Appendix 4

Aquatic Ecology Report

MAIGHNE AQUATIC REPORT

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1 AQUATIC ECOLOGY

1.1 Introduction

This chapter addresses the potential impact of the proposed Maighne wind farm project on aquatic ecology. The proposed Maighne Wind farm is divided into five separate clusters: 'Ballynakill', 'Windmill', 'Cloncumber', 'Drehid-Hortland' and 'Derrybrennan'. This document provides an assessment of the impact of the proposed development on aquatic habitats, aquatic ecological communities, and individual aquatic species. The aims of the aquatic ecology assessment are:

- To carry out a desktop study in order to determine the surface water features affected by the proposed development and surrounding area;
- To carry out a baseline fisheries and aquatic ecological survey of the affected aquatic areas;
- To predict the potential direct, indirect and cumulative impacts of the proposed development on aquatic species and habitats.
- To propose mitigation measures in the construction and operation of the wind farm so as to minimise potential impacts on fisheries and aquatic ecology receptors.

Field survey work to inform current assessment was undertaken during the period August to October 2013. Figure 1 gives the location of the five components of the proposed Maighne wind farm and with respect to water regions (Hydrometric Area and catchment). This report has been prepared by ECOFACT Environmental Consultants on behalf of Fehily Timoney & Company.

1.2 Methodology

1.2.1 Relevant Guidance

The current assessment has been prepared taking account of relevant guidance published by the Environmental Protection Agency (EPA) including '*Guidelines on the Information to be contained in Environmental Impact Statements'* (EPA, 2002) and '*Advice Notes on Current Practice (in the Preparation of Environmental Impact Statements)'* (EPA, 2003). In addition the impact assessment also takes account of the '*Guidelines for Ecological Impact Assessment*' (Institute of Ecology and Environmental Management, 2006). The Heritage Council publication '*Best Practice Guidance for Habitat Survey & Mapping'* (Smith *et al*., 2011) is also referenced.

Relevant guidance published by the National Roads Authority (NRA), and applicable to assessing watercourses in Ireland, was also followed, including '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes – Revision 2*' (NRA 2009a), '*Ecological surveying techniques for protected flora and fauna during the planning of National Road Schemes – Version 2*' (NRA 2009b), '*Environmental Impact Assessment of National Road Schemes – A practical guide*' (NRA 2008a) and '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*' (NRA 2008b).

1.2.2 Legislative context

A diversity of flora and fauna, rare at a national level, are protected under the provisions of the Wildlife Act, 1976 and Wildlife (Amendment) Act, 2000; which includes the Flora Protection Order (1999). The Habitats Directive 1992 has been transposed into Irish legislation as the European Union (Natural Habitats) Regulations SI 94/1997 and amended in 1998 and 2005. The Habitat Regulations have been updated in 2011 as the European Communities (Birds and Natural Habitats) Regulations (2011) to bring the Irish transposition of these regulations into line with the requirements of the EU Habitats Directive (1992).

Under the Fisheries (Consolidation) Act, 1959, it is an offence to disturb the bed of a river; therefore it will be necessary to get written permission from Inland Fisheries Ireland to proceed with the works in any areas where disturbance to the spawning and nursery areas of both salmonids and lampreys will occur as a result of the proposed development. Salmon, all lamprey species and their habitats are further protected under the EU Habitats Directive, 1992.

Under Section 3 of the Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act) it is an offence to cause or permit any polluting matter to enter waters. Suspended solids would be a key parameter here. Likewise any visual evidence of oil/fuel in the river would constitute an offence.

Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter is defined as not only as any substance that is liable to injure fish but is also liable to damage their spawning grounds or the food of any fish or to injure fish in their value as human food or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish.

1.2.3 Selection of watercourses for assessment

All watercourses / water bodies which could be affected directly (i.e. within the site) or indirectly (i.e. lie within 500 m of the site boundary) were considered as part of the current appraisal. Some of the sites assessed are located greater than 500 m from the site boundary. Generally only streams and other watercourses shown on the 1:50,000 Discovery Series Maps were examined, as watercourses smaller than this are not normally of fisheries or aquatic ecological significance.

A total of 10 sites were selected for detailed assessment. The sites selected for assessment are given in Table 1 and the location of these sites is shown in Figure 2.

The surveys completed at each site were at a level required to make an evaluation of biological water quality, fisheries value, aquatic habitat value, and presence of rare/protected/notable aquatic species at each site. Due to land access restrictions sampling could only be undertaken at sites within the land option areas. However, watercourses downslope of the proposed development were observed from public roads and this allowed such watercourses to be adequately evaluated for the purpose of the current appraisal.

1.2.4 Aquatic habitat assessments

Habitat assessment was carried out at the rivers/streams on, and in the vicinity of, the site using the methodology given in the Environment Agency's '*River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003'* (EA, 2003) and the Irish Heritage Council's *'A Guide to Habitats in Ireland'* (Fossitt, 2000). All the affected watercourses were assessed in terms of:

- Stream width and depth and other physical characteristics;
- Substrate type, listing substrate fractions in order of dominance, i.e. large rocks, cobble, gravel, sand, mud etc;
- Flow type, listing percentage of riffle, glide and pool in the sampling area;
- Instream vegetation, listing plant species occurring and their percentage coverage of the stream bottom at the sampling site (as applicable) and on the bankside;
- Estimated cover by bankside vegetation, giving percentage shade of the sampling site.

The results of the physical habitat study were used in conjunction with the leaflet '*The Evaluation of habitat for Salmon and Trout*' (DANI Advisory leaflet No. 1) to assess habitat suitability for salmonids. Stream order is described using the classification system given in Strahler (1957) which defines stream size based on a hierarchy of tributaries (with 1st order streams being the smallest).

The Water Framework Directive status of waterbodies in the study area was estimated with reference to the manual *'European waters — assessment of status and pressures'* by the European Environmental Agency (2012).

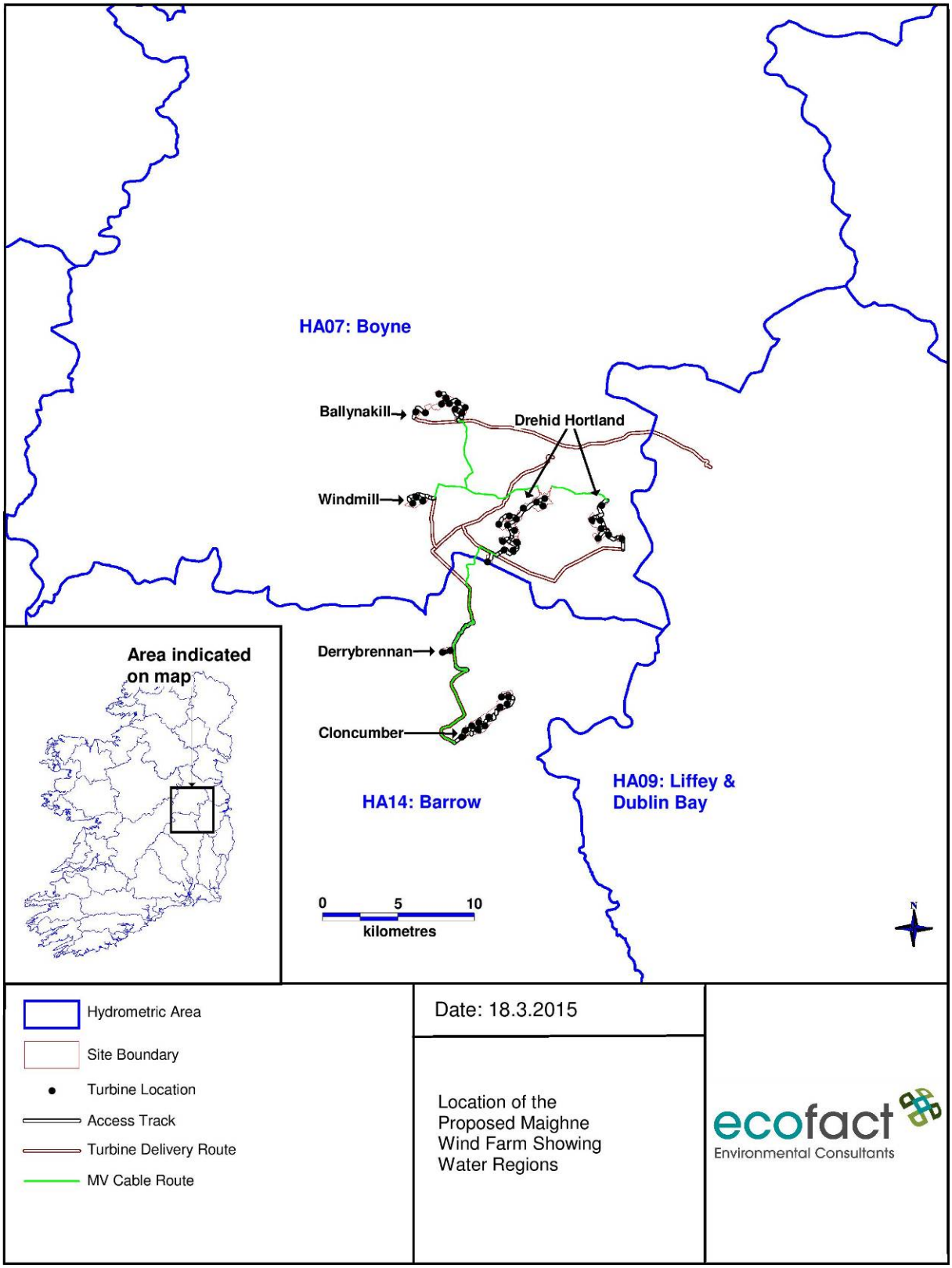

Figure 1: Location of the five components of the proposed Maighne Wind Farm showing Water Regions

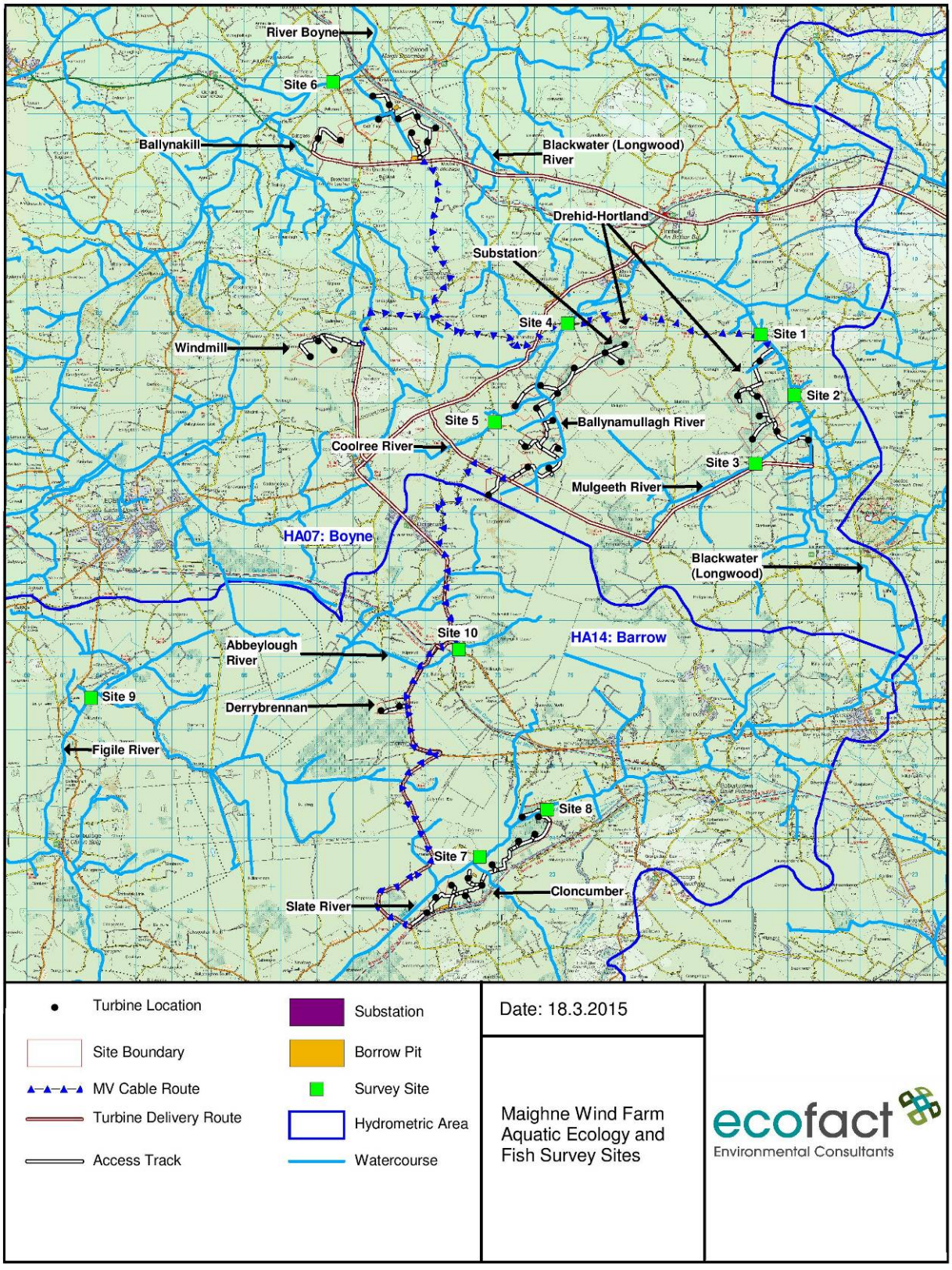

Figure 2: Maighne aquatic ecology and fisheries survey sites

Table 1: Location of the aquatic ecology and fisheries survey sites assessed for the proposed Maighne wind farm site during the August/October 2013 survey

Site No.	Catchment	Relevant component of wind farm	Sub-catchment	River	Tributary	Watercourse Name	Segment code	EPA code
1	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)		Blackwater (Longwood)	07_925	07B02
2	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)		Blackwater (Longwood)	07_1043	07H03
3	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Mulgeeth	Mulgeeth	07_1720	07M54
4	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Coolree 07	Coolree 07	07_1848	07C23
5	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Coolree 07	Coolree 07	07_1230	07C23
6	Boyne	Ballynakill, Windmill	Boyne	Boyne		Boyne	07_951	07B04
7	Barrow	Cloncumber	Figile	Slate		Slate	14_1574	14S01
8	Barrow	Cloncumber	Figile	Slate		Slate	14_235	14S01
9	Barrow	Derrybrennan	Figile	Figile		Figile	14_553	14F01
10	Barrow	Derrybrennan	Figile	Figile	Abbeylough	Abbeylough	14_1678	14A01

1.2.5 Aquatic macroinvertebrate surveys

1.2.5.1 Kick sampling

Qualitative sampling of benthic (or bottom dwelling) macroinvertebrates was undertaken at selected (index) sites using kick-sampling (Toner *et al.*, 2005). This procedure involved the use of a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged on the river bed with its mouth directed upstream. The substrate upstream of the net was then kicked for one minute in order to dislodge invertebrates, which were subsequently caught in the net. This procedure was undertaken at three points along/across the watercourse. Stone washings and vegetation sweeps were also undertaken to ensure a representative sample of the fauna present at each site was collected.

All samples of invertebrates were combined for each site and live sorted on the river bank and indentified to the level required to assign a Q-rating or SSRS score. Samples were also collected and fixed in ethanol for subsequent laboratory identification.

1.2.5.2 Biological water quality

The Quality Rating (Q) System (Toner *et al*, 2005) and the Small Stream Risk Score (SSRS) (Walsh, 2005) were used to obtain a water quality rating / risk assessment for each site.

The Quality Rating System (Q-Value) is based on the well-established sensitivities, abundance and diversity of macroinvertebrates and their relation to water quality. The changes brought about by organic pollution in the bottom dwelling (benthic) macroinvertebrate community in rivers are particularly well documented. These changes are due to the varying sensitivities of the different components of the community to the stresses caused by pollution. It is well documented that community diversity declines in the presence of pollution and that more tolerant forms progressively replace sensitive species as the level of pollution increases. The same basic Quality Rating System (Q-Value) has been used to assess the water quality of Irish rivers since 1971. It has provided the primary basis for mapping long-term trends of water quality in Irish rivers by the EPA. For the purposes of the Irish assessment procedure, benthic macroinvertebrates are divided into five indicator groups ranging from the most disturbance sensitive taxa to the most insensitive taxa as follows:

- Group A, the sensitive forms,
- Group B, the less sensitive forms,
- Group C, the tolerant forms,
- Group D, the very tolerant forms and
- Group E, the most tolerant forms.

The Q-Value assigned to a site depends on inter alia, the degree of departure of the river fauna's taxonomic composition, diversity and abundance from its reference condition at close to natural, undisturbed conditions. A Q-Value of Q5 indicates that conditions are close to reference conditions whereas a Q-Value of Q1 indicates the presence of serious pollution. The Q-Value employs the ratio of disturbance sensitive to insensitive taxa to indicate the degree or extent of change from the natural reference conditions at a site.

The Quality Rating System (Q-Value) has been intercalibrated at European level in both the Northern Geographical Intercalibration Group (NGIG) and the Central/Baltic Geographical Intercalibration Group (CBGIG). The relationship between Q-Value and Ecological Status for macroinvertebrates is as shown in Table 2.

Table 2: Relationship between Q-Value and Ecological Status for macroinvertebrates.

Q Value*	WFD Status	Pollution Status	Condition**
Q5, Q4-5	High	Unpolluted	Satisfactory
Q4	Good	Unpolluted	Satisfactory
Q3-4	Moderate	Slightly polluted	Unsatisfactory
Q3, Q2-3	Poor	Moderately polluted	Unsatisfactory
Q2, Q1-2, Q1	Bad	Seriously polluted	Unsatisfactory

** These values are based primarily on the relative proportions of pollution sensitive to tolerant macroinvertebrates (the young stages of insects primarily but also snails, worms, shrimps etc.) resident at a river site.*
*** "Condition" refers to the likelihood of interference with beneficial or potential beneficial uses*

1.2.5.3 Protected aquatic invertebrates

An assessment of the occurrence of rare protected species (e.g. white-clawed crayfish, freshwater pearl mussels) at sampling sites was assessed by underwater visual observation using bathyscopes.

1.2.6 Fisheries assessments

1.2.6.1 Visual surveys

Many of the streams on the proposed wind farm site were small first order streams or field drains that could be assessed visually and categorised as watercourses of insignificant fisheries importance that contained no fish. Other areas where access could not be provided (i.e. outside the option lands areas) were also assessed visually from publically accessible areas.

