Enniscorthy Flood Defence Scheme
Aquatic Ecology Survey

Version (15th March 2018)

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1. INTRODUCTON

A Flood Defence Scheme (FDS) is proposed for the town of Enniscorthy, Co. Wexford. Ecofact Environmental Consultants Ltd. was engaged to undertake the aquatic ecology surveys to inform the design of this scheme. The River Slaney flows through Enniscorthy and the lower freshwater reaches and upper tidal reaches of this watercourse are affected by the proposed scheme. The affected part of the River Slaney is within the Slaney River Valley Special Area of Conservation (SAC), with several aquatic species listed as conservation interests. A description of the River Slaney is given in Section 1.1 below.

A set of targeted baseline aquatic environmental surveys were carried out between March and September 2016. The baseline aquatic studies involved a River Habitat Survey (RHS) and a hydromorphology assessment to evaluate river physical structure. An aquatic ecology survey including biological sampling, lamprey surveys and a general fish survey was also undertaken. Methodology for these surveys is outlined below in the relevant section. A Freshwater Pearl Mussel (FPM) survey was also undertaken and the results of this assessment are presented in a separate report (Ecofact, 2016). The current report does not include a detailed aquatic plant assessment though some plant records were taken during the surveys to inform this work.

Field work and preparation of this report was carried out in consultation with National Parks and Wildlife Service (NPWS) and Inland Fisheries Ireland (IFI). These bodies were contacted regarding any existing information on the site or surrounding area and were involved in licensing, specifying appropriate methodologies and stipulating conditions for surveys. Local rangers/staff were consulted directly in advance of surveys.

Results are presented in tabular format, illustrated in maps produced using GIS, and in graphs. GIS data downloaded from the websites of EPA and NPWS in addition to aerial mapping and FDS drawings supplied by the client were used to generate maps. In the Plates section, photographs are provided for methodology, survey sites and ecological receptors.

1.2 Statement of authority

This assessment was prepared by Dr. William O'Connor - a senior aquatic scientist who has over 25 year's professional ecological management experience. He is a graduate of the University of Wales, Cardiff where he was awarded an MSc degree in Applied Hydrobiology, and the National University of Ireland, Galway where he received a PhD degree in Zoology. He is a Fellow of the Institute of Biology and a full member of both the Institute of Ecology and Environmental Management, and the Institute of Fisheries Management. He was employed as Senior Fisheries Biologist with the Electricity Supply Board during the period 1992-1998, and has been working as a private consultant since 1999. William's primary expertise lies in Water Quality, Fisheries and Aquatic Ecology; with extensive experience of large-scale projects for public and private clients, including national infrastructure EIS studies. William has operated in a professional consultancy capacity for a number of national statutory bodies including the National Parks and Wildlife Service (NPWS), the Office of Public Works (OPW), the Environmental Protection Agency (EPA), the Northern Ireland Environment Agency (NIES), Waterways Ireland (WI) and the National Roads Authority (NRA). He has also undertaken NPWS wildlife surveys for protected aquatic species, including several catchment-wide studies on lamprey species and a national survey of white-clawed crayfish in Irish lakes, both of which have been published as NPWS Wildlife Manuals. He is a fully trained and licensed NPWS Freshwater Pearl Mussel surveyor, and has held numerous licences for Atlantic salmon, White-clawed crayfish and lamprey species.

1.2 Description of the River Slaney Catchment

The River Slaney (EPA code 12S02) rises at Lugnaquilla Mountain in the Glen of Imaal in the Wicklow Mountains. It has a channel length of approximately 117km long and flows from its source in a southerly direction through Counties of Wicklow, Carlow and Wexford before entering the Irish Sea at Wexford harbour. The Slaney River catchment is located in Hydrometric Area 12 in the South-Eastern River Basin District (SERBD). The Slaney River flows through the towns of Baltinglass, Rathvilly, Tullow, Bunclody and Enniscorthy. The River

Slaney has several tributaries including the Carriggower, Deereen, Derry, Clody, Bann, Urrin, Clonmore, Ballyvoleen and the Boro which collectively drain a catchment of 1631km^2 (O'Reilly, 2004).

According to the Environmental Protection Agency (EPA), the 95%ile flow of the River Slaney is 4.798 m^3 sec^{-1} at Enniscorthy. The 30%ile flow of the River Slaney at Enniscorthy is 31.121 m^3 sec^{-1} taking the mean river flow to correspond to 30%ile river flow, as in MacCarthaigh (1997). The drainage density of the Slaney catchment upstream of Enniscorthy is 1km/km^2. A map of the Slaney River catchment and the Slaney River Valley SAC is presented in Figure 1.

Downstream of Enniscorthy the 6th order River Slaney enters a 19km long estuary before discharging into Wexford Harbour at Wexford town. This transitional water is divided in to the Upper Slaney Estuary (code IE_SE_040_0300) and the Lower Slaney Estuary (code IE_SE_040_0200). Wexford Harbour is an extensive, shallow estuary which dries out considerably at low tide exposing large expanses of mudflats and sandflats.

The underlying geology of the upper and central Slaney catchment almost as far Derry River consists of granite. Above Kilcarry Bridge, the Slaney has cut a gorge into the granite plain. The bedrock geology of the middle and lower reaches of the River Slaney comprises slate, schist and greywacke, with a band of slate, shale, mudstone and siltstone intersecting this formation in a south-westerly aspect at Enniscorthy. The Derry and Bann Rivers are bounded by a narrow line of uplands which corresponds to schist outcrops. Where these tributaries cut through this belt of hard rocks they have carved deep gorges, more than two miles long at Tinahely and Shillelagh.

The characteristic soils of the Slaney catchment are Grey Brown Podzolics and Brown Podzols. Grey-Brown Podzols are generally formed from limestone parent material and are some of the most inherently fertile soils in the region while Brown Podzols are generally formed from glacial till of predominantly sandstone-shale composition and are also some of the most inherently fertile soils in the region. At the northern extremities, there are peats present and in areas along the catchment boundary in Carlow and Wexford there are areas of Acid Brown Earths both of which are acid in character (SERB, 2002). The soils of the River Slaney catchment are predominately well drained with only 22% being considered poorly drained soils (Source: EPA Hydrotool). CORINE land use statistics show that approximately 63% of the River Slaney catchment is under pasture while approximately 24% is under arable agriculture and a further 8.7% is used for forestry (SERB, 2002).

The Slaney River and its main river tributaries the Bann, Glasha, Clody, Derry, Derreen, Douglas and Carrigower Rivers are designated a Special Area of Conservation (code 000781). These watercourses display good examples of floating river vegetation. The site is of high importance for the conservation of fish species, notably Atlantic Salmon *Salmo salar* [1106], Sea Lamprey *Petromyzon marinus* [1095], River Lamprey *Lampetra fluviatilis* [1099], Brook Lamprey [1096] and the very localised Twaite Shad *Alosa fallax fallax* [1103]. There is a significant population of Freshwater Pearl Mussel *Margaritifera margaritifera* [1029] in the Derreen River.

A Water Framework Directive (WFD) surveillance monitoring fish stock survey was carried out on the Slaney Estuary and the North Slob Channels in October 2014 by Inland Fisheries Ireland (IFI) (Kelley *et al*. 2015). A total of 10 fish species were recorded in the Upper Slaney Estuary: Sea Bass *Dicentrarchus labrax*, Salmon, Brown Trout *S. trutta*, European Eel *Anguilla anguilla*, Flounder *Platichthys flesus*, Stone Loach *Barbatula barbatula*, Three-spined stickleback *Gasterosteus aculeatus*, Minnow *Phoxinus phoxinus,* Sand Goby *Pomatoschistus minutus* and unidentified Lampreys. Minnow was the most abundant species, followed by three-spined stickleback and flounder. A total of 18 fish species were recorded in the Lower Slaney Estuary during the 2014 surveys carried out by IFI.

During the reporting period of 2007 - 2009 the main channel of the River Slaney was divided into 6 River segments 5 of which achieved Good Ecological Status and 1 of which achieved Moderate Ecological Status. During the reporting period of 2010 - 2012 the River Slaney was divided into 17 segments 2 of which achieved a High Ecological Status, 10 attained Good Ecological Status, 2 attained Moderate Ecological Status while 2 segments were unassigned.

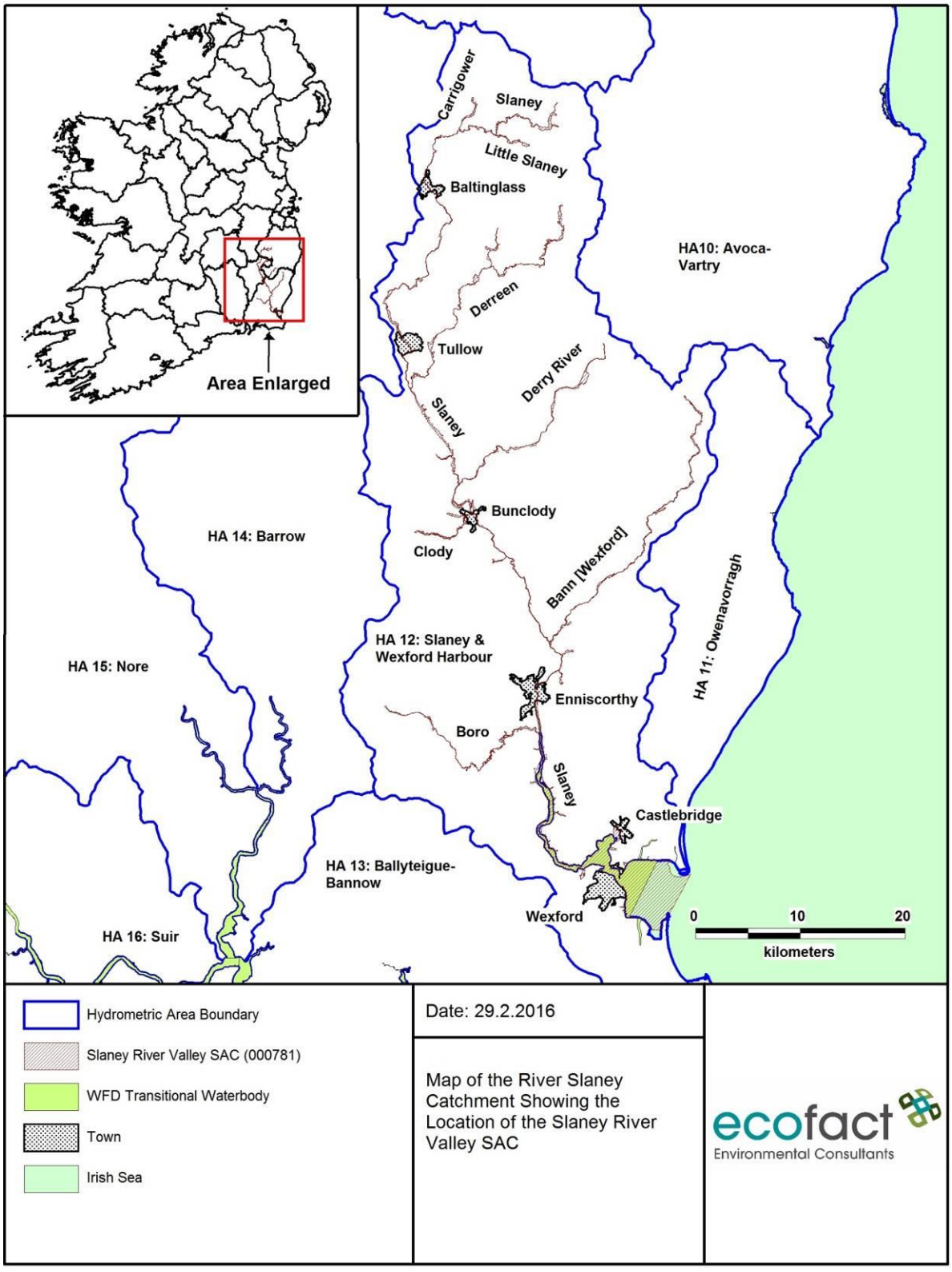

Figure 1: Map of the Slaney River catchment showing the location of the Slaney River Valley SAC.

