6 Population and Human Health

6.1 Introduction

This chapter evaluates the impacts, if any, which the proposed development will have on population and human health. This chapter has been prepared in accordance with the requirements of the EIA Directive (2014/52/EU).

In accordance with the revised draft EPA Guidance (2017), this chapter has considered the "*existence, activities and health of people*" with respect to "*topics which are manifested in the environment such as employment and housing areas, amenities, extended infrastructure or resource utilisation and associated emissions*".

Aspects, examined in this chapter, primarily relate to direct and indirect effects from the proposed development on local community health and on socio-economic activities. The potential effects on population and human health arising from traffic, visual effects, natural amenity, nuisance, built and natural heritage, air and noise emissions, climate change etc, are dealt with in the specific chapters in this EIAR dedicated to those topics. Refer for example to **Chapters 7 *Traffic and Transportation*, 8 *Air Quality*, 9 *Climate*, 10 *Noise and Vibration*, 11 *Biodiversity*, 12 *Archaeological, Architectural and Cultural Heritage*, 13 *Landscape and Visual*, 14 *Land and Soils*, 15 *Water*, 16 *Material Assets* and 17 *Major Accidents and Disasters.***

Human health effects are primarily considered through an assessment of the environmental pathways by which health can be affected such as air, noise, water or soil. Therefore, the health assessment relies on the assessments in the relevant chapters listed above and draws on the findings as necessary to examine whether the effects arising from any identified impacts may have a health impact and to ensure that the effects which may have a health impact are fully considered.

However, the health assessment also considers health and service improvement. Other aspects, such as changes in traffic flows which are dealt with in **Chapter 7 *Traffic & Transportation***, have also been considered in this chapter with regard to air emissions and potential disruption to the local community.

6.2 Assessment Methodology

6.2.1 Guidance

The recitals to the 1985 (85/337/EEC[1]) and 2011 (2011/92/EU[2]) EIA Directives refer to "*human health*" and include "*Human Beings*" as the corresponding

[1] Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment
[2] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment Text with EEA relevance

environmental factor. The 2014 EIA Directive (2014/52/EU[3]) changes this factor to "*Population and Human Health*". However, no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU. In addition, no specific guidance on the assessment of human health in the context of EIA has been issued to date.

6.2.1.1 Environmental Protection Agency

The 2017 draft EPA guidelines on the information to be contained in Environmental Impact Assessment Reports (Section 3.3.6) note that "*while no specific guidance on the meaning of the term Human Health has been issued in the context of Directive 2014/52/EU, the same term was used in the SEA Directive (2001/42/EC*)". The Commission's SEA Implementation Guidance[4] (Section 5.26) states "*The notion of human health should be considered in the context of the other issues mentioned in paragraph (f) and thus environmentally related health issues such as exposure to traffic noise or air pollutants are obvious aspects to study*". (Paragraph (f) (of Annex I of the SEA Directive) lists the environmental factors including soils, water, landscape, air etc.).

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

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

The 2017 draft EPA guidelines also note under Section 3.3.6 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, 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*".

[3] 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 Text with EEA relevance
[4] European Commission Guidance on the implementation of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment

6.2.1.2 Department of Housing, Planning and Local Government

These principles are again supported in *Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment*, August 2018 issued by the Department of Housing, Planning and Local Government (reference page 28):

"consideration of human health effects resulting from the construction and operation of a project should focus on health issues arising in the context of the other environmental factors listed in Article 3 of the Directive/ Section 171A of the Act, namely:

- *Population*
- *Biodiversity, with particular attention to protected species and habitats*
- *Land, soil, water, air and climate*
- *Material assets, cultural heritage and the landscape*
- *Interaction between the above factors."*

6.2.1.3 European Commission

Section 1.3.1 (page 37) of the European Commission guidance (2017) relating to the preparation of the EIAR in reference to "human health" states:

"*Human health is a very broad factor that would be highly Project dependent. The notion of human health should be considered in the context of other factors in Article 3(1) of the EIA Directive and thus environmentally related health issues (such as health effects caused by the release of toxic substances to the environment, health risks arising from major hazards associated with the Project, effects caused by changes in disease vectors caused by the Project, changes in living conditions, effects on vulnerable groups, exposure to traffic noise or air pollutants) are obvious aspects to study. In addition, these would concern the commissioning, operation, and decommissioning of a Project in relation to workers on the Project and surrounding population*".

6.2.1.4 Institute of Environmental Management and Assessment

The Institute of Environmental Management and Assessment (IEMA) is the largest professional body for environmental practitioners in the United Kingdom and worldwide, with nearly 15,000 members. As such it is an authoritative body on Environmental matters. IEMA issued a discussion document in 2017 *Health in Environmental Impact Assessment - A Primer for a Proportionate Approach* which it describes as a primer for discussion on what a proportionate assessment of the impacts on health should be in EIA and is a useful document when considering what can and should be assessed in the context of this EIAR. Due regard has been had to the general approach advocated in this document when undertaking this assessment.

One of the messages in the IEMA document in terms of assessing health in EIA, is that there should be a greater emphasis on health outcomes, (that is the potential effects on human health), rather than simply the health determinants, (that is the agents or emissions which could have the potential to have health effects).

The IEMA document noted that in EIA, there has previously been a strong focus on just the agents or emission levels (e.g. dust) rather than focusing on the effects of these agents/emission levels on human health. This change in emphasis does not mean a complete change in practice. For example, measurement and modelling of dust levels continues to be an essential part of the health assessment.

The IEMA document notes that:

"*Public health is defined as the science and art of promoting and protecting health and well-being, preventing ill-health and prolonging life through the organised efforts of society and has three domains of practice: health protection, health improvement and improving services*".

The IEMA document suggests that these three domains should be considered in the assessment of human health in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles, inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies. This correlates well with Directive 2014/52/EU.

6.2.1.5 World Health Organisation

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

Therefore, health protection, health improvement and improving services are all considered in this assessment of human health effects. The methodology for assessing health protection is considered further below.

6.2.2 Health Impact Assessment and Environmental Impact Assessment

The IEMA document notes that Health Impact Assessment (HIA) and EIA are separate processes and that whilst a HIA can inform EIA practice in relation to human health, a HIA alone will not necessarily meet the requirements of the EIA Directive in relation to human health.

Further, HIA is not routinely carried out for major infrastructure projects in Ireland and it is typically a non-statutory document that is normally prepared on a voluntary basis by developers overseas, e.g. in the UK.

Guidance for performing HIAs was issued by the Institute of Public Health in Ireland in 2009 and they have outlined that there are considerable difficulties in performing a HIA for a project of this nature. Not least of these is the difficulty of getting baseline health data as it is quite difficult (due to patient confidentiality and other reasons) to accurately determine levels of even relatively common medical conditions in a relatively defined population that might be affected. Qualitative and quantitative baseline health data is a vitally important part of the HIA process. This is because it is first important to determine the baseline health status of the community before it is possible to determine the quantitative impact that a proposal might have on health. In the absence of accurate baseline data, it is very difficult to assess qualitative and quantitative changes that might occur as a result of a project of this nature.

More useful generalised data that might exist for larger areas (such as a city or county) may be used, but these datasets would be at most an estimate of the local baseline and not accurate enough to allow for meaningful interpretation specific to the proposed development. Possible local effects, perhaps due to socioeconomic variations or for other reasons would not be evident using data for larger population areas making the process inaccurate. This difficulty is not unique to the project.

The IEMA document (IEMA, 2017), notes that the WHO provides an overview of health in different types of impact assessment (WHO, 2014) and presents the WHO perspective on the relationship of HIA to other types of impact assessment as follows:

"The health sector, by crafting and promoting HIA, can be regarded as contributing to fragmentation among impact assessments. Given the value of impact assessments from a societal perspective, this is a risk not to be taken lightly ... The need ... 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 optimizing 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 can be demonstrated to be of advantage over the assessment of population and human health in the EIAR.

In this case no such advantage exists and indeed given the lack of baseline data, a stand-alone HIA would add very little to the assessment process. It is for these reasons that this assessment of human health is part of this EIAR and that no stand-alone HIA has been prepared for the proposed development.

It is therefore important to note that this assessment on human health is provided as part of the overall EIAR rather than a stand-alone HIA. The HIA is defined as a combination of procedures, methods and tools that systematically judges the potential, and sometimes unintended, effects of a policy, plan, programme or project on both the health of a population and the distribution of those effects within the population. In contrast, the assessment of human health in the context of EIAR 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 Directive 2014/52/EU. Conducting a HIA will not necessarily meet the population and human health requirements of the EIA Directive. Therefore, *health protection, health improvement* and *improving services* are all considered in this assessment.

