8 Air Quality and Climate

8.1 Introduction

This chapter of the Environmental Impact Statement describes the existing environment in relation to Air Quality and Climate in the area of the proposed development, predicts the impacts on air quality and climate arising from the proposed development and, where considered appropriate, mitigation measures have been specified. It is divided into the following sub-sections;

8.1 Introduction

8.2 Climate

- *Methodology*
- *Environmental Impact*
- *Mitigation Measures*
- *Residual Impacts*

8.3 Air Quality

- *General Air Quality - Existing Environment*
- *Environmental Impact*
- *Mitigation Measures*
- *Residual Impacts*

8.2 Climate

8.2.1 Methodology

The assessment methodology of the existing climatic environment involved a desk-based review of the following literature:

- Environmental Protection Agency (2008), *Air Quality in Ireland 2007;*
- EPA Website (2008), http://www.epa.ie/ourenvironment/air/accessmaps;
- UK DEFRA (2008), *Part IV of the Environment Act 1995: Local Air Quality Management, LAQM. TG(08);*
- National Roads Authority (2006), *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes;*
- UK DEFRA (2007), *Design Manual for Roads and Bridges Vol 11 Chapter 3 (Document & Calculation Spreadsheet);*

- USEPA (2005) *AERMOD Description of Model Formulation*;
- USEPA (1995) *User's Guide for the Industrial Source Complex (ISC3) Dispersion Model Vol I & II*;
- EPA (2005), *Guidelines on Air Quality Models, Appendix W to Part 51, 40 CFR Ch.1*;
- USEPA (2008) *Ninth Conference on Air Quality Modelling (2008);*
- USEPA (2005) *Human Health Risk Assessment Protocol, Chapter 3: Air Dispersion and Deposition Modelling, Region 6 Centre for Combustion Science and Engineering*;
- EPA (1999) *Comparison of Regulatory Design Concentrations: AERMOD vs. ISCST3 vs. CTDM PLUS*;
- Schulman et al *"Development and evaluation of the PRIME Plume Rise and Building Downwash Model"* Air & Waste Management Association, 1998;
- Paine, R & Lew, F. *"Consequence Analysis for Adoption of PRIME: an Advanced Building Downwash Model"* Prepared for the EPRI, ENSR Document No. 2460-026-450 (1997);
- Paine, R & Lew, F. *"Results of the Independent Evaluation of ISCST3 and ISC-PRIME"* Prepared for the EPRI, ENSR Document No. 2460-026-3527-02 (1997);
- USEPA (2005) Estimating Exposure to Dioxin-Like Compounds Volume IV, Chapter 3 *Evaluating Atmospheric Releases of Dioxin-Like Compounds from Combustion Sources (Draft);* and
- USEPA (2004) *User's Guide to the AERMOD Meteorological Preprocessor (AERMET).*

(i) Microclimatic Baseline

The climate in the region of the proposed development is characterised by the passage of Atlantic low pressure weather systems, and associated frontal rain belts from the west, during much of the winter period. Over the summer months the influence of anticyclonic weather conditions will result in drier continental air over this part of Ireland, in particular when winds are from the east, interspersed by the Atlantic frontal systems.

Occasionally, the establishment of a high pressure area over Ireland and Britain will result in calm conditions and, during the winter months, these are characterised by clear skies and the formation of low level temperature inversions with slack wind conditions at night time. If anticyclonic conditions become established for a few days or more during the summer months then high daytime temperatures may be recorded, especially at inland locations in Leinster. Prolonged dry weather conditions are relatively infrequent but, should continental air masses dominate over Ireland, a period of drought conditions may occur which could last up to 2 or 3 weeks.

(ii) Wind

The windfall characteristics in the Westmeath region are important climatological elements in examining the potential for the generation of fugitive dust emissions from the existing operations at Derrygreenagh. Fugitive dust emissions from a surface occur if the winds are sufficiently strong and turbulent and the surface dry and loose enough, to cause re-suspension from the ground and road surfaces. The surface needs to have a relatively low moisture content for this type of dust emission to take place and any wetting, either by rainfall or sprayers, will greatly reduce the potential for fugitive dust emissions to take place. A wind speed at ground level in excess of about 5 m/s is considered to be the threshold above which re-suspension of fine-sized material from an exposed surface may occur.

Long-term hourly observations at Mullingar Meteorological station provide an indication of the prevailing wind conditions for the region - see Table 8.1 *Mullingar Meteorological Station – 30 year averages*. Results presented in this table indicate that the mean wind speed is about 4.4 m/s, with approximately 2-3 days per year of gales.

(iii) Rainfall

Precipitation data for the nearest long-term climatological station at Mullingar indicates an average annual rainfall of 934 mm some 15 km from the site, see Table 8.1 *Mullingar Meteorological Station – 30 year averages*. Slightly higher levels are recorded during the winter period compared to the summer period. Historically, highest rainfall occurs in October, with an average of 94 mm and the lowest in April with an average of 59 mm. The precipitation occurring in the winter periods tends to be associated with more prolonged Atlantic frontal weather depressions passing over the region, compared to the summer when rainfall is more likely to be associated with showery conditions.

(iv) Effects on Climate Change in Ireland

The potential effects of climate change on a global scale have been investigated by the Intergovernmental Panel on Climate Change (IPCC). The predicted impacts in Ireland are outlined in the National Climate Change Strategy and by the Environmental Protection Agency (EPA) and include the following:

- Significant increases in winter rainfall, of the order of 10% in the southeast, with a corresponding increase in the water levels in rivers, lakes and soils. Serious flooding more frequent than at present.
- Lower summer rainfall, of the order of 10%, in the southern half of the country. Less recharge of reservoirs in the summer leading to more regular and prolonged water shortages than at present. Loss of carbon stored in peatlands, due to regular water deficits.
- Increased agricultural production, with new crops becoming more viable and potentially reduced agricultural costs. Grass growth could enjoy beneficial effects with an increase of 20% possible with higher temperatures and changes in rainfall patterns.

It is recognised that Ireland cannot, on its own, prevent or ameliorate the impacts of climate change. However, the National Climate Change Strategy states that Ireland must meet its responsibilities with regard to reducing CO_2 emissions in partnership with the EU and the global community.

Table 8.1: Mullingar Meteorological Station – 30 year averages

1961-1990	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Temperature (°C)													
mean daily max.	6.8	7.2	9.4	11.8	14.7	17.5	19.0	18.6	16.4	13.2	9.1	7.5	**12.6**
mean daily min.	1.2	1.2	2.0	3.3	5.6	8.5	10.3	9.8	8.1	6.1	2.7	2.0	**5.1**
mean	4.0	4.2	5.7	7.5	10.1	13.0	14.7	14.2	12.3	9.7	5.9	4.8	**8.8**
Relative Humidity (%)													
mean at 0900 UTC	92	90	89	83	79	80	82	85	88	91	92	92	**87**
mean at 1500 UTC	85	79	73	68	68	70	70	72	74	79	83	86	**76**
Sunshine (hours)													
mean daily duration	1.73	2.31	3.30	4.83	5.56	5.17	4.57	4.39	3.70	2.74	2.18	1.53	**3.50**
Rainfall (mm)													
Mean monthly total	93.1	66.3	72.3	59.1	72.4	66.2	61.8	81.2	85.9	94.0	88.2	93.8	**934.3**
Mean no. of days >= 0.2 mm	20	17	19	16	17	16	16	18	17	20	18	20	**214**
Wind (knots)													
Mean monthly speed	9.7	9.7	10.0	8.5	8.0	7.4	7.3	7.2	7.6	8.4	8.5	9.3	**8.5**
mean no. of days with gales	0.7	0.6	0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.3	**2.5**

8.2.2 Environmental Impact

(i) Methodology

The impact on climate as a result of the road traffic associated with the proposed development has been determined using the procedures given in Annex 2 in the UK Dept. of Transport Design Manual for Roads and Bridges (Revised 2007), Volume 11, Section 3, Part 1, Air Quality. The Annex provides a method for the prediction of the regional impact of CO_2 emissions from road schemes.

(ii) Construction Phase

There is the potential for a number of emissions to atmosphere during the construction phase of the project. Construction vehicles, generators etc., may give rise to CO_2 and N_2O emissions. It is estimated that the number of vehicles accessing the site will be a daily maximum of 40 HGVs during the construction phase in addition to 480 staff vehicles. This will lead to an annual emission of 2,230 tonnes of CO_2 during the construction phase, which is equivalent to 0.0035% of the projected national emissions in Ireland in 2010. With reference to relevant evaluation criteria, such as the Kyoto Protocol, which has set objectives to be achieved by 2008 – 2012, GHG emissions during the construction of the proposed development will be negligible.

