Energy for generations

Derrybrien Wind Farm Project

Gort Windfarms Ltd.

Remedial Environmental Impact Assessment Report

Chapter 8 - Aquatic Ecology & Fisheries

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8 Aquatic Ecology & Fisheries

8.1 Introduction

8.1.1 Chapter Scope

The Derrybrien Wind Farm Project (the Project) is located in the northern part of the Slieve Aughty Mountains in County Galway, approximately 11 km due south of Loughrea, 13 km northeast of Gort and 24 km west of Portumna.

The Project comprises seventy (70) Vestas V52-850 kW wind turbines and substation, a grid connection comprising an overhead line (OHL) (approximately 7.8 km long) and Agannygal Substation connecting the wind farm to the National Grid and all associated works.

This chapter considers the likely significant effects of the Project on the ecology of the receiving waters draining from the Derrybrien Wind Farm, the OHL grid connection and Agannygal Substation. All aspects of the Project have been assessed including the construction, operation and end-of-life decommissioning phases and all related works. During the construction of the wind farm, in October 2003, a section of ground toward the mid-southern side of the site suffered a failure which resulted in a peat slide; that event and associated works is also covered in detail as part of this assessment.

Figures are presented in A4 format as they are referenced within the chapter. Where necessary for clarity these are reproduced at A3 in Appendix 8-7.

8.1.2 Statement of Authority

The chapter was prepared by Gerard Morgan a graduate of University College Cork with an honours BSc in Zoology and MSc. in freshwater ecology. Ger has managed the Aquatic Services Unit, a UCC-based environmental consultancy specialising in aquatic systems, since 1986. He has over 30 years' experience in ecological consultancy, specialising in water quality impacts of a wide range of infrastructural projects including roads, bridges, pipelines, wind farms, power transmission and port & harbour facilities. He also specialises in protected species surveys, including fish and pearl mussels. He is a specialist in algal surveys and identifications in rivers and lakes and is recognised by the Environmental Protection Agency (EPA) as a practitioner of the Q-value biotic index system. His clients include the EPA, Teagasc, Cork County Council, Port Authorities and several large environmental and engineering consultancies and industry. Recent projects include water quality monitoring of the construction phase of the Grousemount Wind Farm in Co. Kerry, aquatic ecological chapters for EIARs for expansions to Dublin Port, Ringaskiddy Port and Foynes Port, numerous Q-value and SSRS[1] surveys, electrofishing surveys and pearl mussel surveys, nationwide macro-algal surveys in rivers for the EPA and phytoplankton identification of lake and reservoir samples for local authorities.

[1] SSRS = Small Stream Risk Score, developed by the EPA to assess water quality risk in head-water streams.

8.1.3 Methodology

8.1.3.1 Overview of Methods for the Aquatic Study

The current assessment relies on a combination of a desktop review of available data sources, consultation and field surveys. The data collected was used to inform a description of the baseline conditions between 1998 - 2001. These data were important as they set the benchmark against which all future changes had to be assessed. However, they were quite limited, although what was available has proven crucial. The data in question consisted almost exclusively of what the EPA had available to it in relation to biological water quality monitoring for the principal river catchments within the drainage area of the wind farm, as well as a limited amount of water chemistry data for Lough Cutra and the lower reaches of the Owendalulleegh River at the time. Water chemistry data collected on a monthly basis since 2007 to the present day, from a site in the lower reaches of the Owendalulleegh River has been important in assessing the water chemistry of the main river since then. At the time of the October 2003 peat slide and for a number of months after it, Galway County Council undertook focused water chemistry testing, looking mainly at, turbidity, colour and pH, at sites along the Owendalulleegh from the site of the peat failure through the outflow river from Lough Cutra (Beagh/Cannahowna/Gort River) as far as Gort and at several sites farther downstream, to assess the potential impacts of the slide on the potable water supply source for Gort. These data have been used to explain the dynamics of the peat slide at the time from a water chemistry standpoint. There was also fish survey data for the lower Owendalulleegh River undertaken by Inland Fisheries Ireland (IFI) in 2009, 2013 and 2016 which was important, in assessing the recovery of the fish population after the peat slide. Other than these main sources of baseline information there was very little available except for occasional qualitative point data for the study area. A feature of the data pool available was the severe paucity of biological water quality (i.e. Q-value), water chemistry and fisheries data for the extensive network of smaller tributaries draining the wind farm site, the OHL corridor and the Agannygal Substation. Accordingly, between 2011 and 2020, several field-surveys were undertaken to fill in these information gaps and to gauge how these subcatchments were responding to ongoing catchment land-use activity within the study area, both inside and outside the immediate project area. The fact that these surveys were conducted across a fairly broad range of weather conditions / flow levels allowed judgements to be made as to how these factors influenced the response of watercourses. These combined data sets helped to inform the assessment of (i) the construction phase, (ii) the peat slide, (iii) the operation phase; past and current and projected, and (iv) the decommissioning phase. In addition to the above, the study has also relied on an examination of aerial imagery available from the Ordinance Survey of Ireland (OSI) from 1995, 2000 and 2005 which allowed high level judgements to be made on forestry clear-felling in the study area and to ground-truth these against mapped forestry management data supplied by Coillte for the same catchments. Google Earth imagery was used to compliment this also.

8.1.3.2 Desk Study

Data sources accessed for the desktop review included the following:

(i) IFI Water Framework Directive Fish Survey Reports on the Water Framework Directive (WFD) Fish web site

(ii) EPA Online Mapping of recent and historical macroinvertebrate Q-value results for each of the main rivers draining the study area. These data go back to the mid-1990's and are the most comprehensive record of the ecological condition of the surface waters in the study area that is available.

(iii) EPA Online Mapping for WFD Status and constituent components for Lough Cutra.

(iv) Geological maps for the study area on the Geological Survey Ireland (GSI) website.

(v) Water chemistry data (2007-2018) for the Owendalulleegh River provided on request by the EPA.

(vi) One-off water chemistry data for November 2003 for Lough Cutra provided by the EPA.

(vii) Other water chemistry data and ecological data provided on request by the EPA for Lough Cutra, some dating back to 2000.

(viii) Water chemistry data provided by Galway County Council for the period of the peat slide as part of their monitoring of the impacts on the Gort public water supply.

(ix) Galway Bay South East Catchment Assessment (2010-2015) (EPA, 2018)

(x) Historic and current maps, reports and data relating to the wind farm site and adjoining areas

(xi) Coillte Forestry Management Unit Maps for the Project study area

(xii) Relevant reports and papers in the scientific literature.

(xiii) Reports of surveys undertaken by the then Shannon Regional Fisheries Boards and consultants for ESBI at the time of the peat slide and a few years afterwards.

(xiv) Mapping of the Derrybrien Wind Farm layout before during and after construction and along the OHL and Agannygal Substation. Showing structures, tracks, and the drainage network, emergency remedial installation etc.

Limited consultation was undertaken with the EPA about the current and historical trophic status and ecological status of Lough Cutra. IFI (Shannon Region) were contacted about the fish kill on the Owendalulleegh River which followed the October 2003 peat slide and an officer of a local angling club was contacted in relation to current and historical fishing activity on Lough Cutra, as well as any recollections of the condition of the lake immediately after the 2003 peat slide.

8.1.3.3 Field Surveys

The following surveys were undertaken as part of the Project -

(i) Macroinvertebrate Q-value surveys in 2011, 2014, 2018, 2019 and 2020

(ii) Electrofishing surveys in 2011, 2014 and 2019

(iii) Water chemistry surveys in 2011, 2018 and 2019.

(iv) A benthic grab sampling survey in Lough Cutra, to characterise the nature of the bottom substrates in the lake and to assess the type of soft sediment benthic macroinvertebrates present (October 2019)

Macroinvertebrate Q-value Surveys

The Q-rating biotic index is used by the EPA on all river water monitoring programmes in Ireland and is based on interpreting collections of aquatic macroinvertebrates. The index assigns a score to the macroinvertebrates collected at a given site, depending on the relative proportion of pollution sensitive and pollution tolerant organisms present. The greater the number and diversity of pollution sensitive types present (particularly, certain mayflies, stoneflies and cased caddis flies), the higher the score or quality class assigned to a given site. The highest score category is Q5, which indicates pristine water quality conditions and is recognised by having a high proportion of pollution sensitive species and very few if any pollution tolerant forms. Q1 at the other end of the scale indicates gross pollution. Table 8.1 lists the Q-value scores, which can be assigned, and the corresponding degree of pollution associated with each.

This system, used in Ireland since the early 1970's, has been inter-calibrated with comparable European systems and now forms one of the cornerstones of Ecological Status classification under the WFD in Ireland. Table 8.1 also includes the corresponding WFD Status for each Q-rating category.

A total of 37 sites: 2011 (11), 2014 (6), 2018 (7), 2019 (26) and 2020 (1) were surveyed for Q-value assessment within the project drainage area and some small adjoining watercourses. Figure 8.1 includes all these sites along with a few where water samples were also collected. Several sites were surveyed in more than one year. They were distributed along the main channel of the Owendalulleegh and Boleyneendorrish rivers, as well as on the smaller streams in these catchments draining the wind farm site or lands immediately adjoining the wind farm site. Two sites were also surveyed in the Duniry catchment to which a tiny portion of the footprint of the wind farm drains to the east. Finally, two sites were surveyed on two small streams draining the OHL corridor and the Agannygal Substation, one that eventually joins the main channel of the Owendalulleegh and the other which flows into the northern shore of Lough Atorick to the south of the study area. The strategy underlying the choice of sites was to cover all the smaller and larger streams draining the wind farm, the Agannygal Substation and the OHL. At each survey site a three-minute moving kick-sample and one-two minute stone washing was taken in riffle-type habitat with a long-handled pond net (1 mm mesh). The material collected was sieved through a 500µm sieve to remove fines and either examined on the bankside in a white tray (2014, 2018, 2019 and 2020) or preserved on site with 70% alcohol and brought back to the laboratory for faunal extraction, enumeration and identification (2011). Relative abundance categories were assigned using

PLACEHOLDER FOR 8.1

Figure 8.1 Locations of ASU,EPA & IFI sampling points

the EPA method (Toner *et al.,* 2005) as follows: Few 1-5, common 6-20, numerous 21-50, dominant 51-75, excessive >75%. Q-values were then assigned based on these findings. In cases where a sample couldn't be definitively placed into one of two adjacent ratings an intermediate position was chosen instead.

Table 8.1 EPA Q-ratings and corresponding pollution status and WFD Status

Q-rating	EPA Pollution Status	WFD Status
Q5, Q4-5	Unpolluted	High
Q4	Unpolluted	Good
Q3-4	Slightly Polluted	Moderate
Q3, Q2-3	Moderately Polluted	Poor
Q2, Q1-2, Q1	Strongly Polluted	Bad

Electrofishing Surveys

Electrofishing surveys were carried out at a total of 19 sites as follows: 2011 (12), 2014 (6), 2019 (11). Several sites were visited on more than one occasion across the three survey years. Survey sites were situated mainly on tributary streams draining the wind farm site in the two main river catchments (Owendalulleegh and Boleyneendorrish) but also at a number of main channel sites in both catchments and at a site in the upper reaches of the Duniry catchment (2011) - see Figure 8.1. The choice of survey site was prompted by a number of considerations. These included the need to assess the smaller tributaries, in particular, given that the 2003 peat slide most profoundly affected a small tributary, and in the absence of pre-slide fish records it was important to get an understanding of the significance of these small streams to the overall fish population within each catchment. It was also considered prudent to survey a number of main channel sites, both upstream and downstream of the stretch on the Owendalulleegh impacted by the peat slide, in order to assess the current fish populations in both the affected and unaffected stretches and to gauge the likely importance of the unaffected stretch with regard to the recovery of the population in the impacted stretch after the slide. Finally, because IFI's fishing surveys over the past decade have been in the lower reaches of the Owendalulleegh River it was considered important to sample at least one site within this area to compare the fish densities and age structures derived from the current surveys with those obtained by IFI. A single main channel site was surveyed also on the Boleyneendorrish River.

On receipt of the necessary permits from IFI via the Department of Agriculture Fisheries and Food (DAFF) and following implementation of the specified biosecurity protocols, electrofishing was undertaken using a quantitative 3-pass depletion method at all of the surveyed sites. This entails securing stop nets upstream and downstream of a defined length of stream channel (usually a minimum of 30m) in order to prevent fish from upstream or downstream of the stretch entering during the survey and to prevent fish within the stretch from escaping. The stretch is fished three times in succession with the fish from each session being identified, measured (length) and counted and then placed into a large holding and recovery bin filled with well oxygenated water. When all three passes are completed and the fish from the final pass have been counted and measured, the nets are removed and all the fish returned live to the stream. The electrofishing equipment used in the 2011 survey was a bankside generator system connected by a long cable to the operator while the 2014 and 2019 surveys employed a back-pack petrol generator system operated at a voltage of 400-750 volts (giving an output of ~200volts) at low ampage.

Water Chemistry

Water chemistry surveys were undertaken at 27 sites, all bar 3 also sampled for Q-values, 2011 (11), 2018 (7) and 2019 (15) – Figure 8.1. They were mainly situated on tributaries rather than on the main channels. Chemistry data was required in order to characterise the nature of the conservative parameters i.e. pH, conductivity, alkalinity, anions and cations etc., i.e. those that would be influenced by the nature of the overburden as well as the underlying geology in the various subcatchments. In addition, the nutrient content was assessed to see if these data could help explain some of the water quality findings derived from the Q-value surveys.

Samples were collected using HDPE litre bottles with conductivity and pH measured using calibrated WTW portable meters. Samples were placed in a cooler pack with ice-packs in the field and delivered within hours of collection to the Aquatic Services Unit (ASU) [2] laboratory where they were either immediately processed or, more usually, retained in a fridge overnight at 4°C until analysis could start the following morning. The methods used to undertake chemical analysis are listed in Table 8.2.

[2] The ASU lab has been on the EPA list of approved laboratories for all 28 parameters it includes in its laboratory intercalibration scheme every year since 2010. This list includes all except one of the parameters analysed for this assessment

Table 8.2 Methods for the present study's chemical analyses in 2011, 2018 and 2019

Parameter	Units	Method
pH		WTW pH330i pH meter
Conductivity	µS/cm @ 25°C	WTW LF330 Conductivity meter @ 25°C
Dissolved Oxygen	mg/l, O_2	WTW portable meter (Oxi 320)
Suspended solids	mg/l	Gravimetric after filtration (GF/C) & drying 103-105°C
Alkalinity	mg/l $CaCO_3$	Gran Titration
Colour	Hazen Units	Colorimetric method (read at 455nm) using platinum/cobalt solution as colour standard
Dissolved Total Organic Carbon	mg/ l C	SHIMADZU TOC-VCPH TOC analyser
Soluble Reactive Phosphorus	mg/l P	Automated Molybdate method using Lachat™ Quikchem FIA
Total Phosphorus	mg/l P	Manual molybdate method after sample digestion
Ammonia	mg/l N	Automated salicylate method using Lachat™ Quikchem FIA
Total Oxidised Nitrogen	mg/l N	Automated colourimetric method using Lachat™ Quikchem FIA after cadmium reduction
Potassium	mg/l K^+	Flame AAS method
Sodium	mg/l Na^+	Flame AAS method
Calcium	mg/l Ca^{2+}	Flame AAS method
Total Aluminium	µg/l Al	Graphite furnace AAS method
Monomeric Aluminium	µg/l Al	Graphite Furnace AAS method (after cation exchange resin separation)
Sulphate	mg/l SO_4^{2-}	Automated IC method using Lachat™ Quikchem IC
Chloride	mg/l Cl^-	Automated IC method using Lachat™ Quikchem IC
ANC	µeq/l	Calculation Alk µeq/l (Gran titration) + (5xDOC mg/l)

Grab Sampling for Sediments and Invertebrates on Lough Cutra

The survey entailed taking a single Van Veen grab sample (0.047m^2) of the bottom sediment at 11 sites from the lower reaches of the Owendalulleegh River to the outflow of the Beagh River (see Figure 8.2 for sample site locations). Grainsize analysis was carried out on oven-dried sediment samples from each site using the protocols described by Holme & McIntyre (1984). The pre-treated and dried sediment was passed through a series of nested brass test sieves with the aid of a mechanical shaker. The sieve meshes chosen were 4mm, 2mm, 1mm, 500µm, 250µm, 125µm and 63µm. The sediments were then divided into three fractions: % Gravel (>2mm), % Sand (<2.0mm >63µm) and % Silt-Clay (<63µm). Organic matter was estimated using the Loss on Ignition (LOI) method. One gram of untreated dried sediment was washed at 450˚C for 6 hours and organic matter was calculated as % sediment weight loss. Macroinvertebrates were extracted after sieving fresh samples through a 1mm sieve and preserved in 70% ethanol. They were identified using standard keys to the freshwater fauna of Britain and Ireland.

8.1.3.4 Impact Assessment Methodology

In undertaking the impact assessment for this chapter, the following guidelines were consulted, particularly for the evaluation of sensitive receptors and characterising the significance of potential impacts:

- Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2017)
- NRA Guidelines for the Assessment of Ecological Impacts of National Road Schemes – Version 1 (NRA, 2003) and Version 2 (NRA, 2009).

Table 8.3 Terminology used to describe Significance of Effects (from EPA, 2017)

Quality of Effects	Positive Effects
	Neutral Effects
	Negative/negative Effects
Describing the Significance of Effects	Imperceptible
	Not significant
	Slight Effects
	Moderate Effects
	Significant Effects
	Very Significant
	Profound
Describing the Extent and Context of Effects	Extent
	Context
Describing the Probability of Effects	Likely Effects
	Unlikely Effects
Describing the Duration and Frequency of Effects	Momentary Effects
	Brief Effects
	Temporary Effects
	Short-term Effects
	Medium Term Effects
	Long-term Effects
	Permanent Effects
	Reversible Effects
	Frequency of Effects

See Appendix 8-1 for definition of each term

PLACEHOLDER FOR 8.2

Figure 8.2 Lough Cutra Sediment Sampling Locations

8.1.4 Difficulties Encountered

The main difficulty encountered was the lack of baseline macroinvertebrate, fisheries or water chemistry data for any of the many small streams which drain the Project area. In addition, except for triennial EPA data on Q-values at several sites on the main channel of the Owendalulleegh, Boleyneendorrish and Duniry Rivers, which have proven crucial in the current assessment, there was also a lack of baseline data for these main channels into which the minor streams draining the wind farm and much of the OHL corridor flow. There is a similar paucity of baseline fisheries, ecological and water chemistry data for Lough Cutra, into which the Owendalulleegh flows as its main inlet river, in the years immediately prior to, during and immediately after the peat slide. Moreover, there were very limited follow-up fisheries, water chemistry or macroinvertebrate surveys carried out in the years immediately following the commissioning of the wind farm, especially given the occurrence of a very large peat slide during the construction. This has made it difficult to assess the speed of recovery of the ecological status and fish populations in some watercourses impacted by the 2003 peat slide.

During the original EISs for phase 1, 2, and 3 of the wind farm, water quality assessments of the nine small subcatchment streams draining the wind farm footprint were not carried out.

Despite these constraints it is considered that the data available, including the data collected during field surveys as part of the current study, is adequate to address this assessment.

8.2 Baseline Environment

8.2.1 River Catchments

The drainage from the 344.5 ha Derrybrien Wind Farm site flows to three river catchments (Table 8.4). The Boleyneendorrish draining the site to the north, the Owenaglanna flows east becoming the Duniry River eventually discharging into Lough Derg and the Owendalulleegh drains the southern part of the site and flows west south west into Lough Cutra 1.5 km downstream of Killafeen Bridge and all its flow, as well as that from smaller tributaries draining to the lake, outflow to the Beagh River at the northern end of the lake. A further 4.6 km downstream to the west, the Beagh drops underground in the Punch Bowl and emerges again 1 km west as the Cannahowna River which then flows north for 2 km to Gort. Thereafter, known as the Gort River, it flows north for a further 4.1 km, dropping underground at Pollatoophil at Castletown and emerges 1.1 km west north west near Kiltartan where it is joined by the combined flows of the Boleyneendorrish and Kilchreest Rivers which drain the northern slopes of the Slieve Aughty Mountains. These combined flows then continue west underground (under the M18 Motorway) for about 0.4 km emerging into the Coole River which flows due south to the Coole-Garryland wetland complex. Flows from here continue entirely underground until they emerge west north west in Galway Bay at Kinvarra. On its underground route to Kinvarra this combined flow is joined by a myriad of small underground flows from the surrounding limestone plain.

The 110kV OHL corridor drains mainly to the Owendalulleegh catchment but the lower 2.26 ha flow south to a small unnamed stream which eventually enters the north shore of Lough Atorick. Natural overland flow from Agannygal Substation at the southern end of the OHL corridor drains towards Lough Atorick. Lough Atorick is within one of the sub-basins of the Bleach River (35.2 km^2 in area) which flows on into Lough Graney which in turn flows into the lower portion of Lough Derg at Scarriff Co. Clare, part of the River Shannon catchment. The Graney River has a historic record of the freshwater pearl mussel (*Margaritifera margaritifera*) from the 1920's. However, that record was from the lower reaches of the river i.e. downstream of both Lough Graney and Lough Atorick and there have been no records since.

Table 8.4 Proportions of wind farm site, OHL Corridor & Agannygal Substation draining into receiving river catchments

(see Figure 8.3 for map of subcatchments draining the wind farm site)

River Catchment	**Area of Wind Farm draining to each River Catchment (ha)**	**Proportion of Wind Farm Site draining to each River Catchment**
Owendalulleegh River	228	66.2 %
Boleyneendorrish River	115.2	33.4 %
Duniry River	1.28	0.4 %
	Area of OHL Corridor and Agannygal Substation draining to each River Catchment (ha)	**Proportion of OHL Corridor and Agannygal Substation draining to each River Catchment**
Flaggy Br Tributary - SC7(a, b, c, d)	19.34	58.5%
Owendalulleegh main channel u/s SC7 confluence	2	6%
Unnamed stream to Owendalulleegh	9.47	28.6%
Unnamed stream to Lough Atorick/Bleach R.	2.26	6.8%

PLACE HOLDER for FIGURE 8.3

Figure 8.3 Subcatchments draining from wind farm site to major rivers

8.2.2 Hard Geology and Soils

The underlying hard geology within the study area is sedimentary including mudstone, siltstone and conglomerate of the Ayle River Formation and greywackes, siltstones and mudstones of the Derrynafadda Formation. In addition, along parts of the main downstream channel of the Owendalulleegh River, there are sections of Visean limestone. The overlying quaternary deposits comprise blanket peat in the uplands, till derived from Devonian sandstones and, close to the main downstream channel of the Owendalulleegh, alluvial deposits. The upland areas comprise blanket peat, which underlies all the forestry in the area, with acid brown earths/brown podzolics and peaty gleys acidic underlying most of the agricultural lands farther down the valleys in both the Boleyneendorrish and Owendalulleegh catchments.

8.2.3 Subcatchments and Landuse

The land use for the small and very small upper tributaries of the Owendalulleegh, Boleyneendorrish, Duniry and Lough Atorick/Bleach rivers that drain the footprint of the Project is almost exclusively a combination of commercial coniferous forest in various states of growth or re-growth and open blanket bog moorland which has not been afforested. Moving down the system, agricultural land begins to form part of the land use within the drainage areas, especially along the mid to lower reaches of the main channels of the Owendalulleegh and Boleyneendorrish rivers, but is absent from most of the small subcatchments draining the wind farm except SC8 and SC9 (see Figure 8.3) where it makes up a small part in the lower reaches. Virtually all of the land along the 7.8 km OHL route corridor between the wind farm site and the Agannygal Substation comprises coniferous plantation as does much of the drainage area between the Agannygal Substation and Lough Atorick to the south into which it eventually drains.

In addition to forestry, blanket bog within the study area contains extensive areas of cut-over bog where turbary is practiced. Within the wind farm site itself, about one third of the area, all on the eastern side, has been drained for turbary, and areas of turbary contribute to subcatchments to varying degrees, with only catchments SC4, SC7(b) and SC7(c) without turbary (see Figure 8.4). The degree to which these extensive areas are actually used for turf cutting, however, is likely to be very variable both spatially and temporally, which is borne out by examination of aerial photography that shows that active cutting tends to be concentrated in any one year in very small parts of otherwise very large areas of cut-over bog. For example the Google Earth image for 2018 shows evidence or active turf cutting (angular deep brown areas where the raw turf has been recently exposed) and clusters and lines of white bags, used to store the dried sods, in several parts of the turbary on the wind farm in SC7(a).

PLACE HOLDER for FIGURE 8.4

Figure 8.4 Subcatchments draining from wind farm site to major rivers showing cut over bog

Table 8.5 lists the area of each subcatchment draining the wind farm shown in Figure 8.3, its forestry cover in hectares and that cover as a percentage of the subcatchment area as it was at the beginning of construction just prior to 2000 and again in 2018. The areas included are those of Coillte's commercial forestry only. The proportion of private forestry is generally not more than 10% on average of the Coillte areas. As part of the construction phase of the wind farm 222 ha of forestry was felled within the wind farm boundary between 2003 and 2005. This area was split between the 3 main river catchments as follows: 66.2% in the Owendalulleegh River catchment, 33.4% in the Boleyneendorrish and just 0.4% in the Duniry River catchment. Table 8.6 further apportions the 222 ha of clearfell among each of the subcatchments draining the wind farm. The table also lists the various survey sites within each of these subcatchments. During the same period (2003-2005) approximately 35ha of forestry was also felled along the OHL corridor and Agannygal Substation.

What is immediately clear from the data is the very high percentage of forestry present within these subcatchments which has remained essentially the same in terms of area throughout the operation phase of the wind farm to date. While forestry management operations have remained at a minimum within the wind farm site itself, given that the area was not replanted post felling, a constant feature of subcatchments draining the wind farm is the regularity of commercial forest felling and replanting that takes place in those sections of the subcatchments beyond the wind farm perimeter. For example, between 2016 and 2018 a total of 257ha of forestry was earmarked for felling on Coillte land, more than the area felled when the wind farm project was being constructed. In the event, a lesser area of timber was actually felled but it shows that clearfelling is a consistent land use activity in lands adjoining the wind farm site. In 2018 for example approximately 81 ha were felled within the subcatchments draining the wind farm but outside its boundary. An examination of how the various watercourses respond to recent current felling events within these subcatchments will help to inform the assessment of the impacts at the time that the wind farm was constructed, wherever contemporary water quality data is not available. A notable feature of the commercial forestry felled in recent times is the fact that the compartments involved are fully mature or nearly so, whereas, a substantial portion of the forestry felled on the wind farm site between 2003 and 2005 was immature. This latter growth would have required lighter machinery to fell.

Table 8.5 Amount of forestry in subcatchments draining the wind farm in 2000 and 2018

Subcatchment Number	Subcatchment area (ha)	Coillte forested area in 2000 (ha)	Coillte forested area in 2018 (ha)	Coillte forestry as % of total area (2000)	Coillte forestry as % of total area (2018)
SC1	643.8	571.6	546.8	88.8	84.9
SC2	316.6	165.5	114.5	52.3	36.2
SC3	95.9	94.1	72.6	98.1	75.7
SC4	173.7	160.3	150.3	92.3	86.5
SC5	221.7	184.1	183.0	83.1	82.5
SC6	513.7	272.7	273.9	53.1	53.3
SC7(a)	586.8	373.1	340.9	63.6	65.3
SC7(b)	302.0	243.7	223.1	80.7	61.5
SC7(c)	354.7	252.0	173.5	71.0	48.9
SC7(d)	61.8	27.5	27.2	44.4	44.6
SC8	280.9	63.0	58.0	22.4	20.6
SC9	648.1	394.7	390.4	60.9	60.2

Table 8.6 Area (ha) of forestry felled on wind farm site during construction phase apportioned to each subcatchment of the study site.

Subcatchment Number	Area felled in wind farm in 2003-2005, apportioned to each subcatchment (ha)	Felled area as a % of subcatchment area	Survey sites within each subcatchment
SC1	18.4	2.9	B4, B4A, B4B, B4C
SC2	36.2	11.4	B2, B2A
SC3	20.1	20.9	B1A
SC4	8.8	5.1	B1B
SC5	1.3	0.6	D1, D1A
SC6	1.9	0.4	O1, O2
SC7(a)	33.8	5.8	O3, O3A
SC7(b)	17.8	5.9	O4, O4A, O4B, O5
SC7(c)	74.7	21.1	O5A
SC7(d)	0	0	O6, O6A
SC8	4.4	1.6	O8A
SC9	4.6	0.7	O9A, O9A1, O9A2

8.2.4 Biological Water Quality

8.2.4.1 EPA Monitoring

The EPA has biological monitoring sites assessing invertebrate Q-values on each of the three rivers draining from the wind farm and also monitors water chemistry at one of these sites on the Owendalulleegh. See Figure 8.1 for the locations of these sites and Table 8.7 for the full EPA codes corresponding to the abbreviated ones used on the map. With one exception each of the EPA sites is located on the main channel of the rivers, each several kilometres downstream of the wind farm location at points below where most of the minor streams flowing from the boundary of the wind farm join the main channels. On the Owendalulleegh there are five EPA Q-value monitoring sites, the first about 7 km downstream from the wind farm boundary and 5 km downstream from the base of the 2003 peat slide (EPA O5) while the last site is just 1.5 km upstream of Lough Cutra i.e. about 22 km downstream from the wind farm site (EPA O1). At the latter site both Q-values and water chemistry are monitored. The outflow river from Lough Cutra (the River Beagh) is also monitored for Q-values at EPA C1, 1.6 km downstream from the lake. There are several more sites on the Boleyneendorrish River, the most upstream situated 4.5 km downstream of the nearest point to the wind farm boundary (EPA B1). Only a very small portion of the wind farm drains east to the Duniry River and the nearest EPA site to the boundary is approximately 6 km downstream (EPA D1). Apart from one small tributary of the Owendalulleegh (EPA OT1) the EPA does not monitor any of the several minor tributary streams which drain the wind farm site.

Table 8.7 List of abbreviated EPA codes used on the map in Figure 8.1 and the corresponding full codes

Map Code (Figure 8.1)	**Full EPA Site Code**	**ITM**	
Owendalulleegh River (main channel)		East	North
EPA O1 (Q-value and water)	RS29O011000	548377	697234
EPA O2	RS29O010900	551710	698438
EPA O3	RS29O010800	554640	698989
EPA O4	RS29O010700	556107	699657
EPA O5	RS29O010500	560122	701247
Owendalulleegh Tributary (SC9)			
EPA OT1 (Knocknarebana Stream)	RS29K040100	555271	701209
Beagh River (outflow from Lough Cutra)			
EPA C1	RS29B020100	547612	700641
Boleyneendorrish River			
EPA B1	RS29B040100	555497	706856
EPA B2	RS29B040300	551350	705655
Duniry River			
EPA D1	RS25D070100	564867	707753

As part of the current assessment, the relevant EPA monitoring data for each of their monitoring sites on the three river systems and one small tributary of the Owendalulleegh (EPA OT1) was accessed from the EPA online data and is presented in Table 8.8. The data selected begins in 1996 several years before commencement of the wind farm construction and continues until 2019. It also includes the data for 2003, which was surveyed within one month of the peat slide. Throughout this period of 23 years, all of the main channel sites have returned High Status results of Q4-5 or Q5. The only exception was in 2003 when sampling was undertaken exactly one month after the peat slide at the wind farm and where the previously High Status dropped to Bad (Q2) at the site closest the slide (5 km d/s) i.e. EPA O5, improving gradually in a downstream direction through Moderate Status (Q3-4) at EPA O4 to Good Status (Q4) at sites EPA O3 to O1, as the amount of peat silt in the channel diminished in a downstream direction (Clabby *et al.,* 2004).

In the next round of sampling in 2006 there was no evidence of an impact from the 2003 peat slide, at four out of five of the survey sites (EPA O2 to O5) which were all High Status. The exception was EPA O1 at Killafeen Bridge which is the farthest site downstream from the wind farm where Good Status (Q4) was recorded. These data indicate that the impact of the 2003 peat slide on biological water quality on the main channel of the Owendalulleegh River was short-term, with pre-slide conditions resuming within 3 years (at most) and remaining essentially the same since. The Q-4 rating at EPA O1 in 2006 may be a borderline result that may or may not point to a residual effect of the 2003 peat slide.

Over the period (1997-2019) the sole survey site on the outflow river from Lough Cutra (EPA C1) returned mixed results. In the years prior to, during and immediately after the peat slide (1997-2006), a Good Status result was recorded even within a month of the peat slide when it was monitored in November 2003. In 2009 the status increased to High Status but thereafter dropped to Good Status again in 2012 and in 2015 and 2018 it dropped to Moderate Status (Q3-4) for the first time. Clearly, this sequence of results indicates that the peat slide had no negative impact on the ecological status of this site.

The EPA monitors one tributary site of the Owendalulleegh, EPA OT1, which is located in subcatchment SC9. It returned High Status results in each survey from 1997 to 2012 with the exception of 2003 when the status was Good (Q4). In 2015 the status dropped to Moderate (Q3-4), which is believed to be related to clearfelling within SC9 outside of the wind farm. In 2018 it had improved to Good Status (Q4) and in 2019 it dropped to Moderate Status (Q3-4) again, which is also believed to have been due to clearfelling upstream in SC9 outside of the wind farm. This shows that smaller watercourses tend to have less buffering against environmental change as compared to main channel sites. SC9 subcatchment was not affected by the 2003 peat slide.

