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DETERMINATION OF POTENTIAL ODOUR EMISSIONS TO ATMOSPHERE FROM THE PROPOSED PUMPING STATION, BALLYVOLANE CORK

Technical Report Prepared For

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EXECUTIVE SUMMARY

An Odour Emissions Report has been undertaken using air dispersion modelling using the United States Environmental Protection Agency's regulatory model AERMOD (Version 19191). The aim of the study was to assess the potential odour emissions associated with the pumping station, based on a stack height of 2 metres, and to quantify the ambient predicted odour levels relative to the ambient odour guideline values. The odour dispersion model study consisted of the following components:

- Review of odour emission data and other relevant information needed for the modelling study;
- Dispersion modelling of odour emissions under the maximum emission scenario;
- Presentation of predicted ground level concentrations of odour at the nearest sensitive receptors;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level odour concentrations are likely to exceed the relevant ambient odour guideline value.

Assessment Summary

The odour dispersion modelling results for the Ballyvolane Pumping Station, at a stack height of 2 metres, are within the relevant odour guideline criteria and thus will not cause a nuisance at the worst-case residential receptor. The maximum hourly odour concentration is 0.22 OU_E/m^3 at the worst-case residential receptor based on a conservative odour emission rate from the station. The worst-case odour concentration of 0.22 OU_E/m^3 is 15% of the relevant odour criterion of 1.5 OU_E/m^3 as a 98^{th}%ile and thus the pumping station will not cause an odour nuisance at nearby receptors.

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1.0 INTRODUCTION

Odour dispersion modelling was carried out using the United States Environmental Protection Agency's regulatory model AERMOD (Version 19191). The aim of the study was to assess the potential odour emissions associated with the pumping station, at a stack height of 2 metres, and to quantify the ambient predicted odour levels relative to the ambient odour guideline values. The assessment was conducted using the methodology outlined in "*Air Dispersion Modelling from Industrial Installations Guidance Note (AG4) (EPA, 2010)*"(1).

This report describes the outcome of this study. The study consists of the following components:

- Review of provided odour emission data and other relevant information needed for the modelling study;
- Dispersion modelling of odour emissions under maximum emission scenario;
- Presentation of predicted ground level concentrations of odour at the nearest sensitive receptors;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level odour concentrations are likely to exceed the relevant ambient odour guideline value.

Information supporting the conclusions has been detailed in the following sections. The assessment methodology and study inputs are presented in Section 2. The odour dispersion modelling results and assessment summaries are presented in Section 3.

2.0 MODELLING METHODOLOGY

Emissions from the facility have been modelled using the AERMOD dispersion model (Version 19191) which has been developed by the U.S. Environmental Protection Agency (USEPA)(4) and following guidance issued by the EPA(1,2). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources and has replaced ISCST3(5) as the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain(6). The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies(7,8).

The odour dispersion modelling input data consisted of information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and five years of appropriate hourly meteorological data. Using this input data the model predicted ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological years. The model post-processed the data to identify the location and maximum of the worst-case ground level concentration.

2.1 Characteristics of Odour

Odours are sensations resulting from the reception of a stimulus by the olfactory sensory system, which consists of two separate subsystems: the olfactory epithelium and the trigeminal nerve. The olfactory epithelium, located in the nose, is capable of detecting and discriminating between many thousands of different odours and can detect some of them in concentrations lower than those detectable by currently available analytical instruments(9). The function of the trigeminal nerve is to trigger a reflex action that produces a painful sensation. It can initiate protective reflexes such as sneezing to interrupt inhalation. The olfactory system is extremely complex and peoples' responses to odours can be variable. This variability is the result of differences in the ability to detect odour; subjective acceptance or rejection of an odour due to past experience; circumstances under which the odour is detected and the age, health and attitudes of the human receptor.

