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ATTACHMENT-7-1-3-2-AIR EMISSIONS IMPACT ASSESSMENT ADSIL CLONSHAUGH BUSINESS & TECHNOLOGY PARK, DUBLIN 17

Technical Report Prepared For

Amazon Data Services Ireland Limited

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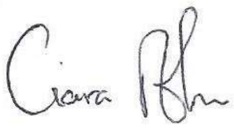
Signature		
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EXECUTIVE SUMMARY

This report presents the assessment of air quality impacts as a result of the operation of the Amazon Data Services Ireland Ltd. ("ADSIL" or 'the applicant') data storage facility (the subject 'installation' under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The site is occupied by five no. data storage facility buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

The installation requires a continuous supply of electricity to operate. During normal operations, the facility is supplied electricity from the national grid. Outside of normal operations, the facility is first supplied electricity by some or all of the onsite battery installations and then by some or all of the onsite backup generators. Outside of routine testing and maintenance, the operation of these back-up generators is typically only required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply,
- Critical maintenance to power systems,
- A request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load.

The air dispersion modelling has been carried out using the United States Environmental Protection Agency's regulated model AERMOD(1). The AERMOD model has USEPA regulatory status and is one of the advanced models recommended within the air modelling guidance document 'Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)' published by the EPA in Ireland(2). The modelling of air emissions is carried out to assess concentrations of nitrogen dioxide (NO_2) at a variety of locations beyond the site boundary. The assessment has been undertaken for Buildings W, X, Y, U and V. Building W has 13 no. back-up generators, Building X has 20 no. back-up generators, Building Y has 7 no. back-up generators, Building U has 11 no. back-up generators and Building V has 1 no. back-up generator. In total, the air dispersion modelling includes 52 no. back-up generators on the campus.

The assessment has determined the ambient air quality impact of the site and any air quality constraints that may be present. The generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the emission limit values outlined in the Medium Combustion Plant Directive are not applicable to the generators on site.

A number of modelling scenarios are investigated for the purposes of this assessment. Both normal day-to-day testing operations are considered as well as emergency operations. Normal testing operations involve the generators operating for 30 minutes on a weekly basis at 25% load using diesel fuel, with no more than one generator tested at the same time. Quarterly maintenance testing of the generators was undertaken on an individual basis at 100% load for 4-hours each on a quarterly basis, which is equivalent to 16 hours per year using diesel fuel was also included in the modelling assessment. Emergency operation is based on 150 emergency hours modelled according to the USEPA methodology.

Cumulative Air Emissions

A cumulative impact assessment of the facility and nearby sites within a 1km radius was also conducted. Sites which hold an IED licence from the EPA were assessed for relevant air emissions. There are 2 no. IE licenced sites within 1km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, both of these facilities

have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment.

Additionally, the Applicant operates a separate data storage facility to the north-west of the subject site which is referred to as Building A through F. Because the Operator has sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at this second facility, these emission sources have been included in the cumulative assessment. Two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Building A to Building F facility), and Digital Realty Trust, north of Buildings U and V, were identified within the study area. The operational details of these facilities are known and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities are available and thus these have been included in the cumulative assessment.

Assessment of The Data Storage Facility Air Quality Impact

The NO_2 modelling results at the worst-case location at and beyond the site boundary are based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*' as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the installation (Building W, Building X, Building Y, Building U and Building V).

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2. For the worst-case year, emissions from the site lead to an ambient NO_2 concentration (including background) which is 93% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 90% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 137 hours using diesel fuel before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

CO concentrations are also in compliance with the relevant ambient air quality standards. In the worst case year, concentrations of CO (including background) are at most 40% of the maximum 8-hour limit value at the worst case receptor modelled.

Regarding particulate matter, concentrations of PM_{10} and $PM_{2.5}$ are in compliance with the relevant limit values. Concentrations of PM_{10} (including background) are 48% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 42% of the annual limit value at the worst-case receptor modelled, with concentrations of $PM_{2.5}$ reaching at most 44% of the annual mean limit value.

Modelled concentrations of SO_2 reached at most 15% of the maximum 1-hour limit value (measured as a 99.7th%ile) and 17% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor modelled, including background concentrations.

Regarding the most impacted ecological habitat site, the Santry Demesne Proposed NHA (000178), operations will lead to ambient NO_X and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 27% and 7% respectively of the annual limit value.

The nitrogen deposition flux for the worst-case year is 5.544 kg/ha/yr and is below the range in worst-case critical loads of 10-15 kg/ha/yr for the habitat types (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of nitrogen deposition on ecological habitat sites due to the facility are not significant.

The total acid deposition (as N and S) flux for the worst-case year is 0.604 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the habitats (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of acid deposition (as N and S) on ecological habitat sites due to the facility are not significant.

Regarding the most impacted Natura 2000 designated habitat site, the Baldoyle Bay SAC, operations will lead to ambient NO_X and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 14% and 5% respectively of the annual limit value.

The nitrogen deposition flux for the worst-case year is 6.87 kg/ha/yr and is within the range in worst-case critical loads of 5-15 kg/ha/yr for the habitat “Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)” in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant.

The total acid deposition (as N and S) flux for the worst-case year is 0.563 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the “Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)” in the Baldoyle Bay SAC, indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant.

There are no significant impacts predicted for any other Natura 2000 SPAs and SACs, as these are all further from the facility than the Baldoyle Bay SAC.

Under the Emergency Operations Scenario the dispersion modelling has determined that concentrations of all pollutants are in compliance with the relevant ambient air quality standards.

Assessment of The Cumulative Air Quality Impact

The NO_2 modelling results at the worst-case location at and beyond the site boundary are based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel, using the USEPA methodology. The cumulative assessment included:

- the emergency operation of Buildings W, X, Y, U and V and the emergency operation of Buildings A - F,
- scheduled weekly testing of all back-up generators from Buildings W, X, Y, U and V and scheduled weekly testing of all back-up generators from Buildings A - F,
- scheduled quarterly maintenance testing of all back-up generators from Buildings W, X, Y, U and V with each generator running for four hours and scheduled quarterly maintenance testing of all back-up generators from Buildings A – F with each generator running for one hour,
- emergency operations, scheduled weekly testing and scheduled quarterly maintenance testing of the Dataplex and Digital Realty data centres.

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2. For the worst-case year, emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 80 hours before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

Conclusion

In summary, emissions to atmosphere of NO_2, as the main polluting substance (as defined in the Schedule of EPA (Industrial Emissions) (Licensing) Regulations 2013, S.I. No. 137 of 2013) from the standby generators, will be in compliance with the ambient air quality standards which are based on the protection of the environment and human health. Therefore, no significant impacts to the ambient air quality environment are predicted.

In terms of impacts in the nearby ecologically sensitive areas, the ambient level of NO_X in the Santry Demesne Proposed NHA (000178); c. 1km west, due to emissions from the subject site, will be a small fraction of the ambient air quality standard for the protection of vegetation. Similarly, cumulative emissions will lead to ambient NO_X levels which will be a small fraction of the ambient air quality standard for the protection of vegetation. The nearest European site is Baldoyle Bay SAC c. 5km east of the facility. The increased distance of this designated area from the subject site means that it is highly unlikely that airborne pollution could affect any European site.

CONTENTS

1.0 INTRODUCTION

This report presents the assessment of air quality impacts as a result of the operation of the Amazon Data Services Ireland Ltd. (“ADSIL” or ‘the applicant’) data storage facility (the subject ‘installation’ under this licence review application) located at Clonshaugh Business & Technology Park, Dublin 17. The site is occupied by five no. data storage facility buildings, termed Building W, Building X, Building Y, Building U and Building V, along with ancillary elements.

The installation requires a continuous supply of electricity to operate. During normal operations, the facility is supplied electricity from the national grid. Outside of normal operations, the facility is first supplied electricity by some or all of the onsite battery installations and then by some or all of the onsite backup generators. Outside of routine testing and maintenance, the operation of these back-up generators is typically only required under the following emergency circumstances:

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The air dispersion modelling has been carried out using the United States Environmental Protection Agency’s regulated model AERMOD[1]. The AERMOD model has USEPA regulatory status and is one of the advanced models recommended within the air modelling guidance document ‘Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)’ published by the EPA in Ireland[2]. The modelling of air emissions is carried out to assess concentrations of nitrogen dioxide (NO_2) at a variety of locations beyond the site boundary. The assessment has been undertaken for Buildings W, X, Y, U and V. Building W has 13 no. back-up generators, Building X has 20 no. back-up generators, Building Y has 7 no. back-up generators, Building U has 11 no. back-up generators and Building V has 1 no. back-up generators. In total, the air dispersion modelling includes 52 no. back-up generators on the campus.

The assessment has determined the ambient air quality impact of the site and any air quality constraints that may be present. The generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the emission limit values outlined in the Medium Combustion Plant Directive are not applicable to the generators on site.

A number of modelling scenarios are investigated for the purposes of this assessment. Both normal day-to-day testing operations are considered as well as emergency operations. Normal testing operations involves the generators using diesel fuel operating for 30 minutes on a weekly basis at 25% load with no more than one generator tested at the same time. Quarterly maintenance testing of the generators on an individual basis at 100% load for 4-hours each, which is equivalent to 16 hours per year was also included in the modelling assessment. Emergency operation is based on 150 emergency hours modelled according to the USEPA methodology.

A cumulative impact assessment of the facility and nearby sites within a 1km radius was also conducted. Sites which hold an IED licence from the EPA were assessed for relevant air emissions. There are 2 no. IE licenced sites within 1km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, both of these facilities have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment.

Additionally, the Applicant operates a separate data storage facility to the north-west of the subject site which is referred to as Building A through F. Because the Operator has sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at this second facility, these emission sources have been included in the cumulative assessment. Two additional data centre, referred to as the Dataplex data centre (located at the eastern boundary of the Building A to Building F facility), and Digital Realty Trust, north of Buildings U and V, were identified within the study area. The operational details of these facilities are known and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities are available and thus this have been included in the cumulative assessment.

The location of Buildings W, X, Y, U and V, Buildings A through F, the additional data centres referred to above and the two actively licenced IED facilities (Forest Laboratories and Global Switch Properties) are shown below in Diagram 1.

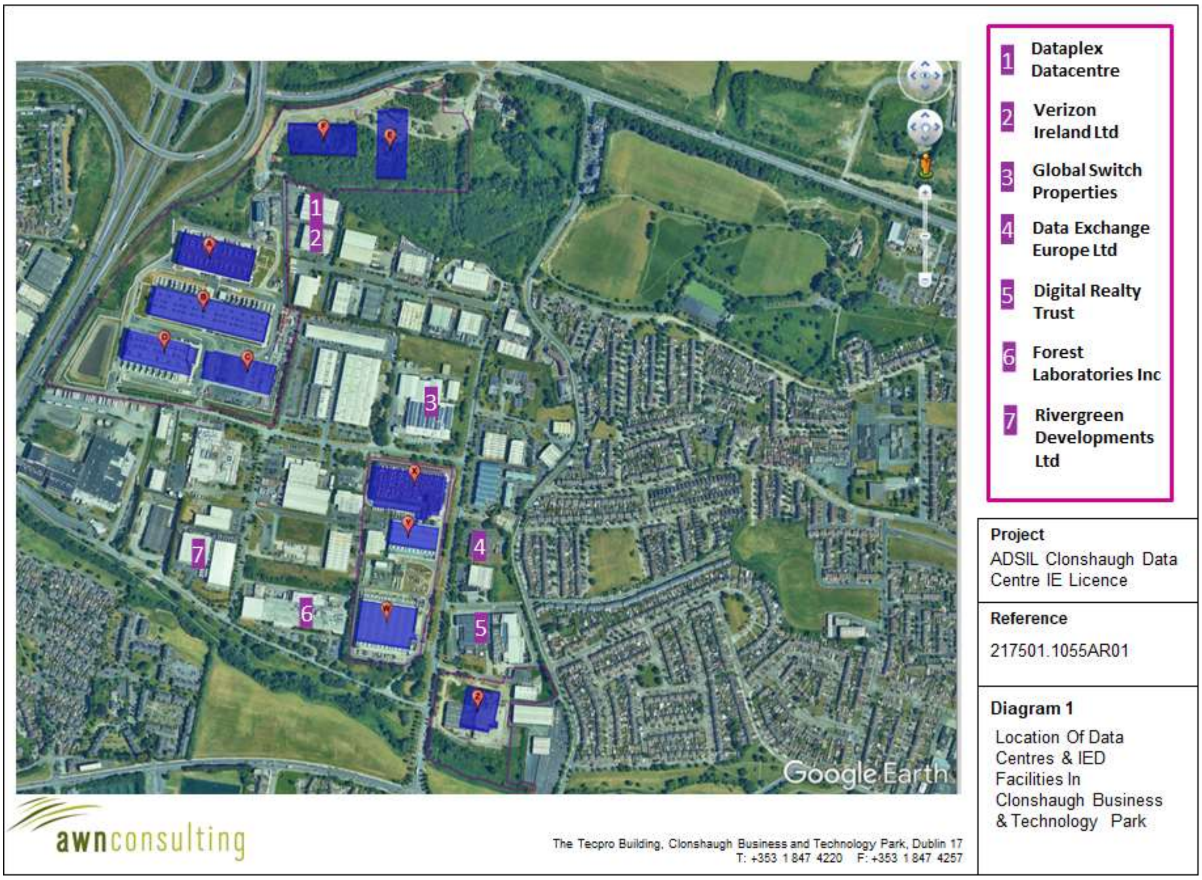


Diagram 1 *Location Of Data Centres & IED Facilities In Clonshaugh Business & Technology Park*

Information supporting the conclusions of the air dispersion modelling assessment is detailed in the following sections. The assessment methodology and study inputs are presented in Section 2 and Section 3. Background pollutant concentrations are summarised in Section 4. The process emissions and modelling inputs for on-site plant are presented in Section 5. The dispersion modelling results are presented in Section 6 and the assessment summaries are presented in Section 7. The model formulation is detailed in Appendix I and a review of the meteorological data used is detailed in Appendix II.

2.0 ASSESSMENT CRITERIA

2.1 Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or “Air Quality Standards” are health or environmental-based levels for which additional factors may be considered. The applicable standards in Ireland include the Air Quality Standards Regulations 2022, implement the obligations under Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (see Table 1). The ambient air quality standards applicable for NO_2, CO, PM_{10}, $PM_{2.5}$ and SO_2 and are outlined in this Directive.

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The standards outlined in Table 1 have been used in the current assessment to determine the potential impact of air emissions from the facility on ambient air quality.

Table 1 *Ambient Air Quality Standards*

Pollutant	Regulation/ Guideline	Limit Type	Value
Nitrogen Dioxide (NO_2)	2008/50/EC Note 1	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 μg/m^3 Note 2
		Annual limit for protection of human health	40 μg/m^3
Carbon Monoxide (CO)	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	10,000 μg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 μg/m^3
		Annual limit for protection of human health	40 μg/m^3
Particulate Matter (as $PM_{2.5}$) Stage 1	2008/50/EC	Annual limit for protection of human health	25 μg/m^3
Particulate Matter (as $PM_{2.5}$) Stage 2	2008/50/EC	Annual limit for protection of human health	20 μg/m^3 Note 3
Sulphur Dioxide (SO_2)	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	350 μg/m^3
		24-Hourly limit for protection of human health - not to be exceeded more than 3 times/year	125 μg/m^3
		Critical level for protection of vegetation (annual and winter)	10-30 μg/m^3

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 μg/m^3 (micrograms per cubic metre)

Note 3 Stage 2 indicative limit value to be reviewed by the European Commission in 2013. Due to come into force in January 2020, however, no update from the Commission has been published.

2.2 Industrial Emissions Directive and Medium Combustion Plant Directive

The Industrial Emissions Directive (IED) (Directive 2010/75/EU) was adopted on 7 January 2013 and is the key European Directive which covers the regulation of the majority of processes in the EU. As part of the IED Article 15, paragraph 2, requires that Emissions Limit Values (ELVs) are based on best available techniques (BAT) and the relevant sector Reference Document of Best Available Techniques (BREF documents).

The most relevant BAT sector document for the activities at the installation is the Best Available Techniques (BAT) Reference Document for Large Combustion Plants LCP. There are no ELVs set out in the LCP BAT that are applicable to the individual emergency back-up generators.

The individual emergency back-up generators are greater than 1 MW_{th} and the Medium Combustion Plant (MCP) Regulations (S.I No. 595 of 2017), which transposed the Medium Combustion Plant Directive ((EU) 2015/2193) is a relevant consideration in respect of the individual plant.

The installation requires a continuous supply of electricity to operate. During normal operations, the facility is supplied electricity from the national grid. Outside of normal operations, the facility is first supplied electricity by some or all of the onsite battery installations and then by some or all of the onsite backup generators. Outside of routine testing and maintenance, the operation of these back-up generators is typically only required under the following emergency circumstances:

- A loss, reduction or instability of grid power supply,
- Critical maintenance to power systems,
- A request from the utility supplier (or third party acting on its behalf) to reduce grid electricity load.

