Chapter 13 Air Quality & Climate

13.1 Introduction

AWN Consulting were requested to assess the impacts on air quality and climate associated with both the construction and operational phases of the proposed N5 Ballaghaderreen to Scramoge Road Project. The legislative air quality background of relevance to the Proposed Road Development is summarized below.

13.1.1 Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, National and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set (see Table 13.1 and Appendix 13.1).

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the *Air Quality Standards Regulations 2011*, which incorporate *European Commission Directive 2008/50/EC* which has set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO (see Tables 13.1-13.2). *Council Directive 2008/50/EC* combines the previous *Air Quality Framework Directive (96/62/EC)* and its subsequent daughter directives (including *1999/30/EC* and *2000/69/EC*). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$ (see Appendix 13.1).

13.1.2 Climate Agreements

Ireland ratified the United Nations Framework Convention on Climate Change (UNFCCC) in April 1994 and the Kyoto Protocol in 1997 (UNFCCC, 1997, 1999). For the purposes of the EU burden sharing agreement under Article 4 of the Kyoto Protocol, Ireland agreed to limit the net anthropogenic growth of the six GHGs (greenhouse gases) under the Kyoto Protocol to 13% above the 1990 level over the period 2008 to 2012 (ERM, 1998). The UNFCCC is continuing detailed negotiations in relation to GHG reductions and in relation to technical issues such as Emission Trading and burden sharing. The most recent Conference of the Parties (COP21) agreement was in Paris, France in December 2015. COP21 was an important milestone in terms of international climate change agreements. The "Paris Agreement", agreed by over 200 nations, has a stated aim of limiting global temperature increases to no more than 2°C above pre-industrial levels with efforts to limit this rise to 1.5°C. The aim is to limit global GHG emissions to 40 gigatonnes as soon as possible whilst acknowledging that peaking of GHG emissions will take longer for developing countries.

Contributions to GHG emissions will be based on Intended Nationally Determined Contributions (INDCs) which will form the foundation for climate action post 2020. Significant progress was also made on elevating adaption onto the same level as action to cut and curb emissions. The EU Effort Sharing Decision 406/2009/EC on GHG emissions, requires Ireland to achieve a 20% reduction, relative to 2005 levels, by 2020 in GHG emissions for sectors of the economy not covered by the EU Emissions Trading Directive (i.e. non-ETS GHG emissions). This is known as the EU 2020 Strategy.

2013 was the first year where the European Union's Effort Sharing Decision "EU 2020 Strategy" (Decision 406/2009/EC) was assessed. Ireland had non-ETS (Emissions Trading Systems) sectors emissions of 42.122 Mt CO_2 e.g. in 2013 when emissions covered by the EU's emissions trading scheme for stationary and aviation operators were removed.

The EU, on the 23/24th of October 2014, agreed the "*2030 Climate and Energy Policy Framework*" (EU, 2014). The European Council endorsed a binding EU target of at least a 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990. The target will be delivered collectively by the EU in the most cost-effective manner possible, with the reductions in the ETS and non-ETS sectors amounting to 43% and 30% by 2030 compared to 2005, respectively. Secondly, it was agreed that all Member States will participate in this effort, balancing considerations of fairness and solidarity. The policy also outlines, under "Renewables and Energy Efficiency", an EU binding target of at least 27% for the share of renewable energy consumed in the EU in 2030.

13.1.3 Gothenburg Protocol

In 1999, Ireland signed the Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution. The initial objective of the Protocol was to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the initial targets Ireland was obliged, by 2010, to meet national emission ceilings of 42kt for SO_2 (67% below 2001 levels), 65kt for NO_X (52% reduction below 2001 levels), 55kt for VOCs (37% reduction below 2001 levels) and 116kt for NH_3 (6% reduction below 2001 levels). In 2012, the Gothenburg Protocol was revised to include national emission reduction commitments for the main air pollutants to be achieved by 2020 and beyond and to include emission reduction commitments for $PM_{2.5.}$

European Commission Directive 2001/81/EC, the National Emissions Ceiling Directive (NECD), prescribes the same emission limits as the 1999 Gothenburg Protocol. A National Programme for the progressive reduction of emissions of these four transboundary pollutants has been in place since April 2005 (DoEHLG, 2003). The most recent data available from the EU in 2010 indicated that Ireland complied with the emissions ceilings for SO_2, VOCs and NH_3 but failed to comply with the ceiling for NO_X (EEA, 2011).

COM (2013) 920 Final is the *"Proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC".* The proposal will apply the 2010 NECD limits until 2020 and establish new national emission reduction commitments which will be applicable from 2020 to 2030 for SO_2, NO_X, NMVOC, NH_3, $PM_{2.5}$ and CH_4. In relation to Ireland, 2020-29 emission targets are for SO_2 (65% below 2005 levels), for NO_X (49% reduction on 2005 levels), for VOCs (25% reduction on 2005 levels), for NH_3 (1% reduction on 2005 levels) and for $PM_{2.5}$ (18% reduction on 2005 levels). In relation to 2030, Ireland's emission targets are for SO_2 (83% below 2005 levels), for NO_X (75% reduction on 2005 levels), for VOCs (32% reduction on 2005 levels), for NH_3 (7% reduction on 2005 levels), for $PM_{2.5}$ (35% reduction on 2005 levels) and for CH_4 (7% reduction on 2005 levels).

Table 13.1 EU Air Quality Standards (Based on *European Commission Directive 2008/50/EC and S.I. 180 of 2011)*

Pollutant	Regulation Note1	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 Critical level 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 critical level for the protection of vegetation	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}
		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 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 EU 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'.*

13.2 Methodology

13.2.1 Local Air Quality Assessment

The air quality assessment has been carried out following procedures described in the publications by the EPA (EPA 2002, 2003, 2017), TII/NRA (TII/NRA, 2011) and using the methodology outlined in the guidance documents published by the UK DEFRA (UK DEFRA 2001, 2007, 2009a, 2009b; UK DETR 1998). The assessment of air quality was carried out using a phased approach as recommended by the UK DEFRA (UK DEFRA 2009a). The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. An examination of recent EPA and Local Authority data in Ireland (EPA 2015), has indicated that SO_2, smoke and CO are unlikely to be exceeded at locations such as the vicinity of the proposed road development and thus these pollutants do not require detailed monitoring or assessment to be carried out. However, the analysis did indicate potential problems in regards to nitrogen dioxide (NO_2) and PM_{10} at busy junctions in urban centres (EPA 2015). Benzene, although previously reported at quite high levels in urban centres (EPA 2015), has recently been measured at several city centre locations to be well below the EU limit value (EPA 2015). Historically, CO levels in urban areas were a cause for concern. However, CO concentrations have decreased significantly over the past number of years and are now measured to be well below the limits even in urban centres (EPA 2015).

The current assessment thus focused firstly on identifying the existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, benzene and CO in the region of the Proposed Road Development, both currently (by carrying out a baseline survey and by analysis of suitable EPA monitoring data), and when the Proposed Road Development is opened (through modelling). Thereafter, the impact of the Proposed Road Development on air quality at the neighbouring sensitive receptors was determined relative to "Do nothing" levels for the opening and design years (2020 and 2035). The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (UK DEFRA 2007) (Version 1.03c, July 2007), the NO_x to NO_2 Conversion Spreadsheet (UK DEFRA, 2010) (Version 5.1 (Released June 2016)) and following guidance issued by the TII/NRA (TII/NRA 2011), UK DEFRA (UK DEFRA 2007, 2009a) and the EPA (EPA 2002, 2003). The inputs to the air dispersion model consist of information on road layouts, receptor locations, annual average daily traffic movements (AADT), annual average traffic speeds and background concentrations. Using these input data the model predicts ambient ground level concentrations at the worst-case sensitive receptors using generic meteorological data. The DMRB model uses conservative emission factors, the formulae for which are outlined in the DMRB Volume 11 Section 3 Part 1 – HA 207/07 Annexes B3 and B4. These worst-case concentrations are then added to the existing background concentrations to give the worst-case predicted ambient concentrations. The worst-case ambient concentrations are then compared with the relevant ambient air quality standards to assess the compliance of the Proposed Road Development with these ambient air quality standards.

Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the TII/NRA *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* (TII/NRA 2011) detail 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 Proposed Road Development. The TII/NRA significance criteria have been adopted for the Proposed Road Development and are detailed in Table 13.2 to Table 13.4. 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 CO, annual benzene and annual $PM_{2.5}$ concentrations for the purposes of this assessment.

Table 13.2 Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO_2 / PM_{10}	No. days with PM_{10} concentration > 50 µg/m^3	Annual Mean $PM_{2.5}$
Large	Increase / decrease ≥4 µg/m^3	Increase / decrease >4 days	Increase / decrease ≥2.5 µg/m^3
Medium	Increase / decrease 2 - <4 µg/m^3	Increase / decrease 3 or 4 days	Increase / decrease 1.25 - <2.5 µg/m^3
Small	Increase / decrease 0.4 - <2 µg/m^3	Increase / decrease 1 or 2 days	Increase / decrease 0.25 - <1.25 µg/m^3
Imperceptible	Increase / decrease <0.4 µg/m^3	Increase / decrease <1 day	Increase / decrease <0.25 µg/m^3

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

Table 13.3 Air Quality Impact Significance Criteria

Absolute Concentration in Relation to Objective / Limit Value	Change in Concentration		
	Small	**Medium**	**Large**
Increase with Road Development			
Above Objective/Limit Value With Road Development (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Road Development (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Road Development (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Road Development (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Adverse
Decrease with Road Development			
Above Objective/Limit Value With Road Development (≥40 µg/m^3 of NO_2 or PM_{10}) (≥25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Road Development (36 - <40 µg/m^3 of NO_2 or PM_{10}) (22.5 - <25 µg/m^3 of $PM_{2.5}$)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Road Development (30 - <36 µg/m^3 of NO_2 or PM_{10}) (18.75 - <22.5 µg/m^3 of $PM_{2.5}$)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Road Development (<30 µg/m^3 of NO_2 or PM_{10}) (<18.75 µg/m^3 of $PM_{2.5}$)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

Table 13.4 Air Quality Impact Significance Criteria For Changes to Number of Days with PM_{10} Concentration Greater than 50 μg/m^3 at a Receptor

Absolute Concentration in Relation to Objective / Limit Value	Change in Concentration		
	Small	Medium	Large
Increase with Road Development			
Above Objective/Limit Value With Road Development (≥35 days)	Slight Adverse	Moderate Adverse	Substantial Adverse
Just Below Objective/Limit Value With Road Development (32 - <35 days)	Slight Adverse	Moderate Adverse	Moderate Adverse
Below Objective/Limit Value With Road Development (26 - <32 days)	Negligible	Slight Adverse	Slight Adverse
Well Below Objective/Limit Value With Road Development (<26 days)	Negligible	Negligible	Slight Adverse
Decrease with Road Development			
Above Objective/Limit Value With Road Development (≥35 days)	Slight Beneficial	Moderate Beneficial	Substantial Beneficial
Just Below Objective/Limit Value With Road Development (32 - <35 days)	Slight Beneficial	Moderate Beneficial	Moderate Beneficial
Below Objective/Limit Value With Road Development (26 - <32 days)	Negligible	Slight Beneficial	Slight Beneficial
Well Below Objective/Limit Value With Road Development (<26 days)	Negligible	Negligible	Slight Beneficial

Note 1 Where the Impact Magnitude is Imperceptible, then the Impact Description is Negligible

Source: *Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes* - National Roads Authority (2011)

Fourteen sensitive receptors have been chosen as they have the potential to be adversely impacted by the development, these receptors are shown in Table 13.5. The receptors were chosen to provide a representative view of impacts both on the current N5 alignment and the proposed road development.

