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Odour Impact Assessment – Integrated Pig Farm at Moate, Co. Laois

Prepared for:

Tulleka Trading Ltd

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Final

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Glossary

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Term	Definition
g/s	gram per second
kg	kilogram
kg/m³	Kilogram per cubic meter
km	kilometre
km/hr	kilometre per hour
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
m^3/hr	cubic metres per hour
mg	milligram
Z_0	roughness length
ou_E/m^3	European odour unit per cubic meter
ou_E/s	European odour unit per second
$\mu g/m^3$	micrograms per cubic meter
Abbreviations	**Definition**
AG4	Air Guidance 4
BAT	Best available techniques
EPA	Environmental Protection Agency
EF	Emission factor
EU	European Union

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EXECUTIVE SUMMARY

Tulleka Trading Ltd commissioned Katestone to complete an odour impact assessment (OIA) for a pig farm located at Graigue, County Laois (Site). The OIA is required to determine the potential impacts of emissions from a proposed development at the pig farm that will include:

- A reduction of the stocking density by:
    - Constructing four new pig housing units to increase the total floor space
    - Maintaining pig numbers at current levels
- Constructing a new farrowing house to improve animal welfare
- Altering manure storage practices at eleven (11) of the thirteen (13) existing housing units at the site, which will be changed from deep pit storage tanks to shallow pit storage tanks to reduce emissions from the site
- Altering ventilation points on some of the pig housing units to reduce the potential impact of emissions exhausted from these sources.

The assessment is required to determine the potential impact of odorous emissions from the proposed development at the pig farm on nearby residential locations. The assessment will be submitted as part of planning and licensing applications for the pig farm.

The odour assessment was conducted in accordance with recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). The dispersion model, CALPUFF, was used to predict ground-level concentrations of odour across the model domain due to the pig farm. The assessment of odour has also been conducted in accordance with EPA's instruction note for the assessment of odour emissions from intensive agriculture pig installations (EPA, 2022).

Final Report Findings

The predicted concentrations of odour at all sensitive receptors are below the EPA limit of 5.0ou_E/m^3.

1. INTRODUCTION

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Tulleka Trading Ltd commissioned Katestone to complete an odour impact assessment (OIA) for a pig farm located at Graigue, County Laois (Site). The OIA is required to determine the potential impacts of emissions from a proposed development at the pig farm that will include:

- A reduction of the stocking density at the site by:
    - Constructing four new pig housing units to increase the total floor space
    - Maintaining pig numbers at current levels
- Constructing a new farrowing house to improve animal welfare
- Altering manure storage practices at eleven (11) of the thirteen (13) existing housing units at the site, which will be changed from deep pit storage tanks to shallow pit storage tanks to reduce emissions from the site
- Altering ventilation points on some of the pig housing units to reduce the potential impact of emissions exhausted from these sources.

The odour impact assessment was used to inform the design of the pig farm to ensure concentrations of odour due to emissions from onsite sources are within the acceptable odour level defined by the Environmental Protection Agency (EPA) in Ireland at nearby sensitive receptors.

The Moate Pig Farm is operated under an Industrial Emissions License (IEL). EPA issued an Integrated Pollution Prevention and Control (IPPC) licence (Register number P0710-03) for the housing units on 22 December 2011 (EPA, 2011). The IPPC licence was amended to an IEL, which was issued by EPA to Mr. Paul Tully on 18 December 2013 (EPA, 2013). The licence boundary of the Site will have to be adjusted to incorporate the proposed new housing units.

This odour impact assessment was undertaken using dispersion modelling techniques. The dispersion modelling has been completed in accordance with the requirements of EPA's Air Dispersion Modelling Guidance Note (AG4). The assessment of odour has also been conducted in accordance with EPA's instruction note for the assessment of odour emissions from intensive agriculture pig installations (EPA, 2022).

2. OVERVIEW OF THE PIG FARM

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The Moate Pig Farm is located approximately 3.0 km northeast of the village of Ballinakill, Co. Laois. It is located in an area of semi-complex terrain close to a number of hills and a river valley.

There are three (3) Natura 2000 sites within 10 km of the Moate Pig Farm. The proposed licence boundary of the Site and its environs are presented in Figure 1. All pig housing units will be located within the proposed licence boundary of the Site.

A Site plan illustrating the layout of the existing housing units and proposed housing units is presented in Figure 1 and Figure 2.

The existing housing units have the following maximum animal holding capacities:

- 650 sows
- 120 maiden gilts
- 4,300 weaners
- 4,800 production pigs (growers and finishers).

As part of the proposed development, emissions from all housing units will be captured and ventilated through elevated chimney stacks. Some of the chimney stacks on current housing units will be increased in height as part of the proposed development. This will significantly reduce the potential impact of emissions in the vicinity of the Site.

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Figure 1 **Moate Pig Farm proposed Site boundary (red line) and the surrounding environment**

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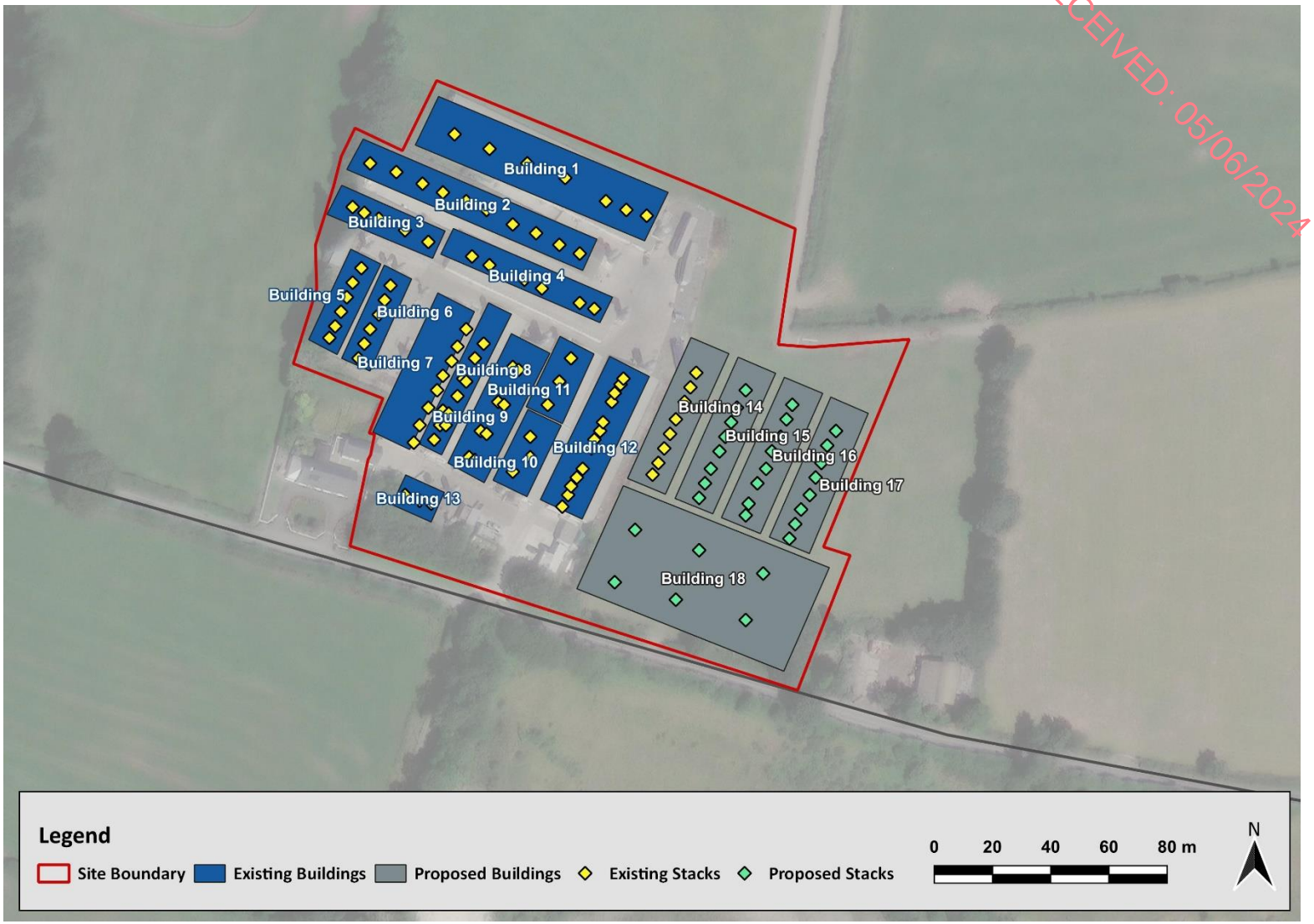

Figure 2 **Moate Pig Farm Site plan – existing and proposed housing units and existing and proposed chimney stacks**

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3. REGULATORY FRAMEWORK AND ASSESSMENT CRITERIA

3.1 *Environmental Protection Agency Acts 1992 and 2003*

The *Environmental Protection Agency Act 1992 (EPA Act)* and Part 2 of the *Protection of the Environment Act 2003* are collectively referred to as the *Environmental Protection Agency Acts 1992 and 2003*. These Acts provide for the management of air emissions from activities (meaning any process, development or operation) that are listed in the First Schedule of the Acts.

Section 4 (2) of the *Environmental Protection Agency Acts 1992 and 2003* defines Air Pollution as follows:

> *"…the direct or indirect introduction to an environmental medium, as a result of human activity, of substances, heat or noise which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment, and includes -*
>
> *(a) 'air pollution' for the purposes of the Air Pollution Act 1987,*
>
> *(b) ……..*
>
> *(c) ……."*

The *Air Pollution Act 1987* (AP Act) provides for the control of air pollution and other matters connected with air pollution. Under the AP Act 'pollutant' means any substance that is specified in the First Schedule or any other substance (including a substance which gives rise to odour) or energy which, when emitted into the atmosphere either by itself or in combination with any other substance, may cause air pollution.

Section 4 of the AP Act defines air pollution as follows:

> *"Air pollution" in this Act means a condition of the atmosphere in which a pollutant is present in such a quantity as to be liable to —*
>
> *(i) be injurious to public health, or*
>
> *(ii) have a deleterious effect on flora or fauna or damage property, or*
>
> *(iii) impair or interfere with amenities or with the environment."*

Section 24 of the AP Act details the obligations of the occupier of a premises in respect to preventing emissions, nuisance and what constitutes defences against prosecution:

(1) The occupier of any premises, other than a private dwelling, shall use the best practicable means to limit and, if possible, to prevent an emission from such premises.