The generators are for emergency back-up only and are not anticipated to operate in excess of 500 hours per annum. Therefore, the emergency generators as proposed are exempt from complying with the relevant ELVs set out in the MCP Directive subject to Section 13(3) of the Medium Combustion Plant (MCP) Regulations.

The UK Environment Agency assessment methodology in Section 6.2 below determined that the standby generators could operate for 137 hours before there is a likelihood of an exceedance of the ambient air quality standard (at a 98^{th} percentile confidence level). However, the UK guidance recommends that there should be no running time restrictions placed on standby generators which provide power on site only during an emergency power outage.

2.3 Sensitive areas or areas of special interest

Appropriate Assessment (AA) Screening Reports (Attachment 6-3-4) have been prepared by Moore Group for the existing Installation (Buildings W, X, Y) and the extended Installation (Buildings U, V) and have been submitted as part of the licence review application for the site.

The AA Screenings identify that the lands in which the overall installation is located have no formal designations, and that the nearest European site to the Installation are the Dublin Bay sites, with the nearest being the Baldoyle Bay SAC (Site Code 000199) at 5km east of the site and South Dublin Bay and River Tolka Estuary SPA (Site Code 004024) situated almost 4km to the south. Other nearby sites are the North Dublin Bay

SAC (000206) and North Bull Island SPA (Site Code 004006); these are located over 4km to the east of the facility.

Emissions of NO_X have the potential to impact vegetation and sensitive plant species. Directive 2008/50/EC has set limit values for vegetation effects as per Table 1. As such it is typical to assess the impact of NO_X emissions from a facility on any nearby sensitive ecological areas in close proximity to the site. There are no European sites within 1 km of the subject site as noted above. The closest sensitive ecological area is the Santry Demesne Proposed NHA (000178) which is located within 1 km south-west of the subject site. Dispersion modelling of NO_X emissions from the installation has been conducted within the Santry Demesne pNHA to determine the potential impact to vegetation as a result of emissions from the back-up generators on site. Emissions from the back-up generators are not predicted to be significant at this distance from the installation as emission concentrations peak at the site boundary and fall off rapidly with increasing distance from the installation.

An annual limit value of 30 µg/m^3 for NO_X and 20 µg/m^3 for SO_2 is specified within EU Directive 2008/50/EC for the protection of ecosystems. The NO_X limit value is applicable only in highly rural areas away from major sources of NO_X such as large conurbations, factories and high road vehicle activity such as a dual carriageway or motorway. Annex III of EU Directive 2008/50/EC identifies that monitoring to demonstrate compliance with the NO_X limit value for the protection of vegetation should be carried out distances greater than:

- 5 km from the nearest motorway or dual carriageway;
- 5 km from the nearest major industrial installation;
- 20 km from a major urban conurbation.

There are sections of designated sites which are near the facility that are close to industrial facilities, so the limit value for NO_X for the protection of ecosystems is not technically applicable at these sites. Regardless, the annual average concentrations for NO_X from all emission points at the facility were predicted at receptors within the designated sites for all five years of meteorological data modelled (2018 – 2022). With receptor spacing of 500 m, 1,777 discrete receptors were modelled in total within the sensitive ecosystems.

In order to consider the effects of nitrogen and acid deposition owing to emissions from the facility on the designated habitat sites, the maximum annual mean NO_2 and SO_2 predicted environmental concentrations must be converted firstly into a dry deposition flux using the equation below which is taken from UK Environment Agency publication “AGTAG06 – Technical Guidance On Detailed Modelling Approach For An Appropriate Assessment For Emissions To Air”(3):

Dry deposition flux (µg/m^2/s) = ground-level concentration (µg/m^3) x deposition velocity (m/s)

The deposition velocities for NO_2 and SO_2 are outlined in AQTAG06 and shown below in Table 2. The dry deposition flux is then multiplied by conversion factors shown in Table 2 (taken from AQTAG06) to convert it to a nitrogen (N) and sulphur (S) deposition flux (kg/ha/yr), and to an acid deposition flux (keq/ha/yr).

Table 2. *Dry Deposition Fluxes for NO_2 and SO_2*

Chemical Species	Habitat Type	Recommended Deposition Velocity (m/s)	Nitrogen Deposition Conversion factor μg/m²/s to kg/ha/yr	Acid Deposition Conversion factor μg/m²/s to keq/ha/yr
NO_2	Grassland	0.0015	95.9	6.84
SO_2	Grassland	0.012	157.7	9.84

Background concentrations for NO_X, nitrogen and acid deposition at the worst-case designated habitat were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website[(4)] in line with UKEA[(5)] and UK Defra[(6)] Guidance and are given in Section 4.0. The background concentrations are added directly to the modelled NO_X, SO_2, nitrogen and acid deposition process contributions to give a total predicted environmental concentration as outlined in Section 6.

3.0 ASSESSMENT METHODOLOGY

Emissions from the facility are modelled using the AERMOD dispersion model (Version 23132) which has been developed by the U.S. Environmental Protection Agency (USEPA)[(1)] and following guidance issued by the EPA[(2)]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources and has replaced ISCST3[(7)] as the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain[(8-10)]. The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies[(11-13)]. An overview of the AERMOD dispersion model is outlined in Appendix I.

The air 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. This worst-case concentration is then added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC is then compared with the relevant ambient air quality standard to assess the significance of the releases from the site.

The modelling aims to achieve compliance with the guidance outlined within the EPA *AG4 Guidance for Air Dispersion Modelling*[(2)]. Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Maximum predicted concentrations are reported in this study, even if no residential receptors are near the location of this maximum;
- Conservative background concentrations are used in the assessment;
- The effects of building downwash, due to on-site buildings, are included in the model;

- Emergency operations were assumed to occur for a maximum of 150 hours per year calculated according to USEPA methodology, in reality generators are likely to be used for maintenance and testing purposes only.

3.1 Air 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:

- Two receptor grids are included at which concentrations are modelled. Receptors are mapped with sufficient resolution to ensure all localised "hot-spots" are identified without adding unduly to processing time. The receptor grids are based on Cartesian grids with the site at the centre. The outer grid measures 10 x 10 km with the site at the centre and with concentrations calculated at 250m intervals. The inner grid measures 2 x 2 km with the site at the centre and with concentrations calculated at 50m intervals. Boundary receptor locations are also placed along the boundary of the site, at 25m intervals, giving a total of 3,567 calculation points for the model.
- Discrete receptors are also added to the model to represent nearby residential receptors.
- All on-site and nearby buildings are mapped to create a three-dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash are incorporated into the modelling.
- Detailed terrain has been mapped into the model using SRTM data with 30m resolution. The site is located in an area of complex terrain. All terrain features have been mapped in detail into the model using the terrain pre-processor AERMAP(14).
- Hourly-sequenced meteorological information has been used in the model. Meteorological data over a five-year period (Dublin Airport 2018 – 2022) is used in the model (see Figure 1 and Appendix II).
- The source and emissions data, including stack dimensions, gas volumes and emission temperatures have been incorporated into the model.

3.2 Terrain

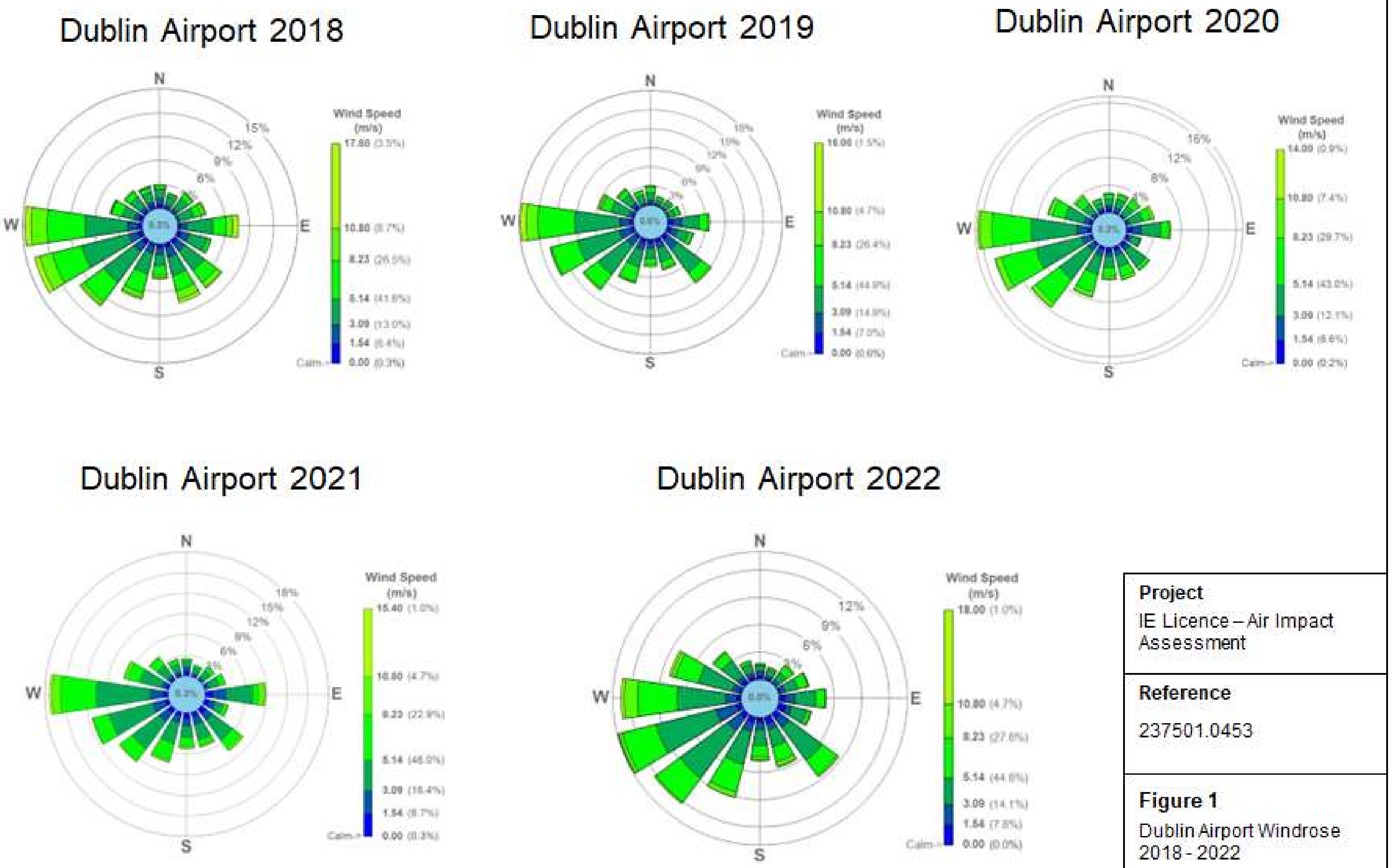
The AERMOD air dispersion model has a terrain pre-processor AERMAP(14) which is used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor is obtained from SRTM. This data is run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digital Elevation Model (DEM) files in AERMAP by computing the relief height of the DEM point relative to the height of the receptor and determining the slope. If the slope is less than 10%, the program goes to the next DEM point. If the slope is 10% or greater, the controlling hill height is updated if it is higher than the stored hill height.

In areas of complex terrain, AERMOD models the impact of terrain using the concept of the dividing streamline (H_c). As outlined in the AERMOD model formulation(1) a plume embedded in the flow below H_c tends to remain horizontal; it might go around the hill or impact on it. A plume above H_c will ride over the hill. Associated with this is a tendency for the plume to be depressed toward the terrain surface, for the flow to speed up, and for vertical turbulent intensities to increase.

The AERMOD model "captures the effect of flow above and below the dividing streamline by weighting the plume concentration associated with two possible extreme states of the boundary layer (horizontal plume and terrain-following). The relative weighting of the two states depends on: 1) the degree of atmospheric stability; 2) the wind speed; and 3) the plume height relative to terrain. In stable conditions, the horizontal plume "dominates" and is given greater weight while in neutral and unstable conditions, the plume traveling over the terrain is more heavily weighted"(1).

3.3 Meteorological Data

The selection of the appropriate meteorological data has followed the guidance issued by the USEPA(1). A primary requirement is that the data used should have a data capture of greater than 90% for all parameters. Dublin Airport meteorological station, which is located approximately 2 km north-west of the site, collects data in the correct format and has a data collection of greater than 90%. Long-term hourly observations at Dublin Airport meteorological station provide an indication of the prevailing wind conditions for the region (see Figure 1 and Appendix II). Results indicate that the prevailing wind direction is westerly to south-westerly in direction over the period 2018 – 2022. The mean wind speed is approximately 5.3 m/s over the period 2018 - 2022.



Project
IE Licence – Air Impact Assessment

Reference
237501.0453

Figure 1
Dublin Airport Windrose 2018 - 2022

awnconsulting
The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
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3.4 Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory[1]. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture. Surface roughness is a measure of the aerodynamic roughness of the surface and is related to the height of the roughness element. Albedo is a measure of the reflectivity of the surface whilst the Bowen ratio is a measure of the availability of surface moisture.

AERMOD incorporates a meteorological pre-processor AERMET[15] to enable the calculation of the appropriate parameters. The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), 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 is 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[16,17] as outlined in Appendix II.

In relation to AERMOD, detailed guidance for calculating the relevant surface parameters has been published[15]. The most pertinent features are:

- The surface characteristics should be those of the meteorological site (Dublin Airport) rather than the installation;
- Surface roughness should use a default 1km radius upwind of the meteorological tower and should be based on an inverse-distance weighted geometric mean. If land use varies around the site, the land use should be sub-divided by sectors with a minimum sector size of 30º;
- Bowen ratio and albedo should be based on a 10km grid. The Bowen ratio should be based on an un-weighted geometric mean. The albedo should be based on a simple un-weighted arithmetic mean.

AERMOD has an associated pre-processor, AERSURFACE[16] which has representative values for these parameters depending on land use type. The AERSURFACE pre-processor currently only accepts NLCD92 land use data which covers the USA. Thus, manual input of surface parameters is necessary when modelling in Ireland. Ordnance survey discovery maps (1:50,000) and digital maps such as those provided by the EPA, National Parks and Wildlife Service (NPWS) and Google Earth® are useful in determining the relevant land use in the region of the meteorological station. The Alaska Department of Environmental Conservation has issued a guidance note for the manual calculation of geometric mean for surface roughness and Bowen ratio for use in AERMET[17]. This approach has been applied to the current site with full details provided in Appendix II.

3.5 Building Downwash

When modelling emissions from an industrial installation, stacks which are relatively short can be subjected to additional turbulence due to the presence of nearby buildings. Buildings are considered nearby if they are within five times the lesser of the building height or maximum projected building width (but not greater than 800m).

The USEPA has defined the “Good Engineering Practice” (GEP) stack height as the building height plus 1.5 times the lesser of the building height or maximum projected building width. It is generally considered unlikely that building downwash will occur when stacks are at or greater than GEP[(18)].

When stacks are less than this height, building downwash will tend to occur. As the wind approaches a building it is forced upwards and around the building leading to the formation of turbulent eddies. In the lee of the building these eddies will lead to downward mixing (reduced plume centreline and reduced plume rise) and the creation of a cavity zone (near wake) where re-circulation of the air can occur. Plumes released from short stacks may be entrained in this airflow leading to higher ground level concentrations than in the absence of the building.

The Plume Rise Model Enhancements (PRIME)[(12,13)] plume rise and building downwash algorithms, which calculates the impact of buildings on plume rise and dispersion, have been incorporated into AERMOD. The building input processor BPIP-PRIME produces the parameters which are required in order to run PRIME. The model takes into account the position of each stack relative to each relevant building and the projected shape of each building for 36 wind directions (at 10º intervals). The model determines the change in plume centreline location with downwind distance based on the slope of the mean streamlines and coupled to a numerical plume rise model[(13)].

Given that the stacks are less than 2.5 times the lesser of the building height or maximum projected building width, building downwash will need to be taken into account and the PRIME algorithm run prior to modelling with AERMOD. The dominant building for each relevant stack will vary as a function of wind direction and relative building heights.

4.0 BACKGROUND CONCENTRATIONS OF POLLUTANTS

Air quality monitoring programmes have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "*Air Quality in Ireland 2022*", details the range and scope of monitoring undertaken throughout Ireland. As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes. Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 25 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000 is defined as Zone D. In terms of air monitoring, Clonshaugh is categorised as Zone A(19, 20).

