Appendix K

Fresh Water Ecology Assessment Report

CORRIB ONSHORE GAS PIPELINE

Freshwater Ecology

January 2009

Aquatic Services Unit

1 - INTRODUCTION

1.1 - Overview

Aquatic Services Unit (ASU) was commissioned by RPS to undertake a freshwater ecological impact assessment for the proposed Corrib Onshore Gas Pipeline. In fulfilment of this work ASU undertook (i) a desk study examining existing data and reports on the freshwater ecology along the proposed route, (ii) consulted with fisheries and conservation bodies and (iii) undertook focused fieldwork along the route of the proposed development. The scope of the ASU study included an assessment of the freshwater habitats and freshwater and migratory freshwater species such as Atlantic salmon and lamprey species.

The key areas of potential impact of the proposed development on the freshwater habitats and associated migratory fish and protected species (lamprey) relate to the construction phase and the commissioning phase of the proposed development. Once in operation, there will be no impacts on freshwater resources.

This report describes the existing environment from a freshwater ecological perspective, outlines the methodology used to assess the existing environment, lists the potential impacts (including residual impacts) associated with the proposed development and recommends mitigation measures to avoid/minimise these impacts.

2. Methodology

The methodology employed for this freshwater ecological assessment comprised the following elements:

- A desk study examining existing data and reports of the freshwater ecology along the proposed route;
- Consultation with fisheries and conservation bodies; and
- Fieldwork along the route of the proposed development.

2.1 - Desk Study

The following reports and information sources were examined as part of the freshwater desk study:

- Aquens Ltd. (2003) *Electrofishing operations in the northern region of the Ballina fishery area, Co. Mayo (Year 3)* - Report to Enterprise Energy Ireland Ltd.;

- Aquens Ltd. (2002) *Electrofishing operations in the northern region of the Ballina fishery area, Co. Mayo*. (Authors: R. Lyons, M. Kelly Quinn and J. Bracken). Report to Enterprise Energy Ireland Ltd.;

- North West Regional Fisheries Board, (2005) *An examination of the causes and factors related to the recent eutrophication of Carrowmore Lake.* Internal Report, North Western Regional Fisheries Board, Ballina.;

- Russell Poole, Elvira deEyto, Bryan Kennedy & Mary Dillane (2005) *Results of a survey of the freshwater salmonid habitat of sub-reaches within the Owenmore River System 2005 A report prepared for Shell E&P Ireland Limited.* The Marine Institute and the North Western Regional Fisheries Board.;

- EPA's On-line publications on river water quality: http://www.epa.ie/;

- Central Fisheries Board on-line publications into its fisheries investigations in Irish Estuaries (METRIC programme) including Sruwaddacon Bay http://www.cfb.ie/fisheries_research/estuaries/sruwaddaconbay.htm;

- National Parks and Wildlife Services (NPWS) publications on lamprey biology and distribution and FW Pearl mussel (*Margaritifera margaritifera)* biology and distributions in Ireland.;

- Discovery Series Ordinance Survey Maps of the region and digitized aerial photographs of the study area upon which the proposed development had been superimposed.; and

- NPWS website showing the boundaries of protected sites and detailed aerial imagery of the study area.

2.2 - Consultation

In preparation of the impact assessment report, ASU consulted the following agencies as part of the fisheries and Annex II species aspects of the Study Area:

- North Western Regional Fisheries Board (NWRFB): Ballina & Bangor Erris Offices, County Mayo;
- Marine Institute: Newport Office, County Mayo;
- Central Fisheries Board: Dublin; and
- National Parks and Wildlife Service (Ballycroy, Co. Mayo).

2.3 Fieldwork

2.3.1 Aims

The aims of the fieldwork were:

(i) To assess the extent and the quality of the habitats at each of the stream crossing points in terms of their bankside and in-channel structure and substrates, their aquatic plant communities and their [1]macroinvertebrate

[1] Macroinvertebrates is the collective name given to the small animals which live in the bed of streams and rivers they include the immature stages and some adult stages of aquatic insects, and the mature stages of aquatic snails, segmented worms, leeches, water mites etc.; they form an important part of the diet of fish.

assemblages, which in turn would determine their uniqueness and sensitivity.

(ii) To determine the presence of Annex II and other fish species using electrofishing means where appropriate.

(iii) To determine water quality based on the EPA's biotic index Q-rating method, which uses collections of aquatic macroinvertebrates to determine the water quality of rivers and streams.

2.3.2 Approach

Using maps and aerial imagery four freshwater rivers and streams were identified along the route of the proposed pipeline. Field surveys of these rivers and streams were carried out in early September 2007 and again in January, September and November 2008 to assess the nature and quality of the habitats present and to assess their water quality. Figure 1 shows the locations of the stream crossing points assessed.

3 EXISTING ENVIRONMENT

3.1 Desk Study

The results of the desk study are presented in the following sections.

3.1.1 General Catchment of the Study Area

From a freshwater ecological perspective, the immediate study area for the proposed route is confined to Sruwaddacon Bay and the rivers and streams draining to it. The most prominent of these watercourses are the Glenamoy and Muingnabo Rivers both of which enter the head of the bay. In addition, there are a few smaller streams, which also drain to the bay. The locations of these watercourses are illustrated on Figure 1.

The proposed route will cross the following watercourses:

(i) A small[2] 1st order stream just east of the landfall at Glengad (Sampling Site 1); This stream will not crossed by the proposed route and although, it lies within the temporary working area, it is not anticipated that any works will occur in this area. However, because of its location it has been considered as part of this assessment
(ii) Lower Sruwaddacon Bay (west to east) (Site 2);
(iii) Upper Sruwaddacon Bay (north west to southeast) (Site 3);
(iv) A small [3]second-order stream draining to the southeast corner of Sruwaddacon Bay, known locally as the Leenamore River in the townland of Aghoos. (Sampling Site 4);

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[2] A first order stream is one at or close to the head of a catchment or sub-catchment which has not yet been joined by other tributaries. They tend to be very small.
[3] A second-order stream is formed by the joining of two first-order streams

(v) A 1st order stream close to the roadside about 0.5km east of the most downstream crossing of the Leenamore River (in the townland of Ballygelly South (Sampling Site 5); and

(vi) A small 1st order stream / drain approximately 0.7km north of the Gas Terminal site in the townland of Ballygelly South (Site 6)

These small rivers and streams listed above (Sites 1, 4, 5 and 6) are all of minor ecological and fisheries importance within the wider study area. Sites 5 & 6 lie outside the Glenamoy Bog Complex SAC, however Site 1 and Site 4 lie within the SAC. However, the temporary working area lies within the boundaries of the SAC. The estuarine sites (Sites 2 and 3) are important as migratory routes for Annex II species, Atlantic salmon in particular.

