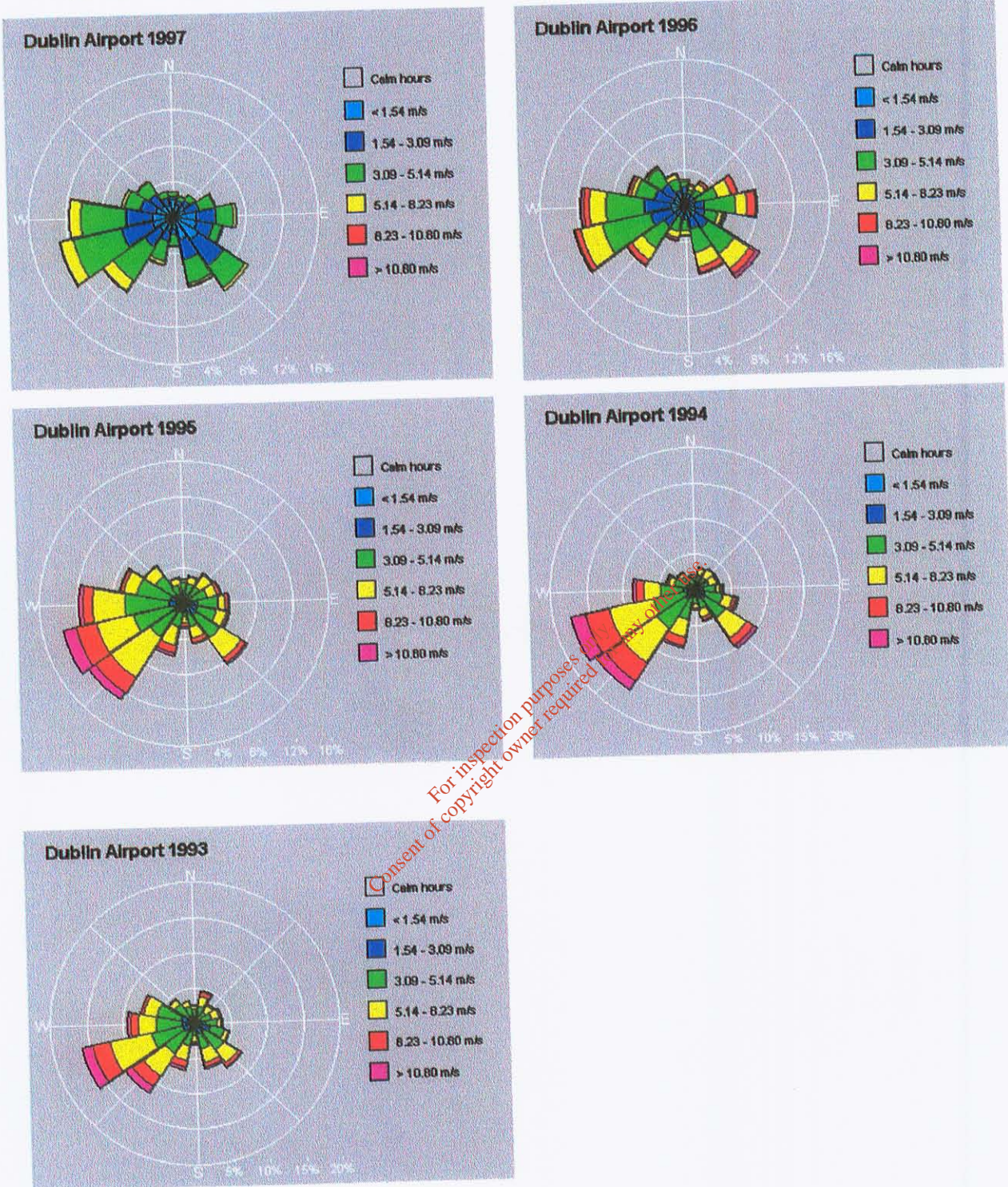


1.10 References

- (1) USEPA (1999) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1
- (2) USEPA (1998) Minimum Meteorological Data Requirements For AERMOD – Study & Recommendations”, 1998, USEPA.
- (3) USEPA (1995) User's Guide for the Industrial Source Complex (ISC3) Dispersion Model Vol I & II
- (4) USEPA (2000) Seventh Conference on Air Quality Modelling (June 2000) Vol I & II
- (5) USEPA (1999) Comparison of Regulatory Design Concentrations: AERMOD vs. ISCST3 vs. CTDM PLUS
- (6) USEPA (1998) AERMOD Description of Model Formulation
- (7) Schulman et al “Development and evaluation of the PRIME Plume Rise and Building Downwash Model” Air & Waste Management Association, 1998.
- (8) Paine, R & Lew, F. “Consequence Analysis for Adoption of PRIME: an Advanced Building Downwash Model” Prepared for the EPRI, ENSR Document No. 2460-026-450 (1997).
- (9) Paine, R & Lew, F. “Results of the Independent Evaluation of ISCST3 and ISC-PRIME” Prepared for the EPRI, ENSR Document No. 2460-026-3527-02 (1997).
- (10) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume IV, Chapter 3 Evaluating Atmospheric Releases of Dioxin-Like Compounds from Combustion Sources (Draft)
- (11) USEPA (1998) Human Health Risk Assessment Protocol, Chapter 3: Air Dispersion and Deposition Modelling, Region 6 Centre for Combustion Science and Engineering
- (12) Auer Jr, (1978) Correlation of Land Use and Cover with Meteorological Anomalies, Journal of Applied Meteorology 17(5):636-643.
- (13) USEPA (1989) Prevention of Significant Deterioration
- (14) Environmental Agency, 1997: Technical Guidance Note E1: “Best Practice Environmental Option Assessments for Integrated Pollution Control”, The Stationary Office
- (15) European Commission (2000) Assessment of Dietary Intake of Dioxins & Related PCBs by the Population of EU Member States(SCOOP Task 3.2.5)
- (16) AEA Technology (1999) Compilation of EU Dioxin Exposure & Health Data Task 2 – Environmental Levels
- (17) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume I, Chapter 1 Introduction (Draft)
- (18) Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States (1998, USEPA (CD-ROM)).
- (19) USEPA (2000) Estimating Exposure to Dioxin-Like Compounds Volume IV, Chapter 5 Demonstration of Methodology (Draft)
- (20) World Health Organisation (1999) Guidelines For Air Quality
- (21) USEPA (2000) Implementation Issues: Mercury Transport & Fate, Combustion Risk Assessments in Region 6.
- (22) European Commission (2000) Ambient Air Pollution By As, Cd and Ni Compounds Position Paper Final Version.
- (23) USEPA (2000) Federal Register, 40 CFR Part 51 Requirements for Preparation, Adoption and Submittal of State Implementation Plans (Guidelines on Air Quality Models) Propose Rule.
- (24) USEPA (1998) User's Guide to the AERMOD Meteorological Preprocessor (AERMET)
- (25) UK DETR, 1998, Review & Assessment: Pollutant-Specific Guidance, The Stationary Office.

Figure 1.1 Windrose from Dublin Airport (1993–1997).



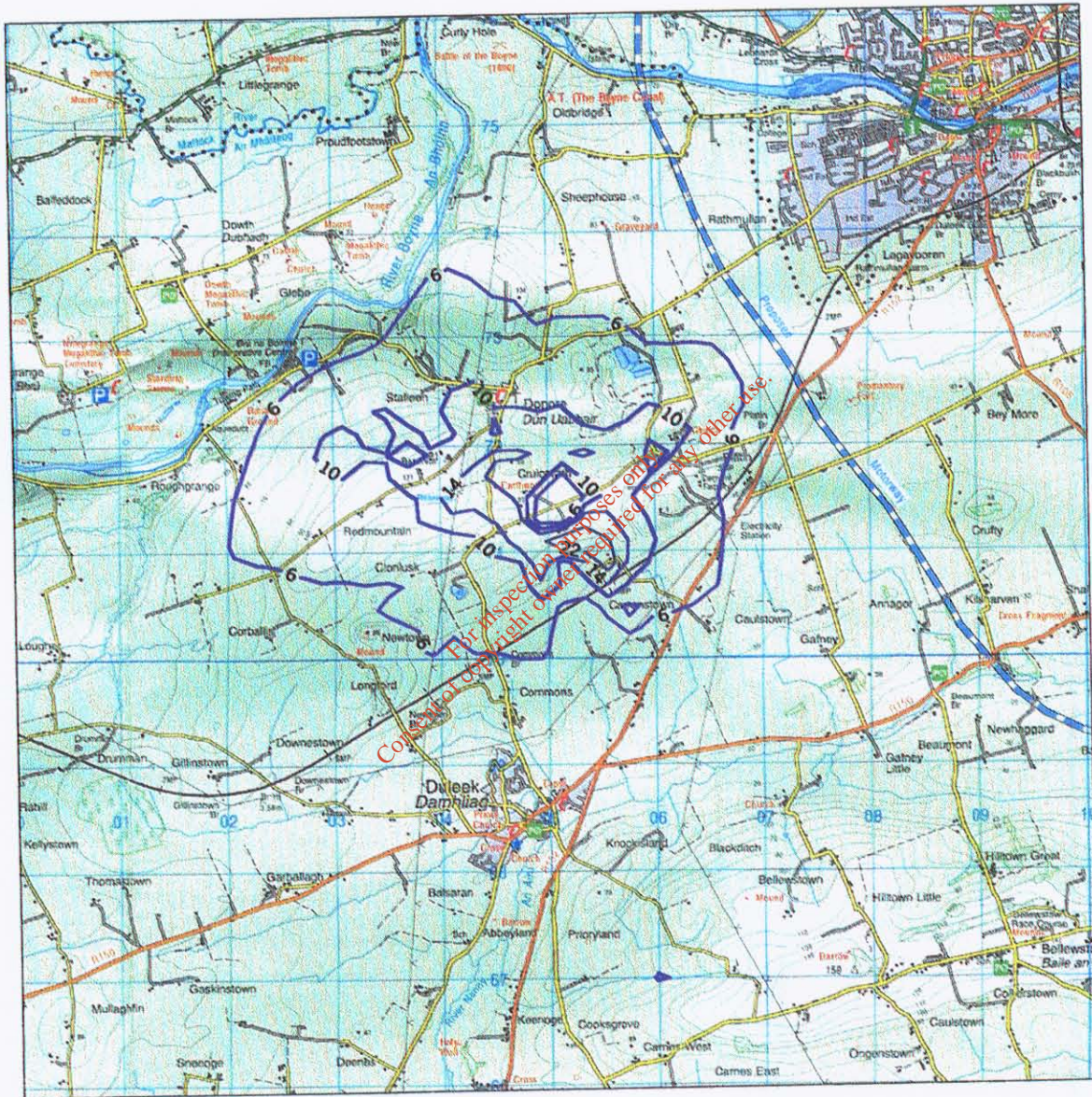
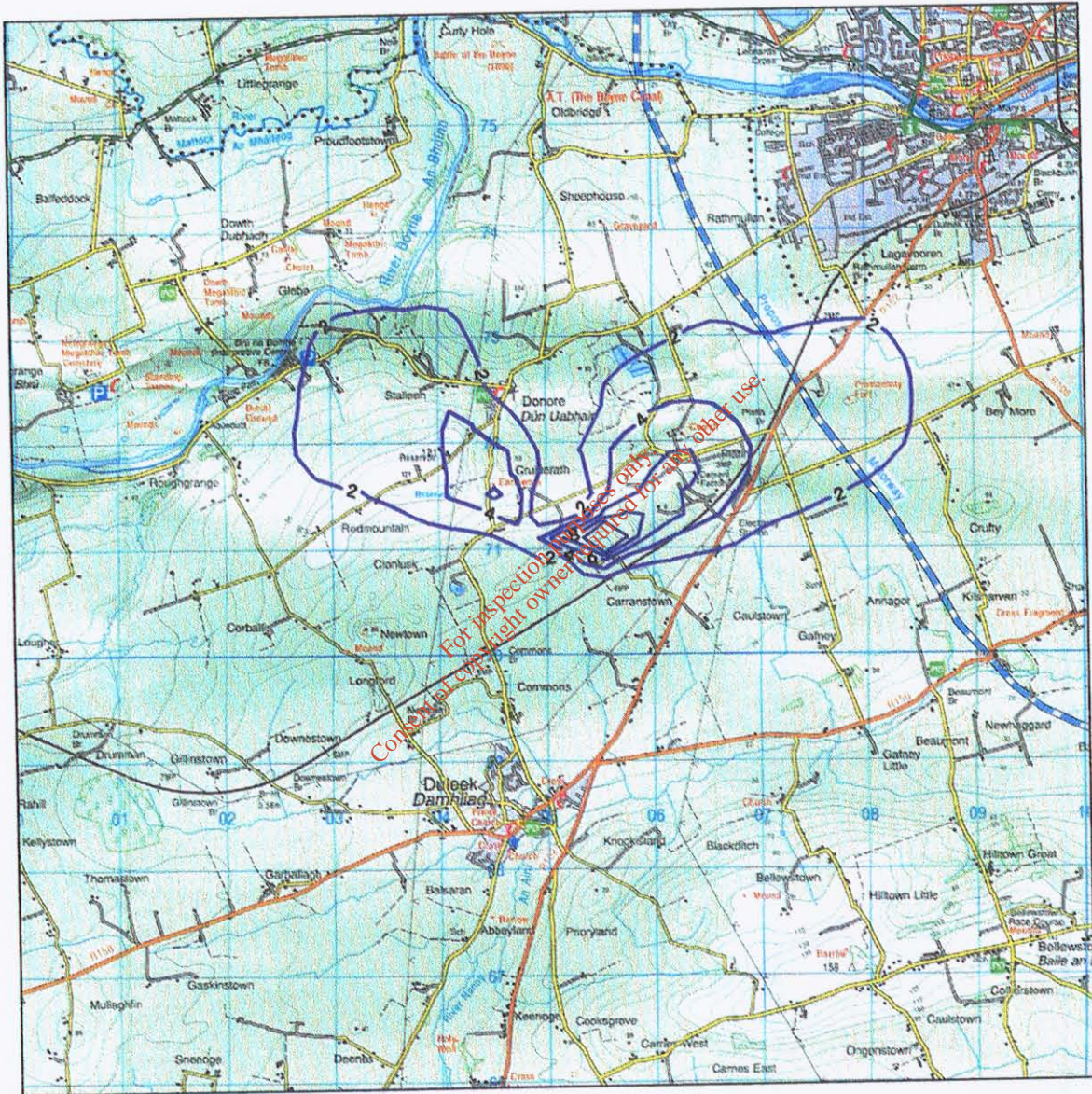


Figure 1.2: Predicted 99.8th%ile of hourly mean nitrogen dioxide concentrations as a % of limit value Maximum operation, Indaver Ireland Waste Management Facility

Scale: 1:70000 approx

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**Figure 1.3: Predicted annual mean nitrogen dioxide concentration as a % of limit value
Maximum Operation, Indaver Ireland Waste-to-Energy Plant**

Scale: 1:70000 approx

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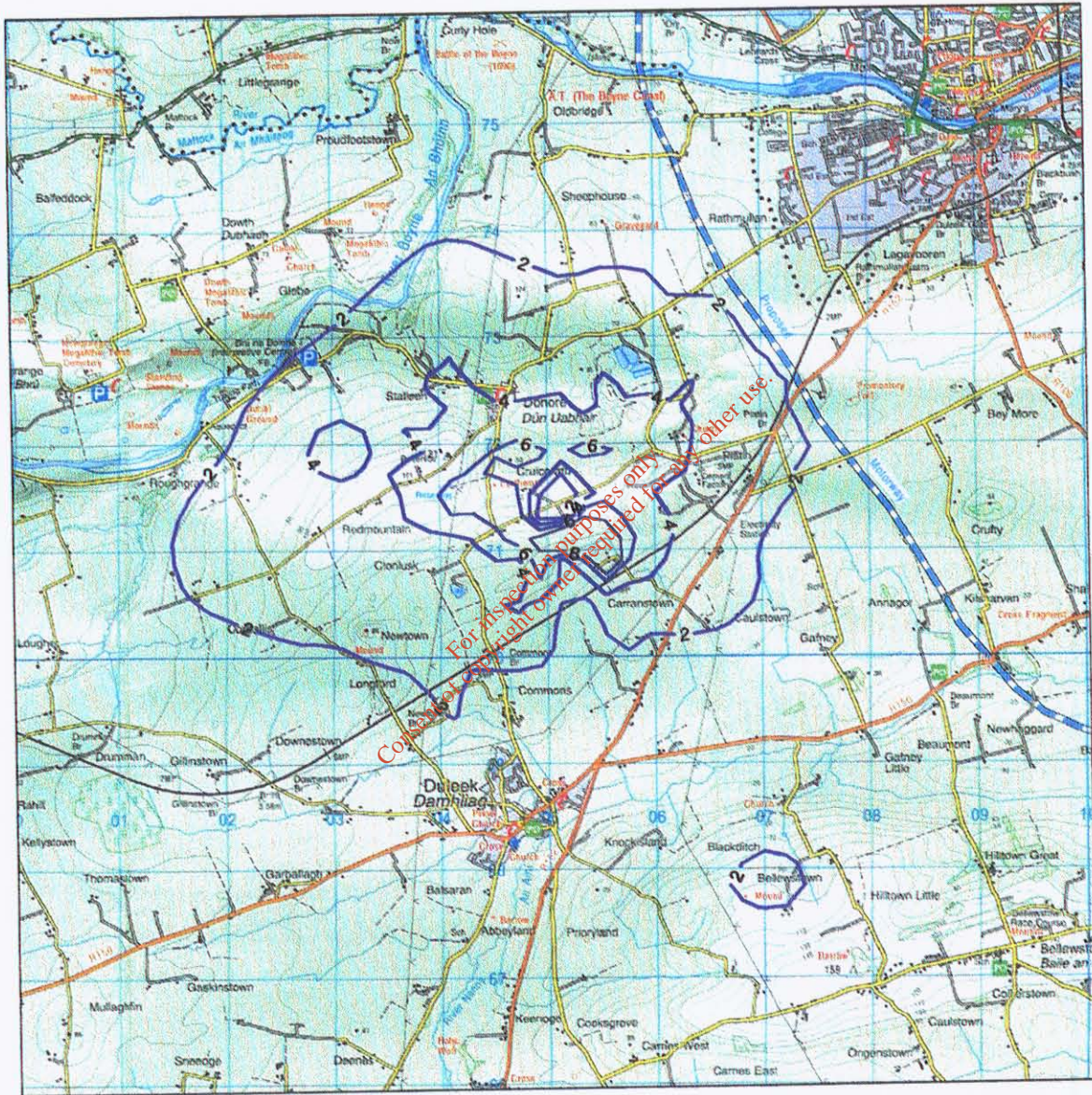


Figure 1.4: Predicted 99.7th%ile of hourly mean sulphur dioxide concentrations as a % of limit value Maximum Operation, Indaver Ireland Waste-to-Energy Plant

