Odour Impact Assessment – Carhue Piggeries Farm, Timoleague, Co. Cork

Prepared for:

Carhue Piggeries Limited

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Final

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Glossary

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
m³/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
µg/m³	micrograms per cubic meter

Abbreviations	Definition
AG4	Air Guidance 4
BAT	Best available techniques
EPA	Environmental Protection Agency
EF	Emission factor
EU	European Union

EXECUTIVE SUMMARY

Carhue Piggeries commissioned Katestone to complete an odour impact assessment (OIA) for a pig farm located at Colligboy, Timoleague, Co. Cork.

The OIA is required to determine the potential impact of odorous emissions from the pig farm on nearby sensitive receptors.

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 OIA has found that odour emissions from the pig farm are unlikely to adversely impact nearby residential locations. Dispersion modelling that has been conducted as part of the OIA shows that predicted concentrations of odour at all sensitive receptors are under EPA limits and, therefore, **comply** with odour criterion recommended by EPA for existing pig farms of 5.0ou_E/m^3 at all modelled sensitive receptor locations.

1. INTRODUCTION

Katestone Environmental Ireland Ltd (Katestone) was commissioned by Carhue Piggeries Limited (Carhue Piggeries) to complete an odour impact assessment (OIA) of a pig farm located at Colligboy, Timoleague, Co. Cork (site).

The pig farm includes two sets of housing units including:

- A set of housing units located in the southern area of the site that was initially constructed in the 1990s (old housing units)
- A set of housing units located in the northern area of the site that has been developed since 2019 (new housing units).

EPA issued an Integrated Pollution Prevention and Control (IPPC) licence (Register number P0621-01) for the old housing units in 2003. In 2013, the licence was amended to an Industrial Emissions Licence (IEL) (Register number P0621-02). Carhue Piggeries anticipates that the new housing units will be incorporated into the IEL, based on a licence review application. This odour assessment will form part of the licence review application, being submitted as a supporting document.

OIA was used to inform the design of the pig farm to ensure that emissions of odour do not reach unacceptable levels at nearby sensitive receptors as defined by the Environmental Protection Agency (EPA) in Ireland.

This OIA has been undertaken using dispersion modelling techniques in accordance with the requirements of EPA's Air Dispersion Modelling Guidance Note (AG4). The OIA 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

The pig farm is located approximately 1.2 km northwest of the village of Timoleague, Co. Cork. It is located at an elevated position that overlooks the agricultural lands of south Co. Cork. The south coast of Cork is approximately 6.5 km south of the site. There are number of rural residences in the vicinity of the site. The boundary of the site and its environs are presented in Figure 1. All pig housing units will be located within the boundary of the site.

A site plan illustrating the layout of the pig housing units within the Site boundary is presented in Figure 2 and Figure 3. The site plan also shows the locations of stacks associated with the pig housing units.

The animal numbers housed in the old housing units as part of the proposed development, are as follows:

- 750 dry sows
- 280 suckling sows
- 160 maiden gilts.
- 3 boars
- 3,090 weaners pigs
- 4,150 fattening pigs

The new housing units will have the following maximum animal holding capacity:

- 480 dry sows
- 240 suckling sows
- 130 maiden gilts.
- 2 boars
- 3,910 weaners pigs
- 4,850 fattening pigs.

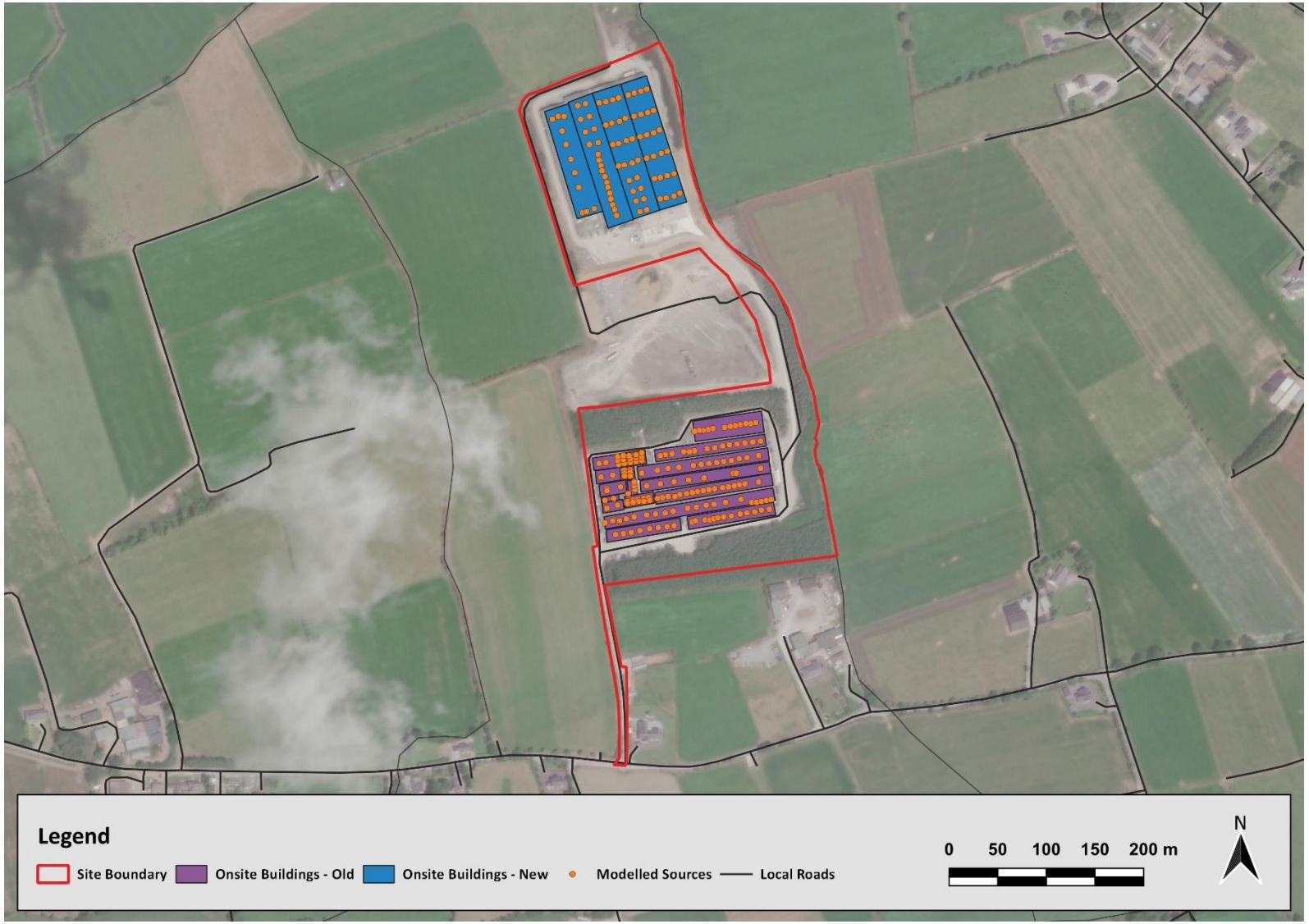

Figure 1 **Carhue Piggeries Site boundary (red line) and the surrounding environment**