On the Boleyneendorrish River the two survey sites on the main channel of the Boleyneendorrish (EPA B1 and B2) both returned High Status (Q4-5 or Q5) results on each sampling occasion from 1997 to 2018. There is no evidence that there has been any impact on the biological water quality of the main channel of the river from activities on the wind farm site either before, during or at any time since the wind farm's construction, based on the long-term Q-rating trend at this site This catchment was not affected by the 2003 peat slide. In 2019, for the first time since monitoring began on that site (EPA B1) the quality dropped from High to Good Status when a Q4 rating was recorded by the EPA, which may have related to some clearfelling in SC1. The EPA site on the Duniry (EPA D1) is just under 6km downstream from the boundary of the wind farm and only drains a very small fraction of its area (1.3ha). Its water quality was High Status (Q4-5 or Q5) from 1996 to 2003 dropping in the four most recent surveys up to 2017, to a consistent Good Status (i.e. Q4). It would seem to be extremely unlikely that the wind farm gave rise to the decline from High to Good Status noted three years after the construction, given the very small proportion of the wind farm site draining to the Duniry catchment, in comparison to the large area of intervening catchment and the length of channel between the survey site and the wind farm boundary (6 km).

Table 8.8 EPA Q-value results for the 3 rivers draining the wind farm site (1996-2019) – see Figure 8.1 for site locations. Note that EPA D1 was usually surveyed in different years to the other four channels.

Year	EPA O1	EPA O2	EPA O3	EPA O4	EPA O5	EPA OT1	EPA B2	EPA B1	EPA C1	Year	EPA D1
1997	4-5	4-5	-	4-5	4-5	4-5	5	5	4	1996	5
2000	4-5	5	5	5	4-5	4-5	5	4-5	4	1999	4-5
2003	4	4	4	3-4	2	4	5	5	4	2003	4-5
2006	4	5	-	4-5	4-5	4-5	4-5	5	4	2006	4
2009	4-5	4-5	5		4-5	4-5	-	-	4-5	2009	4
2012	4-5	4-5	4-5	4-5	4-5	4-5	5	5	4	2012	4
2015	4-5	4-5	4-5	4-5	4-5	3-4	4-5	4-5	3-4	2017	4
2018	5	5	4-5	4-5	4-5	4	4-5	5	3-4	2018	-
2019						3-4		4			

(O1-O5 = Owendalulleegh main channel, OT1 = Owendalulleegh Tributary, C1 = Outflow from Lough Cutra, B1 & B2 = Boleyneendorrish main channel, D1 = Duniry River 5 km downstream of wind farm boundary).

8.2.4.2 Q-Value Surveys for this Assessment

The foregoing Q-value data principally refer to the main channel sites and, in most cases, not to the smaller tributaries draining the immediate wind farm area where evidence of water quality impacts would be more likely to be discernible. To assess these channels a total of 37 sites were surveyed for the current study, which also included a small number of main channel sites. Some sites were surveyed on just one occasion while several were surveyed two or more times. The surveys were undertaken in 2011, 2014, 2018, 2019 and 2020. A grid reference for each survey site is included in Table 8.9 and the summarised results are presented in Table 8.10 and the 2019 results are shown on Figure 8.5. Seven sites were surveyed on the main channel of the Owendalulleegh (O7A & O7B and O7-O11), O11 was 1km d/s EPA O2, Site O10 was at the same sites as EPA O3, O9 = EPA O4 and O7 = EPA O5. There were two sites on the main channel of the Boleyneendorrish (B5 & B3) with B5 coinciding with EPA B1. The remaining thirty sites were almost all situated on tributary streams in the three catchments draining the wind farm, while two (OHL 1 and OHL 2) were on streams draining the OHL route corridor and the Agannygal Substation. Table 8.10 lists these sites and the subcatchments in which they occur and Figure 8.1 shows their positions. Note that EPA OT1 is in subcatchment SC9 just downstream of three survey sites for the current assessment (O9A, O9A1 and O9A2).

Table 8.9 ITM positions for all survey sites for the current study (Q-value, water chemistry, electrofishing and Lough Cutra sediment grab samples).

See Figure 8.1 & Figure 8.2) for site locations

Site	Easting	Northing	Site	Easting	Northing	Site	Easting	Northing
B1	559242	707252	**O3A**	561942	703971	**O9A2**	555648	701680
B1A	559132	707017	**O4**	561355	703613	**O9B**	557222	701285
B1B	559684	706518	**O4A**	561369	703628	**O10**	554623	698968
B2	557160	706458	**O4B**	560122	703936	**O11**	551046	698476
B2A	558830	705969	**O5**	561145	702597	**OHL1**	563756	697352
B3	555860	706871	**O5A**	560309	702507	**OHL2**	562111	700693
B3A	556951	707095	**O6**	561114	701977	**CU1**	547770	697490
B4	555846	706780	**O6A**	561095	701268	**CU2**	547774	697505
B4A	556591	705574	**O7**	560139	701249	**CU3**	547768	697745
B4B	556560	705261	**O7A**	561059	701246	**CU4**	547749	697843
B4C	556829	704589	**O7B**	561134	701215	**CU5**	547748	697893
B5	555451	706853	**O7C**	562447	701486	**CU6**	547279	698287
D1	564088	707702	**O8**	559177	700865	**CU7**	548254	698546
D1A	561580	707058	**O8A**	558798	701824	**CU8**	547435	698805
O1	562231	705635	**O9**	556110	699652	**CU9**	547944	699050
O2	563548	703119	**O9A**	555524	701567	**CU10**	548298	699974
O3	562729	702986	**O9A1**	555625	701661	**CU11**	548442	700256

Table 8.10 Q-value results for sites surveyed for the current study (2011, 2014, 2018, 2019 and 2020) (site locations in Figure 8.1)

Catchment	Site	2011	2014	2018	2019	2020
Owendalulleegh	O11		4 (4-5)			
	O10		4-5			
	O9	4-5				
	O9A			4		
	O9A1				3-4 (4)	
	O9A2				3-4 (4)	
	O9B				3-4 (4)	
	O8		4 (4-5)			
	O8A				3-4 (4)	
	O7			4-5		
	O7A				4	
	O7B				4	
	O6	4-5 (5)	4 (3-4)			
	O6A				4 (4-5)	
	O5		3-4		4-5 (4)	
	O5A				4-5 (4)	
	O4	4	3 (3-4)	4 (3-4)	4 (3-4)	
	O4A				4	
	O4B					4-5
	O3A				4 (4-5)	
	O3	4			4-5 (4)	
	O2	4 (3-4)		3-4 (4)	4 (3-4)	
	O1	3-4		3-4 (4)	3-4 (4)	
	OHL 2				4-5 (4)	
Boleyneendorrish	B5	4-5				
	B4	4 (4-5)		4-5 (5)	4 (4-5)	
	B4B				3-4 (4)	
	B4C				3-4 (3)	
	B3			4-5	4-5	
	B3A				4-5	
	B2	4-5			4-5	
	B2A				4	
	B1	4				
	B1B				3-4	
Duniry	D1	4-5 (5)				
	D1A				3-4 (4)	
Bleach River	OHL 1				4-5	

Appendix 8-2 includes a full list of the taxa and relative abundances of macroinvertebrates recorded at each site during each survey run and Appendix 8-3 gives descriptions for the survey sites, including photos.

PLACE HOLDER for FIGURE 8.5

Figure 8.5 Q Values for 2019 – 2020 ASU sites

The larger channels in the Boleyneendorrish catchment (B2, B3, B3A, B4 and B5) all returned High Status results when surveyed, with the exception of B4 (at the bottom of SC1) in 2011 and 2019 when the quality dropped marginally to Good Status verging on High Status, while in 2018 High Status was recorded. Note that B5 (EPA B1), the most downstream site surveyed within the Boleyneendorrish catchment, incorporating all the tributaries which combined drain 33.4% of the wind farm site, has always been classified as of High Status for macroinvertebrates in both the EPA's current and historical Q-value records (Table 8.8), and in the single sample taken for this report in 2011 (Table 8.10). For the first time in 2019 the EPA recorded a Good Status Q-rating at this site, a drop from High Status (Q5) in 2018. The smaller tributary sites within the Boleyneendorrish, B1, B1B, B2A, B4B and B4C, all bar B1 surveyed only in 2019, returned either Good (Q4) or Moderate (Q3-4) status results. Strictly speaking, Site B4C should have been assigned a Q3 (Poor Status) result based only on the invertebrates recorded. However, its position at the very top of the catchment (SC1), coupled with visibly very clean but very limited substrate for kick-sampling prompted the assigning of a slightly better Q-rating. These smaller tributaries are more susceptible to local land-use disturbances and weather-related stresses such as low water levels, although as the record shows here, the effects tend not to persist into the larger downstream channels. Site D1 (SC5) in the Duniry catchment which drains only a very small portion of the wind farm site (~0.6 %) returned a High Status result for macroinvertebrates in 2011, while its smaller headwater extension (D1A) returned a Moderate Status result verging on Good in 2019.

Each of the main channel sites surveyed on the Owendalulleegh River downstream of the confluence of the SC7 subcatchment stream in 2011, 2014 and 2018, with the exception of O11 in 2014, returned High Status results consistent with the EPA findings over the same general time interval. There was a coating of peat silt present at the margins of the channel at Site O7 (Tooraglassa Ford) when sampled in 2018 but the kick sample in parts of the channel unaffected by the silt gave a High Status result (Q4-5). The provenance of the silt is not known but some was also noted during the same sampling effort at Sites O2 and O3 in SC7(a) and SC6, also in 2018, where turbary is considered to have been a possible source, at least partly. The assignment of a slightly lower status at O11 in 2014 was precautionary because of the presence of a small number of the pollution tolerant species (*Asellus*) in the samples despite four Group A pollution sensitive species also being present. It was the only time that *Asellus* was noted in any sample collected for the study and may relate to some localised runoff near this site at the time during which water levels were very low. In 2019, two additional sites farther upstream on the main Channel O7A and O7B both returned Good Status ratings (Q4).

The remaining 17 sites are all, bar one, situated on tributaries that at least in part drain the footprint of the Derrybrien Wind Farm. The exception, OHL 2, is situated on an unnamed stream that drains the OHL route corridor. The macroinvertebrate water quality in Owendalulleegh tributaries (O1-O9B) surveyed between 2011 and 2020 ranged from High Status, through Good to Moderate Status, mainly, with one Poor verging on Moderate Status (Q3/3-4) result at O4 in 2014. Site O1 is at the top of subcatchment SC6 and only receives a very small portion of its drainage from the wind farm site. It returned Moderate Status (2011) and Moderate Status verging on Good (Q3-4/4) in 2018 and 2019. The substrate at this site was coated in a pronounced iron bacterial biofilm on each sampling occasion, which is believed to have contributed to the impaired results. There has been no recent felling that far up the subcatchment or any other activity that might explain these results, which are believed to be a natural feature of the site. However, there was also a peaty texture noted in this scum in 2019, so some contribution from turbary may also be influencing these results. Further downstream in the same subcatchment at Site O2, conditions were generally marginally better, with Good status verging on Moderate recorded in 2011 and 2019 and Moderate status recorded in 2018. On all 3 occasions iron scum was also noted but in 2018 there was also a thick peaty coating on embedded cobbles. This may well have been related to the felling of just under 10ha of forestry upstream the same year combined with the lower water levels experienced that summer. However, turbary, a continuing activity in the eastern end of the wind farm site and in adjoining parts of SC6, might also have been a contributing factor at the time.

Just to the west in subcatchment SC7(a), Site O3 returned Good Status in 2011 and High bordering on Good in 2019. The latter result is somewhat unexpected as this catchment experienced 15-20ha of felling in 2018, but there doesn't seem to have been any residual impact in the 2019 survey. Further upstream on the same watercourse at O3A, Good verging on High Status was recorded, also in 2019. Just over 17ha of felling occurred upstream of this survey site in 2018. In subcatchment SC7(b), Site O4 at Black Road Bridge is situated just over 1km downstream of the base of the peat slide. It was sampled on four occasions and on three of those returned a Good Status or Good verging on Moderate status except in 2014, when a Poor Status verging on Moderate was recorded. There is no available data for forestry or other activity in the catchment in the couple of years prior to this date, so no clear explanation can be offered for the 2014 result. However, that summer, there was extensive upgrading of access tracks on the wind farm site, which also included works to drains, culverts etc, so this cannot be ruled out as a contributory factor, even though silt control measures were recommended in order to minimise suspended solids losses from those operations. It is also notable that water levels were very low at the time of the 2014 survey, which may have added to the stress on some of the smaller tributaries surveyed at the time.

A very small tributary joining the channel immediately upstream of Black Road Bridge (O4A) was sampled in 2019, it returned a Good Status result, even though there was a thick biofilm on peaty/iron scum biofilm noted on substrate at the time. Farther upstream in the same catchment in the small stream draining beneath Barrage 1 when sampled in January 2020 returned a High Status result (Q4-5). Further downstream, still in SC7(b), Site O5 at Flaggy Bridge was surveyed just once in 2014 when it returned a Moderate Status result. On the same occasion, farther downstream along the same channel in SC7(d), Site O6 returned an improved value of Good Status thereby showing an improvement in quality downstream from O4, through O5 and on to O6, the latter site receiving drainage from side streams SC7(a) and SC7(c) by that point. An earlier survey at O6 in 2011 returned a High Status result (Q4-5). Site O6A, which is at the very bottom of this tributary just upstream of the main Owendalulleegh channel, was surveyed in 2019 when a Good Status verging on High (Q4/Q4-5) was recorded. Site O5A, in the next subcatchment to the west, SC7(c), sampled for the first time in 2019, returned a High Status rating verging on Good.

One sample each was surveyed in 2019 in the next two subcatchments to the west, namely O8A in SC8 and O9B in the next adjoining subcatchment which isn't shown in Figure 8.3, as it doesn't drain any part of the wind farm. In 2019, 5ha of forestry was clearfelled in the catchment of O8A and 8ha in that of O9B. Both returned Moderate Q-ratings verging on Good. Finally, in SC9, Sites O9A1 and O9A2 on two small upper tributaries in this subcatchment both, returned Moderate Q-ratings in 2019, while O9A just below the confluence of both, returned a Good Status Q-rating in 2018, the same year in which the EPA recorded a Good rating at a site on the same channel 500m downstream at the road bridge (EPA OT1 –Table 8.8, Figure 8.1). In December 2019, two additional sites were surveyed. The first, OHL 1, is on a small stream which drains much of the southern half of the Derrybrien – Agannygal OHL corridor and which joins the Owendalulleegh just upstream of Site O7, and OHL 2 which is situated on a small unnamed stream which drains a small portion of the southern end of the OHL corridor and the Agannygal Substation site and flows into the north shore of Lough Atorick. Q-ratings classified these sites as High Status bordering on Good (OHL1) and High Status (OHL2).

Overall, the EPA macroinvertebrate results demonstrate that for all the main channel sites on the Boleyneendorrish River and the Owendalulleegh River, at least as far upstream as the confluence of SC7 (i.e. a channel length of about 18 km), and the most upstream EPA sites on the Boleyneendorrish (EPA B1 and B2) that High Status (Q5 and Q4-5) has been the rule rather than the exception, results which have, in the main, been confirmed during the current study. The one notable exception to this trend on the Owendalulleegh was for the 2003 survey undertaken within a month of the peat slide, when the quality dropped significantly at several main channel sites. However, as the 2006 results indicated, this interruption in the High Status quality norm was mainly short lived. The most recent exception to the trend on the Boleyneendorrish was at EPA B1 on the river when for first time ever the quality dropped at that site from High Status to Good Status (Q5 to Q4) in 2019. Results for the many smaller tributaries in the upper regions of the three study catchments have shown more variable results ranging from High Status, to Good, to Moderate Status mainly, with a very rare drop to Poor status (at just two sites). What is also apparent at several of these sites is that repeat surveys frequently, though not invariably, produced different results. For many of these sites it is postulated that the occurrence of Moderate Status results is linked to forestry activity in the catchment areas up stream of the sites in question in the same year or in the year or two prior to the Q-rating survey in question. This however doesn't explain all of the results and other factors are also likely to be at play, including water levels and to a lesser extent site-specific factors such as turbary on the eastern portion of the wind farm (possibly affecting O2 and O3) and the presence of iron bacterial scum (possibly in combination with peat silt) also affecting O1 and O2. Inter-annual variability in the Q-rating results, especially in the smaller tributaries can be related to variation in the level of land use pressure experienced in the same year or the year before, exacerbated in some years by low water levels Finally, apart from the construction phase and the peat slide in 2003, it is considered likely that the vast bulk of the inter-annual variability in water quality noted in many of the small streams in the subcatchments draining the wind farm site was unrelated to activities on the wind farm itself. One notable exception to this could be in the case of Sites O4, O5 and O6 in 2014, where impaired water quality may have been contributed to by site maintenance measures being undertaken that year on the wind farm, which included access track upgrade and maintenance and culvert/drain cleaning.

8.2.4.3 Lough Cutra – Sediment Survey (October 2019)

Grain Size Analysis

All samples from the general body of the lake (CU6 - CU10) were dominated by mud (i.e. the <63µm silt/clay fraction) Table 8.11, although CU7, closer to the eastern shore and possibly influenced by some onshore wave action, also had a high proportion of sand (see Figure 8.2). These samples also had the highest organic matter content as measured using the LOI (Loss on Ignition) method. The two samples within the final 100m of the Owendalulleegh River (CU3 and CU4) and the first sample within the lake proper (CU 5) were dominated by sand, with a good amount of medium to coarse sand fractions present. This area of the lake is being constantly winnowed of its mud (silt/clay) and fine sand fractions by the power of the water exiting the river during periods of high flow. CU11 in the outflow channel from the lake (River Beagh) is also dominated by sand but in the finer sand fractions and it also contains 14% mud. So, while this site is also affected by fluvial currents, the velocities are clearly lower in this deeper (5.6m) site compared to the outflow area of the Owendalulleegh. The first two samples collected within the lower reaches of the Owendalulleegh (CU1 and CU2) were very different from those from the lake proper. CU1 contained a pure red clay with no visible organic content which was confirmed by the very low LOI value measured, while CU2, which was close by, comprised a consolidated clay and gravel pan with a loose plant-derived fibrous litter overlay. This very coarse composition made it a bit of an outlier in terms of grain-size analysis. The diversity of substrate types in this part of the river is not surprising given the range of depths and the mix of deposition and scour areas within the large meanders present there. In contrast, in the open lake, away from the immediate influences of the river, very slack currents probably prevail and promote the deposition of fine mineral and organic particles. This was confirmed by the high mud content and high organic content of samples CU6 – CU10 in particular.

All of the sites visited turned out to be quite shallow and the brown colour of all the surfaces of all the sediment samples collected indicated that the bottom surface at all these sites was oxygenated. (See Appendix 8-4 for photos of the fresh sediment samples)

Table 8.11 Grains size and organic matter content of bottom sediment at 11 sites in Lough Cutra

Site	Depth (m)	%>2 mm	%>1 mm	%>0.5 mm	%>0.25 mm	%>0.125 mm	%>0.063 mm	%<0.063 mm	LOI %
		Gravel	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Mud	
CU1	3.7	0.0	0.0	0.0	1.4	3.6	1.7	93.2	2.0
CU2	1.5-3	25.3	13.4	7.8	7.5	6.7	7.0	32.2	12.2
CU3	2-3	4.3	12.7	35.5	38.0	6.8	0.0	2.7	11.1
CU4	NM	15.1	19.6	31.7	22.0	5.2	2.0	4.5	0.5
CU5	NM	0.0	2.4	6.9	46.1	32.7	5.4	6.4	7.4
CU6	6.2	0.0	0.0	0.0	0.2	0.8	1.6	97.4	NM
CU7	2.8	0.1	0.1	0.0	0.3	5.1	42.1	52.4	6.8
CU8	3.6	2.6	1.5	1.7	2.3	5.6	5.9	80.5	17.1
CU9	4.3	0.0	0.0	0.0	0.1	0.9	2.7	96.3	14.4
CU10	2.3	0.0	0.0	0.1	0.3	1.6	4.1	93.8	9.3
CU11	5.6	0.1	0.4	1.5	42.8	37.0	3.8	14.4	4.9

NM = not measured

Macroinvertebrates

The 11 grabs samples contained 21 invertebrate taxa (Table 8.12) but there were several additional species including chironomid larvae, oligochaete worms and *Pisidium* (pea mussels) all of which were identified to genus or higher taxonomic level. The mix of species present point to two broad benthic habitat types, (i) open water mud-dominated bottoms (CU6, CU8, CU9 and CU10) that tended to have lower species diversity and (ii) littoral / out-flow / inflow habitats with a much higher proportion of sand (CU3, CU4, CU5, CU7 and CU11) and generally higher species diversity. The two samples in the lower Owendalulleegh, CU1 and CU2, which had only 2 taxa present, are considered non-representative due to the physical nature of the samples collected, rather than the location. The open-water sites were all characterised by a limited range of typical soft sediment species, in particular oligochaete worms and to a lesser extent chironomid midge larvae belonging to the sub-family chironomini. These sites also contained phantom midge larvae of the family Chaoboridae, which prey on zooplankton and are important in juvenile fish diets. They make vertical migrations in the water column, feeding at night and burying in the mud during the day. The samples with higher sand content were located in the inlet and outlet sites to the lake (CU4, CU5 and CU11) and toward the margin (CU7) and these are likely exposed to much greater water movement which combined with the greater structural diversity of the substrate is likely contributing to higher taxa counts at these sites. The presence *of Ephemera danica* and three species of cased caddis larvae at these sites, as well as the mayfly *Caenis horaria* and the uncased caddis *Neureclipsis bimaculata* (in the outflow at CU11) combined with low densities of oligochaete worms and the absence of *Chironomus* larvae at the muddier open-water sites, points to good or moderate water quality rather than poor water quality conditions in the lake. The latter is consistent with the EPA classifying the lake as being Good or Moderate Status since 2010 (see Section 8.2.4.1)

Table 8.12 Macroinvertebrates in 11 bottom grab samples from Lough Cutra (31-10-2019)

	CU1	CU2	CU3	CU4	CU5	CU6	CU7	CU8	CU9	CU10	CU11
MAY FLIES (Ephemeroptera)											
Ephemera danica				7	9		1			2	1
Canis horaria											1
CADDIS FLIES (Trichoptera)											
Ocetis ochracea				1							
Mystacides sp.											1
Arthripsodes cinereus				1							
Neureclipsis bimaculata											1
TRUE FLIES (Diptera)											
Chironomini	1	8	3		7			1	1		6
Tanypodinae								1			
Ceratopogonidae				3	2	1					2
Chaoboridae						7	1	1	1	1	
ALDER FLIES (Megaloptera)											8
Sialis lutaria											
BEETLES (Coleoptera)											
Beetle larvae (indet.)							1				
Elmidae			2	1							
F/W SHRIMPS (Crustacea)											
Asellus				1		1	1				
Crangonyx			1	3	3		1				
SNAILS (Mollusca)											
Potamopyrgus antepodarum				6	8						
Bithynia tentaulata				1			2			2	
Anodonta anatina							1				
Shhaerium sp				1			1			4	7
Pisidium sp(p)					20		7			5	
WORMS (Annelida)											
Oligochaetae	2	1	3	13		6	3	2	4	3	3

8.2.5 Water Chemistry

8.2.5.1 EPA Data

This section presents a summary of the water chemistry data obtained from the EPA as well as the results of a number of surveys undertaken for the current assessment.

The EPA has one water chemistry monitoring station on the lower reaches of the Owendalulleegh, just 1.5 km upstream of Lough Cutra at Killafeen Bridge (EPA O1, Figure 8.1, - full EPA code: RS29O11000), which they monitor on a monthly basis. The earliest data available from the EPA for this site goes back to 2007. Data for the period 2007-2018 is summarised in Table 8.13 as annual averages for the period based on 12 monthly samples in most years, while Table 8.14 summarises the data for a 6-year period 2012-2017 (71 samples) to get overall average, median, max and min values for the selected parameters over an extended period. Water samples for the present study were taken on at least one occasion at twenty-seven sites during three water sampling runs, in October 2011, October 2018 and September 2019 across several lower order tributary streams draining from the wind farm and adjoining subcatchment. Results of these sample runs are listed in Table 8.16. For context, both sets of results can be compared with the physico-chemical conditions supporting the biological elements required under the Water Framework Directive as set out in S.I. 77 of 2019, European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 I nTable 8.15.

The EPA results for the lower reaches of the Owendalulleegh data point to a neutral water chemistry with generally moderately soft water conditions, low nutrient and low [3]BOD concentrations. The annual results consistently fall within the range set for supporting conditions for ecological High Status sites (Surface Water Regulations (S.I. 77 of 2019)) for phosphate, ammonia and BOD. This is fully consistent with the High Status Q-ratings assigned with regularity at this site (Table 8.8). This site, which is just 1.5 km upstream of the inflow to Lough Cutra is showing no impact from the wind farm site and its environment. Certainly, the water chemistry for this site would have been impacted in the weeks and months following the 2003 peat slide, perhaps mainly by increased suspended solids, with possibly a period of increased nutrients (ammonia and phosphate) as well. However, in the absence of any contemporaneous data it isn't possible to quantify this. See section 8.2.4.3 on Lough Cutra for further related discussion.

[3] BOD = Biochemical Oxygen Demand

Table 8.13 Annual average water chemistry data at EPA O1 (12 monthly samples per /annum)

Annual Mean	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
pH	7.5	7.3	7.4	7.6	7.4	7.3	7.4	7.4	7.4	7.4	7.5	7.6
Alkalinity (mg/l,$CaCO_3$)	40.3	32.1	35.5	64.3	36.8	33	48	35	46	50	44	47
Conduct. (µS/cm)	148	131	122	177	122	114	159	125	160	153	144	160
BOD (mg/l, O_2)	0.79	0.70	0.82	0.83	1.27	0.98	0.78	0.68	0.71	0.88	1.07	<1
Ammonia (mg/l, N)	0.017	0.014	0.014	0.016	0.025	0.019	0.016	0.013	0.012	0.013	0.020	<0.012
Ortho-P (mg/l, P)	0.015	0.016	0.015	0.018	0.005	0.010	0.006	0.005	0.006	0.006	0.007	<0.01
TON (mg/l, N)	0.19	0.13	0.17	0.26	0.14	0.20	0.18	0.10	0.10	0.10	0.10	<0.1
Colour (Hazan)	101	136	155	119	131	197	104	147	114	134	146	113

Note: one high outlier of (0.125mg/l, P) was not included in the annual average for ortho-P for 2011

Table 8.14 Summarised statistics for monthly water chemistry data (2012-2017) at EPA O1

Overall Averages (n=71)	Average	Median	Max	Min
pH	7.4	7.4	7.9	6.4
Alkalinity (mg/l, $CaCO_3$)	42	37	105	5
Conductivity (µS/cm)	142	124	261	58
BOD (mg/l, O_2)	0.85	0.50	2.20	0.50
Ammonia (mg/l, N)	0.016	0.015	0.050	0.010
Ortho-P (mg/l, P)	0.006	0.005	0.025	0.005
TON (mg/l, N)	0.13	0.01	0.89	0.01
Colour (Hazan)	139	122	385	39

Table 8.15 European Union Environmental Objectives (Surface Waters) (amendment) Regulations 2019 (S.I. 77 of 2019)

Acidification Status (Soft water)	4.5< pH <9.0	
BOD (mg/l, O_2)	High Status ≤1.3 (mean) ≤2.2 (95%ile)	Good Status ≤1.5 (mean) ≤2.6 (95%ile)
Ammonia (mg/l, N)	High Status ≤ 0.040 (mean) ≤0.090 (95%ile)	Good Status ≤ 0.065 (mean) ≤0.140 (95%ile)
Ortho-P (mg/l, P)	High Status ≤ 0.025 (mean) ≤0.045 (95%ile)	Good Status ≤ 0.035 (mean) ≤0.075 (95%ile)
Dissolved Oxygen (lower limit)	95%ile >80% saturation	
Dissolved Oxygen (upper limit)	95%ile <120% saturation	

8.2.5.2 Water Chemistry – Current Study

Water chemistry results for the current assessment for the upper tributaries of the Boleyneendorrish, Duniry and Owendalulleegh Rivers for the 2011, 2018 and 2019 surveys are presented in Table 8.16. In all, 27 different sites were visited once, while a small number of these were visited on two or three occasions. The 2018 survey was undertaken during dry weather when water levels were generally low, while the 2011, and 2019 surveys were undertaken shortly after wet weather, especially the 2011 survey. With the exception of Sites O7 and O9 which are on the main channel of the Owendalulleegh farther down the system, and B5 the lowest site in the Boleyneendorrish catchment, each of the other sites are within mainly smaller subcatchments dominated by coniferous forest on blanket peat or non-afforested blanket peat. Overall these sites are characterised by generally lower alkalinities and pH than the main channel sites farther down in the system and can be described as soft water sites. A comparison of the pH and alkalinity data for B4 and O2-O4 for 2011, 2018 and 2019 shows how during the wetter weather in 2011 and to a lesser extent in 2019, lower pH and alkalinity results were recorded compared to the drier weather survey of 2018. This is a noted effect of elevated run-off draining from blanket peat sites in many parts of Ireland (Kelly-Quinn *et al.,* 2008). However, only at three of the twenty-seven sites, namely B4 in 2011, and D1A and O8A in 2019 did the pH drop below 5, and in the case of B4 and D1A did the alkalinity turn negative, indicating an acid pulse. Elsewhere there was sufficient buffering in the underlying geology to prevent a similar drop in these parameters. It is significant that at B4 there were no mayfly nymphs present in the macroinvertebrates taken in 2011, and just a single specimen (*Baetis* sp.) in the 2019 survey. Mayflies are a group known to be sensitive to acidification (Feeley *et al.,* 2011). Overall however, the chemistry of these sites seems to be at least partially buffered against acid pulses.

Many of these sites have concentrations of ortho-phosphate (measured as SRP[4]) and to a lesser extent ammonia, at higher concentrations than those consistently measured by the EPA on the main channel of the Owendalulleegh at EPA Site O1 (Figure 8.1) (Table 8.13). Values at several of the sites were within ranges consistent with Good or Moderate Status sites as classified in the Surface Water Regulations (S.I. 77 of 2019), in addition to others with concentrations of these parameters within the High Status range (Table 8.15). For ortho-phosphate (SRP) the highest values were recorded at O9A, O9A1, O9A2, O9B, O8A, O5A and B2A, all bar O9A sampled in 2019 and all within the Moderate range (Table 8.16 & Table 8.6). Most of these sites are within subcatchments where forest clearfelling occurred in either 2018 or 2019. For example, in 2019, 21ha of coniferous plantation on blanket peat was felled in an area just to the south west of and immediately adjoining the wind farm site. An estimated 5ha of this drains to SC8 (which contains O8A), 8ha drains to SC9, which contains O9A and O9A1, while another 8ha drains to the central area between SC8 and SC9 where O9B is situated. Site O8A had the highest SRP value at 0.124mg/l, P, a concentration significantly higher than any others, which may also point to a point source or diffuse point source. Although O5A also returned elevated SRP (phosphate) concentrations, the most recent felling in the SC7(c) catchment was in 2017 as part of turbulence felling when ~7 ha were felled at the top of the catchment. B4A and B4B were both in the Good Status range for phosphate while B4 in both 2011 and 2018 was borderline Good/High as was D1A in 2019. All the other sites had concentrations placing them in the High Status range (i.e. with concentrations <0.025mg/l, P). Some higher ammonia concentrations coincided with sites that also had higher phosphate levels, but not all (Table 8.7). Only three sites fell into the Moderate range for ammonia, B1, B4 and O4 (2011), whereas the following were within the Good range: O9A1, O9A2, O8A, O5A, O3 (2011), O3A, O4 (2018), D1A, B1B, B4 (2011) and B4B. The remaining 20 sample results spread across 18 sites fall into the High Status range.

[4] SRP = Soluble Reactive Phosphorus – generally equivalent to orthophosphate

Table 8.16 Water chemistry data for study area tributaries 2011, 2018 and 2019– coloured cells correspond to nutrient phosphate concentrations in High, Good, Moderate and Poor categories as denoted in the 2019 Surface Water Regulations.