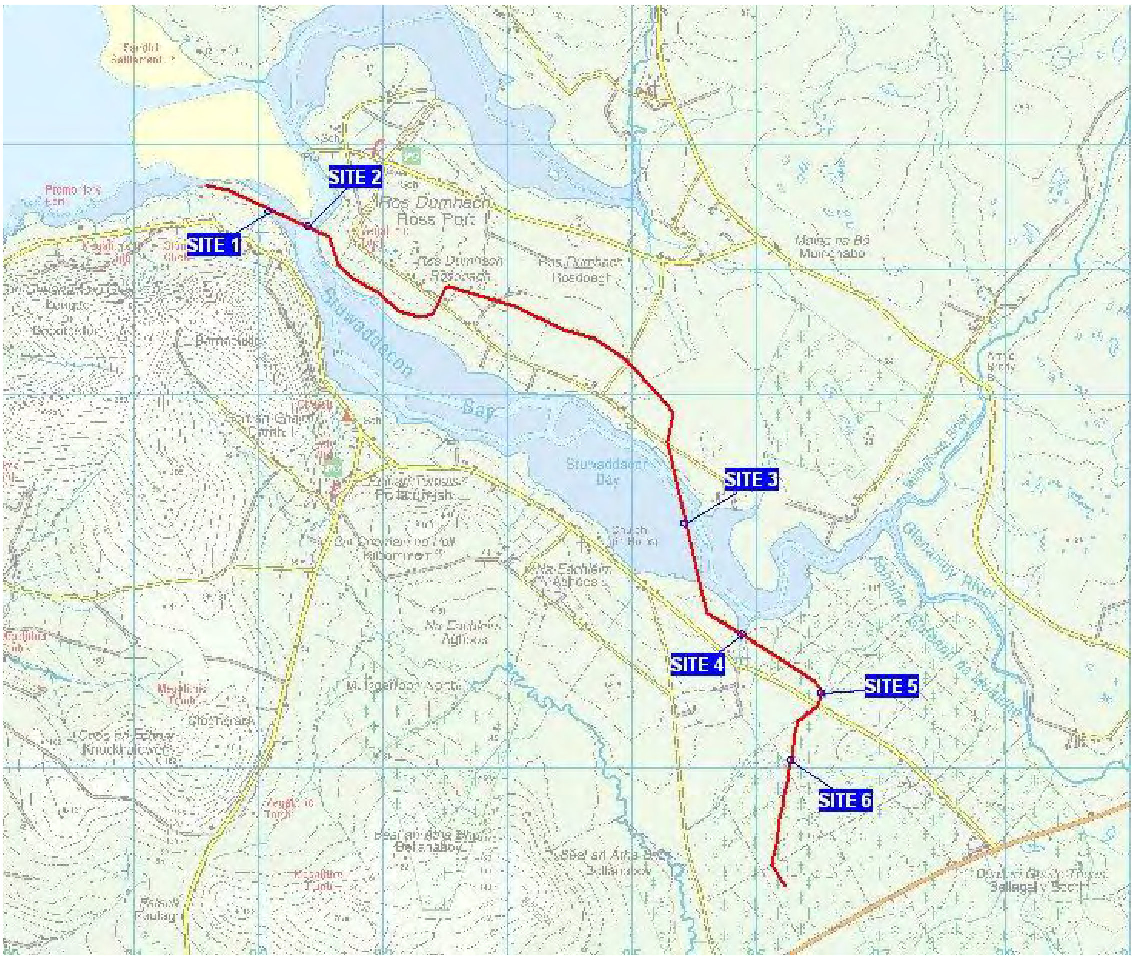

Figure 1 Map showing the positions of watercourse crossing points/sampling sites.

3.1.2 - Land-use

Aerial photography for the proposed route show that to the north of Sruwaddacon Bay and the Glenamoy River, the bulk of the land area comprises blanket bog and upland areas with just pockets of agricultural land (mainly pasture) especially near the coast, near settlements and at the downstream sections of rivers, for example around the upper tidal reaches of the Muingnabo, where there is a large block of plantation forestry to the south of Sruwaddacon Bay. To the south of the Glenamoy River much more of the area is under forestry and pasture, although there are large upland areas west of Pollatomish and north of Carrowmore Lake where cultivation of any sort is also sparse.

3.1.3 Conservation Designated Sites

Sruwaddacon Bay, the Glenamoy River and Muingnabo Rivers are all part of the Glemamoy Bog Complex Special Area of Conservation (Site Code: 00500). Sruwaddacon Bay is also part of the Blacksod Bay/Broadhaven SPA.

3.1.4 Protected Species

Under the EU Habitats Directive several freshwater aquatic species are legally protected. These are referred to as Annex II species and include among others: Atlantic salmon (*Salmo salar*), the Freshwater Pearl Mussel (*Margaritifera margaritifera*), White-clawed Crayfish (*Austropotamobius pallipes*) and lampreys (3 species). Of these species, only one is definitely reported by Fisheries Board and Marine Institute sources from the general study area, namely Atlantic salmon (from the Glenamoy and Muingnabo Rivers). Of the remaining species, the Brook Lamprey (*Lampetra planeri*), which is non-migratory, is the only lamprey species to have been recorded with certainty in the wider study area i.e. in the Bellanboy River (Poole *et al.*, 2005). However, there have been reports of unidentified lampreys in one of the small streams crossed by the route, namely the Leenamore River (at the Site 4 crossing point) (Aquens, 2003). This species is likely to be Brook lamprey also but could possibly be river lamprey (*L. fluviatilis*) as they are very difficult to tell apart when immature. River lampreys usually enter rivers in early spring to spawn and have also been recorded in the Boyne entering in October-November (pers. comm., CFB). The Central Fisheries Board did not record any lamprey from their phyke net surveys undertaken in October 2006 near the confluence of the Muingnabo and Glenamoy rivers in upper Sruwaddacon Bay.

The others species listed above have not been reported and are unlikely to occur on site. Pearl mussels cannot be entirely ruled out, however, as a small remnant population could possibly exist. Nevertheless, were they to be present, it would tend to be confined to larger rivers and streams in deeper, silt-free waters, indicating that within the study area they would only be possible in the freshwater reaches of the Glenamoy and Muingnabo rivers, i.e. they would not occur in the small streams crossed by the proposed route. So far they are not recorded as occurring in either the Muingnabo or Glenamoy on the national database for the species (pers. comm., Dr. Evelyn Moorkens); furthermore they do not occur in estuarine waters and so would not be present in Sruwaddacon Bay.

White-clawed crayfish only occur in medium to hard water rivers (i.e. with significant levels of calcium carbonate). The essentially soft-water non-alkaline conditions within the study area would indicate that this species is almost certainly absent. Furthermore, it was not encountered during current or previous fieldwork in the study area.

Sea lamprey (*Petromyzon marinus*) is a large species, which would only occur, were it present, in the Muingnabo and Glenamoy Rivers, where it would most likely spawn in the lower or middle reaches. It is a large species and unlikely to go undetected by anglers, which suggests that it does not in fact occur within the study area, from where it has not been reported either by the NPWS or the NWRFB.

3.1.5 Water Quality

The most recent survey published by the EPA in their national monitoring scheme for rivers, which included the rivers in the study area (Hydrometric Area 33), refers to surveys undertaken in 2002 (Clabby, Lucey & McGarrigle, 2002) and prior to that date. These data are published on the EPA web site. The report includes data for the Muingnabo and Glenamoy Rivers, but not for the minor streams that will be crossed by the proposed route.

3.1.5.1 Water Quality Assessment

Water quality is assessed in Ireland using the Biotic Index of Water Quality (BIWQ), developed in Ireland by An Foras Forbartha in the early 1970's and continued by the Environmental Research Unit and in recent years by the Environmental Protection Agency (EPA). Q-values and water quality classes are assigned using a combination of habitat characteristics and structure of the macroinvertebrate community within the waterbody. Individual macroinvertebrate species are ranked for their sensitivity to organic pollution and the Q-value determination is made based primarily on their relative abundance within a biological sample. Table 1 shows the EPA biotic indices and water quality status interpretations (Lucey *et al*., 1999). Samples of macroinvertebrates are obtained using a timed kick-sample method where the streambed is disturbed by the heel of a wader boot and the animals thus disturbed are carried into the pond-net used by the current. The sampling is carried out for two minutes moving from downstream to upstream through shallow riffle habitats. The samples are supplemented by washings of the larger substrate elements (cobbles and boulders) to dislodge animals, which are attached and not easily dislodged by kick-sampling alone.