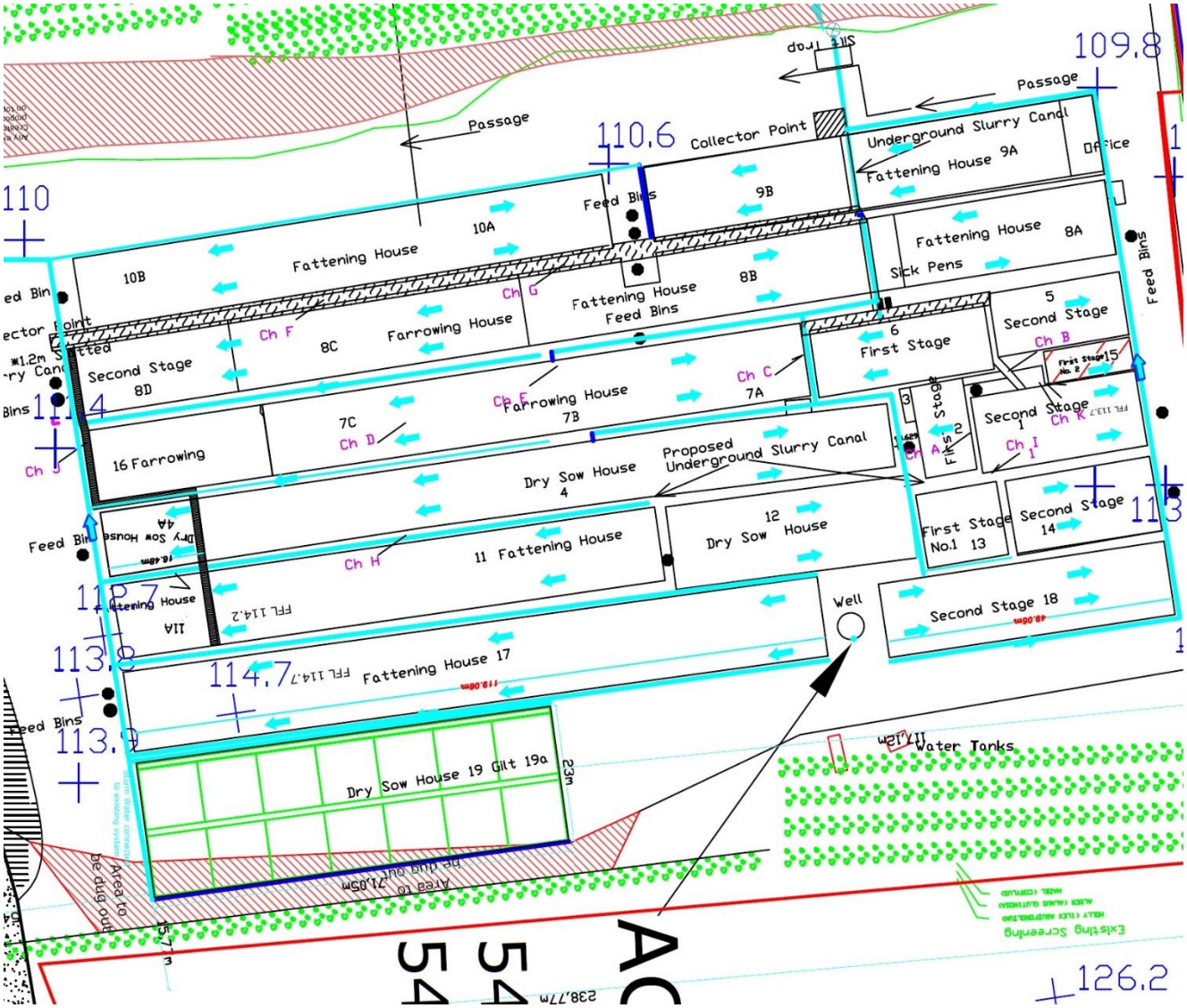

Figure 2 **Carhue pig farm site plan – Old housing units**

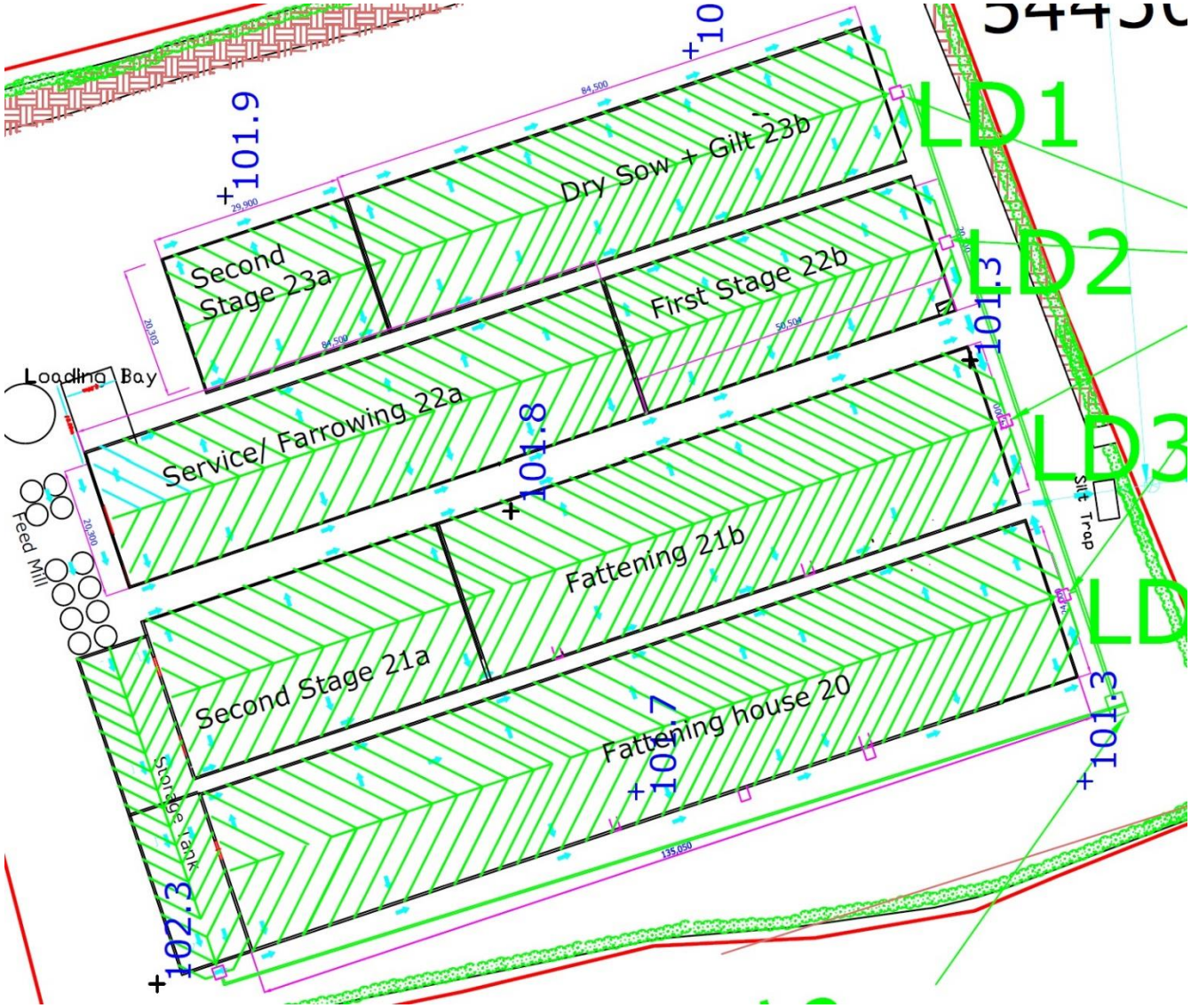

Figure 3 **Carhue pig farm site plan – New housing units**

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.

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.

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*, which 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 the acceptable odour levels apply at odour-sensitive locations only. 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 acceptable odour level that is applicable to the subject 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

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 characterised 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 sensitive odour receptors in all directions from the Site. If the dispersion modelling assessment shows compliance with the acceptable odour level at the nearest sensitive receptors it indicates that odour levels will be lower at sensitive receptor locations further afield

4.1 Local terrain and land-use

The site is in a remote rural location surrounded by pasture. The old housing units are on the south facing slope of an area of elevated terrain. The new housing units are at the top of this area of elevated terrain. The terrain falls north of the new housing units, the north facing slope forming the southern wall of a valley that contains the Argideen River at its lowest point. The Argideen River runs west to east approximately 1.5 km north of the new housing units. It bends to the south approximately 1.8 km northeast of the site boundary, flowing south for approximately 2 km before bending east and entering the Courtmacsharry Estuary approximately 1.7 km southeast of the site.

The terrain of the region that has been included in the dispersion modelling domain is presented in Figure 4.

The Site is in an area that is likely to have complex meteorological conditions. At its closest point, it is 6.5 km from the coastline. The site is 2 km west of the Courtmacsherry Estuary, which runs from west to east into the Celtic Sea. There are valleys both north and south of the Site with water ways that ultimately enter the Courtmacsherry Estuary including:

- The Spittal Stream that runs from southwest to northeast approximately 2 km south of the Site.
- The River Arigideen that runs from west to east approximately 1.5 km north of the Site before meandering southwards approximately 2 km northeast of the Site.

The Site is in an elevated position compared to the surrounding terrain. The site elevation is approximately 135 m. Only land to the west is higher than the Site, gradually rising to approximately 144 m, 700 m west of the site. The terrain elevation falls to:

- 23 m within 1.3 km of the Site to the north
- 2 m within 2 km of the Site to the east
- 30 m within 1.3 km of the Site to the south.

The terrain and land use of the site are relatively complex due to its location near a ridge, in close proximity to a river valley, mountains and the sea. The complexities of the site in terms of local terrain and proximity to multiple water bodies are likely to have an important effect on dispersion conditions near the site and across the modelling domain.

