Odour Impact Assessment – United Utilities Water Limited, Leigh

Document no: 1
Revision no: 1

United Utilities Water Limited

29 November 2022

Odour Impact Assessment - United Utilities Water Limited, Leigh

Client name:	United Utilities Water Limited		
Project name:	-		
Client reference:	-	**Project no:**	B27030BQ
Document no:	1	**Project manager:**	A Tarcsafalvi-Wilson
Revision no:	1	**Prepared by:**	D Howells
Date:	29 November 2022	**File name:**	Leigh Odour Assessment_v2

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0	30/09/2022	Draft for client review	D Howells	S Emmerton	G Wilson	A Tarcsafalvi-Wilson
1	29/11/2022	Amendments following client review	D Howells	G Wilson	G Wilson	A Tarcsafalvi-Wilson

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments

Jacobs U.K. Limited

7th Floor, 2 Colmore Square
38 Colmore Circus, Queensway
Birmingham, B4 6BN
United Kingdom

T +44 (0)121 237 4000
www.jacobs.com

Executive summary

Leigh Wastewater Treatment Works (WwTW) operated by United Utilities Water Limited (hereafter 'UU'), is located in the town of Leigh within the Metropolitan Borough of Wigan, Greater Manchester (WN7 3EY).

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Odour Impact Assessment (OIA) on behalf of UU to support an environmental permit application and assesses the potential impact of odour emissions from the on-site odour control unit (OCU) at the Leigh 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 of 1.5 ou_E/m^3. It should be noted 0.10 ou_E/m^3 predicted at R3 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 OCU is acceptable from an odour perspective.

Contents

Executive summary ..... **i**

1. Introduction **3**

1.1 Odour Regulation and Assessment 3

1.2 Objectives of the report 4

2. Odour Modelling **5**

2.1 Modelling software 5

2.2 Model limitations 5

3. Model Input Data **6**

3.1 Modelled receptor locations 6

3.2 Odour Sources 6

3.3 Modelled operational hours 7

3.4 Surface characteristics 7

3.5 Meteorological data 8

3.6 Output 8

4. Results **9**

5. Conclusion **11**

6. References **12**

Appendices

Appendix A. Meteorological Data – Wind roses **13**

Appendix B. Modelled results **14**

Appendix C. Figures **15**

Tables

Table 1. Modelled receptors **6**

Table 2. Point source odour parameters and emission rates **7**

Table 3. Building parameters **8**

Table 4. Predicted odour concentrations **9**

Table B-1. Full modelled results **14**

1. Introduction

Leigh Wastewater Treatment Works (WwTW), operated by United Utilities Water Limited (hereafter 'UU'), is located in the town of Leigh within the Metropolitan Borough of Wigan, Greater Manchester (WN7 3EY). The area surrounding the site generally comprises a mixture of residential, commercial and light industrial land use. Hope Carr Nature Reserve Local Wildlife Site is located adjacent to the southern boundary of the site.

Jacobs UK Limited (hereafter 'Jacobs') has carried out an Odour Impact Assessment (OIA) on behalf of UU to support the environmental permit application and assesses the potential impact of odour emissions from the on-site odour control unit (OCU) at the Leigh 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 250 m north from the Leigh WwTW OCU stack 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 OCU 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), one OCU emission source and associated odour emission parameters.

The objective of this report is to demonstrate that current operations at the site are compliant with the 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 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 Manchester Airport meteorological station (2015 – 2019, inclusive), which is considered to be a representative meteorological station to the Leigh WwTW (ADM Ltd, 2020). The wind roses are presented in Appendix A.
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 dispersion model was run to provide the odour concentration at the specific receptor locations.
6. 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 rate calculated.

3. Model Input Data

3.1 Modelled receptor locations

Sensitive human receptors have been identified at 15 locations within close proximity to the Leigh WwTW. These receptors comprise nearby residential properties, commercial and light industrial premises, a public right of way (PRoW) and a playing 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) from the OCU stack	Direction from the OCU stack	Description
	X	Y				
R1	366107	399303	High	0.33	NW	Residential property on Siddow Common
R2	366273	399254	Low	0.20	NNW	Playing field
R3	366313	399314	High	0.25	N	Residential property on Hope Carr Road
R4	366382	399167	Medium	0.11	NNE	Commercial premises
R5	366416	399131	Medium	0.10	NE	Commercial premises
R6	366699	399077	High	0.36	E	Residential property on Dakins Road
R7	366381	399021	Medium	0.06	SE	Commercial premises
R8	366441	398760	High	0.32	SSE	Residential property on Hope Carr Terrace
R9	366351	398958	Low	0.11	S	PRoW
R10	366280	398965	Low	0.12	SSW	PRoW
R11	366205	398993	Low	0.15	WSW	PRoW
R12	365770	398879	High	0.60	WSW	Residential property on Alder Close
R13	365786	399006	High	0.55	W	Residential property on Chestnut Lane
R14	365896	399218	High	0.46	WNW	Residential property on Charlock Close
R15	365991	399321	High	0.43	NW	Residential property on Pennington Road

