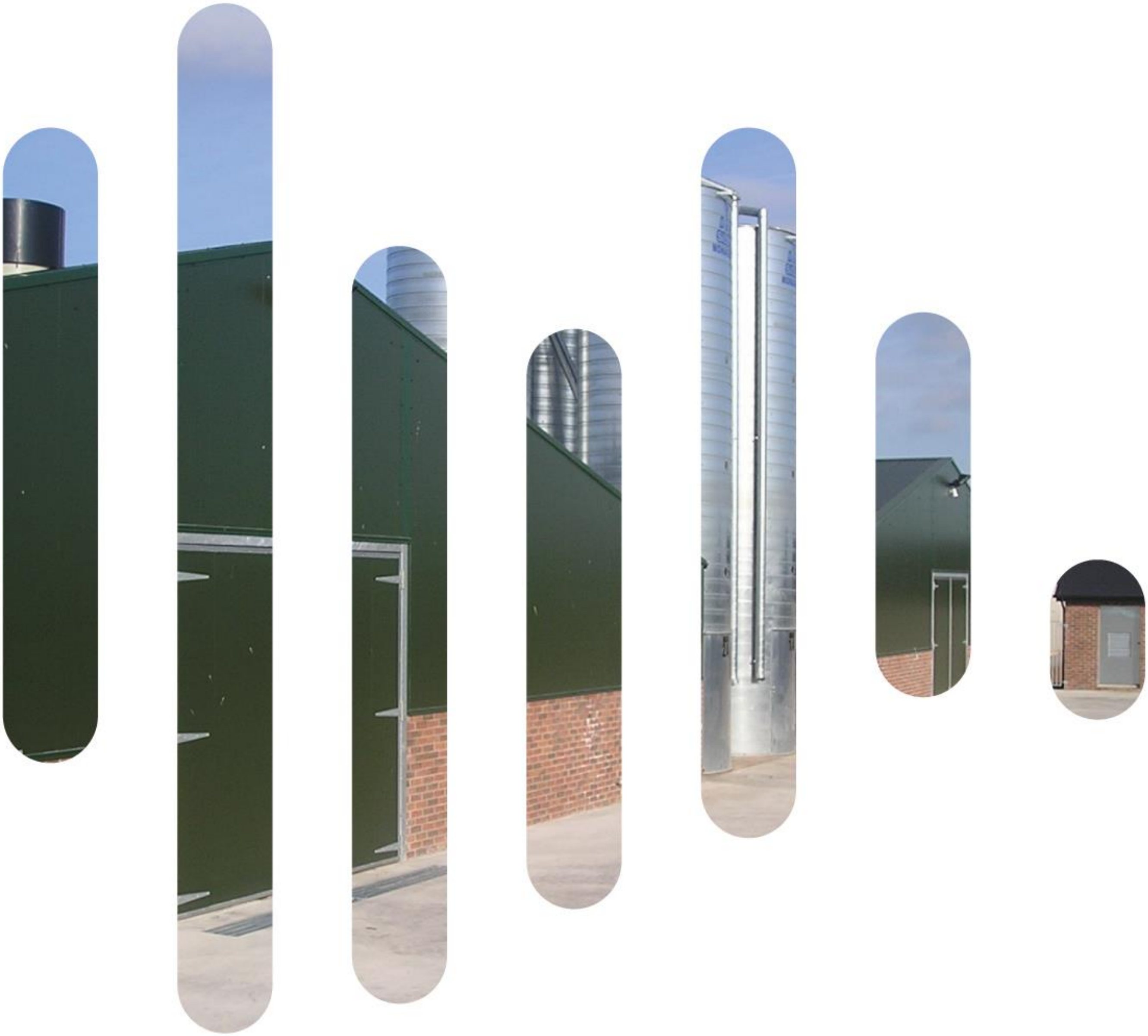

AIR QUALITY IMPACT ASSESSMENT
DOON FARM ENTERPRISES

Rp002 2023152 (Doon Farm Enterprises)
12 March 2024

PROJECT: AIR QUALITY IMPACT ASSESSMENT

PREPARED FOR: DOON FARM ENTERPRISES
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1 INTRODUCTION

Irwin Carr Ltd have been commissioned to undertake air quality dispersion modelling for the license of an existing pig farm at Doon Farm Enterprises, Araglin, Co. Tipperary.

The purpose of this report is to quantify the odour and ammonia levels at sensitive properties and ecologically sensitive areas in the vicinity of the pig farm.

The predicted impact can then be compared to an appropriate criterion and graphically illustrated in the form of 'contours of equal concentration' or isopleths which are superimposed on base maps.

1.1 Application Description

The site currently has the provision for twenty four pig sheds, both naturally and mechanically ventilated. The proposed sheds to be retained shall increase the number of pigs housed onsite to 6,175 pigs of varying size and type, which has been detailed in Section 3.2 below.

In order to accurately predict the odour impact from the site, all 24 sheds have been included as part of this assessment.

For the purposes of the ammonia assessment, the applicant previously received the following EPA correspondence,

> *"Only the legally permitted stock onsite (e.g. ≤750 sows and ≤2,000 production pigs in an integrated unit) may be considered as part of the background ammonia concentration or used when demonstrating a reduction in ammonia emissions due to the implementation of mitigation measures relative to the existing installation."*

Therefore, in order to accurately predict the ammonia impact from the proposed pigs on-site, only the additional 1,500 production pigs have been included, and are detailed in Section 3.2.6 below.

As part of this application, a low protein diet has been included, the associated reductions of which are included in Section 3.2.3 below.

The reductions associated with this mitigation have been included on all sheds included as part of this assessment.

An ancillary storage tank shall also be installed off site to facilitate the frequent removal of slurry from Sheds 2.1, 10.1, 10.2 and Shed B. Shed A shall also be subject to slurry cooling.

1.2 Application History

This assessment is further to an original report completed by Irwin Carr, as well as a consultation response from the EPA in relation to the application.

In their response, the EPA had a query in relation to the reductions associated with low protein diets, as detailed below:

1. *'Regarding the use of low protein feeds onsite. It is noted that protein concentrations in the diets of different categories of pigs vary significantly and that a standard 16% protein ration, as stated in the submitted air modelling report, is not appropriate for all pig categories.*

   Provide the existing and proposed crude protein concentration per pig category to justify the reduced ammonia emission applied. If the reductions in crude protein do not align with those used in the ammonia and odour model to justify reductions in emissions, the model should be updated to reflect the correct values.'

It is accepted that the crude protein concentrations may vary in the diets of different categories of pigs, however they range from 12% - 16% for the pigs on site, and will not exceed this higher level. The wording in Section 3.2.3 below has been updated, and the 16% crude protein level has been confirmed to be a maximum that will not exceeded on site.

It should be noted that the reductions associated with low protein diets should not be compared against existing levels, but rather against baseline levels. As per the information included in Table 5,

> *'Each 1% reduction in CP in the range 20-12% results in a 10% reduction in ammonia emission levels'*

Irrespective of the existing crude protein level fed to pigs on site, the reductions are associated with the level reducing from the 20% baseline figure on which standard emission rates are based.

For clarity, it is understood that the crude protein level for each category of pig (except dry sows) has also reduced by 3% based on the levels they are currently being fed, ensuring the associated reductions are applicable. The crude protein level of dry sows has reduced by 2.6%.

This additional information does not affect the inputs, results or conclusions of the previous report, which remain unchanged as part of this amended assessment.

2 ASSESSMENT CRITERIA

The proposed target levels and method of assessment is described in this section.

2.1 Odour

The Environmental Protection Agency provide guidelines for dispersion modelling as well as identifying target odour levels at the nearest sensitive locations in the vicinity of operations such as proposed pig and poultry sites.

Table 1 below shows how different types of processes are categorised and the appropriate odour benchmark values.

Table 1: Odour Benchmark levels

Relative Offensiveness of odour	Benchmark level (ou/s)
Most Offensive Odours • Processes involving decaying animals or fish • Processes involving septic effluent or sludge • Biological landfill odours	1.5
Moderately Offensive Odours • Intensive livestock rearing • Fat frying (food processing) • Sugar beet processing • Well aerated green waste composting	3.0
Less offensive Odours • Brewery • Confectionery • Coffee roasting • Bakery	6.0

Generally, odour concentrations should be below C98, 1-Hour 5ou_E/m^3 in order to prevent complaints arising from existing intensive pig facilities in Ireland.

For the purposes of assessing odorous emissions from the proposed extension to the intensive livestock rearing facility, and in the interests of conservatism, the odour target value of C98, 1-Hour ≤6 ou/m^3 will be adopted at the nearest sensitive receptor.

To put these guidelines into context, an odour threshold of 1ou/m^3 is the level at which an odour is detectable by 50% of screened panellists. The recognition threshold is about 5 times this concentration i.e. 5ou/m^3. Furthermore, odour concentration of between 5 and 10 ou/m^3 above background will give rise to a faint odour and concentrations greater than 10ou/m^3 constitutes a distinct odour and are likely to give rise to nuisance complaints.

Odour assessments are commonly compared to the 98th percentile of hourly averages. For a typical meteorological year the dispersion model predicts 8,760 hourly concentrations for each receptor location. The 98th percentile is part of the statistical distribution, where 98% of the results fall below this value and 2% of the results fall above this value.

2.2 Ammonia

There are limitations on emissions of ammonia from such installations for the protection of vegetation. They are referenced from *Cape, J.N.; van der Eerden, L.J.; Sheppard, L.J.; Leith, I.D.; Sutton, M.A.. 2009. Evidence for changing the critical level for ammonia. Environmental Pollution, 157 (3). 1033-1037.*

Where the limits are applied to general vegetation such as herbaceous species or forest trees the limit is set at 3 ± 1 μg/m³ of ammonia (ie. 2-4 μg/m³) as a long-term (several year) concentration.

For particularly sensitive plants such as lichens and bryophytes, the limit of 1 μg/m³ is applied to ammonia as a long-term (several year) concentration.

Table 2 shows the target levels for the protection of vegetation.

Table 2: Ammonia limit values

Pollutant	Reason	Guideline Value	Measured as
Ammonia	Protection of Vegetation	1-3 μg/m³	Annual Mean

2.3 Nitrogen Deposition

Critical load values for nutrient nitrogen deposition are provided by the United Nations Economic Commission for Europe (UNECE) as a range (e.g. 10-20 kg N/ha/yr for dry heaths). This table provides indicative values within the critical load range, by habitat type, for use in detailed impact assessments in Ireland.

Table 3: Critical Load Range for atmospheric Nitrogen

Habitat type (EUNIS code)	Critical load (CL) range (kgN/ha/yr)	Value to use at screening stage (kgN/ha/yr)	Recommended value to use at detailed assessment stage (kgN/ha/yr)
Marine habitats			
Mid-upper saltmarshes (A2.53)	20-30	20	20
Pioneer & low-mid saltmarshes (A2.54 and A2.55)	20-30	30	30
Coastal habitats			
Shifting coastal dunes (B1.3)	10 to 20	10	10
Coastal stable dune grasslands (grey dunes) (B1.4)	8 to 15	8	Acid dunes = 8 Calcareous dunes = 10
Coastal dune heaths (B1.5)	10 to 20	10	10
Moist to wet dune slacks (B1.8)	10 to 20	10	Low base availability = 10 High base availability = 15
Inland surface waters			
Softwater lakes (permanent oligotrophic waters) (C1.1)	3 to 10	Seek site specific advice	
Dune slack pools (permanent oligotrophic waters) (C1.16)	10 to 20	10	10
Permanent dystrophic lakes, ponds and pools (C1.4)	3 to 10	Seek site specific advice	

Mire, bog and fen habitats			
Raised & blanket bogs (D1)	5 to 10	5	Apply guidance
Valley mires, poor fens and transition mires (D2)	10 to 15	10	10
Rich fens (D4.1)	15 to 30	15	15
Montane rich fens (D4.2)	15 to 25	15	15
Grasslands and tall forb habitats			
Sub-atlantic semi-dry calcareous grassland (E1.26)	15 to 25	15	15
Non-Mediterranean dry acid and neutral closed grassland (E1.7)	10 to 15	10	10
Inland dune pioneer grasslands (E1.94) Inland dune siliceous grassland (E1.95)	8 to 15	8	Acid dunes = 8 Calcareous dunes = 10
Low and medium altitude hay meadows (E2.2)	20 to 30	20	20
Mountain hay meadows (E2.3)	10 to 20	10	10
Moist & wet oligotrophic grasslands:			
Molinia caerulea meadows (E3.51)	15 to 25	15	15
Heath (Juncus) meadows & humid (Nardus Stricta) swards (E3.52)	10 to 20	10	10
Moss & lichen dominated mountain summits (E4.2)	5 to 10	5	7
Alpine and subalpine acid grasslands (E4.3) Alpine and subalpine calcareous grasslands (E4.4)	5 to 10	5	5
Heathland, scrub & tundra			
Arctic, alpine and subalpine scrub habitats (F2)	5 to 15	5	5
Northern wet heaths (F4.11) Dry heaths (F4.2)	10 to 20	10	10
Forest habitats (general)			
Use if not one of specific forests in section below			
Broadleaved woodland (G1)	10 to 20	10	10
Coniferous woodland (G3)	5 to 15	5	10 (Use 5 if lichens/free-living algae important features of the site).
Forest habitats (specific)			
Fagus woodland (beech) (G1.6)	10 to 20	10	15
Acidophilous Quercus-dominated woodland (oak) (G1.8)	10 to 15	10	10
Meso- and eutrophic Quercus woodland (G1.A)	15 to 20	15	15

Pinus sylvestris woodland south of the taiga (G3.4)	5 to 15	5	12
Coniferous woodland (G3)	5 to 15	5	10 (Use 5 if lichens/free-living algae important features of the site).

3 AERMOD DISPERSION MODELLING DATA

The inputs for the dispersion modelling assessment are described in detail in this Section. A surface roughness factor of 0.2 has been used in the AERMOD modelling process, and the results in this report reflect the use of this factor. The site layout, including the nearest residential properties, is shown in Appendix A.

3.1 AERMOD Dispersion Modelling Package Description

The AMS.EPA Regulatory Model (AERMOD) is the current US EPA regulatory model used to predict pollutant concentrations from a wide range of sources that are present at typical industrial facilities.

The model accepts hourly meteorological data to define the conditions for plume rise, transport, diffusion and deposition. It estimates the concentration or deposition value for each source and receptor combination for each hour of input meteorology and calculates user-selected short term averages. The model also takes into account the local terrain surrounding the facility. Since most air quality standards are stipulated as averages or percentiles, AERMOD allows further analysis of the results for comparison purposes.

Percentile analysis for emissions is calculated for the maximum averages using the AERMOD-percent post-processing utility. This utility calculates the maximum concentration of a pollutant from all receptors at a specific percentile, for a specific period. Employing the percentile facilitates the omission of unusual short-term meteorological events that may cause elevated pollutant concentrations and hence a more accurate representation of the likely average pollutant concentrations over an averaging period.

The following information was input into the model for the prediction of maximum ground level ambient odour and ammonia concentrations from the pig farm.

3.2 Input Parameters

The site layout map, building plans and elevations were used as a template for all sources, relevant structures and the boundary of the facility. The AERMOD package uses the steady state Gaussian plume equation for a continuous elevated point or line source. Table 4 below gives general details of the pig houses.

Table 4: Dimensions of Pig Houses

House No.	Area (Ridge Height)	Total No. of Pigs	Efflux Temp	Emissions
Shed 1	389m^2 (3.8m)	90 x Dry Sows	20 °C	Mechanically Ventilated
Shed 2	797m^2 (4.0m)	130 x Dry Sows	20 °C	Mechanically Ventilated
Shed 2.1 (Low Emission)	422m^2 (4.0m)	38 x Farrowing Sows	20 °C	Mechanically Ventilated
Shed 3	395m^2 (3.4m)	22 x Farrowing Sows	20 °C	Mechanically Ventilated
Shed 5	347m^2 (3.4m)	20 x Farrowing Sows	20 °C	Mechanically Ventilated
Shed 6	88m^2 (3.4m)	440 x Weaners	20 °C	Mechanically Ventilated
Shed 7	269m^2 (3.4m)	20 x Farrowing Sows	20 °C	Mechanically Ventilated
Shed 8	220m^2 (2.4m)	150 x Weaners	20 °C	Naturally Ventilated
Shed 9	147m^2 (3.6m)	200 x Weaners	20 °C	Mechanically Ventilated
Shed 10	480m^2 (3.6m)	640 x Weaners	20 °C	Mechanically Ventilated

Shed 10.1 (Low Emission)	285m² (4.8m)	180 x Weaners	20 ºC	Mechanically Ventilated
Shed 10.2 (Low Emission)	285m² (4.8m)	180 x Weaners	20 ºC	Mechanically Ventilated
Shed 11	588m² (4.5m)	450 x Weaners	20 ºC	Mechanically Ventilated
Shed 12	285m² (4.5m)	115 x Weaners	20 ºC	Mechanically Ventilated
Shed 13	232m² (4.5m)	114 x Fatteners 76 x Growers	20 ºC	Mechanically Ventilated
Shed 14	651m² (4.5m)	306 x Fatteners 204 x Growers	20 ºC	Mechanically Ventilated
Shed 15	433m² (3.3m)	100 x Fatteners	20 ºC	Mechanically Ventilated
Shed 16	433m² (2.4m)	180 x Fatteners 120 x Growers	20 ºC	Naturally Ventilated
Shed 17	433m² (2.4m)	216 x Fatteners 144 x Growers	20 ºC	Naturally Ventilated
Shed 18	433m² (2.4m)	144 x Fatteners 96 x Growers	20 ºC	Naturally Ventilated
Shed 19	651m² (4.5m)	306 x Fatteners 204 x Growers	20 ºC	Mechanically Ventilated
Shed 20	232m² (4.5m)	114 x Fatteners 76 x Growers	20 ºC	Mechanically Ventilated
Shed A (Low Emission)	765m² (5.2m)	180 x Dry Sows	20 ºC	Mechanically Ventilated
Shed B (Low Emission)	1680m² (5.0m)	660 x Fatteners 440 x Growers	20 ºC	Mechanically Ventilated

**Shed 4 is not in use*

It can be seen from the Table above that Sheds 13, 14, 16, 17, 18, 19, 20 and Shed B include both fattener and grower pigs. A recent EU Commission Implementing Decision (CID)[1] defines production pigs, which will be housed on site, as,

> *'typically reared from a live weight of 30 kg to slaughter or first service. This category includes growers, finishers and gilts that have not been serviced.'*

This is evidence that production pigs also include grower pigs. Emission factors for grower pigs are provided in SCAIL and they are defined in BREF as ranging between 30-60kg[2].

It should be noted that not all animals on site will be at the maximum finishing weight prior to slaughter at the same time. When the sheds are fully stocked they operate on a continuous flow, rather than a batch type production system, thus at any one time there will be pigs in all the weight ranges the animals will range in weight between 30kg – market weight (c. 110-120 kg). It is expected that no

[1] *Commission Implementing Decision (EU) 2017/302 of 15 February 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs.*

[2] JRC Science for Policy Report. Best Available Techniques for the Intensive Rearing of Poultry and Pigs. Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control).

more than 60% of the total animal numbers will be 'fatteners' (>60kg) at any time and therefore this assessment considers the worst case scenario of 60% fatteners and 40% growers."

3.2.1 EMISSIONS

The rate of production of an emission, such as odour and ammonia, is best quantified as an emission rate.