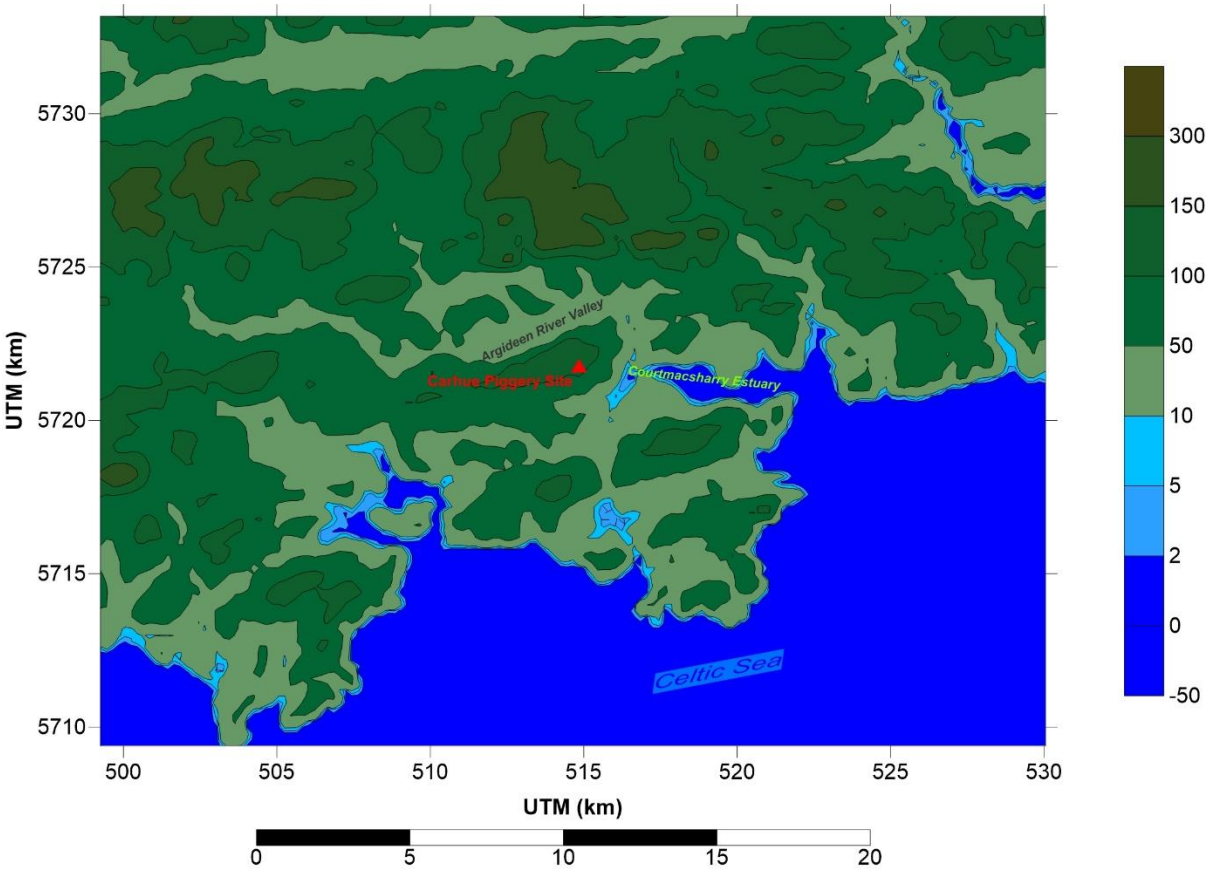

Figure 4 2-dimensional terrain of the modelled domain

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 4.4 m/s. This compares to a 1-hour average wind speed of 4.8 m/s at Cork Airport in 2014. A wind rose representing the annual distribution of 1-hour average winds is presented in Figure 5.

The prevailing wind direction in Ireland is between south and west. It is clear from Figure 5 that these winds have a strong influence on wind patterns 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 6).

The seasonal distribution of wind speed and wind direction is presented in Figure 7. The strongest winds at the site occur most frequently from the west and west-southwest during the winter months. The greatest proportion of light winds occur during summer and autumn. There is a distinct north-westerly component to the wind rose in summer. A significant proportion of light northerly winds occur during autumn.