Note 1: Receptors were modelled at a height of 1.5 m or 'breathing zone'.

3.2 Odour Sources

The location of the modelled odour source is 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	Location (X,Y)	Stack Height (m)	Stack diameter (m)	Efflux velocity (m/s)	Design air flow rate (m^3/s)	Temp. (K)	Odour conc (ou_E/m^3)	Odour release rate (ou_E/s)
A4	OCU 1	E 366335, N 399066	15.00	0.39	15.9	1.905	Ambient	1,000	1904.72

3.3 Modelled operational hours

The assessed emission source was 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 primarily a mixture of residential, commercial and light industrial, a surface roughness length of 0.6 m has been applied.

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				
Building 1	Rectangular	366304	399067	4.44	70.00	13.70	15.0
Building 2	Rectangular	366329	399088	4.10	11.30	6.00	16.0
Building 3	Rectangular	366337	399089	3.50	6.60	6.10	3.0
Building 4	Rectangular	366414	398964	10.00	123.00	38.70	166.0
Building 5	Circular	366322	399123	8.12	24.54	-	-

3.5 Meteorological data

Meteorological data from Manchester Airport have been used for this assessment. Manchester Airport meteorological station is located approximately 21.5 km southeast 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 were 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 odour concentrations at the assessed receptors for each individual year are presented in Appendix B. As discussed previously, the model output was 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 Leigh 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	Residential property on Siddow Common	High	0.05
R2	Playing field	Low	0.10
R3	Residential property on Hope Carr Road	High	0.10
R4	Commercial premises	Medium	0.15
R5	Commercial premises	Medium	0.13
R6	Residential property on Dakins Road	High	0.04
R7	Commercial premises	Medium	0.07
R8	Residential property on Hope Carr Terrace	High	0.03
R9	PRoW	Low	0.08
R10	PRoW	Low	0.10
R11	PRoW	Low	0.11
R12	Residential property on Alder Close	High	0.02
R13	Residential property on Chestnut Lane	High	0.03
R14	Residential property on Charlock Close	High	0.02
R15	Residential property on Pennington Road	High	0.04

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 0.10 ou_E/m^3, which is predicted at R3, representing a residential property on Hope Carr Road approximately 250 m north of the OCU stack location. It should be noted 0.10 ou_E/m^3 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. 2017). 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 on-site OCU at the Leigh 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 of 1.5 ou_E/m^3. R3 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 OCU is acceptable from an odour perspective.

6. References

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

Department for Environment, Food and Rural Affairs (Defra) (2010). Odour Guidance for Local Authorities Available at: https://www.gov.uk/government/publications/odour-guidance-for-local-authorities [Accessed September 2022].

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).

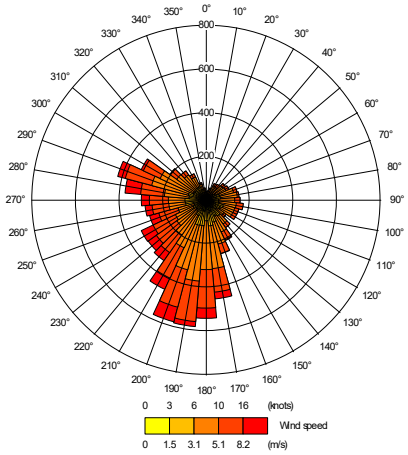
Google Earth (2022). [online]. Available at http://www.google.com/earth/index.html. [online] [Accessed September 2022)

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

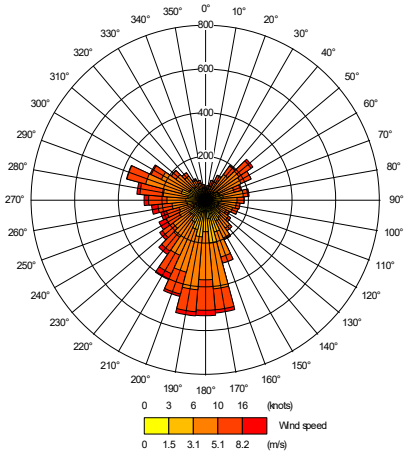
Appendix A. Meteorological Data – Wind roses

