

Chapter 6

Population and Human Health

6.1 Introduction

This chapter addresses the potential impacts of the construction and operation of the Foynes to Limerick Road (including Adare Bypass) (hereafter referred to as “the proposed road development”) in respect of Population and Human Health. ‘Population’ also refers to Socio-economic and Community Impacts. Actual and perceived impacts of the proposed road development on the population and human health may arise from various aspects of the proposed road development. These impacts are dealt with throughout the Environmental Impact Assessment Report (EIAR).

Human health impacts are primarily considered through an assessment of the environmental pathways by which health can be affected such as air, noise, water or soil. Therefore, the human health impact assessment relies on the assessments and draws on the findings in the following chapters as necessary to assess the impacts on human health:

- Chapter 8, Soils and Geology – to identify if there are any areas of contaminated soils;
- Chapter 9, Hydrogeology – to identify areas with any potential impacts on groundwater;
- Chapter 10, Hydrology – to identify areas with any potential impacts on surface water and areas of flood risk;
- Chapter 12, Noise and Vibration – to identify the predicted noise levels at properties adjacent to the proposed road development; and
- Chapter 13, Air Quality and Climate – to identify the predicted air quality values adjacent to the proposed road development.

The human health impact assessment also considers physiological effects, health improvement and improvement to services. Other aspects, such as changes in traffic flows, which are dealt with in Chapter 5 Traffic Analysis, have also been considered in this chapter, in relation to the assessment of Socio-economic and Health impacts, to ensure that the effects of these issues on population and human health have been addressed.

This chapter sets out the methodology applied in the population and human health impact assess, describes the receiving environment in terms of population and human health, and summarises the main characteristics of the proposed road development which are of relevance for population and human health. The evaluation of impacts of the proposed road development on population and human health are described. Measures are proposed to mitigate these impacts and residual impacts are described. The chapter concludes with a summary section, followed by a reference list.

To inform the population and human health impact appraisal, this chapter has utilised the information gathered during the constraints and route selection studies for the proposed road development. Submissions received as part of the extensive public consultations carried out in respect of the proposed road development were analysed and design changes have been made to minimise the potential impacts in terms of population and human health. These submissions also informed the assessment undertaken for this chapter.

6.2 Population Assessment Methodology

6.2.1 Introduction

This Section sets out the methodology employed in the assessment of impacts on the population in the study area, excluding human health impacts, which are addressed in Sections 6.5 – 6.7, below.

6.2.2 Study Area

The study area for the population and human health impact assessment extends from the western extremity of the proposed road development at Foynes to the tie-in with the existing N21 at Attyflin, a short distance east of Adare. It is situated in central County Limerick, in a predominantly rural area located close to the settlements of Foynes, Askeaton, Rathkeale, Croagh and Adare. It includes the Electoral Divisions (EDs) of: Shanagolden, Craggs, Askeaton West, Lismakeery, Nantinan, Riddlestown, Rathkeale Urban, Rathkeale Rural, Dromard, Croagh, Adare North, Adare South, Clarina, and Patrickswell.

6.2.3 Guidelines

The following guidelines have informed the development of this chapter:

- *Revised Guidelines on The Information to be contained in Environmental Impact Assessment Reports (Draft) (EPA, 2017);*
- *Updated Advice Notes on current practice in the preparation of Environmental Impact Statements (Draft) (EPA, 2015); and*
- *Guidelines on the Treatment of Tourism in an Environmental Impact Statement (Fáilte Ireland, 2011).*

Assessment of the impacts on the population has been undertaken in line with these guidelines. The Draft EPA Guidelines (2017) provide advice on impact types, including cumulative impacts, which are often particularly important for socio-economic impact assessments - for instance, where improved accessibility presents opportunities or demand for new development.

In addition, reference is made to the guidelines provided on Community Effects in Volume 11 (Section 3, Part 8) of the UK Department of Transport publication, '*Design Manual for Roads and Bridges*' (1993, as updated 2009). Although these guidelines have not been adopted officially in Ireland, they provide further guidance that can be used to quantify community impacts.

6.2.4 Data Sources and Consultations

A population and human health impact assessment requires that an understanding of the community is built up through background research, site visits, and discussions with local people and community representatives. Specifically, in the case of this study, data has been collected by the following sources / means:

- Primary data sources (e.g. demographic data from Census 2016 and Census 2011 of the Central Statistics Office (CSO));
- Drawings of the proposed road development, including associated junctions;
- Maps of the surrounding area, including Ordnance Survey (OSi) 1:50,000 maps;
- Other relevant environmental data gathered during the process of preparing this EIAR, especially traffic volumes, and noise and visual amenity impacts;

- A review of relevant planning documents, including the *Limerick County Development Plan 2010-2016* (as extended), the *Askeaton Local Area Plan (LAP) 2015-2021*, the *Patrickswell LAP 2015-2021*, the *Rathkeale LAP 2012-2018* (extended to 2022), the *Adare LAP 2015-2021* and the *Croom LAP 2009-2015* (extended to 2019);
- A review of secondary sources, including the *Regional Planning Guidelines for the Mid-West Region 2010-2022*, the *National Planning Framework 2040* and the *National Development Plan 2018-2027*;
- Observation of local settlement and travel patterns and identification of community facilities;
- Review of consultations undertaken by Limerick City and County Council.

6.2.5 Population Impact Categories and Their Assessment

6.2.5.1 Overview

The purpose of the population and human health impact assessment is to identify the likely significant impacts as they might affect users of the proposed road development and local people.

6.2.5.2 Construction Impacts

Impacts on the population which might be expected to arise during the construction phase include:

- Impacts due to construction traffic on journey or general amenity;
- Impacts on environmental and/or residential amenity;
- Purchases of local materials and services; and,
- Construction employment and local expenditure by construction workers.

6.2.5.3 Operational Phase

Impacts during the operational phase fall into five key categories, namely:

1. Journey Characteristics

Potential impacts on local journey time, journey time reliability (i.e. the assurance of completing a journey within a predictable time range), journey safety for road users and travel patterns including connectivity;

2. Community Severance

Potential impacts with regard to any severance from community facilities, particularly those used by older people, children or other sensitive or vulnerable groups (this category includes both new severance and relief from existing severance);

3. Amenity

This category includes potential impacts on journey amenity arising from the exposure of pedestrians and cyclists to traffic (due to proximity, safety, noise, dirt, poor air quality), as well as impacts for all road users arising from factors such as visual intrusion and congestion. In addition, impacts on general amenity are addressed, where amenities and residential quality of life are affected; and,

4. Economic Impacts

Impacts in respect of economic development and employment.

6.2.5.4 Impact Ratings

Impacts are compared between the 'Do-Minimum' and 'Do-Something' scenarios and result from direct, indirect, secondary and cumulative effects on environmental conditions. Effects can be positive, neutral or negative. The significance of an effect is described as one of the following 7 impact levels:

- Imperceptible;
- Not Significant;
- Slight;
- Moderate;
- Significant;
- Very Significant; or
- Profound.

Impacts on population are a function of:

- The location and character of the local environment;
- The sensitivity of the local population and its capacity to absorb change;
- The nature of the environmental effect;
- The scale or extent of the effect in terms of area or population affected;
- The duration (temporary or permanent) and frequency of an effect; and,
- The probability of an impact's occurrence.

The assessment generally addresses impacts at a community level rather than for individuals or identifiable properties, although impacts for individual businesses are discussed where these are located beside the road or are very dependent on road traffic or accessibility. Impacts on individual properties are addressed separately in Chapter 12 Noise and Vibration, Chapter 13 Air Quality and Climate, Chapter 15 Material Assets and Land – Agriculture and Chapter 16 Material Assets and Land – Non-Agriculture.

Journey Characteristics

Assessment of journey times and patterns is inevitably dependent on precisely where an individual journey originates and ends, when it is undertaken (e.g. within or outside peak hours) and by whom it is undertaken (i.e. by drivers, cyclists, users of public transport or pedestrians, including individuals whose transport options may be restricted). The impact varies for each journey, but typical journeys to particular destinations can usually be identified. Impacts have been assessed in accordance with the significance criteria outlined in Table 6.1, which are derived from the Draft EPA Guideline ratings, with positive impacts resulting from a decrease in journey length or duration and negative impacts resulting from an increase.

Table 6.1 Criteria Used in the Assessment of Changes in Journey Length or Duration

Impact Rating	Significance Criteria
Imperceptible	A measurable change to present journey lengths or durations but without significant consequences.
Not Significant	Noticeable changes to journey lengths or durations without significant consequences.

Impact Rating	Significance Criteria
Slight	Slight improvement in journeys where impact is positive. Some inconvenience where impact is negative. Some likelihood of changes in journey habits.
Moderate	Moderate reduction in journeys where impact is positive, moderate increase where impact is negative. Greater likelihood of changes in journey habits.
Significant	Much shorter journey times where impact is positive, much longer journeys where impact is negative. High likelihood of changes in journey habits.
Very Significant	Considerably shorter journey times where impact is positive, considerably longer journeys where impact is negative. Very high likelihood of changes in journey habits.
Profound	An approximate doubling (or halving) in typical journey length or duration sufficient to cause marked change in behaviour of a sizeable proportion of population

Journey length refers to the distance associated with a particular journey, whilst duration is the time taken to make the journey. Average walking speed for pedestrians is taken to be 5km/h. Average cycling speed is assumed at 20 km/h. Impacts on journey amenity and community severance are addressed separately, although there are obvious interactions between each of these categories and with economic impacts. In addition, new transport facilities can improve accessibility or connectivity through the combined effect of reduced journey time and reduced severance. Improved connectivity can have implications for choice of transport mode, for land use and for economic development.

Journey Amenity, General Amenity and Safety for Road Users

The assessment of journey amenity relies on the significance criteria given in Table 6.2, which are derived from the Draft EPA Guideline ratings, and is supported by cross-reference, where necessary, with Chapter 5, Chapter 11 and Chapter 12. The level of traffic on a road, the proximity and separation of footpaths and cycle-paths, the nature of any crossings / junctions to be negotiated, the legibility of a journey (including signage), degree of visual intrusion (including sightlines) and safety for vulnerable road users, such as pedestrians, cyclists and equestrians, are amongst the factors relevant to the assessment of amenity, as are the number and types of people affected. The principal concern is with pedestrians or cyclists, but journey amenity impacts also apply to drivers; for example, due to safety anxiety associated with the crossings of major roads. Such journeys could involve older drivers or vehicles with school children as passengers. There are interactions too with the assessment of journey characteristics and community severance.

Observations can also be made with regard to impacts on the health and general amenity of people living in the vicinity of a proposed road development. The key criteria here are community wellbeing, including social sustainability and the effect of the interactions with traffic experienced by other road users (including pedestrians and cyclists) and nearby residents. Direct impacts on communities due to large numbers of residential acquisitions or the loss of community facilities, such as open space, can also impact on community wellbeing or social interaction. Indirect impacts may result from changes in environmental quality, for instance, from noise or visual intrusion. The possible impact of noise or air quality on people's health is specifically addressed in the relevant chapters of this EIAR and in the Human Health section of this Chapter.

These impacts have a cumulative dimension in that human well-being is affected too; for example, where people live in a highly trafficked environment.

Table 6.2 Criteria Used in the Assessment of Amenity Impacts

Impact Level	Significance Criteria
Imperceptible	No significant amenity or safety impacts are apparent.
Not Significant	Noticeable changes to amenities and safety without significant consequences.
Slight	A small impact on community wellbeing, safety or an amenity can be attributed to the proposed development.
Moderate	A moderate impact on the community wellbeing, safety or an amenity can be attributed to the proposed development.
Significant	A proposed development has the potential to impact on community wellbeing, safety or an amenity such as to significantly affect many people's behaviour and quality of life or the functioning of the amenity.
Very Significant	A proposed development has the potential to substantially impact on community wellbeing, safety or an amenity such as to affect most people's behaviour and quality of life or the viability of the amenity.
Profound	Effects of a scale to significantly impact on community wellbeing or safety to an extent that people's behaviour or quality of life is substantially changed; for example, where significant health issues arise or where people may wish to relocate.

Severance

Severance is a typical impact of road development. Its effect is to discourage community interaction and it occurs where access to community facilities or between neighbourhoods is impeded by a lengthening of journey time or by the physical barrier of a road; for example, high traffic volumes or perimeter fencing. Social severance can occur due to restrictions on people's accessibility, but also where communities become identified by their containment within road boundaries. This can include the psychological effect of traffic or safety concerns as barriers to social interaction. Social severance could occur for busy roads such as motorways even where access is available. On the other hand, relief from existing severance may be provided by a new road where traffic volumes or speed are moderated, by the inclusion of crossing facilities in the design or through the presence of overbridges or underpasses.

The definition of severance is not precise. It depends on the location of community facilities, the level of use of facilities, the time of day or duration when traffic conditions are experienced, the sensitivity of the population affected and the geographical spread of the community. Children, the elderly, the mobility impaired and people without access to a private car would be amongst those most affected by community severance and any corresponding loss of neighbourhood interaction.

New severance is a negative impact and occurs whenever a barrier is created between people and community facilities. The barrier could take the form of a new road, fencing, additional traffic or the need to detour. Table 6.3 provides examples of how new severance can be assessed and is derived from the EPA Draft Guidelines ratings. The criteria are specific to pedestrians, although severance will apply also to cyclists and potentially to local vehicle journeys too, particularly for some sensitive population sub-groups. Quantitative criteria have not been included in the table as impact definitions may vary depending on the nature of road trips and crossings. Similarly,

the introduction of crossing facilities could reduce severance even where traffic levels are increased.

Table 6.3 Criteria Used in the Assessment of New / Increased Severance

Impact Level	Significance Criteria
Imperceptible	Journey patterns maintained.
Not Significant	Noticeable changes to journey lengths or durations without significant consequences.
Slight	Present journey patterns likely to be maintained, albeit with some hindrance to movement.
Moderate	Some residents, including children and elderly people, are likely to encounter severance. For others, journeys will be longer or less attractive.
Significant	Many residents, including children and elderly people, are likely to encounter significant severance which could dissuade them from making particular journeys.
Very Significant	Most residents, including children and elderly people, are likely to encounter significant severance which will be sufficient to induce a reorganisation of their activities, to cause them to make less frequent trips to nearby neighbourhoods or to make less use of particular community facilities.
Profound	People are likely to be deterred from making trips to an extent that includes permanent loss of access or a change in the location of centres of activity.

Relief from Severance

Relief from severance is a positive impact which can be defined in relation to existing severance. Relief from severance could follow from a transfer of traffic including heavy goods vehicles (HGVs), from improvements to road design or sightlines, or from the introduction of crossing facilities, underpasses or bridges. The degree of relief from severance depends on the context in which this change occurs, including the existing volume of road traffic, the speed of traffic, sightlines and the number of crossings by pedestrians, cyclists or others. Table 6.4 provides a guide to criteria used in the assessment of relief from severance and has been derived from the Draft EPA Guidelines ratings. Where the assessment varies from these definitions due to the context in which the relief occurs, the reasons for the assessment are discussed in the text. Where there are implications for real and perceived safety, there are also potential interactions with Journey Amenity.

Table 6.4 Criteria Used in the Assessment of Relief from Severance

Impact Level	Significance Criteria
Imperceptible	<10% reduction in daily traffic levels (AADT) or current journey patterns maintained.
Not Significant	Noticeable changes to journey lengths or durations without significant consequences.
Slight	10-30% reduction in traffic levels (AADT) or some reduction in severance.
Moderate	31-50% reduction in traffic levels (AADT) or a reduction in severance sufficient to encourage some new journeys by foot or bicycle.

Impact Level	Significance Criteria
Significant	51-70% reduction in traffic levels (AADT) or a reduction in severance sufficient to allow residents to make more frequent journeys to particular community facilities by foot or bicycle.
Very Significant	71-90% reduction in traffic levels (AADT) or a very significant reduction in severance sufficient to allow most residents make more frequent journeys to particular community facilities by foot or bicycle.
Profound	More than 90% reduction in traffic levels (AADT) or reductions in severance such as to provide new access to community facilities or to cause a very significant increase in pedestrian or cycle journeys.

