Appendix 8.1

Air Quality Study

8. APPENDIX 8.1 - AIR QUALITY STUDY

Executive Summary

The Ringaskiddy Resource Recovery Centre facility will consist of a grate incinerator for the treatment of residual municipal waste and other suitable wastes.

Air dispersion modelling was carried out using the United States Environmental Protection Agency's (USEPA) regulatory model AERMOD (version 24142). The aim of the study was to assess the effect in the ambient environment of emissions from the facility at the emission limits outlined in Council Directive 2010/75/EU. Modelling was also conducted under abnormal operating conditions to assess any short-term effect due to these infrequent events. The study demonstrates that all substances which will be emitted from the proposed facility will be at levels that are well below even the most stringent ambient air quality standards and guidelines. The dispersion model study consisted of the following components:

- Review of design emission levels and other relevant information needed for the modelling study;
- Identification of the significant substances which will be released from the facility;
- Review of background ambient air quality in the vicinity of the proposed facility;
- Air dispersion modelling of significant substances released from the facility;
- Particulate deposition modelling of Dioxins & Furans, Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals released from the facility;
- Identification of predicted ground level concentrations of released substances beyond the facility boundary and at sensitive receptors in the immediate environment;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines which have been set for the protection of human health;
- Effect on public health and the environment in the unlikely event of "abnormal" operating conditions;
- An assessment of the cumulative effect of the facility and surrounding industrial sources has also been undertaken.

Modelling and a subsequent impact assessment were undertaken for the following substances released from the facility:

- Nitrogen dioxide (NO_2) and Nitrogen Oxides (NO_X);
- Sulphur Dioxide (SO_2);
- Total Dust (as PM_{10} (particulate matter less than 10 microns) and $PM_{2.5}$ (particulate matter less than 2.5 microns));
- Gaseous and vaporous organic substances expressed as total organic carbon (TOC);
- Ammonia (NH_3)
- Hydrogen Chloride (HCl);
- Hydrogen Fluoride (HF);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- PCDD/PCDFs (Dioxins/Furans);
- Mercury (Hg);
- Cadmium (Cd) and Thallium (Tl);
- And Other Heavy Metals (as the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V)).

Assessment Approach

Emissions from the facility have been assessed firstly under maximum operating conditions and secondly under abnormal operating conditions. Maximum operations are based on a moving grate incinerator operating at the emission limits defined in EU Directive 2010/75/EU. Abnormal operating conditions refer to short-term periods in which the limits detailed in EU Directive 2010/75/EU are exceeded.

This is a conservative approach as the proposed facility will typically operate at levels well within emission limits defined in the EU Directive.

Modelling Under Maximum & Abnormal Operating Conditions

In order to assess the potential effect from the proposed facility under maximum and abnormal operations, a conservative approach was adopted that is designed to over-predict ground level concentrations. This cautious approach will ensure that an over-estimation of effects will occur and that the resultant emission standards adopted are protective of ambient air quality. The approach incorporated several conservative assumptions regarding operating conditions at the proposed facility. This approach incorporated the following features.

For the maximum operating scenario, it has been assumed that the emission points are continuously operating at their maximum operating volume flow. This will over-estimate the actual mass emissions from the facility.

For the maximum operating scenario, it has been assumed that the emission points are operating for 24-hrs/day over the course of the full year. Abnormal operating emissions were pessimistically assumed to occur as outlined below:

- NO_X - 400 mg/m^3 for 3% of the year (11 days per annum);
- SO_2 - 200 mg/m^3 for 3% of the year (11 days per annum);
- Total Dust - 30 mg/m^3 for 3% of the year (11 days per annum);
- TOC - 30 mg/m^3 for 3% of the year (11 days per annum);
- HCl - 60 mg/m^3 for 3% of the year (11 days per annum);
- HF - 4 mg/m^3 for 3% of the year (11 days per annum);
- CO - 200 mg/m^3 for 5% of the year (18 days per annum);
- Dioxins & Furans - 0.5 ng/m^3 for 3% of the year (11 days per annum);
- Heavy Metals (other than Hg, Cd & Tl) - 30 mg/m^3 for 3% of the year (11 days per annum);
- Cd & Tl - 0.2 mg/m^3 for 3% of the year (11 days per annum);
- Hg - 1 mg/m^3 for 3% of the year (11 days per annum).

Worst-case meteorological conditions over the period 2020 - 2024 from Cork Airport and the on-site meteorological data from 2007 have been used in all assessments. For all averaging periods the worst-case year from 2007, 2020 - 2024 was used for comparison with the ambient air quality standards.

As a result of these conservative assumptions, there will be an over-estimation of the emissions from the facility and the effect of the proposed facility on human health and the surrounding environment.

Modelled Locations

In relation to the spatial assessment of emissions from the facility, modelling has been carried out to cover locations at the boundary and within a radius of 10 km of the facility, regardless of whether any sensitive receptors are located in the area. Ambient air quality legislation designed to protect human health (i.e. by setting ambient limit values for a range of pollutants) is generally based on assessing ambient air quality

at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient air quality legislation has been applied to all locations regardless of whether any sensitive receptors (such as residential locations) are present for significant periods of time. This represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the maximum value.

Ambient air concentrations have also been predicted at the most sensitive residential receptors in Cobh, Monkstown and Ringaskiddy and the surrounding geographical area as far away as Passage West, Carrigaline and Crosshaven.

Cumulative Assessment

The region around the Ringaskiddy Resource Recovery Centre is partly industrialised and thus has several other potential sources of pollutants. As a result, an investigation of facilities with IED Licences has been undertaken in the region as outlined in **Appendix 8.4**.

The effect of additional traffic associated with the facility has also been incorporated into the existing baseline concentrations thus ensuring all sources of air emissions in the region have been taken into account. This is detailed in **Appendix 8.3**.

Interaction of the nearest wind turbine and potential effects of the plume were also assessed as outlined in **Appendix 8.8**. The assessment found that the difference in the maximum concentrations at the worst-case receptor at ground level for the years modelled are not significantly impacted by the wind turbine. The maximum difference in the "With" and "Without" scenarios for the 1-hour results (measured as a 99.8th%ile) was a difference of 4.3% of the 1-hour limit value whilst annual mean results agreed within 1.1% of the limit value. All other turbines in the region are at a significantly greater distance from the facility and will have an insignificant interaction with the plume.

Baseline Air Quality Assessment

An extensive baseline survey was carried out in the region of the proposed facility over the period from August 2024 – January 2025. The survey focused on the significant pollutants likely to be emitted from the facility and which have been regulated under Council Directive 2010/75/EU. The survey updates previous surveys which were undertaken in 2001, between 2006 – 2008, from August 2014 to July 2015 and and October 2018 to January 2019.

Ambient NO_2, SO_2, benzene, PM_{10} and $PM_{2.5}$ were measured for an approximate 6-month period from August 2024 – January 2025), to account for seasonal variations in these pollutants.

The NO_2 monitoring was carried out using passive diffusion tubes. The average NO_2 concentration measured over the six month period at each of the 16 diffusion tube monitoring locations ranged from 4.0 – 10.3 $\mu g/m^3$, which is between 10% - 26% of the EU annual limit value of 40 $\mu g/m^3$.

The SO_2 diffusion tube concentrations measured over the six-month survey period are below the annual EU limit value of 20 $\mu g/m^3$ for the protection of vegetation. The average SO_2 concentration measured over the six month period at each location ranged from 1.6 – 2.8 $\mu g/m^3$ which is between 8% – 14% of the EU annual limit value of 20 $\mu g/m^3$.

The benzene diffusion tube concentrations measured over the six-month survey period are below the annual EU limit value of 5 $\mu g/m^3$ for the protection of human health. The average benzene concentration measured over the six month period at each location ranged from 0.20 – 0.38 $\mu g/m^3$ which is between 4% - 8% of the EU annual limit value of 5 $\mu g/m^3$.

The 24-hour PM_{10} concentrations measured using a continuous Osiris light scattering monitor over the six-month monitoring period are below the 24-hour EU limit value of 50 $\mu g/m^3$ and there were no exceedances of the 24-hour limit value recorded. The annualised average PM_{10} concentration is 9.4 $\mu g/m^3$ which is only 23% of the EU annual limit value of 40 $\mu g/m^3$.

The annualised average $PM_{2.5}$ concentration is 5.7 $\mu g/m^3$ which is below the annual average EU limit value of 25 $\mu g/m^3$.

In summary, baseline ambient concentrations are in compliance with the ambient air quality standards which are based on the protection of the environment and human health.

Over the period October 2018 to January 2019 HF and HCl diffusion tube concentrations measured over the three-month survey period are well below the UK environmental assessment levels (EALs). The average HF concentration measured over the three-month period is 0.32 $\mu g/m^3$, which is only 2% of the annual limit value of 16 $\mu g/m^3$. The average HCl concentration measured over the three-month monitoring period is 2.21 $\mu g/m^3$ which is 11% of the annual limit value of 20 $\mu g/m^3$.

Over the period October 2018 to January 2019 the average concentrations of antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), thallium (Tl) and vanadium (V) were significantly below their respective annual limit values, with average levels reaching only 0.04% - 47% of these limits.

Background levels of PCDD / PCDFs cannot be compared to ambient air quality concentration or deposition standards. However, levels of PCDDs and PCDFs can be compared to existing levels measured sporadically in Ireland and continuously in the UK as part of the TOMPS network. The mean PCDD/PCDF concentration measured over the period October 2018 – January 2019 indicates that results are in line with measurements conducted elsewhere in Ireland, with an upper limit of 21.5 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3.

Study Conclusions

The main study conclusions are presented below for each substance in turn:

NO_2 & NO_X

NO_2 modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for nitrogen dioxide under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations lead to ambient NO_2 concentrations (including background concentrations) which are 18% of the maximum ambient 1-hour limit value (measured as a 99.97th%ile), 49% of the maximum ambient 24-hour limit value (measured as a 95.1th%ile) and 26% of the annual average limit value at the respective worst-case receptors.

SO_2, CO, PM_{10} & $PM_{2.5}$

Modelling results indicate that ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for sulphur dioxide, carbon monoxide and PM_{10} under maximum and abnormal operation of the facility. Results will also be below the air quality standard for $PM_{2.5}$ under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) ranging from 16% - 68% of the respective limit values at the worst-case receptors.

TOC, NH_3, HCl & HF

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality guidelines for the protection of human health for TOC (assumed pessimistically to consist solely of benzene), HCl and HF under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) for HCl, NH_3 and TOC of only 11%, 1% and 32% respectively of the ambient limit values.

HF modelling results indicate that emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which will be 1% of the maximum ambient 1-hour limit value and 2% of the annual limit value.

PCDD / PCDFs (Dioxins/Furans)

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs (Dioxins/Furans). The EU, USEPA and WHO recommended approach to assessing the risk to human health from Dioxins/Furans entails a detailed risk assessment analysis involving the determination of the effect of Dioxins/Furans in terms of the TDI (Tolerable Daily Intake) or TWI (Tolerable Weekly Intake) approach. The EU currently proposes a maximum TWI of between 14 pg WHO-TEQ/kg of body weight per day.

Ambient background levels of Dioxins/Furans occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Monitoring results indicate that the existing levels are similar to rural areas in the UK and Ireland. The contribution from the facility in this context is minor, with levels at the worst-case receptor to the south of the facility, under maximum and abnormal operation, accounting for only a small fraction of existing levels. Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 1% of the existing background concentration under maximum operating conditions.

PAHs

PAHs modelling results indicate that the ambient ground level concentrations will be below the relevant air quality limit value for the protection of human health under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient benzo[*a*]pyrene concentrations (excluding background concentrations) which are 0.1% of the EU annual average limit value at the worst-case receptor.

Hg

Hg modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient mercury concentrations (including background concentrations) which are only 1% of the annual average limit value at the worst-case receptor.

Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standard for the protection of human health for cadmium under maximum and abnormal operation from the facility. Emissions at maximum levels equate to ambient Cd and Tl concentrations (including background concentrations) which are 28% of the EU annual limit value for Cd close to the facility boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

Sum of As, Sb, Pb, Cr, Co, Cu, Ni, Mn and V

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for arsenic (As), nickel (Ni) and vanadium (V) (the metals with the most stringent limit values) under maximum and abnormal operation emissions from the facility (based on the ratio of metals measured at a Waste to Energy facility in Carranstown, County Meath). Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Ambient concentrations have been compared to the annual limit value for As and Ni and the maximum 1-hour limit value for V as these represent the most stringent limit values for the suite of metals. Emissions at maximum operations equate to ambient As and Ni concentrations (including background concentrations) which are 17% and 48% of the EU annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are only 0.2% of the maximum 1-hour limit value at the worst-case receptor. Emissions under abnormal operations equate to ambient As and Ni concentrations (including background concentrations) which are 24% and 53% of the annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are 3% of the maximum 1-hour limit value at the worst-case receptor.

National Emissions Ceiling

A comparison of the proposed facility's operations with the obligations under the National Emissions Ceiling Directive indicates the effect of the development is to increase SO_2 levels by 0.84% of the ceiling levels to be complied with in 2030, NO_X levels by 0.72% of the ceiling levels, VOC levels will be increased by 0.02% of the ceiling limits, NH_3 levels will be increased by 0.02% of the ceiling limits whilst $PM_{2.5}$ levels will be increased by 0.16% of the ceiling limits.

Summary

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards or guidelines for the protection of human health for all parameters under maximum and abnormal operation of the facility. The modelling results indicate that the long-term maximum concentrations occur near the southern and south-eastern boundaries of the facility. Maximum operations are based on the emission concentrations outlined in EU Directive 2010/75/EU.

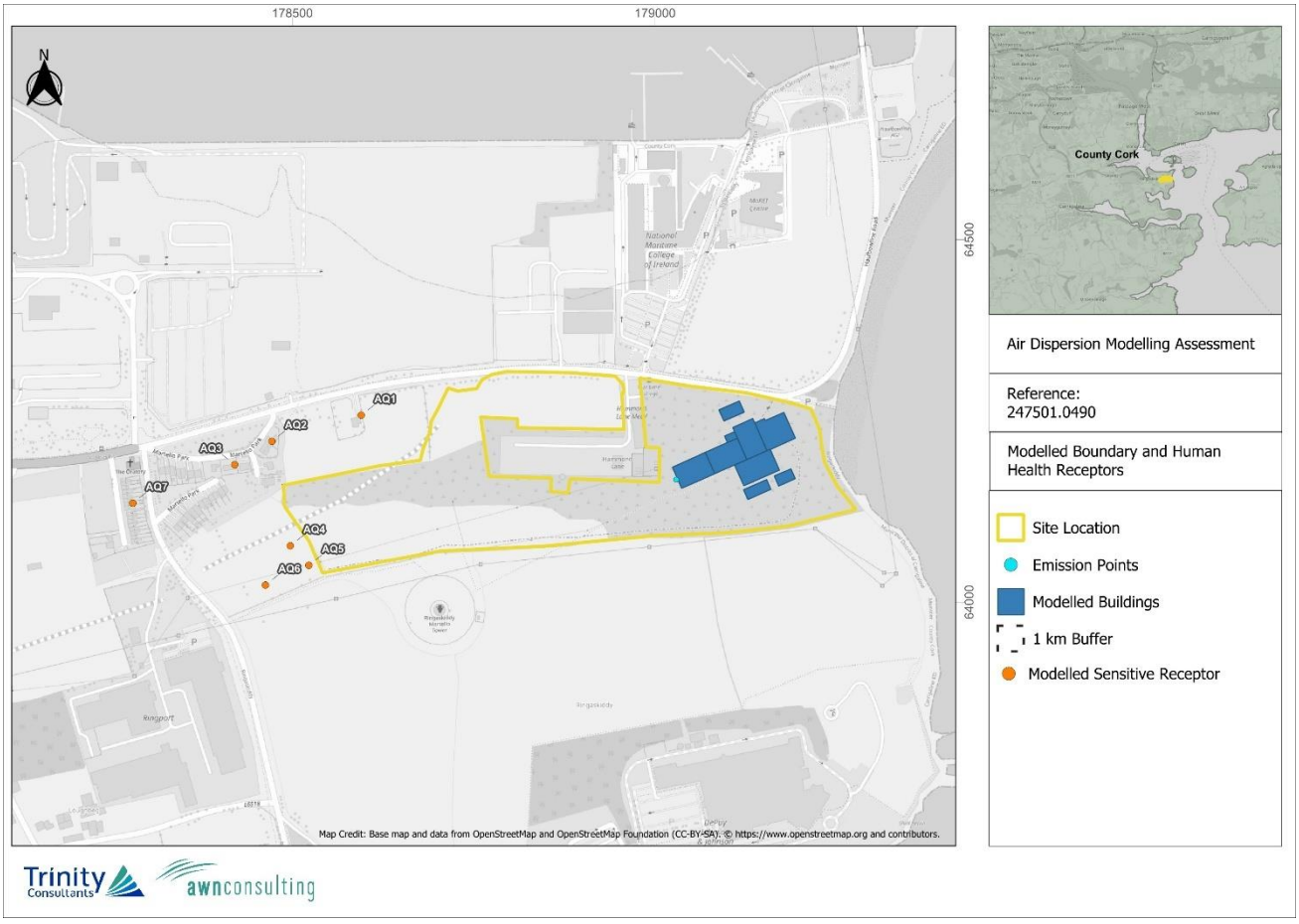
An appropriate stack height has been selected to ensure that ambient air quality standards for the protection of human health will not be approached even under abnormal operating scenarios. The stack height which will lead to adequate dispersion, as determined by air dispersion modelling, is 70 metres.

The spatial effect of the facility is limited with concentrations falling off rapidly away from the maximum peak. For example, the short-term concentrations due to process emissions at the nearest residential receptor will be less than 6% of the short-term ambient air quality limit values. The annual average concentration has an even more dramatic decrease in maximum concentration away from the facility with concentrations from emissions at the proposed facility accounting for less than 1% of the limit value (not including background concentrations) at worst case sensitive receptors near the facility.

8.1 Introduction

The Ringaskiddy Resource Recovery Centre will have one furnace and flue gas cleaning line. The line will have an 80MW moving grate furnace with a state-of-the-art flue gas cleaning system. The location of the facility boundary and nearby human health receptors is shown in Figure 8.1.

Figure 8.1 Modelled Boundary and Human Health Nearby Receptors



The combustion of waste produces a number of emissions, the discharges of which are regulated by the EU Directive on Industrial Emissions (IED) (2010/75/EU). The emissions to atmosphere which have been regulated are:

- Nitrogen Dioxide (NO_2)
- Sulphur Dioxide (SO_2)
- Total Dust (as PM_{10} and $PM_{2.5}$)
- Carbon Monoxide (CO)
- Total Organic Carbon (TOC)
- Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl)
- Dioxins/Furans (PCDD/PCDFs)
- Cadmium (Cd) & Thallium (Tl)
- Mercury (Hg)
- and the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V).

In addition, Ammonia (NH_3) and Polycyclic Aromatic Hydrocarbons (PAHs) have been assessed as incineration is a potential emission source for these compounds.

The scope of the study consists of the following components:

- Review of maximum emission levels and other relevant information needed for the modelling study;
- Identification of the significant substances which are released from the facility;
- Review of background ambient air quality in the vicinity of the facility;
- Air dispersion modelling of significant substances released from the facility;
- Particulate deposition modelling of Dioxins & Furans, Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals released from the facility;
- Identification of predicted ground level concentrations of released substances at the facility boundary and at sensitive receptors in the immediate environment;
- Evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines.

8.1.1 Modelling Under Maximum & Abnormal Operating Conditions

In order to assess the potential effect from the proposed facility under maximum and abnormal operations, a conservative approach was adopted that is designed to over-predict ground level concentrations. This cautious approach will ensure that an over-estimation of effects will occur and that the resultant emission standards adopted are protective of ambient air quality. The approach incorporated several conservative assumptions regarding operating conditions at the proposed facility. This approach incorporated the following features:

- For the maximum operating scenario, it has been assumed that the emission point is continuously operating at its maximum operating volume flow. This will over-estimate the actual mass emissions from the facility.
- For the maximum operating scenario, it has been assumed that the emission point is operating at maximum capacity for 24-hrs/day over the course of the full year.
- Abnormal operating emissions were obtained from the process engineer and are pessimistically assumed to occur as outlined below:
  - NO_X - 400 mg/m^3 for 3% of the year (11 days per annum)
  - SO_2 - 200 mg/m^3 for 3% of the year (11 days per annum)
  - Total Dust - 30 mg/m^3 for 3% of the year (11 days per annum)
  - TOC - 30 mg/m^3 for 3% of the year (11 days per annum)
  - HCl - 60 mg/m^3 for 3% of the year (11 days per annum)
  - HF - 4 mg/m^3 for 3% of the year (11 days per annum)
  - CO - 200 mg/m^3 for 5% of the year (18 days per annum)
  - Dioxins & Furans - 0.5 ng/m^3 for 3% of the year (11 days per annum)
  - Heavy Metals (other than Hg, Cd & Tl) - 30 mg/m^3 for 3% of the year (11 days per annum)
  - Cd & Tl - 0.2 mg/m^3 for 3% of the year (11 days per annum)
  - Hg - 1 mg/m^3 for 3% of the year (11 days per annum).

As a result of these conservative assumptions, there will be an over-estimation of the emissions from the facility and the effect of the proposed facility on human health and the surrounding environment.

8.2 Assessment Criteria

8.2.1 Human Health

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. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set.

8.2.1.1 Ambient Air Quality Standards

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland are set out in Directive (EU) 2024/2881 *of the European Parliament and of the Council of 23 October 2024 on ambient air quality and cleaner air for Europe (recast)*. This Directive sets out new air quality standards for pollutants to be reached by 2030 which are more closely aligned with the World Health Organisation (WHO) air quality guidelines.

The ambient air quality limit values for pollutants are set out in Annex I of Directive (EU) 2024/2881. Table 1 of Annex I in Directive (EU) 2024/2881 sets out the updated air quality limit values for pollutants to be achieved by 1 January 2030, which are more closely aligned with the WHO air quality guidelines. Table 2 of Annex I in Directive (EU) 2024/2881 sets out the limit values for air pollutants which are to be achieved by 11 December 2026 and are also applicable up to 2030. The limit values in Table 2 of Annex I are the same as the limits set under Directive 2008/50/EC and the Air Quality Standards Regulations 2022.

The Air Quality Standards Regulations 2022 (S.I. 739 of 2022) transposed EU Directive 2008/50/EC. With the adoption of Directive (EU) 2024/2881, Ireland must transpose this Directive into national law (i.e. update the Air Quality Standards Regulations) before 11 December 2026.

The ambient air quality standards applicable for nitrogen dioxide (NO_2) and particulate matter (as PM_{10} and $PM_{2.5}$) are outlined in Table 8.1. The limit values set out in Directive (EU) 2024/2881 will need to be achieved by 2030, with the limit values stipulated under Table 2 of Annex I in Directive (EU) 2024/2881 and the Air Quality Standards Regulations 2022 applicable until 2030.

Table 8.1 Ambient Air Quality Limit Values

Pollutant	Directive (EU) 2024/2881			
	Limit Type	Limit Value (to be attained by 2026 and applicable until 2030) [a]	Limit Type	Limit Value (to be attained by 2030)
Nitrogen Dioxide (NO_2)	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	200 µg/m^3	Hourly limit for protection of human health - not to be exceeded more than 3 times/year	200 µg/m^3
	N/A	N/A	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	50 µg/m^3
	Annual limit for protection of human health	40 µg/m^3	Annual limit for protection of human health	20 µg/m^3
NO_X	Annual limit for protection of vegetation	30 µg/m^3	Annual limit for protection of vegetation	30 µg/m^3
Particulate Matter (as PM_{10})	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50 µg/m^3	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	45 µg/m^3
	Annual limit for protection of human health	40 µg/m^3	Annual limit for protection of human health	20 µg/m^3

Pollutant	Directive (EU) 2024/2881			
	Limit Type	Limit Value (to be attained by 2026 and applicable until 2030) [a]	Limit Type	Limit Value (to be attained by 2030)
Particulate Matter (as $PM_{2.5}$)	N/A	N/A	24-hour limit for protection of human health - not to be exceeded more than 18 times/year	25 µg/m^3
	Annual limit for protection of human health	25 µg/m^3	Annual limit for protection of human health	10 µg/m^3

8.2.1.2 WHO Air Quality Guidelines & Clean Air Strategy

In April 2023, the Government of Ireland published the Clean Air Strategy for Ireland (Government of Ireland, 2023), which provides a high-level strategic policy framework needed to reduce air pollution. The strategy commits Ireland to achieving the 2021 WHO Air Quality Guidelines Interim Target 3 (IT3) by 2026, the IT4 targets by 2030 and the final targets by 2040 (shown in Table 8.2). The strategy notes that a significant number of EPA monitoring stations observed air pollution levels in 2021 above the WHO targets; 80% of these stations would fail to meet the final $PM_{2.5}$ target of 5 µg/m^3. The strategy also acknowledges that "*meeting the WHO targets will be challenging and will require legislative and societal change, especially with regard to both $PM_{2.5}$ and NO_2*".

Annex II of Directive (EU) 2024/2881 gives assessment thresholds which align with the clean air strategy final 2040 WHO targets. Directive (EU) 2024/2881 states that *"Member States shall endeavour to achieve and preserve the best ambient air quality and a high level of protection of human health and the environment, with the aim of achieving a zero-pollution objective as referred to in Article 1(1), in line with WHO recommendations, and below the assessment thresholds laid down in Annex II."*

These assessment thresholds relate to monitoring of ambient air quality by Member States, where *"exceedances of the assessment thresholds specified in Annex II shall be determined on the basis of concentrations during the previous 5 years where sufficient data are available. An assessment threshold shall be deemed to have been exceeded if it has been exceeded during at least 3 separate years out of those previous 5 years."*

Table 8.2 WHO Air Quality Guidelines

Pollutant	Limit Type	IT3 (2026)	IT4 (2030)	Final Target (2040)
NO_2	24-hour limit for protection of human health	-	-	25 µg/m^3
	Annual limit for protection of human health	20 µg/m^3	-	10 µg/m^3
PM (as PM_{10})	24-hour limit for protection of human health	75 µg/m^3	50 µg/m^3	45 µg/m^3
	Annual limit for protection of human health	30 µg/m^3	20 µg/m^3	15 µg/m^3
PM (as $PM_{2.5}$)	24-hour limit for protection of human health	37.5 µg/m^3	25 µg/m^3	15 µg/m^3

Pollutant	Limit Type	IT3 (2026)	IT4 (2030)	Final Target (2040)
	Annual limit for protection of human health	15 µg/m^3	10 µg/m^3	5 µg/m^3

The applicable air quality limit values for the purposes of this assessment are those set out in Table 8.1. The limit values stipulated under Directive 2008/50/EC and the Air Quality Standards Regulations 2022 are applicable for the construction phase. The limit values stipulated by Directive (EU) 2024/2881 are applicable for the opening year of 2030 and the design year 2045 for the proposed development.

8.2.1.3 Dust Deposition Guidelines

The concern from a health perspective is focused on particles of dust, which are less than 10 microns, and the EU ambient air quality standards outlined in Table 8.1 have set ambient air quality limit values for PM_{10} and $PM_{2.5}$.

With regard to larger dust particles there are no statutory guidelines regarding the maximum dust deposition levels that may be generated during the construction phase of a development in Ireland.

However, guidelines for dust deposition, the German TA-Luft standard for dust deposition (non-hazardous dust) (German VDI, 2002) sets a maximum permissible emission level for dust deposition of 350 mg/m^2/day averaged over a one-year period at any receptors outside the site boundary. The TA-Luft standard has been applied for the purpose of this assessment based on recommendations from the EPA in Ireland in the document titled *Environmental Management Guidelines - Environmental Management in the Extractive Industry (Non-Scheduled Minerals)* (EPA, 2006). The document recommends that the TA-Luft limit of 350 mg/m^2/day be applied to the site boundary of quarries. This limit value can be implemented with regard to dust effects from construction of the proposed development.

8.2.1.4 Air Quality and Traffic Impact Significance Criteria

The Transport Infrastructure Ireland (TII) guidance document *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022) details a methodology for determining air quality impact significance criteria for road schemes which can be applied to any project that causes a change in traffic. The degree of impact is determined based on the percentage change in pollutant concentrations relative to the Do-Nothing scenario. The TII significance criteria are outlined in Table 4.9 of *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022) and reproduced in Table 8.3. These criteria have been adopted for the proposed development to predict the impact of NO_2, PM_{10} and $PM_{2.5}$ emissions as a result of the traffic associated with the proposed development.

Table 8.3 Air Quality & Traffic Significance Criteria

Long Term Average Concentration at Receptor in Assessment Year	% Change in Concentration Relative to Air Quality Limit Value (AQLV)			
	1%	2-5%	6-10%	>10%
75% or less of AQLV	Neutral	Neutral	Slight	Moderate
76 – 94% of AQLV	Neutral	Slight	Moderate	Moderate
95 – 102% of AQLV	Slight	Moderate	Moderate	Substantial
103 – 109% of AQLV	Moderate	Moderate	Substantial	Substantial
110% or more of AQLV	Moderate	Substantial	Substantial	Substantial

Source TII (TII, 2022a) Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106

As per Table 8.3 a neutral effect is one where a change in concentration at a receptor is:

- 5% or less where the opening year, without the proposed development, annual mean concentration is 75% or less of the standard; or
- 1% or less where the opening year, without the proposed development, annual mean concentration is 94% or less of the standard.

Where an effect does not meet the criteria for neutral, as described above, the effect can either be positive or negative. The TII guidance (2022) states that "*the evaluation of significance of effects for the operational phase should be undertaken for the opening year only as the design year is likely to show lower total pollutant concentrations and changes in concentration*" (TII, 2022).

'Neutral' or 'slight' changes in concentrations are considered to be not significant per the TII guidance (2022) and can be scoped-out while changes in pollutant concentrations that are either 'moderate' or 'substantial' may be significant per the TII Guidance (2022) and should be brought forward for assessment and considered in the context of the project.

The impact descriptors in Table 8.3 used to describe the impact at each modelled receptor location, and the significance of the impacts is then determined, aligning with the terminology in the EPA guidelines (EPA 2022). Whilst it may be determined that there are 'slight', 'moderate' or 'substantial' impacts at one or more receptors, an overall judgement is made of whether the proposed development is 'significant' or 'not significant' in terms of air quality. Factors to consider when determining the overall significance of a proposed development are provided in Table 4.10 of the TII guidance (TII, 2022).

8.2.2 Ecology

8.2.2.1 Critical Levels

The Air Quality Standards Regulations 2022 outline an annual critical level of 30 µg/m^3 for NO_X and a level of 20 µg/m^3 for SO_2 (Table 8.1) for the protection of vegetation and natural ecosystems in general. The CAFE Directive (2008/50/EC) defines 'Critical Levels' as "*a level fixed on the basis of scientific knowledge, above which direct adverse effects may occur on some receptors, such as trees, other plants or natural ecosystems but not on humans*".

An annual critical level of 3 µg/m^3 for NH_3 for the protection of vegetation and natural ecosystems in general, or a critical level of 1 µg/m^3 where lichens or bryophytes are present within an ecosystem is given by the United Nations Economic Commission for Europe and the German Environment Agency (UNECE, 2022).

8.2.2.2 Critical Loads

A 'Critical Load' is defined by the United Nations Economic Commission for Europe (UNECE) as *"a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge"* (UNECE, 2003).

Critical loads are presented as a range, within which there is the potential for effects on sensitive ecological receptors. Critical load ranges for N deposition and acid deposition were derived from the Air Pollution Information System (APIS) website (APIS, 2025) and are reproduced as shown in Table 8.4 and Table 8.5. Also shown in these tables are the site feature code and name (i.e. the qualifying feature the site is designated for), the corresponding critical load class and EUNIS codes (European Nature Information System (EUNIS) by the European Environment Agency).

Critical loads are only available for internationally designated habitats (Special Protection Area (SPA) and Special Area of Conservation (SAC)), and for nationally designated Natural Heritage Areas (NHA).

Critical loads for proposed Natural Heritage Areas (pNHAs) are not defined on the APIS website. In the absence of defined critical loads, and in order to carry out an assessment for pNHAs, the site synopsis for each pNHA (NPWS, 2025) relevant to this assessment was reviewed for its range of habitats. Where possible, pNHA habitats identified from the site synopsis were assigned an equivalent nitrogen deposition or critical load class. These can be derived by searching APIS for the habitat type, rather than a specific site, or by reviewing SACs and SPAs with similar features. Where no equivalent critical load class could be assigned or a site synopsis was not available this has been denoted by "n/a".

As pNHAs are not fully designated Natural Heritage Areas and therefore have not undergone the same process of qualifying feature identification (which can then be processed by APIS), the critical load classes assigned to pNHA habitats are an interpretation as part of this assessment, and may vary from those identified in future should the pNHA become fully designated.

In order to determine the appropriate nitrogen deposition critical load, and in addition to APIS, the EPA publication *Research 390: Nitrogen-Sulfur Critical Loads: Assessment of the Impacts of Air Pollution on Habitats* (EPA, 2021) was consulted. In Table 3.2 of the publication empirical critical loads of nutrient nitrogen are outlined with a worst-case range of 5-10 kg/ha/yr for most habitat types. In addition, for most habitat types, the EPA publication recommends the midpoint is used to define the critical load (e.g. 7.5 kg/ha/yr). Thus, the mid-range critical load for the worst-case habitat type within the relevant sites have been used to compare with modelled process contributions.

Acid deposition critical loads are further categorised by nitrogen (N) or sulphur (S) components. Modelled acid deposition process contributions are therefore calculated in terms of both nitrogen (N) and sulphur (S) where relevant (see Section 8.3.3.2).

Deposition of sulphur (as sulphate (SO_4^{2-})) and nitrogen (as nitrate (NO_3^-), ammonium (NH_4^+) and nitric acid (HNO_3^-)), can cause acidification and both sulphur and nitrogen compounds must be taken into account when assessing acidification of soils. For the purposes of determining links between critical loads and atmospheric emissions of sulphur and nitrogen, critical loads are further derived to produce a maximum critical load for sulphur (CLmaxS), a minimum critical load for nitrogen (CLminN) and a maximum critical load for nitrogen (CLmaxN). These components define the critical load function and when compared with deposition data for sulphur and nitrogen, they can be used to assess critical load exceedances.

The modelled acid deposition process contributions (as N) have been compared to the minimum critical load (N) (MinCLminN). Where a process contribution is greater than 1% of this minimum critical load, the predicted environmental concentration (PEC) should then be calculated by adding the acid deposition background concentration to the process contribution. The PEC should then be compared to the lower end of the maximum critical load (N) range i.e. MaxCLminN. This is in line with the *Screening Acidity Critical Loads* approach taken by APIS (available as a tab in the APIS app) for designated sites. Notably, APIS does not consider the critical load function to be exceeded unless the PEC is larger than the maximum critical load, not the minimum (which is typically considered worst case).

Table 8.4 Critical Loads for Nitrogen Deposition

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
Natura 2000 Sites										
Great Island Channel SAC	001058	H1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
Ballycotton Bay SPA	004022	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cork Harbour SPA	004030	A005	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
National Sites										
Ballycotton, Ballynamona And Shanagarry pNHA	000076	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	000099	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Blarney Bog pNHA	001857	n/a	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	5	15	10	Moist and wet oligotrophic grasslands: Molinia caerulea meadows	E3.51	-	-
Carrigacrump Caves pNHA	001408	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Carrigshane Hill pNHA	001042	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cork Lough pNHA	001081	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cuskinny Marsh pNHA	001987	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
Douglas River Estuary pNHA	001046	n/a	Podiceps cristatus (North-western Europe - wintering)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
Dunkettle Shore pNHA	001082	n/a	Podiceps cristatus (North-western Europe - wintering)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	-	-
Fountainstown Swamp pNHA	000371	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Glanmire Wood pNHA	001054	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
Great Island Channel pNHA	001058	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	-
Leamlara Wood pNHA	001064	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lee Valley pNHA	000094	n/a	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	5	15	10	Moist and wet oligotrophic grasslands: Molinia caerulea meadows	E3.51	No	-
Lough Beg (Cork) pNHA	001066	n/a	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	5	10	7.5	Pioneer, low-mid, mid-upper saltmarshes	A2.54; A2.55; A2.53	No	n/a
Loughs Aderry And Ballybutler pNHA	000446	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minane Bridge Marsh pNHA	001966	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Ecological Receptor		Feature Code	Feature Name	Critical loads for most sensitive feature*			Nitrogen Critical Load Class	EUNIS code	Is species sensitive due to nutrient nitrogen impacts on broad habitat?	Reason
Site Name	Site Code			Min. Critical Load for N (kg N/ha/yr)	Max. Critical Load for N (kg N/ha/yr)	Assessment Criteria				
Monkstown Creek pNHA	001979	n/a	No NPWS site synopsis available	n/a	n/a	n/a	n/a	n/a	-	-
Owenboy River pNHA	001990	n/a	No NPWS site synopsis available	n/a	n/a	n/a	n/a	n/a	-	-
Rockfarm Quarry, Little Island pNHA	001074	n/a	Non-mediterranean dry acid and neutral closed grassland	10	15	12.5	Non-mediterranean dry acid and neutral closed grassland	E1.7	-	-
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	001076	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	000107	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Whitegate Bay pNHA	001084	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 8.5 Critical Loads for Acid Deposition

Ecological Receptor		Feature Code	Feature Name	Acidity Critical Load Class	Max. Critical Load Range (N) (keq/ha/yr)		Min. Critical Load Range (N) (keq/ha/yr)		Is species sensitive due to acidity impacts on broad habitat?	Reason
Site Name	Site Code				MaxCL minN	MaxCL maxN	MinCL minN	MinCL maxN		
Natura 2000 Sites										
Great Island Channel SAC	001058	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ballycotton Bay SPA	004022	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cork Harbour SPA	004030	A017	*Anas clypeata (North-western/Central Europe)*	*Calcareous grassland (using base cation)*	0.714	5.962	0.143	2.383	no	n/a
National Sites										
Ballycotton, Ballynamona And Shanagarry pNHA	000076	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	000099	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Blarney Bog pNHA	001857	n/a	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	Acid grassland	0.143	1.829	0.143	0.524	no	n/a
Carrigacrump Caves pNHA	001408	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Carrigshane Hill pNHA	001042	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cork Lough pNHA	001081	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cuskinny Marsh pNHA	001987	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Douglas River Estuary pNHA	001046	n/a	Phalacrocorax carbo (North-western Europe)	Freshwater	0.714	5.962	5.247	0.143	2.383	2.241
Dunkettle Shore pNHA	001082	n/a	Phalacrocorax carbo (North-western Europe)	Freshwater	0.714	5.962	5.247	0.143	2.383	2.241
Fountainstown Swamp pNHA	000371	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Ecological Receptor		Feature Code	Feature Name	Acidity Critical Load Class	Max. Critical Load Range (N) (keq/ha/yr)		Min. Critical Load Range (N) (keq/ha/yr)		Is species sensitive due to acidity impacts on broad habitat?	Reason
Site Name	Site Code				MaxCL minN	MaxCL maxN	MinCL minN	MinCL maxN		
Glanmire Wood pNHA	001054	n/a	Old sessile oak woods with Ilex and Blechnum in the British Isles	Unmanaged Broadleafed / Coniferous Woodland	0.714	5.634	0.143	0.507	no	n/a
Great Island Channel pNHA	001058	n/a	No information on this site.	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Leamlara Wood pNHA	001064	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Lee Valley pNHA	000094	n/a	Old sessile oak woods with Ilex and Blechnum in the British Isles	Unmanaged Broadleafed / Coniferous Woodland	0.286	5.004	0.143	0.507	no	n/a
Lough Beg (Cork) pNHA	001066	n/a	*Anas clypeata (North-western/Central Europe)*	*Calcareous grassland (using base cation)*	0.714	5.962	0.143	2.383	no	n/a
Loughs Aderry And Ballybutler pNHA	000446	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Minane Bridge Marsh pNHA	001966	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Monkstown Creek pNHA	001979	n/a	No NPWS site synopsis available	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Owenboy River pNHA	001990	n/a	No NPWS site synopsis available	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Rockfarm Quarry, Little Island pNHA	001074	n/a	Old sessile oak woods with Ilex and Blechnum in the British Isles	Unmanaged Broadleafed / Coniferous Woodland	0.714	5.634	0.143	0.507	no	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	001076	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	000107	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Whitegate Bay pNHA	001084	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

8.2.2.3 Appropriate Assessment (AA) & IN2

In October 2024, the EPA published the draft guidance *Licence Application Instruction Note 2 (IN2) (DRAFT): Assessing the Impact of Ammonia Emissions to Air and Nitrogen Deposition from EPA licensable activities on European Sites* (hereafter referred to as IN2).

IN2 and the flowchart shown in Figure 8.2 (reproduced from Appendix 1 of IN2) is designed to assist in determining the course of action to be taken when evaluating the impacts on European sites (Special Areas of Conservation (SACs), Special Protection Areas (SPAs)) and of ammonia emissions to air and nitrogen deposition from main air emission points at EPA licensable industrial sites (Industrial Emissions, Integrated Pollution Control and Waste), excluding intensive agriculture installations, for the purposes of an Appropriate Assessment (AA). This approach may also be applied to NO_X and SO_2 specifically in the context of AA.

Once permitted, the proposed development will be a licensable facility, the methodology from IN2 and the flowchart steps are considered appropriate for determining ecological impacts from a variety of air pollutant emission sources, and have therefore been applied in this assessment:

1. The installation is not within 250 m of a European site. Proceed to Q2.

2. (i) Is the process contribution (PC) ≤1% of the relevant critical level and critical load at all European sites within the zone of influence, and (ii) can significant in-combination effects be ruled out?

    - The PCs for the Cork Harbour SPA are greater than 1% of the relevant critical levels and critical load and therefore, the impact of air emissions at this site have been assessed in further detail. Additionally, the PCs for Lough Beg pNHAs is above 1% of the relevant critical loads for acid deposition. The results of this screening exercise are presented in Section 8.7. Proceed to Q3.

    - Planning applications and the EPA register of Industrial Emissions (IE) licences was reviewed for developments and facilities with the potential for cumulative impact with the proposed development. There are IE licenced facilities within 1 km of the proposed development which operate significant sources of NO_2, and thus a cumulative impact assessment was required as outlined in Appendix 8.4.

3. Does modelling indicate that the Predicted Environmental Concentration (PEC) will exceed a critical level and/or critical load for any qualifying interests for European Sites within the zone of influence?

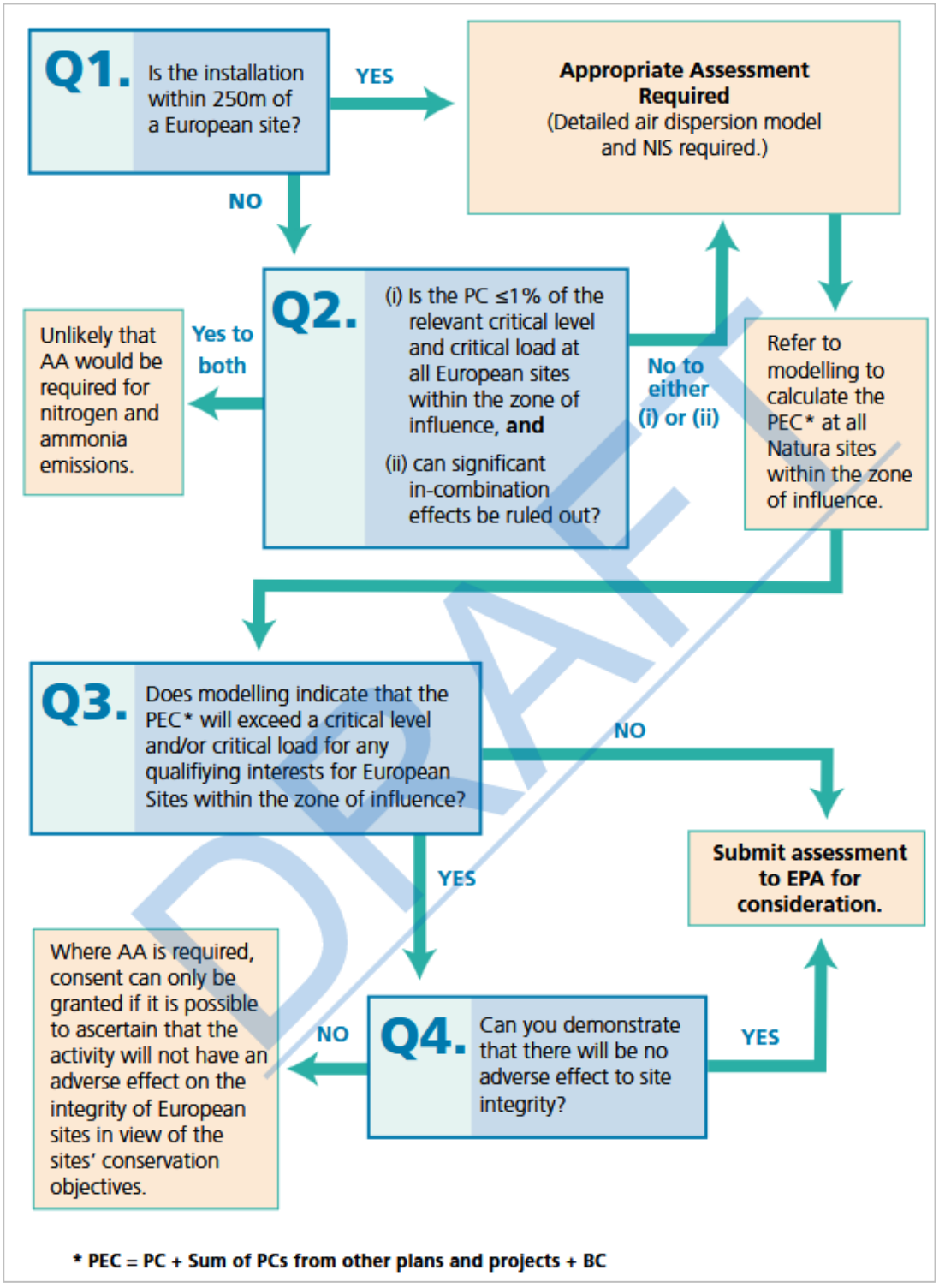
    - Nitrogen deposition and acid deposition PECs have been calculated for all European sites where the PC is greater than 1% of the relevant critical load. These are presented in Section 8.7.4. Whether the PECs exceed critical loads and if there are adverse effects to site integrity was determined in consultation with the project ecologist.

As per the IN2 guidance, where a PC is greater than 1% of the critical level, this site has been included in further assessment, where the PEC is determined by combining the background concentration with the PC. If a PC is less than the 1% threshold then the IN2 guidance states *"emissions are not considered to be likely to have a significant effect on European sites. No need to progress to further questions. Submit application to EPA for consideration".* "Further questions" refers to Question 3 in the IN2 guidance, which states "*Does modelling indicate that the PEC will exceed a critical level and/or critical load for any relevant qualifying interests for European sites within the zone of influence?"*. Calculation of PECs is therefore only technically required if Question 3 requires addressing i.e. if PCs are >1% threshold.

If there are no PCs greater than 1% of the critical level at any of the modelled European sites, no further assessment (i.e. calculation of PEC) is required as per IN2 guidance.

The IN2 process applies specifically to European sites with international designation, namely Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). However, the same approach has been taken to assess the effect of emissions impacts on nationally designated sites such as Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs). SACs and SPAs are protected under the EU Habitats Directive (92/43/EEC), and EU Birds Directive (2009/147/EC) respectively, and are also known as Natura 2000 sites. NHAs are designated under the Wildlife (Amendment) Act 2000, and pNHAs were identified as sites of conservation interest in the 1990s but have not since been statutorily proposed or designated.

Figure 8.2 IN2 flowchart for assessing the impacts of nitrogen deposition and ammonia emissions to air on European Sites



8.2.3 National Air Emissions Targets

Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (hereafter referred to as the National Emissions Reduction Directive) was published in December 2016. The National Emissions Reduction Directive applied the limits set out in *Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national*

emission ceilings for certain atmospheric pollutants (hereafter referred to as the National Emission Ceiling Directive) until 2020 and established new national emission reduction commitments which are applicable from 2020 and 2030 for SO_2, NO_X, non-methane volatile organic compounds (NMVOC), ammonia (NH_3), $PM_{2.5}$ and methane (CH_4). In relation to Ireland, the 2020 to 2029 emission targets are 25kt (kilotonnes) for SO_2 (65% reduction on 2005 levels), 65kt for NO_X (49% reduction on 2005 levels), 43kt for NMVOCs (25% reduction on 2005 levels), 108kt for NH_3 (1% reduction on 2005 levels) and 10 kt for $PM_{2.5}$ (18% reduction on 2005 levels) as shown in Table 8.6. In relation to 2030, Ireland's emission targets are 85% below 2005 levels for SO_2, 69% reduction for NO_X, 32% reduction for VOCs, 5% reduction for NH_3 and 41% reduction for $PM_{2.5}$, also shown in Table 8.6.

The emissions ceilings in relation to NO_X have been used in the current assessment of operational phase renewable electricity production from the proposed solar park development.