Parameter	B1	B1A	B1B	B2	B2A	B3	B4	B4	B4A	B4B	B5
	2011	2019	2019	2011	2019	2018	2011	2018	2019	2019	2011
pH	5.98	6.73	5.99	5.83	6.87	7.3	4.61	6.3	6.48	5.09	6.49
Conduct. (µS/cm)	83	64.2	46.5	81	67.7	137	79	81	57.1	47.9	82
Alkalinity	4.4	13.0	5.0	3.4	17.0	38.8	-0.7	7	8.1	1.1	7.2
Calcium (mg/l,Ca)		6.92	4.66		9.21	15.4		5.4	5.8	3.23	
BOD (mg/l,O_2)	2.2	1.0	1.2	1.3	1.4	1.1	1.2	1.6	1.5	1.0	1.6
Ammonia (mgN/l)	0.089	0.034	0.050	0.039	0.040	0.024	0.049	0.070	0.039	0.052	0.039
SRP (mg P/l)	0.016	0.007	0.008	0.014	0.061	0.007	0.022	0.024	0.034	0.026	0.012
Total P (mg P/l)	0.045	0.021	0.032	0.044	0.104		0.046		0.072	0.053	0.036
TON (mg N/l)	0.07	0.03	0.06	0.04	0.06	0.02	0.03	0.02	0.05	0.06	0.04
DOC (mg C/l)	36.6	27.6	32.8	26.9	35.1		33.4		32.7	38.5	28.5
Colour (Hazan)		353	463		481	159		411	454	463	
ANC (µeq/l)	271	398	264	203	516		153		326	215	287
Total Al (µg/l)	100	138	138	260	149		250		185	186	165
Monomeric Al(µg/l)	49	24	53	176	46		198		61	87	82

Table 8.16 contd:

Parameter	O1	O1	O2	O2	O3	O3	O3A	O4	O4	O4	O4A
	2011	2019	2011	2018	2011	2018	2019	2011	2018	2019	2019
pH	5.94	5.97	6.21	6.74	5.45	6.72	6.70	5.46	6.74	6.17	6.46
Conduct. (µS/cm)	53	31.2	70	94	72	86	50.4	73	124	51.4	87.7
Alkalinity	2	2.7	4.1	19.3	2.2	13.7	11.1	2.4	32.7	6.2	21.9
Calcium (mg/l,Ca)		1.79		8		7.6	6.46		13.5	4.63	10.05
BOD (mg/l,O_2)	0.8	0.6	0.8	1	2	1.4	1.4	1.2	1.3	1.2	0.9
Ammonia (mgN/l)	0.03	0.020	0.03	0.03	0.05	0.03	0.053	0.07	0.05	0.040	0.029
SRP (mg P/l)	0.003	0.003	0.005	0.001	0.005	0.005	0.009	0.006	0.006	0.006	0.005
Total P (mg P/l)	0.01	0.014	0.02		0.03		0.031	0.03		0.026	0.025
TON (mg N/l)	0.02	0.03	0.05	0.01	0.05	0.06	0.07	0.05	0.02	0.04	0.04
DOC (mg C/l)	14.2	16.9	21		29.2		28.0	31.1		30.7	24.2
Colour (Hazan)		211		81		231	391		179	415	227
ANC (µeq/l)	111	139	187		190		362	204		278	559
Total Al (µg/l)	80	91	204		358		163	236		236	173
Monomeric Al(µg/l)	51	50	125		217		42	154		81	67

Table 8.16 contd:

Parameter	O5A	O6	O8A	O7	O9	O9A	O9A1	O9A2	O9B	D1	D1A
	2019	2011	2019	2018	2011	2018	2019	2019	2019	2011	2019
pH	6.09	6.05	4.94	7.46	7.37	6.72	5.76	5.09	7.03	6.52	4.75
Conduct. (µS/cm)	48.4	76	46.5	162	107	85	53.6	41.6	66.3	78	49.8
Alkalinity	4.6	4	0.1	47.1	21.6	11	4.0	1.0	14.7	6.3	-0.3
Calcium (mg/l,Ca)	3.96		2.05	20.3		6.7	4.11	2.44	7.12		2.78
BOD (mg/l,O_2)	1.2	1.5	0.9	1.3	1.5	1.6	1.3	1.0	1.2	1	1.0
Ammonia (mgN/l)	0.038	0.04	0.042	0.02	0.03	0.04	0.056	0.043	0.035	0.041	0.052
SRP (mg P/l)	0.059	0.006	0.242	0.001	0.005	0.039	0.059	0.062	0.050	0.005	0.023
Total P (mg P/l)	0.099	0.03	0.278		0.02		0.097	0.094	0.081	0.022	0.048
TON (mg N/l)	0.05	0.05	0.05	0.03	0.09	0.06	0.05	0.04	0.05	0.06	0.05
DOC (mg C/l)	31.0	28.3	32.5		22.7		39.5	35.0	26.4	24.5	40.9
Colour (Hazan)	379		403	107			514	433	376		505
ANC (µeq/l)	245	222	165		534		278	195	426	249	
Total Al (µg/l)	160	232	190		168	348	265	209	147	173	202
Monomeric Al(µg/l)	57	116	106		73		113	114	44	73	105

Table 8.17 Annual average water chemistry values for Lough Cutra 2001-2019 (EPA data).

Year	pH	Conductivity (µS/cm)	Alkalinity (mg/l, $CaCO_3$)	Colour (Hazen)	Transparency (m)	Chlorophyll (µg/l)		Total-P (µg/l)
						Mean	Max	
2001	7.6	124	33.6	131	1.1	4.0	4	0.030
2002	-	-	-	-	-	-		-
2003	-	-	-	112	1.5	4.4	4.4	0.014
2004	-	-	-	-	-	8.3	18	0.040
2005	-	-	-	-	-	9.0	14	0.065
2006	-	-	-	-	-	5.2	11	0.055
2007	-	-	-	-	-	-	-	-
2008	-	-	-	-	-	-	-	-
2009	-	-	-	-	-	-	-	-
2010	7.6	111	37.6	110	1.4	4.8	9.7	0.015
2011	7.8	113	34.0	120	1.6	7.6	24.0	0.016
2012	7.5	103	34.4	176	1.1	4.7	9.7	0.019
2013	7.7	136	44.3	65	2.3	7.4	11.0	0.010
2014	7.7	146	39.5	69	2.1	4.7	8.5	0.014
2015	7.5	129	32.5	96	1.6	3.4	5.2	0.016
2016	7.5	120	39.0	114	1.1	2.0	6.0	0.017
2017	7.5	119	37.3	121	1.4	4.2	7.5	0.018
2018	7.7	145	43.7	68	2.4	3.4	5.1	0.013
2019	7.6	130	36.8	127	1.1	4.7	8.9	0.019

Note: 2001 and 2003 data refer to just a single sample

PLACE HOLDER for FIGURE 8.6

Figure 8.6 Soluble Reactive Phosphorus (SRP)

PLACE HOLDER for FIGURE 8.7

Figure 8.7 Ammonia (mg/l, N) Values for 2019 ASU sites

8.2.5.3 River Water Chemistry Results

The work of Cummins and Farrell (2003a) and Rodgers *et al.* (2010) both show that forestry clearfelled on blanket peat in the West of Ireland results in sharp increases in orthophosphate run-off, with a tendency for higher concentrations in bog drains and tiny streams rather than in larger streams farther downstream, where the concentrations tend to be diluted. Both papers indicate that phosphate levels can remain elevated for at least two seasons, sometimes taking up to four years to approach pre-felling concentrations (Rodgers *et al.,* 2010). Several blocks of forestry have been felled over the past 3 years within several of the catchments draining the Derrybrien Wind Farm and adjoining area and it is thought likely that this activity has contributed to some of the higher SRP values measured at several sites in 2019 and at least one site in 2018, as noted above. The situation with ammonia is not as clear as with phosphate when it comes to forest felling on peat and although some ammonia increases can be associated with clearfelling (Finnegan *et al*, 2014; Cummins and Farrell, 2003b) the chemistry of nitrogen in terms of nitrate, ammonia and organic N is complex and depends on aspects of site management among other factors. The pattern we see in the present study is that the highest ammonia concentrations tend to be located in the smaller lower order streams and drains closest to their sources, diminishing in concentration farther downstream. The likelihood also is that some at least of these higher values are also associated with forestry management activities in these small catchments. In terms of absolute values of ammonia, however, as mentioned previously, they fall mainly within the Good and High Status ranges.

Another feature of the data noted in the 2011 survey are the high concentrations of total and monomeric aluminium at several sites. Elevated aluminium levels may be a feature of the catchment as a whole because in 2009 the EPA measured the annual average aluminium concentration on the main channel of the Owendalulleegh at 103µg/l with a maximum of 215µg/l the same year. Aluminium at certain concentrations and within certain pH ranges is known to be toxic to fish, especially salmonids. However, calcium and humic substances in the form of dissolved organic carbon are known to ameliorate its toxicity (Brown, 1983; Laudon *et al.,* 2005). The chemistry of aluminium is very complex and the forms and solubility in which it occurs vary depending on the pH. The inorganic monomeric forms are considered most toxic. At pH <5.5 the free aluminium becomes the predominant form along with inorganic monomeric complexes and the increased availability at this pH (and lower) is reflected in higher toxicity. In the pH range 6.0-7.5, solubility declines and generally so does toxicity (Crane *et al,* 2007). Sites with the highest monomeric aluminium values (in 2011) were B2, B4, O3 to O4. However, only B4 had a pH appreciably below pH 5.5. Combined with this, however, each of these sites had high DOC levels contributing to elevated Acid Neutralising Capacities (ANC) and amelioration of the toxic potential of aluminium (see Laudon *et al.,* 2005). The latter author suggested using the ANC/H^+ as an index to predict brown trout mortality potential in acid-affected streams. Applying that index, only Sites B4, D1A and O8A had values for the index that brought them into the range where some trout mortality could occur, as opposed to sites with lower index values where the likelihood of mortalities would be expected to be higher. A low index value doesn't preclude trout from being present (and they were present at B4 when surveyed in September 2011 and 2019) but points to a higher risk. In conclusion, acidification and aluminium, while they cannot be entirely ruled out as having some negative impacts from time to time on trout at the sites listed above, the effects of their impacts are not believed to be significant at the Derrybrien sites, as pH tends to be above 5.5 at most sites most of the time. Moreover, DOC levels are elevated at the same sites offering an ameliorating effect. The level of risk in any susceptible stream is also likely to be variable over time depending on the level of precipitation and the stage in the life cycle of any trout present. While this area may warrant further investigation in itself, it should be noted that elevated aluminium levels are not due to the presence of the wind farm nor are they having any negative impact on fish in the main channels of the 3 main river catchments draining the site.

8.2.5.4 Lough Cutra

The EPA began to systematically monitor the WFD status of Lough Cutra including biological and physico chemical elements in 2010 and have continued annually each year since. The lake is visited four times annually for water sampling with a single sample taken at two open water sites each time. A limited amount of chemistry-only surveys were also undertaken pre-2010. There is a very limited amount of data available for 2001 and 2003, and somewhat more for 2004-2006. There does not appear to be any data available for the lake for 2007-2009. Only one sample run was undertaken in 2001 and 2003, in March and July respectively, and in 2004 and 2005 three visits were made and four in 2006. No additional data for the period 2001 to 2003 has been found. Table 8.17 gives the summarised annual average data for Lough Cutra for the periods outlined for: pH, conductivity, alkalinity, secchi disc transparency, average chlorophyll *a*, maximum chlorophyll *a* and Total-P, bearing in mind that the 2001 and 2003 data are for just a single sample run in each case.

The pH is neutral to slightly alkaline and the water is highly coloured. Chlorophyll *a* and Total P levels generally place the lake in the mesotrophic category, although in 2001 and 2003 it would have been classified as oligotrophic based on maximum chlorophyll *a.* However, the single result for both years would be insufficient on which to gauge the trophic status. It is notable that average annual Total-P and annual average colour in the lake data for 2010 to 2019 shows a strong positive correlation (Figure 8.8) while annual average colour and annual average secchi disc transparency for the same period show negative correlation (Figure 8.9). In the case of Total-P the colour is acting as a proxy for flow with high colour years indicating higher levels of flow from the catchment (mainly via the Owendalulleegh) which in turn would mobilise more Total-P in the form of soluble and particulate components. Within the lake, the high colour has a strong influence on the transparency depth. Over the same period, there is no correlation evident between average Total-P and average chlorophyll *a*, and none between average transparency and average chlorophyll. In each case, high colour levels in the lake are likely to be masking these correlations and in some cases supressing them, i.e. higher Total-P inputs may be having less effect on primary production than would be the case in a clear water lake due to a shading effect from elevated colour.

The WFD ecological status in Lough Cutra is assessed by the EPA in 3-year cycles and to date three of these have been completed i.e. 2010-2012, 2013-2015 and 2016-2018. These have classified the lake as Good, Moderate and Good respectively for each 3-year period (Table 8.18). In each case, the assigned status is based on the results for aquatic macrophyte survey findings.

Table 8.18 EPA ecological status classification of Lough Cutra during 3 recording periods since 2010.

2010-2012	Good
2013-2015	Moderate
2016-2018	Good

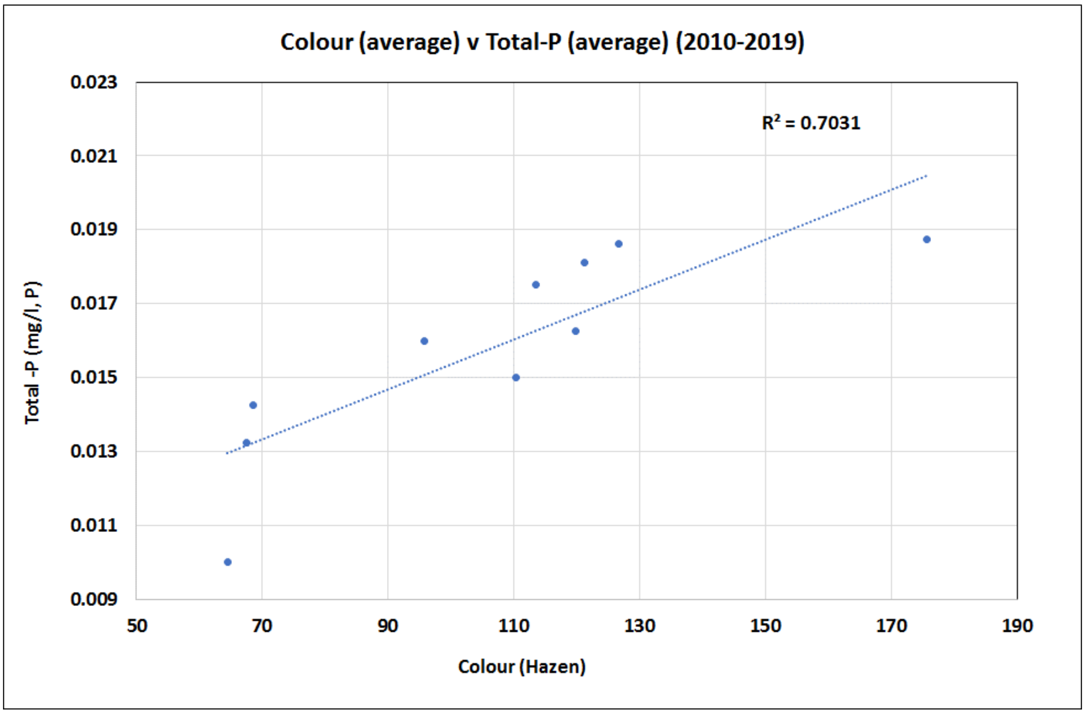

Figure 8.8 Correlation of annual average colour and annual average Total-P in Lough Cutra

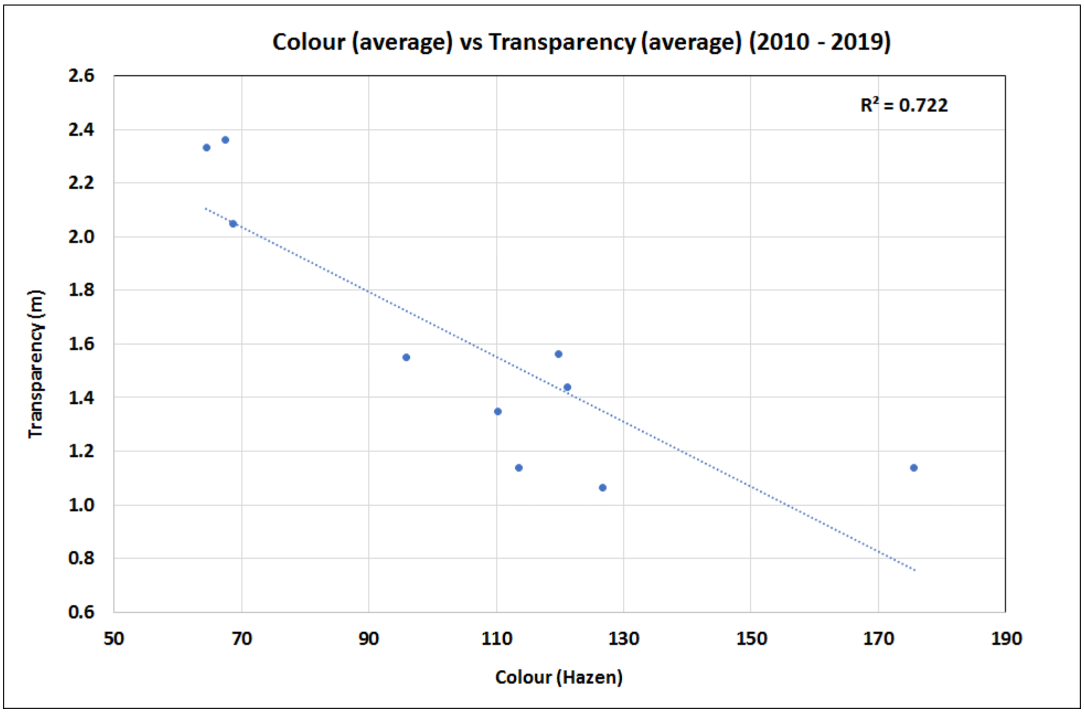

Figure 8.9 Correlation of annual average colour and annual average transparency in Lough Cutra

8.2.6 Fisheries

8.2.6.1 Overview

The Owendalulleegh is known to holds 8 species of fish including: brown trout (*Salmo trutta*), stone loach (*Barbatula barbatula*), eel (*Anguilla anguilla*), lamprey (*Lampetra* sp – more likely to be *L. planeri* – brook lamprey), 3-spined stickleback (*Gasterosteus aculeata*), pike (*Esox lucius*), gudgeon (*Gobio gobio*) and perch (*Perca fluviatilis*). All of these species have been taken in electrofishing surveys and pike are reported from the deep meandering waters of the river just upstream of Lough Cutra. These were also the species (except pike) that were found dead following the 2003 peat slide. Lough Cutra which has a very active pike fishery also contains eel, gudgeon, perch and brown trout.

The Owendalulleegh River flows into Lough Cutra, a 382 ha lake, the outflow from which eventually flows to the sea via an underground river to Kinvarra Bay. This barrier effect explains why, despite excellent salmonid habitat and high status water quality, there are no salmon in the system and although it isn't known, it is assumed that the lampreys present are the non-migratory brook lamprey (*Lampetra planeri*) rather than the migratory river lamprey *(L. fluviatilis*). Only the catadromous species, eel, manages to reach Lough Cutra and the Owendalulleegh from the sea. The Boleyneendorrish system is similarly connected to the sea and would likely have similar barriers to migration as the Owendalulleegh. While the Duniry is not affected in the same way, it discharges to Lough Derg which is upstream of the Ardnacrusha hydropower station and for this reason likely to have very few if any salmon.

8.2.6.2 Findings of Fisheries Surveys

IFI Results and Current Study Results

IFI undertook electrofishing surveys at a single site on the Owendalulleegh about 1.5 km upstream of Lough Cutra in 2009 and 2013 (Bridge SE of Killafeen) and at two additional sites shortly upstream in 2016 (Figure 8.1). Site 3 in IFI's 2016 survey coincides with Site O11, electro-fished for the current assessment in 2014, the most downstream surveyed on the Owendalulleegh. The summarised results from the three IFI surveys are presented in Table 8.19.

As part of the present study, electrofishing surveys were undertaken in the upper tributaries of the Owendalulleegh, Boleyneendorrish and Duniry Rivers in 2011 (September 26th and 27th), in the Owendalulleegh catchment in 2014 (July 17th) and in the Owendalulleegh and Boleyneendorrish catchments in 2019 (September 21st and 22nd). The 2011 conditions were sub-optimal for electrofishing due to high flows and very coloured water levels at the time, whereas the 2014 survey was undertaken in ideal conditions. The 2019 survey was slightly sub-optimal, in that the water was highly coloured at all sites, even though flows were not excessive. This means that the fish numbers encountered in 2011 and 2019, especially the former, are likely to have been at least slight underestimates in the case of all species at some sites. This would have been least noticeable in the case of trout and stone loach, and more the case for lamprey and eel which are more cryptic species, not easily roused from the bottom and therefore more likely to be overlooked, especially in deeper areas. The results from these surveys are presented in Tables 8.20 and 8.21 with details of site characteristics and photos listed in Appendix 8-5. Fish size distribution for trout and stone loach are given in graphical form in Figure 8.10 through to Figure 8.16 at sites where they were sufficiently dense.

The results showed that in the Boleyneendorrish tributaries brown trout were present as the sole species in all four sites surveyed (B1, B2, B4 and B5) and that brown trout and a single minnow were the only species recorded in the Duniry (D1). In the Owendalulleegh and its tributaries (O1-O11) trout, stone loach, eel, lamprey and stickleback were recorded with trout dominating in most of the tributary sites and trout and stone loach in the main channel of the river.

Owendalulleegh Catchment

In the 2011 survey, no fish were recorded in three of the upper tributary sites on the Owendalulleegh, namely at O1 (SC6), O2 (SC6), and O4 (SC7b), whereas there was just a single eel taken at O3 (SC7a) and one trout at O5A (SC7c) on the same occasion. In 2011, 2014 and 2019 no fish were recorded at O5 (SC7b), i.e. just upstream of Flaggy Bridge. In 2019, 3 trout each were returned at O3 (SC7a) and O2 (SC6) with a single stone loach also recorded at O3. In all three years, small numbers of trout were taken on SC7(d) at O6, 800-850m downstream of Flaggy Bridge, 2 in 2011, 9 in 2014 and 2 in 2019. The higher numbers in 2014 probably reflected the better fishing conditions at the time. At the base of this tributary at O6A, just upstream of the main channel of the Owendalulleegh and 1.8 km downstream from Flaggy Bridge, the 2019 survey returned fair number of trout (13) and high numbers of stone loach (41) (Tables 8.20 and 8.21).

Apart from this latter site on the lower portion of SC7 subcatchment, all the small steep tributaries which drain the wind farm site down toward the main channel of the Owendalulleegh, including those not affected by the peat slide, had low densities of trout and other species. This is believed to be due to the generally very course nature of the substrate at several sites and the steeper gradients in these channels that would not be optimal for spawning. Along the main channel of the Owendalulleegh however, the picture is different, with significantly higher densities of trout at all sites in most surveys.

In 2011 only one main channel site was surveyed (O9) where just 2 trout, were recorded as well as 2 lamprey, 1 eel and 26 stone loach. In 2014 at the same site 34 trout and 53 stone loach were recorded, probably attesting to the optimal fishing conditions and lower water level during the 2014 survey. Also in 2014, another two sites were surveyed on the middle and lower reaches of the main channel, O10 which is 10.3 km upstream from Lough Cutra and O11, 5 km upstream. Site O11 coincides with the IFI 2016 survey point, Site 3. In the 2019 survey three other sites were surveyed on the main channel, this time toward the upper reaches: (O7A) situated immediately below the confluence of the Flaggy Bridge tributary (SC7) (i.e. ~18 km u/s Lough Cutra) and O7B and O7C both situated above the confluence at 18.1 km and 19.7 km upstream of the lake respectively. Results from each of these 5 sites recorded a fish community dominated by trout and stone loach. Trout densities at all five sites were similar, ranging from 0.183 fish/m^2 to 0.295 fish/m^2. At the same sites stone loach densities ranged from 0.114 fish/m^2 to 0.226 fish/m^2 with one outlier of 0.006 fish/m^2 at O11 in 2014 (Tables 8.20 and 8.21).

These results show that trout densities on the Owendalulleegh are consistently higher in the main channel than in any of the small tributaries surveyed in the same catchment. Furthermore, the densities encountered are at least as high as those recorded by IFI in their surveys in the lower reaches of the river, suggesting that in the past decade at least overall fish production in the system has been quite stable. The data also shows that the densities of fish encountered in the channel upstream of the tributary impacted by the slide (SC7) are at least as high as those at sites downstream of the confluence and indicate that throughout the main channel trout densities appear to be fairly similar. The latter also confirms that the upper section of the main channel may well have been a very important source of replacement stock during the post-slide recovery period, comprising as they do a full range of age classes.

Boleyneendorrish and Duniry Catchments

Four sites were fished in the Boleyneendorrish catchment in 2011, B1, B2, B4 and B5, and two of these, B2 and B4, were repeat fished in 2019. Densities were generally lower than in the main channel of the Owendalulleegh but similar or higher than in the Owendalulleegh tributaries. Sites B4 and B5 were dominated by 1+ and older fish, while Site B1 in 2011 and B2 in 2011 and 2019 were dominated by 0+ fish, which is thought to be due to the flatter gradient and dominance of gravel and small cobble, suitable for spawning, at Sites B1 and B2, whereas the substrate at B4 and B5 was dominated by large cobbles and boulders. These densities are likely in the case of B4 and B5 to be at least slight underestimates as a result of the very coloured waters, greater depths and very coarse substrate present in both years.

The Duniry which only drains 0.4% of the area of wind farm was fished just once at Site D1 in 2011 when it returned a moderate density of trout (0.13-0.18 fish/m^2) dominated by the 0^+ age cohort.

8.2.6.3 Fish Densities

Overall fish densities encountered in all three catchments were most characteristic of upland soft-water sites. Kelly-Quinn *et al.* (1996) reporting on extensive fish surveys in upland afforested and moorland sites in Wicklow recorded trout densities mainly in the range 0.2-0.6 fish/m^2, while Fahy *et al*. (1984) reported densities of mixed salmonids in waters in Connemara draining granite areas in the range 0.06 to 0.71 fish/m^2. In contrast, Lehane *et al,* (2004) working in the south west reported much higher trout densities in streams draining Old Red sandstone (0.662-0.983 fish/m^2). These observations would indicate that the Owendalulleegh, Boleyneendorrish and Duniry populations are more typical of upland soft water geologies. Kelly-Quinn *et al.* (1996) also reported lower trout densities on steeper, narrow channels with coarse substrates, noting also that lower densities of 1+ and older trout may inhabit suitable pools in such areas. This tendency was also evident in the fish survey results from the current assessment where most of the upper tributaries of the Owendalulleegh and Boleyneendorrish had lower fish densities than the main channels. The only exceptions were B2 (Plate 8.1), and to a lesser extent B1, where the gradient was low and the substrate dominated by gravel, which favoured spawning and hence higher densities of 0+ fish (Plate 8.2).

Electrofishing surveys undertaken by the ESB Fisheries Division at several river sites within 10km of the Owendalulleegh including the Bleach River draining from Lough Atorick, in 1992 (ESB, 1993), 1994 (ESB, 1994) and 1996 (ESB, 1996) returned trout densities in the range of (0.01-0.26/m^2, average 0.1/m^2 across 12 sites) i.e. very much within the range typical of sites surveyed in the Owendalulleegh and Boleyneendorrish for the present study. These data were reported in Inis Environmental Services (2008).

Most of the sites surveyed on the small tributaries of the Owendalulleegh that drain the wind farm, namely O1 and O2 (SC6), O3 (SC7a), O4, O5 (SC7b) (the latter 2 sites on the branch impacted by the 2003 peat slide), and O5A (SC7c), all returned either no fish or generally low densities of fish. Both O4 and O5 returned no fish in 2011 and 2014, while no fish were recorded at O5 when surveyed again in 2019. In 2011 trout were not recorded at O2 or O3 but in 2019 there were 3 trout recorded at both sites. A single eel was recorded in 2011 at O3 and a stone loach at the same site in 2019. In similar vein, just one trout was recorded at O5A in 2011 and 2019.

These results are in keeping with the only earlier electrofishing survey available for the SC7(b) channel. It was undertaken in 2008, where at sites close to Black Road

Bridge (near the present Site O4) and Flaggy Bridge (near Site O5) Inis Environmental Services (2008) found no fish. Whereas in the same survey, at sites 350m and 450m downstream of Flaggy Bridge (i.e. 250-350m u/s of Site O6 in this study) 3 trout were present 350m d/s Flaggy Bridge and 2 trout, 22 stone loach and 1 eel were recorded at the site a further 100m d/s. All trout were either 1+ or 2+, no 0+ fish were recorded. Trout density varied from 0.027-0.05/m^2. The absence of fish at O4 and O5 despite at least some suitable salmonid nursery habitat at both sites may be due in part to the presence of a waterfall situated just under 300m downstream from Flaggy Bridge (Site O5) (Plate 8.3) and Barrages 3 and 4 just downstream of Black Road Bridge (Site O4) (Plate 8.4).

Table 8.19 Fish density (per m^2) data from IFI electrofishing surveys in the lower Owendalulleegh River in 2009, 2013 and 2016

	IFI (1)			IFI (2)	IFI (3)
Species	**2009**	**2013**	**2016**	**2016**	**2016**
Total Trout	0.067	0.070	0.029	0.004	0.026
0+ trout	0.015	0.010	0.004	0.004	0.018
1+ + trout	0.052	0.059	0.025	0.000	0.008
Eel	0.008	0.031	0.004	-	0.004
Lamprey sp.	0.002	0.003	-	0.023	0.003
Perch	0.002	0.003	0.004	-	-
Gudgeon	0.004	0.003	0.002	-	-
Stone loach	0.015	0.003	0.003	-	0.003

Table 8.20 Results for lamprey, eel, 3-spined stickleback and minnow in electrofishing surveys undertaken for the current study in 2011, 2014 and 2019 in densities per m² and numbers (in brackets in front)

Sites	Lamprey	Eel	Stickleback	Minnow
B1				(1) 0.007-0.009 (2011)
O3		(1) 0.013 (2011)		
O6		(3) 0.009 (2011)		
O6A		(1) 0.011 (2014)	(2) 0.022 (2019)	
O7C			(1) 0.009 (2019)	
O9	(2) 0.003 (2011)	(1) 0.002 (2011)		
O10		(1) 0.005 (2014)		
O11	(1) 0.002 (2014)			

Table 8.21 Results for trout and stone loach in electrofishing surveys undertaken for the current study in 2011, 2014 and 2019 as densities per m² and numbers (in brackets)

Sites	Trout	Trout	Trout	Stone loach	Stone loach	Stone loach
	2011	2014	2019	2011	2014	2019
B1	(4) 0.081					
B2	(10) 0.188		(18) 0.174			
B4	(6) 0.050		(7) 0.064			
B5	(13) 0.040-					
D1	(19) 0.13-0.18					
O1	No Fish					
O2	No Fish		(3) 0.032			
O3	No trout		(3) 0.052			(1) 0.017
O4	No Fish	No Fish				
O5		No Fish	No Fish			
O5A	(1) 0.0102		(1) 0.017			
O6	(2) 0.011	(9) 0.045	(2) 0.014			
O6A			(13) 0.143			(41) 0.450
O7A			(43) 0.195			(50) 0.226
O7B			(39) 0.295			(15) 0.114
O7C			(34) 0.289			(14) 0.119
O9	(2) 0.003	(34) 0.101		(26) 0.039	(53) 0.157	
O10		(52) 0.267			(26) 0.134	
O11		(94) 0.183			(3) 0.006	

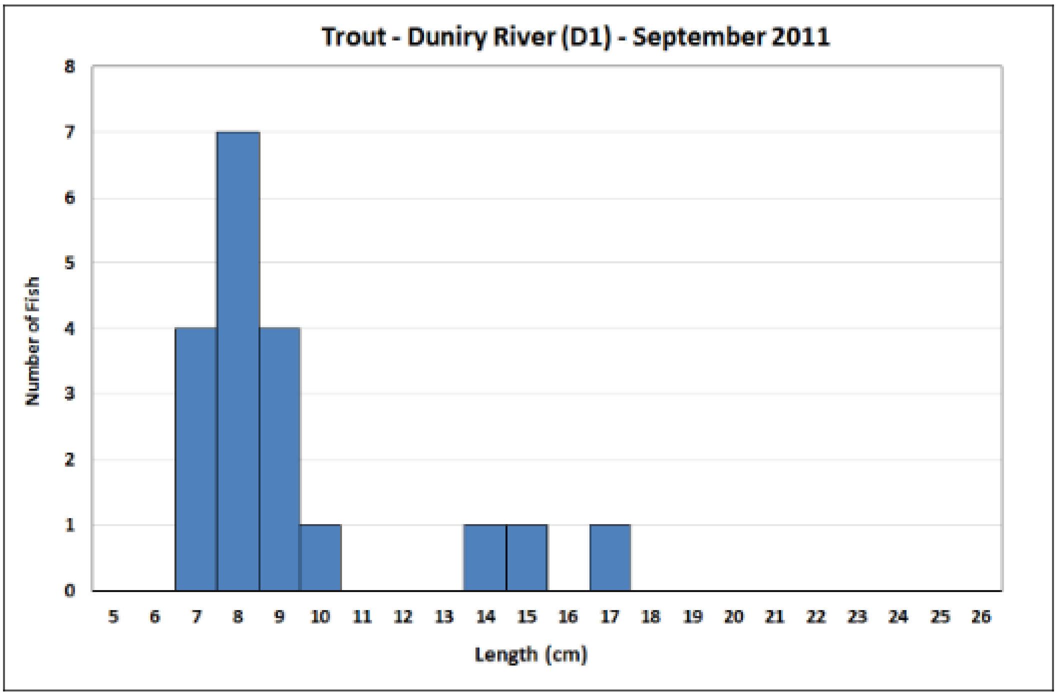

Figure 8.10 Size distribution of trout at Site D1 on the Duniry (September 2011)

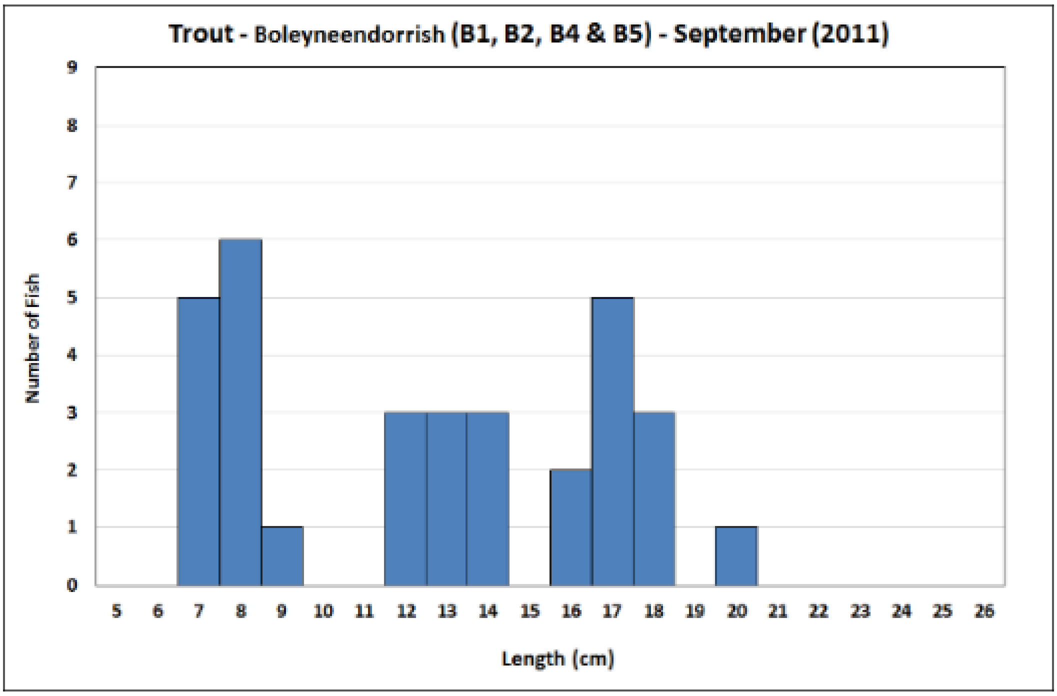

Figure 8.11 Size distribution of trout in the Boleyneendorrish sites surveyed September 2011

