1.10   References
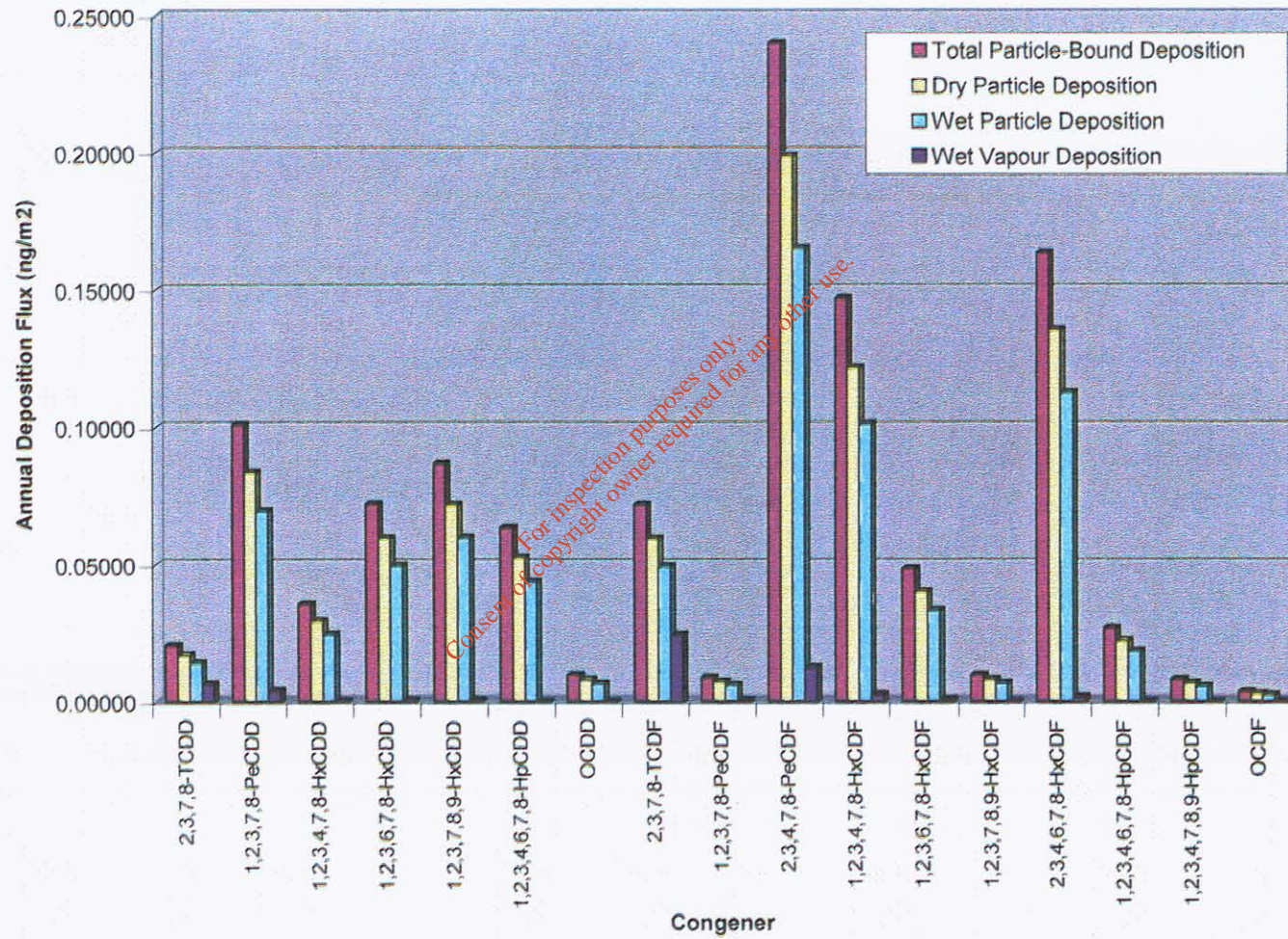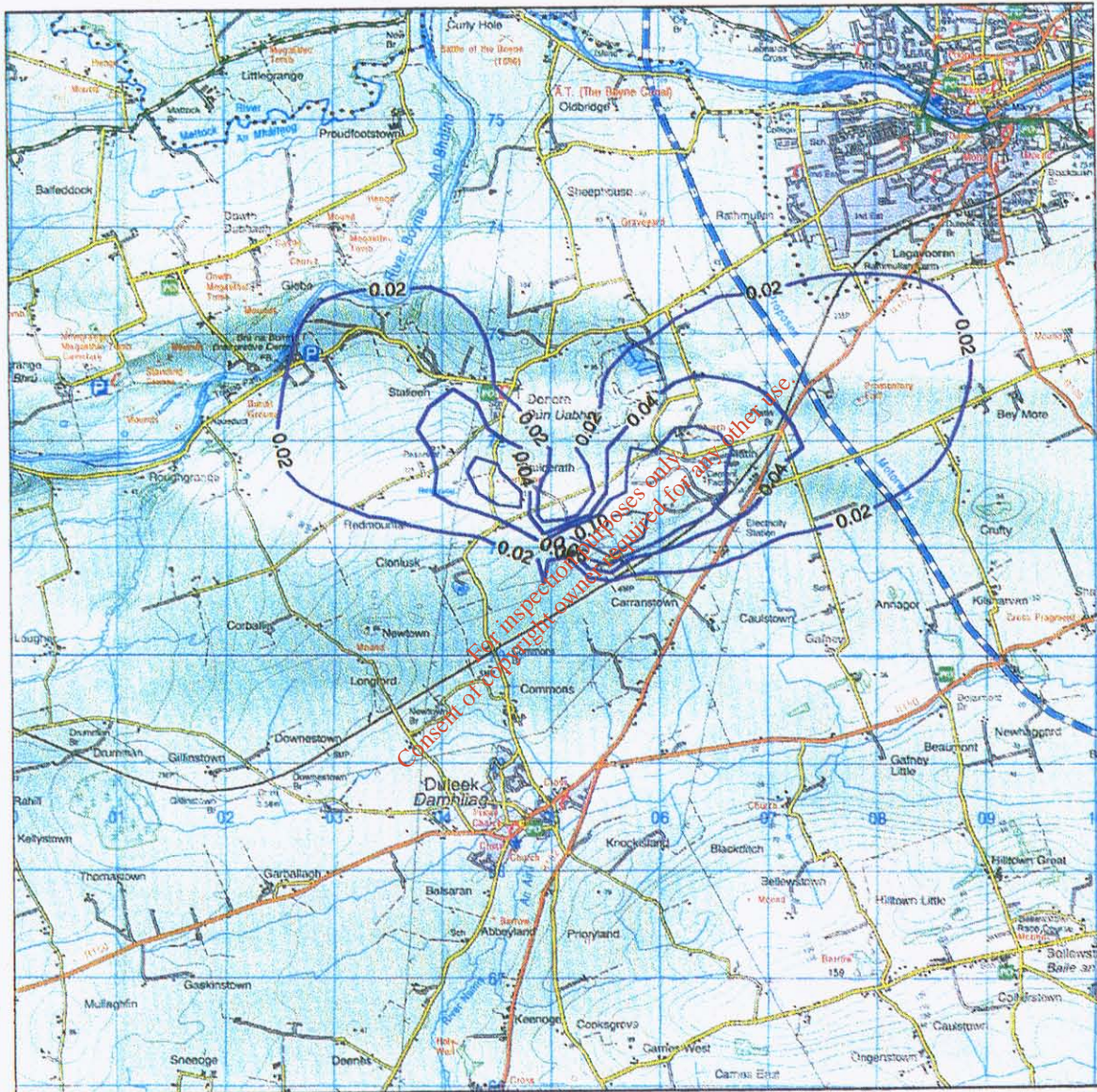
(1)   USEPA (1999) Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1

(2)   USEPA (1998) Minimum Meteorological Data Requirements For AERMOD – Study & Recommendations", 1998, USEPA.

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(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 1.15 PCDD/PCDF Vapour and Particle-Bound Deposition Flux (ng/m^2) Based on a MWI (MB-Ref WS) Profile At Maximum Operating Conditions
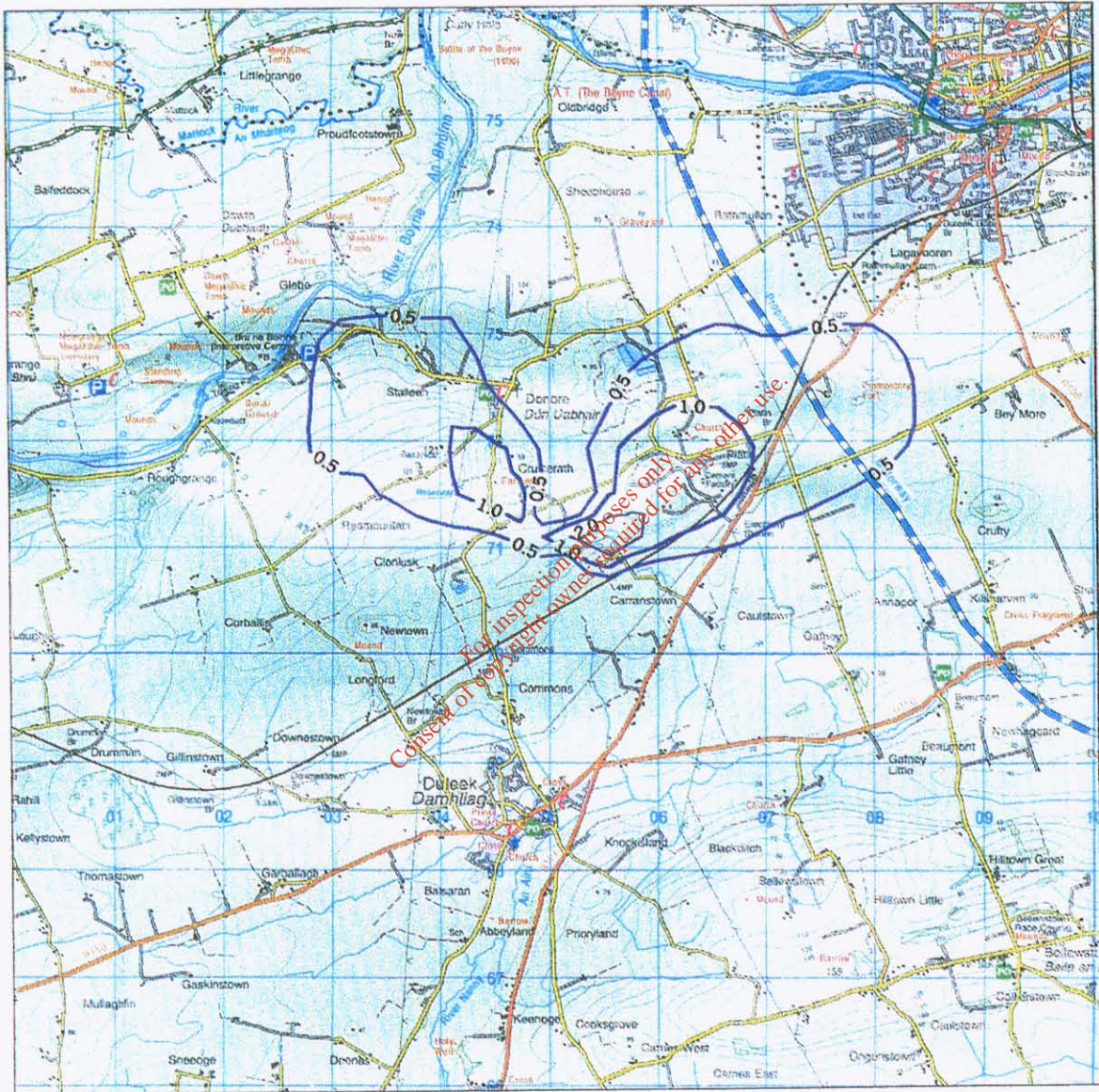
Figure 1.16: Predicted annual average PCDD/PCDF vapour concentrations (fg/m3) Maximum operation, Indaver Ireland Waste Management Facility