Table 13.5 Receptors Data Used in this Assessment See Figure 13.1 in Volume 3

Location Number	Co-Ordinates (UTM Zone 29)		Receptor Ref
	X	Y	
AIR-1	561790	5958145	D53-002
AIR-2	559087	5958636	R245
AIR-3	554220	5957622	R256
AIR-4	549074	5959228	R260
AIR-5	545130	5962582	R264
AIR-6	540719	5965562	R269
AIR-7	540221	5966830	B12-009
AIR-8	537690	5969508	A04-004
AIR-9	536046	5970519	A02-015
AIR-10	534312	5971071	A01-002
AIR-11	556024	5964144	C35-004

Location Number	Co-Ordinates (UTM Zone 29)		Receptor Ref
	X	Y	
AIR-12	553003	5964355	FARM
AIR-13	549466	5965445	B22-001
AIR-14	544789	5965549	B17-002

13.2.2 Regional Impact Assessment Including Climate

The impact of the Proposed Road Development at a national / international level has been determined using the procedures given by the TII/NRA (TII/NRA 2011) and the methodology provided in Annex 2 in the UK DMRB (UK DEFRA 2007). The assessment focused on determining the resulting change in emissions of CO, particulates (PM_{10}), volatile organic compounds (VOCs), nitrogen oxides (NO_x) and carbon dioxide (CO_2). The Annex provides a method for the prediction of the regional impact of emissions of these pollutants from road schemes. The inputs to the air dispersion model consist of information on road link lengths, AADT movements and annual average traffic speeds.

The greenhouse gas emissions associated with peat extraction and abandonment has been assessed using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 7 Wetlands (IPCC, 2006).

13.3 Description of Existing Conditions

13.3.1 Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels) (WHO 2006). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM_{10}, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than $PM_{2.5}$) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles ($PM_{2.5}$ - PM_{10}) will actually increase at higher wind speeds. Thus, measured levels of PM_{10} will be a non-linear function of wind speed.

The nearest representative weather station collating detailed weather records is Claremorris meteorological station, which is located approximately 40km southwest of the western end of the Proposed Road Development. For data collated during nine representative years (2005-2014), the predominant wind ranges from southerly to westerly in direction with an average wind speed of approximately 4m/s. There was 230 days with rainfall greater than 0.2mm on average (1961 – 1990) at Claremorris meteorological station. The station had a mean daily temperature of 8.9 degrees Celsius during the same period.

13.3.2 Trends in Air Quality

Air quality is variable and subject to both significant spatial and temporal variation. In relation to spatial variations in air quality, concentrations generally fall significantly with distance from major road sources (UK Highways Agency 2007). Thus, residential exposure is determined by the location of sensitive receptors relative to major roads sources in the area. Temporally, air quality can vary significantly by orders of magnitude due to changes in traffic volumes, meteorological conditions and wind direction.

In 2011 the UK DEFRA published research (UK DEFRA 2011) on the long term trends in NO_2 and NO_x for roadside monitoring sites in the UK. This study marked a decrease in NO_2 concentrations between 1996 and 2002, after which the concentrations stabilised with little reduction between 2004 and 2010. The result of this is that there now exists a gap between projected NO_2 concentrations which UK DEFRA previously published and monitored concentrations. The impact of this 'gap' is that the DMRB screening model can under-predict NO_2 concentrations for predicted future years. Subsequently, the UK Highways Agency (HA) published an Interim advice note (IAN 170/12) in order to correct the DMRB results for future years. There is a lack of similar modelling in Ireland, however in order to ensure conservative modelling IAN 170/12 is also applied to the predictions for future years.

13.3.2.1 Baseline Air Quality

A baseline monitoring study was carried out close to the alignment of the proposed road. The results of the survey allow an indicative comparison with the annual limit values for NO_2 and PM_{10}, and the 24-hour limit value for PM_{10}. The results also provide information on the influence of road sources relative to the prevailing background level of these pollutants in the area. The monitoring methodology and results are described below.

Council Directive 1999/30/EC outlines the approach which should be taken when assessing ambient levels of nitrogen dioxide. The Directive outlines the assessment regime which is dependent on existing levels of each pollutant. The upper and lower assessment levels for NO_2 are shown below in Table 13.6 (taken from Annex V of the Directive):

Table 13.6 Council Directive 1999/30/EC Annex V. I (a)

NO_x / NO_2	NO_2 Hourly Limit Value Health Protection	NO_2 Annual Limit Value Health Protection	NO_x Annual Limit Value Ecosystem Protection
Upper assessment threshold	70% of 1-hour limit value (140 µg/m^3, not to be exceeded more than 18 times per year)	80% of limit value (32 µg/m^3)	80% of limit value (24 µg/m^3)
Lower assessment threshold	50% of 1-hour limit value (100 µg/m^3, not to be exceeded more than 18 times per year)	65% of limit value (26 µg/m^3)	65% of limit value (19.5 µg/m^3)

When ambient levels are deemed to be below the lower assessment threshold, modelling or objective estimation techniques alone may be used to assess ambient air quality (Article 2.14).

The Directive also outlines minimum data-quality objectives for the required accuracy of the assessment methods, minimum time coverage and of minimum data capture as shown in Table 13.7.

Table 13.7 Council Directive 1999/30/EC Annex VIII I. Data Quality Objectives for Nitrogen Dioxide

Continuous Measurement	
Accuracy	15%
Minimum data capture	90%
Indicative Measurement	
Accuracy	25%
Minimum data capture	90%
Minimum time coverage	14% (One measurement a week at random, evenly distributed over the year, or eight weeks evenly distributed over the year)
Modelling Accuracy	
Hourly averages	50% - 60%
Daily averages	50%
Annual averages	30%

13.3.3 Background Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "Air Quality Monitoring Annual Report 2014" (EPA, 2015), details the range and scope of monitoring undertaken throughout Ireland.

As part of the implementation of the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), four air quality zones have been defined in Ireland for air quality management and assessment purposes (EPA, 2016). Dublin is defined as Zone A and Cork as Zone B. Zone C is composed of 23 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, the region of the Proposed Road Development is categorised as Zone D (EPA, 2015).

13.3.3.1 NO_2

EPA Background Data

Long-term NO_2 monitoring was carried out at the two rural Zone D locations in Ireland (EPA, 2015). The NO_2 annual averages in 2014 across both sites was 3 µg/m^3. The NO_2 annual average in 2013 and 2012 at two rural Zone D sites was 4 µg/m^3 and 6.5 µg/m^3 respectively. Hence long-term average concentrations measured at these locations were significantly lower than the annual average limit value of 40 µg/m^3. Based on the above information, a conservative estimate of the background NO_2 concentration, for the region of the proposed Road Development is 4 µg/m^3.

Monitoring Data

NO_2 was monitored, using nitrogen dioxide passive diffusion tubes, over a two month period at sixteen locations. The monitoring locations were sited close to the route of the Proposed Road Development and along the current N5 route (see Plate 13.1 and Figure 13.1 in Volume 3). Passive sampling of NO_2 involves the molecular diffusion of NO_2 molecules through a polycarbonate tube and their subsequent adsorption onto a stainless steel gauze coated with triethanolamine. Following sampling, the tubes were analysed using Gas Chromatography, at a UKAS accredited laboratory (ESG Laboratories, Oxfordshire).

The locations were chosen in order to assess roadside and rural levels of NO_2. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of NO_2 away from existing road sources. 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.

Studies in the UK have shown that diffusion tube monitoring results generally have a positive or negative bias when compared to continuous analysers. This bias is laboratory specific and is dependent on the specific analysis procedures at each laboratory. A diffusion tube bias of 0.81 was obtained for the ESG laboratory (which analysed the diffusion tubes) from the UK DEFRA website (UK DEFRA, 2015). This bias was applied to the diffusion tube monitoring results.

Diffusion tubes are a useful tool for assessing the spatial variation of NO_2 away from existing road sources. The passive diffusion tube survey was designed to assess rural and roadside levels along the route of the Proposed Road Development. Table 13.8 shows the results of the baseline NO_2 diffusion tube monitoring at 16 locations, as shown in Plate 13.1 and Figure 13.1 in Volume 3. Average bias adjusted roadside concentrations were 10.4 $\mu g/m^3$ and 3.8 $\mu g/m^3$ at rural monitoring locations. The highest concentrations were recorded at tube ref AIR-2C which is located in Strokestown on the current N5 route. This location will be bypassed when the proposed Road Development is completed, which is predicted to result in lower concentrations in the town centre. Baseline concentrations on the proposed road development are less than 50% of the annual mean limit for NO_2 of 40 $\mu g/m^3$ at all locations, and less than 10% at rural locations. Due to low annual mean concentrations, it is not predicted that the maximum 1-hour limit value will be exceeded at any of the monitoring locations.

The results show that ambient levels are deemed to be below the lower assessment threshold; therefore the proposed DMRB modelling technique can be used to assess ambient air quality (Article 2.14 of Council Directive 1999/30/EC Annex V. I (a)).

Table 13.8 NO_2 Diffusion Tube Monitoring Results (Bias adjusted) See Plate 13.1 and Figure 13.1 in Volume 3

Location Type	Ref	Grid Reference (ITM)		Bias Adjusted[2] NO_2 Concentration ($\mu g/m^3$)		
		X	Y	Month 1	Month 2	Average
Rural	NO_2-1P	596078.4	779888	1.9	4.6	3.3
Roadside	NO_2-2C	593166.4	780722.3	20.1	21.7	20.9
Rural	NO_2-3P	587208.9	786205.7	1.7	4.1	2.9
Roadside	NO_2-4P	589813.3	786611.1	2.3	3.5	2.9
Roadside	NO_2-5P	583691.2	787363.6	2.1	3.5	2.8
Rural	NO_2-6P	578994.5	787485.8	2.0	3.1	2.6
Roadside	NO_2-7C	574790.4	787641.1	6.7	8.8	7.8
Roadside	NO_2-8C	574412.5	788858.8	7.4	11.0	9.2
Roadside	NO_2-9C	573263.4	791148.7	10.0	10.8	10.4
Rural	NO_2-10P	572469.6	790617.7	3.5	3.6	3.5
Roadside	NO_2-11C	570989.4	792407.1	11.7	10.1	10.9
Roadside	NO_2-12P	570441.4	792562.9	8.3	6.9	7.6

Location Type	Ref	Grid Reference (ITM)		Bias Adjusted[2] NO_2 Concentration ($\mu g/m^3$)		
		X	Y	Month 1	Month 2	Average
Roadside	NO_2-13P	568574.6	793187.4	4.2	6.1	5.1
Roadside	NO_2-14C	583617.8	780875.7	6.2	7.9	7.0
Roadside	NO_2-15C	579041	784606.3	5.3	7.1	6.2
Roadside	NO_2-16C	588509.2	779598.5	8.7	11.7	10.2

