ATTACHMENT 5.1

- ODOUR, AIR QUALITY & GREENHOUSE GAS ASSESSMENT -

Odour, Air Quality and Greenhouse Gas Assessment - Banagher Beef Processing Plant

Prepared for:

Panther Environmental Solutions Ltd

June 2019

Final

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Document Control

Deliverable #:	D18045-4
Title:	Odour, Air Quality and Greenhouse Gas Assessment - Banagher Beef Processing Plant
Version:	3.0 (Final)
Client:	Panther Environmental Solutions
Document reference:	D18045_4 Banagher Beef Processing Plant Air Quality Assessment.docx
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Approved by:	Simon Welchman 13/06/2019

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Glossary

Term	Definition
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/kg	Milligram per kilogram
MWh	Megawatt hour
$ouE/m^2/s$	odour units per square meter per second
ou_E/m^3	European odour units per cubic meter
ou_E /s	odour units per second
tCO_2-e	tonnes carbon dioxide equivalent
Z_0	roughness length
µg/m^3	micrograms per cubic meter
Nomenclature	**Definition**
CH_4	methane
CO_2	carbon dioxide
CO	carbon monoxide
NH_3	ammonia
NO_2	nitrogen dioxide
N_2O	nitrous oxide
PM_{10}	particulate matter with a diameter less than 10 micrometres
$PM_{2.5}$	particulate matter with a diameter less than 2.5 micrometres
SO_2	sulfur dioxide
Abbreviations	**Definition**
AADT	Annual Average Daily Traffic
AG4	Air Guidance 4
BAT	Best available techniques
CAFE	Cleaner Air for Europe
CAT 1	Category 1
CAT 3	Category 3
CEMP	Construction Emissions Management Plan
DAF	Dissolved Air Flotation
DEFRA	Department for Environment, Food and Rural Affair
DEHLG	Department of Housing, Planning and Local Government
DMRB	Design Manual for Roads and Bridges
EC	European Council
EPA	Environment Protection Agency
EF	Emission factor
ESR	Effort Sharing Regulation
ETS	Emissions Trading Scheme
EU	European Union
HDV	Heavy duty vehicles
LPG	Liquefied petroleum gas
OCU	odour control unit
OER	Odour Emission Rate

Term	Definition
SCAIL	Simple Calculation of Atmospheric Impact Limits
SOER	Specific Odour Emission Rate
NPWS	National Parks and Wildlife Service
SAC	Special Areas of Conservation
SPA	Special Protection Areas
STW	Sewage Treatment Works
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
WWTP	Wastewater treatment plant

1. INTRODUCTION

Katestone Environmental Pty Ltd (Katestone) was commissioned by Panther Environmental Ltd (Panther) on behalf of Banagher Chilling Ltd (Banagher Chilling) to complete air quality, traffic and climate assessments for a beef processing abattoir located approximately 0.5 km from the junction of the five roads on the L3010 Road at Meenwaun, Co. Offaly (site).

The assessments are required to determine the potential impact of the abattoir with a proposed processing capacity to 140 cattle per day. The assessments have been prepared as part of an Environmental Impact Assessment Report (EIAR) for the proposed development. The methodologies, inputs, analysis and findings of the assessments are presented in this report.

The proposed development includes a slaughtering facility and primal deboning facility. An existing abattoir that has been closed for the past year and lairage facility are located at the site. The existing facilities would be upgraded and incorporated into the proposed development.

A wastewater treatment plant (WWTP) will be constructed at the site. The WWTP will include primary and secondary treatment units comprising of:

- A balance tank
- Screens
- Dissolved air flotation (DAF)
- Secondary biological treatment (likely to include anoxic and aerobic treatment)
- Sludge collection and dewatering.

The scope of works for the assessments include:

- Odour impact assessment:
  - Development of an odour emissions inventory for the Plant
  - Development of meteorological dataset suitable for the site
  - Dispersion modelling to assess the potential for odour impacts.
- Air quality impact assessment
  - Development of an inventory of air contaminants from sources at the Plant
  - Dispersion modelling to assess the potential for adverse impacts
  - Assessment of the potential traffic impacts of NO_2, CO, PM_{10}, $PM_{2.5}$ and benzene using the screening model methods described in the Design Manual for Roads and Bridges (DMRB) published by the UK Highways Agency
  - Compare predicted pollutant concentrations with the relevant air quality standards.
- Climate Change Assessment.

2. OVERVIEW OF PROPOSED DEVELOPMENT

The site of the proposed development is approximately 3.0 km southeast of the town of Banagher, Co. Offaly. The site boundary and its environs are presented in Figure 1. There is an existing abattoir and lairage at the site that have been closed for over a year that will be upgraded and incorporated into the proposed development.

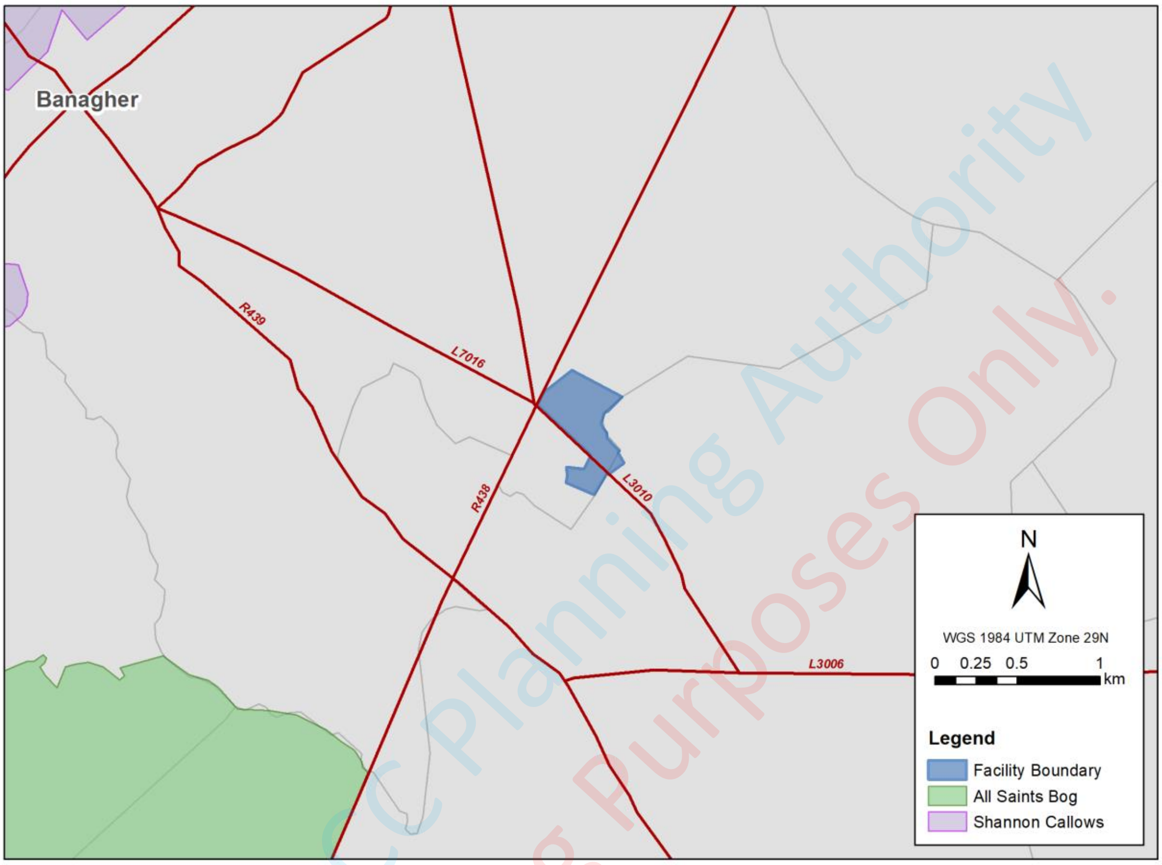

Figure 1 Site boundary and its environs

A site plan illustrating the main processing areas on the site is presented in Figure 2.

The proposed development will include:

- Modification to existing infrastructure including:
  - Expansion of the lairage area and manure storage area
  - Addition of staff facilities next to the current slaughter and chilling infrastructure.
- Addition of:
  - A processing building to facilitate:
    - Chilling
    - De-boning
    - Packaging
    - Loading
    - Cold storage

        - Staff amenities
        - Administration (Office space)
        - Boilers for the generation of steam
        - Power generation
        - Refrigeration
    - A wastewater treatment plant
    - Parking facilities
    - LPG Storage
    - Electricity supply infrastructure
    - Waste storage
    - A truck wash.

The WWTP will be constructed at the site. The WWTP will include primary, secondary treatment and tertiary treatment units comprising of:

- A balance tank
- Screens
- DAF
- Secondary biological treatment (including anoxic and aerobic treatment)
- Sludge collection and dewatering
- Sand filtration
- Constructed wetlands.

Carbon filtration will be included to control odour from the balance tank and sludge storage prior to dewatering.

Facilities to handle animal slurry and by-products from operations at the site include:

- A manure storage tank
- Bellygrass storage
- Category 1 and category 3 offal storage.

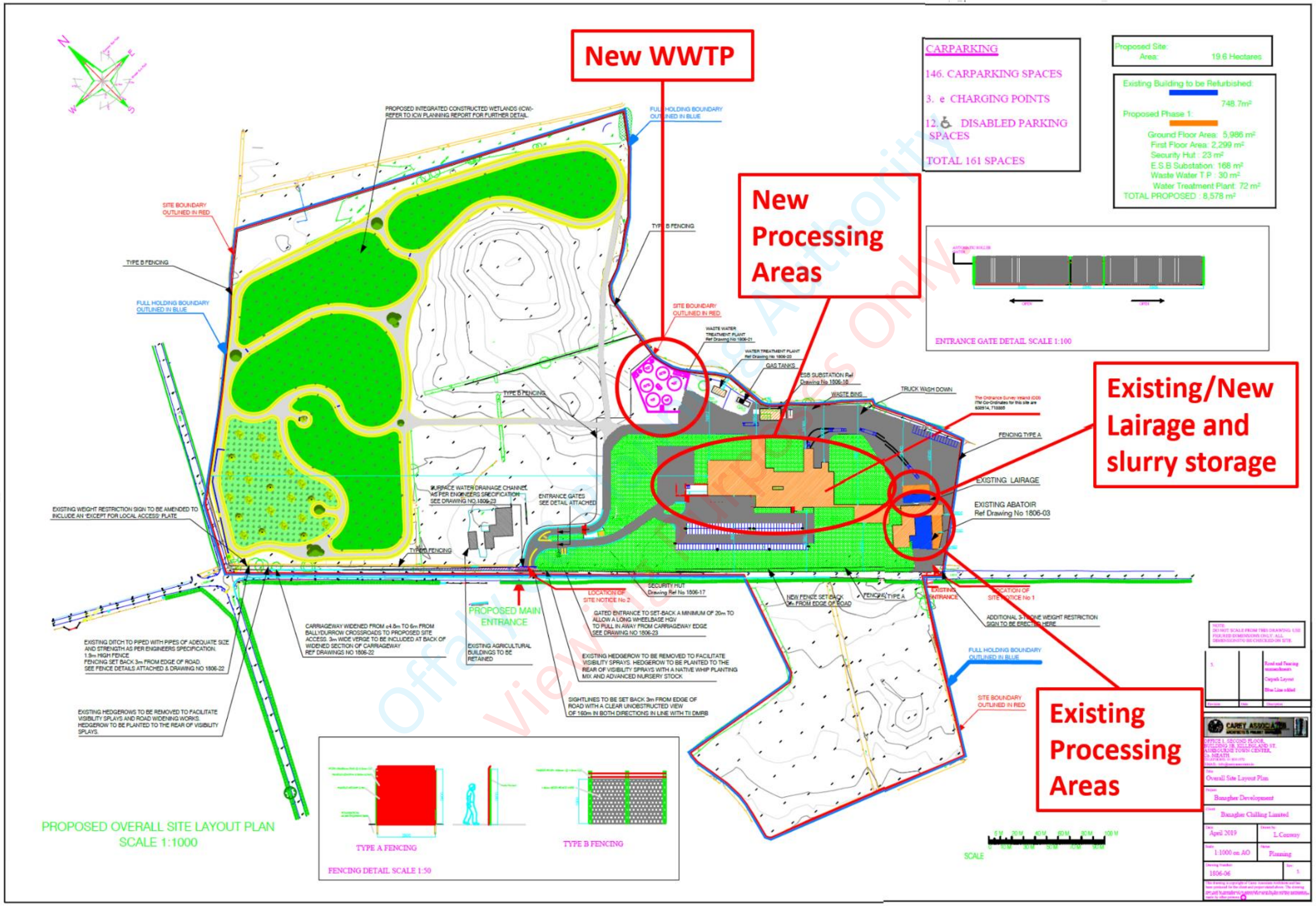

Figure 2 Site Plan

3. EXISTING ENVIRONMENT

3.1 Local terrain and land-use

The site is located in a rural location surrounded by pasture to the west and east and peat bogs and forest to the north and south. The Mullaghakaraun Bog is immediately north of the site's most northerly boundary and there is a forest immediately south of the most southern boundary.

The River Feeghroe runs from northeast to southwest along the site's eastern boundary.

The site is in an area of very flat terrain. It sits at an elevation of approximately 51 metres (m) above sea level. The terrain rises gently to the northeast of the site and falls gently to the south and west of the site. There are no major terrain features that would affect local wind flows in the vicinity of the site.

3.2 Local meteorology

Meteorological parameters recorded at the closest Met Eireann Observation Station to the site at Gurteen College were extracted and processed to assess meteorological conditions.

The observation station at Gurteen College is approximately 15 km southwest of the site and is 70 m above sea level. The terrain surrounding the observation station is relatively flat and used as pasture. The land between the observation station and the site is also flat. There are peat bogs to the north and northeast of the observation station.

The data from the observation station at Gurteen College is considered representative of the site due to:

- The close proximity of the observation station to the site
- The similar nature of the terrain at both locations
- The similar nature of land use at both locations
- The absence of major terrain features between the observation station and the site.

3.2.1 Windspeed and direction

Wind speed and wind direction are important parameters for the transport and dispersion of air pollutants from a source. A wind rose representing the annual distribution of winds between 2013 and 2017 is presented in Figure 3. The annual distribution for each modelled year is presented in Figure 4.

The prevailing wind direction in Ireland is between south and west. It is clear from Figure 3 and Figure 4 that these winds have a strong influence on wind patterns at Gurteen College. Winds at all times of day are heavily influenced by the prevailing winds. During the afternoon there is a greater component of winds from the west-southwest compared to all other times of day 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 Gurteen College occur most frequently from the southwest during the winter months. The greatest proportion of light winds occur during summer and autumn. There is a distinct north-easterly component to the wind rose in spring. A significant proportion of light northerly winds occur during spring.

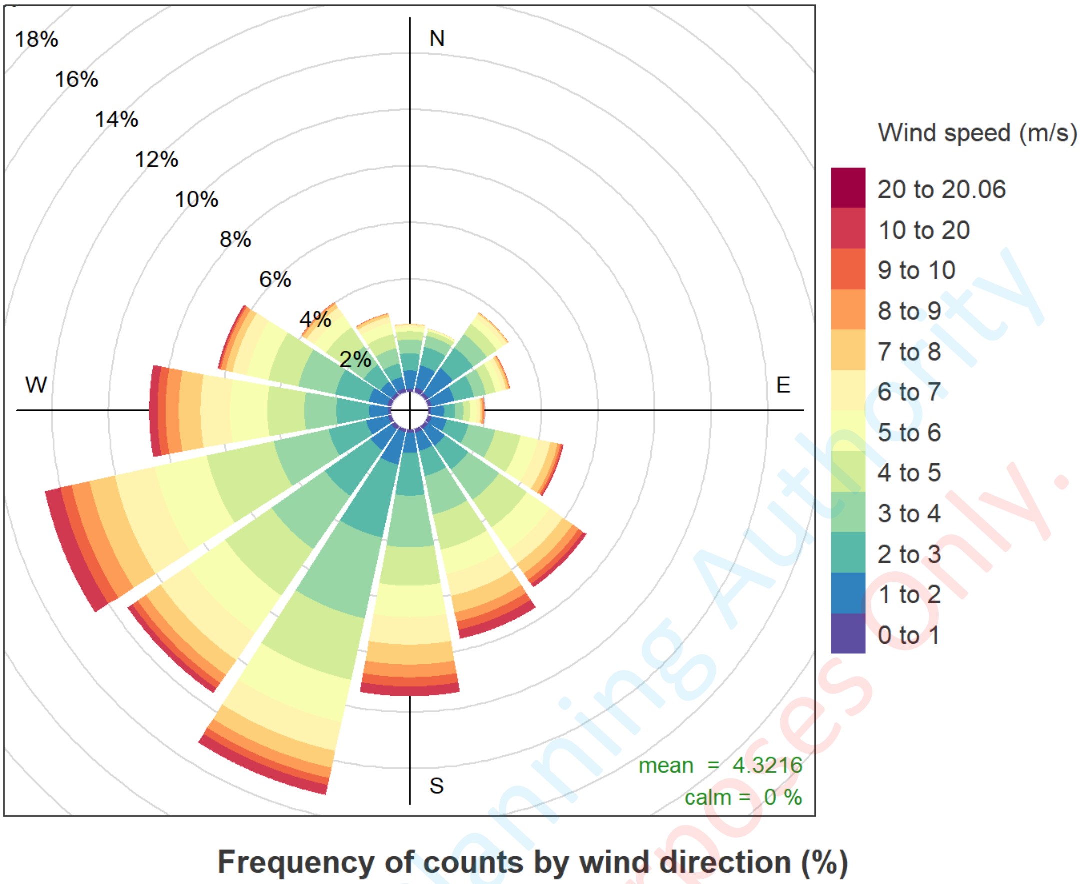

Figure 3 **Wind distribution monitored at Gurteen College between 2013 and 2017**