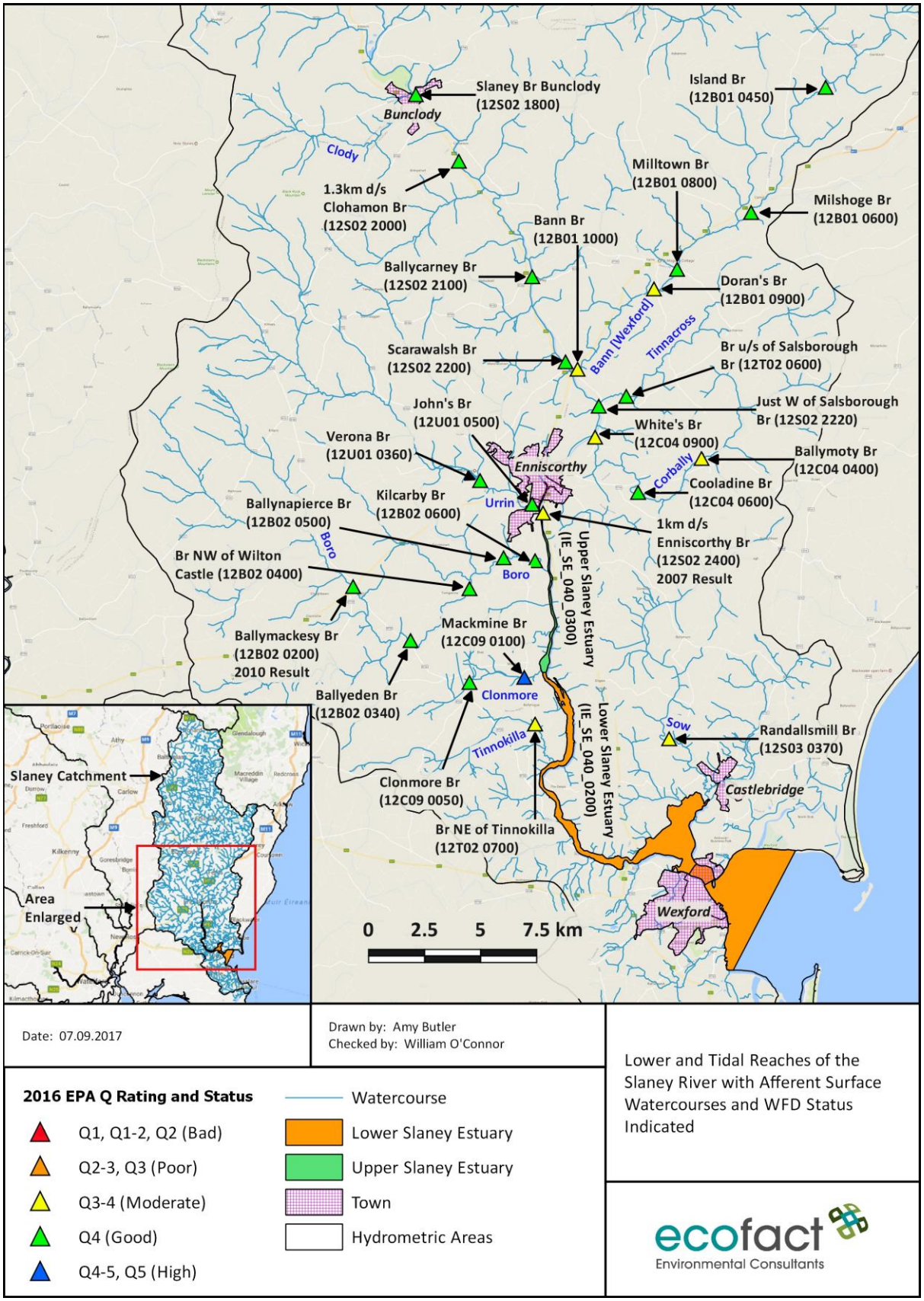

Figure 2: Lower and tidal reaches of the Slaney River with afferent surface watercourses and WFD status indicated.

As part of its rollover monitoring programme, the EPA and its predecessors have monitored biological water quality in the Slaney since the 1970's. The most recent sampling was carried out in 2016 and the results can be seen in Figure 3. A decline in ecological conditions was noted at 3 of the 23 monitoring stations on the River Slaney in 2016. A total 14 stations maintained the same ecological status as the previous monitoring year, while 6 stations received a higher WFD status than that of 2013. The closest EPA monitoring station to the proposed flood drainage scheme at Enniscorthy is John's Br (RS12U010500). This station is located on the Urrin River and has seen an improvement in its ecological status since 2013 where the ecological condition improved from Moderate in 2013 to Good in 2016. While monitoring stations in the upper reaches of the River Slaney recorded macroinvertebrate fauna that indicated a High Ecological Status, further downstream at Mackmine Br (on Side Road) also was well represented by pollution sensitive organisms. The points monitored along River Slaney remains of Good ecological status / satisfactory condition, while stations on the tributaries of the Slaney River were assigned lower ecological ratings. All monitoring stations downstream of Bunclody were found to be in Good Ecological Status. The Upper Slaney Estuary (freshwater tidal) is remains of Good Ecological Status while the Lower Slaney Estuary (transitional) has been assigned Poor Ecological Status.

The River Slaney is crossed by 32 road bridges and one Railway Bridge. Some of the most prominent of these bridges include the crossing of the N11 at Ferrycarrig, Edermine Bridge, Deeps Bridge (between Ferrycarrig and Edermine Bridge), and Wexford Bridge at Wexford Town. Several weirs also occur on the River Slaney namely the weirs at Clohamon, Tullow and Baltinglass. These structures are considered to represent obstacles to upstream migration of a number of fish species. The River Slaney catchment is at risk from numerous threats and pressures such as diffuse agricultural pollution, acute pollution from waste water treatment facilities, water abstractions and morphological impacts from drainage works.

2. METHODS

The methods used during the current survey are given below. Ten aquatic survey locations were selected: 1 downstream of the proposed scheme in the tidal reach of the River Slaney, seven within the stretch of river directly affected by the proposed scheme, and two in the freshwater reaches of the River Slaney upstream of the proposed scheme. The aquatic ecology survey locations are provided in Table 1 and illustrated in Figure 3. Throughout the surveys, the document *IFI Bio-security Protocol for Field Survey Work* (IFI, 2010) was followed to prevent the potential spread of non-native invasive species.

2.1 River Physical Structure

2.1.1 River Habitat Survey

This survey was carried out following the '*River Habitat Survey in Britain and Ireland Field Survey Guidance Manual: 2003 Version*' published by the Environment Agency (EA, 2003). The survey forms utilised were the River Habitat Survey 2003 forms and all data fields for every site were completed.
All RHS site data was entered into the Rapid 2.1 access database developed by the Centre for Ecology and Hydrology (CEH). This database also allows for the generation of Habitat Modification Scores (HMS), Habitat Modification Classifications (HMC) and Habitat Quality Assessment (HQA) scores. These scores are generated as tables for completed RHS sites. Further details regarding the Habitat Modification Scores (HMS), Habitat Modification Classifications (HMC) and Habitat Quality Assessment (HQA) scores are provided in Appendix 1, while an example of the RHS survey forms used in the current assessment is given in Appendix 2.

2.1.2 River Hydromorphology Assessment

The Water Framework Directive 2000/60/EC requires Member States to classify rivers in terms of hydromorphology to support high ecological status (of fish, macrophytes, invertebrates and diatoms) and to put into place mitigation measures necessary to achieve at least "good" status and prevent further deterioration of the water body status. The River Hydro-morphological Assessment Technique (RHAT) method was used to assess the structural elements of the river corridor, and was applied at the three survey sites listed in Table 1. RHAT classifies river hydromorphology based on a departure from naturalness, and assigns a morphological classification directly related to that of the WFD: high, good, moderate, poor and bad, based on semi-qualitative and quantitative criteria. The eight criteria that are scored are:

1. Channel morphology and flow types;
2. Channel vegetation;
3. Substrate diversity and condition;
4. Barriers to continuity;
5. Bank structure and stability;
6. Bank and bank top vegetation;
7. Riparian land cover; and,
8. Floodplain interaction.

Collation of data for RHAT was aided by using RHAT description sheets, full survey sheets and spot-check sheets as in the River Hydromorphology Assessment Technique (RHAT) Training Guide (2009). A screen grab of the RAPID 2.1 RHS software data entry sheet developed by the Centre for Ecology and Hydrology (CEH) is shown in Figure 4.

Table 1: Survey locations on the River Slaney, Co. Wexford to inform studies in advance of the River Slaney (Enniscorthy) Flood Defence Scheme.

Site	Co-ordinates		Location	RHS[1]	RHA[2]	Biological sampling	Juvenile lamprey survey	General fish survey
	X	Y						
1	29754	13741	Ca. 100m downstream of proposed Flood Defence Scheme (LHS)				✓	✓
2	29719	13882	Adjacent to mouth of the River Urrin (RHS)	✓	✓		✓	✓
3	29748	13950	Slipway near hotel downstream of Seamus Rafter Bridge in Enniscorthy (RHS)			✓	✓	✓
4	29747	13985	Between the two road bridges in Enniscorthy			✓		✓
5	29732	14002	Railway Bridge at Enniscorthy (LHS)	✓	✓	✓	✓	✓
6	29735	14058	Ca. 650m upstream of Railway Bridge (LHS)				✓	
7	29758	14072	Ca. 620m upstream of Railway Bridge	✓	✓	✓	✓	✓
8	29772	14071	Ca. 1.1km upstream of Railway Bridge (LHS)					
9	29841	14489	Between Scarawalsh Bridge and N11, ca. 6km upstream of proposed FDS				✓	
10	29327	15479	Clohamon, ca. 19km upstream of proposed FDS			✓		

[1] River Habitat Survey, [2] River Hydromorphology Assessment

2.2 Macroinvertebrates

Semi-quantitative sampling of benthic macroinvertebrates was undertaken at five aquatic survey sites as indicated in Table 1 listed using kick sampling (Toner *et al*, 2005). The biological sampling procedure followed at each site involved the use of a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged on the river bed with its mouth directed upstream. The substrate upstream of the net was then kicked for one minute to dislodge invertebrates, which were subsequently caught in the net. This procedure was undertaken at three points along/across the watercourse. Stone washings and vegetation sweeps were also undertaken over a further 1 minute period to ensure a representative sample of the fauna present at each site was collected.

All three samples of invertebrates from each substation were combined and live sorted on the river bank for 20 minutes with the assistance of a headband magnifier. Specimens were fixed in a 10% formalin solution. Identification was undertaken in the laboratory using high-power and low-power binocular microscopes and macroinvertebrate keys produced by the Freshwater Biological Association.

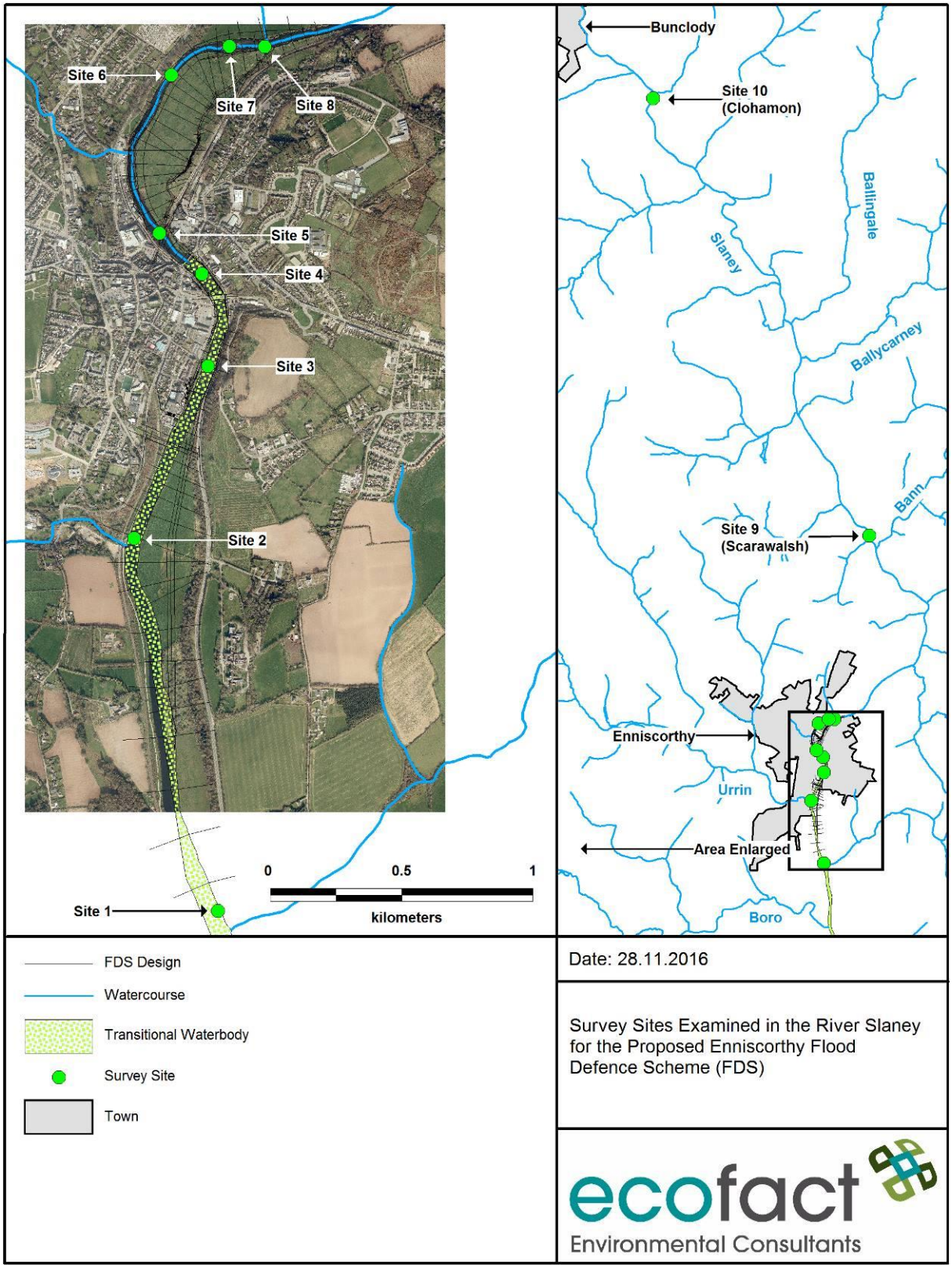

Figure 3: Aquatic ecology survey sites examined in the River Slaney for the proposed flood defence scheme.