Health protection is considered in this EIAR regarding air quality (**Chapter 8 *Air Quality***), noise (**Chapter 10 *Noise and Vibration***), soils and groundwater (**Chapter 14 *Land and Soils***), water quality (**Chapter 15 *Water***) and potential for accidents (**Chapter 17 *Major Accidents and Disasters***).

Health improvement is considered in **Section 6.6** in this chapter regarding the population, employment, potential receptors, economic activity and heritage and amenity identified in the receiving environment (**Section 6.3**).

Improving services is considered in the context of the activities and services that the proposed development will provide to the at a local and national scale where relevant and the potential direct and indirect effect that will have, refer to **Section 6.7.3**.

The IEMA document suggests that these three domains should be considered in the assessment of human health in EIA. Examples of health protection issues to be considered could include issues such as chemicals, radiation, health hazards, emergency response and infectious diseases whilst health improvement issues could include lifestyles, inequalities, housing, community and employment. Examples of improving services issues could include service planning, equity and efficiencies. This correlates well with Directive 2014/52/EU.

6.2.3 Health Protection

The assessment of human health for the proposed development, in terms of health protection, follows the approach set out in the EPA guidelines and in the European Commission's SEA Implementation Guidance. That is, the assessment on potential effects on human health is guided using **health-based standards**. It is also similar in nature to the US EPA guidance. Human Health protection is considered through the assessment of the environmental factors (pathways) through which health could be affected such as air, noise, water and soils. The US EPA guidance includes a four-step approach which is represented graphically in **Figure 6.1** below.

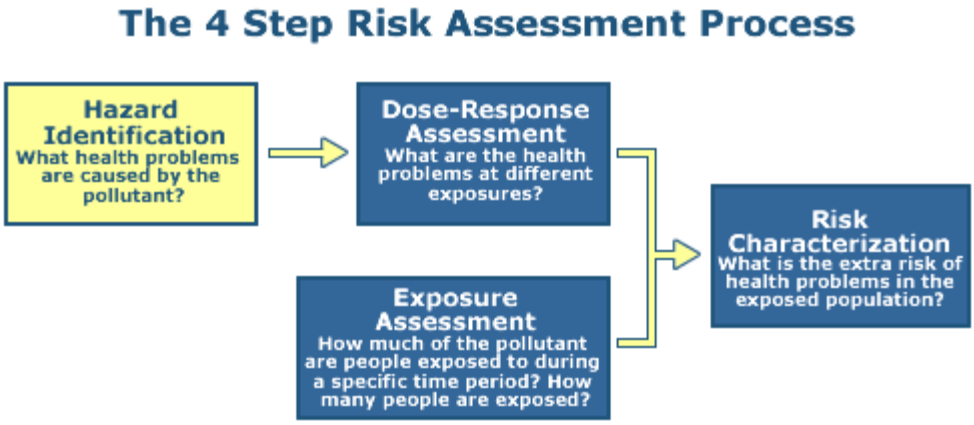

Figure 6.1: Human Risk Assessment. Source US EPA

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

When using a recognised Health Based Standard such as the one issued by the WHO 2009, the dose-response assessment is actually included in the standard. In other words, the authorities or expert committees which recommended a specific threshold or parameter (i.e. a limit value) in a standard will have inherently taken into account of the health problems at the different exposure levels and thus set the limit value within the standard to prevent these health problems (i.e. significant effects on human health) from occurring.

6.2.4 Standards

The next step in the health-based standards approach is the choice of the most appropriate standard. This section outlines the choices made for this assessment.

6.2.4.1 Air Quality - Appropriate Standards

The Air Quality Standards (aqs) are described in **Section 8.2.1.1** of **Chapter 8** ***Air Quality*** but for the convenience of the reader of the salient points are outlined here in **Table 6.1** below.

The starting point in selecting the appropriate standard to apply is Directive 2008/50/EC of the European Parliament and of the Council, as amended by Commission Directive (EU) 2015/1480 on ambient air quality and cleaner air for Europe (CAFE Directive). 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 have been specified in the CAFE Directive for the following air pollutants (as described in detail in Table 6.1):

- Sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x), particulate matter (PM_{10} and PM $_{2.5}$) and lead;

- Carbon monoxide and benzene;
- Ozone; and
- Arsenic, Cadmium, Nickel and Benzo(a)pyrene.

Table 6.1: Limit values as set out in the CAFE Directive

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m^3	Limit Value ppb	Basis of Application of the Limit Value	Limit Value Attainment Date
SO_2	Protection of human health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1 Jan 2005
SO_2	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1 Jan 2005
NO_2	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1 Jan 2010
NO_2	Protection of human health	calendar year	40	21	Annual mean	1 Jan 2010
PM10	Protection of human health	24 hours	50		Not to be exceeded more than 35 times in a calendar year	1 Jan 2005
PM10	Protection of human health	calendar year	40		Annual mean	1 Jan 2005
PM2.5 - Stage 1	Protection of human health	calendar year	25		Annual mean	1 Jan 2015
PM2.5 - Stage 2	Protection of human health	calendar year	20		Annual mean	1 Jan 2020
Lead	Protection of human health	calendar year	0.5		Annual mean	1 Jan 2005
Carbon Monoxide	Protection of human health	8 hours	10,000	8620	Not to be exceeded	1 Jan 2005

Pollutant	Limit Value Objective	Averaging Period	Limit Value ug/m^3	Limit Value ppb	Basis of Application of the Limit Value	Limit Value Attainment Date
Benzene	Protection of human health	calendar year	5	1.5	Annual mean	1 Jan 2010

Additionally, it should be noted that provisions were also made for the inclusion of new ambient limit values relating to $PM_{2.5}$. These are clearly appropriate and robust standards.

Air quality standards protect the vulnerable including those with respiratory illnesses, the old, very young and infirm. Whilst slightly higher levels of oxides of nitrogen above the limit values may have no effect on the vast majority of the population, elevated levels of pollutants in ambient air may be significant for these vulnerable groups within the population. This assessment has relied on compliance with the limit values in the CAFE Directive to determine likely significant effects on human health. Therefore, adherence to these limit values is considered to represent that there will be no adverse effect on human health due to air quality emissions as **Table 6.1** outlines that the levels set primarily for the protection of human health.

6.2.4.2 Noise and Vibration - Appropriate Standards

As set out in **Chapter 10** ***Noise and Vibration***, there is no specific legislation which sets out environmental noise limits that must be achieved. The noise assessment criteria are based on the Guidelines set out by regulatory bodies such as the EPA and the WHO.

Construction 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. Construction activities on larger-scale developments of this nature will inevitably result in noise being generated temporarily.

There is no Irish guidance specifically published for the short to medium-term construction work such as that required for the proposed development.

Operational Noise Criteria

In relation to human health specifically, for the operational phase the most applicable guidelines are those issued by the WHO. There are new Guidelines in relation to Environmental Noise issued in October 2018 (WHO, Environmental Noise Guidelines for the European Region, 2018). These deal with specific sources of noise such as Roads, Rail, Aircraft and Wind Turbines. They do not specifically deal with construction noise or industrial noise.

They supersede and supplement previous Guidelines issues by the WHO including the Community Noise Guidelines 1999 (WHO, WHO (1999) Guidelines for Community Noise, 1999) in relation to community effects of noise and subsequent guidance on Night Time noise in Europe 2009.

In their recent guidance (WHO, Environmental Noise Guidelines for the European Region, 2018), the WHO state that large proportions of the European population are exposed to noise levels in excess of 55dB L_{night}.

The WHO guidelines identify some health effects at quite low night time levels and proposed a population Guidance, for roads, of 45dB L_{night} outside residential properties.

6.3 Receiving Environment

This section describes the population of the receiving environment in the context of socio-economic indicators.

6.3.1 National Context

The Labour Force Survey (LFS) is the official source of data for employment and unemployment in Ireland, compiled by the Central Statistics Office. The CSO LFS Quarter 4 (Q4) of 2019, reported that employment totalled 2,361,200 and this showed an annual increase of 3.5% or 79,900 from Q4 2018. When adjusted for seasonal factors, employment increased by 1.3% or 30,500 between Q3 2019 and Q4 2019.

Long term unemployment, which refers to those persons unemployed for one year or more, accounted for 35.0% of total unemployment in Q4 2019.

In Q4 2019, the total number of persons in the labour force was up 2.6% or 61,600 to 2,471,700 from Q4 2018. The number of persons not in the labour force was 1,471,000 and that was up 0.3% or 4,000 from a year earlier.

6.3.2 Population

CSO data from 2011 and 2016 was used in assessing the number of households within the study area. The number of households in the Duleek ED increased from 1,732 in 2011 to 1,943 in 2016 (+12%).

The population of the Duleek ED has also increased from 5,177 in 2011 to 5,565 in 2016 (+7.5%). Information from the 2016 Census shows that the population in Meath has grown by 5.9% between 2011 and 2016 which is well above the National population increase of 3.6% over the same period, refer to **Table 6.2** below.

