7.5 Air Quality Impact Assessment

7.5.1 Introduction

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 7.5.1).

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland are the EU Air Quality Directives 1999/30/EC and 2000/69/EC, which have recently been adopted into Irish Legislation (S.I. No. 271 of 2002) (see Tables 7.5.1 – 7.5.2). 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 various thresholds have been incorporated into the significance criteria for the scheme and will be appropriate for assessing the significance of the cumulative impact of the scheme plus the baseline environment.

The impact of the scheme is also assessed in terms of the relative additional contribution of the proposed scheme, expressed as a percentage of the limit value. Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the United States Environmental Protection Agency (USEPA) has adopted a relative impact criteria based on the applicable limit value. The criteria termed PSD (Prevention of Significant Deterioration) is used alongside the absolute limit values defined by the USEPA (NAAQS – National Ambient Air Quality Standards) (see Table 7.5.3). The PSD regulations have been formulated to ensure air quality remains good, while maintaining a margin for future growth. The PSD is generally applied to industrial facilities whereas the impact of road schemes are compared with the absolute limits in the NAAQS. However, the PSD approach has been adopted for determining the relative impacts of the scheme in the current context. The significance criteria adopted in the current scheme are detailed in Tables 7.5.5, and take into account both the absolute and relative impact of the scheme.

Trends In Air Quality

In recent years, the focus on urban air pollutants has shifted from the monitoring of black smoke and SO_2 (both historically from home heating), and lead (from leaded petrol) to NO_2, Benzene and PM_{10} (Particulate Matter), all derived mainly from traffic sources. Legislation changes have ensured that levels of black smoke, SO_2 and lead are small fractions of historical levels and now rarely approach the limit values. In recent years, however, EU Directive 1999/30/EC has imposed stricter limits on NO_2 while the carcinogenic properties of Benzene and PM_{10} have been highlighted in recent EU Directives.

Recent EPA (Environmental Protection Agency) data indicates that levels of CO, SO_2, smoke and lead are significantly below the respective limit values even at worst-case roadside locations in major urban centres. However, PM_{10}, NO_2 and Benzene currently approach or may even exceed new EU Directives at kerbside and major junctions in parts of Central Dublin. In addition, spatial variations in air quality are important, with concentrations falling significantly with distance from roadside. Thus, residential exposure across urban and suburban centres will typically be less than that reported by the EPA, which, until recently, focused generally on monitoring worst-case kerbside locations at city centre junctions.

In relation to the current scheme, baseline conditions will be the air quality that exists just prior to the opening of the scheme, assuming that the scheme has not been built, but taking into account the forecast traffic levels in the absence of the scheme. Air quality would be expected to improve as a result of emission reductions in vehicles, despite traffic increases, over the next few years.

7.5.2 Forecasting Methods

The air quality assessment has been carried out following procedures described in publications by the EPA and using the methodology outlined in the guidance documents published by the UK Department of the Environment, Transport and Regions (DETR) now UK Department of the Environment, Food & Rural Affairs (DEFRA). Long term monitoring was carried out through the use of continuous exposure over a period of twelve-weeks of NO_2 and Benzene diffusion tubes at monthly intervals. In addition PM_{10} was monitored at 2 locations for 2 periods of 24 hours at each location using a portable air sampler. In all cases monitoring was carried out using the methodology recommended by the World Health Organisation (WHO (1999)) and the UK DEFRA.

Modelling has been carried out using the procedures laid out in the UK Design Manual For Roads & Bridges (DMRB) Vol. 11 Section 3 "Air Quality" (revised 1999) and using the DMRB spreadsheet (V1.01, Jan 2003). Screening modelling assessments along the proposed N9 Kilcullen to Powerstown Scheme were carried out using the DMRB model. Detailed prediction of traffic-derived pollutants was carried out in the worst-case region of the scheme, using the USEPA approved CAL3QHCR Gaussian air dispersion model which is specifically formulated for complex and over-capacity traffic junctions.

Methodology

The assessment of air quality has been carried out using a phased approach as recommended by the UK DETR. The phased approached recommends that the complexity of an air quality assessment should be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial screening of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. A review of recent EPA and Local Authority data, has indicated that SO_2, smoke and CO are unlikely to be exceeded at locations such as in the receiving environment of the proposed N9 Kilcullen to Powerstown Scheme and thus these pollutants do not require detailed monitoring or assessment to be carried out. However, the review did indicate the potential for problems in regards to nitrogen dioxide (NO_2) and PM_{10} at busy junctions in urban centres. Levels of Benzene are generally found to be below the EU limit value.

The current assessment thus focussed firstly on identifying the existing baseline levels of NO_2, PM_{10} and Benzene in the region of the proposed scheme, in the year of opening and in the design year. Thereafter, the impact of the scheme on air quality at the neighbouring sensitive receptors was determined relative to the existing baseline both when the scheme is initially opened and in the design year. The locations of these receptors are shown in Figures 7.38 to 7.46 in Volume 2, the locations of the receptors along the existing N9 (R10 to R11) however, are not shown in these figures. Consistent with the phased approached, as an initial assessment, the UK DMRB screening model was used to conservatively assess the impact of the whole scheme on the surrounding environment both for the do-minimum scenario and the do-something scenario.

Thereafter, a detailed air dispersion modelling assessment was carried out in the region of the worst-case receptor (as identified from the screening assessment) using the US Environmental Protection Agency (USEPA) approved air dispersion model CAL3QHCR and following guidance issued by the California Department of Transportation and USEPA.

