Odour Impact Assessment - United Utilities Water Limited, Southport

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Executive summary

Southport Wastewater Treatment Works (WwTW) operated by United Utilities Water Limited (hereafter 'UU'), is located on the outskirts of the seaside town of Southport, Lancashire (PR9 9YL).

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Odour Impact Assessment (OIA) on behalf of UU to support the permit variation application and assesses the potential impact of odour emissions from the on-site odour control units (OCU) at the Southport WwTW, making comparison against the odour criteria of 1.5 ou_E/m^3 to demonstrate compliance.

The results indicate that the maximum predicted 1-hour mean (98th percentile) odour concentration at the assessed sensitive receptors is less than 0.2 ou_E/m^3, which is below the H4 odour benchmark for the most offensive odours (for high sensitivity receptors) of 1.5 ou_E/m^3. It should be noted 0.13 ou_E/m^3 predicted at R14 is less than 10% of the benchmark and emissions from the site could roughly increase by 90% without exceeding 1.5 ou_E/m^3. Therefore, applying an emission limit value of 1,000 ou_E/m^3 may be overly conservative and result in unnecessary replacement of odour control media (with associated impact of carbon emissions/footprint /utilisation of raw materials.

Based on the above assessment, it is concluded that the operation of the assessed OCUs is acceptable from an air quality perspective.

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1. Introduction

Southport Wastewater Treatment Works (WwTW) operated by United Utilities Water Limited (hereafter 'UU'), is located on the outskirts of the seaside town of Southport, Lancashire (PR9 9YL). The surrounding land use generally comprises residential properties to the east, south and west of the site, a playing field to the south and a commercial premises to the southeast of the site. Ribble Estuary Site of Special Scientific Interest (SSSI) and National Nature Reserve (NNR) and Ribble & Alt Estuaries Ramsar site, are adjacent to the northern and eastern boundary of the site.

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Odour Impact Assessment (OIA) on behalf of UU to support the permit variation application (permit reference EPR/XP3337QR) and assesses the potential impact of odour emissions from the on-site odour control units (OCU) at the Southport WwTW, making comparison against the relevant odour standards to demonstrate compliance.

1.1 Odour Regulation and Assessment

The legislation under which odours are currently controlled in the UK is as follows:

- Environmental Protection Act (EPA);
- Town and Country Planning Act;
- Environmental Permitting Regulations; and
- Industrial Emissions Directive.

Unacceptable levels of odour impact/odour nuisance arising from emissions associated with a STW fall under the jurisdiction of the Local Authority, whereas odour pollution arising from an installation/facility operating under Environmental Permitting Regulations or Industrial Emissions Directive fall under the authority of the Environment Agency.

Within the UK there are various key items of regulation that relate to odour. In addition to which there are also several industry Codes of Practice and associated institutional policy statements that provide guidance on odour exposure/impact and the risk of odour complaints occurring.

Odour Guidance for Local Authorities as issued by Defra (Defra, 2010) provides the following guidance:

'The concentration at which an odour is just detectable to a 'typical' human nose is referred to as the 'threshold' concentration. This concept of a threshold concentration is the basis of olfactometry in which a quantitative sensory measurement is used to define the concentration of an odour.

…Standardised methods for measuring and reporting the detectability or concentration of an odour sample have been defined by a European standard (BSEN 13725:2003). The concentration at which an odour is just detectable by a panel of selected human 'sniffers' is defined as the detection threshold and as an odour concentration of 1 European odour unit per cubic metre (1 ou_E/m^3)"

The Environment Agency has issued the H4 Odour Management guidance document (Environment Agency, 2011), which covers the regulatory requirements with regard to odour for permitted installations.

1.1.1 Environment Agency H4 guidance

The Environment Agency H4 Odour Management guidance document (Environment Agency, 2011) covers the regulatory requirements with regard to odour for permitted installations or installations that require a permit, and in particular provides benchmark exposure levels with respect to modelling odour exposure at the site boundary or receptors.

The H4 odour benchmarks are based on the of 1-hour mean (98th percentile) odour concentrations over a year at the site boundary.

