Chapter 6:

Geology and Soils in the Existing Environment

6 GEOLOGY AND SOILS IN THE EXISTING ENVIRONMENT

The Study Area is located to the north of Cork City and comprises of the Bride (North) catchment area. The Bride (North) catchment area includes the area surrounding the Bride (North)/ Kiln river, the Glenamought stream and the Glen River.

This chapter of the EIS presents available information on the soils and geology of the Study Area along and in the vicinity of the proposed Drainage Scheme. It investigates how the existing soil and geological environment may be altered in both the short and long-term by the construction and operation of the proposed scheme. Should significant impacts be identified on the soil and geology, mitigation measures will be proposed insofar as practicable.

The River Bride (Blackpool) Certified Drainage Scheme construction phase will include the following;

- detailed site investigation
- site preparation works including temporary fencing / hoarding
- construction of culverts
- replacement of an existing culvert
- construction of reinforced concrete walls
- construction of earthen embankments
- construction of sedimentation trap
- services and utility diversions
- re-instatement of footpaths / roadways / green areas

6.1 METHODOLOGY AND LIMITATIONS

This chapter was compiled in accordance with the EPA publication entitled 'Guidelines on the information to be contained in Environmental Impact Statements' along with 'Advice Notes on Current Practice in the preparation of Environmental Impact Statements'. The Institute of Geologists of Ireland also published a guidance that was consulted during the preparation of this Chapter, entitled 'Geology in Environmental Impact Statement – A Guide'.

A desktop study was carried out in order to ascertain a comprehensive baseline for the Study Area and give a description of the existing environment. This information was then used in assessing the potential impact the Drainage Scheme will have on the geology and soils within the Study Area. It was then possible to propose practicable mitigation measures to ensure that any potential impacts identifies will not have a significant impact on the environment during the construction and operational phase.

No significant difficulties were encountered in the compilation of this Chapter.

6.1.1 Published Material

The baseline study of the existing soil and geological environment throughout the proposed Study Area was prepared using the Geological Survey of Ireland's (GSI) online database and the GSI publication; 'Geology of South Cork' (1994), along with additional source material. A comprehensive list is included below;

- The Geology of South Cork (Sleeman and Pracht, GSI, 1994)
- The GSI online database
- Cork City Development Plan (2015 - 2021)
- Cork County Council Development Plan (2014)

- Cork City Council Planning and Development (Applications for Registration of Quarries under Section 261, Planning and Development Act 2000)
- Cork County Council Planning and Development (Applications for Registration of Quarries under Section 261, Planning and Development Act 2000)
- Concrete Products Directory (Irish Concrete Federation)
- Aerial Photography
- ENVision Mines Site, the EPA's online Historic Mines Inventory
- General Soil Map of Ireland
- Explanatory Bulletin to Soil Map of Ireland 1980

A ground investigation contract was carried out which consisted of boreholes, trial pits and slit trench excavations spread throughout the Study Area. The recorded data was used to confirm and verify information obtained from the above sources.

A study carried out by JBA Consulting entitled 'Lower Lee Flood Relief Scheme Blackpool Hydraulic Modelling Report' was also consulted.

6.1.2 Definitions

Environmental and agricultural scientists generally understand the word 'soil' to refer to the fertile, organic rich layer which occurs on the surface of the Earth and the underlying layers which interact with it in terms of nutrient, ion, water and heat exchange. Using this definition, the depth of the soil layer is typically 0.3m to 1.0m thick. Geologists and engineers, on the other hand, generally understand the word 'soil' to refer to all unconsolidated (non-lithified) organic and inorganic deposits which occur above bedrock.

For the purpose of this EIS, the term 'soil' refers to the unconsolidated, organic rich material closest to the Earth's surface ('topsoil), while the term 'subsoil' (Quaternary Geology) is used to refer to all other unconsolidated (non-lithified) materials which occur above bedrock.

6.2 GEOLOGY

6.2.1 Geomorphology

The topography of the South Cork region is controlled by its geological structure, with the anticlines forming upland areas and the synclines occupied by valleys. These valleys were formed during the Pleistocene glaciations, which occurred 2 million to 10 thousand years ago. Prior to this, the regional topography sloped southwards and the region was drained by southerly flowing rivers. This Tertiary drainage was truncated by glaciers advancing outwards from the mountainous regions of western Ireland, preferentially exploiting the weaker shales resulting in the development of a large number of broad u-shaped valleys, where previously there has only been north-south drainage patterns. Superimposed on these u-shaped valleys are a number of buried valleys infilled with sand and gravel.

At the peak of the last glaciation, 15,000 years ago, when much of Europe was covered in ice, sea levels fell to approximately 130m lower than present day. As a result the rivers eroded down to the new base level cutting new steep sided gorges. When temperatures subsequently improved the ice sheets receded, sea levels rose and the gorges rapidly became infilled with fluvioglacial sand and gravels as the rivers responded again to the changing base level. The south of Ireland continues to sink and so sea levels are still rising. Milenic & Allen, 2002, estimate this rise as being 16m over the past 8,000 years.

6.2.2 Bedrock Geology

The bedrock of South Cork is much less varied than in many parts of the country. With one exception all the rocks exposed are sedimentary and were deposited during the late Devonian and Carboniferous Periods, between about 310 to 370 million years ago.

Sedimentary rocks are deposited in beds or strata. For the purposes of description and mapping related beds of rocks are commonly grouped together into formations. These formations can then be sub-divided into members, which usually represent a distinctive feature or local variations.

The Geology of South Cork (Sleeman and Pracht, GSI, 1994) and the 'Geological Survey of Ireland Online Database' (shown in Appendix 6B of this document) indicates that the majority of the Study Area is underlain by Devonian "Old Red Sandstone" rocks which comprises the Ballytrasna Formation purple mudstone and sandstone and Gyleen Formation sandstone with mudstone and siltstone.

A portion of the Study Area to the north of Blackpool is underlain by Old Head Sandstone Formation which comprises flaser-bedded sandstone and minor mudstone. Another portion of the study area to the south is underlain by Cuskinny Member which comprises flaser-bedded sandstone and mudstone.

The findings of the ground investigation, which was carried throughout the proposed Study Area are broadly in line with the bedrock as described above. Bedrock encountered in rotary core boreholes in the study area comprised purple/brown Mudstone and purple Siltstone and Sandstone with quartz veining.

6.2.3 Geological Heritage

Geological heritage encompasses the earth science component of nature conservation. This includes both bedrock and unconsolidated (soil) deposits close to the surface and processes (past and present) that shaped the land surface. The identification of geological heritage is achieved by finding sites or areas that best demonstrate particular types of geology, processes or phenomena that rank as noteworthy. A site selection process is being undertaken by the Geological Survey of Ireland (GSI), through the Irish Geological Heritage (IGH) Programme.

The IGH programme is a partnership between GSI and the National Parks and Wildlife Service (NPWS) and aims to identify, document the wealth of geological heritage, and protect and conserve it against threats through local authority planning and promote its value with landowners and the public. The primary national site designation for geological heritage (and nature conservation in general) is the Natural Heritage Area (NHA) designation. Designation of national sites is the responsibility of the National Parks and Wildlife Service (NPWS), working in partnership with the IGH programme. The second tier designation is that of County Geological Site (CGS). While a County Geological Site is not statutorily protected, the designation is intended to provide recognition for the site and protection through inclusion within the County/ City Development Plan Policy and Objectives.

The Cork City Development Plan (2015 - 2021) states that the Council '*recognises the need to maintain and preserve important features of geological interest in the city and will work with the Geological Survey of Ireland, as appropriate, to conserve the sites identified as being of geological interest.* '

The Cork City Development Plan identifies 7 sites of geological and geomorphological interest in the county as proposed Natural Heritage Areas (pNHAs). None of the 7 sites are located within the Study Area.

6.2.4 Economic Geology

The term 'economic geology' refers to commercial activities involving soil and bedrock. The activities involved principally comprise aggregate extraction (sand and gravel pits and quarries) and mining. A number of sources were examined for information on such commercial activities within the Study Area, including:

- Cork City Council Planning Department (Application for Registration of Quarries under Section 261, Planning and Development Act 2000)
- Cork County Council Planning Department (Application for Registration of Quarries under Section 261, Planning and Development Act 2000)
- Cork City Development Plan (2015 - 2021)
- Cork County Council Development Plan (2014)
- Concrete Products Directory (Irish Concrete Federation)
- Aerial Photographs (2005)
- ENVision Mines Site, the EPA's online Historic Mines Inventory
- EPA Map Viewer

The sources consulted above indicate that there are no active quarries within the Study Area. The nearest active quarries are presented on Table 6.1:

Table 6.1 Quarries in close proximity to the Study Area

Location	Status	Operators
Classic Pit, c. 15km outside Study Area	Active	Roadstone Ltd.
Garryhesta Pit, c. 17km outside Study Area	Active	Roadstone Ltd.

The locations of these quarries are shown on Drawing SG001 in Appendix 6A.

As the abovementioned quarries are outside the Study Area, it is not envisaged that there will be any impact on these facilities from the proposed Drainage Scheme.

6.2.5 Geohazards

Upon consultation with the GSI National Landslide Database for Ireland, it was found that there are no recorded landslides in the area. There are no known geohazards within or in the immediate vicinity of the Study Area.

6.2.6 Quaternary Geology (Subsoil)

The Quaternary Period, which extended from the beginning of the Ice Age to the present day, is the final one of geological time scale. Most of the surface deposits of this area were deposited during the Quaternary Period, largely during the Ice Age itself. They were deposited either directly by glacier ice or by glacial meltwater. As the ice flowed over the underlying rock surface, pieces of protruding and loose rock became attached to its base. As these were carried along they both abraded the underlying rock and were ground down themselves. The rock that was picked up by the ice and partly ground down was later deposited either directly from the base or margin of the ice, or by meltwater flowing from the ice. In the former case it became till and in the latter case it was separated out and deposited as gravel, sand, silt or clay. The composition of these sediments reflects the type of rock or substrate over which the ice flowed.

Subsoils deposited since the end of the last glaciation are typically referred to as 'recent deposits'. The most widespread recent deposits in Ireland is peat, which occurs both as upland blanket peat and lowland raised bog. Other recent deposits include silt and clay rich alluvium, typically deposited by and along rivers.

According to the 'Geological Survey of Ireland Online Database' the Study Area is comprised of the following subsoils (Extract from GSI Database presented in Appendix 6B);

- Made Ground
- Till derived from mixed Devonian Sandstones
- Alluvium

There are also a number of bedrock outcrops to the north of the Study Area.

6.2.6.1 Made Ground

Made Ground is defined as material, including soil, which has been deposited on land and/or altered by anthropogenic (human) activity. Made Ground is shown in the urbanised areas of the Study Area.

The key risk associated with made ground is its uncertain origin and potential for contamination. However, no evidence of historical activities which could potentially have contributed to soil contamination was identified along or in the vicinity of the proposed scheme.

6.2.6.2 Glacial Till

Glacial till is a generic term which applies to glacially derived and/or transported soil which is deposited beneath or on the margins of a glacier or ice sheet. The Teagasc subsoil map, as presented on the Geological Survey of Ireland Online Database, indicates that glacial till is the predominant subsoil occurring in the north of the Study Area and is principally derived from Devonian sandstones.

It is unlikely that the proposed scheme will impact on this Glacial Till.

6.2.6.3 Alluvium

Alluvium is a young sediment that was recently eroded and carried off the hill side by a surface watercourse. It is ground into finer and finer grains each time it moves downstream, a process that can take thousands of years.

Alluvium soils are typically found at or in the vicinity of a surface watercourse and as such, a large stretch of the Shournagh River within the Study Area is situated within Alluvium subsoils. As these subsoils are located in the immediate vicinity proposed works, it is likely that there will be an interaction with the proposed Drainage Scheme.

6.2.7 Potential Impacts on Geology

The key impact associated with the construction phase of the River Bride (Blackpool) Certified Drainage Scheme is the excavation, handling, storage, processing and transport of earthworks materials. The estimated volume of excavation anticipated during the construction phase is presented on Table 6.2;

Table 6.2 Volumes of Excavated Material

Origin of Excavation	Volume of Material
Wall Foundations	2,200m^3
Embankment Foundations	500m^3
Culverts	6,000m^3
Pipeline Trenches	500m^3
Other (Pumping Stations, bridge upgrades, sediment trap, winter channel)	4,500m^3
TOTAL	**13,700m^3**

There are a number of potentially negative environmental impacts associated with the handling of excavated materials. These impacts can arise directly as a result of on-site excavation and embankment construction activities or indirectly, due to placement of excess unsuitable materials at off-site locations.

Detailed site investigation works will also be carried out prior to the construction stage. These works will include intermittent coring of the bedrock, but impact is predicted to be imperceptible and as such has not been assessed below.

6.2.7.1 Loss of Bedrock

Potential Permanent Slight Negative Impact

The vast majority of the Study Area is underlain by Devonian "Old Red Sandstone" rocks which comprises the Ballytrasna Formation purple mudstone and sandstone and Gyleen Formation sandstone with mudstone and siltstone, as described above in Section 6.2.2.

As the type of bedrock that will be excavated is abundant throughout the Study Area the portion to be removed will be imperceptible in comparison to the volumes retained and as such will not have a significant impact on the bedrock of the Study Area. In addition, the preliminary site investigation indicates that rock is present at significant depths and will therefore not be impacted by the scheme.

Mitigation Measures

Where it is necessary to remove bedrock to facilitate construction of the proposed scheme, suitable material will be reused elsewhere where possible. Material removed from site will be transported to the closest suitably licensed facility to be processed and used on other construction projects in the vicinity, where possible.

Residual Impact – Potential Permanent Imperceptible Negative Impact

It is likely that, with the mitigation in place this impact will constitute a Permanent Imperceptible Negative Impact. This residual impact will be fully identified as the works method statement become finalised.

6.2.7.2 Loss of Geological Heritage

Neutral Impact

There are no sites in the vicinity of the proposed works of sufficient geological or geomorphological importance on a national or county scale to merit consideration for designation as a Natural Heritage Area (NHA) or designated as a County Geological Site. Due to possible exposure of bedrock as a result of proposed excavation works it is just as likely that the impact will be positive as negative.

Should there be exposure of new geological surfaces, especially in bedrock, it may serve to facilitate greater understanding and appreciation of local geological heritage and earth science.

6.2.7.3 Loss of Quaternary Geology

Potential Permanent Slight Negative Impact

As described in Section 6.2.6, the Study Area is predominantly underlain by Made Ground, till derived from mixed Devonian Sandstone and Alluvium. It is likely that excavations for flood defences are to be in Made Ground. The site investigation recorded that gravels are also present.

The impact of the removal of excavated material from the proposed works will be minimal as these subsoils are in abundance throughout the Study Area.

A large portion of the proposed flood defence measures are underlain by made ground and therefore there is a risk that contaminated material may be encountered. No evidence of historic activities which could potentially have contributed to soil contamination were identified in the immediate vicinity of the proposed scheme. Although the key risk with Made Ground is its uncertain origin, on the basis of available evidence and taking into consideration the small volume of made ground to be excavated, the potential impact is regarded as being imperceptible.

Mitigation Measures

Excavated subsoils will be reused as fill, or for the construction of flood defence embankments where possible. Any remaining volumes of unsuitable materials will be transported to the closest suitably licensed facility to be processed and reused in other construction projects in the vicinity, where possible.

Residual Impact – Potential Permanent Imperceptible Negative Impact

It is likely that, with the mitigation in place this impact will constitute a Permanent Imperceptible Negative Impact. This residual impact will be fully identified as the works method statement become finalised.

6.3 SOILS

Soil is the top layer of the earths crust. It is formed by mineral particles, organic matter, water, air and living organisms. It is an extremely complex, variable and living medium and its characteristics are a function of parent subsoil or bedrock materials, climate, relief and the actions of living organisms over time.

Soil can take thousands of years to evolve and is essentially a non-renewable resource. Soil performs many vital functions. It supports food and other biomass production (for example forestry and biofuels) by providing anchorage for vegetation and storing water and nutrients long enough for plant to absorb them. Soil also stores, filters and transforms other substances including carbon and nitrogen. It has a role supporting habitats and serves as a platform for human activity, landscape and archaeology.

6.3.1 Soil Formation

There are three principal soil formation processes that take place in Ireland, leaching, gleisation and calcification.

Through the *leaching* process, soluble constituents are carried down through the soil profile, the soil becomes progressively more acidic until relatively insoluble constitutes such as iron, aluminium and humus are washed deeper into the soil. Organic matter may accumulate on the surface and an iron pan may be formed at a lower level in the soil. At this point the leaching process may be referred to as podzolisation.

Gleisation is the soil-forming process resulting from the water-logging, possibly due to high water tables, or the impermeable nature of the soil itself. The movement of water through the soil is highly restricted and as a result leaching is very limited. Due to anaerobic conditions many soil constituents are converted by chemical processes into reduced forms. The soil usually takes a grey or blue colour as a result of the reoxidation processes.

Calcification is a process resulting in the redistribution of calcium carbonate in the soil profile without complete removal of it. Regions where rainfall is typically 750mm or less are affected by this process. Since the rainfall is low, the percolation of water through the profile is not sufficient to completely remove the calcium carbonate that existed in the parent material or that was produced by reaction between carbonic acid and the calcium hydrolysed from silicate minerals. Accumulation of carbonates at some point in the profile is typical of calcification. Calcium also tends to keep fine clay in a granular condition resulting in very little downward clay movement.

Due to the climate in Ireland, Leaching and Gleisation are the two most common soil formation processes.

6.3.2 Soil Associations

The General Soil Map of Ireland classifies the Study Area as Rolling Lowland. These lands have slopes between 2 and 6 degrees with soils typically derived from shales, sandstone, granite or mica schist.

The Study Area comprises principally of Brown Podzolic soil (60%). Associated soil classifications are defined as Acid Brown Earths (20%) and Gleys (20%). These soils have been derived from sandstone and Lower Avonian Shale glacial till which is consistent with ground conditions as recorded in boreholes carried out as part of the site investigation. Site Investigation records suggest that the soils in the area are shallow, with the deepest level recorded being 1.2 metres below ground level. Made Ground from the surface was recorded in a number of locations.

Brown Podzolic soils have been formed through the leaching process as described above. They are less depleted than other soils formed through this process, and the profile usually consists of a surface in which organic matter is mixed with mineral matter. This overlies a reddish-brown layer in which iron, aluminium and sometimes humus have accumulated and there is no iron pan. Brown Podzolics have desirable physical characteristics and as a result are often devoted to cultivated cropping and pasture production. The low nutrient levels are easily overcome with the addition of lime and fertiliser.

Brown Earths are relatively mature, well drained, mineral soil with a relatively uniform profile. These soils have not been extensively leached with the result that there are no obvious signs of removal and deposition of iron oxides, humus or clays. In many cases a certain degree of leaching has taken place resulting in the translocation of soluble constituents, notably calcium and magnesium. The majority of Brown Earths result from lime deficient parent minerals and are therefore acid in nature. The desirable structure

and drainage characteristics results in these soils being the most extensively cultivated soils, making up for a relatively low nutrient status by responding well to manorial amendments.

Gleys are soils in which the effects of poor drainage dominate and which have developed under the influence of waterlogging, characterised by the Gleisation process described above. Most gleys have poor physical conditions which make them unsuitable for cultivation or for intensive grassland farming. Their productive capacity is also affected by restricted growth in spring and autumn.

6.3.3 Potential Impacts on Soil

6.3.3.1 Loss of Soil

Potential Permanent Imperceptible Negative Impact

As the proposed scheme does not traverse large tracts of agricultural land, and soil was not encountered in all boreholes carried out to date, it is unlikely that the scheme will have a significant impact on the soil in the area. Considering that the majority of the proposed works are to be carried out to existing structures or in urban areas the loss of soil will be minimal.

Any loss of soil, or other potential impacts will be during the construction phase and likely to be associated with excavation, handling, storage, processing and transport of earthworks materials. Where soils are disturbed, excavated and/or stored for re-use during construction, they are prone to erosion by surface water run-off. In-situ soils may be compacted by construction machinery, reducing their ability to store water, which in turn may lead to increased run-off and soil erosion.

As any soils underlying the proposed works are abundant on a local and regional scale, they are of relatively low environmental and/or ecological value. The volume of soils encountered throughout the construction phase will be also be relatively small in comparison to the volume of excavated material generated.

Mitigation Measures

The construction and operation of the River Bride (Blackpool) Certified Drainage Scheme is not likely to have a significant impact on the soil in the area due to the small volumes, if any, of undisturbed soils that are likely to be encountered. Any excavated topsoil is likely to be reused in the construction of the flood defence embankments. It is necessary however to put in place mitigation measures in order to maximise the preservation of soil throughout the scheme.

In order to control the potential loss of soils as a result of erosion due to surface water run-off, a surface water management system will be put in place where necessary. As well as minimising soil erosion, a surface water management system will also minimise the volume of suspended solids transported by surface water run-off and discharged into local watercourses. The following measures will be implemented during the construction phase where applicable;

- Vegetation and soil will be left in place for as long as possible prior to excavation and stockpiling of soil to be minimised during wet weather periods.
- Soil stockpiles will be shaped so as to shed water.
- Surface water run-off from exposed soil surface will be intercepted and channelled to sumps and to silt traps thereafter.
- Granular materials will be placed over bare soil, particularly in the vicinity of watercourses, to prevent erosion of fines and/or rutting by construction machinery.

Residual Impact – Neutral Impact

Taking into account the relatively small volume of soil anticipated to be encountered throughout the construction phase, in conjunction with the mitigation measures as outlined above, the residual impact of the proposed scheme on the soil in the area is insignificant. This impact will constitute a **Neutral Impact**.

6.3.3.2 Contaminated Land

Potential Temporary Moderate Negative Impact

Potential impacts that may result from the improper management, storage and handling of fuels and lubricants for plant and machinery and of non-hazardous or hazardous liquid and solid wastes during the construction phase of the proposed scheme. Localised contamination of soils could result from an accident, spill or leak.

Mitigation Measures

In order to reduce the risk of soil contamination as a result of accidents spill or leaks the following measures will be implemented;

- Fuels, chemicals, liquids and solid wastes will be stored on impermeable surfaces
- Plant refuelling shall be undertaken on impermeable surfaces within a suitably constructed bund in accordance with best practice guidelines. No refuelling will be permitted in or near soil or rock cuttings.
- All hydrocarbons and other potential contaminants will be stored within suitably constructed bunds in accordance with best practice guidelines.
- Spill kits will be provided at refuelling areas and at high risk/sensitive sites.

Residual Impact – Potential Temporary Slight Negative Impact

It is likely that, with the mitigation in place this impact will constitute a **Potential Temporary Slight Negative Impact**. This residual impact will be fully identified as the works method statements become finalised.

6.4 HYDROMORPHOLOGY

Hydro morphology is similar to geomorphology in that it is the study of the structure, evolution and continued morphology of water courses over time.

The material in this section is based on a report prepared by JBA Consulting entitled 'Hydromorphic audit of the Lower Lee watercourse'.

6.4.1 Hydromorphological Characteristics

The watercourses of the Lower Lee are a mixture of semi-natural and heavily modified water bodies. The upper reaches of the Bride channel contains a mixture of pool-riffle-point bar morphology interspersed between impacted reaches where impoundments and historic channel modifications have created extended ponded pool and glide biotopes. Large culverts have been construction on the Bride River, influencing the channel processes and modifying the natural course of the channel. Fine and coarse sediment supply is low and comes from sources such as bank erosion and glacial sediment re-working. Sediment accumulation issues in the channel are a result of modification to the channel processes including impoundment disrupting the downstream transport of sediment, over widening which increases sedimentation due to reduced channel velocity, narrowing which decreases sediment due to increased channel velocity and poor placement of channel features and structures.

The Bride River flows through a confined urban area in which the channel's natural corridor has been reduced and confined by concrete walls in several sections, reducing connectivity to the floodplain. Restoration works such as re-profiling banks have been carried out in a number of areas to improve the channel morphology within the constrained environment. Despite being heavily modified, the channel continues to exhibit a gravel bed with a pool - riffle - run morphology.

The channel is predominantly narrow within the modified sections. The channel remains confined at the Blackpool shopping centre. The channel at Blackpool is heavily modified and enters a series of culverts before reaching the River Lee.

