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ODOUR IMPACT ASSESSMENT OF A PROPOSED EXPANSION OF EXISTING WOODVILLE PIG FARM LTD LOCATED IN WOODVILLE, BALLYMACKEY, NENAGH, CO TIPPERARY.

PERFORMED BY ODOUR MONITORING IRELAND ON BEHALF OF PANTHER ENVIRONMENTAL LTD

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DATE:	15th April 2021 Rev 1, 25th Nov 2021 Rev 2, 02th Dec 2021 Rev 3, 14th March 2022 Rev 4, 06th June 2022 Rev 5, 20th June 2022, 17th Jan 2023 Rev 7, 18th Jan 2023 Rev 8
REPORT NUMBER:	20211003(8)
DOCUMENT VERSION:	Document Ver. 008
REVIEWERS:	Mr. Martin Looney

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Document Amendment Record

Client: *Panther Environmental Ltd.*

Project: Odour impact assessment of a proposed expansion of existing Woodville Pig Farm Ltd located in Woodville, Ballymackey, Nenagh, Co. Tipperary.

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Project Number: 20211003(7)			**Document Reference:** Odour impact assessment of a proposed expansion of existing Woodville Pig Farm Ltd located in Woodville, Ballymackey, Nenagh, Co. Tipperary.		
20211003(1)	Document for review	B.A.S.	JWC	B.A.S.	15/04/2021
20211003(2)	Amendments to pig numbers and emission rates	B.A.S.	JWC	B.A.S.	27/11/2021
20211003(3)	Minor amendments	ML	BAS	B.A.S.	02/12/2021
20211003(4)	Significant amendments and updates	ML	BAS	B.A.S.	14/03/2022
20211003(5)	Amendments to NH3 emission factors	ML	BAS	B.A.S.	06/06/2022
20211003(6)	Minor amendments	ML	BAS	B.A.S.	20/06/2022
20211003(7)	Minor amendments to Table 2.2 and Table 3.4	ML	BAS	B.A.S.	17/01/2023
20211003(8)	Minor amendments to Table 3.4	ML	BAS	B.A.S.	18/01/2023
Revision	**Purpose/Description**	**Originated**	**Checked**	**Authorised**	**Date**

Executive Summary

Odour Monitoring Ireland Ltd was commissioned by Panther Environmental Ltd. to perform a desktop odour and NH_3 dispersion modelling assessment of library odour and NH_3 emissions from a proposed expansion to a pig production facility located in Woodville, Ballymackey, Nenagh, Co. Tipperary. The operation of the proposed pig production facility will lead to emissions of Odours and Ammonia and by using atmospheric dispersion modelling, the potential impact of this pollutants were assessed and compared to relevant ambient guideline odour and Ammonia limit values including the methodology contained within the Irish EPA publication "Odour impacts and odour emissions controls for Intensive Agricultural Facilities", AG4 - Air Dispersion Modelling from Industrial Installations Guidance Note and "Odour Management at Intensive Livestock Installations" published by the Environment Agency UK May 2005. These documents lay out general methodologies for assessing the risks of odours and gaseous pollutants from such sites on a conservative basis.

Odour emissions rates, limits and dispersion modelling guidance were taken from reference data including:

1. "Odour Impacts and Odour Emission Control Measures for Intensive Agriculture" Final Report Environmental Research R&D Report Series No. 14 published by the Irish Environmental Protection Agency 2006,
2. "Odour Management at Intensive Livestock Installations" published by the Environment Agency UK May 2005,
3. "Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)" published by the Irish Environmental Protection Agency 2010.
4. Van Geel, P.L.B.A. (2006) Annex 1 - Odour nuisance and farming act, Netherlands.
5. Sniffer ER26 Final Report, March 2014.
6. http://www.environment-agency.gov.uk/static/documents/Utility/modelling_2104566.pdf
7. http://www.environment-agency.gov.uk/static/documents/Business/Guidance_on__modelling_of_ammonia_from_poultry_pig_farms.pdf.

Odour and NH_3 emission data sets were calculated to determine the potential impact of the existing and proposed pig production facility during its expected operation. The odour emission data set was taken from published sources to include Odour Impacts and Odour Emission Control Measures for Intensive Agriculture" Final Report Environmental Research R&D Report Series No. 14 published by the Irish Environmental Protection Agency 2006, Van Geel, P.L.B.A. (2006) Annex 1 - Odour nuisance and farming act, Netherlands and Sniffer ER26 Final Report, March 2014 and Sniffer ER26 Final Report, March 2014.

The Ammonia emission data set was taken from published figures contained in the publication :

1. Best Available Techniques (BAT) Reference Document for the intensive rearing of Poultry or Pigs, Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control)., 2017.

The dispersion modelling scenarios assessed included:

Ref Scenario 1: Predicted overall Odour emission rate from the existing pig production facility operations (*see Table 3.1*).

Ref Scenario 2: Predicted overall Odour emission rate from the proposed pig production facility operations (*see Table 3.2*).

Ref Scenario 3: Predicted overall Ammonia emission rate from the existing pig production facility operations (*see Table 3.3*).

Ref Scenario 4: Predicted overall Ammonia emission rate from the proposed pig production facility operations (*see Table 3.4*).

Average modelling scenarios were performed to allow for comparison with relevant odour and Ammonia impact criteria as described in *Section 2.6*. These included 1-hour mean, Annual average and maximum number of exceedances expressed as percentiles (i.e. 98th). All processes and source characteristics as outlined within the emission tables were used in conjunction with library air emissions data to construct the basis of the dispersion model. Five years of hourly sequential meteorological data (Shannon Airport 2016 to 2020 inclusive) was screened to ascertain the worst case year. Shannon Airport 2017 was determined as worst case dispersion year used within the dispersion model in order to provide statistical significant conservative ground level concentration estimates over each of the screened five years. Shannon Airport met station was chosen as it is located approximately within 50 km from the existing operating farm (as the crow flies).

Aermod Prime (21112) was used to determine the overall odour impact of the existing and proposed pig production facility operation located in Ballymackey, Nenagh, Co. Tipperary. In terms of prediction of overall odour and Ammonia impact area, the following contour plots were examined and presented as a worst case scenario.

These included:

<u>Ref Scenario 1</u> – Existing Odour impact (excluding background).

- Predicted odour emission contribution of overall existing pig production facility operation (*see Table 3.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 6.0 Ou_E/m^3 for worst case year 2017 (*see Figure 7.2*).

<u>Ref Scenario 2</u> – Proposed Odour impact (excluding background).

- Predicted odour emission contribution of overall proposed pig production facility operation (*see Table 3.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E/m^3 for worst case year 2017 (*see Figure 7.3*).

Ref Scenario 3A & 3B – Existing Ammonia impact (excluding background).

<u>Scenario 3A</u>

- Predicted Ammonia emission contribution of overall existing pig production facility operation (*see Table 3.3*), to Ammonia plume dispersal at the 100th percentile 1 hr average for an Ammonia concentration of less than or equal to 50 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.4*).

<u>Scenario 3B</u>

- Predicted Ammonia emission contribution of overall existing pig production facility operation (*see Table 3.3*), to Ammonia plume dispersal as an Annual average for an Ammonia concentration of less than or equal to 3.0 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.5*).

Ref Scenario 4A & 4B – Proposed Ammonia impact (excluding background).

<u>Scenario 4A</u>

- Predicted Ammonia emission contribution of overall proposed pig production facility operation (*see Table 3.4*), to Ammonia plume dispersal at the 100th percentile 1 hr average for an Ammonia concentration of less than or equal to 50 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.6*).

Scenario 4B

- Predicted Ammonia emission contribution of overall proposed pig production facility operation (*see Table 3.4*), to Ammonia plume dispersal as an Annual average for an Ammonia concentration of less than or equal to 3.0 µg/m^3 for worst case year 2017 (*see Figure 7.7*).

The results of this examination are presented in *Section 4* of this report.

The following conclusions were drawn from the dispersion modelling assessment: Greater detail can be found within the document and it is recommended that the document be read in full. The main conclusions include:

- Dispersion modelling of Odour and Ammonia emissions from the existing and proposed pig production facility was performed in accordance with AG4 and best international practice with a minimum of five years of hourly sequential meteorological data used in the dispersion modelling assessment. Topographical data from Ordnance Survey Ireland was also inputted into the dispersion model in order to take account of the terrain effects in the vicinity of the site. In addition, sensitive receptors were included within the dispersion model in order to predict the level of pollutants at their specific location.

- Worst case referenced library odour and NH_3 emission data was utilised to develop the odour and NH_3 emission dataset for the existing and proposed facility. This was to remain conservative within the assessment.

- With regards to the existing pig production facility operations, the odour plume spread is approximately 150 to 200 m from the facility buildings (*see Figure 7.2*). The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.79 Ou_E/m^3 for the 98th percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value of less than or equal to 6.0 Ou_E/m^3 for the 98th percentile of hourly averages (*see Table 4.1 and Figure 7.2)*.

- With regards to the proposed pig production facility operations, the odour plume spread is approximately 1,300 m from the facility buildings in a north westerly and north easterly direction (*see Figure 7.3*). The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 1.34 Ou_E/m^3 for the 98th percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value of less than or equal to 3.0 Ou_E/m^3 for the 98th percentile of hourly averages (*see Table 4.1 and Figure 7.3)*.

- With regards to the existing pig production facility operations, the Ammonia plume spread is approximately 400 to 500 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 57.60 µg/m^3 for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.4)*.

- With regards to the existing pig production facility operations, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.885 µg/m^3 for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites is less than or equal to 0.020 µg/m^3 (*see Table 4.2*).

- With regards to the proposed pig production facility operations, the Ammonia plume spread is approximately 350 to 400 m from the facility buildings in a south easterly and southerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 44.67 µg/m^3 for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.6)*.

- With regards to the proposed pig production facility operations, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings in an easterly and westerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was 0.921 µg/m^3 for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*).

- The maximum predicted ground level concentration at the identified Natura sites for the existing facility is less than or equal to 0.020 µg/m^3 (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites for the proposed facility is less than or equal to 0.019 µg/m^3. There is no net increase in Ammonia deposition at this worst case identified Natura site (Lough Derg, North-east Shore SAC) as a result of the development of the proposed facility. There is a net increase of annual average Ammonia levels at Natura sites Kilduff, Devilsbit Mountain SAC and Slievefelim to Silvermines Mountains SPA but the overall net increase is less than 0.0010 µg/m^3. This is less than 1% of the critical exposure level of 1 µg/m^3.

- With regards to the proposed facility operations, the facility operations will be in compliance with the guideline Odour and Ammonia impact presented within the document. The facility will not result in a net increase in Ammonia deposition of greater than 1% of the critical exposure level at Natura site. The implementation of mitigation on the proposed facility will minimise the impact from Ammonia deposition from the facility. The key mitigation techniques to be implemented at the facility will include:

  - For the proposed scenarios, proposed Ammonia emission factors for FSR will apply to Hse 1, 2, 4, 8, 13, 1A, 2B, 14, 15 and 16.
  - The proposed IVC$^+$ system will be implemented on Hse 2B, 15 and 16 and is described in BAT reference notes and referenced in Table 3.4.
  - Dietary manipulation (1% drop in crude protein) will be implemented on Hse 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 1A, 2B, 15 and 16. It is confirmed by the site that a 1% crude protein drop will be implemented which equates to a 10% drop in Ammonia emission levels.
  - For the proposed scenarios, pigs located in Hse 7 and 9 will be moved to updated low emission Hse 14.
  - Finally, for the proposed scenario, ventilation air from Hse 1, 14, 15 and 16 will be vented through a single stack (feed bin) at 18 m. This is reflected in Table 3.2 – proposed scenario Odour emission rates and Table 3.4 – proposed scenario Ammonia emission rates.

- The maximum Nitrogen deposition for the proposed facility operation is no greater than 0.099 kg N ha^{-1} yr^{-1}. There is a maximum net improvement in Nitrogen deposition levels at the worst case Natura site by 5%.

1. Introduction and scope

1.1 Introduction

Odour Monitoring Ireland Ltd was commissioned by Panther Environmental Ltd. to perform a predictive odour and Ammonia impact assessment of an existing and proposed extension to pig production facility utilising library emission data and dispersion-modelling software Aermod Prime (21112). Like the majority of industries, the operation of the pig farm is faced with the issue of preventing odours and Ammonia impact to the public at large.

Library based odour and Ammonia emission rates were gathered from reference publications taking into account the current pig housing system in place at the facility. Odour and Ammonia emission scenarios were developed to take account of the existing and proposed design operations. These odour and Ammonia emission rates and specified source characteristics were inputted into Aermod Prime (21112) in order to determine the impact from the existing and proposed facility operations on the surrounding area.

This document presents the materials and methods, results and discussion and conclusions of the desktop examination of potential odours and Ammonia from the facility.

1.2 Scope of the study

The main objective of the odour and Ammonia impact assessment is to ascertain whether the levels of emissions from the proposed pig production facility will result in ground level impact in the vicinity of the site operations. Ground level impact at residential receptors refers to the impact at ground level (i.e. normal breathing height of 1.8 m) in excess of the odour and Ammonia impact criteria contained in *Section 2.6* of this document.

The following assessment will take account of the likely and potential impacts associated with the proposed operation of the pig production facility.

The methodology adapted involved a number of distinct steps. These included:

- Calculation of odour and Ammonia emission rates from library based data;
- Prediction of ground level concentrations (GLC's) of compounds dispersed from the emission point source located within the farm;
- Dispersion modelling was carried in accordance with "Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)" published by the Irish Environmental Protection Agency 2010.

1.3 Model assumptions

The approach adopted in this assessment is considered a standard investigation in respect of emissions to the atmosphere from a facility.

These assumptions used within the dispersion modelling assessment include:

- Emissions to the atmosphere from the named emission point operations were assumed to occur 24 hours each day over a standard year for all sources.
- Five years of hourly sequential meteorological data from Shannon Airport 2016 to 2020 inclusive was used in the modelling screen which will provide statistical significant results in terms of the short and long term assessment. The worst case year for Shannon Airport met station was 2017 and was used for contour plot and odour/Ammonia data presentation. The predicted odour and Ammonia value at the residential receptors is presented for this year. This is in keeping with current national and international recommendations (EPA Guidance AG4 and EA Guidance H4). In addition, AERMOD incorporates a meteorological pre-processor AERMET PRO. The AERMET PRO meteorological preprocessor requires the input of surface

characteristics, including surface roughness (z0), Bowen Ratio and Albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of Albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the meteorological station for Bowen Ratio and Albedo and to a distance of 1km for surface roughness in line with USEPA recommendations.