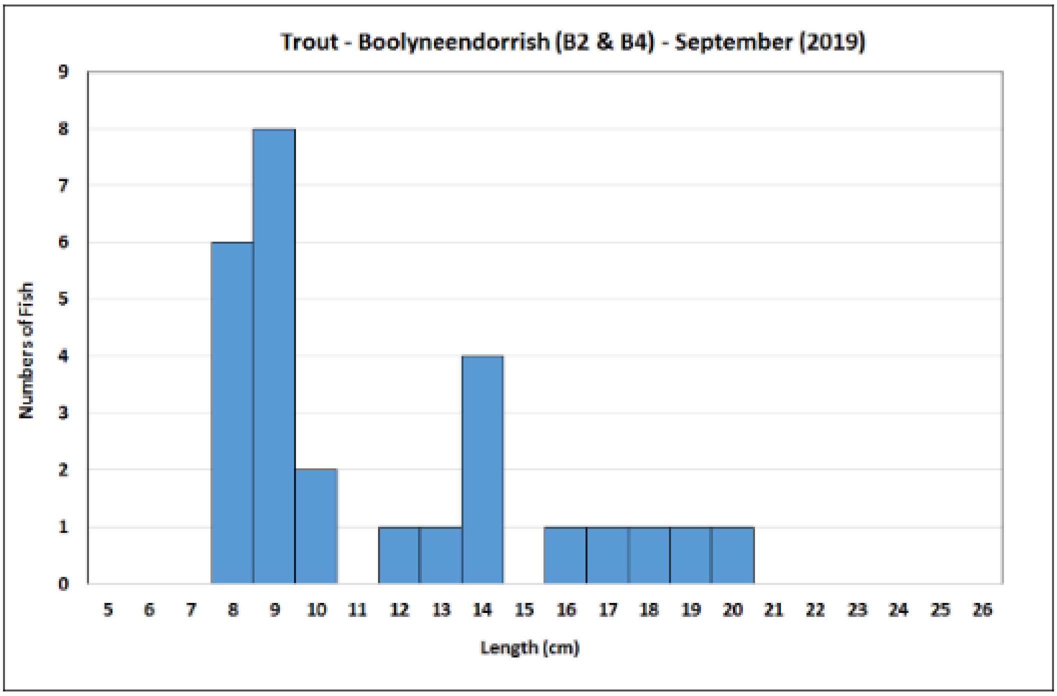

Figure 8.12 Size distribution of trout in the Boleyneendorrish sites – September 2019

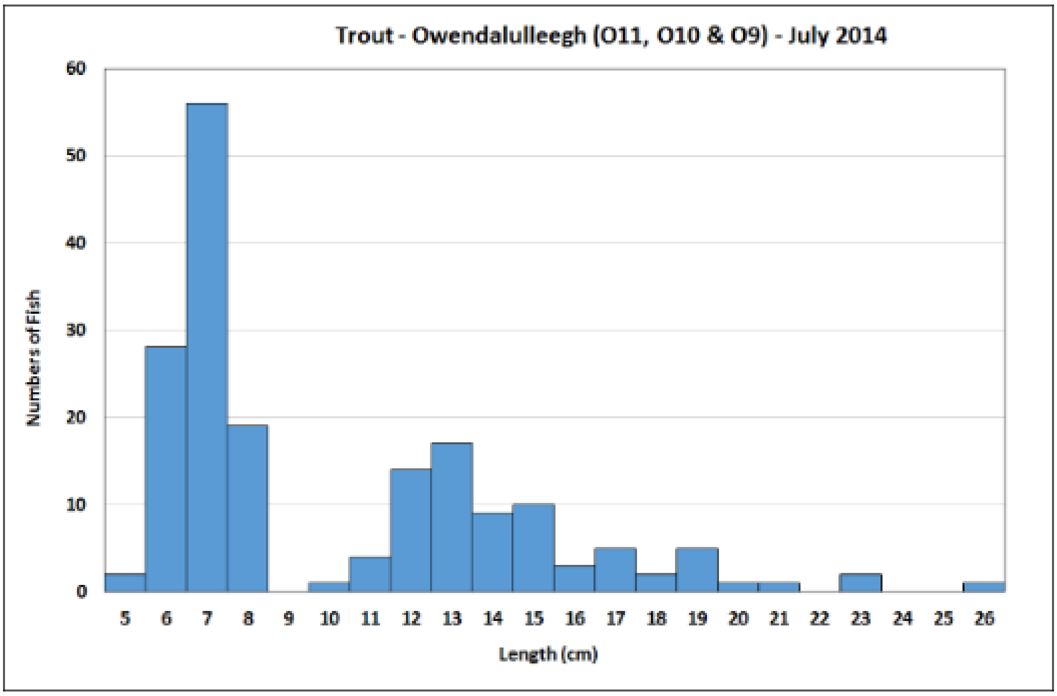

Figure 8.13 Size distribution of trout in the main channel of the Owendalulleegh (July 2014)

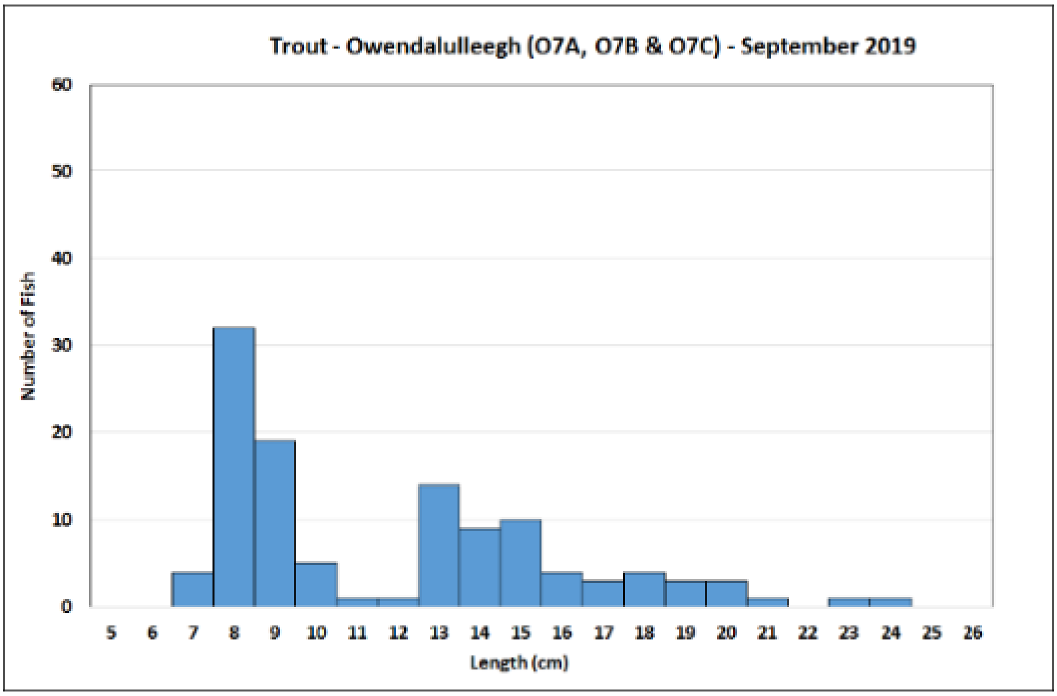

Figure 8.14 Size distribution of trout in the main channel of the Owendalulleegh (Sept 2019)

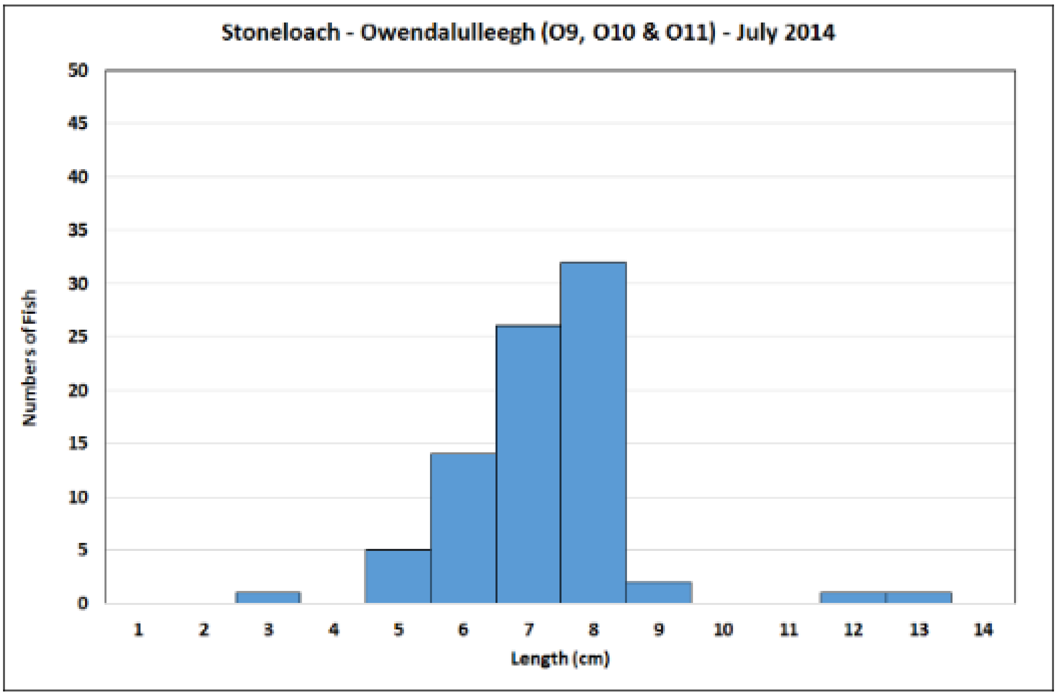

Figure 8.15 Size distribution of stone loach in the main channel of the Owendalulleegh (July 2014)

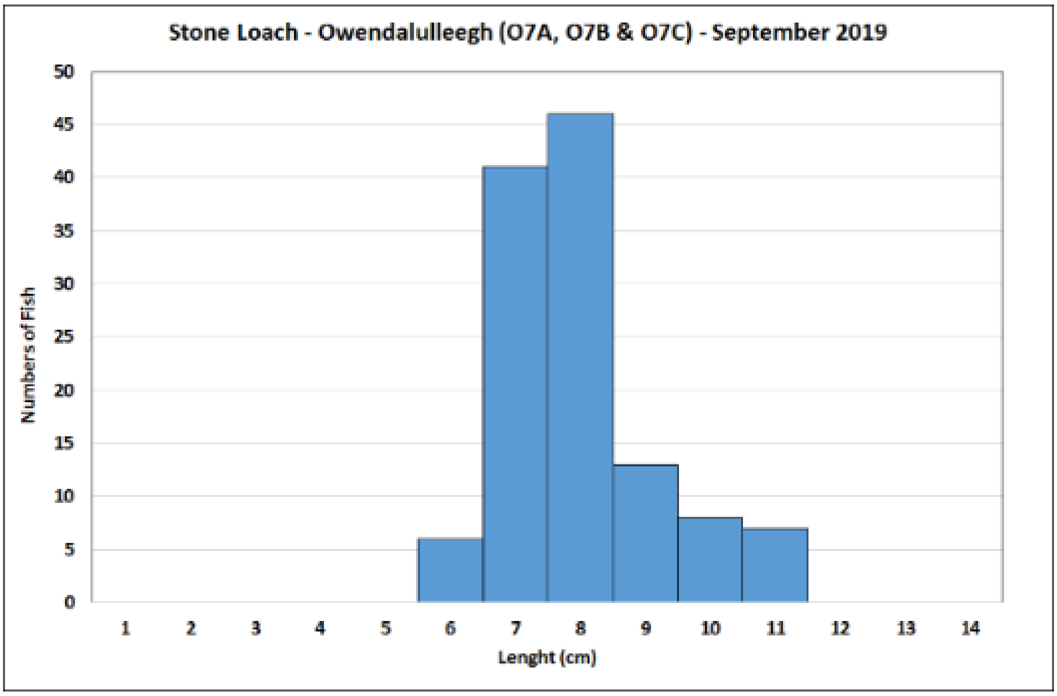

Figure 8.16 Size distribution of stone loach in the main channel of the Owendalulleegh (Sept 2019)

Plate 8.1 Site B2 (September 2019)

Plate 8.2 0+ trout, Site B2 (SC2), September 2019

Plate 8.3 Waterfall ~300m downstream from Flaggy Bridge (Site O5, SC7b) – August 2018

Plate 8.4 Barrage 3, d/s Site O4 – SC7b (January 2020)

Plate 8.5 Site O7C, main channel of the Owendalulleegh immediately downstream of forestry road fording point showing stop net at u/s end of survey reach (September 2019)

Plate 8.6 Site O5A (SC7c) showing large boulders in channel. (September 2019)

Plate 8.7 Only trout (1++) taken at O5A (SC7c) in September 2019.

8.2.7 Ecological and Freshwater Value

Table 8.22 is based on NRA guidelines from 2003, with very slight modifications and these criteria have been used as a guide to classify the value of the aquatic habitats within the study area that have been and may be impacted by the Project. The later revised guidelines (NRA 2009) have been used minimally, as they mainly do not directly reference aquatic habitats or fisheries. Note that only criteria with direct relevance to aquatic habitats and fisheries within the study area have been retained in the table. In terms of geographic scales/area categorisations, alternative headings (in brackets) have been included for each of the categories A-E, corresponding to those of Fossitt and Nairn (2004), for added flexibility. In the context of the current assessment the same water body may be considered important under more than one heading and therefore at more than one local or larger geographical scale.

The rivers into which the Project drains are not designated salmonid waters under the European Communities (Quality of Salmonid Waters) Regulations of 1988, nor are they major salmon rivers. There is a healthy population of brown trout in the Owendalulleegh and the Boleyneendorrish main channels and some of their tributaries with excellent salmonid habitats and in this regard, they can be classed as C: High value locally important/County importance. This designation could also encompass Hydrometric Area 29 (Galway Bay South East) of which the two river systems form a very important part. An Annex II species, lamprey, probably the brook lamprey (*L planeri*) is also present. It is classified as of least concern in the Irish Red Data Book No. 5 (King *et al.,* 2011). In general, the habitats within most of the main channel and tributaries are sub-optimal for lamprey juveniles (ammocoetes), due to the spatey nature of the system and the consequent lack of finer material, which is the preferred substrate for ammocoetes. They are present in small numbers in some channel stretches where pockets of suitable habitat exist at the margins. Eels which are classified as critically endangered in the Irish Red Data Book No. 5 (King *et al.,* 2011) are also present in the system but densities are low. It is worth noting that both these species are more cryptic than trout so that their numbers in the three electrofishing surveys are probably slight underestimates at some sites because highly coloured water, deeper sites and, in the case of eel especially, very coarse substrate make them more difficult to capture. For these 2 species the Owendalulleegh can be classified as category D, Moderate value, locally important/Local importance (higher value), The status of lamprey and eel in the Boleyneendorrish is unknown, as neither species was captured during electrofishing surveys in this catchment for current study.

The main channel of the Owendalulleegh and its tributaries, has an undisturbed hydromorphology which does not appear to have ever been impacted by channelization or other significant man-made physical disturbance. The habitats are generally ideal for salmonid fish with riffle, glide and pool sequences in many parts of the system. This fact, coupled with the consistent High Status Q-ratings of the water quality as reported by the EPA along the main channel for in excess of 20 years, means that overall these habitats can be classed as of category C (High Value

Locally Important/County Value). However, given that the number of High Status river water bodies in Ireland has fallen by nearly a third (91 water bodies) since the baseline assessment in 2007-2009 (EPA, 2019) this highlights the importance of the main channels of both the Boleyneendorrish and the Owendalulleegh in a regional and national context. This assessment is further supported by the knowledge that the highest quality biological sites (Q5) show no sign of recovery nationally, having fallen from 13.4% of sites in 1987-1990 to only 0.7% of sites in (2016-2018). Indeed, the number of Q5 sites currently stands at 20 in the whole country (EPA, 2019). Of these, in 2018, 2 were present on the main channel of the Owendalulleegh and 1 on the main channel of the Boleyneendorrish, raising the ecological value of these channels to level B on the table namely to National/Regional importance. Most of the larger tributaries draining the Derrybrien Wind Farm e.g. B2, B3 and B4, O5A O6A, O9A and D1 can be considered of High Value Local Importance (Category D) having mainly Good or High Status water quality and good brown trout habitat. Smaller upper tributaries including B1A, B4B, B4C, D1A, O1-O5, OHL 1 and OHL2 are of Moderate or Low ecological value by virtue of their generally smaller size, limited fisheries habitats or occasionally less than Good water quality falling somewhere between category D and E.

Lough Cutra is classed as of international importance as a Special Area of Conservation (SAC) and Special Protection Area (SPA) but not for water based conservation objectives. Its status as a regionally important pike fishery, its eel population, combined with its size and generally Good Ecological status would suggest that it is of at least category C status i.e. High value, locally important/County importance. Lough Atorick which hasn't any WFD ecological status as yet assigned to it can be described as category D (Moderate value, locally important), as it is likely to hold a stock of small trout and have at least Good Ecological Status.

Table 8.22 Ecological value ratings of habitats based on NRA ecological guidelines from 2003.

Rating	Description
A	**Internationally Important** Sites designated (or qualifying for designation) as an SAC. Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988) Major salmonid (salmon, trout, or char) lake fisheries
B	**Nationally (or Regionally Important)** Sites or waters designated or proposed as an NHA or Statutory Nature Reserve. Undesignated sights containing <u>significant numbers</u> of resident or regularly occurring populations of Annex II species under the EU habitats directive. Major trout fisheries. Waterbodies with major amenity fisheries value. Commercially important coarse fisheries.
C	**High Value, locally important (County Importance)** Small water bodies with known salmonid populations or with good potential salmonid habitat,

Rating	Description
	Sites containing any resident or regularly occurring populations of Annex II species under the EU Habitats Directive. Large water bodies with some coarse fisheries value.
D	**Moderate value, locally important (Local Importance – Higher Value)** Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any waterbody with unpolluted water (Q-value rating 4-5).
E	**Low value, locally Important (Local Importance - lower value)** Water bodies with no current fisheries value and no significant potential fisheries value.

8.3 Impact of the Project

8.3.1 Overview

The Project was constructed between 2003 and 2006. The current impact assessment addresses likely significant effects of the Project during that time as well as post construction impacts associated with ongoing operation of the wind farm and final decommissioning of the Project.

The impacts in question are any that would affect the rivers and streams draining from the Project area.

The Project can be described under the following headings

(i) Construction of the wind farm between 2003 and 2006.

(ii) Construction of the grid connection (OHL and Agannygal Substation).

(iii) Containment works required from 2003 to 2006 in response to the peat slide which occurred during the construction phase of the wind farm in October 2003.

(iv) Maintenance works on the wind farm, substations and along the overhead line during the lifetime of the wind farm

(v) Decommissioning works associated with the wind farm, the overhead line, Agannygal Substation and the residual containment measures required to stabilise peat slide in 2003.

8.3.2 Impacts which have occurred

Construction phase impacts are dealt with in Section 8.3.2.1 and those specifically relating to the peat slide of October 2003 are dealt with separately in Section 8.3.2.2.

8.3.2.1 Construction phase: June 2003 - 2006

The construction of the Project comprised the following main components that could potentially have given rise to negative impacts on the aquatic environment:

(i) Felling of 222 ha of coniferous forestry at various stages of maturity within the footprint of the wind farm, 33.1 ha along the 7.8 km of the OHL corridor and 1.6 ha for Agannygal Substation.

(ii) Supplementing the existing on-site drainage mainly on the western part of the site, as the eastern portion had already been well supplied with drains for turbary.

(iii) Insertion of tracks-side drains and drains from turbine bases.

(iv) Building a site compound.

(v) Construction of internal access tracks to turbine locations (mainly floating roads).

(vi) Coillte access track upgrade.

(vii) Road upgrades

(viii) Establishment of borrow pits as sources of stone and boulder clay for construction work and as post-construction peat repositories.

(ix) Reinstatement of borrow pits.

(x) Construction of turbine bases and adjoining crane pads.

(xi) Provision of 32 peat repositories throughout the site to store peat excavated during construction.

(xii) Trenching for cables linking turbines to the Derrybrien Substation.

(xiii) Wind farm substation compound construction.

(xiv) Overhead line construction.

(xv) Agannygal Substation construction.

All items listed above pertain to the wind farm site except for xiv and xv which relate to the OHL and the Agannygal Substation, which are off-site. In the interest of clarity, the impacts associated with construction of the wind farm and those of the OHL and the Agannygal Substation have been presented more or less separately, despite some minor overlap.

Wind Farm and associated works

In general, given the nature of the Project, as well as the site's antecedent land-use mix and dominant blanket peat overburden, the main contaminants likely to have arisen from the construction activities on the wind farm were peat solids and nutrients associated with clearfelling required for site preparation and mineral and peat solids associated with construction activities. Considering that these two activities, i.e. clearfelling and general construction, were proceeding more or less in tandem, their potential impacts on receiving streams would also have occurred more or less at the same time. In relation to the evolution of suspended solids contamination during construction this would have been associated with many different components of the infrastructure installation, including access tracks, turbine bases, cable trenches, peat repositories, borrow pits etc. In most cases these components are evenly spread across the site so that it would not be feasible to attempt to separate their proportional contributions to the impacts on receiving streams. With the possible exception, a few features can be more precisely assigned to a given receiving watercourse or subcatchment e.g. the substation or Borrow pit 3. The following paragraphs deal with those aspects of the construction that could have been the source of contaminants. Once these have been described, their combined potential impacts are discussed later in the section.

Coillte Access Track & Road Upgrades

3.1 km of existing Coillte access track to the site had to be widened to 4 m with 4.5 m at bends to facilitate the use of the site as a wind farm. This entailed strengthening, construction of lay-bys and remedial works to drainage along the road as well as the placement of geogrid, rock material and regrading and surfacing works. The track drains to subcatchment SC4 in the upper section of the Boleyneendorrish and SC5 in the upper section of the Duniry catchment. The works would have generated some mineral solids the coarser fractions of which would have been intercepted in roadside drains and intermediate connecting drainage, while the fine fractions would have dispersed widely but very thinly in these upper catchment sections.

In addition, some minor widening and resurfacing of the Black Road was required over a 5 km distance to take the increased level of construction traffic. As part of these improvements, upgrades to Black Road Bridge and Bridges A and B were also undertaken. These works would have generated very little in the way of solids washout due to their minor nature. The re-surfacing, presumably with asphalt would have given rise to a temporary rise in trace hydrocarbon contaminants (PAH's) in the initial run-off events following re-surfacing. Much of which would have been intercepted in roadside soils and the residual amounts rapidly diluted in the receiving waters of SC6, SC7(a) and SC7(b).

Tree Felling

Clearfelling of the 222 ha of coniferous plantation on site was the first action on the site in preparation for the construction and installation of the wind farm infrastructure. It began in June 2003, a month before civil works began on site, was interrupted in mid-October 2003 due to the peat slide and recommenced in the second half of 2004 and finished in September 2005. During the initial period up to October 16th, 2003 felling proceeded along a 15 m wide corridor in order to open up a pathway for the turbine access tracks. Felling at the 3 borrow pits and at the wind farm substation was also undertaken in this initial period. In total, this initial felling amounted to around 31 ha of the total. A significant feature of this felling was its diffuse distribution across the site with any derived runoff divided between at least 9 of the subcatchments draining the site. At the same time as the preliminary on-site clearfelling was being undertaken, felling of the 33.1 ha along the OHL was also beginning at the wind farm end of the 7.8km route. 3.4 ha was felled before work ceased in October 2003 because of the peat slide. This had covered about the first 500 m of the OHL corridor beyond the wind farm which lay within the upper catchment of SC7(b) i.e. upstream of Site O4. After a gap of 8 months the remaining on-site felling of 191 ha of mixed maturity stage forestry and the remaining 29.7 ha of forestry along the OHL were completed in the roughly 12 months between mid-2004 and mid-2005.

The area of forestry that was felled on site between 2003 and 2005 has been apportioned between each of the subcatchments draining the wind farm in Table 8.23

along with the % of the overall area of each of those subcatchments constituted by the felled area. This also includes the smaller areas felled along the section of the OHL that drain to the same subcatchments that drain the wind farm site i.e. in SC7(b) and SC7(d) and from the southern end of the OHL line at Agannygal (2.25ha) and the area felled to accommodate the substation there (1.6ha) which drains towards Lough Atorick (3.85ha in total). Within the wind farm site the greatest proportion of felling occurred in subcatchments SC1, SC2 and SC3, and SC7(a), SC7(b) and SC7(c).

Table 8.23 Areas of forestry felled on wind farm site, along the OHL and at Agannygal Substation within each of the subcatchments

Subcatchment Number	Subcatchment Area (ha)	Area of on-site felling within each Subcatchment (ha)	*OHL felling apportioned Subcatchments Area (ha)	Felled area as a % of Subcatchment Area
SC1	643.8	18.4	0	2.9
SC2	316.6	36.2	0	11.4
SC3	95.9	20.1	0	20.9
SC4	173.7	8.8	0	5.1
SC5	221.7	1.3	0	0.6
SC6	513.7	1.9	0	0.4
SC7(a)	586.8	33.8	3.3	6.2
SC7(b)	302.0	17.8	11.71	9.8
SC7 (c)	354.7	74.7	0.16	21.1
SC7(d)	61.8	0	4.7	7.6
SC8	280.9	4.6	0	1.6
SC9	648.1	4.6	0	0.7
Agannygal (Atorick/Bleach)	200	0	**2.26	1.13

***** Approximate areas.

** A further 1.6ha was felled to accommodate the Agannygal Sub-station

Insertion of Additional Drains

The eastern part of the site already had a well-developed network of drainage channels before work on the wind farm began but additional drainage was required, mainly in the central and western portions of the site where they supplemented the pre-existing drains. Installing drains would have potentially generated some peat silt. However, given that most of the bases of these drains would have been in peat, any solids arising would have been low (Nieminen, 2003). Where the new drains cut into mineral soils below the peat layer, e.g. in some areas toward the southern edge of the site, suspended solids loss would potentially have been higher (Nieminen, 2003).

Site Compound

The site compound for the construction phase was established at the NE corner of the wind farm site not far from Borrow Pit 3 on an existing Coillte track turning area. As activities ramped up this was expanded on either side to a final size of 77 m x 38 m. The extension was formed by stripping the peat and back-filling it with crushed rock from the borrow pit. The surface was finished with imported hardcore. The excavated peat was side cast. The construction of this compound would have generated some silt at the time, mainly associated with washout of fines from the hard core topping layer and the side-cast peat, which could have made its way into the headwater tributary of the Boleyneendorrish in SC4.

Access Tracks

15.5 km of internal roads were laid to provide access to the turbine locations. Over 14.6 km of these roads were floating roads built on top of the existing peat layer, with just a short length of non-floating road. Floating roads were topped with a 500mm layer of crushed rock from the borrow pits on site and a 50 mm layer of imported Clause 804. This was overlain in places by a thin layer of quarry dust. Non-floating roads (0.9km) were finished in a similar manner. In the case of both road types the parallel roadside drainage was maintained throughout.

Non-floating roads (0.9 km) required the initial removal of the mainly thin overlying peat layer which was side-cast and later placed in designated peat repositories.

The construction of floating and non-floating roads would have given rise to run-off of some fine mineral solids, mainly from the finished surfaces in the case of both road types. However, the fact that the vast majority of the tracks were floating, requiring no excavation into mineral sub-soil, significantly reduced the potential for solids loss. This combined with the mainly gentle gradients on much of the site also reduced the level of erosion during heavy rainfall. The main source of suspended solids from these surfaces would have been early in their construction when easily erodible fine solids would have washed from the surfaces before they were fully bedded in. Although some of this washout would have reached the drain network running in parallel to the tracks, these tended in the main to be set back by a few meters so that some solids would have had an opportunity of being filtered out in the intervening vegetation before reaching the drains. At the base of the drains, silt traps were installed in order to intercept the bulk of the solids. Residual solids leaving the site from this aspect of the works would have been broadly distributed among the subcatchments draining the site, given the even spread of roads around the site.

Borrow Pits

The 3 borrow pits developed on site initially had the peat and mineral soil overburden removed and side cast and later amalgamated into repositories adjacent to each. The 3 pits had the potential to be sources of mineral solids associated with initial surface stripping and due to washout of dust and mineral particles associated with concentrated heavy vehicle movements, residual solids from the excavation of stone

(Borrow Pits 1 & 3) and the excavation of boulder clay (Borrow Pit 2) during their operation. Crushed stone in itself would be unlikely to generate high levels of solids and any generated would be amenable to rapid deposition. Constant movement of heavy machinery at entrances could increase the amount of fines available to be washed out at these locations. The management of entrances to these areas would have been important. A rock crusher was used in Borrow Pit 3 but it's location within the pit itself would have precluded it becoming a source of solids. In summary therefore, it's thought that the borrow pits themselves are unlikely to have been a significant source of solids washout because by their nature they are more likely to retain solids within their boundaries. Nevertheless, the entrance areas to each could have been a source of some solids washout into surface drainage during periods of heavy rain and resulted in at least some residual solids exiting the site, especially around Borrow Pit 3, the largest and most active.

Turbine Bases

70 turbines of two different types of bases were constructed on the site. The bases of each type were excavated by removal of the peat layer and any boulder clay rock using a digger on wide tracks to protect the underlying peat. All excavated material was side cast. Where foundations had to be dewatered, the water was broadcast across the vegetated bog to filter out solids. Once the bases were shuttered and reinforced, depending on the size of the turbine base, either 96m^3 or 121m^3 of concrete was poured to form the pads. The concrete was provided by an external supplier; no concrete was batched on site. Once in place the surrounds of the base were backfilled with the boulder clay originally stripped from the footprint and then topped with crushed stone from the borrow pits. At this time also a buried land drain was installed around the base, the outlet of which was connected into the surface drainage network. Water ponding in any of the turbine foundation excavations was pumped out to nearby surface drainage, often over the vegetated surface to filter out solids.

Wind Farm Substation

Peat was stripped from the footprint and brought by dumper truck to the peat repository between T24 and T25. The work began in October 2003 but was stopped after 3 days due to the peat slide and wasn't resumed until December 2004. Prepared ground was brought up to formation level using crushed stone from the borrow pits on site. All concrete used on site was imported rather than batched on site and all pouring was into shuttered or concrete moulds (e.g. for end mast leg foundations). A drainage ditch was dug around the northern and eastern perimeter of the substation compound set back between 7m and 13m from its perimeter. This drain exited the site into the source of SC7(a) via an existing Coillte drain. The edge of the substation is set back 75m from the southern perimeter of the wind farm, so solids-contaminated runoff from the construction area would not have readily exited the wind farm site, assuming that the new perimeter drain was not inserted until after the compound had been completed. However, given the frequent movements of heavy traffic in and around the compound during construction which was undertaken in winter, it is likely that some suspended solids would have reached surface drainage downstream from this site i.e. into subcatchment SC7(a), during construction.

Cable Installation

8 cable routes were constructed within the site, most of them running east-west close to and parallel to the access tracks, all of them eventually linking to the substation. They were laid in shallow peat trenches (without ducting) which were being backed-filled as soon as the cables were being laid with the excavated peat that had been temporarily side cast when opening the trenches. This procedure is likely to have given rise to the washout of small amounts of peat solids which would have entered the drainage network throughout the site with residual amounts exiting the site via the subcatchments draining the site. Where the trenches had to cross under existing cross drains the potential for solids washout would have been higher. Overall, however, given that this was a continuous cut, lay and back-fill exercise, it's unlikely to have given rise to appreciable amounts of peat silt washout. Whatever amount would have exited the site would have been distributed across all subcatchments rather than being concentrated in any one in particular.

Peat Repositories

32 peat repositories were dotted throughout the site and maintained on level ground with no more than 1m of deposited material, these were all inserted post the 2003 slide when work resumed on the site in later 2004. Peat for the repositories came from peat previously side cast beside the 37 wind turbines completed prior to the peat slide and from the balance constructed after the slide. A larger repository between T24 and T25 accommodated the peat stripped from the platform for the on-site substation (see *Wind Farm Substation* above). After completion, these repositories would have rapidly revegetated with pioneer species such as bulbous rush and later by other species, thereby reducing and eventually preventing further erosion of peat solids. Some of the peat silt washed from the repositories while they were still being used would have been intercepted in vegetation at the margins of tracks and between these and the drainage system. However, the assumption is being made that at least a portion of the mobilised solids would have left the site in all drainage channels during heavy rainfall events despite the presence of silt traps on outlet drains.

