Appendix 8.2

Description of AERMOD Model

APPENDIX 8.2

Description of the AERMOD Model

The AERMOD (version 15181) dispersion model has been developed, in part, by the U.S. Environmental Protection Agency (USEPA)(3). 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 2005 Guidelines on Air Quality Models has promulgated AERMOD as the preferred model for a refined analysis from industrial sources, in all terrains(1).

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(3)

AERMOD has made substantial improvements in the area of plume growth rates in comparison to ISCST3(3). 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(3). The treatment of mixing height by ISCST3 is based on a single morning upper air sounding each day. AERMOD, however, calculates mixing height on an hourly basis based on the morning upper air sounding and the surface energy balance, accounting for the solar radiation, cloud cover, reflectivity of the ground and the latent heat due to evaporation from the ground cover. This more advanced formulation provides a more realistic sequence of the diurnal mixing height changes.

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

AERMET

AERMOD incorporates a meteorological pre-processor AERMET[37]. AERMET allows AERMOD to account for changes in the plume behaviour with height. AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-Obukhov length, convective velocity scale, convective (CBL) and stable boundary layer (SBL) height and surface heat flux. AERMOD uses this information to calculate concentrations in a manner that accounts for changes in dispersion rate with height, allows for a non-Gaussian plume in convective conditions, and accounts for a dispersion rate that is a continuous function of meteorology.

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

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

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

The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc) and vary with seasons and wind direction. The assessment of appropriate land-use type was carried out to a distance of 10km from the location of the meteorological station in line with USEPA recommendations[4-6] for albedo and Bowen ratio with a 1km geometric determination undertaken for the surface roughness. In relation to wind direction, a minimum sector arc of 30 degrees is recommended. In the current model, the surface characteristics of Cork Airport were assessed and two sectors identified with distinctly varying land use characteristics.

Surface roughness

Surface roughness length is the height above the ground at which the wind speed goes to zero. Surface roughness length is defined by the individual elements on the landscape such as trees and buildings. In order to determine surface roughness length, the USEPA recommends that a representative length be defined for each sector, based on an upwind area-weighted average of the land use within the sector, by using the eight land use categories outlined by the USEPA. The inverse-distance weighted surface roughness length derived from the land use classification within a radius of 1km from Cork Airport Meteorological Station is shown in Table A8.82.

Table A8.82 Surface Roughness based on an inverse distance weighted average of the land use within a 1km radius of Cork Airport Meteorological Station.

Sector	**Area Weighted Land Use Classification**	**Spring**	**Summer**	**Autumn**	**Winter Note 1**
350-50	60% Urban, 40% Grassland	0.213	0.305	0.093	0.093
50-350	100% Grassland	0.050	0.100	0.010	0.010

(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))[4]. Thus for the current location autumn more accurately defines “winter” conditions in Ireland.

Albedo

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Albedo is used in calculating the hourly net heat balance at the surface for calculating hourly values of Monin-Obuklov length. A 10km x 10km square area is drawn around the meteorological station to determine the albedo based on a simple average for the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Cork Airport Meteorological Station is shown in Table A8.83.

Table A8.83 Albedo based on a simple average of the land use within a 10km × 10km grid centred on Cork Airport Meteorological Station.

Area Weighted Land Use Classification	**Spring**	**Summer**	**Autumn**	**Winter Note 1**
19% Urban, 81% Grassland	0.17	0.18	0.20	0.20

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

Bowen Ratio

The Bowen ratio is a measure of the amount of moisture at the surface of the earth. The presence of moisture affects the heat balance resulting from evaporative cooling which, in turn, affects the Monin-Obukhov length which is used in the formulation of the boundary layer. A 10km x 10km square area is drawn around the meteorological station to determine the Bowen Ratio based on geometric mean of the land use types within the area independent of both distance from the station and the near-field sector. The classification within 10km from Cork Airport Meteorological Station is shown in Table A8.84.

Table A8.84 Bowen Ratio based on a geometric mean of the land use within a 10km × 10km grid centred on Cork Airport Meteorological Station.