- AERMOD Prime (21112) dispersion modelling was utilised throughout the assessment in order to provide the most reliable dispersion estimates.
- All building wake affects on all applicable emission points were assessed within the dispersion model using the building prime algorithm contained within AERMOD Prime (e.g. all buildings / structures were included within the model assessment).
- All receptors were established at normal breathing height of 1.80 above ground level.
- 10 m spaced terrain data was inputted into the model which was taken from Ordnance Survey Ireland.
- Forty seven nearest sensitive receptors including their relative height were inputted into the model in order to assess the level of impact at each receptor location.
- Five natura (NHA, SAC, etc.) sites were included as sensitive receptors within the model in order to assess the predicted levels of Ammonia at these sites.

2. Materials and methods

This section will describe the materials and methods used within the study.

2.1 Odour and Ammonia emission rate values

Table 2.1 illustrates the odour emission rate figures gathered from a review of EPA Research Report Series No. 14 and Sniffer ER26 Final Report, March 2014.

These specific odour emission rates were utilised in the dispersion model to assess the odour impact of the existing and proposed pig production facility on the surrounding area.

Table 2.1. Odour emission rates for specific pig type at the existing and proposed facility.

Pig type	Odour emission factor (Ou_E/pig/s)
Sows and piglets	19
Loose sows	19
Farrowing	20
Gilts	20
Weaners	6
Production pigs >30 kgs	22.50

Table 2.2 illustrates the Ammonia emission rate figures gathered from published data contained in the BAT Reference Notes for the intensive rearing of poultry and pigs (2017). These specific Ammonia emission rates were utilised in the dispersion model to assess the Ammonia impact of the existing and proposed pig production facility on the surrounding area. For clarity, the particular production system is included within the tables. These were provided by the client.

In addition, the following mitigation will be applied upon the proposed facility to include:

- Implementation of IC-V+ system which will result in a net reduction of Ammonia from the housing system. The specific system as described in BAT is referenced and it's published Ammonia emission factor for clarity. This will be implemented on House 15 and 16.
- Frequent slurry removal (FSR) will be implemented on Houses 4, 5, 8, 10, 14, 15 and 16. The specific system as described in BAT is referenced and it's published Ammonia emission factor for clarity.
- 1% reduction in crude protein levels which will result in a 10% reduction in Ammonia emission factors for the proposed scenario (i.e. across all houses).
- House 1, 14, 15 and 16 emissions will be vented through an 18 m meal bin (which will act as a stack to aid dispersion).
- Pigs that were previously located in House 7 and 9 will be moved to the new low emission housing 14.

Table 2.2. Ammonia emission rates for specific pig type at the existing and proposed facility (see BAT Reference Notes for the intensive rearing of poultry and pigs, (2017).

Pig type	**Existing Ammonia emission factor – No mitigation (kg/pig/yr)[1]**	**Proposed Ammonia emission factor – FSR (kg/pig/yr)[1]**	**Proposed Ammonia emission factor – IC-V+ system (kg/pig/yr)**	**Proposed Ammonia emission factor – Dietary manipulation (1% drop in crude protein) – see Table 10.1 for proposed CP levels**
Sows and piglets	Table 4.90 - Section 4.7.3.1, page 410 **8.50**	Table 4.94 - Section 4.7.3.5, page 410 **3.30**	-	Apply 10% reduction factor
Loose sows	Table 4.79 - Section 4.7.2.1, page 388 **4.20**	Table 4.79 - Section 4.7.2.6, page 388 **2.59**	-	Apply 10% reduction factor
Farrowing	Table 4.90 - Section 4.7.3.1, page 410 **8.50**	Table 4.90 - Section 4.7.3.5, page 410 **3.30**	-	Apply 10% reduction factor
Gilts	Table 4.79 - Section 4.7.2.1, page 388 **4.20**	Table 4.79 - Section 4.7.2.1, page 388 **2.59**	-	Apply 10% reduction factor
Weaners	Table 4.94 - Section 4.7.4.1, page 424 **0.78**	Table 4.94 - Section 4.7.4.2, page 424 **0.50**	Table 4.94 – Section 4.7.4.2, page 424 **0.50** Table 4.94 - Section 4.7.4.9, page 424 **0.21**	Apply 10% reduction factor
Production pigs >30 kgs	-	Table 4.102 - Section 4.7.5.2, page 446 **2.25**	Table 4.102 - Section 4.7.5.4, page 446 **1.20**	Apply 10% reduction factor

All this information is available from BAT Reference Document for the intensive rearing of poultry and pigs[1] and is also referenced in each of the emission tables.

For the existing scenario, existing Ammonia emission factors will apply to Hse 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 14A.

For the proposed scenarios, proposed Ammonia emission factors for FSR will apply to Hse 1, 2, 4, 8, 13, 1A, 2B, 14, 15 and 16.

The proposed IVC$^+$ system will be implemented on Hse 2B, 15 and 16 and is described in BAT reference notes.

Dietary manipulation (1% drop in crude protein) will be implemented on Hse 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 1A, 2B, 15 and 16. It is confirmed by the site that a 1% crude protein drop will be implemented which equates to a 10% drop in Ammonia emission levels. Please see Table 10.1 for proposed crude protein levels to be used in farm.

For the proposed scenarios, pigs located in Hse 7 and 9 will be moved to updated low emission Hse 14.

Finally, for the proposed scenario, ventilation air from Hse 1, 14, 15 and 16 will be vented through a single stack (feed bin) at 18 m. This is reflected in Table 3.2 – proposed scenario Odour emission rates and Table 3.4 – proposed scenario Ammonia emission rates.

2.2 Volumetric flow rate values

The volumetric airflow rate values were calculated from fan capacities installed on each pig house on site. This was coupled with diameters and numbers of each emission point in order to calculate efflux velocities from each vent. These are included in *Tables 3.1, 3.2, 3.3 and 3.4.*

2.3 Atmospheric dispersion modelling of air quality: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of emissions for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the compound emission rate from the source is known, (g s^{-1}), the impact on the vicinity can be estimated. These models can effectively be used in three different ways: firstly, to assess the dispersion of compounds; secondly, in a “reverse” mode, to estimate the maximum compound emissions which can be permitted from a site in order to prevent air quality impact occurring; and thirdly, to determine which process is contributing greatest to the compound impact and estimate the amount of required abatement to reduce this impact within acceptable levels (McIntyre et al. 2000). In this latter mode, models have been employed for imposing emission limits on industrial processes, control systems and proposed facilities and processes (Sheridan et al., 2002).

2.4 Atmospheric dispersion modelling of air quality: dispersion model selection

The model chosen in this study was AERMOD Prime (EPA Version 21112). The AERMOD model was developed through a formal collaboration between the American Meteorological Society (AMS) and U.S. Environmental Protection Agency (U.S. EPA). AERMOD is a Gaussian plume model and replaced the ISC3 model in demonstrating compliance with the National Ambient Air Quality Standards (Porter et al., 2003) AERMIC (USEPA and AMS working group) is emphasizing development of a platform that includes air turbulence structure, scaling, and concepts; treatment of both surface and elevated sources; and simple and complex terrain. The modelling platform system has three main components: AERMOD, which is the air dispersion model; AERMET, a meteorological data pre-processor; and AERMAP, a terrain data pre-processor (Cora and Hung, 2003).

AERMOD is a Gaussian steady-state model which was developed with the main intention of superseding ISCST3 (NZME, 2002). The AERMOD modeling system is a significant departure from ISCST3 in that it is based on a theoretical understanding of the atmosphere rather than depend on empirical derived values. The dispersion environment is characterized by turbulence theory that defines convective (daytime) and stable (nocturnal) boundary layers instead of the stability categories in ISCST3. Dispersion coefficients derived from turbulence theories are not based on sampling data or a specific averaging period. AERMOD was especially designed to support the U.S. EPA’s regulatory modeling programs (Porter at al., 2003)

Special features of AERMOD include its ability to treat the vertical in-homogeneity of the planetary boundary layer, special treatment of surface releases, irregularly-shaped area sources, a three plume model for the convective boundary layer, limitation of vertical mixing in the stable boundary layer, and fixing the reflecting surface at the stack base (Curran et al., 2006). A treatment of dispersion in the presence of intermediate and complex terrain is used that improves on that currently in use in ISCST3 and other models, yet without the complexity of the Complex Terrain Dispersion Model-Plus (CTDMPLUS) (Diosey et al., 2002). Additional utilities associated with the dispersion model allow computation of ground level concentrations of pollutants over defined statistical averaging periods, consideration of building wake/downwash effects in the vicinity of the assessed facility.

2.5 Odour and Ammonia impact assessment criteria

Currently, there is no general statutory odour standard in Ireland relating to industrial installations. The EPA has issued guidance specific to intensive agriculture which has outlined:

- The limit of less than 6.0 Ou_E/m^3 at the 98^{th} percentile of hourly averages should be utilised to provide a minimum level of protection against odour annoyance from Existing Pig Facilities as stated in "Odour Impacts and Odour Emission Control Measures for Intensive Agriculture" Final Report Environmental Research R&D Report Series No. 14 published by the Irish Environmental Protection Agency 2006.
- The limit of less than 3.0 Ou_E/m^3 at the 98^{th} percentile of hourly averages should be utilised to provide a minimum level of protection against odour annoyance from Proposed Pig Facilities as stated in "Odour Impacts and Odour Emission Control Measures for Intensive Agriculture" Final Report Environmental Research R&D Report Series No. 14 published by the Irish Environmental Protection Agency 2006.
- The indicative exposure level criterion for new facilities, which equates to 'no pollution', i.e. no reasonable cause for annoyance is 3.0 Ou_E/m^3 at the 98^{th} percentile of hourly averages at sensitive receptors as stated in "Odour Management at Intensive Livestock Installations" published by the Environment Agency UK May 2005.

The predicted odour impact from the operation of the pig farm is compared to relevant odour impact criteria. The relevant odour impact criteria are presented in *Table 2.1*.

With regards to Ammonia impact assessment, the output from the dispersion model will be assessed against the following:

- The limit value of less than 3,300 $\mu g/m^3$ at the 100^{th} percentile of hourly averages should be utilised to provide protection against Ammonia impact at residential receptors.
- The limit value of less than 1 and 3 $\mu g/m^3$ for an Annual average should be utilised to provide protection against Ammonia impact at Natura sites.

2.6 Odour and Ammonia Impact Criteria Guidelines in Ireland and the UK

Table 2.1 illustrates the limit values for odour and NH_3 impact assessments in Ireland.

Table 2.1. Limit odour impact criteria for pig production facilities in Ireland and the UK.

POLLUTANT	Objective				TO BE ACHIEVED BY	VALUE TYPE
	Concentration	**Maximum No. Of exceedences allowed**	**Exceedence expressed as percentile**	**Measured as**		
Odours[1]	less than or equal to 6.0 Ou_E/m^3	175 times in a year	98th percentile	1 hour mean	Existing installation	Limit Value
Odours[1, 2]	less than or equal to 3.0 Ou_E/m^3	175 times in a year	98th percentile	1 hour mean	New installation	Limit Value
Ammonia[3,4]	3,300 $\mu g\ m^{-3}\ NH_3$[3] 3 $\mu g\ m^{-3}\ NH_3$ 1 $\mu g\ m^{-3}\ NH_3$	Protection of human health Critical level – Higher plants[4] Critical level – sensitive plants[4]	100th percentile -- --	1 hour mean Annual mean Annual mean	--	Limit value

Notes: [1] denotes – Values taken from "Odour Impacts and Odour Emission Control Measures for Intensive Agriculture" Final Report Environmental Research R&D Report Series No. 14. Pg 47 and "Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)" published by the Irish Environmental Protection Agency 2010. Pg 68.

[2]"Odour Management at Intensive Livestock Installations" published by the Environment Agency UK May 2005. Pg. 5

[3] denotes EPR H1 (2008) – Environmental Risk Assessment Part 1 – Simple assessment of environmental risk for accidents, odour, noise and fugitive emissions and EPR H1 (2008) - Environmental Risk Assessment Part 2 – Assessment of point source release and cost benefit analysis.

[4] denotes limit value for the protection of vegetation/ecosystem.

2.7 Meteorological data

Five years of hourly sequential meteorological data was chosen for the modelling exercise (i.e. Shannon Airport 2016 to 2020 inclusive). Shannon Airport was chosen as the representative meteorological station due to its proximity to the site relative to other synoptic meteorological stations (i.e. located approx. 45 km from the site operations as the crow flies) and based on the fact that it has all the relevant cloud cover data in line with USEPA requirements.

A schematic windrose and tabular cumulative wind speed and directions of all five years are presented in *Section 8*.

2.8 Terrain data

Due to the fact that the proposed pig facility is located in complex terrain (based on the fact that low stack based emission points are present within the modelling scenario and relative receptor heights are higher relative to stack height) a terrain file was included in the dispersion modelling assessment. A 10 metre Cartesian grid spaced topographical data was obtained from Ordnance survey Ireland and used to create a 10 metre Cartesian grid *.DEM file for use in Aermap software within AERMOD Prime.

2.9 Building wake effects

Building wake effects are accounted for in modelling scenarios (i.e. all building features located within the pig farm) as this can have a significant effect on the compound plume dispersion at short distances and can significantly increase GLC's in close proximity to the facility. This is particularly important due to the significant changes in elevation around the facility.

3. Results-Emission calculations.

The results of predictive estimation of emissions of Odour and Ammonia from the existing and proposed pig production facility are presented in *Tables 3.1 to 3.4.*

3.1 Predicted Odour mass emission rate from the existing and proposed Pig Production facility

Tables 3.1 and 3.2 present the predicted overall odour emission rates for the existing and proposed pig facility operations. Odour emission rate values were gathered from available suitable literature (*see Section 2.1*).