Nature of the Impacts

Clearfelling - Impacts on Water Quality (Chemistry & Q-values)

Studies in the west of Ireland have shown that in upland blanket peat catchments clearfelling can result in a drop in water quality from Q4 to Q3-4 (O'Driscoll *et al.*, 2013). It is likely that this is mediated by an increase in nutrient run-off, in particular phosphorus and may also be contributed to by increased peat solids runoff following felling. Significantly increased concentrations of phosphorus have been shown by Rodgers *et al.,* (2010) and Cummins and Farrell (2003a) to occur in small drainage channels following clearfelling of conifers on upland blanket peat in the west of Ireland, particularly in the first 2 years after felling. Finnegan *et al.*, (2014) and

Rodgers *et al.,* (2011) have also shown that felling on blanket peat can give rise to increased solids in run-off, although the levels in general do not appear to be high or of extended duration. The current study has recorded elevated soluble reactive phosphorus levels (SRP) in several of the small streams draining from the land surrounding the wind farm in 2019 (see Table 8.16 & Figure 8.6This was evident at sites in subcatchments SC9, SC8, SC7(c), SC2 and to a lesser extent (SC1). In several of these instances, the increased concentrations followed clearfelling in 2018 and 2019 in the same subcatchments. These included SC1, SC8, SC9 and an unnamed subcatchment situated between SC9 and SC8. Sites in several of these subcatchments also had Moderate Status Q-value ratings i.e. Q3-4 or Moderate bordering on Good (Q3-4/Q4), when they would have been expected to have at least Good Status (Q4) which, given the observations quoted in the literature cited above, is being attributed to the clear-felling that occurred in the subcatchments in 2018 and 2019. It is important to note that this link could not always be demonstrated in the 2018 and 2019 data for this study, either in terms of water chemistry or Q-ratings, e.g. despite several hectares of felling in subcatchment SC7(a) in 2018, increased SRP concentrations were not recorded at site O3 in 2019 in this subcatchment and a Q-rating of High bordering on Good (Q4-5/Q4) was recorded. One possible explanation for this is precipitation of phosphorus by Iron in the system, especially as iron scum was noted from time to time at Sites O1, O2, O4 and O4A. That notwithstanding, taking a conservative approach and combining the data gleaned from the macroinvertebrate and water chemistry surveys for the current assessment combined with published EPA Q-rating data for the system, the assumption is being made that clearfelling associated with the wind farm construction did have an negative impact on biological water quality in the receiving streams. Furthermore, it is suggested that the level of that impact depended broadly on the size of the area felled as a % of the area of the subcatchment to the monitoring site in the stream where the water quality was being assessed. See below for impacts associated with clearfelling along the OHL corridor and Agannygal Substation.

Suspended Solids – Impacts on Macroinvertebrates & Water Quality

Suspended and deposited inorganic sediments can have a negative impact on macroinvertebrates in streams mediated through a wide variety of mechanisms including burial, reduced oxygen supply to sediment interstices, abrasion of soft body parts such as gills, increased invertebrate drift, dilution of food quality due to increased supply of inorganic particles, reduction of refugia in coarse sediment by clogging with deposited sand, increased habitat instability etc. (Jones *et al.,* 2012). At a localised patch-scale, increased sediment deposition and cover in upland streams in temperate waters has been linked to reduced taxa richness especially of EPT[5] (mayflies, stoneflies and caddis flies), depending on the quantum of sediment involved (Larsen *et al.,* 2009). Despite these observations, however, both cited papers emphasise the difficulty associated with establishing the role and scale of macroinvertebrate impacts in streams attributable specifically to inorganic sediment,

[5] EPT = Ephemeroptera, Plecoptera and Trichoptera

as opposed to other impacts related for example to changes in land use and associated water quality effects.

In the case of the present study area, the Larsen *et al.* (2009) paper would suggest that increased sediment supply as a result of the construction phase could have led to a reduction both in the diversity and the density of mayflies, stoneflies and caddisflies, some or all of which were present in most samples taken as part of the current study between 2011 and 2019/2020 on the streams draining the wind farm. Such alterations in invertebrate composition, could contribute to a deterioration in the Q-rating of a site, although not necessarily. That said, however, the terrain on all sides of the wind farm falls away steeply beyond the boundaries of the site and in the more than 30 sites surveyed as part of this study, fine sediment deposition was very rarely observed in the main channel of any stream. This doesn't mean that sediment lost from the site during the construction phase would not have had an impact, it does suggest however that they would have been very widely distributed, and therefore in the main thinly spread in the downstream watercourses. However, an increase in the runoff of inorganic and peat solids, combined with increased nutrients from clearfelling, mainly, would be more likely to be detectable as reductions in ecological status as revealed by reduced Q-ratings. To conclude therefore, the combined impact of forestry felling, road construction, cable trenching, drain digging, peat repositories and all other on-site construction activities is likely to have resulted in a **moderate, negative but temporary to short-term impact** on the water quality of the small streams draining from the wind farm. This impact would have taken the form of a reduction in the Q-rating from High (Q4-5) to Good (Q4) or Moderate (Q3-4), mainly, and occasionally to Moderate bordering on Poor, (Q3-4/Q3) in those subcatchment sites in which most clearfelling took place. A more site-specific assessment of the combined impacts of clearfelling and general wind-farm site construction on Q-ratings is presented in Table 8.24 below.

Suspended Solids – Impacts on Fish

Deposited solids both organic and inorganic can also have negative impacts on fish recruitment in affected streams. For example, solids deposited on salmonid spawning redds, could result in a reduction in oxygen exchange around the buried eggs due to clogging up of gravels, thereby reducing egg and fry survival. Hatched fry would also be at risk from elevated suspended solids levels in the water column potentially causing gill clogging and/or abrasion leading to mortality due to osmotic stress or leading to gill disease which in turn could result in increased mortality rates. This potentially negative impact is thought unlikely to have been significant for trout survival in the various tributary streams draining the wind farm site because, as noted above, solids would have dispersed widely downstream. It is also important to point out that electrofishing surveys undertaken in several of the streams draining the wind farm site showed that the majority of the fish present tended to be 1+ and older, with a lower representation of 0+ fish, suggesting that they are not productive spawning channels. One notable exception is B2 in subcatchment SC2, where 0+ fish dominated in both fish surveys at the site in 2011 and 2019. To conclude therefore, the impact which washout of mineral and organic solids from the wind farm construction had on fish in the receiving water courses (as opposed to invertebrates) is believed to have been at worst, **slight, negative and temporary to short-term** in duration. The reason why felling and the other construction phase activities on the wind farm site could have impacted moderately negatively on macroinvertebrates as indicated in the previous paragraph and had only a potentially slight negative impact on fish is because it has been shown that the main fish species in the streams draining the wind farm, brown trout, are barely impacted by moderate impairments in water quality i.e. of at least as low as Q3-4, and only marginally negatively impacted by poor water quality (Q3) (Kelly *et al.,* 2007). Also, there is little evidence of spawning in most of these upper tributaries which means that there would have been little if any reduction in recruitment due to the construction operations and while increased nutrients associated with felling would not negatively affect them it could register an negative impact on invertebrates Q-ratings. The impact described here refers only to those accruing from the on-site clearfelling and general construction works and not to the impact on fish and invertebrates caused by the peat slide in SC7(b) and SC7(d) and the associated emergency measures required to contain the slide which were implemented during an extended period over two to three years after the slide took place – these are dealt with in Section 8.3.2.2. It should be noted that these impacts are likely to have been confined in the main to the tributary streams and not to have impacted the main channel of the Boleyneendorrish, Owendalulleegh or Duniry Rivers.

Projected Changes in Water Quality due to the Construction Phase

Table 8.24 lists the changes in quality that could have taken place in the small upland streams draining the wind farm in 2003 and 2005 in response to the clearfelling on the wind farm, OHL and Agannygal Substation during the construction phase combined with those contributed by solids washout from general onsite construction activity undertaken at the same time. For the purposes of this exercise it has been assumed that the streams in question, with the possible exception of site O1 at the upstream end of SC6 were all at High Status of Q4-5 at the outset of the construction of the wind farm, which may not have been the case for all sites at all times. Site O1 was assigned Good Status (Q4) because the present study has shown a consistently impaired quality rating at this site (Q3-4, Table 8.10) which has been attributed to natural causes linked to the presence of iron bacterial biofilms at the site. The analysis has also taken into account the fact that the 2003 peat slide probably completely wiped out the macroinvertebrate communities all down through SC7(b) subcatchment (Site O4 and O5) and its downstream continuation, SC7(d) (Sites O6 and O6A), which would have completely masked any impact of clearfelling on the site or on the OHL corridor, as well as any wash-out of solids associated with on-site construction activities, all of which would have been expected to have been **slight or moderate negative and temporary to short-term** in duration.

In the 2003 column of Table 8.24, Q1-2 (Bad Status) was assigned to all the sites within SC7(b) and SC7(d) because the EPA assigned Q2 (also Bad Status) to EPA O5 at Tooraglassa Ford (Site O7 in this study, Figure 8.1) on the main channel of the Owendalulleegh just 1km downstream from the confluence of SC7. It should be noted that this impact was caused by the mechanical erosive effect of the moving peat rather than to a decline in water quality *per se*. Normally in Irish rivers a Bad Status Q-rating (i.e. Q1, Q1-2 or Q2) is caused by elevated concentrations of organic waste, often accompanied by elevated BOD, ammonia and phosphorus concentrations, this would not have been the case for the peat slide.

It may seem surprising that in the 2005 column the SC7(b) and SC7(d) sites all show a significant improvement in quality since the 2003 peat slide. That is because it has been shown that macroinvertebrates can recover very rapidly (in less than 12 months) from even catastrophic mechanical-related damage (Lamberti *et al,* 1991). Moreover, in 2006 the EPA survey site on the main channel of the Owendalulleegh at O7 (EPA O5 in Figure 8.1) was assigned a High Status (Q4-5) rating, a significant improvement since the Bad Status rating of Q2 in the 2003 survey at the same site. In the case of O6 and O6A in 2005, these are also benefiting from the confluence of side tributaries unaffected by the peat slide i.e. SC7(c) and SC7(a) respectively, which would also have hastened the improvements predicted at these sites. What this analysis also postulates, however, is that any impact that would have affected sites O4, O5, O6 and O6A along the SC7(b)/SC7(d) channel, as a result of the 2004/2005 felling on the wind farm site and along the OHL corridor to that point (~15ha) would have been masked by the residual impact of the 2003 peat slide at the same sites. Site O4A on a very small side tributary joining from the east immediately upstream of Black Road was not in the path of the peat slide but may have been impacted by the emergency remedial works that were undertaken in the adjoining areas upstream, in particular the installation of two peat repositories on its banks in August 2005. In the absence of any significant off-site felling in these catchments over the following 2 years, it would be anticipated that all these sites would have reverted to at least Moderate Status (Q3-4) and in some cases to Good Status (Q4) by 2006. This is supported by the 2006 EPA data for the main channel of the Owendalulleegh and its side tributary EPA OT1 (SC9) (Table 8.8)all of which showed improvements from 2003 to 2006. In conclusion, the impact on macroinvertebrates in the streams and rivers as listed in Table 8.24, outside of the SC7(b) and SC7(d) subcatchment (dealt with in Section 8.3.2.2), can be described as (i) **no impact**: O1, O2, B5 and D1, (ii) **very slight negative and temporary:** B1A, B2, D1A, OHL1 and OHL 2, (iii) **slight, negative, temporary to short-term**: B4, O3, O8A, O9A, O9A1, O9A2, O9B, (iv) **moderate, negative, temporary to short-term:** O3A, B2A, B4B, B4C.

The impact of the peat slide on fish in SC7(b) and SC7(d) as well as the main channel downstream of the confluence of SC7, is dealt with in detail in Section 8.3.2.2. Outside of these stream and river stretches, the slightly more enriched conditions in terms of nutrient levels giving rise to possible changes in Q-ratings from High to Good Status or Moderate Status due to the clear-felling on the wind farm site during the construction period, combined with very light increases in bottom siltation derived from other aspects of the construction, is likely to have had minimal effects on the fish populations in any of the small tributary streams, as all of these are well oxygenated and turbulent. In fact, an increase in macroinvertebrate biomass mediated by a temporary increase in nutrient inputs, in an otherwise oligotrophic system, could have improved feeding for trout in these streams. Overall, the impacts of the construction phase of the wind farm site on fish can be categorised as a **neutral to slightly negative, and temporary to short term in duration.**

Table 8.24 Predicted impacts of wind farm and OHL clearfelling, on-site construction activities and the 2003 peat slide and emergency measures (2003-2006) on water quality (Q-value) in receiving streams between 2003 and 2006.

The site codes in red denote sites directly impacted as a result of the peat slide. Note that B5 = EPA B1 and O9A was just upstream from EPA OT1 (see Figure 8.1).

Site Code	Subcatchment	2000	2003	2005	2006
O1	SC6	4	4	4	4
O2	SC6	4-5	4-5	4-5	4-5
O3	SC7(a)	4-5	4 (4-5)	4	4 (4-5)
O3A	SC7(a)	4-5	4 (4-5)	3-4	4
O4	SC7(b)	4-5	1-2	2-3	3-4 (3)
O4A	SC7(b)	4-5	4	3-4	4
O5	SC7(b)	4-5	1-2	2-3 (3)	3-4
O6	SC7(d)	4-5	1-2	3	3-4
O6A	SC7(d)	4-5	1-2	3-4 (3)	4
O5A	SC7(c)	4-5	4-5	4 (3-4)	4
O8A	SC8	4-5	4-5	4	4-5
O9B	unnamed	4-5	4-5	4	4-5
O9A	SC9	4-5	4-5	4	4-5
O9A1	SC9	4-5	4 (4-5)	4	4 (4-5)
O9A2	SC9	4-5	4 (4-5)	4	4 (4-5)
B1B	SC3	4-5	4-5	4 (4-5)	4-5
B2	SC2	4-5	4-5	4 (4-5)	4-5
B2A	SC2	4-5	4 (4-5)	3-4	4
B4	SC1	4-5	4-5	4	4 (4-5)
B4B	SC1	4-5	4-5	3-4	4
B4C	SC1	4-5	4 (4-5)	3-4	4
B5	SC1	5	5	4-5	4-5
D1	SC5	4-5	4-5	4-5	4-5
D1A	SC5	4-5	4-5	4 (4-5)	4-5
OHL 1	unnamed*	4-5	4-5	4(4-5)	4-5
OHL 2	unnamed**	4-5	4-5	4(4-5)	4-5

* = unnamed stream flowing to Owendalulleegh River just downstream of Site O7
**= small stream which flows to Lough Atorick from Agannygal Substation

OHL & Agannygal Substation and associated works

Clearfelling

The wind farm was connected to the grid at the Agannygal Substation along a 7.8 km corridor of about 45 m in width along which a 110kV line was installed using 34 pole sets, 6 angle masts, 1 intermediate mast and 2 end masts. In preparation for the installation Coillte contractors felled 33.1 ha of forestry along OHL to facilitate access. They also felled 1.6 ha for the Agannygal Substation at the end of the line. 30.82 ha of the OHL corridor felled area drains to the Owendalulleegh catchment, while the remaining 3.86 ha drains to Lough Atorick in the Bleach River catchment to the south. The Owendalulleegh catchment portion can be conveniently divided into 3 segments, (1) 19.34 ha that drain to the SC7 (a-d), including approximately 10 ha which drains to Site O4, 2.5 ha draining between Sites O4 and O5, and a further 6.84 ha between Sites O5 and O6A. The impact of this felling has been addressed in the previous section. (2) A further approximately 2 ha drains to the main channel of the Owendalulleegh near Site O7C, and (3) the remaining 9.47 ha drains to a small unnamed stream (EPA Code: 29D21, Segment Code: 29_361), the lower kilometre of which had been straightened and drained in the past. This small stream joins the main channel of the Owendalulleegh from the southern bank 750 m downstream of the confluence of the SC7 subcatchments at ITM 560397 701227 just upstream from Site O7 (Tooraglassa Ford). Water quality in the latter stream was found to be Good-High in December 2019 at OHL 1 near structure 28A (Table 8.19). As described in the previous section clearfelling over blanket peat is associated with the release of nutrients, especially phosphorus, as well as a variable amount of suspended solids. In the case of a large block of forestry one would expect that this might be a significant effect. However, the OHL corridor is a narrow (45 m wide) linear feature and the opportunities for interception of nutrients and solids before they reach surface drainage would be expected to have been much higher than if the area to be felled had been in the form of a square or rectangular block. The ~2ha draining to the main channel of the Owendalulleegh near Site O7C is such a tiny area relative to the size of the receiving water that it is likely that **any impact would have been negligible** and not resulted in a decline in ecological status nor would it have had any negative impact on fisheries. Felling of the main southern section of the OHL corridor comprising 9.47 ha could have given rise to a **slight negative but temporary impact** on the quality of the unnamed stream referred to above i.e. dropping from Q4-5 to Q4 (i.e. from High to Good). However, this channel only comes close to the corridor in a few limited places and it is possible that even this impact might not have occurred. **No negative impact** would have occurred in the main channel of the Owendalulleegh below the confluence of this small stream.

At the southern end of the OHL corridor, draining to Lough Atorick, there was only a very small amount of felling required including 2.26 ha on the OHL corridor and another 1.6 ha for the Agannygal Substation, amounting to 3.86 ha in total. This ground, flowing via a nexus of small drains joins an unnamed 1st order stream (EPA Segment code: 25_1002, catchment area = 2 km^2) which flows more of less due south to the northern shore of Lough Atorick. By the time nutrients and or solids derived from the felling would have reached this stream they would likely have been much diminished due to biological uptake and sedimentation, so that **no negative impact** on the water quality would likely have been detectable as a result at Site OHL 2 on the small stream in question.

Installation of Structures

Very few of the structures along the OHL corridor, either pole-sets or masts, are constructed close to any of the small streams or to the main channel of the Owendalulleegh where they are crossed by the line. The only exceptions are poleset 8 and 9 toward the northern end of the line and poleset 28A and mast 30 toward the middle of the line. In the latter case, the access track to the mast 30 foundations tracked across a small stony-bottomed stream about 1m wide. In addition, significant local excavations were required between polesets 28A and 29 in order to keep the conductors of the north-south Derrybrien OHL below the east-west conductors of the Moneypoint- Oldstreet 400kV overhead transmission line. The excavated till and topsoil from this area was removed to the sides forming an embankment at either side of the OHL (Plate 8.8). In theory this could have given rise to solids washout into the small unnamed stream (EPA Code: 29D21, Segment Code: 29_361) near invertebrate sampling site OHL 1. However, the fact that the ground is lower than the track close to poleset 28A where the stream is culverted under it and that the embankment formed by the excavations on the eastern side of the area shields the stream on that side, means that the risk of solids washout was probably relatively low at the time. That and the sandy nature of the subsoil would have reduced further the risk of any negative impact.

In order to access angle mast 24 and poleset 25, construction machinery had to cross a shallow fording point on the main channel of the Owendalulleegh at Site O7C (Figure 8.1, ITM: 562447, 701486, Plate 8.5). At those locations where the structures were close to the stream (Code 29D21) there was a risk that suspended solids would have reached the channels due to run-off from damaged ground being tracked by vehicles or from solids-contaminated water that was pumped out of foundations for the structures. In the case of the masts there was the added risk of cement run-off as the foundations for the legs had to be concreted. In the latter case large concrete pipes turned vertically were used as forms for the concrete foundations, so these would have confined any poured cement and thereby very considerably reduced the chances of any significant amounts reaching surface water. Tracking over the small stream at mast 30 would certainly have generated some increase in suspended solids in the stream, although the overburden at that point is very sandy, and the amounts mobilised may well have been quite small.

Vehicular traffic at the fording point on the main channel of the Owendalulleegh to access angle mast 24 could have given rise to some localised juvenile trout and stone loach mortalities. IFI were contacted at the time for their advice about this crossing and although no record exists of the advice provided at the time, the likelihood is that IFI would have requested the contractors to keep the crossing route as narrow as possible i.e. as close as possible to the width of the widest vehicle required and for all vehicles to follow that route (possibly demarcated by red and white tape) and that the operation would be designed in order to keep the number of vehicle movements at the fording point to the absolute minimum required to accomplish the works.

The installation of the structures along the OHL line is likely at most to have given rise to **temporary, negligible to slight negative impacts**, most likely manifest as reductions in macroinvertebrate biomass in affected reaches of the small unnamed stream that joins the Owendalulleegh just upstream of Site O7, with a possible reduction in Q-value at OHL1 (Table 8.24). In addition, a small number of trout and stone loach mortalities would likely have occurred at the Owendalulleegh fording point to access the mast (structure 24), although over a narrow front of about 3-4 meters wide at the crossing, the numbers involved would have been very low and any negative impact on the population, even in that localised part of the river, would have been negligible.

Plate 8.8 OHL corridor showing ground lowered beneath Moneypoint-Oldstreet 400kV OHL. View south from Poleset 28A.

Construction of the Agannygal Substation and Access Routes

The substation compound was 63 m x 47.5 m containing outdoor electrical equipment and a control building.

A short, approximately 138 m, north-south approach road was constructed to access the site and connect it with an existing east-west local road immediately to the south. 80 m of the latter had to be upgraded and widened to 3.5 m with Cl 804. In addition, 2.9 km of an existing Coillte track was widened to 3.5 m to facilitate construction traffic and stoned with Cl 804 to bring it up to the necessary weight bearing standard. This process also required a small amount tree felling along that route. Both these operations would have given rise to some fines washout during heavy rain. The substation site and the short stretch of new road (138 m), as well as about 40% of the 2.8 km of the upgraded Coillte track, drain to the 1st order unnamed stream (EPA Segment code: 25_1002, catchment area = 2km^2), which flows into Lough Atorick on the northern shore toward the eastern end of the lake. The remaining approximately

60% of the upgraded Coillte track lies within the catchment of two smaller unnamed 1st order streams immediately to the east, i.e. EPA Segment Codes: 25_2800 and 25-1116. These also flow into the northern shore of Lough Atorick, 240 m and 400 m respectively east along the shoreline from the inflow of 25_1002. Only at one point does the Coillte track cross any of these three streams i.e. 25_1002, at a point where the bulk of the diffuse drainage from around the substation coalesces at the head of a canal-like stretch of this small watercourse (Plate 8.9) (ITM 563565 697855). The latter would have acted as a large in-line settlement basin, where the bulk of any suspended solids generated at the substation during construction would have dropped out of suspension. Beyond this point the remaining stretch of the Coillte track runs more or less due east, its route well removed from the two small streams draining this last stretch of the track and therefore unlikely to have affected either as a result of sediment washout.

The sandy nature of the overburden at the substation site may have increased the rate of soil erosion during construction once the overlying vegetated layer was removed. However, it would also have facilitated rainfall infiltration and led to a more rapid settlement of eroded sandier solids. This notwithstanding, the presence of the natural settlement basin, referred to above, on the stream draining from the site, would have intercepted much of the solids generated on the site during construction. Impacts arising would have included temporary increases in suspended solids concentrations in each of the three small streams draining the works, mainly Segment 25_1002 (leading to Site OHL 2) and have at most resulted in a reduction in biomass of macroinvertebrates due to abrasion and or localised smothering. In a worst case scenario this may have resulted in a temporary reduction from High to Good water quality status as measured by the Q-value system (Table 8.24), although this may not have actually occurred. Had it occurred this can be described as a **localised, slight negative impact of temporary/short-term duration.** The very lower reaches of Stream 25_1002 were surveyed in late 2019 and found to have a High Status Q-rating (at Site OHL 2, Figure 8.1, Table 8.10) and habitat suitable as trout nursery. However, there is no survey data available to confirm that trout occur in the lower part of this stream, despite the presence of suitable habitat. Certainly, the nexus of small drains flowing to this stream from around the substation have no suitable fisheries habitat. The other two small streams to the east are assumed to have a similar High Status water quality although less if any suitable trout habitat. Overall, the construction of the substation and its associated access track are thought to have had **at most a slight negative impact on fisheries** in any of these 3 streams, which had it occurred would have taken the form of a slight reduction in egg and or fry survival and not persisted for more than one or two seasons.

None of the works referred to above would have had any negative impacts on freshwater pearl mussels (*Margaratifera margaritifera*), which are known from a single historical reference for a site very far down in the Lough Atorick catchment. This is because none of the habitats directly affected by the works have any habitat remotely suitable for the species and because the presence of Lough Atorick and the even larger Lough Graney between the construction site and the only known historical record for the species means that no nutrients or solids generated during the construction could ever reach that far down in the catchment. It is worth noting also that there are no recent records for the species in any part of the catchment.

Plate 8.9 Long depositing stretch on stream draining to Lough Atorick from Agannygal Substation. (View to the south west from ITM 563565 697855).

8.3.2.2 Peat Slide – October 2003

Overview

This section deals with the impacts of the 2003 peat slide and follow-up emergency remedial works on water quality and fisheries in the downstream channels and Lough Cutra.

Relevant Details of the Peat Slide

In October 2003 a peat slide occurred on the south central section of the wind farm which affected several hectares of plantation forestry planted on drained blanket peat. The slide was followed on October 29th and especially the 30th by heavy rainfall which resulted in a very large volume of peat and associated tree and shrub vegetation being displaced into an upper tributary of the Owendalulleegh River, specifically subcatchment SC7(b) (Figure 8.3), flowing down past Black Road Bridge (Site O4), Flaggy Bridge (Site O5) and Unnamed Bridge C (Site O6) in SC7(d) and on into the main channel of the Owendalulleegh, being joined on the way by streams from SC7(a) and SC7(c) . The slide material continued downstream into the lower reaches of the river, eventually reaching Lough Cutra about 22 km downstream of the peat slide. Within the next month, up to November 28th, in order to control the passage of the peat slide, 8 barrages (or boulder dams) (Barrages 1-4 and Barrages A-D) were installed along the route of the slide from the boundary of the wind farm site downstream to just below Flaggy Bridge (Site O5). To facilitate these works and to further reduce the risk from the flowing peat, an extension to an existing Coillte track was constructed to access the site (Barrage 1) from the west and another to access Barrage 2 from an existing Coillte track on the eastern side of the slide. Stone for these tracks and some of the boulder dams was sourced from a newly opened borrow pit very close to and NE of Barrage 1. Also, a diversion drainage channel was excavated along part of the southern edge of the main slide area commencing upstream of Barrage 1 and extending downhill to just below Barrage 2. This was intended to prevent any further instability in the peat mass in the area and to reduce washout of additional peat solids to adjoining lands and downstream drainage channels. Finally, minor amounts of clearfelling was required to assist access to remedial works to control the slide. In addition, three peat repositories were opened to store peat excavated as part of these emergency works, one just ENE of Barrage 2, another beside Barrage 3 and a third, in two sections adjoining each other just upstream of Black Road Bridge. All of these works, of necessity, were undertaken using a wide range of heavy machinery and most were completed by the end of November 2003.

Nature of Physical & Habitat Damage

After the heavy rains of October 30th, a very large mass of peat and associated woody and herbaceous vegetation moved downstream under the weight of the peat. Just over a month later in December 2003 a walk-over survey of the entire 20km of channel from Flaggy Bridge downstream to Lough Cutra was undertaken by the officers of the then Shannon Regional Fisheries Board (ShRFB) in order to establish the extent to which the peat and debris had progressed down the catchment, and to gauge the type and degree of damage to riverine habitats caused. The survey was undertaken over a period of 2 weeks under more or less ideal conditions. The ShRFB staff were also accompanied by an ecological consultant (Inis Environmental Services) on behalf of ESB International. The survey approach taken was to divide the river into two hundred 100m sections, each given a chainage number. Flaggy Bridge was denoted as chainage 200 and the Owendalulleegh’s inflow at Lough Cutra denoted as chainage 0. ShRFB and Inis Environmental Services issued separate reports on the survey but both are in general agreement about the nature and extent of the physical damage.

The findings of the survey were published by ShRFB (Anon, 2004). The following summary is taken from both reports. These point to the impact of the peat slide being most evident along the first 1.8km of channel downstream from Flaggy Bridge as far as the confluence of this tributary, SC7(b)/SC7(d), with the main channel of the Owendalulleegh River at chainage 182. This tributary is steep and narrow and suffered severe physical damage from the peat slide at the time. This was most evident in the first 1.1km downstream (chainage 200-189). All of the loose substrate in this stretch comprising gravel and small and large cobbles was scoured out by the peat and large amounts of peat were deposited on the banks and at the edges of the channel causing severe damage to riparian vegetation. There were large sand deposits evident in bends in the river also and much deposited peat in the channel. Parts of the channel were re-aligned due to the force of the peat flow. The channel between chainage 189 and 182 at the confluence with the main river had been severely impacted but not much scouring had occurred. At the point of confluence, the gradient drops substantially, the channel widens and therefore the force of the flow would have dropped considerably. Downstream from chainage 182 to 151, the river, now the main channel of the Owendalulleegh, seems to have been devoid of bankside damage and while some in-channel physical impacts were evident including damage to aquatic vegetation, the damage was much less than that observed in the tributary. It was noted that there was also good fisheries habitat available in this stretch. From 151 to chainage 0 at Lough Cutra (~15 km) both reports agree that the instream physical habitats all appeared unaffected although peat and sand deposition were still evident in stretches, particularly, although not exclusively, at the margins of the channel and in deeper stretches, all the way to the lake.

These observations agree with those of the EPA who carried out Q-value surveys at 5 points in the middle and lower reaches of the main river two weeks earlier on November 17th, 2003 (Clabby *et al.,* 2004). They noted that the upper 5 km section of the river was effectively wiped out in terms of aquatic invertebrate stream life, while the impact on the lower section was "*not as bad as might have been feared initially*". At the final EPA monitoring site, 1.5 km upstream of Lough Cutra (i.e. some 22 km downstream from the peat slide) the author noted that the impact of the peat slide was "*surprisingly low"* and also noted *that mid-stream kick sampling did not raise peat silt. Deposits of fine peat silt were again noted in the riparian zone and some light-coloured, grass-like plant debris was present among the stones, but the amount of larger woody debris was less than at the upstream sites*. At their site 1.5 km downstream of Lough Cutra on the Beagh River, the EPA report during their Q-value survey of November 18th that '*No major impact was noted with the range of species quite similar to that found on previous occasions and water quality was satisfactory'* (Clabby *et al.,* 2004). The Q-value was Q4 on that occasion, the same as had been measured during the previous monitoring run in 2000. The same day, in Gort town (at Gort Bridge) the EPA survey gave the same result as the 2000 survey there, i.e. Good Status (Q4). These combined observations suggest that there were no measurable negative impacts experienced by the river macroinvertebrate community as a result of the peat slide at sites downstream of Lough Cutra.

Impacts on Water Quality (Q-Value)

In terms of Ecological Status and water quality these impacts indicate that the entire channel of subcatchment SC7(b) and SC7(d) were probably wiped out and that the first 1 km downstream from the confluence of SC7(d) with the main channel of the Owendalulleegh as far as EPA O5 was similarly impacted with a drop from High Status (Q4-5) down to Bad Status Q2 (Table 8.8) This can be described as a **profound negative impact, of short-term duration**. Over the following 5.7km downstream to EPA O4, the water quality dropped from High Status (Q5) to Moderate Status (Q3-4) which can be described as a **very significant negative, short-term impact**. In the next 7.2km downstream from EPA O4, to EPA O1 (1.5km upstream of Lough Cutra), the Q-rating fell from High Status (Q5 and Q4-5) to Good Status (Q4), which can be described as a **significant to moderate negative impact, of short-term duration**. The EPA surveyor also noted that from EPA O5 downstream to EPA O3 *that the fauna of themselves would not indicate the degree of damage to the ecosystem as a whole*, which was denoted by a single asterisk after the Q-value. When assessing these impacts, it's important to note that they occurred over a 20 km stretch of a large 4th order river, that had always been rated as High Quality along that stretch up to the time of the peat slide. We know that these impacts, at least on the main channel of the Owendalulleegh, were short-term because by 2006 all the same sites were back up to High Status (Q4-5) except for EPA O1, which remained at Good Status Q4.

Impacts on Fish

This large influx of peat and woody debris resulted in a large fish kill. Although no systematic count of fish was possible at the time, as the peat buried many of the cadavers, it is known that trout, stone loach, lamprey, eel, gudgeon and perch were included in the kill, the two latter species only known from the lower reaches of the river. Subsequent electrofishing surveys undertaken by IFI and for this study would suggest that brown trout and stone loach were likely to have been the most numerous species killed at the time. When asked recently about where the gudgeon and perch had been found at the time, Michael Fitzsimmons, who was the Environmental and Fisheries Officer for the ShRFB at the time of the slide, indicated that they were recovered from peat deposited about half way down the main channel from the confluence of the SC7 tributary to Lough Cutra. It is possible that even though they were numbered among the dead fish observed that eel and lamprey stood a greater chance of survival than the other species, especially in the lower reaches of the river. This is because lamprey juveniles burrow into soft sediments along the channel margins in particular and eel can also respire through their skin and are a very tolerant species in general. Without knowing what the concentrations of suspended solids were in the river especially in the lower reaches when the first main wave of peat was washed down the river, it is very hard to know whether or not some trout survived the peat slide. A month or so after the event officers from the Shannon Regional Fisheries Board carried out some qualitative spot electro fishing in the river and confirmed the presence of small numbers of fish (pers comm. Mr. Michael Fitzsimmons, IFI). There are no records of the fish density in the river prior to the peat slide and no systematic follow-up surveys were undertaken in the years immediately following the event, so that it isn’t possible to know with any degree of accuracy the numbers of fish lost due to the peat slide nor the rate of recovery in the very early years after the event.

The impact of the peat slide on the fish population in the immediately affected tributary, SC7(b) & (d), was likely to have been very severe with the resident population eliminated by the sheer mechanical force of the peat slurry moving down the channel. Moreover, it’s likely that a full recovery would have taken at least 3 to 5 years (for trout and stone loach) and perhaps up to 6-7 years for brook lamprey to recover, so that overall the impact can be classified as **locally profound, negative and short-term**. The impact on the remaining main channel of the Owendalulleegh can be classified as **very significant or significant, negative and short-term** in relation to fisheries and taken at least 3-5 years to fully reverse for trout stone loach and up to 6-7 years for brook lamprey. The range of possible impact levels suggested here for the fisheries impact stems from the paucity of quantitative information on the extent of the original fish kill on the main channel and the possibility that more fish, survived especially in the lower reaches, than was believed at the time.

Impact on Fisheries in Lough Cutra

There doesn't appear to be any records of fish mortalities having occurred in Lough Cutra at the time and given the observations that the influence of the peat and debris was diminishing toward the lower reaches of the river it is considered that any **direct impact was at worst slight and temporary to short-term negative** on the lake's fish population, especially considering the sheer size of the water body as a whole (382ha). Any impact in terms of direct fish mortalities that would have occurred is likely to have been localised to the immediate inlet area of the Owendalulleegh River. Also supporting this assessment is suspended solids data from Galway County Council for water samples taken down along the Owendalulleegh on Saturday November 1st, 2003 that showed a very strong decline in concentrations from Black Road Bridge in SC7(b) downstream to the lower reaches at Kilafeen Bridge. (Table 8.25 & Figure 8.17)

Table 8.25 Suspended solids measured by Galway County Council in the SC7(b) tributary and main channel of Owendalulleegh as far as Lough Cutra on November 1st 2003.