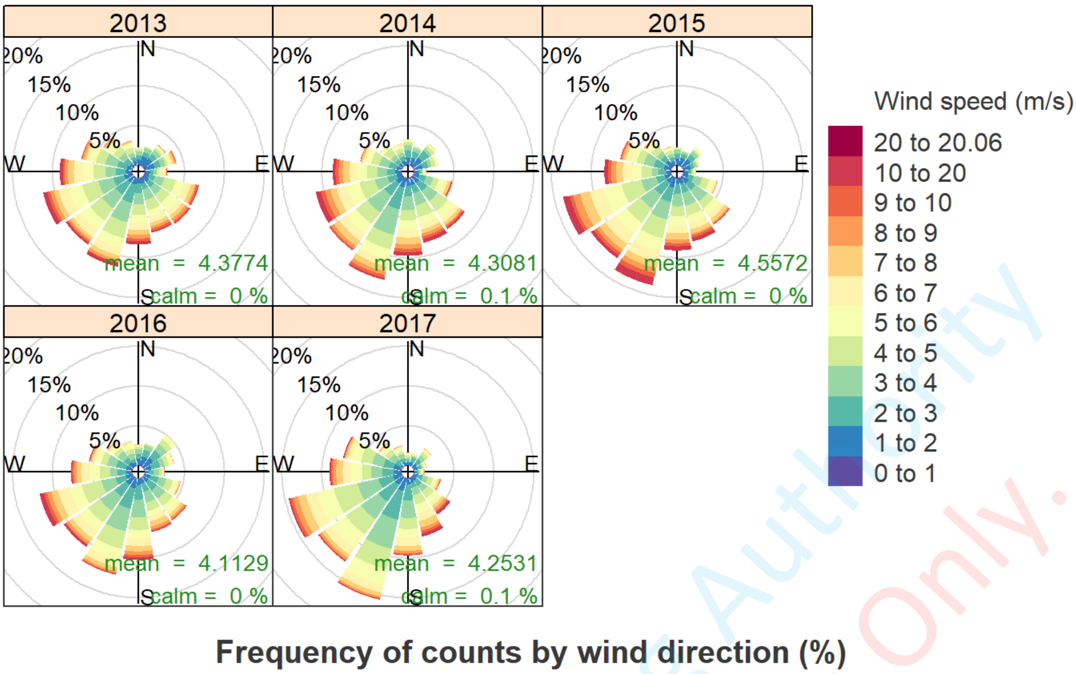

Figure 4 Wind distribution monitored at Gurteen College for each year between 2013 and 2017

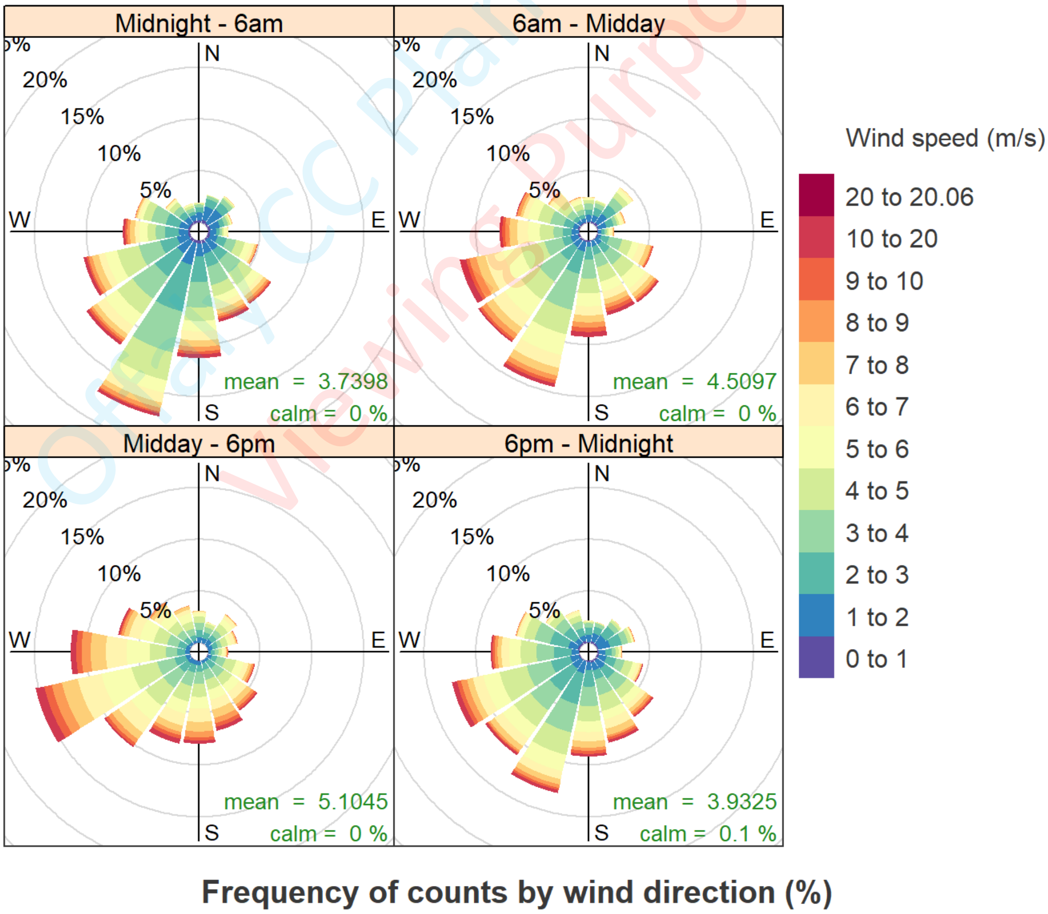

Figure 5 Diurnal wind distribution at Gurteen College between 2013 and 2017

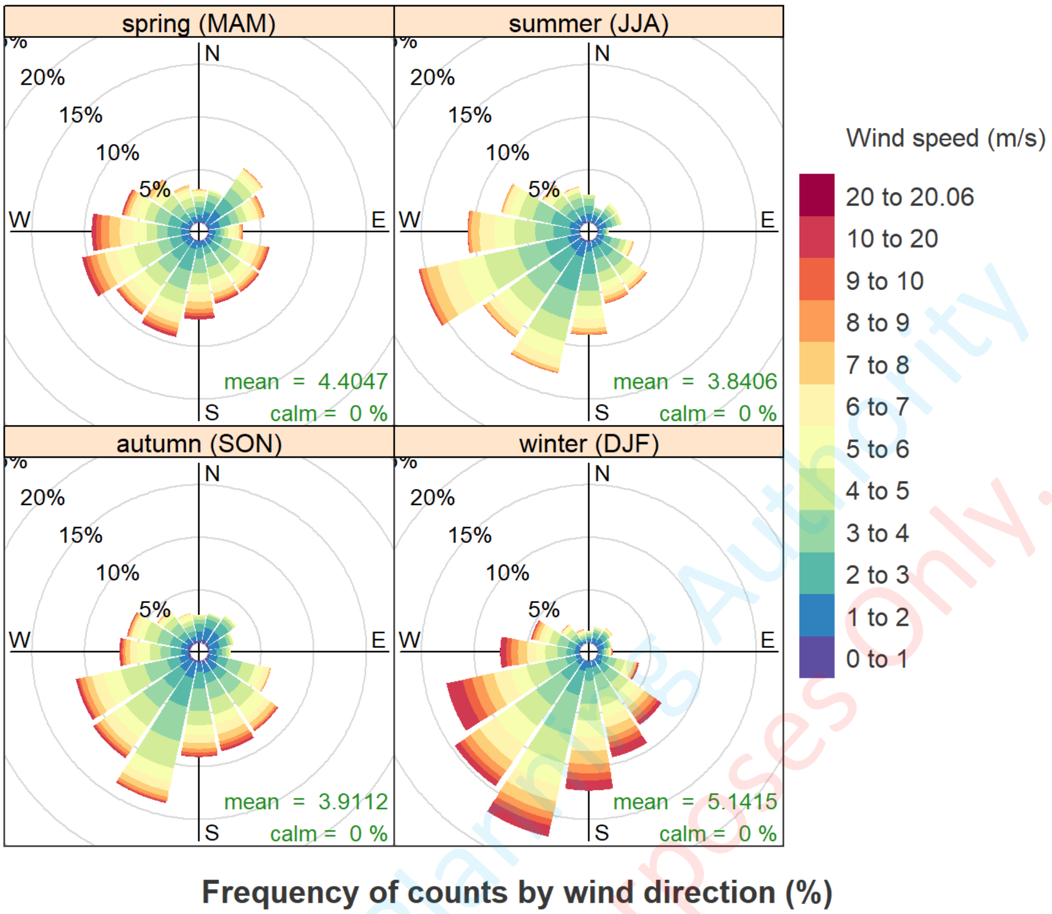

Figure 6 **Seasonal wind distribution at Gurteen College between 2013 and 2017**

3.3 Sensitive receptors

The sensitive receptors that are of interest are located in close proximity to the site. The closest sensitive receptors are presented in Figure 7.

Under the Birds Directive (79/409/EEC) and Habitats Directive (92/43/EEC), Ireland has identified 154 sites as Special Protection Areas (SPA) (NPWS, 2018a) and approximately 13,500 square kilometres of land, lakes and marine environments as Special Areas of Conservation (SAC) (NPWS, 2018b). These are known as Natura 2000 sites and the biodiversity of these sites is required to be protected.

It is well documented that certain forms of atmospheric nitrogen and their deposition into the environment are a threat to biodiversity. Ammonia has been found to reduce biodiversity at Natura 2000 sites. There are two Natura 2000 sites in the vicinity of the site, namely: Shannon Callows and All Saints Bog. There is also a proposed Natural Heritage Area at Lough Coura, east of the site. The location of these sites is illustrated in Figure 8.

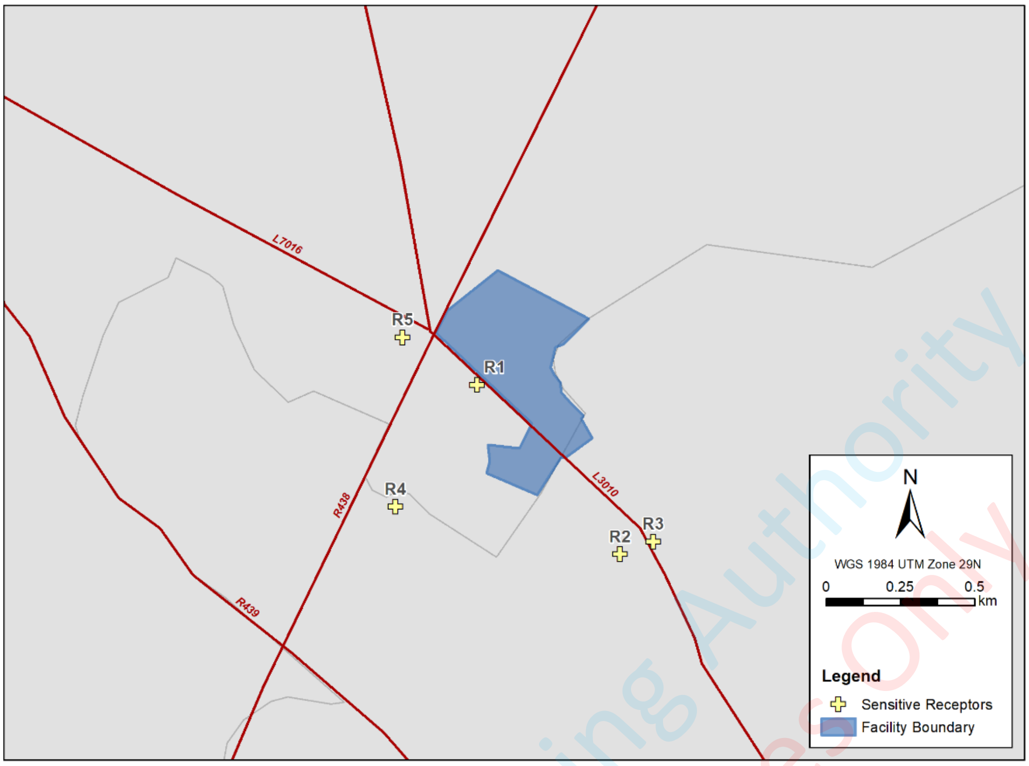

Figure 7 Modelled sensitive receptors in the assessment of odour and air contaminant emissions

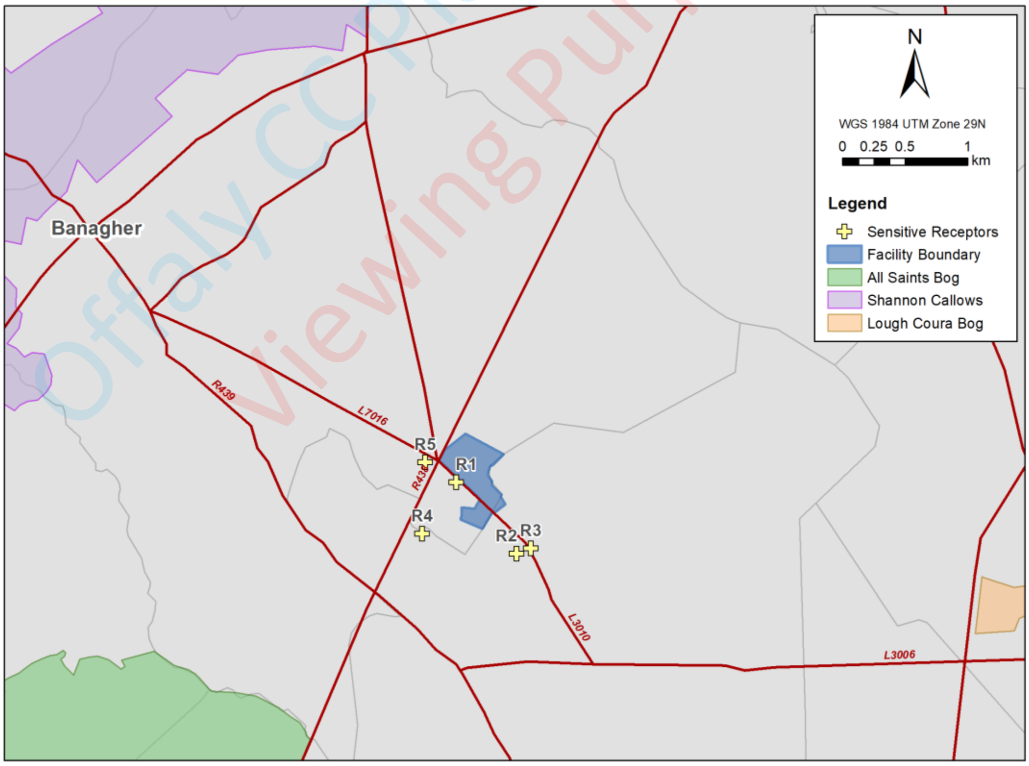

Figure 8 Modelled sensitive receptors in the assessment of ammonia emissions

3.4 Background air quality

Under the Clean Air for Europe Directive, EU member states must designate "Zones" for the purpose of managing air quality. In Ireland, four zones were defined in the Air Quality Standards Regulations (2011) (DEHLG, 2011). The site of the proposed development is in Zone D, that represents rural Ireland.

Background air quality data for Zone D was obtained from the report Air Quality in Ireland 2017 – Indicators of Air Quality (EPA, 2018a). A summary of the background data is provided in Table 1.

Table 1 Ambient background data

Pollutant	Averaging period	Value (µg/m^3)	Source
Nitrogen dioxide	1-hour	112	Maximum from Castlebar
	Annual	7.4	Average from Castlebar
Sulfur dioxide	1-hour	14.8	Maximum from Shannon Estuary
	24-hour	4.1	Maximum from Shannon Estuary
	Annual	2.3	Annual from Shannon Estuary
Carbon monoxide	8-hour	1,240	Maximum from Portlaoise (Zone C)
PM_{10}	24-hour	11.1[1]	Average from Castlebar
	Annual	11.2	Average from Castlebar
$PM_{2.5}$	Annual	9.2	Average from Longford

Note:

[1] UK DEFRA and EPA advise that the 36th high 24-hour mean process contribution can be added to the annual mean background PM_{10}

4. AIR QUALITY ASSESSMENT

4.1 Methodology

The following section describes the modelling methodology that was adopted to assess the potential impacts of air contaminants and odour from the proposed development. 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 (Section 4.2) and best practice approaches.

The assessment methodology has included:

- For odour:
    - Selection of relevant odour assessment criteria
    - Derivation of an odour emissions inventory for the site based on data from the literature.
- For air contaminants
    - Selection of relevant air quality assessment criteria
    - Derivation of an emissions inventory for the site based on data from the literature.
- Characterisation of meteorological conditions in the region and generation of a representative meteorological dataset using observations from Gurteen College.
- Dispersion modelling using the regulatory dispersion model, AERMOD, 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 relevant odour/air contaminant assessment criteria.

4.1.1 Meteorological modelling

The EPA's Air Dispersion Modelling Guidance Note (AG4) (EPA, 2009) states

> "*The dispersion process is dependent on the underlying meteorological conditions and ensuring that the air dispersion model includes representative meteorological data is critical.*
>
> *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."*

Section 3.1 describes local land-use and terrain surrounding the site. Section 3.2 describes why that data gathered at Gurteen College is likely to be representative of meteorological conditions at the site as defined in EPA's Air Dispersion Modelling Guidance Note (AG4).

AERMET provides a general-purpose meteorological preprocessor for organizing available meteorological data into a format suitable for use by the AERMOD air quality dispersion model.

The AERMET meteorological pre-processor was configured with surface data from Gurteen College and upper air data from Valentia in Kerry and used to generate a meteorological file suitable for use in the AERMOD dispersion model.

AERMET requires inputs of roughness length (Zo), Bowen ratio and Albedo. The AERMET Users Guide stipulates that Zo should be determined based on land cover within a 1.0 km radius from the meteorological site. If the value of Zo varies significantly by direction, then sector dependency should be used. Sector width should be >= 30°.

The Bowen ratio and Albedo should be determined based on land cover within a 10 km x 10 km domain. A simple unweighted mean has been used for the Albedo and a weighted geometric mean for the Bowen ratio as required by the AERMET Users Guide.

The calculation used to determine these parameters is described in Appendix A1.

4.1.2 Emissions

Emission rates from the site have been based on data from the literature. Details of derivation of an odour emissions inventory are presented in Section 4.3.1 and an air contaminant emissions inventory are presented in Section 4.3.2.

4.1.3 Dispersion modelling

The assessment was conducted in accordance with recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). AERMOD was used to predict ground-level concentrations of odour and air contaminants across the model domain due to sources at the site.

Details of source characterisation is provided in Appendix A2.1.

4.1.4 Methods for the conversion of NOx to NO_2

A conservative assessment of NO_2 was conducted assuming a 100% conversion of NOx to NO_2 for the 1-hour and annual average concentrations of NO_2.

4.2 Regulatory framework and assessment criteria

4.2.1 Environmental Protection Agency Act 1992

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*. The *Environmental Protection Agency Acts 1992 and 2003* provide for the management of air emissions from activities (meaning any process, development or operation) specified in the First Schedule of the *Environmental Protection Agency Acts 1992 and 2003*.