Scale: 1:70000 approx

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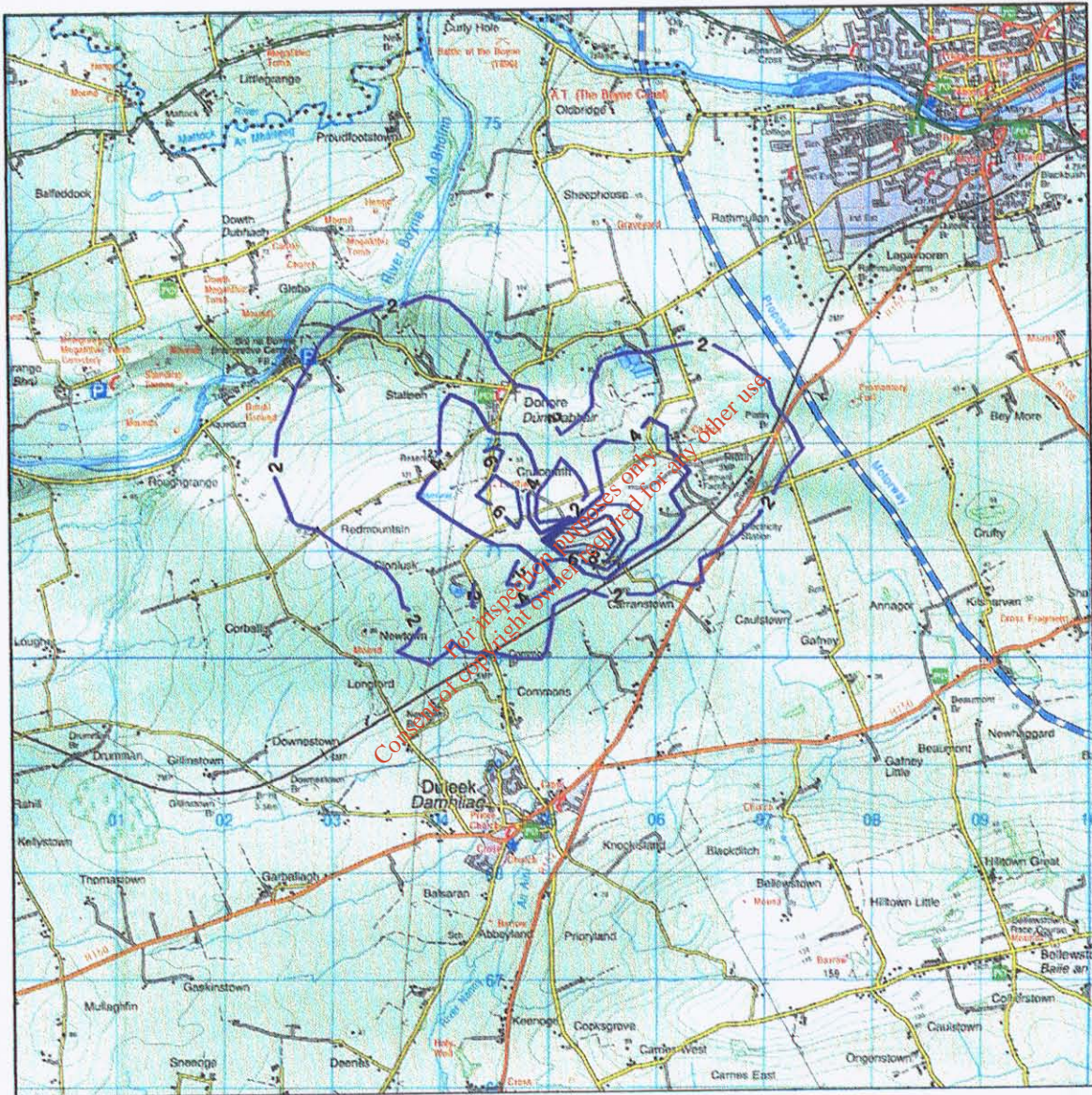
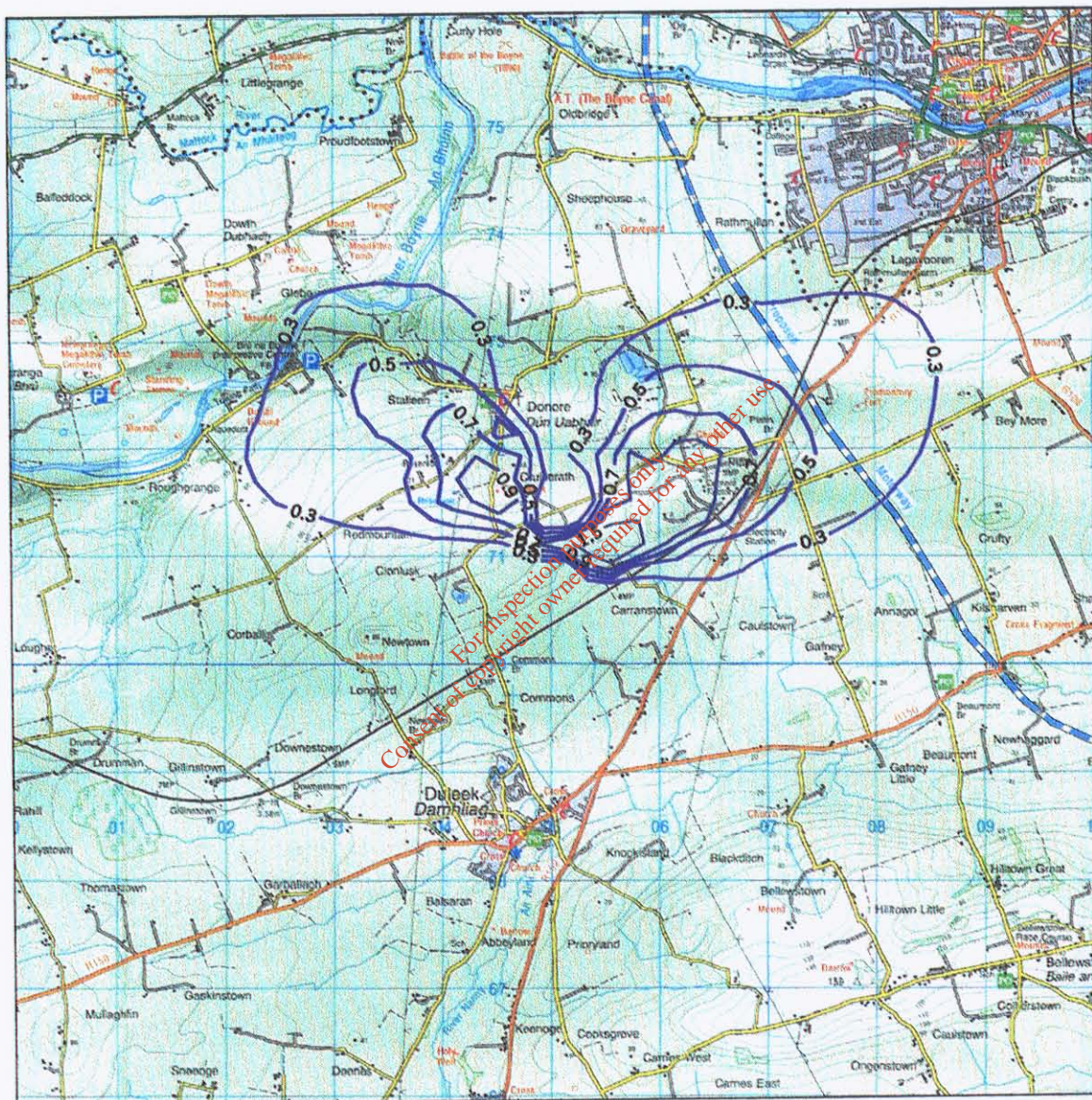


Figure 1.5: Predicted 99.2th%ile of 24-hour mean sulphur dioxide concentrations as a % of limit value, Maximum operation, Indaver Ireland Waste Management Facility

Scale: 1:70000 approx

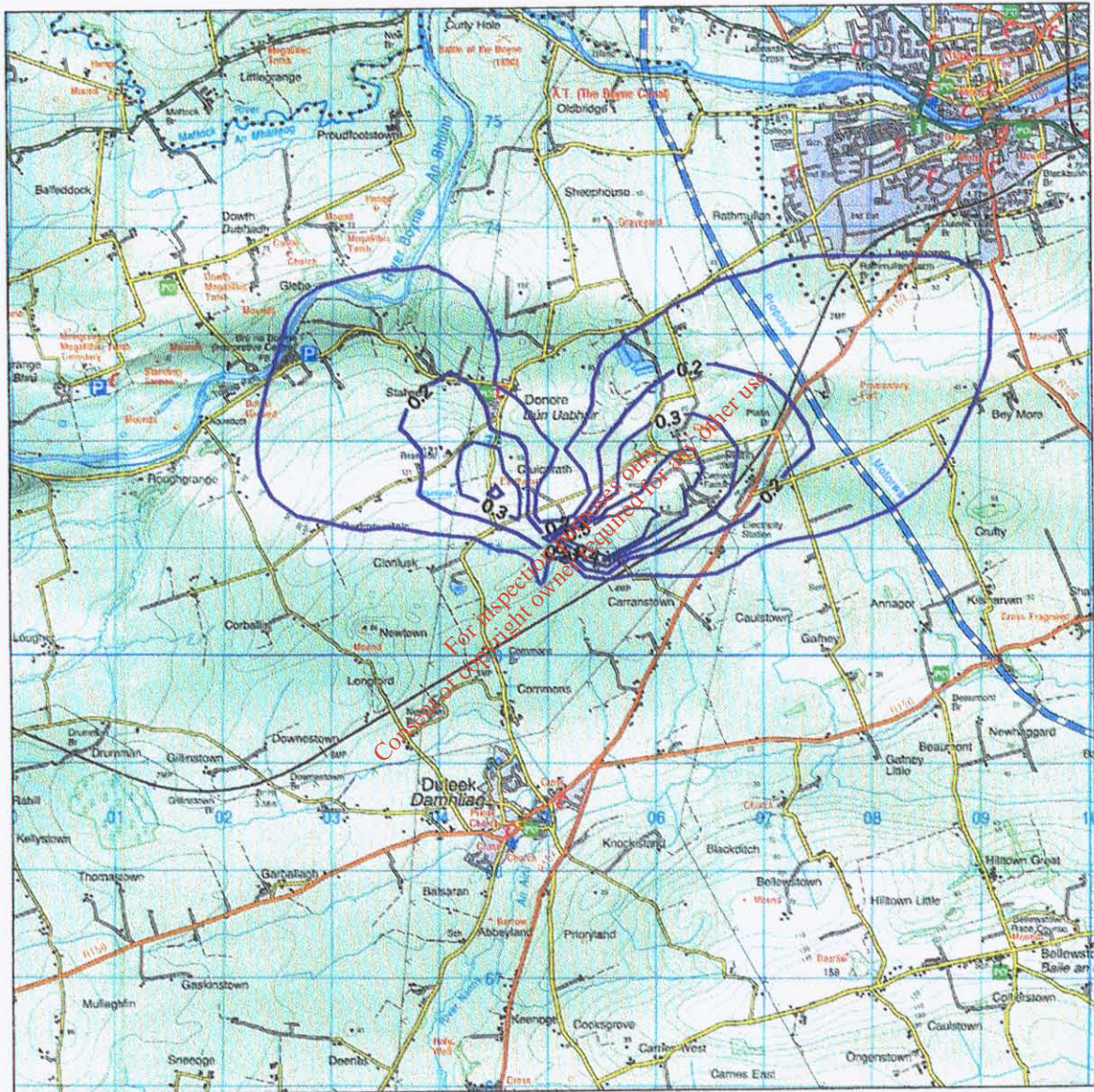
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**Figure 1.6: Predicted 90.5th%ile of 24-hour mean PM10 concentrations as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

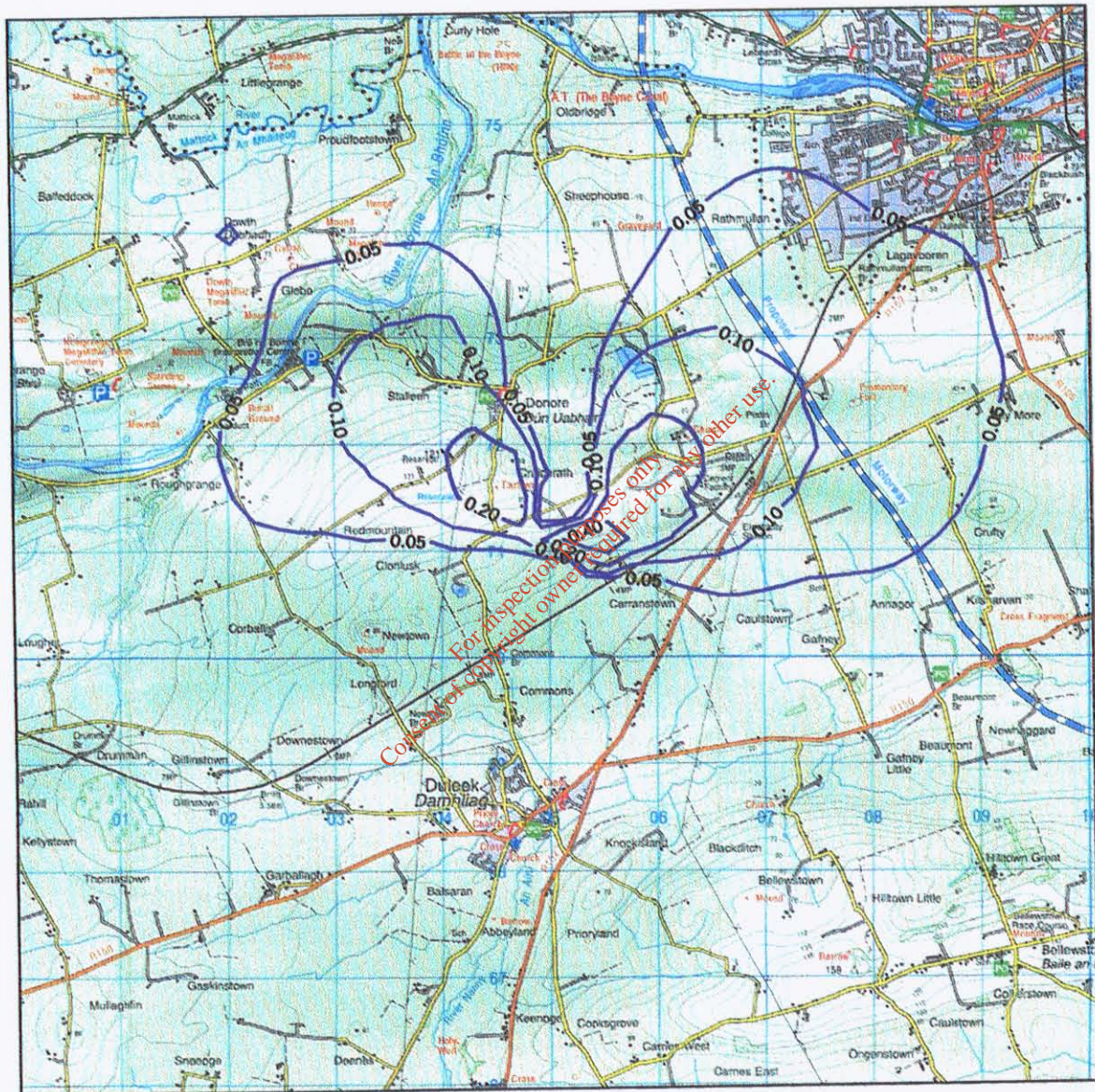
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**Figure 1.7: Predicted annual mean PM10 concentration as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

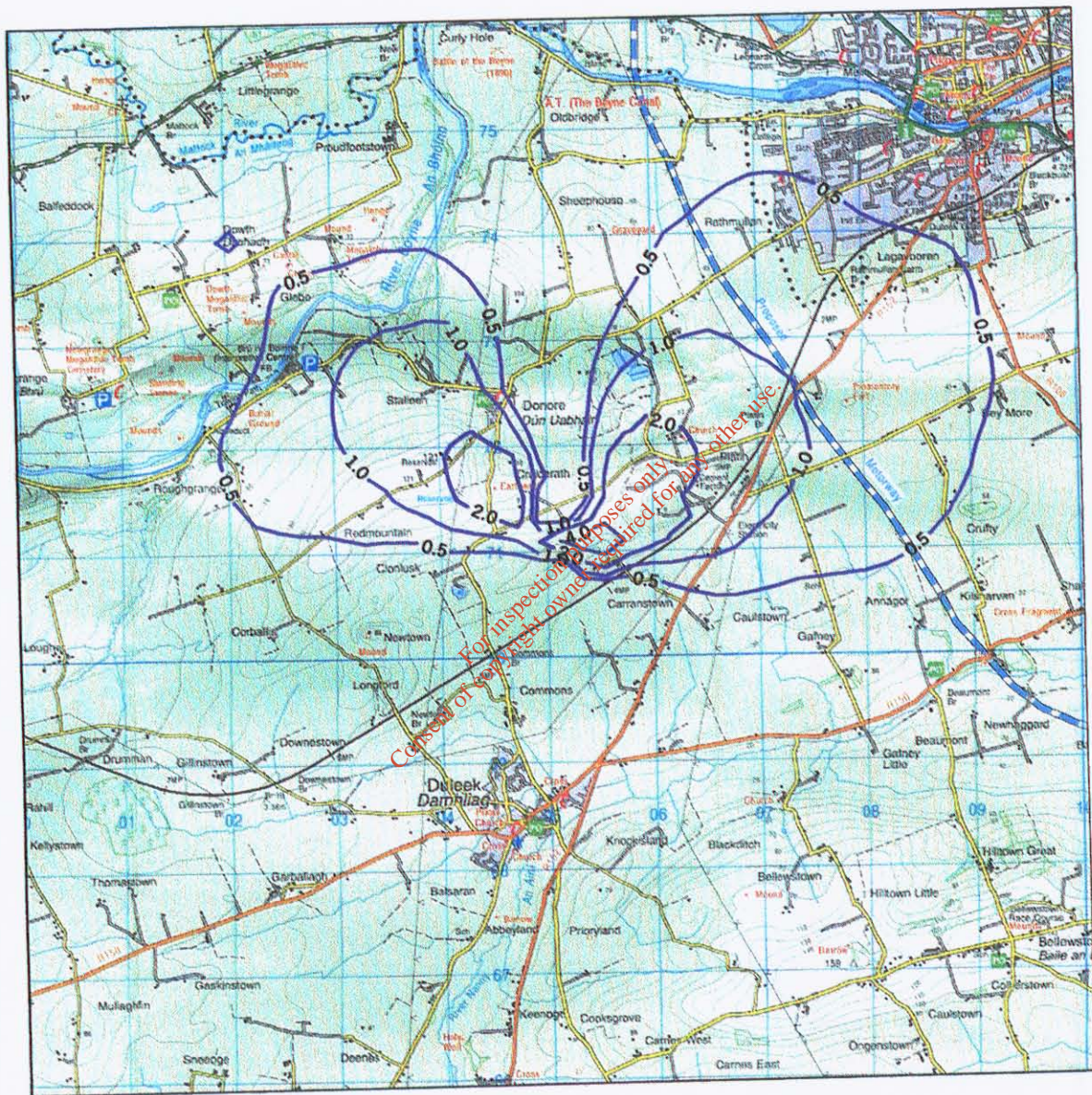
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**Figure 1.8: Predicted 98th%ile of maximum 1-hour TOC concentrations as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

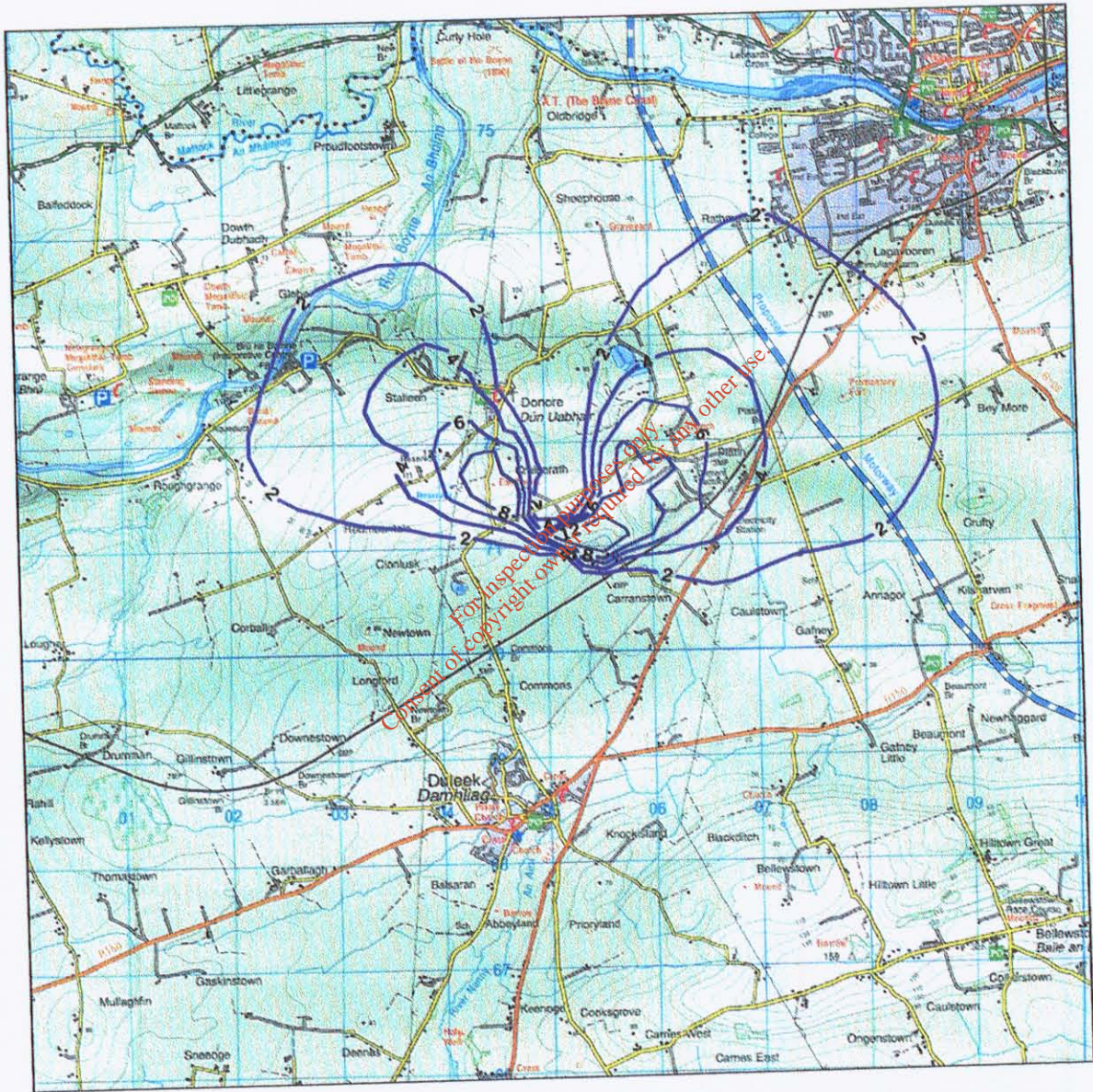
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**Figure 1.9: Predicted 98th%ile of maximum 1-hour HCl concentrations as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