(iii) Operational Phase

Road traffic would be expected to be the dominant incidental sources of greenhouse gas emissions as a result of the proposed development. Vehicles used onsite will give rise to CO_2 and N_2O emissions as a result of the proposed development. It is expected that the number of vehicles accessing the site will be a peak hour maximum of 59 vehicles in 2014. This will lead to the emission of 1,233 tonnes of CO_2 per annum which is equivalent to 0.0020% of the projected national emissions in Ireland in 2010. With reference to relevant evaluation criteria such as the Kyoto Protocol, which has set objectives to be achieved in the period 2008 – 2012, GHG emissions from vehicular traffic will be negligible.

The proposed power plant will consist of two generating units located on the site at Derrygreenagh. These are a flexible combined cycle gas turbine unit (CCGT) of c. 430 MW and a reserve/peaking open cycle gas turbine unit (OCGT) of c. 170 MW. The primary fuel source for the CCGT unit will be natural gas with distillate stored onsite as a back up fuel as required by the Commission for Energy Regulation’s (CER) Secondary Fuelling Obligation. The OCGT unit will be capable of dual firing, running on either natural gas or distillate.

Process emissions of CO_2 will occur from the operation of the power plant. The CCGT unit will have a CO_2 emission rate of approximately 0.36 tonnes CO_2/MWh when fired on natural gas. The OCGT unit will have a CO_2 emission rate of approximately 0.6 tonnes CO_2/MWh when fired on natural gas and 0.8 t CO_2/MWh when fired on distillate. In the unlikely event that both units operated at full capacity for a year at maximum output, CO_2 emissions would amount to 1.36 million tonnes and 0.89 million tonnes from the CCGT and OCGT units respectively, when fired on natural gas.

However, it is estimated that the average life cycle load factor for the CCGT unit will be in the region of 40%- 60%. Based on this load factor range, the estimated annual CO_2 emissions will be in the range of 543,000 - 814,000 tonnes CO_2.

It is estimated that the annual load factor for the OCGT unit will be less than 5%. Based on this load factor, the worst case annual CO_2 emissions will be 45,000 tonnes CO_2 when fired on natural gas, or 60,000 tonnes CO_2 when fired on distillate.

It is more appropriate to compare the carbon intensity of these units, i.e. the amount of CO_2 emitted per unit of electricity generated, with other primary fuels, than to compare annual emission levels. The carbon intensity of a number of different generator types and primary fuel combinations is given in Table 8.2 *Comparison of Carbon Intensity of Various Primary Fuels and Generator Configurations* below. Coal-fired power stations have a CO_2 emission rate which is 2.5 times higher per MWh than a CCGT unit fired on natural gas; peat is three times higher per MWh whilst Heavy Fuel Oil is twice as high per MWh.

The dominant primary fuels, on which the electricity generating system currently relies, are gas (54%), coal (22%) and oil (7%) based on 2007 figures. Gas and coal accounts for 69% of dispatchable installed capacity and 76% of generation in 2007. The Government in the Energy White Paper, *Delivering a Sustainable Energy Future for Ireland (2007)*, has set a 33% target for renewable electricity by 2020. This target for renewable electricity was recently increased to 40%. Even if the level of installed renewable capacity increases to achieve the Government target by 2020, new sources of conventional generating plants will also be required due to: (i) the intermittency and low capacity credit attributed to installed wind capacity; (ii) the increasing demand for electricity; and (iii) the age and technology mix of the current generation portfolio in Ireland. New conventional power plant will be required to be flexible in nature, to complement the intermittent and variable nature of wind, thus allowing the Government's RES-E target of 40% to be achieved by 2020. Gas fired generating plant provides the level of flexibility required to ensure system security standards are met where high levels of wind generation are connected to the system. The proposed development is thus more favourable from a climatic point of view than oil, coal or peat-fired power stations.

Table 8.2: Comparison of Carbon Intensity of Various Primary Fuels and Generator Configurations

Station Configuration	Typical Cycle Efficiency	Primary Fuel	Fuel Emission Factor (Note 1)	Carbon Intensity of Electricity Generator
			kg CO_2/MWh $_{th}$	kg CO_2/MWh $_{el}$
Combined Cycle Gas Turbine	57%	Natural Gas	205	359
Open Cycle Gas Turbine	34%	Natural Gas	205	601
Combined Cycle Gas Turbine	56%	Distillate	264	471
Open Cycle Gas Turbine	33%	Distillate	264	800
Boiler & steam Turbine	38%	Heavy Fuel Oil	274	720
Boiler & steam Turbine	38%	Coal	341	896
Boiler & steam Turbine	38%	Peat	420	1105

Note 1: Source: http://www.sei.ie/Publications/Statistics_Publications/Emission_Factors/

8.2.3 Mitigation Measures

(i) Construction Phase Mitigation

No mitigation measures are deemed necessary.

(ii) Operational Phase Mitigation

This plant will operate under the EU Emissions Trading Scheme, (EU ETS) until 2020 and will thus will need to secure a Greenhouse Gas Emissions Permit from the EPA.. It is expected that the EU ETS will be extended beyond 2020 under international agreement. No additional mitigation measures are deemed necessary.

8.2.4 Residual Impacts

The residual impact on climate from the operation of the proposed development will be very low, due to the comparatively low emission of greenhouse gases and the support offered by the development for the generation of electricity from intermittent renewable sources, as described in Chapter 2, *Background to the Project*.

8.3 Air Quality

8.3.1 General Air Quality – Existing Environment

A detailed baseline assessment was undertaken for PM_{10}, (particulate matter <10 µm), NO_2, SO_2 and benzene at a range of locations around Derrygreenagh, Co. Offaly. Ambient PM_{10} concentrations were measured over a six month period from January 2008 to August 2008, over successive 24-hour periods, using a sequential air sampler. This section details the results obtained over the six-month monitoring period and compares them with the relevant EU Limit values. Ambient NO_2, SO_2 and Benzene concentrations were measured during a three month period, from January 2008 to April 2008, over three successive 4-week periods using diffusion tubes. This section also details the results obtained and compares them with the relevant EU limit values.

(i) Meteorological Environment

Wind speed is of key importance in dispersing air pollutants and, for low level sources, such as vehicle emissions, pollutant concentrations are inversely related to wind speed. Thus, existing air concentrations will be greatest under very calm conditions and low wind speeds when movement of air is restricted. The frequency of these conditions is low. Data from the nearby meteorological station at Casement Aerodrome has been examined to identify the wind field pattern which will be indicative of conditions likely at Derrygreenagh. For data collated during five representative years, from 2003 to 2007, predominant wind directions ranged from westerly to south-westerly, with average wind speeds of approximately 3-5 m/s with a frequency of calms of 2%.

(ii) Baseline Air Quality

PM_{10}

The PM_{10} monitoring program, using a PM_{10} continuous monitor, focused on assessing 24-hour average concentrations over a six-month period at a monitoring station located on-site - see location M7 on Figure 8.1 *Baseline Air Monitoring Locations*. PM_{10} sampling was carried out by means of an R&P Partisol®-Plus Sequential Air Sampler, Model 2025. The sampler is a manual air sampling platform which has been designed to meet US EPA Reference Designation (RFPS-1298-127). Approximately 24 m^3 of air was sampled daily through a size selective inlet, which removed particles with a diameter >10 µm. The remaining particles <10 µm were collected on pre-weighed 47 mm diameter filters. The Partisol® sampler was programmed to automatically replace each sampled filter by a new pre-weighed filter at midnight. This ensured that each filter represented a sampling period of exactly 24 hours. Gravimetric determination was carried out pre- and post-sampling at a UKAS accredited laboratory, Bureau Veritas, UK. The gravimetric results allowed the calculation of the average PM_{10} concentration over each 24-hour period. The results, which are shown in Table 8.3 *Measured PM_{10} Ambient Concentrations at the On-Site Monitoring Station*, can be indicatively compared with the 24-hour limit value, which is set as a 90^{th} %ile, and the six-month average can be indicatively compared with the annual limit value.