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

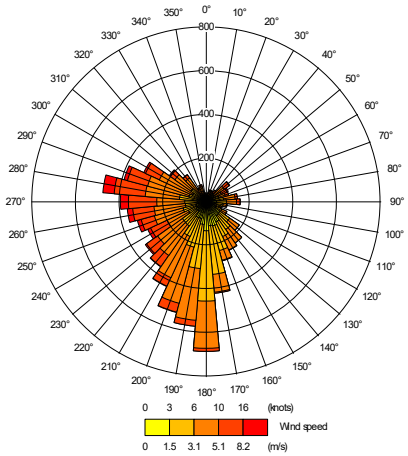
Manchester Airport meteorological station, 2015



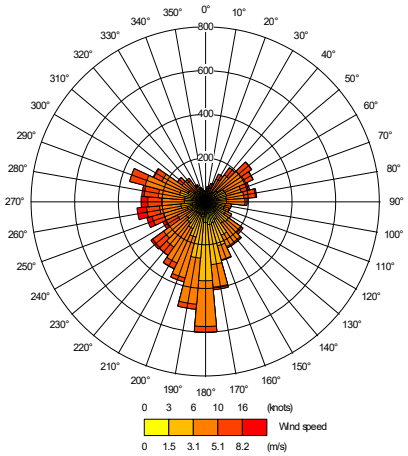
Manchester Airport meteorological station, 2016



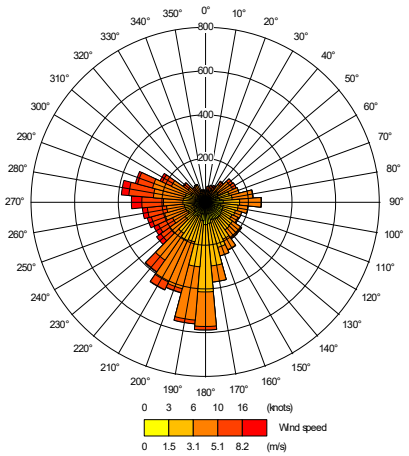
Manchester Airport meteorological station, 2017