To find the emissions from the proposed sheds, it was necessary to calculate the concentration within the building. The Sections below detail the reductions associated with the proposed mitigation measures and the associated emission rates from each shed.

3.2.2 MITIGATION

The baseline emission factors for pigs have been outlined in Guidance published by the Environmental Protection Agency[1]. Section 4.2 of this Guidance document also details the basic principles for reducing odour emissions, namely:

- *Manipulating dietary protein & supplements: Reduction of the protein content in feed (Page 25, Section 4.2.1).*
- *Improved slurry management offered by integrated housing techniques: Frequent removal of slurry and storage in closed tanks (Page 26, Section 4.2.2.)*

This measure is recognised as Best Available Techniques (BAT) and included in the BAT Reference Document as recommended reduction measures for both odour and ammonia.

The relevant Sections included in the points above also detail the reductions associated with each measure:

- Low Protein: For detailed modelling, it would be reasonable to apply a reduction factor of 10% on the basis of a reduction of 1% crude protein in the diet. The maximum reduction factor that can be applied is 30% linked to a reduction of 3% crude protein in the diet. The only pig type to which a 30% reduction has not been applied is sows, to which a reduction of 20% has been applied for odour and ammonia.
- Frequent Removal of Slurry: For carrying out detailed modelling it would be reasonable to apply a reduction factor of 25% irrespective of the technique being employed (e.g., frequent slurry removal / slurry cooling).

It has been confirmed that the pigs on site will be fed a diet with a crude protein level of 16%. As a result, an odour reduction of 30% has been applied to the sheds on site except those housing sows, to which a reduction of 20% has been applied for odour and ammonia. Further information is provided in the Sections below to support the reductions associated with each mitigation measure.

3.2.3 LOW PROTEIN DIET

It is accepted throughout the intensive agriculture industry, through robust scientific evidence, that a reduction in crude protein in animal feed, will lead to a reduction in baseline ammonia emissions from livestock. There is also evidence to show that as ammonia from animals is decreased, so is odour.

There are a number of recent scientific studies that have been carried out, and subsequent documents produced, in relation to the ammonia emissions from pig houses and the impact of mitigation measures associated with Best Available Techniques (BAT).

The recent EU CID[3] states that one of the ways in which to reduce total nitrogen excreted, and consequently ammonia emissions, is to reduce the crude protein content of the pig feed. This statement is supported by a peer review report which has been prepared by Hayes et al[4], which cites Kay and Lee[5]:

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[3] *Commission Implementing Decision (EU) 2017/302 of 15 February 2017 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the intensive rearing of poultry or pigs. Pg 7*

[4] *Hayes, E.T., Leek, A.B.G., Curran, T.P., Dodd, V.A., Carton, O.T., Beattie, V.E. and O'Doherty, J.V. (2004). The influence of diet crude protein level on odour and ammonia emissions from finishing pig houses.* Bioresource Technology, *91: 309-315*

[5] *Kay R.M., and Lee, P.A. (1997). Ammonia emissions from pig buildings and characteristics of slurry produced by pigs offered low crude protein diets. In: Voermans JAM, Monteny GJ. Editors. Ammonia and odur emission from animal production facilities. Wageningen, The Netherlands; CIGR pg 253 – 259*

'Reductions in ammonia emission equivalent to 9.8% per 10 g/kg reduction in dietary crude protein.'

Table 5 below summarises the level of reduction which are included in the conclusions of these reports applicable to this site:

Table 5: Effect of mitigation measures

Crude Protein in feed
Each 1% reduction in CP in the range 20-12% results in a 10% reduction in ammonia emission levels

It has been confirmed that all pigs on site will be fed a diet with a maximum crude protein level of 16%. As a result, a reduction of 30% has been applied for odour and ammonia to all pigs except sows, to which a reduction of 20% has been applied for odour and ammonia. This is considered conservative, as the max reduction associated with a low protein diet in sows is 26%.

3.2.4 REGULAR REMOVAL OF SLURRY

The frequent removal of slurry shall take place in Sheds 2.1, 10.1, 10.2, B on the site. Shed A shall also have slurry cooling, which is subject to a similar reduction.

The ammonia emission factors for pigs have been outlined in Guidance published by the Environment Agency[6], which is used to inform the emission factors detailed in the SCAIL[7] screening tool/ reference report.

There are various housing systems included in the document and the Table below details some the emission factors associated with the housing system on this site, which are compared to standard emissions for a Fully Slatted Floor (FSF).

Table 6: Source Ammonia Emission Factors for Regular Removal of Slurry

Category of Animal	Baseline Emissions for FSF (kg/yr/animal)	Housing Type	Source Levels (kg/yr/animal)	Reduction
Sows	3.01	Fully Slatted Floor (FSF) with vacuum system for frequent slurry removal	2.26	25%
Fatteners	4.14		3.11	25%
Growers	1.59		1.19	25%
Weaners	0.29		0.22	25%
Farrowers	5.84		4.38	25%

It can be seen from the Table above that the housing systems which accounts for the frequent removal of slurry (in line with the Best Available Techniques (BAT) Reference Document) results in a 25% reduction in ammonia emissions, when compared to the baseline emission factor for a fully slatted floor.

3.2.5 TOTAL REDUCTIONS

Section 4.2.3 of the EPA Guidance provides advice on mitigation offered by more than one mitigation technique, as is the case with this proposal. Within the Guidance it is noted,

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

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

Given that the mitigation associated with the second technique (frequent removal of slurry) is 25%, only 50% of this has been applied, and the Section below takes account of an additional 12.5% reduction to account for the regular removal of slurry on site.

[6] *Pollution Inventory Reporting- Intensive Farming Guidance Note. Environment agency, January 2013, Version 5.*

[7] *SCAIL-Agriculture Update, Sniffer ER26: Final Report March 2014*

Table 7 below shows the category of animal and recommended odour emission factors per animal applicable to this project, based on a crude protein content of the feed of 16% (30% reduction) and the frequent removal of slurry (additional 12.5% reduction).

Table 7: Final Odour Emission Factors accounting for Mitigation

Category of Animal	Baseline Emission Factor (ou/s/animal)	Levels after 30% Low Protein Reduction (ou/s/animal)	Levels after Additional 12.5% Frequent Slurry Removal Reduction (ou/s/animal)
Dry Sows*	19	**15.20**	**13.30**
Growers	13.5	**9.45**	**8.27**
Fatteners	22.5	**15.75**	**13.78**
Farrowing Sows	18	**12.60**	**11.03**
Weaners	6	**6**	**4.5**

**Only a 20% reduction for Dry Sows as a result of a low protein diet.*

Table 8 below details the total odour emission rates per shed, based on the emission factors above.

Table 8: Odour Emissions per Building

House No.	No. of Pigs	Odour Emission Factor (ou/s per animal)	Total Odour Emission Factor per Animal Type (ou/s)	Total Odour Emission Rate (ou/s per house)
Shed 1	90 x Dry Sows	15.20	1,368	1,197
Shed 2	130 x Dry Sows	15.20	1,976	1,729
Shed 2.1 (Low Emission)	38 x Farrowing Sows	11.03	419	419
Shed 3	22 x Farrowing Sows	12.60	277.2	277.2
Shed 5	20 x Farrowing Sows	12.60	252.0	252.0
Shed 6	440 x Weaners	6	2,640	2,640
Shed 7	20 x Farrowing Sows	12.60	252.0	252.0
Shed 8	150 x Weaners	6	900.0	900.0
Shed 9	200 x Weaners	6	1,200	1,200
Shed 10	640 x Weaners	6	3,840	3,840
Shed 10.1 (Low Emission)	180 x Weaners	4.5	810.0	810.0
Shed 10.2 (Low Emission)	180 x Weaners	4.5	810.0	810.0
Shed 11	450 x Weaners	6	2,700	2,700

Shed 12	115 x Weaners	6	690.0	690.0
Shed 13	114 x Fatteners	15.75	1,795.5	2,513.7
	76 x Growers	9.45	718.2	
Shed 14	100 x Fatteners	15.75	4,819.5	6,747.3
	204 x Growers	9.45	1,927.8	
Shed 15	100 x Fatteners	15.75	1,575	1,575
Shed 16	180 x Fatteners	15.75	2,835	3,969
	120 x Growers	9.45	1,134	
Shed 17	216 x Fatteners	15.75	3402	4,762.8
	144 x Growers	9.45	1,360.8	
Shed 18	144 x Fatteners	15.75	2268	3,175.2
	96 x Growers	9.45	907.2	
Shed 19	306 x Fatteners	15.75	4,819.5	6,747.3
	204 x Growers	9.45	1,927.8	
Shed 20	114 x Fatteners	15.75	1,795.5	2,513.7
	76 x Growers	9.45	718.2	
Shed A (Low Emission)	180 x Dry Sows	13.30	2,394.8	2,094.8
Shed B (Low Emission)	660 x Fatteners	13.78	9,095.6	12,733.9
	440 x Growers	8.27	3,638.3	

3.2.6 AMMONIA EMISSIONS

As detailed above and further to EPA correspondence to the applicant, only the additional 1,500 production pigs have been included as part of the ammonia assessment.

Table 9 below shows the category of animal and recommended ammonia emission factors per animal applicable to this project, based on a feed crude protein content of 16% (30% reduction) and the frequent removal of slurry (25% reduction).

Table 9: Final Ammonia Emission Factors accounting for Mitigation

Category of Animal	Baseline Ammonia Emissions (kg/yr/animal)	Levels after Reductions (Low Protein) (kg/yr/animal)	Levels after Reductions (Frequent Slurry Removal) (kg/yr/animal)
Growers	1.59	**1.11**	**0.97**
Fatteners	4.14	**2.90**	**2.54**

Table 10 below details the total emission rates per shed, based on the emission factors calculated above. The total emission rates are set as the pollutant leaving the building each second.

Table 10: Ammonia Emissions per Building

House No.	No. of Pigs	Ammonia Emission Factor (kg/yr per animal)	Ammonia Emission Rate (kg/yr per animal type)	Ammonia Emission Rate (kg/yr per house)	Ammonia Emission Rate (g/s per house)
Shed 13	114 x Fatteners	2.90	330.4	415.0	0.0132
	76 x Growers	1.11	84.6		
Shed 14*	20 x Fatteners	2.90	58.0	58.0	0.0018
Shed 20	114 x Fatteners	2.90	330.4	415.0	0.0132
	76 x Growers	1.11	84.6		
Shed B (Low Emission)	660 x Fatteners	2.17	1,434.5	1,801.8	0.0667
	440 x Growers	0.83	367.3		

**Only 20x Fatteners have been included from Shed 14 to account for the 1,500x production pigs included as part of the ammonia assessment.*

3.2.7 STACK EMISSIONS

For the purposes of the modelling process, the emission rate per house was divided by the number of emissions points to obtain the emission value for each source.

Table 11 below shows the emission rates coming out of emission point.

Table 11: Emission Rates for each stack

House No.	No of Fans (and type)	Odour per fan (ou/s)	Ammonia per fan (g/s)*
Shed 1	3 x Ridge A	**456.0**	N/A
Shed 2	6 x Ridge A	**329.3**	N/A
Shed 2.1 (Low Emission)	3 x Ridge A	**139.7**	N/A

Shed 3	6 x Ridge B	46.2	N/A
Shed 5	5 x Ridge B	50.4	N/A
Shed 6	1 x Ridge B	2,640	N/A
Shed 7	3 x Ridge A	84.0	N/A
Shed 8	1 x Line Source	900.0	N/A
Shed 9	2 x Ridge B	600.0	N/A
Shed 10	6 x Ridge A	640.0	N/A
Shed 10.1 (Low Emission)	6 x Ridge A	135.0	N/A
Shed 10.2 (Low Emission)	6 x Ridge A	135.0	N/A
Shed 11	5 x Ridge A	540.0	N/A
Shed 12	2 x Ridge A	345.0	N/A
Shed 13	2 x Ridge A	1256.9	0.0066
Shed 14	5 x Ridge A	1349.5	0.0004
Shed 15	4 x Ridge A	393.8	N/A
Shed 16	1 x Line Source	3,969.0	N/A
Shed 17	1 x Line Source	4,762.8	N/A
Shed 18	1 x Line Source	3,175.2	N/A
Shed 19	5 x Ridge A	1349.5	N/A
Shed 20	2 x Ridge A	1256.9	0.0066
Shed A (Low Emission)	12 x Ridge A	199.5	N/A
Shed B (Low Emission)	24 x Ridge C	530.6	0.0028

**Only Sheds 13, 14, 20 and B are applicable for the ammonia assessment.*

The ventilation rates for the chosen fan type are detailed below in Table 12.

3.2.8 STACK EMISSIONS VELOCITY

Table 12 below shows the ventilation rates for the chosen fan types.

Table 12: Emission Rates for each stack

Extract	Stack Diameter (m)	Cross Sectional Area (m^2)	Exit Velocity (m/s)	Volume Flow (m^3/s)	Volume Flow (m^3/hr)
Ridge A	0.63	0.312	9.81	3.06	11,000
Ridge B	0.45	0.159	10.31	1.64	5,900
Ridge C	0.71	0.396	9.97	3.94	14,200

3.3 Meteorological Data

For this assessment, five years' worth of meteorological data (2016 – 2020) has been derived from the three-dimensional Weather Research and Forecasting (WRF) mesoscale model. The data has been generated from a nested domain area centered on the Shannon Airport meteorological site at a grid resolution of 4 km.

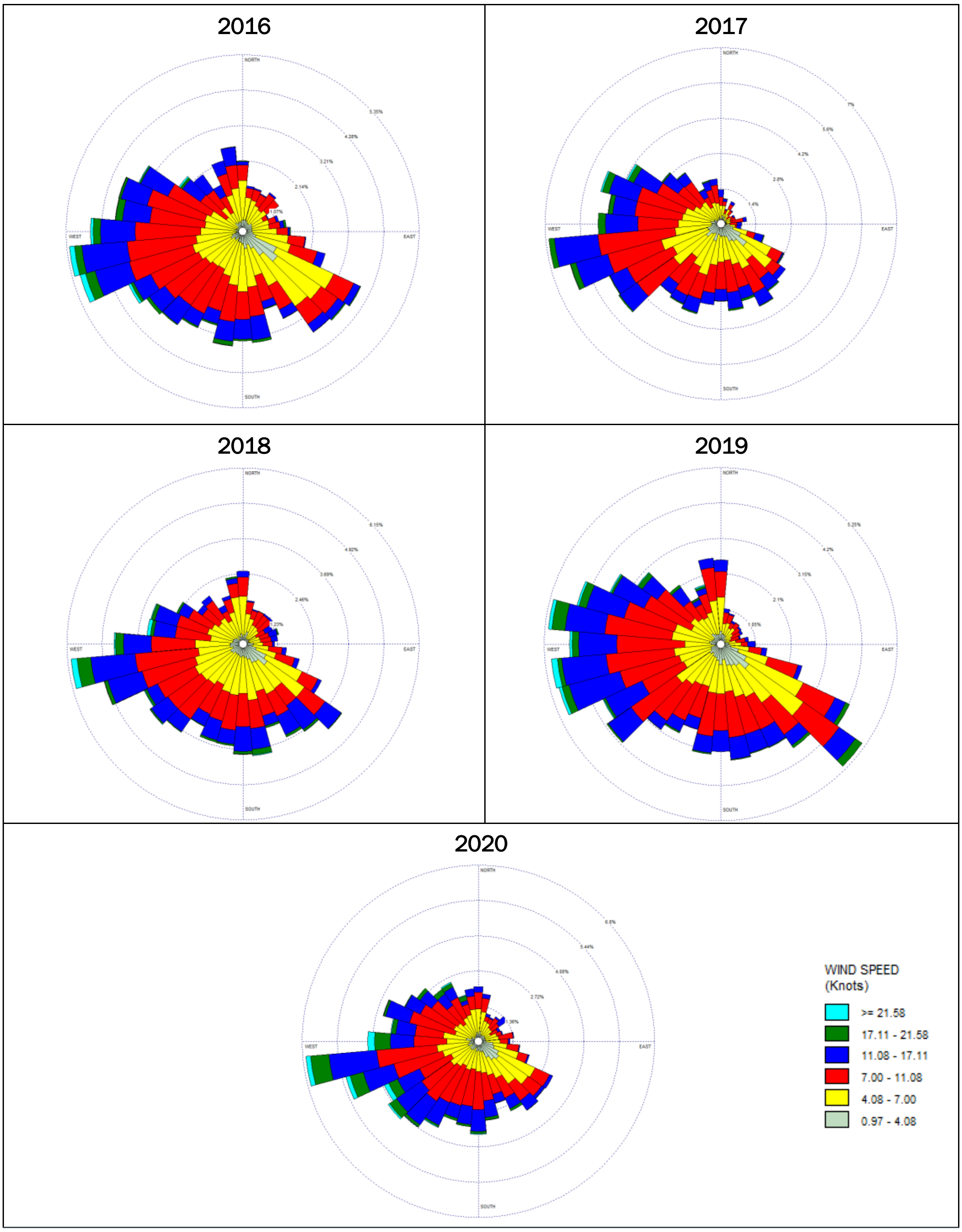
The corresponding meteorological datasets for the assessment have been acquired from Lakes Environmental who utilise the WRF model, a mesoscale numerical weather prediction system designed for both atmospheric research and operational forecasting applications to generate a representative, high resolution meteorological dataset suitable for use within AERMOD. The model is used globally to simulate weather conditions by drawing from observations and archived climatological model data and objective analysis to generate gridded meteorological parameters horizontally and vertically for a region.

Lake Environmental then employ the Mesoscale Model Interface Program (MMIF) to convert the prognostic WRF meteorological model output to AERMET pre-processor data input format prior to use within AERMOD.

Surface roughness of the files was updated and is confirmed as grassland, which is the dominant land type around the site.

The associated wind rose plots derived for each individual year are presented in Figure 1 below.

Figure 1: Annual Windrose Data- Shannon Airport



3.4 Building Downwash

When one or more buildings in the vicinity of a point source interrupt wind flow, an area of turbulence known as a building wake is created. Pollutants emitted from a relatively low level can be caught in this turbulence, affecting their dispersion. This phenomenon is called building downwash. In order to conduct an analysis of downwash effects of the point sources created to mimic the release of odorous air from the pig farm, the dimensions (including heights) of the pig houses and other existing buildings on-site was obtained from drawings.

3.5 Digital Terrain Data

AERMOD contains a terrain data pre-processor called AERMAP. Receptor and source elevation data from AERMAP output is formatted for direct insertion into an AERMOD control file. The elevation data are used by AERMOD when calculating air pollutant concentrations.

Regulatory dispersion models applicable for simple to complex terrain situations require information about the surrounding terrain. With the assumption that terrain will affect air quality concentrations at individual receptors, AERMAP first determines the base elevation at each receptor and source. For complex terrain situations, AERMOD captures the essential physics of dispersion in complex terrain and therefore needs elevation data that convey the features of the surrounding terrain. In response to this need, AERMAP searches for the terrain height and location that has the greatest influence on dispersion for each individual receptor. This height is the referred to as the hill height scale. Both the base elevation and hill height scale data are produced by AERMAP as a file or files which can be directly inserted into an AERMOD input control file.

4 RESULTS

There are four residential properties in the immediate vicinity of the pig sheds. A brief description of each location is provided below, along with the co-ordinates and approximate distance to the nearest pig shed.

