10. AQUATIC ECOLOGY – WIND FARM

Additional information relevant to Section 10 is presented in Appendix G in Volume 2 of 3 of the EIS.

10.1 RECEIVING ENVIRONMENT

10.1.1 Introduction

The aims of the freshwater ecological assessment are as follows:

- To assess the present fishery value, invertebrate fauna, aquatic flora, water quality, habitat value and general ecological condition of streams and rivers in the vicinity of the development and provide baseline data against which any future changes can be assessed
- To assess the general status of the streams from an ecological and fisheries perspective in the context of their wider catchment, based on survey data, published sources, EPA data, and on consultation with IFI and NPWS.
- To assess the potential impact of the proposal on water quality and aquatic flora and fauna.
- To recommend mitigation measures where potential negative impacts are predicted

10.1.2 Scope of Assessment

All watercourses were assessed which are marked on the 1:50,000 OS Discovery Series Sheets 79 & 85 and EPA mapping of streams[20], and which are within 0.5 km downgradient from any part of the wind farm site where works will be carried out. As these maps generally include streams/drains that are too small to be useful salmonid habitat and as general guidelines are presented for procedures at any watercourse crossing, the survey undertaken is considered adequate to ensure that all measures necessary to prevent significant impacts are identified.

Table 10.1: Watercourses Assessed

Location of Aquatic Assessments	River/Tributary
Roughty River Main Channel	Main River Roughty channel
Red Trench South River and Tributaries	Tributaries 2A-2K
Roughty Eastern Tributaries	River/Streams 3-7
Roughty Western Tributaries	River/Stream 8-10
Roughty Southern Tributaries	River/Stream 11-17
Roughty Northern Tributaries	River/Stream 18-20

The potentially affected watercourses, which are shown on Figure 10.1, are all tributaries of the Roughty river system which drains to the Atlantic at Kenmare c. 20 km downstream of the proposed development.

20 http://maps.epa.ie/internetmapviewer/mapviewer.aspx

10.1.3 Methodology

The guidelines used for classification of importance of freshwaters are as follows (NRA, 2006):

Rating A - Internationally Important: Habitats designated as SACs for Annex II species under the EU Habitats Directive. Major Salmon river fisheries. Major salmonid lake fisheries.

Rating B - Nationally or Regionally Important: Other major salmonid waters and waters with major amenity fishery value. Commercially important coarse fisheries. Waters with important populations of species protected under the Wildlife Act and/or important populations of Annex II species under the EU Habitats Directive. Waters designated or proposed as NHAs.

Rating C - High Value, locally important

Small water bodies with known salmonid populations or with good potential salmonid habitat, or any population of species protected under the Wildlife Act and/or listed Annex II species under the EU Habitats Directive. Large water bodies with some fisheries value.

Rating D - Moderate value, locally important: Small water bodies with some coarse fisheries value or some potential salmonid habitat. Any stream with an unpolluted Q-value rating.

Rating E - Low value: Water bodies with no current fisheries value and no significant potential fisheries value. Habitat diversity low and degraded.

Impacts are defined on the basis of severity of impact on aquatic species and/or habitats. If an aspect of a proposed development is judged likely to have a measurable negative effect on salmonid fish populations or any rare or protected species, it would be classified as a significant potential impact. The criteria used for assessing the significance of impacts on flora, fauna and fisheries are taken from NRA (2006).

Habitat Assessment

Stream habitat assessment, which consisted of walking and/or wading the entire channel length, was carried out on c.46 km of stream/river on and downstream of the wind farm site. The assessment took place over the period May-July 2011 (Grousemount area) and November-December 2014 and July-August 2015 (Barnastooka area). All stream/river channels were demarcated into habitat sections based on the following:

- Stream width and depth
- Substrate type, i.e. relative dominance of large rocks, cobble, gravel, sand, mud etc..
- Flow type, i.e. relative dominance of riffle, glide and pool in the sampling area.
- Dominant bank-side vegetation.
- In-stream vegetation.
- Estimated degree of shade by bank-side vegetation

Salmonid, lamprey and freshwater pearl mussel habitat quality were assessed, taking into account the environmental features listed above. Based on these observations and more detailed criteria outlined below, the value of each river section for the different life stages of salmonids, for lamprey and for freshwater pearl mussels was estimated, as shown in

Table 10.2.

Maps referred to herein are presented in Appendix G.6

Table 10.2: Scale of Values, River Bed - Salmonid, Lamprey & Freshwater Pearl Mussels

Definition	Meaning
None	The ecologist carrying out the assessment regards it as impossible that the stream could support the species in the relevant life stage
Poor	Unlikely but possible that the stream could support the species in the relevant life stage
Fair	Species life stage likely to be present at low density
Good	Species life stage likely to be present at moderate density
Very Good	Species life stage likely to be present at high density
Excellent	Conditions ideal for the species life stage

The above assesses the physical suitability of the habitat; the presence / absence / density of salmonids and / or lamprey and / or freshwater pearl mussel at the location will also depend on present and historical water quality and accessibility of the site to the species in question.

Assessment Criteria - Salmonid Habitat Quality

Habitat quality for in-stream invertebrate and plant communities, and for fish, and riparian birds and mammals is primarily a function of 'naturalness' and diversity. The more diverse the stream habitat in terms of substrate, flow rate, depth, riparian vegetation, light conditions etc., the richer the biological community is likely to be, and the more suitable it is likely to be for salmonid fish (trout and salmon). Assessment of the quality of salmonid spawning habitat, nursery habitat and adult habitat is based on personal expertise developed over a period of 20 years of electrofishing and on published information such as the following:

- Favourable locations for salmon spawning are likely to occur where the gradient of a river is 3% or less (Mills 1989).
- Preferred current velocity for spawning is within the range 250–900 mm/s, with a water depth in the range 170–760 mm (Hendry & Cragg-Hine 1997).
- Typical spawning sites are the transitional areas between pool and riffle where flow is accelerating and depth decreasing, where gravel of suitable coarseness is present and interstices are kept clean by up-welling flow (Peterson 1978, Bjorn & Reiser 1991).
- Salmon fry and parr occupy shallow, fast-flowing water with a moderately coarse substrate with cover (Symons & Heland 1978, Baglinière & Champigneulle 1986).
- Deep or slow-moving water, particularly when associated with a sand or silt substrate, does not support resident juvenile salmonids (Wankowski & Thorpe 1979, Baglinière & Champigneulle 1986).
- Suitable cover for juveniles includes areas of deep water, surface turbulence, loose substrate, large rocks and other submerged obstructions, undercut banks, overhanging vegetation, woody debris lodged in the channel, and aquatic

vegetation (Heggenes 1990; Bjorn & Reiser 1991; Haury et al. 1995).

- The juxtaposition of habitat types is also important. The proximity of juvenile habitat to spawning gravels may be significant to their utilisation. In addition, adults require holding pools immediately downstream of spawning gravels in which they can congregate prior to spawning. Cover for adult salmon waiting to migrate or spawn can be provided by overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water and surface turbulence (Bjorn & Reiser 1991).
- Bjorn & Reiser (1991) suggest that proximity of cover to spawning areas may be a factor in the selection of spawning sites by some salmonid species.

Potential obstacles to upstream movement of salmonid fish were mapped, photographed and classified as Significant, Major and Impassable approximately corresponding to the Moderate Risk, High Risk and Impassable categories used by Central Fisheries Board (Anon 2008).

Assessment Criteria - Lamprey Habitat Quality

Lamprey habitat preferences change with the stages of their life cycle. They show a preference for gravel-dominated substratum for spawning. After hatching the larvae (ammocoetes) swim or are washed downstream by the current to areas of sandy silt in still or slow flowing water where they burrow and spend the next few years in tunnels. Lampreys therefore require mainly silt and sand dominated substratum for nursery habitat. Other important environmental characteristics for optimal ammocoete habitat are shallow waters with low water velocity, and the presence of organic detritus and/or plant material. Sub-optimal habitat supporting only a few individuals may consist of a few square centimetres of suitable silt in an open, comparatively high-velocity, boulder-strewn streambed. Spate rivers, with high flow velocities, tend to support fewer ammocoetes because they contain smaller areas of stable sediment (Maitland 2003).

Assessment Criteria - Freshwater Pearl Mussel Habitat Quality

Irish Wildlife Manual No. 12 (Anon 2004) indicates that Margaritifera are more likely to occur in stretches of river that are:

- Below the mountainous initial source of the river, into the reaches marked on OS Discovery Series (1:50,000) maps with a strong blue line.
- Close to and below reaches of 200 m contour lines, i.e. below brown areas, into green areas.
- Away from contour lines that lie close together, i.e. large waterfalls or deep ravines.
- Upstream of any part of the channel that is under saline influence.
- In stretches with variation in river bed, i.e. pools followed by riffles, not a deep, even glide.
- 500 mm and over in depth.
- In stretches with overhanging trees.
- Away from river beds of solid rock, preferably in areas where gravel and/or boulders are present.
- At the exit point of lake outflows.

Moorkens (1999) states that in some rivers, mussels are associated with shaded areas of river, but in very clean waters, they are found in high numbers in open, un-shaded areas.

The characteristics of riverbed substrata are of critical importance for freshwater pearl mussel populations. The typical substrate preference is small sand patches stabilised amongst large stones or boulders in fast-flowing streams and rivers (Skinner *et al* 2003). Such boulder-sheltered mussel beds may be critical for recruitment after heavy floods (Vannote & Minshall 1982). Riffle areas with mixtures of rocks, cobbles and sand are important habitats in low gradient sections, providing a well-oxygenated and silt-free environment. Juveniles are mostly associated with such riffles, and require fine sediment within which to shelter. There is consensus among researchers that the early post-settlement period, when juveniles establish themselves in sediment, is the most sensitive and critical phase in the pearl mussel life cycle. Juveniles are thought to require sediment of low organic content for their further development, with a structure that allows a high rate of exchange between the free water body and the interstitial water. Gradient could affect mussel distribution indirectly by determining the stability of the substrata. Purser (1985) demonstrated that an intermediate gradient range of 0.8–3 m/km was preferred. The majority of adult mussels live in dense beds in substrates of mixed cobble, stone and sand at the tail-end of pools or in the moderate flow channels of river bends. In these sites, stability of the bed is important.

Stream Invertebrate Sampling and Biological Water Quality Assessment

Sampling sites, as shown in Table 10.3 and Figure 10.2, were established for biological water quality assessment, as follows.

Table 10.3: Biological Assessment Sites

Site	Location	Site	Location	Site	Location
A	508560 / 572182	J	508130 / 569703	S	507230 / 571353
B	507900 / 571383	K	508220 / 569663	T	507420 / 571402
C	508740 / 570973	L	508100 / 569063	U	508530 / 572172
D	508910 / 570773	M	508230 / 568903	V	508690 / 572812
E	508960 / 570503	N	508200 / 568903	W	507930 / 573292
F	508450 / 570253	O	506360 / 570903	X	510413 / 573262
G	508415 / 570233	P	506470 / 571053	Y	508705 / 573304
H	508290 / 570143	Q	506920 / 571273	Z	508672 / 573363
I	508300 / 570153	R	507040 / 571313		

A five-minute kick and stone wash sample was taken at each of the water quality assessment sites (ISO 7828:1985). Each sample was retained in a large plastic bag at the sampling site and transported in a thermally insulted container. Sample processing and preservation was carried out under laboratory conditions within 24 hours of sampling. Mud was removed from each sample by sieving under running water through a 500 µm sieve. Sieved samples were then live sorted for 30 minutes in a white plastic sorting tray under a bench lamp (ISO 5667-3:1994) and if necessary using a magnifying lens.

Macroinvertebrates were stored in 70% alcohol. Preserved invertebrates were identified to the level required for the EPA Q-rating method (Clabby *et al,* 2006) using high-power and low-power binocular microscopes when necessary. The preserved samples were archived

for future examination or verification. Based on the relative abundance of indicator species, a biotic index (Q-rating) was determined for each site in accordance with the biological assessment procedure used by the EPA (Clabby *et al* 2006) and more detailed unpublished methodology (McGarrigle, Clabby and Lucey pers. comm.)

Biological water quality assessment data is presented in Appendix G.2.

Table 10.4: EPA Q-Rating System

Biotic Index	EPA Water Quality	WFD Ecological Quality	Quality Status
Q5	Good	High	Unpolluted
Q4-5	Fair - Good	High	
Q4	Fair	Good	
Q3-4	Doubtful - Fair	Moderate	Slightly Polluted
Q3	Doubtful	Poor	Moderately Polluted
Q2-3	Poor - Doubtful	Poor	
Q2	Poor	Bad	Seriously Polluted
Q1-2	Bad - Poor	Bad	
Q1	Bad	Bad	

Fish Habitat Assessment

Timed electrofishing was carried out at 19 sites (see Figure 10.3) to assess the species of fish present and the qualitative abundance (catch per unit effort/minimum density estimate) and age composition of juvenile and adult salmonids.

The area electrofished at each site was estimated based on the length and average width of the channel fished. At each site a representative stream reach was selected and measured such that all primary physical habitat characteristics, i.e. riffle/glide pool, if present, of the stream were included within the reach. Grid references for the upstream and downstream extremities of the surveyed sections were recorded and representative photographs of each survey site were taken.

Fish were captured using a Safari Research Surveyor pulsed direct current backpack electrofisher and were identified. All fish were identified, and fork length of salmonids was measured to the nearest mm.

Scales were taken from a representative sample of captured trout. Trout age was determined by length frequency distribution combined with scale reading using a high power binocular microscope. Trout were classified according to age as less than 1 year old (0+), 1 year old (1+), and 2 year old (2+). Age of juvenile salmon was determined using length frequency distribution.

All fish captured were carefully handled and returned alive where possible to the water from which they were taken, following the gathering of data, and the IFI Biosecurity Protocol for Field Survey Work (December 2010) was followed at all times.

Chemical Water Quality Assessment

Chemical assessment was carried out on each of the 19 fish assessment sites F1 – F19. Conductivity was measured in the field using a TDScan3 or Sibco conductivity meter. pH was measured in the field using a Hanna pH meter. Water samples were taken at site and

delivered to Southern Scientific Services for total suspended solids and turbidity analysis.

Chemical water quality assessment data is presented in Appendix G.3.

10.1.4 General Catchment Information

Fishery Value

O'Reilly (2002) states as follows:

> *The Roughty gets a small run of spring salmon and an excellent run of grilse. No exact figures are available, but it is generally believed that the Kenmare Club's waters at Ardtully produces approximately 200 salmon and grilse in a good season. The seatrout run has improved to excellence. The best of this fishing is just above the tide, at Poultadagh, and on the Slaheny, a tributary. ...the river in its lower reaches is characterized by big slow pools. The salmon fishing, on a spate, extends all the way up to Inchee Bridge and for two miles of the Slaheny up to Shandrum School.*

The total angling and commercial catch of salmon in the Roughty River in 2012 was 270 (IFI 2012). IFI carried out a catchment wide electrofishing survey of the Roughty River in September 2011. This was the first CWEF (catchment-wide electrofishing) survey of this catchment.