Sensitive groups are identified specifically where they comprise a higher proportion of pedestrian journeys or where specific amenities are associated with these groups. Sensitive groups can include young and older population cohorts, the mobility impaired and people at risk of social isolation. Relevant facilities include schools, surgeries, hospitals, churches, post offices and shops.

Economic Impacts

Economic and employment impacts occur at both the regional and local scale and can be either positive or negative. Much road development is proposed with the intention of improving national competitiveness and economic / social linkages; for instance, in relation to reducing journey time and improving journey time reliability for commercial goods or for commuting employees. However, there can also be some negative impacts in relation to loss of passing trade to businesses such as newsagents, grocery stores, service stations, guest houses, etc. Impact levels are defined in Table 6.5, below, and are derived from the Draft EPA Guideline ratings:

Table 6.5 Criteria Used in the Assessment of Economic Impacts

Impact Level	Significance Criteria
Imperceptible	No significant economic impacts are apparent.
Not Significant	Noticeable changes to journey lengths or durations without significant consequences.
Slight	A small effect on the business environment can be attributed to the proposed development.
Moderate	A moderate effect on the business environment can be identified.
Significant	An effect that has the potential to impact on business performance or to influence the location decisions of new business.
Very Significant	An effect that has the potential to substantially impact on business performance or to influence the location decisions of new business.
Profound	Effects of a scale to substantially impact on the performance of a major business or several businesses. Where these businesses are important local employers there is the possibility of major impacts for the general prosperity of the local area or region.

Economic impacts may affect an identifiable local business and such businesses could be important local employers. In this case, impacts on individual companies are discussed in the text. Other economic impacts could affect the wider community, for example where a number of businesses are affected or where the retail or business environment of a town or village is impacted. Again, such impacts can be positive or negative.

6.3 Description of Receiving Environment for Population

6.3.1 Introduction

An accurate assessment of the receiving environment is necessary to predict the likely significance of the impacts of the proposed road development.

6.3.2 Context

The proposed Foynes to Limerick Road (including Adare Bypass) is located in County Limerick in a predominantly rural area, located close to a number of settlements, including Foynes, Askeaton, Rathkeale, Croagh, Adare and Patrickswell.

The route of the proposed road development commences south of the village of Foynes on the N69 Limerick to Tralee National Secondary Road. From there, it proceeds south and west for 6.3km towards the town of Askeaton. At the townland of Ballyclogh, approximately 2km west of Askeaton, the proposed road will split. A short branch will continue east to the town of Askeaton for 1.9km. The main route will continue south for approximately 9.3km where it will join the existing N21 on the northern outskirts of Rathkeale. From this junction at Rathkeale the new M21 motorway will run for 17.5 km eastwards to Attyflin, east of Adare, where it will link with the M20 for connection to Limerick City. The new M21 will therefore bypass Croagh and Adare. There will be two grade separated junctions serving Croagh and Adare, respectively.

According to Census 2016, the study area has a population of 13,537, which represents a slight decline of 82 persons or 0.6% since Census 2011. The population of the study area at the time of Census 2006 was 13,095. The average population density of the study area is just 53.7 persons/km² reflecting the relatively rural nature of the area. In contrast to the slight decline in the population of the study area since 2011, the population of Co. Limerick as a whole increased by 1.6% between Census 2011 and Census 2016, and the population of the State increased by 3.8% over the same period. Full details of population and population change in each ED in the study area are set out in Table 6.6, below:

Table 6.6 Population of the Study Area

Electoral Division	2016	2011	% Change	Persons/km ²
Adare North	585	622	-5.9%	33.5
Adare South	2,031	2,028	0.1%	94.8
Askeaton West	1,186	1,178	0.7%	82.8
Clarina	1,770	1,730	2.3%	84.9
Craggs	258	272	-5.1%	19.5
Croagh	773	748	3.3%	34.9
Dromard	882	857	2.9%	33.0
Lismakeery	433	428	1.2%	20.6
Nantinan	730	759	-3.8%	33.7
Patrickswell	1,451	1,445	0.4%	116.4
Rathkeale Rural	316	321	-1.6%	33.2
Rathkeale Urban	1,371	1,479	-7.3%	228.9

Electoral Division	2016	2011	% Change	Persons/km ²
Riddlestown	586	593	-1.2%	27.0
Shanagolden	927	946	-2.0%	77.5
Total/Average	13,299	13,406	-1.14%	65.8
Limerick City & County	194,899	191,809	1.6%	
State	4,761,865	4,588,252	3.8%	

Source: Census 2016 (CSO, 2017); Census 2011 (CSO, 2012)

Table 6.7, below, gives the employment status of all of the persons aged >15 years in the study area. It shows that 16.7% of this group are retired, compared to an average of 14.5% for the State as a whole. The share of the population who are full time homemakers or carers is also higher than the national average, at 9.1%, compared to 8.1% for the State as a whole. As a result, the share of the population in the study area who are at work is approximately 2% lower (51.5%) than that for the State as a whole (53.3%), despite the fact that the unemployment rate in the study area is only 6%, compared to a national average of 7.1%.

Table 6.7 Employment Status of Persons >15 in the Study Area

	Number	%
At Work	5,549	51.5%
Looking for first Job	65	0.6%
Unemployed	650	6.0%
Student	1,160	10.8%
Looking After Home / Family	979	9.1%
Retired	1,799	16.7%
Unable to Work	521	4.8%
Other	48	0.4%
Total	10,771	100.0%

Source: Census 2016 (CSO, 2017)

Table 6.8, below, shows how residents of the study area of school or working age make their daily journeys to work, school or college. The study area is predominantly rural, so there are limited opportunities for public transport, and journeys to school, work or college tend to be long. As a result, the population of the study area is highly dependent on cars for these essential journeys. A large proportion (69.4%) of the population of the study area travel to work, school or college by car, either as a driver or passenger. This is higher than the national average of 58% and reflects the rural nature of much of the study area.

Table 6.8 Travel to Work, School or College in the Study Area

	Number	%
On foot	697	8.8
Bicycle	40	0.5
Bus, minibus or coach	598	7.5

	Number	%
Train	11	0.1
Motorcycle or scooter	12	0.2
Car driver	3,766	47.5
Car passenger	1,734	21.9
Van	414	5.2
Other	46	0.6
Work at home	334	4.2
Not stated	277	3.5
Total	7,929	

Source: Census 2016

6.3.3 Character and Significance of the Study Area for Population

The study area is rural in character with a low population density. It extends on either side of:

- the current N69 between Foynes and Askeaton;
- the current R518 between Askeaton and Rathkeale; and,
- the current N21 between Rathkeale and the tie in with the M20 east of Adare.

The main settlements in the study area are Foynes, Askeaton, Rathkeale, Croagh, Adare and Patrickswell. Community facilities which are mainly located within these population centres are shown in Figure 6.1 of Volume 3.

Foynes

Foynes is the site of a deep-water port on the Shannon Estuary with industrial and storage facilities including Irish Bulk Liquid Storage and Atlantic Fuels. It has lands zoned for further marine related industrial uses. The town and port are connected to Limerick by the N69 National Secondary Road and to the mainline rail network by a rail track that is not currently in use. In the early years of aviation, the town was a base for flying boats, and it has a museum for these craft. Limerick City and County Council (LCCC) has prepared the "Foynes Theme Town" plan to develop the town as a tourism centre. The town is a model estate town and was a base for transatlantic transport in the 19th and early 20th century. Foynes sits in the Electoral Division of Shanagolden, which had a population of 927 in 2016. The town itself had a population of 520 in 2016, down from 542 in 2006. The current N69 passes through Foynes. The proposed road development will start on the N69 south of Foynes and proceed on towards Rathkeale.

Askeaton

Askeaton is located approximately 8km east of Foynes, 25km west of Limerick City and just south of the N69 Limerick to Tralee road. The hinterland is a lowland rural area defined in the *Limerick County Development Plan 2010 – 2016* (as extended) as an area of 'Strong Agricultural Base' to the west of the town and 'Structurally Weak' to the east of the town. The River Deel flows north through the centre of the town and enters the Shannon Estuary 2.5km to the north. This town was bypassed in the 1980s.

Askeaton is essentially a linear town having developed at a bridging point on the River Deel and has numerous historical structures including the Friary and the Castle. The town performs an important civic, trade / market and service function for the resident

population and for the surrounding hinterland. This is evident from the diverse range of services and businesses operating in the town. Most of the local economic activity is located on Main Street, East Square and West Square and part of Church Street. A 2km long spur from the proposed new road development will extend towards Askeaton from the south-west.

Rathkeale

Rathkeale is essentially a linear town with development having taken place off the side roads to the north and south of Main Street. The Square, the River Deel and the traditional streetscape are all important elements in the makeup of the town's physical appearance. Rathkeale is typical of an urban settlement located in a predominantly rural area. The town performs an important civic and service function with a concentration of civic amenities including churches and schools. The current N21 bypasses north of Rathkeale as it runs eastward towards Limerick, and the proposed new road will connect with the existing route on this corridor such that access will remain largely unchanged but marginally further from the centre of Rathkeale.

Croagh

Croagh is a small settlement on the N21 between Rathkeale and Adare. Following a previous upgrade of the N21, the majority of the settlement, including its main street, now lies north of the existing N21. The settlement consists of approximately 31 dwellings with a variety of local services include a primary school, church, shop, GAA club, music school, doctor's surgery, a large nursing home and a number of other facilities. There are a number of businesses that serve local customers and some level of passing trade from the N21. These businesses include two petrol stations (one on the N21 east of Croagh, and one on the R523 linking Croagh to Rathkeale), a café and garden centre, two public houses and a number of guest houses.

Adare

Adare is located approximately 15km south west of Limerick City on the N21. Adare Manor demesne, with a hotel and golf course, occupies a substantial area of land to the south and east of the town and is characterised by maintained parkland, extensive woodlands, mature tree groups and prominent formal avenues. The old Limerick to Foynes railway line runs to the north of the village.

The village has developed in a linear fashion along the N21, the L-1423 Station Road, which links towards Kildimo and Pallaskenry to the north, and the L-1422 Blackabbey Road towards Cappagh and Askeaton to the northwest. Adare provides services for the surrounding agricultural community.

Adare is a Heritage Village as defined by Fáilte Ireland and possesses a wealth of ancient monuments and historic artefacts which support the town as a major tourist destination. The town performs an important civic and service function with a concentration of civic amenities, including schools, churches and a library. These provide services not only for the resident population but also for a much wider rural based population.

Reflecting the importance of tourism to the village, the Adare Heritage Centre provides a wide range of visitor services including tourist information, a historical exhibition, and heritage tours. Tourist accommodation is provided by the Dunraven Arms Hotel, Adare Manor Hotel and Golf Resort, and the Woodlands House Hotel & Spa, located just outside the village to the east as well as several Bed & Breakfasts located throughout the village and surrounding areas. There are numerous restaurants, cafés and pubs in the village.

The proposed road development will bypass Adare to the north, removing traffic from the village along the existing N21 and reducing the congestion which the village currently experiences, especially on Bank Holiday weekends, when traffic delays are known to be particularly bad. The removal of congestion through Adare village will have a positive effect on tourism within the village, by improving the visitor experience for tourists and providing infrastructure with sufficient capacity for the through traffic. The village will be accessible via a junction on the new M21 a short distance to the northeast.

Patrickswell

Patrickswell is a small village located on the Regional Road R526 just north of the M20. Its located approximately 7km southwest of Limerick and 7km east of Adare. The village is developed in a linear fashion along the R526 which was formerly the N21 before the village was bypassed in 2001. The village can be accessed by the exits east and west of the town from the M20 and is connected to Clarina which is approx. 4km north, via a local road. The proposed road development will tie into the Attyflin junction which is west of Patrickswell and will not effect the existing access to Patrickswell from the national road network.

6.3.4 Existing Road Safety

The Road Safety Authority (RSA) Personal Injury Accident (PIA) database has been consulted regarding collisions along the N69 between Limerick and Foynes and along the N21 between the M20 / N20 / N21 junction at Attyflin and Rathkeale.

Plate 6.1 shows the locations of all collisions along the N69 between Foynes and N18 Junction 2 (Dock Road Junction), while Plate 6.2 shows the collisions along the N21 between the M20 / N20 / N21 Junction and Rathkeale between 2008 and 2015. A summary of the total number collisions and subsequent casualties by severity are presented in Table 6.9.

Table 6.9 Collision Data (2008 - 2015)

Accident Type	N69			N21		
	Fatal	Serious	Minor	Fatal	Serious	Minor
Collisions	1	4	72	5	11	72
Casualties	1	5	102	7	16	118

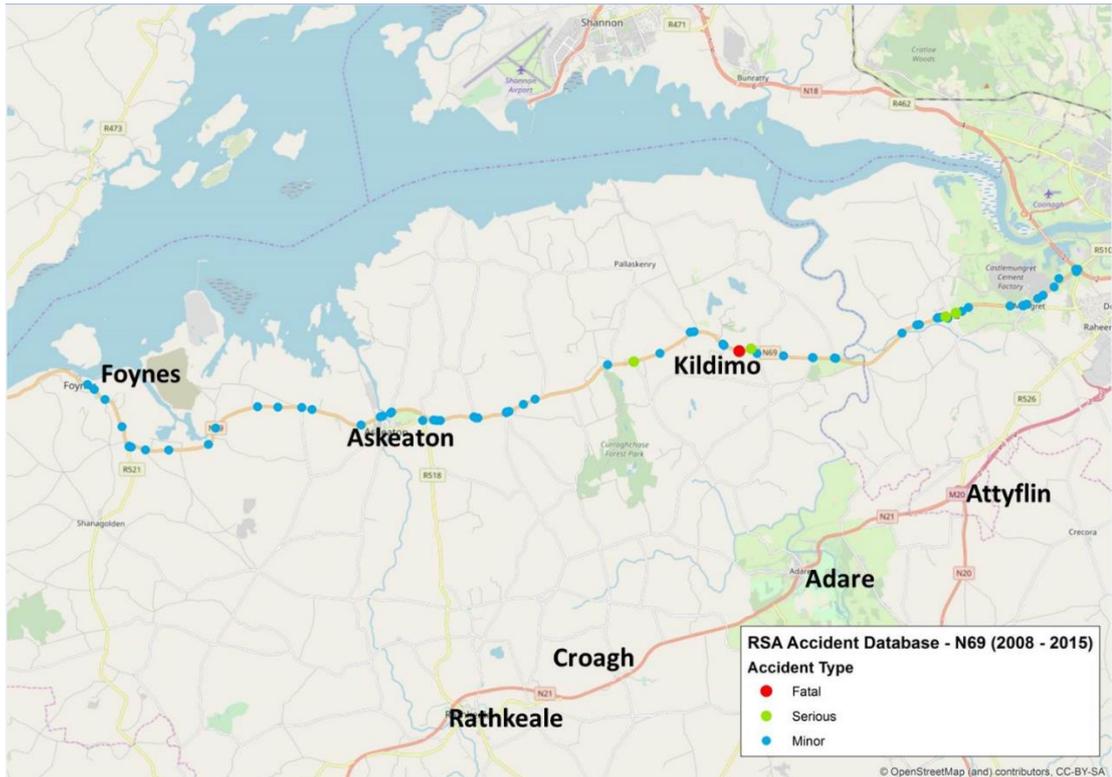


Plate 6.1 N69 RSA Collision Data (2008-2015)