Table 1 EPA Biotic Index and water quality status interpretations

Biotic Index	Quality Status	Quality Class
Q5, 4-5, 4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, 2-3	Moderately Polluted	Class C
Q2, 1-2, 1	Seriously Polluted	Class D

3.1.5.2. Muingnabo Water Quality

The lower reaches of the Muingnabo river have been surveyed by the EPA in the stretch upstream of Annie Brady's Bridge, (which is named on the Discovery Series O.S. map no. about 3km north west of Glenamoy Village) on four occasions since 1994 and on two of those, including in 2002, the river has been classed as Q3-4 i.e. slightly polluted. On the other two occasions it was classed as unpolluted (Q4), although not pristine. The exact causes of the impaired quality are not known (Clabby, Lucey & McGarrigle, 2002). The Muingnabo catchment is dominated by blanket bog but with some pasture and forestry also present.

3.1.5.3 Glenamoy Water Quality

The lower and middle reaches of the Glenamoy River have been surveyed by the EPA on seven occasions since 1981 and only on one of those occasions was it classed as slightly polluted (Q3-4 in 1994). In 2002 the most downstream site sampled (Glenamoy Bridge) was assigned Q4-5, the second highest value, indicating close to pristine quality conditions. The middle reaches, the Bridge S.E. of Bunalty, had a rating of Q4 (un-polluted, although not pristine) and toward the upper reaches (again in 2002) a rating of Q4-5 was assigned at the Bridge north of Glencarly. The impairment in the middle reaches has been noted previously in 1994 and is believed to relate to channel drainage, but the role of sheep grazing, peat harvesting and forestry activities in the catchment as a whole need to be investigated to pin down the main sources of the problem according to the 2002 survey report (Clabby, Lucey & McGarrigle, 2002).

It is clear from the EPA data that despite some water quality impairment, these two rivers are eminently suitable for salmonid fish.

3.1.5.3 Minor Streams

In general, in the absence of point sources of pollution and intensive agriculture over most of the study area, it would be expected that most of the small watercourses within the study area would have satisfactory water quality, i.e. at worst slightly polluted (Q3-4), but generally better than this. The water quality of the watercourses of the Study Area was assessed and results are presented in Section 3.2.1.

3.1.6 Fisheries Information

3.1.6.1 Fisheries at Glenamoy River

The Glenamoy River (Plate 1) is the most important river within the study area for both salmon and seatrout production and it is the only river, consistently fished with rod and line (pers. comm. NWRFB). In the Glenamoy River, spawning takes place outside of the study area from about 200m downstream of the Post Office at Glenamoy Village all the way upstream, where there are extensive stretches of suitable habitat throughout the system, none of which will be impacted by the proposed development. Below Glenamoy village, the river mainly comprises holding and nursery areas for salmon and trout. Some important holding pools exist between Glenamoy Bridge and the estuary. The most important holding area however, is at the mouth of Sruwaddacon Bay in a deep bend in the river situated upstream of Rossport Pier and seaward of Pollathomaish Pier; elsewhere within Sruwaddacon Bay the channel is considered too shallow to hold many fish (pers. comm. NWRFB). Unlike nearby Carrowmore Lake the Glenamoy is a late river, with adult salmon concentrated here between the 2nd week of June into September but more recently salmon are not appearing until mid-July. Now that driftnetting has been banned at sea (since January 1st 2007) there were signs of more fish returning into the system in

2007 (pers comm., NWRFB). Two draft net licences, which operate at the mouth of Sruwaddacon Bay, have been suspended until further notice. This fishery normally didn't catch salmon until the 2nd week in June even though the licence covered the period May 12th to July 31st.

The fish counters installed by the NWRFB on the outfall from Carrowmore Lake indicate that the [4]smolt run (for salmon and seatrout) is finished by the second week in May and this may be a useful guide to when the run also finishes in the Glenamoy. However, it might be a bit later in this river, given that it is a late river for salmon, with peak adult returns in late summer early autumn.

The timing of seatrout returns is less well defined than that of the salmon but the peak of the seatrout run into Sruwaddacon Bay is roughly mid June to mid July and during this period Pollathomais Pier is a popular angling location, although they are fished from the shore in many places throughout the bay, where the channel is accessible (pers. comm. NWRFB).

The Glenamoy Community Angling Association, which has around 40 active members, controls angling for salmon and seatrout on the Glenamoy River; it also issues permits to visiting anglers. The bulk of the club's angling is conducted from mid-July to October in the freshwater reaches of the river. In 2007 a programme of catch-and-release was in operation and again in 2008. This conservation measure means that all fish taken on rod-and-line have to be returned to the river. The Glenamoy is a spate river, fishing best after floods, especially later in a series of floods as the water clarity improves. Most salmon taken by anglers are [5]grilse of 6-7lbs although larger fish are occasionally taken later in the season. Seatrout range from 1.5-4lbs, mainly 2-2.5lbs.

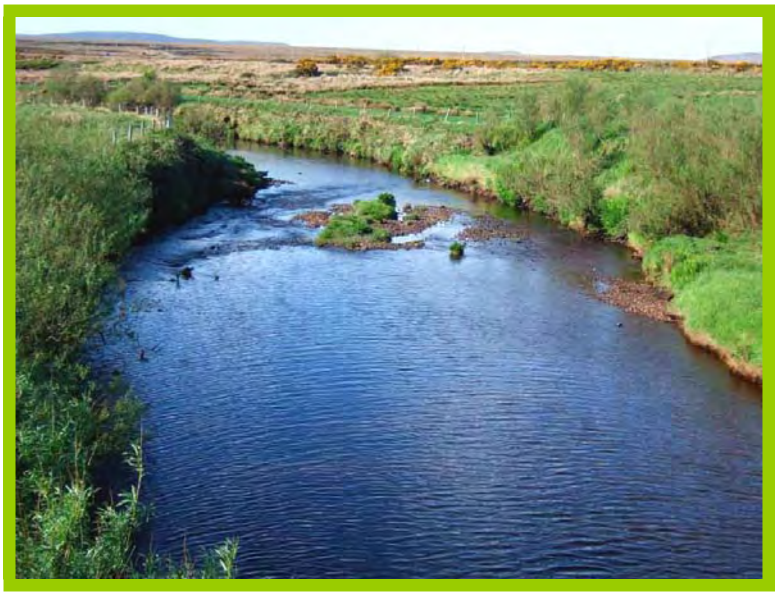

Plate 1 Glenamoy River looking downstream from Glenamoy Bridge about 5km upstream of the proposed crossing of Sruwaddacon Bay.

[4] Smolts are juvenile salmon or seatrout, usually around 2 years old, which have altered physiologically while still in freshwater to allow them to migrate into saline waters.
[5] grilse are salmon which have spent one winter at sea before returning to freshwater

3.1.6.2 Fisheries at Muingnabo River

There is very limited electrofishing data available for the Muingnabo river, and what is available indicates trout to be present (pers. comm., Salmon Research Agency). The hydromorphology of the system as revealed by aerial photos and maps would indicate that the middle and upper reaches are likely to contain spawning areas suitable for both salmon and trout. However, in discussions with NWRFB, it is clear that the river is more important for trout and seatrout than salmon. Some limited angling is believed to occasionally take place in the lower reaches (pers comm. NWRFB), just upstream and downstream of Annie Brady's Bridge (Plate 2) and up until a few years ago nets for poaching were regularly taken from this part of the river. This is usually a sign that a watercourse is reasonably productive for fish.

Plate 2 Muingnabo River looking downstream from Annie Brady's Bridge and about 3km upstream of proposed route crossing in Sruwaddacon Bay.