Scale: 1:70000 approx

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

Scale: 1:70000 approx

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

Scale: 1:70000 approx
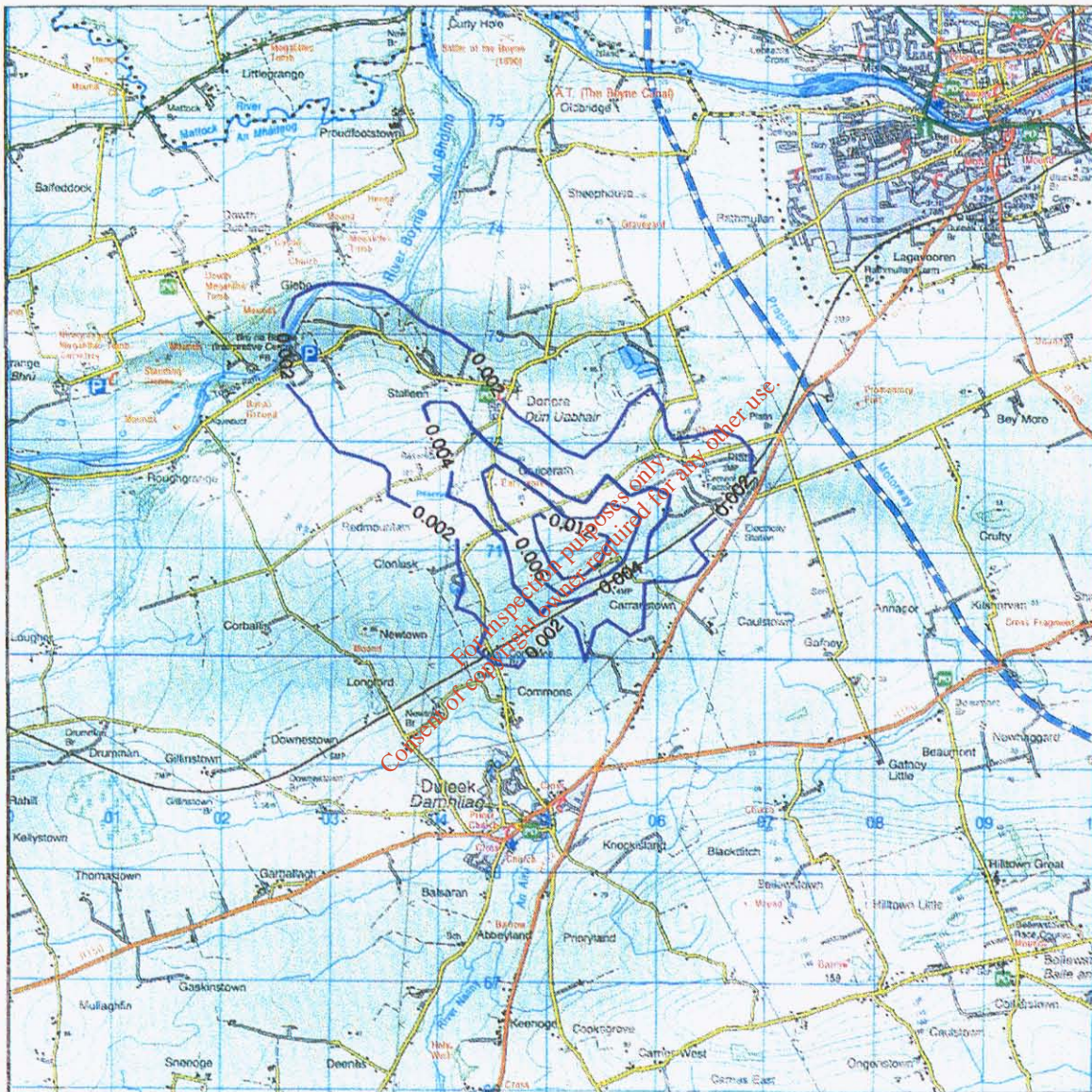
**Figure 1.19: Predicted annual average PCDD/PCDF total deposition (ng/m2)
Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

Figure 1.20: Predicted annual average Hg vapour concentration as a % of limit value Maximum operation, Indaver Ireland Waste Management Facility

Scale: 1:70000 approx

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

Scale: 1:70000 approx

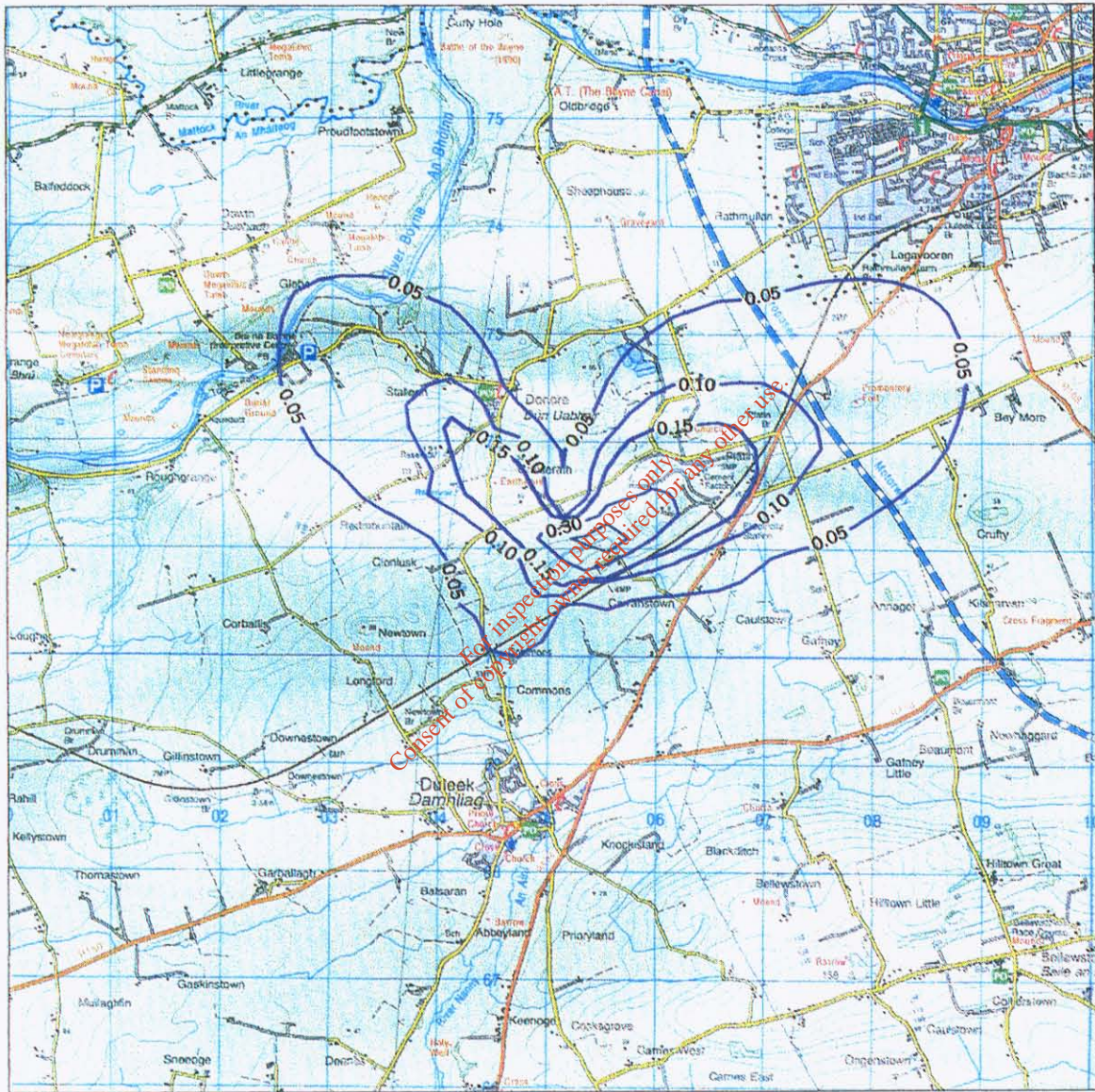**Figure 1.22: Predicted annual average Cd particle phase concentration as a % of limit value Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

Figure 1.23: Predicted annual average Cd total particle deposition flux (mg/m2)

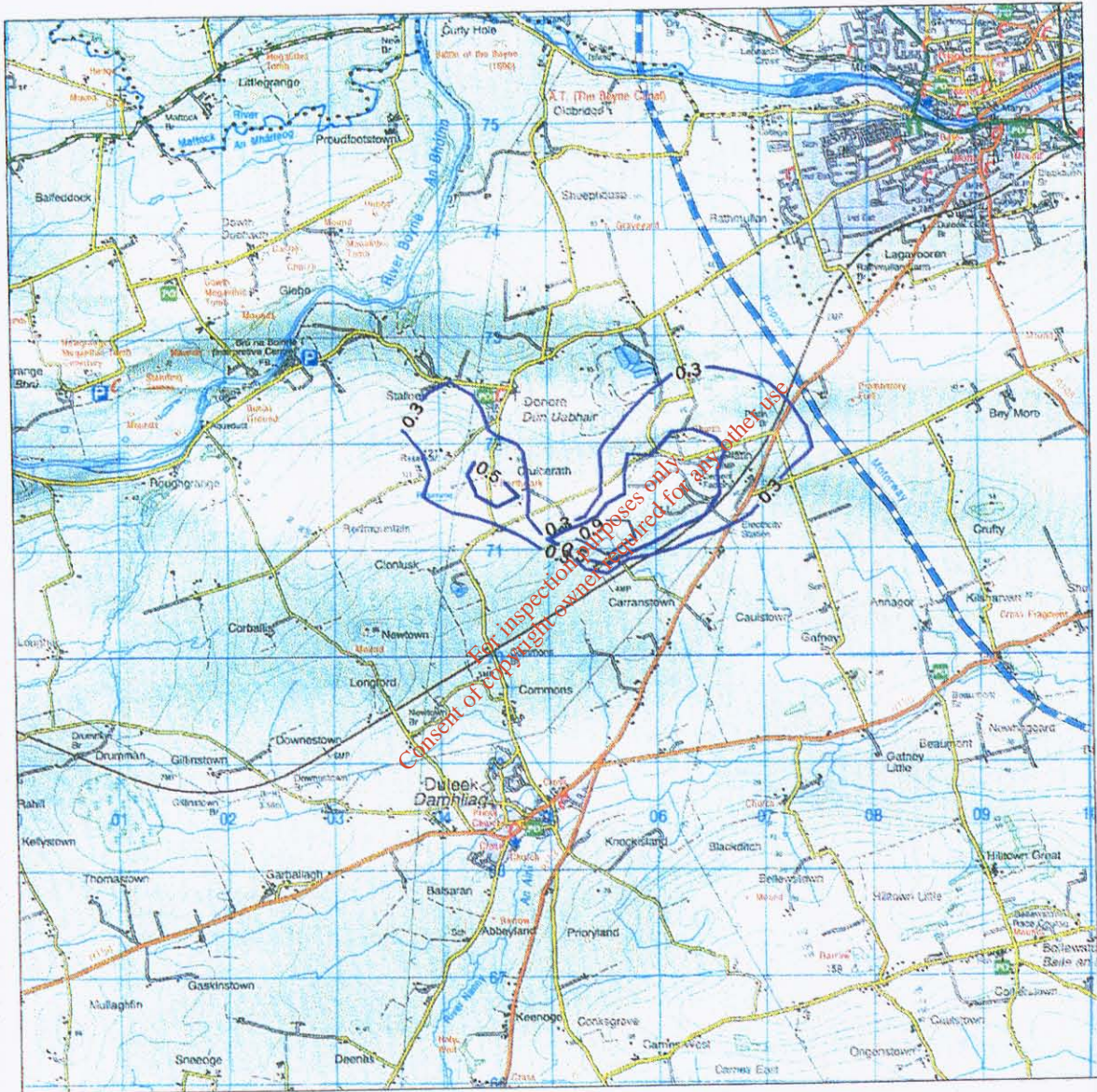**Maximum operation, Indaver Ireland Waste Management Facility**