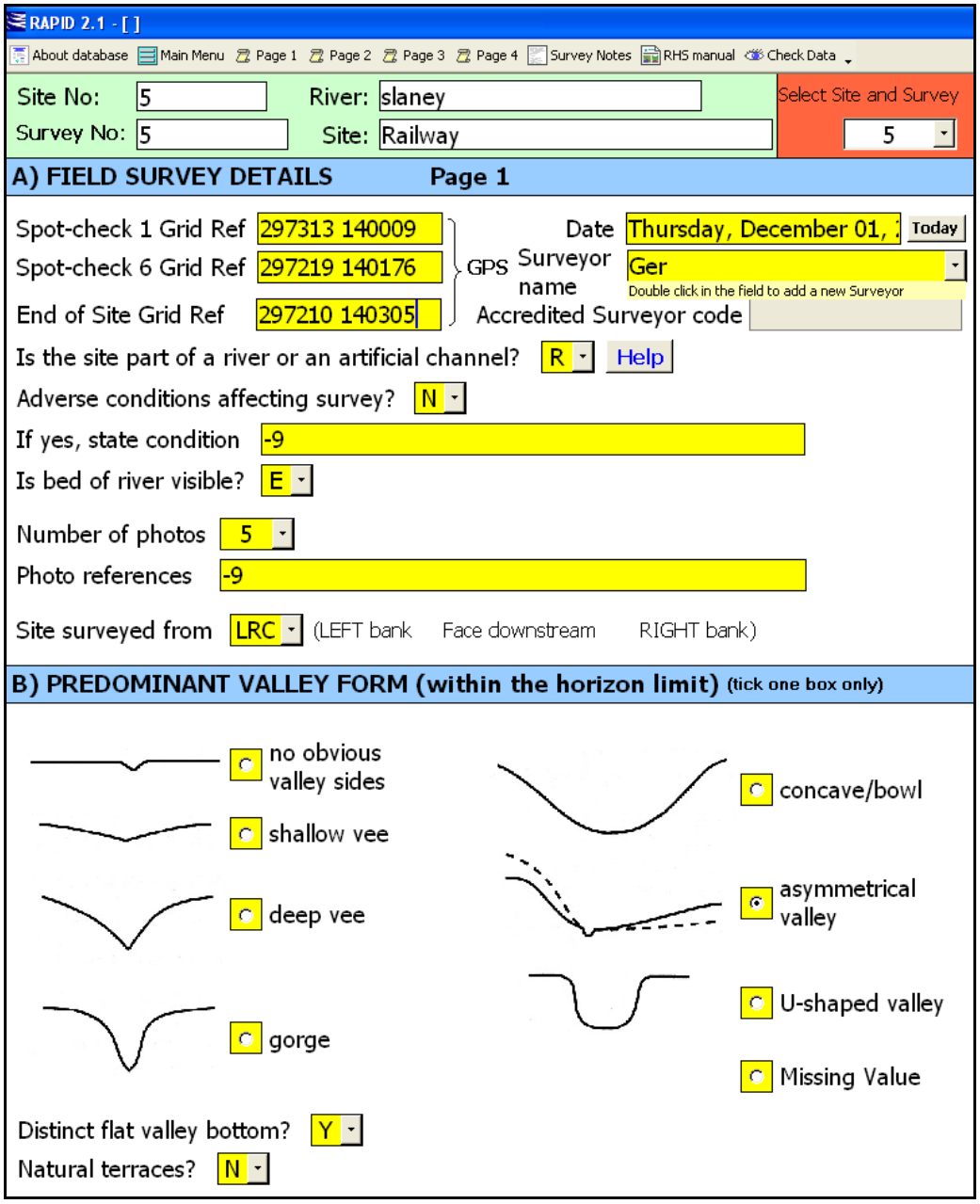

Figure 4: Screen grab of the RAPID 2.1 RHS software Access database developed by the Centre for Ecology and Hydrology (CEH).

2.1.3 Salmonid and Lamprey Habitats

The results of the river corridor survey were used in conjunction with the leaflet '*The Evaluation of habitat for Salmon and Trout*' (DANI, 1995) to assess habitat suitability for salmonids at Site 3, 5 and 7. These locations were selected on the basis that they are representative of the wider study area. This leaflet (Advisory leaflet No. 1) was produced by the Department of Agriculture for Northern Ireland Fisheries Division and was designed for use in the EU salmonid enhancement programme. An evaluation of lamprey nursery habitat was also carried out based on the habitat requirements of juvenile lampreys outlined in Maitland (2003).

2.3.1 Biological Water Quality Index

The Quality Rating (Q) System (Toner *et al*, 2005) is the standard biotic index which is used by the EPA and was used to assess biological water quality at each site. The Q-index is a quality measurement ranging from Q1-Q5 with Q1 being of the poorest quality and Q5 being pristine / unpolluted. The Quality Rating System has been shown to be a robust and sensitive measure of riverine water quality and has been linked with both chemical status and land-use pressures in catchments (Donohue *et al*., 2006). The system facilitates rapid and effective assessment of the water quality of rivers and streams. There are nine Q-value scores, ranging from 1 to 5 (intermediate scores such as Q4–5 are also possible). High ecological quality is indicated by Q5, Q4–5 while Q1 indicates bad quality.

Selected sites where aquatic macroinvertebrates were collected were assigned a Q-rating. It is noted that Site 3 and Site 4 were located on a stretch of the River Slaney that is influenced by the tide and is classed as a transitional water. These two sites were therefore not assigned a Q-rating, as this biological water quality index was designed for freshwater reaches where riffles are the focus of the sampling.

2.3 Lamprey Surveys

The River Slaney is known to support all three lamprey species that occur in Ireland (King and Linnane (2004). These are River Lamprey *Lampetra fluviatilis*, Brook Lamprey *L. planeri* and Sea Lamprey *Petromyzon marinus*. Maitland (2003) notes that all three species spawn in fresh waters, and juveniles of all three species, known as ammocoetes, are found within the same catchments in similar microhabitats, but with varying geographical distribution. Sea Lampreys and River Lampreys are migratory species and their distribution in rivers is often restricted to below migration barriers, such as weirs. Lampreys cannot jump or climb and are often restricted to below obstacles which salmonids have no difficulty passing (e.g. crump weirs). Lamprey surveys completed included lamprey habitat surveys, adult spawning surveys, and ammocoete surveys.

2.3.1 Adult Lamprey / Spawning Survey

The manual *Monitoring the River, Brook and Sea Lamprey, Lampetra fluviatilis, L. planeri and Petromyzon marinus* by Harvey and Cowx (2003) does not specify a methodology for monitoring adults except for using fish counters where available. In the current survey adult spawning surveys were completed during qualitative observations. Redd (nest) counts are an unreliable method for estimating population numbers, however red counts do provide a general assessment of the areas where lampreys spawn. Observations during the spawning season also assist in identifying areas used by different species as the juveniles of River Lampreys and Brook Lampreys cannot be distinguished by external examination. Spawning surveys are also useful for detecting Sea Lampreys where numbers are very low and larvae are unlikely to be detected during ammocoete surveys.

In view of the spawning times of the three lamprey species, the River Slaney was visited regularly between mid April 2016 and mid June 2016 (14th, 15th and 22nd April, 4th, 5th,14th, 15th and 26th May, 7th and 14th June). The focus of these visits was to examine potential spawning areas with reference to the document *Ecology of the River, Brook and Sea Lamprey* by Maitland (2003). Aggregations of adult lampreys and bed disturbances/depressions in gravels were sought by viewing the river from the bank and by wading instream. Polarised sunglasses were worn when appropriate to reduce glare and increase detection.

By exploring potential adult lamprey and spawning areas, an aim of this survey was to gain an understanding of the numbers and distribution of migratory lampreys in the mid-lower reaches of the river. In particular, the survey aimed to provide an insight into lamprey spawning within the stretch of river affected by the proposed scheme to help develop an opinion of the importance of this stretch. Areas outside of the proposed works area were also examined, including the River Slaney at Scarawalsh, Ballycarney and Clohamon, as well as the lower reaches of the River Bann and the Ballingale Stream.

2.3.2 Juvenile Lamprey Survey

A juvenile lamprey survey was completed using electrical fishing during July 2016. Electrical fishing was performed using a portable electrical fishing unit (Smith Root-LR 24 backpack) under authorisation from the Department of Communication, Energy and Natural Resources under Section 14 of the Fisheries Act (1980). Table 1 gives the electrical fishing locations and type of assessment carried out at each of the sites.

Electrical fishing for juvenile lampreys was carried out within $1m^2$ sub-site enclosures. Three $1m^2$ enclosures were surveyed at each site. Methodology for lampreys followed that outlined in *Monitoring the River, Brook and Sea Lamprey, Lampetra fluviatilis, L. planeri and Petromyzon marinus* (Harvey & Cowx, 2003). In each case, the enclosures were located in the most optimal juvenile lamprey habitats that could be found with reference to Maitland (2003): *Ecology of the River, Brook and Sea Lamprey*. Substrate characteristics at each sub-site were recorded. One fully quantitative assessment (3 depletion passes) was completed within three of the $1m^2$ enclosure across the survey area. It is noted however that no lampreys were recorded at one of these sites.

Captured lampreys were collected and placed into containers of river water after individual surveys, anaesthetised using a solution of 2-phenoxyethanol, counted and measured to the nearest mm on a measuring board. Identification of lampreys followed the manual *'Identifying Lamprey - A Field key for Sea, River and Brook Lamprey'* by Gardiner (2003). Subsequent to this, the lampreys were allowed to recover in a container of river water. All lampreys were released alive and spread evenly over the sampling area. Results of the investigations are presented using a Catch per Unit Effort (CPUE) index of lamprey number/m^2.

2.4 General Fish Survey

General fish surveys using electrical fishing assessments were also carried out at selected sites. The purpose of this survey was to provide information on the presence of Annex II listed fish species (Atlantic Salmon, Twaite Shad) and other fish (e.g. Brown Trout and European Eel) present at the selected sites. Sites were surveyed following the methodology outlined in the CFB guidance *Methods for the Water Framework Directive - Electric fishing in wadable reache*s. A portable electrical fishing unit (Smith Root-LR 24 backpack) was again used during the assessment.

Semi-quantitative electrical fishing was carried out continuously for a set time. Captured fish were collected into a container of river water and were then anaesthetised using a solution of 2-phenoxyethanol. Fish captured during sampling were recorded and identified with reference to the *Key to British Freshwater Fish with notes on their ecology and distribution* by Maitland (2004) and *Keys to Larval and Juvenile Stages of Coarse Fishes from Fresh Waters in the British Isles* by Pinder (2001). All fish were measured to the nearest mm using a measuring board. Fish were allowed to recover in a container of river water. All fish were released alive and spread evenly over the sampling area. Following completion of the fishing the dimensions and physical habitat characteristics of each site were recorded. Results of the investigations are presented using two Catch per Unit Effort (CPUE) indices: fish number/m^2 and fish number/minute.

3. RESULTS

3.1 River Physical Structure

3.1.1 River Habitat Survey

The Habitat Modification Score (HMS), Habitat Modification Classifications (HMC) and Habitat Quality Assessment (HQA) results the study area are presented in Table 2. Detailed results for all RHS sites across all parameters from the Rapid 2.1 database output are presented in Appendix 3. Total HQA scores for UK (and Irish) rivers tend to vary from 10 – 80; with scores for the current suite of RHS sites ranging between 24 and 32.