Section 4 (2) of the *Environmental Protection Agency Acts 1992 and 2003* states that Air Pollution:

> *"means 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) is “*an act to provide for the control of air pollution and other matters connected with air pollution”.* According to the AP Act *“‘pollutant’ means any substance 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 states:

> *“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 states:

(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) the *Environmental Protection Agency Acts 1992 and 2003* states:

> *“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.”*

4.2.2 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.*

The odour exposure criterion that has been applied to the proposed development is $C_{98,\ 1\text{-}hour} \leq 1.5\ ou_E/m^3$.

4.2.3 Air contaminants

The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives. The fourth Daughter Directive (2004/107/EC) will be included in CAFE at a later stage. The limit and target values for both Directives are outlined below.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011) (DEHLG, 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and S.I. No. 33 of 1999.

The limit values of the CAFE Directive that were applied in this assessment are presented in Table 2.

Table 2 Limit values of CAFE Directive 2008/50/EC

Air contaminant	Averaging period	Limit value (µg/m³)	Basis of application of limit value
CO	8-hour	10000	Maximum
NO_2	1-hour	200	Not to be exceeded more than 18 times in a calendar year
	annual	40	Average
PM_{10}	24-hour	50	35th Highest
	annual	40	Average
$PM_{2.5}$	annual	25	Average
SO_2	1-hour	350	Not to be exceeded more than 24 times in a calendar year
	24-hour	125	Not to be exceeded more than 3 times in a calendar year
	annual	20	Average

4.2.4 Ammonia

The impact of ammonia emissions on Natura 2000 sites is introduced in Section 3.3. EPA is currently working on an assessment approach to consider the impacts from intensive agricultural developments on Natura 2000 sites, including relevant assessment criteria. EPA currently adopts the assessment approach detailed by the Environment Agency in England (Environment Agency, 2018), which allows approval without further consideration of a development in isolation if is likely to cause an impact less than 4% of the "Critical Level".

Aherne and Wolniewicz (2017) states:

> *A critical load is defined as "a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"*

The most stringent critical load adopted for ambient levels of ammonia is 1 µg/m³ at sensitive Natura 2000 sites. This critical level has been adopted in this assessment.

The assessment criteria for a facility in isolation for ammonia is therefore 0.04 µg/m³, which is 4% of the adopted critical level. If this level cannot be achieved a cumulative assessment including background ammonia levels should be conducted.

4.3 Emissions

Air contaminants and greenhouse gases will be generated from:

- Construction activities
- Emissions from the combustion of LPG in onsite boilers
- Emissions from logistics associated with the site
- Cattle contained at the site
- Manure storage
- Treatment of wastewater

- Storage of waste products and animal by-products.

4.3.1 Odour emissions

Odorous emissions will be generated from:

- Wastewater treatment and sludge handling
- Animal by-product collection and storage
- Containment of animals prior to slaughter
- Manure storage.

As the existing abattoir is not operational at present it was not possible to take site specific odour measurements. Odour emission rates have been adopted for the site based on values in publicly available literature or based on manufacturer specifications.

The odour emission rates adopted for WWTP sources with emission surfaces that are open to the atmosphere are presented in Table 3.

The SOER for the raw inlet sump/Meva screen and drum screen are based on measurements from a beef processing plant at Duleek, Meath (Odour Monitoring Ireland, 2008). The SOER measured from the balance tank in this assessment was considered conservative for the fresh wastewater that passes through the raw inlet sump/Meva screen and drum screen.

The SOER for the anoxic tank is based on measurements from a poultry processing plant at Ballyhaunis, Mayo (Odour Monitoring Ireland, 2007). The SOER measured from the anoxic tank at this site was considered conservative for a WWTP incorporating modern DAF technology. Recent (not yet published) measurements undertaken by Katestone from anoxic wastewater at an abattoir that with a modern DAF unit were considerably lower than the SOER adopted here.

The SOER for the aerobic tank and clarifier are based on measurements from a poultry processing plant at Ballyhaunis, Mayo (Odour Monitoring Ireland, 2007). The SOER measured from the aerobic tank at this site was considered conservative for a WWTP incorporating modern DAF technology. Recent (not yet published) measurements undertaken by Katestone from the aerobic wastewater at an abattoir that with a modern DAF unit were considerably lower than the SOER adopted here.

Table 3 Odour emission rates from WWTP sources

Source	Surface area	SOER	OER
	m²	$ou_E/m^2/s$	ou_E/s
Raw Inlet Sump/Meva Screen	9.0	24.8	223
Drum Screen	9.0	24.8	223
Anoxic Tank	113.1	8.8	995
Aerobic 1	95.0	6.1	580
Aerobic 2	95.0	6.1	580
Clarifier	50.3	6.1	307
Sludge Removal Skip	16.3	66[1]	1079

[1] Katestone was not able to find a SOER for dewatered sludge from wastewater generated at a meat processing plant taken in accordance with European Standard EN13725. This SOER was adopted from a measurement taken from the Sludge Cake

Source	Surface area	SOER	OER
	m^2	$ou_E/m^2/s$	ou_E/s
storage at the Carrick-on-Shannon municipal sewage treatment works. The OER measured was 1,200 ouE/s from a cake storage area of 18 m^2			

The odour emission rates adopted for processing areas sources with emission surfaces that are open and not-open to the atmosphere are presented in Table 4.

Table 4 Odour emission rates from processing areas sources

Source	Surface area	SOER	OER
	m^2	$ou_E/m^2/s$	ou_E/s
Lairage[1]	373.7	20[3]	7474
Lairage Slurry Tank[1]	72.0	20[3]	1440
BellyGrass Trailer[1]	16.3	98.5[4]	1610
Cat 1 Trailer Bay[2]	4.0	98.5[4]	389
Cat 3 Trailer Bay[2]	15.0	98.5[4]	1478

Note:

[1] Emission surface open to the atmosphere

[2] Emission surface within an enclosed building

[3] Based on the conservative odour emission rate used in the SCAIL model for *'Slurry - Circular Store with no Cover*. The SCAIL model is a conservative screening tool adopted by EPA in Ireland for the assessment of impacts from intensive agricultural operations

[4] Based on measurements from a beef processing plant at Duleek, Meath (Odour Monitoring Ireland, 2008). The SOER measured from the Belly grass / Offal storage was adopted for these sources in the proposed development

The odour emission rates adopted for covered sources with emissions that are not captured and vented to the atmosphere are presented in Table 5.

Table 5 Odour emission rates adopted for covered sources that are not captured

Source	Surface Area	SOER	OER
	m^2	$ou_E/m^2/s$	ou_E/s
Sludge Thickening - Screw Press	-	-	6195[3]
DAF Unit	10.0[1]	21.2[2]	212

Note:

[1] Assumed based on a surface area of 2 m x 5 m

[2] No odour emission rate from the DAF unit at a meat processing plant was sourced from the literature. The SOER adopted is based on measurements from a beef processing plant at Duleek, Meath (Odour Monitoring Ireland, 2008). The SOER measured from the balance tank was considered conservative for the DAF unit.

[3] There is limited data in the literature for measured odour concentrations and air flowrates from enclosed dewatering operations for abattoir sludge. The odour emission rate adopted here is from a municipal STW in Warwickshire in England (Odournet, 2017). The OER assumes three air changes per hour from an enclosed dewatering operation and a measured odour concentration of 1,539 ou_E/m^3. The adopted OER is larger than OERs adopted for similar sources at abattoirs in Ireland in previous assessments and is considered conservative.

The odour emission rates for sources that are captured and vented to odour control units (OCU) are presented in Table 6.

Table 6 **Odour emission rates adopted for covered sources with emissions that are captured and vented to odour control units**

Source	Airflow rate	Odour concentration	OER
	m^3/s	ou/m^3	ou_E/s
Balance Tank Carbon Filter	0.14[1]	400[3]	56
Sludge Holding Tank Carbon Filter	0.11[2]	400[3]	44

Note:
[1] Based on an hourly air flowrate of 500 m^3/hr provided by Panther
[2] Based on an hourly air flowrate of 400 m^3/hr provided by Panther
[3] The outlet odour concentration limit from the carbon filter OCU

4.3.2 Air contaminant emissions

4.3.2.1 Construction

The construction phase of the proposed development includes the upgrade of existing abattoir facilities (including lairage) and the installation of a WWTP. The main air contaminant emissions during construction will be dust. The potential sources of dust from construction activities are as follows:

- Wheel generated dust from vehicles
- Excavation works and earthmoving activities
- Material handling, storage and stockpiling
- Wind erosion of exposed areas and stockpiles.

Dust emissions during construction will be managed through the implementation of a Construction Emissions Management Plan (CEMP). Dust control measures that will be implemented through the CEMP include:

- Cognisance would be taken of the guidelines published by the Institute of Air Quality Management (IAQM), "Assessment of dust from demolition and construction 2014"
- Material handling systems would be designed to minimise exposure to wind
- Stockpiles of materials would be laid out to minimise exposure to wind
- Avoiding prolonged storage of materials at the site
- A 15kph speed limit would be implemented for all traffic at the site
- Vehicles that transport materials to and from the site will be fitted with covers to prevent material loss
- Public roads outside the site would be regularly inspected for cleanliness and cleaned as necessary using a road sweeper or other effective measures
- Any un-surfaced roads would be restricted to essential construction site traffic only
- While the natural recolonisation of exposed areas of soil during reinstatement activities is preferred, re-seeding would be undertaken where required to promote the rapid stabilisation of soils
- Regular visual inspections would be undertaken around the site to monitor the effectiveness of dust control measures.
- Water misting plant, such as bowsers and sprays would be used as required and where necessary
- Wheel-wash facilities would be provided for vehicles exiting the site to reduce track-out of potential dust materials onto public roads

- Where practicable, stockpiles of excavated soils and other exposed surfaces would be dampened down via misting plant.

Construction activities are expected to occur over a relatively short period of time and the management of the construction activities will minimise emissions of dust to air and therefore emissions during construction have not been considered further.

4.3.2.2 Operation

The sources of air contaminant emissions at beef processing plants includes emissions from fuel combustion and from the storage of process by-products such as offal, wastewater and manure.

An air contaminant emissions inventory has been derived based on published emission factors for fuel combustion rates for proposed development and on mass threshold emission levels stated in EPA publication titled *(BAT) guidance notes on best available techniques for the slaughtering sector (1st Edition)* (EPA, 2008).

The air contaminants that were included in this assessment are:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Particulate matter less than 10 microns in Diameter (PM_{10})
- Particulate matter less than 2.5 microns in Diameter ($PM_{2.5}$)
- Sulphur dioxide (SO_2)
- Ammonia (NH_3).

There will be two boilers at the site located in the plant room. The type and model of the boiler has not yet been finalised; however, the fuel used will be LPG. LPG will be delivered to the site and stored in an onsite tank. It is anticipated that each boiler will combust 40 m^3 of LPG per annum. Assuming that the plant is operational 10 hours per day, 5 days per week, 260 days per year, the hourly combustion rate will be 7.58 kg/hr per boiler based on an LPG density of 493 kg/m^3.

There is limited data on emission factors for the combustion of LPG in Ireland and Europe. The emission rate from combustion in the boiler has been determined using emission factors for LPG published by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) emission estimation technique manual for combustion in boilers (DSWEPC, 2011). The emission factors are detailed in Table 7.

Table 7 Emission factors adopted for the combustion of LPG in boilers

Air contaminant	Unit	Emission factor
CO	g/kg	0.75
NO_x	g/kg	4.46
PM_{10}	g/kg	0.26
$PM_{2.5}$	g/kg	0.08
SO_2	g/kg	4.1E-03 × S[a]
[a] Sulphur content of the LPG, there is no published data on the sulphur content of LPG in Ireland. A value of 100 mg/kg has been assumed as recommended in DSEWPC, 2011)		

The exhaust emission rates for each boiler are presented in Table 8.

Table 8 Emission rates for air contaminants from LPG combustion

Air contaminant	Emission rate
	g/s
CO	1.58E-03
NO_x	9.39E-03
PM_{10}	5.47E-04
$PM_{2.5}$	1.68E-04
SO_2	8.63E-04

The main source of ammonia emissions on the site will be from waste and by-products including from manure, offal and wastewater. The BAT Guidance Note for the Slaughtering Sector (EPA, 2008) lists mass flow thresholds for specific air contaminants including ammonia to air. The mass threshold for emissions of ammonia to air is listed as 150 g/hr. The emission rate of ammonia for the site has been modeled at a constant rate of 150 g/hr for the site as this is the maximum level that should be emitted according to BAT.

4.4 Results

The following sections present the predicted ground-level concentrations of odour, CO, NO_2, SO_2, PM_{10}, $PM_{2.5}$ and ammonia. 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 concentrations for each year are presented in Appendix A3.

4.4.1 Odour

Predicted 1-hour average, 98^{th} percentile, ground-level concentrations of odour due to the proposed development at the nearest sensitive receptors are presented in Table 9. Plate 1 is a contour plot presenting the highest 1-hour, 98^{th} percentile ground-level concentrations across the model domain during the five-year period.

The results show that predicted concentrations are well below the criterion of 1.5 ou_E/m^3.

Table 9 Predicted 1-hour, 98^{th} percentile concentrations of odour

Receptor	Odour (ou_E/m^3)
	1-hour, 98^{th} percentile
R1	1.2
R2	0.3
R3	0.3
R4	0.5
R5	0.4
Criteria Level	**1.5 ou_E/m^3**

4.4.2 Air contaminants

The predicted ground-level concentrations of CO, NO_2, SO_2, PM_{10} and $PM_{2.5}$ due to the proposed development at the nearest sensitive receptors are presented in Table 10. Also provided in Table 10 is the highest cumulative ground-level concentrations at any sensitive receptor due to the proposed development and ambient background.

Predicted ground-level concentrations of ammonia due to the proposed development in isolation at the Natura sites near the site are presented in Table 11. Plate 11 is a contour plot presenting the annual average ground-level concentrations across the model domain during the five-year period due to the proposed development in isolation.

Contour plots are provided for the various air contaminants due to the proposed development in isolation as follows:

- NO_2 – 1-hour average (Plate 2) and annual average (Plate 3)
- CO – 8-hour average (Plate 4)
- SO_2 – 1-hour average (Plate 5), 24-hour average (Plate 6) and annual average (Plate 7)
- PM_{10} – 24-hour average (Plate 8) and annual average (Plate 9)
- $PM_{2.5}$ – annual average (Plate 10).

The results show:

- Ground-level concentrations of NO_2 due to the proposed development plus ambient background are predicted to comply with the criteria levels at all the sensitive receptors. The incremental increase in NO_2 concentrations predicted due to the proposed development is less than 4% of the criteria levels.
- Ground-level concentrations of CO due to the proposed development plus ambient background are predicted to comply with the criterion level at all the sensitive receptors. The incremental increase in CO concentrations predicted due to the proposed development is less than 0.01% of the criterion level.
- Ground-level concentrations of SO_2 due to the proposed development plus ambient background are predicted to comply with the criteria levels at all the sensitive receptors. The incremental increase in SO_2 concentrations predicted due to the proposed development is less than 0.2% of the criteria levels.
- Ground-level concentrations of PM_{10} due to the proposed development plus ambient background are predicted to comply with the criteria levels at all the sensitive receptors. The incremental increase in PM_{10} concentrations predicted due to the proposed development is less than 0.06% of the criteria levels.
- Ground-level concentrations of $PM_{2.5}$ due to the proposed development plus ambient background are predicted to comply with the criteria levels at all the sensitive receptors. The incremental increase in $PM_{2.5}$ concentrations predicted due to the proposed development is less than 0.01% of the criteria levels.
- Ground-level concentrations of NH_3 due to the proposed development are predicted to comply with the criteria levels at all the sensitive receptors. The incremental increase in NH_3 concentrations predicted due to the proposed development is approximately 25% of the screening criteria levels.

Table 10 Predicted ground-level concentrations of air contaminants

Receptor	CO (µg/m^3)	NO_2 (µg/m^3)		PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	SO_2 (µg/m^3)		
	Maximum 8-hr	1-hour 19th high	Annual	24-hour 36th high	Annual	Annual	1-hour 19th high	24-hour 4th high	Annual
R1	0.55	8.1	0.15	0.030	0.008	0.0026	0.7	0.11	0.013
R2	0.27	2.5	0.03	0.006	0.002	0.0006	0.2	0.03	0.003
R3	0.16	1.6	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R4	0.19	2.2	0.04	0.008	0.002	0.0007	0.2	0.04	0.003
R5	0.22	2.7	0.05	0.011	0.003	0.0009	0.2	0.04	0.005
Background	1240	112	7.4	11.2[1]	11.2	9.2	14.8	4.1	2.3
Max including Background	1240	120	7.6	11.2*	11.2	9.2	15.5	4.2	2.3
Criteria Level	**10000**	**200**	**40**	**50**	**40**	**25**	**350**	**125**	**20**

[1] UK DEFRA and EPA advise that 36th high 24-hour mean process contribution can be added to the annual mean background PM_{10}

Table 11 Predicted annual average concentrations of ammonia

Natura site	Ammonia (µg/m^3)
	Annual average
All Saints Bog	0.01
Shannon Callows	0.006
Lough Coura Bog	0.004
Criteria level	**0.04**

5. ROAD TRAFFIC ASSESSMENT

5.1 Methodology

Road transport sources from a development can account for emissions of several air pollutants, although most of the pollutants emitted by road vehicles are also produced by a wide range of industrial, commercial and domestic processes. The pollutants of most concern near roads are nitrogen dioxide (NO_2) and particles (PM_{10}) in relation to human health and oxides of nitrogen (NO_x) in relation to vegetation and ecosystems.

The assessment of potential transport related air quality impacts for the proposed development was conducted using the screening method set out in the Design Manual for Roads and Bridges (DMRB) Section 11.3.1, published in May 2007 (DMRB HA207/07).

The overall objective of DMRB is to define the depth of assessment necessary to enable informed decision-making at as early a stage of the proposed development as possible. This necessitates a 'fit-for-purpose assessment method and relies on four 'Assessment Levels', namely:

- Scoping
- Simple
- Detailed
- Mitigation/enhancement and monitoring.

For air quality, each assessment level has two components. The first is for local air quality, that is, estimation of pollutant concentrations that could change as a result of the proposed development at specific locations. These concentrations are compared with the air quality criteria set to protect human health or vegetation, as appropriate. The second component is for the regional impact assessment and examines the change in emissions of a range of pollutants (oxides of nitrogen, particles, carbon monoxide, hydrocarbons and carbon) as a result of operation of the scheme as these can have impacts on the regional, national or international scale. The two components may require different assessment levels.