Table 8.6 National Air Emission Targets

Pollutant	2020 – 2029 Reduction Commitments		2030 Reduction Commitments	
	kt	% Reduction Compared to 2005 Levels	kt	% Reduction Compared to 2005 Levels
SO_2	25.6	-65%	10.96	-85%
NO_X	66.8	-49%	40.6	-69%
NMVOC	56.3	-25%	51.1	-32%
NH_3	112.1	-1%	107.5	-5%
$PM_{2.5}$	15.6	-18%	11.2	-41%

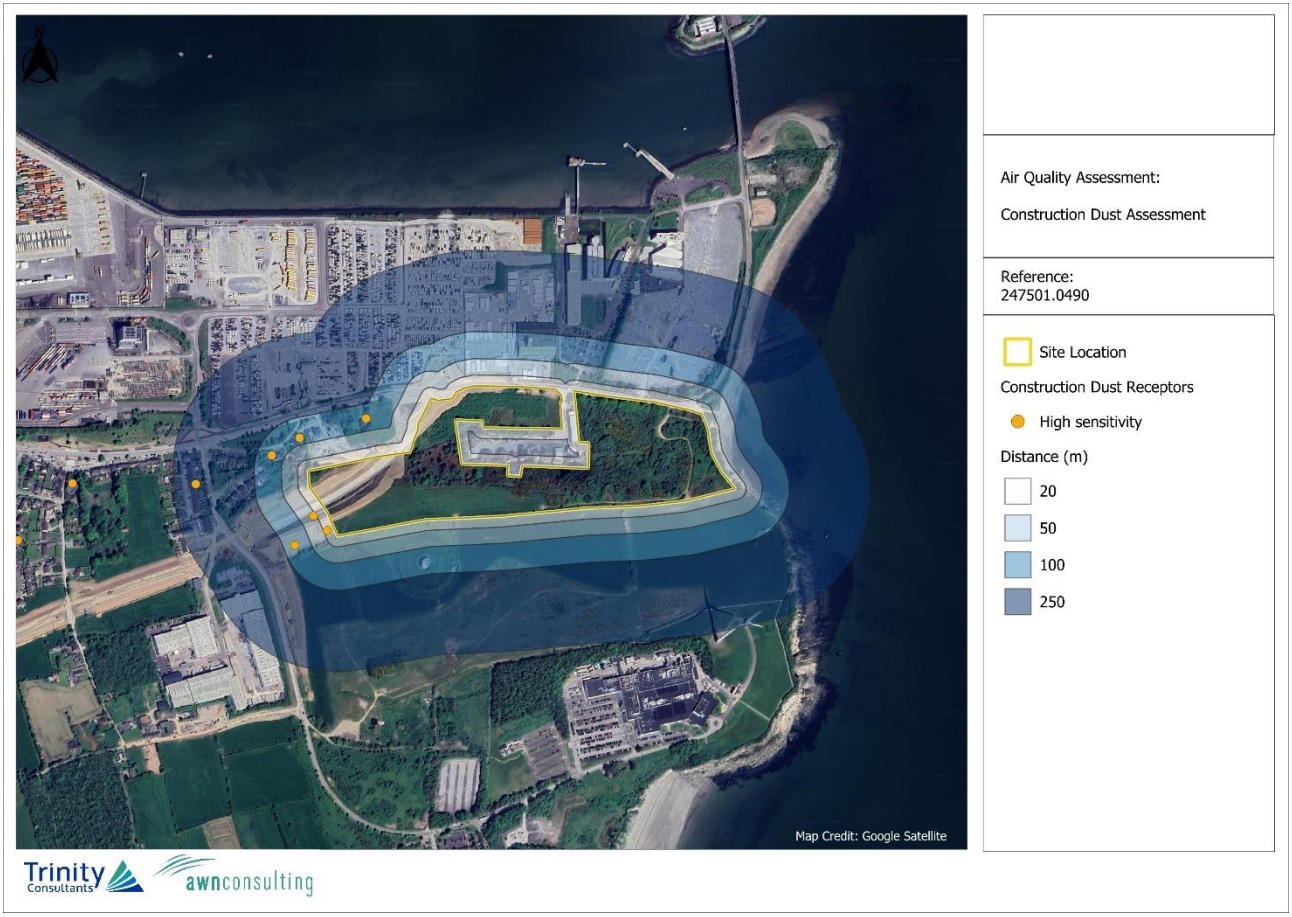
8.3 Study Methodology

8.3.1 Construction Phase

8.3.1.1 Construction Dust Assessment

The Institute of Air Quality Management in the UK (IAQM) guidance document '*Guidance on the Assessment of Dust from Demolition and Construction*' (2024) outlines an assessment method for predicting the impact of dust emissions from construction activities based on the scale and nature of the works and the sensitivity of the area to dust impacts. The nearby dust sensitive receptors are shown in Figure 8.3.

Figure 8.3 Construction Dust Receptors



The IAQM methodology has been applied to the construction phase of this development in order to predict the dust impacts and any likely significant effects of same in the absence of mitigation measures and to determine the level of site-specific mitigation required. The use of UK guidance is recommended by Transport Infrastructure Ireland in their guidance document *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022).

The major dust generating activities are divided into four types within the IAQM guidance (2024) to reflect their different potential impacts. These are:

- Demolition;
- Earthworks;
- Construction; and
- Trackout (transport of dust and dirt from the construction site onto the public road network).

The magnitude of each of the four categories is divided into Large, Medium or Small scale depending on the nature of the activities involved. The criteria for determining the category for the works involved are outlined in Table 8.7, these are based on the IAQM guidance (2024). The magnitude of each activity is combined with the overall sensitivity of the area to determine the risk of dust impacts from site activities. This allows the level of site-specific mitigation to be determined.

Table 8.7 IAQM Criteria to Determine Dust Emissions Magnitude

Dust Emission Magnitude		
Small	**Medium**	**Large**
Demolition		
► total building volume <12,000 m^3 ► construction material with low potential for dust release (e.g. metal cladding or timber) ► demolition activities <6 m above ground ► demolition during wetter months	► total building volume 12,000 - 75,000 m^3 ► potentially dusty construction material ► demolition activities 6 – 12 m above ground level	► total building volume >75,000 m^3 ► potentially dusty construction material (e.g. concrete) ► on-site crushing and screening ► demolition activities >12 m above ground level
Earthworks		
► total site area <18,000 m^2 ► soil type with large grain size (e.g. sand) ► <5 heavy earth moving vehicles active at any one time ► formation of bunds <3 m in height ► earthworks during wetter months	► total site area 18,000 m^2 - 110,000 m^2 ► moderately dusty soil type (e.g. silt) ► 5 – 10 heavy earth moving vehicles active at any one time ► formation of bunds 3 – 6 m in height	► total site area >110,000 m^2 ► potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) ► >10 heavy earth moving vehicles active at any one time ► formation of bunds >6 m in height
Construction		
► total building volume <12,000 m^3 ► construction material with low potential for dust release (e.g. metal cladding or timber)	► total building volume 12,000 - 75,000 m^3 ► potentially dusty construction material (e.g. concrete) ► on-site concrete batching	► total building volume >75,000 m^3 ► on-site concrete batching ► sandblasting
Trackout (truck movements)		
► <20 HDV (>3.5 t) outward movements in any one day ► surface material with low potential for dust release ► unpaved road length <50 m	► 20 – 50 HDV (>3.5 t) outward movements in any one day ► moderately dusty surface material (e.g. high clay content) ► unpaved road length 50 – 100 m	► >50 HDV (>3.5 t) outward movements in any one day ► potentially dusty surface material (e.g. high clay content) ► unpaved road length >100 m

Once the dust emission magnitude has been determined the next step, according to the IAQM guidance (2024), is to establish the level of risk by combining the magnitude with the overall sensitivity of the area to dust soiling, human health and ecological effects. The level of risk associated with each activity is determined using the criteria in Table 8.8.

Table 8.8 IAQM Criteria to Determine Risk of Dust Impacts

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High risk	Medium risk	Medium risk
Medium	High risk	Medium risk	Low risk
Low	Medium risk	Low risk	Negligible
Earthworks			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Construction			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible
Trackout			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible

8.3.1.2 Construction Traffic Assessment

Construction phase traffic has the potential to affect air quality. The TII guidance *Air Quality Assessment of Specified Infrastructure Projects – PE-ENV-01106* (TII, 2022), states that road links meeting one or more of the following criteria can be defined as being 'affected' by a proposed development and should be included in the local air quality assessment. While the guidance is specific to infrastructure projects the approach can be applied to any development that causes a change in traffic.

- Annual average daily traffic (AADT) changes by 1,000 or more;
- Heavy duty vehicle (HDV) AADT changes by 200 or more;
- Daily average speed change by 10 kph or more;
- Peak hour speed change by 20 kph or more;
- A change in road alignment by 5m or greater.

The construction stage traffic will not increase by 1,000 AADT or 200 HDV AADT. In addition, there are no proposed changes to the traffic speeds or road alignment. As a result, a detailed air assessment of construction stage traffic emissions has been scoped out from any further assessment as there is no potential for significant impacts or effects to air quality.

8.3.2 Operational Phase

8.3.2.1 Introduction

The air dispersion modelling input data consists of detailed information on the physical environment (including building dimensions and terrain features), design details from all emission points on-site and a full year of worst-case meteorological data. Using this input data, the model predicts ambient ground level concentrations beyond the facility boundary for each hour of the modelled meteorological year. The model post-processes the data to identify the location and maximum value of the worst-case ground level concentration in the applicable format for comparison with the relevant limit values. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted

ambient concentration. The worst-case ambient concentration is then compared with the relevant ambient air quality standard for the protection of human health to assess the significance of the emissions from the facility.

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:

- Emissions from all emission points in the assessment were assumed to be operating at their maximum emission level, 24 hours/day over the course of a full year. This represents a very conservative approach as typical emissions from the proposed facility will be well within the emission limit values set out in the Industrial Emissions Directive.
- Maximum predicted ambient concentrations for all pollutants within a 10 km radius of the facility were reported in this study even though, in many cases, no residential receptors were near the location of this maximum ambient concentration. Concentrations at the nearest residential receptors are generally significantly lower than the maximum ambient concentrations reported.
- Worst-case background concentrations were used to assess the baseline levels of substances released from the facility.
- Worst-case meteorological conditions over the period 2020 - 2024 from Cork Airport and the on-site meteorological data from 2007 have been used in all assessments. For all averaging periods the worst-case year from 2007, 2020 - 2024 was used for comparison with the ambient air quality standards.

8.3.2.2 Air Dispersion Modelling Methodology

The selection of appropriate modelling methodology has followed the guidance from the EPA[9] and the USEPA[1,10,11] which have issued detailed and comprehensive guidance on the selection and use of air quality models. Based on guidance from the USEPA, the most appropriate regulatory model for the current application is the AERMOD model.

Emissions from the proposed facility have been modelled using the AERMOD dispersion model (Version 24142) which has been developed by the U.S. Environmental Protection Agency (USEPA)[3]. The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources. The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and complex terrain[1]. An overview of the model is outlined in **Appendix 8.2**.

The model is applicable in both simple and complex terrain, urban or rural locations and for all averaging periods[1,3]. The selection of the urban/rural classification is based on the land use procedure of Auer[12] as recommended by the USEPA[1]. If 50% of the land use within a 3km circumference of the source is classified as high density residential, medium to heavy industry or commercial, the urban boundary layer option should be used; otherwise the rural boundary layer should be used. An examination of the land-use type around the facility indicated that the rural boundary layer was appropriate.

The AERMOD model is capable of modelling most meteorological conditions likely to be encountered in the region. However, unusual meteorological conditions may occur infrequently, which may not be modelled adequately using AERMOD. One such condition is fumigation which occurs when a plume is emitted into a stable layer of air which subsequently mixes to ground level through either convective transfer of heat from the surface or because of advection to less stable surroundings[1]. An alternative air dispersion model is CALPUFF[1] (full details are outlined in Section 8.6).

8.3.2.3 Meteorological Considerations

Meteorological data is an important input into the air dispersion model. The local airflow pattern will be influenced by the geographical location. Important features will be the location of hills and valleys or land-water-air interfaces and whether the facility is located in simple or complex terrain.

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, including cloud cover, based on an analysis of the data on a quarterly basis. One synoptic meteorological station operated by Met Eireann was identified near the Facility – Cork Airport. Data collection of greater than 90% for all parameters in each quarter is required for air dispersion modelling. Cork Airport fulfils this requirement.

The additional requirements of the selection process depend on the degree to which the data is considered to be representative of the modelled domain. This criterion can be defined as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application"(2). The meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the area of interest as determined by the location of the sources and receptors being modelled.

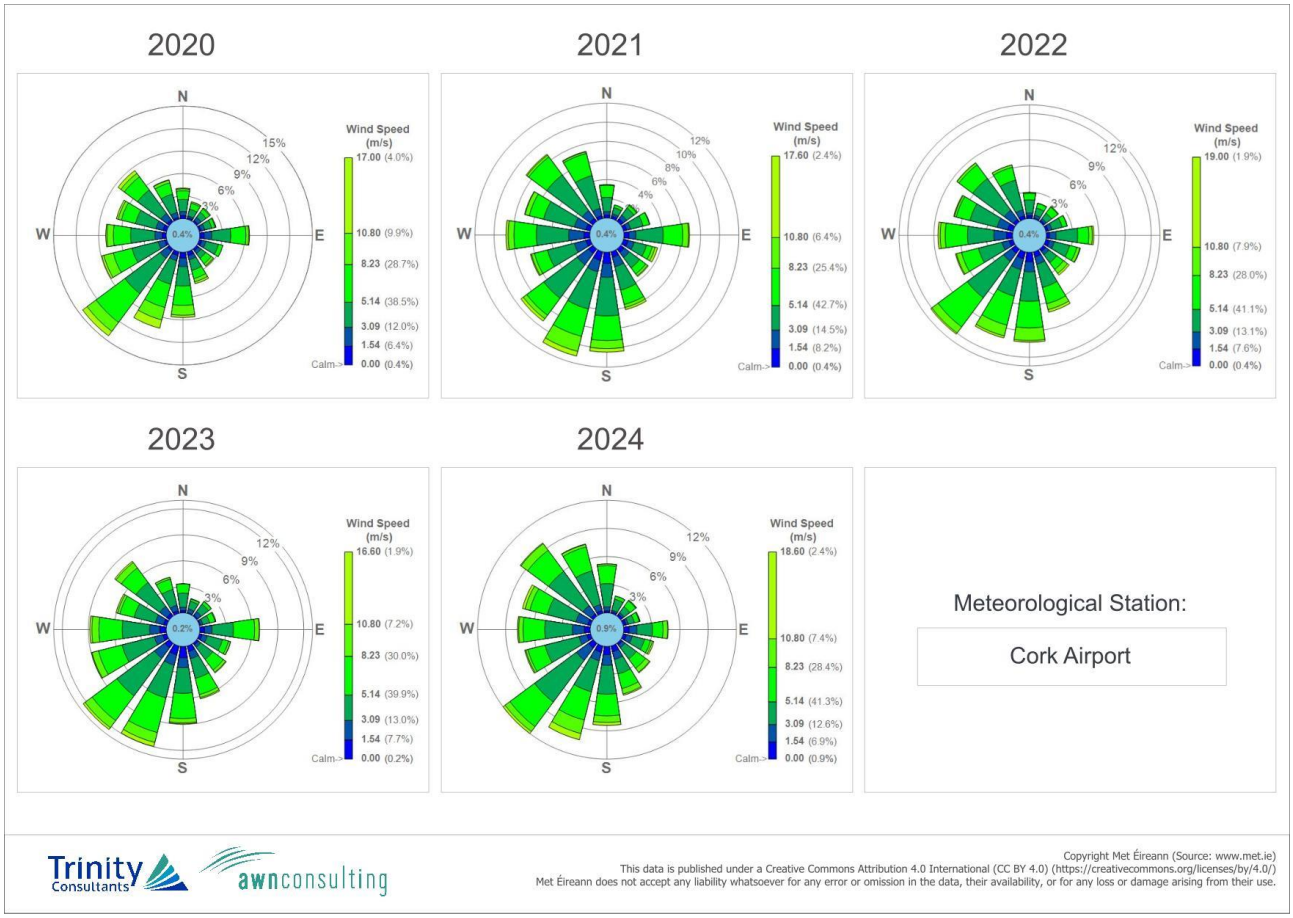
The representativeness of the data is dependent on(1):

1. the proximity of the meteorological monitoring site to the area under consideration,
2. the complexity of the terrain,
3. the exposure of the meteorological monitoring site (surface characteristics around the meteorological site should be similar to the surface characteristics within the modelling domain),
4. the period of time during which data is collected.

In the region of the facility, Cork Airport meteorological station is in a region of gentle rolling terrain and is 12km of the site. The meteorological data used in the assessment (2020 - 2024) is a recent dataset. The final issue relates to the exposure of the meteorological monitoring site and specifically relating to the surface characteristics of the station compared to the site of the proposed facility. Cork Airport is 12km from the coast and in a region of mainly agricultural land with urban characteristics to the north of the airport. In contrast, Ringaskiddy is in a coastal setting with a range of surface characteristics including water, agricultural and urban within a few kilometres of the site. Thus, some differences in surface characteristics are apparent between the meteorological station and the site. In order to ascertain the likely significance of the difference in surface characteristics, a sensitivity study was conducted as shown in **Appendix 8.5** including comparing with Roches Point meteorological station which is located within the modelling domain. Roches Point is an automatic station which collects all relevant meteorological data with the exception of cloud cover. Roches Point was used in the model with the missing cloud cover data substituted with Cork Airport data for the same time period. Additionally, a weather station was installed on-site which measured wind speed, wind direction, temperature and relative humidity starting in October 2006 and finished at the end of December 2007. The on-site meteorological data for 2007 was used in AERMOD modelling study and in the CALPUFF modelling study as detailed in Section 8.6.

The windrose from Cork Airport for the years 2020 - 2024 is shown in Figure 8.4 with detailed data outlined in **Appendix 8.2**. The windrose indicates the prevailing wind speed and direction over the five-year period. The prevailing wind direction is generally from the south to north-westerly in direction over the period 2020 - 2024. The mean wind speed is approximately 5.0 m/s over the period 1991-2020. Calm conditions account for only a small fraction of the time in any one year peaking at 31 hours in 2021 (0.4% of the time). The number of missing hours is also very low with no missing hours / year over the period 2020 – 2024.

Figure 8.4 Cork Airport Windrose 2020 -2024



8.3.2.4 Sensitive Receptors

In relation to the spatial assessment of emissions from the facility, modelling has been carried out to cover locations at the boundary and within a radius of 10 km of the facility, regardless of whether any sensitive receptors are located in the area. Ambient air quality legislation designed to protect human health (i.e. by setting ambient limit values for a range of pollutants) is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient air quality legislation has been applied to all locations regardless of whether any sensitive receptors (such as residential locations) are present for significant periods of time. This represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these receptors generally experience ambient concentrations significantly lower than that reported for the maximum value.

The closest sensitive receptors to the facility are the residential properties at the eastern edge of Ringaskiddy village which are located 200 m west of the facility boundary. The Cork Harbour SPA is 420m south of the facility at its nearest point whilst the Lough Beg proposed NHA is also approximately 420 m south of the facility boundary.

8.3.2.5 Terrain

The AERMOD air dispersion model has a terrain pre-processor AERMAP[4] which was used to map the physical environment in detail over the receptor grid. The digital terrain input data used in the AERMAP pre-processor was obtained from the US Jet Propulsion Laboratory Shuttle RADAR Topography Mission

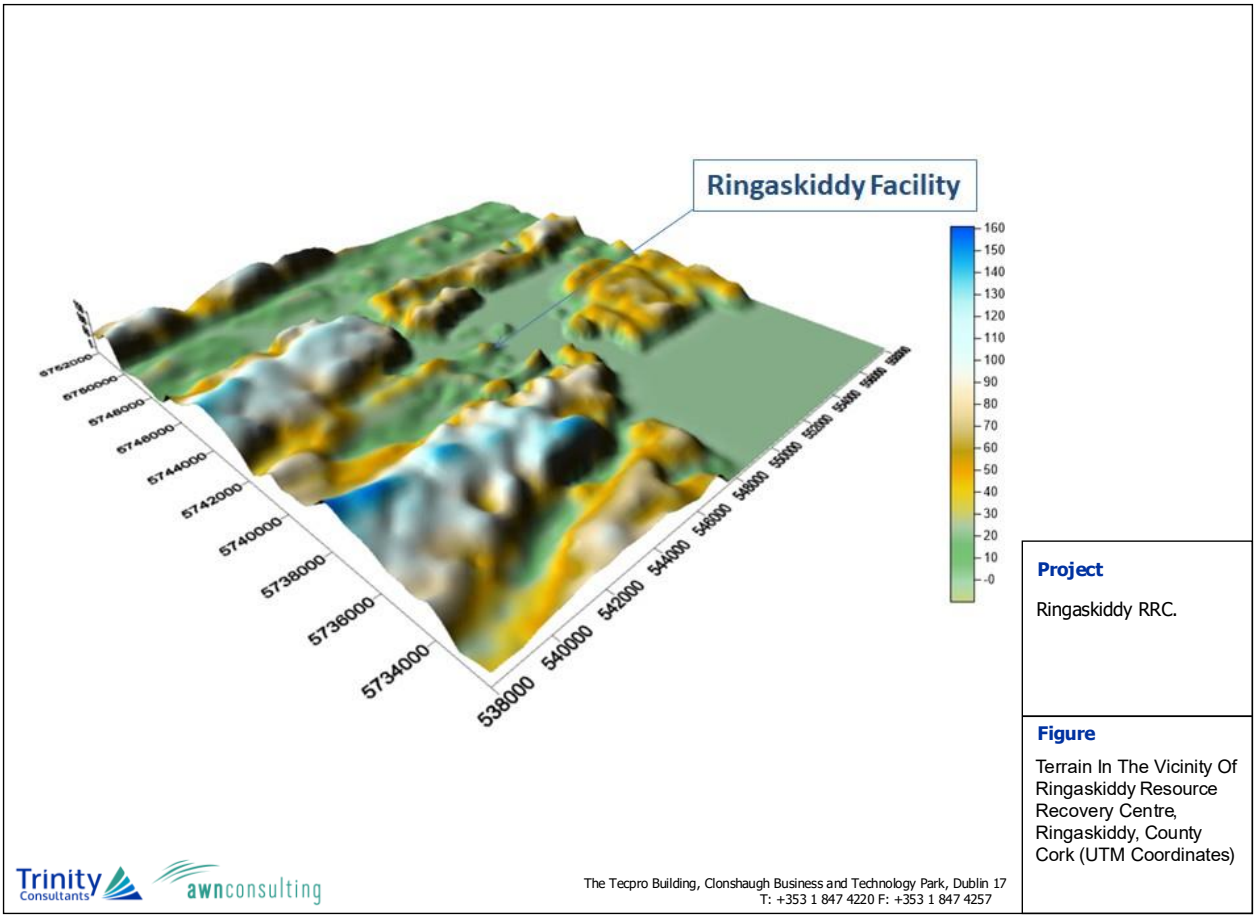
(SRTM) at 1 arc-second (30m) resolution. This data was run to obtain for each receptor point the terrain height and the terrain height scale. The terrain height scale is used in AERMOD to calculate the critical dividing streamline height, H_{crit}, for each receptor. The terrain height scale is derived from the Digitial 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.

AERMOD model formulation 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(2).

The terrain in the region of the facility is complex in the sense that the maximum terrain in the modelling domain peaks at 162m which is above the stack top of all emission points onsite. However, in general, as shown in Figure 8.5, the region of the site has gentle or moderately sloping terrain.

Figure 8.5 Terrain Near Ringaskiddy RRC, Ringaskiddy, County Cork



8.3.2.6 Geophysical Considerations

AERMOD simulates the dispersion process using planetary boundary layer (PBL) scaling theory[3]. 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[35] 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 was carried out to a distance of 10km from the meteorological station for Bowen Ratio and albedo and to a distance of 1km for surface roughness in line with USEPA recommendations[4,5] as outlined in **Appendix 8.2**.

In relation to AERMOD, detailed guidance for calculating the relevant surface parameters has been published[6]. The most pertinent features are:

- The surface characteristics should be those of the meteorological site (Cork 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[5], 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[6]. This approach has been applied to the current site with full details provided in **Appendix 8.2**.

8.3.2.7 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[1].

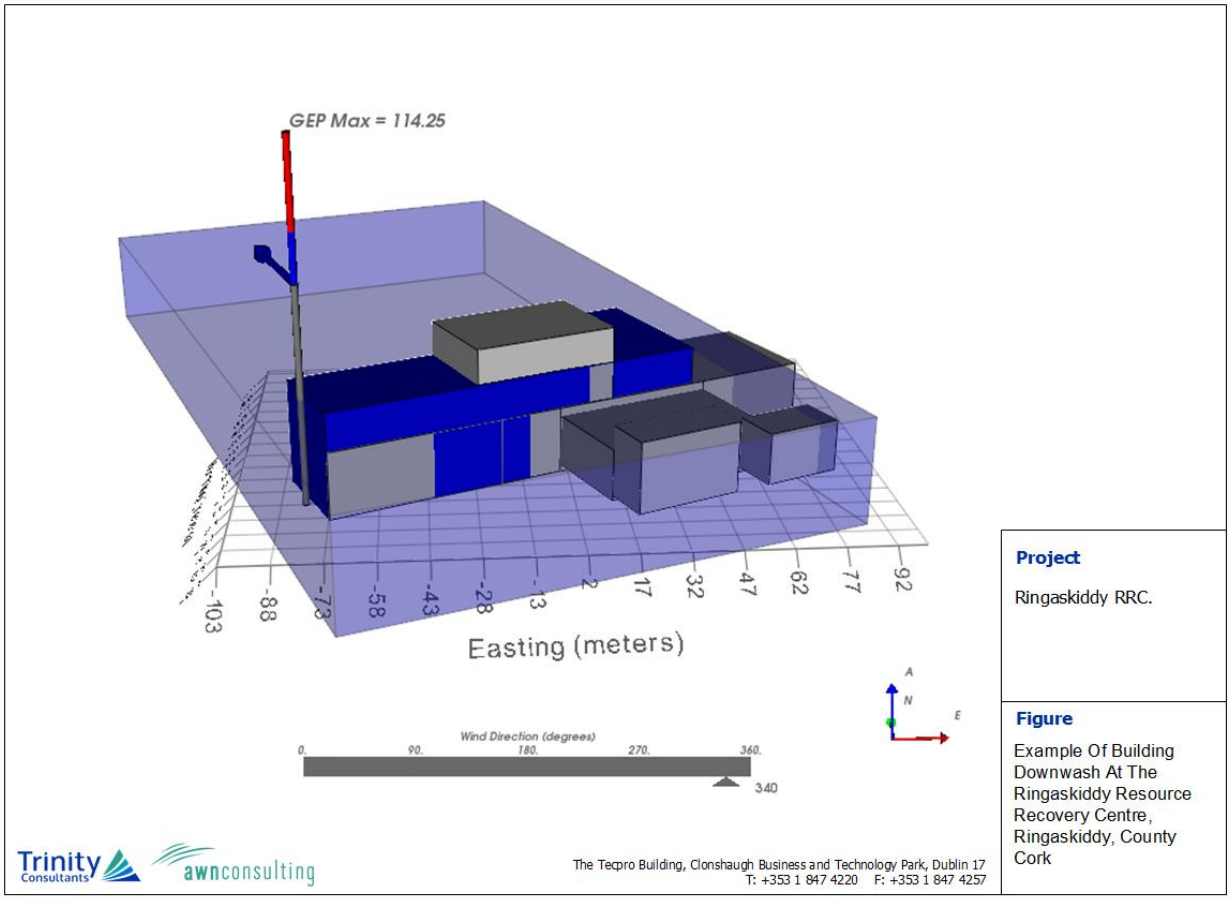
When stacks are less than this height, building downwash will tend to occur. As the wind approaches a building it is forced upwards and around the building leading to the formation of turbulent eddies. In the

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)[7,8] 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[8].

Given that the main stack onsite is 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. Shown in Figure 8.6 is an example of the dominant building (in blue) which is influencing the building downwash for the main stack (A1-1). The dominant building may change as the wind direction changes for each of the 36 wind directions. The dominant building will vary as a function of wind direction and relative building heights.

Figure 8.6 Building Downwash Associated With Ringaskiddy RRC.



8.3.2.8 Process Emissions

8.3.2.8.1 Introduction

Emissions from the proposed facility have been modelled using the AERMOD dispersion model which is the USEPA's regulatory model used to assess pollutant concentrations associated with industrial sources(1). Emissions have been assessed, firstly under maximum emission limits of the EU Directive 2010/75/EU and secondly under abnormal operating conditions.

8.3.2.8.2 Council Directive 2010/75/EU

Council Directive 2010/75/EU on Industrial Emissions (IED) has outlined air emission limit values as set out in Table A8.1. The Directive has also outlined stringent operating conditions in order to ensure sufficient combustion of waste thus ensuring that dioxin formation is minimised. Specifically, the combustion gases must be maintained at a temperature of 850°C for at least two seconds under normal operating conditions for non-hazardous waste whilst for hazardous waste containing more than 1% halogenated organic substances, the temperature should be raised to 1,100°C for at least two seconds. These measures will ensure that dioxins/furans, polychlorinated biphenyls (PCBs) and PAHs are minimised through complete combustion of waste.

Specific emission measurement requirements have been outlined in the directive for each pollutant:

- continuous measurements of the following substances; NO_x, CO, total dust, TOC, HCl, and SO_2;
- bi-annual measurements of heavy metals, dioxins and furans.

Indaver is committed, as a minimum, to meeting all the requirements of Council Directive 2010/75/EU. Indeed, due to the advanced post-combustion flue gas cleaning technology employed, expected average emission values will be lower than the maximum values used in this study. The maximum and average emission concentrations and mass emission rates have been detailed in Table A8.2.

The advanced post-combustion flue gas cleaning technology which will be employed to control emissions of pollutants is detailed in Chapter 4.

Table 8.9 Council Directive 2010/75/EU, Annex V Air Emission Limit Values

Daily Average Values	**Concentration**	
Total Dust	10 mg/m^3	
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	10 mg/m^3	
Hydrogen Chloride (HCl)	10 mg/m^3	
Hydrogen Fluoride (HF)	1 mg/m^3	
Sulphur Dioxide (SO_2)	50 mg/m^3	
Nitrogen Oxides (as NO_2)	200 mg/m^3	
Half-hourly Average Values	**Concentration**	
	(100%)	**(97%)**
Total Dust(1)	30 mg/m^3	10 mg/m^3
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	20 mg/m^3	10 mg/m^3
Hydrogen Chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen Fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur Dioxide (SO_2)	200 mg/m^3	50 mg/m^3
Nitrogen Oxides (as NO_2)	400 mg/m^3	200 mg/m^3
Average Value Over 30 mins to 8 Hours	**Concentration**(2)	
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	
Thallium and its compounds, expressed as Tl		
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	
Antimony and its compounds, expressed as Sb	Total 0.5 mg/m^3	
Arsenic and its compounds, expressed as As		
Lead and its compounds, expressed as Pb		
Chromium and its compounds, expressed as Cr		
Cobalt and its compounds, expressed as Co		
Copper and its compounds, expressed as Cu		
Manganese and its compounds, expressed as Mn		
Nickel and its compounds, expressed as Ni		
Vanadium and its compounds, expressed as V		
Average Values Over 6 – 8 Hours	**Concentration**	
Dioxins and furans	0.1 ng/m^3	
Average Value	**Concentration**(3)	
	Daily Average Value	**30 Min Average Value**
Carbon Monoxide	50 mg/m^3	100 mg/m^3

Note 1 Total dust emission may not exceed 150 mg/m^3 as a half-hourly average under any circumstances

Note 2 These values cover also the gaseous and vapour forms of the relevant heavy metals as well as their compounds

Note 3 Exemptions may be authorised for incineration plants using fluidised bed technology, provided that emission limit values do not exceed 100 mg/m^3 as an hourly average value.

Table 8.10 Air Emission Values From The Proposed Ringaskiddy Resource Recovery Centre, County Cork.

Maximum 30-Minute Values	EU Maximum Emission Concentration	Annual Average Daily Emission Concentration	Maximum Operating Values(1)	Average Operating Values(2)
			Emission Rate (g/s)	Emission Rate (g/s)
Total Dust	30 mg/m^3	10 mg/m^3	1.76	0.45
Gaseous & vaporous organic substances expressed as total organic carbon (TOC)	20 mg/m^3	10 mg/m^3	1.17	0.45
Hydrogen Chloride (HCl)	60 mg/m^3	10 mg/m^3	3.52	0.45
Hydrogen Fluoride (HF)	4 mg/m^3	1.0 mg/m^3	0.23	0.045
Sulphur Dioxide (SO_2)	200 mg/m^3	50 mg/m^3	11.7	2.25
Nitrogen Oxides (as NO_2)	400 mg/m^3	200 mg/m^3	23.4	9.0
Daily Average Value	**Emission Concentration**	**Emission Concentration**	**Emission Rate (g/s)**	**Emission Rate (g/s)**
Cadmium and its compounds, expressed as Cd	Total 0.05 mg/m^3	Total 0.05 mg/m^3	0.0029	0.0023
Thallium and its compounds, expressed as Tl				
Mercury and its compounds, expressed as Hg	0.05 mg/m^3	0.05 mg/m^3	0.0029	0.0023
Antimony and its compounds, expressed as Sb	Total 0.5 mg/m^3	Total 0.50 mg/m^3	0.029	0.023
Arsenic and its compounds, expressed as As				
Lead and its compounds, expressed as Pb				
Chromium and its compounds, expressed as Cr				
Cobalt and its compounds, expressed as Co				
Copper and its compounds, expressed as Cu				
Manganese and its compounds, expressed as Mn				
Nickel and its compounds, expressed as Ni				
Vanadium and its compounds, expressed as V				
Average Values Over 6 – 8 Hours	**Emission Concentration**	**Emission Concentration**	**Emission Rate (μg/s)**	**Emission Rate (μg/s)**
Dioxins and furans	0.1 ng/m^3	0.1 ng/m^3	0.0059	0.0045
Average Value	**Emission Concentration**	**Emission Concentration**	**Emission Rate (g/s)**	**Emission Rate (g/s)**
Carbon Monoxide	100 mg/m^3	50 mg/m^3	5.86	2.25

Note 1 Maximum operating value based on maximum emission concentration in Council Directive 2010/75/EC and maximum volume flow.

Note 2 Average operating value based on maximum emission concentration in Council Directive 2010/75/EC and average volume flow.

8.3.2.8.3 Process Emissions

The Ringaksiddy Resource Recovery Centre facility has one main process emission point (flue). The operating details of this major emission point are outlined in Table 8.11. Full details of emission concentrations and mass emissions are given in **Appendix 8.6**.

Table 8.11 Process Emission Design Details

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temp (K)	Volume Flow (Nm^3/hr)(1)	Exit Velocity (m/sec actual)(2)
Grate	70	2.30	4.15	408	211,000 – Maximum 158,250 – 75% of Maximum	19.9 14.95

Note 1 Normalised to 11% O_2, dry, 273K.

Note 2 Actual, 408K, 6.9% O_2, 16.9% H_2O

The AERMOD model was run using a unitised emission rate of 1 g/s for the stack. The unitised concentration output has then been adjusted for each substance based on the specific emission rate of each.

8.3.3 Ecology Methodology

8.3.3.1 Ecology Receptors

The impact of emissions of NO_X, NH_3, SO_2 and nutrient and acid deposition from the facility on ambient ground level concentrations was assessed using AERMOD within designated conservation areas such as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) (collectively referred to as European sites or Natura 2000 sites), and Natural Heritage Areas (NHAs), as well as non-designated conservation areas - proposed Natural Heritage Areas (pNHAs).

A geospatial search was conducted (NPWS, 2025) to identify all European sites within 10 km of the facility that could potentially be affected by the project, and the nearest national sites (NHA or pNHA) within 2 km of the facility that could potentially be affected by the project, based on the methodology recommended by the UK Environment Agency in their guidance *Air emissions risk assessment for your environmental permit* (UKEA, 2025). This search zone ensures that all European sites with the potential to be impacted via direct, indirect or cumulative pathways from air emissions are appropriately considered. Beyond these distances, the effects on ecology due to emissions from the facility are expected to be not significant.

The UKEA guidance *Air emissions risk assessment for your environmental permit* (UKEA, 2025) recommends that the screening distance for air emissions on protected conservation areas be increased to 15 km where emissions from *"natural gas (or fuels with a similarly low sulphur content) fired combustion plants with more than 500 megawatt thermal input, or from larger combustion plants using more sulphurous fuels with more than 50 megawatt thermal input"*, are being assessed. The facility does not meet these criteria, therefore the screening distances of 10 km for SPAs and SPAs, and 2 km for nationally designated sites is appropriate for this assessment.

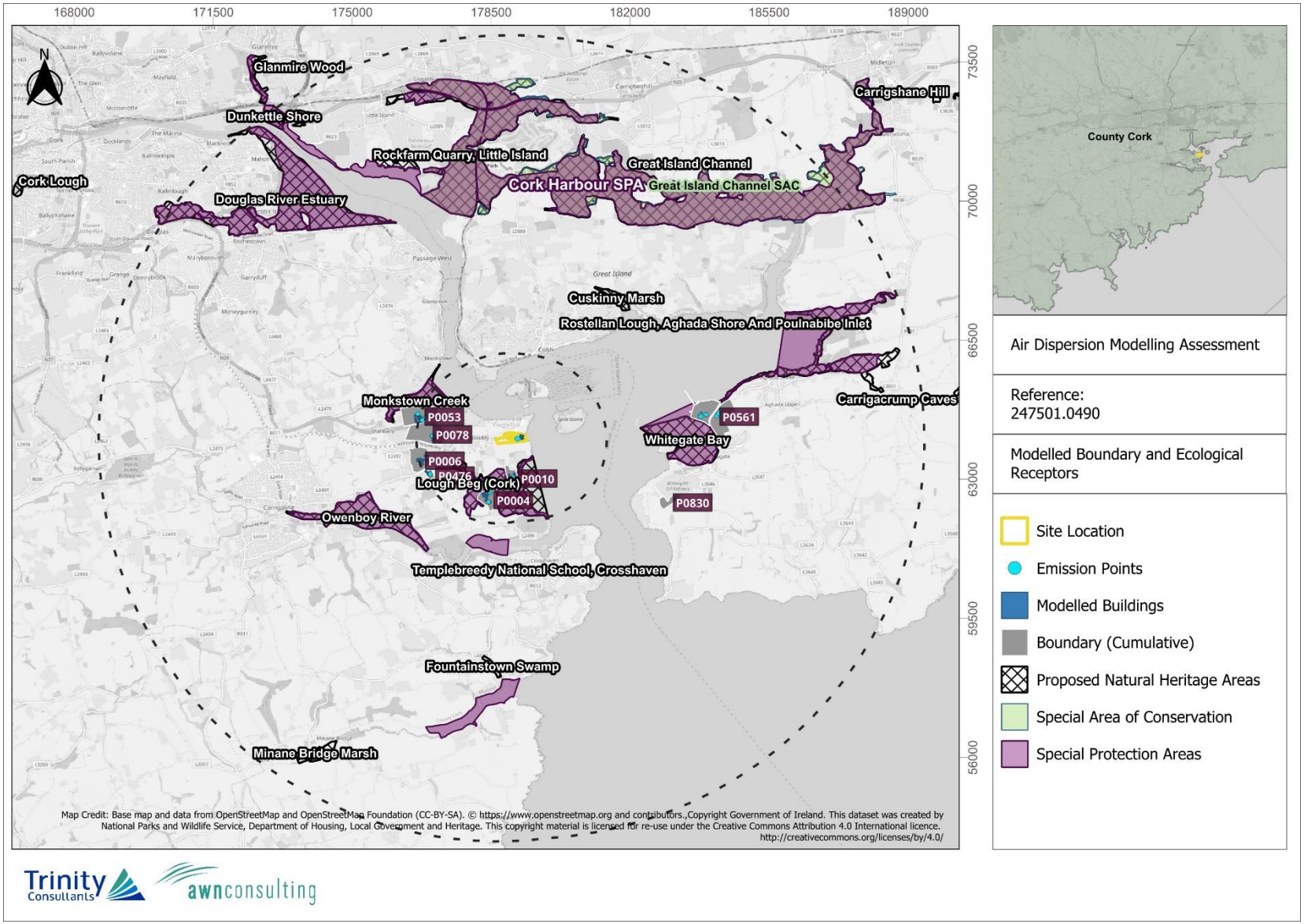
The ecology receptors included in the dispersion model are shown in Table 8.12 and Figure 8.7.

Table 8.12. Ecology Receptors Included in Dispersion Model

Special Area of Conservation (SAC)	Special Protection Area (SPA)	Proposed Natural Heritage Area (pNHA)	Natural Heritage Area (NHA)
Great Island Channel SAC	Ballycotton Bay SPA Cork Harbour SPA	Ballycotton, Ballynamona And Shanagarry pNHA Ballynaclashy House, North Of Midleton pNHA Blarney Bog pNHA Carrigacrump Caves pNHA Carrigshane Hill pNHA Cork Lough pNHA Cuskinny Marsh pNHA Douglas River Estuary pNHA Dunkettle Shore pNHA Fountainstown Swamp pNHA Glanmire Wood pNHA Great Island Channel pNHA Leamlara Wood pNHA Lee Valley pNHA Lough Beg (Cork) pNHA Loughs Aderry And Ballybutler pNHA Minane Bridge Marsh pNHA Monkstown Creek pNHA Owenboy River pNHA Rockfarm Quarry, Little Island pNHA Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA Templebreedy National School, Crosshaven pNHA Whitegate Bay pNHA	No NHA within 2 km of facility

Dispersion modelling of relevant pollutant emissions from all emission points at the facility were predicted at receptors within the ecological sites for all five years of meteorological data modelled. For modelling purposes, worst-case exposure is expected at the boundaries of the sensitive ecosystems. Ecological receptors were modelled 0 m above ground.

Figure 8.7 Modelled Boundary and Ecology Receptors



8.3.3.2 Nitrogen and Acid Deposition Methodology

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* (UKEA, 2014):

Dry deposition flux (µg/m²/s) = ground-level concentration (µg/m³) x deposition velocity (m/s)

The deposition velocities for NO_2 and SO_2 are outlined in AQTAG06 (UKEA, 2014) and shown below in Table 8.13. The dry deposition flux is then multiplied by conversion factors shown in Table 8.13 (taken from AQTAG06 (UKEA, 2014)) to convert it to a nitrogen (N) and sulphur (S) deposition flux (kg/ha/yr), and to an acid deposition flux (keq/ha/yr).

Background concentrations for NO_x, NH_3, SO_2 and nitrogen and acid deposition at the most impacted ecological receptors were derived from the 1 km grid square concentrations provided on the Air Pollution Information System (APIS) website (APIS, 2025), in line with UKEA (UKEA, 2014) and UK DEFRA (UK DEFRA, 2022) guidance, and are given in Section 8.7. The background concentrations are added directly to the modelled NO_2, NH_3, SO_2, nitrogen and acid deposition process contributions to give a total predicted environmental concentration (PEC).

Table 8.13. Dry Deposition Fluxes for NO_2, NH_3 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
NH_3	Grassland	0.02	260	18.5
SO_2	Grassland	0.012	157.7	9.84

8.4 Baseline Air Quality

8.4.1 Introduction

An extensive baseline survey was carried out in the region of the proposed Ringaskiddy Resource Recovery Centre facility over the period August 2024 – January 2025. This supplements the extensive baseline surveys undertaken in November 2006 to February 2007, from April 2008 to July 2008, August 2014 to July 2015, October 2018 to January 2019 and a second 3-month period from June 2019 – September 2019. These surveys focused on the significant pollutants likely to be emitted from the facility and which have been regulated in Council Directive 2010/75/EU. The substances monitored over these survey periods were NO_2, NO_x, PM_{10}, $PM_{2.5}$, benzene, SO_2, heavy metals, HCl, HF and PCDDs/PCDFs. The air monitoring program was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the region. NO_2, benzene and SO_2 were also monitored at a number of additional locations to give some spatial representation of the levels of these species.

The updated extensive baseline survey which was carried out in the region of the proposed Ringaskiddy Resource Recovery Centre facility over the period August 2024 – January 2025 focused on NO_2, PM_{10}, $PM_{2.5}$, benzene and SO_2 over a 3-month long period. The air monitoring program was used to determine long-term average concentrations for these pollutants in order to help quantify the existing ambient air quality in the region. NO_2, benzene and SO_2 were also

monitored at a number of additional locations to give greater spatial representation of the levels of these species.

8.4.2 Baseline Monitoring

8.4.2.1 Methodology

8.4.2.1.1 NO_2

Monitoring of nitrogen dioxide in the vicinity of Ringaskiddy was carried out using two sampling methods: chemiluminescent analysis and passive diffusion. Continuous monitoring of NO_2 was performed using a chemiluminescent analyser (Thermo Environmental Instruments, Model 42C) over a three-month period (03rd October 2018 – 03rd January 2019) at one static monitoring station (Hammond Lane Metals Recycling, see Figure 8.8) which is adjacent to the proposed waste to energy site. In this method, the NO_x ($NO + NO_2$) concentration is determined based on its direct relationship with the level of energy emitted by chemiluminescent NO_2, which is formed when nitric oxide (NO) is reacted with ozone (O_3) in an evacuated chamber within the analyser. One of the major advantages of this monitoring method is that it provides high resolution continuous measurement of NO_2, and hence the results can be used to compare with the hourly limit value. In addition, the average NO_2 level measured over the three-month monitoring period allows an approximate comparison with the annual limit value.

The spatial variation in NO_2 levels away from sources is particularly important, as a complex relationship exists between NO, NO_2 and O_3 leading to a non-linear variation of NO_2 concentrations with distance from sources. In order to assess the spatial variation in NO_2 levels in the region around Ringaskiddy, NO_2 was monitored using passive diffusion tubes over six one-month periods (from August 2024 to January 2025) at 16 locations in the Ringaskiddy, Monkstown and Cobh areas (see Locations N1 – N16 in Figure 8.8 and Figure 8.9). Passive sampling of NO_2 involves the molecular diffusion of NO_2 molecules through a polycarbonate tube and their subsequent adsorption onto a stainless steel disc coated with triethanolamine. Following sampling, the tubes were analysed using UV spectrophotometry, at a UKAS accredited laboratory (SOCOTEC laboratories, Burton-on-Trent). The diffusion tube locations were strategically positioned to allow an assessment of both background levels and typical exposure of the residential population. The passive diffusion tube results allow an indicative comparison with the annual average limit value.

Studies in the UK have shown that diffusion tube monitoring results generally have a positive or negative bias when compared to continuous analysers. This bias is laboratory specific and is dependent on the specific analysis procedures at each laboratory. A diffusion tube bias of 0.81 was obtained for the Gradko laboratory (which analysed the diffusion tubes) from the UK DEFRA website (DEFRA, 2024).

In addition to the bias adjustment, an annualisation factor is required as the monitoring period did not extend to a full year. The annualisation factor was prepared as per LAQM (TG22) (DEFRA, 2022), using the DEFRA annualisation tool v1.0 (DEFRA, 2020). The annualisation factor is necessary as NO_2 concentrations vary across the year and this should be accounted for within the baseline monitoring. This factor was calculated using 2023 EPA published annual and period averages (EPA, 2024; 2025) from Zone B locations, with more than 85% data coverage (UCC Distillery Fields and Lower Glanmire Road), and was calculated as 0.887 for the period of the diffusion tube monitoring.

8.4.2.1.2 SO_2

In order to assess the spatial variation in sulphur dioxide levels in the area, SO_2 was monitored using passive diffusion tubes over six one-month periods (21st August 2024 – 31st January 2025) at seven locations (see locations S1 – S7 in Figure 8.8 and Figure 8.9). Passive sampling of SO_2 involves the molecular diffusion of SO_2 molecules through a tube fabricated of PTFE and their

subsequent adsorption onto a stainless steel gauze coated with sodium carbonate. Following sampling, the adsorbed sulphate is removed from the tubes with deionised water and analysed using ion chromatography. Analysis was carried out by Gradko International Ltd in Hampshire, UK.

No annualisation factor could be calculated, as there is no suitable continuous monitoring data available for SO_2 (the most appropriate site of Munster Technological University did not measure SO_2 concentration during the baseline monitoring period) (EPA, 2025).

8.4.2.1.3 Benzene

In order to assess the spatial variation in benzene levels in the area, benzene was monitored using automated thermal desorption (ATD) tubes over six one-month periods (21st August 2024 – 31st January 2025) at seven locations (see Location B1 – B7 in Figure 8.8 and Figure 8.9). Passive sampling of benzene involves the molecular diffusion of benzene molecules through a stainless steel tube and their subsequent adsorption onto a stainless steel gauze coated with Tenax. Following sampling, the tubes were analysed using Gas Chromatography – Mass Spectrometry (GC-MS), by Gradko International Ltd in Hampshire, UK.

No annualisation factor could be calculated, as there is no national continuous monitoring data available for benzene (EPA, 2024; 2025).

8.4.2.1.4 PCDD/PCDFs

Sampling for dioxins/furans was conducted using R&P Partisol®-Plus Sequential Air Sampler (Model 2025) fitted with a PU inlet over the period October 2018 – January 2019. The PU inlet housed a filter and PUF (polyurethane foam) combination. Air was drawn through the fine porosity quartz filter and PUF to trap the particulate and volatile fractions respectively. Monitoring took place at one static location (see Figure 8.8) over 3 one-month periods, with three samples collected in total. Each sample was analysed for dioxins and furans based on USEPA Method 23 using Gas Chromatography – Mass Spectrometry (GC-MS), by Concept Life Sciences laboratory, Manchester.

8.4.2.1.5 HCl & HF

Monitoring for HF and HCl was carried out at one static location (Hammond Lane Metals Recycling, see Figure 8.8) over 3 one-month periods over the period October 2018 – January 2019. Duplicate samples for HF and HCl were taken each month. Monitoring was conducted using passive diffusion tubes and the samples were analysed for HF and HCl using ion chromatography at Gradko Environmental laboratory, Hampshire (a UKAS accredited laboratory).

8.4.2.1.6 PM_{10}

The PM_{10} and $PM_{2.5}$ monitoring program focused on assessing 24-hour average concentrations over a six-month period (21st August 2024 – 31st January 2025) at one static location (Hammond Lane Metals Recycling, see Figure 8.8) which is adjacent to the proposed waste to energy site.

Sampling for PM_{10} and $PM_{2.5}$ was conducted using a continuous Turnkey Osiris monitor at the static monitoring location (Hammond Lane Metals Recycling, see Figure 8.8). The Osiris instrument is a light scattering device capable of continuous measurement of PM_{10} and $PM_{2.5}$. The air sample was continuously drawn into the instrument by a pump through a heated inlet at a flow rate of 600 ml/min. The incoming air passed through a laser beam in a photometer. The light scattered by the individual particles of dust was measured by the photometer and this information used to measure the size and concentration of the dust particles.