Table 13: Nearest Residential Properties

Location	Description*	ING Grid Co-ordinates		Approx. distance to pig shed (m)
H1	Property to the North-East	197819	106918	615
H2	Property to the South-East	198154	105857	1,160
H3	Property to the South-West	196305	105854	1,160
H4	Property to the West	196661	106578	480

**While the property addresses could not be identified, the exact co-ordinates used in the modelling process are provided in the Table above, and all of the properties are shown in the figure in Appendix A.*

4.1 Odour

Odour modelling was carried out for each individual year with the results at the nearest sensitive locations presented in Table 14. All results are the odour concentration in (ou/m^3).

Table 14: 98th Percentile of the max 1-hr odour levels at nearest residential properties

Location	2016	2017	2018	2019	2020	Average
H1	0.50	0.64	0.59	0.44	0.47	**0.53**
H2	0.14	0.17	0.14	0.16	0.16	**0.16**
H3	0.15	0.11	0.14	0.11	0.14	**0.13**
H4	0.64	0.36	0.47	0.43	0.66	**0.51**

For the site layout, it can be seen from the Table above that there is no exceedance of the 5ou/m^3 in each of the 5 years, or when considered as a 5-year average at all of the receptors in the vicinity of the sheds.

5 AMMONIA RESULTS

The ammonia levels were assessed in areas of specific interest in relation to vegetation.

It is noted within Section 3.2.3 of the Environment, Heritage and Local Government Guidance document[8] that as part of the screening for an appropriate assessment, Natura 2000 sites within a distance of 15km from plans should be assessed, however for projects this distance could be much less than 15km.

As this application is considered a project (as defined by Section 5.3 of the Guidance document) and given the nature, size, and location of the project, only sites within a 7.5km distance have been included. Furthermore, this detailed modelling is not considered to be screening and therefore the distance utilised in this report is less than that included in the Guidance.

All areas within approximately 7.5km of the site were searched on the EPA website for the four types of designated areas listed below:

- Special Areas of Conservation (SAC)

  These areas are given special protection under the European Union's Habitats Directive to protect some of the most seriously threatened habitats and species across Europe.

- Special Protection Areas (SPA)

  Areas designated under the European Commission on the conservation of wild birds (the Birds Directive). All EU member states are required to identify internationally important areas for breeding, over-wintering and migrating birds and designate them as SPA's.

- Natural Heritage Area (NHA)

  This is an area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection.

- Proposed Natural Heritage Area (pNHAs)

  These proposed sites are of significance for wildlife and habitats. The pNHAs cover approximately 65,000ha and designation will proceed on a phased basis over the coming years.

There were five designated sites located within 7.5km of the pig sheds which are shown in Table 15 below.

Table 15: Designated areas in vicinity of the site

Location	Description	Approx. distance to shed (km)	ING Grid Co-ordinates	
E1	Blackwater River (Cork/Waterford) (SAC)	2.73	194581	106013
E2	Lower River Suir (SAC)	6.47	196047	112946
E3	Blackwater Callows (SPA)	7.03	196007	99666
E4	Glenmore Wood (NHA)	5.43	199373	101596
E5	Blackwater River Callows (NHA)	7.11	196978	099480
E6	Blackwater River (Cork/Waterford) (SAC) (South)	5.43	199371	101590

Two locations were included for 'Blackwater River (Cork/Waterford) (SAC) to account for the closest point of that receptor in two directions. Ammonia modelling was carried out for each individual year with the results at the nearest identified locations presented in Table 16 below. All results are the Ammonia concentration in μg/m^3.

[8] *Appropriate Assessment of Plans and Projects in Ireland. Guidance for Planning Authorities. Environment, Heritage and Local Government. 10 December 2009.*

Table 16: Annual Average Ammonia Concentrations from Pig Sheds

Location	2016	2017	2018	2019	2020	Average
E1	0.0113	0.0065	0.0075	0.0064	0.0089	**0.0081**
E2	0.0034	0.0034	0.0038	0.0041	0.0027	**0.0035**
E3	0.0026	0.0024	0.0026	0.0023	0.0033	**0.0026**
E4	0.0038	0.0038	0.0032	0.0033	0.0032	**0.0035**
E5	0.0031	0.0025	0.0026	0.0027	0.0028	**0.0027**
E6	0.0038	0.0038	0.0032	0.0033	0.0032	**0.0035**

All of the predicted Ground Level Concentrations of ammonia detailed in the Table above are significantly below the limit values as provided in Table 2 in relation to the protection of vegetation.

Table 17 below compares the highest annual average predicted levels from the site at the designated areas where:

- The Process contribution (PC), the maximum modelled concentration of the substance due to process emissions alone.
- Predicted Environmental Concentration (PEC) – that is, the maximum modelled concentration (of ammonia) due to process emissions combined with estimated baseline concentrations.
- PC and PEC as a percentage of the objective or guideline.

For the assessment of annual mean concentrations, the annual mean contribution of the process can be added to the annual mean estimate for background.

Table 17: Ammonia concentration at EPA designated ecologically sensitive location from pig sheds

	Location	Guideline (µg/m^{-3})	Background (µg/m^{-3})	Highest PC (µg/m^{-3})	PEC (µg/m^{-3})	PC/ Guideline level (%)	PEC/ Guideline level (%)
E1	Blackwater River (Cork/Waterford) (SAC)	3	2.44	0.0113	2.45125	**0.38**	82
E2	Lower River Suir (SAC)	3	2.46	0.0041	2.4641	**0.14**	82
E3	Blackwater Callows (SPA)	3	3.02	0.0033	3.0233	**0.11**	101
E4	Glenmore Wood (NHA)	3	2.26	0.0038	2.2638	**0.13**	75
E5	Blackwater River Callows (NHA)	3	3.02	0.0031	3.0231	**0.10**	101
E6	Blackwater River (Cork/Waterford) (SAC) (South)	1	2.26	0.0038	2.2638	**0.38**	226

The ammonia concentrations at the sites are dominated by the background concentrations, which are approximately 75 – 226% of the air quality guideline for ammonia.

6 NITROGEN DEPOSITION

The Critical Load specifies the annual amount of ammonia that can be deposited for a given area per year. Below this level, sensitive habitat should not be affected.

The dry deposition flux (µg/m²/s of ammonia) was calculated using AQTAG06[9] where the predicted ground level of ammonia (in µg/m³) was multiplied by the relevant deposition velocity.

The dry deposition was then multiplied by the conversion factor provided in the guidance to convert to the levels of kgN/ha/yr. The conversion factors are provided in Table 8.1 and 8.2 of the AQTAG06 as presented in the Table 18 below.

Table 18: Conversion Factors

Pollutant	NH_3 Deposition Velocity (m/s)	Conversion Factor
NH_3 to N	0.02 (short vegetation)	260

Table 19 below converts the highest Process Contribution in µg/m^{-3} to kg.N/ha/yr, using the conversion factors detailed in Table 18 above.

Table 19: Conversion of Highest NH_3 Results (Worst Case)

Location	Pollutant	Highest PC (µg/m^{-3})	NH_3 Deposition Velocity (m/s)	Conversion Factor	Highest PC (kg.N/ha/yr)
E1	NH_3 to N	0.011	0.02 (short vegetation)	260	0.059
E2		0.004			0.021
E3		0.003			0.017
E4		0.004			0.020
E5		0.003			0.016
E6		0.004			0.020

Using similar methodology to the ammonia assessment in Section 5 above the PC and PEC can be seen in Table 20 below.

[9] Technical Guidance on Detailed Modelling Approach for an Appropriate Assessment for Emissions to Air, AQTAG06

Table 20: Nitrogen concentration at designated ecologically sensitive locations

	Location	Guideline (kg N/ha/yr)	Background (kg N/ha/yr)	Highest PC (kg.N/ha/yr)	PEC (kg N/ha/yr)	PC/ Guideline level (%)	PEC/ Guideline level (%)
E1	Blackwater River (Cork/Waterford) (SAC)	10	2.59	0.059	2.65	**0.59**	26
E2	Lower River Suir (SAC)	3	12.78	0.021	12.80	**0.70**	427
E3	Blackwater Callows (SPA)	10	7.95	0.017	7.97	**0.17**	80
E4	Glenmore Wood (NHA)	10	7.26	0.020	7.28	**0.20**	73
E5	Blackwater River Callows (NHA)	10	7.95	0.016	7.97	**0.16**	80
E6	Blackwater River (Cork/Waterford) (SAC) (South)	3	7.26	0.020	7.28	**0.66**	243

It can be seen from Table 20 that the nitrogen concentrations at the sites are dominated by the background concentrations, which are approximately 26 – 427% of the guideline (critical load) for each site.

The PC at all Locations is less than 0.3kg.N/ha/yr, and as a result would be considered deminimus for the purposes of the Nitrogen assessment.

7 CUMULATIVE ASSESSMENT

Within the EPA Guidance[10], specific information is provided in relation to the consideration of Cumulative Impact Assessments. Section 3.2 notes that,

> *'As a first step the applicant/licensee should confirm the background ammonia concentrations and nitrogen deposition levels at the sensitive receptor and indicate whether there is already an exceedance of the ammonia critical level or nitrogen critical load.*
>
> *Where background levels are already exceeded at sensitive receptors, detailed modelling of emissions, including in-combination effects, a Natura Impact Statement (NIS) and additional mitigation measures are likely to be required. This is dependent on the sensitivity of the habitat at the Natura impacted area'.*

Annex 1 of the document shows a flowchart for undertaking a cumulative impact assessment of a nearby industrial installation, which is shown is Figure 2 below.

The following points detail whether or not a cumulative assessment is necessary as part of this assessment, taking account of the flowchart below:

- It is noted that Step 1 of the flowchart states *"Are the background levels already exceeded for the ammonia critical level or nitrogen critical load at Natura sites within the zone of influence? (Go to step 4)*

  It can be seen from Table 20 above that the Critical Levels are already exceeded at two of the Natura 2000 sites (Lower River Suir SAC and Blackwater River (Cork/Waterford) SAC (South), and therefore the assessment continues to Step 4:

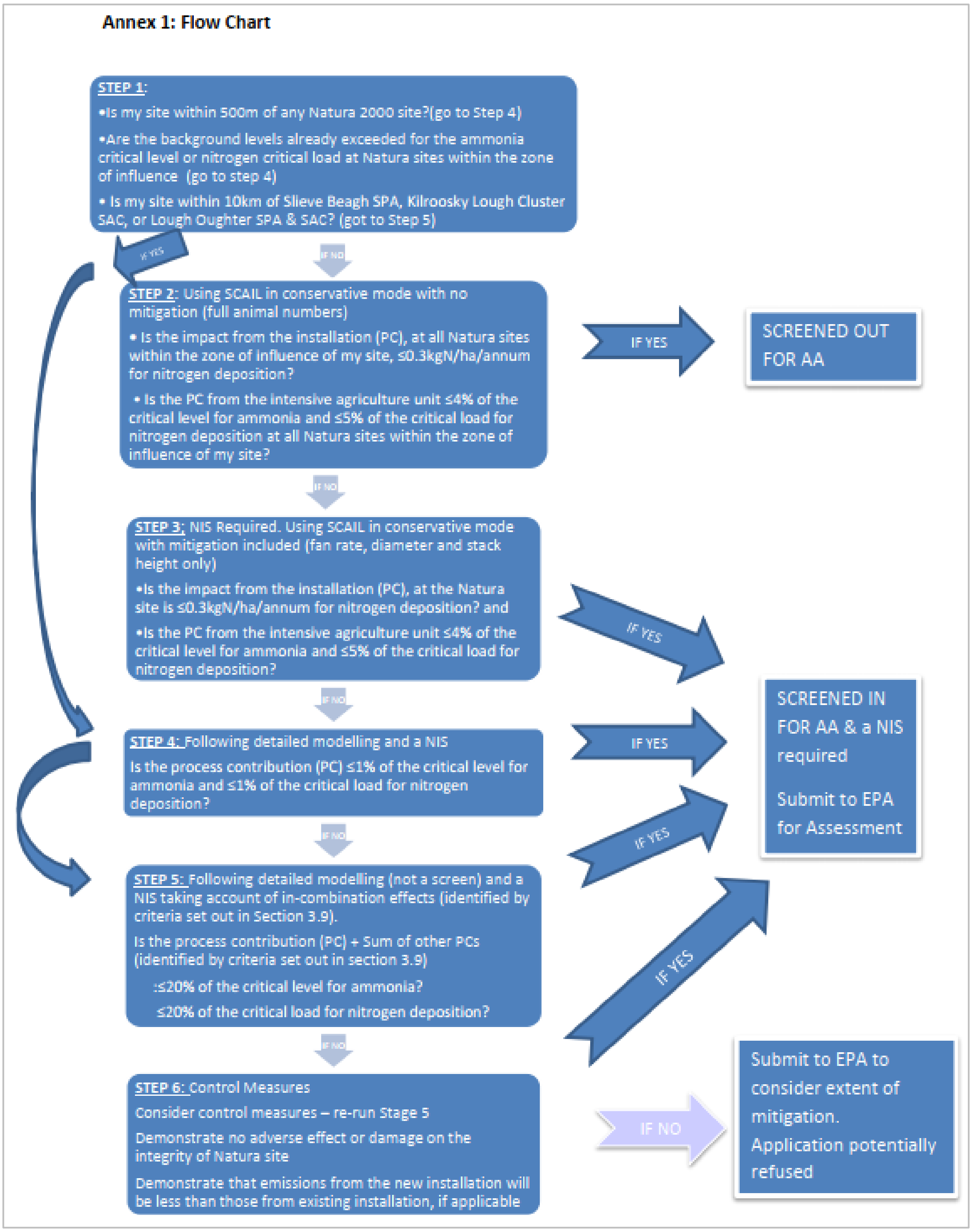
- *'Following detailed modelling and a NIS, is the process contribution (PC) ≤1% of the critical level for ammonia and ≤1% of the critical load for nitrogen deposition?'*

  It can be seen from Table 20 that the total ammonia at both of these Locations is less than 1% and as a result, a cumulative assessment is not required at these locations.

Taking into account the points above, a cumulative/ in-combination assessment is not required for this application.

[10] *Licence Application Guidance. Assessment of the Impact of Ammonia and Nitrogen on Natura 2000 sites from Intensive Agriculture Installations. Environmental Protection Agency (EPA). Version 1.0, May 2021.*

Figure 2: Flowchart for undertaking a Cumulative Assessment of a nearby Industrial Installation.



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8 CONCLUSIONS

An air quality impact assessment has been undertaken for the license of an existing pig farm at Doon Farm Enterprises, Araglin, Co. Tipperary.

The maximum ground level odour concentration is predicted to be primarily confined to the immediate environs of the pig sheds.

Under the site layout, the maximum 98th percentile of 1-hour ground level odour concentration at the worst effected residential property with no interest in the operation of the pig farm, in the vicinity of the site is in accordance with the target limit value for of $\leq 5ou_E/m^3$ when taken as an average of the 5-year period.

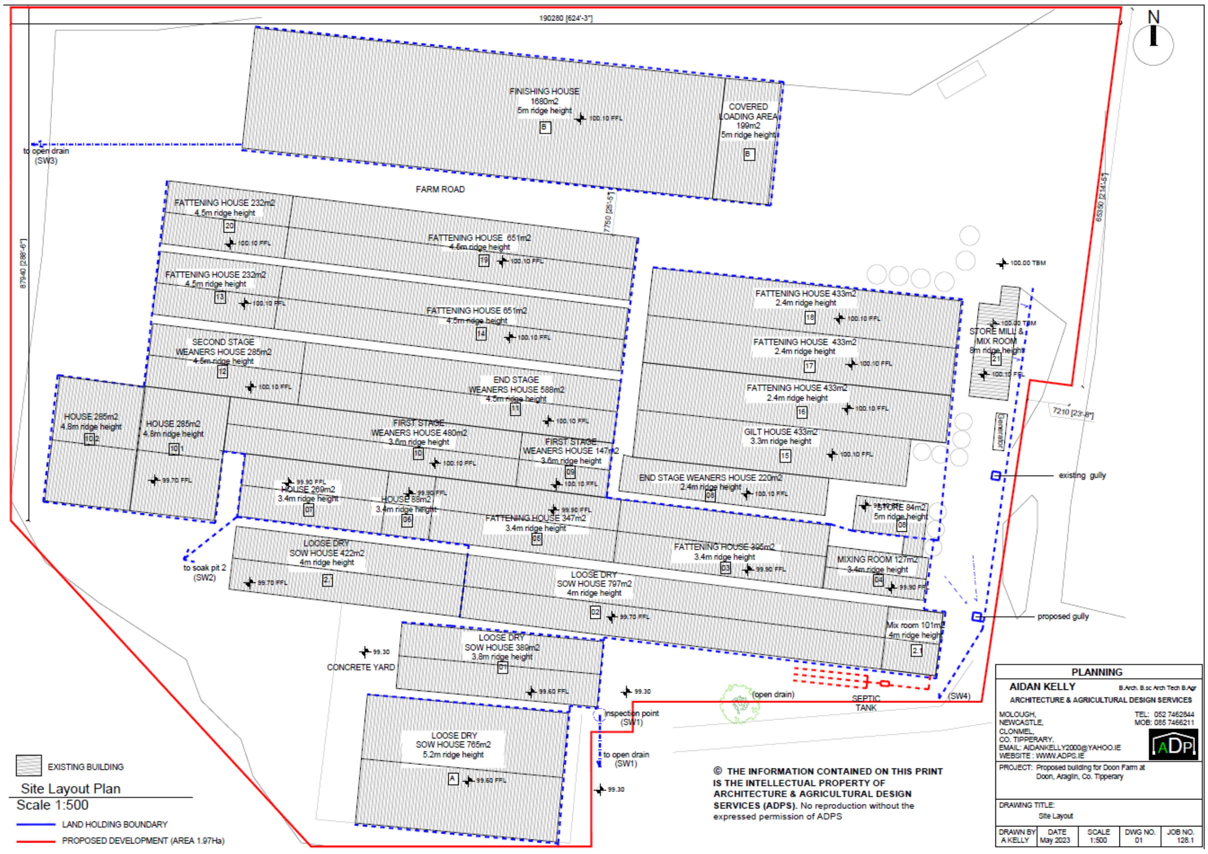
The predicted results of the ammonia modelling process show that the emissions of each pollutant from the pig sheds will not cause significant Ground Level Concentrations at any residential property in the vicinity of the shed.