3.2 Field Study Results

3.2.1 Site Descriptions of Proposed Route Crossing/Sampling Points

Crossing Points /Sampling Sites	Grid Ref.	Chainage	Q-Rating	Description	Fishery Value	Ecological Value
Site 1	F82063 38465	84.15	Q3-4	Very little wetted channel, so that both diversity and numbers of fish likely to occur would be low. For this reason, and the fact that the stream was immediately upstream of the seashore, it was decided not to electro-fish it.	**low**	**low**
Site 2	F82400 38350	84.05-84.5	This is a marine site and covered in the Marine Ecology Assessment for the EIS		**high**	**high**
Site 3	F9550 3590	88.6-89.5	This is a marine site and covered in the Marine Ecology Assessment for the EIS		**high**	**high**
Site 4	F85880 35062	90.1	Estuarine influence at the crossing point thus unsuitable for Q-rating: Q4-5 10m upstream	Moderate to slow flow glide, coarse (angular cobble substrate)	**moderate**	**moderate**
Site 5	F86477 34520	90.5	Q4	Very slow-flow, canal-like stream with typical macroinvertebrate types present (water beetles, damselfly larvae, water boatmen) etc.). Out of season at time of sampling (January 2008) for electrofishing	**low**	**low**
Site 6	F86258 34069	91.5	n/a	Very small flow over soft organic (peat) substrate; overgrown with bankside vegetation so that the channel was not visible. Too small and unsuitable habitat for electrofishing.	**low**	**low**

Site 1

This is a very small first-order stream at Irish National Grid (82063 38465), which has little [6]cover for fish and very little wetted channel, so that both diversity and numbers of fish likely to occur would be low. For this reason, and the fact that the stream was immediately upstream of the seashore, it was decided not to electro-fish it.

Kick-samples indicated that the water quality at Site 1 was slightly polluted (Q3-4), see Table 2 for macroinvertebrates encountered. It can be concluded that this stream has a low ecological value. It drains into the Glenamoy Bog Complex SAC.

Plate 3 Site 1 stream showing close-up of channel (full wetted width) and substrate with *Montia fontana* (Blinks) present at the margin (6-9-07).

[6] Cover here refers to overhanging banks, heavy instream vegetation, bouders, pools etc.

Taxa	EPA Quality Category	Abundance Rating
Ephemeroptera		
Heptageniidae	A	N
Baetidae	C	D
Plecoptera		
Amphinemoura	B	C
Trichoptera		
Polycentropus sp.	C	F
Philopotomus sp.	C	F
Hemiptera		
Hemiptera indet.	C	F
Diptera		
Chironomidae	D	D
Simuliidae	C	F
Crustacea		
Gammarus sp.	C	C
Annelida		
Oligochaetae	E	C
Q- value		**Q 3-4**

- Few (F) = 1 - 5 individuals
- Common (C) = 6 - 20 individuals
- Numerous (N) = 21 – 50 individuals
- Dominant (D) = 51 – 75 individuals
- Excessive (E) = >75% of total abundance

Table 2 Macroinvertebrates taken in a kick-sample at Site 1

2.6.2 - Site 2

This is the lower Sruwaddacon Bay crossing. It is a fully marine site and details of its habitats are presented in a separate report (Appendix L), which deals with the marine environment. The channel here is a holding area for salmon and seatrout on their upriver migrations to the Glenamoy and Muingnabo rivers (pers. comm. NWRFB) and these species can be expected to occur in this channel during the mid June to September period. Smolts would pass this area in the March-May period on their seaward migrations. It is a very sensitive site whose main importance is as a migratory route at certain times of the year. Species, namely salmon and seatrout feeding may also occur in this area. Other Annex II species such as (lamprey) may travel through this channel if they occur within the system; they would be expected to have a spring and possibly also a late autumn-winter migration, although no records exist (see earlier Section 3.2.1).

Site 3

This is the upper Sruwaddacon Bay crossing. It is an estuarine site and details of its habitats are presented in a separate report (Appendix L), which deals with the marine environment. The channel here is a holding area for salmon and seatrout on their upriver migrations to the Glenamoy and Muingnabo rivers (pers. comm. NWRFB) and these species can be expected to occur in this channel during the mid June to September period. Smolts pass this area in the March-May period on their seaward migrations. It is a very sensitive site whose main importance is as a migratory route at certain times of the year species, namely salmon; seatrout feeding may also occur in this area. Other Annex II species such as (lamprey) may also travel through this channel if they occur within the system; they would be expected to have a spring and possibly also a late autumn-winter migration

Site 4

Crossing 4 ([7]ING: F85880 35062)

The proposed crossing point (Site 4) is situated at the lower freshwater - upper estuarine limits of the small Leenamore River, which drains to a small tidal embayment at the south east corner of Sruwaddacon Bay. It is in the very lowest riverine reaches extending onto the top of the shore (Plate 4) and the macroinvertebrate community present in the stony substrate is notable for a mixture of freshwater and estuarine elements (Table 3).

Plate 4 View of the shoreline with brown seaweed (*Fucus* sp.), where the Leenamore River flows on to it just downstream from the Site 4 crossing point (view to the SSE, 28-1-2008).

[7] ING = Irish National Grid

Plate 5 Site 4 Crossing point in the right foreground and Sruwaddacon Bay in the background – view to the NNW (17-11-2008)

Upstream, between the proposed crossing point and the road, the channel is a series of meanders with riffles and pools, typical of eroding salmonid waters. This section is noticeable for its luxuriant cover of the aquatic moss *Fontinalis antipyretica* on boulders and large cobbles (Plate 6). The substrate is similarly coarse to the crossing point but with more gravel and coarse sand patches. A site chosen here (ING: F 85875 34947) was 1.7m wide and 15-20cm deep with a moderate-flow glide with boulder substrate (with heavy cover of *Fontinalis*) interspersed with gravel patches. The bank was 0.7-0.8m high, open and grassed with stands of rushes abundant and frequent Marsh Thistle and Lesser celandine, occasional Yellow Flag and patches of *Sphagnum* and other mosses. Marginally, in-stream there were small, restricted patches of Watercress, Fool's Watercress and Water Starwort. The invertebrates at this site were without estuarine influence and diverse (Table 3) and they indicate fair to good water quality conditions (Q4-5).

Further downstream shortly above the crossing at a site which is influenced by spring tides (pers comm. local landowner) (ING: F 85885 35039), the stream divides into two channels with one forming a shallow run or riffle-glide with a coarse cobble, boulder and gravel substrate in moderate shallow turbulent flow. The channel width here was 1.5-2.2m with depth ranging from 5-15cm. The banks were open, low (0.8m LHS, 0.45m RHS) and grassed with brown seaweed (*Fucus* sp.) clothing the vertical under-cut of the bank. In-stream, the boulders were covered with algal scum and a very occasional stunted *Fucus* stipe. Kick-samples revealed the presence of 5 gobies, attesting to the stronger estuarine nature of the site at this point.

Kick-samples taken on the shoreline in the shallow eastern low-tide stream at the crossing point revealed a fully estuarine low diversity fauna of brown shrimp (*Crangon crangon*), gobies (*Pomatoschistus* sp.) and gammarids.

Below the crossing the east and west margins of the intertidal area were dominated by small boulders and cobbles covered in brown seaweed (mainly *Fucus* sp.). A central area comprised silty sand with an infauna dominated by polychaete worms (nereids), oligochaet worms and small numbers of the crustacean (*Corophium sp.*) sp. These are very typical low-salinity estuarine macroinvertebrates.