1.2.6.2 Dip netting surveys

Qualitative netting with a 'D' shaped dip net (35cm diameter, 2mm mesh) was carried out at selected sites to check for the presence / absence of small fish. This method was generally employed in drains and very small watercourses. The net was used in a circular motion to intercept small fish sheltering in instream vegetation stands and under the bank vegetation overhang.

1.2.6.3 Electrofishing survey

An electrical fishing assessment was carried out at Site 9 on the Figile River under authorisation from the Department of Communication, Energy and Natural Resources under Section 14 of the Fisheries Act (1980). The purpose of this survey was to provide information on the presence of Annex II listed fish species (i.e. lampreys and salmon) and other fish (i.e. Brown Trout and Eels).

This survey was carried out following the methodology outlined in the CFB guidance "*Methods for the Water Framework Directive - Electric fishing in wadable reaches*".

A portable electrical fishing unit (Smith Root-LR 24 backpack or Marine Electrics Safari Researcher 660D) was used during the assessment. Fishing was carried out continuously for 5 minutes and captured fish were collected into a container of river water. Captured fish were then anaesthetised using a solution of 2-phenoxyethanol and measured to the nearest mm using a measuring board. Subsequent to this the fish were allowed to recover in a container of river water. All fish were released alive and spread evenly over the sampling area. Following completion of the fishing the dimensions and physical habitat characteristics of the site were recorded.

1.2.7 Evaluation Criteria

The evaluation criteria used in the current assessment follows the '*Guidelines for the Assessment of Ecological Impacts of National Realignments – Revision 2*' (NRA, 2009). The evaluation of impact significance is a combined function of the value of the affected feature (its ecological importance), the type of impact and the magnitude of the impact. It is therefore necessary to identify the value of ecological features within the study area in order to evaluate the significance and magnitude of possible impacts.

Following the guidance set out by the NRA (2009) the study area for the *Proposed Development* has been evaluated based on an identified zone of influence with regard to the potential for pathways for impacts affecting ecological features of interest (habitats, flora and fauna).

Ecological features are assessed on a scale ranging from international-national-county-local. The local scale is taken as corresponding to the zone of influence of the development and extending to a parish area. The evaluation criteria are presented below. Watercourses, evaluated following the NRA (2009) criteria were evaluated on the basis of a number of characteristics and features defined as follows:

- Aquatic habitat refers to the in-water conditions of any watercourse; including substrate and stream structure (i.e. proportion of riffles, runs and pools).
- The fisheries value of a watercourse refers to its suitability for fish, primarily salmonids (salmon and trout), and to the associated value for recreational angling purposes.
- Annex II species are those that are listed under the EU Habitats Directive (92/43/EEC).
- Annex I habitats are those that are listed under the EU Habitats Directive, including Priority Habitats.
- The evaluation of water quality uses a five-point biotic index (Q-value) based on the presence and relative abundance of various invertebrates using the Environmental Protection Agency's (EPA) standard technique.

Table 3: Criteria used to determine the value of ecological resources (NRA 2009)

Importance	Criteria
International Importance	'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation. Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended). Features essential to maintaining the coherence of the Natura 2000 Network Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive. Resident or regularly occurring populations (assessed to be important at the national level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and/or Species of animal and plants listed in Annex II and/or IV of the Habitats Directive. Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl

Importance	Criteria
	Habitat 1971). World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972). Biosphere Reserve (UNESCO Man & The Biosphere Programme) Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979). Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979). Biogenetic Reserve under the Council of Europe. European Diploma Site under the Council of Europe. Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988).
National Importance	Site designated or proposed as a Natural Heritage Area (NHA). Statutory Nature Reserve. Refuge for Fauna and Flora protected under the Wildlife Acts. National Park. Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park. Resident or regularly occurring populations (assessed to be important at the national level) of the following: Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing 'viable areas' of the habitat types listed in Annex I of the Habitats Directive.
County Importance	Area of Special Amenity. Area subject to a Tree Preservation Order. Area of High Amenity, or equivalent, designated under the County Development Plan. Resident or regularly occurring populations (assessed to be important at the County level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive; Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance. County important populations of species; or viable areas of semi-natural habitats; or natural heritage features identified in the National or Local BAP; if this has been prepared. Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county. Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.
Local Importance (higher value)	Locally important populations of priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared; Resident or regularly occurring populations (assessed to be important at the Local level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive;

Importance	Criteria
	Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality; Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.
Local Importance (lower value)	Sites containing small areas of semi-natural habitat that are of some local importance for wildlife; Sites or features containing non-native species that are of some importance in maintaining habitat links.

*SAC = Special Area of Conservation; SPA = Special Protection Area; NHA = Natural Heritage Area.

1.3 Existing Environment

The study area is described below in terms of affected catchments, designated sites with aquatic dependant key conservation interests, waterbody types in the study area, protected aquatic flora and fauna, fish communities and fisheries, aquatic macroinvertebrates and biological water quality, and aquatic plant communities. Each of the above are discussed in relation to the Drehid-Hortland, Ballynakill, Windmill, Cloncumber and Derrybrennan components of the proposed Maighne wind farm.

1.3.1 Affected catchments

For the purposes of hydrological activities and by agreement between the various hydrological agencies in Northern Ireland and the Republic of Ireland, Ireland was divided into 40 hydrometric areas. Each Hydrometric Area comprises a single large river basin, or a group of smaller ones, and neighbouring coastal areas. Each area was assigned a number from 01 to 40 beginning at the Foyle Catchment and proceeding in a clockwise direction (an exception to this general scheme is the catchment of the River Shannon and its tributaries which, because of its size, was divided into two hydrometric areas, 25 (Lower Shannon) and 26 (Upper Shannon)). A brief overview of the two Hydrometric Areas (or part of) affected by the proposed development is given below.

1.3.1.1 Hydrometric Area 07 Boyne

Hydrometric Area 07 consists of the River Boyne catchment. The River Boyne main channel rises near Edenderry on the borders of Counties Offaly and Kildare and flows in a north-easterly direction for 112 km before entering the Irish Sea at Drogheda. Together with its tributaries, it drains a catchment of approximately 2,500 km^2. The River Boyne corridor together with its tributary the Kells Blackwater River are designated as a Special Area of Conservation (SAC) (SAC Code 002299). In addition, the River Boyne main channel is also a designated salmonid river under the EU Freshwater Fish Directive (78/659/EEC).

The Boyne has eleven major tributary sub-catchments. The watercourses in the Boyne catchment affected by the proposed development are the Boyne River and Glash River (Ballynakill), the Balrinnet and Glash Rivers (Windmill), and the Coolree, Ballynamullagh, Mulgeeth and Longwood Blackwater Rivers (Drehid-Hortland), where the names in parenthesis are components of the proposed development in the various sub-catchments.

Most of the Boyne catchment is underlain by limestone-based glacial till (O'Grady 1998). The Boyne catchment drains a mainly lowland area, and consequently all sub-catchments are fed by percolating ground water to a greater extent rather than by runoff. Farming practices in the catchment include dairy, beef production and tillage. There are many large towns in the catchment, including Slane, Navan, Kells, Trim, Athboy and Ballivor.

O'Grady (1998) reported that three major ecological impacts on the Boyne catchment have occurred in 'recent' times. These are (1) excavation of peat lands in the headwater area of the catchment to fuel power stations, (2) the 1980's arterial drainage scheme which affected virtually the entire catchment, and (3) the onset of serious eutrophication problems on Lough Ramor in the Kells Blackwater sub catchment.

The excavation of the peat bogs in headwater areas led to a runoff of fine peat silt particles causing siltation of the headwater tributaries and excessive growth of reeds on these lateral silt beds. This led to a narrowing and deepening of the stream channels; particularly in the catchment area above Trim (O'Grady 1998). The second major event to impinge on the system was the implementation of an arterial drainage programme throughout the catchment. This programme commenced in 1969 and continued until 1985 (O'Grady 1998). The only major section of this catchment which was not drained was the lower reaches of the main Boyne channel - from Navan downstream, and a section of the Kells Blackwater.

The Ballynakill, Drehid-Hortland and Windmill components of the proposed Maighne wind farm are within the Boyne catchment and watercourses draining these areas are discussed below.

1.3.1.1.1 Drehid-Hortland

The Drehid-Hortland component of the proposed development is drained by the Blackwater (Longwood) River (EPA code 07B02). The western extent of the Drehid-Hortland site is drained by the Coolree River (EPA code 07C23). This river rises to the east of the site and flows into the 4th order Blackwater (Longwood) from the south as a 3rd order watercourse. The 3rd order Ballynamullagh River rises within the Drehid-Hortland site and flows into the Coolree River from the south. The Mulgeeth River (EPA code 07M54) rises within the southern extent of the Drehid-Hortland component of the proposed development. It has a channel length of ca. 8km and flows east into the Blackwater (Longwood) River a 2nd order watercourse.

1.3.1.1.2 Ballynakill

The Ballynakill section of the proposed development is located to the southwest of Longwood and comprises 10 turbines. The proposed development at Ballynakill is drained by the River Boyne (EPA code 07B04, segment code 07_951) to the north, the Boolykeagh River (EPA code 07B44) and the Glash River (EPA code 07G02) to the west. The River Boyne within the study area is a large drained 5th order river with little physical variation. The Boolykeagh River is a 2nd order watercourse that is formed by the joining of two 1st order streams that are within the Ballynakill site. These streams join and the Boolykeagh River flows north for approximately 2km before flowing into the River Boyne. The Glash River is a 4th order watercourse that is formed by numerous tributaries to the south west of the site. A 1st order stream of ca. 1.5km long (Mulphedder Stream, EPA code 07M18) within the Glash River sub-catchment flows approximately 0.5km to the west of the site. The Ashfield Stream (EPA code 07A14) drains the north eastern portion of the site. This 1st order watercourse has a channel length of ca. 2km and flows into the River Boyne approximately 1km downstream of the Royal Canal crossing.

1.3.1.1.3 Windmill

The Windmill portion of the proposed development is located in the Glash River sub-catchment where the lands are drained by the 2nd order Balrinnet River (EPA code 07B26). The Balrinnet River is formed by two 1st order streams that rise approximately 1km north and 1.5km south-east of the proposed development site (Glash Stream to the south east). The Balrinnet River flows into the Kilrainy River (EPA code 07K22) to form the Glash River which flows into the River Boyne. The headwaters of the Glash Stream flow within 0.2km from the site. The overland hydrological distance from the proposed Windmill site to the River Boyne is approximately 8.5km.

1.3.1.2 Hydrometric Area 14 Barrow

Hydrometric Area 14 is the Barrow catchment, which is one of the largest river catchments in Ireland. The River Barrow itself is 192 kilometres long and drains a catchment of 2,983km^2. It rises on sandstones in the Slieve Bloom Mountains at an elevation of 580 m to flow south to confluence with the River Suir estuary at Waterford Harbour. The River Barrow corridor (together with the adjacent River Nore) is a designated Special Area of Conservation (SAC) (SAC Code 002162).

Being a very large catchment there is variation in the underlying geology and soil types across this large catchment. The highlands of the Slieve Blooms consist of blanket peat and peaty gleys of sandstone origin. These give way to gleys of limestone origin or to river alluvium in the catchment downstream to Monasterevin. The extensive area drained by the Slate and Figile systems has soils of basin peat and of podzolics of limestone origin. From Monasterevin to Goresbridge, the principal soil association is one of grey brown podzolics, all of limestone origin. In the area between Athy and Goresbridge a narrow ribbon of soils is composed of morainic gravels and sands and these materials are extensively quarried in surface excavations. As with the geological changes at Goresbridge, so the soils also change and have their origins in granitic or Silurian glacial till or shales.

The Barrow has eleven major tributary sub-catchments. The main tributaries, on the left bank, are the Cushina, Figile and Slate, all of which form one tributary at Monasterevin, the Greese, Lerr, Burren, Mountain and Pollmounty; those on the right bank are the Owenass, Triogue, Stradbally, Douglas, Fushoge, Gowran, Powerstown and Duiske. The current proposed development affects the Cushina, Figile, Slate, Stadbally and Triogue River sub-catchments. A number of other minor sub-catchments draining directly into the main channel of the River Barrow are also affected.

The River Barrow has been the subject of an arterial drainage scheme (1926 – 1934) with 210 km of main rivers and tributaries and 175 km of smaller drains deepened and widened, to improve conveyance, in the course of the works programme. The extent of the drainage programme was largely confined to the catchment upstream of Athy and included the extensive Figile-Slate systems.

There are extensive areas of peat in the catchment, bogland having an area in excess of 159 km^2 in the catchment. The Cushina – Philipstown – Figile – Slate system in particular drains extensive areas of flat land with large-scale commercial peat workings present. The Cloncumber, Derrybrennan, Drehid-Timahoe components of the current proposed development are located in this sub-catchment where these areas are drained by the Slate and Abbeylough Rivers.

To accommodate navigation, as well as providing hydropower to a number of industrial units, the River Barrow was regulated by a number of major weirs, creating a series of very low gradient reaches between each weir. Navigation at each weir was accommodated through a network of 23 lock gates. Downstream of Athy, the Grand Canal – Barrow Line navigation switches from being an exclusively canal-like channel to one where navigation takes place within the riverine channel.

The Cloncumber and Derrybrennan components of the proposed Maighne wind farm are within the Barrow catchment and watercourses draining these areas are discussed below.

1.3.1.2.1 Cloncumber

The Cloncumber component of the proposed development is located in the Slate River (EPA code 14S01) sub-catchment within the Barrow catchment. Much of the northern boundary of the proposed Cloncumber component of the proposed development, a stretch of approximately 4km is defined by the stretch of the 3rd order Slate River upstream of Agar Bridge. An external road is proposed to access the proposed Cloncumber development site from the north which would involve a crossing of the Slate River. The Cloncumber Stream (EPA code 14C17) flows north through the proposed Cloncumber component of the proposed development to meet the Slate River from the south. The Cloncumber Stream is a highly modified low gradient 2nd order channel. The 3rd order Slate River joins the 4th order Figile River approximately 12km downstream of the Cloncumber site. Approximately 1km downstream, the Figile River is fed from the west by the 3rd order Cushina River (EPA code 13C04). A further 7km or so downstream the Figile River flows into the River Barrow (EPA code 14B01).

1.3.1.2.2 Derrybrennan

The Figile River (EPA code 14F01) drains the Derrybrennan component of the proposed development. The Abbeylough River (EPA code 14A01) is a 1st order watercourse of approximately 6km long. This watercourse flows in an easterly direction and to within 1.2km north of the proposed Derrybrennan site. It flows into the 2nd order Figile River approximately 2km north west of the proposed development site. The 3rd order Slate River joins the 4th order Figile River.

1.3.2 Designated sites

1.3.2.1 SACs designated for aquatic interests

There are two Natura 2000 river systems in the study area. These are the River Barrow and River Nore cSAC (Site Code 002162) and the River Boyne and River Blackwater cSAC (Site Code 002299). These two Natura 2000 are discussed hereunder with reference to the Drehid-Hortland, Ballynakill and Windmill components of the proposed Maighne wind farm in Hydrometric Area 04 and with reference to the Cloncumber and Derrybrennan components of the site in Hydrometric Area 14.

Rye water valley / Carton cSAC (001398) is also within 15km of the proposed development where the Drehid-Hortland component of the Maighne wind farm is located approximately 14.5km to the west. Rye water valley / Carton cSAC is a river valley site which includes at its western end a large area of estate woodland and an artificial lake. The eastern section of the site includes a section of railway, canal and aqueduct; it continues as far as Leixlip town. The site is underlain by carboniferous limestone over which has been laid a layer of glacial drift.
Rye water valley / Carton cSAC is within Hydrometric Area 09 (Liffey and Dublin Bay) so is hydrologically disconnected from any component of the proposed Maighne wind farm i.e. the proposed Maighne development is located in Hydrometric Areas 07 (Boyne) and 14 (Barrow).

Ballynafagh Lake is located within the Barrow catchment and lies approximately 5km to the north east of the Cloncumber component of the proposed development. Ballynafagh Lake comprises a former reservoir (generally called Ballynafagh Lake) and an associated canal feeder (Blackwood feeder), the latter now disused and mostly dry. The lake is shallow and is now very overgrown with various wetland vegetation types with only a small area of open water remaining. Fen is the predominant habitat, with reed-swamp, wet grassland and some bog or heath also occurring. A strip of deciduous woodland occurs on some drier ground. The main habitats along the canal feeder are dry grassland (partly improved), wet grassland, swamp vegetation and scrub. The site supports a population of *Euphydryas aurinia* and contains a number of other rare invertebrate species, some of which are good wetland indicator species, including the mollusc *Pisidium pseudosphaerium*.

Ballynafagh Lake is located in the upper Figile catchment in the north-eastern most part of the River Barrow basin. Assuming there is a hydrological link with the proposed development, it is located approximately 7km upstream of the Cloncumber site via the River Slate and other surface waters. There are no overland pathways between Ballynafagh Lake and other components of the proposed development.

1.3.2.1.1 River Boyne and the River Blackwater cSAC

The River Boyne and the River Blackwater SAC comprises the freshwater element of the River Boyne as far as the Boyne Aqueduct, the Kells Blackwater as far as Lough Ramor and the Boyne tributaries including the Deel, Stoneyford and Tremblestown Rivers. This site is a candidate SAC selected for Alkaline fens [7230] and Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*) [91E0], both listed on Annex I of the E.U. Habitats Directive. The site is also listed for the following Annex II species; River lamprey (*Lampetra fluviatilis*) [1099], Atlantic salmon (*Salmo salar*) [1106] and Otter (*Lutra lutra*) [1355].

1.3.2.1.1.1 Drehid-Hortland

The Drehid-Hortland component of the proposed development is within the Blackwater (Longwood) River sub-basin and approximately 10km to the southeast at its closest. The Blackwater (Longwood) River flows into River Boyne and the River Blackwater SAC. The shortest pathway between the Drehid-Hortland component of the proposed development and the River Boyne and the River Blackwater SAC is approximately 18.9km where the overland hydrological distance from the eastern portion of the Drehid-Hortland site and the River Boyne and the River Blackwater SAC is approximately 18.9km via the Blackwater (Longwood) River.

The distance from the western portion of the proposed development site to the River Boyne within the cSAC is approximately 19km where the Coolree River drains the western extent of the site and flows into the Blackwater (Longwood) River before discharging to the River Boyne.