[1] C - Current Location, P- Proposed Location

[2] Bias adjustment factor 0.81 for ESG Didcot

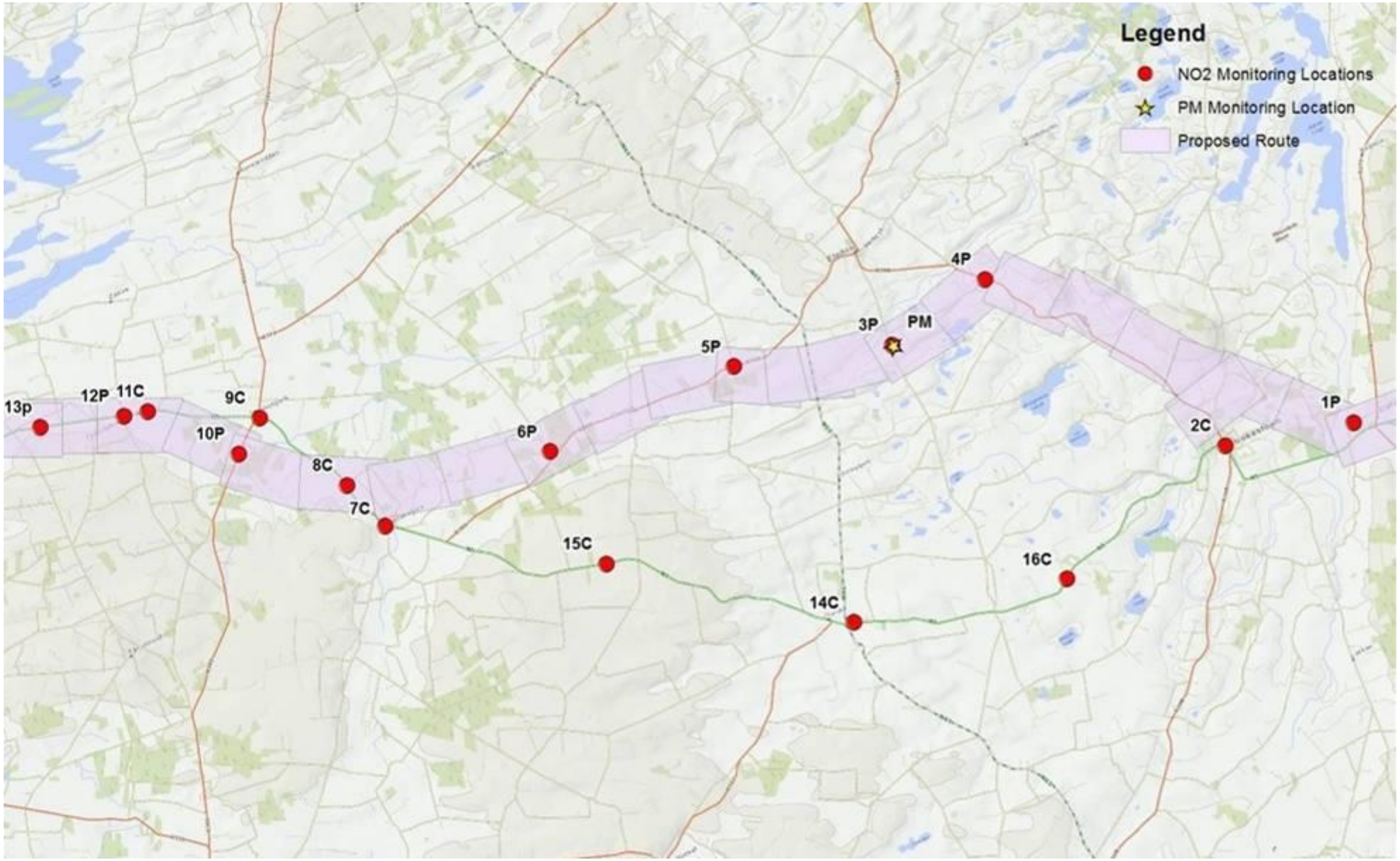

Plate 13. 1 Air Quality Monitoring Locations

13.3.3.2 PM_{10}

EPA Background Data

Long-term PM_{10} monitoring was carried out at two rural Zone D locations in 2014. The average concentration measured at these sites in 2014 was 9.5 µg/m^3 and 12 µg/m^3 in 2013. Long-term PM_{10} measurements carried out at an urban Zone D location in 2014 and 2013 gave average levels of 17 µg/m^3 and 15 µg/m^3 respectively. Based on the above information a conservative estimate of the 2015 background PM_{10} concentration for the region of the proposed Road Development is 11 µg/m^3 on the current N5 due to its rural location. Hence long-term average PM_{10} concentrations measured at these locations were significantly lower than the annual average limit value of 40 µg/m^3.

The results of $PM_{2.5}$ monitoring at an urban Zone D site in 2014 indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.50. Similarly, with PM_{10}, it is noted that the route is in a Zone D classification and that the monitoring station is representative of a more heavily trafficked area. Based on this information, a conservative ratio of 0.50 was used to generate a rural background $PM_{2.5}$ concentration in 2015 of 5.5 µg/m^3. Hence long-term average $PM_{2.5}$ concentrations measured at these locations were significantly lower than the annual average limit value of 25 µg/m^3.

Monitoring Data

The PM_{10} & $PM_{2.5}$ monitoring program was carried out by means of Turnkey Instruments® Osiris Environmental Dust Monitor at one location (see Plate 13.1 for PM_{10} monitoring location). The location was positioned to allow an assessment of rural background levels in the region of the proposed road. The Osiris instrument is a light scattering device capable of continuous measurement of Total Suspended Particulate (TSP), PM_{10}, $PM_{2.5}$ and PM_1. The air sample was continuously drawn into the instrument by a pump through a heated inlet at a flow rate of 600 ml/min. The incoming air passed through a laser beam in a photometer. The light scattered by the individual particles of dust was measured by the photometer and this information used to measure the size and concentration of the dust particles.

Monitoring of PM_{10} and $PM_{2.5}$ concentrations was carried out at a rural location on the proposed road development (on the LP-1412), roughly 3km south of Elphin (see Plate 13.1). Data for PM_{10} concentration measured over a 68 day period (28/10/15-05/1/15) found that both PM_{10} and $PM_{2.5}$ are at maximum 66% of the respective limit values (Table 13.9). The average background value for PM_{10} at the rural location was 26.6 µg/m^3, although well below the ambient air quality standard it is significantly above representative EPA data for rural Zone D locations. PM_{10} data was monitored on a farmyard location and the time series of data indicates a clear shift in the second half (25/11/15-05/1/15) of monitoring has influenced results. Frequent bad weather during December caused the cattle to be kept in the sheds next to the monitor, which has the potential to create a localised PM_{10} source. The rural background value for PM_{10} for the first month of monitoring, when weather was better and therefore cattle were not in the sheds, was 9.2 µg/m^3. This is similar to the background concentrations monitored at rural locations by the EPA.

A secondary indication that the source of increased concentrations was due to a localised increase rather than a regional background shift was the altering of the PM_{10} to $PM_{2.5}$ ratio from 0.59 to 0.25. The low ratio of 0.25 is an indication of a local source of PM_{10}. UK Defra (UK Defra, 2005) found $PM_{2.5}/PM_{10}$ ratios of below 0.5 alongside PM_{10} values of above 100 µg/m^3 due to local sources such as construction activities, while a study (Pace, 2005) presented to the US EPA found that $PM_{2.5}/PM_{10}$ ratios were in the region of 0.15-0.2 when influenced by agricultural processes.

Therefore, it is reasonable to assume that monitoring conducted in December was potentially influenced by local sources and should be considered with caution.

Due to the reasons outlined above, the rural background concentration used in the assessment will be based on the above EPA background monitoring and informed by the initial month of monitoring. The estimate of the 2015 background PM_{10} concentration for the region of the proposed Road Development is 11 µg/m^3.

Table 13.9 PM_{10} / $PM_{2.5}$ Monitoring Results Summary

Overall			28/10/15-25/11/15			25/11/15-05/1/15		
PM_{10} Results	Total No. Days Sampling	68	PM_{10} Results	Total No. Days Sampling	29	PM_{10} Results	Total No. Days Sampling	39
	No. Days > 50 µg/m^3	10		No. Days > 50 µg/m^3	0		No. Days > 50 µg/m^3	10
	90.4th%ile of 24-hour Averages (µg/m^3)	52.9		90.4th%ile of 24-hour Averages (µg/m^3)	13.0		90.4th%ile of 24-hour Averages (µg/m^3)	57.8
	PM_{10} Average (µg/m^3)	26.7		PM_{10} Average (µg/m^3)	9.2		PM_{10} Average (µg/m^3)	39.8
	Limit Value	*50 µg/m^3 Note 1, 40 µg/m^3 Note 2*		*Limit Value*	*50 µg/m^3 Note 1, 40 µg/m^3 Note 2*		*Limit Value*	*50 µg/m^3 Note 1, 40 µg/m^3 Note 2*
$PM_{2.5}$ Results	Total No. Days Sampling	68	$PM_{2.5}$ Results	Total No. Days Sampling	29	$PM_{2.5}$ Results	Total No. Days Sampling	39
	$PM_{2.5}$ / PM_{10} Ratio	0.30		$PM_{2.5}$ / PM_{10} Ratio	0.59		$PM_{2.5}$ / PM_{10} Ratio	0.25
	$PM_{2.5}$ Average (µg/m^3)	8.0		$PM_{2.5}$ Average (µg/m^3)	5.4		$PM_{2.5}$ Average (µg/m^3)	9.9
	Limit Value	*25 µg/m^3 Note 3*		*Limit Value*	*25 µg/m^3 Note 3*		*Limit Value*	*25 µg/m^3 Note 3*

Note 1: 90.4th%ile of 24-hour Average, EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 PM_{10} Annual Average, EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 3 $PM_{2.5}$ Annual Average EU 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'.*

13.4 Characteristics of the Proposed Road Development

The proposed Road Development has an opening year of 2020 and a design year of 2035. The assessment assumes medium traffic growth for future and design years.

When considering a development of this nature, the potential air quality and climate impact on the surroundings must be considered for each of two distinct stages:

- Construction Phase, and;
- Operational Phase.

The primary sources of air and climatic emissions in the operational context are deemed long term and will involve the changes in traffic flows or reductions in congestion in the local area which are associated with the development.

Road traffic is expected to be the dominant source of emissions resulting from the Proposed Road Development and thus is the focus of the current assessment. Road traffic would also be expected to be the dominant source of greenhouse gas emissions resulting from the Proposed Road Development.

13.5 Predicted Impacts of the Proposed Road Development

13.5.1 Construction Phase: Air Quality

The greatest predicted impact on air quality during the construction phase is from construction dust emissions and the potential for nuisance dust. Construction dust emissions can come from a variety of sources including construction traffic. Activities such as rock blasting and demolition of any properties should be considered sensitive activities with respect to dust generation.

Six areas have been identified as potentially being suitable as construction compounds and have been assessed as such in this EIAR. These have an increased dust generation potential due to the storage of potentially dusty materials. The compounds are located at:

- Section A – Proposed Site Compound No. 1 – Ch. 5+500 Frenchpark Roundabout
- Section B – Proposed Site Compound No. 2 – Ch. 12+900
- Section B – Proposed Site Compound No. 3 – Ch.17+400
- Section C – Proposed Site Compound No. 4 – Ch. 30+100 N61 Roundabout
- Section C – Proposed Site Compound No. 5 – Ch. 34+900
- Section C – Proposed Site Compound No. 6 – Ch. 40+500 Strokestown Roundabout

While construction dust tends to be deposited within 200m of a construction site, the majority of the deposition occurs within the first 50m. Most importantly, if the dust minimisation measures specified in Section 13.6.1 and Appendix 13.3 of this chapter are implemented, fugitive emissions of dust from the proposed road development will be insignificant and pose no nuisance at nearby receptors.