(2) The occupier of any premises shall not cause or permit an emission from such premises in such a quantity, or in such a manner, as to be a nuisance.

(3) In any prosecution for a contravention of this section, it shall be a good defence to establish that—

(a) the best practicable means have been used to prevent or limit the emission concerned, or

(b) the emission concerned was in accordance with a licence under this Act, or

(c) the emission concerned was in accordance with an emission limit value, or

(d) the emission concerned was in accordance with a special control area order in operation in relation to the area concerned, or

(e) in the case of an emission of smoke, the emission concerned was in accordance with regulations under section 25, or

(f) the emission did not cause air pollution.

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Section 75 (1) of the *Environmental Protection Agency Acts 1992 and 2003* requires the EPA to publish reasonable and desirable quality objectives to protect the environment, namely:

"The Agency shall, in relation to any environmental medium and without prejudice to its functions under section 103, specify and publish quality objectives which the Agency considers reasonable and desirable for the purposes of environmental protection."

3.2 Odour

In 2001, the EPA issued an assessment framework that "*aims to define a set of criteria for odour exposure to achieve a common environmental quality objective in licencing procedures"* (EPA, 2001). This framework is specific to intensive pig units; however, in the absence of other environmental quality objectives specified by EPA, the criterion for odour exposure to intensive pig units has been adopted for this assessment. The Environmental Quality criteria are:

- *Target value:* $C_{98,\ 1\text{-}hour} \leq 1.5\ ou_E/m^3$
    - *The target value provides a general level of protection against odour annoyance for the general public, aiming to limit the percentage of people experiencing some form of odour-induced annoyance to 10% or less. The target value is to be used as an environmental quality target for all situations.*
    - *The target value is achieved when the calculated odour exposure for all locations of odour sensitive receptors is less than an hourly average odour concentration of 1.5* ou_E/m^3 *in 98% of all hours in an average meteorological year.*
- *Limit value for new pig production units:* $C_{98,\ 1\text{-}hour} \leq 3.0\ ou_E/m^3$
    - *The limit value for new pig production units provides a minimum level of protection against odour annoyance, aiming to limit the percentage of those experiencing some form of odour-induced annoyance to 10% or less in the general public, assuming some degree of acceptance of the rural nature of their living environment.*
    - *The limit value for new pig production units shall not be exceeded in the vicinity of new pig production units to ensure a minimum environmental quality. The limit value for new pig production units is complied with when for all locations of odour sensitive receptors the calculated odour exposure is less than an hourly average odour concentration of 3.0* ou_E/m^3 *in 98% of all hours in an average meteorological year.*
- *Limit value for existing pig production units:* $C_{98,\ 1\text{-}hour} \leq 6.0\ ou_E/m^3$
    - *The limit value for existing pig production units provides a minimum level of protection against odour annoyance, aiming to limit the percentage of people experiencing some form of odour-induced annoyance to 10% or less*
    - *The limit value for existing pig production units shall not be exceeded in the vicinity of existing pig production units to ensure the minimum environmental quality in an agricultural setting. A phased plan must be made to reduce the odour impact, with time, to the limit value for new pig production units and, eventually, the target value. The limit value for existing production units is complied with when for all locations of odour sensitive receptors the calculated odour exposure*

is less than an hourly average odour concentration of 6.0 ou_E/m^3 in 98% of all hours in an average meteorological year.

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In 2020, EPA released an updated version of its dispersion modelling guidance titled Air Dispersion Modelling from Industrial Installations Guidance Note (AG4) (EPA, 2020a). AG4 includes an appendix that describes *Relevant Odour Standards*. It states:

Currently there is no general statutory odour standard in Ireland relating to industrial installations. The EPA(53) has issued guidance specific to intensive agriculture which has outlined the following standards:

- *Target value for new pig-production units of 1.5 OUE/m3 as a 98th%ile of one hour averaging periods,*
- *Limit value for new pig-production units of 3.0 OUE/m3 as a 98th%ile of one hour averaging periods,*
- *Limit value for existing pig-production units of 6.0 OUE/m3 as a 98th%ile of one hour averaging periods.*

Guidance from the UK (EA, 2011, and adapted for Irish EPA use) recommends that odour standards should vary from 1.5 – 6.0 OUE/m3 as a 98th%ile of one hour averaging periods at the worst-case sensitive receptor based on the offensiveness of the odour and with adjustments for local factors such as population density(54). A summary of the indicative criterion is given below in Table A4:

In 2022, EPA issued a document titled "Instruction note for the assessment of odour emissions from Intensive Agriculture pig installations" (EPA, 2022) which is referred to here as the EPA 2022 Pig Instruction Note. Its stated objective is to:

"provide applicants with a methodology on how to screen for and assess odour impacts from the licensable intensive agriculture pig sector, as well as assisting in how applicants can demonstrate compliance with BAT 13 (to reduce odour emissions and / or odour impact) of the Commission Implementing Decision (CID) 2017/302. This instruction note replaces the EPA's 2001 'Odour Impacts and Odour Emission Control Measures for Intensive Agriculture' guidance document and screening methodology.".

The EPA 2022 Pig Instruction Note sets out acceptable odour levels, below which licenced Sites can operate without generating unacceptable odour pollution at sensitive receptors. According to the EPA 2022 Pig Instruction Note, the acceptable odour levels specific to intensive agriculture are defined as follows:

- 3.0 ou_E/m^3 for new pig-production units
- 5.0 ou_E/m^3 for existing pig-production units (includes Sites licensed by the EPA between 2001 and 15th February 2017 only)
- 6.0 ou_E/m^3 for existing pig-production units (includes Sites licensed by the EPA prior to 2001 and not reviewed since this date only).

The acceptable odour levels are based on the 98th percentile of hourly mean concentrations of odour modelled over a year at the odour-sensitive locations.

The EPA 2022 Pig Instruction Note states that applicability of the above levels will be at odour-sensitive locations only. Note, for the purposes of this instruction note, the applicant's dwelling and farmyard are not considered to be odour sensitive locations. Where there are no third-party odour-sensitive receptors present, a higher odour level may be considered acceptable e.g., at the applicant's dwelling, farmyard, or countryside.

The odour level that is applicable to the pig farm is 5.0 ou_E/m^3 reported at the 98th percentile of hourly mean concentrations of odour modelled over a year at the odour-sensitive locations.

4. EXISTING ENVIRONMENT

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This section presents information on the existing environment in the vicinity of the Site, within the dispersion modelling domain and within the meteorological modelling domain. The meteorological modelling domain has been generated using geophysical data (terrain and land use) and meteorological data.

The extents of the dispersion modelling domain were determined based on the locations of the nearest ecological receptors in all directions from the Site.

4.1 Local terrain and land-use

The Site is in a remote rural location surrounded by pasture. The site is located near the base of a valley that is oriented north to south; however, the valley bends to an east west orientation immediately north of the site. The Owenbeg River follows the valley and flows from north to south at a point 500 m due east of the site.

The Moate Pig Farm is at an elevation of approximately 180 m. The terrain drops to 150 m approximately 500 to east of the site and from this point rises to rises to over 282 m within 2.5 km. This elevated land extends south for about 5 km with further elevated land approximately 5 km due south of the site. The terrain is relatively flat north, west and southeast of the site. There are rolling hills immediately southwest, south and southeast of the site with parts of the terrain both higher and lower than the site.

The complexities of the local terrain and proximity of the Owenbeg River and river valley are likely to have an important effect on dispersion conditions in the vicinity of the proposed farm.

The terrain of the modelling domain is presented as a 2-dimenstional surface plot in in Figure 3.

The hills of the modelling domain will affect synoptic scale wind patterns in the area by:

- Blocking wind coming from certain directions
- Channelling winds along the valleys created by the hills
- Creating very specific local air flows under low windspeed conditions due to katabatic and anabatic air flows created by the slopes of the hills.

The hills to the east of the pig farm result in a north-south oriented valley.

The proximity of the Site to local terrain and the Owenbeg River is likely to have an important effect on dispersion conditions near the Site and across the modelling domain.

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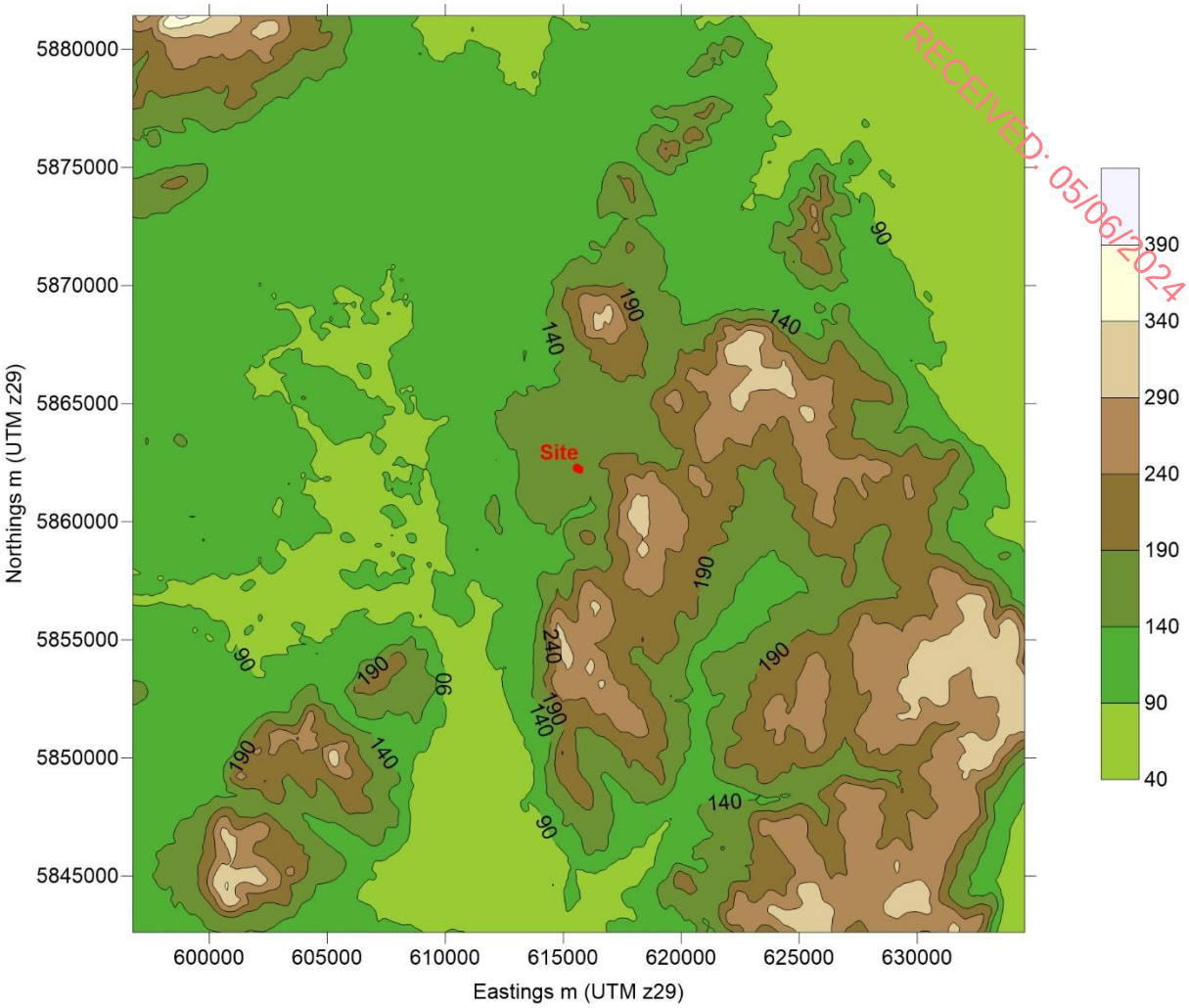