In 2020 the EPA reported that Ireland was compliant with EU legal limits at all locations, however this was largely due to the reduction in traffic due to Covid-19 restrictions. The EPA report details the effect that the Covid-19 restrictions had on stations, which included reductions of up to 50% at some monitoring stations which have traffic as a dominant source. The report also notes that Central Statistics Office (CSO) figures show that while traffic volumes are still slightly below 2019 levels, they have significantly increased since 2020 levels. 2020 concentrations are therefore predicted to be an exceptional year and not consistent with long-term trends. For this reason, they have been reported in the baseline section but not included in the long-term trend analysis.

NO_2 concentrations at the Zone A monitoring locations of Ballyfermot, Swords and Tallaght show that current levels of NO_2 are below both the annual and 1-hour limit values, with annual average levels ranging from 12 – 14 μg/m^3 in 2022 (see Table 3). The 5-year average data for Ballyfermot and Swords for the period 2017 – 2022 (excluding 2020 due to COVID-19) and 2-year average data for Tallaght (2021 – 2022) was used to estimate the current background NO_2 concentration in the region of the facility. Over the period 2017 – 2022 annual mean NO_2 concentrations at the selected sites ranged from 11 – 20 μg/m^3 with an overall 5-year average across the three sites of 14.2 μg/m^3. In addition, there were no exceedances of the 1-hour limit value for NO_2.

Based on these results, a conservative estimate of the background NO_2 concentration in the region of the facility is 15 μg/m^3.

Table 3. Annual Mean and 99.8th Percentile 1-Hour NO_2 Concentrations In Zone A Locations ($\mu g/m^3$)

Station	Averaging Period	Year					
		2017	2018	2019	2020	2021	2022
Ballyfermot	Annual Mean NO_2 ($\mu g/m^3$)	17	20	12	13	14	13
	99.8th%ile 1hr NO_2 ($\mu g/m^3$)	112	87	102	81	69	81
Swords	Annual Mean NO_2 ($\mu g/m^3$)	14	16	15	11	11	12
	99.8th%ile 1hr NO_2 ($\mu g/m^3$)	79	85	80	65	63	70
Tallaght	Annual Mean NO_2 ($\mu g/m^3$)	-	-	-	14	13	14
	99.8th%ile 1hr NO_2 ($\mu g/m^3$)	-	-	-	79	71	88

Note 1 Annual average limit value of 40 $\mu g/m^3$ and hourly limit value of 200 $\mu g/m^3$ (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

The Ozone Limiting Method (OLM) was used to model NO_2 concentrations. The OLM is a regulatory option in AERMOD which assumes that the amount of NO converted to NO_2 is proportional to the ambient ozone concentration. The concentration is usually limited by the amount of ambient O_3 that is entrained in the plume. Thus, the ratio of the moles of O_3 to the moles of NO_X gives the ratio of NO_2/NO_X that is formed after the NO_X leaves the stack. In addition, it has been assumed that 10% of the NOx from the backup generators is already in the form of NO_2 before the gas leaves the stack. The equation used in the algorithm to derive the ratio of NO_2/NO_X is:

$$NO_2/NO_X = (\text{moles } O_3/ \text{ moles } NO_X) + 0.10$$

A background ozone concentration of 55 $\mu g/m^3$ was used in the modelling assessment, based on a review of worst case background ozone data for Zone A sites.

For the modelling assessment as per Section 3.0, the modelled process concentration is added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC is then compared with the relevant ambient air quality standard to assess the significance of the releases from the site. NO_2 has ambient air quality standards for both annual mean and hourly concentrations that must be complied with (see Section 2.1). In relation to the annual average background, the ambient background concentration was added directly to the process concentration with the short-term (hourly) peaks assumed to have an ambient background concentration of twice the annual mean background concentration.

CO

In terms of CO, monitoring has been conducted at the suburban background Zone A site of Dublin Airport over the period 2020 – 2022. There are no other suitably representative CO monitoring stations within Zone A. Monitored concentrations of CO are significantly below the ambient limit value of 10 mg/m^3. Maximum 8-hour concentrations at the Dublin Airport site ranged from 0.7 mg/m^3 – 3.7 mg/m^3 over the period 2020 – 2022. Based on these results a background 8-hour CO concentration of 3.7 mg/m^3 has been used in the modelling assessment.

This estimated background concentration has been added directly to the modelled 8-hour maximum result to produce the predicted environmental concentration (PEC) in terms of CO.

PM_{10}

Continuous PM_{10} monitoring carried out at the suburban background locations of Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park showed annual mean concentrations ranging from 11–14 µg/m^3 in 2022 (Table 4), with at most 7 exceedances (in Ballyfermot) of the daily limit value of 50 µg/m^3 (35 exceedances are permitted per year). Sufficient data is available for Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park and St. Anne's Park to observe trends over the period 2018 – 2022. Average annual mean PM_{10} concentrations ranged from 10 – 16 µg/m^3 over this period, suggesting an upper average concentration of no more than 16 µg/m^3. Based on these results, a conservative estimate of the background PM_{10} concentration in the region of the facility is 16 µg/m^3.

Table 4. Annual Mean and 24-Hour Mean PM_{10} Concentrations In Zone A Locations (µg/m^3)

Station	Averaging Period	Year				
		2018	2019	2020	2021	2022
Ballyfermot	Annual Mean PM_{10} (µg/m^3)	16	14	12	12	13
	24-hr Mean > 50 µg/m^3 (days)	0	7	2	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	26	26	20	21	21
Dún Laoghaire	Annual Mean PM_{10} (µg/m^3)	13	12	12	11	12
	24-hr Mean > 50 µg/m^3 (days)	0	2	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	25	24	20	19	21
Finglas	Annual Mean PM_{10} (µg/m^3)	11	13	12	12	12
	24-hr Mean > 50 µg/m^3 (days)	1	2	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	-	21	20	19
Marino	Annual Mean PM_{10} (µg/m^3)	12	14	13	12	14
	24-hr Mean > 50 µg/m^3 (days)	0	4	0	0	3
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	74	23	20	23
Phoenix Park	Annual Mean PM_{10} (µg/m^3)	11	11	10	10	11
	24-hr Mean > 50 µg/m^3 (days)	0	2	0	0	0
	90.4th%ile 24-hr PM_{10} (µg/m^3)	19	18	18	17	18
St. Anne's Park	Annual Mean PM_{10} (µg/m^3)	11	12	11	11	13
	24-hr Mean > 50 µg/m^3 (days)	0	1	0	0	1
	90.4th%ile 24-hr PM_{10} (µg/m^3)	-	-	19	18	22

Note 1 Annual average limit value of 40 µg/m^3 and hourly limit value of 200 µg/m^3 (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

In relation to the annual averages, the ambient background concentration is added directly to the process concentration. However, in relation to the short-term peak concentration, concentrations due to emissions from elevated sources cannot be combined in the same way. Guidance from the UK DEFRA(5) and the EPA(2) advises that for PM_{10} an estimate of the maximum combined pollutant concentration can be obtained as shown below:

PM_{10} - The 90.4th%ile of total 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

A 90.4th percentile 24-hour background concentration of 22.9 µg/m³ was used in the assessment, based on average concentrations for the above stations over the period 2018 – 2022.

$PM_{2.5}$

Continuous $PM_{2.5}$ monitoring carried out at the Zone A suburban background locations of Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park showed annual mean concentrations ranging from 6 – 9 µg/m³ in 2022 (see Table 5). Sufficient data is available for Ballyfermot, Dún Laoghaire, Finglas, Marino, Phoenix Park, and St. Anne's Park to observe trends over the period 2018 – 2022. Average annual mean $PM_{2.5}$ concentrations ranged from 6 – 10 µg/m³ over this period, suggesting an upper average concentration of no more than 10 µg/m³. Based on this information, a conservative estimate of the background $PM_{2.5}$ concentration in the region of the facility is 10 µg/m³.

Table 5. Annual Mean $PM_{2.5}$ Concentrations In Zone A Locations (µg/m³)

Station	Averaging Period	Year				
		2018	2019	2020	2021	2022
Ballyfermot	Annual Mean $PM_{2.5}$ (µg/m³)	7.0	10.0	8.0	7.8	7.5
Dublin Airport	Annual Mean $PM_{2.5}$ (µg/m³)	-	-	6.0	6.4	6.7
Finglas	Annual Mean $PM_{2.5}$ (µg/m³)	8.0	9.0	7.0	7.5	7.3
Marino	Annual Mean $PM_{2.5}$ (µg/m³)	6.0	9.0	8.0	7.9	8.9
Phoenix Park	Annual Mean $PM_{2.5}$ (µg/m³)	6.0	8.0	7.0	6.4	6.3
St. Anne's Park	Annual Mean $PM_{2.5}$ (µg/m³)	7.0	8.0	7.0	6.9	7.8

Note 1 Annual average limit value of 25 µg/m³ (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

SO_2

Continuous SO_2 monitoring carried out at the Zone A suburban background locations of Rathmines and Dublin Airport showed annual mean concentrations ranging from 1.7 – 5.8 µg/m³ in 2022 (see Table 6). Sufficient data is available for Rathmines and Ringsend to observe trends over the period 2018 – 2022. Average annual mean SO_2 concentrations ranged from 1.1 – 3.3 µg/m³ over the period of 2018 – 2022, suggesting an upper average concentration of no more than 3.3 µg/m³. Based on this information, a conservative estimate of the background SO_2 concentration in the region of the facility is 4 µg/m³. The 99.7th%ile of 1-hour means in 2022 ranged from 7.9 – 19.7 µg/m³ whilst the 99.2th%ile of 24-hour means in 2022 ranged from 4.7 – 12.1 µg/m³.

A 1-hour background of 51 µg/m³ was used in the assessment based on the maximum 1-hour concentrations over the period 2018 – 2022. A 24-hour background concentration of 20 µg/m³ was used In the assessment based on the maximum 24-hour concentrations over the period 2018 – 2022.

Table 6. Annual Mean, 1-Hour and 24-Hour Mean SO_2 Concentrations In Zone A Locations (μg/m³)

Station	Averaging Period	Year				
		2018	2019	2020	2021	2022
Rathmines	Annual Mean SO_2 (μg/m³) Note 1	2.3	1.3	1.4	1.1	1.8
	99.7th%ile of 1-hour mean SO_2 (μg/m³) Note 2	25.0	29.3	14.6	23.1	7.9
	99.2th%ile of 24-hour mean SO_2 (μg/m³) Note 3	8.0	4.3	5.1	6.1	4.7
Dublin Airport	Annual Mean SO_2 (μg/m³)	-	-	3.8	4.6	5.8
	99.7th%ile of 1-hour mean SO_2 (μg/m³) Note 2	-	-	20.2	23.9	13.3
	99.2th%ile of 24-hour mean SO_2 (μg/m³) Note 3	-	-	13.6	18.4	12.1
Dublin Port	Annual Mean SO_2 (μg/m³)	-	-	2.4	2.3	1.7
	99.7th%ile of 1-hour mean SO_2 (μg/m³) Note 2	-	-	84.3	49.9	19.7
	99.2th%ile of 24-hour mean SO_2 (μg/m³) Note 3	-	-	26.6	22.1	10.1
Ringsend	Annual Mean SO_2 (μg/m³)	3.3	1.4	2.1	2.7	2.9
	99.7th%ile of 1-hour mean SO_2 (μg/m³) Note 2	51.0	42.8	18.4	12.5	12.8
	99.2th%ile of 24-hour mean SO_2 (μg/m³) Note 3	20.0	6.9	8.1	8.0	5.6

Note 1 Annual average limit value of 20 μg/m³ (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

Note 2 24 hour limit value of 125 μg/m³ not to be exceeded more than 3 times per year (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

Note 3 Hourly limit value of 350 μg/m³ not to be exceeded more than 24 times per year (EU Council Directive 2008/50/EC & S.I. No. 739 of 2022)

When calculating the short-term peak results, concentrations due to emissions from stacks cannot be combined by directly adding the annual background level to the modelling results. Guidance from the UK DEFRA(5) and EPA(2) advises that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2)

SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

Sensitive Designated Habitat

Background concentrations for NO_X, SO_2, and nitrogen and acid deposition at the most impacted modelled designated habitats, Baldoyle Bay SAC and the Santry Demesne Proposed NHA, were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website[(4)], in line with UKEA[(6)] and UK Defra[(5)(5)] guidance and are shown in Table 7. The background concentrations are added directly to the modelled process contributions to give a total predicted environmental concentration.

Table 7. Background Concentrations for NO_X, SO_2, Nitrogen and Acid Deposition (Grid Average) (APIS, 2024)

Closest Sensitive Designated Habitat	NO_x (μg/m^3)	SO_2 (μg/m^3)	Nitrogen Deposition (kg/ha/yr)	Acid Deposition (keq/ha/yr)
Santry Demesne pNHA	4.0	1.5	6.8	0.5
Baldoyle Bay SAC	7.6	2.0	5.4	0.5

5.0 PROCESS EMISSIONS

The installation has no major emissions to air and only has minor (emergency generators) emissions that will generate quantities of air pollutants listed as a Principal Pollution Substance (*S.I. No. 137/2013 - Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations 2013*).

Building W has been modelled with 13 no. back-up generator stacks which have a minimum height of 6m above ground level and Building X has 7 no. back-up generator stacks which have a minimum height of 16m above ground level. Building Y has 20 no. back-up generator stacks which have a minimum height of 16m above ground level. Building U has 11 no. back-up generator stacks which have a minimum height of 25m above ground level whilst Building V has 1 no. back-up generator stack which has a minimum height of 15.6m above ground level. Two of the back-up generators in each Building W, Y and U and one of the back-up generators in Building X are modelled as “catcher” generators to provide redundancy for the other back-up generators i.e. 45 no. of the 52 no. back-up generators are assumed to be running simultaneously in the event of a power failure to the site.

In addition to the emergency back-up generators which will power the site in the event of a power failure to the site, the site also includes 6 no. Fire Pump generators (two at 0.423 MWth, two at 0.337 MWth and two at 0.57 MWth). The Fire Pump generators have been scoped out of this air modelling assessment as it is not expected that they would cause any significant impacts on ambient air quality considering their smaller scale (compared to the data hall back-up generators) and the low number required for use at any one time.

The scenarios modelled for this assessment also include the following types of testing of the back-up generators:

- **Test 1:** Testing once per week of all 52 no. back-up generators on the campus at 25% load for a maximum of 30 minutes each, one generator at a time, sequentially;

- **Test 2:** All 52 no. back-up generators will be periodically tested on an individual basis at 100% load for a maximum of 16 hours per year. This is incorporated into the dispersion model as each generator operating on an individual basis, at 100% load, for four hours, once per quarter (assumed to be January, April, June and October for the purpose of this assessment); and
- All testing is assumed to only occur between 8am and 5pm, Monday to Friday.

5.1 Emergency Operations

The generators will operate in an emergency scenario as per the criteria in Section 2.2. In addition, testing of the generators will be required as outlined above.

There are two methodologies used to determine the impact from the operation of the generators using diesel fuel on ambient air quality. Both methodologies from the USEPA and UK EA have been used in this assessment, this follows the guidance outlined in Appendix K of the Irish EPA document AG4(2). Emission details can be seen in Table 4.

USEPA Guidance suggests that for emergency operations, an average hourly emission rate should be used rather than the maximum hourly rate(21). As a result, the maximum hourly emission rates from the generators are reduced by $\frac{150}{8760}$ and the generators are modelled over a period of one full year.

A second methodology has been published by the UK Environment Agency. The consultation document is entitled "*Diesel Generator Short-Term NO_2 Impact Assessment*"(22). The methodology is based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value (18 exceedances are allowable per year before the air standard is deemed to have been exceeded). The assessment assumes a hypergeometric distribution to assess the likelihood of exceedance hours coinciding with the emergency operational hours of the generators. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The guidance suggests that the 95th percentile confidence level should be used to indicate if an exceedance is likely. More recent guidance(23) has recommended this probability should be multiplied by a factor of 2.5 and therefore the 98th percentile confidence level should be used to indicate if an exceedance is likely. The guidance suggests that the assessment should be conducted at the nearest residential receptor or at locations where people are likely to be exposed and that there should be no running time restrictions on these generators when providing power on site during an emergency.

Both the methodology advised in the USEPA guidance as well as the approach described in the UK EA guidance have been applied for the emergency scenario modelled in this study to ensure a robust assessment of predicted air quality impacts from the generators. This also follows the guidance outlined in Appendix K of the EPA AG4 guidance(2).

