9 Noise and Vibration

9.1 Introduction

This section assesses the likely noise and vibration impacts arising from the proposed development. During its operational phase, the proposed scheme will have negligible noise or vibration impacts, therefore it is only considered necessary to assess the potential impacts of the construction phase. The section will also identify required or possible mitigation measures.

9.2 Methodology

An assessment was carried out to determine the noise and vibration impacts of the construction phase of the proposed scheme. Due to the nature of the works, significant noise and vibration impacts are not expected during the operational phase. The assessment has therefore analysed the potential impacts of the noise generated during the construction phase of the proposed scheme on the sensitive receptors. In doing so, it has taken cognisance of the following standards and guidelines:

- Revised Guidelines on the Information to be contained in Environmental Impact Statements Draft September 2015;
- Advice Notes for Preparing Environmental Impact Statements Draft September 2015,
- Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4), 2012
- Cork Agglomeration Noise Action Plan 2013-2018, Cork County and City Councils.

The Transport Infrastructure Ireland (TII, formerly NRA) *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes* (TII, 2014), the *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (TII, 2004) was also considered in the preparation of the assessment. This document sets out noise and vibration limits for the construction phase which are generally applied by planning authorities to all construction projects.

9.2.1 Noise Assessment Criteria

9.2.1.1 Construction Phase

There is currently no statutory guidance relating to the maximum permissible noise level for a project's construction phase. Current guidance on permissible noise levels is therefore considered somewhat limited.

In the absence of any statutory guidance or other specific limits prescribed by local authorities, an appropriate best practice measure has been adopted as the standard for this project.

Best practice guidelines are taken from the British Standard BS 5228 – 1: 2009 +A1 2014: '*Code of practice for noise and vibration control on construction and open sites – Noise'.*

BS 5228 sets out an approach for setting appropriate construction noise limits for residential dwellings, but it does not provide guidance for commercial or office buildings. The BS 5228 'ABC Method' calls for the designation of a noise sensitive location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. This then sets a threshold noise value that, if exceeded, indicates a significant noise impact is associated with the construction activities as summarised in **Table 9.1**.

Table 9.1: Example Threshold of Significant Effect at Dwellings

Assessment Category and Threshold Value Period (L_{Aeq})	Threshold Value (dB)		
	Category A	Category B	Category C
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings & Weekends [D]	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Note A: Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.

Note B: Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.

Note C: Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.

Note D: 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

As a conservative estimate, Category A noise limits have been selected for day-time, evening time and night time noise limits. These limits are outlined in Table 9.2 and will be applied at the nearest sensitive receptor to each of the construction work areas. Sensitive receptors are defined in BS5228 as any occupied premises outside a site used as a dwelling, place of worship, educational establishment, hospital or similar institution or any other property likely to be adversely affected by an increase in noise level.

Table 9.2: Noise limits to be applied at sensitive receptors.

Assessment Category and Threshold Value Period (L_{Aeq})	Threshold Value (dB) Category A [A]
Night-time (23:00 to 07:00hrs)	45
Evenings & Weekends [D]	55
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65

The closest sensitive receptors are located c. 10m from the works. Predictions outlined in Section 9.5.1 have been made at this distance in order to estimate noise levels at worst case receptor.

9.2.2 Vibration Assessment Criteria

Vibration standards come in two varieties: those dealing with human comfort, and those dealing with cosmetic or structural damage to buildings. There are no expected significant vibration sources associated with the development once the construction phase has been completed.

Building Damage Building Response British Standard 7385-2 (1993) gives guidance regarding acceptable vibration in order to avoid damage to buildings. British Standard BS 5228-2 (2009) reproduces these guidance values.

These standards differentiate between transient and continuous vibration. Surface construction activities are transient because they occur for a limited period of time at a given location. Risk of cosmetic damage to residential buildings starts at a Peak Particle Velocity (PPV) of 15mm/s at 4Hz. Below 12.5 mm/s PPV, the risk of damage tends to zero. Important buildings that are difficult to repair might require special consideration on a case by case basis, but buildings of historical importance should not (unless they are structurally unsound) be assumed to be more sensitive. If a building is in a very unstable state, then it will tend to be more vulnerable to the possibility of damage arising from vibration or any other ground borne disturbance.

The most significant sources of transient vibration during the construction phase of the development are likely to be from the following activities:

- Excavation;
- Breaking of existing road surfaces and removal of bridges;
- Construction traffic;
- Channel widening and deepening, and.
- Piling foundations and flood defence walls, depending on the methodologies chosen.