The River Slaney at Site 3 is influenced by the tide. This site attained a (HMS) of 210 and a (HMC) of 3, a value that signifies that a channel that has been 'obviously modified'. Resectioning, particularly along the left bank has taken place in the past and livestock have caused some poaching along this side of the channel. The HQA for Site 3 was 24. This low score was attributed to the generally low physical diversity in this part of the river and riparian areas.

Site 5 was allocated a HMS of 250 and a HMC of 3 implying that this stretch of the River Slaney has been 'obviously modified'. The presence of a Railway Bridge and an outfall at the right side of the channel contribute to this score. The HQA for this site was 33, achieved by a combination of physical attributes including mixed channel substrates, bank features as well as aquatic and terrestrial flora.

The HMS for Site 7 was 50 which suggests that this stretch of the River Slaney is 'predominantly unmodified'. This score was brought about by the occurrence of only low level modifications (bank resectioning and some poaching). The HQA for Site 5 was 32. This score was attained due to a combination of factors such as varied flow, mixed substrates and diverse bank features (including bank slippage).

Table 2: Results of the HMS* score, HMC* and HQA* scores for the River Slaney RHS sites.

Site	HMS Score	HMC	HQA score
3	210	3	24
5	250	3	33
7	50	2	32

*Habitat Modification Scores (HMS), Habitat Modification Classifications (HMC) and Habitat Quality Assessment (HQA) scores: See Appendix 1.

3.1.2 River Hydromorphology Assessment

The structural elements of the three sites where RHAT was carried out are summarised in Tables 3 (features of rivers) and Table 3 (flora and fauna). River type and condition categories / WFD status of the three sites are given in Table 5. The non-native plant Himalayan Balsam has become well established along the banks of the River Slaney within the study area. The occurrence of this undesirable plant can reduce the hydromorphological status of a river as it reduces the vegetation score and can negatively influence other factors used in assigning hydromorphological status. There is a stand of Japanese knotweed on the left bank near the Railway Bridge, another non-native invasive plant. The reach of the river downstream of Enniscorthy had the appearance of a channel that has been subject to some drainage in the past and where some resectioning may have been carried out, but vegetation has concealed same.

There are some anthropogenic alterations to hydromorphological quality elements (e.g. channel form and flow types, substrate condition) at all three sites, with subsequent deviation from those associated with that type under undisturbed conditions. The only element for which the subject stretch of river attains the maximum score is for barriers to continuity due to the absence of weirs dams and fish passes etc. Site 2, Site 5 and Site 7 had hydromorph scores of 0.51, 0.57 and 0.66 respectively so are classed as WFD hydromorphological 'Good' status using the RHAT scheme (score of >0.6 – 0.8 = Good).

3.1.3 Salmonid and Lamprey Habitats

The stretch of the River Slaney downstream of Enniscorthy is influenced by the tide. From observations at low tide, it is clear that there are numerous suitable spawning areas within this reach of the river. Due to the largely uniform character of the riverbed in this reach, it is difficult to predict the best spawning areas. Since the stretch of the River Slaney downstream of Enniscorthy is inundated at high tide times, it is considered that the spawning potential of the lower end of the study area is significantly reduced. Ova require well oxygenated substrates for survival and as such, the river reaches downstream of Enniscorthy may not be used for spawning purposes due to low flow at times of high tide. Indeed, no evidence of spawning was recorded in the River Slaney downstream of the Seamus Rafter Bridge in Enniscorthy during any of the 2016 surveys.

Table 3: Features of rivers subject to RHAT.

	Site 2	Site 5	Site 7
Resectioning	✓	✓	x
Reinforcement	x	✓	x
Embankments	x	x	x
Culverts	x	x	x
Over deepening	x	x	x
Over widening	x	x	x
Narrowing	x	x	x
Fords	x	x	x
Bridges	x	✓	x
Weirs	x	x	x
Fish pass	x	x	x
Deflectors	x	x	x
Jetties	x	x	x
Side channels	x	x	x
Mid channel bar	x	✓	x
Field drains	✓	x	x
Mill race	x	x	x
Arterial drainage	✓	x	x
Left bank	1.9m	1m	2m
Right bank	0.9m	0.8m	1.6m

Table 4: Flora and Fauna of sites subject to RHAT.

	Site 2	Site 5	Site 7
Rhododendron	x	x	x
Himalayan balsam	✓	✓	✓
Japanese knotweed	x	✓	x
Giant hogweed	x	x	x
Snowberry	x	x	x
Cherry laurel	x	x	x
Gunnera	x	x	x
Sycamore	x	✓	✓
Beech	x	x	x
Blackthorn	x	x	x
Oak	x	x	x
Ash	x	x	✓
Alder	✓	x	✓
Willow	✓	✓	✓
Hazel	x	x	x
Hawthorn	x	x	✓
Blackthorn	x	x	x
Heron	x	✓	✓
Sand martin	x	x	x
Grey wagtail	x	x	x
Dippers	x	x	x
Kingfishers	x	x	x
Sewage fungus	x	x	x
Diatomous algae	x	✓	✓
Oil	x	✓	x
Cladophora	✓	✓	✓
Vaucheria	x	x	x
Dumping	x	✓	x
Silt on substrate	✓	✓	✓
Instream Debris /Timber	✓	✓	✓

The stretch of the River Slaney within the study and above the influence of the tide has some areas deemed suitable for lamprey and salmonid spawning. There is a large proportion of the riverbed composed of gravel within this area, a substrate used by lampreys and salmon for spawning. The combination of flows and suitable substrate at the downstream end of pools in the study area provides good spawning conditions. For example, the downstream end of the deeper area downstream of the upper bridge and the downstream end of the sluggish stretch upstream of the Railway Bridge were deemed suitable in this regard. In the context of the overall proposed FDS, there are few areas within the River Slaney deemed suitable with respect to salmonid and lamprey spawning. Indeed, no Young of the Year (YOY) salmonids were recorded within the study area affected by the proposed FDS, indicating that it is not used extensively by salmonids for spawning. Numerous YOY salmon and trout were recorded at Scarawalsh during the surveys carried out in 2016. The three sites used to physically describe the affected stretch of the River Slaney were rated in terms of salmonid spawning, nursery and holding (See Table 6).

The substrates within the affected stretch of the River Slaney generally increase in size with distance upstream. For example, the bed of the river downstream of Enniscorthy was found to be composed mostly of gravel, sand and silt, while a substratum dominated by cobble/gravel was seen to occur within the town. The low gradient stretch of the river upstream of the town had a mixed substrate comprising rock, cobble, gravel, sand and silt. The ideal habitat for juvenile salmonids comprises fast flowing shallow water over rock/cobble substrate. This combination of factors occurs in only a few areas within the study area, namely in the fast waters around the upper bridge and Railway Bridge in Enniscorthy (with exception of times during high tide) and in the fast-flowing water near the upper extent of the proposed FDS. Overall, the stretch of the River Slaney affected by the proposed FDS is suboptimal in light of salmonid spawning and rearing.

Within the study area, depositing habitat in the river alongside the banks of the river are considered important with respect to the larval lampreys, which depend on soft substrates into which they can burrow. Many of the slower flowing areas of the River Slaney within the study area are considered suitable for the juvenile life stages of lampreys including deposited sand/silt associated with sluggish waters around pillars of bridges within the town of Enniscorthy.

3.2 Macroinvertebrates

Macroinvertebrate family richness, Q-ratings and corresponding Water Framework Directive (WFD) status at selected locations on the River Slaney are given in Table 7. The macroinvertebrates recorded at these survey locations are listed in Table A4.1. It is noted that Site 3 and Site 4 were located on a stretch of the River Slaney that is influenced by the tide and is classed as a transitional water. These two sites were therefore not assigned a Q-rating, as this biological water quality index was designed for freshwater reaches where riffles are the focus of the sampling. Such riffled habitat was not present at Sites 3 and 4.

Four families of mayfly (Ephemeroptera) were recorded in the study area: pollution sensitive Heptagenidae and less sensitive Seratellidae, Baetidae and Caenidae. Larvae of *Baetis rhodani* was the most frequently occurring mayfly which ranged from ‘fair numbers’ to ‘common’ across Sites 4, 5, 7 and 10. Larvae of *Heptagenia sulphurea* was ‘scarce’ and ‘present’ at Site 5 and Site 10 respectively. Larval *Seratella ignita* was ‘present’ at Site 5 but was not recorded elsewhere. The diversity of Plecoptera was limited to one family within the environs of Enniscorthy, where stonefly larvae of less sensitive *Leuctra* sp. was generally ‘scarce’. Pollution sensitive stonefly larvae of *Isoperla grammatica* was recorded at Site 10 (Clohamon). The Trichopterans (caddisflies) were a well represented group with five less sensitive taxa (cased) and three pollution tolerant (caseless) taxa recorded. Larvae of *Oecetis* sp. and *Hydropsyche pellucidula* were found to be distributed across the lower reaches of the River Slaney. Larvae of *Agapetus fuscipes, Goera pilosa, Lepidostoma* sp., *Rhyacophila dorsalis* and *Polycentropus kingi* has scattered distribution and were generally ‘scarce’. Only a single Odonate was recorded during the sampling – larvae of the damselfly *Agrion* sp. at Site 10. Larvae of the Alderfly *Sialis* sp. (Megaloptera) was recorded at Site 4.

Pollution tolerant true fly larvae (Diptera) were well represented in the study area with families Simulidae (*Similium* sp.), Tipulidae, Chironomidae and Ceratopogonidae recorded. Cranefly larvae were found throughout the study area where *Dicronata sp.* and *Tipula sp.* ranged in relative abundance from 'present' to 'common'. Simulid larvae were recorded at all locations with the exception of Site 3. Green chironomids were recorded at all sites. The Coeloptera (beetles) recorded were limited to *Limnius* sp. (Site 4, 5, 7, 10), *Gyrinus substriatus* (Site 5) and *Hydraena sp.* (Site 10). Gastropod Molluscs in four families were recorded. These were the snails *Lymnaea peregra, Planorbis carinatus*, *Bithynia tentaculata* and *Potamopyrgus antipodarium* as well the River Limpet *Ancylus fluviatilis*. It is noted that live *B. tentaculata* were recorded only at Site 10 but shells of this species were recorded at Ennsicorthy. The Orb Mussel *Pisidium* sp. was recorded at Site 4. It is noted that a specific Freshwater Pearl Mussel (FPM) survey was undertaken. During this study, live FPM and live Duck Mussel *Anodonta anatina* were recorded within the stretch of the river affected by the proposed development.

Macroinvertebrates in Class Crustacea were also recorded with the amphipods *Gammarus duebeni* and *Corophium* sp. occurring throughout and in the lower reach of the study area, in that order. The very tolerant Hog Louse *Asellus aquaticus* was 'present' at the three lower locations i.e. Site 3, 4 and 5. The Hemipteran (bug) *Aphelocheirus aestivalis* was recorded at all sites with the exception of Site 3, while Corixidae were recorded at Site 3 and Site 5. The very tolerant leeches *Erpobdella testacea* and *Glossiphonia complanata* were recorded at Site 3 with the former species also found at Site 4.

Table 5: River Cytomorphology Assessment Technique (RHAT) results. Maximum possible score for each parameter = 4 to yield a maximum score of 32.

	Site 2	Site 5	Site 7
River type	Lowland	Lowland	Lowland
Channel form and flow types	1	2	2
Channel vegetation	2	2	3
Substrate condition	2	2	3
Barriers to continuity	4	4	4
Bank structure and stability L+R	1.5+1.5	1+1	1.5+1.5
Bank vegetation L+R	0.5+1	1+1	0.5+1
Riparian Land cover L+R	0+1	0+0.5	0+0.5
Floodplain connectivity L+R	1+1	2+2	2+2
Total	16.5	18.5	21
Hydromorph score	0.51	0.57	0.66
WFD Class[1]	Good	Good	Good

[1]WFD Class > 0.8 = High, >0.6 – 0.8 = Good, >0.4 – 0.6 = Moderate, >0.2 - 0.4 = Poor, < 0.2 = Bad.

Table 6: Habitat rating of RHS sites (Following DCAL's advisory leaflet "*The Evaluation of habitat for Salmon and Trout*"). *Grade 1 is optimal habitat and habitat quality reduces with increasing grade (Grade 4 = poor).*

	Habitat Grades	%
Site 2	Spawning: 4	0
	Nursery: 4	0
	Holding: 2-3	50
Site 5	Spawning: 2	10
	Nursery: 2-3	50
	Holding: 3-4	10
Site 7	Spawning: 2	10
	Nursery: 2	70
	Holding: 3-4	15

Table 7: Macroinvertebrate family richness, Q-ratings and corresponding Water Framework Directive (WFD) status at selected locations on the River Slaney.