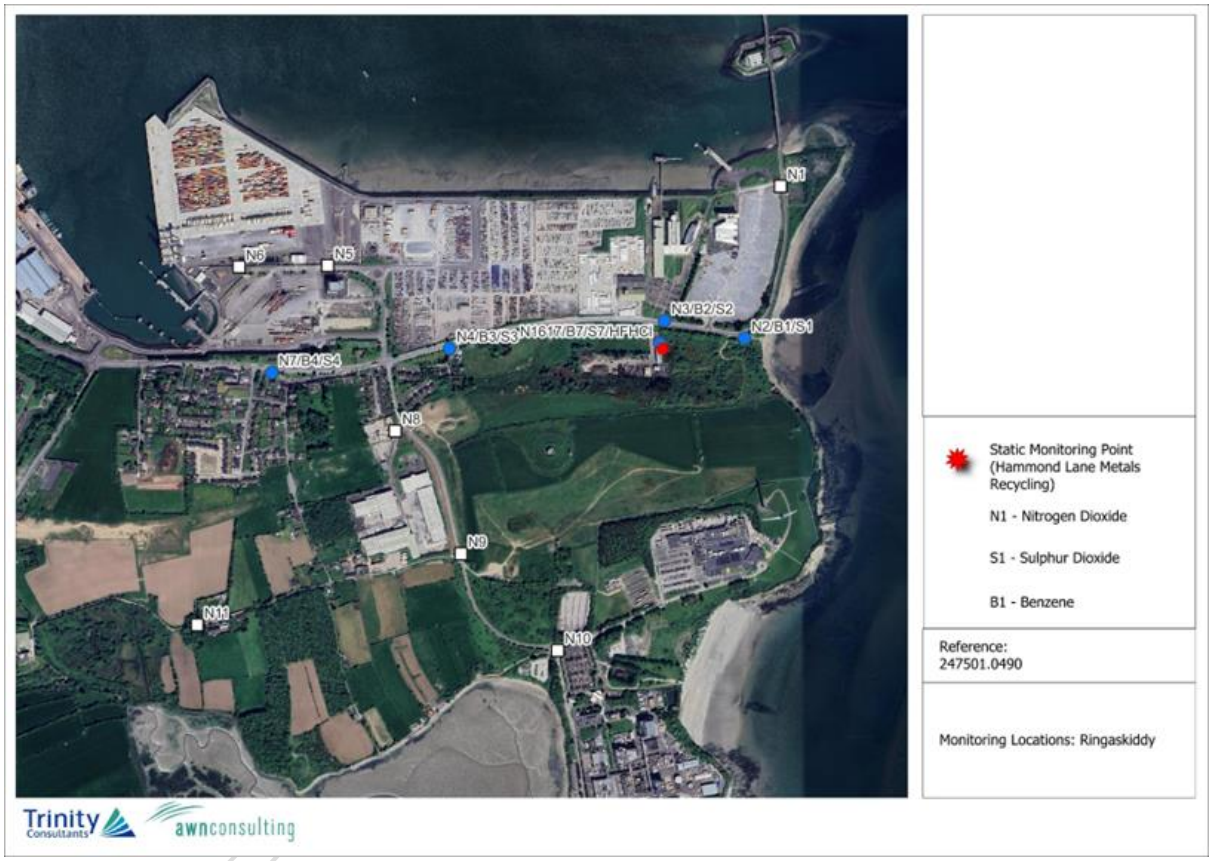
An annualisation factor is required as the monitoring period did not extend to a full year. The annualisation factor was prepared as per LAQM (TG22) (DEFRA, 2022). The annualisation factor is necessary as PM_{10} and $PM_{2.5}$ concentrations vary across the year and this should be accounted for within the baseline monitoring. This factor was calculated using 2023 EPA published annual

and period averages (EPA, 2024; 2025) from Zone B locations, with more than 85% data coverage (Munster Technological University and Heatherton Park), and was calculated as 0.889 for PM_{10} and 0.818 for $PM_{2.5}$ for the period of the continuous monitoring.

8.4.2.1.7 Heavy Metals

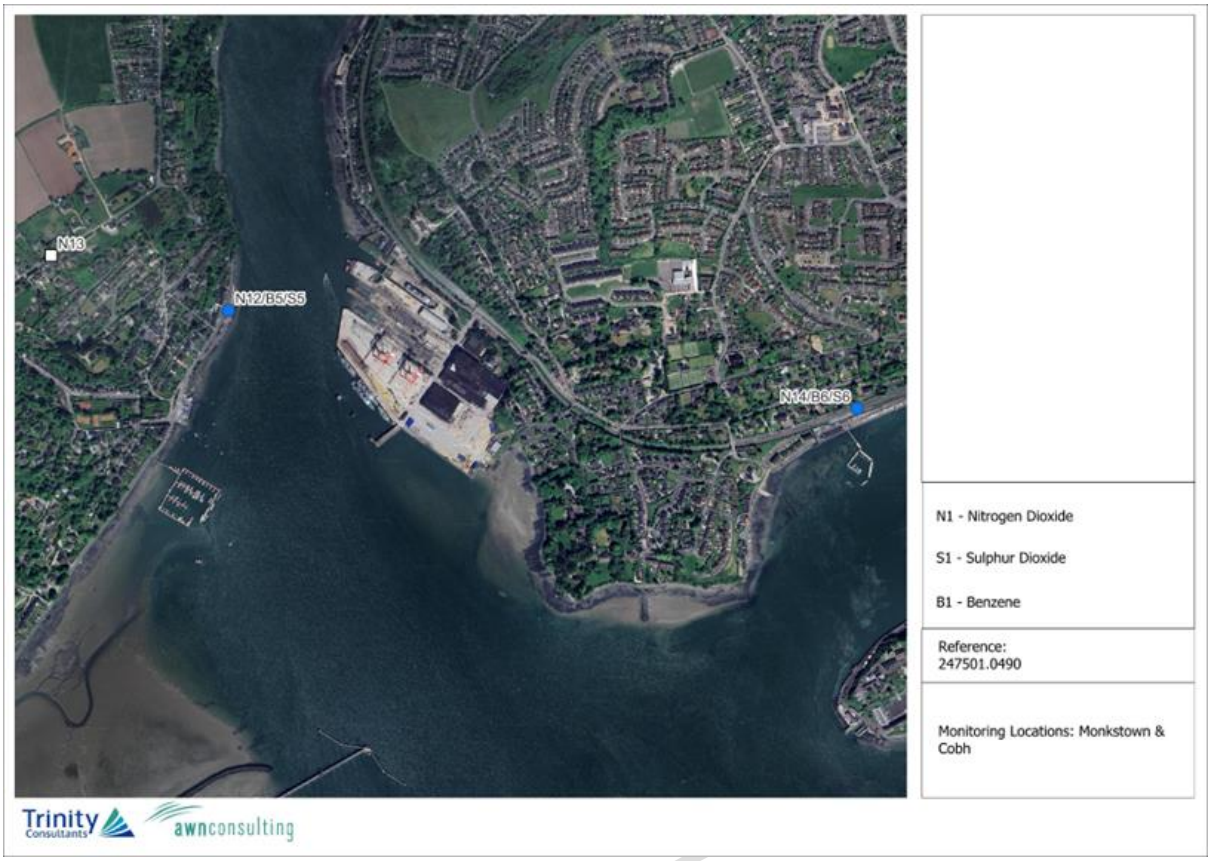
Sampling for heavy metals was conducted at one static location (Hammond Lane Metals Recycling, see Figure 8.8) using the same methodology as for PM_{10}. Quartz filters were utilised as they have low background heavy metal concentrations over the period October 2018 – January 2019. Following sampling and re-weighing, the quartz filters were acid digested in batches of 5 - 7 samples and the metals suite determined by inductively coupled plasma – mass spectrometry (ICP-MS) by SOCOTEC Laboratories, Burton-on-Trent.

Figure 8.8 Ambient Air Quality Monitoring Locations - Ringaskiddy



a. Red marker denotes continuous monitoring locations, blue markers represent combined NO_2/SO_2/Benzene diffusion tube monitoring locations and white markers denote NO_2 diffusion tube monitoring locations.

Figure 8.9 Ambient Air Quality Monitoring Locations – Monkstown and Cobh



a. Blue markers represent combined NO_2/SO_2/Benzene diffusion tube monitoring locations and white markers denote NO_2 diffusion tube monitoring locations.

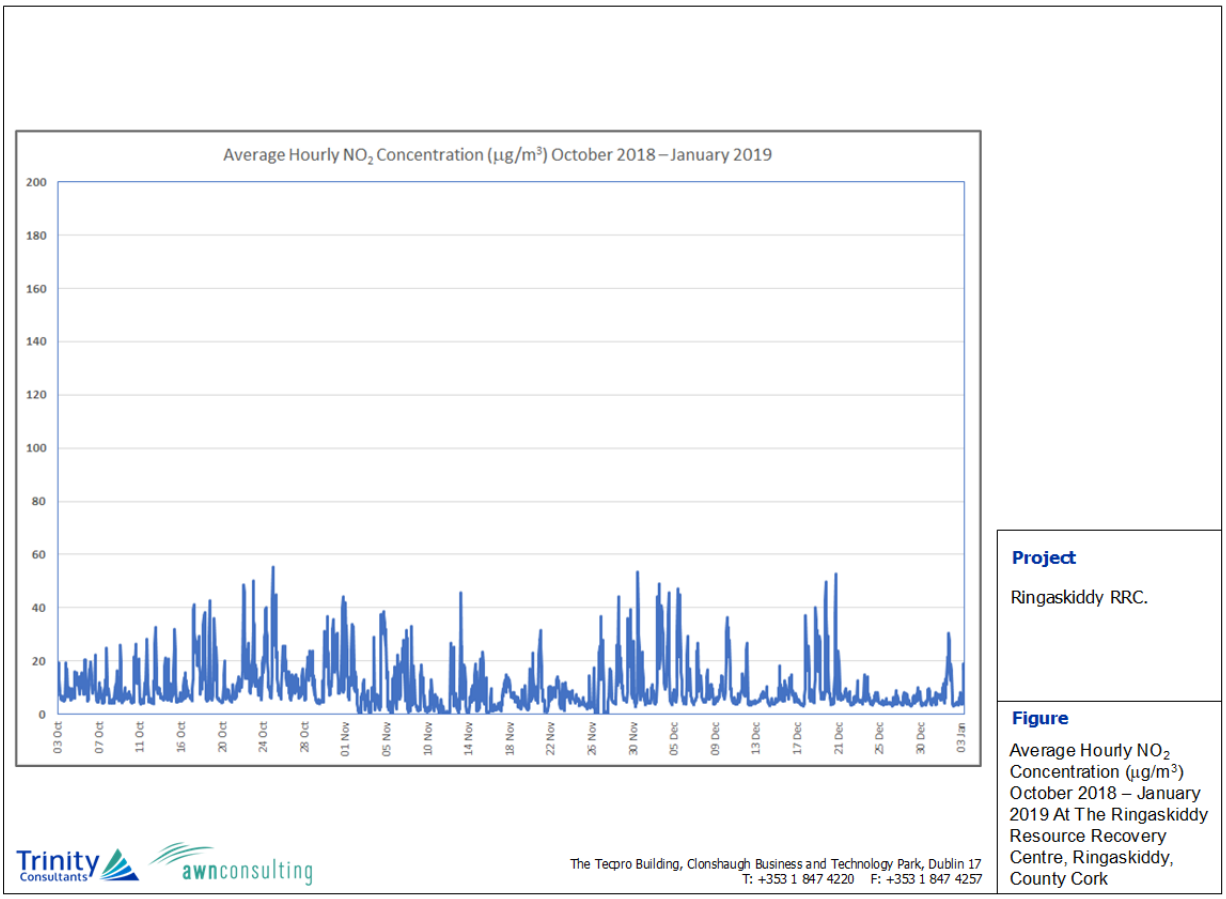
8.4.2.2 Results And Discussion

8.4.2.2.1 NO_2

Nitrogen dioxide (NO_2) results are presented in Table 8.14 and Table 8.15. The NO_2 chemiluminescent results, undertaken in 2018-19, indicated compliance with NO_2 limit values over the three-month monitoring period. During the monitoring period no exceedance of the 1-hour limit value of 200 $\mu g/m^3$ was observed whilst the mean over this period was 10.1 $\mu g/m^3$ which is 25% of the annual NO_2 limit value (see Figure 8.10). Nitrogen dioxide (NO_2) results are presented in Table 8.15 for the passive diffusion tube method undertaken between August 2024 – January 2025. The NO_2 diffusion tube concentrations measured over the six-month survey period are below the annual EU limit value of 40 $\mu g/m^3$ for the protection of human health. The annualised and bias adjusted average NO_2 concentration measured over the six-month period at each location ranged from 4.0 – 10.3 $\mu g/m^3$, which is between 10% - 26% of the EU annual limit value of 40 $\mu g/m^3$. The results indicate a weak NO_2 spatial concentration gradient in the region.

Previous results at these locations also indicated compliance with the NO_2 annual limit value over the same geographical area. NO_2 diffusion monitoring results, amounting to six months of data over the period October 2018 – January 2019 and from June 2019 – September 2019, indicated an average concentration of between 5.5 – 16.6 $\mu g/m^3$, which is between 14% - 42% of the EU annual limit value as shown in Table 8.16.

Figure 8.10 NO_2 Concentrations Measured in Ringaskiddy, Oct 2018 – Jan 2019.



8.4.2.2.2 SO_2

Sulphur dioxide (SO_2) results are presented in Table 8.17. The SO_2 diffusion tube concentrations measured over the six-month survey period are below the annual EU limit value of 20 µg/m^3 for the protection of vegetation. The average SO_2 concentration measured over the six month period at each location ranged from 1.6 – 2.8 µg/m^3 which is between 8% – 14% of the EU annual limit value of 20 µg/m^3.

Previous SO_2 diffusion monitoring results amounting to six months of data over the period October 2018 – January 2019 and from June 2019 – September 2019, at six locations in Ringaskiddy, Cobh and Monkstown, indicated an average concentration of between 2.7 – 4.5 µg/m^3 which is between 14% – 23% of the EU annual limit value for the protection of vegetation as shown in Table 8.18.

8.4.2.2.3 Benzene

Benzene results are presented in Table 8.19. The benzene diffusion tube concentrations measured over the survey period are below the annual EU limit value of 5 µg/m^3 for the protection of human health. The average benzene concentration measured over the six month period at each location ranged from 0.20 – 0.38 µg/m^3 which is between 4% - 8% of the EU annual limit value of 5 µg/m^3.

Previous benzene diffusion monitoring results amounting to six months of data over the period October 2018 – January 2019 and from June 2019 – September 2019, at six locations in Ringaskiddy, Cobh and Monkstown, indicated an average concentration of between 0.68 – 1.97 µg/m^3 which is between 16% - 39% of the EU annual limit value as shown in Table 8.20.

8.4.2.2.4 PCDDs & PCDFs

Background levels of PCDD/PCDFs occur everywhere and existing levels in the Ringaskiddy area have been monitored over a continuous three-month period. The results are detailed in Table 8.21. No ambient air quality concentration or deposition standards currently exist for PCDD/PCDFs.

Non-detects (i.e. levels below the limit of detection) may be assigned a value of either zero, half the limit of detection or the limit of detection. Depending on the number of congeners below the limit of detection and the approach to non-detects, significant variations may be perceived in inter-comparison exercises of samples. For the purposes of this monitoring study, non-detects have been assigned a value of zero for the lower limit TEQ calculation and assigned a value equal to the limit of detection for the upper limit TEQ calculation.

Historically, a number of systems for assessing the toxicity of PCDD/F have been developed, all using the concept of Toxic Equivalence Factors (TEQ). This concept assess the toxicity of other PCDD/F congeners and assigns a weighting compared to the known toxicity of 2,3,7,8 TCDD. The US EPA, NATO/CCMS system and the EC systems now use the same TEF Factors and the World Health Organisation has also adopted a similar system, allowing direct comparability of TEQ values. The NATO/CCMS TEFs (giving a result which is defined as I-TEQ), which correspond exactly with the EC and US EPA TEFs, have been used to calculate TEQs for the PCDD/Fs measured during this study.

The lower limit TEQ for the first monitoring period (October/November 2018) was 1.3 fg/m^3 and 24.7 fg/m^3 for the upper limit. For the second monitoring period (November/December 2018) results for all congeners were below the limit of detection. As a result, the lower limit TEQ is 0 fg/m^3 and the upper limit TEQ is 17.3 fg/m^3 by assuming results are equal to zero and the limit of detection in turn as referenced above. Results for the third and final monitoring period (December 2018/January 2019) were 41.5 fg/m^3 for the lower limit TEQ and 47.3 fg/m^3 for the upper limit TEQ. This results in an average lower limit TEQ for the three-month monitoring period of 14.3 fg/m^3 and an upper limit TEQ of 29.8 fg/m^3.

Previous monitoring was carried out over four 4-5 (approx.) day periods. A summary of the results for the one-month period is detailed in Table 8.22. The mean PCDD/PCDF concentration measured over the four one-week periods during April - May 2008 indicates that results are in line with measurements conducted elsewhere in Ireland, with an upper limit of 13.5 fg/m^3 compared to previous measurements ranging from 2.8 – 46 fg/m^3.

8.4.2.2.5 HCl & HF

Results of the HF and HCl monitoring at the static monitoring point (Hammond Lane Metals Recycling) are presented in Table 8.23 for HF and Table 8.24 for HCl. The HF and HCl diffusion tube concentrations measured over the three-month survey period are well below the UK EALs. The average HF concentration measured over the three-month period is 0.32 µg/m^3, which is only 2% of the annual limit value of 16 µg/m^3. The average HCl concentration measured over the three-month monitoring period is 2.21 µg/m^3 which is 11% of the annual limit value of 20 µg/m^3.

8.4.2.2.6 PM_{10}

Daily concentrations of PM_{10} measured using the sequential PM_{10} sample are shown in Table 8.25. The results can be directly compared with the 24-hour limit value (which is set as a 90.4th%ile), and the three-month average can be indicatively compared with the annual limit value.

The 24-hour PM_{10} concentrations measured over the three-month period are below the 24-hour EU limit value of 50 µg/m^3 and there were no exceedances of the 24-hour limit value recorded

over the three months of this monitoring campaign. The 90.4th%ile, which means the 36th highest value measured over a full year is compared to the limit value. Since there were no exceedances recorded over the three months of monitoring, it is extremely unlikely that 35 exceedances would occur over 365 days at the current location.

The maximum 24-hour mean PM_{10} concentration measured during the six-month period was 40.6 $\mu g/m^3$, which is below the 24-hour EU limit value of 50 $\mu g/m^3$, and there were no exceedances of the 24-hour limit value recorded.

The annualised average PM_{10} concentration measured over the period is 9.4 $\mu g/m^3$, which is 23% of the EU annual limit value of 40 $\mu g/m^3$.

Previous monitoring results, amounting to three months of data over the period October 2018 – January 2019, indicated average PM_{10} concentrations measured during the monitoring campaigns of 16.4 $\mu g/m^3$, which is below the annual limit value of 40 $\mu g/m^3$ as shown in Table 8.26. Monitoring for PM_{10} was also conducted for the summer period from 07/06/19 06/09/19 using a continuous Osiris light scattering monitor. This gave an average PM_{10} concentration over the 3-month period of 10.9 $\mu g/m^3$ which is 27% of the annual limit value of 40 $\mu g/m^3$. There were no exceedances of the daily limit value of 50 $\mu g/m^3$ over the summer 3-month period.

8.4.2.2.7 $PM_{2.5}$

Daily concentrations of $PM_{2.5}$ measured using the Osiris continuous $PM_{2.5}$ monitor are shown in Table 8.25. The annualised average $PM_{2.5}$ concentration measured over the six-month period is 5.7 $\mu g/m^3$ which is below the annual average EU limit value of 25 $\mu g/m^3$. A $PM_{2.5}/PM_{10}$ ratio for the monitoring period of 0.61 has been calculated.

Previous monitoring results, amounting to three months of data over the period October 2018 – January 2019 and from June 2019 – September 2019, indicated average $PM_{2.5}$ concentrations measured during the monitoring campaigns of 10.0 $\mu g/m^3$, which is below the annual limit value of 25 $\mu g/m^3$ as shown in Table 8.26.

8.4.2.2.8 Metals

Ambient concentrations of the suite of metals were measured over 13 sets of 5 - 7 day periods spread over three months at the static monitoring point during the period October 2018 – January 2019. The results for each sample are detailed in Table 8.27 and Table 8.28. The average concentrations of antimony (Sb), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), nickel (Ni), lead (Pb), thallium (Tl) and vanadium (V) were significantly below their respective annual limit values, with average levels reaching only 0.04% - 47% of these limits (see Table 8.27 and Table 8.28).

Previous heavy metal monitoring results amounting to six months of data over the period August 2014 to July 2015 indicated an average concentration for each of the heavy metals which was between 0.004 – 37% of the EU annual limit value (see Table 8.29 - Table 8.31).

Table 8.14 Summary of Continuous NO_2 Monitoring Results at On-Site Monitoring Station (Year 2018-19)

Monitoring Period	Details	
October 2018	Total No. Days Sampling	29
	No. Hourly Averages >200 µg/m^3	0
	Monthly Average	12.6 µg/m^3
November 2018	Total No. Days Sampling	30
	No. Hourly Averages >200 µg/m^3	0
	Monthly Average	8.3 µg/m^3
December 2018	Total No. Days Sampling	31

Monitoring Period	Details	
	No. Hourly Averages >200 µg/m^3	0
	Monthly Average	9.3 µg/m^3
January 2019	Total No. Days Sampling	3
	No. Hourly Averages >200 µg/m^3	0
	Monthly Average	9.3 µg/m^3
March - May 2008 Monitoring Period	*Total No. Days Sampling*	*93*
	No. Hourly Averages >200 µg/m^3	*0*
	99.8th%ile of 1-hour Averages	*49.5 µg/m^3*
	Monitoring Period Average	*10.1 µg/m^3*
	Limit Values	**200 µg/m^3 Note 1, 40 µg/m^3 Note 2**

Note 1 EU Council Directive 2008/50/EC - 1-hour limit of 200 µg/m^3 as a 99.8th%ile (i.e. 18 hours >200 µg/m^3 permitted per year).

Note 2 EU Council Directive 2008/50/EC - Annual average limit value.

Table 8.15 Average NO_2 Concentrations Measured in Ringaskiddy, Cobh & Monkstown Using Passive Diffusion Tubes (August 2024 – January 2025).

Monitor	NO_2 Concentrations (µg/m³)							
	21 Aug – 16 Sep 2024	16 Sep – 14 Oct 2024	14 Oct – 11 Nov 2024	11 Nov – 9 Dec 2024	9 Dec 2024 – 10 Jan 2025	10 Jan – 31 Jan 2025	Period Average	Annualised & Bias Adjusted Annual Average Note 3
N1 - Before Bridge to Haulbowline Island	5.1	5.7	6.5	8.8	7.1	8.3	6.9	4.9
N2 - Car Park East Hammond Lane	Tube removed by public in Month 1, location omitted from further monitoring							
N3 - Outside Marine Institute on L2545	6.3	7.9	7.6	Note 1	Note 1	Note 1	7.3	5.7
N4 - L2545 (Martello Park)	8.0	9.4	10.3	Note 1	Note 1	Note 1	9.3	7.2
N5 - Entrance to NVD	10.3	9.6	10.7	15.4	11.9	14.1	12.0	8.4
N6 - Ringaskiddy Terminal Car Park	8.9	8.7	12.2	Tube missing	9.5	12.9	10.4	7.2
N7 - Ringaskiddy Village	11.2	11.5	10.7	Note 1	Note 1	Note 1	11.1	8.7
N8 - Ringport Business Park	Tube missing	9.8	9.3	Tube missing	10.7	15.3	11.3	7.1
N9 - Loughbeg 1	6.9	7.6	7.6	10.0	6.9	8.6	7.9	5.5
N10 - Before Entrance to Johnson & Johnson	7.5	8.0	8.0	11.2	8.0	9.7	8.7	6.1
N11 - Loughbeg 2 (Near National School)	4.6	5.9	4.6	8.7	6.2	5.9	6.0	4.2
N12 - Monkstown Car Park	6.7	8.2	11.3	10.8	8.1	12.2	9.6	6.6
N13 - Scotsmans Road	4.1	5.2	5.7	7.9	5.5	6.2	5.8	4.0
N14 - Cobh Promenade	10.1	11.3	11.6	12.6	12.1	Tube missing	11.5	8.5
N15 - Cobh Cathedral	13.7	10.9	15.4	15.7	15.2	17.2	14.7	10.3
N16 - Hammond Lane Metals Recycling	5.5	5.5	4.7	10.2	7.8	Tube missing	6.7	5.0
Annual Mean Limit Value Note 2								40 µg/m³

Note 1 Roadworks - location inaccessible

Note 2 EU Council Directive 2008/50/EC (as an annual average).

Note 3 Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology. The diffusion tube bias is 0.81 annualisation factor of 0.887.

Table 8.16 Average NO_2 Concentrations Measured in Ringaskiddy, Cobh & Monkstown Using Passive Diffusion Tubes (October 2018 – January 2019 and June 2019 – September 2019).

Location	NO_2 ($\mu g/m^3$) 03/10/18 – 01/11/18	NO_2 ($\mu g/m^3$) 01/11/18 – 28/11/18	NO_2 ($\mu g/m^3$) 12/12/18 – 17/011/19	NO_2 ($\mu g/m^3$) 07/06/19 – 08/07/19	NO_2 ($\mu g/m^3$) 08/07/19 – 07/08/19	NO_2 ($\mu g/m^3$) 07/08/19 – 06/09/19	NO_2 Average ($\mu g/m^3$)	*Adjusted NO_2 Average ($\mu g/m^3$)*
N1 – Before Bridge to Haulbowline Island	17.5	16	10.4	9.4	9.2	7	11.6	*8.5*
N2 – Car Park East of Hammond Lane	12.4	13.1	9	7.3	5.9	6.2	9.0	*6.6*
N3 – Opposite Bus Stop on L2545	16.4	15.7	12	9.7	6.9	8.7	11.6	*8.4*
N4 – L2545 (Martello Park)	13.2	11	9.5	9.0	6.3	8.1	9.5	*6.9*
N5 – Entrance to NVD	15.3	12.9	12.7	13.4	9.6	13	12.8	*9.4*
N6 – Ringaskiddy Terminal Car Park	16.3	15.8	14.4	14.8	10.7	20.1	15.4	*11.2*
N7 – Ringaskiddy Village	16.3	17.1	12.1	12.8	8.5	8.5	12.6	*9.2*
N8 – Ringport Business Park	13.7	11.8	8.6	9.4	6	8.4	9.7	*7.0*
N9 – Loughbeg 1	14.2	14.3	10.6	10.6	8.7	7.5	11.0	*8.0*
N10 – Before Entrance to Johnson & Johnson	13.8	11.5	8.7	9.9	7.4	9.6	10.2	*7.4*
N11 – Loughbeg 2 (Near National School)	11.1	8.7	6.1	missing	5.6	6.1	7.5	*5.5*
N12 – Monkstown Car Park	20.3	19.7	15.6	15.0	8.5	8.2	14.6	*10.6*
N13 – Scotsman's Road	7.8	11.4	8.1	5.9	5.1	15.8	9.0	*6.6*
N14 – Cobh Promenade	19.6	21.5	missing	16.4	missing	missing	19.2	*14.0*
N15 – Cobh Cathedral	25	19.7	23.6	18.7	23.8	17	22.8	*16.6*
N16 – Onsite Hammod Lane	13.6	14.8	9.8	9.1	6.3	7.8	12.7	*9.3*
N17 – Onsite Hammod Lane	15.3	13.6	9.8	8.2	6.1	7.8	12.9	*9.4*
Limit Value								**40 $\mu g/m^3$** Note 1

Note 1 EU Council Directive 2008/50/EC (as an annual average).

Note 2 Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology. The diffusion tube bias is 0.73.

Table 8.17 Average SO_2 Concentrations Measured in Ringaskiddy Using Passive Diffusion Tubes (August 2024 – January 2025).

Monitor	SO_2 Concentrations ($\mu g/m^3$)						
	21 Aug – 16 Sep 2024	16 Sep – 14 Oct 2024	14 Oct – 11 Nov 2024	11 Nov – 9 Dec 2024	9 Dec 2024 – 10 Jan 2025	10 Jan – 31 Jan 2025	Period Average
S1 - Car Park East of Hammond Lane	Tube removed by public in Month 1, location omitted from further monitoring						

Monitor	SO_2 Concentrations (µg/m³)						
	21 Aug – 16 Sep 2024	16 Sep – 14 Oct 2024	14 Oct – 11 Nov 2024	11 Nov – 9 Dec 2024	9 Dec 2024 – 10 Jan 2025	10 Jan – 31 Jan 2025	Period Average
S2 - Outside Marine Institute on L2545	1.7	1.6	1.6	Note 1	Note 1	Note 1	1.6
S3 - L2545 (Martello Park)	1.7	1.6	1.6	Note 1	Note 1	Note 1	1.6
S4 - Ringaskiddy Village	1.7	1.6	1.8	Note 1	Note 1	Note 1	1.7
S5 - Monkstown Car Park	1.7	1.6	1.6	3.5	5.3	3.2	2.8
S6 - Cobh Promenade	1.7	1.6	1.6	2.2	4.4	Tube missing	2.3
S7 - Hammond Lane Metals Recycling	1.7	1.9	1.6	1.6	1.4	2.1	1.7
Annual Mean Limit Value Note 2							**20 µg/m³**

Note 1 Roadworks - location inaccessible

Note 2 EU Council Directive 2008/50/EC (as an annual average).

Table 8.18 Average SO_2 Concentrations Measured in Ringaskiddy Using Passive Diffusion Tubes (October 2018 – January 2019 and June 2019 – September 2019).

Location	SO_2 (µg/m³) 03/10/18 – 01/11/18	SO_2 (µg/m³) 01/11/18 – 28/11/18	SO_2 (µg/m³) 12/12/18 – 17/01/19	SO_2 (µg/m³) 07/06/19 – 08/07/19	SO_2 (µg/m³) 08/07/19 – 07/08/19	SO_2 (µg/m³) 07/08/19 – 06/09/19	SO_2 Average (µg/m³)
S1 - Car Park East of Hammond Lane	2.6	13.6	2.5	2.9	3.0	<2.5	4.5
S2 - Outside Marine Institute on L2545	2.6	2.8	7.6	2.9	<2.5	<2.5	3.5
S3 - L2545 (Martello Park)	2.6	3.4	3.4	2.9	<2.5	5.1	3.3

S4 - Ringaskiddy Village	2.6	5.7	4.2	3.9	<2.5	<2.5	3.6
S5 - Monkstown Car Park	2.6	2.8	2.5	3.9	<2.5	<2.5	2.8
S6 - Cobh Promenade	2.6	5.7	3.4	3.9	3.0	missing	3.7
S7 - Hammond Lane Metals Recycling	2.6	2.8	2.1	2.9	3.0	<2.5	2.7
Limit Value Note 1							**20 µg/m³**

Note 1 EU Council Directive 2000/69/EC (annual average limit for the protection of ecosystems).

Table 8.19 Average Benzene Concentrations Measured in Ringaskiddy Using Passive Diffusion Tubes (August 2024 – January 2025).

Monitor	Benzene Concentrations (µg/m³)						
	21 Aug – 16 Sep 2024	16 Sep – 14 Oct 2024	14 Oct – 11 Nov 2024	11 Nov – 9 Dec 2024	9 Dec 2024 – 10 Jan 2025	10 Jan – 31 Jan 2025	Period Average
S1 - Car Park East of Hammond Lane	Tube removed by public in Month 1, location omitted from further monitoring						
S2 - Outside Marine Institute on L2545	0.17	0.23	-	Note 1	Note 1	Note 1	0.20
S3 - L2545 (Martello Park)	0.31	0.20	0.30	Note 1	Note 1	Note 1	0.27
S4 - Ringaskiddy Village	0.29	0.29	0.48	Note 1	Note 1	Note 1	0.35
S5 - Monkstown Car Park	0.27	0.25	0.41	0.30	0.65	0.40	0.38
S6 - Cobh Promenade	0.28	0.31	0.35	0.39	0.53	0.37	0.37
S7 - Hammond Lane Metals Recycling	0.38	0.29	0.38	0.41	0.44	0.33	0.37
Limit Value Note 2							**5 µg/m³**

Note 1 Roadworks - location inaccessible

Note 1 EU Council Directive 2008/50/EC (as an annual average).

Table 8.20 Average Benzene Concentrations Measured in Ringaskiddy Using Passive Diffusion Tubes (October 2018 – January 2019 and June 2019 – September 2019).

Location	Benzene (µg/m³) 03/10/18 – 01/11/18	Benzene (µg/m³) 01/11/18 – 28/11/18	Benzene (µg/m³) 12/12/18 – 17/01/19	Benzene (µg/m³) 07/06/19 – 08/07/19	Benzene (µg/m³) 08/07/19 – 07/08/19	Benzene (µg/m³) 07/08/19 – 06/09/19	Benzene Average (µg/m³)
B1 - Car Park East of Hammond Lane	0.9	0.9	0.9	0.5	0.5	0.5	0.70
B2 - Outside Marine Institute on L2545	0.9	0.8	0.7	0.5	0.8	0.5	0.70
B3 - L2545 (Martello Park	0.8	3	0.8	0.5	0.5	damaged	1.12
B4 - Ringaskiddy Village	1	8.4	0.9	0.5	0.5	0.5	1.97
B5 - Monkstown Car Park	3	0.9	1	0.5	0.5	damaged	1.18
B6 - Cobh Promenade	1	0.6	0.8	0.5	damaged	0.5	0.68
B7 - Hammond Lane Metals Recycling	0.9	0.7	0.8	damaged	0.7	damaged	0.78
	Limit Value Note 1						**5 µg/m³**

Note 1 EU Council Directive 2008/50/EC (as an annual average).

Note 2 A number of tubes were damaged during the exposure period and results could not be obtained.

Table 8.21 Average PCDD/PCDF Concentrations Measured at the On-Site Monitoring Station (Sampling Periods 1, 2 & 3) (October 2018 – January 2019).

PCDD Congeners	I-TEF Note 1	Sampling Period 1: Oct / Nov 18			Sampling Period 2: Nov / Dec 18			Sampling Period 3: Dec 18 / Jan 19		
		Concentration Note 2	Lower Limit TEQ Note 3	Upper Limit TEQ Note 4	Concentration Note 2	Lower Limit TEQ Note 3	Upper Limit TEQ Note 4	Concentration Note 2	Lower Limit TEQ Note 3	Upper Limit TEQ Note 4
		(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)	(fg/m³)
2,3,7,8-TCDD	1	*<7.5*		7.5	*<5.4*		5.4	*<3.7*		3.7
1,2,3,7,8-PeCDD	0.5	*<4.3*		2.1	*<5.4*		2.7	28.1	14.0	14.0
1,2,3,4,7,8-HxCDD	0.1	*<4.3*		0.4	*<5.4*		0.5	*<5.6*		0.6
1,2,3,6,7,8-HxCDD	0.1	*<6.4*		0.6	*<5.4*		0.5	9.7	1.0	1.0
1,2,3,7,8,9-HxCDD	0.1	*<4.3*		0.4	*<6.5*		0.7	8.2	0.8	0.8
1,2,3,4,6,7,8-HpCDD	0.01	*<427.7*		4.3	*<43.5*		0.4	76.7	0.8	0.8
OCDD	0.001	151.8	0.2	0.2	*<149.7*		0.1	170.3	0.2	0.2
PCDF Congeners	**I-TEF** Note 1									

2,3,7,8-TCDF	0.1	*<10.7*		1.1	*<8.2*		0.8	17.4	1.7	1.7
1,2,3,7,8-PCDF	0.05	*<4.3*		0.2	*<6*		0.3	13.3	0.7	0.7
2,3,4,7,8-PCDF	0.5	*<8.6*		4.3	*<5.4*		2.7	26.2	13.1	13.1
1,2,3,4,7,8-HxCDF	0.1	*<6.4*		0.6	*<7.1*		0.7	22.5	2.2	2.2
1,2,3,6,7,8-HxCDF	0.1	*<7.1*		0.7	*<6.5*		0.7	24.3	2.4	2.4
1,2,3,7,8,9-HxCDF	0.1	*<11.1*		0.4	*<5.4*		0.6	*<28.1*		1.5
2,3,4,6,7,8-HxCDF	0.1	4.3	1.1	1.1	*<6*		0.5	15	2.8	2.8
1,2,3,4,6,7,8-HpCDF	0.01	*<47*		0.5	*<38.1*		0.4	117.9	1.2	1.2
1,2,3,4,7,8,9-HpCDF	0.01	*<10.7*		0.1	*<6.8*		0.1	22.5	0.2	0.2
OCDF	0.001	*<85.5*		0.1	*<40.8*		0.04	355.5	0.4	0.4
		Total TEQ	1.3	24.7	Total TEQ	0.0	17.3	Total TEQ	41.5	47.3

Note 1 Annex 1, Council Directive 2000/76/EC.

Note 2 Ambient concentration of congener (values in italics indicate levels below the limit of detection).

Note 3 Lower Limit TEQ calculated assuming non-detects are equal to zero (i.e. congeners with ambient levels below the limit of detection not included in Total TEQ)

Note 4 Upper Limit TEQ calculated assuming non-detects are equal to the limit of detection (i.e. congeners with ambient levels below the limit of detection included in Total TEQ).

Table 8.22 Summary of PCDD / PCDF Concentrations Measured at On-Site Monitoring Station (April - May 2008)

Pollutant	Averaging Period	Minimum PCDDs/PCDFs (I-TEQ) (fg/m³)	Maximum PCDDs/PCDFs (I-TEQ) (fg/m³)
April / May 2008 Monitoring			
PCCD/PCDFs	21/04/08 - 25/04/08	18.6	18.6
PCCD/PCDFs	02/05/08 - 06/05/08	9.5	11.8
PCCD/PCDFs	08/05/08 - 13/05/08	13.9	14.2
PCCD/PCDFs	19/05/08 - 23/05/08	7.4	9.3
PCCD/PCDFs	4-Week Average	12.4	13.5

Table 8.23 Average HF Concentrations Measured at On-Site Monitoring Station (October 2018 – January 2019).

Location	HF (µg/m³) 03/10/18 - 01/11/18	HF (µg/m³) 01/11/18 - 28/11/18	HF (µg/m³) 28/11/18 - 03/01/19	Average HF (µg/m³)
Hammond Lane Metals Recycling	0.32	0.33	0.32	0.32
Hammond Lane Metals Recycling	0.32	0.33	0.32	0.32
			Limit value	*16 µg/m³ Note 1*

Note 1 UK Environment Assessment Level (EAL) as an annual average

Table 8.24 Average HCl Concentrations Measured at On-Site Monitoring Station (October 2018 – January 2019).

Location	HCl (µg/m³) 03/10/18 - 01/11/18	HCl (µg/m³) 01/11/18 - 28/11/18	HCl (µg/m³) 28/11/18 - 03/01/19	Average HCl (µg/m³)
Hammond Lane Metals Recycling	2.23	2.45	1.94	2.21
Hammond Lane Metals Recycling	2.23	2.45	1.94	2.21
			Limit value	*20 µg/m³ Note 1*

Note 1 UK Environment Assessment Level (EAL) as an annual average

Table 8.25 Results of PM_{10} / $PM_{2.5}$ monitoring carried out at an on-site location in Ringaskiddy, Co. Cork (August 2024 – January 2025).

Date	24-Hour Mean Concentrations (µg/m³)		Date	24-Hour Mean Concentrations (µg/m³)	
	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$
21-Aug-24	21.9	15.8	11-Nov-24	14.2	9.0
22-Aug-24	12.1	8.2	12-Nov-24	12.6	6.8
23-Aug-24	9.2	6.3	13-Nov-24	10.2	5.6
24-Aug-24	8.1	6.0	14-Nov-24	6.1	2.0
25-Aug-24	18.3	14.8	15-Nov-24	7.5	2.6
26-Aug-24	17.5	12.4	16-Nov-24	8.0	4.3
27-Aug-24	16.6	8.6	17-Nov-24	5.5	3.9
28-Aug-24	11.1	7.0	18-Nov-24	6.6	2.9
29-Aug-24	9.7	6.4	19-Nov-24	8.8	4.3
30-Aug-24	10.9	7.0	20-Nov-24	9.9	3.5
31-Aug-24	11.5	7.9	21-Nov-24	2.7	2.0
01-Sept-24	20.5	15.0	22-Nov-24	5.1	2.8
02-Sept-24	7.0	4.8	23-Nov-24	27.7	23.7
03-Sept-24	10.9	7.2	24-Nov-24	14.0	11.9
04-Sept-24	12.2	7.2	25-Nov-24	6.7	4.3
05-Sept-24	5.7	3.6	26-Nov-24	6.2	3.6
06-Sept-24	14.6	8.0	27-Nov-24	6.7	4.4
07-Sept-24	17.0	10.5	28-Nov-24	17.0	14.2
08-Sept-24	8.8	4.9	29-Nov-24	36.2	28.2
09-Sept-24	15.0	10.9	30-Nov-24	40.6	28.0
10-Sept-24	8.2	6.0	01-Dec-24	14.6	9.2
11-Sept-24	8.9	6.3	02-Dec-24	9.9	5.8
12-Sept-24	8.5	4.9	03-Dec-24	4.9	3.1
13-Sept-24	8.1	4.6	04-Dec-24	7.8	3.8
14-Sept-24	11.5	7.9	05-Dec-24	10.6	7.7
15-Sept-24	5.0	2.9	06-Dec-24	12.7	10.1
16-Sept-24	4.5	2.2	07-Dec-24	11.0	10.0
17-Sept-24	4.4	2.6	08-Dec-24	6.5	5.6
18-Sept-24	7.4	4.4	09-Dec-24	6.0	3.9
19-Sept-24	13.6	6.8	10-Dec-24	11.4	6.7
20-Sept-24	15.2	8.4	11-Dec-24	12.3	7.0
21-Sept-24	11.6	7.3	12-Dec-24	5.4	2.1
22-Sept-24	10.7	6.6	13-Dec-24	13.0	5.7
23-Sept-24	8.1	4.9	14-Dec-24	3.4	2.3
24-Sept-24	3.4	1.2	15-Dec-24	2.0	1.5
25-Sept-24	4.9	2.7	16-Dec-24	11.6	8.1
26-Sept-24	2.2	1.1	17-Dec-24	21.7	18.2
27-Sept-24	5.5	4.3	18-Dec-24	10.0	7.5
28-Sept-24	4.8	3.2	19-Dec-24	6.6	4.6

Date	24-Hour Mean Concentrations (µg/m³)		Date	24-Hour Mean Concentrations (µg/m³)	
	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$
29-Sept-24	12.0	10.4	20-Dec-24	7.3	5.6
30-Sept-24	5.3	3.4	21-Dec-24	12.5	11.1
01-Oct-24	7.3	4.8	22-Dec-24	9.1	8.5
02-Oct-24	10.4	6.8	23-Dec-24	6.4	4.4
03-Oct-24	14.5	10.6	24-Dec-24	2.0	0.9
04-Oct-24	10.9	7.7	25-Dec-24	3.0	1.8
05-Oct-24	19.7	16.5	26-Dec-24	2.0	0.5
06-Oct-24	18.5	12.4	27-Dec-24	2.5	0.6
07-Oct-24	23.3	18.5	28-Dec-24	3.1	0.9
08-Oct-24	4.5	2.5	29-Dec-24	4.1	2.3
09-Oct-24	3.7	2.2	30-Dec-24	3.4	2.5
10-Oct-24	6.1	4.2	31-Dec-24	12.0	9.1
11-Oct-24	3.8	2.0	01-Jan-25	4.2	3.1
12-Oct-24	4.0	2.5	02-Jan-25	4.3	2.8
13-Oct-24	7.0	5.3	03-Jan-25	6.2	3.9
14-Oct-24	4.7	3.1	04-Jan-25	4.2	3.3
15-Oct-24	10.6	8.1	05-Jan-25	0.7	0.5
16-Oct-24	12.8	6.8	06-Jan-25	2.4	2.0
17-Oct-24	12.1	7.8	07-Jan-25	3.4	2.3
18-Oct-24	19.2	12.9	08-Jan-25	3.6	2.8
19-Oct-24	15.5	10.0	09-Jan-25	6.7	4.2
20-Oct-24	25.8	21.6	10-Jan-25	6.7	5.2
21-Oct-24	15.3	10.7	11-Jan-25	8.0	5.1
22-Oct-24	8.5	4.1	12-Jan-25	18.8	15.2
23-Oct-24	12.0	7.3	13-Jan-25	23.5	16.4
24-Oct-24	19.6	15.6	14-Jan-25	9.4	4.6
25-Oct-24	15.3	13.0	15-Jan-25	12.4	7.4
26-Oct-24	14.5	10.8	16-Jan-25	14.3	9.2
27-Oct-24	10.3	6.8	17-Jan-25	14.1	9.4
28-Oct-24	4.5	1.2	18-Jan-25	17.6	12.6
29-Oct-24	4.0	1.0	19-Jan-25	17.5	11.8
30-Oct-24	3.4	0.8	20-Jan-25	6.6	4.0
31-Oct-24	6.1	1.7	21-Jan-25	6.9	2.7
01-Nov-24	12.4	4.4	22-Jan-25	7.6	2.7
02-Nov-24	5.1	2.7	23-Jan-25	12.6	9.6
03-Nov-24	9.5	5.0	24-Jan-25	17.5	13.7
04-Nov-24	15.5	7.7	25-Jan-25	25.9	9.1
05-Nov-24	16.7	9.5	26-Jan-25	23.8	21.9
06-Nov-24	12.9	7.9	27-Jan-25	19.2	16.9
07-Nov-24	16.3	11.6	28-Jan-25	7.4	6.1
08-Nov-24	14.4	8.7	29-Jan-25	8.2	4.8
09-Nov-24	10.6	6.3	30-Jan-25	7.3	4.8

Date	24-Hour Mean Concentrations (µg/m³)		Date	24-Hour Mean Concentrations (µg/m³)	
	PM_{10}	$PM_{2.5}$		PM_{10}	$PM_{2.5}$
10-Nov-24	6.6	3.4	31-Jan-25	13.5	10.9
PM_{10} Average (µg/m³)			10.5		
Annualised PM_{10} Average (µg/m³)			**9.4**		
No. Days > 50 µg/m³			0		
90.4th percentile (µg/m³)			18.6		
$PM_{2.5}$ Average (µg/m³)			7.0		
Annualised $PM_{2.5}$ Average (µg/m³)			**5.7**		

Table 8.26 Results of PM_{10} / $PM_{2.5}$ monitoring carried out at an on-site location in Ringaskiddy, Co. Cork (October 2018 – January 2019).

Date	Partisol PM_{10}	Date	Osiris $PM_{2.5}$
04-Oct-18	12.85	13-Nov-18	18.20
05-Oct-18	12.18	14-Nov-18	22.64
06-Oct-18	11.68	15-Nov-18	14.93
07-Oct-18	14.18	16-Nov-18	13.89
08-Oct-18	23.33	17-Nov-18	15.35
09-Oct-18	27.90	18-Nov-18	16.13
10-Oct-18	34.51	19-Nov-18	8.48
11-Oct-18	21.21	20-Nov-18	3.83
12-Oct-18	23.41	21-Nov-18	3.15
13-Oct-18	11.35	22-Nov-18	10.24
14-Oct-18	9.90	23-Nov-18	11.45
15-Oct-18	12.93	24-Nov-18	7.31
16-Oct-18	14.68	25-Nov-18	6.15
17-Oct-18	25.53	26-Nov-18	4.80
18-Oct-18	5.20	27-Nov-18	17.83
19-Oct-18	24.83	28-Nov-18	34.84
20-Oct-18	36.14	12-Dec-18	16.63
21-Oct-18	13.97	13-Dec-18	21.41
22-Oct-18	13.51	14-Dec-18	16.18
23-Oct-18	25.99	15-Dec-18	15.25
24-Oct-18	25.82	16-Dec-18	4.78
25-Oct-18	24.83	17-Dec-18	31.21
26-Oct-18	22.00	18-Dec-18	24.88
27-Oct-18	15.64	19-Dec-18	10.85
28-Oct-18	11.89	20-Dec-18	8.91
29-Oct-18	16.72	21-Dec-18	12.07
30-Oct-18	15.64	22-Dec-18	15.28
31-Oct-18	14.80	23-Dec-18	2.38
01-Nov-18	8.32	24-Dec-18	4.15
02-Nov-18	3.04	25-Dec-18	8.35
03-Nov-18	32.85	26-Dec-18	8.48
04-Nov-18	7.36	27-Dec-18	3.88
05-Nov-18	5.86	28-Dec-18	11.98
14-Nov-18	18.67	29-Dec-18	1.10
15-Nov-18	19.54	30-Dec-18	3.58
16-Nov-18	24.20	31-Dec-18	10.12
17-Nov-18	27.03	01-Jan-19	6.53
18-Nov-18	31.89	02-Jan-19	7.68
19-Nov-18	16.88	03-Jan-19	9.79
20-Nov-18	10.48	08-Jan-19	15.07
21-Nov-18	14.06	09-Jan-19	3.44
22-Nov-18	24.08	10-Jan-19	3.38

Date	Partisol PM_{10}	Date	Osiris $PM_{2.5}$
23-Nov-18	18.30	11-Jan-19	2.59
24-Nov-18	19.38	12-Jan-19	2.13
25-Nov-18	20.29	13-Jan-19	5.64
26-Nov-18	12.64	14-Jan-19	13.64
27-Nov-18	20.54	15-Jan-19	3.81
28-Nov-18	23.83	16-Jan-19	4.85
29-Nov-18	11.27	17-Jan-19	5.08
30-Nov-18	2.08	29-Jan-19	23.18
01-Dec-18	12.43	30-Jan-19	4.90
02-Dec-18	7.24	31-Jan-19	10.28
03-Dec-18	15.64	01-Feb-19	4.75
04-Dec-18	18.71	02-Feb-19	4.47
05-Dec-18	12.10	03-Feb-19	9.59
06-Dec-18	7.73	04-Feb-19	7.99
07-Dec-18	8.57	05-Feb-19	13.96
08-Dec-18	13.18	06-Feb-19	18.61
09-Dec-18	16.05	07-Feb-19	8.74
10-Dec-18	8.48	08-Feb-19	33.11
11-Dec-18	19.09	09-Feb-19	14.59
12-Dec-18	16.59	10-Feb-19	6.07
13-Dec-18	9.11	11-Feb-19	14.82
14-Dec-18	16.67	12-Feb-19	23.26
15-Dec-18	12.85	13-Feb-19	31.20
16-Dec-18	9.90	14-Feb-19	19.55
17-Dec-18	10.94	15-Feb-19	28.79
18-Dec-18	24.66	16-Feb-19	25.97
19-Dec-18	19.29	17-Feb-19	21.60
20-Dec-18	11.02	18-Feb-19	12.11
21-Dec-18	14.72	19-Feb-19	19.40
22-Dec-18	14.10	20-Feb-19	23.35
23-Dec-18	7.65	21-Feb-19	39.24
24-Dec-18	8.23	22-Feb-19	42.84
25-Dec-18	16.43	23-Feb-19	40.11
26-Dec-18	12.02	24-Feb-19	22.25
27-Dec-18	9.52	25-Feb-19	33.21
28-Dec-18	17.09	26-Feb-19	17.03
29-Dec-18	5.90	27-Feb-19	14.49
30-Dec-18	7.94	28-Feb-19	21.17
31-Dec-18	16.97	-	-
01-Jan-19	19.13	-	-
02-Jan-19	13.18	-	-
03-Jan-19	12.60	-	-
04-Jan-19	13.60	-	-
05-Jan-19	16.97	-	-
06-Jan-19	19.00	-	-
07-Jan-19	17.96	-	-
08-Jan-19	28.11	-	-
Average	**16.14**	**Average**	**14.19**
No. Days > 50	**0**	**$PM_{2.5}/PM_{10}$ ratio**	**0.88**
90.4th percentile	**25.69**		
Limit Values Note 1	**Daily 50 µg/m³ Annual 40 µg/m³**	**Limit Values** Note 1	**Annual 25 µg/m³**

Note 1 EU Council Directive 2008/50/EC - annual limit value.