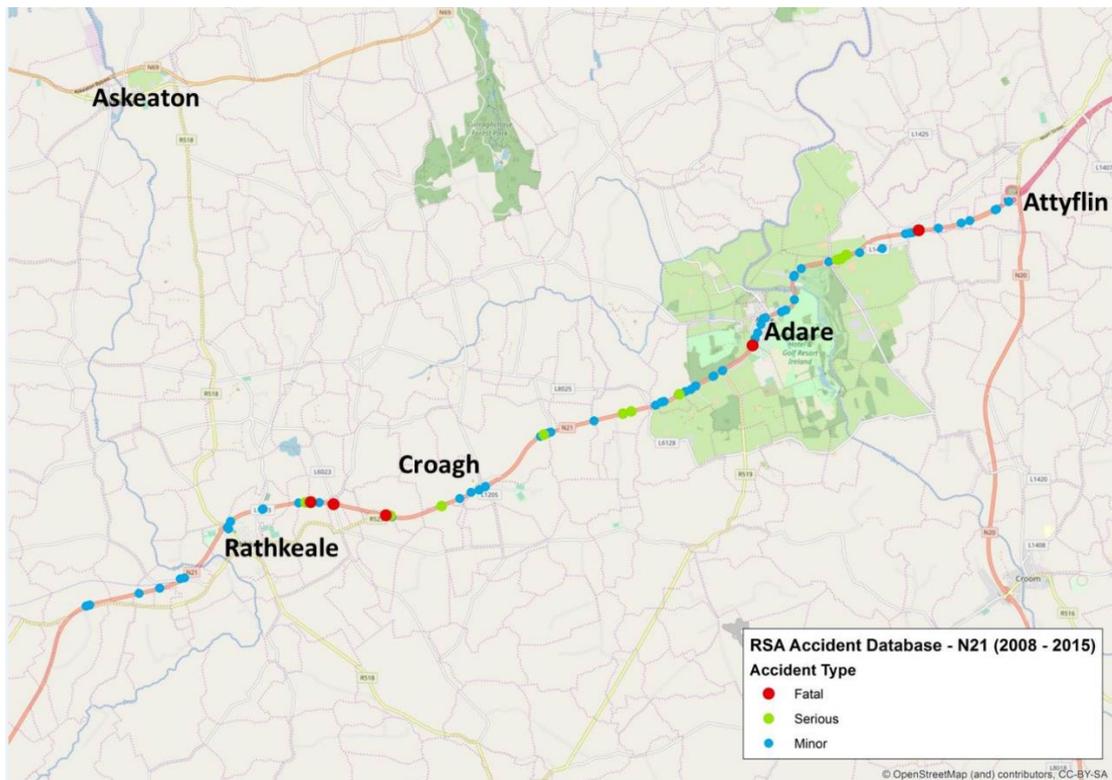


Plate 6.2 N21 RSA Collision Data (2008-2015)

TII Standard, *GE-STY-01022 Network Safety Analysis*, is used to identify sections of the national road network which have a high concentration of collisions and to rank the safety of the road network. The ranking is based on the collision rate (number of collisions per 100 million vehicle kilometres travelled) on road sections of

approximately 1km compared against the national average collision rate for a similar road type. Plate 6.3 shows the ranking of both the N69 and N21 corridors for 2014 to 2016. Both roads are considered to be 'Rural Single Carriageways' and the ranking of collisions is categorised as follows:

- Twice above national average collision rate;
- Above national average collision rate;
- Below national average collision rate; and
- Twice below national average collision rate.

There are several sections on both corridors which have a ranking of above or twice above the national average collision rate for a rural single carriageway road, which would require rectification as a priority. On the N69, 38% of the route is classified as having an accident rate greater than the national average, of which 11% of the route is twice above the national average. For the N21, 43% of the route is classified as having an accident rate greater than the national average, of which 0% of the route is twice above the national average.

EuroRAP Risk Rating for Road Safety

EuroRAP, 'The European Road Assessment Programme' identifies the current safety standing of major roads within the EU. It calculates this based on collision statistics and vehicular traffic flows on the roads in question. The N69 between Limerick and Foynes has been identified as a 'Medium Risk' road with the N21 between Rathkeale and Attyflin identified as a 'Low - Medium Risk'. Plate 6.4 shows the EuroRAP Risk Rating map for Ireland.

In addition to the EuroRAP Risk rating, a EuroRAP Road Protection Score (RPS) has been developed to assess the protection that the road environment will provide to the occupants of a car in a collision. For this score, a star rating has been assigned to sections of road based on the features of the road which either increase or decrease the risk to the occupant of the vehicle ranging from 1 Star (worst) to 5 Star (best).

Based on the EuroRAP rating system, the N69 between Foynes and Limerick was awarded a 1 Star rating indicating the highest level of risk to vehicle occupants. The N21 has a 2 Star rating over its entire length (see Plate 6.5). These poor safety ratings reflect the low-quality of the existing roads in relation to the design standards, as appropriate to the current traffic demands.



Plate 6.3 N69 & N21 HD15 Collision Rates 2014 - 2016

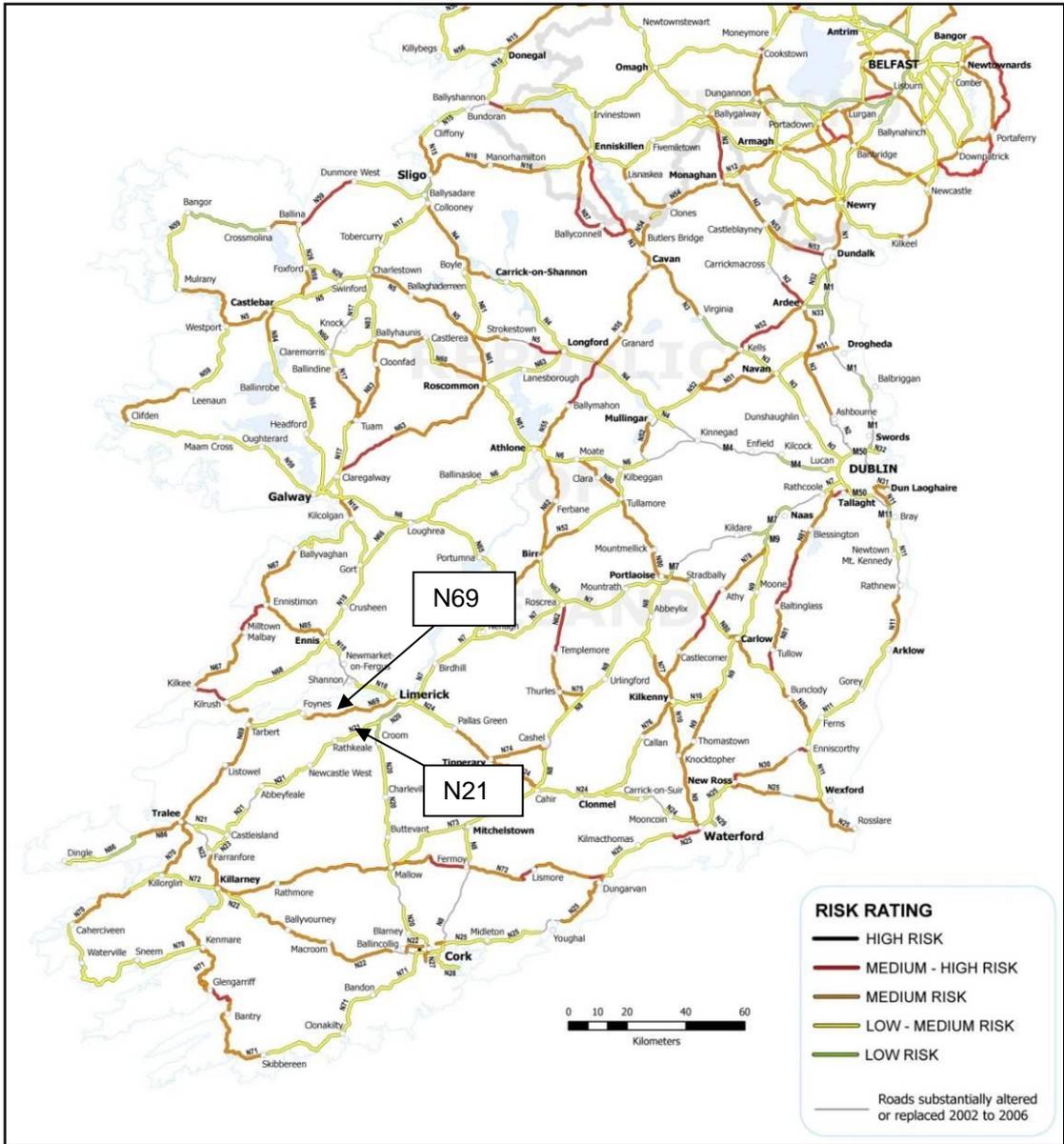


Plate 6.4 EuroRAP Risk Rating Map Source: EuroRAP 2008: Ireland Results

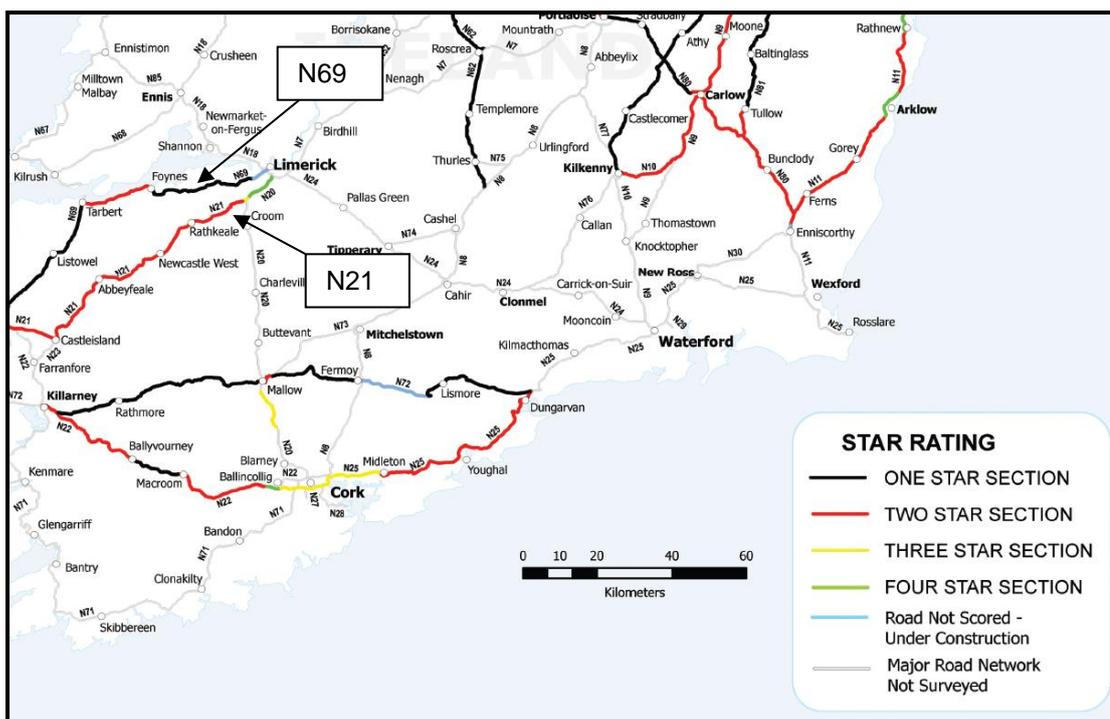


Plate 6.5 EuroRAP Star Rating Map Source: EuroRAP 2008: Ireland Results

6.3.5 Sensitivity for Population

The proposed road development will provide a replacement of the following sections of the National and Regional road network for most traffic:

- N69 between Foynes and Askeaton;
- R518 between Askeaton and Rathkeale; and
- N21 from Rathkeale to Attyflin, just west of Patrickswell.

Currently, the N69 from Foynes towards Askeaton runs through an agricultural landscape with scattered housing, farmyards and businesses located on or near the road as well as several villages at Kilcornan, Kildimo, Clarina and Mungret. The N69 then bypasses Askeaton, passing close to the northern fringe of the town.

The R518 extends southward from Askeaton across a rural area towards Rathkeale. Between Askeaton and Rathkeale, the R518 runs through an agricultural landscape with scattered housing and farmyards located on or near the road. The R518 has its junction with the N21 on the northern fringe of Rathkeale.

The N21 bypasses Rathkeale to the north. Some housing, a GAA club and a large meat plant are currently severed from the rest of Rathkeale by the N21, but this is mitigated by the provision of two under-bridges on the R518 and L-1203, which enable local movements to avoid crossing the busy N21.

From Rathkeale, the N21 continues east towards Croagh. The majority of Croagh lies to the north of the N21, following an earlier upgrade of this road which had the effect of partially bypassing Croagh. Some housing and a GAA club are severed from Croagh by the N21. This is partially mitigated by traffic-calming and a 60 km/h speed limit on the N21 at the village.

The N21 continues east, passing through the centre of Adare, as it follows the line of the main street in the town, where the high volumes of traffic give rise to significant

community impacts and severance with regular traffic congestion and delay. Local movements around Adare and to-and-from the wider surrounding area are adversely affected by the major traffic flow through the village.

After Adare the N21 continues towards Limerick City. It ends at a grade-separated junction of the N20 and the M20 in the townland of Attyflin, just west of Patrickswell.

6.4 Predicted Impacts on Population

6.4.1 Journey Impacts

The proposed road development will have a very significant positive impact in terms of journey times and journey time reliability due to the separation of regional and national traffic from local traffic, as described in Chapter 5. For illustrative purposes, the current driving time from Attyflin to Foynes is 32 minutes off peak¹, representing an average speed of 60 kph. The proposed road development, with Motorway speeds on half of this journey and Express Road speeds on the remainder, would produce significant time savings of 7 minutes for light goods vehicles and 12 minutes for HGVs typically, and in the order of 15 to 20 minutes at peak times (refer to Chapter 5 for more details on journey time savings). The proposed road development will be used for a wide range of local, regional and national journeys and will provide time savings for all trips.

The proposed road development will represent a significant positive impact on journey amenity for regional and national road users due to the avoidance of the current significant congestion and delay at Adare. The proposed new roads will provide safer opportunities for overtaking, provided by the segregation of slower moving local traffic on the 'old' road and the provision of dual lanes on the new roads.

The reduced volume of traffic on the existing roads will lead to a significant positive impact on the safety of the existing road network for pedestrians, cyclists and vehicular drivers. As discussed in Section 6.3.4, sections of the N21 and N69 are found to have collision rate thresholds twice above the national average. In particular, sections of the road which travel through villages such as Foynes, Kildimo, Croagh, Adare and on the bypasses of Rathkeale and Askeaton, have collision rate thresholds above the national average. The reduced volume of traffic, especially HGVs, will significantly improve the safety of the roads along the existing N69 and N21. The reduction in road collisions and the improvement of the safety of the road network will result in a profound positive impact on the population, as it will reduce the number of collisions and potential fatalities on the road network. Modelling completed as part of the traffic analysis (Chapter 5) found that the proposed road development can be expected to result in a reduction in the number of collisions in the study area of 427 over the 30-year appraisal period. This equates to a reduction in the number of casualties of 659 of which 11 are fatalities, 36 are serious injuries, and 612 are slight injuries. This will have a positive impact on the lives and health of individuals within the community.

The reduced volume of traffic on the existing roads will lead to a significant positive impact on journey amenity at a local level, particularly within villages. Crossings of the existing roads and right hand exits from these roads onto minor side roads will be safer due to reduced traffic on the former main roads. In addition, school and other drop-offs of children, local journeys and journeys on foot will experience a significant positive impact in both safety and amenity in Croagh and Adare, where these settlements will now be bypassed. Some similar benefits will arise from reduction in HGV traffic volumes on the N69 route through the settlements of Kilcornan, Kildimo, Clarina and

¹ Google Maps journey time from Attyflin to Foynes via N69 and N21, obtained 31st May 2019.

Mungret. Although few at present, pedestrian and cyclist journeys between properties along the existing roads, but outside settlements, will be safer and more pleasant, representing a moderate positive impact on vulnerable road users.

6.4.2 Amenity Impacts

A significant positive impact on general amenity will apply in the existing villages and towns along the N21 and N69 routes due to the transfer of traffic to the proposed new roads. There will be significant beneficial impacts due to reduced severance, noise, visual intrusion and improved local air quality due to reduced volumes of through traffic, as described in the relevant chapters of this EIAR (see Chapter 12 Noise and Vibration and Chapter 13 Air Quality and Climate). Much the same positive impact applies to individual residences along the existing road. The transfer of existing traffic to the proposed road development will have a positive impact on the general amenity of people living along the existing route due to a reduction in environmental impacts and also due to ease of access onto the existing roads due to lower traffic volumes, less severance and better connectivity along the existing and proposed roads. The community facilities within existing towns and villages and along existing roads, which will benefit from improved access and amenity are illustrated in Figure 6.1 of Volume 3.