The benchmarks are:

- 1.5 odour units (i.e. ou_E/m^3)for the most offensive odours such as odours from processes involving decaying animal or fish remains, processes involving septic effluent or sludge or biological landfill odours;

- 3 odour units for moderately offensive odours such as odours from intensive livestock rearing, fat frying, sugar beet processing or well aerated green waste composting; and
- 6 odour units for less offensive odours such as odours from a brewery, confectionary or coffee.

The H4 guidance also states that "*The condition and the benchmarks given in this guidance are based on odour levels at the boundary. If there are no receptors close to the boundary we will normally permit a facility that meets the criteria at the nearest receptor*." As described in more detail in Section 3.1 the closest residential property is approximately 110 m west from the Southport WwTW OCUs and so the assessment is based on the predicted odour concentrations at the identified receptor locations.

1.1.2 Selected Odour Criterion

For this modelling exercise, emissions of odour from the on-site OCUs were assessed against the benchmark level of 1.5 ou_E/m^3 at nearby sensitive receptors as set out in the EAs H4 guidance document.

1.2 Objectives of the report

Odour dispersion modelling has been conducted using ADMS 5.2.4 software to quantify the odour impacts at relevant sensitive receptor locations, surrounding the site. The dispersion model included the site layout buildings and infrastructure (as appropriate), two OCU emission sources and associated odour emission parameters.

The objective of this report is to demonstrate that current operations at the site are compliant with H4 odour benchmark.

2. Odour Modelling

2.1 Modelling software

The odour assessment was carried out using an atmospheric dispersion modelling technique. Atmospheric Dispersion Modelling System (ADMS) version 5.2.4 was used to model odour releases. The ADMS model predicts the dispersion of operational emissions from a specific source (e.g. a stack), and the subsequent concentrations over an identified area (e.g. at ground level across a grid of receptor points) or at specified points (e.g. a residential property). ADMS was selected because this model is fit for the purpose of modelling odour emissions from the WwTW and is accepted as a suitable assessment tool by local authorities and the Environment Agency.

The modelling assessment was undertaken in accordance with the H4 guidance (Environment Agency, 2011).

A summary of the dispersion modelling procedure is set out below.

1. Information on the odour emission parameters were provided by UU (UU, 2022).
2. Five years of hourly sequential data recorded at the Blackpool Airport meteorological station (2015 – 2019 inclusive), which is considered to be a representative meteorological station to the Southport WwTW (ADM Ltd, 2020). The wind roses are presented in Appendix A**Error! Reference source not found.**.
3. The above information was entered into the dispersion model.
4. The 98th percentile of 1-hour mean odour concentrations were considered at the assessed receptor locations for any of the five years of meteorological data used.
5. The assessment of the modelled results was based on the numerical values outputted by the dispersion model at the specific receptor locations and were processed using Microsoft Excel.

2.2 Model limitations

Any modelling exercise is an approximation of the true behaviours of odours in the environment. It is impossible to account for every variation in atmospheric conditions and still keep the model within the bounds of practicability. The key limitations on the results are as follows.

- Variations considered in the model include the meteorological conditions. There are only a limited number of weather stations across the UK which record all the necessary parameters for dispersion modelling and it is not always possible to use data from a site close to the study area.
- The measured odour emission concentrations are generated from olfactometry studies, which by their nature can have an associated margin of error.
- Results are based on hourly-averaged data. When monitoring, it is possible that odour levels much higher than the average value could occur for short periods of time (i.e. even for a few minutes). If compliance is based on those relatively short duration odour measurements (over a period of minutes), then complaints could be recorded even though the overall hourly averaged data would suggest no exceedance had occurred.

Despite the limitations, dispersion modelling is a useful tool in the prediction of ground level concentrations. The use of dispersion models has been widely used in the UK for both regulatory and compliance purposes for a number of years and is an accepted approach for this type of assessment.

2.2.1 Conservative Assumptions

The conservative assumptions adopted in this study are summarised below:

- to quantify the 1-hour mean (98th percentile) odour concentrations, odour emissions were assumed to be emitted continuously all year (i.e. 8,760 hours each calendar year); and
- the study is based on odour emissions being continuously at the emission rates calculated.