Compliance Criteria

PM_{10}

EU Directive 1999/30/EC has set 24 hour and annual limit values for PM_{10} (see Table 7.5.1) which will come into force in 2005. A 24 hour limit of 50 $\mu g/m^3$ is set as a 90^{th}%ile, which means it must not be exceeded more than 35 times per year. EU Directive 1999/30/EC has set an annual limit value of 40 $\mu g/m^3$. In addition, an indicative limit value of 20 $\mu g/m^3$ may be applicable in 2010. However, this is to be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of the current limit values in the EU Member States (see Table 7.5.1).

NO_2

EU Directive 1999/30/EC has set a 1 hour and annual limit values for NO_2 (see Table 7.5.1) which will come into force in 2010. An hourly limit of 200 $\mu g/m^3$ is set which must not be exceeded more than 18 times per year (99.8^{th}%ile). The annual limit value is 40 $\mu g/m^3$ (see Table 7.5.1).

Benzene

EU Directive 2000/69/EC has set an annual limit value of 5 $\mu g/m^3$ for Benzene which will come into force in 2010. A margin of tolerance of 100% currently applies. This will reduce linearly from 2006 to reach 0% by 2010 (see Table 7.5.2).

Baseline Monitoring Methodology

NO_2

Monitoring of nitrogen dioxide in the region of the scheme was carried out using passive diffusion tubes over 3, one month periods at 12 locations (see Figure 7.38 to 7.46 in Volume 2). 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 disc coated with triethanolamine. Following sampling, the tubes were analysed using UV spectrophotometry, at a UKAS accredited laboratory (Casella Analytic Ltd, Manchester, UK, which is part of the Department of the Environment, Food & Rural Affairs (DEFRA's) UK Monitoring Network). The diffusion tube locations were strategically positioned to allow an assessment of background levels along the proposed route, roadside levels along the proposed and existing route and both worst-case and typical exposure of the residential population in Carlow Town. The passive diffusion tube results, which are given in Table 7.5.7, allow an indicative comparison with the annual average limit value.

A detailed baseline air monitoring program has been carried out along the proposed route to assess baseline levels of the significant pollutants likely to be emitted from traffic-derived sources. The substances monitored were NO_2, PM_{10} and Benzene.

Benzene

Monitoring of Benzene in the region of the scheme was carried out using passive diffusion tubes over 3, one-month periods at 6 locations (see Figures 7.38 to 7.46 in Volume 2). Passive sampling of Benzene involves the molecular diffusion of Benzene molecules through a stainless steel tube and their subsequent adsorption onto a stainless steel gauze coated with Chromasorb 106. Following sampling, the tubes were analysed using Gas Chromatography (Casella Analytic Ltd). The diffusion tube locations were strategically positioned to allow an assessment of background levels along the proposed route, roadside levels along the proposed and existing route and both worst-case and typical exposure of the residential population in Carlow Town to be assessed (see Table 7.5.8).

PM_{10}

The PM_{10} monitoring program, using a PM_{10} portable monitor, focused on assessing 24-hour average concentrations over 2 sets of 24 hour periods at 2 locations (R8 and R9, see Figure 7.38 to 7.46 in Volume 2). PM_{10} sampling was carried out by means of an Airmetrics MiniVol Portable Sampler. Approximately 7.2m^3 of air was sampled daily through a particle size separator, which was contained within the PM_{10} sampling head. The impactor removed particles with a diameter >10 μg and the remaining particles were collected on pre-weighed 47mm diameter filters. Gravimetric determination was carried out pre- and post-sampling using a calibrated scientific balance. The results, which are shown in Table 7.5.9, allowed an indicative comparison with both the 24 hour and annual limit values.

7.5.3 The Receiving Environment

Section A Kilcullen to Mullamast

NO_2

The passive diffusion tube survey was designed to identify existing baseline levels in the region of the existing N9 and the proposed N9 Kilcullen to Powerstown Scheme (see Table 7.5.7). NO_2 concentrations, using diffusion tubes, indicated current baseline concentrations of the order of 50% of the EU limit value for roadside locations.

Benzene

Average concentrations of Benzene measured near the M9/N78 Interchange (see Table 7.5.8) indicates that existing baseline levels are significantly below the proposed EU annual limit value, which is enforceable in 2010 averaging around 20% of the limit value which is set at 5 μg/m^3.

Section B Mullamast to Prumplestown

PM_{10}

Daily concentrations of PM_{10} measured at one monitoring station (R8) are shown in Table 7.5.9. The results show that the levels of PM_{10} are significantly within the 24 hour EU limit value of 50 μg/m^3 during the two-day survey period. The average level of PM_{10} measured over the two-day period is approximately 25% of the limit value which is set at 40 μg/m^3.

NO_2

The passive diffusion tube survey was designed to identify appropriate background levels in the region of the proposed scheme (R8) and existing baseline levels near the existing N9 (R4).

NO_2 concentrations, using diffusion tubes, indicates a low background level of nitrogen dioxide in the area (see Table 7.5.7). The background concentration is generally less than 20% of the EU limit value. Existing levels at roadside indicated baseline concentrations of the order of 50% of the EU limit value.

Section C Prumplestown to Powerstown

PM_{10}

Daily concentrations of PM_{10} measured at one monitoring station (R9) are shown in Table 7.5.9. The results show that the levels of PM_{10} are within the 24-hour EU limit value of 50 $\mu g/m^3$ during the two-day survey period. The average level of PM_{10} measured over the two-day period is approximately 40% of the limit value which is set at 40 $\mu g/m^3$.