6.4.3 Severance Impacts

Construction Stage Severance

Construction works for the proposed road development will have a potential impact on traffic where the proposed new roads will cross existing roads at new junctions or bridges. The proposed traffic management arrangements are described in Chapter 4 Description of the Proposed Road Development and will aim to minimise / avoid delays and disruption for travel by the local population during the construction period, apart from some short-term limited traffic controls for safety reasons during tie-in works. Traffic management measures and diversions are detailed in Table 4.21 of Chapter 4, outlining the roads which will be affected during the construction stage.

Construction works will have an impact on general amenity where the alignment is close to individual residences or where local roads are to be realigned. These impacts are described in detail in Chapter 11 The Landscape.

The lands to be acquired for the proposed road development include lands which are suitable for use as construction compounds, at all of the necessary locations. A general restriction will apply for all construction compounds not to be located within 100m of any inhabited dwelling so as to limit risk of noise nuisance impacts.

The main construction compound will be accommodated within the lands immediately west of the proposed Rathkeale Junction (see Section 4.16.10 of Chapter 4 for further information). The main compound site will be up to 2.5 hectares in size and may include stores, offices, materials storage areas, plant storage and parking for site and staff vehicles. This site is likely to remain in place for the duration of the construction phase.

Smaller temporary sites required for the construction of particular structures and bridges, excavation and processing of materials, specialised earthwork construction and at certain drainage areas, may also be sited at various locations along the length of the proposed road development. Such temporary sites will be subject to the provisions of this EIAR in terms of dust control and noise, including at night-time, etc.

Operational Stage Severance

There are four locations, as described in Chapter 4, where permanent road closures or diversion will occur, as listed below. Turning heads have been incorporated into the design to accommodate traffic which may need to turn on these severed roads. Diversions or new access tracks have been provided as discussed below and will result in slight increases in journey times for local users.

- L-6068 at Rincullia (Robertstown / Barrigone area east of Foynes): This road is to be permanently closed, which will involve up to 2km long diversions for access to some lands. This impact will be moderate with increased journey time of about 3 minutes per vehicle.
- Coopers Lane (Mulderricksfield): This private access track, which is to be severed, will be replaced by a new access track 300m further east, with a bridge over the proposed road. This impact will be slight due to the length of the diversion.
- The L-8027 Clogh Road intersects the L-6023 at Blossomhill Road and will be severed by the proposed motorway, which will be in cutting. A new link road will be provided north of the motorway over a length of 0.5km, which will connect the severed L-8027 Clogh Road to the L-6023 Blossomhill Road. The 500m diversion will have a slight impact on road users.
- L-8026 at Clonshire More (near Croagh): This road is to be diverted eastwards to the L-8025, which will involve a diversion by car of up to 1km for some local access. This impact will be slight with increased journey time of about 2 minutes per vehicle. For pedestrians, an underpass will be provided 150m east of the existing road, where the proposed motorway embankment will be sufficiently high above ground level to provide the necessary vertical clearance. This underpass will shorten the diversion length for people walking to 300m (3 – 4 minute's walk), compared to a 1km journey by road.

The proposed road development will attract significant transfers of through traffic from the following existing national and regional roads:

- N69 between Foynes and Askeaton;
- R518 between Askeaton and Rathkeale; and
- N21 from Rathkeale to Attyflin, just west of Patrickswell.

The proposed new roads will provide the benefit of greatly improved journey times for most traffic in the region. There will be considerable benefits for local amenity in the villages and towns along the existing routes due to lower through traffic flows. The improvement in regional journey times will make a positive contribution to the potential for economic development in Limerick City and County.

6.4.4 Economic Impacts

Reduced journey time and improved journey time reliability will provide an economic stimulus to the Midwest and Southwest Regions by improving general accessibility, as intended in the various policies described in Chapter 2 Policy Context and Need for the Proposed Road Development.

The transfer of through traffic from the existing roads will, however, have a negative impact on local businesses located beside these roads, which currently benefit from passing trade or from people's familiarity with the businesses. These effects will be felt in Adare and Croagh primarily on the busy N21 corridor, and to a lesser extent along the N69 corridor and the villages of Kilcornan, Kildimo, Clarina and Mungret.

Businesses in Adare

Adare has numerous businesses which benefit from passing trade on the current N21 through the centre of the village. Such businesses will lose some passing trade once the new M21 is opened and bypasses Adare. These effects will be ameliorated to an extent by the provision of a junction from the M21 serving Adare, which will allow motorists to break their journey at Adare, if they choose. The reduction in traffic may also attract more local customers to shop in the village, as the shopping experience will improve for those travelling to and parking in the village, having positive effects.

Adare is a significant tourism and leisure destination, which should provide greater resilience for the local services to retain a significant share of the existing business, despite the loss of through traffic. Hotels, for example, are unlikely to lose accommodation business, although demand for meals is likely to reduce.

There is a petrol station on the N21 in Adare which may be significantly adversely affected, with a large decrease in passing traffic. Another petrol station, on Station Road, is off the main traffic route on the N21 and is unlikely to be affected by the bypass.

Reducing the severance within Adare due to the current high volumes of through traffic on the N21 will increase its attractiveness as a tourism and leisure destination and increase the opportunities for these businesses.

Overall, a moderate negative effect on the business environment in Adare is expected as a consequence of the proposed road development, due to the loss of passing trade.

Businesses in Croagh

There is a motor services station on the N21 at Smithfield at the eastern edge of Croagh, for which a significant amount of business comes from passing trade by motorists on the N21. This service station will lose much of this passing trade when the new M21 bypasses Croagh, with more than three quarters of traffic likely to be diverted onto the new route. However, motorists will have the opportunity to exit from the M21 at Croagh Junction and travel the short distance of 0.5km on the link road to just west of the service station to avail of services. A very significant negative effect on the service station business at Smithfield is expected as a consequence of the proposed road development due to the loss of passing trade, which accounts for most of the existing business.

There are a number of other businesses in Croagh that benefit to a greater or lesser extent from passing trade. These include a café at a garden centre, three guest houses and two public houses. Many of these businesses are in the centre of the village and are already bypassed at close proximity by the N21 relief route. However, further slight to moderate negative impacts will arise for these businesses due to the reduction in passing trade associated with a more remote bypass. These effects will be ameliorated to an extent by the provision of an exit from the M21 serving Croagh, which will allow motorists to break their journey and travel a distance of up to 2.2km (3 – 4 minutes driving time) to access a range of services at Croagh.

Businesses along the N69

There will be reduced numbers of HGV trips along the existing N69, as most Shannon-Foynes Port traffic will divert to the proposed new route to Limerick. A modest reduction in other traffic is also expected for trips originating in the Foynes area and further west, although the overall share of this traffic will diminish further east along the corridor. A slight negative economic impact may arise for businesses along the N69

route that rely on passing trade due to reduced traffic volumes. Proposed mitigation measures for socio-economic effects and residual impacts are described in Sections 6.8 and 6.9 of this Chapter.

6.5 Human Health Impact Assessment – Methodology

Introduction

This section sets out the methodology that was used in order to assess the impact of the proposed road development on human health.

This assessment has been prepared in accordance with the relevant guidelines produced by the Environmental Protection Agency (EPA). Data has been collected primarily through a review of relevant documents, as listed below, information gathered through the extensive public consultations detailed in Chapter 3 Alternatives Considered, and mapping provided by the design team. A literature review on the potential impacts of roads on human health has also been carried out and is detailed below.

Aspects examined in this chapter primarily relate to impacts from the proposed road development on socio-economic activities and on local community health. These two themes are discussed together in some sections of this chapter but separately in other sections, where appropriate.

Relevant Guidelines, Data Sources and Consultations

This assessment has been prepared having regard to the following guidelines:

- *Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, 2017)
- *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002)
- *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements* (EPA 2003)
- *Draft Advice Notes for Preparing Environmental Impact Statements* (EPA, 2015)
- *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment* (Department of Housing, Planning and Local Government, 2018)
- *Guidance on the Implementation of Directive 2001/42 on the assessment of the effects of certain plans and programmes on the environment* (European Commission, 2003)
- *Night Noise Guidelines for Europe* (World Health Organisation (WHO), 2009)
- *Health Impact Assessment Resource and Tool Compilation* (USEPA, 2016)
- *Guidelines for Community Noise* (WHO, 1999)
- *Environmental Noise Guidelines for the European Region* (WHO, 2018)
- *Health in Environmental Impact Assessment - A Primer for a Proportionate Approach* (Institute for Environmental Management and Assessment (IEMA), 2017)
- *Health Impact Assessment* (Institute of Public Health Ireland, 2009)
- *Health in Impact Assessments: Opportunities not to be Missed* (WHO, 2014)

Data Sources and Consultations

An assessment of the potential impacts on human health requires an understanding of the community which is built up through background research, co-ordination with project team members, a review of health related consultations and project submissions to date, and the findings of the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water, soils, property acquisition or demolition and traffic volumes. The potential impacts of the proposed road development on human health is then assessed against this background data.

Background data has been collected for the proposed road development by means of:

- Primary data sources (e.g. demographic data from CSO Census 2016, Census 2011 and Census 2006);
- Maps of the surrounding area, including OSi 1:50,000 maps and aerial mapping;
- A review of the design of the proposed road development and its potential impacts on material assets (such as houses) to be acquired, and the associated potential impacts for the residents;
- Observation of local settlement and travel patterns and identification of community facilities;
- Public consultation submissions, which included discussions with local organisations, residents and relevant statutory bodies;
- A literature review on the potential impacts of roads on human health, with a focus on reviewing scientific evidence of the potential impacts of roads on human health (detailed in the relevant Sections, below); and
- Collating the results of the assessment of the environmental factors (pathways) through which health could be affected, such as air, noise, water, soils and traffic volumes, based on reference to accepted standards / guidelines / limits for the protection of human health.

In this Chapter an assessment is performed by considering health in its broader aspects. As well as considering the protection of health, this chapter also considers opportunities for health improvements and improved access to health-related services. The data used to assess opportunities for health improvements and access to services included information gathered during the extensive public consultations.

Guidance on the Methodology for Assessing Human Health Impacts in EIA

The recitals to the 1985 and 2011 EIA Directives refer to “human health” and include “Human Beings” as the corresponding environmental factor. The 2014 EIA Directive (2014/52/EU) changes this factor to “Population and Human Health”. However, no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU. In addition, no specific guidance on the assessment of human health in the context of EIA has been issued to date.

The 2017 *Draft EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* note that “while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in the SEA Directive (2001/42/EC)” (p. 29). The European Commission’s SEA Implementation Guidance document states that: “The notion of human health should be considered in the context of the other issues mentioned in paragraph (f) and thus environmentally related health issues such as exposure to traffic noise or air pollutants are obvious aspects to study” (p. 29 – 30). Paragraph (f) of

Annex I of the SEA Directive lists the relevant aspects of the environment, including soils, water, landscape, air, etc.

The 2017 Draft EPA Guidelines note that the above health assessment approach is consistent with the approach set out in the 2002 EPA Guidelines, where health was considered through assessment of the environmental pathways through which it could be affected, such as air, water or soil, viz:

“The evaluation of effects on these pathways is carried out by reference to accepted standards (usually international) of safety in dose, exposure or risk. These standards are in turn based upon medical and scientific investigation of the direct effects on health of the individual substance, effect or risk. This practice of reliance upon limits, doses and thresholds for environmental pathways, such as air, water or soil, provides robust and reliable health protectors [protection criteria] for analysis relating to the environment” (p. 12).

The 2017 Draft EPA guidelines also note that in an EIAR,

“the assessment of impacts on population & human health should refer to the assessments of those factors under which human health effects might occur, as addressed elsewhere in the EIAR e.g. under the environmental factors of air, water, soil etc [...] Assessment of other health & safety issues are carried out under other EU Directives, as relevant. These may include reports prepared under the Integrated Pollution Prevention and Control, Industrial Emissions, Waste Framework, Landfill, Strategic Environmental Assessment, Seveso III, Floods or Nuclear Safety Directives. In keeping with the requirement of the amended Directive, an EIAR should take account of the results of such assessments without duplicating them” (p. 29).

The Institute for Environmental Management and Assessment (IEMA) in the UK issued a document in 2017, *Health in Environmental Impact Assessment - A Primer for a Proportionate Approach*, which serves as a primer for discussion. The document discusses what a proportionate assessment of the impacts on health should be in environmental impact assessment and is a useful document when considering what can and should be assessed in this context. Regard has been given to the general approach advocated in this document when compiling this chapter.

One of the messages in the IEMA document in terms of assessing health in environmental impact assessment, is that there should be a greater emphasis on health outcomes (that is, the potential effects on human health), rather than simply the health determinants (that is, the agents or emissions which could have the potential to have health effects). The IEMA document notes that in EIA, there has previously been a strong focus on just the agents or emission levels (e.g. dust) rather than focussing on the effects of these agents / emission levels on human health. This change in emphasis does not mean a complete change in practice. For example, measurement and modelling of dust levels continues to be an essential part of the health assessment.

The IEMA document notes that *“public health is defined as the science and art of promoting and protecting health and well-being, preventing ill-health and prolonging life through the organised efforts of society and has three domains of practice: health protection, health improvement and improving services” (p. 6)*. The IEMA document suggests that these three domains should be considered in the assessment of human health impacts in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles,

inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies.

The WHO defined health in its broader sense in its 1948 constitution as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (p. 1). Therefore, whilst the EPA guidance is useful in terms of health protection, for a more holistic assessment as per the IEMA document, it is also worthwhile to look at broader health effects in terms of opportunities for improvement of health and for improvement of access to health-related services. While it is important to do this, it is also important not to consider every conceivable effect to be a health effect. To further rely on the WHO definition, a health effect would be something that would have a material impact on somebody's physical, mental and / or social well-being, be that positive or negative.

Therefore, *health protection, health improvement and improving services* are all considered in this chapter of the EIAR. The methodology for assessing health protection is considered further below.

Health Impact Assessment and EIA

The IEMA document notes that Health Impact Assessment (HIA) and EIA are separate processes and that, whilst a HIA can inform EIA practice in relation to human health, a HIA alone will not necessarily meet the human health requirement. HIA is not routinely carried out for major infrastructure developments in Ireland.

Guidance for performing a HIA was issued by the Institute of Public Health in Ireland in 2009. There are, however, considerable difficulties in performing a HIA as outlined by the Institute of Public Health for a project such as a road development. Not least of these is the difficulty of getting baseline health data. It is quite difficult, due to patient confidentiality and other reasons to accurately determine levels of even relatively common medical conditions in a relatively defined population that might be affected by a road project. Qualitative and quantitative baseline health data are a vitally important part of the appraisal section of the HIA. In the absence of accurate baseline health data, it is very difficult to assess qualitative and quantitative changes that might occur. One could use more generalised data that might exist for larger areas, such as a city or county, but these would be at most an estimate of the local baseline and not accurate enough to allow for meaningful interpretation.

The IEMA document notes that the WHO provides an overview of health in different types of impact assessment² and presents the WHO perspective on the relationship of HIA to other types of impact assessment, as follows:

"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Given the value of impact assessments from a societal perspective, this is a risk not to be taken lightly [...] the need of, and justification for separate HIA cannot automatically be derived from the universally accepted significance of health; rather, it should be demonstrated whether and how HIA offers a comparative advantage in terms of societal benefits" (p. 115).

"Health issues can, and need to, be included [in impact assessment] irrespective of levels of integration. At the same time, from a civic society perspective, it would be unacceptable for HIA to weaken other impact assessments. A prudent attitude suggests optimizing the coverage of health along all three avenues:

² WHO (2014). *Health in impact assessments: opportunities not to be missed.*

- *better consideration of health in existing impact assessments other than HIA;*
- *dedicated HIA; and*
- *integrated forms of impact assessment” (p. 116)*

It is clear, therefore, that even the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over the assessment in an EIAR. It is for these reasons that this health assessment is part of the EIAR and there is no stand-alone HIA.

It is therefore important to note that this assessment on human health is part of an overall EIAR rather than a stand-alone HIA. The HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population, whilst the human health impact assessment in the context of EIA focuses the attention of the assessment on likely significant effects, i.e. on effects that are deemed likely to occur and, if they were to occur, would be expected to be significant (as per the requirements of the EIA Directive). Conducting a HIA will not necessarily meet the population and human health requirement of an EIA.