The river at the crossing was not electrofished at the time of assessment. However the stretch immediately upstream has been electrofished by Aquens on three occasions in the recent past i.e. in 2001, 2002 and 2003 at a point about 200m upstream of the proposed crossing at ING: F 85864 34889. Only 3 trout were taken in the 2002 survey and 3 in 2003 (3 x 0+ trout in 2002 and 3 x 1+ trout in 2003); there were no trout taken at the site in 2001. Other fish taken there were 1 lamprey (unidentified *Lampetra* sp.?), 1 stickleback and 3 young eels in 2003, 1 stickleback, 2 minnow and 1 eel in 2002 and 7 stickleback and 5 eels in 2001 (Aquens, 2003). Aquens (2002) indicated that this site was poor from a fisheries perspective and perhaps too close to the sea. These returns for electrofishing indicate that the site is of low fisheries value. This proposed crossing lies just outside the Glenamoy Bog Complex SAC. However, the temporary working area lies within the SAC.

Table 3 Macroinvertebrates taken in a kick-sample at, upstream and at the Site 4 crossing point.

Taxa	**EPA Quality Category**	**Abundance Rating**	**Abundance Rating**	**Abundance Rating**	**Abundance Rating**
Ephemeroptera		Crossing Point	10m upstream of Crossing Point	50m upstream of Crossing Point	60m upstream of Crossing Point
Heptagenia	A				F
Baetidae	C			F	F
Plecoptera					
Isoperla	A				F
Leuctra	B				F
Trichoptera					
Hydropsyche sp.	C				F
Polycentropidae	C		F		
Rhyacophila sp.	C				F
Tinodes	C			F	F
Limnephilidae	C		F	F	
Silo	B				F
Sericostoma	B				F
Colepotera					
Elmis	C			F	F
Limnius	C				F
Diptera					
Dicranota	C			F	F
Tipula sp.	C	F			
Chironomidae	D	F			F
Diptera sp.	~	F			
Crustacea					
Gammaridae sp.	C	E	D	D	C
Crangon	~	C			
Jaera sp.	~	C	E	D	
Mollusca					
Sphaeridae	D				
Potamopyrgus jenkinsi	D		F	F	F
Hirudinae					
Glossiohonia	D				F
Annelida					
Oligochaetae	E	D			C
Q- value		**N/A**	**N/A**	**N/A**	**Q 4-5**

- Few (F) = 1 - 5 individuals
- Common (C) = 6 - 20 individuals
- Numerous (N) = 21 – 50 individuals
- Dominant (D) = 51 – 75 individuals
- Excessive (E) = >75% of total abundance

Plate 6 Channel upstream of the Site 4 crossing point showing *Fontinalis* moss-covered boulders and gravel on the streambed. (28-1-2008).

Site 5 (Crossing at ING: F86477 34520)

This crossing point is on a small stream situated immediately adjacent to the road (northern side) at a point where the flow is very restricted and no more than a grass-choked flush. Immediately below this (ING: F86493 34533) the stream opens out (1.0-1.2m wide) and deepens (0.6m water over 0.5m organic detritus/mud) into a canal-like channel with floating macrophytes (Water starwort *Callitriche stagnalis*, and Pondweed *Potamogeton sp.* - Plate 7). Macroinvertebrate fauna taken in netsweeps through the vegetation and loose upper detritus revealed a typical pond-type fauna (Table 4). The banks are backed by open-planted conifer and broadleaf (Alder) trees with an understorey of ferns, rushes and bramble. Although the site was not electro-fished because of seasonal considerations, it is unsuitable for salmonids and lamprey by virtue of its bottom substrate and extremely sluggish flows; it would be suitable for 3-spined sticklebacks. Further downstream the watercourse may contain habitat suitable for eel and small trout but its small size means that it is of low fisheries importance.

Upstream of the road this small stream, which is very close to its source (based on map and aerial photo observations) at this point, lies under a dense canopy of Rhododendron beside coniferous plantation and bog. It eventually joins the lower tidal reaches of the Glenamoy River about 1km upstream of its confluence with the lower tidal reaches of the Muingnabo River. Almost the entire catchment of the stream is within coniferous plantation.

The stream macroinvertebrates ranged across several families and classes including some sensitive groups and indicate that the water quality is unpolluted, although not pristine, i.e. Q4 rather than a Q5 quality rating (Table 4).

Plate 7 Channel immediately downstream of the Site 5 crossing point showing floating Starwort and bank-side rushes moss-covered boulders (28-1-2008)

Table 4 Macroinvertebrates taken in netsweeps through the vegetation and superficial sediments at Site 5

Taxa	EPA Quality Category	Abundance Rating
Plecoptera		
Nemoura sp	B	N
Trichoptera		
Limnephilidae	C	C
Hemiptera		
Hespercorixa sahlbergi	C	F
Corixid sp.		
Odonata		
Coenagrion	C	C
Phyrenasoma	B	F
Coleoptera		
Ilibyius spp.	C	F
Larva indet	C	C
Diptera		
Chironomidae	D	N
Dixidae	-	F
Crustacea		
Asellus	D	F
Mollusca		
Lymnea peregra	D	C
Sphaeridae	D	F
Annelida		
Oligochaetae	E	N
Q- value		**Q 4**

- Few (F) = 1 - 5 individuals
- Common (C) = 6 - 20 individuals
- Numerous (N) = 21 – 50 individuals
- Dominant (D) = 51 – 75 individuals
- Excessive (E) = >75% of total abundance

Site 6

This is the final watercourse crossing of the proposed route before it joins the Bellanaboy Bridge Gas Terminal site. The watercourse in question is a first order stream, which was surveyed on September 6th 2007. It is a [8]headwater tributary of a small stream, which flows to the southeastern corner of Sruwaddacon Bay. At the crossing it is surrounded by coniferous plantation forestry with immediate land-use associated with a bog mat road. It is culverted under the latter temporary road immediately upstream of the proposed crossing point in a steel pipe. The stream in question is considered to be a trickle, in places broadening into a stagnant wetland seepage or flush (Plate 8) and reverting back to a trickle. The wetland/flush areas are dominated by Flote grass (*Glyceria* sp.) and Water starwort (*Callitriche stagnalis)*, while the trickle area is overgrown with bankside grasses and other vegetation so that the channel, less than 0.5m across, is totally hidden from view. Bankside vegetation

[8] Headwater refers to the top of the catchment i.e. close to the source of a watercourse

includes Marsh cinquefoil, Soft rush, Wild Angelica, Creeping buttercup, Bent (*Agrostis spp.)* and Bramble, with some Greater Tussock sedge. The bed comprises peaty detritus-filled soft sediment. The site is clearly unsuitable for salmonids and probably contains no fish or lampreys. Bottom invertebrates including *Asellus*, corixid nymhs (immature waterboatmen insects) and pea mussels (Sphaeridae) were noted in net sweeps. The site did not lend itself to a water quality rating using the Q-value system because of the nature of the substrate, which comprised soft organic sediment, with very low and sluggish flows. The ecological and fisheries value of the site is very low because of its small size, the very sluggish flows and very organic deep sediment.

Plate 8 Site 5: Crossing point of a small first order stream about 0.7km north of the Gas Terminal (6/09/2007).

2.7 – POTENTIAL IMPACTS

2.7.1 - Overview

The key areas of potential impact of the proposed development on the freshwater habitats and associated migratory fish and lamprey species relate to the construction phase of the pipeline and the commissioning phase. Once the pipeline is in operation, there will be no impacts on freshwater resources. The following sections therefore deal in particular with the potential impacts associated with the construction phase and the commissioning / testing phase of the project. A review of the proposed construction methods was undertaken in order to examine the potential impact of the proposed development. The following section deals with key potential impacts.