Scale: 1:70000 approx

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

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

Scale: 1:70000 approx

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

Scale: 1:70000 approx

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

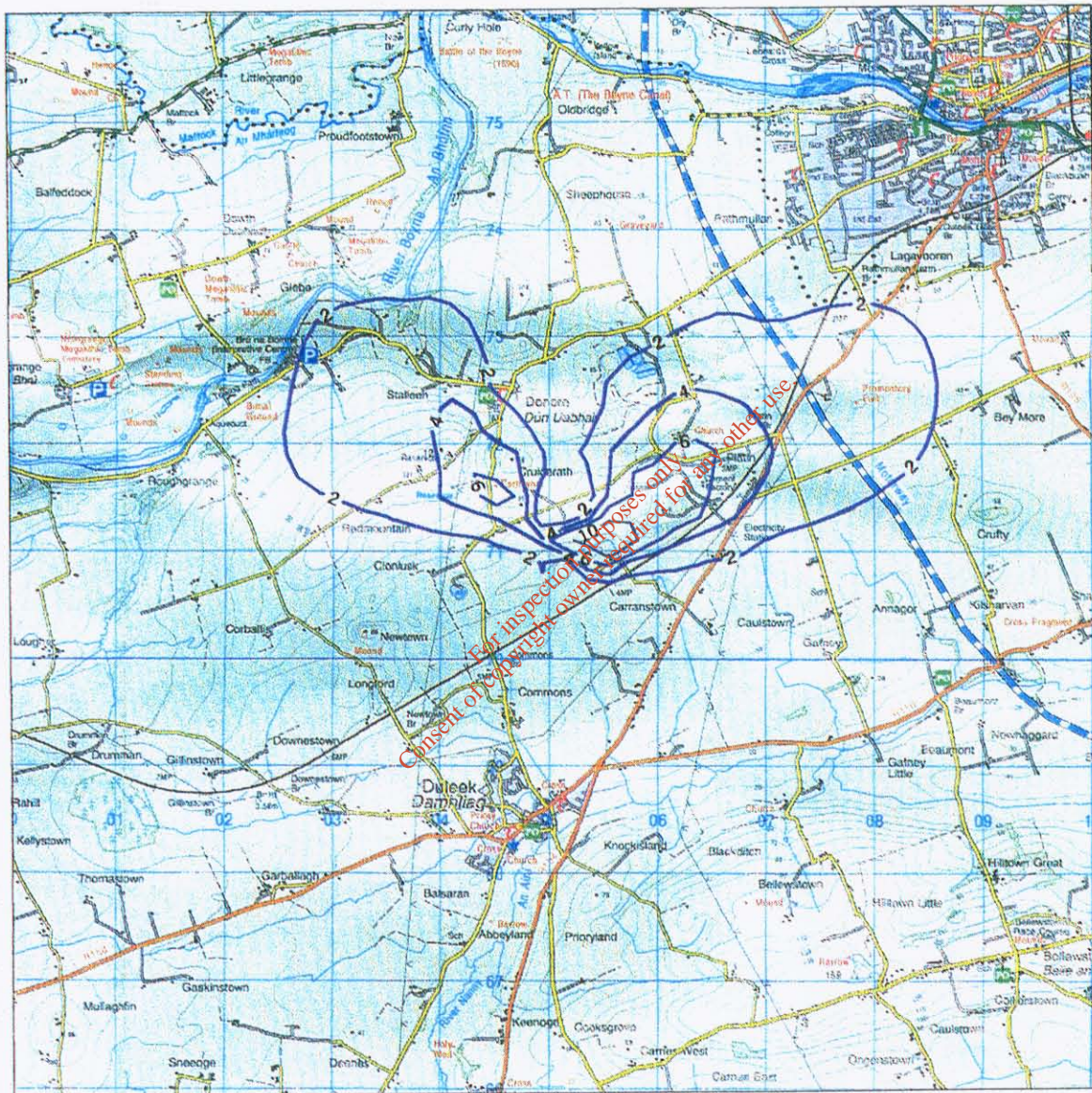**Figure 1.28: Predicted annual average nickel total deposition flux (mg/m2)**
Maximum operation, Indaver Ireland Waste Management Facility
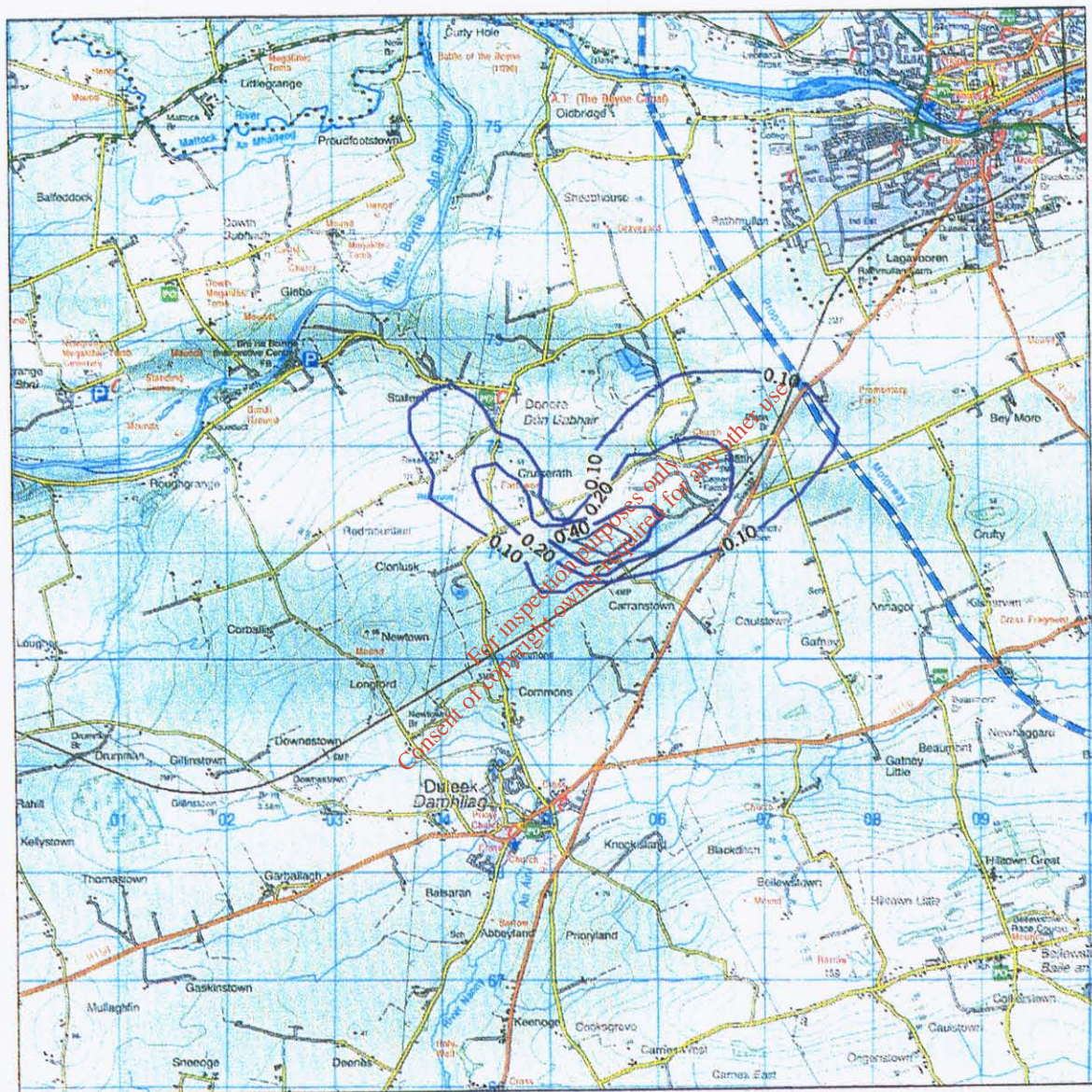
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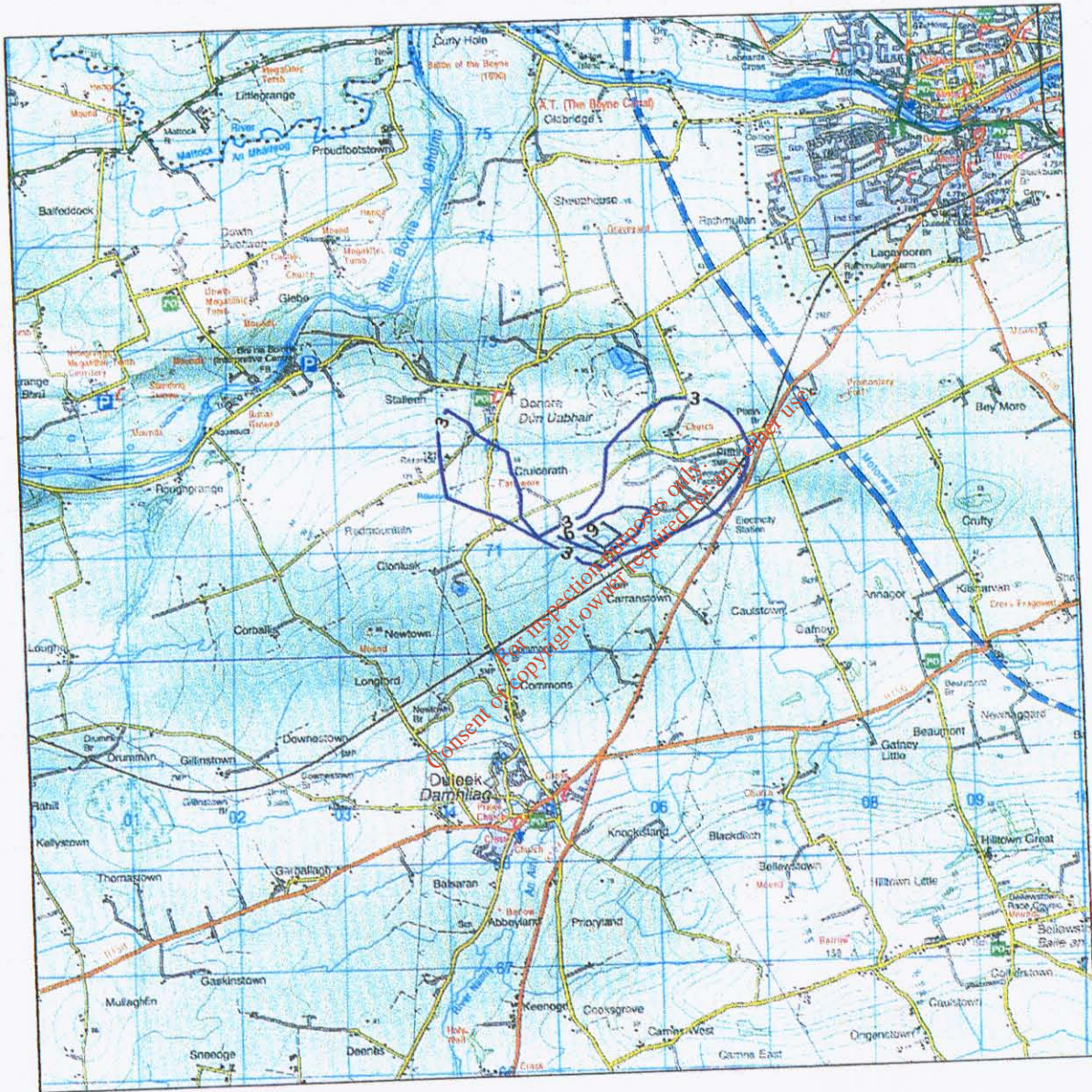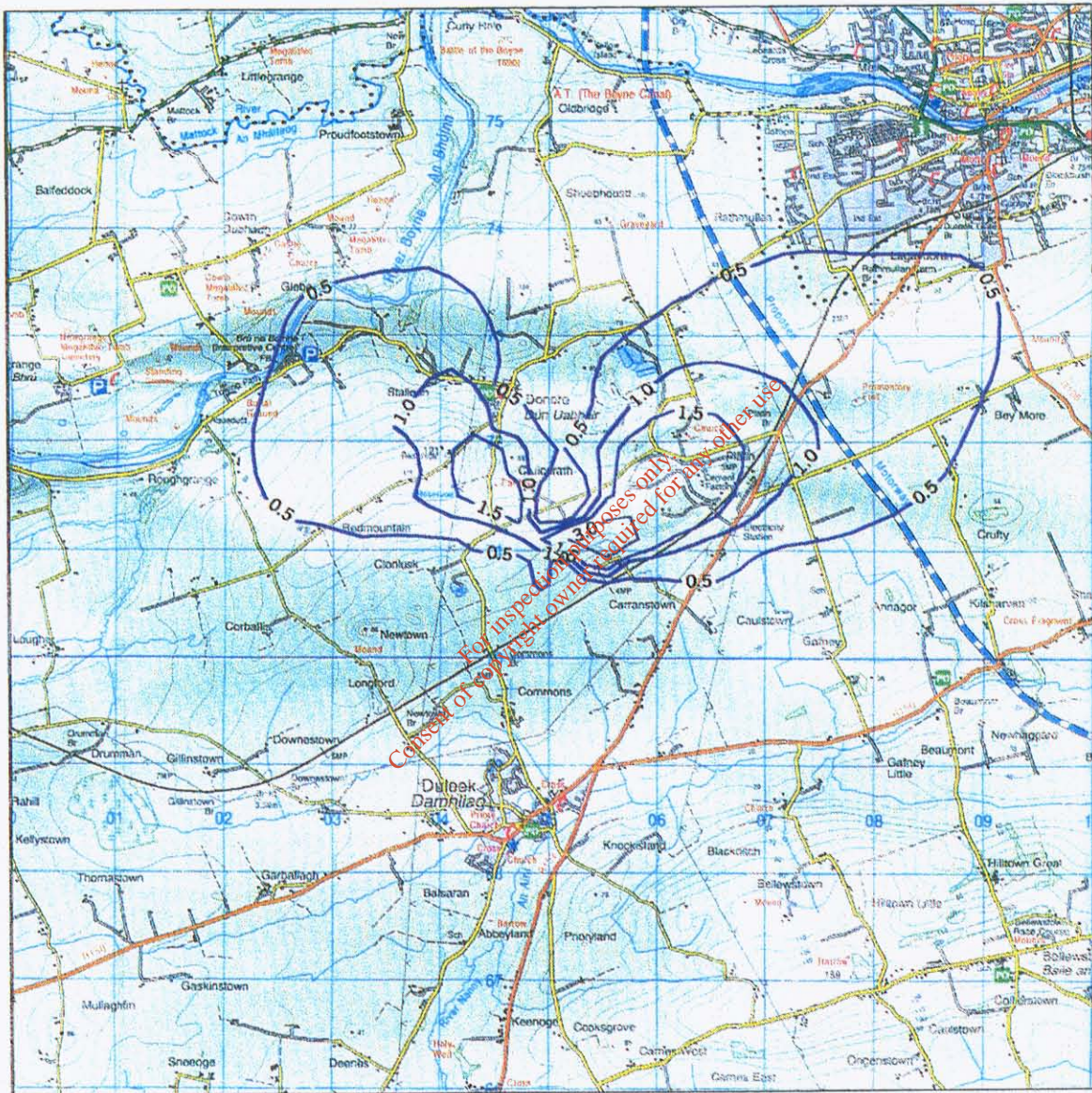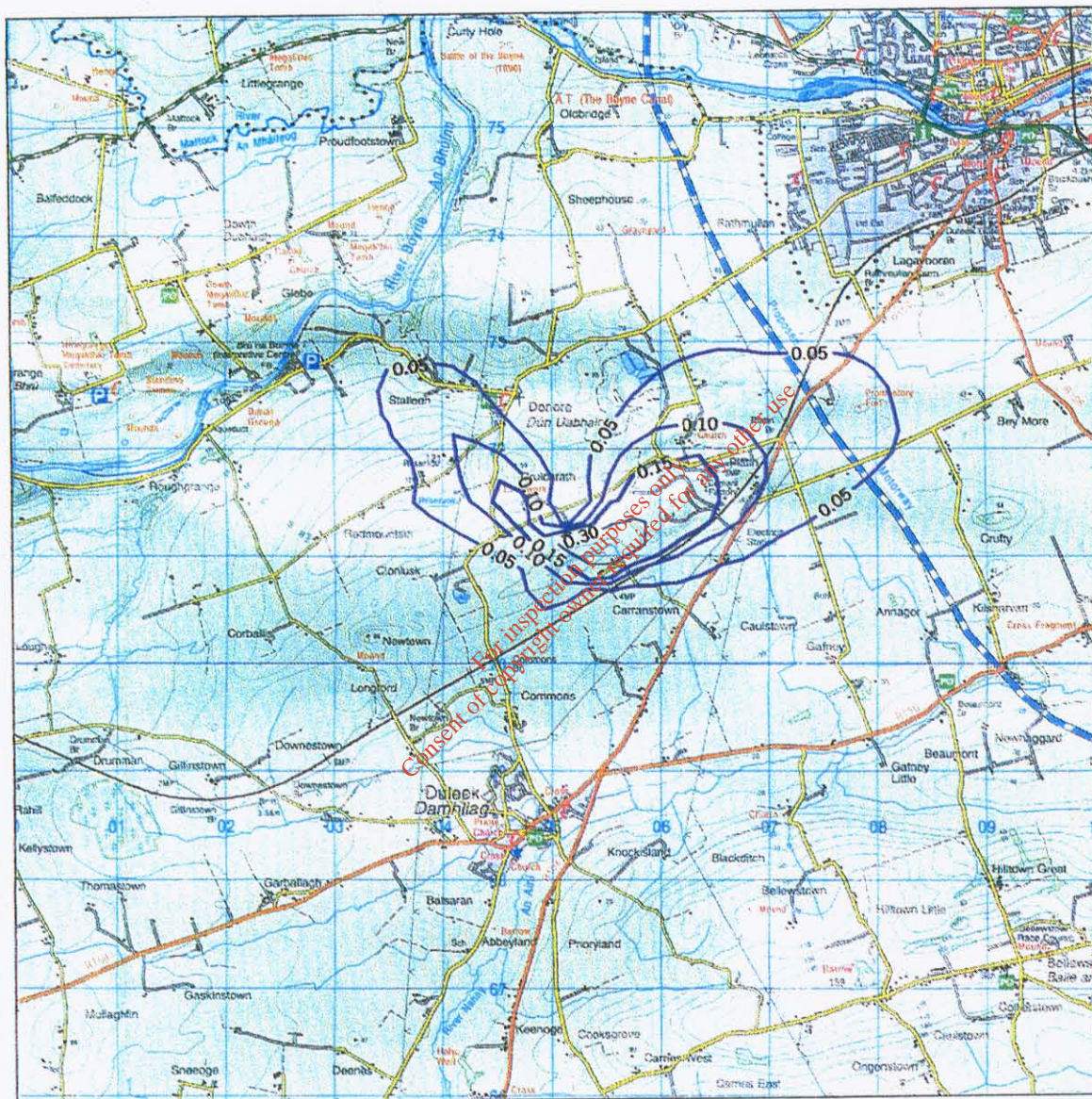Reproduced from Ordnance Survey Ireland
Permit No: 7438