Table 9.3 summarises the vibration levels below which there is no risk of damage to buildings. These limits apply to vibration frequencies below 15Hz where the most conservative limits are required. For protected or potentially vulnerable buildings, the recommended construction vibration limit is reduced by 50%.

Table 9.3: Transient Vibration Impact Criteria for Buildings (conservative criteria below which there is no risk of cosmetic damage).

Category of Building	Threshold of potential significant effect (Peak Particle Velocity - PPV - at building foundation) for Transient Vibration
Structurally sound and non-protected buildings	12 mm/s
Protected and / or potentially vulnerable buildings	6 mm/s

9.2.2.1 Human Perception

Humans are sensitive to vibration stimuli, and perception of vibration at high magnitudes may cause concern. Vibration typically becomes perceptible at around 0.15 to 0.3 mm/s and may become disturbing or annoying at higher magnitudes.

During surface construction works, the vibration limits set within Table 9.1 would be perceptible to building occupants and would have the potential to cause subjective impacts.

However, higher levels of vibration are typically tolerated for single events or events of short term duration, particularly during construction projects and when the origin of vibration is known. For example, piling can typically be tolerated at vibration levels up to 6 mm/s during the daytime and the evening if those affected are aware of the time-frame and origin of the vibration, and if they have been informed about the limit values relating to the structural integrity of neighbouring properties.

Therefore, regarding the human perception of vibration, the best way to reduce impacts on those in the locale is to plan and implement an effective public communications strategy informing neighbours about the time and duration of the vibration, that the vibration is being monitored, and that it is within safe limits.

9.2.2.2 Operational Phase

As the proposed scheme contains no operational noise sources and will generate no traffic, no operational traffic assessment has been undertaken.

9.3 Receiving Environment

Construction works for the proposed scheme will take place in four separate areas along the Tramore River and Ballybrack Stream as follows:

Area 1: Ballybrack Stream through Douglas.

Area 2: Tramore River through St Patrick's Mills, Douglas

Area 3: Grange Stream (tributary of Ballybrack Stream) through Donnybrook Commercial Centre

Area 4: Tramore River through Togher

The general study area is shown in **Figure 1.1**. **Figures 1.2a** and **1.2b** show key plans of the proposed flood defence works in Douglas and Togher.

Douglas

As this is a mainly residential and commercial zone, the existing noise environment in this section of the scheme is characterised by traffic noise.

The most southern point of the scheme in Douglas is at the Donnybrook Commercial Centre (Area 3). The centre comprises of both purpose built commercial units and older structures some of which are protected. The purpose built units are in closest proximity to the proposed works. The Grange Stream currently runs through part of this centre before being culverted.

There are a number of buildings to the east of the culvert and included in the commercial centre. Some of these buildings are listed on the National Inventory of Architectural Heritage or as National Monuments. The Jesus Christ Centre Church is located in one of these protected structures to the east of the culverted stream.

There are a number of residential areas surrounding the commercial centre; Grange Park north and behind the commercial units; to the south, Bromley Park and on Donnybrook Hill. The closest residence is approximately 45m north of the Grange Stream culvert and behind the commercial units in Grange Park.

The next section of the proposed flood relief scheme is downstream of the Grange Stream after the convergence of the Grange Stream into the Ballybrack Stream in Ballybrack Woods (Area 1). This area is used for recreation with a combined cycle/walkway through the woods that runs parallel to the Ballybrack Stream. Refer also to Chapters 1 and 3 for further details on the surrounding environment. In Ravensdale, there are a number of one off residential houses adjacent to the stream. Where Church Road crosses over the Ballybrack Stream, the surrounding area is a mix of retail, residential and recreational facilities. The Irish Countrywomen's Association (ICA) Hall is located on the left bank of the stream near Church Road (Refer to Figure 3.1). There is a retirement home and a number of retail units to the west of the ICA Hall. North of Church Road is St Luke's National School and Douglas Community Centre. The Ballybrack Stream flows under Church Road and north through Douglas Community Park towards Douglas village. There are a number of residential houses along the left bank of the stream opposite the Community Park. Many of these houses are c. 10m from the stream. On the right bank of the Ballybrack Stream is Douglas Community Park which runs parallel to the stream. The park contains a playground, large green areas, adult exercise equipment, and a cycle path and footpath that run parallel to the stream connecting Church Road and Church Street. At Church Street the stream is culverted.