NO_2

The passive diffusion tube survey was designed to identify appropriate background levels in the region of the proposed scheme (R9, R1) and existing baseline levels near the existing N9 (R2) and N80 (R3).

NO_2 concentrations, using diffusion tubes, indicates a low background level of nitrogen dioxide in the area. The background concentration are generally less than 20% of the EU limit value. Existing levels at roadside indicated baseline concentrations of the order of 70% of the EU limit value near the existing N9 and of the order of 25% near the N80 (see Table 7.5.7).

Benzene

Average concentrations of Benzene measured near the existing N9 (R2) (see Table 7.5.8) indicates that existing baseline levels are significantly below the proposed EU annual limit value, which is enforceable in 2010 averaging around 20% of the limit value. The levels at roadside (R2) are similar to background levels (R9) indicating that the local road source is less dominant than prevailing background levels.

Section D Athy to R747 Link Road

NO_2

The passive diffusion tube survey was designed to identify appropriate background levels in the region of the proposed scheme (R5).

Diffusion tube data indicated a low background level of nitrogen dioxide in the area (see Table 7.5.7). The background concentration is less than 20% of the EU limit value.

Benzene

The passive diffusion tube survey was designed to identify appropriate background levels in the region of the proposed scheme (R5).

Diffusion tube data indicates a low background level of Benzene in the area (see Table 7.5.8). The background concentration was approximately 10% of the EU limit value during the monitoring program.

Carlow Town

NO_2

The passive diffusion tube survey was designed to identify current levels of NO_2 within Carlow Town Centre (R11, R12) and in a suburban area (R10).

Diffusion tube data indicated existing suburban (R10) levels of nitrogen dioxide in Carlow Town of the order of 50% of the EU limit value. Town centre levels (R11, R12) in Carlow currently approach or exceed the EU limit value which will be applicable in 2005 (see Table 7.5.7).

Benzene

The passive diffusion tube survey was designed to identify existing baseline levels of Benzene within Carlow Town Centre (R11) and in a suburban area (R10).

Diffusion tube data indicated existing suburban (R10) levels of Benzene in Carlow Town of the order of 40% of the EU limit value. Town centre levels (R11) in Carlow are currently of the order of 60% of the EU limit value which will be applicable in 2010 (see Table 7.5.8).

7.5.4 Predicted Impacts

General

Construction activities are likely to generate some dust emissions in the vicinity of the proposed scheme. This and all other construction phase impacts and mitigation measures, are addressed in detail in Chapter 11 Construction Phase.

With the scheme in place, road traffic would be expected to be the dominant source of emissions in the region of the proposed scheme (with the possible exception of PM_{10}). Detailed traffic flow information was obtained and has been used to model pollutant levels under various traffic scenarios and under sufficient temporal and spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur.

Cumulative effects have been assessed using the air dispersion model, as recommended in the EU Directive on EIA (Council Directive 97/11/EC) and using the methodology of the UK DETR. Firstly, background concentrations have been included in the modelling study, for both "do-minimum" and "do-something" scenarios. These background concentrations are year-specific and account for non-localised sources of the pollutants of concern. Appropriate background levels were selected based on the available monitoring data provided by the EPA and on the current site-specific monitoring data (see Table 7.5.10).

Once appropriate background concentrations were established, the existing situation (including background levels) was assessed in the absence of the scheme for both the opening year (Year 2007) and design year (Year 2022). The cumulative effect of the baseline situation and the additional impact of the scheme has also been assessed for the opening year (Year 2007) and design year (Year 2022). This assessment allows the significance of the scheme, with respect to both relative and absolute impact, to be determined in the opening and design years.

Screening Air Modelling Assessment

The assessment methodology involved air dispersion modelling using the UK DMRB Model and following guidance issued by the UK DETR. The inputs to the air dispersion model consist of information on road layouts, receptor locations, annual average traffic movements in vehicles / hour (e.g. AADT), annual average traffic speeds and background concentrations. Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptor using generic meteorological data. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentration. The worst-case ambient concentration is then compared with the relevant ambient air quality standard to assess the compliance of the proposed development with these ambient air quality standards.

Section A Kilcullen to Mullamast

Baseline Modelling Assessment (Do Minimum)

CO and Benzene

Concentrations of CO and Benzene are significantly within the limit value for both pollutants. Baseline screening levels of these pollutants range from 8% of the limit value for CO to 13% of the annual limit value for Benzene in 2007. Future trends for the "do-minimum" scenario indicate even lower levels of both CO and Benzene. Baseline levels of these pollutants range from 7.5% of the limit value for CO to 11% of the annual limit value for Benzene in 2022.

PM_{10}

Baseline levels of PM_{10} peak at 34% of the annual limit value in 2007. Results also indicate that no exceedence of the maximum 24-hour limit value will occur in 2007.

Future trends for the "do-minimum" scenario are complex as a large proportion of the modelled concentration is derived from background sources whilst a significant proportion of the PM_{10} composite emission factor is derived from re-suspended dust rather than tail-pipe emissions. The reductions in both background levels and re-suspended dust are predicted to be significantly less than tail-pipe emission reductions. Nevertheless, a general reduction in annual average PM_{10} concentrations is predicted for the "do-minimum" scenario in 2022. Baseline levels of PM_{10} peak at 27% of the annual limit value in 2022. Again, results indicate that no exceedence of the maximum 24 hour limit value will occur in 2022.