The DMRB air quality scoping assessment methodology has been followed for this assessment, for both local and regional air quality. If the scoping level assessment is triggered, then a simple assessment will be conducted as per the DMRB methodology. The DMRB methodology has been designed to assess high-level local and regional transport related air quality impacts and requires the following input data:

- Background pollutant concentration data
- Annual Average Daily Traffic (AADT) flows both without the development and with the development
- Average vehicle speed
- Vehicle classification by light and heavy-duty vehicles (LDV/HDV)
- Type of road
- Distance from the centre of the road to the Receptor being assessed.

5.2 Assessment criteria

The assessment criteria for the DMRB assessment are defined in HA207/07. It states that a quantitative estimate of the change in local air quality (simple assessment) must be undertaken where the changes on local roads meet any of the following criteria:

- Daily traffic flow will change by 1,000 Annual Average Daily Traffic (AADT) or more
- Heavy duty vehicles (HDV) flows will change by 200 AADT or more
- Daily average speed will change by 10 kph or more
- Peak hour speed will change by 20 kph or more
- Road alignment will change by 5 m or more.

For the regional air quality assessment, HA207/07 states that a quantitative estimate (simple assessment) of the change in regional air quality must be undertaken where the changes on local roads meet any of the following criteria:

- A change of more than 10% AADT
- A change of more than 10% to the number of HDVs
- A change in the daily average speed of more than 20km/hr.

5.3 Traffic data

The traffic data for this assessment was provided by Panther and NRB Consulting Engineers Ltd. Traffic information on the local road network included consideration of the following roads as shown in Figure 9:

- L3010
- R438
- L7016.

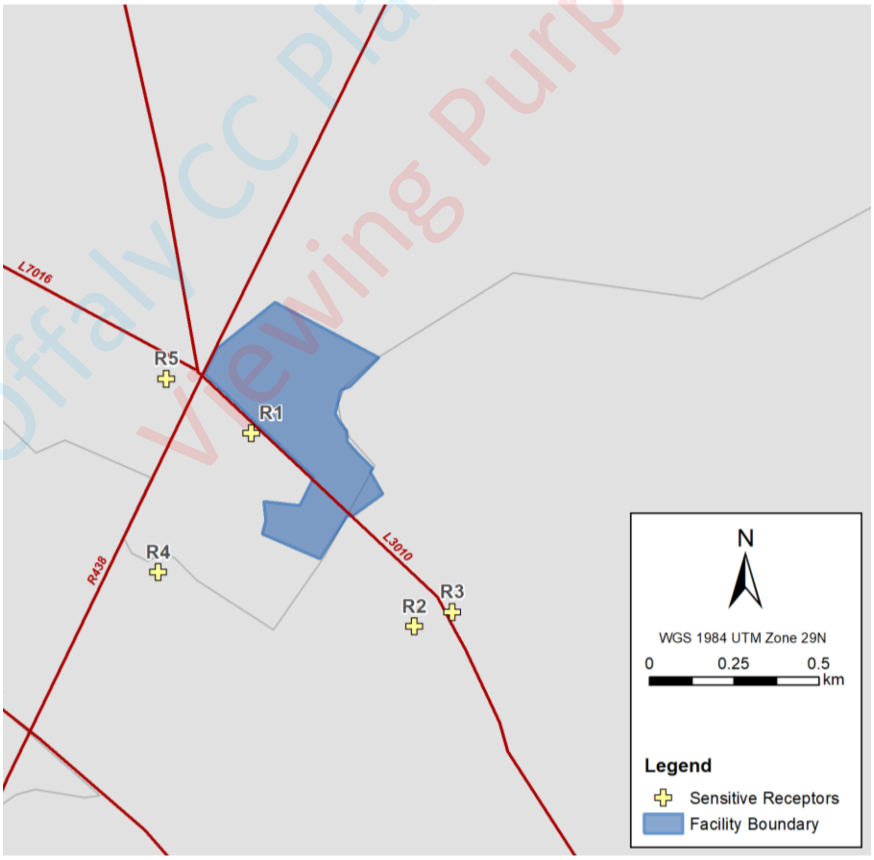

Figure 9 Roads considered in the road traffic assessment

Traffic data was provided for the opening year of the expanded operation (2021) for both the "Without development" and "With development" scenarios. Traffic data considered in this assessment is provided in Table 12 and the change with the development in Table 13.

Table 12 Traffic data for the proposed development

Road Link	Link Length (km)	Posted Road Speed	Without Development		With Development	
			AADT	% HDVs	AADT	% HDVs
L3010 East	1.50	70	120	6.2%	120	6
L3010 West	0.47		120		442	19
R438 North	4.60		1449		1569	8
R438 South	1.18		1543		1679	8
L7016 East	0.03		403		468	9
L7016 West	2.60		262		301	8
L3010 Northwest	3.30		235		261	8

Table 13 Change in traffic with the proposed development

Road Link	Change in AADT with Development	Change in %HDVs with Development	Change in road speed
L3010 East	0	0%	No change in posted road speed limit.
L3010 West	322	12%	
R438 North	120	1%	
R438 South	136	1%	
L7016 East	65	2%	
L7016 West	39	2%	
L3010 Northwest	26	2%	

5.4 DMRB assessment

5.4.1 Local air quality - scoping assessment

A local air quality scoping assessment has been conducted for the proposed development following the DMRB methodology detailed in the previous sections. The results of the local air quality assessment are detailed in Table 14 and show that based on the anticipated traffic data a simple assessment of local air quality is not required. The proposed development's potential impact on roadside local air quality is negligible.

Table 14 Scoping level local air quality assessment results

DMRB Criteria	Project Data	Simple Assessment Trigger
Road alignment will change by 5m or more	L3010 widened from 4.8m to 6m	NO
Daily traffic flows will change by 1,000 AADT or more	Max change in traffic flow with development is 322 AADT	NO
Heavy Duty Vehicle (HDV) flows will change by 200 AADT or more	Max change in HDV flow with development is 75 AADT (see Table 13)	NO
Daily average speed will change by 10 km/hr or more	No change to posted road speed limit	NO
Peak hour speed will change by 20 km/hr or more	No change to posted road speed limit	NO

5.4.2 Regional air quality – scoping assessment

A regional air quality scoping assessment has been conducted for the proposed development following the DMRB methodology detailed in the previous sections. The results of the regional air quality assessment are detailed in Table 15 and show that based on the anticipated traffic data, a simple assessment of regional air quality is required due to the change in AADT and HDVs on L3010 west.

Table 15 Scoping level regional air quality assessment results

DMRB Criteria	Project Data (see Table 13)	Simple Assessment Trigger
A change of more than 10% in AADT	L3010 west AADT changes by 73% with development (see Table 13)	YES
A change of more than 10% to the number of HDVs	L3010 HDV % changes by 12% with development	YES
A change in the daily average speed of more than 20km/hr	No change to posted road speed limits	NO

5.4.3 Regional air quality – simple assessment

A regional air quality simple assessment has been conducted for the proposed development using the DMRB Screening Method spreadsheet (v1.03c). The screening level assessment uses the traffic information for the proposed development (detailed in Table 12) coupled with road length to estimate the change in annual emissions of air pollutants released by vehicles.

The input data for the regional assessment are shown in Figure 10 and Figure 11 for the without development and with development scenarios, respectively.

DMRB: Regional Assessment INPUT

Name	2021 WITHOUT DEV
Year	2021
Number of links	7

Link number	Link title	Link length (km)	Traffic flow &		Road type (A,B,C,D)	Traffic composition						
						Vehicles <3.5t GVW (LDV)			Vehicles>3.5t GVW (HDV)			
			AADT (combined,veh/day)	Annual average speed (km/h)		% passenger cars	% light goods vehicles	Total % LDV	% buses and coaches	% rigid HGV	% articulated HGV	Total % HDV
1	L3010 East	1.50	120	70	C			93.8				6.2
2	L3010 West	0.47	120	70	C			93.8				6.2
3	R438 North	4.60	1,449	70	C			93.8				6.2
4	R438 South	1.18	1,543	70	C			93.8				6.2
5	L7016 East	0.03	403	70	C			93.8				6.2
6	L7016 West	2.60	262	70	C			93.8				6.2
7	L3010 Northwest	3.30	235	70	C			93.8				6.2

Figure 10 Simple regional air quality assessment input data – without Development

DMRB: Regional Assessment INPUT

Name	2021 WITH DEV
Year	2021
Number of links	7

Link number	Link title	Link length (km)	Traffic flow &		Road type (A,B,C,D)	Traffic composition						
						Vehicles <3.5t GVW (LDV)			Vehicles>3.5t GVW (HDV)			
			AADT (combined,veh/day)	Annual average speed (km/h)		% passenger cars	% light goods vehicle	Total % LDV	% buses and	% rigid HGV	% articulated HGV	Total % HDV
1	L3010 East	1.50	120	70	C			93.8				6.2
2	L3010 West	0.47	442	70	C			81.4				18.6
3	R438 North	4.60	1,569	70	C			92.5				7.5
4	R438 South	1.18	1,679	70	C			92.4				7.6
5	L7016 East	0.03	468	70	C			91.4				8.6
6	L7016 West	2.60	301	70	C			91.6				8.4
7	L3010 Northwest	3.30	261	70	C			92.1				7.9

Figure 11 Simple regional air quality assessment input data – with Development

The results of the regional air quality assessment are detailed in Table 16 and show that based on the anticipated traffic data, annual emissions of CO, THC, NO_x, PM_{10} and carbon increase with the proposed development. This is due to the increase in vehicle movements per year. The largest change in annual emissions is for NO_x which increase by 22% on the L3010 due to increased movements on this road with the proposed development. However, the magnitude of annual emissions regionally is small compared to likely annual emissions from vehicles using the major roads in the region (M6 and M4), located approximately 20km away.

Table 16 Simple regional air quality assessment results

Scenario	Year	Total Emissions				
		CO	THC	NOx	PM_{10}	Carbon
		kg/ year				t /year
Without Development	2021	2,287	307	1,341	37	177
With Development		2,542	359	1,630	42	207
Change with development		*255*	*52*	*289*	*5*	*30*
		11%	*17%*	*22%*	*15%*	*17%*

6. CLIMATE CHANGE ASSESSMENT

6.1 Methodology

The assessment has been conducted in line with guidance provided in:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Draft August 2017 (EPA Ireland, 2017) – EIAR Guidelines
- SEA and Climate change: Integrating Climate Change into Strategic Environmental Assessment in Ireland – Guidance Note (EPA, 2015).

Pollutants of importance to climate change associated with the proposed development are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). This study has assessed the annual emissions of GHG associated with the proposed development based on activity data representative of proposed activities using methodology consistent with the following guidance documents:

- IPCC Guidelines for National Greenhouse Gas Inventories (2006)
    - Volume 4 – Chapter 10 Emissions from Livestock and Manure Management
    - Volume 5 – Chapter 6 Wastewater Treatment and Discharge
- The Greenhouse Gas Protocol (WBCSD and WRI, 2015)
- Ireland's National Inventory Report 2019 (EPA Ireland, 2019).

The highest annual GHG emissions associated with the proposed development have been considered on an annual basis. In addition to this, GHG emissions have been categorised according the 'scope' of emissions as defined by the Greenhouse Gas Protocol:

- Scope 1 – direct emissions from owned or controlled sources
- Scope 2 – indirect emissions associated with the use of purchased electricity
- Scope 3 – indirect emissions (excluding Scope 2 emissions) associated with the value chain of the reporting company.

Scope 1 and Scope 2 emissions have been reported in this assessment. A summary of estimated emissions associated with the proposed development, expressed as tonnes carbon dioxide equivalent (tCO_2-e) is presented. The emissions factors (EF) and substance properties used in the assessment are summarised in Table 17.

Table 17 Greenhouse gas source substances - properties

Substance	Properties						Reference
	Net calorific value		Emission factor (EF)		Density		
LPG	47.3	GJ/t	63	$kgCO_2$-e/ GJ	0.55	t/m^3	European Commission, 2012
Electricity	3.6	MJ/kWh	0.428	$kgCO_2$-e/ GJ			National Inventory Report, 2019
Methane (CH_4)			25	$kgCO_2$-e/ $kgCH_4$			European Commission, 2018
Nitrous Oxide (N_2O)			298	$kgCO_2$-e/ kgN_2O			European Commission, 2018

GHG emissions associated with manure management have been estimated based on country specific EF provided in Ireland's National Inventory Report 2019. The range of EF associated with non-dairy cattle range from 0.25 $kgCH_4$/head/year for "female cattle >2 years" (1990) to 7.09 $kgCH_4$/head/year for "male cattle 1-2 years" (1990). To provide an indication of maximum annual emissions associated with manure management an EF of 7.09 $kgCH_4$/head/year has been used in this assessment.

6.2 Emission sources

The construction phase of the proposed development includes the upgrade of existing abattoir facilities (including lairage) and the installation of a WWTP. GHG emissions during the construction phase will result from diesel use on earthmoving equipment, transportation and other heavy machinery and vehicles. Construction activities are expected to occur over a relatively short period of time. Initial estimates indicate that GHG emissions associated with the construction phase of the proposed development are insignificant and have not been included in this report.

Activities associated with the operational phase of the proposed development that will result in GHG emissions, organised according to scope, are:

- Scope 1
  - LPG combustion for boilers and forklifts
  - Treatment of wastewater
  - Manure management
- Scope 2
  - Purchased electricity.

The estimation of the highest anticipated annual GHG emissions associated with each of these activities has been made based on the following activity data:

- LPG
  - Annual consumption – 80m^3.
- WWTP
  - Effluent throughput of 250 L/day
  - Effluent COD 8,000 mg/L
  - Water treatment consists of a combination of aerobic and anoxic treatment processes.

- Manure management
  - 450 head of cattle onsite on a continuous basis (to provide an indication of maximum.
- Purchased electricity.
  - Annual consumption - 922 MWh

6.3 Existing environment

Ireland's National Inventory Report 2018 (EPA, 2018b) is the official submission for Ireland for 2018 under the UNFCCC and the Kyoto Protocol. The National Inventory Report includes a detailed summary of national emissions for 2017 together with an overview of national emissions from 1990 until 2017. Ireland's national GHG emissions for 2017 were estimated to be 60,744 ktCO_2-e with 32% attributable to agriculture, as a sector. Table 18 provides a summary of annual national GHG emissions including GHG emissions associated with agricultural activities. Figure 12 provides a pictorial summary of the sectoral contributions to national GHG emissions.

Table 18 Ireland National GHG emissions - 2017

Category	GHG Emissions (ktCO_2-e)	% National Emissions
Ireland National*	60,744	100%
Agriculture	19,581	32%
Note: *excluding Land Use, Land-Use Change and Forestry (LULUCF)		

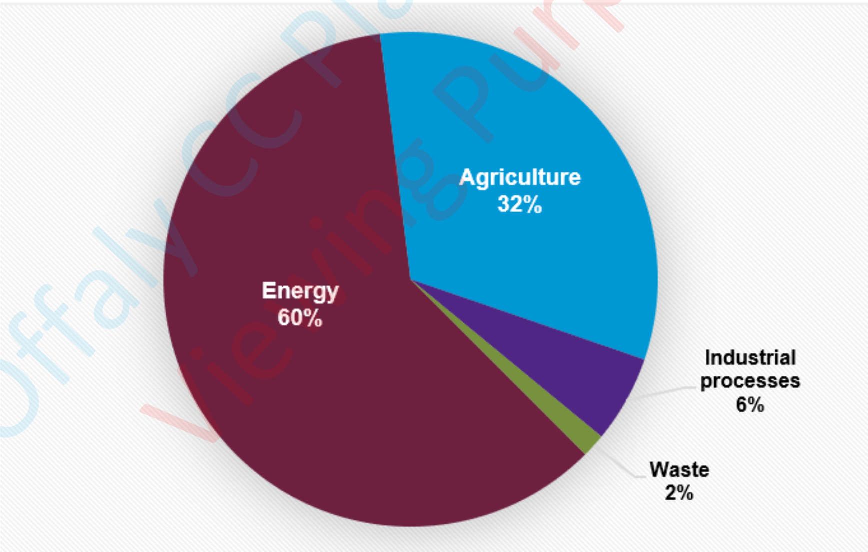

Figure 12 GHG emissions Ireland 2017 – sectoral summary

6.4 Climate change policy and legislative framework

6.4.1 Global climate change response

Ireland is a party to both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, which together provide an international legal framework for addressing climate change. The Paris

Agreement is the new legally binding, global agreement on addressing climate change under the UNFCCC. The Paris Agreement was adopted by 195 Parties to the UNFCCC, representing 95% of global emissions, at the twenty-first session of the Conference of the Parties to the UNFCCC in December 2015. The ratification of the Agreement by the European Union triggered its entry into force on 4 November 2016, the same date the Agreement was ratified by Ireland. This legally-binding Agreement, represents a global milestone in international efforts to achieve a peaking of greenhouse gas emissions as soon as possible and to achieve net zero emissions by the second half of the century.

Each party to the agreement must commit to a Nationally Determined Contribution (NDC) that sill increase in ambition over time, with progress being tracked by a series of global stocktakes, to be held every five years, starting in 2023. Ireland's contribution to the Paris Agreement will be via the NDC tabled by the EU on behalf of its Member States. The EU as a whole has committed to reducing its greenhouse gas (GHG) emissions by at least 40% by 2030, compared to 1990 levels.

6.4.2 European Union response

The European Council (EC) are committed to an EU objective of reducing GHG emissions by 80-95% by 2050 compared to 1990. Complimentary to this the EU has adopted interim objectives for 2020 and 2030:

- 2020 – reduce GHG emissions by 20% compared to 1990 levels
- 2030 – reduce GHG emissions by 40% compared to 1990 levels

These objectives will be achieved through a combination of the EU Emissions Trading Scheme (ETS) and individual targets for each EU Member State for non-ETS sectors. Negotiations on these draft Effort Sharing Regulation (ESR) proposals are ongoing. Complementary to this the EC's Climate and Energy Framework includes binding targets of 27% renewable energy and an energy efficiency increase of at least 27% across the EU.

6.4.3 National policy and long term vision

In 2014, the Government adopted the *National Policy Position on Climate Action and Low Carbon Development (National Policy Position)*. The National Policy Position establishes the fundamental national objective of achieving transition to a competitive, low carbon, climate-resilient and environmentally sustainable economy by 2050. It sets out the context for the objective, clarifies the level of greenhouse gas mitigation ambition envisaged and establishes the process to pursue and achieve the overall objective. Specifically, the National Policy Position envisages that policy development will be guided by a long-term vision based on:

- An aggregate reduction in carbon dioxide (CO_2) emissions of at least 80% (compared to1990 levels) by 2050 across the electricity generation, built environment and transport sectors
- In parallel, an approach to carbon neutrality in the agriculture and land-use sector, including forestry, which does not compromise capacity for sustainable food production.