6.4.2 Potential Impacts on Hydromorphology

Potential Permanent Significant Negative Impact

The proposed works include culverting an open section of river channel between Old Commons Road and the existing culvert under the Commons Road (N20), local channel widening (winter channel) and the construction of a sediment trap at Sunbeam Industrial Estate, both on the River Bride. These works are included in the scheme as sediment management measures, and in the case of the sediment trap, as a conveyance improvement during high flows.

It is envisaged that the winter channel will increase the channel capacity by providing a secondary route into the existing bank during high flow conditions. The existing channel will be undisturbed apart from cutting back vegetation and, during normal flow conditions, the river is confined to the existing channel. Therefore it is envisaged that the impact on the channel hydromorphology as a result of the winter channel will be imperceptible.

The purpose of the sediment trap at the Sunbeam Industrial Estate is to capture fluvial sediments (primarily small cobble sized material), to help minimise the risk of large sediments settling in the Blackpool culvert system, which would reduce hydraulic capacity. The river channel along the route of the proposed culvert will be constructed, currently contains natural sediment deposits, but will cease to do so following construction of the proposed scheme and successful implementation of the sediment control measures proposed as part of the scheme upstream of the culvert.

A second potential sedimentation area has been identified upstream of the Common's Inn Hotel and this has provisionally been identified on the scheme drawings, if following detailed design or operation of the primary sediment trap, it becomes apparent that the addition of this area would provide an overall benefit to the management of sediment within this reach. The purpose of this trap would be to naturalise and reconnect the floodplain at this location. Flood scalping and lowering of the inside channel bends along a gently meandering section of river channel have the potential to enhance natural sediment controls upstream of the sediment trap at Sunbeam. In addition to regrading ground levels, this sediment management feature may incorporate instream geomorphic features, such as riffles. The potential inclusion of this feature in the scheme will be subject to review following detailed geotechnical investigations, detailed design and at a later point during the scheme operation. Nonetheless, its impact will be assessed in this Chapter.

In addition to the above features, removal of sediment from the river channel will form a key part of the sediment management regime.

Mitigation Measures

It has been observed that stone, silt and sand accumulate at hydraulically sensitive locations in the existing culvert system. If left unchecked, sediment has the potential to collect and accumulate at culvert inlets, bridge piers, channel bends etc, increasing the risk of flooding. Therefore in order to maximize hydraulic capacity and minimize defence height upstream, it is necessary to ensure that the culvert system is maintained as clean as possible.

Sediment management and sediment control will be an ongoing issue and will form a fundamental part of the scheme.

Sediment removal and sediment controls upstream of Sunbeam Industrial Estate will be carried out in consultation with Inland Fisheries Ireland, so as to minimise the volumes of sediment removed and the resultant impact on the morphological diversity upstream of the sediment trap at Sunbeam, while not compromising on the function of sediment control as a fundamental element of the proposed scheme.

Residual Impact – Potential Permanent Significant Negative Impact

The sediment controls will affect the hydromorphology of the river most significantly between the sediment trap and the existing culvert at Old Commons Road, limiting sediment deposition over a distance of approximately 1km incorporating culverts and open channel. Although the existing river channel through Blackpool Retail Park has been engineered, the river channel through Orchard Court along which the culvert is proposed currently displays patterns of natural sedimentation, with typically 40% riffle, 40% glide and 20% pool. Therefore it is envisaged that the impact on the channel hydromorphology over this 1km stretch as a result of the sediment controls at the Sunbeam Industrial Estate will have a **Permanent significant negative impact**. It is noted however that the significant negative impact is localised to this section of channel.

In addition, the proposed sediment controls will reduce the sediment contribution from the catchment of the River Bride to the intertidal zone of the River Lee downstream of the point of confluence at Christy Ring Bridge (N20). It is also noted that the river channel is dredged downstream of Custom House, so the channel affected is less than 1km in length. The reduction in sediment volumes may therefore have a **Permanent moderate negative impact**.

The sediment controls upstream of Commons Inn, which have been included in the scheme on a provisional basis, have the potential to enhance natural sediment controls at this location and over the stretch of river downstream to the sediment trap at Sunbeam (a total length of 1,160km) and promote more diverse channel morphology as a result. The effects on channel morphology could alternatively prove negative, the outcome being largely dependent on the detailed design of the features and the sediment management following construction. Although it is acknowledged that this measure could result in a permanent moderate positive impact, applying the precautionary principle, this could have a **Permanent moderate negative impact** along this section of channel should it be included in the scheme.

Chapter 7:

Water – Hydrology and Hydrogeology

7 WATER – HYDROLOGY & HYDROGEOLOGY

7.1 INTRODUCTION

This Chapter of the Environmental Impact Statement covers the potential impact of the proposed River Bride (Blackpool) Certified Drainage Scheme on the Water Environment. The chapter discusses the existing aquatic environment, the potential impacts of the scheme and remedial measures on both surface water and groundwater along with the hydrological and hydrogeological regimes of the Study Area. Impacts on Water: Hydrology and Hydrology are broken down into the following sections:

- Surface Water Quality;
- Hydrogeology;
- Flooding and Hydrology.

7.2 SURFACE WATER QUALITY

7.2.1 Legislative Review

7.2.1.1 Water Framework Directive

The EU Water Framework Directive (WFD) was adopted on the 23rd of October 2000 came into effect on the 22nd December 2000. It is the most significant piece of water legislation to be introduced by the European Commission in twenty years.

The Directive takes a broad approach to the protection, enhancement and restoration of all coastal waters, rivers, lakes, estuaries and groundwaters in Europe. It requires all countries to control, manage and protect their water resources from all impacts – physical, polluting or otherwise. Under the Directive, all waters within Europe must achieve at least 'Good' status by December 2015 unless otherwise agreed upon by the relevant authority and the European Commission and the status of any waters must not deteriorate.

7.2.1.2 The European Communities Environmental Objectives (Surface Water) Regulations, 2009 and Amendment Regulations 2012

The European Communities Environmental Objectives (Surface Waters) Regulations, 2009 came into effect on the 30th July 2009. They have a significant effect on the Water Framework Directive and also the Dangerous Substances and Priority Substances Directives.

The Directive, similar to the requirements of the Water Framework Directive, requires that all waters must be maintained at or improved to at least 'Good Status' by 22 December 2015. No deterioration in quality is permitted.

'Status' is a descriptor term that incorporates ecological and hydrochemical data and facilitates catchment comparisons on an EU scale. The catchment scale is referred to as the 'macro-scale'. Its status cannot be used to assess the potential impacts at a micro-scale i.e. a point discharge on a river, without there first being validation by monitoring data at the source of the point discharge. The EPA is responsible for assigning Status.

The European Communities Environmental Objectives (Surface Waters) Regulation, 2009, specify the conditions and physico-chemical concentrations that should be considered in the assessment of Status.

The 2012 Regulations set standards for a range of pesticide, herbicide and heavy metals in surface waters. It clarifies the role of public authorities in the protection of surface waters, include standards and sets limits for priority hazardous substances.

Table 7.1 below shows the surface water quality standards applied across a range of relevant legislation.

Table 7.1 Mandatory levels for physiochemical parameters for specific legislation

Parameter	Units	European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No. 294/1989)*	European Communities Environmental Objectives (Surface Water) Regulations (S.I. No. 272 of 2009)	European Communities Drinking Water Regulations S.I. 106 of 2007	Salmonid Water Regulations (Mandatory Level) (S.I. No. 293 of 1988)
BOD	mg/l	5 –A1 & A2 7 – A3	High status ≤1.3 (mean) or ≤2.2 (95%ile) Good status ≤1.5 (mean) or ≤2.6 (95%ile)	N/A	≤ 5
Suspended Solids	mg/l	50	N/A	N/A	≤ 25
pH	-	5.5-8.5 – A1 5.5-9.0 – A2 & A3	4.5-9.5 (Soft Water) 6.0-9.0 (Hard Water)	≥ 6.5 & ≤ 9.5	≥ 6 & ≤ 9
Conductivity	µS/cm	1,000	N/A	2,500	N/A
Phosphates	mg/l P_2O_5	0.5 – A1 & A2 0.7 A3	N/A	N/A	N/A
Molybdate Reactive Phosphorus (MRP)	mg/l P	N/A	High status ≤0.025 (mean) or ≤0.045 (95%ile) Good status ≤0.035 (mean) or ≤0.075 (95%ile)	N/A	N/A
Chloride	mg/l Cl	250	N/A	250	N/A
Ammonium	mg/l NH_4	0.2 – A1 1.5 – A2 4 – A3	N/A	N/A	≤ 1.0
Total Ammonia	mg/l N	N/A	High status ≤0.040 (mean) or ≤0.090 (95%ile) Good status ≤0.065 (mean) or ≤0.140 (95%ile)	N/A	N/A
Nitrate	mg/l NO_3	50	N/A	50	N/A
Nitrite	mg/l NO_2	N/A	N/A	0.5	≤ 0.05
Dissolved Oxygen	-	>60% - A1 >50% - A2 >30% - A3	Lower limit: 95%ile>80% saturation	N/A	50% ≥ 9 mg/l

Parameter	Units	European Communities (Quality of Surface Water Intended for the Abstraction of Drinking Water) Regulations, 1989 (S.I. No. 294/1989)*	European Communities Environmental Objectives (Surface Water) Regulations (S.I. No. 272 of 2009)	European Communities Drinking Water Regulations S.I. 106 of 2007	Salmonid Water Regulations (Mandatory Level) (S.I. No. 293 of 1988)
			Upper limit: 95%ile<120 %saturation		
Total Hardness	mg/l $CaCO_3$	N/A	N/A	N/A	N/A
Copper	mg/l Cu	0.05 –A1 0.1– A2 1.0 – A3	5 - water hardness ≤100mg/l $CaCO_3$ 30 – water hardness >100mg/l $CaCO_3$	2.0	≤ 0.005 [1, 6] ≤ 0.022 [2, 6] ≤ 0.04 [3, 6] ≤ 0.112 [4, 6]
Zinc	mg/l Zn	3–A1 5- A2 & A3	0.008 - water hardness ≤10mg/l $CaCO_3$ 0.05 - water hardness>10 ≤100mg/l $CaCO_3$ 0.1- water hardness >100mg/l $CaCO_3$	N/A	≤ 0.03 [1, 6] ≤ 0.2 [2, 6] ≤ 0.3 [3, 6] ≤ 0.5 [5, 6]
Total coliforms	no/100ml	5,000 – A1 25,000 – A2 100,000 – A3	N/A	N/A	N/A
Faecal coliforms	no/100ml	1,000 – A1 5,000 – A2 40,000 – A3	N/A	0	N/A

[1] At water hardness 10 mg/l CaCO3; [2] At water hardness 50 mg/l CaCO3.; [3] At water hardness 100 mg/l CaCO3 ; [4] At water hardness 300 mg/l CaCO3; [5] At water hardness 500 mg/l CaCO3; [6] To be conformed with by 95% of samples over a period of 12 months where sampling is carried out at least once a month; where sampling is less frequent, to be conformed with by all samples.

*S.I. No. 294/1989 is superseded by S.I. No. 272 of 2009. If a particular parameter is not found in SI 272 of 2009 then the 1989 value applies.

7.2.2 Methodology

7.2.2.1 Desk Study

A desk study of relevant hydrological data was conducted. The following documentation and sources were reviewed:

- Environmental Protection Area (EPA) water quality database and maps (http://gis.epa.ie/Envision)
- Cork City Council Surface Water Results for the River Lee
- South Western River Basin District Management Plan (2009 – 2015)
- The Water Framework Directive website www.WFD.ie

7.2.2.2 Field Assessment

Q Values were determined for the River Bride (North) and Glenamought in order to determine the baseline biological water quality for the study area.

Q Values are biotic indices used to express biological water quality and are based on changes in the macro invertebrate communities of riffle areas brought about by organic pollution. Q1 indicates a seriously polluted water body and Q5 indicates unpolluted water of high quality. A value of Q3 indicates moderately polluted water. These Q value ratings are shown in Table 7.2. In addition, various chemical parameters are also tested by the EPA and are available for some of the monitoring points.

Table 7.2 Q value classification

Quality Ratings	Quality Class	Pollution Status	Condition (re beneficial uses)
Q5, Q4-5, Q4	Class A	Unpolluted	Satisfactory
Q3-4	Class B	Slightly Polluted	Unsatisfactory
Q3, Q2-3	Class C	Moderately Polluted	Unsatisfactory
Q2, Q1-2, Q1	Class D	Seriously Polluted	Unsatisfactory

Kick samples of aquatic macro-invertebrates were collected on the Bride River (North) and the Glenamought River between the 2nd and 5th May 2015. Where possible the macro-invertebrate sampling stations were situated in the vicinity upstream or downstream of the works areas, given the selection of the sampling sites also depended on the presence of riffle/ glide habitat from which samples could be collected. Kick sampling was carried out at 4 locations in the River Bride (North) and the Glenamought River. Kick sampling was performed for 2.5 minutes in the faster flowing areas (riffles) of the river. The kick sample was taken moving across the riffle zone and also involved washing large rocks from the riffle zone to ensure a full representation of the species composition from this micro-habitat type. Collected samples were elutriated, refrigerated and identified live within 24 hours of each site visit. The samples were identified using a Nikon SMZ 1000 stereo microscope and numerous Freshwater Biological Association invertebrate keys. Invertebrate taxa were identified to species level where possible. The relative proportions of taxonomic groups were recorded based on the EPA categories (i.e. 8 categories ranging from present to excessive) (Appendix I of Toner et al., 20051). Biological water quality data as prescribed by the Environmental Protection Agency (EPA; Toner et al. 2005), group invertebrates into classes whereby very pollution intolerant species are denoted class A, and species with greater pollution tolerance fall into successive classes (B through E respectively). As such the presence or absence of these groups and their relative abundances

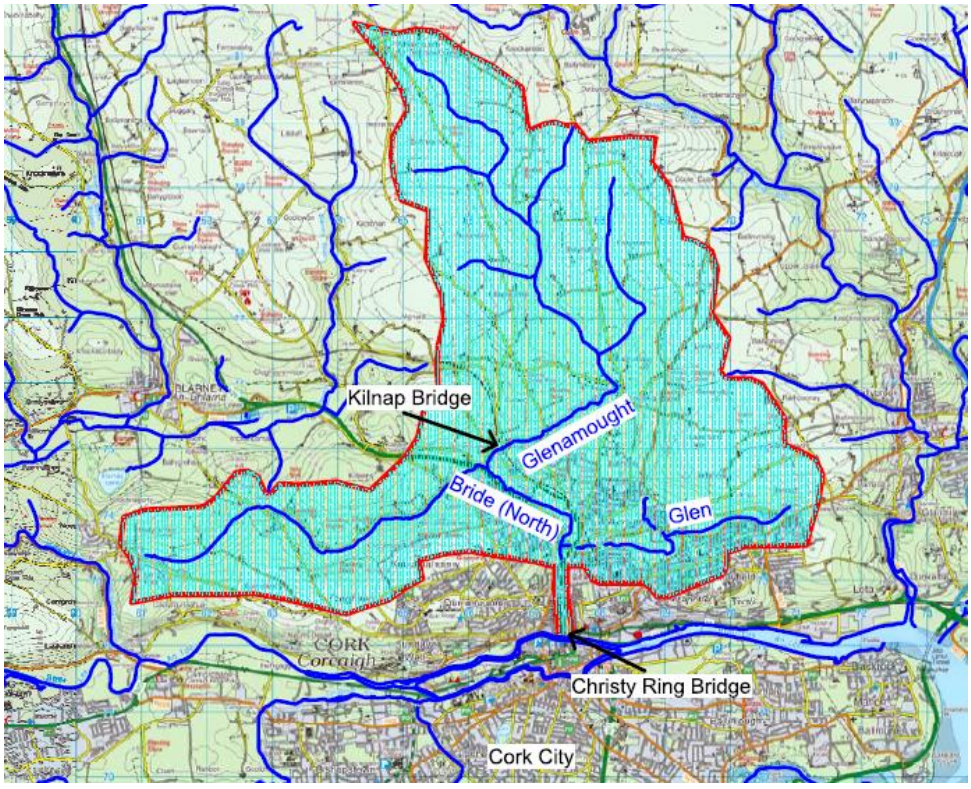
facilitates an assessment of biological river health. Using Appendix 1 of the Environmental Protection Agency publication Water Quality in Ireland, Q values were determined for all sites sampled, based on the faunal assemblage found at each sampling location.

7.2.3 Description of the Study Area

The Study Area consists of the of the River Bride (Blackpool) Certified Drainage Scheme which will alleviate flooding in the Blackpool area on the River Bride (North) of Cork City. The study area encompasses three major water courses: the Bride (North), the Glenamought and the Glen. The total catchment area upstream of Blackpool Village is 41.7km2.

The Bride (North) rises in the townland of Ballycannon, near Healy's Bridge, before flowing in an easterly direction towards Cork City. It is the most easterly tributary of the River Lee joining it east of Ovens. The Glenamought River rises in Whitechurch and flows in a southerly direction before making an abrupt right-turn in the townland of Ballincrokig. The Bride (North) and the Glenamought meet each other in a culverted system at the North Point Business Park on the N20. The Glen River flows in a westerly direction from Mayfield, through the Glen River Park, before entering a culvert under Spring Lane. It then merges with the Bride (North) in a large culvert junction under Madden's Buildings, 100m downstream of Blackpool Church. Downstream of the confluence of the Bride (North) and the Glen, the watercourse has traditionally been known as the Kiln River. The Kiln River discharges to the River Lee at Christy Ring Bridge. The culverted system in Blackpool has been incrementally constructed since the early the 1980s as part of the Glen-Bride-Kiln River Improvement Scheme which was commissioned by Cork Corporation in 1981. The topography of the entire catchment varies between 188mOD at Whitechurch and 25mOD in the Blackpool river valley.

Figure 7.1 Study Area Catchment and Rivers



7.2.3.1 EPA Water Quality Data

The EPA website, http://gis.epa.ie/Envision, contains information regarding water quality in selected Irish rivers based on surveys carried out by the EPA as part of the Water Framework Directive (WFD) Monitoring Programme. Biological information is provided in the form of Q values. The River Bride (North), the Glenamought River and the Glen River do not have any monitored points within the study area, therefore no EPA monitoring data was available for the River Bride (North), Glenamought River or the Glen River.

The closest EPA monitoring point on the River Lee, into which the Bride (North) flows is at Leemount Bridge, > 5km upstream of the confluence of the River Bride (North) and the River Lee. The water quality status at this monitoring point is Q4 "Good" status. The River Lee, approximately 3km upstream of the confluence of the River Lee and the River Bride (North) has "moderate" status under The River Waterbody Water Framework Directive (2010-2012 monitoring results).

The lower reaches of the River Lee, into which the River Bride (North) is a transitional coastal waterbody, i.e. the Lee (Cork) Estuary upper. The Lee (Cork) Estuary Upper Transitional Waterbody and the Lee (Cork) Estuary Lower Transitional WaterTransitional Waterbody, which lies downstream of the confluence both have "moderate" status under the Transitional Waterbody Water Framework Directive Status (2010-2012 monitoring results).

Water Framework Directive Operational Monitoring Data

Water quality monitoring, as required under the terms of the Water Framework Directive (WFD), is one of the functions of the Environment Section of Cork County Council and Cork City Council. The most recent physico-chemical data from monitoring points within and close to the Study Area taken by Cork City Council are presented in Table 7.3.

Table 7.3 Cork City Council Physico-chemical Monitoring Data for the River Lee

Parameter	Unit	River: Bride North. Station name and reference: Blackstone Bridge RS19B140110			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	14.2	14.0	10.6	10.4
Dissolved Oxygen	% Sat.	59.4	51.8	64.3	59.8
pH	pH units	7.4	7.7	7.7	7.6
Conductivity @20°C	µS/cm	314	319	355	288
Biochemical Oxygen	mg/l O_2	2.9	2.9	2.5	1.0
Ammonia	mg/l N	0.004	0.004	0.023	0.031
Nitrogen	mg/l N	6.3	6.6	4.82	7.60
Ortho-phosphate	mg/l P	0.048	0.080	0.079	0.070
Suspended solids	mg/l	6.5	23.0	12.0	3.0
Parameter	Unit	River: Bride North. Station name and reference: Kilnap RS19G880990			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	14.7	14.9	10.0	10.8
Dissolved Oxygen	% Sat.	79.6	84.2	85.4	79.0
pH	pH units	8.0	7.9	7.8	7.6
Conductivity @20°C	µS/cm	304	310	307	265
Biochemical Oxygen	mg/l O_2	2.7	1.2	1.5	2.1
Ammonia	mg/l N	0.004	0.004	0.016	0.027

Nitrogen	mg/l N	8.3	5.5	8.93	11.86
Ortho-phosphate	mg/l P	0.144	0.154	0.102	0.097
Suspended solids	mg/l	3.6	5.0	7.0	9.0
Parameter	Unit	River: Bride North. Station name and reference: Fitz's Boreen RS19B140300			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	14.8	15.1	10.7	10.6
Dissolved Oxygen	% Sat.	78.6	76.7	79.9	79.5
pH	pH units	7.9	7.8	7.8	7.6
Conductivity @20°C	µS/cm	315	321	332	277
Biochemical Oxygen	mg/l O_2	1.0	1.2	1.0	1.0
Ammonia	mg/l N	0.004	0.004	0.039	0.031
Nitrogen	mg/l N	11.1	4.3	9.32	6.01
Ortho-phosphate	mg/l P	0.097	0.097	0.110	0.083
Suspended solids	mg/l	2.4	4.0	2.8	3.2
Parameter	Unit	River: Bride North. Station name and reference: Blackpool RS19B140800			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	13.9	14.5	10.2	10.7
Dissolved Oxygen	% Sat.	77.6	79.4	79.5	82.2
pH	pH units	7.6	7.7	7.6	7.7
Conductivity @20°C	µS/cm	341	346	331	282
Biochemical Oxygen	mg/l O_2	1.0	1.0	1.1	1.1
Ammonia	mg/l N	0.004	0.004	0.016	0.026
Nitrogen	mg/l N	4.2	5.3	6.18	4.85
Ortho-phosphate	mg/l P	0.095	0.102	0.102	0.088
Suspended solids	mg/l	2.0	4.4	2.4	3.2
Parameter	Unit	River: Glen. Station name and reference: Glen Rec. Park RS19G090400			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	13.6	14.3	9.1	11.1
Dissolved Oxygen	% Sat.	72.7	75.7	76.0	83.1
pH	pH units	7.8	7.6	7.3	7.6
Conductivity @20°C	µS/cm	345	355	353	300
Biochemical Oxygen	mg/l O_2	1.0	1.0	1.5	1.4
Ammonia	mg/l N	0.039	0.124	0.078	0.054
Nitrogen	mg/l N	1.3	0.5	4.45	6.26
Ortho-phosphate	mg/l P	0.169	0.217	0.137	0.097
Suspended solids	mg/l	4.0	3.6	5.2	3.6
Parameter	Unit	River: Glen. Station name and reference: Spring Lane RS19G090800			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	14.4	14.5	9.7	10.8
Dissolved Oxygen	% Sat.	71.8	77.7	81.1	86.1
pH	pH units	7.7	7.7	7.1	7.4
Conductivity @20°C	µS/cm	349	363	347	297
Biochemical Oxygen	mg/l O_2	1.4	1.5	1.0	1.1

Ammonia	mg/l N	0.004	0.070	0.109	0.039
Nitrogen	mg/l N	0.2	0.4	1.36	5.70
Ortho-phosphate	mg/l P	0.140	0.169	0.209	0.110
Suspended solids	mg/l	1.6	2.0	1.6	1.6
Parameter	Unit	River: Kiln. Station name and reference: Leitrim St. RS19K750900			
		11/06/2014	07/08/2014	24/09/2014	04/12/2014
Temperature	°C	14.6	14.7	11.2	10.8
Dissolved Oxygen	% Sat.	78.7	73.2	61.4	81.7
pH	pH units	7.2	7.2	7.5	7.2
Conductivity @20°C	µS/cm	903	1,503	2,430	290
Biochemical Oxygen	mg/l O_2	5.9	6.2	258.4	1.7
Ammonia	mg/l N	0.004	0.552	0.537	0.062
Nitrogen	mg/l N	5.4	12.0	18.00	6.87
Ortho-phosphate	mg/l P	0.547	0.317	0.758	0.152
Suspended solids	mg/l	0.5	3.0	15.2	3.2

7.2.3.2 Water Framework Directive

The Study Area is located within the Water Framework Directive (WFD) South Western River Basin District (SWRBD). The main objectives of the SWRBD Management Plan is to prevent deterioration, restore good status, reduce chemical pollution in surface waters and to achieve protected areas objectives. The programme of measures designed to achieve these objectives include the following:

- Control of urban waste water discharges;
- Control of unsewered waste water discharges;
- Control of agricultural sources of pollution;
- Water pricing policy;
- Sub-basin management plans and programmes of measures for the purpose of achieving environmental water quality objectives for Natura 2000 sites designated for the protection of Freshwater Pearl Mussel populations;
- Pollution reduction programmes for the purpose of achieving water quality standards for designated shellfish waters; and
- Control of environmental impacts from forestry.