Table 8.26 (cont.) Results of PM_{10} / $PM_{2.5}$ monitoring carried out at an on-site location in Ringaskiddy, Co. Cork (June 2019 – September 2019).

Date	Osiris PM_{10} ($\mu g/m^3$)	Osiris $PM_{2.5}$ ($\mu g/m^3$)	Date	Osiris PM_{10} ($\mu g/m^3$)	Osiris $PM_{2.5}$ ($\mu g/m^3$)
07-Jun-19	9.52	4.07	23-Jul-19	9.64	7.11
08-Jun-19	5.26	3.33	24-Jul-19	13.01	10.28
09-Jun-19	3.48	2.3	25-Jul-19	28.28	24.04
10-Jun-19	5	2.58	26-Jul-19	12.86	8.47
11-Jun-19	4.75	2.65	27-Jul-19	9.65	5.11
12-Jun-19	5.97	4.1	28-Jul-19	6.13	4.13
13-Jun-19	17.49	8.64	29-Jul-19	5.91	2.93
14-Jun-19	14.16	7.01	30-Jul-19	8.73	3.48
15-Jun-19	2.99	1.75	31-Jul-19	7.82	3.67
16-Jun-19	6.92	5.2	01-Aug-19	8.43	4.48
17-Jun-19	19.98	12.01	02-Aug-19	5.6	2.68
18-Jun-19	11.32	6.2	03-Aug-19	8.17	5.64
19-Jun-19	24.21	7.17	04-Aug-19	10.49	6.14
20-Jun-19	14.74	5.88	05-Aug-19	12.38	8.71
21-Jun-19	9.41	5.04	06-Aug-19	9.96	6.90
22-Jun-19	6.98	5.03	07-Aug-19	6.96	3.58
23-Jun-19	15.25	11.53	08-Aug-19	6.97	4.54
24-Jun-19	11.84	8.92	09-Aug-19	25.42	19.48
25-Jun-19	5.74	3.37	10-Aug-19	9.8	6.53
26-Jun-19	5.76	3.07	11-Aug-19	5.5	3.23
27-Jun-19	9.69	6.25	12-Aug-19	6.31	3.3
28-Jun-19	20.69	17.06	13-Aug-19	5.97	3.37
29-Jun-19	7.92	5.88	14-Aug-19	8.63	4
30-Jun-19	5.78	4.37	15-Aug-19	9.04	5.84
01-Jul-19	10.86	5.08	16-Aug-19	13.78	9.6
02-Jul-19	7.45	4.23	17-Aug-19	14.45	10.4
03-Jul-19	6.43	4.09	18-Aug-19	13.14	9.19
04-Jul-19	8.52	3.9	19-Aug-19	10.35	5.78
05-Jul-19	9.1	3.49	20-Aug-19	9.93	6.54
06-Jul-19	2.59	1.15	21-Aug-19	17.07	9.81
07-Jul-19	3.15	2.08	22-Aug-19	20.55	12.69
08-Jul-19	3.98	2.12	23-Aug-19	13.08	7.62
09-Jul-19	6.58	2.01	24-Aug-19	24.2	13.3
10-Jul-19	9.01	4.2	25-Aug-19	4.54	1.88
11-Jul-19	8.27	3.79	26-Aug-19	15.65	3.95
12-Jul-19	6.92	2.86	27-Aug-19	9.95	4.97
13-Jul-19	3.31	1.77	28-Aug-19	11.82	4.88
14-Jul-19	4.7	2.77	29-Aug-19	27.68	15.58
15-Jul-19	9.38	6.14	30-Aug-19	34.29	21.18
16-Jul-19	10.13	6.26	31-Aug-19	11.15	6.02
17-Jul-19	9.44	6.08	01-Sep-19	9.01	4.9
18-Jul-19	8.84	4.53	02-Sep-19	9.24	4.43
19-Jul-19	12.19	8.04	03-Sep-19	6.22	3.18
20-Jul-19	4.75	2.94	04-Sep-19	20.74	9.7
21-Jul-19	15.81	11.48	05-Sep-19	23.4	9.41
22-Jul-19	21.95	15.29	06-Sep-19	9.34	5.42

Average	**10.86**	**Average**	**6.37**
No. Days > 50	**0**	**$PM_{2.5}/PM_{10}$ ratio**	**0.58**
90.4^{th} percentile	**20.70**		
Limit Values [Note 1]	**Daily 50 µg/m³ Annual 40 µg/m³**	**Limit Values** [Note 1]	**Annual 25 µg/m³**

Table 8.27 Levels of heavy metals measured at an on-site location in Ringaskiddy during the period 04/10/18 – 27/11/18.

Species	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Limit Values (ng/m^3)(1)
	04/10/18 - 10/10/18 (ng/m^3)	11/10/18 - 17/10/18 (ng/m^3)	18/10/18 - 24/10/18 (ng/m^3)	25/10/18 - 31/10/18 (ng/m^3)	01/11/18 - 05/11/18 (ng/m^3)	14/11/18 - 20/11/18 (ng/m^3)	21/11/18 - 27/11/18 (ng/m^3)	
Antimony	0.60	<0.60	<0.60	<0.60	<3.33	<0.12	0.18	5000
Arsenic	<1.79	<1.79	<1.79	<1.79	<3.33	<0.24	0.30	6(2)
Cadmium	<0.60	<0.60	<0.60	<0.60	<4.17	<0.18	0.30	5(2)
Chromium	23.81	<17.86	<17.86	<17.86	7.50	5.95	5.95	5000
Cobalt	<1.19	<1.19	1.19	<1.19	<1.67	0.12	0.24	200
Copper	17.86	5.36	11.90	11.90	4.17	4.17	5.36	2000
Lead	5.95	4.17	4.76	4.17	4.17	2.98	3.99	500
Manganese	17.86	<4.76	11.90	5.95	8.33	4.17	5.36	150
Mercury	<17.86	<17.86	<17.86	<17.86	<4.17	<0.48	<0.48	1000
Nickel	<11.90	<11.90	<11.90	<11.90	8.33	2.38	2.38	20(2)
Thallium	<0.60	<0.60	<0.60	1.19	<5.00	<0.12	0.30	1000
Vanadium	<3.57	<3.57	<3.57	<3.57	3.33	1.85	0.60	5000

Note 1 Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
Note 2 EU Directive 2004/107/EC

Table 8.28 Levels of heavy metals measured at an on-site location in Ringaskiddy during the period 28/11/18 – 08/01/19.

Species	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Average (ng/m^3)	Limit Values (ng/m^3)(1)
	28/11/18 - 04/12/18 (ng/m^3)	05/12/18 - 11/12/18 (ng/m^3)	11/12/18 - 17/12/18 (ng/m^3)	18/12/18 - 24/12/18 (ng/m^3)	25/12/18 - 31/12/18 (ng/m^3)	01/01/19 - 08/01/19 (ng/m^3)		
Antimony	<0.30	0.48	<0.30	<0.30	<0.30	0.36	0.6	5000
Arsenic	<0.18	<0.18	<0.18	<0.18	<0.18	<1.56	1.0	6(2)
Cadmium	<0.12	0.24	0.42	<0.12	<0.12	<1.04	0.7	5(2)
Chromium	5.95	5.95	5.36	5.95	5.95	5.21	10.1	5000
Cobalt	<0.60	<0.60	<0.60	<0.60	<0.60	<0.42	0.8	200
Copper	<3.57	<3.57	<3.57	3.57	<3.57	5.21	6.4	2000
Lead	3.57	5.95	46.43	3.57	11.90	2.60	8.0	500
Manganese	<0.24	2.68	3.33	1.79	1.19	5.21	5.6	150
Mercury	<5.95	5.95	<5.95	<5.95	<5.95	<1.04	8.3	1000
Nickel	<11.90	<11.90	<11.90	<11.90	<11.90	<2.60	9.4	20(2)
Thallium	<0.06	<0.06	<0.06	<0.06	<0.06	<1.56	0.8	1000
Vanadium	<0.36	<0.36	0.54	<0.36	2.38	<4.17	2.2	5000

Note 1 Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.
Note 2 EU Directive 2004/107/EC

Table 8.29 Levels of heavy metals measured at an on-site location in Ringaskiddy during the period 04/09/14 – 13/11/14.

Species	Period 1 04/09/14 - 09/09/14 (ng/m³)	Period 2 10/09/14 - 14/09/14 (ng/m³)	Period 3 15/09/14 - 21/09/14 (ng/m³)	Period 4 22/09/14 - 28/09/14 (ng/m³)	Period 5 10/10/14 - 16/10/14 (ng/m³)	Period 6 17/10/14 - 23/10/14 (ng/m³)	Period 7 24/10/14 – 30/10/14 (ng/m³)	Period 8 31/10/14 - 06/11/14 (ng/m³)	Period 9 07/11/14 - 13/11/14 (ng/m³)	Limit Values (ng/m³)(1)
Antimony	0.63	0.50	0.95	0.65	5.60	5.60	5.48	5.42	5.30	5000
Arsenic	0.21	0.17	0.60	0.30	0.60	0.60	0.60	0.42	0.60	6(2)
Cadmium	0.35	0.33	0.46	0.18	0.18	0.18	0.12	0.12	0.24	5(2)
Chromium	13.89	15.00	14.29	11.90	36.31	34.52	36.31	33.93	39.88	5000
Cobalt	0.69	0.58	0.65	0.47	0.60	0.36	0.48	0.42	0.54	200
Copper	7.64	6.67	6.55	3.45	5.95	7.14	4.88	3.81	5.30	2000
Lead	9.72	10.00	15.48	4.82	8.33	7.14	5.54	5.77	5.89	500
Manganese	15.28	15.83	14.88	10.12	12.50	11.90	13.10	12.50	14.29	150
Mercury	0.56	0.67	0.42	0.42	0.36	0.36	0.12	0.12	0.12	1000
Nickel	9.72	10.83	11.31	7.14	8.33	7.14	5.48	5.42	8.33	20(2)
Thallium	0.07	0.08	0.02	0.01	0.04	0.03	0.02	0.05	0.03	1000
Vanadium	2.15	2.92	3.10	1.79	0.60	0.60	3.57	1.61	1.19	5000

Note 1 Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.

Note 2 EU Directive 2004/107/EC

Table 8.30 Levels of heavy metals measured at an on-site location in Ringaskiddy during the period 14/11/14 – 12/03/15.

Species	Period 10 14/11/14 - 20/11/14 (ng/m³)	Period 11 21/11/14 - 27/11/14 (ng/m³)	Period 12 28/11/14 - 03/12/14 (ng/m³)	Period 13 29/01/15 - 04/02/15 (ng/m³)	Period 14 05/02/15 - 11/02/15 (ng/m³)	Period 15 12/02/15 and 14/02/15 - 19/02/15 (ng/m³)	Period 16 20/02/15 – 26/02/15 (ng/m³)	Period 17 27/02/15 - 05/03/15 (ng/m³)	Period 18 06/03/15 - 12/03/15 (ng/m³)	Limit Values (ng/m³)(1)
Antimony	7.74	5.71	6.53	4.82	2.38	1.49	1.25	1.49	1.19	5000
Arsenic	2.02	1.19	0.69	0.12	0.30	0.42	0.18	1.19	0.60	6(2)
Cadmium	0.42	0.25	0.28	0.12	0.18	0.18	0.12	0.12	0.12	5(2)
Chromium	35.12	36.90	36.11	39.88	50.60	47.02	45.83	48.21	31.55	5000
Cobalt	0.60	0.53	0.46	0.50	0.55	0.57	0.77	0.60	0.36	200
Copper	9.52	7.74	8.33	5.00	5.36	3.87	3.21	8.93	8.33	2000
Lead	101.19	14.29	9.72	6.55	7.14	7.74	3.75	4.58	8.93	500
Manganese	14.88	16.67	17.36	14.29	19.05	14.29	13.10	14.29	12.50	150
Mercury	0.12	0.06	0.06	0.04	0.04	0.12	0.06	0.12	0.12	1000
Nickel	5.71	5.60	6.32	5.65	5.95	7.14	5.65	5.95	4.17	20(2)
Thallium	0.04	0.02	0.04	0.04	0.04	0.03	0.02	0.06	0.05	1000
Vanadium	1.90	1.43	2.22	0.71	0.36	1.49	0.77	1.55	0.83	5000

Note 1 Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.

Note 2 EU Directive 2004/107/EC

Table 8.31 Levels of heavy metals measured at an on-site location in Ringaskiddy during the period 17/03/15 – 08/07/15.

Species	Period 19 17/03/15 - 23/03/15 (ng/m³)	Period 20 24/03/15 - 26/03/15 (ng/m³)	Period 21 03/04/15 - 12/04/15 (ng/m³)	Period 22 29/04/15 - 02/05/15 (ng/m³)	Period 23 03/05/15 and 08/05/15 - 11/05/15 (ng/m³)	Period 24 14/05/15 - 20/05/15 (ng/m³)	Period 25 25/06/15 - 01/07/15 (ng/m³)	Period 26 02/07/15 - 08/07/15 (ng/m³)	Averages – Sept 14 – July 15 (ng/m³)	Limit Values (ng/m³)(1)
Antimony	1.96	2.08	1.92	2.19	1.67	1.85	4.76	4.76	3.2	5000
Arsenic	0.06	0.14	0.63	0.21	0.33	0.24	4.76	4.76	0.8	6(2)
Cadmium	0.30	0.14	5.42	0.31	0.17	0.18	5.95	5.95	0.9	5(2)
Chromium	51.8	50.0	62.5	54.2	52.5	50.6	45.2	44.1	39.2	5000
Cobalt	0.65	0.63	0.88	0.73	0.53	0.54	1.79	1.79	0.7	200
Copper	3.81	1.39	6.25	3.13	4.67	3.81	5.95	5.95	5.6	2000
Lead	8.33	7.50	17.92	6.04	4.83	4.70	23.81	5.95	12.1	500
Manganese	18.45	16.67	21.25	16.67	15.00	14.88	17.86	11.90	15.0	150
Mercury	0.03	0.07	0.04	0.21	0.75	0.18	5.36	5.36	0.6	1000
Nickel	7.14	6.11	8.75	6.88	14.17	10.12	5.95	5.36	7.3	20(2)
Thallium	0.02	0.04	0.03	0.02	0.08	0.06	5.95	5.95	0.5	1000
Vanadium	1.73	0.92	2.46	0.67	1.92	2.08	3.57	3.57	1.8	5000

Note 1 Annual average limit values set by the EU, WHO, TA Luft Guidelines or a derived as an Environmental Assessment Level.

Note 2 EU Directive 2004/107/EC

8.4.3 Background Concentrations

The ambient concentrations detailed in the following sections include both the emissions from the facility and the ambient background concentration for that substance. Background concentrations have been derived from a conservative analysis of the existing background air quality and an analysis of cumulative sources in the region in the absence of the development. A detailed baseline air quality assessment (Section 8.4.2) was carried out to assess background levels of those pollutants, which are likely to be released from the site. Appropriate background values have been outlined in Table 8.32. In arriving at the combined annual background concentration, cognisance has been taken of the accuracy of the approach and the degree of double counting inherent in the assessment. In relation to NO_2, PM_{10}, $PM_{2.5}$ and benzene the baseline monitoring program will have taken into account the existing traffic levels and existing home heating and minor industrial sources. However, traffic levels associated with the development have been incorporated into the final combined background levels. The values have been rounded accordingly based on this conservative approach. A similar approach has been adopted for the other pollutants.

Table 8.32 Estimated annual background concentrations in the region of Ringaskiddy (μg/m³).

	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	TOC (2)	HCl	HF	NH_3	Dioxins(1)	B(*a*)P	Cd	Hg	As	V	Ni
Baseline Monitoring Program - Year 2024 – 2025 & 2018 - 2019	8	3	9.4	5.7	-	1	2.2	0.32	-	0.030 pg/m³	-	0.001	0.008	0.001	0.002	0.009
Annual Background Concentration - Year 2030	8	3	9.4	5.7	450	1	2.2	0.32	1.9	0.030 pg/m³	0.54 ng/m³	0.001	0.008	0.001	0.002	0.009
Facility Traffic - Year 2030(3)	0.1	-	0.3	0.3	-	-	-	-	-	-	-	-	-	-	-	-
Cumulative Assessment	1.5	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)	0.001 pg/m³	-(4)	-(4)	-(4)	-(4)	-(4)	-(4)
Annual Background & Facility Traffic Concentration (Year 2030)	**10**	**3**	**10**	**6**	**500**	**1.0**	**2.2**	**0.32**	**1.9**	**0.031 pg/m³**	**0.54 ng/m³**	**0.001**	**0.008**	**0.001**	**0.002**	**0.009**

Note 1 Dioxins reported as non-detects as equal to the limit of detection.

Note 2 Assumed to consist solely of benzene as a worst-case.

Note 3 Derived using the TII REM screening model (see Appendix 8.3).

Note 4 No other significant source in the region.

8.5 Human Health – Proposed Operations

8.5.1 Nitrogen Dioxide Emissions and Results

8.5.1.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in **Appendix 8.6**.

8.5.1.2 Modelling of Nitrogen Dioxide

Nitrogen oxides (NO_X), containing both nitrogen oxide (NO) and nitrogen dioxide (NO_2) are emitted from the combustion process on-site, although it is the latter which is considered the more harmful to human health. These combustion processes lead to emissions which are mainly in the form of nitrogen oxide (NO) (typically 95%) with small amounts of the more harmful nitrogen dioxide.

Ambient Ground Level Concentrations (GLCs) of Nitrogen Dioxide have been predicted for the following scenarios in Table 8.33.

Table 8.33 Emission Scenario for Nitrogen Dioxide

Pollutant	Scenario	Concentration	Emission Rate (g/s)
NO_2	Maximum 1-Hr Operation	400 mg/m^3	23.4
	Maximum 24-Hr Operation	200 mg/m^3	11.7
	Abnormal Operation(1)	400 mg/m^3	23.4

Note 1 Abnormal operation scenario based on an emission level of 400 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month (12 days per annum)).

8.5.1.3 Concentration Contours

The geographical variation in NO_2 ground level concentrations beyond the facility boundary are illustrated as concentration contours in Figure 8.11, Figure 8.12 and Figure 8.13.

8.5.1.4 Result Findings

In relation to the maximum one-hour limit value, modelling results indicate that the ambient ground level concentrations are below these ambient standards for the protection of human health under maximum and abnormal operation of the facility as outlined in Table 8.34. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient NO_2 concentrations (including background concentrations) which are 20% of the maximum ambient 1-hour limit value (measured as a 99.97th%ile) at the worst-case receptor (to the south of the stack) and 49% of the maximum ambient 24-hour limit value (measured as a 95.1th%ile) at the worst-case receptor (to the south of the stack). The annual average NO_2 concentration (including background concentration) is also below the limit value for the protection of human health accounting for 52% of the annual limit value at the worst-case receptor which is located at the south-east boundary of the facility. The effect under abnormal operation is essentially unchanged compared to normal operation due to the infrequent nature of the occurrence (abnormal operation is assumed to occur for approximately 3% of the time in any one year).

The modelling results indicate that the maximum 1-hour and annual average NO_2 concentrations occur at or near the facility's southern and south-eastern boundaries. Concentrations fall off rapidly away from this maximum and for the maximum 1-hour concentration (as a 99.8th%ile) will be only 6% of the limit value (not including background concentrations) at the nearest sensitive receptor to the facility (see Table 8.35). The annual average NO_2 concentration decreases away from the facility with concentrations from emissions at the proposed facility accounting for only 1% of the limit value (not

including background concentrations) at worst case sensitive receptors near the facility. Thus, the results indicate that the potential effect from the proposed facility on human health and the environment is minor and limited to the immediate environs of the facility (i.e. close to the facility boundary).

In the surrounding areas of Cobh, Carrigaline and Monkstown, NO_2 levels associated with the proposed development are significantly lower than background concentrations, with the concentration from emissions at the proposed facility accounting for less than 1% of the NO_2 annual limit value for the protection of human health.

Table 8.34 Dispersion Model Results – Nitrogen Dioxide

Pollutant / Year	Averaging Period	Worst Case Receptor		PC (µg/m³)	Back-ground Conc. (µg/m³)	PEC (µg/m³)	Limit Values (µg/Nm³)	PEC as a % of Limit Value
		Type	X,Y (UTM Zone 29 N)					
NO_2 / Onsite Met Data 2007	Annual Mean	Boundary	548725, 5741950	0.43	10	10.4	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	547000, 5747250	20.9	20	40.9	200	20%
	24-hr Mean (as 95.1st%ile)	Grid	547650, 5741550	2.3	20	22.4	50	45%
NO_2 / 2020	Annual Mean	Boundary	548600, 5741500	0.4	10	10.4	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	547600, 5740900	13.1	20	33.1	200	17%
	24-hr Mean (as 95.1st%ile)	Grid	548575, 5741525	4.5	20	24.5	50	49%
NO_2 / 2021	Annual Mean	Sensitive	548600, 5741475	0.4	10	10.4	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	547200, 5742800	13.0	20	33.0	200	17%
	24-hr Mean (as 95.1st%ile)	Grid	548625, 5741425	3.4	20	23.4	50	47%
NO_2 / 2022	Annual Mean	Boundary	548600, 5741525	0.4	10	10.4	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	546900, 5743550	15.6	20	35.6	200	18%
	24-hr Mean (as 95.1st%ile)	Grid	548675, 5741400	3.7	20	23.7	50	47%
NO_2 / 2023	Annual Mean	Boundary	548575, 5741550	0.4	10	10.4	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	547350, 5742975	12.9	20	32.9	200	16%
	24-hr Mean (as 95.1st%ile)	Grid	547300, 5743075	4.2	20	24.2	50	48%
NO_2 / 2024	Annual Mean	Boundary	548575, 5741475	0.49	10	10.5	20	52%
	1-hr Mean (as 99.97th%ile)	Grid	548025, 5741425	14.6	20	34.6	200	17%
	24-hr Mean (as 95.1st%ile)	Grid	547350, 5743025	4.0	20	24.0	50	48%

Table 8.35 Dispersion Model Results – Nitrogen Dioxide Maximum Operation, Specific Receptors

Pollutant / Location	Averaging Period	Process Contribution (μg/m³)	Background Concentration (μg/m³)(1)	Predicted Emission Concentration (μg/Nm³)	Standard(2) (μg/Nm³)	Facility emissions as a % of ambient limit value
NO_2 Maximum / Worst-case Residential Receptor	Annual Mean	0.10	10	10.10	20	0.5%
	99.97th%ile of 1-hr means	12.18	20	32.18	200	6.1%
	95.1th%ile of 24-hr means	0.47	20	20.47	50	0.9%
NO_2 Maximum / Ringaskiddy School	Annual Mean	0.07	10	10.07	20	0.4%
	99.97th%ile of 1-hr means	9.05	20	29.05	200	4.5%
	95.1th%ile of 24-hr means	0.58	20	20.58	50	1.2%
NO_2 Maximum / Ringaskiddy Centre	Annual Mean	0.08	10	10.08	20	0.4%
	99.97th%ile of 1-hr means	8.24	20	28.24	200	4.1%
	95.1th%ile of 24-hr means	0.60	20	20.60	50	1.2%
NO_2 Maximum / Cobh	Annual Mean	0.17	10	10.17	20	0.8%
	99.97th%ile of 1-hr means	12.46	20	32.46	200	6.2%
	95.1th%ile of 24-hr means	0.81	20	20.81	50	1.6%
NO_2 Maximum / Carrigaline	Annual Mean	0.04	10	10.04	20	0.2%
	99.97th%ile of 1-hr means	6.16	20	26.16	200	3.1%
	95.1th%ile of 24-hr means	0.17	20	20.17	50	0.3%
NO_2 Maximum / Crosshaven	Annual Mean	0.20	10	10.20	20	1.0%
	99.97th%ile of 1-hr means	9.77	20	29.77	200	4.9%
	95.1th%ile of 24-hr means	0.90	20	20.90	50	1.8%

Note 1 Includes contribution from traffic and background sources (based on baseline monitoring results).

Note 2 Directive (EU) 2024/2881

Figure 8.11 Maximum Operations: Predicted NO_2 99.97th Percentile Concentration

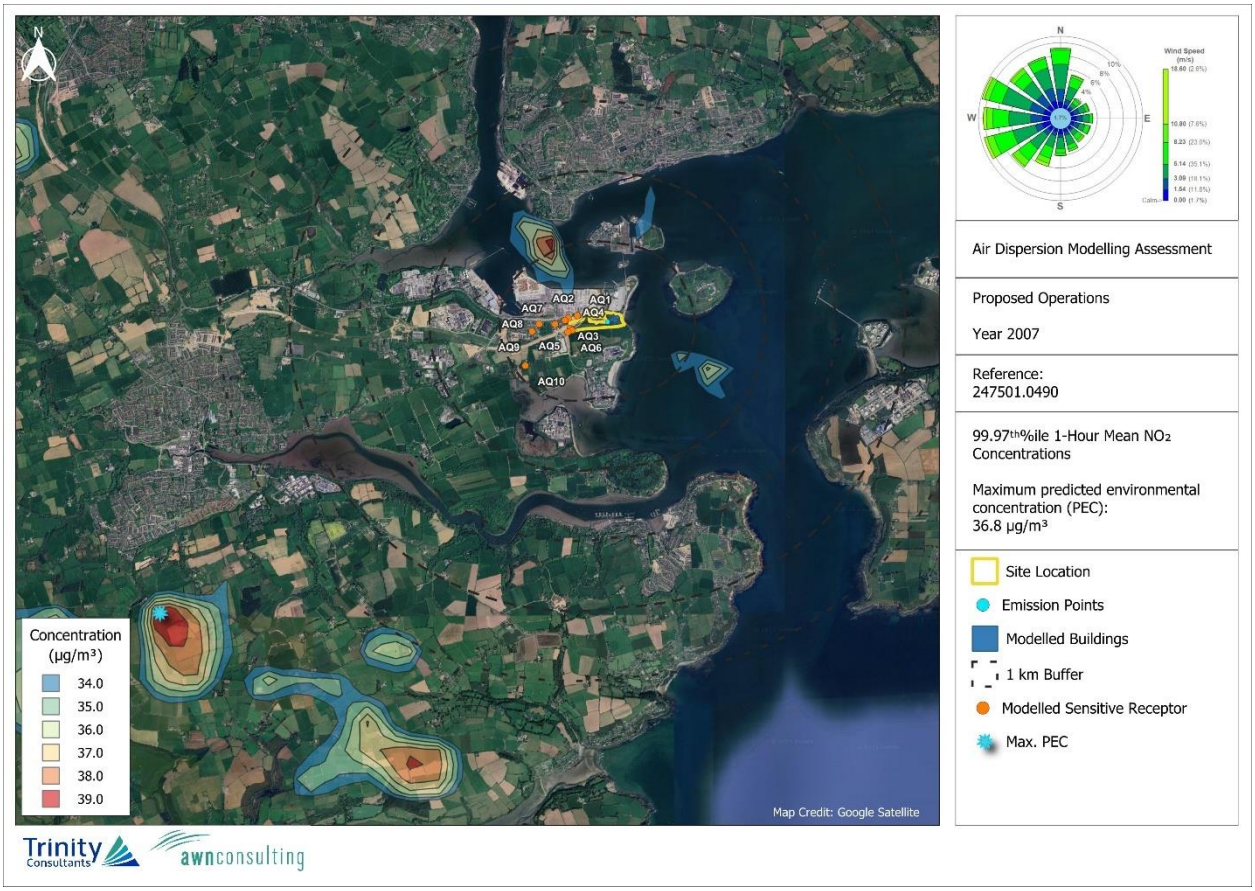


Figure 8.12 Maximum Operations: Predicted NO_2 Annual Average Concentration

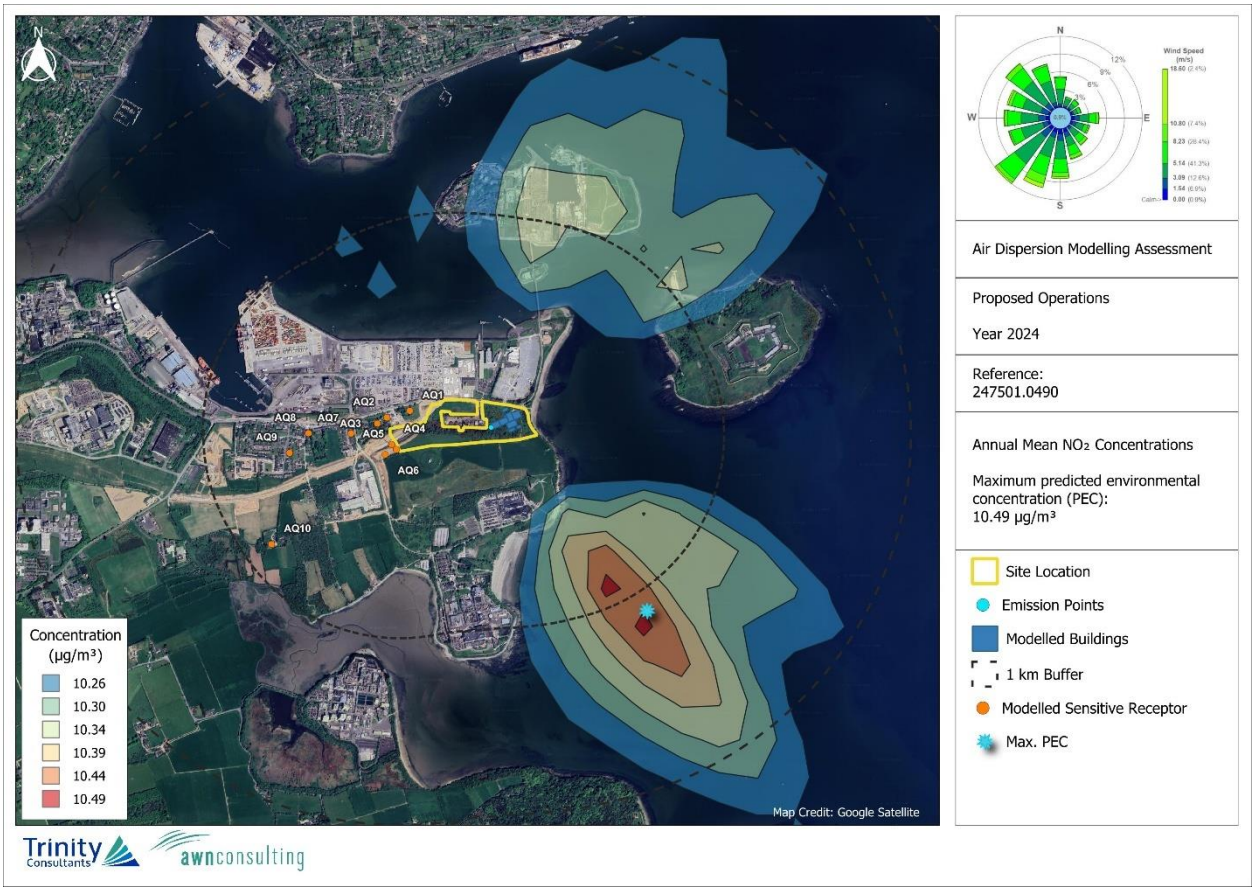
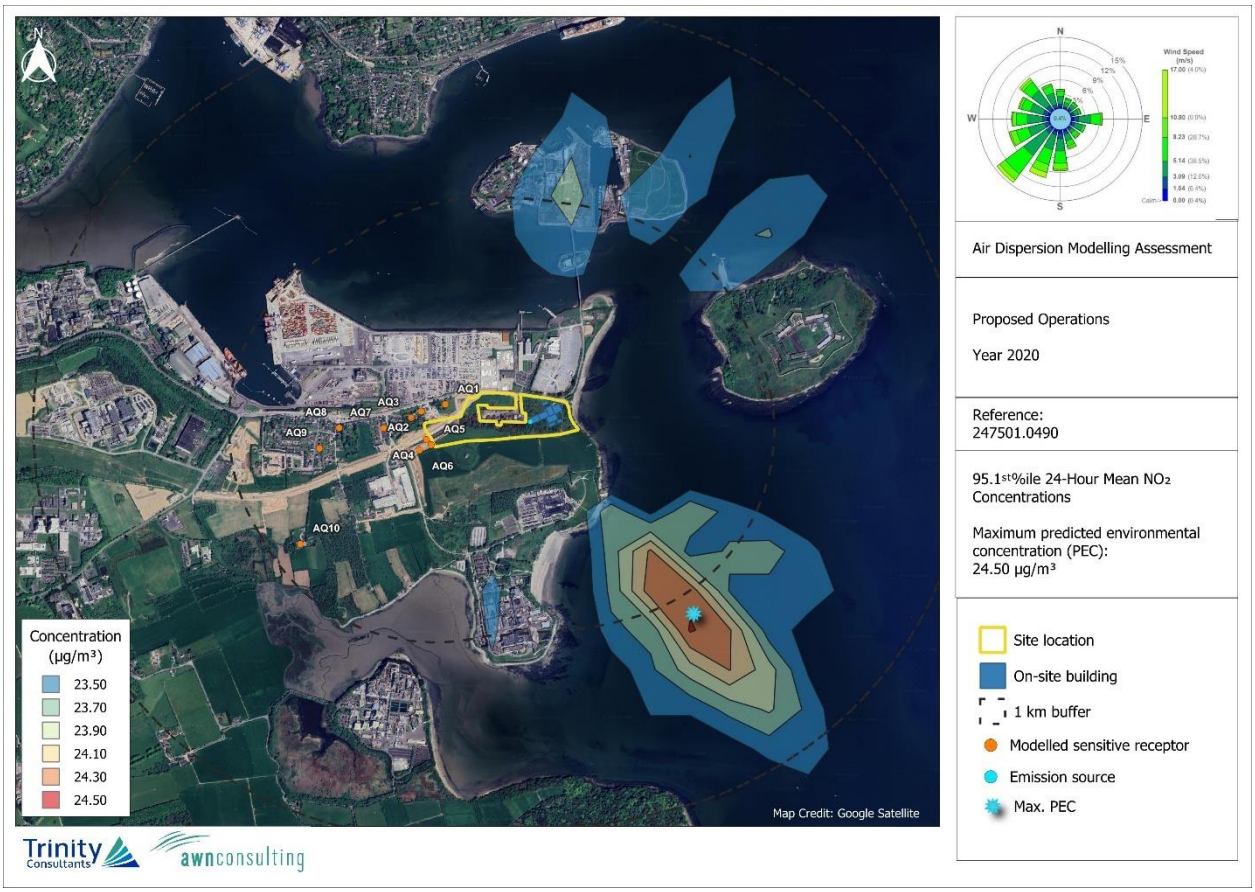


Figure 8.13 Maximum Operations: Predicted NO_2 95.1st Percentile Concentration



8.5.2 Sulphur Dioxide, Carbon Monoxide and Total Dust (as PM_{10} and $PM_{2.5}$) Emissions and Results

8.5.2.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in **Appendix 8.6**.

Ambient Ground Level Concentrations (GLCs) of Sulphur Dioxide (SO_2), Carbon Monoxide (CO) and Total Dust (as PM_{10} and $PM_{2.5}$) have been predicted for the following scenarios in Table 8.36.

Table 8.36 Emission Scenario for Sulphur Dioxide, Carbon Monoxide and Total Dust (as PM_{10} and $PM_{2.5}$)

Pollutant	Scenario	Concentration	Emission Rate (g/s)
SO_2	Maximum 1-Hr Operation	200 mg/m^3	11.72
	Maximum 24-Hr Operation	50 mg/m^3	2.93
	Abnormal 24-Hr Operation(1)	200 mg/m^3	11.72
CO	Maximum 1-Hr Operation	150 mg/m^3	8.79
	Maximum 24-Hr Operation	50 mg/m^3	2.93
	Abnormal 24-Hr Operation(2)	200 mg/m^3	11.72
Total Dust	Maximum 1-Hr Operation	30 mg/m^3	1.76
	Maximum 24-Hr Operation	10 mg/m^3	0.586
	Abnormal 24-Hr Operation(3)	30 mg/m^3	1.76

Note 1 Abnormal operation scenario based on an emission level of 200 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Note 2 Abnormal operation scenario based on an emission level of 200 mg/m^3 for 5% of the time (assumed to occur for one 36-hour period once per month).

Note 3 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

8.5.2.2 Modelling Results

Modelling was carried out for the three scenarios described in Section 8.5.2.1.

Table 8.37– Table 8.40 detail the predicted SO_2, CO, PM_{10} and $PM_{2.5}$ GLC for each scenario.

Table 8.37 Dispersion Model Results – Sulphur Dioxide

Pollutant / Scenario	Averaging Period	Process Contribution (µg/m^3)	Background (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard(1) (µg/Nm^3)	PEC as % of Standard
SO_2 / Maximum Operation	Annual Mean	0.41	3	3.41	20	17%
	99.97th%ile of 1-hr means	53.69	6	59.69	350	17%
	95.1th%ile of 24-hr means	2.08	6	8.08	50	17%
SO_2 / Abnormal Operation(2)	Annual Mean	0.45	3	3.45	20	16%
	99.97th%ile of 1-hr means	53.69	6	59.69	350	17%
	95.1th%ile of 24-hr means	2.30	6	8.30	50	17%

Note 1 Directive (EU) 2024/2881

Note 2 Abnormal operation scenario based on an emission level of 200 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.38 Dispersion Model Results – Carbon Monoxide

Pollutant / Scenario	Averaging Period	Process Contribution (mg/m^3)	Background (mg/m^3)(1)	Predicted Emission Concentration (mg/Nm^3)	Standard(2) (mg/Nm^3)	PEC as % of Standard
CO / Maximum	Rolling Eight Hour	28.7	1900	1929	1000	19%
CO / Maximum	24-hr Mean	6.3	700	706	4000	18%

Pollutant / Scenario	Averaging Period	Process Contribution (mg/m^3)	Background (mg/m^3)[1]	Predicted Emission Concentration (mg/Nm^3)	Standard[2] (mg/Nm^3)	PEC as % of Standard
CO / Abnormal Operation[3]	Rolling Eight Hour	28.7	1900	1929	1000	193%
CO / Abnormal Operation[3]	24-hr Mean	6.3	700	706	4000	18%

Note 1 Directive (EU) 2024/2881

Note 2 Abnormal operation scenario based on an emission level of 200 mg/m^3 for 5% of the time (assumed to occur for one 36-hour period once per month).

Table 8.39 Dispersion Model Results – Total Dust (referenced to PM_{10})

Pollutant / Scenario	Averaging Period	Process Contribution ($\mu g/m^3$)	Background ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)	PEC as % of Standard
PM_{10} / Maximum	Annual Mean	0.08	10	10.08	20	50%
	95.1th%ile of 24-hr means	0.42	21.9	22.4	45	50%
PM_{10} / Abnormal Operation[2]	Annual Mean	0.09	10	10.09	20	50%
	95.1th%ile of 24-hr means	0.42	21.9	22.4	45	50%

Note 1 Directive (EU) 2024/2881

Note 2 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.40 Dispersion Model Results – Total Dust (referenced to $PM_{2.5}$)

Pollutant / Scenario	Averaging Period	Process Contribution ($\mu g/m^3$)	Background ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[1] ($\mu g/Nm^3$)	PEC as % of Standard
$PM_{2.5}$ / Maximum	Annual Mean	0.08	6.0	6.08	20	30%
	95.1th%ile of 24-hr means	0.42	16.5	16.92	45	38%
$PM_{2.5}$ / Abnormal Operation[2]	Annual Mean	0.09	6.0	6.09	20	30%
	95.1th%ile of 24-hr means	0.42	16.5	16.92	45	38%

Note 1 Directive (EU) 2024/2881

Note 2 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

8.5.2.3 Concentration Contours

The geographical variation in SO_2, PM_{10} and $PM_{2.5}$ ground level concentrations beyond the Facility boundary are illustrated as concentration contours in Figure 8.14, Figure 8.15, Figure 8.16 and Figure 8.17.

Figure 8.14 Maximum Operations: Predicted SO_2 99.97th Percentile of Hourly Concentrations

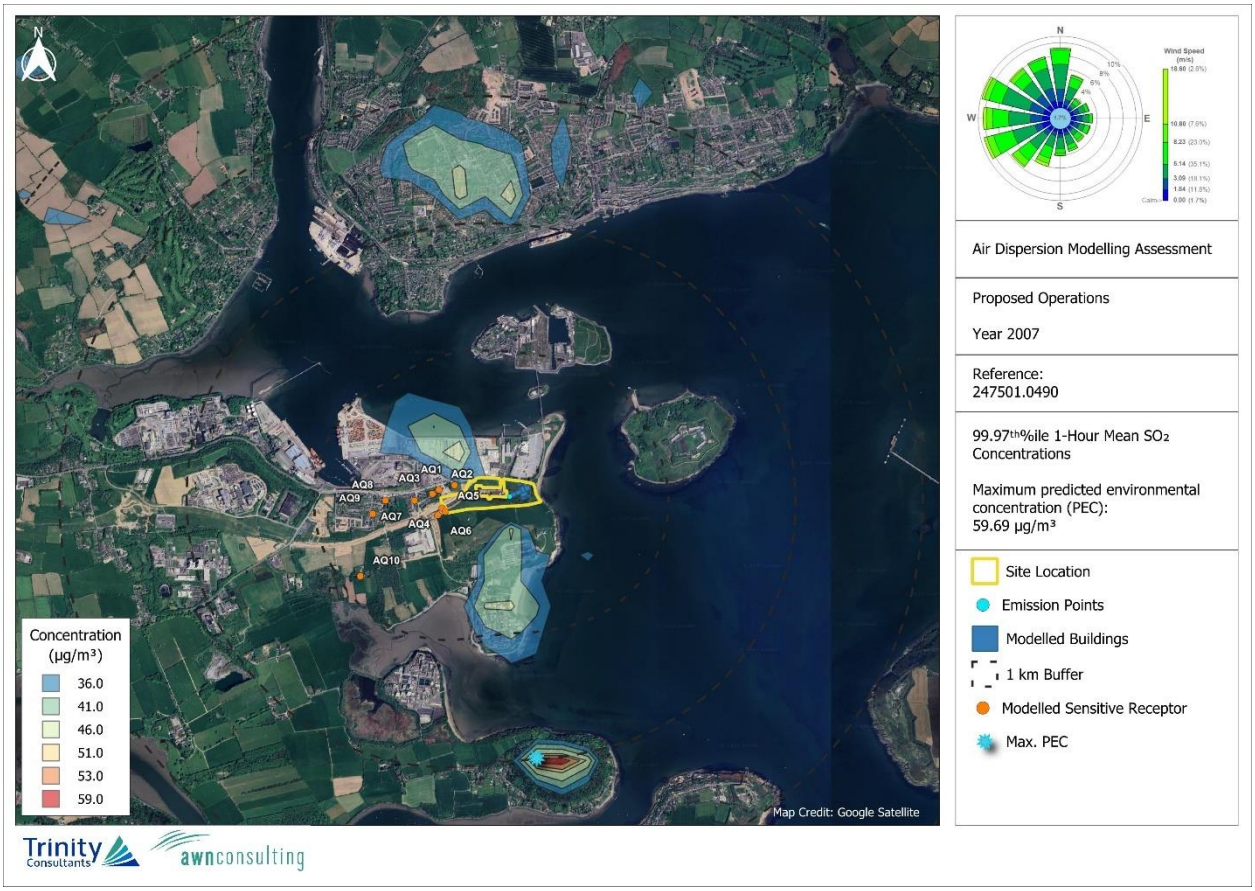


Figure 8.15 Maximum Operations: Predicted SO_2 95.1st Percentile of 24-Hourly Concentrations

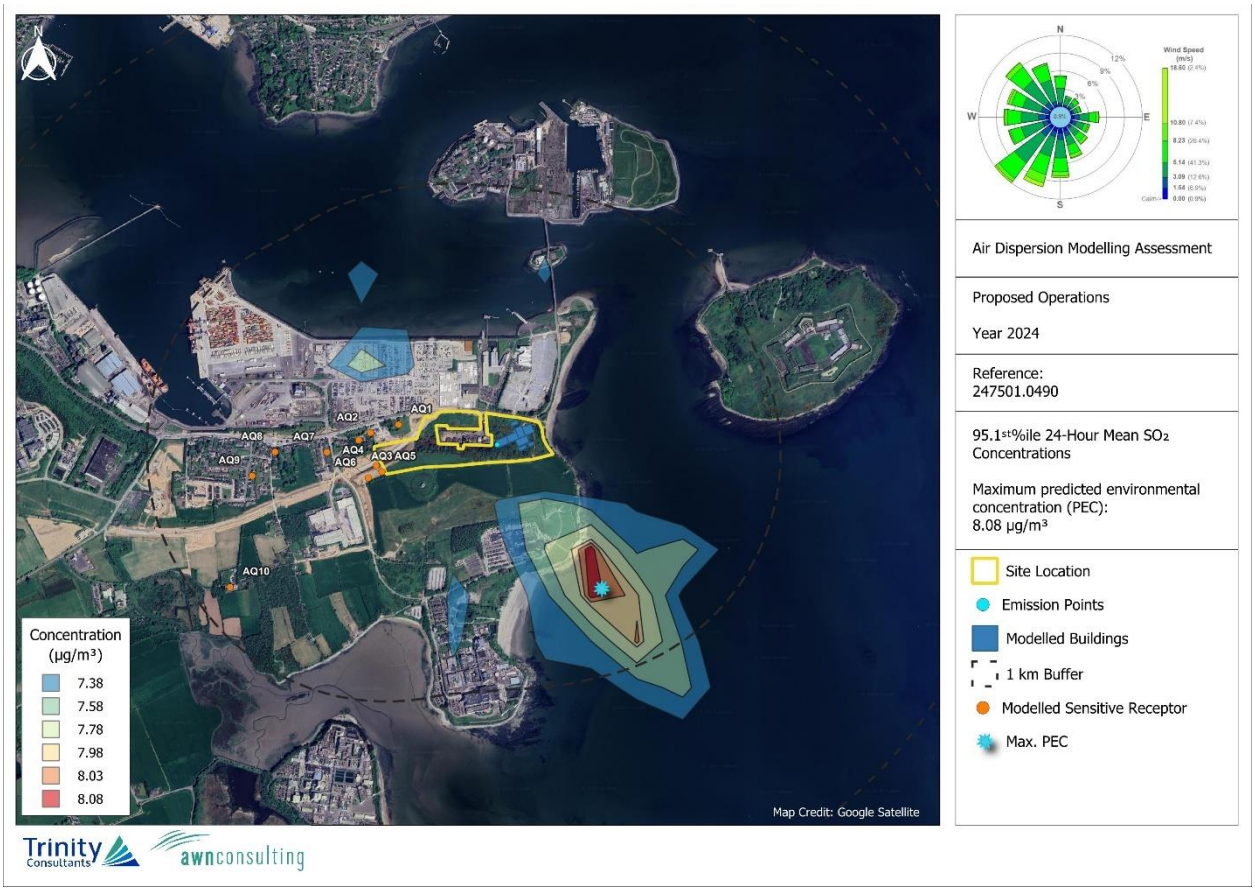


Figure 8.16 Maximum Operations: Predicted PM_{10} 95.1st Percentile of 24-Hourly Concentrations

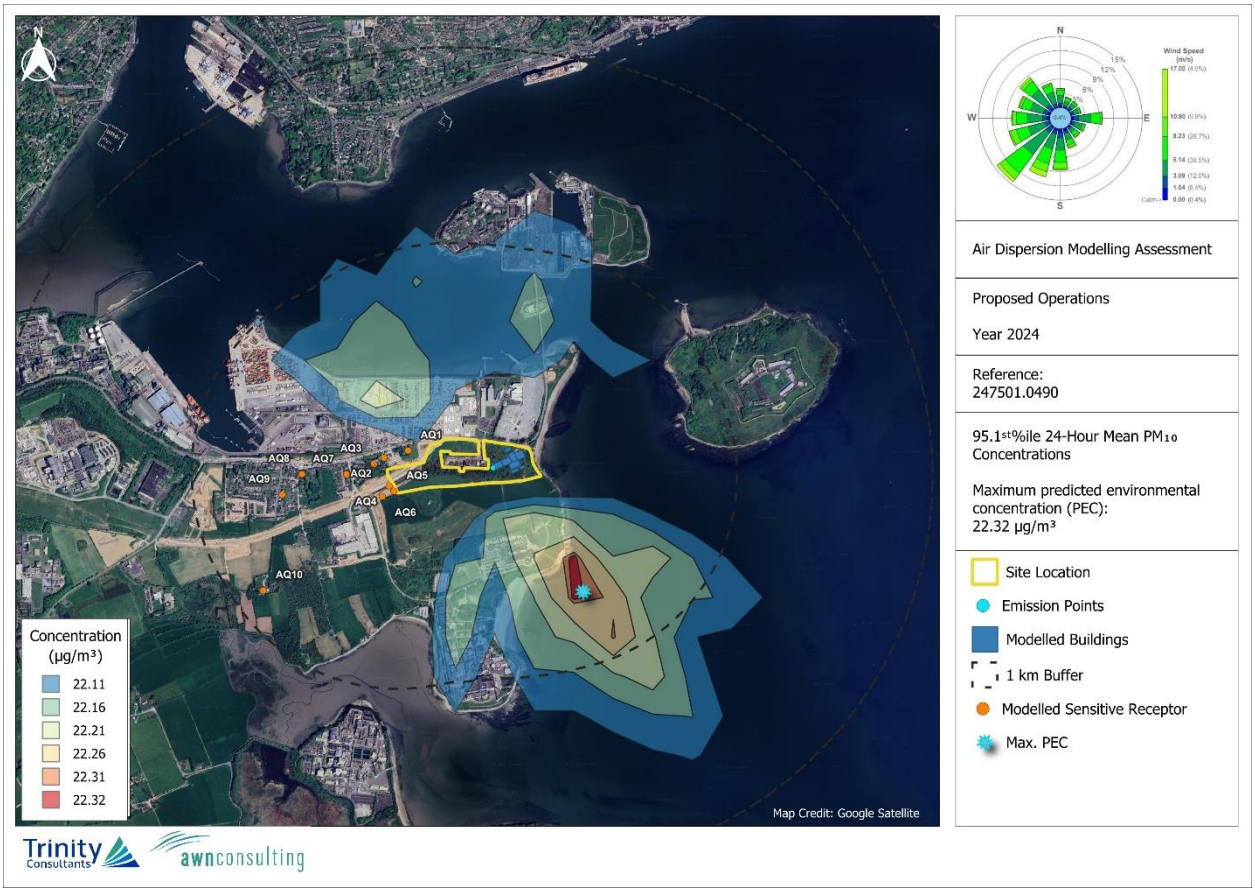
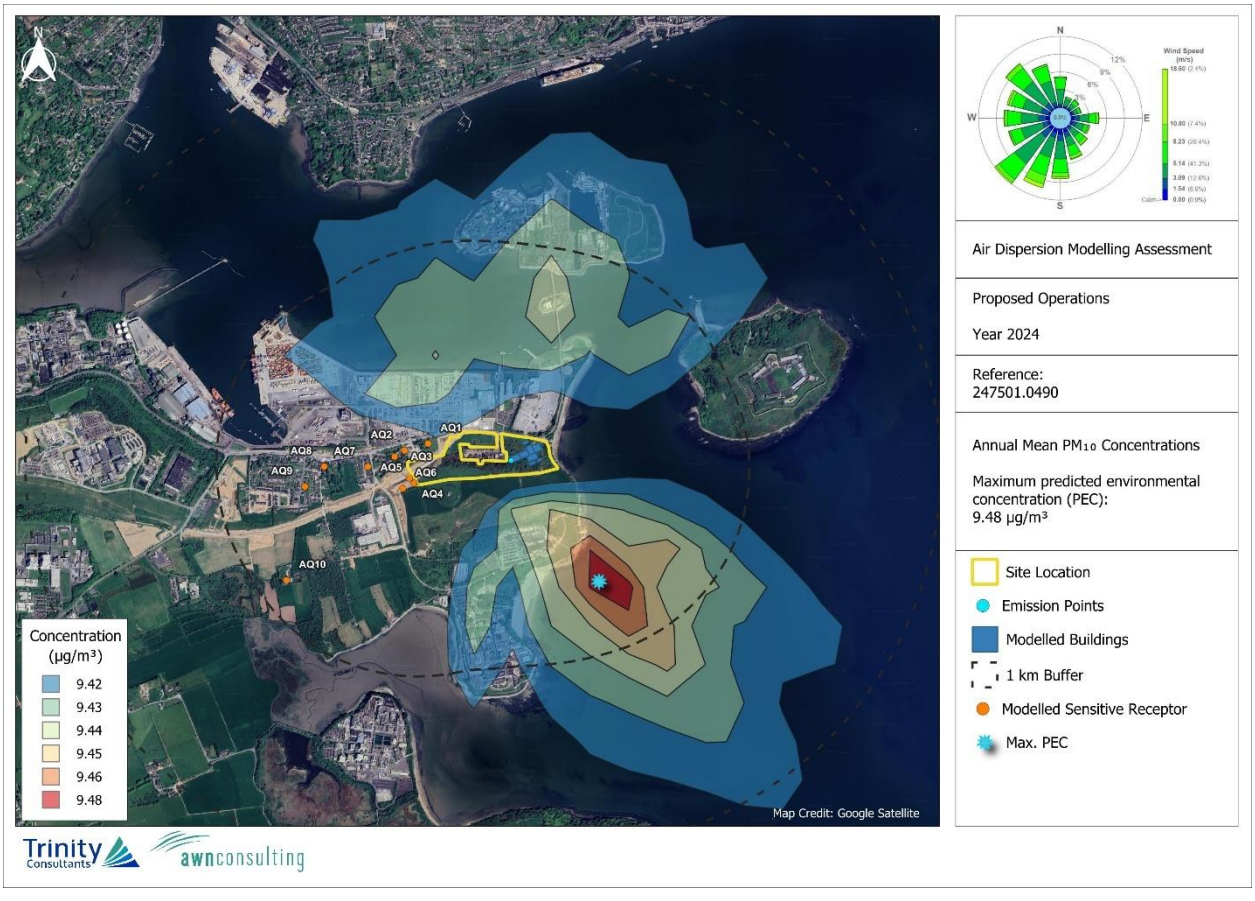


Figure 8.17 Maximum Operations: Predicted PM_{10} Annual Concentrations



8.5.2.4 Result Findings

8.5.2.4.1 SO_2

SO_2 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for sulphur dioxide under maximum and abnormal operation of the facility as shown in Table 8.37. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient SO_2 concentrations due to process emission which are 2% of the annual mean, 15% of the maximum ambient 1-hour limit value (measured as a 99.97th%ile) and 4% of the maximum ambient 24-hour limit value (measured as a 95.1th%ile) at the worst-case receptor. When background concentrations are included this rises to 17% of the annual mean, 17% of the maximum ambient 1-hour limit value (measured as a 99.7th%ile) and 16% of the maximum ambient 24-hour limit value (measured as a 99.2th%ile) at the worst-case receptor.