Figure 3 2-dimensional terrain of the modelled domain

4.2 Meteorology

Wind speed and wind direction are important parameters for the transport and dispersion of air pollutants from a source. The winds in the vicinity of the Site have been characterised using a three-dimensional meteorological model called CALMET. The 1-hour average wind speed for the modelling period is 3.99m/s. This compares to a 1-hour average wind speed of 4.3 m/s at Gurteen between 2008 and 2018 (EPA, 2020). A wind rose representing the annual distribution of 1-hour average winds is presented in Figure 4.

The prevailing wind direction in Ireland is between south and west. It is clear from Figure 4 that these winds influence wind patterns at the Site. A significant proportion of wind from the northeast is also prevalent at the site. Daytime winds between 6 am and 6 pm are heavily influenced by the prevailing winds. During late evening and early morning, prevailing winds also dominate; however, there is also a substantial proportion of winds from the northwest as indicated in the diurnal wind roses (Figure 5).

The seasonal distribution of wind speed and wind direction is presented in Figure 6. The strongest winds at the Site occur most frequently from the south during the winter months. The greatest proportion of light winds occur during summer. There is a distinct north-easterly component to the wind rose in all seasons. A significant proportion of light north-easterly winds occur during spring months.

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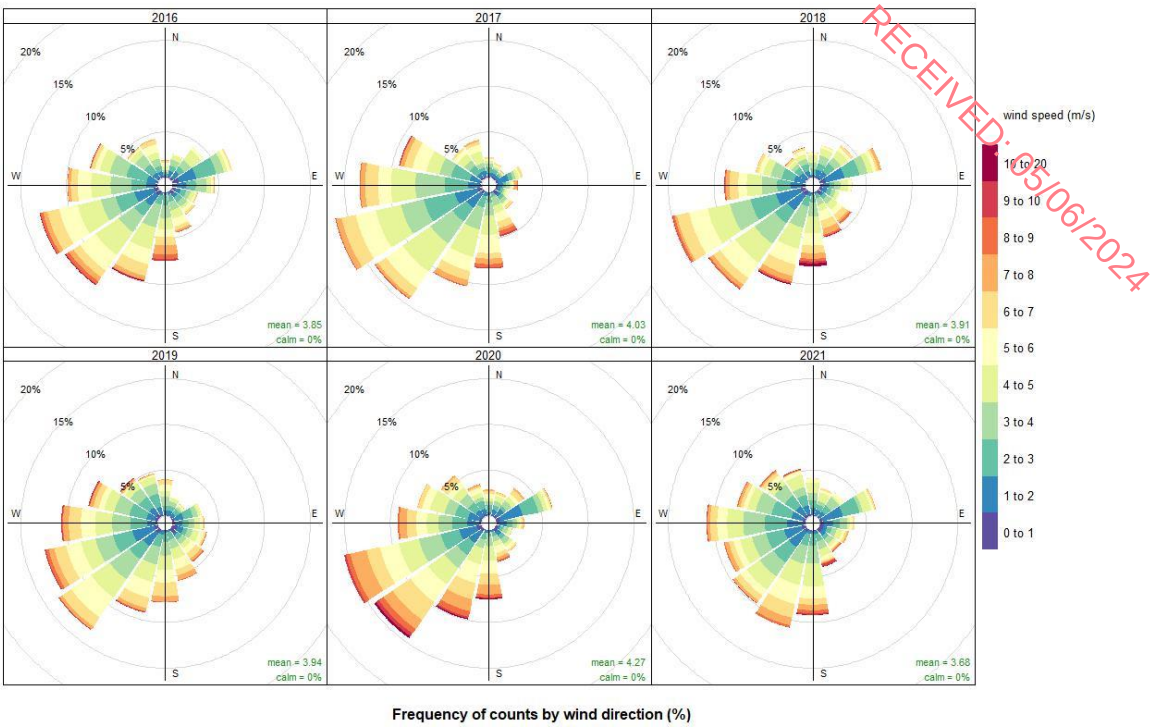

Figure 4 **Annual wind distribution predicted at the Site using CALMET for 2016 to 2021**

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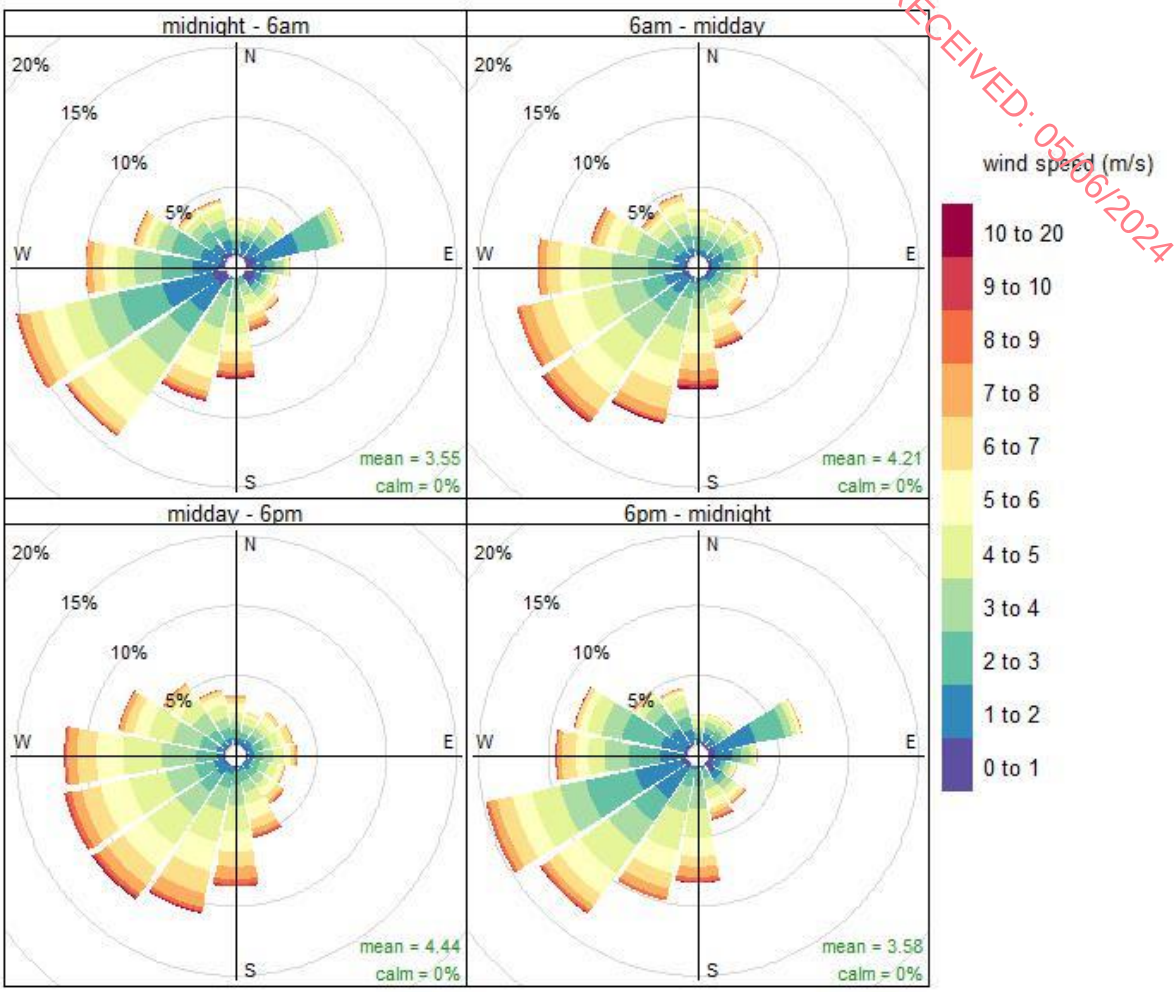