Information on status, objectives and measures in the SWRBD has been compiled for smaller, more manageable geographical areas than river basin districts, termed Water Management Unit Action Plans. There are twenty-eight Water Management Units (WMUs) in the SWRBD. These units represent smaller river and lake basins where management of the pressures, investigations and measures are focussed and refined during implementation of the plan. In addition, action plans focusing on groundwater and a transitional and coastal water management have been prepared for the SWRBD. WMU Action Plans are a key background document to the plan.

The Study Area is within the Lower Lee Owenboy Water Management Unit (WMU). There are 43 river water bodies in the Lower Lee Owenboy WMU with the following status:

- 9 High;
- 9 Good;

- 11 Moderate; and
- 14 Poor Status.

The status of the various water bodies in this area is calculated using the EPA data described above, physio-chemical data and fish status data.

The status of the Lee including its tributaries is described in the Lower Lee Owenboy WMU Action Plan (2010) as follows:

- 2001: Satisfactory apart from Inishcarra Bridge (0600) where again highly eutrophic. The protected pearl mussel has apparently become scarce in the river in the past two decades.
- 2005- Major disruption to fauna at first location, upstream of Gouganebarra Lake (0010), where salmonid parr and other age classes had been killed. Further downstream the water quality status was the same as that of the previous survey with highly eutrophic conditions again recorded at Inishcarra Bridge (0600).
- 2008- Satisfactory apart from at Inishcarra Bridge where again poor ecological quality was recorded. 2009: Poor status dictated by Q score

The identified pressures/risks in this WMU Action Plan include the following:

- Nutrient Sources: Main source of TP is from unsewered industry (64%) and agriculture (26%). P
- Point Pressures: There are 24 Waste-water Treatment Plants (WwTP), 2 Water Treatment Plants (WTP), 21 Section 4 licenced facilities, 26 Integrated Pollution Prevention and Control (IPPC) licenced facilities and 1 contaminated site within the WMU.
- Quarries: There are14 quarries and 5 landfills within the WMU. 3 WB are at risk from quarries
- Agriculture: 39 water bodies have been determined to be at risk from agriculture within the WMU.
- On-site Water Treatment Systems (OSWTS): There are 15275 septic tanks in this WMU. 963 of these are located in areas of very high or extreme risk.
- Forestry: Significant area of SW_19_1910 is under forestry
- Morphology: There are 3 water bodies that have been determined to be at risk from morphology within the WMU. Water Regulation and Impoundments - Inniscarra Reservoir is a HMWB. (the local authority also note some drainage & channelisation of WB 19-1584 in the past particularly between Ballinhassig & Halfway when road was realigned, also some drainage upstream of Halfway in 2006)
- Abstractions: One water body has been determined to be at risk from abstractions within the WMU : SW_19_1663

Q Rating / Biological Water Quality

A full description of the sampling locations and the results of each sample taken are presented in Appendix 5 to this EIS.

Results of kick samples showed that only small numbers of very clean water (class A) invertebrates were present at sites sampled on the River Bride (North), while only one species from class B was present (also indicative of clean water). The sites were dominated by class C (moderately pollution tolerant) invertebrate species that included good numbers of the mayfly species *Baetis rhodani*, a mayfly species characteristic of slightly polluted waters. In summary the water quality at sites on the River Bride (North) were indicative of Q3-4 moderate status, slightly polluted water.

Both sites sampled on the Glenamought River had a good diversity of clean water stoneflies and mayflies present indicating good quality water. Pollution tolerant invertebrate forms were virtually absent apart from the leech species *Haemoptis sanguisuga* (class D) at one site. In summary the invertebrate composition encountered at sites 8 and 9 were representative of Q4 unpolluted, good status water quality.

Figure 7.2 Q Ratings Blackpool

The Glenamought River was among the cleanest of the river sites surveyed with Q4, good status water quality recorded at both sites sampled. The Glenamought River was located in a non-urbanised environment and rises in a wooded river valley with limited human interference. The river retained a very natural profile with riffle, glide and pool habitat. While some localised realignments have occurred in its lower reaches the water quality appears to be unaffected. The Glenamought River between the Viaduct and the Industrial Estate downstream near its confluence with the River Bride (North) had very high densities of salmonids as observed during electro-fishing surveys in 2014 (See Chapter 5). The river had clean swift flowing water and clean substrata which evidently have helped maintain the rivers unpolluted status. Along the River Bride (North) the water quality deteriorated. This was likely as a result of urban encroachment and associated storm drain point sources of pollution that are entering the river. As such the water quality was recorded as Q3-4 slightly polluted (moderate status).

7.2.3.3 Surface Water Abstraction

The Lee Road Water Treatment Plant is the main source of drinking water for Cork City (70%) with the remaining supplied for the Cork Harbour and City Scheme (30%). Surface water is abstracted from the River Lee for the Lee Road Plant and at Inniscarra Lake for the Cork Harbour and City Supply Scheme. Neither abstraction locations, treatment plants nor their associated reservoirs are within the zone of influence of the proposed River Bride (Blackpool) Certified Drainage Scheme.

7.2.4 Impacts and Mitigation for Surface Water Quality

7.2.4.1 Generation of Silt-Laden Run-off & Increase in Suspended Solids

Short-term Moderate Negative Impact

The preparation phase, site clearance and preparatory groundworks including site compound set-up etc. will lead to exposure of bare ground and the potential for the generation of silt-laden run-off in works areas along the river bank. The potential for the generation of silt-laden surface run-off on the adjacent banks and along access and egress routes is likely to continue through the construction phase of the works and until the ground has consolidated. Stockpiled excavated material also poses an increased threat of increased siltation in the watercourse.

Excessive suspended sediment in the water column can clog and cause abrasions to fish gills, interfere with fish navigation and feeding, affect egg and fry development, while also affecting populations of aquatic invertebrates, on which the fishes' diet is based. Once deposited, excessive amounts of silt may damage fish habitat by clogging interstices between gravels in spawning grounds, resulting in diminished flow of oxygenated water to eggs and rendering these gravels unsuitable for egg incubation. Deposited sediment may also impact on the habitat of bottom dwelling aquatic invertebrates and damage nursery habitat for young fish (See also Chapter 5, Flora and Fauna).

Mitigation Measures

- Measures to minimise the suspension and transfer of sediment downstream will be implemented. These measures are likely to include the use of silt barriers downstream of the works areas and removal of any accumulated silt, construction of silt sumps downstream of the works areas, cofferdamming and dewatering of works areas where concrete and other building works are proposed. Any stockpiling will also be greater than 10 metres from the river bank.
- All works undertaken on the banks will be fully consolidated to prevent scour and run off of silt. Consolidation may include use of protective and biodegradable matting (coirmesh) on the banks and also the sowing of grass seed on bare soil.
- Works will only be undertaken during normal working hours (8:00 – 6:00) thus allowing the river to run clean for 14 hours per day.
- An Environmental Management Plan (EMP) will be prepared prior to the commencement of any works in order to ensure all works are carried out in a manner designed to avoid and minimise any adverse impacts on the receiving environment

Residual Impact - Temporary Slight Negative Impact

It is likely that, with mitigation measures in place this impact will constitute a Temporary Slight Negative Impact.

7.2.4.2 Use of Potential Water Contaminants

Potential Temporary Moderate to Significant Negative Impact

Numerous substances used on construction sites have the potential to pollute both ground and surface water if not properly managed and treated. Such substances include fuels, lubricants, cement, mortar, silt, soil and other substances which arise during construction. The washing of construction vehicles and equipment also poses a pollution risk to watercourses. The spillage or leaking of fuel or oil from fuel tanks or construction vehicles has the potential to contaminate soils, groundwater and surface water. Such substances entering the

River could damage the habitat of local populations of fish and aquatic invertebrates and also cause direct harm to aquatic fauna.

Mitigation Measures

- All concrete works will be carried out in dry conditions with no in-stream pouring of concrete.
- There will be no refuelling of machinery within the river channel. Refuelling will take place at designated locations at distances of greater than 30 metres from the watercourse.
- No vehicles will be left unattended when refuelling and a spill kit including an oil containment boom and absorbent pads will be on site at all times.
- Any fuel that is stored on the site will be in a double skinned, bunded container that will be located within a designated works compound at a location that is removed from the river. All other construction materials and plant will be stored in this compound. The compound will also house the site offices and portaloo toilets. This compound will either be located on ground that is not prone to flooding or will be surrounded by a protective earth bund to prevent inundation.
- All vehicles will be regularly maintained and checked for fuel and oil leaks.

Residual Impact – Neutral Impact

It is likely that, with proper implementation of the above mitigation this impact will constitute a slight negative short term impact and a Neutral long-term Impact.

7.3 HYDROGEOLOGY

This section describes the existing hydrogeological environment within the Study Area and assesses the potential impacts of the River Bride (Blackpool) Certified Drainage Scheme.

7.3.1 Methodology

A desktop study was carried out in order to ascertain a comprehensive baseline for the Study Area and give a description of the existing environment. This information was then used in assessing the potential impact the proposed works will have on the hydrogeology within the Study Area.

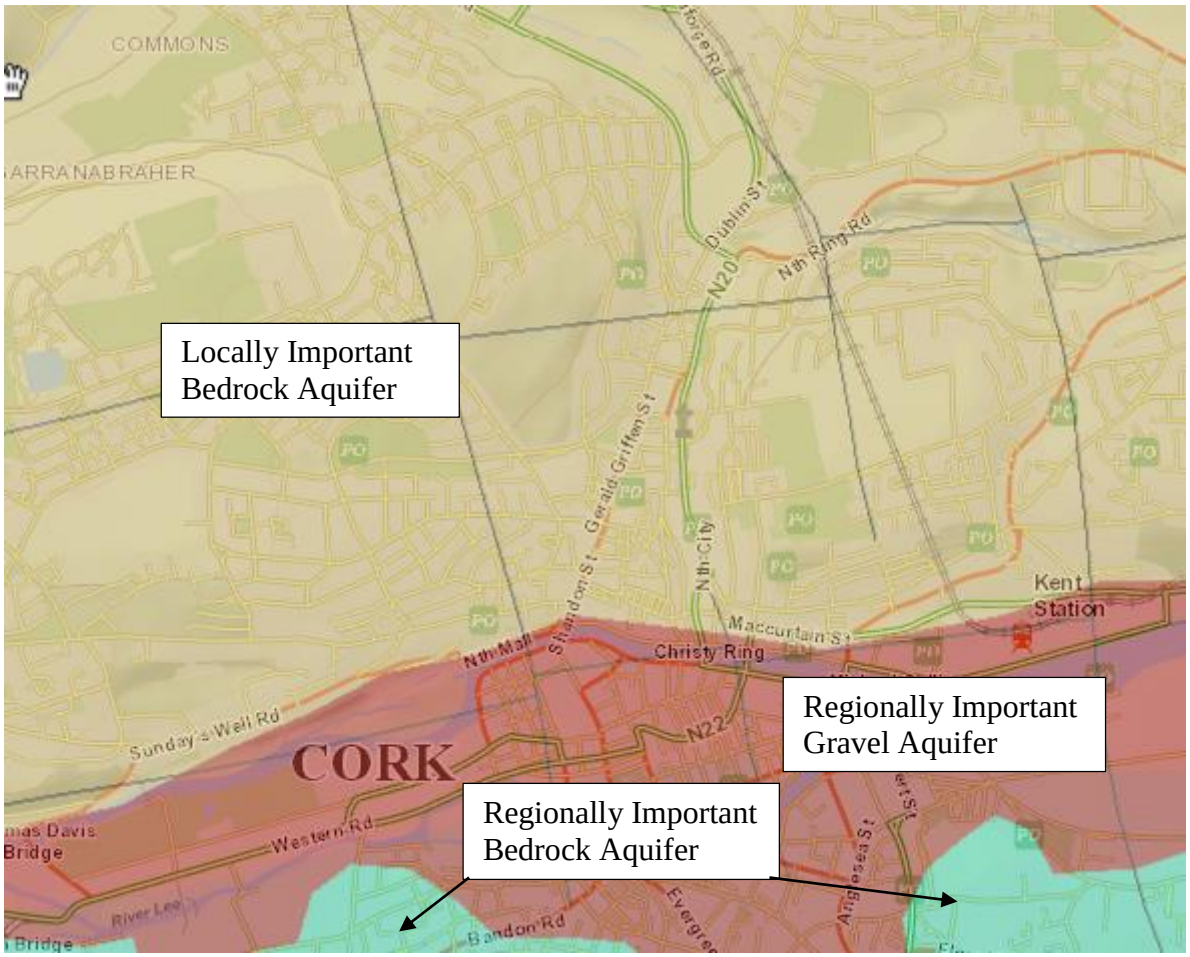
The following documents were consulted during the preparation of this section:

- The Geology of South Cork (1994)
- The Geological Survey of Ireland (GSI) online database

7.3.2 Hydrogeology in the Existing Environment

The Geological Survey of Ireland (GSI) online database shows the Study Area as being underlain by Devonian Old red sandstone with dinantian mudstone and sandstsone. The site is locally important aquifer with bedrock which is moderately productive only in Local Zones. Groundwater flows through fractures, fissures or joints in the bedrock. The groundwater body is generally covered by till derived from its sandstone parent material. An extract from the GSI Online Database is provided.

Figure 7.3 GSI Groundwater Resources (Aquafers) (www.gsi.ie)



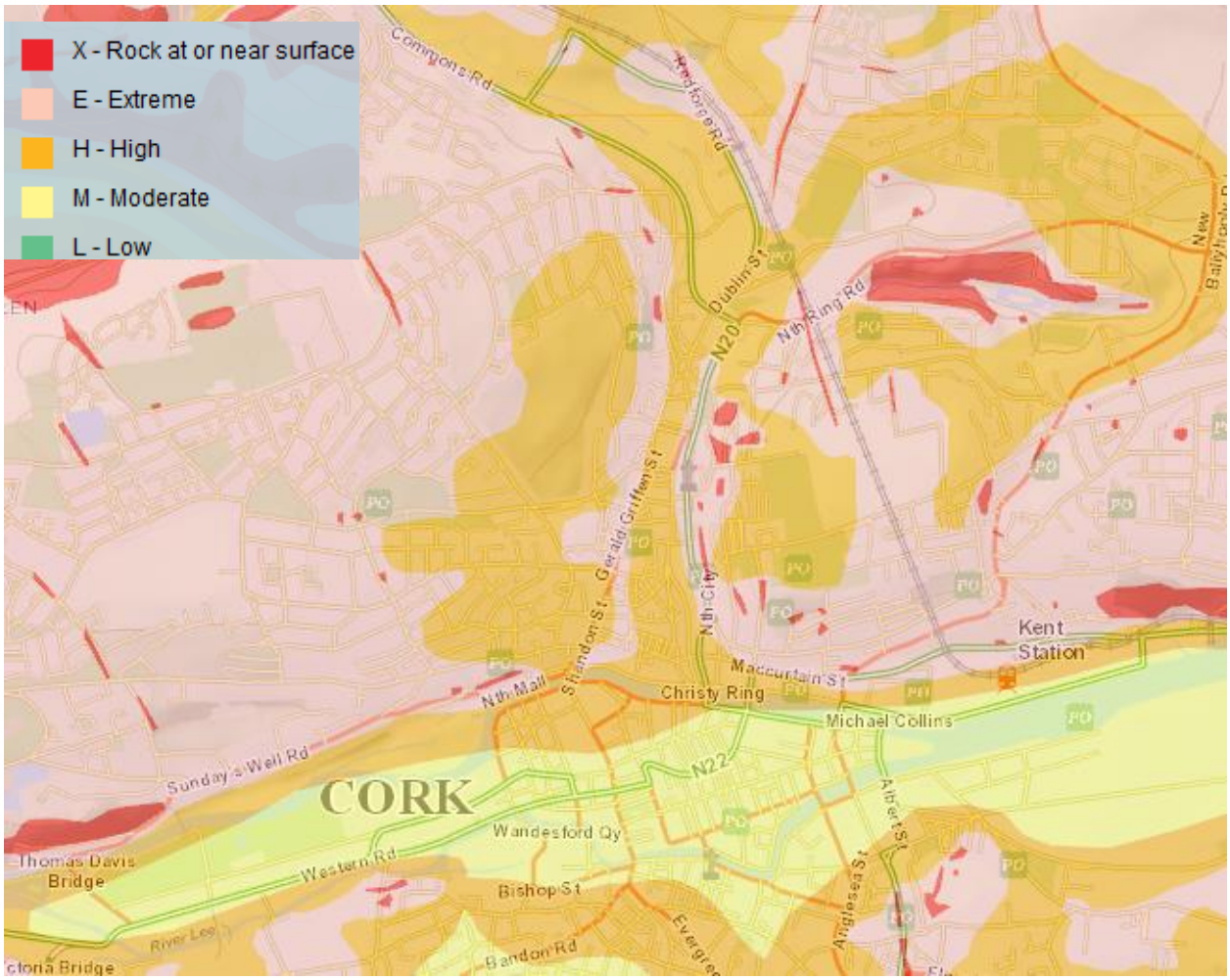
The direction of groundwater flow is likely to be influenced by the topography of the surrounding area. Groundwater within the Study Area is more than likely hydraulically connected to the River Lee and its tributaries including the River Bride (North), River Glen and River Glenamought.

Groundwater Vulnerability

Groundwater vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities.

The Geological Survey of Ireland (GSI) online database was referenced regarding the vulnerability of the local aquifers to contamination from ground waters. The vulnerability mapping indicates that the local aquifers are generally highly or extremely vulnerable within the Study Area. An extract from the GSI Online Database is included below.

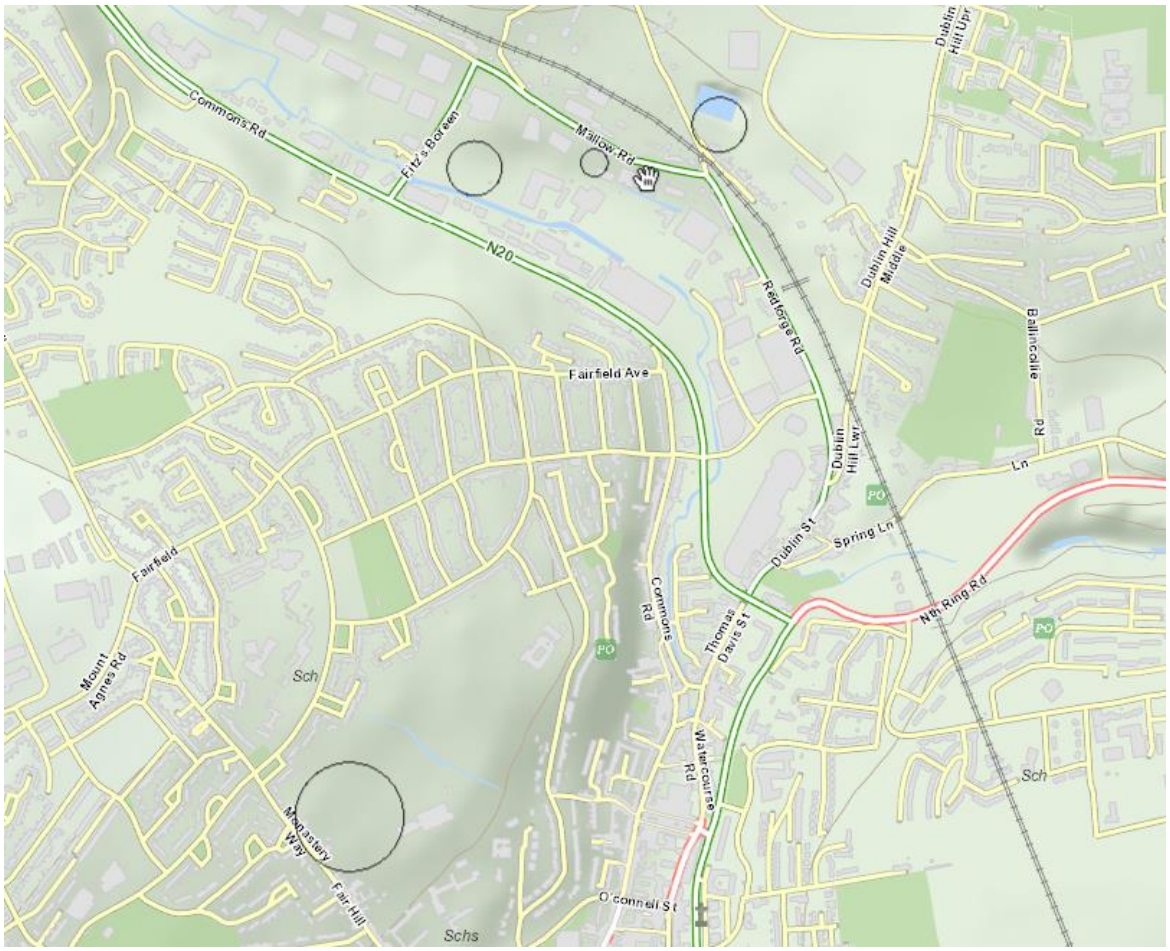
Figure 7.4 GSI Aquafer Vulnerability (www.gsi.ie)



Wells and Boreholes

The well card data by the Geological Survey of Ireland (GSI) indicates that a number of wells are in proximity to the scheme, in particular three wells are identified to the east of the scheme at Mallow Road. All other wells are either a sufficient distance for gradient that they are not within the zone of influence of the scheme. An extract from the GSI Online Database is included in Figure xxx the locations of the groundwater wells within the Study Area.

Figure 7.5 GSI Wells and Springs



A list of abstractions for is provided in Table 7.6.

Table 7.6 – GSI Well Card Data (Boreholes)

Townland	Depth (m)	Depth to Rock (m)	Source Use	Yield Class	Yield (m^3/day)
Kilnap	91	4	Industrial	Moderate	50
Kilnap	60	2	-	-	-
Kilbarry	99.1	6.1	Unknown	Good	272

7.3.3 Potential Impacts on Hydrogeology

Potential Temporary Slight Negative Impact

There are numerous substances that will be used during the construction phase such as fuel, oil, lubricants, cement, silt, soil and other hydrocarbons which have the potential to pollute ground water. Washing of construction vehicles and machinery also poses a risk of polluting ground water. The impacts to hydrogeology as a result of the River Bride (Blackpool) Certified Drainage Scheme are temporary and not significant. Any impacts associated with the scheme will occur during the construction or maintenance phase.

As set out in Section 7.3.2 above, the aquifers in the study area are classified as highly to extremely vulnerable to infiltration but are very poor aquifers. Should any of the above mentioned substances contaminate the ground water in the study area presence of a poor aquifer means that there is limited risk to any ground water supply.

Mitigation Measures

A bunded area will be constructed within the site compound in order to avoid any polluting substances infiltrating the ground water during the construction and operation phase of the Scheme. All plant refuelling, maintenance and washing will be carried out within the bunded area. Spill kits will be available at the bunded area in order to ensure the quick and effective cleaning of any substances.

Residual Impact - Potential Negligible Impact

Taking into account the abovementioned mitigation measures, it is considered that the impact will constitute a Negligible Impact.