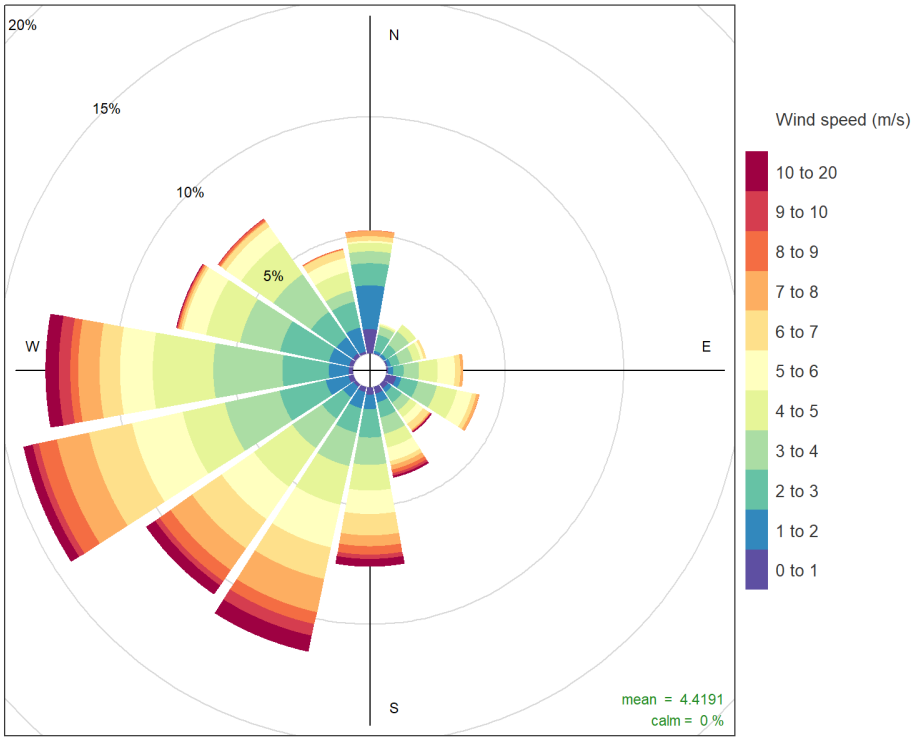

Figure 5 **Annual wind distribution predicted at the site using CALMET**

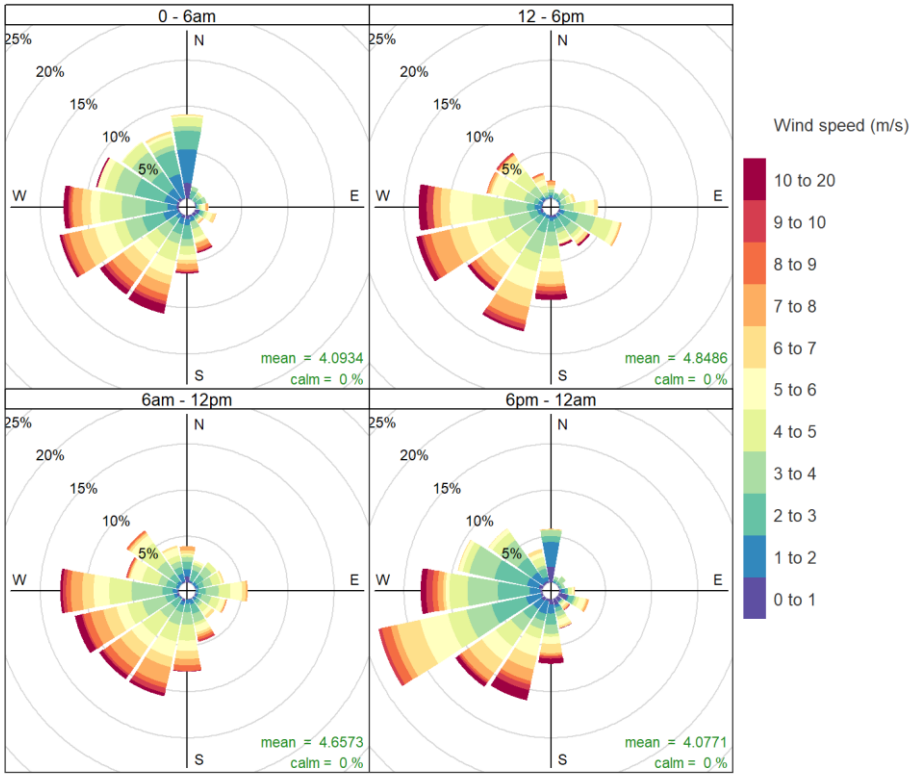

Figure 6 **Diurnal wind distribution predicted at the site using CALMET**

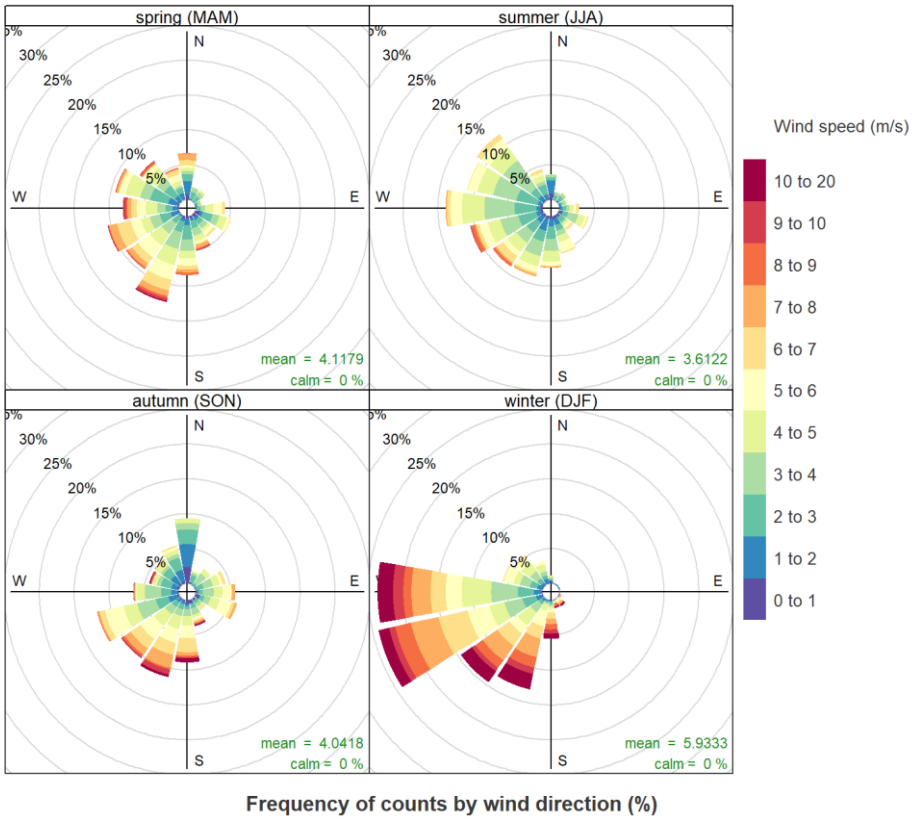

Figure 7 Seasonal wind distribution predicted at the site using CALMET

4.3 Sensitive receptors

The sensitive receptors that are nearest to the Site and have been incorporated into the dispersion model as discrete receptors are presented in Figure 8. The closest sensitive receptor is approximately 90 m south of the Site boundary and 160 m south of the closest pig housing unit. Other sensitive receptors are located further away to the north, northeast, east, southeast, south and southwest.

The property adjacent to the entrance road within the site boundary is the dwelling of the owner by Carhue Piggeries. Consequently, the dwelling on this property is not regarded as sensitive receptors for the purpose of this OIA.

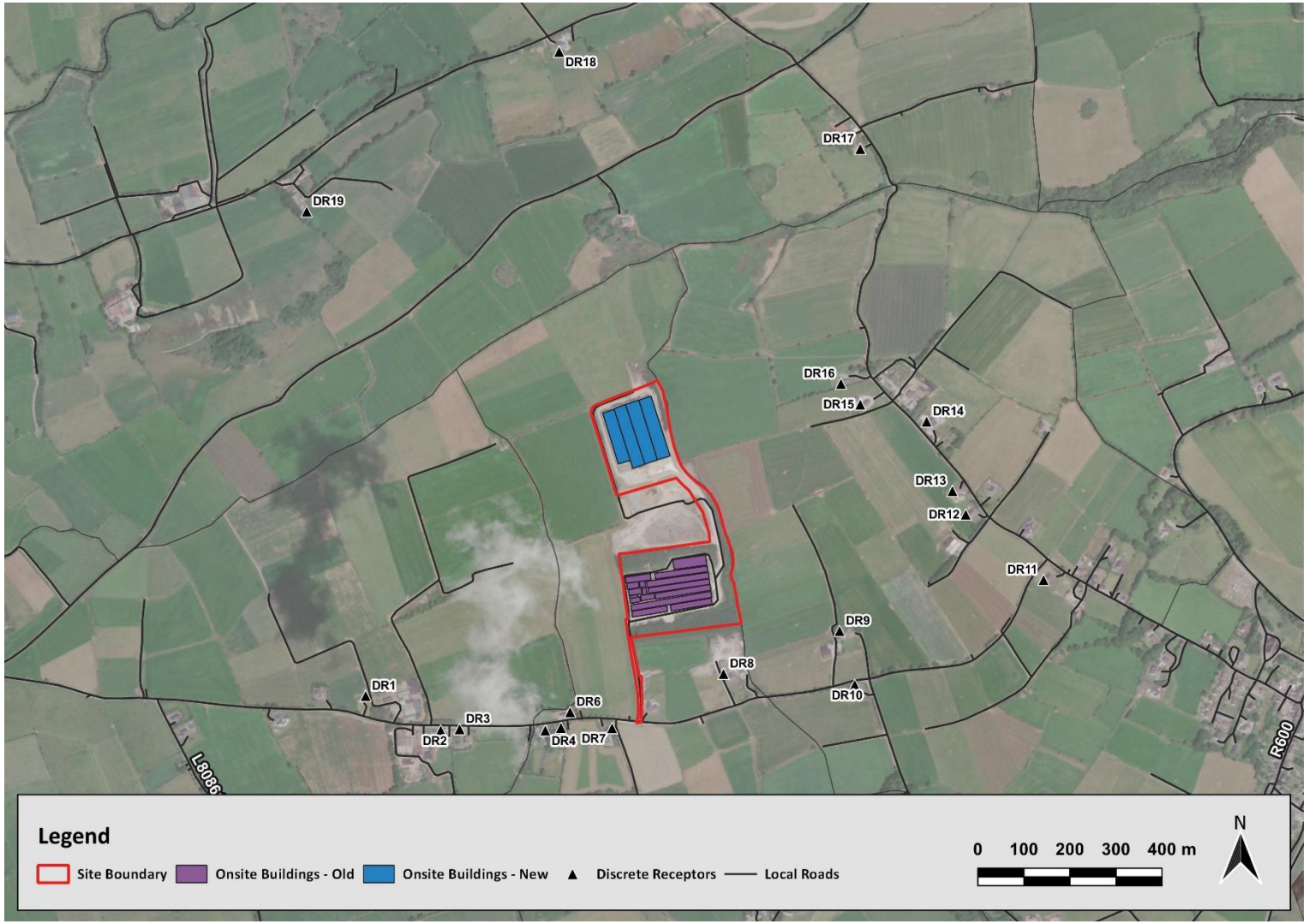

Figure 8 **Nearest sensitive odour receptors to the pig farm**

5. ODOUR IMAPCT ASSESSMENT

5.1 Methodology

The following section describes the modelling methodology that was adopted to assess the potential odour impacts 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 that it is critical to ensure that the air dispersion model includes representative meteorological data. 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 complex terrain and coastal areas. The meteorological parameters that affect dispersion are likely to vary spatially and temporally across the modelling domain due to these factors.

The closest Met Eireann monitoring location to the Site is at Cork Airport, which is 30 km northeast. This monitoring station is in rural rolling landscape. It sits at a high point in the local terrain. There are a number of small river tributaries in the vicinity of Cork Airport that are aligned from north to south. Because of its elevation, exposed location and distance from the coast, the meteorological data collected at Cork Airport is not likely to be representative of meteorological conditions at the Site.

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 and the proximity to the sea. 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 Section A1 of 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.

5.3 Odour Emission Rates

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.

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 Section 5.3.1and 5.3.2 below.

5.3.1 Screening odour emission rates

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 below.

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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
Maiden Gilts	20.0

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.

5.3.2 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).*

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 (new and old housing units).
- The use of reduced manure volume pit and the frequent removal of slurry (new and old housing units)

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.

Carhue Piggeries 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.

If dietary crude protein exceeds the dietary requirements of a pig it will be excreted resulting in higher levels of nitrogen in slurry. Research has indicated that in addition to lower levels of nitrogen in the slurry, odour emission rates from slurry reduce if the level of crude protein in the diets fed to the pigs are reduced. It is therefore desirable to optimise the level of crude protein in diets to meet the pig's nutritional requirements for growth while minimising nitrogen levels in excrement and odour emission rates from the slurry. For weaner and finisher pigs, the level of crude protein required in the diet declines with age and as growth slows. Younger pigs therefore require more crude protein than older pigs in each of the weaner (8kg to 30kg) and finisher (30kg to 120kg) categories.

The site will adopt low protein diets as a BAT technique to reduce ammonia emissions to the atmosphere. The level of protein in diets at the pig farm will be limited (as a weighted average) to:

- 14.5% for sows
- 17.5% for weaners
- 15% for fatteners.

The crude protein levels stated here are weighted average levels over an annual period (corresponding to the annual average assessment criterion for ammonia and nitrogen deposition) across the diets fed each category of pigs listed including sows, weaners and finishers because the overall level of nitrogen that ends up in the slurry tanks of pig housing units is correlated with the average level of crude protein in the diets fed to pigs in the housing unit.

The diets of younger pigs in each of the weaner and fattener categories will be above the levels specified and the diets of older pigs in each of these categories will be below the levels specified overall. However, the weighted average crude protein levels for the categories of pigs will be maintained below the levels specified above.