3. Model Input Data

3.1 Modelled receptor locations

Sensitive human receptors have been identified at 16 locations within close proximity to the Southport WwTW. These receptors comprise nearby residential properties, a commercial premises, a public right of way (PRoW), a bridleway and a sports field. The modelled receptors are presented in Table 1 and Figure 1 (see Appendix C).

Table 1. Modelled receptors

Receptor[1]	Co-ordinates		Sensitivity to odour	Distance (km)[2]	Direction[2]	Description
	X	Y				
R1	336720	420674	Low	0.12	WNW	Bridleway
R2	336783	420721	Low	0.10	NNW	Bridleway
R3	336846	420768	Low	0.13	N	Bridleway
R4	336918	420820	Low	0.20	NNE	Bridleway
R5	337282	420768	High	0.47	ENE	Residential property on Harrogate Way
R6	337289	420712	High	0.46	E	Residential property on Harrogate Way
R7	337076	420673	Low	0.25	E	PRoW
R8	337097	420572	Medium	0.27	ESE	Commercial (warehouse)
R9	337083	420457	High	0.31	SE	Residential property on Ferryside Lane
R10	337003	420409	High	0.28	SE	Residential property on Eamont Avenue
R11	336860	420403	High	0.23	S	Residential property on Crediton Avenue
R12	336803	420491	High	0.15	SSW	Residential property on Bodmin Avenue
R13	336755	420551	High	0.11	SW	Residential property on Treen Close
R14	336731	420590	High	0.11	WSW	Residential property on Exmoor Close
R15	336719	420618	High	0.11	W	Residential property on Exmoor Close
R16	336889	420549	Low	0.10	SSE	Sports field

Note 1: Receptors were modelled at a height of 1.5 m or 'breathing zone'.
Note 2: Based on the average geographic location of the assessed emission sources (National Grid Reference (NGR) E 336833, N 420634)).

3.2 Odour Sources

The locations of the modelled odour sources are presented in Figure 1 (see Appendix C) and the modelled odour emission parameters are presented in Table 2. Information on the odour emission parameters were supplied by UU (UU, 2022). Information on the main buildings located on-site which could influence dispersion of odour emissions from the assessed sources were estimated from on-site photography, Defra's environmental open-data applications and datasets (Defra, 2022) and Google Earth (Google Earth, 2022).

Table 2. Point source odour parameters and emission rates

Emission point	Source	Co-ordinates (X,Y)	Stack Height (m)	Stack diameter (m)	Effective stack diameter (m)	Efflux velocity (m/s)	Design air flow rate (m^3/s)	Temperature (K)	Design Odour concentration (ou_E/m^3)	Design Odour release rate (ou_E/s)
A2	Import Break Tank OCU	E 336847, N 420614	3.10	0.30	0.13[1]	15.0	0.201	Ambient	1,000	200.833
A3	Mixing and Balancing Tank OCU	E 336819, N 420654	4.20	0.30	0.18[1]	15.0	0.378	Ambient	1,000	377.778

Note 1: As the OCU stacks house an efflux cone, which increases the efflux velocity to 15.0 m/s, an effective stack diameter was applied in the model based on the design air flow rate divided by an efflux velocity of 15.0 m/s.

3.3 Modelled operational hours

All assessed emission sources were assumed to be in continuous operation (i.e. 24 hours a day, 365 days per year).

3.4 Surface characteristics

The predominant surface characteristics and land use in a model domain have an important influence in determining turbulent fluxes, and hence the stability of the boundary layer and atmospheric dispersion. Factors pertinent to this determination are detailed below.

3.4.1 Surface roughness

The surface roughness represents the aerodynamic effects of surface friction. This value is an important parameter used to interpret the vertical profile of wind speed and estimate friction velocities which are, in turn, used to define heat and momentum fluxes and turbulence levels.

The surface roughness is related to the height of surface elements, typically, the surface roughness is approximately 10% of the height of the main surface features. Thus, it follows that surface roughness is higher in urban and congested areas than in rural and open areas. The higher the surface roughness value used the more mixing and dispersion of odours will occur.

As the land use in the modelled domain is a mixture of residential, commercial and marine, a variable surface roughness file was used in the model to capture the variable surface roughness length. A surface roughness length of 0.005m was applied for the study area covered with marshland and water, 0.2 m was applied for agricultural areas and 0.7 m was applied for residential areas.

