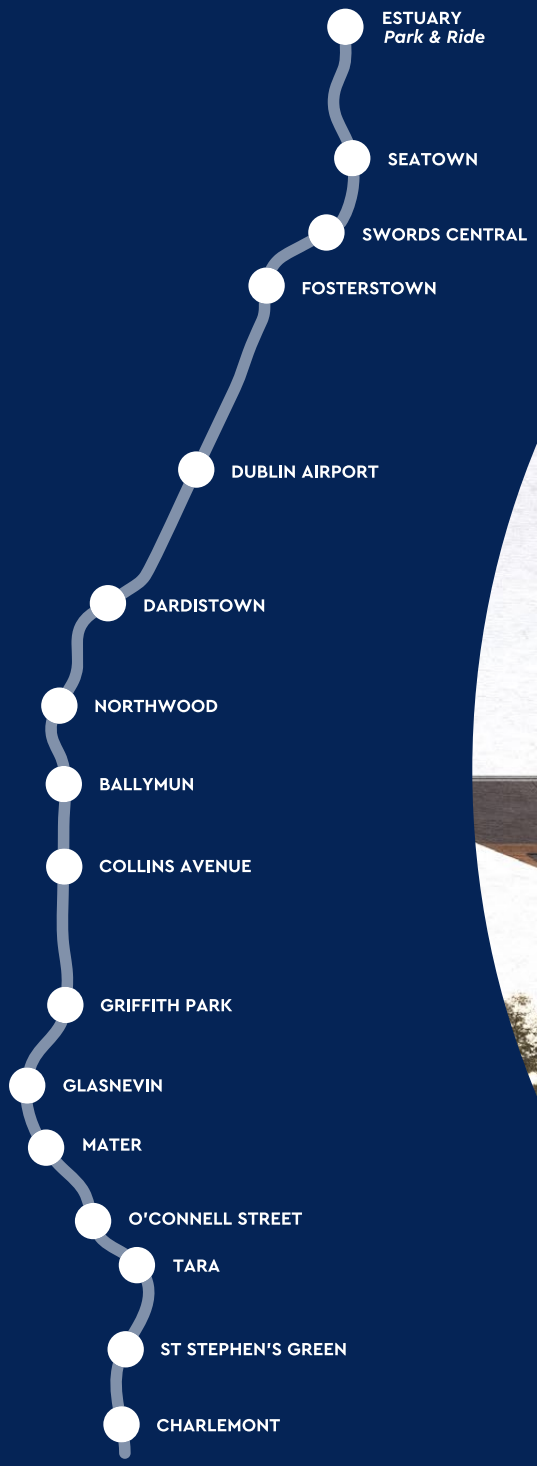

10 Human Health

Contents

List of Abbreviations

Acronym	Meaning
AIMDs	Active Implantable Medical Devices
ASD	Autism Spectrum Disorder
ANSI	American National Standards Institute
Bq	Becquerel
BSI	British Standard Institute
CAFE	Cleaner Air for Europe
CCTV	Closed-Circuit Television
CI	Confidence Interval
DANP	Dublin Airport North Portal
DART	Dublin Area Rapid Transit
DASP	Dublin Airport South Portal
dB	Decibel – the scale in which sound pressure level is expressed
DC	Direct Current
DCC	Dublin City Council
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMC	Electromagnetic compatibility
EMF	Electric and Magnetic Fields
EMF	Electromagnetic Frequency
EPA	Environmental Protection Agency
ERF	Exposure-Response Function
EU	European Union
FCC	Fingal County Council
GAC	Generic Assessment Criteria
GDG	Guideline Development Group for the Environmental Noise Guidelines for the European Region (WHO, 2018)
HA	High Annoyance
HAVS	Hand Arm Vibration Syndrome
HEPA	High Efficiency Particulate Air
HIA	Health Impact Assessment
HPA	Health Promotion Agency
HSE	Health Services Executive
HSD	Highly Sleep Disturbed
IAIA	International Association for Impact Assessment
ICNIRP	International Commission for Non-Ionising Radiation Protection
IEMA	Institute of Environmental Management and Assessment
IHD	Ischaemic Heart Disease
ISO	International Standard Organization
LA_{eq}	A-weighted equivalent continuous steady sound level during the sample period and effectively represents an average value
NDSC	National Disease Surveillance Centre

Acronym	Meaning
NO_2	Nitrous oxide
NO_X	Oxides of nitrogen
OR	Odds Ratio
PM_{10}	Particulate matter of an aerodynamic diameter of equal or less than 10 micrometres
$PM_{2.5}$	Particulate matter of an aerodynamic diameter of equal or less than 2.5 micrometres
PPE	Personal Protective Equipment
PPV	Peak Particle Velocity
RANCH	Road traffic and Aircraft Noise Exposure and Children's Cognition and Health
RR	Respiratory Rate
SEA	Strategic Environmental Assessment
SO_2	Sulphur dioxide
TBM	Tunnel Boring Machine
TCD	Trinity College Dublin
TII	Transport Infrastructure Ireland
UCD	University College Dublin
US	United States
WBG	Women's Budget Group
WBV	Whole Body Vibration
WHO	World Health Organisation

10. Human Health

10.1 Background

This Chapter of the Environmental Impact Assessment Report (EIAR) assesses the impact of the MetroLink Project (hereafter referred to as the proposed Project), on Human Health during the Construction Phase and Operational Phase.

This chapter describes and assesses the likely direct and indirect significant effects of the proposed Project on Human Health, in accordance with the requirements of Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (i.e. the EIA Directive) (European Union, 2014a).

This Chapter should be read in conjunction with the following Chapters, and their Appendices, which present related impacts arising from the proposed Project and proposed mitigation measures to ameliorate the predicted impacts:

- Chapter 9 (Traffic & Transport);
- Chapter 11 (Population & Land Use);
- Chapter 12 (Electromagnetic Compatibility & Stray Current);
- Chapter 13 (Airborne Noise & Vibration);
- Chapter 14 (Groundborne Noise & Vibration);
- Chapter 16 (Air Quality);
- Chapter 18 (Hydrology);
- Chapter 19 (Hydrogeology);
- Chapter 20 (Soils & Geology); and
- Chapter 28 (Risk of Major Accidents & Disasters).

The assessment is based on identifying and describing the likely significant effects arising from the proposed Project as described in Chapters 4 to 6 of this EIAR. The proposed Project description is based on the design prepared to inform the planning stage of the project and to allow for a robust assessment as part of the Environmental Impact Assessment (EIA) Process.

Where it is required to make assumptions as the basis of the assessment presented here, these assumptions are based on advice from competent project designers and are clearly outlined within the Chapter.

Limits of deviation have been set for the proposed Project and this is addressed in the Wider Effects Report annexed at Appendix A5.19.

10.2 Outline Project Description

A full description of the proposed Project is provided in the following chapters of this EIAR:

- Chapter 4 (Description of the MetroLink Project);
- Chapter 5 (MetroLink Construction Phase); and
- Chapter 6 (MetroLink Operations & Maintenance).

Table 10.1 presents an outline description of the key proposed Project elements which are appraised in this Chapter. Diagram 10.1 presents an outline of the main elements of the proposed Construction Phase

that are appraised in this Chapter and Diagram 10.2 presents an outline of the main elements of the Operational Phase that are appraised in this Chapter.

Table 10.1: Outline Description of the Principal Project Elements

Project Elements	Outline Description
Permanent Project Elements	
Tunnels	It is proposed to construct two geographically separate, single-bore tunnels, using a Tunnel Boring Machine (TBM). Each section of tunnel will have a 8.5m inside diameter and will contain both northbound and southbound rail lines within the same tunnel. These tunnels will be located as follows: The Airport Tunnel: running south from Dublin Airport North Portal (DANP) under Dublin Airport and surfacing south of the airport at Dublin Airport South Portal (DASP) and will be approximately 2.3km in length; and The City Tunnel: running for 9.4 km from Northwood Portal and terminating underground south of Charlemont Station.
Cut Sections	The northern section of the alignment is characterised by a shallow excavated alignment whereby the alignment runs below the existing ground level. Part of the cut sections are open at the top, with fences along the alignment for safety and security. While other sections are 'cut and cover', whereby the alignment is covered.
Tunnel Portals	The openings at the end of the tunnel are referred to as portals. They are concrete and steel structures designed to provide the commencement or termination of a tunnelled section of route and provide a transition to adjacent lengths of the route which may be in retained structures or at the surface. There are three proposed portals, which are: ▪ DANP; ▪ DASP; and ▪ Northwood Portal. There will be no portal at the southern end of the proposed Project, as the southern termination and turnback would be underground.
Stations	There are three types of stations: surface stations, retained cut stations and underground stations: ▪ Estuary Station will be built at surface level, known as a 'surface station'; ▪ Seatown, Swords Central, Fosterstown Stations and the proposed Dardistown Station will be in retained cutting, known as 'retained cut stations'; and ▪ Dublin Airport Station and all 10 stations along the City Tunnel will be 'underground stations'.
Intervention Shaft	An intervention shaft will be required at Albert College Park to provide adequate emergency egress from the City Tunnel and to support tunnel ventilation. Following the European Standard for safety in railway tunnels TSI 1303/2014: Technical Specification for Interoperability relating to 'safety in railway tunnels' of the rail system of the European Union, it has been recommended that the maximum spacing between emergency exits is 1,000m. As the distance between Collins Avenue and Griffith Park is 1,494m, this intervention shaft is proposed to safely support evacuation/emergency service access in the event of an incident. This shaft will also function to provide ventilation to the tunnel. The shaft will require two 23m long connection tunnels extending from the shaft, connecting to the main tunnel. At other locations, emergency access will be incorporated into the stations and portals or intervention tunnels will be utilised at locations where there is no available space for a shaft to be constructed and located where required (see below).

Project Elements	Outline Description
Intervention Tunnels	In addition to the two main 'running' tunnels, there are three shorter, smaller diameter tunnels. These are the evacuation and ventilation tunnels (known as Intervention Tunnels): ▪ Airport Intervention Tunnels: parallel to the Airport Tunnel, there will also be two smaller diameter tunnels; on the west side, an evacuation tunnel running northwards from DASP for about 315m, and on the east side, a ventilation tunnel connected to the main tunnel and extending about 600m from DASP underneath Dublin Airport Lands. In the event of an incident in the main tunnel, the evacuation tunnel will enable passengers to walk out to a safe location outside the Dublin Airport Lands. ▪ Charlemont Intervention Tunnel: The City Tunnel will extend 360m south of Charlemont Station. A parallel evacuation and ventilation tunnel is required from the end of the City Tunnel back to Charlemont Station to support emergency evacuation of maintenance staff and ventilation for this section of tunnel.
Park and Ride Facility	The proposed Park and Ride Facility next to Estuary Station will include provision for up to 3,000 parking spaces.
Broadmeadow and Ward River Viaduct	A 260m long viaduct is proposed between Estuary and Seatown Stations, to cross the Broadmeadow and Ward Rivers and their floodplains.
Proposed Grid Connections	Grid connections will be provided via cable routes with the addition of new 110kV substations at DANP and Dardistown. (Approval for the proposed grid connections to be applied for separately but are assessed in the EIAR).
Dardistown Depot	A maintenance depot will be located at Dardistown. It will include: ▪ Vehicle stabling; ▪ Maintenance workshops and pits; ▪ Automatic vehicle wash facilities; ▪ A test track; ▪ Sanding system for rolling stock; ▪ The Operations Control Centre for the proposed Project; ▪ A substation; ▪ A mast; and ▪ Other staff facilities and a carpark.
Operations Control Centre	The main Operations Control Centre (OCC) will be located at Dardistown Depot and a back-up OCC will be provided at Estuary.
M50 Viaduct	A 100m long viaduct to carry the proposed Project across the M50 between the Dardistown Depot and Northwood Station.
Temporary Project Elements	
Construction Compounds	There will be 34 Construction Compounds including 20 main Construction Compounds, 14 Satellite Construction Compounds required during the Construction Phase of the proposed Project. The main Construction Compounds will be located at each of the proposed station locations, the portal locations and the Dardistown Depot Location (also covering the Dardistown Station) with satellite compounds located at other locations along the alignment. Outside of the Construction Compounds there will be works areas and sites associated with the construction of all elements of the proposed Project, including an easement strip along the surface sections.
Logistics Sites	The main logistics sites will be located at Estuary, near Pinnock Hill east of the R132 Swords Bypass and north of Saint Margaret's Road at the Northwood Compound. (These areas are included within the 14 Satellite Construction Compounds).
Tunnel Boring Machine Launch Site	There will be two main tunnel boring machine (TBM) launch sites. One will be located at DASP which will serve the TBM boring the Airport Tunnel and the second will be located at the Northwood Construction Compound which will serve the TBM boring the City Tunnel.

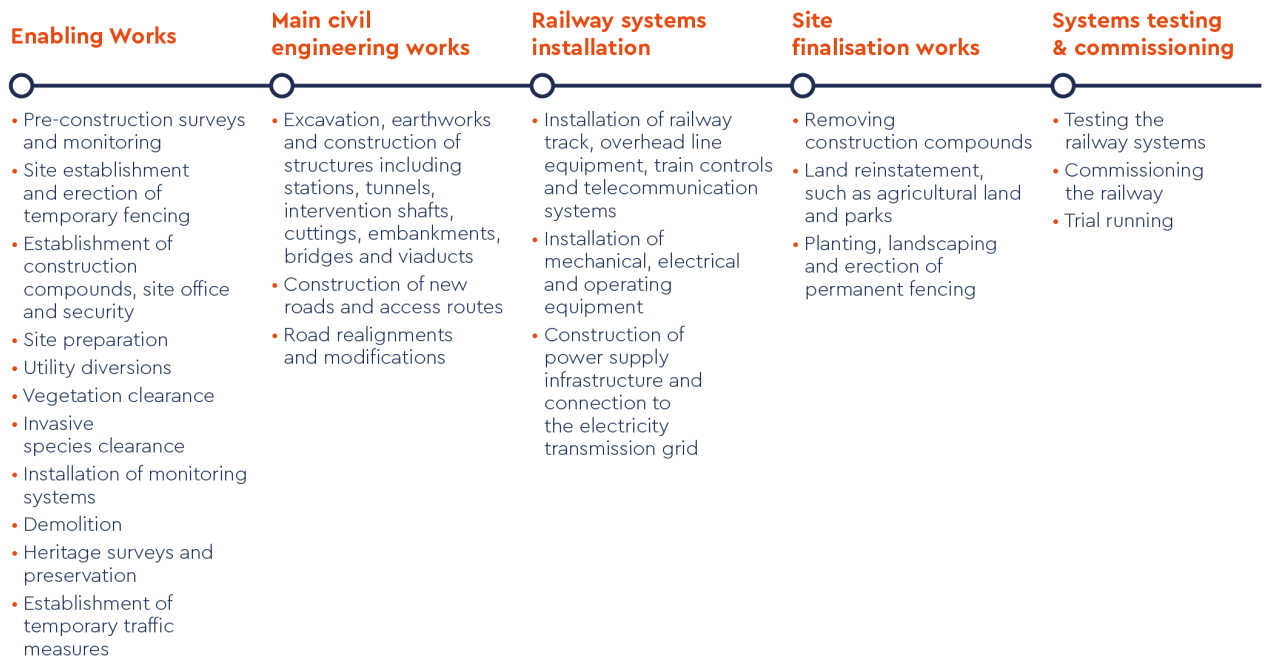

Diagram 10.1: Summary of Key Activities during the Construction Phase of the Proposed Project

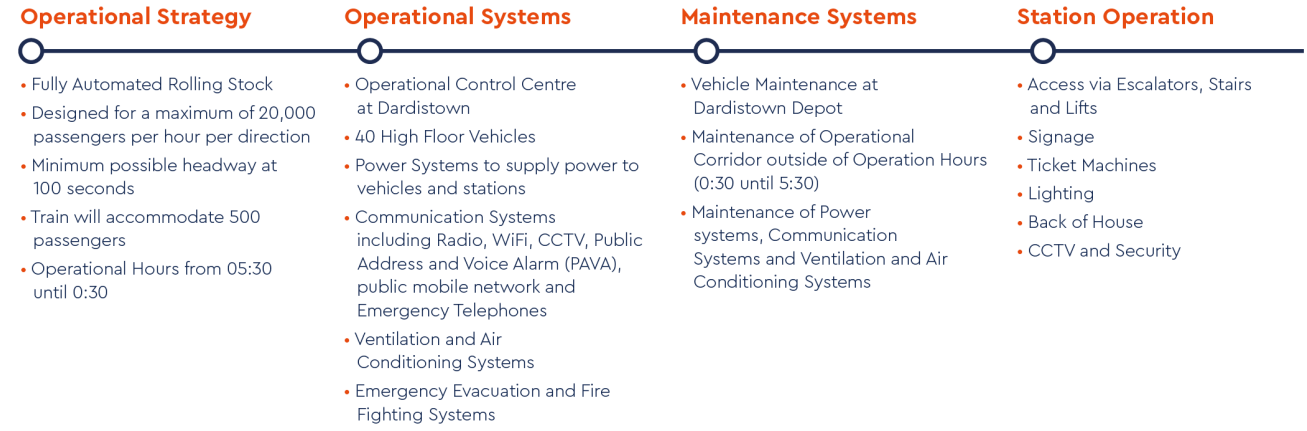

Diagram 10.2: Summary of Key Activities during the Operational Phase of the Proposed Project

10.3 Methodology

This section sets out the methodology that was used to assess the impact of the proposed Project on human health, including the guidance and policies that inform human health assessment and how sensitive receptors are defined.

10.3.1 Study Area

The proposed Project covers an extensive linear study area between Estuary and Charlemont Stations via Dublin City Centre.