Vehicles (including HGV's and LGV's) travelling to and from the site during the construction phase have the potential to cause dust nuisance and increased pollutant concentrations at nearby sensitive receptors. The receptors modelled (see Table 13.5) represent the worst-case locations close to both the affected links and the proposed development and were chosen due to their close proximity (within 200m) to the road links which will be most impacted by the addition of construction traffic during the construction phase of the proposed development. The traffic data used in this assessment was provided by Project Engineers and the worst case construction year (year 2) was modelled. Although the various phases of construction will take place over a number of years; background concentrations and vehicle emission concentrations for 2017 and 2020 traffic data were used in the modelling assessment as a conservative scenario.

13.5.1.1 Predicted Construction Phase Air Quality Impacts

<u>CO and Benzene</u>

The results of the construction phase modelling assessment for CO and benzene have been calculated for the worst case construction scenario and are shown in Table 13.12. Concentrations are well within the limit values at all worst-case receptors. Levels of both pollutants are at maximum 2% and 21% of the respective limit values during the construction phase. The impact of the proposed development can be assessed relative to "Do nothing" levels in 2017. Relative to baseline levels, imperceptible impacts in pollutant levels at all fourteen receptors are predicted as a result of the construction phase of the development. The greatest adverse impact on CO and benzene concentrations during the construction phase will be an increase of 0.04% of their respective limit values at Receptor AIR-12. Thus, using the assessment criteria for NO_2 and PM_{10} and applying these criteria to CO and benzene, the impact of the proposed construction phase of the development in terms of CO and benzene is negligible.

PM_{10}

Predicted annual average PM_{10} concentrations in the region of the proposed development are below the ambient standards at all worst-case receptors, with levels at most 42% of the limit value during the construction phase. In addition, the 24-hour PM_{10} concentration of 50 µg/m^3, which can only be exceeded 35 times per year within the limit, is found to be in compliance at all receptors. These results are shown in Table 13.11.

The impact of the construction phase can be assessed relative to "Do nothing" levels during the construction phase. Relative to baseline levels, some small increases in PM_{10} levels at the worst-case receptors are predicted as a result of the construction phase. With regard to impacts at individual receptors, none of the fourteen receptors assessed will experience an increase in concentrations of over 1.9% of the limit value during the construction phase. Thus, the magnitude of the changes in air quality are negligible at all receptors based on the criteria outlined in Table 13.2 to Table 13.4.

$PM_{2.5}$

Predicted annual average concentrations during the construction phase in the region of the proposed development are below the ambient standards at all worst-case receptors, with levels at most 44% of the limit value. These results are shown in Table 13.11.

The impact of the proposed development can be assessed relative to "Do nothing" levels during the construction phase. Relative to baseline levels, small increases in $PM_{2.5}$ levels at the worst-case receptors are predicted as a result of the proposed development. None of the fourteen receptors assessed will experience an increase in concentrations of over 1.9% of the limit value during the construction phase. Thus, the magnitude of the changes in PM2.5 is negligible at all receptors based on the criteria outlined in Table 13.2 to Table 13.4.

NO_2

The annual average construction phase concentration is within the limit value at all worst-case receptors using both the Defra and more conservative IAN technique, as shown in Table 13.10. Levels of NO_2 are 59% of the annual limit value during the construction phase using the IAN technique, while concentrations are 53% of the annual limit value during the construction phase using the Defra technique. Maximum one-hour NO_2 levels with the proposed development in place are not predicted to be exceeded using either technique. The impact of the construction phase of the proposed development on annual mean NO_2 levels can be assessed relative to "Do nothing" levels during the construction phase. Relative to baseline levels, some imperceptible and small increases in pollutant levels are predicted as a result of the construction phase of the proposed development. With regard to impacts at individual receptors, none of the fourteen receptors assessed will experience an adverse impact in concentrations of over 1.5% of the limit value in the construction phase. Thus, using the assessment criteria outlined Table 13.2 to Table 13.4, the impact of the proposed development during the construction phase in terms of NO_2 is negligible.

Table 13.10 Annual Mean Construction Phase NO_2 Concentrations (μg/m^3)

Receptor	IAN 170/12 V3 Long Term NO_2 Trend Projections					Defra's Technical Guidance Projections				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	3.2	3.3	0.02	Imperceptible	Negligible Increase	2.9	2.9	0.02	Imperceptible	Negligible Increase
AIR-2	23.5	23.5	0.01	Imperceptible	Negligible Increase	21.3	21.4	0.01	Imperceptible	Negligible Increase
AIR-3	13.0	13.0	0.00	Imperceptible	Negligible	12.0	12.0	0.00	Imperceptible	Negligible
AIR-4	10.8	10.8	0.00	Imperceptible	Negligible	10.1	10.1	0.00	Imperceptible	Negligible
AIR-5	8.3	8.3	0.00	Imperceptible	Negligible	7.6	7.6	0.00	Imperceptible	Negligible
AIR-6	11.2	11.3	0.09	Imperceptible	Negligible Increase	10.4	10.5	0.08	Imperceptible	Negligible Increase
AIR-7	11.4	11.6	0.13	Imperceptible	Negligible Increase	10.5	10.6	0.12	Imperceptible	Negligible Increase
AIR-8	3.5	3.5	0.01	Imperceptible	Negligible Increase	3.1	3.1	0.01	Imperceptible	Negligible Increase
AIR-9	11.3	11.4	0.12	Imperceptible	Negligible Increase	10.5	10.6	0.11	Imperceptible	Negligible Increase
AIR-10	7.9	8.1	0.20	Imperceptible	Negligible Increase	7.3	7.5	0.19	Imperceptible	Negligible Increase
AIR-11	3.2	3.3	0.09	Imperceptible	Negligible Increase	3.0	3.0	0.08	Imperceptible	Negligible Increase
AIR-12	2.9	3.5	0.60	Small	Small Increase	2.6	3.1	0.54	Small	Small Increase
AIR-13	3.7	3.8	0.10	Imperceptible	Negligible Increase	3.4	3.5	0.09	Imperceptible	Negligible Increase
AIR-14	2.5	2.6	0.10	Imperceptible	Negligible Increase	2.3	2.4	0.09	Imperceptible	Negligible Increase

Table 13.11 Annual Mean Construction Phase Particulate Matter Concentrations (μg/m^3)

Receptor	PM_{10} Construction Phase					$PM_{2.5}$ Construction Phase				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	15.5	15.5	0.00	Imperceptible	Negligible	10.1	10.1	0.00	Imperceptible	Negligible Increase
AIR-2	16.0	16.5	0.46	Small	Small Increase	10.4	10.7	0.30	Imperceptible	Negligible Increase
AIR-3	14.2	14.7	0.57	Small	Small Increase	9.2	9.6	0.37	Imperceptible	Negligible Increase
AIR-4	16.1	16.7	0.58	Small	Small Increase	10.5	10.9	0.38	Imperceptible	Negligible Increase
AIR-5	15.9	16.3	0.40	Small	Small Increase	10.4	10.6	0.26	Imperceptible	Negligible Increase
AIR-6	11.5	12.2	0.67	Small	Small Increase	7.5	7.9	0.44	Small	Small Increase

Receptor	PM_{10} Construction Phase					$PM_{2.5}$ Construction Phase				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-7	14.1	14.5	0.46	Small	Small Increase	9.1	9.4	0.30	Imperceptible	Negligible Increase
AIR-8	13.6	13.6	0.00	Imperceptible	Negligible	8.8	8.8	0.00	Imperceptible	Negligible
AIR-9	14.4	15.1	0.76	Small	Small Increase	9.3	9.8	0.49	Small	Small Increase
AIR-10	11.4	12.0	0.57	Small	Small Increase	7.4	7.8	0.37	Imperceptible	Negligible Increase
AIR-11	10.9	11.0	0.08	Imperceptible	Negligible Increase	7.1	7.2	0.05	Imperceptible	Negligible Increase
AIR-12	15.5	15.6	0.05	Imperceptible	Negligible Increase	10.1	10.1	0.04	Imperceptible	Negligible Increase
AIR-13	13.6	13.7	0.05	Imperceptible	Negligible Increase	8.9	8.9	0.03	Imperceptible	Negligible Increase
AIR-14	10.9	10.9	0.01	Imperceptible	Negligible Increase	7.1	7.1	0.01	Imperceptible	Negligible Increase

Table 13.12 Annual Mean Construction Benzene and CO Concentrations

Receptor	Benzene Concentrations (µg/m^3)					Maximum 8-hour CO Concentrations (mg/m^3)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	2.00	2.00	0.000	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Increase
AIR-2	2.11	2.11	0.000	Imperceptible	Negligible Increase	0.11	0.11	0.000	Imperceptible	Negligible Decrease
AIR-3	2.07	2.07	0.000	Imperceptible	Negligible Decrease	0.10	0.10	0.000	Imperceptible	Negligible Decrease
AIR-4	2.14	2.14	0.000	Imperceptible	Negligible Decrease	0.12	0.12	0.000	Imperceptible	Negligible Decrease
AIR-5	2.05	2.05	0.000	Imperceptible	Negligible Decrease	0.10	0.10	0.000	Imperceptible	Negligible Decrease
AIR-6	2.09	2.09	0.000	Imperceptible	Negligible Increase	0.11	0.11	0.000	Imperceptible	Negligible Decrease
AIR-7	2.06	2.06	0.000	Imperceptible	Negligible Increase	0.10	0.10	0.000	Imperceptible	Negligible Decrease
AIR-8	2.00	2.00	0.000	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Increase
AIR-9	2.10	2.10	0.000	Imperceptible	Negligible Increase	0.11	0.11	0.000	Imperceptible	Negligible Decrease
AIR-10	2.07	2.07	0.001	Imperceptible	Negligible Increase	0.10	0.10	0.000	Imperceptible	Negligible Decrease
AIR-11	2.01	2.01	0.001	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Increase
AIR-12	2.00	2.00	0.004	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Increase
AIR-13	2.01	2.01	0.000	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Decrease
AIR-14	2.00	2.00	0.001	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Increase

13.5.2 Construction Phase: Climate

During the construction phase of the project, a significant amount of peat will be excavated in order to construct the proposed road. The total estimated peat volume (including alluvium and lacustrine deposits) to be excavated is c.740,240m^3. Some peat may be used to enhance unsuitable material for the purposes of landscaping within the Proposed Road Development, however, the peat material is generally of limited re-use value on the Proposed Road Development and a number of material deposition areas have been identified within the lands made available to store the peat (and other unacceptable material) and allow it to recover its natural condition in a controlled manner (See Chapter 8 Soils and Geology for more detail).

The greenhouse gas emissions associated with this peat excavation has been assessed using the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Volume 4: Agriculture, Forestry and Other Land Use, Chapter 7 Wetlands (IPCC, 2006).

The guidelines are designed to estimate and report on national inventories of anthropogenic Greenhouse Gas (GHG) emissions and removals in order to ensure compliance with the Kyoto Protocol. Anthropogenic refers to GHG emissions and removals that are a direct result of human activities or are a result of natural processes that have been affected by human activities (IPCC, 2006). The quantity of carbon from natural cycles through the earth's atmosphere, waters, soils and biota is much greater than the quantity added by anthropogenic GHG sources. However, the focus of the UNFCCC and the IPCC is on anthropogenic emissions because it is these emissions that have the potential to alter the climate by disrupting the natural balances in carbon's biogeochemical cycle, and altering the atmosphere's heat-trapping ability. The carbon from biogenic sources such as pristine peatland was originally removed from the atmosphere by photosynthesis, and under natural conditions, it would eventually cycle back to the atmosphere as CO_2 due to degradation processes. Thus, these sources of carbon are not considered anthropogenic sources and do not contribute to emission totals considered in the Kyoto Protocol (IPCC, 2006). The guidelines do however outline a methodology to calculate the anthropogenic greenhouse gas emissions associated with the extraction and abandonment of peat. This methodology has been used to assess the potential impact on climate from the project by quantifying the carbon dioxide (CO_2) emissions from the disturbance of peat during the construction of the Proposed Road Development.