As outlined in Directive 1999/30/EC, an indicative limit value of 20 $\mu g/m^3$ limit value in 2010 for PM_{10} will be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of Stage 1 limit values in the EU Member States. Therefore, no comparison has been made with this limit value in this study.

NO_2

The modelling assessment for NO_2 indicates that baseline levels peak at 45% of the limit value. The EU limit value for the maximum one-hour standard for NO_2 is based on a one-hour mean not to be exceeded more than 18 times a year (99.8th%ile). The maximum 1 hour limit value (as a 99.8th%ile) in 2007 is predicted to peak at 45% of the limit value. Temporally, baseline levels of maximum one-hour NO_2 concentrations over the period 2007 to 2022 will decrease appreciably, with levels peaking at 33% of the annual limit value and at 33% of the maximum 1 hour limit value.

Modelled Impact of the Scheme (Do Something)

CO and Benzene

Modelled concentrations of CO and Benzene are again significantly within the ambient standards. Levels of these pollutants range from 9% of the limit value for CO to 13% of the annual limit value for Benzene in 2007. For both CO and Benzene, relative to baseline levels, the impact of the scheme will be insignificant with some small increases as a result of the scheme. As a worst-case, levels will increase by less than 1% of the respective limit values. However, all scenarios will be significantly below the limit value.

Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of CO and Benzene is not significant.

PM_{10}

Modelled concentrations of PM_{10} are within the ambient standards under all scenarios. Predicted levels of PM_{10} range from 28 – 35% of the annual average limit value in 2007 and 2022. For the annual average concentration, relative to baseline levels, the impact of the scheme will be minor with some small increases as a result of the scheme. Levels are predicted to increase by at most 1% of the limit value. In addition, all scenarios will be below the limit values.

Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of PM_{10} is not significant.

NO_2

Concentrations of NO_2 are within the ambient standards under worst-case rush hour traffic speeds. Predicted levels of NO_2 range from 35 – 50% of the limit values in 2007 and 2022. For both the annual average and maximum 1 hour concentration, relative to baseline levels, the impact of the scheme will be minor with some small increases as a result of the scheme. As a worst-case, levels will increase by 1% of the respective limit values. However, all scenarios will be below the applicable limit values. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of NO_2 is not significant.

Section B Mullamast to Prumplestown

Baseline Modelling Assessment (Do Minimum)

CO and Benzene

Baseline screening levels of CO and Benzene pollutants range from 5% of the limit value for CO to 12% of the annual limit value for Benzene in 2007. Future trends for the "do-minimum" scenario indicate even lower levels of both CO and Benzene. Baseline levels of these pollutants range from 5% of the limit value for CO to 10% of the annual limit value for Benzene in 2022.

PM_{10}

Baseline levels of PM_{10} peak at 24% of the annual limit value in either 2007 or 2022. Results also indicate that no exceedence of the maximum 24 hour limit value will occur in either year.

NO_2

The modelling assessment for NO_2 indicates that baseline levels peak at 16% of the limit value in either year. The maximum 1-hour limit value (as a 99.8^{th}%ile) in either 2007 or 2022 is predicted to peak at 16% of the limit value.

<u>Modelled Impact of the Scheme (Do Something)</u>

CO and Benzene

Levels of CO and Benzene pollutants range from 12% of the limit value for CO to 13% of the annual limit value for Benzene in 2007. For both CO and Benzene, relative to baseline levels, the impact of the scheme will be insignificant with some small increases as a result of the scheme. As a worst-case, levels will increase by less than 2% of the respective limit values. However, all scenarios will be significantly below the limit value. Thus, using the assessment criteria outlined in Tables 7.5.5, the impact of the scheme in terms of CO and Benzene is not significant.

PM_{10}

Modelled concentrations are within the ambient standards under all scenarios. Predicted levels of PM_{10} range from 23 – 27% of the annual average limit value in 2007 and 2022. For the annual average concentration, relative to baseline levels, levels are predicted to increase by at most 3% of the limit value. In addition, all scenarios will be below the limit values. Thus, using the assessment criteria outlined in Tables 7.5.4 and 7.5.5, the impact of the scheme in terms of PM_{10} is not significant.

NO_2

Predicted levels of NO_2 range from 23-28% of the limit values in 2007 and 2022. As a worst-case, levels will increase by 12% of the respective limit values. However, all scenarios will be significantly below the applicable limit values. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of NO_2 is not significant.

Section C Prumplestown to Powerstown

<u>Baseline Modelling Assessment (Do Minimum)</u>

CO and Benzene

Baseline screening levels of CO and Benzene pollutants range from 8% of the limit value for CO to 13% of the annual limit value for Benzene in either 2007 or 2022.

PM_{10}

Baseline levels of PM_{10} peak at 25% of the annual limit value in either 2007 and 2022. Results also indicate that no exceedence of the maximum 24 hour limit value will occur in either year.

NO_2

The modelling assessment for NO_2 indicates that baseline levels peak at 42% of both limit value in either year.

<u>Modelled Impact of the Scheme (Do Something)</u>

CO and Benzene

Levels of CO and Benzene pollutants range from 10% of the limit value for CO to 13% of the annual limit value for Benzene in either 2007 or 2022. For both CO and Benzene, as a worst-case, levels will increase by 3% of the respective limit values. However, all scenarios will be significantly below the limit value. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of CO and Benzene is not significant.