Health Protection

The assessment of human health for the proposed road development, in terms of health protection, follows the approach set out in the EPA guidelines and in the European Commission’s SEA Implementation Guidance. It is also similar in nature to the US EPA guidance. Human health protection is considered through the assessment of the environmental factors (pathways) through which health could be affected, such as air, noise, water and soils. The USEPA guidance includes a four-step approach which is represented graphically below.

The 4 Step Risk Assessment Process

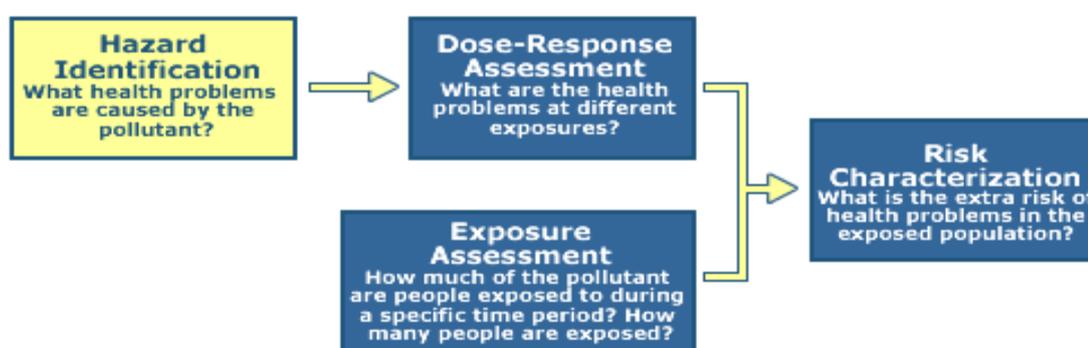


Plate 6.6 Human Risk Assessment (Source: USEPA, 2016)

The potential noise, air, soils and / or water, impacts which could affect human health were identified (Hazard Identification), the scale of these potential impacts (Dose-Response Assessment) and their duration (Exposure Assessment) were assessed, and the significance of the potential impacts on human health were determined (Risk Characterization).

When using a recognised Health Based Standard, the dose-response assessment is actually included in the standard. In other words, the authorities or expert committees

which recommended the level of the standard will have taken into account the health problems at the different exposure levels and set the level within the standard to prevent these problems from occurring.

Health Improvement

Projects that have the potential to support regeneration, reduce unemployment and improve socio-economic circumstances, could contribute to improving the health and wellbeing of socio-economically deprived communities.

The assessment of human health for the proposed road development, in terms of health improvement, includes an assessment on how the proposed road development would impact on the socioeconomics of the community.

Improvement of Access to Health-related Services

Improving access to services such as hospitals or recreational facilities will have an impact on the health of a community. Therefore, the assessment of human health for the proposed road development includes an assessment on whether or not the proposed road development will improve accesses to these services.

6.6 Human Health Impact Assessment

6.6.1 Literature Review

A literature review on the potential impacts of roads on human health has been carried out, the results of which are presented in this section. Studies which have informed this literature review are referenced in Section 6.13.

One of the first areas in the literature review to consider is the health determinants relevant to the proposed road development – that is, the agents or emissions which could have the potential to have health effects. Health outcomes – that is, the potential effects on human health arising from those health determinants, are then considered.

The environmental factors (pathways) through which health could be affected by a road development both during construction and / or operational phases include:

- Noise and Vibration – for example, potential exposure of people to noise emissions from vehicles and construction activities;
- Air – for example, potential exposure of people to dust and air emissions from vehicles and construction activities;
- Water – for example, potential exposure of people to changes in water quality (surface and ground water) or changes in water flows and / or flood risk;
- Soils – for example, potential exposure of people to contaminated land; and
- Biological risk, including vermin and vermin-borne diseases.

The health outcomes arising from such emissions are discussed further below.

In addition, the impacts of the proposed road development on psychological health, and also health improvements and improvements to services have been included in the literature review below. These topics fall under the area of 'Wellness'.

The last fifteen years in Ireland have seen the development of the modern motorway network between the major urban centres, as well as relief roads in urban areas. The literature review included a review of any published data of reported health effects from

either the construction or operation of these roads. Using a *PubMed*³ search, keywords, such as 'Health', 'Effects', 'Roads', and 'Ireland' found that there were no published studies in peer reviewed literature. There was, however, a significant tranche of literature from outside of Ireland, in particular, in relation to emissions to air and noise. The vast majority of the studies deal with potential emissions from operational roads, with a particular emphasis on Noise, Particulate Matter (including PM₁₀ and PM_{2.5}), as well as other air pollutants such as Nitrogen Dioxide (NO₂) and Sulphur Dioxide (SO₂), amongst others. The literature is clear that these are the major hazards in relation to Air Quality with the potential for human health effects. The literature is also strongly consistent with a Dose-response effect as presented below with regard to noise and air emissions - the lower the dose, the lesser the effect, and *vice versa*. Health Based Standards⁴, such as WHO and EU standards, incorporate literature evidence in the setting of these standards. The standards are set at levels for which there will be no significant health effects and there is little evidence of significant health effects from air and noise emissions when these standards are not exceeded. It is important to note that these standards are set to protect vulnerable subsections of the population (as described in Section 6.6.3 later) including its most vulnerable members, which include children and persons with disabilities and, accordingly, will necessarily protect the more robust subsections. Other emissions, such as to water and soil, can be an issue if there is potential contamination to water or soil, or an enhanced flood risk. Again, there is little evidence of significant adverse health effects from water and soil emissions when these standards are not exceeded.

The human health impacts assessment in this EIAR considers the results of technical assessments for environmental factors listed above which are dealt with in Chapter 8 Soils and Geology, Chapter 9 Hydrogeology, Chapter 10 Hydrology, Chapter 12 Noise and Vibration and Chapter 13 Air Quality and Climate, and their proposed mitigation measures to establish any potential human health hazards directly attributed to what is proposed.

These assessments use standards (such as air quality standards) in order to identify whether significant impacts will arise or not. These health-based standards are discussed further below in relation to the various environmental pathways but it is also appropriate to understand the principles behind the setting of such standards.

Noise

Noise is measured using the standard decibel scale (dBA). The 'A' represents a weighting that mimics human hearing. It is important to note that, because the decibel is a log scale, the figure can be somewhat confusing. In energy terms, an increase of 3 dB is equivalent to a doubling of the sound intensity. The human ear, however, does not perceive this degree of increase in volume. Normally, a 10dB increase in noise level equates to a subjective doubling in audible sound. Very few noise sources are constant. A series of noise events can be averaged over any given period of time using the equivalent continuous sound level (L_{eq}). L_{eq} is the method of averaging recommended in industry and environmental assessments and in guidelines issued by, for example, the WHO. The WHO Guidelines use two classes of L_{eq}, in particular. Namely, L_{DEN}, reflecting a weighted Day / Evening / Night figure, and L_{Night}, reflecting night-time levels.

³ PubMed is a search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics.

⁴ The term 'standards', in this instance, refers to guideline standards (for example, noise guidelines), as official standards are not currently available.

It is normally assumed that noise inside a building with the windows open will be at least an estimated 15dB less than that outside. The WHO Guidelines estimate that the average indoor levels are around 10 dB for open windows, 15 dB for tilted or half-open windows and about 25 dB for closed windows. With modern closed windows, noise levels are reduced further inside by 35dB or more, depending on the building materials, the size of the windows and other factors.

It should be noted that the human health impact assessment relates to environmental exposure to noise. Undoubtedly, those with the highest noise exposure will be those working on the construction of the proposed road development. Legislation is in place for control of workplace noise and is policed by the Health and Safety Authority (HSA).

A Europe-wide study (WHO, 2011) and another paper by Hellmuth and colleagues (2012), published by WHO, demonstrate a significant burden of adverse human health impacts associated with environmental noise exposure, drawing from earlier WHO publications summarising health evidence and recommending guidelines for community noise exposure. A review of noise exposure across Europe in 2014 by the European Environment Agency (EEA, 2014) likewise recommends and applies metrics for various health outcomes. In general terms, increasing noise in communities is associated with adverse health outcomes. The nature and the severity of these outcomes is further discussed below.

The potential health impacts due to noise include:

- Noise-induced hearing impairment;
- Annoyance
- Interference with speech communication;
- Disturbance at schools;
- Sleep disturbance; and
- Hypertension and cardiovascular disease.

These potential impacts are discussed in the following sections.

Noise-Induced Hearing Impairment

Hearing impairment is typically defined as an increase in the threshold of hearing. It is assessed by threshold audiometry. It only occurs, however, above a certain noise level. Data from the International Standards Organisation (ISO) and WHO (2018) states that Noise-induced hearing loss will not occur at noise levels below 70dB no matter how long the exposure continues. Therefore, any further consideration of hearing impairment is ruled out within this assessment based on findings of the noise assessment for the proposed road development (refer to Chapter 12).

Annoyance

While annoyance is not in itself a health effect, there is no doubt that it can affect the enjoyment of life. Annoyance by its nature is very subjective. What one person perceives as annoying, another might not. It is not something that can be readily measured except by self-reporting. The notion of 'highly annoyed' is one that is sometimes assessed by bodies such as the WHO, although this again is only measured by self-reporting. This will be further discussed below in relation to the WHO *Environmental Noise Guidelines* (2018).

Interference with Speech Communication

Noise can interfere with speech comprehension. These may include problems with concentration, fatigue, uncertainty and lack of self-confidence, irritation, misunderstandings, decreased working capacity, problems in human relations, and a number of stress reactions. Particularly vulnerable to these types of effects are the hearing impaired, the elderly, children in the process of learning, and individuals who are not familiar with the spoken language. Sensitive communication in the form of speech takes place indoors for the majority of the time and, as noted above, the average noise attenuation of being inside a building with the windows fully open is conservatively estimated to be 10dB, 15dB for half open or tilted windows and 25dB for closed windows (WHO, 2018).

Disturbance at Schools

There are several studies on the effect of environmental noise on education. Most of these relate to airport noise, but there are some that address traffic noise. From the literature review undertaken, school learning may be the factor most affected by environmental noise.

In 2011 the WHO published *Burden of Disease from Environmental Noise – Quantification of healthy life years lost in Europe*. This concluded:

“Reliable evidence indicates the adverse effects of chronic noise exposure on children’s cognition. There is no generally accepted criterion for quantification of the degree of cognitive impairment” (p. 52).

The ‘RANCH study’ (Matheson *et al.*, 2010) was one of the largest studies performed on this matter in Europe. While showing little new data, it suggests a small effect on reading comprehension in 9 to 10-year old primary school children. It also stated *“Neither aircraft noise nor traffic noise affected sustained attention, self-reported health, or overall mental health”* (Abstract). It was surprising that the study suggested significantly improved memory function in children exposed to high levels of traffic noise. This appears intuitively difficult to understand, but certainly does not suggest that there is the opposite effect. Based on this, disturbance at schools will not be an issue.

Sleep Disturbance

Sleep disturbance is considered to be a major adverse environmental noise effect on human health. It is however estimated, as stated in the WHO *Community Noise Guidelines* (1999), that 80-90% of the reported cases of sleep disturbance in noisy environments are for reasons other than noise originating outdoors. Understanding of the impact of noise exposure on sleep stems mainly from experimental research in controlled environments. Field studies conducted with people in their normal living situations are scarce. Most of the more recent field research on sleep disturbance has been conducted for aircraft noise.

Sensitive groups include the elderly, shift workers, persons especially vulnerable to physical or mental disorders and other individuals with sleeping difficulties. There is evidence that habituation to night-time noise events occurs, and that noise-induced awakening decreases with increasing number of sound exposures per night. Studies have also shown that the frequency of noise-induced awakenings decreases for at least the first eight consecutive nights with people becoming accustomed to the noise thereafter (Miedma & Vos, 2007). In summary, people get used to the noise and the potential for interference with sleep diminishes.

As stated above, most of the published research is related to aircraft noise but in a published study (Babish, 2006) which studied some 23,000 people, the authors concluded that, at the same average night-time noise-exposure level, aircraft noise is associated with more self-reported sleep disturbance than road traffic, and road traffic noise is associated with more sleep disturbance than railways.

People also sleep during the daytime, for example shift workers, but ambient noise levels are much greater during the day and, therefore, it is less likely that an additional noise source will have a significant effect to those who try to sleep during daytime. This is further explored below in reviewing the current WHO *Environmental Noise Guidelines for the European Region* (2018).

Hypertension and Cardiovascular Disease

A number of studies have postulated a link between environmental noise and hypertension and / or cardiovascular disease. There is somewhat more evidence in relation to airport noise rather than noise due to road traffic. Some of the studies, particularly in relation to noise due to road traffic, have problems in that there are potential confounders⁵. One of the issues was trying to differentiate whether effects may be due to air pollution rather than noise. That is any changes in proximity to roads may not be due to the noise at all but rather levels of air pollution. Some more recent studies have suggested that noise may have an independent effect. The extent of the effect is difficult to determine but it is clear that it is only at higher levels of environmental noise that any measurable effect is likely to occur.

Regarding road noise specifically, several meta-analyses of cardiovascular disease have been published by W. Babisch. These date from 2006 to 2014 and show evidence to provide a risk ratio for all ischaemic heart disease (IHD), also known as coronary heart disease (CHD) risk. A meta-analysis published by Vienneau and colleagues in 2015 used many of the same studies to establish an IHD risk ratio that was used in the 2014 European Environment Agency quantification of noise health impacts across Europe. A limited number of studies of stroke risk associated with environmental noise exposure have also been published by Houthuijjs (see Houthuijjs *et al.*, 2014). These postulated links have been considered by expert bodies such as the WHO when they set their noise guidelines and in particular the night-time noise guidelines.

In 2009, the WHO issued *Night Noise Guidelines for Europe* which explore the effects of night-time noise. It stated that, in the two European countries studied (Switzerland and The Netherlands), almost 50% of the population are exposed to night-time noise in excess of 45dB L_{night}. These guidelines quote some health effects at quite low night-time levels and proposed an ideal night-time noise level of 40dB L_{night} outside residences. They did, however, accept that this is essentially unachievable in the foreseeable future and, therefore, proposed an interim value of 55dB L_{night} outside instead. It should also be stated that the effects detected at lower night-time levels (below 55dB L_{night}) are relatively benign in terms of health effects such as increased mobility (tossing and turning) while asleep. More significant health effects are only linked to much higher noise levels, usually in excess of 70dB L_{night}.

The WHO *Night Noise Guidelines* (2009) referred to L_{night} parameter which relates specifically to noise levels over the night-time period. The TII *Guidelines on the Treatment of Noise and Vibration* and quoted in Chapter 12 Noise and Vibration set a design goal in terms of a composite 24-hour parameter, the L_{den}. Whilst the L_{den}

⁵ In statistics, a confounder (also confounding variable or confounding factor) is a variable that influences both the dependent variable and independent variable, causing a spurious association.

includes for night-time noise, direct comparison of the two parameters is not possible as they relate to different averaging time periods.

In most urban environs, one would expect many areas at or above 55dB L_{night} . In this context any assessment of potential impacts must take into account the baseline or existing noise levels.

It is important to note that, whilst the WHO Guidelines are used in assessing potential health impacts, they can at times be misinterpreted. They are not, and were never intended to be, considered as a threshold. For example, the difference between a property experiencing a night-time noise level of 54dB and another property experiencing a night-time noise level of 55.1dB would be imperceptible for individuals living there and differences in health status would also be imperceptible.

In 2018, the WHO issued updated *Environmental Noise Guidelines for the European Region*. They issued specific guidelines for road noise. For average noise exposure, they recommend reducing noise levels produced by road traffic below 53 decibels (dB) L_{den} , as road traffic noise above this level is associated with adverse health effects. It is of note that the main effect which gave rise to this particular level was self-reported highly annoyed persons. In Section 5.4 of the guidelines the WHO states that:

“cultural differences around what is considered annoying are significant, even within Europe. It is therefore not possible to determine the “exact value” of %HA (Highly Annoyed) for each exposure level in any generalized situation. Instead, data and exposure-response curves derived in a local context should be applied whenever possible to assess the specific relationship between noise and annoyance in a given situation” (p. 109).