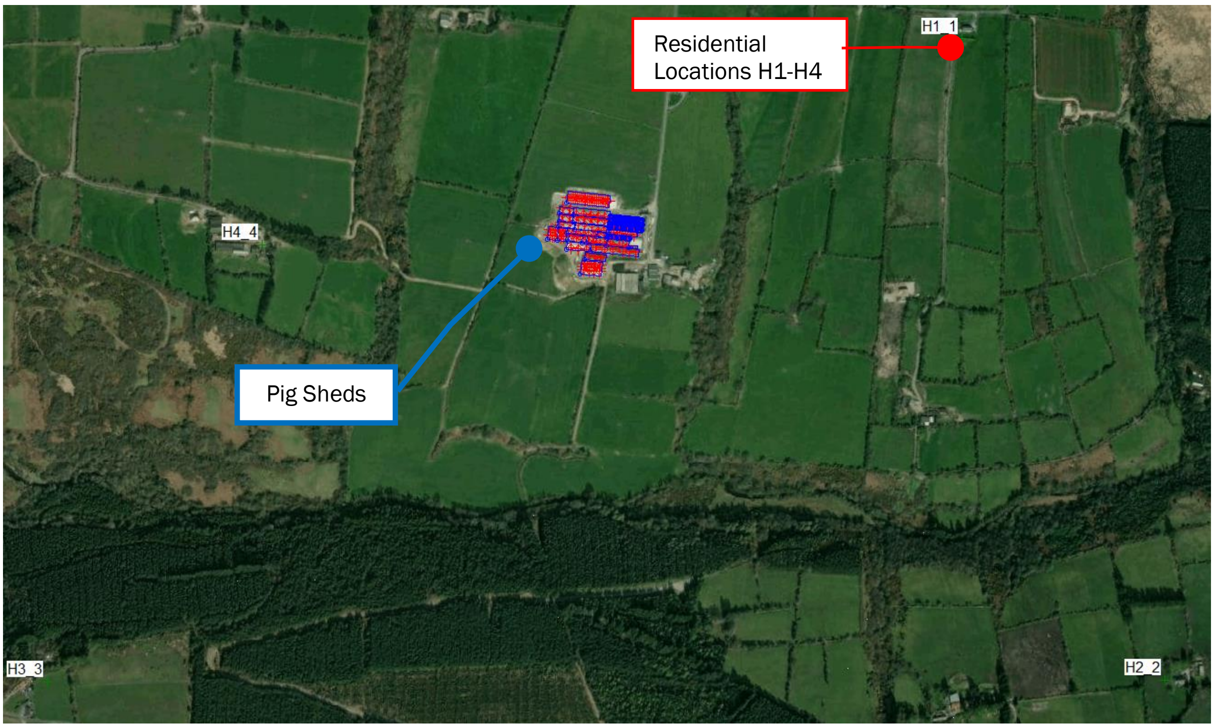
In addition, it can be shown that the limits for the protection of vegetation are not exceeded at any designated habitats within the vicinity of the pig sheds. Thus, any areas of ecological interest will not be adversely affected from the ammonia emissions for the operation of the shed.

It is expected that the typical operation of the site will result in lower predicted odour, ammonia and nitrogen impacts at the closest sensitive receptors than the worst case results presented in this report.

Appendix C indicates the predicted dispersion of the odour and ammonia plumes for 2020 for the site.

APPENDIX A SITE LAYOUT





***Note- The above diagram is not to scale and is for illustrative purposes only. Exact co-ordinates are given in Table 19 and 22 above.*

APPENDIX B SOURCE AND RECEPTOR LOCATIONS

The information below details the AERMOD model inputs, specifically in relation to source locations, building inputs and grid receptor inputs.

Table 21: Receptor Locations

Receptor Location	Irish Grid Co-ordinates	
H1	197819	106918
H2	198154	105857
H3	196305	105854
H4	196661	106578

Table 22: Building Location

Building Number	ING Co-ordinates (SW Corner)	
Shed 1	197195	106554
Shed 2	197204	106567
Shed 2.1 (Low Emission)	197164	106571
Shed 3	197231	106577
Shed 5	197198	106581
Shed 6	197190	106582
Shed 7	197167	106584
Shed 8	197232	106589
Shed 9	197215	106591
Shed 10	197165	106597
Shed 10.1 (Low Emission)	197149	106585
Shed 10.2 (Low Emission)	197133	106587
Shed 11	197178	106604
Shed 12	197150	106607
Shed 13	197152	106618
Shed 14	197195	106616
Shed 15	197235	106596
Shed 16	197235	106604
Shed 17	197236	106611
Shed 18	197237	106620
Shed 19	197176	106627
Shed 20	197153	106630
Shed A (Low Emission)	197187	106530
Shed B (Low Emission)	197165	106647

Table 23: Source Locations

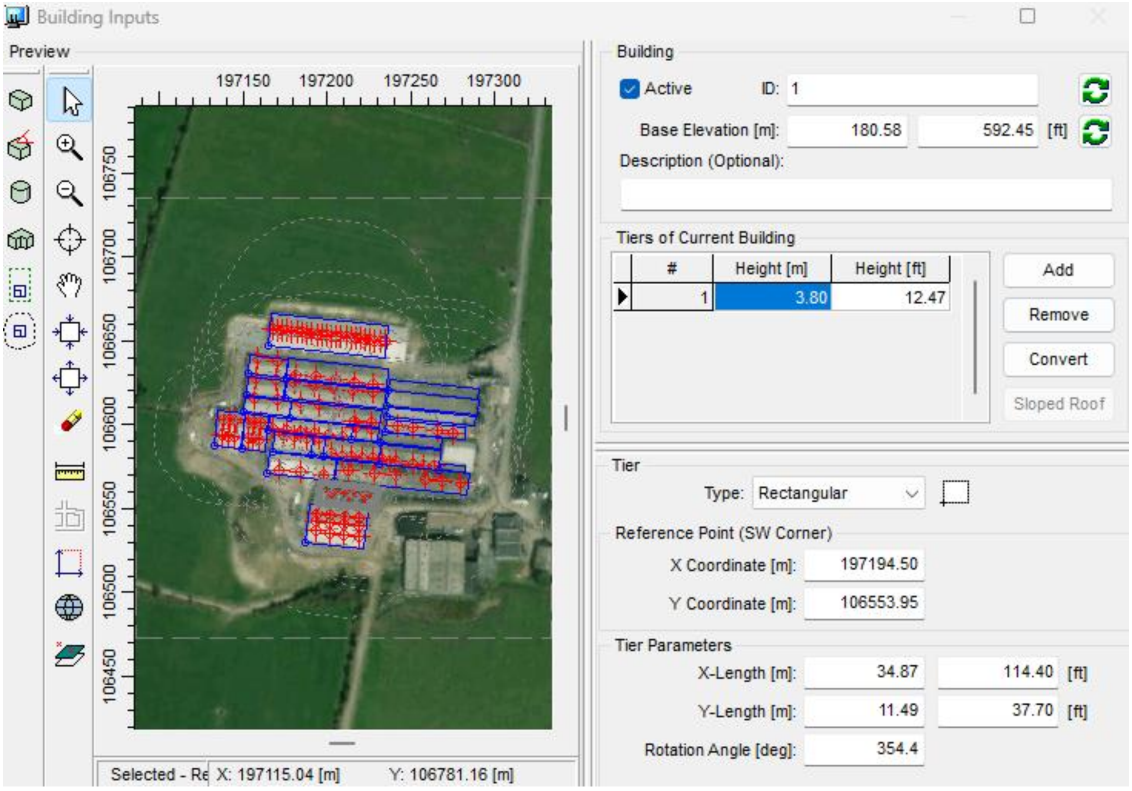
Building Number	Source	Release Height (m)	Approx. ING Co-ordinates (to the nearest 1m)	
Shed 1	1	4.6m	197203	106560
	2		197213	106559
	3		197222	106557
Shed 2	1	4.8m	197212	106573
	2		197228	106571
	3		197241	106570
	4		197258	106568
	5		197268	106567
	6		197279	106566
Shed 2.1 (Low Emission)	1	4.8m	197171	106573
	2		197184	106572
	3		197198	106570
Shed 3	1	4.2m	197233	106579
	2		197237	106579
	3		197241	106578
	4		197251	106577
	5		197258	106576
	6		197264	106576
Shed 5	1	3.4m	197203	106583
	2		197209	106581
	3		197215	106581
	4		197221	106580
	5		197227	106580
Shed 6	1	4.2m	197195	106592
Shed 7	1	4.2m	197174	106594
	2		197181	106593
	3		197187	106592
Shed 8	Line Source (Start)	2.4m	197232	106592
	Line Source (End)		197268	106589
Shed 9	1	4.4m	197218	106599
	2		197226	106598
Shed 10	1	4.4m	197168	106598
	2		197176	106596

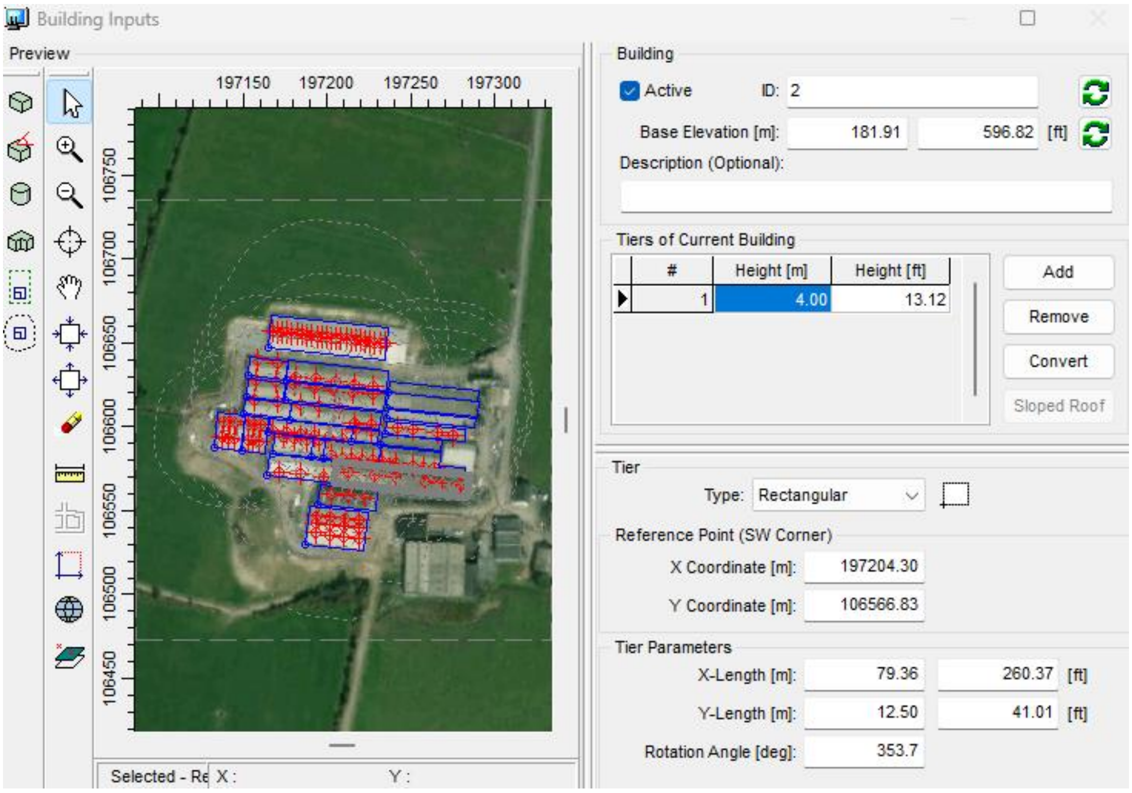
Building Number	Source	Release Height (m)	Approx. ING Co-ordinates (to the nearest 1m)	
	3		197184	106596
	4		197192	106595
	5		197201	106594
	6		197209	106593
Shed 10.1 (Low Emission)	1	5.6m	197153	106602
	2		197157	106601
	3		197160	106601
	4		197153	106592
	5		197156	106592
	6		197159	106591
Shed 10.2 (Low Emission)	1	5.6m	197139	106603
	2		197142	106603
	3		197146	106603
	4		197138	106594
	5		197142	106593
	6		197145	106593
Shed 11	1	5.3m	197226	106601
	2		197217	106602
	3		197184	106613
	4		197195	106612
	5		197207	106611
Shed 12	1	5.3m	197157	106616
	2		197170	106615
Shed 13	1	5.3m	197158	106628
	2		197169	106627
Shed 14	1	5.3m	197180	106625
	2		197192	106623
	3		197204	106622
	4		197216	106621
	5		197227	106619
Shed 15	1	4.1m	197242	106599
	2		197251	106598
	3		197265	106596
	4		197275	106595

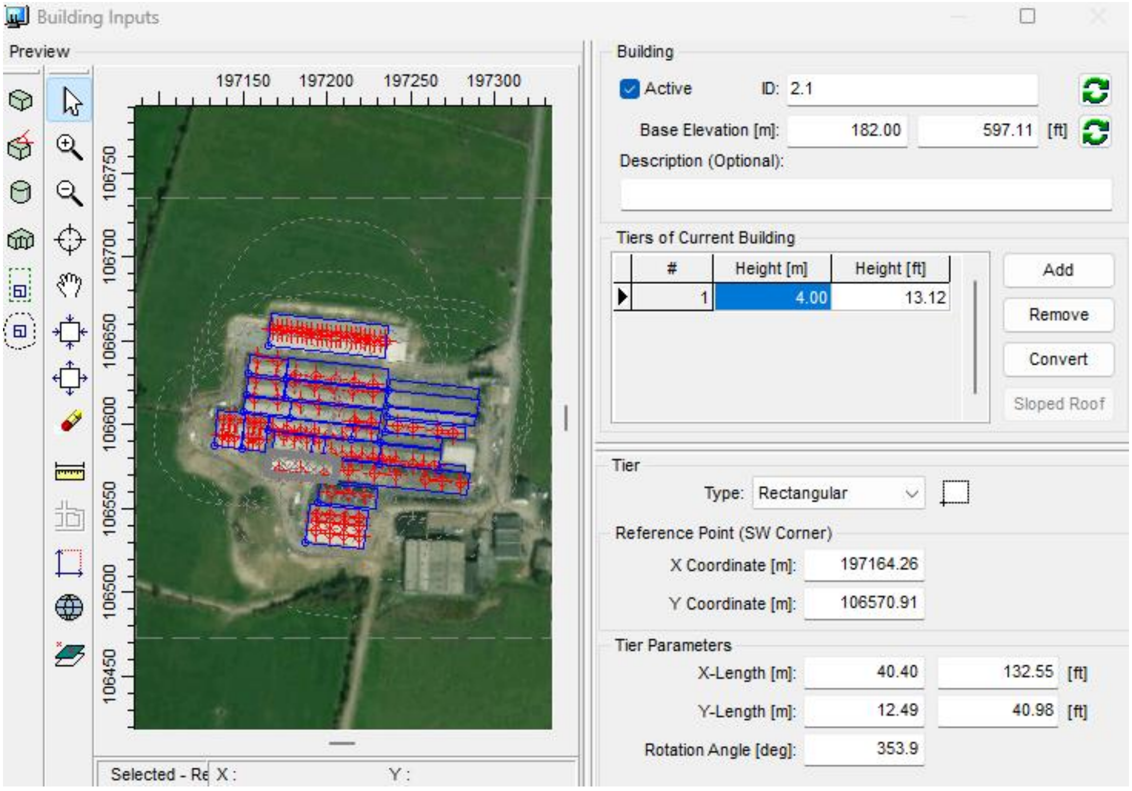
Building Number	Source	Release Height (m)	Approx. ING Co-ordinates (to the nearest 1m)	
Shed 16	Line Source (Start)	2.4m	197236	106607
	Line Source (End)		197288	106602
Shed 17	Line Source (Start)	2.4m	197236	106616
	Line Source (End)		197290	106610
Shed 18	Line Source (Start)	2.4m	197237	106624
	Line Source (End)		197290	106619
Shed 19	1	5.3m	197181	106630
	2		197193	106629
	3		197205	106627
	4		197217	106625
	5		197227	106625
Shed 20	1	5.3m	197159	106640
	2		197171	106638
Shed A (Low Emission)	1	6.0m	197194	106547
	2		197202	106546
	3		197211	106545
	4		197219	106544
	5		197193	106542
	6		197202	106541
	7		197210	106540
	8		197219	106539
	9		197193	106537
	10		197201	106536
	11		197210	106535
	12		197219	106534
Shed B (Low Emission)	1	5.8m	197168	106657
	2		197171	106657
	3		197174	106656
	4		197176	106656
	5		197179	106655
	6		197182	106655
	7		197185	106655
	8		197188	106654
	9		197191	106654

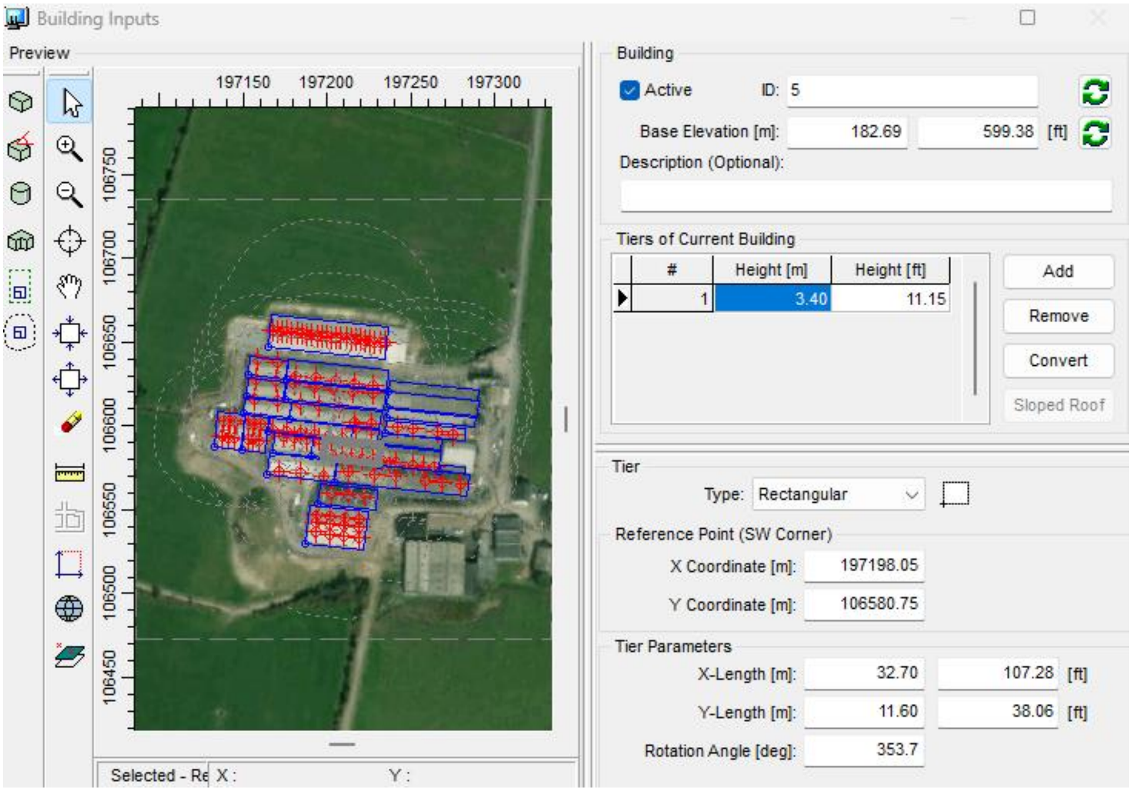
Building Number	Source	Release Height (m)	Approx. ING Co-ordinates (to the nearest 1m)	
	10		197194	106654
	11		197197	106654
	12		197199	106653
	13		197203	106653
	14		197206	106653
	15		197208	106652
	16		197211	106652
	17		197214	106652
	18		197217	106652
	19		197220	106651
	20		197223	106651
	21		197226	106651
	22		197228	106650
	23		197231	106650
	24		197234	106650