3.4.2 Terrain

Topographical features such as hills can have significant effect on the dispersion of pollutants, generally when the ground level varies by more than 1:10 (i.e., a 100 m change in elevation per 1 km in horizontal distance in the horizontal plane). As the gradient encompassing the site and surrounding area is less than 1:10, a terrain file has not been included in the model.

3.4.3 Buildings

Atmospheric flow is disrupted by aerodynamic forces in the immediate vicinity of buildings. These disruptions generate an area of stagnation behind the structure known as the building cavity region. The flow within this region is highly turbulent and the area beyond the cavity region is known as the building wake, where air turbulence generated by the building gradually decays to background levels. The entire area covered by the cavity region and turbulent wake is known as the building envelope.

The above phenomena can result in a plume being drawn down towards the ground in the building envelope, resulting in elevated ground level concentrations, which is known as building-induced downwash. Generally, buildings that are more than one third of the stack height or are within a distance of 5L (where L is the stack height) from the base of the stack should be included in the model. The structures that have been included within this modelling assessment and are presented in Table 3 and Figure 1 (see Appendix C).

Table 3. Building parameters

ID	Modelled building shape	Co-ordinates of building centre (m)		Height (m)	Length (m) / Diameter (m)	Width (m)	Angle to North (Deg)
		E	N				
Mixing and Balancing tank	Circular	336829	420640	9.58	12.56	-	-
Import Break tank	Circular	336839	420623	5.63	5.88	-	-
SAS wet well	Rectangular	336864	420587	11.88	32.54	11.88	145
Primary digester	Circular	336877	420611	18.67	16.23	-	-
Building 1	Rectangular	336872	420636	3.45	33.00	12.80	56
Building 2	Rectangular	336807	420672	7.25	17.93	15.70	55
Building 3	Rectangular	336836	420679	13.67	24.20	10.60	56
Building 4	Rectangular	336849	420653	9.13	17.20	10.10	145

3.5 Meteorological data

Meteorological data from Blackpool Airport have been used for this assessment. Blackpool Airport meteorological station is located approximately 11.5 km north-northwest of the site and is considered the closest most representative meteorological monitoring station to the site. Five years of hourly sequential data (2015– 2019 inclusive) were used in this assessment. Wind roses for each year of meteorological data used are set out in Appendix A. A surface roughness value of 0.5 m has been used to represent the meteorological site.

3.6 Output

The output of the models was based on the 1-hour mean (98th percentile) odour concentrations. The results presented in this report are based on the highest concentration predicted from any of the five years of meteorological data modelled. The predicted concentrations at the assessed receptors for each individual year are presented in Appendix B. As discussed previously, the model output were compared against the benchmark odour concentration of 1.5 ou_E/m^3.

4. Results

Table 4 presents the maximum 1-hour mean (98th percentile) odour concentrations at assessed receptor locations as a result of odour emissions to air from the Southport WwTW for any of the five years of meteorological data used for the assessment.

The full results for each year of meteorological data are provided in Appendix B with an isopleth of the modelled results provided in Figure 2 (see Appendix C).

Table 4. Predicted odour concentrations

Receptor	Description	Receptor sensitivity	Modelled 1-hour mean (98th percentile) concentrations (ou_E/m^3)
R1	Bridleway	Low	0.13
R2	Bridleway	Low	0.10
R3	Bridleway	Low	0.05
R4	Bridleway	Low	0.02
R5	Residential property on Harrogate Way	High	0.01
R6	Residential property on Harrogate Way	High	0.01
R7	PRoW	Low	0.02
R8	Commercial (warehouse)	Medium	0.01
R9	Residential property on Ferryside Lane	High	0.01
R10	Residential property on Eamont Avenue	High	0.01
R11	Residential property on Crediton Avenue	High	0.02
R12	Residential property on Bodmin Avenue	High	0.04
R13	Residential property on Treen Close	High	0.07
R14	Residential property on Exmoor Close	High	0.13
R15	Residential property on Exmoor Close	High	0.10
R16	Sports field	Low	0.09

The results in Table 4 indicate that the maximum predicted odour concentration at the assessed sensitive receptors is less than 0.2 ou_E/m^3. As discussed in Section 1.1.1, the H4 odour benchmark for the most offensive odours is 1.5 ou_E/m^3.