Odour Intensity and Threshold

Odour intensity is a measure of the strength of the odour sensation and is related to the odour concentration. The odour threshold refers to the minimum concentration of an odorant that produces an olfactory response or sensation. This threshold is normally determined by an odour panel consisting of a specified number of people, and the numerical result is typically expressed as occurring when 50% of the panel correctly detect the odour. This odour threshold is given a value of one odour unit and is expressed as 1 OU_E/m^3. The odour threshold is not a precisely determined value, but depends on the sensitivity of the odour panellists and the method of presenting the odour stimulus to the panellists. An odour detection threshold relates to the minimum odorant concentration required to perceive the existence of the stimulus, whereas an odour recognition threshold relates to the minimum odorant concentration required to recognise the character of the stimulus. Typically, the recognition threshold exceeds the detection threshold by a factor of 2 to 10[9-10].

Odour Character

The character of an odour distinguishes it from another odour of equal intensity. Odours are characterised on the basis of odour descriptor terms (e.g. putrid, fishy, fruity etc.). Odour character is evaluated by comparison with other odours, either directly or through the use of descriptor words.

Hedonic Tone

The hedonic tone of an odour relates to its pleasantness or unpleasantness. When an odour is evaluated in the laboratory for its hedonic tone in the neutral context of an olfactometric presentation, the panellist is exposed to a stimulus of controlled intensity and duration. The degree of pleasantness or unpleasantness is determined by each panellist's experience and emotional associations. The responses among panellists may vary depending on odour character; an odour pleasant to many may be declared highly unpleasant by some.

Adaptation

Adaptation, or Olfactory Fatigue, is a phenomenon that occurs when people with a normal sense of smell experience a decrease in perceived intensity of an odour if the stimulus is received continually. Adaptation to a specific odorant typically does not interfere with the ability of a person to detect other odours. Another phenomenon known as habituation or occupational anosmia occurs when a worker in an industrial situation experiences a long-term exposure and develops a higher threshold tolerance to the odour.

2.2 Odour Guidelines

The exposure of the population to a particular odour consists of two factors; the concentration and the length of time that the population may perceive the odour. By definition, 1 OU_E/m^3 is the detection threshold of 50% of a qualified panel of observers working in an odour-free laboratory using odour-free air as the zero reference.

Currently there is no general statutory odour standard in Ireland relating to industry or wastewater treatment. The EPA(2) has issued guidance specific to intensive agriculture which has outlined the following standards:

- Target value for new pig-production units of 1.5 OU_E/m^3 as a 98^{th}%ile of one hour averaging periods,
- Limit value for new pig-production units of 3.0 OU_E/m^3 as a 98^{th}%ile of one hour averaging periods,
- Limit value for existing pig-production units of 6.0 OU_E/m^3 as a 98^{th}%ile of one hour averaging periods.

Guidance from the UK(3), and adapted for Irish EPA use, recommends that odour standards should vary from 1.5 – 6.0 OU_E/m^3 as a 98^{th}%ile of one hour averaging periods at the worst-case sensitive receptor based on the offensiveness of the odour and with adjustments for local factors such as population density. A summary of the indicative criterion is given below in Table 1 (taken from EPA Guidance document AG9(2)):

Industrial Sectors	Relative Offensiveness of Odour	Indicative Criterion Note 1
• Processes involving decaying animal or fish remains. • Processes involving septic effluent or sludge • Waste sites including landfills, waste transfer stations and non-green waste composting facilities.	Most Offensive	1.5 OU_E/m^3 as a 98^{th}%ile of hourly averages at the worst-case sensitive receptor
• Intensive Livestock Rearing • Fat Frying / Meat Cooking (Food Processing) • Animal Feed • Sugar Beet Processing • Well aerated green waste composting Most odours from regulated processes fall into this category i.e. any industrial sector which does not obviously fall within the “most offensive” or “less offensive” categories.	Moderately Offensive	3.0 OU_E/m^3 as a 98^{th}%ile of hourly averages at the worst-case sensitive receptor
• Brewery / Grain / Oats Production • Coffee Roasting • Bakery • Confectionery	Less Offensive	6.0 OU_E/m^3 as a 98^{th}%ile of hourly averages at the worst-case sensitive receptor

Note 1 Professional judgement should be applied in the determination of where the worst-case sensitive receptor is located.