Site	Survey locations in Figure 8.1	Suspended Solids (mg/l)
Black Rd Bridge	Site O4	690
Flaggy Bridge	Site O5	1410
Tooraglassa Ford	Site O7	230
Inchamore Bridge	Site O8	33
Killafeen Bridge	EPA Site O1	44

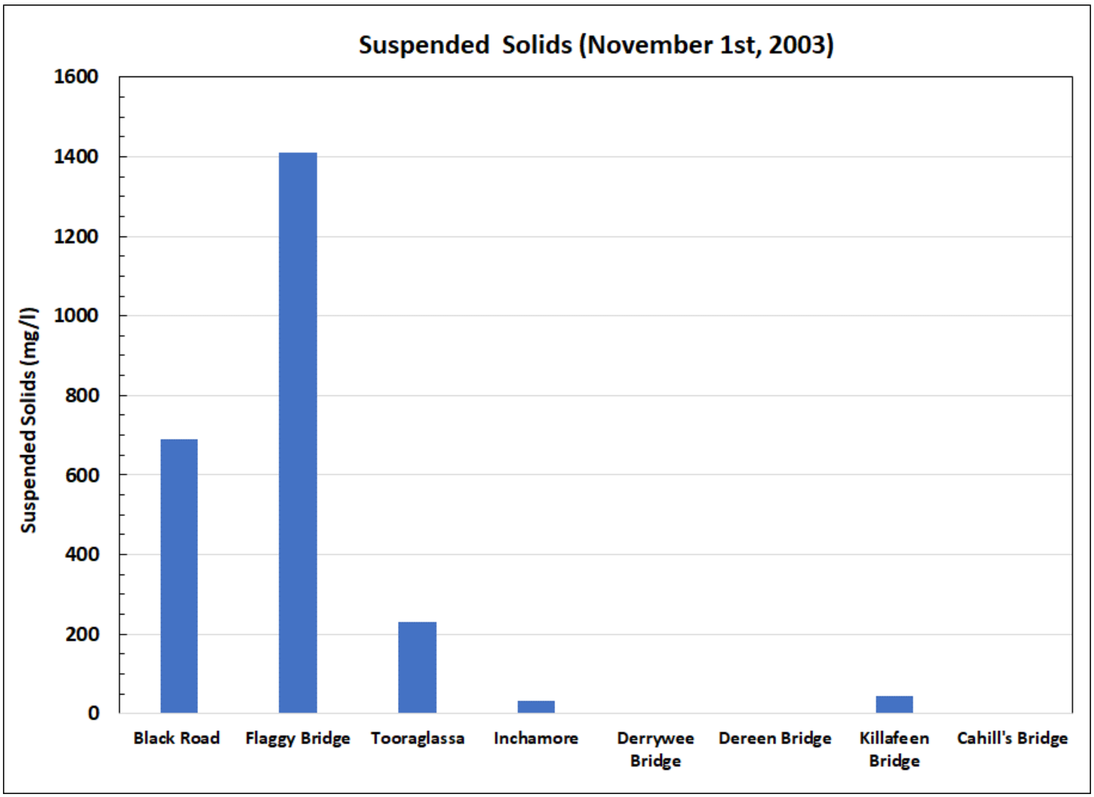

Figure 8.17 Suspended solids in the Owendalulleegh on November 1st 2003

The EPA made the following observation when undertaking a biological survey on the outlet river from Lough Cutra (River Beagh) '*Straw bales were placed at the lake outflow in order to settle peat silt and prevent it from causing siltation in the river'*. The result of the Q-value assessment at their survey point, located 1.55 km downstream from the lake outlet (EPA C1 in Figure 8.1), stated that *'no major impact was noted with the range of species quite similar to that found on previous occasions and water quality was satisfactory*'. These observations combined with observations of a fisherman very familiar with Lough Cutra is that peat silt did enter the lake and did spread, at least as far as the outflow river. Depending on how long it lasted, there is a possibility that more coloured and turbid conditions in the lake could have temporarily disrupted the normal predator-prey interactions between fish species or among different age classes of the same species, mediated by a change in the rate of visual capture success. However, without any previous or more recent qualitative or semi-quantitative knowledge of the fish population in the lake, it is impossible to say whether these factors had a significant effect (positive or negative) on any of the species present. It is important to note however, that the occurrence of the peat influx late in the season when fish activity and biological activity in general in the lake would have been at its lowest, probably significantly reduced any impact that may have arisen. The following spring and summer after winter floods would have facilitated the flushing of silt from the system, the significance of any silt-related impacts would be expected to have diminished substantiality.

Impact on Water Quality in Lough Cutra

The flux of the finer fractions of the peat slide would have deposited in littoral and open water areas within Lough Cutra in the days and weeks following the event with the main pulse arriving in the first few floods, thereafter diminishing with time. The light nature and larger particle size of peat probably facilitated its dispersal over a wide area within the lake thereby reducing the thickness of the deposited layer. Furthermore, given that during floods there would be a definite flow tendency up the lake from the inflow of the Owendalulleegh to the outflow of the Beagh River this would have tended to direct suspended solids toward the outlet. About a third of the lake lies to the south of this line, which may indicate that it received much less peat. The fact that straw bales were placed across the lake outlet shortly after the peat slide confirms that the silt was reaching the outflow river and therefore peat flushing from the lake was taking place very early in the event. While much of the peat slide material was probably flushed within a short timescale, residual amounts in pools, along channel margins and on banksides may have taken longer to flush completely out of the Owendalulleegh. In fact, there appears to be some evidence of an effect of the peat slide in the lake chemistry data for Total-P and to a lesser extent for chlorophyll *a* for up to 3 years after the slide. Figure 8.18 shows the annual average Total-P and annual average chlorophyll *a* (just a single reading for 2001 and 2003), with several gaps, between 2001 and 2019. The most obvious feature of these data are the three elevated Total-P results for 2004-2006 when compared to the 2001 (March) and 2003 (July) results, as well as all the 2010-2019 results. The 2004 and 2005 average chlorophyll *a* concentrations are also the highest recorded, even though the disparity between the chlorophyll in this and the later period is much less pronounced and probably not significant or only marginally so. Not a lot can be gleaned from the 2001 and 2003 data for either parameter and indeed the 2001 result for Total-P (measured in March) is itself higher than all of the 2010 to 2019 data. However, as that only refers to a single reading it has limited value. If the Total-P results for 2004, 2005 and 2006 are correct, it might point to a residual influx of fine peat particulates from the peat slide site, resuspension of un-consolidated peat fines within the lake proper or a combination of both. Unfortunately, there isn't any means of independently verifying this as, for example, the EPA do not analyse for Total-P or suspended solids in their river monitoring site at Killafeen Bridge and in any case the river data only stretches back to 2007.

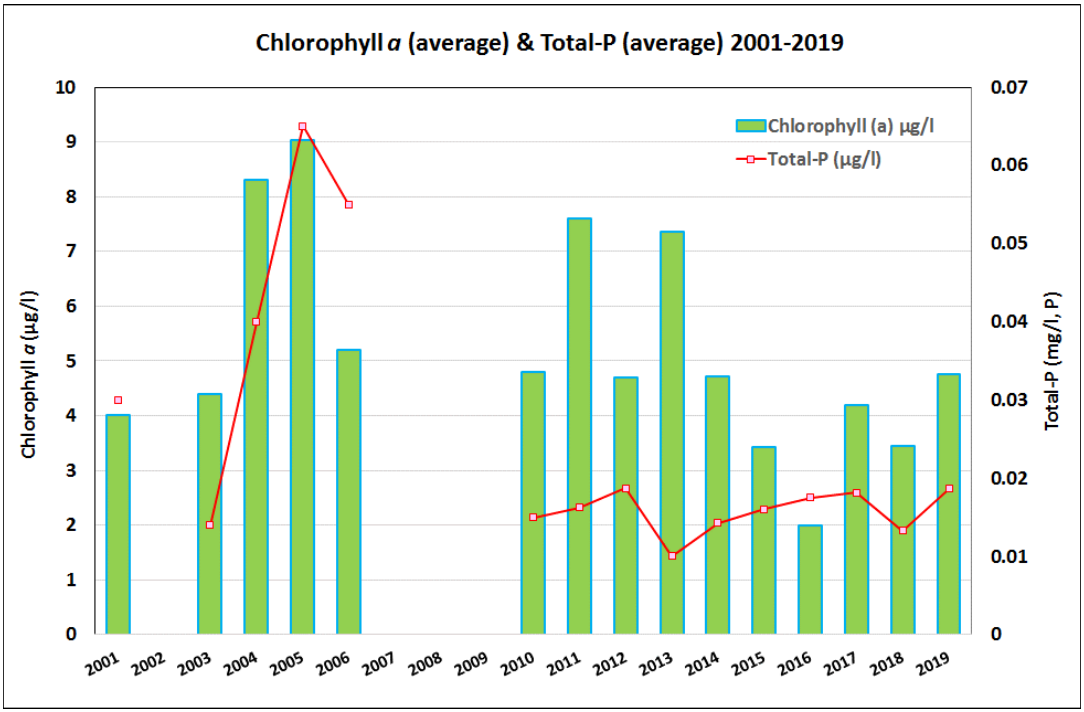

Figure 8.18 Annual average chlorophyll a and Total-P in Lough Cutra

In the case of the heavier mineral fractions in the form of medium and course sands scoured out by the peat slide, these would only have gradually migrated to the lake perhaps over years during successive floods and unlike the peat would have dropped out almost immediately on arrival at the lake. This latter flux is naturally ongoing all the time, but the Derrybrien peat slide marked a short-term increase in the natural rate of supply.

A recent survey of the benthos of the Lough Cutra (see Section 8.2.4.3) indicates that the open water sites are dominated by a small range of invertebrates all of which have the ability to burrow, while shallower sites with coarser sediment components had a more diverse range of species and also included more mobile species. Littoral macrophyte beds which are scattered all around the lake in shallow depths (<2m) would be expected to hold the highest diversity of invertebrates and these are regularly surveyed by the EPA. Overall, the peat slide may have caused localised reductions in diversity and biomass of benthic macroinvertebrates in both littoral and open water areas wherever deposits were thick. The fact that the event occurred late in the year, just before the main winter rains, was probably a positive factor, as much of the peat would have flushed out of the lake by the following spring and early summer when macroinvertebrates would begin to reproduce and when annual phytoplankton and zooplankton blooms would help drive biological activity within the system again. Macrophyte beds would also be beginning their annual growth spurt in spring and summer. It isn’t possible to measure the level of these impacts on the fish population via food-chain effects, as very little fish population density data is available from before or after the event from Lough Cutra. However, the late seasonal occurrence of the event and the likelihood that impacts on benthic invertebrate biomass were probably **minor in effect** and that the following annual spring/summer coarse fish spawning season would not have been disrupted suggests that the impact on fisheries can be classified as **neutral or slight negative, temporary to short-term.** Anecdotal accounts from a local angler indicated that there was no obvious change in angling success in the years immediately following the slide, although there is some suggestion that fish sizes have declined in recent years, which if it is true would have nothing to do with the events of 2003.

Impact on Water Quality Downstream of Lough Cutra

Section 8.2.1 earlier in the chapter details the complex course of the Beagh/Cannahowna River draining out of Lough Cutra that reaches the sea at Kinvarra, which will help to put the following section in context. At the time of the peat slide, from mid-October 2003 until mid-January 2004, Galway County Council undertook water analysis from sites from Black Road bridge, down the length of the Owendalulleegh at bridges and downstream of Lough Cutra, including the Beagh River, Cannahowna/Gort River, the Gort Raw Water supply, the Gort River, Coole River, Kiltartan and Kinvarra among others. The parameters tested included suspended solids, turbidity, colour and pH. Not all sites were sampled on every date and not all parameters were analysed on the samples collected. Nevertheless, the data (see Appendix 8-6) provides a unique dataset with which to attempt to assess the impact of the peat slide on the downstream water quality at the time.

As suspended solids tended to be measured less frequently in samples than turbidity, by correlating turbidity with suspended solids in samples in which both parameters were assessed we can use turbidity as a proxy to gauge what the suspended solids would have been in samples where only turbidity results are available. Figure 8.19 shows the correlation between suspended solids and turbidity in all the samples for which both were measured. This shows a very strong correlation between both, although, as would be expected there is some scatter around the trend line. In general, the data indicates that turbidity is a very good direct proxy for suspended solids with both parameters giving very similar readings. Below about 20mg/l suspended solids. However, this correlation changes, as demonstrated when just the low concentrations are correlated (Figure 8.20). In this case it can been seen that suspended solids are significantly lower than the corresponding turbidity readings, especially at the lowest turbidities, varying from about 65-70% of the turbidity value at turbidity 20 to just 30% at ~turbidity 3.5. So, bearing this caveat in mind for lower concentrations, the two parameters can be used more or less interchangeably for this assessment.

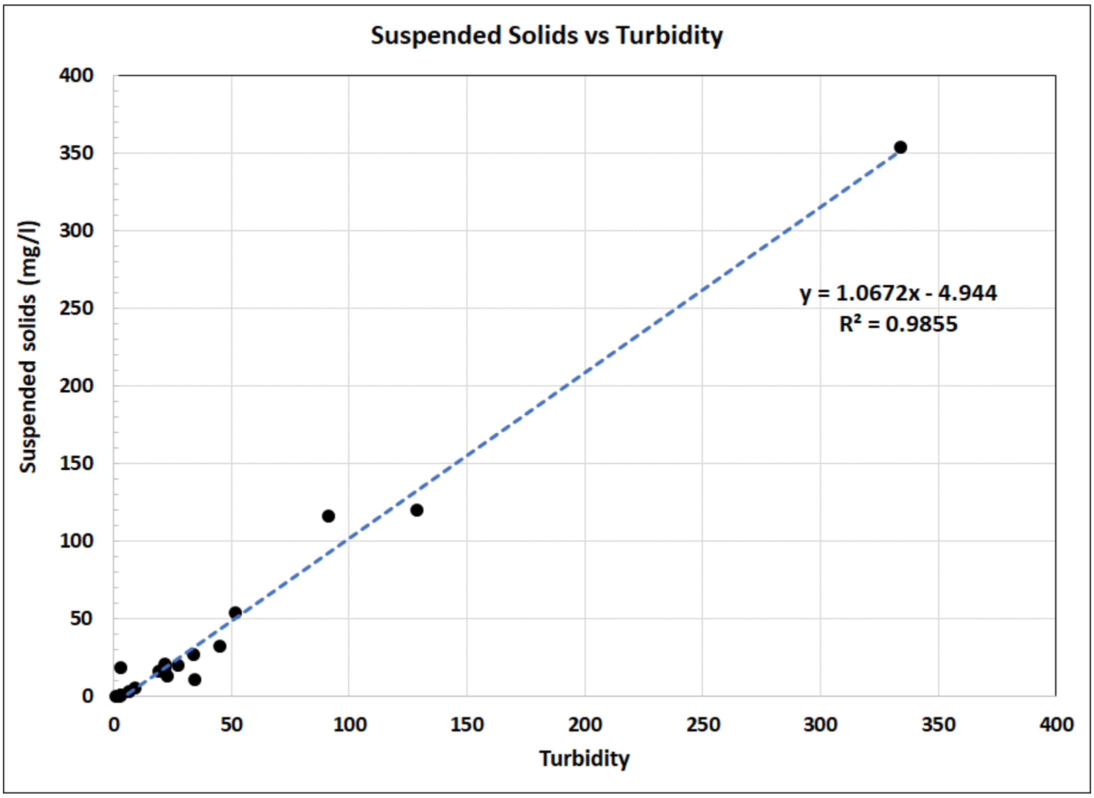

Figure 8.19 Correlation between suspended solids and turbidity (all data)

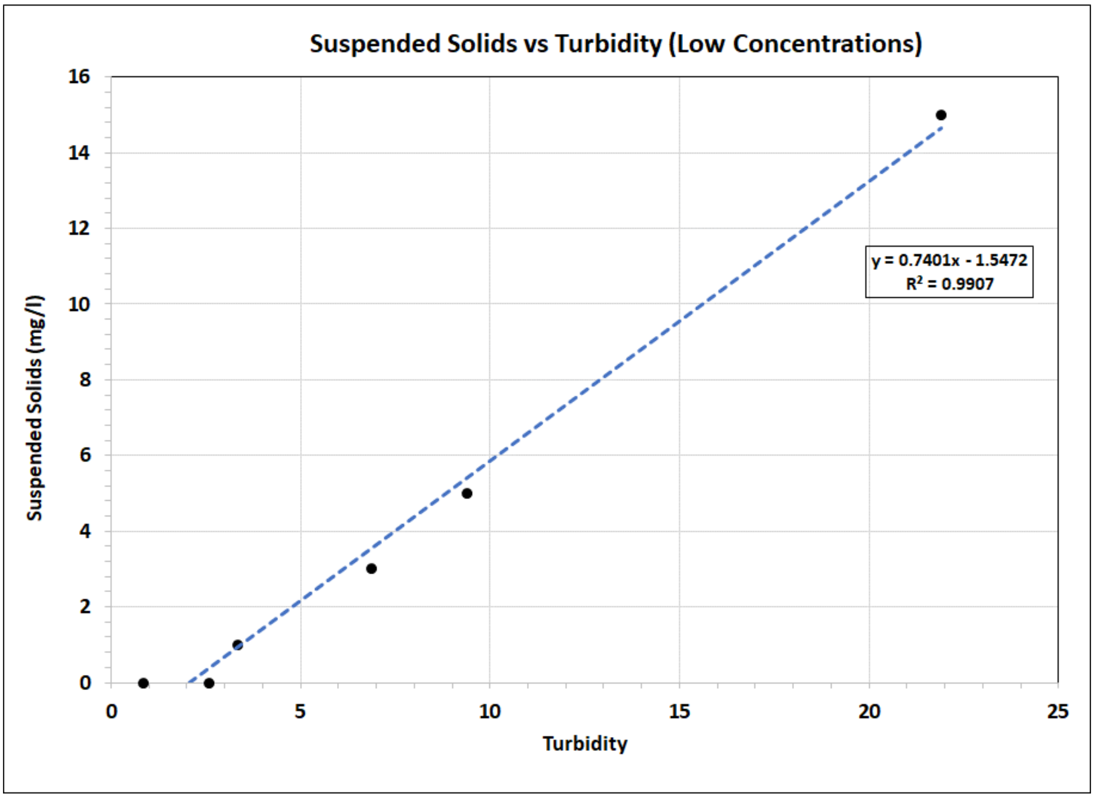

Figure 8.20 Correlation between suspended solids and turbidity (low concentrations only)

Figure 8.21 Turbidity (Hazen) measured at selected sites upstream and downstream of Lough Cutra between November 3rd, 2003 and January 22nd, 2004. shows the turbidity measured upstream of Lough Cutra at Killafeen Bridge, i.e. the last monitoring site on the Owendalulleegh, just 1.5 km upstream of the lake, and at two sites downstream of the lake, Cahill's Bridge on the Beagh River and at the Raw Water Intake at the Gort Water Treatment Plant. The intake is partially supplied by the Gort/Cannahowna River, which is the name of the Beagh River after it emerges from the Punch Bowl just upstream. The graph covers thirteen sampling occasions from November 3rd, 2003 to January 22nd, 2004. Note that the downstream data set is more comprehensive and that the upstream set (for Killafeen Bridge) is patchy, although very instructive. The graph indicates that early on in the period covered and close to the time of the main mobilisation of the peat slide that samples taken both upstream and downstream of the lake revealed elevated values but that after 2.5 months the levels had dropped considerably at the sites downstream of the Lough but remained periodically much higher upstream in the Owendalulleegh. This indicates that the turbidity, and by extension the suspended solids levels, peaked downstream of the lake between the 5th and 6th of November and then gradually decreased in concentration over the following seven to ten days up to November 18th, thereafter remaining low until the end of the monitoring period at around turbidity 10 (Hazen units), which, as discussed above, probably only equated to around 5mg/l suspended solids. Also noteworthy in the data for the two downstream sites is the stable and gradual change in turbidity observed, which contrasts markedly with the changes observed in the Owendalulleegh site during the same period, which were much more erratic. This points to Lough Cutra acting (i) as a strong buffer, dampening downstream changes in concentration and (ii) functioning as a sink for the peat solids as time went on. This suggests that early in the event a large amount of peat fines discharged and settled in the lake which became a source of increased suspended solids for a limited period. However, subsequently, despite periodic spikes in concentrations in the lower Owendalulleegh, these appear to have had no or very minimal effect on concentrations downstream. This indicates that solids which had already settled in the lake were not being re-suspended and flushed out. The graph also shows that while the Killafeen Bridge turbidity levels are responding to rainfall levels (measured in Derrybrien), rainfall is having no influence on the downstream trends, presumably again due to the dampening effect of the lake. It is important to point out that while the upstream concentrations at Killafeen Bridge were elevated at the time, they are much lower than the concentrations in the impacted tributary at Black Road Bridge and Flaggy Bridge around the same time (see Table 8.25 and Figure 8.17).

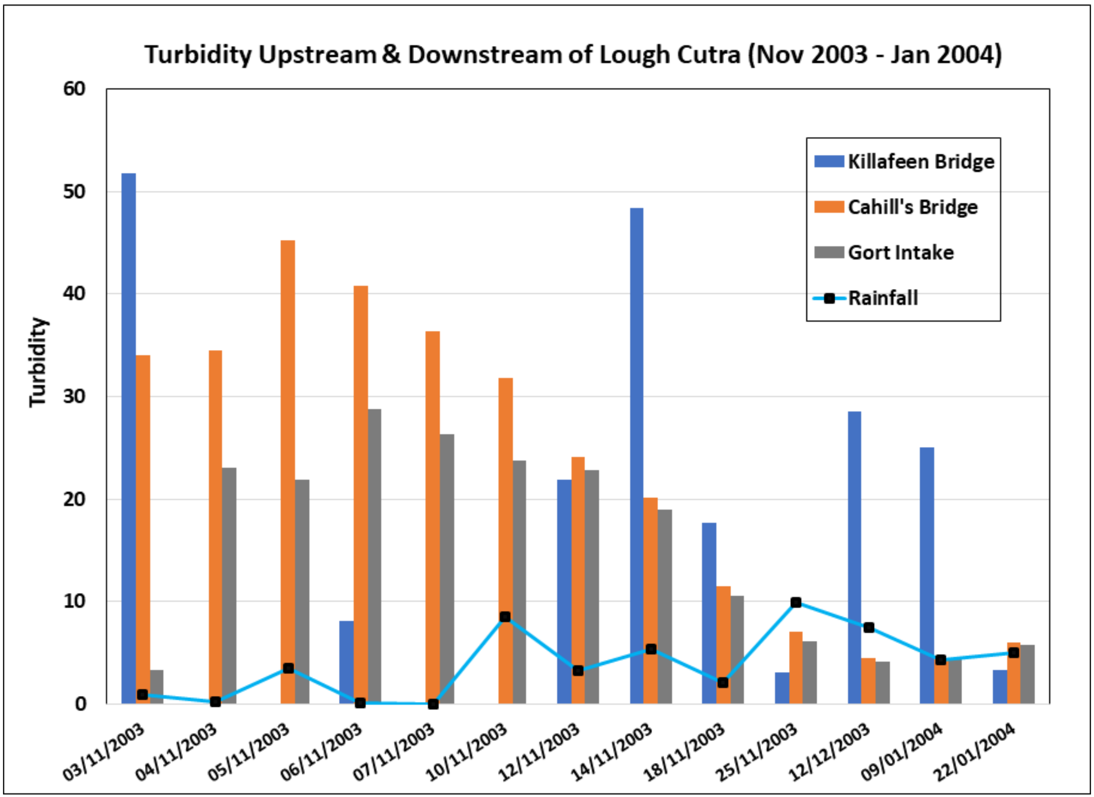

Figure 8.21 Turbidity (Hazen) measured at selected sites upstream and downstream of Lough Cutra between November 3rd, 2003 and January 22nd, 2004.

(Note there are data gaps at Killafeen Bridge. Daily rainfall in millimetres is from Derrybrien).

Figure 8.22 presents the data on colour for sites downstream of Lough Cutra as far as Kinvarra Raw water intake. These data are presented in order to demonstrate the influence of the mixing of water sources i.e. surface and groundwater, which demonstrates the diluting effect of the latter and also shows how the influence of the Owendalulleegh, even at a time when the system was most impacted by the peat slide, diminished markedly with progression downstream. In this respect also it's worth noting that there is a strong linear correlation between turbidity and colour in the data set indicating that as colour diminished so also did turbidity. It should be noted that at the time of the Derrybrien peat slide the Gort water supply was fed from both surface and groundwater sources, with surface water abstracted from the Cannahowna River comprising circa 70% of the supply and the balance coming from three boreholes. The treatment afforded was basic, slow sand filtration which removed the turbidity and some associated colour, followed by disinfection. The graph shows that the colour values at Cahill's Bridge, the Gort Raw Water Intake and Gort Bridge all had essentially the same colour values for the six day period observed, with a slight diminution between Cahill's Bridge and Gort Bridge, which may be due to some small level of groundwater ingress in the intervening channel distance. The notable exception is the November 3rd measurement at the Gort Raw Water intake, which, considering the trend in all the other data, appears to be an outlier. The Community Centre Hydrant values are much lower in colour than the Gort River because it represents the water supply post treatment after having been mixed with the low colour bore-hole sources. Coole River and Kiltartan are effectively the same flow and hence have almost the same colour levels which were about 50% of the colour levels of the Cannahowna/Gort River. This is because the Kiltartan-Coole channels contain the combined flows of all three river systems i.e. the Owendalullegh/Beagh/Gort River and the Boleyneendorrish and Kilchreest Rivers. Clearly, the latter two rivers which were unaffected by the peat slide and may also have lower natural colour at the point of mixing have diluted the Gort River flow very substantially. Finally, the colour in the Kinvarra Raw water, downstream of all three rivers which coalesced in Coole-Garrylands wetland complex had the lowest colour levels (and the lowest suspended solids and turbidity levels) of any of the sites, indicating the very strong influence of groundwater on this supply in its 7-8 km underground passage from Coole Garrylands to the sea. These data as a whole point to a relatively short period of 2 to 3 weeks when elevated turbidity/suspended solids and colour levels in the Owendalulleegh spilled over into the Gort-Kinvarra system but thereafter resumed what were probably more representative seasonal trends in the system for all these parameters. The data also reveals a very rapid decline in the influence from the peat slip from the Black Road Bridge, down through the 22 km of the Owendalulleegh as far as the lake, a subsequent dampening and settlement effect in the lake and thereafter a diminution in all concentrations moving down that system due to additional sedimentation but especially due to the mixing of low solids, low colour groundwater and surface waters from the two other main river systems.

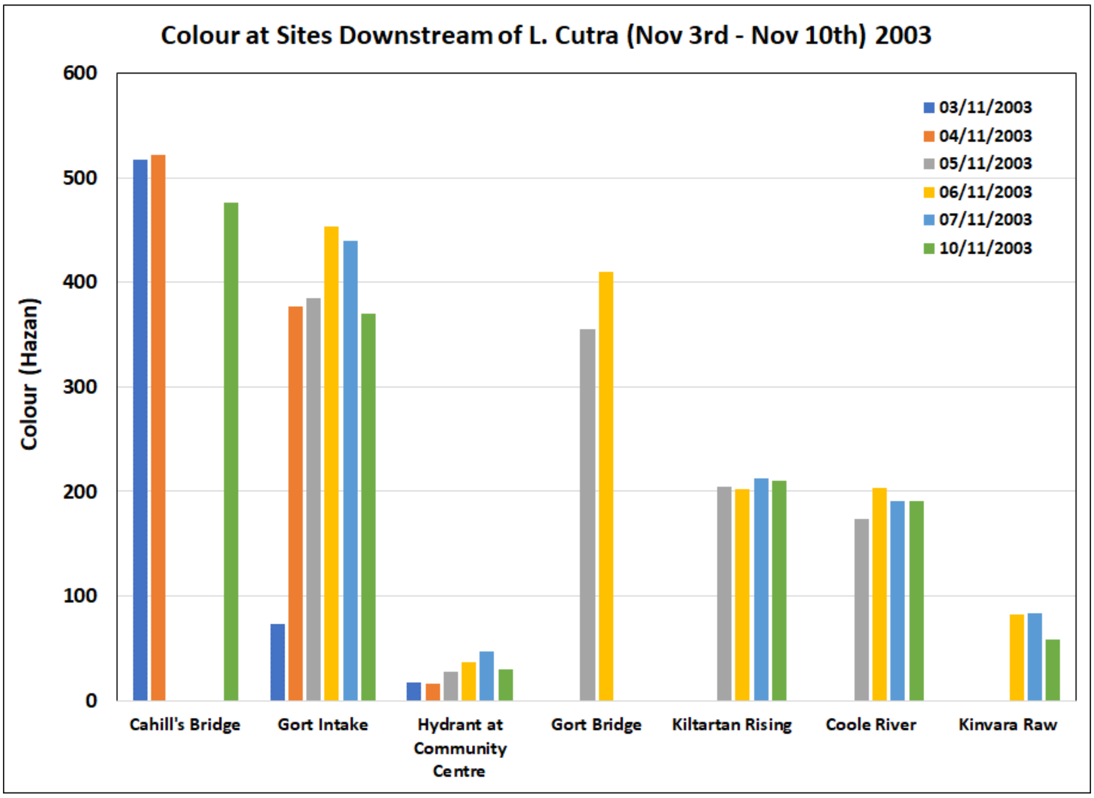

Figure 8.22 Colour measured at sites downstream of Lough Cutra between November 3rd and November 10th, 2003.

Offsite peat slip works: Oct 2003-end 2005

Between early October 2004 and January 2005 several remedial works were undertaken upstream and downstream of Black Road Bridge in order to improve drainage, manage newly mobilising peat and clear peat build-ups. These works were undertaken by ESB contractors and Galway County Council (GCC) and involved significant peat handling and storage in adjoining repositories. The following autumn between August 2nd, 2005 and September 2nd, 2005 two large peat repositories were created beside the river immediately upstream of Black Road Bridge between sites O4 and O4A (Figure 8.1). Straw bales were put in the river at the time to prevent peat solids washing downstream. Within the same period the temporary dam (Barrage B) which had been installed by GCC was removed from upstream of Black Road Bridge (September 2nd, 2005).

The likelihood is that both of these sets of activities would have mobilised appreciable amounts of peat solids at the time, which would have washed down into the system at SC7(b) after heavy rainfall in the days and weeks following these activities. The impact, however, is likely to have been limited given that they would have occurred late in the season in both years. Nevertheless, they probably delayed the recovery at Sites O4, O4A, O5 and O6 as reflected in the predicted Q-rating for 2005 and 2006 in Table 8.24, which can be described as a **moderate, negative temporary impact**. Impacts on fisheries would have been expected to have been very **slight to moderate, negative and temporary,** if peat silt lodged in spawning gravels in the lower reaches of SC7(d) and in the upper sections of the main channel of the Owendalulleegh downstream of the confluence of SC7, thereby reducing hatching success or fry swim-up. If such an effect occurred, it's likely to have only affected a small number of redds as the volumes of escaped peat would have been relatively minor and much lower than that mobilised at the time of the main slide in 2003.

Recovery of Fish Population

'*Assessing post-disturbance recovery of fish populations are difficult to implement and are often opportunistic, given the unpredictable nature of fish kill episodes and frequent lack of baseline information detailing natural pre-disturbance conditions*' (Sheldon and Meffe, 1995 quoted in Kennedy *et al.,* 2012). There are several small to medium-sized tributaries flowing into the Owendalulleegh from both the northern (RHS) and southern (LHS) bank of the river and probably most important of all the main channel of the river upstream from where the impacted tributary (SC7b&d) joins the Owendalulleegh. None of these watercourses were impacted by the peat slide and all of them would have provided trout and stone loach, and to a lesser extent lamprey to recolonise the main channel. It is likely that a very large proportion of the spawning trout population was already in the Owendalulleegh when the peat slide occurred resulting in a large cull of that cohort. However, it is possible that some larger trout resident in Lough Cutra, or some surviving the peat slide in the larger pools farther downstream, would have run into the main channel and tributaries to spawn in the weeks immediately following the peat slide. In this case, any spawning in the main channel would have resulted in poorer hatching success due to the presence of peat silt in the gravels, especially in the middle and upper reaches as far as the confluence with the impacted tributary. In contrast, any spawning in the unaffected tributaries would have had the normal level of success, especially in the main channel stretch upstream of the confluence of the impacted tributary. In addition, as lake trout do not necessarily spawn every year, some spawning only every second year (see Kennedy & Fitzmaurice, 1971), any trout from Lough Cutra spawning in the main channel of the Owendalulleegh the following year (2004) would have had a greater chance of their eggs hatching successfully. In any case, recolonization would have been expected to begin immediately and be largely reaching full biomass within 3 to 5 years after the peat slide.

The rate of recolonization would have been facilitated in the initial years by a reduction in intraspecific competition for territories and food by newly hatched alevins due to the drop-in fish density and the reduction in competition from older age classes following the slide, both of which would be expected to improve survival and recruitment rates. Initial recruitment would have been from fish in the tributaries moving down into the main channel and maturing to spawning age which would range from 1 to 3 years depending on the age of the fish initially and assuming that the bulk of trout would have reached sexual maturity by their 3rd year. Some re-colonisation of the impacted tributary, especially in the lower 1km would have been expected to occur within this time scale also.