The maximum predicted 1-hour mean (98th percentile) odour concentration at a high sensitivity receptor is 0.13 ou_E/m^3, which is predicted at R14, representing a residential property on Exmoor Close. R14 is approximately 110 m west-southwest of the average geographic location of the assessed emission sources (i.e. NGR E 336833, N 420634). It should be noted 0.13 ou_E/m^3 predicted at R14 is less than 10% of the benchmark and emissions from the site could roughly increase by 90% without exceeding 1.5 ou_E/m^3. Therefore, applying an emission limit value of 1,000 ou_E/m^3 may be overly conservative and result in unnecessary replacement of odour control media (with associated impact of carbon emissions/footprint /utilisation of raw materials.

An isopleth of the odour emission concentrations is presented in Figure 2 (see Appendix C). It should be noted the predicted concentrations presented in Table 4 are based on the maximum concentrations predicted from any of the five years of meteorological data, whereas the odour isopleth presented in Figure 2 is based on the year in which the maximum odour concentration was predicted at the assessed high sensitivity receptors (i.e. 2016). The predicted odour concentrations for all years of meteorological data considered in this assessment are shown in Appendix B.

5. Conclusion

Detailed odour dispersion modelling has been undertaken to assess the potential impact of odour emissions from the Southport WwTW, making comparison against the H4 odour benchmark of 1.5 ou_E/m^3 to demonstrate compliance.

The results indicate that the maximum predicted 1-hour mean (98th percentile) odour concentration at the assessed sensitive receptors is less than 0.2 ou_E/m^3, which is below the H4 odour benchmark for the most offensive odours of 1.5 ou_E/m^3.

Based on the above assessment, it is concluded that the operation of the assessed OCUs is acceptable from an odour perspective. R14 is less than 10% of the benchmark and emissions from the site could roughly increase by 90% without exceeding 1.5 ou_E/m^3. Therefore, applying an emission limit value of 1,000 ou_E/m^3 may be overly conservative and result in unnecessary replacement of odour control media (with associated impact of carbon emissions/footprint /utilisation of raw materials.

6. References

ADM Ltd (2020). Hourly sequential meteorological data for Blackpool Airport meteorological station 2015-2019 [online] Further information available at: http://www.aboutair.com/met-data.htm.

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Department for Environment, Food and Rural Affairs (Defra) (2021). Environmental open-data applications and datasets. [online] Available at: http://uk-air.defra.gov.uk [Accessed September 2022].

Environment Agency, (2011). H4 Odour Management – How to comply with your environmental permit. [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296737/geho0411btqm-e-e.pdf. [Accessed September , 2022).

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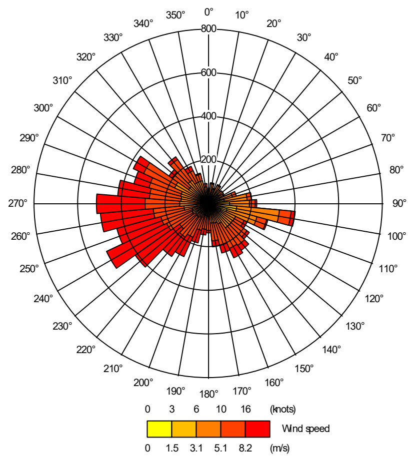
United Utilities (UU) (2022). Data and information provided to Jacobs via email communication, August 2022.

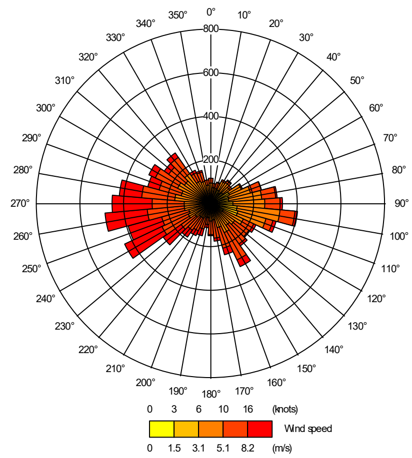
Appendix A. Meteorological Data – Wind roses

The wind roses for each year of meteorological data utilised in the assessment are shown below.

