

Appendix A.6.5.1

Human Health Assessment Methodology

Appendix A.6.4

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A1 Guidance on the methodology for assessing human health 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)*”. The Commission’s SEA Implementation Guidance (section 5.26) states “*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*”. (Paragraph (f) (of Annex I of the SEA Directive) lists the environmental factors 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:

“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”.

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

One of the messages in the IEMA document in terms of assessing health in EIA, 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 noted 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*”. The IEMA document suggests that these three domains should be considered in the assessment of health 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 World Health Organization (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*”. 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 services. While it is important to do this, it is also important not to attribute every conceivable event as being 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 social well-being be that positive or negative.

A2 Literature Review

A literature review on the potential impacts of transport projects including roads on human health has been carried out. This section presents the results of that literature review which informed the methodology used for human health assessment.

One of the first areas in the literature review to consider is the health determinants relevant to the proposed alternatives and options – 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 transport project including a road both during construction and 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 – flood risk
- Soils – for example potential exposure of people to contaminated land

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

In addition, the impacts of the alternatives and options on psychological health and also health improvements and improvements to services have been included in the literature review below. These topics also fall under the area of “Wellness”.

The last fifteen years in Ireland has 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 “PubMed¹” search, key words such as “Health Effects Roads Ireland” found that there were no published studies in peer reviewed literature. There was however a significant tranche of literature from outside Ireland and 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 NO₂ and SO₂ amongst others. The literature is clear that these are the major hazards with the potential for human health effects. The literature is also strongly consistent with a Dose response effect as presented in Table 1 below with regard to noise and air emissions - the lower the dose the lower the effect. Health based standards² such as WHO and EU standards incorporate literature evidence in the setting of these standards. In essence 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 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 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 health effects from water and soil emissions when these standards are not exceeded.

These noise, air, water and soil assessments use standards (such as air quality standards) in order to identify whether significant impacts will arise or not. Again, as noted above, the health standards such as those set by the WHO are primarily intended to protect the vulnerable subsections of the population and, accordingly, will necessarily protect the more robust subsections. The standards are set at levels for which there will be no significant health effects, but do not exclude each and every effect, i.e. slight or moderate health effects are possible even below the levels at which health based standards would apply.

These health based standards are discussed further below in relation to the various environmental pathways but it is also appropriate to understand the principle behind the setting of such standards.

A2.1 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 logarithmic scale i.e. a non-linear scale, the figure can be somewhat

¹ PubMed is a search engine accessing primarily the MEDLINE database of references and abstracts on life sciences and biomedical topics.

² The term standards in this instance covers guidelines for example noise guidelines as such standard are not currently available.

confusing. Essentially, an increase by 3dB means a doubling of the sound intensity in energy terms.

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 (Leq). Leq is the method of averaging recommended in industry and environmental assessments and in guidelines issued by, for example, the World Health Organization.

It is normally assumed that noise inside a building with the windows open, will be at least an estimated 15dB less than that outside. With windows closed, noise levels are reduced further inside, up to in excess of 35dB, depending on the building fabric. The actual attenuation varies depending on the type of building, size of the windows and other factors.

It should be noted that the human health assessment relates to environmental exposure to noise. Undoubtedly those with the highest noise exposure will be those working on the construction of the transport solution. Legislation is in place for control of work place noise and is policed by the Health and Safety Authority.

A Europe-wide study by Fritschi, 2011³) and another paper by Hellmuth, 2012⁴, published by WHO demonstrate a significant burden of adverse 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) likewise recommends and applies metrics for various health outcomes. In general terms, increasing noise in communities is associated with adverse health outcomes and vice versa. The nature and the severity of these outcomes is further discussed below.