Table 8.3: Measured PM_{10} Ambient Concentrations at the On-Site Monitoring Station

Date	**PM_{10} (µg/m^3)**	**Date**	**PM_{10} (µg/m^3)**	**Date**	**PM_{10} (µg/m^3)**
27-Jan-08	15	27-Feb-08	17	02-Apr-08	19
28-Jan-08	24	29-Feb-08[2]	11	03-Apr-08	17
29-Jan-08	13	01-Mar-08	16	04-Apr-08	15
30-Jan-08	10	03-Mar-08[2]	8	05-Apr-08	11
31-Jan-08	16	06-Mar-08[2]	13	06-Apr-08	10
01-Feb-08	12	07-Mar-08	12	07-Apr-08	13
02-Feb-08	12	08-Mar-08	8	08-Apr-08	12
03-Feb-08	9	09-Mar-08	8	09-Apr-08	15
04-Feb-08	9	10-Mar-08	7	10-Apr-08	8
05-Feb-08	6	11-Mar-08	16	11-Apr-08	8
06-Feb-08	13	12-Mar-08	11	12-Apr-08	6
07-Feb-08	15	13-Mar-08	7	13-Apr-08	9
08-Feb-08	19	14-Mar-08	13	14-Apr-08	13
09-Feb-08	24	15-Mar-08	14	15-Apr-08	13
10-Feb-08	29	16-Mar-08	7	16-Apr-08	21
11-Feb-08	50	17-Mar-08	11	17-Apr-08	31
12-Feb-08	48	18-Mar-08	13	18-Apr-08	27
13-Feb-08	41	19-Mar-08	8	19-Apr-08	36
14-Feb-08	47	20-Mar-08	8	20-Apr-08	35
15-Feb-08	46	21-Mar-08	22	21-Apr-08	29
16-Feb-08	48	22-Mar-08	10	22-Apr-08	31
17-Feb-08	48	23-Mar-08	10	23-Apr-08	16
18-Feb-08	**55**	24-Mar-08	8	24-Apr-08	14
19-Feb-08	**62**	25-Mar-08	12	25-Apr-08	13
20-Feb-08	**58**	26-Mar-08	10	26-Apr-08	14
21-Feb-08	10	27-Mar-08	13	27-Apr-08	14
22-Feb-08	24	28-Mar-08	8	28-Apr-08	10
23-Feb-08	11	29-Mar-08	9	29-Apr-08	11
24-Feb-08	12	30-Mar-08	9	30-Apr-08	17
25-Feb-08	14	31-Mar-08	9	01-May-08	13
26-Feb-08	19	01-Apr-08	27	02-May-08	12
Annual Average Ambient Air Quality Standard				40[(1)]	

(1) Council Directive 1999/30/EC
(2) There is no available data for missing dates.

Date	PM_{10} ($\mu g/m^3$)	Date	PM_{10} ($\mu g/m^3$)	Date	PM_{10} ($\mu g/m^3$)
03-May-08	23	02-Jun-08	15	29-Jun-08	15
04-May-08	12	03-Jun-08	23	30-Jun-08	18
05-May-08	10	04-Jun-08	10	01-Jul-08	13
06-May-08	31	05-Jun-08	18	02-Jul-08	13
07-May-08	42	06-Jun-08	11	03-Jul-08	12
08-May-08	37	07-Jun-08	12	04-Jul-08	12
09-May-08	16	08-Jun-08	9	05-Jul-08	12
10-May-08	19	09-Jun-08	20	06-Jul-08	10
11-May-08	20	01-Jun-08	19	07-Jul-08	14
12-May-08	44	02-Jun-08	15	08-Jul-08	15
13-May-08	38	10-Jun-08	18	09-Jul-08	14
14-May-08	32	11-Jun-08	8	10-Jul-08	11
15-May-08	34	12-Jun-08	9	11-Jul-08	13
16-May-08	28	13-Jun-08	16	12-Jul-08	11
17-May-08	22	14-Jun-08	17	13-Jul-08	11
18-May-08	13	15-Jun-08	9	14-Jul-08	11
19-May-08	18	16-Jun-08	19	15-Jul-08	16
20-May-08	21	17-Jun-08	20	16-Jul-08	18
21-May-08	29	18-Jun-08	7	17-Jul-08	12
22-May-08	24	19-Jun-08	9	18-Jul-08	8
23-May-08	25	20-Jun-08	12	19-Jul-08	13
24-May-08	25	21-Jun-08	10	20-Jul-08	12
25-May-08	**98**	22-Jun-08	10	21-Jul-08	15
26-May-08	**54**	23-Jun-08	12	22-Jul-08	11
27-May-08	20	24-Jun-08	8	23-Jul-08	17
28-May-08	19	25-Jun-08	16	24-Jul-08	28
29-May-08	14	26-Jun-08	10	25-Jul-08	25
30-May-08[2]	24	27-Jun-08	13		
01-Jun-08	19	28-Jun-08	16		
Average				**18**	
Annual Average Ambient Air Quality Standard				40[(1)]	

(1) Council Directive 1999/30/EC

(2) There is no available data for missing dates

NO_2

Background levels of NO_2 were monitored using nitrogen dioxide passive diffusion tubes over three four-week periods at eight locations in the region of the proposed development - see locations M1-M8 on Figure 8.1 *Baseline Air Monitoring Locations*. The locations selected allow an assessment of both roadside and typical residential exposure at locations in the region of the development. A background sample was also located on the nearby Black Castle Bog NHA, in order to determine existing compliance with the NO_X (NO + NO_2) Ambient Air Quality Standard for the protection of vegetation. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of NO_2 concentration in the region. The spatial variation is particularly important for NO_2, as a complex relationship exists between NO, NO_2 and O_3, leading to a non-linear variation of NO_2 concentrations with distance. Additional sampling was undertaken in Rochfortbridge at four locations as outlined in Figure 8.1B *Baseline Air Monitoring Locations in Rochfortbridge.,* These locations, M9-M12, were used to ascertain the prevailing baseline levels of NO_2 in the Rochfortbridge urban environment.

Studies in the UK have shown that diffusion tube monitoring results generally have a positive or negative bias when compared to continuous analysers. This bias is laboratory specific and is dependent on the specific analysis procedures at each laboratory. The diffusion tube bias for the Bureau Veritas laboratory, of 0.87 based on 2006 data, was obtained from the UK Air Quality Review and Assessment website (www.uwe.ac.uk/aqm/review) and applied to the diffusion tube monitoring results.

SO_2

Background levels of SO_2 were monitored using sulphur dioxide passive diffusion tubes over three four-week periods at four locations in the region of the proposed development - see Locations M1, M4, M5, M7 on Figure 8.1 *Baseline Air Monitoring Locations*. The locations allow an assessment of both roadside and typical residential exposure at locations in the region of the development. A background sample was also located on the nearby Black Castle Bog NHA, in order to determine existing compliance with the SO_2 Ambient Air Quality Standard for the protection of ecosystems. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of SO_2 concentration in the region. Additional sampling was undertaken in Rochfortbridge at two locations as outlined in Figure 8.1B *Baseline Air Monitoring Locations in Rochfortbridge.* Locations M9 & M11 were selected to ascertain the prevailing baseline levels of SO_2 in the Rochfortbridge urban environment.

Benzene

Background levels of benzene were monitored using benzene passive diffusion tubes over three four-week periods at four locations in the region of the proposed development - see Locations M1, M2, M4, and M7 on Figure 8.1 *Baseline Air Monitoring Locations*. The locations allow an assessment of both roadside and typical residential exposure at locations in the region of the development. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of benzene concentration in the region. Additional sampling was undertaken in Rochfortbridge at two locations as outlined in Figure 8.1B *Baseline Air Monitoring Locations in Rochfortbridge.,* Locations M9 & M11 were selected to ascertain the prevailing baseline levels of benzene in Rochfortbridge.

(iii) Ambient Air Quality Compliance Criteria

PM_{10}

Directive 2008/50/EC on ambient air quality and cleaner air for Europe, published on 11/06/08, has set 24-hour and annual limit values for PM_{10} - see Table 8.4 *EU Council Directive 2008/50/EC*. A 24-hour limit of 50 µg/m^3 is set as a 90th %ile, i.e. it must not be exceeded more than 35 times per year. EU Directive 2008/50/EC has also set an annual limit value of 40 µg/m^3.

The Directive has also set out a new ambient standard for $PM_{2.5}$. The approach adopted is to establish a limit value for $PM_{2.5}$ of 25 µg/m^3, as an annual average, to be attained by 2015, coupled with a target to reduce human exposure generally to $PM_{2.5}$ between 2010 and 2020 - see Table 8.4 *EU Council Directive 2008/50/EC*.