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 Scrire (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 CTDMPLUS 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 results, 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

[1] Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))[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

[1] Winter defined as periods when surfaces covered permanently by snow whereas autumn is defined as periods when freezing conditions are common, deciduous trees are leafless and no snow is present (Iqbal (1983))[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

[1]   As 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 $\mu g/m^3$) 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.

Table A1.4   Comparison of Dispersion Model Results – Unitised Emission Rate (1 g/s) ISCST3, AERMOD and AERMOD-PRIME (μg/m^3)[1]

Model	Year	Maximum 1-Hour	99.8th%ile of 1-Hour	99.7th%ile of 1-Hour	99th%ile of 1-Hour	98th%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 99.8th%ile and annual average which is the assessment criteria for nitrogen dioxide.

APPENDIX 1.2

Ambient NO₂/NOₓ Ratio

NO_2 has been modelled following the approached 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 NO_2. 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 NO_2 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 NO_2/NO_X ratio. The guidance suggests that the NO_2/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 NO_2/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 NOₓ	99.8th %ile 1-hr NOₓ	Annual NO₂	99.8th %ile 1-hr NO₂	Annual Ratio NO₂/NOₓ	99.8th %ile Ratio NO₂/NOₓ
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 USEPA[1]. 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 NO_2/NO_X ratio. The site-specific method requires ambient monitors to be sited to obtain the NO_2 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 NO_2/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 $\mu g/m^3$, while for higher concentrations of NO_X, the average concentration of NO_2 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 99.8[th]%ile of one-hour maximum concentrations.

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 $\mu g/m^3$ 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 $\mu g/m^3$). 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 ($\mu g/m^3$ annual average)	Indaver Ireland GLC ($\mu g/m^3$ annual average)	Significance
NO$_2$	1	8	√
SO$_2$	1	3	√
PM$_{10}$	1	0.5	-
TOC	20 (98th%ile of 1-hr)	7	-
HCl	2 (98th%ile 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.

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

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 – 99.8th%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 – 99.8th%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 NO_2 / 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 ($\mu g/m^3$)

Pollutant	Plant 1	Plant 2	Indaver Ireland	All Sources Except Indaver	Significance Criteria	All Sources	Limit Value
Impact of each source at Indaver Maximum – 99.7th%ile 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 – 99.7th%ile 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%ile)

(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

NO$_2$

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 99.8[th]%ile 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 99.8[th]%ile 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.

SO$_2$

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 99.7[th]%ile 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%ile 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.

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 approached 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 SO_2, 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 (NO_2) and benzene at busy junctions in Dublin and Cork. PM_{10} 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 NO_2, PM_{10} 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]. PM_{10} 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, SO_2 (both historically from home heating) and lead (from leaded petrol) to NO_2, benzene and PM_{10}, all derived mainly from traffic sources[3-5]. Legislation changes have ensured that levels of black smoke, SO_2 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 NO_2 while the carcinogenic properties of benzene and PM_{10} 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, SO_2, smoke and lead are significantly below the respective limit values even at worst-case roadside locations in major urban centres. In contrast, PM_{10}, NO_2 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 NO_2 in Dublin at College Green and Rathmines and of PM_{10} 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 NO_2, benzene and PM_{10}. Some data is available over the period 1996-99 in relation to the monitoring of NO_2 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 NO_2, benzene and PM_{10} 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 NO_2, benzene and PM_{10} 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 NO_2 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, NO_2 and PM_{10} 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

PM_{10}, CO and Benzene

The results of the baseline modelling assessment for PM_{10}, 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 PM_{10} in 2020 have been compared with the proposed PM_{10} 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 PM_{10} in 2020.

NO_2

The results of the baseline assessment for NO_2 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 NO_2. Baseline levels of NO_2 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 NO_2 is based on a one-hour mean not to be exceeded more than 18 times a year (99.8th%ile). 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 99.8th%ile 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 NO_2 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 NO_2 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

PM_{10}, CO and Benzene

The results of the modelled impact of the development for PM_{10}, 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 PM_{10}, 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 PM_{10}, 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 PM_{10}, CO and benzene is not significant.

NO_2

The results of the assessment of the impact of the development for NO_2 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 NO_2. Levels of NO_2 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 NO_2 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 NO_2 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 NO_2 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 NO_2 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 NO_2 is not significant.

Summary of Modelling Assessment

Baseline modelling assessments for PM_{10}, 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 NO_2 indicates that annual concentrations will be significantly within the air quality standards under all scenarios, with and without the development in place. Levels of NO_2 will range from 1 - 3% of the annual limit value in 2004 and 2020.

The maximum one-hour modelling assessment for NO_2 also indicates that levels will be within the applicable limit value in 2004 and 2020 for all scenarios. The impact of the development on NO_2 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 NO_2 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 NO_2, 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 NO_2, PM_{10}, 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 pollutants which need to be assessed in the cumulative assessment is nitrogen dioxide (NO_2) 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 NO_2 (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).

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(26) USEPA (1997) Mobile 5B
(27) USEPA (1998) Part 5B

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	Carbon Monoxide (ppm)		Hydrocarbons (µg/m³)			Nitrogen Dioxide (µg/m³)		Particulates (PM$_{10}$) (µg/m³)	
	(km/hr)	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   [2] EU Council Directive 1999/30/EC

[3] 1-hr limit of 200 µg/m³ not to be exceeded > 18 times/year (99.8 %ile)   [4] Indicative annual limit of 20 µg/m³ which may be applicable in 2010

[5] 24-Hr limit of 50 µg/m³ not to be exceeded > 35 times/year (90.5 %ile)

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 ($\mu g/m^3$)	Annual Concentrations ($\mu g/m^3$)	99.8[th]%ile of One-hour Concentrations ($\mu g/m^3$)	Annual Concentrations ($\mu g/m^3$)
Process Emissions	31	0.4	69	8.2
Traffic-Derived Emisisons	64	1.1	1.0	0.01
Background Concentration	20	10	20	10
Cumulative	115	11.5	90	18.2
Standard ($\mu g/m^3$)	**200[1]**	**40[1]**	**200[1]**	**40[1]**

[1]   EU Council Directive 1999/30/EC

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 NO_2, SO_2 and PM_{10}. 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 PM_{10}, 50% for the hourly and annual limit value for NO_2 and 43% for hourly SO_2 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 SO_2 and smoke. However, data from urban centres around Ireland list 98th percentiles of between 25-98 $\mu g/m^3$ and 27-52 $\mu g/m^3$ for SO_2 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 NO_2, benzene and PM_{10} than that encountered in Central Dublin and Cork. In relation to NO_2, the 99.8[th]%ile 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 PM_{10}, levels were higher in Blackpool, Cork City averaging 49 $\mu g/m^3$ during the monitoring period. However levels were significantly lower in Limerick and Waterford averaging 24 $\mu g/m^3$ and 31 $\mu g/m^3$ over the eight and three month monitoring periods during 2000.

The EPA Annual Report 1999 also includes data in relation to NO_2, benzene and PM_{10} in suburban Dublin[5]. 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 $\mu g/m^3$ 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, NO_2 and PM_{10} 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 NO_2 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 PM_{10}, CO, NO_2 and benzene worst-case year-specific background concentrations were derived from the UK DMRB[17]. The background concentrations of NO_2 were added to the modelling results which were derived using the discrete-parcel method. The discrete-parcel method involves a reaction series between O_3, NO and NO_2 which are assumed to react within a parcel of air independent of the dispersion process[22].