For night noise exposure, they recommended reducing noise levels produced by road traffic during night-time below 45dB L_{night} , as night-time road traffic noise above this level is associated with adverse effects on sleep.

To reduce health effects, the Guideline Development Group (GDG) strongly recommends that policymakers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure. One might ask how one can reconcile these guidelines with road traffic anywhere. It is important to note that no economic cost-benefit assessment of setting the guidelines at these levels has informed the WHO Environmental Noise Guidelines.

We know, as outlined earlier, socioeconomic development has potential for very positive effects on human health. One cannot consider health effects in relation to noise alone without considering other factors which could have far greater effects on human health than those associated with noise.

The fact is that these guidelines are for populations. The WHO absolutely realise that every individual residence will not be below 53dB L_{DEN} or 45dB L_{night} . However, the question in relation to the assessment of the impact on health will be determined by the overall impact on the population. The WHO Guidelines are guidelines for protection of health in the community. To put this in perspective, in terms of potential impacts on health, noise, even night-time noise, is far less important in terms of the magnitude of its effect, and does not merit being considered in the same way as other factors such as diet, exercise, cigarette smoking and genetics. The slight change in

health effects that might occur with an increase or decrease in night-time noise that might occur on individual residences would be so small as to be unmeasurable. They become important when viewed in terms of large populations which in European terms is in the order of hundreds of millions.

Therefore, in assessing overall noise exposure or indeed night-time noise in the context of the WHO Guidelines, it should only be in the context of overall noise levels in the community rather than the increase or decrease at individual residences or clusters of residences. Whilst noise levels are often quoted with respect to potential effects on health and they are used in the significance assessment, it should be noted that the differences in significance between the different levels are relative rather than absolute.

Summary for Noise & Human Health

In terms of the health effects of environmental noise, there is some limited evidence of effects on blood pressure, cardiovascular risk, school performance and in relation to sleep disturbance. Any effects demonstrated are more likely at higher noise levels. Many effects are only demonstrated with ambient noise in excess of 70dB.

The much lower levels as suggested in the WHO Environmental Noise Guidelines (2018) are ideal levels for populations but should not be seen as thresholds for individual receptors and must always be seen against the background of other determinants of human health such as socio-economic effects.

Vibration

Vibration has the potential to have adverse health effects when perceptible. These could include, for example, sleep disturbance. Another issue which is sometimes described is infrasound. The latter is sound but at a frequency so low that it is not audible to the human ear. If at high levels it may be perceived as vibration. These effects, in relation to vibration and infrasound, however, only occur when the levels are high and perceptible to human beings, for example an underground train or construction activities such as piling and rock excavation involving heavy hammering or blasting.

Air Quality

Vehicles with internal combustion engines emit air pollutants, including particulate matter, carbon monoxide, nitrogen oxides and a variety of hydrocarbons. Previously, lead compounds added to petrol and lead emissions were a major issue, but the sale of leaded petrol has been banned for many years. In the last few years in Ireland, partly because of tax driven reasons, there has been a switch in the type of internal combustion engines in cars from primarily petrol to primarily diesel cars in newer vehicles. Emissions would be broadly similar. However, there are some differences and, in particular, there is a higher level of particulate emissions from diesel cars. Nitrogen oxides and hydrocarbons can oxidise oxygen in the air to ozone if exposed to high levels of sunlight. While this is problematic in some countries, it is less likely to be an issue in the Limerick area for reasons outlined further below.

The following components of air emissions of motor vehicles were considered for the health assessment:

- Carbon monoxide;
- Other products of combustion; and
- Fine particulates.

Carbon Monoxide

Carbon monoxide is formed by the incomplete combustion of fuels such as petrol and diesel. It can be absorbed into the blood stream and reduce the oxygen carrying capacity of blood. It is present in all forms of combustion and for example is a particular issue with regard to cigarette smoking and air levels of carbon monoxide is one way of monitoring people's smoking habits. High levels are associated with increased hospital admissions, cardiovascular disease and mortality after high exposure.

Other Products of Combustion

Nitrogen Dioxide, and oxides of Nitrogen in general, directly affect the lungs. This gas is also produced during fuel combustion and impairs the lungs' immune defence mechanism. When it makes contact with water, which would line the lungs, it forms an acid to essentially burn the airways, there can be an increased severity of asthmatic attacks, etc.

Fine Particulates

Fine particulates include PM₁₀ (i.e. particulate matter less than 10 microns in diameter) but also in more recent time, more emphasis has been made on small particles, including PM_{2.5} (i.e. particulate matter less than 2.5 microns), PM₁ and even nanoparticles (which are smaller particles again). These have been known to exacerbate respiratory conditions such as bronchitis and pneumonia and there is increased mortality with higher levels.

Particulate emissions have received attention in recent years, given increasing evidence of their adverse health effects. Indeed, there have been calls to ban diesel vehicles in larger cities because of potential adverse effects. However, when assessing the human health impacts of the proposed road development, one must consider that the Do-Nothing scenario would lead to those vehicles continuing to go through congested built-up areas, with slow average speeds giving the potential for greater emissions. Overall, therefore, the proposed road development will have potential benefits regarding particles than the Do-Nothing scenario.

Appropriate Standards

The starting point in selecting the appropriate standards is to apply EU Directives which have set these standards. In Ireland, these are monitored by the EPA. The current applicable directive is the Clean Air for Europe (CAFÉ) Directive which gave rise to the Air Quality Standards Regulations 2011.

The following tables show the limit or target values specified by the five published Directives that set down limits for specific air pollutants. The directives cover:

- Sulphur dioxide (SO₂);
- Nitrogen dioxide (NO₂), and other oxides of nitrogen;
- Particulate matter (PM¹⁰ and PM^{2.5});
- Lead;
- Carbon monoxide (CO);
- Benzene; and
- Ozone.

As discussed previously, air quality standards are set to protect the vulnerable such as those with respiratory illnesses, the old and infirm. Slightly higher levels of oxides of nitrogen above the standards may have no effect on the vast majority of the

population but may be significant adverse effects on the vulnerable. Hence, the human health impact assessment has relied on compliance with the Air Quality Standards to determine whether significant impacts on human health will arise or not. The standards used in Chapter 13 include the Air Quality Standards Regulations 2011, which incorporate European Commission Directive 2008/50/EC which has set limit values for the pollutants SO₂, NO₂, PM₁₀, benzene and carbon monoxide. The 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}. These are clearly appropriate and robust standards. Table 6.10 shows that the levels set are primarily for the protection of human health. Therefore, provided these levels are not exceeded one can be confident that there will be no adverse effect on human health due to air emissions.

Table 6.10 Limit Values of CAFÉ Directive 2008/50/EC / Air Quality Standards Regulations 2011

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m ³	Limit Value ppb (Parts per Billion)	Basis of Application of the Limit Value	Limit Value Attainment Date
SO ₂	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1 Jan 2005
SO ₂	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1 Jan 2005
NO ₂	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1 Jan 2010
NO ₂	Protection of human health	calendar year	40	21	Annual mean	1 Jan 2010
PM ¹⁰	Protection of human health	24 hours	50	n/a	Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM ¹⁰	Protection of human health	calendar year	40	n/a	Annual mean	1 Jan 2005
PM ^{2.5} - Stage 1	Protection of human health	calendar year	25	n/a	Annual mean	1 Jan 2015
PM ^{2.5} - Stage 2	Protection of human health	calendar year	20	n/a	Annual mean	1 Jan 2020
Lead	Protection of human health	calendar year	0.5	n/a	Annual mean	1 Jan 2005
Carbon Monoxide	Protection of human health	8 hours	10,000	8,620	Not to be exceeded	1 Jan 2005
Benzene	Protection of human health	calendar year	5	1.5	Annual mean	1 Jan 2010

Potential Health Impacts from Air

In 2010, the Health Effect Institute (HEI) Panel in the US, in a study partially funded by the US EPA on the Effects of Traffic-Related Air Pollution, concluded that exposure to air pollutants specifically from roads is likely to be associated with⁶, cardiovascular disease incidence and mortality, and reduced lung function, albeit with weaker evidence (due to fewer and smaller studies) than the wider air pollution health evidence base.

The WHO published a review in 2005 of the health effects of transport-related air pollution which concluded that health effects include increased cardiopulmonary mortality risk and respiratory morbidity risk. Since 2013, the International Agency for Research on Cancer (IARC) defines diesel engine exhaust as carcinogenic to humans. Petrol engine exhaust is classified by IARC as possibly carcinogenic, as there is inadequate evidence to form a firmer conclusion.

A relatively recent article (Chen *et al.*, 2017) showed a small (7%) increase in the incidence of dementia in those living less than 50m from major roads but no increase in the incidence of Multiple Sclerosis or Parkinson's disease. The authors postulated that increased levels of PM_{2.5} and NO₂ may be associated factors. However, there were important limitations on the study as the study was based in Ontario, Canada where major roads are some of the busiest in the world. Perhaps the most significant criticism of the study was that the authors could not control adequately for socio-economic effects. Socio-economic effects are related to the incidence of dementia. If the individuals living within 50 metres of major roads in Ontario were of lower socio-economic status than those living further away, this might explain the relatively small effect. Overall, while further studies are recommended, one can draw relatively little from this one study.

While there are some difficulties making comparisons between the impact of road building in, for example China, far more relevant information can be gleaned with similar projects within Ireland while being conscious of international published data. This is due to the fact that the baseline environment in densely populated countries such as China, which currently includes polluted air quality in its baseline, is not comparable to that of Ireland and in particular County Limerick.

The 2014 publication from the OECD, *The Cost of Air Pollution: The Health Impacts of Road Transport* points out that, while the health impacts of air pollution in western countries is decreasing, it is increasing in countries like China and India. It is more important for us in Ireland to consider the data from this country and similar countries.

While it is now 13 years old, an important document in Ireland is *the Health Impacts of Transport: A Review*, published in March 2005 by the Institute of Public Health in Ireland (Kavanagh *et al.*, 2005). This remains the most recent publication from this body on this subject.

The document reviews the elements of health impacts of transport. It originated as part of the transport HIA in Ballyfermot organised by the Eastern Regional Health Authority and proceeds from the Institute's strategic objective to strengthen the capacity of those working for public health.

⁶ This is mortality from all causes e.g. cancer, heart, lung etc.

In the Executive Summary, they stated:

“the effect of air quality on human health has been extensively researched and expert opinion is available in this area. Currently, evidence is strongest for air pollution as a cause for short-term health problems in certain groups such as the elderly and those with underlying health problems such as heart or lung disease. Longer term health impacts are suspected to result from certain components of air pollution. However, it has been difficult to ascribe a cause and effect with certainty. Traffic is a leading source of air pollution and any issues which would reduce traffic volume can have potential benefits to health by improving air quality. Vehicle speed is also a factor warranting consideration. Low average speeds such as those on congested routes are less efficient in the use of fuel and result in greater pollution emissions” (p. 6).

It can be concluded that the principle of moving traffic to a road with higher average speeds has a potential benefit on health.

It is important in these areas to consider the baseline environment. The EPA Air Quality Index shows that the air quality in County Limerick is very good. There are multiple reasons for this. One is Limerick's geographical location on the edge of the Atlantic Ocean, exposed to prevailing winds which predominantly blow air pollution away from the centres of population. There have also been very good controls with regard to potential sources of pollution in the Limerick area. This was further supported by the site-specific air quality monitoring undertaken for the proposed road development.

Water

Accessibility to high quality clean water is obviously a very important contributor to human health. In Ireland these are regulated by the European Union (Drinking Water) Regulations 2014. These regulations impose duties on Irish Water and local authorities in relation to the sampling and recording of water quality. There are strict standards in relation to the quality of water in relation to its chemical content as well as microbiological aspects. Provided the standards are observed, one can be confident that there will be no adverse effect on human health due to effects on water quality. Reference can be made to Chapters 9 and 10 of this EIAR in relation to the impact assessment for well sources for water supply in the vicinity of the proposed road development.

Flooding also has potential for adverse human health effects. Apart from the economic impacts of flooding, particularly of repeated flooding in certain areas, individuals who have their homes and residences flooded can be subject to very significant psychological impacts. Financial loss can occur, particularly in areas which previously experienced flooding and were no longer insured. This loss can relate to the actual damage to the properties caused by the flooding and also to potential loss in value of the property. These can be associated with increased levels of anxiety and even depression. Flooding can also potentially lead to spread of disease. This may be spread by vermin or alternatively flooding of the sewers and septic tanks. When considering the potential health effects of the proposed road development in relation to flooding, it is important to consider if the risk of whether the flooding is increased or decreased (or indeed, unaffected) by the proposed road development.

Soils

Contamination of Land

If a project has the capacity to contaminate land, there is also the potential for human health effects. This contamination could, for example, arise if previously buried contaminated material is unearthed during the construction process. Examples of this might include an unidentified landfill, previous industrial contamination or indeed naturally occurring sources of contamination. Contaminated land could in turn affect health either by direct contact (e.g. of people living and working on the land or of children playing on the land) or indirectly (e.g. via the concentration of contaminants in food crops grown on contaminated land).

Radon

Radon is a naturally occurring radioactive gas that originates from the decay of uranium in rocks and soils. It is colourless, odourless and tasteless and can only be measured using special equipment. When radon surfaces in the open air, it is quickly diluted to harmless concentrations, but when it enters an enclosed space, such as a house or other building, it can sometimes accumulate to unacceptably high concentrations. Radon decays to form tiny radioactive particles, some of which remain suspended in the air. When inhaled into the lungs, these particles give a radiation dose that may damage cells in the lung and eventually lead to lung cancer. It is only when radon has potential to build up in buildings that are inhabited by human beings that the health risk occurs. Indeed, these buildings due to heating or otherwise can, in certain areas draw in radon from the ground as warm air rises within the buildings. If radon is found at high levels in buildings, one of the most effective remedies is to create a sump which creates its own negative pressure and draws the radon away from entering the building. More information on this can be found on the EPA website (EPA, 2019).

Biological Risks / Vermin

Vermin have the potential to carry disease and anything which has the potential to increase vermin numbers has the potential to have an adverse effect on human health. Earth moving in the construction phase of the proposed road development has the potential to move vermin. However, unless there is a food source, there is no reason for an increase in vermin population. Indeed, standard vermin control measures implemented would, if anything, reduce the vermin population.

During the operational phase, the road itself will not contribute to the vermin population. One could argue that if food was discarded from moving vehicles that this could encourage vermin, but this risk would be the same for any road development and would be the same along the existing road network in the Do-Nothing scenario. Vermin will, therefore, not be considered further in this assessment.

6.6.2 Significance of Health Impacts

There is a difficulty in assigning levels of significance to human health impacts. In medicine, as in all science, the concept of statistical significance is used. This involves attaching a value to significance, often expressed as a percentage level of confidence in the data. Confidence intervals of 95%, or even 99%, are often used to indicate levels of certainty or changes that are not due to chance alone.

This is a valid approach for the study of the human health impacts on a population but does not absolutely exclude a particular response from an individual person. However, it is difficult to assign levels of significance to individual human health impacts without detailed information about that individual. Thus, the significance of health effects is

assessed on a group or community basis rather than on an individual basis. There is such a variability in human response that one could never identify all possible individual effects and so, in accordance with the guidance referred to above, it is considered to be more appropriate to assess the significance of health effects at a population level. The significance criteria for the assessment of the health of communities are, therefore, as outlined in Table 6.11, below.

Table 6.11 Criteria Used in the Assessment of Community Human Health Protection Impacts

Impact Level	Significance Criteria
Imperceptible	No significant human health impacts are apparent
Not Significant	An impact which causes noticeable changes but without significant consequences
Slight	A small impact on individual reported symptoms but no change in health status can be attributed to the proposed road development
Moderate	A moderate impact on health status of an individual but no change in morbidity or mortality can be attributed to the proposed road development
Significant	The proposed road development has the potential to impact on individual health status with an associated change in morbidity
Very Significant	The proposed road development has the potential to impact on the health status of groups of people
Profound	The proposed road development has the potential to impact on the health status of communities

Asthma can be used as an example when using these criteria:

- An Imperceptible impact would be one with no measurable effect on asthma;
- A Slight impact might be a temporary increase in symptoms in an individual but no change in the severity of the underlying condition or treatment required;
- A Moderate impact might be an individual increasing their use of inhalers, attributable to the proposed road development, but no change in underlying condition and no effect on the vast majority of asthmatics;
- A Significant effect might be an individual becoming asthmatic or an individual's asthma becoming measurably more severe as a result of the proposed road development;
- A Very significant effect might be a group of individuals becoming asthmatic or their asthma becoming measurably more severe as a result of the proposed road development; and
- A Profound effect might be a measurable increase in the incidence or severity of asthma in a community as a result of the proposed road development.