7.4 FLOODING

This section describes the existing hydrological environment within the Study Area and potential impacts of the proposed works on Flooding. Mitigation measures are also provided for any potentially significant impacts identified.

7.4.1 Methodology

A desktop study was carried out in order to obtain a baseline for the Study Area and provide a description of the existing environment. The information was then used to assess the potential impact the Scheme will have on the hydrology of the Study Area.

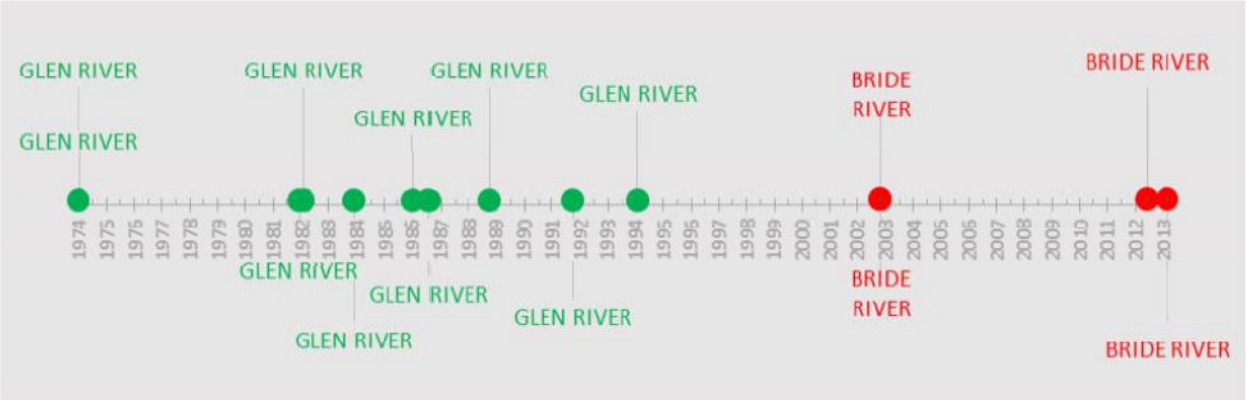
The following documents were consulted during the preparation of this section:

- Ryan Hanley McCarthy Keville and O'Sullivan (2014) Lower Lee Flood Relief Scheme – Constraints Study;
- The Office of Public Works (2010) Lower Lee Draft Catchment Flood Risk Management Plan;
- JBA Feasibility Study, Modelling Report

7.4.2 Flooding and Hydrology in the Existing Environment

There has been a history of extensive flooding in the Blackpool area of Cork City in recent years. Prior to the early 2000s the primary source of flood risk came from the Glen River. However, in recent years this risk has transferred over to the River Bride (North). Figure 7.6 below summarises the flood history and illustrates the transition of risk between watercourses.

Figure 7.6 Timeline and source of recent flood events in Blackpool



The River Bride (Blackpool) Certified Drainage Scheme proposes a combination of flood defence measures at specific locations and a rigorous and organised channel maintenance programme though the reach of the catchment.

The channel maintenance programme will include the River Bride (North) from its confluence with the Glenamought River, down along the Kiln to its outfall into the River Lee (approximately 3,470m). The maintenance programme also includes the predominantly culverted Brewery Branch reach of the Kiln River (approximately 825m). The channel maintenance programme will pay particular attention to locations where debris is likely to accumulate, such as at structures, sharp bends, culverts inlets etc.

The locations and extents of the proposed flood defence measures are outlined in the scheme drawings contained in Appendix 3 of the EIS and will included the following:

- Site investigation,
- Construction of new culverts,
- Replacement of four existing bridges/ culverts,
- Construction of new flood walls/ earthen embankments,
- Constructing bridge parapets,
- Local channel widening of the River Bride (referred to as a 'Winter Channel'),
- Construction of a sedimentation trap on the left bank of the River Bride,
- Removal of approximately 100m of existing culvert and restoration of open channel (River Bride) at this location,
- Construction of a new trash screen and roughing screens, and removal of existing trash screens on the River Bride (north) and Glen and Glenamought Rivers,
- Modifications to the existing foul and surface water collection networks in the vicinity of the proposed works, including construction of pumping stations, in order to prevent flooding,
- Removal of an existing sluice structure in the channel of the River Bride to the rear of the Dulux factory,
- Localised regrading of ground levels, erection of fencing and access to gates, to facilitate pedestrian /vehicular access to and around flood defences, or to redirect overland surface water flow paths,
- Filling in an existing open watercourse,
- Introduction of a flow control structure on the entrance to the Brewery culvert on the River Bride and the Spring Lane culverted branch of the River Glen, and
- Regular maintenance of the river channel and pumping stations.

7.4.3 Potential Impacts on Flooding

Impact on Flooding and Hydrology

Permanent Significant Positive Impact

The River Bride (Blackpool) Certified Drainage Scheme improves flood protection with the provision of a suite of measures including replacement of culverts, embankment works and defence wall improvements and therefore reduces the risk of water levels overtopping the bank and flooding the surrounding area.

Impact on Water Levels Upstream and Downstream of Proposed Works

Permanent Negligible Impact

The Flood improvements works will not affect the water levels upstream and downstream of the proposed scheme during normal flow conditions. During a storm event the flood defence measures will prevent waters flooding the surrounding area and therefore water levels downstream of the proposed flood defence walls may increase slightly over short stretches.

Chapter 8:

Air Quality & Climate / Noise & Vibration

8 AIR QUALITY & CLIMATE / NOISE & VIBRATION

This section, prepared by McCarthy Keville O'Sullivan Ltd. with Damian Brosnan Acoustics, assesses both the air quality & climate and the likely noise & vibration impact of the proposed works, in the context of current relevant standards and guidance, and identifies any requirements or possibilities for mitigation.

The proposed works will not have any air quality or noise and vibration impact during its operational phase. As a result, it is only considered necessary to assess the potential noise and vibration impact on the surroundings during the construction phase.

The construction phase will be short term in nature and will generally comprise of the following works:

- Site investigation,
- Construction of new culverts,
- Replacement of existing bridges/ culverts,
- Construction of new flood walls/ earthen embankments,
- Constructing bridge parapets,
- Local channel widening of the River Bride (referred to as a 'Winter Channel' on the scheme drawings in Appendix 3A),
- Construction of a sedimentation trap on the left bank of the River Bride,
- Removal of approximately 100m of existing culvert and restoration of open channel (River Bride) at this location,
- Construction of a new trash screen and roughing screens, and removal of existing trash screens on the River Bride, and the Glen and Glenamought Rivers,
- Modifications to the existing foul and surface water collection networks in the vicinity of the proposed works, including construction of pumping stations, in order to prevent flooding,
- Removal of an existing sluice structure in the channel of the River Bride to the rear of the Dulux factory,
- Localised regrading of ground levels, erection of fencing and access gates, to facilitate pedestrian/ vehicular access to and around flood defences, or to redirect overland surface water flow paths,
- Filling in an existing open watercourse,
- Introduction of a flow control structure on the entrance to the Brewery culvert on the River Bride and the Spring Lane culverted branch of the River Glen, and
- Regular maintenance of the river channel and pumping stations.

8.1 AIR QUALITY & CLIMATE – EXISTING ENVIRONMENT

Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on factors such as wind speed, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels)(12). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM10, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than PM2.5) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles (PM2.5 – PM10) will actually increase at higher wind speeds. Thus, measured levels of PM10 will be a non-linear function of wind speed.

County Cork has a temperate oceanic climate, resulting in mild winters and cool summers. The Met Éireann weather station at Cork Airport is the nearest weather and climate monitoring station to the proposed development site located approximately 5.8 kilometres south of the site. Meteorological data recorded at Cork Airport over the 30-year period from 1981-2010 is shown in Table 8.1 overleaf. The wettest months are October and December, and July is usually the driest. July is also the warmest month with an average temperature of 18.7° Celsius.

Table 8.1 Data from Met Éireann Weather Station at Cork Airport, 1981 to 2010

	Monthly and Annual Mean and Extreme Values												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
TEMPERATURE (degrees Celsius)													
Mean daily max	8.2	8.3	9.9	11.8	14.4	17	18.7	18.5	16.5	13.2	10.3	8.5	12.9
Mean daily min	3	3.1	4	4.9	7.4	10	11.8	11.8	10.2	7.7	5.2	3.7	6.9
Mean temperature	5.6	5.7	6.9	8.4	10.9	13.5	15.3	15.2	13.3	10.5	7.8	6.1	9.9
Absolute max.	16.1	14	15.7	21.2	23.6	27.5	28.7	28	24.7	21.4	16.2	13.8	28.7
Absolute Min.	-4.3	-1.6	1.4	5	7.6	10.7	12.8	11.9	10.4	6	0.6	-3.2	-4.3
Mean No. of Days With Air Frost	10.6	10.6	10.9	11.4	15.1	16.2	19	18.4	17.3	15.4	12.8	11.6	19
Mean No. of Days With Ground Frost	-8	-4.7	-4.3	-2.3	-0.9	3.7	6.7	5.3	2.3	-0.9	-3.3	-7.2	-8
RELATIVE HUMIDITY (%)													
Mean at 0900UTC	89.8	89.4	87.8	83.1	80.6	81.3	83.2	85.4	88.4	90.1	90.7	90.5	86.7
Mean at 1500UTC	83.7	78.9	75.5	71.3	70.9	71.5	72.9	72.8	75.4	80.4	83.4	85.4	76.8
SUNSHINE (Hours)													
Mean daily duration	1.8	2.4	3.3	5.3	6.2	5.8	5.4	5.2	4.3	3	2.3	1.7	3.9
Greatest daily duration	8.5	10	11.5	13.6	15.5	16	15.3	14.4	11.9	10.3	8.7	7.6	16
Mean no. of days with no sun	10.1	7.9	6.3	3.1	2.1	2.5	2	2.6	3.6	6.4	8.6	11.9	67.1
RAINFALL (mm)													
Mean monthly total	131.4	97.8	97.6	76.5	82.3	80.9	78.8	96.8	94.6	138.2	120	133.1	1227.9
Greatest daily total	45.7	49.9	55.2	34.2	34.9	59.7	73.2	60.9	58.9	52.1	47.9	41.9	73.2
Mean num. of days with >= 0.2mm	20	17	19	16	15	14	15	15	16	19	19	19	204
Mean num. of days with >= 1.0mm	16	13	14	11	12	10	10	11	11	15	14	15	152
Mean num. of days with >= 5.0mm	9	6	5	5	5	5	5	5	5	8	7	8	73
WIND (knots)													
Mean monthly speed	12.1	12	11.6	10.3	10.1	9.4	9	9	9.4	10.7	10.9	11.6	10.5
Max. gust	78	83	70	62	59	49	57	54	58	75	66	80	65.9
Max. mean 10-minute speed	52	54	43	40	40	33	40	38	39	48	46	56	44.1
Mean num. of days with gales	2.3	1.8	1.3	0.3	0.3	0	0.1	0.2	0.3	1	1.2	1.9	10.8
WEATHER (Mean No. of Days With:)													
Snow or sleet	3.1	3.1	2	0.7	0	0	0	0	0	0	0.3	2.2	11.3
Snow lying at 0900UTC	0.7	0.5	0.2	0.1	0	0	0	0	0	0	0	0.5	2
Hail	1	1.1	1.4	1.9	0.7	0.2	0.1	0	0.1	0.3	0.2	0.4	7.4
Thunder	0.2	0.1	0.1	0.1	0.6	0.5	0.8	0.3	0	0.4	0.1	0.1	3.3
Fog	7.8	6.8	8.5	7.5	7.6	7.6	8.4	8.8	9.1	8.7	7.6	8.4	96.8

Available Background Data

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality "Air Quality Monitoring Report 2010"(10), details the range and scope of monitoring undertaken throughout Ireland. The Environmental Protection Agency (EPA) has designated four Air Quality Zones for Ireland:

- Zone A: Dublin City and environs
- Zone B: Cork City and environs
- Zone C: 16 urban areas with population greater than 15,000
- Zone D: Remainder of the country.

These zones were defined to meet the criteria for air quality monitoring, assessment and management described in the Framework Directive and Daughter Directives. The site of the proposed development lies within Zone B, which represents Cork city and its environs.

The EPA publishes Air Monitoring Station Reports for monitoring locations in all four Air Quality Zones. The ambient air quality monitoring carried out closest to the proposed development site is at Blackpool, Co. Cork, located adjacent to the proposed development site. EPA air quality data is available for Blackpool in the report '*Ambient Air Monitoring at Blackpool, Cork City 19th January 2000 to 31st May 2000*', as detailed below. This monitoring location also lies within Zone B. Similar measurement values for all air quality parameters would be expected for the proposed development site as it lies directly adjacent to this monitoring location.

Sulphur Dioxide (SO2)

Sulphur dioxide data for the 2000 monitoring period in Blackpool is presented in Table 8.2. A technical problem with the monitor meant that no data was collected between 29th March and 18th May 2000.

Table 8.2 Sulphur Dioxide Data Blackpool January to May 2000

Parameter	Measurement
No. of hours	3,188
No. of measured values	1,952
Percentage Coverage	61.2%
Maximum hourly value	161.3 µg/m3
98 percentile for hourly values	96.1 µg/m3
Mean hourly value	25.3 µg/m3
Maximum 24-hour mean	58.3 µg/m3
98 percentile for 24-hour mean	47.3 µg/m3

During the period of operation there were no exceedences of the 350 µg/m3 hourly limit for the protection of human health. There were two exceedences of the 50 µg.m-3 lower assessment threshold. The directive stipulates that the lower assessment threshold should not be exceeded more than three times in the calendar year. The mean hourly value of 25.1 µg/m3 exceeds the limit value for the protection of ecosystems. However, the report states that this limit may not be relevant to monitoring in an urban environment. It would be expected that SO2 values at the proposed development site (directly adjacent to this monitoring location) would be similar to those recorded at the Blackpool monitoring site.

Particulate Matter (PM10)

Particulate matter (PM_{10}) data for the 2000 monitoring period in Blackpool is presented in Table 8.3.

Table 8.3 Particulate Matter (PM10) Data Blackpool January to May 2000

Parameter	Measurement
No. of days	133
No. of measured values	117
Percentage Coverage	87.9%
Maximum daily value	239.4 µg/m3
98 percentile for daily values	111.5 µg/m3
Mean daily value	49.1 µg/m3

The 24-hour limit for the protection of human health was breached 46 times during the measurement period; the Directive permits the limit value to be exceeded only 35 times in a calendar year. The mean of the daily values during the measurement period (49.1 µg/m3) also exceeds the annual limit value for the protection of human health (40.0 µg/m3). It would be expected that PM_{10} values at the proposed development site would be similar to those recorded during the 2000 Blackpool monitoring period.

Nitrogen Dioxide (NO2)

Nitrogen dioxide and oxides of nitrogen (NOx) data for the 2000 monitoring period in Blackpool is presented in Table 8.4. No data was collected between 29th February and 18th May because of a technical problem with the monitor.

Table 8.4 Nitrogen Dioxide and Oxides of Nitrogen Data Blackpool January to May 2000

Parameter	Measurement
No. of hours	3,188
No. of measured values	1,254
Percentage Coverage	39.3%
Maximum hourly value (NO2)	107.1 µg/m3
98 percentile for hourly values (NO2)	72.9 µg/m3
Mean hourly value (NO2)	26.8 µg/m3
Mean hourly value (NOx)	55.4 µg/m3 NO2

All hourly mean NO2 values were below the lower assessment threshold (100 µg/m3) except for one exceedence. The Directive stipulates that the lower assessment threshold should not be exceeded more than 18 times in a calendar year. The mean hourly NO2 value (26.9 µg/m3) during the period of measurement was below the annual limit for the protection of human health (40 µg/m3) but just above the annual lower assessment threshold for the protection of human health (26 µg/m3). The mean hourly value of NOX (55.1 µg/m3 NO2) during the measurement period exceeds the annual limit value for the protection of vegetation (30 µg/m3 NOX). However, the report states that the applicability of this limit to urban air pollution monitoring is questionable. It would be expected that NO2 and NOx values at the proposed development site would be similar to those recorded during the 2000 Blackpool monitoring period.

Carbon Monoxide (CO)

Carbon monoxide data for the 2000 monitoring period in Blackpool is presented in Table 8.5. A limited dataset from 19th January until 13th February is available due to a technical problem with the carbon dioxide monitor.

Table 8.5 Carbon Monoxide Data Blackpool January to February 2000

Hourly Values	Result
No. of hours	3,188
No. of measured values	601
Percentage Coverage	18.8%
Maximum hourly value	21.8 mg/m3
98 percentile for hourly values	2.9 mg/m3
Mean hourly value	0.9 mg/m3
Maximum 8-hour mean	10.9 mg/m3
98 percentile for 8-hour mean	3.8 mg/m3

During the monitoring period there was an exceedence of the 10 mg/m3 limit. This was an isolated result and may have been attributable to a local effect at the sampling location. Otherwise, all data is below the lower assessment threshold for the protection of human health. It would be expected that carbon monoxide values at the proposed development site would be similar to those recorded during the 2000 Blackpool monitoring period.

Dust

A study by the UK ODPM(13) gives estimates of likely dust deposition levels in specific types of environments. In open country a level of 39 mg/(m2*day) is typical, rising to 59 mg/(m2*day) on the outskirts of town and peaking at 127 mg/(m2*day) for a purely industrial area. As a worst-case, a level of 127 mg/(m2*day) can be estimated as the existing dust deposition level for the current location.

8.2 NOISE & VIBRATION - EXISTING ENVIRONMENT

8.2.1 Noise receptors

The study site follows the course of the River Bride and its tributaries from the fringes of the city into Blackpool. The noise environment graduates from semi-rural to entirely urban over the approximately 3.5 km length of the study site. The chief feature of the noise environment is road traffic noise, particularly traffic on national route N20 which becomes the Blackpool bypass. From north to south, the noise environment consists of the following zones:

- A built up rural area to the immediate north of North Point Business Park represents the most northerly zone. A number of one-off houses are located in this area, one of which lies in a secluded position in the Glenamought valley, adjacent to the base of the railway bridge. The noise environment here is dominated by traffic on the local road network in this area, in addition to N20 traffic which runs to the west and south. Receptors close to the Glenamought River are also affected by water flow noise.
- A detached dwelling at the end of the Killeens off-ramp from the N20 northbound forms a small isolated zone. Although this location lies only several hundred metres from the area described in the previous paragraph, the noise environment is markedly different due to (a) the dwelling's

position immediately adjacent to a road junction, and (b) its location close to the N20, albeit at a lower elevation. The noise environment here is consequently dominated by road traffic noise.

- The N20 corridor forms the largest zone in the study site, extending from the Killeens interchange to Blackpool Shopping Centre, a distance of almost 2 km. The zone is dominated by traffic on the N20 which runs parallel to the Bride here. The zone may be divided into a number of sub-zones. The most northerly of these is occupied by the Commons Inn. Downstream of the hotel, nine dwellings form a short length of ribbon development adjacent to the N20. Immediately downstream of these, the area becomes decidedly commercial, and consists of a mixture of old and new commercial and industrial premises, several of which lie in the grounds of the former Sunbeam complex. At the southern end of the zone, Blackpool Retail Park consists of several commercial buildings, a number of which include office floors. To the south of the retail park lies Blackpool Shopping Centre, most of which is occupied by carpark spaces. Apart from the nine dwellings identified, there are no receptors located in proximity to the watercourse. A number of receptors along the southern side of the N20 are situated 70 m or more from the proposed works area. These include apartments at Brideholm, ribbon development opposite the former Sunbeam complex, and dwellings on the Old Commons Road opposite Blackpool Retail Park.
- Downstream of Blackpool Shopping Centre, the River Bride runs to the rear of terraced dwellings along Old Commons Road over a distance of approximately 350 m, and this marks the next zone. A land bank between the river and the N20 is occupied by Orchard Court, a suburban residential development of approximately 50 dwellings with limited retail space at its southern end. The river flows between Orchard Court and the rear of the Old Commons Road terraces. At the northern end of this zone, the noise environment is dominated by N20 traffic which gradually becomes elevated above Orchard Court. The southern end of the zone is less affected by N20 and Blackpool bypass traffic due to increased separation distance and screening provided by buildings. Although N20 traffic remains nonetheless significant at the southern end of the zone, its reduced contribution allows other sources to become audible, including traffic on surrounding streets, and typical residential estate activities such as local car movements, dog barking, pedestrian voices, birdsong and playing children.
- The most southerly zone is entirely urban, following Watercourse Road from Blackpool Church to Madden's Buildings, which marks the southern extent of the flood relief works area. A number of terraced dwellings lie alongside Watercourse Road, or on side roads. The noise environment here is dominated by road traffic, both on Watercourse Road itself and on the N20 which runs to the immediate east.

Descriptions of the various noise environments above relate to daytime hours, as the proposed works will chiefly be carried out during the daytime. The descriptions are based on site inspections, and particularly on a noise survey undertaken across the study site as described below. The evening noise environment in each zone is likely to be similar to the daytime environment, as traffic noise is likely to continue into evening hours. Indeed, previous surveys undertaken by Damian Brosnan Acoustics in relation to other projects in the local area indicate that road traffic noise on both urban streets and on the N20 continues right through the evening and into the night. The most recent such survey, undertaken September 2015 on Watercourse Road, indicated elevated street traffic noise throughout the evening. Night-time ambient levels are also likely to remain elevated due to N20 traffic noise intrusion

Traffic is the chief noise source present across the study site, arising on the N20 and Blackpool bypass, on streets such as Old Commons Road, Watercourse Road and Thomas Davis Street, and through residential

estates and retail parks. The only other noise source of significance noted during site inspections is commercial/industrial noise from scattered premises. These include sources at premises across the Sunbeam site, and industrial emissions at the Dulux facility.

The EPA defines a noise sensitive location (NSL) as:

> '*Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or area of high amenity which for its proper enjoyment requires absence of noise at nuisance levels.*'

NSLs across the study site consist almost entirely of residential dwellings. Bedrooms at the Commons Inn hotel may warrant NSL status. While Blackpool Retail Park includes a number of office floors, these are not considered to be NSLs in the context of the proposed project for several reasons:

- The office floors lie at a significantly higher elevation than the works zone, several floors above ground level.
- These floors are likely to be exposed to elevated traffic noise levels on the N20.
- A cursory inspection indicates that the office floors are fitted with acoustic grade windows.
- The proposed floor relief works will be undertaken at ground level, to the rear of several commercial units. None of these opens to this area.

8.2.2 Noise survey methodology

Existing daytime ambient noise levels (see glossary in Appendix 8A) across the study site were quantified through a noise survey undertaken Thursday October 22 2015. Survey methodology, equipment specifications and weather conditions are listed in Appendix 8B. Monitoring was undertaken at seven stations, designated N1-N7, as described in Table 8.6, shown in Figures 8.1-8.6, and shown in Photographs 8.1-8.7. Stations were selected on the basis of the following criteria:

- Flood relief works are proposed locally.
- Dwellings are located in proximity.
- The noise environment is likely to be different to those at other stations, due to geography, terrain, road layout, screening, etc.

A preliminary inspection indicates that there are no sensitive receptors in Sunbeam commercial estate, and monitoring was not carried out here. While a multi-storey office development at Blackpool Retail Park includes office space which overlooks a proposed flood relief works zone, monitoring was not conducted here as the office floors lie several floors above ground level.

Table 8.6: Noise station locations.

Station	ITM NGR	Location
N1	567414 573130	T&A Builders Providers carpark, 6 m from Watercourse Rd. verge, 10 m from rear wall of Madden's Buildings terrace. Selected to represent dwellings at Madden's Buildings and in vicinity of Foley's Row.
N2	567404 573351	Paved area at Blackpool Church, 8 m N of NE corner. Selected to represent terraced receptors in vicinity of Watercourse Rd., Thomas Davis St. and Old Commons Rd.
N3	567382 573436	NW side of square at S end of Orchard Court, 17 m from Old Commons Rd. Selected to represent dwellings around square.
N4	567388 573611	N end of Orchard Court, 10 m from nearest dwelling façade. Selected to represent Orchard Court dwellings. Also selected to represent noise environment in rear gardens of riverside terraced dwellings along Old Commons Rd.
N5	566565 574475	Near S corner of carpark at Commons Inn, 30 m NNE of rear façade at dwelling SE of Commons Inn entrance. Selected to represent noise environment of rear gardens of 9 dwellings on Commons Rd. between Commons Inn and unoccupied commercial premises.
N6	566020 574737	Paved area 27 m NW of dwelling adjacent to roundabout at end of N20 N-bound Killeens off-ramp. Selected to represent adjacent dwelling.
N7	566380 575019	Front lawn of secluded dwelling in valley SW of Kilnap railway bridge, 12 m SW of dwelling SW corner. Selected to represent local noise environment at dwelling.