The modelling is undertaken to assess the impact to ambient air quality from the following three emergency operations scenarios:

- **The Facility:** This includes the emergency operation of 45 no. of the 52 no. generators (the remaining seven generators serving as "catcher" generators for Buildings W, X, Y, U and V) using diesel fuel. The scenario also included testing of all 52 no. generators as described above. The process emissions are outlined in Table 3;

- **Cumulative Impact Scenario:** A cumulative impact assessment of the facility and nearby sites within a 1km radius was also conducted. Sites which hold an IED licence from the EPA were assessed for relevant air emissions. There are 2 no. IE licenced sites within 1km of the facility, these are Global Switch Property (Dublin) Ltd (Licence No. P0109) and Forest Laboratories Ireland Ltd (Licence No. P0306) within Clonshaugh Business & Technology Park. However, both of these facilities have no licenced NO_X emission points and thus have not been included in the cumulative air modelling assessment. Additionally, the Applicant operates a separate data storage facility to the north-west of the subject site which is referred to as Building A, B, C, D, E and F. Because the Operator has sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at the facility they operate, these emission sources have been included in the cumulative assessment. Two additional data centres, referred to as the Dataplex data centre (located at the eastern boundary of the Building A to Building F facility) and Digital Realty data centre, located directly north of Building U have been identified within the study area. The operational details of these facilities are known through a review of the relevant planning permissions and sufficient information about the emissions associated with emergency back-up generator testing, maintenance and emergency operations at these facilities is available and thus these have been included in the cumulative assessment.

Table 8. *Summary of Process Emission Information for all Buildings associated with the Facility*

Stack Reference	Stack Height Above Ground Level (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr at 15% Ref. O_2)	Exit Velocity (m/sec actual)
Emergency Operation and Testing of Back-up Generators in Buildings W, X and Y (100% load)	16.0 – Building X and Y 6.0 – Building W	0.5	0.20	784.3	16,724	41.4
Testing of Generators (25% load) in Buildings W, X, and Y				619.1	4,516	13.8
Emergency Operation and Testing of Back-up Generators in Building U (100% load)	25.0 – Building U	0.3	0.07	738.2	19,557	120
Testing of Generators (25% load) in Building U				655.2	8,300	49.8
Emergency Operation and Testing of Back-up Generator in Building V (100% load)	15.6 – Building V	0.4	0.13	790.2	9,126	33.4
Testing of Generator (25% load) in Building V				639.2	4,032	13.3

Table 9. *Summary of Process Emission Information for all Buildings associated with the Facility*

Stack Reference	NO_x		CO		PM_{10} / $PM_{2.5}$		SO_2	
	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)	Concentration (mg/Nm^3 at 15% Ref. O_2)	Mass Emission (g/s)
Emergency Operation and Testing of Back-up Generators in Buildings W, X and Y (100% load)	673	0.054 Note 1 / 3.13 Note 2	172	0.014 Note 1 / 0.80 Note 2	15.7	0.001 Note 1 / 0.07 Note 2	18.6	0.001 Note 1 / 0.09 Note 2
Testing of Generators (25% load) in Buildings W, X, and Y	847	1.06 Note 3	122	0.15 Note 3	27.1	0.03 Note 3	18.6	0.02 Note 3
Emergency Operation and Testing of Back-up Generators in Building U (100% load)	726	0.068 Note 1 / 3.94 Note 2	98	0.009 Note 1 / 0.53 Note 2	8.5	0.001 Note 1 / 0.05 Note 2	14.1	0.001 Note 1 / 0.08 Note 2
Testing of Generators (25% load) in Building U	600	1.38 Note 3	98	0.23 Note 3	8.5	0.02 Note 3	14.1	0.03 Note 3
Emergency Operation and Testing of Back-up Generators in Building V (100% load)	726	0.032 Note 1 / 1.84 Note 2	379	0.017 Note 1 / 0.96 Note 2	19.7	0.001 Note 1 / 0.05 Note 2	18.6	0.001 Note 1 / 0.05 Note 2
Testing of Generators (25% load) in Building V	600	0.81 Note 3	85	0.09 Note 3	8.9	0.01 Note 3	18.6	0.02 Note 3

Note 1 Reduced emission rates based on USEPA protocol (assuming 150 hours / annum) used to model emissions during emergency operation of generators (100% load)

Note 2 Maximum emission rates for generators (based on 100% load using diesel fuel) used to model emissions during emergency operation of generators for UK EA assessment methodology and for quarterly testing for USEPA assessment methodology

6.0 RESULTS

6.1 The Facility - Emergency Operations Scenario (USEPA Methodology)

6.1.1 NO_2

The NO_2 modelling results at the worst-case location at and beyond the site boundary are detailed in Table 10 based on the operation of 45 of the 52 no. back-up generations for 150 hours per year using diesel fuel, and using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*'[(3)] as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the installation.

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2. For the worst-case year modelled, emissions from the site lead to an ambient NO_2 concentration (including background) which is 93% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) (boundary receptor, location shown in Figure 2) and 90% of the annual limit value at the worst-case off-site receptor (boundary receptor, location shown in Figure 3). Concentrations decrease with distance from the site boundary. The geographical variations in the 1-hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Facility Scenario are illustrated as concentration contours in Figures 2 and 3. The locations of the maximum concentrations for NO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 10. Emergency Operations - Dispersion Model Results for Nitrogen Dioxide (NO_2)

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (PC) (µg/m^3)	Background Concentration (µg/m^3)	Predicted Environmental Concentration (PEC) (µg/m^3)	Limit Value (µg/Nm^3) Note 1	PEC as a % of Limit Value
NO_2 / 2018	Annual Mean	684911, 5920658	19.6	15	34.6	40	86%
	99.8th%ile of 1-hr means	684911, 5920659	146.8	30	176.8	200	88%
NO_2 / 2019	Annual Mean	684911, 5920658	20.9	15	35.9	40	90%
	99.8th%ile of 1-hr means	684911, 5920659	152.7	30	182.7	200	91%
NO_2 / 2020	Annual Mean	684911, 5920658	21.1	15	36.1	40	90%
	99.8th%ile of 1-hr means	684914, 5920683	146.4	30	176.4	200	88%
NO_2 / 2021	Annual Mean	684911, 5920658	19.8	15	34.8	40	87%
	99.8th%ile of 1-hr means	684905, 5920609	155.7	30	185.7	200	93%
NO_2 / 2022	Annual Mean	684911, 5920658	20.1	15	35.1	40	88%
	99.8th%ile of 1-hr means	684905, 5920609	147.7	30	177.7	200	89%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

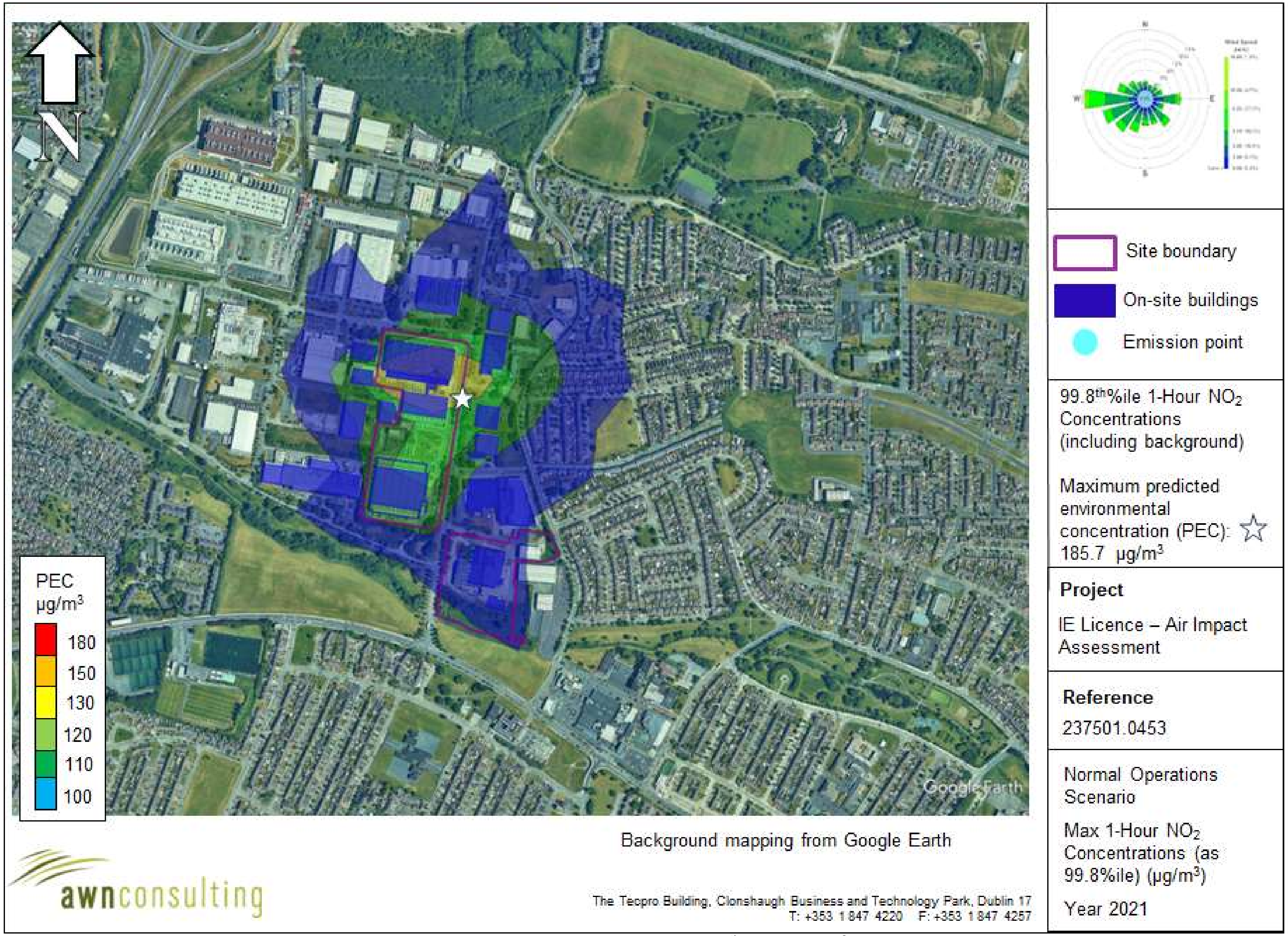

Figure 2 Emergency Operations - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m^3) (including background concentrations)

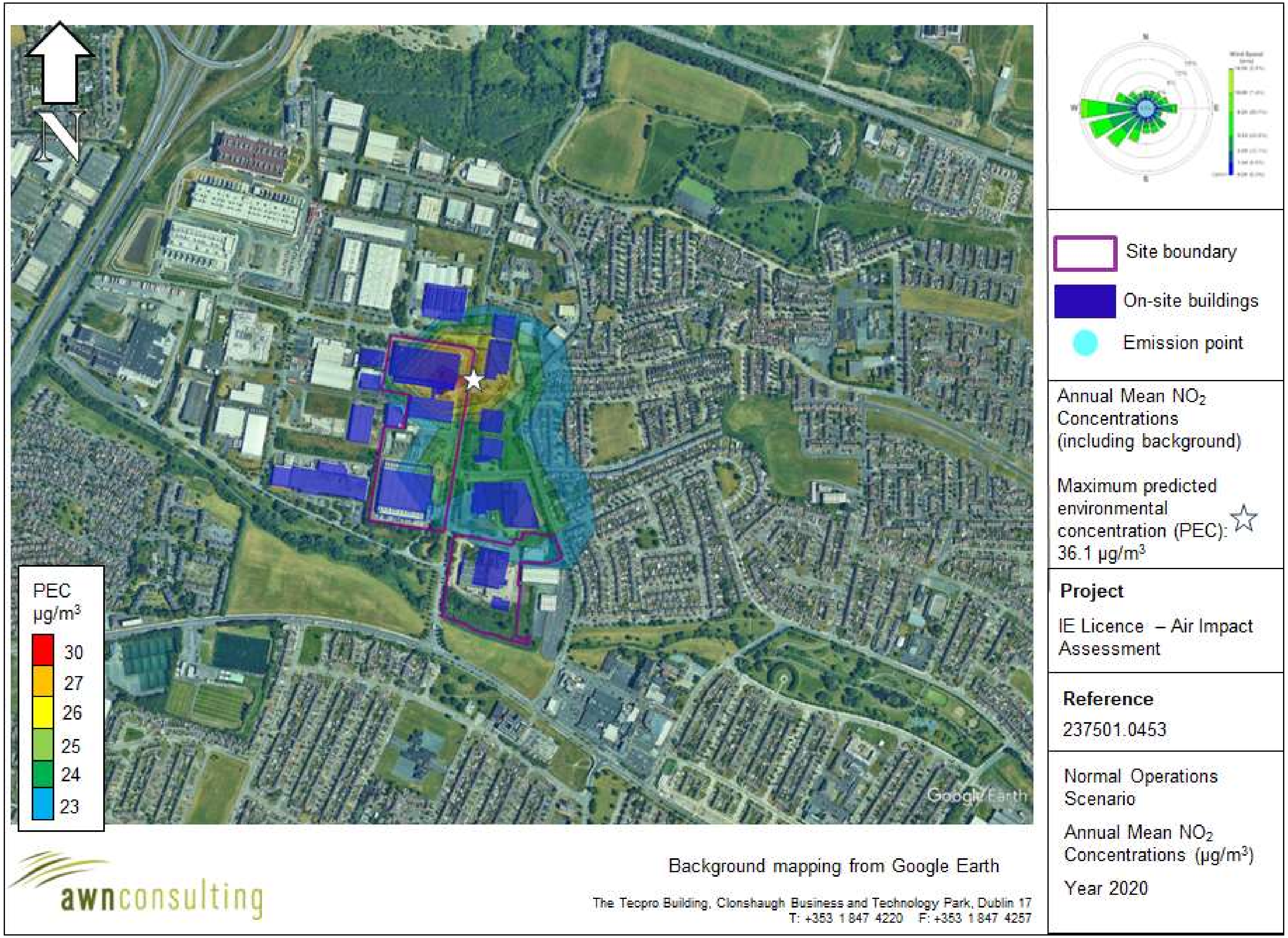

Figure 3 Emergency Operations – Annual Mean NO_2 Concentrations (µg/m^3) (including background concentrations)

6.1.2 CO

The CO modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 11. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for CO. For the worst-case year, emissions from the site lead to an ambient CO concentration (including background) which is 40% of the maximum ambient 8-hour limit value at the worst-case receptor. The locations of the maximum concentrations for CO are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 11. Emergency Operations – Dispersion Model Results for Carbon Monoxide (CO)

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (PC) (mg/m^3)	Background Concentration (mg/m^3)	Predicted Environmental Concentration (PEC) (mg/m^3)	Limit Value (mg/Nm^3) Note 1	PEC as a % of Limit Value
CO / 2018	Maximum Daily 8-Hour Mean	684862, 5920735	0.23	3.7	3.93	10	39%
CO / 2019	Maximum Daily 8-Hour Mean	684911, 5920658	0.23	3.7	3.93	10	39%
CO / 2020	Maximum Daily 8-Hour Mean	684837, 5920738	0.32	3.7	4.02	10	40%
CO / 2021	Maximum Daily 8-Hour Mean	684905, 5920609	0.24	3.7	3.94	10	39%
CO / 2022	Maximum Daily 8-Hour Mean	684837, 5920738	0.32	3.7	4.02	10	40%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.1.3 PM_{10}

Ambient Ground Level Concentrations (GLCs) of PM_{10} modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 12. The results indicate that the ambient ground level concentrations are below the relevant air quality standards for all modelled years for PM_{10}. For the worst-case year, emissions from the site lead to an ambient PM_{10} concentration (including background) which is 48% of the maximum ambient 24-hour limit value (measured as a 90.4^{th}%ile) (2.5% of the limit value excluding background) at the worst-case receptor (boundary receptor, location shown in Figure 4) and 42% of the annual limit value at the worst-case receptor (boundary receptor, location shown in Figure 5).

The geographical variation in the 24-hour mean (90.4^{th}%ile) ground level process contribution (PC) concentrations and annual mean PM_{10} ground level predicted environmental concentrations (PEC) are illustrated as concentration contours in Figure 4 and Figure 5, to demonstrate the direction and extent of the emission plume.

The 24-hour mean PM_{10} predicted environmental concentration contours are not displayed in Figure 4 due to the methodology for calculating the PEC. This is calculated in line with guidance from the UK DEFRA[5] and EPA[2] explained in detail in Section 4.0 which states that the 90.4th%ile of 24-hour mean PM_{10} is equal to the maximum of either A or B below:

a) 90.4th%ile of 24-hour mean background PM_{10} + annual mean process contribution PM_{10}

b) 90.4th%ile 24-hour mean process contribution PM_{10} + annual mean background PM_{10}

Calculating the 24-hour mean (90.4th%ile) PM_{10} PEC using the above two methods results in a maximum PEC based on method A. This is presented in Table 12. Therefore, a contour plot of the 24-hour mean (90.4th%ile) PEC would be based on the annual mean rather than demonstrate the plume behaviour of the 24-hour mean (90.4th%ile) process contribution.