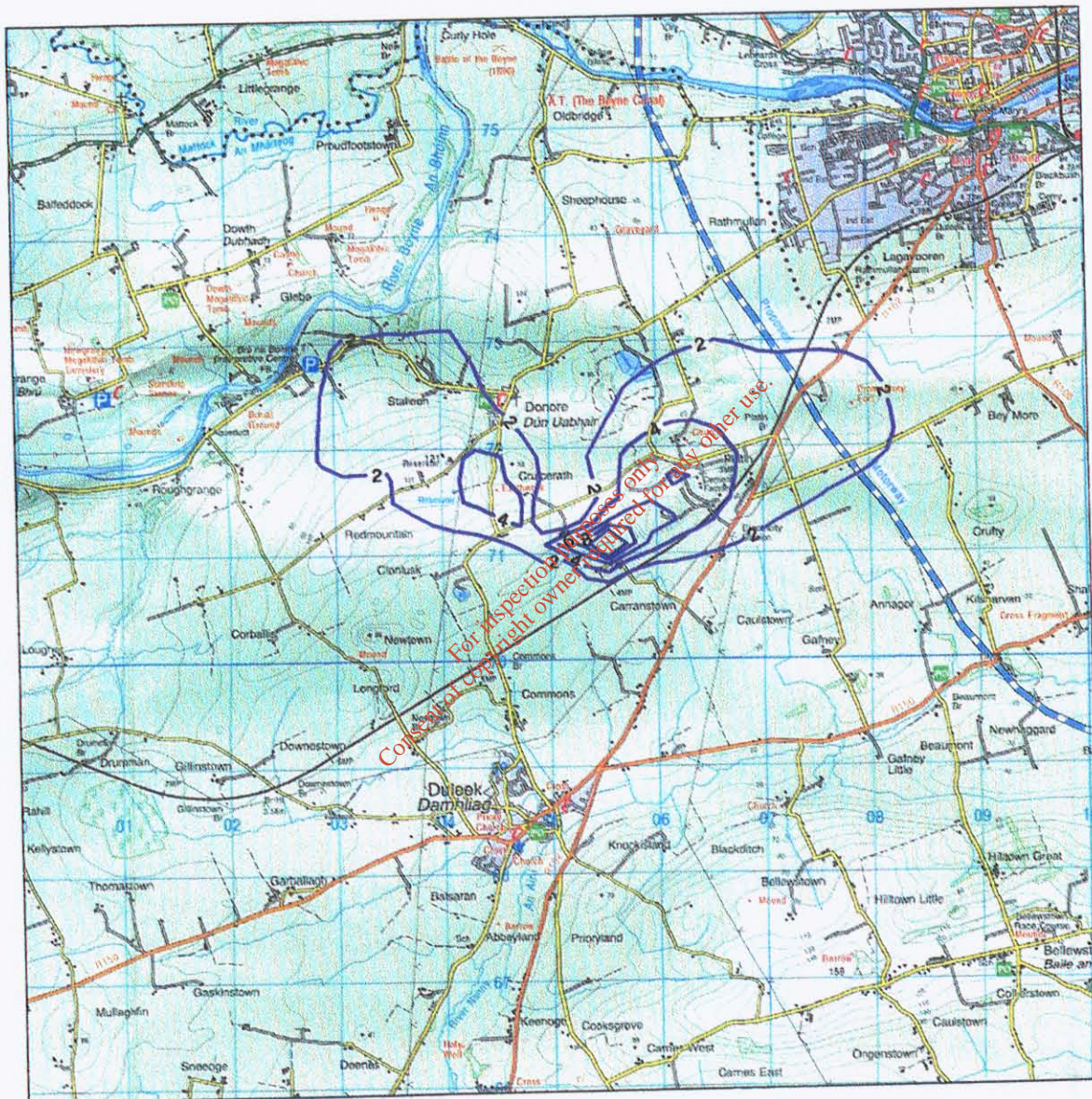
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**Figure 1.10: Predicted 98th%ile of maximum 1-hour HF concentrations as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

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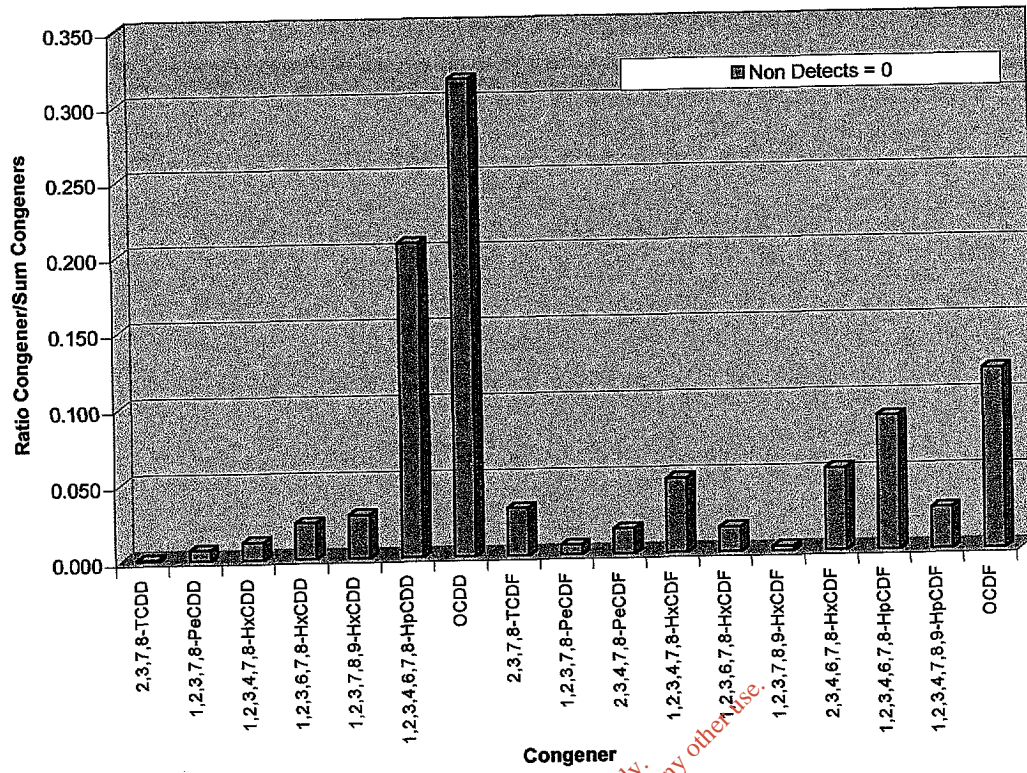


**Figure 1.11: Predicted annual average HF concentrations as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

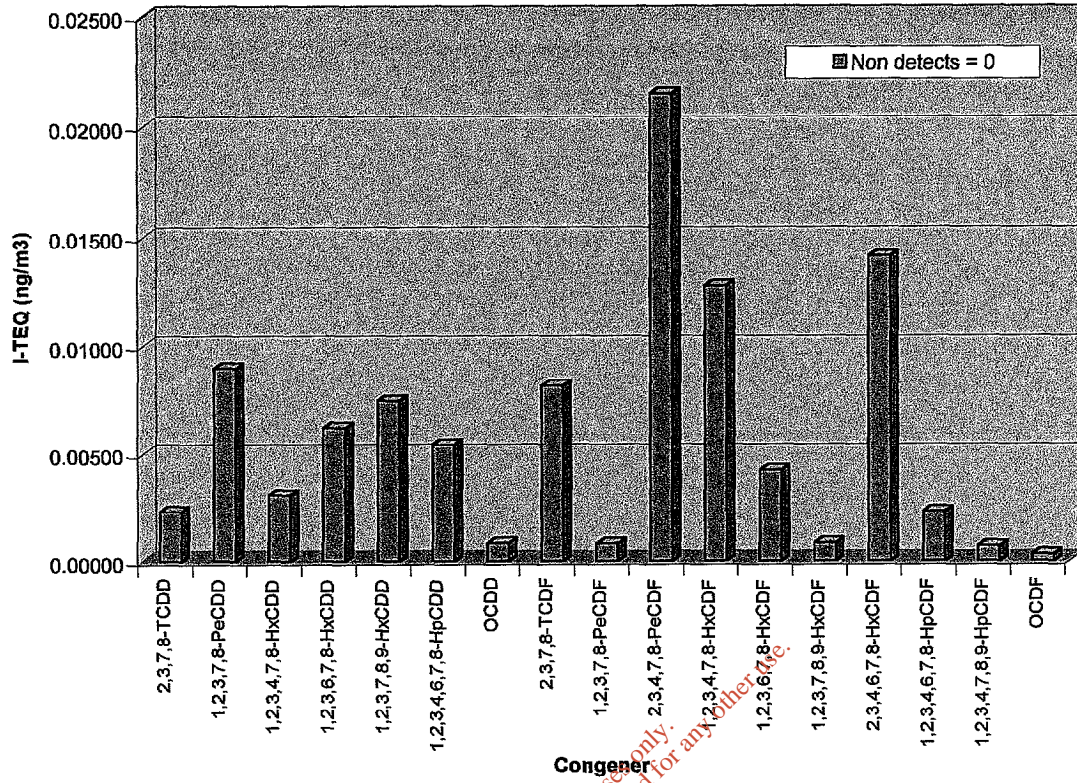
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Figure 1.12 PCDD/PCDF Congener Profile Based on a MWI (MS-Ref WS) Profile



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Figure 1.13 PCDD/PCDF Congener Emission Rate (ng/m³) Based on a MWI (MS-Ref WS) Profile At Maximum Operating Conditions



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Figure 1.14 PCDD/PCDF Vapour and Particle-Bound Concentrations (fg/m³) Based on a typical MWI (MS-Ref WS) Profile At Maximum Operating Conditions

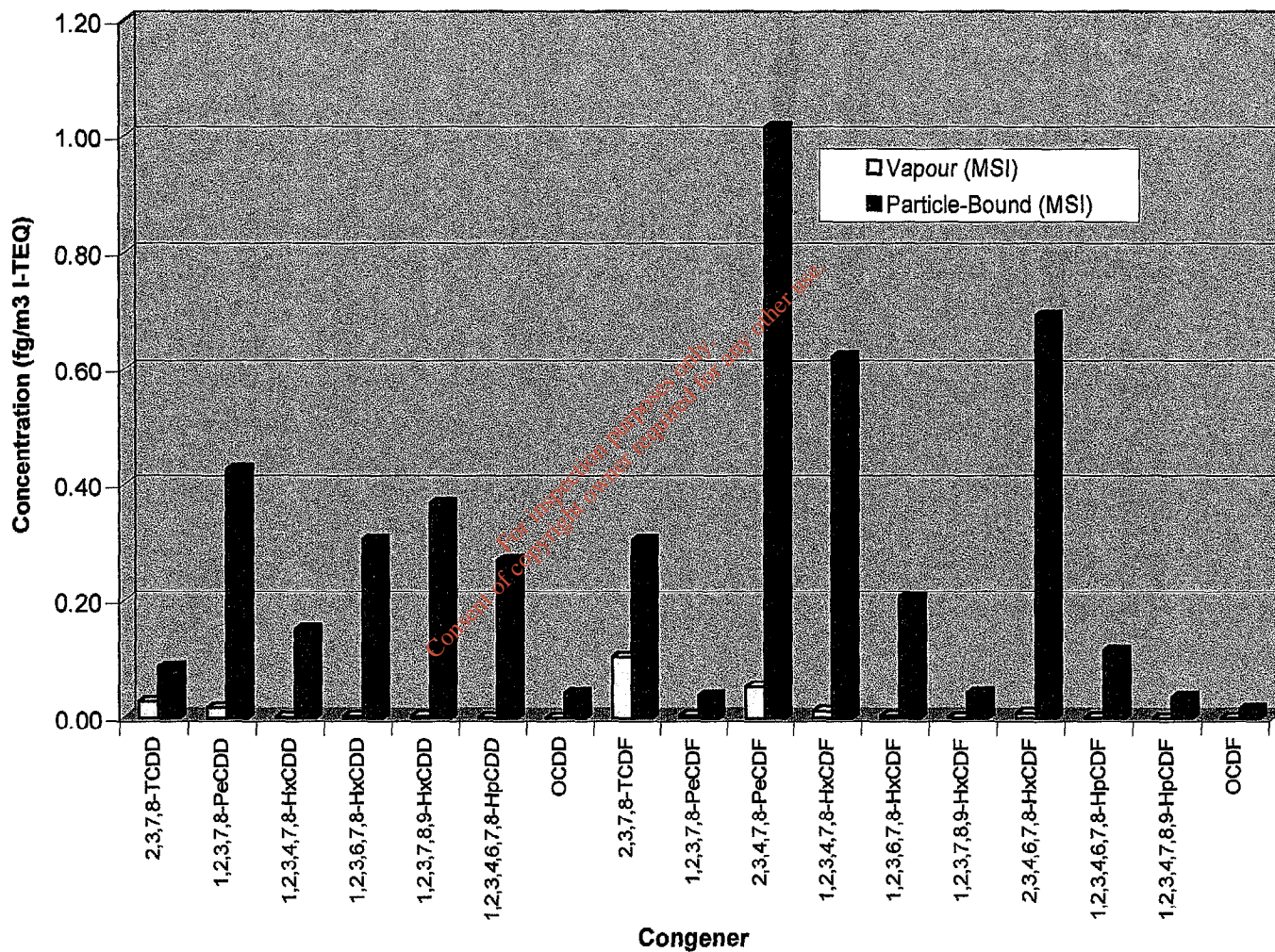
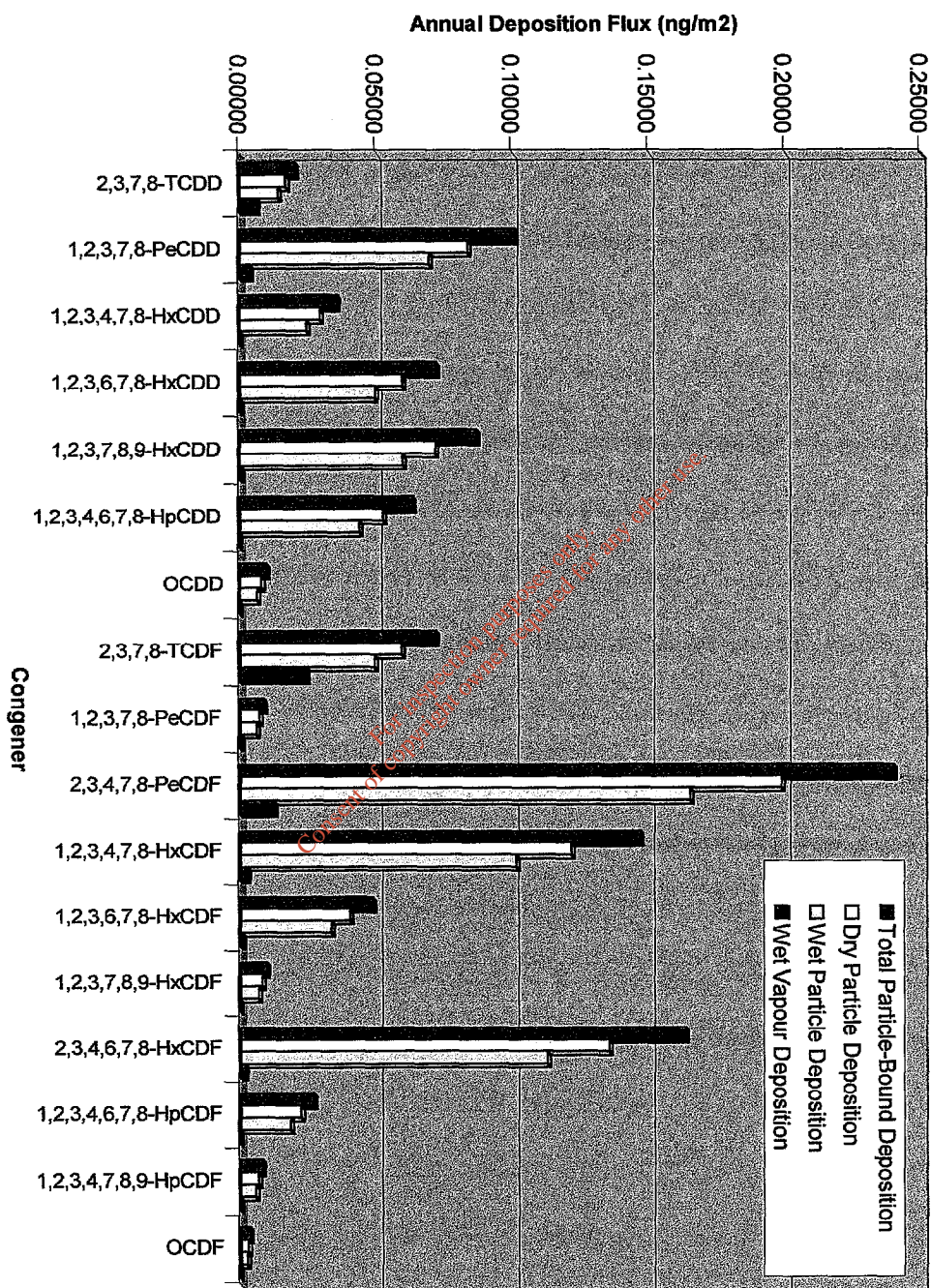
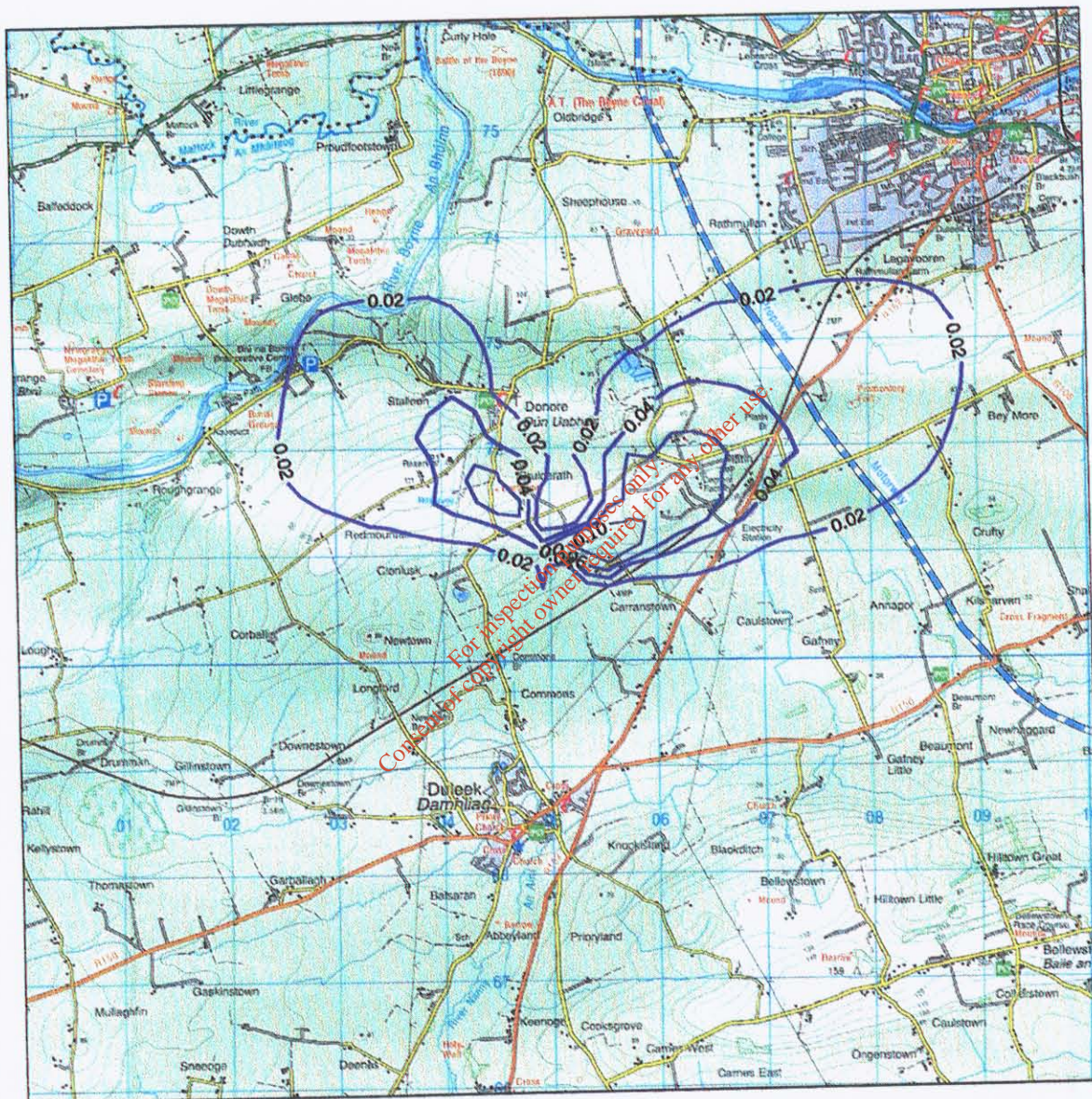


Figure 1.15 PCDD/PCDF Vapour and Particle-Bound Deposition Flux (ng/m²) Based on a MWI (MB-Ref WS) Profile At Maximum Operating Conditions