> *The survey comprised 13 sites, 8 of which were included in the analysis. …Salmon fry were present at 12 sites visited and all of those included in the analysis. The maximum fry catch was 27 salmon …the minimum catch was 0 fry…. The mean catch of included sites was 19.78 salmon fry/5min. … The other fish recorded were Eel and Minnow. Two cohorts of juvenile salmon were captured, …The modal length of 0+ fry caught was 6 cm and their approximate range was 5 to 8cm….*

The mean catch of 19.78 salmon-fry/5min which is above the Conservation Limit (CL) threshold level of 17 salmon fry/5min. Based on outputs from the Scientific Committee on Salmon model IFI has estimated that the Roughty has exceeded its CL since individual river CL assessments have been carried out. (Gargan et al 2011).

Water Quality

EPA biological water quality monitoring data 1982–2012 for the Roughty River are presented in Appendix G.1.

After the 2012 round of monitoring, the Roughty River was described by EPA[21] as "*Continuing satisfactory, with High ecological quality, at the three locations* .".

Ecological Importance

None of the potentially affected watercourses are designated NATURA 2000 sites. The closest SAC is Kenmare River SAC, a marine site c.20 km downstream of the proposed wind farm site. Two aquatic Habitats Directive Annex II species are known to occur in the Roughty River, namely Salmon (*Salmo salar*) and Freshwater Pearl Mussel (*Margaritifera margaritifera*).

The ecological value classification is assigned in accordance with the criteria of NRA (2006).

[21] http://www.epa.ie/qvalue/webusers

Freshwater Pearl Mussel

For the purposes of the present EIS a survey of Freshwater Pearl Mussels in the Roughty river was carried out by Dr Eugene Ross of Freshwater Bivalve Investigations Ltd. (see G7). The following are the findings of the survey.

> *"The previously known furthest upstream record for Margaritifera was at Morley's Bridge. Results of the current survey have extended the known range of the Margaritifera population in the Roughty upstream by 5.7km to a point approximately 1.27km upstream of Inchee Bridge at W 08699 73508, and consequently closer to the proposed development. The observed distributional pattern of mussels in the sections of river investigated appears to be determined by the availability of patches of stable substrate suitable for mussels.*
>
> *The habitat quality observed all along the river sections examined was very high, and since 2004, EPA biological assessment of the three monitoring sites on the Roughty (Ford near Knockanruddig, Inchee Bridge, Ford d/s Slaheny River confluence) has delivered Q Values of 4-5 (High Status), confirming that habitat conditions in the river are of high quality. The virtual absence of silt plumes throughout the stretches examined is noteworthy and unusual in the context of Irish freshwater pearl mussel rivers, most of which are negatively impacted by siltation and eutrophication, both of which are inimical to the survival of juvenile mussels and effective recruitment (Hastie et al., 2000).*
>
> *Despite its relatively small size, the Roughty River mussel population is significant because of the torrential nature of the river, its high quality status and clean silt-free substrates. Given the high quality of the habitat, the lack of obvious siltation, the presence of concentrations of mussels at some points, and the presence of good numbers of salmonids, it is possible that a level of juvenile mussel recruitment might be occurring in the river.*
>
> *Although no small mussels (<60mm) or juveniles (<30mm) were observed on the substrate surface in the river sections examined, it would be prudent to carry out a Stage 3 pearl mussel survey on the Roughty to ascertain the demographic composition of the population and to assess whether or not juvenile recruitment is, or has recently occurred on the Roughty River. If recruitment is occurring in the Roughty River, the population would be regarded as very significant in both a national and international context, and would necessarily be regarded as extremely sensitive in relation to negative impact that might arise from any hydrological change or increased levels of siltation."*

The possibility of Annex II freshwater crayfish (*Austropotomobius pallipes*) cannot be definitively ruled out in the Roughty River as the lowest sections of the river flow over limestone. However, the absence of any records for the species in west Cork or Kerry and the absence of any records of the species from the Roughty in published accounts of the species distribution in Ireland (Lucey & McGarrigle 1987; Demers et al 2005; Reynolds 2007) renders it highly unlikely that the species occurs in this river system.

Likewise, published accounts of the national distribution of the three Annex II species of Lamprey include no reference to lamprey in the Roughty River (Kelly & King 2001; Kurz & Costello 1999). However, as lamprey are relatively under recorded species, the precautionary principle would require that the presence of lamprey should be assumed wherever suitable habitat is present.

As a good salmon and sea trout fishery with a small population of freshwater pearl

mussel, the Roughty River would be classified as of regional importance.

10.1.5 Roughty River - Main Channel (River/Stream 1) (Maps 1-6)

Habitat Assessment

A total of c.8.95 km of the Roughty main channel was surveyed.

Salmonid Habitat Quality: Adult salmonid habitat was very good on c.2 km of channel, good to very good on c.3 km of channel, good on c.2 km of channel, and the remaining c.3 km was classified as fair to good adult salmonid habitat. Salmonid nursery habitat quality was very good on c.2.5 km of channel, good on c.3.5 km, fair to good on c.2.2 km and fair on c.1. 8km. Spawning habitat was good on c.4.5 km, fair to good on c.700 m, fair on c.3.5 km and either poor or poor-fair c.1.3 km.

Lamprey Habitat Quality: No significant lamprey nursery habitat was recorded on the main channel of the Roughty River. Whereas much of the channel would constitute fair lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channel as of no significant potential habitat value for lamprey.

Freshwater Pearl Mussel Habitat Quality: Of the c. 10 km of channel surveyed, the lower c.4 km was classified as fair-good potential Freshwater Pearl Mussel habitat. Of the remaining 5.9 km surveyed c.700 m was classified as fair (habitat section 1.9) and the remaining c.5.2 km was classified as less than fair i.e. none, poor or poor-fair. This section of the channel was dominated by large rocks, boulders and cobble with sections of bedrock. Finer sediments, i.e. gravel and sand, were very poorly represented

Barriers to Upstream Movement of Salmonid Fish

Five major obstacles to upstream salmonid movement were identified In the c.10 km of the Roughty main channel surveyed (see Map 7). Each is likely to prevent upstream movement of salmon and trout in most or all flow conditions.

Biological Water Quality

Biological water quality assessment was carried out at six sites (A, C, F, N, V & Z – Figure 10.2).

Table 10.5: Biological Quality – Roughty River Main Channel

Site	Q-rating	WFD Ecological Quality	Quality Status
A	Q4-5	High	Unpolluted
C	Q4-5	High	Unpolluted
F	Q5	High	Unpolluted
N	Q4-5	High	Unpolluted
V	Q4-5	High	Unpolluted
Z	Q4	Good	Unpolluted

Fish Assessment

A single site (F9) was electrofished on the Roughty main channel (Figure 10.3).

Table 10.6: Summary of Fish Recorded at Site F9

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Fish Recorded	0	13	2	0
CPUE (catch / 5 min)	0	3.25	0.5	0
Minimum density/m²	0.032		0.005	0

The only fish species recorded at the site was Brown Trout. No eels or juvenile salmon were recorded at the site. Juvenile and adult brown trout were recorded at low densities.

Fishery Value

It is unlikely that salmon are present in the upper half of the main channel of the Roughty within the wind farm site i.e. upstream of Barrier 32. A site was surveyed by IFI in 2011 at Grid Ref. 108793 070881 which is a short distance upstream of Barrier 32. This site *"yielded no salmon and was excluded as is above barrier"* (W. Roche pers. comm.) In the present assessment Salmon were not recorded at any of the eight sites surveyed in the catchment upstream of Barrier 32.

Barrier 76 c.1.5km downstream of Barrier 32 is also likely to constitute a major obstacle to upstream salmon movement. However, as salmon were recorded at a single site on Tributary 2 (Red Trench South River), which is upstream of this barrier, it is evident that salmon can pass Barrier 76 under some flow conditions. It is therefore concluded that salmon are likely to have restricted access to the c.1.5 km of the Roughty River between Barriers 32 & 76, and restricted access to the Red Trench River . Downstream of Barrier 76 salmon are likely to have relatively unrestricted access. In the present assessment salmon were recorded at the downstream extremity of the proposed wind farm site, in Tributary 20 just upstream of its confluence with the Roughty main channel.

The results of the fish and habitat surveys indicate that, despite the obstacles to upstream fish movement, brown trout are present in the entire potentially affected section of the Roughty River main channel.

Ecological Value

Salmon: Salmon have access to the main channel of the Roughty River downstream of Barrier 32, i.e. from c.150 m downstream the bridge east of Knockanruddig at W 08573 72121. Upstream of this point there are no records of salmon and it is unlikely that they occur.

Freshwater Pearl Mussel: The survey carried out in August 2015 indicates that FPM are not present within the site boundaries of the proposed wind farm. In the c.6 km section from the proposed wind farm site to Morley's Bridge FPM are present at low but significant densities. In the c.5 km of the Roughty River from Morley's Bridge to Cahergal Bridge Roughty main channel higher densities were recorded.

Lamprey: On the basis of the habitat survey it is concluded that the surveyed section of the Roughty River has no significant habitat value for lamprey.

Brown Trout Genetic Diversity: The presence of a series of major barriers to upstream fish movement is likely to have resulted in some degree of genetic separation between trout populations upstream and downstream of the barriers. Whereas trout would undoubtedly move downstream, upstream movement may occur rarely or never at some

of these barriers. It was noted for instance that the markings of the brown trout at sites electrofished upstream of Barrier 16 seemed significantly different from those observed downstream. Such genetic diversity within species is regarded as an important element of biodiversity.

Ecological Value Classification: The c.6.5 km of the Roughty River within the proposed wind farm site is classified as of high local value on the basis of its near pristine water quality, extensive areas of significant brown trout habitat throughout, and salmon habitat in its northern section. The entire Roughty River downstream of the proposed wind farm site is classified as of national importance on the basis of having significant populations of Freshwater Pearl Mussels and salmon.

10.1.6 Red Trench South River and Tributaries (Tributaries 2A–2K) (Maps 8-11)

Habitat Assessment

A total of c.11.75 km of the Red Trench South River and its potentially affected tributaries was surveyed.

Salmonid Habitat Quality: *Tributary 2A – Main Channel of Red Trench South River:* The main channel of the Red Trench South River (c.3.6 km) comprises fair adult salmonid habitat in the upstream c.1.86km and fair–good adult habitat for the remaining c.1.75 km section of channel as far as the confluence with the Roughty River. Approximately 2 km of the main channel surveyed comprises good and good–very good salmonid nursery habitat and mostly good and fair-good spawning habitat. The remaining c.1.6 km comprises fair salmonid nursery and spawning habitat.

Tributaries 2B, 2C & 2K: These very small tributaries have no significant salmonid nursery or spawning habitat.

Tributaries 2D, 2F, 2G, 2I, & 2J : These tributaries have some significant (fair or fair-good) salmonid spawning and nursery habitat in their lowest (<500 m) sections. The upper reaches of these tributaries do not have significant salmonid nursery or spawning habitat.

Tributaries 2E & 2H: These tributaries have significant (fair or fair-good) salmonid nursery habitat for much of their length (for c.1 km from the confluence with the main channel). The lowest c.400 m of Tributary 2H has good salmonid spawning habitat. The lowest c.300 m of Tributary 2E has fair salmonid nursery habitat.

Lamprey Habitat Quality: No significant lamprey nursery habitat was recorded on the main channel of the Red Trench South River or its potentially affected tributaries. Whereas much of the main channel and some sections of the tributaries would constitute fair or better lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channel as of no significant potential habitat value for lamprey.

Freshwater Pearl Mussel Habitat Quality: No potential freshwater pearl mussel habitat was recorded in the potentially affected sections of the Red Trench South River or its potentially affected tributaries

Barriers to Upstream Movement of Salmonid Fish

In the potentially affected sections of Red Trench South River and its tributaries, 40 obstacles to upstream salmonid movement were identified (see Maps 12 & 18), of which six were classified as impassable, 32 were classified as major and two as significant.

Biological Water Quality

Biological water quality assessment was carried out at a single site (Site B) on the Red Trench South main channel and at six tributary sites (Sites O – T). (Figure 10.2).

Table 10.7: Biological Quality – Red Trench South Main Channel and Tributaries

Site	Q-rating	WFD Ecological Quality	Quality Status
B	Q4	Good	Unpolluted
O	Q4	Good	Unpolluted
P	Q4	Good	Unpolluted
Q	Q4	Good	Unpolluted
R	Q4-5	High	Unpolluted
S	Q4	Good	Unpolluted
T	Q4	Good	Unpolluted

Fish Assessment

Two sites (F1 & F10) were electrofished on the Red Trench South main channel; four sites (F11 – F14) were electrofished on the Red Trench South tributaries (Figure 10.3).

Table 10.9: Summary - Fish Recorded Site F1

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Site F1 (Main Chanel 2A)				
Fish Recorded	7	26	5	0
CPUE (catch / 5 min)	1.75	6.5	1.25	0
Minimum density/m²	0.106		0.016	0
Site F10 (Main Chanel 2F)				
Fish Recorded	11	0	4	11
CPUE (catch / 5 min)	3.6	0	1.3	1.8
Minimum density/m²	0.061		0.022	0
Site F11 (Main Chanel 2G)				
Fish Recorded	3	9	2	0
CPUE (catch / 5 min)	1.2	3.7	0.8	0
Minimum density/m²	0.150		0.025	0
Site F12 (Main Chanel 2H)				
Fish Recorded	2	0	3	0
CPUE (catch / 5 min)	1.2	0	1.88	0
Minimum density/m²	0.044		0.067	0

Fishery Value

On the basis of the findings of the fish, habitat and barriers surveys, the following conclusions are reached:

Tributary 2A – Main Channel of Red Trench South River: Brown trout were recorded at moderate density at the two sites site assessed. Similar densities are likely throughout the potentially affected main channel of the river. Juvenile salmon were recorded at low density at Site F10.

Tributaries 2B & 2C: These small watercourses are unlikely to have trout.

Tributary 2D: This tributary flowing from Knockanruddig is likely to have a sparse population of trout in its lowest c.300m, but no trout are likely further upstream.

Tributary 2E: This tributary is likely to have brown trout present at low density for c.900 m upstream of the confluence with the main river. Applying the precautionary principle, on the basis of fair-good nursery habitat, it is assumed that trout may also be present for a further c.700 m upstream (see Map 19). However, there is an impassable barrier at the downstream end of this section and the section may be inadequate to sustain a permanent breeding population.