Table 6.2: Population change from 2011 to 2016. Source CSO.

Population Change 2011 - 2016			
	2011	2016	% Change 2011 - 2016
State	4,588,252	4,757,976	+3.6%
Meath County	184,135	195,044	+5.9%
Duleek ED	5,177	5,565	+7.5%

The age profile of Duleek ED shows the age group with the highest proportion are 0-19 years (35.4% or 1,972 No. persons), higher than both the State and Meath for the same age bracket. Compared to County Meath and the State the proportion of people aged 40-59 years (13.4%) and 60-70 years (6.4%) is much lower and approximately half of that for the State, refer to **Table 6.3**.

Table 6.3: Age profile for State, County Meath and Duleek Electoral Division recorded during the 2016 Census. Source CSO.

Area	**Age 0-19**	**Age 20-39**	**Age 40-59**	**Age 60-79**	**Age 80+**
State	27.50%	27.77%	26.33%	15.28%	3.12%
Meath County	31.7%	25.6%	27.5%	8.2%	2.2%
Duleek ED	35.4%	26.3%	13.4%	6.4%	5.2%

6.3.3 Employment

The 2016 Census data[5] shows that in Duleek ED, of those aged 15 years and over (1,959), 63.4% of the population are 'At work', while 7.7% of the population are 'Unemployed having lost or given up on previous job'. The occupations of the majority of the population at work or unemployed in the Duleek ED (1,394 No. persons) are "Skilled Trades Occupation" (337 No. persons) and "Process, Plant and Machine Operatives" (285 No. persons).

6.3.4 Principal Potential Receptors

As discussed previously, Indaver currently operates a Waste to Energy (WtE) facility (waste incinerator) at the site in Carranstown, Duleek, Co Meath. Refer to **Figures 1.1** to **1.3** of **Chapter 1** ***Introduction*** of this EIAR.

The existing facility has been in operation since August 2011 and is licensed under an Industrial Emissions Licence (No. W0167-03) by the Environmental Protection Agency (EPA).

[5] Central Statistics Office, Census 2016 Sapmap Area: Electoral Division Duleek. Available at: http://census.cso.ie/sapmap2016/Results.aspx?Geog_Type=ED3409&Geog_Code=2AE19629188213A3E055000000000001#SAPMAP_T13_1301

The facility is located 1.8km west of the M1, bound to the south by the R152 regional road and surrounded by greenfield on all other sides.

The principal potential receptors within the environs of the facility include residential homes and industrial premises. Irish Cement Platin is to the immediate north of the site and the rest of the surrounding land is used for industrial, agricultural and residential purposes. Residential development in Carranstown is predominantly ribbon development along the main road (R152). These vary from one off housing to garages and two-storey farmhouses with associated sheds. There are nine private residences located within 200m of the site boundary with one directly adjacent at the north eastern site boundary. The village of Duleek is located approximately 2.7km south west of the site. There are four primary schools located within the general area. These are listed in **Table 6.4**.

Table 6.4: Educational Facilities in the Area. Source MyPlan.ie

School Type	Name	Address	Approx. Distance from existing facility (km)
Primary	Scoil Colm Cille	Mt. Hanover, Duleek, Co. Meath	1
Primary	Donore Primary	Donore, Duleek, Co. Meath	2
Primary	Duleek Girls NS	Duleek, Co. Meath	2.5
Primary	Duleek Boys NS	Duleek, Co. Meath	2.5

6.3.5 Economic Activity

The existing Indaver facility employs a total of 60 No. employees at the plant.

In proximity to the facility, a number of small commercial/industrial units including a petrol station and forecourt shop have been constructed approximately halfway between the facility and Duleek village. Northwards along the R152 from the Indaver facility there are also commercial businesses mostly related to car sales, servicing and testing. There are a number of shops and businesses in the towns of Duleek and Donore with a medium sized commercial Business Park located on the outskirts of Duleek.

Irish Cement Ltd. operate a large quarrying and cement manufacturing facility to the north of the site in the townland of Platin. The plant is a major employer in the area. The Navan Drogheda railway line runs between the plant and the Indaver facility. The output capacity at the Platin facility is in the region of 2.8 million tonnes of cement annually.

A significant portion of the study area is farmland so a number of non-residential buildings outside of the towns are farm sheds and related agri-business. There are numerous small and large farms scattered across the study area.

6.3.6 Heritage and Amenity

Social and community facilities located in the study area include the local football club adjacent to Carranstown Lodge and Duleek pitch and putt course. Bellewstown Golf Club is located approximately 5km to the south-east of the site.

The area is classified under the Meath County Development Plan 2013 - 2019 as *'Rural and Agricultural'*. The closest *'Areas of Visual Quality'* to the facility are the Lower Boyne Valley located about 2km to the north and the River Valleys located about 2km to the south. The area immediately surrounding the facility is not a significant tourist attraction, however Duleek is identified as a settlement with potential to be a tourist base and is considered a secondary tourist attraction in the County Development Plan. The village of Duleek attracts tourists related to River Boyne fishing holidays and the town has heritage connections to the historic Battle of the Boyne.

Duleek is located within *Central Lowlands Landscape Character Area* which is identified by the Meath County Development Plan 2013 - 2019 as being of regional importance, of high landscape value, and as having medium landscape sensitivity. Refer to **Chapter 13** ***Landscape and Visual*** for further details on landscape character. The core area of Duleek town is designated as an Area of Archaeological Interest. The Duleek Heritage Trail has been established because of the high-quality built heritage and historic buildings within Duleek and includes monastic facilities and facilities linked to the Battle of the Boyne.

The village has a number of religious crosses, churches and Abbeys as well as the oldest lime tree in Ireland, historically linked to the Battle of the Boyne.

Further detail on the local cultural heritage, including heritage structures/amenities and natural heritage and visual aspects is presented in **Chapter 12** ***Archaeology, Architectural and Cultural Heritage*** and **Chapter 11** ***Biodiversity*** and **Chapter 13** ***Landscape and Visual*** respectively**.**

6.4 Characteristics of the Proposed Development

6.4.1 Construction Phase

The proposed construction phase is described in detail in **Chapter 5** ***Construction Activities***. Population aspects of relevance to the construction phase of the proposed development include economic and employment opportunities, construction traffic generation, and the potential for nuisances associated with the construction works such as noise and dust emissions.

As described in **Chapter 5**, the proposed development is to be constructed in two phases, with phase one expected to take approximately 16 months to construct and phase two expected to take a further 12 months.

It is envisaged that the peak number of construction personnel on site for phase one will be 120 and during phase two construction personnel are expected to peak at 100 people.

The construction of the proposed development will involve significant capital investment by Indaver. There will also be associated off-site secondary employment and economic activity associated with the supply and fabrication of construction materials and services to the site.

The movement of construction staff to and from the site has the potential to generate additional traffic on local roads in the short-term. The characteristics of the proposed development with regards to traffic has been assessed and is described in further detail in **Chapter 7** ***Traffic and Transportation***.

General construction activities including excavation, pilling, as well as the movement of construction vehicles to and from the site, have the potential to give rise to atmospheric emissions, and to generate noise and vibration during the construction phase. The characteristics of the proposed development with regards to air quality and climate, and noise and vibration are assessed and described in further detail in **Chapter 8** ***Air Quality*** and **Chapter 10** ***Noise and Vibration***, respectively.

6.4.2 Operational phase

The proposed development is described in detail in **Chapter 4** ***Description of the Proposed Development***.

The proposed development does not propose any significant changes to the waste to energy (WtE) operating processes at the facility. Although additional tonnage (15,000 tpa) is proposed to be processed at the plant, this is primarily for the treatment of aqueous wastes.

The ongoing operations at the facility will be carried out in compliance with Indaver's IE Licence (W0167-03) issued by the EPA and any additional waste accepted, stored or processed on the site will be done so in accordance with the emission and operational limit requirements set out in this licence and any future required amendments. IE Licence operational limits will also continue to apply to noise emissions from the site.

Population aspects of relevance to the proposed development include economic and employment opportunities, journey patterns, potential for atmospheric emissions, and risk of major accidents and disaster.

The development will take place within the site boundary of the existing Indaver facility and there will be no additional land-use changes outside of this area. The proposed tank farm and ancillary works will serve to improve the efficiency of activities at the facility and provide additional sustainable recovery solutions to the Irish waste market. The hydrogen generation unit (HGU) will utilise energy generated on site which would have otherwise gone to waste.

The hydrogen generated can then be either fed into the natural gas grid or stored on site for fuelling trucks, buses and other vehicles that have been either designed or retrofitted to run on hydrogen fuel cells

6.5 Literature Review

6.5.1 Introduction and Methodology

6.5.1.1 Overview

A literature review was performed to identify potential significant effects on human health.