1.3.2.1.1.2 Ballynakill

The upper limit of the River Boyne and River Blackwater cSAC on the main channel of the River Boyne is approximately 2km west of Longwood where the royal Canal crosses the River Boyne. The Ballynakill component of the proposed development lies approximately 1km due south of this part of the River Boyne and River Blackwater cSAC. This part of the cSAC is a receptor for Ballynakill component of the proposed development as the Boolykeagh River flows from the Ballynakill site into the River Boyne. The western extent of the Ballynakill site also drains into the River Boyne and River Blackwater cSAC via the Glash River.

1.3.2.1.1.2 Windmill

The Windmill portion of the proposed development is located in the Glash River sub-catchment which discharges to the River Boyne approximately 1.5km upstream of the designation. The closest watercourse to the Windmill component of the proposed development is a 1st order tributary of the Balrinnet River which flows approximately 0.2km to the east of the proposed development site. This stream would be crossed by the proposed MV cable. The distance from this location to the River Boyne and River Blackwater cSAC is approximately 11km via the Balrinnet River which flows into the Glash River before meeting the River Boyne.

1.3.2.1.2 River Barrow and the River Nore cSAC

The River Barrow and River Nore cSAC is a very large site that consists of the freshwater stretches of the Barrow/Nore River catchments as far upstream as the Slieve Bloom Mountains and it also includes the tidal elements and estuary as far downstream as Creadun Head in Waterford. The site is a candidate SAC selected for a number of habitats listed on Annex I of the E.U. Habitats Directive, including Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260] which is a fully aquatic habitat. The site is also selected for the following species listed on Annex II of the same directive; *Vertigo moulinsiana* [1016], Freshwater pearl mussel (*Margaritifera margaritifera*) [1029], Nore pearl mussel (*Margaritifera durrovensis*) [1990] White-clawed crayfish (*Austropotamobius pallipes*) [1092], Sea lamprey (*Petromyzon marinus*) [1095], Brook lamprey (*Lampetra planeri)* [1096], River lamprey (*Lampetra fluviatilis*) [1099], Allis shad (*Alosa alosa*) [1102], Twaite shad (*Alosa fallax fallax*) [1103], Otter (*Lutra lutra*) [1355] and Salmon (*Salmo salar*) [1106].

1.3.2.2.1 Cloncumber

The Cloncumber component of the proposed development is in the Slate River catchment so the River Barrow within the River Barrow and River Nore cSAC is receiving water for this part of the proposed Maighne wind farm. The Cloncumber site is located approximately 18km to the north west of the River Barrow cSAC where the main channel of the Rive Barrow is within the designation. The closest part of the proposed Cloncumber component of the proposed development to the River Barrow and River Nore cSAC hydrologically is where the MV cable route crosses the Slate River. This crossing location is approximately 18km upstream of the River Barrow and River Nore cSAC where the lower reach of the Figile River is part of the designation.

1.3.2.2.2 Derrybrennan

The Derrybrennan component of the proposed development is within the Figile River sub-catchment. At its closest, the Derrybrennan component of the proposed development is located 17.5km to the north east of the River Barrow and River Nore cSAC. The proposed MV cable would cross the Abbeylough River and the Lullymore East Stream, these stream crossings located approximately 34km via watercourse pathways.

1.3.2.2 Designated salmonid waters

1.3.2.2.1 Boyne catchment

The River Boyne main channel is a designated Salmonid Water under the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293/1988).

1.3.2.2.1.2 Ballynakill

The River Boyne is located approximately 1km north of the proposed Ballynakill component of the proposed development. The Boolykeagh River flows from the northern boundary of the proposed development site to the River Boyne. The Glash River system to the west of the proposed development which drains part of the site also flows into the main channel of the River Boyne.

1.3.2.2.1.3 Windmill

The Windmill portion of the proposed development is located in the Glash River sub-catchment and is located approximately 9.5km upstream of the main channel of the River Boyne.

1.3.2.2.1.1 Drehid-Hortland

The Drehid-Hortland component of the proposed development is drained by the Blackwater (Longwood) River. The Blackwater (Longwood) River flows into River Boyne approximately 18.9km downstream of the Drehid-Hortland site.

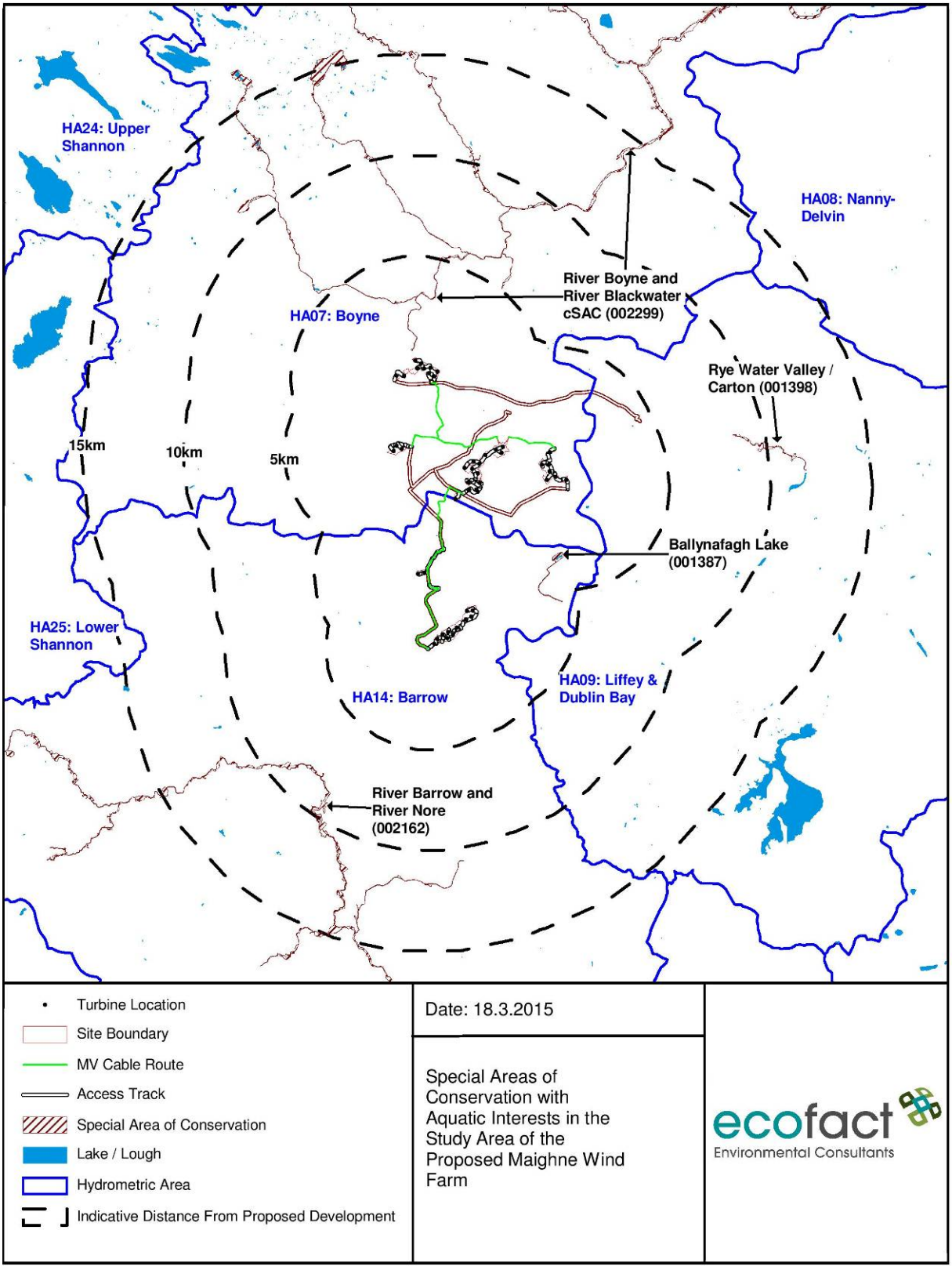

Figure 3: Proposed wind farm in relation to Natura 2000 river sites and Special Areas of Conservation with aquatic interests. The River Boyne and River Blackwater candidate Special Areas of Conservation are the principal designations within 15km of the proposed development.

1.3.2.2.1 Barrow catchment

There are no designated Salmonid Waters in the Barrow catchment.

1.3.3 Waterbody types

Figure 2 shows the principal watercourses in the study area. These water features correspond with rivers and streams shown on the EPA map viewer where spatial data such as watercourse locations can be downloaded from the EPA geoportal website. These watercourses are also indicated on the 1:50,0000 scale Discovery Series maps. Watercourses in the study area are discussed below under drains (FW4) and depositing/lowland rivers (FW2). These are the only habitat types in the study area following the classifications given in Fossitt (2000). A significant proportion of 1st order watercourses in the region correspond to the habitat drainage ditch owing to the low gradient topography of the study area. Indeed, there is no clear delineation between Hydrometric Area 7 (Barrow) and Hydrometric Area 14 (Barrow) with respect to surface water features, some 1st order streams crossing from one of these water regions to another. For example, the Clonkeen Stream (EPA code 07C36) rises within the Barrow catchment and flows north into the River Boyne approximately 2km east of Edenderry.

1.3.3.1 Drains (FW2)

There are a number of highly modified waterbodies in the study area corresponding to the habitat 'Drainage ditch (FW4)'. These waterbodies include drainage ditches, field drains and channelised streams. The drainage ditch and depositing lowland river habitats in the study areas of the Drehid-Hortland, Ballynakill and Windmill components of the proposed Maighne wind farm within the Boyne catchment, and the Cloncumber and Derrybrennan sites within the Barrow catchment are discussed below.

Typical characteristics of waterbodies classified as drains are evidence of significant, and modification including deepening and straightening, absence of any visible flow, dominance of mud or silt substrate, and choking by aquatic vegetation. This category of waterbody is highly modified and generally not of any significant aquatic ecological importance, and rarely of any fisheries importance. These watercourses usually contain populations of three-spined stickleback (*Gasterosteous aculeatus)* however. This fish species can be expected to occur in most of the watercourses in the study area. The land drainage network in the study area has many drainage ditches that are not indicated by the EPA i.e. watercourses smaller than 1st order.

Drainage ditches in the study area are evaluated as being of Local Importance (lower value). It is noted that these waterbodies can be of importance to amphibians (i.e. frogs and newts) and the presence of frogs and/or newts would raise their overall ecological value. It is also possible that whorl snails (*Vertigo moulinsiana*) could use these habitats in some limited areas. Small drains can also occasionally be used by white-clayed crayfish (*Austropotamobius* pallipes); however this species was not found in the current study. However, most of the drains assessed during the current study were physically degraded and organically enriched.

1.3.3.1.1 Drehid-Hortland

The Mulgeeth River at southern extent of the Drehid-Hortland component of the proposed development is a sluggish watercourse of trapezoidal cross section. It flows into the Blackwater (Longwood) River.

1.3.3.1.2 Ballynakill

Two 1st order watercourses within the Ballynakill site are channelised and deepened and classified as a drainage ditches.

1.3.3.1.3 Windmill

Two 1st order streams that rise approximately 1km north and 1.5km south-east of the proposed Windmill development site and join to form the Balrinnet River are classified as drainage ditches. These linear watercourses drain predominantly peaty soils and are slowing flowing.

1.3.3.1.4 Cloncumber

There are three minor 1st order tributaries within / adjoining the proposed Cloncumber component of the Maighne wind farm that flows into the Slate River from the north of the Slate River and fall into the habitat category 'drainage ditch. The longest of these has a channel length of ca. 4km.

1.3.3.1.5 Derrybrennan

The Abbeylough River which drains the Derrybrennan component of the proposed development and the Lullymore Stream to the south are classified as drainage ditches, being artificial / deeply drained linear channels.

1.3.3.2 Depositing/lowland rivers (FW2)

Larger watercourses in the study area are low gradient with deposits of fine sediments on the river bed with slow water flow. All watercourses in the study area have been modified to one degree or another, with many channels subjected to severe modifications in part as a result of the OPW arterial drainage schemes. Such reaches of these watercourses would typically hold populations of small fish such as Minnow, Stone loach, Pike, perch and brown trout. Atlantic salmon *Salmo salar*, Brook lamprey *Lampetra planeri* and White-clawed crayfish could also potentially be present in these stretches. The lowland depositing rivers in the study area are evaluated as being of Local Importance (higher value).

1.3.3.2.1 Drehid-Hortland

The Drehid-Hortland component of the proposed development is drained by the Blackwater (Longwood) River which corresponds to the habitat lowland/depositing river. This watercourse has a trapezoidal cross section and banks of up to 2m high.

1.3.3.2.2 Ballynakill

The Boolykeagh and Glash Rivers downstream of the proposed Ballynakill component of the Maighne wind farm site are lowland / depositing rivers, having been drained / highly modified in the past.

1.3.3.2.3 Windmill

The Balrinnet, Boolykeagh and Glash Rivers downstream of the proposed Ballynakill component of the Maighne wind farm site are lowland / depositing rivers that have been drained / highly modified in the past.

1.3.3.2.4 Cloncumber

The Slate River and the Cloncumber Stream correspond to the habitat lowland/depositing river. The Slate River has encroaching marginal vegetation and large stands of instream club rush. The Cloncumber Stream is artificially deepened and widened and has a large proportion of instream emergent vegetation.

1.3.3.2.5 Derrybrennan

The Figile River which is the receiving water for the Derrybrennan component of the proposed development corresponds to the habitat lowland/depositing river.

1.3.4 Protected aquatic flora and fauna

The study area is within the 10km Grid squares N62, N63, N64, N72, N73 and N83. Every six years, Member States of the European Union are required to report on the conservation status of all habitats and species listed on the annexes of the Habitats Directive as required under Article 17 of the Directive.

Following a period of public consultation Ireland submitted these status assessments to the European Commission in June 2013. Table 4 shows the current distribution of protected aquatic fauna in the 10km grid squares relevant to the Drehid-Hortland, Ballynakill, Windmill, Cloncumber and Derrybrennan components of the proposed Maighne wind farm based on the 2013 Article 17 Assessments (NPWS, 2013).

Table 4: Distribution of protected aquatic species in the 10km grid squares relevant to the proposed Maighne wind farm. Based on NPWS (2013) Article 17 Assessments

	Component of windfarm and Relevant 10km grid square(s)				
	Drehid-Hortland (N73, N83)	**Ballynakill (N64, N74)**	**Windmill (N63)**	**Cloncumber (N72)**	**Derrybrennan (N62, N72)**
Atlantic salmon (1106)	✓	✓	✓	✓	✓
Freshwater pearl mussel (1029)	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded
White-clawed crayfish (1092)	✓*	✓	✓	✓	✓
Brook lamprey	✓ (N83 only)	✓ (N74 only)	✓	Not recorded	Not recorded
River lamprey	✓ (N83 only)	✓ (N74 only)	✓	Not recorded	Not recorded
Sea lamprey	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded

*Indicated as occurring by NBDC.

1.3.4.1 Atlantic salmon

The Atlantic salmon is listed under Annexes II and V of the EU Habitats Directive and Appendix III of the Bern Convention. It is an economically important species and salmon recreational and commercial fisheries occur throughout Ireland. Atlantic salmon are present in the main river channels and tributaries of the Boyne and Barrow catchments. Atlantic salmon are an anadromous species, meaning they are spawned in freshwater habitats and then migrate to the sea. Salmon habitats are usually fast flowing riffle and glide habitats with cobble or gravel substrates. Salmon angling areas are usually located on main river channels or small rivers in deep glides of 1.5m depth or more.

Crisp (2000) notes that salmon spawning site selection is governed by a complex of environmental factors including intra-gravel flow, gravel size, water depth as well as stream velocity and cover, which are all essential for successful spawning, egg survival and hatching. One of the most important factors for salmon egg survival is oxygen supply, which is dependent upon dissolved oxygen concentration and inter-gravel flow. High concentrations of suspended solids in the river are undesirable as they are likely to result in infilling of the gravel pores with fine material (Cowx and Fraser, 2003). Watercourses in the study area including the Boyne, Blackwater (Longwood), Slate and Figile Rivers are unsuitable/suboptimal with regard to salmonid spawning considering the lack of gravel substrates, poor aeration due to sluggish flows and degree of siltation. It is noted that many of these watercourses drain the Bog of Allen and that the substrate in many watercourses in the study area have artificially high levels of suspended solids during flood events and peaty deposits on the river beds. These conditions do not coincide with the habitat requirements of salmon spawning.

McGinnity *et al.* (2003) give the distribution of salmon in watercourses in Ireland and indicate that the species is present in all rivers of equal or greater than 2nd order in both the Boyne and Barrow catchments (with the exception of the upper reaches of the Owenass River in the upper Barrow catchment). Within the study area these waters include the Blackwood (Longwood), and the lower reaches of the Glash, Coolree and Mulgeeth Rivers in the Boyne catchment and the in the Barrow catchment. The Figile, Abbeylough, Lullymore and Slate Rivers and Cloncumber Stream area within the Barrow catchment are also indicated as supporting salmon.

Atlantic salmon populations in Ireland have been recently assessed as being 'unfavourable - inadequate' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013).

1.3.4.1.1 Boyne catchment

Atlantic salmon are widely distributed in the Boyne catchment and main tributaries, and the Boyne is subject to famous folklore stories about the great warrior Fionn mac Cumhaill and the mythical "*salmon of Knowledge*" that was caught on the River Boyne. Unfortunately as it is put in the book '*A celebration of salmon rivers'* published by NASF (2007) "*the salmon is no longer an image associated with the Boyne, nor is wisdom a quality to be associated with the management of this natural resource*".

The main problem currently facing salmon in the Boyne catchment is water quality. The catchment was also significantly affected in the past by a major extended OPW arterial drainage scheme that involved deepening and channelisation works affecting almost every channel in the catchment above Navan. O'Grady (1998) argued that this drainage scheme may have inadvertently improved salmonid production in the catchment. He concluded that this was due to (a) the restoration of a natural river form in the middle reaches of the main channel as a result of the removal of a series of large weirs and (b) the post-drainage fishery enhancement programmes. However, few anglers in the Boyne catchment would agree with this hypothesis, and it is clear that the scheme had a devastating effect on the physical ecological diversity of the river corridors in this catchment. The lower reaches of the main Boyne channel, from Navan to Drogheda, was not subject to arterial drainage and this coupled with the lengthy nature (17 years) of the drainage scheme was also probably advantageous in terms of maintaining salmonid production (O'Grady 1998). However, the delay in this scheme was apparently due to budgetary constraints rather than a mitigation measure and does not take into account other ecological impacts. O'Grady (1998) reported that spawning sites for both salmon (and trout) in the Boyne catchment are confined principally to the tributaries as there are very limited gravel deposits in the main channel. He also noted that sub-tributaries in the catchment are generally not of importance in fisheries terms; probably a legacy of the arterial drainage scheme. O'Grady (1998) states that the tributaries function as nursery areas for salmonids and the larger of these channels, and the main Boyne channel, support substantial populations of salmon parr (and adult brown trout). According to Inland Fisheries Ireland the River Boyne catchment contains 5.93% of the accessible juvenile salmon habitat in Ireland, comprising 6.69 million m^2 of suitable juvenile salmon habitat. Salmon angling areas in the River Boyne are largely limited to the main Boyne downstream of Navan and the lower reaches of the Kells Blackwater. Adult salmon seldom move upstream of this point in the channel until late in the year, after the angling season (O'Grady 1998; O'Reilly 2002).