Tributary 2F: It is likely that a low density of juvenile trout is present in this stream at least as far upstream as the proposed windfarm access track. Above this point the stream is very small and flowing over peat. Trout may not be present above this point.

Tributary 2G: A moderate density of brown trout were recorded at the lower end of this stream. It is likely that a low to moderate density of juvenile trout is present as far upstream as the lowest proposed access track crossing. In the c.400 m upstream of this point there is a succession of four major barriers to upstream salmonid movement (Barriers 60 – 63). This combined with poor to fair salmonid nursery habitat quality makes it unlikely but not impossible that trout are present in this tributary as far upstream at proposed Turbine T33.

Tributary 2H: A low density of juvenile brown trout and a fairly good density of adult brown trout were recorded in the lower reaches of this tributary. Most of this tributary has fair salmonid nursery habitat but upstream of the lowest proposed windfarm track crossing the spawning habitat quality is poor. This combined with a closely placed series of major barriers to upstream fish movement makes it unlikely that trout are present above the location of the lowest proposed track crossing. Below the lowest proposed track crossing gravel is more abundant and the habitat is potentially good for salmonid spawning. There are three major obstacles to fish movement in this section.

Tributary 2I: There are nine major barriers to upstream movement on both branches of this tributary. The lowest c.400 m of the main western branch of the stream has fair salmonid nursery habitat; however no trout were recorded in this section. The remaining upstream sections and the smaller eastern branch of the stream are unlikely to have trout due to a combination of major barriers, very small stream size, and at best poor to fair salmonid spawning and nursery habitat quality.

Tributary 2J: The lowest 100 m of this stream has fair salmonid nursery and spawning habitat. Above this section a combination of four major obstacles to upstream fish movement and at best poor-fair salmonid spawning and nursery habitat quality makes it unlikely that a trout population is present.

Tributary 2K: No fish were recorded in the lowest section of this stream. A combination of

very small stream size, three major barriers to upstream fish movement and poor salmonid nursery and spawning habitat quality makes it unlikely that trout are present in this stream. Furthermore the invertebrates recorded in this stream are consistent with an ephemeral stream with little or no flow in drier conditions.

Ecological Value

Salmon: Juvenile salmon were recorded at Site F10 at the upper end of the Red Trench River channel. This is a notable result as this is the only site of the six assessed on the Red Trench River and tributaries at which salmon were recorded. This record of salmon is upstream of two major barriers to upstream salmon migration on the Red Trench River (Barriers 42 & 59) and upstream of a major barrier in the main channel of the Roughty River (Barrier 76) downstream of its confluence with the Red Trench River. The parent fish successfully surmounted these barriers in the winter of 2014/15. No juveniles from the previous winter were recorded. It is therefore likely that spawning by salmon on the Red Trench River may be restricted and sporadic.

Freshwater Pearl Mussel: There are no records of Freshwater Pearl Mussels in the Red Trench River. On the basis of data available and the complete absence of suitable habitat, it is concluded that freshwater pearl mussel are unlikely to be present in the potentially affected sections of the Red Trench South River or its tributaries.

Lamprey: On the basis of the habitat survey it is concluded that the surveyed section of the Roughty River has no significant habitat value for lamprey.

Ecological Value Classification: The surveyed section of the main channel of the Red Trench South River is classified as of high local value on the basis of its unpolluted water quality and extensive areas of good brown trout nursery habitat and small population of salmon. All the surveyed tributaries are also classified as of local importance high value with the exception of tributaries 2B, 2C and 2K which are classified as local importance moderate value.

10.1.7 Roughty Eastern Tributaries (River/Stream 3-7) (Maps 20-23)

Habitat Assessment

Salmonid Habitat Quality: Tributaries 3 & 4: These are very small steep streams with no significant (fair or better) salmonid habitat.

Tributary 5: The potentially affected section (c.1 km) has fair adult salmonid habitat and fair-good salmonid spawning and nursery habitat

Tributary 6: The most downstream c.250 m of this small stream constitutes fair salmonid nursery and spawning habitat. The more upstream sections have no significant salmonid habitat quality.

Tributary 7: This tributary consists of approximately seven small headwater streams with a combined length of c.2.8 km which join to form the main stream channel which then flows for c.700 m to the confluence with the Roughty River. The main channel constitutes mostly fair adult and spawning habitat and fair–good salmonid nursery habitat. The headwater tributaries have no significant (fair or better) adult habitat but have c.1.2 km of channel with fair salmonid spawning and nursery habitat quality.

Lamprey Habitat Quality: No significant lamprey nursery habitat was recorded in tributaries 3-7. Whereas much of the channels would constitute fair or better lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channels as of no significant potential habitat value for lamprey.

Freshwater Pearl Mussel Habitat Quality : No potential freshwater pearl mussel habitat was recorded in the potentially affected sections of tributaries 3-7.

Barriers to Upstream Movement of Salmonid Fish

Eight obstacles to upstream salmonid movement were identified in tributaries 3-7 of which two were classified as impassable, four as major and two as significant (Map 24).

Biological Water Quality

Biological water quality assessment was carried out at Site D on Tributary 5 and at Site E on Tributary 7 (Figure 10.2).

Table 10.9: Biological Quality – Roughty River Eastern Tributaries

Tributary	Site	Q-rating	WFD Ecological Quality	Quality Status
5	D	Q5	High	Unpolluted
7	E	Q4-5	High	Unpolluted

Fish Assessment

Sites were electrofished on Tributary 5 (F2) and Tributary 7 (F3) (Figure 10.3).

Table 10.10: Summary - Fish Recorded Sites F2 & F3

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Site F2 (Tributary 5)				
Fish Recorded	0	9	1	0
CPUE (catch / 5 min)	0	3	0.33	0
Minimum density/m²	0.064		0.007	0
Site F3 (Tributary 7)				
Fish Recorded	2	8	0	0
CPUE (catch / 5 min)	0.66	2.66	0	0
Minimum density/m²	0.067		0	0

The only fish species recorded on either tributary was Brown Trout. No eels or juvenile salmon were recorded at the sites. Juvenile brown trout were recorded at low density at both sites. Adult brown trout were recorded at low density at the site on Tributary 5 but were not recorded at the site on Tributary 7.

Fishery Value

On the basis of the findings of the fish, habitat and barriers surveys the following conclusions are reached (Map 25):

- Salmon are likely to be absent from Tributaries 3-7.
- Brown Trout are likely to be absent or present at extremely low densities in Tributaries 3 & 4.
- Brown trout are likely to be present at low densities throughout most of the potentially affected section of Tributary 5.

- Brown Trout are likely to be present at low density in the lowest c.200 m of Tributary 6.
- On Tributary 7 a major obstacle to upstream salmonid fish movement c.100 m upstream of its confluence with the Roughty River main channel may exclude trout from all sections further upstream. Brown trout were recorded at low density below this barrier. Applying the precautionary principle it is assumed that trout are present above this barrier. C.500 m further upstream two impassable barriers are located a short distance downstream of the confluence of the seven headwater streams. A further three barriers (two classified as major and the third as significant) are located on the headwater streams. These barriers, combined with the very small size of the headwater streams and the generally fair or insignificant spawning and nursery habitat value, combine to make it very unlikely that brown trout are present in the headwater streams.

Ecological Value

Salmon: The presence of salmon in the potentially affected sections of Tributaries 3-7 must be regarded as unlikely for the following reasons:

- No juvenile salmon were recorded at any of the sites electrofished.
- A major obstacle to upstream salmonid movement is present on Tributary 7 with a series of further barriers, two of which are impassable, distributed up this tributary.
- Two major obstacles to upstream movement of salmonid fish are present in the main channel of the Roughty River downstream of the confluence with Tributaries 5–7. Local information indicates that salmon have never migrated this far up the Roughty River system because of impassable barriers further downstream (J. Lucey pers. comm.)

Freshwater Pearl Mussel: On the basis of data available and the complete absence of suitable habitat, it is concluded that freshwater pearl mussel are unlikely to be present in the potentially affected sections of tributaries 3-7.

Lamprey: On the basis of the habitat survey it is concluded that Tributaries 3-7 have no significant habitat value for lamprey.

Ecological Value Classification: Tributaries 3 & 4 are classified as of moderate local value and Tributaries 5 - 7 are classified as of high local value.

10.1.8 Roughty Western Tributaries (River/Stream 8-10) (Maps 26-29)

Habitat Assessment

Salmonid Habitat Quality: Tributary 8: The lowest c.250 m of this small stream has poor adult salmonid habitat and fair salmonid spawning and nursery habitat. The further upstream sections have no have no significant salmonid habitat value.

Tributary 9: The lowest c.250 m of this small stream has poor to non-existent adult salmonid habitat, fair and fair-good salmonid nursery habitat, and fair salmonid spawning habitat. The further upstream sections have no significant salmonid habitat value.

Tributary 10: This stream has no significant (i.e. fair or better) adult salmonid habitat. For c.700 m upstream of the confluence with the Roughty River the stream has fair and fair-good salmonid nursery but spawning habitat is only poor-fair. There is no significant nursery or spawning habitat further upstream.

Lamprey Habitat Quality: No significant lamprey nursery habitat was recorded in tributaries 8-10. Whereas some of the channels constitute fair lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channels as of no significant potential habitat value for lamprey.

Freshwater Pearl Mussel Habitat Quality: No potential freshwater pearl mussel habitat was recorded in the potentially affected sections of tributaries 8-10.

Barriers to Upstream Movement of Salmonid Fish

Seven obstacles to upstream salmonid movement were identified in Tributaries 8-10, of which one was classified as impassable, four as major and two as significant (Map 30).

Biological Water Quality

Biological water quality assessment was carried out at Site G on Tributary 8, Site H on Tributary 9 and Site I on Tributary 10 (Figure 10.2).

Table 10.11: Biological Quality - Roughty River Western Tributaries

Tributary	Site	Q-rating	WFD Ecological Quality	Quality Status
8	G	Q4-5	High	Unpolluted
9	H	Q4-5	High	Unpolluted
10	I	Q4-5	High	Unpolluted

Fish Assessment

A site was electrofished on Tributary 10 (Site F4) (Figure 10.3).

Table 10.12: Summary - Fish Recorded Site F4

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Fish Recorded	1	5	4	0
CPUE (catch / 5 min)	0.25	1.25	1	0
Minimum density/m²	0.040		0.027	0

The only fish species recorded was Brown Trout. No eels or juvenile salmon were recorded at the site. Juvenile and adult brown trout were recorded at low density at the site.

Fishery Value

On the basis of the findings of the fish, habitat and barriers surveys, the following conclusions are reached (see Map 25):

- Salmon are likely to be absent from the western tributaries of the Roughty River (Tributaries 8-10).
- There is no significant likelihood of Brown Trout any more than c.250 m upstream on Tributaries 8 & 9. As there are significant and major barriers to upstream salmonid movement just above the confluence of Tributaries 8 & 9 respectively with the Roughty River, it is possible that trout are absent from these small streams. Applying the precautionary principle it is assumed that trout are present at low densities in the lowest c.250 m of these streams (Map 31).

- Brown trout are likely to be present at low densities in the lowest c.700 m of Tributary 10, but absent further upstream (see Map 31).

Ecological Value

Salmon The presence of salmon in the potentially affected sections of Tributaries 8-10 is unlikely for the following reasons:

- No juvenile salmon were recorded in this river section or at any of the nine sites electrofished in the potentially affected section of the Roughty catchment.
- Significant obstacles to upstream salmonid movement are present on each of the three tributaries close to their confluence with the Roughty River.
- No significant (i.e. fair or better) spawning habitat was recorded in tributaries 9 & 10. And only c.200 m of fair salmonid spawning habitat was recorded in Tributary 8.
- There are two major barriers to upstream salmonid movement on the main channel of the Roughty River downstream of the confluence with these tributaries. Local information indicates that salmon have never migrated this far up the Roughty River system because of impassable barriers further downstream (J. Lucey pers. comm.)

Freshwater Pearl Mussel: On the basis of data available and the complete absence of suitable habitat, it is concluded that freshwater pearl mussel are unlikely to be present in the potentially affected sections of Tributaries 8-10.

Lamprey: On the basis of the habitat survey it is concluded that Tributaries 8-10 have no significant habitat value for lamprey.

Ecological Value Classification: Tributaries 8-10 are classified as of high local importance.

10.1.9 Roughty Southern Tributaries (River/Stream 11-17) (Maps 32-35)

Habitat Assessment

Salmonid Habitat Quality: Tributary 11: No significant (i.e. fair or better) salmonid adult habitat was recorded in this tributary. A short 150 m section at the very bottom of the stream is classified as fair-good nursery habitat; however the most downstream c.900 m of the stream constitutes mostly fair salmonid nursery and spawning habitat. No significant (i.e. fair or better) salmonid habitat was recorded further upstream.

Tributary 12: No significant (i.e. fair or better) salmonid habitat.

Tributary 13 This very small stream has c.250 m of fair salmonid spawning habitat at its downstream end. Otherwise the stream has no significant salmonid habitat.

Tributary 14: This stream has no significant (i.e. fair or better) adult salmonid habitat. The lowest c.150 m of the stream constitutes good salmonid nursery habitat and fair salmonid spawning habitat. The next c.1 km upstream constitutes fair salmonid nursery habitat and poor-fair salmonid spawning habitat. The section further upstream and the small tributary joining from the north have no significant (fair or better) salmonid habitat.

Tributary 15: This stream is formed by the confluence of six headwater streams. Significant adult salmonid habitat is confined to the most downstream c.500 m of the main channel where adult habitat value is fair. Most of this stream system has significant nursery habitat value i.e. fair or fair-good and intermittent sections of fair and fair- good

spawning habitat within c.700 m of the confluence with the Roughty River. The upper ends of the headwater streams generally lack significant spawning and nursery habitat value. Tributary 16: This very small stream has no significant salmonid habitat.

Tributary 17: This stream has no significant (i.e. fair or better) adult salmonid habitat. The lowest c.200 m of the stream has good salmonid nursery habitat and poor-fair spawning habitat. The next c.600 m section upstream is fair nursery habitat and poor-fair spawning habitat. The headwaters have poor-fair spawning and nursery habitat.

Lamprey Habitat Quality: No lamprey nursery habitat was recorded in Tributaries 11-17. Whereas some of the channels constitute fair lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channels as of no significant potential habitat value for lamprey.

Freshwater Pearl Mussel Habitat Quality: No potential freshwater pearl mussel habitat was recorded in the potentially affected sections of Tributaries 11-17.

Barriers to Upstream Movement of Salmonid Fish

Fifteen obstacles to upstream salmonid movement were identified in Tributaries 11-17, of which one was classified as impassable, eight as major and five as significant (Map 30).