Whilst there are a number of elements to the proposed development, most of these are inherently unlikely to have significant human health effects. For example, a storage area for bottom ash is proposed but this is for bottom ash which is already produced on site as part of the existing process and will provide the flexibility to export bottom ash to continental Europe for recovery in the event that there are no bottom ash recycling plants developed in the next five to ten years, as described in **Section 4.5.5** of **Chapter 4** and **Section 16.5.3.10** of **Chapter 16**, ***Material Assets***.

To identify potential significant effects on human health, a literature review was conducted. This is not a new facility and the changes in air emissions are minimal and will be related to increase in traffic rather than from the existing facility, therefore a full literature review is unnecessary but has been performed for completeness and it addresses the waste to energy aspects of the proposal regarding human health.

6.5.1.2 Waste to Energy Studies

The introduction of waste incinerators has resulted in numerous studies of the effects of this process on human health.

These have been carried out in either the occupational or community setting. Most of the published studies have looked at incinerators whose emissions of dioxins, particulates and heavy metal were far greater than would be emitted by a modern incinerator such as that operating at Carranstown. Basic scientific principles indicate that the more controlled the emissions are, the lower the level of toxins which are emitted, the less potential for any health effects.

Therefore, the studies that are available, which will be discussed in more detail in the following literature review section, in many ways show a “worse than worst” case scenario for modern incinerators. They can nevertheless be valuable in making an assessment of the possible human health effects whereby if there is little discernible effect with poor controls, we can therefore be scientifically certain there will be still fewer effects with greater controls.

The health outcomes that have been examined in the various published studies include respiratory symptoms and illness, reproductive effects and the development of cancer.

In addition to studies of the possible consequences of non-specific exposure to emissions from waste incinerators, research has also been conducted to determine the presence or effects of exposure to certain substances known to be present in

incinerator emissions. In recent years, more attention has also been given to particulate matter such as PM_{10} and $PM_{2.5}$.

6.5.1.3 Review Methodology

A PubMed electronic search was performed on the 4th April 2020 using the key word "incineration" to identify further studies and any more recently published studies. A total of 6,299 articles were identified. When the search was narrowed using the two words "incineration health", 1,352 articles were identified. This could be further reduced if the terms were "waste incineration health" which identified 966 articles. These are all of varying age and relevance.

Using other terms such as incinerator tended to narrow the search further but perhaps might omit relevant articles. A Google search on the same day revealed over 20 million hits for the term "incineration". Even narrowing this by using "waste incineration health" nearly 6,000,000 were found but of course the tool used by the Medical profession is normally PubMed.

It is possible to refine searches in PubMed using a "review" filter and when this was done with the terms "waste incineration health" there were a total of 99 articles. This identifies the articles published in peer reviewed medical journals which attempted to review the available scientific information from other publications.

6.5.2 Literature Review Results

6.5.2.1 HRB report and DEFRA report

Previously, reliance has been on the publication from 2003 by the Health Research Board on *Health and Environmental Effects of Landfilling and Incineration of Waste* and the publication *A review of the environmental and Health effects of Waste Management* was published in May 2004 by the UK Department of the Environment, Food and Rural Affairs (DEFRA).

Both of these publications are now somewhat dated. The studies quoted were largely related to older generation incinerators and prior to EU Directives which set limits on emissions but can be assessed in addition to more recent publications.

The Health Research Board (HRB) report was commissioned in 2003 to review existing data on waste management methods at that time. It presented the available data at that time. In general, it did not make recommendations on the best solutions and in some ways, this is disappointing but that was not its remit. Regarding the human health effects of incineration, it stated:

"*There is some evidence that incinerator emissions may be associated with respiratory morbidity. Acute and chronic respiratory symptoms are associated with incinerator emissions.*

A number of well-designed studies have reported associations between developing certain cancers and living close to incinerator sites. Specific cancers identified include primary liver cancer, laryngeal cancer, soft-tissue sarcoma and lung

cancer. It is hard to separate the influences of other sources of pollutants, and other causes of cancer and, as a result, the evidence for a link between cancer and proximity to an incinerator is not conclusive.

Further research, using reliable estimates of exposure, over long periods of time, is required to determine whether living near landfill sites or incinerators increases the risk of developing cancer.

Studies of specific environmental agents and specific cancers may prove more definitive in the future."

The current status of this statement and its implications for facilities such as Carranstown will be explored in more detail in this assessment.

The DEFRA report (2004) although covering many of the same studies went further in terms of scientific interpretation and in those terms was probably more helpful in an assessment of the risks or otherwise associated with a technology such as incineration. For example, it stated:

"We looked in detail at studies of incineration facilities and found no consistent or convincing evidence of a link between cancer and incineration. There is little evidence that emissions from incinerators make respiratory problems worse. In most cases the incinerator contributes only a small proportion to local levels of pollutants."

Since the DEFRA report, several important reviews were made. Some of the more important are summarised below.

6.5.2.2 WHO Workshop

The World Health Organisation (WHO) published *Population health and waste management*: *scientific data* and *policy options*. *Report of a WHO workshop*. *Rome, Italy*, in March 2007. Published 2008.

It states:

"Evidence is inadequate to draw conclusions that can be used to determine optimal policy choice on incineration: relatively few good quality studies exist, and they refer to old generation incineration plants-an important distinction, as stack emissions from modern plants are much reduced compared to old generation plants. The adoption of emission abating technology enforced by European Union EU has resulted in a less likely occurrence of measurable health effects on populations resident in the proximity of newer generation incinerators."

And

"Studies pointing to an increase in soft tissue sarcomas (STS) and non-Hodgkin's lymphomas (NHL) support a possible aetiological role of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8 T4CDD). The evidence is inadequate to draw conclusions that can be used to determine optimal policy choices on incineration: relatively few good quality studies exist, and they refer mostly to old generation incineration plants – an important distinction, as stack emissions from modern

plants are much reduced compared to old generation plants. The adoption of emission-abating technology, enforced by the European Union (EU), has resulted in a less likely occurrence of measurable health effects on populations resident in the proximity of new generation incinerators."

6.5.2.3 Porta Review 2009

The Porta review[6] (2009) is a '*Systematic review of epidemiological studies on health effects associated with management of municipal solid waste'*, concentrated on municipal solid wastes (MSW) sites but did include other studies as well. It reported:

"In most cases the overall evidence was inadequate to establish a relationship between a specific waste process and health effects; the evidence from occupational studies was not sufficient to make an overall assessment. For community studies, at least for some processes, there was limited evidence of a causal relationship and a few studies were selected for a quantitative evaluation. In particular, for populations living within two kilometres of landfills there was limited evidence of congenital anomalies and low birth weight with excess risk of 2 percent and 6 percent, respectively. The excess risk tended to be higher when sites dealing with toxic wastes were considered. For populations living within three kilometres of old incinerators, there was limited evidence of an increased risk of cancer, with an estimated excess risk of 3.5 percent. The confidence in the evaluation and in the estimated excess risk tended to be higher for specific cancer forms such as non-Hodgkin's lymphoma and soft tissue sarcoma than for other cancers".

This is broadly in line with previous reviews. Of course, the most important point is that these findings relate to "old" incinerators, 20 years or older. As pointed out in this EIAR, and indeed in the WHO review quoted above, the existing licensed facility already complies with the strictest EU emission standards and the proposed development will also have to comply with the strictest EU emission standards and therefore cannot be compared to the older generation studied.

6.5.2.4 Giusti Review 2009

Giusti et al.[7] (2009) concluded:
"The main conclusion of the overall assessment of the literature is that the evidence of adverse health outcomes for the general population living near landfill sites, incinerators, composting facilities and nuclear installations is usually insufficient and inconclusive."

[6] Porta, D., Milani, S., Lazzarino, A.I., Peruci, C.A., Forastiere, F. (2009) Systematic review of epidemiological studies on health effects associated with management of solid waste. Environmental Health, 8:60

[7] Giusti, L., 2009 A review of waste management practices and their impact on human health, Waste Management, 29(8):2227-39.

6.5.2.5 Forastiere 2011

Forastiere et al.[8] (2011) performed a Health Impact Assessment of the effects of waste management including incineration in three countries, England, Italy and Slovakia. It is somewhat historical as it looked incinerators operating in 2001. It made some assumptions based on populations living within 3 km of incinerators based on assumed increases in environmental levels of particulate matter and NO_2 which do not occur around modern incinerators. Nevertheless, their conclusions were:

"Past exposures from incinerators were likely to cause a sizeable health impact, especially for cancer, in Italy and England. However, the current impacts of landfilling and incineration can be characterized as moderate when compared to other sources of environmental pollution, e.g. traffic or industrial emissions, which have an importance on public health".

6.5.2.6 Mattiello 2013

The Mattiello[9] *et al*. (2013) review concluded:

"It is confirmed that historically incinerators are an important source of pollution and harm for the health of populations living nearby; however, changes in technology are producing more reassuring results".

