Saputo Dairy UK

DAVIDSTOW CREAMERY ENVIRONMENTAL PERMIT VARIATION – EPR/BN6137IK

Odour Impact Assessment

70053935-AQ2
FEBRUARY 2022

CONFIDENTIAL

Saputo Dairy UK

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CONTENTS

TABLES

APPENDICES

1 INTRODUCTION

1.1.1. WSP have been commissioned by Saputo Dairy UK, a trading name used by Dairy Crest Limited, to undertake an odour modelling assessment in relation to changes to site operations associated with the application for a variation to their existing environmental permit (*EPR/BN6137IK)* for the Davidstow Creamery in Cornwall.

1.1.2. Dairy Crest remains the named operator on the environmental permit. The sites address is:

Davidstow Creamery
Camelford
Cornwall
PL32 9XW

1.2 SITE LOCATION

1.2.1. The site, as shown in Figure 1 in **Appendix A**, is located approximately 88 km to the west of Exeter and 56 km to the north of Plymouth. The National Grid Reference (NGR) of the approximate centre of the creamery facility is SX13825 86588.

1.2.2. The site is located in a predominantly rural location, with the villages of Treworra and Trewassa situated in proximity to the onsite water processing facility (WPF). The nearest residential properties to the WPF are approximately 200 m to the north and northwest in Trewassa and 600 m to the east in Treworra.

1.2.3. The current installation boundary, shown in red in Figure 2 in **Appendix A**, includes the main creamery facility and the WPF, which is located approximately 1 km to the east of the creamery and is connected by a pipeline.

1.3 OVERVIEW OF EXISTING PERMIT & PERMIT VARIATION

1.3.1. The site is regulated by environmental permit reference *EPR/BN6137IK* under the *Environmental Permitting (England and Wales) Regulations 2016*, as amended. The original permit was issued in June 2006 and the permit has since been varied on eight occasions. Dairy Crest is now applying for an environmental permit variation in order to reflect a number of changes at the site, a number of which have already been implemented (as has previously been communicated to the EA), in order to drive operational improvements since the last operator-initiated permit variation was granted in 2014.

1.3.2. The site receives milk which is pasteurised and processed into cheese. Whey from the cheese making process is then used to manufacture whey cream and demineralised whey powder. The site also imports lactose powder which is processed to produce galacto-oligosaccharide (GOS), a prebiotic syrup. Process effluent which is generated during the manufacturing process is transported by pipeline and treated at the onsite WPF which incorporates primary, secondary and tertiary treatment. A proportion of the treated effluent is recycled back to the creamery for re-use via the water reuse plant (WRP) and the remainder is discharged to the River Inny.

1.3.3. With respect to odour, Condition 3.4 of the environmental permit states:

"*Emissions from the activities shall be free from odour at levels likely to cause pollution outside of the site, as perceived by an authorised officer of the Environment Agency, unless*

the operator has used appropriate measures, including, but not limited to, those specified in any approved odour management plan, to prevent or where that not practicable to minimise the odour.

The operator shall:

A) if notified by the Environment Agency that the activities are giving rise to pollution outside the site due to odour, submit to the Environment Agency for approval within the period specified an odour management plan (OMP) which identifies and minimises the risks of pollution from odour;

B) implement the approved odour management plan, from date of approval, unless otherwise agreed in writing by the Environment Agency."

1.3.4. The changes at the site included in this application for a permit variation include six creamery projects, predominantly designed to maximise the utilisation of the main raw material (milk), thus increasing the hourly (t/hr) production capacity for cheese, in addition to several changes as part of the redevelopment of the WPF. A number of the changes have already taken place over recent years; these have previously been communicated to the Environment Agency, but specific permit variation applications were not requested by the Environment Agency at the time they were implemented. Therefore, this current application seeks to address all relevant changes at the site, at both the creamery and the WPF, in order to bring the environmental permit up to date.

1.3.5. The redevelopment of the WPF forms the focus of this odour impact assessment, given that the main odour sources at the site are located at the WPF. As part of the permit variation, the changes and improvements at the WPF include:

- New contingency lagoon with extraction to an odour control unit (OCU) (note this is physically located at the creamery but forms part of the redevelopment of the WPF);
- Two new dissolved air flotation (DAF) units;
- Covering and extraction of existing balance tank (BT1) and divert tank to a new OCU;
- Upgrade to activated filter media (AFM) filtration tanks;
- Enclosure of sludge centrifuges and trailer; and
- Installation of an automated forward / divert solution for both cheese/whey and Demin/GOS.

1.4 SCOPE OF ASSESSMENT

1.4.1. Based on annual odour complaint records provided by Dairy Crest (2016-2020), there have been frequent and recurring odour complaints made by residents in the local area that are attributable to activities undertaken at the site. These complaints were predominantly received from residents within Trewassa, which is to the northeast of the Dairy Crest creamery site and to the northwest of the existing WPF; from Treworra, which is to the north-northeast of the existing WPF; and to a lesser extent Tremail, which is located to the east of the WPF.

1.4.2. The proposed redevelopment of the WPF, as per the application for a permit variation, will assist in reducing odour releases from the WPF and thereby the potential for complaints within the local area. As such, the scope of this assessment is to predict ground level odour concentrations within the local area, including within Trewassa and Treworra, based on the implementation of the changes and improvements at the WPF.

1.4.3. The odour impact assessment has been undertaken with the application of an atmospheric dispersion model, using five years of hourly sequential meteorological data and odour emissions data obtained from baseline surveys carried out between 2019 and 2021 inclusive by Olfasense UK Ltd (see Section 4 Assessment Methodology).

1.4.4. The results of the dispersion modelling assessment have been compared with appropriate benchmark criteria to establish the potential for odour impacts at identified sensitive receptors in the local area. Furthermore, the results are compared to the equivalent outputs from a modelling assessment completed for Dairy Crest in 2017[1] based on observed emissions at that time and prior to the recent improvement works included in the permit variation. This comparison is used to demonstrate the effect (positive or otherwise) of the changes and improvements at the WPF on ambient odour levels within the local area.

1.4.5. All figures referenced within this document are contained within **Appendix A**.

[1] H&M Environmental Ltd (May 2017) Dairy Crest WwTW Odour Modelling

2 REGULATORY CONTEXT AND BENCHMARKS

2.1 ODOUR

2.1.1. Most odours comprise a mixture of chemicals and the perception of odour by any individual, which can be found to be acceptable, objectionable or offensive, is highly subjective to that individual. For an odour to have an adverse effect, exposure to an odour must exist, which requires an established source-pathway-receptor chain to be present:

- *Source of emissions* – a means for the odour to be emitted into the atmosphere;
- *Pathway* – required for the odour to travel through the air to locations off site, with an increased length of pathway (e.g. emitting from a high stack) and/or anything that increases dilution and dispersion of the emission as it travels from source to receptor typically resulting in reduced exposure at the receptor;
- *Receptor* – a person or people that could experience an adverse effect, dependent on sensitivity and subjective perception of the odour.

2.1.2. Exposure to odour can lead to adverse effects such as loss of amenity, annoyance, nuisance and possibly complaints. The technical differences between annoyance and nuisance are outlined as follows[2]:

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

2.1.3. It is important to note that 'nuisance' is also a term in law (e.g. Statutory Nuisance). The legal use of Nuisance precedes the above technical definition, which has only relatively recently been put forward and generally accepted[2]. The definition of Statutory Nuisance in relation to odour is provided in section 79(1) of the *Environment Protection Act 1990,* stating "…*any dust, steam, smell or other effluvia arising on industrial, trade or business premises and being prejudicial to health or a nuisance*."

2.1.4. The EPA 1990 contains no technical definitions of nuisance, such as maximum concentrations, frequencies or durations of odour in air. Hence, the decision as to whether a legal Nuisance is being caused is only determined by the Court.

2.2 REGULATION OF ODOUR

2.2.1. Odour 'pollution' from regulated industries is controlled through the *Environmental Permitting (England and Wales) Regulations 2016*, as amended (herein referred as the 'EPR'). Pollution is defined by the EPR as being '…*an emission which may be harmful to human health or the quality of the environment, cause offence to a human sense or impair or interfere with amenities or other legitimate uses of the environment*'.

2.2.2. The Dairy Crest facility has been issued with an environmental permit (*EPR/BN6137IK*) as a Part A1 installation, whereby ongoing pollution control of site operations are regulated by the Environment Agency (EA) under the EPR which implements the requirements of the Industrial Emissions Directive (IED).

[2] Institute of Air Quality Management (July 2018) Guidance on the assessment of odour for planning

2.2.3. Any permit the EA issues for the Dairy Crest site will contain conditions requiring the operators to apply Best Available Techniques (BAT) and implement appropriate measures such as an Odour Management Plan (OMP) to minimise odour.

2.2.4. The EA may then issue enforcement notices on the operators, to obtain information and legally require steps to be taken to address any non-compliances associated with the permitted site operations.

Exposure Criteria for Odour

2.2.5. There are no statutory limits in England and Wales for ambient odour levels in units of odour concentrations. However, there are guideline limits and custom and practice standards have been used for different applications.

Environment Agency Technical Guidance H4 Odour Management

2.2.6. The EA's Horizontal Guidance document – H4 Odour Management[3] – is designed to help permit holders understand how to apply, vary and comply with their permits and cover regulatory requirements with regard to odour, advice on the management of odour and the information that should be provided in an OMP.

2.2.7. The H4 Guidance proposes industry-specific exposure benchmarking for the assessment and indication of unacceptable odour pollution, on the basis that not all odours are equally offensive, and not all receptors are equally as sensitive.

2.2.8. Appendix 3 of the H4 Guidance document provides benchmark exposure levels to help form a judgement of unacceptable pollution. The benchmarks are based on the 98th percentile (C_{98}^{th}) of hourly average odour concentrations (measured as European odour units per cubic metre, OU_E/m^3) modelled over a year at the site/installation boundary and are presented in Table 2-1.

Table 2-1 Environment Agency H4 Benchmark Odour Criteria

Criterion (C_{98}^{th} OU_E/m^3)	Offensiveness	Odour Emission Sources
1.5 OU_E/m^3	*Most offensive*	Processes involving decaying animal or fish remains; Processes involving septic effluent or sludge; Biological landfill odours.
3 OU_E/m^3	*Moderately offensive*	Intensive livestock rearing; Fat frying (food processing); Sugar beet processing; Well aerated green waste composting.
6 OU_E/m^3	*Less offensive*	Brewery; Confectionary; Coffee roasting.

CIWEM Policy Position Paper

2.2.9. In consideration of an appropriate assessment criterion to determine potential odour impacts, the Chartered Institution of Water and Environmental Management (CIWEM), in their Policy Position Paper[4], state:

[3] Environment Agency (2011) H4 Odour Management odour guidance - How to comply with your environmental permit

[4] Chartered Institution of Water and Environmental Management (Sept 2012) Policy Position Paper: Control of Odour

"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}^{th} OU_E/m^3 more than 10 OU_E/m^3 – complaints are highly likely and odour exposure at these levels represents an actionable nuisance;*
- *C_{98}^{th} OU_E/m^3 of hourly average concentrations more than 5 OU_E/m^3, – complaints may occur and depending on the sensitivity of the locality and nature of the odour this level may constitute a nuisance; and*
- *C_{98}^{th} OU_E/m^3 less than 3 OU_E/m^3, – complaints are unlikely to occur and exposure below this level are unlikely to constitute significant pollution or significant detriment to amenity unless the locality is highly sensitive or the odour highly unpleasant in nature."*

Odour Benchmark for Dairy Crest Study

2.2.10. Odours from wastewater treatment can vary between the *moderately offensive* and *most offensive* benchmark categories, as defined by the EA (see Table 2-1).

2.2.11. Whilst no specific standards exist for the releases of odour from wastewater treatment, a common guideline value is that the short-term average concentration of odour above five times the detection threshold can be considered as having the potential to cause annoyance[5] (5 OU_E/m^3). In addition, epidemiological studies[6] and planning precedent have established that odour complaints are rarely observed at residential receptor locations for odour levels below 5 OU_E/m^3, modelled as C_{98}^{th} OU_E/m^3.

2.2.12. It is not certain, however, whether this criterion is applicable to this study. In particular, available data generally relate to existing populations and processes, which may, to a degree and across the population of average, have become de-sensitised to odour emissions. New residents of developments in proximity to wastewater treatment may be more sensitive to odours and/or have tendency to make complaint.

2.2.13. Given the history of odour complaints received in relation to the Dairy Crest WPF (see Section 1.4) and that the WPF processes involve the handling of sludge, **the appropriate assessment benchmark for this study is 1.5 OU_E/m^3, modelled as C_{98}^{th} OU_E/m^3 at the nearest identified sensitive receptor, which is equivalent to the criterion given by EA guidance for 'most offensive' odours.**

2.2.14. This means that an odour concentration of 1.5 OU_E/m^3 should not be exceeded for more than 2% of the hours in a year at any sensitive receptor outside of the site boundary (equivalent to approximately 175 hours per annum).

[5] Valentin, F.H.H. and North, A.A. (1980). Odour Control – a concise guide. Department of the Environment.
[6] Miedema., H.M.E., Walpot, J.I, Vos, H., Steunenberg, C.F. (2000). Exposure-annoyance relationships for odour from industrial sources. Atmospheric Environment 34, 2927-2936

3 LOCAL ENVIRONMENT

3.1 EXISTING ODOUR SOURCES

3.1.1. The land use surrounding the Dairy Crest creamery and WPF is predominantly rural and agricultural, with a low population density. Whilst there is potential for seasonal and/or intermittent odour releases from local farming practices, the predominant source(s) of odour within the local area is the Dairy Crest facility.