The on-site removal and subsequent abandonment of peat can be calculated based on the formula below and based on an estimated total material deposition area of 55.3ha (IPCC, 2006):

$$CO_{2peat\ on\text{-}site} = [(A_{peatRich} \times EF_{CO2\ peatRich}) + (A_{peatPoor} \times EF_{CO2\ peatPoor})]*44/12$$

where:

$CO_{2peat\ on\text{-}site}$ = *on-site CO_2 emissions from peat deposits (all production phases) tonnes yr^{-1}*

$A_{peatRich}$ = *area of nutrient-rich peat soils managed for peat extraction (all production phases), ha (estimated at* 55.3 *ha)*

$A_{peatPoor}$ = *area of nutrient-poor peat soils managed for peat extraction (all production phases), ha*

$EF_{CO2peatRich}$ = *CO_2 emission factor for nutrient-rich peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha^{-1} yr^{-1} (default of 1.1 tonnes C ha^{-1} yr^{-1})*

$EF_{CO2peatPoor}$ = *CO_2 emission factor for nutrient-poor peat soils managed for peat extraction or abandoned after peat extraction, tonnes C ha^{-1} yr^{-1} (default of 0.2 tonnes C ha^{-1} yr^{-1})*

Using a worst-case assumption that all peat is nutrient-rich leads to the following emission total for CO_2 emissions during the construction phase of the project:

$CO_{2peat\ on\text{-}site}$ = *(55.3 ha x 1.1 tonnes C ha^{-1} yr^{-1})*44/12 = 223 tonnes CO_2 / annum*

Similarly, for N_2O, the greenhouse gas emissions associated with the extraction and disposal of peat can be estimated based on the formula:

$N_2O_{peat\ extraction}$ = $[(A_{peatRich} \times EF_{N2O\text{-}N\ peatRich})]*(44/28)*10^{-3}$

where:

$N_2O_{peat\ extraction}$ = *direct N_2O emissions from peatland managed for peat extraction, tonnes N_2O yr^{-1}*

$EF_{N2O\text{-}N\ peatRich}$ = *emission factor for drained nutrient-rich wetlands organic soils, kg N_2O-N ha^{-1} yr^{-1} (default = 1.8 kg N_2O-N ha^{-1} yr^{-1})*

Again, using a worst-case assumption that all peat is nutrient-rich leads to the following emission total for N_2O emissions during the construction phase of the project:

$N_2O_{peat\ extraction}$ = *[(55.3 ha x 1.8 kg N_2O-N ha^{-1} yr^{-1})]*(44/28)*10^{-3} = 0.156 tonnes N_2O /annum*

Methane emissions from peat extraction and abandonment are considered negligible by the IPCC (IPCC, 2006).

GHGs have different efficiencies in retaining solar energy in the atmosphere and different lifetimes in the atmosphere. In order to compare different GHGs, emissions are calculated on the basis of their Global Warming Potential (GWPs) over a 100-year period, giving a measure of their relative heating effect in the atmosphere. The GWP100 for CO_2 is the basic unit (GWP = 1) whereas CH_4 has a global warming potential equivalent to 21 units of CO_2 and N_2O has a GWP100 of 310. Thus the overall greenhouse gas emissions from the peat disturbance, based on converting all emissions to an equivalent CO_2 emission, are:

*GHG Emissions From Peat Removal & Abandonment = 223 tonnes CO_2 + (0.156 tonnes N_20)*310*

GHG Emissions From Peat Removal & Abandonment = 271.5 tonnes CO_{2eq} / annum.

The emissions from peat removal and disposal are 0.000465% of the estimated total GHG emissions in Ireland in 2013 based on compliance with the EU 2020 Strategy on Climate Change Target (European Commission, 2010).

13.5.3 Construction Phase: Regional Air Quality Impacts

The regional impact of the construction phase of the proposed N5 Ballaghaderreen to Scramoge Road Project on emissions of NO_x and VOCs has been assessed using the procedures of the National Roads Authority (TII/NRA, 2011) and the UK Department for Environment, Food and Rural Affairs (UK DEFRA 2007). They indicate that the impact of the construction phase on Ireland's obligations under the Targets set out by "*Proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC*" are negligible. For the construction phase assessment year of 2017, the predicted impact of the changes in AADT is to increase NO_x levels by 0.002989% of the NO_x emissions ceiling and increase VOC levels by 0.0005449% of the VOC emissions ceiling to be complied with in 2017.

13.5.4 Construction Phase: Regional Climate Impacts

The regional impact of the construction phase of the proposed N5 Ballaghaderreen to Scramoge Road Project on emissions of CO_2 was assessed using the Design Manual for Roads and Bridges screening model. The results show that the impact of the construction phase of the proposed road in 2017 will be to increase CO_2 emissions by 0.0012868869% of Ireland's obligations under the EU 2020 target. Thus, the construction phase impact on national greenhouse gas emissions will be insignificant in terms of Ireland's obligations under the EU 2020 target (EPA, 2013).

13.5.5 Operational Phase

Detailed traffic flow information has been obtained for the project and has been used to model pollutant levels under various traffic scenarios and under sufficient spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur. The traffic data corresponds to the opening year of 2020 and design year of 2035. The methodology for the use of the UK DMRB screening assessment (Version 1.03c) (UK Highways Agency 2007) is outlined in Appendix 13.2 and significance criteria for assessing the impact of the modelled impacts is outlined in the TII/NRA Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes *(*TII/NRA 2011). The degree of impact is determined based on both the absolute and relative impact of the Proposed Road Development. Appropriate background levels were selected based on the available monitoring data provided by the EPA and Local Authorities (EPA, 2015 and 2016) and the specific monitoring carried out for the project.

The receptors have been modelled to represent the worst-case locations close to the proposed road development. They have been selected due to their close proximity (within 200m) to the road links impacted by proposed road development.

All traffic data which has been used in this assessment was provided in the form of AADT using a high growth scenario. The resulting AADT flows for the required links and the link numbers are show in Plate 13.2. The sensitive receptors modelled in the assessment are shown Table 13.5.

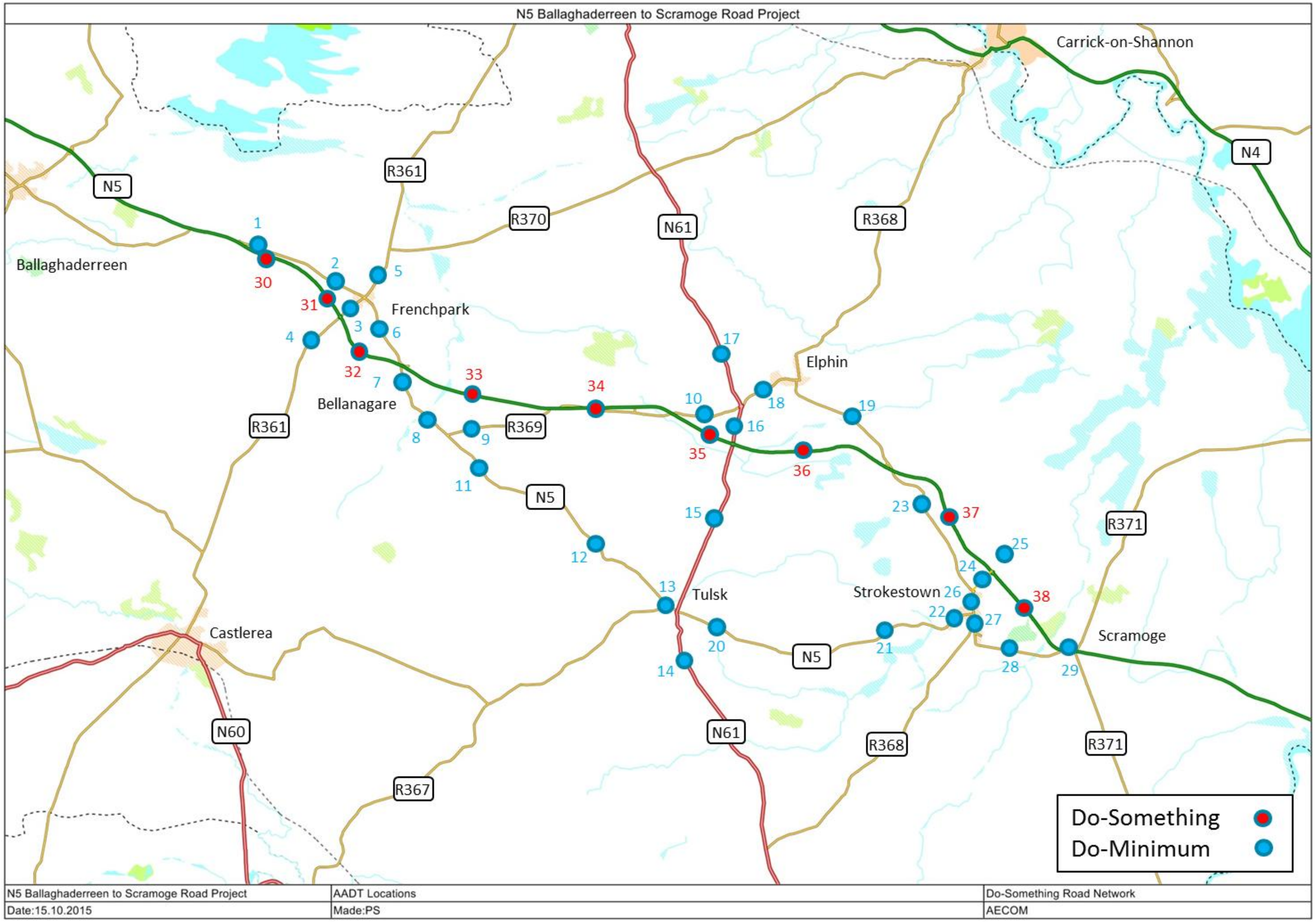

Plate 13.2 Traffic Link Locations

13.5.5.1 "Do Nothing" Modelling Assessment

CO and Benzene

The results of the "do nothing" modelling assessment for CO and benzene in the opening and design years are shown in Table 13.17 and Table 13.18. Concentrations are well within the limit values at all worst-case receptors. Levels of both pollutants are at maximum 2% and 21% of the respective limit values in 2020 and 2% and 20% in 2035.

PM_{10}

The results of the "do nothing" modelling assessment for PM_{10} in the opening and design years are shown in Table 13.15. Concentrations are well within the annual limit value at all worst-case receptors. In addition, the 24-hour PM_{10} concentration of 50 $\mu g/m^3$, which can only be exceeded 35 times per year within the limit, is found to be in compliance at all receptors. There are no days of exceedances predicted. Annual average PM_{10} concentrations are 39% of the limit value in 2020 and 40% in 2035.

$PM_{2.5}$

The results of the "do nothing" modelling assessment for $PM_{2.5}$ in the opening and design years are shown in Table 13.16. The predicted concentrations at all worst-case receptors are well below the $PM_{2.5}$ limit value of 25$\mu g/m^3$. The annual average $PM_{2.5}$ concentration peaks at 41% of the limit value in 2020 and 2035.