Table 1 Indicative Odour Standards Based On Offensiveness Of Odour And Adapted for Irish EPA(2)

Based on the guidance above, an odour threshold of 1.5 OU_E/m^3 as a 98th%ile of hourly mean values has been selected for identifying the potential for odour nuisance for the Ballyvolane Pumping Station as a worst-case. The selection of the "most offensive" category is conservative as all odours will be extracted under negative pressure to the odour control unit and thus no raw sewage will be emitted untreated from the station.

2.3 Odour Dispersion Modelling Methodology

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level concentrations (GLC) of compounds emitted from the principal emission sources on-site.

The modelling incorporated the following features:

- A receptor grids were created at which concentrations would be modelled. The receptor grid was based on a Cartesian grid with the site at the centre. A grid extended to 200 m with the site at the centre and with concentrations calculated at 10 m intervals. Boundary receptor locations were also placed along the boundary of the site, at 10 m intervals, giving a total of 441 calculation points. All receptors have been modelled at 1.5 m to represent breathing height.

- Detailed terrain has been mapped into the model using SRTM data with 30m resolution. The site is located in rolling terrain. This takes account of all significant features of the terrain.

- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five year period (Cork Airport 2014 - 2018) was used in the model (see Figure 1).

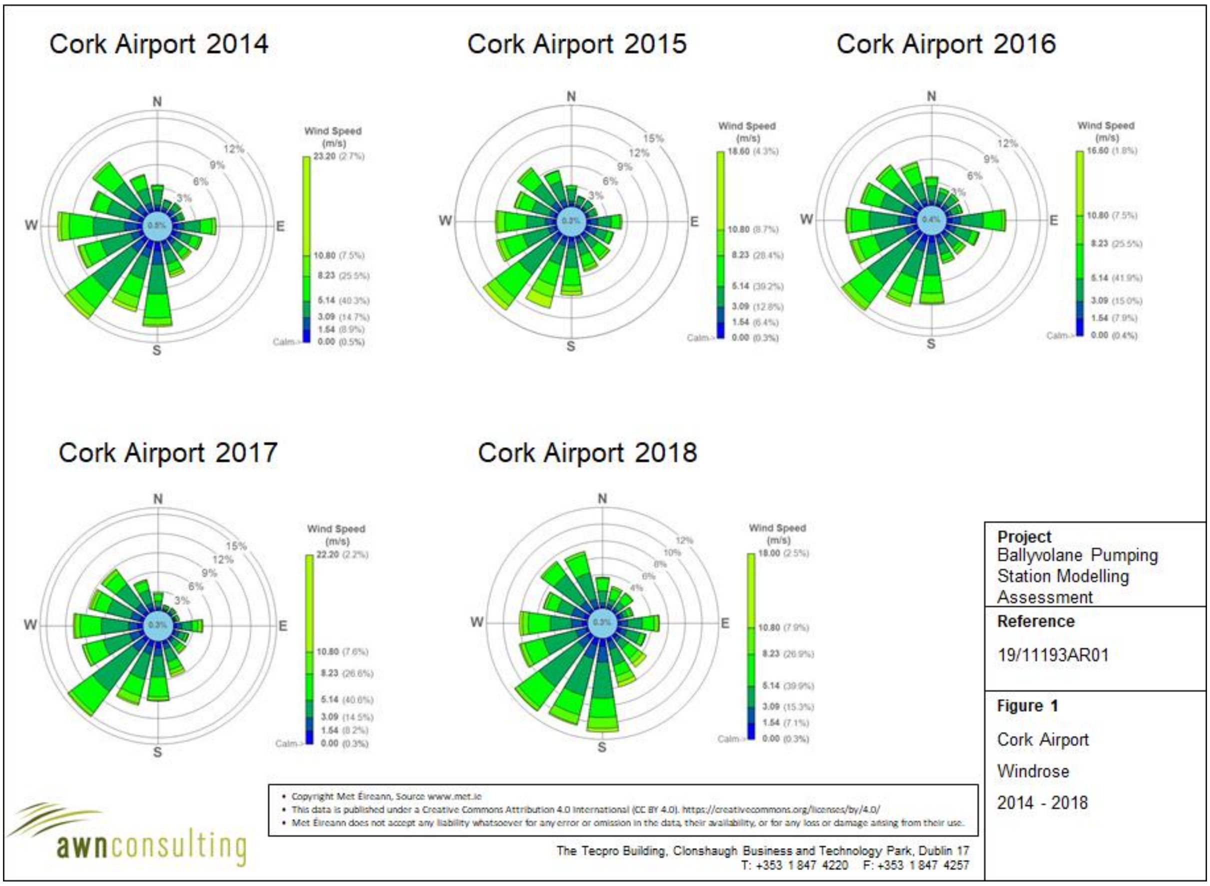
- The source and emission data, including stack dimensions, volume flows and emission temperatures have been incorporated into the model as shown in Table 2 and 3. The proposed odour control unit (OCU), with a stack height of 2 m, will be an absorption unit with a maximum fan rating of 122 Nm^3/hr and a maximum odour concentration, after abatement, of 600 OU_E/m^3 at the stack. As a conservative measure, the assumed emission rate has been increased from 20.3 OU_E/s (based on 600 OU_E/m^3) to 40.6 OU_E/s (based on 1,200 OU_E/m^3) to allow for any variability in the OCU abatement efficiency.