3.1.2. Based on five years of hourly sequential meteorological data obtained from Cardinham weather station, the prevailing winds within the region of the Dairy Crest facility are from the west-southwest, west and northwest (see **Appendix B**), with a secondary component from the southeast and relatively minor frequency of winds from the south and southwest. Given that the majority of odour complaints relating to Dairy Crest operations were received from residents in Trewassa to the northwest of the WPF and Treworra to the east-northeast, the wind frequencies from the southeast and west-southwest are responsible for transporting any odours from the WPF to the sensitive properties.

3.1.3. The odour modelling undertaken for this study does not include the measurement of odour generated from any external odour sources. However, the presence, or otherwise, of background odour sources should be considered with respect to any complaints received in relation to odour nuisance from the Dairy Crest facility.

4 ASSESSMENT METHODOLOGY

4.1 OVERVIEW

4.1.1. Odour is often transitory, though if intense or offensive can have a residual impact. Emissions from specific odour sources can vary significantly and are dependent on both process temperature and ambient air temperature, atmospheric conditions including wind speed, wind direction and atmospheric pressure.

4.1.2. As such, the approach taken to the assessment of odours for this study has been to derive odour emission rates for each respective source primarily based on site-specific monitoring and, where necessary, to review the previous odour modelling study completed for the Dairy Crest creamery and WPF in 2017[1]. These data have been used as key inputs to an atmospheric dispersion modelling program, along with hourly sequential meteorological data over a five-year period, to assess the impact of odours associated with emissions from the Dairy Crest creamery and WPF within the identified model domain.

4.2 DAIRY CREST ODOUR MONITORING SURVEYS (2019-2021)

4.2.1. An odour monitoring survey at the Dairy Crest creamery and WPF was conducted by Olfasense UK Ltd over a three-day period from the 20th to 22nd April 2021[7]. This survey captured the influence of a number of the WPF improvement works that are included within the permit variation, specifically those completed in 2020, comprising:

- New contingency lagoon with extraction to an odour control unit (OCU) (note this is physically located at the creamery but forms part of the redevelopment of the WPF);
- Two new dissolved air flotation (DAF) units;
- Covering and extraction of existing balance tank (BT1) and divert tank to a new OCU; and,
- Partial enclosure of sludge centrifuges and trailer.

4.2.2. However, to account for the inherent variability in odour emissions (e.g. daily/seasonal variability) associated with wastewater treatment and the relative short-term duration of the survey period, respective odour emission surveys from earlier years (March 2019[8] and May 2020[9]) have also been accounted for in this assessment as described below.

4.2.3. Unless otherwise stated, an average odour emission rate has been derived based on Olfasense's 2019-2021 survey results for all area emissions sources at the WPF. Odour emissions sources at the Dairy Crest creamery were not surveyed in 2019 and 2020, therefore the assessment of odour from these sources are based on 2021 survey results only. The results of the odour survey(s) were used within the dispersion modelling to assess the odour concentrations associated with the site.

4.2.4. Each of the surveys reported in 2019-2021 were conducted using Olfasense's UK accreditation services (UKAS) accredited procedures, which fully conform with the requirements of the

[7] Olfasense Ltd (July 2021) Odour survey at the WPF and Calcium Phosphate Plant at Saputo Dairy UK, Davidstow
[8] Olfasense Ltd (May 2020) Odour survey of the WwTW at Dairy Crest Davidstow, Cornwall
[9] Odournet (March 2019) Odour survey of the WwTW at Dairy Crest Davidstow, Cornwall

international standard ISO 17025:2005[10] and the European standard for olfactometry BS EN 1375:2003[11].

4.2.5. The results of the odour survey(s) were used to derive odour emission estimates for each source. The emission estimates were used in combination with details of the dimensions, physical characteristics, and operation of each source to estimate the odour emissions from each area of the creamery and WPF. These data were used to generate a breakdown of the odour emissions generated from each aspect of the process under the current operational conditions.

4.2.6. Details of the odour emission sources captured by the survey are summarised in Table 4-1. The odour emission rates derived for each source, which were used in the dispersion modelling study, are covered in Section 4.3.

Table 4-1 Summary of odour sources included in 2019-2021 surveys

Area	Stage of Treatment	Source	Nature of odorous material / level of enclosure	Frequency / duration of release	No. of samples (each year)
WPF	Preliminary	Inlet well	Influent / open well	Continuous	3
		DAF units 1-3	Partially treated effluent / open units within buildings *		2 per unit
		Balance Tank 2	Partially treated effluent / open tank		3
	Primary	Anoxic Tanks 1-3	Partially treated effluent / open tanks		3 per tank (Tanks 2 & 3)
		Aeration Tanks 1a, 1b, 2 & 3	Aerated effluent / open tanks		2 per tank
	Sludge treatment & handling	RAS / WAS Chambers	Sludge / open wells		n/a**
		Bottom sludge pit	Sludge / open chamber		n/a^
		Top sludge pit	Sludge / open pit		3
		Sludge conveyor	Dewatered sludge / agitation	19 hours per day	n/a^^
		Sludge trailer	Dewatered sludge / open trailer	Continuous	3
	Odour Control	OCU (Balance Tank 1 & Divert tanks)	Treated emissions / vertical stack		3 at OCU outlet (based on 2021 survey)***
Main creamery (Calcium Phosphate Plant)	Primary	Open top buffer tank	Partially treated effluent / open tanks		3 (2021 only)
	Sludge treatment & handling	Flocculation tank	Partially treated effluent / open tanks		3 (2021 only)
		Sludge conveyor	Dewatered sludge / agitation	19 hours per day	n/a^^

[10] ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories.*
[11] BS EN 13725:2003, *Air quality - Determination of odour concentration by dynamic olfactometry*.

		Sludge trailer	Dewatered sludge / open trailer	Continuous	3 (2021 only)
	Odour control	OCU (storage lagoon)	Treated emissions / vertical stack		3 at OCU outlet (2021 only)

* DAF unit 3 not operational prior to 2021 survey and not currently enclosed but will be housed as part of improvement works associated with permit variation. DAF 2 doors were open during survey period. Discussion held between WSP and Saputo Dairy to confirm that doors will be closed as part of ongoing operation. Therefore, emissions from DAF 2 & 3 are assumed to be equivalent to DAF 1 as measured in 2021 survey[7] for purposes of this study.

** Returned Activated Sludge (RAS) and Waste Activated Sludge (WAS) chambers assumed to be equivalent to the emissions rate from Anoxic tank 2 (Olfasense UK, July 2021[7])

*** Based on 2021 survey[7], due to installation of acceleration cone in October 2020 and wet scrubber additive dosing system to the OCU in November 2020

^ Surveyed emissions from '*Top sludge pit*' used as proxy for bottom pit at WPF[7]

^^ Reference data taken from other facilities by Olfasense UK, 2021 report[7]

4.3 ATMOSPHERC DISPERSION MODELLING

Model Selection

4.3.1. The assessment of odorous emissions from the Dairy Crest creamery and WPF, inclusive of the WPF improvement works as part of the permit variation, has been undertaken using the latest version of ADMS (ADMS v5.2). This model was developed by Cambridge Research Consultants Ltd (CERC) and is used extensively throughout the UK for air quality modelling associated with permitted activities.

4.3.2. ADMS v5.2 is an advanced steady-state Gaussian atmospheric dispersion model used to model the impacts of emissions to air from industrial installations and can simulate the impacts of buildings, complex terrain, coastlines, and surface roughness variations on the dispersion of emissions. The model also allows emissions to be modelled from varying source types, including point (e.g., stack), line, area, and volume sources either at ground level or elevated above ground.

Model Domain & Sensitive Receptors

4.3.3. The model domain encompasses an area measuring 5 km x 3 km and captures the respective sources of odour at both the Dairy Crest creamery site and WPF (see '*Model Inputs*' below), which are separated by approximately 1 km, in addition to including locally sensitive areas such as Trewassa, Treworra, Davidstow, and Tremail. A Cartesian receptor grid was modelled across the study domain at a resolution of 50 m, which enabled odour contour plots to be generated for assessment against the benchmark criterion and comparison with the previous odour modelling study completed in 2017[1] (i.e., prior to improvement works).

4.3.4. In addition to the modelled grid area, a total of 42 discrete receptor locations were included in the model, comprising residential dwellings in proximity to the Dairy Crest creamery and WPF, particularly focussing on those receptors that are referenced in odour complaint logs held by Dairy Crest. Details of the discrete sensitive receptor locations are presented in Table 4-2 and depicted on Figure 3 along with the model domain extents.

4.3.5. All discrete and gridded receptor locations were modelled at 1.5 m above ground level (agl) to represent average breathing height.

Table 4-2 Modelled discrete receptor locations

Receptor ID	Name	Easting (m)	Northing (m)
R1	Treveth	213972.9	86776.8
R2	The Pines	215192.6	87231.5
R3	Trehane House	214598.1	87142.9
R4	Tremblary Cottage	215991.3	87445.2
R5	Trewinnow Bungalow	216462.4	86178.5
R6	Canapark	215619.6	86963.6
R7	45 Inny Vale	215836.5	86908.7
R8	Ivydene	215882.0	86825.9
R9	Fowey Bungalow	213996.8	86206.0
R10	Homeleigh	214044.8	86158.7
R11	Barn Park Bungalow	214134.4	86039.6
R12	Owls Gate, Treworra	215391.2	86524.2
R13	4 Lillipark	215358.8	86989.9
R14	Penmarrod	215444.1	86957.5
R15	St. Lawrence, Tremail	216082.4	86389.1
R16	Oxencombe, Tremail	216172.4	86529.9
R17	Bell View, Davidstow	215937.7	86271.9
R18	Hendawle Farm	215804.1	86086.0
R19	Higher Tremail Farm	215700.9	85712.0
R20	Butterwell, Davidstow	215202.2	85732.9
R21	Nettings Park, Davidstow	213631.2	86714.1
R22	Rose Tree Cottage, Davidstow	214267.4	86954.5
R23	Moor View Farm, Davidstow	214149.0	86910.7
R24	Newhouse, Davidstow	214139.0	86865.9
R25	Tresplatt Farm, Davidstow	213758.9	86969.4
R26	Wayside, Davidstow	213909.4	86833.5
R27	Victoria, Davidstow	213912.1	86819.3
R28	Moorcroft, Davidstow	213917.7	86801.3
R29	The Bungalow, Davidstow	213934.5	86783.0
R30	Barnpark Farm, Davidstow	214410.7	86311.8
R31	Greenwood Cottage, Trewassa	214716.3	86761.9
R32	Tremar Cottage, Trewassa	214683.2	86797.7
R33	Wicketts Cottage, Trewassa	214673.1	86791.2
R34	Greenvalley Bungalow, Trewassa	214739.9	86801.3
R35	Lowertown, Trewassa	214745.8	86866.4
R36	Manor Park, Trewassa	214654.2	86838.0
R37	Rest Holme, Trewassa	214598.9	86849.1
R38	Trewassa Flats	214535.0	86789.7
R39	Treworra Barton	215398.9	86612.9

Receptor ID	Name	Easting (m)	Northing (m)
R40	Nottles Park	213998.1	86404.7
R41	Old Forge Cottage	216191.0	86469.9
R42	St. Kitt's Farm	213407.0	86395.0

Model Inputs

Odour Sources & Emission Rates

4.3.6. The dispersion model has been used to predict odour concentrations across the model domain at each gridded receptor point and discrete receptor based on the current site layout at both the creamery and WPF, which accounts for the improvement works at the WPF as detailed in Section 4.2.

4.3.7. The modelled odour emission rates for each source surveyed by Olfasense (see Section 4.2), are provided in Table 4-3 along with the respective source dimensions and source type (e.g., point, area, volume) as represented in the model.

4.3.8. Where applicable, the WPF odour source emission rates data in Table 4-3 have been derived as an average of the surveyed emission rates for the relevant sources from the 2019-2021 surveys. A detailed table presenting the discrete survey results at each source from each of the 2019-2021 surveys[7,8,9] is given in **Appendix C**.

4.3.9. Further to these, there are some monitored and modelled odour sources at the creamery and WPF that were included in the 2017 assessment[1], but were not surveyed in the 2019-2021 surveys. Given that these sources are still operational, they have also been included in the model for completeness. The respective odour emission rates, source type, and dimensions for these sources are included in Table 4-3 and are based on the parameters reported in the 2017 assessment, which is appropriate given that there have been no changes to the associated plant that would affect them. Namely, these comprise:

- 2 x primary settlement tanks at WPF;
- Filtrate lamella at creamery site; and,
- Filtrate tank at creamery site.

4.3.10. All emissions source releases included in the model were assumed to be at ambient temperature (15 ^{o}C), with the exception of the OCU stacks, for which the modelled emissions parameters were based on the April 2021 survey[7]. Emissions from each modelled source were assumed to be released continuously for each hour of the year.

4.3.11. The modelled configuration of each odour source at the creamery and WPF is presented in Figure 4 (creamery) and Figure 5 (WPF), respectively, based on scaled site plans provided by Saputo Dairy UK.