With 2015 GHG emission as a starting point, this equates to average annual reductions of 0.75MtCO_2, compared to the projected position in 2035, which would require average annual reductions of almost 2 MtCO_2. Highlighting the need for earlier action. The White Paper on Energy Policy, *Ireland's Transition to a Low Carbon Energy Future 2015-2030* recognises that a radical transformation of Ireland's energy system is required to meet national, EU and international climate objectives and sets a course for an energy sector where the State will provide the supports that enable consumers to become active energy citizens. The vision is to reduce GHG emissions from the energy sector by between 80% and 95% compared to 1990 levels by 2050, while ensuring that secure supplies of competitive and affordable energy remain available to citizens and businesses. The White Paper sets out how the energy transition will depend on accelerated and diversified renewable energy generation, and a renewed focus on energy efficiency.

The *Climate Action and Low Carbon Development Act 2015* provides the statutory basis for the national transition objective – the goal of progressively pursuing a low carbon, climate resilient and environmentally sustainable economy by 2050. It provides the legislative framework for the development and submission to Government for approval of national mitigation plans and national adaptation frameworks. This includes the institutional and governance framework for the development of these plans on a regular basis, together with independent advisory and Oireachtas accountability arrangements.

6.4.3.1 EU commitments

The EU ETS includes approximately 11,000 installations across the EU with 102 installation currently permitted in Ireland. It covers approximately 45% of total EU emissions and 28% of total emissions in Ireland as indicated by Figure 13.

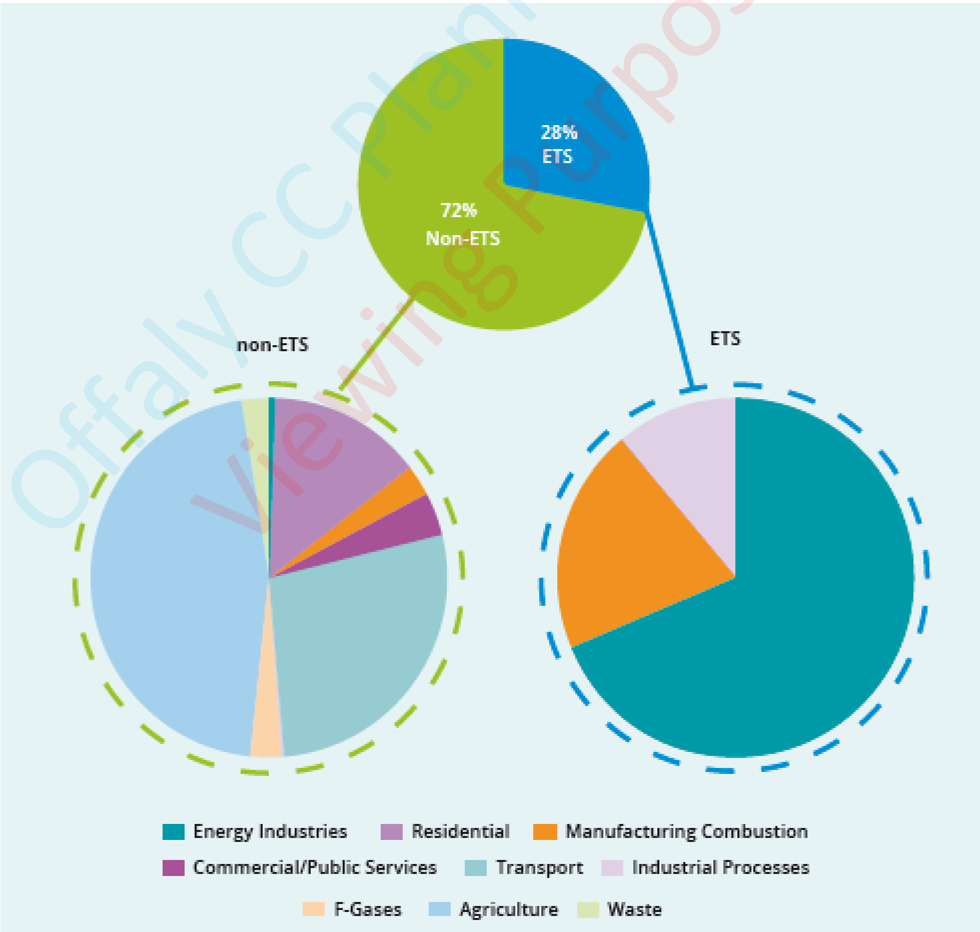

Figure 13 Ireland GHG emissions - ETS/non-ETS

The 2009 Effort Sharing Decision set individual Member State targets for non-ETS emissions out to 2020. Under this decision Ireland has an emissions reduction target for each year between 2013 and 2020. The 2020 target set for Ireland is that GHG emissions should be 20% below their 2005 level.

6.4.3.2 Environmental impact assessment

Climate has been identified as a factor of significance to the proposed development. As a result, the aspects of the project relevant to climate change that have been considered for the proposed development are:

- The impact of the project on climate change in terms in terms of GHG
- The potential vulnerability of the proposed development to climate change.

6.5 Greenhouse gas assessment

The energy use and GHG emissions associated with the proposed development are summarised in Table 19. The highest annual GHG emissions associated with the proposed development have been estimated to be 1,111 tCO_2-e (Scope 1: 716 tCO_2-e and Scope 2: 395 tCO_2-e) with annual energy used estimated to be 5,398 GJ.

Table 19 Summary of annual energy use and GHG emissions

Emission source	Energy (GJ)	GHG emissions (tCO_2-e)		
		Scope 1	Scope 2	Total Emissions (Scope 1 + Scope 2)
LPG	2,079	131	-	131
WWTP		473	-	473
Manure management		113	-	113
Electricity	3,319	- -	395	395
TOTAL	**5,398**	**716**	**395**	**1,111**

Annual GHG emissions, of 1,111 tCO_2-e, associated with the project compared to 2017 emissions are:

- 0.002% of annual total national GHG emissions
- 0.006% of annual GHG emissions for the agriculture sector.

6.6 Management and mitigation of GHG emissions

Management and mitigation of GHG emissions has been integrated into the design of the proposed development including:

- Selection of an aerobic/anoxic WWTP (avoiding the need for anaerobic digestion)
- Use of LPG fuel for boilers
- LED lighting throughout the facility.

Other factors that have the potential to further mitigate GHG emissions associated with the proposed development, but have not been factored into the estimates of annual GHG emissions, include:

- The constructed wetland is likely to act as carbon (GHG) sink

- Waste segregation, management and disposal practices that will be adopted for animal by-products will mitigate Scope 3 GHG emissions.

6.7 Climate vulnerability

In addition to the potential impact of the proposed development on climate change as a result of GHG emissions, the potential vulnerability of the proposed development to the impacts of climate change is considered in this section. The key impacts of climate change on agriculture based on 'Integrating Climate Change into Strategic Environmental Assessment in Ireland – A Guidance Note' (EPA, 2015) are summarised in Table 20. The nature of operations of the proposed development, including short term housing of cattle and enclosed beef processing operations, provide a high level of resilience to the potential impacts of climate change. Water availability is likely to have the most significant impact on operation of the Project in terms of:

- Animal welfare – cattle require access the water
- Cleaning operations – water relied upon for the majority of cleaning operations.

Table 20 Key impacts of climate change on agriculture (EPA, 2015)

Related aspects	Effects on agriculture
• Air temperature • Soil temperature • Extreme weather events • Water availability	• Decrease in soil condition • Increase in pests, pathogens and invasive species • Increase in plant growth • Animal welfare • Infrastructure and access to the land

7. CONCLUSIONS

The air quality assessment is required to understand impacts of expanding an existing abattoir to facilitate operations with a processing capacity of 140 cattle per day.

The sources of emissions at the proposed development include:

- Odour
  - Manure that accumulates in areas used to contain animals prior to slaughter
  - Manure that is stored in onsite slurry tanks
  - By-products of animal slaughter
  - Treatment of wastewater generated
  - Treatment of sludges generated by through onsite wastewater treatment.
- Combustions gases
  - Boilers

Emission rates from the site have been based on data from the literature.

The air quality assessment was conducted in accordance with recognised techniques for dispersion modelling specified in EPA's Air Dispersion Modelling Guidance Note (AG4). AERMOD was used to predict ground-level concentrations of odour and air contaminants across the model domain due to sources at the site.

The air quality assessment found:

- The predicted concentrations of odour are well below the criterion of 1.5 ou_E/m^3 due to the proposed development at sensitive receptors
- The predicted concentrations of NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$ are well below the relevant criteria levels due to the proposed development at sensitive receptors
- The predicted concentrations of ammonia are well be the relevant criteria due to the proposed development at the Natura sites located near the site.

The road traffic assessment found the proposed development's potential impact on roadside local air quality is negligible and the magnitude of annual emission on regional air quality is low compared to major regional roads in the vicinity of the proposed development

An assessment of the potential change in road traffic emissions with the proposed development has been undertaken using the DMRB methodology.

The assessment found that changes in local air quality (at the roadside) due to the proposed development are likely to be negligible. This is due to the relatively small volume of traffic on the existing road network and the small addition from the proposed development.

The assessment of regional air quality found that the proposed development is likely to result in increases in annual emissions of air pollutants; however, the magnitude of these is small compared to emissions from the major roads in the region (M6 and M4).

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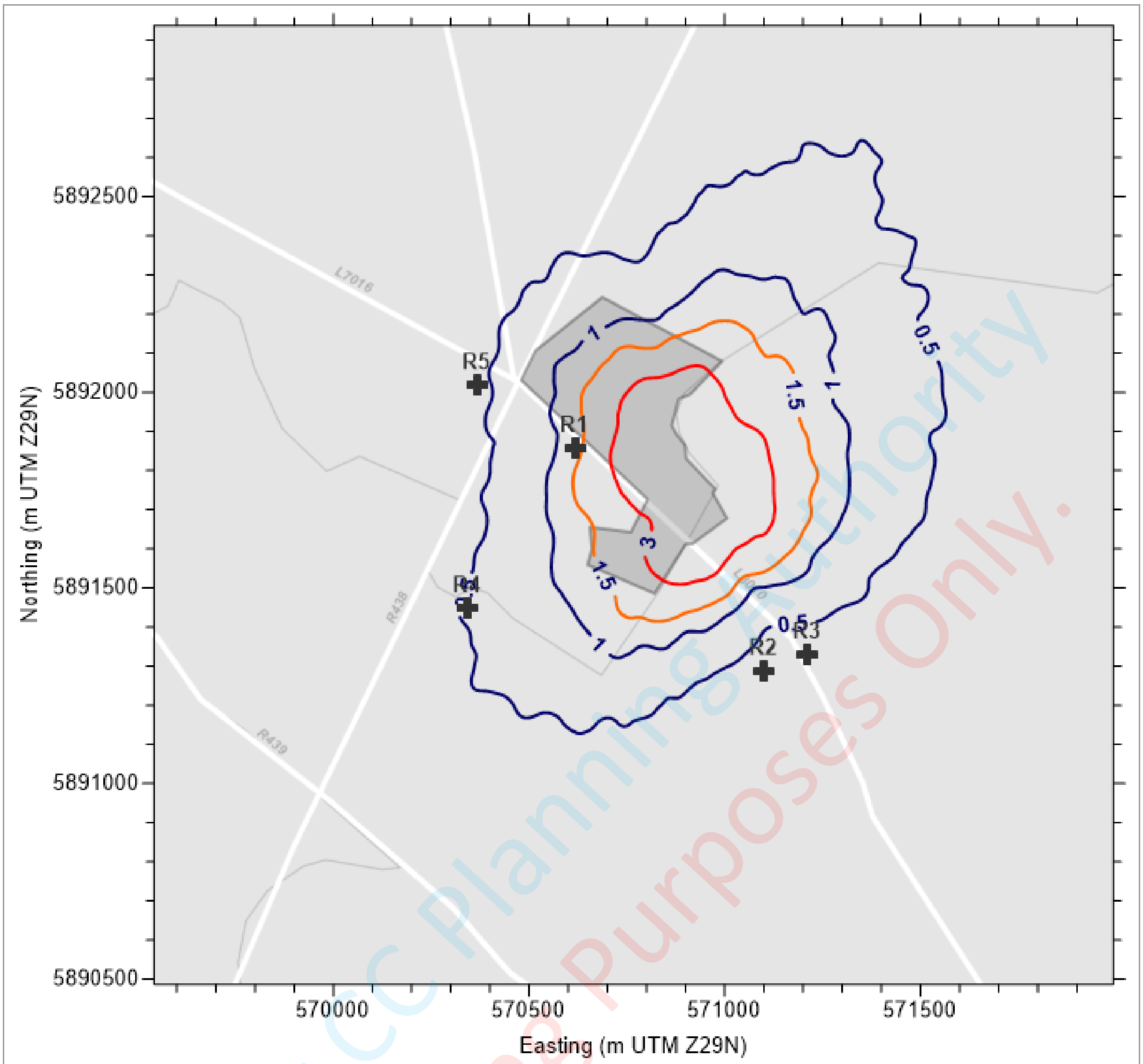

Plate 1 **Predicted odour concentrations due to the proposed development**

Location:	**Averaging period:**	**Data source:**	**Units:**
Banagher, Co. Offaly	1-hour	AERMOD	ou_E/m^3
Type:	**Criterion level:**	**Prepared by:**	**Date:**
98^{th} percentile	1.5 (Orange Line)	M Fogarty	April 2019

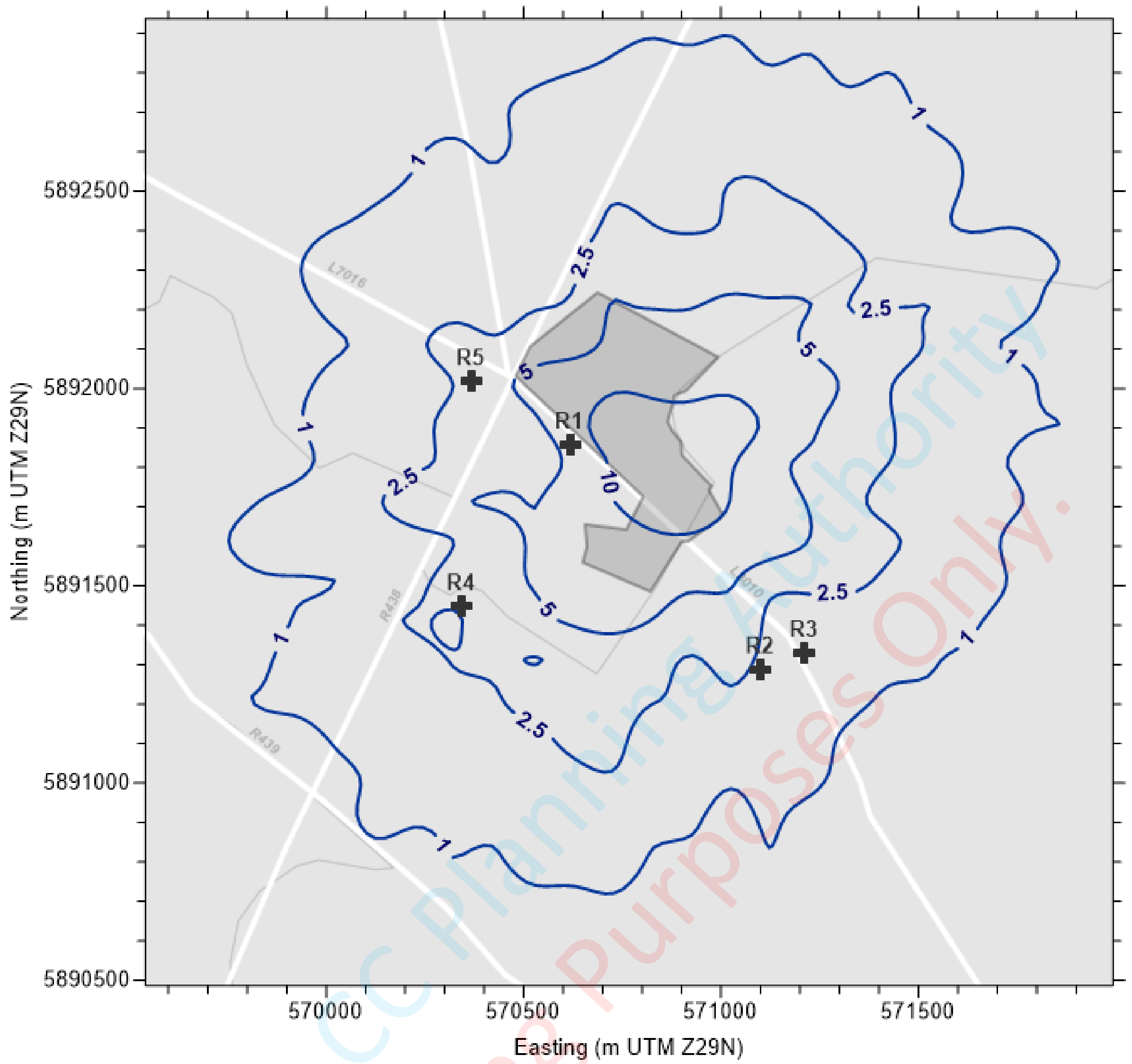

Plate 2	**Predicted 1-hour average concentrations of NO_2 due to the proposed development**		
Location: Banagher, Co. Offaly	**Averaging period:** 1-hour	**Data source:** AERMOD	**Units:** µg/m³
Type: 19th high	**Criterion level:** 200 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