The potential health impacts due to noise include:

- Noise-Induced Hearing Impairment
- Interference with Speech Communication
- Disturbance at schools
- Sleep Disturbance
- Hypertension and Cardiovascular Disease

A2.1.1 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 states

³ Fritschi, L. et al., 2011. Burden of disease from environmental noise, Copenhagen: WHO Regional Office for Europe

⁴ Hellmuth, T., Classen, T., Kim, R. & Kephelopoulous, S., 2012. Methodological guidance for estimating the burden of disease from environmental noise, Copenhagen: WHO Regional Office for Europe

that Noise Induced Hearing Loss will not occur at noise levels below 70dB no matter how long the exposure continues.

A2.1.2 Interference with Speech Communication

Noise interference 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 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 open is conservatively estimated to be 15dB.

A2.1.3 Disturbance at schools

There are several studies on the effect of environmental noise on education. However, most of these relate to airport noise and to a lesser extent traffic noise. From the literature review undertaken, school learning may be the factor most affected by environmental noise.

The RANCH study was one of the largest studies performed on this matter in Europe and was published in the Lancet in 2005. 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.” 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 literature review, disturbance at schools will not be a significant issue.

A2.1.4 Sleep Disturbance

Sleep disturbance is considered to be a major environmental noise effect on human health. It is however estimated 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. However 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 (Journal Behavioural Sleep Medicine, 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, and instances where ambient noise levels are much greater during the day it is therefore less likely that an additional noise source will have a significant effect to those who try to sleep during day time.

A2.1.5 Hypertension and Cardiovascular Disease

A number of studies have postulated a link between environmental noise and hypertension and also 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 due to potential confounders⁵. One of the issues was trying to differentiate whether effects may be due to air pollution rather than noise. 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 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 Houthuijs.

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) that 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 noise level of 40dB L_{night} as measured outside residences. They do however accept that this is essentially unachievable in the foreseeable future and therefore proposes 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 refer to L_{night} parameter which relates specifically to noise levels over the night-time period. The NRA Guidelines on the Treatment of Noise and Vibration sets a design goal in terms of a composite 24 hour parameter, the L_{den} . Whilst the L_{den} 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 to have noise levels at or above 55dB L_{night} and Carrick-on-Shannon is no different. In this context any assessment of potential impacts must take into account the baseline or existing noise levels.

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.

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.

The WHO Guidelines are guidelines for protection of health in communities. In terms of potential impacts on health, night time noise is far less important and does not merit being considered in the same way as other factors such as diet, exercise, cigarette smoking and genetics. The slight increase or decrease in night-time noise that might occur on individual residences would be so small as to be unmeasurable in terms of health effects. Therefore, in assessing 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 an individual residence 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.

A2.1.6 Summary Noise

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.

A2.2 Vibration

Vibration has the potential to have 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.

A2.3 Air Quality

Vehicles with internal combustion engines emit air pollutions, including particular matter, carbon monoxide, nitrogen oxides and a variety of hydrocarbons. Previously, lead compounds were 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.

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

- carbon monoxide
- other products of combustion
- fine particulates

A2.3.1 Carbon Monoxide

Carbon monoxide is formed by 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. High levels of carbon monoxide exposure are associated with increased hospital admissions, cardiovascular disease and mortality.

A2.3.2 Products of combustion

Nitrogen dioxide, and oxides of Nitrogen in general, directly affects the lungs. It is also gas produced during fuel combustion and impairs the lungs immune defence mechanism. When contacted 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. due to high levels of exposure to nitrogen dioxide.

A2.3.3 Fine particles

Fine particles include PM₁₀, i.e. particulate matter less than 10 micrograms in diameter but also in more recent time, more emphasis has been made on smaller particles, again including PM_{2.5}, i.e. 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 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, one must consider the Do-Nothing scenario would lead to those vehicles continuing to go through congested areas with slow average speeds giving the potential for greater emissions. Overall therefore the alternatives and options may have potential benefits regarding particles compared to the Do-Nothing scenario.

A2.3.4 Appropriate Standards

The starting point in selecting the appropriate standard to apply is EU directives which had been set down. In Ireland, these are monitored by the EPA. The current applicable directive is the Clean Air for Europe (CAFÉ) Directive.