Table 4-3 Odour emission rates for all modelled odour sources in ADMS v5.2

Area	Source	Model Source Type	Dimensions	Odour Emission Rate (Area $OU_E/m^2/s$; Vol. $OU_E/m^3/s$; Point OU_E/s)
WPF	Inlet well	Area	30 m^2; Ground level	29.5
	Balance Tank 2	Area	262 m^2; 6 m agl	45.1
	DAF 1	Volume	684 m^3; building height = 4.5 m agl	0.2
	DAF 2	Volume	531 m^3; building height = 4.5 m agl	0.3
	DAF 3 *	Volume	482 m^3; building height = 4.5 m agl	0.3
	Anoxic Tank 1	Area	50 m^2; 6 m agl	1.4
	Anoxic Tank 2	Area	28 m^2; 1 m agl	1.4
	Anoxic Tank 3	Area	28 m^2; 1 m agl	14.7
	Aeration Tank 1a	Area	492.5 m^2; 6 m agl	0.4
	Aeration Tank 1b	Area	492.5 m^2; 6 m agl	0.9
	Aeration Tank 2	Area	706 m^2; 5.6 m agl	0.4
	Aeration Tank 3	Area	227 m^2; 9 m agl	0.9
	Sludge Pit **	Area	53.5 m^2; 1 m agl	159.3
	Sludge Trailer & Conveyor *	Volume	68 m^3; 4 m agl	11.0
	RAS / WAS chambers	Area	7 m^2; Ground level	2.3
	OCU (Balance Tank 1 & Divert Tank)	Point [A]	0.25 m diameter; 10 m agl	1,970
	Settlement Tank 1 ^	Area	154 m^2; 3.5 m agl	0.7
	Settlement Tank 2 ^	Area	234 m^2; 3.5 m agl	0.5
Main creamery (Calcium Phosphate Plant)	Open top buffer tank	Area	28 m^2; 6 m agl	3.1
	Flocculation tank	Area	5 m^2; 4.5 m agl	113.0
	Sludge Conveyor	Area	8.5 m^2; 3.5 m agl	2.7
	Sludge Trailer	Area	35 m^2; 2.5 m agl	16.0
	OCU (storage lagoon)	Point [B]	0.6 m diameter; 4 m agl	2,017
	Filtrate Tank ^	Area	2.8 m^2; 1 m agl	20.8
	Filtrate Lamella ^	Area	7.6 m^2; 3.8 m agl	20.8

* Modelled within proposed building as part of improvement works. DAF 3 odour emissions assumed to be equivalent to DAF 1.

** Accounts for both top and bottom sludge pits.

^ Assumed to be as per source parameters reported in 2017 assessment[1], in absence of more recent monitoring data.

[A] Flow rate = 1.1 m^3/s; Exit velocity = 22.4 m/s; Temperature = 17.8 °C

[B] Flow rate = 0.4 m^3/s; Exit velocity = 1.4 m/s; Temperature = 14.3 °C

Meteorological Data

4.3.12. The assessment has utilised five years of hourly sequential meteorological data (2015-2019) from Cardinham Airfield, Bodmin. The weather station is located approximately 16.5 km to the south of Davidstow, providing data that is considered to be representative of conditions within the modelled domain.

4.3.13. The use of five years of data enabled a sensitivity test to be undertaken to identify the calendar year that represents the relative worst-case dispersion conditions with respect to predicted odour concentrations within the model domain (i.e., the year that predicts the highest concentrations overall). The year identified as representing relative worst-case dispersion conditions at each discrete receptor is that which has been used to report the results of the modelling assessment (see Section 5).

4.3.14. In each year of data used in the odour modelling assessment, the number of hours with calm winds (<0.75 m/s) is less than 1% of all hours modelled with the exception of 2016, where the number of calm hours equates to 1.7% of all hours.

4.3.15. By default, ADMS v5.2 does not model meteorological data for which the wind speed is classed as 'calm' (<0.75 m/s) at 10 m above ground level. However, calm winds can be represented using a specified option in the model, which enables the user to define a minimum wind speed at 10 m agl (U_{10}). For this assessment, U_{10} was set to 0.3 m/s, meaning that any wind speed lower than 0.3 m/s was increased to U_{10}, with the model adjusting friction velocity and surface heat flux accordingly. Model default values were applied with respect to the 'wind speed at 10 m agl for radial solution' (0.5 m/s) and the 'parameter for critical wind' (1.0 m/s), which are parameters required to define the behaviour of the model.

4.3.16. Wind rose plots for each year of hourly data are presented in **Appendix B**.

Treatment of Terrain

4.3.17. Complex terrain data were obtained from the Ordnance Survey OS Terrain 50 website[12]. The data is available for 10 km by 10 km tiles, with a 50 m resolution. The data were manipulated for input into the ADMS model as per CERC Guidance[13], allowing a three-dimensional flow and turbulence field to be applied to the dispersion modelling calculations (e.g., accounting for the influence of hills on wind flow and turbulence).

4.3.18. The terrain data applied to the model are visualised in Figure 6.

Treatment of Buildings

4.3.19. Scaled drawings[14] provided by Dairy Crest for the creamery site and WPF were used to input existing and proposed building structures, which may impact the dispersion of emissions from the OCU stacks (i.e., point sources). Buildings in proximity to a point source have the potential to entrain pollutants (odour) into the region in the immediate leeward side of the building, thereby increasing ground level concentrations nearer to the source ('building downwash') and thus resulting in decreased concentrations further away.

[12] Ordnance Survey (2017) *OS Terrain 50* [online] Accessed via https://www.ordnancesurvey.co.uk/business-and-government/products/terrain-50.html Accessed on 28/04/20

[13] Cambridge Environmental Research Consultants (2017) *Note 11: Setting up terrain data for input into CERC Models*

[14] Norder Consulting - Drawings 8394-NDA-ST-XX-DR-A-1001-P2 and 7974-NDA-ST-XX-DR-A-1005

4.3.20. The dimensions for buildings in proximity to each OCU stack, as represented within the model, are presented in Table 4-4 and depicted in Figure 7.

4.3.21. It is only possible to model the effect of buildings on dispersion from point sources within ADMS v5.2. As such, the effect of buildings in proximity to the modelled area and volume sources has not been modelled.

Table 4-4 Dimensions of buildings included in model at Dairy Crest creamery and WPF

Building	Centre Coordinates (m)		Height (m)	Length / Diameter (m)	Width (m)	Angle (deg)
	X	Y				
Balance Tank 1*	214856.0	86579.0	6.0	21.9	Circular	
Divert Tank	214835.8	86572.2	5.5	13.2	Circular	
Aeration Tank 2	214906.9	86591.9	5.6	33.3	Circular	
DAF 1	214841.1	86546.1	4.5	10.5	14.5	101.9
DAF 2	214872.2	86578.12	4.5	7.5	16.0	100.0
DAF 3	214878.3	86589.6	4.5	14.5	7.5	98.7
Creamery Main^	213858.7	86474.5	20.0	28	60	329.1

* Assigned as 'main building' in ADMS for the WPF OCU stack. ^ Assigned as 'main building' in ADMS for the creamery storage lagoon OCU stack

Model Outputs

4.3.22. The dispersion model has been used to provide a statistical analysis of the predicted odour concentrations that are likely to occur within the model domain for each modelled meteorological year. In accordance with EA guidance[3], odour concentrations have been presented as the $C_{98}{}^{th}$ OU_E/m^3 of all hourly mean concentrations over a calendar year at each receptor point, both discrete and gridded, for comparison with the assessment benchmark criterion (1.5 OU_E/m^3).

4.4 LIMITATIONS AND ASSUMPTIONS

4.4.1. Uncertainty in odour modelling, as in all modelling, arises as a consequence of a combination of the uncertainties in the input data and the assumptions necessary in the modelling process. This section outlines the potential limitations associated with the dispersion modelling assessment and any assumptions made.

4.4.2. Given that some of the improvement works included in the permit variation application have been incrementally implemented prior to 2021, the odour emission rates applied in this modelling exercise are primarily based on sampling undertaken over separate three-day periods in March 2019, May 2020, and April 2021. In addition, there are expected to be natural seasonal fluctuations in the emission rates of odour, particularly with respect to the influence of ambient temperature changes. Variations in wastewater flow from the Dairy Crest facility throughout the day could also influence the emission rate from certain sources, as do variations in operation of the WPF such as sludge age and sludge pit inventory. As such, where

applicable, the odour emission rates included in this dispersion modelling study are based on an average of the surveyed odour emissions from each year of sampling (2019-2021).

4.4.3. As all emissions sources operate continuously within the creamery and WPF, the odour emission rates presented in Table 4-3 have been applied to each hour of the modelled year.

4.4.4. Odour emissions sources at the Dairy Crest creamery were not surveyed in 2019 and 2020, therefore the assessment of odour from these sources are based on 2021 survey results only. Similarly, there are some monitored and modelled odour sources at the creamery (filtrate lamella and filtrate tank) and WPF (two primary settlement tanks) that were included in the 2017 assessment[1], but were not surveyed in the 2019-2021 surveys. Given that these sources are still operational, they have also been included in the model for completeness. The respective odour emission rates, source type, and dimensions for these sources are included in Table 4-3 and are based on the parameters reported in the 2017 assessment.

4.4.5. Other assumptions applied to the modelling of odour emissions from the WPF are outlined below:

- DAF unit 3 was not operational prior to the 2021 survey and is not currently enclosed but will be housed as part of the improvement works associated with the permit variation; During the 2021 survey, DAF 2 building doors were open, resulting in anomalously high surveyed odour emissions. Discussions held between WSP and Saputo Dairy as part of this study confirmed that DAF 2 doors will be closed as part of the ongoing operation. Therefore, emissions from DAF 2 and DAF 3 are assumed to be equivalent to DAF 1 for the purposes of this study, based on the 2021 odour survey[7];
- Due to the installation of an acceleration cone in October 2020 and a wet scrubber additive dosing system in November 2020 to the WPF OCU, odour emissions from the OCU are based on the 2021 survey only[7];
- The sludge trailer is currently only partially enclosed but will be housed as part of the improvement works associated with the permit variation. As such, this source has been modelled as a volume source for the purposes of this assessment; and,
- The surveyed emissions from the 'top sludge pit' have been used as a proxy for the bottom pit, based on all surveys completed in 2019-2021 inclusive. Similarly, surveyed emissions from anoxic tank 2 over the same period are assumed to be equivalent to the RAS/WAS chambers.

4.4.6. The use of five years data can be considered to represent the majority of adverse meteorological conditions that would be experienced during the operation of the facility. Results from each year are reported in Section 5 Odour Assessment Results for each discrete receptor.

4.4.7. In general, dispersion models have difficulty in accurately predicting dispersion under light wind speeds (i.e., less than 1 m/s) due to the dominance of physical processes other than advection and or turbulent diffusion under such conditions. However, as outlined in Section 4.3, the ADMS v5.2 model includes an option to be able to model 'calm' winds (<0.75 m/s), thereby reducing the number of hours in each year that are excluded from the modelling assessment.

4.4.8. The inability of dispersion models to accurately predict the minimum mixing height is another limiting factor of dispersion modelling and is particularly important when dealing with low level, non-buoyant (or low buoyancy) emission sources such as those present at the Dairy Crest creamery and WPF. For this study, the minimum atmospheric mixing height, specifically

referred to as the ‘minimum Monin-Obukhov length’, was assumed to be 5 m throughout the model domain and reflects the relative stability of low-level atmospheric conditions in rural areas relative to urban areas. Similarly, a surface roughness length of 0.5 m was modelled throughout the model domain, representative of rural land uses with relatively limited significant protrusions at the surface, whilst also accounting for some significant protrusions within the Dairy Crest creamery and WPF itself (i.e., buildings and sources). The same values for these parameters were applied to the weather station site (Cardinham Airfield).

5 ODOUR ASSESSMENT RESULTS

5.1 DISCRETE SENSITIVE RECEPTORS

5.1.1. The maximum predicted C_{98}^{th} OU_E/m^3 of all hourly mean concentrations at each of the discrete sensitive receptors identified within the model domain are presented in Table 5-1, based on the operation of the site with the implementation of the improvement works.

5.1.2. The maximum C_{98}^{th} values presented for each receptor are based on ground level predictions from each of the modelled five years of hourly sequential meteorological data (2015-2019).

Table 5-1 Modelled C_{98}^{th} odour concentrations for each year (2015-2019) at each discrete sensitive receptor

Receptor	Annual C_{98}^{th} Odour Concentration (OU_E/m^3)					Maximum C_{98}^{th} (OU_E/m^3)
	2015	2016	2017	2018	2019	
R1	0.2	0.2	0.2	0.2	0.2	0.2
R2	0.2	0.2	0.3	0.2	0.3	0.3
R3	0.2	0.2	0.2	0.3	0.3	0.3
R4	0.1	0.1	0.1	0.1	0.1	0.1
R5	0.1	0.2	0.2	0.1	0.1	0.2
R6	0.2	0.3	0.3	0.2	0.3	0.3
R7	0.2	0.2	0.3	0.2	0.2	0.3
R8	0.1	0.2	0.3	0.2	0.2	0.3
R9	0.2	0.3	0.3	0.3	0.3	0.3
R10	0.2	0.3	0.2	0.3	0.2	0.3
R11	0.1	0.2	0.1	0.2	0.1	0.2
R12	0.5	0.6	0.7	0.4	0.4	0.7
R13	0.2	0.3	0.4	0.3	0.3	0.4
R14	0.2	0.3	0.3	0.3	0.3	0.3
R15	0.1	0.2	0.2	0.1	0.1	0.2
R16	0.1	0.1	0.1	0.1	0.1	0.1
R17	0.1	0.2	0.2	0.2	0.1	0.2
R18	0.1	0.2	0.2	0.2	0.1	0.2
R19	0.1	0.1	0.1	0.1	0.1	0.1
R20	0.1	0.2	0.2	0.2	0.2	0.2
R21	0.1	0.2	0.2	0.2	0.2	0.2
R22	0.2	0.3	0.3	0.3	0.3	0.3
R23	0.2	0.2	0.2	0.2	0.3	0.3
R24	0.2	0.3	0.2	0.2	0.2	0.3
R25	0.1	0.1	0.1	0.1	0.2	0.2
R26	0.1	0.2	0.2	0.2	0.2	0.2
R27	0.1	0.2	0.2	0.2	0.2	0.2
R28	0.1	0.2	0.2	0.2	0.2	0.2

Receptor	Annual C_{98}^{th} Odour Concentration (OU_E/m^3)					Maximum C_{98}^{th} (OU_E/m^3)
	2015	2016	2017	2018	2019	
R29	0.1	0.2	0.2	0.2	0.2	0.2
R30	0.3	0.4	0.3	0.4	0.3	0.4
R31	0.9	1.2	1.1	1.4	1.5	**1.5**
R32	0.7	0.9	0.8	1.1	1.2	1.2
R33	0.7	1.0	0.8	1.1	1.3	1.3
R34	0.8	0.9	0.9	1.2	1.2	1.2
R35	0.6	0.6	0.7	0.9	0.9	0.9
R36	0.5	0.7	0.6	0.9	0.9	0.9
R37	0.5	0.6	0.6	0.8	0.8	0.8
R38	0.5	0.7	0.5	0.6	0.7	0.7
R39	0.3	0.5	0.5	0.4	0.4	0.5
R40	0.5	0.7	0.7	0.5	0.5	0.7
R41	0.1	0.1	0.2	0.1	0.1	0.2
R42	0.1	0.1	0.1	0.1	0.1	0.1
Benchmark	**1.5**					

5.1.3. The results of the odour assessment demonstrate that the benchmark criterion is not predicted to be exceeded at any location throughout each of the five years modelled.