Table 3.1. Predicted mass emission value results for odour for existing pig production facility operations.

Pig housing type	Woodville Farm House numbers	Fan Capacity (m3/hr)	Max Stack height (m)	Max Building height (m)	Ventilation type	No. of Fans	Fan location	Fan diameter (m)	Pig numbers in house	Type of pig unit	Flooring type	Fan flowrate (m3/s)	Odour emission rate per pig place (Ou_E/pig/s)	Total odour emission rate (Ou_E/s)	Total ventilation rate per house (m^3/hr)	Ventilation rate (m3/s)	Ventilation capacity per pig place (m^3/pig/hr)	Odour emission rate per vent (Ou_E/s)	Temperature (K)	Max efflux velocity (m/s)	Notes
Farrowing House	1	13400	6.85	6.4	Mechanical	10	Centre of house	0.6	220	Sows and piglets	Slatted	3.72	19	4,180	134,000	37.22	609.09	418	293.15	13.16	Vertical
Existing Farrowing House	2	4338	4.95	4.5	Mechanical	11	Centre of house	0.4	0	To be farrowing	Slatted	1.21	-	0	47,718	13.26	-	-	293.15	9.59	Vertical
Ex. Sow House	2A	11634	4.95	4.5	Mechanical	4	Centre of house	0.6	100	Loose sows	Slatted	3.23	19	1,900	46,536	12.93	465.36	475	293.15	11.43	Vertical
Gilt House	3	12700	4.85	4.4	Mechanical	2	Centre of house	0.6	0	-	Slatted	3.53	-	0	25,400	7.06	-	-	293.15	12.48	Vertical
Gilt House	4	10575	4.85	4.4	Mechanical	6	Centre of house	0.6	0	-	Slatted	2.94	-	0	63,450	17.63	-	-	293.15	10.39	Vertical
Gilt House	5	10575	4.75	4.3	Mechanical	3	Centre of house	0.6	0	-	Slatted	2.94	-	0	31,725	8.81	-	-	293.15	10.39	Vertical
Gilt House	6	5751	4.85	4.4	Mechanical	4	Centre of house	0.45	109	Gilts	Slatted	1.6	20	2,180	23,004	6.39	211.05	545	293.15	10.04	Vertical
First stage weaner	7	10575	4.15	3.7	Mechanical	4	Centre of house	0.6	900	Weaners	Slatted	2.94	6	5,400	42,300	11.75	47.00	1350	293.15	10.39	Capped point source
Loose Sow House	8	12700	6.85	6.4	Mechanical	8	Centre of house	0.6	600	Loose sows	Slatted	3.53	19	11,400	101,600	28.22	169.33	1425	293.15	12.48	Vertical
First Stage Weaner House	9	6400	4.25	3.8	Mechanical	2	Centre of house	0.45	900	Weaners	Slatted	1.78	6	5,400	12,800	3.56	14.22	2700	293.15	11.18	Vertical
Weaner Hse	10	12700	4.95	4.5	Mechanical	4	Centre of house	0.6	360	Weaners	Slatted	3.53	6	2,160	50,800	14.11	141.11	540	293.15	12.48	Vertical
First Stage Weaner House	13	6482	4.15	3.7	Mechanical	2	Centre of house	0.4	400	Weaners	Slatted	1.8	6	2,400	12,964	3.60	32.41	1200	293.15	14.33	Vertical
First Stage Weaner House	14	13400	4.15	3.7	Mechanical	2	Centre of house	0.6	900	Weaners	Slatted	3.72	6	5,400	26,800	7.44	29.78	2700	293.15	13.16	Vertical
First Stage Weaner House	14A	13400	4.1	3.5	Mechanical	1	Centre of house	0.6	400	Weaners	Slatted	3.72	6	2,400	13,400	3.72	33.50	2400	293.15	13.16	Vertical
Total Odour emission rate (OuE/s)	-	-	-	-	-	-	-	-	-	-	-	-	-	**42,820**	-	-	-	-	-	-	-

Table 3.2. Predicted mass emission value results for odour for proposed pig production facility operations.

Pig housing type	Woodville Farm House numbers	Fan Capacity (m3/hr)	Max Stack height (m)	Max Building height (m)	Ventilation type	No. of Fans	Fan location	Fan diameter (m)	Pig numbers in house	Type of pig unit	Flooring type	Fan flowrate (m3/s)	Odour emission rate per pig place (Ou_E/pig/s)	Total odour emission rate (Ou_E/s)	Total ventilation rate per house (m^3/hr)	Ventilation rate (m3/s)	Ventilation capacity per pig place (m3/pig/hr)	Odour emission rate per vent (Ou_E/s)	Temp (K)	Max efflux velocity (m/s)	Notes
Farrowing House	1	13400	6.85	6.4	Mechanical	10	Centre of house	0.6	220	Sows and Piglets	Slatted + Feed manipulation	3.72	19	See new feed bin	134,000	37.22	609	See new feed bin -	293.15	-	-
Existing Farrowing House	2	4338	4.95	4.5	Mechanical	11	Centre of house	0.4	80	To be farrowing	Slatted + Feed manipulation	1.21	20	1,600	47,718	13.26	596	145	293.15	9.59	Vertical
Ex. Sow House	2A	11634	4.95	4.5	Mechanical	4	Centre of house	0.6	150	Loose Sows	Slatted + Feed manipulation	3.23	19	2,850	46,536	12.93	310	713	293.15	11.43	Vertical
Gilt House	3	12700	4.85	4.4	Mechanical	2	Centre of house	0.6	81	Gilt	Slatted + Feed manipulation	3.53	20	1,620	25,400	7.06	314	810	293.15	12.48	Vertical
Gilts and Production pigs >30 kgs	4	10575	4.85	4.4	Mechanical	6	Centre of house	0.6	30	Gilts	Slatted + Feed manipulation	2.94	20	600	63,450	17.63	302	775	293.15	10.39	Vertical
	4								180	Production pigs over 30 kg			22.5	4,050							
Gilt House	5	10575	4.75	4.3	Mechanical	3	Centre of house	0.6	300	Maiden Gilts	Slatted + Feed manipulation	2.94	20	6,000	31,725	8.81	106	2000	293.15	10.39	Vertical
Gilt House	6	5751	4.85	4.4	Mechanical	4	Centre of house	0.45	109	Gilts	Slatted + Feed manipulation	1.6	20	2,180	23,004	6.39	211	545	293.15	10.04	Vertical
First stage weaner	7	10575	4.15	3.7	Mechanical	4	Centre of house	0.6	Moved to Hse 14	Weaners	-	-	-	Moved to Hse 14	-	-	-	Moved to Hse 14	293.15	-	Capped emission point.
Loose Sow House	8	12700	6.85	6.4	Mechanical	8	Centre of house	0.6	850	Loose Sows	FSR + Feed manipulation	3.53	19	16,150	101,600	28.22	120	2019	293.15	12.48	Vertical
First Stage Weaner House	9	6400	4.25	3.8	Mechanical	2	Centre of house	0.45	Moved to Hse 14	Weaners	-	-	-	Moved to Hse 14	-	-	-	Moved to Hse 14	293.15	-	Vertical
Loose Sow House	10	12700	4.95	4.5	Mechanical	4	Centre of house	0.6	250	Loose Sows	Slatted + Feed manipulation	3.53	19	4,750	50,800	14.11	203	1188	293.15	12.48	Vertical
First Stage Weaner House	13	6482	4.15	3.7	Mechanical	2	Centre of house	0.4	400	Weaners	Slatted + Feed manipulation	1.8	6	2,400	12,964	3.60	32	1200	293.15	14.33	Vertical
First Stage Weaner House	14	13400	4.15	3.7	Mechanical	2	Centre of house	0.6	2700	Weaners	FSR + Feed manipulation + IVC+ system	3.72	6	See new feed bin	26,800	7.44	30	See new feed bin	293.15	-	-
New Farrowing House	1A	13400	6.95	6.5	Mechanical	5	Centre of house	0.6	100	Sows	Slatted + Feed manipulation	3.72	19	1,900	67,000	18.61	670	380	293.15	13.16	Vertical
New Weaner House	2B	13400	3.95	3.5	Mechanical	5	Centre of house	0.6	950	Weaners	Slatted + Feed manipulation	3.72	6	5,700	67,000	18.61	71	1140	293.15	13.16	Vertical
Weaners and Production pigs >30kgs	15	13400	5.05	4.6	Mechanical	20	Centre of house	0.6	4350	Weaners	FSR + Feed manipulation + IVC+ system	3.72	6	See new feed bin	268,000	74.44	38	See new feed bin	293.15	-	-
	15								2720	Production pigs over 30 kg			22.5	See new feed bin							
New Finisher House	16	10000	4.75	4.3	Mechanical	12	Centre of house	0.6	1000	Production pigs over 30 kg	FSR + Feed manipulation + IVC+ system	2.78	22.5	See new feed bin	120,000	33.33	120	See new feed bin	293.15	-	-
New Feed bin emission point	596513.5, 682101	548,800	18	9	Mechanical	2	Next Hse 13	4.04	-	Pig air from Hse 1, 14, 15, 16	Collected air vented through feed bin	152.44	-	130,180	-	-	-	130,180	293.15	12	Vertical
External covered storage tank	-	1,122.4 m^2	9	-	Covered tank	-	-	-	-	-	-	-	0.50 $Ou_E/m^2/s$	561	-	-	-	-	-	-	Covered with double membrane
Total Odour emission rate (Ou_E/s)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**180,541**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3.2 Predicted Ammonia mass emission rate from the existing and proposed Pig Production facility

Tables 3.3 and 3.4 present the predicted overall Ammonia emission rates for the existing and proposed pig facility operations. Ammonia emission rate values were gathered from available suitable literature (*see Section 2.1*).

Table 3.3. Predicted mass emission value results for Ammonia for existing pig production facility operations.

Pig housing type	Woodville Farm House No.	Fan Capacity (m^3/hr)	Max Stack height (m)	Max Building height (m)	No. of Fans	Fan location	Fan diameter (m)	Pig numbers in house	Type of pig unit	Flooring type	Fan flowrate (m3/s)	BAT description of housing system	Base Ammonia emission factor - No mitigation ($kgNH_3$/pig place/yr)	NH_3 emission rate per pig place (µg/pig/s)	Total NH_3 emission rate (g/s)	Total ventilation rate per house (m^3/hr)	Ventilation rate (m^3/s)	Ventilation capacity per pig place (m3/pig/hr)	NH3 emission rate per vent (µg/s)	Temp (K)	Max efflux velocity (m/s)	Notes
Farrowing House	1	13400	6.85	6.4	10	Centre of house	0.6	220	Sows and piglets	Slatted	3.72	Table 4.90 - Section 4.7.3.1, page 410	8.5	269.53	0.059297	134,000	37.22	609.09	0.0059297	293.15	13.16	Vertical
Existing Farrowing House	2	4338	4.95	4.5	11	Centre of house	0.4	0	To be farrowing	Slatted	1.21	Table 4.90 - Section 4.7.3.1, page 410	8.5	269.53	-	47,718	13.26		-	293.15	9.59	Vertical
Ex. Sow House	2A	11634	4.95	4.5	4	Centre of house	0.6	100	Loose sows	Slatted	3.23	Table 4.79 - Section 4.7.2.1, page 388	4.2	133.18	0.013318	46,536	12.93	465.36	0.0033295	293.15	11.43	Vertical
Gilt House	3	12700	4.85	4.4	2	Centre of house	0.6	0	-	Slatted	3.53	-	-	-	-	25,400	7.06	-	-	293.15	12.48	Vertical
Gilt House	4	10575	4.85	4.4	6	Centre of house	0.6	0	-	Slatted	2.94	-	-	-	-	63,450	17.63	-	-	293.15	10.39	Vertical
Gilt House	5	10575	4.75	4.3	3	Centre of house	0.6	0	-	Slatted	2.94	-	-	-	-	31,725	8.81	-	-	293.15	10.39	Vertical
Gilt House	6	5751	4.85	4.4	4	Centre of house	0.45	109	Gilts	Slatted	1.6	Table 4.79 - Section 4.7.2.1, page 388	4.2	133.18	0.014517	23,004	6.39	211.05	0.0036292	293.15	10.04	Vertical
First stage weaner	7	10575	4.15	3.7	4	Centre of house	0.6	900	Weaners	Slatted	2.94	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.022260	42,300	11.75	47	0.0055651	293.15	10.39	Capped point source
Loose Sow House	8	12700	6.85	6.4	8	Centre of house	0.6	600	Loose sows	Slatted	3.53	Table 4.79 - Section 4.7.2.1, page 388	4.2	133.18	0.079909	101,600	28.22	169.33	0.0099886	293.15	12.48	Vertical
First Stage Weaner House	9	6400	4.25	3.8	2	Centre of house	0.45	900	Weaners	Slatted	1.78	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.022260	12,800	3.56	14.22	0.0111301	293.15	11.18	Vertical
Weaner Hse	10	12700	4.95	4.5	4	Centre of house	0.6	360	Weaners	Slatted	3.53	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.008904	50,800	14.11	141.11	0.0022260	293.15	12.48	Vertical
First Stage Weaner House	13	6482	4.15	3.7	2	Centre of house	0.4	400	Weaners	Slatted	1.8	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.009893	12,964	3.6	32.41	0.0049467	293.15	14.33	Vertical
First Stage Weaner House	14	13400	4.15	3.7	2	Centre of house	0.6	900	Weaners	Slatted	3.72	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.022260	26,800	7.44	29.78	0.0111301	293.15	13.16	Vertical
First Stage Weaner House	14A	13400	4.1	3.5	1	Centre of house	0.6	400	Weaners	Slatted	3.72	Table 4.94 - Section 4.7.4.1, page 424	0.78	24.73	0.009893	13,400	3.72	33.5	0.0098935	293.15	13.16	Vertical
Total NH_3 emission rate (g/s)	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4,889**	**-**	**-**	**-**			**-**	**0.2625**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 3.4. Predicted mass emission value results for Ammonia for proposed pig production facility operations.

