
Chapter 26

Interaction between the Environmental Factors

Contents

26	INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS	26-1
26.1	Introduction.....	26-1
26.2	Methodology.....	26-1
26.2.1	Legislation, Policy and Guidance.....	26-1
26.2.2	Zone of Influence	26-1
26.2.3	Assessment Approach.....	26-2
26.3	Potential Impacts.....	26-2
26.3.1	Interactions Matrix	26-2
26.3.2	Description of Interactions	26-4
26.4	Mitigation.....	26-17
26.5	Chapter References	26-18

Tables

Table 26-1:	Interactive Effects Summary Matrix	26-3
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26 INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

26.1 Introduction

The potential for interaction of environmental effects has been assessed throughout this EIAR, as part of the impact assessment process of the individual environmental factors in **Chapters 7 – 23**. These previous chapters have identified, described and assessed the relevant interactions arising between one or more of the individual environmental factors. This chapter of the EIAR identifies and describes those potential interactions and points to where in the specialist chapters the interactions have been assessed.

Close coordination and discussion between the wider EIA team has informed the assessment of interactions and the preparation of this chapter to ensure that interactions identified have been adequately assessed and, where necessary, mitigation proposed.

26.2 Methodology

26.2.1 Legislation, Policy and Guidance

26.2.1.1 Legislation

The consideration of interactions derives from the provisions of the EIA Directive 2011/92/EU as amended by Directive 2014/52/EU ('the EIA Directive'). Article 3(1)(e) of the EIA Directive requires, inter alia, that the EIAR shall identify, describe and assess in an appropriate manner, the direct and indirect significant effects of a project including the interaction of environmental factors.

26.2.1.2 Policy

There is no specific policy in relation to the consideration of interactions between environmental factors. Relevant policy for each environmental topic is set out in the policy section of **Chapters 7 – 23**.

26.2.1.3 Guidance

The methodology and associated impact assessment has had regard to the general guidance regarding the undertaking of an EIA (as presented in **Section 1.3.3 of Chapter 1 – Introduction**) and the following topic-specific guidance on interactions:

- Guidelines on the information to be Contained in Environmental Impact Assessment Reports (EPA, 2022); and
- Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions European Commission, (EC, 1999).

The EIAR coordination team facilitated data exchange and the subsequent assessment reviews by the relevant specialists to inform the assessment of interaction of effects. This was undertaken throughout the specialist impact assessment process.

26.2.2 Zone of Influence

The study area is defined by the zones of influences of each of the individual environmental topic assessments, which are set out in the relevant topic EIAR **Chapters 7 – 23**.

26.2.3 Assessment Approach

The assessment approach taken has been to:

- Identify the potential for interactions between different environmental topics over the life cycle of the Proposed Scheme in a matrix format, including consideration of cumulative effects. The determination of interactions was facilitated through an iterative design process that included consultation between the designers, environmental specialists and technical specialists. It also considers the potential for mitigation measures prescribed in respect of one particular environmental factor to give rise to unintended negative impacts in respect of one or more other factor(s), as appropriate; and
- Prepare a summary of the interactions between different environmental topics which have been identified and addressed in this EIAR.

26.3 Potential Impacts

26.3.1 Interactions Matrix

The potential impact interactions between the environmental factors/topic areas are identified in **Table 26-1**. The effects matrix identifies the factors in the left-hand column, which have the potential to impact on other factors listed in the top row of the matrix. Where a tick '✓' is present, this indicates that the Proposed Scheme has the potential to result in an interaction between the two environmental factors. Where there is no potential for an interaction between factors, this is indicated by a hyphen '-' in the matrix. 'C' denotes the construction phase, and 'O' denotes the operational phase of the Proposed Scheme.

The purpose of the matrix is to identify the likely interactive effects of significance. A description of the interactive effect is provided in **Section 26.3.2**, along with a reference to where the assessment has been completed in **Chapters 7 – 23**.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Table 26-1: Interactive Effects Summary Matrix

	Traffic & Transport		Population		Noise & Vibration		Air Quality & Climate		Human Health		Landscape & Visual		Archaeological & Cultural Heritage		Architectural Heritage		Biodiversity (Terrestrial & Aquatic)		Water		Land, Soils, Geology & Hydrogeology		Material Assets: Agricultural Properties		Material Assets: Non-agricultural Properties & Utilities		Material Assets: Resource & Waste Management		
	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	
Traffic & Transport																													
Population	✓	✓																											
Noise & Vibration	✓	✓	✓	✓																									
Air Quality & Climate	✓	✓	✓	✓	-	-																							
Human Health	✓	✓	✓	✓	✓	✓	✓	✓																					
Landscape & Visual	✓	✓	✓	✓	✓	✓	-	-	-	-																			
Archaeological & Cultural Heritage	-	-	-	-	-	-	-	-	-	-	✓	✓																	
Architectural Heritage	✓	✓	-	-	✓	✓	-	-	-	-	✓	✓	✓	✓															
Biodiversity (Terrestrial & Aquatic)	✓	✓	-	-	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-													
Water	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓											
Land, Soils, Geology & Hydrogeology	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓									
Material Assets: Agricultural Properties	✓	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-							
Material Assets: Non-agricultural Properties & Utilities	✓	-	-	-	✓	-	✓	-	-	-	✓	✓	-	-	-	-	✓	-	-	-	-	-	✓	-					
Material Assets: Resource & Waste Management	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	✓	-			

Note: 'C' denotes construction phase, 'O' denotes operational phase.