It is proposed to cross Site 2 and 3 crossings using micro-tunnelling i.e. trenchless methods, which will minimise surface intervention. However, in the event that an intervention pit is required during the construction phase, then there is potential to cause impact to migratory Annex II species if such works occur during the migratory season. It is proposed to cross Sites 4, 5 and 6 using open cut methods (see chapter 5 of the EIS for further details).

2.7.2 - Construction Phase

2.7.2.1 - Crossings of Small Streams/ Rivers (Site 1, Site 4, Site 5, Site 6)
The proposed development will entail the crossing of three small streams / rivers and works within close proximity to one small stream. Sites 1, 5 and 6 are approximately 1m in breath or less in width, while Site 4 is approximately 40m in breath. All have minor or negligible fishing resources. None of these streams /rivers hold significant populations of aquatic species, animal or plant although Aquens (2003) recorded a lamprey (*Lampetra* sp.) about 200m the upstream of the proposed crossing point, within the freshwater reaches of the Leenamore River. Sites 5 & 6 are outside the Glenamoy Bog Complex SAC at the proposed crossing points, while Site 4 lies within the SAC. There are three principal types of potential impact associated with the proposed open cut construction.

1. <u>Suspended Sediment and Habitat Loss/Damage</u>

The potential impact associated with the crossings will be the disturbance of the habitat of the streams in question, associated with the open-cut crossings. These will account for a short length of stream channel coinciding with the footprint of the crossing and amounting to a maximum of 20m of channel length, resulting in the potential disruption of about 20m^2 of streambed habitat. This marks a maximum, however, and in reality the actual crossing point will be much narrower than the temporary working area width, every effort being made to confine it to just a few metres. There is also the potential for siltation to occur downstream of each crossing if basic mitigation measures are not carried out. In this case the streambed downstream of each crossing could become blanketed with silt dislodged during trenching. This in turn would decrease the quality of the habitat (which in all cases besides Sites 5 and 6 - comprises gravels, cobbles and coarse sand), by smothering it with finer sediment thus adversely impacting the macroinvertebrates and any fish species present, which would likely emigrate out of the affected area until the substrate reverted to pre-construction conditions. Siltation of bottom substrates could also damage spawning beds were these present. It is unlikely that any of these small streams hold significant spawning beds for any species given their small size. However, pockets of spawning gravel for trout probably occur throughout the channel in each case and given the upstream locations of Sites 5 and 6 on their respective watercourses, and therefore the potential for a greater length of downstream channel to be impacted, in these cases special care will need to be taken during construction.

The streams at Sites 5 and 6 could potentially be adversely impacted depending on the degree of sediment escapement and deposition during the construction of these crossings. The streams in question, however, by virtue of their size and habitats, are of minor ecological importance, which reduces the significance of the impacts, which could occur. The crossing of the Leenamore River (Site 4) is located on the foreshore where the river is subject to full tidal inundation when the tide is in. The crossing at this point will be at least 40m in length. The adjoining habitats comprise low-diversity, soft sediment and boulder shore with brown seaweeds in variable salinity. These habitats can sustain a degree of sedimentation without significant adverse impact. Thus, provided efforts are made to reduce the quantity of solids escaping during the construction phase, there should be negligible impact from the crossing at this point. Ideally the coarse surface material (30c-50cm) should be removed along the line of the crossing in advance of trench excavation so that they can be replaced as the surface material on the back-filled trench by way of reinstatement. Likely impacts to the streams as a result of open-cut crossings, before mitigation measures are taken, would be considered to be:

Minor localised, temporary, negative impacts would occur in the case of Site 4, while the unmitigated impacts at Site 5 and 6 could be termed minor to moderate, local impacts.

These will not persist for longer than 2 to 3 years (possibly only 1) after construction, when any deposited silts would have had time to wash away in floods. All these impacts can be easily reduced by good construction site management and simple mitigation measures as described below.

<u>2. Release of Contaminants - Cement and Oil</u>

Only cured, precast concrete elements will be used at open-cut stream crossings and so the possibility of cement spills into and of the streams in question will not arise.

Oil accidentally discharged to streams can give rise to fish kills and the death of streambed macroinvertebrates (Lytle and Peckarsky, 2001). Again this can be readily avoided by careful construction site management and appropriate mitigation measures.

Estuarine Crossings

The proposed development will entail two crossings of Sruwaddacon Bay and one crossing of Leenamore River, which is also estuarine. These crossings are within the

Glenamoy Bog Complex SAC. It is proposed to construct both bay crossings using trenchless methods and the Leenamore crossing using open-cut. While trenchless methodologies largely avoid works in the bay, the following potential impacts are associated with these methodologies:

In the event of an intervention pit, the Sruwaddacon Bay crossings have the greatest potential to give rise to significant adverse impacts because of the importance of both crossing points as migratory routes for Atlantic salmon and seatrout in particular, but also potentially for lamprey.

The greatest potential threat during construction of these crossings comes from suspended solids, generated either by the disturbance of the in situ marine sediments if a temporary intervention pit is required or through the escape of bentonite. Bentonite is a clay that is used in construction projects. It is mixed with water to form slurry, the consistency of which depends on the application. For trenchless construction, bentonite is used to lubricate and cool drilling heads, and as a liquid medium for removing excavated spoil by pumping. Bentonite in a denser form is also used to lubricate the advancing sleeve pipe (it is injected into the annulus around the sleeve pipe) and as a grouting material to fill voids (e.g. if for some reason the TBM is retracted for a distance).

<u>Suspended solids can have the following impacts on fish in the environment:</u>

Behavioural:
(altered swimming behaviour, breakdown in schooling, altered foraging rates and success, avoidance – lateral and or vertical).

Sublethal:
(physiological changes including increased blood sugar, increased blood cortisol, increased coughing response and reduced feeding success all of which are considered signs of stress or alarm. Repeated stress can lead to reduced growth rates).

Lethal: (direct mortality due to severe gill damage).

The affects of suspends solids depends principally on a combination of concentration and duration of exposure. The nature of the solids involved is also a factor with larger angular silt and sand particles considered more damaging than smaller particles.

Essentially, the higher the concentration of solids is and the longer the exposure period, the higher the risk is of adverse impacts occurring to fish. Thus while a fish may be exposed to relatively high levels of suspended solids for a short time period with no adverse impacts, a much lower concentration over an extended period of exposure can have chronic or lethal impacts.

Direct mortalities from high suspended solids in nature is likely to be rare because in experiments these affects are not normally observed until concentration of tens or hundreds of thousands of milligrams per litre of suspended solids are in question and these levels rarely occur in nature (Alabaster and Lloyd 1980, McDonald & Jensen 1996). In the case of the Sruwaddacon Bay sediment, most of the material known to occur in the surficial layers, based on geotechnical surveys undertaken, is sand or gravel in both Bay crossings, with some silt and clay also found in the longer Bay crossing. The bulk of this sediment will fall out of suspension very rapidly so that any plumes arising are unlikely to contain high suspended solids concentrations except within relatively close proximity to the site of the works (50-100m).

In laboratory experiments the onset of avoidance can be demonstrated in coho salmon (*Oncorhynchus kisutch*) at concentrations at around 300mg/l when 1% of the test animals surfaced in test vessels. This effect didn't become pronounced (i.e. affected individuals went above 5% of the test population) until concentrations reached >2500mg/l of suspended solids (Servizi & Martens 1992). However the authors indicate that there is a greater tendency for lateral avoidance than vertical avoidance movements at lower solids concentrations. This can be explained by the fact that fish which surface have a greater risk of predation by avian predators e.g. gulls and terns.