The assessment of the identified study areas is split into four geographical zones which are listed in Table 10.2 below.

Table 10.2: Geographical Split of Assessment Zones

Ref.	Geographical Split	Description of Extent of Geographical Section
AZ1	Northern Section	Estuary Station to DANP. It includes the railway crossing on a viaduct over the Broadmeadow and Ward Rivers and associated flood plains. This section will include open, retained cut, and cut and cover sections. Section AZ1 includes the Park and Ride facility at Estuary Station as well as stations at Seatown, Swords Central and Fosterstown.
AZ2	Airport Section	Section AZ2 of the proposed Project includes the ESBN connection and new substations, the DANP, the tunnel underneath Dublin Airport, Dublin Airport Station and DASP and associated intervention and ventilation tunnels.
AZ3	Dardistown to Northwood	Section AZ3 of the proposed Project covers from south of DASP to the Northwood Portal. Section AZ3 includes Dardistown station, the Dardistown Depot, ESBN connection and substations, the M50 Crossing, Northwood station and the TBM launch site at Northwood. This section will include open, retained cut, and cut and cover sections of the alignment.
AZ4	Northwood to Charlemont	Section AZ4 extends from a location south of the Northwood Portal to the tunnel termination located south of Charlemont Station, ten underground stations, and the Albert College Park Intervention shaft.

10.3.1.1 AZ1 Northern Section – Construction Activities

Proposed construction in AZ1 includes the construction of the Park and Ride Facility, Estuary Station and ancillary infrastructure, construction of the above ground rail line between the Park and Ride Facility and the Dublin Airport North Portal, rail stations and platforms and construction of ancillary structures (bridges/structures). In addition, a number of utility diversion works will be required at each of the construction areas. Potentially sensitive locations from a human health perspective include residential dwellings to the east and west of the R132 between Estuary and Fosterstown Stations and schools, pre-schools, creches, a (previous) retreat centre and offices in proximity to construction sites.

10.3.1.2 AZ2 Airport Section – Construction Activities

Proposed construction in AZ2 includes the construction of the Dublin Airport Station and the Dublin Airport South Portal. In addition, a number of utility diversion works will be required at each of the construction areas. Sensitive locations from a human health perspective within this study area include office, hotel buildings and Our Lady Queen of Heaven Church at Dublin Airport and residential buildings along the Old Airport Road.

10.3.1.3 AZ3 Dardistown - Northwood - Construction Activities

Proposed construction in AZ3 includes the construction activities and utility diversion works within the Dardistown Depot, the M50 Viaduct and the TBM launch site at Northwood, including Northwood Station. Sensitive locations from a human health perspective in this study area include residential buildings along the Old Airport Road, at Ballymun Cross immediately south of the M50, along the R108 Ballymun Road and residential building and hotels within Ballymun North.

10.3.1.4 AZ4 Northwood – Charlemont – Construction Activities

Proposed construction in AZ4 includes the surface works relating to station box construction at Ballymun, Collins Avenue, Griffith Park, Mater Hospital, O'Connell Street, Tara Street, St Stephen's Green and Charlemont, construction of rail interchange and rail realignment works at Glasnevin, and an intervention shaft at Albert Park College Park. In addition, a number of utility diversion works will be required across the extent of the proposed Project at each of the main work areas. Sensitive locations from a human health perspective within this study area include a mix of residential dwellings, schools, churches, hospitals and other sensitive buildings adjacent to the construction sites.

The population that has the highest potential to experience effects arising from the construction and operation of the proposed Project will be those primarily living within a relatively short distance of the proposed Project infrastructure. Those individuals have the potential to be exposed to various emissions such as noise and vibration and emissions to air which are predicted to occur in both the Construction and Operational Phases (Refer to Chapter 13: Airborne Noise & Vibration, Chapter 14: Groundborne Noise & Vibration and Chapter 16: Air Quality for further details). It is important to note that not everybody within the study area would be equally affected by the same level of emissions, from a human health perspective.

Individuals living within 250m from the proposed Project will potentially be most affected, given the way noise and vibration and air emissions attenuate with distance. Therefore, the study area for the human health assessment will be predominantly within 250m of the proposed Project, although it is recognised that some potential effects could extend beyond this including impacts on human health from traffic and waste disposal and these will be considered if deemed relevant to this assessment. Similarly, those at the outer limit of the study area, outside 250 metres may have imperceptible effects from some emissions such as airborne and groundborne noise and may be scoped out if the evidence is of no effect.

It is predicted that those most likely to experience positive effects during the Operational Phase will be the population using the proposed Project on completion, which will extend well beyond 250m from the alignment.

10.3.2 Relevant Guidance, Policy and Plan Context

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

- Addressing Human Health in Environmental Impact Assessment As per EU Directive 2011/92/EU amended by 2014/52/EU CONSULTATION DRAFT November 2019 (IAIA, 2019);
- Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, May 2022);
- Guidelines on the Information to be contained in Environmental Impact Statements (EPA 2002);
- Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA 2017);
- Advice notes on Current Practice in the preparation of Environmental Impact Statements (EPA 2003) and draft revised notes for preparing Environmental Impact Statements (EPA draft September 2015);
- Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA 2003);

- Air Quality Standards Regulations 2011 (SI No. 180 of 2011);
- British Standard (BS) 5228-1:2009+A1:2014 – Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1: Noise;
- Department of Housing, Planning and Local Government (2018) Guidelines for Planning Authorities and an Bord Pleanála on carrying out Environmental Impact Assessment, (Government of Ireland, August 2018);
- European Public Health Association (EUPHA) (2019) Addressing Human Health in Environmental Impact Assessment (EUPHA, 2019);
- Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (EPA, 2016);
- Guidelines for treatment of tourism in an Environmental Impact Statement (Fáilte Ireland, 2011);
- DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe (OJ L 152 11.6.2008, p. 1);
- Health Impact Assessment (Institute of Public Health Ireland, 2009);
- Health Impact Assessment Resource and Tool Compilation (US EPA, 2016);
- Health in Environmental Impact Assessment - A Primer for a Proportionate Approach (IEMA, 2017);
- Impact Assessment Outlook Journal (Volume 8: October 2020)- Health Impact Assessment in Planning (IEMA, 2020);
- Institute of Public Health (IPH) (2021) Health Impact Assessment Guidance (IPH, 2021);
- International Association for Impact Assessment (IAIA) 2020 Human Health Ensuring a High Level of Protection
- Noise and Health - The Evidence from Ireland;
- Revised Guidelines on the Information to be Contained in Environmental Impact Statements (EPA, draft September 2015b);
- US Environmental Protection Agency Dose Response Risk Assessment Guidance (2017);
- World Health Organisation (WHO) Night-time Noise Guidelines for Europe (WHO, 2009);
- WHO Environmental Noise Guidelines for the European Region 2018; (WHO, 2018);
- World Health Organisation (WHO) Air Quality Guidelines (WHO, 2006);
- World Health Organisation (WHO) Air Quality Guidelines (WHO 2021); and
- World Health Organisation Guidelines for Community Noise (WHO,1999).

These guidelines have helped inform the proposed Project's approach to the Human Health chapter (Chapter 10) and Health Impact Assessment (HIA) in general.

HIA is defined by the Institute of Public Health in Ireland, 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. A 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 EIA Directive).

The Institute of Environmental Management and Assessment (IEMA) Health in Environmental Impact Assessment – A Primer for a Proportionate Approach (IEMA, 2017) (hereafter referred to as the IEMA discussion document) notes that HIA and EIA are separate processes and that, whilst a HIA can inform EIA practice in relation to human health, an HIA alone will not necessarily meet the EIA human health requirement. HIAs are not routinely carried out for major infrastructure schemes in Ireland, nor are they required to be.

The recitals to the 1985 and 2011 EIA Directives refer to 'human health' and the operative texts refers to 'human beings' as the corresponding environmental factor. The most recent amendment of the EIA Directive in 2014 changed this factor to 'Population and Human Health'. Further details on population impacts can be found in Chapter 11 (Population & Land Use).

The EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2022) note that this health assessment approach is consistent with the approach set out previously 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 current guidelines state:

'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'.

In terms of human health protection, emissions during the Construction or Operational Phase of the Proposed Project will need to be identified and compared against reliable Health Based Standards. Reliable sources of the standards may be regulatory such as provided by the EU, e.g. Air Quality Standards, or based on expert opinion such as is provided by the WHO as is the case with noise guidelines.

The EPA Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (EPA, 2022) 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.', and that,

'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 [SEA], 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'.

The Impact Assessment Outlook Journal (Volume 8: October 2020)- Health Impact Assessment in Planning (IEMA, 2020) is a primer for 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. Regard has been given to the general approach advocated in this document when compiling this Chapter.

The IEMA discussion document states that there should be a greater emphasis on health outcomes, as opposed simply to the health determinants or the agents or emissions (e.g. dust) which could have the potential to have health effects, which has previously been the focus of EIA. This change in emphasis does not mean a complete change in practice. The IEMA discussion document recommendations are consistent with the EPA Guidelines (EPA, 2022) on what should be contained in an EIAR.

The IEMA discussion document notes that public health has three domains of practice that should be considered in the assessment of health in EIA:

- Health protection (including chemical and radiation exposure, health hazards, emergency response and infectious diseases);
- Health improvement (including lifestyle, inequalities, housing, community and employment); and
- Improving services (including service planning, equity and efficiencies).

The WHO defined health in its broader sense in its 1948 constitution (WHO, 1948) as:

'a state of complete physical, mental, and social wellbeing 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 discussion document referenced above, 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 wellbeing be that positive or negative.

Therefore, health protection, health improvement and improving services are all considered in this Chapter.

The IEMA discussion document notes that the WHO provides an overview of health in different types of impact assessment (Fehr et al. 2014) and presents the WHO's 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... 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...'

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 optimising the coverage of health along all three avenues:

- *Better consideration of health in existing impact assessments other than HIA;*
- *Dedicated HIA; and*
- *Integrated forms of impact assessment.*

It is clear therefore that the WHO does not support a stand-alone HIA unless it could be demonstrated to be of advantage over an EIAR. It is therefore clearly appropriate that this health assessment is part of the EIAR. In addition, there is no competent authority in Ireland who can assess a HIA as there clearly is for an EIAR. For these reasons it was deemed most appropriate to deal with human health impacts as is statutorily required, that is in the EIAR and that a stand-alone HIA was therefore deemed unnecessary and inappropriate.

10.3.3 Data Collection and Collation

There are difficulties in performing a quantitative health assessment for EIA as outlined by the Institute of Public Health. Not least of these is the difficulty in getting baseline health data (due to patient confidentiality, GDPR (General Data Protection Regulation) and other reasons), to accurately determine levels of even relatively common medical conditions in a defined population that might be affected by such a project. Qualitative and quantitative baseline health data are a vitally important part of the appraisal section of the HIA and in the absence of an accurate baseline, it is very difficult to assess qualitative and quantitative changes that might occur. Generalised data may exist for larger areas such as a city or county, but this would at most, provide an estimate of the local baseline and not be accurate enough to allow for meaningful interpretation.

Such data collection would only be necessary if it was proposed to perform a HIA and it is appropriate to consider if a HIA is necessary or event appropriate. It is still entirely possible to perform an appropriate and in-depth assessment of human health impacts in the absence of an HIA, using the methodology in the EPA guidelines 2022 as outlined above and used for this assessment.

10.3.4 Sensitive Receptors

Sensitive receptor data were collected through desk-based research and analysis of existing documentation within the study area that informed the baseline, as evidenced throughout the EIAR.

In practice, some human beings are more sensitive than others, due to their age, health status or other reasons. However, no attempt has been made to try to identify specific individual sensitivities or vulnerabilities as this would not be feasible nor necessarily worthwhile. Patient confidentiality and GDPR would prevent doctors and healthcare practitioners from divulging information about their patients. Even if it were possible, it still would not aid the assessment of human health impacts. The humans that are vulnerable today, will not necessarily be those who are vulnerable during the Construction and/or Operational Phases. In order to be conservative, and in keeping with the worst-case approach described above it has been assumed that there are vulnerable individuals at every receptor. In addition, the assessment is aided because Health Based Standards are derived to protect the vulnerable and not the robust.

For reasons of consistency, sensitive or vulnerable receptors are looked at in terms of their importance and sensitivity. When carrying out the human health assessment with regard to specific locations it is clear that hospitals and nursing homes have increased potential for housing important and sensitive receptors and these locations are given heightened attention.

10.3.4.1 Importance

In terms of Human Health, all human beings are considered to be equally important. The use of the term 'importance' in this context refers to areas or buildings occupied by people. Their importance is considered to increase as the number of people increases and the duration of time spent there increases.

The EPA Advice Notes for Preparing Environmental Impact Statements (May 2022) indicates that neighbouring occupied premises and land uses that should be considered include the following:

- Homes;
- Hospitals;
- Healthcare facilities;
- Hotels and hotel accommodation;
- Schools and rehabilitation workshops;
- Tourism and recreational facilities; and
- Visitor attractions.

Residential areas, public and private health facilities, workplaces, hotels and educational facilities are considered to be 'very important' areas because a number of persons usually spend a substantial amount of time at these locations. Places of worship and recreational areas are considered to be 'important areas' of the baseline environment because they are used in a more transient way and people usually spend less time in these places.

10.3.4.2 Sensitivity

The sensitivity of an area or building in this context refers to the vulnerability of the population. Reasons for this include inherent vulnerability such as is the case for the very young or old. Locations where there are higher numbers of vulnerable individuals such as hospitals and nursing homes are considered to be 'very highly sensitive' and require special consideration where potential effects are possible. Where it is clear however that very highly sensitive receptors have negligible effects, perhaps because of their distance from the line, these are scoped out.

Residences, schools, workplaces, commercial areas and places of worship are considered 'highly sensitive'. This is because these areas will include populations of elderly, young people and people with

health conditions. However, the majority of the population in these locations are likely to be less vulnerable than those in the very highly sensitive locations.

Areas where recreational activities are carried out are considered to be 'sensitive' as these locations are typically only occupied during the day, and not necessarily continually. They will be used by children and the elderly but usually only for limited periods of time.

Sensitivity is also considered to increase with increased duration of exposure to emissions. It is true that those indoors for example are less sensitive to emissions than those outdoors, as potential exposures are less. However, this is balanced by the fact that people tend to spend much more time indoors. Therefore, no major distinction has been made between indoors and outdoors.

10.3.5 Identifying and Assessing Potential Impacts

This section outlines the general principles for assessing impacts on Human Health in an EIA. The health impact assessment will be carried out for all, but particular emphasis and individual attention is given to the receptors in hospitals and nursing homes.

As outlined in the International Association on Impact Assessment Document of 2020 human health within EIA (IAIA, 2019), the Public Health perspective is underpinned by five principles:

- A comprehensive approach to health: Physical, psychological and social wellbeing is determined by a wide range of factors across society and consideration of these wider determinants and their interrelationships will inform the assessment of human health. Inter-sectoral collaboration, between public health and other sectors, should be a feature of coherent coverage of health in EIA.
- Equity: The distribution of health impacts across the population must be considered, paying specific attention to vulnerable groups. Where impacts that are unfair and avoidable are identified, appropriate measures must be included to avoid or reduce adverse health outcomes, or to improve health outcomes for affected groups.
- Transparency: A transparent EIA process facilitates cooperation and communication, external to the organisation conducting the EIA. It enhances the process and improves effectiveness. The reporting of the EIA must demonstrate a clear and consistent method and reasoned conclusions.
- Proportionality: The scoping of human health issues into EIA will focus on whether the potential impacts are likely to be significant. Effort is then focused on identifying and gaining commitment to avoiding or reducing adverse effects and to enhancing beneficial effects. The assessment findings should be presented clearly and aim to be concise and precise and to give appropriate weight to health as a material consideration,
- Consistency: The assessment should be based on evidence and on sound judgment. The assessment process should follow an acceptable, explicit logic path and retain common sense in applying relevant guidance. Divergence from accepted practice should be explained. The assessment, its process and conclusions, should be in accordance with up-to-date policy, guidance and scientific consensus. This acknowledges the potential for conflict between policy and emerging evidence.

The EIAR Chapter topics have been reviewed for their potential to create effects that would impact human health. Table 10.3 lists the EIAR Chapters and states whether they are included in the human health assessment and the rationale for this.

Table 10.3: EIAR Chapters included in the human health assessment

Chapter	Input into the Human Health Assessment (Yes/No)	Rationale
Chapter 9 (Traffic & Transport)	Yes	Covered in terms of traffic congestion and its relation to 'annoyance', and the positive impacts of traffic relief from the Operational Phase.
Chapter 11 (Population & Land Use)	Yes	Both Chapters refer to Human impacts although there is relatively little overlap.
Chapter 12 (Electromagnetic Compatibility & Stray Current)	Yes	Covered in terms of impacts on equipment at hospitals on the line of route.
Chapter 13 (Airborne Noise & Vibration)	Yes	Covered in terms of human health risk arising from noise and vibration emissions.
Chapter 14 (Groundborne Noise and Vibration)	Yes	Covered in terms of human health risk arising from noise and vibration emissions.
Chapter 15 (Biodiversity)	No	No relevant overlap with this Chapter.
Chapter 16 (Air Quality)	Yes	Covered in terms of human health risk arising from air quality and dust emissions, including from traffic.
Chapter 17 (Climate)	No	No relevant overlap with this Chapter.
Chapter 18 (Hydrology)	Yes	Covered in terms of human health risk arising from contamination of water supply via discharge.
Chapter 19 (Hydrogeology)	Yes	Covered in terms of human health risk arising from contamination of water supply.
Chapter 20 (Soils & Geology)	Yes	Covered in terms of human health risk arising from contaminated land or Radon.
Chapter 21 (Land Take)	No	No relevant overlap with this Chapter.
Chapter 22 (Infrastructure & Utilities)	No	No relevant overlap with this Chapter.
Chapter 24 (Resource & Waste Management)	No	No relevant overlap with this Chapter.
Chapter 25 (Archaeology & Cultural Heritage)	No	No relevant overlap with this Chapter.
Chapter 26 (Architectural Heritage)	No	No relevant overlap with this Chapter.
Chapter 27 (Landscape & Visual)	No	No relevant overlap with this Chapter.
Chapter 28 (Risk of Major Accidents & Disasters)	No	No relevant overlap with this Chapter.