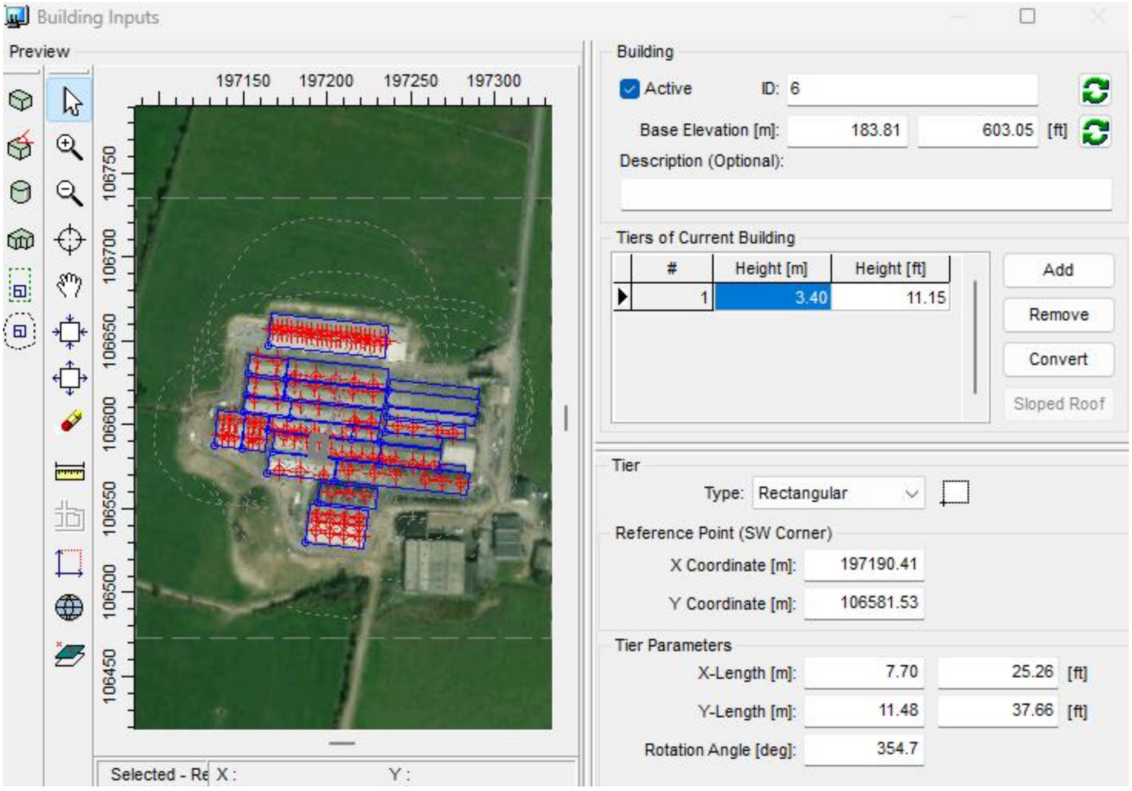
Figure 3: Building Inputs of Sheds

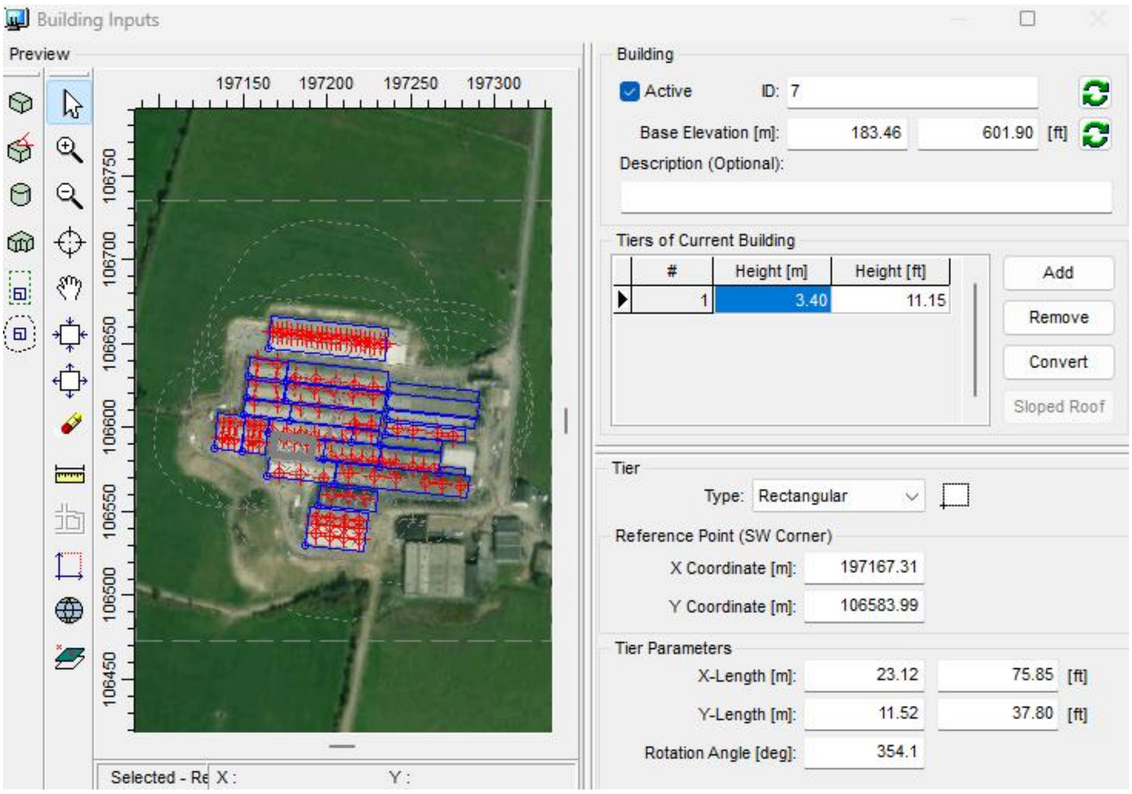


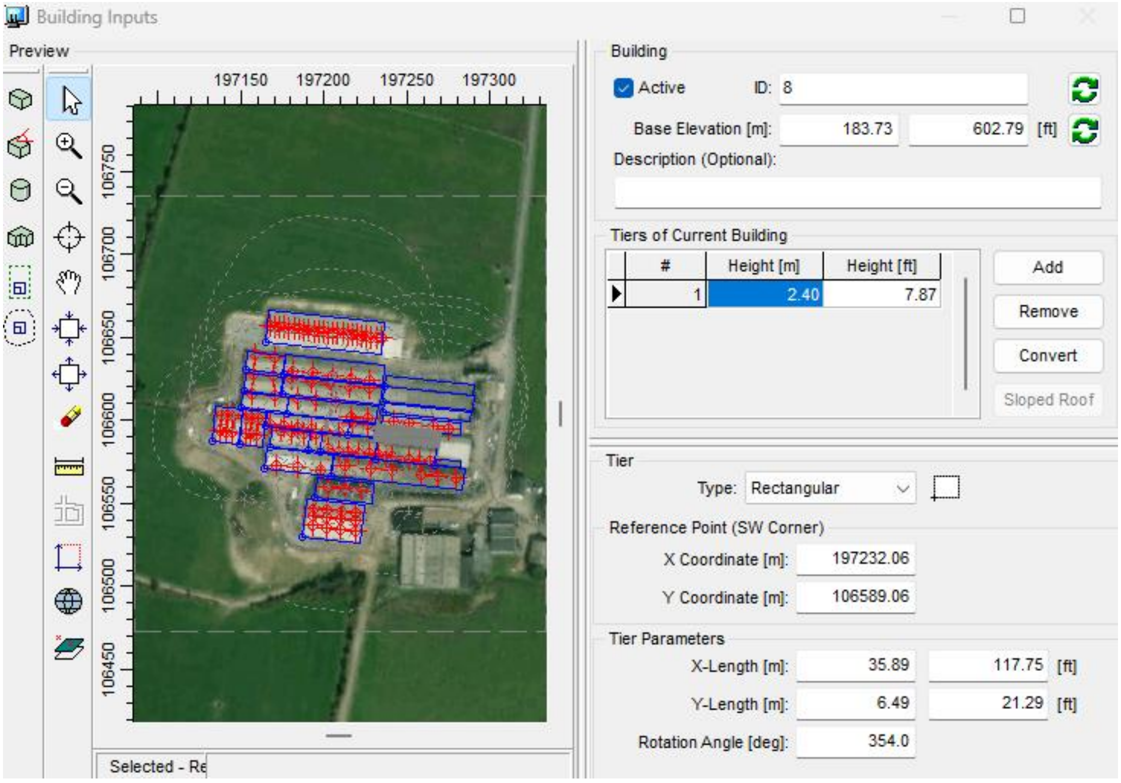


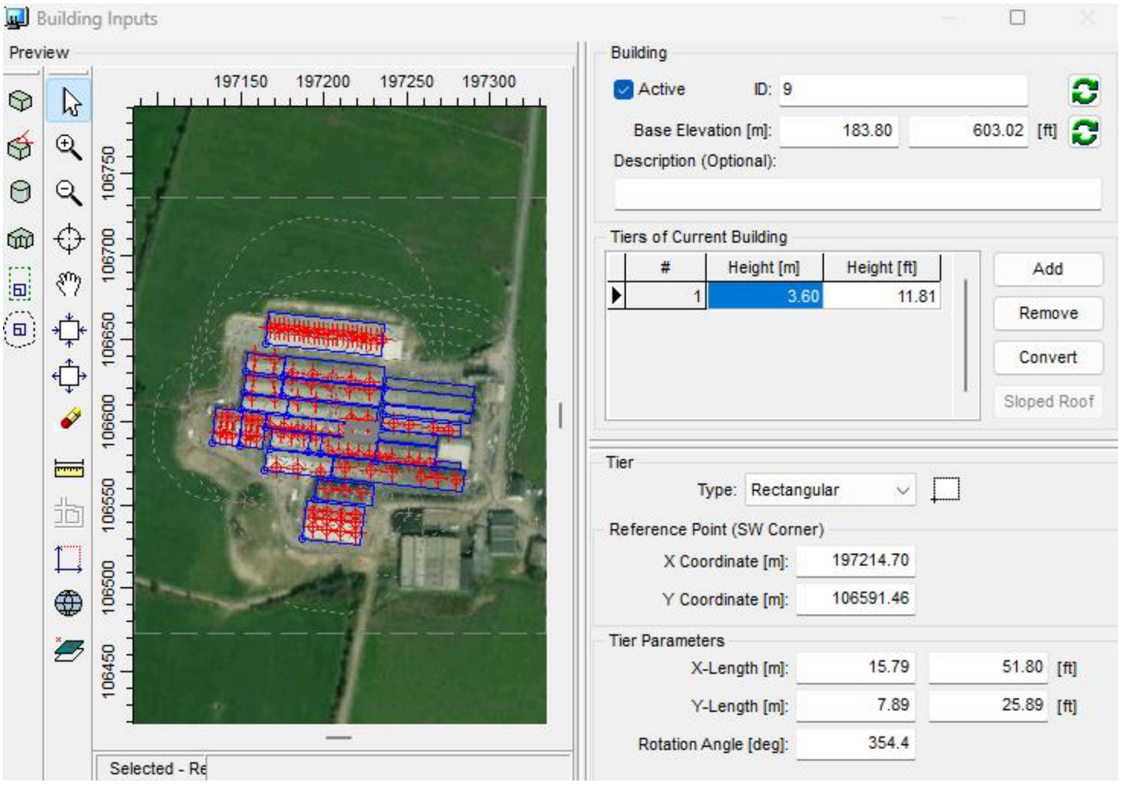

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re X : Y :
Building
Active ID: 2.1
Base Elevation [m]: 182.00 597.11 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.00 13.12
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197164.26
Y Coordinate [m]: 106570.91
Tier Parameters
X-Length [m]: 40.40 132.55 [ft]
Y-Length [m]: 12.49 40.98 [ft]
Rotation Angle [deg]: 353.9

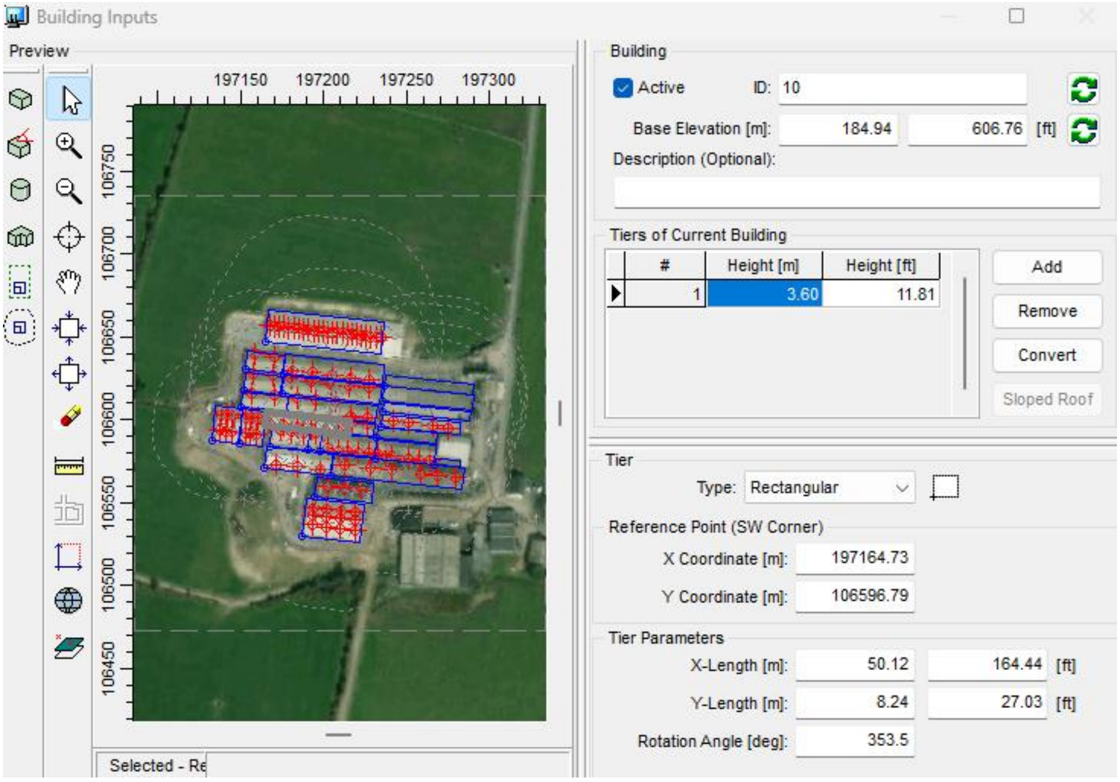

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re X : Y :
Building
Active ID: 5
Base Elevation [m]: 182.69 599.38 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.40 11.15
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197198.05
Y Coordinate [m]: 106580.75
Tier Parameters
X-Length [m]: 32.70 107.28 [ft]
Y-Length [m]: 11.60 38.06 [ft]
Rotation Angle [deg]: 353.7

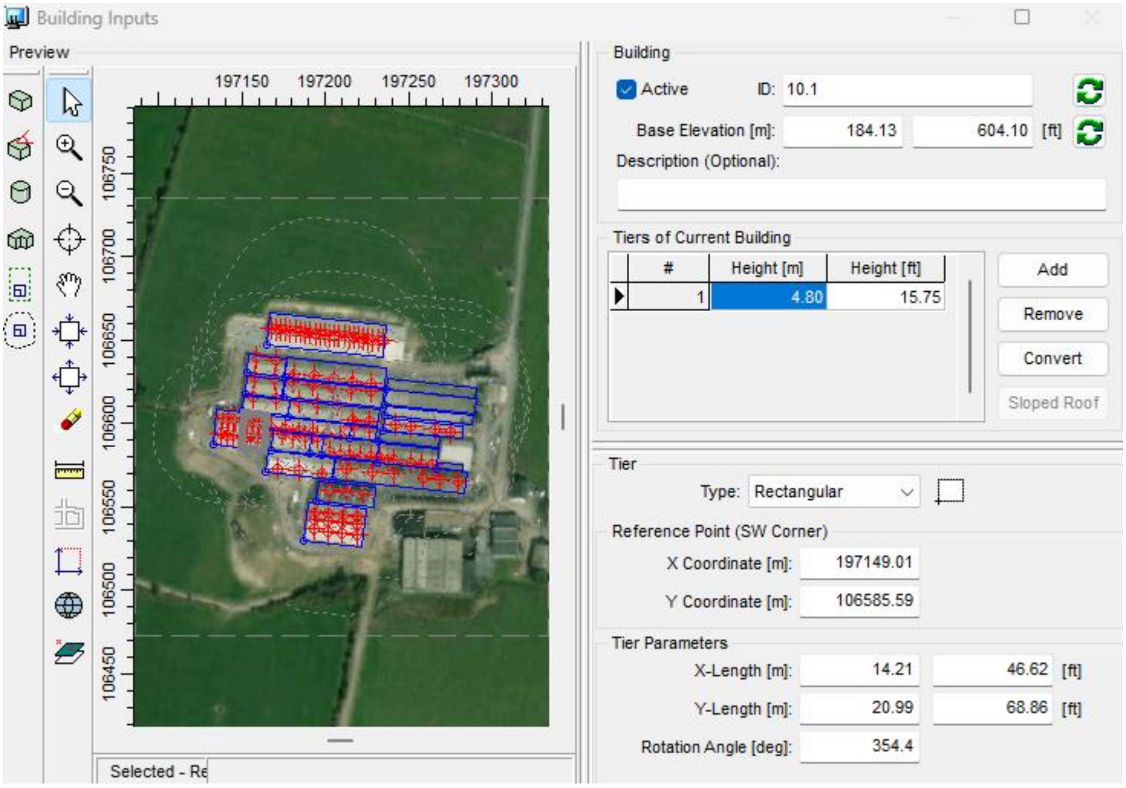

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re X : Y :
Building
Active ID: 6
Base Elevation [m]: 183.81 603.05 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.40 11.15
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197190.41
Y Coordinate [m]: 106581.53
Tier Parameters
X-Length [m]: 7.70 25.26 [ft]
Y-Length [m]: 11.48 37.66 [ft]
Rotation Angle [deg]: 354.7

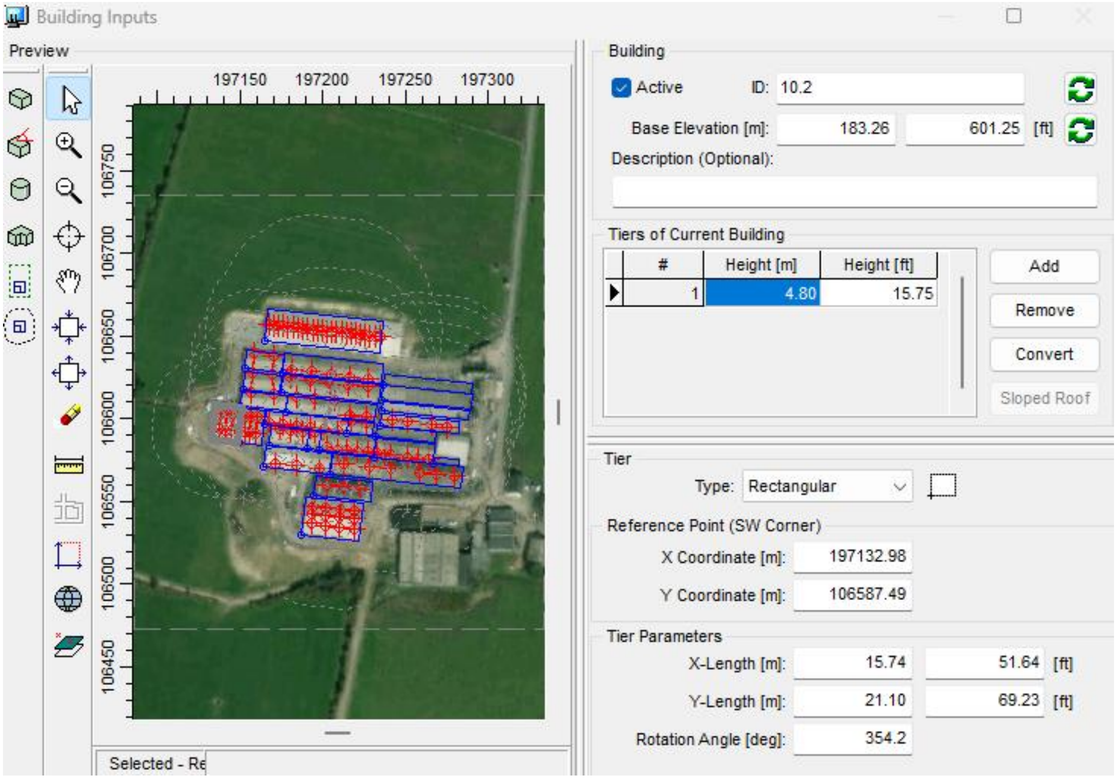

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re X : Y :
Building
Active ID: 7
Base Elevation [m]: 183.46 601.90 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.40 11.15
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197167.31
Y Coordinate [m]: 106583.99
Tier Parameters
X-Length [m]: 23.12 75.85 [ft]
Y-Length [m]: 11.52 37.80 [ft]
Rotation Angle [deg]: 354.1