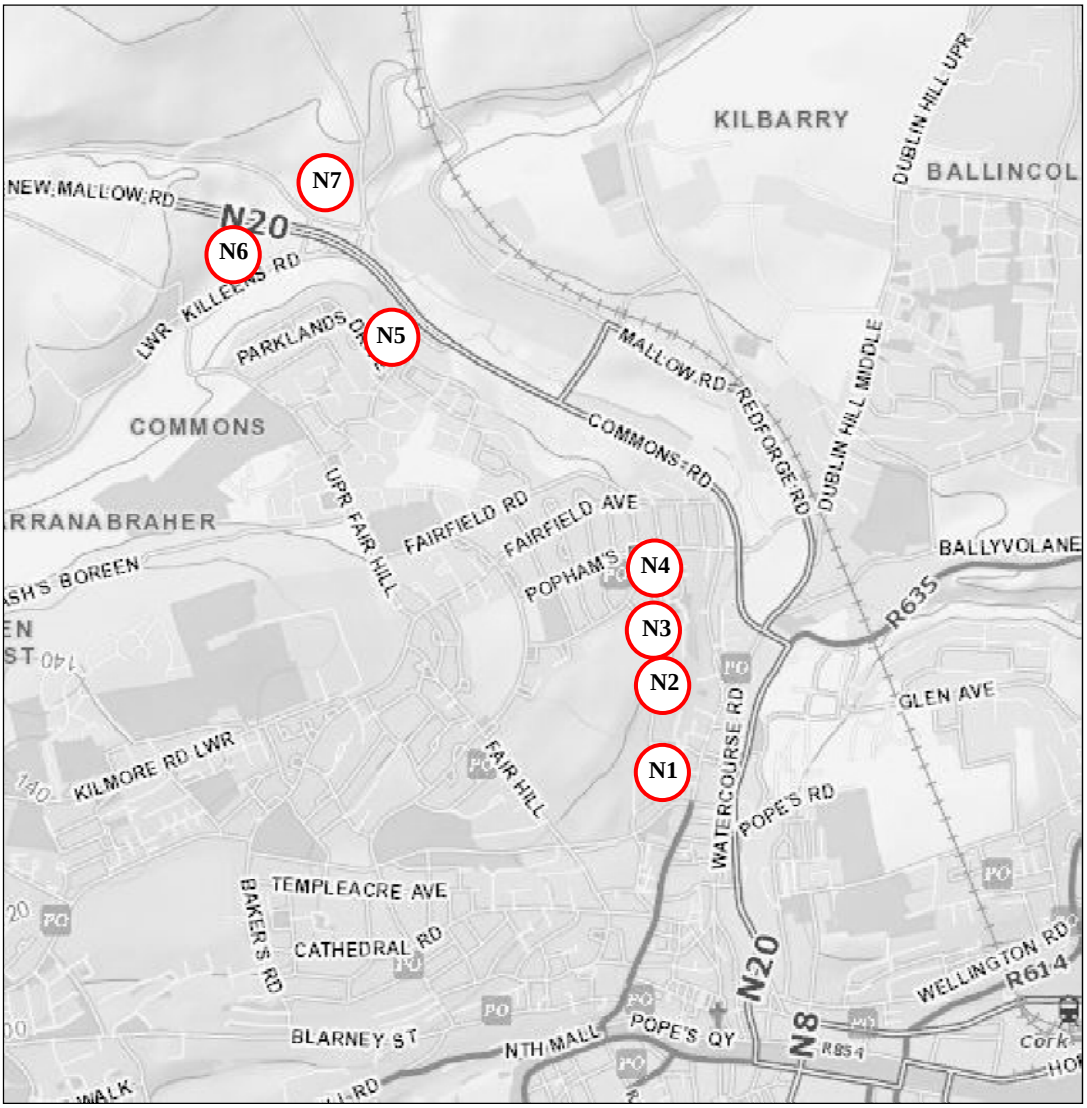


Figure 8.1: Monitoring locations overview. N

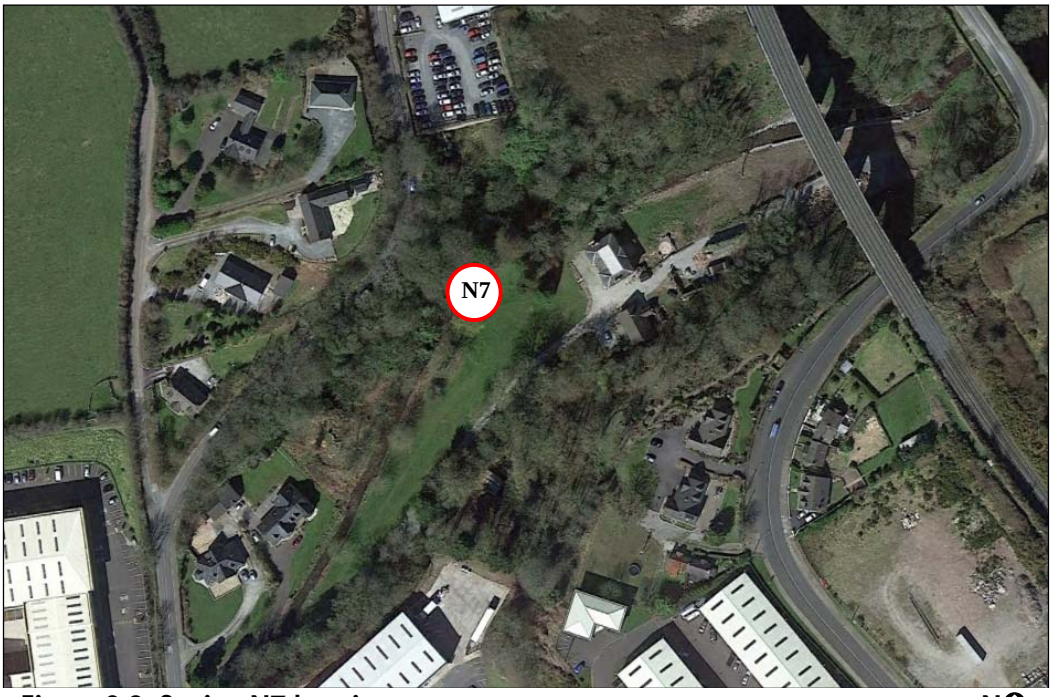


Figure 8.2: Station N7 location. N

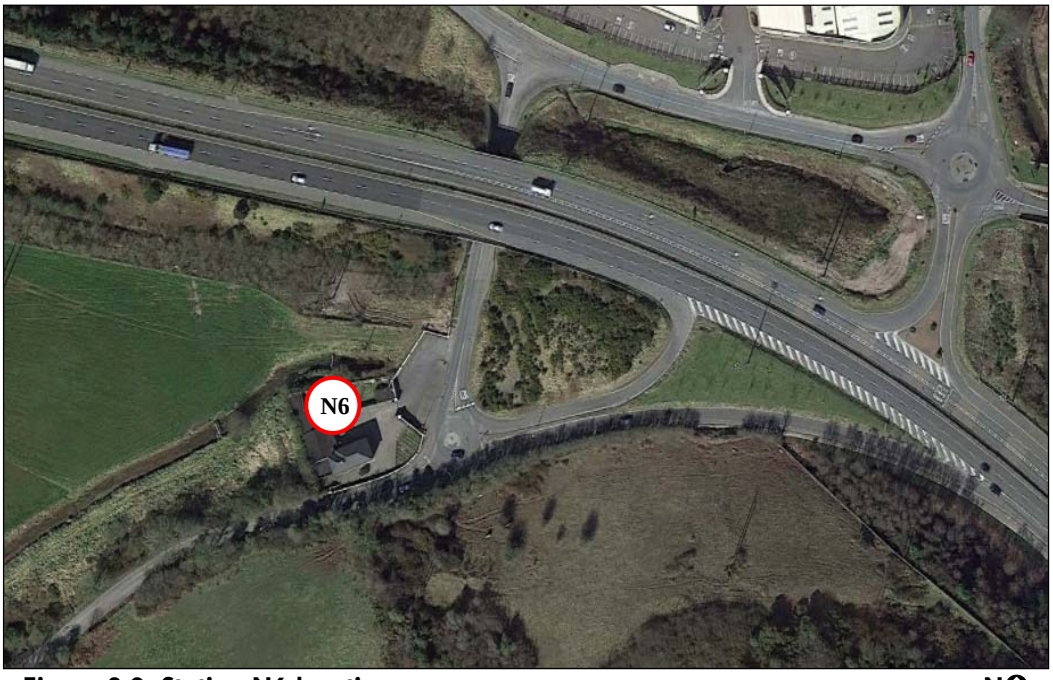


Figure 8.3: Station N6 location. N

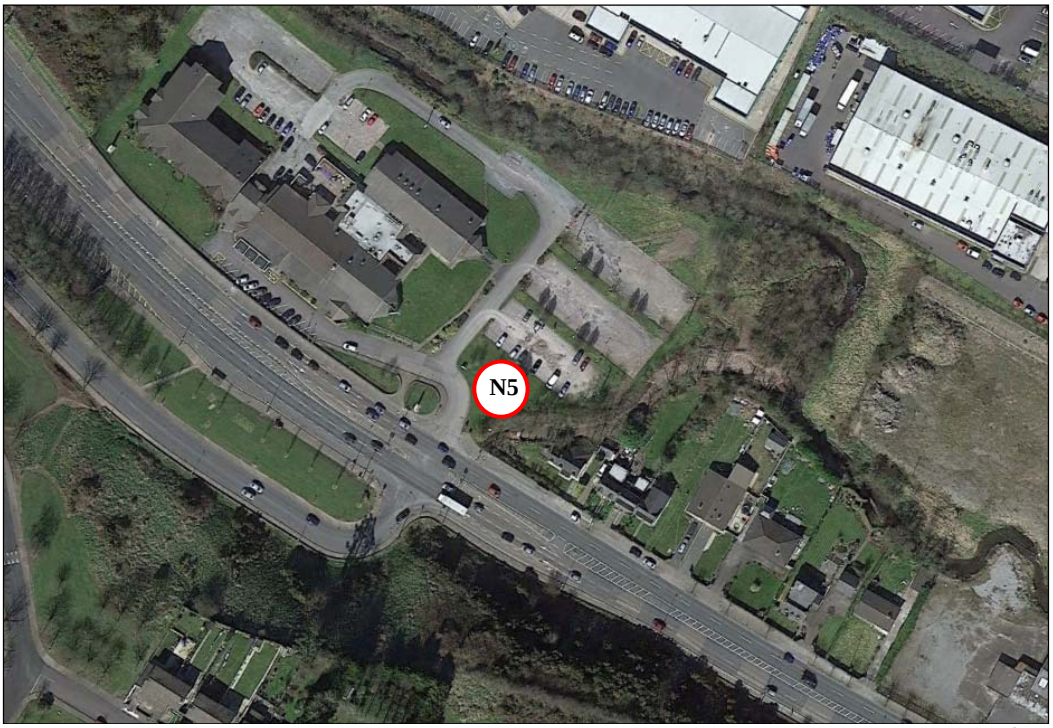
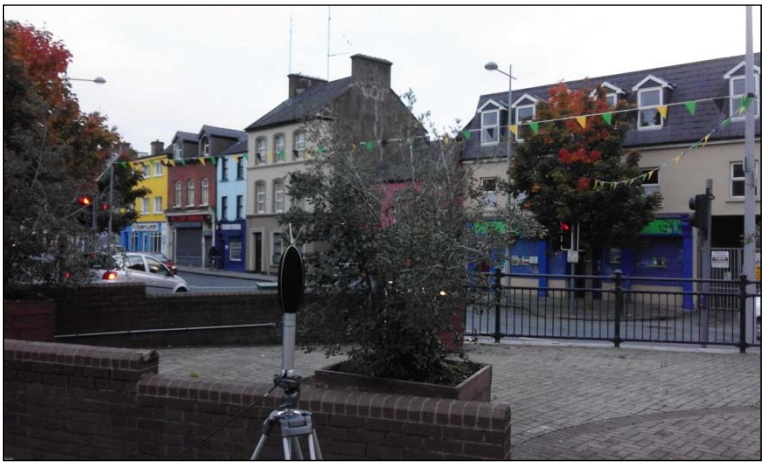


Figure 8.4: Station N5 location. N

Figure 8.5: Stations N3 & N4 locations N

Figure 8.6: Stations N1 & N2 locations. N

Photograph 8.1: N1
T&A Builder's Providers carpark, with roof of nearest dwelling at Madden's Buildings visible, looking S.



Photograph 8.2: N2
Blackpool Church, looking NE towards Thomas Davis St.

Photograph 8.3: N3
Orchard Court (south), looking N.

Photograph 8.4: N4
Orchard Court (north), looking SE.

Photograph 8.5: N5
Commons Inn carpark, with rear of nearby dwelling visible through trees, looking SE.

Photograph 8.6: N6
Dwelling at end of N20 Killeens off-ramp, looking SW.

Photograph 8.7: N7
Front lawn of secluded dwelling, looking N.

8.2.3 Results

Noise data recorded are presented in Appendix 8C and summarised in Table 8.7 below. Frequency spectra and time history profiles are shown in Appendix 8D.

Table 8.7: Ambient noise data summary.

Station	Location	$L_{Aeq\ 15\ min}$ dB	$L_{AF90\ 15\ min}$ dB	Dominant noise sources
N1	Madden's Buildings, Watercourse Rd.	66	58-59	Watercourse Rd. traffic dominant continuously. N20 traffic also clearly audible.
N2	Blackpool Church	62-64	55-57	Traffic through local junction dominant.
N3	Orchard Court south	51-55	47-49	Road traffic on surrounding streets clearly audible and dominant, although screened by buildings and walls.
N4	Orchard Court north	56-58	52-53	N20 Blackpool bypass traffic continuously clearly audible and dominant.
N5	Commons Inn	55-56	52	N20 traffic continuously dominant.
N6	Killeens off-ramp	65	54-57	Intermittent traffic through adjacent junction dominant. N20 traffic continuously clearly audible.
N7	Dwelling below Kilnap railway br.	51-52	49-50	Water flow in nearby river clearly audible continuously, co-dominant with continuously audible N20 traffic noise.

Noise levels measured at each location were markedly consistent, showing relatively unchanged levels across all three measurement intervals. This is a typical feature of noise environments dominated by road traffic noise. Also a feature of such environments is the elevated noise levels prevailing throughout the day. The highest levels were measured at locations close to street and road verges (N1, N2 and N6), with LAeq 15 min levels of 62-66 dB recorded. Reductions of several decibels were measured at stations more removed from road noise (N3, N4 and N5), where LAeq 15 min levels fell to 51-58 dB. At N7, located in a sheltered position 330 m from the N20, LAeq 15 min levels decreased to 51-52 dB. Here, N20 traffic and local river flow maintained a steady noise environment.

Regardless of location, measured levels at all stations were relatively elevated, and reflect the intrusion of both local and distant road traffic. The impact of traffic light sequences, which resulted in traffic waves, is readily apparent in most time history profiles shown in Appendix 8D. No tones were noted at any station.

8.3 ASSESSMENT CRITERIA

8.3.1 Air Quality & Climate

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set. Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values.

In 1996, the Air Quality Framework Directive (96/62/EC) was published. This Directive was transposed into Irish law by the Environmental Protection Agency Act 1992 (Ambient Air Quality Assessment and

Management) Regulations 1999. The Directive was followed by four Daughter Directives, which set out limit values for specific pollutants:

- The first Daughter Directive (1999/30/EC) deals with sulphur dioxide, oxides of nitrogen, particulate matter and lead.
- The second Daughter Directive (2000/69/EC) addresses carbon monoxide and benzene. The first two Daughter Directives were transposed into Irish law by the Air Quality Standards Regulations 2002 (SI No. 271 of 2002).
- A third Daughter Directive, Council Directive (2002/3/EC) relating to ozone was published in 2002 and was transposed into Irish law by the Ozone in Ambient Air Regulations 2004 (SI No. 53 of 2004).
- The fourth Daughter Directive, published in 2007, deals with polyaromatic hydrocarbons (PAHs), arsenic, nickel, cadmium and mercury in ambient air.

The Air Quality Framework Directive and the first three Daughter Directives have been replaced by the Clean Air for Europe (CAFE) Directive (Directive 2008/50/EC on ambient air quality), which encompasses the following elements:

- The merging of most of the existing legislation into a single Directive (except for the Fourth Daughter Directive) with no change to existing air quality objectives.
- New air quality objectives for PM2.5 (fine particles) including the limit value and exposure concentration reduction target.
- The possibility to discount natural sources of pollution when assessing compliance against limit values.
- The possibility for time extensions of three years (for particulate matter PM10) or up to five years (nitrogen dioxide, benzene) for complying with limit values, based on conditions and the assessment by the European Commission.

Table 8.8 below sets out the limit values of the CAFE Directive, as derived from the Air Quality Framework Daughter Directives. Limit values are presented in micrograms per cubic metre (µg/m3) and parts per billion (ppb). The notation PM10 is used to describe particulate matter or particles of ten micrometres or less in aerodynamic diameter. PM2.5 represents particles measuring less than 2.5 micrometres in aerodynamic diameter.

Table 8.8 Limit values of Directive 2008/50/EC, 1999/30/EC and 2000/69/EC (Source: EPA)

Pollutant	Limit Value Objective	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Basis of Application of Limit Value	Attainment Date
Sulphur dioxide (SO2)	Protection of Human Health	1 hour	350	132	Not to be exceeded more than 24 times in a calendar year	1st Jan 2005
Sulphur dioxide (SO2)	Protection of human health	24 hours	125	47	Not to be exceeded more than 3 times in a calendar year	1st Jan 2005
Sulphur dioxide (SO2)	Protection of vegetation	Calendar year	20	7.5	Annual mean	19th Jul 2001
Sulphur dioxide (SO2)	Protection of vegetation	1st Oct to 31st Mar	20	7.5	Winter mean	19th Jul 2001
Nitrogen dioxide (NO2)	Protection of human health	1 hour	200	105	Not to be exceeded more than 18 times in a calendar year	1st Jan 2010
Nitrogen dioxide (NO2)	Protection of human health	Calendar year	40	21	Annual mean	1st Jan 2010
Nitrogen monoxide (NO) and nitrogen dioxide (NO2)	Protection of ecosystems	Calendar year	30	16	Annual mean	19th Jul 2001
Particulate matter 10 (PM10)	Protection of human health	24 hours	50	-	Not to be exceeded more than 35 times in a calendar year	1st Jan 2005
Particulate matter 2.5 (PM2.5)	Protection of human health	Calendar year	40	-	Annual mean	1st Jan 2005
Particulate matter 2.5 (PM2.5) Stage 1	Protection of human health	Calendar year	25	-	Annual mean	1st Jan 2015
Particulate matter 2.5 (PM2.5) Stage 2	Protection of human health	Calendar year	20	-	Annual mean	1st Jan 2020
Lead (Pb)	Protection of human health	Calendar year	0.5	-	Annual mean	1st Jan 2005
Carbon Monoxide (CO)	Protection of human health	8 hours	10,000	8,620	-	1st Jan 2005
Benzene (C6H6)	Protection of human health	Calendar Year	5	1.5	-	1st Jan 2010

The Ozone Daughter Directive 2002/3/EC is different from the other Daughter Directives in that it sets target values and long-term objectives for ozone rather than limit values. Table 8.9 presents the limit and target values for ozone.

Table 8.9 Target values for Ozone Defined in Directive 2008/50/EC

Objective	Parameter	Target Value for 2010	Target Value for 2020
Protection of human health	Maximum daily 8 hour mean	120 mg/m3 not to be exceeded more than 25 days per calendar year averaged over 3 years	120 mg/m3
Protection of vegetation	AOT40 calculated from 1 hour values from May to July	18,000 mg/m3.h averaged over 5 years	6,000 mg/m3.h
Information Threshold	1 hour average	180 mg/m3	-
Alert Threshold	1 hour average	240 mg/m3	-

There are no statutory guidelines regarding the maximum dust deposition levels that may be generated during the construction phase of a development in Ireland. Furthermore, no specific criteria have been set in respect of this development. However, guidelines from the Department of the Environment, Heritage and Local Government currently exist for dust emissions from quarrying and ancillary activities(1). These can be implemented with regard to dust emissions from the proposed construction sites.

With regard to dust deposition, the German TA-Luft standard for dust deposition (non-hazardous dust)(2) sets a maximum permissible immission level for dust deposition of 350 mg/(m2*day) averaged over a one year period at any receptors outside the site boundary. Recommendations outlined by the Department of the Environment, Health & Local Government(1), apply the Bergerhoff limit of 350 mg/(m2*day) to the site boundary of quarries.

The concern from a health perspective is focused on particles of dust which are less than 10 microns. EU ambient air quality standards (Council Directive 2008/50/EC transposed into Irish law as S.I. 180 of 2011) centres on PM10 (particles less than 10 microns) as it is these particles which have the potential to be inhaled into the lungs and cause some adverse health impact. The Directive also sets an ambient standard for PM2.5 (particles less than 2.5 microns) which will come into force in 2015 (see Table 8.8).

Climate Agreements

Ireland is a Party to the Kyoto Protocol, which is an international agreement that sets limitations and reduction targets for greenhouse gases for developed countries. It is a protocol to the United Nations Framework for the Convention on Climate Change. The Kyoto Protocol came into effect in 2005, as a result of which, emission reduction targets agreed by developed countries, including Ireland, are binding.

At Kyoto in 2007, the European Union committed to an average annual greenhouse gas (GHG) emission reduction of 8% below the 1990 levels, over the five year period 2008-2012, with the reductions to be shared between EU Member States. Ireland negotiated an increase of 13% above the 1990 level for the period 2008-2012. Other Member States committed to a reduction of more than 8% to facilitate Ireland's increase in emissions.

In Doha, Qatar, on 8th December 2012, the 'Doha Amendment to the Kyoto Protocol' was adopted. The amendment includes:

- New commitments for Annex I Parties (including Ireland) to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and

- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

During the first commitment period, 37 industrialised countries and the European Community committed to reduce GHG emissions to an average of five percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020; however, the composition of Parties in the second commitment period is different from the first. Under the protocol, countries must meet their targets primarily through national measures, although market based mechanisms (such as international emissions trading can also be utilised.)

Research Methodology

The assessment of air quality has been carried out using a phased approach as recommended by the UK DEFRA(7, 8). The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of possible key pollutants was carried out and the likely location of air pollution "hot-spots" identified. An examination of recent EPA data (9–11) has indicated that SO2, smoke and CO are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed monitoring or assessment to be carried out. Nevertheless, CO was included in the impact assessment. The initial scoping of pollutants did, however, indicate potential problems in regards to nitrogen dioxide (NO2) and PM10 at busy junctions in urban centres(9–11). Benzene, although previously reported at quite high levels in urban centres(9), has recently been measured at several city centre locations to be well below the EU limit value(10-11).

The current assessment thus focused firstly on identifying the existing baseline levels of NO2, PM10 and benzene in the region of the proposed development by an assessment of EPA monitoring data. Thereafter, the impact of the development during the construction phase of the project on air quality at the neighbouring sensitive receptors was determined by an assessment of the dust generating construction activities associated with the proposed development.

8.3.2 Noise criteria

The proposed flood relief works will not give rise to any noise emissions following commissioning. While the current draft proposal includes seven underground pumping stations, noise emissions from installed pumps at these are expected to be entirely negligible. Operational noise emissions may therefore be discounted. In contrast, construction phase emissions are of greater significance.

There are no mandatory noise limits applicable to the construction phase of projects in Ireland. In granting permission for projects, regulatory authorities may specify maximum noise limits at receptors which construction works are required to meet. In selecting suitable limits, authorities may refer to two guidance documents.