Area 2 consists of construction works at Saint Patrick's Mills, north of Church Street and on the right bank of the Tramore River. The N40 national primary road or South Link runs over West Douglas Street and is a significant source of traffic noise in the area. East of Saint Patrick's Mills is the Douglas Village Shopping Centre which attracts significant traffic including cars which park in the multi-level car park.

Togher

As detailed in **Chapter 3**, the existing culvert between Lehenaghmore Industrial Estate and Greenwood Estate will be replaced and extended with a new reinforced concrete culvert. Lehenaghmore Industrial Estate is located at the southern and upstream end of Area 4 (Togher). A small number of commercial properties, as well as the housing estate at Brooke Avenue lie in close proximity to the river bank. The noise environment in this area is characterised by road traffic.

The existing culvert runs partially along the Lehenaghmore Road, through Togher cross and along Togher Road. The culverted section of the Tramore River is beneath the Togher Rd, which is lined with housing estates, the Togher Girls' National School, Togher Boys' National School and the Church of the Way of the Cross. The noise environment in this area is characterised by road traffic, which experiences school- and work-related peaks.

At the northern (downstream) extent of the scheme lies Greenwood Estate, which is a residential estate where numerous residential properties back onto the Tramore River before it is culverted.

A number of commercial properties including Griffin's piano shop are located on the river bank. The noise environment in this area is characterised by road traffic.

9.4 Characteristics of the Proposed Scheme

The proposed scheme consists of a number of construction activities as described in detail in **Chapter 3** of this EIS. The main aspects of the proposed scheme in relation to noise and vibration include the following:

- Construction of new flood defence walls and/or replacement of existing walls with new flood defence walls
- Replacement of and/or extension of existing culverts
- Removal of and/or replacement of bridges
- Removal of existing trash screens and construction of new screens
- Local channel widening, deepening, realignment and regrading
- Construction of new earthen flood defence embankment
- Provision of civil works such as road/footpath regrading at a number of locations;
- Removal of vegetation and trees to facilitate construction works
- Construction of 2 no. underground surface water pumping stations

All construction works are likely to generate noise and vibration to varying degrees, due to the intensity of the works and the machinery involved. In addition, the noise and vibration will be perceived differently in proportion to the distance from the receptor to the source.

9.5 Evaluation of Impacts

9.5.1 Construction Impacts

The TII guidance advises that noise levels associated with construction may be calculated in accordance with the methodology set out in BS 5228: Part 1. This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations. The TII guidance notes that definitive construction methods and number of plant items are not usually set out at the EIS stage and that the overriding requirement of the contractor will be to construct the scheme to the final design within the constraints of the construction noise limits. These limits are set out in **Table 9.2**.

Table 9.4 to **9.6** presents input data and calculations of indicative noise levels for typical noise sources associated with the construction of the proposed scheme. The numbers in respect of plant presented in the tables below are also indicative.

Noise levels have been predicted using guidance set out in BS 5228: *Code of Practice for Noise and Vibration Control on Construction and Open Sites (Part 1: Noise)* (BSI, 2009+A1:2014).

The assessment has been conducted to be representative of a worst case scenario. The following assumptions have also been made in the preparation of these construction noise prediction calculations:

- Plant items are operating between 25% and 80% of the time;
- All plant items associated with the individual phases are operating simultaneously and at the same distance for any one scenario; and
- The provision of a 2.4m hoarding around the construction works. This has been inputted as a 10dB reduction for each noise source, although a greater level of noise reduction would be expected.

BS 5228: 2009+2014 sets out typical noise levels for items of construction plant. **Table 9.4** sets out assumed plant items during the key phases of construction with the associated source reference from BS 5228.

The first relates to construction of flood defence walls, embankments, culverts and bridges, the second examines noise generated from works to roads.

Table 9.4: Typical construction noise levels from proposed plant (dB $L_{Aeq,1hr}$)

Phase	Typical Plant Item	Sound Power Level (dB $L_{Aeq,1hr}$)[1]	% of time in operation
Construction of flood defence walls, embankments, culverts and bridges	Chainsaw	100	25
	Water pump	90	80
	Mini Tracked Excavator	96	50
	Concrete Pump + Cement Mixer Truck (Discharging)	95	50
	Sheet Steel Piling - Hydraulic Jacking	91	50
Works to roads	Mini Tracked Excavator	96	50
	Mini Planer	96	50
	Asphalt Paver(+Tipper Lorry)	103	50

[1]: BS 5228-1 Code of practice for noise and vibration control on construction and open sites. Noise

It is expected that works in the distinct zones will be confined to very short periods of time, with a predicted maximum of several months. This will minimise the length of time that receptors are exposed to noise and vibration emissions.