Pig housing type	Woodville Farm House numbers	Fan Capacity (m^3/hr)	Max Stack height (m)	Max Building height (m)	No. of Fans	Fan location	Fan diameter (m)	Ventilation type
Farrowing House	1	13400	6.85	6.4	10	Centre of house	0.6	Mechanical
Existing Farrowing House	2	4338	4.95	4.5	11	Centre of house	0.4	Mechanical
Ex. Sow House	2A	11634	4.95	4.5	4	Centre of house	0.6	Mechanical
Gilt House	3	12700	4.85	4.4	2	Centre of house	0.6	Mechanical
Gilts and Production pigs >30 kgs	4 4	10575	4.85	4.4	6	Centre of house	0.6	Mechanical
Gilt House	5	10575	4.75	4.3	3	Centre of house	0.6	Mechanical
Gilt House	6	5751	4.85	4.4	4	Centre of house	0.45	Mechanical
First stage weaner	7	10575	4.15	3.7	4	Centre of house	0.6	Mechanical
Loose Sow House	8	12700	6.85	6.4	8	Centre of house	0.6	Mechanical
First Stage Weaner House	9	6400	4.25	3.8	2	Centre of house	0.45	Mechanical
Loose Sow House	10	12700	4.95	4.5	4	Centre of house	0.6	Mechanical
First Stage Weaner House	13	6482	4.15	3.7	2	Centre of house	0.4	Mechanical
First Stage Weaner House	14	13400	4.15	3.7	2	Centre of house	0.6	Mechanical
New Farrowing House	1A	13400	6.95	6.5	5	Centre of house	0.6	Mechanical
New Weaner House	2B	13400	3.95	3.5	5	Centre of house	0.6	Mechanical
Weaners and Production pigs >30kgs	15 15	13400	5.05	4.6	20	Centre of house	0.6	Mechanical
New Finisher House	16	-	4.75	4.3	12	Centre of house	0.6	Mechanical
New Feed bin emission point	-	548,800	18	9	2	Next Hse 13	4.04	Mechanical
External covered storage tank	-	1,122.4 m^2	9	-	-	Covered tank	-	Covered tank

Table 3.4 continued. Predicted mass emission value results for Ammonia for proposed pig production facility operations.

Pig housing type	Woodville Farm House numbers	Pig numbers	Type of pig unit	Flooring type	Fan flowrate (m^3/s)	BAT description of housing system	Mitigation strategy	Base Ammonia emission factor - No mitigation ($kgNH_3$/pig place/yr)	Ammonia emission factor - with mitigation ($kgNH_3$/pig place/yr)	Ammonia emission factor (μgNH_3/pig place/yr)	Total NH_3 emission rate (g/s)	Total ventilation rate per house (m^3/hr)	Ventilation rate (m^3/s)	Ventilation capacity per pig place (m^3/pig/hr)	NH_3 emission rate per vent (g/s)	Temp (K)	Max efflux velocity (m/s)	Notes
Farrowing House	1	220	Sows and Piglets	Slatted + Feed manipulation	3.72	Table 4.90 - Section 4.7.3.5, page 410	FSR+ CP reduction 1.0% + Stack vent	3.3	2.97	94.2	0.0207	134,000	37.22	609	See new feed bin	293.15	13.16	Vertical
Existing Farrowing House	2	80	To be farrowing	Slatted + Feed manipulation	1.21	Table 4.90 - Section 4.7.3.5, page 410	FSR + CP reduction 1.0%	3.3	2.97	94.2	0.0075	47,718	13.26	596	0.0006849	293.15	9.59	Vertical
Ex. Sow House	2A	150	Loose Sows	Slatted + Feed manipulation	3.23	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0180	46,536	12.93	310	0.0044949	293.15	11.43	Vertical
Gilt House	3	81	Gilt	Slatted + Feed manipulation	3.53	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0097	25,400	7.06	314	0.0048545	293.15	12.48	Vertical
Gilts and Production pigs >30 kgs	4	30	Gilts	Slatted + Feed manipulation	2.94	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0036	63,450	17.63	302	0.0025257	293.15	10.39	Vertical
	4	180	Production pigs over 30 kg			Table 4.102 - Section 4.7.5.2, page 446	FSR + CP reduction 1.0%	2.25	2.025	64.2	0.0116							
Gilt House	5	300	Maiden Gilts	Slatted + Feed manipulation	2.94	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0360	31,725	8.81	106	0.0119863	293.15	10.39	Vertical
Gilt House	6	109	Gilts	Slatted + Feed manipulation	1.6	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0131	23,004	6.39	211	0.0032663	293.15	10.04	Vertical
First stage weaner	7	0	Weaners	-	2.94	-	Moved to Hse 14	-	-	-	-	42,300	11.75	47	Moved to Hse 14	293.15	10.39	Capped emission point.
Loose Sow House	8	850	Loose Sows	FSR + Feed manipulation	3.53	Table 4.79 - Section 4.7.2.6, page 388	FSR + CP reduction 1.0%	2.59	2.331	73.9	0.0628	101,600	28.22	120	0.0078535	293.15	12.48	Vertical
First Stage Weaner House	9	0	Weaners	-	1.78	-	Moved to Hse 14	-	-	-	-	12,800	3.56	14	Moved to Hse 14	293.15	11.18	Vertical
Loose Sow House	10	250	Loose Sows	Slatted + Feed manipulation	3.53	Table 4.79 - Section 4.7.2.1, page 388	CP reduction 1.0%	4.2	3.78	119.9	0.0300	50,800	14.11	203	0.0074914	293.15	12.48	Vertical
First Stage Weaner House	13	400	Weaners	Slatted + Feed manipulation	1.8	Table 4.94 - Section 4.7.4.2, page 424	FSR + CP reduction 1.0%	0.5	0.45	14.3	0.0057	12,964	3.6	32	0.0028539	293.15	14.33	Vertical
First Stage Weaner House	14	2700	Weaners	FSR + IV-C system + Feed manipulation	3.72	Table 4.94 - Section 4.7.4.2, page 424	FSR + CP reduction 1.0% + Stack vent	0.5	0.45	14.3	0.0385	26,800	7.44	30	See new feed bin	293.15	13.16	Vertical
New Farrowing House	1A	100	Sows	Slatted + Feed manipulation	3.72	Table 4.94 - Section 4.7.3.5, page 410	FSR + CP reduction 1.0%	3.3	2.97	94.2	0.0094	67,000	18.61	670	0.0018836	293.15	13.16	Vertical
New Weaner House	2B	950	Weaners	Slatted + IV-C system + Feed manipulation	3.72	Table 4.94 - Section 4.7.4.9, page 424	FSR + flushing + IV+C system + CP reduction 1.0%	0.21	0.189	6.0	0.0057	67,000	18.61	71	0.0011387	293.15	13.16	Vertical
Weaners and Production pigs >30kgs	15	4350	Weaners	FSR + Feed manipulation + IVC⁺ system	3.72	Table 4.94 - Section 4.7.4.2, page 424	FSR + IV+C system + CP reduction 1.0% + Stack vent	0.5	0.45	14.3	0.0621	268,000	74.44	38	See new feed bin	293.15	13.16	Vertical
	15	2720	Production pigs over 30 kg			Table 4.102 - Section 4.7.5.4, page 446	FSR + IV+C system, PSF +CP reduction 1.0% + Stack vent	1.2	1.08	34.2	0.0932							
New Finisher House	16	1000	Production pigs over 30 kg	FSR + Feed manipulation + IVC⁺ system	2.78	Table 4.102 - Section 4.7.5.4, page 446	FSR + IV+C system, PSF +CP reduction 1.0% + Stack vent	1.2	1.08	34.2	0.0342	120,000	33.33	120	See new feed bin	293.15	9.82	Vertical
New Feed bin emission point	-	-	Pig air from Hse 1, 14, 15, 16	Collected air vented through feed bin	152.44	-	Stack bin to improve ventilation	-	-	-	0.2487	-	-	-	0.2487	293.15	12	Vertical
External covered storage tank	-	1,122.40	-	-	-		Double membrane covering system	-	-	4.43	0.0050	-	-	-	0.0049	-	-	Covered with double membrane
Total NH_3 emission rate (g/s)	-	14,470	**-**	**-**	**-**	**-**	-	-	-	-	**0.4667**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

3.3. Dispersion model input data – Source characteristics

Tables 3.1 to 3.4 illustrate the source characteristics utilised within the dispersion model. Stack height (A.G.L), number of fans, ventilator orientation, efflux velocity and temperature of the emission point are presented within this table for reference purposes only.

3.4 Emission rate calculations and mass emission rates

The contaminant concentration from a stack is best quantified by a mass emission rate. For a chimney or ventilation stack, this is equal to the compound concentration (µg/m^3 or mg/m^3) of the discharge air multiplied by its flow-rate (m^3 s^{-1}). It is equal to the volume of air contaminated every second to the concentration limit (g s^{-1}). The mass emission rate (g s^{-1}) is used in conjunction with dispersion modelling in order to estimate the approximate radius of impact. All data used in the dispersion modelling exercise was obtained through library data. *Tables 3.1 to 3.4* illustrates the overall volume flow values, mass emission rate values and general source characteristics used as input data to the model for each *Scenario* to estimate the radius of impact for the particular pollutant.

3.5 Dispersion modelling assessment

AERMOD Prime (21112) was used to determine the overall ground level impact of the pig farm emission points. These computations give the relevant GLC's at each 20 and 200 meter X Y Cartesian grid receptor location that is predicted to be exceeded for the specific air/odour quality impact criteria (fine and course grid assessment). A total Cartesian grid receptors of 4,086 points was established giving a total grid coverage area of 25 square kilometres around the emission points. In addition, individual sensitive receptors were also inputted into the model at 53 specific receptor points in the vicinity of the facility. 5 of these sensitive receptors represented Natura sites all of which are located circa 9.5 to 14 km from the site (*see Figure 7.1 for local sensitive residential receptors only*).

Five years of hourly sequential meteorological data from Shannon Airport (Shannon Airport 2016 to 2020 inclusive) and source characteristics (including emission date contained in *Sections 3.1 to 3.2*) were inputted into the dispersion model for all parameters.

3.6 Dispersion model Scenarios

AERMOD Prime (USEPA ver. 21112) was used to determine the overall odour and Ammonia air quality impact of the existing and proposed pig production facility operations.

Impacts from the emission points were assessed in accordance with the impact criterion contained in *Section 2.5 and 2.6*.

Four scenarios were assessed within the dispersion model. The output data was analysed to calculate the following:

Ref Scenario 1 – Existing Odour impact (excluding background).

- Predicted odour emission contribution of overall existing pig production facility operation (*see Table 3.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 6.0 Ou_E/m^3 for worst case year 2017 (*see Figure 7.2*).

Ref Scenario 2 – Proposed Odour impact (excluding background).

- Predicted odour emission contribution of overall proposed pig production facility operation (*see Table 3.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 3.0 Ou_E/m^3 for worst case year 2017 (*see Figure 7.3*).

Ref Scenario 3A & 3B – Existing Ammonia impact (excluding background).

Scenario 3A

- Predicted Ammonia emission contribution of overall existing pig production facility operation (*see Table 3.3*), to Ammonia plume dispersal at the 100th percentile 1 hr average for an Ammonia concentration of less than or equal to 50 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.4*).

Scenario 3B

- Predicted Ammonia emission contribution of overall existing pig production facility operation (*see Table 3.3*), to Ammonia plume dispersal as an Annual average for an Ammonia concentration of less than or equal to 3.0 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.5*).

Ref Scenario 4A & 4B – Proposed Ammonia impact (excluding background).

Scenario 4A

- Predicted Ammonia emission contribution of overall proposed pig production facility operation (*see Table 3.4*), to Ammonia plume dispersal at the 100th percentile 1 hr average for an Ammonia concentration of less than or equal to 50 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.6*).

Scenario 4B

- Predicted Ammonia emission contribution of overall proposed pig production facility operation (*see Table 3.4*), to Ammonia plume dispersal as an Annual average for an Ammonia concentration of less than or equal to 3.0 $\mu g/m^3$ for worst case year 2017 (*see Figure 7.7*).

4. Discussion of Results from Dispersion modelling exercise

This section will present the discussion of results from the dispersion modelling assessment.

AERMOD GIS Pro Prime (Ver. 21112) was used to determine the overall proposed odour and Ammonia impact of the existing and proposed pig production facility operations.

One hour, Annual and Percentile averaging intervals were chosen to allow direct comparison of predicted GLC's with the relevant odour/Ammonia assessment criteria as outline in *Table 2.1*. In particular, 1-hour 98 percentile GLC's for odour were calculated at 20 and 200 metres grid distribution in the vicinity of the facility. For Ammonia, 1 hour and Annual average. A total Cartesian grid receptors of 4,086 points was established giving a total grid coverage area of 25 square kilometres around the emission points.

4.1 Odour impact

The plotted odour concentrations of ≤ 6.0 Ou_E/m^3 for the 98^{th} percentile for the existing pig production facility for worst case meteorological year 2017 is illustrated in *Figure 7.2*. As can be observed in *Figure 7.2*, the odour plume spread is approximately 150 to 200 m from the facility buildings. The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.79 Ou_E/m^3 for the 98^{th} percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value (*see Table 4.1 and Figure 7.2)*.

The plotted odour concentrations of ≤ 3.0 Ou_E/m^3 for the 98^{th} percentile for the proposed pig production facility for worst case meteorological year 2017 is illustrated in *Figure 7.3*. As can be observed in *Figure 7.3*, the odour plume spread is approximately 400 m from the facility buildings in a north westerly and north easterly direction. The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 1.34 Ou_E/m^3 for the 98^{th} percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value (*see Table 4.1 and Figure 7.3)*.

Table 4.1. Predicted 98th percentile ground level concentrations of odour at receptor locations in the vicinity of the facility for the worst case meteorological year 2017 (*see Figure 7.1 for locations*).