This approach has reduced dietary crude protein by levels that surpass 3%. Consequently, an odour reduction factor of 30% can be applied as specified in the EPA 2022 Pig Instruction Note.

In relation to the use of a reduced manure volume pit, the depth of manure in the old and new pig housing units at the Site will be maintained at a level of 60 cm or less. Slurry will be removed from the site consistently throughout the year and will be transported to a local anaerobic digestion plant (Timoleague Agri Gen).

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.*

As per the EPA 2022 Pig Instruction Note the following odour emission reductions were applied in the odour modelling assessment for the old housing units and the new housing units:

- Dietary manipulation – 30% odour reduction compared to the screening odour emission factor
- Reduced manure volume pit and frequent slurry removal – 12.5% odour reduction compared to the screening odour emission factor (half of the odour reduction offered by this mitigation as this is the second mitigation technique as per the EPA 2022 Pig Instruction Note)

The odour emission rates adopted in the detailed dispersion modelling assessment for the housing units at the site are presented in Table 2.

Table 2 The odour emission rates adopted for each category of pig in the existing housing units at the pig farm

Type of Pig	Recommended odour emission Factor
	OU_E/s/pig
Dry Sow	12.1
Farrowing Sows	11.5
Weaners	3.5
Growers	6.9
Finishers	11.5
Maiden Gilts	12.1

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 20 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 old pig housing units in the PRIME BPIP model for this assessment are presented in Table 3. The coordinates used in the configuration of the new pig housing units in the PRIME BPIP model for this assessment are presented in Table 3.

Table 3 Buildings included and configuration of the old pig housing units in BPIP

Building	Easting	Northing
	UTM (m)	UTM (m)
Old Housing Unit 1	514930	5721710
	514933	5721697
	514843	5721682
	514841	5721695
Old Housing Unit 2	514834	5721694
	514836	5721681
	514759	5721669
	514758	5721682
Old Housing Unit 3	514930	5721725
	514932	5721712
	514757	5721683
	514756	5721695
Old Housing Unit 4	514928	5721740
	514930	5721727
	514810	5721708
	514808	5721720
Old Housing Unit 5	514807	5721721
	514808	5721709
	514778	5721704
	514777	5721716
Old Housing Unit 6	514777	5721703
	514755	5721699
	514754	5721709
	514775	5721713
Old Housing Unit 7	514771	5721718
	514772	5721713
	514754	5721709
	514753	5721715
Old Housing Unit 8	514780	5721720
	514752	5721715
	514751	5721728
	514778	5721733
Old Housing Unit 9	514790	5721718
	514781	5721717
	514780	5721732
	514789	5721733
Old Housing Unit 10	514928	5721740
	514794	5721721
	514793	5721732
	514926	5721752

Building	Easting	Northing
	UTM (m)	UTM (m)
Old Housing Unit 11	514926	5721753
	514791	5721733
	514790	5721747
	514924	5721766
Old Housing Unit 12	514788	5721734
	514775	5721733
	514775	5721746
	514787	5721748
Old Housing Unit 13	514772	5721746
	514774	5721733
	514748	5721729
	514747	5721742
Old Housing Unit 14	514800	5721750
	514746	5721743
	514744	5721756
	514798	5721764
Old Housing Unit 15	514923	5721768
	514809	5721752
	514808	5721764
	514921	5721780
Old Housing Unit 16	514921	5721782
	514850	5721773
	514847	5721793
	514918	5721804

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

Building	Easting	Northing
	UTM (m)	UTM (m)
New Housing Unit 1 (Fattening House)	514813	5722010
	514841	5722019
	514800	5722149
	514773	5722140
New Housing Unit 2 (Fattening and Second Stage Weaner House)	514786	5722001
	514813	5722010
	514773	5722140
	514744	5722131
New Housing Unit 3 (Service /S\Farrowing and First Stage Weaner House)	514760	5721992
	514786	5722001
	514744	5722131

Building	Easting	Northing
	UTM (m)	UTM (m)
	514719	5722121
New Housing Unit 4(Second Stage Weaner Dry Sow + Gilt House)	514729	5722002
	514755	5722009
	514719	5722120
	514695	5722112

5.6 Sources of Emissions and Modelled Emission Rates

The pig housing units included in the dispersion modelling assessment are presented in Table 5 and Table 6, which specify:

- The housing unit at the pig farm
- The type of pigs housed
- The type of ventilation
- The number of pigs housed in the building
- The number of sources used to represent the mechanical ventilation points in the modelling assessment
- The modelled emission rate per modelled source.

The pig housing units at the Site are mechanically ventilated and were configured as point sources in the modelling assessment.

To represent the existing pig housing units in the dispersion modelling assessment point 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 5.

To represent the new pig housing units in the dispersion modelling assessment point 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 **Old pig housing units included in the dispersion modelling assessment, number of pigs housed, modelled sources per housing unit and odour emission rate per modelled source.**

Housing Unit	Type of Pig	Type of Ventilation	Number of Housed Pigs	Number of modelled sources	Odour Emission Rate per source (ou/s)
Housing Unit 1	Second stage	Mechanical	450	3	518
Housing Unit 2	First Stage	Mechanical	200	4	173
Housing Unit 4	Dry Sow	Mechanical	250	7	431
Housing Unit 4a	Dry Sow	Mechanical	40	1	483
Housing Unit 5	Second stage	Mechanical	300	2	518
Housing Unit 6	First Stage	Mechanical	400	10	138
Housing Unit 7a	Farrowing	Mechanical	55	5	127
Housing Unit 7b	Farrowing	Mechanical	55	6	105
Housing Unit 7c	Farrowing	Mechanical	55	4	158
Housing Unit 8a	Fattening	Mechanical	300	5	598
Housing Unit 8b	Fattening	Mechanical	315	8	392
Housing Unit 8c	Farrowing	Mechanical	60	2	299
Housing Unit 8d	Second stage	Mechanical	240	5	166
Housing Unit 9a	Fattening	Mechanical	300	4	747
Housing Unit 9b	Fattening	Mechanical	300	4	747
Housing Unit 10a	Fattening	Mechanical	520	6	864
Housing Unit 10b	Fattening	Mechanical	320	7	456
Housing Unit 11	Fattening	Mechanical	770	7	1096
Housing Unit 11a	Fattening	Mechanical	100	1	997
Housing Unit 12	Dry Sow	Mechanical	128[1]	5	309
Housing Unit 13	First Stage	Mechanical	250	6	144
Housing Unit 14	Second stage	Mechanical	400	2	690
Housing Unit 15	First Stage	Mechanical	100	2	173
Housing Unit 16	Farrowing	Mechanical	55	2	316
Housing Unit 17	Fattening	Mechanical	1225	14	872
Housing Unit 18	Second stage	Mechanical	750	17	152
Housing Unit 19	Dry Sow	Mechanical	335	8	506
Housing Unit 19a	Gilt	Mechanical	160	4	483

[1] includes three (3) boars

Table 6 **New pig housing units included in the dispersion modelling assessment, number of pigs housed, modelled sources per housing unit and odour emission rate per modelled source.**

Housing Unit	Type of Pig	Type of Ventilation	Number of Housed Pigs	Number of modelled sources	Odour Emission Rate (ou/s)
New Housing Unit 20	Fattening	Mechanical	2950	24	1,225
New Housing Unit 21a	Second stage	Mechanical	1700	8	733
New Housing Unit 21b	Fattening	Mechanical	1900	16	1,184
New Housing Unit 22a	Service/Farrowing	Mechanical	240	12	230
New Housing Unit 22b	First Stage	Mechanical	1700	8	733
New Housing Unit 23a	Second stage	Mechanical	510	5	352
New Housing Unit 23b	Dry Sow/Gilt	Mechanical	612[1]	6	1,234

[1] The 612 pigs comprise of 480 dry sows and 130 gilts and 2 boars will be housed in this section of New Housing Unit 23

5.7 Source configuration

The pig housing units at the pig farm are mechanically ventilated housing units and were, therefore, modelled as point sources in the modelling assessment. The redundant slurry tank is covered and was therefore included as a volume source in the modelling assessment. This section describes the configuration of the sources included in the CALPUFF 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.

Table 8 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.

