is greater than the $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ benchmark criterion, it is considered that the dispersion modelling is overestimating the potential for odour impacts, or indeed that the indicative benchmark odour criterion could potentially be higher. Consequently, it is considered that the 'geomean' calculated emission rates are more representative of actual odour generated by the Bolton on Dearne WwTW during a typical calendar year.

6.2 Odour Constraints Assessment

Dispersion modelling undertaken as part of this Odour Constraints Assessment has considered predicted odour impacts from the standard operation of the Bolton on Dearne WwTW, and determined an appropriate stand-off distance from which odour impacts would not be witnessed. This impact assessment is to inform an appropriate stand-off distance for a proposed residential development.

The odour isopleths contour plots presented within Appendix AQ1 illustrate those areas of land within which odour is predicted to be in excess of the applied benchmark criteria ($C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$). This impact criteria has been frequently quoted and accepted and is applied as being sufficient to prevent nuisance for a number of industry sectors, based upon an appeal decision for a residential development adjacent to a WwTW²¹. This impact criteria has more recently been applied within the context of odour assessment from WwTW related odour adjacent to existing and proposed residential receptors, including a planning appeals from Leighton Linlade in 2010²², where the inspector '*considered 5 OU_E/m^3 a reasonable threshold in terms of both nuisance and amenity*', and from a site in Haverhill in 2011²³, where the inspector found that a proposed development approximately 7m from the boundary of a WwTW where odour dispersion modelling '*predicted levels [...] between 3 and 5 OU_E/m^3 . The Inspector found that proposal acceptable, with no significant harm caused.*'

²⁰ E-mail correspondence between SLR Consulting and Andrew Hunt, Technical Support Office within Barnsley Council, dated 11/05/2012.

²¹ Department of the Environment (15th July 1993) Appeal by Northumbrian Water Ltd: Land Adjacent to Spital Burn, Newbiggin-by-the-sea, Northumberland. Case ref: APP/F2930/A/92 206240.

²² Planning Inspectorate – Appeal Reference: APP/P0240/A/09/2110667.

²³ Planning Inspectorate – Appeal Reference: APP/E3525/A/11/2145235.

In a High Court Appeal in relation to Mogden WwTW, one of the largest WwTW in the Country, in London Borough of Hounslow, Mr. Justice Ramsey considered the $5\text{ou}_E/\text{m}^3$ assessment criteria for application and assessment of complaints from existing residents surrounding the WwTW, and concluded that *'as the odour concentration rises to 5ou_E per m^3 I consider that this is the area where nuisance from Mogden STW would start [...]*.

Therefore, it is considered that assessment of odour from the standard operation of the Bolton on Dearne WwTW against an applied benchmark criteria of $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ demonstrates that impacts would be witnessed. It is noted that at locations of existing residential exposure at a similar stand-off distance to that of the proposed development site, no historical WwTW related odour complaints have been made, including those locations where predicted odour concentrations are in excess of $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ at existing exposure.

7.0 DISCUSSION AND CONCLUSION

SLR has undertaken an Odour Constraints Assessment of identified sources of odour from the Bolton on Dearne WwTW, Bolton on Dearne. Odour emissions from the WwTW were measured during an odour monitoring survey undertaken by SLR personnel, with subsequent analysis by dynamic olfactometry undertaken by Silsoe Odours. A number of worst-case scenario assumptions were considered during the dispersion modelling in order to provide a robust assessment.

Dispersion modelling of emissions from the standard operation of the Bolton on Dearne WwTW illustrates those areas of the proposed Gleeson development sites (Site A and Site B) which are not exposed to levels above the impact criterion, i.e. in excess of $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$. The use of the $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ assessment criterion accords with:

- the recommendations of the CIWEM; and
- the level which was accepted by a Planning Inspector at the Newbiggin-by-the-Sea, Leighton Linlade and Haverhill public enquiries where circumstances were very similar.

On the basis of this Odour Constraints Assessment, and reference to Drawings AQ1-1 to AQ1-2 for an illustration of geomean modelled odour, it is considered that those locations of Site A and Site B outside of the predicted $C_{98, 1\text{-hour}} 5.0\text{ou}_E/\text{m}^3$ exposure criteria are sufficient to ensure the amenity of residents of the Gleeson development would not be witness to any significant detrimental impact.