6.5.2.7 Sharma 2013

One review which is out of step with the others is an Indian article published in 2013 by Sharma[10]. This concentrated on potential options for dealing with health care waste. It stated:

"Incinerators releases a wide variety of pollutants depending on the composition of the waste, which leads to health deterioration and environmental degradation. The significant pollutants emitted are particulate matter, metals, acid gases, oxides of nitrogen, and sulphur, aside from the release of innumerable substances of unknown toxicity. This process of waste incineration poses a significant threat to public health and the environment. The major impact on health is the higher incidence of cancer and respiratory symptoms; other potential effects are congenital abnormalities, hormonal defects, and increase in sex ratio. The effect on the environmental is in the form of global warming, acidification, photochemical ozone or smog formation, eutrophication, and human and animal toxicity".

It suggested greater use of autoclaves and plasma pyrolysis being a solution for the biological hazards of health care waste. This is simply not consistent with the

[8] Forastiere (2011) Health Impact Assessment of Waste Management in three Countries, Environmental Health, 10:53.
[9] Mattiello (2013) Health effects associated with the disposal of solid waste in landfills and incinerators in populations living in surrounding areas: a systematic review, International Journal of Public Health, 58(5):725-35.
[10] Sharma (2013) *The impact of incinerators on human health and environment,* Reviews on Environmental Health, 28(1):67-72.

vast majority of published reviews so should be treated with great caution but also as the emphasis of the review was on health care waste, it is much less relevant in the context of the proposed development.

6.5.2.8 De Titto 2019

The article by De Titti and Savino[11] (2019), presents a mini review of the published research focused on understanding environmental and human health impacts nearby waste incineration plants. It is the most recently published of the reviews but broadly shares the conclusions of the others:

"*We found no studies indicating that modern technology waste incineration plants, which comply with the legislation on emissions, are a cancer risk factor or have adverse effects on reproduction or development.*

There are several factors in favour of this affirmation: (a) the emission levels of the plants currently built in the developed countries are several orders of magnitude lower than those of the plants in whose environments epidemiological studies have been carried out and which have found some kind of negative association in terms of health; (b) risk assessment studies indicate that most of the exposure is produced through the diet and not by a direct route; and (c) monitoring dioxin level studies in the population resident in the environment of incineration plants did not reveal increases of these levels when compared with a population living in reference areas."

6.5.2.9 Public Health England

Public Health England is a governmental body in the UK charged with analysing information and making recommendations on issues that may pertain to human health in England. Public Health England made a noteworthy statement in 2015 when Dr Simon Bouffler deputy director of PHE's Centre for Radiation, Chemical and Environmental Hazards stated (Bouffler, 2015):

"that well run and regulated modern municipal waste incinerators are not a significant risk to public health remains valid, and the study is being carried out to extend the evidence base and to provide further information to the public on this subject".

Font et al. in Atmospheric Environment in a separate article published in July 2015[12] stated:

"From our analysis we found no evidence of incinerator emissions in ambient metal concentrations around four UK MWIs [municipal waste incinerators]. The

[11] de Titto E[1], Savino A[2]. (2019) *Environmental and health risks related to waste incineration.* Waste Manag. Res. 2019 Oct; 37(10):976-986. doi: 10.1177/0734242X19859700. Epub 2019 Jul 18.

[12] Font, A., de Hoogh, K., Leal-Sanchez, M., Ashworth, D.C., Brown, R.J.C., Hansell, A.L., Fuller, G.W. (2015) Using metal ratios to detect emissions from municipal waste incinerators in ambient air pollution data. Atmospheric Environment, 113: 177-186

six UK MWIs studied contributed little to ambient PM10 [particulate matter] concentrations"'.

Public Health England funded a study into the health effects of emissions from energy-from-waste plants and was carried out by the Small Area Health Statistics Unit (SAHSU) at Imperial College and the Environmental Research Group at King's College London, looking at data gathered between 2003 and 2010 The paper by Douglas et al.[13] stated that that incinerators emit a 'low level' of air pollutants. Details of the study were published in the Environmental Science & Technology Journal in 2017. *Environ. Sci. Technol.* 2017, 51, 13, 7511-7519.

It stated:

"Overall this study suggests that PM10 exposures related to MWI emissions in Great Britain are extremely low (annual means ranging from 1.00 × 10–5 to 5.53 × 10–2 μg m–3) especially when compared to annual mean background concentrations (typically ranging between 2.00 × 101 and 5.00 × 101 μg m–3 in Europe)".

6.5.2.10 Health Protection Agency UK 2010

The Health Protection Agency (HPA, 2010) is another UK Governmental agency who are responsible for making recommendation on the protection of health.

They issued a report in 2010. They said:

"While it is not possible to rule out adverse health effects from modern well regulated incinerators with complete certainty, any potential damage to health of those living close by is very small if detectable".

It goes on:

"Since any possible health effects are very small, if detectable, studies of Public Health around modern well managed municipal waste incinerators are not recommended".

This latter point is important as an agency as when a reputable and independent as the Health Protection Agency says this it is very reassuring. As already stated, these studies have proceeded anyway to give further evidence again.

6.5.2.11 SAHSU 2018

The UK Small Area Health Statistics Unit (SAHSU) study (Ghosh, 2018)[14] has been published. This was funded by Public Health England amongst others was

[13] Douglas, P., Freni-Sterrantino, A., Leal Sanchez, M., Ashworth, A.C., Ghosh, R.E., Fecht, D., Font, A., Blangiardo, M., Gulliver, J., Toledano, M.B., Elliott, P., de Hoogh, K., Fuller, G.W., Hansell, A. (2017) Estimating particulate exposure from modern municipal waste incinerators in Great Britain. Environmental Science and Technology, 51, 13:7511-7519

[14] Ghosh. (2018). Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators; retrospective population based cohort and case-control study. Environment International, https://doi.org/10.1016/j.envint.2018.10.060

one of the largest studies ever published. Of importance is that it studied incinerators operating under modern limits. It was titled *"Fetal growth, stillbirth, infant mortality and other birth outcomes near UK municipal waste incinerators* [MWI]*; retrospective population-based cohort and case-control study".*

Indeed, interestingly in the now normal conflict of interest statements, one of the 14 authors declared Greenpeace membership and another Friends of the Earth membership. This most robust study was therefore entirely independent from the incineration industry. The study was large enough to be able to detect even small changes if such existed.

The result of the study was:

"Analyses included 1,025,064 births and 18,694 infant deaths. There was no excess risk in relation to any of the outcomes investigated during pregnancy or early life of either mean modelled MWI PM10 or proximity to an MWI".

The conclusion was:

"This large national study found no evidence for increased risk of a range of birth outcomes, including birth weight, preterm delivery and infant mortality, in relation to either MWI emissions or living near an MWI operating to the current EU waste incinerator regulations in Great Britain. The study should be generalisable to other MWIs operating to similar regulations and with similar waste streams."

While one might say that this may have been expected given the other studies above, it is the first study that one might say extends to the level of proof that there are no adverse health effects with a modern incinerator.

6.5.3 European Council Directives

The Waste Incineration Directive (WID) introduced in 2000 set stringent operating conditions and sets minimum technical requirements for waste incineration and co-incineration. It consolidated new and existing incineration controls into a single piece of European legislation.

The requirements of the Directive were developed to reflect the ability of incineration plants to more cost effectively achieve high standards of emission control in comparison to the 1980s. Previous waste incineration directives only applied to municipal and hazardous waste. WID updated the requirements of the 1989 municipal waste incineration (MWI) directives (89/429/EEC and 89/369/EEC) and, merged them into the 1994 Hazardous Waste Incineration Directive (94/67/EC), consolidated new and existing incineration controls into a single piece of European legislation (2000/76/EC).

This has now been superseded by the Industrial Emissions (IE) Directive. The Directive specifies air emission limits which must not be exceeded. The basis of the emission limits is to prevent, or limit as far as is practicable, negative effects on the environment and the resulting risks to human health. The proposed development will have to continue to abide by the strictest of criteria under the IE licence (W0167-03) issued by the EPA.

6.5.4 Dioxins

Dioxins and furans will form spontaneously in a combustion process from chlorine atoms, carbon that has not been fully oxidised, and various catalysts in cooling smoke; hence, the process is the same for waste incineration plants, turf fires and tiled stoves alike. Each of the 200 dioxin and furan compounds is of a different degree of toxicity; for that reason, their so-called toxicity units (TUs) are determined and summarized into units of grams per toxicity unit (g TU).

Indeed, the public concern on dioxins was so significant that the Food Safety Authority of Ireland (FSAI) published a report in 2003 (FSAI, 2003) on the potential effect on food if waste incineration of municipal waste was introduced into Ireland. They stated:

" *In relation to the introduction of waste incineration in Ireland, as part of a national waste management strategy, the FSAI considers that such incineration facilities, if properly managed, will not contribute to dioxin levels in the food supply to any significant extent and will not affect food quality or safety*".