26.3.2 Description of Interactions

26.3.2.1 Traffic and Transport

As identified in **Table 26-1**, interactions between Traffic and Transport and the following factors have been identified and assessed: Population; Noise and Vibration; Air Quality and Climate; Human Health; Landscape and Visual; Architectural Heritage; Biodiversity: Terrestrial and Aquatic Ecology; Water; Land, Soils, Geology and Hydrogeology; Material Assets: Agricultural Properties; Material Assets: Non-agricultural Properties & Utilities; and Material Assets: Resource and Waste Management. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 7.4.8** of this EIAR.

Population

Traffic modelling data has been used in the population assessments to determine the impact significance for receptors during both construction and operation of the Proposed Scheme.

The construction of the Proposed Scheme will result in increased construction traffic, including but not limited to heavy goods vehicles (HGVs), in the village of Slane and surrounding road network. In particular this will occur in the vicinity of the construction compounds and along designated haulage routes for the Proposed Scheme. This will likely impact on the journey characteristics and journey amenities of road users (motorised vehicles, cyclists and pedestrians) which could potentially generate negative impacts on population. Delays and longer commute times for some road traffic are anticipated due to increased traffic levels, reduced road carriageway widths and temporary diversions to accommodate the mainline, N51 improvements and public realm works. However, negative impacts arising from the construction phase will be temporary. Impacts during the operational phase on population will overall be positive. The reduction in traffic, particularly HGV vehicles, through the centre of Slane village will have positive impacts on population during the operational phase including improved safety for pedestrians and cyclists. The Proposed public realm enhancements include reorganised traffic lanes, pedestrian crossings and road resurfacing; this will enable better pedestrian and cycle movement and will have a positive impact on local communities, in addition to decreased noise in the village.

The impact of the interactions between Traffic and Transport and Population have been assessed in **Section 7.4.1 to 7.4.6** and **Section 8.4.1** and **Section 8.4.2** of this EIAR.

Noise and Vibration

Traffic modelling data has been used directly in the noise and vibration assessments to determine the impact significance for noise sensitive receptors during both construction and operation of the Proposed Scheme.

During the construction phase, the increase in traffic volume on the local road network, particularly around construction compounds and along haul routes, has the potential to result in increased noise and vibration. However, these impacts will be short-term and mitigation measures will include best practice noise control measures e.g. appropriate hours of operation and scheduling of works. This will ensure noise impacts are controlled as far as practicable during the construction phase along public roads. Vibration impacts relating to construction traffic will be limited given the low generation of vibration from vehicles along well-maintained roads. Once operational, traffic along the Proposed Scheme will generate new noise emissions and result in a change in the baseline noise environment both along the bypass and within Slane Village. Noise levels will be increased overall at a number of noise sensitive receptors along the bypass and N51, due to an increase in traffic volumes and percentage of HGVs. The Proposed Scheme, however, has been designed to reduce operational noise levels through the incorporation of detailed noise mitigation measures e.g., noise barriers and low-noise road surfaces. The proposed bypass will reroute significant volumes of traffic that currently pass-through Slane village on to the bypass, including large numbers of HGV vehicles. Therefore, the operational phase will result in a positive noise impact due a decrease in noise at receptors in the village. In particular, reduced HGV movements through the village will contribute to reduced noise emissions.

The impact of the interactions between Traffic and Transport and Noise and Vibration have been assessed in **Section 9.4.1.12** and **Section 9.4.1.13** and in **Section 9.4.2** of this EIAR.

Air Quality and Climate

Traffic modelling data has been used directly in the air quality and climate assessments to determine the impact significance for sensitive receptors during both construction and operation of the Proposed Scheme.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

The generation of road traffic due to construction phase delivery of materials, removal of waste and redistribution of road users has the potential to impact air quality including an increase in the emissions of particulate matter and nitrogen oxides as well as greenhouse gas (GHG) emissions associated with construction traffic. This will be the case in particular where localised congestion occurs during the construction stage. HGV traffic leaving the construction compounds and areas where construction is underway also has the potential to generate dust emissions due to track-out of dust from the vehicle wheels to public roads. This will have negative, short-term impacts during the construction phase. As for noise and vibration, the impact of traffic in terms of air quality varies across the Proposed Scheme. Within Slane village, the removal of HGV and through-traffic will improve the air quality in the village. While the proposed N2 bypass also introduces emissions along the mainline bypass route, levels will remain within the relevant air quality limits. The Transport Infrastructure Ireland (TII) Carbon Assessment Tool has been utilised to estimate the GHG impacts of the Proposed Scheme.

The impact of the interactions between Traffic and Transport and Air Quality have been assessed in **Section 10.4.1** and **Section 10.4.2**. The impact of the interactions between Traffic and Transport and Climate have been assessed in **Section 19.4.1** and **Section 19.4.2** of this EIAR.

Human Health

Traffic modelling data has been used directly in the population, air quality and noise and vibration assessments which have in turn been used to determine the impact significance for sensitive receptors during both construction and operation of the Proposed Scheme.

The generation of traffic during both the construction and operational phase has the potential to indirectly affect human health through traffic-generated air and noise emissions. Changes in traffic flow and typical traffic patterns can also increase the risks of accidents/ injuries occurring across the community, particularly during construction. However, the opportunities for income and employment generation will have the possibility to affect human health positively through the delivery of the Proposed Scheme. During the operational phase, the Proposed Scheme will significantly reduce traffic volumes in Slane village and provide increased amenity and recreational enjoyment for local residents and tourists. This will have potential positive implications for human health within the local community.

The impact of the interactions between Traffic and Transport and Human Health have been assessed in **Section 11.4.1** and **Section 11.4.2** of this EIAR.

Landscape and Visual

During the construction phase, construction machinery and plant movements along the Proposed Scheme corridor and the surrounding road networks are likely to have temporary visual impacts on landscape character and on visual receptors. During the operational phase, there will be permanent change to visual amenity due to introduction of traffic over the proposed bridge crossing and bypass and also permanent change to landscape character from traffic movements along the bypass. Proposed mitigation planting will offset and filter views towards the Proposed Scheme, associated infrastructure and traffic on the road. The removal of traffic, and HGVs in particular, from the village also provides for the opportunity for public realm enhancements to improve the visual amenity of the village.