8.5.2.4.2 CO

CO modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for CO under maximum and abnormal operation of the facility as shown in Table 8.38. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient CO concentrations due to process emission which are less than 0.3% of the maximum rolling 8-hour limit value and less than 0.2% of the maximum 24-hour limit value at the worst-case receptor. When background concentrations are included this rises to 19 and 18% of the maximum rolling 8-hour and 24-hour limit value limit value at the worst-case receptor.

8.5.2.4.3 PM_{10}

PM_{10} modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for PM_{10} under maximum and abnormal operation of the facility as shown in Table 8.39. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient PM_{10} concentrations (including background concentrations) which are 50% of the maximum ambient 24-hour limit value (measured as a 95.1th%ile) with the contribution from the proposed facility equating to 0.9% of the limit value. Emissions at maximum operations equate to ambient PM_{10} concentrations which are 47% of the annual average limit value at the worst-case receptor with the contribution from the proposed facility equating to less than 0.4% of the limit value.

8.5.2.4.4 $PM_{2.5}$

$PM_{2.5}$ modelling results indicate that the ambient ground level concentrations are below the proposed air quality standard for the protection of human health for $PM_{2.5}$ under maximum and abnormal operation of the facility as shown in Table 8.40. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient $PM_{2.5}$ concentrations (including background concentrations) which are 68% of the maximum ambient 24-hour limit value (measured as a 95.1th%ile) with the contribution from the proposed facility equating to 1.7% of the limit value. Emissions at maximum operations equate to ambient $PM_{2.5}$ concentrations which are 58% of the annual average limit value at the worst-case receptor with the contribution from the proposed facility equating to less than 0.8% of the limit value.

8.5.3 Total Organic Carbon (TOC), Hydrogen Chloride and Hydrogen Fluoride Emissions and Results

8.5.3.1 Source Information

Source information including emission release heights, volume flows, locations and stack diameters has been summarised in **Appendix 8.6**.

Ambient Ground Level Concentrations (GLCs) of Total Organic Carbon (TOC), Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF) have been predicted for the following scenarios in Table 8.41.

Table 8.41 Emission Scenario for TOC, HCl and HF

Pollutant	Scenario	Concentration	Emission Rate (g/s)
TOC	Maximum 1-Hr Operation	30 mg/m^3	1.17
	Maximum 24-Hr Operation	10 mg/m^3	0.586
	Abnormal Operation(1)	30 mg/m^3	1.17
HCl	Maximum 1-Hr Operation	60 mg/m^3	3.52
	Maximum 24-Hr Operation	10 mg/m^3	0.586
	Abnormal Operation(2)	60 mg/m^3	3.52
HF	Maximum 1-Hr Operation	4 mg/m^3	0.234
	Maximum 24-Hr Operation	1 mg/m^3	0.059
	Abnormal Operation(3)	4 mg/m^3	0.234
NH_3	Maximum Operations	15 mg/m^3	0.879

Note 1 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Note 2 Abnormal operation scenario based on an emission level of 60 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Note 3 Abnormal operation scenario based on an emission level of 4 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

8.5.3.2 Comparison with Standards and Guidelines

The organic compound emissions from the facility will consist of a range of aliphatic and aromatic compounds at low concentration. The toxicity of these compounds will vary by several orders of magnitude. Ambient benzene levels have been regulated by the EU (Directive (EU) 2024/2881) due to the higher toxicity of this compound compared to other common hydrocarbons (see Table A8.34). In this assessment, it has been assumed that all emissions from the facility are composed of benzene. This is a very pessimistic assumption and thus will significantly overestimate the effect of TOC emissions from the facility.

In the absence of specific Irish air quality guidelines, air quality guidelines for the protection of humans, which have been set by the UK DEFRA (Expert Panel on Air Quality Standards (2008)), have been used in the assessment. Ambient air quality standards for HCl, HF and NH_3 are based on the UK DEFRA environmental assessment levels (EALs) (see Table 8.42).

Table 8.42 Air Standards for TOC, HCl, HF and NH3

Pollutant	Regulation	Limit Type	Value
TOC (assumed to be benzene)	Directive (EU) 2024/2881	Annual Average	3.4 μg/m^3
HCl	UK DEFRA EAL	Maximum 1-Hour	800 μg/m^3
HCl	UK DEFRA EAL	Annual Average	20 μg/m^3
HF	UK DEFRA EAL	Maximum 1-Hour	160 μg/m^3
HF	UK DEFRA EAL	Annual Average	16 μg/m^3

NH_3	UK DEFRA EAL	Maximum 1-Hour	2500 μg/m^3
NH_3	UK DEFRA EAL	Annual Average	180 μg/m^3

8.5.3.3 Modelling Results

Modelling was carried out for the three scenarios described in Section 8.5.3.1 for each pollutant. Table 8.43 – Table 8.45 details the predicted TOC, HCl, HF and NH_3 GLC for each scenario.

Table 8.43 Dispersion Model Results – TOC (assumed to be benzene)

Pollutant / Scenario	Averaging Period	Process Contribution (μg/m^3)	Background (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard[1] (μg/Nm^3)
TOC / Maximum	Annual Average	0.08	1	1.1	3.4
TOC / Abnormal Operation[2]	Annual Average	0.08	1	1.1	3.4

Note 1 Directive (EU) 2024/2881

Note 2 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.44 Dispersion Model Results – HCl

Pollutant / Scenario	Averaging Period	Process Contribution (μg/m^3)	Background (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard[1] (μg/Nm^3)
HCl / Maximum	Maximum 1-hour	17.3	4.4	21.7	800
HCl / Maximum	Annual	0.08	2.2	2.08	20
HCl / Abnormal Operation[2]	Maximum 1-hour	17.3	4.4	21.7	800
HCl / Abnormal Operation[2]	Annual	0.10	2.2	2.30	20

Note 1 UK DEFRA EAL

Note 2 Abnormal operation scenario based on an emission level of 60 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.45 Dispersion Model Results – HF

Pollutant / Scenario	Averaging Period	Process Contribution (μg/m^3)	Annual Mean Background (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard (μg/Nm^3) [1]
HF / Maximum	Maximum 1-hr	1.15	0.64	1.79	160
	Annual Average	0.008	0.32	0.33	16
HF / Abnormal Operation[2]	Maximum 1-hr	1.15	0.64	1.79	160
	Annual Average	0.009	0.32	0.33	16

Note 1 UK DEFRA

Note 2 Abnormal operation scenario based on an emission level of 4 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.46 Dispersion Model Results – NH_3

Pollutant / Scenario	Averaging Period	Process Contribution ($\mu g/m^3$)	Background ($\mu g/m^3$)	Predicted Emission Concentration ($\mu g/Nm^3$)	Standard[(1)] ($\mu g/Nm^3$)
NH_3 / Maximum	Maximum 1-hr	4.3	3.8	8.1	2500
	Annual Average	0.12	1.9	2.02	180

Note 1 UK DEFRA

8.5.3.4 Concentration Contours

The geographical variation in TOC (as benzene), HCl, HF and NH_3 ground level concentrations beyond the facility boundary is illustrated as concentration contours in Figure 8.18 to Figure 8.22.

Figure 8.18 Maximum Operations: Predicted TOC (as benzene) Annual Average Concentration

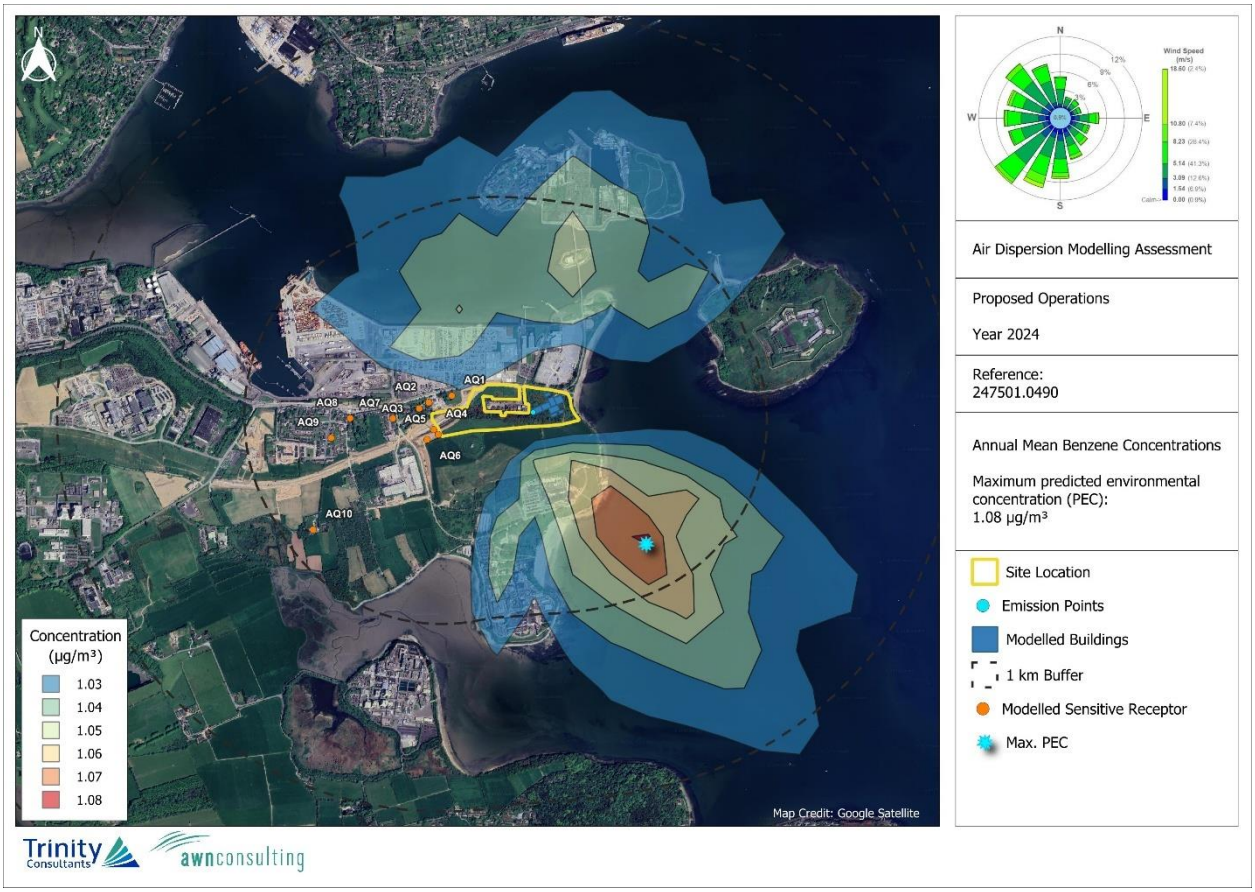


Figure 8.19 Maximum Operations: Predicted HCl Maximum 1-Hour Concentration

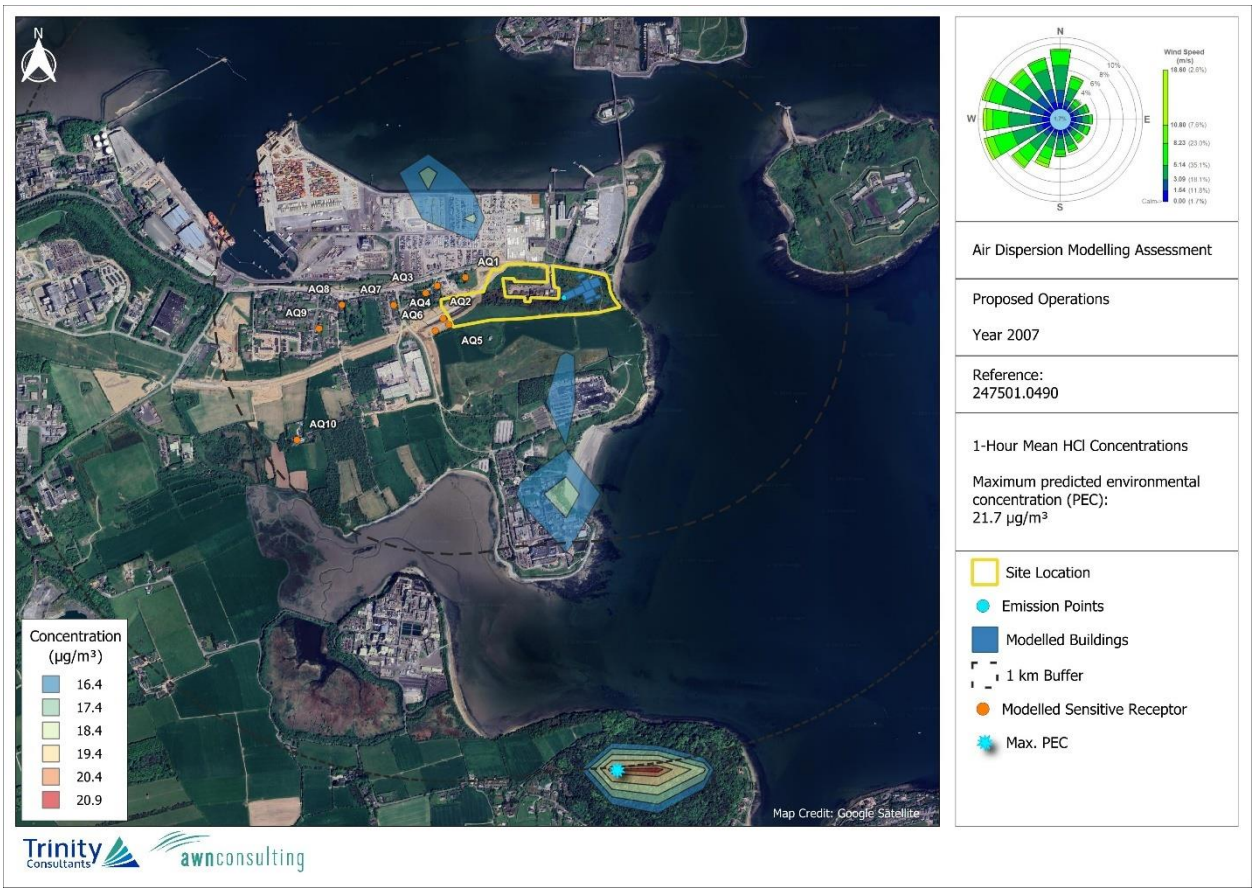


Figure 8.20 Maximum Operations: Predicted HCl Annual Mean Concentration

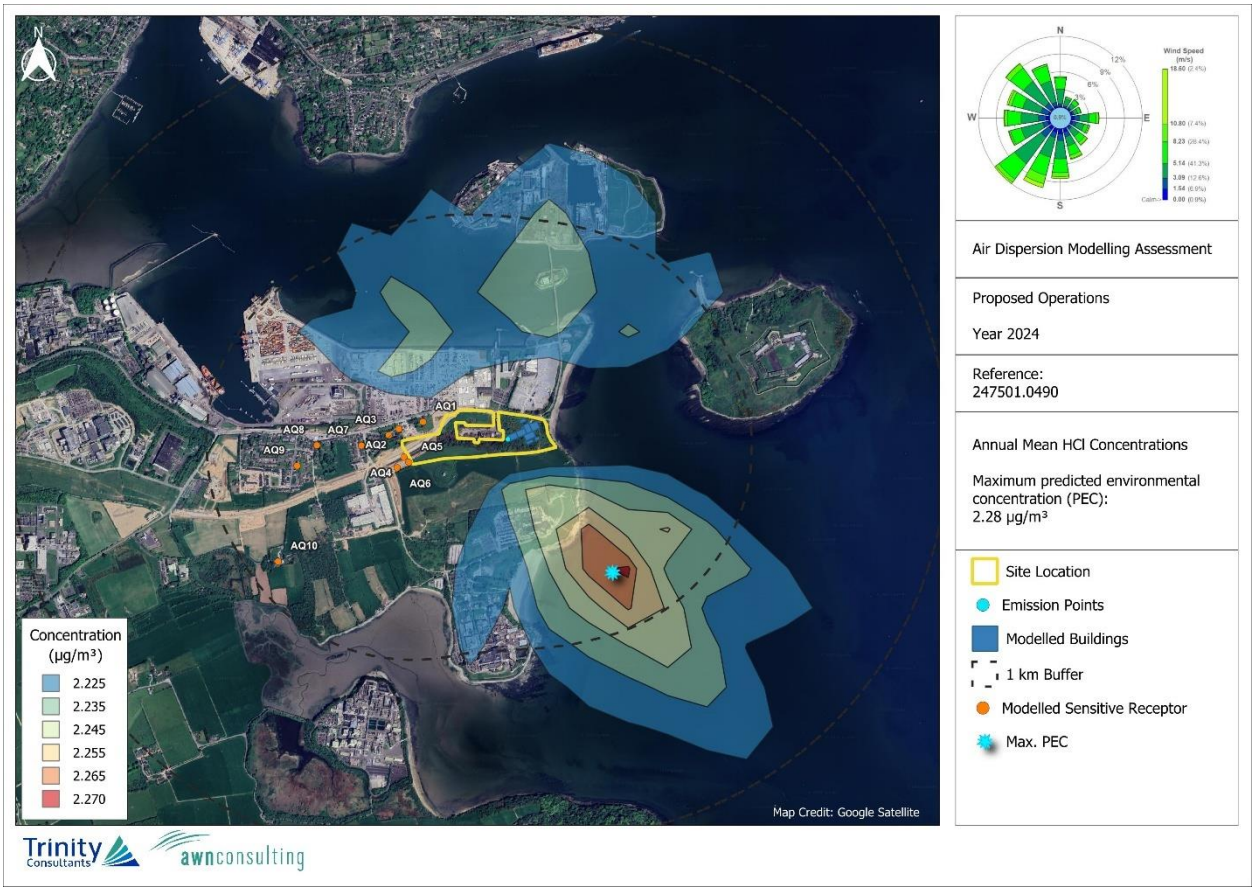


Figure 8.21 Maximum Operations: Predicted Maximum 1-Hr HF Concentration

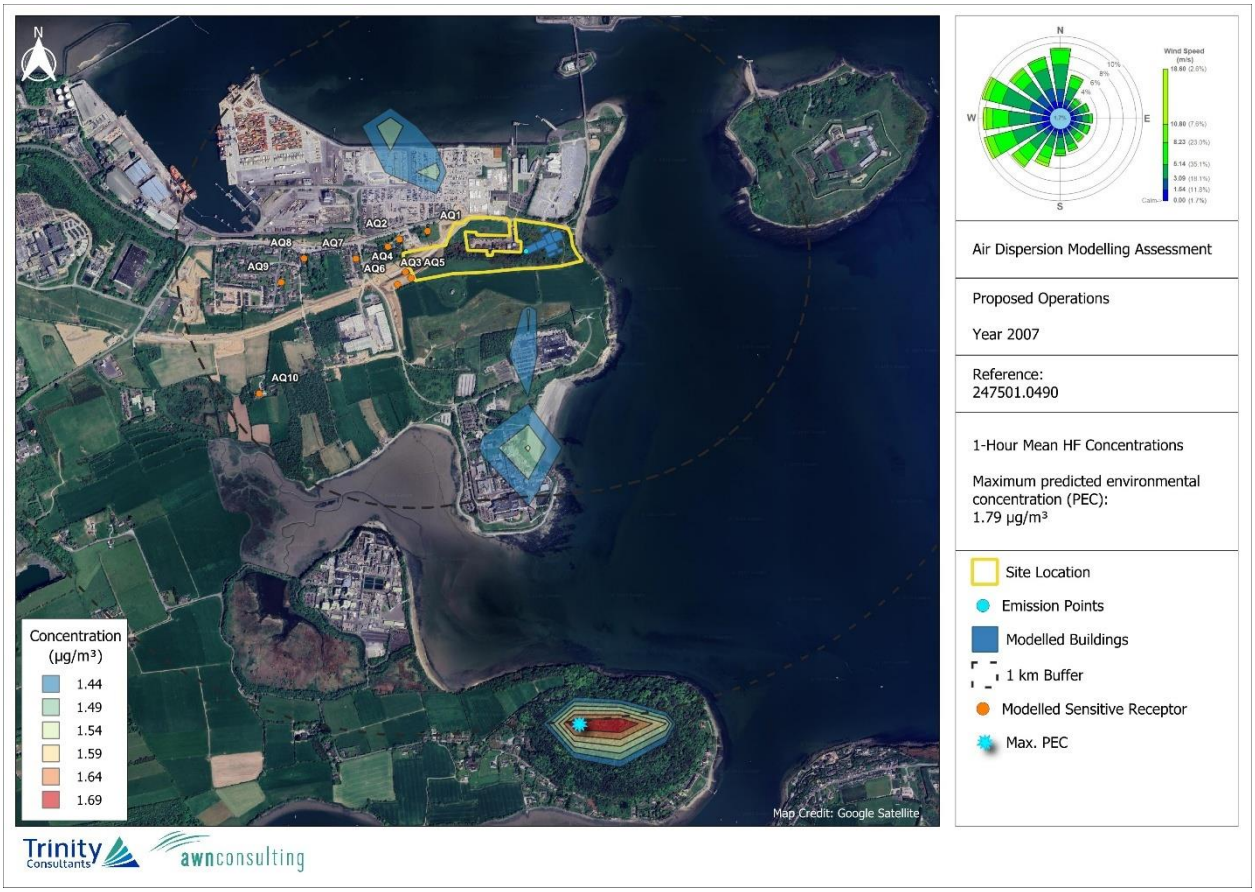


Figure 8.22 Maximum Operations: Predicted HF Annual Average Concentration

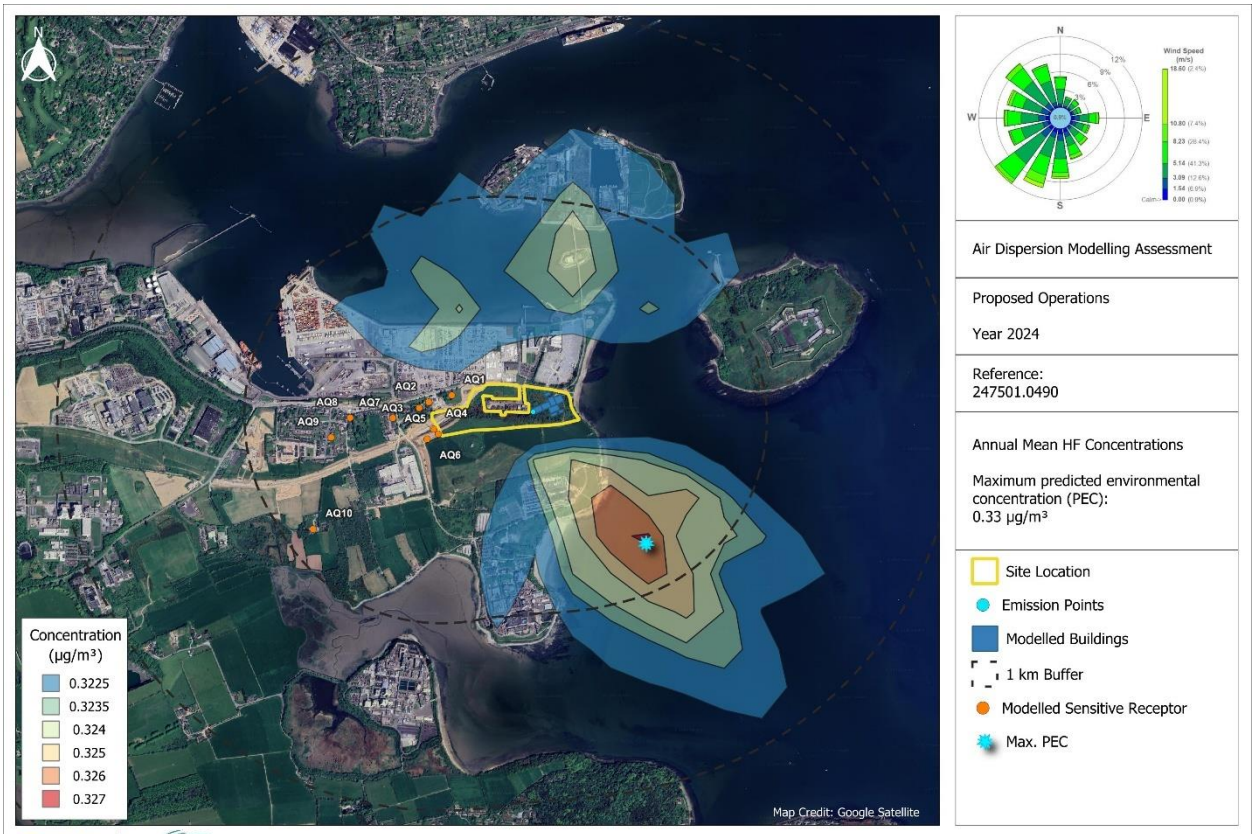


Figure 8.23 Maximum Operations: Predicted Maximum 1-Hr NH_3 Concentration

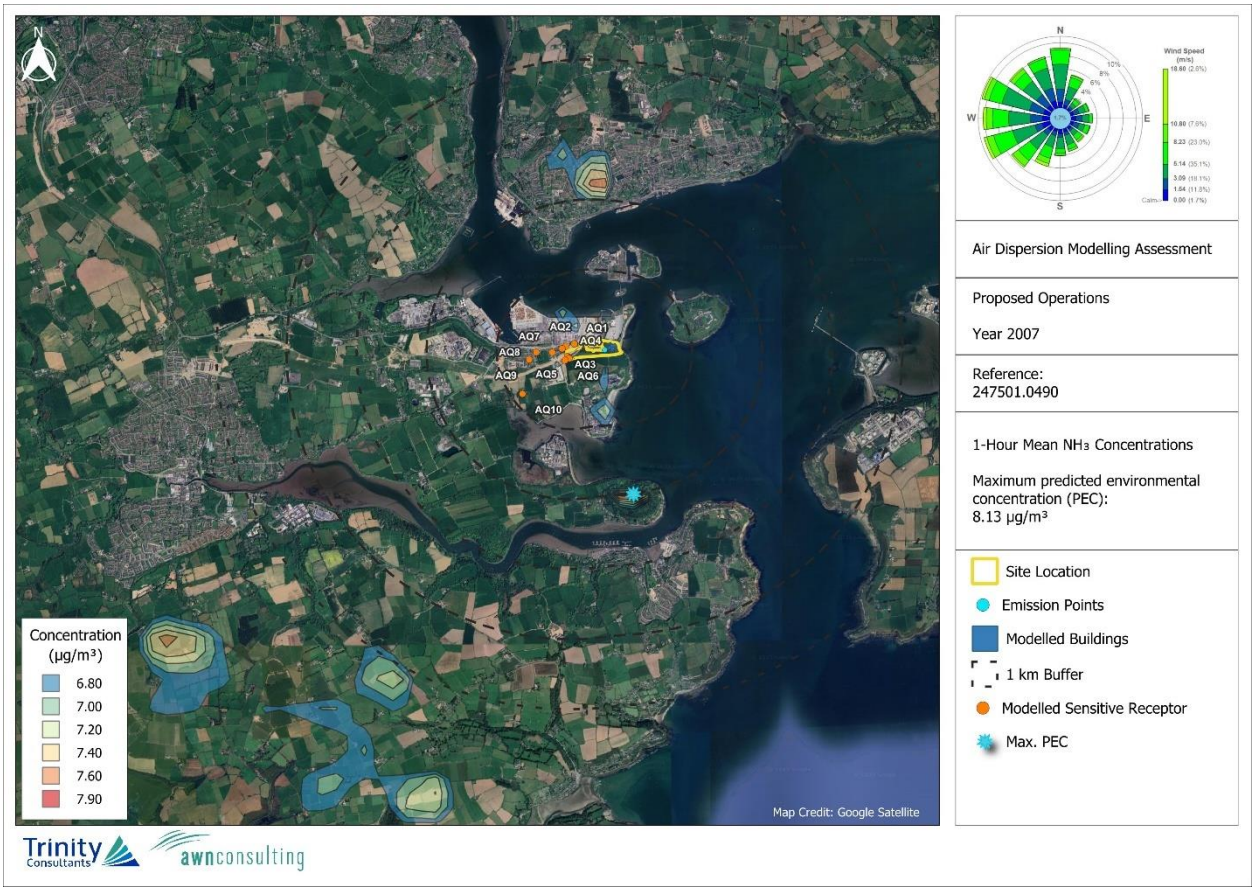
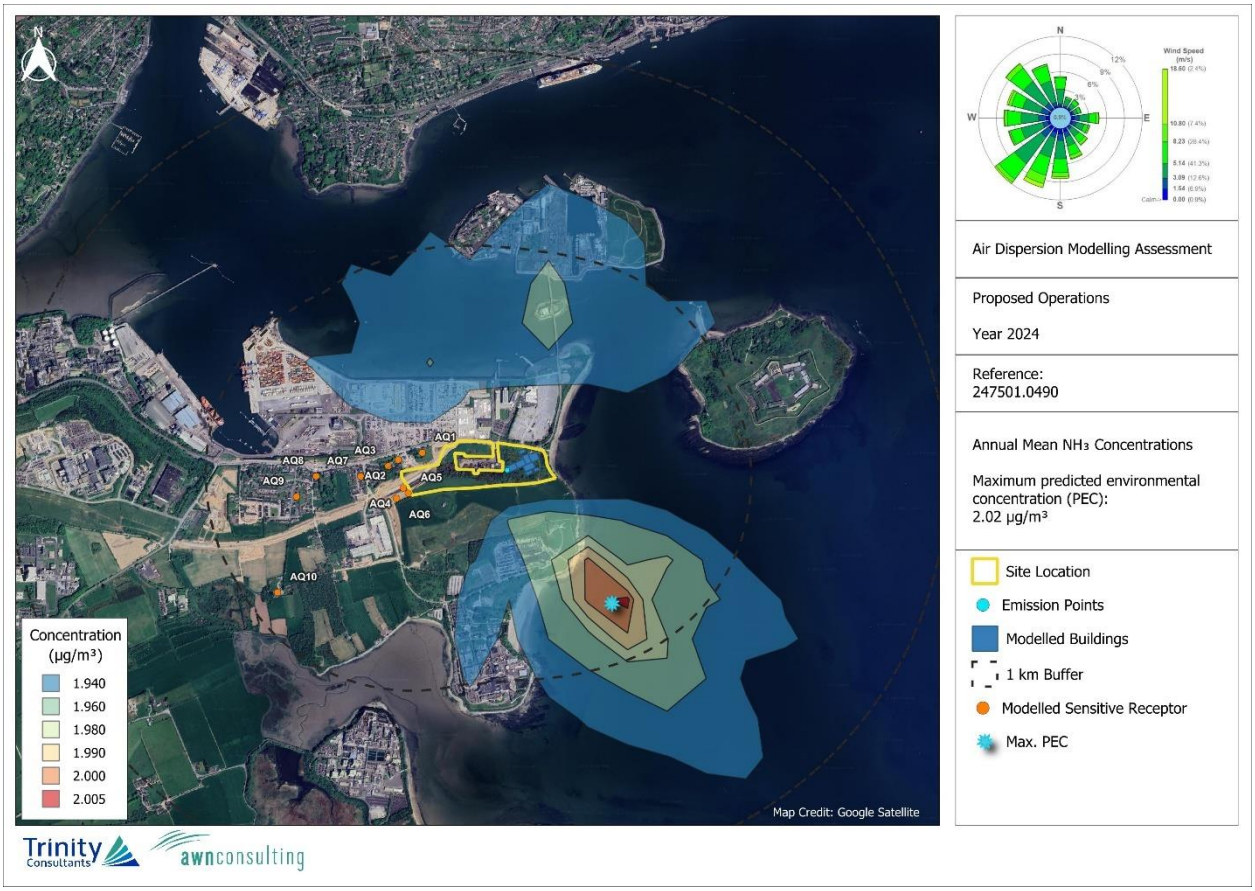


Figure 8.24 Maximum Operations: Predicted NH_3 Annual Average Concentration



8.5.3.5 Result Findings

8.5.3.5.1 TOC

TOC modelling results indicate that the ambient ground level concentrations are below the relevant air quality standard for the protection of human health for benzene under maximum and abnormal operation of the facility as shown in Table 8.43. Thus, no adverse effect on public health or the environment is predicted to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to a maximum ambient TOC concentration (including background concentration) which is 32% of the benzene annual limit value.

8.5.3.5.2 HCl

HCl modelling results indicate that the ambient ground level concentrations are below the relevant air quality guideline for the protection of human health for HCl under maximum and abnormal operation of the facility as shown in Table 8.44. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient HCl concentrations (including background concentrations) which are 2.7% of the maximum ambient 1-hour limit value and 11% of the annual mean limit value.

8.5.3.5.3 HF

HF modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards and guidelines for HF for the protection of human health under maximum and abnormal operation of the facility as shown in Table 8.45. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which are 1.1% of the maximum ambient 1-hour limit value and 2.1% of the annual limit value.

8.5.3.5.4 NH_3

NH_3 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards and guidelines for NH_3 for the protection of human health under maximum and abnormal operation of the facility as shown in Table 8.46. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient NH_3 concentrations (including background concentrations) which are 0.33% of the maximum ambient 1-hour limit value and 1.1% of the annual limit value.

8.5.4 Dioxin-Like Compounds

8.5.4.1 Description of Dioxin-Like Compounds

The term "Dioxin-like Compounds" generally refers to three classes of compounds; polychlorinated dibenzo-p-dioxins (PCDDs or CDDs), polychlorinated dibenzofurans (PCDFs or CDFs), and polychlorinated biphenyls (PCBs). PCDDs include 75 individual compounds, or congeners, PCDFs include 135 congeners and PCBs include 209 congeners (see Table 8.47). Both PCDDs and PCDFs are usually formed as unintentional by-products through a variety of chemical reactions and combustion processes. These compounds are lipophilic, and bind to sediment and organic matter in the environment and tend to be absorbed in animal and human fatty tissue. They are also generally extremely resistant towards chemical and biological degradation processes, and, consequently, persist in the environment and accumulate in the food chain[14].

The toxic effects of dioxins are initiated at the cellular level, by the binding of the dioxin to a specific protein in the cytoplasm of the body cells, the aryl hydrocarbon receptor (AhR). The binding of TCDD to the AhR constitutes a first and necessary step to initiate the toxic and biochemical effects of this compound. Dioxins effects in humans include increased prevalence of diabetes, immunotoxic effects and effects on neurodevelopment and neurobehaviour in children. Studies have shown TCDD to be carcinogenic but a lack of direct DNA-damaging effects indicates that TCDD is not an initiator but a promoter of carcinogenesis[15].

130 of the 209 PCB congeners have historically been manufactured for a variety of uses including dielectric fluids in transformers and capacitors and as lubricants and adhesives. However, the marketing, use and disposal of PCBs has been severely restricted in the EU through Directives 85/467/EC and 96/59/EC[14].

The toxicity of dioxins varies widely with 2, 3, 7, 8-TCDD being the most potent dioxin congener and with only particular configurations of these compounds thought to have dioxin-like toxicity (See Table 8.48). For PCDDs (Dioxins), only 7 of the 75 congeners have dioxin-like toxicity; these are the ones with chlorine substitutions in, at least, the 2, 3, 7 and 8 positions. For PCDFs (Furans), only 10 of the 135 congeners have dioxin-like toxicity; these are again the ones with chlorine substitutions in, at least, the 2, 3, 7 and 8 positions. In relation to PCBs, only 13 of the 209 congeners are likely to have dioxin-like toxicity; these are the PCBs with four or more chlorines with just one or no substitutions in the ortho position (coplanar)[14,15].

As dioxin-like compounds have varying degrees of toxicity, a toxicity equivalency procedure has been developed to describe the cumulative toxicity of these mixtures. The procedure involved assigning individual Toxicity Equivalency Factors (TEFs) to the 2, 3, 7, 8- substituted PCDD and PCDF congeners and to selected coplanar and mono-ortho PCBs. The TEFs are referenced to 2, 3, 7, 8-TCDD, which is assigned a TEF of 1.0. Calculation of the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Since 1989, three different TEF schemes have been developed[16,17]:

I-TEQ$_{DF}$ – Developed by NATO/CCMS in 1988, the I-TEQ$_{DF}$ (DF = dioxin, furan, I = International) procedure assigns TEFs only for the 7 dioxins (PCDDs) and 10 furans (PCDFs). This scheme does not include dioxin-like PCBs. This scheme has been adopted in Council Directive 2010/75/EU and has been applied in the current assessment.

TEQ$_{DFP}$-WHO$_{94}$ – In 1994, the WHO added 13-dioxin-like PCBs to the TEF scheme for dioxins and furans. However, no changes were made to the TEFs for dioxins and furans I-TEQ$_{DF}$ (DFP = dioxin, furan, PCBs).

TEQ$_{DFP}$-WHO$_{98}$ – In 1998, the WHO re-evaluated the TEF scheme for dioxins, furans and dioxin-like PCBs. Changes were made to the TEFs for dioxins, furans and dioxin-like PCBs. Table 8.48 outlines the TEF for the most recent scheme for comparison with the scheme recommended in Council Directive 200/76/EC (I-TEQ$_{DF}$).

8.5.4.2 Modelling Strategy

The emissions of dioxin-like compounds from the facility have been evaluated in this chapter. Firstly, the stack emissions have been characterised in terms of mass of each Dioxin/Furan congener released, and the partitioning of these releases into a vapour and particle phase. Thereafter, air dispersion modelling has been used to translate these releases to ambient air vapour and particle phase concentrations, and wet and dry particulate deposition fluxes, in the vicinity of the release.

As recommended by the USEPA, individual dioxin congeners have been modelled from source to receptor. Only at the interface to human exposure, e.g., ingestion, inhalation, dermal absorption, etc., are the individual congeners recombined and converted into the toxic equivalence of 2, 3, 7, 8-TCDD to be factored into a quantitative risk assessment.

8.5.4.2.1 Emission Rate

The dioxin emission factor is defined as the total mass (in vapour and particulate form) of dioxin-like compound emitted per mass of feed material combusted. For the current proposal, a test burn is not possible as the Ringaskiddy Resource Recovery Centre has not been commissioned yet. However, Indaver has several flue gas cleaning systems similar to that proposed in the current facility, in operation in Europe. An analysis of these flue gas cleaning systems has suggested that the likely emission rate will outperform the most stringent limit value set by the EU in the Council Directive on Industrial Emissions (2010/75/EU).

Congener-specific emission data are needed for the analyses of the ambient air effects and deposition flux of dioxin-like compounds using air dispersion and deposition models. As each specific congener has different physico-chemical properties, the proportion of each congener will affect the final result. Thus, the congener profile expected from the current facility must be derived. The congener profile will be dependent on various factors including the type of waste being burnt, the temperature of combustion, the type of combustion chamber being operated and the air pollution control devices (APCDs) installed. In the present case, no site-specific stack testing for specific congeners is possible as the facility is not yet built.

Shown in Table 8.49 are typical relative PCDD/PCDF congener emission factors for municipal waste incinerators (MWI) as reported by the USEPA (1998)[18] for a municipal waste incinerator similar to that proposed in the current scheme, a mass burn refractometry system with wet scrubbing (MB-REF WS) (Indaver however differs in that semi-dry scrubbing is proposed rather than wet scrubbing) taken from the Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (USEPA, 1998 (CD-ROM))[18]. It would be expected that the relative congener profiles for this type of incinerator to be somewhat similar to the current case. Figure 8.25 and Figure 8.26 show the ratio of congeners and the TEQ equivalent releases from this type of facility corrected to the maximum emission limit outlined in Council Directive 2010/75/EU..

Figure 8.25 Default Municipal Waste Incinerator Congener Profile Corrected To 0.1 ng/m³ TEQ

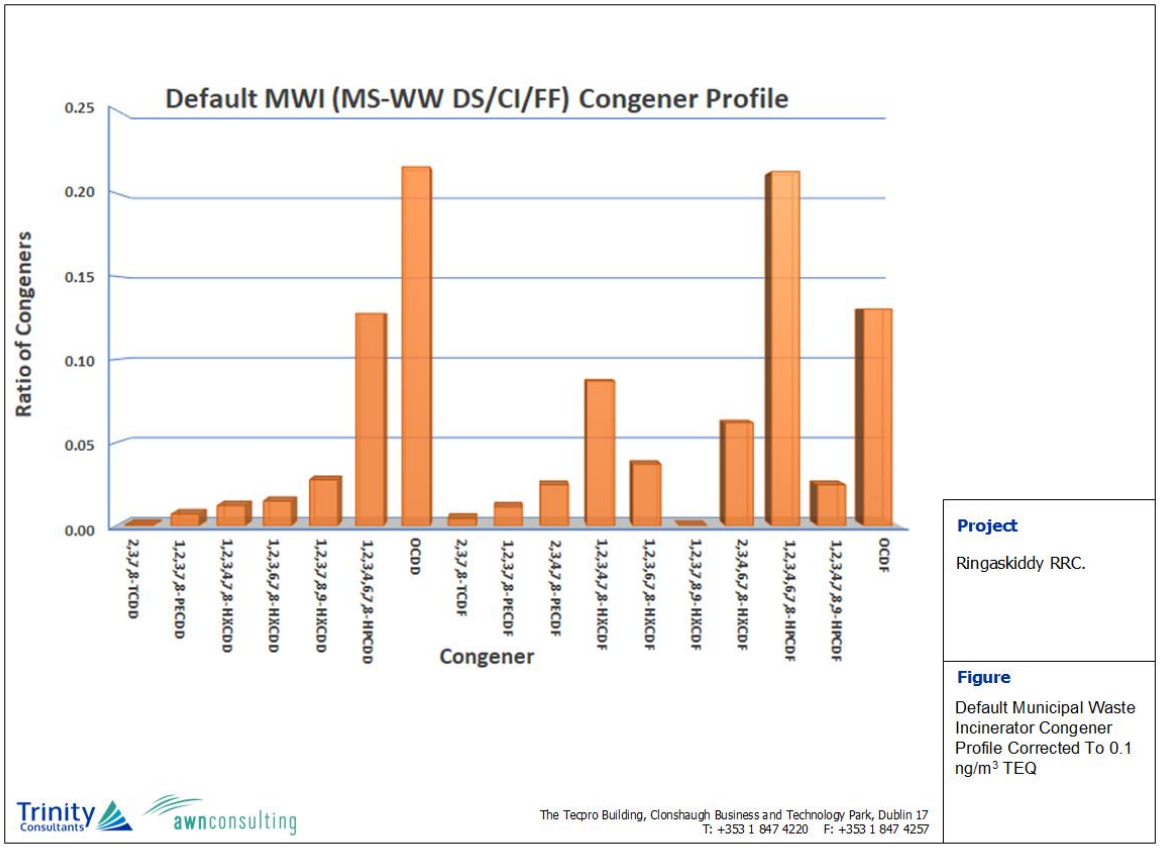
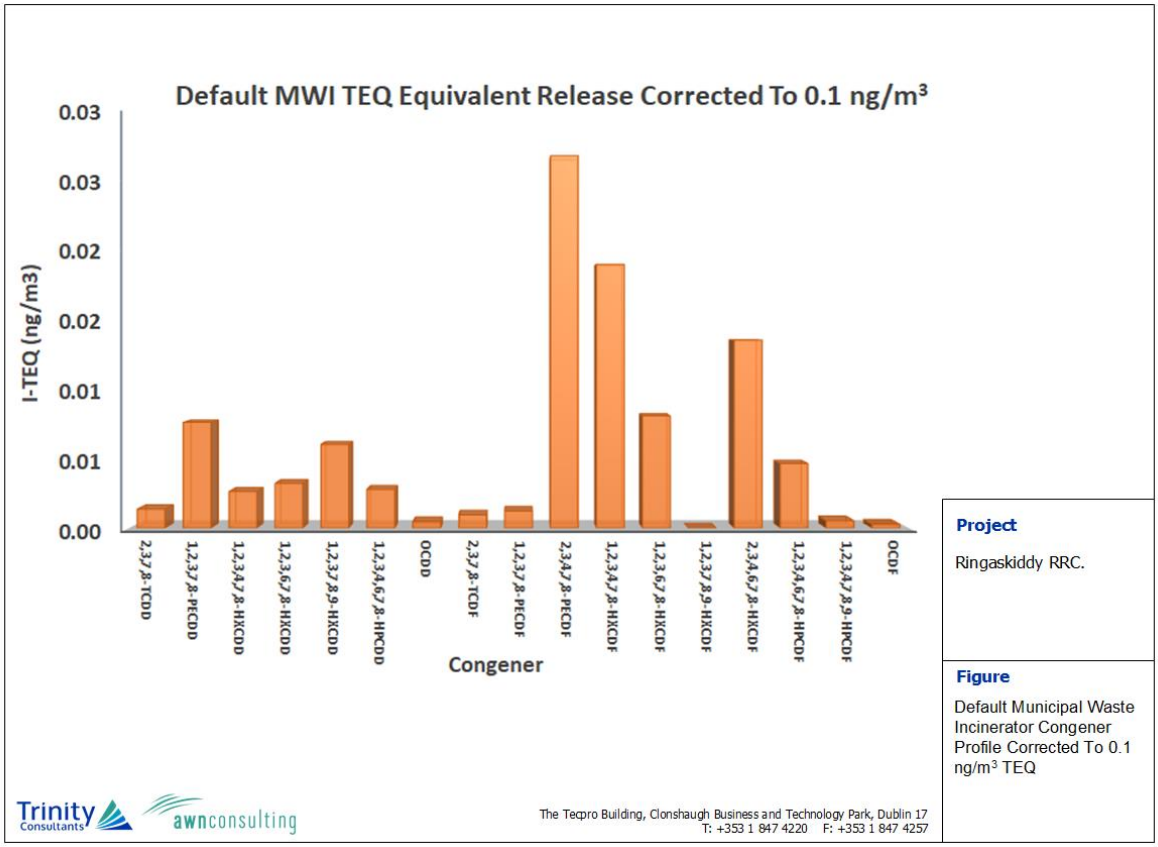


Figure 8.26 Default Municipal Waste Incinerator Congener Profile Corrected To 0.1 ng/m³ TEQ



8.5.4.2.2 Vapour / Particulate Partitioning

In order to accurately model emissions of PCDD/PCDFs (Dioxins/Furans), PAHs and mercury, the partitioning of stack emissions into the vapour and particle (V/P) state is required.