In a follow-up study of a fish kill in the Ulster Blackwater which resulted in a 2.4km stretch of the river being effectively wiped out by a silage effluent spill, it took 3 years for the trout population structure in the impacted zone to reach the same level of density and biomass as the control sites which were immediately upstream and downstream of the impacted reach or the levels recorded previously in the impacted reach (Kennedy *et al.,* 2012). It was also notable that the majority of the early colonisers were 0+ fish, i.e. young-of-the-year, which may well have been the case in the Owendalulleegh also. In other studies, a major oil spill in the US which affected 37km of river and around 30 different fish species took 4 years and 4 months to fully recover (Kubach *et al.,* 2011). In an incident not too dissimilar to the Derrybrien peat slide, Lamberti *et al.,* (1991) report on the impact of a 'catastrophic debris flow' in the Pacific North West which decimated a cutthroat trout (*Oncorhynchus clarkii*) population over a 500m stretch of channel, further progress of the slide being halted by a large debris dam, with a lesser impact for a distance below the debris dam. Follow up work noted that within 2 years the population in the affected reaches were higher than in the pre-slide densities upstream. The recovery was attributed to immigration of 1+ fish and increased reproductive success and survival of fry in the impacted reach. In a review of fish recovery after kills in the US (Detenbeck *et al.,* 1992) it was reported that salmonids generally took longer than other species to fully recover. The study also noted that recovery was more rapid in response to 'push' rather than 'press' events. A push event being one caused for example by a nonpersistent toxicant e.g. silage effluent or a strong acid or alkali solution while a ‘press’ event would be one that fundamentally altered the habitat e.g. arterial drainage.

The Derrybrien peat slide can be largely described as a ‘push’ event (also known as a ‘pulse’ event). However, the ShRFB suggest in their report (Anon, 2004) that part of the upper reaches of the Owendalulleegh channel for 3.7km downstream of Flaggy Bridge, in particular the upper 0.5-1.1km of channel, was scoured of gravel, thereby reducing or removing habitat suitable for trout spawning. However, the findings of the electrofishing surveys undertaken for the current assessment in the tributaries draining the wind farm would suggest that several of these, including several unaffected by the 2003 peat slip, are sub-optimal for trout spawning. A 2014 survey at Black Road Bridge (O4) and another at the same site and at Flaggy Bridge (O5) in 2011 and 2019 recorded no fish (Table 8.21). In the 2011 survey no trout were caught in very similar channel and substrate types in two adjoining tributaries east of the impacted tributary, SC7(b), at O2 (SC6) and O3 (SC7a) (Figure 8.1), neither of which were affected by the peat slide. In a repeat survey in 2019 at the same sites only a very small number of fish were recorded (see Sections 8.2.6.2 & 8.2.6.3). The tributary immediately west of Flaggy Bridge along the same road (Site O5A – Plate 8.3) only returned 1 trout each in surveys in 2011 and 2019 (Plate 8.4). The first site downstream of Flaggy Bridge in which trout were recorded for the current study, in both 2011 and 2014, was at site O6 in SC7(d) i.e.800-850m downstream near a farm vehicle bridge (Unnamed Bridge C) and again in 2019 at the base of the tributary at O6A. In July 2018 the stretch from Flaggy Bridge down past O6 as far as the Ford at Tooraglassa on the main channel was walked. Along most of this 2km stretch the substrate was very coarse, comprising mainly cobble and in the more upstream parts boulders and bedrock also. In fact, the stretch from Flaggy Bridge downstream to O6 (800m d/s) is torrential in long stretches with much bedrock and step and pool type habitat with only very limited amounts of gravel suitable for spawning. However, given the steep nature of the channel it seems unlikely that much finer material could be retained within the channel during conditions of high flow in this stretch of the river. It’s only as the gradient diminishes rapidly just before and immediately after the confluence with the main channel of the Owendalulleegh i.e. 1.2km downstream from O6 that finer substrate more suitable for spawning begins to appear within the channel itself.

Three electrofishing surveys in the lower reaches of the Owendalulleegh undertaken by IFI in 2009, 2013 and 2016, (see Table 8.19, Section 8.2.6.3) recorded a fish diversity the same as that reported in the October 2003 peat slide with very similar size distributions of trout between the three surveys, suggesting a population that had regained equilibrium. This contention is supported by surveys undertaken for this study in 2014 at a nearby site (O11), where a slightly higher trout density with a good spread of age cohorts was also noted (Table 8.20 Figure 8.13, Section 8.2.6.3) and again in the 2019 survey at sites O7A, O7B and O7C on the main channel of the Owendalulleegh farther upstream (Table 8.21, Figure 8.1). In conclusion, it is thought likely that the pre-peat slide diversity, biomass and population structure for all fish species in the watercourses would have been fully restored by between 2009 and 2010, possibly sooner. Stone loach would have recovered first, probably within 2-3 years, trout next within 3-5 years, followed by lamprey within 6-7 years. Any vacant niches left for eel after the peat slide would have been recolonised by immigration from other sections of the Owendalulleegh and its tributaries, but full replacement could only occur by immigration from the marine environment which likely would have required several years to complete.

The question of whether a 3.7 km stretch in the upper reaches suffered a significant reduction in its spawning capacity by the loss of gravel as suggested at the time by the fisheries board (Anon, 2004) cannot be definitively determined from the available information. What we do know is that repeated surveys in the upper reaches of the impacted tributary upstream of Flaggy Bridge (SC7b) returned no fish, which is believed to be due to the inability of spawning fish to access these upper reaches due to the presence of a waterfall and a culvert within the first 300m downstream of Flaggy Bridge (Plate 8.1) and two barrages (No. 3 & 4) between it and Black Road Bridge (Plate 8.2 shows Barrage 3). Surveys in 2011 and 2019 have shown that the middle reaches of this tributary (i.e. 0.65-0.85 km d/s Flaggy Bridge) do contain trout in low densities and that the lower reaches of the same tributary, just upstream of the confluence with the Owendalulleegh i.e. 1.8km d/s Flaggy Bridge, hold reasonable densities of trout and good densities of stone loach (i.e. at Site O6A in the 2019 survey – Tables 8.20 and 8.21). These data combined with the very poor fishing returns from the three adjoining tributaries, SC6, SC7(a) and SC7(c), with similar physical habitats but unaffected by the peat slide, suggests that if the peat slide diminished the spawning capacity of SC7(b) the effect was largely confined to the first 1km downstream and probably diminished gradually over time with the transport downstream of replacement gravel eroded from banks. Taken as a whole and considering the narrowness of this channel, and what seems to be a natural patchiness of suitable spawning habitat, even a complete loss, or more likely a reduction in the spawning capacity of this stretch for trout, can be described as at most a **slight negative and short to medium term impact** on the overall trout population of the Owendalulleegh.

In contrast to trout, the likelihood is that the stone loach population would have made a full recovery faster because they are summer spawners and therefore likely to have encountered a much reduced deposit of peat silt during their first spawning, 6-8 months after the slide. They also have an extended spawning season and a very short time for hatching ~3 weeks, and they don’t bury their eggs like salmonids, all factors likely to favour them over salmonids in the circumstances of the slide, at least for the first season post the event. Overall, the impact on the species can be described as **significant, negative and short-term** in duration.

Brook lamprey remain for 5-6 years in soft marginal sediment during the larval or ammocoete stage after which they transform into adults and are ready to reproduce. At this stage they usually range in size from 13-15cm. That would suggest that the Owendalulleegh population would take a minimum of 7 years before reaching pre-peat slide levels. However, it is likely that many vacant niches were filled by immigrants from tributaries such that even in a few years after 2003 suitable larval habitats would have been at least partially re-colonised. It is possible that there may also have been a residual population surviving in the lower reaches after the peat slide. IFI recorded one lamprey at their catchment survey sites (see Table 8.19, Section 8.2.6.3) in 2009, 2013 and 2016. The present study recorded two lampreys, both 11cm at Site O9 in 2011, and in 2014 at the same site another three of 4, 8 and 9cm in length, while a single specimen (of 11cm) was also recorded at Site O11 the same year (Table 8.20). Lampreys are more difficult to survey using electrofishing methods unless they are being specifically targeted, so general electrofishing surveys are likely to underestimate their densities. The very spatey nature of the upper tributary sites on the Owendalulleegh and its very coarse substrate means that the density of lamprey in these areas is likely to be very low. It may also be the case that the mobilisation of sand and peat silt noted during the follow-up walkover survey in December 2003 may have boosted marginal pockets of finer material where juveniles of the species would have colonised after the slide. Overall, the impact on the species can be described as **moderate to significant, negative and short to medium medium-term** in duration.

Eel are a robust species, and some are likely to have survived the peat slide in the mid to lower reaches of the river. Those that were killed as a result of the peat slide could only be replaced by immigration either from tributaries within the catchment or from beyond the catchment, as the species does not reproduce in freshwater. It is presumed that eel reach Lough Cutra and the Owendalulleegh catchment by some underground river, given the lack of a surface water connection to the sea. In either case, full replacement may take several years. This can be described as a **moderate to significant, negative impact and short to medium-term** in duration. During the 1970’s and 80’s Moriarty (1975 and 1986) reported eel densities of between 0.6 and 2.3 per unit effort (i.e. 1 fyke x 1 night) in the lake. Current eel densities in the lake are not known.

8.3.2.3 Operation Phase: 2006 - mid 2020

Onsite Road Upgrade and Maintenance

In April and May 2014 many parts of the floating road system on the wind farm needed to be repaired and upgraded due to wear and tear. These remedial works were assessed in detail in 2013 as part of an Appropriate Assessment screening process for the works and included recommendations for silt control mitigation on any of the drains likely to receive silt run-off from sections of the track ear-marked for repair. While no targeted follow-up assessments were undertaken after these works, the assessment at the time concluded that the silt control measures would have been sufficient, given the nature of the works and the gently sloping terrain, to prevent any downstream impacts on the ecology of the receiving waters caused by solids runoff. It should be noted that Q-value macroinvertebrates surveys undertaken in July 2014 indicated poor or moderate water quality conditions at Sites O4, and O5 in SC7(b) which could have been attributed to these maintenance activities on the wind farm (see Section 8.2.4.2 and Table 8.10). If this was the source of the impact it can be described as **slight to moderate, negative and short-term** on invertebrates, and **slight, negative and short-term** on fish in affected tributaries.

Onsite Drain Cleaning

A visit to the wind farm site undertaken in July 2018 showed that the site overall had well vegetated soil cover apart from very localised and small areas of exposed peat or mineral soil, and with most drains stable and not showing signs of excessive erosion. Drains on the site require to be cleaned from time to time in order to maintain conveyance. This entails removal of accumulated vegetation and any deposited material build-up using a back-hoe digger which side-casts the removed sediment and vegetation from the drains. This activity could generate suspended solids which could have a negative impact on fish spawning in the streams draining the site if silt were to accumulate in spawning beds during the spawning or hatching periods in winter and spring. Depending on the extent of such an effect the impact could range from **slight to moderate, negative, temporary,** in affected tributaries

Tree Growth Cut-back

Cut back of tree regrowth is also required at intervals. Small amounts were undertaken in 2018 for a distance of 10 m either side of access tracks in selected areas around the site. This was also carried out along the OHL corridor. Cutting back of tree regrowth will continue to be required throughout the site and along the OHL over the remaining operational life of the project. These actions could potentially generate increased nutrients and suspended solids. However, their limited extent and dispersed nature strongly suggest that any impacts in receiving waters will either be **negligible or slight, negative and temporary** and in most if not all cases unlikely to result in a change of ecological status in the receiving waters downstream.

Turbulence Felling (2016-2018)

In order to optimise the energy production of the wind farm, it was necessary to clearfell some of the maturing forestry adjoining the site. This was undertaken in 2016, 2017 and 2018 immediately beside the western boundary and southwestern and north western corners of the wind farm. The total area felled came to 46.2 ha divided as 22.30 ha (2016), 20.47 ha (2017) and 3.43 ha (2018). It is worth noting that much of this forestry was already ear-marked by Coillte for commercial felling as it was coming to maturity. The felled area drained to subcatchments SC1, SC7(c), SC8 and SC9. The approximate breakdown apportioned to these catchments in the 3 years of the felling is given in Table 8.26.

Table 8.26 Areas in hectares of turbulence felling divided approximately between the four subcatchments adjoining the western boundary of the wind farm, undertaken in 2016, 2017 and 2018.

	2016 (ha)	**2017 (ha)**	**2018 (ha)**
SC1	10.03	0.00	0.00
SC7(c)	0.00	6.95	0.05
SC8	0.49	8.72	3.37
SC9	11.77	4.78	0.00

Q-value samples undertaken in SC9 in 2018 (at O9A) gave a Q-4 result (i.e. Good Status) the same results as the EPA in 2018 at a station less than 500 m downstream on the same channel (EPA OT1, Table 8.8). The latter marked an improvement from the previous EPA survey at the same site in 2015 when a value of Q3-4 (Moderate Status) was recorded, a result thought to relate to a significant amount of felling in the catchment upstream in the interval since the previous survey in 2012 when a High Status result of Q4-5 had been recorded. The nearest points of the turbulence felling in 2016 and 2017 in SC9 to the EPA OT1 site were 4.2 km and 3.9 km respectively, which suggests that much of the peaty/organic solids and some of the nutrient that would have emanated from the felling, would have settled, and been biologically adsorbed/consumed along the intervening channel, only giving rise to a very marginal, if any, effect at EPA OT1. When Site O9A in the current study was also surveyed in 2018, the same result recorded at EPA OT1 was obtained, i.e. Q4 (Good Status). Turbulence felling in SC9 is therefore thought to have given rise at worst to a **slight, negative, temporary impact** on macroinvertebrates.

The following year in 2019 the EPA recorded a Moderate Q-rating of Q3-4, a drop from the previous year. This agreed with the same rating recorded upstream in Sites O9A1 and O9A2 the same year for the current study, which is being attributed to felling in the upper part of SC9 in 2018 and 2019, that was unrelated to the earlier turbulence felling.

Drainage from the felling which occurred in SC1, travelled via a small nexus of drains including B4B and B4C to site B4 at the end of the catchment over a distance of 3-4 km. In 2018, that site returned a High Status Q-value (Q4-5/5) and therefore doesn't appear to have been impacted by the clearfelling which occurred in 2016. However, in 2019, for the first time in over 20 years, the Q ratings at EPA B1 fell from High to Good (Q4) and it is possible that this was connected with clearfelling in SC1 carried out since 2016 but not associated with turbulence felling. Sites B4B & B4C in the upper part of that tributary surveyed for the current study in 2019 did return Moderate (Q3-4) ratings, although the site at the bottom of the tributary and just upstream of

EPA B1, returned a Q4 (4-5) i.e. Good verging on High. In 2019, the Owendalulleegh, subcatchment SC7(c), sampled at Site O5A returned a High Status Q-value (Table 8.10) suggesting that the felling in that catchment left no residual ecological impact from the 2017 felling, even though the SRP concentration was elevated above background when sampled around the same time (Table 8.16). A water sample taken at the base of SC8 in August 2019 returned the highest SRP value of any site sampled (0.214 mg/l) and it is considered unlikely that all of that was contributed by felling in the upper catchment. At around the same time a Q-rating of Q3-4 was recorded at the same site. However, it is doubtful that this can be attributed in its entirety to the clearfelling in the catchment carried out in 2017 and 2018.

Overall, therefore, it is believed that the 46.2 ha of turbulence felling undertaken between 2016 and 2018 across 4 subcatchments probably did give rise to an increase in nutrient runoff (as SRP primarily) but had at worst only **slight negative and temporary** impacts on ecological status at sites lower down in the subcatchments in question.

8.3.3 Impacts which are occurring

8.3.3.1 Construction

Currently there are no construction related impacts occurring that would give rise to negative impacts in the aquatic environment.

8.3.3.2 Operation

Currently no aspect of the operation of the wind farm, the OHL line or the Agannygal Substation is known to be giving rise to any negative impacts on surface waters.

8.3.4 Impacts which are likely to occur

8.3.4.1 Mid 2020 - end of operational phase

Drain cleaning, road upgrades, and maintenance tree felling on-site and along the OHL corridor have been discussed in Section 8.3.2.3 above.

8.3.4.2 Decommissioning phase

Overview

Decommissioning will entail works on the wind farm site itself, along the OHL corridor and the Agannygal Substation, and in relation to the remaining off-site measures constructed at the time of the 2003 peat slide, in particular the boulder barrages installed to stem the flow of peat down.

Wind Farm

All access tracks including floating roads, all drains, concrete turbine bases, crane pads, substation hardstanding, peat repositories, and the borrow pits are intended to be left undisturbed such that the site will not become a source of sediment or nutrient loss above that which would be expected from a control site with a similar vegetation cover and landform.

All of the works will be undertaken on the existing trackways and crane hardstands and will generate the minimum amount of silt. All decommissioned materials i.e. turbine components, electrical equipment and demolished substation buildings, will be removed off site for re-use or licensed disposal. A limited amount of temporary track widening may be required along the 1km of narrow turbary road between T31 and T45 in places where the track is too narrow for the crane that will need to travel along it. The widening will be achieved using steel plates, bog mats or equivalent means as required. Properly planned and supervised, these activities should have at most **minor, negative and temporary impacts** on downstream watercourses close to the wind farm boundary. The impacts would be confined mainly to aquatic invertebrates with the possibility of slight negative impacts on spawning success in the streams concerned, depending on the degree of siltation. This latter effect would not be expected to extend into the main channel of any of the 3 main channels draining the site.

OHL and Agannygal Substation

The OHL corridor between the wind farm to the north and the Agannygal Substation to the south is well served by stoned Coillte forest tracks as well as several local roads which more than adequately provide for suitable access track starting points to each of the pole and mast structures to be decommissioned. Six preliminary access routes have been proposed (see Figure 2.28 and 2.29 Chapter 2). With the exceptions of minor drains, which are likely to be present in places, the majority of these routes do not traverse recognisable surface drainage channels except where these are already culverted, thereby posing a very low risk of solids wash-out. There are a small number of exceptions to this situation, however. The most important is the proposed access route to AM24 and PS23 & PS25 which requires a crossing of the main channel of the Owendalulleegh. This was the same route used during the installation of these three structures. In terms of average density, we know that this crossing point holds about 0.3 trout and 0.1 stone loach per m^2 which would suggest that about 5-6 trout and about 2 stone loach, on average, might be present in a 3.5m wide corridor at a point where the river is about 5m across and that number of fish could be killed at the crossing due to vehicular traffic. These figures could be higher however if there were frequent over-and-back trafficking. Were this to be the case the impact could be described as **slight to moderate, negative and temporary.**

The other exception referred to is the access route from PS28A south to PS31 which crosses the unnamed 1st order stream (EPA Code: 29D21, Segment Code: 29_361) in two places. The stream is dominated by cobble and pebble with coarse sand common in places. It is of High Status quality and may also have a small trout population present. Access from the Agannygal Substation to the final structures at the southern end of the OHL i.e. from PS40 to AM38 is over slightly sloping ground where repeated tracking might cause ground damage, which in turn could become a source of suspended solids washout during wet weather. This could also be the case for the first 9 or 10 structures immediately south of the wind farm site where the ground falls more steeply toward channels at Black Road Bridge (Site O4) and Flaggy Bridge (Site O5). In fact, to some extent the latter could be an issue at any point along the route where very minor drains could allow contaminated surface run-off to reach one of the larger drainage channels along the route. These activities could lead to **slight negative and temporary impacts** in some of these watercourses, mainly in the form of changes to the relative abundance of some aquatic macroinvertebrate groups favouring less sensitive groups such as chironomids. Direct impacts on fish are highly unlikely except on the main channel of the Owendalulleegh because electrofishing surveys in the streams close to the northern half of the OHL corridor revealed mainly fishless channels or low numbers of mainly older fish, i.e. very little evidence of spawning.

Removal of Barrages 3 and 4

It has been decided that barrages 1 and 2 will remain in place but that barrages 3 and 4 will be removed. The barrages comprise dam-like structures straddling the main SC7(b) channel between Black Road Bridge and Flaggy Bridge (Plate 8.2). Both are made of massive boulders which allow water from upstream to flow through the gaps in the structure but at the same time retain soft, now compacted material upstream of the barrages. The proposal is to remove the boulders that form the main structure of the barrages and to also remove the finer material which has accumulated behind the structures. It is imperative that all the softer material is removed in its entirety before the boulders are removed because otherwise it could release suddenly under the weight of gravity and the force of the water upstream, potentially constituting a significant debris slide which in a worst-case scenario could cause a fish kill downstream. Although such a fish kill, were it to occur, would only impact the first approximately 1 to 2 km downstream of the barrage sites, the potential impact would still be described as a **moderate to significant negative, localised and short-term impact**.

The proposal therefore is to remove any material currently being held back by the barrages and batter back the edges of the channel to the extent that once the boulder face of the barrage is removed that the stream, even in a spate, would not give rise to new channel erosion or would only remove a minimum of residual loose material. Even the initial removal of compacted material from behind the barrage using a backhoe digger could give rise to substantial loss of suspended solids which in turn could negatively impact macroinvertebrates and fish downstream. If this is undertaken without mitigation, the downstream impact can be described as **slight or moderate, negative, temporary,** affecting the ecological status of the SC7(b) channel at Site O5, possibly dropping from Q4-5 or Q4 to Q3-4. There could also be **a slight negative and temporary** impact on spawning in the lower part of the subcatchment around Site O6A, depending on the amount of solids generated by the works, resulting in a slight reduction in trout fry recruitment at the site. Both these impacts would be localised within the SC7(b)/(d) subcatchment.

8.4 Cumulative Impacts

8.4.1 Cumulative impacts which have occurred

8.4.1.1 Overview

A number of projects and activities which are or were located within the same main river catchments as the Derrybrien Wind Farm project which could potentially have acted or to act cumulatively with the wind farm project to impact aquatic ecology and fisheries by virtue of their proximity or size are listed here:

- Turbary activity
- Wind farms in Slieve Aughty Mountains
- Adjacent coniferous forestry plantations
- Planting in lieu of felling on wind farm site
- Overhead transmission lines
- Gort Regional Water Supply Scheme
- Sand extraction at Cloghvoley
- Ballynakill Quarry
- Coillte Quarry
- Woks to Beagh Bridge

8.4.1.2 Turbary activity

Cut-over bog where turbary rights occur exist widely within the subcatchments that drain the Derrybrien Wind Farm and to a lesser extent the OHL route and Agannygal Substation catchment (see Figure 2.7 Chapter 2 and Figure 8.4). However, the existence of turbary rights provides no indication of the amount of peat extraction occurring. Indeed, it is estimated in Ireland that only around 10% of turbary owners actively exercise their right to extract peat (Renou-Wilson *et al.,* 2011). Moreover, because it is estimated that more than 80% of peat extracted by rural contractors is privately traded (Fitzgerald, 2006, quoted in Renou-Wilson *et al.* (2011)), it is difficult to know how much is extracted in any given year or in any given area of cut-over bog. In addition, the overall intensity of extraction in any given year is likely to vary due to a range of factors including for example the price of other domestic heating fuels. Therefore, unlike forestry activity where Coillte and the Forest Service keep detailed records of management activities e.g. clearfelling, and re-planting, which in any case can also be tracked by aerial imagery, there is no coordinated record of the intensity or extent of peat extraction in turbary plots. Moreover, depending on the drainage of individually active plots within a larger block of cutover bog, the connectivity of individual plots to surface water drainage and therefore the likelihood or otherwise of peat silt generated during peat extraction reaching rivers and streams is unknown. Furthermore, while the environmental impacts of every aspect of forestry management on surface waters has been researched widely and intensively in Ireland and elsewhere, there is very little research available on the impact of turbary on surface waters in Ireland. The only research available relates to the industrial scale extraction of peat in large midlands raised bog systems operated by Bord na

Mona, much of it done in the 1960, 70's and 80's. Studies on small catchments with drained blanket peat bogs in the UK have shown that receiving waters are prone to higher suspended solids concentrations, especially in the winter months as well as greater amounts of fine particulate organic matter (FPOM) in the sediments. In the same areas the macroinvertebrate community had higher abundances of Chironimid midge larvae and Simuliid midge larvae, as well as lower representation of mayflies (Ephemeroptera), stone flies (Plecoptera) and caddis larvae (Trichoptera) i.e. more sensitive groups to peat silt. In areas where these drains have been blocked for several years it was noted that each of these trends was reversed i.e. lower amounts of organic solids and greater representation of the more sensitive invertebrates (Ramchunder *et al.,* 2012). These data suggest that if turbary were impacting on the receiving waters around Derrybrien Wind Farm, that a greater amount of deposited organic particulate matter i.e. peat silt would be recorded and impaired Q-values due to a lower representation of more sensitive groups. It is possible that if turbary were ongoing during and before the construction of the wind farm site it may have depressed the water quality at Sites O3 and O2 respectively, dropping it from High Status (Q4-5) to Good (Q4) or from Q4 (it started out as Good Status) to Moderate (Q3-4). Combined with suspended solids generated during the construction phase these conditions may have become more impaired, possibly falling to Q3 (poor Status) at these two sites but for that to have occurred the solids leaving the site due to both turbary and the construction would have had to have been considerable, and bearing in mind that silt traps were placed on all the main outlets drains from the wind farm, this is unlikely to have arisen. It should be noted also that any cumulative impacts during construction would likely have dissipated before either of these tributaries (SC6) and (SC7(a) reached the main channel of the Owendalulleegh, so the cumulative effect, had it occurred at all, could be described as **slight to moderate, negative and temporary** in terms of potential impacts on macroinvertebrates and **slight, negative and temporary** in terms of impacts on fish in the two affected channels.

Peat Disturbance in Turbary Plot

Description of Peat Disturbance Area

On June 9th, 2020 a site visit was made to the Derrybrien Wind Farm to assess the impact from the localised peat disturbance in one of the turbary plots. It is situated 125 m NNW of Turbine 38 and 160m SE of Turbine 34. The disturbance is 60 m along its longest axis i.e. SSE-NNW and at its widest is 40m across its southern, downslope base. In total the affected area is 0.2ha. It is only noticeable when one is up close to it and is characterised by roughly 12-15 curved and more or less parallel tears in the peat surface running east-west across the affected turbary plot. The tears are about 2-3m apart and about 1-2m wide, where the surface vegetated layer has been prised apart and the underlying peat cleft (Plate 8.10(A)). Some of these have water collected in the base and there is evidence of loose peat silt having collected in the bases of some (Plate 8.10(B)). Immediately north of where these tears appear in the peat surface the remaining 65m of the plot is showing no sign of failure. However, the surface vegetative cover has all but disappeared, eroded by constant machinery movements associated with spreading the extruded sods to dry flat or in small piles (Plate 8.10(C)). This surface may be subject to peat silt loss during intense rainfall. Machinery pressure and the absence of a vegetative cover on this part of the plot may have contributed to its destabilisation. Adjoining turbary plots are separated by drains running parallel to their long axes and the one on the eastern side of the affected site adjoining the failed section appears to have been widened and peat excavated out of it.

Drainage and Water Quality

At the base of the affected plot, there is an east-west running drain which carries runoff drainage from the plot itself and from the adjoining inter-plot drains running perpendicular to it. Drainage from the plot that enters this drain splits more or less in the centre of the plot, one half flowing west and one half flowing east. At the base of the adjoining turbary plot to the east, where it joins this east-west drain, a large rectangle of peat cutting has been excavated in right up to the eastern-flowing section of the drain (Plate 8.10 (D)) The east-flowing drain continues for about 210m in a narrow channel with a gravel base denoting running water when the drain is active (Plate 8.10 (E)) and at the end of that run (ITM 560725, 705195) it turns at right angles to the south to join the trackside drain beside Turbine 41. From there it flows east along the northern edge of the track for 540m down past Turbine 46 to the bottom south eastern corner of the turbary area where it flows under the track in a SSE direction (ITM 561350, 704990) forming the eastern head-water branch of SC7(a) which contains the O3 survey sites.

The western flowing runoff from the affected turbary plot is more sluggish with a soft, peat bottomed channel (Plate 8.10 (F)), which flows 270m westward where it joins a drain coming from the west and the resulting flow turns south in a highly eroded channel with much bedrock along its base which emerges beside Turbine 35. From there it flows under the track (ITM 56041 704885) south east into the forestry immediately below the track where it shortly joins another drain flowing from the west and the resultant channel emerges into a 17ha plot of recently clear-felled forestry where it forms the western head-water branch of SC7(a). A kick-sample was taken on the day in this stream at a point about 310m downstream of the wind farm boundary at (ITM 561814, 702025), which returned a High Status rating (Q4-5) – Table 8.27. This site has been denoted O3B. The substrate was mobile and very coarse and completely free of peat silt, with a mixture of riffle and pool habitats, and no in-stream vegetation (Plate 8.10 (G)). This stream continues for another 1km where it joins the eastern branch of SC7(a) and the combined flow continues for another 4.7km before it joins the SC7(d) channel 0.67km upstream of the main channel of the Owendalulleegh. A kick-sample was taken at about 600m upstream of this latter confluence i.e. close to the base of SC7(a) where the rating was Q4 (Q4-5), i.e. Good Status, verging on High, Table 8.27. The channel, which was just over a metre wide, showed signs of cattle access below the kick-sample point. The water was clear and the coarse, stable substrate surface was silt free, although a small amount of peaty silt rose when the substrate was disturbed during kick-sampling.

There was a heavy cover of moss and liverwort on the substrate in places (Plate 8.10 (H)).

The timing of the occurrence of the peat disturbance is unknown, and it may have occurred over an extended period. The likelihood is that over the weeks or months since its appearance, peat silt will have eroded out of the exposed tears in the peat, which are the main feature of the disturbance, during periods of intense rainfall. These will have flushed out in the east and west drain at the base of the disturbance entering the two main upper branches of the SC7(a) subcatchment, as described above. However, the impact of these appears to have been minimal, based on the results of the two kick-samples referred to above. In the case of the one at O3B at the head of the catchment there would seem to have been no local impact, given the High Status result obtained. The Good Status result obtained closer to the base of the catchment is likely derived from a broad range of sources of silt and nutrient in the catchment, not just from this very confined peat slide. While the upper site is likely to be too torrential and unstable to be important for trout spawning, the lower site at O3C will be used by trout in places. Overall, the impact of this event is thought to have been **slight, negative and temporary, cumulative impact** resulting in a low level diffuse addition of peat silt to the affected SC7(a) watercourse, barely perceptible, if at all, in terms of biological water quality.

	EPA Quality Class	**O3B**	**O3C**
Mayflies (Ephemeroptera)			
Ecdyonurus	A	N	F/C
Heptagenia	A	+	
Rhitrogena	A	C	
Siphlonurus	A	F	
Serratella	C		C
Baetis	C	F/C	
Stone Flies (Plecoptera)			
Isoperla	A	F/C	F/C
Chloroperla/Siphonoperla	A	F/C	F+
Leuctra	B		F
Caddis Flies (Trichoptera)			
Silo	B	+/F	+
Rhyacophila	B	+	+/F
Hydropsyche	C		F
Plectrocnemia	C	+/F	
Limnephilidae	C	+	F
True Flies (Diptera)			
Chironomidae	C		
Simuliidae	C		
Dicranota		F	F
Beetles (Coleoptera)	C		
Elmidae	C	F/C	N
Small Dytiscid adult	C	C	C
F/W SHRIMPS (Crustacea)			
Gammarus	C		+

Snails (Mollusca)			
Radix balthica			+
Potamopyrgus antipodarum			+
Worms (Oligochaetae)			
Oligochaete	E	+/F	+
Lumbricidae	E		
Q-rating		**Q4-5**	**Q4 (Q4-5)**

Table 8.27 Macroinvertebrates taken in kick-sample at site O3B and O3C, June 9th, 2020

Plate 8.10 (A-H) Peat Disturbance in Turbary Plot in Wind Farm Site

A = disturbance showing peat tears, B = shows close-up of peat tear with water, C = badly eroded surface of turbary plot upslope of peat disturbance, D = shows peat excavation rectangle at base of turbary plot adjoining and east of disturbance area plot, E = eastern section of east-west drain shoring eroding base, F = east-west drain western section showing deposited peat in base, G = substrate at Q-rating survey site (O3B) and H = photo of stream at O3C Q-rating survey area.

The potential for ongoing impacts from a peat slide due to turbary

A peat stability risk assessment (refer to Chapter 10 Soils, Geology and Land) was carried out in the area of turbary in and immediately adjacent to the wind farm, which concluded that without mitigation the chances of peat failure occurring in the turbary plots ranged from **Possible to Likely** to **Possible to Very Likely** depending on the plots involved. The corresponding peat stability impacts were estimated to range from **High** and **Significant,** and **Medium to High** and **Moderately Significant.** Given that the active turbary plots are only cut seasonally once a year in late spring/early summer, the frequency of the stability impact is **Occasional** and because peat extraction within any turbary plot only takes a few days, the duration of the impact is described as **Brief** to **Temporary**. If the failure involved was on the same scale as the one outlined in the previous section ('Peat Disturbance in Turbary Plot') then cumulative impacts on the aquatic habitats SC7(a) would be **Slight**, **Negative** and **Temporary** in duration. However, if a major failure occurred, at the level of the 2003 peat slide then the cumulative impacts would be **Profound** or **Very Significant, Negative** and potentially **Short-term** to **Medium term** in duration, impacting water quality and fisheries in the Owendalulleegh via the SC7(a) tributary which is the watercourse draining the turbary area.

The stability assessment concluded that in terms of the range of wind farm activities that occurred on the site between 2006 and Q2, 2020 involving surcharge loads on the peat or floating roads, the effect that surcharge loads had on the stability of the peat was **Low** to **Very Low** and only **Slightly Significant** and concluded that no peat failures occurred as a result of the wind farm activities during this time.

The assessment further concluded that when this is compared to the significance of the stability impacts of site activities for peat extraction in the turbary plots it can be seen that, due to the increased level of mechanical extraction carried out in the area since 2012, the cumulative effect on the stability of the peat temporarily increased to **Moderately Significant** or **Significant** in the plots where the mechanical peat extraction was being carried out. The highest risk of a peat failure was at the time that the works were being carried out and the effect was brief or temporary, lasting only a few days in each area.

Following the risk assessment, a series of significant mitigation measures (refer to Chapter 10 Section 10.4.5.2.4) was drawn up for future mechanical peat extraction in the turbary plots in order to *reduce the likelihood of a peat failure and the cumulative effect of the activities on the stability of the peat in the Project area to an acceptable level over the remaining operational life of the wind farm and during decommissioning*. The assessment concluded that once these mitigation measures were implemented, the likelihood of a peat failure occurring dropped to **Low**, with the corresponding effect on the stability on the peat falling to **Medium to Low**, which is of **Slight Significance**. In addition, the cumulative effect of wind farm related activities during the remaining operational phase and the decommissioning phase would still rank as **Slight Significant**. In this scenario, the likelihood of negative cumulative impacts in the downstream receiving waters would also be **low** and **slight, negative** and **temporary** in terms of significance.