Biological Water Quality

Biological water quality assessment was carried out at five sites on the southern Roughty tributaries (Figure 10.2).

Table 10.13: Biological Water Quality – Roughty River Southern Tributaries

Tributary	Site	Q-rating	WFD Ecological Status	Quality Status
11	J	Q4-5	High	Unpolluted
12	K	Q4-5	High	Unpolluted
14	L	Q4-5	High	Unpolluted
15	M	Q4	Good	Unpolluted
17	N	Q4-5	High	Unpolluted

Fish Assessment

Five sites were electrofished on the Roughty southern tributaries (Figure 10.3).

Table 10.14: Summary - Fish Recorded Sites F5 – F9

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Roughty Southern Tributaries - Site F5 (Tributary 11)				
Fish Recorded	0	1	0	
CPUE (catch / 5 min)	0	0.25	0	
Minimum density/m²	0.007		0	0
Roughty Southern Tributaries - Site F6 (Tributary 12)				
Fish Recorded	0	0	0	0

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
CPUE (catch / 5 min)	0	0	0	0
Minimum density/m²	0		0	0
Roughty Southern Tributaries - Site F7 (Tributary 14)				
Fish Recorded	0	2	4	0
CPUE (catch / 5 min)	0	0.66	1.33	0
Minimum density/m²	0.019		0.038	0
Roughty Southern Tributaries - Site F8 (Tributary 15)				
Fish Recorded	0	9	2	0
CPUE (catch / 5 min)	0	3	0.66	0
Minimum density/m²	0.045		0.010	0
Roughty Southern Tributaries - Site F9 (Tributary 17)				
Fish Recorded	0	13	2	0
CPUE (catch / 5 min)	0	3.25	0.5	0
Minimum density/m²	0.032		0.005	0

The only fish species recorded was Brown Trout. No eels or juvenile salmon were recorded at any of the sites surveyed. Juvenile trout were recorded at low densities at all sites except Site F6 where no fish were recorded. Adult brown trout were recorded at low densities at sites F7, F8 & F9. It was notable that only one trout was recorded during 20 minutes of electrofishing at Site F4 on Tributary 11, despite fair-good salmonid nursery habitat at the assessment site location a short distance upstream of the Roughty River confluence. Whereas the cause of the virtual absence of fish at this site cannot be determined with certainty, it may be due to a landslide which denuded an area of c. 1 ha. of steep hillside adjacent to the stream c.1.2 km upstream of the Roughty confluence. This landslide hit the stream at Grid Ref. W0722 6949. The landslide would appear to have occurred within the last year.

Fishery Value

On the basis of the findings of the fish, habitat and barriers surveys it is concluded that there is no significant likelihood of salmon being present Tributaries 11-17.

The following conclusions are based on the results of the fish survey, the barriers survey and the habitat survey (Map 37).

Tributary 11: On the basis of the habitat and barriers survey it is concluded that there is a significant likelihood of brown trout being present at low density in the lowest c.800 m of this stream (Map 37). However it appears likely that the entire section of this stream with significant salmonid habitat may have been severely affected by a recent landslide event. As only a single fish was recorded in the lowest section of the stream in 20 minutes of electrofishing, and as this lowest section of the stream is below a major barrier to upstream fish movement, the possibility that the stream above the barrier is now devoid of trout cannot be ruled out. In this scenario the re-colonisation of the stream could take a

very long time.

Tributary 12: No fish were recorded in this stream. It is unlikely that this very small steam has any brown trout population.

Tributary 13: It is unlikely that this very small steam has any brown trout population.

Tributary 14: Brown trout were recorded at the downstream end of this stream. Brown trout at low density can be assumed to occur in the most downstream c.500m of this stream .Given the presence of two major obstacles to upstream fish movement and only fair salmonid nursery habitat, there is a strong possibility that the section from 500m to c.1.1km upstream has no trout population. However applying the precautionary principle it is concluded that there is no significant likelihood of trout in this stream above a point c.1.1km upstream of its confluence with the Roughty River (see Map 37).

Tributary 15: Brown trout were recorded at the downstream end of this stream. This stream is likely to have a low density population of brown trout on its main channel to c.800m upstream of the confluence with the Roughty River and to c.500m upstream of the Roughty on its northern channel. Above these points the headwater streams are unlikely to have trout (Map 37).

Tributary 16: It is unlikely that this very small stream has any brown trout population.

Tributary 17: Brown trout were recorded at the downstream end of this stream. It is assumed that this stream has a sparse population of brown trout for c.1km upstream of its confluence with the Roughty River (Map 37).

Ecological Value

Salmon: There is no significant likelihood of salmon being present in the potentially affected sections of Tributaries 11-17 for the following reasons:

- No juvenile salmon were recorded in this river section or at any of the nine sites electrofished in the potentially affected section of the Roughty catchment.
- Multiple significant obstacles to upstream salmonid movement are present on each of the tributaries with significant salmonid habitat, and on the main channel of the Roughty River downstream of these tributaries.
- Local information indicates that salmon have never migrated this far up the Roughty River system because of impassable barriers further downstream (J. Lucey pers. comm.).

Freshwater Pearl Mussel: On the basis of data available and the complete absence of suitable habitat, it is concluded that freshwater pearl mussel are unlikely to be present in the potentially affected sections of the southern tributaries of the Roughty River.

Lamprey: On the basis of the habitat survey it is concluded that Tributaries 11-17 have no significant habitat value for lamprey.

Ecological Value Classification: Tributaries 12 & 16 are classified as of moderate local value. Tributaries 11, 13-15 & 17 are classified as of high local importance.

10.1.10 Roughty Northern Tributaries 18-20 (Maps 38-41 & 44-47)

Habitat Assessment

Salmonid Habitat Quality: Tributary 18: The c.150 m of Tributary 18 immediately upstream of the confluence with the Roughty River constitutes fair-good salmonid nursery

habitat and fair salmonid spawning habitat. Above this section the Tributary is fed by several very small headwater streams which constitute salmonid nursery habitat quality ranging from fair to good for up to c.300 m upstream after which the streams become too steep and too small to be of significant salmonid habitat value.

Tributary 19: The c.350 m of Tributary 19 immediately upstream of the confluence with the Roughty River constitutes fair-good adult salmonid habitat, good salmonid nursery habitat and fair salmonid spawning habitat. The next c.180 m comprises a steeply cascading section over large rocks and bedrock with rocky pools. This section constitutes mediocre salmonid habit. At c.530 upstream of the Roughty confluence this tributary has an impassable barrier to upstream movement of salmonid fish. The c.200 m of stream above this impassable barrier constitutes fair-good salmonid nursery and spawning habit but there is a further major barrier to fish movement in this section. Above this both branches of this tributary have mediocre salmonid nursery and spawning habit and further obstacles to fish movement.

Tributary 20: The potentially affected c.3km section of Tributary 20 has fair–good salmonid adult habitat in the lowest c.1.25 km and fair adult salmonid habitat over its remaining length . Most of the channel constitutes fair – good salmonid nursery habitat but the most upstream c.60 0m section has good salmonid nursery habitat. Salmonid spawning habitat quality is fair–good on c.38% of the channel with the remainder being fair or less.

Lamprey Habitat Quality: No significant lamprey nursery habitat was recorded in Tributaries 18-20. Whereas some of the channels constitute fair lamprey spawning habitat, the absence of silty substrates suitable as nursery habitat renders the surveyed channels as of no significant potential habitat value for juvenile lamprey.

Freshwater Pearl Mussel Habitat Quality: No potential freshwater pearl mussel habitat was recorded in the potentially affected sections of Tributaries 18-20.

Barriers to Upstream Movement of Salmonid Fish

Three obstacles to upstream salmonid movement were identified on Tributary 18 of which two were classified as major and on was classified as significant (Map 42).

On Tributary 19 five barriers to upstream salmonid movement were identified of which two were classified as impassible (including an impassible barrier c.530 m upstream of the confluence with the Roughty River) and three were classified as major.

On Tributary 20 four major barriers to upstream salmonid movement were identified (see Map 48).

Biological Water Quality

Biological water quality assessment was carried out at Site G on Tributary 8, Site H on Tributary 9 and Site I on Tributary 10 (Figure 10.2).

Table 10.15: Biological Water Quality River Roughty Northern Tributaries

Tributary	Site	Q-rating	WFD Ecological Quality	Quality Status
18	U	Q4-5	High	Unpolluted
19	W	Q4-5	High	Unpolluted
20	X	Q4	Good	Unpolluted
20	Y	Q4	Good	Unpolluted

Fish Assessment

Electrofishing was carried out at one site on each of Tributaries 18 and 19 and at three sites on Tributary 20 (see Figure 10.3).

Table 10.16: Summary - Fish Recorded Sites F15 – F19

Species	Juvenile Trout 0+	Juvenile Trout 1+	Adult Trout 2+	Others
Roughty Northern Tributaries - Site F15 (Tributary 18)				
Fish Recorded	22	0	0	0
CPUE (catch / 5 min)	7.33	0	0	0
Minimum density/m²	0.349		0	0
Roughty Northern Tributaries - Site F16 (Tributary 19)				
Fish Recorded	10	3	2	1
CPUE (catch / 5 min)	2.78	0.83	0.56	0.28
Minimum density/m²	0.067		0.010	0.005
Roughty Northern Tributaries - Site F17 (Tributary 20)				
Fish Recorded	0	0	0	0
CPUE (catch / 5 min)	0	0	0	0
Minimum density/m²	0.019		0	0
Roughty Northern Tributaries - Site F18 (Tributary 20)				
Fish Recorded	7	0	9	0
CPUE (catch / 5 min)	2.06	0	2.65	0
Minimum density/m²	0.020		0.026	0
Roughty Northern Tributaries - Site F19 (Tributary 20)				
Fish Recorded	9	4	6	7
CPUE (catch / 5 min)	2.25	1.00	1.50	1.75
Minimum density/m²	0.034		0.016	0.018

Fishery Value

Tributary 18: A good density of juvenile brown trout was recorded at the lower end of this stream. This small stream is likely to serve a spawning and nursery area for brown trout. Though there is a major obstacle to upstream fish movement on the Roughty River a few hundred metres downstream of the confluence with Tributary 18, the possibility that salmon may spawn in the lowest section of the tributary cannot be ruled out, although juvenile salmon were not recorded in the course of the fish survey.

Tributary 19: Juvenile and adult trout at low density, and a single juvenile salmon, were recorded at the lower end of this stream. The c.350m of Tributary 19 immediately upstream of the confluence with the Roughty River is likely to serve as a spawning and nursery area for brown trout and salmon. The more upstream sections of the stream have

three major obstacles to upstream fish movement and a single impassable obstacle.

Tributary 20: Juvenile and adult brown trout were recorded at low density in this stream. Juvenile salmon were also recorded at low density at the lower end of this tributary. The c.250m of Tributary 20 immediately upstream of the confluence with the Roughty River serves as a spawning and nursery area for brown trout and salmon. Upstream of this section there are three major obstacles to upstream fish movement, and salmon were not recorded above this point. Brown trout were recorded at low density in the middle reaches of the stream (Site F18) but no fish were recorded at the upper site (F17). As physical habitat quality at the upper section is good for juvenile trout, and biological water quality is good, the reason for the absence of fish is not clear

Ecological Value

Salmon: The fish survey establishes that salmon use the lowest sections of Tributary 19 and 20 as a spawning and nursery area. The possibility that juvenile salmon may also occur in low numbers in the lowest section of Tributary 18 cannot be ruled out, although juvenile salmon were not found here in the course of the fish survey.

Freshwater Pearl Mussel: On the basis of the complete absence of suitable habitat, it is concluded that freshwater pearl mussel are unlikely to be present in the potentially affected sections of Tributaries 18-20.

Lamprey: On the basis of the habitat survey it is concluded that Tributaries 18-20 have no significant nursery habitat value for lamprey.

Ecological Value Classification: Tributaries 18-20 are classified as of high local importance.

10.2 IMPACT OF THE DEVELOPMENT

The potential significant impacts of the proposed development on aquatic ecology will be:

- Pollution of watercourses with suspended solids due to runoff of soil from construction areas.
- Pollution of watercourses with nutrients due to ground disturbance during construction
- Pollution of watercourses with nutrients due to decomposition of brash after forestry clear-felling
- Pollution of watercourses during construction phase with other substances such as fuels, lubricants, waste concrete, waste water from temporary site facilities, etc.
- Pollution of watercourses with surface drainage water from paved areas and access track surfaces.
- Hydrological impact due to changes in the flow rates of streams/rivers.
- Permanent loss of habitat due to culverting or bank/stream alteration.
- Obstruction to upstream movement of aquatic fauna due to culverting.

Potential impacts are described in relation to the construction phase and significant long-term effects of the presence of the wind farm on freshwater invertebrate fauna, flora, fish and habitats.

The following factors will determine the scale of potential impacts arising:

- The ecological / fishery value of the watercourse.
- Whether significant habitat will be directly affected by tracks etc. constructed across or in close proximity to the watercourse.
- If the watercourse will be potentially affected only by up-gradient construction works.

Table 10.17: Watercourse Status

Watercourse	Watercourse Ecological Importance	Construction Over / Adjacent to Significant Fish Habitat	Distance Up-gradient to Significant Fish Habitat
Roughty River Main Channel 1	Regional / National	✓	
Tributary 2A (Red Trench South River)	High Local	✓	
Tributary 2B	Moderate Local	X	c.400 m
Tributary 2C	Moderate Local	X	c.350 m
Tributary 2D	High Local	X	c.400 m
Tributary 2E	High Local	X	c.400 m
Tributary 2F	High Local	✓	
Tributary 2G	High Local	✓	
Tributary 2H	High Local	✓	
Tributary 2I	High Local	✓	
Tributary 2J	High Local	✓	
Tributary 2K	Moderate Local	X	c.150 m
Tributary 3	Moderate Local	X	c.450 m
Tributary 4	Moderate Local	X	c.600 m
Tributary 5	High Local	✓	
Tributary 6	High Local	X	c.500 m
Tributary 7	High Local	X	c.300 m
Tributary 8	High Local	X	c.300 m
Tributary 9	High Local	X	c.300 m
Tributary 10	High Local	X	c.500 m
Tributary 11	High Local	X	c.700 m
Tributary 12	Moderate Local	X	c.400 m
Tributary 13	High Local	X	c.900 m
Tributary 14	High Local	✓	
Tributary 15	High Local	✓	
Tributary 16	Moderate Local	X	c.300 m

Watercourse	Watercourse Ecological Importance	Construction Over / Adjacent to Significant Fish Habitat	Distance Up-gradient to Significant Fish Habitat
Tributary 17	High Local	✓	
Tributary 18	High Local	✓	
Tributary 19	High Local	X	c.400 m
Tributary 20	High Local	✓	

10.2.1 Potential Impacts During Construction

Pollution of Streams With Suspended Solids

In the absence of adequate mitigation any construction activity involving excavation or placement of soils has potential for suspended solids contamination of surface waters. Any works proposed in areas with significant depths of peat may also pose risks of serious environmental impact due to peat failure or slippage resulting in contamination of watercourses.