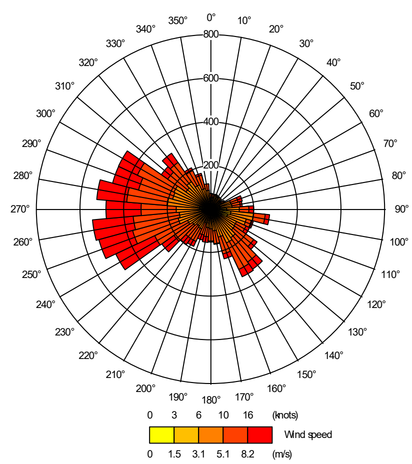
Blackpool Airport meteorological station, 2015



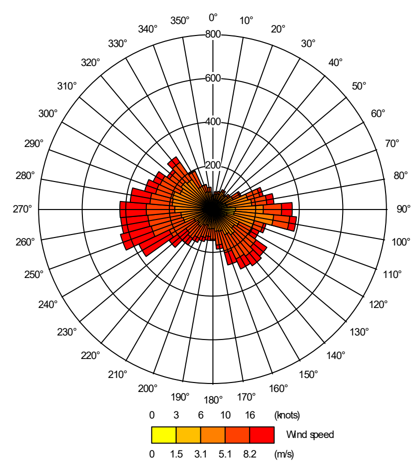
Blackpool Airport meteorological station, 2016



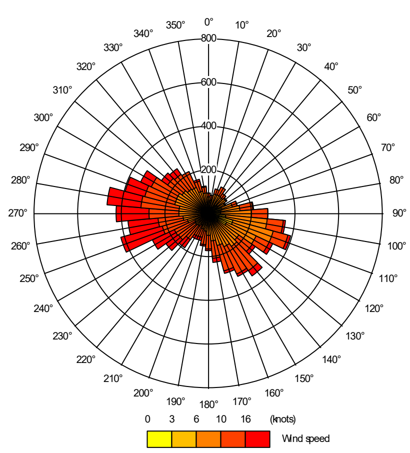
Blackpool Airport meteorological station, 2017



Blackpool Airport meteorological station, 2018



Blackpool Airport meteorological station, 2019



Appendix B. Modelled results

Table B-1. Full modelled results

Receptor	Description	Receptor sensitivity	Modelled 1-hour mean (98th percentile) odour concentrations (ou_E/m^3)					Year resulting in maximum predicted concentration
			2015	2016	2017	2018	2019	
R1	Bridleway	Low	0.11	0.13	0.11	0.11	0.13	2016
R2	Bridleway	Low	0.09	0.09	0.09	0.09	0.10	2019
R3	Bridleway	Low	0.04	0.04	0.05	0.05	0.05	2017
R4	Bridleway	Low	0.02	0.02	0.02	0.02	0.02	2017
R5	Residential property on Harrogate Way	High	0.00	0.01	0.01	0.01	0.00	2017
R6	Residential property on Harrogate Way	High	0.00	0.00	0.01	0.01	0.00	2017
R7	PRoW	Low	0.01	0.01	0.02	0.01	0.01	2017
R8	Commercial (warehouse)	Medium	0.01	0.01	0.01	0.01	0.01	2018
R9	Residential property on Ferryside Lane	High	0.01	0.01	0.01	0.01	0.01	2018
R10	Residential property on Eamont Avenue	High	0.01	0.01	0.01	0.01	0.01	2016
R11	Residential property on Crediton Avenue	High	0.02	0.02	0.01	0.02	0.02	2016
R12	Residential property on Bodmin Avenue	High	0.03	0.04	0.03	0.04	0.03	2018
R13	Residential property on Treen Close	High	0.05	0.07	0.04	0.06	0.06	2016
R14	Residential property on Exmoor Close	High	0.09	0.13	0.05	0.08	0.08	2016
R15	Residential property on Exmoor Close	High	0.09	0.10	0.06	0.08	0.08	2016
R16	Sports field	Low	0.08	0.09	0.09	0.09	0.08	2016