The WHO issued a fact sheet on dioxins No. 255 which was updated in October 2016 (WHO, Dioxins and their effects on human health, WHO Fact sheet N°225 , 2016).

This stated:

"Proper incineration of contaminated material is the best available method of preventing and controlling exposure to dioxins. It can also destroy PCB-based waste oils. The incineration process requires high temperatures, over 850°C. For the destruction of large amounts of contaminated material, even higher temperatures - 1000°C or more - are required".

Regarding effects on human health it commented:

"*Short-term exposure of humans to high levels of dioxins may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions.*

Chronic exposure of animals to dioxins has resulted in several types of cancer. TCDD was evaluated by the WHO's International Agency for Research on Cancer (IARC) in 1997 and 2012. Based on animal data and on human epidemiology data, TCDD was classified by IARC as a "known human carcinogen". However, TCDD does not affect genetic material and there is a level of exposure below which cancer risk would be negligible".

"Due to the omnipresence of dioxins, all people have background exposure and a certain level of dioxins in the body, leading to the so-called body burden. Current normal background exposure is not expected to affect human health on average. However, due to the high toxic potential of this class of compounds, efforts need to be undertaken to reduce current background exposure".

Much of the attention in debates in the past about the human health effects of incinerators has concentrated on dioxins and furans.

The dioxin emissions from modern incinerators are up to 1,000 times less than 20 years ago. This can be seen from the situation in Germany, one of the countries in Europe that has studied this area most closely and one where environmental concerns are taken very seriously. Whereas in 1990 one third of all dioxin emissions in Germany came from waste incineration plants, for the year 2000, the figure was less than 1%. It is estimated that in Germany now for example that chimneys and tiled stoves in private households alone discharge approximately twenty times more dioxins into the environment than all the waste incineration plants together (UN, 1999). This is also evident from the fact that in winter airborne dioxin loads are up to five times higher than in summer when heating systems are out of operation, but the incineration plants are still operating.

Most dioxins we are exposed to are in our diet. The major sources are dairy products, as well as some other foods. One however rarely sees this fact highlighted in the press except perhaps after occasional “scares” such as the 2008 Italian one when high levels of Dioxins were found in some agricultural products around Naples. Interesting this was attributed to illegal landfills not incineration.

In addition, there was in 2008 a recall of Irish pork products in relation to elevated dioxins. This was detected through routine monitoring of food. This was traced to contaminated feed which in turn traced back to contaminated oil. There was no evidence of a public health issue.

Because the food we eat is increasingly not from the immediate vicinity in which we live but rather from the broader national and international sources the effect of any source may be dispersed far and wide but equally we may be more vulnerable to high levels coming from all parts of the world rather than our own “back-yard”.

6.5.5 Heavy Metals

Heavy metals, such as lead and mercury, are retained in the filtering devices of waste incineration plants. They are not regarded as carcinogens. Whether or not they are poisonous for human beings will depend on whether they reach their thresholds of effectiveness. In effect, for these to have a human health effect, they must leave the incinerator in the form of emissions and enter the human body either by inhalation or ingestion and theoretically, but rarely in practice, through the skin.

For these substances, too, there has been an impressive decline in emissions from modern incinerators compared with historical measures. Improved controls and reduction in amounts in wastes presenting for treatment explains the marked reduction experience in their emissions.

For example whereas in 1990, emissions in Germany amounted to as much as 57,900 kilograms (kg) of lead and 347 kg of mercury from the incineration of household waste, the respective levels declined to 130.5 kg (equivalent to 0.2% of initial emissions) and 4.5 kg (1.3% of initial emissions) in the year 2001[15]. Thus, lead and mercury emissions from the incineration of household waste are also no longer significant for human exposure to emissions of toxic substances.

[15] http://www.seas.columbia.edu/earth/wtert/sofos/Waste_Incineration_A_Potential_Danger.pdf

6.5.6 Specific Health Issues

6.5.6.1 Respiratory symptoms and illness

Some older studies, described in the 2003 Health Research Board (HRB) report did show that symptoms of respiratory illness, such as chronic cough, wheeze and sinus trouble, were significantly greater in those living near a hazardous waste incinerator than in their control community. It should be noted that these studies predated much stricter environmental controls on the emissions of particulates to which the Indaver facility does and will continue to operate within.

Studies of self-reported symptoms must always be treated with caution as they can be more revealing about peoples' concerns rather than actual health effects. Again, while there have been some of these in the past none were without issues.

As any respiratory symptom that might occur must in turn be related to increase in some airborne contaminant, be it particulate matter or products of combustion such as Sulphur Dioxide or Nitrogen Dioxide. It follows that with the vast reduction of the emission of these in newer incinerators, to levels where there is little or no change in the baseline conditions, these effects will not occur.

In effect the emissions from modern incinerators will not cause coughs or respiratory symptoms.

6.5.6.2 Reproductive effects

Very often when one discusses incineration, concerns are expressed about potential reproductive effects. It is true that in the 1980s studies quoted in the HRB report, there were reported to be an increase in the frequency of twinning in human and cattle populations in an area in central Scotland at increased risk from incinerator emissions.

These findings have not been replicated.

The HRB report also mentions a study of open chemical combustion in the Netherlands in the 1960's was carried out to investigate the incidence of orofacial clefts in the region and to determine any association with the local combustion facility. The authors concluded that these results inferred an association between the incinerator and the increased local incidence of orofacial clefts. Although this increase was probably a true finding, the possibility of other influencing factors, such as alternative sources of exposure, could not be ruled out.

This study is of open chemical burning and bears no relation to modern incineration and so is of no relevance to the existing facility or the proposed development, but again is described here as it is often quoted by persons opposing incineration per se.

A review performed by Ashworth et al (Ashworth, 2014) entitled *Waste incineration and adverse birth and neonatal outcomes: a systematic review* was published in 2014 and is probably the most authoritative ever published.

This concluded:

"*that a comprehensive literature search yielded fourteen studies, encompassing a range of outcomes (including congenital anomalies, birth weight, twinning, stillbirths, sex ratio and infant death), exposure assessment methods and study designs. For congenital anomalies most studies reported no association with proximity to or emissions from waste incinerators and "all anomalies", but weak associations for neural tube and heart defects and stronger associations with facial clefts and urinary tract defects. There is limited evidence for an association between incineration and twinning and no evidence of an association with birth weight, stillbirths or sex ratio, but this may reflect the sparsity of studies exploring these outcomes".*

It went on:

"The current evidence-base is inconclusive and often limited by problems of exposure assessment, possible residual confounding, lack of statistical power with variability in study design and outcomes. However, we identified a number of higher quality studies reporting significant positive relationships with broad groups of congenital anomalies, warranting further investigation.

Future studies should address the identified limitations in order to help improve our understanding of any potential adverse birth outcomes associated with incineration, particularly focussing on broad groups of anomalies, to inform risk assessment and waste policy."

The recently published SASHU study (Ghosh, 2018) confirms no adverse effects with modern incinerators. This studied over 1 million births so is an extremely robust study.

6.5.6.3 Cancer

It is fair to say some studies have reported putative links between incinerators and cancers. However not one of these studies was without problems. In the past incinerators were often sited in urban, industrial and otherwise polluted areas. This introduced major confounders for studying cancers such as deprived populations, urban living, other sources of industrial pollutions, cigarette smoking habits etc.

It is also true that other studies did not support such a link.

The largest study by Elliot (Elliot, 1996) in 1996 examined 72 incinerators. This included essentially all incineration plants, irrespective of age, up to 1987. This was by far the largest and statistically probably the best study ever conducted.

It studied a total of 14 million people. It nevertheless was unable to convincingly demonstrate an excess of cancers in areas within 7.5 km of incinerators once socio-economic confounding was taken into account.

There were reported individual increases for stomach, lung, colorectal and primary liver cancers. This however was thought to be largely due to residual confounding by socio-economic factors. Liver cancer, for example, was the most strongly significant (37% excess risk within 1 km of municipal waste incinerators) but, on review of cancer registration data, this cancer category was reported to be

frequently misclassified or misdiagnosed (mainly secondary liver tumours). In a follow up study to investigate the validity of these liver cancer diagnoses, Elliot et al. (2000) attempted to determine the size of any true excess in the vicinity of municipal waste incinerators. In a sample of cases subjected to histological and medical record reviews, only about half were reported to be true primary liver cancer. This resulted in a re-estimation and significant reduction of the calculated excess risk previously reported.

The strong association between deprivation and primary liver cancer was thought to remain an influence on the residual result.

Nevertheless, the overall finding from this very large study was of no increase in cancers in those living close to incinerators.