10.3.5.1 Areas of Assessment

The assessment of potential impacts resulting in health effects on the population is undertaken by way of the following assessments as detailed further below:

- Risk Assessment - to identify the potential risk to human health in response to identified hazards;
- Socioeconomic impacts on human health;
- Impacts on amenity resources and subsequent effects on human health; and
- Potential for psychological effects.

10.3.5.1.1 Risk Assessment

The main tool used to assess the potential impacts on human health is the risk assessment process. This process identifies a hazard and assesses the potential effects on human health. A hazard is something that has the potential to cause harm and the risk is the likelihood that harm will occur. A risk assessment therefore determines the likelihood of harm occurring. The likelihood of harm occurring is, in most instances, related to the amount or dose to which a human being may be exposed.

10.3.5.1.2 Dose Response Risk Assessment

A dose response relationship indicates that the higher the dose the more likely a response is to occur, and in many instances the more severe a response. Even psychological risks show this dose response relationship as the more stress and annoyance people experience, the more likely there is to be an actual impact on psychological health.

This knowledge that the risk to health is usually associated with the magnitude of the exposure to the hazard allows an assessment of likely effects on human health to be determined given the likely exposure. That is, risk can be assessed if the likely exposure is predicted.

The first step is therefore to identify the hazards, then the magnitude of exposure and then to assess the likely health effects. Within this EIAR, the potential impacts which could affect human health have been identified (Hazard Identification). The scale of these potential impacts (Dose-Response Assessment) and their duration (Exposure Assessment) is assessed and the significance of the potential effect on human health determined (Risk Characterization). The US EPA Guidance presents this four-step approach graphically and this is shown in Diagram 10.3 below. It should be stated that this is the same approach as outline by the Irish EPA.

When using a recognised Health Based Standard for a particular hazard, the dose response assessment is included in the standard. This means that 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.

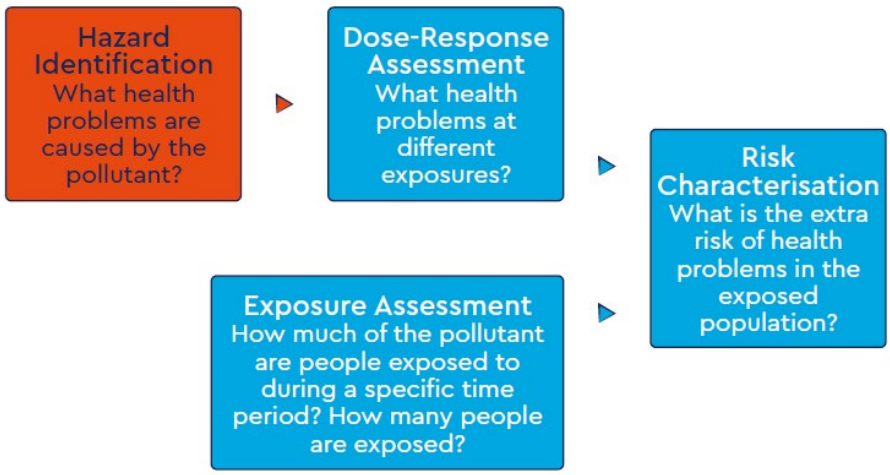

Diagram 10.3: Four-Step Human Risk Assessment Process (US EPA 2017)

10.3.5.1.3 Socioeconomic impacts on human health

Improved socioeconomic status is associated with improved health measures such as longevity. People who work generally enjoy better health than the unemployed, who generally suffer poorer physical and psychological health outcomes. Indeed, providing and encouraging employment and with it improved financial means is one of the most important contributors to public health. Whilst socioeconomic gains may be worthwhile in themselves, it is important to realise that they are also associated with an improvement in health status. It is also important to consider sustainability, the approach to which is explored further in Chapter 4 (Description of the MetroLink Project).

Projects that provide environmental benefits, protect the population from public health dangers, support regeneration, reduce unemployment and improve socioeconomic circumstance can contribute to improving the health and wellbeing of communities. Some of the ways these goals can be achieved are that they can make an area more attractive to investment, increase tourism and facilitate sustainable travel. Although negative effects on socioeconomic development may also be possible, the link between socioeconomic conditions and positive health comes is so strong that improving socioeconomic situations can be used as a surrogate for human health effects. In other words, by predicting an improving socioeconomic situation one can anticipate an improvement in health outcomes. A 2019 publication by the HSE, Population Health and Demographics states:

'There is a strong link between poverty, socioeconomic status and health'.

The assessment of human health for the proposed Project, in terms of health improvement, includes an assessment on how the proposed Project would impact on the socioeconomics of the community (in addition to the assessment undertaken in Chapter 11 (Population & Land Use). Chapter 11 (Population & Land Use) focuses on how the proposed Project would impact on health inequalities as a result of socioeconomic impacts.

The most recent assessment of socioeconomic status in the Dublin area was performed after the 2016 census and is represented graphically in Figure 10.1.

10.3.5.1.4 Impacts on amenity resources and subsequent effects on human health

Amenity can be described as a desirable or useful feature of a place. It is something that helps provide comfort, convenience or enjoyment for people. In human health terms amenity can relate to factors such as the ability to exercise using sporting facilities, parks, pathways and roads. Amenity also extends to the ability for individuals to relax, which has definite human health benefits.

The human health assessment of impacts on amenity primarily relate to opportunities for exercise for all including able bodied and disabled individuals. The assessment covers potential loss and gains of amenity.

The key criterion in relation to general amenity is community wellbeing. Direct effects on communities due to loss of facilities, amenity space and natural areas can impact on community wellbeing and interaction. Indirect effects may result from changes in environmental quality, for instance, from noise or visual intrusion and are cross-referenced where applicable with relevant chapters of the EIAR. Impact levels are defined in Table 10.4 below.

Table 10.4: Criteria used in the Assessment of Amenity impacts

Impact Level	Significance Criteria
Imperceptible	No noticeable change in the character of the environment
Not significant	An effect which can cause noticeable changes in the character of the environment, but without significant consequences for the community's wellbeing, amenity or health
Slight	A small impact on community wellbeing can be attributed to the proposed Project
Moderate	A moderate impact on the community wellbeing can be attributed to the proposed Project

Impact Level	Significance Criteria
Significant	An effect which has the potential to impact on community wellbeing such as to affect people's behaviour and quality of life
Very significant	An effect which has the potential to substantially impact on community wellbeing such as to affect most people's behaviour and quality of life
Profound	Effects of a scale to significantly impact on community wellbeing 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

10.3.5.1.5 Potential for psychological effects

In the EIA process, potential adverse effects on psychological health are often mentioned, for example, anxiety and stress experienced by people worried that they would experience a change in the environment in which they live.

Within the EIAR Chapters, human receptors that may experience annoyance from the temporary and short-term effects of the Construction Phase, such as noise or dust, are identified. Annoyance is not in itself a health effect, although it is recognised that there can be potential impacts on a person's overall psychological wellbeing. If someone develops a psychological illness such as anxiety or depression this becomes a medical impact.

There are various degrees of psychological impact, and these can be both positive and negative. Although identifying the potential impacts is possible, quantifying them is difficult as there are no direct measurements available, and the same impacts may have different effects on different people. For example, for some individuals demolishing an old building could be viewed as removing an eyesore or making way for something better but alternatively for others, it can be seen as a loss of heritage.

Another example of this is how people reacted to the COVID-19 pandemic. Many had considerable concerns about contracting Covid, with increased levels of anxiety and even leading to increased psychological ill health, whereas others were anxious because of movement restrictions or requirements to wear masks in public. While some impacts on health are very predictable, such as the impacts of increasing noise or decreasing air quality, the impacts on psychological health from the same situation can differ very significantly between people depending on their perspectives.

An example of a positive impact could be those looking forward to increasing employment opportunities; both directly, in the potential for employment in construction and operation of the proposed Project, and indirectly by improved public transport during the Operational Phase.

There will also be negative effects of varying degrees. These can be minimised by construction and operational mitigation measures and also by communication and provision of regular factual information.

In terms of assessing the psychological impact, an impact is assessed as either positive or negative, if it is likely that the overwhelming majority of people will experience that effect. Where different psychological impacts are anticipated from the same scenario the assessed psychological impact is neutral.

10.3.5.1.6 Psychiatric Patients Sensitivity to Noise and Vibration

While in the population it is reasonable to conclude that any community will have a range of vulnerability to psychological effects, it is reasonable to consider inpatients in a psychiatric ward to be of near universal higher vulnerability and sensitivity. In this case the Psychiatric Ward in the Mater Hospital deserves special consideration. To aid an assessment of likely impact a literature review was carried out to inform this assessment.

The literature review was carried out using Pubmed on the 7th July 2022 using the search key words "sensitivity", "noise", "psychiatric", "patients". There is perhaps a surprising dearth of relevant research in relation to airborne or groundborne noise, and even less with regards to vibration.

A paper published by Cammuchio (2019) examined typical noise levels present in a psychiatric ward during day-to-day activities. It found that average noise levels in the studied ward was 62.5 dB(A) L_{eq} in the morning, 55.8 dB in the afternoon, and 51.5 dB at night. A total of 23 patients took part in the study: 65.2% of this sample did not perceive the noise in the ward as disturbing. It concluded that the main source of noise is verbal communication, and acoustic pressure also derived from care activities based around relationships. Other sources of noise perceived as disturbing came from the opening and closing of doors and the entry doorbell.

A paper by Stansfeld (1992) found studies of noise sensitivity associated with psychiatric disorder and a disposition to negative affectivity. It also found that noise sensitivity levels did fall with recovery from depression but still remained high, suggesting an underlying high level of noise sensitivity.

There are several papers on the impacts of noise on sleep in general hospital wards but in these cases the source of noise was largely from activities within the ward themselves.

Whilst it is reasonable to assume therefore that psychiatric patients may be more sensitive to noise disturbance than the general population, there may be individuals in the ward that will have a higher sensitivity again to extraneous noise and this should not be ignored.

10.3.6 Health effects of emissions

This section considers the health effects of potential emissions such as noise, vibration, air quality, electro-magnetic frequency, water, *Aspergillus fumigates*, soils and geology, and vermin related disease. Traffic impacts are not considered as these are addressed under noise and air quality.

Where relevant, the appropriate Health Based Standards that are used to inform the assessment of human health effects are outlined, particularly in relation to air quality and noise.

This section also summarises information available in medical literature and explains our understanding of amenity.

10.3.6.1 Potential Noise Impacts on Human Health

With regard to noise impacts, an important factor is Noise and Health - Evidence from Ireland. This study was conducted by University College Dublin (UCD) and the Economic and Social Research Institute (ESRI) and aimed to identify and assess the noise-health relationship in an international and national context and identify policy recommendations and integration pathways for considering noise in various strands of public policy.

The study states:

'It is now well established that excessive environmental noise disturbs sleep and is a public health concern. If the disturbance is at a level that is severe enough, it can lead to sleep deprivation which can seriously affect the physical and mental health of an individual (Murphy and King, 2014).'

'The WHO (2011) estimate that 90,300 disability-adjusted life years (DALYs) in populations greater than 50,000 are lost to sleep disturbance as a result of environmental noise exposure in the EU. The European Environment Agency (EEA) estimates that almost 20 million adults are annoyed and a further 8 million suffer sleep disturbance due to environmental noise (EEA, 2014). The WHO's seminal Burden of Disease from Environmental Noise study concludes that one in three individuals in Europe is annoyed during the daytime and one in five has disturbed sleep at night and that is from traffic noise alone'.

In terms of health effects of environmental noise the study says:

'For road noise, the most 'sufficient' evidence exists for health impacts including elevated blood pressure and hypertension, obesity, diabetes, respiratory conditions (particularly in combination with air pollution) and immune system dysfunction in children, all mediated by annoyance and sleep disturbance.'

'For aircraft noise, the most sufficient evidence exists for cognitive impairment and psychological stress including depression and anxiety annoyance and obesity'.

While rail noise is often considered the least impactful source of transportation noise, rapid urbanisation and more people living proximate to busier rail lines, evidence is increasingly sufficient for elevated blood pressure and hypertension mediated by annoyance and is improving for other cardiovascular impacts.

Four thematic areas were addressed in this review:

1) Noise exposure, sleep disturbance and related effects;
2) Noise exposure and annoyance;
3) Vulnerable groups (the elderly and children); and
4) Special cases (e.g. low frequency noise).

It also gives context to the extent of the current burden of Environmental Noise, stating:

'The burden of disease from environmental noise in Europe is estimated to be approximately 1.6 million morbidity-free years lost annually in the metropolitan regions of Western Europe (WHO, 2011). As such, it is estimated that noise exposure is responsible for between 30,000 and 50,000 deaths each year (WHO, 2011). Such figures are generally considered to be underestimates due to incomplete measurement and data.'

This is further outlined in the European Environmental Agency publication, Noise in Europe (2020). This states:

'Long-term exposure to environmental noise is estimated to cause 12,000 premature deaths and contribute to 48,000 new cases of ischaemic heart disease per year in the European territory. It is estimated that 22 million people suffer chronic high annoyance and 6.5 million people suffer chronic high sleep disturbance. As a result of aircraft noise, 12,500 schoolchildren are estimated to suffer learning impairment in school.'

'Environmental noise (i.e. road, rail, aircraft and industry) features among the top environmental risks to health, with an estimated 1 million healthy years of life lost every year from health effects including annoyance, sleep disturbance and ischaemic heart disease.'

10.3.6.1.1 Sleep Disturbance

Sleep disturbance is considered to be a major environmental noise effect. 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.

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 an 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.

People also sleep during the daytime, for example shift workers, but ambient noise levels are much greater at this time so it is less likely that an additional noise source will have a significant effect. The assessment of impact on sleep is therefore based on night-time noise. Chapter 13 (Airborne Noise & Vibration) and Chapter 14 (Groundborne Noise & Vibration) detail the methodology used in modelling this and also explain the choice of 'significant' effects in night-time noise exposure.

The WHO Guidelines do not give guidance on construction noise and therefore cannot be used to inform an assessment of the Construction Phase. The guidelines do give guidance on railway noise and as such are useful in assessing the Operational Phase.

The association between railway noise and the probability of being sleep-disturbed was Odds Ratio (OR): 3.1 (95% CI: 2.4–3.9) per 10 dB increase in noise, see Table 10.5 below. This evidence was rated of moderate quality in the WHO Guidelines.

Table 10.5: The Association between Exposures to Railway Noise (L_{night}) and Sleep Disturbance (% Highly Sleep Disturbed (HSD))

L_{night} (dB)	% HSD	95% CI
40	2.1	0.79-3.48
45	3.7	1.63-5.71
50	6.3	3.12-9.37
55	10.4	5.61-15.26
60	17.0	9.48-24.37
65	26.3	15.20-37.33

Additional analyses were conducted for sleep quality measures, which provided supporting evidence on the overall relationship between railway noise and sleep. When the noise source was not specified in the question, the relationship between railway noise and self-reported sleep outcomes was still positive but no longer statistically significant, with an Odds Ratio (OR) of 1.27 (95% CI: 0.89–1.81) per 10 dB increase (Bodin *et al*, (2015); Brink, (2011); Frei *et al*, (2014). This evidence was rated very low quality in the WHO Guidelines.

There was evidence rated of 'moderate quality' for an association between railway noise and the probability of additional awakenings, measured with polysomnography, with an OR of 1.35 (95% CI: 1.21–1.52) per 10 dB increase in indoor LAmax (Elmenhorst *et al*, 2012). Finally, evidence rated low quality was available for an association between railway noise and sleep outcomes measured as motility in adults (Griefahn *et al*, (2000); Hong *et al*, (2006); Lercher *et al*, (2010); Passchier-Vermeer *et al*, (2007), and rated very low quality for an association between railway noise and both self-reported and motility measured sleep disturbance in children (Ising & Ising, (2002); Lercher *et al*, (2013); Tiesler *et al*, (2013).

10.3.6.1.2 Cardiovascular (including hypertension) and Physiological Effects

Acute noise exposures activate the autonomic and hormonal systems, leading to temporary changes such as increased blood pressure, increased heart rate and vasoconstriction. After prolonged exposure, susceptible individuals in the general population may develop permanent effects, such as hypertension and ischaemic heart disease associated with exposures to high sound pressure levels. Most of the studies are based on occupational studies with often very high noise levels, 90 dB or greater however there have been some which have suggested a link to airport noise. In general, these studies have not been statistically significant or not supported by other studies.

The WHO Environmental Noise Guidelines (2018) stated that no evidence was available on the relationship between railway noise and the incidence of or mortality from IHD (Ischaemic Heart Disease). Four cross-sectional studies were identified, however, that assessed the prevalence of IHD in a total of 13,241 participants, including 283 cases (Heimann *et al*, (2007); Lercher *et al*, (2008); van Poll *et al*, (2014). The overall risk was not statistically significantly increased, the relative risk was 1.18 (95% CI: 0.82–1.68) per 10 dB Lden increase, with inconsistency across studies. The evidence was rated very low quality.