1.3.4.1.2 Barrow catchment

The Barrow is a highly modified river with the lower and middle reaches of the river canalised for navigation. The river still has a good run of salmon which spawn downstream of the weirs on the main channel, and also run into the tributaries. Most of the tributaries have been subjected to arterial drainage schemes and water quality is a significant pressure in the catchment. It is a river that has had recurring serious water pollution problems in recent times, and fish kills have occurred. Despite this salmon stocks are improving according to Inland Fisheries Ireland. A catchment wide electrofishing survey of juvenile salmon abundance was undertaken on the River Barrow during summer 2011 by Inland Fisheries Ireland. The mean catch in 2011 at 79 sites was 24.75 salmon fry per 5 minute fishing which is considered a high abundance level. The mean catch over the four years sampled was 15.35 salmon fry per five minute fishing. It is clear that all the 2^{nd} order and larger streams in the study area of the proposed wind farm developments have salmon populations. According to Inland Fisheries Ireland the River Barrow catchment contains 5.75% of the accessible juvenile salmon habitat in Ireland, comprising 6.49 million m^2 of suitable juvenile salmon habitat. The salmon fishing in the River Barrow is generally regarded as poor, and what fish are taken are mostly grilse, taken either during the summer or late in the season. The salmon fisheries on the River Barrow are located well downstream of the study area.

1.3.4.2 Freshwater Pearl Mussel

The freshwater pearl mussel (*Margaritifera margaritifera* (L.)) does not occur in the study area or in downstream areas. The Freshwater Pearl Mussel is a large bivalve species found in oligotrophic, soft to neutral waters of rivers and, occasionally, in lakes. In Ireland, the species is concentrated along the western sea-board, but also occurs in the south and east where geology allows.

The biology and ecology of the species are particularly notable in that individuals can grow to very large sizes relative to other freshwater molluscs, building up thick calcareous valves, in rivers with relatively soft water and low levels of calcium. Their shell building is consequently very slow, and individuals in natural conditions live to over a hundred years of age.

In Ireland, a total of 27 populations have been designated within 19 SAC areas for *Margaritifera margaritifera.* NPWS (2013) note that the freshwater pearl mussel (FPM) is found in 162 rivers in 104 catchments / sub-catchments across 14 counties (Carlow, Cavan, Clare, Cork, Donegal, Galway, Kerry, Limerick, Mayo, Sligo, Tipperary, Waterford, Wexford and Wicklow). The Freshwater Pearl Mussel does not occur in the study area or in downstream areas. Freshwater Pearl Mussel populations in Ireland have been recently assessed as being 'unfavourable - bad' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013).

1.3.4.2.1 Boyne catchment

The Drehid-Hortland, Ballynakill and Windmill components of the proposed development are located within the Boyne catchment. The Drehid-Hortland and Windmill components are located in Co. Kildare as is the bulk of the Ballynakill site. A small portion of the northern extent of the Ballynakill site is located in Co. Meath. There are no records of FPM in these counties and the species does not occur in the study area. The Article 17 report (NPWS, 2013) which shows the current distribution of FPM shows the Boyne catchment to be outside the known distribution of FPM in Ireland.

1.3.4.2.2 Barrow catchment

The Cloncumber and Derrybrennan components of the proposed development are located within the Barrow catchment in Co. Kildare. Co. Kildare is not listed in NPWS (2013) as an area where FPM is found and the study area is not indicated within the current distribution of FPM.

Lucey (1993) gives the distribution of *Margaritifera margaritifera* in southern Irish rivers and streams. This study area encompassed Hydrometric Areas 11 to 24. The distribution of FPM given in Lucey (1993) for the River Barrow is within the distribution given in NPWS (2013). Again, the proposed development is outside of this distribution range.

Tributaries of the Barrow, Nore and Suir River were examined for freshwater pearl mussels *Margaritifera margaritifera* and *M. m. Durrovensis* from June to August 1991 (Moorkens *et al.,* 1992). Rivers surveyed included the Figile, Cushina, Lerr and Greese in the upper Barrow catchment. Of the 79 rivers surveyed, only four were found to have living freshwater pearl mussels. Two of these rivers were in the Barrow catchment: the Mountain River and the Ballymurphy River. In the 1991 study (Moorkens *et al.,* 1992), mussels were found in sandy gravel towards the river banks, and under overhanging trees. It is noted in Moorkens *et al.* (1992) that alteration in a river's flow regime, such as that caused by drainage for forestry or agriculture, may result in summer flows being insufficient to support Freshwater Pearl Mussel. The same can be said of drainage carried out for harvesting of peat. A large proportion of rivers in the study area have soft substrates deemed unsuitable for FPM, beds of these rivers thought to be influenced by peat runoff from peat harvesting, suspended solids from ploughed lands and diffuse enrichment from agricultural activities, all known pressures on FPM (Moorkens, 1999).

There are three *Margaritifera margaritifera* populations in the Barrow catchment within the River Barrow and River Nore cSAC (002162). These mussels are present in the Mountain, Ballymurphy and Aughavaud Rivers and are in excess of 65km to the south of the Cloncumber component of the proposed Maighne wind farm.

1.3.4.3 White-clawed crayfish

The white-clawed crayfish is the only freshwater crayfish recorded in Ireland. Populations of the species in the rest of Europe have declined dramatically and Ireland is seen as a unique stronghold for this species in a European context (Reynolds 1998). The white-clawed crayfish is protected under both European and Irish legislation. It is protected by the Wildlife Act, 1976 and has been classified as endangered in the IUCN Red List. It is also listed under Appendix III of the Bern Convention and Annexes II and V of the EU Habitats Directive (1992).

The white-clawed crayfish is Ireland's only crayfish species. Ireland is understood to hold some of the best European stocks of this species, under least threat from external factors. Irish stocks are therefore of substantial conservation importance (Reynolds, 1998). Throughout its natural range across Western Europe, the distribution and abundance of white-clawed crayfish has been dramatically reduced in the last 150 years due to human disturbances such as overfishing, habitat destruction, pollution and the introduction of foreign crayfish species (Reynolds, 1998). In Britain, the North American signal crayfish (*Pacifastacus leniusculus*) was introduced for aquaculture and subsequently escaped into the wild, where it has had a devastating effect on white-clawed crayfish populations. While this species has not been recorded in Ireland, there is a real threat that this alien crayfish species will reach this country. The crayfish plague, which was transmitted by introduced crayfish species and is caused by the fungus *Aphanomyces astaci*, has been found in Ireland since the late 1980s.

White-clawed crayfish is widespread in areas which are underlain by Carboniferous limestone, or its derivative - glacial drift (Reynolds, 1998). Demers *et al.* (2005) reported that white-clawed crayfish are still widespread in the rivers of the Irish midlands, where the geology is predominantly limestone. However, these authors also report that the distribution of white-clawed crayfish in rivers has been restricted since the mid-1980s. This was attributed in part to an outbreak of the crayfish plague. Recent data from the EPA suggests a decline in crayfish populations in the north midlands (Reynolds, 2006). According to Reynolds (1998), the main threats to the white-clawed crayfish in Ireland are stream drainage, pollution and the introduction of predators, competitors or diseases. Ongoing drainage maintenance on arterially drained rivers in Ireland has also been identified as having a significant adverse effect of this species (O'Connor & McDonnell, 2008). The overall Article 17 assessment for white-clawed crayfish is Unfavourable-Inadequate (NPWS, 2013).

1.3.4.3.1 Boyne catchment

White-clawed crayfish is generally considered to be widespread in lowland rivers such as the River Boyne and tributaries (e.g. Lucey and McGarrigle, 1987). Demers *et al*. (2005) also reported that crayfish populations in the lakes and rivers of the Boyne catchment were likely to have been affected by crayfish plague, but are currently recuperating, according to Reynolds (2007). However, this effect is geographically isolated (Gallagher *et al*., 2006). All components of the proposed development within the Boyne catchment are located within 10km grid squares within the current distribution of White-clawed crayfish (as in Table 4). This species can be expected to occur in the watercourses draining the Drehid-Hortland, Ballynakill and Windmill components of the proposed development.

1.3.4.3.2 Barrow catchment

All components of the proposed development within the Barrow catchment are located within 10km grid squares within the current distribution of White-clawed crayfish (see Table 4). This species can be expected to occur in the watercourses draining the Cloncumber and Derrybrennan components of the proposed development.

1.3.4.4 Brook lamprey

The brook lamprey is the smallest of the three lampreys native to Ireland and it is the only one of the three species that is non-parasitic and spends all its life in freshwater (Maitland & Campbell 1992). Brook lamprey is listed in Annex II of the EU Habitats Directive (92:43:EEC) and in Appendix III of the Bern Convention. Brook lampreys are the most common and widespread of the three Irish lamprey species (Kurtz & Costello, 1999). They are found in most 2nd order and larger streams and rivers throughout the study area. Brook lampreys live for up to five years burrowed into silt deposits in rivers. They metamorphose into adults and spawn in the early spring in fast flowing streams with gravel substrates. Unlike the other two Irish lamprey species they are not parasitic as adults, and undertake only localised migrations. Lampreys show a preference for gravel-dominated substratum for spawning, and mainly silt and sand-dominated substratum for nursery habitat (Harvey & Cowx, 2003). The spawning season of brook lampreys starts when the water temperatures reach 10–11ºC (Maitland, 2003). This usually occurs in March/April.

Although still common in Ireland they are under significant threat from drainage and navigation maintenance works and also from water quality deterioration. Brook lampreys are also doing less well across the rest of European Union.

In this regard Irish populations of Brook lampreys are of International Importance. Ireland has failed to protect lampreys with a close season for instream works during their spawning season so they are vulnerable due to the lack of this type of protection. Responsibility for protecting lampreys in Ireland falls within the remit of Inland Fisheries Ireland; although there are none and never have been any fisheries for this species in Ireland. Brook lamprey populations in Ireland have been recently assessed as being 'favourable' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013).

1.3.4.4.1 Boyne catchment

During a survey of juvenile lamprey populations in the Boyne Catchment (O'Connor, 2006), brook lampreys were found to be widely distributed in the catchment. Lampreys were present at 70 out of the 91 sites investigated (77%). Mean minimum densities of river/brook juveniles recorded was 5.16 ± 2.43 juvenile lampreys per m^2, which was considered high in the context of Irish rivers. These were considered to be primarily brook lampreys, although river lampreys were also likely to be represented in samples taken from the lower reaches of the Boyne main channel.

1.3.4.4.1.1 Drehid-Hortland

During the O'Connor (2006) survey of juvenile lampreys in the River Boyne catchment, juvenile lampreys were recorded in the Blackwater (Longwood) River. This species can be expected to occur in the Mulgeeth and Coolree Rivers which drain the Drehid-Hortland component of the proposed development.

1.3.4.4.1.2 Ballynakill

Juvenile lampreys occurred in the main channel of the Boyne upstream and downstream of the Boolykeagh River confluence when surveyed in 2005 (O'Connor, 2006).

1.3.4.4.1.3 Windmill

The main channel of the River Boyne was found to have suitable habitat for lampreys at surveyed locations both upstream and downstream of the Glash River confluence, the watercourse draining the Windmill site. This species can be expected to occur in the Glash River also.

1.3.4.4.2 Barrow catchment

King (2006) gives the distribution of the three species of lampreys in the River Barrow cSAC and found brook lampreys to be widely distributed in the main channel of the River Barrow. Taking into account the spawning requirements of the brook lamprey, this species can be expected to occur in only low densities within the study area, the lack of suitable spawning areas considered a limiting factor. Drained rivers such as those in the study area have a much reduced lateral heterogeneity and a lower availability of flow refugia and backwater habitats than un-drained rivers and this can be expected to restrict lamprey production.

1.3.4.4.2.1 Cloncumber

The Abbeylough, Cloncumber and Slate Rivers are likely to support brook lamprey in low densities. These watercourses are regarded as suboptimal for this species however with consideration for the spawning requirements.

1.3.4.4.2.2 Derrybrennan

The Figile and Lullymore Rivers may support small populations of brook lampreys. These watercourses are regarded as suboptimal for this species however with regard to the spawning requirements of the species. These watercourses generally have soft substrates and little gravelly substrates, the latter essential for successful spawning.

1.3.4.5 River lamprey

The river lamprey is larger in size than the brook lamprey and exhibits an anadromous life cycle. River lamprey is listed in Annex II and IV of the Habitats Directive (92:43:EEC), and also in Appendix III of the Bern Convention. River lampreys are poor swimmers and climbers and are confined to the lower reaches of the Boyne catchment - well downstream of the study area of the currently proposed wind energy development. King (2006) notes the presence of river / brook lampreys in the Barrow upstream of Portarlington. It is considered that these lampreys were most likely brook lampreys, taking account of the distance from the tide and the number of weirs on the river.

River lamprey populations in Ireland have been recently assessed as being 'favourable' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013). However, this has been based on the fact that they have been grouped together with Brook lamprey populations due to identification difficulties.

1.3.4.6 Sea lamprey

The sea lamprey is the largest of the Irish lampreys species and again has an anadromous life cycle. They are also listed in Annex II of the Habitats Directive and Appendix III of the Bern Convention. In the NPWS Irish Wildlife Manuals No. 21 (King, 2006), the sea lamprey is indicated as occurring as far upstream as Carlow on the main channel of the River Barrow. Although more capable than river lampreys, sea lampreys are again poor swimmers and climbers would be confined to the lower reaches of the Boyne and Barrow Rivers, if present - well downstream of the study area of the currently proposed wind energy development. Indeed, NPWS (2013) notes that in several sea lamprey rivers, (e.g. the Mulkear, the Feale, the Fergus, the Barrow) severe barriers to passage occur at the upstream end of the tidal freshwater and that this does not represent a favourable situation. Sea lamprey populations in Ireland have been recently assessed as being 'unfavourable' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013).

1.3.4.7 Floating river vegetation

The plants characteristic of this habitat include a number of *Ranunculus* species and all *Callitriche* species, including other submerged aquatic plants. The community Callitricho–Batrachion includes species of the *Ranunculus* subgenus *Batrachium* and two species of *Callitriche*, *C. hamulata* and *C. platycarpa* as diagnostic species. There are few published records for descriptions of this habitat in Ireland and no comprehensive island-wide descriptions. According to NPWS (2013) the EU definition of this habitat is very broad, especially when the presence of aquatic mosses is taken into account. Using this broad definition the habitat will be found in most watercourses in Ireland. There is to date no satisfactory definition of the habitat and its sub-types or their distribution in Ireland. Consequently there is a lack of relevant monitoring data concerning the habitat. What is clear is that the habitat can occur over a wide range of physical conditions, from acid, oligotrophic, flashy upland streams dominated by bryophytes to more eutrophic, slow flowing streams dominated by Ranunculus and Callitriche species. While the former will be sensitive to diffuse pollution the latter, especially in shallow streams, will be relatively more resistant. Flora associated with the Annex I habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' (3260) includes *Ranunculus saniculifolius, Ranunculus trichophyllus, Ranunculus fluitans, Ranunculus penicillatus ssp. penicillatus, Ranunculus penicillatus* ssp. *Pseudofluitantis, Ranunculus aquatilis, Myriophyllum* spp., Callitriche spp., *Sium erectum* (or *Berula erecta*), *Zannichellia palustris, Potamogeton* spp., and the moss *Fontinalis antipyretica*. *Groenlandia densa* (Opposite leaved pondweed) is also included in the list. The flowering rush *Butomus umbellatus* may be present as part of the bank flora where floating river vegetation has been identified. The habitat 'Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation' in Ireland has been recently assessed as being 'inadequate' by NPWS in the 2013 Article 17 Conservation Status Assessments (2013).

1.3.5 Fish communities and fisheries

Table 5 presents the results of the physical habitat assessments at the aquatic ecology and fisheries survey sites, Table 6 presents the results of the River Habitat Survey (RHS) assessments, Table 7 presents the results of the fisheries habitat assessments and Table 8 presents the biological water quality and WFD status at the aquatic ecology and fisheries survey sites. The results of the aquatic ecology and fisheries survey are also presented on Figure 4.

1.3.5.1 Boyne catchment

A single site was surveyed in the River Boyne catchment within the Eastern River Basin District as part of Water Framework Directive fish surveillance monitoring in 2010 (Kelly *et al, 2011*). This site was located close to the river's source, approximately 1.5km north of Edenderry. This location is approximately 18km upstream of the Fear English River confluence with the River Boyne, the Fear English River draining the Drehid-Hortland component of the proposed development. A total wetted area of 936m^2 was surveyed at Boyne Bridge by IFI in 2010 (117m m long channel of wetted width 8m). Emergent macrophyte vegetation was abundant throughout this stretch, while submerged and floating species were also present. Three fish species were recorded in the River Boyne at Boyne Bridge: brown trout (0.05/m^2), three-spined stickleback (0.004/m^2) and minnow (0.002/m^2). It is noted that the stretch of the River Boyne surveyed during 2010 (Kelley *et al*, 2010) was drained, corresponding to channel characteristics of some watercourses in the current survey area.

1.3.5.2 Barrow catchment

During the current assessment, electrical fishing was carried out at Site 9 on the Figile River. A total of three fish species were recorded at this location: brown trout, European eel and pike.