PM_{10}

Modelled concentrations of PM_{10} are within the ambient standards under all scenarios. Predicted levels of PM_{10} range from 29 – 32% of the annual average limit value in 2007 and 2022. For the annual average concentration, relative to baseline levels, levels are predicted to increase by at most 6% of the limit value. In addition, all scenarios will be below the limit values. Thus, using the assessment criteria outlined in Tables 7.5.4 and 7.5.5, the impact of the scheme in terms of PM_{10} is not significant.

NO_2

Predicted levels of NO_2 range from 23 – 28% of the limit values in 2007 and 2022. As a worst-case, levels will increase by 12% of the respective limit values. However, all scenarios will be significantly below the applicable limit values.

Thus, using the assessment criteria outlined in Tables 7.5.4 and 7.5.5, the impact of the scheme in terms of NO_2 is not significant.

Section D Athy to R747 Link Road

Baseline Modelling Assessment (Do Minimum)

CO and Benzene

Baseline screening levels of these pollutants range from 10% of the limit value for CO to 13% of the annual limit value for Benzene in either 2007 or 2022.

PM_{10}

Baseline levels of PM_{10} peak at 29% of the annual limit value in either 2007 and 2022. Results also indicate that no exceedence of the maximum 24 hour limit value will occur in either year.

NO_2

The modelling assessment for NO_2 indicates that baseline levels peak at 34% of both limit value in either year.

Modelled Impact of the Scheme (Do Something)

CO and Benzene

Levels of CO and Benzene pollutants range from 10% of the limit value for CO to 13% of the annual limit value for Benzene in either 2007 or 2022. For both CO and Benzene, levels will decrease by up to 1% of the respective limit values. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of CO and Benzene is not significant.

PM_{10}

Modelled concentrations of PM_{10} are within the ambient standards under all scenarios. Predicted levels of PM_{10} range from 25 – 28% of the annual average limit value in 2007 and 2022. For the annual average concentration, relative to baseline levels, levels are predicted to decrease by up to 1% of the limit value. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of PM_{10} is not significant.

NO_2

Predicted levels of NO_2 range from 26 – 31% of the limit values in 2007 and 2022. As a worst-case, levels will decrease by up to 3% of the respective limit values.

Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of NO_2 is not significant.

Detailed Air Modelling Assessment: M9 / N78 Junction (Junction 1)

Detailed traffic flow information was obtained 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 as a result of the scheme.

The inputs to the air dispersion model consist of information on road layouts, hourly traffic movements and a full year of meteorological data. Site-specific composite traffic emission factors have been derived based on an analysis of vehicle type, average speeds and model year of vehicle. The year giving the highest ambient concentrations of NO_2 over a 5 year period (1998-2002) has been incorporated into the model (Casement Aerodrome 1998) and has been used to determine hourly concentrations for all pollutants of concern at each specified receptor in the region.

Peak, 1 hour concentrations for CO, Benzene, NO_2 and PM_{10} for years 2007 and 2022, at the nearest sensitive receptors to the M9 / N78 junction (Junction 1 of the proposed scheme), have been modelled using the USEPA approved CAL3QHCR dispersion model, which is based on the USEPA approved CALINE3 dispersion model, in conjunction with the most recent European emissions database (COPERT III). This region has been chosen for the detailed analysis as it represents the region of highest ambient concentration when the scheme is in place, as derived from the screening analysis.

In the modelling assessment a number of specific sensitive receptors were identified within several hundred metres of the proposed scheme. "Do-minimum" and "do-something" modelling was carried out at the building façade of each of these receptors for all scenarios including the maximum one-hour NO_2 scenarios (as a 99.8^{th}%ile). An assessment was also carried out for nitrogen dioxide at 2 different average traffic speeds on slip roads, roundabouts and link roads. The average speeds modelled were typical of worst-case peak-hour and design speeds as NO_X emissions are generally sensitive to this parameter.

<u>Baseline Modelling Assessment (Do Minimum)</u>

CO and Benzene

Baseline levels of these pollutants range from 4% of the limit value for CO to 14% of the annual limit value for Benzene in 2007.

Future trends for the "do-minimum" scenario indicate even lower levels of both CO and Benzene. Baseline levels of these pollutants range from 2% of the limit value for CO to 11% of the annual limit value for Benzene in 2022 (see Table 7.5.11).

PM_{10}

Baseline levels of PM_{10} peak at 29% of the annual limit value in either 2007 and 2022 (see Table 7.5.11). Results also indicate that no exceedence of the maximum 24-hour limit value will occur in either year.

NO_2

The modelling assessment for NO_2 indicates that baseline levels peak at 27% of the limit value in either year (see Table 7.5.11). The maximum 1-hour limit value (as a 99.8^{th}%ile) in either 2007 and 2022 is predicted to peak at 27% of the limit value. Spatially, worst-case annual average concentrations of NO_2 occur at a roadside receptor to the south-east of the M9 / N78 junction in 2007 in the absence of the scheme.

Modelled Impact of the Scheme (Do Something)

CO and Benzene

Levels of these pollutants range from 3% of the limit value for CO to 13% of the annual limit value for Benzene in 2007 (see Table 7.5.11). For both CO and Benzene, relative to baseline levels, the impact of the scheme will be insignificant with some small increases and decreases as a result of the scheme. As a worst-case, levels will increase by less than 1% of the respective limit values. However, all scenarios will be significantly below the limit value. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of CO and Benzene is not significant.