NO_2 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 NO_2 concentration of 20 $\mu g/m^3$ and a default background NO concentration of 10 $\mu g/m^3$ in 2004[17]. The background concentrations for the year 2018 assumed a NO_2 concentration of 20 $\mu g/m^3$ and a default background NO concentration of 10 $\mu g/m^3$ 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, NO_2 and PM_{10} 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, NO_2 and PM_{10} 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 PM_{10} 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 PM_{10}, 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 PM_{10} 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 PM_{10}.

Idling emission factors were taken from the USEPA approved emission factor models MOBILE5B (for NO_2)[26] and PART5 (for PM_{10})[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 (m²)	Temperature (K)	Max Volume Flow (Nm³/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm³)	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/m³ 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/m³ 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

Table A1.13: Source Emission Data For Emissions of Plant 1[1]

| Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m²)	Temperature (K)	Max Volume Flow (Nm³/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm³)	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 (m²)	Temperature (K)	Max Volume Flow (Nm³/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm³)	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.
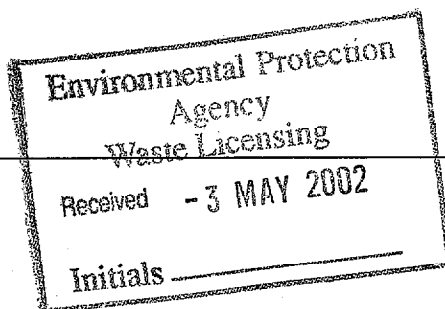
4. AIR QUALITY

4.1 Introduction

This section assesses the potential impacts of the Waste Management Facility on air quality. Air Quality Standards (AQSs) and guidelines have been reviewed for a number of air emissions. An ambient air quality survey has been carried out on site to establish baseline conditions and assess the air quality of the existing environment by comparison to AQSs.

Emissions to air include the flue gases from the waste to energy plant, occasional emissions from the emergency diesel generator and minor dust emissions from the ash silos and the activated carbon storage.

The ash silos will be fitted with high quality dust filters which will effectively eliminate any dust emissions. Ash will be discharged into trucks within enclosed areas and the trucks will be covered to prevent windblown ash emissions.

There will be no emissions to air from the community recycling park or the waste sorting plant.

Air Dispersion Modelling has been carried out to assess the effect of atmospheric emissions from the stack during the operation of the waste to energy plant on ground level concentrations (GLCs) of various air emissions. Mitigation measures are outlined to minimise any significant impacts identified.

Air Dispersion Modelling is a developed and approved science, which uses complex equations and detailed meteorological data to calculate predicted ground level concentrations from an emission source.

Basically, the ground level concentration depends on the stack height, proximity to buildings, concentration of substance of interest, temperature of discharge and meteorological conditions. Certain meteorological conditions tend to lead to higher ground level concentrations, for example when there is a large amount of turbulence in the atmosphere, the emissions come to ground quicker and lead to higher concentrations. In contrast, on very stable days the emissions remain at the height of discharge for a large distance and are very dilute when they reach ground.

4.1.1 Air Quality Standards

Air Quality Standards for the protection of human health and the environment have been developed at European level and implemented into Irish legislation for a number of air emissions. Air Quality Standards (AQSs) set limit values for Ground Level Concentrations (GLCs) of certain emissions for both the short term (hourly, daily) and long term (eg annual averages). Limit values are often expressed as percentiles eg 98 percentile of mean hourly values which means that only 2% of the results obtained during the monitoring period can exceed the stated limit value.

The following AQSs apply in Ireland:

- The Air Pollution Act, 1987 (Air Quality Standards) Regulations (SI No. 244 of 1987) which implements EU Directive 80/779/EEC on limit and guideline values for sulphur dioxide and suspended particulates, EU Directive 85/203/EEC on limit and guideline values for nitrogen dioxide, EU Directive 82/884/EEC on a limit value for lead in the air.

- EU Directive 99/30/EC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. The limit values specified in this directive are more stringent than the existing limit values and will start to come into effect from July 2001 and onwards.

Emissions to atmosphere from the waste to energy plant will include the emissions covered in the above AQSs. The plant may also emit a number of substances for which Irish and EU AQS limit values have not been set, namely hydrocarbons (expressed as Total Organic Carbon), hydrogen chloride (HCl), hydrogen fluoride (HF), polychlorinated dibenzo dioxins (PCDD) and polychlorinated dibenzo furans (PCDF), and could potentially emit a number of metals: Cadmium (Cd), Thallium (Tl), Mercury (Hg), Antimony (Sb), Arsenic (As), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V). In order to assess the impact that the emission of these substances could have on human health and the environment the following guidelines were also used in the assessment:

- World Health Organisation (WHO) 1987 & 1999 Air Quality Guidelines for Europe

- The National Authority for Occupational Safety and Health Code of Practice (1999) for the Safety, Health and Welfare at Work (Chemical Agents) Regulations, 1994 (S.I. No. 445 of 1994). Environmental AQS limit values were not available for a number of substances, so occupational exposure limits (OELs) were used as a basis for setting AQSs. One fortieth of the OEL was taken as the AQS limit value.

The various AQS limit values and guidelines are summarised in Table 4.1a & b.

Table 4.1a Air Quality Standards

Emission	Limit/Guideline	SI No. 244 of 1987 ($\mu g/m^3$)	Directive 99/30/EC ($\mu g/m^3$)	WHO 1987 & 1999 ($\mu g/m^3$)	SI No. 445 of 1994 ($\mu g/m^3$)[1]
NO_2	98th Percentile of a Years Hourly Average	200	-----	-----	-----
NO_2	99.8th percentile of a Years Hourly Average	----	200	-----	-----
NO_2	Annual Average	-----	30-40 [2]	-----	-----
SO_2	99.7th percentile of a Years Hourly Average	-----	350	-----	-----
SO_2	Daily Average	-----	-----	125	-----
SO_2	98th Percentile of a Years Daily Average	250-350 [3]	-----	-----	-----
SO_2	99.2th percentile of a Years Daily Average	-----	125	-----	-----
SO_2	Annual Average	-----	20 [4]	50	-----
Particulates	98th Percentile of a Years Daily Average	250	-----	-----	-----
Particulates	90th Percentile of a Years Daily Average	-----	50 [5]	-----	-----
Particulates	Annual Average	-----	40 [5]	-----	-----
TOC	Hourly Average	-----	-----	1,000 [6]	-----
HCl	Hourly Average	----	-----	-----	350
HF	Annual Average	----	----	1 [7]	-----
PCDD / PCDF [8]	Hourly Average / Annual Average	-----	----	-----	-----

Notes to Table 4.1a:

(1) Limit value is derived by dividing the Occupational Exposure Limit (OEL) by a factor of 40
(2) Limit value of 30 $\mu g/m^3$ is for the protection of vegetation and limit value of 40 $\mu g/m^3$ is for the protection of human health.
(3) Limit value of 250 $\mu g/m^3$ applies when corresponding percentile of suspended particulates >150 $\mu g/m^3$ and limit value of 350 $\mu g/m^3$ applies when corresponding percentile of suspended particulates ≤ 150 $\mu g/m^3$.
(4) Limit value is for the protection of ecosystems.
(5) Directive 99/30/EC sets limit values for PM_{10} (particulate matter ≤ 10 µm in diameter) rather than all particulate matter. After the limit values have been implemented in Member States they will be reviewed and more stringent limit values may be applied as part of Stage 2 of the Directive.
(6) Limit value is for Toluene which can be used as a standard for measuring Total Organic Carbon (TOC). The limit value is a 1987 WHO guideline and is based on an averaging time of 30 minutes.
(7) The 1999 WHO guideline value is for 'fluorides'.
(8) There are no air quality standard limit values for dioxins and furans. The 1999 WHO guidelines expressed a limit for dioxin like compounds in terms of Tolerable Daily Intake in TEQ/ kg bwd (Toxic Equivalent uptakes per kilogram of body weight per day). The Tolerable Daily Intake for dioxin like compounds is 1-4 TEQ/ kg bwd.

Table 4.1b Air Quality Standards For Metals

Pollutant	Regulation	Limit Type	Value
Inorganic Mercury (as Hg)	WHO	Annual Average	$1.0 \ \mu g/m^3$
Cd	TA Luft	Annual Average	$0.04 \ \mu g/m^3$
Cd	WHO	Annual Average	$0.005 \ \mu g/m^3$
Cd	EU	Annual Average	$0.005 \ \mu g/m^{3(2)}$
Tl	EAL	Annual Average	$1.0 \ \mu g/m^3$
Sb (organic compounds)	EAL[1]	Maximum One-Hour	$5 \ \mu g/m^3$
Sb (organic compounds)	EAL	Annual Average	$1.0 \ \mu g/m^3$
As	WHO	Annual Average	$0.005 \ \mu g/m^3$
As	EU	Annual Average	$0.004 \ \mu g/m^{3(2)}$
Pb	EU	Annual Average	$0.5 \ \mu g/m^3$
Cr (except VI)	EAL	Annual Average	$5.0 \ \mu g/m^3$
Cr (VI)	EAL	Annual Average	$0.5 \ \mu g/m^3$
Co	EAL	Annual Average	$1.0 \ \mu g/m^3$
Cu (fumes)	EAL	Annual Average	$2.0 \ \mu g/m^3$
Cu (dust & mists)	EAL	Annual Average	$10 \ \mu g/m^3$
Mn	WHO	Annual Average	$0.15 \ \mu g/m^3$
Mn (fume)	EAL	Maximum One-Hour	$75 \ \mu g/m^3$
Ni	EU	Annual Average	$0.01 \ \mu g/m^{3(2)}$
V (fume & respirable dust)	EAL	Annual Average	$0.4 \ \mu g/m^3$
V	WHO	24-Hour Average	$1.0 \ \mu g/m^3$

Notes to Table 4.1b:

(1) EAL – Environmental Assessment Levels. EAL's are used to derive ambient air quality standards from Occupational Exposure Limits (OEL). The OEL can be expressed on the basis of two averaging periods; an 8 hour and a 15 min. average. The 8 hour reference divided by a factor of 100 generates an OEL comparibale with predicted annual averages. The 15 min. reference divided by a factor of 40 may be applied for comparison with one hour concentrations.

(2) Proposed standard recommended by majority of the EU working group for setting emission factors

4.1.2   Existing Environment

The levels of dioxins in the ambient air and soils on site were determined in a survey carried out by ASEP. A full copy of their report is included in Attachment 3. An ambient air quality survey at the development site was carried out by TMS Environment Ltd and a full copy of their report is included in Attachment 4.

Levels of nitrogen dioxide (NO_2), sulphur dioxide (SO_2), suspended particulates (smoke), hydrogen chloride (HCl), hydrogen fluoride (HF), and a total of nineteen metals were monitored over an 28 day period during June and July 2000. Hourly average NO_2 concentrations were measured over a 28-day period during September and October 2000. In addition a three month PM_{10} monitoring programme was conducted between December 2001 and March 2002.

The results of the ambient air quality survey are summarised in Tables 4.2-4.4 below.

Table 4.2 Ambient Air Concentrations of nitrogen dioxide (NO₂), sulphur dioxide (SO₂), suspended particulates (smoke and PM₁₀)

Average Daily [NO₂] (µg/m³)	Average Daily [SO₂] (µg/m³)	Average Daily [Smoke] (µg/m³)	3 month Average [PM₁₀] (µg/m³)
1.3	1	4.3	18

Table 4.3 Ambient Air Concentrations of Hydrogen Chloride (HCl) and Hydrogen Fluoride (HF)

Average Daily [HCl] (µg/m3)	Average Daily [HF] (µg/m3)
0.0002	<0.0001

Table 4.4 Ambient Air Concentrations of Metals

Metal	Daily Concentration (µg/m³)
Cadmium	< 0.002
Thallium	< 0.021
Mercury	< 0.005
Lead	< 0.003 – 0.13
Antimony	< 0.0003 – 0.012
Arsenic	< 0.02
Chromium	<0.003 – 0.12
Cobalt	< 0.001
Copper	< 0.003 – 0.03
Nickel	< 0.003 – 0.069
Vanadium	< 0.001
Zinc	< 0.005 – 0.08
Selenium	< 0.005 – 0.38
Molybdenum	< 0.001 – 0.007
Titanium	< 0.002 – 0.01
Tin	<0.011 – 4.7
Barium	< 0.0002
Boron	< 0.004 – 0.22
Silver	< 0.01

Average daily levels of NO_2 were 1.3 μg/m^3 and the maximum recorded level was 2.6 μg/m^3. Although not directly comparable to AQS hourly and annual average limit values of 200 μg/m^3 and 30-40 μg/m^3 respectively, it can be seen that the levels recorded are well below these limit values. Annual mean concentrations of nitrogen oxides range from 0-30 μg/m^3 in rural atmospheres and 20-90 μg/m^3 in urban atmospheres so the levels recorded fall well within those expected for a rural location. The hourly average NO_2 concentration averaged 8.1 μg/m^3, and ranged from <2.1 to 36 μg/m^3, which are within the range typically expected for a rural environment.