10.3.6.1.3 Effects of Noise on Residential Behaviour and Annoyance

It is estimated that at least 20% of the population of the EU live in areas of significant annoyance due to noise levels. A definition of annoyance is as per the European Environment Agency, *'a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them'.* In addition to 'annoyance', people may feel a variety of negative emotions when exposed to community noise including anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation and exhaustion.

In total, 10 studies on the association between railway noise and annoyance were included in various analyses (Champelovier *et al*, (2003); Gidloef-Gunnarsson *et al*, (2012); Lercher *et al*, (2007); Sato *et al*, (2004); Schreckenberg, (2013); Yano *et al*, (2005); Yokoshima *et al*, (2008). The studies incorporated individual data from 10,970 participants. The lowest category of noise exposure considered in any of the studies, and hence included in the systematic review is 40 dB, corresponding to approximately 1.5%HA (High Annoyance). The 10% benchmark for %HA is reached at 53.7 dB Lden.

10.3.6.1.4 Overall Health Effects of Noise and WHO Guidelines

The WHO Guidelines state that there is sufficient evidence that adverse health effects of long-term exposure to railway noise exists if there are high noise levels. Based on the quality of the available evidence, the WHO set the strength of recommendation on railway noise as 'Strong'. This means that there is a strong evidence base, based on objective criteria in the published literature, for WHO recommendations.

As a second step, it qualitatively assessed contextual factors to explore whether other considerations could have a relevant impact on the recommendation strength. These contextual considerations mainly concerned the balance of harms and benefits, values and preferences, and resource use and implementation.

When assessing the balance of harms and benefits of interventions to reduce exposure to railway noise and minimise noise-associated adverse health effects, the WHO recognised that railway transportation is the second most dominant source of environmental noise in Europe.

This illustrates that solutions to achieve recommended noise levels can be implemented at a reasonable cost to society. Overall, the WHO agreed that the benefit of implementation of the recommendation to minimise the risk of adverse health effects due to railway noise for a majority of the population exceeds the (monetary) resources needed.

In light of the assessment of the contextual factors in addition to the quality of evidence, the recommendation remains strong.

Overall, the WHO Guidelines on railway noise are:

- Evidence for a relevant absolute risk of annoyance at 54 dB Lden was rated Moderate quality and was the guideline recommendation;
- Evidence for a relevant relative risk increase of the incidence of hypertension was rated Low quality (one study met the inclusion criteria but did not find a significant increase);
- Evidence that different types of intervention reduce noise annoyance from railways was rated Very Low quality;
- Evidence for a relevant absolute risk of sleep disturbance related to night noise exposure from railways at 44 dB L_{night} was rated Moderate quality and was the Guideline recommendation; and
- No evidence was available on the effectiveness of interventions to reduce noise exposure and/or sleep disturbance from railway noise.

The WHO has noted however that it is important to consider the relevance of railways as an environmentally friendly mode of transportation. It states:

'At a societal level, an environmental and economic benefit from the use of rail transportation is expected: trains contribute to lower environmental pollution and carbon emission than road transportation. Therefore, there is a need to balance the expected health benefits from reduced continuous railway noise exposure and the overall positive effects on the health of the population from increased reliance on the comparatively environmentally friendly mode of railway transportation. Overall, the GDG (Guideline Development Group) agreed that even though fewer people are exposed to railway noise than road traffic noise, it remains a major source of localized noise pollution; therefore, considerable benefits are gained by reducing exposure to railway noise.'

The WHO made decisions with a recommendation strength:

- Strong recommendation for guideline value for average noise exposure 54 dB (Lden);
- Strong recommendation for guideline value for night noise exposure 44 dB (Lnight); and
- Strong recommendation for specific interventions to reduce noise exposure.

The WHO also commented:

'Overall, the low-carbon, low-polluting nature of railway transport, especially using electric trains, means that rail is favoured over road and air traffic. However, night-time railway traffic on busy lines, including freight traffic, can be a significant source of sleep disturbance. Thus, guideline values should be set to encourage the development of rail traffic in Europe while at the same time giving adequate protection to residents from sleep disturbance.'

As referred to above, the WHO does not intend to guide effects on individual receptors but rather populations. It also does not give any guidance on construction noise which in a project such as MetroLink can be more important.

BS 5228 has useful guidelines in relation to this which are appropriately used to assess noise impacts.

10.3.6.2 Vibration

Vibration is movement of a surface or structure perceived by humans by the tactile sense, or which directly affects the function of an item of equipment such as an electron microscope. Vibration in buildings can interfere with activities and affect human occupants in many ways, quality of life can be reduced, and working can be impacted primarily through distraction. There are many complex factors determining the human response to vibration, and there is also a paucity of consistent quantitative data.

There are basically two kinds of vibration that affect people in buildings, specifically:

- Vibration transmitted to the human body as a whole through the supporting surface, through the feet when standing, the buttocks when seated, or the supporting area when reclining; and
- Vibrations of the building and the resulting reactions of the occupants from the gross structure vibration (whole-structure deformation), floor vibration (primarily horizontal motions producing secondary noises or rattling).

The human health effects of vibration are normally divided into:

- Hand Arm Vibration Syndrome (HAVS);
- Whole Body Vibration (WBV); and
- Other effects.

HAVS may be an occupational issue for some persons involved in construction but can be discounted as an issue for the general public.

For WBV, recent legislation has introduced action levels and limit values for occupational exposure. To be vulnerable to WBV the person has to be in contact with a vibration surface, most typically seated or lying down. Even allowing for a 24 hr 7 day a week exposure the possible vibrations do not approach

the levels defined in the Safety Health and Welfare at Work (General Applications) Regulations (2007). Therefore, we can say that WBV will not be an issue for the general public.

The vibration emissions from the Construction and Operational Phases of the proposed Project will be quite different. Construction, by its nature, will be time defined and may be for quite limited periods for any single receptor. Higher vibration levels may be associated with lesser effects if they are for relatively short periods of time. By contrast, operational vibration can be assumed to continue indefinitely so lesser effects may be significant. The contractor will be obliged to work within the limits outlined in BS 5228-2 (vibration).

Certain activities, particularly the tunnelling phase of construction, may be associated with significant local vibration for a limited period of time. From a health perspective however, it is very likely that any potential effect will be mitigated by the relatively temporary duration of exposure. Tunnelling is predicted to advance, so as to be perceptible at any single stationary receptor for a period of about two weeks at most.

10.3.6.3 Potential Air Quality Impacts on Human Health

The WHO issued new air quality guidelines on 22 September 2021. These were aligned with the clear evidence of the damage of air pollution on human health at lower concentrations than previously understood. It estimates that every year exposure to air pollution is estimated to cause 7 million premature deaths worldwide. It also states that in children, the effects can include reduced lung growth and function, respiratory infections and aggravation of asthma. In adults, heart disease and strokes are the common cause of premature death attributable to air pollution. The guidelines recommend new air quality levels for six pollutants including particulate matter, ozone, nitrogen dioxide, sulphate oxide and carbon monoxide.

In relation to the different dimensions of particulate matter, they discuss PM_{10}, particulate matter which is less than 10 microns in diameter and $PM_{2.5}$, particulate matter which is less than 2.5 microns in diameter. They outline air quality guidelines but also give intermediate targets, up to four targets which should be aimed at if the ultimate air quality guideline itself is unachievable. An example might be $PM_{2.5}$ micrograms where it gives an initial target of 35 µg m^{-3} for annual $PM_{2.5}$ and decreasing levels over four interim targets to an eventual air quality guideline of 5 µg m^{-3}. This is a seven-fold decrease.

A similar approach would be with PM_{10}, with again four intermediate targets and the eventual air quality guideline being 15 annual micrograms per cubic metre. It may be of note that they believe some air quality guidelines were unaffected in this latest review. These included nitrogen dioxide per cubic metre averaged over one hour (as opposed to annual NO_2 which was changed), sulphur dioxide measured over ten minutes and carbon monoxide measured over eight hours, one hour and fifteen minutes.

These WHO air quality guidelines may be seen as unachievable because virtually all urban areas in the world including Dublin, exceed some of these measures.

It is important to realise that WHO air quality guidelines are not binding and that the relevant binding standards are the air quality standards. However, they do provide guidance as to where efforts should be aimed in the future. In order to achieve these levels or get close to achieving them, fossil fuels as a source of energy for things like home heating and transport would have to be removed or significantly reduced. While this may be a long way off, contributions would be made by providing sustainable transport options such as MetroLink, which do not rely on the internal combustion engine. An electrified transport system which has the ability to transport large numbers of people would go some way to reducing emissions in the Dublin area and contribute towards the aspiration of WHO air quality guidelines.

In relative terms, Dublin has a higher quality of air, certainly when compared with cities in China, India and Europe (Eurostat, 2021). While the improvement of air quality levels should be the ultimate goal, it is accepted by the WHO that this might be a difficult task for many countries and regions struggling with high pollutions levels. Therefore, they suggest a gradual progress in improving air quality, marked by

achievement of interim targets which should be considered a critical influencer of improving health conditions for populations. The proposed Project would be a key part of this process.

In order to protect our health and ecosystems, EU directives set down air quality standards in Ireland and the other Member States for a wide variety of pollutants. These rules include how ambient air quality should be monitored, assessed and managed. The European Commission set down the principles to this approach in 1996 with its Air Quality Framework Directive. Four "daughter" directives lay down limits for specific pollutants:

- 1st Daughter Directive: Sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead;
- 2nd Daughter Directive: Carbon monoxide and benzene;
- 3rd Daughter Directive: Ozone; and
- 4th Daughter Directive: Polyaromatic hydrocarbons, arsenic, nickel, cadmium and mercury in ambient air.

The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives. The fourth Daughter Directive (2004/107/EC) will be included in CAFE at a later stage. The limit and target values for both Directives are outlined below.

The CAFE Directive was transposed into Irish legislation by the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011). It replaces the Air Quality Standards Regulations 2002 (S.I. No. 271 of 2002), the Ozone in Ambient Air Regulations 2004 (S.I. No. 53 of 2004) and S.I. No. 33 of 1999.

The fourth Daughter Directive was transposed into Irish legislation by the Arsenic, Cadmium, Mercury, Nickel and Polycyclic Aromatic Hydrocarbons in Ambient Air Regulations 2009 (S.I. No. 58 of 2009).

It is appropriate that these standards are the test used in determining what is a significant effect in terms of human health.

10.3.6.4 Electromagnetic Frequency (EMF)

In Ireland the Radiological Protection Act (Non-Ionising Radiation) Order 2019 (S.I. No 190/2019) assigns responsibility to the EPA for providing advice to the Government and the public on exposure to electromagnetic fields. The limits contained are mostly derived in relation to equipment. The limit levels for human exposure are many times higher again. These are outlined in Chapter 12 (Electromagnetic Compatibility & Stray Current).

Internationally, the allowable exposure levels for EMF are published by the International Commission for Non-Ionising Radiation Protection (ICNIRP), which are frequently updated. ICNIRP has issued guidelines for limiting exposure to static and time varying electric and magnetic fields from 100 kHz up to 300 GHz. The latest update on static fields is covered by ICNIRP Guidelines on limits of exposure to Static Magnetic Fields (ICNIRP, 2020).

The ICNIRP limits have been adopted by the European Commission for both occupational and public application. For occupational purposes, a directive was published:

EU Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks from EMFs was transposed into Irish law on 1st July 2016 by the Safety, Health and Welfare at Work (Electromagnetic Fields) Regulations 2016 (S.I. No. 337 of 2016).

The Regulations impose a number of duties on employers, these include:

- Carrying out a risk assessment;
- Avoiding and reducing risks;
- Employee information, training and consultation; and

- Health surveillance where appropriate.

The EU has produced three guides to assist employers complying with the Directive and regulations as follows:

- Non-binding guide to good practice for implementing Directive 2013/35/EU Guide for SMEs (Small and Medium Size Enterprises);
- Non-binding guide to good practice for implementing Directive 2013/35/EU Volume 1: Practical Guide; and
- Non-binding guide to good practice for implementing Directive 2013/35/EU Volume 2: Case Studies.

The occupational EMF Directive 2013/35/EU (European Union, 2013) states an action level of 500 micro-Tesla for static magnetic fields reasoned by interference with the operation of Active Implantable Medical Devices (AIMDs).

For public application, the EU published a Council Recommendation, 1999/519/EC: Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz) (European Union Council, 1999).

In addition to the health limits outlined in the above Directives and Recommendations, there are also limits for Electromagnetic Compatibility (EMC) and potentially susceptible devices such as AIMDs including cardiac pacemakers, implanted defibrillators and cochlear implants. Pacemakers have particular standards that they need to adhere to with respect to electromagnetic fields. One such example is EN 50527-2-1:2016 'Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices. Specific assessment for workers with cardiac pacemakers', which states that pacemakers are expected to work uninfluenced as long as the General Public Reference levels of Council Recommendation 1999/519/EC (European Union Council, 1999) are not exceeded. The ICNIRP notes that these levels can be as low as 500 micro-Tesla.

These limits for various frequencies are reproduced in Chapter 12 (Electromagnetic Compatibility & Stray Current) of this EIAR.

Levels up to the limits contained in the ICNIRP EMF Guidelines are considered safe for members of the public and, for the purpose of this assessment, are classed as having a significance of effect of imperceptible with the quality of effect classed as neutral. Any predicted levels in excess of the limits set out in these guidelines are classed as having a significant effect, with the quality of the effect classed as negative.

10.3.6.5 Water

The assessment of human health effects from water will be by consideration of the potential for impacts from drinking water.

Clean drinking water is essential and the potential for contamination of water supplies could have very significant effects on human health. Drinking water has to meet rigorous public health standards including both chemical and biological levels and the look, smell and taste. In Ireland, standards are based on the Water Framework Directive (Directive 2000/64/EC) which sets standards for the quality of water within the EU. These are health-based standards and are used as the standard to assess human health impacts.

10.3.6.6 Aspergillus fumigates

Aspergillus fumigates is a fungus and one of many microorganisms which bring about the everyday decay of leaves, wood and other organic matter in our environment. It may be found virtually everywhere on earth, and although humans are exposed to it regularly it does not normally cause

disease, unless it invades tissues whereby the bodies' immune system responses will protect it from infection, very much as it does from pathogenic bacteria or viruses.

Spores (also called Conidia), one of the stages of the fungus' life cycle, are the resistant form of the fungus, and the form responsible for dispersal in the ambient environment. The spores are very light in weight and therefore are easily spread by air currents. Also, the small size of spores (2.0 to 3.5 micrometres on average) allows them to enter the alveolar space in the lungs.

In the ambient environment, *Aspergillus* spp. is commonly found in a great range of sites and materials, including soils, mouldy grains, straw, hay, bark, woodchips, house dust and sewage sludges. The spores are very common in bird droppings and can be found in the dung of cattle, horse and sheep. Inhalation of spores is the most common route of human exposure.

Aspergillus spp. is a normal and integral part of the composting process, participating with other microbes in the final breakdown of materials to a finished, stabilized compost. The composting process is one of the most common sources of high levels of *Aspergillus*.

Dust created by the construction process can be associated with increased *Aspergillus* levels in air. The concentration will depend on a number of factors including, duration and size of works, indoor or outdoor activities, and weather conditions. A clear dose-response curve, threshold spore concentration or duration of sensitisation needed to cause ill health, has not yet been demonstrated.

While there is no good data on infective doses of these organisms, it is reasonable to expect that increasing the potential does increase the likelihood of eliciting a response, even in otherwise healthy people. Therefore, in preventing or reducing health risks from *Aspergillus,* it is considered important to limit exposure to spores by following a set of best management practices as outlined in the National Guidelines for the Prevention of Nosocomial Invasive *Aspergillosis* During Construction/renovation Activities (Updated 2022) as produced by the National Disease Surveillance Centre (NDSC).

10.3.6.6.1 Aspergillus in Immunocompromised People

There is no doubt that the individuals most vulnerable to *Aspergillus*, as an infective organism, are the immunocompromised. These are usually (but not always) hospital based and it should be stated that as well as being vulnerable to *Aspergillus* they are usually vulnerable to a multitude of other organisms as well.

Hospital outbreaks of invasive *Aspergillus* are a potential complication of construction and demolition activities in or near hospital wards accommodating immunocompromised patients and a potential cause of severe illness and mortality in these patients. The assessment of potential human health effects as a result of exposure to *Aspergillus* should largely concentrate on the potential for exposure of highly vulnerable individuals which are typically the immunocompromised.

10.3.6.7 Soils and Geology

The impact on human health from soils and geology will be dependent on potential exposure to chemical or biological contaminants, typically termed contaminated soils. Some soils may have heavy metals inherent or deposited as a result of contamination from human activity such as waste deposition and some geological features may contain naturally occurring asbestos. A factor to consider is the process for managing the discovery of contaminated soils and how they will be transported, and the potential for exposure to the population.

Radon is a naturally occurring radioactive gas which originates form 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 if allowed to enter an enclosed space it can 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 which may damage cells leading to lung cancer.

The Radiological Protection Institute of Ireland (RPII) has issued further information on Radon. Concentration is measured in becquerels per cubic metre of air (Bq/m^3). The Becquerel is a unit of radioactivity and corresponds to one radioactive disintegration per second. The reference level for long-term exposure to Radon in a house, above which the need for remedial action should be considered, is 200 Bq/m^3 (determined in accordance with the RPII's standard protocol). Based on current knowledge it is estimated that in Ireland, for the population as a whole, a lifetime exposure of 70 years to Radon in the home at the reference level of 200Bq/m^3 carries a risk of about 1 in 50 of contracting fatal lung cancer.

The human health assessment will consider whether any human health effects are likely following the discovery of contaminated soils during the works.