Potential peat instability has been are addressed in Section 14 (Geology & Soils). The assessment concludes as follows:

> *Taking account of the mitigation measures applying at preliminary design stage, detailed design stage and construction stage, it is concluded that Grousemount Wind Farm can be constructed safely from a geotechnical perspective. There will be no significant risk of stream contamination due to peat instability and the proposed development will not result in long-term adverse environmental impacts.*

Suspended sediment due to runoff of soil from construction areas, or due to disturbance of fine sub-surface sediments in the course of in-stream construction and excavation, can have severe negative impacts on invertebrate and plant life and on all life stages of salmonid fish. Peat soils have high erodability (Forest Service 2008) and may be less amenable to removal by conventional settlement ponds.

- Suspended sediment can settle on spawning areas, infill the intragravel voids and smother the eggs and alevins (newly hatched fish) in the gravel.
- Bed Load (coarse material transported along the bottom of the stream) and settled sediments can infill pools and riffles, reducing the availability and quality of rearing habitat for fish.
- Suspended sediment can reduce water clarity and visibility in the stream, impairing the ability of fish to find food items.
- Settled sediments can smother and displace aquatic organisms such as macroinvertebrates, reducing the amount of food items available to fish.
- Increased levels of sediment can displace fish out of prime habitat into less suitable areas. (Chilibeck *et al* 1992)
- Suspended solids can abrade or clog the gills of salmonid fish. It takes a high concentration of solid wastes to clog a fish gill and cause asphyxiation, but only a little to cause abrasions and thus permit the possibility of infections. (Solbe 1988)

In the absence of adequate mitigation measures, contamination of water courses with

suspended solids, particularly in the event of bog failure, with the resultant potential impact on salmonid spawning and nursery areas, is one of the most significant potential impacts of the proposed development.

Impact of Suspended Solids on Freshwater Pearl Mussel

Silt has been identified in the scientific literature as a serious threat to Margaritifera; the IUCN Red Data Book states that in the UK Margaritifera is *'threatened by siltation'* and in North America *'accelerated siltation from land development could endanger them in future'* (Wells et al 1983); Valovirta (1989) cites increase in the silt load of rivers as a reason for the decline of Margaritifera in Finland. Hendelberg (1960) and Young and Williams (1983) also implicate silt in damaging or eliminating Margaritifera populations. As juvenile Margaritifera are fully buried in the sand and gravel of the river bed they are more vulnerable to siltation. *'Any siltation of the river bed results in a rapid decrease in the oxygen content of the interstitial water and death of the juveniles living there'* (Buddensiek et al 1993).

Pollution With Nutrients due to Ground Disturbance

The main potential sources of nutrient inputs to freshwater due to ground disturbance are nutrients adsorbed or chemically bound to eroded suspended solids.

Pollution with Nutrients due to Decomposition of Brash after Forestry Clearfelling

Part of the access route from the L3021 public road river passes through a recently clear-felled forestry site with stumps and brash still in situ. In Ireland it is now recognised that a significant potential source of nutrient leaching to receiving waters from forestry on peat comes via decaying organic matter, including the foliage and branches, unwanted stems, stumps and dead roots, left on site after crop thinning or felling which are added to the soil at the same time that nutrient uptake is reduced. (Hutton et al 2008; Kennedy 2005; Campbell & Foy 2008; Rogers et al 2008; Forest Service 2008). Dr Martin McGarrigle of EPA indicated that standing crop of 20 kg/ha phosphorus in brash may have loss rates *"similar to intensive farmland with just 10% loss per annum"* (McGarrigle 2008). *"The rate of decomposition is influenced by temperature, moisture and humidity. Consequently, phosphorus loss tends to be greatest during the warmer months and may be particularly problematic during a flood event following a prolonged hot and dry period."* (Forest Service 2008).

Pollution With Other Substances

There potential exists for a range of serious pollutants to enter watercourses during construction. For example any of the following will have deleterious effects on fish, plants and invertebrates if allowed to enter watercourses.

- Raw or uncured concrete and grouts.
- Wash down water from exposed aggregate surfaces, cast-in-place concrete and from concrete trucks.
- Fuels, lubricants and hydraulic fluids used in construction plant.
- Waste from on site toilet and wash facilities.

10.2.2 Potential Significant Long-Term Aquatic Effects

Pollution with Surface Runoff from Completed Development

Operational wind farms produce no discharges and, other than lubricants, use no

chemicals. While the risk of significant pollution from paved areas following construction is minimal, due care and best practice will be required to prevent any contamination of surface waters with hydrocarbons.

Harmful effects include:

- The prevention of gaseous exchange at the water surface, leading to reduced dissolved oxygen in the underlying water (Solbe 1988)
- In the case of turbulent waters the oil becomes dispersed as droplets into the water. In such cases, the gills of fish can become mechanically contaminated and their respiratory capacity reduced (Svobodova et al 1993).
- Oil products may contain various highly toxic substances, such as benzene, toluene, naphthenic acids and xylene which are to some extent soluble in water; these penetrate into the fish and can have a direct toxic effect. It is generally agreed that the lighter oil fractions (including kerosene, petrol, benzene, toluene and xylene) are much more toxic to fish than the heavy fractions (heavy paraffins and tars) reduced (Svobodova et al 1993).

The wind farm will have the potential for ongoing pollution of watercourses with suspended solids due to eroding of access tracks and drains.

Hydrological Impacts

Should they occur, major changes in hydrology reflected in significant changes in peak and minimum flows of individual streams would have significant effects on instream flora and fauna, both directly and through the effects of increased erosion. Potential impacts are addressed in Section 15 (Hydrology, Hydrogeology & Water).

Permanent Loss of Habitat due to Track Construction

The wind farm access tracks/roads include 47 stream/river crossings (see Table 10.17). One of these is via an existing public road bridge (Crossing 47), and two are proposed crossings of the main channel of the Roughty River by single span bridges (Crossings 1 & 44). Excluding the existing and proposed main channel bridges, 14 of these crossings are likely to have trout present upstream and are therefore likely to constitute an obstruction to upstream trout movement in the absence of adequate mitigation, i.e. crossings 2, 12, 14, 18, 19, 24-27, 30, 32, 33, 43, & 45.

Proposed access tracks cross salmon migratory channels at two locations (Crossings 1 & 44). Both of these crossings are on the main channel of the Roughty River and will be single span crossings requiring no instream works or structures and will therefore have no potential impact on upstream salmon migration.

As well as the 14 proposed crossings with potential to obstruct upstream trout movement, the access track network will cross streams at 30 other locations and will cross a significant number of drains on the site with the potential to cause habitat fragmentation. Habitat fragmentation, the splitting of natural habitats and ecosystems into smaller and more isolated patches, is recognised as one of the most important global threats to the conservation of biological diversity. Effective watercourse protection requires consideration of the needs of all species, including invertebrates and insects, fish, amphibians such as frogs and newts, and mammals such as otters. Streams and the interconnectedness of different parts of a stream or watershed are essential to these animals. For reasons as simple as escaping random disaster or as complex as maintaining genetic diversity, animals living in or along streams, ephemeral watercourses.

Table 10.18: Habitat Quality at Stream Crossings and Estimated Presence /Absence Based on Habitat and Accessibility to Trout

Stream Crossing	Stream / River	Grid Ref.	Potential Channel Habitat Loss (m)*	Trout Adult Habitat	Trout Nursery Habitat	Trout Spawning Habitat	Estimated Trout Presence / Absence**	Distance Downstream to Trout Population	Trout Status Upstream*
1	1	W0872 7325	None (Clear span bridge)	Very good	Poor	Poor	Present	At crossing	Present
2	5	W0978 7040	10m	Fair	Fair - Good	Fair - Good	Present	At crossing	Present
3	7	W0980 7009	10m	None	None	None	Absent	c.400m	Absent
4	7	W0980 7004	10m	None	None - Poor	None - Poor	Absent	c.400m	Absent
5	7	W0979 7000	10m	Poor - Fair	Fair - Good	Fair	Absent	c.400m	Absent
6	7	W0974 6989	10m	None	Poor - Fair	Poor - Fair	Absent	c.400m	Absent
7	7	W0969 6980	10m	None	None - Poor	Poor	Absent	c.450m	Absent
8	7	W0966 6978	10m	Poor	Fair	Fair	Absent	c.450m	Absent
9	12	W0893 6970	10m	None	None	None	Absent	c.800m	Absent
10	12	W0873 6956	10m	None	None	None	Absent	c.600m	Absent
11	15	W0920 6890	10m	None - Poor	Poor - Fair	Poor - Fair	Absent	c.200m	Absent
12	15	W0856 6875	10m	Poor	Poor - Fair	Poor - Fair	Present	At crossing	Present
13	15	W0925 6877	10m	None - Poor	Poor	Poor	Absent	c.100m	Absent
14	15	W0874 6888	10m	None - Poor	Fair	Poor	Present	At crossing	Present
15	15	W0864 6873	10m	Fair	Fair - Good	Fair	Present	At crossing	Present
16	15	W0852 6869	10m	Poor	Poor - Fair	Poor - Fair	Absent	c.150m	Absent
17	16	W0839 6867	10m	None	None	None	Absent	c.300m	Absent

Stream Crossing	Stream / River	Grid Ref.	Potential Channel Habitat Loss (m)*	Trout Adult Habitat	Trout Nursery Habitat	Trout Spawning Habitat	Estimated Trout Presence / Absence**	Distance Downstream to Trout Population	Trout Status Upstream*
18	1	W0797 6854	10m	Fair - Good	Fair - Good	Fair	Present	At crossing	Present
19	14	W0730 6875	10m	Poor	Fair	Poor - Fair	Present	At crossing	Present
20	14	W0706 6887	10m	None - Poor	Poor	Poor	Absent	c.150m	Absent
21	9	W0806 7050	10m	None	None	None	Absent	c.550m	Absent
22	2D	W0735 7065	10m	None	Poor	Poor	Absent	c.280m	Absent
23	2D	W0731 7065	10m	None	None - Poor	None	Absent	c.280m	Absent
24	2E	W0655 7069	10m	Poor	Poor	Poor	Present	At crossing	Present
25	2F	W0599 7071	10m	Poor	Fair	Fair	Present	At crossing	Present
26	2A	W0587 7089	10m	Fair	Fair	Poor - Fair	Present	At crossing	Present
27	2G	W0612 7107	10m	None - Poor	Poor - Fair	Poor - Fair	Present	At crossing	Present
28	2G	W0605 7137	10m	None - Poor	Poor - Fair	Poor - Fair	Absent	c.100m	Absent
29	2H	W0651 7178	10m	Poor	Fair	Poor	Absent	c.100m	Absent
30	2G	W0614 7106	10m	None - Poor	Poor - Fair	Poor - Fair	Present	At crossing	Present
31	2H	W0679 7138	10m	Fair	Fair - Good	Good	Present	At crossing	Absent
32	2H	W0680 7135	10m	Fair	Fair - Good	Good	Present	At crossing	Present
33	2I	W0699 7140	10m	Poor	Fair	Fair	Present	At crossing	Present
34	2I	W0703 7141	10m	Poor	Poor - Fair	Poor - Fair	Absent	c.70m	Absent
35	2J	W0723 7142	10m	None	Poor	Poor - Fair	Present	At crossing	Absent
36	2K	W0745 7137	10m	None - Poor	Poor	Poor	Absent	c.70m	Absent

Stream Crossing	Stream / River	Grid Ref.	Potential Channel Habitat Loss (m)*	Trout Adult Habitat	Trout Nursery Habitat	Trout Spawning Habitat	Estimated Trout Presence / Absence**	Distance Downstream to Trout Population	Trout Status Upstream*
37	2I	W0694 7154	10m	None - Poor	Fair	Fair	Present	At crossing	Absent
38	2I	W0701 7164	10m	Poor	Poor - Fair	Poor - Fair	Absent	c.300m	Absent
39	2J	W0714 7169	10m	None	Poor - Fair	Poor - Fair	Absent	c.290m	Absent
40	2K	W0746 7167	10m	None	None	None	Absent	c.430m	Absent
41	18	W0818 7185	10m	Poor	Fair	Poor - Fair	Present	At crossing	Absent
42	18	W0828 7190	10m	Poor	Fair	Poor - Fair	Present	At crossing	Absent
43	18	W0843 7207	10m	Poor	Fair - Good	Fair	Present	At crossing	Present
44	1	W0859 7230	None (Clear span bridge)	Good	Fair	Fair	Present	At crossing	Present
45	2I	W0698 7144	10m	None - Poor	Fair	Fair	Present	At crossing	Present
46	2I	W0702 7145	10m	Poor	Poor - Fair	Poor - Fair	Absent	c.150	Absent
47	20	W0903 7322	None (existing bridge no instream works)	Fair - Good	Fair - Good	Fair	Present	At crossing	Present

* In the absence of mitigation

** Precautionary principle applied

Table 10.19: Summary of Significance of Potential Impacts Without Mitigation

Potentially Impacted Watercourse	Impacts During Construction			Long-Term Impacts		
	Suspended Solids Pollution*	Other Pollutants	Nutrient Inputs	Potential Loss of Habitat	Obstruction to Movement of Aquatic Fauna	Pollution in Run-Off
Roughty River Main Channel 1	Major	Major	Moderate	Moderate	Major	Moderate
Tributary 2A	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Tributary 2B	Minor	Minor	Minor	None	None	Minor
Tributary 2C	Minor	Minor	Minor	None	None	Minor
Tributary 2D	Moderate	Moderate	Minor	Minor	None	Moderate
Tributary 2E	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 2F	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 2G	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 2H	Moderate	Moderate	Minor	Moderate	Minor	Moderate
Tributary 2I	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 2J	Moderate	Moderate	Minor	Moderate	Minor	Moderate
Tributary 2K	Minor	Minor	Minor	Minor	Minor	Minor
Tributary 3	Minor	Minor	Minor	None	None	Minor
Tributary 4	Minor	Minor	Minor	None	None	Minor
Tributary 5	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 6	Moderate	Moderate	Minor	None	None	Moderate
Tributary 7	Moderate	Moderate	Minor	None	Minor	Moderate

Potentially Impacted Watercourse	Impacts During Construction			Long-Term Impacts		
	Suspended Solids Pollution*	Other Pollutants	Nutrient Inputs	Potential Loss of Habitat	Obstruction to Movement of Aquatic Fauna	Pollution in Run-Off
Tributary 8	Moderate	Moderate	Minor	None	Minor	Moderate
Tributary 9	Moderate	Moderate	Minor	None	Minor	Moderate
Tributary 10	Moderate	Moderate	Minor	None	Minor	Moderate
Tributary 11	Moderate	Moderate	Minor	None	Minor	Moderate
Tributary 12	Minor	Minor	Minor	Minor	Minor	Minor
Tributary 13	Moderate	Moderate	Minor	None	None	Moderate
Tributary 14	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 15	Moderate	Moderate	Minor	Moderate	Moderate	Moderate
Tributary 16	Minor	Minor	Minor	Not Significant	Not Significant	Minor
Tributary 17	Moderate	Moderate	Minor	None	None	Moderate
Tributary 18	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Tributary 19	Moderate	Moderate	Moderate	Minor	Minor	Minor
Tributary 20	Moderate	Moderate	Moderate	None	None	Moderate
All other watercourses	Minor	Minor	Minor	Not Significant	Minor	Not Significant

* With the exception of substantial bog failure, in which case major impact would occur in downstream waters.