The impact of the interactions between Traffic and Transport on Landscape and Visual have been assessed in **Section 12.4.1** to **12.4.4** of this EIAR.

Architectural Heritage

As with Landscape and Visual above, the Proposed Scheme has the potential to cause visual impacts on architectural heritage features due to a temporary change in the landscape and streetscape character of the receiving historical environment; during construction, there will be temporary visual changes for architectural heritage receptors such as the Ledwidge Museum, Slane Village Architectural Conservation Area (ACA), and Slane Mill ACA, through the carrying out of construction immediately adjacent to or in the viewshed of these heritage features. This includes visual, and noise intrusion and potential vibration effects from construction traffic passing close to the features. The reduction in traffic, particularly HGV vehicles, through the centre of Slane village will have positive impacts on architectural heritage during the operational phase, which would see the removal of a large volume of HGV traffic utilising the existing medieval Slane Bridge. The works to the public realm in Slane village, which will include undergrounding of built service material assets (i.e. utilities), will also bring about a positive effect through improvements to the streetscape.

The impact of the interactions between Traffic and Transport and Architectural Heritage have been assessed in **Section 14.4.1** to **14.4.2** of this EIAR.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Biodiversity: Terrestrial and Aquatic Ecology

The construction phase of the Proposed Scheme will result in increased traffic and transportation within the study area. These increases have the potential to negatively impact on Biodiversity through temporary habitat fragmentation, increased noise and light disturbance, pollution and species mortality. Construction traffic and other related construction activities such as watercourse crossings can present as a temporary barrier and/or hazard to mobile species such as otter, bats, badger, and fish. Construction vehicles produce dust and sediment (tracked on vehicle tyres) may produce run-off if mixed with water. There is also potential for spillage of hydrocarbons and other materials with potential to impact on water quality. This may subsequently have negative impacts for aquatic species. Furthermore, the transport of machinery, equipment and material during the construction phase can facilitate the introduction and/or spread of invasive species. During the operational phase there is also further potential for the introduction and/or spread of invasive species via the movement of vehicles (i.e. both general road-users/commuters and maintenance vehicles). There is also potential for traffic-related emissions to air to impact plant growth, especially adjacent to the carriageways and traffic-related run-off to impact water quality. The comprehensive drainage design for the Proposed Scheme has been designed to address risks from road run-off on the receiving water environment associated with the River Boyne, which is a designated European site with salmon as a qualifying interest; it is also a designated salmonid river.

The impact of the interactions between Traffic and Transport and Biodiversity (Terrestrial) have been assessed in **Section 16.4.1** and **Section 16.4.2** of this EIAR.

The impact of the interactions between Traffic and Transport and Biodiversity (Aquatic) has been assessed in **Section 16.4.1.3**, **Section 16.4.2.1** and **Sections 16.4.2.7 to 16.4.2.9** of this EIAR.

Water

Traffic and Transport has the potential to interact with water during the construction phase. The increased traffic and transportation levels associated with the construction works increase the risk of hydrological contamination via diffuse and point sources, such as road run-off or oil/fuel spills. Any such spills have the potential to negatively impact water quality in the River Boyne. During the operational phase, water quality can be impacted with road run-off including any accidental release of oils, fuels, and chemicals from road traffic. The comprehensive drainage design for the Proposed Scheme has been designed to address risks from road run-off on the receiving water environment associated with the River Boyne which is a designated European site with salmon as a qualifying interest; it is also a designated salmonid river.

The impact of the interactions between Traffic and Transport and Water has been assessed in **Section 17.4.2.1** of this EIAR.

Land, Soils, Geology and Hydrogeology

Traffic and Transport has the potential to interact with Land, Soils, Geology and Hydrogeology during the construction phase. There is potential for accidental spillages of fuels or other contaminants from construction vehicles, which can affect the quality of groundwater and/or soils, particularly where below-ground excavations are required. Furthermore, construction vehicles may produce sediment run-off during the haulage of materials, which can infiltrate and cause short-term effects on groundwater quality. Mitigation measures are proposed to minimise the effects of Traffic and Transport on Land, Soils, Geology and Hydrogeology.

The impact of the interactions between Traffic and Transport and Land, Soils and Hydrogeology has been assessed in **Section 18.5.1** and **Section 18.5.2** of this EIAR.

Material Assets: Agricultural Properties

During the construction phase, the additional traffic on the local road network will potentially impact the local agricultural activities as these roads will be used more frequently by agricultural vehicles, particularly during harvest times. This effect may be further increased with the introduction of advisory traffic diversions in certain locations.

The impact of interactions between Traffic and Transport and Material Assets: Agriculture are assessed in **Section 20.4.1.3** of this EIAR.

Material Assets: Non-agricultural Properties & Utilities

During the construction phase, the generation of construction traffic will result in road diversions and general short-term disruption for properties in the area which could potentially negatively impact on residential and commercial properties. This will be mitigated by way of traffic management during the construction phase,

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

and disruption to accesses (both temporary and permanent) will be dealt with by way of accommodation works and reinstatement of accesses for the operational phase.

The impact of the interactions between Traffic and Transport and Material Assets (Properties & Utilities) has been assessed in **Section 21.4.1** of this EIAR.

Material Assets: Resource and Waste Management

The design team has developed the construction strategy provided in **Chapter 5 – Description of the Construction Phase** using waste and resource management facilities identified by the waste management specialists. This has fed into the design of haul routes.