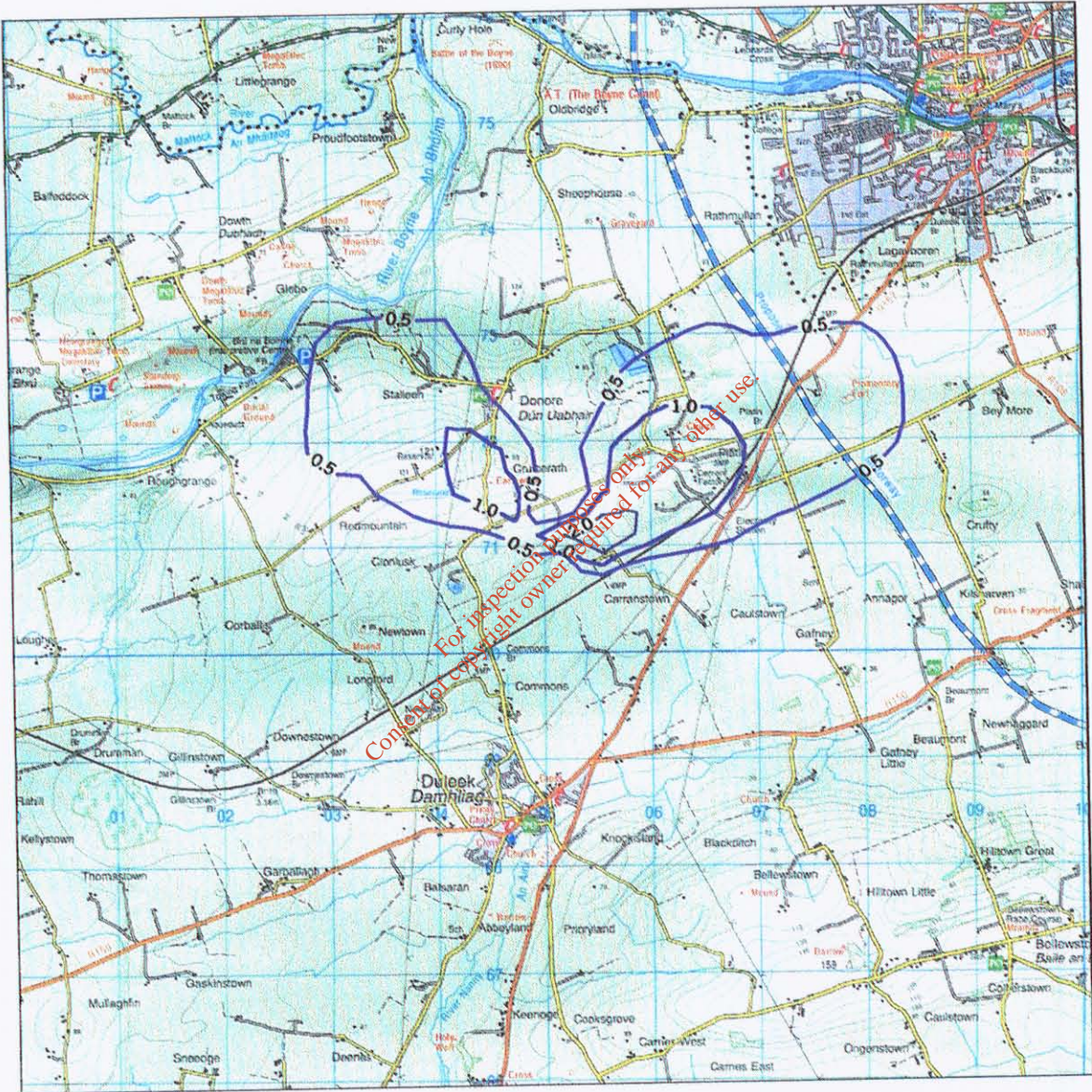




**Figure 1.16: Predicted annual average PCDD/PCDF vapour concentrations (fg/m³)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

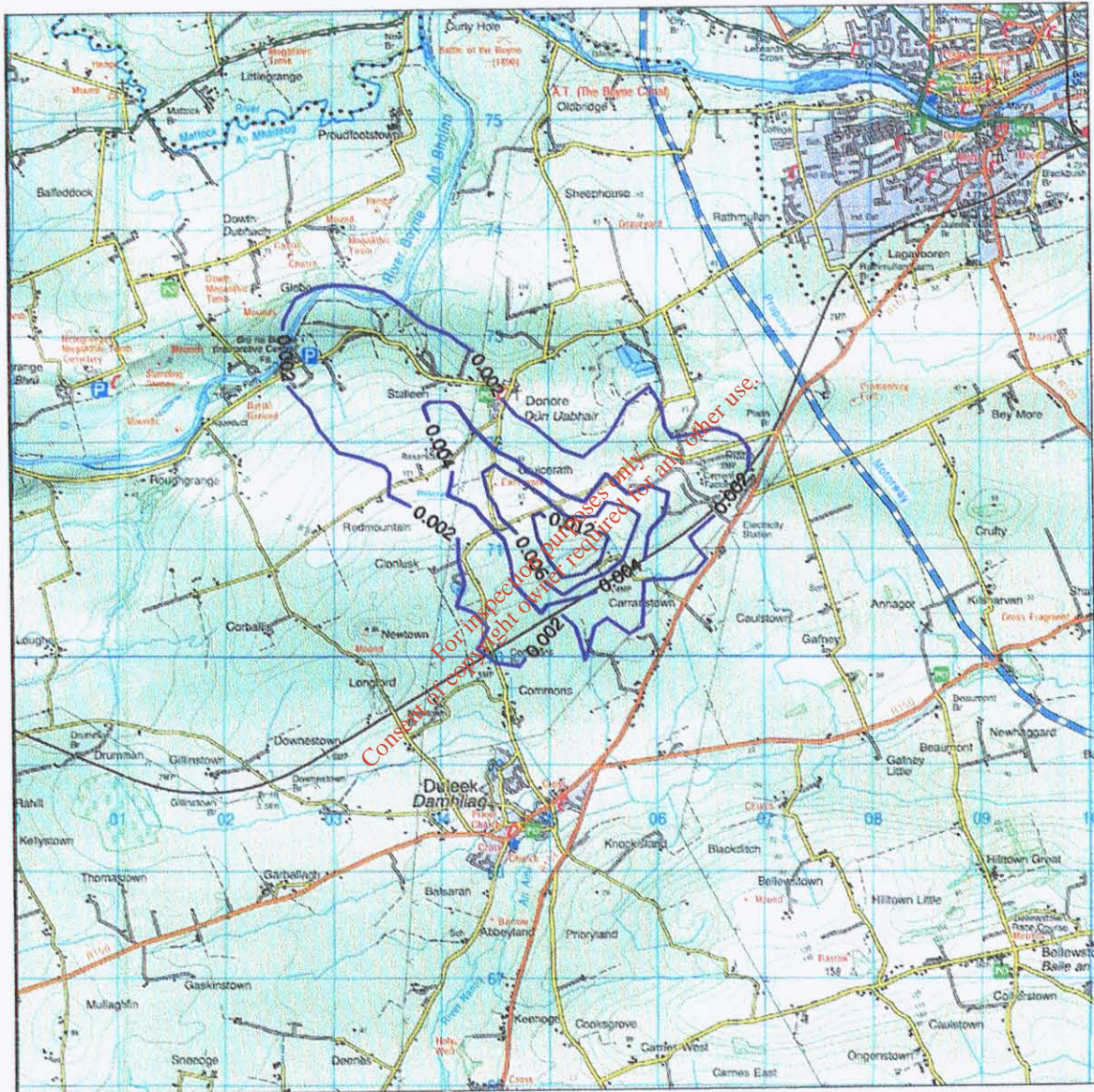
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**Figure 1.17: Predicted annual average PCDD/PCDF particle-bound concentrations (fg/m3)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

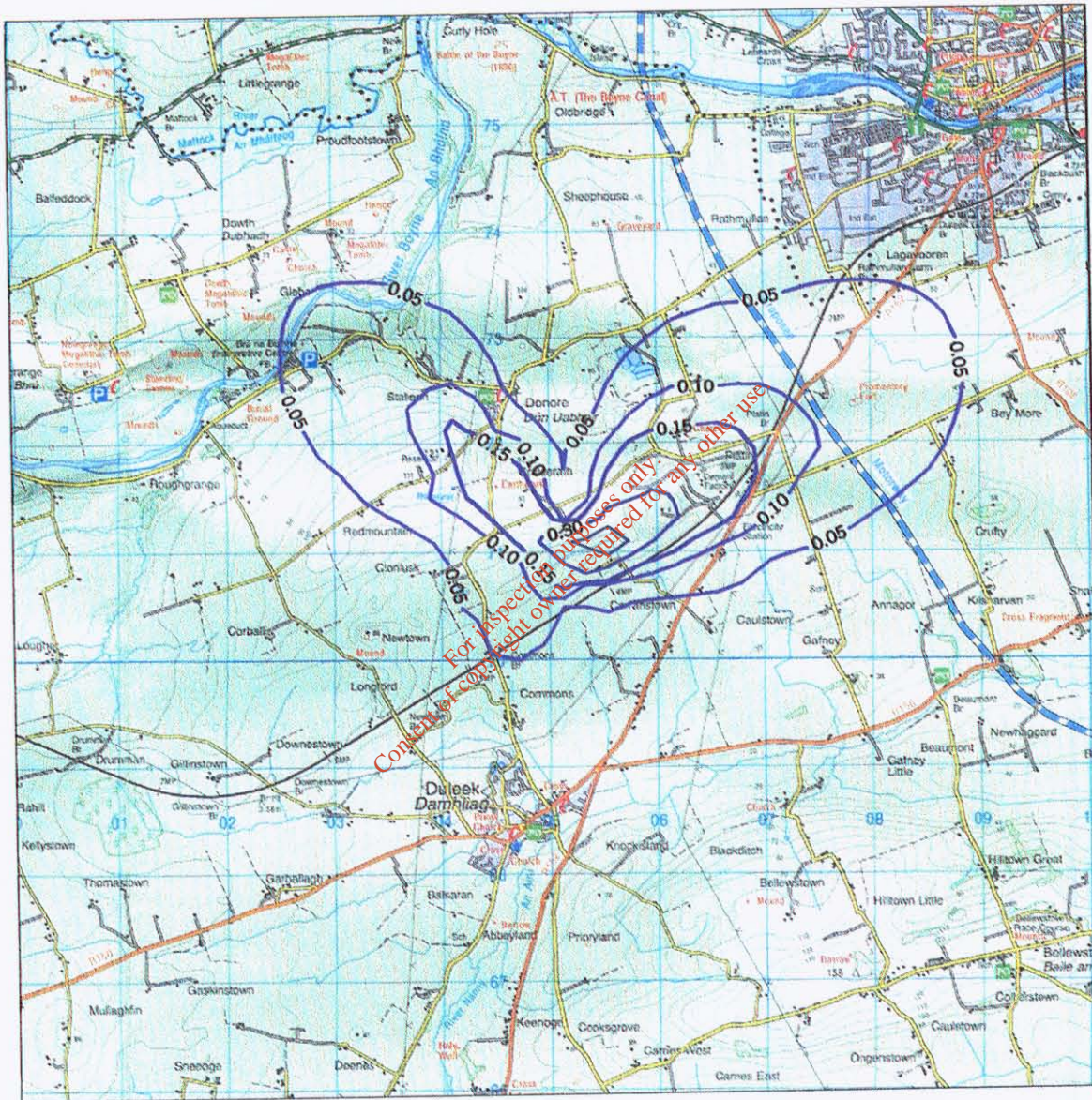
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**Figure 1.18: Predicted annual average PCDD/PCDF wet vapour deposition (ng/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

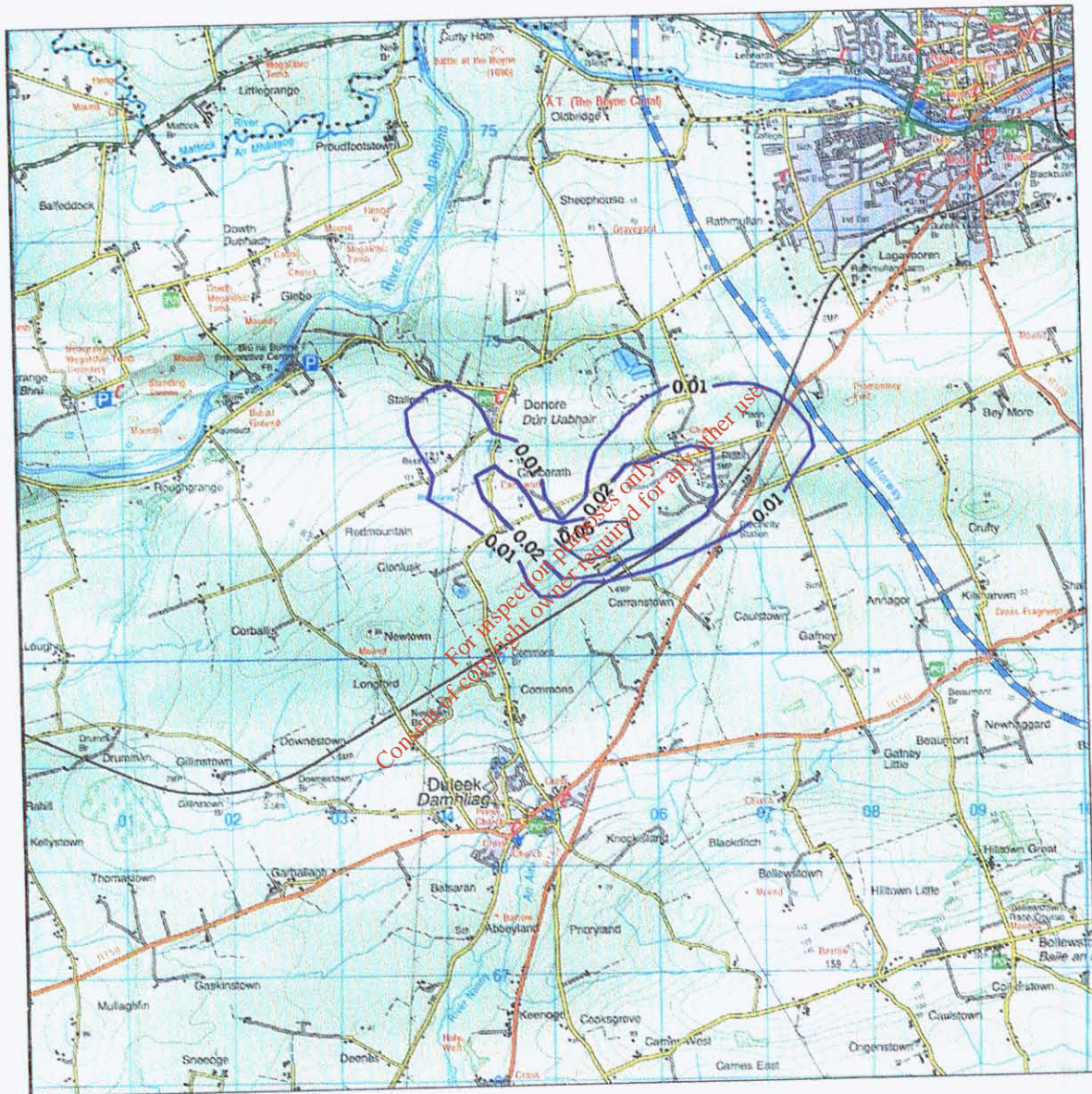
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**Figure 1.19: Predicted annual average PCDD/PCDF total deposition (ng/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

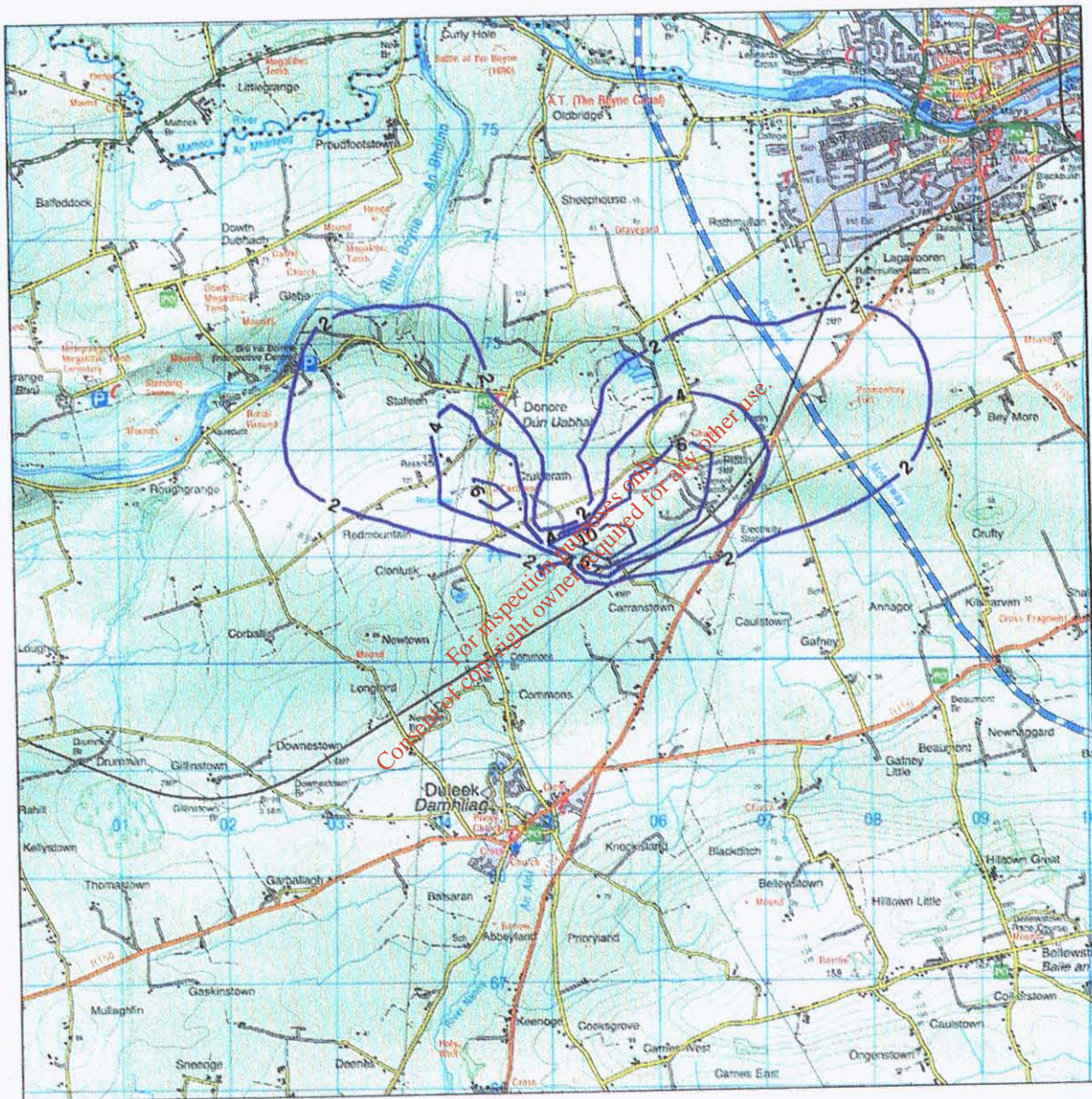
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**Figure 1.21: Predicted annual average Hg particle-bound deposition (mg/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

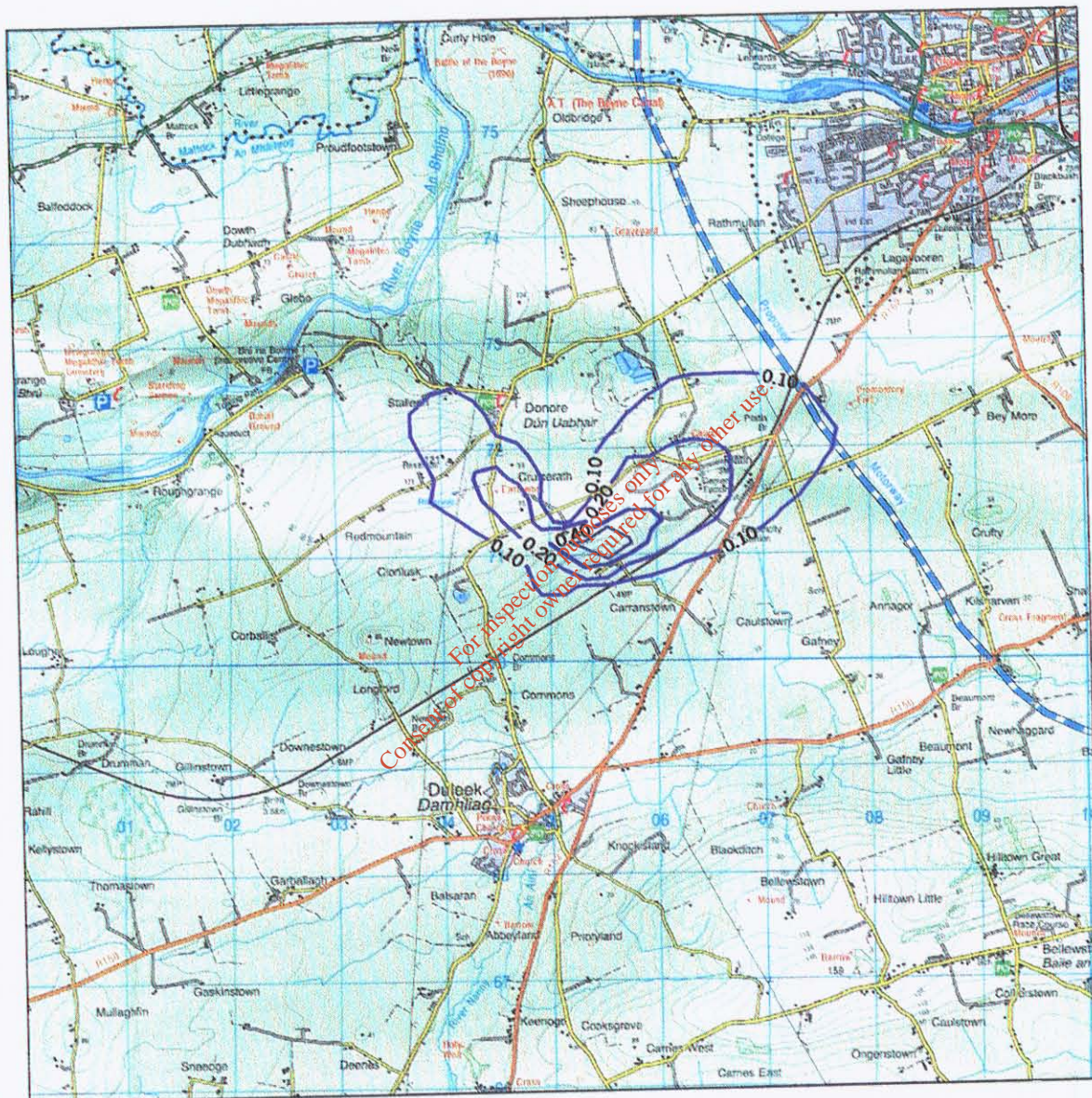
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**Figure 1.22: Predicted annual average Cd particle phase concentration as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