Area Weighted Land Use Classification	**Spring**	**Summer**	**Autumn**	**Winter Note 1**
19% Urban, 81% Grassland	0.47	0.95	1.14	1.14

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

Detailed Meteorological Data – Cork Airport 2010 - 2014

Cork Airport 2010

Dir \ Spd	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	3	35	310	174	13	0	535
22.5	9	26	183	88	9	0	315
45.0	10	25	161	116	5	0	317
67.5	10	22	110	52	5	0	199
90.0	10	44	190	99	27	6	376
112.5	6	32	176	106	36	13	369
135.0	4	27	153	144	45	16	389
157.5	9	26	152	103	33	10	333
180.0	22	74	249	133	59	10	547
202.5	23	91	325	214	50	6	709
225.0	15	70	479	211	68	5	848
247.5	14	55	365	142	34	7	617
270.0	29	76	235	103	13	3	459
292.5	17	70	450	166	35	12	750
315.0	8	71	671	269	54	9	1,082
337.5	6	31	441	382	25	6	891
Total	195	775	4,650	2,502	511	103	8,736
Calms							24
Missing							0
Total							8,760

Cork Airport 2011

Dir \ Spd	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	3	35	146	27	2	0	213
22.5	9	18	82	16	0	0	125
45.0	6	38	77	29	5	0	155
67.5	6	33	98	35	8	0	180
90.0	17	64	164	70	17	0	332
112.5	11	43	165	82	22	1	324
135.0	12	49	116	78	39	7	301
157.5	14	35	118	152	58	34	411
180.0	25	79	269	244	104	10	731
202.5	31	90	337	269	129	55	911
225.0	20	73	627	454	168	99	1,441
247.5	16	42	519	319	69	14	979
270.0	13	71	304	256	76	15	735
292.5	11	55	357	234	107	10	774
315.0	9	65	341	171	49	5	640
337.5	7	38	241	168	22	1	477
Total	210	828	3,961	2,604	875	251	8,729
Calms							31
Missing							0
Total							8,760

Cork Airport 2012

Dir \ Spd	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	8	26	134	117	32	10	327
22.5	3	15	91	37	18	7	171
45.0	6	18	85	75	16	2	202
67.5	8	19	101	40	14	1	183
90.0	7	30	184	108	26	5	360
112.5	11	40	183	118	25	9	386
135.0	10	30	177	123	57	13	410
157.5	21	29	172	89	28	1	340
180.0	21	83	345	159	44	13	665
202.5	22	69	330	230	89	26	766
225.0	13	78	599	354	71	17	1,132
247.5	15	48	521	298	34	2	918
270.0	33	59	388	206	51	9	746
292.5	24	52	390	207	72	16	761
315.0	16	59	402	233	63	7	780
337.5	8	18	205	251	66	15	563
Total	226	673	4,307	2,645	706	153	8,710
Calms							66
Missing							8
Total							8,784

Cork Airport 2013

Dir \ Spd	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	39	84	194	98	15	2	432
22.5	12	36	94	32	2	0	176
45.0	17	30	93	47	21	2	210
67.5	9	32	49	33	8	5	136
90.0	34	93	212	273	117	29	758
112.5	24	51	165	155	86	8	489
135.0	27	47	102	99	40	7	322
157.5	16	22	83	68	15	3	207
180.0	77	88	257	288	69	38	817
202.5	71	92	247	193	52	48	703
225.0	46	103	435	254	67	38	943
247.5	34	85	267	145	43	17	591
270.0	64	154	356	267	80	15	936
292.5	54	111	268	162	55	14	664
315.0	26	118	376	238	68	18	844
337.5	23	52	182	168	54	3	482
Total	573	1,198	3,380	2,520	792	247	8,710
Calms							50
Missing							0
Total							8,760

Cork Airport 2014

Dir \ Spd	<= 1.54	<= 3.09	<= 5.14	<= 8.23	<= 10.80	> 10.80	Total
0.0	34	38	168	46	12	0	298
22.5	20	32	81	9	0	0	142
45.0	30	43	70	18	1	0	162
67.5	37	26	58	21	1	0	143
90.0	52	74	185	131	43	2	487
112.5	49	58	119	93	23	8	350
135.0	39	45	115	70	20	20	309
157.5	35	82	152	91	34	32	426
180.0	109	150	333	272	79	20	963
202.5	88	103	251	213	122	46	823
225.0	60	134	551	239	103	43	1,130
247.5	45	89	350	194	61	14	753
270.0	52	148	351	271	91	39	952
292.5	51	109	255	166	18	7	606
315.0	41	90	318	257	31	0	737
337.5	36	66	173	141	16	3	435
Total	778	1,287	3,530	2,232	655	234	8,716
Calms							44
Missing							0
Total							8,760