Obstruction to Upstream Movement of Aquatic Fauna due to Culverting

Twenty two of the 45 stream/river crossings are likely to have trout present at the crossing point and 19 of these are likely to have trout present upstream, thereby likely to constitute an obstruction to upstream fish movement in the absence of adequate mitigation (i.e. crossings 1, 2, 14, 15, 18, 19, 24-27, 30, 32, 33, 37 & 41-45).

In addition, tracks will cross streams/rivers at 23 other locations and will cross a significant number of site drains with the potential to cause habitat fragmentation. Habitat fragmentation, the splitting of natural habitats and ecosystems into smaller and more isolated patches, is recognised as one of the most important global threats to the conservation of biological diversity. Effective watercourse protection requires consideration of the needs of all species, including invertebrates and insects, fish, amphibians such as frogs and newts, and mammals such as otters. Streams and the interconnectedness of different parts of a stream or watershed are essential to these animals. For reasons as simple as escaping random disaster or as complex as maintaining genetic diversity, animals living in or along streams, ephemeral watercourses and linear wetlands need to be able to move unimpeded through the watershed.

10.2.3 Impacts on Conservation Sites

There are no Natura 2000 sites within 15 km of any part of the site that have a hydrological connection to the wind farm. The nearest site is the Kenmare River SAC (Site Code 00215) toward the western side of the study area. This site will not be adversely impacted by the development.

10.2.4 Cumulative Impacts on NATURA 2000 Associated with Underground Cable

The potential impacts on aquatic ecology of the provision of the underground cable connection from Coomataggart to Ballyvouskill is presented in Section 11 herein. The impact of the underground cable on the receiving aquatic environment was assessed as being minor, adverse and temporary. In that context, no cumulative impacts will arise

Further to the above, whereas the overall length of the cable route is approximately 31 km, only approximately 7 km of this is within the Roughty River catchment.

10.3 MITIGATION

10.3.1 Mitigation - Suspended Solids Pollution

General Recommendations

Total suspended solids in discharges to all mapped streams & rivers (see Figure 10.1) will not exceed levels that could cause significant impacts to downstream populations of Freshwater Pearl Mussels. The limits to be applied to all discharges to surface waters and/or to downstream receiving waters will be established in consultation with the relevant expert scientists in the National Parks & Wildlife Service. Subject to this requirement a maximum limit of 25 mg/l will apply for suspended solids in all direct discharges to mapped watercourses. Drains receiving runoff will not exceed these limits at the point where they join the mapped streams/rivers.

The following recommendations are made from the aquatic ecological perspective and it is recognised that the specific means by which suspended solids in discharges to streams will be prevented from exceeding limits set is a matter of detailed engineering design

The key factors in erosion and sediment control are to intercept and manage off- and on-site runoff, and maximise the distance between construction areas and sensitive

watercourses. This limits the potential for soils to be eroded and enter streams in runoff. Runoff and surface erosion control is more effective and less expensive than control with sediment control ponds only.

The following general guidelines for erosion and sediment control, which are largely based on Goldman *et al* (1986), will be followed:

- Schedule development close to watercourses to minimise risk of potential erosion by, where possible, planning construction activities during drier months, halting construction during periods of heavy precipitation and run-off to minimise soil disturbance, and restrict vehicular and equipment access or provide working surfaces/pads.
- In-stream works and any other works with a high risk of suspended solids pollution to streams will not be carried out in the period October - April.
- Retain existing vegetation where possible and physically mark clearing boundaries on the construction site.
- Revegetate denuded areas, particularly cut and fill slopes and disturbed slopes as soon as possible. Use mulches or other organic stabilisers to minimise erosion until vegetation is established on sensitive soils. However, it should be noted that re-sodding is essential on upland and lowland peatlands, and all other upland sites, as reseeding is likely to be unsuccessful and exposed peat is liable to erode. Non-development site vegetation will not be introduced on semi-natural sites such as peatlands. (DOEHLG 2006)
- Divert runoff away from denuded areas.
- Minimise the length and steepness of slopes where possible.
- Minimise runoff velocities and erosive energy by maximising the lengths of flow paths for precipitation runoff, constructing interceptor ditches and channels with low gradients to minimise secondary erosion and transport, and lining unavoidably steep interceptors or conveyance ditches with filter fabric, rock or polyethylene lining to prevent channel erosion.
- Retain eroded sediments on site with erosion and sediment control structures such as sediment traps (mobile or constructed), silt fences and sediment control ponds.
- Access roads will be constructed or topped with a suitable coarse granular material/non-woven geotextile.
- No stream diversions are proposed. However, in the case of temporary watercourse diversions (such as to facilitate culvert installation), the diversion will be excavated in isolation of stream flow, starting from the bottom end of the diversion channel and working upstream to minimise sediment production. The temporary channel will be constructed in such a way as to minimise suspended solids released when the river is re-routed. Upon completion the bank will be stabilised around the temporary diversion.
- Other than single span temporary bridges with no in-stream structures, no temporary stream crossings or temporary culverting will take place without the prior agreement of IFI.
- Machinery will never cross a watercourse by entering it, e.g. at fords.

10.3.2 Mitigation – Turbines, Trenches and Tracks

The following are recommended:

- The drainage system with settlement ponds, soak-aways and interceptor drains will be installed prior to any excavation work along access tracks to be constructed.
- Settlement ponds/ silt traps will be installed towards the end of drainage channels. However, where practicable these will not be closer than 100 m to the receiving watercourse.
- Machinery and vehicles used in track construction will be operated from the track as it is constructed and trench digging machinery will be operated from bog mats where appropriate.
- Surface vegetation turves will be laid out, stored and watered for restoration use after construction, in suitably designated areas. The stored turves will be used to reinstate turbine foundations, etc. following construction.
- If during excavation, spoil is to be stored or is likely to fall onto the adjacent bog surface, the bog surface will be protected with shuttering boards or geotextile.
- At locations where excavated materials are stored, French drains will surround and intercept surface runoff from materials mounds and distribute this water to the controlled drainage system in place.
- Works with a high risk of suspended solids pollution to streams will not be carried out between the end of September and the end of April.
- All electrical and communications cabling will run underground alongside the site tracks. The cable trench will be dug to a width of approximately 0.5 m. The excavated material will be laid alongside the trench for use in reinstatement following the laying of the cables. Silt runoff from excavated material to surface waters will be prevented using methods outlined above, and any water pumped from trenches will be passed through a suitable silt removal facility before discharge to surface waters.
- Works on the bridge over the Sillahertane Stream may include bridge strengthening works. As salmon and Freshwater Pearl Mussel are present within a few hundred metres downstream of the bridge, instream works will be avoided and special measures to prevent contamination of the Sillahertane Stream with debris, suspended solids and other pollutants will be adopted. A method statement will be agreed in advance with IFI.

10.3.3 Mitigation - Pollution With Nutrients Due To Ground Disturbance

Most of the potential nutrient input to streams during peatland disturbance and forest harvesting is bound to suspended soil particles. The measures outlined elsewhere apply equally to prevention of nutrient inputs to streams.

10.3.4 Mitigation - Contamination With Other Substances

The following guidelines will be followed:

- Raw or uncured waste concrete will be disposed of by removal from the site.
- Only ready-mixed concrete will be used during the construction phase, with all ready-mixed concrete being delivered from batching plants in sealed concrete

delivery trucks.

- Only the chute of the concrete delivery truck will be cleaned on site, using the smallest volume of water necessary. Concrete trucks will be directed back to their batching plant for washout. Before release to the environment rinse down water will be treated to a level which will ensure that total suspended solids in discharges to any watercourses will not exceed the limit agreed with IFI and NPWS for the protection of salmon, trout and Freshwater Pearl Mussels. Wash out water will not be released to the environment until it has reached a neutral pH .
- So as to avoid spillage concrete will not be transported around the site in open trailers or dumpers. All concrete used in the construction of turbine bases will be pumped directly into the shuttered formwork from the delivery truck.
- The arrangements for concrete deliveries to the site will be discussed with suppliers before commencement of work, agreeing routes, prohibiting on-site washout and discussing emergency procedures.
- Clearly visible signs will be placed in prominent locations close to concrete pour areas, stating that washout of concrete lorries is not permitted on the site.
- Large concrete pours will be avoided where prolonged periods of heavy rain are forecast and covers will be available for freshly placed concrete to avoid the surface washing away in heavy rain.
- Wash down water from exposed aggregate surfaces and cast-in-place concrete will be trapped on site to allow sediment to settle out and reach neutral pH before clarified water is released.
- Fuels, lubricants and hydraulic fluids for equipment used on the construction site will be carefully handled to avoid spillage, properly secured against unauthorised access or vandalism, and provided with spill containment according to best codes of practice. (Enterprise Ireland BPGCS005).
- Fuelling and lubrication of equipment will be carried out in a specially bunded area.
- Any spillage of fuels, lubricants or hydraulic oils will be immediately contained and the contaminated soil removed from the site and properly disposed of.
- Waste oils and hydraulic fluids will be collected in leak-proof containers and removed from the site for disposal or re-cycling.
- Cranepads may serve as a storage areas for materials, e.g. reinforced steel, during construction and runoff will be to a drainage system that incorporates silt removal.
- Prior to any work close to watercourses it will be ensured that all construction equipment is mechanically sound to avoid leaks of oil, fuel, hydraulic fluids and grease.
- All pumps using fuel or containing oil will be locally and securely bunded when situated within 25 m of waters or when sited such that taking account of gradient and ground conditions there is the possibility of discharge to waters.
- Where site works involve the discharge of drainage water to receiving surface waters, temporary oil interceptor facilities will be installed and maintained.

- Appropriate spill control equipment, such as oil soakage pads, will be kept at the site to deal with any accidental spillage and emergency response procedures will be put in place.
- Foul drainage from site offices etc. will be directed to an enclosed system for removal to a suitable off-site treatment facility.

10.3.5 Mitigation - Miscellaneous Impacts

Location of Temporary Facilities

In general, such sites will be located as far as is practicable from watercourses and at a minimum distance of 100 m. Disposal of spoil will not be carried out in any location where runoff into watercourses can occur.

Method Statement / Environmental Operating Plan

The Contractor will draw up a Construction Environmental Management Plan (CEMP), which will include all of the avoidance and detailed mitigation measures as outlined. This Plan will be strictly adhered to by the contractor and will detail how the effectiveness of these mitigation measures will be monitored. There will be ongoing consultation with NPWS and IFI throughout all phases of the works. A mechanism for reporting of pollution incidents will be agreed in advance between the contractor(s) and the developer.

In addition, the Contractor will be required to consult with the NPWS and IFI in relation to the final detail of the Plan and will include their requirements in this regard.

Before earthworks commence on site and before they are needed, erosion control and sediment control measures will be in place and functioning, and will be inspected and approved by the Ecological Clerk of Works (EcOW).

Ecological Clerk of Works

An Ecological Clerk of Works (EcOW) will be employed who will make at least weekly site visits for the duration of the construction works and more frequently at start-up, decommissioning and during critical construction events such as concrete pours as outlined below.

The EcOW will be the liaison in consulting environmental bodies including the NPWS and IFI. The EcOW will be responsible for carrying out regular audits of the Contractor's CEMP and will be the primary person involved in the developer's monitoring role. The EcOW will be delegated sufficient powers so that he/she will be authorised to instruct the contractor to stop works and to direct the carrying out of emergency mitigation/clean-up operations.

The Ecological Clerk of Works will be supported by an independent Project Ecologist to provide advice as necessary on all matters relating to ecology. The Project Ecologist will be engaged prior to the commencement of any works and oversee audit of mitigation measures, which will carried out at least once each week throughout the course of construction and more frequently at critical times. In addition, the EcOW will maintain a register indicating whether all mitigation measures have been carried out satisfactorily. This register will be signed off by both the Project Ecologist and a representative of the contractor.

In addition to the ongoing and detailed monitoring carried out by the contractor as part of the CEMP, the EcOW will carry out the inspection/ monitoring regime described below on behalf of the Client. The results will be retained by the EcOW and will be available for inspection / audit by the Client, NPWS or IFI staff. The main elements of the inspection/

monitoring regime will be as follows:

- Inspect surface water treatment measures (silt fencing, ponds, tanks, mini-dams, sandbags, etc.) on a daily basis.
- Daily visual inspection of the watercourses in proximity to the works.
- Wheel wash facilities will be inspected on a weekly basis.
- Stockpiles will be monitored on a daily basis while being filled or emptied and otherwise on a weekly basis.
- Control measures for works at or near water bodies will be inspected on a daily basis.
- Concrete operations at or near watercourses will be supervised and designated chute washing out facilities will be inspected on a daily basis.
- Site Compounds will be inspected on a weekly basis.
- Inspection of attenuation ponds, their release systems and other attenuation features such as silt traps etc.
- The Contractor's CEMP monitoring results will be audited on a frequent basis (weekly at a minimum).

Where the EcOW has carried out an investigation of a release of sediment to a watercourse causing a plume, the following procedure will be followed:

- The relevant NPWS and IFI staff will be notified immediately.
- The discharge generating the sediment discharge will be stopped immediately.
- The contractor will be required to take immediate action and to implement measures to ensure that such discharges do not recur.
- Works will not recommence until appropriate corrective measures to avoid any repetition are put in place. Such measures will be agreed with the EcOW following consultation with NPWS and IFI and will be in accordance with the requirements of these control measures.
- Where the discharge is from one of the control measures the discharge will not recommence until written consent is received from the EcOW.
- Where the EcOW considers that the risk of a sediment release is high, he / she will inform the contractor and request protective action to be taken. Where the contractor does not take immediate action the EcOW will instruct the contractor to take action and same will be reported to the Contract Manager and the Client.
- The EcOW will be delegated with sufficient powers for these instructions to be issued and for an instruction to stop works or carry out emergency works.