As a result of this study but also taking into account studies previously published, the UK Department of Health's Committee on Carcinogenicity (COC) published a statement in March 2000 (COC, 2000), evaluating the evidence linking cancer with proximity to municipal solid waste incinerators in the UK.

The Committee specifically examined the results of these studies, and concluded that,

"*Any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques".*[23]

The Committee agreed that the observed excess of all cancers, stomach, lung and colorectal cancers was due to socio-economic confounding and was not associated with emissions from incinerators. The Committee agreed that, at that time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators.

Indeed, the DEFRA report published in 2004 and referred to in the introduction of the Literature Review concluded:

"We looked in detail at studies of incineration facilities and found no consistent or convincing evidence of a link between cancer and incineration. There is little evidence that emissions from incinerators make respiratory problems worse. In most cases the incinerator contributes only a small proportion to local levels of pollutants."

This absence of a measurable effect was evident even with older and undoubtedly dirtier incinerators.

When this is true, we can be as scientifically certain as we can be that there can be no effect with lower emissions from modern facilities regulated to the highest standards.

6.5.7 Repeatedly Quoted Papers

British Society of Ecological Medicine (2006) The health effects of waste incinerators.

This document was published by the British Society of Ecological Medicine (BSEM) in February 2006. This "Society" appear to have little academic standing and we are addressing the report here not because of scientific merit but rather the fact that it has been submitted by objectors in previous applications by Indaver.

Enviros, now known as SKM Enviros, was the company commissioned by the UK government to produce a literature review on health effects of waste management in 2004 commented on the BSEM report. The Enviros report, '*Evaluation of the 4th Report of the British Society for Ecological Medicine: "The Health Effects of Waste Incinerators"*' was published in 2006 and makes the following points about the BSEM report (2006):

"The study makes the common mistake of identifying incinerators as a significant source of emissions of fine particulate matter, dioxins and furans, volatile organic compounds and metals. In fact, incinerators do not make a significant contribution to emissions of these substances. This means that, while the report may make valid comments about the risks to health associated with exposure to these substances, the conclusion should be to consider what needs to be done to deal with the main sources of these emissions.
For example, emissions of PM_{10} from MSW incineration are approximately 100 tonnes per year, compared to 22,000 tonnes per year from electricity generation. Emissions of finer particles (e.g. $PM_{2.5}$ and PM_1) and secondary particles would be expected to be in a similar proportion. If it is right to be concerned about fine particulate matter, then attention needs to be paid to controlling emissions from electricity generation, road transport, agriculture and domestic sources. No discernible benefit would be gained by any policy change relating to waste incineration, because the source is simply too small to be significant."

It concluded:

"The report falls down badly in its understanding of incineration processes. It fails to consider the significance of incineration as a source of the substances of concern. It does not consider the possible significance of the dose of pollutants that could result from incinerators. It does not fairly consider the adverse effects that could be associated with alternatives to incineration. It relies on inaccurate and outdated material. In view of these shortcomings, the report's conclusions with regard to the health effects of incineration are not reliable."

The Health Protection Agency in the UK also reviewed the report and stated:

"*The BSEM report is not a systematic review of the literature and there is no critical analysis of the quality of the included studies. Consequently, the report presents a selective and inaccurate review of the scientific literature. For example the report has not considered important reviews such as the Defra review of environmental and health effects of waste management, the Committee on Carcinogenicity (COC) statement on cancer incidence near municipal solid waste incinerators in Great Britain or the Royal Society critique of the Defra review. In*

addition, several statements regarding health risks are not supported by appropriate scientific references, for example '…increased ischaemic heart disease has been reported in incinerator workers' is taken from a study regarding cement kilns 'They are therefore capable of extremely serious health consequences'.
The authors have also failed to acknowledge the impact of the current legislative changes which minimises the potential for public exposure to emissions. The Waste Incineration Directive for example has strengthened the regulatory regime and provides for strict operating robust monitoring programmes.

There are misleading statements on health issues such as carcinogenicity and it misinterprets the 'precautionary principle'. The precautionary principle should be invoked if there is good reason to believe that harmful effects may occur and the level of scientific uncertainty regarding the consequences or likelihood of the risk is such, that the best available scientific methods to assess the risk with sufficient confidence is not complete, to inform decision making.

As there is a body of evidence strongly indicating that contemporary waste management practices of modern incinerators have at most, a minor effect on human health and the environment, there are no reasons for adopting the 'precautionary principle' to restrict the introduction of new incinerators".

Again, this has been referred to in the above "report" and also by opponents to previous Indaver applications. Again, the Enviros response (2006) is quoted below which adequately deals with this area.

"The BSEM Enviros Response states that "… incinerators will create vast amounts of dioxins, particularly in the ash for periods of 20-30 years…" An incinerator accepting 100,000 tonnes of waste per year over 25 years will result in the production of approximately 25 grams of dioxins and furans in solid residues and approximately 1 gram in emissions to air (expressed as toxic equivalent). For context, sources such as accidental fires, agricultural waste burning, industrial combustion and small-scale waste burning (e.g. on building sites) all give rise to a thousand times more emissions to air.

Information on emissions in residues is harder to obtain, but landfill of household waste results in the production of more than one hundred times as much dioxin as would be contained in the ash from an incinerator. What can we conclude from this? The BSEM concludes that emissions at this level would constitute "tearing up" the Stockholm treaty. A more appropriate conclusion is that the UK should fulfil its responsibilities under the Stockholm treaty by dealing with sources such as those listed above. Enviros is working with the UK Government in this area.

Preventing further development of waste incineration on these grounds risks diverting attention from much more important sources of unintentional persistent organic pollutants and will make no detectable or significant difference to the unintentional production of dioxins and furans."

The same comments are equally applicable to Ireland.

6.6 Likely Significant Effects

6.6.1 Do Nothing Scenario

The "Do Nothing" scenario will involve the facility operating as it currently does without construction related impacts such as noise or dust emissions and additional traffic related emissions. Under this scenario, ambient air quality at the site will remain as per the baseline and will change in accordance with trends within the wider area (including influences from potential new developments in the surrounding area, changes in road traffic, etc).

In the absence of the proposed development, the existing Indaver facility would operate as it does currently without the additional capacity for additional waste including hazardous aqueous waste from industry, pre-treatment of third-party boiler ash and flue gas cleaning residues and the new hydrogen generation unit.

Under the 'do-nothing' scenario, no additional employment opportunities would be generated, and no subsequent economic benefits would be gained locally, regionally or nationally.

Should the proposed development not proceed, there would be no change in existing traffic movements or journey patterns and the risk of major accidents or disasters occurring on site would remain to be determined based on existing facility operations.

6.6.2 Construction Phase

6.6.2.1 Population

The construction of the proposed development will have a direct effect on population in terms of employment opportunities. As described in **Section 6.4.1.1**, the construction phase will provide additional employment opportunities with up to 120 construction workers on site during the peak.

There will be secondary economic benefit associated with the supply and fabrication of construction materials and services to the site.

Potential indirect effects will be associated with potential temporary disruption to nearby residents and road users; potential indirect effects from air quality due to localised dust generation; and noise from construction activities for example truck movements, excavations and piling.

No local amenities will be significantly affected by the proposed development during construction. The site is removed from the Duleek village where most local amenities are centred.

As discussed in **Section 7.9.2** of **Chapter 7** ***Traffic & Transportation***, any additional traffic associated with construction traffic will not have a residual effect as a robust Construction Traffic Management Plan (see Section 9 of the ***Construction Environmental Management Plan*** in **Appendix 5.1** of **Volume 3**

in this EIAR) will be put in place for the duration of the works. Therefore, local residents are unlikely to be significantly disrupted regarding traffic.

6.6.2.2 Human Health

The greatest potential for effects on human health during the construction phase of the proposed development is from construction noise and the potential for nuisance dust. These potential effects are outlined in detail in **Chapter 8** ***Air Quality*** and **Chapter 10** ***Noise***. Dust minimisation measures will be implemented for the duration of the construction works to ensure any effects on air quality will not be significant and short-term in duration, as described in **Section 8.8.1** of **Chapter 8**. As described in **Section 10.8.2** of **Chapter 10**, the residual effect of noise will be intermittent and temporary in nature and below the construction noise limits at the nearest noise sensitive properties. Provided the mitigation measures outlined in **Chapters 8** and **10** are adhered to, the effects on the air quality and noise during the construction phase will not be significant on human health.

There is also the potential for traffic related air and noise emissions during the construction phase of the proposed site suitability project. This has been considered in **Chapter 8** ***Air Quality*** and **Chapter 10** ***Noise***.

The change in Daily Traffic Values is not of the magnitude to require an air quality assessment as per the Design Manual for Roads and Bridges (DMRB) screening criteria outlined in **Section 8.5.2** of **Chapter 8**. It can therefore be determined that traffic related air quality impacts during the construction phase are short-term and imperceptible.