Receptor identity	**X coordinate (m)**	**Y coordinate (m)**	**Predicted 98th %ile Ground level Odour conc. for Existing Pig Production Facility (Ou_E/m^3) Year 2017**	**Predicted 98th %ile Ground level Odour conc. for Proposed Pig Production Facility (Ou_E/m^3) Year 2017**
R1	597975	681984	0.08	0.26
R2	597968	682026	0.08	0.26
R3	597986	682054	0.08	0.26
R4	597984	682082	0.07	0.25
R5	597945	682136	0.07	0.27
R6	-	-	Omitted due to building type	Omitted due to building type
R7	597949	682176	0.07	0.27
R8	596058	682055	0.79	1.34
R9	597917	682218	0.07	0.28
R10	596796	681795	0.60	1.07
R11	598020	682283	0.07	0.27
R12	597758	682145	0.09	0.32
R13	597835	682228	0.08	0.32
R14	597972	682309	0.07	0.28
R15	596855	681777	0.40	0.86
R16	598289	682337	0.06	0.22
R17	598337	682335	0.05	0.21
R18	597659	682142	0.10	0.36
R19	598378	682331	0.05	0.20
R20	597857	682332	0.09	0.31
R21	597725	681399	0.05	0.23
R22	598375	682399	0.05	0.20
R23	598410	682405	0.05	0.20
R24	598535	682350	0.04	0.18
R25	598567	682355	0.04	0.17
R26	597708	682422	0.09	0.37
R27	598599	682383	0.04	0.17
R28	598841	681673	0.04	0.15
R29	598634	682368	0.04	0.16
R30	598864	681816	0.04	0.14
R31	598599	682438	0.04	0.17
R32	597371	682019	0.12	0.44
R33	595679	682193	0.48	0.75
R34	598631	682443	0.04	0.17
R35	598279	682616	0.06	0.23
R36	598941	681850	0.03	0.13
R37	597315	682040	0.13	0.48
R38	597176	681664	0.13	0.44
R39	596589	681215	0.05	0.15
R40	596234	681230	0.53	0.70
R41	597565	681155	0.05	0.21
R42	597795	681010	0.05	0.19
R43	596641	681193	0.05	0.17
R44	596091	681219	0.19	0.32
R45	599022	682104	0.03	0.12
R46	598139	680884	0.04	0.14
R47	595472	682174	0.25	0.44
R48	597928	680863	0.04	0.16
Max predicted value (Ou_E/m^3)	**-**	**-**	**0.79**	**1.34**
Limit value (Ou_E/m^3)	**-**	**-**	**6.0**	**3.0**

4.2 Ammonia impact

The plotted Ammonia concentrations of ≤ 50 µg/m^3 for the 100th percentile for the existing pig production facility for worst case meteorological year 2017 is illustrated in *Figure 7.4*. As can be observed in *Figure 7.4*, the Ammonia plume spread is approximately 400 to 500 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 57.60 µg/m^3 for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.4)*.

The Annual average ground level concentration for the existing pig production facility is present in the *Figure 7.5 and Table 4.2*. As can be observed in *Figure 7.5*, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.885 µg/m^3 for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites is less than or equal to 0.020 µg/m^3 (*see Table 4.2*).

The plotted Ammonia concentrations of ≤ 50 µg/m^3 for the 100th percentile for the proposed pig production facility for worst case meteorological year 2017 is illustrated in *Figure 7.6*. As can be observed in *Figure 7.6*, the Ammonia plume spread is approximately 350 to 400 m from the facility buildings in a south easterly and southerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 44.67 µg/m^3 for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.6)*.

The Annual average ground level concentration for the proposed pig production facility is present in the *Figure 7.7 and Table 4.2*. As can be observed in *Figure 7.7*, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings in an easterly and westerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was 0.921 µg/m^3 for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*).

The maximum predicted ground level concentration at the identified Natura sites for the existing facility is less than or equal to 0.020 µg/m^3 (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites for the proposed facility is less than or equal to 0.019 µg/m^3. There is no net increase in Ammonia deposition at this worst case identified Natura site (Lough Derg, North-east Shore SAC) as a result of the development of the proposed facility.

There is a net increase of annual average Ammonia levels at Natura sites Kilduff, Devilsbit Mountain SAC and Slievefelim to Silvermines Mountains SPA but the overall net increase is less than 0.0010 µg/m^3. This is less than 1% of the critical exposure level of 1 µg/m^3.

With regards to the proposed facility operations, the facility operations will be in compliance with the guideline Odour and Ammonia impact presented within the document. The facility will not result in a net increase in Ammonia deposition of greater than 1% of the critical exposure level at Natura site. The implementation of mitigation on the proposed facility will minimise the impact from Ammonia deposition from the facility. The key mitigation techniques to be implemented at the facility will include:

1. For the proposed scenarios, proposed Ammonia emission factors for FSR will apply to Hse 1, 2, 4, 8, 13, 1A, 2B, 14, 15 and 16.

2. The proposed IVC$^+$ system will be implemented on Hse 2B, 15 and 16 and is described in BAT reference notes and referenced in Table 3.4.

3. Dietary manipulation (1% drop in crude protein) will be implemented on Hse 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 1A, 2B, 15 and 16. It is confirmed by the site that a 1%

crude protein drop will be implemented which equates to a 10% drop in Ammonia emission levels.

4. For the proposed scenarios, pigs located in Hse 7 and 9 will be moved to updated low emission Hse 14.

5. Finally, for the proposed scenario, ventilation air from Hse 1, 14, 15 and 16 will be vented through a single stack (feed bin) at 18 m. This is reflected in Table 3.2 – proposed scenario Odour emission rates and Table 3.4 – proposed scenario Ammonia emission rates.

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4.3 Nitrogen deposition

The following guidance document provide information on the calculation of nitrogen deposition. These include:

1. AQTAG06 (2014)., Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.
2. IAQM, 2020., A guide to the assessment of air quality impacts on designated nature conservation sites.

Within these documents, the process of calculating the nitrogen deposition at the habitat is clearly defined.

Dry deposition flux

The maximum annual average ground level concentration at any point in a site can be obtained from air dispersion modelling.

The annual dry deposition flux can be obtained from the modelled annual average ground level concentration via use of the formula:

Dry deposition flux = ground level concentration × deposition velocity.
$(\mu g\ m^{-2}\ s^{-1}) = (\mu g\ m^{-3})$ by $(m\ s^{-1})$

:where µg refers to µg of the chemical species under consideration.

The deposition velocities for Ammonia considered in this calculation is 0.020 $m\ s^{-1}$

To convert the dry deposition flux from units of $\mu g\ m^{-2}\ s^{-1}$ (where µg refers to µg of the chemical species) to units of kg N ha^{-1} $year^{-1}$ (where kg refers to kg of nitrogen) multiply the dry deposition flux by the fixed conversion factor for Ammonia is 260.

Table 4.2 presents the Nitrogen load at the specific habitat based on the above fixed factors.

The maximum Nitrogen deposition for the proposed facility operation is no greater than 0.099 kg N ha^{-1} yr^{-1}. There is a maximum net improvement in Nitrogen deposition levels at the worst case Natura site by 5%.

Table 4.2. Predicted 1 hr max and Annual average ground level concentrations of Ammonia at receptor locations in the vicinity of the facility and at Natura sites for the worst case meteorological year 2017 (*see Figure 7.1 for locations*).

Receptor identity	X coordinate (m)	Y coordinate (m)	Predicted 1hr max Ground level NH_3 conc. for Existing Pig Production Facility (µg/m^3) Year 2017	Predicted Annual average max Ground level NH_3 conc. for Existing Pig Production Facility (µg/m^3) Year 2017	Predicted 1hr max Ground level NH_3 conc. for Proposed Pig Production Facility (µg/m^3) Year 2017	Predicted Annual average max Ground level NH_3 conc. for Proposed Pig Production Facility (µg/m^3) Year 2017	Existing Nitrogen deposition load (kg ha^{-1} yr^{-1})	Proposed Nitrogen deposition load (kg ha^{-1} yr^{-1})
R1	597975	681984	14.519	0.079	12.257	0.097	-	-
R2	597968	682026	14.309	0.079	11.678	0.098	-	-
R3	597986	682054	13.107	0.077	10.788	0.096	-	-
R4	597984	682082	13.275	0.076	11.270	0.095	-	-
R5	597945	682136	13.300	0.077	10.762	0.099	-	-
R6	-	-	Omitted due to building type	0.885	40.827	0.921	-	-
R7	597949	682176	11.560	0.076	9.484	0.098	-	-
R8	596058	682055	57.604	0.569	35.176	0.489	-	-
R9	597917	682218	12.765	0.078	11.043	0.102	-	-
R10	596796	681795	49.298	0.481	44.673	0.520	-	-
R11	598020	682283	12.893	0.071	10.881	0.093	-	-
R12	597758	682145	14.228	0.093	11.306	0.121	-	-
R13	597835	682228	13.833	0.085	11.790	0.112	-	-
R14	597972	682309	13.203	0.075	10.876	0.099	-	-
R15	596855	681777	39.684	0.373	37.208	0.416	-	-
R16	598289	682337	11.206	0.056	9.335	0.073	-	-
R17	598337	682335	10.947	0.053	9.186	0.070	-	-
R18	597659	682142	15.043	0.104	11.895	0.137	-	-
R19	598378	682331	10.687	0.051	9.032	0.067	-	-
R20	597857	682332	14.888	0.086	12.622	0.114	-	-
R21	597725	681399	13.408	0.075	11.535	0.086	-	-
R22	598375	682399	10.404	0.053	9.039	0.070	-	-
R23	598410	682405	10.227	0.052	8.879	0.068	-	-
R24	598535	682350	9.976	0.046	8.407	0.060	-	-
R25	598567	682355	9.840	0.045	8.287	0.058	-	-
R26	597708	682422	16.751	0.106	13.866	0.138	-	-
R27	598599	682383	9.735	0.044	8.114	0.057	-	-
R28	598841	681673	9.442	0.039	7.904	0.048	-	-
R29	598634	682368	9.542	0.043	8.043	0.055	-	-
R30	598864	681816	9.457	0.041	8.089	0.049	-	-
R31	598599	682438	9.336	0.045	8.063	0.059	-	-
R32	597371	682019	21.098	0.138	17.995	0.187	-	-
R33	595679	682193	23.846	0.260	13.743	0.226	-	-
R34	598631	682443	9.195	0.044	7.915	0.057	-	-
R35	598279	682616	11.529	0.065	9.520	0.081	-	-
R36	598941	681850	9.148	0.039	7.754	0.047	-	-
R37	597315	682040	22.642	0.152	18.921	0.209	-	-
R38	597176	681664	22.767	0.154	19.690	0.181	-	-
R39	596589	681215	19.267	0.056	15.864	0.059	-	-
R40	596234	681230	36.618	0.300	24.720	0.259	-	-
R41	597565	681155	16.737	0.076	14.446	0.084	-	-
R42	597795	681010	16.734	0.063	14.188	0.068	-	-
R43	596641	681193	20.736	0.057	17.698	0.060	-	-
R44	596091	681219	18.826	0.139	16.583	0.126	-	-
R45	599022	682104	8.835	0.035	7.447	0.043	-	-
R46	598139	680884	12.621	0.048	10.575	0.052	-	-
R47	595472	682174	25.943	0.155	17.465	0.140	-	-
R48	597928	680863	15.049	0.054	12.769	0.058	-	-
Scohaboy (Sopwell) Bog SAC	596522.9	691710.9	-	**0.018**	-	**0.016**	**0.096**	**0.086**
Kilduff, Devilsbit Mountain SAC	605867.1	675525.9	-	**0.0006**	-	**0.0009**	**0.003**	**0.005**
Slievefelim to Silvermines Mountains SPA	590287.3	670289.1	-	**0.0010**	-	**0.0020**	**0.005**	**0.010**
Sharavogue Bog SAC	603971.3	693249.8	-	**0.011**	-	**0.010**	**0.055**	**0.052**
Lough Derg, North-east Shore SAC	584072.8	689620.8	-	**0.020**	-	**0.019**	**0.102**	**0.099**
Max predicted value at receptor (µg/m^3)	**-**	**-**	**57.604**	**0.885**	**44.673**	**0.921**	**-**	**-**
Max predicted value at Natura (µg/m^3			**-**	**0.020**	**-**	**0.019**	**-**	**-**
Limit value (µg/m^3)	**-**	**-**	**3,600**	**3.0 (Natura only)**	**3,600**	**1.0 (Natura only) 3.0 (Natura only)**	**--**	**--**

5. Conclusions

The following conclusions were drawn from the dispersion modelling assessment: Greater detail can be found within the document and it is recommended that the document be read in full. The main conclusions include:

- Dispersion modelling of Odour and Ammonia emissions from the existing and proposed pig production facility was performed in accordance with AG4 and best international practice with a minimum of five years of hourly sequential meteorological data used in the dispersion modelling assessment. Topographical data from Ordnance Survey Ireland was also inputted into the dispersion model in order to take account of the terrain effects in the vicinity of the site. In addition, sensitive receptors were included within the dispersion model in order to predict the level of pollutants at their specific location.

- Worst case referenced library odour and NH_3 emission data was utilised to develop the odour and NH_3 emission dataset for the existing and proposed facility. This was to remain conservative within the assessment.

- With regards to the existing pig production facility operations, the odour plume spread is approximately 150 to 200 m from the facility buildings (*see Figure 7.2*). The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.79 Ou_E/m^3 for the 98th percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value of less than or equal to 6.0 Ou_E/m^3 for the 98th percentile of hourly averages (*see Table 4.1 and Figure 7.2)*.

- With regards to the proposed pig production facility operations, the odour plume spread is approximately 1,300 m from the facility buildings in a north westerly and north easterly direction (*see Figure 7.3*). The maximum predicted ground level concentration of odour at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 1.34 Ou_E/m^3 for the 98th percentile of hourly averages for the worst case meteorological year (*see Table 4.1*). This is less than the guideline odour limit value of less than or equal to 3.0 Ou_E/m^3 for the 98th percentile of hourly averages (*see Table 4.1 and Figure 7.3)*.

- With regards to the existing pig production facility operations, the Ammonia plume spread is approximately 400 to 500 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 57.60 $\mu g/m^3$ for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.4)*.

- With regards to the existing pig production facility operations, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 0.885 $\mu g/m^3$ for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites is less than or equal to 0.020 $\mu g/m^3$ (*see Table 4.2*).