9.5.1.1 Construction of flood defence walls, embankments, culverts and bridges

Works proposed: Reinstatement or replacement of existing flood defence wall and construction of new flood defence walls; river bank regrading and embankments; construction or replacement of culverts; trash screen removal/construction, river widening and deepening; replacement of a bridge; bridge removal; tree removal.

Where in-stream works are required as part of construction, this will require over pumping of water or temporary stream diversions, which will produce noise adding to the construction noise. Pumps are also a source of vibration, which is likely to be a constant low-frequency vibration for the duration of the use of the pump.

Ground breaking will be required for accessing and constructing culverts, bridge removal and replacement, and new flood defence walls. Excavators, scrapers, concrete mixers and concrete pumping will be used. In Areas 1, 3 and 4, some trees will be required to be felled and removed from site using chainsaws and elevated work platforms. **Table 9.5** outlines indicative construction noise predictions during this phase at various distances from the construction works.

Table 9.5: Indicative construction noise calculations during construction of flood defence walls, embankments, culverts and bridges

Construction of flood defence walls, embankments, culverts and bridges	Calculated $L_{Aeq,\ T}$ at distance from works (dB)			
	10m	20m	40m	80m
Chainsaw	61.0	55.0	48.9	42.9
Water pump	51.0	45.0	39.0	33.0
Mini Tracked Excavator	55.0	49.0	42.9	36.9
Concrete Pump + Cement Mixer Truck (Discharging)	54.0	48.0	41.9	35.9
Sheet Steel Piling - Hydraulic Jacking	50.0	44.0	37.9	31.9
Combined L_{Aeq} from all plant	*63*	*57*	*51*	*45*

The results of the assessment in **Table 9.5** indicate that for the construction of flood defence walls, embankments, culverts and bridges, the construction daytime noise limit of 65dB LAeq can typically be complied with for the scenario assessed. The nearest sensitive receptor is located c. 10m from these works.

9.5.1.2 Works to Roads

Works proposed: Provision of and re-grading of road/footpaths; replacement of culverts below roadways

Works required to roads generate noise. It is likely that the increased movement of HGVs will result in an increase in overall noise levels, but this impact is not expected to be significant due to the noise environment already being dominated by traffic noise. Road construction activities, including excavation, will also generate noise.

Replacing existing culverts below the Togher Road and Church Road will require ground breaking excavation, pumping and regrading works. The impact is likely to be moderate temporary but not significant as existing noise levels in these areas are already dominated by traffic noise.

Table 9.6 outlines indicative construction noise predictions during this phase at various distances from the construction works.

Table 9.6: Indicative construction noise calculations during works to roads

Works to Roads	Calculated $L_{Aeq,T}$ at distance from works (dB)			
	10m	20m	40m	80m
Mini Tracked Excavator	55.0	49.0	42.9	36.9
Mini Planer	55.0	49.0	42.9	36.9
Asphalt Paver (and Tipper Lorry)	62.0	56.0	49.9	43.9
Combined L_{Aeq} from all plant	63	57	51	45

The results of the assessment in **Table 9.6** indicate that for the construction of works in roads, the construction daytime noise limit of 65dB LAeq can typically be complied with for the scenario assessed. The nearest sensitive receptor is located c. 10m from these works.

9.5.2 Operational Impacts

Once the works are complete it is not envisaged that there will be any operational impacts. Channel maintenance works may be necessary during operation such as trash screen clearing but it is not envisioned that these works will have a significant impact on noise and vibration in the area.

The two surface water pumping stations proposed (located adjacent to Church Road and in St Patricks Mills) as part of the scheme have the potential to generate noise when operational. However, the surface water stations will be installed underground so it is not envisaged that they will have a significant impact. The pumps will also be in operation during flood events only.

9.6 Mitigation Measures

9.6.1 Construction Mitigation Measures

The construction contractor will be required to manage noise and vibration aspects of the project in accordance with BS 5228 Part 1 (2009) and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001 *Code of Practice for Noise and Vibration Control on Construction and Open Sites*. This document provides for practical measures that limit the hours in which noisy activities are permitted, provision of acoustic screening for noisy activities, use of silencers on equipment, siting of noisy mobile equipment away from sensitive receptors, and the provision of relevant training with respect to minimising noise disturbance. It is recommended that the contractor liaises with residents of nearby dwellings in advance of works to assist in managing expectations with regard to length and duration of works, to minimise upset and aggravation.