Appendix C. Figures

Figure 1: Approximate site fenceline, modelled emission sources, modelled buildings and sensitive human receptor locations

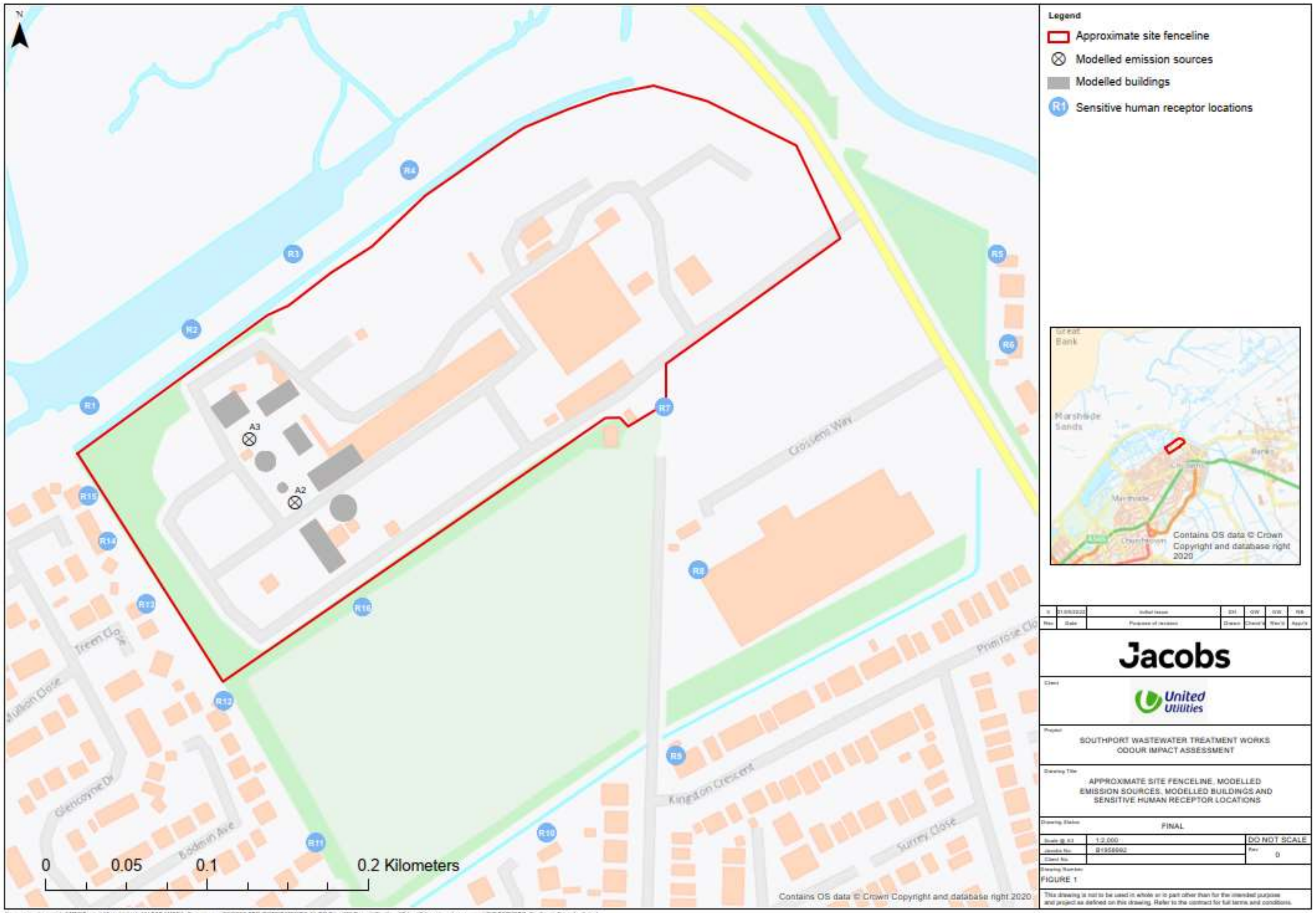


Figure 2: 1-hour mean (98th percentile) odour process contributions, 2016 meteorological data