NO_2

The results of the "do nothing" assessment of annual average NO_2 concentrations in the opening and design years are shown in Table 13.13 using the Highways Agency IAN 170/12 and Table 13.14 using the Defra technique respectively. The purpose of IAN 170/12 was to account for the conclusions of UK's Defra's advice on long term trends that there is now a gap between current projected vehicle emission reductions and projections on the annual rate of improvements in ambient air quality as previously published in Defra's technical guidance and observed trends. Hence the projections calculated via the IAN 170/12 technique show a slower than previously predicted reduction between the base year and future year predictions. The concentrations are below the limit value at all locations, with levels ranging up to 62% of the limit value in 2020 and 2035, using the more conservative IAN prediction.

The hourly limit value for NO_2 is 200$\mu g/m^3$ is expressed as a 99.8th percentile (i.e. it must not be exceeded more than 18 times per year) is predicted to be at maximum 124$\mu g/m^3$. Therefore, the 1-hour Maximum 1-hour NO_2 concentrations for the "do nothing" scenario is not predicted to be exceeded in either 2020 or 2035.

13.5.5.2 "Do Something" Modelling Assessment

CO and Benzene

The results of the modelled impact of the Road Development for CO and benzene in the opening and design years are shown in Table 13.17 and Table 13.18 respectively. Predicted pollutant concentrations with the Proposed Road Development in place are below the ambient standards at all locations. Levels of both pollutants range from 2% to 21% of the respective limit values in 2020 and 2035. Future trends indicate similarly low levels of CO and benzene. There are significant changes in traffic flows due to altered road layouts between 2020 and 2035, therefore at some receptors increases are predicted while decreases in concentrations are predicted at others.

The impact of the proposed development can be assessed relative to "Do nothing" levels in 2020 and 2035. Relative to baseline levels, imperceptible increases in pollutant levels at seven receptors are predicted as a result of the proposed development. An imperceptible beneficial decrease in concentrations also occurs at seven other receptors due to the decrease in traffic along the current N5 alignment. The greatest adverse impact on CO and benzene concentrations in either 2020 or 2035 will be an increase of 0.32% of their respective limit values at Receptor AIR-12. Beneficial impacts of up to 1% for CO were predicted at Receptor AIR-9. Thus, using the assessment criteria for NO_2 and PM_{10} and applying these criteria to CO and benzene, the impact of the proposed development in terms of CO and benzene is negligible.

PM_{10}

The results of the modelled impact of the proposed development for PM_{10} in the opening and design years are shown in Table 13.15. Predicted annual average concentrations in the region of the proposed development are below the ambient standards at all worst-case receptors, with levels at most 39% of the limit value in 2020. In addition, the 24-hour PM_{10} concentration of 50 µg/m^3, which can only be exceeded 35 times per year within the limit, is found to be in compliance at all receptors. Future trends with the proposed development in place indicate similarly low levels of PM_{10}. Annual average PM_{10} concentrations are 39% of the limit in 2035.

The impact of the proposed development can be assessed relative to "Do nothing" levels in 2020 and 2035. Relative to baseline levels, some imperceptible increases in PM_{10} levels at the worst-case receptors are predicted as a result of the proposed development. With regard to impacts at individual receptors, none of the fourteen receptors assessed will experience an increase in concentrations of over 0.25% of the limit value in 2020 and 2035. Thus the magnitude of the changes in air quality are negligible at all receptors based on the criteria outlined in Table 13.2 to Table 13.4.

$PM_{2.5}$

The results of the modelled impact of the proposed development for $PM_{2.5}$ in the opening and design years are shown in Table 13.16. Predicted annual average concentrations in the region of the proposed development are below the ambient standards at all worst-case receptors, with levels at most 40% of the limit value in 2020. Future trends with the proposed development in place indicate similarly low levels of $PM_{2.5}$. Annual average $PM_{2.5}$ concentrations are also 41% of the limit in 2035.

The impact of the proposed development can be assessed relative to "Do nothing" levels in 2020 and 2035. Relative to baseline levels, imperceptible increases and decreases in $PM_{2.5}$ levels at the worst-case receptors are predicted as a result of the proposed development. None of the fourteen receptors assessed will experience an increase or decrease in concentrations of over 0.53% of the limit value in 2020 and 2035. Thus, the magnitude of the changes in $PM_{2.5}$ is negligible at all receptors based on the criteria outlined in Table 13.2 to Table 13.4.

NO_2

The result of the assessment of the impact of the proposed development for NO_2 in the opening and design years are shown in Table 13.13 for the Highways Agency IAN 170/12 and Table 13.14 using the Defra technique. The annual average concentration is within the limit value at all worst-case receptors using both the Defra and more conservative IAN technique. Levels of NO_2 are 56% and 52% of the annual limit value in 2020 and 2035 using the IAN technique, while concentrations are 39% and 32% of the annual limit value in 2020 and 2035 using the Defra technique. Maximum one-hour NO_2 levels with the proposed development in place are not predicted to be exceeded using either technique. The impact of the proposed development on annual mean NO_2 levels can be assessed relative to "Do nothing" levels in 2020 and 2035. Relative to baseline levels, some small and medium increases and decreases in pollutant levels are predicted as a result of the proposed development. In addition, a large decrease is also predicted at Receptor AIR-9 in 2020. With regard to impacts at individual receptors, none of the fourteen receptors assessed will experience an adverse impact in concentrations of over 2.5% of the limit value in 2020 and 2035. Beneficial impacts of up to 5.26% of the limit value are predicted for Receptors AIR-3, AIR-6 and AIR-9. Thus, using the assessment criteria outlined Table 13.2 to Table 13.4, the impact of the proposed development in terms of NO_2 is slight beneficial.

Table 13.13 Annual Mean NO_2 Concentrations (µg/m^3) (Using IAN 170/12 V3 Long Term NO_2 Trend Projections)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	3.2	3.4	0.27	Imperceptible	Negligible Increase	2.9	3.3	0.39	Imperceptible	Negligible Increase
AIR-2	24.8	22.2	-2.61	Medium	Medium Decrease	24.6	20.9	-3.69	Medium	Medium Decrease
AIR-3	14.2	11.2	-3.06	Medium	Medium Decrease	14.7	10.5	-4.18	Large	Large Decrease
AIR-4	12.7	10.1	-2.65	Medium	Medium Decrease	13.6	10.0	-3.58	Medium	Medium Decrease
AIR-5	8.9	6.9	-2.04	Medium	Medium Decrease	9.1	6.4	-2.74	Medium	Medium Decrease
AIR-6	12.0	8.9	-3.11	Medium	Medium Decrease	12.5	8.3	-4.18	Large	Large Decrease
AIR-7	11.7	10.0	-1.77	Small	Small Decrease	11.7	9.4	-2.36	Medium	Medium Decrease
AIR-8	3.4	3.5	0.16	Imperceptible	Negligible Increase	3.1	3.4	0.23	Imperceptible	Negligible Increase
AIR-9	11.0	6.9	-4.12	Large	Large Decrease	11.2	5.9	-5.26	Large	Large Decrease
AIR-10	7.3	7.5	0.21	Imperceptible	Negligible Increase	7.4	7.7	0.35	Imperceptible	Negligible Increase
AIR-11	2.9	3.3	0.36	Imperceptible	Negligible Increase	2.8	3.3	0.49	Small	Small Increase
AIR-12	2.8	4.3	1.50	Small	Small Increase	2.6	4.8	2.17	Medium	Medium Increase
AIR-13	3.4	3.4	0.07	Imperceptible	Negligible Increase	3.1	3.2	0.08	Imperceptible	Negligible Increase
AIR-14	2.5	3.0	0.58	Small	Small Increase	2.3	3.1	0.83	Small	Small Increase

Table 13.14 Annual Mean NO_2 Concentrations (µg/m^3) (Using Defra's Technical Guidance)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	2.3	2.5	0.20	Imperceptible	Negligible Increase	1.8	2.1	0.24	Imperceptible	Negligible Increase
AIR-2	17.6	15.7	-1.85	Small	Small Decrease	15.0	12.7	-2.25	Medium	Negligible Decrease
AIR-3	10.1	8.0	-2.17	Medium	Medium Decrease	9.2	6.6	-2.62	Medium	Negligible Decrease
AIR-4	8.7	6.9	-1.81	Small	Small Decrease	8.4	6.2	-2.21	Medium	Negligible Decrease
AIR-5	6.5	5.0	-1.48	Small	Small Decrease	5.9	4.1	-1.77	Small	Small Decrease
AIR-6	8.9	6.6	-2.31	Medium	Medium Decrease	8.4	5.6	-2.81	Medium	Medium Decrease

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-7	8.8	7.5	-1.33	Small	Small Decrease	7.8	6.2	-1.57	Small	Small Decrease
AIR-8	2.5	2.6	0.12	Imperceptible	Negligible Increase	2.0	2.1	0.14	Imperceptible	Negligible Increase
AIR-9	9.0	5.6	-3.39	Medium	Medium Decrease	8.5	4.5	-3.99	Medium	Medium Decrease
AIR-10	6.3	6.5	0.18	Imperceptible	Negligible Increase	5.9	6.2	0.28	Imperceptible	Negligible Increase
AIR-11	2.4	2.7	0.30	Imperceptible	Negligible Increase	2.0	2.4	0.36	Imperceptible	Negligible Increase
AIR-12	2.1	3.2	1.10	Small	Small Increase	1.6	3.0	1.34	Small	Small Increase
AIR-13	2.7	2.8	0.06	Imperceptible	Negligible Increase	2.2	2.3	0.06	Imperceptible	Negligible Increase
AIR-14	1.8	2.2	0.43	Small	Small Increase	1.4	1.9	0.52	Small	Small Increase

Table 13.15 Annual Mean PM_{10} Concentrations ($\mu g/m^3$)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	15.3	15.3	0.04	Imperceptible	Negligible Increase	15.3	15.3	0.05	Imperceptible	Negligible Increase
AIR-2	15.7	15.4	-0.30	Imperceptible	Negligible Decrease	15.8	15.5	-0.36	Imperceptible	Negligible Decrease
AIR-3	13.9	13.5	-0.45	Small	Small Decrease	14.0	13.5	-0.54	Small	Small Decrease
AIR-4	15.8	15.5	-0.29	Imperceptible	Negligible Decrease	16.0	15.6	-0.35	Imperceptible	Negligible Decrease
AIR-5	15.7	15.4	-0.31	Imperceptible	Negligible Decrease	15.7	15.4	-0.36	Imperceptible	Negligible Decrease
AIR-6	11.3	10.8	-0.50	Small	Small Decrease	11.5	10.9	-0.60	Small	Small Decrease
AIR-7	13.8	13.5	-0.29	Imperceptible	Negligible Decrease	13.9	13.5	-0.34	Imperceptible	Negligible Decrease
AIR-8	13.4	13.4	0.02	Imperceptible	Negligible Increase	13.4	13.4	0.03	Imperceptible	Negligible Increase
AIR-9	14.1	13.4	-0.69	Small	Small Decrease	14.2	13.4	-0.81	Small	Small Decrease
AIR-10	11.2	11.3	0.03	Imperceptible	Negligible Increase	11.3	11.4	0.04	Imperceptible	Negligible Increase
AIR-11	10.8	10.8	0.06	Imperceptible	Negligible Increase	10.8	10.8	0.07	Imperceptible	Negligible Increase
AIR-12	15.3	15.5	0.21	Imperceptible	Negligible Increase	15.3	15.5	0.25	Imperceptible	Negligible Increase
AIR-13	13.4	13.4	0.01	Imperceptible	Negligible Increase	13.4	13.4	0.01	Imperceptible	Negligible Increase
AIR-14	10.7	10.8	0.08	Imperceptible	Negligible Increase	10.7	10.8	0.10	Imperceptible	Negligible Increase