Figure 5 **Diurnal wind distribution predicted at the Site using CALMET**

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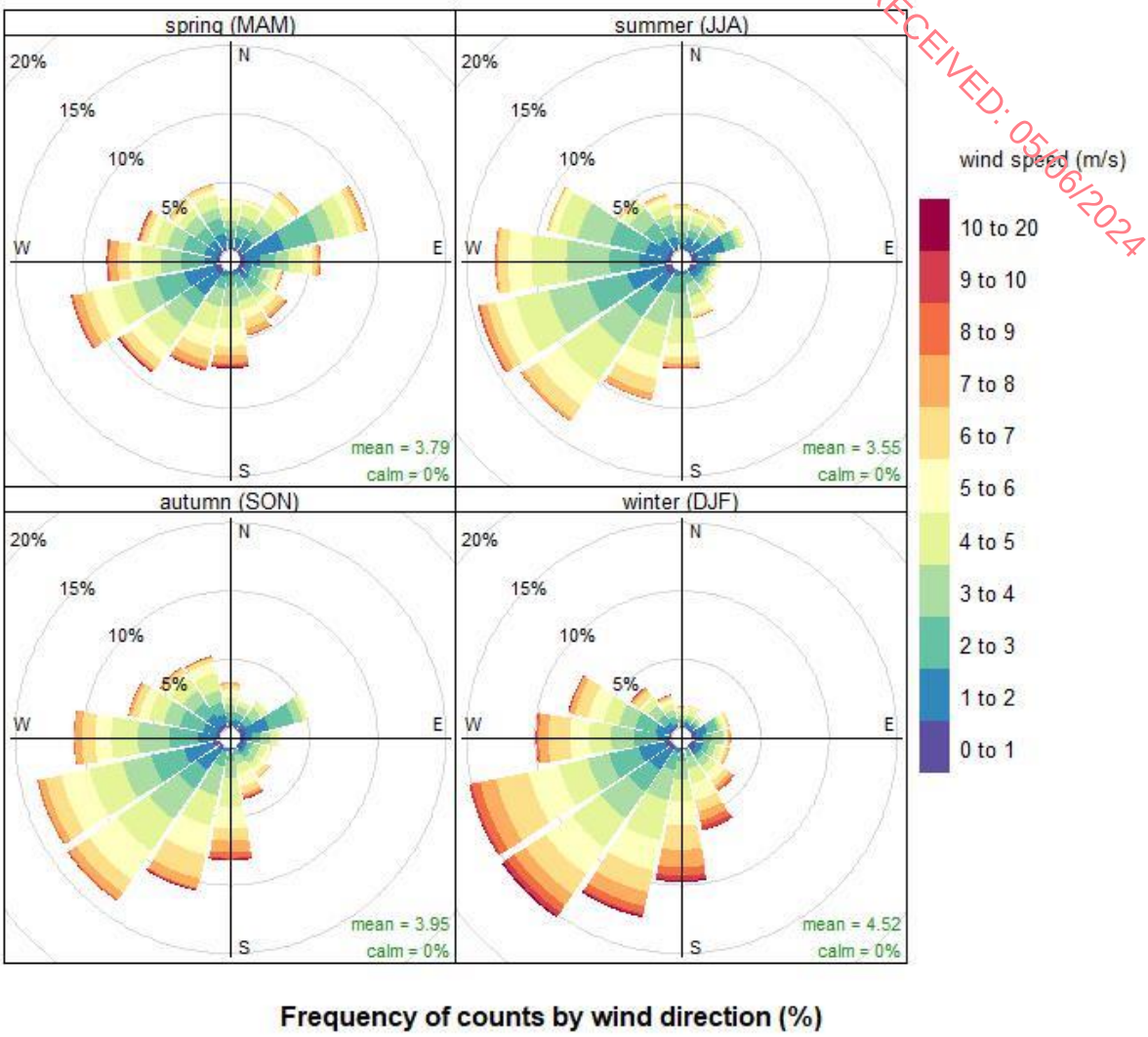

Figure 6 Seasonal wind distribution predicted at the Site using CALMET

4.3 Sensitive receptors

The sensitive receptors that are nearest to the Site are presented in Figure 7. The closest sensitive receptor is 82 m northwest of the Site boundary and 95 m northwest of the closest pig housing unit at the Site. Other sensitive receptors are located further away to the northeast, east, southeast and west. These sensitive receptors were included in the modelling assessment.

There is a single property located adjacent to the boundary of southwestern boundary the pig farm, that is not considered as a sensitive receptor. This house belongs to the former proprietor of pig farm who built his house adjacent to the pig farm and has lived there for a long number of years. The former proprietor sold the pig farm to Tulleka Trading. There is an understanding between the former proprietor and Tulleka Trading that this property will be offered to Tulleka Trading if it is ever to be sold. In such an instance this property will be utilised by Tulleka Trading for its farm manager and staff at the pig farm.

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Figure 7 **Nearest sensitive odour receptors to the pig farm**

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5. ODOUR IMAPCT ASSESSMENT

5.1 Methodology

The following section describes the modelling methodology that was adopted to assess the potential impacts of odour from the pig farm. The methodology is based on a dispersion modelling study incorporating source characteristics and operational activity data with meteorological data that is representative of the Site and surrounding region. The assessment has been prepared in accordance with industry standards, regulatory requirements and best practice approaches.

The assessment methodology has included:

- Selection of odour assessment criteria from Irish guidance.
- Derivation of an emissions inventory for the pig farm based on:
    - The layout and design of the housing units and sources
    - Emission factors from the EPA 2022 Pig Instruction Note.
- Generation of a representative meteorological dataset using prognostic meteorological modelling techniques.
- Characterisation of meteorological conditions in the region using prognostic meteorological data
- Dispersion modelling using the regulatory dispersion model, CALPUFF, to predict ground-level concentrations of odour across a Cartesian grid that covers the study area.
- Comparison of the predicted ground-level concentrations of odour against the odour assessment criteria.

5.2 Meteorological modelling

5.2.1 Overview

EPA's Air Dispersion Modelling Guidance Note (AG4) states that the dispersion process is dependent on the underlying meteorological conditions and ensuring that the air dispersion model includes representative meteorological data is critical. In the absence of Site-specific meteorological data, AG4 requires the use of representative data observed at a Met Eireann monitoring location. AG4 states:

> *The USEPA (24) has defined meteorological representativeness as:*
>
> > *"the extent to which a set of {meteorological} measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"*
>
> *and has expanded on this definition by outlining the factors to consider in the selection of appropriate meteorological data:*
>
> - *Proximity of the meteorological station to the modelling domain;*
> - *The complexity of the terrain;*
> - *The exposure of the meteorological monitoring Site;*
> - *The period of time during which data is collected."*

The modelling domain includes areas of semi-complex terrain. The meteorological parameters that affect dispersion are likely to vary spatially and temporally across the modelling domain due to the complexity of the terrain.

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The closest Met Eireann monitoring location to the Site is at Oak Park, Co. Carlow, which is 25 km east of the pig farm. This monitoring station is in rural rolling landscape. It sits at a low point in the local terrain and is close to the River Barrow. Meteorological data at Barrow Park is characterised by frequent northerly and southerly winds that occur due to the north-south orientation of the valley in which the monitoring station is located. The meteorological station at Oak Park is not likely to be representative of meteorological conditions at the Site as the terrain at both locations is very different.

A review by Katestone indicates that there are no other meteorological observation stations on the Met Eireann Network that meet the requirements specified in AG4 to be considered representative of the modelling domain.

Where Site specific or representative meteorological data is not available, AG4 provides the following alternatives:

> *Prognostic meteorological data should be considered in locations where there is no comparable representative Met Eireann station particularly in areas of complex terrain or at a land / sea interface.*

and

> *Prognostic meteorological data may be useful in locations where there is no comparable representative Met Eireann station. Locations where prognostic meteorological data may be required include regions of complex terrain and at a land/sea interface in circumstances where the nearest meteorological stations are outside of the modelling domain. As outlined by the USEPA, meteorological data should be spatially representative of the modelling domain and in particular of the pathway from the source to the most impacted receptor.*

Accordingly, prognostic meteorological data was generated for the Site due to the complexity of the terrain. The approach adopted to generate representative Site-specific data utilised a numerical model to generate a 3-dimensional grid of spatially varying meteorological parameters to represent conditions surrounding the Site. The approach is described in Appendix A1.

5.2.2 Meteorology

The prognostic model TAPM (developed in Australia by the Commonwealth Scientific and Industrial Research Organisation [CSIRO], version 4.0.5) and the diagnostic meteorological model CALMET (developed by EarthTec, version 6.5) were used to generate the three-dimensional meteorological dataset for the region.

The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the innermost nest. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

The three-dimensional wind field produced by TAPM/CALMET was then used to create a meteorological file suitable for us with the CALPUFF dispersion model.

Details of the model configuration and evaluation are presented in Appendix A.

The TAPM/CALMET approach has been used in jurisdictions like Australia to generate suitable meteorological data for modelling odour impacts for over 15 years. It has been adopted in for the assessment of a number proposed projects in Ireland in the last 5 years. There is significant experience using these approaches in jurisdictions such as Australia. Industry specific guidance on modelling odour dispersion from sources such as intensive poultry farms and cattle feedlots recommend the use of TAPM/CALMET to generate representative

Site-specific data. Research in Europe indicates that meteorological data generated using a numerical model provided a better indication of locations where odour nuisance occurred (Feliubadaló et al. 2008). In that study, locations of likely odour nuisance were determined using the German VDI grid assessment approach. The correlation between observed and modelled odour concentrations was significantly better using the TAPM/CALMET approach compared to traditional steady state gaussian models such as AERMOD.

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5.3 Emissions

5.3.1 Overview

The derivation of an odour emissions inventory for the Site is presented in this section.

There is no emissions monitoring data available for the pig farm. Odour emission rates from the pig housing units at pig farms vary considerably depending on factors such as:

- The ventilation rate which is heavily influenced by:
    - The target temperature of the pigs in the unit, which is influenced by:
        - Type of pig (sow, weaner, finisher)
        - The age of the pigs.
    - The ambient temperature outside the pig unit.
- The design of the housing system including but not limited to the following:
    - Depth of manure holding pits
    - Frequency on manure removal
    - Ventilation design
    - Surface area of manure exposed beneath the slats.
- The depth of manure in the house, which varies considerably with season.

The odour emission rates for the pig farm were derived from EPA recommended emission factors published in the EPA 2022 Pig Instruction Note. Whilst a site-specific odour emissions inventory could be developed by sampling the subject Site, it would require a significant amount of sampling to be conducted over different seasons and farm operating conditions, which is not economically viable.

5.3.2 Odour Emission Rates

The EPA 2022 Pig Instruction Note presents recommended approaches for the assessment of odour impact from pig farms in Ireland using:

- A screening tool approach (Screening Approach)
- A detailed modelling for odour assessment approach (detailed modelling approach).

The screening tool approach defined in the EPA 2022 Pig Instruction Note mandates the use of screening odour emission rates to determine if a pig farm is compliant with the relevant odour impact criterion.

The detailed modelling approach described in the EPA 2022 Pig Instruction Note presents lower emission factors that may be used in a detailed modelling assessment. Lower emission factors may be used when applicable emission reduction techniques are adopted on a pig farm.

The odour emission rates adopted in this assessment are based on screening odour emission rates presented in EPA 2022 Pig Instruction Note, which are reproduced in Table 1 below.

5.3.2.1 Screening odour emission rates

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The EPA 2022 Pig Instruction Note requires the calculation of a baseline odour emission rate by pig type based on the odour emission rates presented in Table 1.