6.6.3 Identification of Vulnerable Groups

While every human being should be considered a sensitive receptor, the vulnerable are the most sensitive. These vulnerable groups may be more susceptible to impacts associated with the proposed road development. Vulnerable groups and their particular sensitivities are described in this Section.

Children and adolescents constitute a vulnerable group partly due to their need to be able to move around freely to-and-from school and recreational activities. They lack

the experience and judgement displayed by adults when moving around traffic in public spaces. Studies⁷ show that they may also be more sensitive than adults to air pollution and other environmental factors.

Elderly people constitute a very variable group when it comes to their need and scope for moving around the community. Generally speaking, elderly people are slower in their movements and more health conditions may occur. Elderly people in general have greater sensitivity to air pollution and potential effects on the respiratory system and cardiovascular system and are more likely to express anxieties in relation to potential air quality or noise impacts due to the proposed road development. There are many reasons for this sensitivity, including the possible presence of other medical conditions such as respiratory or cardiovascular disease. Subtle changes in the environment have the potential to have an adverse effect that would not be experienced by younger, more resilient persons.

There are other vulnerable groups also, for example, persons with disabilities or persons with mental illness. It is important to note that, in this assessment, it is assumed that all areas contain highly vulnerable individuals including the elderly, the very young, persons with disabilities, as well as people who are sick today or who may be sick at the time the proposed road development is being constructed or operational. However, as noted above, there are some particular areas with higher levels of sensitive population subsets than others.

Vulnerable groups of people occur throughout the receiving environment for the proposed road development. However, places with especially high densities of vulnerable persons include, among others, a crèche, schools, nursing home and areas with a higher number of older family groups.

6.6.4 Community Profile of County Limerick

Evidence shows that different communities have varying susceptibilities to health impacts, both positive and negative, as a result of social and demographic structure, behaviour and relative economic circumstances.

Whilst specific health data for individuals in the vicinity of the proposed road development is confidential and difficult to establish, a community profile has been used to establish the baseline and identify unequal distributions in existing factors such as deprivation or burden of poor health, in order that changes in community exposure to certain health pathways and their degree of impact on the population or community can be assessed.

Lenus, the Irish Health Repository (part of HSE) have published health profiles for all the Local Authorities areas in Ireland and a health profile is available for County Limerick. The most recent profiles published relate to 2015 and have been used to establish a community health profile for the proposed road development.

County Limerick is the eighth most affluent Local Authority area nationally with 54% of the population either being marginally above average affluence or affluent. County Limerick was found to have the following statistics:

- The lone parent rate is the lowest nationally at 9.1% (national 10.9%);
- A below average rate of Local Authority housing of 4.8% (national 7.8%);
- The lowest breast-feeding rate nationally of 32.4% (national 46.6%);

⁷ <http://www.who.int/ceh/risks/en/>

- A higher than national incidence of female colorectal cancer, but is average or below average for all other cancers (Limerick City and County data);
- Above average mortality rates for all causes and for the four major causes of death (Limerick City and County data); and
- Immunisation uptake of 96% at 24 months for the third 6 in 1 vaccine and 92% for the MMR1 vaccine, which are higher and lower than the national rate, respectively.

In terms of deprivation, the health profile report includes a map which shows deprivation levels as a percentage of population compared to national levels (see Plate 6.7, below). It is important to note that, while the statistics are taken directly from the HSE document, it reflects relatively large areas and does not reflect what is happening on a smaller, more local scale. In other words, areas which are categorised as affluent will contain small areas which are disadvantaged and similarly areas shown as disadvantaged will contain individuals or groups of considerable advantage. However, as there is no publicly available data to give a true reflection of the health profile of County Limerick and while it is accepted that this map does not give a true representation, they are included here to inform the reader of the general population situation. This shows that, geographically, County Limerick has relatively large areas which are marginally above average in terms of affluence or marginally below average. From this information we can see that the route of the proposed road development travels through areas that are predominantly neither particularly affluent nor particularly disadvantaged.

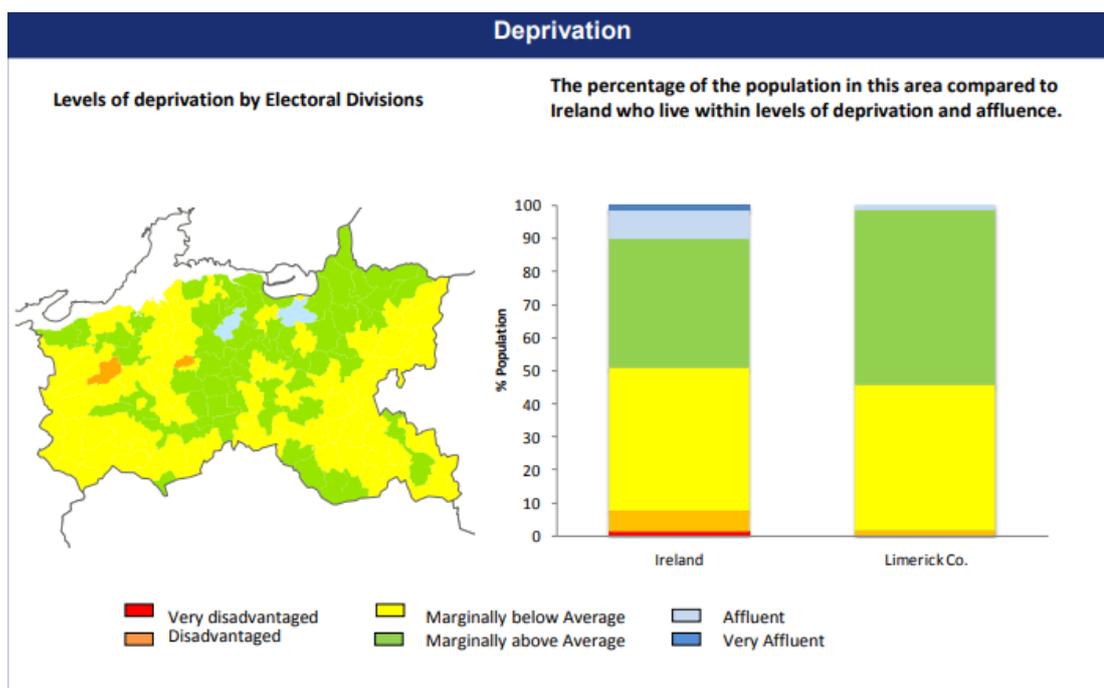


Plate 6.7 Deprivation Map for County Limerick (source: Health Profile 2015 Limerick County, Health Service Executive)

The Revitalising Areas by Planning, Investment and Development Programme (RAPID) is a central government focused initiative to tackle social inclusion and disadvantage by prioritising resources from agencies and Government Departments. RAPID targets the most disadvantaged urban areas and provincial towns in the country. The implementation of the RAPID programme is led by the Department of Community, Rural and Gaeltacht Affairs. Within the study area for the proposed development, Rathkeale has been designated as a RAPID area. Areas designated

under RAPID can apply for funding to provide community-based developments to help improve the towns.

6.7 Predicted Impacts on Human Health

6.7.1 'Do-Nothing'

Traffic demands in County Limerick and its environs are predicted to continue to grow whether the proposed road development proceeds or not (Chapter 5, Traffic Analysis). The number of people living in Limerick City and County and its environs has increased and is predicted to continue to do so. Traffic levels to the Shannon-Foynes Port are also predicted to increase as a result of planned development.

Negative impacts (dust, noise, nuisance, etc.) currently experienced by people as a result of traffic congestion on existing routes will continue to increase as traffic increases. This is particularly true in traffic bottlenecks such as Adare.

From a noise point of view, the increase in traffic demands on the existing road network will result in increased noise levels over and above the current scenario at properties located along the main national and regional roads.

In the Do-Nothing scenario, traffic congestion will persist along the existing road networks, with vehicles continuing to go through congested areas, with slow average speeds giving the potential for greater particulate emissions. Particulate emissions have received particular attention in recent years given increasing evidence of their health effects.

In the Do-Nothing scenario, there would also be potential adverse impacts on social interaction and inclusion due to the persistence of high levels of severance along existing roads and the potential that this has for containing populations within particular neighbourhoods combined with the direct discouragement to the movement of sensitive groups. The risk of road accidents will continue, particularly for pedestrians and cyclists, due to the need to ensure traffic movements which may restrict opportunities for new dedicated crossing facilities and a reduced availability of road space for footpaths or cycle lanes.

6.7.2 Human Health – Potential Construction and Operational Impacts

Health protection covers the health effects of the proposed development arising from noise, vibration, air emissions, water and soil contamination and psychological issues. These are all discussed further below.

Health Protection

Noise

It is noted that, despite the extent of the proposed road development and the overall construction period, the potential noise impact on any individual receptor during construction will be limited to a temporary and short term impact as the activity in any one location will be limited in scale and time. Thus, the potential for human health effects will be similarly limited.

The potential noise impacts are assessed in Chapter 12, Noise and Vibration in accordance with the relevant TII Guidelines. The results of the baseline noise monitoring and potential impacts which are described in full in Chapter 12, Noise and Vibration have been compared against the reliable noise guidelines to determine if any human health effect is likely.

As discussed previously, the potential adverse health effects of noise can include:

- Noise-induced hearing impairment;
- Interference with speech communication;
- Disturbance at schools;
- Sleep disturbance; and
- Hypertension and cardiovascular disease.

As noted above, any of these effects demonstrated are more likely at higher noise levels. Many, but not all, effects are only demonstrated with ambient noise in excess of 70dB_{L_{DEN}}. Sleep disturbance, and self-reported annoyance are the exceptions and, as such, have already been addressed in the 2018 WHO Environmental Noise Guidelines for Europe.

These Guidelines, as well as the effects mentioned above, take into account factors such as annoyance and so, for average noise exposure, they recommend reducing noise levels produced by road traffic below 53 decibels (dB) L_{den}, as road traffic noise.

For night noise exposure, they recommended reducing noise levels produced by road traffic during night-time below 45dB L_{Night}, as night-time road traffic noise above this level is associated with adverse effects on sleep on a small percentage of the population. It is of note the WHO Environmental Noise Guidelines for the European Region assessed approximately 3% of participants reported Highly Disturbed Sleep at this noise level.

Construction Phase

The noise assessment detailed in Chapter 12 identified that, during the construction phase of the proposed road development, there is potential for some temporary moderate to significant impacts on nearby residential and business properties due to noise emissions from certain construction activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that potential noise impacts are kept to a minimum. As detailed in Chapter 12, the contract documents will clearly specify the construction noise criteria which the construction works must operate within. The Contractor undertaking the construction of the proposed road development will be obliged to take specific noise abatement measures and comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Noise* and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001 and the TII *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* (2013). Therefore, significant noise impacts will not arise during construction and no associated adverse human health effects are predicted during construction. Therefore, the impact is determined to be not significant.

Operational Phase

The noise assessment for the operational phase of the proposed road development indicates that, without mitigation measures, the potential noise levels at a number of receptors exceeded the specified TII Noise Mitigation Criteria and necessary mitigation measures have been specified. Once such measures are implemented, it was shown that all locations, bar one, comply with the adopted criterion (See Section 12.6 of Chapter 12).

Properties within the towns and villages on the N69 and N21 as well as many properties along the existing roads, which currently experience high levels of traffic, will experience a notable reduction in noise levels depending on the distance from the proposed road, traffic volume reductions and increased speeds. Indeed, an assessment of the houses along the existing roads within the study area (within a 50m buffer), which will benefit from reduced traffic and noise levels and improved air quality was carried out. These number:

- N69 between Askeaton and the M7, west of Limerick: 153
- N69 between Foynes and Askeaton: 52
- N21 between Rathkeale and Adare: 72

These are in addition to those properties (including residential, retail, educational, community facilities etc.) within the towns and villages along these existing routes which will benefit from reduced noise levels.

Baseline noise levels are important to consider when assessing human health impacts. Human perceptions of volume are such that changes of less than 3dB are usually not perceived. If noise levels do not increase by at least 3dB, there will be no adverse outcome over those experienced prior to the change. In this regard, a threshold of 3dB is appropriate to identify a change in noise levels which can be reliably perceived by humans.

As mentioned above, the WHO night-time noise guidelines and subsequent WHO *Environmental Noise Guidelines for Europe* (2018) are for communities rather than individual residences and, in addition, it is important to remember that the levels are not thresholds. It is also important to remember that the health effects being prevented by a 53dB L_{DEN} are predominantly annoyance rather than the more significant health effects. This is no suggestion, for example, that if the differential noise levels can be maintained below 60dB L_{DEN} , there will not be any cardiovascular effects, such as hypertension.

As mentioned above, the proposed road development, by diverting traffic away from more populated areas, overall has benefits in terms of community night-time noise. Therefore, the overall health effect would be positive. However, this is of little comfort to individuals who actually experience an increase in noise and the potential noise impacts on individual properties have been assessed and mitigation measures proposed in Chapter 12.

During the operational phase, the predicted noise levels (prior to mitigation) at receptors requiring mitigation has been presented in Table 12.11 of Chapter 12. Analysis of the modelled results indicates that, during the Design Year of 2039, 124 properties meet the three criteria for noise mitigation. These locations are along section A (Foynes to Ballyclogh), Section C (Ballyclogh to Rathkeale) and Section D (Rathkeale to Adare). Mitigation is proposed including low noise road surface and noise barriers. The noise barriers proposed are listed in Table 12.14 of Chapter 12. The residual effects after mitigation are summarised in Table 12.15 of Chapter 12.

The results of the assessment have indicated that, for the vast majority of receptors along the length of the proposed road development, traffic noise levels at or below 60dB L_{den} can be achieved, and / or the Do-Something noise levels can be reduced to the equivalent Do-Nothing traffic noise levels at the vast majority of locations with the recommended mitigation measures in place.

There is one location (D51-001A) where the residual Do-Something noise level is calculated to be 1dB above the Do-Nothing scenario and remains above 60dB L_{den} . This modelled location represents the rear façade of the property facing towards the new M21 alignment. An increase of this magnitude above the Do-Nothing scenario is negligible. A reduction in noise level of 8dB L_{den} will, however, be experienced to the front façade of the same property due to the reduction in traffic along the existing N21 road, which will result in a perceptible reduction in traffic noise along this façade of the property.

The proposed road development will result in a reduction in traffic volumes along the existing road network, due to traffic being diverted onto the proposed road. The modelled locations within the study area of the operational noise model has indicated that, of the 467 locations assessed, 30% (143 noise sensitive locations) will experience either a reduction or no change as a result of the proposed road development. Based on information supplied by the traffic engineers for the wider road network, the greatest reduction in traffic volumes will be experienced along sections of the N69 between Foynes and Limerick and along the N21 between Rathkeale and Adare.

Between Foynes and Askeaton, an approximate reduction in traffic noise levels of 7dB(A) is calculated. There are approximately 52 residential properties within 50m of this section of this road. A positive impact will, therefore, be experienced at these properties and those at further distances back from the roadside. Sections of the N69 between Askeaton and the M7 west of Limerick are calculated to experience a reduction in traffic noise between 1 and 3dB(A). A minor positive impact will be experienced at noise sensitive properties along these roads. There are approximately 153 noise sensitive properties located within 50m of this section of road.

Along the N21 between Rathkeale and Adare, a significant portion of existing traffic will divert onto the proposed road development. Reductions in traffic noise levels of between 10 and 13dB are calculated as a result of traffic reductions along this road, resulting in a major positive impact. There are approximately 72 properties along this section of road between Rathkeale and Adare. Noise sensitive properties within both town centres will also experience a similar reduction in traffic noise levels

In population terms, therefore, there is a significant positive effect as the traffic is being moved from more populated areas. Therefore, there is overall a significant positive effect on human health and a project such as this goes some distance towards achieving the recent WHO *Environmental Noise Guidelines* (2018) which recommended (Executive Summary, p. xvi):

“to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure”.