PM_{10}

Modelled concentrations are within the ambient standards under all scenarios. Predicted levels of PM_{10} range from 29 – 30% of the annual average limit value in 2007 and 2022. Results also indicate that no exceedence of the maximum 24 hour limit value (as a 90.1^{th}%ile) will occur in either year (see Table 7.5.11). For the annual average concentration, the impact of the scheme will be insignificant with some small increases and decreases as a result of the scheme. As a worst-case, levels will increase by less than 2% of the respective limit values. However, all scenarios will be significantly below the limit value. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of PM_{10} is not significant.

NO_2

Predicted levels of NO_2 range from 24 – 29% of the limit values in 2007 and 2022. For both the annual average and maximum 1 hour concentration, the impact of the scheme will be insignificant with some small increases as a result of the scheme. As a worst-case, levels will increase by less than 3% of the respective limit values. However, all scenarios will be significantly below the limit value (see Table 7.5.11). Spatially, worst-case annual average concentrations of NO_2 occur at the roadside receptor, in the presence of the scheme, which is located to the south-east of the M9 / N78 junction in 2007. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of NO_2 is not significant.

Summary of Modelling Assessment

Detailed baseline modelling assessments for CO and Benzene indicate that concentrations will be significantly within the ambient air quality standards. In addition, the scheme will increase ambient concentrations by no more than 1% of the respective limit values at the worst-case receptor. Cumulatively, levels will be significantly within the ambient air quality limit values under worst-case traffic speeds. Levels of both pollutants range from 2-14% of the respective limit values in 2007 and 2022. Thus, the impact of the scheme for CO and Benzene is not significant.

Baseline modelling assessment for PM_{10} indicates that concentrations will be within the ambient air quality standards. In addition, the scheme will increase ambient concentrations by no more than 1% of the respective limit values at the worst-case receptor. Cumulatively, levels will be significantly within the ambient air quality limit values under worst-case traffic speeds. Predicted levels of PM_{10}, with the scheme in place, will peak at 29% of the limit value for the annual average in 2007. Results also indicate that no exceedence of the maximum 24-hour limit value will occur in either year. Thus, the impact of the scheme for PM_{10} is not significant.

Baseline modelling assessment for NO_2 indicates that concentrations will be within the ambient air quality standards. In addition, the scheme will increase ambient concentrations by no more than 3% of the respective limit values at the worst-case receptors. Cumulatively, levels will be significantly within the ambient air quality limit values under worst-case traffic speeds. Predicted levels of NO_2, with the scheme in place, will peak at 29% of the limit value for the annual average and at 29% of the maximum 1 hour limit value in 2007. Thus, the impact of the scheme for NO_2 is of not significant**.**

In summary, levels of traffic-derived air pollutants will not exceed the ambient air quality standards both with and without the scheme in place for both the opening and design year. Although the scheme will increase ambient concentrations for some pollutants and averaging periods, levels will still be within the ambient air quality limit values under all traffic speeds. Thus, using the assessment criteria outlined in Table 7.5.5, the impact of the scheme in terms of NO_2, PM_{10}, CO and Benzene is not significant.

7.5.5 Remedial Or Reductive Measures

General

Mitigating measures in relation to traffic-derived pollutants has focused generally on improvements in both engine technology and fuel quality. Recent EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (Euro III and Euro IV (98/69/EC) for passenger cars to be complied with in 2002 and 2004 respectively and Euro III, IV and V for diesel HGVs to be introduced in 2001, 2004 and 2008). In relation to fuel quality, a recent EU Fuel Directive (98/70/EC) has introduced significant reductions in both sulphur and Benzene content of fuels.

In relation to design and operational aspects of road schemes, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems. An important consideration in the current context is that the proposed road scheme will redirect traffic away from populated areas, such as Carlow Town, to areas where fewer people are exposed to traffic emissions. Moreover, as the flow of traffic will be smoother and a steady speed maintained, emissions will be lower than urban areas where stop-start motions and queuing will lead to higher emissions. Further improvements in air quality are also likely over the next few years as a result of the introduction of a comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

A dust minimisation plan has been formulated for the construction phase of the project. Once the dust minimisation plan is implemented, the residual impact of construction on air quality will not be significant. This is discussed in more detail in Chapter 11 "Construction Phase".

No specific mitigation measures are anticipated following completion of the scheme.

7.5.6 Residual Impact

General

No residual negative impacts are anticipated, there will however be a significant reduction in air pollution levels in the built up areas such as Carlow Town and Castledermot.

Table 7.5.1 EU Ambient Air Standard - Council Directive 1999/30/EC

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	50% until 2001 reducing linearly to 0% by 2010	200 μg/m^3 NO_2
		Annual limit for protection of human health	50% until 2001 reducing linearly to 0% by 2010	40 μg/m^3 NO_2
		Annual limit for protection of vegetation	None	30 μg/m^3 NO + NO_2
Lead	1999/30/EC	Annual limit for protection of human health	100% until 2001 reducing linearly to 0% by 2005	0.5 μg/m^3
Sulphur dioxide	1999/30/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	43% until 2001 reducing linearly until 0% by 2005	350 μg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 μg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 μg/m^3
Particulate Matter Stage 1	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50% until 2001 reducing linearly to 0% by 2005	50 μg/m^3 PM_{10}
		Annual limit for protection of human health	20% until 2001 reducing linearly to 0% by 2005	40 μg/m^3 PM_{10}
Particulate Matter Stage 2[1]	1999/30/EC	24-hour limit for protection of human health - not to be exceeded more than 7 times/year	To be derived from data and to be equivalent to Stage 1 limit value	50 μg/m^3 PM_{10}
		Annual limit for protection of human health	50% until 2005 reducing linearly to 0% by 2010	20 μg/m^3 PM_{10}