Table 8.4: EU Council Directive 2008/50/EC

Pollutant	Regulation Note 1	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	40% until 2003 reducing linearly to 0% by 2010	200 µg/m^3 NO_2
		Annual limit for protection of human health	40% until 2003 reducing linearly to 0% by 2010	40 µg/m^3 NO_2
		Annual limit for protection of vegetation	None	30 µg/m^3 $NO + NO_2$
Lead	2008/50/EC	Annual limit for protection of human health	100%	0.5 µg/m^3
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	150 µg/m^3	350 µg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 µg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 µg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50%	50 µg/m^3 PM_{10}

Pollutant	Regulation Note 1	Limit Type	Margin of Tolerance	Value
		Annual limit for protection of human health	20%	40 µg/m^3 PM_{10}
$PM_{2.5}$ (Stage 1)	2008/50/EC	Annual limit for protection of human health	20% from June 2008. Decreasing linearly to 0% by 2015	25 µg/m^3 $PM_{2.5}$
$PM_{2.5}$ (Stage 2) Note 2	-	Annual limit for protection of human health	None	20 µg/m^3 $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 µg/m^3
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	60%	10 mg/m^3 (8.6 ppm)

Note 1 *EU Council Directive 2008/50/EC* replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 EU Council Directive 2008/50/EC states - 'Stage 2 — indicative limit value to be reviewed by the Commission in 2013 in the light of further information on health and environmental effects, technical feasibility and experience of the target value in Member States'

NO_2

EU Council Directive 2008/50/EC has set 1-hour and annual limit values for NO_2. An hourly limit of 200 µg/m^3 has been set, which must not be exceeded more than 18 times per year (99.8th%ile). The annual limit value is 40 µg/m^3 - see Table 8.4 *EU Council Directive 2008/50/EC.*

An annual average limit for NO_X (NO and NO_2) is applicable for the protection of vegetation in highly rural areas, away from major sources of NO_X such as large conurbations, factories and high road vehicle activity, such as a dual carriageway or motorway. Annex VI of EU Directive 1999/30/EC identifies that monitoring, to demonstrate compliance with the NO_X limit for the protection of vegetation, should be carried out at distances greater than:

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

As a guideline, a monitoring station should be indicative of approximately 1000 km^2 of surrounding area. Due to the presence of several National Heritage Areas (NHAs) nearby, the annual NO_X limit value has been applied in the region of the NHAs.

Benzene

EU Council Directive 2008/50/EC, which has been adopted into Irish Legislation, has set an annual limit value of 5 µg/m^3 for benzene - see Table 8.4 *EU Council Directive 2008/50/EC*. A margin of tolerance of 40% applied during the monitoring study. This will reduce linearly to reach 0% by 2010.

SO_2

EU Council Directive 2008/50/EC has set hourly, daily and annual limit values for SO_2 - see Table 8.4 *EU Council Directive 2008/50/EC*. The hourly limit value is 350 µg/m^3 which must not be exceeded more than 25 times per year (99.7th %ile). The 24-hour limit value, which is expressed as a 99.2nd %ile, is 125 µg/m^3. The annual limit value for the protection of ecosystems is 20 µg/m^3.

(iv) Results and Discussion

PM_{10}

Daily concentrations of PM_{10}, measured using the sequential PM_{10} sampler, are shown in Figure 8.2 *Baseline PM_{10} Results* and Table 8.3 *Measured PM_{10} Ambient Concentrations at the On-Site Monitoring Station*,. The 24-hour PM_{10} concentrations measured over the six-month period are significantly below the 24-hour EU limit value of 50 µg/m^3 which is applicable since 2005.

Five exceedances of the 24-hour limit value were recorded over the six month monitoring campaign. The 90th %ile, which means the 36th highest 24-hour value measured over a full year, is compared to the limit value. The 90th %ile of 24-hour concentrations during the monitoring period was 35 µg/m^3. Since only five exceedances were recorded over the six-month monitoring survey, it is unlikely that 35 exceedances would occur over 365 days at the current location.

The average PM_{10} concentration measured over the six-month period is 18 µg/m^3 which is 45% of the EU annual limit value of 40 µg/m^3, which has been applicable since 2005.

NO_2

Nitrogen dioxide (NO_2) results are presented in Table 8.5 *Average NO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured by Passive Diffusion Tubes*. The NO_2 diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 40 µg/m^3 for the protection of human health. The average NO_2 concentrations measured over the three month period at each location ranged from 5 - 10 µg/m^3, which are between 13 - 25% of the EU annual limit value of 40 µg/m^3. The additional survey centred in Rochfortbridge - See Table 8.5 B *Average NO_2 Concentrations in Rochfortbridge, During the Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes*, reported levels ranging from 6-10 µg/m^3, which are between 15-25% of the EU annual limit value of 40 µg/m^3.

SO_2

Sulphur dioxide (SO_2) results are presented in Table 8.6 *Average SO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured by Passive Diffusion Tubes*. The SO_2 diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 20 $\mu g/m^3$ for the protection of vegetation. The average SO_2 concentrations measured over the three month period at each location ranged from 1.3 - 3.2 $\mu g/m^3$, which are between 7 - 16% of the EU annual limit value of 20 $\mu g/m^3$. The additional survey centred in Rochfortbridge - See Table 8.6B *Average SO2 Concentrations In Rochfortbridge, During The Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes*, reported levels ranging from 0.3-0.9 $\mu g/m^3$, which are between 2-5% of the EU annual limit value of 20 $\mu g/m^3$.

Benzene

Benzene results are presented in Table 8.7 *Average Benzene Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured By Passive Diffusion Tubes*. The benzene diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 5 $\mu g/m^3$ for the protection of human health. The average benzene concentrations measured over the three month period at each location ranged from 0.5 - 0.8 $\mu g/m^3$, which is between 9 - 16% of the EU annual limit value of 5 $\mu g/m^3$. The additional survey centred in Rochfortbridge - See Table 8.7B *Average Benzene Concentrations In Rochfortbridge, During The Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes,* reported levels peaking at 0.6 $\mu g/m^3$, which are 12% of the EU annual limit value of 5 $\mu g/m^3$.

(v) Summary

Ambient PM_{10} concentrations were measured over a six month period, from January 2008 to August 2008, over successive 24-hour periods using a sequential air sampler. The 24-hour PM_{10} concentrations measured over the six-month survey period are below the 24-hour EU limit value of 50 $\mu g/m^3$. Five exceedances of the 24-hour limit value were recorded over the monitoring campaign. The 90^{th} %ile of 24-hour concentrations during the monitoring period was 35 $\mu g/m^3$. The average PM_{10} concentration measured over the six-month period was 18 $\mu g/m^3$ which is 45% of the EU annual limit value of 40 $\mu g/m^3$.

Ambient NO_2, SO_2 and Benzene concentrations were measured during a three month period, from January 2008 to April 2008, over three successive 4-week periods using diffusion tubes. This report details the results obtained and compares them with the relevant EU Limit Values.

The NO_2 diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 40 $\mu g/m^3$ for the protection of human health. The average NO_2 concentration measured over the three month period at each location ranged from 5 - 10 $\mu g/m^3$, which is between 13 - 25% of the EU annual limit value of 40 $\mu g/m^3$.

The SO_2 diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 20 $\mu g/m^3$ for the protection of vegetation. The average SO_2 concentration measured over the three month period at each location ranged from 1.3 - 3.2 $\mu g/m^3$, which is between 7 - 16% of the EU annual limit value of 20 $\mu g/m^3$.

The benzene diffusion tube concentrations measured over the three-month survey period are below the annual EU limit value of 5 µg/m^3 for the protection of human health. The average benzene concentration measured over the three month period at each location ranged from 0.5 - 0.8 µg/m^3, which is between 9 - 16% of the EU annual limit value of 5 µg/m^3.

In summary, existing baseline levels of PM_{10}, NO_2, SO_2 and benzene are low and significantly below the ambient air quality standards in the region of Derrygreenagh.

Table 8.5: Average NO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured By Passive Diffusion Tubes.