10.3.6.8 Vermin related disease

It is well accepted that vermin carry disease, the most common of which is Leptospirosis also known as Weil's disease.

Leptospirosis is caused by a spirochaete bacterium called *Leptospira* spp. This has five different disease-causing types, the most important being *Icterohaemorrhagiae*.

Leptospirosis is transmitted by an infected animal's urine, which is contagious as long as it is still moist. Although rats and mice are important primary hosts, a wide range of other mammals including dogs, deer, rabbits, hedgehogs, cows and sheep can also carry and transmit the disease as secondary hosts. The type of habitats most likely to carry infective bacteria are muddy riverbanks, ditches, gullies and livestock rearing areas where there is regular passage of wild or farm mammals. There is a direct correlation between the amount of rainfall and the incidence of Leptospirosis.

Humans become infected though consuming water, food or soil contaminated with urine from these infected animals. It can also be transmitted through skin contact but the disease is not known to spread from person to person and cases of bacterial dissemination in convalescence are extremely rare in humans. Leptospirosis is most common among water sport enthusiasts as prolonged immersion in water can promote the entry of bacteria, but it is also an occupational hazard for wastewater engineers and sewage workers.

The assessment on the potential human effects of vermin related diseases will be determined by any likely changes in the vermin population as a result of the activities.

10.3.6.9 Health Based Standards and Criteria

As explained above, standards are used to inform the Human Health assessment where such Health Based Standards are available. The appropriate standards used in the remainder of this Chapter are detailed below.

10.3.6.9.1 Air Quality - Appropriate Standards

The statutory ambient air quality standards in Ireland are outlined in the ambient air quality limits set out in Directive 2008/50/EC of the European Parliament, as amended by Commission Directive (EU) 2015/1480 on ambient air quality and cleaner air for Europe (hereafter referred to as the CAFE Directive), for a range of air pollutants. These are discussed in greater detail in Chapter 16 (Air Quality) and Appendix 16.1 (Ambient Air Quality Standards).

WHO air quality guidelines are not standards and are at this time aspirational. They are for those reasons not the appropriate standards to base an assessment of impact in accordance with the EPA Guidelines. The appropriate standards are clearly the Air Quality Standards.

In Ireland, air quality is monitored by the EPA to ensure that the relevant limit values specified by EU directives (that set out the targets for specific air pollutants) are achieved. Limit values are specified in the CAFE Directive for the protection of human health and are defined below in Table 10.6. These limit

values are set for the protection of human health. Below the limit values, concentrations are considered to be acceptable in terms of what is scientifically known about the effects of each pollutant.

Table 10.6: Limit Values as set out in the CAFE Directive

Pollutant	Limit Value Objective	Averaging Period	Limit Value µg/m³	Limit Value ppb	Basis of Application of the Limit Value
SO_2	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year
SO_2	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year
NO_2	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year
NO_2	Protection of human health	Calendar year	40	21	Annual mean
PM_{10}	Protection of human health	24 hours	50	N/A	Not to be exceeded more than 35 times in a calendar year
PM_{10}	Protection of human health	Calendar year	40	N/A	Annual mean
$PM_{2.5}$ - Stage 1	Protection of human health	Calendar year	25	N/A	Annual mean
$PM_{2.5}$ - Stage 2	Protection of human health	Calendar year	20	N/A	Annual mean
Lead	Protection of human health	Calendar year	0.5	N/A	Annual mean
Carbon Monoxide	Protection of human health	8 hours	10,000	8,620	Not to be exceeded
Benzene	Protection of human health	Calendar year	5	1.5	Annual mean
Ozone	Protection of Human Health	8 Hours	120	-	Maximum daily 8 hour mean

10.3.6.9.2 Construction Phase Noise Criteria

Construction noise is temporary in nature and usually experienced over a short to medium-term period. This characteristic requires it to be considered differently to other longer-term sources of noise.

There is no Irish guidance specifically published for the short to medium-term construction work such as that required for the proposed Project. The WHO Guidelines do not refer to or give guidance on construction noise and so cannot be used for the Construction Phase.

However, there are well established standards such as *BS 5228 Code of Practice for the Control of Noise and Vibration on Construction and Open Sites. Part 1 – Noise and Part 2 – Vibration (2009 +A1 2014*).

10.3.6.9.3 Operational Phase Noise Criteria

In relation to human health specifically, for the Operational Phase the most applicable guidelines are those issued by the WHO including Environmental Noise Guidelines for the European Region (WHO, 2018) which were developed by a high-level Guideline Development Group (GDG) and are referred to in this Chapter as the WHO Guidelines. These deal with specific sources of operational noise such as roads, rail, aircraft and wind turbines. They supersede and supplement previous guidelines issued by the

WHO including the Community Noise Guidelines (WHO, 1999) in relation to community effects of noise and subsequent guidance on night-time noise in Europe 2009.

The WHO state that large proportions of the European population are exposed to noise levels in excess of 55 dB L_{night}. The WHO have issued three Guidelines:

1) *For average noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic below 54 dB Lden, as railway noise above this level is associated with adverse health effects.*
2) *For night noise exposure, the GDG strongly recommends reducing noise levels produced by railway traffic during night-time below 44 dB L_{night}, as railway noise above this level is associated with adverse effects on sleep.*
3) *To reduce health effects, the GDG strongly recommends that policymakers implement suitable measures to reduce noise exposure from railways in the population exposed to levels above the guideline values for average and night noise exposure.*

It is important to realise that these guidelines cannot be taken in isolation. For example, in the same guidelines, there are equally strong recommendations in reference to noise emitted from roads. It is entirely feasible that noise may increase at some receptors but decrease in others. The WHO Guidelines are largely designed with populations in mind rather than individual residences or other receptors. While useful in human health terms and while they do inform part of the general human health assessment, they must be seen in context.

It is important to note that these guidelines cannot be used to give a quantitative assessment on the impact on human health. The actual effect will vary with the sensitivity of the actual human beings, which is unknown. But they can be used for qualitative assessment. In other words, if these guidelines are not breached, allowing for proposed mitigation, it can be stated that there will be no significant human health impacts.

10.3.7 Suicide, Violence and Terrorism

Suicide, violence and terrorism are assessed as potential impacts on human health during the Operational Phase and are discussed further in Section 10.5.

10.3.8 Consultation

The following bodies were consulted in the production of this Chapter:

- Health Services Executive (HSE);
- Healthcare facilities such as the Mater and Rotund Hospitals; and
- Other interested parties as outlined in general consultation in Chapter 8 (Consultation).

The submissions received have been considered in the formulation of the relevant chapters of the EIAR and the concerns raised have been addressed in this Chapter where relevant.

10.4 Baseline Environment

10.4.1 Overview

This Section describes the baseline environment with regard to human health. The baseline effectors on human health are outlined in the relevant EIAR chapters as per Table 10.3 and are not repeated here.

Information on sensitive receptors and on general socioeconomic conditions within the study area that relate to health has been analysed and considered to ensure a robust understanding of human health within the Study Area.

10.4.2 Baseline and Sensitive Receptors

Receptors have been identified within each of the specialist EIAR chapters and assessed in line with the Study Area requirements, guidance and methodologies relevant and specific to these chapters. As mentioned in Section 10.3, there has been no attempt to identify each specific location where there are sensitive individuals. Instead, all receptors which are occupied by human beings are being considered as sensitive.

While residential units and homes will be considered in general, from a human health perspective the two specific receptor types which merit special attention are healthcare facilities such as hospitals and nursing homes and educational facilities, especially schools. The occurrence of these sensitive locations is outlined in the following sections.

10.4.2.1 Healthcare Facilities

Healthcare facilities, as described in the Methodology section are very important but vary in their sensitivity. There are hospitals and nursing homes that care for the sick and vulnerable 24 hrs a day that are very highly sensitive but also facilities such as health centres, which may only treat patients over a short period of time that are highly sensitive. Greater emphasis is therefore given to facilities such as hospitals and nursing homes within the Study Area. Facilities within the Study Area have been identified in Table 10.7 to Table 10.9.

Table 10.7: Health Centres in the Study Area

Sections	Health Centres per AZ
AZ1	4
AZ2 & AZ3	0
AZ4	23

Table 10.8: Hospitals in the Study Area

Sections	Hospitals per Section
AZ1	0
AZ2 & AZ3	1
AZ4	10

Table 10.9: Nursing Home Facilities in the Study Area

Sections	Nursing homes per Section
AZ1	2
AZ2	0
AZ3	1
AZ4	8

10.4.2.2 Educational Facilities

Educational facilities can broadly be divided into primary, secondary and third level. These are, as described in Section 10.3, deemed very important, and of high sensitivity, as opposed to the hospitals and nursing homes deemed as very highly sensitive. Also considered are facilities either dedicated to or who provide educational services to persons with special needs and/or disabilities. It is reasonable to consider that vulnerable children, such as those with special needs, may need to be assessed separately. However, this assessment is aided by the fact that Health Based Standards are there to protect the vulnerable rather than the robust. If the standards are observed, then it is reasonable to predict no significant adverse effects no matter how vulnerable individuals are. The numbers of educational facilities are outlined below in Table 10.10 to Table 10.12.

Table 10.10: Primary Schools within the Study Area

Sections	Primary Schools per Section
AZ1	3
AZ2 & AZ3	0
AZ4	42

Table 10.11: Secondary Schools within the Study Area

Sections	Secondary Schools per Section
AZ1	1
AZ2 & AZ3	0
AZ4	16

Table 10.12: Third-level Education Establishments within the Study Area

Sections	Third-level Education per Section
AZ1	0
AZ2 & AZ3	0
AZ4	41

10.4.3 Baseline Environment in the Study Area

The proposed Project lies in the Fingal County Council (FCC) and Dublin City Council (DCC) areas. To the north are largely agricultural areas separating the city from the suburbs of Malahide and Swords and the growing hinterland in Fingal.

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 circumstance.

Whilst specific health data for individuals in the vicinity of the proposed Project 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.

A group made up of the HSE and Lenus (the Irish Health Repository) have published health profiles for all the Local Authorities areas in Ireland. The most recent profiles published at the time of writing relate to 2015 and have been used to establish a community health profile for the proposed Project.

10.4.3.1 Fingal County Council (FCC)

The key facts in the 2015 Health Profile relating to the FCC area are:

- It is the second most affluent Local Authority in Ireland, 85% of its population are either above average or affluent;
- It has a low dependency ratio of 46% (i.e. those aged 0-14 and 65 years and over as a proportion of those aged 15-64). The national rate 49.3%;
- It has the lowest percentage nationally of those who report their health being bad or very bad at 1.1%, or persons with disability at 10.2%. The national rate is 1.5% and 13% respectively;
- It has the highest birth rate nationally at 20.2/100,000 population and the second highest rate for breast feeding of 53.7%. The national rate is 46.6%;
- Cancer incidence rates are higher than average for female malignant melanoma, male colorectal cancer and male and female lung cancers; and

- It has the lowest suicide rate nationally of 5.6/100,000 population.

These figures relate to the entire FCC administrative area and are based on a 2016 census population of 273,991. Whilst it can be assumed these figures are accurate, they do not necessarily reflect the health profile of smaller areas which are close to the proposed Project. For example, the FCC area is identified as the second most affluent in Ireland and the map of deprivation included in the profile shows large areas at average or above average affluence levels. There are nevertheless small areas of deprivation in the wider area where the statistics described above do not apply. Although the data do give a valuable insight into the general area, it is not possible to get reliable baseline information on small scale populations for the reasons outlined in Section 10.3.

10.4.3.2 Dublin City Council

The key facts in the 2015 Health Profile relating to the DCC area are:

- It has a dependency ratio of 38.4% (i.e. those aged 0-14 and 65 years and over as a proportion of those aged 15-64). The national rate is 49.3%;
- It has a high level of households which are local authority rented at 11.5%. The national rate is 7.8%;
- It has a higher-than-average number of people who report their health as being bad or very bad at 2%, or persons with disability at 14.9%. The national rate is 1.5% and 13% respectively;
- It has a greater than average birth per 1,000 rate for those aged under 20 at 19%. The national rate is 12.3%;
- Cancer incidence rates are higher than average for female malignant melanoma, male colorectal cancer and male and female lung cancers; and
- Mortality rates are above the national average for heart disease and stroke in those aged under 65 years.

The population of the DCC area is given as 527,612. The deprivation map within the health profile clearly shows that the area to the north of the city, through which the proposed Project will traverse has some of the areas of highest deprivation in Dublin. This is an important consideration when considering potential impacts of the proposed Project. It is likely that those in more deprived areas may be more vulnerable to adverse effects during construction. For example, if land currently available for recreation is required as part of the Construction Phase, deprived persons may be less well able to access alternatives than those in more affluent areas.

Conversely, if the Operational Phase was to lead to socioeconomic opportunities and improvements then deprived areas may have most to gain. For example, the provision of new jobs may be of limited benefit for those already in work but could be a life changing event for those who are currently unemployed.

For these reasons, deprivation and socioeconomic opportunities should form an important part of any assessment.

10.4.3.3 Socioeconomic Baseline

The Pobal HP Deprivation Index builds upon previous indices based on the 2006 and 2011 censuses. The Index is a series of maps measuring the relative affluence or disadvantage of a particular geographical area in the Republic of Ireland. Based on the most up to date data from the 2016 census, the figures from the 2022 census are as yet unavailable, it is developed right down to street level based on small-area statistics that relate to between 80 and 100 households on average, showing the extent to which every neighbourhood, suburb and village in the State is affluent or deprived.

The measurements look at 10 key indicators including: the proportion of skilled professionals, education levels, employment levels, and single-parent households. These data are particularly useful in assessing predicted health outcomes, depending on how deprived or affluent an area is.

In a 2019 publication by the HSE, Population Health and Demographics, the following observations were made:

- There is a strong link between poverty, socioeconomic status and health;
- In total, 22.5% of the population (n = 1,072,707) are exposed to disadvantage, these numbers have increased between 2011 and 2016 by 9.1% while those living in extreme disadvantage increased by 9.8%;
- Out-of-pocket payments often stop people seeking preventative and necessary healthcare, which can often result in more serious conditions and further expense;
- In 2017, the consistent poverty rate in Ireland was 6.7%, compared with 8.2% in 2016;
- The average life expectancy for a homeless person is just over 42 years;
- In July 2019 there were 6,497 adults and 3,788 children who were homeless in Ireland. Between July 2018 and July 2019, homeless figures have increased by 7.9% for adults (6,024 to 6,497) and decreased by 2.3% for children (3,867 to 3,778) nationally. The Dublin region accounts for 66% of all homelessness; and
- Drug-related deaths in 2016 among people who inject drugs was 5%, 65% of which were in Dublin City. Alcohol was implicated in 132 drug-related deaths in 2016.

10.5 Predicted Impacts of the Proposed Project

This section details the predicted human health impacts of the proposed Project, separating these into Construction and Operational Phases.

As previously discussed, while it is relatively straightforward to assess qualitative impacts on a population or a community it is not possible to predict fully effects on an individual person or receptor. A quantitative assessment is not possible. This is because impacts on the most vulnerable cannot be fully assessed. Health Based Standards take into account the vulnerable, but each and every person's response cannot be predicted. An example of this may be somebody suffering from Autism Spectrum Disorder (ASD) who suffers from Hyperacusis (an unusual tolerance or intolerance of normal environmental sounds, inconspicuous to a typical person). It is unknown where such a vulnerable person resides so the precise human health effect for any individual receptor cannot be predicted. One of the few exceptions to this includes the Mater Hospital and the Northwood Nursing Home which are known to always be occupied by vulnerable patients and are deemed as very highly sensitive in Section 10.3. While there are other facilities within the study area which are deemed to be very highly sensitive none are as close or as significantly affected as the two mentioned. They are therefore scoped out of the need for further assessment. What follows therefore is the predicted qualitative human health impacts on the population or community.

For the purposes of clarity, a sift has been carried out of the identified impacts in the EIAR chapters relevant to the human health assessment. These are shown in Table 10.13 and the potential health impact included. It should be noted that no significant air quality impacts were identified and therefore are not shown in the table. The subsequent sections go on to discuss the health impacts in more detail.