Average daily levels of SO_2 were 1 μg/m^3 and the maximum recorded level was 7 μg/m^3. The existing AQS daily limit value is 250-350 μg/m^3 (98th percentile) and the new limit value is 125 μg/m^3 (99.2th percentile), so the levels recorded are only a small fraction of the limit values. Annual mean concentrations of sulphur dioxide range from 3-6 μg/m^3 (5-25) in rural atmospheres and 25-100 μg/m^3 in urban atmospheres so the levels recorded fall well within those expected for a rural location.

Average daily levels of smoke were 4.3 μg/m^3 and the maximum recorded level was 11 μg/m^3. The three month average PM10 level was 18 μg/m^3 The existing AQS daily limit value for suspended particulates is 250μg/m^3 (98th percentile) and the EU annual limit value for PM_{10} is 40 μg/m^3 (90th percentile), so the levels recorded are well below both the existing and new limit values.

Levels of hydrogen fluoride in the air at the site were below the limit of detection of the survey method (< 0.0001 μg/m^3) and levels of hydrogen chloride were also very low with an average concentration of 0.0002 μg/m^3 and a maximum concentration of 0.0018 μg/m^3. Although there are no AQS limit values for HF or HCl the levels were a small fraction of the limit values derived from occupational exposure limits (OELs).

The results in Table 4.4 show that most of the suite of nineteen metals analysed for were below the limit of detection of the survey method. There are no established AQS limit values for the majority of the nineteen metals, but for those that there are AQS limit values such as cadmium, lead and mercury the recorded levels are well below the limit values. All of the metals are well below their corresponding limit values derived from occupational exposure limits (OELs).

In summary the results of the survey indicate that the existing air quality on the site is good as would be expected of the rural area in which the site is located.

4.2   Construction Impacts and Mitigation

Construction activities on site including excavation and earthmoving could result in the generation of dust. Transportation of loose materials that are not properly contained on or off site could also result in dust generation as would the transfer of mud/soil from the wheels of construction traffic onto surrounding roads. A number of factors will affect the extent of dust generation and potential impacts on air quality including wind speed and direction, the dryness of the soil, and the proximity of sensitive receptors to the site.

The following mitigation measures will be put in place to minimise any dust generation and thus prevent any significant impacts on air quality:

- Good housekeeping and site management including the proper storage of spoil/loose materials on site

- Wheel washing of all vehicles leaving site

- Proper containment of loose materials that are transported on or off site

- Damping of site roads as necessary

4.3   Operational Impacts and Mitigation

4.3.1   Atmospheric Emissions from the Waste Management facility

(a)   Stack Emissions

There will be one main stack on site through which atmospheric emissions will be discharged. The substances emitted from the waste to energy plant will include the following:

- Oxides of nitrogen (NO_x)

- Sulphur dioxide (SO_2)

- Carbon monoxide (CO)

- Particulates (Dust)

- Hydrocarbons (expressed as Total Organic Carbon (TOC))

- Hydrogen Chloride (HCl)

- Hydrogen Fluoride (HF)

- Poly-Chlorinated Dibenzo Dioxins (PCDD) and Poly-Chlorinated Dibenzo Furans (PCDF)

- Heavy metals: Cadmium (Cd), Thallium (Tl), Mercury (Hg), Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V).

The maximum emission concentrations and mass emission rates from the stack are listed in Table 4.5 below.

Table 4.5. Worst Case Emission Data on the basis of Hourly Averages

Emission	Maximum Values		Expected Average Values	
	Emission Concentration (mg/Nm^3)	Emission Rate (g/s)	Emission Concentration (mg/Nm^3)	Emission Rate (g/s)
NO$_x$ (as NO$_2$)	200	8.389	150	5.25
SO$_2$	50	2.097	20	0.7
Dust	10	0.419	1	0.035
CO	100	4.2	20	0.7
TOC	10	0.419	1	0.035
HCl	10	0.419	1	0.035
HF	1	0.042	1	0.035
PCDD / PCDF[1] (ng/m^3)	0.1	4.19×10^{-9}	0.01	3.5×10^{-10}
Cd & Tl	0.05	0.002	0.025	0.000875
Hg	0.05	0.002	0.025	0.000875
Sum of 9 Heavy Metals: Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5	0.021	0.25	0.00875

Notes:

1) The emission concentration and emission rate for dioxins is based on the limit value contained in the new EU Directive on incineration. Due to the fact that the proposed plant will be equipped with a two stage dioxin removal process, the actual dioxin emissions are likely to be only 10% of the proposed limit.

The emission concentrations in the flue gas will be below the limits specified in Council Directive on the Incineration of Waste (2000/76/EC),.

In fact it is expected that the emission concentrations will be significantly below those contained in the Directive for all parameters. This has been the experience of Indaver's plant in Beveren, where, for example, the average heavy metal concentrations are only 10% of the limit values.

(b)   Other Emissions to Air

Another source of potential air emissions from the facility would be odours from the waste collection areas. The waste bunker which will receive all incoming waste to be treated in the waste to energy plant will be maintained under negative pressure to prevent any odorous emissions by treating them in the waste to energy plant.

The Waste Community Recycling Park will provide a collection area for a number of wastes including paper, plastics, glass, waste oils, used batteries etc. from members of the public. The Waste Community Recycling Park will not provide for the collection of any organic / putrescible waste which could give rise to odours. The area will be properly maintained and good housekeeping will minimise the potential for the generation of odours.

The construction and operational phases of the development will generate additional traffic on the surrounding road network. Traffic can contribute to ground level concentrations of certain substances, particularly NO_X. However the amount of additional traffic generated will not be significant (refer to Section 7.0 on Traffic) and therefore emissions from traffic will not have a significant impact on air quality.

4.3.2   Air Dispersion Modelling

Air dispersion modelling was carried out to determine effects of atmospheric emissions from the waste to energy plant on GLCs of air emissions. A screening exercise was first carried out to determine a stack height which would adequately disperse the atmospheric emissions without creating any undue impact. A detailed assessment of the impacts of atmospheric emissions from the chosen stack height was then carried out. Finally the cumulative impact of emissions from the waste to energy plant and two other developments in the vicinity was assessed using the dispersion model.

A full copy of the Air Dispersion Modelling report is included in Attachment 5.

The Industrial Source Complex (ISC 3) model was used to carry out the dispersion modelling. ISC 3 is a Gaussian dispersion model, which represents the emission plume as having a normal distribution in both the horizontal and vertical directions. The model is USEPA approved and is one of the models which the Irish EPA accept when assessing impacts from point source emissions.

The short term model (ISCST 3) model uses hourly meteorological data and calculates a range of hourly, daily and annual average concentrations from which percentiles of hourly and daily concentrations can be calculated for comparison to all relevant ambient AQS limit values. The meteorological data required by the dispersion model is wind speed, wind direction, Pasquill-Gifford stability category, boundary layer height and ambient temperature. The most recent available five years (1993-1997) of meteorological data for Dublin Airport was used in the model.

The model takes several factors which influence dispersion of plumes into account, such as building downwash, stack tip downwash, terrain effects etc. The most significant of these is building downwash whereby the turbulence created by buildings tends to increase the ground level concentrations experienced. The main buildings on the site were therefore incorporated into the Building Profile Input Program (BPIP) module of ISCST3.

Elevated terrain may increase the ground level concentrations by reducing the vertical dimension within which the plume can disperse. ISCST3 uses two algorithms to treat terrain based on the relative height variation between the sources's stack and surrounding terrain. Simple terrain is defined as terrain below stack height while complex terrain is defined as when the plume centreline height is below the terrain height. Intermediate terrain is defined as when terrain exceeds the height of release but is below the plume centreline height. In the model, for intermediate terrain, concentrations from both the simple terrain algorithm and the complex terrain algorithm are obtained and the higher of the two concentrations is used. The model automatically identifies whether a receptor point is located within simple, complex or intermediate terrain.

To calculate ground level concentrations, either rural or urban dispersion parameters must be specified for the model. USEPA guidelines were used to determine whether the area is urban or rural. According to these guidelines if the land use categories within a circle of 3 km radius comprise less than 50% of the following categories: heavy or medium industrial, commercial or multi family residential, the area should be classified as rural. It was found that this is the case at the proposed site and rural dispersion parameters were chosen.

Two nested receptor grids were used in the dispersion model, mapping at sufficient resolution to ensure all localised "hot spots" were identified. The first grid extended to 1,500 m based on a Cartesian grid with the site at the centre. Concentrtions were calculated at 100 m intervals. The second grid extended to 5,000 m based on a Cartesian grid with the site at the centre. Concentrtions were calculated at 1,000 m intervals. In addition, boundary receptor locations were placed along the boundary of the site, at 100 m intervals, giving a total of 1,100 calculation points for each model case.

4.3.3   Stack Height Determination

Dispersion modelling was carried out for stack heights at 5m intervals from 35m to 45m. The highest concentration of any emission from the stack will be NO_X (modelled as NO_2) and therefore the stack height determination was carried out with respect to NO_X emissions. The maximum 99.8[th] percentile hourly average ground level NO_2 concentrations were calculated for the range of stack heights. The results are shown in Figure 4.1. The new 99.8[th] percentile (not to be exceeded for more than 18 hours per annum) limit value as per EU Directive 99/30/EC is also indicated on Figure 4.1 for reference.

The maximum ground level concentration of NO_2 decreases steadily as the stack height increases. At forty metres the maximum ground level concentration is less than two-thirds of that for a 35m stack. It is also well below the 200 $\mu g/m^3$ limit value. Although the concentrations arising from a 45m stack are lower again, the criteria for choosing a stack height are based on providing adequate emission dispersion without creating any undue visual impact, and therefore a 40m stack height was chosen for the waste to energy plant.

Figure 4.1: Maximum 99.8th Percentile Hourly Average Ground Level Concentrations of NO$_2$
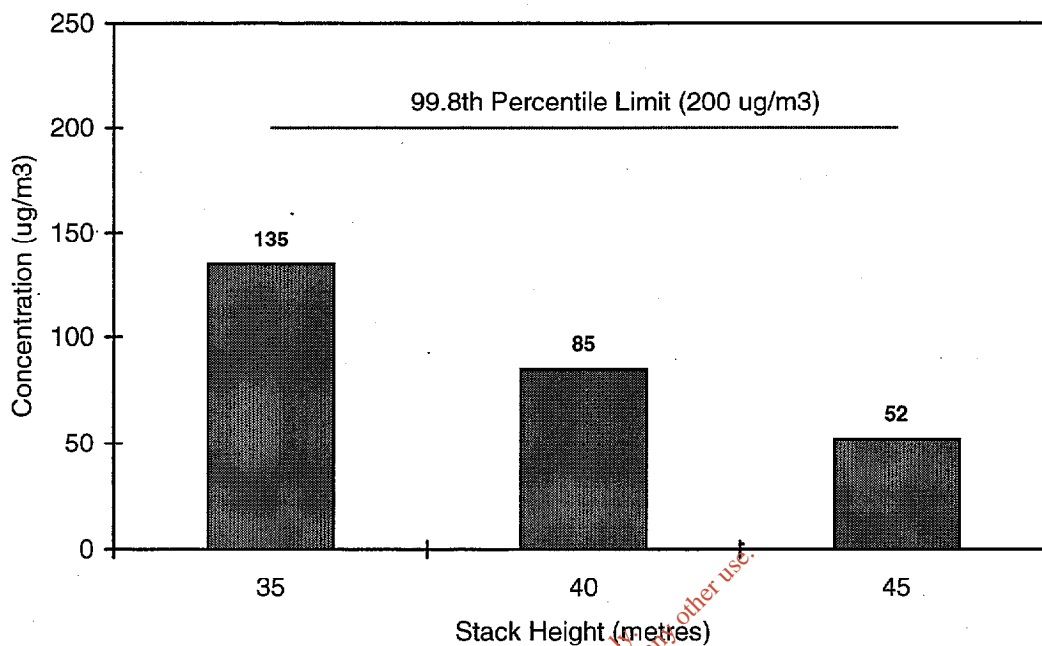
4.3.4 Potential Effects of Emissions via a 40m Stack

Atmospheric emissions can have adverse impacts on human health, if present at a sufficiently high concentration. This section outlines the principal effects on human health, both acute and chronic, that the emissions from the waste to energy plant can have. Exposure to the emissions could be as a result of:

- direct inhalation,

- skin absorption (of little importance)

- ingestion through water and food intake as a result of contamination of surface water, soil or crops

A large amount of research has been carried out on the potential health effects of exposure to high concentrations of emissions, most notably by the WHO. This research has enabled the AQSs listed in Section 4.1 to be devised and set at a level to eliminate potential health effects. The following sections summarise the potential effects of all substances emitted from the plant, when present at high concentrations.