Location	Period One (25/01/08 - 22/02/08) (μg/m³)	Period Two (22/02/08 - 21/03/08) (μg/m³)	Period Three (21/03/08 - 18/04/08) (μg/m³)	3-Months NO_2 Average (μg/m³)	3-Month Adjusted NO_2 Average (μg/m³)(2)
M1	15	5	1	7.0	**6.1**
M2	22	6	2	10.0	**8.7**
M3	10	5	3	6.0	**5.2**
M4	-(1)	7	6	6.5	**5.7**
M5	14	2	8	8.0	**7.0**
M6	7	6	11	8.0	**7.0**
M7	10	3	6	6.3	**5.5**
M8	16	12	7	11.7	**10.2**
Limit Value					**40 μg/m³(3)**

(1) Samples were tampered with.
(2) Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology (Bias = 0.87).
(3) EU Council Directive 1999/30/EC (as an annual average).

Table 8.5B: Average NO_2 Concentrations In Rochfortbridge, During The Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes.

Location	Period One (13/08/08 - 12/09/08) (μg/m³)	Period Two (12/09/08 - 09/10/08) (μg/m³)	Period Three (09/10/08 - 06/11/08) (μg/m³)	3-Month NO_2 Average (μg/m³)	3-Month Adjusted NO_2 Average (μg/m³)(2)
M9	-(1)	-(1)	8	8	**7**
M10	9	-(1)	11	10	**9**
M11	-(1)	-(1)	7	7	**6**
M12	-(1)	11	11	11	**10**
Limit Value					**40 μg/m³(3)**

(1) Samples were tampered with
(2) Diffusion tube monitoring bias adjustment carried out based on UK DEFRA methodology (Bias = 0.87).
(3) EU Council Directive 1999/30/EC (as an annual average).

Table 8.6: Average SO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured By Passive Diffusion Tubes.

Location	**Period One (25/01/08 - 22/02/08) ($\mu g/m^3$)**	**Period Two (22/02/08 - 21/03/08) ($\mu g/m^3$)**	**Period Three (21/03/08 - 18/04/08) ($\mu g/m^3$)**	**3-Month SO_2 Average (□g/m^3)**
M1	1.7	1.4	4.9	**2.7**
M4	-(1)	0.5	2.2	**1.3**
M5	8.3	0.0	1.3	**3.2**
M7	3.0	0.7	1.6	**1.8**
Limit Value				**20 $\mu g/m^3$(2)**

(1) Samples were tampered with
(2) EU Council Directive 1999/30/EC (as an annual average for the protection of ecosystems).

Table 8.6B Average SO_2 Concentrations In Rochfortbridge, During The Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes.

Location	**Period One (13/08/08 - 12/09/08) ($\mu g/m^3$)**	**Period Two (12/09/08 - 09/10/08) ($\mu g/m^3$)**	**Period Three (09/10/08 - 06/11/08) ($\mu g/m^3$)**	**3-Month SO_2 Average ($\mu g/m^3$)**
M9	-(1)	-(1)	0.3	**0.3**
M11	-(1)	-(1)	0.9	**0.9**
Limit Value				**20 $\mu g/m^3$(2)**

(1) Samples were tampered with.
(2) EU Council Directive 1999/30/EC (as an annual average for the protection of ecosystems).

Table 8.7: Average Benzene Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured By Passive Diffusion Tubes.

Location	Period One (25/01/08 - 22/02/08) (μg/m^3)	Period Two (22/02/08 - 21/03/08) (μg/m^3)	Period Three (21/03/08 - 18/04/08) (μg/m^3)	3-Month Benzene Average (μg/m^3)
M1	1.0	0.6	-[1]	**0.8**
M2	0.8	0.2	0.4	**0.5**
M4	-[1]	0.7	0.4	**0.6**
M7	1.2	0.6	0.4	**0.7**
Limit Value				**5 μg/m^3[2]**

(1) Samples were tampered with
(2) EU Council Directive 2000/69/EC (as an annual average).

Table 8.7B Average Benzene Concentrations In Rochfortbridge, During The Period August 2008 - November 2008, As Measured By Passive Diffusion Tubes.

Location	Period One (13/08/08 - 12/09/08) (μg/m^3)	Period Two (12/09/08 - 09/10/08) (μg/m^3)	Period Three (09/10/08 - 06/11/08) (μg/m^3)	3-Month Benzene Average (μg/m^3)
M9	-[1]	-[1]	0.6	**0.6**
M11	-[1]	-[1]	0.6	**0.6**
Limit Value				**5 μg/m^3[2]**

(1) Samples were tampered with
(2) EU Council Directive 2000/69/EC (as an annual average).

(vi) Available Background Data

Continuous air quality monitoring programs are currently carried out in Ireland by the EPA and by the Local Authorities. The most recent annual report on air quality entitled “Air Quality in Ireland 2007”, details the range and scope of monitoring undertaken throughout Ireland.

As part of the implementation of the Framework Directive on Air Quality (1996/62/EC), four air quality zones have been defined in Ireland for air quality management and assessment purposes. Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 16 towns with a population of greater than 15,000. The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D. In terms of air monitoring, Derrygreenagh is categorised as Zone D.

Long-term NO_2 monitoring is carried out at the two rural Zone D locations, Glashaboy and Kilkitt. The NO_2 annual average in 2007 for both sites was 9 and 2 $\mu g/m^3$, respectively. The results of NO_2 monitoring carried out at the urban Zone D locations in Navan and Ferbane in 2007 indicated average NO_2 concentrations of 16 and 6 $\mu g/m^3$, with no exceedances of the 1-hour limit value. Furthermore, average NO_2 concentrations measured at Limerick, Ennis and Waterford in 2007 (Zone C locations) ranged from 14 to 18 $\mu g/m^3$ respectively. Hence long-term average concentrations measured at these locations were significantly lower than the annual average limit value of 40 $\mu g/m^3$. Based on the above information and the results from the on-site survey - see Table 8.5 *Average NO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured by Passive Diffusion Tubes*, a conservative estimate of the background NO_2 concentration for Derrygreenagh in 2008 is 10 $\mu g/m^3$. This value is used in Table 8.8 *Background levels used in the dispersion modelling.*

Long-term SO_2 monitoring is carried out at the two rural Zone D locations, Shannon Estuary and Kilkitt. The average levels measured in 2007 were 3 and 2 $\mu g/m^3$ respectively, with no exceedances of the 1-hour or 24-hour limit values. The results of SO_2 monitoring carried out in Ferbane and Navan in 2007 (urban Zone D) showed no exceedances of the 1-hour or 24-hour limit values, with average levels of 5 and 4 $\mu g/m^3$. Data for the Zone C stations in Ennis and Waterford in 2007 indicated averages of 10 and 4 $\mu g/m^3$ respectively. Based on the above information and the results from the on-site survey - see Table 8.6 *Average SO_2 Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured by Passive Diffusion Tubes*, a conservative estimate of the background SO_2 concentration for Derrygreenagh in 2008 is 5 $\mu g/m^3$. This is used in Table 8.8 *Background levels used in the dispersion modelling*.

The results of long-term PM_{10} measurements carried out at the urban Zone D stations of Drogheda, Navan, Ferbane and Castlebar in 2007 gave average levels of 14 - 23 $\mu g/m^3$. Furthermore, data for the Zone C locations Galway, Ennis and Waterford in 2007 indicated averages of 16 - 36 $\mu g/m^3$. Data from the Phoenix Park provides a good indication of urban background levels, with an annual average in 2007 of 12 $\mu g/m^3$. Based on the above information and the results from the on-site survey - see Table 8.3 *Measured PM_{10} Ambient Concentrations at the On-Site Monitoring Station*, a conservative estimate of the background PM_{10} concentration for Derrygreenagh in 2008 of 18 $\mu g/m^3$ has been used as shown in Table 8.8 *Background levels used in the dispersion modelling*.

The results of $PM_{2.5}$ monitoring in Old Station Road in Cork in 2007 indicated a $PM_{2.5}/PM_{10}$ ratio of 0.53. Based on this information, a conservative ratio of 0.6 was used to generate a background $PM_{2.5}$ concentration in 2008 of 11 $\mu g/m^3$.

With regard to benzene, continuous monitoring was carried out at Ennis and Bray in 2006, with a long-term averages of 0.6 and 0.3 µg/m^3 respectively. The results of monitoring carried out in the Zone C location of Waterford in 2007 indicated a long-term average of 0.8 µg/m^3. Based on the above information and the results from the on-site survey - see Table 8.7 *Average Benzene Concentrations in the Region of Derrygreenagh, During the Period January 2008 - April 2008, As Measured By Passive Diffusion Tubes*, a conservative estimate of the background benzene concentration for Derrygreenagh in 2008 is 0.8 µg/m^3.