8.0 CLOSURE

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

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

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

APPENDIX AQ1 – Drawings

APPENDIX AQ2 – Figures

Figure AQ2-1 – Robin Hood Airport Meteorological Station Wind Rose 2007

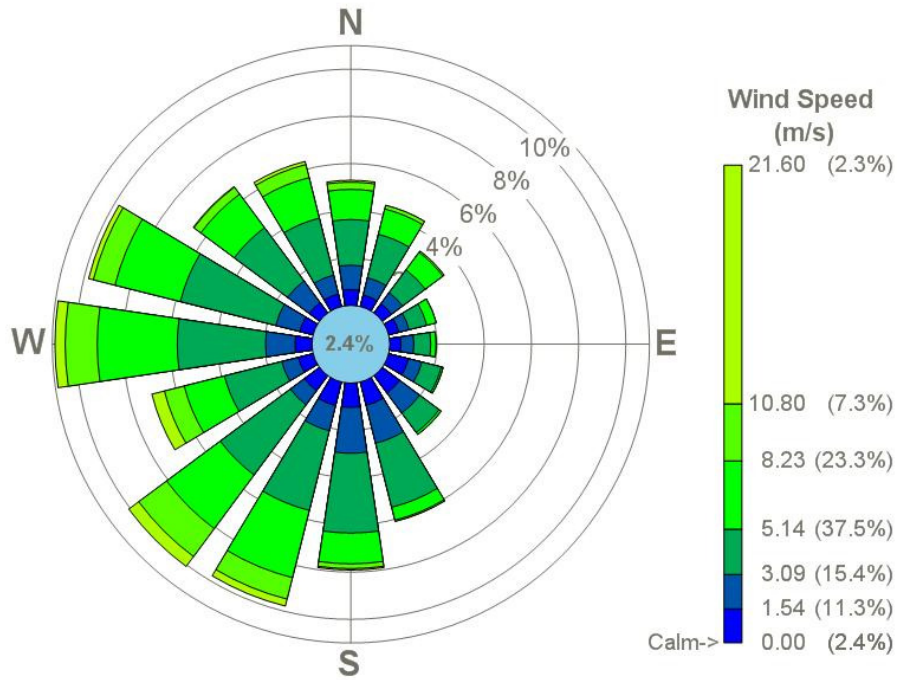


Figure AQ2-2 – Robin Hood Airport Meteorological Station Wind Rose 2008

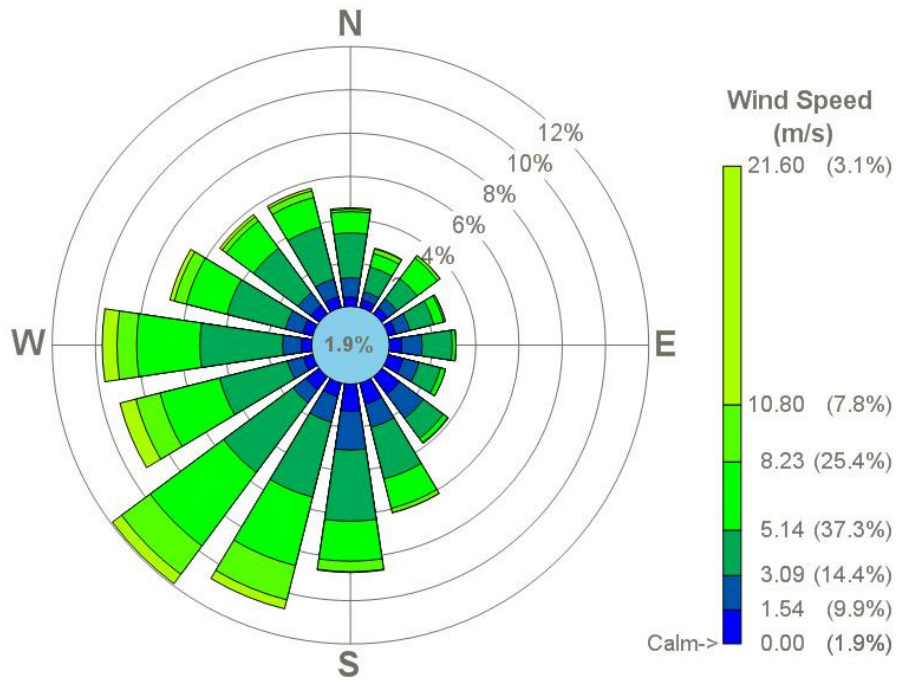


Figure AQ2-3 – Robin Hood Airport Meteorological Station Wind Rose 2009

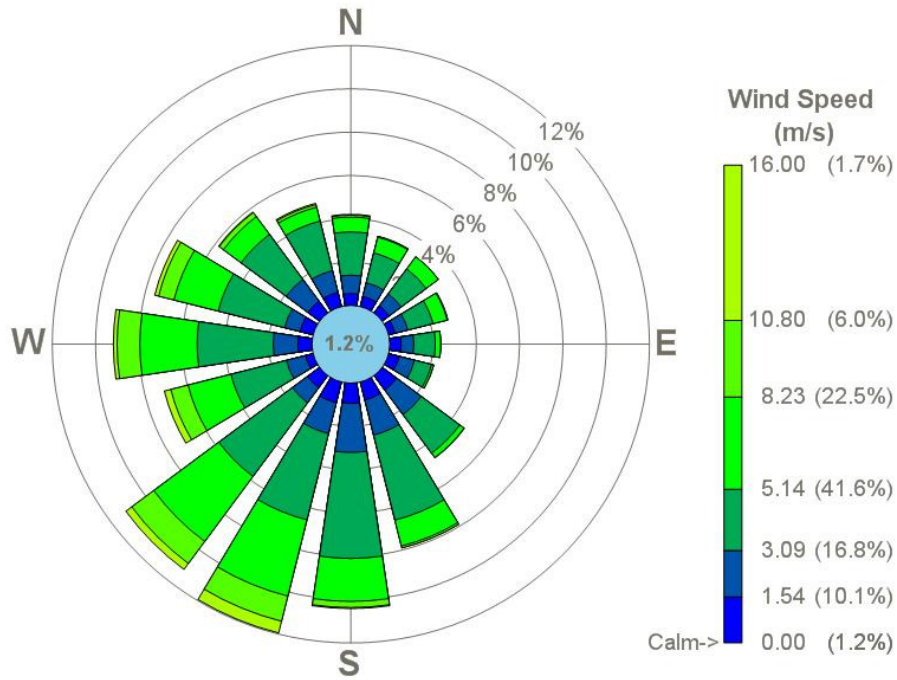


Figure AQ2-4 – Robin Hood Airport Meteorological Station Wind Rose 2010

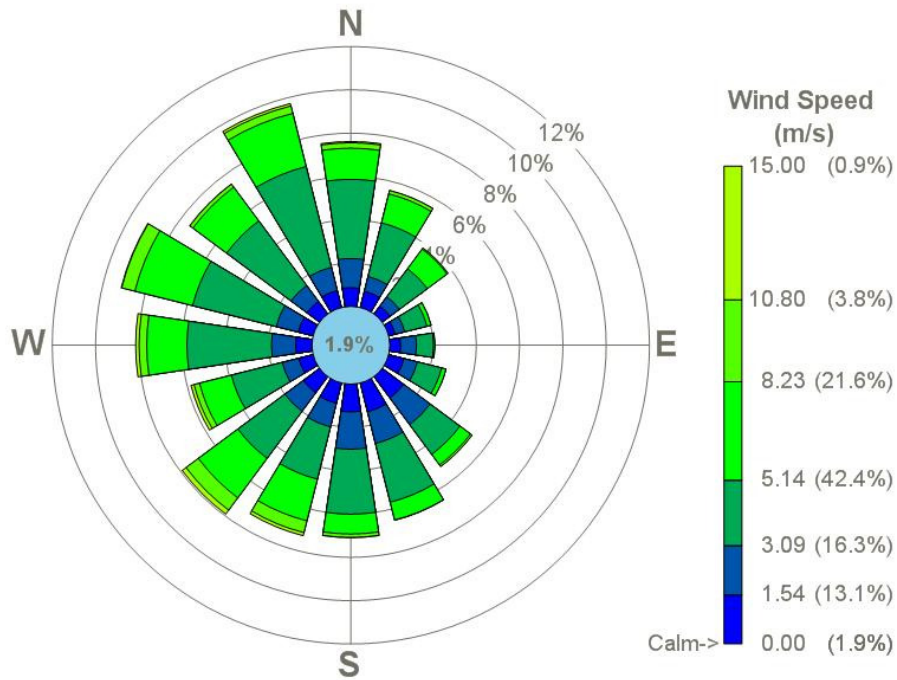
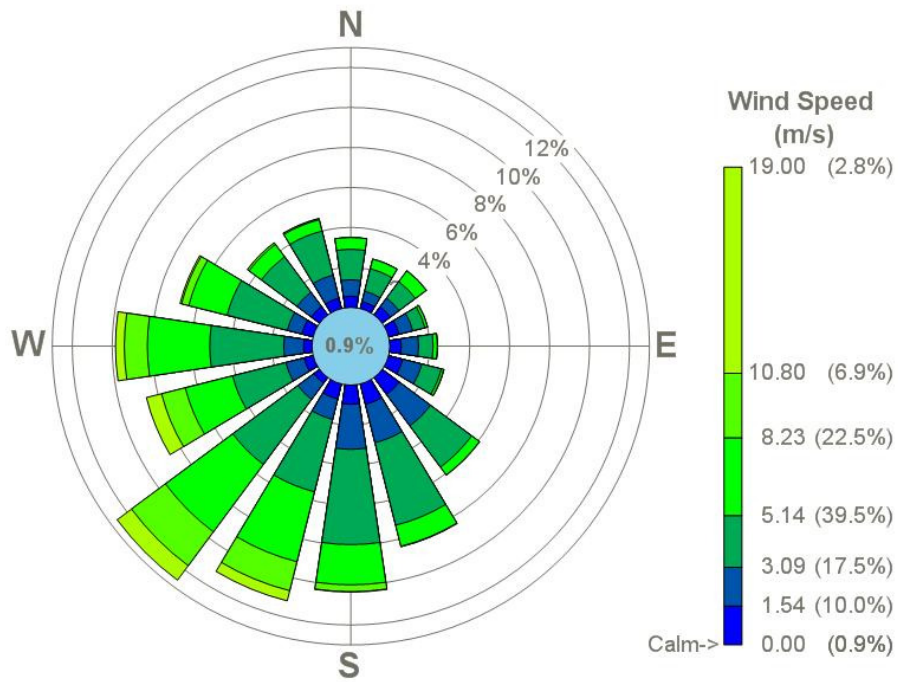


Figure AQ2-5 – Robin Hood Airport Meteorological Station Wind Rose 2011



APPENDIX AQ3 – Hydrogen Sulphide Monitoring Results and Analysis