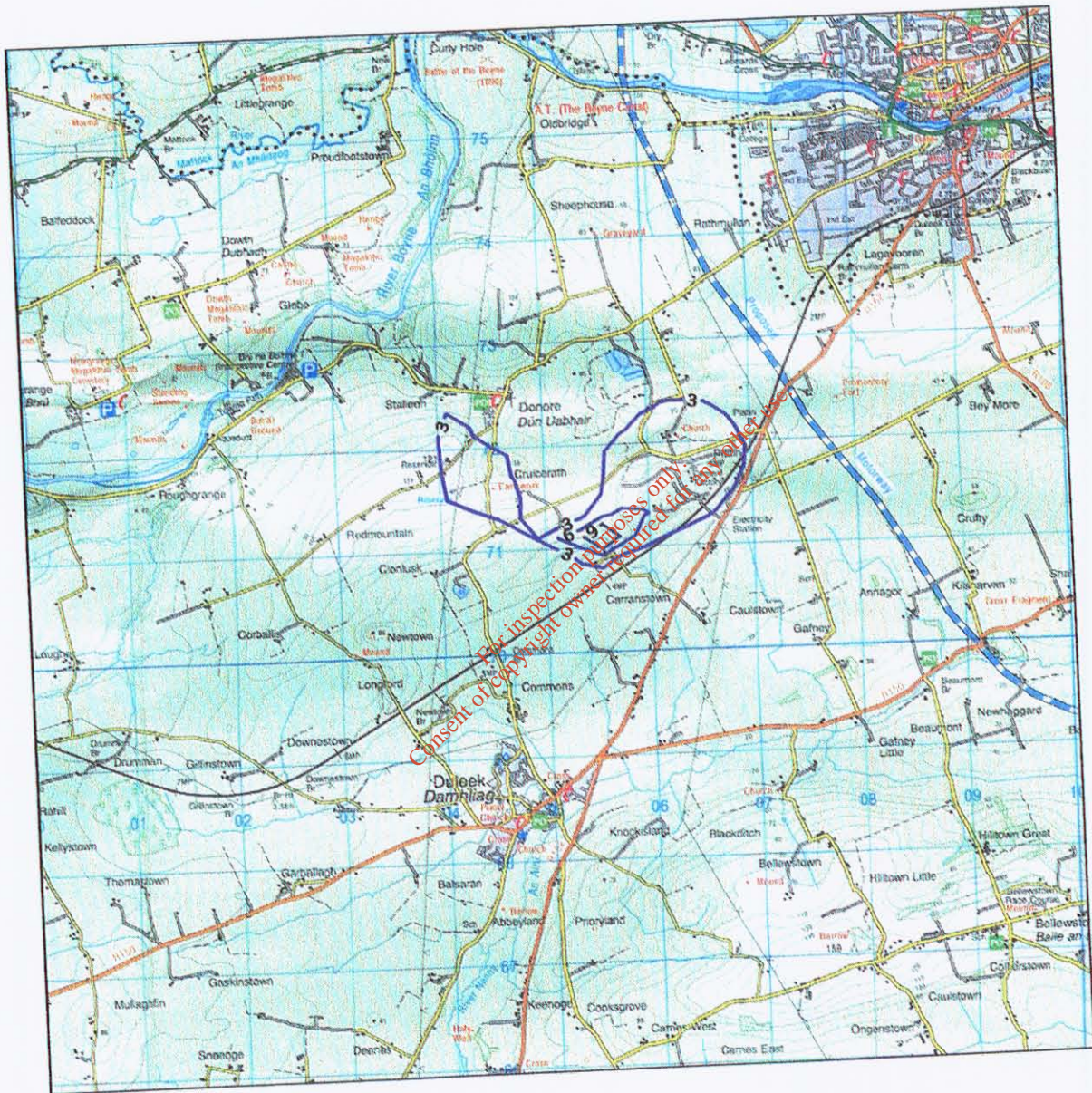
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**Figure 1.23: Predicted annual average Cd total particle deposition flux (mg/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

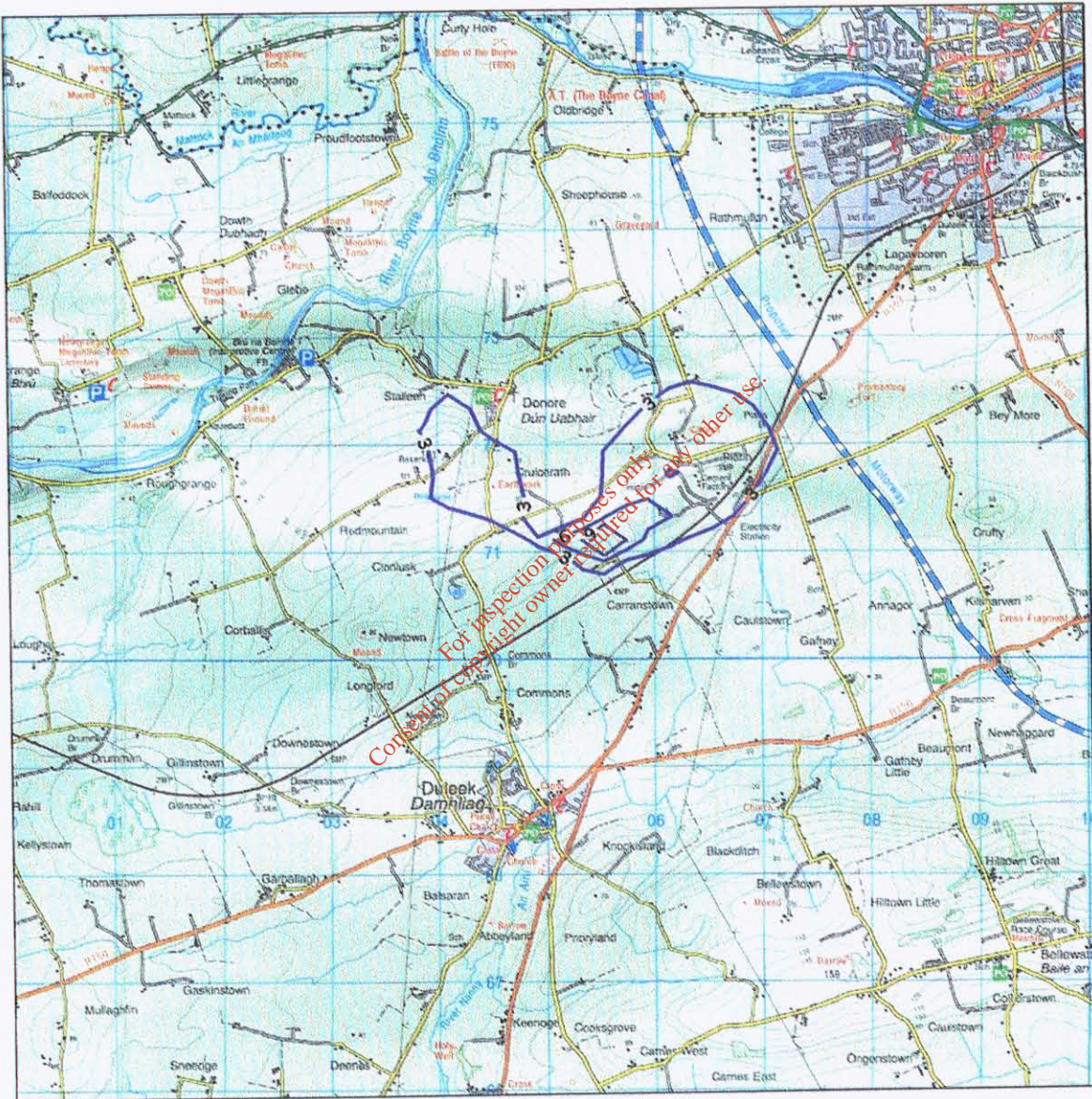
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**Figure 1.24: Predicted annual average sum of metals concentration as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

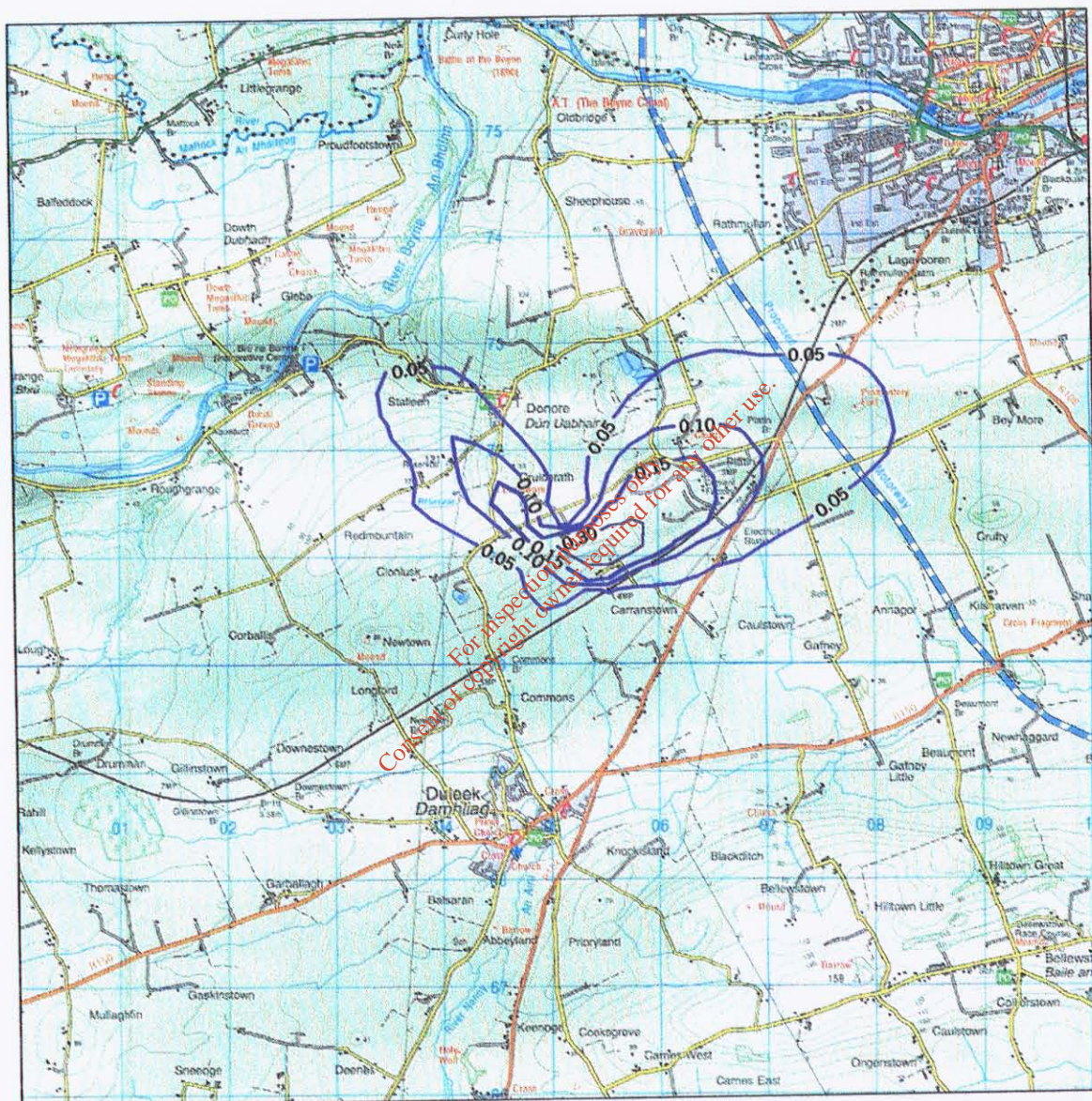
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**Figure 1.25: Predicted annual average arsenic concentration as a % of limit value
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

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**Figure 1.26: Predicted annual average arsenic total deposition flux (mg/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

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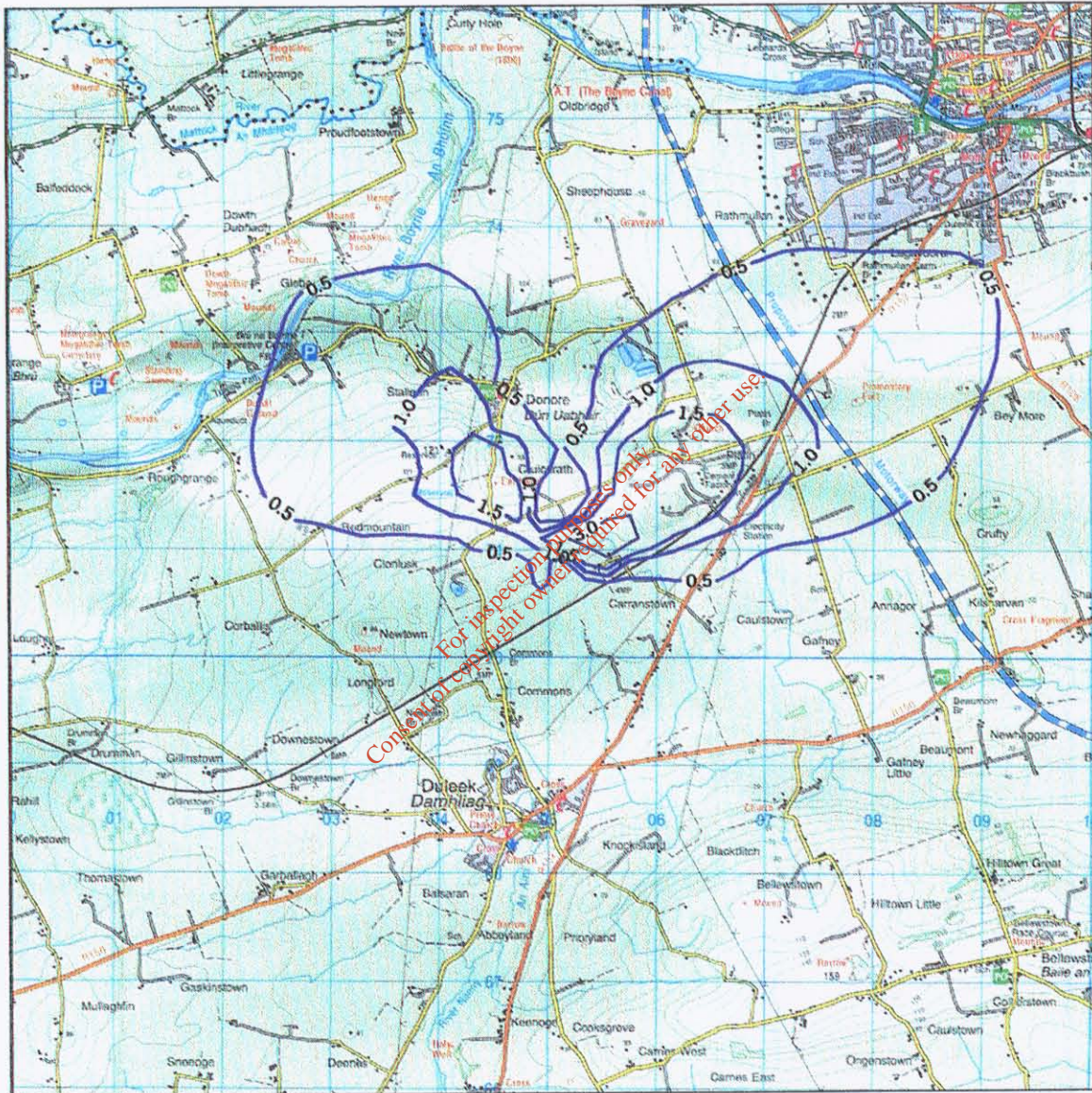
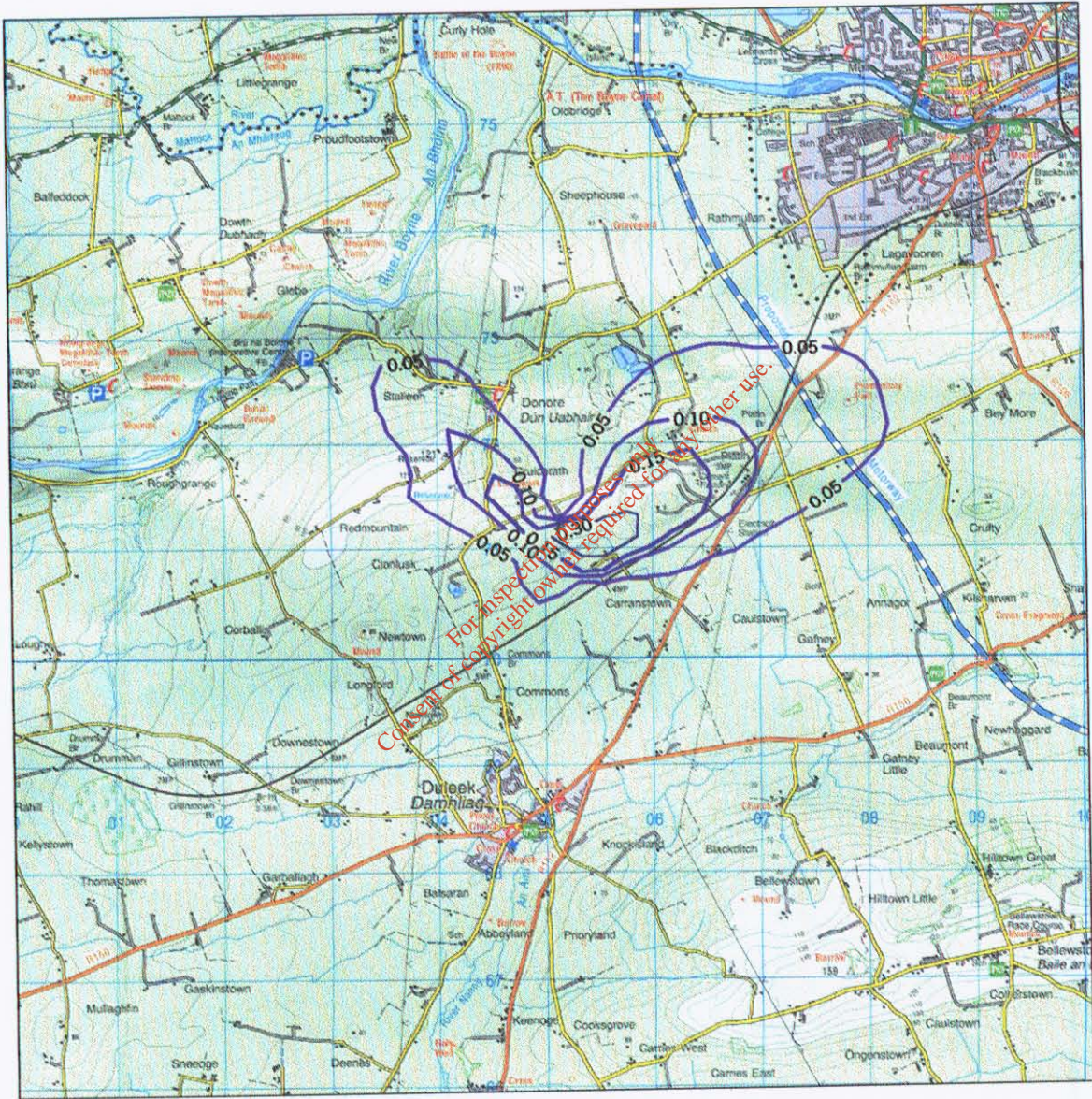


Figure 1.27: Predicted annual average nickel particle phase concentration as a % of limit value Maximum operation, Indaver Ireland Waste Management Facility

Scale: 1:70000 approx

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**Figure 1.28: Predicted annual average nickel total deposition flux (mg/m²)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

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APPENDIX 1.1

Description of the ISCST3 Model

The ISCST3 (Industrial Source Complex – Short Term 3) Model is a steady state bi-Gaussian plume model used to assess pollutant concentrations from a wide variety of sources. It is currently the USEPA regulatory model for industrial complexes such as the one under investigation in the current case⁽¹⁾.

The ISCST3 model, in common with most dispersion models, deals separately with plume rise and diffusion. The treatment of diffusion is based on the Pasquill-Gifford system (updated by Turner) in which meteorological conditions are classified into a set of stability categories, defined by solar radiation, cloud cover and wind speed, with values of plume spread given for each category. The plume spread is based on a Gaussian distribution in both the horizontal and vertical.

Plume Rise and Behaviour

The core of the plume rise equations use algorithms developed by Briggs (1969, 1971 and 1975). The height of the final plume rise is dependant on the prevailing wind speed, atmospheric stability and momentum and buoyancy associated with the plume. The plume is also influenced by stack tip and building downwash, the equations of which used in this study have been calculated by Briggs (1974) and Schulman Scire (1980) and subsequently refined by the USEPA. Downwash is a function of the structure dimensions, wind speed, wind-direction and emission height⁽³⁾.

The plume is assumed to rise initially due to momentum and buoyancy and gradually rise to its maximum height above ground level once the heat and subsequent buoyancy of the plume has equilibrated with the surrounding air. Once the maximum plume height has been reached, the model assumes that the centre of the plume remains at this height while the plume is dispersed both horizontally and vertically.

Gaussian Dispersion

When the height of the plume has stabilised, the dispersion of pollutants is then based on Gaussian dispersion horizontally and vertically from the plume centreline. A number of dispersion coefficients are available to the model. In this study rural dispersion coefficients as opposed to equations used in densely populated areas have been used.