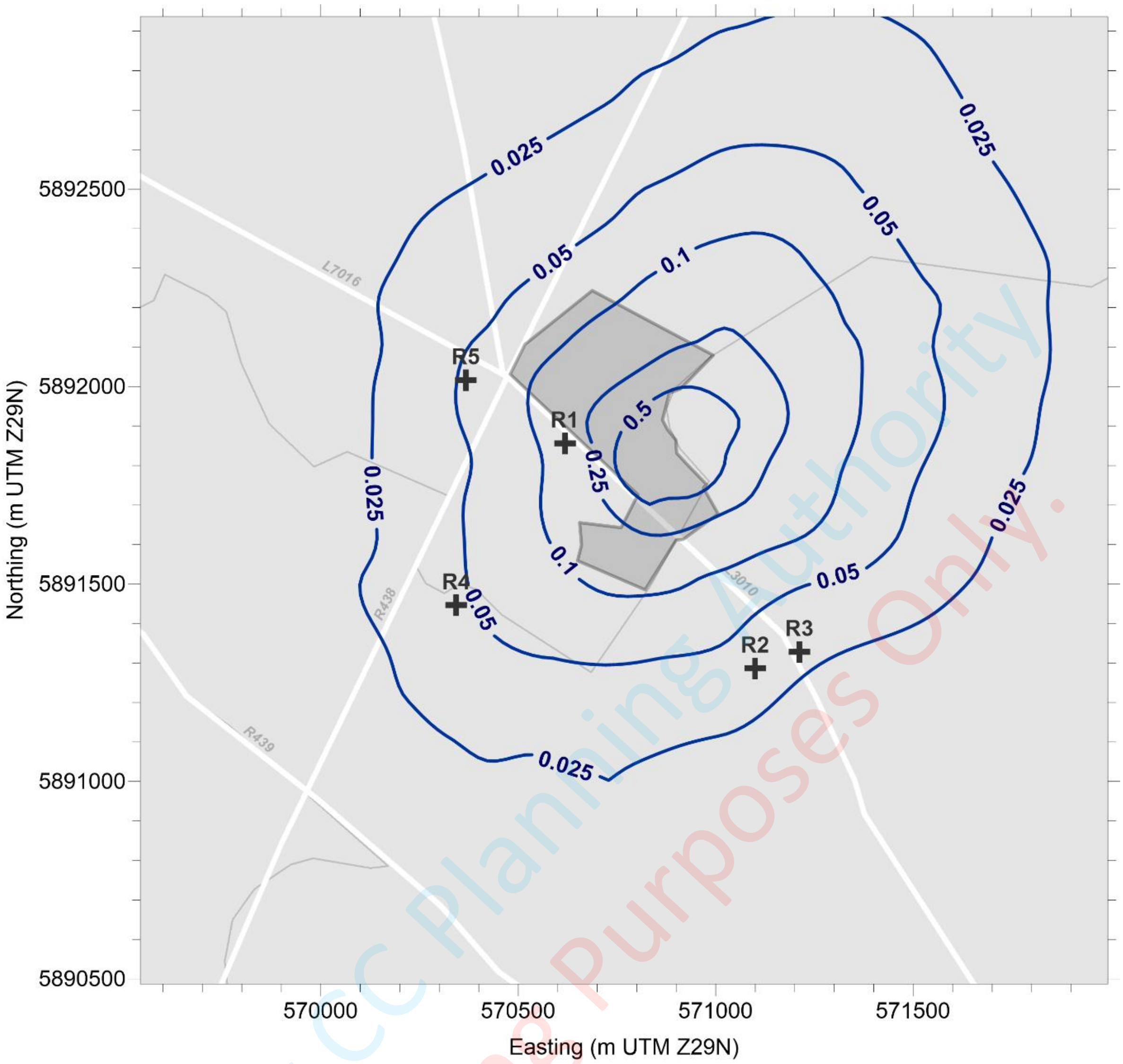

Plate 3 **Predicted annual average concentrations of NO_2 due to the proposed development**

Location:	**Averaging period:**	**Data source:**	**Units:**
Banagher, Co. Offaly	Annual	AERMOD	µg/m³
Type:	**Criterion level:**	**Prepared by:**	**Date:**
Average	40 (Red Line)	M Fogarty	April 2019

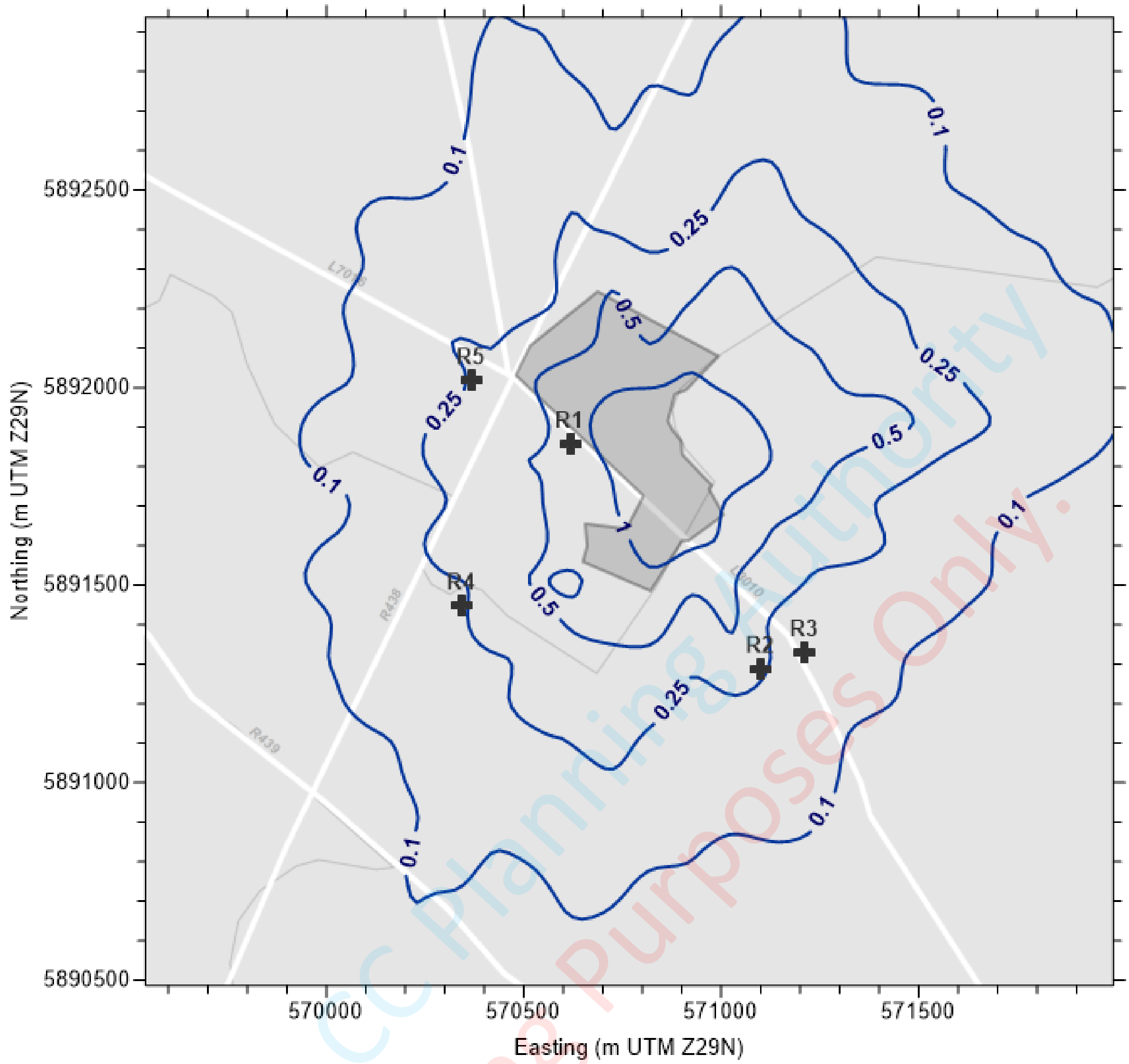

Plate 4	**Predicted 8-hour average concentrations of CO due to the proposed development**		
Location: Banagher, Co. Offaly	**Averaging period:** 8-hour	**Data source:** AERMOD	**Units:** µg/m³
Type: Maximum	**Criterion level:** 10000 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

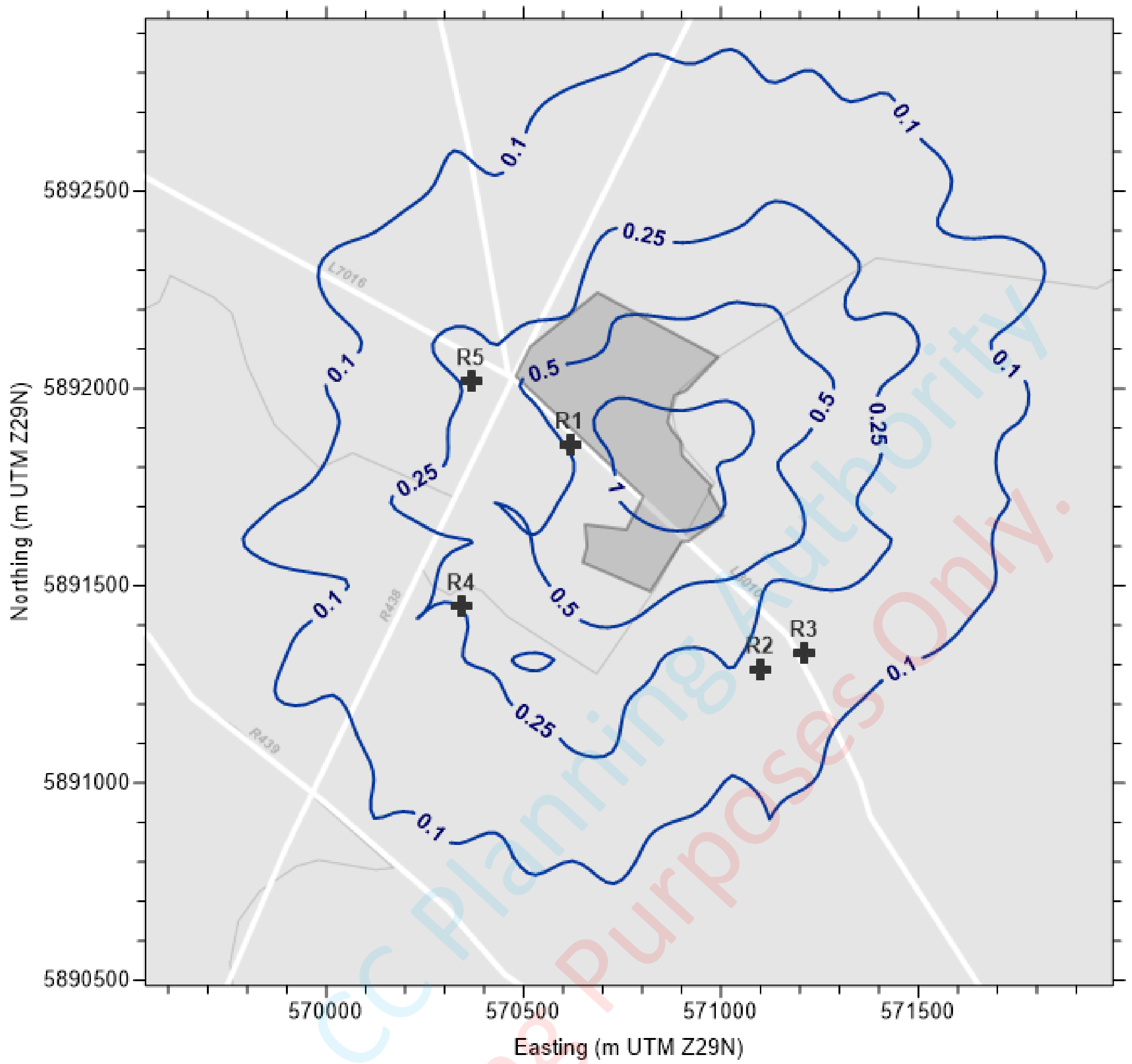

Plate 5	**Predicted 1-hour average concentrations of SO_2 due to the proposed development**

Location:	**Averaging period:**	**Data source:**	**Units:**
Banagher, Co. Offaly	1-hour	AERMOD	µg/m³
Type:	**Criterion level:**	**Prepared by:**	**Date:**
19th high	350 (Red Line)	M Fogarty	April 2019

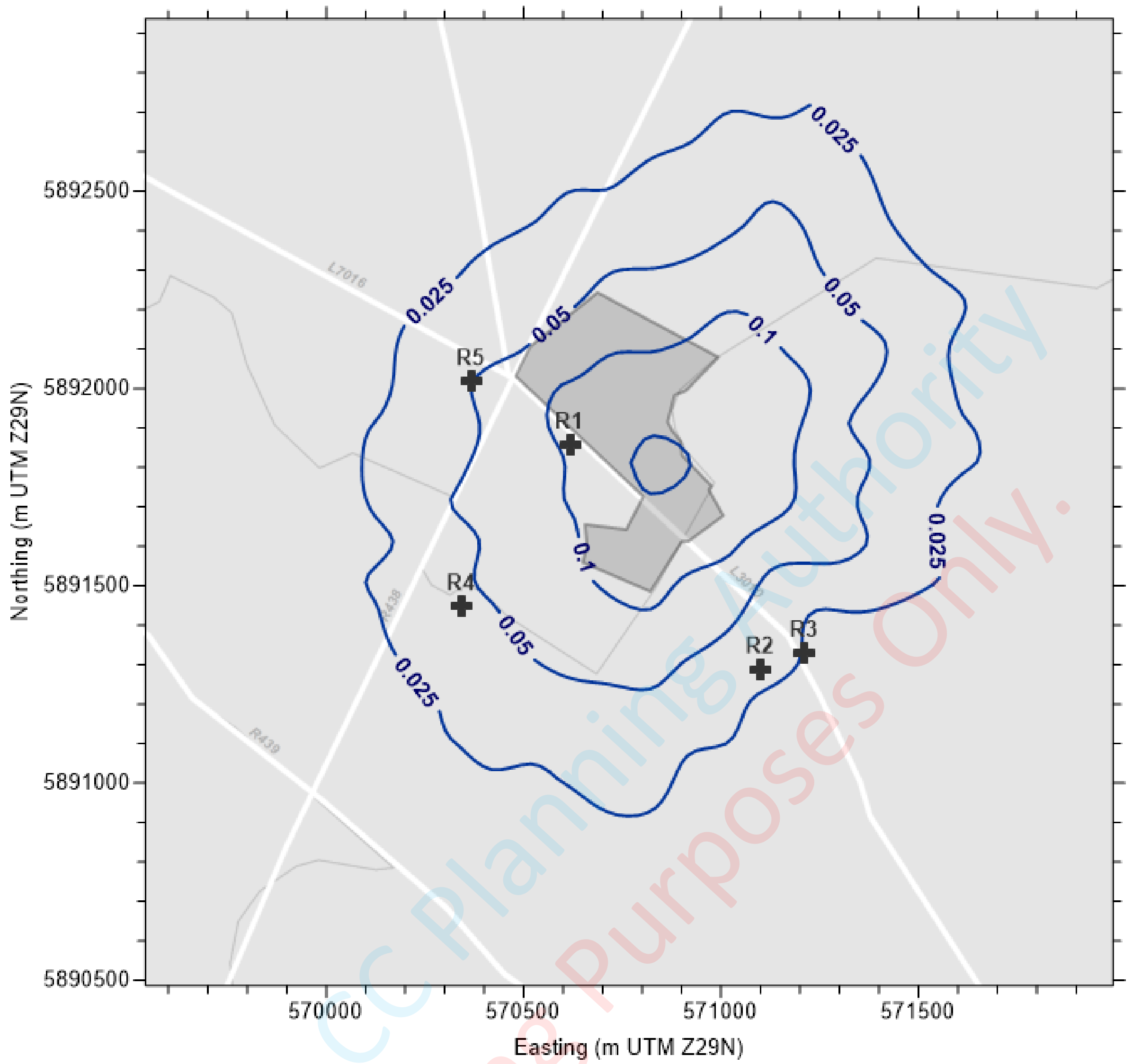

Plate 6	**Predicted 24-hour average concentrations of SO_2 due to the proposed development**		
Location: Banagher, Co. Offaly	**Averaging period:** 24-hour	**Data source:** AERMOD	**Units:** µg/m³
Type: 4th high	**Criterion level:** 125 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

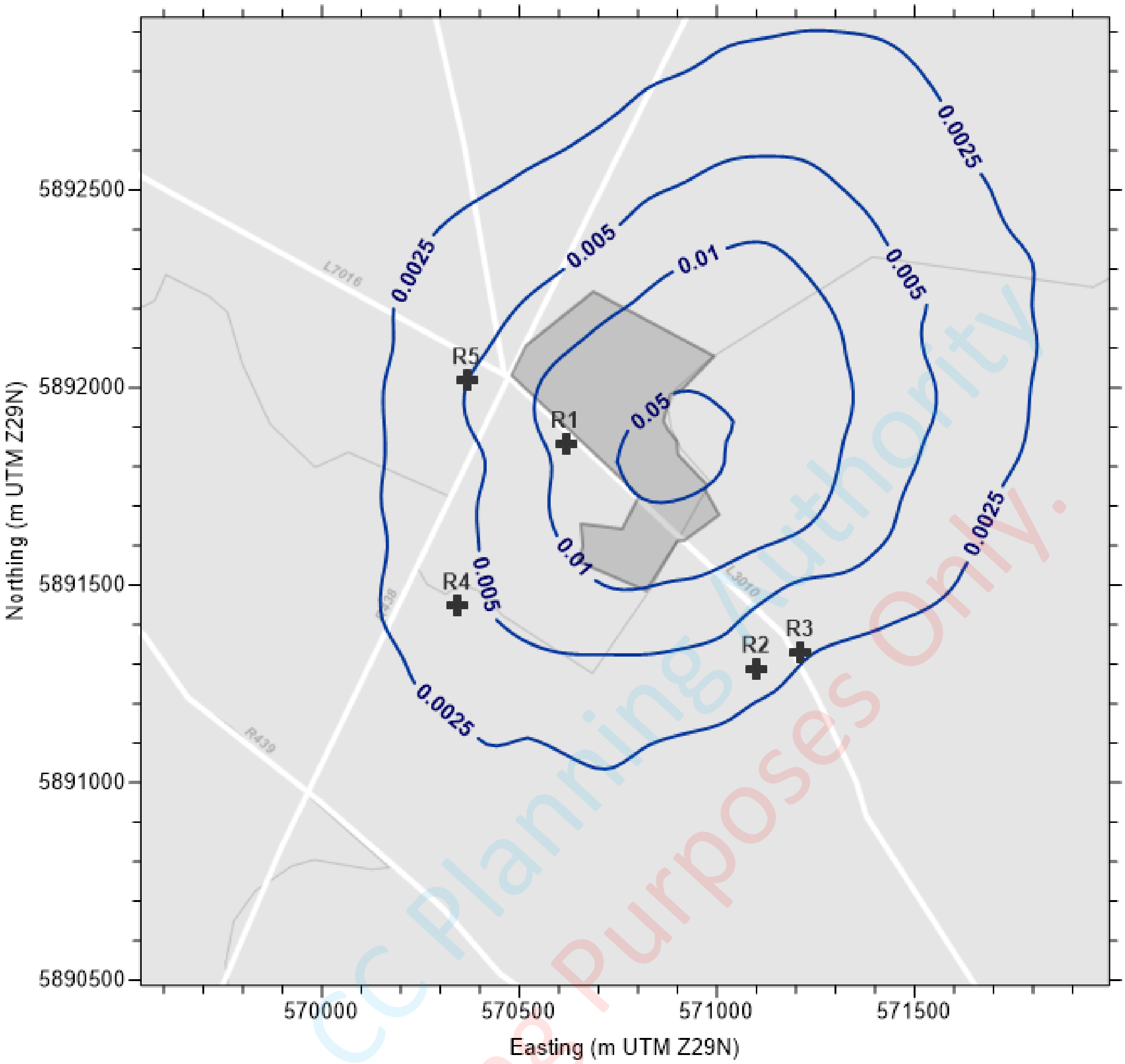

Plate 7 **Predicted annual average concentrations of SO_2 due to the proposed development**