H₂S concentrations were sampled directly from the odour bags prior to odour analysis by Silsoe Odours using a hand held Arizona Instruments Jerome 631-X monitor, as presented within Table AQ3-1.

Table AQ3-1
H₂S Concentrations from Odour Bags

Source Location	Average of H₂S Concentration (ppm) ^(A)
Inlet Works	3.867
PST	0.333
Percolating Filters	0.003
Final Tank	0.004

(A) – Parts per million (ppm) denotes 1No. part of a given substance for every 999,999No. parts of air

To place the monitored H₂S concentrations in Table AQ3-1 into context, the odour threshold for H₂S is 0.005ppm. This equates to a mass concentration of 0.76µg/m³. However, this odour threshold limit is derived under “sterile” laboratory conditions, in an outdoor atmosphere the concentration required for odour detection could be up to five times higher. Typical H₂S ambient background concentrations in urban areas are associated with diesel exhaust emissions and rotting vegetables²⁴, for example.

As noted within Section 4.0 of the main body of the report, elevated H₂S concentrations were analysed from inlet works odour bag samples. As YWS have confirmed that the Bolton on Dearne WwTW is not typically associated with septicity of incoming flows, the removal of grit from the inlet channels is considered to be the resulting factor in the generation and detection of elevated H₂S concentrations.

All other H₂S concentrations monitored are within typical ranges for site processes, as identified by UKWIR for gravity sewer systems.

²⁴ National Monitoring and Assessment Technical Report, Study of Ambient Air Quality, NMA/TR/2007/09, Environment Agency, 2007.

APPENDIX AQ4 –Olfactometry Laboratory Results



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