The plume is confined within a body of air defined by the mixing height, the height of which is dependant upon the atmospheric stability and extent of sun-radiation reaching the ground, wind speed and surface roughness. Mixing height measurements by radiosonde are only carried out by Met Eireann in Valentia and therefore the mixing heights used in this study have been inferred for each hour from the fore-mentioned parameters.

Due to the proximity to surrounding buildings, the Building Profile Input Program (BPIP) has been incorporated into the model to determine the influence (wake effects) of these buildings on dispersion in each direction considered.

The ISCST3 model incorporated the following features:

- Two nested receptor grids were identified at which concentrations would be modelled. The receptors were mapped with sufficient resolution to ensure all localised "hot-spots" were identified without adding unduly to processing time. The first grid extended to 1500m based on a Cartesian grid with the site at the centre. Concentrations were calculated at 100m intervals. The second grid extends to 5000m based on a Cartesian grid with the site at the centre. Concentrations are calculated at 1000m intervals. In addition, boundary receptors locations were placed along the boundary of the site, at 100m intervals, giving a total of 1100 calculation points for each model case.
- All on-site buildings and significant process structures were mapped into the computer to create a three dimensional visualisation of the site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash). The stacks themselves can influence airflow in the same way as buildings by causing low pressure regions behind them (termed stack tip downwash). Both building and stack tip downwash were incorporated into the modelling.
- Hourly-sequenced meteorological information has been used in the model. The worst-case year of meteorological data over a five-year period was selected for use in the model. A site-specific surface roughness factor was developed for the site using the methodology outlined below.
- Detailed terrain has been mapped into the model. The site is located adjacent to a modest terrain feature to the north of the site. However, this would not be expected to be significant at stack height due to the modest nature of this terrain feature.

Description of the AERMOD Model

The AERMOD dispersion model has been recently developed, in part, by the U.S. Environmental Protection Agency (USEPA)⁽⁶⁾. The model is a steady-state Gaussian model used to assess pollutant concentrations associated with industrial sources. The model is an enhancement on the Industrial Source Complex-Short Term 3 (ISCST3) model which has been widely used for emissions from industrial sources. The Proposed Determination 2000 Federal Register Part II (Guidelines on Air Quality Models) has proposed that AERMOD become the preferred model for a refined analysis from industrial sources, in all terrains⁽²³⁾. A ruling by the USEPA on this proposal is due shortly.

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

In contrast to ISCST3, AERMOD is widely applicable in all types of terrain. Differentiation of the simple versus complex terrain is unnecessary with AERMOD. In complex terrain, AERMOD employs the dividing-streamline concept in a simplified simulation of the effects of plume-terrain

interactions. In the dividing-streamline concept, flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. Extensive validation studies have found that AERMOD performs better than ISCST3 for many applications and as well or better than CTDMPPLUS for several complex terrain data sets⁽⁵⁾.

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3⁽⁶⁾. ISCST3 approximates turbulence using six Pasquill-Gifford-Turner Stability Classes and bases the resulting dispersion curves upon surface release experiments. This treatment, however, cannot explicitly account for turbulence in the formulation. AERMOD is based on the more realistic modern planetary boundary layer (PBL) theory which allows turbulence to vary with height. This use of turbulence-based plume growth with height leads to a substantial advancement over the ISCST3 treatment.

Improvements have also been made in relation to mixing height⁽⁶⁾. The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

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

AERMET PRO

AERMOD incorporates a meteorological pre-processor AERMET PRO⁽²⁴⁾. AERMET PRO allows AERMOD to account for changes in the plume behaviour with height. AERMET PRO calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

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

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

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

surface friction velocity to the sensible heat flux; the daytime mixed layer height; the nocturnal surface layer height and the convective velocity scale which combines the daytime mixed layer height and the sensible heat flux. These parameters all depend on the underlying surface.

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 3km from the source location in line with USEPA recommendations⁽¹¹⁾. In relation to wind direction, a minimum sector arc of 30 degrees is recommended. In the current model, the surface characteristics for the site were assessed and one sector identified which could adequately characterise the surrounding land use.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on an area-weighted average of the land use within the sector, by using the eight land use categories outlined by the USEPA. The area-weighted surface roughness length derived from the land use classification within a radius of 3km from the site is shown in Table A1.1.

Table A1.1 Surface Roughness based on an area-weighted average of the land use within a 3km radius of Carranstown.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter ¹
0-360	1.0 (Cultivated Land)	0.03	0.20	0.05	0.01

Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))⁽¹²⁾. Thus for the current location autumn more accurately defines "winter" conditions in Carranstown.

Albedo

Noon-time Albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface which in turn is used to calculate hourly values of the Monin-Obuklov length. The area-weighted albedo derived from the land use classification within a radius of 3km from the site is shown in Table A1.2.

Table A1.2 Albedo based on an area-weighted average of the land use within a 3km radius of Carranstown

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter ¹
0-360	1.0 (Cultivated Land)	0.14	0.20	0.18	0.60

Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))⁽¹²⁾. Thus for the current location autumn more accurately defines "winter" conditions in Carranstown.

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. The area-weighted Bowen ratio derived from the land use classification within a radius of 3km from the site is shown in Table A1.3.

Table A1.3 Bowen ratio based on an area-weighted average of the land use within a 3km radius of Carranstown.

Sector	Area Weighted Land Use Classification	Spring	Summer	Autumn	Winter ¹
0-360	1.0 (Cultivated Land)	0.30	0.50	0.70	1.50

¹As snow is seldom, autumn more accurately defines "winter" conditions in Carranstown.

Comparison of ISCST3, AERMOD and AERMOD-PRIME Models

Emissions from the Indaver Ireland site have been modelled using the ISCST3 air dispersion model which has been developed by the U.S. Environmental Protection Agency (USEPA). The model has been designated the regulatory model by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain.

As part of an on-going program to improve the theoretical basis and accuracy of air dispersion models, the USEPA has recently reassessed the regulatory status of ISCST3. At the recently convened 7th Conference on Air Dispersion Modelling (2000)⁽⁴⁾, a new modelling formulation was suggested as a replacement for ISCST3 – AERMOD. This model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies⁽⁵⁻⁶⁾. Although AERMOD is a new generation model, the building downwash algorithm is similar to ISCST3. In recognition of this shortcoming, the USEPA are currently reviewing the possibility of incorporating a more advanced building downwash algorithm (PRIME Module) into the AERMOD modelling platform⁽⁷⁻⁹⁾. Thus, the current status of this model is still under review and thus it has not been granted regulatory approval at the current time.

In order to ensure that the current assessment is protective of air quality into the future and does not under-estimate air concentrations in the current application, a comparison of emissions from Indaver Ireland has been made with AERMOD and AERMOD-PRIME. In the current comparison the three models have been modelled using a unitised emission rate (1 g/s). In all models, specific guidance has been adhered to. In the case of ISCST3, the current version of the Guidelines on Air Quality Models⁽¹⁾ has been followed whereas in the case of AERMOD and AERMOD-PRIME, the Proposed Determination issued in April 2000 has been used⁽²³⁾.

In all cases, five years of meteorological data was examined and the worst-case years highlighted in bold. For completeness and in order to assess year-to-year variations, all five years have been reported for each model.

Significant differences are apparent between the models due to very significant differences in the modelling formulations. As AERMOD is a new generation model, the algorithm is both more complex and advanced. Of particular significance in the current application, in a region of rolling hills, is the treatment of the terrain. The more advanced treatment indicates that for very extreme meteorological conditions, ISCST3 is conservative. Although AERMOD is a new generation

model, the building downwash algorithm is similar to ISCST3. The more advanced building downwash algorithm (PRIME Module) has recently been incorporated into the AERMOD modelling platform⁽⁸⁻¹⁰⁾. This model has also been assessed below as shown in Table A1.4. AERMOD-PRIME results indicate that for both very extreme meteorological conditions and long-term averages, ISCST3 is conservative in the current assessment. Indeed, the comparison between AERMOD and AERMOD-PRIME indicates that the more advanced building downwash algorithm leads to significantly lower long-term concentrations, in particular.

An examination of the five-years of modelling results indicates significant variations year-on-year (see Table A1.4). In relation to ISCST3, this is particularly apparent for the annual averaging period. In the current assessment, the worst-case annual average has been used (Year 1994 – 1.21 $\mu\text{g}/\text{m}^3$) which has then been used to assess the impact of heavy metals and PCCD/PCDFs, in particular, in the surrounding environment. An examination of the long-term average indicates that the worst-case year is over 30% higher than that which would be expected over the five-year period. Moreover, a comparison with both ISCST3 and AERMOD-PRIME indicates that the worst-case annual modelling result estimated by ISCST3 is over three times the long-term annual average predicted by AERMOD-PRIME whereas the worst-case short-term (99.8%ile of 1-hour values) modelling result estimated by ISCST3 is over 2.3 times the short-term annual average predicted by AERMOD-PRIME.

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Table A1.4 Comparison of Dispersion Model Results – Unitised Emission Rate (1 g/s) ISCST3, AERMOD and AERMOD-PRIME ($\mu\text{g}/\text{m}^3$)⁽¹⁾

Model	Year	Maximum 1-Hour	99.8 th ile of 1-Hour	99.7 th ile of 1-Hour	99 th ile of 1-Hour	98 th ile of 1-Hour	Annual
ISCST3	1997	43.9	21.0	20.2	11.9	5.8	0.36
	1996	40.6	24.0	23.0	18.5	11.2	0.56
	1995	43.8	25.7	24.4	20.6	17.8	1.00
	1994	39.5	27.3	25.0	20.3	17.7	1.22
	1993	40.0	25.5	24.2	19.5	15.6	0.96
AERMOD	1997	27.6	14.5	13.7	8.2	7.3	0.63
	1996	21.1	17.4	16.3	9.9	7.1	0.67
	1995	21.9	17.5	15.6	8.9	7.0	0.95
	1994	24.5	17.3	16.0	11.4	7.4	1.21
	1993	26.0	17.6	16.7	11.3	7.3	1.01
AERMOD-PRIME	1997	18.7	11.5	11.2	7.3	4.3	0.28
	1996	17.4	10.7	9.6	5.7	3.0	0.29
	1995	15.0	10.4	9.6	4.6	2.9	0.39
	1994	14.9	9.8	8.5	4.9	3.2	0.51
	1993	14.7	9.9	9.1	4.5	2.9	0.42

(1) Bold indicates the worst-case year in relation to both the 99.8thile and annual average which is the assessment criteria for nitrogen dioxide.

APPENDIX 1.2

Ambient NO₂/NO_x Ratio

NO₂ has been modelled following the approach outlined by the USEPA⁽¹⁾ for assessing the impact of NO_x from point sources. The approach involves assessing the air quality impact through a three tiered screening technique. The initial analysis, termed the Tier 1 approach, assumes a worst-case scenario that there is total conversion of NO_x to NO₂. The guidance indicates that if this worst-case assumption leads to an exceedance of the appropriate limit value, the user should proceed to the next Tier. Tier 2 is appropriate for estimating the annual average NO₂ concentration, though not for estimating the maximum one-hour limit value. The Tier 2 approach indicates that the annual average concentration should be derived from an empirically derived NO₂/NO_x ratio. The guidance suggests that the NO₂/NO_x ratio should be based on data representative of area wide quasi-equilibrium conditions.

Evidence from monitoring stations in Ireland (see Table A1.5) indicate a low annual ratio over a wide range of annual average concentrations. Empirical evidence suggests that a conservative estimate of this site-specific ratio would be 0.75. Thus a ratio of 0.75 for NO₂/NO_x has been used in the current assessment for the annual average conversion ratio. This is also in line with the USEPA recommended default value for annual averages.

Table A1.5 Nitrogen Oxides Results For Irish Monitoring Stations (EPA Monitoring Report 1999 (ppb))

Station	Year	Annual NO _x	99.8 th %ile 1-hr NO _x	Annual NO ₂	99.8 th %ile 1-hr NO ₂	Annual Ratio NO ₂ /NO _x	99.8 th %ile Ratio NO ₂ /NO _x
Rathmines, Dublin	1999	19	229	9	34	0.47	0.15
College Street	1999	193	1399	37	299	0.19	0.21
Whitehall	1999	14	49	9	223	0.64	0.22
Cork Centre	1999	32	346	16	160	0.50	0.46

In relation to the maximum one-hour value, the Tier 3 approach is recommended by the USEPA¹. The Tier 3 approach involves the application of a detailed screening method on a case-by-case basis. The suggested methodologies include the ozone-limiting method or a site-specific NO₂/NO_x ratio. The site-specific method requires ambient monitors to be sited to obtain the NO₂ and NO_x concentrations under quasi-equilibrium conditions. For the maximum one-hour concentration, no site-specific ratio has been developed because the data from the baseline monitoring program measured much lower concentrations than that predicted to occur during operations very occasionally at the boundary of the site. Thus, a literature study was used to derive a conservative NO₂/NO_x ratio at the location of the maximum concentration.

Evidence from monitoring stations in Ireland (see Table A1.5) indicates a ratio over a wider range of 99.8th %ile concentrations of around 0.25. Guidance from the UK⁽²⁸⁾, has indicated that for a third stage assessment of nitrogen dioxide emissions, a maximum ratio of 0.25 should be assumed when NO_x concentrations are of the order of 400 µg/m³, while for higher concentrations of NO_x, the average concentration of NO₂ increases at a rate of 10-15% that of NO_x.

Thus, empirical evidence suggests that a conservative estimate of this site-specific ratio would be 0.30. Thus a ratio of 0.30 for NO_2/NO_x has been used in the current assessment for the 99.8th percentile of one-hour maximum concentrations.

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APPENDIX 1.3

Cumulative Impact Assessment

As the region around Carranstown is partly industrialised and thus has several other potentially significant sources of air emissions, a detailed cumulative assessment has been carried out using the methodology outlined by the USEPA. Table 1.3 (see main report) outlined the recommended range of operating conditions to be assessed in the cumulative assessment. Full details are given below of the cumulative assessment carried out for the current study.

The impact of nearby sources should be examined where interactions between the plume of the point source under consideration and those of nearby sources can occur. These include:

- a. the area of maximum impact of the point source,
- b. the area of maximum impact of nearby sources,
- c. the area where all sources combine to cause maximum impact^(1,13).

The approach taken in the cumulative assessment followed the USEPA recommended Prevention of Significant Deterioration (PSD) Increment approach⁽¹³⁾ as outlined in Section 1.2.

As previously discussed in Section 1.2, the current location would be considered a Class II area and thus the PSD applicable to Class II areas has been applied in the current case. Due to the variations in pollutant averaging times and standards between the USA and the EU, only relative PSD can be derived. The relative PSD, as a percentage of the respective National Ambient Air Quality Standards (NAAQS), is shown in Table 1.4 with the corresponding concentration as it would be applied to the EU ambient air quality standards. In the current context, the PSD increment has been applied to zones where significant overlap occurs between plumes from each of the sources. The PSD increment has not been applied per se, as existing facilities were not designed to this standard.

In the context of the cumulative assessment, all significant sources should be taken into account. The USEPA has defined "significance" in the current context as an impact leading to a $1 \mu\text{g}/\text{m}^3$ annual increase in the annual average concentration of the applicable criteria pollutant. However, no significance ambient impact levels have been established for non-criteria pollutants (defined as all pollutants except PM_{10} , NO_2 , SO_2 , CO and lead). The USEPA does not require a full cumulative assessment for a particular pollutant when emissions of that pollutant from a proposed source would not increase ambient levels by more than the significant ambient impact level (annual average of $1 \mu\text{g}/\text{m}^3$). A similar approach has been applied in the current assessment. A significance criterion of 2% of the ambient air quality standard or guideline has been applied for all non-criteria pollutants. Table A1.6 outlines the significant releases from Indaver Ireland. These releases consist of NO_2 , SO_2 , HCl , HF , Dioxins, Cd & Tl , Hg and the sum of Sb , As , Pb , Cr , Co , Cu , Mn , Ni and V . As emissions of Total Dust (and PM_{10}), CO and TOC are not significant, no cumulative assessment need be carried out for these pollutants.

The project's impact area is the geographical area for which the required air quality analysis for PSD increments are carried out. The USEPA has defined the "impact area" as a circular area with a radius extending from the source to the most distant point where dispersion modelling predicts a significant ambient impact will occur irrespective of pockets of insignificant impact occurring within it. Within this impact area, all nearby sources should be modelled, where "nearby" is defined as

any point source expected to cause a significant concentration gradient in the vicinity of the proposed new source.

In order to determine compliance, the predicted ground level concentration (based on the full impact analysis and existing air quality data) at each model receptor is compared to the applicable ambient air quality limit value or PSD increment. If the predicted pollutant concentration increase over the baseline concentration is below the applicable increment, and the predicted total ground level concentrations are below the ambient air quality standards, then the applicant has successfully demonstrated compliance.

When an air quality standard or PSD increment is predicted to be exceeded at one or more receptor in the impact area, it should be determined whether the net emissions increase from the proposed source will result in a significant ambient impact at the point of each violation, and at the time the violation is predicted to occur. The source will not be considered to cause or contribute to the violation if its own impact is not significant at any violating receptor at the time of each violation.

In relation to nearby sources, several significant sources of releases were identified as outlined in Table A1.7. For each significant nearby source, an assessment was made of which pollutants from each source were significant. Due to the absence of any other significant sources of HCl, HF, Dioxins, Cd & Tl, Hg and the sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V in the nearby environment, no cumulative assessment need be carried out for these substances. The significant pollutants from each site have been outlined in Table A1.7.

Table A1.6 Assessment of Significant Releases from Indaver Ireland

Pollutant	Significance Criteria ($\mu\text{g}/\text{m}^3$ annual average)	Indaver Ireland GLC ($\mu\text{g}/\text{m}^3$ annual average)	Significance
NO ₂	1	8	√
SO ₂	1	3	√
PM ₁₀	1	0.5	-
TOC	20 (98 th percentile of 1-hr)	7	-
HCl	2 (98 th percentile of 1-hr)	7	√
HF	0.006	0.7	√
Dioxins	-	5.1E-9	√
Cd & Tl	0.0001	0.001	√
Hg	0.002	0.007	√
Sum of metals	0.00008	0.02	√

Table A1.7 Assessment of Significant Releases From Nearby Sources

Pollutant	Plant 1	Plant 2
NO ₂	√	√
SO ₂	√	√
HCl	-	-
HF	-	-
Dioxins	-	-
Cd & Tl	-	-
Hg	-	-
Sum of metals	-	-

Summary of Nearby Sources

Plant 1 Marathon Power

Plant 2 Platin Cement

The cumulative impact assessment has been carried out to assess the impact of emissions from Indaver Ireland on the surrounding environment. As such, several conservative approximations have been made in regards to the operating details and physical characteristics of the surrounding sources. Furthermore, the guidance for assessing cumulative impacts includes assessing everywhere off-site, including within the site boundary of all nearby sources⁽¹³⁾. Thus, the results outlined in this chapter, in regards to emissions from nearby sources, may apply to areas on-site within each source (and thus will not fall under the domain of ambient legislation) and will also most likely overestimate the impact of these sources in the surrounding environment.

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Table A1.8 Assessment of Cumulative Impact of Nitrogen Dioxide Emissions ($\mu\text{g}/\text{m}^3$)

Pollutant	Plant 1	Plant 2	Indaver Ireland	All Sources Except Indaver	Significance Criteria	All Sources	Limit Value ⁽³⁾
Impact of each source at Indaver Maximum – 99.8 th ile ⁽¹⁾	6.5 (306300, 271100)	0.04 (306300, 271100)	-	6.5 (306300, 271100)	50 ⁽⁴⁾	65 (306300, 271100)	200
Impact of each source at Indaver Maximum – Annual Average ⁽²⁾	0.38 (306455, 271004)	0.003 (306455, 271004)	-	0.38 (306455, 271004)	10 ⁽⁴⁾	8.1 (306455, 271004)	40
Indaver Impact At Maximum of Each Source – 99.8 th ile ⁽¹⁾	20 (306900, 270900)	23 (304000, 272000)	-	-	50 ⁽⁴⁾	20 (308000, 267000)	200
Indaver Impact At Maximum of Each Source – Annual Average ⁽²⁾	0.87 (307000, 270900)	1.0 (305000, 273000)	-	-	10 ⁽⁴⁾	7.7 (306500, 271100)	40

(1) Conversion factor, following guidance from USEPA (Tier 3 analysis), based on empirically derived site-specific maximum 1-hour value for NO₂ / NO_x of 0.30

(2) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on a default ratio of 0.75 (worst-case).

(3) Directive 1999/30/EC

(4) PSD Increment for Nitrogen Dioxide applicable in the current application (except for the All Sources scenario).

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 1.5 for input information on nearby sources

Table A1.9 Assessment of Cumulative Impact of Sulphur Dioxide Emissions ($\mu\text{g}/\text{m}^3$)

Pollutant	Plant 1	Plant 2	Indaver Ireland	All Sources Except Indaver	Significance Criteria	All Sources	Limit Value
Impact of each source at Indaver Maximum – 99.7 th percentile of 1-Hr ⁽¹⁾	2.1 (306300, 271100)	0.15 (306300, 271100)	-	2.1 (306300, 271100)	88 ⁽²⁾	54 (306300, 271100)	350
Indaver Impact At Maximum of Each Source – 99.7 th percentile of 1-Hr ⁽¹⁾	16 (306900, 270900)	17 (304000, 272000)	-	-	88 ⁽²⁾	5.0 (308000, 267000)	350

(1) Directive 1999/EU/30 – Maximum one-hour concentration not to be exceeded more than 24 times per year (99.7th percentile)

(2) PSD Increment for Sulphur Dioxide applicable in the current application (except for the All Sources scenario)

Note: Grid co-ordinates are National Grid co-ordinates and refer to the location of local maximum

Note: Refer to Appendix 1.5 for input information on nearby sources

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NO₂

The cumulative impact of nitrogen dioxide has been assessed in Table A1.8. Each individual source has been modelled both separately and as part of the cumulative assessment.