Manchester Airport meteorological station, 2018



Manchester Airport meteorological station, 2019



Appendix B. Modelled results

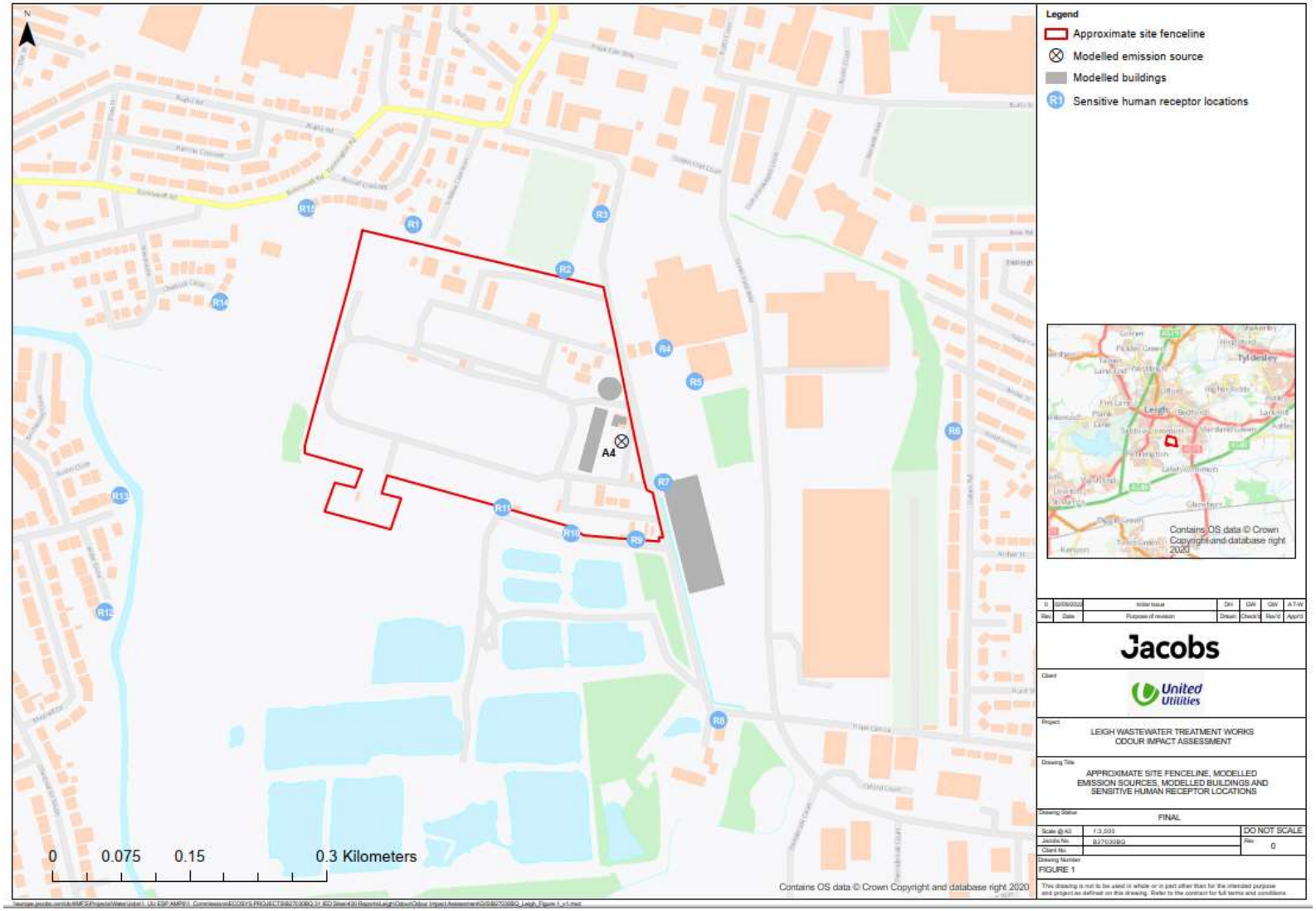
Table B-1. Full modelled results

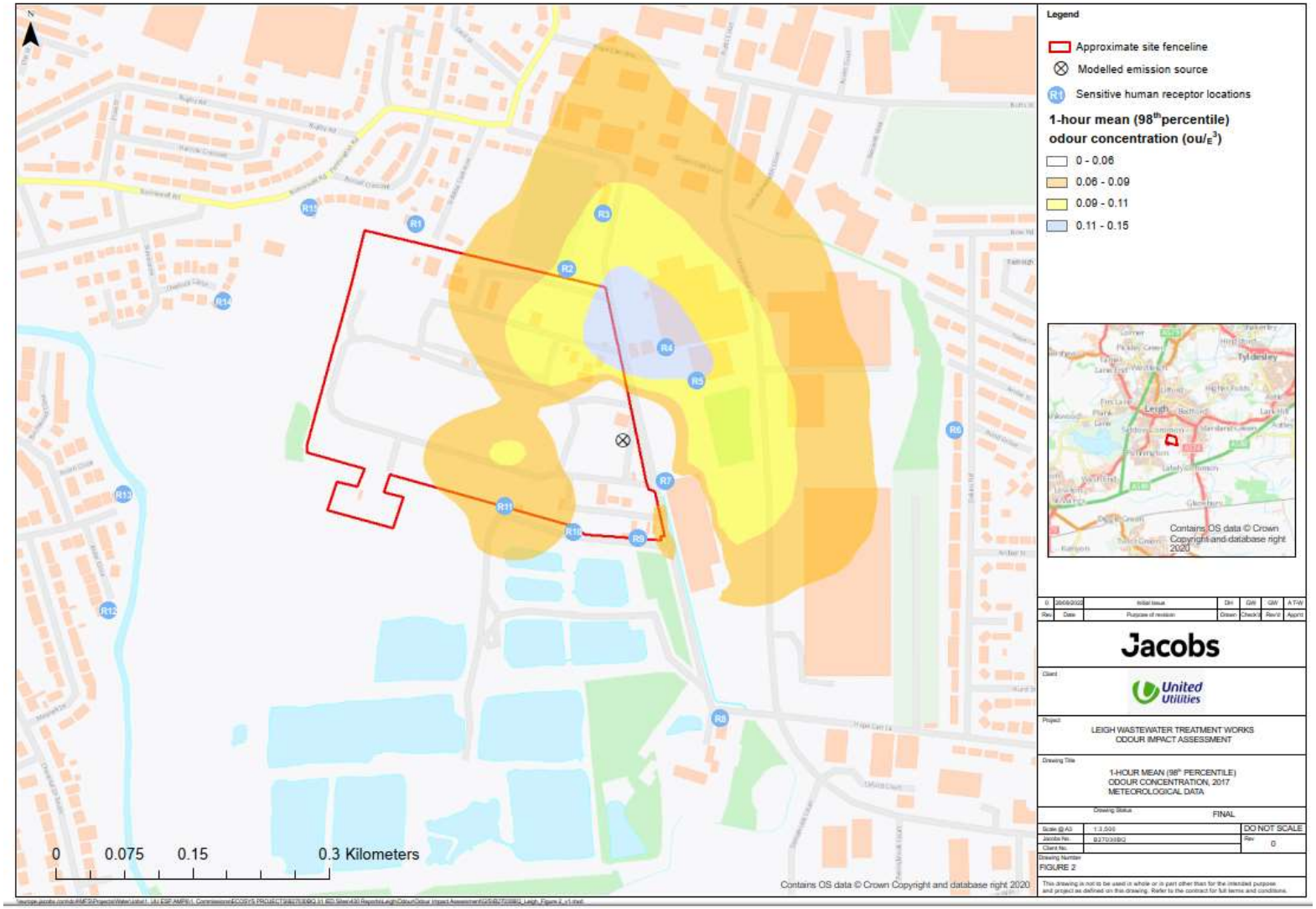
Receptor	Description	Receptor sensitivity	Modelled 1-hour mean (98th percentile) odour concentrations (ou_E/m^3)					Year resulting in maximum prediction concentration
			2015	2016	2017	2018	2019	
R1	Residential property on Siddow Common	High	0.04	0.04	0.05	0.05	0.05	2018
R2	Playing field	Low	0.09	0.10	0.10	0.09	0.10	2017
R3	Residential property on Hope Carr Road	High	0.07	0.08	0.10	0.09	0.09	2017
R4	Commercial premises	Medium	0.12	0.12	0.14	0.14	0.15	2019
R5	Commercial premises	Medium	0.11	0.11	0.12	0.13	0.13	2019
R6	Residential property on Dakins Road	High	0.04	0.04	0.04	0.04	0.04	2017
R7	Commercial premises	Medium	0.07	0.07	0.06	0.06	0.05	2015
R8	Residential property on Hope Carr Terrace	High	0.03	0.03	0.02	0.02	0.02	2016
R9	PRoW	Low	0.05	0.08	0.03	0.06	0.04	2016
R10	PRoW	Low	0.08	0.09	0.05	0.10	0.08	2018
R11	PRoW	Low	0.08	0.10	0.08	0.11	0.10	2018
R12	Residential property on Alder Close	High	0.02	0.02	0.01	0.02	0.02	2019
R13	Residential property on Chestnut Lane	High	0.02	0.02	0.02	0.02	0.03	2019
R14	Residential property on Charlock Close	High	0.02	0.02	0.01	0.02	0.02	2015