	Site 3	Site 4	Site 5	Site 7	Site 10
No. of different families	15	20	19	16	17
Q-rating	n/a	n/a	3-4	3	4
Corresponding WFD Status[1]	-	-	M	P	G

[1] H = High, G = Good, M = Moderate, P = Poor, B = Bad.

3.3 Lamprey Surveys

3.3.1 Spawning Survey

An account of lamprey activity is given below for each visit to the River Slaney between April and June 2016. Figure 5 shows records of Lamprey activity from May to July in the wider study area of the River Slaney (Enniscorthy) Flood Defence Scheme. Records of lamprey spawning and other important aquatic ecological observations within the study area are indicated in Figure 6. Figure 7 illustrates records of lamprey spawning. These areas are confined to upstream of the Seamus Rafter Bridge at Enniscorthy.

3.3.1.1 April 14th and 15th 2016

No lamprey spawning activity was observed or evidence of same recorded during the surveys carried out on the 14th and 15th April. Both the bridge at Ballycarney and Clohamon Weir were considered obstacles for upstream migrating lampreys. A Grey Heron was seen under the bridge at Clohamon on 14th April and was deemed to have been preying on River Lampreys. Indeed, a River Lamprey was found under the bridge thereafter and was probably removed from the river by the Heron which dropped its quarry upon being disturbed. This conclusion was based on the fact that the lamprey was still alive. The observation of a River Lamprey at Clohamon indicates that this species is able to negotiate the fast waters at bridges downstream, namely those at Scarawalsh and Ballycarney. Based on the mid April visit, it was obvious that River Lampreys were present in the river but had not started spawning.

During an investigation of the lower 600m reach of the Ballingale Stream, no lamprey activity or evidence of spawning was recorded, despite areas of ideal spawning habitat in this watercourse.

3.3.1.2 April 22nd 2016

Both Brook and River Lampreys were recorded during the April 22nd visit. A dead Brook Lamprey was recorded in the river between the two road bridges within the town of Enniscorthy. It was unclear if the area downstream of the upper bridge had been used by spawning lamprey as disturbances of the substrate may have been caused by anglers. One mature River Lamprey was recorded in the River Slaney approximately 20m upstream of the Railway Bridge (S97276 40075). Two redds believed to be those of Salmon were also detected in this area at the right side of the river.

A single River Lamprey was recorded near the upper end of the study area on 22nd (S97556 40705). Two redds considered to have been built by Brook Lampreys were recorded in the River Slaney at the end of the pool downstream of Scarawalsh Bridge. A mature River Lamprey was recorded in this area amongst floating river vegetation near the left side of the channel. A mature female Brook Lamprey laden with eggs was also recorded here. A redd deemed to be that of a River Lamprey was recorded near the right bank of the right channel of the River Slaney between Scarawalsh Bridge and the N11. Searches for spawning Lampreys and evidence of spawning (redds) was also carried out in the River Slaney at Ballycarney, Moyeady/Tombrick (large pool) and Clohamon. A disturbance considered to have been caused by a River Lamprey was noted in the main channel at the downstream end of the pool just downstream of the hydroelectric scheme tailrace.

The River Bann was surveyed from Bann Bridge (approximately 250m upstream of the Slaney River) to the River Slaney. Flow and substrate conditions at the end of the pool immediately downstream of Bann Bridge provide an ideal spawning habitat for lampreys and salmonids but no evidence of spawning was recorded here or elsewhere in the River Bann in the surveys carried out to date.

3.3.1.3 May 5th 2016

River Lampreys were recorded spawning in the River Slaney at several locations on the 5th May. Within the town of Enniscorthy, two River Lampreys were recorded redd building approximately 8m upstream of the upper bridge.

Five additional redds deemed to have resulted from lamprey spawning were recorded in this area upstream of the bridge. These redds were centred around the NOS grid reference S97413 39911. A large gathering of River Lampreys and spawning was considered to have taken place a short distance upstream of the Railway Bridge. Up to 25 redds were recorded between the Railway Bridge to approximately 70m upstream. Activity in this part of the river was concentrated towards the left side of the channel around S97321 40029. A pair of River Lampreys was seen nest building at one of these redds. Four redds were recorded at S97285 40052.

A stretch of the river approximately 800m upstream of the Railway Bridge was also found to be used as a spawning area, as evident by pockets of disturbed gravels. It is believed that most spawning in this area took place at an earlier stage with regard to the spawning downstream, as silt had already started to accumulate on some redds in this area. This part of the river was deeper and flows were faster during previous visits. Conditions at this earlier time were probably more suited to lamprey spawning but were not detected then. Three clusters of redds were recorded in this part of the river, at S97383 40628 (10+ redds), S97400 40648 (4 redds) and at S97434 40681 (2 redds).

Another lamprey spawning area was identified around the island within the river where flows are relatively high and depths are shallow. Two redds were recorded downstream of the island at S97551 40710 and a single redd at S97579 40704. The main area of spawning activity in this part of the river was at the end of the pool upstream of the island where approximately 25 redds were recorded. Some disturbances here could possibly have been caused by anglers however. At Scarawalsh, at least 10 redds most likely to have been those of River Lamprey were recorded at the end of the pool immediately downstream of the bridge. Three River Lampreys were recorded at one of these redds. Redds were not recorded in the River Slaney at Ballycarney, Moyeady/Tombrick (large pool) and Clohamon despite extensive searches being carried out.

3.3.1.4 May 26th 2016

On this date no lamprey activity was recorded in the footprint of the scheme. A walkover visual survey was undertaken at Scarawalsh, Ballycarney and Clohamon and no signs of lamprey activity was recorded. Flows were low on the day of the survey and visibility was good. The overall conclusion was that River Lampreys had finished spawning and there was no Sea Lamprey spawning activity. The Clohamon small hydroelectric scheme was inspected in detail on this day. The scheme was abstracting a significant volume of water on the day of the visit, and it is was clear that lampreys (and sea trout and salmon) would be able to enter the tailrace here.

3.3.1.5 June 7th 2016

The entire footprint of the proposed flood scheme was surveyed on this day to assess the presence / absence of adult Sea Lampreys. Expensive survey work was completed at Scarawalsh, Ballycarney and Clohamon. A single dead Sea Lamprey was found at Clohamon. This lamprey had been dead for some time and may have been killed by a predator. No other evidence of Sea Lamprey activity was recorded despite extensive searching.

3.3.1.6 June 14th 2016

The entire footprint of the proposed flood scheme was again surveyed on this day to assess the presence / absence of adult Sea Lampreys. Expensive survey work was completed at Scarawalsh, Ballycarney and Clohamon. On this day extensive snorkelling work was undertaken to look for Sea Lamprey redds. No evidence of Sea Lamprey activity was recorded.

3.3.2 Juvenile Lamprey Survey

Specific surveys were carried out for lampreys at seven locations on the River Slaney, including both semi-quantitative and quantitative assessments. Water levels during the course of these surveys were very low. In combination with good bright light, it is considered that electrical fishing was carried out under optimal conditions. A total of 268 juvenile (larval) lampreys were recorded. All were identified as River/Brook Lamprey. At the lower

end of the study area within the stretch affected by tidal fluctuations, lampreys were not recorded at Site 1 and Site 2. Near the upper limit of the tidally influenced reach of the Slaney Estuary (Site 3), only a single juvenile lamprey was recorded. The timing of the survey at these sites was designed to coincide with the low tide insofar as possible. It is noted that the surveys on this reach of the river were limited to the sides of the channel due to depth and occurrence of deep silt. On grounds of health and safety due to these substrate conditions, the sides of the channel were the focus of the survey at Site 1 and Site 2. Deeper areas also considered suitable for juvenile lampreys were recorded at these sites but could not be accessed. Selected physical characteristics of the juvenile lamprey sites investigated are provided in Table 8. Table 9 gives statistics for lampreys intercepted and Catch Per Unit Effort indices at each of the seven locations. Table 10 shows the results of the depletion electrical fishing for lampreys, with derivation of population estimates for these sites also shown. Figure 7 shows depletion lines for the numbers of fish captured during the quantitative electrical fishing investigations on the River Slaney. The results of the electrical fishing surveys examined on the River Slaney are discussed below by site.

3.3.2.1 Site 1

Site 1 was located on the left bank of a tidally influenced stretch of the River Slaney ca. 100m downstream of proposed Flood Defence Scheme. The substrates at this site were dominated by silt and deemed optimal for larval lampreys. Lampreys were not recorded within the three $1m^2$ areas surveyed. Only the shallows could be examined at this location owing to poor clarity. The mean depth at subsite A, B and C was 35cm, 15cm and 20cm respectively. Other areas regarded as suitable habitats were also checked for the presence of juvenile lampreys but were not found.

3.3.2.2 Site 2

Site 2 was located on the right side of the River Slaney Estuary adjacent to the mouth of the River Urrin. Lampreys were not detected at this site. There was a large accumulation of silt at this confluence. Electrical fishing was performed at subsite A, B and C where mean depths were 45cm, 40cm and 35cm in that order. The substrates at subsites B and C comprised of 100% silt. At subsite C, located directly adjacent to the bank in 100% shade, the substrate consisted of ca. 5% cobble, 55% gravel, 15% sand and 25% silt.

3.3.2.3 Site 3

Site 3 was located near the slipway close to the hotel situated on the right bank of the Slaney Estuary downstream of the Seamus Rafter Bridge in Enniscorthy. In general, the substrates at this site were deemed suboptimal – unsuitable for juvenile lampreys, due to the scarcity of soft substrates. Lampreys were not recorded at two of the three $1m^2$ areas surveyed at this location (subsite A and B). The substrates at subsite A consisted mainly of coarse sand while that of subsite B comprised a mix of sand and silt. Subsite C had a substrate combination of sand and silt. A single juvenile River/Brook Lamprey of 4.5cm long was recorded here, where shade was at ca. 20%.

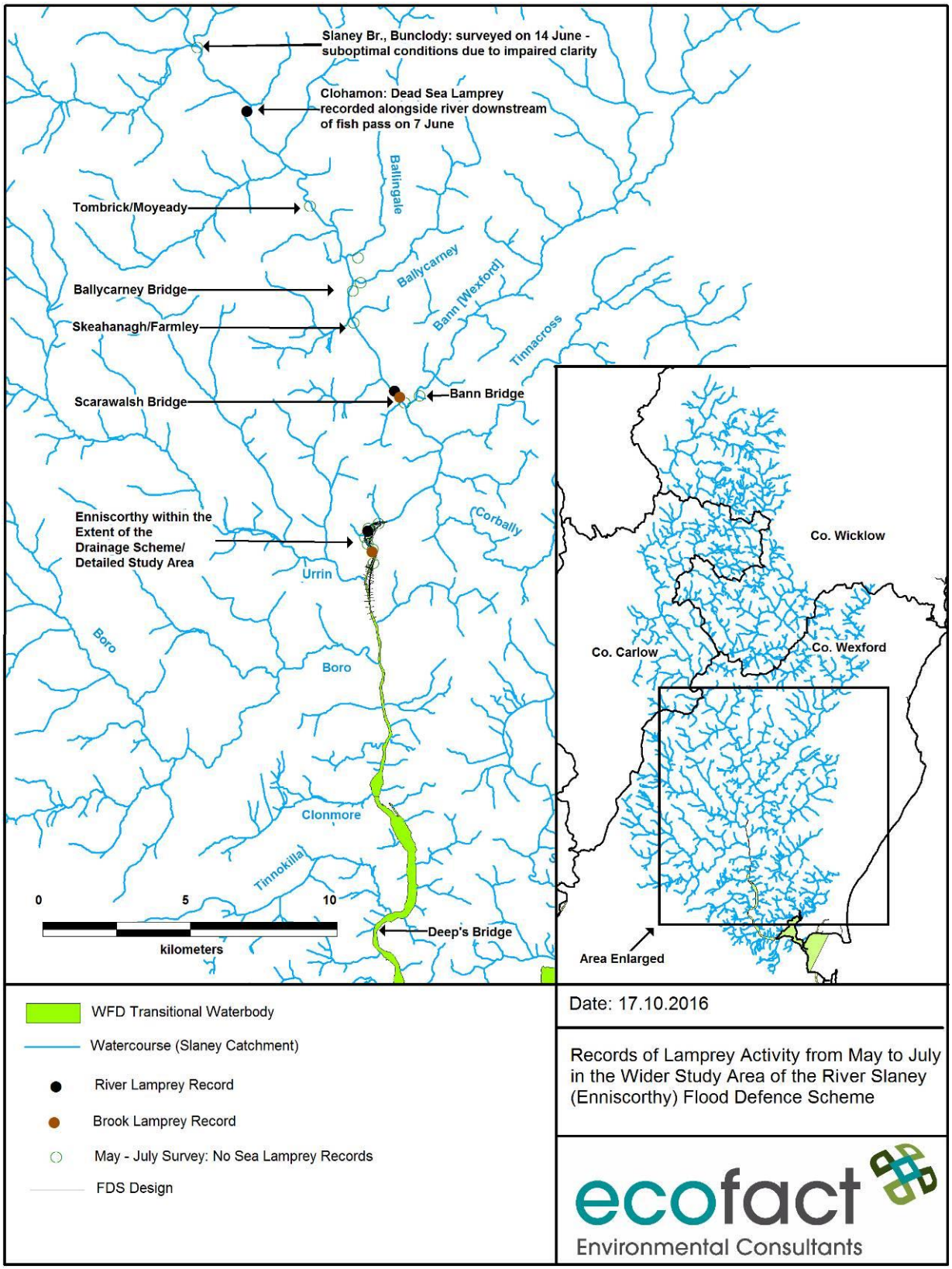

Figure 5: Records of Lamprey activity from May to July in the wider study area of the River Slaney (Enniscorthy) Flood Defence Scheme.