Table 12. Emergency Operation – Dispersion Model Results for Particulate Matter (PM_{10})

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m³)	Back-ground (µg/m³)	Predicted Environmental Concentration (µg/m³) Note 2	Limit Value (µg/m³) Note 1	PEC as % of Limit Value
PM_{10} / 2018	Annual Mean	684911, 5920658	0.87	16	16.87	40	42%
	90.4th%ile 24-hr Mean	684911, 5920659	2.33	23	23.87	50	48%
PM_{10} / 2019	Annual Mean	684911, 5920658	0.94	16	16.94	40	42%
	90.4th%ile 24-hr Mean	684911, 5920659	2.21	23	23.94	50	48%
PM_{10} / 2020	Annual Mean	684911, 5920658	0.96	16	16.96	40	42%
	90.4th%ile 24-hr Mean	684911, 5920659	2.48	23	23.96	50	48%
PM_{10} / 2021	Annual Mean	684911, 5920658	0.90	16	16.90	40	42%
	90.4th%ile 24-hr Mean	684908, 5920634	2.08	23	23.90	50	48%
PM_{10} / 2022	Annual Mean	684911, 5920658	0.84	16	16.84	40	42%
	90.4th%ile 24-hr Mean	684908, 5920634	2.11	23	23.84	50	48%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

Note 2 24-hour mean (as 90.4th %ile) PM_{10} predicted environmental concentration derived from calculation as per UK DEFRA[5] and EPA[2] guidance, as described above, and is not a simple addition of background concentration to process contribution.

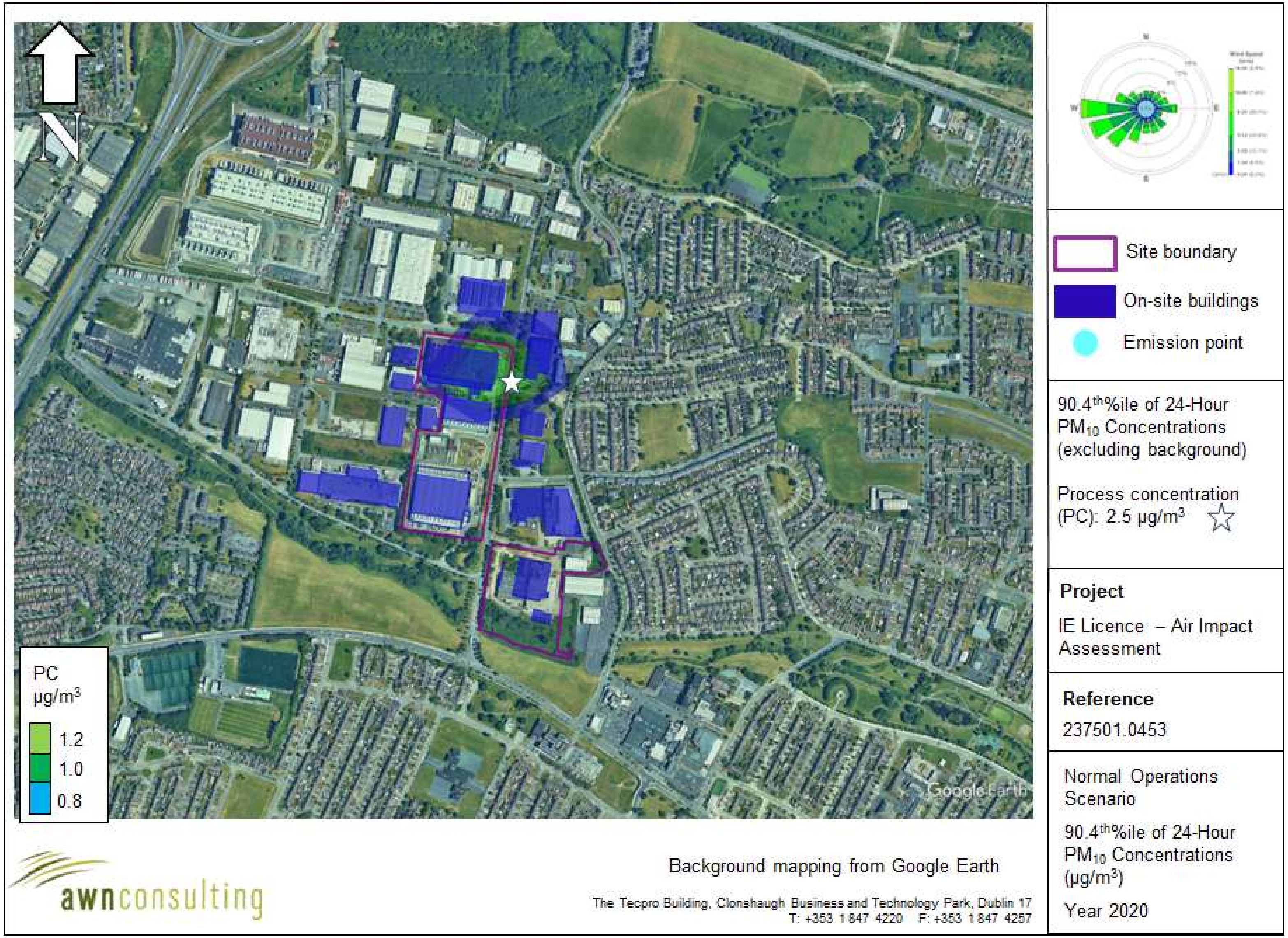

Figure 4 Emergency Operation - Maximum 24-Hour PM_{10} Concentration (µg/m³) (excluding background concentrations)

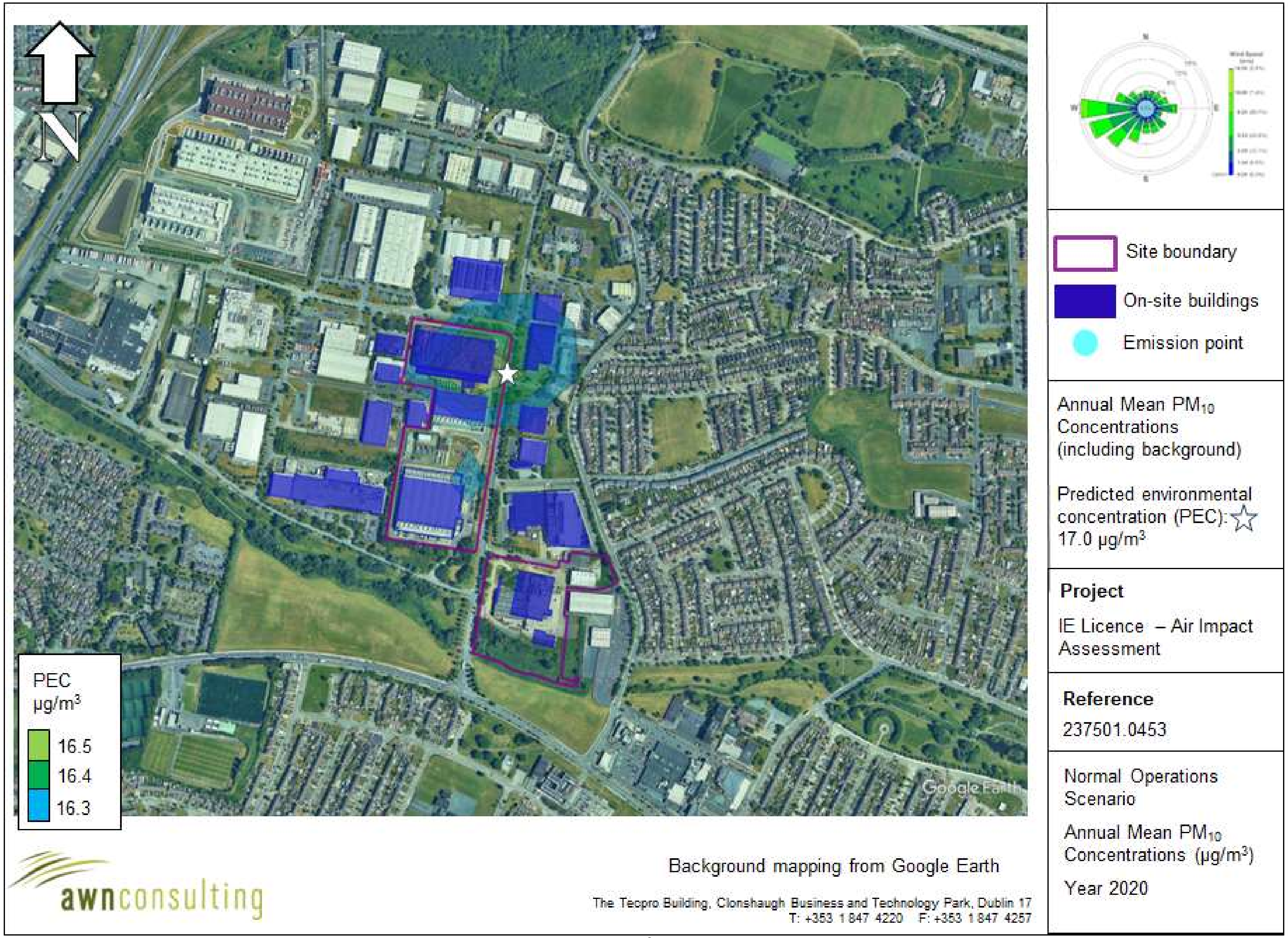

Figure 5 Emergency Operation - Annual Mean PM_{10} Concentration (µg/m³) (including background concentrations)

6.1.4 $PM_{2.5}$

The $PM_{2.5}$ modelling results are detailed in Table 13. These are derived from a worst-case assumption that all PM_{10} emissions from the facility are of a particle size of 2.5 microns or less ($PM_{2.5}$). This assumption is necessitated due to the lack of availability of $PM_{2.5}$ emission concentration data for emission sources and therefore $PM_{2.5}$ emissions could not be directly modelled. In reality, particles greater than 2.5 microns will also be present and thus the mass of $PM_{2.5}$ released has been overestimated.

For the worst-case year, ambient concentrations (including background) will be 44% of the annual mean $PM_{2.5}$ limit value of 25 µg/m^3 or 55% of the Stage 2 annual mean limit value of 20 µg/m^3 at the worst-case receptor (boundary receptor, location shown in Figure 5). As the annual mean $PM_{2.5}$ concentrations have been conservatively assumed equal to the annual mean PM_{10} concentrations, the direction and extent of the emission plume is identical to that shown in Figure 6.

Table 13. Emergency Operation – Dispersion Model Results for Particulate Matter ($PM_{2.5}$)

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m^3)	Back-ground (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Limit Value (µg/m^3) Note 1	PEC as % of Limit Value
$PM_{2.5}$ / 2018	Annual Mean	684911, 5920658	0.87	10	10.87	25	43%
$PM_{2.5}$ / 2019	Annual Mean	684911, 5920658	0.94	10	10.94	25	44%
$PM_{2.5}$ / 2020	Annual Mean	684911, 5920658	0.96	10	10.96	25	44%
$PM_{2.5}$ / 2021	Annual Mean	684911, 5920658	0.90	10	10.90	25	44%
$PM_{2.5}$ / 2022	Annual Mean	684911, 5920658	0.84	10	10.84	25	43%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.1.5 SO_2

The SO_2 modelling results at the worst-case receptor (considers boundary, gridded and sensitive receptors) are detailed in Table 14. The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for SO_2. Emissions from the facility lead to an ambient SO_2 concentration (including background) which is 15% of the maximum 1-hour limit value (measured as a 99.7th%ile) at the worst-case receptor (boundary receptor, location shown in Figure 6) and 17% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor (off-site gridded receptor, location shown in Figure 7). The locations of the maximum concentrations for SO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

The geographical variations in ground level SO_2 process contribution (PC) concentrations beyond the facility boundary for the worst-case years modelled are illustrated as concentration contours in Figure 6 and Figure 7 to demonstrate the direction and extent of the emission plume.

The 24-hour mean SO_2 (99.2nd%ile) and the 1-hour mean SO_2 (99.7th%ile) predicted environmental concentration contours are not displayed in Figure 6 and Figure 7 due to the methodology for calculating the PEC. This is calculated in line with guidance from the UK DEFRA(5) and EPA(2), explained in detail in Section 4.0 which states that for SO_2 an estimate of the maximum combined pollutant concentrations can be obtained as shown below:

99.2nd%ile of total 24-hour SO_2 - The 99.2th%ile of total 24-hour SO_2 is equal to the maximum of either A or B below:

a) 99.2th%ile of 24-hour mean background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.2th%ile 24-hour mean process contribution SO_2 + (2 x annual mean background contribution SO_2)

99.7th%ile of total 1-hour SO_2 - The 99.7th%ile of total 1-hour SO_2 is equal to the maximum of either A or B below:

a) 99.7th%ile hourly background SO_2 + (2 x annual mean process contribution SO_2)
b) 99.7th%ile hourly process contribution SO_2 + (2 x annual mean background contribution SO_2)

Calculating the 24-hour mean SO_2 (99.2nd%ile) and the 1-hour mean SO_2 (99.7th%ile) PEC using the above two methods results in a maximum PEC based on method A. This is presented in Table 14. Therefore contour plots of the 24-hour mean SO_2 (99.2nd%ile) and the 1-hour mean SO_2 (99.7th%ile) PEC would be based on the annual mean rather than demonstrate the plume behaviour of the 24-hour mean SO_2 (99.2nd%ile) and the 1-hour mean SO_2 (99.7th%ile) process contributions.

Table 14. Emergency Operation – Dispersion Model Results for Sulphur Dioxide (SO_2)

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution ($\mu g/m^3$)	Back-ground ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/m^3$) Note 2	Limit Value ($\mu g/m^3$) Note 1	PEC as a % of Limit Value
SO2 / 2018	Annual Mean	684922, 5920663	0.7	4	4.75	-	
	99.7th%ile 1-hr Mean	684733, 5920712	17.5	51	52.49	350	15%
	99.2nd%ile 24-hr Mean	684733, 5920712	5.4	20	21.49	125	17%
SO2 / 2019	Annual Mean	684921, 5920651	0.8	4	4.81	-	
	99.7th%ile 1-hr Mean	684922, 5920429	18.3	51	52.62	350	15%
	99.2nd%ile 24-hr Mean	684921, 5920651	6.3	20	21.62	125	17%
SO2 / 2020	Annual Mean	684921, 5920651	0.8	4	4.84	-	
	99.7th%ile 1-hr Mean	684723, 5920638	19.3	51	52.67	350	15%
	99.2nd%ile 24-hr Mean	684723, 5920638	6.2	20	21.67	125	17%
SO2 / 2021	Annual Mean	684921, 5920651	0.8	4	4.80	-	
	99.7th%ile 1-hr Mean	684723, 5920638	17.8	51	52.61	350	15%

Pollutant / Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (µg/m^3)	Back-ground (µg/m^3)	Predicted Emission Concentration (µg/m^3) Note 2	Limit Value (µg/m^3) Note 1	PEC as a % of Limit Value
	99.2nd%ile 24-hr Mean	684922, 5920663	5.9	20	21.61	125	17%
SO2 / 2022	Annual Mean	684921, 5920651	0.8	4	4.76	-	
	99.7th%ile 1-hr Mean	684723, 5920638	19.2	51	52.52	350	15%
	99.2nd%ile 24-hr Mean	684861, 5920742	5.7	20	21.52	125	17%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

Note 2 1-hour mean (as 99.7th %ile) and 24-hour mean (as 99.2nd %ile) SO_2 predicted environmental concentrations derived from calculation as per UK DEFRA and EPA guidance, as described above, and is not a simple addition of background concentration to process contribution.