During the construction phase there is potential for direct and indirect interaction between resource management and construction of the Proposed Scheme. Resources are also required to deliver the Proposed Scheme. This material will have to be transported by road to the construction site. Similarly, materials arising from construction of the Proposed Scheme e.g. excavated spoils, concrete, glass, bricks, wood etc from demolitions, and which cannot be reused on site, will require transport off site to suitable recovery, recycling, treatment and disposal facilities. This will require truck and HGV movements, resulting in construction traffic on the road network. During the operational phase, there will be limited resource and waste management requirements outside of general maintenance.

The impact of the interactions between Traffic and Transport and Material Assets (Waste and Resources) has been assessed in **Section 5.3**, **Section 5.4**, **Section 5.5** and in **Section 23.4.1** of this EIAR.

26.3.2.2 Population

As identified in **Table 26-1**, interactions between Population and the following factors have been identified and assessed: Traffic and Transport; Noise and Vibration; Air Quality and Climate; Human Health; Landscape and Visual; and Water. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 8.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above for a description of the interactions between population and Traffic and Transportation. The impact of the interactions have been assessed in **Section 7.4.1** to **7.4.6** and **Section 8.4.1** and **Section 8.4.2** of this EIAR.

Noise and Vibration

The nearest noise sensitive locations including residential, commercial and recreational amenity space identified in the population chapter have been modelled to determine impacts from construction and operational phase noise and vibration.

The increased noise and vibration levels during the construction works will emanate from traffic and transport sources (see also **Section 26.3.2.1** above) and from construction activities such as demolitions, excavations and piling (for the proposed bridge). These noise and vibration generating activities will cause disturbance to local populations in the surrounding areas of the Proposed Scheme, negatively impacting on enjoyment of indoor and outdoor spaces including residential, recreational areas and public spaces in the surrounding areas due to exposure to increased noise levels.

During the operational phase, the populations along the Proposed Scheme will experience changes in noise and vibration character as a result of changes in traffic patterns. At the operational phase, positive impacts on noise levels are predicted from the shift of HGVs and through-traffic in the village toward the proposed bypass providing more road space in Slane village for vulnerable road users. The introduction of cycleways will also benefit the wider population.

The impact interactions between Population and Noise and Vibration have been assessed in **Section 8.4.1** and **8.4.2** and in **Sections 9.4.1** and **9.4.2** of this EIAR.

Air Quality and Climate

The nearest sensitive receptors including residential and recreational amenity space identified in the population chapter have been modelled to determine impacts from construction and operational phase air emissions and the population exposure to air pollution.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Similar to noise and vibration air emissions will emanate from traffic and transport sources (see also **Section 26.3.2.1** above) and from construction activities such as demolitions, site clearance and excavations. These activities will cause disturbance to local populations in the surrounding areas of the Proposed Scheme, particularly from dust, negatively impacting on enjoyment of indoor and outdoor spaces including residential, recreational areas and public spaces in the surrounding areas due to exposure to increased dust. During the operational phase, the populations along the Proposed Scheme will experience changes in exposure to air emissions as a result of changes in traffic patterns. At the operational phase, net positive impacts on air quality are predicted from the shift of HGV and through traffic toward the Slane bypass providing improved air quality in Slane village.

The impact interactions between Population and Air Quality and Climate have been assessed in **Section 8.4.1** and **8.4.2** and in **Sections 10.4.1** and **10.4.2** of this EIAR.

Human Health

The interactions between Population and Human Health are via lifestyle, socio-economic and environmental conditions, and safety factors among others. This impact is on residents of local communities and various population groups, with often distinct responses.

The impact interactions between Population and Human Health have been assessed in **Section 8.4.1** and **8.4.2** and in **Sections 11.4.1** and **11.4.2** of this EIAR.

Landscape and Visual

The Proposed Scheme has the potential for visual effects on Population through effects on sensitive visual receptors and changes to residential amenity and visual intrusion on residences. As part of the of visual effects assessment associated with the Proposed Scheme, an assessment of the predicted visual impacts on residents of residential properties that occur within the study area associated with the Proposed Scheme has also been undertaken.

The impact interactions between Population and Landscape and Visual have been assessed in **Section 8.4.1** and **8.4.2** and in **Sections 12.4.1** and **12.4.2** of this EIAR.

Water

There is potential for interactions between Water and Population during the construction and operational phases of the Proposed Scheme. During the construction phase, temporary working platforms will be installed during the construction of the bridge over the River Boyne. This has the potential to increase the risk of flooding in the vicinity of the works, which could have a further negative impact on population, through local residential and commercial receptors. Temporary storage of construction materials within the floodplain may also increase the flood risk. A Flood Risk Assessment (FRA) has been carried out for the Proposed Scheme and records were identified of historical flooding in the area. The proposed temporary working platforms will be built within Flood Zone A and Zone B. Detailed hydraulic modelling was undertaken to inform the construction platform designs to minimise flood risk both to the construction works and to properties along the river.

As part of the of water and flood risk assessment associated with the Proposed Scheme, an assessment on residential and commercial properties within the study area associated with the Proposed Scheme has also been undertaken.

The impact interactions between Population and Water have been assessed in **Section 8.4.1** and **8.4.2** and in **Sections 17.4.1** and **17.4.2** of this EIAR.

26.3.2.3 Noise and Vibration

As identified in **Table 26-1**, interactions between Noise and Vibration and the following factors have been identified and assessed: Traffic and Transport; Population; Human Health; Landscape and Visual; Biodiversity; Architectural Heritage; Material Assets: Agricultural Properties and Material Assets Non-agricultural Properties & Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 9.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Population

See **Section 26.3.2.2** above.

Human Health

The interactions between Human Health and Noise and vibration are via environmental conditions arising from construction activities and construction and operational traffic.