British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 1: Noise (2009) sets out a procedure which may be used to determine the impacts of construction noise at surrounding receptors. The procedure involves setting threshold values based on ambient LAeq T levels. Table 8.10 lists threshold levels determined using the methodology set out in the standard, taking into account ambient noise levels measured across the study site. The standard recommends that, during the construction phase, total noise levels including construction emissions should not exceed these threshold levels.

Table 8.10: Noise threshold levels (LAeq T) determined in accordance with BS 5228:2009.

Period	Receptors adjacent to streets/roads	Receptors set back from streets/roads
Weekdays 0700-1900 h	70 dB	65 dB
Weekdays 1900-2300 h	60 dB	55 dB
Saturdays 0700-1300 h	70 dB	65 dB
Saturdays 1300-2300 h	60 dB	55 dB
Sundays 0700-2300 h	60 dB	55 dB
Night-time 2300-0700 h	50 dB	45 dB

The National Roads Authority (NRA) document Guidelines for the treatment of noise and vibration in national road schemes (2004) also recommends limits applicable to the construction phase of projects. Although the guidance is applicable specifically to road construction projects, the limits are widely applied in Ireland to other construction projects. The limits are presented in Table 8.11.

Table 8.11: Noise limits recommended by the NRA (2004).

Period	LAeq 1 h	LASmax
Weekdays 0700-1900 h	70 dB	80 dB
Weekdays 1900-2200 h	60 dB	65 dB
Saturdays 0700-1630 h	65 dB	75 dB
Sundays & bank holidays 0800-1630 h	60 dB	65 dB

BS 5228:2009 and NRA guidance differs in several ways:

- The NRA document does not include night-time or weekend evening limits.
- The NRA document includes LAmax criteria. It is noted that the LASmax parameter is specified rather than the more common LAFmax.
- Evening cut-off times differ by one hour (2200 h v 2300 h).
- BS 5228:2009 specifies Saturday limits of 70 dB up to 1300 h, falling to 60 dB thereafter. In contrast, the NRA document specifies a limit of 65 dB up to 1630 h.
- BS 5228:2009 guidance relates to free field levels (measured more than 3.5 m from any wall), whereas NRA limits are façade levels (usually measured at 1 m from the façade). Due to reflections, façade levels are typically 3 dB higher than free field levels.

Despite the above differences, both documents specify an identical weekday daytime limit of 70 dB, and an identical weekday evening limit of 60 dB, at least in noisier areas. The 60 dB Sunday limit is also identical. On the basis of the foregoing, Table 8.12 suggests limits considered suitable for the proposed project. Given the importance of the project, and the long term benefit which will accrue to all receptors, including those in more secluded positions, the higher criteria determined in Table 8.10 are applied. In the absence of any NRA LASmax criteria for night-time hours, LASmax limits are adopted from LAFmax limits included in the World Health Organisation document Guidelines for community noise (1999).

Table 8.12: Suggested noise limits at all receptors, based on BS 5228:2009 and NRA guidance.

Period	LAeq 1 h	LASmax
Weekdays 0700-1900 h	70 dB	80
Weekdays 1900-2300 h	60 dB	65
Saturdays 0700-1630 h	65 dB	75
Saturdays 1630-2300 h	60 dB	60
Sundays & bank holidays 0700-2300 h	60 dB	65
Night-time 2300-0700 h	50 dB	60

Given the project's importance to the long term welfare of residents across the study site, it is suggested that limits proposed in Table 8.12 should be free field rather than façade levels. On this basis, levels measured at facades may be up to 3 dB higher than Table 8.12 limits.

It is expected that most construction activity will be undertaken during daytime hours Monday-Saturday. Indeed the NRA document notes that construction activities outside of these times, other than emergency works, will 'normally require the explicit permission of the relevant local authority'.

8.3.3 Vibration criteria

The proposed flood relief works are not expected to give rise to ground borne vibration. Vibration emissions, however, may arise during the construction phase. As with noise, there are no mandatory vibration limits, and reference may instead be made to a number of standards, all of which refer to peak particle velocity (PPV, measured in mm/s) which is usually used to quantify ground borne vibration

British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 2: Vibration (2009) notes that human beings are highly sensitive to vibration, and will detect vibration at levels far lower than those which may cause building damage. Examples of human reactions described by the standard are summarised in Table 8.13.

Table 8.13: Human reactions to vibration, from BS 5228:2009.

PPV	Effect
0.14 mm/s	Just about perceptible in the most sensitive situations for typical construction frequencies.
0.3 mm/s	Just perceptible in residential environments.
1 mm/s	Likely to cause complaint in residential environments, although will be tolerated id prior warning and explanation is given.
10 mm/s	Likely to be intolerable for any more than a very brief exposure.

In contrast to the markedly low levels presented in Table 8.13, PPV levels which may cause cosmetic or structural damage to buildings are considerably higher. On the basis of extensive studies, limits recommended by the two most respected international authorities are presented in Table 8.14. The limits are those below which cosmetic damage (hairline cracking, etc.) to buildings is unlikely to occur. Limits relating to structural damage are significantly higher.

Table 8.14: Recommended vibration limits.

Source	Structure	Lower frequencies	Higher frequencies
1	Modern dwellings	<40 Hz: 19 mm/s	>40 Hz: 51 mm/s
	Older dwellings	<40 Hz: 12.7 mm/s	>40 Hz: 51 mm/s
2 & 3	Industrial & heavy commercial	4-15 Hz: 50 mm/s	>15 Hz: 50 mm/s
	Residential & light commercial	4-15 Hz: 15-20 mm/s	>15 Hz: 20-50 mm/s

Sources:

[1]US Bureau Of Mines report RI 8507: Structural response and damage produced by ground vibration from surface mines blasting (1980).

[2]British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration.

[3]British Standard BS 7385:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration.

The strictest limit included in Table 8.14 is 12.7 mm/s reported by the US Bureau Of Mines with respect to older dwellings (typically plaster on wood lath in the US). Limits reported for newer buildings by both US and British authorities are 15 mm/s or higher. With respect to older buildings, such as period dwellings across the study site, British Standard BS 7385:1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration states that 'a building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive'.

The NRA's 2004 guidance document includes vibration criteria relevant to the construction phase of road projects, reproduced in Table 8.15. The NRA limits were drawn up taking international guidance into account, and appear to incorporate significant safety margins. It is suggested that the NRA criteria be applied to the proposed development.

Table 8.15: Construction phase vibration criteria recommended by the NRA (2004).

Frequency	<8 Hz	10-50 Hz	>50 Hz
PPV limit	8 mm/s	12.5 mm/s	20 mm/s

8.4 POTENTIAL IMPACTS

8.4.1 Air Quality & Climate

Air Quality

Material handling activities on site may typically emit dust. Dust is characterised as encompassing particulate matter with a particle size of between 1 and 75 microns (1-75 µm). Deposition typically occurs in close proximity to each site and potential impacts generally occur within 500 metres of the dust generating activity as dust particles fall out of suspension in the air. Larger particles deposit closer to the generating source and deposition rates will decrease with distance from the source. Sensitivity to dust depends on the duration of the dust deposition, the dust generating activity, and the nature of the deposit. Therefore, a higher tolerance of dust deposition is likely to be shown if only short periods of dust deposition are expected and the dust generating activity is either expected to stop or move on.

The potential for dust to be emitted will depend on the type of activity being carried out in conjunction with environmental factors including levels of rainfall, wind speed and wind direction.

As indicated, dust generation rates depend on the site activity, particle size (in particular the silt content, defined as particles smaller than 75 microns in size), the moisture content of the material and weather conditions. Dust emissions are dramatically reduced where rainfall has occurred due to the cohesion created between dust particles and water and the removal of suspended dust from the air. It is typical to assume no dust is generated under "wet day" conditions where rainfall greater than 0.2 mm has fallen. Information collected from Cork Airport Meteorological Station (1962-1991) identified that typically 204 days per annum are "wet". Thus for greater than 55% of the time no significant dust generation will be likely due to meteorological conditions.

Large particle sizes (greater than 75 microns) fall rapidly out of atmospheric suspension and are subsequently deposited in close proximity to the source. Particle sizes of less than 75 microns are of interest as they can remain airborne for greater distances and give rise to the potential dust nuisance at the sensitive receptors. This size range would broadly be described as silt. Emission rates are normally predicted on a site-specific particle size distribution for each dust emission source.

Whilst construction activities are likely to produce some level of dust during earth moving and excavating phases of the project, these activities will mainly be confined to particles of dust greater than 10 microns. Particles of dust greater than 10 microns are considered a nuisance but do not have the potential to cause significant health impacts. For instance, bulldozing and compacting operations release 84% of particles which are greater than PM10 with only 16% of particles being less than 10 microns(14).

It is envisaged that the construction of the development will occur in distinct phases. As such, the potential for dust nuisance and significant levels of PM10 & PM2.5 concentrations will vary both temporally and spatially as the construction develops.

Worst-case truck movements during the peak construction period would be about 4 inward and 4 outward / hour. Construction traffic of this level will lead to dust emissions of the order of 3 g/m2 each hour along the haul roads based on no mitigation being implemented(14). However, provided vehicle speeds are restricted to less than 40 km/hr, this level of construction traffic will lead to dust emissions of the order of 2 g/m2 each hour along the haul roads(14). Thus, it is unlikely that the emissions of this magnitude will lead to dust deposition levels at the site boundary which exceed the TA Luft limit value for dust nuisance of 350 mg/(m2*day).

With effective implementation of a dust minimisation plan, the proposed development is expected to have a negligible impact on air quality during the construction phase. Due to the size, nature and location of the development, which will lead to no increase in road traffic emissions, the proposed development is expected to have an imperceptible impact on air quality once it is operational.

Hence the impact on air quality of the proposed development will be insignificant.

Climate

Construction traffic would be expected to be the dominant source of greenhouse gas emissions as a result of the development. Vehicles will give rise to CO2 and N2O emissions during construction of the proposed development. This activity will result in a temporary negligible impact on climate.

8.4.2 Noise sources

The proposed development will not give rise to audible noise emissions following commissioning. While seven underground pumping stations will include pumps which will operate during high flow events, noise emissions from these are expected to be entirely negligible at the nearest receptors. Occasional maintenance works following commissioning, including sediment trap cleaning, will not be audible beyond their immediate vicinity due to masking by road traffic noise. Accordingly, operational noise emissions may be discounted.

Construction phase emissions, albeit occurring over a confined period, have greater potential to cause local noise intrusion. The construction phase will involve installation of a number of flood defence measures, the final design and positioning of which will be determined at detailed design stage. The measures will include the following, proposed at various positions:

- Channel cleaning, including debris removal and dredging where required.
- Bridge and culvert replacement or reconstruction.
- Construction of new walls and repairs to existing parapet walls.
- Construction of flood embankments.
- Sluice removal.
- Installation of sediment trap and trash screens.
- Construction of winter channel above existing watercourse.

Implementation of the above works is likely to require the following activities:

- Where debris/sediment removal is required, this typically involves use of bankside excavators which transfer material to HGVs or dump trucks.
- Embankment construction works, involving use of 1-2 midsized tracked excavators, and possibly a small number of dumpers or dump trucks. Such works are proposed at the Commons Inn, at Blackpool Retail Park, and adjacent to the secluded dwelling near the railway bridge.
- Concrete breaking may be required at several locations, involving either hydraulic breakers on tracked excavators, or handheld pneumatic breakers powered by compressors. Concrete saws may also be required.
- Wall and parapet wall repair and construction works, proposed between North Point Business Park and Blackpool Shopping Centre, and adjacent to the dwelling at the end of the Killeens off-ramp, are likely to involve a number of activities, including blockwork and concrete pours. Plant such as telescopic handlers and mini-excavators may be required. Various activities are likely to require mobile generators to power equipment, lights and pumps. Larger works areas are likely to be surrounded by temporary hoarding to a height of 2.4 m.
- Although the construction method for the proposed sediment trap at Sunbeam has yet to be finalised, one of the possible methods is sheet piling. While unlikely, sheet piling may also be required at other works zones. The requirement for piling, and selection of piling method, will not be determined until site specific investigations are undertaken in due course. Sheet piling may involve use of driven or pressed-in piles, or use of vibro-displacement techniques.
- Removal of dredged material, rubble and spoil, and deliveries of concrete and other materials will require a large number of HGV movements throughout the project. These will be concentrated at specific areas where easements are available.

The overall duration of the construction phase is expected to be approximately 18 months. However, activities at each of the proposed works zones are expected to last no more than several months, depending on the works involved.

8.4.3 Noise impacts

The proposed construction works will be finalised following detailed site inspections, environmental assessment and public review. Although the works required at each location are unlikely to change significantly, the methodologies, plant and timeframes may only be determined by the appointed contractor(s). It is therefore not possible to accurately predict noise impacts at surrounding receptors at this stage. Moreover, prediction of noise impacts associated with the construction phase of any project is complicated by several additional factors:

- The timing, duration and amplitude of emissions associated with activity in each works zone will vary considerably.
- Construction details and plant requirements will alter on a daily basis as construction progresses.
- Plant requirements and activities may vary considerably due to unforeseen changes in the construction program.
- There will be extended periods when little or no construction noise emissions arise eg. during concrete drying periods.
- Each individual source may be relocated frequently eg. excavators.
- The overall construction period will be relatively short. The duration of individual stages will be limited, lasting days or weeks at most eg. excavation.

Due to the foregoing, it is not possible to accurately calculate the noise output which will arise onsite throughout the construction phase at each receptor across the study site. An alternative approach here is to calculate likely noise levels expected to arise in the vicinity of work zones. The calculation is presented in Table 8.16, based on typical plant sound pressure levels at 10 m provided by British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 1: Noise (2009). The worst case scenario assumed in each zone is unlikely to occur routinely, if at all. With respect to sheet piling, it is assumed that pressed-in piles will be used where possible.

Table 8.16: Expected sound pressure level (SPL) in work zones.

Activity	Worst case scenario	SPL at 10 m	Total SPL at 10 m
Dredging	Long-reach tracked excavator x1 Dump truck x1	78 dB (178 kW) 78 dB (187 kW)	81 dB
Embankment construction	Tracked excavators x2 Dump trucks x2	75 dB (134 kW) 78 dB (187 kW)	83 dB
Concrete breaking	Hydraulic breaker x1 Consaw x1	72 dB (143 kW) 91 dB (3 kW)	72-91 dB
Wall construction	Telescopic handler x1 Discharging mixer truck x1 Generator x1	71 dB (60 kW) 75 dB 65 dB	77 dB
Sheet piling	Pressed-in piling rig x1	60-70 dB	60-70 dB

Noise impacts at receptors associated with emissions presented in Table 8.16 are assessed in Table 8.17 in light of the 70 dB daytime LAeq 1 h criterion discussed above. The table does not take into account screening provided by possible hoarding panels around each work zone.

Table 8.17: Noise impacts at receptors.

Activity	Total SPL at 10 m	Impacts
Dredging	81 dB	LAeq 1 h will reduce to 75 dB at 20 m, and 69 dB at 40 m where operations progress continuously over 1 h. A number of dwellings immediately upstream of North Point Business Park, and several dwellings on Old Commons Road and at Orchard Court, may receive LAeq 1 h levels above 70 dB.
Embankment construction	83 dB	Proposed at the Commons Inn, at Blackpool Retail Park, and adjacent to the secluded dwelling near the railway bridge. The last, and bedroom at the Commons Inn, both lie within 10 m of proposed embankments, and will thus be subject to LAeq 1 h levels which exceed 70 dB.
Concrete breaking	72-91 dB	Where required, concrete breaking is unlikely to exceed the 70 dB criterion. Cutting of concrete using a consaw will reach 91 dB LAeq 1 h at 10 when undertaken continuously over 1 h. Any NSLs within approximately 100 m of consaw operations will receive emissions over 70 dB.
Wall construction	77 dB	Proposed between North Point Retail Park and Blackpool Shopping Centre. The only NSLs here are located immediately downstream of the Commons Inn. Most of these are sufficiently removed from the proposed flood defence wall, and noise levels will not exceed 70 dB. However, LAeq 1 h levels at the most northerly dwellings may exceed 70 dB during certain operations. At the hotel itself, there are no bedrooms in the vicinity of the proposed wall. Works proposed immediately adjacent to the dwelling at the end of the Killeens off-ramp may also give rise to noise levels above 70 dB at the dwelling.
Sheet piling	60-70 dB	Sheet piling will not give rise to levels which exceed the 70 dB criterion at any receptor where pressed-in piles are used.

On the basis of the foregoing, the 70 dB criterion may be exceeded in the following cases:

- A number of dwellings immediately upstream of North Point Business Park, and several dwellings on Old Commons Road and at Orchard Court, may be exposed to LAeq 1 h levels above 70 dB if channel dredging is undertaken within approximately 40 m.
- The secluded dwelling near the railway bridge, and bedrooms at the Commons Inn will be subject to LAeq 1 h levels which exceed 70 dB during local embankment construction.
- Any dwelling within approximately 100 m of consaw operations, and with a direct line of sight, may be exposed to levels above 70 dB.
- During construction of flood defence walls, a small number of dwellings immediately downstream of the Commons Inn, and one dwelling adjacent to the Killeens off-ramp, may receive LAeq 1 h levels above 70 dB during certain operations.

With respect to 70 dB exceedances identified above, consaw operations may be readily controlled by erecting a hoarding around the cutting area. In addition, the flood defence wall construction operation downstream of the Commons Inn, and at the Killeens off-ramp dwelling, may be similarly treated by erecting a hoarding along the boundary of the works zone. In each case, the hoarding should extend to a height of 2.4 m, and should consist of plywood boarding on both sides of timber framework, with waterproofed cavity to be filled with mineral wool or similar. Gaps at partition interfaces should be boarded. If such measures are installed, consaw and wall construction operations are expected to meet the 70 dB LAeq 1 h criterion.

Given the size of plant associated with dredging, and the proximity of receptors at certain locations, use of hoarding to screen noise emissions is unlikely to be practical. In this case, it is considered more suitable to notify residents in advance of operations. The affected NSLs consist of three dwellings upstream of North Point Business Park, and a number of dwellings along Old Commons Road and at Orchard Court.

Like dredging, embankment construction is similarly unsuitable for treatment using hoarding. A more practical solution is to liaise with both affected receptors (the secluded dwelling near the railway bridge, and the Commons Inn) in advance.

In addition to the sources discussed above, noise emissions will also arise from HGV movements across the study area associated with import of materials and export of soils, etc. HGV access to work zones will be facilitated using the local road network, and through privately owned access points by agreement. The number of HGV movements required has not been accurately quantified at this point. On the basis of experience with other large scale construction projects, the number of movements at most work zones is unlikely to exceed two per hour. Where civil engineering works are required, such as embankment construction, this may increase to five per hour.

Noise levels attributable to HGV movements may be determined using:

$L_{Aeq\ 1\ h} = L_{AE} + 10\log N - 10\log T$

L_{AE} Sound exposure level from vehicle pass. Truck L_{AE} will vary. Typical L_{AE} value of 83 dB at 5m is assumed, based on experience at other sites.

N: Number of passes.

T: 1 hour.

On this basis, $L_{Aeq\ 1\ h}$ levels associated with up to five movements per hour will be 54 dB at 5 m. It follows that $L_{Aeq\ 1\ h}$ levels will be significantly lower than the 70 dB criterion at all receptors. Given the dominance of existing traffic noise in the local environment, HGV movements are highly unlikely to alter existing traffic noise levels.

During the construction phase, noise impacts at all receptors will be temporary and localised. At most of these, impacts will be imperceptible. At a small number of dwellings, particularly those immediately adjacent to dredging or embankment construction works, impacts will range from slight negative to noticeable negative. Given the benefit which will accrue to these dwellings in particular, the overall long term impact is expected to be positive.

8.4.4 Vibration impacts

Three potential sources of ground borne vibration may arise during the construction phase: vibratory compaction, concrete breaking, and sheet piling.

Vibratory compaction of infill may be required over small areas prior to the laying of finished surfaces. This source is unlikely to be significant offsite due to the small areas involved and the limited time present. Moreover, the fluidic nature of infill when vibrated tends to attenuate ground vibration; most of the vibration energy is lost through particle settlement before reaching underlying strata. Low peak particle velocity (PPV) levels in the order of 1.5 mm/s have been reported at a distance of 25 m at some sites. At the nearest receptors, PPV levels are therefore likely to be significantly lower than criteria presented in Tables 8.11 and 8.12.

Concrete breaking, where required, will involve hydraulic breaker units fitted to tracked excavators, or pneumatic handheld units. Although this activity may give rise to high levels of ground vibration in proximity to the breaking area, the vibration tends to contain relatively little energy in the lower frequencies at which buildings and occupants are most vulnerable. In addition, higher frequencies attenuate more rapidly than low frequencies, thus minimising the impact zone. For this reason, most vibration guidance documents such as British Standard BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration ignore concrete breaking vibration. Table 8.18 lists various PPV levels reported in literature at sites where hydraulic rock breaking has been undertaken. The range in levels noted reflects variations in equipment power and rock type.

Table 8.18: Reported rock breaking vibration levels.

Distance	5 m	10 m	20 m	50 m
PPV	0.2-4.5 mm/s	0.06-3.0 mm/s	0.02-1.5 mm/s	0.1-0.3 mm/s

The highest PPV level presented in Table 8.18 is 4.5 mm/s, measured at 5 m from the breaking operation. This level is considerably lower than criteria presented in Tables 8.11 and 8.12. It should be noted that levels presented in Table 8.18 relate to rock breaking. PPV levels associated with concrete breaking are likely to be lower.

Sheet piling may be required when constructing the proposed sediment trap. Although unlikely, piling may also be required when constructing or repairing bank defences. Traditional piling methods such as driven piling may generate high levels of ground borne vibration. Vibo-displacement piles may also give rise to elevated PPV levels. If either of these is deemed necessary, it is recommended that real time monitoring of PPV levels is undertaken at surrounding receptors. It is also recommended that prior test piling be

undertaken, with concurrent PPV measurement, to determine piling parameters required to meet criteria presented in Tables 8.11 and 8.12.

It is noted that the piling method most likely to be used at the study site will be pressed-in piling where ground conditions allow. British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 2: Vibration (2009) notes that vibration levels associated with pressed-in piling are minimal. The document refers to PPV levels measured in the vicinity of two separate pressed-in piling projects where the following levels were measured: 2.5-4.3 mm/s at 4.5 m, 0.3-0.7 mm/s at 7.1 m, and <0.5 mm/s at 24 m.

In summary, vibration impacts are expected to be imperceptible where pressed-in piles are used. Any other piling methods are likely to result in temporary community-wide impacts, ranging from noticeable negative to substantial negative depending on separation distance.

8.5 MITIGATION MEASURES

8.5.1 Air Quality & Climate

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within several hundred metres of the construction area[13].

In order to ensure that no dust nuisance occurs, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface. Furthermore, any road that has the potential to give rise to fugitive dust must be regularly watered, as appropriate, during dry and/or windy conditions.

Speeds shall be restricted on hard surfaced roads as site management dictates. Vehicles delivering material with dust potential shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust.

Public roads in the vicinity of the site shall be regularly inspected for cleanliness, and cleaned as necessary.

At all times, the dust mitigation measures put in place will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movement of materials will be immediately terminated and satisfactory procedures implemented to rectify the problem before the resumption of the operations.

The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

8.5.2 Noise & Vibration

Following completion of the proposed flood relief works, noise emissions are expected to be satisfactory, and no specific mitigation measures are required.

Noise emissions associated with the construction phase will in general be satisfactory at most receptors. At each work zone, operations will be confined to a relatively short period, extending to several months at most. Apart from a small number of exceptions, noise emissions at each zone will comply with the daytime 70 dB LAeq 1 h criterion. The exceptions are as follows:

- Three dwellings immediately upstream of North Point Business Park, and several dwellings on Old Commons Road and at Orchard Court, may be exposed to LAeq 1 h levels above 70 dB if channel dredging is undertaken within approximately 40 m. It is recommended that the contractor liaises with the occupants of these dwellings prior to undertaking works.
- The secluded dwelling near the railway bridge, and bedrooms at the Commons Inn will be subject to LAeq 1 h levels which exceed 70 dB during local embankment construction. It is again recommended that the contractor liaise with the occupants of these dwellings prior to undertaking works.
- Any dwelling within approximately 100 m of consaw operations, and with a direct line of sight, may be exposed to levels above 70 dB. This may be readily mitigated by erecting hoarding between the operations area and nearby receptors.
- During construction of flood defence walls, a small number of dwellings immediately downstream of the Commons Inn, and one dwelling adjacent to the Killeens off-ramp, may receive LAeq 1 h levels above 70 dB during certain operations. As above, this may also be readily mitigated by erecting hoarding.