Table 9 lists the volume sources included in the modelling assessment and relevant modelling parameters including:

- The source coordinates
- The base elevations
- Effective height

- Sigma-y
- Sigma-z

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

Table 7 Source parameters for the point sources of the old housing units at the pig farm

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
1	O_2nd1_1	514773	5721726	112.4	4.5	0.6	25	6.2
	O_2nd1_2	514759	5721724	112.6	4.5	0.6	25	6.2
	O_2nd1_3	514759	5721722	112.4	4.5	0.6	25	6.2
2	O_1st2_1	514788	5721723	112.1	4.5	0.5	25	4.5
	O_1st2_2	514787	5721727	112.3	4.5	0.5	25	4.5
	O_1st2_3	514787	5721731	112.5	4.5	0.5	25	4.5
	O_1st2_4	514781	5721719	112.0	4.5	0.6	25	6.2
4	O_DS4_1	514859	5721735	111.3	4.5	0.6	21	6.2
	O_DS4_2	514843	5721733	111.7	4.5	0.6	21	6.2
	O_DS4_3	514828	5721731	111.9	4.5	0.6	21	6.2
	O_DS4_4	514814	5721729	112.0	4.5	0.6	21	6.2
	O_DS4_5	514800	5721727	112.1	4.5	0.6	21	6.2
	O_DS4_6	514889	5721740	110.2	4.5	0.6	21	6.2
	O_DS4_7	514892	5721740	110.1	4.5	0.6	21	6.2
	O_DS4a_1	514917	5721745	109.2	4.5	0.6	21	6.2
5	O_2nd5_1	514770	5721707	111.5	4.5	0.6	25	6.2
	O_2nd5_2	514759	5721704	111.5	4.5	0.6	25	6.2
6	O_1st6_1	514780	5721711	111.6	4.5	0.5	25	4.5
	O_1st6_2	514780	5721709	111.5	4.5	0.5	25	4.5
	O_1st6_3	514786	5721712	111.6	4.5	0.5	25	4.5
	O_1st6_4	514786	5721710	111.5	4.5	0.5	25	4.5
	O_1st6_5	514791	5721713	111.6	4.5	0.5	25	4.5
	O_1st6_6	514792	5721711	111.5	4.5	0.5	25	4.5
	O_1st6_7	514797	5721714	111.5	4.5	0.5	25	4.5
	O_1st6_8	514797	5721711	111.4	4.5	0.5	25	4.5
	O_1st6_9	514802	5721715	111.5	4.5	0.5	25	4.5
	O_1st6_10	514803	5721712	111.4	4.5	0.5	25	4.5
7a	O_Far7a_1	514834	5721718	111.2	4.5	0.406	25	5.2
	O_Far7a_2	514829	5721716	111.2	4.5	0.406	25	5.2
	O_Far7a_3	514822	5721716	111.3	4.5	0.406	25	5.2
	O_Far7a_4	514816	5721715	111.3	4.5	0.406	25	5.2
	O_Far7a_5	514811	5721714	111.4	4.5	0.406	25	5.2
7b	O_Far7b_1	514870	5721724	110.4	4.5	0.406	25	5.2
	O_Far7b_2	514864	5721723	110.6	4.5	0.406	25	5.2
	O_Far7b_3	514858	5721722	110.8	4.5	0.406	25	5.2
	O_Far7b_4	514852	5721721	111.0	4.5	0.406	25	5.2

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
	O_Far7b_5	514847	5721720	111.1	4.5	0.406	25	5.2
	O_Far7b_6	514841	5721719	111.2	4.5	0.406	25	5.2
7c	O_Far7c_1	514895	5721728	109.5	4.5	0.406	25	5.2
	O_Far7c_2	514890	5721727	109.7	4.5	0.406	25	5.2
	O_Far7c_3	514884	5721726	109.9	4.5	0.406	25	5.2
	O_Far7c_4	514878	5721725	110.1	4.5	0.406	25	5.2
8a	O_f8a_1	514757	5721689	110.8	4.5	0.6	21	5.8
	O_f8a_2	514765	5721691	110.8	4.5	0.6	21	5.8
	O_f8a_3	514772	5721691	110.7	4.5	0.6	21	5.8
	O_f8a_4	514779	5721693	110.7	4.5	0.6	21	5.8
	O_f8a_5	514787	5721695	110.8	4.5	0.6	21	5.8
8b	O_f8b_1	514800	5721697	110.7	4.5	0.6	21	5.8
	O_f8b_2	514809	5721698	110.7	4.5	0.6	21	5.8
	O_f8b_3	514819	5721699	110.6	4.5	0.6	21	5.8
	O_f8b_4	514827	5721701	110.6	4.5	0.6	21	5.8
	O_f8b_5	514842	5721704	110.6	4.5	0.6	21	5.8
	O_f8b_6	514851	5721705	110.4	4.5	0.6	21	5.8
	O_f8b_7	514861	5721707	110.1	4.5	0.6	21	5.8
	O_f8b_8	514869	5721708	109.8	4.5	0.6	21	5.8
8c	O_f8c_1	514881	5721710	109.4	4.5	0.6	21	6.2
	O_f8c_2	514897	5721713	108.9	4.5	0.6	21	6.2
8d	O_2nd8d_1	514908	5721710	108.3	4.5	0.6	25	6.2
	O_2nd8d_2	514913	5721710	108.1	4.5	0.6	25	6.2
	O_2nd8d_3	514918	5721711	108.0	4.5	0.6	25	6.2
	O_2nd8d_4	514923	5721712	107.8	4.5	0.6	25	6.2
	O_2nd8d_5	514928	5721713	107.6	4.5	0.6	25	6.2
10a	O_F10a_1	514847	5721690	109.9	4.5	0.6	21	6.2
	O_F10a_2	514850	5721691	109.9	4.5	0.6	21	6.2
	O_F10a_3	514860	5721692	109.6	4.5	0.6	21	6.2
	O_F10a_4	514865	5721692	109.4	4.5	0.6	21	6.2
	O_F10a_5	514869	5721693	109.3	4.5	0.6	21	6.2
	O_F10a_6	514873	5721694	109.1	4.5	0.6	21	6.2
10b	O_F10b_1	514879	5721695	108.9	4.5	0.6	21	5.8
	O_F10b_2	514887	5721696	108.7	4.5	0.6	21	5.8
	O_F10b_3	514896	5721698	108.4	4.5	0.6	21	5.8
	O_F10b_4	514903	5721699	108.1	4.5	0.6	21	5.8

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
	O_F10b_5	514911	5721700	107.9	4.5	0.6	21	5.8
	O_F10b_6	514918	5721702	107.7	4.5	0.6	21	5.8
	O_F10b_7	514926	5721703	107.4	4.5	0.6	21	5.8
9b	O_F9b_1	514828	5721686	110.0	4.5	0.6	21	5.8
	O_F9b_2	514821	5721685	110.0	4.5	0.6	21	5.8
	O_F9b_3	514812	5721684	110.0	4.5	0.6	21	5.8
	O_F9b_4	514803	5721683	110.0	4.5	0.6	21	5.8
9a	O_F9a_1	514793	5721681	110.0	4.5	0.6	21	5.8
	O_F9a_2	514784	5721679	110.0	4.5	0.6	21	5.8
	O_F9a_3	514776	5721678	110.0	4.5	0.6	21	5.8
	O_F9a_4	514768	5721677	110.0	4.5	0.6	21	5.8
11a	O_F11a_1	514915	5721758	109.7	4.5	0.6	21	6.2
	O_F11_1	514903	5721756	110.2	4.5	0.6	21	6.2
	O_F11_2	514895	5721755	110.5	4.5	0.6	21	6.2
	O_F11_3	514887	5721753	110.8	4.5	0.6	21	5.8
	O_F11_4	514879	5721752	111.1	4.5	0.6	21	5.8
	O_F11_5	514872	5721751	111.3	4.5	0.6	21	5.8
	O_F11_6	514864	5721750	111.6	4.5	0.6	21	5.8
	O_F11_7	514856	5721749	111.9	4.5	0.6	21	5.8
12	O_DS12_1	514848	5721748	112.2	4.5	0.6	21	6.2
	O_DS12_2	514833	5721746	112.4	4.5	0.6	21	6.2
	O_DS12_3	514822	5721745	112.5	4.5	0.6	21	6.2
	O_DS12_4	514811	5721743	112.6	4.5	0.6	21	6.2
	O_DS12_5	514795	5721740	112.8	4.5	0.6	21	6.2
13	O_1st13_1	514783	5721743	113.1	4.5	0.61	25	5.7
	O_1st13_2	514783	5721741	113.0	4.5	0.61	25	5.7
	O_1st13_3	514783	5721737	112.8	4.5	0.61	25	5.7
	O_1st13_4	514777	5721743	113.2	4.5	0.61	25	5.7
	O_1st13_5	514777	5721740	113.1	4.5	0.61	25	5.7
	O_1st13_6	514777	5721737	112.9	4.5	0.61	25	5.7
14	O_2nd14_1	514765	5721738	113.2	4.5	0.6	25	6.2
	O_2nd14_2	514753	5721736	113.3	4.5	0.6	25	6.2
15	O_1st15_1	514766	5721714	111.9	4.5	0.5	25	4.5
	O_1st15_2	514757	5721712	112.0	4.5	0.5	25	4.5
16	O_Far16_2	514901	5721729	109.3	4.5	0.6	25	6.2
	O_Far16_1	514915	5721731	108.8	4.5	0.6	25	6.2
17	O_F17_1	514917	5721773	110.2	4.5	0.6	21	6.2