5.1.4. However, the maximum modelled C_{98}^{th} odour concentration, predicted for the 2019 meteorological data at R31 (Greenwood Cottage, Trewassa) is equal to the benchmark criterion (1.5 OU_E/m^3). The modelled C_{98}^{th} concentrations at R31 for all other modelled years are below the criterion, ranging from 0.9 to 1.4 OU_E/m^3. Receptor R31 is located approximately 205 m to the northwest of the Dairy Crest WPF, representing the closest sensitive receptor to the WPF site.

5.1.5. With the exception of receptors R31-R34 inclusive, which are located within Trewassa to the northwest of the WPF, all other modelled discrete sensitive receptors are not predicted to experience a C_{98}^{th} concentration above 1.0 OU_E/m^3 in any of the modelled years.

5.1.6. The majority of odour complaints received between 2016 and 2020 were from residents within Trewassa and Treworra. The results of the dispersion modelling are shown to be highest within the same areas, particularly within Trewassa as stated above (R31-R38 inclusive) and also within Treworra (R12 and R39). This comparison demonstrates that the dispersion model performance verifies well with the location of odour complaints.

5.2 CARTESIAN RECEPTOR GRID

5.2.1. Odour contour plots, depicting the spatial distribution of modelled C_{98}^{th} odour concentrations throughout the model domain and for each modelled year, are presented in Figures 8 to 12, respectively, in **Appendix A**.

5.2.2. Based on the contour plots, in combination with the discrete receptor modelling presented in Table 5-1, it is evident that the highest C_{98}^{th} odour concentrations in sensitive areas outside of the site occur within Trewassa in each of the modelled meteorological years (2015-2019). This is consistent with the odour complaints history, where the majority of complaints between 2016 and 2020 were received from properties within Trewassa.

5.2.3. However, the contour plots confirm that the 1.5 Ou_E/m^3 benchmark criterion is not exceeded in any of the modelled years at any sensitive location. Of the years modelled, 2019 meteorological data exhibits the highest predicted concentrations, thus representing the worst case meteorological conditions with respect to the dispersion of odour releases from the WPF and potential impacts at sensitive receptors within Trewassa.

Comparison with 2017 Baseline Odour Modelling Study

5.2.4. The odour contour plots presented in **Appendix A** have been used as a basis to compare the results of this assessment with the equivalent outputs from the modelling assessment completed for Dairy Crest in 2017[1]. The 2017 assessment was based on observed emissions at that time and prior to the recent improvement works included in the application for a permit variation, which are represented in this assessment. The relevant 2017 odour contour plot is presented as Figure 13 in **Appendix A**.

5.2.5. It is evident from comparing the 2017 plot to each of the plots relating to this assessment that the improvement works implemented for the Dairy Crest creamery and WPF site are expected to significantly reduce odour emissions and associated impacts at identified sensitive receptors.

5.2.6. In the 2017 assessment, all receptors within Trewassa were shown to exceed both the benchmark criterion (1.5 Ou_E/m^3) and the 3 Ou_E/m^3 criterion, with the majority of properties within the hamlet also exceeding 5 Ou_E/m^3 as the C_{98}^{th} value. Based on reviewing Figure 13 and in the absence of discrete modelling of receptors, the modelled concentration at the equivalent location for R31 in Trewassa was close to the 10 Ou_E/m^3 contour line. The benchmark criterion was also shown to be exceeded in Treworra and parts of Davidstow.

5.2.7. By contrast, the results of this assessment have demonstrated that odour concentrations at properties within Trewassa, and the wider model domain, are predicted to reduce to below 1.5 Ou_E/m^3 and, at worst, are equal to the benchmark at one location (R31) when modelling the relative worst-case meteorological year (2019).

6 CONCLUSIONS

6.1.1. Saputo Dairy UK are applying for a variation to the existing environmental permit (EPR/BN6137IK) for the Davidstow Creamery in Cornwall (named operator referred to as 'Dairy Crest'), which comprises changes to site operations at both the creamery site and WPF.

6.1.2. WSP, on behalf of Saputo Dairy UK, have completed a detailed odour modelling assessment to establish the potential impacts of these changes to odour emissions released from the site and the associated odour concentrations experienced at existing sensitive locations in the local area. Given that the main odour sources are located at the WPF and that the majority of odour complaints received between 2016 and 2020 have originated from Trewassa and Treworra, the changes at the WPF have formed the focus of the modelling assessment.

6.1.3. The modelled odour emissions from both the creamery and WPF odour sources were based on an average of the emission rates obtained from annual odour monitoring surveys completed between 2019 and 2021. This was done to account for daily and seasonal influences on odour releases from the site and also to account for the incremental improvements applied to the WPF in recent years, which form part of the permit variation works. Each surveyed odour source was represented in the dispersion model based on their physical dimensions and source type (e.g., area, volume, point). Where applicable, the dimensions and source types were modelled to represent the proposed changes associated with the improvement works.

6.1.4. The odour model domain encompassed a Cartesian receptor grid measuring 5 km x 3 km, which captured the respective sources of odour at both the creamery site and WPF, whilst also including sensitive areas such as Trewassa, Treworra, Davidstow, and Tremail. In addition, a total of 42 discrete receptor locations were modelled, comprising residential dwellings in proximity to the creamery and WPF, focussed on those that were referenced in odour complaint logs held by Dairy Crest.

6.1.5. At each discrete and gridded receptor point, the model provided outputs for the 98th percentile of all hourly average odour concentrations (C_{98}^{th}) for each of the five modelled meteorological years (2016 – 2020). The results of the modelling exercise were compared to the assessment benchmark (C_{98}^{th} = 1.5 OU_E/m^3), which equates to the criterion recommended by the EA[3] for 'most offensive' odours.

6.1.6. The results of the assessment have demonstrated that the benchmark criterion is not predicted to be exceeded at any of the identified sensitive receptors. The maximum predicted C_{98}^{th} odour concentration is predicted to occur at the nearest receptor to the WPF in Trewassa, based on modelling 2019 hourly meteorological data, and is equal to the benchmark (1.5 OU_E/m^3). Of the years modelled, 2019 meteorological data exhibits the highest predicted concentrations, thus representing the relative worst case dispersion conditions with respect to odour releases from the WPF and potential impacts at sensitive receptors within Trewassa.

6.1.7. The outputs of this odour modelling assessment were compared to equivalent odour baseline modelling results presented in the 2017 assessment for the site, thereby enabling a comparison of potential odour impacts before and after the implementation of the improvement works covered by the permit variation application. This comparison has demonstrated that the improvement works already implemented and proposed for the Dairy Crest creamery and WPF site are expected to significantly reduce odour emissions and associated impacts at identified sensitive receptors relative to the 2017 baseline.

6.1.8. In the 2017 assessment, all properties within Trewassa, Treworra and parts of Davidstow were shown to exceed the benchmark criterion, with those in Trewassa experiencing levels between 5 Ou_E/m^3 and 10 Ou_E/m^3. By contrast, with the improvements implemented at the site, this assessment has shown that all receptors within these areas and the wider model domain are predicted to experience odour levels below the benchmark criterion (1.5 Ou_E/m^3) and, at worst, equal to the benchmark at the nearest receptor to the WPF under relative worst case dispersion conditions.

6.1.9. Overall, with the implementation of the improvement works associated with the Dairy Crest permit variation application, the results of this assessment demonstrate that odour emissions from the Dairy Crest creamery and WPF should not result in any significant detriment to amenity within the local area. Furthermore, the odour concentrations experienced within sensitive areas close to the WPF are expected reduce significantly relative to the 2017 baseline assessment.