Appendix 8.3

Air Quality Impact from Traffic Sources

APPENDIX 8.3

Air Quality Impact From Traffic Sources

The impact of the operational traffic accessing the Ringaskiddy Resource Recovery facility has been assessed using the UK DMRB Screening Model[38] which is a recommended screening model to assess air quality impacts from road traffic[13]. The worst-case operational impact in the region of the facility has been assessed and is outlined in Table A8.85. Cumulative impacts due to the Port of Cork expansion project have also been included in the “do-something” scenario. Development traffic data was taken from Table 7.9 of the Traffic Chapter of the EIS (Chapter 7).

Peak contributions to ambient air quality concentration tend not to overlap between traffic sources and industrial releases both temporally and spatially as these peak contributions from each source often occur under different weather conditions. However, for the purposes of this assessment, the maximum ambient levels due to operational traffic sources and process emissions have been combined to derive the worst-case cumulative impact from the facility.

Table A8.85 Summary Of Predicted Traffic Derived Pollutant Levels At Nearest Receptor To The Proposed Ringaskiddy Resource Recovery Facility.

Scenarios	**Traffic Speed**	**Carbon Monoxide (mg/m^3)**		**Benzene ($\mu g/m^3$)**		**Nitrogen Dioxide ($\mu g/m^3$)**			**Particulates (PM_{10}) ($\mu g/m^3$)**	
	(km/hr)	**Annual Mean**	**Maximum 8-hour**	**Annual mean benzene**	**Rolling annual mean benzene**	**Annual average NO_x**	**Annual average NO_2**	**Maximum 1-Hour NO_2**	**Annual average**	**No of Days > 50 $\mu g/m^3$**
2020 Existing Traffic	30	0.01	0.05	0.01	0.01	0.80	0.44	1.5	0.09	0
2020 Do Something Traffic (Including Port Of Cork)	30	0.005	0.025	0.005	0.005	1.2	0.61	2.1	0.12	0
Standards			10(1)		5(1)	-	40(2)	200(2,3)	40(2)	35(2,4)

(1) EU Council Directive 2000/69/EC (S.I. 180 of 2011)

(2) EU Council Directive 2008/50/EC (S.I. 180 of 2011)

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

(4) 24-Hr limit of 50 $\mu g/m^3$ not to be exceeded > 35 times/year (90.1th %ile)

Appendix 8.4

Cumulative Impact Assessment

APPENDIX 8.4

Cumulative Impact Assessment

As the region around Ringaskiddy is industrialised and thus has several other potentially significant point sources of air emissions, a detailed cumulative assessment has been carried out using the methodology outlined by the USEPA.

The impact of nearby point 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)].

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 significant 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. These releases consist of NO_2, SO_2, HCl, HF, Dioxins, Cd, PAHs, As and Ni. As emissions of Total Dust (as PM_{10}), CO and TOC are not significant, no cumulative assessment will be carried out for these pollutants. Furthermore, as there are no significant releases of HCl, HF, PAHs, Cd, As and Ni in the vicinity of the facility, no detailed cumulative assessment is necessary for these compounds. Table A8.86 outlines the significant releases from Indaver which also have a nearby facility which is releasing the same pollutants at significance levels.

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 A8.87. The emission data used in the cumulative assessment is based on the maximum emission limits and volume flows contained in each facilities' IED Licence. For each significant nearby source, an assessment was made of which pollutants from each source were significant. The significant pollutants from each site have been outlined in Table A8.87. In addition, air modelling of road emissions associated with the project have also been undertaken and added to the existing worst-case background pollutant levels. Cumulative impacts due to the Port of Cork expansion project have also been included in both the "do-nothing" and "do-something" scenario.