In order to obtain the predicted environmental concentration (PEC), background concentration levels were added to the process emissions. In relation to the annual averages, the ambient background concentration was added directly to the process concentration. However, in relation to the short-term peak concentrations, concentrations due to emissions from elevated sources cannot be combined in the same way. Recent guidance from the UK Environment Agency advises that an estimate of the maximum combined pollutant concentration can be obtained as shown below for each of the relevant pollutants (NO_2, SO_2 and PM_{10}):

NO_2 - The 99.8th%ile of total NO_2 is equal to the minimum of either a) or b) below:

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

b) The maximum of either:

- 99.8th%ile process contribution NO_X + 2 x (annual mean background NO_2); or
- 99.8th%ile hourly background NO_2 + 2 x (annual mean process contribution NO_x).

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

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

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

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

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

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

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

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

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

The above formulae were used to derive the appropriate background concentrations which were subsequently used in the assessment of the impact of the facility on the surrounding environment. The appropriate background concentrations, for both the short-term and annual mean averaging periods, are shown in Table 8.8 *Background levels used in the dispersion modelling.*

Table 8.8: Background levels used in the dispersion modelling

Substance	ANNUAL MEAN BACKGROUND CONCENTRATION ($\mu g/m^3$)	MAXIMUM 1-HR BACKGROUND CONCENTRATION ($\mu g/m^3$)
NO_2	10	20
SO_2	5	10
PM_{10}	18	35 Note 1
$PM_{2.5}$	11	-
Benzene	0.8	-

Note 1 PM_{10} short term background refers to a 24-hr averaging period (as a 90^{th}%ile).

8.3.2 Environmental Impact

(i) Impact Methodology

In line with the EPA Guidelines (EPA 2002), the following terms are defined when quantifying duration:

- Temporary: up to 1 year
- Short-term: from 1-7 years
- Medium-term: 7-15 years
- Long-term: 15-60 years
- Permanent: over 60 years

The impact of the development should also be assessed in terms of the relative additional contribution of the development, expressed as a percentage of the limit value. Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the National Roads Authority document "*Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes*" details a methodology for determining air quality impact significance criteria for road schemes. The degree of impact is determined based on both the absolute and relative impact of the development. The NRA significance criteria have been adopted for the current development and are detailed in Table 8.9 *Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations* and Table 8.10 *Air Quality Impact Significance Criteria*. The significance criteria are based on PM_{10} and NO_2, as these pollutants are most likely to exceed the limit values. However, the criteria have also been applied to the predicted 8-hour carbon monoxide (CO), annual benzene and annual $PM_{2.5}$ concentrations for the purposes of this assessment.

Table 8.9: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO_2 / PM_{10}	Days PM_{10} > 50 µg/m^3
Very Large	Increase / decrease >25%	Increase / decrease >25 days
Large	Increase / decrease 15-25%	Increase / decrease 15-25 days
Moderate	Increase / decrease 10-15%	Increase / decrease 10-15 days
Small	Increase / decrease 5-10%	Increase / decrease 5-10 days
Very Small	Increase / decrease 1-5%	Increase / decrease 1-5 days
Extremely Small	Increase / decrease <1%	Increase / decrease <1 days

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2006)

Table 8.10: Air Quality Impact Significance Criteria

Absolute Concentration in Relation to Standard Note 1	**Change in Concentration**					
	Extremely Small	**Very Small**	**Small**	**Moderate**	**Large**	**Very Large**
Decrease with Scheme						
Above Standard with Scheme	slight beneficial	slight beneficial	substantial beneficial	substantial beneficial	very substantial beneficial	very substantial beneficial
Above Standard in Do-min, Below with Scheme	slight beneficial	moderate beneficial	substantial beneficial	substantial beneficial	very substantial beneficial	very substantial beneficial
Below Standard in Do-min, but not Well Below	negligible	slight beneficial	slight beneficial	moderate beneficial	moderate beneficial	substantial beneficial
Well Below Standard in Do-min	negligible	negligible	slight beneficial	slight beneficial	slight beneficial	moderate beneficial
Increase with Scheme						
Above Standard in Do-min	slight adverse	slight adverse	substantial adverse	substantial adverse	very substantial adverse	very substantial adverse
Below Standard in Do-min, Above with Scheme	slight adverse	moderate adverse	substantial adverse	substantial adverse	very substantial adverse	very substantial adverse
Below Standard with Scheme, but not Well Below	negligible	slight adverse	slight adverse	moderate adverse	moderate adverse	substantial adverse
Well Below Standard with Scheme	negligible	negligible	slight adverse	slight adverse	slight adverse	moderate adverse

Note 1 Well Below Standard = <75% of limit value.
Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2006)

(ii) Air Quality Impact Assessment

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland are the EU Air Quality Directives 1999/30/EC and 2000/69/EC, which have been adopted into Irish Legislation (S.I. No. 271 of 2002) and which supersede existing ambient air quality standards. These directives shall soon be superceded in Irish law by Council Directive 2008/50/EC, published on 11/06/08, which combines the previous air quality framework and subsequent daughter directives - see Table 8.4 *EU Council Directive 2008/50/EC*.

In regards to existing ambient air quality standards, it is not proposed to modify the standards but to strengthen existing provisions to ensure that non-compliances are removed. In addition, new ambient standards for $PM_{2.5}$ are included in Directive 2008/50/EC. The approach for $PM_{2.5}$ is to establish a target value of 25 µg/m^3, as an annual average, to be attained everywhere by 2010, and a limit value of 25 µg/m^3, as an annual average, to be attained everywhere by 2015, coupled with a target to reduce human exposure generally to $PM_{2.5}$ between 2010 and 2020. This exposure reduction target will range from 0%, for $PM_{2.5}$ concentrations of less than 8.5 µg/m^3, to 20% of the average exposure indicator (AEI) for concentrations of between 18 - 22 µg/m^3. Where the AEI is currently greater than 22 µg/m^3, all appropriate measures should be employed to reduce this level to 18 µg/m^3 by 2020. The AEI is based on measurements taken in urban background locations averaged over a three year period from 2008 – 2010, and again from 2018 - 2020. Additionally, an exposure concentration obligation of 20 µg/m^3 has been set to be complied with by 2015, again based on the AEI.

(iii) Construction Phase Impact

Construction activities are likely to generate some dust emissions in the vicinity of the proposed development. Construction vehicles, generators etc., may also give rise to NO_2, PM_{10}, CO_2 and N_2O emissions. The impact on air quality as a result of the construction phase of the development has been determined using the procedures given in Annex 2 of the UK Dept. of Transport's *Design Manual for Roads and Bridges* (Revised 2007), Volume 11, Section 3, Part 1, Air Quality. The results of this assessment are outlined in Table 8.11 *Air Quality Impact due to Traffic Accessing the Facility*. The impact of site traffic is insignificant during the construction phase, based on the ambient concentrations of NO_2, CO, PM_{10}, $PM_{2.5}$ and benzene emissions. Thus, the impact of background concentrations and the additional concentration due to site traffic during the construction phase will lead to levels which are still significantly below the ambient air quality limit values as outlined in S.I. 271 of 2002 and Council Directive 2008/50/EC. Thus, the impact of the proposed development in terms of general air quality is negligible during the construction phase of the development.

(iv) Operational Phase Impact - Traffic

Operational phase impacts are discussed in two parts. The first deals with the emissions from vehicles associated with the operational phase of the proposed development. These include NO_2, SO_2, PM_{10}, $PM_{2.5}$, and benzene. The second part deals with process emissions from the operation of the generating units. The principal emissions from the generating units include NO_2, NO_x, SO_2, PM_{10} and $PM_{2.5}$.

The baseline concentrations of the ambient air pollutants of concern are significantly below the ambient air quality limit values. The impact on air quality as a result of traffic accessing the proposed development has been determined using the procedures given in Annex 2 in the *UK Dept. of Transport Design Manual for Roads and Bridges* (Revised 2007), Volume 11, Section 3, Part 1, Air Quality[(5)]. The results of this assessment are outlined in Table 8.11 *Air Quality Impact due to Traffic Accessing the Facility*. The impact of background concentrations and the additional concentration due to site traffic will lead to levels which are still significantly below the ambient air quality limit values as outlined in S.I. 271 of 2002 both in 2012, 2014 and in 2029. Thus, the impact of vehicular traffic associated with the development, in terms of general air quality, is negligible.