Table 10.13: EIAR Chapters impacts and the potential health effects

EIAR Chapter	Impact Reference	Identified Impact	Construction or Operational Impact	Potential Health Effect
Chapter 12 (Electromagnetic Compatibility & Stray Current)	EMI1	Potential Slight impact on existing SEMs at Rotunda and exclusion of the placement of equipment in areas close to alignment without mitigation.	Operational	Potential interference with important health care equipment

EIAR Chapter	Impact Reference	Identified Impact	Construction or Operational Impact	Potential Health Effect
Chapter 13 (Airborne Noise & Vibration)	NV1	Slight to Moderate impacts on Emmaus Retreat Centre (now used to house refugees) during construction.	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 13 (Airborne Noise & Vibration)	NV2	Moderate to Very Significant impacts on Hertz building (call centre/offices) from daytime construction work	Construction	Potential annoyance and interference with communication
Chapter 13 (Airborne Noise & Vibration)	NV3	Moderate to Significant impacts on Airport church prior to mitigation.	Construction	Potential annoyance and interference with communication
Chapter 13 (Airborne Noise & Vibration)	NV4	Slight to Very Significant impact on Dalcassian Downs (Significant to Very Significant for Dalcassian Downs Court) post mitigation.	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 13 (Airborne Noise & Vibration)	NV5	Moderate to Very Significant noise impacts on Whitehall College post mitigation.	Construction	Potential annoyance and interference with communication
Chapter 13 (Airborne Noise & Vibration)	NV6	Slight to Moderate impacts on Scoil Mobhi post mitigation.	Construction	Potential annoyance and interference with communication
Chapter 13 (Airborne Noise & Vibration)	NV7	Slight to Very Significant impacts on Mater Hospital post mitigation.	Construction	May cause annoyance to patients and staff but as areas of the hospital primarily affected are the upper floors that do not contain wards, no human health impact predicted.
Chapter 13 (Airborne Noise & Vibration)	NV8	Significant to Very Significant impacts on St Joseph's Church post mitigation.	Construction	Potential annoyance and interference with communication
Chapter 13 (Airborne Noise & Vibration)	NV9	Slight to Very Significant impacts on Berkeley Road properties post mitigation	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 13 (Airborne Noise & Vibration)	NV10	Slight to Very Significant impacts on Dartmouth Square and Cambridge Square properties (Significant to Very Significant) and Hines Office Buildings post mitigation.	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 14 (Groundborne Noise & Vibration)	GNV1	Significant impact on Our Lady Queen of Heaven Church from the TBM and impacts from blasting (Dublin Airport).	Construction	Potential annoyance and interference with communication
Chapter 14 (Groundborne Noise & Vibration)	GNV2	Significant impact along alignment for buildings within 75m of the tunnel centre, including on Scoil an	Construction	Potential annoyance and significant disturbance of sleep

EIAR Chapter	Impact Reference	Identified Impact	Construction or Operational Impact	Potential Health Effect
		Tseachtar Laoch, Our Lady of Victories, Albert College Court, Dalcassian Downs, Cross Guns Quay Apartments, Berkely Road, Mater Hospital, St Joseph's Church, Rotunda Hospital, Dartmouth Square West, Oversite Development at Charlemont during TBM advancement.		for residents for a two week period
Chapter 14 (Groundborne Noise & Vibration)	GNV3	Significant impacts on St Joseph's Church and Charlemont Station oversite development from mechanical excavation.	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 14 (Groundborne Noise & Vibration)	GNV4	Significant impacts on St Joseph's Church, 42 O'Connell Street, Dublin Fire Brigade HQ and Charlemont Station oversite development from blasting.	Construction	Potential annoyance and disturbance of sleep for residents
Chapter 18 (Hydrology)	HY1	Flood risk during Construction Phase.	Construction	Potential for contamination of groundwater
Chapter 20 (Soils & Geology)	SG3/SG4	Potential Radon / Ground gas build up in enclosed spaces during excavation and construction.	Construction	Potential exposure to cancer causing Radon, asphyxiation from ground gases such as carbon dioxide
Chapter 20 (Soils & Geology)	SG7/SG8	Potential for impacts on human health of construction workers and neighbouring site users from mobilisation and exposure to contaminants within the sub-surface during construction.	Construction	Potential exposure to harmful contaminants
Chapter 28 (Risk of Major Accidents & Disasters)	N/A	Potential for spread of infectious disease.	Construction	Potential increase in human infectious disease

10.5.1 Construction Phase

10.5.1.1 Air Quality

The predicted air quality impacts from the Construction Phase are outlined in detail in Chapter 16 (Air Quality) of the EIAR. Chapter 16 (Air Quality) outlines the potential dust impacts of vegetation clearance, concrete and bentonite batching, demolition and construction vehicles at each construction site. It also considers the potential impacts associated with shallow excavation works, blasting and tunnel boring machine spoil management.

There are some areas where there is significant potential for dust emission, an example being the Estuary to Seatown section where on site blasting could lead to significant dust. Extensive mitigation is proposed in relation to the control of dust and this is outlined in Chapter 16 (Air Quality).

Construction dust tends to be quite large in size in relative terms (greater than 30 microns in diameter) and falls to the ground relatively quickly. This gives the potential for soiling of cars or windows in the vicinity, but from a human health perspective would not be deemed to have a significant adverse health impact as the dust does not stay airborne and is not inhaled. Inhalable dust tends to be less than 30 microns in diameter and can stay suspended in the air within the breathing zone of humans (approximately 15cm radius around the nose and mouth). Dust that travels deep inside the lungs is termed respirable and is usually less than 10 microns in diameter, this dust is termed PM_{10}.

In keeping with the methodology outlined in previous sections and in accordance with EPA Guidelines on Information contained in an Environmental Impact Assessment Report (May 2022), Health Based Standards have been used to inform this assessment in terms of Human Health. When the dust minimisation measures detailed in the mitigation section of Chapter 16 (Air Quality) are implemented, fugitive emissions of dust from the site are not predicted to be significant and to pose no nuisance to human health and there will be no residual Construction Phase dust impacts.

The Construction Phase of the Air Quality assessment, as detailed in Chapter 16 (Air Quality), identifies a generally negligible or slight negative impact on air quality in the vicinity of the proposed project during the Construction Phase post mitigation. No exceedances of air quality standards are predicted, therefore, no significant adverse human health impacts are predicted.

10.5.1.1.1 Very Highly Sensitive Receptors

Mater Hospital
In the vicinity of the Mater Hospital there are considerable earth works and the dust emission magnitude for the proposed site area is classified as large. However, with the extensive mitigation measures proposed for the construction process, it is predicted that dust emissions from construction sites will not be significant. Therefore, no exceedance of air quality standards is expected at the façade of the Mater Hospital and no significant adverse effects to human health.

Northwood Nursing Home
In the vicinity of the Northwood Nursing Home there are considerable earth works and the dust emission magnitude for the proposed site area is classified as large. However, with the extensive mitigation measures in place during the construction process, it is predicted that dust emissions from construction sites will not be significant. Therefore, no exceedance of air quality standards is expected at the façade of Northwood Nursing Home and no significant adverse effects to human health.

10.5.1.2 Airborne Noise and Vibration

As stated in Chapter 13 (Airborne Noise & Vibration), there is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the Construction Phase of a project. In general, higher noise levels are generally accepted during a short-term Construction Phase of a project compared to its long-term Operational Phase, as construction works are temporary and tend to be varied.

In the absence of specific statutory guidance, the TII Guidelines on noise and vibration for national road projects, (TII Noise Guidelines 2004 (TII 2004) and TII Noise Guidelines 2014 (TII 2014)) set appropriate noise construction criteria and the limits are set out in Chapter 13 (Airborne Noise & Vibration).

Vibration standards dealing with human comfort for airborne vibration impacts associated with surface construction activities consider the magnitude of vibration in terms of Peak Particle Velocity (PPV). BS 5228 – 2 (BSI 2009 +A1 2014b) notes that vibration typically becomes perceptible at around 0.15mm/s to 0.3mm/s and may become disturbing or annoying at higher magnitudes. During surface construction works associated with breaking of ground, piling and excavation the vibration limits would be clearly perceptible to building occupants and would have the potential to cause subjective effects, depending

on the methodologies involved. However, higher levels of construction related vibration are typically related to single events or events of short-term duration and hence typically tolerated by humans.

An extensive baseline noise survey by area is detailed in Chapter 13 (Airborne Noise & Vibration). For purposes of brevity this information is not repeated in this Chapter, but nevertheless is an important part of the assessment. As is true of urban environments everywhere, the baseline noise environment does in many instances reflect relatively high noise levels from existing sources, mainly from road traffic. Additional noise related health effects are not likely if there is not a significant change from the baseline.

The potential residual noise impacts of the Construction Phase of the proposed Project are extensively detailed in Chapter 13 (Airborne Noise & Vibration). As outlined in the methodology section above and in keeping with the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports (May 2022), the human health assessment is based on whether noise levels breach BS 5228 (Noise) criteria and if so, what is the nature of the breach. Therefore, specific locations along the route have been assessed below, where, by the nature either of the noise impacts or of the sensitivity of the receptors, further comment is merited on a human health basis.

A number of properties are identified as being potentially impacted by noise arising from construction phase activity from concurrent piling excavation and concreting including capping works and Chapter 13 (Airborne Noise & Vibration) identifies where noise insulation is triggered along the route. With noise insulation, any significant health effects are expected to be prevented. Further information can be found in Appendix A14.6 (Airborne Noise & Groundborne Noise Mitigation Policy).

Dublin Airport
Airports by their nature are very noisy and the high baseline level of noise significantly reduces the impacts of any additional noise associated with the Construction Phase. There are some noise impacts suggested from piling and ground excavation around the Airport Church, but no significant adverse human health impacts are anticipated, as places of worship are occupied for relatively short time periods. Therefore, there are limited noise impacts predicted near Dublin Airport as outlined in Chapter 13 (Airborne Noise & Vibration) but no significant adverse effects to human health are predicted.

Collins Avenue
Piling and ground level excavation are predicted to have moderate impacts in the area of Our Lady of Victories Church, but sites of worship are only occupied for relatively short periods of time. While background noise maybe a nuisance this would not result in any human health impact given the relative short duration of occupancy. The Tara Winthrop Clinic (Private Hospital and Aged Care) is predicted to have moderate impacts during construction and due to track laying that occurs over a short period of time at night. The Dublin County Council Assisted Living building (also referred to as Albert College Court) will only be moderately impacted during daytime works and with the mitigation from noise barriers in place any impacts are within significance thresholds. Therefore, there are limited noise impacts predicted as outlined in Chapter 13 (Airborne Noise & Vibration) near these receptors but no significant adverse effects to human health.

Whitehall College - Griffith Avenue
Significant impacts are predicted on the third floor of the Whitehall College. However, areas of work and study will be occupied for relatively short periods of time. Noise may be a temporary nuisance and may at times make communication more difficult, but this does not in itself constitute a health effect. Therefore, there are limited noise impacts predicted near this receptor as outlined in Chapter 13 (Airborne Noise & Vibration) but no significant adverse effects to human health.

Glasnevin
A number of residences in Glasnevin are identified which could have significant effects during construction as outlined in Chapter 13 (Airborne Noise & Vibration). Mitigation measures are proposed including 4m high hoarding to the north, south, east and west construction boundaries which will significantly reduce any effect. The residual noise levels are not predicted to exceed noise limits even with the proposed extended working hours (24hrs) for some activities at this location, and therefore using the EPA Guidelines as detailed in Section 10.3 no significant adverse human health effect is

predicted. Therefore, there are limited noise impacts predicted near this receptor and no significant adverse effects to human health.

O'Connell Street
For the O'Connell Street area, potential moderate significant noise effects are predicted during construction as outlined in Chapter 13 (Airborne Noise & Vibration), particularly around the south-east façade and upper floor of the Jury's Inn hotel. Hotel rooms are frequently unoccupied during the day, when most of the noise is expected to be experienced and therefore no human health adverse effects are predicted. Behaviour such as closing windows would reduce any short-term effect although this is not a formal mitigation measure for the proposed Project. Therefore, there are limited noise impacts predicted near this receptor but no significant adverse effects to human health.

Tara Street
Some likely significant effects are predicted in this area including impacts on Trinity Plaza Apartments as outlined in Chapter 13 (Airborne Noise & Vibration) but with mitigation, noise limits will not be exceeded and therefore using the EPA Guidelines as detailed in Section 10.3, no adverse human health effects are predicted. Therefore, there are limited noise impacts predicted near this receptor and no significant adverse effects to human health are predicted.

St Stephen's Green
A number of buildings are likely to experience moderate to significant effects, including the Jurys Hotel as outlined in Chapter 13 (Airborne Noise & Vibration). However, this will be in the daytime only and any night-time works will be controlled through scheduling and localised mitigation. No impacts on sleep are predicted and subsequently no adverse human health effects are anticipated. Therefore, there are limited noise impacts predicted near this receptor and no significant adverse effects to human health are predicted.

Ashely Avenue/Estuary Court
A number of residential buildings will be moderately impacted during the Construction Phase. These works will take place during the day and therefore no significant adverse human health impacts are predicted.

Charlemont
There are a number of residences which are predicted to have significant adverse effects from construction noise during the day as outlined in Chapter 13 (Airborne Noise & Vibration), particularly in relation to the upper floors. Significant mitigation including 4m high hoarding is proposed. While residual effects are possible, these would be during the day and will not apply to night-time and therefore will not affect the potential for sleep. Consequently no human adverse effects are expected and although limited noise impacts are predicted near this receptor no significant adverse effects to human health are predicted.

10.5.1.2.1 Very Highly Sensitive Receptors

Mater Hospital Psychiatric Ward
While the entire construction period would be up to six years, for most of that period of time, the air borne noise level will be well below the 70 dB significance threshold as outlined in Chapter 13 (Airborne Noise & Vibration). The highest noise levels will occur during the construction of the station box along Eccles Street which is approximately 15 to 20 metres from the building façade.

The Mater Hospital psychiatric ward is assisted, in terms of airborne noise, by the fact that it is at basement level. There are higher noise levels predicted on the first and second floor of the Mater Hospital, however these areas may be considered significantly less sensitive than the psychiatric ward as they largely house administrative rooms rather than patients.

The majority of noisy activities will take place during standard working hours (07:00hrs to 19:00hrs on weekdays (excluding Bank and Public Holidays) and from 07:00hrs to 13:00hrs on Saturdays) and will not have the unwanted effect of disturbing restful sleep during the night. Individuals that are particularly sensitive to noise could be moved to rooms that are less impacted by any residual noise.

Overall, the predicted effects on the psychiatric ward from airborne noise are manageable. The levels at the façade and therefore the levels of noise inside the building would be compatible with urban environments in general and at peak levels would only occur for a relatively short period of time. Extra protection if required, including installation of insulation, is achievable although may not be necessary.

This location is also dealt with extensively below as groundborne noise is the major construction impact. The areas of the Mater Hospital that may be affected by airborne noise are not areas which contain patients and therefore human health impacts are minimised. Therefore, there are limited airborne noise impacts predicted near this receptor and no significant adverse effects to human health.

NorthWood Nursing Home
The impact with mitigation as outlined in Chapter 13 (Airborne Noise & Vibration) is considered to be moderate to significant but importantly at night-time, no significant effects are predicted. Significant mitigation, including enclosure tents to reduce impacts from ongoing activity at night are proposed. Given this, and particularly that no significant exceedances are predicted at night, no significant adverse human health impacts are predicted.

10.5.1.3 Groundborne Noise and Vibration

Groundborne Noise and Vibration is assessed in Chapter 14 (Groundborne Noise & Vibration). The greatest impact from groundborne noise will come from the advancement of the TBM, underground mechanical excavation from blasting.

Mitigation measures will include a series of controls to reduce groundborne noise and vibration to acceptable levels, these include the following points.

- Blasting will only take place at defined discrete times (maximum of two per day) during the daytime. Suitable advanced warning will be given to anyone who may experience noise or vibration. Vibration from each blast will be monitored to enable blasting parameters to be optimised and to ensure that damaging levels of vibration are not reached. If necessary, alternative chemical or hydraulic splitting methods will be used.
- Coordination with sensitive neighbours, such as Mater Hospital, will be an important mitigation measure to prevent adverse impacts, such as to patients in the psychiatric ward.

While the impact of groundborne noise and vibration associated with the TBM would be transient in nature, at any particular location it is likely to cause a significant effect in terms of annoyance and sleep deprivation, for at most approximately two weeks. Noise and vibration levels will not be evenly distributed over that period as it would peak for 2 to 3 days when the TBM is closest. Speed of the TBMs is also impacted by the geology of the underlying area.

For those receptors which are on or close to the proposed line of the TBM the noise and vibration may be very significant. TBM noise will be audible at night in many homes, but the noise threshold is sufficient to ensure that TBM noise at night meets widely adopted standards for the prevention of sleep disturbance and monitoring will be in place to ensure that these thresholds are not exceeded.

Therefore, adverse effects on human health are prevented by mitigation up to and including temporary relocation where thresholds may be exceeded. A vibration monitoring programme adds further confidence that the predicted levels will not be exceeded.

10.5.1.3.1 Very Highly Sensitive Receptors

Mater Hospital Psychiatric Ward
Following consultation with the Mater Hospital, concerns were expressed in relation to the potential effects on the psychiatric ward of the hospital in the construction of the proposed Project. Any psychological impacts are most likely to occur due to noise issues. It is important to realise that there are a number of variables when performing this assessment, one of which is the nature of the noise itself which in the case of the Mater Hospital psychiatric ward, groundborne noise is considered the most important.

Groundborne noise at Mater Hospital Psychiatric Ward
The psychiatric ward is located in a part of the hospital which is closest to the route of the tunnels and hence the TBM. It is proposed to keep the TBM going 24 hrs a day as detailed in Chapter 5 (MetroLink Construction Phase). The frequency of groundborne noise is low and it may be perceived differently to airborne noise. The entire psychiatric ward will be within the contours for significant groundborne noise and vibration. Indeed, the tunnel itself is immediately under the corner of the ward.

Although there is a lack of evidence of the adverse effects of noise on psychiatric patients, there is evidence that lack of sleep not only is a symptom of many psychiatric illnesses but also may exacerbate existing psychological conditions. Psychiatric patients for this reason are deemed highly vulnerable and therefore the duration that there would potentially be significant effects from the TBM may be greater than it would be for persons who are not suffering from psychiatric illness.

It should be noted that the ward itself is at basement level. It is almost certain that for the two to three days as the TBM passes the location that it is difficult to envisage any part of the psychiatric ward being usable, particularly given the night-time noise and vibration which would disturb the potential for restful sleep. It is possible that the patients may be best managed without being moved during the passage of the TBM but consideration may have to be given to alternatives if this became intolerable. This would potentially mean moving patients to other parts of the hospital or to other hospitals for that period of time. The length and duration of the move is variable and difficult to predict but a best-case scenario would be three days and a worst-case scenario would be two weeks.

Concerns have been expressed that it would not be possible to move the number of patients that would normally occupy this ward for any significant period of time as accommodation does not readily exist elsewhere, either in other psychiatric hospitals or within the Mater Hospital. Variation in the groundborne noise and vibration over a two-week period, it being at its highest level for 2-3 days, is likely to mean that some areas of the ward have reasonably acceptable noise and vibration levels so the number of patients that need to be moved, could be reduced. Negotiations would have to take place with the hospital authorities in relation to mitigation including temporarily moving of patients.