A site on the main channel of the River Barrow was surveyed in the River Barrow catchment within the Eastern River Basin District as part of Water Framework Directive fish surveillance monitoring in 2009 (Kelly *et al., 2010*), so data from this site was also considered in the current assessment. This site was located at Pass Bridge in Monasterevin, Co. Kildare, approximately 10km downstream of the Figile-Slate confluence, or approximately 22km downstream of Cloncumber, the nearest component of the proposed wind farm (Cloncumber). One electric-fishing pass was conducted using four boat-based electric-fishing units on the 6th of July 2009 along a 426m length of channel. The mean wetted width of the surveyed stretch was 25.6m and the mean depth was 96.0cm. Riffle and glide dominated the habitat, while the substrate was a mixture of cobble, gravel and sand. Macrophyte vegetation consisted mostly of riparian grasses but some submerged species were also present. A total wetted area of 10906m^2 was surveyed. A total of eleven fish species were recorded in the River Barrow (Pass Bridge) site (as well as roach x bream hybrids). Gudgeon *Gobio gobio* was the most abundant species (0.0037/m^2), followed by roach *Rutilus rutilus*(0.0031/m^2), salmon *Salmo salar* (0.0031/m^2), perch *Perca fluviatilis* (0.0026/m^2), pike *Esox lucius* (0.0024/m^2), minnow *Phoxinus phoxinus* (0.0013/m^2), brown trout *Salmo trutta* (0.0009/m^2), stone loach *Barbatula barbatula* (0.0007/m^2), European eel *Anguilla anguilla* (0.0006/m^2), dace *Leuciscus leuciscus* (0.0006/m^2), roach x bream hybrids *Rutilus rutilus* x *Abramis brama* (0.0004/m^2) and bream *A. Brama* (0.0001/m^2).

Gudgeon ranged in length from 8.2cm to 12.0cm (Fig. 4.12). Roach ranged in length from 5.5cm to 25.0cm. Four age classes (2+, 3+, 4+ and 5+) were present, accounting for approximately 14.7%, 35.3%, 29.4% and 17.6% of the total roach catch respectively. Salmon ranged in length from 9.0cm to 14.0cm. All individuals were aged 1+. Perch ranged in length from 10.6cm to 36.0cm. Six age classes (1+, 2+, 3+, 4+, 5+ and 8+) were present. Pike ranged in length from 17.5cm to 59.0cm. Three age classes (1+, 2+ and 3+) were present, accounting for approximately 77%, 8% and 15% of the total pike catch respectively. Brown trout ranged in length from 12.0cm to 38.5cm. Three age classes (1+, 2+ and 3+) were present, accounting for approximately 20%, 70% and 10% of the total brown trout catch respectively. Mean brown trout L1, L2 and L3 were 10.6cm, 18.3cm and 19.4cm respectively, indicating a fast rate of growth for brown trout in this river site according to the classification scheme of Kennedy and Fitzmaurice (1971). Eels ranged in length from 46.0cm to 58.0cm.

1.3.5.3 Salmonid habitats and fisheries

Atlantic salmon are discussed in detail in Section 1.3.4.1. As well as salmon, brown trout also occur in the study area. Arterial drainage programmes dating from the 19th and first half of the 20th century impacted on many catchments throughout Ireland. Brown trout occur in virtually every catchment in Ireland with suitable water quality and spawning grounds, and are one of the most common and recognisable fish species in Ireland. Indeed, they have less protection in Ireland from anglers than non-native invasive cyprinid fish species such as the dace and roach, presumably due to their abundance. Brown trout occur as resident 'brown trout' and also as an anadromous form, the 'sea trout'. In many catchments throughout Ireland trout make extensive migrations between spawning grounds in streams and feeding grounds in lakes or larger rivers.

The Boyne catchment was severely affected by these schemes which degraded habitats for species such as trout. In many cases trout populations were more affected than salmon, with the removal of features such as undercut banks, large woody debris etc. from these channels. The larger river channels in the study area are still considered to be important trout fisheries, i.e. the Boyne, Blackwater (Longwood), Slate and Figile are all still noted for the quality and size of brown trout that they produce (O'Reilly, 2004).

1.3.5.4 Coarse fish habitats and fisheries

Coarse fish are essentially any freshwater fish other than salmon and trout and generally include members of the cyprinidae family (i.e. roach, dace, rudd, bream, tench), pike and perch. The term coarse fishing originated in the United Kingdom in the early 19th century. Prior to that time, recreational fishing was a sport of the gentry, who angled for salmon and trout which they called game fish. Other fish were disdained as coarse fish.

Almost all coarse fish in Ireland are considered to be non-native species. However, there is recent evidence that pike may be native to Ireland (Pedreschi *et al*, 2013). Coarse fish in Ireland are afforded a higher level of protection in Ireland than native brown trout, with strict limits on the number and sizes of these fish that can be killed by anglers. Coarse fisheries are of significant economic value in Ireland, particularly for tourist anglers. Coarse fisheries and coarse fish spawning areas are generally located in large lowland rivers and lakes. The main channel of Moynalty is important in this regard.

1.3.5.5 Eel habitats

The European eel *Anguilla anguilla* is a native fish of significant ecological importance. In recent decades, this species has undergone a dramatic decline throughout its range. In response to the decline in European eel populations European Council Regulation 1100/2007 "Establishing measures for the recovery of the stock of European eel" has now been adopted in member states. European eel is listed as 'Critically endangered' and is now 'Red Listed' according to the recently published 'Red List No. 5: Amphibians, Reptiles & Freshwater Fish' (King *et al*., 2011).

Eels are considered present throughout the study area, but are generally only found in larger watercourses, rivers and lakes. Eels have a catadromous life cycle, which means they spawn in the sea and migrate into freshwater to feed and grow. This is opposite of the life cycle of the salmon, for example. The upstream migration of eels in rivers is restricted by weirs and their obstacles. However unlike lampreys they are able to climb over weirs. Despite the international decline in this species, they are still common in the main rivers in the study area.

1.3.5.6 Lamprey habitats

Lampreys are discussed above in Sections 1.3.4.4, 1.3.4.5, and 1.3.4.6. The most common lamprey species in the study area is Brook lamprey and they are generally common and widespread in the study area in 2nd order and larger streams and rivers.

1.3.5.7 Others

The majority of the watercourses within the proposed wind farm site are small fish populations dominated by species such as the three-spined stickleback, nine-spined stickleback, minnow and stone loach. These small fish communities are not of significant ecological or economic importance. These small fish populations, and particularly ones dominated by sticklebacks, can be present in even small drains that have permanent water.

1.3.6 Aquatic macroinvertebrates

1.3.6.1 Macroinvertebrate communities

The aquatic macroinvertebrate community in Ireland is impoverished due to glaciation with many species not reaching Ireland following the retreat of the ice and sea level changes.

Macroinvertebrate assemblages were recorded from Site 2 on the Longwood Blackwater in the Boyne catchment, and Site 8 on the Slate River and Site 9 on the Figile River in the Barrow catchment. The macronivertebrates recorded at these locations are provided in Table 9.

The macroinvertebrate communities in the study area were typically associated with slow flowing watercourses. Pollution tolerant macroinvertebrates were found to dominate the macroinvertebrate assemblage at these sites. Watercourse morphology including physical characteristics such as depth and wetted width, as well as gradient, substrate conditions and instream/emergent vegetation coupled with water quality all dictate the macroinvertebrate families and relative abundance at the sites surveyed. The macroinvertebrate community assemblages recorded on the Longwood Blackwater, Slate River and Figile River are considered to be representative of the watercourses in the study area at large. Owing to their large size, these sites probably support the richest aquatic macroinvertebrate communities in the study area, as the smaller watercourses (drainage ditches) in the study area are prone to fluctuations and have less diverse structural diversity. The only protected macroinvertebrate in the study area is white clawed crayfish (see Section 1.3.4.3). This species was not recorded during the current assessment but is likely to occur.

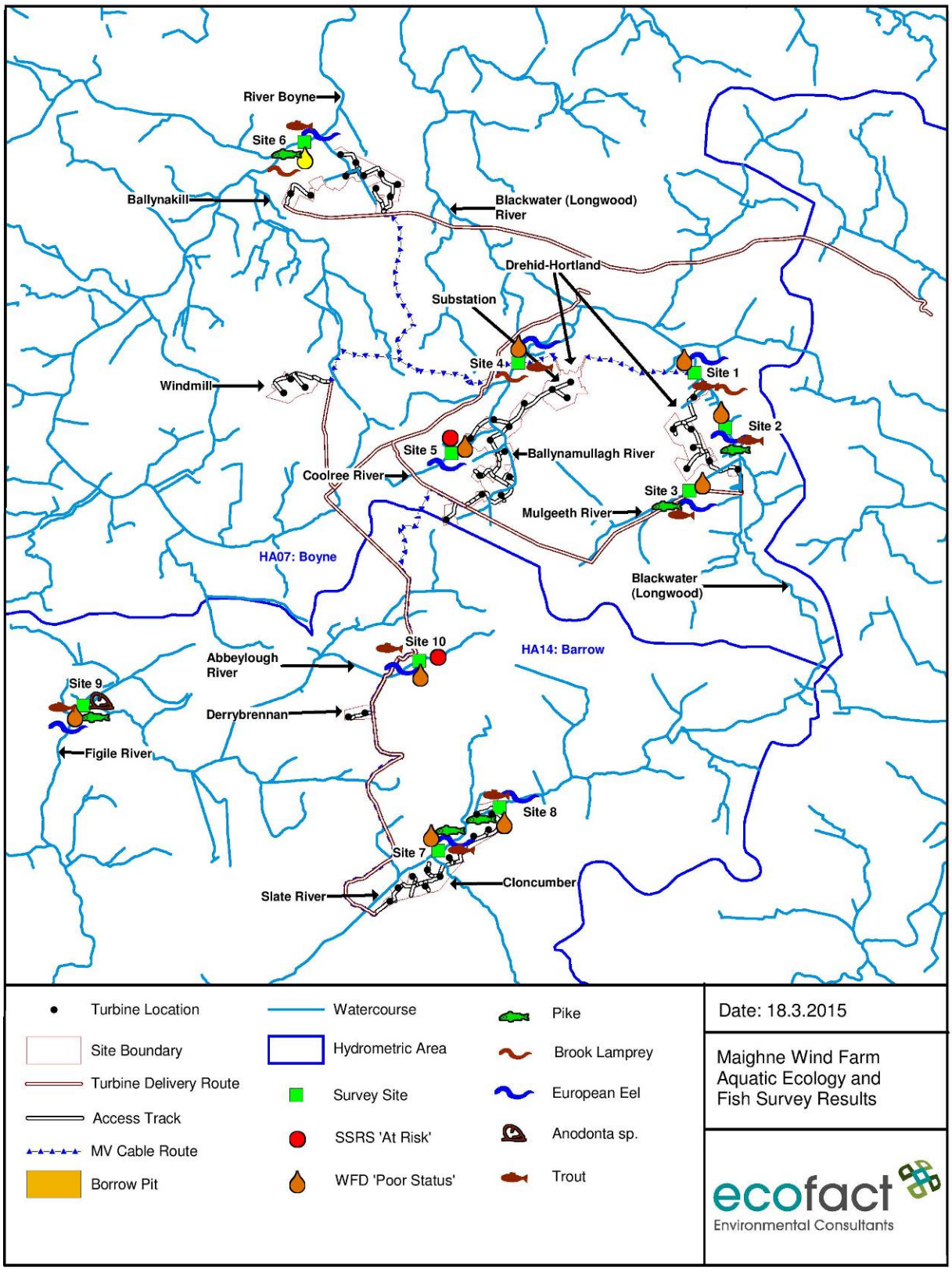

Figure 4: Maighne proposed wind farm site; aquatic ecology and fisheries survey sites and results

1.3.6.1.1 Boyne catchment

1.3.6.1.1.1 Drehid-Hortland

Site 2 was located on the Blackwater (Longwood) River in the Boyne catchment to the east of the proposed Drehid-Hortland component of the proposed Maighne wind farm. A macroinvertebrate family diversity of eight was recorded at this site. The pollution tolerant crustaceans *Gammarus deubeni* and *Asellus aquaticus*, as well as the snail *Bithynia tentaculata* were common. The snai *Lymnaea peregra* and beetles *Potamonectes depressus elegans* and *Stictotarsus duodecimpustulatus* were also recorded. The only Trichopteran recorded was *Hydropsyche sp.* (common).

1.3.6.1.2 Barrow catchment

1.3.6.1.2.1 Cloncumber

Site 8 was located on the Slate River at the eastern estent of the proposed Cloncumber component of the proposed Maighne wind farm. Macroinvertebrates in 10 families were recorded here. The only Ephemeropteran recorded was larval *Baetis rhodani*, a pollution tolernat indicator. Fair numbers and small numbers of *A. Aquaticus* and *Gammarus duebeni* were recorded respectively. The non-native snail *Potamopyrgus jenkinsi* was numerous. The leeches *Glossiphonia complanata* and the fish parasite *Piscicola geometra* as well as Aquatic worm (Lumbriculidae) were present at this site.

1.3.6.1.2 Derrybrennan

Site 9 was located on the Figile River downstream of the Derrybrennan component of the proposed Maighne wind farm. The macroinvertebrate family diveristy at this location was 16. Trivhopterans were well represented with cased larvae of Group (less sensitive) *Phryganea sp.* (scarce) and caseless larvae of *Hydropsyche sp.* (fair numbers) and *Polycentropus* sp. (scarce). Larvae of the banded jewelwing damselfly *Agrion splendens* the true fly *Dicranota* sp. were recorded in small numbers. Molluscs were the most diverse group with the following recorded: *Planorbis carinatus, P. Jenkinsi, Lymnaea stagnalis* and freshwater duck mussel *Anodonta anatina.*

A. anatina has been previously recorded from the Figile River (based on distribution maps in Byrne *et al,* 2009). Its habitat in Ireland is lowland lake, slow moving rivers and canals. Microhabitat for this species in Ireland comprises muddy or silty beds in areas of still or slow flow. The Slate River is also considered to support this species. There are a total of 31 Irish non-marine molluscan species that either have a threat status or with important Irish populations (Moorkens, 2006), including Duck Mussel. The IUCN status of *A. anatina* is 'Vulnerable' (Byrne *et al,* 2009) and its threat status is 'Vulnerable' (Moorkens, 2006).

1.3.7 Biological water quality

Water quality has been monitored in the River Boyne and Barrow main stem and in selected tributaries by the Environmental Protection Agency (EPA) and its predecessors since 1971. As part of its rollover monitoring programme, biological sampling is carried out periodically by the EPA. Below is an account of biological water quality in the study area based on EPA data. Table 10 gives the biological water quality ratings of watercourses assessed in August / September 2013. Figure 5 gives the most EPA Biological Water Quality Results for Watercourses Draining the Proposed Maighne Wind Farm.

1.3.7.1 Hydrometric Area 07 (Boyne)

1.3.7.1.1 Drehid Hortland

The Drehid-Hortland component of the proposed development is drained by the Blackwater (Longwood) River and was most recently monitored by the EPA in 2012. The uppermost EPA biologicla surey location on this river in 2012 is at the bridge south of Hortland (07B02 60), to the east of the proposed development. Biological water quality at this locatioon was rated Q3 at this time, equivalent to WFD poor status. Biological water quality at the bridge at Johnstown was rated Q3-4 in 2012, equivalent to WFD moderate status.

The following is the most recent EPA assessment of the Blackwater (Longwood) River based on the 2012 results: *the dominance of pollution tolerant and paucity of pollution sensitive macroinvertebrate taxa indicated unsatisfactory ecological conditions at all sites surveyed on the Blackwater (Longwood) River in September 2012. Enriched conditions were evident with enhanced macrophyte growth noted downstream of Johnstown at Longwood (0300) and in the lower reaches (0600).*

1.3.7.1.2 Ballynakill

A stretch of the River Boyne between the EPA biological monitoring station at Ashfield Bridge (07B04 600) and Inchamore Bridge (07B04 800) lies approximately 1km north of the Ballynakill component of the proposed development site. At the upstream location (Ashfield Bridge), biological water quality was rated Q3-4 in 2012, corresponding to WFD moderate status. At the downstream location (Inchamore Bridge), biological water quality was rated Q4 in 2012, corresponding to WFD good status. The following is the most recent EPA assessment of the Blackwater (Longwood) River based on the 2012 results: *the majority of the fifteen stations surveyed on the Boyne River remain in an unsatisfactory ecological condition in 2012. The macroinvertebrate fauna indicated satisfactory ecological conditions at six of the stations examined. An unwelcome decline in ecological status was noted at three stations. The macroinvertebrate fauna indicated a decline from good to moderate ecological conditions in the upper reaches at Boyne Bridge (0200) and at Scarriff Bridge (0900) and a decline from high to good ecological conditions at Inchamore Bridge (0800). A welcome improvement from moderate to good ecological conditions was noted downstream of Broadboyne Bridge (2010). Unsatisfactory ecological conditions continue downstream of Edenderry (0300), at Ashfield Bridge downstream of the Glash River confluence (0600), downstream of the Blackwater (Longwood) confluence (0900), at Trim and downstream (1200, 1400), at Bective Bridge downstream of the Knightsbrook and Boycetown confluences (1500), Kilcarn Old Bridge, downstream of the Clady and Skane river confluences (1700) and at Obelisk Bridge, upstream of Drogheda (2200)*.

The Mulphedder Stream drains the western extent of the proposed development site and flows in to the Glash River upstream of Bunglass Bridge (07G02 600). Biological water quality at this site was rated Q3-4 in 2012, corresponding to WFD moderate status.

1.3.7.1.3 Windmill

The Windmill component of the proposed development is drained by the Glash River system River which most recently monitored by the EPA in 2012. Biological monitoring is carried out at four locations within this sub-basin. The uppermost location is at the bridge NW of Calfstown (07G02 200) which is ca. 1km to the northeast of the proposed development site. Biological water quality at all locations surveyed by the EPA in 2012 were rated Q3, equivalent to WFD poor status.

The following is the most recent EPA assessment of the Glash River based on the 2012 results: *the dominance of pollution tolerant macroinvertebrate taxa, complete lack of pollution sensitive taxa and excessive instream siltation continues to indicate unsatisfactory poor ecological conditions at all stations surveyed on the Glash River in 2012. Excessive peat siltation of the instream substratum was noted in particular near Calfstown (0200) and at Clonuff Bridge (0400).*

1.3.7.2 Hydrometric Area 14 Barrow

1.3.1.2.1 Cloncumber

The Cloncumber component of the proposed development is drained by the Slate River and the Cloncumber Stream and these watercourses were most recently monitored by the EPA in 2011.

The Slate River is monitored at Ford Bridge (14S01 50) upstream of the proposed development and at Agar Bridge (14S01 100) downstream. Biological water quality at both of these locations were rated Q3-4 in 2011, equivalent to WFD moderate status.

The following is the most recent EPA assessment of the Slate River based on the 2011 results: *Only one of the six stations surveyed on the Slate River was in a satisfactory ecological condition in 2011. Poor ecological conditions persist downstream of Prosperous (0020) and Allenwood (0050).*

A slight improvement from poor to moderate ecological conditions was noted at Agar Bridge (0100) and downstream of Rathangan (0210). The increased diversity of sensitive macroinvertebrate fauna indicated a welcome improvement in the lower reaches (0300) however signs of enrichment (heavy siltation, enhanced instream algal growth, elevated dissolved oxygen and pH readings) were still evident.