The impact of nearby sources has been examined where interactions between the plume of the point source under consideration and those of nearby sources may occur. These locations were:

- 1) the area of maximum impact of the point source,
- 2) the area of maximum impact of nearby sources,
- 3) the area where all sources combine to cause maximum impact⁽¹³⁾.

In the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306300, 271100), the impact from each source was minor. In relation to the 99.8th percentile of maximum one-hour concentrations, the cumulative impact at this point was 4% of the limit value in the absence of Indaver Ireland. However, in the presence of Indaver Ireland, the assessment indicated that the cumulative impact was 33% of the limit value at this point. This was similar to the maximum concentration of Indaver Ireland alone and thus indicates that the contribution of each nearby source was separated in time and thus did not lead to any significant increase in levels above the impact of Indaver Ireland alone.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306455, 271004). The overall impact leads to an increase of 1% in the annual average levels leading to a cumulative level of 20% of the limit value.

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.8th percentile of maximum one-hour concentrations, the impact of Indaver Ireland at the point of maximum impact of each nearby source was always less than 12% of the limit value. Moreover, the maximum one-hour impact of Indaver Ireland at each nearby source was separated in time and thus did not lead to any significant increase in levels above the impact of each individual source separately.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of each individual source. The overall impact leads to an increase of 3% in the annual average level of the worst-case nearby source. Indeed, in the region where all sources combine to cause the maximum impact, an examination of the impact of Indaver Ireland reveals no significant impact at all.

SO₂

The cumulative impact of sulphur dioxide has been assessed in Table A1.9. Each individual source has been modelled both separately and as part of the cumulative assessment.

In the area of the maximum impact of Indaver Ireland (Grid Co-ordinate 306300, 271100), the impact from each source was minor. In relation to the 99.7th percentile of maximum one-hour concentrations, the cumulative impact at this point was less than 1% of the limit value in the absence of Indaver Ireland. However, in the presence of Indaver Ireland, the cumulative impact with maximum concentrations rose to 16% of the limit value, which is almost identical to the maximum concentration of Indaver Ireland alone.

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.7th percentile of maximum one-hour concentrations, the impact of Indaver Ireland at the point of maximum impact of each nearby source was always less than 5% of the limit value. In the region where all sources combine to cause the maximum impact, an examination of the impact of Indaver Ireland reveals no significant impact at all.

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APPENDIX 1.4

AIR QUALITY IMPACT FROM TRAFFIC SOURCES

STUDY METHODOLOGY

The assessment of air quality has been carried out using a phased approach as recommended by the UK DETR^(1,2). The phased approach recommends that the complexity of an air quality assessment should be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial screening of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. A review of recent EPA and Local Authority data in Ireland⁽³⁻⁵⁾ (see Appendix A1.4), has indicated that SO₂, smoke, CO and lead are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed assessments to be carried out. However, the review did indicate potential problems in regards to nitrogen dioxide (NO₂) and benzene at busy junctions in Dublin and Cork. PM₁₀ has also been highlighted as a problem in large urban centres and in regions with significant local sources of diesel traffic⁽³⁻⁵⁾.

The current assessment thus focussed firstly on identifying the existing baseline levels of NO₂, PM₁₀ and benzene in the region of the proposed development (CO was also assessed as the model was originally derived for this pollutant). Thereafter, the impact of the development on air quality at the neighbouring sensitive receptors was determined relative to the existing baseline. The assessment methodology involved detailed air dispersion modelling using the US Environmental Protection Agency (USEPA) approved air dispersion model CAL3QHCR⁽⁶⁾ and following guidance issued by the California Department of Transportation and USEPA⁽⁷⁻⁹⁾. The inputs to the air dispersion model consist of information on road layouts, hourly traffic movements, site-specific composite vehicle emission factors and a full year of meteorological data. Using this input data the model predicts ambient ground level concentrations at each sensitive receptor for each hour of the modelled meteorological year. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentration (see Table 1.6 of the main report).

Forecasting Methods

The air quality assessment has been carried out following procedures described in the publications by the EPA^(10,11) and using the methodology outlined in the guidance documents published by the UK DETR^(1-2,12-13).

Prediction of traffic derived pollutants was carried out using the USEPA approved CAL3QHCR dispersion model (USEPA, 1995)⁽⁶⁾, which has been specifically formulated for modelling complex intersections, in conjunction with the most recent CORINAIR database, which was formulated by the European Environment Agency (EEA) (COPERT III, 2000)⁽¹⁵⁾. PM₁₀ emission factors from re-suspended dust have been calculated using the AP-42 emissions database from the USEPA⁽¹⁶⁾.

THE RECEIVING ENVIRONMENT - AIR

Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health- or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set (see Appendix A1.4).

In the current assessment, new EU ambient air quality standards which will shortly be enacted in Ireland have been used to describe significance criteria in both 2004 and 2020 (see Tables 1.8 and 1.12 of the main body of the report).

Trends In Air Quality

In recent years, the focus of concern in relation to ambient air quality has shifted from black smoke, SO₂ (both historically from home heating) and lead (from leaded petrol) to NO₂, benzene and PM₁₀, all derived mainly from traffic sources⁽³⁻⁵⁾. Legislation changes have ensured that levels of black smoke, SO₂ and lead are small fractions of historical levels and now rarely approach the limit values. In recent years, however, EU Directive 1999/30/EC has imposed stricter limits on NO₂ while the carcinogenic properties of benzene and PM₁₀ have been highlighted in recent EU Directives.

A summary of recent EPA and Local Authority data in Ireland is presented in Appendix A1.4⁽³⁻⁵⁾. In summary, the EPA data indicates that levels of CO, SO₂, smoke and lead are significantly below the respective limit values even at worst-case roadside locations in major urban centres. In contrast, PM₁₀, NO₂ and benzene currently approach or may even exceed new EU Directives at kerbside and major junctions in parts of Central Dublin and Cork. However, spatial variations in air quality are important, with concentrations falling significantly with distance from roadside⁽¹⁷⁾. Thus, residential exposure across urban background and suburban areas will typically be significantly less than that reported by the EPA, which focused generally on monitoring worst-case kerbside locations at city centre junctions.

Continuous monitoring of NO₂ in Dublin at College Green and Rathmines and of PM₁₀ at four stations in central Dublin does not show a clear trend although no significant increases have been observed over the last 4-5 years despite significant increases in traffic volume and congestion⁽³⁾. Little data is available outside of urban centres in order to assess trends in air quality for the key pollutants of NO₂, benzene and PM₁₀. Some data is available over the period 1996-99 in relation to the monitoring of NO₂ in suburban areas of Dublin which have been carried out by the local authorities^(4,5). The temporal pattern in annual average concentrations indicates that levels are slowly decreasing despite significant increases in traffic numbers and congestion. This decrease is due to significant improvements in emissions from catalyst-equipped vehicle compared to pre-catalyst vehicles and these improvements will continue over the next few years as the number of pre-catalyst vehicles rapidly diminishes. Emission reductions of NO₂, benzene and PM₁₀ by 15-25% between 2001 and 2004⁽¹⁷⁾ are expected.

Recent data carried out by the EPA's mobile monitoring unit indicates much lower levels of NO₂, benzene and PM₁₀ in regional towns such as Waterford and Limerick⁽³⁾. Levels in the region of the proposed scheme would be expected to experience even levels lower than those reported in regional centres.

Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors can experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels)⁽¹⁴⁾. Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will be greatest under very calm conditions and low wind speeds when the movement of air is restricted. The nearest representative weather station collating detailed weather records is Dublin Airport, approximately 30km south-east of the site. Dublin Airport has been examined to identify the year giving rise to the highest predicted ambient concentrations. For data collated during five representative years (1993-97), the worst-case year was 1995. This year has been used in all modelled scenarios (see Figure 1.1 of the main body of the report). For data collated during five representative years (1993-97), the worst-case conditions occurred for approximately 3% of the time. The predominant wind directions in the worst-case year (1995) are south-westerly with average wind speeds of approximately 3-5 m/s.

CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

Road traffic would be expected to be the one of the dominant source of emissions in the region of the development (the second major source will be process emissions which has been addressed in the main body of the report). Detailed traffic flow information was obtained from the traffic section of the Statement and has been used to model pollutant levels under various traffic scenarios and under sufficient temporal and spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur.

Cumulative effects have been assessed in the main body of the report, as recommended in the EU Directive on EIA (Council Directive 97/11/EC) and using the methodology of the UK DETR^(1,2). Firstly, background concentrations have been included in the main modelling study. These background concentrations are based on the baseline monitoring study and account for non-localised sources of the pollutants of concern and existing sources of pollutants in the region. In the air modelling from traffic sources, the existing situation (excluding background levels) has been assessed in the absence of the scheme for both the baseline and design year. Thereafter, the additional impact of the scheme has also been assessed, relative to baseline conditions, for both years. Thus, the significance of the scheme, has been assessed for both the baseline and design year. This information has then been used as shown in Table 1.6 of the main report to assess the cumulative impact of the scheme (both process and traffic-derived emissions) and existing background and nearby sources.

Air Dispersion Modelling

The inputs to the air dispersion model consist of information on road layouts, hourly traffic movements and a full year of meteorological data. Site-specific composite traffic emission factors also need to be derived based on an analysis of vehicle age, vehicle type, average speeds and model year of vehicle. The year giving the highest ambient concentrations of NO₂ over a five-year period (1993-1997) has been incorporated into the model (Dublin Airport 1995) and has been used to determine hourly concentrations for all pollutants of concern at each specified receptor in the region.

Peak, one-hour concentrations for CO, benzene, NO₂ and PM₁₀ for years 2004 and 2020, at the nearest sensitive receptors to the development, have been modelled using the USEPA approved CAL3QHCR⁽⁶⁾ dispersion model, which is based on the USEPA approved CALINE3⁽¹⁸⁾ dispersion model, in conjunction with the most recent European emissions database from the CORINAIR working group⁽¹⁵⁾. Detailed modelling methodology has been outlined in Appendix A1.4.

In the modelling assessment a number of specific sensitive receptors were identified within several hundred metres of the proposed scheme. Baseline and "with development" modelling was carried out at the building façade of each of these receptors for both the opening year and the design year (sixteen years after opening). The assessment was also carried out at two different average traffic speeds, worst-case peak-hour and design speed, as vehicle emissions are particularly sensitive to this parameter.

THE POTENTIAL IMPACT OF THE PROPOSED DEVELOPMENT

Baseline Modelling Assessment

PM₁₀, CO and Benzene

The results of the baseline modelling assessment for PM₁₀, CO and benzene in the opening year are shown in Table A1.10. Concentrations are significantly within the limit value under both traffic speed scenarios. Levels of all three pollutants range from 1 - 12% of the respective limit values in 2004.

The temporal trend in these pollutants can be established by an examination of levels in 2004 and 2020 (see Table A1.10). Future trends for the "Do nothing" scenario indicate even lower levels of both CO and benzene. As a worst-case, annual baseline levels of PM₁₀ in 2020 have been compared with the proposed PM₁₀ limit value which may be introduced in 2010. Baseline levels of all three pollutants range from 1% of the limit value for benzene in 2020 to 10% of the more stringent proposed annual limit value for PM₁₀ in 2020.

NO₂

The results of the baseline assessment for NO₂ in the opening year are shown in Table A1.10. Concentrations are significantly within the annual limit values under both traffic speed scenarios. Future trends for the "Do nothing" scenario indicates decreasing annual levels of NO₂. Baseline levels of NO₂ range from 1 - 2% of the annual limit value in both 2004 and 2020.

The EU limit value for the maximum one-hour standard for NO₂ is based on a one-hour mean not to be exceeded more than 18 times a year (99.8thile). A limitation of the model is the inability to calculate percentiles and thus only a maximum value is calculated. The likely variation between the maximum one-hour and 99.8thile can be estimated by a comparison between the continuous monitoring stations based in Dublin and Cork⁽³⁻⁵⁾. Shown in Table A1.5 is the ratio between these two values. A likely ratio at the concentration predicted would be of the order 0.5 - 0.6. However, in the current assessment, a worst-case ratio of 0.75 has been applied to the modelled maximum.

Thus, the maximum one-hour concentrations for NO₂ have been used directly in Table A1.10. Existing baseline levels in 2004 will be significantly below this limit value, with levels at the worst-case receptor peaking at 29% of the EU limit value.

Temporally, baseline levels of maximum one-hour NO₂ concentrations over the period 2004 to 2020 will decrease significantly with levels at 15% of the limit value at the worst-case receptor in the design year (2020) (see Table A1.10).

Modelled Impact of the Scheme On The Surrounding Environment

PM₁₀, CO and Benzene

The results of the modelled impact of the development for PM₁₀, CO and benzene in the opening year are shown in Table A1.10. The cumulative impact of both baseline traffic levels and additional traffic due to the development are presented. Concentrations are again significantly within the ambient standards under both traffic speed scenarios. Levels of all three pollutants range from 1 - 13% of the respective limit values in 2004.

Future trends, with the development in place, indicate some decreases in the levels of PM₁₀, CO and benzene. Levels of all three pollutants range from 1 - 11% of the respective limit values in 2020.

The impact of the development can be assessed relative to existing baseline levels in both the opening and design year (see Table A1.10). For PM₁₀, CO and benzene, relative to baseline levels, the impact of the development will generally be minor with some small increases as a result of the scheme. As a worst-case levels will increase by 1% of the respective limit values.

Thus, the impact of the development in terms of PM₁₀, CO and benzene is not significant.

NO₂

The results of the assessment of the impact of the development for NO₂ in the opening year (2004) are shown in Table A1.10. Annual average concentrations are significantly within the annual limit values under both traffic speed scenarios. Future trends, with the development in place, indicates even lower annual levels of NO₂. Levels of NO₂ range from 1 - 3% of the annual limit value in 2004 and 2020. The impact of the development will account for less than 1% of these annual limit values in either 2004 or 2020.

A worst-case ratio of 0.75 has been applied to the modelled maximum in Table A1.10. Maximum one-hour NO₂ levels in 2004, with the development in place, will be significantly below the limit value, with levels peaking at the worst-case receptor at 32% of the limit value.

Temporally, as a worst case, levels of maximum one-hour NO₂ concentrations, with the development in place, will decrease by 16% of the limit value between 2004 and 2020.

The impact of the development on maximum one-hour NO₂ levels can be assessed relative to existing baseline levels in both the opening and design year (see Table A1.10). Levels are higher with the development in place, with impacts ranging between 2 - 3% of the respective limit values in either 2004 and 2020. However, predicted levels will still be significantly below the NO₂ maximum one-hour limit value, with worst-case levels peaking at 16% of the limit value in 2020.

Thus, the impact of the development in terms of NO₂ is not significant.

Summary of Modelling Assessment

Baseline modelling assessments for PM₁₀, CO and benzene indicate that concentrations will be significantly within the ambient air quality standards under all scenarios. In addition, the impact of the development will account for only 1% of the respective limit values. Cumulatively, levels will still be significantly within the ambient air quality limit values under all scenarios. Levels of all three pollutants range from 1 - 13% of the respective limit values in 2020. Thus, the impact of the development for these three pollutants is not significant.

The modelling assessment for NO₂ indicates that annual concentrations will be significantly within the air quality standards under all scenarios, with and without the development in place. Levels of NO₂ will range from 1 - 3% of the annual limit value in 2004 and 2020.

The maximum one-hour modelling assessment for NO₂ also indicates that levels will be within the applicable limit value in 2004 and 2020 for all scenarios. The impact of the development on NO₂ levels will be to increase levels by, at most, 3% of the maximum one-hour limit value in either 2004 or 2020. However, predicted levels will still be significantly below the NO₂ maximum one-hour limit value, with worst-case levels peaking at 32% in 2004 and at 16% of the limit value in 2020. Thus, the impact of the development, in terms of NO₂, is not significant.

In summary, levels of traffic-derived air pollutants will not exceed the ambient air quality standards both with and without the development in place. Thus, the impact of the development in terms of NO₂, PM₁₀, CO and benzene is not significant.

Cumulative Assessment

The cumulative assessment has taken into account pollutants which are emitted in significant quantities both from road traffic emissions and by the process industries in the immediate area, including the proposed facility. The only pollutant which needs to be assessed in the cumulative assessment is nitrogen dioxide (NO₂) which is emitted in significant quantities from both the process industries and traffic emissions.

Table A1.8 of this report outlines the results from the cumulative assessment for nitrogen dioxide and the two nearby facilities in addition to background and traffic-derived emissions. When comparing the impact from both traffic and process emissions, both the cumulative impact at the point of maximum impact from the process emissions and the cumulative impact at the point of maximum impact from traffic emissions was assessed.

In the cumulative assessment, a worst-case approach has been adopted. For the maximum one-hour concentration for nitrogen dioxide, it has been assumed that both traffic emissions and process emissions occur during the same time period in that year. This is not only very unlikely on a statistical basis but also very unlikely theoretically as the conditions which generally lead to peaks in traffic-derived emissions (calm conditions) generally result in low ground level conditions from point sources with tall stacks, as in the current case.

Results from the cumulative assessment for NO₂ (see Table A.12) indicates compliance with the limit value under even this worst-case scenario. The results from the traffic-derived emissions are particularly conservative as it has been assumed that peak hour traffic levels are maintained at these levels 24 hours/day throughout the full modelled year.

REMEDIAL AND MITIGATION MEASURES

Mitigating measures in relation to traffic-derived pollutants has focused generally on improvements in both engine technology and fuel quality. Recent EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (Euro III and Euro IV (98/69/EC) for passenger cars to be complied with in 2002 and 2006 respectively and Euro III, IV and V for diesel HGVs to be introduced in 2001, 2006 and 2008). In relation to fuel quality, a recent EU Fuel Directive (98/70/EC) has introduced significant reductions in both sulphur and benzene content of fuels.

In relation to design and operational aspects of road schemes, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems⁽¹⁹⁾. Further improvements in air quality are also likely as a result of a comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the replacement of old vehicles with cleaner, more fuel-efficient vehicles in recent years.

Construction Impacts and Mitigation Measures

There is the potential for a number of emissions to atmosphere during the construction of the scheme. In particular, the construction activities may generate quantities of dust. Construction vehicles, generators etc., will also give rise to some exhaust emissions.

Predicted Impacts

If a satisfactory environmental impact minimisation plan is implemented, the effect of construction on air quality will not be significant.

Mitigation Measures

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions (detailed in Appendix A1.4).

REFERENCES

- (1) UK DETR, (2000) Framework for Reviews & Assessments of Air Quality, LAQM.G1(00)
- (2) UK DETR (1998) Preparation of Environmental Statements for Planning Projects That Require Environmental Assessment – A Good Practice Guide, Appendix 8 – Air & Climate
- (3) Environmental Protection Agency (2001) Preliminary Assessment Under Article 5 of Council Directive 96/62/EC - Ireland
- (4) Dublin Corporation (2000) Air Monitoring Report 1999
- (5) Environmental Protection Agency (2001) Air Quality Monitoring Report 1999
- (6) US EPA (1995) Addendum To The User's Guide To CAL3QHC Version 2 (CAL3QHCR User's Guide)
- (7) California Department of Transportation (1997) Transportation Project-Level Carbon Monoxide Protocol
- (8) USEPA (1992) Guideline For Modelling Carbon Monoxide From Roadway Intersections
- (9) SCAG (1993) Carbon Monoxide Transportation Project Protocol Chapter 2: Key Transportation Variables Required For Air Quality Modelling
- (10) EPA (2001) Preliminary Draft Of Revised EPA Guidelines
- (11) EPA (1995) Advice Notes On Current Practice (In The Preparation Of Environmental impact Statements) (Draft)
- (12) UK DETR, (2000) Monitoring for Air Quality Reviews & Assessments, LAQM.TG1(00)
- (13) UK DETR (1998) UK Diffusion Tube Network Instruction Manual

- (14) World Health Organisation (1999) Guidelines For Air Quality
- (15) European Environment Agency (2000) COPERT III, Computer Programme to Calculate Emissions from Road Transport: Methodology & Emission Factors (Final Report)
- (16) USEPA(1997) AP42 – Mobile Emissions – Paved Roads
- (17) UK DETR (1999) Design Manual for Roads and Bridges
- (18) Benson, P (1979) CALINE3 - A Versatile Dispersion Model For Predicting Air Pollution Levels Near Highways And Arterial Streets
- (19) UK DETR, (1997) Air Quality And Traffic Management, LAQM.G3 (97)
- (20) USEPA (1999) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1
- (21) US EPA (1995) User's Guide To CAL3QHC Version 2.0
- (22) Benson, P (Revised 1989) CALINE4 - A Dispersion Model For Predicting Air Pollution Concentrations Near Roadways
- (23) DOE (2001) Irish Bulletin of Vehicle and Driver Statistics 2000
- (24) European Commission (1999) MEET - Estimating of Pollutant Emissions From Transport
- (25) London Research Centre (1999) Atmospheric Emission Inventories
- (26) USEPA (1997) Mobile 5B
- (27) USEPA (1998) Part 5B

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Table A1.10 Air Quality Assessment, Carranstown Waste To Energy Facility. Summary Of Predicted Air Quality At Worst-Case Receptors Located Near The Proposed Scheme.