Table 13.16 $PM_{2.5}$ Annual Mean $PM_{2.5}$ Concentrations (μg/m^3)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	9.9	10.0	0.02	Imperceptible	Negligible Increase	9.9	10.0	0.03	Imperceptible	Negligible Increase
AIR-2	10.2	10.0	-0.20	Imperceptible	Negligible Decrease	10.3	10.0	-0.24	Imperceptible	Negligible Decrease
AIR-3	9.0	8.8	-0.29	Imperceptible	Negligible Decrease	9.1	8.8	-0.35	Imperceptible	Negligible Decrease
AIR-4	10.3	10.1	-0.19	Imperceptible	Negligible Decrease	10.4	10.1	-0.23	Imperceptible	Negligible Decrease
AIR-5	10.2	10.0	-0.20	Imperceptible	Negligible Decrease	10.2	10.0	-0.24	Imperceptible	Negligible Decrease
AIR-6	7.4	7.1	-0.32	Imperceptible	Negligible Decrease	7.5	7.1	-0.39	Imperceptible	Negligible Decrease
AIR-7	9.0	8.8	-0.19	Imperceptible	Negligible Decrease	9.0	8.8	-0.22	Imperceptible	Negligible Decrease
AIR-8	8.7	8.7	0.02	Imperceptible	Negligible Increase	8.7	8.7	0.02	Imperceptible	Negligible Increase
AIR-9	9.2	8.7	-0.45	Small	Small Decrease	9.2	8.7	-0.53	Small	Small Decrease
AIR-10	7.3	7.3	0.02	Imperceptible	Negligible Increase	7.4	7.4	0.03	Imperceptible	Negligible Increase
AIR-11	7.0	7.0	0.04	Imperceptible	Negligible Increase	7.0	7.0	0.05	Imperceptible	Negligible Increase
AIR-12	9.9	10.1	0.14	Imperceptible	Negligible Increase	9.9	10.1	0.16	Imperceptible	Negligible Increase
AIR-13	8.7	8.7	0.01	Imperceptible	Negligible Increase	8.7	8.7	0.01	Imperceptible	Negligible Increase
AIR-14	7.0	7.0	0.05	Imperceptible	Negligible Increase	7.0	7.0	0.06	Imperceptible	Negligible Increase

Table 13.17 Maximum 8-hour CO Concentrations (mg/m^3)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	2.00	2.00	0.005	Imperceptible	Negligible Increase	2.00	2.01	0.006	Imperceptible	Negligible Increase
AIR-2	2.11	2.03	-0.075	Imperceptible	Negligible Decrease	2.12	2.04	-0.084	Imperceptible	Negligible Decrease
AIR-3	2.07	2.02	-0.054	Imperceptible	Negligible Decrease	2.09	2.02	-0.061	Imperceptible	Negligible Decrease
AIR-4	2.14	2.06	-0.072	Imperceptible	Negligible Decrease	2.15	2.07	-0.082	Imperceptible	Negligible Decrease
AIR-5	2.05	2.02	-0.036	Imperceptible	Negligible Decrease	2.06	2.02	-0.042	Imperceptible	Negligible Decrease
AIR-6	2.09	2.03	-0.056	Imperceptible	Negligible Decrease	2.10	2.03	-0.067	Imperceptible	Negligible Decrease

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-7	2.06	2.03	-0.032	Imperceptible	Negligible Decrease	2.07	2.03	-0.037	Imperceptible	Negligible Decrease
AIR-8	2.00	2.00	0.003	Imperceptible	Negligible Increase	2.00	2.00	0.004	Imperceptible	Negligible Increase
AIR-9	2.10	2.01	-0.091	Imperceptible	Negligible Decrease	2.11	2.01	-0.103	Imperceptible	Negligible Decrease
AIR-10	2.07	2.08	0.004	Imperceptible	Negligible Increase	2.08	2.09	0.006	Imperceptible	Negligible Increase
AIR-11	2.01	2.02	0.005	Imperceptible	Negligible Increase	2.02	2.02	0.006	Imperceptible	Negligible Increase
AIR-12	2.00	2.03	0.027	Imperceptible	Negligible Increase	2.00	2.03	0.032	Imperceptible	Negligible Increase
AIR-13	2.01	2.01	0.001	Imperceptible	Negligible Increase	2.01	2.01	0.000	Imperceptible	Negligible Decrease
AIR-14	2.00	2.01	0.011	Imperceptible	Negligible Increase	2.00	2.01	0.012	Imperceptible	Negligible Increase

Table 13.18 Annual Mean Benzene Concentrations (μg/m^3)

Receptor	Impact Opening Year (2020)					Impact Design Year (2035)				
	DM	DS	DS-DM	Magnitude	Description	DM	DS	DS-DM	Magnitude	Description
AIR-1	0.09	0.09	0.001	Imperceptible	Negligible Increase	0.09	0.09	0.001	Imperceptible	Negligible Increase
AIR-2	0.11	0.10	-0.016	Imperceptible	Negligible Decrease	0.12	0.10	-0.017	Imperceptible	Negligible Decrease
AIR-3	0.10	0.09	-0.010	Imperceptible	Negligible Decrease	0.10	0.09	-0.011	Imperceptible	Negligible Decrease
AIR-4	0.12	0.10	-0.015	Imperceptible	Negligible Decrease	0.12	0.10	-0.017	Imperceptible	Negligible Decrease
AIR-5	0.10	0.09	-0.007	Imperceptible	Negligible Decrease	0.10	0.09	-0.007	Imperceptible	Negligible Decrease
AIR-6	0.11	0.10	-0.010	Imperceptible	Negligible Decrease	0.11	0.10	-0.012	Imperceptible	Negligible Decrease
AIR-7	0.10	0.09	-0.006	Imperceptible	Negligible Decrease	0.10	0.10	-0.006	Imperceptible	Negligible Decrease
AIR-8	0.09	0.09	0.001	Imperceptible	Negligible Increase	0.09	0.09	0.001	Imperceptible	Negligible Increase
AIR-9	0.11	0.09	-0.017	Imperceptible	Negligible Decrease	0.11	0.09	-0.018	Imperceptible	Negligible Decrease
AIR-10	0.10	0.10	0.001	Imperceptible	Negligible Increase	0.10	0.11	0.001	Imperceptible	Negligible Increase
AIR-11	0.09	0.09	0.001	Imperceptible	Negligible Increase	0.09	0.09	0.001	Imperceptible	Negligible Increase
AIR-12	0.09	0.10	0.005	Imperceptible	Negligible Increase	0.09	0.10	0.006	Imperceptible	Negligible Increase
AIR-13	0.09	0.09	0.000	Imperceptible	Negligible Increase	0.09	0.09	0.000	Imperceptible	Negligible Decrease
AIR-14	0.09	0.09	0.002	Imperceptible	Negligible Increase	0.09	0.09	0.002	Imperceptible	Negligible Increase

13.5.6 Operational Phase: Regional Air Quality Impacts

The regional impact of the proposed N5 Ballaghaderreen to Scramoge Road Project on emissions of NO_x and VOCs has been assessed using the procedures of the National Roads Authority (TII/NRA, 2011) and the UK Department for Environment, Food and Rural Affairs (UK DEFRA 2007). The results (see Table 13.19) indicate that the impact of the proposed development on Ireland's obligations under the Targets set out by "*Proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC*" are negligible. For the assessment year of 2020, the predicted impact of the changes in AADT is to increase NO_x levels by -0.002149% of the NO_x emissions ceiling and decrease VOC levels by -0.0006991% of the VOC emissions ceiling to be complied with in 2020. For the assessment year of 2035, the predicted impact of the changes in AADT is to increase NO_x levels by 0.005782% of the NOx emissions ceiling and decrease VOC levels by 0.0009524% of the VOC emissions ceiling to be complied with in 2035.

13.5.7 Operational Phase: Regional Climate Impacts

The regional impact of the proposed N5 Ballaghaderreen to Scramoge Road Project on emissions of CO_2 were also assessed using the Design Manual for Roads and Bridges screening model (see Table 13.19). The results show that the impact of the proposed road in 2020 will be to decrease CO_2 emissions by 0.0012868869% of Ireland's EU 2020 Target. In the design year of 2035, the proposed road will decrease CO_2 emissions by 0.0016164568 % of EU 2020 Target. Thus, the impact of the proposed road development on national greenhouse gas emissions will be insignificant in terms of Ireland's obligations under the EU 2020 Target (EPA, 2013).

Table 13.19 Regional Air Quality Assessment

Year	Scenario	VOC (kg/annum)	NO_X (kg/annum)	CO_2 (tonnes/annum)
2020	Do Nothing	3184	16696	7640
	Do Something	2859	15491	7098
2035	Do Nothing	3828	20534	9158
	Do Something	3427	18944	8477
Increment in 2020		-325.1 kg	-1205.6 kg	-541.8 Tonnes
Increment in 2035		-401.5 kg	-1590.1 kg	-680.5 Tonnes
Emission Ceiling (kilo Tonnes) 2020		46.5 [Note 1]	56.1 [Note 1]	42,100 [Note 2]
Emission Ceiling (kilo Tonnes) 2035		42.2 [Note 1]	27.5 [Note 1]	42,100 [Note 2]
Impact in 2020 (%)		-0.0006991%	-0.002149%	-0.0012868869%
Impact in 2035 (%)		-0.0009524%	-0.005782%	-0.0016164568%

Note 1 Targets under the "*Proposal for a Directive on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC*"

Note 2 20-20-20 Climate and Energy Package

13.5.8 Air Quality Impacts on Sensitive Ecosystems

The EU Habitats Directive (92/43/EEC) provides the EU legislative framework of protecting rare and endangered species of flora and fauna, and habitats. This legislation requires the establishment and conservation of a network of sites of particular conservation value that are to be termed 'European Sites'.

There are three principal types of European site, a Special Area of Conservation (SAC), a Special Protection Area (SPA) and Sites of Community Importance. The candidate forms of each of these are also included and are afforded the same legislative protection as defined under SI 473/2011. These sites form part of "Natura 2000" a network of protected areas throughout the European Union. Natural Heritage Areas (NHAs) and proposed Natural Heritage Areas (pNHAs) are heritage sites that are designated for the protection of flora, fauna, habitats and geological sites under Irish domestic legislation being the Wildlife (Amendment) Act 2000. These sites do not form part of the Natura 2000 network however.

The TII/NRA guidelines state that as the potential impact of a development is limited to a local level, detailed consideration need only be given to roads where there is a significant change to traffic flows (>5%) and the designated site lies within 200m of the road centre line. There are a number of designated areas of conservation within 2km of the proposed development. The Bellanagare Bog SPA is located 0.218km from the proposed development at the closest point and therefore outside the 200m assessment zone. While a further assessment is not required for this development, in terms of air quality, one has been carried out due to the proximity to the SPA to the assessment zone.

The impact of NO_x (i.e. NO and NO_2) emissions resulting from the proposed road at the Bellanagare Bog SPA was assessed. Dispersion modelling and prediction was carried out at typical traffic speeds at the closest location of the road to the SPA. Ambient NO_x concentrations predicted for the opening and design years at 218m from the Bellanagare Bog SPA. The road contribution to dry deposition along the transect is also given and was calculated using the methodology of the TII/NRA (TII/NRA, 2011).