There is significant uncertainty as to the concentrations of suspended solids and duration of exposure likely to pertain for the various construction techniques, which will be adopted for the two Sruwaddacon Bay crossings required. Clearly, as trenchless techniques are proposed for both Sruwaddacon Bay crossings (Sites 2 & 3), then the risk of any adverse impacts on migratory fish is negligible.

If sheet-piling, coffer-dam, or other open-cut type techniques are adopted (in the event that an intervention pit is required e.g. where a drilling head needs to be recovered or the pipe tunnel encounters an obstruction, which has to be removed from a part of the crossing within the bay, then there is the possibility of elevated suspended sediment concentrations arising. These would result from disturbance of the native sediments while the structures were being installed. Open-cut work in the main low tide channel(s) is likely to give rise to greatest exposure risk to fish during migratory periods as they would be expected to be concentrated in these areas, especially as the tide ebbs, whereas, works in intertidal areas exposed during low tide are less likely to give rise to suspended solids problems as (i) these may be accessed and resolved during low water periods or (ii) if they have to be enclosed in sheet pile enclosures, the latter will be off the channels and in areas of lower currents. Dewatering of sheet-pile trenches and cofferdams could also give rise to intermittent or sustained suspended solids pulses in the receiving waters. This situation may occur where smolts on their seaward migrations in the March-May period or adults salmon and seatrout returning to the Muingnabo (but especially the Glenamoy River) would have to pass through or around plumes of increased turbidity. However, the exact concentrations or durations of such occurrences are uncertain and they would be over very short duration, namely when the structures are being constructed.

In their review of suspended sediment impacts on fish, Wilber and Clarke (2001) indicate that for juvenile and adult salmon the 'most probable' suspended solids dosage range (i.e. concentration x duration of exposure) for outward migrating smolts and inward migrating adults in the context of estuarine dredging would be concentrations of up to 1000mg/l for periods of up to 24hrs. They base these figures on average smolt emigration rates and adult immigration rates. Quoting from an extensive previous review of sediment impacts on fish (MacDonald and Jensen 1996), they indicate that for concentrations and exposures within this range, most studies indicated behavioural and sub-lethal rather than lethal responses by salmonids. In a worst case scenario, i.e. if cofferdams need to be installed in or close to permanent low-tide channels, the works in Sruwaddacon Bay may produce similar suspended solids concentrations for short periods, at least close to the works and especially in areas where tidal currents are strong (e.g. by the main tidal channels and in the outer bay) giving rise to scour around temporary structures. In situations where this occurs, smolts may alter their swimming behaviour or slow their emigration rates, possibly exposing them to greater risk of predation by birds or to increased stress and poorer growth or greater risk of gill damage. Returning adults would be less at risk from predation if their advance up the bay were slowed. It is worth noting however, salmon still make their upriver spawning migrations annually under natural conditions in some estuaries where high turbidity levels are recorded (e.g. the river Suir with suspended solids levels of up to several hundred milligrams per litre - pers. obs.) and the Severn estuaries, where solids levels of more than a thousand have been noted (Alabaster & Lloyd 1980). It seems unlikely therefore that returning adults would be prevented from passing the works at either estuarine crossing site in Sruwaddacon, although slowing their rate of immigration during periods of increased solids washout from the works is possible.

Without fish counters on the Glenamoy River, in particular, there isn't a clear understanding of the timing of juvenile salmon or seatrout movements in Sruwaddacon Bay. It is believed that during the summer salmon may enter the bay from the sea on high tide and drop back down again during the ebb and that this may persist over an extended period until a rise in river flow will prompt fish to ascend the rivers. In this situation their exposure to suspended sediment plumes could be greater than the averages suggested in Wilber and Clarke (2001). However, even in these situations, salmon may still be able to avoid any plumes generated or those plumes may have suspended solids below levels likely to have significant adverse impacts. The risk however, would be increased. In the latter case, significant adverse impacts would be those that would prevent the salmon spawning successfully, as these would affect the species at a population level, rather than at the level of individuals. Such impacts are considered to be very unlikely to occur.

Impact of Bentonite

Bentonite is used in trenchless drilling methods. When used successfully, there is very little risk to the environment, as the bentonite remains sealed within the drill shaft. However, there is a very low risk of bentonite seeping out through soil or rock fissures into the overlying watercourses. If the concentrations are high enough, i.e. tens or hundreds of thousands of milligrams, then direct fish mortality could occur in a relatively short period, i.e. less than a day. Lower concentration of several thousands of milligrams could produce the same impacts over more extended periods (a week or more). Much lower concentrations i.e. several hundreds of milligrams per litre are likely to cause very turbid conditions because of the slow settlement rate of bentonite. This could reduce feeding rates in fish but clearly the more important impact would be associated with catastrophic release amounts. The risks associated with these events are considered to be low because the bentonite will be used at low pressures and low quantities relative to other trenchless methods. Nevertheless, mitigation measures will be required and will be utilised.

There is also a risk from bentonite handling near the shore, where it is being batched in preparation for grouting etc. or where it is being recycled from spoil for reuse in the drilling. If these are not properly secured then spills and leakages could introduce the slurry into marine surface waters with potential for serious adverse impacts. This eventuality is considered low but will need to be mitigated against also.

Hydrostatic Testing

Hydrostatic testing of pipes requires large amounts of water to be abstracted from a surface or groundwater sources to fill the pipeline. This is then increased to the test pressure of the pipe to ensure its structural integrity. The water in the pipe is then treated and returned to the same or another water body. Although high pressure can give rise to supersaturation of the water (and subsequently lead to gas bubble disease in fish) with nitrogen gas from any air trapped in the pipe during testing, there will be no measurable quantities within the test water. The water may also become contaminated with suspended solids, heavy metals and hydrocarbons from the inside of the pipe all of which might have a detrimental impact on fish, depending on the concentrations involved if discharged untreated into a receiving water body. However, the test water will be analysed for a range of parameters (temperature, pH, dissolved oxygen, total gas pressure, suspended solids, iron, chromium, cadmium, nickel, copper, lead, zinc and total petroleum hydrocarbons), details of which will be agreed with the NWRFB prior to undertaking. The discharge point for this test water will be agreed with NWRFB in advance of the testing.

No Development Option

In the absence of the development it is likely that the habitats and water quality along the proposed route would remain unchanged, although both are subject to natural and other anthropogenic variability.

MITIGATION

Construction Phase

Small stream crossings

In the case of the stream / river crossings along the route, open cut crossings will be used to carry the pipe under the streambed. In order to mitigate against the loss of solids into the streams downstream of the open cuts, the stream water will be diverted around the crossing point in a flume pipe (the preferred option in all cases) or the upstream end will be dammed and water pumped around the crossings to maintain flow downstream. These methods will allow all in-stream works to proceed in the dry.

Where the stream sediment comprises coarse materials e.g. sand gravel and cobble (Site 1 and Site 4) the surface 20-30cm of sediments over the full area of the crossing footprint will be excavated in the dry and set aside on a geotextile mat for later re-instatement.

In order to prevent unnecessary damage to streambeds and to prevent the generation of large amounts of suspended sediment, construction vehicles will only traverse the three identified watercourse crossings using temporary bridging structures, which will remain in place as running-tracks. These may consist for example of flume pipes secured with clean, crushed stone free from fines and topped with bog mat or other rip-proof material to act as a secure surface for vehicular traffic.

Ideally, the works will be carried out in the May-September period when water levels will be at their lowest. However, given the relatively minor ecological and fisheries value of the streams involved, this timing should be flexible in terms of season, although it is recommended that the actual crossings should only be commenced during dry weather. Even in the middle of winter the flow in all of these streams will drop very substantially even after a few days of dry weather because they all have small catchment areas.