Only a single site is monitored on the Cloncumber Stream, at Old River Bridge (14C17 0200), ca. 3km upstream of the proposed development site. Biological water quality at this site was rated Q3-4 in 2011, equivalent to WFD moderate status. The following is the most recent EPA assessment of the Cloncumber Stream based on the 2011 results: *the macroinvertebrate fauna continues to indicate unsatisfactory moderate ecological conditions on the Cloncumber Stream at Old River Bridge (0200) when surveyed in May 2011.*

1.3.7.2.2 Derrybrennan

The Derrybrennan component of the proposed development is drained by the Figile River and was most recently monitored by the EPA in 2011. The Slate River is assessed by the EPA both upstream and downstream of the proposed development: at Ticknevin Bridge (14F01 200) and Cushaling Bridge (14F01 100) respectively. In 2011, biological water quality was rated Q, equivalent to WFD poor status at Ticknevin Bridge, and Q3-4, equivalent to WFD moderate status at Cushaling Bridge.

The following is the most recent EPA assessment of the Figile River based on the 2011 results: *The dominance of pollution tolerant macroinvertebrate species, enhanced instream plant and algal growth and excessive siltation indicated continued unsatisfactory ecological conditions in the upper reaches (0050, 0100, 0200) of the Figile River in May 2011. The increased diversity and abundance of sensitive macroinvertebrate species indicated good ecological conditions at Clonbulloge (0300), Derrygarran (0400) and Andra Bridge (0500) although the enhanced macrophyte and algal growth continues to indicate some enrichment.*

1.3.8 Aquatic plant communities

Plants recorded during the current surveys consisted of *Sparganium erectum*, *Apium nodiflorum*, *Rorippa nasturtium-aquaticum*, *Glyceria maxima*, *Phalaris arundinacea, Mentha aquatica*, *Myosotis scorpioides, Iris pseudacorus, Schloenoplectus lacustris, Nuphar lutea, Callitriche* spp., *Lemna* spp. and *Potamegeton* sp. The moss *Fontinalis antipyretica* is widespread the Boyne catchment while the filamentous green algae *Cladophora glomerata* is common in both the Boyne and Barrow catchments, especially in the enriched lower reaches of rivers and some tributaries within the study area.

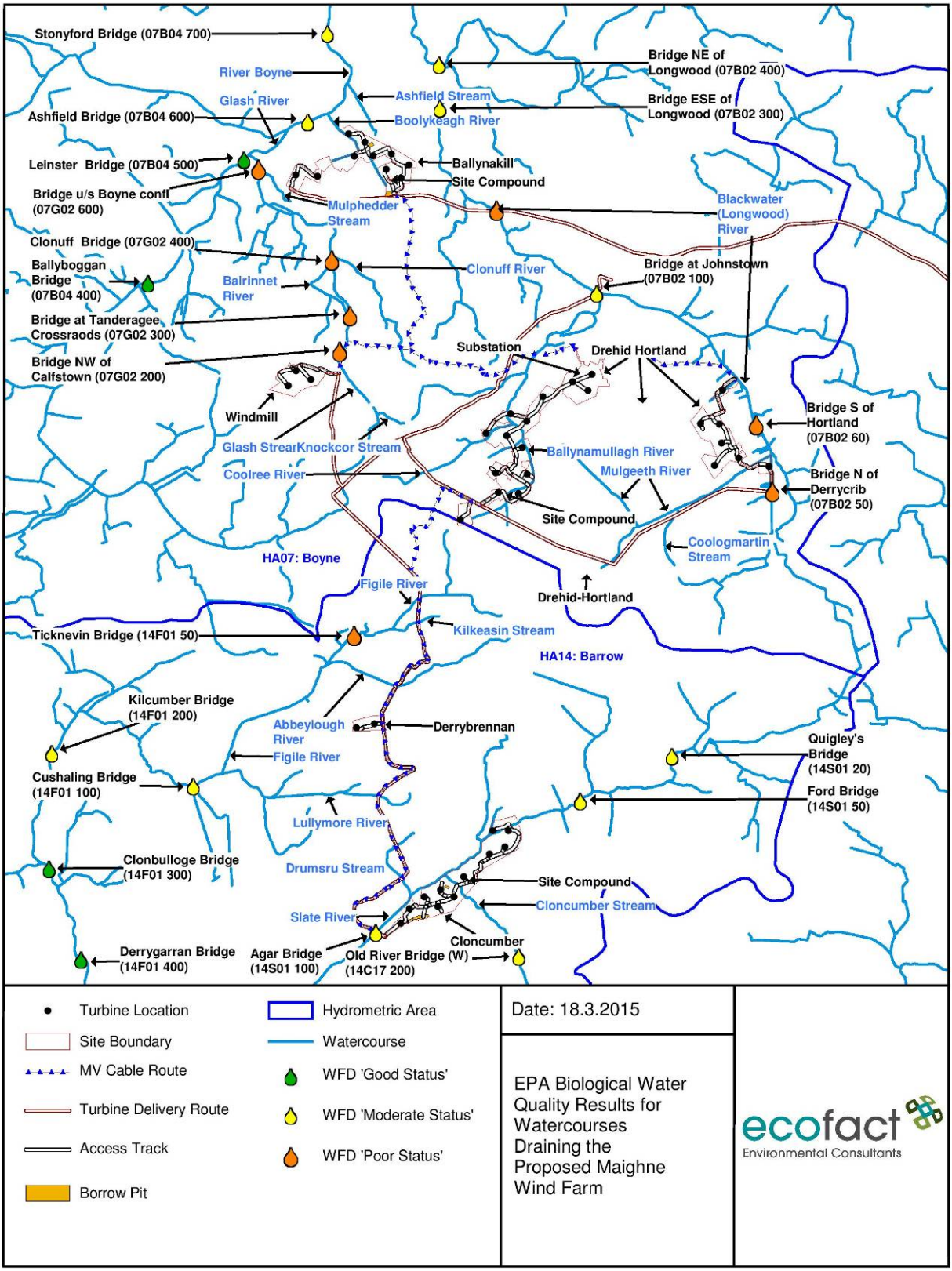

Figure 5: Most EPA Biological Water Quality Results for Watercourses Draining the Proposed Maighne Wind Farm.

Table 5: Results of the physical habitat assessments* of the aquatic ecology and fisheries survey sites at proposed Maighne wind farm site

Site	Watercourse Name	Wetted width (m)	Mean Depth (cm)	Max Depth (cm)	Instream vegetation (%)	Bank Height (m)	Bank slope (°)	Bank Cover (%)	Canopy Cover (%)	Riffle (%)	Glide (%)	Pool(%)	Flow Velocity (m/s)	Rock (%)	Cobble(%)	Gravel (%)	Fine(%)	Shade(%)
1	Blackwater (Longwood)	3	30	50	40	4	45	100	85	0	100	0	0.2	20	20	20	40	50
2	Blackwater (Longwood)	2.5	30	40	20	0.5	45	100	20	0	100	0	0.02	0	0	0	100	20
3	Mulgeeth	2.5	30	40	20	0.5	45	100	20	0	100	0	0.02	0	0	0	100	20
4	Coolree 07	2	15	20	40	1	90	100	40	20	80	0	0.3	20	20	10	50	40
5	Coolree 07	0.5	5	20	0	1.5	80	95	95	30	40	30	0.2	0	30	40	30	95
6	Boyne	6	1	1.8	8	2	20	100	0	0	50	50	0.2	0	5	70	25	0
7	Slate	1.2	40	50	80	2.5	75	100	0	0	100	0	0.03	0	0	20	80	0
8	Slate	2.5	30	40	20	0.5	45	100	20	0	100	0	0.02	0	0	0	100	20
9	Figile	6	50	100	40	1.8	75	100	0	0	100	0	0.02	0	10	80	10	0
10	Abbeylough	1.5	15	20	40	1	80	100	70	0	100	0	0.01	10	40	40	10	70

**Assessment follows Environment Agency (2003) River Habitat Survey in Britain and Ireland Field Survey Guidance Manual 2003.*

Table 6: Results of the River Corridor Survey (RHS) assessments of survey sites at proposed Maighne wind farm site.

Site	Watercourse Name	EPA code	Drained	Wetted width (m)	Gradient (Low/Med/High) *	Siltation (Heavy/Moderate/Normal/Free)*	Filamentous algae (Y/N)	Eroding banks (Y/N)	Braided channel (Y/N)	Artificial features (Y/N)
1	Blackwater (Longwood)	07B02	Yes	3	L	H	N	N	N	Y
2	Blackwater (Longwood)	07H03	Yes	2.5	L	H	N	N	N	Y
3	Mulgeeth	07M54	Yes	2.5	L	H	N	N	N	Y
4	Coolree 07	07C23	Yes	2	L	H	N	N	N	Y
5	Coolree 07	07C23	Yes	0.5	L	M	Y	N	N	Y
6	Boyne	07B04	Yes	6	L	M	Y	N	N	Y
7	Slate	14S01	Yes	1.2	L	M	Y	N	N	N
8	Slate	14S01	Yes	2.5	L	H	N	N	N	Y
9	Figile	14F01	Yes	6	L	N	N	N	N	Y
10	Abbeylough	14A01	Yes	1.5	L	M	N	N	N	Y

**Visual assessment.*

Table 7: Results of the fisheries habitat assessments of survey sites at proposed Maighne wind farm site.

Site	Watercourse Name	Salmonid nursery (Y/N)	Salmonid fishery (Y/N)	Coarse nursery (Y/N)	Coarse fishery (Y/N)	Salmon (P/A)	Trout (P/A)	Coarse fish (P/A)	Eel (P/A)	Lamprey Habitat (P/A)	Lamprey (P/A)	Crayfish (P/A)	FWPM (P/A)	Floating river vegetation (Y/N)
1	Blackwater (Longwood)	N	N	N	N	A	P	A	L	P	L	A	A	N
2	Blackwater (Longwood)	N	N	N	N	A	L	L	L	A	A	A	A	N
3	Mulgeeth	N	N	N	N	A	L	L	L	A	A	A	A	N
4	Coolree 07	Y	N	N	N	A	L	A	L	P	L	A	A	N
5	Coolree 07	N	N	N	N	A	A	A	L	A	A	A	A	N
6	Boyne	Y	Y	Y	Y	P	P	P	P	P	P	P	A	Y
7	Slate	Y	N	Y	N	P	P	P	P	A	A	A	A	N
8	Slate	N	N	N	N	A	L	L	L	A	A	A	A	N
9	Figile	Y	Y	Y	N	A	A	P	A	A	A	A	A	N
10	Abbeylough	Y	N	N	N	A	P	P	P	A	A	A	A	N

Y = Yes, N= No, P = Present, A = Absent, L = not recorded but likely to occur in the waterbody

Table 8: Biological water quality and WFD status at the aquatic ecology and fisheries survey sites.

Site	Watercourse Name	EPA code	EPA Q-value	ECOFACT Q-value	ECOFACT SSRS	WFD status	Morphological status* (High / Good / Moderate / Poor / Bad)	Biological status* (High / Good / Moderate / Poor / Bad)	Fisheries status* (High / Good / Moderate / Poor / Bad)
1	Blackwater (Longwood)	06B02	N/A	Q3	N/A	Poor	P	M	M
2	Blackwater (Longwood)	06B02	Q3/Q3-4	Q3	N/A	Poor/Moderate	P	P	P
3	Mulgeeth	07M54	N/A	Q3	N/A	Poor	P	P	P
4	Coolree 07	07C23	N/A	Q3	N/A	Poor	P	P	P
5	Coolree 07	07C23	N/A	Q3	Bad	Poor	P	P	P
6	Boyne	07B04	Q3-4	Q3-4	N/A	Moderate	P	M	M/G
7	Slate	14S01	Q3-4	Q3	N/A	Poor/Moderate	P	P	M
8	Slate	14S01	N/A	Q3	N/A	Poor	P	P	P
9	Figile	14F01	N/A	Q3	N/A	Poor	P	P	M
10	Abbeylough	14A01	N/A	Q3	Bad	Poor	P	P	P

**categories follow EEA (2012).*

Table 9: Macroinvertebrates recorded during the biological surveys.

	Pollution sensitivity group	Functional group	Site 2- Longwood Blackwater	Site 8 - Slate River	Site 9 - Figile River
MAYFLIES (Uniramia, Ephemeroptera)					
Large dark olive Baetis rhodani	C	Scraper & gathering collector		****	
CASED CADDIS FLIES (Trichoptera)					
Northern caddisflies (Limnephilidae)				**	
Phryganeidae					
Phryganea sp.	B	Shredder			**
CASELESS CADDIS FLIES (Trichoptera)					
Grey flags (Hydropsychidae)					
Hydropsyche sp.	C	Filtering Collector	*****	****	****
Trumpet-net caddisflies (Polycentopodidae)					
Polycentropus sp.	C	Filtering collector			**
DAMSELFLIES (Odonata, Zygoptera)					
Jewelwings/Demoiselles (Agriidae)					
Banded jewelwing *Agrion splendens*	B	Predator			***
TRUE FLIES (Diptera)					
Craneflies (Tipulidae)	C	Shredder			
Dicronata sp.	C	Shredder			***
Family Chironomidae					
BEETLES (Coeloptera)					
Gyrinidae					
Whirligig beetle larvae (Gyrinidae)					
Common whirligig beetle *Gyrinus sp.*	C	Predator			**
Haliplidae	C	Predator			
Diving beetles (Dytiscidae)					
Sub family Hydroporinae					
Stictotarsus duodecimpustulatus	C	Predator	***		
Potamonectes depressus elegans	C	Predator	**		
SNAILS (Mollusca, Gastropoda)					
Family Lymnaeidae					
Wandering Snail *Lymnaea peregra*	D	Shredder	**		
Great Pond Snail *Lymnaea stagnalis*	C	Shredder			**
Family Planorbiidae					
Keeled Ramshorn Snail *Planorbis carinatus*	C	Scraper			*****
Hydrobiidae					
Bithynia tentaculata	C	Shredder	*****		
Jenkins spire shell *Potamopyrgus*	C	Grazer		******	*****

	Pollution sensitivity group	Functional group	Site 2- Longwood Blackwater	Site 8 - Slate River	Site 9 - Figile River
jenkinsi					
Family Ancylidae					
River limpet *Ancylus fluviatilis*	C		****	**	
MUSSELS (Mollucsa, Lamellibranchiata)					
Duck mussel Anodonta anatina					*
Orb/Pea Mussels (Family Sphaeridae)	D	Filtering Collector	**		
CRUSTACEANS (Crustacea)					
Amphipods (Amphipoda, Gammaridae)					
Freshwater shrimp *Gammarus sp*	C	Shredder	*****	***	**
Isopods, Asellidae					
Hog louse *Asellus aquaticus*	D	Shredder	*****	****	***
LEECHES (Hirudinae)					
Piscicolidae					
Piscicola geometra	C	Predator		*	*
Glossiphonidae					
Glossiphonia complanata	D	Predator		*	
BUGS (Hemiptera)					
Lesser Water Boatmen (Corixidae)		Predator			**
Notonectidae					
Notonecta sp.	C	Predator			*
ALDERFLIES (Megaloptera)					
Alderfly larvae (Sialidae)					*
OLIGOCHAETAE					
Aquatic worm (Lumbriculidae)	D	Collector		*	

**Present (1 or 2 individuals), **Scarce/Few (<1%), ***Small Numbers (<5%), ****Fair Numbers (5-10%), *****Common (10-20%), ******Numerous (25-50%), *******Dominant (50-75%), ********Excessive (>75%).*

Table 10: Biological water quality results for sites assessed for the proposed Maighne wind farm site during the August/October 2013 survey.

Site	Catchment	Relevant component of wind farm	Sub-catchment	River	Watercourse	Q-value	WFD Status	SSRS
1	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Blackwater (Longwood)	Q3	Poor	-
2	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Hortland	Q3	Poor	-
3	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Mulgeeth	Q3	Poor	-
4	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Coolree 07	Q3	Poor	-
5	Boyne	Drehid-Hortland	Blackwater (Longwood)	Blackwater (Longwood)	Coolree 07	Q3	Poor	Bad
6	Boyne	Ballynakill, Windmill	Boyne	Boyne	Boyne	Q3-4	Moderate	-
7	Barrow	Cloncumber	Figile	Slate	Slate	Q3	Poor	-
8	Barrow	Cloncumber	Figile	Slate	Slate	Q3	Poor	-
9	Barrow	Derrybrennan	Figile	Figile	Figile	Q3	Poor	-
10	Barrow	Derrybrennan	Figile	Figile	Abbeylough	Q3	Poor	-

1.4 Potential Impacts

Wind farm developments, as with all major construction projects, have the potential to have significant negative impacts on aquatic habitats and the key ecological receptors in the aquatic environment. Wind farm projects are often located near the sources of streams or rivers. These reaches are generally minor watercourses and are therefore potentially vulnerable to even relatively small pollution events. Such areas can also be important salmonid spawning and nursery areas; or can act as vectors of pollution to downstream areas which are important in this respect. Minor headwaters and upper reaches can be of importance to protected or ecologically important features downstream.

The impacts of wind farm developments on aquatic areas generally occur only during the construction phase. Ongoing operation and maintenance of wind farms is unlikely to result in any significant effects in the receiving aquatic environment. Impacts may also potentially occur during wind farm decommissioning.

It is likely that that the proposed development will require clearance of some trees/vegetation to build site access roads, turbine foundations, borrow pits, hardstanding areas, cable trenches and provide site drainage. These operations can impact on the quality of habitats present for aquatic organisms. Wind farm construction can increase suspended solids loading of watercourses, alter recharge or drainage/runoff patterns and change surface water quantity thereby increasing flood risk for downstream watercourses, eroding watercourse banks and edges, widenening channels and altering stream beds. No matter where a road/track is built, it must intersect a drainage basin, and where this occurs, alteration of the local hydrology is inevitable (Tsunokawa and Hoban, 1997).

The potential impacts of the proposed wind farm development are outlined below for the construction, operation and decommissioning (as applicable) phases of the project. These are the potential impacts that could potentially occur in the absence of mitigation measures.

Under Section 173 of the Fisheries (Consolidation) Act, 1959, it is an offence to '*obstruct the passage of the smolts or fry of salmon, trout, or eels or injure or disturb the spawn or fry of salmon, trout or eels or injure or disturb any spawning bed, bank or shallow where the spawn or fry of salmon, trout or eels may be*'.