8.4.1.3 Wind Farms in Slieve Aughty Mountains

The Sonnagh Wind Farm

This wind farm is a small development of 9 turbines situated on high ground immediately east of Lough Belsrah about 3.4 km north west of the Derrybrien Wind Farm. Part of the site drains into the upper tributaries of the Boleyneendorrish River at a point upstream of B3 and EPA B1, the latter coinciding with B5 in the current study (see Figure 8.1). Biological water quality results at both sites have recorded High Status (Q4-5 or Q5). The EPA B1 site results returning High Status results consistently for over 2 decades up to 2018 with a drop to Good Status (Q4) for the first time in 2019 (Table 8.8, Section 8.2.4.1). The same year (2019) a Q rating of Q4-5 was recorded in the present study at B3, i.e. upstream of the EPA B1 site and downstream of the confluence of the Sonnagh Wind Farm tributary indicating that there has been **no cumulative** impact from this project on aquatic habitats in the Boleyneendorrish.

Keelderry Wind Farm

The site of this proposed wind farm is situated 3.5 km west of the Derrybrien Wind Farm. The project was abandoned in 2007 after the access tracks to the turbine sites were completed. The site drains to a small catchment due west of SC9 which joins the main channel of the Owendalulleegh immediately upstream from EPA O3. This site had always returned a High Status value except in 2003 after the peat slide at Derrybrien, and in more recent years, and therefore there has been **no cumulative** impact with this project.

8.4.1.4 Forestry in Wind Farm Subcatchments

There is a degree of uncertainty attached to some of the Coillte data for the period 2000-2006 in terms of felling activity in each of the subcatchments draining from the wind farm site. This is because, although there is data in relation to which forestry block was to be felled in any given year, from time to time felling proceeded either earlier or later than the dates shown on harvesting plans and it hasn’t always been easy to confirm the exact year trees were felled. The following analysis is a combination of hind-cast felling data available from more recent digitised Coillte maps, with the caveats mentioned above, as well as an examination of Google Earth imagery from 2006, 2011, 2015 and 2018 and, in particular, OSI aerials photos from 2000 and 2005.

In the period 2000 to 2005 there was either very limited clearfelling in most of the subcatchments to which substantial portions of the Derrybrien Wind Farm drain or if there was substantial felling, then the wind farm on-site felling in the same subcatchment was quite limited, thereby limiting any potential for cumulative impacts in either scenario. In SC9, for example, while there was extensive felling within the Coillte forestry blocks between 2003 and 2006 (~66ha) particularly in 2005/2006, during the construction phase of the wind farm, only around 2ha was felled within the wind farm site that drained to the same subcatchment, so effectively any cumulative impact was likely to have been negligible. Throughout SC7(c), no off-site Coillte felling took place, during the 2000-2005 period, so no cumulative impact would have arisen, for example at Site O5A. A small amount of Coillte felling did occur in SC7(b) between 2000 and 2005. However, any cumulative impact would have been completely masked by the 2003 peat slide in the same catchment. During the same period no off-site felling took place in subcatchment SC7(a), so no cumulative impact would have arisen. In SC6, although there was extensive Coillte off-site felling, there was very little in that portion of the wind farm site, therefore again, effectively no cumulative impact would have occurred. In SC5 in the Duniry catchment, while there was a significant amount of Coillte off-site felling between 2000-2005, within the same window there was only a tiny portion of felling in the NE corner of the wind farm, therefore any cumulative impact would have been negligible. There was no Coillte off-site felling in SC3 and SC4 between 2000 and 2005 and while there was around 19ha felled in SC2 in the same period, an examination of the OSI aerial photo for 2005 indicates that it occurred at least one year but probably more, prior to the on-site felling within the same subcatchment, so that any cumulative impact would have been slight to moderate locally, persisting for at most one to two years and taking the form of a drop in ecological status from High Status to Good Status at B2, an effect unlikely to have persisted for more than one or two years. This can be described as a **slight, negative impact of localised and temporary to short-term duration.** SC1, which is the largest of the subcatchments draining the wind farm, registered a large area of off-site felling in the period 2000-2005 including a significant amount that would have coincided with the on-site felling. It is likely therefore that some cumulative effects would have occurred at the time, which would most likely have resulted in a slight drop in Q-ratings at B4. From EPA data it can be seen however, that immediately downstream on the main channel of the Boleyneendorrish that High Status (Q4-5) was maintained at the time (Table 8.8, Section 8.2.4.1), so that any cumulative impact that may have occurred would have been confined to the smaller tributaries. Had these occurred at the time they would have been **slight to moderate, localised, and temporary to short-term in duration.**

8.4.1.5 Planting in lieu of felling on wind farm site

Coillte planted forestry in Counties Roscommon and Tipperary in order to compensate for the forestry felled on the Derrybrien Wind Farm site. These comprised six planting areas, three in Co. Roscommon in the Upper River Shannon Catchment and three in Co. Tipperary in the Lower Shannon Catchment. Those in the Upper Shannon Catchment are not situated in a water-based SAC, nor are they close enough to any downstream. The Co. Tipperary sites are either in or very close to the Lower Shannon SAC. Neither set of plantings can have any cumulative impacts on the Derrybrien Wind Farm project. The Roscommon sites are more than 128 km upstream of the northern end of the Lough Derg (Shannon) SPA (004058) and 135 km upstream of where the Duniry River reaches North East Shore Lough Derg SAC (002241), as well as 185 km upstream of where the Bleach River eventually joins the Lower Shannon in Lough Derg. The Co. Tipperary sites in the Bilboa River catchment discharge to the Lower River Shannon via the Mulkear River which at that point is more than 35 km downstream of where the Bleach River (Lough Atorick catchment) eventually joins Lough Derg near Scarriff and 53km downstream of where the Duniry River eventually joins the Lough Derg NE Shore SAC, and 19 km downstream of the Lough Derg (Shannon) SPA (004058). Thus, while all the sites are connected eventually to the River Shannon catchment, they are all too far from each other to possibly have a cumulative effect.

All of the Co. Roscommon plantings (Table 8.28) are on or adjoining 1st order streams and two flow into channels that have been extensively drained/straightened downstream (Oldtown and Brackloon). Moreover, one of the plantings, Ardcocoran, is almost 3.8 km from the 1st order channel that it most likely eventually drains to. The drains around that plot seem to blind-end after short distances and it's difficult to be certain the direction of eventual flow but based on contours on the OSI Discovery series maps and EPA online mapping, it seems to be into Lough Gara in Co. Sligo. All three plantings are on mineral soils so the risk of phosphorus leaching as a result of planting is likely to have been low. Moreover, the flat terrain reduced the risk of solids erosion also. Overall impact from these works is assessed as having been imperceptible or slight in terms of water quality and imperceptible in terms of fisheries.

Two of the three Co Tipperary plantings (Folimahonmore and Coonmore) are either bordering (Folimahonmore) or partly overlapping with the Lower Shannon SAC boundary (Coonmore), while the Knocknabansha plot is 2.4 km upstream of the SAC boundary (Table 8.28). The Lower Shannon SAC is designated for the Annex II species freshwater pearl mussel (*Margaritifera margaritifera*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*), brook lamprey (*Lampetra planeri*), otter (*lutra lutra*) and Atlantic salmon (*Salmo salar*). Of these, the pearl mussel doesn't occur in the Bilboa and it is less likely that either river lamprey or the sea lamprey occur that far up the system or are scarce there due to barriers to migration farther downstream. Salmon are the most plentiful Annex II species in the main channel of the Bilboa adjoining the Coonmore forestry plots, with brook lamprey also likely to occur. Salmon are almost certainly absent from the 1st order stream adjoining the other two plots, but brook lamprey could be present.

Knocknabansha and Folimahanmore plantings are adjoining or bordering 1st order streams, while the Coonmore planting (both plots) are bordering a 4th order river (the Bilboa) one set back 10-15m from the edge the other with a 35m broadleaf edge. One of the Coonmore plots (the larger one) has 20% of its area over blanket peat, which would have resulted in increased leaching of soluble phosphorus if fertilisation occurred during planting time. However, the fact that any drainage arising would have entered a 4th order channel, means that it would have had minimal impact on the ecology of that channel, which was High Status at the time. The first order stream bordering Folimahonmore plot flowed a further 0.25km to join a second order stream which flowed a further 0.31 km to reach the main 4th order channel of the Bilboa, 0.7 km upstream of the smaller and more upstream Coonmore plot. It would have had **no negative impact** on the main channel of the Bilboa and no more than imperceptible to slight impacts on the water quality of the two lower order streams given that there was only a low risk of phosphorus leaching during the planting, as the soils are mineral. The Knocknabansha re-planting is over 90% mineral soil and 10% blanket peat. The 1st order stream within the site was Poor Status (Q3) (see Table 8.2.8) before the planting and the adjoining 1st order stream was Moderate Quality (Q3-4), so any impact arising would be expected to have been slight at worst and more likely would have been masked by the existing impaired quality. It would have had **no negative** impact on the SAC, a further 2.2 km downstream.

Table 8.28 List of Roscommon and Tipperary Coillte In-Lieu Planting Areas along with associated SAC, water quality and potential impact data

Townland	Nearest Stream	Proximity to SAC	Q-Value	Aquatic Impacts
Ardcorcoran	Upper Shannon Catchment Unnamed 1st order stream, 3.8km to the west. River Code: IE_SH_26B080100 Segment Code:26_3726 EPA Name: Ardolana	No water-based SACs (flows to Lough Gara, Co. Sligo)	None attributed	No nearby drainage except forestry and land drains
Oldtown	1st order stream. Head of River Bella catchment – marks northern boundary River Code: IE_SH_26B090300 Segment code: 26_1213	No water-based SACs (flows to Lough Gara, Co Sligo)	Nearest Q-rating stations = 4.9km d/s Derryragh Bridge (2nd order stream – drained) EPA code: RS26B020400 1992 (Q4), 2017 (Q3-4)	Imperceptible impact on this 1st order stream with most of the site very flat and to the south of the stream. Low opportunity for solids run-off and very low risk of phosphorus leaching from mineral soils. Downstream sites varied from Q4 (Good in the past to Q3-4 (Moderate) currently
Brackloon	Unnamed 1st order stream. River code: IE_SH_26B090300 Segment code: 26_2279	No water-based SACs (flows to Lough	Nearest Q-rating station = 2.3km downstream in an area of very dense forestry and extensive turf cutting.	Imperceptible to slight impact on this 1st order stream. Low opportunity for solids run-off

Townland	**Nearest Stream**	**Proximity to SAC**	**Q-Value**	**Aquatic Impacts**
		Gara, Co. Sligo)	Station name = 100m u/s Breedoge confl EPA Code: RS26O040200 1999 (Q4), 2002 (Q4-5), 2005 (Q4), 2008 (Q4), 2011 (Q3)	and very low risk of phosphorus leaching from mineral soils on low gradient site. Good or High Status d/s around time of planting, deteriorating later but extremely unlikely linked to Brackloon planting
Knocknabansha	Unnamed (1st order) IE_SH_25B030800	2.2km u/s of Lower Shannon SAC	Station: Br SE of Loughbrack EPA Code: RS25B030004 (1ST Order stream – in (Q3) 1999 Station: Bridge in Kilcommon, EPA Site Code: RS25B030010 2nd order stream 4.5km d/s. 1999 (Q3-4), 2002 (Q3-4), 2005 (Q4) 2018 (Q3-4)	Imperceptible impact on this tiny, sluggish drainage network. No impact on SAC qualifying interests. Water quality already Poor to Moderate at the time. Fluctuating Good to Moderate since, at nearest monitoring station downstream
Foilmahonmore	Unnamed (1st order) River code: IE_SH_25B030080 Segment Code: 25_2577)	Directly adjoining Lower Shannon SAC	Nearest station: Bilboa - SE of Cappaharoe (3.2km d/s) 4th order EPA Code:RS25B030050 1996 (Q4-5) Next station (11.4km d/s) = Br u/s Blackboy Bridge (5th order river) EPA Code: RS25B030080. 1999 (Q5) 2005 (Q4-5), 2018 (Q4-5)	Imperceptible to slight impact on water quality in adjoining 1st order stream. No impact on SAC qualifying interests. Water quality consistently High Status before and after the planting period at downstream stations

Townland	Nearest Stream	Proximity to SAC	Q-Value	Aquatic Impacts
Coonmore (Large Compartment 24.3 ha)	Bilboa River (4th order) River Code IE_SH_25B030080 Segment code: 25_1922	Directly adjoining Lower Shannon SAC	Nearest station: Bilboa - SE of Cappaharoe (0.86km d/s) 4th order EPA Code:RS25B030050 1996 (Q4-5) Next station (9.1km d/s) = Br u/s Blackboy Bridge (5th order river) EPA Code: RS25B030080. 1999 (Q5) 2005 (Q4-5), 2018 (Q4-5). IFI Recorded high densities of salmon at this station in 2009	Imperceptible impact. large 4th order river. network. No impact on SAC qualifying interests. Water quality consistently High Status before and after the planting period.
Coonmore (Small compartment 14.26 ha)	Bilboa River (4th order) River Code IE_SH_25B030080 Segment code: 25_1910	Directly adjoining Lower Shannon SAC	Nearest station: Bilboa - SE of Cappaharoe (1.5 d/s) EPA Code: RS25B030050: 1996 (Q4-5) 4th order Next station (9.7km d/s) = Br u/s Blackboy Bridge (5th order river) EPA Code: RS25B030080: 1999 (Q5), 2005 (Q4-5), 2018 (Q4-5). IFI Recorded high densities of salmon at this station in 2009	Imperceptible impact on this large 4th order river. network. No impact on SAC qualifying interests. Water quality consistently High Status before and after planting

8.4.1.6 Overhead Transmission Lines

Moneypoint - Oldstreet 400kV OHL

This line was constructed prior to the Derrybrien Project so that no cumulative impact could have occurred during construction. The ground below the line had to be lowered between structure 28A and 29 to facilitate the stringing of the Derrybrien – Agannygal 110kV OHL which required localised earth movements. This is addressed in the Impacts Section (see OHL & Agannygal Substation and associated works). The line will be refurbished in 2020 and 2021 when the structures will be repaired and repainted. The concrete shear blocks, which are the above-ground concrete structures holding the feet of the pylons, will be re-capped, the structure foundations will not be touched. The two structures nearest the OHL corridor are 120 m and 280 m respectively away from the small stream that drains to the Owendalulleegh River from the central part of the OHL corridor. Moreover, they are readily accessible from nearby forest tracks which should minimise the potential for ground damage causes by tracking of works vehicles. Overall, the likelihood is that this operation will have **negligible impacts** on surface waters and no cumulative impacts with the Derrybrien Project.

Ennis – Shannonbridge 110 kV Line

Ennis - Shannonbridge line was installed in 1952 with some further structures installed in 1968.

The Derrybrien Wind Farm Project connected into this line. Specifically, the construction of Agannygal Substation resulted in the line being split into two circuits: Agannygal - Shannonbridge (Galway West) and Agannygal - Ennis (Galway West).

Agannygal Substation with control room in palisade fenced compound and all associated works and services connecting into National Grid on the Ennis-Shannonbridge (Galway West) 110kV line, including removal of approximately 1.3 km of pre-existing conductor on the pre-existing Ennis-Shannonbridge line and replacement with 2 spans emanating from Agannygal Substation comprising: End mast and Agannygal-Shannonbridge line span (approximate length 0.7 km): End mast and Agannygal-Ennis line span (approximate length 0.6 km). These works would have been integral to the construction of the Agannygal Substation and therefore the cumulative impacts would be the same as the construction impacts described under the heading *Installation of Structures* in Section 8.3.2.1 (Construction Phase: 2003-2006).

Ennis-Shannonbridge Line reinstatement

When the Derrybrien-Agannygal 110kV OHL is ultimately removed, reinstatement of the Ennis-Shannonbridge 110kV Overhead Line will be required, involving the re-conductoring of the OHL span at Agannygal Substation.

The full section of line between angle masts will be wheeled and re-tensioned (approximate length 1.3km).

Stringing equipment utilised will comprise 4x4 vehicles, puller – tensioners, teleporters, stringing wheels, conductor drums, compressor & head, transit vans, chains and other small tools, drum stands and drum carriers. It is estimated that the work would take less than a month to undertake.

These activities have the potential to cause localised ground damage in and around the affected structures. However, this will be a diffuse impact in the main and given the paucity of surface water drainage channels in the area is likely to have a worst, a

slight, negative and temporary impact on the water quality in small drains between the Agannygal Substation and Lough Atorick, with no impact on water-based SAC's farther downstream (Lower Shannon SAC and Lough Derg SPA) by virtue of the great intervening distances involved.

8.4.1.7 Gort Regional Water Supply Scheme

The water supply from Gort is derived from a combination of both groundwater supplies and surface water sources, which at the time of the peat slide were in the ratio of approximately 3:7 groundwater to surface water. The surface water supply came from the Cannahowna River which emerges from a subterranean cavern (Polldouagh) on the west side of Gort. The Cannahowna River is a continuation of the Beagh River, Lough Cutra and the Owendalulleegh River. In the period after the peat slide the colour of the treated water in the supply increased, although the supply periodically registered very high colour levels at that time of year in any case. Galway County Council also reported an increase in the frequency of the back-wash cycle for the rapid sand filters in the treatment plant which was probably due to an increase in suspended solids in the surface water source caused by the peat slide. This persisted at the time for several weeks. However, at no time was the supply interrupted. The raw water sources currently supplying the town remain essentially the same as in 2003.

8.4.1.8 Sand Extraction at Cloghvoley

Planning permission was granted for a sand extraction site (GCC Ref. Ref. 08/1664) located at Cloghvoley 4.5 km to the south-east of the Project in May 2008 after the Project was constructed. On inspection of the planning files, there is no indication that there was historic activity that could have coincided with the construction stages of the Derrybrien Wind Farm Project. The quarry is within the catchment of the very upper reaches of the main channel of the Owendalulleegh River about 4 km upstream of Site O7C. However, there is no direct stream or drain connection between the quarry and the river. Even if the assessment allows for the possibility of some solids contamination, for example in overflow water from the quarry during times of very heavy rainfall, the significant distance between it and the nearest point in the Owendalulleegh River which receives drainage from the wind farm i.e. at the base of SC6, i.e. 2.5 km downstream, would indicate that there was **no cumulative** impact between the two projects.

8.4.1.9 Quarry at Ballynakill

Ballinakill Quarry is operated by Ballinakill Quarries Ltd at Cregg on the R353. The quarry is registered under Section 261 of the Planning and Development Act 2000 (as amended) ((ref QY 6). In October 2013, An Bórd Pleanála granted a substitute consent for works and operations undertaken prior to August 2012 (Ref. 07.SU0038).

Planning permission was granted in December 2018 for the quarry extension (GCC Ref:18/687). An examination of the EIS for the project indicates that the quarry is within the drainage area of the Ballinlough Stream (River Waterbody Code: IE_SH_25B150300) draining ultimately to Lough Derg in the River Shannon catchment. Only a very small portion of the north eastern corner of the wind farm, covering ~0.4 % of its entire area drains via the Duniry River towards Lough Derg. This combined with the very large distance between the wind farm and Lough Derg would indicate that there was **no cumulative impact** between the wind farm project and the Ballynakill Quarry development.

8.4.1.10 Coillte Quarry

There is a registered quarry just east of the junction between the R353 and the Black Road, to the south-east of the Derrybrien Wind Farm site. The reference number for the site is QRY62 and this is a quarry that was accepted as being post-1964 but without the benefit of planning. Documents in relation to quarry registration were submitted to GCC in April 2005 by Coillte – the site owners. It is a relatively small (1.8 ha aggregate quarry with an extraction area of 1.3 ha), the aggregate being used for forest road repairs. The area where the quarry is situated shows no surface drainage channels on the 6 inch:1mile map for the area nor is there any indication from aerial photos of the area. The downslope over-ground distance between the quarry and the nearest stream, SC7(a) between sites O3 and O6A, is just over 500 m through forestry and damp grassland/blanket peat. Given that the material being quarried was predominantly coarse, the likelihood of any suspended solids from the site reaching any of the wind farm drainage streams is considered to have been extremely low. For that reason, it is considered **extremely unlikely** that there would have been **any cumulative impacts** between the quarry and the wind farm project.

8.4.1.11 Works to Beagh Bridge

The privately owned four-span Beagh Bridge at the outlet of Lough Cutra underwent a structural assessment by ESBI in August 2004. This followed on from the temporary erection of straw bale filter barriers on the upstream face of the bridge in the aftermath of the peat slide to capture and filter any suspended sediment that may have transported from the peat slide area. Evidence of damage and deterioration to two of the three intermediate piers was highlighted although it was deemed by ESBI engineers at the time that the peat slide most likely could not have caused or contributed to this damage. ESBI recommended in their assessment report that all river flow be diverted away from these piers. The recommendations were addressed in January 2005 and left the pier foundations in what was deemed by ESBI as being in better condition than prior to the initial assessment.

Given the nature and scale of the remedial works at Beagh Bridge and the fact that they were undertaken in 2005, the potential for cumulative impacts with the wind farm project is considered **not likely to** have occurred.

8.4.2 Cumulative impacts which are likely to occur

The assessment has already indicated that ongoing maintenance on the Project i.e. both on the wind farm site itself and along the OHL corridor until the end of the operational life, will give rise to intermittent, **slight to moderate, negative, impacts**, with these impacts confined to the minor streams draining the wind farm site, the OHL corridor and Agannygal Substation. On-going annual turbary activity on the wind farm site will contribute to these impacts as they occur but will not cause them to increase to a higher level of significance. The same can be said for the decommissioning phase of the Project including within the wind farm site, along the OHL corridor, Agannygal Substation and in connection with the removal off-site post-slide remedial measures (Barrages 3 and 4) and therefore any cumulative impacts will not be significant.

8.5 Mitigation Measures and Monitoring

8.5.1 Remedial Measures & Monitoring for significant effects

As set out above, the operation of the wind farm to date (post commissioning in 2006) and going forward, the continued operation, maintenance and ultimate decommissioning of the wind farm is not predicted to give rise to any significant negative effects on the aquatic environment. Going forward, in order to minimise the potential impact of the aquatic environment, the following mitigation measures will be undertaken in relation to the wind farm project operation phase maintenance and end-of-life decommissioning and in relation to the removal of post-slide remedial structures namely Barrages 3 and 4.

- During the removal of Barrages 3 and 4, a pump-over system will be used to minimise the escape of suspended solids into the watercourse downstream of Site O4 in SC7(b). In order to minimise such an effect, the work will only be undertaken during a period of dry weather between May and September. This entails damming the channel immediately upstream of the works using sandbags and then pumping the clean water down below the barrage until all the retained material upstream has be removed and the channel re-profiled to its original pre-slide form and gradient. This will minimise the solids escapement during the initial phase of the removal. If it is possible to maintain the pump-over during the removal of the large boulders, then this should be undertaken. However, boulder removal is less likely to give rise to much in the way of solids, so the pump-over can be dispensed with if necessary, for this phase.
  The same system will be used to decommission both barrages. Access to Barrage 3 should be simple as the ground is compact, whereas, the route to Barrage 4 is longer and the ground softer and bog mats will be necessary to prevent ground damage due to the passage of heavy vehicles. The silt material and boulders removed from the barrages will be loaded onto separate dumper trucks and transported off-site to a suitable location.

- During the removal of structures along the OHL, all decommissioning traffic will follow only the proposed access tracks indicated on Figures 2.27 and 2.28 Chapter 2 and until they reach the entrance points to the OHL corridor itself. Along the corridor every effort will be made to plot a course between structures that avoids direct crossing of all minor or larger drains and streams in order to minimise solids loss. Where crossings cannot be avoided, bog mats or other suitable bridging method will be used to protect the drains in question. Planning for this will require that each stretch will initially be traversed on foot or with a 4x4 to identify drains. It's important to note that all the pole-sets and masts will be cut at the base and left in-situ, i.e. they will require little if any ground excavation and any that will take place at masts will be very limited.
- For each of the OHL spans accessible via the 10 proposed access tracks, silt control measures should be used in all minor drains likely to act as conduits for solids-contaminated water arising as a result of vehicular-associated ground damage, thereby preventing them from reaching any of the larger watercourses along the OHL corridor. This will be more important during wet weather, which if possible, should be avoided.
- For access to structures AM 24 and poles sets 23 and 25, at the Owendalulleegh fording point by Site O7C, in the absence of alternative advice from IFI, the fish rescue and protection options outlined here will be implemented in order to prevent or minimise fish mortalities at the fording place: (1) The operation will be planned so that the minimum number of vehicles required will be used and the lowest possible frequency of over-and-back crossings will take place. (2) As narrow a crossing corridor as possible will be used that will still accommodate the largest vehicle needed for the decommissioning and all traffic will stick to this lane. This will be facilitated by (a) demarcating the lane with red and white marker tape which will be maintained as necessary throughout and (b) only one vehicle at a time to will be allowed to cross and at a very slow speed. This approach should reduce to the absolute minimum the number of fish likely to be killed due to crossing.
- Suitable sized bog mats or steel plates should be placed over the small stream that will be crossed at two points between PS 28A and PS 31.
- For the main crossing of the Owendalulleegh for access to AM 24, etc. IFI should be consulted in advance about the most appropriate crossing method. In terms of average density, we know that this crossing point holds about 0.3 trout and 0.1 stone loach per m^2 which would suggest that about 5-6 trout and about 2 stone loach, on average, might be present in a 3.5 m wide corridor at a point where the river is about 5 m across. These figures could be higher however if there was frequent over-and-back trafficking. It is unlikely that all fish that happened to be present at the time would be killed if the vehicles crossed slowly. However, to reduce the risk to the absolute minimum the crossing corridor could be electrofished in advance in the following manner- Place fish stop-nets 1 m upstream and 1 m downstream of the crossing lane and in advance of the vehicles crossing, preferably all at the one time, electrofish out all the fish between the nets and carry them in bins of water a

couple of hundred meters downstream and release them back into the channel. Leave the stop nets in place until all the vehicles have crossed. If the larger vehicles could remain on site for the duration and only smaller vehicles such as 4x4s allowed to cross in the interim, that would reduce the likelihood of more fish mortalities which would be further minimised if someone walked across the river in waders just in front of a very slow moving vehicle. This would have the effect of scattering any small fish within the path to be displaced away from the vehicle advancing behind. Clearly, this approach would not be practicable if the job required very frequent back-and-forth trafficking, in which case a more structured approach might be required e.g. the installation of a baily bridge.

8.5.2 Mitigation Measures for non-significant effects

- Maintenance works on the wind farm site such as tree cut-back, access road upgrade and maintenance, and drain cleaning should be undertaken regularly rather than be allowed to accumulate and thereby require more widespread and intensive interventions.
- All on-site maintenance including tree felling, access track repair, and drain cleaning work should be detailed in advance, ideally on an annual basis and the plan sent for assessment to a trained aquatic ecologist before any works are started. This would help to identify any potential for ground damage and silt and nutrient runoff which could then be targeted for mitigation.
- All works should be scheduled to take place between late spring and late summer and timed to coincide with dry weather. This is provided there are no nesting birds close to the works which could be disturbed.
- All heavy machinery should travel on access roads and hard stand areas only as set out in Chapter 10 Soils, Geology and Land. Any machinery required to track across the vegetated areas of the site should have wide tracks in order to prevent ground damage or otherwise travel on bog mats or equivalent.
- All material removed from drains should be side cast in such a way as to ensure that subsequent rainfall doesn’t wash sediment back into the drainage system. This may mean that in very wet or steep areas that material is removed from such areas and placed in borrow pits or suitable hollows where it can safely dry out and become revegetated.
- Temporary silt fences should be placed on the downstream end of drain stretches earmarked for cleaning in order to intercept dislodged silt. These should remain in place for some time after the cleaning is finished, and any silt accumulated behind the traps should be regularly removed and spread on open vegetated ground before the silt trap is removed during dry weather or if the conditions do not allow removed off site for safe disposal.
- During the decommissioning phase the contractors shall nominate a pollution control officer who will report to the site manager and the client for the duration of the works. They will be responsible for (1) preventing any unnecessary ground damage and (2) installing silt control measures on all of the drains

leaving the site in order to prevent solids or other contaminants reaching off-site drainage channels. They will be responsible for maintaining these measures on a continuous basis as required, particularly before, during and after heavy rainfall. They will also be required to identify any developing pollution risks e.g. related to borrow pit use, vehicle re-fuelling or temporary fuel storage measures and possible oil leaks during the decommissioning of the substation buildings as well as initiate control measures to prevent the escape of hydrocarbons into the soil from the site.

8.6 Residual Impacts

The principal negative impact associated with the Project was the 2003 peat slide which at the time had moderate to profound negative impacts on the main channel of the Owendalulleegh River and the directly affected tributary SC7(b), both in terms of water quality and fisheries. The current assessment estimated that this impact was short-term in duration and that all habitats and associated aquatic biodiversity was restored to its pre peat slide condition within 6-7 years of the event, at most. There may however be a localised slight residual impact in the upper to middle sections of the SC7(b) tributary which was the channel most impacted by the peat slide at the time. This impact, should it exist, relates to the scouring out of spawning gravels from the upper and middle sections of this channel reported at the time of the slide. There is evidence from the current assessment, however, that this tributary may never have been important for spawning even before the peat slide and also that gravel scoured out at the time may have at least partially returned due to natural bank erosion upstream, gradually reducing such an effect during the intervening 17 years. In either case, the residual impacts on fish recruitment to the Owendalulleegh system arising would be considered, slight negative and diminishing with time.

There are no residual impacts remaining from the construction of the Project. In relation to the ongoing and future maintenance at the wind farm, OHL and Agannygal Substation until the anticipated end-of-life of the project, and the proposed decommissioning of all aspect of the project, slight negative temporary impacts are anticipated. However, with implementation of the mitigation measures outlined in Section 8.5 any residual impacts can be kept to an absolute minimum. These will take the form mainly of diffuse sediment and to a lesser extent nutrient loss which will have an **intermittent, imperceptible to slight temporary impact** on the quality of small headwater streams in the Owendalulleegh, Boleyneendorrish and Duniry river catchments. However, the current High Status biological water quality on the main channels of the Owendalulleegh and Boleyneendorrish will not be diminished by either the remaining operation phase as envisaged or any aspect of the decommissioning phase. Lough Cutra and Lough Atorick will remain unaffected by any aspect of these works.

8.7 Conclusions

The **slight negative impacts** arising from the construction of the Derrybrien Wind Farm and the installation of the 7.8 km OHL and Agannygal Substation took the form of diffuse suspended solid loss due to ground damage associated with excavations and construction traffic movements and with nutrient loss from tree felling on blanket peat. The main impacts from these activities were confined to the small headwater streams draining the wind farm site itself and took the form of a **temporary to short term slight decline** in biological water quality, all of which was probably reversed within 12 to 24 months of the wind farm's commissioning in 2006. These impacts would not have given rise to any drop in the ecological status of the main channels of the rivers draining the site, namely the Owendalulleegh, Boleyneendorrish and Duniry rivers. Moreover, they would have had no negative impact on the ecological status of Lough Cutra.

This notwithstanding, the occurrence of a large peat slide in late 2003, combined with the associated remedial measures required on and off site to control it, had **significant to profound, short-term, negative impacts** on the riverine habitats all along the SC7(b) and SC7(d) channel from the wind farm as far as the confluence with the main channel of the Owendalulleegh and for the first 1-2 km or so of that channel below the confluence of SC7. Beyond that point, in effect for most of the remaining 16 to 17 km of the main channel of the Owendalulleegh, the impact on the riverine habitats can be described as **moderate, negative and temporary** because their physical nature was not appreciably altered and the main physical damage was caused to instream aquatic plants (mainly aquatic liverworts and mosses) and due to the build-up of peat silt and woody debris as well as increased levels of sand in slower flowing stretches. These latter effects were reported at the time to clearly diminish with distance downstream until close to the outlet to Lough Cutra they were barely perceptible. In terms of water quality, the impact on the SC7(b) & (d) tributary can be described as **profound negative and short term**, while those on the main channel of the Owendalulleegh as being **significant to very significant, negative and short-term.** As reported at the time, the peat slide led to a very large fish kill involving 6 species but particularly in terms of numbers of brown trout and stone loach. This impact can be described as **very significant to profound, negative and short-term**. The impact is classified as 'short-term' because it is thought likely that the population would have fully recovered within 6-7 years at most, assisted by immigration of fish from unaffected side tributaries and in particular from the main channel of the Owendalulleegh upstream of the confluence of SC7 where the full range of age classes would have been present in late October 2003. Older trout from Lough Cutra running up the Owendalulleegh in subsequent years to spawn may also have contributed to the recovery. Stone loach are likely to have recovered first, probably within 2-3 years, then trout within 3-5 and probably lamprey last, 6-7 years due to the longer growth period of their larval stages. Eel, which do not reproduce in fresh waters would have been replaced through immigration from the marine environment, which would occur annually.

The ongoing operation of the wind farm and the OHL up to the end-of-life of the project will have **no significant negative impacts** on the surface receiving waters, with any impacts occurring being **slight and not significant**. This will also be true of the decommissioning stage provided all recommended mitigation measures are implemented.

8.8 References

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Appendices

Appendix 8-1 Significance Terminology - Table 3.3 of the Guidelines (EPA, 2017)

Appendix 8-2 Macroinvertebrate Tables (2011-2020)

Appendix 8-3 Macroinvertebrate Sampling Site Descriptions and Photos

Appendix 8-4 Lough Cutra Sediment Photos (2019)

Appendix 8-5 Electrofishing Results (2011, 2014, 2019)

Appendix 8-6 Galway County Council Historic Water Monitoring Data

Appendix 8-7 Figures

See Volume 2 Section 3 for A3 figures