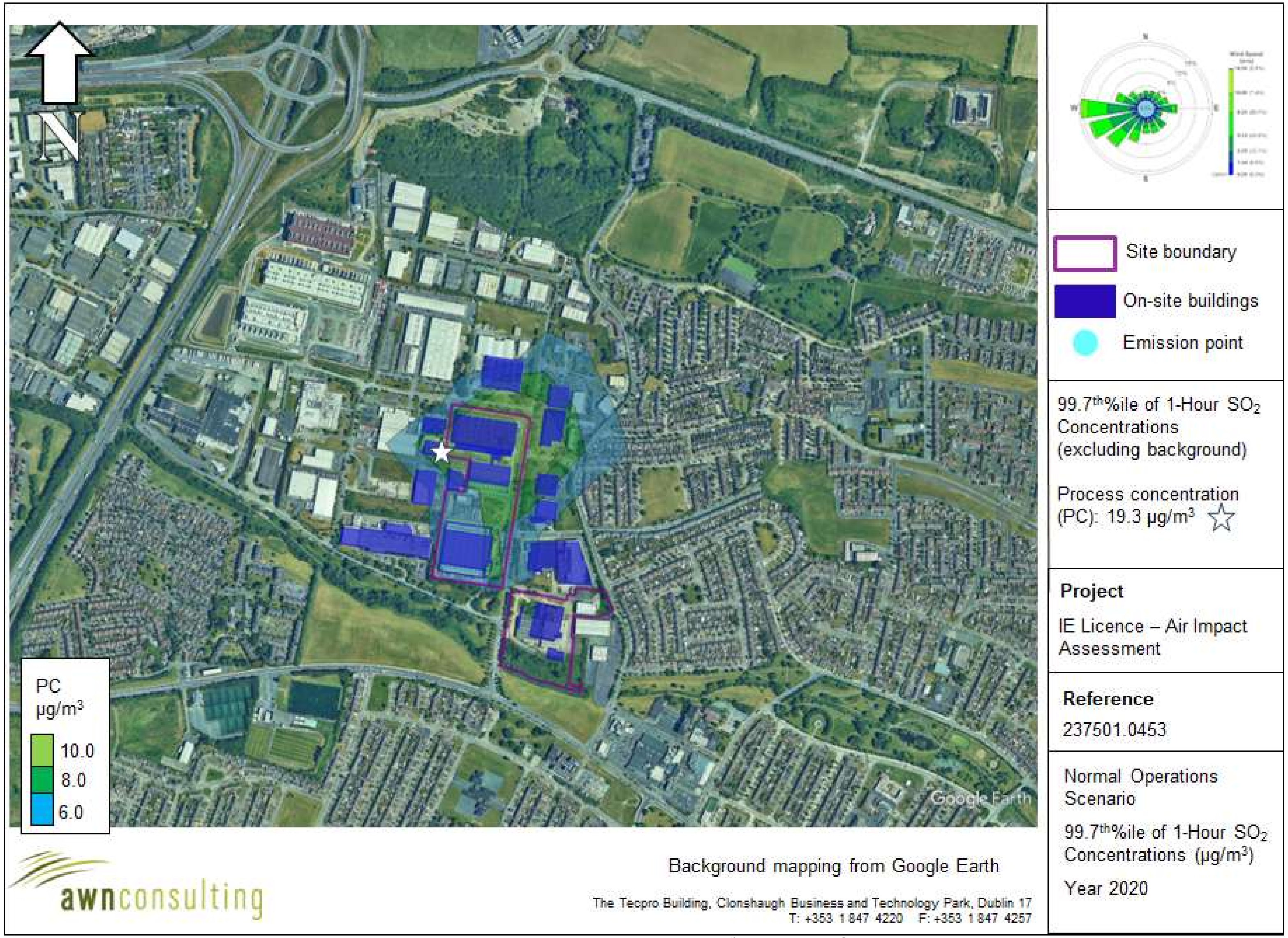

Figure 6 Emergency Operations - Maximum 1-Hour SO_2 Concentrations (as a 99.7th%ile) (µg/m^3) (excluding background concentrations)

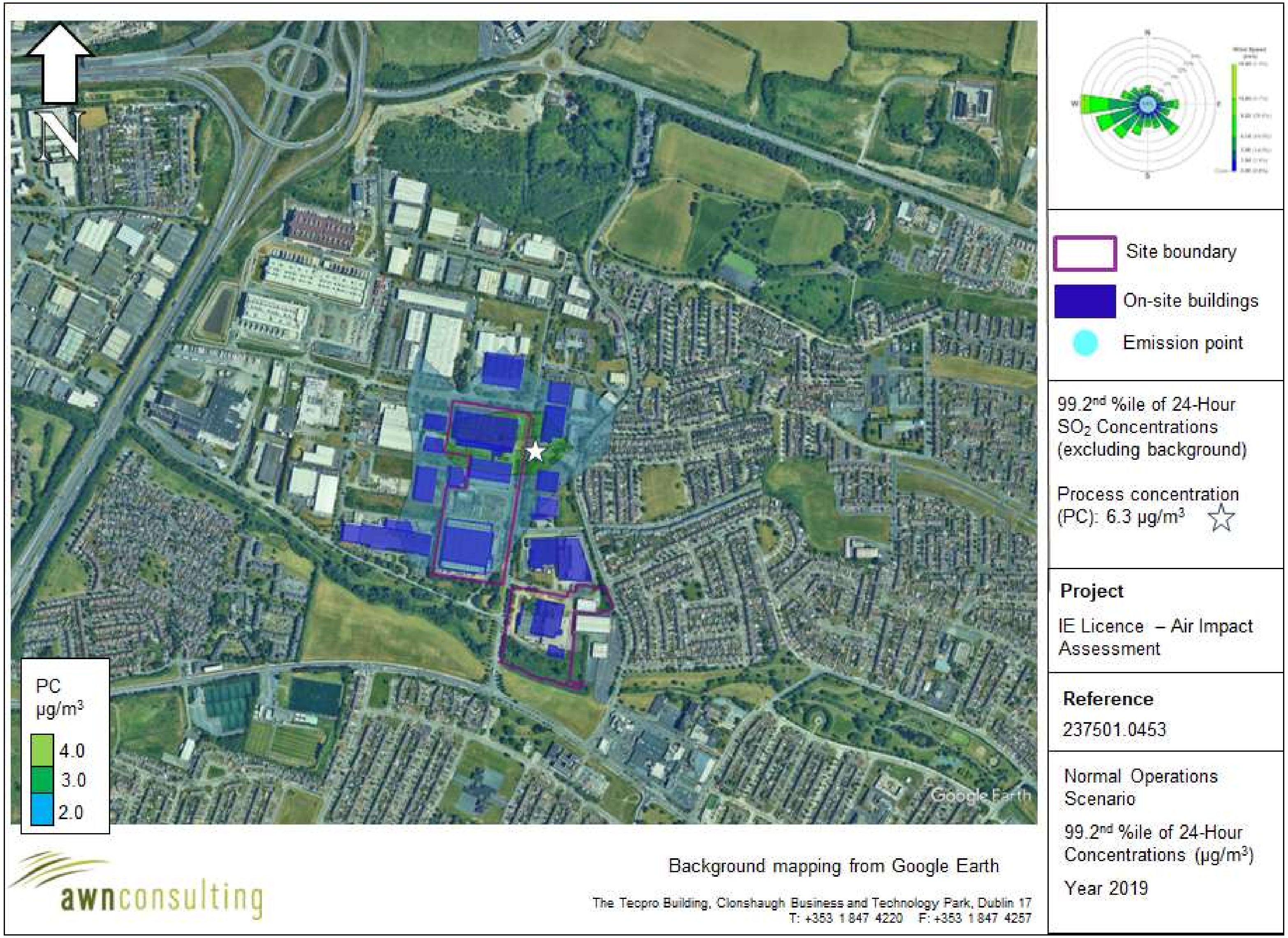

Figure 7 Emergency Operations – Maximum 24-Hour SO_2 Concentrations (as a 99.2th%ile) (excluding background concentrations)

6.2 Emergency Operations Scenario (UK EA Methodology)

Emissions of NO_2 from 45 of the 52 no. standby generators were assessed using the UK Environment Agency methodology. The methodology, based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value assuming a hypergeometric distribution, has been undertaken at the worst-case residential receptor for the Facility Scenario. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The results have been compared to the 98^{th} percentile confidence level to indicate if an exceedance is likely at various operational hours for the generators. The results (Table 15 and Figure 8) indicate that in the worst-case year, the generators can operate for the 137 hours per year using diesel fuel before there is a likelihood of an exceedance of the ambient air quality standard (at a 98^{th} percentile confidence level).

Table 15. *Hypergeometric Statistical Results at Worst-case Residential Receptor – Emergency Operations*

Pollutant / Year / Scenario	Hours of operation (Hours) (98^{th}%ile) Allowed Prior To Exceedance Of Limit Value	UK Guidance – Probability Value = 0.02 (98^{th}%ile)[Note 1]
NO_2 / 2018	344	0.02
NO_2 / 2019	330	
NO_2 / 2020	137	
NO_2 / 2021	317	
NO_2 / 2022	141	

Note 1 Guidance Outlined In UK Environment Agency (2019) Emissions from specified generators - Guidance on dispersion modelling for oxides of nitrogen assessment from specified generators

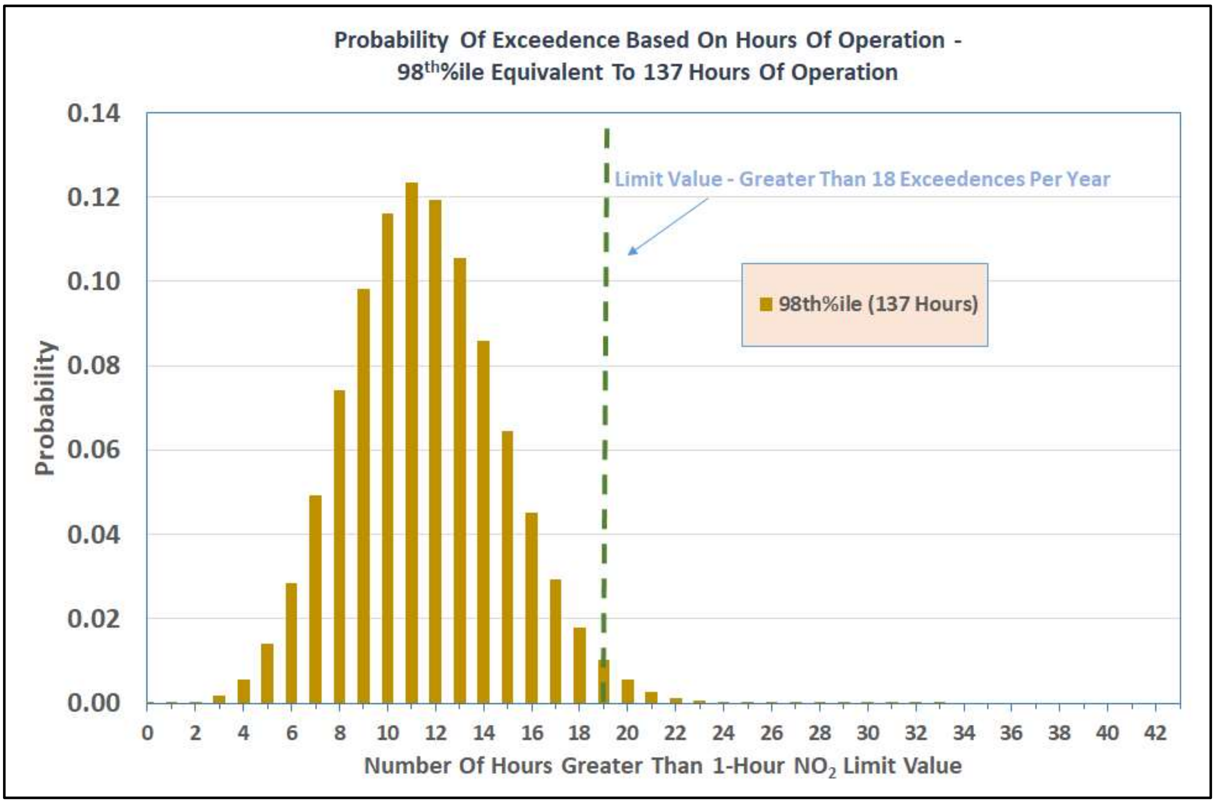

Figure 8 Hypergeometric Statistical Result at Worst-case Residential Receptor – Emergency Operations

6.3 Most Impacted Ecological Habitat Site

The ecological habitat site closest to and most impacted by the facility, and where the highest modelled concentrations are predicted, is the Santry Demense pNHA.

6.3.1 NO_X

The NO_X modelling results are detailed in Table 16. Emissions from the facility lead to an ambient NO_X concentration (including background) which is at most 27% of the annual limit value at the worst-case location within the most impacted ecological habitat site over the five years of meteorological data modelled.

Table 16. NO_X Dispersion Model Results at Most Impacted Ecological Habitat Site – Emergency Operations

Pollutant / Year	Averaging Period	Process Contribution (µg/m^3)	Background (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Standard (µg/m^3)	PEC % of Limit Value
NO_X / 2018	Annual mean	0.38	7.6	7.98	30	27%
NO_X / 2019	Annual mean	0.43	7.6	8.03	30	27%
NO_X / 2020	Annual mean	0.33	7.6	7.93	30	26%
NO_X / 2021	Annual mean	0.43	7.6	8.03	30	27%
NO_X / 2022	Annual mean	0.38	7.6	7.98	30	27%

6.3.2 SO_2

The SO_2 modelling results are detailed in Table 17. Emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 7% of the annual limit value at the worst-case location within the most impacted ecological habitat site over the five years of meteorological data modelled.

Table 17. SO_2 Dispersion Model Results at Most Impacted Ecological Habitat Site – Emergency Operations

Pollutant / Year	Averaging Period	Process Contribution (µg/m^3)	Background (µg/m^3)	Predicted Emission Concentration (µg/m^3)	Standard (µg/m^3)	% of Limit Value
SO_2 / 2018	Annual Mean	0.03	0.6	0.627	20	3%
SO_2 / 2019	Annual Mean	0.85	0.6	1.448	20	7%
SO_2 / 2020	Annual Mean	0.03	0.6	0.627	20	3%
SO_2 / 2021	Annual Mean	0.03	0.6	0.632	20	3%
SO_2 / 2022	Annual Mean	0.03	0.6	0.626	20	3%

6.3.3 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the facility on the most impacted ecological habitat site, the maximum annual mean NO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then nitrogen deposition fluxes (as described in Section 2.3 and shown in Table 18.

The nitrogen deposition flux for the worst-case year is 5.455 kg/ha/yr, shown in Table 18, and is below the range in worst-case critical loads of 10-15 kg/ha/yr(4) for the habitat types (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demense pNHA, indicating that the effects of nitrogen deposition on ecological habitat sites due to the facility are not significant.

Table 18. Nitrogen Deposition at Most Impacted Ecological Habitat Site – Emergency Operations

Met. Year	NO_2 Annual Mean PC ($\mu g/m^3$)	NO_2 Dry Deposition ($\mu g/m^2/s$)	NO_2 Nitrogen Deposition (kg/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	NO_2 PEC Nitrogen Deposition kg/ha/yr
2018	0.34	0.0005	0.05	5.4	5.448
2019	0.38	0.0006	0.06	5.4	5.455
2020	0.30	0.0004	0.04	5.4	5.443
2021	1.00	0.0015	0.14	5.4	5.544
2022	0.34	0.0005	0.05	5.4	5.449

6.3.4 Acid Deposition

In order to consider the effects of acid deposition (as N and S) owing to emissions from the facility on the most impacted ecological habitat site, the maximum annual mean NO_2 and SO_2, process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 2.3 and shown in Table 19 and Table 20).

Table 19. Acid Deposition (as N) at Most Impacted Ecological Habitat Site – Emergency Operations

Met. Year	NO_2 Annual Mean PC ($\mu g/m^3$)	NO_2 Dry Deposition ($\mu g/m^2/s$)	NO_2 Acid Deposition (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	NO_2 PEC Acid Deposition (keq/ha/yr)
2018	0.34	0.0005	0.00	0.5	0.50
2019	0.38	0.0006	0.00	0.5	0.50
2020	0.30	0.0004	0.00	0.5	0.50
2021	1.00	0.0015	0.01	0.5	0.51

Met. Year	NO_2 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	NO_2 PEC Acid Deposition (keq/ha/yr)
2022	0.34	0.0005	0.00	0.5	0.50

Table 20. Acid Deposition (as S) at Most Impacted Ecological Habitat Site

Met. Year	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2+SO_2) PEC Acid Deposition (keq/ha/yr)
2018	0.027	0.0003	0.050	0.003	0.5	0.507
2019	0.848	0.0102	1.605	0.100	0.5	0.604
2020	0.027	0.0003	0.051	0.003	0.5	0.506
2021	0.032	0.0004	0.060	0.004	0.5	0.514
2022	0.026	0.0003	0.048	0.003	0.5	0.507

The total acid deposition (as N and S) flux for the worst-case year is 0.604 keq/ha/yr, shown in Table 20 and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the habitats (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demense pNHA[4] indicating that the effects of acid deposition (as N and S) on ecological habitat sites due to the facility are not significant.

6.4 Most Impacted European Habitat Site

The European Natura 2000 ecological habitat site most impacted by the facility, and where the highest modelled concentrations are predicted, is the Baldoyle Bay SAC.

6.4.1 NO_X

The NO_X modelling results are detailed in Table 21. Emissions from the facility lead to an ambient NO_X concentration (including background) which is at most 14% of the annual limit value at the worst-case location within the most impacted European habitat site over the five years of meteorological data modelled.

Table 21. NO_X Dispersion Model Results at Most Impacted European Habitat Site – Emergency Operations

Pollutant / Year	Averaging Period	Process Contribution (µg/m^3)	Background (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Standard (µg/m^3)	PEC % of Limit Value
NO_X / 2018	Annual mean	0.26	4	4.26	30	14%
NO_X / 2019	Annual mean	0.27	4	4.27	30	14%

Pollutant / Year	Averaging Period	Process Contribution (µg/m³)	Background (µg/m³)	Predicted Environmental Concentration (µg/m³)	Standard (µg/m³)	PEC % of Limit Value
NO_X / 2020	Annual mean	0.27	4	4.27	30	14%
NO_X / 2021	Annual mean	0.26	4	4.26	30	14%
NO_X / 2022	Annual mean	0.26	4	4.26	30	14%

6.4.2 SO_2

The SO_2 modelling results are detailed in Table 22. Emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 5% of the annual limit value at the worst-case location within the most impacted European habitat site over the five years of meteorological data modelled.