Under Section 3 of the Local Government (Water Pollution) Act, 1977 (as amended by Sections 3 and 24 of the 1990 Act) it is an offence to cause or permit any polluting matter to enter waters.

Section 171 of the Fisheries (Consolidation) Act 1959 creates the offence of throwing, emptying, permitting or causing to fall onto any waters deleterious matter. Deleterious matter is defined as any substance that is liable to injure fish; to damage their spawning grounds; or the food of any fish; or to injure fish in their value as human food; or to impair the usefulness of the bed and soil of any waters as spawning grounds or other capacity to produce the food of fish.

Under the European Community (Surface Water) Regulations, 2009, it is noted under Part III, Section 33 that '*Failure to achieve good ecological status, or where relevant, good ecological potential or to prevent deterioration in the status of a body of surface water resulting from new modifications or alterations to the physical characteristics of a surface water body, or failure to prevent deterioration of a body of surface water from high status to good status resulting from new sustainable human development activities shall not be a breach of these Regulations when all the following conditions are met:*

(1) All practicable steps are taken to mitigate the adverse impact on the status of the body of surface water.

(2) The reasons for those modifications or alterations are specifically set out and explained in the river basin management plan required under Article 13 of the 2003 Regulations and the objectives are reviewed every six years.

(3) The reasons for those modifications or alterations are of overriding public interest and/or the benefits to the environment and to society of achieving the objectives established by Article 28 of these Regulations are outweighed by the benefits of the new modifications or alterations to human health, to the maintenance of human safety or to sustainable development, and

(4) The beneficial objectives served by these modifications or alterations of the water body cannot for reasons of technical feasibility or disproportionate cost be achieved by other means, which are a significantly better environmental option'.

It is therefore imperative that no significant impacts (direct, indirect or cumulative) occur on the streams on the site or the downstream catchment areas during the construction, operation of decommissioning phases of the proposed wind farm project.

1.4.1 Potential Impacts during Construction

1.4.1.1 Location of proposed development in relation to surface water features

All the rivers and streams which drain the various components of the proposed development are potential receiving water for pollutants arising from construction operations associated with the proposed development. Figures 6.1 and 6.2 show the water features in the study area - these watercourses potentially affected by the proposed development at crossing points and where works take place in close proximity in particular. The individual components of the proposed Maighne Wind Farm are discussed below under the Boyne and the Barrow catchments. The proposed MV cable route which traverses the Boyne and the Barrow catchments is also discussed. It is noted that a proposed external access track follows the same route as the cable.

1.4.1.1.1 Boyne catchment

1.4.1.1.1.1 Drehid-Hortland

The Blackwater (Longwood) River and a number of its tributaries (Mulgeeth River, Ballynamullagh River, Coolree River) drain the Drehid-Hortland component of the proposed development. There are a number of proposed turbines located near watercourses at this site. Turbines 16 and 22 are located approximately 120m from the Ballynamullagh River while turbine 17 is a similar distance from the Coolree River. Proposed access tracks would cross the Ballynamullagh River at four locations and there one be one crossing of a 1st order tributary of the Ballynamullagh River.

An access track to turbine 48 would run alongside a 1st order tributary of the Ballynamullagh River for a distance of ca. 120m. An access track to the south of turbine would run adjacent to the Blackwater (Longwood) River over a distance of 550m and this track would also cross this watercourse at two locations as well as the Mulgeeth River and Coologmartin Stream. There is a proposed site compound located approximately 30m from the headwaters of the Ballynamullagh River.

Within the Drehid-Hortland section of the proposed Maighne wind farm, the MV cable would cross the Blackwater (Longwood) River, the Mulgeeth River (twice), the Coologmartin Stream, the Ballynamullagh River, the Coolree River and the Knockcor Stream.

1.4.1.1.1.2 Ballynakill

The proposed development at Ballynakill is drained by the River Boyne main channel to the north, the Boolykeagh River and the Glash River to the west. Within this part of the development, turbine 4 is located ca. 80m to the east of the 1st order reach of the Boolykeagh River while turbine 3 is located ca. 60m to the south of a 1st order tributary of the Boolykeagh River. Turbine 1 would be located ca. 60m from the Boolykeagh River which flows into the River Boyne less than 1km upstream of the cSAC. An access track would run alongside the Boolykeagh River between turbine 3 and 4 over a distance of ca. 270m and a borrow pit is proposed ca. 50 from this watercourse.

1.4.1.1.1.3 Windmill

The Windmill portion of the proposed development is located in the Glash River sub-catchment where the development lands are drained by the 2nd order Balrinnet River and the Glash Stream. The nearest component of the proposed development to a surface watercourse in this part of the site is the MV cable, where there would be a single crossing of the Glash Stream. There are three proposed turbines in this part of the wind farm site and none of these turbines are located within 500m of a watercourse. The MV cable would cross the upper reaches of the Knockcor Stream and the Clonuff River to the east of the Windmill site where it links the Drehid-Hortland and Ballynakill components of the wind farm.

1.4.1.1.2 Barrow catchment

1.4.1.1.2.1 Cloncumber

The Cloncumber component of the proposed development is located in close proximity to the Slate and Cloncumber Rivers. There would be one crossing of the Slate River where an access track is proposed between turbines 30 and 31 and a single crossing of the Cloncumber Stream between turbines 33 and 34. Proposed turbines 29 and 30 would be located ca. 90m and 95m from the Slate River. There are 5 borrow pits proposed within the Cloncumber site. One of these is located ca. 200m to the south-west of the Cloncumber Stream and another ca. 270m south east of the Slate River. The MV cable route from the Cloncumber site connects to the Derrybrennan site. It traverses the Slate River at Agar Bridge to the west of the Cloncumber site, the Drumsru Stream twice and a 1st order reach of the Lullymore River.

1.4.1.1.2.2 Derrybrennan

The Figile River (EPA code 14F01) drains the Derrybrennan component of the proposed development. The closest watercourse to this site is the Abbeylough River which is approximately 900m to the north. There would be one MV cable route crossing of the Abbeylough River, the Kileasin Stream, and the Figile River between the Derrybrennan and Drehid-Hortland components of the proposed development.

1.4.1.2 Potential Direct Impact

Access tracks will be built/upgraded to access proposed turbine locations where no access tracks currently exist. The proposed works will also include comprise trenching to facilitate the laying of cabling. Where these cables need to cross watercourses there will be the potential direct impacts on the aquatic environment (disturbance and degradation of fluvial and riparian habitats). Where possible a trenchless crossing technique will be employed, using directional drilling techniques.

Alternative trenchless techniques are also being considered and these overground methods would have less significant potential direct impacts on watercourses (e.g. fixing of cables to bridges). The entire cable route is along existing roadways for example at Agar Bridge over the Slate River and the bride over the Coolree River.

There is potential for releases of suspended solids and other substances associated with upgrading, realigning and construction of access roads and trenching within the site and also during the excavation work associated with proposed borrow pits. Installation, upgrading and/or extension of an internal road network on a wind farm site and excavations can result in increased silt runoff. Suspended solids in even quite small quantities may have a serious effect on the spawning sites of salmonids (O'Connor & Andrew, 1998; Turnpenny & Williams, 1980; Shackle *et al*., 1999).

Engineering works in the vicinity of streams and at stream crossings can also impact directly on physical habitat, for example the spawning or nursery areas of fish. Permanent loss of aquatic habitats can also occur where access roads are constructed over or in close proximity to streams/rivers or where streams/rivers are permanently diverted to new channels. Obstruction to upstream movement of fish, particularly salmon and trout, due to construction of culverts can also potentially occur.

'Improved' drainage of the site can potentially result in increased erosion of nearby streams, and may result in lower water levels in dry weather, which will reduce the habitat available to fish. Any operations which result in loss of sediment will also result in increased nutrients being released from the soil. This has the potential to cause eutrophication of streams thereby lowering the capacity of the streams to support fish and invertebrate fauna. The construction of the wind farm is not expected to significantly affect the drainage regime on the site, with direct impacts affecting watercourses and aquatic ecology minimised via the protection of water quality within the site.

1.4.1.3 Potential Indirect Impacts

The most likely potential impact during the construction phase of the Drehid-Hortland, Ballynakill, Windmill, Cloncumber and Derrybrennan wind energy developments on receiving watercourses and aquatic habitats arises indirectly via impacts affecting water quality, such as accidental releases of silt laden runoff. Other potential impacts affecting aquatic ecology during the construction phase could also occur as a result of accidental spillage of cement or hydrocarbons stored on site impacting upon water quality. Waste from on-site toilets and wash facilities could also potentially impact on aquatic ecology.

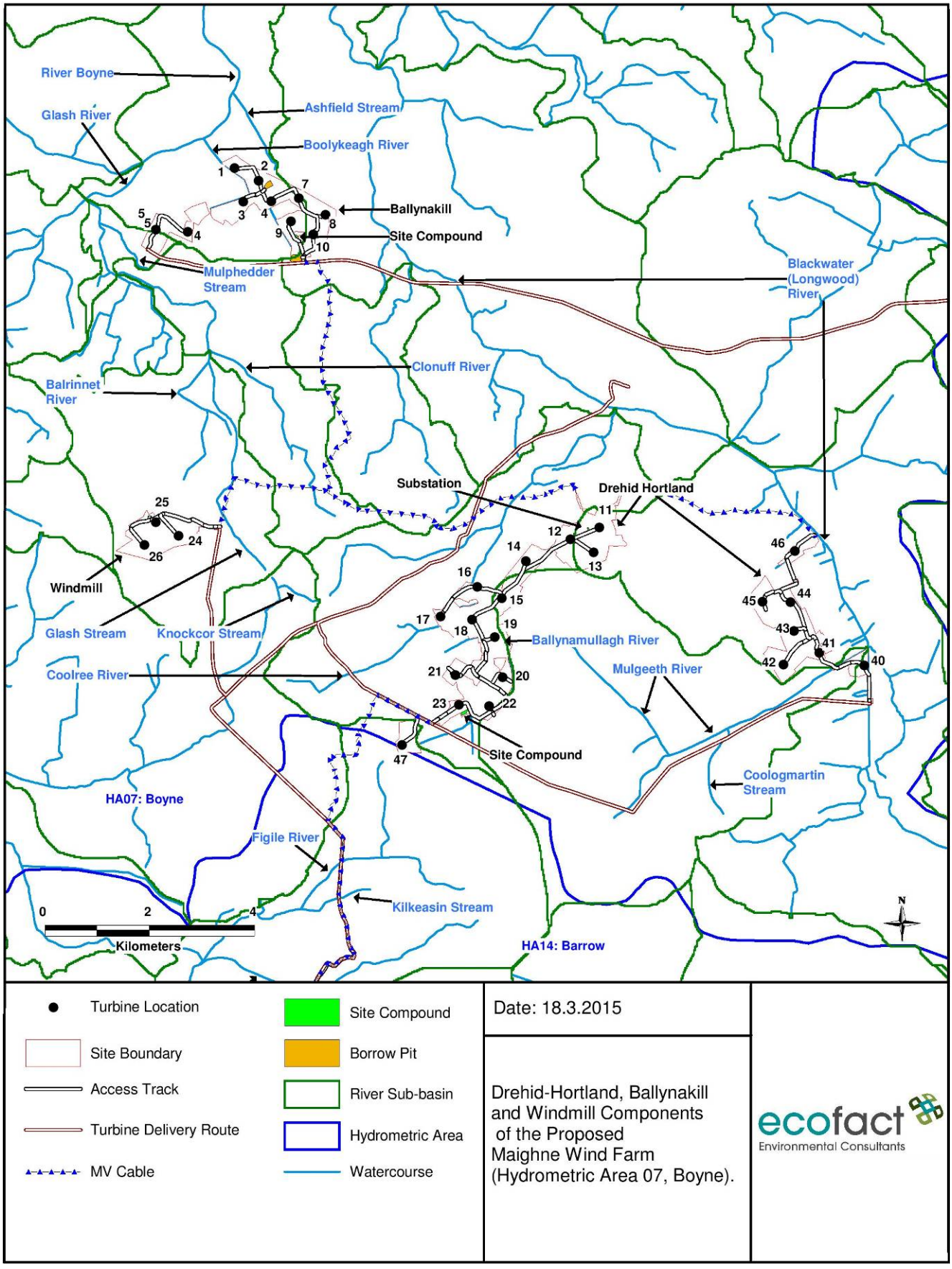

Figure 6: Drehid-Hortland, Ballynakill and Windmill components of the proposed Maighne Wind Farm (Hydrometric Area 14, Barrow)

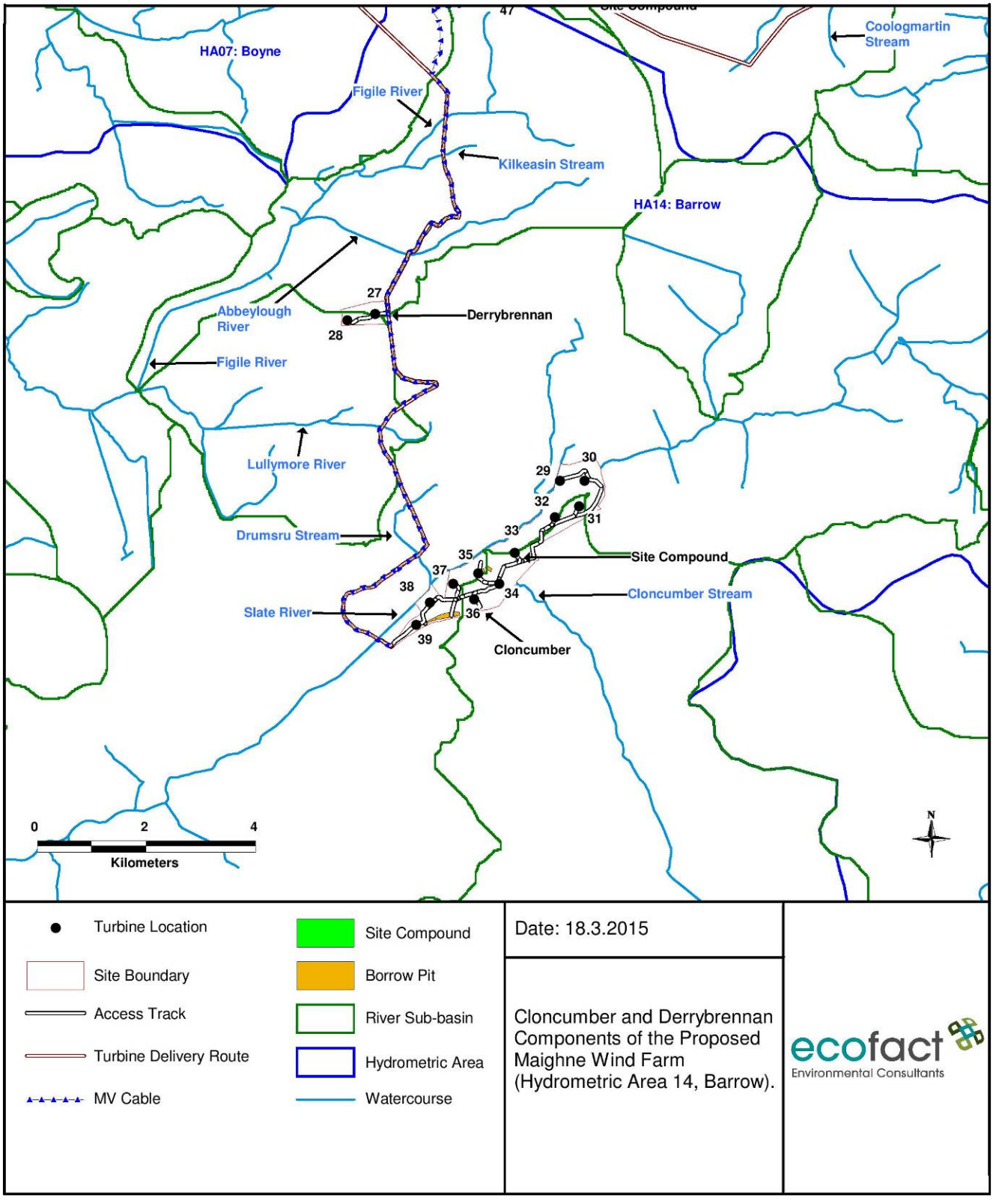

Figure 7: Cloncumber and Derrybrennan components of the proposed Maighne Wind Farm (Hydrometric Area 14, Barrow).

Indirect water quality impacts can potentially occur during trenching work. This would involve machines digging linear trenches and would result in excavated material being accumulated. This material could be a source of contaminated runoff particularly if it were to be stockpiled near a sensitive watercourse during a period of wet weather. The trenching works could also generate a significant amount of waste material which is not suitable for backfilling and this would be a risk to adjoining watercourses if not stored and disposed of appropriately. Trenches can also become flooded (i.e. during a high rainfall event) and if this water was pumped into an adjoining sensitive watercourse then significant water quality impacts could be realised. The proposed wind farm development poses a potential risk to watercourses in terms of alteration of drainage regimes, silt run-off and pollution events originating from site works which gives rise to the potential for impacts affecting fish and fisheries, as well as aquatic invertebrate communities within the study area.

Any engineering works which cause runoff of sediments can also increase the levels of nutrients in receiving streams. This can result in the enrichment or eutrophication of the affected streams and catchment areas further downstream, and a possible change in overall water quality status. Suspended solids or sediment in a river is also a major concern and can have serious negative impacts on aquatic invertebrate and instream flora. Aquatic species listed on Annex II of the EU Habitats Directive (1992) within the study area include the Atlantic salmon and the white-clawed crayfish. Potential impacts affecting these species could occur as a result of water quality impacts arising through accidental pollution events including the increased erosion which may give rise to elevated suspended solids and siltation effects.

There is a risk that machinery or materials imported onto the site could act as a vector for introducing or dispersing non-native invasive species.

1.4.1.4 Potential Cumulative Impacts

The area of the proposed site is subject to additional pressures on water quality and aquatic ecology, particularly in relation to agricultural activities. Where wind farm construction and agricultural activities occur at the same time there is the potential for significant in-combination or cumulative impacts on local watercourses. The risk of such impacts would, for example, greatly increase if such works were taking place during the winter months or times of very high rainfall.

Within the River Boyne catchment, other cumulative impacts could occur in relation to the construction of the proposed Emlagh wind farm. A component of this wind farm is located within the Moynalty River within the Boyne catchment. Impacts arising from this development correspond to those outlined above for the current proposal. The proposed development is also located in an area where huge quantities of peat are extracted from the Bog of Allen annually. Peat extraction and associated operations have the potential or adversely affect water quality in the Slate, Figile and Blackwater (Longwood) Rivers.