Stack Reference	Stack Height (m)	Exit Diameter (m)	Temp (K)	Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)
Air Vent	2	0.1	Ambient	122	4.5

Table 2 Estimated Process Emission Details For Ballyvolane Pumping Station Odour Control Unit (OCU)

Parameter	Worst-Case Emission Concentration (OU_E/Nm^3)	Emission Rate (OU_E/s)
Odour	1,200	40.6

Table 3 Air Emission Rates From Ballyvolane Pumping Station Odour Control Unit (OCU) Under Worst-case Conditions


Cork Airport 2014
Cork Airport 2015
Cork Airport 2016
Cork Airport 2017
Cork Airport 2018
Project
Ballyvolane Pumping Station Modelling Assessment
Reference
19/11193AR01
Figure 1
Cork Airport
Windrose
2014 - 2018
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3.0 RESULTS & DISCUSSION

3.1 Air Dispersion Modelling Results

Details of the 98th%ile of 1-hour mean odour concentrations for the pumping station at the worst case sensitive receptor are given in Table 4 over a five-year period based on the USEPA approved AERMOD model (version 19191). The worst case scenario for the 98th%ile of 1-hour concentrations occurs in 2017 where the maximum off-site concentrations is 15% of the guideline value at the worst case receptor.

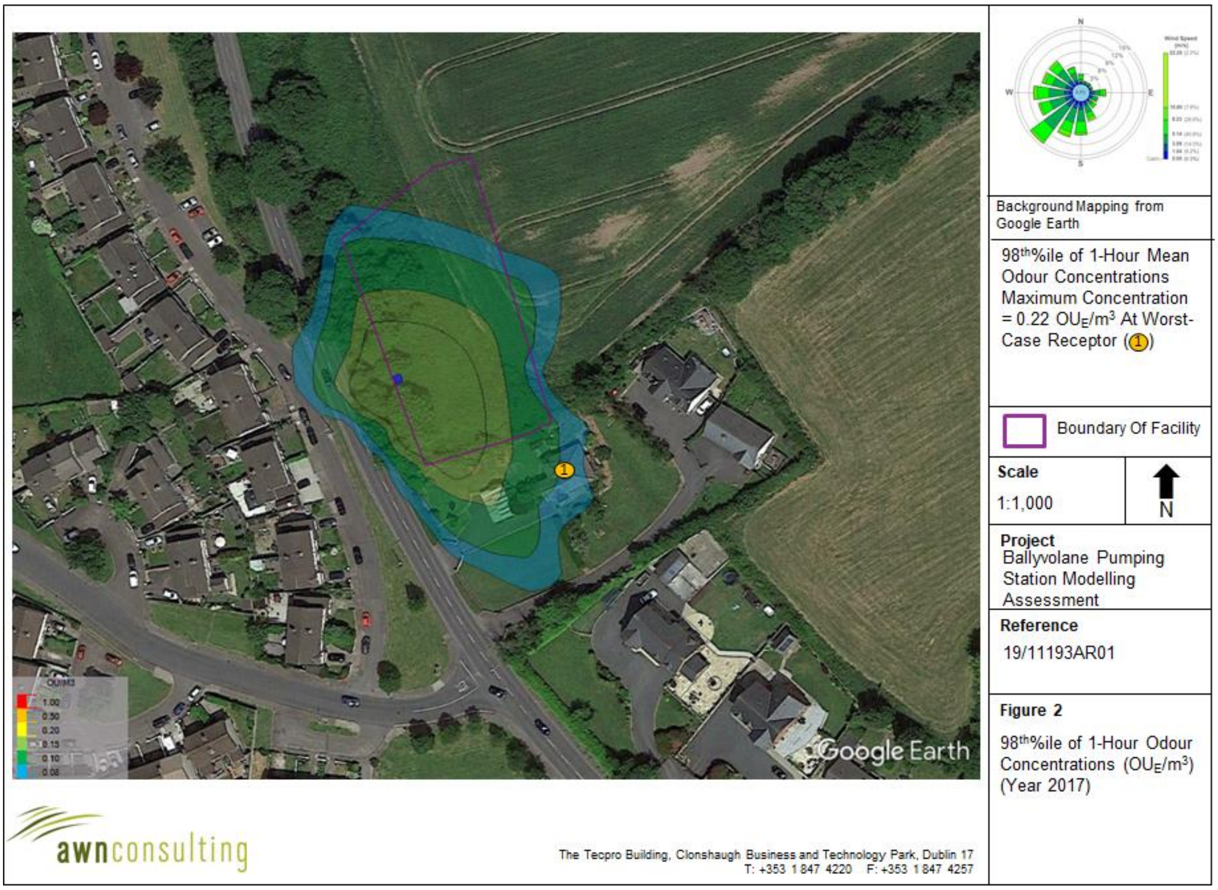
Figure 2 shows the ambient odour concentration contour pattern (as a 98th%ile of one-hour concentrations) in the vicinity of the pumping station for the worst-case year of 2017.

Based on the results detailed below, none of the nearby receptors are predicted to experience odour nuisance as a result of the pumping station.