Table 22. SO_2 Dispersion Model Results at Most Impacted European Habitat Site – Emergency Operations

Pollutant / Year	Averaging Period	Process Contribution (µg/m³)	Background (µg/m³)	Predicted Emission Concentration (µg/m³)	Standard (µg/m³)	% of Limit Value
SO_2 / 2018	Annual Mean	0.01	0.4	0.415	20	2%
SO_2 / 2019	Annual Mean	0.51	0.4	0.914	20	5%
SO_2 / 2020	Annual Mean	0.02	0.4	0.415	20	2%
SO_2 / 2021	Annual Mean	0.02	0.4	0.415	20	2%
SO_2 / 2022	Annual Mean	0.01	0.4	0.415	20	2%

6.4.3 Nitrogen Deposition

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the facility on the most impacted European habitat site, the maximum annual mean NO_2 process contribution concentration (PC) are converted into the dry deposition fluxes and then nitrogen deposition fluxes (as described in Section 2.3 and shown in Table 23.

The nitrogen deposition flux for the worst-case year is 6.87 kg/ha/yr, shown in Table 23, and is below the range in worst-case critical loads of 10-15 kg/ha/yr(4) for the habitat types (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on ecological habitat sites due to the facility are not significant.

Table 23. Nitrogen Deposition at Most Impacted Ecological Habitat Site – Emergency Operations

Met. Year	NO_2 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NO_2 Nitrogen Deposition (kg/ha/year)	APIS Background Nitrogen Deposition (kg/ha/yr)	NO_2 PEC Nitrogen Deposition kg/ha/yr
2018	0.23	0.0003	0.03	6.8	6.83
2019	0.24	0.0004	0.04	6.8	6.84
2020	0.24	0.0004	0.04	6.8	6.84
2021	0.48	0.0007	0.07	6.8	6.87
2022	0.23	0.0003	0.03	6.8	6.83

6.4.4 Acid Deposition

In order to consider the effects of acid deposition (as N and S) owing to emissions from the facility on the most impacted European habitat site, the maximum annual mean NO_2 and SO_2, process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 2.3 and shown in Table 24 and Table 25).

Table 24. Acid Deposition (as N) at Most Impacted European Habitat Site – Emergency Operations

Met. Year	NO_2 Annual Mean PC (µg/m^3)	NO_2 Dry Deposition (µg/m^2/s)	NO_2 Acid Deposition (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	NO_2 PEC Acid Deposition (keq/ha/yr)
2018	0.23	0.0003	0.002	0.5	0.502
2019	0.24	0.0004	0.003	0.5	0.503
2020	0.24	0.0004	0.003	0.5	0.503
2021	0.48	0.0007	0.005	0.5	0.505
2022	0.23	0.0003	0.002	0.5	0.502

Table 25. Acid Deposition (as S) at Most Impacted European Habitat Site – Emergency Operations

Met. Year	SO_2 Annual Mean PEC (µg/m^3)	SO_2 Dry Deposition (µg/m^2/s)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2+SO_2) PEC Acid Deposition (keq/ha/yr)
2018	0.015	0.0002	0.028	0.002	0.5	0.504
2019	0.514	0.0062	0.972	0.061	0.5	0.563
2020	0.015	0.0002	0.029	0.002	0.5	0.504
2021	0.015	0.0002	0.029	0.002	0.5	0.507

Met. Year	SO_2 Annual Mean PEC ($\mu g/m^3$)	SO_2 Dry Deposition ($\mu g/m^2/s$)	SO_2 Sulphur Deposition (kg/ha/year)	SO_2 Acid Deposition (as S) (keq/ha/year)	APIS Background Acid Deposition (keq/ha/yr)	Total (NO_2+SO_2) PEC Acid Deposition (keq/ha/yr)
2022	0.015	0.0002	0.027	0.002	0.5	0.504

The total acid deposition (as N and S) flux for the worst-case year is 0.563 keq/ha/yr, shown in Table 25 and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the habitats (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Baldoyle Bay SAC(4) indicating that the effects of acid deposition (as S) on ecological habitat sites due to the facility are not significant.

6.5 Cumulative Assessment

6.5.1 Cumulative Emergency Operations Scenario (USEPA Methodology)

The cumulative NO_2 modelling results at the worst-case location at and beyond the site boundary are detailed in Table 25 based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel, using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*'(3) as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the subject site in addition to emissions associated with a number of other data storage facilities within 1 km of the subject site as outlined in Section 5.1.

The results indicate that the ambient ground level concentrations are within the relevant air quality standards for NO_2. For the worst-case year modelled, emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor, both of which are at the boundary of the facility. Concentrations decrease with distance from the site boundary. The geographical variations in the 1-hour mean (99.8th percentile) and annual mean NO_2 ground level concentrations for the Cumulative Scenario are illustrated as concentration contours in Figures 9 and 10. The locations of the maximum concentrations for NO_2 are close to the boundary of the site with concentrations decreasing with distance from the facility.

Table 26. Dispersion Model Results for Nitrogen Dioxide (NO_2) – Cumulative Assessment

Pollutant/ Year	Averaging Period	Worst Case Receptor X,Y (UTM Zone 29 N)	Process Contribution (PC) (µg/m^3)	Background Concentration (µg/m^3)	Predicted Environmental Concentration (PEC) (µg/m^3)	Limit Value (µg/Nm^3) Note 1	PEC as a % of Limit Value
NO2 / 2018	Annual Mean	684911, 5920658	22.6	15	37.65	40	94.1%
	99.8th%ile of 1-hr means	684911, 5920659	146.8	30	176.77	200	88.4%
NO2 / 2019	Annual Mean	684911, 5920658	23.9	15	38.87	40	97.2%
	99.8th%ile of 1-hr means	684911, 5920659	152.7	30	182.69	200	91.3%
NO2 / 2020	Annual Mean	684911, 5920658	24.1	15	39.08	40	97.7%
	99.8th%ile of 1-hr means	684905, 5920609	148.4	30	178.39	200	89.2%
NO2 / 2021	Annual Mean	684911, 5920658	23.1	15	38.06	40	95.2%
	99.8th%ile of 1-hr means	684905, 5920609	158.6	30	188.60	200	94.3%
NO2 / 2022	Annual Mean	684911, 5920658	23.3	15	38.34	40	95.9%
	99.8th%ile of 1-hr means	684905, 5920609	152.2	30	182.20	200	91.1%

Note 1 Air Quality Standards 2022 (from EU Directive 2008/50/EC and S.I. 739 of 2022)

6.5.2 Cumulative Emergency Operations Scenario (UK EA Methodology)

The methodology, based on considering the statistical likelihood of an exceedance of the NO_2 hourly limit value assuming a hypergeometric distribution, has been undertaken at the worst-case residential receptor for the Cumulative Scenario. The cumulative hypergeometric distribution of 19 and more hours per year is computed and the probability of an exceedance determined. The results have been compared to the 98th percentile confidence level to indicate if an exceedance is likely at various operational hours for the generators. The results (Table 27 and Figure 11) indicate that in the worst-case year, the generators can operate for the 80 hours per year before there is a likelihood of an exceedance of the ambient air quality standard (at a 98th percentile confidence level).

Table 27. Hypergeometric Statistical Results at Worst-case Residential Receptor – Cumulative Assessment

Pollutant / Year / Scenario	Hours of operation (Hours) (98th%ile) Allowed Prior To Exceedance Of Limit Value	UK Guidance – Probability Value = 0.02 (98th%ile) Note 1
NO_2 / 2018	144	0.02
NO_2 / 2019	80	
NO_2 / 2020	114	
NO_2 / 2021	106	
NO_2 / 2022	110	

Note 1 Guidance Outlined In UK Environment Agency (2019) Emissions from specified generators - Guidance on dispersion modelling for oxides of nitrogen assessment from specified generators

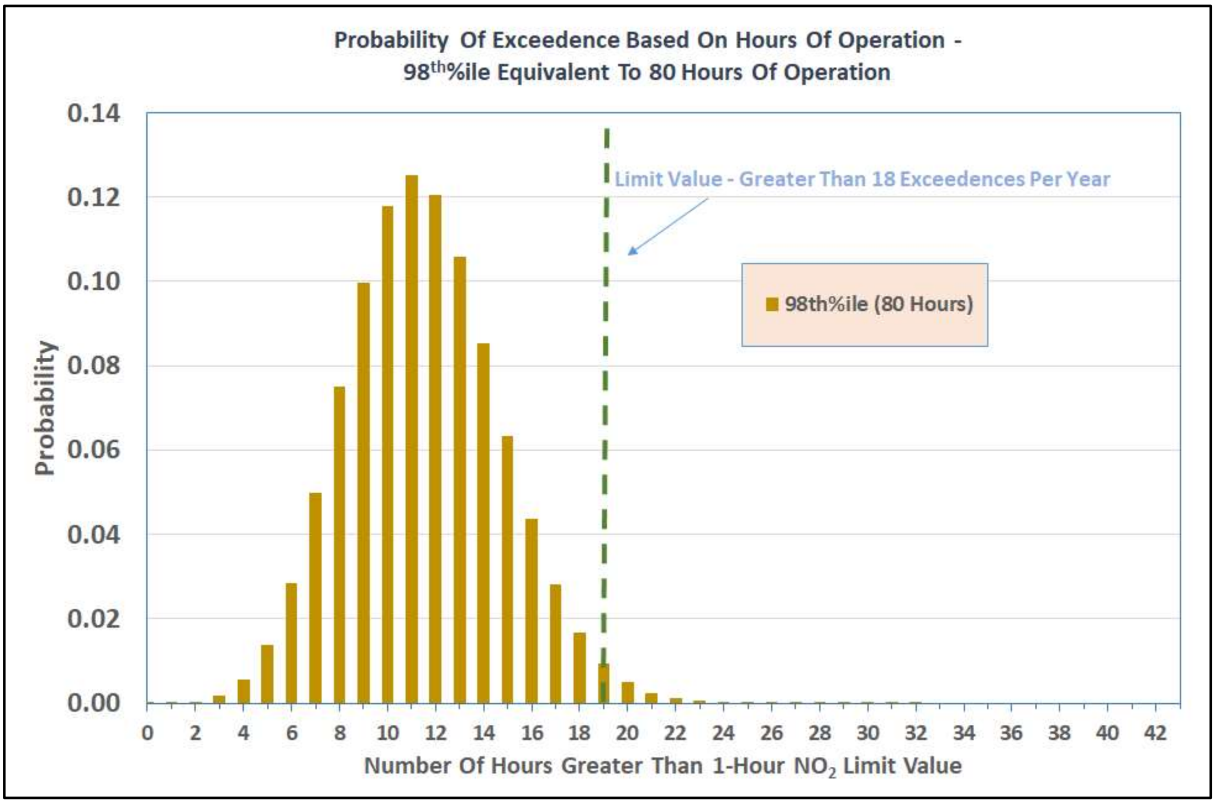

Figure 11 Hypergeometric Statistical Result at Worst-case Residential Receptor – Cumulative Assessment

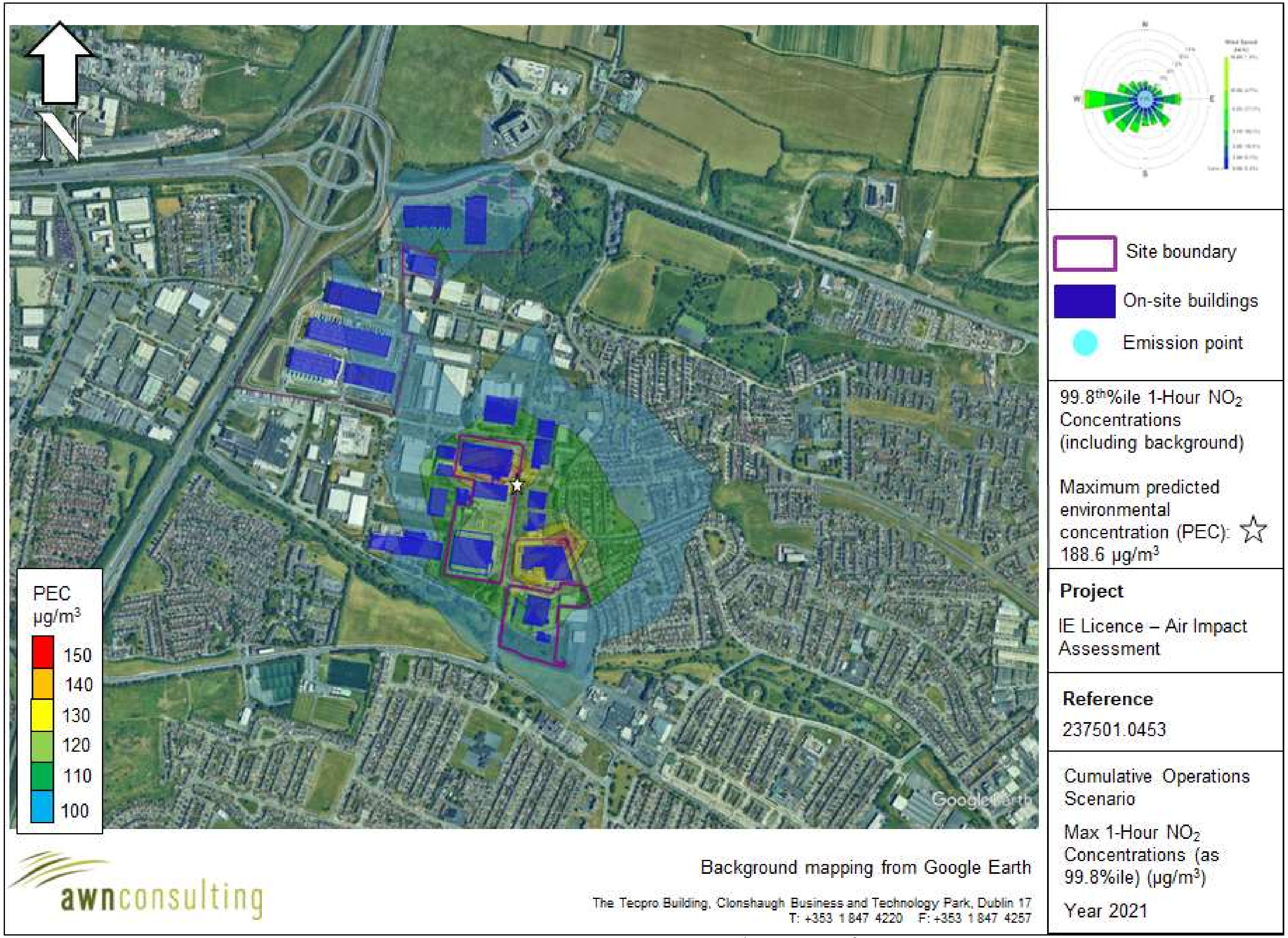

Figure 9 Cumulative Assessment - Maximum 1-Hour NO_2 Concentrations (as a 99.8th%ile) (µg/m^3) (including background concentrations)