Table 8.11: Air Quality Impact Due to Traffic Accessing the Facility

Pollutant	Averaging Period	Background Concentration In 2012 / 14 (µg/m^3)	Background Concentration In 2029 (µg/m^3)[Note 1]	Ambient Concentration In 2012 (µg/m^3) During The Construction Phase	Ambient Concentration In 2014 (µg/m^3) (Operational)	Ambient Concentration In 2029 (µg/m^3) (Operational)	Air Quality Standard (µg/m^3)
Nitrogen Dioxide	1-Hour	20	20	22.5	21.7	21.7	200
	Annual	10	10	10.5	10.3	10.3	40
Benzene	Annual	0.8	0.8	0.81	0.81	0.81	5
Carbon Monoxide	Maximum 8-Hour	4.0	4.0	4.1	4.1	4.1	10
PM_{10}	24-Hour	-	-	-	-	-	-
	Annual	18	18	18.1	18.1	18.1	40
$PM_{2.5}$	Annual	11	11	11.1	11.1	11.1	25

Note 1 Background concentrations are assumed to remain unchanged in future years as a worst-case.

(v) Air Quality Process Emissions Impact Assessment

Emissions from the proposed OCGT and CCGT units have been modelled using the AERMOD dispersion model, which has been developed by the US Environmental Protection Agency (USEPA). The model is a steady-state Gaussian plume model used to assess pollutant concentrations associated with industrial sources, and has replaced ISCST3 as the regulatory model used by the USEPA for modelling emissions from industrial sources in both flat and rolling terrain since 2006. The model has more advanced algorithms and gives better agreement with monitoring data in extensive validation studies. An overview of the AERMOD dispersion model is outlined in Appendix 5A *Description of the AERMOD Model*.

The air dispersion modelling input data consisted of information on the physical environment, including building dimensions and terrain features, design details from all emission points on-site and a full year of appropriate meteorological data. Using this input data, the model predicted ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological year. The model post-processed the data to identify the location and maximum of the worst-case ground level concentration. This worst-case concentration was then added to the background concentration to give the worst-case predicted environmental concentration (PEC). The PEC was then compared with the relevant ambient air quality standard to assess the significance of the releases from the site.

Throughout this study a worst-case approach was taken. This will most likely lead to an over-estimation of the levels that will arise in practice. The worst-case assumptions are outlined below:

- Maximum predicted concentrations were reported in this study, even if no residential receptors were near the location of this maximum,
- Worst-case background concentrations were used to assess the baseline levels of substances released from the site,
- The stack height determination is based on the use of distillate for both the CCGT and OCGT units for the full year as a worst-case,
- The effects of building downwash, due to on-site and any nearby off-site buildings, have been included in the model using the advanced PRIME module.

Details of Air Dispersion Model

The United States Environmental Protection Agency (USEPA) approved AERMOD dispersion model has been used to predict the ground level concentrations (GLC) of compounds emitted from the principal emission sources on-site.

The modelling incorporated the following features:

- Two Cartesian receptor grids were identified at which concentrations would be modelled. The first extended 8,000 m and the second to 20,000 m from the site. Concentrations were calculated at 100 m and 500 m intervals for the two grids respectively. In addition, boundary receptors locations were placed at the site boundary, giving a total of 8,240 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 downwash and stack tip downwash were incorporated into the modelling.

- AERMOD incorporates a meteorological pre-processor AERMET PRO. The AERMET PRO meteorological pre-processor requires the input of surface characteristics, including surface roughness (z_0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type, e.g., urban, cultivated land etc, and vary with seasons and wind direction - see Appendix 5B *AERMET PRO* for details. The assessment of appropriate land-use type was carried out to a distance of 3 km from the meteorological station location, in line with USEPA recommendations.

- The source and emission data, including stack dimensions, gas volumes and emission temperatures have been incorporated into the model.

- Terrain has been included in the modelling. The immediate area on-site is relatively flat but has some slight changes in terrain. The surrounding grid of 20 km by 20 km is generally characterised by modest terrain features.

Meteorological data collected at Casement Aerodrome meteorological station, located approximately 80 km east of the site, from 2003 to 2007 has been used as input to the model. As part of the sensitivity analysis for the model, Casement Aerodrome was modelled over the five year period from 2003 to 2007, with the worst-case year (2006) used in the assessment - see Appendix 5B *AERMET PRO*.

Long-term hourly observations at Casement Aerodrome station provide an indication of the prevailing wind conditions for the region - see Figure 8.3 *Casement Aerodrome Windrose 2003-2007* for the wind profile over the period 2003 - 2007. Data from Casement is utilised rather than the closer Mullingar meteorological station due to the requirement for cloud cover data as a modelling input, which is available from Casement but not from Mullingar. Results indicate that the main wind direction is from south to westerly in direction with an annual incidence of 53%. The mean wind speed is approximately 5.7 m/s over the period 1968-1996. The incidence of calm conditions is about 2%, with strong winds of over 9 m/s occurring about 10% of the time.

Process Emissions

The information used in the dispersion model for the two main emission points is shown in Table 8.12 *Stack Release Points Used in the Air Modelling*.

Table 8.12: Stack Release Points Used in the Air Modelling

Stack Reference	STACK LOCATION	Stack Height Above Ground Level (m)	Exit Diameter (m)
CCGT Stack	249673E 238325N	50	6.9
OCGT Stack	249730E 238141N	40	5.5

Emission data for the model was taken from design information supplied by Mott McDonald Pettit. Details of the input parameters are given in Table 8.13 *Derrygreenagh OCGT and CCGT Facility – Stack Emission Details* and in more detail in Appendix 5C *Emission Data for Proposed Power Plant Facility, Derrygreenagh, County Offaly.* The emissions of NO_X and PM_{10} are based on maximum levels as outlined in the Large Combustion Plant Directive (2001/81/EC) for gas turbines.

Stack Height Determination

Ambient Ground Level Concentrations (GLCs) of NO_2 have been predicted with the proposed facility in operation, based on various stack heights for the CCGT unit, and based on a constant stack height for the OCGT unit of 40m. The appropriate stack height for the CCGT unit was determined to be 50m, taking a balance between capital costs, visual impact and modelled ground level concentrations. This will result in process emissions from the facility which are less than 30% of the ambient limit value when using distillate for the full year, and less than 12% of the ambient limit value when using natural gas for the full year - See Figure 8.4 *Stack Height Determination*.

Table 8.13: Derrygreenagh OCGT and CCGT Facility – Stack Emission Details

Stack Reference	Temperature (K)	Actual Stack Exit Velocity (m/s)	Stack cross-section area (m^2)	NO_X (mg/Nm^3)	SO_2 (mg/Nm^3)	PM_{10} / $PM_{2.5}$ (mg/Nm^3)	NO_X (g/s)	SO_2 (g/s)	PM_{10} / $PM_{2.5}$ (g/s)
CCGT - Gas	350	24.8	37.4	50			36.2		
CCGT - Distillate	414	31.9	37.4	120	51	5	94.3	40.1	3.9
OCGT - Gas	543	38.8	23.8	50			23.2		
OCGT - Distillate	543	39.1	23.8	120	51	5	56.1	23.9	2.3

NO_X Emissions

NO_2 modelling results indicate that the ambient ground level concentrations are below the relevant air quality standards for nitrogen dioxide under maximum operation at the power plant - see Table 8.14 *Dispersion Model Results – NO_2*, when using natural gas or distillate for the full year.

Table 8.14 also indicates the impact of NO_X (NO and NO_2) emissions on the closest National Heritages Areas (NHAs) to the site, including the Black Castle Bog NHA.