Table A8.86 Assessment of Significant Releases from Indaver

Pollutant	Significance Criteria ($\mu g/m^3$ annual average)	Indaver GLC ($\mu g/m^3$ annual average)	Significance
NO_2	1	1.25	√
SO_2	1	0.42	x
Dioxins	-	0.83 fg/m^3	x

Table A8.87 Assessment of Significant Releases From Nearby Sources

Pollutant	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7
NO_2	√	√	√		√	√	√
SO_2	√	√	√	√	√	√	√
Dioxins		√		√	√	√	

Summary of Nearby Sources

Plant 1: Janssen Biologics Ltd
Plant 2: Hovione Cork
Plant 3: ESB Aghada
Plant 4: Novartis Ringaskiddy Ltd.
Plant 5: GSK Ireland
Plant 6: Pfizer Ireland Pharmaceuticals (Ballintaggart)
Plant 7: BGE Whitegate

The cumulative impact assessment has been carried out to assess the impact of emissions from Indaver 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(1). 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 over-estimate the impact of these sources in the surrounding environment.

Table A8.87 Assessment of Cumulative Impact of Nitrogen Dioxide Emissions ($\mu g/m^3$)

Pollutant	Indaver	All Point Sources Except Indaver	Significance Criteria	All Point Sources[5]	Limit Value[3]
Impact of each source at Indaver Maximum – 99.8^{th}%ile[1]	28.8 (547925, 5742125)	20.7 (547925, 5742125)	100[4]	52.8 (547925, 5742125)	200
Impact of each source at Indaver Maximum – Annual Average[2]	1.2 (547900, 5742150)	2.9 (547900, 5742150)	20[4]	16.1 (547900, 5742150)	40
Impact of each source of maximum of All Sources – 99.8^{th}%ile[1]	3.6 (545900, 5742900)	126.0 (545900, 5742900)	100[4]	150.0 (545900, 5742900)	200
Impact of each source of maximum of All Sources – Annual Average[2]	0.16 (545900, 5742900)	27.1 (545900, 5742900)	20[4]	39.3 (545900, 5742900)	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 0.40

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

(3) Directive 2008/50/EC

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

(5) All sources include the background concentration (12 $\mu g/m^3$ for the annual mean and 24 $\mu g/m^3$ for 1-hr maximum (as a 99.8^{th}%ile)).

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

Table A8.88 Assessment of Cumulative Impact of Sulphur Dioxide Emissions (μg/m^3)

Pollutant	Indaver	All Point Sources Except Indaver	Significance Criteria	All Point Sources[(4)]	Limit Value
Impact of each source at Indaver Maximum – 99.7th%ile of 1-hr averages[(1)]	35.7 (547925, 5742100)	12.7 (547925, 5742100)	88[(3)]	56.4 (547925, 5742100)	350
Impact of each source at Indaver Maximum – 99.2th%ile of 24-hr averages[(2)]	5.2 (547875, 5742150)	3.5 (547875, 5742150)	31.25[(3)]	18.1 (547875, 5742150)	125
Impact of each source of maximum of All Sources – 99.7th%ile of 1-hr averages[(2)]	3.1 (545700, 5742100)	136.6 (545700, 5742100)	88[(3)]	157.3 (545700, 5742100)	350
Impact of each source of maximum of All Sources – 99.2th%ile of 24-hr averages(1)	0.67 (545600, 5741900)	62.8 (545600, 5741900)	31.25[(3)]	75.7 (545600, 5741900)	125

(1) Directive 2008/50/EC – Maximum one-hour concentration not to be exceeded more than 24 times per year (99.7th%ile)

(2) Directive 2008/50/EC – Maximum 24-hour concentration not to be exceeded more than 3 times per year (99.2th%ile)

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

(4) All sources include the background concentration (20.7 μg/m^3 for the 1-hr maximum (as a 99.7th%ile) and 12.8 μg/m^3 for the 24-hr (as a 99.2th%ile)).