Vibration

The potential vibration impacts as a result of the proposed road development, both during construction and operation have been assessed in Chapter 12. Overall, the predicted impact from vibration is very low and characterised as not significant. While there may be some degree of local vibration transmitted during some aspects of construction, such as blasting or drilling, these will typically be momentary or brief and very localised and will occur only during construction phase working hours. Given the momentary or brief duration, it will not have any significant negative health impacts.

The potential vibration impact during the operational phase as assessed in Chapter 12 is predicted as being not significant. Therefore, there will be no negative health impacts.

Using the criteria for the significance of human health impact detailed in Table 6.11, above, the impact associated with vibration as a result of the proposed road development is assessed as being Imperceptible.

Air Quality

As discussed above, provided the air quality standards are not exceeded, one can be confident that there will be no adverse effect on human health due to air emissions. This is discussed further below.

As detailed in Chapter 13, certain sensitive receptors have been identified in the study area, which are listed in Table 13.7. These are all residences. It has been predicted that, for the proposed road development, the dusts that are likely to be generated during the construction phase are normally heavier and larger particles. There are potential occupational health issues for the works, which would require, for example, the use of respiratory protection equipment in certain phases. However, as also pointed out in Chapter 13, in the event of such large dust leaving the site, by nature of its relatively large size (greater than 10 microns), it is not respirable and will not have significant human health effects.

It is also noted that, despite the extent of the proposed road development, the potential air quality impact on any individual receptor will be limited as the activity in any one location will be limited in scale and time. Thus, the potential for human health effects will be similarly limited.

The results of the baseline air quality monitoring and potential impacts which are described in full in Chapter 13, have been compared against the reliable air quality standards both during the construction and operational phases to determine if any health effect is likely.

The greatest potential impact on air quality during the construction phase of the proposed road development is from construction dust emissions and the potential for nuisance dust and PM₁₀ / PM_{2.5} emissions - particulate matter of less than 10 µm and 2.5 µm respectively. As this is a major scale development, there is the potential for soiling impacts up to 100m from the source, as detailed in Chapter 13. There are a number of sensitive receptors, predominantly residential properties along the length of the proposed road development, in close proximity to potential works areas. Best practice mitigation measures are proposed for the construction phase of the proposed road which will focus on the pro-active control of dust and other air pollutants to minimise the generation of emissions at source. The mitigation measures that will be put in place during construction of the proposed road as defined in Chapter 13 Air Quality and Climate, will ensure that the impact of the proposed road complies with all EU ambient air quality legislative limit values which are based on the protection of human health. Therefore, the impact of construction of the proposed road is likely to be short-term and imperceptible with respect to human health.

During the operational phase, levels of traffic-derived air pollutants for the development will not exceed the ambient air quality standards either with or without the proposed road development in place. Using the assessment criteria outlined in Appendix 13.2, and Tables 13.1 to 13.3 of Chapter 13, the impact of the development in terms of Nitrogen Dioxide (NO₂), is slightly negative at the majority of receptors along the route of the proposed road development, but there is a slightly positive impact in bypassed areas such as Adare village. In terms of all other pollutants (PM₁₀, PM_{2.5}, Carbon Monoxide (CO) and benzene) the impact is considered imperceptible and long-term.

Twenty-two sensitive residential receptors were included in the air dispersion modelling of traffic emissions for the operational phase of the proposed road development. Based on the air dispersion modelling results, the impact of the proposed road development in terms of ambient levels of nitrogen dioxide is considered long-term, slight and adverse at the majority of receptors along the route of the proposed road development. However, there is a predicted slight beneficial impact at receptors in bypassed areas such as Adare village. The impacts associated with particulate matter less than 10 microns, particulate matter less than 2.5 microns, carbon monoxide and benzene are considered long-term and imperceptible for the operational phase of the proposed road development. Consequently, no mitigation is proposed apart from good practice.

The proposed road development is therefore predicted to have a negligible impact on air quality, as defined in Chapter 13⁸, across the study area during the construction phase and as such will have an imperceptible impact on human health.

Overall, whilst some areas of the study area will experience a permanent imperceptible to slight negative impact on air quality during the operational phase, other bypassed areas will see slight positive impacts and, most importantly, all air quality levels will remain well within air quality standards. As such, there will be an imperceptible impact on human health.

Water

Water Quality

As is identified in Chapter 9 and Chapter 10, no negative impact of water quality in supply sources for drinking water from either surface water or groundwater is anticipated. In this regard, human health effects will not occur. The hydrogeology assessment concluded that, given the mitigation proposed, there is a slight residual impact from the proposed road development with respect to groundwater quality as a resource. In terms of the quantity of groundwater available within any aquifer (the yield of the resource) there will be an imperceptible effect at the regional scale. The operational phase also presents a pollution risk to this supply both from accidental spillages and from routine road run-off discharges. Design pollution control measures have been put in place to reduce the risk.

Given that all residual water supplies will comply with water quality standards, the potential impacts on human health associated with water quality, as a result of the proposed road development, are assessed as imperceptible.

Flooding

The design of the construction and operational phase of the proposed road development has considered the risk of flooding at every stage. Bridge and ancillary works will ensure that there is no increased risk of flooding and indeed flood protection measures have been included.

In addition, in the broader context, the flood risk assessment has demonstrated that there is no significant flooding impact arising from the proposed development and, hence, no potential impact on human health.

⁸ Where the impact magnitude of the changes in concentration of PM₁₀ is imperceptible, then the impact description is negligible.

Soils

Soil Contamination

As detailed in Chapter 8, there are no known areas of contaminated lands crossed by the proposed road development. While it is not anticipated that any of the construction or operational works would lead to soil contamination, the Contractor will be obliged to monitor the construction works at all stages. In the event that any source of contamination is identified, by excavation or other means, this would have to be addressed at that time in consultation with statutory bodies such as the Environmental Protection Agency (EPA). This will ensure that, in the unlikely event that a source of contamination is discovered, appropriate mitigation measures will be put in place to ensure no adverse effects on human health.

Radon

Within the area of County Limerick which the proposed road development traverses, some areas are known to be high radon areas. This is true of the area west of Limerick City, around Pallaskenry and towards Askeaton. As noted previously in Section 6.6.1, it is only when radon builds up in buildings that are inhabited by human beings that the health risk occurs. During construction, there will be excavations which will have the potential to cause some release of radon gas. However, this will be almost instantaneously dissipated and will be harmless. Radon escape from rock will take the path of least resistance. Radon is escaping all the time but when it escapes to the open air there are no associated adverse health effects.

Although it is most likely that there will be no effects in respect of radon, if the excavation is to have any effect at all on radon, it will actually be to divert radon away from residences rather than towards them, as the radon may find an easier route to surface via the excavations rather than its current route. Therefore, people who may be at risk because they live and work in a high radon area, will not be at a higher risk because of the proposed construction or operation of the proposed road development.

The potential human health impact of the construction and operational phases of the proposed road development with regards to radon are assessed as negligible.

Psychological

The proposed road development has been designed to avoid as many properties as possible through the route selection process. However, there is a requirement to acquire 9 dwelling houses as part of the proposed road development, as addressed in Chapter 4. The people living in these homes have genuine concerns that their lives will be adversely affected. Many have lived in these areas for many years or, indeed, all of their lives. Compensation for these impacts are to be assessed by a valuer at a later stage, following appropriate liaison with the property owners affected.

The community will also experience annoyance as a result of the temporary and short-term impacts of traffic management measures and other potential sources of nuisance during the construction phase. Conversely, there is the potential reduction in annoyance amongst road users during the operational phase, where there are reduced journey times.

Whilst individual annoyance cannot be discounted, annoyance is not a health effect. There is no evidence that there are any significant effects on human health from simply transient levels of annoyance. In these circumstances, the negative impacts are assessed as slight. In addition, while there may be positive impacts of reduced annoyance for those experiencing reduced journey delays during the operational

phase, there is little evidence of associated positive impacts on human health and the positive impact is also assessed as slight.

It is worth noting that the proposed road development will remove significant congestion from certain areas and the potential for conflict between vehicular traffic and pedestrians and cyclists, thereby reducing the potential number of collisions and possible fatalities. Not only would the avoidance of fatalities and serious injuries (as discussed in Section 6.4.1, above) have a very significant positive impact on an individual basis, any such injury or fatality would have a profound adverse impact on the individual's family, friends and colleagues such as that there can be a wider impact on the psychological health of the community.

The Do-Nothing scenario has potential for adverse psychological impacts. Progressively longer journey times and uncertainty will be associated with increased annoyance at least, and, at worst, an adverse impact on psychological health.

As detailed in Section 6.4.3, the proposed road development will cause a degree of physical and social severance. Where severance does occur, there is potential for psychological impact. Loneliness can occur if someone feels cut off, for example. Conversely, there may be positive psychological effects where improved connectivity permits greater ease of movement around the area. This would potentially facilitate closer connections with friends or relatives which might be deterred if journeys were perceived to be lengthy or difficult.

Overall, therefore, the assessment of the psychological impact on a population or community basis is that the proposed road development would have an impact that is overall positive. However, one cannot escape the fact that certain individuals - particularly those whose homes are to be acquired - may not experience the community benefit.

6.7.3 Health Improvement

As detailed above, the proposed road development has the potential to bring with it significant socio-economic benefits. It will facilitate transport of goods and people in a more timely, reliable and efficient manner. The full economic benefit will be realised once the proposed road development is completed. Accessibility to the Shannon-Foynes Port will improve, with resultant benefits for businesses who need efficient and timely access. Vehicular traffic will be better facilitated by the proposed road development and the resulting reduction in congestion. This will benefit residents, commuters and tourists accessing highly popular tourist locations in Kerry from, for example, Shannon Airport. It will also bring with it benefits to business and public facilities in Adare Village by reducing noise and air pollution. This all translates into an increased potential for economic prosperity for the Mid-West Region, with Limerick City as a thriving city at the core but impacting as far as Shannon to the North and Kerry to the South.

As a result of the proposed road development, improved conditions on existing roads will lead to increased opportunities to exercise and improve social interaction among neighbours which may currently be inhibited by excessive traffic. All of these provide significant opportunities for health improvement.

Increased opportunities for exercise also have the potential to bring benefits in terms of human health. Exercise is a well-recognised method of reducing risk in terms of obesity, diabetes, hypertension, cardiovascular disease and osteoporosis amongst other conditions. There are also significant psychological benefits and studies have

consistently shown self-reported well-being is significantly higher in those who frequently exercise.

Chapter 2 sets out a number of safety objectives as part of the development objectives. The proposed road development is designed to optimal safety levels. It is well established that roads which are designed to safe standards are associated with reduced accident levels. The proposed road development also has the added benefit of moving the traffic away from pedestrian traffic, reducing the opportunities for pedestrian injury or death. It introduces opportunities for safer travel for cyclists, with the possible introduction of cycle measures on existing roads which are bypassed.

Improvement of Access to Health Services

The proposed road development would further improve access to health care through enhanced public and private transport connectivity and may facilitate faster and safer emergency response through improved road capacity and resilience. Ambulances being able to get to an emergency situation in minutes, as opposed to being delayed in heavy traffic, has obvious benefits for health and could potentially be lifesaving. A much-quoted article by Lyon *et al.* (2004) showed a much-improved survival rate from out-of-hospital cardiac arrests was strongly influenced by reduced response times for emergency services. The ability for emergency services such as ambulances to rapidly access emergency situations, therefore, has the ability to save lives⁹.

Improving access to parks, retail and other recreational activities will therefore make it easier for people to undertake recreational activities. Improved access to medical services will also have added benefits to health, as will access to education facilities, as outlined above in the Health Improvement section.

Many of the potential impacts have already been extensively assessed above. For vehicle drivers, the ability to access services will be improved by the proposed road development. The diversion of traffic away from congested areas will mean that people will be able to access shops, restaurants and other services more easily and with less delay. Similarly, for people needing to pass through villages or cross streets in villages / towns such as Adare to access services, access will be facilitated and greatly improved. It is clear, therefore, that with regards to access to services, the proposed road development impact is overwhelmingly positive for the general population. In the four cases of proposed road closure or diversion, this will not perceptibly affect journey times for access to emergency medical services for the people living in the vicinity.

Health Improvements – Summary

In summary, therefore, the impacts of the proposed road development in the operational phase will be largely positive with significant opportunities for health improvements. These include, but are not limited to, improved access to services, including emergency services and the potential for socio-economic development with the associated health improvements.

6.8 Mitigation Measures for Population & Human Health

6.8.1 Mitigation Measures for Community Severance

In most locations, the local road network will remain connected through the provision of bridges under or over the new roads so as to maintain local community connectivity. One local road, the L-6068 at Rincullia (Km3.6) will be closed by the proposed road

⁹ Emerg Med J. 2004 Sep;21(5):619-24. Surviving out of hospital cardiac arrest at home: a postcode lottery? Lyon RM1, Cobbe SM, Bradley JM, Grubb NR.

development. However, mitigation is not necessary, due to the absence of community severance impacts at this location. One private road 'Cooper's Lane' at Mulderricksfield (Km5.5) will also be closed, but an alternative will be provided c300m to the east.

At two other local roads, L-8027 at Clogh / Amogan Beg (Km52), and L-8026 at Smithfield / Clonshire (Km56.2), the local roads will be closed and will have short diversions to maintain connectivity and to minimise community severance. Where private access tracks and access to land has been severed, underpasses and diversions have been accommodated, where possible, into the design.

6.8.2 Mitigation Measures for Economy

Appropriate signage will be provided at the junctions along the route at Adare, Croagh, Rathkeale, Ballyclogh, Askeaton and Foynes to direct drivers towards the available local services.

6.8.3 Mitigation Measures for Human Health

Mitigation measures for Noise and Vibration and Air Quality and Climate are detailed in Chapters 12 and 13 respectively. Any residual potential negative impacts will not be significant, and therefore no further mitigation measures are proposed for human health as a result of the proposed road development.

6.9 Residual Impacts for Population & Human Health

The proposed road development will provide a very significant positive impact by reducing journey time and improving journey time reliability between Limerick City and the rest of the Southwest and Mid-West, which will have a positive economic impact by improving the prospects for regional development. At a local level, the transfer of traffic to the proposed road development will improve journey amenity along the existing roads for local journeys. Crossings of the existing roads will be significantly easier and safer, benefitting more vulnerable drivers. For cycling, there will be a significant improvement in journey amenity through removal of most through traffic on the existing N21 route, and to a lesser extent along the existing N69 route. A loss of passing trade and reduced familiarity could impact on some businesses located beside or near the existing N21 in Adare, Croagh, Kilcornan, Kildimo and Clarina.

With respect to human health, based on the assessment above, no residual adverse human health effects are expected.

6.10 Difficulties Encountered

No particular difficulties were encountered in the preparation of this chapter.

6.11 Interactions and Cumulative Impacts

This chapter has specifically addressed interactions in terms of the relationship between human health and noise and air quality impacts. In the absence of other major proposed developments along the route of the proposed road development, cumulative impacts will not arise in respect of population and human health.

6.12 Summary of Impacts for Population & Human Health

The principal impacts, positive and negative, of the proposed road development, from the perspective of population and human health, are as follows:

1. Reduced occurrence of fatalities and serious and slight injuries, as a result of improved safety on the road network in the study area;
2. Reduced journey times for national and regional traffic will benefit the human population at a local, regional and national level;
3. Improved journey amenity will be derived for regional traffic and all modes of local traffic including cycling and walking through reduced traffic volumes on existing roads;
4. Improved safety conditions along existing roads and through villages and towns reducing accident levels and improving conditions for vulnerable road users;
5. Improved general amenity will arise due to transfer of major traffic flows from the local communities of Adare and Croagh on the existing N21 route, and to a lesser extent for the various communities along the existing N69 route;
6. Reduced exposure of population to noise and air pollution;
7. There will be some loss of passing trade for some businesses beside the existing roads that are bypassed by the proposed new road; and
8. Improved access to services including emergency services.

6.13 References

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