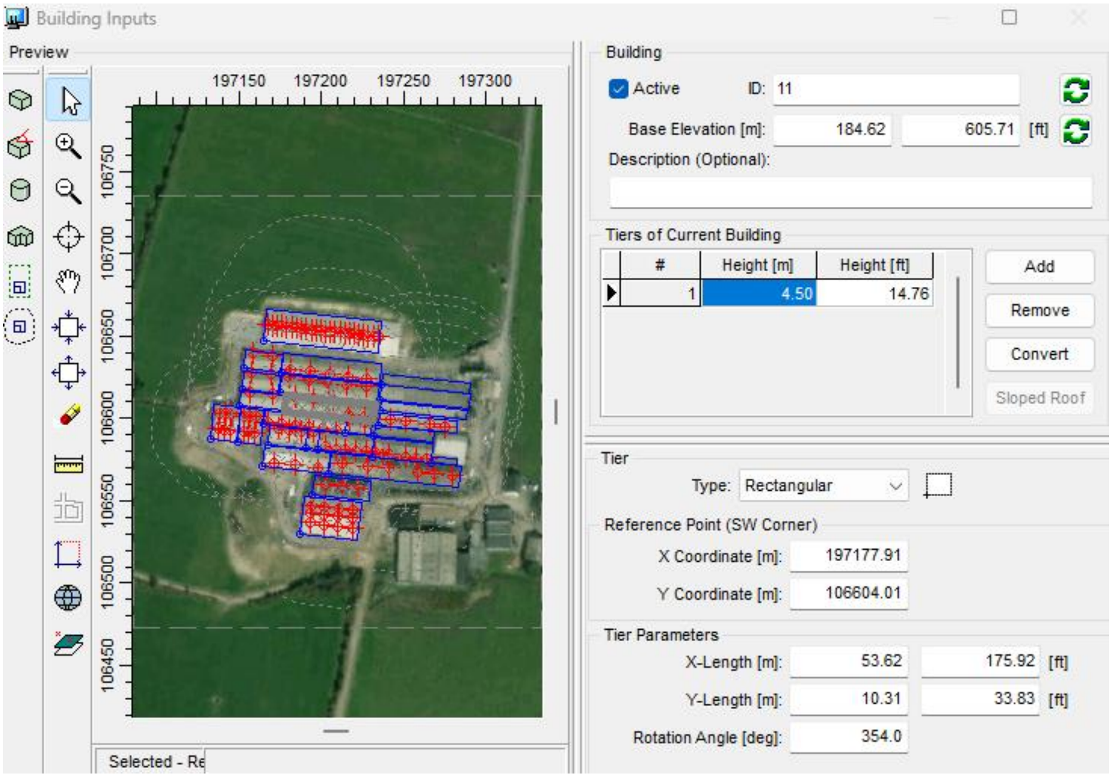

Building Inputs
Preview
Selected - Re
Building
Active
ID: 8
Base Elevation [m]: 183.73 602.79 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 2.40 7.87
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197232.06
Y Coordinate [m]: 106589.06
Tier Parameters
X-Length [m]: 35.89 117.75 [ft]
Y-Length [m]: 6.49 21.29 [ft]
Rotation Angle [deg]: 354.0

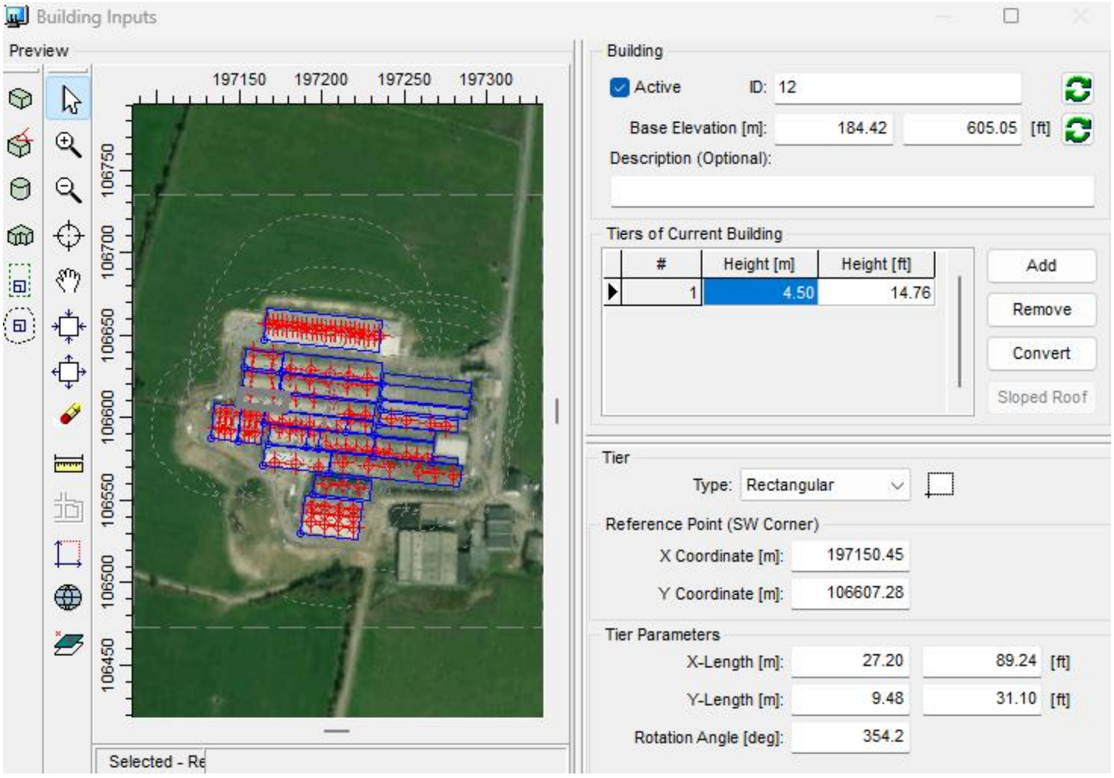

Building Inputs
Preview
Selected - Re
Building
Active
ID: 9
Base Elevation [m]: 183.80 603.02 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.60 11.81
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197214.70
Y Coordinate [m]: 106591.46
Tier Parameters
X-Length [m]: 15.79 51.80 [ft]
Y-Length [m]: 7.89 25.89 [ft]
Rotation Angle [deg]: 354.4

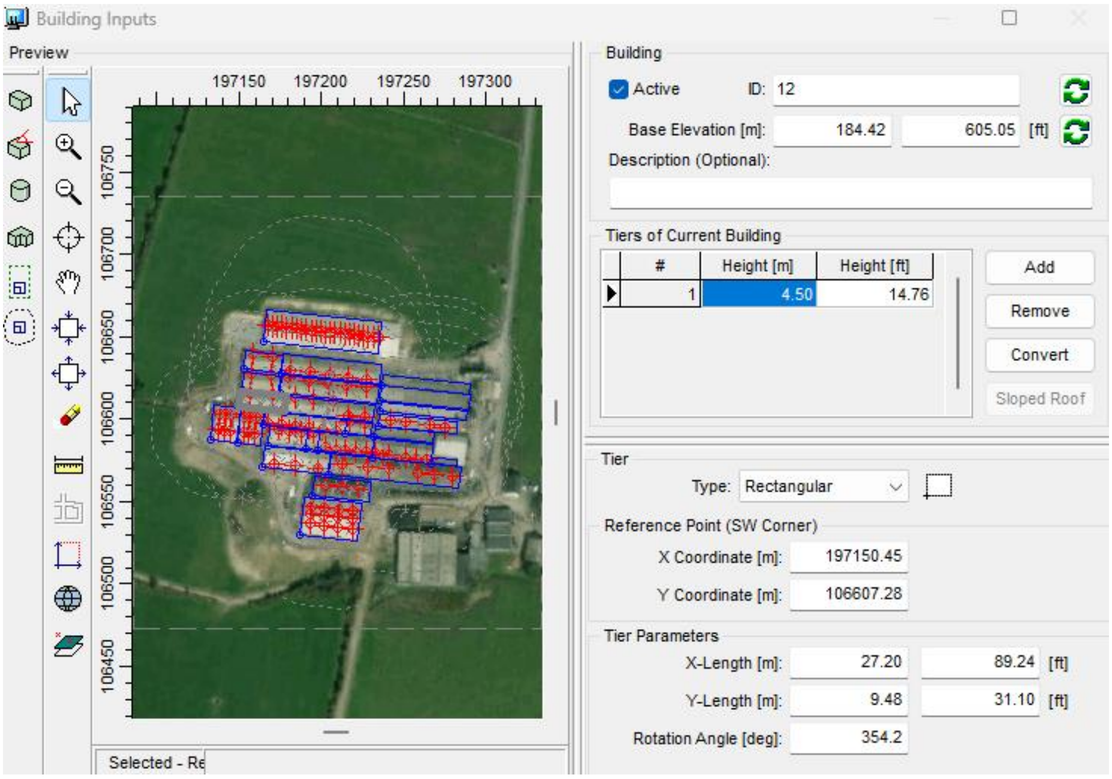

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 10
Base Elevation [m]: 184.94 606.76 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.60 11.81
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197164.73
Y Coordinate [m]: 106596.79
Tier Parameters
X-Length [m]: 50.12 164.44 [ft]
Y-Length [m]: 8.24 27.03 [ft]
Rotation Angle [deg]: 353.5

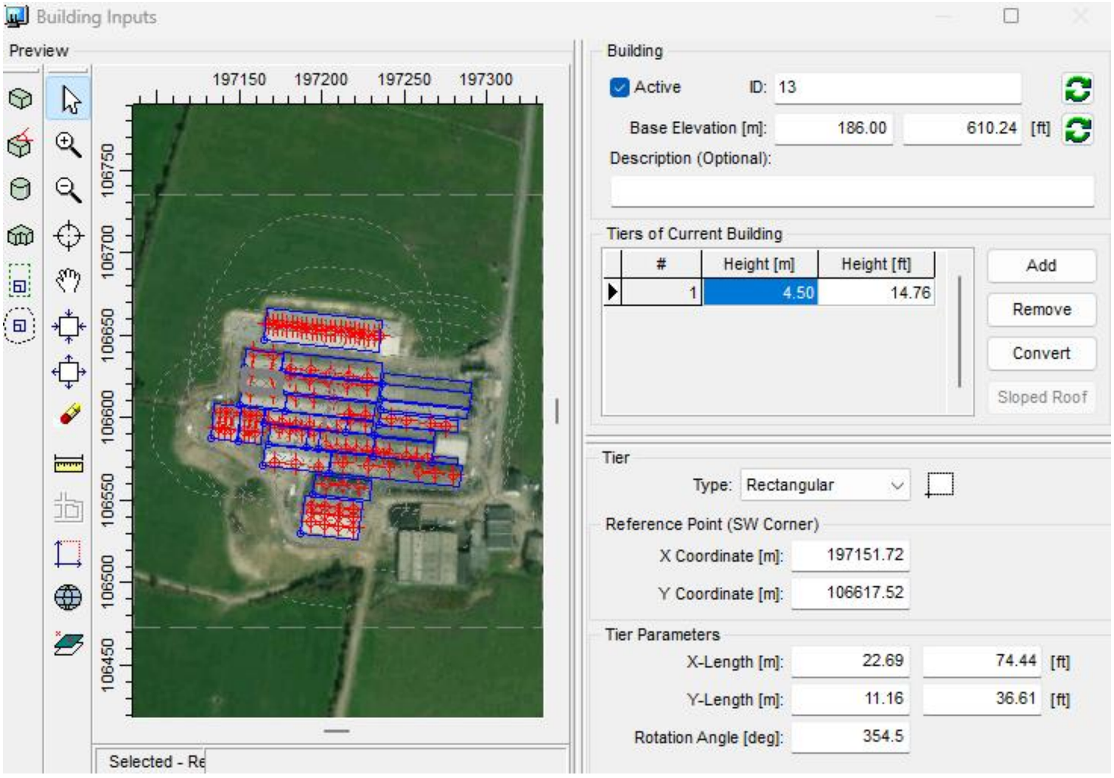

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 10.1
Base Elevation [m]: 184.13 604.10 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.80 15.75
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197149.01
Y Coordinate [m]: 106585.59
Tier Parameters
X-Length [m]: 14.21 46.62 [ft]
Y-Length [m]: 20.99 68.86 [ft]
Rotation Angle [deg]: 354.4

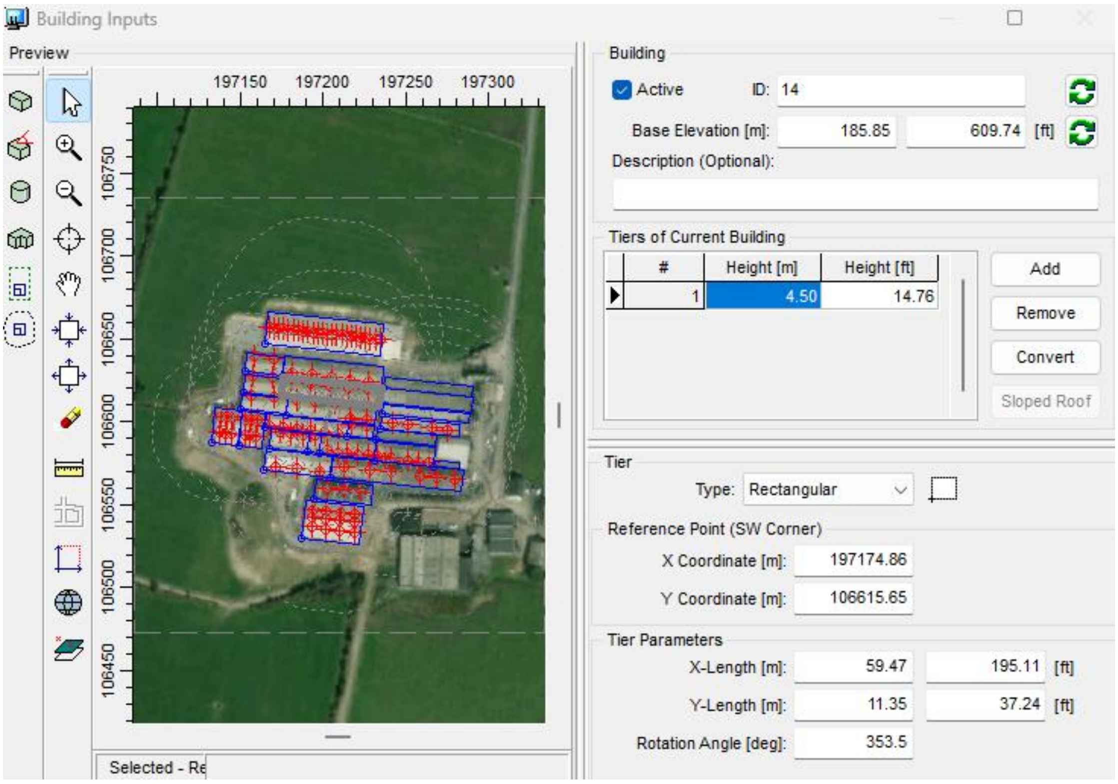

Building Inputs
Preview
197150
197200
197250
197300
106750
106700
106650
106600
106550
106500
106450
Selected - Re
Building
Active
ID: 10.2
Base Elevation [m]:
183.26
601.25
[ft]
Description (Optional):
Tiers of Current Building
#
Height [m]
Height [ft]
1
4.80
15.75
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]:
197132.98
Y Coordinate [m]:
106587.49
Tier Parameters
X-Length [m]:
15.74
51.64
[ft]
Y-Length [m]:
21.10
69.23
[ft]
Rotation Angle [deg]:
354.2

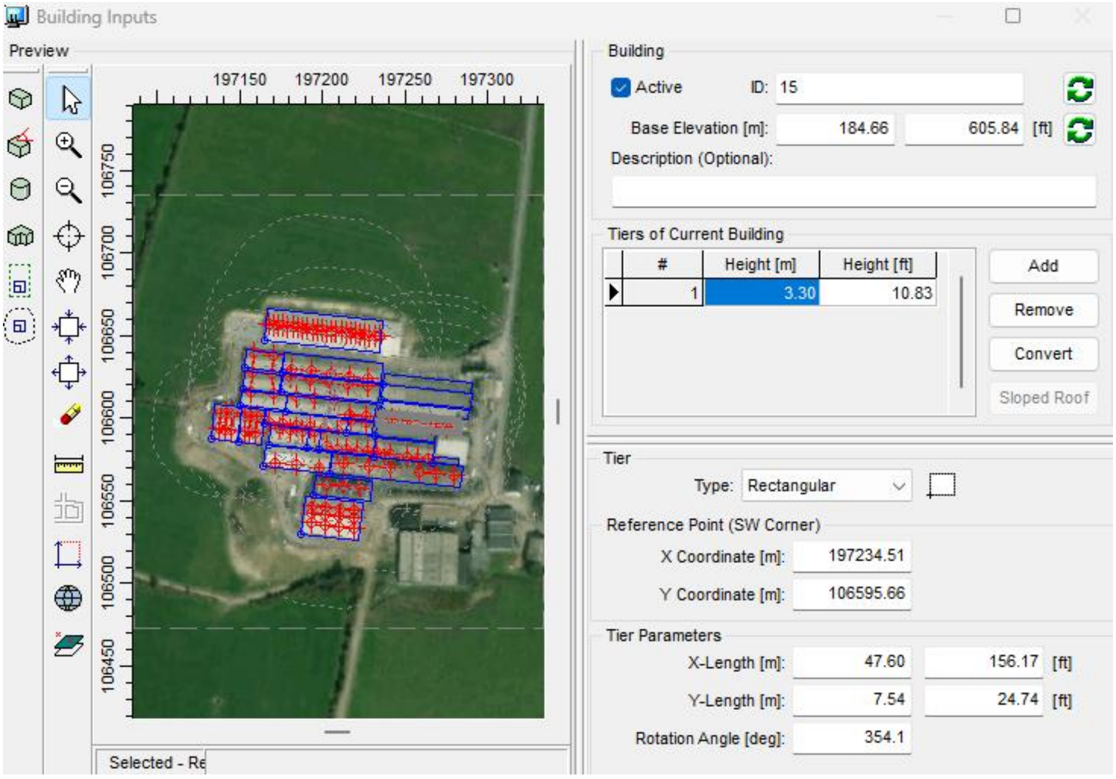

Building Inputs
Preview
197150
197200
197250
197300
106750
106700
106650
106600
106550
106500
106450
Selected - Re
Building
Active
ID: 11
Base Elevation [m]:
184.62
605.71
[ft]
Description (Optional):
Tiers of Current Building
#
Height [m]
Height [ft]
1
4.50
14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]:
197177.91
Y Coordinate [m]:
106604.01
Tier Parameters
X-Length [m]:
53.62
175.92
[ft]
Y-Length [m]:
10.31
33.83
[ft]
Rotation Angle [deg]:
354.0