There is potential for interactions between Noise and Vibration and Human Health particularly during the construction of the proposed Scheme. These include noise emissions from construction traffic along haul routes, enhanced road traffic movements associated with temporary diversions, machinery used for demolition and excavations, machinery used for construction and significant noise generation activities such as piling. All of these activities will be carried out in proximity to residential, commercial and recreational facilities. These activities will take place in the main during daytime hours but limited periods of night-time works will be required e.g. for the upgrades to the N51. Sensitive noise receptors are expected to experience noise and vibration over the construction phase with potential for negative effects on human health in the short-term. During operation there is potential for improved noise and vibration conditions within Slane village as a result of removal of HGVs from the centre of the village with positive impacts for the local population. Increased noise and vibration will however be experienced during operation of the bypass.

The impact interactions between Human Health and Noise and Vibration have been assessed in **Section 9.4.1** and **9.4.2** and in **Sections 11.4.1.3.2** and **11.4.2.3.2** of this EIAR.

Landscape and Visual

Noise and Vibration has the potential to interact with Landscape and Visual due to the creation of noise attenuation measures which will be put in place during the construction phase and will remain throughout the operational phase. The specific noise attenuation measures proposed have been considered as part of the Proposed Scheme and are included in the assessment of likely significant effects outlined in the Landscape and Visual impact assessment. Noise barriers are included for as construction phase measures to block line of sight to construction traffic.

The impact interactions between Noise and Vibration and Landscape and Visual have been assessed in **Section 12.4.3** of this EIAR and mitigation measures proposed as relevant.

Biodiversity: Terrestrial and Aquatic

There is potential for interactions between Noise and Vibration and Biodiversity during the construction and operational phases, related to disturbance from construction traffic, demolitions, earthworks, piling and ongoing disturbance during operation from road traffic associated with construction of the Proposed Scheme. The construction works in particular will result in disturbance to fauna in the areas within, and in proximity to, the Proposed Scheme's boundary, including otters, birds and bats, as well as hydroacoustic effects on fish. This noise and vibration disturbance may result in reduction or limitations to use of available feeding, resting, nesting and breeding areas. The construction strategy for the Proposed Scheme has taken into account this disturbance, particularly in relation to the bridge construction and low impact piling techniques have been included to reduce vibration effects on aquatic biodiversity and on otters. During the operational phase, the source of noise and vibration will be the redistributed traffic on the Proposed Scheme, namely the proposed bypass.

The impact interactions between Noise and Vibration and Biodiversity have been assessed in **Sections 9.4.1** and **9.4.2** and in **Sections 15.4.1** and **15.4.2** (terrestrial) and in **Sections 16.4.1** and **16.4.2** (aquatic) biodiversity in this EIAR.

Architectural Heritage

The interactions between Architectural Heritage and noise and vibration give rise to indirect effects arising from noise and vibration from construction activities and construction and operational traffic. The introduction of noise barriers to alleviate noise impacts also presents further interactions for these factors. The impact interactions have been assessed in **Sections 9.4.1** and **9.4.2** and in **Sections 14.4.1** and **14.4.2** in this EIAR.

Material Assets: Agricultural Properties

During the construction phase, the increased traffic may lead to noise disturbances on some farm animals particularly those of a more sensitive nature such as horses.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

The impact interactions between Noise and Vibration and Material Assets: Agriculture have been assessed in **Section 20.4.1.1** of this EIAR.

Material Assets: Non-agricultural Properties & Utilities

There will be an increase in novel noises during the construction of the Proposed Scheme elements, which has the potential to impact on residents. The significance of this impact will depend upon the activity taking place around and within the property.

The impact interactions between Noise and Vibration and Material Assets: Non-agricultural Properties have been assessed in **Section 21.4.1.1** and **Section 9.4.1** of this EIAR.

26.3.2.4 Air Quality and Climate

As identified in **Table 26-1**, interactions between Air Quality and Climate and the following factors have been identified and assessed: Traffic and Transport; Population; Human Health; Biodiversity; Material Assets: Agricultural Properties and Material Assets Non-agricultural Properties & Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 10.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Population

See **Section 26.3.2.2** above.

Human Health

The interactions between Human Health and Air Quality are via environmental conditions arising from construction activities and construction and operational traffic.

Construction activities such as demolition, traffic movements and excavations can give rise to significant air emissions, particularly fugitive dust and particulate matter, which have the potential to cause negative effects on human health. However, any additional airborne concentrations of particulate matter arising from construction would be small and very local due to the construction activity, minimising human exposure.

Air emissions will also arise during the operational phase, from traffic movements using the new road scheme. Such emissions have the potential to impact on human health receptors. However, an air quality assessment was carried out and the results of the analysis indicate that predicted levels of airborne pollution during all phases of the Proposed Scheme will remain below the statutory limits for the protection of human health.

The impact interactions between Human Health and Air Quality have been assessed in **Section 10.4.1** and **10.4.2** and in **Sections 11.4.1** and **11.4.2** of this EIAR.

Biodiversity: Terrestrial

There is potential for interactions between Air Quality, Climate and Biodiversity during the construction and operational phases, related to emissions of nitrogen oxides and particular matter/dust settling on vegetation which can hamper growth. These emissions can be generated by both construction and operational traffic.

The impact interactions between Air Quality and Biodiversity have been assessed in **Section 10.4.1** and **10.4.2** and in **Sections 15.4.1** and **15.4.2** of this EIAR.

Material Assets: Agricultural Properties

During the construction phase, the additional traffic on the local road network may lead to eye irritation for livestock from high levels of wind-blown dust particles. Dust and other particulate matter deposited onto crops may also impact the quality of agricultural crops growing close to the construction activities.

The impact interactions between Noise and Vibration and Material Assets: Agriculture have been assessed in **Section 20.4.1.2** of this EIAR.