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
	O_F17_2	514909	5721772	110.5	4.5	0.6	21	6.2
	O_F17_3	514901	5721771	110.8	4.5	0.6	21	6.2
	O_F17_4	514893	5721770	111.1	4.5	0.6	21	5.8
	O_F17_5	514885	5721769	111.4	4.5	0.6	21	5.8
	O_F17_6	514878	5721768	111.7	4.5	0.6	21	5.8
	O_F17_7	514870	5721766	112.0	4.5	0.6	21	5.8
	O_F17_8	514862	5721765	112.3	4.5	0.6	21	5.8
	O_F17_9	514849	5721763	112.8	4.5	0.6	21	5.8
	O_F17_10	514844	5721762	112.8	4.5	0.6	21	5.8
	O_F17_11	514838	5721762	113.0	4.5	0.6	21	5.8
	O_F17_12	514826	5721760	113.1	4.5	0.6	21	5.8
	O_F17_13	514819	5721759	113.2	4.5	0.6	21	5.8
	O_F17_14	514814	5721758	113.3	4.5	0.6	21	5.8
18	O_1st18_1	514795	5721753	113.4	4.5	0.61	25	5.7
	O_1st18_2	514795	5721757	113.6	4.5	0.61	25	5.7
	O_1st18_3	514795	5721761	113.8	4.5	0.61	25	5.7
	O_1st18_4	514789	5721752	113.5	4.5	0.61	25	5.7
	O_1st18_5	514789	5721756	113.6	4.5	0.61	25	5.7
	O_1st18_6	514789	5721759	113.8	4.5	0.61	25	5.7
	O_1st18_7	514783	5721751	113.5	4.5	0.61	25	5.7
	O_1st18_8	514783	5721755	113.7	4.5	0.61	25	5.7
	O_1st18_9	514782	5721758	113.9	4.5	0.61	25	5.7
	O_1st18_10	514777	5721750	113.6	4.5	0.61	25	5.7
	O_1st18_11	514776	5721754	113.8	4.5	0.61	25	5.7
	O_1st18_12	514776	5721758	114.0	4.5	0.61	25	5.7
	O_1st18_13	514771	5721749	113.6	4.5	0.61	25	5.7
	O_1st18_14	514770	5721753	113.9	4.5	0.61	25	5.7
	O_1st18_15	514770	5721757	114.1	4.5	0.61	25	5.7
	O_1st18_16	514758	5721751	114.0	4.5	0.6	25	6.2
	O_1st18_17	514751	5721750	114.0	4.5	0.6	25	6.2
19	O_DS1_1	514912	5721792	111.3	4.5	0.6	21	6.2
	O_DS1_2	514907	5721791	111.5	4.5	0.6	21	6.2
	O_DS1_3	514902	5721791	111.7	4.5	0.6	21	6.2
	O_DS1_4	514896	5721790	111.9	4.5	0.6	21	6.2
	O_DS1_5	514891	5721789	112.1	4.5	0.6	21	6.2

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
	O_DS1_6	514886	5721788	112.2	4.5	0.6	21	6.2
	O_DS1_7	514880	5721787	112.4	4.5	0.6	21	6.2
	O_DS1_8	514868	5721786	112.9	4.5	0.6	21	6.2
19a	O_DS1_9	514863	5721785	113.0	4.5	0.6	21	6.2
	O_DS1_10	514858	5721784	113.2	4.5	0.6	21	6.2
	O_DS1_11	514854	5721784	113.4	4.5	0.6	21	6.2
	O_DS1_12	514849	5721783	113.6	4.5	0.6	21	6.2

Table 8 Source parameters for the point sources of the new housing units at the pig farm

Housing Unit	Source Number	x-coordinate	y-coordinate	Base Elevation	Stack Height	Diameter	Temperature	Exhaust Velocity
		km	km	m	m	m	°C	m/s
House20	H20_R1_1	514781	5722130	133.1	6.5	0.91	21	5.4
	H20_R1_2	514787	5722131	132.9	6.5	0.91	21	5.4
	H20_R1_3	514795	5722133	132.8	6.5	0.91	21	5.1
	H20_R1_4	514801	5722136	132.6	6.5	0.91	21	5.1
	H20_R2_1	514788	5722108	132.5	6.5	0.91	21	5.4
	H20_R2_2	514794	5722109	132.4	6.5	0.91	21	5.4
	H20_R2_3	514801	5722111	132.2	6.5	0.91	21	5.1
	H20_R2_4	514808	5722114	132.0	6.5	0.91	21	5.1
	H20_R3_1	514794	5722087	132.0	6.5	0.91	21	5.4
	H20_R3_2	514800	5722089	131.8	6.5	0.91	21	5.4
	H20_R3_3	514808	5722091	131.6	6.5	0.91	21	5.1
	H20_R3_4	514814	5722093	131.4	6.5	0.91	21	5.1
	H20_R4_1	514801	5722065	131.4	6.5	0.91	21	5.4
	H20_R4_2	514807	5722067	131.2	6.5	0.91	21	5.4
	H20_R4_3	514815	5722069	130.9	6.5	0.91	21	5.1
	H20_R4_4	514821	5722071	130.8	6.5	0.91	21	5.1
	H20_R5_1	514808	5722043	130.7	6.5	0.91	21	5.4
	H20_R5_2	514815	5722045	130.5	6.5	0.91	21	5.4
	H20_R5_3	514822	5722047	130.3	6.5	0.91	21	5.1
	H20_R5_4	514828	5722048	130.1	6.5	0.91	21	5.1
	H20_R6_1	514815	5722022	130.1	6.5	0.91	21	5.4
	H20_R6_2	514821	5722023	129.9	6.5	0.91	21	5.4
	H20_R6_3	514829	5722026	129.7	6.5	0.91	21	5.1
	H20_R6_4	514834	5722028	129.5	6.5	0.91	21	5.1
	H21b_1_1	514752	5722121	133.9	6.5	0.91	21	5.4

House21b	H21b_1_2	514758	5722122	133.8	6.5	0.91	21	5.1
	H21b_1_3	514765	5722125	133.6	6.5	0.91	21	5.1
	H21b_1_4	514772	5722127	133.4	6.5	0.91	21	5.1
	H21b_2_1	514759	5722099	133.4	6.5	0.91	21	5.4
	H21b_2_2	514765	5722100	133.2	6.5	0.91	21	5.1
	H21b_2_3	514772	5722103	133.0	6.5	0.91	21	5.1
	H21b_2_4	514779	5722105	132.8	6.5	0.91	21	5.1
	H21b_3_1	514765	5722078	132.8	6.5	0.91	21	5.4
	H21b_3_2	514771	5722080	132.6	6.5	0.91	21	5.1
	H21b_3_3	514779	5722082	132.4	6.5	0.91	21	5.1
	H21b_3_4	514785	5722084	132.2	6.5	0.91	21	5.1
	H21b_4_1	514772	5722057	132.3	6.5	0.91	21	5.4
	H21b_4_2	514778	5722057	132.0	6.5	0.91	21	5.1
	H21b_4_3	514786	5722060	131.8	6.5	0.91	21	5.1
	H21b_4_4	514792	5722062	131.6	6.5	0.91	21	5.1
House21a	H21a_W1	514783	5722042	131.6	6.5	0.91	25	5.4
	H21a_W2	514791	5722045	131.4	6.5	0.91	25	5.1
	H21a_W3	514786	5722031	131.3	6.5	0.91	25	5.4
	H21a_W4	514795	5722034	131.0	6.5	0.91	25	5.1
	H21a_W5	514790	5722020	131.0	6.5	0.91	25	5.4
	H21a_W6	514798	5722022	130.7	6.5	0.91	25	5.1
	H21a_W7	514793	5722009	130.7	6.5	0.91	25	5.4
	H21a_W8	514801	5722012	130.4	6.5	0.91	25	5.1
House22b	H22b_W9	514729	5722118	134.6	6.5	0.91	25	5.4
	H22b_W10	514737	5722121	134.4	6.5	0.91	25	5.1
	H22b_W11	514733	5722105	134.3	6.5	0.91	25	5.4
	H22b_W12	514741	5722108	134.1	6.5	0.91	25	5.1
	H22b_W13	514737	5722092	134.0	6.5	0.91	25	5.4
	H22b_W14	514746	5722094	133.7	6.5	0.91	25	5.1
	H22b_W15	514742	5722078	133.6	6.5	0.91	25	5.4
	H22b_W16	514750	5722080	133.4	6.5	0.91	25	5.1
House22a	H22a_1	514750	5722069	133.2	6.5	0.63	25	6.8
	H22a_2	514752	5722063	133.1	6.5	0.63	25	6.8
	H22a_3	514753	5722057	132.9	6.5	0.63	25	6.8
	H22a_4	514755	5722051	132.8	6.5	0.63	25	6.8
	H22a_5	514757	5722046	132.6	6.5	0.63	25	6.8
	H22a_6	514759	5722040	132.4	6.5	0.63	25	6.8
	H22a_7	514761	5722035	132.3	6.5	0.63	25	6.8
	H22a_8	514762	5722029	132.1	6.5	0.63	25	6.8
	H22a_9	514764	5722023	132.0	6.5	0.63	25	6.8
	H22a_10	514766	5722017	131.8	6.5	0.63	25	6.8
	H22a_11	514768	5722011	131.7	6.5	0.63	25	6.8