Appendix A

FIGURES

Figure 1 Site Location

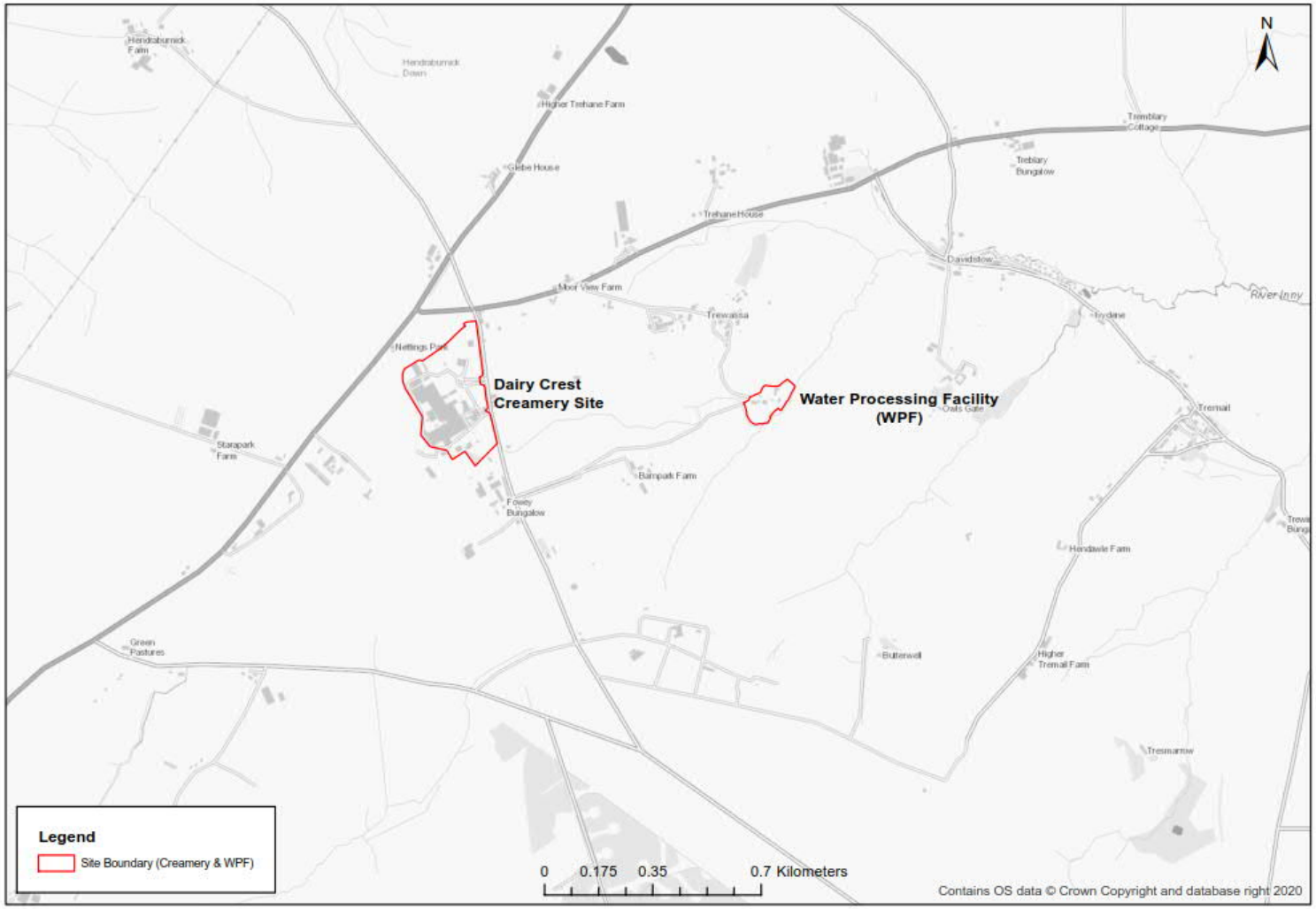


Figure 2 Site Layout Plan

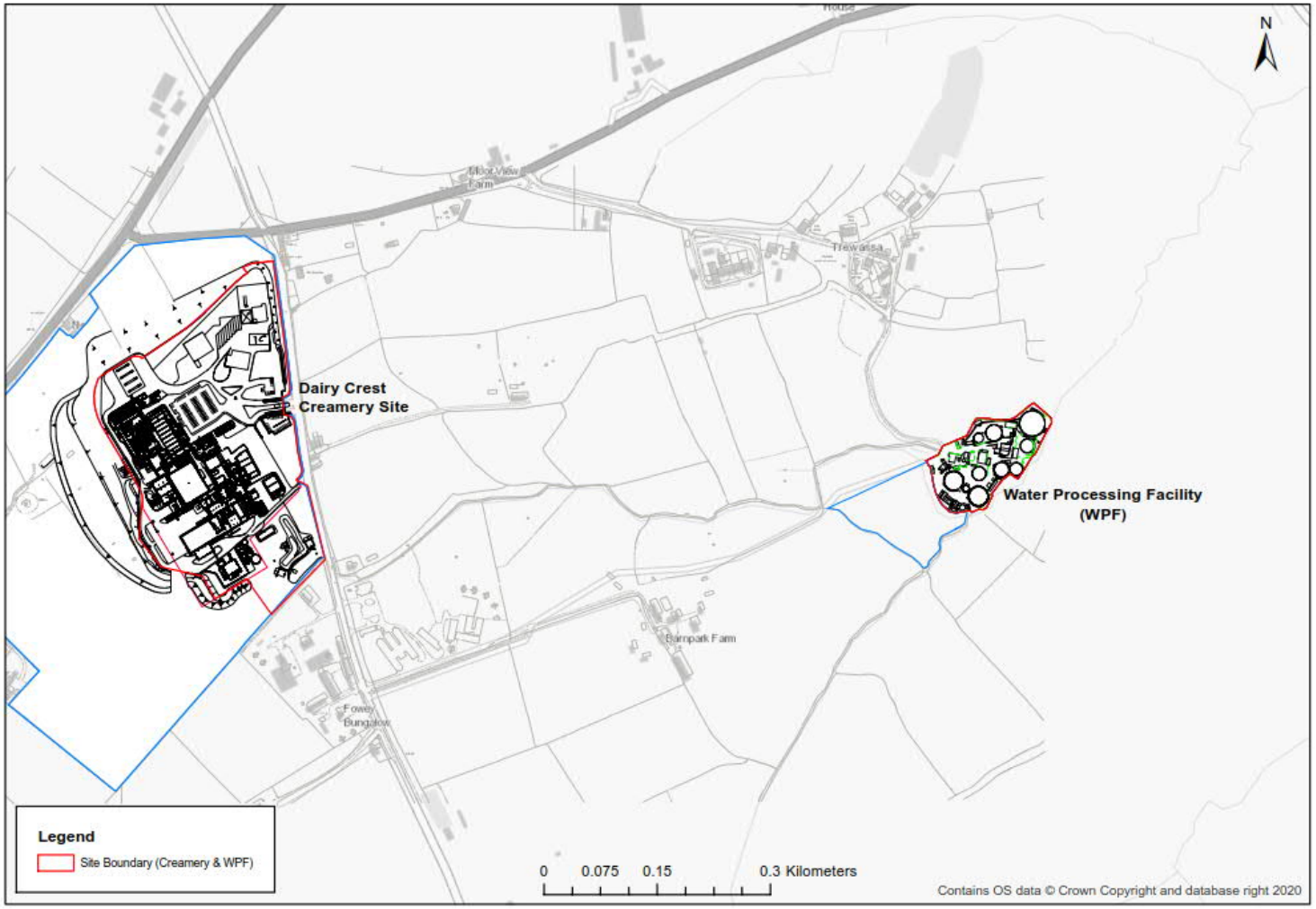


Figure 3 Modelled discrete sensitive receptors and Cartesian receptor grid extent