10.5.1.4 Psychological Effects

There are potential psychological impacts from the Construction Phase. These may have started already as individuals, once possible details of a scheme such as this are made public, can become anxious and worried about potential effects on their property or themselves.

Human psychological impacts are very complex and not easily predicted. There is no simple methodology to predict effects in groups of people, often the most efficient way of predicting future psychological impacts is by looking at what has happened in similar projects. One relevant example is the recent construction of the Elizabeth Line (Crossrail) in London. A Pubmed search was conducted to determine if this project was associated with adverse psychological impacts and there is no publication suggesting that this is the case.

Potential psychological effects are not equally distributed. Some people, due to the location of their residence or work may have very significant effects. The demolition required at College Gate Apartments is seen as essential in order to provide an appropriate station to service the area. While these negative psychological impacts are recognised and accepted, it is also recognised that the individuals affected will have to be compensated and rehoused appropriately. While this may give rise to some disruption and annoyance it is not considered likely that there will be long-term deleterious effects, as there is no evidence of a higher incidence of psychological illness where people were rehoused in similar circumstances. It also must be balanced against the positive psychological impacts of the Operational Phase and the benefits and convenience to residents of the area given the proximity to the proposed MetroLink stations.

While there is a significant and extensive traffic management plan in the Construction Phase, there may be delays in what are already busy streets and roads as outlined in Chapter 9 (Traffic & Transport). This may lead to annoyance in some drivers which may precipitate complaints. As outlined above however annoyance is not in itself a human health effect.

On balance there is no reason to predict significant adverse effects on human health from a psychological perspective.

10.5.1.5 Electromagnetic Frequency (EMF)

As outlined in Chapter 12 (Electromagnetic Compatibility & Stray Current) the impacts on exposure from EMF during the Construction Phase are imperceptible and do not differ from any other large construction project.

There is no reason to predict significant adverse effects on human health related to EMF.

10.5.1.6 Water

The potential effect on human health from water is primarily by means of possible contamination or pollution of water intended for human consumption. The potential impacts on water are extensively assessed in Chapter 18 (Hydrology) and Chapter 19 (Hydrogeology) of the EIAR. Mitigation as outlined in these chapters will be implemented to minimise the risk of any pollution impacts on water.

The receiving environment is primarily an urban area. Drinking water is not generally abstracted from the ground locally but rather transferred from reservoirs some distance away. Wastewater goes into a sewage system and is transported to wastewater treatment plants by sewers. This minimises the potential for any human health impact from the construction or Operational Phase.

There will be no effect on drinking water quality as a result of the construction of the proposed Project due to the construction management techniques employed and the mitigation proposed and therefore no human health impacts in relation to contamination of water are predicted. There is no reason to predict significant adverse effects on human health.

10.5.1.7 Soils and Geology

The potential for disruption of contaminated soils is extensively assessed in Chapter 20 (Soils & Geology) of the EIAR. As outlined in Chapter 20 (Soils & Geology), the soil chemical data with regard to chronic exposure risk, have been screened against human health Generic Assessment Criteria (GAC).

A comprehensive Geotechnical Investigation was undertaken for the proposed Project with a large number of sample boreholes assessed in order to determine any existing groundwater contamination or potential impacts arising from the proposed Project. Any exceedances of the GAC are reported in Chapter 20 (Soils & Geology).

Contaminated land is anticipated at a number of sites as outlined in Chapter 20 (Soils and Geology) including a site in the vicinity of the proposed Dublin Airport Station location. Mitigation measures including the use of personal protective equipment, safe handling and disposal of contaminated soils should prevent any human exposure to these agents.

For the majority of the tunnelling project the rock will be predominantly limestone. The fugitive release of Radon is highly unlikely as limestone carries an inherently low risk of Radon exposure and no significant difficulties that could impact on human health are expected from extraction and handling.

No significant adverse human health impacts are predicted from the extraction or handling of soils or geological material.

10.5.1.8 Amenity

There will be some loss of general amenity areas during the Construction Phase and because they are going to be taken up for several years the impact on amenity is significant. However, the provision of alternative recreation and sports areas in the same or other locations will ameliorate the loss and TII is working with the various stakeholders to ensure this restoration takes place.

The loss of amenity could cause potential health and psychological impacts and is aggravated by the fact that many of the recreation areas which will be temporarily lost are in relatively socially deprived areas. It is recognised that many individuals will overcome this by seeking other parks or sporting facilities elsewhere but the less motivated may not. Many of the facilities outlined are utilised by clubs which will continue to operate and motivate their members.

Not all individuals have equal ability to move to other facilities. Those people who are reliant on public transport may have limited options compared with people who have their own car. This may mean a greater impact in communities where there is less access to private transport such as socially deprived areas. In addition, people with disabilities who already have limitations in moving around may find this is exacerbated by loss of local amenity. These considerations need to be taken into account when considering the location and accessibility of alternative amenity areas. Provision of suitable alternatives in suitable accessible locations will minimise any effect.

10.5.1.9 Aspergillus fumigates

As was outlined in Section 10.3, the National Guidelines for the Prevention of Nosocomial Invasive Aspergillosis during construction/renovation activities were issued in 2002 by the NDSC. For the Construction Phase, mitigation measures described in the guidelines will be applied where appropriate.

10.5.1.9.1 Very Highly Sensitive Receptors

Mater Hospital
In terms of biological risk, there may be vulnerable patients in the Mater Hospital and there are extensive guidelines in relation to how this risk can be managed and reduced. Vulnerable patients will typically be people with decreased immune systems due to illness or treatments for illnesses such as bone marrow transplants or haematological diseases. These, however, will be typically in wards that are designed to prevent *Aspergillus* build up in the area. These wards will have HEPA (High Efficiency Particulate Air) filters on windows and ventilation systems and controls in relation to items such as flowers or plants being on site. In this protected environment there are no significant increased risks because of the additional activity related to construction.

Northwood Nursing Home, Tara Winthrop Clinic, Dublin County Council Assisted Living
By using the mitigation measures outlined in Chapter 16 (Air Quality), it is not anticipated that there would be any human health impacts as a result of exposure to *Aspergillus* in these locations.

10.5.1.10 Vermin (Leptospirosis)

Rodent control, good sanitation, disinfecting contaminated work areas, worker education via tool box talks and using personal protective equipment (PPE) when handling infected animals are important actions for prevention of Leptospirosis (or Weil's Disease).

While rodents will be temporarily displaced as a result of initial construction activities, there is nothing in the Construction Phase which would lead to an increase in the number of rodents. It could be argued that with the rodent control policies in place, there will be a reduction in the level of rodents and the subsequent risk associated with Leptospirosis.

Because there will be no increase in vermin numbers and more likely a decrease because of vermin control measures there will be no increase in vermin transmitted disease over and no significant adverse effect on human health.

10.5.2 Operational Phase

It is important that the positive effects of the proposed Project whilst in operation are considered, although it is also true that even in the Operational Phase there could be potential negative impacts on human health.

The most likely sources of these impacts are listed here and described in further detail below:

- Air Quality;
- Airborne Noise and Vibration, (this includes noise from both the actual trains on the railway but also the noise from people using those trains);
- Groundborne Noise and Vibration;
- EMF;
- Water;
- Soils and Geology;
- Suicide, Violence and Terrorism;
- Tourism;
- Amenity;
- Equity; and
- Socioeconomic Development.

10.5.2.1 Air Quality

The trains themselves will be electric and so will not generate any adverse emissions. However, there have been studies that have reviewed the potential health effects of dust generated within an operational underground railway.

A thorough review of this was performed by McKenzie (2018). A literature search found 27 publications directly assessing the potential health effects of underground particulate matter, including in vivo exposure studies, in vitro toxicology studies, and studies of particulate matter which might be similar to that found in underground railways. The methodology, findings, and conclusions of these studies were reviewed in depth, along with further publications directly relevant to the initial search results. In vitro studies suggest that underground particulate matter may be more toxic than exposure to ambient/urban particulate matter, especially in terms of endpoints related to reactive oxygen species generation and oxidative stress. This appears to be predominantly a result of the metal-rich nature of underground particulate matter, which is suggestive of increased health risks. However, while there are measurable effects on a variety of endpoints following exposure in vivo, there is a lack of evidence for these effects being clinically significant as may be implied by the in vitro evidence.

This would suggest that dust in underground railways is similar to other dust and can be assessed as such. In addition, the stations are effectively sealed from the railway line by the Platform Screen Doors (PSD) so this will not lead to any exposure of passengers to dust cause for example by moving trains. During the Operational Phase, all the evidence suggests that no significant adverse effect on human health due to changes in air quality are predicted. The potential for diversion of journeys to an electrified rail system and away from cars is likely to have positive impacts on human health.

10.5.2.2 Airborne Noise and Vibration

As outlined in the methodology section there has been extensive research into human health effects of railway noise. These include issuance of WHO Guidelines in relation to relevant noise.

As outlined in Chapter 13 (Airborne Noise & Vibration), operational noise exposure to sensitive receptors is very limited. Noise from the underground sections is all but eliminated due to attenuation and in the overground sections with the proposed mitigation, WHO Guidelines will not be breached. This is important as these are Health Based Guidelines published in 2018 and are based on the most up-to-date review of available evidence. As no WHO guideline for railway noise will be exceeded, no adverse human health impact is predicted.

Given the potential for diversion away from other modes of transport associated with more environmental noise, the net impact on human health from environmental noise of the operational system may even be positive.

10.5.2.3 Groundborne Noise and Vibration

Vibration modelling is described in Chapter 14 (Groundborne Noise & Vibration). Vibration is unlikely to have impacts on human beings beyond a distance of 25m from an operating light-rail line, whether at grade or in tunnel. However, the operation of the proposed Project could affect highly sensitive equipment up to a distance of 100m. Groundborne noise is unlikely to have an impact beyond 50m at grade or in tunnel, although recording studios or performance spaces may require consideration up to 100m.

In addition, contours of groundborne noise outlined in Chapter 14 (Groundborne Noise & Vibration) have been prepared which indicate that significance criteria for groundborne noise in residential buildings and other sensitive receptors would not be exceeded.

Modelling of groundborne noise, vibration effect in humans and vibration affecting sensitive equipment in healthcare facilities has also been carried out. Vibration sensitive equipment is located at Mater Hospital, Rotunda Hospital and Trinity College Dublin (TCD).

Modern railways incorporate specific track forms and continuously welded rails which completely avoid significant effects due to groundborne noise, provided that an adequate maintenance regime is followed. These track forms will be provided in the tunnels and in surface areas where necessary. Embedded rail will be used to control noise on some above ground sections. All these are design options within the proposed Project.

All areas are within guideline levels as outlined in the WHO Environmental Noise Guidelines for the European Region. Once in operation no significant noise impacts are expected.

If some noise generating overground journeys can be avoided, then this could have beneficial effects for environmental noise.

10.5.2.4 Electromagnetic Interference (EMF)

Measures to minimise stray current have been incorporated into the design specifications and will be implemented during the construction and operation of the proposed Project. These measures may include the use of a stray current collector system, together with other design measures such as resilient insulating polymer around the rails. Monitoring of the earthing system in the tunnel sections is to be carried out to locate any faults in the earthing system. Active and passive measures such as insulated shielding or cathodic protection can be applied to protect any critical components. The system contractor will ensure that the electrical systems and equipment associated with the proposed Project comply with European legislation. With regard to some types of sensitive electric appliances, relocation of the affected appliance (even a short distance from a railway boundary) may be possible.

The potential for significant impacts to occur due to stray current is considered to be low provided that the mitigation measures detailed above are put in place. The technical design of the proposed Project conforms to current best practice. During normal scheme operations, the expected direct current and electromagnetic effects have been evaluated and were found to be less than 50% of the field strength of the Earth's natural magnetic field. These levels are unlikely to pose a threat to the normal operation of receptors such as electromagnetic equipment located along the alignment. The described impacts can be regarded of low significance and do not present any significant safety risk.

As outlined in Chapter 12 (Electromagnetic Compatibility & Stray Current), locations within the Trinity, Rotunda and Mater campuses - where DC (Direct Current) and quasi-DC magnetic field perturbations are at elevated levels from the operation of the proposed Project - may not be suitable for the installation or relocation of equipment with sensitivities to these types of fields.

Despite applied mitigation measures to minimise the magnitude of stray current, it is an inevitable phenomenon associated with DC rail systems. Continued monitoring of the performance of the traction circuit with respect to current returns to the substation will be required. Also, the monitoring of nearby

buried structures and pipes periodically to indicate potential changes in the stray current environment would be expected to be carried out by the proposed Project operators.

During the Operational Phase the impacts from all types of EMF are extensively assessed in Chapter 12 (Electromagnetic Compatibility & Stray Current). ICNIRP levels as outlined in Section 10.3 will not be exceeded for human receptors. As these are Health Based Standards and in keeping with the EPA Guidelines no significant adverse human health impact is predicted.

10.5.2.5 Water

The significance of the residual impact from the proposed Project on river and stream flow is considered in Chapter 18 (Hydrology) as Imperceptible to Slight and of permanent duration.

There is potential for accidental spillages to result in water quality changes to receiving waters. However, as the trains are electrically operated, the potential for contamination is low, as outlined in Chapter 18 (Hydrology). Maintenance and car parking areas will have oil / petrol interceptors included in their design to manage accidental discharges locally. The significance of the residual impact in this regard is considered to be Imperceptible and of permanent duration.

No impact is predicted on the quality of drinking water and therefore, no significant adverse human health impacts are predicted.

10.5.2.6 Soils and Geology

The potential impacts of soils and geology occur during the Construction Phase when soils are being broken, moved and handled. No such activity takes place during the Operational Phase and therefore no operational impacts from soils and geology on human health are predicted.

In addition, no human health effects as a consequence of changes in Radon levels related to the operation of the proposed Project are predicted. Therefore, no significant adverse human health effects are predicted.

10.5.2.7 Suicide, Violence and Terrorism

Suicide is a problem on railway networks worldwide. O'Donnell *et al,* (1992) investigated the characteristic features of railway suicide, data were gathered from 23 Metro systems around the world. The similarities in the nature of this problem across systems were striking. Universally the victims were young (aged less than 40 years); most incidents involved men; case fatality was generally less than 60%; there was no consistent seasonal variation in incidence; the peak time of day for incidents was 10.00-12.00; proximity to psychiatric institutions was possibly a risk factor.

In an article by Krysinska, (2008) a number of strategies for reducing suicide were put forward including:

- Reducing public access to the tracks;
- Improving surveillance by station staff;
- Facilitating emergency stops; and
- Reducing speeds.

The proposed project has been designed to prevent access to the track, including the installation of Platform Screen Doors (PSDs) at all stations and security fencing around the surface sections of the alignment. Unauthorised access will be monitored by CCTV placed at key locations and via the Access Control and Intrusion Detection system (ACID).

Violence is not a human health effect but is mentioned here for sake of completeness. Violence is always possible where groups of people meet, particularly later at night and following the consumption of alcohol or drugs. Security assessments will take place to determine what precise measures are required

at each station. This will mean that there is no greater risk of violence occurring in the stations than anywhere else in society.

Terrorism is not a human health effect but is mentioned here for sake of completeness. Events on the London Underground highlighted the potentially disastrous effects of terrorist attacks on transport systems. There is, however, no evidence that the presence or absence of a railway line has any effect on the nature or the risk of terrorism. The risk of accidental or deliberate incursions of vehicles onto the railway line or at station entrances has been designed out through the construction of a vehicle restraint system - where the station entrances and alignment is closde to the local highway network - comprising 600mm concrete parapets with fencing on top and the placement of bollards near station entrances.

Further information on the design of the proposed Project and the Operational Phase can be found in Chapter 4 (Description of the MetroLink Project) and Chapter 6 (MetroLink Operations & Maintenance).

10.5.2.8 Amenity

An efficient public transport system, as would be provided by the proposed Project, has the potential to greatly increase amenity as there is greater access to other areas of the city without the reliance on cars. As was discussed in the construction impacts section above, the loss of amenity in some areas will be reversed during operation and in many cases the amenities enhanced. Improved access to amenities is particularly felt in those living closest to the line, however this will also be felt by all residents and visitors to the city. Therefore, improvements to amenity are predicted during the Operational Phase.

10.5.2.9 Access to Services

Having a rapid and efficient public transport system will provide an increase in access to services for all, but in particular those who do not have access to private transport. From a human health perspective, it is noteworthy that the Mater Hospital is adjacent to the proposed Project and will have a convenient station located nearby that will improve access for staff and patients alike. In relation to access to services the Operational Phase is considered to have significant benefits for human health.

The proposed Project will be entirely accessible to wheelchairs and others with significant disabilities. Currently people in wheelchairs using public transport have to use accessible buses and wheelchair accessible taxis that are not always readily available. Having a reliable, accessible means of transport will give significant benefit to the disabled. The proposed Project has taken a Universal Design approach, specifically to help medically impaired people (e.g. people in wheelchairs, with poor mobility or poor vision/hearing) to have access to MetroLink. Further information can be found in Chapter 4 (Description of the MetroLink Project) and Chapter 6 (MetroLink Operations & Maintenance).

10.5.2.10 Equity

Transport is an important facilitator of social inclusion and wellbeing, which can affect economic and social outcomes, and therefore inequality.