Table 1 Odour emission factors for the different pig types used in the screening tool described in the EPA 2022 Pig Instruction Note

Type of Pig	Recommended odour emission Factor
	OU_E/s/pig
Dry Sow	21.0
Farrowing Sows	20.0
Weaners	6.0
Growers	12.0
Finishers	20.0
Fatteners[1]	17.3
Maiden Gilts	20.0

[1] In this document fatteners refer to the combined number of growers and finishers, which are defined in the EPA 2022 Pig Instruction Note. Growers and finisher are reared in the same housing units on pig farms. The emission rates for growers and finishers are therefore modelled using a single emission factor, presented for fatteners, which is calculated as a weighted average odour emission rate based on the proportion of growers/finishers on a pig farm and the odour emission rate specified in the EPA 2022 Pig Instruction Note for each category of pig

The typical pig weights by animal category are defined in the EPA 2022 Pig Instruction Note as:

- Between 8 kg and 30 kg for weaners
- Between 30 kg and 60 kg for growers
- Between 60 kg and 120 kg for finishers.

The typical pig weights by animal category defined in the EPA 2022 Pig Instruction Note indicate that in relation to pigs between 30 kg and 120 kg:

- 33.3% are growers weighing between 30 kg and 60 kg
- 66.6% are finishers weighing between 60 kg and 120 kg.

Pig farms in Ireland generally separate pigs into dedicated houses for weaners (8 kg and 30 kg) and pigs above 30 kg classified as fatteners (which includes growers and finishers).

Considering that growers and finishers are housed in the same housing units at the subject pig farm, a weighted average odour emission rate has been determined for fatteners based on:

- The odour emission rates for growers and finishers defined in the EPA 2022 Pig Instruction Note
- The proportion of fatteners made up of growers and finishers as per the EPA 2022 Pig Instruction Note.

An odour emission rate of 17.33 ou_E/s/pig has been determined for fatteners at the pig farm.

5.3.2.2 Detailed dispersion modelling odour emission rate

On 15 February 2017, the European Commission adopted Commission Implementing Decision (EU) 2017/302 (2017 CID). The 2017 CID establishes best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs. The 2017 CID and its associated BAT Reference document (BREF document) include the theory behind the sources of odour and possible odour control techniques available for the intensive agriculture (poultry and pigs) sector.

The EPA 2022 Pig Instruction Note states

> *The 2017 CID and BREF note include techniques to reduce emissions of odour (BAT 13) from the whole farm and to reduce ammonia (BAT 30) from animal housing. Whilst BAT 30 is specific to reducing ammonia emissions, the BREF outlines how odour emissions can also be reduced by implementing various BAT 30 techniques*
>
> *The BREF note describes how emissions associated with standard housing with a deep pit can be reduced for existing animal housing through their use in combination with other techniques (e.g., nutritional management, an air cleaning system, pH reduction of slurry, or slurry cooling).*

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Further detail of pig housing types and housing systems to reduce emissions of odour are presented in the EPA 2022 Pig Instruction Note (EPA, 2022).

The EPA 2022 Pig Instruction Note presents recommended levels of mitigation (odour emission reduction factors) that can be applied to the screening odour emission rates presented for the screening approach.

The odour emission mitigation measures that will be employed at the pig farm include:

- Manipulation of dietary protein and supplements
- The use of reduced manure volume pit.

In relation to the Manipulation of dietary protein and supplements, the EPA 2022 Pig Instruction Note states

> *Manipulating animal feed by reducing dietary protein will reduce the amount of unused protein that passes through a pig's digestive system. Fewer precursor compounds present in the slurry will reduce potential odour.*
>
> *For detailed modelling, it would be reasonable to apply a reduction factor of 10% on the basis of a reduction of 1% crude protein in the diet. The maximum reduction factor that can be applied is 30% linked to a reduction of 3% crude protein in the diet.*

Tulleka Trading has worked with animal nutritionists to reduce crude protein and supplements in the pigs diet. The levels of crude protein and supplements has been optimised at levels that minimise the amount of unused protein that passes through the pig's digestive system. This approach has reduced dietary crude protein by levels that surpass 3%. A reduction of 30%, which is the maximum reduction factor that can be applied as specified in the EPA 2022 Pig Instruction Note, has therefore been applied to the emission factors for all pig types at the pig farm as part of the detailed modelling assessment.

In relation to the use of a reduced manure volume pit, the depth of manure in the proposed new pig housing units at the Site will be maintained at a level of 60 cm or less. The depth of manure in all existing housing units with the exception of housing unit 1 and housing unit 4 will be kept below 60 cm. Considering that the stocking density of the existing housing units will be reduced due to the additional floor space created by the new housing units, there will be sufficient manure storge space at the farm to meet regulatory storage requirements without the use of external manure storage.

The use of a reduced manure volume pit and frequent slurry removal results in an odour emission reduction efficiency of 25% as specified in the EPA 2022 Pig Instruction Note.

The EPA 2022 Pig Instruction Note has a comprehensive section on odour mitigation offered when multiple odour mitigation techniques are adopted and states:

> *The main focus of odour mitigation used to abate odour from a pig rearing activity seeks to either prevent the amount of precursor compounds present which will degrade or to manipulate the anaerobic environment to avoid any precursors degrading, and odorous compounds being released. It can therefore be seen that when dietary manipulation is used in conjunction with a system integrated*

housing technique, there would be a degree of 'double counting' if the applicant were to add the individual reductions set out above.

Until further scientific evidence is available to the contrary, where two mitigation techniques are operated on the same pig rearing installation, the applicant should be limited to:

- *100% of the odour reduction offered by the first mitigation technique; and*
- *no more than 50% of the odour reduction offered by the second mitigation technique.*

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The odour emission rates adopted for the existing housing units with deep pits (Housing Unit 1 and Housing Unit 4) at the pig farm were determined as the screening odour emission factors specified in the EPA 2022 Pig Instruction Note reduced by 30% to account for dietary manipulation, which will be adopted by Tulleka Trading.

The odour emission rates adopted for the existing housing units that will operate with manure levels at 60 cm or less and the proposed housing units at the pig farm were determined as the screening odour emission factors specified in the EPA 2022 Pig Instruction Note reduced by 42.5% to account for:

- Dietary manipulation adopted by Tulleka Trading which reduces emissions by 30%
- Reduced manure volume pit which reduces emission by 25%; however, based on the requirements of adopting multiple odour mitigation techniques, the EPA 2022 Pig Instruction Note mandates that half of this abatement efficiency (12.5%) can be included in the calculation of reduced odour emission factors in a detailed dispersion modelling assessment.

The odour emission rates adopted in the detailed dispersion modelling assessment for the existing housing units that operate deep pit manure storage are presented in Table 2.

The odour emission rate adopted in the detailed dispersion modelling assessment for the existing housing units that will operate with manure levels below 60 cm and the proposed housing units, which will only house farrowing and finisher pigs is presented in

Table 3.

Table 2 The odour emission rates adopted for each category of pig in the existing housing units at the pig farm the operate deep pit manure storage

Type of Pig	Recommended odour emission Factor
	OU_E/s/pig
Dry Sow	14.7
Farrowing Sows	14.0
Weaners	4.2
Growers	8.4
Finishers	14.0
Fatteners[1]	12.1
Maiden Gilts	14.0

[1] In this document fatteners refer to the combined number of growers and finishers, which are defined in the EPA 2022 Pig Instruction Note. Growers and finisher are reared in the same housing units on pig farms. The emission rates for growers and finishers are therefore modelled using a single emission factor, presented for fatteners, which is calculated as a weighted average odour emission rate based on the proportion of growers/finishers on a pig farm and the odour emission rate specified in the EPA 2022 Pig Instruction Note for each category of pig

Table 3 The odour emission rates adopted for each category of pig in the existing housing units at the pig farm

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Type of Pig	Recommended odour emission Factor
	OU_E/s/pig
Farrowing	11.5
Fatteners[1]	10.0

[1] In this document fatteners refer to the combined number of growers and finishers, which are defined in the EPA 2022 Pig Instruction Note. Growers and finisher are reared in the same housing units on pig farms. The emission rates for growers and finishers are therefore modelled using a single emission factor, presented for fatteners, which is calculated as a weighted average odour emission rate based on the proportion of growers/finishers on a pig farm and the odour emission rate specified in the EPA 2022 Pig Instruction Note for each category of pig

5.4 Dispersion modelling

The assessment was conducted in accordance with recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). CALPUFF was used to predict ground-level concentrations of odour across the modelling domain and at sensitive receptor locations due to sources at the pig farm.

The details of source characterisation utilised for the pig farm in the modelling assessment are provided in Section 5.7.

5.5 Building downwash

When modelling emissions from an industrial installation it should be borne in mind that stacks that are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800m) (EPA, 2020).

A plume of a short stack is likely to be downwashed if its height is less than two and a half times the height of nearby buildings within a distance of 10 x L from each source, where L is the lesser of the height or width of the building. A Building Profile Input Program (BPIP) was used to determine the effects of buildings at the Site on the point sources of emissions at the pig farm. The Plume Rise Model Enhancements (PRIME) algorithm is recommended in EPA Guidance for use with AERMOD. PRIME was used in the dispersion modelling assessment to determine the effect of building induced turbulence on plumes from point sources at the pig farm.

The PRIME algorithm takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model.

There were 18 onsite buildings/structures included in the BPIP program to represent pig housing units and other onsite buildings. The coordinates used in the configuration of the pig housing units and onsite buildings in the PRIME BPIP model for this assessment are presented in Table 4.