Where hoarding is required, it is recommended that hoarding panels should extend to a height of 2.4 m, and should consist of plywood boarding on both sides of timber framework, with waterproofed cavity to be filled with mineral wool or similar. Gaps at panel interfaces should be boarded. If such measures are installed, consaw and wall construction operations are expected to meet the 70 dB LAeq 1 h criterion at receptors.

Installation of hoarding will be less suitable for control of dredging and embankment construction works. At the affected properties, it is recommended that the contractor liaises with the occupants of these dwellings prior to commencing works. It is noted that the dwellings lie in close proximity to the channel, and are therefore vulnerable to flooding. The proposed works will eliminate the possibility of flooding at these receptors. In this light, short term construction works are likely to be considered acceptable.

It is recommended that appointed contractor(s) be required to adopt practices set out in British Standard BS 5228:2009 Code of practice for noise and vibration control on construction and open sites Part 1: Noise and Part 2: Vibration (2009). Measures recommended in the standard include:

- Appointing a project representative responsible for noise and vibration issues, and for liaising with local representatives. A clear communication channel should be established between all parties prior to project commencement.
- Requiring that contractors ensure that site personnel are familiar with potential noise and vibration issues, and that personnel apply a common-sense approach to eliminating unnecessary noise emissions.
- Use of quieter plant and methods where possible.

- Installation of temporary barriers or enclosures around local sources such as compressors and generators.
- Limiting times of activities which may generate elevated noise or vibration emissions.

With respect to sheet piling, no mitigation measures are considered necessary where pressed-in piles are used. If ground conditions require an alternative piling method, it is recommended that real-time monitoring of PPV levels is undertaken at surrounding receptors. It is also recommended that prior test piling be undertaken, with concurrent PPV measurement, to determine piling parameters required to meet criteria presented in Tables 8.11 and 8.12.

The assessment above relates to daytime operations. Where evening or night-time operations are required, it is recommended that noise impacts associated with proposed works be assessed in advance.

8.6 RESIDUAL IMPACT

8.6.1 Air Quality & Climate

There are no residual impacts expected on air quality and climate from the proposed development

8.6.2 Noise & Vibration

Noise and vibration impacts during the construction phase, inclusive of mitigation, are expected to be temporary, localised and imperceptible at most locations. At dwellings close to proposed works zones, particularly adjacent to dredging and embankment construction areas, impacts are likely to be slight negative to noticeable negative. Impacts may increase to noticeable negative or substantial negative where piling methods other than pressed-in piles are used. However, it should be noted that these impacts will be entirely short term in nature, lasting several days or weeks locally in most cases. Implementation of mitigation measures described above will further reduce impacts. Moreover, the long term impact is expected to be positive, given the elimination of flood risk in these areas.

8.7 MONITORING

8.7.1 Air Quality & Climate

The dust mitigation measures put in place will be strictly monitored and assessed throughout the construction phase to ensure their effectiveness. If a dust minimisation plan is effectively implemented there will be no need for dust monitoring during the construction phase.

8.7.2 Noise and Vibration

Monitoring of noise and vibration levels at receptors may be undertaken at specified locations across the study site while certain operations are in progress. The following monitoring criteria are suggested:

- Noise monitoring in accordance with International Standard ISO 1996-2 Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels (2007). Attended measurement of LAeq 15 min, LAF10 15 min, LAF90 15 min, LASmax and LAFmin (LASmax rather than LAFmax is recommended to assess compliance with NRA criteria). Monitoring locations should be selected to represent the nearest receptors to work zones at the time of the survey.
- Vibration monitoring in accordance with British Standard BS 7385:1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from groundborne vibration. Maximum PPV levels to be measured over 15 min at each location. Monitoring locations

should be selected to represent the nearest and/or most vulnerable receptors to work zones at the time of the survey.

Chapter 9:

Landscape

9 LANDSCAPE

9.1 Introduction

This section of the Environmental Impact Statement addresses the landscape and visual aspects of the proposed River Bride (Blackpool) Certified Drainage Scheme. The main elements of the proposed development is briefly described, The relevant sections of the River Bride have been described with reference to Landscape Character and the relevant landscape policy recommendations that have been set out for this area by Cork City Council in Cork City Development Plan 2015-2021 in terms of landscape and visual characteristics are also addressed. A number of photomontages are included to assist the assessment of landscape and visual impacts. This chapter should be read in conjunction with the drawings for the proposed drainage scheme in Appendix 3A.

9.1.1 Proposed works

The proposed works for the River Bride (Blackpool) Certified Drainage Scheme comprise works at a variety of locations, as set out in Chapter 3. The works which are relevant from a landscape and visual point of view are as follows:

- Site investigation works
- Construction of new culverts,
- Replacement of a number of existing bridges/ culverts, and removal of existing pedestrian bridges, and also changes to pedestrian access and constructing bridge parapets
- Construction of new flood walls/ earthen embankments.
- Local channel widening of the River Bride (referred to as a 'Winter Channel' on the scheme drawings in Appendix 3A),
- Construction of a sedimentation trap on the left bank of the River Bride,
- Removal of approximately 100m of existing culvert and restoration of open channel (River Bride) at this location,
- Construction of a new trash screens and roughing, and removal of an existing trash screen on the River Bride, and the Glen and Glenamought Rivers,
- Modifications to the existing foul and surface water collection networks in the vicinity of the proposed works, including construction of pumping stations, in order to prevent flooding,
- Localised regrading of ground levels, erection of fencing and access gates, to facilitate pedestrian/ vehicular access to and around flood defences, or to redirect overland surface water flow paths,
- Filling an existing open watercourse

9.1.2 Study Area

The study area for the Landscape and Visual Assessment was defined following the desk study and again following site visit, and the examination of the proposed works.

The proposed works are located along the northern section of the River Bride in Blackpool, and a small section of the River Glenamought and Fairhill Stream just inside the Cork City Boundary in Blackpool in the north of Cork City. The study area also includes a short section of the River Glen, to the east of Blackpool Shopping Centre and south of Spring lane.

To the north, the proposed works begin close to the Railway Viaduct over the River Glenamought, where the City and County Boundary runs along the river. The works continue in various locations along the River

Bride in Blackpool. The proposed works finish close to where Watercourse Road meets the N20 Blackpool Bypass.

For the Landscape and Visual Impact Assessment, the Study Area takes in the river itself as well as lands immediately on both sides of the river, including areas where the proposed works will be visible or will have a potential landscape or visual impact. Due to the nature of the proposed drainage works as well as the nature of the Rivers Bride, Glenamought and Glen, and the landscape context, a Study Area which extends on both sides of the rivers and takes in the immediate features, views and prospects and areas from where the proposed works will be most visible is considered appropriate. The built form and topography restrict views of the rivers considerably and the majority of views of the river are available only from the immediate vicinity of the proposed works.

This follows the LI/IEMA (2013) Guidance referenced below which proposes that the level of detail in the landscape baseline studies should be "appropriate and proportionate to the scale and development. The Guidelines also state that for the landscape baseline the aim is to provide an understanding of the landscape in the area that may be visually affected. The Study Area is illustrated in Figure 9.1

9.2 METHODOLOGY

This section broadly outlines the methodology used to undertake the landscape and visual assessment of the proposed development, and the guidance used to in the preparation of each section. There are four main sections to the assessment:

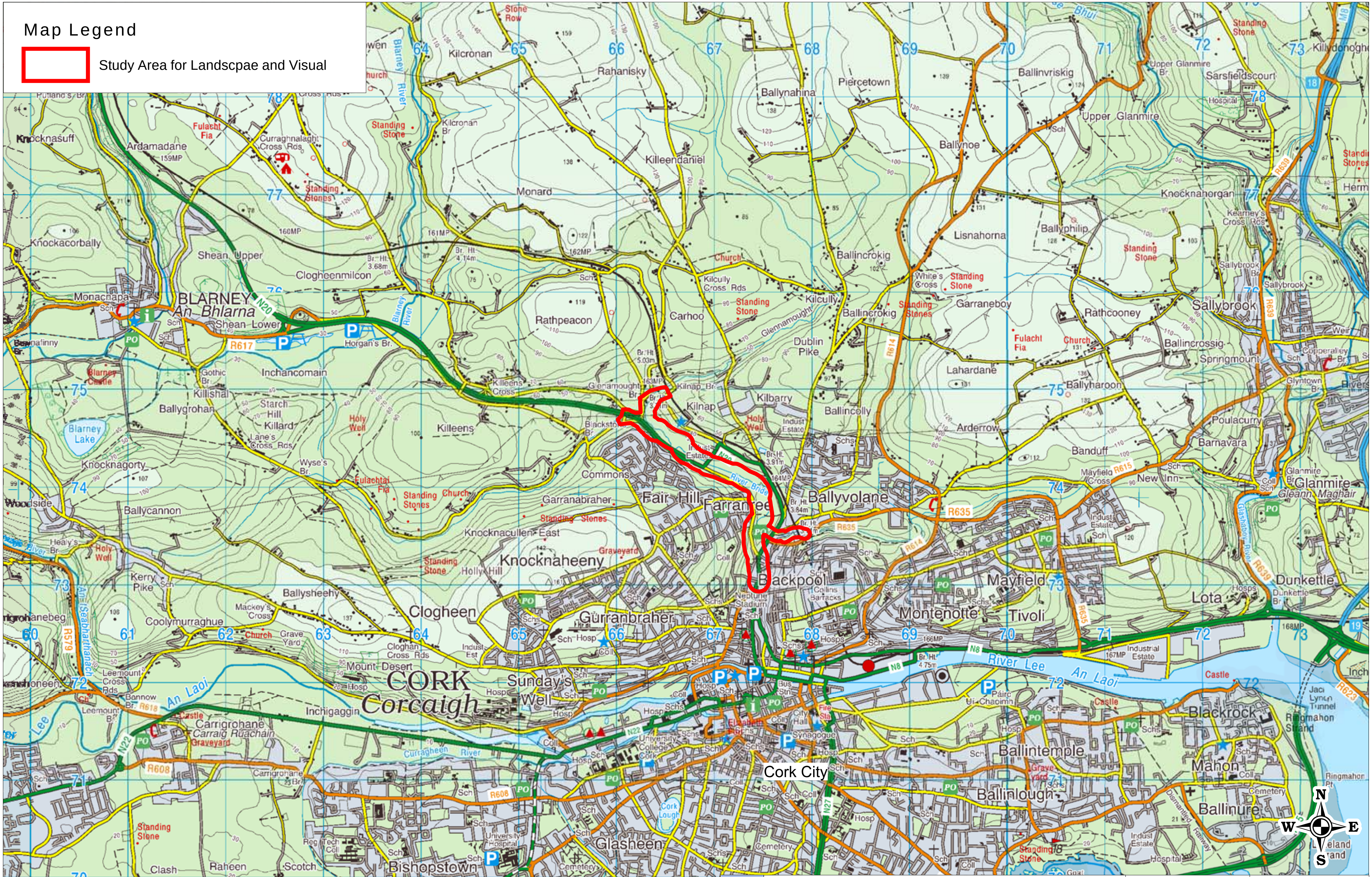
- Outline of guidance followed
- Baseline landscape and visual assessment
- Nature and visibility of the proposed development
- Assessment of potential impacts

9.2.1 Guidance Documents

The only available, quasi-official document providing guidance on landscape quality for some time at a national level was 'Outstanding Landscapes', published by An Foras Forbartha in 1976. However in 2000, the Department of the Environment and Local Government built on this document by producing 'Landscape and Landscape Assessment: Consultation Draft of Guidelines for Planning Authorities', which recommended that all Local Authorities adopt a standardised approach to landscape assessment for incorporation into Development Plans and consideration as part of the planning process.

In 2002, Ireland signed and ratified the European Landscape Convention (ELC), which introduces a pan-European concept which centres on the quality of landscape protection, management and planning. The Department of Arts, Heritage and the Gaeltacht has published a National Landscape Strategy for Ireland in 2015. The Strategy aims to ensure compliance with the ELC and contains six main objectives, which include developing a national Landscape Character Assessment and developing Landscape Policies.

Although the DoEHLG 2000 guidance remains in draft form, this section of the EIS has been informed by the landscape assessment guidelines presented in the DoELHG document, as well as a range of other guidelines which include:



MAP TITLE:	Landscape and Visual Study Area	MAP NO.: Figure 9.1	SCALE: 1:50,000
PROJECT TITLE:	121004a - River Bride (Blackpool) Certified Drainage Scheme		DATE: 28-10-2015
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McCarthy Keville O'Sullivan

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

- Guidelines for Landscape and Visual Impact Assessment (The Landscape Institute/Institute of Environmental Management and Assessment, UK, 2013)
- EPA Guidelines on the information to be contained on Environmental Impact Statements (EPA 2002)
- EPA Advice Notes on Current Practice in the preparation of Environmental Impact Statements (EPA, 2003).

9.2.2 Baseline Landscape Assessment

One of the first stages of carrying out a Landscape and Visual Impact Assessment is to establish the baseline landscape and visual conditions. In order to carry out this assessment, an initial desk study was undertaken which identified relevant policies and guidelines, both at national and local level. This includes any relevant Cork City Council policies on landscape and landscape character, designated landscapes, and scenic routes.

The Study area consists of the areas to which works are to be carried out is described in Section 9.1.2 and are described in general terms of Landscape Character Areas and types as identified 'Landscape and Landscape Assessment: Consultation Draft of Guidelines for Planning Authorities' (Department of the Environment and Local Government, 2000), and as defined in the Cork City Development Plan 2014-2020. In addition, a field visit was undertaken in Autumn 2015 to assess the landscape character and elements both in the Study area and in the wider landscape.

The desk study reviews previous landscape character assessments and reviews that have been carried out within the Study Area. The desk study also includes information on landscape within the immediate vicinity of the proposed works. It incorporates a description of the policies and objectives of Cork City Council and Cork City Council with regards to the Landscape Appraisal, including any Landscape Character Units, Scenic Routes and Protected Views, Landscapes, with specific reference to the Study Area location. The primary sources of information consulted during the course of the desk study include:

- Cork City Development Plan 2014-2020
- Cork City Landscape Study 2008

A site visit was conducted to gain familiarity with the Study Area and to ascertain the limits of the visual unit and a walkover survey of the Study Area to assess the landscape character and verify the extents of the Study Area. Photographs illustrating the landscape attributes of the Study Area were taken and notes were taken on landscape features and views in the Study Area.

9.2.3 Visibility of the Proposed Development

The locations of viewpoints for photographs (described further in Section 9.5) were informed by the nature of the proposed development, and the landscape context, maps and aerial images, with actual visibility being verified on the ground by a site visit.

In addition, a number of photomontages representing the likely visual effects of the development were prepared. These were based on an artist's impression and give an indication rather than the specific description of the likely appearance of the proposed flood relief works.

These were taken at varying locations along the river. The selection of photo locations is designed to give a representative range of views of the proposed development site and the choice of viewpoints (photo locations) is influenced by both the view available and the type of viewer. Due to the site location and the nature of the proposed development, visibility by the general public will be possible only in certain areas.

9.2.4 Assessment of Potential Impacts

Landscape and Visual Impact Assessment

Landscape and Visual Impact Assessment, though related, can be described separately. Descriptions based on the LI/IEMA Guidelines on Landscape and Visual Impact Assessment (2013) define each as follows:

Landscape Impact Assessment: This can be described as deriving from changes to the physical landscape, and which may result in changes to the landscape character and how it is experienced, as well as changes to the landscape as a resource.

Visual Impact Assessment: The assessment which relates to the changes in the composition of views available to people a result in changes to the landscape, including human response to the change and the overall changes to visual amenity.

The potential impacts of the proposed development in terms of visual and landscape impact are informed by both the desktop study, the site visit which outlines current visibility from chosen viewpoints, and study of the proposed works. The impact assessment is also assisted by the production of photomontages or artist's impressions which show the likely appearance of the proposed works. The assessment of impacts is assessed using the terminology recommended by the EPA (2002/3) as set out in Chapter 1 Introduction.

9.3 RECEIVING ENVIRONMENT

9.3.1 Cork City Landscape Study 2008

The Cork City Landscape Study was prepared in 2008 and has been incorporated into Chapter 10 of the Cork City Development Plan 2015-2021 (see below). The Study establishes principles for protecting and enhancing the City's natural environment. The Study includes a Landscape Character Assessment, Analysis of Key Landscape Elements, identification of Key Landscape Elements and Formulation of Policy Recommendations and the elements which are contained in the Development Plan are outlined in Section 1.2.2 below.

9.3.2 Cork City Development Plan 2014-2020

The Cork County Development Plan 2014-2020 refers to policies and objectives for landscape in Chapter 10. These policies and objectives are based on the Cork City Landscape Study 2008.

The Council seek to enhance the landscape through the development of a framework including developing and enhancing primary green links along the river Lee Corridor, extending public access along Secondary Green links along the other river tributaries, developing and improving Key Landscape areas in the City and creating new Urban woodlands.

9.3.3 Landscape Character Areas

Eight Landscape Character areas were identified in the Study. These are shown in Figure 9.2 and include:

- Estuarine/Riverine
- Natural harbour
- Historic urban core
- Fine-grained inner city residential
- Suburban residential
- Urban sylvan character
- Urban industrial/commercial
- Rural agricultural

The proposed works are to be carried out largely in areas characterised as Suburban residential, Urban sylvan character and Urban industrial/ commercial.

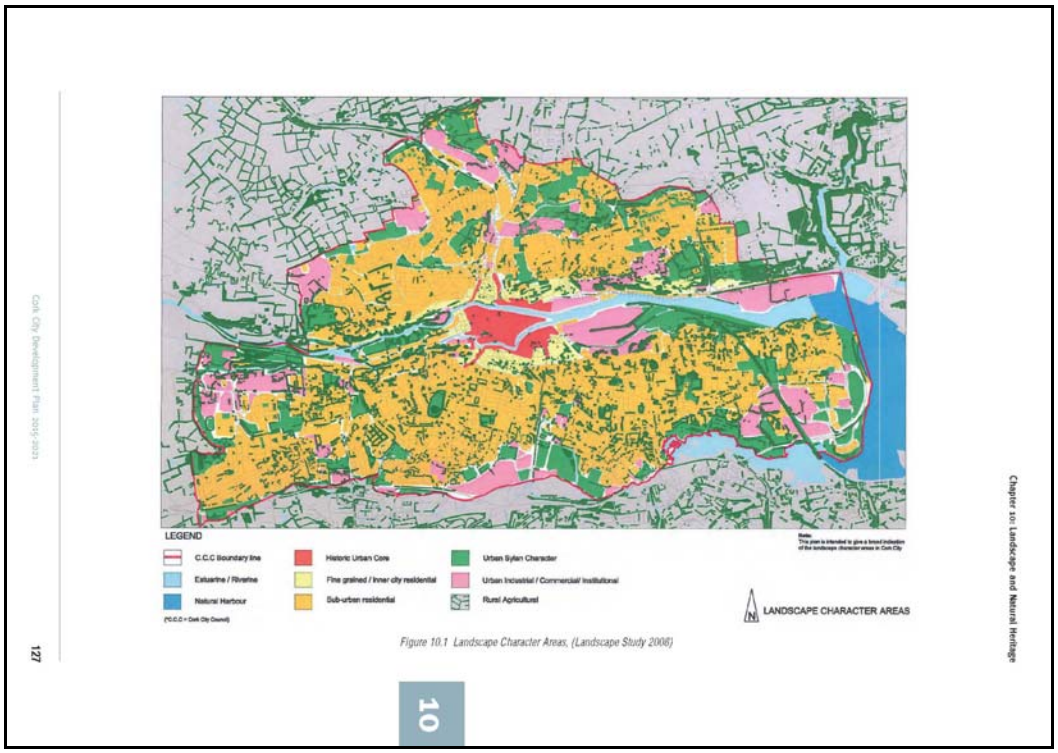


Figure 9. 2 Cork City Landscape Character Areas

9.3.4 Key Landscape Assets

The Landscape Study identifies a number of landscape assets which combine to create Cork's unique cityscape. The Key landscape assets are included in Table 10.1 in the Development Plan and are summarised below:

- Topography (ridges, slopes and escarpments).
- Water/River Corridors (river, estuary, harbour)
- Tree Canopy
- Ecology
- Visually Important Land (includes views and prospects)
- Historic Core
- Landmarks
- Public or Private Open Space
- Institutional Open Space
- Historic Landscapes
- Rural Character Green Belt
- Built Form
- Public Realm
- Gateways to the City
- Bridges
- Pedestrian/Cycle Routes in the City
- Vehicular Access
- The Railway in the City

Key Landscape Assets which are potentially relevant to the areas of the proposed drainage works include river corridors, visually important land, open space, gateways to the city, and bridges.

- **Objective 10.1**: Landscape Strategic Objectives: To preserve and enhance Cork's landscape character and key landscape assets, and to preserve and enhance Cork's views and prospects of special amenity value.
- **Objective 10.2:** Cork City Landscape: To preserve Cork's unique and distinctive landscape character through appropriate management and enhancement of Key Landscape Assets as set out in Table 10.1)
- **Objective 10.3**: To preserve and enhance Cork's landscape and where appropriate, to increase access to and utilise the landscape for recreational purposes through the implementation of the Landscape Structure Plan.

9.3.5 Landscape Protection Designations

The Development Plan includes several categories of landscape designations which aim to preserve and enhance the significant landscape elements of the city. These include Areas of High Landscape Value and Landscape Preservation Zones.