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

Table A8.89 Assessment of Cumulative Impact of PCDD/PCDF Particulate Emissions (fg/m^3)

Pollutant	Indaver Ireland	All Point Sources Except Indaver	All Point Sources	Limit Value
Impact of each source at Indaver Maximum – Annual Average[(1)]	0.83 (547900, 5742150)	1.1 (547900, 57421250)	1.9 (547900, 5742150)	-
Impact of each source of maximum of All Sources – Annual Average[(1)]	0.3 (547875, 5741225)	8.4 (547875, 5741225)	8.7 (547875, 5741225)	-

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

Note: Refer to Appendix 8.6 for input information on nearby sources

NO_2

The cumulative impact of nitrogen dioxide has been assessed in Table A8.87. In the area of the maximum impact of Indaver (Grid Co-ordinate 547925, 5742125), the impact from all sources was minor. In relation to the 99.8th%ile of maximum one-hour concentrations, the cumulative impact at this point was only 10% of the limit value in the absence of Indaver. In the presence of Indaver, the cumulative impact with maximum concentrations rose to 26% of the limit value (not including background concentration), which is minor increase to the maximum concentration of Indaver alone (at 14% of the limit value). The results therefore indicate that the contribution of each nearby sources were generally separated in time and thus did not lead to any significant increase in levels above the impact of Indaver alone.

The annual average cumulative assessment was likewise minor at the area of the maximum impact of Indaver (Grid Co-ordinate 547900, 5742150). The overall impact leads to an increase of 7% in the annual average levels leading to a cumulative level of 11% of the limit value (not including background concentration).

In the area of the overall maximum impact, the impact from Indaver was very small. In relation to the 99.8th%ile of maximum one-hour concentrations, the impact of Indaver at the point of maximum impact of all nearby sources was 1.8% of the limit value. Moreover, the maximum one-hour impact of Indaver 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 all nearby sources. In the region where all sources combine to cause the maximum impact, the impact of Indaver represents only 0.4% of the limit value.

SO_2

The cumulative impact of sulphur dioxide has been assessed in Table A8.88. In the area of the maximum impact of Indaver (Grid Co-ordinate 547925, 5742100), the impact from all sources was minor. In relation to the 99.7th%ile of maximum one-hour concentrations, the cumulative impact at this point was less than 4% of the limit value in the absence of Indaver. In the presence of Indaver, the cumulative impact with maximum concentrations rose to 10% of the limit value (not including background concentration), which is very similar to the maximum concentration of Indaver alone (at 10% of the limit value).

The cumulative assessment of 99.2nd%ile of 24-hour concentrations also showed insignificant impacts at the area of the maximum impact of Indaver (Grid Co-ordinate 547875, 5742150).

In the area of the maximum impact of all nearby sources, the impact from Indaver was very small. In relation to the 99.7th%ile of maximum one-hour concentrations, the impact of Indaver at the point of maximum impact of all nearby sources represents only 0.9% of the limit value. With regard to the 99.2nd%ile of 24-hour concentrations, the impact of Indaver at the point of maximum impact of all nearby sources represents only 0.5% of the limit value.

PCDD/PCDFs

The cumulative impact of PCDD/PCDFs has been assessed in Table A8.89. In the area of the maximum impact of Indaver (Grid Co-ordinate 547900, 5742150), the impact from each source was minor. In relation to the annual concentration, the cumulative impact was only 1.1 fg/m^3 in the absence of Indaver, at the location of the maximum impact from Indaver. In the presence of Indaver, the assessment indicated that the cumulative annual concentrations is 1.9 fg/m^3 at this location which includes the contribution from Indaver and all other nearby sources. Thus the cumulative impact leads to an increase in dioxin levels of approximately 7.8% as compared to Indaver alone in the area of the maximum impact of Indaver (relative to existing background concentration).

In the area of the maximum impact of all nearby sources, the impact from Indaver was very small. In relation to the annual concentration, the impact of Indaver at the point of maximum impact of each nearby source was 0.3 fg/m^3. In the region where all sources combine to cause the maximum impact (not including Indaver's maximum), an examination of the impact of Indaver reveals an insignificant impact.