Several reports highlighted that men and women have different transport needs when it comes to supporting access to employment. Programmes involving subsidised as well as free travel for different modes of transport are found to differentially affect men and women. None of the reports discussed non-binary or transgender people. Personal safety is of concern for many people, particularly for women, many of whom prefer to travel by car which is considered to be safer than public transport (TII, 2020). Safety has been central to the design development of stations and the surrounding areas to ensure that they are safe for all users to use.

The UK Women's Budget Group (WBG 2018) highlighted the disproportionate impact that cuts to subsidised bus services have had on women, since they make more bus journeys than men as they are more likely to be in part-time work and exercise caring responsibilities that may require them to make multiple journeys during a day. The report emphasised that a lack of adequate public transport creates barriers to women accessing employment and educational opportunities, thus hindering their ability to participate in public life.

In this respect, the Operational Phase has the potential to improve gender equity.

10.5.2.11 Socioeconomic Development

Several papers have discussed how transport can generate wider economic benefits. The Urban Transport Group (2018) presented a series of case studies outlining the ways in which a range of transport related measures aim to widen access to employment, education, and training in towns. Such measures work by widening the accessible labour market, improving housing options and increasing investment.

As outlined in the methodology section, positive socioeconomic development is one of the greatest influences on positive health outcomes. It is reasonable to predict that there will be a socioeconomic benefit from the Operational Phase of the proposed Project. This benefit is likely to be felt well beyond the study area, extend throughout the city and urban area of Dublin and potentially the whole country.

10.6 Mitigation Measures

Detail on the mitigation measures that are linked to human health outcomes in both the Construction and Operational Phases can be found in the following EIAR chapters: Chapter 12 (Electromagnetic Compatibility & Stray Current), Chapter 13 (Airborne Noise & Vibration), Chapter 14 (Groundborne Noise & Vibration), Chapter 16 (Air Quality), Chapter 18 (Hydrology), Chapter 20 (Soils & Geology) and Chapter 28 (Risk of Major Accidents & Disasters).

The construction contractor and MetroLink operator will have to prepare and implement an Environmental Management Plan and a Health and Safety Plan to protect workers, control environmental pollution, and protect members of local communities from construction and operational activities. An Outline Construction Environmental Management Plan (CEMP) has been prepared for the EIAR and can be found in Appendix A5.1.

No additional mitigation, over and above that outlined in the chapters above, is proposed for Human Health.

For the purpose of clarity, the identified mitigation proposed in the above chapters for the impacts relevant to the human health assessment are contained in Table 10.14 below. The residual health effect is also included.

Table 10.14: EIAR Chapter mitigation and residual health effects

EIAR Chapter	Impact Reference	Identified Impact	Identified Mitigation	Residual Health Effect
Chapter 12 (Electromagnetic Compatibility & Stray Current)	EMI1	Potential Slight impact on existing SEMs at Rotunda and exclusion of the placement of equipment in areas close to alignment without mitigation.	None required. Consultation and mitigation should new equipment be installed.	No residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV1	Slight to Moderate impacts on Emmaus Centre (now used to house refugees) during construction.	Noise barriers (up to 4m tall)	May cause annoyance to residents but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV2	Moderate to Very Significant impacts on Hertz building (call centre/offices) from daytime construction work	Noise barriers (up to 4m tall)	May cause annoyance to users but no residual health effect predicted.

EIAR Chapter	Impact Reference	Identified Impact	Identified Mitigation	Residual Health Effect
Chapter 13 (Airborne Noise & Vibration)	NV3	Moderate to Significant impacts on Airport church prior to mitigation.	Noise barriers (up to 4m tall)	May cause annoyance to users but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV4	Slight to Very Significant impact on Dalcassian Downs (Significant to Very Significant for Dalcassian Downs Court) post mitigation.	Noise barriers (up to 4m tall) - very close to apartments blocking light. Noise insulation for some properties	May cause annoyance to residents but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV5	Moderate to Very Significant noise impacts on Whitehall College post mitigation.	Noise barriers (up to 4m tall)	May cause annoyance to users but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV6	Slight to Moderate impacts on Scoil Mobhi post mitigation.	Noise barriers (up to 4m tall)	May cause annoyance to users but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV7	Slight to Very Significant impacts on Mater Hospital post mitigation.	Noise barriers (up to 4m tall) Noise insulation in some locations in the hospital	May cause annoyance to patients and staff but as areas of the hospital primarily affected are the upper floors that do not contain wards, no residual health impact predicted.
Chapter 13 (Airborne Noise & Vibration)	NV8	Significant to Very Significant impacts on St Joseph's Church post mitigation.	Noise barriers (up to 4m tall)	May cause annoyance to users but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV9	Slight to Very Significant impacts on Berkeley Road properties post mitigation	Noise barriers (up to 4m tall) Noise insulation for some properties	May cause annoyance to residents but no residual health effect predicted.
Chapter 13 (Airborne Noise & Vibration)	NV10	Slight to Very Significant impacts on Dartmouth Square and Cambridge Square properties (Significant to Very Significant) and Hines Office Buildings post mitigation.	Noise barriers (up to 4m tall) Noise insulation for some properties	May cause annoyance to residents but no residual health effect predicted.
Chapter 14 (Groundborne Noise & Vibration)	GNV1	Significant impact on Our Lady Queen of Heaven Church from the TBM and impacts from blasting (Dublin Airport).	Reduced blast charges and max twice daily discrete blasts.	May cause annoyance to users but no residual health effect predicted.
Chapter 14 (Groundborne Noise & Vibration)	GNV2	Significant impact along alignment for buildings within 75m of the tunnel centre, including on Scoil an Tseachtar Laoch, Our Lady of Victories, Albert College Court, Dalcasian Downs, Cross Guns Quay Apartments, Berkely	Communication and Notification.	May cause annoyance to residents, users and others but with mitigation including potential temporary relocation, no residual health impacts predicted.

EIAR Chapter	Impact Reference	Identified Impact	Identified Mitigation	Residual Health Effect
		Road, Mater Hospital, St Joseph's Church, Rotunda Hospital, Dartmouth Square West, Oversite Development at Charlemont during TBM advancement.		
Chapter 14 (Groundborne Noise & Vibration)	GNV3	Significant impacts on St Joseph's Church and Charlemont Station oversite development from mechanical excavation.	Communication and Notification.	May cause annoyance to users but no residual health effect predicted.
Chapter 14 (Groundborne Noise & Vibration)	GNV4	Significant impacts on St Joseph's Church, 42 O'Connell Street, Dublin Fire Brigade HQ and Charlemont Station oversite development from blasting.	Reduced blast charges and max twice daily discrete blasts.	May cause annoyance to residents but no residual health effect predicted.
Chapter 18 (Hydrology)	HY1	Flood risk during the Construction Phase.	Production of the Outline Construction Environmental Management Plan (CEMP) and implementation of the appropriate controls and processes.	No residual health effect predicted
Chapter 20 (Soils & Geology)	SG1	Radon /Ground gas emissions during excavations	Monitoring of emissions.	Will dissipate rapidly so no residual health impact predicted.
Chapter 20 (Soils & Geology)	SG2	Moderate impacts on human health (Contaminated Material) to nearby residents due to exposure to contaminated material.	Monitoring and management of material based on updated ground investigation.	With appropriate handling and disposal, no residual health impacted predicted.
Chapter 28 (Risk of Major Accidents & Disasters)	N/A	Potential for spread of Infectious Disease.	Regular cleaning and maintenance regime in place.	With mitigation including pest control management no residual health impact predicted. Identified as a residual impact that cannot be designed out. Would need measures implemented similar to those used for COVID-19.

10.7 Residual Impacts

During the Construction Phase there will be temporary and short-term, but significant, adverse effects at certain locations. These are largely attributable to emissions from the construction process such as groundborne noise and vibration from the TBM, noise emissions and impact on air quality.

Some sites will be significantly adversely affected for a period of time because of the sensitivity of the individuals there and the nature of the emissions. Perhaps the most significant effect will be groundborne noise and vibration attributable to the TBM and blasting. The psychiatric ward of the Mater Hospital is deemed as a particularly vulnerable location and there is the possibility that patients will have to be moved out of this ward for periods up to two weeks. This may also be the case for some residences along the line of the TBM but likely to be for a shorter duration.

There will also be some psychological impacts, particularly for those whose homes are to be acquired. There will be some negative impacts on amenity as some leisure facilities such as pitches and playing fields will be unavailable during the Construction Phase. There will be some degree of annoyance with changes to traffic routes and potential delays, but this is minimised by having an appropriate management plan in place as has been outlined in the EIAR.

During the Operational Phase there will be permanent and significant benefits in terms of human health including direct effects by improving the environment in Dublin over the do-nothing scenario but also indirect effects such as facilitating exercise, reducing social inequalities and improving access to services including for disabled persons. These benefits will be ongoing and very significant. Having an efficient public transport system such as MetroLink will also bring benefits for physical and psychological human health directly and provide a positive contribution to the environment.

Overall, the residual impacts on human health terms are assessed as overwhelmingly positive.

10.7.1 Cumulative Impacts

Following a review of other projects within the vicinity of the proposed Project, no cumulative adverse impacts on human health are anticipated. However, potential positive cumulative impacts on human health are predicted when the proposed Project is completed alongside the proposed Bus Connects scheme, as these will lead to significantly improved public transport in the Dublin area.

10.7.2 Additional Projects

Following a review of the Proposed MetroLink Grid Connections and the Hammersons Dublin Central Site 2 Project, there are no significant adverse human health effects predicted.

10.8 Difficulties Encountered

No difficulties were encountered during this phase of the EIAR.

10.9 Glossary

Term	Meaning
Alignment	Alignment refers to the three-dimensional (3D) route of the railway, considering both the horizontal and vertical alignment.
Construction Compound	An area occupied temporarily for construction-related activities. The main construction compounds will act as strategic hubs for core project management activities (ie engineering, planning and construction delivery) and for office-based construction personnel. The main construction compounds will include: offices and welfare facilities, workshops and stores, and storage and laydown areas for materials and equipment (e.g. aggregate, structural steel, and steel reinforcement).
Electric field	a region around a charged particle or object within which a force would be exerted on other charged particles or objects.
Enabling Works	These are works to prepare a site in advance of the main construction works, for example, demolition, removal of vegetation, land levelling.
Hand Arm Vibration Syndrome	caused by occupational exposure to vibrating hand tools, which has three main components: 1. Peripheral neuropathy of the hands that produces numbness, tingling, or both in a glove distribution. 2. Secondary Raynaud's phenomenon of the hands - characteristically producing intermittent well-demarcated blanching of the fingers. 3. Musculoskeletal problem, that may include complaints of weakness, discomfort, and pain of the hands, wrists, forearms, and elbows.
Intervention Shaft	A tunnel to provide emergency access and egress from the railway tunnel.
Intervention Tunnel	A tunnel parallel to the railway tunnel to provide emergency access / egress.
Park & Ride Facility	A location usually sited out of the main urban areas comprising a large car park and connected with a mass transit system, in the case of MetroLink an urban metro to attract potential travellers to drive and park at the facility and take the metro into the city centre and avoid driving into the city centre.
Retained Cut Station	A railway station constructed primarily below ground level with vertical retaining walls either side of the alignment to reinforce the walls and no roof or enclosure overhead.
Surface Station	A railway station designed at ground level.
Underground Stations	A railway station located fully underground with a roof slab over the station to enclose it fully.
Whole Body Vibration	a generic term used when vibrations (mechanical oscillations) of any frequency are transferred to the human body. Large shocks and jolts caused by that, may cause health risks.

10.10 References

10.10.1 Technical and Planning Documents

Barregard et al., 2009; Eriksson et al., 2012; Lercher et al., 2008; 2011; van Poll et al., 2014

Basner & McGuire, 2018

Bodin et al., 2015; Hong et al., 2010; Sato et al., 2004; Schreckenberg, 2013

Bodin et al., 2015; Brink, 2011; Frei et al., 2014

British Standard (BS) 5228-1:2009+A1:2014 – Code of Practice for Noise and Vibration Control on. Construction and Open Sites Part 1: Noise

BS 5228 – 2 (BSI 2009 +A1 2014b)

Bronzaft,1981; Bronzaft & McCarthy, 1975 The effect of elevated train noise on reading ability. Environment and Behavior, 7(4), 517–527. https://doi.org/10.1177/001391657500700406

BS 5228 Code of Practice for the Control of Noise and Vibration on Construction and Open Sites. Part 1 – Noise and Part 2 – Vibration (2009 +A1 2014)

Elmenhorst et al., 2012

Environmental Noise Guidelines for the European Region issued by WHO in October 2018 (WHO Guidelines 2018)

Environmental Noise in Europe 2022 European Environmental Agency

Environmental Protection Agency (EPA) (2002). Guidelines on the Information to be contained in Environmental Impact Statements

Environmental Protection Agency (EPA) (2003). Advice Notes on Current Practice in the Preparation of Environmental Impact Statements

Environmental Protection Agency (EPA) (2015a). Advice Notes for Preparing Environmental Impact Statements – Draft

Environmental Protection Agency (EPA) (2015b). Revised Guidelines on the Information to be Contained in Environmental Impact Statements - Draft

Environmental Protection Agency (EPA) (2017a). Advice Notes for Preparing Environmental Impact

Environmental Protection Agency (EPA) (2017b). Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports

Environmental Protection Agency (EPA) (2017c). Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)

European Commission (2003) Implementation of Directive 2001/42 on the assessment of the effects of certain plans and programmes on the environment

Eurostat; How Polluted is Air in Urban Environments June 2021 https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20210603-1

Fáilte Ireland (2011). Guidelines for treatment of tourism in an Environmental Impact Statement

Fehr Rainer, Viliani Francesca, Nowacki Julia, Martuzzo Marco. (2014). Health in Impact Assessments. WHO Regional Office for Europe

Griefahn et al., 2000; Hong et al., 2006; Lercher et al., 2010; Passchier-Vermeer et al., 2007

Government of Ireland, Department of Housing, Planning and Local Government (2018). Guidelines for Planning Authorities and an Bord Pleanála on carrying out Environmental Impact Assessment

Heimann et al., 2007; Lercher et al., 2008; 2011; van Poll et al., 2014

Int J Environ Res Public Health. 2017 Dec; 14(12): 1539.Published online 2017 Dec 8. doi: 10.3390/ijerph14121539 PMCID: PMC5750957 PMID: 29292769

Institute of Environmental Management and Assessment (IEMA) (2017). Health in Environmental Impact Assessment - A Primer for a Proportionate Approach

Institute of Environmental Management and Assessment (IEMA) (2017). Health in Environmental Impact Assessment – A Primer for a Proportionate Approach

Institute of Environmental Management and Assessment (IEMA) (2020). Impact Assessment Outlook Journal. Volume 8 - Health Impact Assessment in Planning

Institute of Public Health Ireland (2009). Health Impact Assessment

International Association for Impact Assessment (IAIA) (2019). Addressing Human Health in Environmental Impact Assessment - Draft consultation Document

I. O'Donnell,R. D. T. Farmer First published: July 1992 https://doi.org/10.1111/j.1600-0447.1992.tb03227.x

Ising & Ising, 2002; Lercher et al., 2013; Tiesler et al., 2013

Issues Ment Health Nurs. 2019 Jun;40(6):493-502. doi: 10.1080/01612840.2018.1557301. Epub 2019 Apr 4. Noise Levels in an Acute Psychiatric Unit: An Exploratory Observational Study C A Camuccio et al

Lancet 2005 Jun 4-10;365(9475):1942-9. doi: 10.1016/S0140-6736(05)66660-3. Aircraft and road traffic noise and children's cognition and health: a cross-national study S A Stansfeld , B Berglund, C Clark, I

Lopez-Barrio, P Fischer, E Ohrström, M M Haines, J Head, S Hygge, I van Kamp, B F Berry, RANCH study team

Lercher et al., 2003 Ambient Noise and Cognitive Processes among Primary Schoolchildren

National Guidelines for the Prevention of Nosocomial Invasive Aspergillosis During Construction/renovation Activities were issued in 2002 by the National Disease Surveillance Centre (NDSC).HPA 2012

Matheson Mark, Clark Charlotte, Martin Rocio, van Kempen Elise, Haines Mary, Lopez Barrio Isabel, Hygge Staffan, Stansfeld Stephen (2010). The effects of road traffic and aircraft noise exposure on children's episodic memory: The RANCH Project

Ment Health Nurs. 2019 Jun;40(6):493-502.Noise Levels in an Acute Psychiatric Unit: An Exploratory Observational Study

Peter Lercher, Gary W. Evans, Markus Meis November 1, 2003 https://doi.org/10.1177/0013916503256260

Psychol Med Monogr Suppl. 1992;22:1-44. Noise, noise sensitivity and psychiatric disorder: epidemiological and psychophysiological studies

Sörensen et al., 2011; 2012a

TII Noise Guidelines 2014 (TII 2014)

TII Noise Guidelines 2004 (TII 2004

United States Environmental Protection Agency (2016). Health Impact Assessment Resource and Tool Compilation

UCD, ESRI Noise-Health: Review of Current Knowledge 2022

World Health Organisation (WHO) (1948). Constitution of the World Health Organization

World Health Organisation (WHO) (1999). Guidelines for Community Noise

World Health Organisation (WHO) (2006). Air Quality Guidelines

World Health Organisation (WHO) (2009). Night time Noise Guidelines for Europe

World Health Organisation (WHO) (2018). Environmental Noise Guidelines for the European Region

WHO Community Noise Guidelines 1999

WHO Environmental Noise Guidelines for the European Region: A Systematic Review on Environmental Noise and Annoyance Rainer Guski Dirk Schreckenberg, and Rudolf Schuemer

10.10.2 Directives

- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)
- Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe (CAFE Directive)
- Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment

10.10.3 Regulations

- Air Quality Standards Regulations 2011 (SI No. 180 of 2011).