Areas of High Landscape Value

These are areas which comprise one of more landscape assets listed above as identified in the Cork Landscape Study 2008. These areas display an intrinsic landscape character and a special amenity value. The Plan notes that development will be appropriate only where it results in a neutral or positive impact on the landscape and that new developments in AHLVs must respect the dominance of the landscape. The Council's objective is as follows:

> ***Objective 10.4 Areas of High Landscape Value***
> *To conserve and enhance the character and visual amenity of Areas of High Landscape Value (AHLV) through the appropriate management of development, in order to retain the existing characteristics of the landscape, and its primary landscape assets. Development will be considered only where it safeguards to the value and sensitivity of the particular landscape. There will be a presumption against development where it causes significant harm or injury to the intrinsic character of the Area of High Landscape Value and its primary landscape assets, the visual amenity of the landscape; protected views; breaks the existing ridge silhouette; the character and setting of buildings, structures and landmarks; and the ecological and habitat value of the landscape.*

There are two Areas of High Landscape Value within the Study Area. One area occurs along the Glenamought River where it borders the City Boundary. This areas consists of a period residence in in a riverside landscape setting, with the Railway Viaduct also located within this area. This is illustrated in Plate 9.1

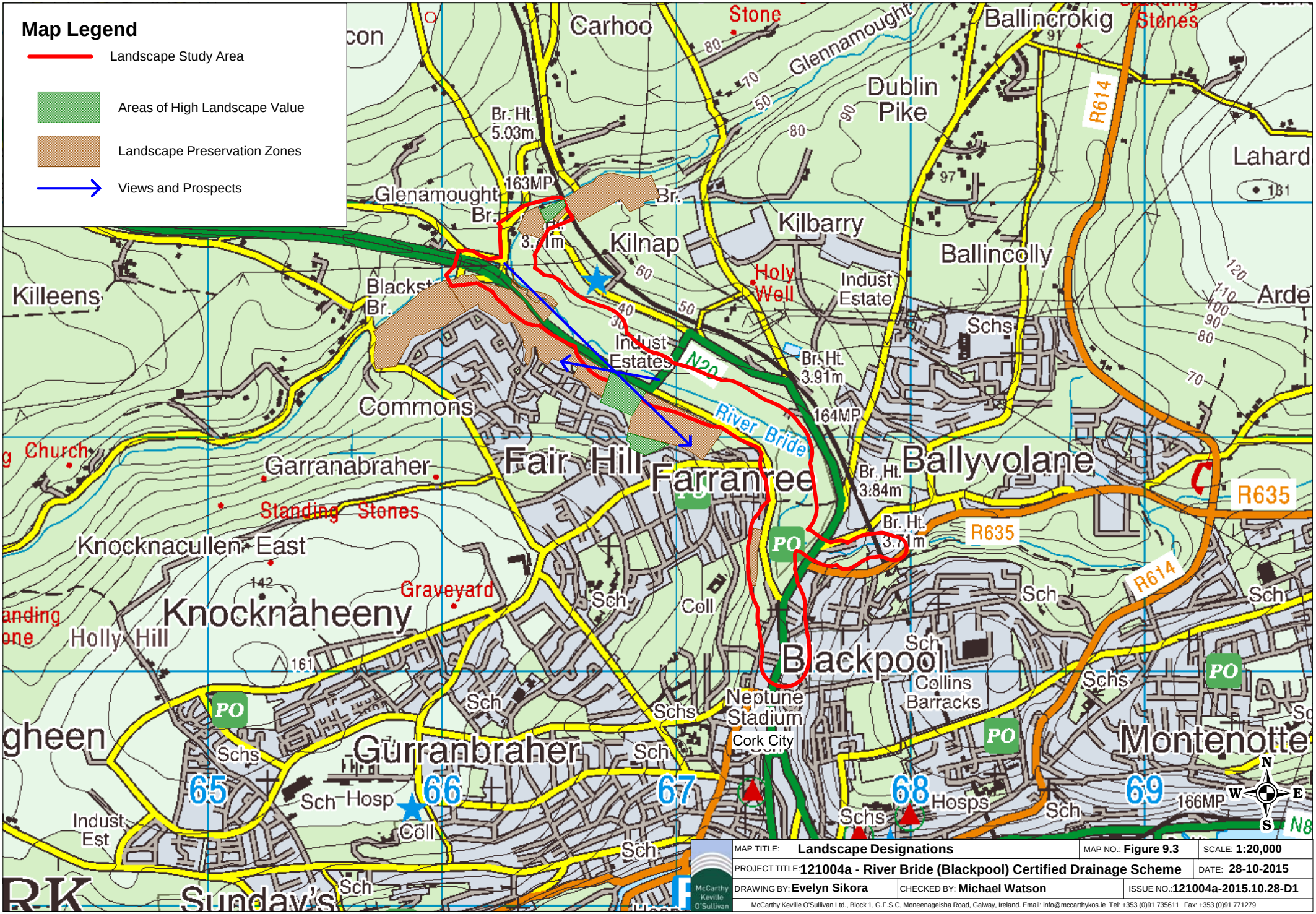
Plate 9.1: Area of High Landscape Value at Kilnap, looking through Kilnap Viaduct along the Glenamought River.

A second area occurs along the west side of the N20 at Brideholm, which is also an area occupied by residential development. These Areas of High Landscape Value are illustrated on Figure 9.3

Landscape Preservation Zones (LPZ).

Landscape Preservation Zones (LPZ) are areas which are considered highly sensitive to development, and typically combine distinctive landscape assets such as topography, tree cover, settings to historic structures or open spaces and other landscape assets. These areas have limited development potential. The Plan contains the following Objective:

> ***Objective 10.5 Landscape Preservation Zones***
> *To preserve and enhance the character and visual amenity of Landscape Preservation Zones through the control of development. Development will be considered only where it safeguards to the value and sensitivity of the particular landscape and achieves the respective site specific objectives, as set out in Table 10.2.*



MAP TITLE: **Landscape Designations**		MAP NO.: **Figure 9.3**	SCALE: **1:20,000**
PROJECT TITLE: **121004a - River Bride (Blackpool) Certified Drainage Scheme**			DATE: **28-10-2015**
DRAWING BY: **Evelyn Sikora**	CHECKED BY: **Michael Watson**	ISSUE NO.: **121004a-2015.10.28-D1**	

McCarthy Keville O'Sullivan Ltd., Block 1, G.F.S.C, Moneenageisha Road, Galway, Ireland. Email: info@mccarthykos.ie Tel: +353 (0)91 735611 Fax: +353 (0)91 771279

There are six LPZs which fall within or partially within the Study Area. The Cork City Development Plan also the Landscape Assets to be protected and also site-specific objectives for each LPZ. These are as follows:

Table 9.1 Landscape Preservation Zones

LPZ	Landscape Assets to be protected	Site Specific Objectives
NE1 Bride Valley	Topography, River, Tree Canopy, Ecology, Visually Important Land (from train)	Re-establish river as a key element of the valley floor by providing a linear park with publicly accessible riverside treed walk
NE2 Bride Valley	Topography, River, Tree Canopy, Ecology, Visually Important Land (from train)	Re-establish river as a key element of the valley floor by providing a linear park with publicly accessible riverside treed walk
NE3 Bride Valley	Topography, River, Tree Canopy, Ecology, Visually Important Land (from train)	Re-establish river as a key element of the valley floor by providing a linear park with publicly accessible riverside treed walk with new tree coverage and linked spaces.
NW11Farranferris Ridge Upper	Topography, River, Tree Canopy, Ecology, Visually Important Land	Provide a passive amenity space which benefits from an enhanced landscape structure and significant tree planting. To protect and enhance the watercourse and its setting.
NW12 Farranferris Ridge	Landmarks, Open Space	To seek the development of a passive public open space to provide for the surrounding residential areas.
NW13 Commons Road/Lover's Walk Ridge	Tree Canopy, Landmarks, Historic Core	To connect between Commons Road and Seminary Walk/Lover's Walk
NW14 Blackpool Valley (west) Ridge Commons Road	Rural Character/Green Belt, Topography, Tree Canopy, Visually Important Land, Gateway to the City	To develop a woodland park on the southern valley slope to provide an attractive landscape feature at the gateway and to connect the rural landscape with the city; To provide pedestrian linkages between residential areas at the top of the slope and Fitz's Boreen and Sunbeam development area.

Plate 9.2: View towards the Landscape Preservation Zone on Commons Ridge

9.3.6 Protected Views

Chapter 10 of the Development Plan lists a number of Views and Prospects. There are several types of views, and these include Linear Views of Landmark Buildings, Panoramic Views, River Prospects, Townscape and Landscape Features and Approach Road Views.

The views which relate to the Study Area are shown on Figure 9.3. The views relevant to the study area are categorised as Landscape and Townscape as follows:

Table 9.1 Landscape and Townscape Views

View		
LT24A	Woodland on Commons Ridge	N20/Commons Road Inbound
LT24B	Woodland on Commons Ridge	N20/Commons Road Outbound

Both views are towards the Commons Ridge, a wooded ridge which lies to the west of the N20 Cork-Mallow road as it enters Cork City. The river lies to the east of the N20 and is not visible in either of the protected views, being at a lower level that the N20 and screened by vegetation and earthworks from the N20. View LT24A is shown in Plate 9.3 below.

Plate 9.3: Protected View LT24A with the Commons ridge on the right of the image

The Objective associated with protection of the views and prospects is as follows:

> ***Objective 10.6 Views and Prospects***
> *To protect and enhance views and prospects of special amenity value or special interest and contribute to the character of the City's landscape from inappropriate development, in particular those listed in the development plan. There will be a presumption against development that would harm, obstruct or compromise the quality or setting of linear views of landmark buildings, panoramic views, rivers prospects, townscape and landscape views and approach road views.*
> *To identify and protect views of local significance through the preparation of local area plans, site development briefs and the assessment of development proposals on a case-by-case basis.*

9.4 LANDSCAPE CHARACHTER

The topography, vegetation and anthropological features on the land surface in an area combine to set limits on the amount of the landscape that can be seen at any one time. These physical restrictions form individual areas or units, known as physical units, whose character can be defined by aspect, slope, scale and size. A physical unit is generally delineated by topographical boundaries and is defined by landform and land cover.

9.4.1 Physical Unit

The physical landscape unit in which the Study Area is located is defined largely by the Rivers Bride and Glenamought and a small section of the Glen River, and their associated river valleys. While in certain areas such as along the River Glenamought, to the northeast of the study area, the river valley and associated woodlands are evident, changes to the landcover of the physical landscape are evident further downstream in the built up areas where the river edges have been modified. Although the Bride valley is somewhat evident, built form has strongly influenced the landscape further downstream in Blackpool.

Landform

Present-day landscapes owe their form to the geological materials from which they were carved. Landform is the term used to describe the spatial and formal arrangement of landscape components as a natural product of geological and geomorphologic processes in the past, and refers primarily to topography and drainage.

9.4.2 Topography

The topography of the Glenamought River in the Study Area is characterised by a vegetated river valley which slopes sharply in certain areas. The level of the riverbanks and surrounding land ranges from approximately 20 to 40 metres OD. The change in level in the landscape is particularly evident in this part of the Study Area as the Cork-Dublin railway line travels over the viaduct in the northeast of the study area, as shown in Plate 9.4 below. In the wider landscape, there are several hills – Rathpeacon Hill and the Commons Ridge to the northwest and west, the latter which is a feature of the City's landscape. To the east of the rivers lie the hills of Kilbarry/Ballyvolane.

Plate 9.4: Steep topography and Urban sylvan character adjacent to Railway Viaduct

To the northwest of the Study Area, close to the Lower Killeens Road, the river valley of the River Bride is also evident along the urban fringe and here it is characterised by a tree lined corridor. However, as one moves further towards the City, the road drops in level and enters the built up area of the city, where the river valley is evident, as shown in 9.5 below. Plate 9.3 also shows the view down the valley, which is defined by the Commons Ridge which lies adjacent to the N20 and to the west of the river. The higher ground at Kilbarry and Ballyvolane lies to the east of the river. The river itself is hidden somewhat as the river is surrounded by the urban fabric. Further downstream in Blackpool village, along the valley floor, the natural river valley topography is more difficult to perceive due to the urban fabric.

Plate 9.5: Views to the River Bride Valley from sloping ground along the N20. The river lies to the rear of the vegetation on the far side of the N20 while the Commons Ridge lies to the right of the image.

Plate 9.6: Topography and character of riverbank in Orchard Court, Blackpool

9.4.3 Drainage

The River Bride rises near Kerry Pike, some 4.9 kilometres to the west of the Study Area boundary. The River Glenamought rises near the townland of Coole East, approximately 4.4 kilometres north of the study area boundary.

9.4.4 Geological Processes

Chapter 6 refers to the geomorphology of the South Cork region, where uplands and valleys are characteristic of the region. The Study Area is underlain by Devonian 'Old Red Sandstone'. (The geology of Cork City is reflected in the use of sandstone and limestone in the buildings and walls in the city).

Landcover and Landuse

Landcover

Landcover is the term used to describe the combinations of vegetation and land-use that cover the land surface. It comprises the more detailed constituent parts of the landscape and encompasses both natural and man-made features. Landcover includes vegetation, structures and built form.

The CORINE land cover data (2012) for the Study Area was obtained from the Environmental Protection Agency (EPA). CORINE land cover is a map of the environmental landscape based on the interpretation of satellite images. It provides comparable digital maps of land cover for each country for much of Europe.

The CORINE data for the Study Area shows that on a broad level, to the north of the study area, there are small areas characterised as *Agricultural Areas – Land Principally Occupied by agriculture with significant*

areas of natural vegetation (243) as well as a small area of *Discontinuous Urban Fabric* (112). However the majority of the Study Area, which lies further south, is characterised as *Artificial Surfaces – Industrial and Commercial units* (121) with a portion to the south of the Study Area in Blackpool characterised as Continuous Urban Fabric (111).

Glenamought River

On the ground, it is evident that the landcover in the Study Area changes as one moves from north to south. In the north, along the city periphery, land cover in the Study Area along the riverbank consists mainly of vegetation – grass, shrubs and trees, with considerable areas of tree cover. Some of these areas are also designated as Areas of High Landscape Value and Landscape Preservation Zones as illustrated in Figure 9.3. Plate 9.7. below shows the type of landcover found along the Glenamought River to the northeast of the study area, which is also a Landscape Preservation Zone.

Plate 9.7: Vegetated land cover along Glenamought River to north of study area

River Bride

Landcover along the River Bride, in the north of the study areas along the City and County Boundary, is predominantly rural in character, consisting of fields and hedgerows, with some scattered built form as shown in Plate 9.8 below.

As one moves further south along the river corridor, towards the Commons Inn, the landcover is characterised by some areas of vegetation close to the river, along with areas covered by roads, (the N20), and hard surfaces and buildings, such as areas close to the North Point Business Park and to the rear of buildings such as the Commons Inn and the MacDonald's Drive Thru. Further downstream, the landcover

close to the river becomes characteristic of industrial areas, as it flows through the Dulux Paints yard and the Sunbeam Industrial Estate, as shown in Plate 9.9 below.

Plate 9.8: Rural character and vegetated land cover along Bride River to north of study area

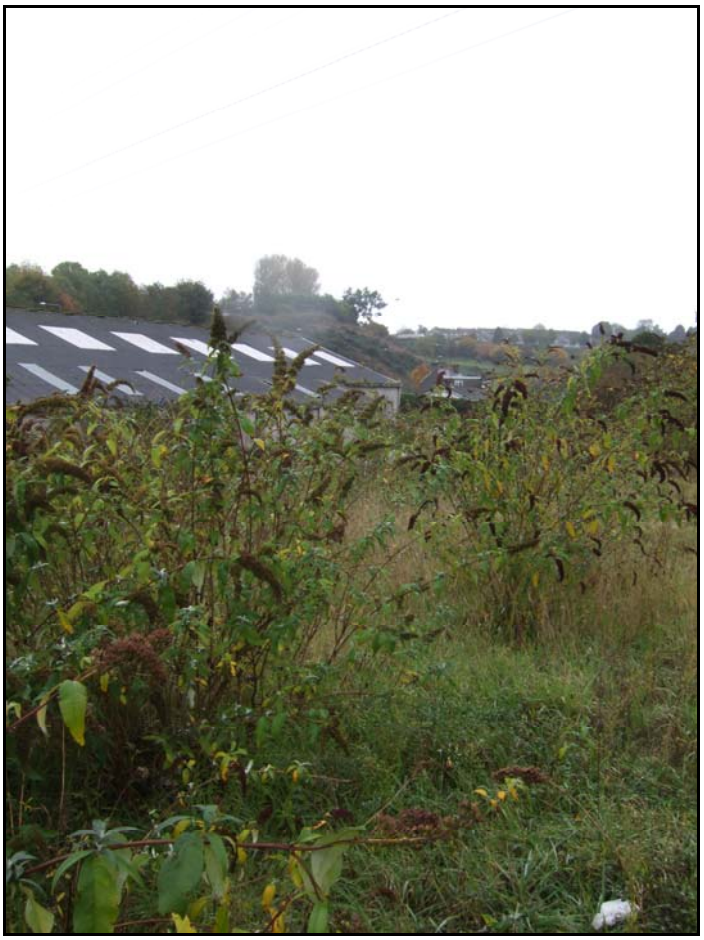


Plate 9.9: Built form (industrial units) and areas of vegetation along River Bride in Blackpool

Further downstream of the Sunbeam Industrial Estate, the river Bride flows through open space at the Blackpool Retail Park where it can be clearly seen from the surrounding paths, bridges and open space as shown in Plate 9.10 below. From the Blackpool Retail Park through Orchard Court, to Blackpool Church and Watercourse Road, the landcover is predominantly hard surfaced and the built form and urban fabric becomes denser, as shown in Plate 9.11 below. The river is culverted in sections but remains open along Orchard Court. Adjacent to Blackpool Church the river is partially culverted and a plaza exists over the culverted sections. To the south of the plaza, there is a section of open channel (as shown in Plate 9. 11).

Plate 9.10: Open Space along the River Bride in Blackpool Retail Park

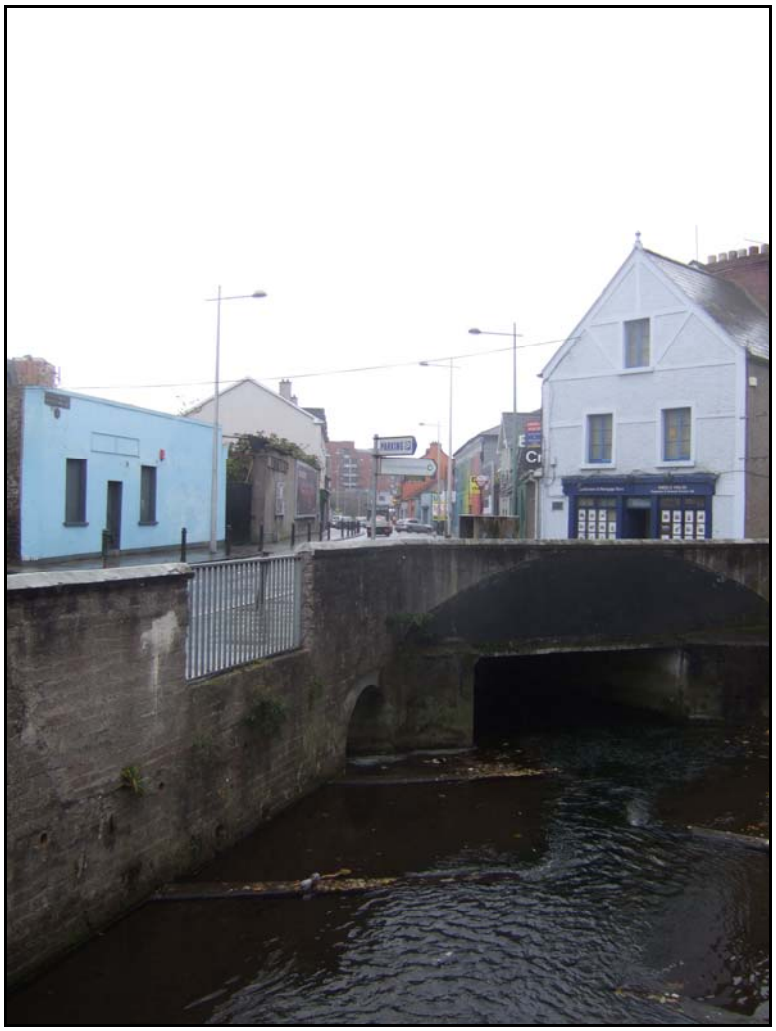


Plate 9.11: Landcover composed of hard surfaces and buildings in Blackpool

Glen River

The study area includes a small section of the Glen River to the east of Blackpool Shopping Centre and south of Spring Lane. A large part of this river is currently culverted, and the landcover in this area varies between hard surfaces - commercial and residential built form and roads – in the area around the shopping centre, to an area of semi-natural vegetation of grass and trees close to the Cork-Mallow railway line and on both sides of the North Ring Road. There is an informal pedestrian path from the North Ring Road along to the east of the railway line which connects with Spring Lane.

Land Use

Land Use, as it is related to landcover, in the Study Area ranges from a small area of residential and agricultural fields in the north of the study area along the City Boundary, while some residential land uses and areas of open space also occur. Further south along the N20 the land uses become urban, and are mostly commercial and industrial units with several business parks and industrial estates, and including the Blackpool Retail Park, which contains some open space also. Residential and commercial land uses are predominant to the south of the study area as the river flows through Orchard court and through Blackpool Village.

9.4.5 Visual Unit

When describing landscape character, physical units can be restricted in terms of visibility due to landform or land cover and may be made up of smaller visual units.

A visual landscape unit is defined by spatial enclosure and pattern, i.e. by landform and landcover. The limits of the views that are available from a particular area are therefore determined by the physical landscape, such as topographical and vegetation boundaries. In addition to the definition of the physical unit of the river valley, the visual unit of the Study Area is further restricted by the development of built form which increases as one moves from the north to the south of the study area.

The visual unit to the north of the site is contained by the topography and vegetation. It should also be noted that a portion of the north part of the study area is visible from the elevated railway viaduct.

As one moves further south, the river itself is screened in many areas due to built form along the east of the River Bride. From the higher ground to the east and west of the River Bride, large areas of the Study Area are visible, while on the valley floor and closer to the river, visibility is restricted due to vegetation and built form. Views to and from the river are described in Section 9.4.7

Image Unit

An image unit is a feature that acts as a major focal point within the landscape, such as Croagh Patrick in Co. Mayo. Such features contribute to the creation of a strong identity or sense of place. From the south of the study area, on Watercourse Road, there are some views to Ct Anne's Church at Shandon which is a well-known landmark associated with Cork City.

9.4.6 Landscape Value and Sensitivity

The sensitivity of a landscape to development and therefore to change varies according to its character and to the importance that is attached to any combination of landscape values. The sensitivity of a landscape is derived from consideration of designations such as Special Protection Areas (SPAs), Special Areas of Conservation (SACs), Natural Heritage Areas (NHAs) and National Parks, from information such as tourist maps, guidebooks and brochures, and from the evaluation of indicators such as uniqueness, popularity, distinctiveness, and quality of the elements of the area.

An assessment of landscape sensitivity in the vicinity of the Study Area was carried out during a site visit in October 2015. The methodology for this assessment was based on that set out in the Department of the Environment and Local Government (DoEHLG) guidance document '*Landscape and Landscape Assessment – Consultation Draft of Guidelines for Planning Authorities*' (2000). This document recommends an assessment of landscape sensitivity based on an evaluation of individual features, such as the quality, integrity, etc. The results of the assessment are presented in Table 9.3 below.

Table 9 .3 Features of Landscape Sensitivity

Feature	Description
Quality	The quality of the landscape in this area can be described as somewhat modified, with areas of agricultural pasture and semi natural vegetation to the north of the study area, while the majority of the study area is covered by artificial surfaces within the urban settlements.
Integrity	Much of the Study Area, especially the southern sections, and the river bank in these areas, has been modified by the interaction of man with the natural environment, primarily in the form of urban development and infrastructure and agricultural and general land management.

Feature	Description
Distinctiveness	Feature of the landscape which could be described as distinctive include the Commons Ridge. The other landmark seen form the Study Area is St Anne's Church Shandon.
Popularity	A sense of popularity is created where landscape features are widely recognised or appreciated.
Rarity	The closest Natura 2000 sites and pNHAs are more than 5 kilometres downstream form the proposed works – these do not occur within the works area.
Cultural Meaning	A sense of cultural meaning arises where a site or features within a site are deemed to explain, represent or inspire cultural values. There are a number of noteworthy buildings in the Study Area which are detailed in the Cultural Heritage Chapter 10.
Sense of Public Ownership and Importance	In a city it is likely that there are several areas which have a sense of ownership, and these may include the plaza adjacent to Blackpool Church which is used by the public.

9.4.7 Landscape and Site Context

This section of the EIS describes the views of the surrounding landscape that are available to the Study Area. It describes the existing views towards the Study Area from the surrounding area, with particular reference to the views from roads, houses, and areas of amenity value, and describes the areas of proposed works in more details.

Views to the Northern section of the River Glenamought are available from the Railway viaduct, however views of the river from the local vicinity are restricted. Views of the river are available from the private grounds at Kilnap Glen House, and a view of the river near the entrance to the North Point Business Park as shown in Plate 9.12 below.

Plate 9.13 shows that while relatively open views to the area around the River Bride are available from the higher ground, especially to the northwest of the river, from the Commons Ridge and along the N20, however views to the rivers themselves are intermittent, due to the location, the natural topography and the screening afforded by the built form on both sides of the river but particularly along the N20.

Plate 9.12: View looking south along river near North Point Business Park

Plate 9.13: View looking across the N20- the river is partially screened by vegetation and buildings

Plate 9.14: Intermittent views of the river with screening by vegetation behind the Commons Inn

The river runs to the rear of buildings including commercial, residential and industrial buildings to the east of the N20. Visibility is intermittent, even from areas close to the riverbank as shown in Plate 9.14 above.

More open views are available from close to the junction of the N20 with Fitz's Boreen, where the river and bridges are visible from the public areas and car park as seen in Plate 9.15 below. Further to the south, the river runs to the rear of several industrial areas, and is bordered by the Dulux Paints factory to the west and the factory yard and buildings to the east, as seen in Plate 9.16 below. However some of these areas are not publicly accessible.