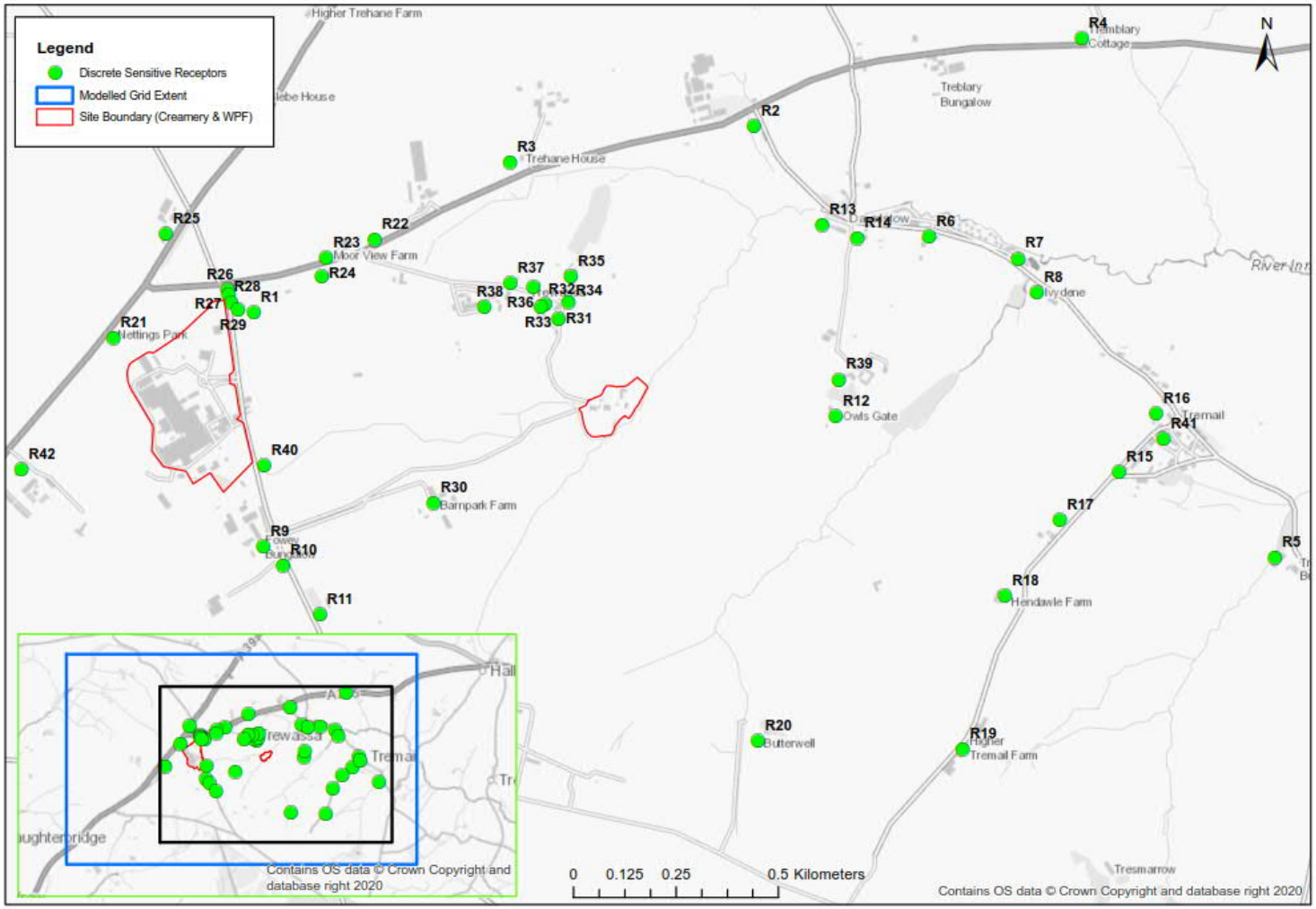


Figure 4 Modelled odour sources within Dairy Crest Creamery site

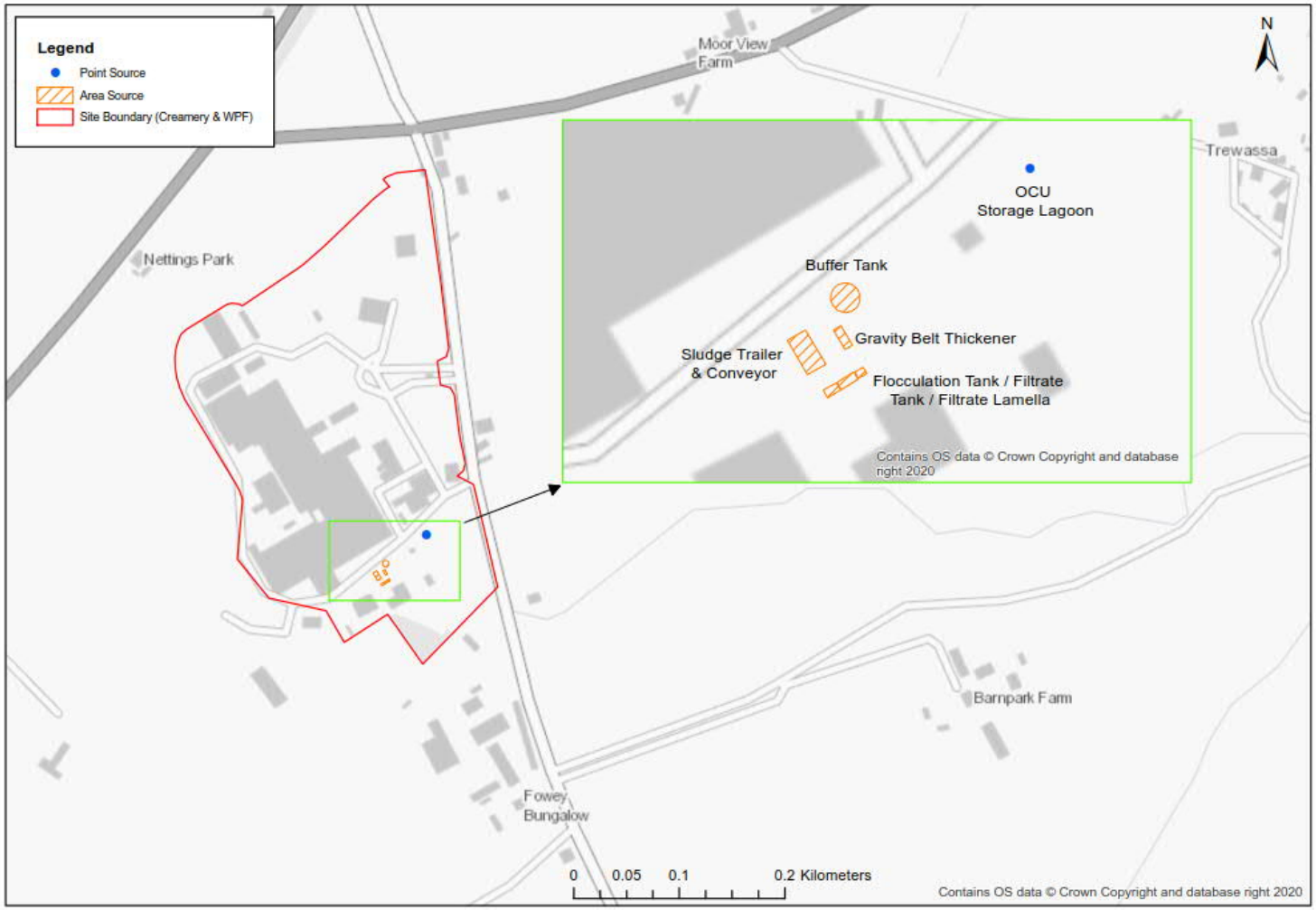


Figure 5 Modelled odour sources within Dairy Crest WPF

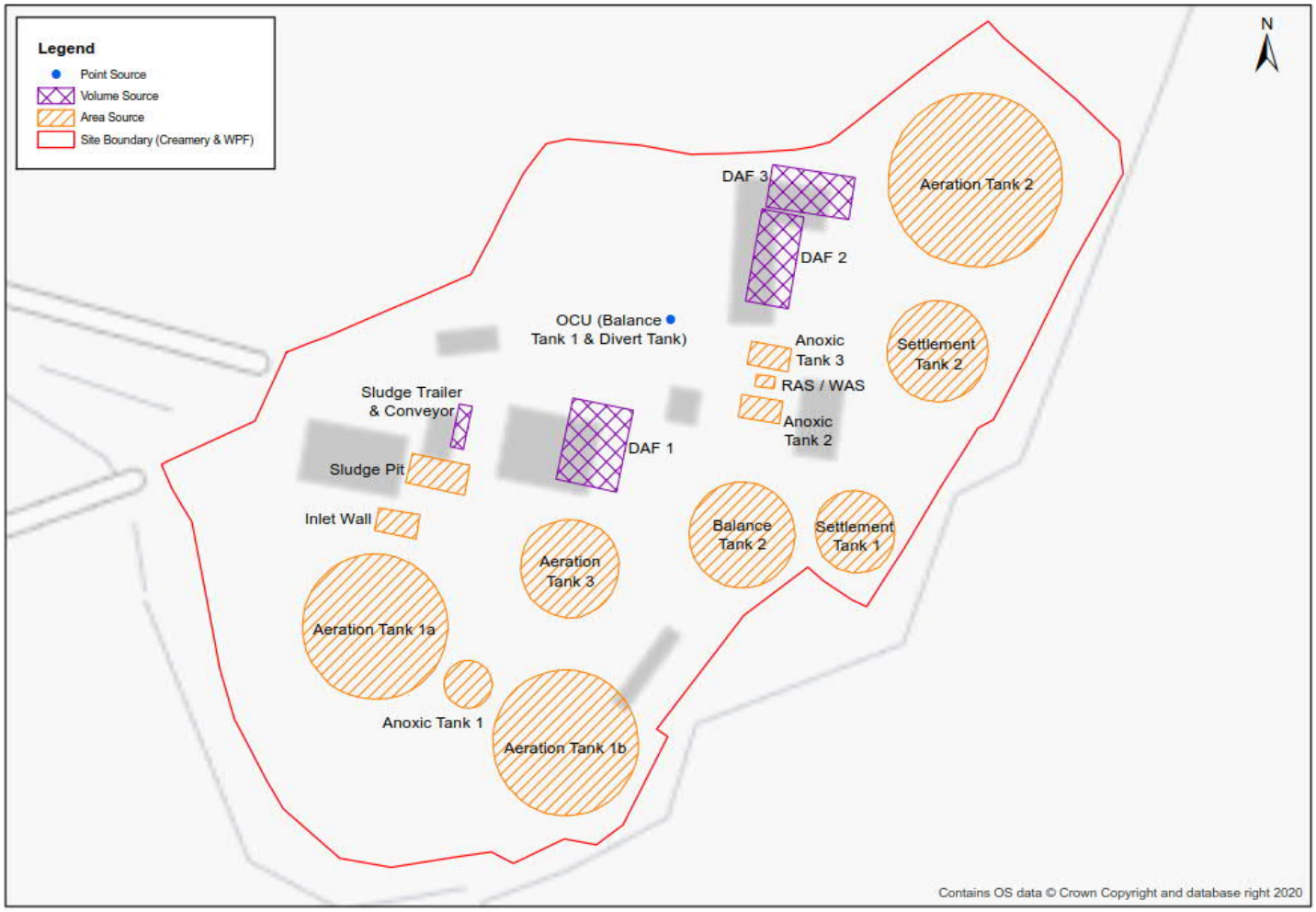


Figure 6 Terrain variations represented within dispersion model domain

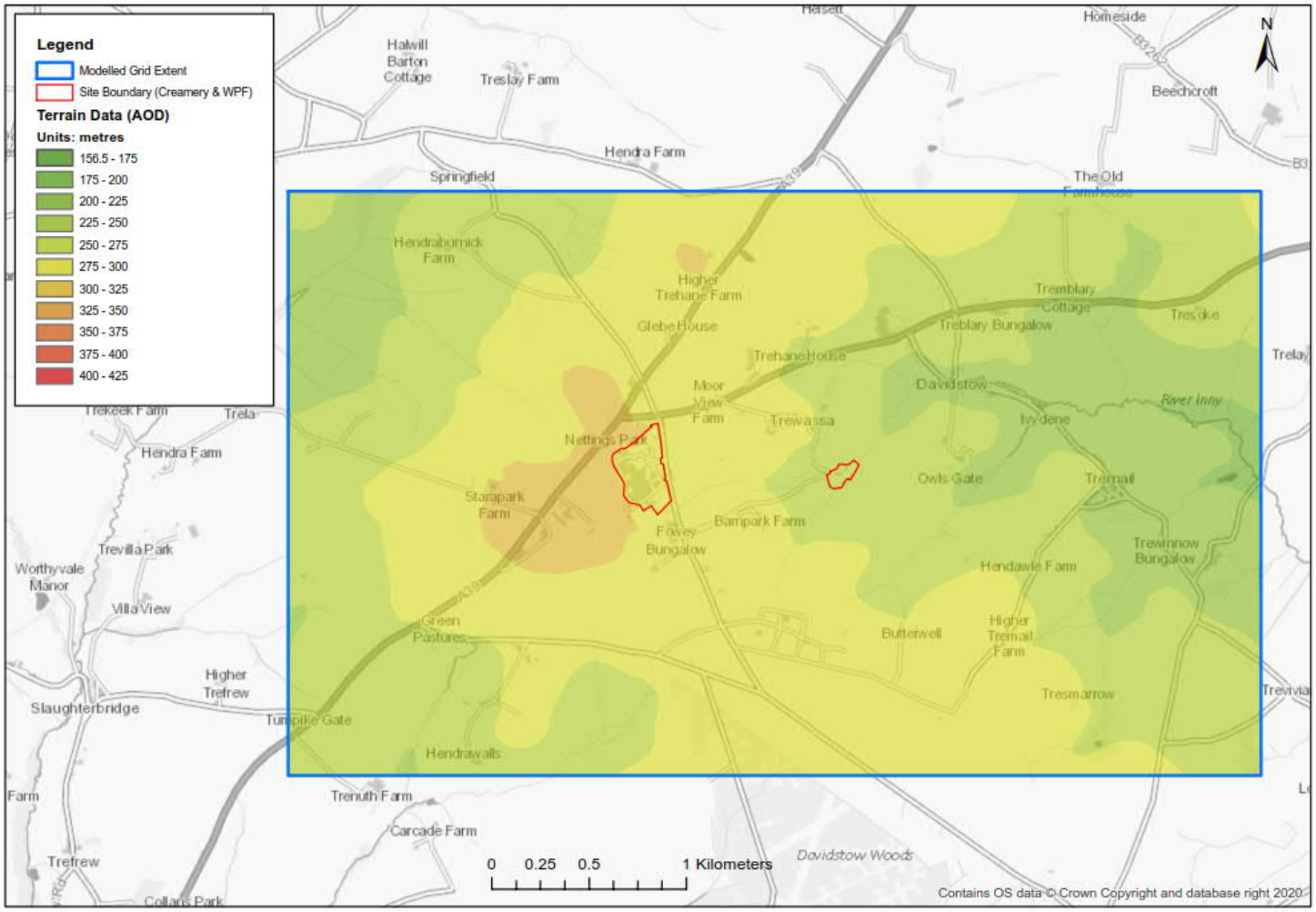


Figure 7 Modelled buildings included to represent building downwash effects

Figure 8 **Modelled C_{98}^{th} odour concentrations throughout model domain for year 2015 (Units: Ou_E/m^3)**

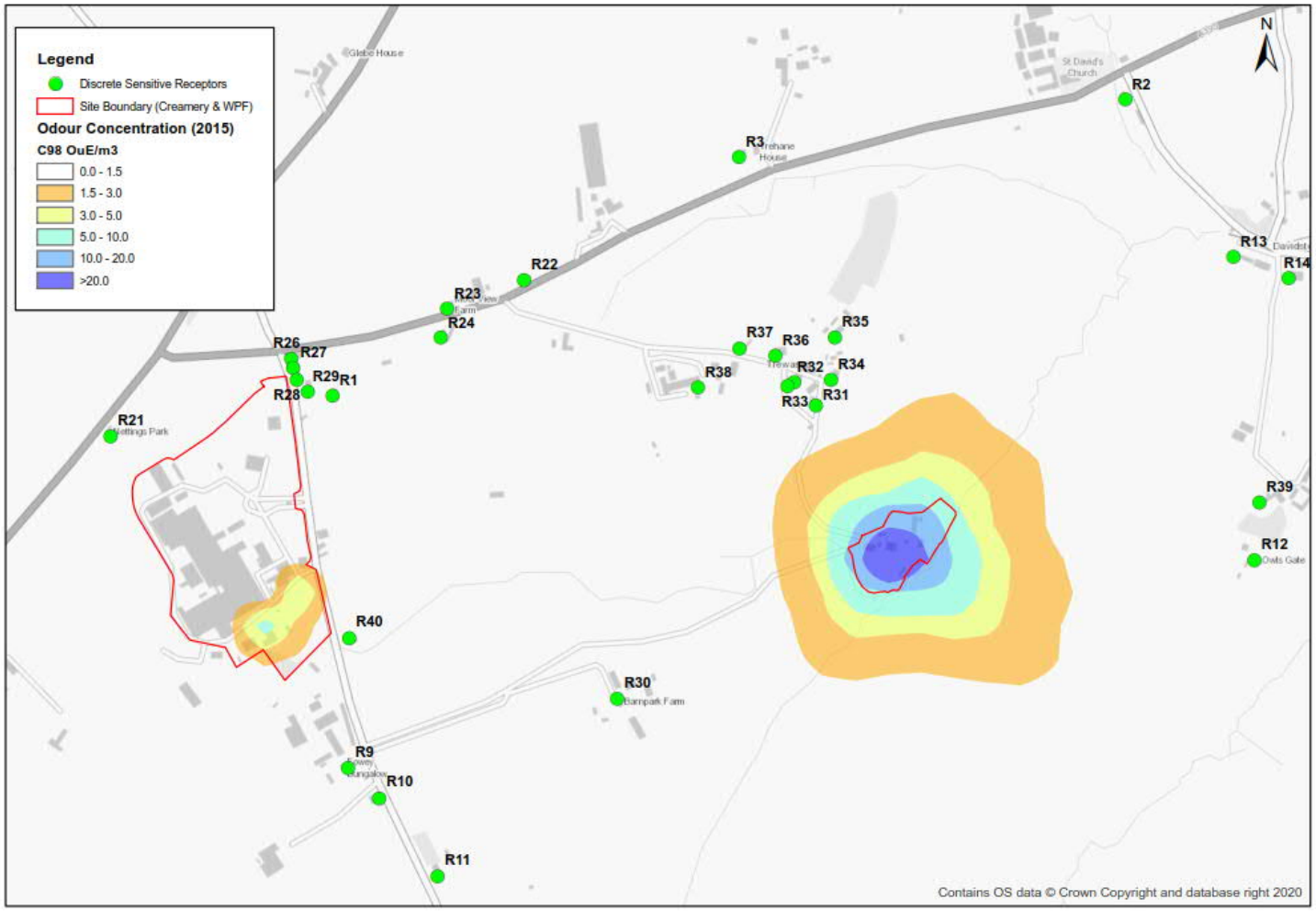


Figure 9 Modelled C_{98}^{th} odour concentrations throughout model domain for year 2016 (Units: Ou_E/m^3)

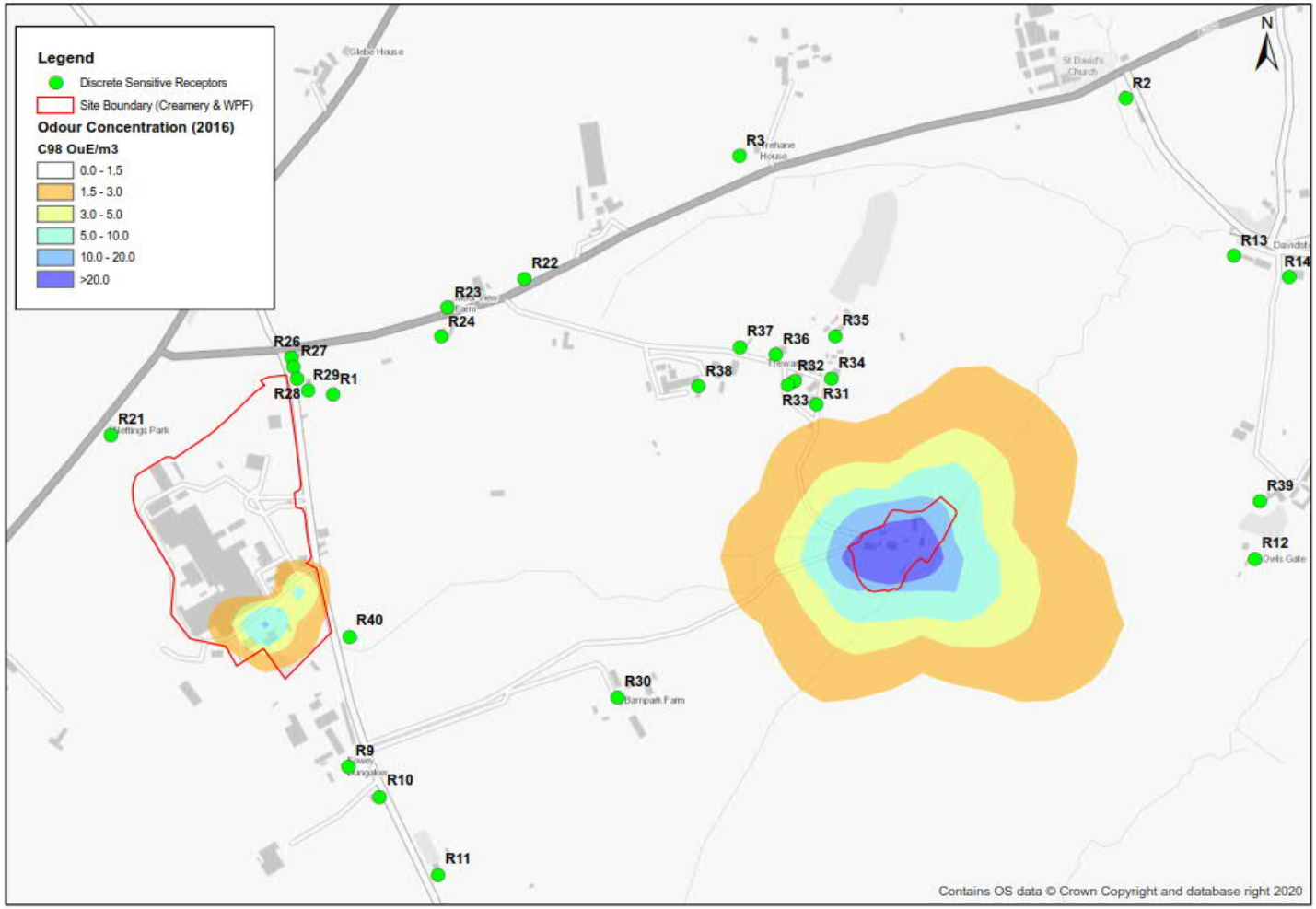


Figure 10 Modelled C_{98}^{th} odour concentrations throughout model domain for year 2017 (Units: Ou_E/m^3)