Material Assets: Non-agricultural Properties & Utilities

During the construction phase, the activity of construction machinery can generate dust in the immediate vicinity of the Proposed Scheme and construction works areas. The proliferation of dust has a nuisance value and may impact on the activity on a property.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

The impact interactions between Air Quality and Material Assets: Non-agricultural Properties have been assessed in **Section 21.4.1.1** and **Section 10.4.1** of this EIAR.

26.3.2.5 Human Health

As identified in **Table 26-1**, interactions between Human Health and the following factors have been identified and assessed: Traffic and Transport; Population; Noise and Vibration; and Air Quality and Climate. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects. The cumulative impact assessment with other approved development is presented in **Section 11.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Population

See **Section 26.3.2.2** above.

Noise and Vibration

See **Section 26.3.2.3** above.

Air Quality and Climate

See **Section 26.3.2.4** above.

26.3.2.6 Landscape and Visual

As identified in **Table 26-1**, interactions between Landscape and Visual and the following factors have been identified and assessed: Population; Noise and Vibration; Archaeological and Cultural Heritage; Architectural Heritage; Biodiversity; and Material Assets: Non-agricultural Properties & Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 12.4.5** of this EIAR.

Population

See **Section 26.3.2.2** above.

Noise and Vibration

See **Section 26.3.2.3** above.

Archaeological and Cultural Heritage

The Proposed Scheme has the potential to cause visual impacts on archaeological and cultural heritage features, including in relation to the Brú na Bóinne World Heritage Property. Construction impact interactions relate to introduction of construction compounds, stockpiling, cranes and other machinery and construction traffic into the landscape of the highly sensitive receiving environment. The landscape impacts on archaeological and cultural heritage features will be temporary and short-term. However, the operational phase has the potential to alter the landscape character of the receiving historical environment permanently. The evolution of the design of the Proposed Scheme has recognised the archaeological and cultural heritage and landscape and visual interactions from the outset, including through the constraints and route selection stages as well as the preliminary design, to ensure that the crossing point and bridge form used for the Proposed Scheme result in the minimum intrusion on the landscape of the receiving environment as much as possible. The approaches to the bridge and the final rendering of the bridge have also been informed by a multi-disciplinary team that includes archaeologists, a World Heritage Property specialist, landscape specialists and the design team to reduce its impacts on operational phase views from key locations. The photomontage produced as part of the landscape and visual assessment have been used to determine visual intrusion of the scheme on key archaeology and cultural heritage features.

The impact interactions between Landscape and Visual and Archaeological and Cultural Heritage have been assessed in **Sections 12.4.1** to **12.4.5** and in **Sections 13.4.1** to **13.4.2** in this EIAR.

Architectural Heritage

As described for Archaeological and Cultural Heritage above, the Proposed Scheme has the potential to cause visual impacts on architectural heritage features due to a change in the landscape character/setting of

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

the receiving historical environment. During construction, there will be temporary landscape and visual changes for heritage receptors such as the Ledwidge Museum, Slane Village Architectural Conservation Area (ACA) and Slane Mill ACA, through the carrying out of construction immediately adjacent to or in the viewshed of these heritage features. During the operational phase there will be some effects along the route of the proposed N2 bypass arising from the presence of a new road feature and its effect on the heritage settings of structures and features of architectural heritage significance along its route. However, the proposed public realm works in Slane village will bring about a positive effect through improvements to the streetscape and the settings of various structures. The photomontage produced as part of the landscape and visual assessment have been used to determine visual intrusion of the scheme on key architectural heritage features.

The impact interactions between Landscape and Visual and Architectural Heritage have been assessed in **Sections 12.4.1 to 12.4.5** and in **Sections 14.4.1 to 14.4.2** in this EIAR.

Biodiversity: Terrestrial

The proposed mitigation to address landscape and visual impacts arising from the scheme have the potential for interaction with biodiversity by way of the nature and extent of planting proposed. To support biodiversity and contribute to maintenance of the ecological network, appropriate planting is required in the landscape design and has been considered as part of the landscape mitigation proposals. The choice of species and the extent of planting will have operational interactions with potential for positive effects on biodiversity.

The impact interactions between Landscape and Visual and Biodiversity have been assessed in **Section 15.5.2.1.5** of this EIAR.

Material Assets: Non-agricultural Properties & Utilities

Potential for interactions between Landscape and Visual and Material Assets: Non-agricultural Properties & Utilities has been noted for both the construction and operational phases. Land use changes required to deliver the Proposed Scheme will result in a change to the landscape character along the route. Construction will necessitate demolition of buildings, removal of hedgerows and modification of boundary treatments. All will be reinstated following construction. The longer-term operational effects will see altered land use patterns associated with the proposed bypass.

The impact interactions between Landscape and Visual and Material Assets: Non-agricultural Properties & Utilities have been assessed in **Section 21.4.1.1** and **Section 12.4.4** and mitigation measures proposed as relevant.

26.3.2.7 Archaeological and Cultural Heritage

As identified in **Table 26-1**, interactions between Archaeological and Cultural Heritage and the following factors have been identified and assessed: Landscape and Visual; Architectural Heritage and Biodiversity. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 13.4.3** of this EIAR.

Landscape and Visual

See **Section 26.3.2.6** above.

Architectural Heritage

The term 'cultural heritage' itself is a broad term that now has come to include a wide range of tangible and intangible cultural considerations; it encompasses aspects of archaeology, architecture, history, landscape and garden design, folklore and tradition, and topography. A number of features also have shared heritage value in terms of overlap between the Archaeological & Cultural Heritage and Architectural Heritage assessments e.g. the existing Slane bridge (parts of which are medieval and parts of which date from the 18th century), and the Francis Ledwidge Museum (which represents both tangible and intangible cultural heritage); these are addressed in the architectural heritage assessment. Impacts have the potential to arise during the construction phases for such features such as Slane bridge due to the Public Realm works, and indirect effects for Ledwidge as a result of construction occurring adjacent to the structure. During the operational phase of the Proposed Scheme, the reduction in heavy traffic in particular crossing Slane Bridge will result in a reduction in wear and tear on the bridge.