1 Indicative limit values to be reviewed in the light of further information on health and environmental effects, technical feasibility and experience in the application of Stage 1 limit values in the Member States

Table 7.5.2 EU Ambient Air Standard - Council Directive 2000/69/EC

Pollutant	Regulation	Limit Type	Margin of Tolerance	Value
Benzene	2000/69/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% by 2010	5 $\mu g/m^3$
Carbon Monoxide	2000/69/EC	8-hour limit (on a rolling basis) for protection of human health	60% until 2003 reducing linearly to 0% by 2006	10 mg/m^3

Table 7.5.3 US National Ambient Air Quality Standards (NAAQS) & PSD Increments

Pollutant	Averaging Period	Primary & Secondary Standard(1) ($\mu g/m^3$)	*PSD Increment Class II(2)* ($\mu g/m^3$)
PM_{10}	Annual – Average over 3 years	50	17
	24-Hour – as a 99th%ile over 3 years	150	30
NO_2	Annual Mean	100	25
CO	8-Hour – 3-year average of annual 4th highest daily maximum 8-hour conc.	10,000	-
	1-Hour – not to be exceeded more than 3 times in 3 consecutive years	40,000	-
Hydrocarbon (Benzene)	3 Hours (6-9 AM) (corrected for methane)	160	-

(1) Primary standards to protect public health whilst secondary standards are set to protect public welfare
(2) Class I areas are national parks and similar areas. Class II are all areas not originally classified as Class I.

Table 7.5.5 Criteria to Quantify the Potential Impact of Scheme – Specific Pollutant Guidance

Degree of Significance	Criteria (as assessed by detailed air quality modeling)	Carbon Monoxide (mg/m^3)	Benzene ($\mu g/m^3$)	Nitrogen Dioxide ($\mu g/m^3$)		Particulates (PM_{10}) ($\mu g/m^3$)	
		Maximum 8-hour[2]	Annual mean[2]	Maximum 1-hr NO_2[1]	Annual average O_2[1]	Annual average[1]	Maximum 24-hr values[1]
Profound	*Exceedance of Alert Threshold as detailed in EU Air Quality Directive*	>20[7]	>15[7]	>400	>80[7]	>80[6],[7]	>100[6],[7]
Severe	*Exceedance of any EU Air Quality Directive and Margin of Tolerance*	>15	>10	>300	>60	>48	>75
Major	Exceedance of EU Air Quality Directive (although below the Margin of Tolerance) and Exceedance of PSD Increment	>10 >2[3]	>5.0 >1.3[3]	>200 >50[3]	>40 >10[4]	>40 >13[4]	>50 >10[4]
Moderate	Exceedance of EU Air Quality Directive (although below the Margin of Tolerance) but no Exceedance of PSD Increment	>10 <2[3]	>5.0 <1.3[3]	>200 <50[3]	>40 <10[4]	>40 <13[4]	>50 <10[4]
Minor	Exceedance of Upper Assessment Threshold (although below the EU Air Quality Directive) as detailed in any EU Air Quality Directive and Exceedance of PSD Increment	>7 >2[3]	>3.5 >1.3[3]	>140 >50[3]	>32 >10[4]	>28 >13[4]	>30 >10[4]
Not Significant	Below the EU Air Quality Directive as detailed in any EU Air Quality Directive with no Exceedance of PSD Increment	<10 <2[3]	<5.0 <1.3[3]	<200 <50[3]	<40 <10[4]	<40 <13[4]	<50 <10[4]
Minor Beneficial	Improvement to below the Upper Assessment Threshold as detailed in any EU Air Quality Directive by a margin greater than the PSD Increment	<7 >2[3]	<3.5 >1.3[3]	<140 >50[3]	<32 >10[4]	<28 >13[4]	<30 >10[4]
Moderate Beneficial	Improvement to below the EU Air Quality Directive as detailed in any EU Air Quality Directive by a margin greater than the PSD Increment	<10 >2[3]	<5.0 >1.3[3]	<200 >50[3]	<40 >10[4]	<40 >13[4]	<50 >10[4]

1 EU Council Directive 1999/30/EC
2 EU Directive 2000/69/EC
3 No PSD Increment Available – based on average of other PSD increments
4 Relative PSD Increment, USEPA Limit Values vary from EU Limits
5 USEPA PSD (Prevention of significant deterioration) Increments
6 Alert threshold to be considered by end of 2003 – Council Directive 1999/30/EC
7 No alert threshold set – limit relative to the alert threshold for NO_2

Table 7.5.6 WHO Air Quality Guidelines 1999

Substances	Time-weighted Average	Averaging Time
Lead	0.5-1.0 $\mu g/m^3$	1 year
Nitrogen dioxide	200 $\mu g/m^3$ 40-50 $\mu g/m^3$	1 hour annual
Carbon monoxide	100 $\mu g/m^3$ 60 $\mu g/m^3$ 30 $\mu g/m^3$ 10 $\mu g/m^3$	15 minutes 30 minutes 1 hour 8 hour
Benzene	(a)	
Particulate matter (PM_{10})	(b)	

(a) No safe level recommended owing to carcinogenicity.
(b) No specific guideline recommended because no obvious exposure concentration and duration that could be judged a threshold and decreased by uncertainty factors to avoid risk.