The predicted annual average NO_x level in the Bellanagare Bog SPA is within the limit value of 30µg/m^3 for the "do minimum" scenario in 2020 and 2035, with NO_x concentrations reaching at most 23% of this limit in 2020 and 2035. Levels with the Proposed Scheme in place are similar reaching 23% of the limit value for the "do something" scenario in 2020 and 24% of the limit value in 2035.

The predicted annual average NO_x levels at the Bellanagare Bog SPA is within the limit value of 30µg/m^3 for the "do something" scenario in both the opening and design years. The impact of the Proposed Scheme leads to an increase in NO_x concentrations of at most 0.05µg/m^3 at the Bellanagare Bog SPA. The TII/NRA guidelines state in Appendix 9 that where the scheme is expected to cause an increase of more than 2µg/m^3 and the predicted concentrations (including background) are close to, or exceed the standard, then the sensitivity of the habitat to NO_X should be assessed by the project ecologist.

The road contribution to the NO_2 dry deposition rate at 218m is also calculated. The maximum decrease in the NO_2 dry deposition rate is 0.0026 Kg(N)/ha/yr in 2020 and 0.0025 Kg(N)/ha/yr in 2035. This is a negligible impact within the Bellanagare Bog SPA for NO_2 dry deposition due to the scheme.

13.6 Remedial and Mitigation Measures

13.6.1 Construction Phase: Air Quality

A dust minimisation plan has been formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions. In order to minimise dust emissions during construction, a series of mitigation measures have been prepared in the form of a dust minimisation plan, see Appendix 13.3. Provided the dust minimisation measures outlined in the plan are adhered to, the air quality impacts during the construction phase will be not be significant. Activities such as rock blasting and demolition of any properties should be considered sensitive activities with respect to dust generation. In summary the measures which will be implemented will include:

- Hard surface roads will be swept to remove mud and aggregate materials from their surface while any un-surfaced roads will be restricted to essential site traffic.
- Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions.
- Vehicles using site roads will have their speed restricted, both on un-surfaced site roads and on hard surfaced roads, as site management dictates.
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities such as rock blasting or demolition are necessary during dry or windy periods.
- Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions and cleaned as necessary.

At all times, these procedures will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movements of materials likely to raise dust will be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

When the dust minimisation measures detailed in the mitigation section of this chapter are implemented, fugitive emissions of dust from the site will be insignificant and pose no nuisance at nearby receptors.

13.6.2 Construction Phase: Climate

CO_2 and other climate emissions during construction are predicted to have an imperceptible impact on climate, therefore no mitigation measures are required. Where possible, peat removal should be limited, however the impact due to peat is predicted to be 0.000466% of the estimated total GHG emissions in Ireland in 2013 based on compliance with the EU 2020 Strategy on Climate Change Target. In addition to this the construction phase traffic impact is predicted to be 0.000756%, providing a cumulative climate impact of 0.00122%. Therefore, the impact due to climate during the construction phase is predicted to be imperceptible.

13.6.3 Operational Phase: Air Quality

The results of the dispersion modelling study show that no site-specific mitigation measures are required during the operational phase of the proposed development.

Nevertheless, mitigation measures in relation to traffic-derived pollutants have focused generally on improvements in both engine technology and fuel quality. EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (REGULATION (EC) No 715/2007) for passenger cars which were to be complied with in 2009 (Euro V) and 2014 (Euro VI). With regard to heavy duty vehicles, EU Directive 2005/78/EC defines the emission standard, Euro IV, as well as the next stage (Euro V) which entered into force in October 2009. In addition, it defines a non-binding standard called Enhanced Environmentally-friendly Vehicle (EEV). In relation to fuel quality, SI No. 407 of 1999 and SI No. 72 of 2000 have introduced significant reductions in both sulphur and benzene content of fuels.

In relation to design and operational aspects of road developments, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems (UK DEFRA, 2014). Removing traffic from the current N5, particularly in towns, will result in reductions in emissions. Improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

13.6.4 Operational Phase: Climate

The impact of the proposed development on climate will be imperceptible. Thus no site-specific mitigation measures are required.

CO_2 emissions for the average new car fleet were reduced to 120g/km over the period 1995 - 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels. This measure reduced CO_2 emissions from new cars by an average of 25% in the period from 1995 to 2008/2009 whilst 15% of the necessary effort towards the overall climate change target of the EU was met by this measure alone DEHLG, 2000).

Additional measures included in the National Climate Change Strategy (DEHLG, 2006, 2007) include: (1) VRT and Motor Tax rebalancing to favour the purchase of more fuel-efficient vehicles with lower CO_2 emissions; (2) Continuing the Mineral Oils Tax Relief (MOTR) II Scheme and introduction of a biofuels obligation scheme, which enabled Ireland to achieve the EU target of 5.75% biofuels market penetration by 2010 and which will to ensure that the Government target of 10% by 2020 is met; (3) implementation of a national efficient driving awareness campaign, to promote smooth and safe driving at lower engine revolutions; and (4) enhancing the existing mandatory vehicle labelling system to provide more information on CO_2 emission levels and on fuel economy.

13.7 Conclusion

The results of the air quality and climate assessment have shown that, with appropriate mitigation measures in place, residual impacts of the proposed Road Development on air quality and climate for the long and short term result in negligible impacts or in the case of local air quality slight beneficial impacts.

13.8 References

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APPENDIX 13.1
Ambient Air Quality Standards

National standards for ambient air pollutants in Ireland have generally ensued from Council Directives enacted in the EU (& previously the EC & EEC). The initial interest in ambient air pollution legislation in the EU dates from the early 1980s and was in response to the most serious pollutant problems at that time. In response to the problem of acid rain, sulphur dioxide, and later nitrogen dioxide, were both the focus of EU legislation. Linked to the acid rain problem was urban smog associated with fuel burning for space heating purposes. Also apparent at this time were the problems caused by leaded petrol and EU legislation was introduced to deal with this problem in the early 1980s.

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

As part of these measures to improve air quality, the European Commission has adopted proposals for daughter legislation under Directive 96/62/EC. The first of these directives to be enacted, Council Directive 1999/30/EC, was passed into Irish Law as S.I. No 271 of 2002 (Air Quality Standards Regulations 2002), and has set limit values which came into operation on 17th June 2002. The Air Quality Standards Regulations 2002 detail margins of tolerance, which are trigger levels for certain types of action in the period leading to the attainment date. The margin of tolerance varies from 60% for lead, to 30% for 24-hour limit value for PM_{10}, 40% for the hourly and annual limit value for NO_2 and 26% for hourly SO_2 limit values. The margin of tolerance commenced from June 2002, and started to reduce from 1 January 2003 and does so every 12 months by equal annual percentages to reach 0% by the attainment date. A second daughter directive, EU Council Directive 2000/69/EC, details limit values for both carbon monoxide and benzene in ambient air. This has also been passed into Irish Law under the Air Quality Standards Regulations 2002.

The most recent EU Council Directive on ambient air quality was published on the 11/06/08. Council Directive 2008/50/EC combines the previous Air Quality Framework Directive and its subsequent daughter directives. This has also been passed into Irish Law under the Air Quality Standards Regulations 2011 (S.I. 180 of 2011). Provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. 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 $\mu g/m^3$, as an annual average (to be attained everywhere by 2010) and a limit value of 25 $\mu g/m^3$, as an annual average (to be attained everywhere by 2018), 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 $\mu g/m^3$ to 20% of the average exposure indicator (AEI) for concentrations of between 18 - 22 $\mu g/m^3$. Where the AEI is currently greater than 22 $\mu g/m^3$ all appropriate measures should be employed to reduce this level to 18 $\mu g/m^3$ 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 $\mu g/m^3$ has been set to be complied with by 2018, again based on the AEI.

Although the EU Air Quality Limit Values are the basis of legislation, other thresholds outlined by the EU Directives are used which are triggers for particular actions. The Alert Threshold is defined in Council Directive 2008/50/EC as "a level beyond which there is a risk to human health from brief exposure and at which immediate steps shall be taken as laid down in Directive 2008/50/EC". These steps include undertaking to ensure that the necessary steps are taken to inform the public (e.g. by means of radio, television and the press).

The Margin of Tolerance is defined in Council Directive 2008/50/EC as a concentration which is higher than the limit value when legislation comes into force. It decreases to meet the limit value by the attainment date. The Upper Assessment Threshold is defined in Council Directive 2008/50/EC as a concentration above which high quality measurement is mandatory. Data from measurement may be supplemented by information from other sources, including air quality modelling.

An annual average limit for both 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 III of EU Directive 2008/50/EC identifies that monitoring to demonstrate compliance with the NO_X limit for the protection of vegetation should be carried out 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.

Under the terms of EU Framework Directive on Ambient Air Quality (96/62/EC), geographical areas within member states have been classified in terms of zones. The zones have been defined in order to meet the criteria for air quality monitoring, assessment and management as described in the Framework Directive and Daughter Directives. Zone A is defined as Dublin and its environs, Zone B is defined as Cork City, Zone C is defined as 21 urban areas with a population greater than 15,000 and Zone D is defined as the remainder of the country. The Zones were defined based on among other things, population and existing ambient air quality.

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

APPENDIX 13.2
Air Dispersion Modelling

The inputs to the DMRB model consist of information on road layouts, receptor locations, annual average daily traffic movements, annual average traffic speeds and background concentrations(A1). Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptor using generic meteorological data.

The DMRB underwent an extensive validation exercise as part of the UK's Review and Assessment Process to designate areas as Air Quality Management Areas (AQMAs). The validation exercise was carried out at 12 monitoring sites within the UK DEFRAs national air quality monitoring network. The validation exercise was carried out for NO_x, NO_2 and PM_{10}, and included urban background and kerbside/roadside locations, "open" and "confined" settings and a variety of geographical locations(A2).

In relation to NO_2, the model generally over-predicts concentrations, with a greater degree of over-prediction at "open" site locations. The performance of the model with respect to NO_2 mirrors that of NO_x showing that the over-prediction is due to NO_x calculations rather than the NO_x:NO_2 conversion. Within most urban situations, the model overestimates annual mean NO_2 concentrations by between 0 to 40% at confined locations and by 20 to 60% at open locations. The performance is considered comparable with that of sophisticated dispersion models when applied to situations where specific local validation corrections have not been carried out.

The model also tends to over-predict PM10. Within most urban situations, the model will over-estimate annual mean PM_{10} concentrations by between 20 to 40%. The performance is comparable to more sophisticated models, which, if not validated locally, can be expected to predict concentrations within the range of ±50%.

Thus, the validation exercise has confirmed that the model is a useful screening tool for the Second Stage Review and Assessment, for which a conservative approach is applicable.

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APPENDIX 13.3
Dust Minimisation Plan

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions such as rock blasting, peat movement and demolition. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within 200m of the construction area.

In order to ensure mitigation of the effects of dust nuisance, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions, in particular during activities such as rock blasting.

Vehicles using site roads shall have their speeds restricted where there is a potential for dust generation. Access gates to site compounds be located at least 10m from receptors where possible.

Vehicles exiting the site compounds shall make use of a wheel wash facility where appropriate, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions. Record will be kept of all inspections of the haul routes and any subsequent action in a site log book.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place. Water misting or sprays shall be used as required if particularly dusty activities, such as rock blasting, are necessary during dry or windy periods, activities such as scabbling should be avoided. Bulk cement and other fine powder materials shall be delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.

Prior to demolition of any properties they should be soft stripped inside the buildings (retaining walls and windows in the rest of the building where possible, to provide a screen against dust). During the demolition process explosive blasting should be avoided, water suppression should be used, preferably with a hand held spray.

At all times, the procedures put in place will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, satisfactory procedures will be implemented to rectify the problem.

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