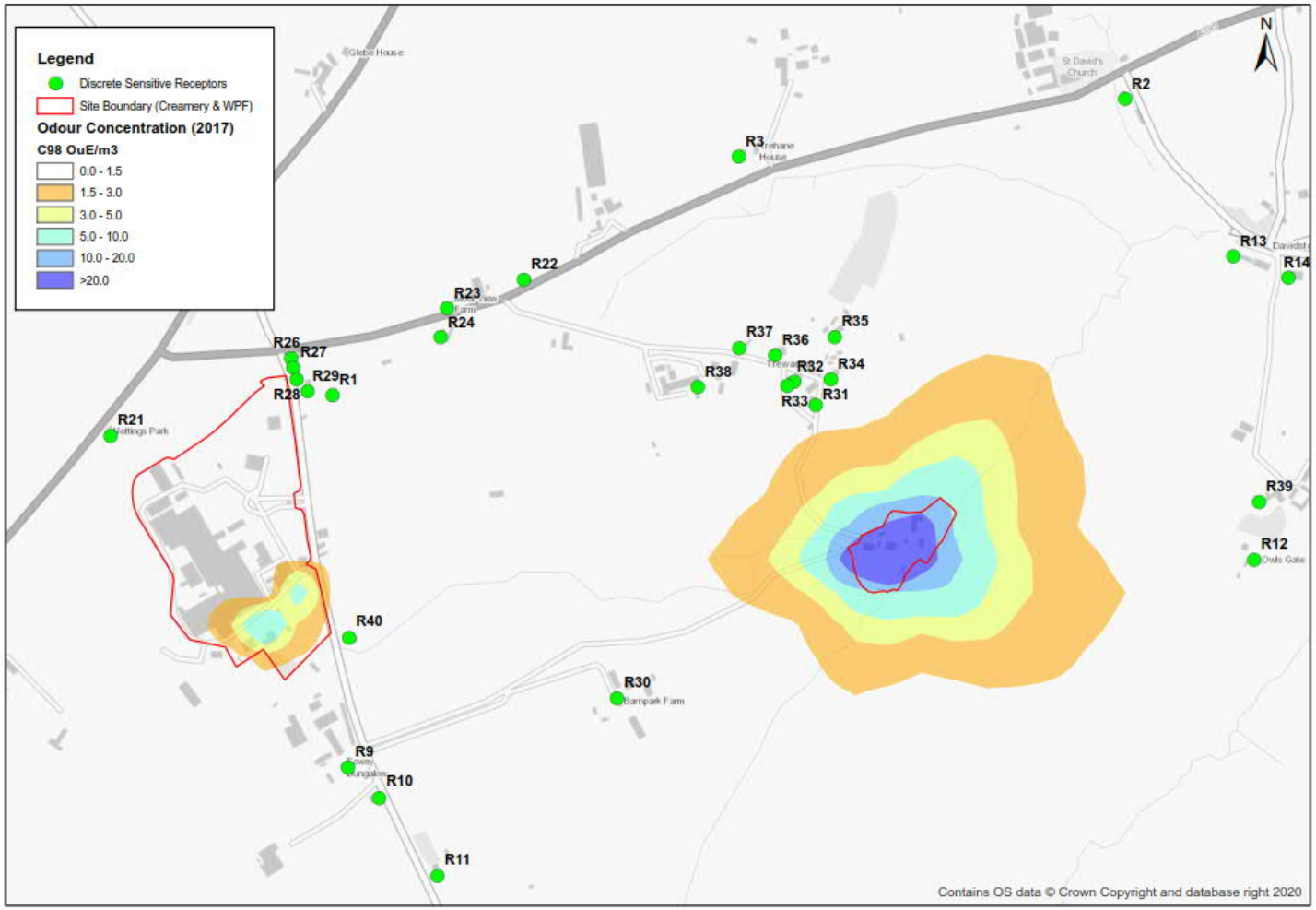


Figure 11 Modelled C_{98}^{th} odour concentrations throughout model domain for year 2018 (Units: Ou_E/m^3)

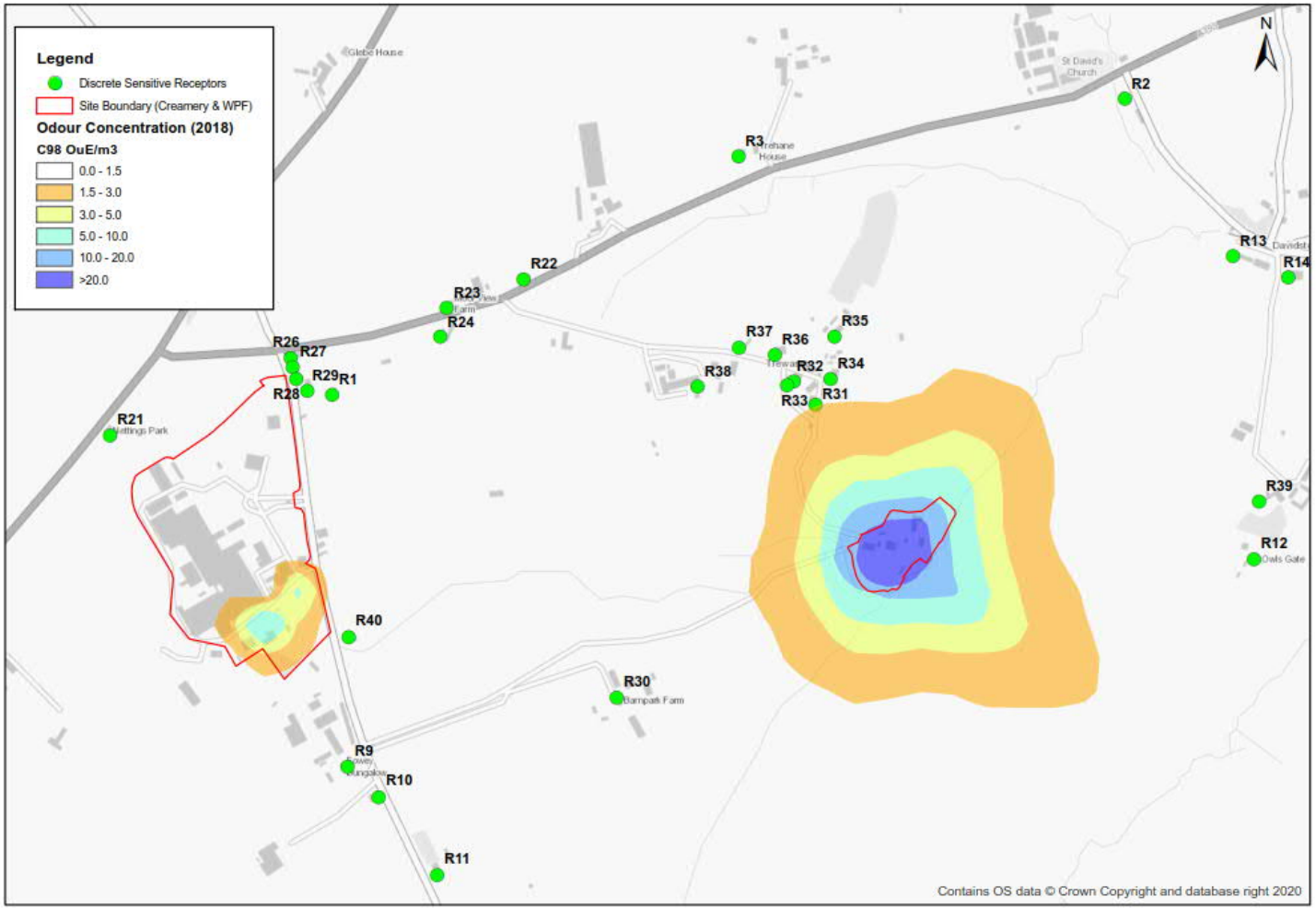


Figure 12 Modelled C_{98}^{th} odour concentrations throughout model domain for year 2019 (Units: Ou_E/m^3)

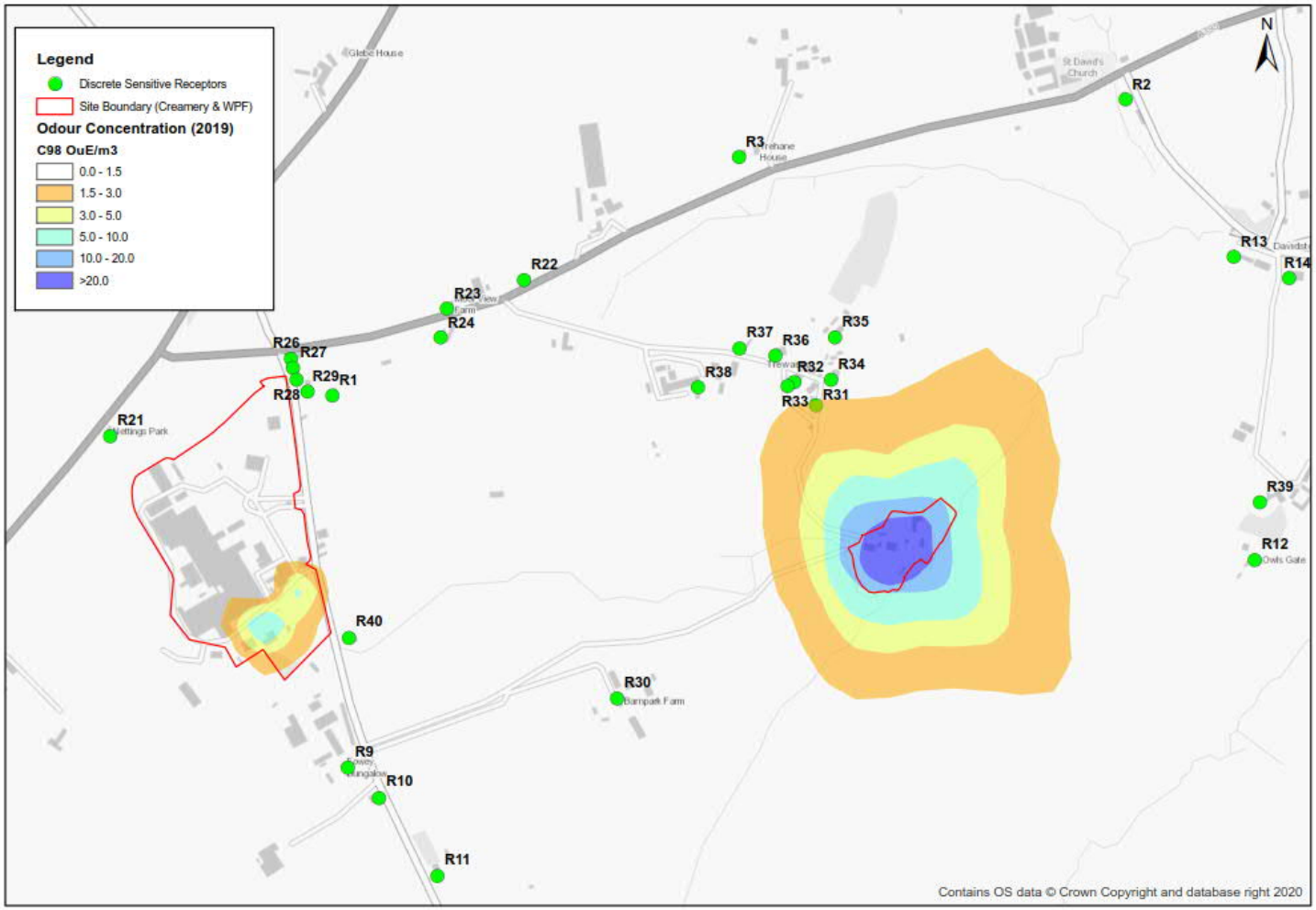
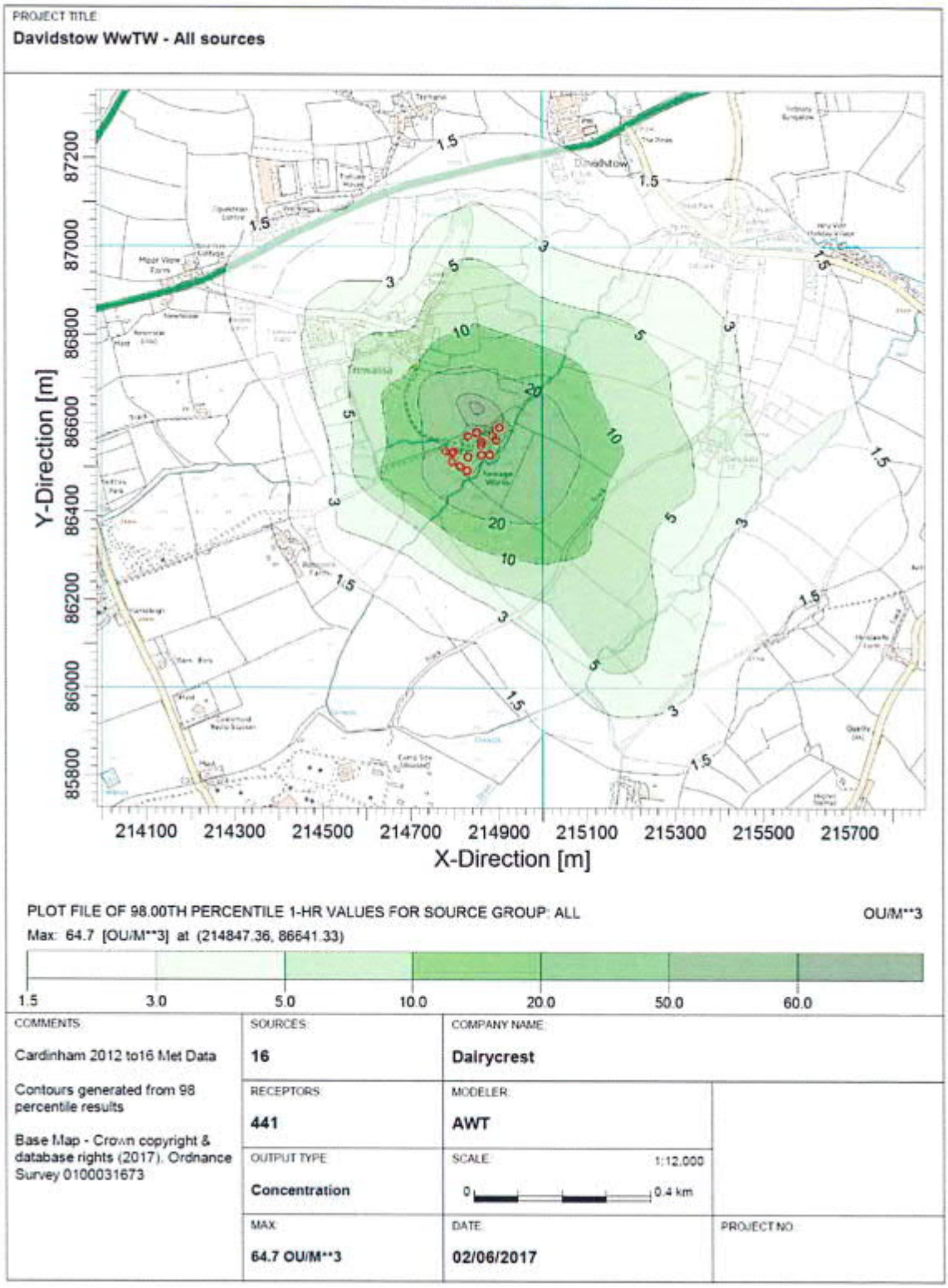