In relation to PCDD/PCDFs (Dioxins/Furans), V/P partitioning based on stack tests data is highly uncertain[10]. Research has indicated that higher temperatures favour the vaporous states for the lower chlorinated congeners and the particulate state for the higher chlorinated congeners[10]. However, measured data has indicated significant variability in the V/P partitioning. For these reasons, the USEPA has indicated that V/P distributions obtained from stack sampling should not be used.

Data can also be obtained from ambient air sampling using a glass fibre particulate filter and polyurethane foam (PUF) absorbent trap. As the sampler is not subjected to artificial heating or cooling, the method can be used to imply the vapour phase and particle bound partitioning of PCDD/Fs (Dioxins/Furans) in ambient air. However, the results will be only approximate as mass transfer between the particulate matter on the filter and the vapour trap cannot be ruled out[10].

The recommended USEPA approach to obtaining the vapour/particulate partitioning at the current time is theoretical and based on the Junge-Pankow model for estimating the particle/gas distribution of PCDD/PCDFs (Dioxins/Furans)[10]. This model is the one most commonly used for estimating the adsorption of semi-volatile compounds to aerosols:

$$\Phi = c\Theta / (\rho^{o}_{L} + c\Theta)$$

where:

Φ = fraction of compound adsorbed to aerosol particles
c = constant (assumed 17.2 Pa-cm)

Θ = particle surface area per unit volume of air, cm^2 aerosol/cm^3 air
ρ^o_L = saturation liquid phase vapour pressure, Pa

The particulate fraction can also be expressed by:

$$\Phi = C_p(TSP) / (C_g + C_p(TSP))$$

where:

Φ = fraction of compound adsorbed to aerosol particles
C_p = concentration of semi-volatile compounds associated with aerosols, ng/μg particles
C_g = gas-phase concentration, ng/m^3
TSP = total suspended particle concentration, $\mu g/m^3$

In the above calculations, it is assumed that all compounds emitted from the combustion sources are freely exchangeable between vapour and particle fractions. This may be a simplification as some of the particulate fraction may be trapped and be unavailable for exchange.

As the ρ^o_L is referenced to 25ºC and an ambient temperature of 10ºC has been assumed which is appropriate for average annual temperatures in Ireland, the ρ^o_L has been converted to the ambient temperature as indicated in Table 8.50. Other relevant data used in the calculations and the derived particle fraction at 10ºC is also shown in Table 8.50.

The advantage of the theoretical approach is that it is based on current adsorption theory, considers the molecular weight and degree of halogenation of the congeners and uses the availability of surface area for adsorption of atmospheric particles corresponding to specific airsheds (background plus local sources used in the current case).

8.5.4.3 Modelling of Vapours and Particles Concentrations

PCDD/PCDFs have a range of vapour pressures and thus exist in both vapour and particle-bound states to varying degrees. In order to adequately model dispersion and deposition of PCDD/PCDFs, modelling of both vapour and particle-bound states is thus necessary.

For the deposition modelling of PCDD/PCDFs, both wet and dry gaseous and particulate deposition were calculated.

8.5.4.3.1 Gaseous Deposition

Dry Gaseous Deposition

For the dry gaseous deposition modelling of PCDD/PCDFs, four physiochemical parameters are required for dioxins / furans. The dry gaseous deposition velocity formulation is based on three resistance terms; aerodynamic resistance, quasi-laminar resistance to bulk transfer and a bulk surface resistance term. The four physiochemical parameters required to calculate these resistance terms are D_a (diffusivity of modelled gas in air (cm/s)), D_w (diffusivity of modelled gas in water (cm/s)), Henry's Law constant for modelled gas (Pa-m^3/mol) and r_{cl} (leaf cuticular resistance (s/m). The values derived for the 2,3,7,8-TCDD is shown in Table 8.51.

Wet Gaseous Deposition

Wet gaseous deposition physically washes out the chemically contaminated vapours from the atmosphere. Wet gaseous deposition flux depends on the precipitation rate, the concentration of the pollutant in the liquid phase and the molecular weight of the pollutant. The AERMOD model formulation assumes that the wet gaseous deposition flux is the same for snow as for rain.

For the vapour phase modelling, both dry and wet gaseous deposition was considered. Using the congener profile from Table 8.49 and the vapour – particle partitioning from Table 8.50, the vapour

concentrations of the respective dioxin congeners was determined as outlined in Table 8.53 for the stack and diagrammatically in Figure 8.27. Results are shown under maximum operating conditions. The results from wet and dry gaseous deposition modelling have also been reported in Table 8.53 and diagrammatically in Figure 8.28.

Figure 8.27 Vapour & Particulate Dioxin Congener Concentration (fg/m³) – Maximum Operations

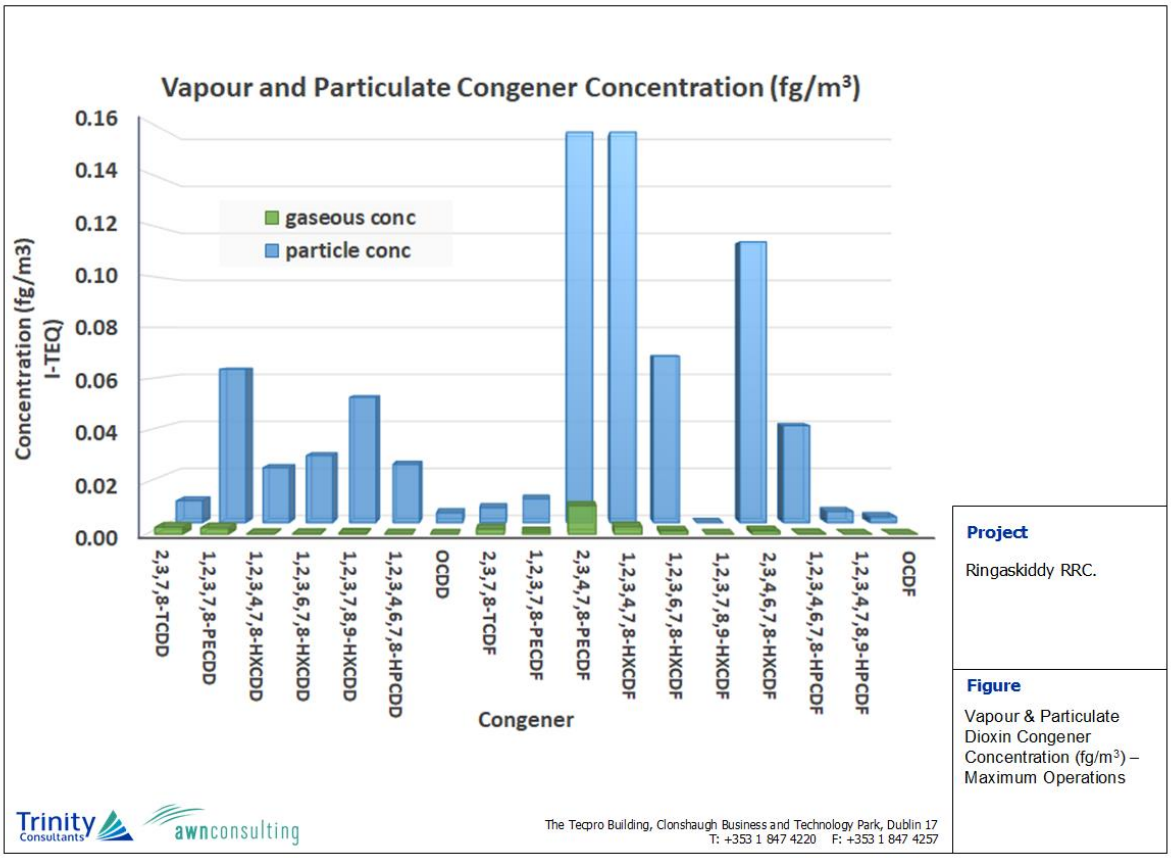
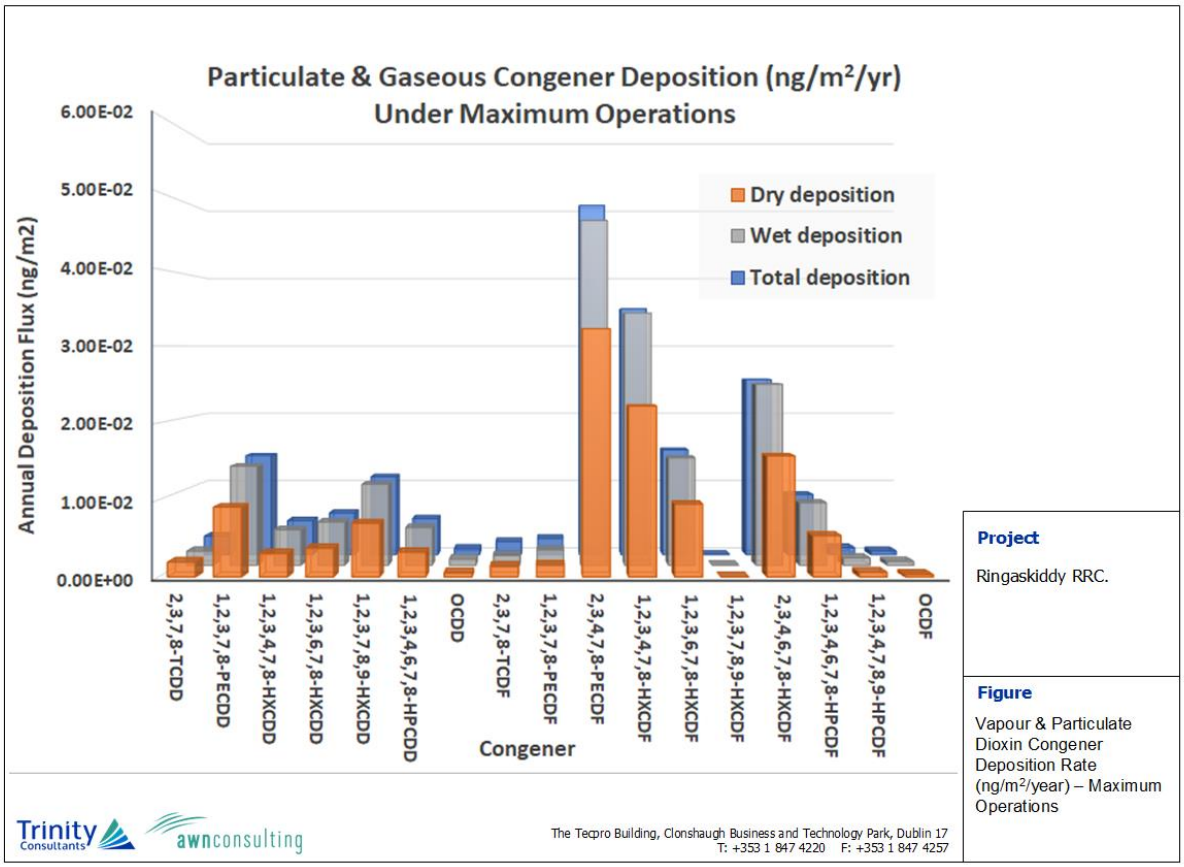


Figure 8.28 Vapour & Particulate Dioxin Congener Deposition Rate (ng/m²/year) – Maximum Operations



8.5.4.3.2 Particulate Deposition

Dry Particulate Deposition

When modelling particulate PCDD/PCDFs, the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 8.50). This distribution is suitable as a default for some combustion facilities equipped with either electrostatic precipitators (ESPs) or fabric filters, because the distribution is relatively typical of particle size arrays that have been measured at the outlet to advanced equipment designs[10]. Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

Dry particulate deposition is based on a resistance scheme in which the deposition velocity is based on the predominant particle size distribution via two methods. Method 1 is used when a significant fraction (> 10%) of the total particulate mass has a diameter greater than 10 microns and the particle size distribution is reasonably well known. The method is based on the gravitational settling velocity and two resistance terms; aerodynamic resistance and quasi-laminar resistance to bulk transfer. Method 2 is used when the particle size distribution is not well known and when a small fraction (less than 10% of the mass) consists of particles with a diameter of 10 microns or larger. The deposition velocity for method 2 is given as the weighted average of the deposition velocity for the coarse mode and fine mode. In the results below method 1 has been used, based on the generalised particle-size distribution recommended by the USEPA as outlined in Table 8.50[6], as it gives similar concentrations to method 2 but significantly higher deposition results.

Wet Particulate Deposition

Wet particulate deposition physically washes out the chemically contaminated particulate from the atmosphere. Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The AERMOD model formulation is based on a particle washout coefficient which is based on the collision efficiency and the mean diameter of raindrops. It is also assumed that the wet deposition flux is the same for snow as for rain.

For the particle-phase concentration, the congener profile from Table 8.49 and the vapour – particle partitioning from Table 8.49 were used to give the particulate concentrations of the respective dioxin congeners as determined in Table 8.54 and diagrammatically in Figure 8.27. Results are shown under maximum operating conditions.

For the particle-bound deposition, the congener profile from Table 8.49 and the vapour – particle partitioning from Table 8.50 were used to give the particulate emission rate of the respective dioxin congeners. The deposition flux for each congener was calculated by multiplying the emission rate of each congener by the unitised deposition flux as shown in Table 8.55 and diagrammatically in Figure 8.28. Results are shown under maximum operating conditions.

8.5.4.4 Comparison with Standards And Guidelines

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs (Dioxins/Furans). Both the USEPA and WHO recommended approach to assessing the risk to human health from Dioxins/Furans entails a detailed risk assessment analysis involving the determination of the effect of Dioxins/Furans in terms of the EU TWI (Tolerable Weekly Intake) approach[17,18]. The TWI was set by the EU in order to protect human health and was based on applying a safety factor to the LOAEL (Lowest Observed Abnormal Effect Levels) for dioxin and furans. Occasional short term exceedances of the TWI would have no health consequences provided the long-term average is not exceeded. The EU currently proposes a maximum TWI of 14 pg WHO-TEQ /kg body weight. This reflects the concept that guidance values for the protection of human health should consider total exposure to the substance including air, water, soil, food and other media sources (further details in Chapter 6 (Population And Human Health)).

Table 8.47 The number of dioxin-like and total congeners within dioxin, furan, and coplanar PCB Homologue groups[1].

Homologue Group	n: Number of Dioxin-Like Congeners	N: Number of Congeners	1/N
I. Dioxins			
Tetra-CDD	1	22	0.022
Penta-CDD	1	14	0.071
Hexa-CDD	3	10	0.100
Hepta-CDD	1	2	0.500
Octa-CDD	1	1	1.000
II. Furans			
Tetra-CDF	1	38	0.026
Penta-CDF	2	28	0.036
Hexa-CDF	4	16	0.063
Hepta-CDF	2	4	0.250
Octa-CDF	1	1	1.000
III. Mono-ortho coplanar PCBs			
Tetrachloro-PCBs	1	42	0.024
Pentachloro-PCBs	5	46	0.022
Hexachloro-PCBs	4	42	0.024
Heptachloro-PCBs	3	24	0.042

Note 1 USEPA (2004) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3

Table 8.48 The TEF scheme for TEQ_{DFP}-WHO_{98} and I-TEQ_{DF} (1).

Dioxin Congeners	TEF	Furan Congeners	TEF
2,3,7,8-TCDD	1.0	2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDD	1.0 (0.5)(2)	1,2,3,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDD	0.1	2,3,4,7,8-PeCDF	0.5
1,2,3,6,7,8-HxCDD	0.1	1,2,3,4,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1	1,2,3,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDD	0.01	1,2,3,7,8,9-HxCDF	0.1
OCDD	0.0001 (0.001)(2)	2,3,4,6,7,8-HxCDF	0.1
PCB Chemical Structure	**TEF**	1,2,3,4,6,7,8-HpCDF	0.01
3,3′,4,4′-TeCB	0.0001	1,2,3,4,7,8,9-HpCDF	0.01
3,4,4′,5-TCB	0.0001	OCDF	0.0001 (0.001)(2)
2,3,3′,4,4′-PeCB	0.0001		
2,3,4,4′,5-PeCB	0.0005		
2,3′,4,4′,5-PeCB	0.0001		
2′,3,4,4′,5-PeCB	0.0001		
3,3′,4,4′,5-PeCB	0.1		
2,3,3′,4,4′,5-HxCB	0.0005		
2,3,3′,4,4′,5′-HxCB	0.0005		
2,3′,4,4′,5,5′-HxCB	0.00001		
3,3′,4,4′,5,5′-HxCB	0.01		
2,3,3′,4,4′,5,5′-HpCB	0.0001		

Note 1 USEPA (2004) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 1

Note 2 Values in parentheses are those given in Annex VI, Council Directive 2010/75/EU and equate to I-TEQ_{DF}.

Table 8.49 PCDD/PCDF Relative Emission Factors for Municipal Waste Incinerator (MB-Ref WS)(18)

	Emission Factor (relative to sum of toxic congeners)	Emission Concentration (ng/m^3 from stack)	Grate Incinerator Emission Factor (ng/sec from stack)
Congener Group	**Nondetects set to zero**	**Nondetects set to zero**	**Nondetects set to zero**
2,3,7,8-TCDD	0.0006	0.0014	0.08091
1,2,3,7,8-PeCDD	0.0070	0.0077	0.45007
1,2,3,4,7,8-HxCDD	0.0121	0.0027	0.15590
1,2,3,6,7,8-HxCDD	0.0148	0.0033	0.19054
1,2,3,7,8,9-HxCDD	0.0276	0.0061	0.35613
1,2,3,4,6,7,8-HpCDD	0.1276	0.0028	0.16454
OCDD	0.2159	0.0005	0.02782
2,3,7,8-TCDF	0.0114	0.0012	0.07321
1,2,3,7,8-PeCDF	0.0246	0.0270	1.58311
2,3,4,7,8-PeCDF	0.0870	0.0191	1.12206
1,2,3,4,7,8-HxCDF	0.0370	0.0081	0.47757
1,2,3,6,7,8-HxCDF	0.0000	0.0000	0.00000
1,2,3,7,8,9-HxCDF	0.0620	0.0136	0.79963
2,3,4,6,7,8-HxCDF	0.2130	0.0047	0.27458
1,2,3,4,6,7,8-HpCDF	0.0246	0.0005	0.03168
1,2,3,4,7,8,9-HpCDF	0.1304	0.0003	0.01680
OCDF	0.0006	0.0014	0.08091
Total PCDD/PCDF	1.0	0.1 ng/m^3	5.86 ng/sec

Note 1 Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (1998, USEPA (CD-ROM)).

Table 8.50 PCDD/PCDF Particle Fraction, Φ, at 10ºC In Airshed (Background plus Local Sources)(10)

Congener Group	E-$H\rho^{o}_{L}$ (25ºC)	E-$H\rho^{o}_{L}$ (10ºC)(2)	Particle Fraction
2,3,7,8-TCDD	1.14×10^{-4}	1.87×10^{-5}	0.763
1,2,3,7,8-PeCDD	1.74×10^{-5}	2.47×10^{-6}	0.961

1,2,3,4,7,8-HxCDD	3.96 x 10^{-6}	4.98 x 10^{-7}	0.992
1,2,3,6,7,8-HxCDD	3.96 x 10^{-6}	4.98 x 10^{-7}	0.992
1,2,3,7,8,9-HxCDD	3.96 x 10^{-6}	4.98 x 10^{-7}	0.992
1,2,3,4,6,7,8-HpCDD	1.02 x 10^{-6}	1.18 x 10^{-7}	0.998
OCDD	2.77 x 10^{-7}	2.91 x 10^{-8}	0.9995
2,3,7,8-TCDF	1.23 x 10^{-4}	2.01 x 10^{-5}	0.75
1,2,3,7,8-PeCDF	3.64 x 10^{-5}	5.46 x 10^{-6}	0.917
2,3,4,7,8-PeCDF	2.17 x 10^{-5}	3.11 x 10^{-6}	0.951
1,2,3,4,7,8-HxCDF	10.09 x 10^{-6}	1.09 x 10^{-6}	0.982
1,2,3,6,7,8-HxCDF	10.09 x 10^{-6}	1.09 x 10^{-6}	0.982
1,2,3,7,8,9-HxCDF	4.99 x 10^{-6}	6.49 x 10^{-7}	0.989
2,3,4,6,7,8-HxCDF	4.99 x 10^{-6}	6.49 x 10^{-7}	0.989
1,2,3,4,6,7,8-HpCDF	2.24 x 10^{-6}	2.77 x 10^{-7}	0.995
1,2,3,4,7,8,9-HpCDF	1.31 x 10^{-6}	1.56 x 10^{-7}	0.9974
OCDF	2.60 x 10^{-7}	2.71 x 10^{-8}	0.9995

Note 1 USEPA (2004) Estimating Exposure to Dioxin-Like Compounds Volume II, Chapter 3

Note 2 Background plus local sources default values: Θ = 3.5 x 10^{-6} cm^2 aerosol/cm^3 air, TSP = 60 $\mu g/m^3$.

Table 8.51 Gas Deposition Physiochemical Parameters for 2,3,7,8-TCDD

Compound	Da (cm/s)	Dw (cm/s)	H (Pa m3 mol-1)	rcl (sm-1)
2,3,7,8-TCDD	0.05196	0.00000439	1.46	9.67

Table 8.52 Generalized Particle Size Distribution & Proportion of Available Surface Area(10)

Mean Particle Diameter (μm)	Particle Radius (μm)	Surface Area/Volume (μm^{-1})	Fraction of Total Mass(2)	Proportion Available Surface Area	Fraction of Total Surface Area(3)
>15.0	7.50	0.400	0.128	0.0512	0.0149
12.5	6.25	0.480	0.105	0.0504	0.0146
8.1	4.05	0.741	0.104	0.0771	0.0224
5.5	2.75	1.091	0.073	0.0796	0.0231
3.6	1.80	1.667	0.103	0.1717	0.0499
2.0	1.00	3.000	0.105	0.3150	0.0915
1.1	0.55	5.455	0.082	0.4473	0.1290
0.7	0.40	7.500	0.076	0.5700	0.1656
>0.7	0.40	7.500	0.224	1.6800	0.4880

Note 1 USEPA (2004) Chapter 3: Air Dispersion and Deposition Modelling, Human Health Risk Assessment Protocol, Region 6 Centre for Combustion Science and Engineering

Note 2 Used in the deposition modelling of metals (except Hg)

Note 3 Used in the deposition modelling of PCDD/PCDFs, PAHs and Hg.

8.5.4.5 Modelling Results

Table 8.53 – Table 8.57 detail the predicted PCCD/PCDFs (Dioxins/Furans) GLC and deposition flux for the maximum scenario based on a default municipal waste incinerator profile under maximum operating conditions.

Table 8.53 PCDD/PCDF Annual Vapour Concentrations and Deposition Under Maximum Operations

Congener Group	Vapour Fraction	Vapour Emission Rate (ng/sec)	Annual Vapour Concentration (fg/m^3)	Annual Dry Vapour Deposition (ng/m^2)	Annual Wet Vapour Deposition (ng/m^2)
2,3,7,8-TCDD	0.237	1.92E-02	2.67E-03	1.15E-03	2.90E-05

1,2,3,7,8-PeCDD	0.039	1.76E-02	2.45E-03	1.05E-03	2.65E-05
1,2,3,4,7,8-HxCDD	0.008	1.25E-03	1.74E-04	7.48E-05	1.88E-06
1,2,3,6,7,8-HxCDD	0.008	1.52E-03	2.12E-04	9.15E-05	2.30E-06
1,2,3,7,8,9-HxCDD	0.008	2.85E-03	3.97E-04	1.71E-04	4.30E-06
1,2,3,4,6,7,8-HpCDD	0.002	3.29E-04	4.59E-05	1.97E-05	4.97E-07
OCDD	0.0005	1.39E-05	1.94E-06	8.35E-07	2.10E-08
2,3,7,8-TCDF	0.25	1.41E-02	1.97E-03	8.48E-04	2.13E-05
1,2,3,7,8-PeCDF	0.083	6.08E-03	8.47E-04	3.65E-04	9.17E-06
2,3,4,7,8-PeCDF	0.049	7.76E-02	1.08E-02	4.65E-03	1.17E-04
1,2,3,4,7,8-HxCDF	0.018	2.02E-02	2.82E-03	1.21E-03	3.05E-05
1,2,3,6,7,8-HxCDF	0.018	8.60E-03	1.20E-03	5.16E-04	1.30E-05
1,2,3,7,8,9-HxCDF	0.011	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	0.011	8.80E-03	1.23E-03	5.28E-04	1.33E-05
1,2,3,4,6,7,8-HpCDF	0.005	1.37E-03	1.91E-04	8.24E-05	2.07E-06
1,2,3,4,7,8,9-HpCDF	0.0026	8.24E-05	1.15E-05	4.94E-06	1.24E-07
OCDF	0.0005	8.40E-06	1.17E-06	5.04E-07	1.27E-08
Sum			0.025 fg/m^3	0.011 ng/m^2	0.00027 ng/m^2
Equivalent Daily Deposition Flux				0.030 pg/m^2/day	0.00074 pg/m^2/day

Table 8.54 PCDD/PCDF Annual Particulate Concentrations Under Maximum Operations

Congener Group	Particulate Fraction	Particulate Emission Rate (ng/sec)	Annual Particulate Concentration (fg/m^3)
2,3,7,8-TCDD	0.763	6.17E-02	9.00E-03
1,2,3,7,8-PeCDD	0.961	4.33E-01	6.31E-02
1,2,3,4,7,8-HxCDD	0.992	1.55E-01	2.26E-02
1,2,3,6,7,8-HxCDD	0.992	1.89E-01	2.76E-02
1,2,3,7,8,9-HxCDD	0.992	3.53E-01	5.15E-02
1,2,3,4,6,7,8-HpCDD	0.998	1.64E-01	2.40E-02
OCDD	0.9995	2.78E-02	4.06E-03
2,3,7,8-TCDF	0.75	4.24E-02	6.19E-03
1,2,3,7,8-PeCDF	0.917	6.71E-02	9.79E-03
2,3,4,7,8-PeCDF	0.951	1.51E+00	2.20E-01
1,2,3,4,7,8-HxCDF	0.982	1.10E+00	1.61E-01
1,2,3,6,7,8-HxCDF	0.982	4.69E-01	6.84E-02
1,2,3,7,8,9-HxCDF	0.989	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	0.989	7.91E-01	1.15E-01
1,2,3,4,6,7,8-HpCDF	0.995	2.73E-01	3.98E-02
1,2,3,4,7,8,9-HpCDF	0.9974	3.16E-02	4.61E-03
OCDF	0.9995	1.68E-02	2.45E-03
Sum			0.829 fg/m^3

Table 8.55 PCDD/PCDF Annual Particulate Deposition Fluxes Under Maximum Operations

Congener Group	Particulate Emission Rate (ng/sec)	Dry Particulate Deposition Flux (ng/m^2)	Wet Particulate Deposition Flux (ng/m^2)	Combined Particulate Deposition Flux (ng/m^2)
2,3,7,8-TCDD	6.17E-02	8.57E-04	3.15E-03	3.15E-03

1,2,3,7,8-PeCDD	4.33E-01	6.01E-03	2.21E-02	2.21E-02
1,2,3,4,7,8-HxCDD	1.55E-01	2.15E-03	7.89E-03	7.89E-03
1,2,3,6,7,8-HxCDD	1.89E-01	2.63E-03	9.64E-03	9.65E-03
1,2,3,7,8,9-HxCDD	3.53E-01	4.91E-03	1.80E-02	1.80E-02
1,2,3,4,6,7,8-HpCDD	1.64E-01	2.28E-03	8.37E-03	8.38E-03
OCDD	2.78E-02	3.86E-04	1.42E-03	1.42E-03
2,3,7,8-TCDF	4.24E-02	5.89E-04	2.16E-03	2.16E-03
1,2,3,7,8-PeCDF	6.71E-02	9.32E-04	3.42E-03	3.43E-03
2,3,4,7,8-PeCDF	1.51E+00	2.09E-02	7.68E-02	7.68E-02
1,2,3,4,7,8-HxCDF	1.10E+00	1.53E-02	5.62E-02	5.62E-02
1,2,3,6,7,8-HxCDF	4.69E-01	6.51E-03	2.39E-02	2.39E-02
1,2,3,7,8,9-HxCDF	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,3,4,6,7,8-HxCDF	7.91E-01	1.10E-02	4.03E-02	4.04E-02
1,2,3,4,6,7,8-HpCDF	2.73E-01	3.79E-03	1.39E-02	1.39E-02
1,2,3,4,7,8,9-HpCDF	3.16E-02	4.39E-04	1.61E-03	1.61E-03
OCDF	1.68E-02	2.33E-04	8.57E-04	8.57E-04
Sum		0.079 ng/m^2	0.290 ng/m^2	0.301 ng/m^2
Equivalent Daily Deposition Flux		0.216 pg/m^2/day	0.794 pg/m^2/day	0.824 pg/m^2/day

Table 8.56 Dispersion Model Summary of Combined Vapour and Particulate Concentrations – PCCD/PCDFs

Pollutant / Scenario	Annual Mean Background[(1)] (fg/m^3)	Averaging Period	Process Contribution (fg/m^3)	Predicted Emission Concentration (fg/Nm^3)
PCCD/PCDFs / Maximum Operation	31	Annual Average	0.854	31.85
PCCD/PCDFs / Abnormal Operation	31	Annual Average	0.940	31.94

Note 1 Baseline results for dioxins given as sum of cumulative effects (in the absence of the proposed facility) and baseline monitoring data as Non-detects = limit of detection.

Note 2 Abnormal operation scenario based on an emission level of 0.5 ng/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.57 Deposition Model Summary of Combined Particulate & Gaseous Deposition Flux

Pollutant / Scenario	Averaging Period	Background Particulate Deposition Flux (pg/m^2/day)	Process Contribution (pg/m^2/day)	Predicted Total Particulate Deposition Flux (pg/m^2/day)
PCCD/PCDFs / Maximum	Annual Average	30	0.824	30.82
PCCD/PCDFs / Abnormal	Annual Average	30	0.852	30.85

Table 8.58 I-TEQ values derived from measurements of airborne dioxins in various locations

Location	Site Type	I-TEQ[(1)] (fg/m^3)
Kilcock , Co. Meath (1998)[(2)]	Rural	Range 2.8 – 7
Ireland[(2)]	Baseline	Mean – 26
	Potential Effect Areas	Mean – 49
Ringaskiddy (2001)[(3)]	Industrial	Lower Limit – 4.0[(6)] Upper Limit – 16.4[(7)]
Poolbeg (2003-2006)[(8)]	Industrial	Lower Limit – 42[(6)] Upper Limit – 44[(7)]
Germany (1992)[(4)]	Rural	< 70
	Urban	71 – 350
	Close to Major Source	351 – 1600

Manchester (2008 - 2010)[5]	Urban	Range – 19 - 48
London (2008 - 2010)[5]	Urban	Range –- 11 - 41
Auchencorth (2008 - 2010)[5]	Semi-rural	Range – 1 - 6
High Muffles (2008 - 2010)[5]	Rural	Range – 2 - 9
Haulbowline (2008)[9]	Industrial	19.2[9]

Note 1 I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2010/75/EU.

Note 2 Taken from Chapter 8 of Thermal Waste Treatment Plant, Kilcock EIS, Air Environment (1998)

Note 3 Taken from Chapter 9 of Waste Management Facility, Indaver Ringaskiddy EIS, Baseline Dioxin Survey (2001)

Note 4 Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* **Vol. 68**, No. 9, pp 1781-1789

Note 5 Taken from TOMPS Network website, http://uk-air.defra.gov.uk/data/tomps-data

Note 6 Lower Limit TEQ calculated assuming non-detects are equal to zero.

Note 7 Upper limit assuming non-detects are equal to limit of detection.

Note 8 Taken from Chapter 8 of Dublin Waste To Energy Facility EIS, Baseline Dioxin Survey (2006).

Note 9 Taken From REC Ltd Monitoring Report For WYG In 2008, Haulbowline Island.

Table 8.59 Mean I-TEQ Deposition Fluxes Of Dioxins In Various Locations

Location	Site Type	Mean I-TEQ[1] (pg/m^2/ day)
Germany (1992)[2]	Rural	5 – 22
	Urban	10 – 100
	Close to Major Source	123 – 1293
UK[3]	Stevenage	3.2
	London	5.3
	Cardiff	12
	Manchester	28

Note 1 I-TEQ$_{DF}$ values based on NATO/CCMS (1988) and as used in Annex 1, Council Directive 2010/75/EU.

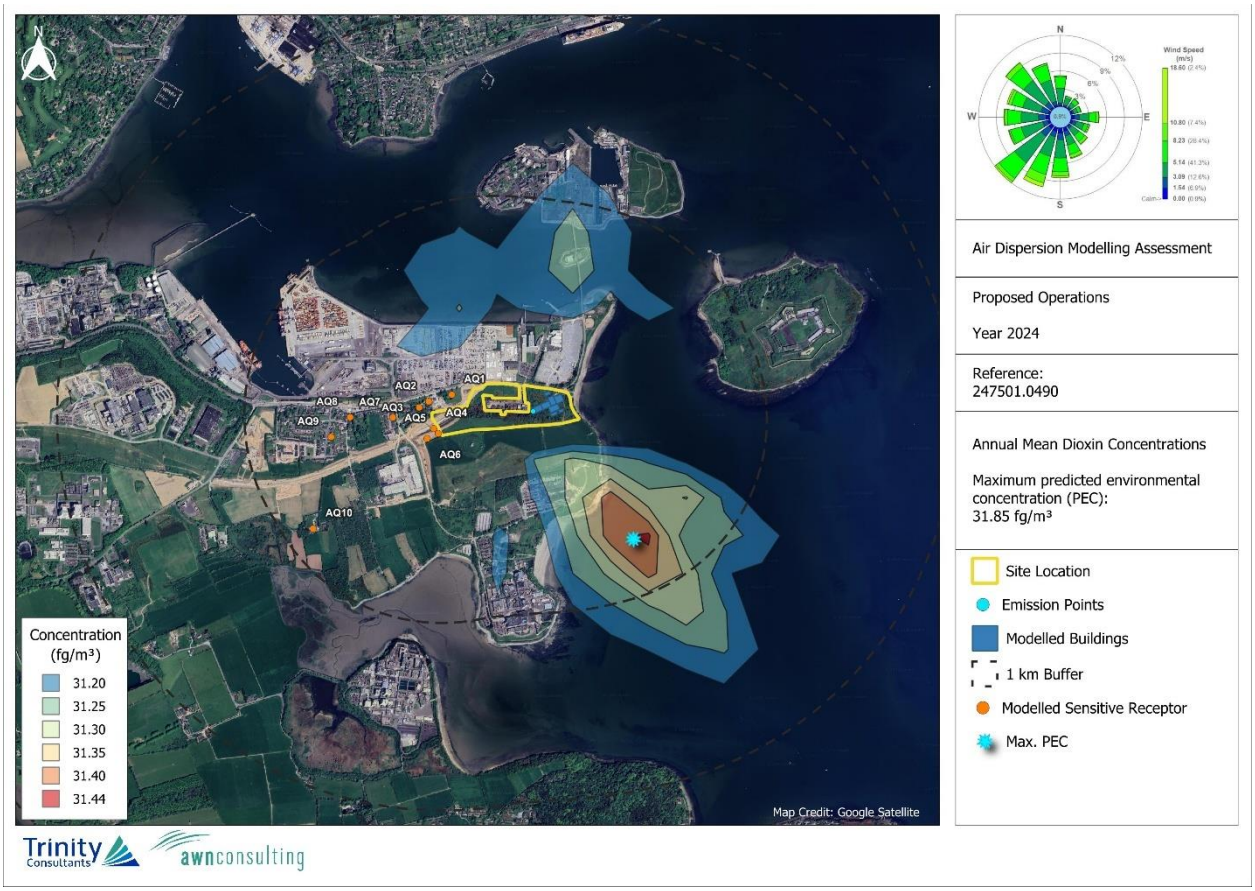
Note 2 Raffe, C (1996) Sources and environmental concentrations of dioxins and related compounds, *Pure & Appl. Chem* Vol. 68, No. 9, pp 1781-1789

Note 3 Duarte-Davidson et al (1994) Polychlorinated Dibenzo-*p*-Dioxins (PCDDs) and Furans (PCDFs) in Urban Air and Deposition, *Environ. Sci. & Pollut. Res.*, 1 (4), 262-270

8.5.4.6 Concentration Contours

The maximum PCCD/PCDFs (Dioxins/Furans) ground level concentrations and deposition fluxes beyond the Facility boundary are shown in Figure 8.29.

Figure 8.29 Maximum Operations: Predicted PCCD/PCDFs (Dioxins/Furans) Annual Average Particulate Concentration



8.5.4.7 Result Findings

Background levels of PCDD/PCDFs (Dioxins/Furans) occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Monitoring results indicate that the existing levels are typical of rural areas in Ireland and the UK (as shown in Table 8.58). The contribution from the facility in this context is minor with levels under maximum and abnormal scenarios remaining significantly below levels which would be expected in urban areas even at the worst-case receptor located at the southern and south-eastern boundaries of the facility. Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 1% of the existing background concentration under maximum and abnormal operating conditions.

Shown in Table 8.57 is the maximum dioxin deposition rate. Modelled total dioxin particulate deposition flux indicate that deposition levels under maximum and abnormal operations would be expected to be significantly less than that experienced in urban background locations (see Table 8.59).

8.5.5 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous chemicals found in urban airsheds throughout the world[20]. They are formed from the incomplete combustion of organic matter and are released into ambient air as constituents of highly complex mixtures of polycyclic organic matter (POM). They are also found in crude oil, coal tar, creosote and asphalt. In towns and cities, road traffic emissions are the dominant source of PAHs. In a recent study in Birmingham, 88% of the concentration of benzo[*a*]pyrene (B[*a*]P) in air was due to road traffic emissions[21].

PAHs can occur in the form of gases (e.g. 2-ringed naphthalene), solids adsorbed to surfaces of fine particles (e.g. 5-ringed benzo[*a*]pyrene) and in both gas- and particle-phases (e.g. 3-ringed phenanthrene). The air concentrations of gas-phase 2- and 3-ring PAHs are generally significantly

higher than those of the 5- and 6- ring particle phase species. Moreover, the percentage found in the gas phase decreases with the size of the PAH. It has also been found that at higher masses of suspended particulate matter (TSP) in the air parcel the percentage of PAHs in the particle phase increases significantly[20].

The International Agency for Research on Cancer (IARC) has classified 48 PAHs according to their likely human carcinogenicity in 1987[20]. The three potent animal carcinogens benzo[*a*]pyrene, benz[*a*]anthracene and dibenz[*ah*]anthracene are classified as "probably carcinogenic to humans". "Possible human carcinogens" consists of four compounds – benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, indeno[123-*cd*]pyrene and chrysene. The USEPA has also classified seven chemicals as probable human carcinogens (USEPA Class B2). In 1993, the USEPA formally adopted provisional guidance for estimating cancer risks associated with PAHs[22]. The procedure makes use of the relative potencies of several PAHs with respect to benzo[*a*]pyrene which is thought to be one of the most potent PAHs[20-24].

Various approaches have been adopted to quantify exposure to the complex mixtures of PAHs including Total PAH levels or the level of a marker substance such as benzo[*a*]pyrene. Recent studies have found that the relation of B[*a*]P to the levels of 18 other individual PAHs was relatively stable[25]. Together these 19 PAH compounds constitute 90-95% of the PAHs measured in the air in this study[25]. The UK DETR Expert Panel on PAHs[24] has reviewed extensively the data available in terms of animal toxicology in deriving an ambient air quality standard for PAHs. The approach used by the Panel was to compare the sum of potential carcinogenic contribution of seven individual PAHs (possible & probable carcinogens, see above) in ambient air with that of B[*a*]P. Contributions to total carcinogenicity from other PAH compounds are expected to be small relative to those considered above. Results from the comparison indicated that the estimated contribution of B[*a*]P to the total carcinogenicity of the seven chosen PAH compounds was similar in the three locations studied (ranging from 37.5% - 49.3%)[24]. The overall conclusion from this approach was that using B[*a*]P as a marker of PAH exposure in the environment was suitable so long as major changes in the ambient mixture of PAH compounds do not occur in the future and that an air quality standard for PAH mixtures could be expressed in terms of the ambient concentration of B[*a*]P.

The EU has confirmed the validity of this approach in Directive (EU) 2024/2881which designates B[*a*]P as a marker for PAHs in general. The Directive set a limit value for the protection of human health for B[*a*]P of 1.0 ng/m^3.

Background PAHs are monitored at four sites in Ireland over the period 2019 - 2023[26]. Shown in Table 8.60 are B[*a*]P concentrations at these sites. Annual average background concentrations of B[*a*]P in this network ranged from 0.10 – 0.31 ng/m^3 over the period 2019 - 2023. Shown in Table 8.61 are B[*a*]P deposition rates at two sites in Ireland. Annual average background deposition rates of B[*a*]P ranged from 2.7 – 39.6 ng/m^2/day over the period 2019 - 2023.

Table 8.60 Annual average B[a]P concentration at selected sites in Ireland In 2019 - 2023[26]

Year	B[a]P Annual Mean Concentration (ng/m^3) in 2019 - 2023			
	Rathmines	Heatherton Park	Galway	Kilkitt
	Zone A	Zone B	Zone C	Zone D
2019	0.16	0.26	0.22	0.19
2020	0.16	0.31	0.31	0.26
2021	0.08	0.23	0.21	0.12
2022	0.14	0.21	0.26	0.11
2023	0.2	-	0.2	0.1
Average	**0.15**	**0.25**	**0.24**	**0.16**

Table 8.61 Annual average B[a]P deposition rate at selected sites in Ireland In 2019 - 2023[26]

Year	B[a]P Annual Mean Deposition (ng/m²/day) in 2019 - 2023	
	Rosemount, UCD	Shannon Estuary
	Zone A	Zone D
2019	5	3
2020	2.7	-
2021	9.5	4.7
2022	15.9	10.4
2023	9.3	39.6
Average	**8.5**	**14.4**

8.5.5.1 Modelling Strategy

For the purposes of this assessment, emissions of B[*a*]P from the facility have been assumed to be at the upper range of the levels outlined in the Waste Incineration BREF document (1.0 μg/m³). Literature data has indicated that B[*a*]P exists almost solely in the particulate phase[20] and the EU reference method for the monitoring of B[*a*]P is based on particulate sampling only[27]. Therefore, the current analysis assumes that B[a]P exists in the particulate phase only.

The emission of B[*a*]P from the facility has thus been evaluated in terms of mass of release into the particle-bound phase. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient air particle phase concentration and wet and dry particulate deposition amounts, in the vicinity of the release. The maximum scenario has been modelled as outlined in Table 8.62.

When modelling PAHs the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 8.50). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particles which is available for chemical adsorption. The ambient particulate concentration of B[a]P was determined as shown in Table 8.62. Results are shown under both maximum and abnormal operating conditions.

8.5.5.2 Deposition Modelling of Particulates

In order to model dry deposition of PAHs, using AERMOD, the generalised particle-size distribution recommended by the USEPA has again been used as outlined in Table 8.50[10,11]. For the deposition modelling of B[*a*]P both wet and dry particulate deposition were calculated.

Table 8.62 Emission Scenario for B[*a*]P

Pollutant	Scenario	Emission Concentration	Emission Rate (mg/s)
B[*a*]P	Maximum Operation	1.0 μg/m³	0.059

8.5.5.3 Comparison With Standards And Guidelines

Predicted GLCs have been compared with the applicable EU ambient air quality limit value for B[*a*]P as set out in Table 8.63.

Table 8.63 B[a]P Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Limit Value
B[a]P	Directive (EU) 2024/2881	Annual Average	1.0 ng/m³

8.5.5.4 Modelling Results

Table 8.64 – Table 8.66 details the predicted B[*a*]P GLC for the particulate concentration and deposition scenarios.

Table 8.64 B[a]P Particulate Concentrations Under Maximum Operating Conditions

Compound	Particulate Fraction	Particulate Emission Rate (µg/sec)	Annual Averaged Particulate Concentration (pg/m^3)
B[a]P	1.0	Maximum – 58.6	8.6

Table 8.65 B[*a*]P Deposition Fluxes – Maximum Operating Conditions

Compound	Fraction	Emission Rate (µg/sec)	Annual Deposition Flux (µg/m^2)
B[a]P - Maximum Operation	Dry particulate	58.6	0.820
	Wet particulate		3.01
	Total particulate		3.01
Sum of Total Particulate Deposition			**3.01 µg/m^2**
			8.25 ng/m^2/day

Table 8.66 Dispersion Model Summary Of Particulate B[a]P Concentrations Under Maximum Operating Conditions.

Pollutant / Scenario	Annual Mean Background (pg/m^3)	Averaging Period	Process Contribution (pg/m^3)	Predicted Emission Concentration (pg/Nm^3)	Standard (pg/Nm^3)
B[a]P / Maximum	250	Annual mean	8.6	258.6	1000

8.5.5.5 Result Findings

B[*a*]P modelling results indicate that the ambient ground level concentrations are significantly below the EU limit value for the protection of human health under maximum operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations lead to ambient B[a]P particle-bound concentrations (excluding background concentrations) which are only 1.0% of the annual average limit value at the boundary of the facility.

8.5.6 Mercury

8.5.6.1 Mercury's Environmental Transport & Fate

Mercury exists in three oxidation states; metallic or elemental (Hg^0); mercurous (Hg_2^{2+}); and mercuric (Hg^{2+}). Elemental Hg is a liquid at room temperature with low volatility. Other forms of mercury are solids with low vapour pressures. It is naturally occurring and cycles between the atmosphere, land and water through a series of complex transformations. Elemental mercury is the most common form of mercury found in the atmosphere whereas in all other environmental media, mercury is found in the form of inorganic mercuric salts and organo-mercury compounds[28].

USEPA methodology assumes that stack emissions containing mercury include both vapour and particle-bound phases. Additionally, the USEPA assumes that mercury exits the stack in only the elemental and divalent species. These assumptions were also used for the current assessment. Of the total mercury in the stack, 80% is estimated to be in the vapour phase and 20% is particle-bound. In addition, the USEPA assumes that speciation of the total mercury is 80% divalent (20% in the particle-bound and 60% in the vapour phase) and 20% elemental (all 20% in the vapour phase)[28]. Although

the USEPA allows a loss to the global cycle for each form of mercury (99% of the elemental vapour form, 32% of the divalent vapour form, and 64% of the particle-bound form are assumed lost to the global cycle and do not deposit within the localized study area), this has not been incorporated into the current assessment in keeping with the worst-case approach adopted throughout.

8.5.6.2 Comparison With Standards And Guidelines

Predicted GLCs have been compared with the applicable WHO ambient air quality guideline for mercury as set out in Table 8.67.

Table 8.67 Hg Ambient Air Quality Standards & Guidelines

Pollutant	Regulation	Limit Type	Value
Inorganic Mercury (as Hg)	WHO	Annual Average	1.0 μg/m^3

8.5.6.3 Deposition Modelling of Mercury Vapours

8.5.6.3.1 Dry Gaseous Deposition

For the dry gaseous deposition modelling of mercury, four physicochemical parameters are required for both elemental gaseous mercury and divalent gaseous mercury. The dry gaseous deposition velocity formulation is based on three resistance terms; aerodynamic resistance, quasi-laminar resistance to bulk transfer and a bulk surface resistance term. The four physiochemical parameters required to calculate these resistance terms are D_a (diffusivity of modelled gas in air (cm/s)), D_w (diffusivity of modelled gas in water (cm/s)), Henry's Law constant for modelled gas (Pa-m^3/mol) and r_{cl} (leaf cuticular resistance (s/m)). The values derived for the two relevant mercury states are shown in Table 8.68.

Table 8.68 Gas Deposition Physiochemical Parameters(3)

Mercury Phase	D_a (cm/s)	D_w (cm/s)	H (Pa m^3 mol^{-1})	r_{cl} (sm^{-1})
Elemental Gas	0.055	6.4E-06	719	100000
Divalent Gas	0.045	5.2E-06	7.2e-5	100000

8.5.6.3.2 Wet Gaseous Deposition

Wet gaseous deposition physically washes out the chemically contaminated vapours from the atmosphere. Wet gaseous deposition flux depends on the precipitation rate, the concentration of the pollutant in the liquid phase and the molecular weight of the pollutant. The AERMOD model formulation assumes that the wet gaseous deposition flux is the same for snow as for rain.