Appendix 8.5

Sensitivity Assessment of Modelling Input Parameters

APPENDIX 8.5

Sensitivity assessment of modelling input parameters

The sensitivity of the modelling results to variations in the model input parameters was investigated. The key parameters which are likely to influence the air dispersion modelling algorithms are outlined below:

- Meteorological Station
- Surface roughness
- Urban boundary layer options / rural option
- Land Use Characterisation

Meteorological Station

The influence of the meteorological station on the ambient ground level concentration has been investigated. For the detailed modelling Cork Airport (2010 – 2014) and the onsite station (2007) was used. As part of the sensitivity assessment Roches Point data (1986 – 1990) was also modelled to determine the sensitivity of this parameter to the modelled concentration (Roches Point manned station closed in 1991). As shown in Table A8.90, changing the meteorological station leads to a small increase in the annual average concentration and 99.8th%ile of one hour means compared to the onsite station in 2007.

Surface Roughness

The influence of surface roughness on the ambient ground level concentration has been investigated. For the detailed modelling the surface roughness for the rural boundary layer option was selected which is representative of the area as outlined in Table A8.82. As part of the sensitivity assessment surface roughness of 0.001 and 1.0 were also modelled to determine the sensitivity of this parameter to the modelled concentration. As shown in Table A8.90, changing the surface roughness to 1.0 which is representative of an urban area leads to a small increase in the annual average concentration and a small decrease in the 99.8th%ile of one hour means. Reducing the surface roughness to 0.001 leads to a small increase in both the maximum one hour (as a 99.8th%ile) and a small decrease in the annual average.

Land Use Characterisation

The influence of the land use characterisation near the facility on the ambient ground level concentration has been investigated. For the detailed modelling, land use characterisation was undertaken as outlined in Table A8.83 based on the location of the facility at an urban / rural interface. As part of the sensitivity assessment modelling assuming solely a rural character (0-360°) consisting of grasslands was also modelled to determine the sensitivity of this parameter to the modelled concentration. As shown in Table A8.90 assuming that the land use surrounding the facility is entirely grasslands leads to a minor short-term increase relative to the predicted level (base case). Table A8.90 also shows that the scenario where the urban boundary layer was used (instead of the default rural boundary layer) leads to a small change in the predicted level (relative to the base case).

Average / Wet Bowen Ratio Comparison

The influence of the Bowen ratio (which characterises the available surface moisture) on the ambient ground level concentration has been investigated. For the detailed modelling an average bowen ratio was selected based on the rainfall totals for Cork. As part of the sensitivity assessment modelling assuming higher rainfall pattern (wet) was undertaken to determine the sensitivity of this parameter to the modelled concentration. As shown in Table A8.90, the effect of changing the Bowen ratio from average to wet is a negligible for the maximum one hour (as a 99.8^{th}%ile) and the annual average.

Table A8.90 Dispersion Model Results – Sensitivity Study (Based on Ringaskiddy Onsite data 2007)

Pollutant / Scenario	Mean Background (μg/m³)(1)	Averaging Period	Process Contribution NOx (μg/m³)	Predicted Emission Concentration (μg/Nm³)	Standard (μg/Nm³)	Ringaskiddy Facility emissions as a % of ambient limit value
NO_2 / Default (Varying Surface Roughness as shown in Table 8.75, Rural Boundary Layer, Average Bowen ratio, Land Use as shown in Table 8.75)	12	Annual Mean(3)	0.85	12.9	40(2)	3%
	105.1	99.8th%ile of 1-hr means(4)	71.6	124.8	200(2)	36%
NO_2 / Roches Point 1986 - 1990	12	Annual Mean(3)	1.28	13.3	40(2)	3%
	105.1	99.8th%ile of 1-hr means(4)	72.3	125.5	200(2)	36%
NO_2 / Surface Roughness 0.001	12	Annual Mean(3)	0.76	12.8	40(2)	2%
	105.1	99.8th%ile of 1-hr means(4)	73.3	126.5	200(2)	36%
NO_2 / Surface Roughness 1.0	12	Annual Mean(3)	0.92	12.9	40(2)	2%
	105.1	99.8th%ile of 1-hr means(4)	64.3	117.5	200(2)	32%
NO_2 / Rural Option (All grassland)	12	Annual Mean(3)	0.84	12.8	40(2)	2%
	105.1	99.8th%ile of 1-hr means(4)	73.3	126.5	200(2)	37%
NO_2 / Urban Boundary Layer	12	Annual Mean(3)	0.88	12.9	40(2)	2%
	105.1	99.8th%ile of 1-hr means(4)	72.6	125.8	200(2)	36%
NO_2 / Bowen Ratio - Wet	12	Annual Mean(3)	0.85	12.9	40(2)	2%
	105.1	99.8th%ile of 1-hr means(4)	71.7	124.9	200(2)	36%

(1) Includes contribution from traffic and background sources and incorporating the cumulative assessment results.
(2) S.I. 180 of 2011.
(3) Conversion factor following guidance from USEPA (Tier 2 analysis, annual average) based on a site-specific ratio of 0.75.
(4) Conversion factor following guidance from UK (IPPC H1).