No waters that may seep into the pipe trench during construction will be discharged directly to any watercourse or the sea without first being treated by settlement and filtration in order to remove suspended solids. Suspended solids should be monitored at the outfalls from treatment works to ensure that they are below 50mg/l.

If there is a requirement for refuelling it should be done in accordance with the Environmental Management Plan, which will address the specific requirements for fuelling equipment.

All plant such as compressors and pumps will be placed on drip trays with absorbent material to prevent contamination of surface or groundwaters with hydrocarbons. Spill kits should be available in the event of a spillage.

Concrete will be pre-cast before use at any stream crossing. All cement contaminated washings, if they arise, will first be neutralised to pH 6-8.5 and settled to removed solids before being discharge to watercourses.

Sruwaddacon Bay Crossings

These crossings are potentially the most sensitive and consequently will require the greatest degree of planning and mitigation to ensure minimal adverse impact on migratory fish species.

<u>Mitigation by Avoidance - Timing</u>

In the case of surface intervention being required in Sruwaddacon Bay crossings (sites 2 & 3) the use of certain time windows during the works can considerably reduce the potential for adverse impacts between the works and migrating fish (in particular salmon and sea trout). There is uncertainty at present as to the precise period when smolts descend into Sruwaddacon Bay from the Muingnabo and Glenamoy rivers. In the nearby Carrowmore lake, smolts run until the end of May and it is possible therefore that this may also be the situation in the Glenamoy (pers. comm. NWRFB). Adult salmon on the Glenamy are late returning from mid June (mainly mid July) to September with peaks in the latter part of that window during 2008.

A smolt trap will be placed on the lower Glenamoy River to assess the timing of the peak smolt runs during the March-May 2009 period. This data will be compared with the same statistics where available for other rivers in the region.

Given that smolts would be considered more vulnerable than adults both to predators and suspended solids, it would be more important to halt any surface intervention activities (e.g. sheet-piling) during their passage through Sruwaddacon Bay than that for adult salmon or trout. The choice of trenchless crossing techniques will considerably reduce the likelihood of any surface interventions in the bay. However, if these should be required during the smolt run (i.e. March-May) the bay will be monitored upstream of the works and if smolt are detected the works will be halted temporarily until they pass. If any surface intervention work is required in the bay the NWRFB will be consulted and notified in advance.

Site preparation, including low-risk work such as construction of sheet-pile trenches in upper shore sandy areas at the landward side of the crossing points, and other ground preparation works, would be possible at any time of the year after careful risk-assessment and consultation with the NWRFB, as these would be much less likely to produce sediment outwash into the main channel.

Mitigation by Method - Trenchless Crossings

A trenchless crossing method (micro-tunnelling) will be employed for the two Sruwaddacon Bay crossing (Sites 2 & 3) to minimise potential impacts. Although this method of drilling uses bentonite, the latter will be used at low pressure, so that the risk of seepage into the overlying waters of the bay will be much reduced. Furthermore, during the drilling process, the pressure at the pump will be monitored and any unusual fluctuation, that would indicate a leak or other eventuality, will result in pumping being stopped immediately. Also, the bay will be under constant observation in case bentonite seeps through fissures. If this happens, the bentonite pumping will also be stopped and grout pumped into the fissure before drilling recommences.

Bentonite is recycled by separation from the spoil-bentonite mixture emanating from the drill shaft and the spoil removed off site for disposal under licence. Residual bentonite will be disposed of in a similar manner. All bentonite batching and recycling plants on the shore will be bunded to prevent any material washing onto the shore.

The contractors will draw up a detailed method statement describing how the trenchless crossing will be achieved at Sites 2 and 3, including monitoring and mitigation measures which will be employed to prevent bentonite spills into the environment.

Intervention Pit

If during the drilling process, the drill-head encounters an impenetrable obstruction, e.g. a large lump of rock and non-surface intervention methods cannot remove the obstacle, then an intervention pit will be sunk at the point along the pipe tunnel where the obstruction is encountered. This can be a sheet-pile cofferdam or similar large pipe segments, which are vertically drilled or jacked into place, with each additional pipe segment being sealed to the foregoing section. Where these open-cut structures have to be situated within the permanent low-tide channel (i.e. in permanently wet areas) they could give rise to the escapement of sediment into the water column during their installation, with consequences for any migratory fish present. This would be relevant for both lower crossing of the bay (Site 2) or the upper bay crossing point (Site 3). This being the case, such structures will not be installed without prior agreement with NWRFB. In addition, where it is observed that adult salmon or smolts were congregating upstream or downstream of the works within the bay as a results of sediment escape, then the works would be temporarily halted for a few tides to allow fish to pass. The requirement for these downtimes and their duration will be decided in consultation with the NWRFB.

The contractors will draw up a detailed method statement describing how the cofferdams or other open-cut structures will installed and how they will be managed in order to minimise potential pollution emanating from them at Sites 2 and 3.

If an intervention pit is required for either crossing of Sruwaddacon Bay comprehensive pre-construction, construction and post-construction suspended solids monitoring will be undertaken to ensure that excessive amounts of solids are not escaping from the works. A programme of monitoring will be agreed in advance with NWRFB.

The NWRFB will be kept informed of the progress of all crossing activities within Sruwaddacon Bay including any pollution incidents, if they occur.

Handling of Excavated Spoil and Dewaterings

Spoil excavated from cofferdams will not be stockpiled where it will be exposed to tidal scour. Instead it will be conveyed onshore to temporary stockpiles or it will be retained within the sheet-pile or causeways structures' footprint, separated from tidal scour by protective bunds.

All cofferdam and sheetpile enclosure de-watering will be pumped onto adjoining pontoons where they will be settled and filtered to an acceptable standard before being discharged into the bay. Suspended solids should be monitored at the outfalls from treatment works to ensure that they are below 100mg/l for marine discharges.

Any bentonite that might seep out from the active drill shaft into a sheetpile enclosure, e.g. during drill head recovery or obstruction removal, will be pumped into containers on board the adjoining pontoons and conveyed ashore.

Where it was observed that adult salmon or smolts were congregating upstream or downstream of the works within the bay as a results of sediment escape, then the works would be temporarily halted for a few tides to allow fish to pass. The requirement for these downtimes and their duration will be decided in consultation with the NWRFB.

Hydrostatic Testing

Once the pipe is in place, it must be pressure tested for safety reasons. This is accomplished using the hydrostatic method, which requires the pipe to be filled, with water. Water for testing will be abstracted at a rate that will not endanger the habitats or fisheries of the source. The post testing water will be analysed for contaminants and if found to be present at unacceptable levels the water will be subject to appropriate treatment as required, e.g. settlement, advanced hydrocarbon separation, microfiltration, metal ion removal etc. The discharge point for this test water will be agreed with NWRFB in advance of the testing.

RESIDUAL IMPACTS

Once the pipeline is in operation, there will be no impacts on freshwater resources.

Small Stream Crossings

All small streams crossed are of minor ecological importance and once the mitigation measures as outlined are adopted then there will be negligible, short-term impacts on them. The impact occurring will relate to siltation of the streambed for some distance downstream of the crossing point resulting in temporary reduction of macroinvertebrate and fish biomass. Such impacts are unlikely to affect more than 100-200m of stream and will constitute a very minor impact.

Sruwaddacon Bay Crossings

Once all necessary mitigation measures are taken in the case of the Sruwaddacon Bay crossings, there will be no residual impacts on migratory salmonids or EU Annex II listed species as a result for the construction and commissioning phases of the project.

If in the event that an intervention pit is required and provided that the in-channel works do not impede the smolt run in any way, then serious adverse impacts at a population scale for salmon, trout and lamprey will be avoided.

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