8.5.6.4 Modelling of Particulate Mercury

When modelling particulate mercury (Hg), the surface area weighting rather than mass weighting is used for deposition. The surface weighting reflects the mode of formation where volatiles condense on the surface of particulates in the flue gas cleaning system (see Column 6 of Table 8.50). Thus, the apportionment of emissions by particle size becomes a function of the surface area of the particle which is available for chemical adsorption.

8.5.6.4.1 Dry Particulate Deposition

Dry particulate deposition is based on a resistance scheme in which the deposition velocity is based on the predominant particle size distribution via two methods. Method 1 is used when a significant fraction (> 10%) of the total particulate mass has a diameter greater than 10 microns and the particle size distribution is reasonably well known. The method is based on the gravitational settling velocity and two resistance terms; aerodynamic resistance and quasi-laminar resistance to bulk transfer.

Method 2 is used when the particle size distribution is not well known and when a small fraction (less than 10% of the mass) consists of particles with a diameter of 10 microns or larger. The deposition velocity for method 2 is given as the weighted average of the deposition velocity for the coarse mode and fine mode. In the results below method 1 has been used, based on the generalised particle-size distribution recommended by the USEPA as outlined in Table 8.50[11], as it gives similar concentrations to method 2 but significantly higher deposition results.

8.5.6.4.2 Wet Particulate Deposition

Wet particulate deposition physically washes out the chemically contaminated particulate from the atmosphere. Wet deposition flux depends on the fraction of the time precipitation occurs and the fraction of material removed by precipitation per unit of time by particle size. The AERMOD model formulation is based on a particle washout coefficient which is based on the collision efficiency and the mean diameter of raindrops. It is also assumed that the wet deposition flux is the same for snow as for rain.

8.5.6.4.3 Modelling Strategy

The emissions of mercury from the stack have been evaluated in terms of mass of release into both vapour and particle-bound phases. Thereafter, air dispersion and deposition modelling has been employed to translate these releases into ambient air vapour and particle phase concentrations, and wet and dry gaseous and particulate deposition amounts, in the vicinity of the release. The maximum emission scenario has been modelled as outlined in Table 8.69.

Table 8.69 Emission Scenario for Mercury

Pollutant	Scenario	Emission Concentration	Emission Rate (g/s)
Hg	Maximum	0.05 mg/m^3	0.00293
Hg	Abnormal(1)	1 mg/m^3	0.0586

(1) Abnormal operation scenario based on an emission level of 1 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

For the deposition modelling of mercury both wet and dry particulate and gaseous deposition were calculated.

8.5.6.5 Modelling Results

Table 8.70 – Table 8.73 detail the predicted mercury GLC for each vapour and particulate concentration and deposition scenario.

Table 8.70 Mercury Vapour Concentrations Under Maximum Operating Conditions

Oxidation State	Vapour Fraction	Vapour Emission Rate (g/sec)	Vapour Concentration (ng/m^3)
Elemental Hg	0.20	Maximum - 0.00059	0.082
Divalent Hg^{2+}	0.60	Maximum - 0.0018	0.245
Sum			0.327 nng/m^3

Table 8.71 Mercury Particulate Concentrations Under Maximum Operating Conditions

Oxidation State	Particulate Fraction	Particulate Emission Rate (g/sec)	Particulate Concentration (ng/m^3)
Divalent Hg^{2+}	0.20	Maximum - 0.00059	0.085

Table 8.72 Mercury Deposition Fluxes – Maximum Operating Conditions

Oxidation State	Fraction	Emission Rate (g/sec)	Annual Deposition Flux ($\mu g/m^2$/year)
Elemental Hg	Dry Gas	0.00059	0.049
	Wet Gas		<0.0001
	Total Gas		0.049
Divalent Hg^{2+}	Dry Gas & Particle	0.0023	0.53
	Wet Gas & Particle		0.80
	Total Gas & Particle		0.94
Sum of Total Deposition			0.94 $\mu g/m^2$/year

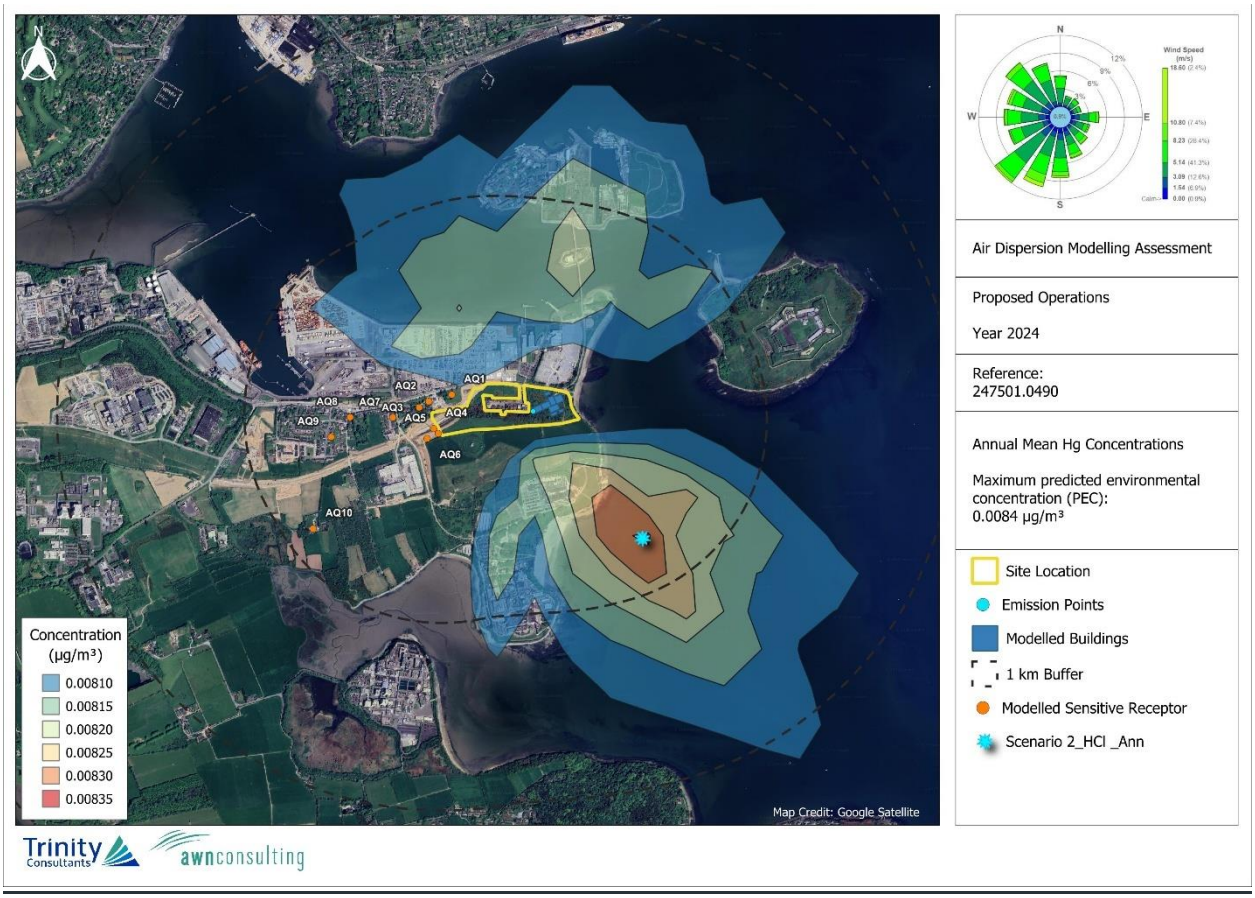
Table 8.73 Dispersion Model Summary Of Combined Vapour And Particulate Hg Concentrations Under Maximum And Abnormal Operating Conditions.

Pollutant / Scenario	Annual Mean Background (ng/m^3)	Averaging Period	Process Contribution (ng/m^3)	Predicted Emission Concentration (ng/Nm^3)	Standard (ng/Nm^3)
Hg / Maximum	8	Annual mean	0.41	8.41	1000
Hg / Abnormal	8	Annual mean	0.68	8.68	1000

8.5.6.6 Concentration Contours

The geographical variation in vapour mercury ground level concentrations beyond the Facility boundary is illustrated as concentration contours in Figure 8.30.

Figure 8.30 Maximum Operations: Predicted Mercury Annual Average Vapour and Particulate Concentration



8.5.6.7 Result Findings

Hg modelling results indicate that the ambient ground level concentrations are significantly below the WHO guideline under both typical and maximum operation of the facility. Thus, no adverse environmental effect is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient mercury combined concentration (both vapour and particle-bound) (including background concentrations) which are less than 1% of the annual average limit value at the boundary of the facility.

8.5.7 Heavy Metal Emissions and Results (excluding Mercury)

8.5.7.1 Modelling Approach

The emissions of heavy metals (except Hg) from the Ringaskiddy Resource Recovery Centre have been evaluated in terms of mass of release into the particulate phase only as recommended by the USEPA[10,11]. Thereafter, air dispersion and deposition modelling has been employed to translate these releases to ambient particle phase concentrations, and wet and dry particulate deposition amounts, in the vicinity of the release.

When modelling heavy metals (except Hg) the mass weighting rather than surface weighting is used for deposition as it is assumed that the metals are all in the particulate state (see Column 4 of Table 8.50). Results are shown under both maximum and abnormal operating conditions.

For the deposition modelling of heavy metals (except Hg) both wet and dry particulate deposition were calculated.

Ambient ground level concentrations (GLCs) and deposition values of Cadmium and Thallium (Cd & Tl) and the Sum of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu),

manganese (Mn), nickel (Ni) and vanadium (V) have been investigated using the concentration limits outlined in Council Directive 2010/75/EU (see Table 8.74 and Table 8.75 respectively) and also under abnormal operations at the facility.

Table 8.74 Maximum And Abnormal Operations for Cd & Tl

Pollutant	Scenario	Concentration	Emission Rate (g/s)
Cd & Tl	Maximum 24-Hr Operation	0.05 mg/m^3	0.00293
	Abnormal Operation(1)	0.2 mg/m^3	0.0117

Note 1 Abnormal operation scenario based on an emission level of 0.2 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.75 Emission Scenario for Heavy Metals Taken From Council Directive 2010/75/EU

Pollutant	Scenario	Concentration	Emission Rate (g/s)
Sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V	Maximum Operation	0.50 mg/m^3	0.0293
	Abnormal Operation(1)	30 mg/m^3	1.76

Note 1 Abnormal operation scenario based on an emission level of 30 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Data is available from the Carranstown incinerator facility operated by Indaver in Duleek, County Meath (see Table 8.76) indicating the emission levels of these metals based on typical and maximum recorded levels over the period 2017 - 2018. This source of data has been used to identify the likely ratio of metals when emitting under both maximum and abnormal operations (Table 8.77).

Table 8.76 Actual Measured Emission Data From An Incinerator Facility operated by Indaver In Duleek, County Meath Over The Period 2017 - 2018 (mg/Nm^3) (*Non-detects reported at the detection limit).*

Parameter	2017		2018		Average	Maximum
	Q1	Q2	Q1	Q2	2017-2018	2017-2018
As	0.0002	0.0005	0.0001	0.0001	0.0002	0.0005
Co	0.0001	0.0005	0.0001	0.0001	0.0002	0.0005
Cr	0.0008	0.0168	0.0014	0.0010	0.0050	0.0168
Cu	0.0014	0.0440	0.0015	0.0020	0.0122	0.0440
Mn	0.0002	0.0017	0.0003	0.0010	0.0008	0.0017
Ni	0.0016	0.0100	0.0007	0.0024	0.0037	0.0100
Pb	0.0003	0.0016	0.0003	0.0013	0.0009	0.0016
Sb	0.0001	0.0005	0.0001	0.0001	0.0002	0.0005
V	0.0001	0.0003	0.0001	0.0001	0.0002	0.0003

Table 8.77 Ratio Of Metals Emitting Based On Actual Measured Emission Data From Indaver In Duleek, County Meath Over The Period 2017 - 2018 (mg/Nm^3)

Parameter	Average[1]	Maximum[1]	Maximum Operation[2]	Abnormal Operation[2]
	2017 - 2018 (mg/m^3)	2017 - 2018 (mg/m^3)	0.50 mg/m^3	30 mg/m^3
As	0.0002	0.0005	0.003	0.198
Co	0.0002	0.0005	0.003	0.198
Cr	0.0050	0.0168	0.111	6.640
Cu	0.0122	0.0440	0.290	17.391
Mn	0.0008	0.0017	0.011	0.672
Ni	0.0037	0.0100	0.066	3.953
Pb	0.0009	0.0016	0.011	0.632
Sb	0.0002	0.0005	0.003	0.198
V	0.0002	0.0003	0.002	0.119
Sum Sb/As/Pb/Cr/Co/Cu/Mn/Ni/V	0.023 mg/m^3	0.076 mg/m^3	0.50 mg/m^3	30 mg/m^3

Note 1 Non-detects reported at the detection limit.

Note 2 Based on the ratio under maximum operation.

8.5.7.2 Comparison with Standards And Guidelines

In the absence of statutory standards, ambient air quality guidelines can also be derived from occupational exposure limits (OEL). Guidance has issued by the UK Environment Agency entitled "*IPPC Environmental Assessment for BAT*" (Environment Agency, 2003)[29]. The guidance outlines the approach for deriving both short-term and long-term environmental assessment levels (EAL). In relation to the long-term (annual) EAL, this can be derived by applying a factor of 100 to the 8-hour OEL. The factor of 100 allows for both the greater period of exposure and the greater sensitivity of the general population. For short-term (1-hour) exposure, the EAL is derived by applying a factor of 10 to the short term exposure limit (STEL). In this case, only the sensitivity of the general population need be taken into account as there is no need for additional safety factors in terms of the period of exposure. Where STELs are not listed then a value of 3 times the 8-hour time weighted average occupational exposure limit may be used. Predicted GLCs have been compared with the applicable ambient air quality guidelines and standards for the protection of human health as set out in Table 8.78 and Table 8.79.

A comparison of Table 8.76 and Table 8.77 with Table 8.79 indicates that Arsenic is the metal which is emitted at the most significant level relative to its annual average limit value and thus has been reported below. All other metals will have a lower effect on the ambient environment. Vanadium has also been investigated as it is emitted at the most significant level relative to the short-term limit values.

Table 8.78 Cd and Tl Ambient Air Quality Standards & Guidelines For The Protection of Human Health

Metal	Short-Term EAL (1-Hr)	Long-Term EAL (Annual)	Regulation
Cd	-	0.005 μg/m^3	WHO[3]
Cd	1.5 μg/m^3	0.005 μg/m^3	EU[1] / EAL[2]
Tl	30 μg/m^3	1.0 μg/m^3	EAL[2]

Note 1 Directive (EU) 2024/2881

Note 2 Environmental Agency (2003) "IPPC H1 - Environmental Assessment & Appraisal of BAT"

Note 3 WHO (2006) Air Quality Guidelines

Table 8.79 Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V Ambient Air Quality Standards & Guidelines For The Protection of Human Health

Metal	Short-Term EAL (1-Hr)	Long-Term EAL (Annual)	Regulation
Sb	150 μg/m^3	5 μg/m^3	EAL[2]
As	15 μg/m^3	0.006 μg/m^3[1]	EU[1] / EAL[2]
Pb	-	0.5 μg/m^3	EU[1]
Cr (except VI)	150 μg/m^3	5.0 μg/m^3	EAL[2]
Cr (VI)[4]	-	0.0002 μg/m^3	EAL[2]
Co	6 μg/m^3	0.2 μg/m^3	EAL[2]
Cu (fumes)	60 μg/m^3	2.0 μg/m^3	EAL[2]

Metal	Short-Term EAL (1-Hr)	Long-Term EAL (Annual)	Regulation
Cu (dust & mists)	200 μg/m³	10 μg/m³	EAL(2)
Mn	1500 μg/m³	1.0 μg/m³	WHO(3)
Ni (inorganic)	30 μg/m³	0.020 μg/m³(1)	EU(1)
V	1.0 μg/m³	5.0 μg/m³	EAL(2)

Note 1 Directive (EU) 2024/2881

Note 2 Environmental Agency (2003) "IPPC H1 - Environmental Assessment & Appraisal of BAT"

Note 3 WHO (2000) Air Quality Guidelines for Europe

Note 4 Environmental Agency (2011) "H1 Annex F Air Emissions v 2.2"

8.5.7.3 Modelling Results

8.5.7.3.1 Cadmium & Thallium

Air dispersion and deposition modelling was carried out for the two scenarios described in Section 8.11.1. Table 8.80, Table 8.81 and Table 8.82 detail the predicted Cd & Tl GLC and deposition value for each scenario and averaging period. The annual mean Cd contour plot is shown in Figure 8.31.

Table 8.80 Cd & Tl Particulate Concentrations Under Maximum And Abnormal Operation

Heavy Metal	Emission Rate (g/sec)	Ambient Concentration (ng/m³)
Cd & Tl	Maximum Operation - 0.00293	0.43
	Abnormal Operation - 0.0117	0.45

Note 1 Abnormal operation scenario based on an emission level of 0.2 mg/m³ for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.81 Cadmium & Thallium Deposition Fluxes – Maximum Operation

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (μg/m²/day)
Cd & Tl / Maximum Operation	Dry particulate	0.00293	0.62
	Wet particulate		2.61
Sum of Total Deposition			2.61 μg/m²/day
Cd & Tl / Abnormal Operation	Dry particulate	0.0117	0.63
	Wet particulate		2.82
Sum of Total Deposition			2.61 μg/m²/day

Note 1 Abnormal operation scenario based on an emission level of 0.2 mg/m³ for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.82 Cadmium & Thallium Particulate Concentration Summary

Pollutant / Scenario	Averaging Period	Process Contribution (ng/m³)	Annual Mean Background (ng/m³)	Predicted Emission Concentration (ng/Nm³)	Standard (ng/Nm³)(1)
Cd & Tl / Maximum	Annual mean	0.41	1	1.41	5.0
Cd & Tl / Abnormal	Annual mean	0.45	1	1.45	5.0

Note 1 Directive (EU) 2024/2881

8.5.7.3.2 Arsenic, Nickel and Vanadium

Table 8.83 – Table 8.86 detail the predicted GLC and deposition values for each scenario for Arsenic, Nickel and Vanadium. In terms of Vanadium, emission levels are based on the ratio of the Sum of Other Metals (Mn, Sb, Sn, V, Pb, Cr, Cu, Co & Ni) as outlined in Table 8.77. The annual mean Arsenic and Nickel contour plots are shown in Figure 8.32 and Figure 8.33.

Table 8.83 Arsenic, Nickel and Vanadium Particulate Concentration Under Maximum & Abnormal Operating Conditions

Heavy Metal	Emission Rate (g/sec)	Maximum 1-hour Concentration (ng/m3)	Annual Concentration (ng/m3)
Arsenic	Maximum - 0.000193	-	0.038
Nickel	Maximum - 0.0039	-	0.538
Vanadium	Maximum - 0.00012	0.572	-
Arsenic(1)	Abnormal - 0.0116	-	0.12
Nickel(2)	Abnormal - 0.232	-	1.67
Vanadium(3)	Abnormal - 0.0069	0.888	-

Note 1 Abnormal operation scenario based on an emission level of 0.26 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Note 2 Abnormal operation scenario based on an emission level of 3.8 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Note 3 Abnormal operation scenario based on an emission level of 0.084 mg/m^3 for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.84 Arsenic Deposition Fluxes – Maximum & Abnormal Operating Conditions

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (μg/m^2/day)
Arsenic / Maximum	Dry particulate	0.00019	0.055
	Wet particulate		0.230
Sum of Total Deposition			0.230 μg/m^2/day
Arsenic / Abnormal(1)	Dry particulate	0.0116	0.219
	Wet particulate		0.630
Sum of Total Deposition			0.630 μg/m^2/day

Note 1 Abnormal operation scenario based on an emission level of 0.0104 g/sec for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.85 Nickel Deposition Fluxes – Maximum & Abnormal Operating Conditions

Heavy Metal	Fraction	Emission Rate (g/sec)	Annual Deposition Flux (mg/m^2)
Nickel / Maximum	Dry particulate	0.0039	0.781
	Wet particulate		3.30
Sum of Total Deposition			3.30 μg/m^2/day
Nickel / Abnormal(1)	Dry particulate	0.232	2.99
	Wet particulate		8.88
Sum of Total Deposition			8.88 μg/m^2/day

Note 1 Abnormal operation scenario based on an emission level of 0.15 g/sec for 3% of the time (assumed to occur for one 24-hour period once per month).

Table 8.86 Dispersion Model Results – Arsenic and Vanadium

Heavy Metal / Scenario	Averaging Period	Process Contribution (ng/m^3)	Background (ng/m^3)	Predicted Emission Concentration (ng/Nm^3)	Standard (ng/Nm^3)
Arsenic / Maximum	Annual mean	0.038	1.0[1]	1.04	**6.0**[4]
Nickel / Maximum	Annual mean	0.43	9.0[2]	9.4	**20**[5]
Vanadium / Maximum	Maximum One-Hour	0.57	2.0[3]	2.6	**1000**[6]
Arsenic / Abnormal	Annual mean	0.12	1.0[1]	1.12	**6.0**[4]
Nickel / Abnormal	Annual mean	1.67	9.0[2]	10.67	**20.0**[5]
Vanadium / Abnormal	Maximum One-Hour	20.1	2.0[3]	22.1	**1000**[6]

Note 1 Background concentration for arsenic based on on-site monitoring
Note 2 Background concentration for nickel based on on-site monitoring
Note 3 Background concentration for vanadium based on on-site monitoring
Note 4 Ambient standard for arsenic which is the most stringent applicable limit value for this averaging period
Note 5 Ambient standard for nickel which is the most stringent applicable limit value for this averaging period
Note 6 Ambient standard for vanadium which is the most stringent applicable limit value for this averaging period.

8.5.7.3.3 Chromium (VI)

The UK Environment Agency (UKEA) has issued guidance on the release of Chromium (VI) from municipal waste incinerators[31]. The UKEA has recently published a substantially lower EAL for Cr(VI) of 0.2 ng/m^3. The guidance indicates that data on the release of Cr(VI) is limited but that in relation to the data gathered to date from 13 incinerators in the UK, based on measurements of total chromium and the ratio of Cr(VI) to total chromium in Air Pollution Control (APC) residues, the range in emission data is as follows:

- Mean = $3.5*10^{-5}$ mg/Nm^3
- Minimum = $2.3*10^{-6}$ mg/Nm^3
- Maximum = $1.3*10^{-4}$ mg/Nm^3

Shown in Table 8.87 is the estimated Cr(VI) release from the Ringaskiddy Resource Recovery facility and the predicted process contribution to the ambient environment as a results of these estimated releases.

Table 8.87 Dispersion Model Results – Chromium (VI)

Heavy Metal / Scenario	Emission Concentration ($\mu g/Nm^3$)[1]	Emission Rate (mg/s)	Averaging Period	Ambient Process Contribution (ng/m^3)	Standard (ng/Nm^3)[2]
Cr(VI) / Mean	0.035	0.00205	Annual mean	0.0049	0.25
Cr(VI) / Maximum	0.13	0.00762	Annual mean	0.018	0.25

Note 1 Cr(VI) emission rate taken from UKEA guidance[31]
Note 2 Air emissions risk assessment for your environmental permit - GOV.UK [30]

The results indicate that under typical conditions the Cr(VI) emissions from the facility are likely to lead to an ambient Cr(VI) concentration which is less than 2% of the EAL. Assuming maximum emissions of Cr(VI) for a full year at maximum operations leads to an ambient Cr(VI) concentration which is 7% of the EAL. Thus, Cr(VI) emissions from the facility are insignificant and will not increase existing background levels of this pollutant by a significant amount.

Figure 8.31 Maximum Operation: Predicted Cd Annual Average Concentration

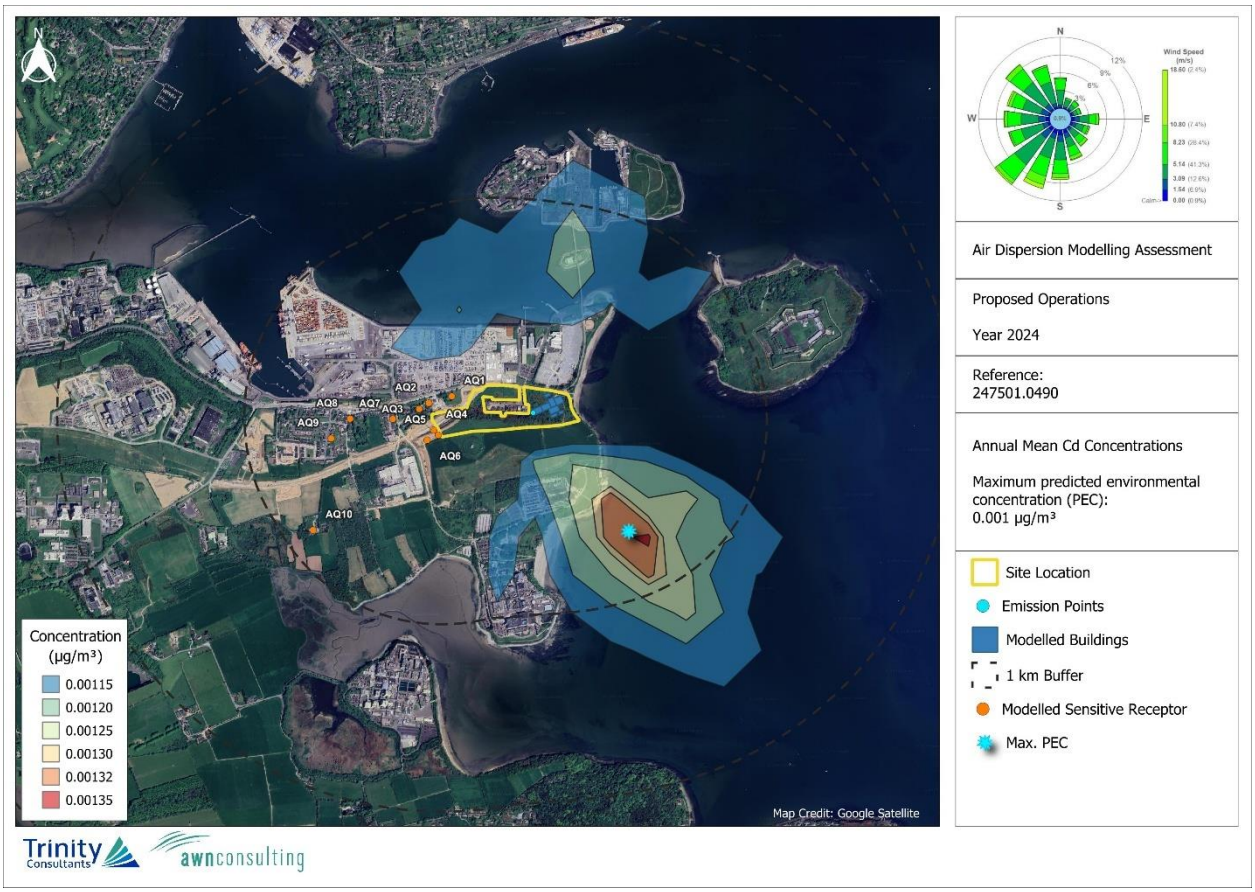


Figure 8.32 Maximum Operation: Predicted As Annual Average Concentration

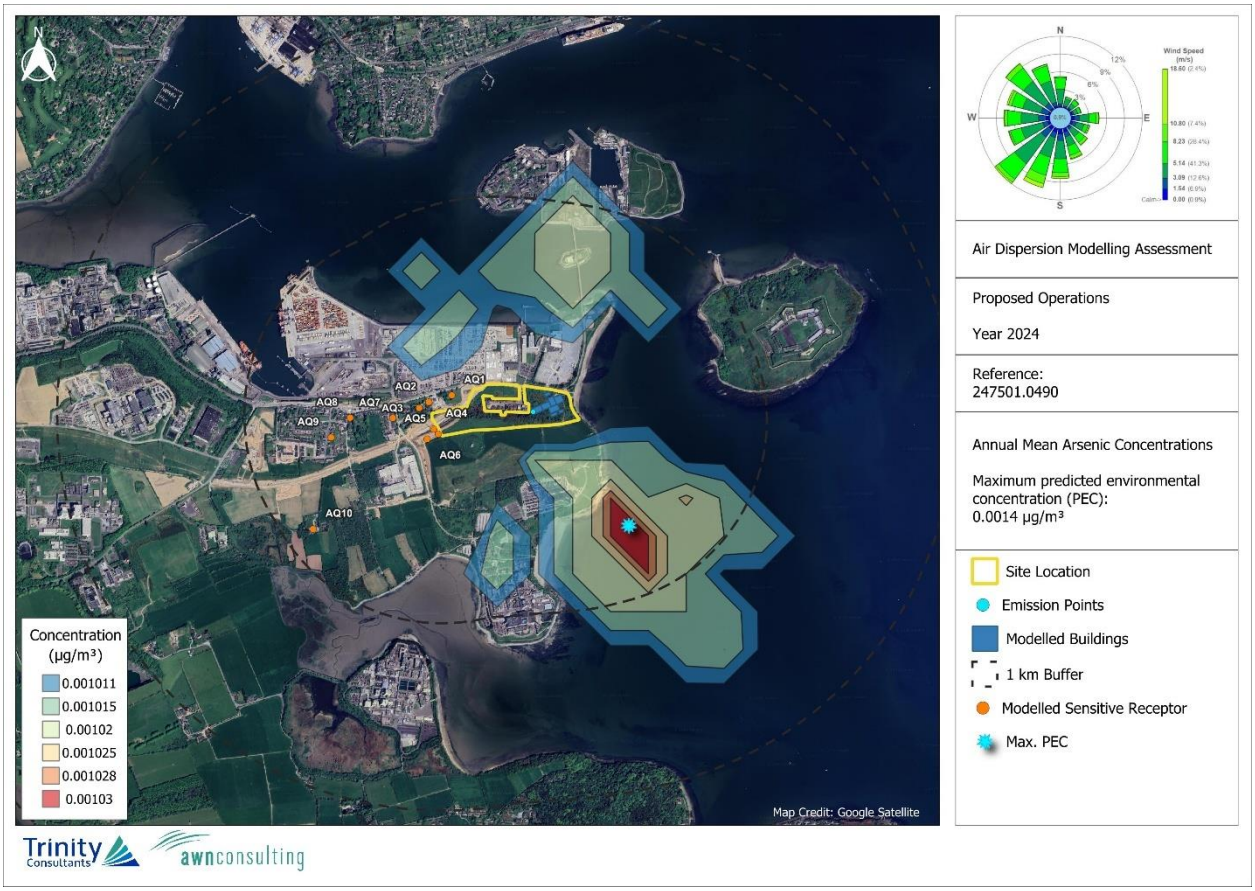
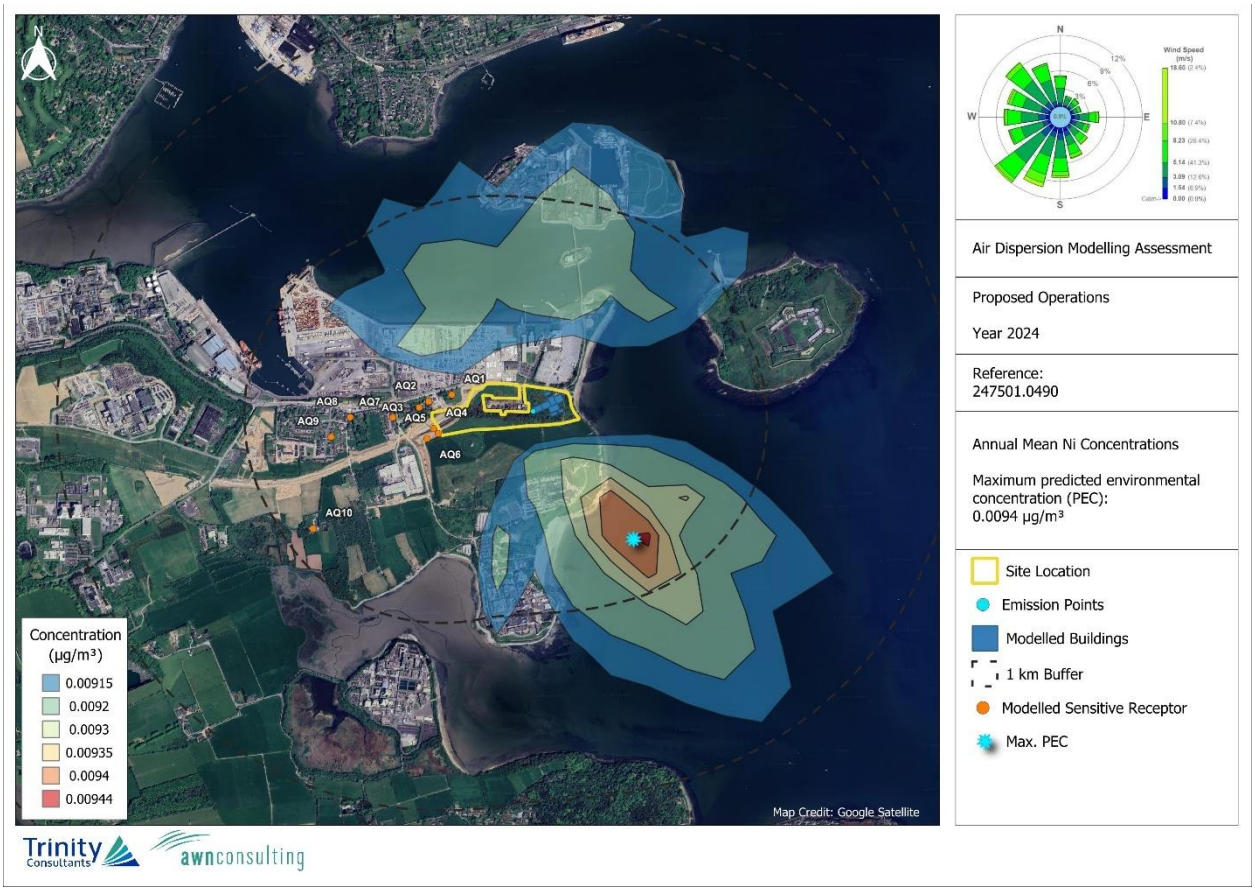


Figure 8.33 Maximum Operation: Predicted Ni Annual Average Concentration



8.5.7.4 Result Findings

8.5.7.4.1 Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for cadmium under maximum and abnormal operations of the facility. Emissions at maximum operations equate to an ambient Cd and Tl concentration (including background concentration) which is 29% of the annual limit value for Cd close to the facility boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

8.5.7.4.2 Sum of As, Ni, Sb, Pb, Cr, Co, Cu, Mn and V

Modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for the protection of human health for arsenic, nickel and vanadium (the metals with the most stringent limit values) under maximum and abnormal emissions from the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient As and Ni concentrations (including background concentrations) which are 17% and 47% of the annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are only 0.2% of the maximum 1-hour limit value at the worst-case receptor. Emissions under abnormal operations equate to ambient As and Ni concentrations (including background concentrations) which are 24% and 53% of the annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are 2% of the maximum 1-hour limit value at the worst-case receptor.

8.5.8 Summary of Effects

Based on the emission guidelines outlined in Council Directive 2010/75/EU, detailed air dispersion modelling has shown that the most stringent ambient air quality standards for the protection of human health are not exceeded either as a result of operating under maximum or abnormal operating conditions.

The modelling results indicate that the maximum long-term ambient GLC occurs at or near the facility's southern and south-east boundaries. The spatial effect of the facility is limited with concentrations falling off rapidly away from the maximum peak. Concentrations fall off rapidly away from this maximum and for the short-term averaging periods, at the nearest residential receptors, concentrations will be less than 6% of the short-term limit values under the maximum operating scenario (not including background concentrations). The annual average concentration has an even more dramatic decrease in maximum concentration away from the facility with concentrations from emissions at the proposed facility accounting for less than 1% of the limit value (not including background concentrations) at worst case sensitive receptors near the facility under the maximum operating scenario for the facility.

In the surrounding areas of Cobh, Carrigaline and Monkstown levels are significantly lower than most background sources with the concentrations from emissions at the proposed facility accounting for less than 1% of the annual limit values for the protection of human health for all pollutants under maximum operations of the facility.

8.6 CALPUFF Assessment

The CALPUFF modelling system has been recommended by the USEPA as a Guideline Model for source-receptor distances of greater than 50km and for use on a case-by-case basis in complex flow situations within 50km[(1)]. CALPUFF has some important advantages over steady-state Gaussian models such as AERMOD in areas of complex meteorology. Firstly, AERMOD, being a steady state straight line plume model cannot respond to the terrain-induced spatial variability in wind fields. Secondly, as AERMOD is based on a single-station wind observation, the wind fields do not vary spatially within the modelling domain. Thirdly, AERMOD cannot treat calm conditions and does not calculate concentrations during these hours. Because of these limitations, CALPUFF would be expected to more accurately reflect the meteorological and dispersion characteristics of the modelling domain and thus lead to more accurate ambient air concentrations. As shoreline fumigation was also raised as a possible concern in the previous application and AERMOD does not have the capability to model this phenomenon, CALPUFF (version 6.42) was selected as the most appropriate model which could assess all possible meteorological conditions within the one air dispersion model with the modelling domain shown in Figure 8.34.

8.6.1 MM5 / CALMET Set-Up

Meteorological data is an important input into the air dispersion model. The local airflow pattern will be influenced by the geographical location. Important features will be the location of hills and valleys or land-water-air interfaces and whether the existing and proposed facilities are located in simple or complex terrain.

Meteorological data for the assessment was based on various sources of information. Firstly, the Fifth Generation Penn State/NCAR (National Centre for Atmospheric Research) Mesoscale Model (known as MM5) was used for the years 2006 and 2007. The model output consists of hourly values of wind speed, wind direction, temperature and pressure on a grid size of 80 km x 80 km centred in Ringaskiddy. The data had 18 vertical levels with a base level of 15 m and a horizontal resolution of 12 km.

CALMET meteorological pre-processor used the three-dimensional MM5 data along with all available surface observations within the 80km x 80km grid. As no upper air observation stations were located within or near to the modelling domain, upper air data was obtained from MM5 and extrapolation of

surface observations. One synoptic meteorological station operated by Met Éireann was identified near the site – Cork Airport. Data collection of greater than 90% for all parameters is required for air dispersion modelling. Cork Airport fulfils this requirement. A second surface station operated by Indaver as part of the current application was available for the year 2007 and thus was also used in the assessment. Buoy data for the stations M3 and M5 for 2006 and 2007 was obtained from the Marine Institute.

The CALMET modelling domain covered an area of 80km x 80km centred in Ringaskiddy. The CALMET wind field data had 11 vertical levels with a base level of 10m and a horizontal resolution of 1 km. The eleven vertical levels are at 20, 40, 80, 160, 320, 650, 1000, 1500, 2200, 3000 and 4000 metres.

The horizontal resolution of 500 metres was used to resolve the terrain variations in the region. Terrain data was obtained from the Shuttle Radar Topography Mission (SRTM) which is a digital elevation data set that spans the globe from 60° north latitude to 56° south latitude. It has a horizontal grid spacing of 1 arc-seconds (approximately 30m) and is shown in Figure 8.30 for the CALMET modelling domain as shown in Figure 8.35.

Land use data from the U.S. Geological Survey (USGS) and the European Commission's Joint Research Centre (JRC) based on a 1-km resolution Global Land Cover Characteristics (GLCC) database was processed to generate a gridded field of dominant land use categories and land-use weighted values of surface and vegetation properties for each grid cell. The predominant land use in the CALMET domain is shown in Figure 8.36.

Gridded MM5 meteorological fields which were purchased from TRC (Lowell, MA, USA), were used to define the initial guess fields for the CALMET simulations. The MM5 simulations were made for the periods January to December 2006 and January to December 2007, the same period selected for the CALMET/CALPUFF runs. The MM5 data were produced at a horizontal resolution of 12 km and at 18 vertical sigma levels.

Two stages are involved in developing the CALMET wind field. The first step, the Step 1 wind field, CALMET adjusts the initial guess field to reflect slope flows and blocking effects. Slope flows are a function of the local slope and altitude of the nearest crest. The crest is. defined as the highest peak within a radius TERRAD around each grid point. A value of TERRAD of 15 km was considered most appropriate for the computational domain. The Step 1 field produces a flow field consistent with the fine-scale CALMET terrain resolution (0.5 km).

In the second step, the Step 2 wind field, observations are incorporated into the Step 1 wind field to produce a final wind field. The philosophy behind the Step 2 wind field is to ensure that observational data strongly influences the final wind field in the region of the observational stations whilst the MM5 data is strongly weighted in the region were no observational data is available. Parameters R1 at the surface and R2 aloft determine the weighting of the Step 1 (MM5 data) and observational data. In the current application, relatively small values (5 km) for R1 and R2 were selected because the two meteorological stations (Cork Airport and the On-site Station) in the vicinity of the proposed facility and existing facilities are located quite close to each other (at a distance of less than 15 km), and each of these stations should have an important weighting in the vicinity of each station.

A second set of parameters defines the area of influence of each station (parameters RMAX1 at the surface and RMAX2 aloft). Since the initial guess field is driven by the MM5 winds and terrain effects are expected to be important, RMAX1 and RMAX2 were set to 10 km in order to give greater weight to the surface station and RMIN=0.1 km. As the buoys (M3 and M5) are located at a distance of up to 60 km off-shore, RMAX3 which defines the radius of influence of the buoy was set to 100km.

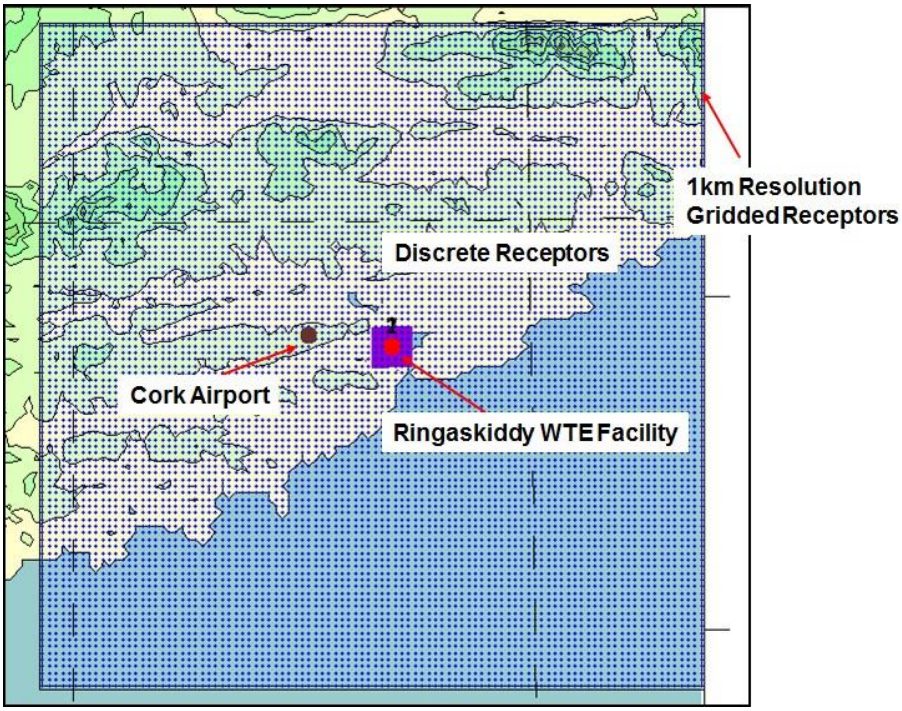
8.6.2 CALPUFF Set-Up

Emissions from the proposed site have been modelled using the CALPUFF dispersion model (Version 6.42) which has been developed by Earth Tech (now part of Exponent) and has been approved by the U.S. Environmental Protection Agency (USEPA)[(1)] for long-range transport and on a case-by-case

basis for near-field (less than 50km) applications involving complex meteorological conditions. The model is a non-steady-state Lagrangian puff model used to assess pollutant concentrations associated with a wide range of sources including industrial sources.

A receptor grid measuring 80 km by 80 km with the site at the centre was mapped out with terrain information at each receptor, derived from Shuttle Radar Topography Mission (SRTM) with 30 m resolution as input into the model.

Figure 8.34 CALPUFF Modelling Grid For The Ringaskiddy Resource Recovery Centre, Ringaskiddy, County Cork



Trinity Consultants awnconsulting

The Tecpro Building, Clonshaugh Business and Technology Park, Dublin 17
T: +353 1 847 4220 F: +353 1 847 4257

Project
Ringaskiddy RRC.

Figure
CALPUFF Modelling Grid For The Ringaskiddy Resource Recovery Centre, Ringaskiddy, County Cork

Figure 8.35 SRTM Terrain Data In Region of Ringaskiddy

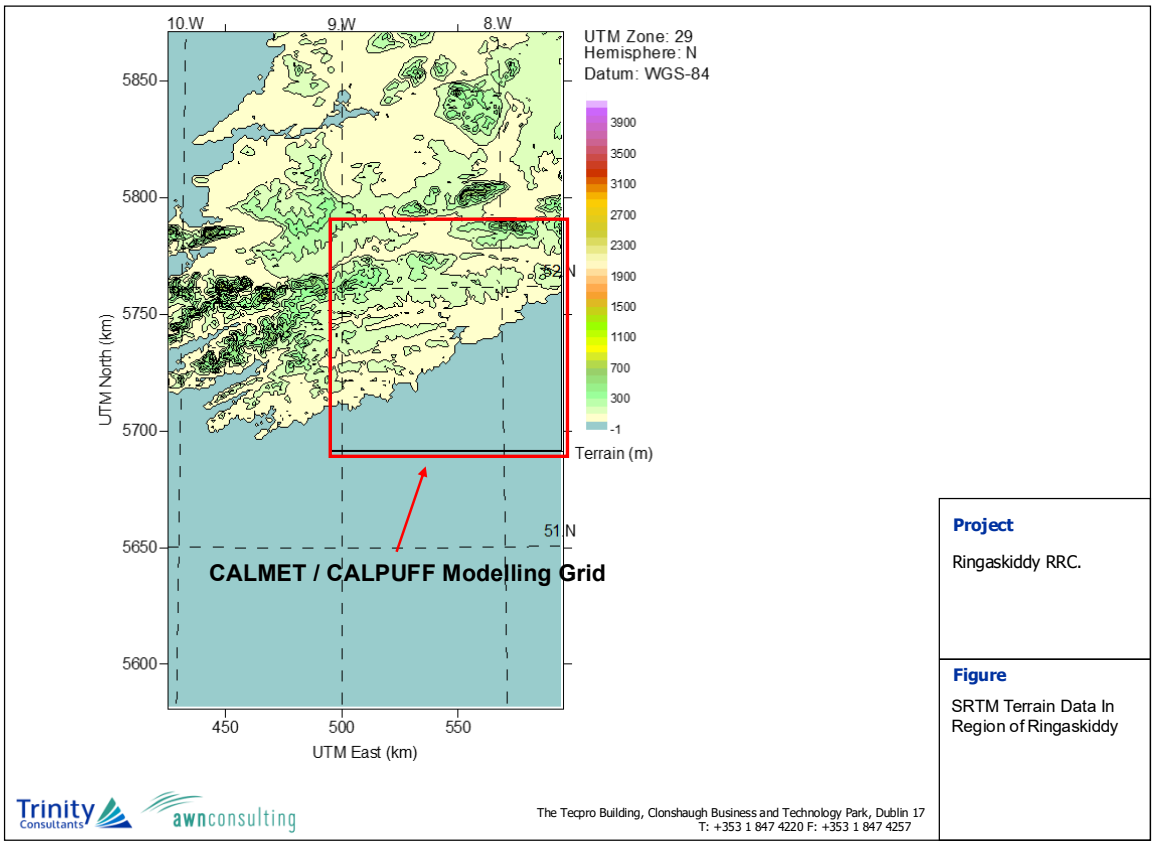
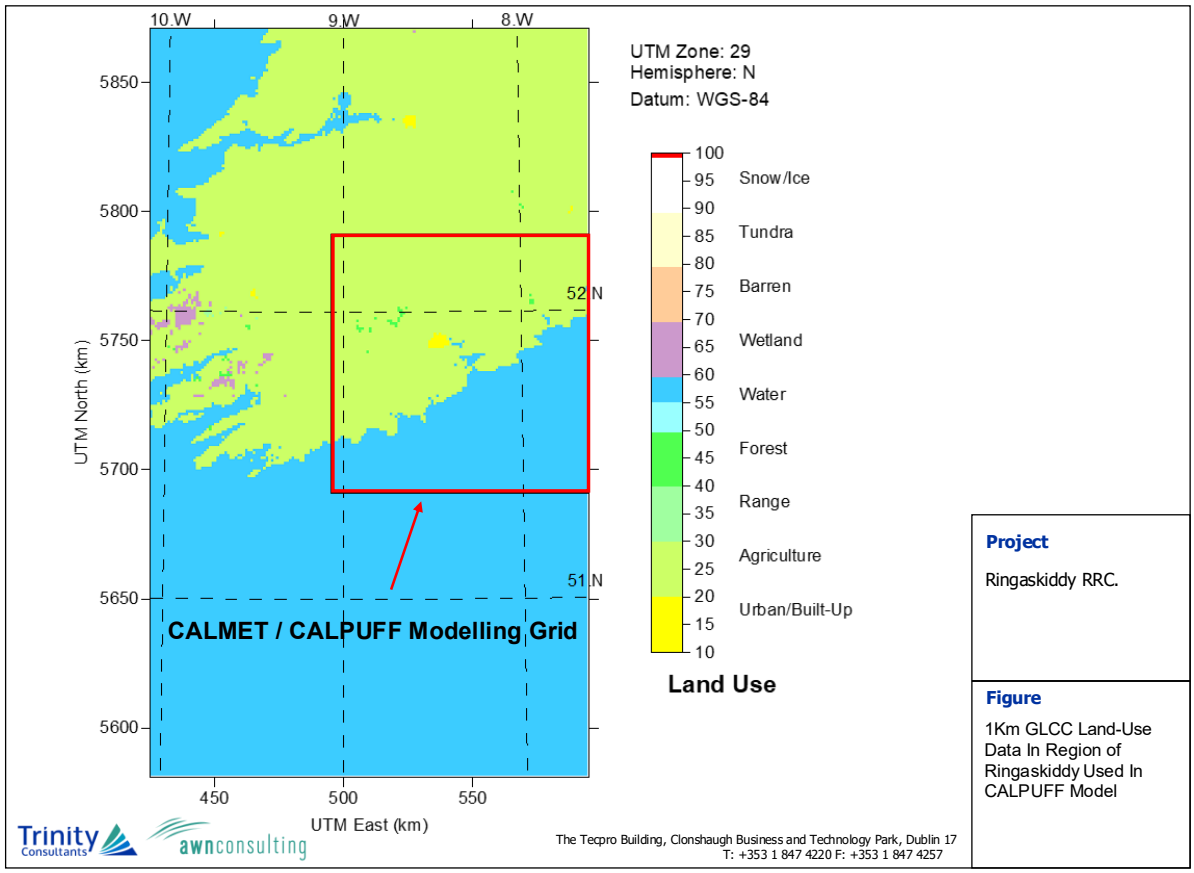


Figure 8.36 1Km GLCC Land-Use Data In Region of Ringaskiddy Used In CALPUFF Model



8.6.3 CALPUFF Modelling Results

The main study conclusions are presented below for each substance in turn with a graphical summary of results in comparison to the previously obtained AERMOD results presented in Figures 8.6 and 8.7 and in Table 8.88 and Table 8.89. Modelling was undertaken for both 2006 and 2007 with the worst-case result for either year reported for each averaging period.