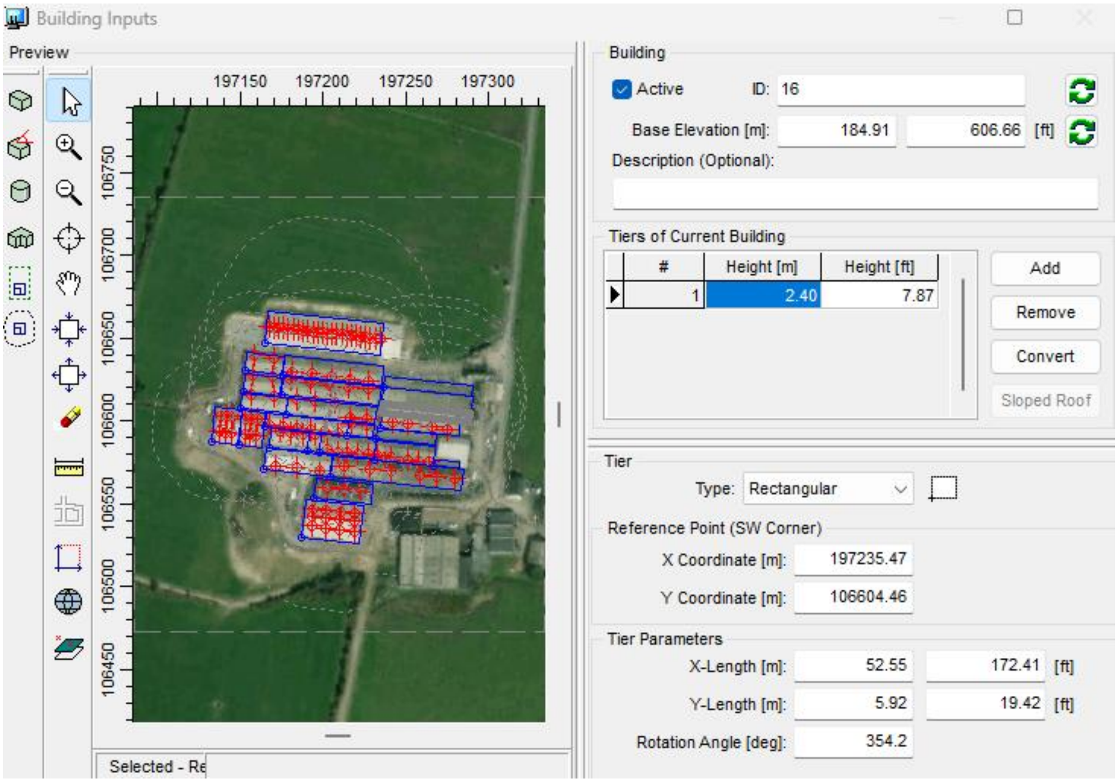

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 12
Base Elevation [m]: 184.42 605.05 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197150.45
Y Coordinate [m]: 106607.28
Tier Parameters
X-Length [m]: 27.20 89.24 [ft]
Y-Length [m]: 9.48 31.10 [ft]
Rotation Angle [deg]: 354.2

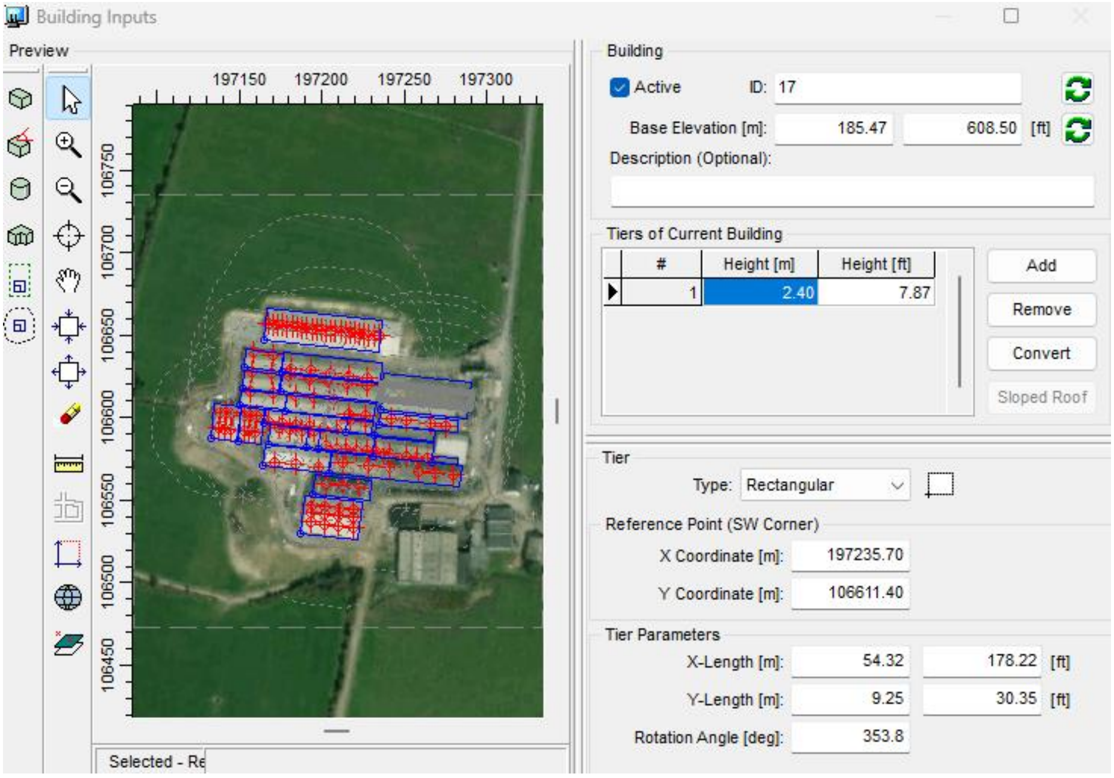

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 12
Base Elevation [m]: 184.42 605.05 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197150.45
Y Coordinate [m]: 106607.28
Tier Parameters
X-Length [m]: 27.20 89.24 [ft]
Y-Length [m]: 9.48 31.10 [ft]
Rotation Angle [deg]: 354.2


Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 13
Base Elevation [m]: 186.00 610.24 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197151.72
Y Coordinate [m]: 106617.52
Tier Parameters
X-Length [m]: 22.69 74.44 [ft]
Y-Length [m]: 11.16 36.61 [ft]
Rotation Angle [deg]: 354.5

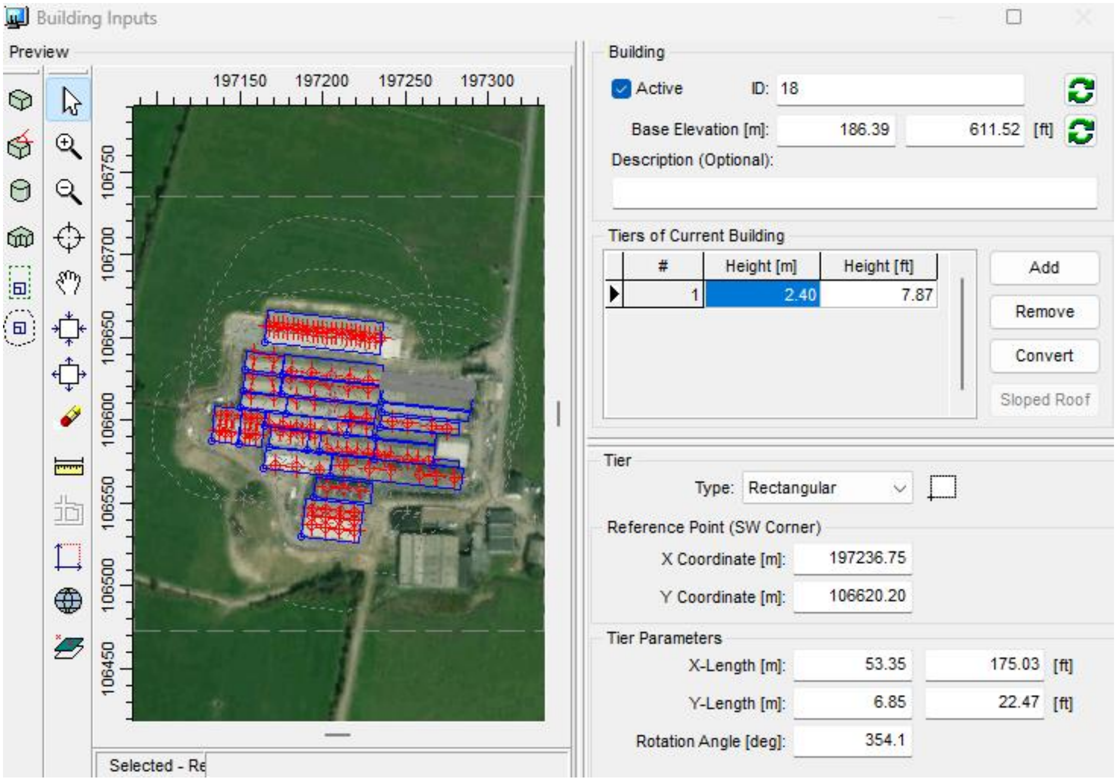

Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 14
Base Elevation [m]: 185.85 609.74 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197174.86
Y Coordinate [m]: 106615.65
Tier Parameters
X-Length [m]: 59.47 195.11 [ft]
Y-Length [m]: 11.35 37.24 [ft]
Rotation Angle [deg]: 353.5


Building Inputs
Preview
197150
197200
197250
197300
106750
106700
106650
106600
106550
106500
106450
Selected - Re
Building
Active
ID: 15
Base Elevation [m]: 184.66
605.84 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 3.30 10.83
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197234.51
Y Coordinate [m]: 106595.66
Tier Parameters
X-Length [m]: 47.60
156.17 [ft]
Y-Length [m]: 7.54
24.74 [ft]
Rotation Angle [deg]: 354.1

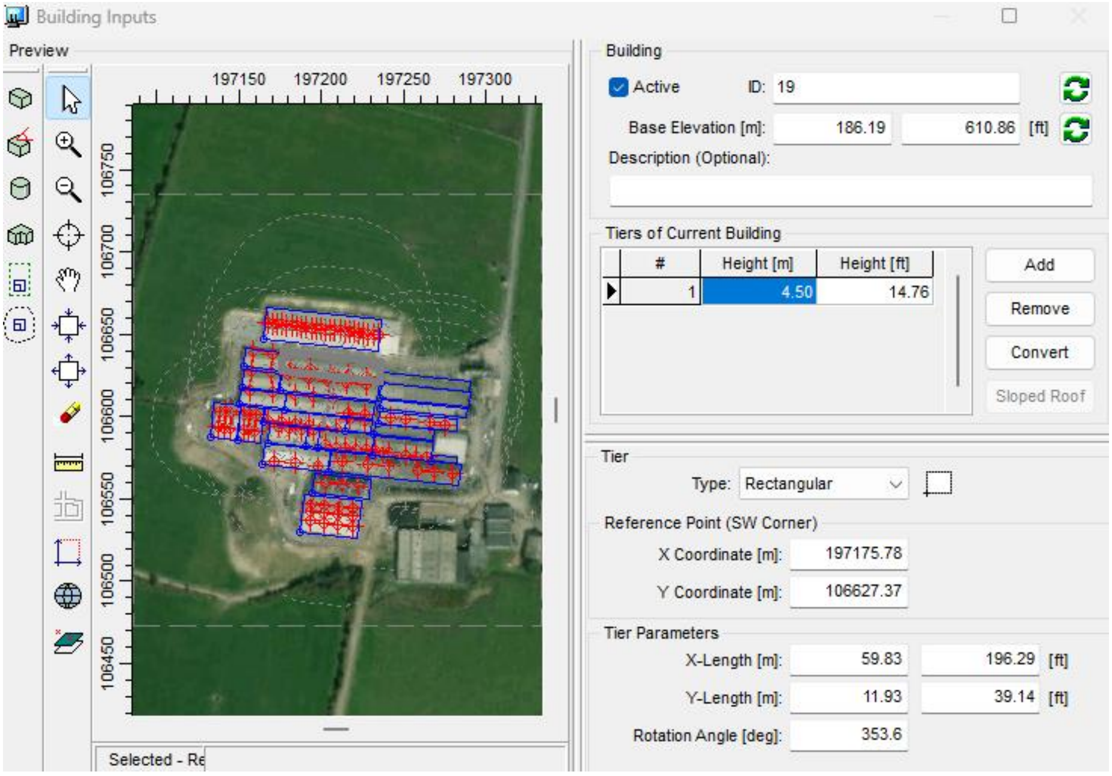

Building Inputs
Preview
197150
197200
197250
197300
106750
106700
106650
106600
106550
106500
106450
Selected - Re
Building
Active
ID: 16
Base Elevation [m]: 184.91
606.66 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 2.40 7.87
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197235.47
Y Coordinate [m]: 106604.46
Tier Parameters
X-Length [m]: 52.55
172.41 [ft]
Y-Length [m]: 5.92
19.42 [ft]
Rotation Angle [deg]: 354.2

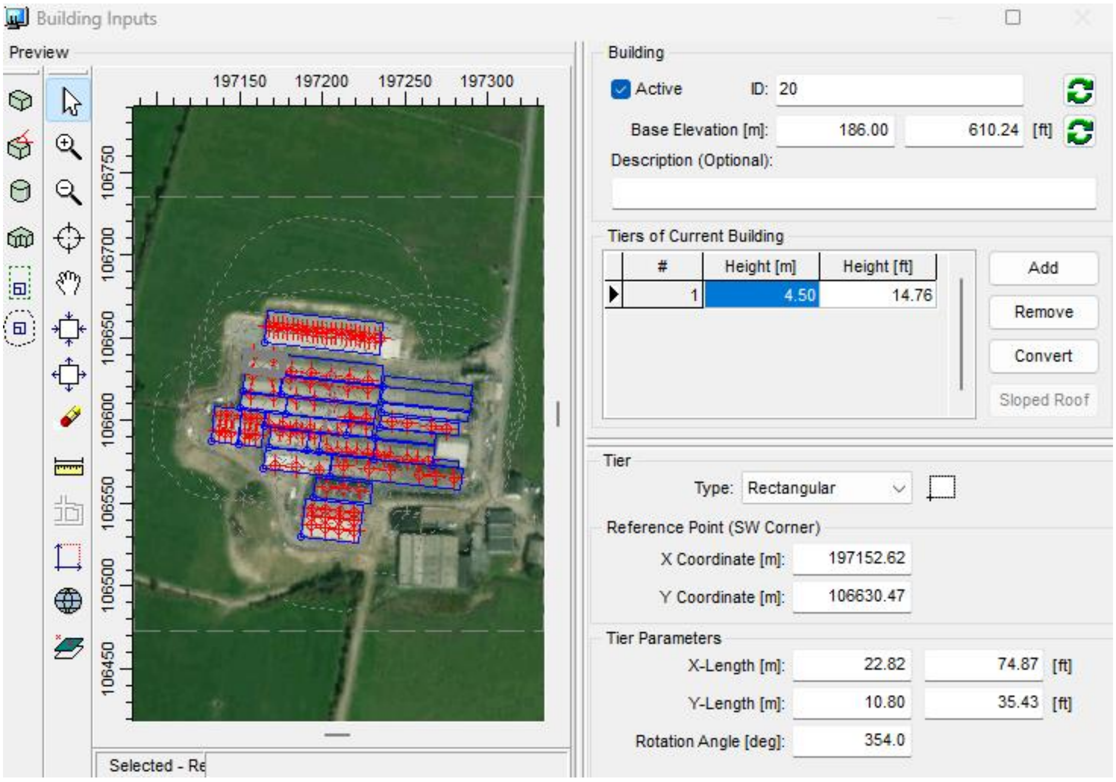


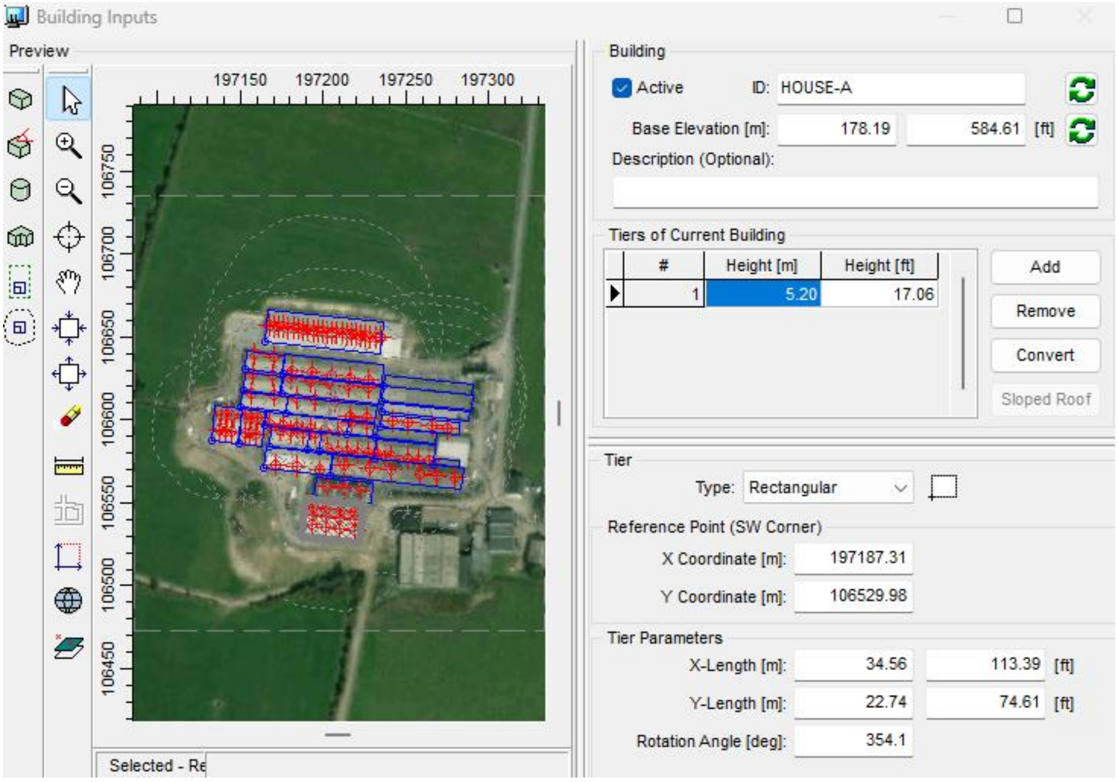
Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active
ID: 17
Base Elevation [m]: 185.47 608.50 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 2.40 7.87
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197235.70
Y Coordinate [m]: 106611.40
Tier Parameters
X-Length [m]: 54.32 178.22 [ft]
Y-Length [m]: 9.25 30.35 [ft]
Rotation Angle [deg]: 353.8



Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active
ID: 18
Base Elevation [m]: 186.39 611.52 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 2.40 7.87
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197236.75
Y Coordinate [m]: 106620.20
Tier Parameters
X-Length [m]: 53.35 175.03 [ft]
Y-Length [m]: 6.85 22.47 [ft]
Rotation Angle [deg]: 354.1


Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 19
Base Elevation [m]: 186.19 610.86 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197175.78
Y Coordinate [m]: 106627.37
Tier Parameters
X-Length [m]: 59.83 196.29 [ft]
Y-Length [m]: 11.93 39.14 [ft]
Rotation Angle [deg]: 353.6


Building Inputs
Preview
197150 197200 197250 197300
106750 106700 106650 106600 106550 106500 106450
Selected - Re
Building
Active ID: 20
Base Elevation [m]: 186.00 610.24 [ft]
Description (Optional):
Tiers of Current Building
Height [m] Height [ft]
1 4.50 14.76
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197152.62
Y Coordinate [m]: 106630.47
Tier Parameters
X-Length [m]: 22.82 74.87 [ft]
Y-Length [m]: 10.80 35.43 [ft]
Rotation Angle [deg]: 354.0


Building Inputs
Preview
Building
Active
ID: HOUSE-A
Base Elevation [m]: 178.19 584.61 [ft]
Description (Optional):
Tiers of Current Building
| Height [m] | Height [ft]
1 | 5.20 | 17.06
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197187.31
Y Coordinate [m]: 106529.98
Tier Parameters
X-Length [m]: 34.56 113.39 [ft]
Y-Length [m]: 22.74 74.61 [ft]
Rotation Angle [deg]: 354.1
Selected - Re

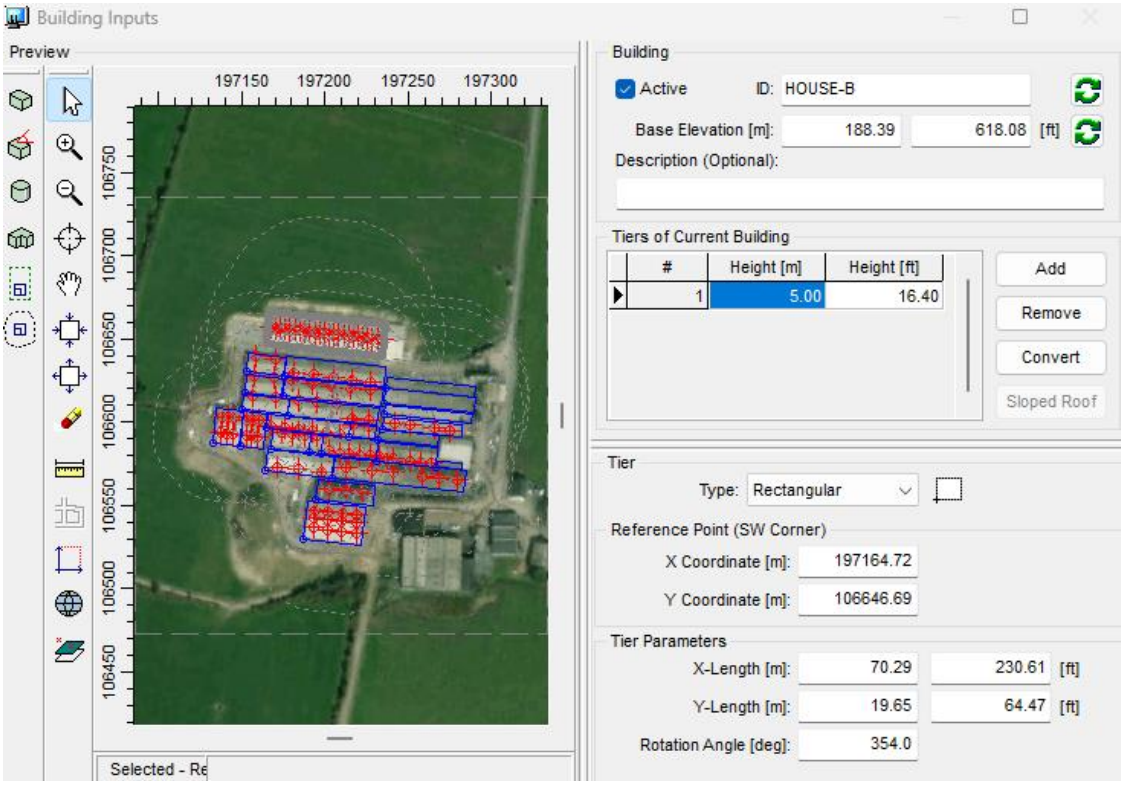

Building Inputs
Preview
Building
Active
ID: HOUSE-B
Base Elevation [m]: 188.39 618.08 [ft]
Description (Optional):
Tiers of Current Building
| Height [m] | Height [ft]
1 | 5.00 | 16.40
Add
Remove
Convert
Sloped Roof
Tier
Type: Rectangular
Reference Point (SW Corner)
X Coordinate [m]: 197164.72
Y Coordinate [m]: 106646.69
Tier Parameters
X-Length [m]: 70.29 230.61 [ft]
Y-Length [m]: 19.65 64.47 [ft]
Rotation Angle [deg]: 354.0
Selected - Re

Figure 4: Details of Nested Grid Receptors

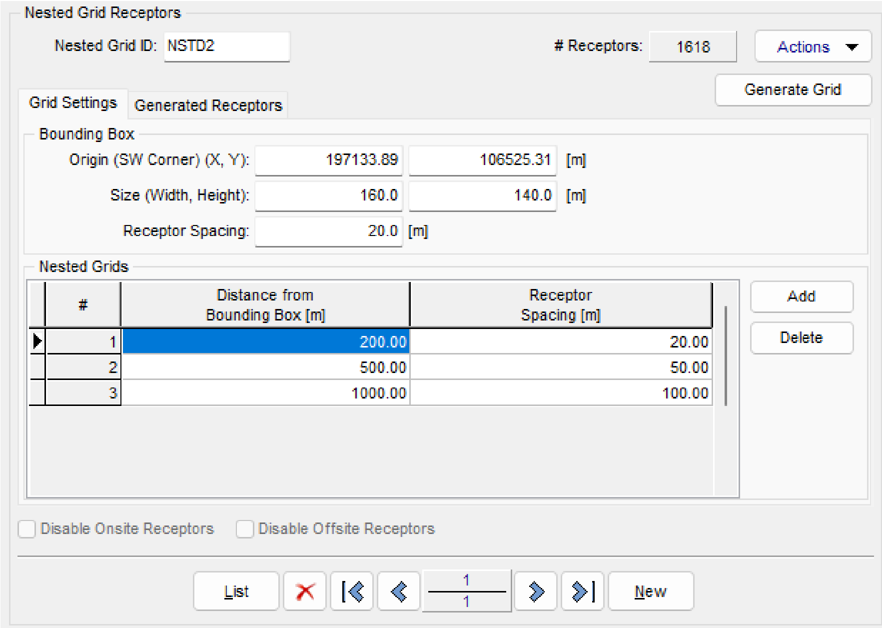
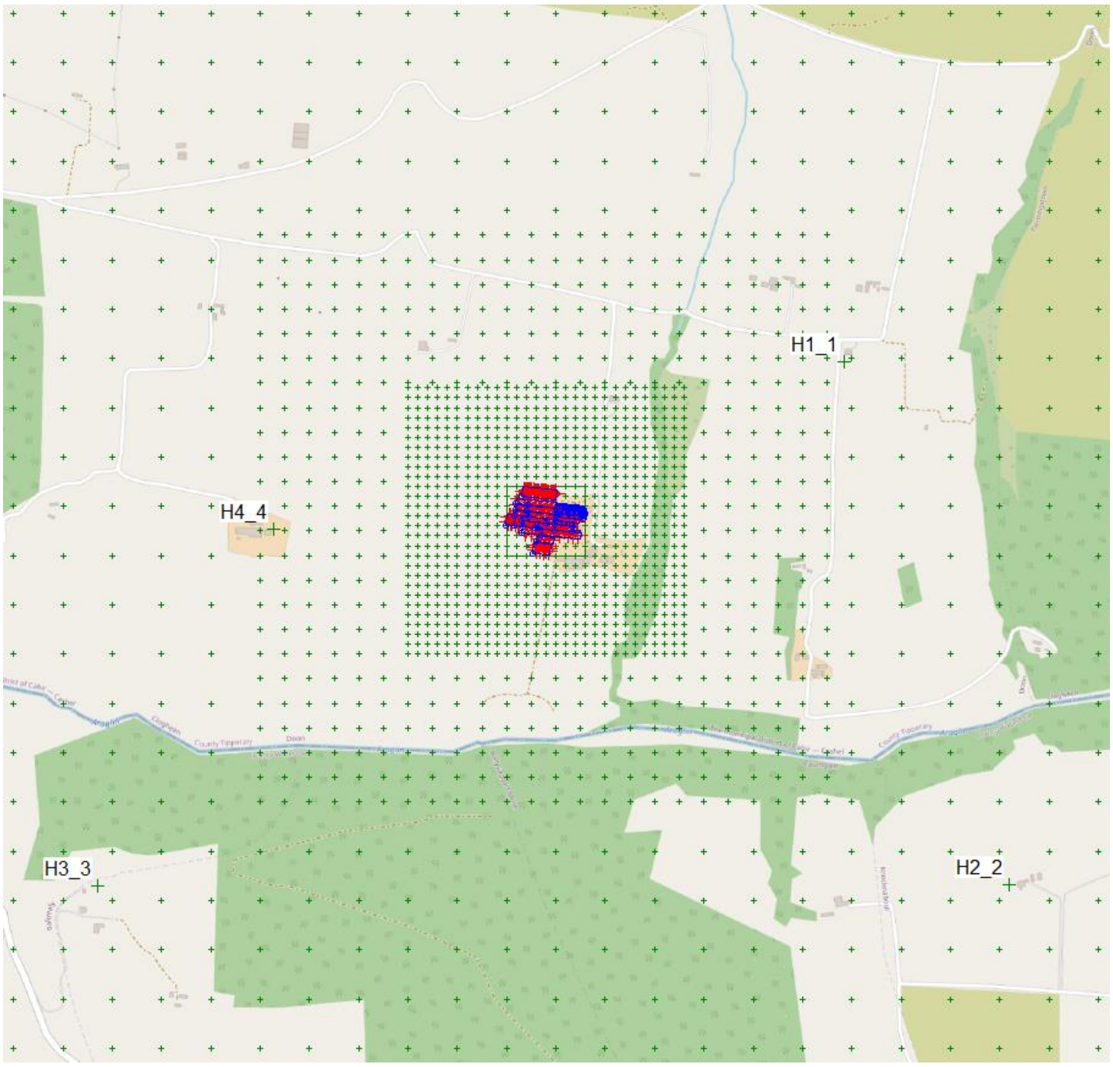


Figure 5: Graphical Representation of Nested Grid Receptors



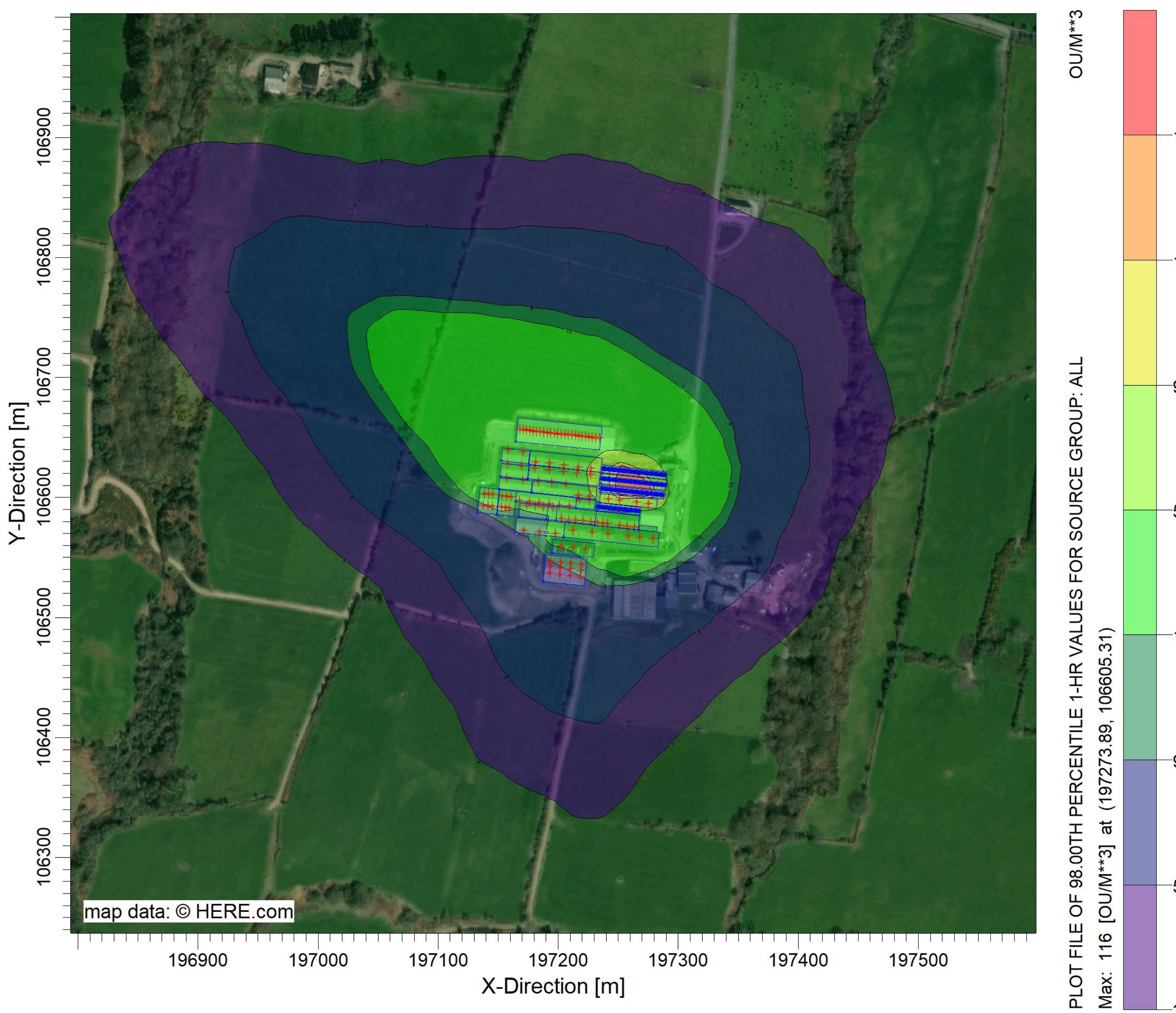
APPENDIX C MODELLING RESULTS

The ammonia plume below shows the annual average ammonia impact in the vicinity of the site. It should be noted that the outermost contour (0.058µg/m^3) corresponds to a nitrogen deposition of 0.3kg.N/ha/yr, which is considered de minimis for the purposes of a Nitrogen assessment.

There are no sensitive habitats located within this area (the 0.058µg/µm^3 contour line) that would be subject to a nitrogen deposition that is considered 'significant' (0.3kg.N/ha/yr).

PROJECT TITLE:

Doon Farm Enterprises
98th Percentile of Max 1-Hour Ground Level Odour Concentration (ou/m3) (2020)



COMMENTS:

SOURCES:
112

RECEPTORS:
1084

OUTPUT TYPE:
Concentration

MAX:
116 OU/M3**

MODELER:
Mark Burke

DATE:
15/01/2024

SCALE: 1:5,218

0 0.1 km

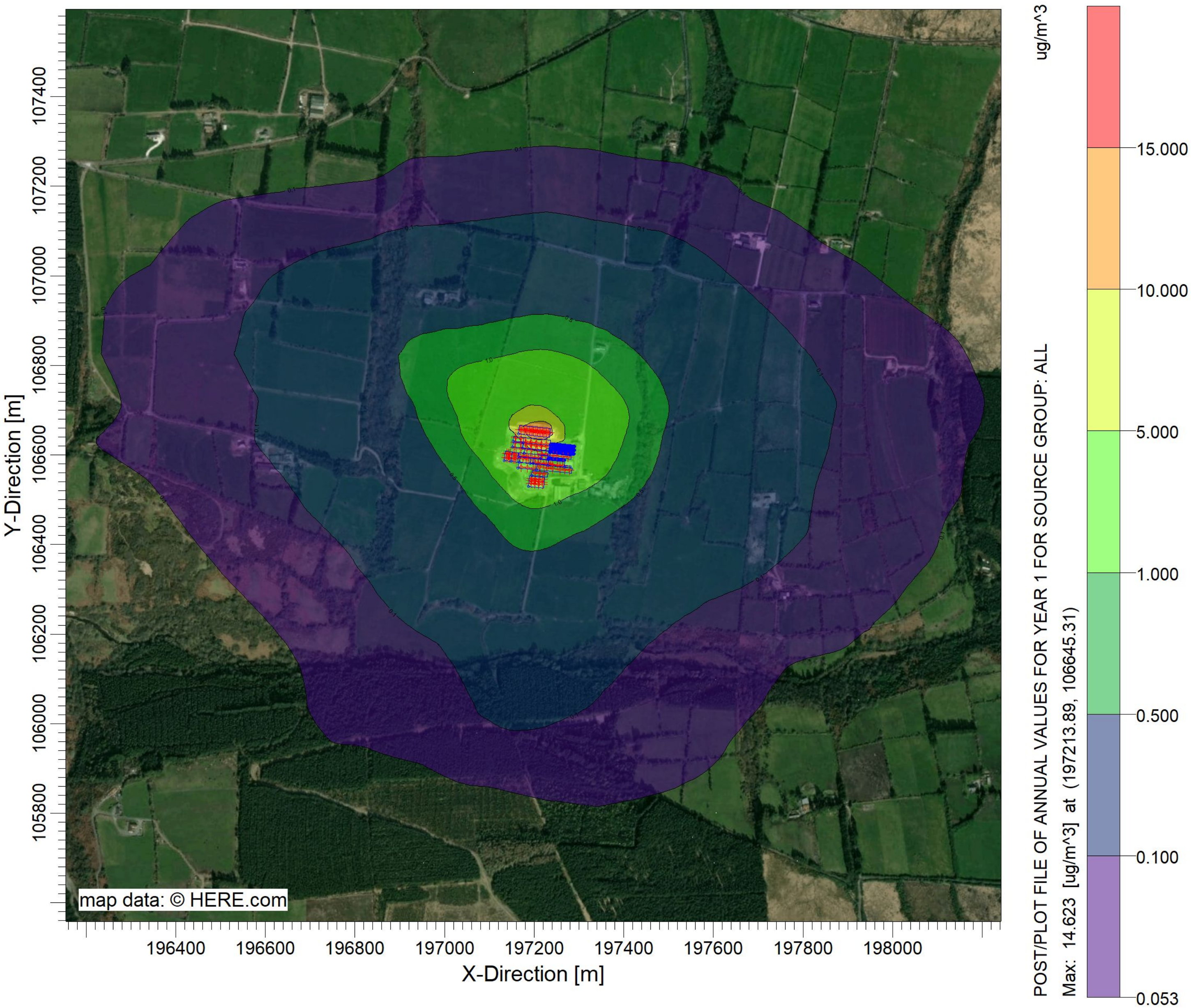
IRWIN CARR CONSULTING

PROJECT NO.:
2023152

AERMOD View - Lakes Environmental Software

PROJECT TITLE:

Doon Farm Enterprises
Annual Average Ground Level Ammonia Concentration (ug/m3) (2020)



COMMENTS:

SOURCES:
112

RECEPTORS:
1980

OUTPUT TYPE:
Concentration

MAX:
14.623 ug/m^3

MODELER:
Mark Burke

DATE:
16/01/2024

SCALE: 1:13,870
0 — 0.4 km

IRWIN CARR CONSULTING

PROJECT NO.:
2023152

AERMOD View - Lakes Environmental Software