Figure 13 **2017 Odour Baseline Report[1]: Maximum modelled C_{98}^{th} odour concentrations throughout model domain (Units: Ou_E/m^3)**



Appendix B

WIND ROSE PLOTS

Figure B1 **Wind Rose Plot – Cardinham Met Station (2015)**

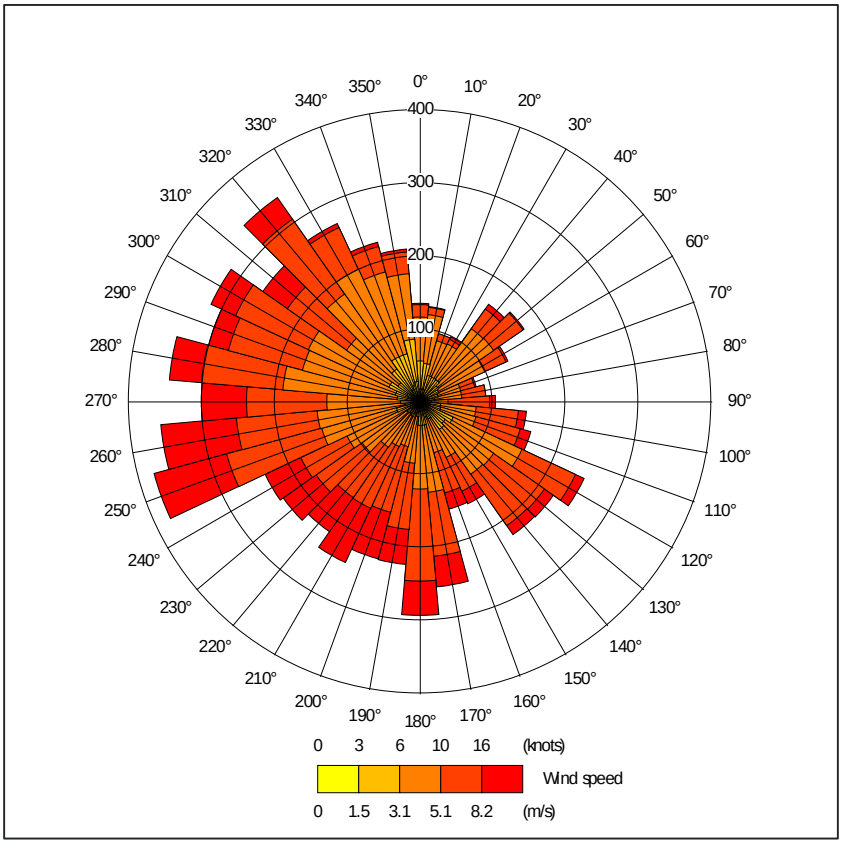


Figure B2 **Wind Rose Plot – Cardinham Met Station (2016)**

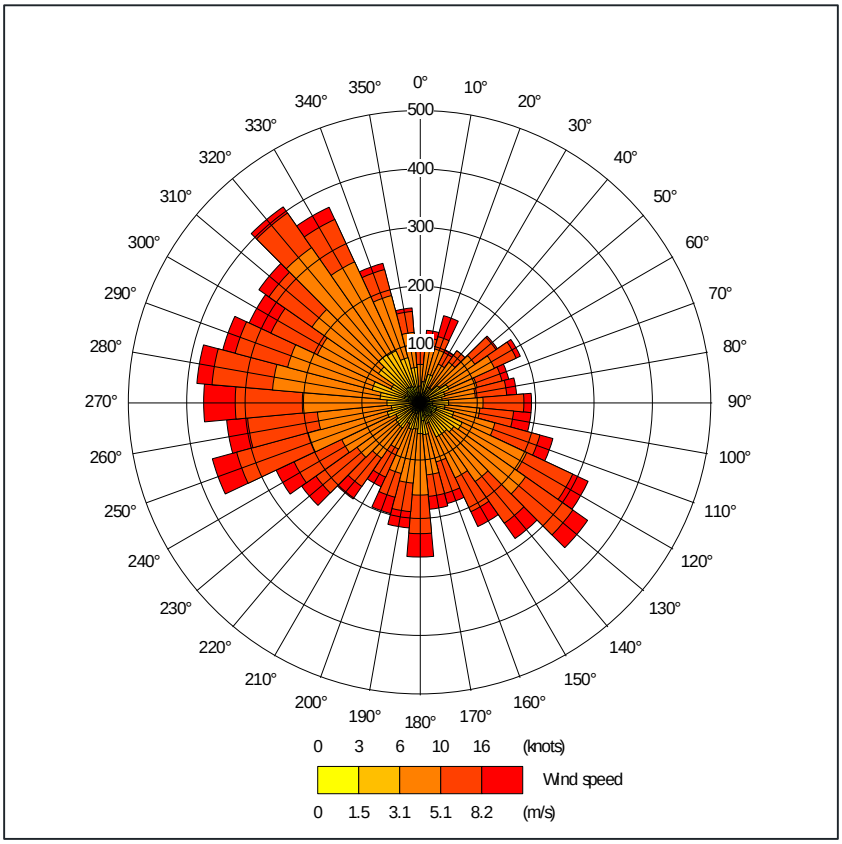


Figure B3 **Wind Rose Plot – Cardinham Met Station (2017)**

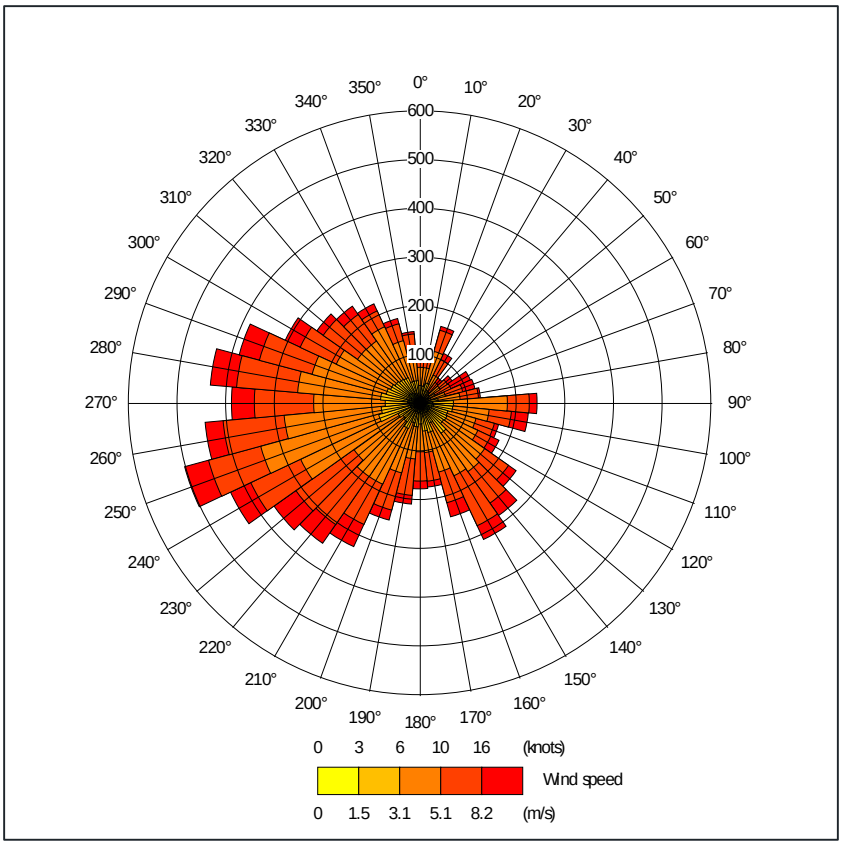


Figure B4 **Wind Rose Plot – Cardinham Met Station (2018)**

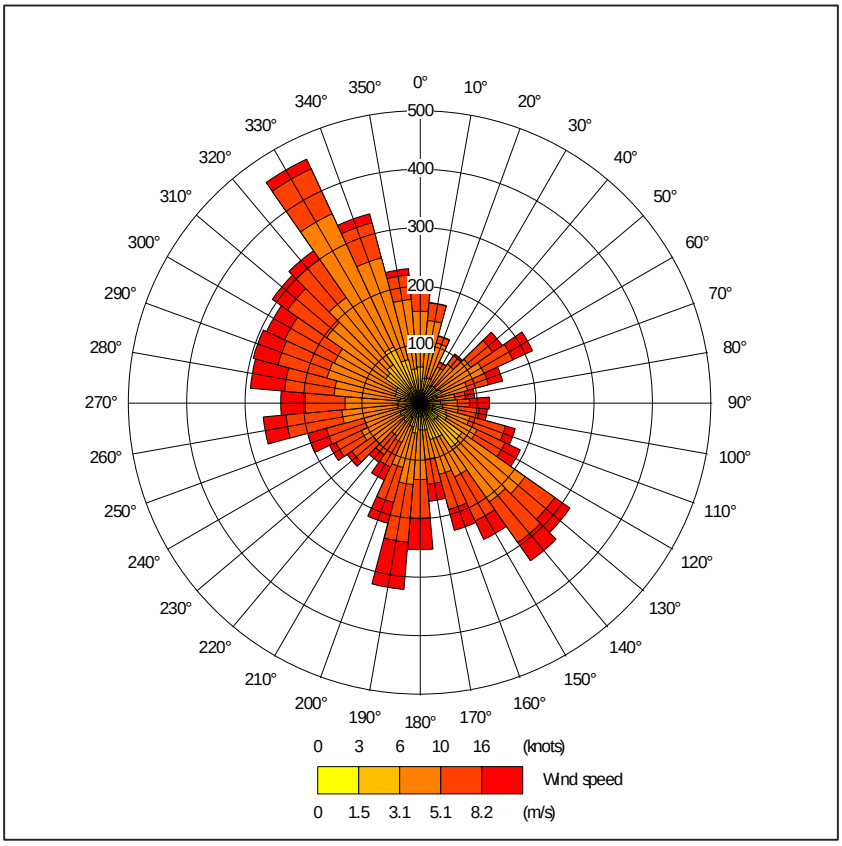
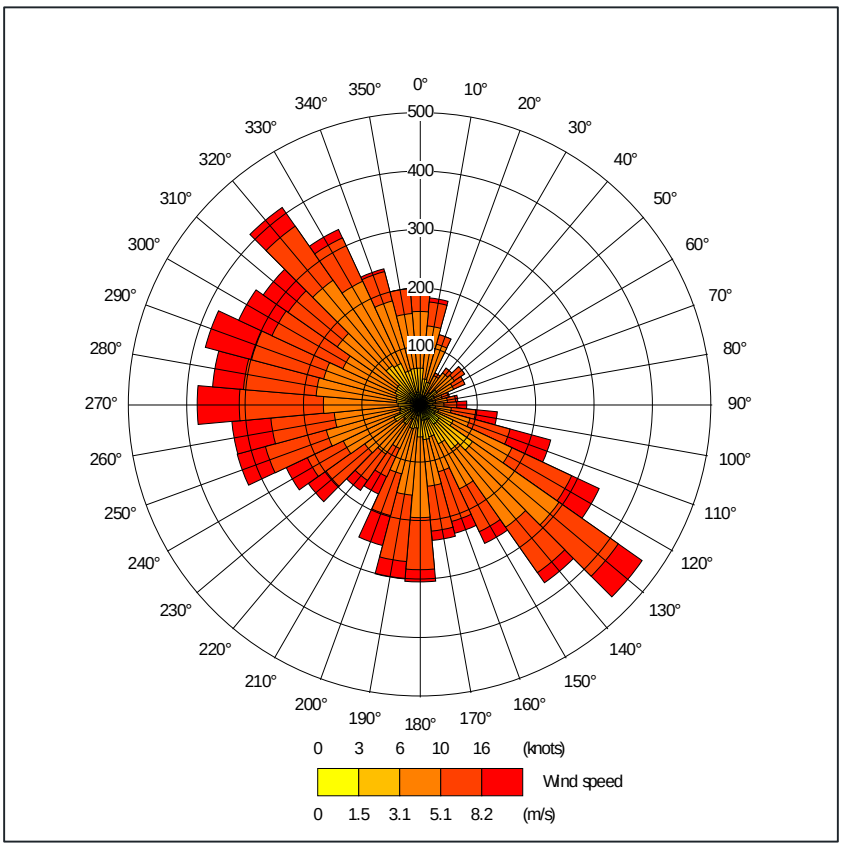


Figure B5 Wind Rose Plot – Cardinham Met Station (2019)



Appendix C

ODOUR SURVEY RESULTS (WPF SOURCES): 2019 - 2021

Table C1 Odour survey results for relevant WPF odour sources reported between 2019 and 2021[7,8,9]

Area	Source	Odour Emission Rate ($Ou_E/m^2/s$)			
		2019	2020	2021	Average (2019-2021)
WPF	Inlet well	2.5	70.2	15.8	29.5
	Balance Tank 2	6.1	95.2	34.1	45.1
	Anoxic Tank 1	1.8	-	0.9	1.4
	Anoxic Tank 2	1.4	1.4	1.5	1.4
	Anoxic Tank 3	2.3	41.3	0.5	14.7
	Aeration Tank 1a	0.8	0.3	0.2	0.4
	Aeration Tank 1b	0.8	0.2	1.6	0.9
	Aeration Tank 2	0.4	0.2	0.7	0.4
	Aeration Tank 3	1.2	0.2	1.2	0.9
	Sludge Pit	108.2	107.8	261.9	159.3
	Sludge Trailer & Conveyor	13.8	5.2	116.7	45.2*
	RAS / WAS chambers	1.8	4.1	2.7	2.9

*** Based on existing 'open top' area source configuration (represented within model to be inside proposed building as part of improvement work i.e. as volume source)**

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