Model Scenario / Meteorological Year	Averaging Period	Predicted Odour Concentration (OU_E/m^3)	Guideline (OU_E/m^3) Note 1
Ambient Odour Concentration / 2014	Maximum 1-Hour (as a 98th%ile)	0.18	1.5
Ambient Odour Concentration / 2015	Maximum 1-Hour (as a 98th%ile)	0.17	
Ambient Odour Concentration / 2016	Maximum 1-Hour (as a 98th%ile)	0.20	
Ambient Odour Concentration / 2017	Maximum 1-Hour (as a 98th%ile)	0.22	
Ambient Odour Concentration / 2018	Maximum 1-Hour (as a 98th%ile)	0.18	

Note 1 Guideline limit value based on EPA Guidance AG9 (2019).

Table 4 Predicted Odour Concentration At Worst-Case Offsite Receptor(OU_E/m^3)



3.2 Conclusion

The odour dispersion modelling results for the Ballyvolane Pumping Station, based on a stack height of 2 metres, are within the relevant odour guideline criteria and thus will not cause a nuisance at the worst-case residential receptor. The maximum hourly odour concentrations is 0.22 OU_E/m^3 at the worst-case residential receptor based on a conservative odour emission rate from the station. The worst-case odour concentration of 0.22 OU_E/m^3 is 15% of the relevant odour criterion of 1.5 OU_E/m^3 as a 98th%ile and thus the pumping station will not cause an odour nuisance at nearby receptors.

References

(1) EPA (2010) Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)
(2) EPA (2019) Odour Emissions Guidance Note (AG9)
(3) UK EA(2011) H4 – Odour Management
(4) USEPA (2018) AERMOD Description of Model Formulation
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