The impact interactions between Archaeological and Cultural Heritage and Architectural Heritage have been assessed in **Sections 13.4.1 to 15.4.3** and in **Sections 14.4.1 to 14.4.3** of this EIAR.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Biodiversity: Terrestrial and Aquatic

During the pre-construction site enabling works, archaeological testing will be undertaken along the Proposed Scheme. This has the potential to result in disturbance of habitats and mortality to species encountered prior to ecological resolution on site e.g. relocation of badger setts, fencing of invasive species etc. It is essential that the sequence of enabling works permits the advanced survey work necessary to secure all biodiversity receptors in advance topsoil stripping for archaeological testing. Similarly, prior to interference with any features identified as ecological receptors, notably structures with bat roost potential, resolution of bat issues must precede any works on these features. A Project Ecologist will be essential to inform the sequencing. No interactions are anticipated during the operational phase, subject to resolution of issues at pre-construction.

The impact interactions between Archaeological and Cultural Heritage and Biodiversity have been assessed in **Sections 15.4.1 to 15.4.3** and in **Sections 16.4.1 to 16.4.3** of this EIAR.

26.3.2.8 Architectural Heritage

As identified in **Table 26-1**, interactions between Architectural Heritage and the following factors have been identified and assessed: Traffic and Transport; Landscape and Visual; Archaeological & Cultural Heritage; and Biodiversity. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 14.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Landscape and Visual

See **Section 26.3.2.6** above.

Archaeological and Cultural Heritage

See **Section 26.3.2.7** above.

Biodiversity: Terrestrial

As with Archaeological and Cultural Heritage described above, Architectural Heritage has the potential to interact with Biodiversity, particularly with regard to potential bat roosts and bat habitat in heritage buildings and features.

Prior to interference with any architectural heritage features a bat specialist will be engaged to ensure bats are dealt with appropriately under the necessary license from NPWS. No interactions are anticipated during the operational phase subject to resolution of any issues at pre-construction.

The impact interactions between Architectural Heritage and Biodiversity have been assessed in **Sections 15.4.1 to 15.4.3** of this EIAR.

26.3.2.9 Biodiversity

As identified in **Table 26-1**, interactions between Biodiversity (including Terrestrial Ecology and Aquatic Ecology) and the following factors have been identified and assessed: Traffic and Transport; Noise and Vibration; Air Quality and Climate; Landscape and Visual; Archaeological and Cultural Heritage; Architectural Heritage; Water; Material Assets: Agricultural Properties and Material Assets: Non-agricultural Properties & Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 15.4.3** (terrestrial ecology) and **Section 16.4.3** (aquatic ecology) of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Noise and Vibration

See **Section 26.3.2.3** above.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Air Quality and Climate

See **Section 26.3.2.4** above.

Landscape and Visual

See **Section 26.3.2.6** above.

Archaeological and Cultural Heritage

See **Section 26.3.2.7** above.

Architectural Heritage

See **Section 26.3.2.8** above.

Water

During all phases of the Proposed Scheme, there is potential for interactive effects between water and biodiversity, particularly aquatic habitats and species. The River Boyne is designated for a number of water dependant interests including otter and salmon. During construction in particular, there is potential for construction vehicles and/or activities to result in the accidental release of hazardous substances or increases in suspended sediment into water courses, impacting water quality and subsequently biodiversity. These potential impacts were considered at a very early stage and pollution control measures have been incorporated into the design, including the installation of drainage prior to commencement of the main construction works near the River Boyne, and minimising the amount of in-stream works for the Mattock (Mooretown) Stream. Furthermore, considerable design effort has been put into developing working platforms as well as use of cofferdams for the construction of the proposed Boyne bridge crossing to ensure that suspended solids and any oils/ fuels are not released during flood events etc.

During the operational phase of the Proposed Scheme, there is also potential for pollution impacts on water quality from operational traffic, which may in turn impact upon biodiversity. The long-term drainage design has also been developed with the highly sensitive ecological receptors to the fore. During the operational phase of the Proposed Scheme, inspection and maintenance will take place to ensure that the attenuation ponds continue operate as intended for the design life of the Proposed Scheme.

The impact interactions between Biodiversity and Water have been assessed in **Sections 15.4.1 to 15.4.3** and in **Section 16.4.1 to 16.4.3** as well as in **Sections 17.4.1 to 17.4.4** of this EIAR.

Material Assets: Agricultural and Non-agricultural Properties & Utilities

As similarly described for Architectural Heritage features, agricultural and non-agricultural properties may contain ecological receptors, notably bats and birds. Prior to any house or farm building demolitions or removal of boundary treatments, the biodiversity mitigation specifies that a Project Ecologist will assess the ecological feature(s) and advise on best practice to avoid impacts.

The impact interactions between Biodiversity and Material Assets: Agricultural and Non-agricultural Properties & Utilities have been assessed in **Sections 15.4.1 to 15.4.3** of this EIAR.

26.3.2.10 Water

As identified in **Table 26-1**, interactions between Water (including Hydrology and flood Risk) and the following factors have been identified and assessed: Traffic and Transport; Population; Human Health; Biodiversity; and Land, Soils, Geology and Hydrogeology. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 17.4.4** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Population

See **Section 26.3.2.2** above.

Human Health

See **Section 26.3.2.5** above.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Biodiversity

See **Section 26.3.2.9** above.