The following table shows the limit or target values specified by the directive that set down limits for specific air pollutants. The directive covers:

- Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter (PM₁₀ and PM_{2.5}) and lead
- Carbon monoxide and benzene
- Ozone
- Arsenic, Cadmium, Nickel and Benzo(a)pyrene

Table 1: Limit Values of CAFE Directive 2008/50/EC

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m3	Limit Value ppb	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		Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM ₁₀	Protection of human health	calendar year	40		Annual mean	1 Jan 2005
PM _{2.5} - Stage 1	Protection of human health	calendar year	25		Annual mean	1 Jan 2015
Lead	Protection of human health	calendar year	0.5		Annual mean	1 Jan 2005
Carbon Monoxide	Protection of human health	8 hours	10,000	8620	Not to be exceeded	1 Jan 2005
Benzene	Protection of human health	calendar year	5	1.5	Annual mean	1 Jan 2010

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 for the vulnerable. Hence the human health assessment relies on compliance with the Air Quality Standards to determine whether significant impacts will arise on human health or not. The standards used in the Air Quality assessment 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 CO. 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. The table above shows that the levels are set 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.

A2.3.5 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 with all-cause mortality⁶, 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 by Chen et Al published in the Lancet in early 2017 showed a small (7%) increase in the incidence of dementia in those living less than 50 meters from major roads but no increase in the incidence of Multiple Sclerosis or Parkinsons 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 would include very busy highways and trunk roads. Perhaps the most significant criticism of the study was that the authors could not account for socio-economic effects. Socio-economic effects are related to the incidence of dementia. Therefore, 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 increase in the occurrence of dementia in this study. Overall while further studies are recommended one can draw relatively little from this one study.

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

While there are some difficulties making comparisons between the impact of road building in say 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 counties such as China, which currently includes polluted air quality in its baseline, is not comparable to that of Ireland and in particular Leitrim.

The 2014 publication from the OECD The Cost of Air Pollution, The Health Impacts of Road Transports points out that while the health impacts of air pollution in western countries is decreasing, that 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 16 years old, an important document in Ireland was the Health Impacts of Transport, a Review published in March 2005 by the Institute of Public Health in Ireland. 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.

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 speeds 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.”

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

It is important in these areas to consider the baseline environment.

A2.4 Water

Accessibility to high quality clean water is obviously 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.

Flooding also has potential for 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 but also the potential loss in value of the property. These can be associated with increased levels of anxiety and even depression. Flooding can also be a potential source for the spread of disease. This made the spread by vermin or alternatively flooding the sewers and septic tanks. When considering the potential health effects of the project in relation to flooding, it is important to consider if the risk of flooding is increased or decreased or indeed unaffected by the project.

A2.5 Soils

A2.5.1 Contamination of Land

If a project has the capacity to contaminate land this also has 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, either people living and working on the land itself or for example children playing on the land. Some contaminants may be concentrated in food grown in the land and this is another manner in which contaminated land could have a health effect.

A2.5.2 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 website⁷.

⁷ <http://www.epa.ie/radon/getinformed/>

A2.6 Psychological

In the planning process, potential adverse effects on psychological health are often mentioned, for example, anxiety and stress experienced by those whose homes are to be unfortunately compulsory acquired or those whom will experience a change in the environment in which they live.

The community will also experience annoyance from the temporary impacts of traffic management and other effects during the construction phase. As against this there is the potential reduction in annoyance amongst road users in the operational phase where there are reduced journey times. Annoyance however, is not in itself a health effect.

For virtually every proposal for any road development there are concerns about potential adverse effects on a person's overall psychological well-being. This is somewhat a more difficult matter to assess as there are no direct measurements one can use. While one can give great detail in predicting for example noise emissions one cannot use the same scientific certainty in predicting psychological impacts. It is not possible to use a standards-based approach for example.