It is expected that works in the distinct zones will be confined to very short periods of time, with a predicted maximum of several months. This will minimise the length of time that receptors are exposed to noise and vibration emissions. Noise emissions will comply with daytime noise limits (65dB $L_{Aeq\ 1h}$).

The following measures will also be employed by the Main Contractor(s):

- Selection of plant machinery with low inherent potential for generation of noise and/or vibration. All construction plant and equipment to be used at the site will be modern equipment and will comply with the relevant legislation and regulations
- A site representative shall be appointed to be responsible for matters relating to noise and vibration.
- Unnecessary revving of engines shall be avoided and equipment shall be switched off when not required;
- Internal haul routes shall be well maintained and shall avoid steep gradients;
- Rubber linings shall be used in chutes and dumpers etc. to reduce noise impact;
- Drop heights of materials shall be minimised;
- Plant and vehicles shall be started sequentially rather than all together.
- Construction plant and activities to be employed on site shall be reviewed to ensure that they are the quietest available for the required purpose;
- Where required, improved sound reduction methods, e.g. enclosures shall be used;
- Site equipment shall be located away from noise sensitive areas, as much as is feasible;
- Regular and effective maintenance by trained personnel shall be carried out to reduce noise and/or vibration from plant and machinery;
- Any compressors used on-site will be of the "sound reduced" models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machines, which are used intermittently, will be shut down or throttled back to a minimum during those periods when they are not in use.
- Any plant, such as generators or pumps, which are required to work outside of normal working hours, will be surrounded by an acoustic enclosure.
- A 2.4m hoarding will be provided around the construction works area where possible. However if this is not suitable for the construction of embankments, the use of pressed-in sheet piling where possible will avoid vibration nuisance. Screens will be positioned as close as possible to either the source or the receptor. The screen will ensure that there is no direct line of sight between the source and the receptor. The site layout will be considered as this can also contribute to noise screening - the position of storage, offices, or other elements of the construction compound can also provide a degree of noise screening if placed between source and receptor;
- Site activities shall be limited to 8am - 7pm, Monday to Friday; and 9am - 4pm, Saturday (It may be necessary in exceptional circumstances to undertake certain types of activities outside of normal construction core working hours. Any such working hours outside the normal construction core working hours will be agreed with Cork County Council. The planning of such works will have regard to nearby sensitive receptors;

- The Main Contractor(s) shall be required to carry out continuous noise and vibration monitoring in areas where residential properties are directly adjacent to the works. These levels will be compared to the limit values outlined in **Table 9.2** and **Table 9.3**. If exceedances are recorded, alternative construction methodologies will be proposed to ensure limits are complied with.

9.6.2 Operational Mitigation Measures

In operation, the scheme will not generate significant noise or vibration impacts and therefore mitigation is not required for this phase. Channel maintenance activities may be required where necessary during operation but these activities are not envisaged to have any impacts on noise and vibration.

9.7 Residual Impacts

9.7.1 Construction Phase

A preliminary noise assessment of the construction phase impacts has shown that compliance with limit values can be achieved. Noise and vibration monitoring will be undertaken in areas where residential properties are directly adjacent to the works, as outlined in Section 9.6.1. No significant residual impacts are predicted.

9.7.2 Operational Phase

No residual impacts on noise and vibration are predicted during the operational phase.

9.8 References

BS 5228-1 and 2:2009+A1:2014 (2014) *Code of practice for noise and vibration control on construction and open sites.* Noise and Vibration.

European Communities (2001) *Noise Emission by Equipment for Use Outdoors Regulations*, 2001

International Electrotechnical Commission (IEC), 2002, IEC 61672-1 Electroacoustics – Sound Level Meters – Part 1: Specifications. IEC, Geneva, Switzerland.

International Standard ISO 1996: 2007: Acoustics – Description, measurement and assessment of environment.

Transport Infrastructure Ireland (TII), (formerly the National Roads Authority (NRA)) (2004) *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*, NRA, 2004.

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UK Highways Agency, 2011. Design Manual for Roads and Bridges (DMRB) Volume III, Section 3, Part 7 Noise and Vibration.