4.4.5 Dispersion Modelling Results

The maximum predicted Ground Level Concentrations (GLCs) of emissions and the relevant air quality standards are presented in Table 4.7. Contour plots of the dispersion modelling results are included in the Dispersion Modelling Report.

The maximum predicted ground level concentrations of emissions generally occur approximately 200m north-east of the stack. The prevailing wind is from a south-westerly direction however occasionally when the wind is blowing from the opposite direction the maximum ground level concentrations can also occur 400m south-west of the stack. The results are discussed in more detail in the following Sections.

4.3.6 Nitrogen Dioxide

Nitrogen dioxide can act as a respiratory irritant at elevated concentrations, and it has been noted that the incidence of asthma and bronchitis is increased by exposure to NO_2 at high concentrations.

The EU limit values and WHO guideline values for NO_2 have been set at levels which ensure that no such health effects would occur.

The maximum predicted ambient NO_2 concentration, including background concentrations, is 43% of the EU hourly limit value (measured as a 99.8[th] percentile) and is 45% of the EU annual limit.

4.3.7 Sulphur Dioxide and Particulates

As with NO_2, sulphur dioxide (SO_2) can affect the respiratory system, primarily by causing the bronchi to constrict, and very high concentrations of SO_2 have been linked with increased hospital admissions.

Only fine suspended particulate matter (SPM) such as PM_{10} (< 10μm, 1μm = 0.001 mm) or $PM_{2.5}$ (< 2.5μm) can penetrate deeply into the lung and therefore the health effects of SPM in humans depends very much on particle size and concentration. As with NO_2 and SO_2, fine particulates can irritate the respiratory system.

The EU limit values and WHO guideline values for SO_2 and particulates have been set at levels which ensure that no such health effects would occur.

The predicted maximum ambient SO_2 concentrations, including background concentrations, are 17% of the ambient 1 hour limit value (measured as a 99.7[th] percentile) and are 19% of the daily average limit value (measured as a 99.2[th] percentile).

Based on the conservative assumption that all particulate emissions from the plant will be in the form of PM_{10}, the maximum predicted ambient concentrations, including background concentrations, are 44% of the ambient 24-hour limit value (measured as a 90.5[th] percentile) and 51% of the annual average limit value.

4.3.8 Total Organic Carbon and Acid Gases

The maximum ambient hourly concentration of hydrocarbons (Total Organic Carbons or TOC), including background concentrations, is only 11% of the TA Luft Immission Standard of 1,000 μg/Nm^3 (measured as a 98th percentile).

HCl and HF can also cause irritation of the respiratory system and can also cause irritation of the eyes, nose and throat.

The maximum predicted ambient HCl concentration, including background concentrations, is 7% of the hourly TA Luft Immission Standard of 100 $\mu g/Nm^3$ (measured as a 98th percentile).

The maximum predicted HF concentrations, including background concentrations, are 23% of the hourly TA Luft Immission Standard of 3 $\mu g/Nm^3$ (measured as a 98th percentile) and 19% of the WHO annual average limit value.

4.3.9 Mercury

Exposure to high concentrations of mercury vapour can damage the nervous system, and also the oral mucosa and the kidneys. The WHO has set a guideline value of 1 $\mu g/m^3$ as an annual average for mercury. The predicted GLC from the plant is only 7% of this guideline value.

4.3.10 Heavy Metals (excluding Mercury)

The waste to energy plant will not produce heavy metals but may emit heavy metals if present in the waste stream. Notwithstanding this, modelling was carried out based on the assumption that heavy metals are continuously emitted at the EU emission limit value (see Table 4.7).

Unless particular wastes (containing individual heavy metals) are present in the waste stream, individual heavy metals will rarely be emitted at significant concentrations.

Exposure to high levels of cadmium primarily affects the kidneys. The International Agency for Research on Cancer (IARC) has classified cadmium as a Group 2B carcinogen on the basis that there was sufficient evidence of it being carcinogenic in animals and there is limited evidence of cadmium being a human carcinogen. Acute exposure to thallium can cause gastrointestinal effects (abdominal pain, vomiting, diarrhoea). An EU working group has proposed emssion standards for nickel, cadmium and arsenic. This group has set a guideline value of 0.005 $\mu g/m^3$ as an annual average limit for cadmium. The maximum predicted cadmium GLC (assuming that cadmium and thallium emissions are 100% cadmium) is only 24% of this guideline limit value. Background concentrations have been excluded.

The maximum hourly ambient concentration, including background concentrations, is 16% of the antimony Environmental Assessment Level (EAL) limit value, which is the most stringent limit value for this averaging period. The maximum annual average ambient concentration, including background concentrations, is 23% of the manganese Environmental Assessment Level (EAL) limit value, which is the most stringent limit value for this averaging period.

Arsenic is a cellular and tissue poison. Acute exposure to arsenic can result in irritation of the respiratory system and skin, gastrointestinal effects (nausea, vomiting, abdominal pain, diarrhoea) and circulatory effects. Arsenic is also classified as a human carcinogen. As stated above, an EU working group has proposed emssion standards for nickel, cadmium and arsenic. This group has set a guideline value of 0.004 $\mu g/m^3$ as an annual average limit for arsenic. The maximum predicted GLC of 0.0008 $\mu g/m^3$ is 20% of this guideline limit value.

Exposure to nickel can cause skin irritation and dermatitis (due to sensitisation), and skin ulcers. Nickel and certain nickel compounds are probable human carcinogens of the lung and nasal passages. The EU group referred to above

has set a guideline value of 0.01 µg/m³ as an annual average limit for nickel. The maximum predicted GLC is only 8% of this guideline limit value.

4.3.11 Potential Impacts of Dioxin Emissions

Dioxins refer to a large group of structurally similar compounds which include both dioxins are furans. The polychlorinated-dibenzo-dioxins (PCDDs) include 75 individual compounds and the polychlorinated-dibenzo-furans (PCDFs) include 135 different compounds. These individual compounds are referred to as congeners. The most toxic of these compounds and also the most widely researched is 2,3,7,8-tetra-chloro-dibenzo-dioxin (TCDD). The toxicity of the other congeners is assessed relative to TCDD which is used as a reference compound. Only 7 of the 75 congeners of CDDs and only 10 of the 135 congeners of CDFs are thought to have dioxin like toxicity.

Very little of the toxicity data available for dioxins relates to exposure through inhalation and the majority of studies carried out have been for oral exposure in animals. These data indicate that TCDD is one of the most toxic compounds known and it produces a wide spectrum of toxic effects following both short-term and long-term exposure.

The most noted health effect in people exposed to large amounts of dioxin is chloracne which is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other effects of exposure to large amounts of dioxin include skin rashes, skin discoloration, excessive body hair, and possibly mild liver damage. TCDD is a human carcinogen and long term exposure may result in a number of different cancers. Studies have also shown dioxins to have a number of other effects including include dermal toxicity, immunotoxicity, endocrine disruption, reproductive effects and teratogenicity. Reproductive or developmental effects have not been seen in human studies however there is concern that exposure to low levels of dioxins over long periods might result in these effects including weakened immune responses and behaviour changes in offspring.

The emissions of dioxins from incineration processes is often the most controversial element associated with the project. It is worth considering here the position adopted by the World Health Organisation (WHO) in their publication Waste Incineration, namely:

- Dioxins is a generic name used to describe a family of 75 polychlorinated dibenzo-p-dioxins (PCDDs). There are also 135 structurally similar compounds of polychlorinated dibenzofurans (PCDFs).

- Dioxins and furans are physically and biologically stable. None is deliberately manufactured but they occur as trace elements in a number of organic chemicals and in the ash and emissions from most combustion processes. These combustion processes include garden bonfires, steel mills, crematoria and waste incinerators. Traces of dioxins have also been found in paper made from pulp which was bleached by chlorine.

- The majority of dioxins are not toxic at the concentration at which they would be found in the environment of waste incinerators.

- The concern about dioxins is mostly about one known as 2,3,7,8 TCDD which in certain animal species has been shown to be fatal at low dosages.

- Sweden's Environmental Protection Board has estimated that dioxin levels in the environment are contributed in equal quantities by car exhausts, steel mills and municipal waste incinerators to air, and by sewage sludge and pulp mills to water.

- There is no record of human fatality linked to dioxin, and the most severe case of exposure – following an industrial accident at Seveso, Italy – resulted in a skin condition called chloroacne, which was not permanent.

- In waste incineration, processes to limit the production of dioxins include burning at high temperature, the use of sufficient air, and the rapid cooling of exhaust gases.

While dioxins were always present as combustion by-products from the burning of wood and coal, the end of the 19th Century saw the development of chlorine based chemistry in Germany, in particular the manufacture of trichlorophenol, a wood preservative. Workers involved in this chemical manufacturer started to develop chloroacne. This was later traced to exposure to dioxins. A large number of similar dioxin exposures have occurred in the intervening period.

The largest such exposure was the Seveso accident in 1976, in which a runaway chemical reaction discharged dioxins to the general environment. A total of 5,000 people were exposed and 193 displayed symptoms of chloroacne, though no other adverse health effects were experienced. These data are given in detail in the WHO publication 'Polychlorinated Dibenzo-para-dioxins and Dibenzofurans' and the US EPA publication 'Dioxins'.

While experience with accidental human exposure to dioxins over the last 100 years has not indicated an acute toxicity to humans, the experience with animal studies has shown a high level of toxicity. For example, the toxic dose for guinea pigs is as low as 0.6 parts per billion body weight. Carcinogenic and mutagenic properties have also been observed in animal testing. It is the extrapolation of this data to humans, which has often led to the controversy associated with these compounds. However dioxins, and dioxin-like compounds which may have similar effects, are found in all environmental compartments, are persistent and, being fat soluble, tend to accumulate in higher animals, including humans. They are also resistant to degradation. By far the majority of toxicologists are of the opinion that entry of dioxins and furans into the environment and subsequently into the human food chain needs to be reduced as a precautionary measure. Over the past two decades the European Commission has implemented wide ranging legislation aimed at directly or indirectly reducing or controlling the release of dioxins into the environment, with the objective of reducing human exposure and protecting human health. In particular the '5th European Programme of Policy and Action in Relation to the Environment and Sustainable Development' aims to reduce the emissions of dioxins by 90% by 2005 based on 1985 levels. The WHO have also recommended a Tolerable Daily Intake of 1-4 pg TEQ/kg body weight (including dioxin-like PCBs). The proposed project will comply with all WHO and EU standards.

(a)   Emissions of Dioxins to Air

The proposed plant will meet EU legislation for the control of dioxin emissions. Namely a minimum combustion temperature of 850 C for waste with a halogenated organic content (expressed as chlorine) of less than 1%, maintained for at least 2 seconds in the presence of at least 6% oxygen. These conditions for the combustion of waste will minimise the formation of dioxins. For the stack emissions the EU has set an emission discharge limit of 0.1 ng I-TEQ/m3, where 1 nanogramme (ng) is equal to 1/ 1,000,000,000 of a gramme. The I-TEQ or International Toxic Equivalent is a means of ranking the complex mixtures of dioxin compounds based on their relative toxicity.

Incinerator dioxin emissions were in the past one of the major sources of dioxin releases to the environment. While this technology is over a hundred years old, early units were little more than covered bonfires with resultant high emission values. Due to growing awareness of the environmental impacts of these compounds in 1989 the EU introduced directives 89/369/EEC and 89/429/EEC for the control of emissions from existing and new municipal waste incineration plants. These directed member states, in the absence of a community directive on dioxin emissions, to set a dioxin limit.

The German authorities implemented through their incineration regulations BImSchV 17 of 1990 the limit of 0.1 ng I-TEQ/m3. In 1994 the EU introduced a further directive 94/67/EC on incineration of hazardous waste, which set the same limit of 0.1 ng/m3 to be implemented by 1 January 1997. The proposed new EU directive for municipal incineration (98/0289 SYN) will make the 0.1 ng/m3 emission level mandatory, and it is on this basis that the proposed plant has been designed. Indeed it is anticipated that the proposed plant will emit only 10% of the proposed emission limit value.