R15	Residential property on Pennington Road	High	0.02	0.02	0.03	0.04	0.03	2018

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 concentration, 2017 meteorological data


N
Legend
Approximate site fenceline
Modelled emission source
Modelled buildings
Sensitive human receptor locations
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
A4
0
0.075
0.15
0.3 Kilometers
Contains OS data © Crown Copyright and database right 2020
Contains OS data © Crown Copyright and database right 2020
Jacobs
United Utilities
LEIGH WASTEWATER TREATMENT WORKS
ODOUR IMPACT ASSESSMENT
APPROXIMATE SITE FENCELINE, MODELLED EMISSION SOURCES, MODELLED BUILDINGS AND SENSITIVE HUMAN RECEPTOR LOCATIONS
FINAL
DO NOT SCALE
FIGURE 1


Legend
Approximate site fenceline
Modelled emission source
Sensitive human receptor locations
1-hour mean (98th percentile) odour concentration (ou/E3)
0 - 0.06
0.06 - 0.09
0.09 - 0.11
0.11 - 0.15
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
0
0.075
0.15
0.3 Kilometers
Contains OS data © Crown Copyright and database right 2020
Contains OS data © Crown Copyright and database right 2020
Jacobs
United Utilities
LEIGH WASTEWATER TREATMENT WORKS
ODOUR IMPACT ASSESSMENT
1-HOUR MEAN (98th PERCENTILE)
ODOUR CONCENTRATION, 2017
METEOROLOGICAL DATA
FINAL
DO NOT SCALE
FIGURE 2