There are various degrees of psychological impact and these can be both positive and negative. There can be a positive impact, whereby people may look forward to better transport. There can also be adverse effects of varying degrees. At the lower end of this impact might be annoyance where somebody is annoyed by for example, outside noise, dust depositing or temporary traffic delays associated with construction of the roads. This is not a medical impact as such. If someone develops a psychological illness such as anxiety or depression this would be a medical impact.

Construction by its very nature is transient but it is expected that construction activities will cause some annoyance such as from road diversions and temporary road closures. The potential effects are minimised by use of appropriate traffic management and avoidance of extended night time closures. There has been a considerable amount of road construction in Ireland over the last few decades. However, there is no documented evidence from these projects to link adverse outcomes with psychological health in Ireland.

A2.7 Health Improvements

Transport projects have the potential to provide opportunities for health improvements.

Employment and income are among the most significant determinants of long-term health, influencing a range of factors including the quality of housing, education, diet, lifestyle, coping skills, access to services and social networks. Many epidemiological studies consistently show better health outcomes are associated with higher socio-economic status.

Consequently, poor economic circumstances can influence health throughout life, where communities subject to socio-economic deprivation are more likely to suffer from morbidity, injury, mental anxiety, depression and tend to suffer from higher

rates of premature death than those less deprived. One of the most reliable methods to improve health within a community is to raise its socio-economic status.

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

In social health terms, economic development also brings the opportunity for reducing inequities in society. Long-term unemployment for example is detrimental to the individual, family and society. It has potential to transfer across generations so that families where the head of household is long term unemployed are themselves far more likely to become or stay unemployed. This has potential to create and sustain social inequities. The economic development opportunities provided by a transport project have the potential to create more employment and reduce the risk of long-term unemployment. This in turn can lead to greater opportunities for equity in society.

A2.8 Improvement of Access to Services

Studies show that recreational activities can have a positive impact on a person's wellbeing and their health.

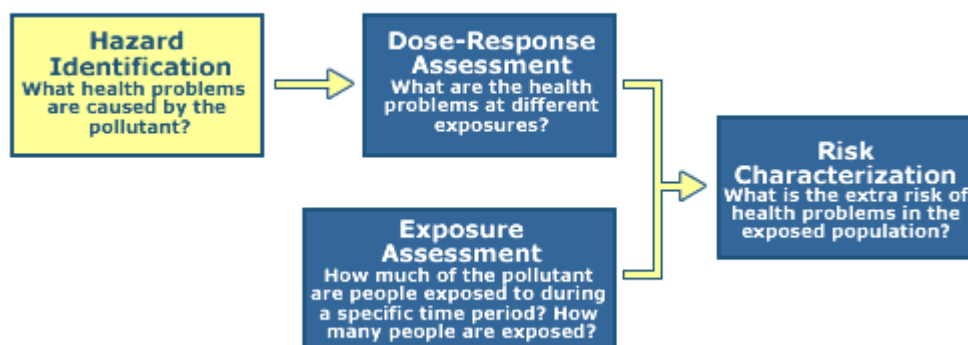
A study by Lyon et al⁸ from 2004 showed a much improved survival rate from out-of-hospital cardiac arrests was strongly influenced by reduced response times for emergency services. The ability for emergency services such as ambulances to rapidly access emergency situations therefore has the ability to save lives.

Improving access to cinemas, 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 a person's health as will access to education facilities.

A3 Health Protection

The assessment of human health, 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 US EPA guidance includes a four step approach which is represented graphically in **Plate 1** below.

⁸ Emerg Med J. 2004 Sep;21(5):619-24| Lyon RM1, Cobbe SM, Bradley JM, Grubb NR.

Plate 1: Human Risk Assessment**The 4 Step Risk Assessment Process**

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

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.

A4 Health Improvement

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

The assessment of human health for the project, in terms of health improvement, includes an assessment on how the project would impact on the socio-economics of the community.

A5 Improvement of access to 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 project includes an assessment on whether or not the project will improve accesses to these services.