Land, Soils, Geology and Hydrogeology

Water has the potential to interact with Land, Soils, Geology and Hydrogeology through the surface water/hydrological and groundwater/hydrogeological connection. There is potential for accidental spillages of fuels or other contaminants from construction vehicles, which can affect the quality of both surface and groundwaters, as well water supplies and/or soils, particularly where below-ground excavations are required. Furthermore, construction vehicles may produce sediment run-off during the haulage of materials, which can infiltrate and cause short-term effects on groundwater quality.

The impact interactions between Water and Land, Soils, Geology and Hydrogeology for the construction phase have been assessed in **Section 16.4.1** and for the operational phase have been assessed in **Section 17.4.2.1** of this EIAR, with mitigation measures proposed as relevant.

26.3.2.11 Land, Soils, Geology and Hydrogeology

As identified in **Table 26-1**, interactions between Land, Soils, Geology and Hydrogeology and the following factors have been identified and assessed: Traffic and Transport; Water; and Material Assets: Agricultural Properties. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 18.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Water

See **Section 26.3.2.10** above.

Material Assets: Agricultural Properties

During the construction phase, the additional traffic on the local road network may lead to land reinstatement following construction activities of land.

The impact interactions between Land, Soils, Geology and Hydrogeology and Material Assets: Agricultural Properties have been assessed in **Section 20.4.1.5** of this EIAR.

26.3.2.12 Material Assets: Agricultural Properties

As identified in **Table 26-1**, interactions between Material Assets: Agricultural Properties and the following factors have been identified and assessed: Traffic and Transport; Noise and Vibration; Air Quality; Land, Soils, Geology and Hydrogeology; and Material Assets: Non-agricultural Properties and Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 20.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Noise and Vibration

See **Section 26.3.2.3** above.

Air Quality

See **Section 26.3.2.4** above.

Land, Soils, Geology and Hydrogeology

See **Section 26.3.2.11** above.

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Material Assets: Non-agricultural Properties & Utilities

The construction of the Proposed Scheme will potentially disturb or sever current piped water supplies for livestock where the proposed bypass crosses these piped supplies. Access to surface drinking points will also be potentially divided or curtailed during construction.

Furthermore, many farms utilise electric fencing to manage stock. In some instances, the electric fencing will be supplied by a battery-operated system, which will not be affected. However, many farms utilise a main supply to operate their electric fencing and severance of this connectivity from the supply to the fence will impact negatively on the management of the farm.

In some instances, landholders have shared-use tracks/ lanes e.g. where a track or laneway is used to access both field plots/ farming facilities, as well as a dwelling. The land take assessments have therefore covered both potential impacts to agricultural properties and farming enterprises as well as land take from non-agricultural plots and such shared-use facilities.

The impact interactions between Material Assets: Agricultural Properties and Material Assets: Agricultural Non-agricultural Properties and Utilities have been assessed in **Section 20.4.1.6**, **Section 21.4.2** and **Section 22.4.1** of this EIAR.

26.3.2.13 Material Assets: Non-agricultural Properties & Utilities

As identified in **Table 26-1**, interactions between Material Assets: Properties & Utilities and the following factors have been identified and assessed: Traffic and Transport; Noise and Vibration; Air Quality; Landscape and Visual; and Material Assets: Resource and Waste Management. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 21.4.3** of this EIAR.

There is potential for planned and unplanned service interruptions (e.g. to electricity supply), and/or severance/disturbance of services as part of the construction works (e.g. to facilitate diversion or undergrounding of services). The impact interactions between Non-agricultural Properties & Utilities have been assessed in **Section 21.4.1**, and **Section 22.4.1** and **Section 22.4.2** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Noise and Vibration

See **Section 26.3.2.3** above.

Air Quality

See **Section 26.3.2.4** above.

Landscape and Visual

See **Section 26.3.2.6** above.

Material Assets: Resource and Waste Management

The Proposed Scheme has potential for impact interaction between Material Assets: Properties & Utilities and Resource and Waste Management. During construction it will be necessary to demolish a number of properties and modify boundary treatments and curtilage of a number of properties. This material will need to be managed and disposed of appropriately and in accordance with waste management regulations. In addition, sustainable use of materials will drive the reuse of earthworks material onsite as far as possible. This will be in the form of use of fill material where required and use of excess for landscape and noise bunds to mitigate negative effects on Properties.

The impact interactions between Material Assets: Non-agricultural Properties & Utilities and Material Assets: Resource and Waste Management have been assessed in **Section 21.4.1** and **Section 21.4.2**, **Section 22.4.1** and **Section 22.4.2**, as well as **Section 23.4.1** and **Section 23.4.2** of this EIAR.

26.3.2.14 Material Assets: Resource and Waste Management

As identified in **Table 26-1**, interactions between Resource and Waste Management and the following factors have been identified and assessed: Traffic and Transport; and Material Assets: Non-agricultural

VOL. 2 CHAPTER 26 – INTERACTION BETWEEN THE ENVIRONMENTAL FACTORS

Properties & Utilities. There is also potential for these interactions to go beyond the Proposed Scheme in cumulation with other projects; the cumulative impact assessment with other approved development is presented in **Section 23.4.3** of this EIAR.

Traffic and Transport

See **Section 26.3.2.1** above.

Material Assets: Non-agricultural Properties & Utilities

See **Section 26.3.2.13** above.

26.4 Mitigation

Where any potential interactive negative impacts have been identified in the above, a full suite of appropriate mitigation measures has already been included in the relevant sections (**Chapters 7 – 23**) of this EIAR. The implementation of these mitigation measures will reduce or remove the potential for these effects. Information on potential residual impacts and the significance of effects, is also presented in each relevant chapter.

26.5 Chapter References

EC (2009) Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, EC DG X1 Environment, Nuclear Safety and Civil Protection.

EPA (2022) Guidelines on the information to be contained in Environmental Impact Assessment Reports.