Location:	**Averaging period:**	**Data source:**	**Units:**
Banagher, Co. Offaly	Annual	AERMOD	µg/m³
Type:	**Criterion level:**	**Prepared by:**	**Date:**
Average	20 (Red Line)	M Fogarty	April 2019

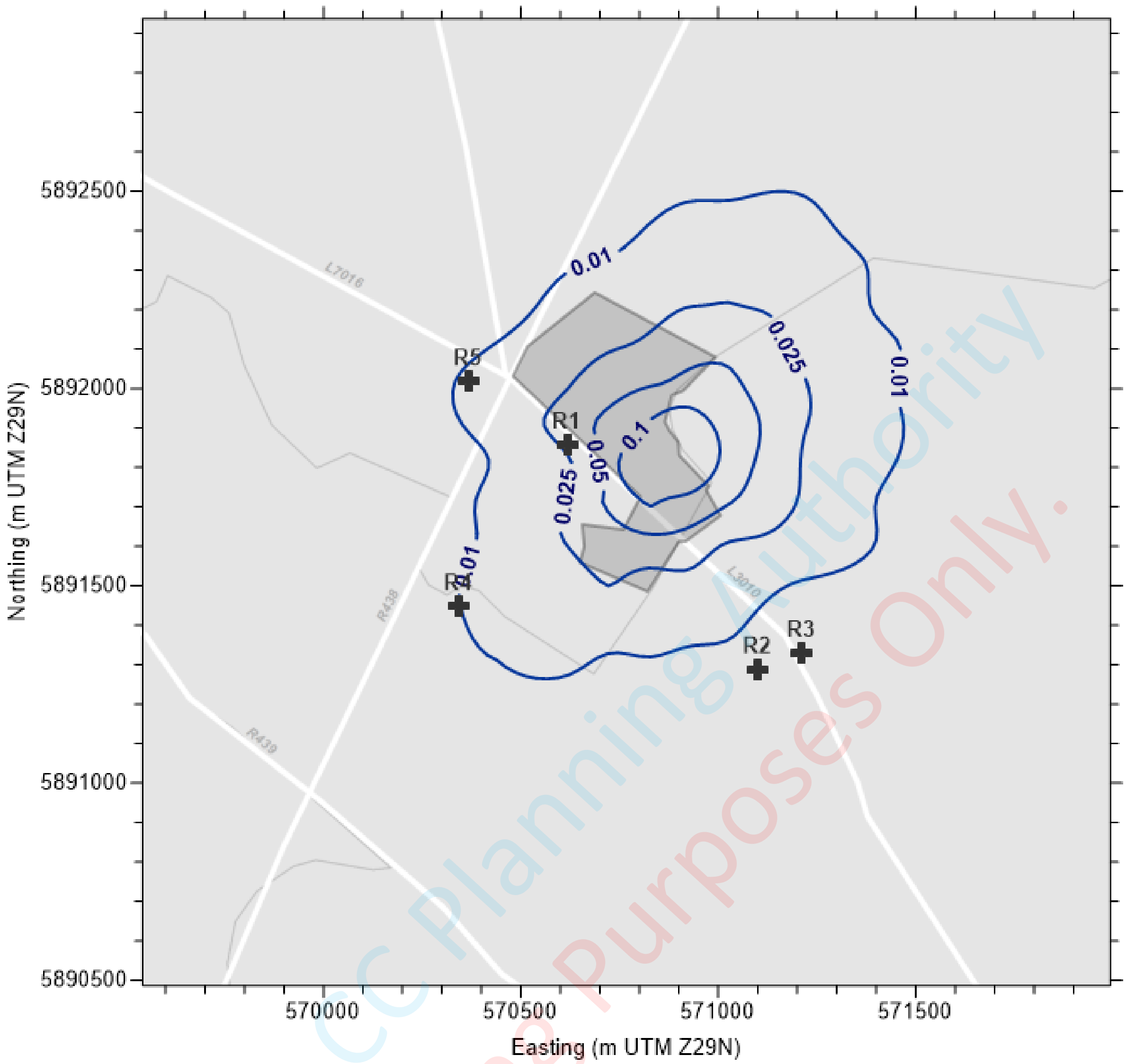

Plate 8 **Predicted 24-hour average concentrations of PM_{10} due to the proposed development**

Location:	**Averaging period:**	**Data source:**	**Units:**
Banagher, Co. Offaly	24-hour	AERMOD	µg/m³
Type:	**Criterion level:**	**Prepared by:**	**Date:**
36th high	50 (Red Line)	M Fogarty	April 2019

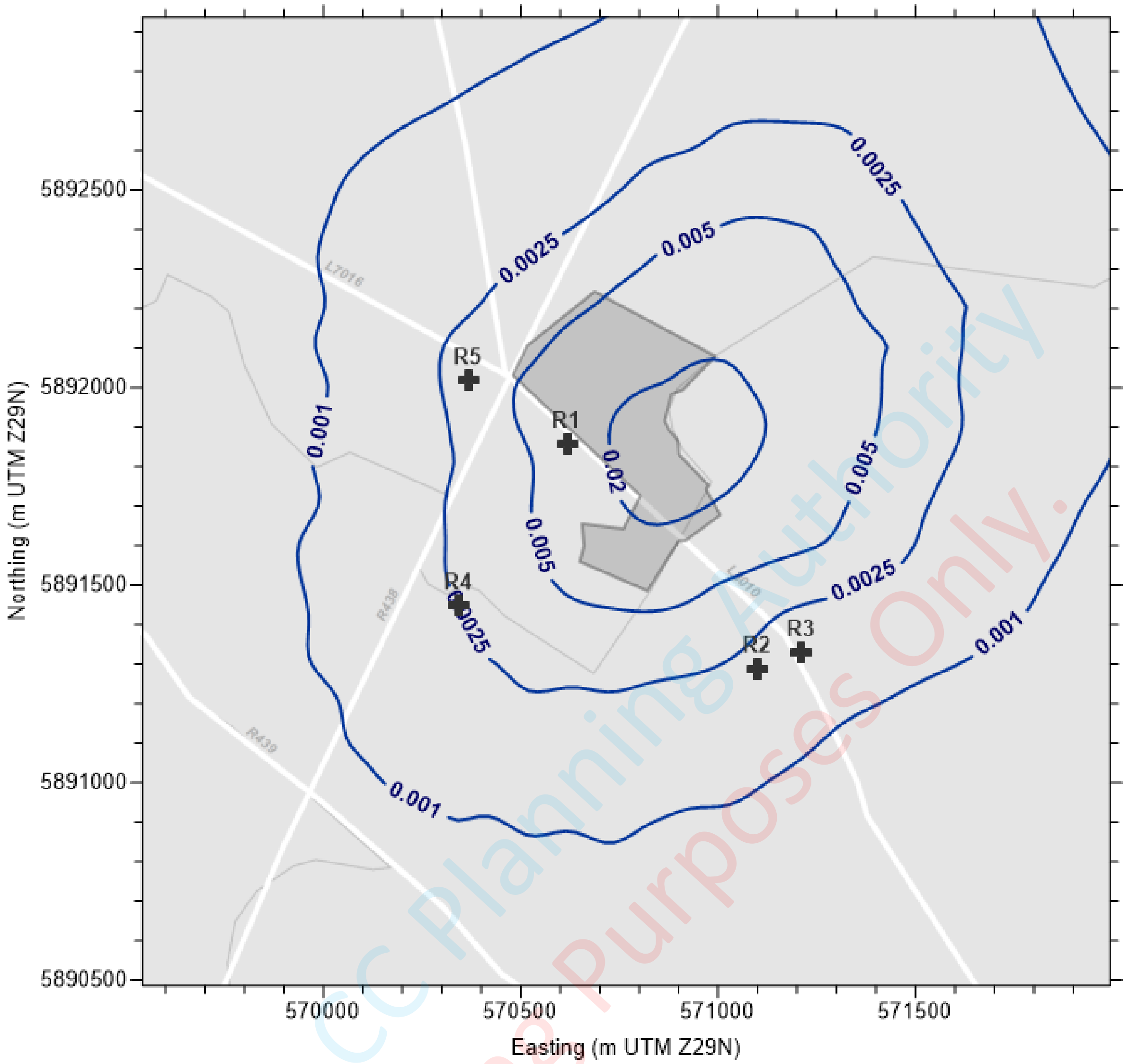

Plate 9	**Predicted annual average concentrations of PM_{10} due to the proposed development**		
Location: Banagher, Co. Offaly	**Averaging period:** annual	**Data source:** AERMOD	**Units:** µg/m³
Type: Average	**Criterion level:** 40 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

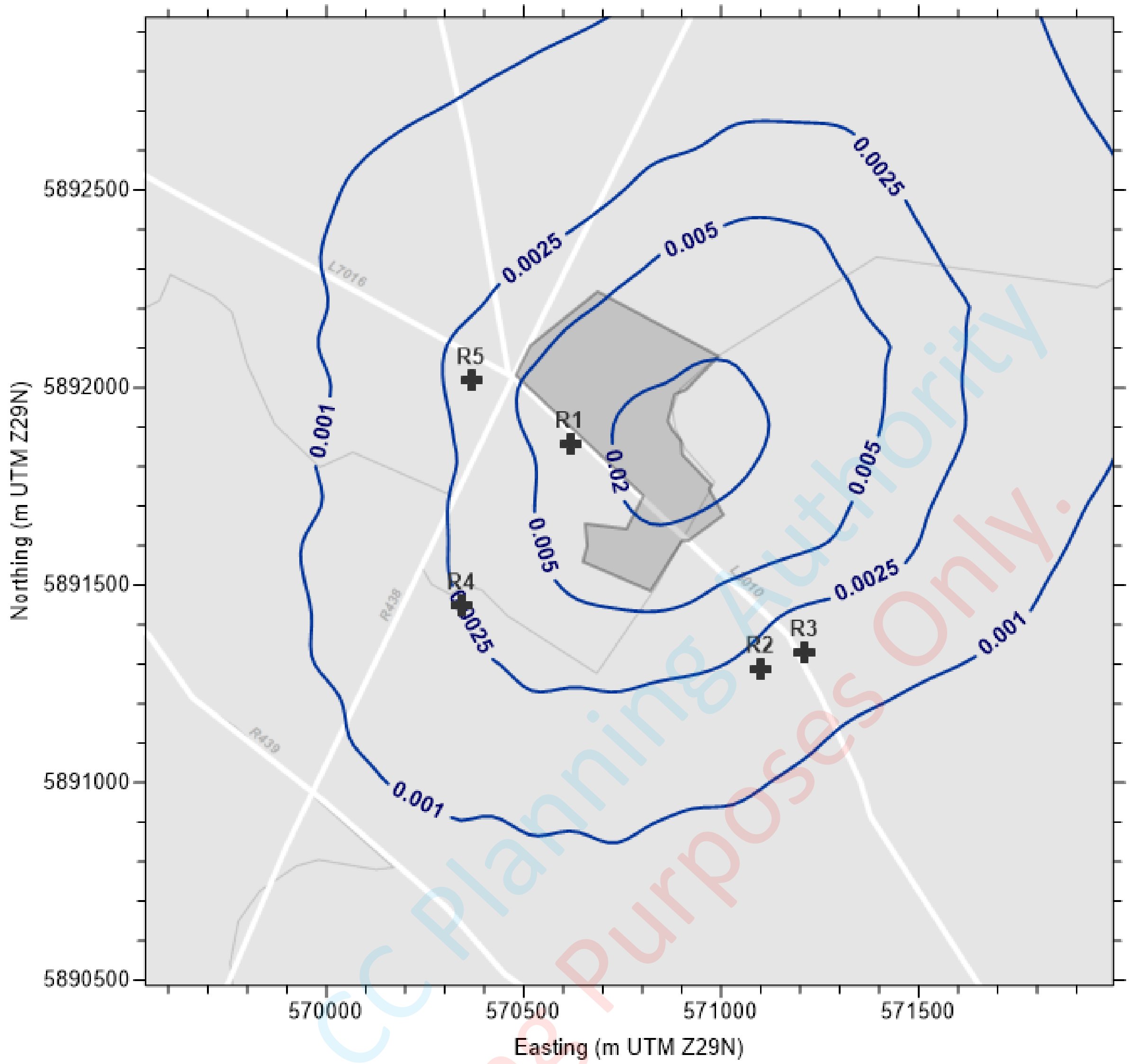

Plate 10	Predicted annual average concentrations of $PM_{2.5}$ due to the proposed development		
Location: Banagher, Co. Offaly	**Averaging period:** Annual	**Data source:** AERMOD	**Units:** µg/m³
Type: Average	**Criterion level:** 25 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

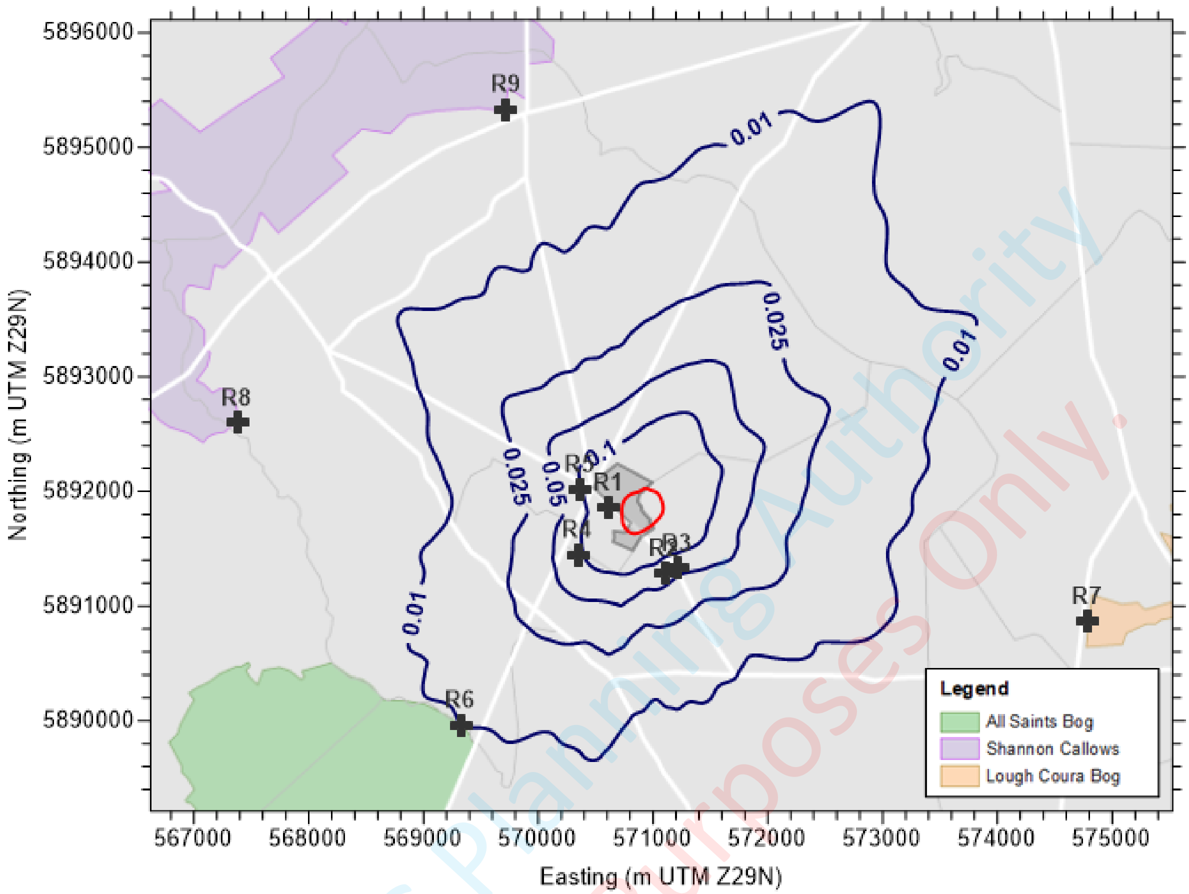

Plate 11	Predicted annual average concentrations of ammonia due to the proposed development		
Location: Banagher, Co. Offaly	**Averaging period:** Annual	**Data source:** AERMOD	**Units:** µg/m³
Type: maximum	**Criterion level:** 0.4 (Red Line)	**Prepared by:** M Fogarty	**Date:** April 2019

APPENDIX A MODELLING METHODOLOGY

A1 METEOROLOGY

A1.1 Calculation of Z_0 and the Albedo and Bowen Ratio TAPM meteorology

A1.1.1 Calculation of Z_0

According to the AERMET Users guide, Z_0 should be determined based on land cover within a 1.0 km radius from the meteorological site. The land use in the vicinity of the meteorological monitoring site at Gurteen College is presented in Figure A1. If the value of Z_0 varies significantly by direction, sector dependency should be used; sector width >= 30 degrees.