	H22a_12	514769	5722005	131.5	6.5	0.63	25	6.8
House23b	H23b_1	514704	5722104	135.3	6.5	0.91	21	5.4
	H23b_2	514709	5722107	135.2	6.5	0.91	21	5.4
	H23b_3	514715	5722108	135.0	6.5	0.91	21	5.4
	H23b_4	514713	5722092	134.8	6.5	0.91	21	5.4
	H23b_5	514718	5722078	134.5	6.5	0.91	21	5.4
	H23b_6	514722	5722063	134.1	6.5	0.91	21	5.4
House23a	H23a_7	514726	5722049	133.8	6.5	0.63	25	6.8
	H23a_8	514731	5722035	133.4	6.5	0.63	25	6.8
	H23a_9	514735	5722008	132.9	6.5	0.63	25	6.8
	H23a_10	514739	5722009	132.7	6.5	0.63	25	6.8
	H23a_11	514747	5722012	132.5	6.5	0.63	25	6.8

Table 9 **Source parameters for the manure storage which was modelled as a volume sources at the new pig farm**

Source Number	x-coordinate	y-coordinate	Base Elevation	Effective Height	Sigma-y	Sigma-z
	km	km	m	m	m	m
MS1	514.820	5722.003	129.5	1.3	2.9	0.6

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 at the nearest sensitive receptors.

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 10. 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 existing pig farms of 5.0ou_E/m^3 at all sensitive receptor locations included in the assessment.

Table 10 Predicted ground-level concentrations of odour (1-hour average, 98th percentile) at the nearest sensitive receptors due to the pig farm

Receptor	1-hour average, 98th Percentile						
	2016	2017	2018	2019	2020	Maximum 5-year	Limit
DR1	0.7	0.9	0.5	0.6	0.4	0.9	5.0
DR2	0.9	1.0	0.6	0.8	0.5	1.0	
DR3	0.9	1.0	0.6	0.9	0.5	1.0	
DR4	1.3	1.4	1.0	1.4	0.9	1.4	
DR5	1.4	1.4	1.1	1.6	1.0	1.6	
DR6	1.6	1.6	1.3	1.8	1.2	1.8	
DR7	2.0	2.1	1.6	2.2	1.6	2.2	
DR8	3.7	3.5	4.3	4.3	4.0	4.3	
DR9	2.1	2.1	1.9	1.9	2.2	2.2	
DR10	1.4	1.5	1.4	1.3	1.5	1.5	
DR11	0.9	1.0	0.9	0.9	1.1	1.1	
DR12	1.3	1.5	1.5	1.7	1.6	1.7	
DR13	1.4	1.6	1.6	1.7	1.7	1.7	
DR14	1.7	1.9	1.9	2.3	2.0	2.3	
DR15	2.1	2.5	2.6	3.2	2.8	3.2	
DR16	2.1	2.5	2.8	3.1	3.0	3.1	
DR17	0.7	0.9	0.8	1.0	1.0	1.0	
DR18	0.5	0.4	0.4	0.4	0.4	0.5	
DR19	0.5	0.5	0.5	0.3	0.3	0.5	

7. CONCLUSIONS

Carhue Piggeries commissioned Katestone to complete an odour impact assessment (OIA) for a pig farm located at Colligboy, Timoleague, Co. Cork.

The OIA is required to determine the potential impact of odorous emissions from the pig farm on nearby sensitive receptors. The assessment will be submitted as part of an Industrial Emissions Licence review application to EPA 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 OIA has found that odour emissions from the pig farm are unlikely to adversely impact nearby residential locations. Dispersion modelling that has been conducted as part of the OIA shows that predicted concentrations **comply** with the odour criterion recommended by EPA for existing pig farms of 5.0ou_E/m^3 at all sensitive receptors included in the assessment.

8. REFERENCES

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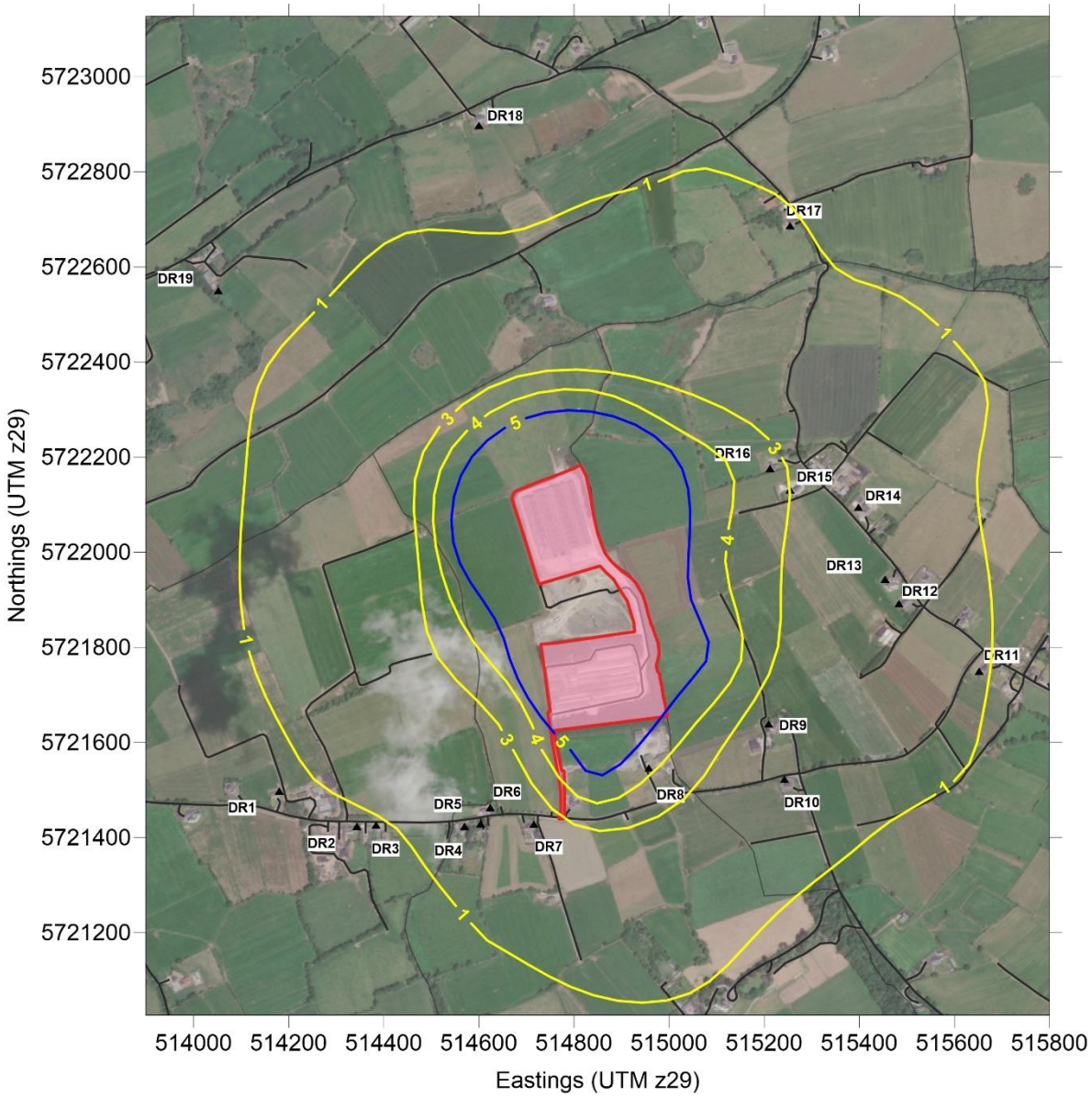

Plate 1 **Highest predicted 98th percentile 1-hour average ground-level concentrations of odour of five modelled years due to the pig farm**

Location:	**Averaging period:**	**Data source:**	**Units:**
Timoleague, Co. Cork	1-hour	CALPUFF	ou_E/m^3
Type:	**Criterion level:**	**Prepared by:**	**Date:**
98th percentile	5 ou (Blue Line)	P McDowell	April 2024

APPENDIX A MODELLING METHODOLOGY

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:

- 40 x 40 grid point domain with an outer grid resolution of 30 kilometres and nesting grids of 10, 3. 1 and 0.3 kilometres.
- 5 modelled years (1 January 2016 to 31 December 2020)
- Grid centered near the Project site at latitude 52°4’29 and longitude -7°41’
- 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.

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 156 x 156 grid cells at 250m 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 7km
- 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 156 x 156 grid cells at 250m spacing, the same as the CALMET domain
- 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.