8.6.3.1 NO_2 & NO_X

NO_2 modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for nitrogen dioxide under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations lead to ambient NO_2 concentrations (including background concentrations) which are 67% of the maximum ambient 1-hour limit value (measured as a 99.8th%ile) and 32% of the annual average limit value at the respective worst-case receptors.

8.6.3.2 SO_2, CO, PM_{10} & $PM_{2.5}$

Modelling results indicate that ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for sulphur dioxide, carbon monoxide and PM_{10} under maximum and abnormal operation of the facility. Results will also be below the air quality standard for $PM_{2.5}$ under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) ranging from 10% - 58% of the respective limit values at the worst-case receptors.

8.6.3.3 TOC, HCl & HF

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality guidelines for the protection of human health for TOC (assumed pessimistically to consist solely of benzene), HCl and HF under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient concentrations (including background concentrations) for HCl and TOC of only 18% and 21% respectively of the ambient limit values.

HF modelling results indicate that emissions at maximum operations equate to ambient HF concentrations (including background concentrations) which will be 6% of the maximum ambient 1-hour limit value and 2% of the annual limit value.

8.6.3.4 PCDD / PCDFs (Dioxins/Furans)

Currently, no internationally recognised ambient air quality concentration or deposition standards exist for PCDD/PCDFs (Dioxins/Furans). The EU, USEPA and WHO recommended approach to assessing the risk to human health from Dioxins/Furans entails a detailed risk assessment analysis involving the determination of the effect of Dioxins/Furans in terms of the TDI (Tolerable Daily Intake) or TWI (Tolerable Weekly Intake) approach. The EU currently proposes a maximum TWI of between 14 pg WHO-TEQ/kg of body weight per day.

Background levels of Dioxins/Furans occur everywhere and existing levels in the surrounding area have been extensively monitored as part of this study. Monitoring results indicate that the existing levels are similar to rural areas in the UK and Ireland. The contribution from the facility in this context is minor, with levels at the worst-case receptor to the south of the Facility, under maximum and abnormal operation, accounting for only a small fraction of existing levels. Levels at the nearest residential receptor will be minor, with the annual contribution from the proposed facility accounting for less than 1% of the existing background concentration under maximum operating conditions.

8.6.3.5 PAHs

PAHs modelling results indicate that the ambient ground level concentrations will be below the relevant air quality limit value for the protection of human health under maximum and abnormal operation of the Facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient benzo[*a*]pyrene concentrations (excluding background concentrations) which are only 0.5% of the EU annual average limit value at the worst-case receptor.

8.6.3.6 Hg

Hg modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health under maximum and abnormal operation of the facility. Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Emissions at maximum operations equate to ambient mercury concentrations (including background concentrations) which are only 0.8% of the annual average limit value at the worst-case receptor.

8.12.3.7 Cd and Tl

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standard for the protection of human health for cadmium under maximum and abnormal operation from the facility. Emissions at maximum levels equate to ambient Cd and Tl concentrations (including background concentrations) which are 25% of the EU annual limit value for Cd close to the facility boundary (the comparison is made with the Cd limit value as this is more stringent than that for Tl).

8.12.3.8 Sum of As, Sb, Pb, Cr, Co, Cu, Ni, Mn and V

Modelling results indicate that the ambient ground level concentrations will be below the relevant air quality standards for the protection of human health for arsenic (As), Nickel (Ni) and vanadium (V) (the metals with the most stringent limit values) under maximum and abnormal operation emissions from the facility (based on the ratio of metals measured at a Waste to Energy facility in Carranstown, County Meath). Thus, no adverse effect on public health or the environment is envisaged to occur under these conditions at or beyond the facility boundary. Ambient concentrations have been compared to the annual limit value for As and Ni and the maximum 1-hour limit value for V as these represent the most stringent limit values for the suite of metals. Emissions at maximum operations equate to ambient As and Ni concentrations (including background concentrations) which are 17% and 47% of the EU annual limit value respectively at the worst-case receptor whilst emissions at maximum operations equate to ambient V concentrations (including background concentrations) which are only 0.7% of the maximum 1-hour limit value at the worst-case receptor.

Table 8.88 CALPUFF Modelling Results Under Maximum Operations μg/m³).

Pollutant	NO_2		NO_x	SO_2			PM_{10}		$PM_{2.5}$		CO	TOC	HCl	
Averaging Period	1-hr	Annual	Annual	1-hr	24-hr	Annual	24-hr	Annual	24-hr	Annual	8-Hr	Ann	1-hr	Annual
Baseline & Site Traffic Concentration (Year 2030)	20	10	13	6	6	3	21.9	10	21.9	6	3400	1	4.4	2.2
Process Emissions	109.5	0.73	1	41.4	3.6	0.15	0.2	0.05	0.2	0.05	49	0.048	144	0.048
Predicted Environmental Concentration (Year 2030)	129.5	10.73	14	47.4	9.6	3.15	22.1	10.05	22.1	6.05	3449	1.048	148.4	2.248
Ambient Air Quality Standard	**200**	**20**	**30**	**350**	**50**	**20**	**45**	**20**	**25**	**10**	**10000**	**3.4**	**800**	**20**

Table 8.89 CALPUFF Modelling Results Under Maximum Operations (μg/m³).

Pollutant	HF		Dioxins (fg/m³)	PAHs	Hg	Cd (ng/m³)	As (ng/m³)	Ni (ng/m³)	V
Averaging Period	1-hr	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Maximum 1-Hr
Annual Baseline & Site Traffic Concentration (Year 2030)	0.64	0.32	31	0.25	0.008	1	1	9	0.002
Process Emissions	9.6	0.0048	0.71	0.005	0.0002	0.24	0.02	0.32	0.005
Predicted Environmental Concentration (Year 2030)	10.2	0.33	31.7	0.255	0.009	1.24	1.02	9.32	0.007
Ambient Air Quality Standard	**160**	**16**	**N/A**	**1,000**	**1**	**5**	**6**	**20**	**1**

8.7 Ecology Results – Proposed Operations

8.7.1 NO_X – Proposed Operations

The NO_X modelling results for ecological receptors under the Proposed Operations scenario are detailed in Table 8.90.

As per Section 8.2.2.3, process contributions (PCs) of NO_X at the ecological receptors within the Zone of Influence (ZoI) identified in Section 8.3.3.1 were compared to the relevant critical level (identified in Section 8.2.2.1).

Where a PC is greater than 1% of the critical level, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC. The potential for adverse effect of these PECs is determined by the project ecologist in the AA.

PCs are greater than 1% of the relevant critical level within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, emissions from the facility lead to an ambient NO_x concentration (including background) which is at most 20% of the annual limit value site over the five years of meteorological data modelled.

PCs are greater than 1% of the relevant critical level within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, emissions from the facility lead to an ambient NO_x concentration (including background) which is at most 19% of the annual limit value site over the five years of meteorological data modelled.

Table 8.90. Proposed Operations – NO_X Designated Habitat Dispersion Model Results

Ecological Receptor	NO_X Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³) (screened in)	PEC % of critical level
	2020	2021	2022	2023	2024						
European Sites (Natura 2000)											
Great Island Channel SAC	0.12	0.11	0.10	0.12	0.11	30	0.4%	No	n/a	n/a	n/a
Ballycotton Bay SPA	0.02	0.02	0.02	0.02	0.02	30	0.1%	No	n/a	n/a	n/a
Cork Harbour SPA	1.13	1.16	1.02	1.01	1.31	30	4.4%	Yes	4.7	6.01	20%
National Sites											
Ballycotton, Ballynamona And Shanagarry pNHA	0.02	0.02	0.02	0.02	0.02	30	0.1%	No	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.05	0.06	0.05	0.06	0.05	30	0.2%	No	n/a	n/a	n/a
Blarney Bog pNHA	0.01	0.02	0.02	0.02	0.01	30	0.1%	No	n/a	n/a	n/a
Carrigacrump Caves pNHA	0.02	0.02	0.02	0.03	0.02	30	0.1%	No	n/a	n/a	n/a
Carrigshane Hill pNHA	0.09	0.05	0.08	0.08	0.08	30	0.3%	No	n/a	n/a	n/a
Cork Lough pNHA	0.02	0.02	0.02	0.02	0.02	30	0.1%	No	n/a	n/a	n/a
Cuskinny Marsh pNHA	0.15	0.14	0.12	0.16	0.15	30	0.5%	No	n/a	n/a	n/a
Douglas River Estuary pNHA	0.04	0.04	0.05	0.05	0.05	30	0.2%	No	n/a	n/a	n/a
Dunkettle Shore pNHA	0.03	0.03	0.03	0.04	0.04	30	0.1%	No	n/a	n/a	n/a
Fountainstown Swamp pNHA	0.04	0.03	0.03	0.04	0.04	30	0.1%	No	n/a	n/a	n/a
Glanmire Wood pNHA	0.02	0.03	0.03	0.04	0.03	30	0.1%	No	n/a	n/a	n/a

Ecological Receptor	NO_x Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³) (screened in)	PEC % of critical level
	2020	2021	2022	2023	2024						
Great Island Channel pNHA	0.12	0.11	0.10	0.12	0.11	30	0.4%	No	n/a	n/a	n/a
Leamlara Wood pNHA	0.06	0.07	0.06	0.08	0.06	30	0.3%	No	n/a	n/a	n/a
Lee Valley pNHA	0.01	0.02	0.02	0.02	0.01	30	0.1%	No	n/a	n/a	n/a
Lough Beg (Cork) pNHA	1.20	1.32	1.11	1.04	1.48	30	4.9%	Yes	4.2	5.7	19%
Loughs Aderry And Ballybutler pNHA	0.07	0.04	0.06	0.06	0.06	30	0.2%	No	n/a	n/a	n/a
Minane Bridge Marsh pNHA	0.02	0.02	0.02	0.02	0.02	30	0.1%	No	n/a	n/a	n/a
Monkstown Creek pNHA	0.17	0.18	0.21	0.21	0.22	30	0.7%	No	n/a	n/a	n/a
Owenboy River pNHA	0.05	0.04	0.05	0.04	0.04	30	0.2%	No	n/a	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.04	0.06	0.06	0.06	0.05	30	0.2%	No	n/a	n/a	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.06	0.05	0.05	0.06	0.06	30	0.2%	No	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.06	0.06	0.05	0.05	0.09	30	0.3%	No	n/a	n/a	n/a
Whitegate Bay pNHA	0.08	0.08	0.08	0.08	0.08	30	0.3%	No	n/a	n/a	n/a

8.7.2 NH_3 – Proposed Operations

The NH_3 modelling results for ecological receptors under the Proposed Operations scenario are detailed in Table 8.91.

As per Section 8.2.2.3, process contributions (PCs) of NH_3 at the ecological receptors within the Zone of Influence (ZoI) identified in Section 8.3.3.1 were compared to the relevant critical level (identified in Section 8.2.2.1).

Where a PC is greater than 1% of the critical level, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC. The potential for adverse effect of these PECs is determined by the project ecologist in the AA.

PCs are greater than 1% of the relevant critical level within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, emissions from the facility lead to an ambient NH_3 concentration (including background) which is at most 70% of the annual limit value site over the five years of meteorological data modelled.

PCs are greater than 1% of the relevant critical level within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, emissions from the facility lead to an ambient NH_3 concentration (including background) which is at most 70% of the annual limit value site over the five years of meteorological data modelled.

Table 8.91 Proposed Operations – NH_3 Designated Habitat Dispersion Model Results

Ecological Receptor	NH_3 Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critical level
	2020	2021	2022	2023	2024						
European Sites (Natura 2000)											
Great Island Channel SAC	0.009	0.008	0.007	0.009	0.008	3	0.3%	No	n/a	n/a	n/a
Ballycotton Bay SPA	0.001	0.001	0.001	0.001	0.001	3	0.0%	No	n/a	n/a	n/a
Cork Harbour SPA	0.085	0.087	0.076	0.076	0.098	3	3.3%	Yes	2.0	2.1	70%
National Sites											
Ballycotton, Ballynamona And Shanagarry pNHA	0.001	0.001	0.001	0.002	0.001	3	0.1%	No	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.004	0.004	0.004	0.005	0.004	3	0.2%	No	n/a	n/a	n/a
Blarney Bog pNHA	0.001	0.001	0.001	0.001	0.001	1	0.1%	No	n/a	n/a	n/a
Carrigacrump Caves pNHA	0.002	0.002	0.002	0.002	0.002	3	0.1%	No	n/a	n/a	n/a
Carrigshane Hill pNHA	0.007	0.004	0.006	0.006	0.006	3	0.2%	No	n/a	n/a	n/a
Cork Lough pNHA	0.001	0.002	0.002	0.002	0.001	3	0.1%	No	n/a	n/a	n/a
Cuskinny Marsh pNHA	0.011	0.010	0.009	0.012	0.011	3	0.4%	No	n/a	n/a	n/a
Douglas River Estuary pNHA	0.003	0.003	0.004	0.004	0.004	3	0.1%	No	n/a	n/a	n/a
Dunkettle Shore pNHA	0.002	0.002	0.003	0.003	0.003	3	0.1%	No	n/a	n/a	n/a
Fountainstown Swamp pNHA	0.003	0.003	0.002	0.003	0.003	3	0.1%	No	n/a	n/a	n/a
Glanmire Wood pNHA	0.002	0.002	0.002	0.003	0.003	3	0.1%	No	n/a	n/a	n/a
Great Island Channel pNHA	0.009	0.008	0.007	0.009	0.008	3	0.3%	No	n/a	n/a	n/a
Leamlara Wood pNHA	0.005	0.006	0.005	0.006	0.005	3	0.2%	No	n/a	n/a	n/a
Lee Valley pNHA	0.001	0.001	0.001	0.001	0.001	1	0.1%	No	n/a	n/a	n/a
Lough Beg (Cork) pNHA	0.090	0.099	0.083	0.078	0.111	3	3.7%	Yes	2.000	2.1	70%
Loughs Aderry And Ballybutler pNHA	0.005	0.003	0.004	0.005	0.004	3	0.2%	No	n/a	n/a	n/a
Minane Bridge Marsh pNHA	0.002	0.001	0.002	0.001	0.001	3	0.1%	No	n/a	n/a	n/a
Monkstown Creek pNHA	0.013	0.014	0.015	0.016	0.016	3	0.5%	No	n/a	n/a	n/a
Owenboy River pNHA	0.003	0.003	0.003	0.003	0.003	3	0.1%	No	n/a	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.003	0.004	0.005	0.004	0.004	3	0.2%	No	n/a	n/a	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.005	0.003	0.004	0.004	0.004	3	0.2%	No	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.005	0.005	0.004	0.003	0.006	3	0.2%	No	n/a	n/a	n/a
Whitegate Bay pNHA	0.006	0.006	0.006	0.006	0.006	3	0.2%	No	n/a	n/a	n/a

8.7.3 SO_2 – Proposed Operations

The SO_2 modelling results for ecological receptors under the Proposed Operations scenario are detailed in PCs are greater than 1% of the relevant critical level within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 5% of the annual limit value site over the five years of meteorological data modelled.

PCs are greater than 1% of the relevant critical level within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 5% of the annual limit value site over the five years of meteorological data modelled.

As per Section 8.2.2.3, process contributions (PCs) of SO_2 at the ecological receptors within the Zone of Influence (ZoI) identified in Section 8.3.3.1 were compared to the relevant critical level (identified in Section 8.2.2.1).

PCs are greater than 1% of the relevant critical level within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 6% of the annual limit value site over the five years of meteorological data modelled.

PCs are greater than 1% of the relevant critical level within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, emissions from the facility lead to an ambient SO_2 concentration (including background) which is at most 5% of the annual limit value site over the five years of meteorological data modelled.

Table 8.92. Proposed Operations – SO_2 Designated Habitat Dispersion Model Results

Ecological Receptor	SO_2 Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critical level
	2020	2021	2022	2023	2024						
European Sites (Natura 2000)											
Great Island Channel SAC	0.029	0.027	0.024	0.031	0.028	20	0.2%	No	n/a	n/a	n/a
Ballycotton Bay SPA	0.004	0.004	0.004	0.005	0.004	20	0.0%	No	n/a	n/a	n/a
Cork Harbour SPA	0.284	0.289	0.254	0.253	0.328	20	1.6%	Yes	0.60	0.928	5%
National Sites											
Ballycotton, Ballynamona And Shanagarry pNHA	0.004	0.004	0.004	0.005	0.004	20	0.0%	No	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.013	0.014	0.013	0.016	0.014	20	0.1%	No	n/a	n/a	n/a
Blarney Bog pNHA	0.004	0.004	0.004	0.004	0.004	20	0.0%	No	n/a	n/a	n/a
Carrigacrump Caves pNHA	0.006	0.006	0.006	0.006	0.006	20	0.0%	No	n/a	n/a	n/a
Carrigshane Hill pNHA	0.024	0.013	0.020	0.020	0.019	20	0.1%	No	n/a	n/a	n/a
Cork Lough pNHA	0.004	0.005	0.005	0.006	0.004	20	0.0%	No	n/a	n/a	n/a
Cuskinny Marsh pNHA	0.038	0.035	0.031	0.039	0.037	20	0.2%	No	n/a	n/a	n/a
Douglas River Estuary pNHA	0.009	0.011	0.012	0.013	0.012	20	0.1%	No	n/a	n/a	n/a
Dunkettle Shore pNHA	0.007	0.008	0.009	0.010	0.009	20	0.1%	No	n/a	n/a	n/a
Fountainstown Swamp pNHA	0.010	0.009	0.008	0.009	0.010	20	0.0%	No	n/a	n/a	n/a
Glanmire Wood pNHA	0.006	0.007	0.008	0.009	0.009	20	0.0%	No	n/a	n/a	n/a

Ecological Receptor	SO_2 Process Contributions (µg/m³)					Critical Level (µg/m³)	Max PC % of Critical Level	Considered for further assessment?	Back-ground (µg/m³)	PEC (µg/m³)	PEC % of critical level
	2020	2021	2022	2023	2024						
Great Island Channel pNHA	0.029	0.026	0.024	0.030	0.028	20	0.2%	No	n/a	n/a	n/a
Leamlara Wood pNHA	0.015	0.018	0.015	0.021	0.016	20	0.1%	No	n/a	n/a	n/a
Lee Valley pNHA	0.004	0.004	0.004	0.005	0.004	20	0.0%	No	n/a	n/a	n/a
Lough Beg (Cork) pNHA	0.301	0.330	0.278	0.261	0.370	20	1.9%	Yes	0.600	0.970	5%
Loughs Aderry And Ballybutler pNHA	0.017	0.010	0.014	0.015	0.015	20	0.1%	No	n/a	n/a	n/a
Minane Bridge Marsh pNHA	0.005	0.004	0.006	0.005	0.005	20	0.0%	No	n/a	n/a	n/a
Monkstown Creek pNHA	0.044	0.045	0.051	0.052	0.054	20	0.3%	No	n/a	n/a	n/a
Owenboy River pNHA	0.011	0.010	0.012	0.010	0.011	20	0.1%	No	n/a	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.010	0.014	0.015	0.014	0.012	20	0.1%	No	n/a	n/a	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.016	0.011	0.012	0.014	0.014	20	0.1%	No	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.015	0.015	0.012	0.011	0.022	20	0.1%	No	n/a	n/a	n/a
Whitegate Bay pNHA	0.019	0.021	0.021	0.019	0.020	20	0.1%	No	n/a	n/a	n/a

8.7.4 Nitrogen Deposition – Proposed Operations

In order to consider the effects of nitrogen deposition (as N) owing to emissions from the facility on ecological receptors, 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 8.3.3.2) and shown in Table 8.93 and Table 8.94.

As per Section 8.2.2.2, process contributions (PCs) of nitrogen deposition at ecological receptors were compared to the relevant critical load (identified in Section 8.2.2.2).

Where a PC is greater than 1% of the lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC. The potential for adverse effect of these PECs is determined by the project ecologist in the AA.

PCs are greater than 1% of the worst-case critical load within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, the maximum nitrogen deposition level is 5.954 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature Pioneer, low-mid, mid-upper saltmarshes and below the midpoint critical load of 7.5 kg/ha/yr as established in Section 8.2.2.2.

PCs are greater than 1% of the worst-case critical load within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, the maximum nitrogen deposition level is 6.032 kg/ha/yr. This is within the critical load range of 5-10 kg/ha/yr for the most sensitive feature Pioneer, low-mid, mid-upper saltmarshes and below the midpoint critical load of 7.5 kg/ha/yr as established in Section 8.2.2.2.

Table 8.93 Proposed Operations – Nitrogen Deposition Dispersion Model Results at Ecological Receptors

NO_2							
Ecological Receptor	NO_2 Process Contributions (µg/m³)					NO_2 Dry Deposition (µg/m²/s)	NO_2 Nitrogen Deposition (kg/ha/year)
	2020	2021	2022	2023	2024		
European Sites (Natura 2000)							
Great Island Channel SAC	0.10	0.09	0.09	0.11	0.10	0.0002	0.016
Ballycotton Bay SPA	0.01	0.01	0.01	0.02	0.01	0.0000	0.002
Cork Harbour SPA	0.26	0.26	0.23	0.23	0.29	0.0004	0.042
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.01	0.01	0.02	0.02	0.01	0.0000	0.003
Ballynaclashy House, North Of Midleton pNHA	0.05	0.05	0.05	0.06	0.05	0.0001	0.008
Blarney Bog pNHA	0.01	0.01	0.01	0.01	0.01	0.0000	0.002
Carrigacrump Caves pNHA	0.02	0.02	0.02	0.02	0.02	0.0000	0.003
Carrigshane Hill pNHA	0.08	0.05	0.07	0.07	0.07	0.0001	0.012
Cork Lough pNHA	0.01	0.02	0.02	0.02	0.01	0.0000	0.003
Cuskinny Marsh pNHA	0.13	0.12	0.11	0.14	0.13	0.0002	0.020
Douglas River Estuary pNHA	0.03	0.04	0.04	0.05	0.04	0.0001	0.007
Dunkettle Shore pNHA	0.02	0.03	0.03	0.04	0.03	0.0001	0.005
Fountainstown Swamp pNHA	0.03	0.03	0.03	0.03	0.03	0.0000	0.005
Glanmire Wood pNHA	0.02	0.03	0.03	0.03	0.03	0.0000	0.005
Great Island Channel pNHA	0.10	0.09	0.09	0.11	0.10	0.0002	0.015
Leamlara Wood pNHA	0.05	0.06	0.05	0.06	0.05	0.0001	0.009
Lee Valley pNHA	0.01	0.01	0.01	0.02	0.01	0.0000	0.002
Lough Beg (Cork) pNHA	0.31	0.34	0.29	0.26	0.38	0.0006	0.054
Loughs Aderry And Ballybutler pNHA	0.06	0.03	0.05	0.05	0.05	0.0001	0.009
Minane Bridge Marsh pNHA	0.02	0.01	0.02	0.02	0.02	0.0000	0.003
Monkstown Creek pNHA	0.11	0.12	0.13	0.12	0.11	0.0002	0.018
Owenboy River pNHA	0.04	0.03	0.04	0.03	0.03	0.0001	0.005
Rockfarm Quarry, Little Island pNHA	0.03	0.05	0.05	0.05	0.04	0.0001	0.008
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.05	0.04	0.04	0.05	0.05	0.0001	0.008
Templebreedy National School, Crosshaven pNHA	0.05	0.05	0.04	0.03	0.07	0.0001	0.010
Whitegate Bay pNHA	0.06	0.07	0.07	0.07	0.07	0.0001	0.010
NH_3							
Ecological Receptor	NH_3 Process Contributions (µg/m³)					NH_3 Dry Deposition (µg/m²/s)	NH_3 Nitrogen Deposition (kg/ha/year)
	2020	2021	2022	2023	2024		
European Sites (Natura 2000)							
Great Island Channel SAC	0.009	0.008	0.007	0.009	0.008	0.00018	0.048
Ballycotton Bay SPA	0.001	0.001	0.001	0.001	0.001	0.00003	0.008
Cork Harbour SPA	0.085	0.087	0.076	0.076	0.098	0.00197	0.512
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.001	0.001	0.001	0.002	0.001	0.00003	0.008
Ballynaclashy House, North Of Midleton pNHA	0.004	0.004	0.004	0.005	0.004	0.00010	0.025
Blarney Bog pNHA	0.001	0.001	0.001	0.001	0.001	0.00003	0.007

Carrigacrump Caves pNHA	0.002	0.002	0.002	0.002	0.002	0.00004	0.010
Carrigshane Hill pNHA	0.007	0.004	0.006	0.006	0.006	0.00014	0.037
Cork Lough pNHA	0.001	0.002	0.002	0.002	0.001	0.00003	0.009
Cuskinny Marsh pNHA	0.011	0.010	0.009	0.012	0.011	0.00023	0.061
Douglas River Estuary pNHA	0.003	0.003	0.004	0.004	0.004	0.00008	0.021
Dunkettle Shore pNHA	0.002	0.002	0.003	0.003	0.003	0.00006	0.016
Fountainstown Swamp pNHA	0.003	0.003	0.002	0.003	0.003	0.00006	0.015
Glanmire Wood pNHA	0.002	0.002	0.002	0.003	0.003	0.00006	0.015
Great Island Channel pNHA	0.009	0.008	0.007	0.009	0.008	0.00018	0.047
Leamlara Wood pNHA	0.005	0.006	0.005	0.006	0.005	0.00012	0.032
Lee Valley pNHA	0.001	0.001	0.001	0.001	0.001	0.00003	0.007
Lough Beg (Cork) pNHA	0.090	0.099	0.083	0.078	0.111	0.00222	0.578
Loughs Aderry And Ballybutler pNHA	0.005	0.003	0.004	0.005	0.004	0.00010	0.027
Minane Bridge Marsh pNHA	0.002	0.001	0.002	0.001	0.001	0.00003	0.009
Monkstown Creek pNHA	0.013	0.014	0.015	0.016	0.016	0.00032	0.084
Owenboy River pNHA	0.003	0.003	0.003	0.003	0.003	0.00007	0.018
Rockfarm Quarry, Little Island pNHA	0.003	0.004	0.005	0.004	0.004	0.00009	0.024
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.005	0.003	0.004	0.004	0.004	0.00009	0.024
Templebreedy National School, Crosshaven pNHA	0.005	0.005	0.004	0.003	0.006	0.00013	0.034
Whitegate Bay pNHA	0.006	0.006	0.006	0.006	0.006	0.00013	0.033

Table 8.94 Proposed Operations – Nitrogen Deposition Dispersion Model Results at Ecological Receptors (continued)

Ecological Receptor	Total PC Nitrogen Deposition kg/ha/yr)	Assessment critical load (kg/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Background Nitrogen Deposition (kg/ha/yr)	Total PEC Nitrogen Deposition (kg/ha/yr)
European Sites (Natura 2000)						
Great Island Channel SAC	0.063	7.5	0.8%	No	n/a	n/a
Ballycotton Bay SPA	0.010	n/a	n/a	No	n/a	n/a
Cork Harbour SPA	0.554	7.5	7.4%	Yes	5.400	5.954
National Sites						
Ballycotton, Ballynamona And Shanagarry pNHA	0.011	7.5	0.1%	No	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.033	7.5	0.4%	No	n/a	n/a
Blarney Bog pNHA	0.009	10.0	0.1%	No	n/a	n/a
Carrigacrump Caves pNHA	0.013	7.5	0.2%	No	n/a	n/a
Carrigshane Hill pNHA	0.049	7.5	0.7%	No	n/a	n/a
Cork Lough pNHA	0.012	7.5	0.2%	No	n/a	n/a

Ecological Receptor	Total PC Nitrogen Deposition kg/ha/yr)	Assessment critical load (kg/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Background Nitrogen Deposition (kg/ha/yr)	Total PEC Nitrogen Deposition (kg/ha/yr)
Cuskinny Marsh pNHA	0.081	7.5	1.1%	Yes	#N/A	#N/A
Douglas River Estuary pNHA	0.028	7.5	0.4%	No	n/a	n/a
Dunkettle Shore pNHA	0.021	7.5	0.3%	No	n/a	n/a
Fountainstown Swamp pNHA	0.020	7.5	0.3%	No	n/a	n/a
Glanmire Wood pNHA	0.019	7.5	0.3%	No	n/a	n/a
Great Island Channel pNHA	0.062	7.5	0.8%	No	n/a	n/a
Leamlara Wood pNHA	0.042	7.5	0.6%	No	n/a	n/a
Lee Valley pNHA	0.010	10.0	0.1%	No	n/a	n/a
Lough Beg (Cork) pNHA	0.632	7.5	8.4%	Yes	5.400	6.032
Loughs Aderry And Ballybutler pNHA	0.036	7.5	0.5%	No	n/a	n/a
Minane Bridge Marsh pNHA	0.012	7.5	0.2%	No	n/a	n/a
Monkstown Creek pNHA	0.103	7.5	1.4%	Yes	#N/A	#N/A
Owenboy River pNHA	0.023	7.5	0.3%	No	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.032	12.5	0.3%	No	n/a	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.032	7.5	0.4%	No	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.044	7.5	0.6%	No	n/a	n/a
Whitegate Bay pNHA	0.043	7.5	0.6%	No	n/a	n/a

8.7.5 Acid Deposition – Proposed Operations

In order to consider the effects of acid deposition (as N) owing to emissions from the facility on ecological habitat sites, the maximum annual mean NO_2 and NH_3 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 8.3.3.2).

As per Section 8.2.2.2, process contributions (PCs) of acid deposition (as N) at ecological receptors were compared to the relevant critical load (identified in Section 8.2.2.2), and are shown in and

Where a PC is greater than 1% of the lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC. The potential for significant effect of these PECs is determined by the project ecologist in the AA.

PCs are greater than 1% of the worst-case critical load within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, the maximum total acid deposition (as N) flux is 0.439 keq/ha/yr. This is within the maximum critical load range of 0.714 – 5.962 keq/ha/yr for the most sensitive feature *Calcareous grassland (using base cation).*

PCs are greater than 1% of the worst-case critical load within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, the maximum total acid deposition (as N) flux for the worst-case year is 0.445 keq/ha/yr. This is within the maximum critical load range of 0.714 – 5.962 keq/ha/yr for the most sensitive feature *Calcareous grassland (using base cation)* as established in Section 8.2.2.2.

Table 8.95 Proposed Operations – Acid Deposition (as N) Dispersion Model Results at Ecological Receptors

NO_2							
Ecological Receptor	NO_2 Process Contributions (µg/m³)					NO_2 Dry Deposition (µg/m²/s)	NO_2 Acid Deposition (keq/ha/year)
	2020	2021	2022	2023	2024		
European Sites (Natura 2000)							
Great Island Channel SAC	0.10	0.09	0.09	0.11	0.10	0.00016	0.001
Ballycotton Bay SPA	0.01	0.01	0.01	0.02	0.01	0.00003	0.000
Cork Harbour SPA	0.26	0.26	0.23	0.23	0.29	0.00044	0.003
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.01	0.01	0.02	0.02	0.01	0.00003	0.000
Ballynaclashy House, North Of Midleton pNHA	0.05	0.05	0.05	0.06	0.05	0.00009	0.001
Blarney Bog pNHA	0.01	0.01	0.01	0.01	0.01	0.00002	0.000
Carrigacrump Caves pNHA	0.02	0.02	0.02	0.02	0.02	0.00003	0.000
Carrigshane Hill pNHA	0.08	0.05	0.07	0.07	0.07	0.00013	0.001
Cork Lough pNHA	0.01	0.02	0.02	0.02	0.01	0.00003	0.000
Cuskinny Marsh pNHA	0.13	0.12	0.11	0.14	0.13	0.00021	0.001
Douglas River Estuary pNHA	0.03	0.04	0.04	0.05	0.04	0.00007	0.000
Dunkettle Shore pNHA	0.02	0.03	0.03	0.04	0.03	0.00005	0.000
Fountainstown Swamp pNHA	0.03	0.03	0.03	0.03	0.03	0.00005	0.000
Glanmire Wood pNHA	0.02	0.03	0.03	0.03	0.03	0.00005	0.000
Great Island Channel pNHA	0.10	0.09	0.09	0.11	0.10	0.00016	0.001
Leamlara Wood pNHA	0.05	0.06	0.05	0.06	0.05	0.00010	0.001
Lee Valley pNHA	0.01	0.01	0.01	0.02	0.01	0.00002	0.000
Lough Beg (Cork) pNHA	0.31	0.34	0.29	0.26	0.38	0.00057	0.004
Loughs Aderry And Ballybutler pNHA	0.06	0.03	0.05	0.05	0.05	0.00009	0.001
Minane Bridge Marsh pNHA	0.02	0.01	0.02	0.02	0.02	0.00003	0.000
Monkstown Creek pNHA	0.11	0.12	0.13	0.12	0.11	0.00019	0.001
Owenboy River pNHA	0.04	0.03	0.04	0.03	0.03	0.00006	0.000
Rockfarm Quarry, Little Island pNHA	0.03	0.05	0.05	0.05	0.04	0.00008	0.001
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.05	0.04	0.04	0.05	0.05	0.00008	0.001
Templebreedy National School, Crosshaven pNHA	0.05	0.05	0.04	0.03	0.07	0.00010	0.001
Whitegate Bay pNHA	0.06	0.07	0.07	0.07	0.07	0.00011	0.001
NH_3							
Ecological Receptor	NH_3 Process Contributions (µg/m³)					NH_3 Dry Deposition (µg/m²/s)	NH_3 Acid Deposition (keg/ha/year)
	2020	2021	2022	2023	2024		
European Sites (Natura 2000)							
Great Island Channel SAC	0.009	0.008	0.007	0.009	0.008	0.00018	0.003
Ballycotton Bay SPA	0.001	0.001	0.001	0.001	0.001	0.00003	0.001
Cork Harbour SPA	0.085	0.087	0.076	0.076	0.098	0.00197	0.036
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.001	0.001	0.001	0.002	0.001	0.00003	0.001
Ballynaclashy House, North Of Midleton pNHA	0.004	0.004	0.004	0.005	0.004	0.00010	0.002

Blarney Bog pNHA	0.001	0.001	0.001	0.001	0.001	0.00003	0.000
Carrigacrump Caves pNHA	0.002	0.002	0.002	0.002	0.002	0.00004	0.001
Carrigshane Hill pNHA	0.007	0.004	0.006	0.006	0.006	0.00014	0.003
Cork Lough pNHA	0.001	0.002	0.002	0.002	0.001	0.00003	0.001
Cuskinny Marsh pNHA	0.011	0.010	0.009	0.012	0.011	0.00023	0.004
Douglas River Estuary pNHA	0.003	0.003	0.004	0.004	0.004	0.00008	0.001
Dunkettle Shore pNHA	0.002	0.002	0.003	0.003	0.003	0.00006	0.001
Fountainstown Swamp pNHA	0.003	0.003	0.002	0.003	0.003	0.00006	0.001
Glanmire Wood pNHA	0.002	0.002	0.002	0.003	0.003	0.00006	0.001
Great Island Channel pNHA	0.009	0.008	0.007	0.009	0.008	0.00018	0.003
Leamlara Wood pNHA	0.005	0.006	0.005	0.006	0.005	0.00012	0.002
Lee Valley pNHA	0.001	0.001	0.001	0.001	0.001	0.00003	0.001
Lough Beg (Cork) pNHA	0.090	0.099	0.083	0.078	0.111	0.00222	0.041
Loughs Aderry And Ballybutler pNHA	0.005	0.003	0.004	0.005	0.004	0.00010	0.002
Minane Bridge Marsh pNHA	0.002	0.001	0.002	0.001	0.001	0.00003	0.001
Monkstown Creek pNHA	0.013	0.014	0.015	0.016	0.016	0.00032	0.006
Owenboy River pNHA	0.003	0.003	0.003	0.003	0.003	0.00007	0.001
Rockfarm Quarry, Little Island pNHA	0.003	0.004	0.005	0.004	0.004	0.00009	0.002
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.005	0.003	0.004	0.004	0.004	0.00009	0.002
Templebreedy National School, Crosshaven pNHA	0.005	0.005	0.004	0.003	0.006	0.00013	0.002
Whitegate Bay pNHA	0.006	0.006	0.006	0.006	0.006	0.00013	0.002

Table 8.96 Proposed Operations – Acid Deposition (as N) Dispersion Model Results at Ecological Receptors (continued)

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
European Sites (Natura 2000)							
Great Island Channel SAC	0.0045	n/a	n/a	No	n/a	n/a	n/a
Ballycotton Bay SPA	0.0007	n/a	n/a	No	n/a	n/a	n/a
Cork Harbour SPA	0.0394	0.143	27.6%	Yes	0.400	0.439	0.714
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.0007	n/a	n/a	No	n/a	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.0024	n/a	n/a	No	n/a	n/a	n/a
Blarney Bog pNHA	0.0006	0.143	0.4%	No	n/a	n/a	0.143
Carrigacrump Caves pNHA	0.0009	n/a	n/a	No	n/a	n/a	n/a
Carrigshane Hill pNHA	0.0035	n/a	n/a	No	n/a	n/a	n/a
Cork Lough pNHA	0.0008	n/a	n/a	No	n/a	n/a	n/a
Cuskinny Marsh pNHA	0.0058	n/a	n/a	No	n/a	n/a	n/a

Ecological Receptor	PC Acid Dep. (N) (keq/ ha/yr)	Critical load (MinCL minN) for PC (keq/ ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ ha/yr)	Total PEC Acid Dep. (N) (keq/ ha/yr)	Critical load (MaxCL minN) for PEC (keq/ ha/yr)
Douglas River Estuary pNHA	0.0020	0.143	1.4%	Yes	0.560	0.562	0.714
Dunkettle Shore pNHA	0.0015	0.143	1.0%	Yes	0.600	0.601	0.714
Fountainstown Swamp pNHA	0.0014	n/a	n/a	No	n/a	n/a	n/a
Glanmire Wood pNHA	0.0014	0.143	1.0%	No	n/a	n/a	0.714
Great Island Channel pNHA	0.0044	n/a	n/a	No	n/a	n/a	n/a
Leamlara Wood pNHA	0.0030	n/a	n/a	No	n/a	n/a	n/a
Lee Valley pNHA	0.0007	0.143	0.5%	No	n/a	n/a	0.286
Lough Beg (Cork) pNHA	0.0450	0.143	31.5%	Yes	0.400	0.445	0.714
Loughs Aderry And Ballybutler pNHA	0.0026	n/a	n/a	No	n/a	n/a	n/a
Minane Bridge Marsh pNHA	0.0008	n/a	n/a	No	n/a	n/a	n/a
Monkstown Creek pNHA	0.0073	n/a	n/a	No	n/a	n/a	n/a
Owenboy River pNHA	0.0017	n/a	n/a	No	n/a	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.0022	0.143	1.6%	Yes	0.600	0.602	0.714
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.0023	n/a	n/a	No	n/a	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.0031	n/a	n/a	No	n/a	n/a	n/a
Whitegate Bay pNHA	0.0031	n/a	n/a	No	n/a	n/a	n/a

In order to consider the effects of acid deposition (as S) owing to emissions from the facility on ecological habitat sites, the maximum annual mean SO_2 process contribution concentrations (PC) are converted into the dry deposition fluxes and then acid deposition fluxes (as described in Section 8.3.3.2).

As per Section 8.2.2.2, process contributions (PCs) of acid deposition (as S) at ecological receptors were compared to the relevant critical load (identified in Section), and are shown in Table 8.97 and Table 8.98.

Where a PC is greater than 1% of the lowest critical load, this site has been included in further assessment where the PEC is determined by combining the background concentration with the PC. The potential for adverse effect of these PECs is determined by the project ecologist in the AA.

PCs are greater than 1% of the worst-case critical load within the most impacted European site (Cork Harbour SPA). Therefore, at the worst-case location, the maximum total acid deposition (as S) flux for the worst-case year is 0.404 keq/ha/yr. This is within the maximum critical load range of 2.241 – 5.247 keq/ha/yr for the most sensitive feature *Calcareous grassland (using base cation)* as established in Section 8.2.2.2.

PCs are greater than 1% of the worst-case critical load within the most impacted national site (Lough Beg pNHA). Therefore, at the worst-case location, the maximum total acid deposition (as S) flux for the worst-case year is 0.404 keq/ha/yr. This is within the maximum critical load range of 2.241 – 5.247 keq/ha/yr for the most sensitive feature *Calcareous grassland (using base cation)* as established in Section 8.2.2.2.

Table 8.97 Proposed Operations – Acid Deposition (as S) Dispersion Model Results at Ecological Receptors (continued)

Ecological Receptor	SO_2 Process Contributions (µg/m³)					SO_2 Dry Deposition (µg/m²/s)	SO_2 Acid Deposition (S) (keq/ha/year)
	2020	2021	2022	2023	2024		
European Sites (Natura 2000)							
Great Island Channel SAC	0.029	0.027	0.024	0.031	0.028	0.0004	0.004
Ballycotton Bay SPA	0.004	0.004	0.004	0.005	0.004	0.0001	0.001
Cork Harbour SPA	0.284	0.289	0.254	0.253	0.328	0.0039	0.039
National Sites							
Ballycotton, Ballynamona And Shanagarry pNHA	0.004	0.004	0.004	0.005	0.004	0.0001	0.001
Ballynaclashy House, North Of Midleton pNHA	0.013	0.014	0.013	0.016	0.014	0.0002	0.002
Blarney Bog pNHA	0.004	0.004	0.004	0.004	0.004	0.0001	0.000
Carrigacrump Caves pNHA	0.006	0.006	0.006	0.006	0.006	0.0001	0.001
Carrigshane Hill pNHA	0.024	0.013	0.020	0.020	0.019	0.0003	0.003
Cork Lough pNHA	0.004	0.005	0.005	0.006	0.004	0.0001	0.001
Cuskinny Marsh pNHA	0.038	0.035	0.031	0.039	0.037	0.0005	0.005
Douglas River Estuary pNHA	0.009	0.011	0.012	0.013	0.012	0.0002	0.002
Dunkettle Shore pNHA	0.007	0.008	0.009	0.010	0.009	0.0001	0.001
Fountainstown Swamp pNHA	0.010	0.009	0.008	0.009	0.010	0.0001	0.001
Glanmire Wood pNHA	0.006	0.007	0.008	0.009	0.009	0.0001	0.001
Great Island Channel pNHA	0.029	0.026	0.024	0.030	0.028	0.0004	0.004
Leamlara Wood pNHA	0.015	0.018	0.015	0.021	0.016	0.0002	0.002
Lee Valley pNHA	0.004	0.004	0.004	0.005	0.004	0.0001	0.001
Lough Beg (Cork) pNHA	0.301	0.330	0.278	0.261	0.370	0.0044	0.044
Loughs Aderry And Ballybutler pNHA	0.017	0.010	0.014	0.015	0.015	0.0002	0.002
Minane Bridge Marsh pNHA	0.005	0.004	0.006	0.005	0.005	0.0001	0.001
Monkstown Creek pNHA	0.044	0.045	0.051	0.052	0.054	0.0006	0.006
Owenboy River pNHA	0.011	0.010	0.012	0.010	0.011	0.0001	0.001
Rockfarm Quarry, Little Island pNHA	0.010	0.014	0.015	0.014	0.012	0.0002	0.002
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.016	0.011	0.012	0.014	0.014	0.0002	0.002
Templebreedy National School, Crosshaven pNHA	0.015	0.015	0.012	0.011	0.022	0.0003	0.003
Whitegate Bay pNHA	0.019	0.021	0.021	0.019	0.020	0.0003	0.002

Table 8.98 Proposed Operations – Acid Deposition (as S) Dispersion Model Results at Ecological Receptors (continued)

Ecological Receptor	PC Acid Dep. (S) (keq/ha/yr)	Critical load (MinCL maxS) (keq/ha/yr)	PC % of critical load	Considered for further assessment?	APIS Back-ground Acid Dep. (keq/ha/yr)	Total PEC Acid Dep. (S) (keq/ha/yr)
European Sites (Natura 2000)						
Great Island Channel SAC	0.004	n/a	n/a	No	n/a	n/a
Ballycotton Bay SPA	0.001	n/a	n/a	No	n/a	n/a
Cork Harbour SPA	0.039	2.241	1.7%	Yes	0.560	0.599
National Sites						
Ballycotton, Ballynamona And Shanagarry pNHA	0.001	n/a	n/a	No	n/a	n/a
Ballynaclashy House, North Of Midleton pNHA	0.002	n/a	n/a	No	n/a	n/a
Blarney Bog pNHA	0.000	0.381	0.1%	No	n/a	n/a
Carrigacrump Caves pNHA	0.001	n/a	n/a	No	n/a	n/a
Carrigshane Hill pNHA	0.003	n/a	n/a	No	n/a	n/a
Cork Lough pNHA	0.001	n/a	n/a	No	n/a	n/a
Cuskinny Marsh pNHA	0.005	n/a	n/a	No	n/a	n/a
Douglas River Estuary pNHA	0.002	2.241	0.1%	No	n/a	n/a
Dunkettle Shore pNHA	0.001	2.241	0.1%	No	n/a	n/a
Fountainstown Swamp pNHA	0.001	n/a	n/a	No	n/a	n/a
Glanmire Wood pNHA	0.001	0.365	0.3%	No	n/a	n/a
Great Island Channel pNHA	0.004	n/a	n/a	No	n/a	n/a
Leamlara Wood pNHA	0.002	n/a	n/a	No	n/a	n/a
Lee Valley pNHA	0.001	0.365	0.2%	No	n/a	n/a
Lough Beg (Cork) pNHA	0.044	2.382	1.85%	Yes	0.40	0.404
Loughs Aderry And Ballybutler pNHA	0.002	n/a	n/a	No	n/a	n/a
Minane Bridge Marsh pNHA	0.001	n/a	n/a	No	n/a	n/a
Monkstown Creek pNHA	0.006	n/a	n/a	No	n/a	n/a
Owenboy River pNHA	0.001	n/a	n/a	No	n/a	n/a
Rockfarm Quarry, Little Island pNHA	0.002	0.365	0.5%	No	n/a	n/a
Rostellan Lough, Aghada Shore And Poulnabibe Inlet pNHA	0.002	n/a	n/a	No	n/a	n/a
Templebreedy National School, Crosshaven pNHA	0.003	n/a	n/a	No	n/a	n/a
Whitegate Bay pNHA	0.002	n/a	n/a	No	n/a	n/a

8.8 National Emissions Ceilings Assessment

The effect of the facility on emissions of SO_2, NO_X and VOCs has been assessed. Results, outlined in Table 8.99 indicate that the effect of the Facility on Ireland's obligations under the Gothenburg Protocol is slight. The overall effect of the development is to increase SO_2 levels by 0.83% of the ceiling levels to be complied with in 2030, NO_X levels by 0.72% of the ceiling levels, VOC levels will be increased by 0.02% of the ceiling limits, ammonia levels will be increased by 0.02% of the ceiling limits whilst $PM_{2.5}$ levels will be increased by 0.16% of the ceiling limits.

Table 8.99 Effect of Ringaskiddy WTE Facility on the Ireland's National Emission Ceiling Obligations.

Year	Scenario	SO_2 (tonnes/ annum)	VOC (tonnes/ annum)	NO_X (tonnes/ annum)	NH_3 (tonnes/ annum)	$PM_{2.5}$ (tonnes/ annum)
2030	Facility In Operation (8760 Hours)	92	18	370	28	18
Emission Ceiling (kilo-tonnes) In 2030		11.1	81.5	51.3	117.6	11.0
Effect of Facility (%) (National)		0.83%	0.02%	0.72%	0.02%	0.16%

Note 1 Directive (EU) 2016/2284 "On the Reduction of National Emissions of Certain Atmospheric Pollutants and Amending Directive 2003/35/EC and Repealing Directive 2001/81/EC"

8.9 Conclusions

Based on the emission guidelines outlined in Council Directive 2010/75/EU, detailed air dispersion modelling has shown that the most stringent ambient air quality standards for the protection of human health are not exceeded either as a result of operating under maximum or abnormal operating conditions.

The modelling results, using both the USEPA regulatory model AERMOD and the more advanced CALPUFF model, indicate that the maximum ambient GLC occurs at or near the facility's boundary. The spatial effect of the facility is limited with concentrations falling off rapidly away from the maximum peak. For example, the short-term limit values at the nearest residential receptor will be less than 6% of the short-term ambient air quality limit values. The annual average concentration has an even more dramatic decrease in maximum concentration away from the facility with concentrations from emissions at the proposed facility accounting for less than 1% of the limit value (not including background concentrations) at worst case sensitive receptors near the facility.

In the surrounding areas of Cobh, Carrigaline and Monkstown, levels are significantly lower than most background sources with the concentrations from emissions at the proposed facility accounting for less than 1% of the annual limit values for the protection of human health for all pollutants under maximum operations of the facility.

In terms of Ireland's obligations under the Gothenburg Protocol and the POPs Convention, the effect of the facility will not be significant.

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