Table 4 Pig housing units included and configuration of the pig housing units in BPIP

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Building	Easting	Northing	Height (m)
	UTM (m)	UTM (m)	
B1	615620.3	5862310	5.4
	615541.5	5862343	
	615549.5	5862360	
	615628.3	5862327	
B2	615599	5862300	5.4
	615518	5862335	
	615523.6	5862345	
	615603.9	5862311	
B3	615547.5	5862304	4.6
	615511.2	5862319	
	615516.3	5862329	
	615551.7	5862314	
B4	615604.9	5862282	5.1
	615550.3	5862306	
	615554.6	5862315	
	615609.3	5862291	
B5	615514.7	5862271	3
	615504.9	5862276	
	615519.4	5862308	
	615529.7	5862302	
B6	615526	5862266	3.5
	615516.2	5862270	
	615530.9	5862302	
	615540.2	5862297	
B7	615539.6	5862239	2
	615527	5862245	
	615549.3	5862292	
	615561.8	5862286	
B8	615550.6	5862237	3.1
	615542.8	5862241	
	615566.7	5862289	
	615574.5	5862285	
B9	615565.2	5862227	3.5
	615552.7	5862234	
	615574.5	5862278	
	615587.7	5862272	
B10	615579.9	5862222	5.1
	615568.2	5862228	

Building	Easting	Northing	Height (m)
	UTM (m)	UTM (m)	
	615580.2	5862252	
	615591.6	5862247	
B11	615592	5862248	3.2
	615579.6	5862253	
	615591.2	5862278	
	615602.9	5862271	
B12	615598.8	5862215	4.4
	615584.5	5862221	
	615608.3	5862271	
	615621.9	5862264	
B13	615547	5862214	3.6
	615551.4	5862224	
	615538.2	5862230	
	615533.5	5862220	
B14	615614.8	5862229	4.37
	615635.7	5862275	
	615648.4	5862270	
	615627.6	5862223	
B15	615630.9	5862222	4.37
	615652.1	5862268	
	615664.6	5862263	
	615643.8	5862217	
B16	615646.9	5862215	4.37
	615668.1	5862261	
	615680.5	5862256	
	615659.7	5862210	
B17	615683.6	5862254	4.37
	615695.9	5862249	
	615676.3	5862203	
	615663.5	5862209	
B18	615683.7	5862198	7.1
	615668	5862162	
	615597	5862191	
	615613	5862226	

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5.6 Sources of Emissions

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The pig housing units included in the dispersion modelling assessment are presented in Table 5, which specifies:

- The housing unit at the pig farm (existing and proposed)
- The type of pigs housed (proposed development as modelled)
- The type of ventilation (proposed development as modelled)
- The number of pigs housed in the building (proposed development as modelled)
- The number of sources used to represent the mechanical ventilation points in the modelling assessment.

All pig housing units at the Site will be mechanically ventilated sheds and were configured as point sources in the modelling assessment. The sources included in the modelling assessment, the number of pigs per source and the odour emission rate per source included in the modeling assessment are presented in Table 6.

Table 5 Pig housing units included in the dispersion modelling assessment

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Housing Unit	Type of Pig	Type of Ventilation	Number of Housed Pigs	Number of modelled sources
B1	Dry Sow	Mechanical	607[a]	6
B2	Fattener	Mechanical	723	10
B3	2nd stage weaner	Mechanical	637	5
B4	Fattener	Mechanical	407	6
B5	2nd stage weaner	Mechanical	590	6
B6	2nd stage weaner	Mechanical	563	6
B7	Farrowing	Mechanical	28	8
B8	Farrowing	Mechanical	18	10
B9	1st stage weaner	Mechanical	1720	8
B10	Fattener	Mechanical	303	3
B11	2nd stage weaner	Mechanical	541	3
B12	Fattener	Mechanical	739	13
B13	2nd	Mechanical	249	3
B14	Fattener	Mechanical	657	8
B15	Fattener	Mechanical	657	8
B16	Fattener	Mechanical	657	8
B17	Fattener	Mechanical	657	8
B18	Farrowing	Mechanical	117	6

[a] 487 dry sows plus 120 Maiden Gilts

Table 6 Sources and odour emission rate of sources included in the modelling assessment

Housing unit	Source number	Number of pigs per source[1]	Ammonia emission rate (g/s)
B1	B1_DS_1	101	1488
	B1_DS_2	101	1488
	B1_DS_3	101	1488
	B1_DS_4	101	1488
	B1_DS_5	101	1488
	B1_DS_6	101	1488
B2	B2_Ft1_1	72	720
	B2_Ft1_2	72	720
	B2_Ft1_3	72	720
	B2_Ft1_4	72	720
	B2_Ft1_5	72	720
	B2_Ft1_6	72	720
	B2_Ft1_7	72	720

Housing unit	Source number	Number of pigs per source[1]	Ammonia emission rate (g/s)
	B2_Ft1_8	72	720
	B2_Ft1_9	72	720
	B2_Ft1_10	72	720
B3	B3_Ft2_1	127	440
	B3_Ft2_2	127	440
	B3_Ft2_3	127	440
	B3_Ft2_4	127	440
	B3_Ft2_5	127	440
B4	B4_Ft3_1	68	822
	B4_Ft3_2	68	822
	B4_Ft3_3	68	822
	B4_Ft3_4	68	822
	B4_Ft3_5	68	822
	B4_Ft3_6	68	822
B5	B5_2nd_1	98	339
	B5_2nd_2	98	339
	B5_2nd_3	98	339
	B5_2nd_4	98	339
	B5_2nd_5	98	339
	B5_2nd_6	98	339
B6	B6_2nd_1	94	324
	B6_2nd_2	94	324
	B6_2nd_3	94	324
	B6_2nd_4	94	324
	B6_2nd_5	94	324
	B6_2nd_6	94	324
B7	B7_Fr1_1	4	40
	B7_Fr1_2	4	40
	B7_Fr1_3	4	40
	B7_Fr1_4	4	40
	B7_Fr1_5	4	40
	B7_Fr1_6	4	40
	B7_Fr1_7	4	40
	B7_Fr1_8	4	40
B8	B7_Fr2_1	2	20
	B7_Fr2_2	2	20
	B7_Fr2_3	2	20
	B7_Fr2_4	2	20
	B7_Fr2_5	2	20
	B7_Fr2_6	2	20

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Housing unit	Source number	Number of pigs per source[1]	Ammonia emission rate (g/s)
	B7_Fr2_7	2	20
	B7_Fr2_8	2	20
	B7_Fr2_9	2	20
	B7_Fr2_10	2	20
B9	B9_Wn_1	215	742
	B9_Wn_2	215	742
	B9_Wn_3	215	742
	B9_Wn_4	215	742
	B9_Wn_5	215	742
	B9_Wn_6	215	742
	B9_Wn_7	215	742
	B9_Wn_8	215	742
B10	B10_2nd_1	101	1007
	B10_2nd_2	101	1007
	B10_2nd_3	101	1007
B11	B11_2nd_1	180	623
	B11_2nd_2	180	623
	B11_2nd_3	180	623
B12	B12_Ft6_1	57	566
	B12_Ft6_2	57	566
	B12_Ft6_3	57	566
	B12_Ft6_4	57	566
	B12_Ft6_5	57	566
	B12_Ft6_6	57	566
	B12_Ft6_7	57	566
	B12_Ft6_8	57	566
	B12_Ft6_9	57	566
	B12_Ft6_10	57	566
	B12_Ft6_11	57	566
	B12_Ft6_12	57	566
	B12_Ft6_13	57	566
B13	B13_2nd_1	83	286
	B13_2nd_2	83	286
	B13_2nd_3	83	286
B14	B14_FT7_1	82	819
	B14_FT7_2	82	819
	B14_FT7_3	82	819
	B14_FT7_4	82	819
	B14_FT7_5	82	819
	B14_FT7_6	82	819

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Housing unit	Source number	Number of pigs per source[1]	Ammonia emission rate (g/s)
	B14_FT7_7	82	819
	B14_FT7_8	82	819
B15	B15_FT7_1	82	819
	B15_FT7_2	82	819
	B15_FT7_3	82	819
	B15_FT7_4	82	819
	B15_FT7_5	82	819
	B15_FT7_6	82	819
	B15_FT7_7	82	819
	B15_FT7_8	82	819
B16	B16_FT7_1	82	819
	B16_FT7_2	82	819
	B16_FT7_3	82	819
	B16_FT7_4	82	819
	B16_FT7_5	82	819
	B16_FT7_6	82	819
	B16_FT7_7	82	819
	B16_FT7_8	82	819
B17	B17_FT7_1	82	819
	B17_FT7_2	82	819
	B17_FT7_3	82	819
	B17_FT7_4	82	819
	B17_FT7_5	82	819
	B17_FT7_6	82	819
	B17_FT7_7	82	819
	B17_FT7_8	82	819
B18	B18_FW9_1	19	224
	B18_FW9_2	19	224
	B18_FW9_3	19	224
	B18_FW9_4	19	224
	B18_FW9_5	19	224
	B18_FW9_6	19	224

[1] Calculated as the total number of pigs in the housing unit divided by the number of sources included in the modelling assessment for that housing unit

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5.7 Source configuration

This section describes the configuration of the point sources included in the CALPUFF modelling assessment. The pig housing units at the pig farm are all mechanically ventilated and were, therefore, modelled as point sources in the modelling assessment.

Table 7 lists the point sources included in the modelling assessment and relevant modelling parameters including:

- The source coordinates
- The base elevations
- Stack height
- Stack diameter
- Exhaust temperature
- Exhaust velocity.

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The building locations, configuration and heights were determined from Site plans provided by Tulleka Trading, correspondence between Katestone and Tulleka Trading, site plans and from satellite imagery.

Table 7 Source parameters for the point sources at the pig farm

Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
B1_DS_1	615555	5862347	175.8	10.0	0.55	21	7.60
B1_DS_2	615567	5862342	175.9	10.0	0.55	21	7.60
B1_DS_3	615580	5862337	176.1	10.0	0.55	21	7.60
B1_DS_4	615593	5862332	176.2	10.0	0.55	21	7.60
B1_DS_5	615607	5862324	176.4	10.0	0.55	21	7.60
B1_DS_6	615614	5862321	176.5	10.0	0.55	21	7.60
B2_Ft1_1	615526	5862337	176.3	10.0	0.55	21	7.03
B2_Ft1_2	615535	5862334	176.2	10.0	0.55	21	7.03
B2_Ft1_3	615544	5862330	176.1	10.0	0.55	21	7.03
B2_Ft1_4	615551	5862327	176.0	10.0	0.55	21	7.03
B2_Ft1_5	615559	5862324	176.1	10.0	0.55	21	7.03
B2_Ft1_6	615566	5862321	176.1	10.0	0.55	21	7.03
B2_Ft1_7	615575	5862316	176.3	10.0	0.55	21	7.03
B2_Ft1_8	615583	5862313	176.4	10.0	0.55	21	7.03
B2_Ft1_9	615591	5862309	176.5	10.0	0.55	21	7.03
B2_Ft1_10	615598	5862306	176.5	10.0	0.55	21	7.03
B3_Ft2_1	615520	5862322	176.5	10.0	0.55	25	7.03
B3_Ft2_2	615524	5862320	176.5	10.0	0.55	25	7.03
B3_Ft2_3	615529	5862318	176.4	10.0	0.55	25	7.03
B3_Ft2_4	615538	5862314	176.3	10.0	0.55	25	7.03
B3_Ft2_5	615546	5862310	176.3	10.0	0.55	25	7.03
B4_Ft3_1	615561	5862305	176.3	10.0	0.55	21	7.60
B4_Ft3_2	615567	5862302	176.3	10.0	0.55	21	7.60
B4_Ft3_3	615579	5862297	176.5	10.0	0.55	21	7.60
B4_Ft3_4	615585	5862294	176.6	10.0	0.55	21	7.60
B4_Ft3_5	615598	5862289	176.7	10.0	0.55	21	7.60

Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
B4_Ft3_6	615603	5862287	176.8	10.0	0.55	21	7.60
B5_2nd_1	615512	5862277	177.1	4.0	0.40	25	7.07
B5_2nd_2	615514	5862281	177.0	4.0	0.40	25	7.07
B5_2nd_3	615516	5862286	176.9	4.0	0.40	25	7.07
B5_2nd_4	615518	5862291	176.8	4.0	0.40	25	7.07
B5_2nd_5	615520	5862296	176.8	4.0	0.40	25	7.07
B5_2nd_6	615523	5862301	176.7	4.0	0.40	25	7.07
B6_2nd_1	615522	5862270	177.0	4.0	0.40	25	7.07
B6_2nd_2	615524	5862275	176.9	4.0	0.40	25	7.07
B6_2nd_3	615526	5862280	176.8	4.0	0.40	25	7.07
B6_2nd_4	615529	5862285	176.7	4.0	0.40	25	7.07
B6_2nd_5	615531	5862290	176.7	4.0	0.40	25	7.07
B6_2nd_6	615533	5862295	176.6	4.0	0.40	25	7.07
B7_Fr1_1	615541	5862241	177.0	2.0	0.40	25	5.35
B7_Fr1_2	615543	5862247	176.9	2.0	0.40	25	5.35
B7_Fr1_3	615546	5862253	176.8	2.0	0.40	25	5.35
B7_Fr1_4	615549	5862259	176.7	2.0	0.40	25	5.35
B7_Fr1_5	615551	5862264	176.6	2.0	0.40	25	5.35
B7_Fr1_6	615554	5862269	176.5	2.0	0.40	25	5.35
B7_Fr1_7	615556	5862274	176.5	2.0	0.40	25	5.35
B7_Fr1_8	615559	5862280	176.5	2.0	0.40	25	5.35
B7_Fr2_1	615548	5862242	176.9	3.5	0.45	25	5.59
B7_Fr2_2	615550	5862247	176.8	3.5	0.35	25	5.10
B7_Fr2_3	615552	5862247	176.8	3.5	0.35	25	5.10
B7_Fr2_4	615551	5862252	176.7	3.5	0.35	25	5.10
B7_Fr2_5	615553	5862251	176.7	3.5	0.35	25	5.10
B7_Fr2_6	615556	5862257	176.7	3.5	0.35	25	5.10
B7_Fr2_7	615558	5862263	176.6	3.5	0.35	25	5.10
B7_Fr2_8	615559	5862262	176.7	3.5	0.65	25	3.85
B7_Fr2_9	615562	5862270	176.6	3.5	0.65	25	5.11
B7_Fr2_10	615565	5862275	176.6	3.5	0.65	25	5.11
B9_Wn_1	615560	5862236	176.9	3.9	0.65	25	5.44
B9_Wn_2	615562	5862235	176.9	3.9	0.65	25	5.44
B9_Wn_3	615564	5862245	176.9	3.9	0.65	25	5.44
B9_Wn_4	615566	5862244	176.9	3.9	0.65	25	5.44
B9_Wn_5	615570	5862255	176.8	3.9	0.65	25	5.44
B9_Wn_6	615572	5862254	176.8	3.9	0.65	25	5.44
B9_Wn_7	615575	5862267	176.7	3.9	0.65	25	5.44
B9_Wn_8	615577	5862266	176.8	3.9	0.65	25	5.44

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Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
B10_2nd_1	615581	5862243	177.0	5.5	0.65	21	5.44
B10_2nd_2	615575	5862231	177.1	5.5	0.65	21	5.44
B10_2nd_3	615581	5862236	177.1	5.5	0.65	21	5.44
B11_2nd_1	615595	5862270	176.9	3.6	0.65	25	5.44
B11_2nd_2	615591	5862262	176.9	3.6	0.65	25	5.44
B11_2nd_3	615587	5862254	177.0	3.6	0.65	25	5.44
B12_Ft6_1	615592	5862219	177.3	6.0	0.55	21	7.60
B12_Ft6_2	615594	5862223	177.4	6.0	0.55	21	7.60
B12_Ft6_3	615595	5862226	177.3	6.0	0.55	21	7.60
B12_Ft6_4	615597	5862229	177.3	6.0	0.55	21	7.60
B12_Ft6_5	615599	5862232	177.3	6.0	0.55	21	7.60
B12_Ft6_6	615602	5862239	177.3	6.0	0.55	21	7.60
B12_Ft6_7	615603	5862242	177.2	6.0	0.55	21	7.60
B12_Ft6_8	615605	5862245	177.2	6.0	0.55	21	7.60
B12_Ft6_9	615606	5862248	177.2	6.0	0.55	21	7.60
B12_Ft6_10	615609	5862255	177.2	6.0	0.55	21	7.60
B12_Ft6_11	615610	5862258	177.1	6.0	0.55	21	7.60
B12_Ft6_12	615612	5862261	177.1	6.0	0.55	21	7.60
B12_Ft6_13	615613	5862263	177.1	6.0	0.65	21	5.44
B13_2nd_1	615538	5862223	176.8	4.0	0.65	25	5.44
B13_2nd_2	615543	5862221	176.9	4.0	0.65	25	5.44
B13_2nd_3	615547	5862220	176.9	4.0	0.65	25	5.44
B14_FT7_1	615623.2	5862230	177.6	8.5	0.55	21	7.60
B14_FT7_2	615625	5862235	177.5	8.5	0.55	21	7.60
B14_FT7_3	615627.5	5862239	177.5	8.5	0.55	21	7.60
B14_FT7_4	615629.5	5862245	177.5	8.5	0.55	21	7.60
B14_FT7_5	615631.7	5862249	177.4	8.5	0.55	21	7.60
B14_FT7_6	615634	5862255	177.4	8.5	0.55	21	7.60
B14_FT7_7	615636.6	5862260	177.4	8.5	0.55	21	7.60
B14_FT7_8	615639	5862266	177.3	8.5	0.55	21	7.60
B15_FT7_1	615639	5862222	177.8	8.5	0.55	21	7.60
B15_FT7_2	615641	5862227	177.8	8.5	0.55	21	7.60
B15_FT7_3	615643.5	5862232	177.7	8.5	0.55	21	7.60
B15_FT7_4	615646.1	5862239	177.7	8.5	0.55	21	7.60
B15_FT7_5	615648.2	5862243	177.6	8.5	0.55	21	7.60
B15_FT7_6	615650.7	5862249	177.6	8.5	0.55	21	7.60
B15_FT7_7	615652.8	5862254	177.6	8.5	0.55	21	7.60
B15_FT7_8	615655.3	5862259	177.5	8.5	0.55	21	7.60
B16_FT7_1	615655.9	5862217	177.8	8.5	0.55	21	7.60

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Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Velocity
	km	km	m	m	m	°C	m/s
B16_FT7_2	615656.7	5862221	178.0	8.5	0.55	21	7.60
B16_FT7_3	615659.8	5862227	177.9	8.5	0.55	21	7.60
B16_FT7_4	615662.3	5862233	177.9	8.5	0.55	21	7.60
B16_FT7_5	615664.6	5862238	177.9	8.5	0.55	21	7.60
B16_FT7_6	615667.5	5862244	177.8	8.5	0.55	21	7.60
B16_FT7_7	615669.8	5862249	177.8	8.5	0.55	21	7.60
B16_FT7_8	615671.8	5862254	177.7	8.5	0.55	21	7.60
B17_FT7_1	615670.7	5862209	177.7	8.5	0.55	21	7.60
B17_FT7_2	615672.9	5862214	177.9	8.5	0.55	21	7.60
B17_FT7_3	615674.8	5862218	178.1	8.5	0.55	21	7.60
B17_FT7_4	615677.3	5862224	178.1	8.5	0.55	21	7.60
B17_FT7_5	615679.6	5862229	178.1	8.5	0.55	21	7.60
B17_FT7_6	615681.3	5862234	178.1	8.5	0.55	21	7.60
B17_FT7_7	615683.5	5862240	178.0	8.5	0.55	21	7.60
B17_FT7_8	615686.4	5862246	178.0	8.5	0.55	21	7.60
B18_FW9_1	615617	5862211	177.3	7.7	0.65	25	5.44
B18_FW9_2	615639.2	5862205	177.3	7.7	0.65	25	5.44
B18_FW9_3	615661.5	5862197	177.3	7.7	0.65	25	5.44
B18_FW9_4	615610.3	5862194	176.8	7.7	0.65	25	5.44
B18_FW9_5	615631.9	5862187	176.8	7.7	0.65	25	5.44
B18_FW9_6	615655.6	5862181	176.8	7.7	0.65	25	5.44

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6. ASSESSMENT RESULTS

Dispersion modelling has been conducted for five years of meteorological data. The following sections present the highest concentrations across the five-year modelled period.

Predicted ground-level concentrations of odour (1-hour average, 98th percentile) at the nearest sensitive receptors due to the pig farm are presented in Table 8. Plate 1 is a contour plot that presents the highest ground-level concentrations (1-hour average, 98th percentile) across the model domain during the five-year period.

The results show that predicted concentrations **comply** with the odour criterion recommended by EPA for new pig farms of 5.0ou$_E$/m^3 at all sensitive receptors included in the modelling assessment.