Procedure for Contractors

Contractors will be required to establish contact with IFI before works commence, with ongoing liaison throughout the construction process. Contractors will be in possession of, and familiar with the contents of "*Control of water pollution from construction sites - Guidance for consultants and contractors*" published by the Construction Industry Research and Information Association (CIRIA 2001) (e-mail enquiries@ciria.org.uk).

10.3.6 Mitigation - Long-Term Aquatic Impacts

Pollution of Watercourses

The following is recommended:

- Kerbs will be incorporated into the design of the bridges/crossings to prevent roadway run-off directly into streams.
- A sustainable drainage system will be installed on the new tracks, which will prevent significant pollution to surface receiving waters. The system installed will have a proven capability of achieving and sustaining at least an 85% reduction of suspended solids in runoff.
- As virtually all treatment options require proper maintenance in order to function properly, and as some can become a source of pollution if not properly maintained, a programme of regular cleaning, maintenance and inspection of the road runoff treatment system will be adopted to ensure it functions correctly.
- Only competent rock that is not subject to mechanical breakdown will be used in construction of access. Capping and regular maintenance of access tracks on site will be carried out to ensure heavily trafficked areas are not allowed to degrade either during the construction phase or thereafter during the operational phase of the project.

Hydrological Impacts

The following is recommended:

- Flow attenuation will be included in the road drainage design if necessary to ensure that no significant increase in peak stream/river flows is caused by the proposed development.
- Natural drainage patterns will be restored after the completion of road construction by allowing surface drainage to pass under the proposed new road at closely placed intervals, corresponding with existing natural drainage lines.
- Where necessary to avoid bank erosion and significant changes to watercourse flow patterns, energy breaks will be installed to reduce the velocity of the outfalls from drains to receiving waters.
- Water abstraction from watercourses for any purpose should only take place at locations, in a manner and during a time period agreed with IFI.

Habitat Loss

One of the most effective methods of minimising loss of stream and riparian habitat during developments such as track construction etc. is the establishment of of Leave Strips. Leave strips are the areas of land and vegetation adjacent to watercourses that are to remain in an undisturbed state, throughout and after the development process (Chilibeck *et al* 1992). Leave strips are valuable not only because riparian vegetation is a vital component of a healthy stream ecosystem, but because this vegetation acts as an effective screen/barrier between the stream and the development area, intercepting runoff and acting as an effective filter for sediment and pollutants from the development area. Where development is to take place close to rivers/streams, a riparian leave strip at least 20m wide will be clearly marked and its significance explained to machinery operators.

Obstruction to Upstream Movement of Aquatic Fauna

Tracks have been designed and will be constructed in such a way as to ensure that watercourses remain passable for aquatic fauna. In that context IFI has stated as follows:

> "*It is a fishery requirement that span type structures which do not interfere with the bed or immediate bank of the river are introduced on all fishery waters to insure fish passage, flow and river bed substrates are not interfered with.*"

Single span structures with no in-stream structures and supports set back from stream bank will be provided at all stream crossings where significant salmonid habitat, i.e. fair or better, has been recorded.

The following guidelines will be taken into consideration when designing permanent culverts at non fishery watercourse crossings including drains:

- Ideally, a culvert will not change the hydrological conditions that existed prior to that installation. This means that the cross-sectional area will not be restricted by the culvert, the slope will not change, and the roughness coefficients will remain the same. Any change in these conditions will result in a velocity change which could alter the sediment transportation capacity of the watercourse.
- Aquatic fauna passage problems can usually be avoided if culverts are constructed without a bottom or are installed well below stream grade.
- Culverts will be installed at the stream gradient otherwise they may result in a change in water velocities which may create a drop below the culvert or may create a hydraulic jump at the end of the culvert.
- Culverts will not be aligned so that culvert outflows are directed into a watercourse bank.
- The culvert will be installed so that it has a constant slope through its length except for the appropriate camber allowance where settlement is anticipated.
- If pipe culverts are used, the culvert diameter will be at least 1.2 times the bankfull width of the stream + 0.5 m and culverts will be embedded to a depth of at least 25% of the pipe diameter.
- If box culverts are used they will be embedded at least 300 mm below the existing stream bed with cross walls not less than 80 mm to collect natural streambed material.
- Gabions will not be used as support structures or for bank protection as they are incompatible with the environment at this location, as they do not easily recolonise with native flora and fauna and tend to slump over a period of time. Rock armour using local stone is a more sustainable alternative.

The crossing methods outlined in Table 10.20 are recommended.

Table 10.20: Watercourse Crossings

Recommended Crossing Type	Watercourse Crossing
Span structure or Fauna Passable Culvert	3, 4, 6, 7, 9-13, 16, 17, 20-23, 28, 29, 34-36, 38-40
Span structure which does not interfere with the bed or immediate bank of the river/stream	1, 2, 5, 8, 14, 15, 18, 19, 24-27, 30-33, 37, 41-45

10.3.7 Monitoring

A biological and chemical monitoring system will be put in place on potentially affected streams, including as a minimum at watercourses 1, 2A, 2D, 2E, 2F, 2G, 2H, 2I, 2J, 2K, 5, 7, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19 & 20 (Figure 10.1).

As a minimum the monitoring system will measure Q-value, suspended solids, molybdate reactive phosphorus & pH.

Chemical analysis will be carried out only at laboratories that have been accredited by EPA for the analyses to be carried out.

Biological water quality assessment will be carried out only by operatives that have inter-calibrated their Q-ratings analysis with EPA.

Continuous automated online monitoring of suspended solids will be carried out at key locations agreed with NPWS & IFI. This monitoring includes four sites shown on Figure 10.6.

A statistically meaningful baseline of conditions will be established prior to the commencement of construction works. In particular, the online monitoring of suspended solids will commence at least 12 months prior to the commencement of construction work in order to determine the existing profile of suspended solids in the Roughty system.

Details of the monitoring system, including duration, frequency of sampling, monitoring locations, and parameters to be monitored will be agreed in advance with IFI and NPWS.

10.4 CONCLUSIONS

If all mitigation measures are fully implemented, the residual impact of the proposed development will be minor.