Prior to the implementation of this legislation in 1989, the German authorities estimated that average municipal incinerator dioxin emissions were 80 times the new limits, giving a total estimated discharged from municipal incinerators in West Germany of 400 g I-TEQ/a. A programme of upgrading incineration facilities has occurred in Europe since 1989, leading to the closure of a number of older and often smaller incineration plants, and the shift to larger newer or upgraded facilities. It is estimated in Germany that dioxin emissions from municipal incineration as a result of the implementation of this legislation has been reduced below 4 g I-TEQ/a. These emissions are now considered by German authorities to be of reduced relevance with regard to other sources of dioxin release to atmosphere.

In October 1999 the EU produced a summary report on the Compilation of EU Dioxin Exposure and Health Data. The report concluded that dioxin exposure is decreasing within the EU, and regulatory activity already applied to the stack emissions of waste incinerators, is now moving towards industrial processes, such as ferrous and non ferrous metal production processes and other sources.

As part of this work for the EU Commission, the German State Environment Agency of North Rhine-Westphalia produced an inventory of dioxin air emissions in 1997. This report was the outcome of a two year research programme which is currently being extended to include all dioxin emissions in addition to those to air. The report collected information for the 15 EU members and Norway and Switzerland for the reference period 1993 to 1995 and concluded that an annual PCDD/F air emission of 6,500 g I-TEQ/a is released by all known sources in the 17 countries considered. The selected most relevant sources, which represent about 90% of the actual total emissions are tabulated below.

With regard to emissions from incineration facilities the report concluded that these could be decreased to near zero level by burning the waste entirely in plants complying to the 0.1 ng I-TEQ/m3 limit. This limit is currently being phased in throughout Europe and when the updated dioxin inventory is published at the end of 2000, the revised figures should show this reduction. For the proposed project the annual dioxin emissions would be 0.1 g I-TEQ/a based on the 0.1 ng/m3 limit and 0.01 g I-TEQ/a based on the expected emission concentration of 0.01 ng/m^3.

This is a small fraction of the total figure above and well below that given to non-industrial sources such as domestic wood combustion and accidental fires, which can only be reduced to a limited extent and are therefore likely to form an unavoidable 'background' level.

Table 4.6 Dioxin Sources in the EU (1993 – 1995)

(Summary of the PCDD/F air emission rates in g I-TEQ gained by using default emission factors and activity data – data for incineration based on emissions prior to Directive 94/67/EC and new incineration Directive)

Source	Aggregate Emissions	% of Total Emissions
Residential combustion (Wood): Boilers, stoves, fireplaces	945.0	16.4
Residential combustion (coal/lignite): Boilers, stoves, fireplaces	30.5	0.5
Combustion in Industry, boilers, gas turbines, stationary engines	20.9	0.4
Sinter plants	1010.1	17.6
Secondary zinc production	19.9	0.3
Secondary copper production	76.9	1.3
Secondary aluminium production	39.0	0.7
Cement	20.4	0.4
Lime	0.0	0.0
Other: Metal reclamation from cables	1.7	0.0
Electric furnace steel plant	83.4	1.5
Other: Non-ferrous metal foundries	3.0	0.1
Other: Sintering of special materials and drossing facilities	115.0	2.0
Preservation of wood	381.4	6.6
Road transport	111.1	1.9
Incineration of domestic or municipal waste (legal)	1467.1	25.5
Incineration of domestic or municipal waste (illegal)	173.9	3.0
Incineration of industrial wastes	37.5	0.7
Incineration of hospital wastes	815.6	14.2
Cremation of corpses	16.8	0.3
Fires	379.8	6.6
Total	**5749**	

There are no Irish, European or World Health Organisation AQS limit values for dioxins or furans. The WHO expresses a limit value in terms of Tolerable Daily Intake which cannot be accurately related to ambient air concentration of dioxins. However, for maximum operating conditions, the predicted maximum annual average GLC of dioxins is 0.005 pg/m^3, which accounts for less than 10% of the existing background dioxin/furan concentration of 0.028 pg/m^3. As can be seen from the above, dioxins/furans emissions from the waste to energy plant will not lead to a perceptible increase over background levels and will thus not any impact on human health or the environment.

Table 4.7   Predicted Maximum Ground Level Concentrations Compared to Air Quality Standards

Emission	Type of Prediction	Modelling Concentration ($\mu g/m^3$)	Background ($\mu g/m^3$)	Concentration Including Background ($\mu g/m^3$)	Limit Value	Compliance
NO_2	99.8th percentile of a Years Hourly Average	65	20	85	200	**Yes**
NO_2	Annual Average	8	10	18	40	**Yes**
SO_2	99.7th percentile of a Years Hourly Average	52	8	60	350	**Yes**
SO_2	99.2th percentile of a Years Daily Average	20	4	.24	125	**Yes**
Dust (as PM_{10})	90.5th Percentile of 24-hr concentrations	1.9	20	21.9	50	**Yes**
Dust	Annual Average	0.51	20	20.5	40	**Yes**
TOC	Hourly Average (as a 98th%ile)	6.7	100	107	1000	**Yes**
HCl	Hourly Average (as a 98th%ile)	6.7	0.01	6.7	100	**Yes**
HF	Hourly Average (as a 98th%ile)	0.68	0.01	0.69	3	**Yes**
HF	Annual Average	0.051	0.005	0.056	0.3	**Yes**
PCDD/PCDF	Annual Average (ng/m^3)	5.0	28 – 46	**Range: 33 - 51**	-	-
Hg	Annual Average	0.0024	< 0.005	**0.0074**	0.1	**Yes**
Cd & Tl	Annual Average (Emission conc. = 0.025 mg/m^3)	0.0012	< 0.023[2]	**< 0.024**	0.005	**Yes**[1]
Sum of Metals	Annual Average (for antimony)	0.023	0.012	**0.035**	0.14	**Yes**
Sum of Metals	Maximum 1-Hour (for manganese)	0.77	0.024	**0.79**	5.0	**Yes**
Arsenic	Annual Average (Emission conc. = 0.015 mg/m^3)	0.0008	< 0.02[2]	**< 0.0208**	0.004	**Yes**[1]
Nickel	Annual Average (Emission conc. = 0.015 mg/m^3)	0.0008	0.006[2]	**0.0068**	0.010	**Yes**[1]

(1)   Cd, As & Ni predicted ambient concentration within the applicable PSD Increment of 25% for a Class II area.
(2)   Based on non-detects being equal to the limit of detection.

4.3.12   Assessment of Cumulative Impacts

There is currently one, and there may potentially be another significant point source of atmospheric emissions in the vicinity of the proposed Waste Management Facility, the existing Platin Cement factory and the proposed Marathon Combined Cycle Gas Turbine power plant. Atmospheric emissions from all three developments could potentially give rise to a cumulative impact on ground level concentrations of NO_2, SO_2 and particulates.

In order to assess the potential for a cumulative impact, air dispersion modelling was carried out based on the emission data contained in the Platin Cement IPC Application and the Platin Power Project EIS.

As the emissions of particulates from the proposed Marathon power plant are insignificant and the predicted particulate GLCs from the waste to energy plant are at most 2% of the AQSs, cumulative particulate emissions were not modelled. Therefore air dispersion modelling was carried out to assess the cumulative impact of the three developments on ground level concentrations of NO_2 and SO_2.

The results of the cumulative impact modelling together with the relevant air quality standards are presented in Table 4.8. Contours plots of the GLCs are included in the Air Dispersion Modelling report.

The maximum predicted GLCs of NO_2 and SO_2 from the Platin cement factory occur approximately 5-6 km north-east of the factory and therefore do not coincide with GLCs of emissions from the proposed waste to energy plant or the Marathon power plant. The maximum predicted GLCs from the waste to energy plant (as a 99.8[th]%ile) occur approximately 200m north-east of the stack while maximum predicted GLCs from the Marathon power plant occur approximately 170m north-east of the Marathon stack and do not coincide with the maximum GLC's from the waste to energy plant.

The results demonstrate that the predicted maximum GLCs of NO_2 and SO_2 of emissions from the proposed waste to energy plant, Platin cement factory and the proposed Marathon power plant are below all Air Quality Standard limit values or guidelines.

The cumulative impact modelling results are based on the Marathon power plant running on distillate oil (rather than natural gas) which results in much higher emissions of NO_2 and SO_2. According to the Marathon EIS, distillate oil will be only be used as a short term backup fuel in case of an interruption in the natural gas supply. During normal operation on natural gas much lower levels of NO_2 and SO_2 will be emitted and consequently any cumulative impact will be greatly reduced.

The cumulative modelling is based on the worst case discharge conditions occurring at the three plants at the same time and also at the same time as the worst case meteorological conditions. The maximum predicted GLCs are therefore based on a worst case scenario which is unlikely to arise and the modelling is therefore very conservative.

4.3.13   Nitrogen Dioxide

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.8^{th} 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.

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.

4.3.14   Sulphur Dioxide

In the area of the maximum impact of each nearby source, the impact from Indaver Ireland was very small. In relation to the 99.7^{th} 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.

In summary, the cumulative atmospheric emissions of NO_2 and SO_2 from the waste to energy plant, Platin cement factory and Marathon power plant will not cause ground level concentrations to exceed the relevant Air Quality Standard limit values or guidelines.

Table 4.9 Predicted Assessment of Cumulative Impact of Nitrogen Dioxide Emissions ($\mu g/m^3$)

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 – 99.8th%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 – 99.8th%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 NO_2 / 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 of Air Modelling Report for input information on nearby sources
Note: Plant 1 refers to Marathon Power Plant and Plant 2 refers to Platin Cement Factory.

Table 4.10   Assessment of Cumulative Impact of Sulphur Dioxide Emissions ($\mu g/m^3$)

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]%ile 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]%ile 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 (99.7[th]%ile)

(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

Note: Plant 1 refers to Marathon Power Plant and Plant 2 refers to Platin Cement Factory.

4.3.15   Operational Mitigation Measures

A number of measures have been incorporated into the design of the waste to energy plant to ensure that emissions from the plant do not exceed regulatory emission limit values and the impact on human health or the environment would be insignificant. These measures have already been discussed in detail in Section 2.4, and can be summarised as follows.

Emissions of nitrogen oxides (NO_X) will be minimised by optimising combustion conditions in the furnace to minimise the formation of NO_X and using a $DeNO_X$ urea injection system to reduce NO_X to nitrogen and water vapour. Two wet scrubbers using a lime (or limestone) based neutralisation agent will be used in sequence to remove acidic compounds (SO_2) and traces of heavy metals. A small amount of activated carbon will be injected into the flue gases leaving the evaporating spray tower, which will react with and adsorb trace levels of organic compounds and heavy metals. These carbon granules as well as other dust and particulates in the flue gases will be removed the baghouse filters. The plant will remove dioxins and furans from the flue gases using a two stage process. The first stage involves the injection of activated carbon into the flue gases as previously mentioned which will adsorb dioxins and furans. The second stage will involve passing the flue gases from the wet scrubbers through an activated lignite coke filter which will remove dioxins and furans as well as other hydrocarbons, acids and heavy metals. The furnace and flue gas cleaning plant will be operated under negative pressure which will ensure that the only emissions from the plant will be those fully treated and discharged through the stack. These design measures will ensure that emissions do not exceed regulatory emission limit values.

Flue gas monitoring equipment consisting of continuous monitors and regular grab sampling will be used to monitor emissions from the plant. This will include a state of the art dioxin sampler and analyser which will allow dioxin emissions to be continuously sampled. The flue gas monitoring will allow any changes in emission levels to be immediately detected and appropriate action to be taken if required.

4.4   Conclusions

The only emissions from the proposed facility that has the potential to affect air quality are the flue gases discharged via the 40m stack.

As the waste sorting plant and the waste bunker are contained in the waste acceptance hall, which is maintained under negative pressure there is no potential for odours.

As no kitchen waste will be accepted at the community recycling park and the area will be constantly manned and maintained clean, there will be no odours from this area.

The existing air quality in the area is good as would be expected of the rural area in which the site is located. Emissions from the waste to energy plant, at sufficiently high concentrations, could have a number of adverse impacts on human health and the environment. The concentrations of these emissions from the proposed waste to energy plant will be below regulatory limit values. Air dispersion modelling has shown that the ground level concentrations of these emissions will not exceed Air Quality Standard limit values which are designed for the protection of human health and the environment as a result of atmospheric emissions from the waste to energy plant.

Dispersion modelling has also shown that there will be no significant cumulative impact on air quality as a result of atmospheric emissions from the waste to energy plant or other developments in the vicinity. A number of design and mitigation measures will be put in place to minimise the impacts that the construction and operational phases of the development have on air quality and therefore the waste to energy plant is not predicted to have any significant adverse impacts on air quality.