Table 8.14: Dispersion Model Results – NO_2

Pollutant / Scenario	Background Concentrations (µg/m^3)	Averaging Period	Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard (µg/Nm^3)$^{Note 1}$
NO_2 / Maximum Operation (Natural Gas)	10	Annual Mean$^{Note 2}$	0.83	10.8	40
	20	99.8th%ile of 1-hr means$^{Note 3}$	23.8	43.8	200
	20	99.8th%ile of 1-hr means$^{Note 4}$	47.5	67.5	200
NO_2 / Maximum Operation (Distillate)	10	Annual Mean$^{Note 2}$	2.1	12.1	40
	20	99.8th%ile of 1-hr means$^{Note 3}$	60.4	80.4	200
	20	99.8th%ile of 1-hr means$^{Note 4}$	120.7	140.7	200
NO_X / Maximum Operation (Distillate)	13	Annual Mean	0.4	13.4	30$^{Note 5}$
NO_X / Maximum Operation (Natural Gas)	13	Annual Mean	0.2	13.2	30$^{Note 5}$

Note 1 Directive 1999/30/EC (S.I. No. 271 of 2002)
Note 2 Conversion factor following based on a worst-case ratio of 0.80.
Note 3 Conversion factor based on an existing facility of an empirically derived maximum 1-hour (as a 99.8th%ile) value for NO_2 / NO_X of 0.50.
Note 4 Conversion factor based worst-case assumption of maximum 1-hour value (as a 99.8th%ile) for NO_2 / NO_X of 1.0.
Note 5 This value is the annual limit for the protection of vegetation, which applies to NHAs in the region

Emissions at maximum operation for both units fired on distillate, of 60.4 µg/m^3, equate to ambient NO_2 concentrations which are 30% of the maximum ambient 1-hour limit value measured as a 99.8th%ile. This is based on an empirically-derived conversion factor for NO_2/NO_X of 0.5. Annual NO_2 emissions, of 2.1 µg/m^3, are also 5% of the annual average limit value at the worst-case receptor. When background concentrations are included, these values rise to 40% of the maximum ambient 1-hour limit value and 30% of the annual limit value at the worst-case receptor.

Emissions at maximum operation for both units fired on distillate, equate to ambient NO_X concentrations due to process emissions which are 1% of the annual mean limit value at the worst-case receptor in the nearby NHAs. When background concentrations are included, this rises to 45% of the annual limit value at the worst-case receptor in the NHA.

SO_2 Emissions

SO_2 modelling results indicate that the ambient ground level concentrations are significantly below the relevant air quality standards for sulphur dioxide under maximum operation of the power plant when using distillate for the full year - see Table 8.15 *Dispersion Model Results – SO_2*. No SO_2 emissions are expected when natural gas is used as a fuel.

Table 8.15 *Dispersion Model Results – SO_2* also indicates the impact of SO_2 emissions on the closest National Heritages Areas (NHAs) to the site, including the Black Castle Bog NHA.

Table 8.15: Dispersion Model Results – SO_2

Pollutant / Scenario	Background Concentration (µg/m^3)	Averaging Period	Contribution (µg/m^3)	Predicted Emission Concentration (µg/Nm^3)	Standard (µg/Nm^3)$^{Note 1}$
SO_2 / Maximum Operation (Distillate)	10	99.7th%ile of 1-hr means	51.3	61.3	350
	10	99.2nd%ile of 24-hr means	20.0	30.0	125
SO_2 / Maximum Operation (Distillate)	5	Annual Mean	0.2	5.2	20$^{Note 2}$

Note 1 Directive 1999/30/EC (S.I. No. 271 of 2002)

Note 2 This value is the annual limit for the protection of vegetation, which applies to NHAs in the region

Emissions at maximum operation on distillate, of 51.3 μg/m^3, equate to ambient SO_2 concentrations due to process emissions which are 15% of the maximum ambient 1-hour limit value, measured as a 99.7th%ile. Daily emissions of 20.0 μg/m^3, equate to 16% of the maximum ambient 24-hour limit value, measured as a 99.2th%ile, at the worst-case receptor. When background concentrations are included these values rise to 18% of the maximum ambient 1-hour limit value and 24% of the maximum ambient 24-hour limit value at the worst-case receptor.

Emissions at maximum operation on distillate equate to ambient SO_2 concentrations due to process emissions which are 1% of the annual mean limit value at the worst-case receptor in the nearby NHAs. When background concentrations are included, this rises to 26% of the annual limit value at the worst-case receptor in the NHA.

PM_{10} Emissions

PM_{10} modelling results indicate that the ambient ground level concentrations are significantly lower than the relevant air quality standards for PM_{10} under maximum operation of the power plant when using distillate for the full year - see Table 8.16 *Dispersion Model Results – PM $_{10}$*. No PM_{10} emissions are expected when natural gas is used as a fuel.

Table 8.16: Dispersion Model Results – PM $_{10}$

Pollutant / Scenario	Background Concentration (μg/m^3)	Averaging Period	Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard (μg/Nm^3)$^{Note 1}$
PM_{10} / Maximum Operation	18	Annual Mean	0.15	18.2	40
(Distillate)	30	90.4th%ile of 24-hr means	0.5	30.5	50

Emissions at maximum operation on distillate, of 0.5 μg/m^3, equate to ambient PM_{10} concentrations due to process emission which are 1% of the maximum ambient 24-hour limit value, measured as a 90th%ile. Annual emissions of 0.15 μg/m^3, are 0.4% of the annual average limit value at the worst-case receptor. When background concentrations are included these values rise to 61% of the maximum ambient 24-hour limit value and 46% of the annual average limit value at the worst-case receptor.

$PM_{2.5}$ Emissions

$PM_{2.5}$ modelling results indicate that the ambient ground level concentrations are significantly lower than the proposed air quality standard for $PM_{2.5}$ under maximum operation of the power plant when using distillate for the full year - see Table 8.17 *Dispersion Model Results – PM $_{2.5}$*. No $PM_{2.5}$ emissions are expected when natural gas is used as a fuel.

Table 8.17: Dispersion Model Results – PM $_{2.5}$

Pollutant / Scenario	Annual Mean Background Concentration (μg/m^3)	Averaging Period	Contribution (μg/m^3)	Predicted Emission Concentration (μg/Nm^3)	Standard (μg/Nm^3)$^{Note\ 1}$
$PM_{2.5}$ / Maximum Operation (Distillate)	11	Annual Mean	0.15	11.2	25

Emissions at maximum operation on distillate, of 0.15 μg/m^3, equate to an ambient $PM_{2.5}$ concentration due to process emissions which is 0.6% of the annual average limit value at the worst-case receptor. When the background concentration is included this rises to 45% of the annual average limit value at the worst-case receptor.

Concentration Contour Plots

The geographical variation in ground level concentrations, under maximum operating condition where both units are fired on distillate, is illustrated as concentration contours in Figure 8.5 *Maximum 1 hr NO_2 Concentration as a 99.8th %ile (ug/m^3),* Figure 8.6 *Annual mean NO_2 Concentration (ug/m^3),* Figure 8.7 *Maximum 1 hr SO_2 Concentration as a 99.7th %ile (ug/m^3), and* Figure 8.8 *Maximum 24 hr SO_2 Concentration as a 99.2th %ile (ug/m^3).* The contents of each figure is described below.

Figure 8.5 Predicted 99.8th%ile of Hourly NO_2 Concentrations (μg/m^3) (Distillate)

Figure 8.6 Predicted Annual Average NO_2 Concentrations (μg/m^3) (Distillate)

Figure 8.7 Predicted 99.7th%ile of Hourly SO_2 Concentrations (μg/m^3) (Distillate)

Figure 8.8 Predicted 90.2nd%ile of 24-Hour SO_2 Concentrations (μg/m^3) (Distillate)

The concentrations listed in Tables 8.14 - 8.17 are for the maximum predicted concentrations at any location off-site. All other locations are below these values. The concentration contours, illustrated in Figures 8.5 – 8.8, show where the maximum concentrations are predicted to occur, and the reduction in concentration with distance away from the maximum.

The maximum concentrations occur to the north-northeast, and are observed within 2 km of the boundary of the site. The contour plots show a significant fall in concentrations with distance from this maximum.

Assessment Summary

With the Derrygreenagh power plant operating at maximum capacity for the full year, predicted levels of NO_2, SO_2 and PM_{10} are well below their ambient EU air quality limit values, when using either distillate or natural gas based on a stack height of 50m for the CCGT unit and a stack height of 40m for the OCGT unit.

8.3.3 Mitigation

(i) Construction Phase Mitigation

A dust minimisation plan will be formulated for the construction phase of the project, detailed in Appendix 5D *Dust Minimisation Plan*.

(ii) Operational Phase Mitigation

A stack height determination was undertaken to ensure that the appropriate stack heights were selected such that the impact on the surrounding environment would not be significant. The stack height selection process established that a stack height of 50m for the CCGT unit, and a stack height of 40m for the OCGT unit, were appropriate in ensuring that no adverse impact would occur in the surrounding environment in terms of air quality.

8.3.4 Residual Impacts

No residual impacts are envisaged during the construction and operational phases of the development.