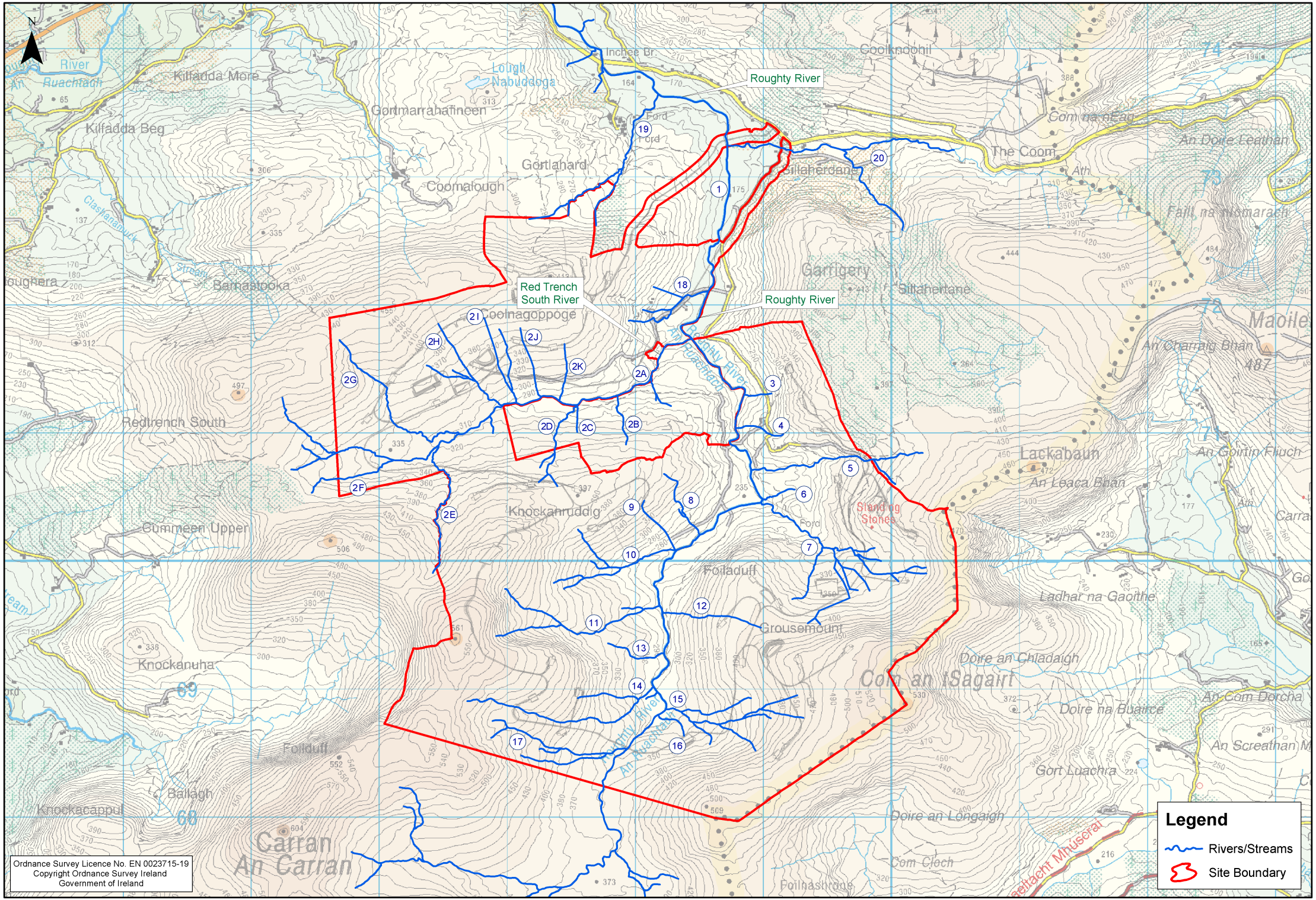

Figure 10.1 - Potentially Affected Watercourses

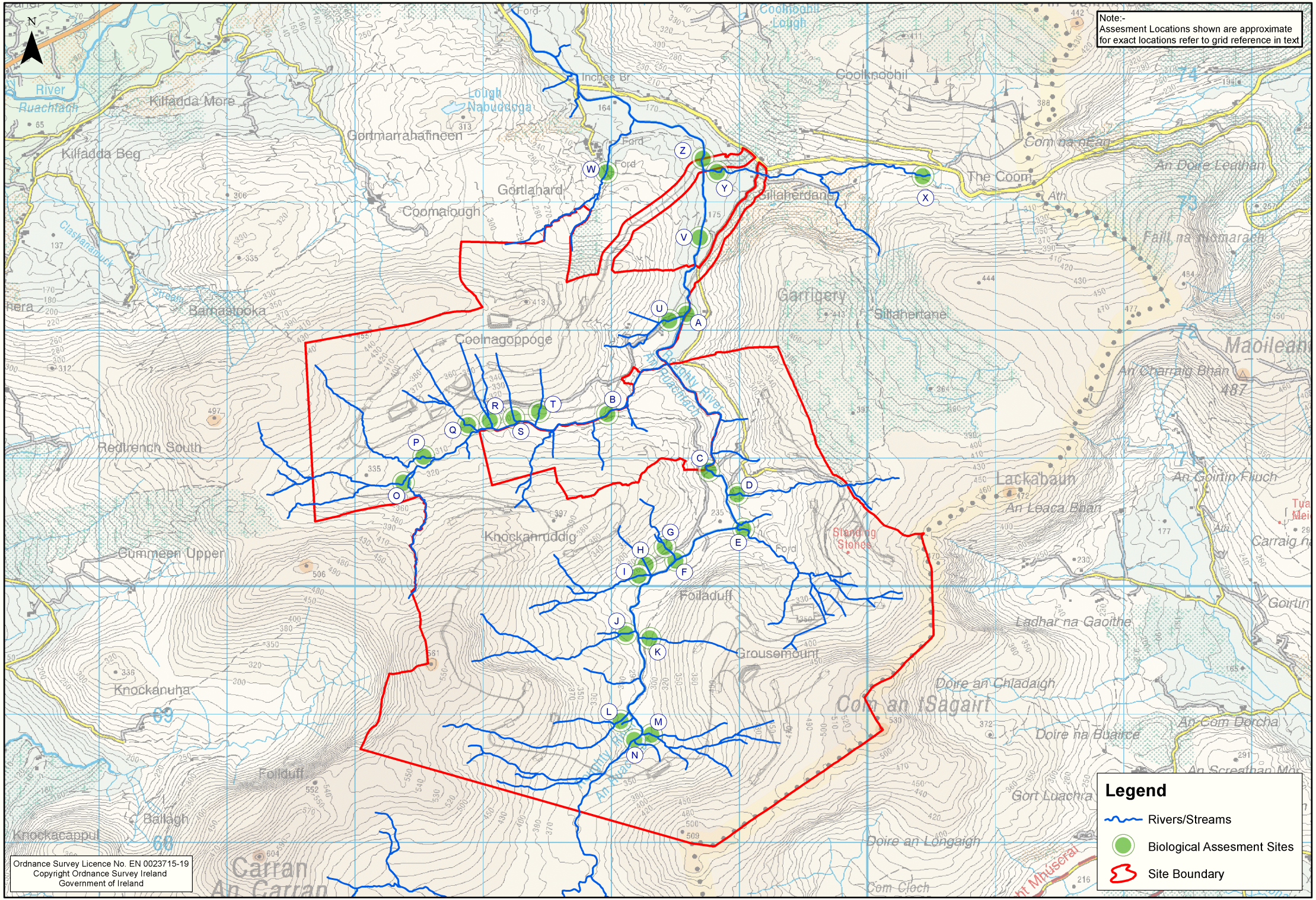

Figure 10.2 - Biological Assesment Sites

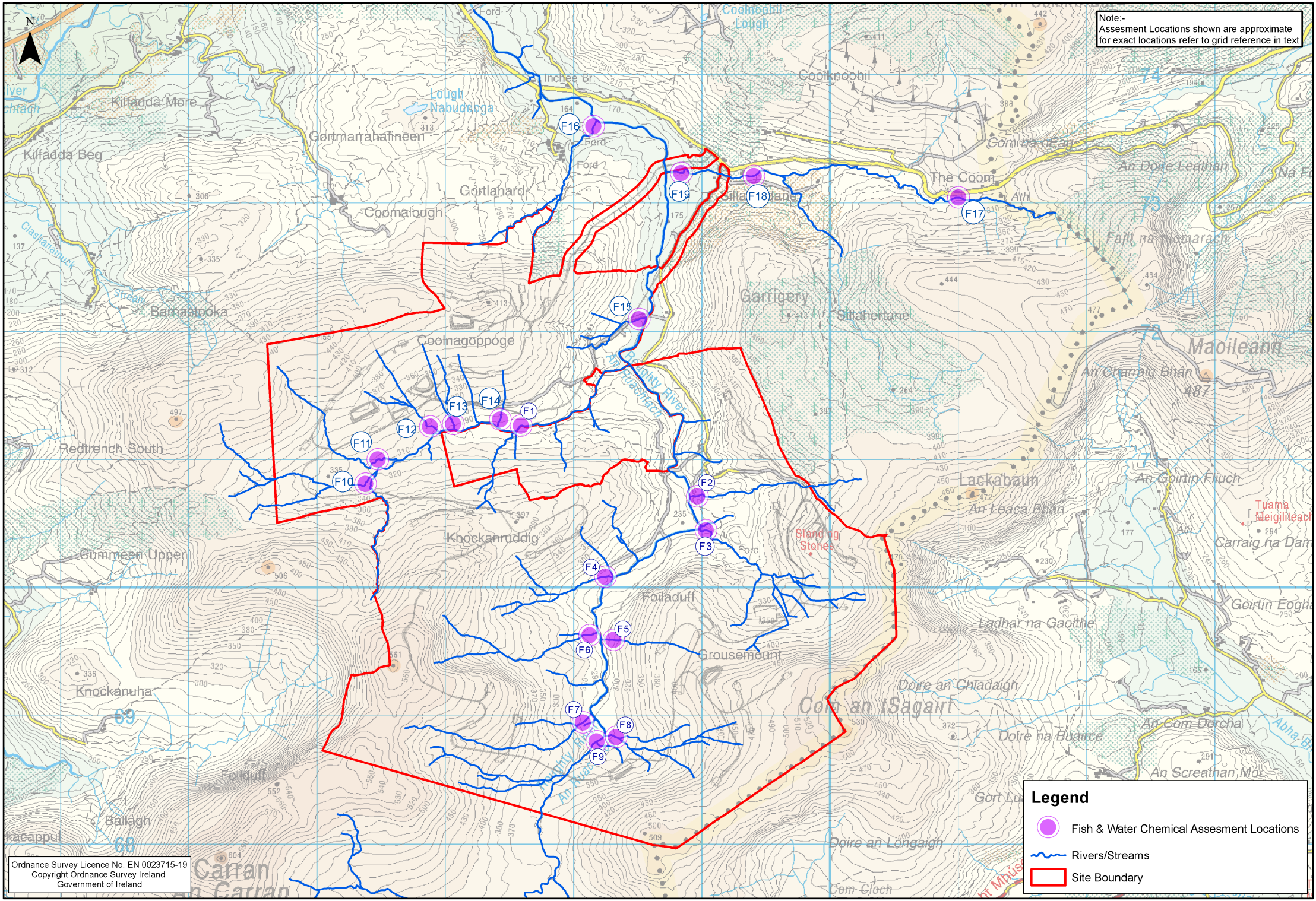

Figure 10.3 - Fish & Water Chemical Assesment Locations

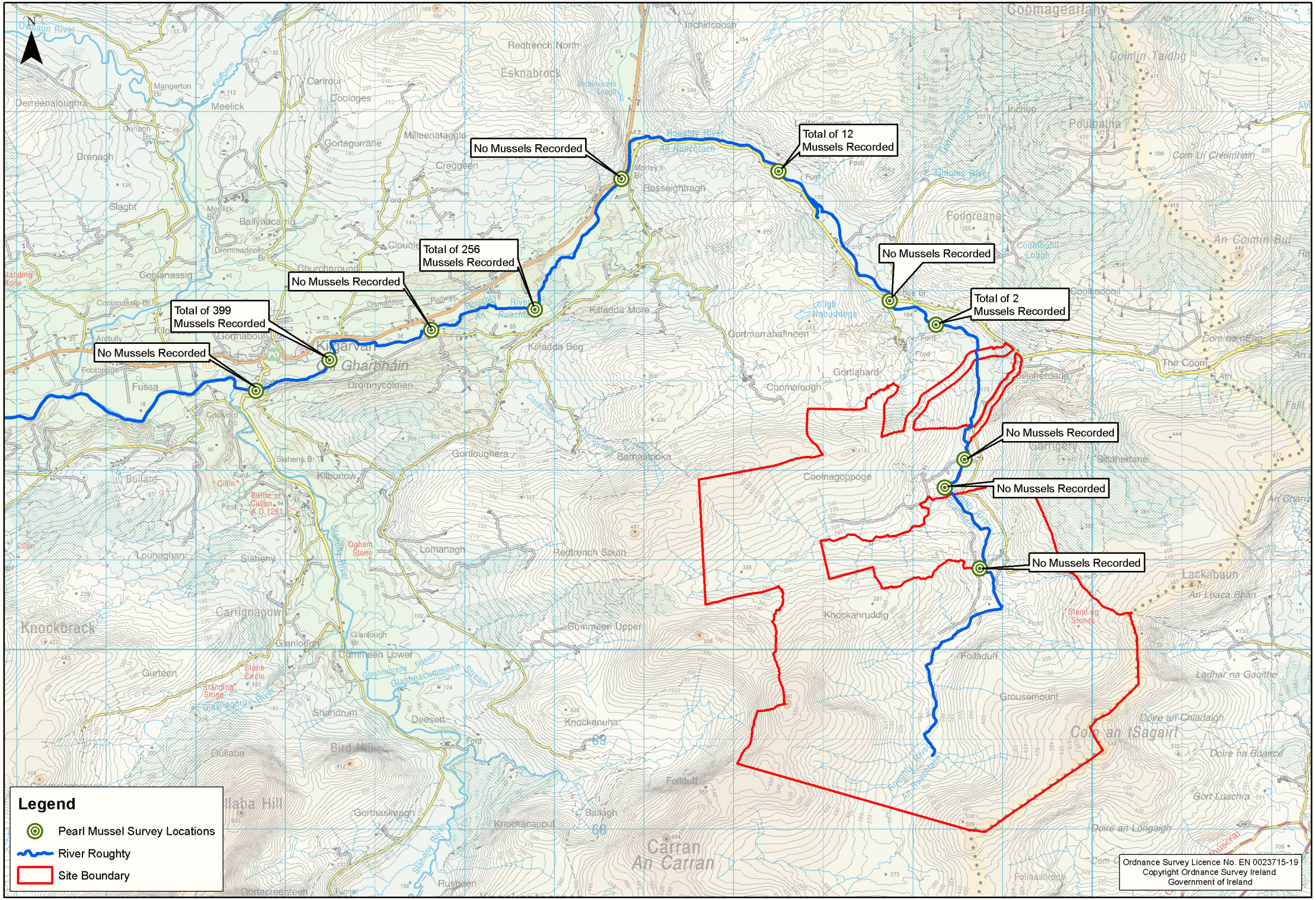

Figure 10.4 - Result of Mussel Survey August 2015

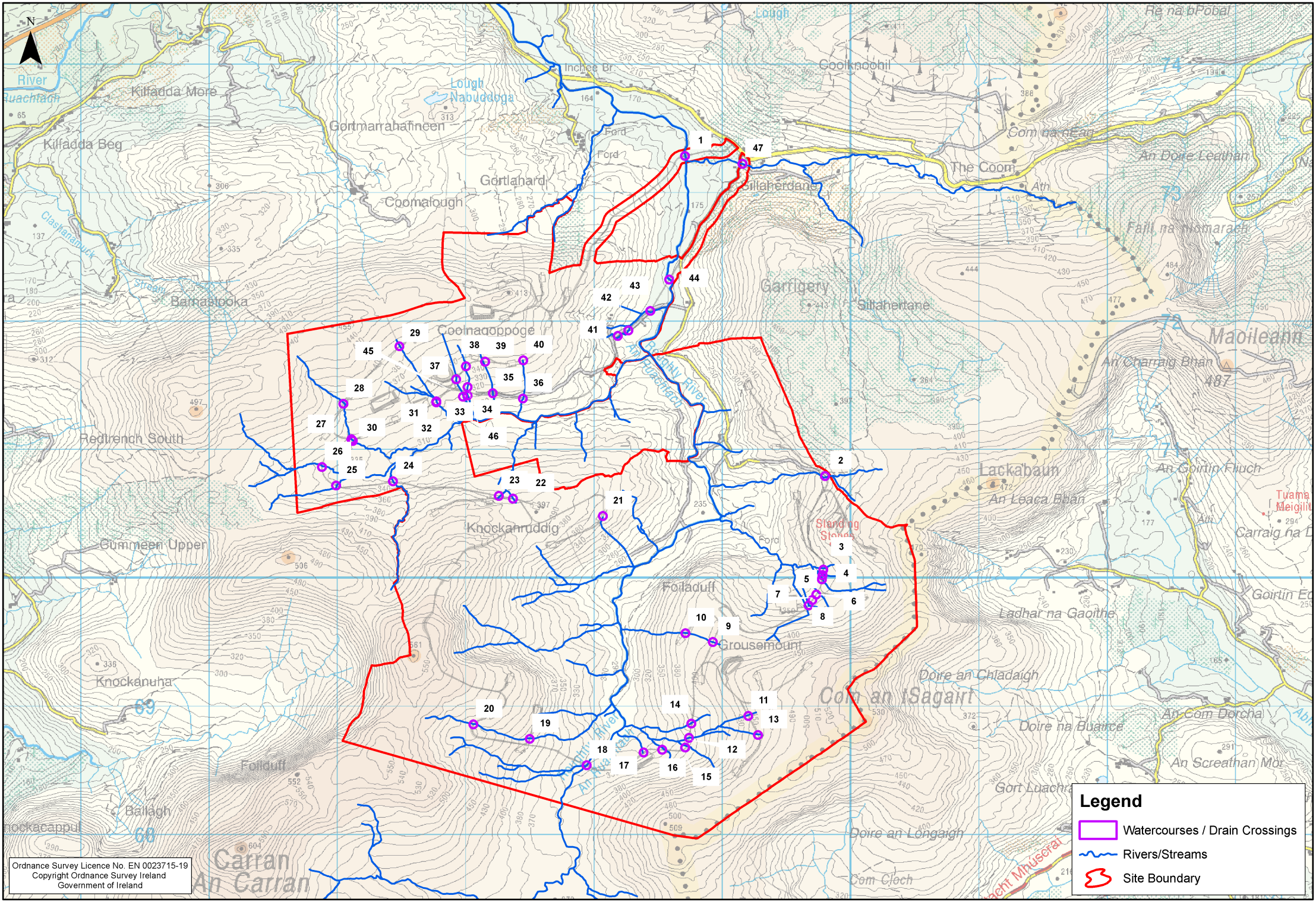

Figure 10.5 - Watercourses / Drain Crossings

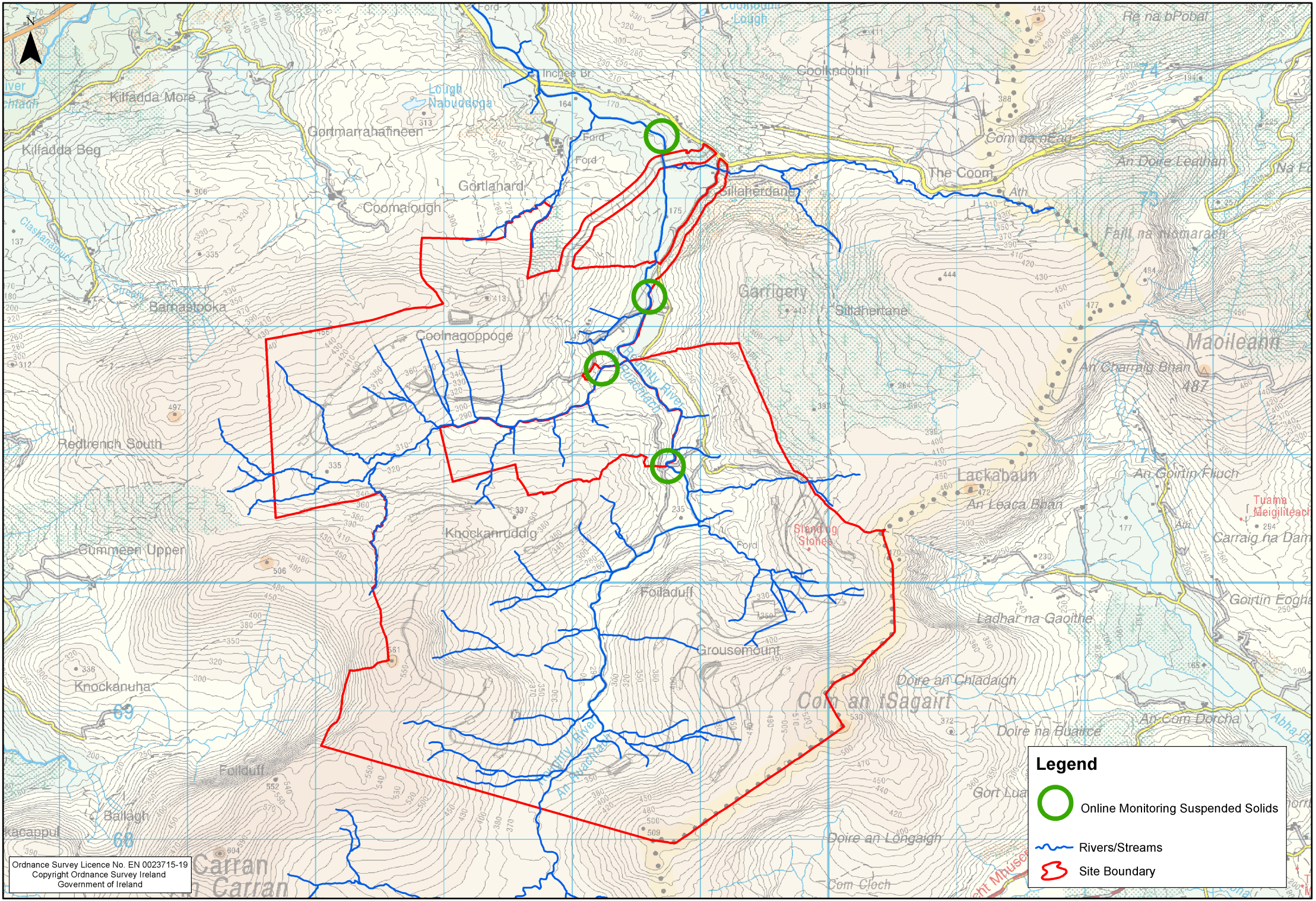

Figure 10.6 - Continuous Online Monitoring of Suspended Solids