- With regards to the proposed pig production facility operations, the Ammonia plume spread is approximately 350 to 400 m from the facility buildings in a south easterly and southerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was less than or equal to 44.67 $\mu g/m^3$ for the 100th percentile of 1 hour averages for the worst case meteorological year (*see Table 4.2*). This is less than the guideline Ammonia limit value for the protection of human health (*see Table 4.2 and Figure 7.6)*.

- With regards to the proposed pig production facility operations, the Ammonia plume spread is approximately 200 to 250 m from the facility buildings in an easterly and westerly direction. The maximum predicted ground level concentration of Ammonia at the worst case sensitive receptor in the vicinity of the facility was 0.921 $\mu g/m^3$ for the Annual averages for the worst case meteorological year 2017 (*see Table 4.2*).

- The maximum predicted ground level concentration at the identified Natura sites for the existing facility is less than or equal to 0.020 $\mu g/m^3$ (*see Table 4.2*). The maximum predicted ground level concentration at the identified Natura sites for the proposed facility is less than or equal to 0.019 $\mu g/m^3$. There is no net increase in Ammonia deposition at this worst case identified Natura site (Lough Derg, North-east Shore SAC) as a result of the development of the proposed facility. There is a net increase of annual average Ammonia levels at Natura sites Kilduff, Devilsbit Mountain SAC and Slievefelim to Silvermines Mountains SPA but the overall net increase is less than 0.0010 $\mu g/m^3$. This is less than 1% of the critical exposure level of 1 $\mu g/m^3$.

- With regards to the proposed facility operations, the facility operations will be in compliance with the guideline Odour and Ammonia impact presented within the document. The facility will not result in a net increase in Ammonia deposition of greater than 1% of the critical exposure level at Natura site. The implementation of mitigation on the proposed facility will minimise the impact from Ammonia deposition from the facility. The key mitigation techniques to be implemented at the facility will include:

  - For the proposed scenarios, proposed Ammonia emission factors for FSR will apply to Hse 1, 2, 4, 8, 13, 1A, 2B, 14, 15 and 16.
  - The proposed IVC$^+$ system will be implemented on Hse 15 and 16 and is described in BAT reference notes and referenced in Table 3.4.
  - Dietary manipulation (1% drop in crude protein) will be implemented on Hse 1, 2, 2A, 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 1A, 2B, 15 and 16. It is confirmed by the site that a 1% crude protein drop will be implemented which equates to a 10% drop in Ammonia emission levels.
  - For the proposed scenarios, pigs located in Hse 7 and 9 will be moved to updated low emission Hse 14.
  - Finally, for the proposed scenario, ventilation air from Hse 1, 14, 15 and 16 will be vented through a single stack (feed bin) at 18 m. This is reflected in Table 3.2 – proposed scenario Odour emission rates and Table 3.4 – proposed scenario Ammonia emission rates.

- The maximum Nitrogen deposition for the proposed facility operation is no greater than 0.099 kg N ha^{-1} yr^{-1}. There is a maximum net improvement in Nitrogen deposition levels at the worst case Natura site by 5%.

6. References

3. Odour Impacts and Odour Emission Control Measures for Intensive Agriculture, Final Report Environmental Research R&D Report Series No. 14 published by the Irish Environmental Protection Agency 2006,
4. Odour Management at Intensive Livestock Installations published by the Environment Agency UK May 2005,
5. Air Dispersion Modelling from Industrial Installations Guidance Note (AG4) published by the Irish Environmental Protection Agency 2010.
6. Van Geel, P.L.B.A. (2006) Annex 1 - Odour nuisance and farming act, Netherlands.
7. H4 Odour guidance Parts 1 and 2, Environment Agency, UK.
8. IPPC Reference Document on Best Available Techniques for Intensive.
9. Sniffer ER26 Final Report, March 2014.
10. Curran, T.P., Per communication, Nov 2021.
11. AQTAG06 (2014)., Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air.
12. IAQM, 2020., A guide to the assessment of air quality impacts on designated nature conservation sites.
13. BAT Reference Notes for the intensive rearing of poultry and pigs (2017).

7. *Appendix I* - Contour plots for dispersion modelling assessment

Odour and Ammonia contour plots are illustrated in this section. Contour plots are only supplied in this section for illustrative purposes only.

7.1. Site layout and location

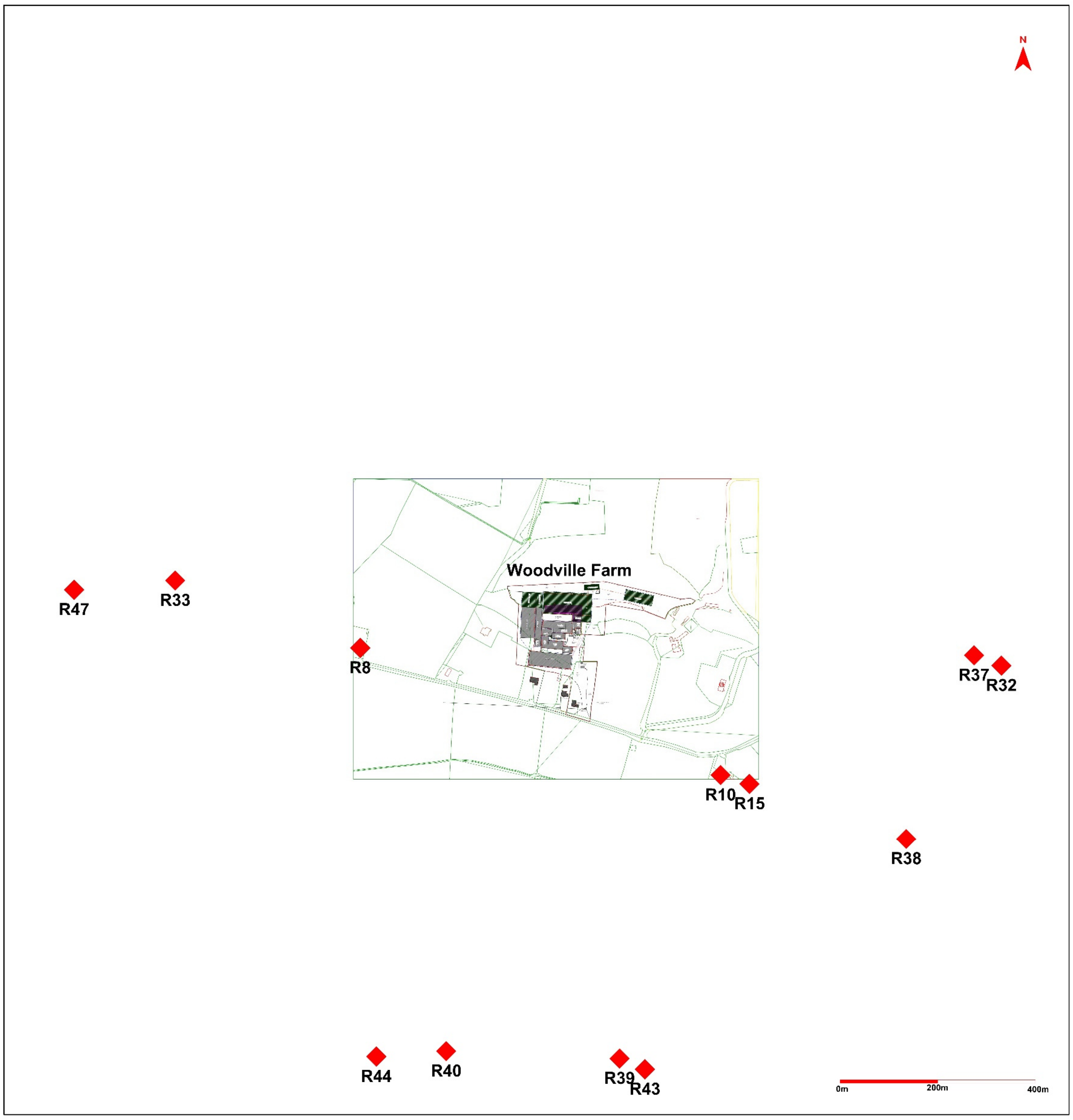

Figure 7.1. Aerial facility layout map showing relative location of the pig production facility, Woodville Farms with sensitive receptors.

7.2. Dispersion modelling contour plots for – Odour: REF SCENARIO 1 Existing

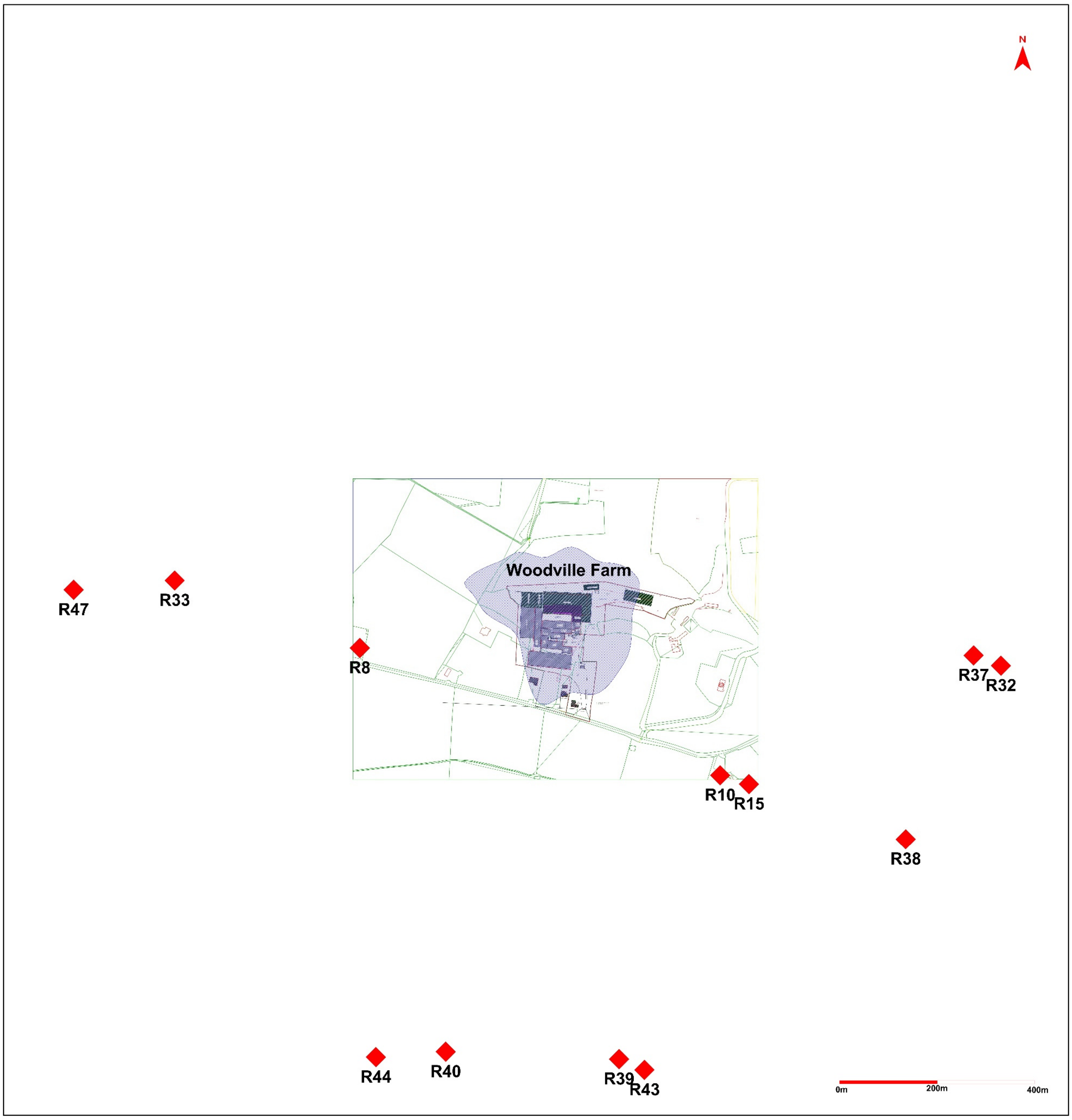

Figure 7.2. Predicted odour plume spread of the existing pig production facility for at the 98th percentile of hourly averages for an odour concentrations of ≤ 6.0 Ou_E/m^3 yr 2017 ( ).

7.3. Dispersion modelling contour plots for – Odour: REF SCENARIO 2 Proposed

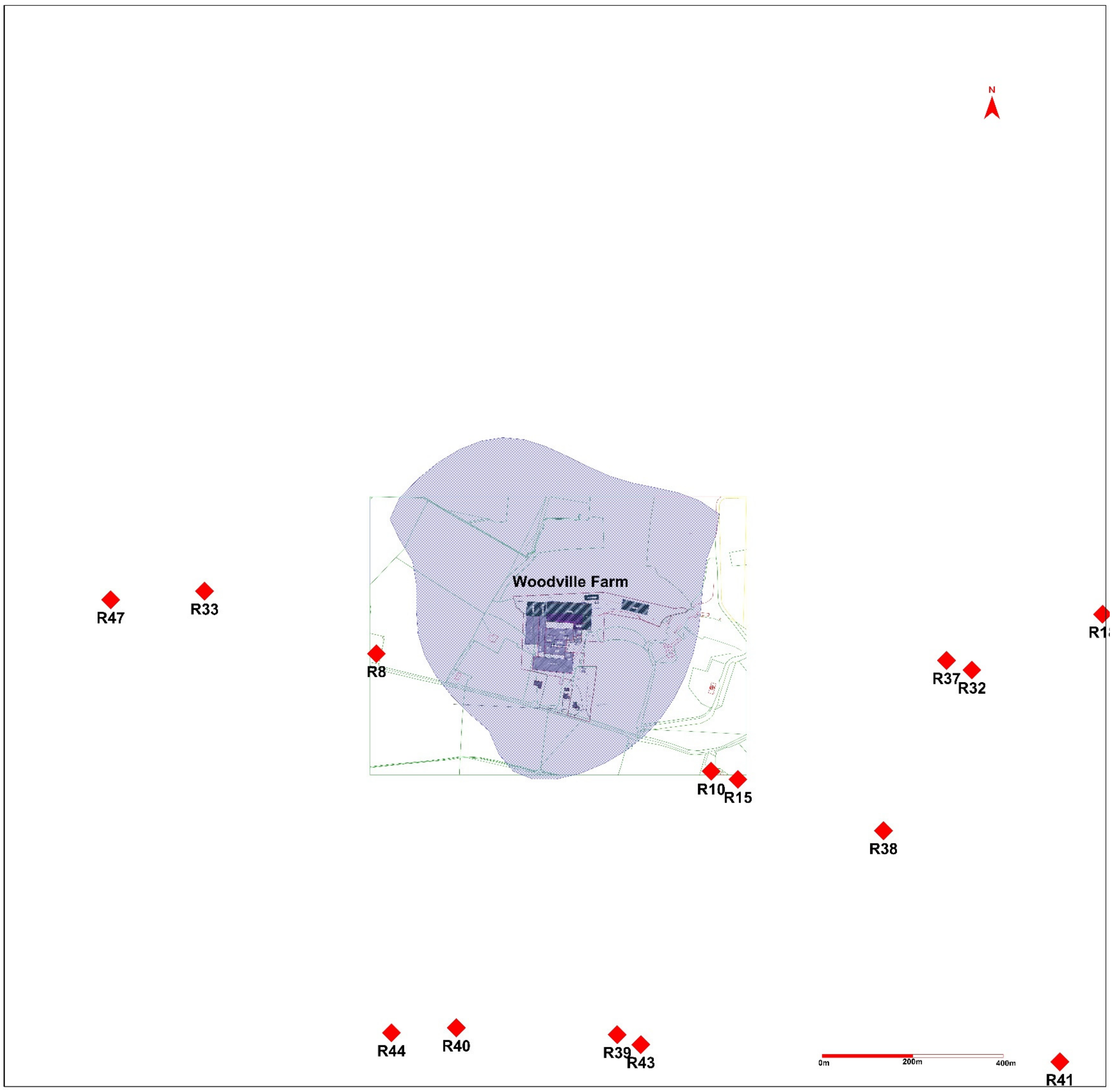

Figure 7.3. Predicted odour plume spread of the proposed pig production facility for at the 98th percentile of hourly averages for an odour concentrations of ≤ 3.0 Ou_E/m^3 yr 2017 ( ).