Scenarios	Traffic Speed (km/hr)	Carbon Monoxide (ppm)		Hydrocarbons ($\mu\text{g}/\text{m}^3$)			Nitrogen Dioxide ($\mu\text{g}/\text{m}^3$)		Particulates (PM_{10}) ($\mu\text{g}/\text{m}^3$)	
		Maximum 1-Hour	Maximum 8-hour	Maximum 1-hr hydrocarbon	Annual average hydrocarbon	Annual mean benzene	Maximum 1-hr NO_2	Annual average NO_2	Annual average	Maximum 24-hr values
2004	10	0.56	0.33	157	7.00	0.06	59	0.75	1.50	5.90
no change	80	0.32	0.22	169	7.45	0.06	51	0.66	1.50	5.90
2004	10	0.61	0.36	176	7.80	0.06	64	1.10	1.58	6.40
with development	80	0.44	0.32	187	8.08	0.06	57	1.01	1.60	6.40
2020	10	0.33	0.21	104	4.60	0.04	30	0.38	1.30	5.20
no change	80	0.20	0.15	104	4.60	0.04	20	0.25	1.30	5.20
2020	10	0.35	0.22	113	4.76	0.04	32	0.49	1.40	5.50
with development	80	0.22	0.18	113	4.76	0.04	22	0.38	1.40	5.50
Standards			8.6 ⁽¹⁾			5 ⁽¹⁾	200 ^(2,3)	40 ⁽²⁾	40 ⁽²⁾ , 20 ⁽⁴⁾	50 ^(2,5)

¹ EU Council Directive 2000/69/EC

³ 1-hr limit of $200 \mu\text{g}/\text{m}^3$ not to be exceeded > 18 times/year (99.8 %ile)

⁵ 24-Hr limit of $50 \mu\text{g}/\text{m}^3$ not to be exceeded > 35 times/year (90.5 %ile)

² EU Council Directive 1999/30/EC

⁴ Indicative annual limit of $20 \mu\text{g}/\text{m}^3$ which may be applicable in 2010

Table A1.11 Results From The Cumulative Assessment of Nitrogen Dioxide

Emissions	Roadside (Maximum of traffic-derived emissions)		Region of Cumulative Process Maximum	
	99.8 th ile of One-hour Concentrations ($\mu\text{g}/\text{m}^3$)	Annual Concentrations ($\mu\text{g}/\text{m}^3$)	99.8 th ile of One-hour Concentrations ($\mu\text{g}/\text{m}^3$)	Annual Concentrations ($\mu\text{g}/\text{m}^3$)
Process Emissions	31	0.4	69	8.2
Traffic-Derived Emisions	64	1.1	1.0	0.01
Background Concentration	20	10	20	10
Cumulative	115	11.5	90	18.2
Standard ($\mu\text{g}/\text{m}^3$)	200¹	40¹	200¹	40¹

¹ EU Council Directive 1999/30/EC

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APPENDIX A1.4

Ambient Air Quality Standards

National standards for ambient air pollutants in Ireland have generally ensued from Council Directives enacted in the EU (& previously the EC & EEC). The initial interest in ambient air pollution legislation in the EU dates from the early 1980s and was in response to the most serious pollutant problems at that time. In response to the problem of acid rain, sulphur dioxide and later, nitrogen dioxide, were both the focus of EU legislation. Linked to the acid rain problem was the urban smog associated with fuel burning for space heating purposes. Also apparent at this time were the problems caused by leaded petrol and EU legislation was introduced to deal with this problem in the early 1980s. The current ambient air quality standards for sulphur dioxide, suspended particulates, lead and nitrogen dioxide, which have been given effect in Ireland, are based on Directives 80/779/EEC, 82/884/EEC and 85/203/EEC. National standards for these pollutants have been passed into Irish Law by the Air Pollution Act, 1987 (Air Quality Standards) Regulations, 1987.

In recent years the EU has focused on defining a basis strategy across the EU in relation to ambient air quality. In 1996, a Framework Directive, Council Directive 96/62/EC, on ambient air quality assessment and management was enacted. The aims of the Directive are fourfold. Firstly, the Directive's aim is to establish objectives for ambient air quality designed to avoid harmful effects to health. Secondly, the Directive aims to assess ambient air quality on the basis of common methods and criteria throughout the EU. Additionally, it is aimed to make information on air quality available to the public via alert thresholds and fourthly, it aims to maintain air quality where it is good and improve it in other cases.

As part of these measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, Council Directive 1999/30/EC, has set limit values, which should replace existing limit values under Directives 80/779/EEC, 82/884/EEC and 85/203/EEC with effect from 19th July 2001. The new Directive, as relating to limit values for sulphur dioxide, nitrogen dioxide, lead and particulate matter, is detailed in Table 1.8 and 1.12 of the main body of the report in relation to NO₂, SO₂ and PM₁₀. The new Directive also details margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance varies from 100% for lead, to 50% for 24-hour limit value for PM₁₀, 50% for the hourly and annual limit value for NO₂ and 43% for hourly SO₂ limit values. The margin of tolerance will commence from May 1999, and will start to reduce from 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by the attainment date. A second daughter directive, EU Council Directive 2000/69/EC, has recently published limit values for both carbon monoxide and benzene in ambient air.

Although the EU Air Quality Limit Values are the basis of legislation other thresholds outlined by the EU Directives are used which are triggers for particular actions. The Alert Threshold is defined in Council Directive 96/62/EC as "a level beyond which there is a risk to human health from brief exposure and at which immediate steps shall be taken as laid down in Directive 96/62/EC". These steps include undertaking to ensure that the necessary steps are taken to inform the public (e.g. by means of radio, television and the press).

The Margin of Tolerance is defined in Council Directive 96/62/EC as a concentration which is higher than the limit value when legislation comes into force. It decreases to meet the limit value

by the attainment date. The Upper Assessment Threshold is defined in Council Directive 96/62/EC as a concentration above which high quality measurement is mandatory. Data from measurement may be supplemented by information from other sources, including air quality modelling. These various thresholds have been incorporated into the significance criteria for the proposed scheme and will be appropriate for assessing the significance of the combined impact of the scheme plus the background environment.

EU Council Directive 96/62/EC on ambient air quality and assessment has been adopted into Irish Legislation (S.I. No. 33 of 1999). The act has designated the Environmental Protection Agency (EPA) as the competent authority responsible for the implementation of the Directive and for assessing ambient air quality in the State. Other commonly referenced ambient air quality standards include the World Health Organisation. The WHO guidelines differ from air quality standards in that they are primarily set to protect public health from the effects of air pollution. Air quality standards, however, are air quality guidelines recommended by governments, for which additional factors, such as socio-economic factors, may be considered.

Baseline Air Quality Review

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "Air Quality Monitoring Report 1999" (EPA, 2001)⁽⁵⁾, details the range and scope of monitoring undertaken throughout Ireland. Additionally, Dublin Corporation has published a report entitled "Air Quality Monitoring Report 1999"⁽⁴⁾ relating to extensive measurements carried out in 1999 across Dublin. However, historically, monitoring has focused on the major urban centres and little data is available in regards to other urban and rural locations. No EPA data is available near the current scheme for SO₂ and smoke. However, data from urban centres around Ireland list 98th percentiles of between 25-98 µg/m³ and 27-52 µg/m³ for SO₂ and smoke respectively all of which are well in compliance with the significance criteria⁽⁵⁾.

The recent publication "Preliminary Assessment Under Article 5 of Council Directive 96/62/EC – Ireland" (EPA, 2001)⁽³⁾ details recent mobile monitoring surveys in Limerick City Centre, Waterford and Blackpool, Cork City. Results from this survey indicate significantly lower levels of NO₂, benzene and PM₁₀ than that encountered in Central Dublin and Cork. In relation to NO₂, the 99.8th percentile during the monitoring period was always less than 50% of the limit value whereas the annual average in all three locations was less than 68% of the limit value. Similarly, benzene levels at all three locations were less than 14% of the limit value. In relation to PM₁₀, levels were higher in Blackpool, Cork City averaging 49 µg/m³ during the monitoring period. However levels were significantly lower in Limerick and Waterford averaging 24 µg/m³ and 31 µg/m³ over the eight and three month monitoring periods during 2000.

The EPA Annual Report 1999 also includes data in relation to NO₂, benzene and PM₁₀ in suburban Dublin⁽⁶⁾. Results indicate high levels in city centre locations with correspondingly lower levels at suburban and urban background locations. It would be expected that levels at the current location would subsequently be significantly lower than even urban background levels and well within current and proposed EU limit values.

The EPA Annual Report 1999 also included lead data from six locations across Dublin⁽⁵⁾. The annual mean values range from 0.01-0.27 µg/m³ in 1999, all of which are well within the existing and new limit values for lead.

Carbon monoxide data published by the EPA for College Green, Dublin in 1999 indicated that levels were generally well within the proposed EU limit value for eight-hour averaging periods (10 mg/m^3)⁽⁵⁾.

In summary, the current location, based on monitoring studies carried out in Limerick City Centre and Waterford would be expected to currently experience good quality and have concentrations of traffic-derived pollutants significantly below levels in urban centres.

Air Dispersion Modelling

The air dispersion model accurately maps the physical environment and derives site-specific composite traffic emission factors based on an analysis of vehicle age, vehicle type, average speeds and model year of vehicle. Furthermore, meteorological data was incorporated into the model using representative data from the nearest appropriate weather station and used to determine hourly concentrations for pollutants of concern at each specified receptor in the region.

Peak, one-hour concentrations for CO, benzene, NO₂ and PM₁₀ for the years of 2004 and 2020, at the nearest occupational receptors to the scheme, have been modelled using the USEPA approved CAL3QHCR⁽⁶⁾ dispersion model in conjunction with the most recent European emissions database from the CORINAIR working group COPERT III (Final Report, Nov. 2000)⁽¹⁵⁾. In 1991, the USEPA issued a notice of proposed rulemaking identifying CAL3QHC as the recommended model for estimating carbon monoxide concentrations in the vicinity of intersections⁽²⁰⁾. CAL3QHC Version 2 (Released 1995) replaces the original version with the additional capability of analysing particulate matter impacts⁽²¹⁾. The model combines CALINE3⁽¹⁸⁾ (a Gaussian line source dispersion model) with a traffic model to calculate delays and queues that occur at signalised intersections. The model also incorporates the Industrial Source Complex (ISC) mixing height algorithm while also allowing the conversion of NO_x to NO₂ using CALINE4 algorithms⁽²²⁾. In 1995, CAL3QHCR was created by the USEPA by enhancing the basic algorithms of CAL3QHC to allow the capability to process a year of hourly meteorological, traffic and signalisation data, to incorporate the complete ISCST3 mixing height algorithm and to incorporate various concentration averaging algorithms⁽⁶⁾.

For PM₁₀, CO, NO₂ and benzene worst-case year-specific background concentrations were derived from the UK DMRB⁽¹⁷⁾. The background concentrations of NO₂ were added to the modelling results which were derived using the discrete-parcel method. The discrete-parcel method involves a reaction series between O₃, NO and NO₂ which are assumed to react within a parcel of air independent of the dispersion process⁽²²⁾.

NO₂ has been modelled using the discrete-parcel method using the worst-case year (1999) of hourly values measured at Kilkitt, Co. Monaghan by the EPA between 1999 - 2000⁽⁵⁾ and incorporating a background NO₂ concentration of $20 \text{ } \mu\text{g/m}^3$ and a default background NO concentration of $10 \text{ } \mu\text{g/m}^3$ in 2004⁽¹⁷⁾. The background concentrations for the year 2018 assumed a NO₂ concentration of $20 \text{ } \mu\text{g/m}^3$ and a default background NO concentration of $10 \text{ } \mu\text{g/m}^3$ in 2020⁽¹⁷⁾ as a worst-case.

Emission Formulation

The vehicle fleet for the current scheme was assumed to be in line with the national fleet⁽²³⁾ for petrol and diesel LVs. The percentage HGV was assumed to be 15%, which is a worst-case for the scheme. Worst-case assumptions were used throughout the formulation to ensure the emission rates were over-estimates.

Emission rates have been derived from COPERT III (Final Report, Nov. 2000) which has been developed by the CORINAIR working group and follows on from extensive work carried out by the MEET program (Methodologies for Estimating Air Pollutant Emissions from Transport) and COST 319 – “Estimating of Pollutant Emissions From Transport”⁽²⁴⁾.

Emission rates for CO, VOC, NO₂ and PM₁₀ used to predict air pollutant concentrations for the year 2004 were calculated assuming a vehicle fleet breakdown in 2004 as predicted from the National Fleet age breakdown in 2000 & by applying the emission factors outlined in COPERT III⁽¹⁵⁾.

CO, VOC, NO₂ and PM₁₀ emission rates for the year 2020 were calculated assuming a vehicle fleet age breakdown as predicted from the National Fleet in 2000 & by applying the emission factors outlined in COPERT III⁽¹⁵⁾.

Emission rates of PM₁₀ from tail-pipe emissions for all years were obtained from the emission inventory produced by the London Research Centre on behalf of the UK DETR Air & Environment Quality Division⁽²⁵⁾ and using emission rates from COPERT III.

In relation to PM₁₀, both the tail-pipe emissions and fugitive emissions from re-suspended dust were included in the calculation. Although COPERT III does not assess fugitive dust, this will be a significant fraction of measured PM₁₀ for all roads. Detailed calculations have been carried out by the USEPA (AP-42 Document, 1997)⁽¹⁶⁾ on fugitive dust emissions from paved roads and other sources. The calculation is based on the average weight of the vehicles, the number of vehicles and the silt loading of the road. Reductions in future years will be related to the reduction in background concentrations⁽¹⁷⁾ as this will be the dominant source of the re-suspended PM₁₀.

Idling emission factors were taken from the USEPA approved emission factor models MOBILE5B (for NO₂)⁽²⁶⁾ and PART5 (for PM₁₀)⁽²⁷⁾. Future year emission factor reductions, for both LV and HGV, were assumed to be in accordance with the relative reductions cited in COPERT III.

Model Selection

The selection of models is based on guidance from the USEPA. The USEPA Federal Register (40 CFR Part 51) “Guidelines On Air Quality Models” (2001)⁽²⁰⁾ outlines the recommended models to be used in particular situations. The USEPA regulatory model for the refined modelling of complex intersections is CAL3QHCR which combines CALINE3 with a traffic model (Highway Capacity Model) to calculate delays and queues that occur at signalised junctions.

The USEPA has stated in relation to selection of appropriate models that⁽²⁰⁾:

“Appendix A (of the Guidelines on Air Quality Models) identifies refined models that are preferred for use in regulatory applications. If a model is required for a particular application, the user should select a model from the appendix. These models may be used without a formal

demonstration of applicability as long as they are used as indicated in each model summary of Appendix A.”

Tier I & II Assessment

CAL3QHCR allows a two-tiered approach to traffic data. In the first approach, called Tier I, a full year of hourly meteorological data is entered into CAL3QHCR as well as one hour of ETS data (vehicular emissions, traffic volume and signalisation).

In the Tier II approach the same meteorological data as Tier I is used. The ETS data however, are more detailed and reflect traffic conditions for each hour of a week. The weekly traffic data conditions are assumed to be the same for each week throughout the modelled period.

In the current assessment, a Tier I approach was followed using worst-case peak hour traffic data for the one hour of ETS data for all pollutants. This is a worst case approach and a Tier II approach would give lower concentrations as traffic levels will generally be significantly less than the peak hour.

Calms

Like all Gaussian models, dispersion is modelled under steady state conditions and assuming conservation of mass. The gaussian dispersion equation is inversely proportional to wind speed. Thus, under calm conditions, concentrations become unrealistically large. CAL3QHCR has developed a procedure to prevent the occurrence of overly conservative concentrations estimates during periods of calms. The procedure is outlined below is taken from the “Guidelines For Air Quality Models (2001)”⁽²⁰⁾:

“Critical concentrations for 3-, 8- and 24-hour averages should be calculated by dividing the sum of the hourly concentrations for the period by the number of valid or non-missing hours. If the total number of valid hours is less than 18 for 24-hour averages, less than 6 for the 8-hour averages or less than 3 for the 3-hour averages, the total concentration should be divided by 18 for the 24-hour average, 6 for the 8-hour average and 3 for the 3-hour average. For annual averages, the sum of all valid hourly concentrations is divided by the number of non-calm hours during the year.”

Model Validation

CAL3QHC model has been extensively validated by the USEPA⁽²¹⁾. A major air quality monitoring study was conducted in 1989-90 at Route 9A in New York City at two background stations and six different intersections. Site-specific meteorological data and videos recording traffic data were used continuously over three months. Six different models were compared with this extensive database.

This extensive monitoring data was compared with the modelling results under worst-case conditions. CAL3QHC gives the best agreement by a factor of two over other models using the composite model comparison measure (CM). On February 13, 1991, EPA issued a notice of proposed rulemaking identifying CAL3QHC as the recommended model for estimating carbon monoxide concentrations in the vicinity of intersections and stated that the model is a reliable tool for estimating the air quality impact from traffic sources.

In relation to model validation the USEPA has stated that:

“Appendix A (of the Guidelines on Air Quality Models) identifies refined models that are preferred for use in regulatory applications. If a model is required for a particular application, the user should select a model from the appendix. These models may be used without a formal demonstration of applicability as long as they are used as indicated in each model summary of Appendix A.”⁽²⁰⁾

Calibration of Models

It is not appropriate to use short-term survey results over a short time period as a calibration exercise for the model. The USEPA refers to this in the “Guidelines For Air Quality Models” (1999)⁽²⁰⁾;

“Calibration of models is not common practice and is subject to much error and misunderstanding. There have been attempts by some to compare model estimates and measurements on an event-by-event basis and then to calibrate a model with results of that comparison. This approach is severely limited by uncertainties in both source and meteorological data and therefore it is difficult to precisely estimate the concentration at an exact location for a specific increment of time. Such uncertainties make calibration of models of questionable benefit. Therefore, model calibration is unacceptable.”⁽²⁰⁾

Model Accuracy

The USEPA has conducted a number of studies on model accuracy and have found that :

“for errors in highest estimated concentrations of ± 10 to 40 percent are found to be typical.”⁽²⁰⁾

In relation to the use of uncertainty in decision-making the USEPA has stated:

“Given a range of possible outcomes, it is easiest and tends to ensure consistency if the decision-maker confines his judgement to use of the “best estimate” provided by the modeller (i.e. the design concentration estimated by a model recommended in the Guidelines or an alternate model of known accuracy.”⁽²⁰⁾

Dust Minimisation Plan

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within several hundred metres of the construction area.

In order to ensure that no dust nuisance occurs, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions.

Vehicles using site roads shall have their speed restricted, and this speed restriction must be enforced rigidly. Indeed, on any un-surfaced site road, this shall be 20 km per hour, and on hard surfaced roads as site management dictates. Vehicles delivering material with dust potential shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust.

All vehicles exiting the site shall make use of a wheel wash facility, preferably automatic, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods.

Furthermore, during movement of the soil both on and off-site, trucks will be stringently covered with tarpaulin at all times. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

At all times, the procedures put in place will be strictly monitored and assessed. In the event of dust emissions occurring outside the site boundary, movement of these soils will be immediately terminated and satisfactory procedures implemented to rectify the problem before the resumption of the operations.

The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practise and procedures.

APPENDIX 1.5

Summary of Source Emission Data

Plant 1 Marathon Power
 Plant 2 Pfizer Loughbeg

Table A1.12: Source Emission Data for Emissions of Indaver Ireland

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m ²)	Temperature (K)	Max Volume Flow (Nm ³ /hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm ³)	Mass Emission (g/s)
Maximum	40	2.0	3.14	373	150980	20.5	NO ₂ - 200 SO ₂ - 50 PM ₁₀ - 10 CO - 100 TOC - 10 HCl - 10 HF - 1.0 Dioxins - 0.1 ng/m ³ Cd & Tl - 0.05 Hg - 0.05 Sum of Metals - 0.5	NO ₂ - 8.39 SO ₂ - 2.10 PM ₁₀ - 0.42 CO - 4.2 TOC - 0.42 HCl - 0.42 HF - 0.042 Dioxins - 4.2E-9 Cd & Tl - 0.0021 Hg - 0.0021 Sum of Metals - 0.021
Typical	40	2.0	3.14	373	126000	17.2	NO ₂ - 150 SO ₂ - 20 PM ₁₀ - 1.0 CO - 20 TOC - 1.0 HCl - 1.0 HF - 1.0 Dioxins - 0.01 ng/m ³ Cd & Tl - 0.025 Hg - 0.025 Sum of Metals - 0.25	NO ₂ - 5.25 SO ₂ - 0.7 PM ₁₀ - 0.035 CO - 0.7 TOC - 0.035 HCl - 0.035 HF - 0.035 Dioxins - 3.5E-10 Cd & Tl - 0.00088 Hg - 0.00088 Sum of Metals - 0.0088

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Table A1.13: Source Emission Data For Emissions of Plant 1⁽¹⁾

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m ²)	Temperature (K)	Max Volume Flow (Nm ³ /hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm ³)	Mass Emission (g/s)
Stack	49.9	7.0	38.5	369	2451600	17.7	NO ₂ - 120 SO ₂ - 140	70 60.5 ⁽¹⁾

(1) Taken from IPC Licence Application for the site.

Table A1.14: Source Emission Data For Emissions of Plant 2⁽¹⁾

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m ²)	Temperature (K)	Max Volume Flow (Nm ³ /hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm ³)	Mass Emission (g/s)
Stack 1	106.7	2.3	4.15	513	96,000	12.06	NO ₂ - 1,800 SO ₂ - 4,000	48 107.6
Stack 2	103.3	3.7	10.8	397	299,000	11.233	NO ₂ - 1,800 SO ₂ - 4,000	149.5 335.1

(1) Taken from EIS for the site.

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