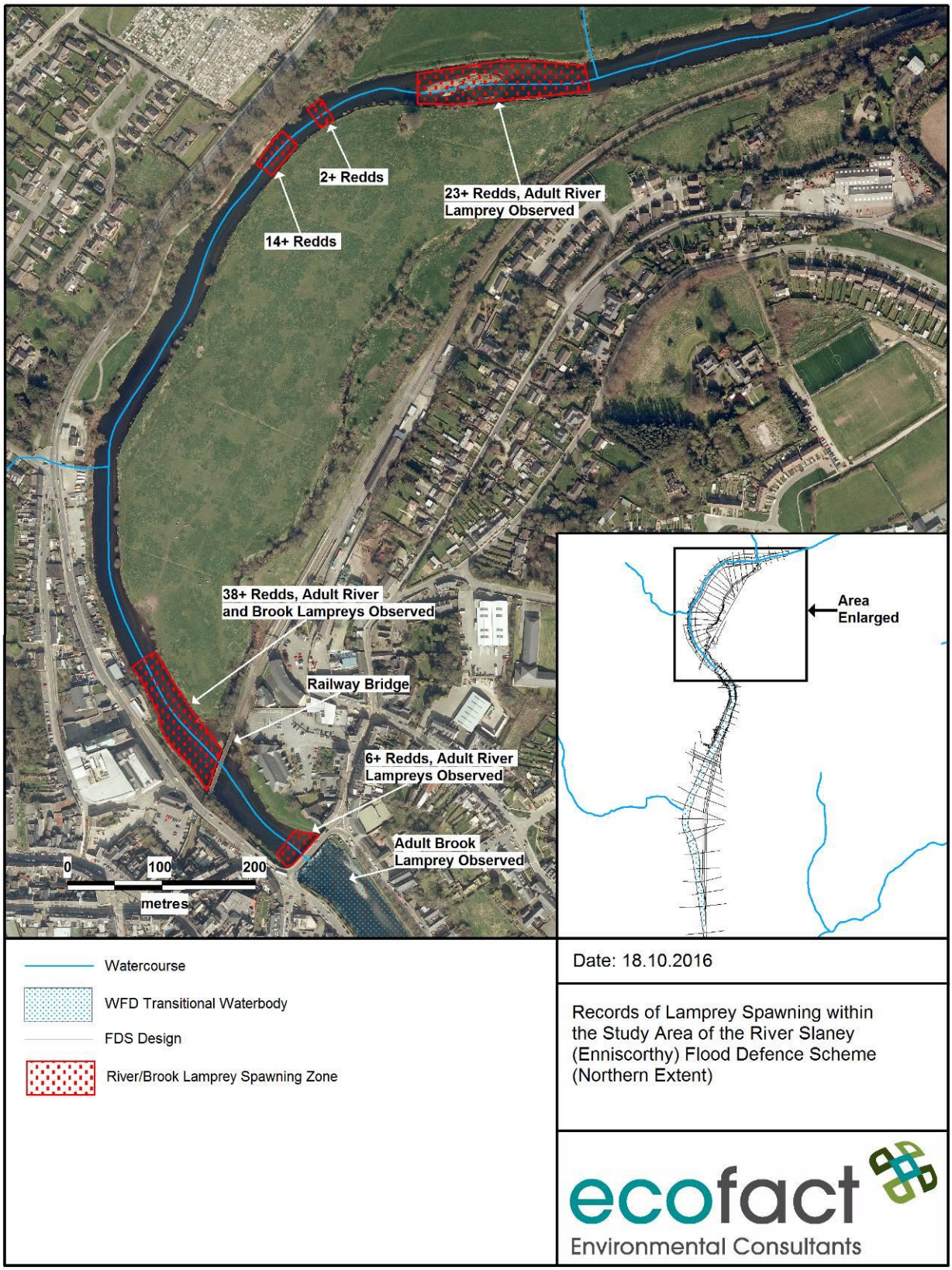

Figure 6: Records of lamprey spawning within the study area of the River Slaney (Enniscorthy) Flood Defence Scheme.

Table 8: Substrate compositions at the sites surveyed for lampreys on the Slaney River during July 2016.

Site	Sub-site	%							Mean depth (cm)
		Cobble	Gravel	Sand	Silt	Clay	Shade	Vegetation cover	
1	A	0	0	0	100	0	30	0	35
	B	0	0	0	100	0	25	20	15
	C	0	5	75	20	0	0	25	20
2	A	0	0	0	100	0	100	0	45
	B	0	0	0	100	0	0	0	40
	C	5	55	15	25	0	100	0	35
3	A	10	20	70	0	0	5	0	15
	B	0	0	50	50	0	30	0	25
	C	0	5	40	55	0	20	0	20
5	A	0	0	50	40	10	0	0	10
	B	0	0	50	40	10	20	10	20
	C	0	0	60	30	10	0	0	20
6	A	0	0	80	15	15	0	0	5
	B	0	0	30	50	20	10	5	20
	C	0	0	25	60	15	0	0	20
8	A	40	30	25	5	0	0	0	30
	B	0	0	15	60	25	0	0	15
	C	15	15	10	55	5	0	0	20
9	A	0	0	60	30	10	10	0	15
	B	0	0	30	65	5	0	40	40
	C	0	0	60	40	0	10	0	10

Table 9: Summary statistics (length) and Catch Per Unit Effort (CPUE) indices for lampreys intercepted at electrical fishing sites on the River Slaney in July 2016.

Site	Sub-site	SQ / Q[1]	N	Length descriptive statistics				Area (m^2)	Lampreys/m^2
				Mean	Min	max	St. dev		
1	A	SQ	0	-	-	-	-	1	0
	B	SQ	0	-	-	-	-	1	0
	C	SQ	0	-	-	-	-	1	0
2	A	SQ	0	-	-	-	-	1	0
	B	SQ	0	-	-	-	-	1	0
	C	SQ	0	-	-	-	-	1	0
3	A	SQ	0	-	-	-	-	1	0
	B	SQ	0	-	-	-	-	1	0
	C	SQ	1	4.5	4.5	4.5	-	1	1
5	A	SQ	34	4.8	2	8	1.4	1	34
	B	Q	79	5.3	1.1	9.3	1.6	1	79
	C	SQ	11	5.2	2.8	9.2	2.3	1	11
6	A	SQ	17	6.7	3.8	9.2	1.5	1	17
	B	SQ	20	6.1	1.4	9.6	2.1	1	20
	C	SQ	18	5.6	3.4	8.2	1.7	1	18
8	A	SQ	2	7.5	5.8	9.1	2.3	1	2
	B	Q	21	5.2	2.5	7.2	0.9	1	21
	C	SQ	8	4.4	1.4	6.8	1.8	1	8
9	A	SQ	18	6.7	4.1	9.3	1.7	1	18
	B	SQ	26	6.7	3.8	10	1.6	1	26
	C	SQ	13	7.6	6.4	9.5	1.3	1	13

[1] SQ = semi-quantitative; Q = quantitative.

Table 10: Results of the depletion electrical fishing surveys at subsite 5B and 8B and population estimate/m^2.

	5B	8B
Pass 1	44	10
Pass 2	24	6
Pass 3	11	4
Total	75	20
Population estimate (lampreys/m^2)	86	26

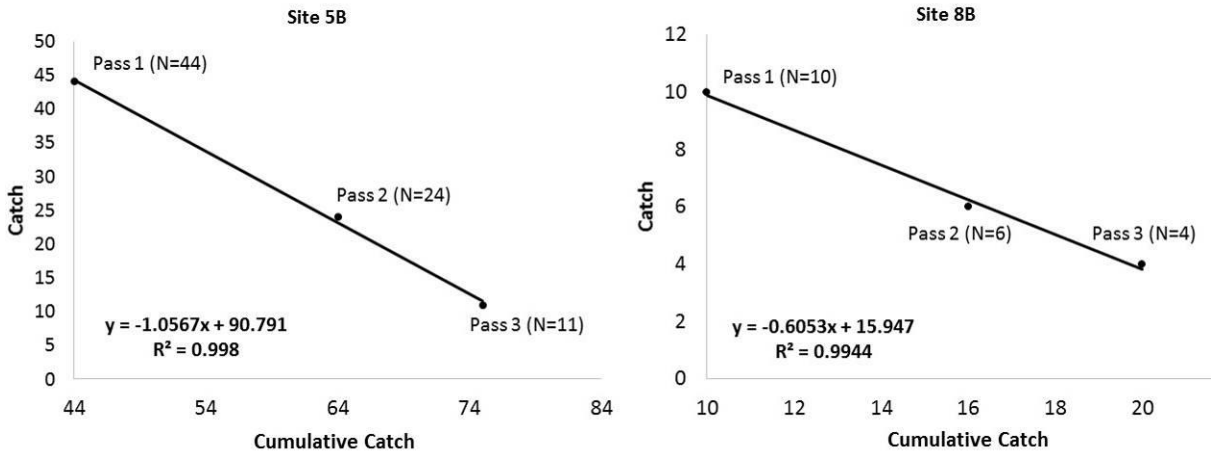

Figure 7: Depletion lines, Leslie-Davies method, for the numbers of lampreys captured during the quantitative electrical fishing investigations on the River Slaney (Site 5B and Site 8B).

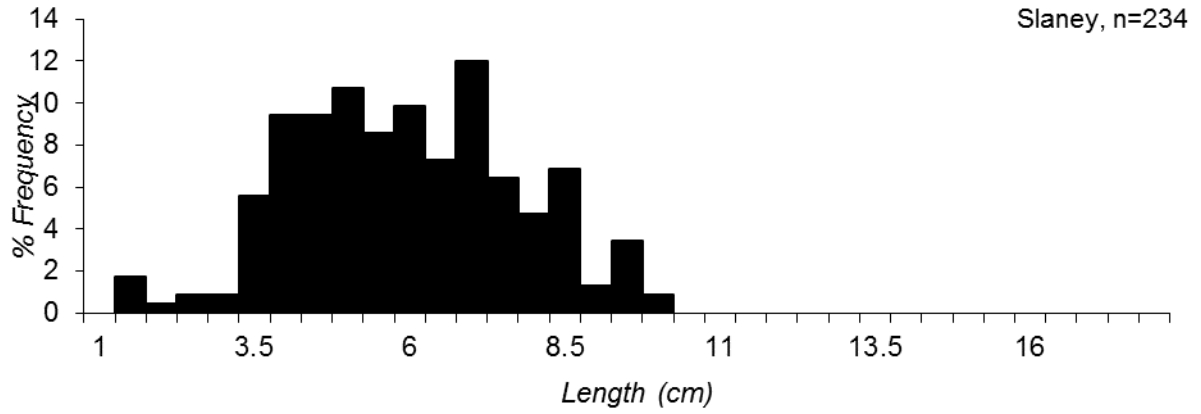

Figure 8: Length (cm) percentage frequency distribution of 234 River/Brook Lamprey ammocoetes from the July 2016 survey. This is a typical size distribution of a *Lampetra fluviatils* dominated population which metamorphose earlier (and smaller) and migrate to the sea/estuary to feed.

3.3.2.4 Site 5

Site 5 was located on the left side of the river in the environs of the Railway Bridge at Enniscorthy. The general substrate composition of the surveyed areas was sand (50%), silt (40%) and clay (10%). Subsites A and C were fully exposed while subsite B was ca. 20% shaded. Semi-quantitative surveying was carried out at subsite A and C where 34 and 11 juvenile River/Brook Lampreys were recorded respectively. Quantitative electrical fishing was carried out at subsite B where a total of 86 River/Brook Lampreys were captured. In the first, second and third pass, 44, 24 and 11 River/Brook Lampreys were intercepted in that order. The depletion at this location was plotted graphically and the regression equation of y = -1.0567x + 90.791 indicates a population estimate of 86 River/Brook Lampreys/m^2. This is deemed reasonably accurate considering the R^2 value of 0.998.