Table 7.5.7 Results Of NO_2 Diffusion Tube Monitoring

Section	Location	NO_2 (μg/m^3) (24/7/02 - 20/8/02)	NO_2 (μg/m^3) (20/8/02 - 25/9/02)	NO_2 (μg/m^3) (25/9/02 - 30/10/02)	Average (μg/m^3)
Section A – Kilcullen to Mullamast	R6 – N9-N78 Interchange	12	18	24	18
	R7 – Ballymount	19	21	20	20
Section B – Mullamast to Prumplestown	R8 – Ballynamony	5	5	10	7
	R4 – Prumplestown	20	18	24	21
Section C – Prumplestown to Powerstown	R9 – Russelstown	4	6	-(2)	5
	R3 – Rathcrogue	10	8	19	12
	R2 – Powerstown	18	29	36	28
	R1 – Ballynolan	5	5	8	6
Section D – Athy to R747 Link Road	R5 – Mullamast	5	6	9	7
Existing Carlow Environment	R10 – Larkfield	17	16	31	21
	R11 – Carlow Centre	39	37	-(1)	38
	R12 – Carlow South	38	-(1)	46	42
Limit Value					40(3)

(1) Sample lost in the field
(2) Sample tube damaged
(3) EU Council Directive 1999/30/EC (as an annual average).

Table 7.5.8 Results Of Benzene Diffusion Tube Monitoring

Section	Location	Benzene (μg/m³) (24/7/02 - 20/8/02)	Benzene (μg/m³) (20/8/02 - 25/9/02)	Benzene (μg/m³) (25/9/02 - 30/10/02)	Average (μg/m³)
Section A – Kilcullen to Mullamast	R6 – N9-N78 Interchange	0.6	1.2	0.5	0.8
Section C –Prumplestown to Powerstown	R9 – Russelstown	0.6	3.0	0.3	1.3
	R2 – Powerstown	0.6	1.1	-(1)	0.9
Section D – Athy to R747 Link Road	R5 – Mullamast	0.6	0.7	0.3	0.5
Existing Carlow Environment	R10 – Larkfield	1.7	3.6	0.8	2.0
	R11 – Carlow Centre	1.9	6.1	1.1	3.0
Limit Value					5(2)

(1) Sample lost in the field
(2) EU Council Directive 2000/69/EC (as an annual average).

Table 7.5.9 Results Of PM_{10} Monitoring

Section	Location	Sampling Date	PM_{10} ($\mu g/m^3$)
Section B – Mullamast to Prumplestown	R8 - Ballynamony	20/08/02	<6.5
		21/08/02	13.7
Average			10.1
Section C – Prumplestown to Powerstown	R9 - Russelstown	30/10/02	23.4
		31/10/02	<7.0
Average			15.2
Limit Value (Compliance Date 2005)			Maximum 24–Hour = 50(1) Annual = 40(1)

(1) EU Council Directive 1999/30/EC

Table 7.5.10 Summary Of Background Concentrations Used In The Air Dispersion Model

Background Values	Nitrogen Dioxide ($\mu g/m^3$)	Benzene ($\mu g/m^3$)	Particulates (PM_{10}) ($\mu g/m^3$)	Carbon Monoxide (ppm)
Year 2007	8	0.6	10	0.1
Year 2022	7	0.5	9	0.1

Table 7.5.11 Summary Of Predicted Air Quality At Worst-Case Receptors Located Near The Proposed Scheme

Scenarios	Traffic Speed (km/hr)[(1)]	Carbon Monoxide (ppm)		Hydrocarbons ($\mu g/m^3$)			Nitrogen Dioxide ($\mu g/m^3$)		Particulates (PM_{10}) ($\mu g/m^3$)		
		Maximum 1-Hour	Maximum 8-hour	Maximum 1-hr hydrocarbon	Annual average hydrocarbon	Annual mean Benzene	Maximum 1-hr NO_2 99.8$^{th\%ile}$ of 1-hr NO_2	Annual average NO_2	Annual average	Maximum 24-hr value	90.1th%ile of maximum 24 hr values
2007 Do-minimum	**Design**	0.58	0.34	86	4.2	0.68	54.8	11.0	11.5	19.5	14.6
2007 Do-something	**Design**	0.43	0.23	49	3.7	0.67	57.6	11.5	11.7	15.1	13.5
2022 Do-minimum	**Design**	0.30	0.20	68	3.4	0.57	43.1	8.6	11.4	18.9	15.6
2022 Do-something	**Design**	0.26	0.16	47	3.5	0.57	48.2	9.6	11.8	15.3	14.3
Standards		–	8.6[(2)]	–	–	5[(2)]	200[(3,4)]	40[(3)]	40[(3)]	–	50[(3,5)]

(1) Traffic 90 Km/hr N9, 40 km/hr all side roads
(2) EU Council Directive 2000/69/EC
(3) EU Council Directive 1999/30/EC
(4) 1-hr limit of 200 $\mu g/m^3$ not to be exceeded > 18 times/year (99.8th %ile)
(5) 24-Hr limit of 50 $\mu g/m^3$ not to be exceeded > 35 times/year (90.1th %ile)

7.5 APPENDIX I: REFERENCES

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