Appendix 8.6

Process Information

APPENDIX 8.6 - Process Information

Table A8.91a Source Emission Data for Maximum Emissions From The Ringaskiddy Resource Recovery Facility

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temperature (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Maximum Stack - Grate Incinerator	70	2.3	4.15	418.15	142,089	13.5	NO_2 – 400 SO_2 – 200 Dust – 30 CO – 150 TOC – 20 HCl – 60 HF – 4.0 Dioxins – 0.1 ng/m^3 Cd & Tl – 0.05 Hg – 0.05 Sum of Metals – 0.5	NO_2 – 15.79 SO_2 – 7.9 Dust – 1.18 CO – 5.9 TOC – 0.79 HCl – 2.4 HF – 0.16 Dioxins – 3.5E-9 Cd & Tl – 0.00197 Hg – 0.00197 Sum of Metals – 0.0197

Table A8.91b Source Emission Data for Average Emissions From The Ringaskiddy Resource Recovery Facility

Stack Reference	Stack Height (m)	Exit Diameter (m)	Cross-Sectional Area (m^2)	Temperature (K)	Max Volume Flow (Nm^3/hr)	Exit Velocity (m/sec actual)	Concentration (mg/Nm^3)	Mass Emission (g/s)
Nominal Stack - Grate Incinerator	70	2.3	4.15	418.15	106,922	10.5	NO_2 – 200 SO_2 – 50 Dust – 10 CO – 50 TOC – 10 HCl – 10 HF – 1.0 Dioxins – 0.05 ng/m^3 Cd & Tl – 0.05 Hg – 0.05 Sum of Metals – 0.5	NO_2 – 5.9 SO_2 – 1.5 Dust – 0.30 CO – 1.5 TOC – 0.30 HCl – 0.30 HF – 0.030 Dioxins – 3.0E-9 Cd & Tl – 0.0015 Hg – 0.0015 Sum of Metals – 0.015

Appendix 8.7

Detailed NOx Process Calculations

APPENDIX 8.7 - Detailed NO_X Process Calculations

A) 99.8[th]%ile hourly background total oxidant (O_3 & NO_2) + 0.05 x (99.8[th]%ile process contribution NO_X)

Year	99.8th%ile hourly background total oxidant (O_3 & NO_2)	99.8th%ile process contribution NO_X	NO_2 PEC
2007	133.9	71.6	**137.5**
2010	133.9	72.1	**137.5**
2011	133.9	64.8	**137.2**
2012	133.9	71.3	**137.5**
2013	133.9	67.7	**137.3**
2014	133.9	65.7	**137.2**

Minimum
124.8
125.3
118.0
124.5
120.9
118.9

B) 1 99.8th%ile process contribution NO_X + 2 x (annual mean background NO_2)

Year	99.8th%ile process contribution	Annual Mean Background NO_2	NO_2 PEC
2007	71.6	26.6	**124.8**
2010	72.1	26.6	**125.3**
2011	64.8	26.6	**118.0**
2012	71.3	26.6	**124.5**
2013	67.7	26.6	**120.9**
2014	65.7	26.6	**118.9**

Maximum
124.8
125.3
118.0
124.5
120.9
118.9

B) 2 99.8[th]%ile hourly background NO_2 + 2 x (annual mean process contribution NO_X).

Year	99.8th%ile hourly background NO_2	Annual Mean Process NO_X	NO_2 PEC
2007	105.05	1.13	**107.3**
2010	105.05	1.67	**108.4**
2011	105.05	1.00	**107.1**
2012	105.05	1.05	**107.2**
2013	105.05	1.33	**107.7**
2014	105.05	1.19	**107.4**