Details of the noise assessment for the construction stage traffic flows are outlined in **Section 10.5.5.2** of **Chapter 10**. The change in traffic noise level was calculated between 0 to 0.3dB. A change of this magnitude will not result in any notable change in noise level over existing road traffic noise levels and is considered short-term and imperceptible.

Psychological Impacts Construction Phase

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

The community will experience annoyance from the temporary effects of the construction phase which in this case is very limited. This is probably the same as for any construction project and will be relatively limited given the location of the site. Annoyance, however, is not in itself a health effect.

6.6.3 Operational Phase

6.6.3.1 Population

The proposed development will have no direct nor indirect significant negative effects on the population of Duleek and surrounding areas in terms of employment, economic activity or amenities.

Projects that have the potential to generate environmental benefits, protect the population from public health dangers as well as support regeneration, reduce unemployment and improve socio-economic circumstance, which can contribute to improving the health and wellbeing of communities.

The proposed development will have a positive effect on the wider economic environment in Ireland by providing additional hazardous waste treatment capacity on the island of Ireland. As described in **Section 2.5.2.1** of ***Chapter 2 Policy and Planning Framework and Need for the Scheme***, in 2018, 76% of hazardous material managed in Ireland was exported to disposal and recovery facilities in Europe. While hazardous waste is currently accepted at Indaver, the increased capacity will provide additional solutions for other operators in terms of waste disposal and facilitate socioeconomic development.

Indirect effects are associated with the additional capacity of the site to accept waste as proposed will result in additional vehicles coming to the site during operation. However, as discussed in **Section 7.9** of **Chapter 7** ***Traffic & Transportation***, the proposed development will have minimal impact on junctions.

6.6.3.2 Human Health

The Waste to Energy process (WtE) would be expected to be the dominant source of air emissions and to a lesser extent, noise emission associated with the facility during operation. It is proposed to increase the annual tonnage of waste accepted from 235,000 to 250,000 tonnes per annum, comprising of up to 15,000 tonnes of additional hazardous wastes. The majority of this increase is intended for the treatment of aqueous wastes which, when evaporated, is converted to water vapour in the flue gas flow. As outlined in **Chapter 8** as the flue gas flow is corrected to standard, dry conditions, so the total flue gas flowrate will not increase.

As discussed in **Section 8.5.3.1** of **Chapter 8** ***Air Quality***, the facility will still be obligated to comply with its licensed emission limit values and maximum flue gas flowrate and thus the increase in waste tonnage proposed will not cause a significant impact to the ambient air quality. Detailed modelling assessments were undertaken as part of the licensing process at the site in 2009 EIS[16] & 2012. Both assessments concluded that the impact on air quality would not be significant.

[16] Available to view from EPA IE Licence portal for W0167-02, http://www.epa.ie/terminalfour/ippc/index.jsp

The modelling assessment was updated in 2019 as part of this EIAR and the results (see **Table 8.6** in **Chapter 8**) indicate that the facility will continue to be in compliance with its licence requirements and no significant impacts to ambient air quality are predicted.

Section 4.6 of **Chapter 4** describes stormwater and firewater management on site. **Chapter 15** ***Water***, assessed the potential effects of the proposed development on the water environment and determined that no significant negative effects are predicted on water quality. The assessment considered the existing and proposed site management and infrastructure regarding drainage and wastewater management. It is highly unlikely for waste contaminated water to pollute any receiving waters. Therefore, no adverse effect on human health from water contamination is predicted.

Psychological Impacts Operational Phase

In the operational phase there will be no perceivable difference from outside other than perhaps somewhat increased traffic. No psychological effects are anticipated.

6.7 Cumulative Effects

There are a number of planned or permitted developments in the vicinity of the existing facility which have the potential to cumulatively impact human health. Each project has been reviewed in turn below for the potential cumulative effect on population and human health. Refer also to the cumulative assessment presented in **Chapters 8** ***Air Quality*****, 10** ***Noise and Vibration*****, 14** ***Land and Soils*** **& 15** ***Water*** for specific details relating to cumulative effects of emissions to air, noise, soils/ground and water.

6.7.1 Irish Cement Ltd (Ref. LB150375) - Cement silo

Should the construction of the planned cement silo at Irish Cement and the proposed development occur concurrently, there is potential for temporary indirect cumulative effects on population and human health due to increased construction traffic and nuisances associated with site activities (dust, noise). However, given the scale of the of the planned development it is unlikely there will be a significant direct or indirect cumulative effect on population during construction. No significant direct or indirect cumulative effects on population or human health are predicted during the operation of the planned and proposed development.

As this planned development will not result in any additional emissions to atmosphere during operation the cumulative effects on population and human health are deemed imperceptible.

6.7.2 Irish Cement Ltd (PL17.PA0050) - Alternative fuels and raw materials

Should the construction of the planned development at Irish Cement and the proposed development occur concurrently, there is potential for temporary indirect effects on population due to increased construction traffic and nuisances associated with site activities (dust, noise). However, given the location of the of the planned development in relation to the Indaver site, it is unlikely there will be a significant cumulative indirect effect on population and human health during construction. No significant direct or indirect cumulative effects are predicted during the operation of the planned and proposed developments.

6.7.3 SSE Generation Ireland Ltd (PL17.303678) - 110kV transmission substation

Should the construction of the planned substation and the proposed development occur concurrently, there is potential for temporary indirect effects on population due to increased construction traffic and nuisances associated with site activities (dust, noise). However, given the scale of the of the planned development, it is unlikely there will be significant indirect cumulative effects on population and human health during construction. No significant direct or indirect cumulative effects are predicted during the operation of the planned and proposed developments.

6.7.4 Highfield Solar Ltd. (PL17.248146) - Solar Farm

Should the construction of the planned substation and the proposed development occur concurrently, there is potential for temporary indirect cumulative effects on population due to increased construction traffic and nuisances associated with site activities (dust, noise). However, cumulative noise or air quality impacts associated with the construction of the proposed development and the planned solar farm development are not envisaged due to the low volume of construction required and the use of materials with a low dust generation potential planned for the solar farm. In addition, given the location of the of the planned development in relation to Indaver, it is unlikely there will be significant indirect cumulative effects on population and human health during construction.

There are no emissions to atmosphere associated with the operational stage of this development. Therefore, no direct or indirect cumulative human health impacts are predicted.

6.7.5 Highfield Solar Ltd. (PL17.303568) - Electrical substation (110kV)

Should the construction of the planned substation and the proposed development occur concurrently, there is potential for temporary indirect effects on population due to increased construction traffic and nuisances associated with site activities (dust, noise). However, given the location of the of the planned development, it is unlikely there will be significant indirect cumulative effects on population during construction.

No significant direct or indirect cumulative effects on population or human health are predicted during the operation of the planned and proposed developments as there will be no emissions from the substation.

Overall, taking all of the projects together in-combination with the proposed development, cumulative population and health effects during the construction phase have been assessed to be imperceptible. Cumulative operational phase effects are also imperceptible.

6.8 Mitigation Measures and Monitoring

6.8.1 Construction Phase

Construction phase mitigation measures relating to those factors under which population and human health effects might occur have been addressed elsewhere in this EIAR, under the environmental factors for traffic and transportation, air quality and noise and vibration. Other than the mitigation measures outlined in **Chapters 7** ***Traffic & Transportation***, **8** ***Air Quality***, **10** ***Noise and Vibration***, **14** ***Land and Soils***, **15** ***Water*** and **17** ***Major Accidents and Disasters*** no further mitigation measures are proposed with respect to population and human health.

6.8.2 Operational Phase

Operational phase mitigation measures relating to those factors under which population and human health effects might occur have been addressed elsewhere in this EIAR, under the environmental factors for traffic and transportation, noise and vibration and major accidents and disasters. Other than the mitigation measures outlined in **Chapters 7** ***Traffic & Transportation***, **10** ***Noise and Vibration*** and **17** ***Major Accidents and Disasters***, no further mitigation measures are proposed with respect to population.

As there will be no significant change in emissions in the operational phase, no further mitigation is proposed regarding human health.

6.9 Residual Effects

6.9.1 Construction Phase

As outlined above, with the mitigation proposed any effects are short term or negligible, so no residual human health impacts are predicted.

Given the nature and duration (temporary) of effects identified which could potentially impact the local population regarding the nuisances associated with the construction phase, the proposed development will not have a significant negative residual effect on the population.

6.9.2 Operational Phase

The impact of the proposed development on noise and air quality is predicted to be imperceptible with respect to the operational phase.

Therefore, no residual significant human health effects are predicted for the operational phase of the proposed development.

Given the nature of the activities associated with the operation of the proposed development and the potential effects identified which may pose a nuisance or risk to the population, it is determined that there will be no significant negative effect on the population.

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