The River/Brook Lampreys recorded at this site ranged in length from 1.1cm to 9.2cm. The small size of some individuals indicate that the nearby habitats are likely to be used spawning adults.

3.3.2.5 Site 6

Site 6 was located on the left side of the river ca. 650m upstream of the Railway Bridge at Enniscorthy. The substrates at this site were influenced by a partially submerged large slab of concrete projecting from the bank out into the river, which resulted in adjacent deposits of fine materials (sand, silt and clay). River/Brook Lampreys were recorded at $1m^2$ subsite A, B and C in the order 17, 20 and 18. These fish ranged in length from 1.4cm to 9.2cm. The substrates at the river margins along this part of the river were considered the most suitable for larval lampreys.

3.3.2.6 Site 8

Site 8 was located on the left side of the river ca. 1.1km upstream of the Railway Bridge at Enniscorthy. At subsite A, located ca. 5m from the bank at a mean depth of ca. 30cm, the substrate comprised cobble (ca. 40%), gravel (ca. 30%), sand (ca. 25%) and clay (ca. 5%). Only 2 River/Brook Lampreys were recorded here. Subsites B and C were located in a silt bed next to the verge of the river where the mean depth was 15cm and 20cm respectively. Semi-quantitative surveying was carried out at subsite C where 8 juvenile River/Brook Lampreys were recorded.

Quantitative electrical fishing was carried out at subsite B where a total of 21 River/Brook Lampreys were captured. Ten, six and 4 River/Brook Lampreys were intercepted in the first, second and third pass, in that order. The depletion recorded returned the linear equation y = -0.6053x + 15.947 (R^2 = 0.9944), signifying a population estimate of 26 River/Brook Lampreys/m^2.

The River/Brook Lampreys recorded at this site ranged in length from 1.4cm to 9.2cm, indicating that the nearby habitats are likely to be used spawning adults.

3.3.2.7 Site 9

Site 9 was located between Scarawalsh Bridge and the N11 approximately 5km upstream of the proposed flood defence scheme. The substrates at the subsites at this location were dominated by sand and silt, and were deemed optimal juvenile lamprey habitats. River/Brook Lampreys were intercepted at subsite A (N=18), B (N=26) and C (N=13). The mean length of these fish at subsite A and B was 6.7cm, and 7.6cm at subsite C. The minimum and maximum length of River/Brook Lampreys recorded at this site was 3.8cm and 10cm in that order.

3.4 General Fish Survey

The characteristics of the general fish survey sites examined on the River Slaney in July 2016 are presented in Table 11. Fish species recorded and summary statistics (length) for fish intercepted at the selected sites are listed in Table 12 and Table 13 respectively. Catch Per Unit Effort (CPUE) indices for fish caught per site by

fish/minute and fish/m^2 are shown in Table 14. A total of 199 fish were captured during the collective fishings carried out at the six sites surveyed (continuous fishing time of 50 minutes). It is noted that electrical fishing was restricted to the margins of the river at Sites 1 and 2 due to the increasing depth away from the bank combined with soft substrates.

The species recorded were Minnow *Phoxinus phoxinus* (N=135), European Eel *Anguilla anguilla* (N=24), Three-spined Stickleback (N=20), Stone Loach *Barbatula barbatula* (N=12), Flounder *Platichthys flesus* (N=4), Atlantic Salmon *Salmo salar* (N=2) and Brown Trout *Salmo trutta* (N=2). The results for each site are discussed below.

3.4.1 Site 1

An area of ca. 68m^2 was surveyed at this location, corresponding to a length of 17m long X 4m wide. The substrates at this site were mainly of cobble (ca. 40%) and gravel (ca. 40%) with a smaller proportion of fines (ca. 20%). The water within the area fished was characteristic of the channel at large, being sluggish.

Two species were recorded at this site: Three-spined Stickleback (N=5) and Minnow (N=4). The Three-spined Stickleback and Minnow had mean lengths of 3.1cm and 5.7cm in that order.

Table 11: Characteristics of the general fish survey sites examined on the River Slaney in July 2016.

	1	2	3	4	5	7
Length fished (m)	17	20	11	10	24	40
Width fished (m)	4	3.5	6	7.5	5	5.5
Area fished (m^2)	68	70	66	75	120	220
Time fished (min)	5	5	5	5	10	20
Mean depth (cm)	50	60	50	45	55	40
Maximum depth (cm)	100	100	90	80	95	90
Rock (%)	0	5	25	0	20	5
Cobble (%)	40	20	35	25	40	50
Gravel (%)	40	45	20	65	30	40
Fine (%)	20	30	20	10	10	5
Riffle (%)	0	0	0	35	30	60
Glide (%)	0	10	20	45	50	35
Pool (%)	100	90	80	20	20	10
Shade (%)	0	15	0	0	20	0
Instream vegetation (%)	10	20	0	0	5	5

Table 12: Fish species recorded at selected aquatic ecology survey sites on the River Slaney, Co. Wexford in July 2016 to inform studies in advance of the proposed River Slaney (Enniscorthy) Flood Defence Scheme.

Species	Site					
	1	2	3	4	5	7
Atlantic Salmon *Salmo salar*					□	□
Brown Trout *Salmo trutta*					□	□
European Eel *Anguilla anguilla*			□	□	□	□
Three-spined Stickleback *Gasterosteus aculeatus*	□	□	□	□	□	
Stone Loach *Barbatula barbatula*				□	□	□
Minnow *Phoxinus phoxinus*	□	□	□	□	□	□
Flounder *Platichthys flesus*			□		□	□

3.4.2 Site 2

During the 5-minute electrical fishing survey carried out at this location, an area of ca. 70m^2 was examined. The substrate at this site comprised rock (ca. 5%), cobble (ca. 20%), gravel (ca. 45%) and fine (ca. 30%). Three-spined Stickleback (N=3) and Minnow (N=15) were the only fish species recorded at this site. The Minnow had a mean length of 5.7cm and ranged in length from 5.2cm to 7cm.

3.4.3 Site 3

A band of length of 11m and 6m wide adjacent to the bank was surveyed at Site 3, equivalent to an area of ca. 66m^2. The substrate at this site comprised rock (ca. 25%), cobble (ca. 35%), gravel (ca. 20%) and fine (ca. 20%). Flow was generally sluggish at this location and instream vegetation was not recorded. The most frequently recorded fish at this site was Minnow (N=19) followed by Flounder (N=2), with a single European Eel (9.5cm) and Three-spined Stickleback (5.7cm) recorded. The Minnows had a mean length of 3cm. Young of the year (YOY) Minnow were recorded which had lengths of 0.6-1cm.

3.4.4 Site 4

Site 4 was located between the two bridges within Enniscorthy. An area of ca. 75m^2 was surveyed here, where the substrate was mostly of gravel (ca. 65%). There were varied flows at this location: riffle (ca. 35%), glide (ca. 45%) and pool (ca. 20%). European Eel (N=3), Stone Loach (N=7), Minnow *P. phoxinus* (N=38) and Three-spined Stickleback (N=3) were the species recorded. The Minnow ranged in length from 1.6cm to 7.3cm with a mean length of 5.6cm. The minimum and maximum length of Stone Loach was 6cm and 8.3cm respectively.

3.4.5 Site 5

Site 5 was located in the environs of the Railway Bridge at Enniscorthy. During this 10 minute survey, an area of ca. 120m^2 was covered. The substrates consisted of rock (ca. 20%), cobble (ca. 40%), gravel (ca. 30%) and fine (ca. 10%). The extent of larger type substrates provided suitable habitat for European Eel and Stone Loach. Flows were varied at ca. 30% riffle, 50% glide and 20% pool. The species recorded were Minnow *P. phoxinus* (N=16), Three-spined Stickleback (N=8), Stone Loach *B. barbatula* (N=3), European Eel *A. anguilla* (N=2), Flounder *P. flesus* (N=1), Atlantic Salmon *Salmo salar* (N=1) and Brown Trout *S. trutta* (N=1).

3.4.6 Site 7

Site 7 was located at the upper extent of the proposed FDS. A 20 minute survey was carried out over an area of ca. 220m^2. The surveyed area included part of a braided channel on the right side of an exposed gravel bar. The substrates at this location were mostly of cobble (ca. 50%) and gravel (ca. 40%), with occasional rock and patches of fine material. Flow was generally fast this site and riffle accounted for ca. 60% of the channel. Instream vegetation cover was in the order of 5%. Five fish species were recorded: Minnow *P. phoxinus* (N=47), European Eel *Anguilla anguilla* (N=18), Stone Loach *B. barbatula* (N=2), Flounder *P.flesus* (N=1), Atlantic Salmon *S. salar* (N=1) and Brown Trout *S. trutta* (N=1).

Table 13: Summary statistics (length) for fish intercepted at electrical fishing sites investigated in the River Slaney in July 2016.

Site	Species	N	Length descriptive statistics			
			Mean	Min	Max	St. Dev.
1	Atlantic Salmon *Salmo salar*	0	-	-	-	-
	Brown Trout *Salmo trutta*	0	-	-	-	-
	European Eel *Anguilla anguilla*	0	-	-	-	-
	Three-spined Stickleback *Gasterosteus aculeatus*	5	3.1	2.5	3.6	0.5
	Stone Loach *Barbatula barbatula*	0	-	-	-	-
	Minnow *Phoxinus phoxinus*	4	5.7	5.3	6.1	0.4
	Flounder *Platichthys flesus*	0	-	-	-	-
2	Atlantic Salmon *Salmo salar*	0	-	-	-	-
	Brown Trout *Salmo trutta*	0	-	-	-	-
	European Eel *Anguilla anguilla*	0	-	-	-	-
	Three-spined Stickleback *Gasterosteus aculeatus*	3	3.3	2.7	3.6	0.5
	Stone Loach *Barbatula barbatula*	0	-	-	-	-
	Minnow *Phoxinus phoxinus*	15	5.7	5.2	7.0	0.5
	Flounder Platichthys flesus	0	-	-	-	-
3	Atlantic Salmon *Salmo salar*	0	-	-	-	-
	Brown Trout *Salmo trutta*	0	-	-	-	-
	European Eel *Anguilla anguilla*	1	9.5	9.5	9.5	-
	Three-spined Stickleback *Gasterosteus aculeatus*	1	5.7	5.7	5.7	-
	Stone Loach *Barbatula barbatula*	0	-	-	-	-
	Minnow *Phoxinus phoxinus*	19	3.0	0.6	7.1	2.8
	Flounder *Platichthys flesus*	2	7.3	6.5	8	1.1
4	Atlantic Salmon *Salmo salar*	0	-	-	-	-
	Brown Trout *Salmo trutta*	0	-	-	-	-
	European Eel *Anguilla anguilla*	3	11.6	10.6	12.8	1.1
	Three-spined Stickleback *Gasterosteus aculeatus*	3	2.5	2.4	2.7	0.2
	Stone Loach *Barbatula barbatula*	7	7.1	6	8.3	0.7
	Minnow *Phoxinus phoxinus*	38	5.6	1.6	7.3	1.2
	Flounder *Platichthys flesus*	0	-	-	-	-
5	Atlantic Salmon *Salmo salar*	1	11.2	11.2	11.2	-
	Brown Trout *Salmo trutta*	1	15.7	15.7	15.7	-
	European Eel *Anguilla anguilla*	2	15	10	20	7.1
	Three-spined Stickleback *Gasterosteus aculeatus*	8	2.3	1.2	3.4	0.8
	Stone Loach *Barbatula barbatula*	3	8.3	7.8	9.2	0.8
	Minnow *Phoxinus phoxinus*	16	3.5	2.2	5.6	0.8
	Flounder Platichthys flesus	1	6	6	6	-
7	Atlantic Salmon *Salmo salar*	1	10	10	10	10
	Brown Trout *Salmo trutta*	1	10.5	10.5	10.5	-
	European Eel *Anguilla anguilla*	18	11.8	9	22	3.8
	Three-spined Stickleback *Gasterosteus aculeatus*	0	-	-	-	-
	Stone Loach *Barbatula barbatula*	2	4.7	1.8	17.5	3.3
	Minnow *Phoxinus phoxinus*	47	3.9	1.8	7.7	1.7
	Flounder *Platichthys flesus*	1	8	8	8	-

Table 14: Catch Per Unit Effort indices for fish caught per site at electrical fishing sites investigated River Slaney in July 2016.