1.4.2 Potential Impacts during Operation

Operational wind farms are not normally considered to have the potential to significantly impact on the aquatic environment. The main risk to watercourses is when oils and lubricants are used on the site. If such substances leaked from the turbines or maintenance areas or were disposed of inappropriately, there is a risk of water pollution. However, the likelihood of this occurring is very low and the potential significance of this impact can be mitigated through proper management. Spills of any oil or fuels from site vehicles onto the access roads may find its way to the local stream network. However, this is unlikely to be a significant impact considering the low numbers of vehicles involved and the high quality standards that are implemented on a well managed site.

Upgrading of the site track/road network could allow increased public access to the site. This could potentially result in illegal dumping of domestic rubbish or possibly facilitate access of poachers to fish spawning areas. Provision of access to off road vehicles (including quad bikes) is also a potential impact. Such vehicles can cause direct damage to streams, particularly in the headwaters of catchments and indirect effects on aquatic sites such as erosion of soils.

1.4.3 Potential Impacts during Decommissioning

The decommissioning phase of the proposed wind farm site gives rise to similar potential impacts as can be realised during the construction phase; although the magnitude of the impact of decommissioning is normally reduced as all infrastructure is already in place on the site. With suitable planning and provision of adequate mitigation potential impacts on the receiving aquatic environment during decommissioning can be minimised.

1.5 Mitigation Measures

1.5.1 Construction

In advance of any works taking place, a method statement for protecting watercourses and waterbodies on the site, along with a Surface Water Management Plan will be drawn up and agreed with the IFI and NPWS. An outline Construction Environmental Management Plan (CEMP) has been prepared and is included in the Environmental Impact Statement. The Construction Method Statement will be distributed and discussed with all parties involved in the construction of the wind farm site (including any sub-contractors) in order to protect aquatic conservation interests within the study area. The Surface Water Management Plan will set out measures to avoid siltation, erosion, surface water run-off and accidental pollution events which all have the potential to adversely affect water quality within the site during the construction phase.

The Surface Water Management Plan and detailed method statement will include preparatory works on the site, including installation of silt fences and bunds. The preparatory work including assessment of existing bridge crossings will be undertaken in advance of any excavations on the site. A sealed silt fence will be placed at both sides of the crossing points and to a minimum of 10m upstream and downstream of each crossing at both sides of the road. All measures provided for the protection of aquatic ecology and fisheries within the proposed development site, in addition to the mitigation measures for water quality protection to be detailed in the Surface Water Management Plan, will effectively protect aquatic ecological interests downstream of the proposed development.

All access tracks will be designed to minimise excavation on the site and reduce the risk of sediment runoff. Swales for turbine bases and hard standings will be constructed. It is not expected that overland flows will be obstructed to any great extent as a result of the layout of the wind farm, however where required, interceptor channels will collect overland flows on the upslope side of the access tracks and hard standing areas. The interceptor channels will cross the access tracks in cross-drains which will be provided at regular intervals

A buffer of 50 m from watercourses has been adopted. Where site tracks are existing rather than a new site track, this buffer will not apply.

All infrastructure should set back 50 m away from all streams within the site except for the main crossing The contractor should also ensure that trafficking on site is kept to a minimum and the routes of haul roads are kept away from watercourses as far as possible. Where haul roads pass close to watercourses, silt fencing will be used to protect the streams. Again, maintenance and monitoring of such silt fences will be subject to an on-site quality management system set out in the CEMP.

Cross-drains will be provided for drainage crossings and conveying flows from existing and proposed drains across the access tracks. Any new or upgraded culverts will be sized appropriately. A method statement for streams crossings (roads and cables) will be agreed in advance with NPWS and IFI and will follow the guidelines set out in (Murphy, 2004) and the NRA (2008) '*Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*' and also the latest IFI guidelines. In relation to cable crossing, directional drilling will be used when other alternatives (i.e. placing cables on bridges) are not practical. There are two options available:

1. Horizontal Directional Drilling is a method of installing underground pipes and cables whereby a surface-launched drilling rig would be used to drill in an underground arc beneath the watercourse, with minimal impact on the surrounding area.
2. An alternative option would involve digging two pits, an entrance pit and a receiving pit, on either side of the watercourse. The two pits would then be connected by ducts underground, installed either by a drilling or pipe ramming method, without disturbing the watercourse above.

The optimal construction technique will be selected on the basis of detailed site investigation at the crossing locations and following consultation with Meath County Council and statutory authorities including Inland Fisheries Ireland."

The contractor shall ensure that erosion control and attenuation facilities, namely silt fences and silt curtains are regularly maintained during the construction phase. Spoil heaps from the excavations for the turbine bases and trenches (if cables are to be buried) will be covered with geotextile and surrounded by silt fences to filter sediment from the surface water run-off from excavated material. Berms will be covered with a geo-textile matting to avoid sediment runoff; berms will be surrounded by silt fencing until vegetation has been established in the following growing season. If cables will be installed in trenches, the will be located underneath and directly adjacent to access tracks as far as possible. Trenches will be excavated during dry periods where possible in short sections and left open for minimal periods to avoid acting as a conduit for surface water flows. Clay bunds will be constructed within any cable trenches at intervals.

An Emergency Erosion and Silt Control Response Plan will be included as a contingency in the Surface Water Management Plan which will detail the required measures for the Contractor to implement in the event of a 'worst case' scenario on the site. Timing of the proposed works will also take account of the fisheries constraints within the study area, where no works will be undertaken in the instream environment during the salmonid close season.

A risk assessment will be prepared prior to any wet concrete operations being carried out. This will be agreed with NPWS and the IFI authorities in advance of works taking place and will require specific mitigation and water quality protection measures at a micro-site level. All concreting works will be fully detailed in the Contractor's Construction Method Statement and will be minimised, particularly adjacent to the aquatic environment.

Standing water in the excavations at the turbine bases will contain an increased concentration of suspended solids. The excavations will be pumped into temporary settlement basins as necessary which will be lined and which will drain into existing or proposed drainage channels on site. The settlement basins will be constructed in advance of any excavations for the turbine bases.

Wheel washing facilities will be provided at the site entrance draining to silt traps. Additional silt fencing will be kept on site for the ongoing maintenance of the structures provided. Portaloos will be used to provide toilet facilities for site personnel. Sanitary waste will be removed from site via a licensed waste disposal contractor and will not be discharged on site.

Any diesel or fuel oils stored on site will be bunded to 110 % of the capacity of the storage tank. Such facilities will not be located near any drain or watercourse. Design and installation of fuel tanks will be in accordance with best practice guidelines. Refuelling of plant during construction will be carried out at a number of dedicated refuelling station locations on site, typically at each compound or at least 100m from a watercourse using mobile bowsers. Drip trays and spill kits will be kept available on site. Only emergency breakdown maintenance will be carried out on site. Appropriate containment facilities will be provided to ensure that any spills from the vehicle are contained and removed off site.

Appropriate preventative measures will be detailed within the CEMP to ensure that non-native aquatic/riparian species are not introduced into the site. These measures should follow as relevant the manual '*The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads'* by NRA (2010).

The contractor will carry out visual examinations of watercourses receiving flows from the proposed development during the construction phase and regular water samples will be taken.

The provision of a detailed Surface Water Management Plan for the site will effectively result in the control of erosion and siltation on the site. This is considered to be the key mitigation measure for the protection of aquatic species located in downstream receiving waters. The works programme for the site will incorporate erosion and sediment control to be detailed in the Surface Water Management Plan including the installation of drainage and runoff controls before starting site clearance and earthworks; minimisation of the area of exposed ground; preventing runoff entering the site from adjacent ground; provision of appropriate control and containment measures on site; monitoring and maintenance of erosion and sediment controls throughout the project; and establishing vegetation as soon as practical on all areas where soil has been exposed.

The design of all silt and erosion control measures on the site including silt traps and siltation ponds, culverts and cross-drains will be based on the peak flood flows determined using the procedure set out in CIRIA (2006).

Due to fact that the proposed site is located within the catchment areas of important salmonid rivers, effective water runoff protection methods will be integrated into the Construction Environmental Management Plan (CEMP) and contractor's method statement. The Water Quality chapter of the EIS also provides run-off prevention measures that will be utilised in the preparation of a Surface Water Management Plan for the development. The implementation of the water quality protection measures will be incorporated into an Environmental Commitments audit checklist for the site.

There will no excavations in close proximity to watercourses / riparian habitats, no instream works will be undertaken during the salmonid close season (October–March annually) in order to protect spawning salmonids, incubating ova and emerging fry. Any upgraded bridges or culverts must be designed to be passable by fish. Details of any such crossings, and any crossing areas for cables, will need to be agreed in advance with IFI and NPWS.

1.5.2 Operation

The operational wind farm will have a negligible effect on aquatic ecological interests and fisheries, as there are no further potential impacts on surface water run-off or watercourses within the site. During the operation phase, oils will required for cooling the transformers giving rise to the potential for oil spills within the site. However, the transformers will be bunded to over 110 % of the volume of oil within them.

It is not envisaged that maintenance will involve any significant impacts on the hydrological regime of the area. Weekly inspections of the erosion and sediment control measures on site will be required during the construction period, followed by fortnightly inspections until the risk of erosion or siltation has declined following the successful establishment of vegetation during the operational phase.

Access to the site will be limited using a gate to prevent illegal dumping on the site, use off road vehicles etc.

1.5.3 Decommissioning

In the event of decommissioning of the proposed wind farm, activities will take place in a similar fashion to the construction phase. There will be disturbance to underlying soils and therefore a risk again of silt laden run-off entering the receiving watercourse. Mitigation measures for this phase will be agreed in advance with the relevant authorities (IFI and NPWS). The mitigation measures outlined above will be implemented for the protection of aquatic ecological interests during the decommissioning phase.

1.6 Residual Impacts

The proposed wind farm will have a Slight negative impact on aquatic ecology and fisheries during the construction phase in the local context in the absence of mitigation measures. However, this will be effectively reduced to an Imperceptible negative impact with the mitigation measures proposed; where the direct loss of riparian habitats due to the required crossings of watercourses within the site remain the most sensitive receptors. The limitation of indirect impacts arising from water quality pollution events such as siltation and run-off of suspended solids will significantly reduce the potential for impacts affecting aquatic ecological interests within the site.

Localised water quality impacts as a result of construction phase will be reduced by undertaking the most sensitive elements of the works outside the salmonid close season and protection of water quality following the implementation of the water management measures detailed in the Water Quality section of the EIS. With the mitigation measures proposed, residual impacts are evaluated to be limited to a local context and will not affect the conservation status of aquatic ecology receptors in the receiving waters.

It is important to note that the failure to implement the mitigation measures proposed for the minimisation of impacts affecting aquatic ecology and fisheries would negate the results of the impact assessment provided in the current assessment.

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Plates

Boyne catchment

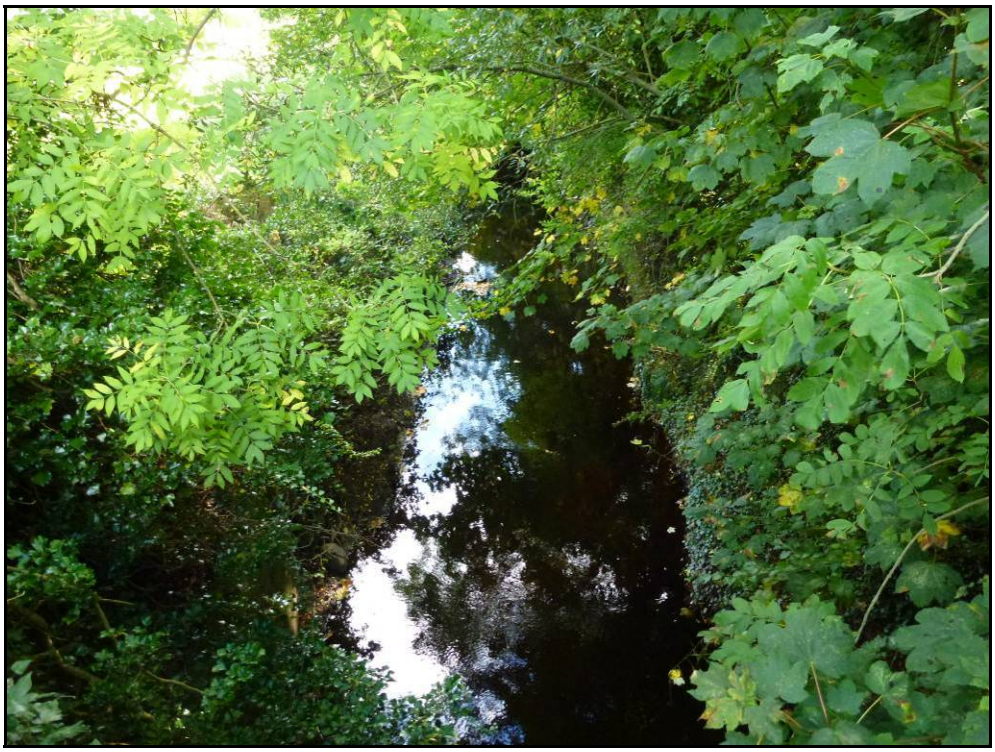

Plate 1: Site 1 was located on the Blackwater (Longwood) River approximately 1km downstream of New Bridge. This part of the Longwood River is a highly modified and sluggish watercourse. It drains the eastern extent of Drehid-Hortland component of the proposed development

Plate 2: The Blackwater (Longwood) River at Site 2. This watercourse drains the eastern extent of Drehid-Hortland component of the proposed development

Plate 3: Biological sampling on the Blackwater (Longwood) at Site 2.

Plate 4: Site 3 was located on the Mulgeeth River approximately 2km upstream of the Blackwater (Longwood) River. This 2nd order watercourse drains the southern extent of the proposed Drehid-Hortland component of the proposed development

Plate 5: Mulgeeth River at Timahoe Cross Roads. This 1st order watercourse drains the Timahoe component of the proposed development.

Plate 6: Site 4 was located on the Fear English River, a tributary of the Blackwater (Longwood) River. This 3rd order stream drains the northern component of the proposed Drehid-Hortland development.

Plate 7: Site 5 was located on the Coolree (Kilcooney) River at Art's Bridge. This site drains the eastern extent of the Drehid-Hortland component of the proposed development

Plate 8: The River Boyne at Ashfield Bridge (Site 6). This stretch of the river drains the Ballynakill component of the proposed development.

Barrow catchment

Plate 9: **The Slate River drains the Cloncumber component of the proposed development within the Barrow catchment. It is a channelised and highly modified river. Shown above is the stretch upstream of Agar Bridge at the western extent of the proposed Cloncumber component of the proposed development.**

Plate 10: **Site 7 was located on the Slate River on the northern boundary of the Cloncumber component of the proposed development. An external road is proposed to access the proposed development site from the north which would involve a crossing of this river.**

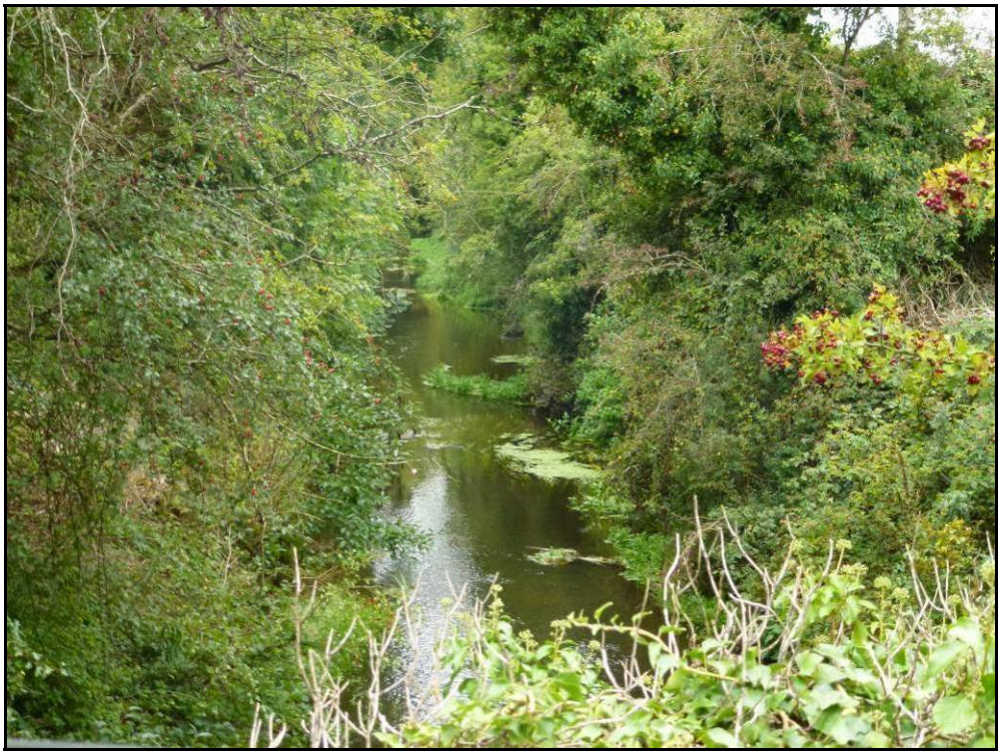

Plate 11: Site 8 was located on the Slate River at the upstream extent of the Cloncumber component of the proposed development.

Plate 12: Site 9 was located on the Figile River approximately 4km south of Edenderry. The Figile River drains the Derrybrennan component of the proposed development.

Plate 13: **Pike *Esox lucius* recorded during electrical fishing at Site 9 on the Figile River**

Plate 14: **European eel occurs in most watercourses draining the proposed development**

Plate 15: Duck/Swan mussel *Anodonta* sp. recorded during biological sampling at Site 9 on the Figile River

Plate 16: Larvae of the cased caddisfly *Phryganea* sp. was recorded in the Figile River during the current assessment (Site 9).

Plate 17: Site 10 was located on the Abbeylough River at the R403 Bridge. This part of the watercourse is approximately 2.5km north east of the Derrybrennan component of the proposed development.

Plate 18: Cloncumber Stream approximately 1km upstream of the Slate River (downstream view). The Cloncumber Stream flows through the proposed Cloncumber component of the proposed development to meet the Slate River where it forms the northern boundary of this proposed development site.

Plate 19: Cloncumber Stream approximately 1km upstream of the Slate River confluence (downstream view).

Plate 20: Otter recorded in the Slate River at Agar Bridge.