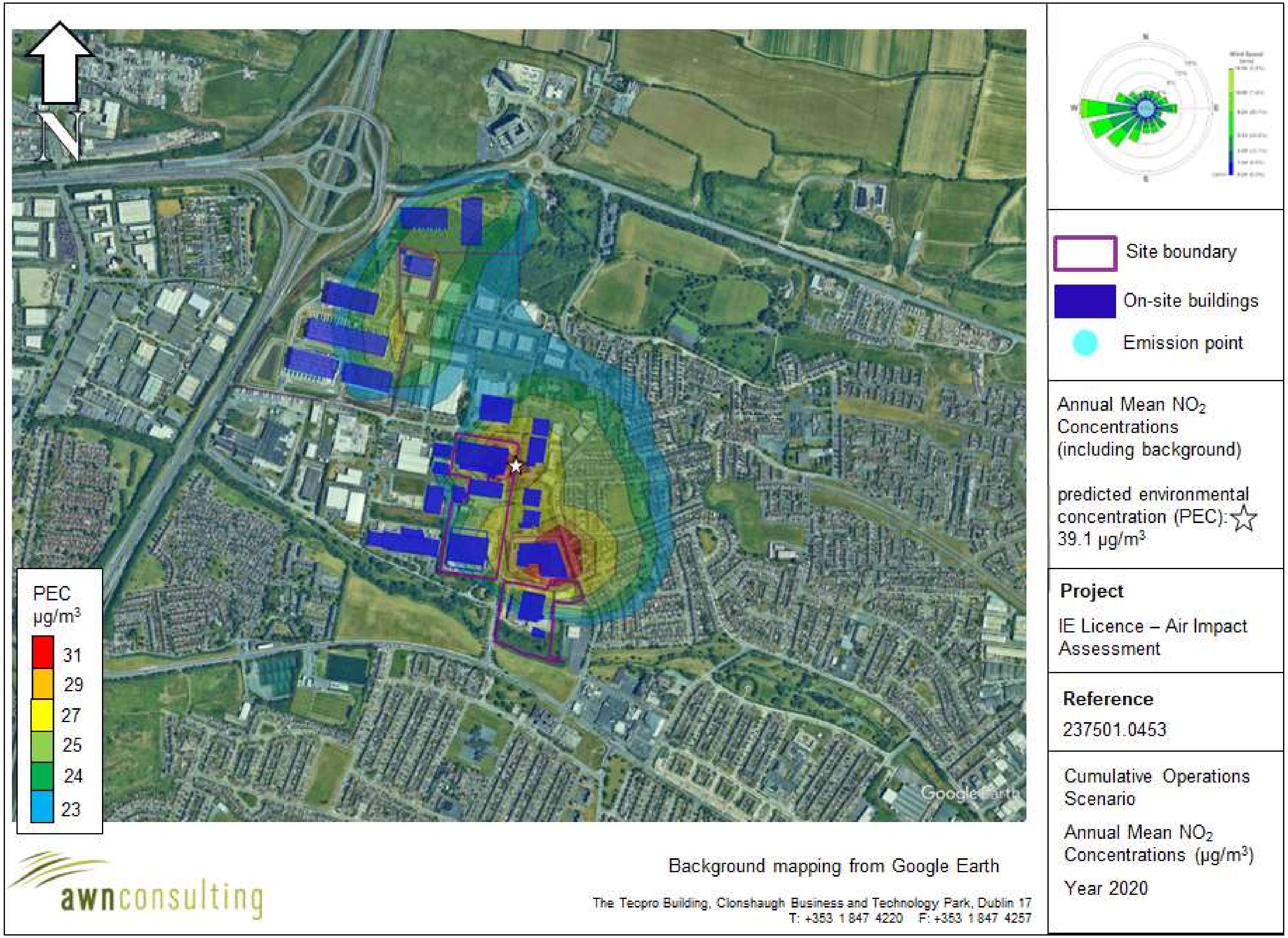

Figure 10 Cumulative Assessment - Annual Mean NO_2 Concentrations (µg/m^3) (including background concentrations)

6.6 Cumulative Air Quality Impact On Ecological Sites

The cumulative modelling of air emissions from the site was carried out to assess the concentrations of nitrogen dioxide (NO_x) beyond the site boundary at the nearest Ecological Site. The modelling undertaken has been reviewed and compared with the limit values in Table 1 above.

The nearest ecologically sensitive site to the facility is the Santry Demesne Proposed NHA (000178) which is approximately 1km south-west of the facility.

The results shown in Table 28 indicate that for the cumulative modelling of air emissions from the combined facilities that the ambient ground level concentrations at the nearest ecologically sensitive areas are within the relevant air quality standard for NO_x. For the worst-case year modelled, emissions from the site and cumulative sites combined lead to an ambient NO_x concentration which is no more than 29% of the annual limit value at the worst-case ecological receptor as shown in Table 28.

Table 28. Cumulative NO_x Dispersion Model Results In Ecologically Sensitive Areas

Pollutant / Year	Averaging Period	Process Contribution (µg/m^3)	Background (µg/m^3)	Predicted Environmental Concentration (µg/m^3)	Standard (µg/m^3)	PEC % of Limit Value
NO_X / 2018	Annual mean	0.94	7.6	8.54	30	28%
NO_X / 2019	Annual mean	0.94	7.6	8.54	30	28%
NO_X / 2020	Annual mean	0.94	7.6	8.54	30	28%
NO_X / 2021	Annual mean	1.11	7.6	8.71	30	29%
NO_X / 2022	Annual mean	0.90	7.6	8.50	30	28%

In terms of impacts in the nearby ecologically sensitive areas, the ambient level of NO_X in the Santry Demesne Proposed NHA (000178); c. 1km south-west, due to emissions from the subject site, will be a small fraction of the ambient air quality standard for the protection of vegetation. Similarly, cumulative emissions will lead to ambient NO_X levels which will be a small fraction of the ambient air quality standard for the protection of vegetation.

The nearest European site is Baldoyle Bay SAC c. 5km east of the site. The increased distance of this designated area from the subject site means that it is highly unlikely that airborne pollution could affect any European site.

7.0 ASSESSMENT SUMMARY

The assessment was carried out to determine the ambient air quality impact of the site and any air quality constraints that may be present. It is determined that as the generators will be used solely for emergency operation (i.e. less than 500 hours per year) and thus the emission limit values outlined in the Medium Combustion Plant Directive are not applicable to the generators on site.

The NO_2 modelling results at the worst-case location at and beyond the site boundary are based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using diesel fuel and using the USEPA methodology outlined within the guidance document titled '*Additional Clarification Regarding Application of Appendix W Modelling Guidance for the 1-Hour National Ambient Air Quality Standard*' as well as considering scheduled weekly testing and quarterly maintenance testing of all 52 no. back-up generators from the installation (Building W, Building X, Building Y, Building U and Building V).

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2. For the worst-case year, emissions from the site lead to an ambient NO_2 concentration (including background) which is 93% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 90% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 137 hours using diesel fuel before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

CO concentrations are also in compliance with the relevant ambient air quality standards. In the worst case year, concentrations of CO (including background) are at most 40% of the maximum 8-hour limit value at the worst case receptor modelled.

Regarding particulate matter, concentrations of PM_{10} and $PM_{2.5}$ are in compliance with the relevant limit values. Concentrations of PM_{10} (including background) are 48% of the maximum ambient 24-hour limit value (measured as a 90.4th%ile) and 42% of the annual limit value at the worst-case receptor modelled, with concentrations of $PM_{2.5}$ reaching at most 44% of the annual mean limit value.

Modelled concentrations of SO_2 reached at most 15% of the maximum 1-hour limit value (measured as a 99.7th%ile) and 17% of the maximum 24-hour limit value (measured as a 99.2nd%ile) at the worst-case receptor modelled, including background concentrations.

Regarding the most impacted ecological habitat site, the Santry Demesne Proposed NHA (000178), operations will lead to ambient NO_X and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 27% and 7% respectively of the annual limit value.

The nitrogen deposition flux for the worst-case year is 5.544 kg/ha/yr and is below the range in worst-case critical loads of 10-15 kg/ha/yr for the habitat types (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of nitrogen deposition on ecological habitat sites due to the facility are not significant.

The total acid deposition (as N and S) flux for the worst-case year is 0.604 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the habitats (hedgerow, tall herbs, calcareous grassland, reed fringe, open water, scrub and woodland) in the Santry Demesne Proposed NHA (000178), indicating that the effects of acid deposition (as N and S) on ecological habitat sites due to the facility are not significant.

Regarding the most impacted Natura 2000 designated habitat site, the Baldoyle Bay SAC, operations will lead to ambient NO_X and SO_2 concentrations (including background) which are in compliance with the relevant limit values, reaching at most 14% and 5% respectively of the annual limit value.

The nitrogen deposition flux for the worst-case year is 6.870 kg/ha/yr and is within the range in worst-case critical loads of 5-15 kg/ha/yr for the habitat “Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)” in the Baldoyle Bay SAC, indicating that the effects of nitrogen deposition on designated sites due to the facility are not significant.

The total acid deposition (as N and S) flux for the worst-case year is 0.563 keq/ha/yr and is below the worst case maximum critical load range of 0.714 – 5.146 keq/ha/yr for the “Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)” in the Baldoyle Bay SAC, indicating that the effects of acid deposition (as N and S) on designated sites due to the facility are not significant.

There are no significant impacts predicted for any other Natura 2000 SPAs and SACs, as these are all further from the facility than the Baldoyle Bay SAC.

Under the Emergency Operation Scenario the dispersion modelling has determined that concentrations of all pollutants are in compliance with the relevant ambient air quality standards.

Assessment of The Cumulative Air Quality Impact

The NO_2 modelling results at the worst-case location at and beyond the site boundary are based on the operation of 45 of the 52 no. back-up generators for 150 hours per year using the USEPA methodology. The cumulative assessment included:

- the emergency operation of Buildings W, X, Y, U and V and the emergency operation of Buildings A - F,
- scheduled weekly testing of all back-up generators from Buildings W, X, Y, U and V and scheduled weekly testing of all back-up generators from Buildings A - F,
- scheduled quarterly maintenance testing of all back-up generators from Buildings W, X, Y, U and V with each generator running for four hours and scheduled quarterly maintenance testing of all back-up generators from Buildings A – F with each generator running for one hour,
- emergency operations, scheduled weekly testing and scheduled quarterly maintenance testing of the Dataplex and Digital Realty data centres.

The results indicate that the ambient ground level concentrations are in compliance with the relevant air quality standards for NO_2. For the worst-case year, emissions from the site lead to an ambient NO_2 concentration (including background) which is 94% of the maximum ambient 1-hour limit value (measured as a 99.8th percentile) and 98% of the annual limit value at the worst-case off-site receptor.

The UK EA assessment methodology determined that, in any year, the generators can run for 80 hours using diesel fuel before there is a likelihood of an exceedance at the nearest residential receptor (at a 98th percentile confidence level).

Conclusion

In summary, emissions to atmosphere of NO_2, as the main polluting substance (as defined in the Schedule of EPA (Industrial Emissions) (Licensing) Regulations 2013, S.I. No. 137 of 2013) from the standby generators, will be in compliance with the ambient air quality standards which are based on the protection of the environment and human health. Therefore, no significant impacts to the ambient air quality environment are predicted.

In terms of impacts in the nearby ecologically sensitive areas, the ambient level of NO_X in the Santry Demesne Proposed NHA (000178); c. 1km west, due to emissions from the subject site, will be a small fraction of the ambient air quality standard for the protection of vegetation. Similarly, cumulative emissions will lead to ambient NO_X levels which will be a small fraction of the ambient air quality standard for the protection of vegetation. The nearest European site is Baldoyle Bay SAC c. 5km east. The increased distance of this designated area from the subject site means that it is highly unlikely that airborne pollution could affect any European site.

8.0 REFERENCES

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APPENDIX I

Description of the AERMOD Model

The AERMOD dispersion model has been developed in part by the U.S. Environmental Protection Agency (USEPA)[1,5]. The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources.

Improvements over the ISCST3 model include the treatment of the vertical distribution of concentration within the plume. ISCST3 assumes a Gaussian distribution in both the horizontal and vertical direction under all weather conditions. AERMOD with PRIME, however, treats the vertical distribution as non-Gaussian under convective (unstable) conditions while maintaining a Gaussian distribution in both the horizontal and vertical direction during stable conditions. This treatment reflects the fact that the plume is skewed upwards under convective conditions due to the greater intensity of turbulence above the plume than below. The result is a more accurate portrayal of actual conditions using the AERMOD model. AERMOD also enhances the turbulence of night-time urban boundary layers thus simulating the influence of the urban heat island.

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD (precursor to AERMOD with PRIME) performs better than ISCST3 for many applications and as well or better than CTDMPLUS for several complex terrain data sets[7].

Due to the proximity to surrounding buildings, the PRIME (Plume Rise Model Enhancements) building downwash algorithm has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered. The PRIME algorithm takes into account the position of the stack relative to the building in calculating building downwash. In the absence of the building, the plume from the stack will rise due to momentum and/or buoyancy forces. Wind streamlines act on the plume leads to the bending over of the plume as it disperses. However, due to the presence of the building, wind streamlines are disrupted leading to a lowering of the plume centreline.

When there are multiple buildings, the building tier leading to the largest cavity height is used to determine building downwash. The cavity height calculation is an empirical formula based on building height, the length scale (which is a factor of building height & width) and the cavity length (which is based on building width, length and height). As the direction of the wind will lead to the identification of differing dominant tiers, calculations are carried out in intervals of 10 degrees.

In PRIME, the nature of the wind streamline disruption as it passes over the dominant building tier is a function of the exact dimensions of the building and the angle at which the wind approaches the building. Once the streamline encounters the zone of influence of the building, two forces act on the plume. Firstly, the disruption caused by the building leads to increased turbulence and enhances horizontal and vertical dispersion. Secondly, the streamline descends in the lee of the building due to the reduced pressure and drags the plume (or part of) nearer to the ground, leading to higher ground level concentrations. The model calculates the descent of the plume as a function of the building shape and, using a numerical plume rise model, calculates the change in the plume centreline location with distance downwind.

The immediate zone in the lee of the building is termed the cavity or near wake and is characterised by high intensity turbulence and an area of uniform low pressure. Plume mass captured by the cavity region is re-emitted to the far wake as a ground-level volume source. The volume source is located at the base of the lee wall of the building but is only evaluated near the end of the near wake and beyond. In this region, the disruption caused by the building downwash gradually fades with distance to ambient values downwind of the building.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3[4,8]. ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height[4,8]. The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

AERMOD also has the capability of modelling both unstable (convective) conditions and stable (inversion) conditions. The stability of the atmosphere is defined by the sign of the sensible heat flux. Where the sensible heat flux is positive, the atmosphere is unstable whereas when the sensible heat flux is negative the atmosphere is defined as stable. The sensible heat flux is dependent on the net radiation and the available surface moisture (Bowen Ratio). Under stable (inversion) conditions, AERMOD has specific algorithms to account for plume rise under stable conditions, mechanical mixing heights under stable conditions and vertical and lateral dispersion in the stable boundary layer.

AERMOD also contains improved algorithms for dealing with low wind speed (near calm) conditions. As a result, AERMOD can produce model estimates for conditions when the wind speed may be less than 1 m/s, but still greater than the instrument threshold.

APPENDIX II
Meteorological Data - AERMET

AERMOD incorporates a meteorological pre-processor AERMET(14). AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

The AERMET meteorological preprocessor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. A morning sounding from a representative upper air station, latitude, longitude, time zone, and wind speed threshold are also required.

Two files are produced by AERMET for input to the AERMOD dispersion model. The surface file contains observed and calculated surface variables, one record per hour. The profile file contains the observations made at each level of a meteorological tower, if available, or the one-level observations taken from other representative data, one record level per hour.

From the surface characteristics (i.e. surface roughness, albedo and amount of moisture available (Bowen Ratio)) AERMET calculates several boundary layer parameters that are important in the evolution of the boundary layer, which, in turn, influences the dispersion of pollutants. These parameters include the surface friction velocity, which is a measure of the vertical transport of horizontal momentum; the sensible heat flux, which is the vertical transport of heat to/from the surface; the Monin-Obukhov length which is a stability parameter relating the surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

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 types is carried out in line with USEPA recommendations(5) and using the detailed methodology outlined by the Alaska Department of Environmental Conservation(16). AERMET has also been updated to allow for an adjustment of the surface friction velocity (u*) for low wind speed stable conditions based on the work of Qian and Venkatram (BLM, 2011). Previously, the model had a tendency to over-predict concentrations produced by near-ground sources in stable conditions.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on an upwind area-weighted average of the land use within the sector, by using the eight land use categories outlined by the USEPA. The inverse-distance weighted surface roughness length derived from the land use classification within a radius of 1km from Dublin Airport Meteorological Station is shown in Table A1.

Table A1 Surface Roughness based on an inverse distance weighted average of the land use within a 1km radius of Dublin Airport Meteorological Station.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter[Note 1]
0-360	100% Grassland	0.050	0.100	0.010	0.010

Note 1: Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal, 1983). Thus for the current location autumn more accurately defines “winter” conditions at the facility.

Albedo

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. A 10km x 10km square area is drawn around the meteorological station to determine the albedo based on a simple average for the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Dublin Airport Meteorological Station is shown in Table A2.

Table A2 Albedo based on a simple average of the land use within a 10km × 10km grid centred on Dublin Airport Meteorological Station.

Area-weighted Land Use Classification	Spring	Summer	Autumn	Winter[1]
0.5% Water, 30% Urban, 0.5% Coniferous Forest 38% Grassland, 19% Cultivated Land	0.155	0.180	0.187	0.187

(1) For the current location autumn more accurately defines “winter” conditions in Ireland.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. A 10km x 10km square area is drawn around the meteorological station to determine the Bowen Ratio based on geometric mean of the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Dublin Airport Meteorological Station is shown in Table A3.

Table A3 Bowen Ratio based on a geometric mean of the land use within a 10km × 10km grid centred on Dublin Airport Meteorological Station.

Geometric Mean Land Use Classification	Spring	Summer	Autumn	Winter[1]
0.5% Water, 30% Urban, 0.5% Coniferous Forest 38% Grassland, 19% Cultivated Land	0.549	1.06	1.202	1.202

(1) For the current location autumn more accurately defines “winter” conditions in Ireland.