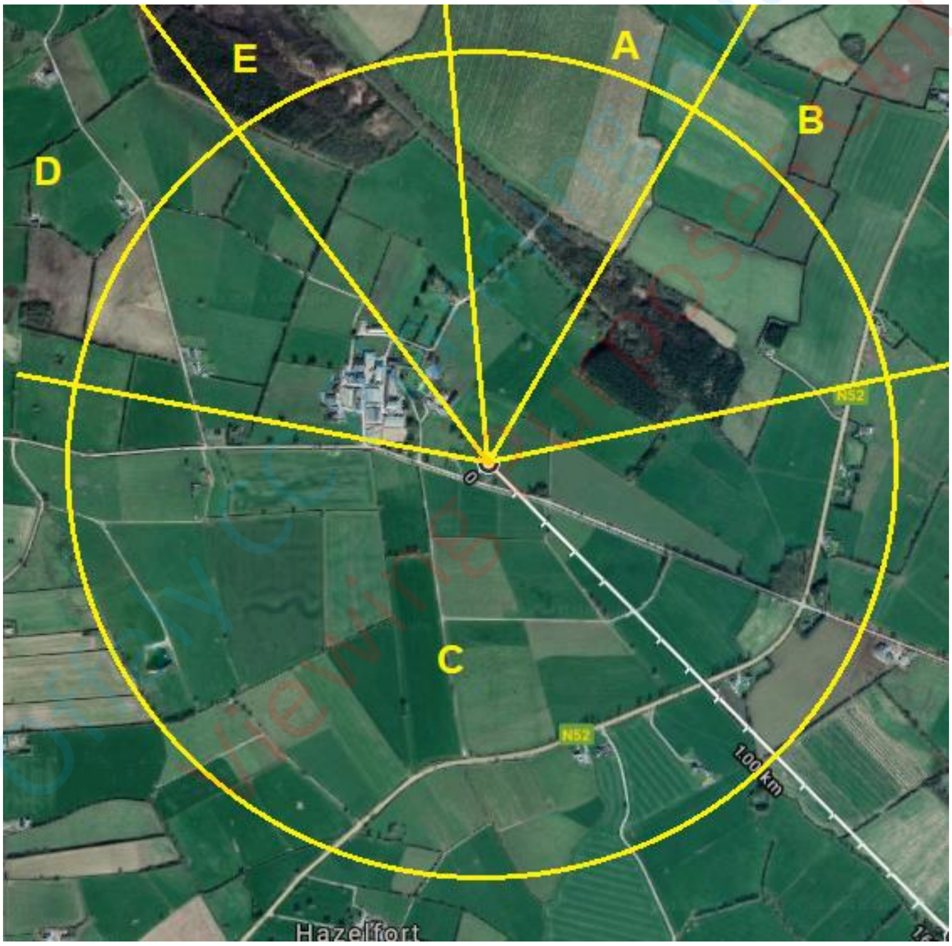

Figure A1 Land use in the vicinity of the meteorological monitoring site at Gurteen College

From the 1 km aerial view image we see that the land use is predominantly grassland or non-arid shrubland (including low level ferns, heather and grasses typically up to 30 cm in height with sparse higher vegetation such as small trees). Non-arid shrub was used in this analysis. From the mosaic of fields, it is assumed that these are cultivated areas. Also present are small areas of recently disturbed peat. The sector boundaries, land use, seasonal Z_0 values for each sector and individual sector weights are presented in Table A1 and Table A2.

Table A1 Sector boundaries and seasonal Zo values

Sector	WDir-1	WDir-2	Summer	Autumn	Winter	Spring
A	355	29	0.3	0.3	0.3	0.3
B	30	79	0.3	0.3	0.3	0.3
C	80	279	0.3	0.3	0.3	0.3
D	280	324	0.437	0.437	0.437	0.437
E	325	354	0.3	0.3	0.3	0.3

Table A2 Land use and weightings for each sector

Sector	Land_Use	LandUse Weight (%)	Distance Weight (%)	Final Zo Weight (% normalised)
Sector A	Quarries/Strip Mines/Gravel	11	56	13
	Shrub land (Non-Arid Region)	89	70	86
Sector B	Quarries/Strip Mines/Gravel	22	50	28
	Shrub land (Non-Arid Region)	78	70	71
Sector C	Shrub land (Non-Arid Region)	100	40	100
Sector D	Industrial/Commercial	10	10	44
	Quarries/Strip Mines/Gravel	10	94	4
	Shrub land (Non-Arid Region)	80	70	50
Sector E	Quarries/Strip Mines/Gravel	14	87	9
	Shrub land (Non-Arid Region)	86	55	90

A1.1.2 Calculation of Albedo and Bowen Ratio

These should be determined based on land cover within a 10km x 10km domain. A simple unweighted mean should be used for the Albedo and a weighted geometric mean for the Bowen ratio, no need for sector dependency. From the 10 km aerial view image (Figure A2), it was estimated the land use as about 83% grassland and 17% recently peat. Boundary layer research (Sottocornola, 2007) over peatland suggests a value of about unity for the Bowen ratio during the growing season (April – September) corresponding to the summer months. Referring to the AERMOD User Guide, the average Bowen Ratio for shrub land (non-arid) for the summer is also stated as unity, increasing to 1.5 in Autumn and Winter (October to March). Disturbed peatland consists of a barren clay-like surface that can dry and become crusty with no rain.

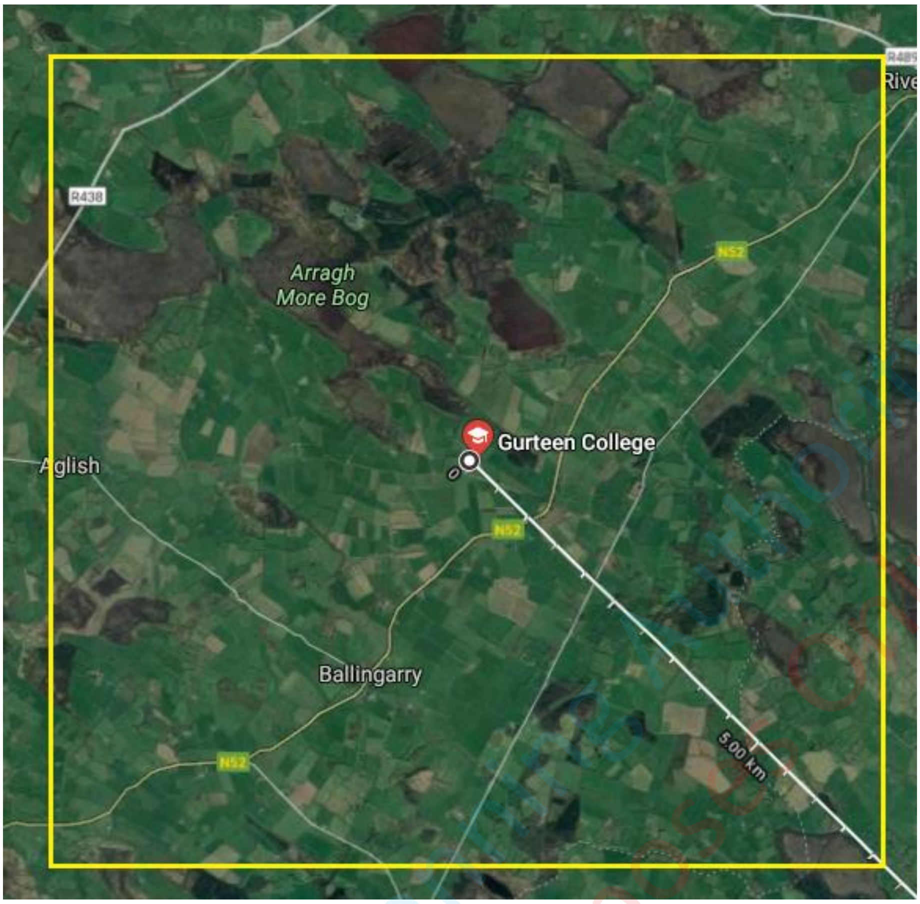

Figure A2 Land cover within a 10km x 10km domain of Gurteen College monitoring location

The Albedo for a disturbed surface will be similar to dark clay (corresponding to the quarry, strip mine option in the AERMOD user's manual). The undisturbed surface will be similar to non-arid scrubland.

The results for the albedo and ("average", i.e. - not "wet", not "dry") Bowen ratio are presented in Table A3.

Table A3 Seasonal Albedo and Bowen ratio values using quarries/strip mines/gravel for disturbed peatland

Albedo	Fraction(%)	Summer	Autumn	Winter	Spring
Quarries/Strip Mines/Gravel	17	0.2	0.2	0.2	0.2
Shrub land (Non-Arid Region)	83	0.18	0.18	0.18	0.18
Weighted Average	**-**	**0.183**	**0.183**	**0.183**	**0.183**
Bowen	**Fraction(%)**	**Summer**	**Autumn**	**Winter**	**Spring**
Quarries/Strip Mines/Gravel	17	1.5	1.5	1.5	1.5
Shrub land (Non-Arid Region)	83	1	1.5	1.5	1
Geometric Mean	**-**	**1.071**	**1.5**	**1.5**	**1.071**

A2 DISPERSION MODELLING

A2.1 Emission source configuration

A2.1.1 Odour emission sources

The area source modelling parameters used in AERMOD for WWTP sources with emission surfaces that are open to the atmosphere are presented in Table A4 and Table A5.

Table A4 Extents of area sources used to represent WWTP sources in AERMOD with emission surfaces that are open to the atmosphere in AERMOD

Source	southwest corner		southeast corner		northeast corner		northwest corner	
	UTM (m)							
Raw Inlet Sump/Meva Screen	570851	5891917	570854	5891917	570854	5891920	570851	5891920
Drum Screen	570851	5891899	570854	5891899	570854	5891902	570851	5891902
Anoxic Tank	570838	5891894	570849	5891894	570849	5891905	570838	5891905
Aerobic 1	570848	5891904	570858	5891904	570858	5891914	570848	5891914
Aerobic 2	570859	5891900	570869	5891900	570869	5891910	570859	5891910
Clarifier	570861	5891911	570868	5891911	570868	5891918	570861	5891918
Sludge Removal Skip	570868	5891885	570875	5891885	570875	5891887	570868	5891887

Table A5 Source parameters used to represent WWTP sources in AERMOD with emission surfaces that are open to the atmosphere

Source	Height	Sigma z
	m	m
Raw Inlet Sump/Meva Screen	0.0	1.0
Drum Screen	3.0	1.0
Anoxic Tank	6.5	1.0
Aerobic 1	5.7	1.0
Aerobic 2	5.7	1.0
Clarifier	2.5	1.0
Sludge Removal Skip	1.0	1.0

The area source modelling parameters used in AERMOD for process sources with emission surfaces that are open to the atmosphere are presented in Table A6 and Table A7.

Table A6 **Extents of area sources used to represent process area sources in AERMOD with emission surfaces that are open to the atmosphere**

Source	Southwest corner		Southeast corner		Northeast corner		Northwest corner	
	UTM (m)							
Lairage	570937	5891677	570956	5891660	570966	5891672	570948	5891688
Lairage Slurry Tank	570982	5891680	570984	5891677	570998	5891689	570995	5891692
BellyGrass Trailer	570987	5891697	570994	5891697	570994	5891700	570987	5891700

Table A7 **Source parameters used to represent process area sources in AERMOD with emission surfaces that are open to the atmosphere**

Source	Height	Sigma z
	m	m
Lairage	0.0	1.0
Lairage Slurry Tank	0.0	1.0
Bellygrass Trailer	1.0	1.0

The volume source modelling parameters used in AERMOD for process sources with emission surfaces that are confined within buildings are presented in Table A8.

Table A8 **Source parameters used to represent process volume sources in AERMOD with emission surfaces that are confined within buildings**

Source	Modelled location		Effective Height	Sigma z	Sigma y
	UTM (m)		m	m	m
Cat 1 Trailer Bay	570951.2	5891650.8	3.0	0.7	0.35
Cat 3 Trailer Bay	570954.8	5891647.2	3.0	0.7	0.58

The volume source modelling parameters used in AERMOD for process sources with emission surfaces that are covered without venting to odour control are presented in Table A9.

Table A9 **Source parameters used to represent WWTP volume sources in AERMOD with emission surfaces that are covered but not vented to odour control**

Source	Modelled location		Effective Height	Sigma z	Sigma y
	UTM (m)		m	m	m
Sludge Thickening - Screw Press	570871	5891886	2.0	0.5	1.0
DAF unit	570852	5891896	3.0	0.7	1.2

The volume source modelling parameters used in AERMOD for WWTP sources with emission surfaces that are covered without venting to odour control are presented in Table A10.

Table A10 Source parameters used to represent WWTP volume sources in AERMOD with emission from OCU

Source	Modelled location		Effective height	Sigma z	Sigma y
	UTM (m)		m	m	m
Balance tank carbon filter	570861	5891891	2.0	0.5	2.8
Sludge holding tank carbon filter	570844	5891889	2.0	0.5	1.9

A2.1.2 Air contaminant emission sources

The source modelling parameters used for combustion sources in AERMOD are presented in Table A11.

Table A11 Source modelling parameters used for combustion sources in AERMOD

Source	X[1]	Y[1]	Height[2]	Exhaust Temperature[3]	Diameter	Air flowrate[5]	Velocity[6]
	m	m	m	°C	m	m^3/s	m/s
Boiler 1	570876	5891804	9	194.4	0.6	0.05	0.16
Boiler 2	570880	5891800	9	194.4	0.6	0.05	0.16

Note:

[1] UTM coordinates

[2] Stacks height modelled at heights 2 m above the plant room roof, which is 7 m high (Panther, 2019)

[3] The lowest temperature provided for a boiler stack in data provided by Panther. This is conservative as lower temperature plume have less buoyancy and therefore higher ground level impacts in flat terrain

[4] Diameter supplied by Panther

[5] The LPG combustion rate is 7.58 kg/hr. This equates to an LPG volume of 4.01 m^3/hr based on an LPG gas density of 0.53 m^3/kg at STP. The stoichiometric air-fuel ratios for Propane is 23.9:1. The total volume of uncombusted air:fuel mixture is 100.03 m^3/hr at STP. At an exhaust temperature of 467.5 K this gas expands to 165.2 m^3/hr (0.05 m^3/s)

[6] Based on an airflow rate of 0.05 m^3/s and an exhaust diameter of 0.6 m

The source modelling parameters used for ammonia sources in AERMOD are presented in Table A12.

Table A12 Source modelling parameters used for ammonia sources in AERMOD

Source	Coordinates			Release height	Initial sigma
		m	m	m	m
Ammonia	X1 Y1	570876	5891765	1	1
	X2 Y2	570848	5891792		
	X3 Y3	570875	5891823		
	X4 Y4	570905	5891795		

A2.2 Predicted concentrations based on year

A2.2.1 Odour

The predicted ground-level concentrations of odour at nearby sensitive receptors due to the proposed development in isolation are shown in Table A13.

Table A13 Predicted concentrations of odour to due proposed development

Receptor	1-hour, 98th percentile odour (ou_E/m^3)				
	2013	2014	2015	2016	2017
R1	1.2	1.2	1.2	1.2	0.7
R2	0.3	0.3	0.2	0.3	0.2
R3	0.3	0.3	0.3	0.3	0.3
R4	0.5	0.4	0.4	0.4	0.1
R5	0.4	0.4	0.4	0.4	0.3
Criteria Level	**1.5 ou_E/m^3**				

A2.2.2 Air contaminants

The predicted ground-level concentrations of air contaminants at nearby sensitive receptors due to the proposed development in isolation are shown in Table A14 to Table A18.

Table A14 Predicted concentrations of contaminants due to proposed development in isolation – meteorological data 2013

Receptor	CO (µg/m^3)	NO_2 (µg/m^3)		PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	SO_2 (µg/m^3)		
	Maximum 8-hr	1-hr 19th high	Annual	24-hour 36th high	Annual	Annual	1-hr 19th high	24-hour 4th high	Annual
R1	0.46	5.3	0.15	0.030	0.008	0.0026	0.5	0.10	0.013
R2	0.21	2.5	0.03	0.005	0.002	0.0006	0.2	0.03	0.003
R3	0.10	1.1	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R4	0.17	2.2	0.04	0.008	0.002	0.0007	0.2	0.04	0.003
R5	0.17	2.7	0.05	0.011	0.003	0.0009	0.2	0.03	0.005

Table A15 Predicted concentrations of contaminants due to proposed development in isolation – meteorological data 2014

Receptor	CO (µg/m^3)	NO_2 (µg/m^3)		PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)	SO_2 (µg/m^3)		
	Maximum 8-hr	1-hr 19th high	Annual	24-hour 36th high	Annual	Annual	1-hr 19th high	24-hour 4th high	Annual
R1	0.51	8.1	0.12	0.021	0.007	0.0022	0.7	0.09	0.011
R2	0.15	2.5	0.03	0.006	0.002	0.0006	0.2	0.02	0.003
R3	0.14	1.6	0.03	0.004	0.002	0.0005	0.1	0.02	0.003
R4	0.16	2.2	0.03	0.007	0.002	0.0006	0.2	0.03	0.003
R5	0.20	2.3	0.05	0.008	0.003	0.0009	0.2	0.04	0.004

Table A16 Predicted concentrations of contaminants due to proposed development in isolation – meteorological data 2015

Receptor	CO (µg/m³)	NO_2 (µg/m³)		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)		
	Maximum 8-hr	1-hr 19th high	Annual	24-hour 36th high	Annual	Annual	1-hr 19th high	24-hour 4th high	Annual
R1	0.55	4.8	0.11	0.020	0.007	0.0020	0.4	0.08	0.010
R2	0.27	1.6	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R3	0.14	1.6	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R4	0.19	2.2	0.03	0.006	0.002	0.0005	0.2	0.03	0.003
R5	0.21	2.7	0.05	0.008	0.003	0.0008	0.2	0.04	0.004

Table A17 Predicted concentrations of contaminants due to proposed development in isolation – meteorological data 2016

Receptor	CO (µg/m³)	NO_2 (µg/m³)		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)		
	Maximum 8-hr	1-hr 19th high	Annual	24-hour 36th high	Annual	Annual	1-hr 19th high	24-hour 4th high	Annual
R1	0.51	5.3	0.14	0.024	0.008	0.0024	0.5	0.11	0.012
R2	0.17	1.8	0.03	0.005	0.002	0.0005	0.2	0.02	0.003
R3	0.16	1.6	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R4	0.14	2.0	0.04	0.008	0.002	0.0007	0.2	0.03	0.003
R5	0.22	2.3	0.05	0.010	0.003	0.0009	0.2	0.04	0.005

Table A18 Predicted concentrations of contaminants due to proposed development in isolation – meteorological data 2017

Receptor	CO (µg/m³)	NO_2 (µg/m³)		PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)		
	Maximum 8-hr	1-hr 19th high	Annual	24-hour 36th high	Annual	Annual	1-hr 19th high	24-hour 4th high	Annual
R1	0.53	5.3	0.11	0.016	0.006	0.0019	0.5	0.09	0.010
R2	0.21	2.1	0.03	0.005	0.002	0.0005	0.2	0.02	0.003
R3	0.11	1.3	0.03	0.005	0.002	0.0005	0.1	0.02	0.003
R4	0.16	1.2	0.02	0.004	0.001	0.0004	0.1	0.02	0.002
R5	0.21	2.3	0.04	0.006	0.002	0.0007	0.2	0.04	0.004

A2.2.3 Ammonia

The predicted ground-level concentrations of ammonia at nearby Natura sites due to the proposed development in isolation are shown in Table A19.

Table A19 Predicted concentrations of ammonia due to proposed development in isolation

Natura site	Annual average ammonia (µg/m^3)				
	2013	**2014**	**2015**	**2016**	**2017**
All Saints Bog	0.009	0.009	0.008	0.01	0.005
Shannon Callows	0.005	0.005	0.005	0.004	0.006
Lough Coura Bog	0.003	0.002	0.003	0.003	0.004
Criteria level	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**