7.4. Dispersion modelling contour plots Ref Scenario 3A - Existing 1 hr max Ammonia impact (excluding background).

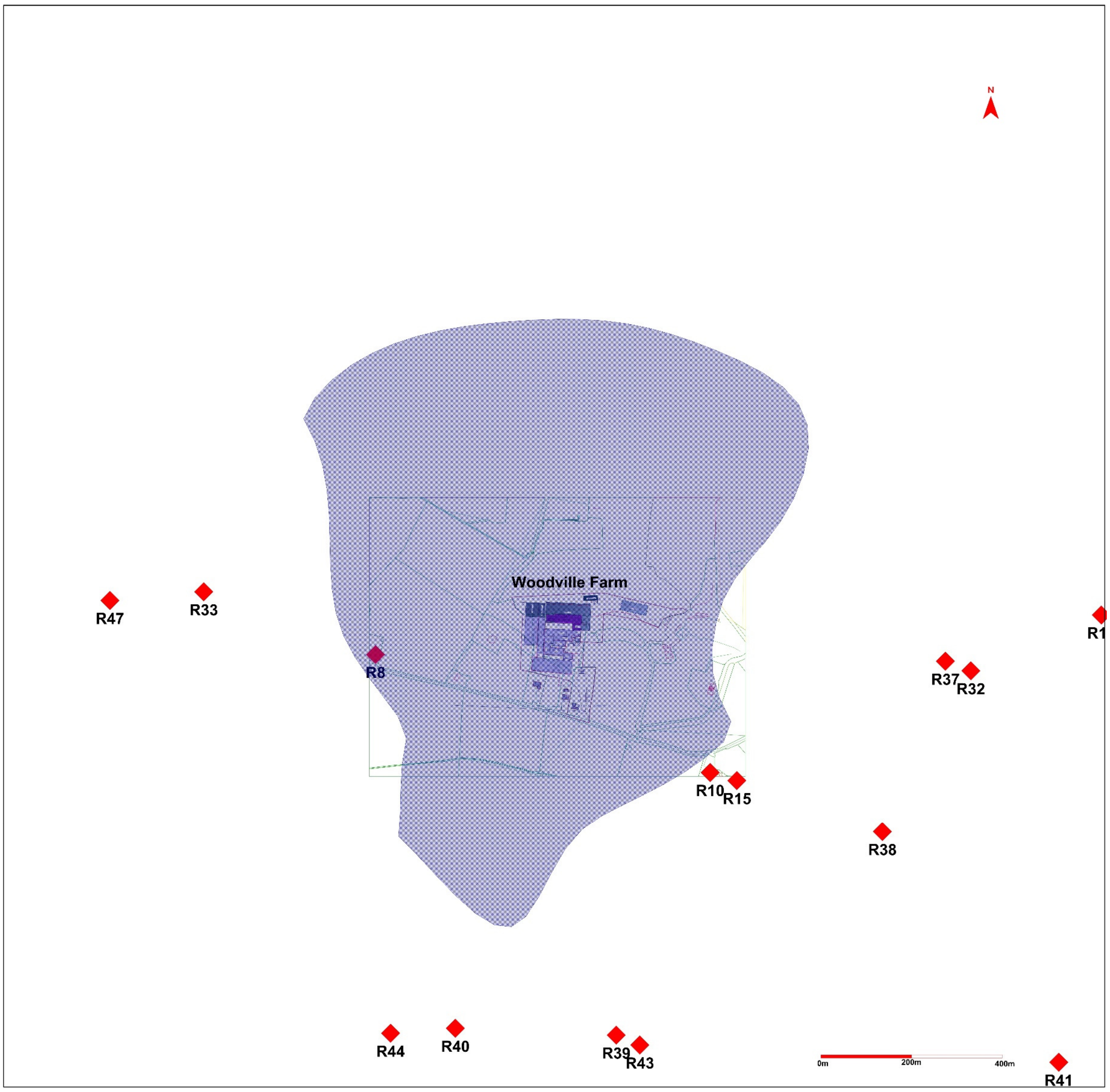

Figure 7.4. Predicted Ammonia plume spread of the existing pig production facility for the 100th percentile of 1 hour averages for an Ammonia concentrations of ≤ 50 µg/m³ yr 2017 ( ).

7.4. Dispersion modelling contour plots Ref Scenario 3B - Existing Annual Average max Ammonia impact (excluding background).

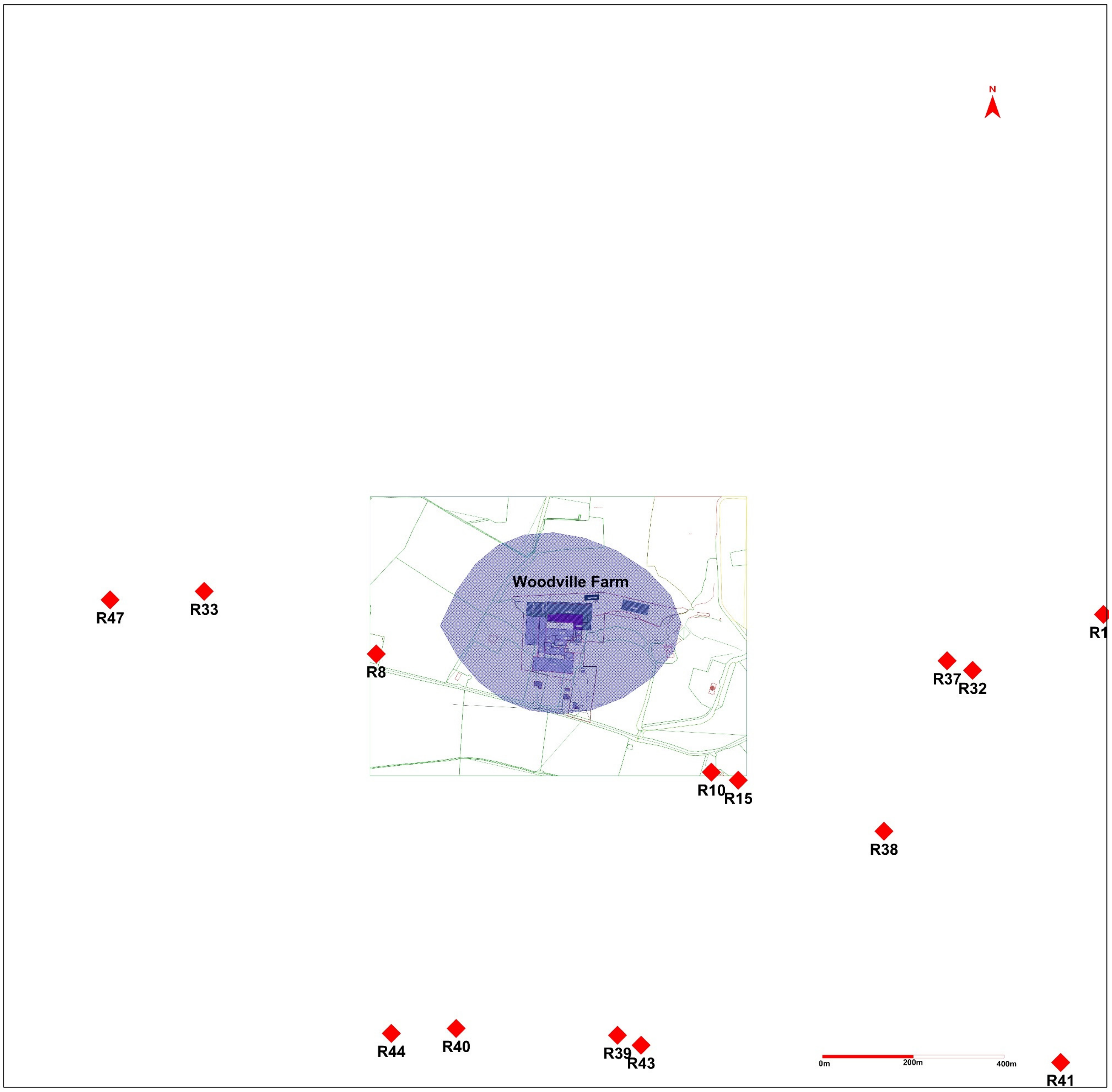

Figure 7.5. Predicted Ammonia plume spread of the existing pig production facility for the Annual averages Ammonia concentrations of ≤ 3.0 µg/m³ yr 2017 (▬▬).

7.5. Dispersion modelling contour plots Ref Scenario 4A - Proposed 1 hr max Ammonia impact (excluding background).

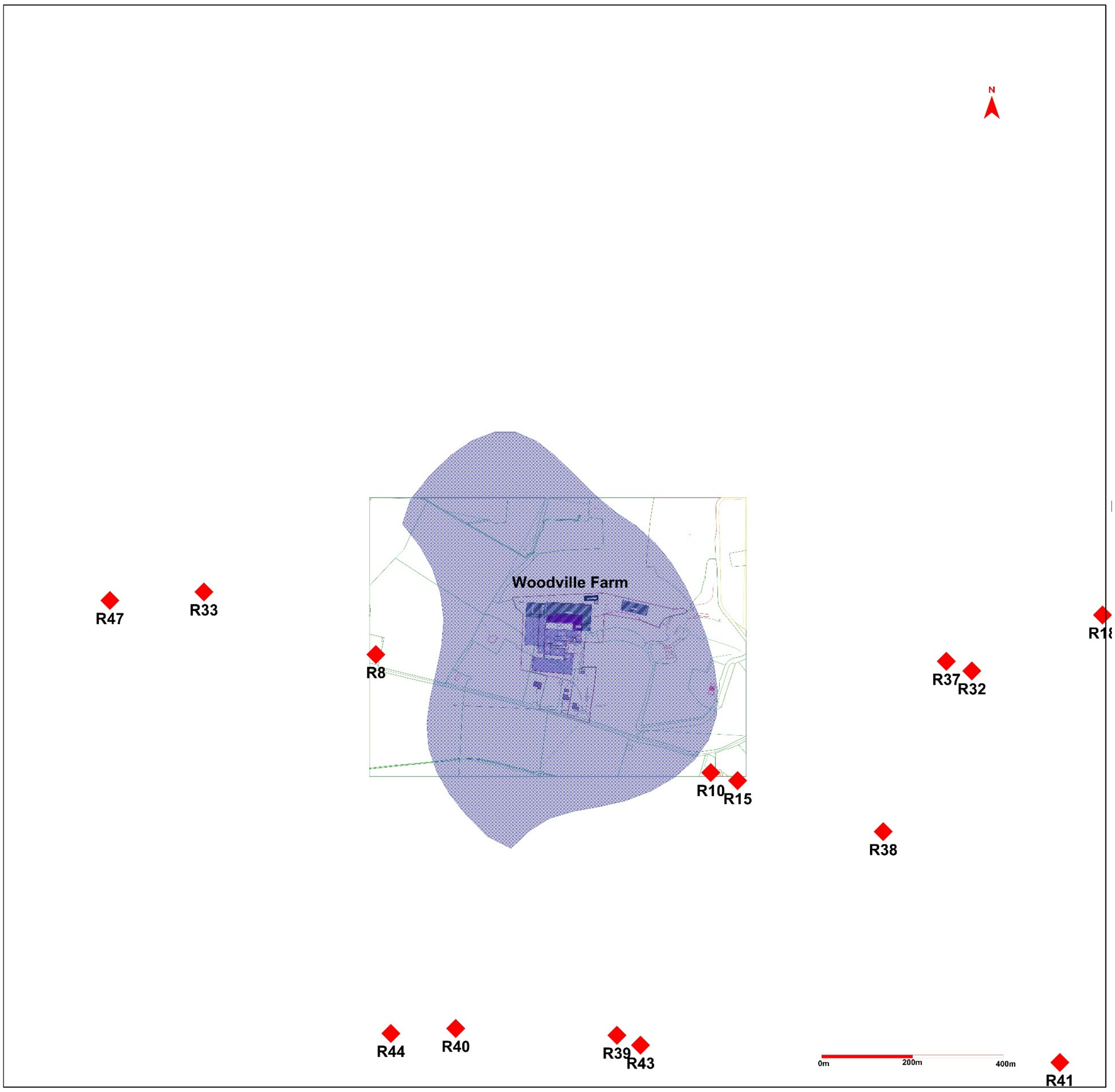

Figure 7.6. Predicted Ammonia plume spread of the proposed pig production facility for the 100th percentile of 1 hour averages for an Ammonia concentrations of ≤ 50 µg/m³ yr 2017 ( ).