Table 8 Predicted ground-level concentrations of odour (1-hour average, 98th percentile) at the nearest sensitive receptors due to the pig farm

Receptor	1-hour 98th Odour Concentrations (ou$_E$/m^3)				
	2016	2017	2018	2019	2020
DR1	3.2	3.7	3.4	3.1	3.2
DR2	4.7	3.6	4.6	4.8	4.3
DR3	3.5	1.3	2.3	2.6	2.5
DR4	0.9	0.3	1.0	0.4	0.7
DR5	0.6	0.6	0.5	0.8	0.5
Odour Criteria (Current)	**5.0 ou$_E$/m^3**				

7. CONCLUSIONS

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Tulleka Trading Ltd commissioned Katestone to complete an odour impact assessment (OIA) for a pig farm located at Graigue, County Laois (Site). The OIA is required to determine the potential impacts of emissions from a proposed development at the pig farm that will include:

- A reduction of the stocking density by:
    - Constructing four new pig housing units to increase the total floor space
    - Maintaining pig numbers at current levels
- Constructing a new farrowing house to improve animal welfare
- Altering manure storage practices at eleven (11) of the thirteen (13) existing housing units at the site, which will be changed from deep pit storage tanks to shallow pit storage tanks to reduce emissions from the site
- Altering ventilation points on some of the pig housing units to reduce the potential impact of emissions exhausted from these sources.

The assessment is required to determine the potential impact of odorous emissions from the proposed development at the pig farm on nearby residential locations. The assessment will be submitted as part of planning and licensing applications for the pig farm.

The odour assessment was conducted in accordance with recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). The dispersion model, CALPUFF, was used to predict ground-level concentrations of odour across the model domain due to the pig farm. The assessment of odour has also been conducted in accordance with EPA's instruction note for the assessment of odour emissions from intensive agriculture pig installations (EPA, 2022).

The predicted concentrations of odour at all sensitive receptors are below the EPA limit of 5.0 ou_E/m^3.

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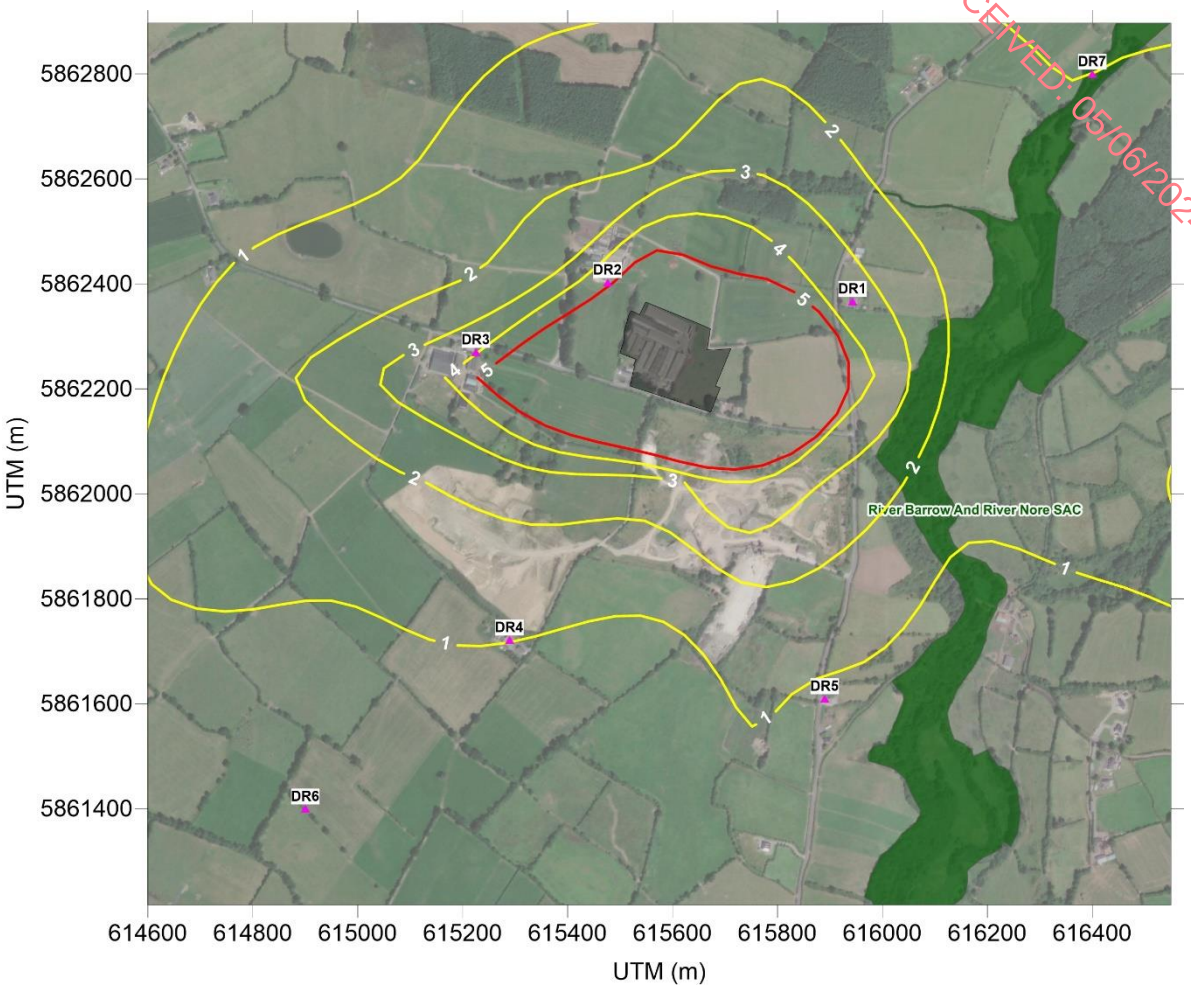

Plate 1 **Highest predicted 98th percentile 1-hour average ground-level concentrations of odour of five modelled years due to the pig farm**

Location:	**Averaging period:**	**Data source:**	**Units:**
Moate, Co Laois	1-hour	CALPUFF	ou_E/m^3
Type:	**Criterion level:**	**Prepared by:**	**Date:**
98th percentile	5 ou (Red Line)	P McDowell	September 2023

APPENDIX A MODELLING METHODOLOGY

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A1 METEOROLOGICAL MODELLING

A1.1 TAPM

The meteorological model, TAPM (The Air Pollution Model) Version 4.0.5, was developed by the CSIRO and has been validated by the CSIRO, Katestone and others for many locations in Australia, southeast Asia, North America and Ireland. Katestone has used the TAPM model throughout Australia and has performed well for simulating regional winds patterns. Katestone has recently used the TAPM model to generate gridded data over Cork city and Harbour. The data generated correlated well with observed data at Cork Airport. TAPM has proven to be a useful model for simulating meteorology in locations where monitoring data is unavailable.

TAPM requires synoptic meteorological information for the region surrounding the project. This information is generated by a global model similar to the large-scale models used to forecast the weather. The data are supplied on a grid resolution of approximately 75 km, and at elevations of 100 metres to five kilometres above the ground. TAPM uses this synoptic information, along with specific details of the location such as surrounding terrain, land-use, soil moisture content and soil type to simulate the meteorology of a region as well as at a specific location.

TAPM resolves local terrain and land-use features that may influence local meteorology and generates a meteorological dataset that is representative of Site-specific geographic conditions. A year of synoptic data must be selected as input for TAPM. The selection of this year should be such that the year is representative of typical meteorological conditions (and therefore is not necessarily the most recent year of available data) and whether monitoring data is available for the time period to validate the output dataset. In addition, Katestone's experience elsewhere suggests that variability of dispersion meteorological conditions from year to year are unlikely to change the outcome of the air quality assessment.

TAPM was configured as follows:

- 42 x 42 grid point domain with an outer grid resolution of 30 kilometres and nesting grids of 10, 3.0 1.0 and 0.3 kilometres.
- 5 modelled years (1 January 2016 to 31 December 2020)
- Grid centered near the Project Site at latitude 52°53'59.99 and longitude - 7°17'0.02
- US Geological Survey EROS global terrain height database
- TAPM default land use database, modified to be consistent with aerial imagery in the innermost grid
- 25 vertical grid levels
- No data assimilation.

A1.2 CALMET meteorological modelling

CALMET is an advanced non-steady-state diagnostic 3D meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system. CALMET is capable of reading hourly meteorological data as data assimilation from multiple Sites within the modelling domain; it can also be initialised with the gridded three-dimensional prognostic output from other meteorological models such as TAPM. This can improve dispersion model output, particularly over complex terrain as the near surface meteorological conditions are calculated for each grid point.

CALMET (version 6.5.0) was used to simulate meteorological conditions in the region. The CALMET simulation was initialised with the gridded TAPM 3D wind field data from the 1 km grid. CALMET treats the prognostic model output as the initial guess field for the CALMET diagnostic model wind fields. The initial guess field is then adjusted for the kinematic effects of terrain, slope flows, blocking effects and 3D divergence minimisation.

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CALMET was configured with twelve vertical levels with heights at 20, 60, 100, 150, 200, 250, 350, 500, 800, 1600, 2600 and 4600 metres at each grid point.

All options and factors were selected in accordance with NSW EPA CALPUFF Guidance released by TRC Environmental in 2011 except where noted below.

Key features of CALMET used to generate the wind fields are as follows:

- Domain area of 190 x 195 grid cells at 200m spacing
- 5 years modelled (1 January 2015 to 31 December 2019)
- Prognostic wind fields input as MM5/3D.dat for “initial guess” field (as generated by TAPM)
- Gridded cloud cover from prognostic relative humidity at all levels
- No extrapolation of surface wind observations to upper layers (not used in no-obs mode)
- Terrain radius of influence set to 7 km
- Maximum search radius of 10 grid cells in averaging process
- Use prognostic relative humidity
- Land use data modified to be consistent with aerial imagery.

All other options set to default.

A2 CALPUFF DISPERSION MODELLING

CALPUFF simulates the dispersion of air pollutants to predict ground-level concentration and deposition rates across a network of receptors spaced at regular intervals, and at identified discrete locations. CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing parameterisations for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation. CALPUFF employs the 3D meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal. CALPUFF takes into account the geophysical features of the study area that affects dispersion of pollutants and ground-level concentrations of those pollutants in identified regions of interest. CALPUFF contains algorithms that can resolve near-source effects such as building downwash, transitional plume rise, partial plume penetration, sub-grid scale terrain interactions, as well as the long-range effects of removal, transformation, vertical wind shear, overwater transport and coastal interactions. Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

Key features of CALPUFF used to simulate dispersion:

- Domain area of 190 x 195 grid cells at 200m spacing
- 5 years modelled (1 January 2015 to 31 December 2019)
- Gridded 3D hourly-varying meteorological conditions generated by CALMET
- Partial plume path adjustment for terrain modelled
- Dispersion coefficients calculated internally from sigma v and sigma w using micrometeorological variables.

All other options set to default.