7.6. Dispersion modelling contour plots Ref Scenario 4B - Proposed Annual Average max Ammonia impact (excluding background).

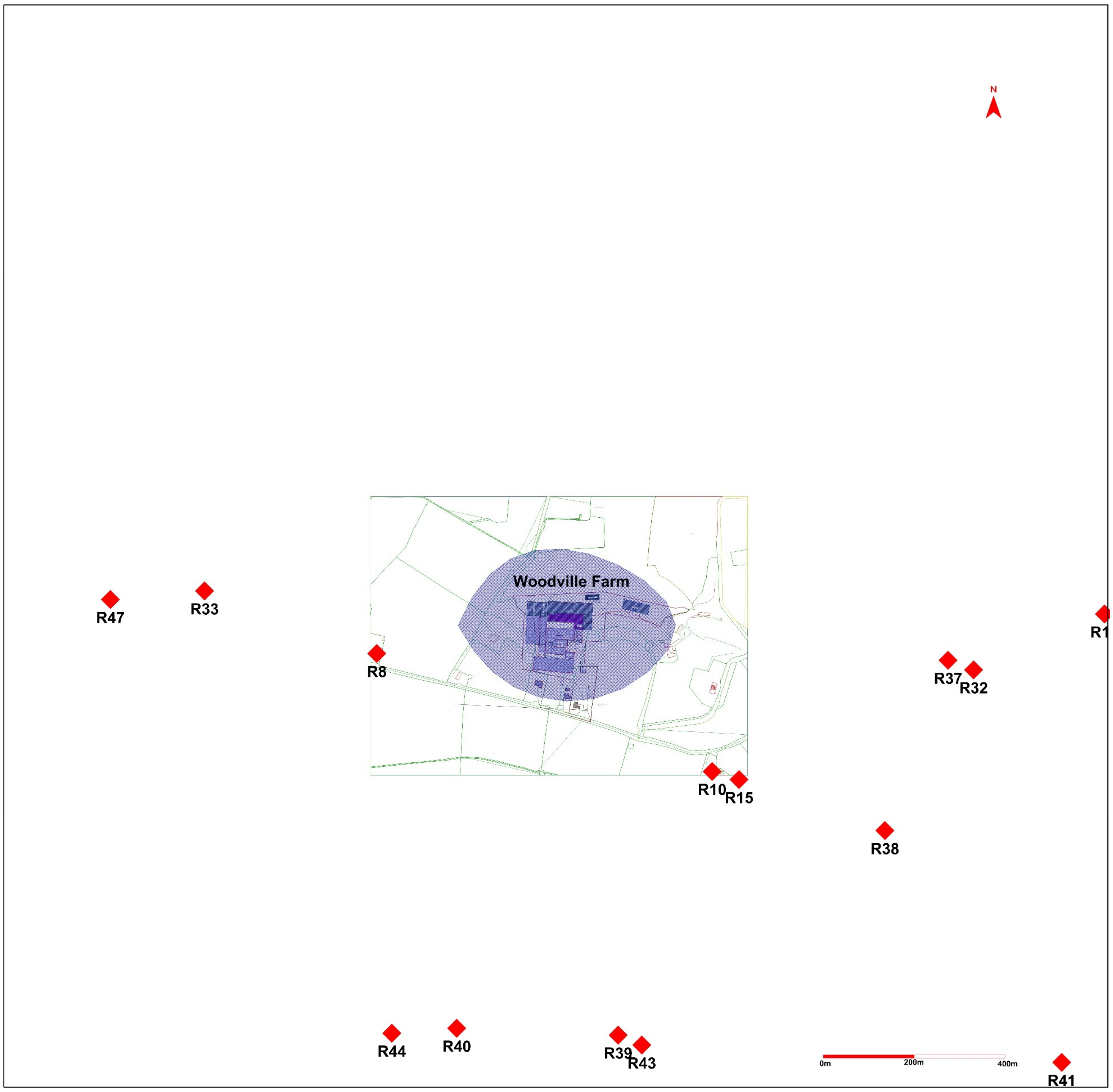

Figure 7.7. Predicted Ammonia plume spread of the proposed pig production facility for the Annual averages Ammonia concentrations of ≤ 3.0 µg/m³ yr 2017 ( ).

8. *Appendix II* - Meteorological data used within the Dispersion modelling study.

8.1 Meteorological file Shannon Airport 2016 to 2020 inclusive

Table 8.1. Tabular illustration of Shannon Airport meteorological files for Years 2016 to 2020 inclusive (5 years).

5 year Meteorological file for Shannon Airport 2016 to 2020 inclusive							
Dir \ Speed	**<= 1.54 m/s**	**<= 3.09 m/s**	**<= 5.14 m/s**	**<= 8.23 m/s**	**<= 10.80 m/s**	**> 10.80 m/s**	**Total**
0.0	0.58	0.82	0.65	0.37	0.03	0.00	2.44
22.5	0.76	1.29	1.39	0.84	0.10	0.00	4.38
45.0	0.46	0.60	0.69	0.72	0.09	0.00	2.56
67.5	0.34	0.47	0.66	0.47	0.04	0.01	2.00
90.0	0.32	0.83	1.38	0.98	0.17	0.01	3.68
112.5	0.42	2.16	3.73	2.01	0.56	0.23	9.11
135.0	0.53	1.77	2.56	2.41	0.81	0.27	8.35
157.5	0.29	1.26	2.93	2.90	0.97	0.34	8.69
180.0	0.23	0.94	2.09	1.59	0.33	0.10	5.28
202.5	0.23	1.19	2.36	2.10	0.49	0.17	6.54
225.0	0.34	1.47	2.40	3.32	0.97	0.48	8.99
247.5	0.39	1.72	3.74	5.02	1.88	1.27	14.02
270.0	0.42	1.50	2.37	2.82	0.90	0.38	8.38
292.5	0.42	1.48	1.80	1.89	0.55	0.17	6.30
315.0	0.49	1.74	1.56	0.88	0.17	0.03	4.87
337.5	0.40	1.26	1.61	0.92	0.10	0.02	4.31
Total	6.59	20.49	31.91	29.25	8.17	3.48	99.90
Calms	-	-	-	-	-	-	**0.10**
Missing	-	-	-	-	-	-	**0.00**
Total	-	-	-	-	-	-	**100.00**

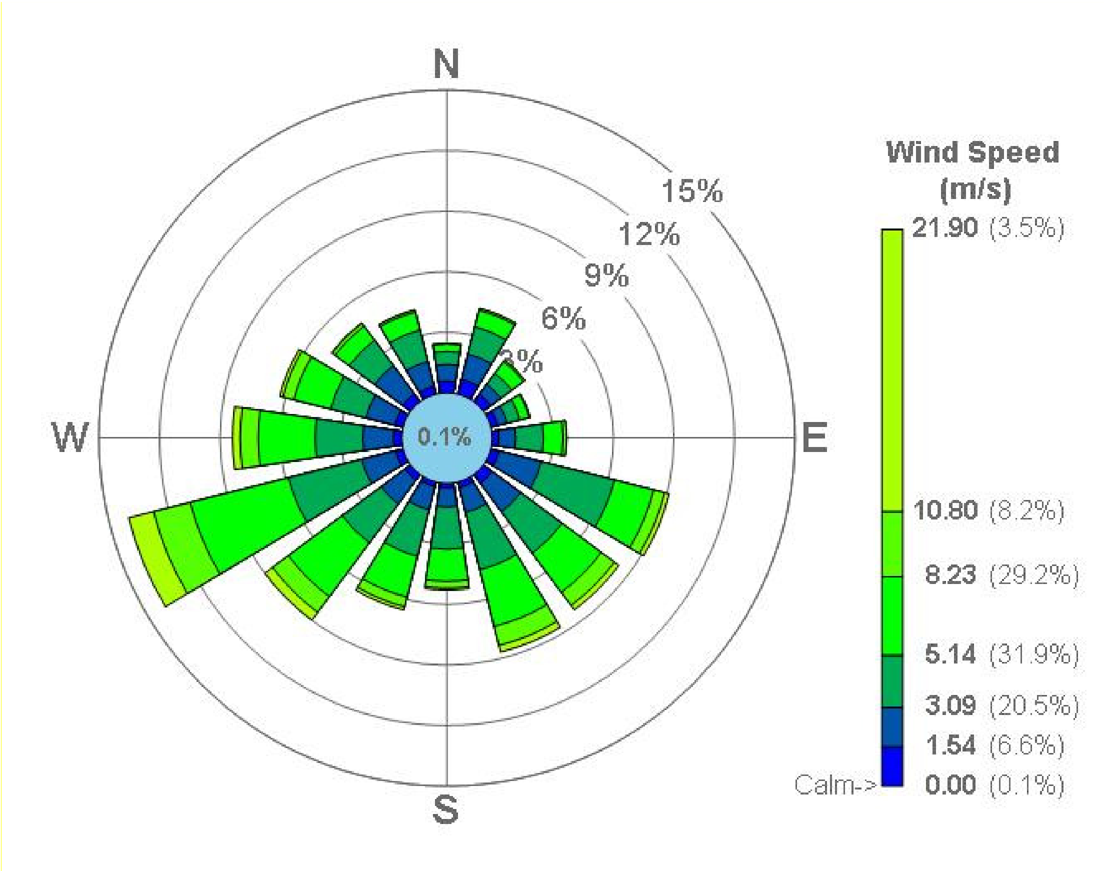

Figure 8.1. Windrose illustration of meteorological files Shannon Airport meteorological files for Years 2016 to 2020 inclusive.

9. Farm key diagram

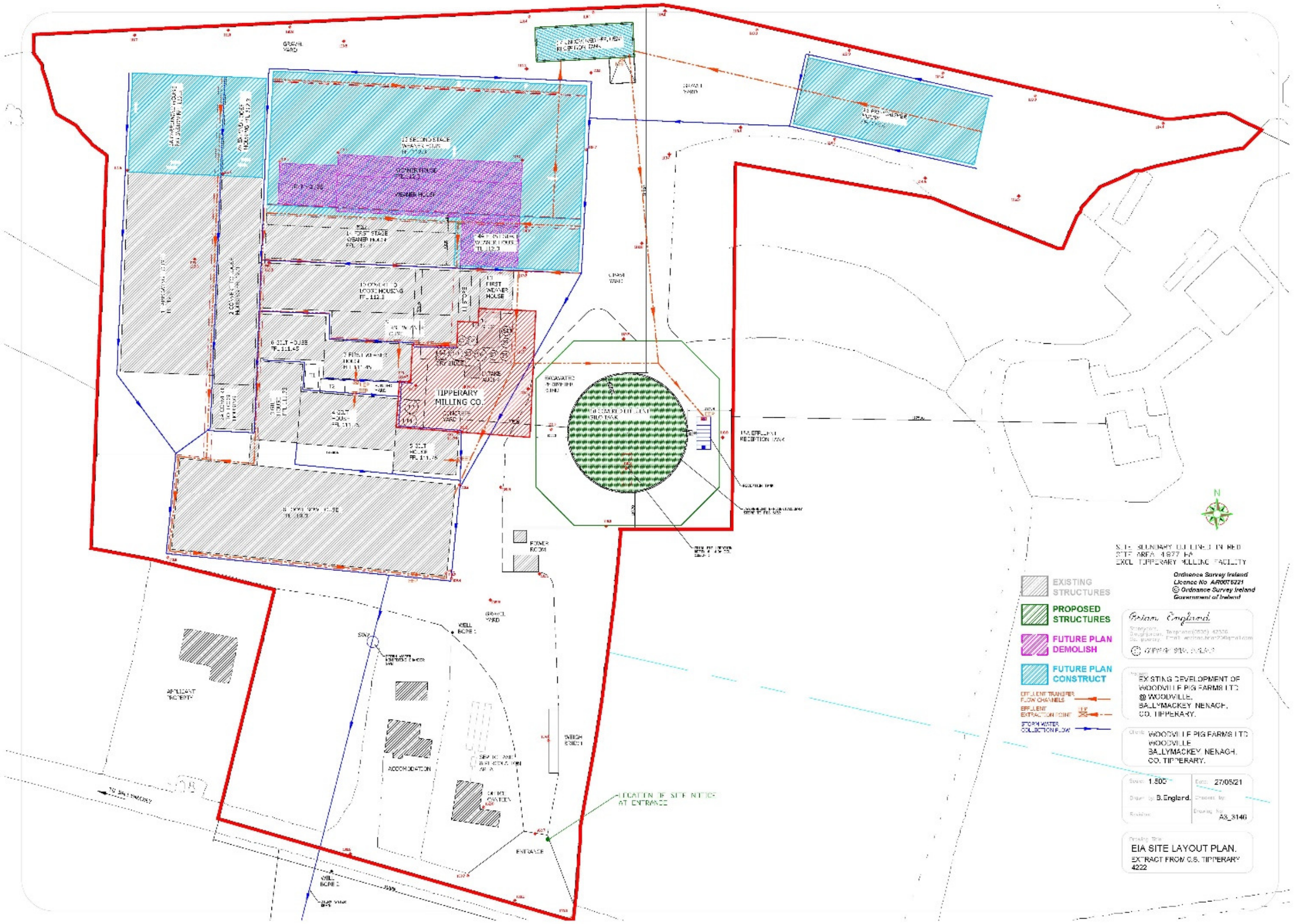

Figure 9.1. Farm key diagram

10. Proposed crude protein content in Pig Diets

Woodville Pig Farms Limited have worked closely with their nutritionists over the years to reduce the protein levels in the pig diets. They have engaged in the progress that has been made by the Irish pig sector on nutritional improvements over the years. The diets to be used at Woodville Pig Farm will have the following maximum crude protein levels:

Table 10.1. Proposed Crude Protein content in Pig Diets.

Diet Type	% Crude Protein
Dry Sow	14.5
Lactating Sow	18.5
Weaner Ration	18.0
Finisher Ration	16.5