Site	Species	N	Length descriptive statistics			
			Time (mins)	Fish / min	Area (m^2)	Fish / m^2
1	Atlantic Salmon *Salmo salar*	0	5	0	68	0
	Brown Trout *Salmo trutta*	0	5	0	68	0
	European Eel *Anguilla anguilla*	0	5	0	68	0
	Three-spined Stickleback *Gasterosteus aculeatus*	5	5	1	68	0.07
	Stone Loach *Barbatula barbatula*	0	5	0	68	0
	Minnow *Phoxinus phoxinus*	4	5	0.8	68	0.06
	Flounder *Platichthys flesus*	0	5	0	68	0
2	Atlantic Salmon *Salmo salar*	0	5	0	70	0
	Brown Trout *Salmo trutta*	0	5	0	70	0
	European Eel *Anguilla anguilla*	0	5	0	70	0
	Three-spined Stickleback *Gasterosteus aculeatus*	3	5	0.6	70	0.04
	Stone Loach *Barbatula barbatula*	0	5	0	70	0
	Minnow *Phoxinus phoxinus*	15	5	3	70	0.21
	Flounder *Platichthys flesus*	0	5	0	70	0
3	Atlantic Salmon *Salmo salar*	0	5	0	66	0
	Brown Trout *Salmo trutta*	0	5	0	66	0
	European Eel *Anguilla anguilla*	1	5	0.2	66	0.02
	Three-spined Stickleback *Gasterosteus aculeatus*	1	5	0.2	66	0.02
	Stone Loach *Barbatula barbatula*	0	5	0	66	0.00
	Minnow *Phoxinus phoxinus*	19	5	3.8	66	0.29
	Flounder *Platichthys flesus*	2	5	0.4	66	0.03
4	Atlantic Salmon *Salmo salar*	0	5	0	75	0
	Brown Trout *Salmo trutta*	0	5	0	75	0
	European Eel *Anguilla anguilla*	3	5	0.6	75	0.04
	Three-spined Stickleback *Gasterosteus aculeatus*	3	5	0.6	75	0.04
	Stone Loach *Barbatula barbatula*	7	5	1.4	75	0.09
	Minnow *Phoxinus phoxinus*	38	5	7.6	75	0.51
	Flounder *Platichthys flesus*	0	5	0	75	0
5	Atlantic Salmon *Salmo salar*	1	10	0.1	120	0.01
	Brown Trout *Salmo trutta*	1	10	0.1	120	0.01
	European Eel *Anguilla anguilla*	2	10	0.2	120	0.02
	Three-spined Stickleback *Gasterosteus aculeatus*	8	10	0.8	120	0.07
	Stone Loach *Barbatula barbatula*	3	10	0.3	120	0.03
	Minnow *Phoxinus phoxinus*	16	10	1.6	120	0.13
	Flounder *Platichthys flesus*	1	10	0.1	120	0.01
7	Atlantic Salmon *Salmo salar*	1	20	0.05	220	0
	Brown Trout *Salmo trutta*	1	20	0.05	220	0
	European Eel *Anguilla anguilla*	18	20	0.9	220	0.08
	Three-spined Stickleback *Gasterosteus aculeatus*	0	20	0	220	0
	Stone Loach *Barbatula barbatula*	2	20	0.1	220	0.01
	Minnow *Phoxinus phoxinus*	47	20	2.35	220	0.21
	Flounder *Platichthys flesus*	1	20	0.05	220	0

4. EVALUATION

The affected stretch of the River Slaney is included in the Slaney River Valley cSAC and is evaluated as 'Internationally Important'.

5. DISCUSSION

The current survey has shown that the footprint of the proposed scheme provides an important habitat for River Lamprey. Brook Lampreys are also present but the results of the current survey suggest that *L. fluviuatils* dominates. River Lampreys are a key conservation interest of the Slaney River Valley SAC. They are currently listed as being of favorable conservation status in Ireland. However, this conservation status assessment is primarily due to the fact that juveniles of River and Brook Lampreys cannot be distinguished and the two species are grouped together in the Article 17 assessment. The non-migratory Brook Lamprey is widely distributed in Ireland and is generally doing well. However, River Lamprey are generally confined to the lower reaches of rivers as they have difficultly passing weirs and other barriers. This makes them vulnerable and it is likely that their true conservation status is less than favorable. The migratory Sea Lamprey is currently at unfavourable conservation status nationally, and River Lampreys are subject to the same pressures and threats.

River Lampreys enter rivers in two distinct runs – one in the autumn and one again peaking in the spring. This strategy may allow this species to penetrate farther up river systems by taking advantage of flooding to pass barriers etc. It has been reported by King & Linnane (2004) that "*a major site of River Lamprey spawning was recorded downriver of Aghade Bridge*" by IFI staff. This site is located in the upper reaches of the River Slaney, well above Clohamon weir. King & Linnane (2004) also report that River Lampreys were captured by fyke netting upstream of Clohamon weir during a survey completed during the period October to December 2001, and that River Lamprey specimens were also recorded at Derry "*as early as July*" by IFI staff. It is noted that there are no records of Sea Lampreys above Clohamon weir and King & Linnane (2004) only recorded this species below that weir. During the current assessment, a number of inspections of Clohamon weir were undertaken and at all times it was concluded that the weir would act as a barrier to River Lamprey migration under normal ambient conditions.

It is not known how River lampreys pass Clohamon weir and it is clear that this is still a major fish migration barrier. One possible mechanism by which River Lampreys could pass this weir would be if the weir was flooded out as this would potentially provide a pathway along the right bank under the normally dry arch by which River Lampreys could possibly pass upstream. However, such conditions were not observed during the current survey and it is likely that such a passage opportunity at this weir may not always occur. Another mechanism would be that the lampreys find small leaks and holes in the weir and pass upstream though these. This issue was discussed with Dr. Jimmy King of Inland Fisheries Ireland in January 2017 and it is accepted that at least some River Lampreys can pass Clohamon weir. It is concluded that migratory River Lampreys could potentially pass Clohamon weir if flood conditions flooded the dry arch of the bridge during a period when River Lampreys were migrating. However, it must also be concluded that such conditions would not always occur and coincide with lamprey migration (e.g. winter 2016/2017). The weir does have a number of leaking crevices and some lamprey may perhaps use these to apss upstream. However this has not been observed. During normal flow conditions Clohamon weir is generally an impassable barrier to the movements of all three-lamprey species. Moreover, the barrier in the tailrace of this scheme would not stop lampreys entering. It is almost certain that significant numbers of migrating lampreys enter here and run up the tailrace only to get trapped below the turbines. It is noted that adult Salmon and Sea Trout also enter this tailrace – a significant rescue operation involving several hundred salmon and sea trout had to be undertaken in 2016 by IFI staff (Alan Cullagh pers. Comm.). A single Twaite shad was also found during this operation.

Overall it is concluded that migratory lampreys are (generally) confined to below Clohamon weir. In the current survey, significant numbers of adult River Lampreys were observed all along the River Slaney between Enniscorthy and Clohamon. There are no other significant barriers along this stretch – only the underpinning of Scarawalsh and Ballycarney bridges which lampreys are able to pass, probably at higher flows. It is noted that

the spawning habitats upstream of Enniscorthy – especially in the stretch of river at Scarawalsh – are much more suitable for lampreys than those within the scheme footprint.

Only one Sea Lamprey was recorded during the current survey – a dead specimen found below Clohamon weir. Unfortunately, this species may be lost from the River Slaney. Sea Lampreys do not return to their natal rivers as Salmon do. They are instead attracted into river catchments by pheromones released by juvenile conspecifics. It is of concern that no juvenile Sea Lampreys were recorded during the current survey so the absence of juvenile pheromones may deter Sea Lampreys from entering this catchment in the future. However, much is not known about the reasons why Sea Lampreys enter certain catchments, and it is quite possible that Sea Lampreys could appear here again the future. There could also be large numbers of Sea Lampreys ammocoetes in the lower river which were not detected in the current survey. There is suitable Sea Lamprey spawning habitat in the footprint of the proposed scheme and no impact on this species would be acceptable due to the precarious status of this species in the Slaney River Valley SAC.

The current survey did not detect any juvenile shad. No shad were recorded in the Slaney estuary by the King & Linnane (2004). It is possible that shad are no longer regularly present in the Lower Slaney, and if they still occur are clearly only present in very low numbers. A single Twaite shad was also found during the IFI fish rescue operation in the Clohamon tailrace in 2016. It is of concern however that two of the listed fish species for this SAC may now be on the verge of extinction.

Adult salmon were seen in the scheme area during the current survey, and juvenile salmon were recorded during the electrical fishing survey. However, no 0-group (young-of-the-year) salmon (or Brown Trout) were recorded. This means that the salmon did not spawn in the scheme area during the winter of 2015/16. However, it is noted that some old redds were recorded upstream of the Railway Bridge and salmon may spawn here in the future. However, salmon are well distributed throughout the Slaney catchment and do not depend on the scheme area for production.

The River Slaney in the study area has already been modified to some degree, and it is likely that river modification works have taken place here to some extent. There are few large boulders in the river and much of the substrate in the scheme area is cobble and gravel which is generally unstable. The banks in the scheme area are eroding in some places, and many areas of river bank between Enniscorthy and Clohamon are eroding with some armouring having taken place in some locations. Much of the farmland along the lower river is managed as tillage and there are no buffer areas between these fields and the river. This is a major source of silt and other material into the lower reaches of the river. The silt and moving gravels are likely to have increased flood risk in Enniscorthy.

The affected stretch of river is already modified and physically degraded. However, there are significant numbers of juvenile lampreys present and extensive River Lamprey spawning activity was recorded within the footprint of the proposed scheme. The spawning activity was all recorded in the upper end of the scheme footprint (e.g. from the railway bridge upstream). Juvenile lamprey populations are expected to occur throughout the footprint of the proposed scheme, but are more common in the areas upstream of the railway bridge. Twaite shad may spawn in the affected area and use it as a nursery. However, this species was not detected during the current survey. Adult and juvenile salmon are present in the study area.

Biological water quality is the study area was rated as Q3-4 to Q3 which is Moderate to Poor status. This rating ids to some degree a reflection of the degraded physical status of the river, and in particular the high levels of siltation and unstable substrates. It will also of course reflect the chemical water quality status which will be under pressures as this is the lower end of a large river catchment. Upstream agricultural pressures have been identified as being the main water quality pressure on the Lower River Slaney WMU.

The affected stretch of the River Slaney is included in the Slaney River Valley cSAC and is evaluated as Internationally Important.

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APPENDIX 1 RHS SCORES

The RHS allows for the collection and collation of information for river sites which allows for sites to be characterised and compared using two standardised indices; the Habitat Quality Assessment (HQA) which provides a measure of river habitat diversity and the Habitat Modification Score (HMS) which indicates the extent of artificial modification to the river channel. The RAPID 2.1 software, developed by the Centre for Ecology and Hydrology (CEH) was used to log and store the field-data collected for all RHS sites. This software provides a calculation of the Habitat Quality Assessment score (2.1 version) and Habitat Modification Score (2003 version) for each completed survey in the database. It also provides the sub-scores behind both indices.

The habitat quality assessment (HQA) scoring system, based on features of wildlife importance was used to compare sites surveyed by the RHS method. The HQA scores are presented in conjunction with a measure of artificial modification to the channel i.e. the Habitat Modification Score (HMS). When describing individual RHS sites, both the HQA and HMS scores are used in conjunction, as together they can give a broad indication of how overall habitat quality and structural modification to the channel might be linked. It is important to bear in mind, however, that the HMS score relates only to modification of the channel, while the HQA score is derived from features in the channel and the river corridor.

The Habitat Quality Assessment (HQA) is a broad indication of overall habitat diversity provided by natural features in the channel and river corridor. Points are scored for the presence of features such as point, side and mid-channel bars, eroding cliffs, large woody debris, waterfalls, backwaters and floodplain wetlands. Additional points are attributed to reflect the variety of channel substrata, flow-types, in-channel vegetation, and also the distribution of bank-side trees and the extent of near-natural land-use adjacent to the river. The HQA score for a site is the total of all the component scores in each of the habitat / channel diversity categories; with no single hydromorphological feature dominating. The higher the score, the more highly rated / diverse the site; attribute points and cumulative scores are developed within the RAPID 2.1 database. Total HQA scores for UK (and Irish) rivers tend to vary from 10 – 80.

Habitat Modification Score (HMS) is an indication of artificial modification to river channel morphology. Data from RHS and the supplementary bank vegetation notes were used to provide a broad assessment of the naturalness of the river banks with regard to the degree and persistence of artificial modifications which are evaluated as the Habitat Modification Score (HMS). To calculate the HMS for a site, points are allocated for the presence and extent of artificial features such as culverts and weirs and also modifications caused by the re-profiling and reinforcement of banks. Greater and more severe modifications result in a higher score. The cumulative points total provides the Habitat Modification Score (HMS).

A Habitat Modification Class (HMC) protocol has been developed which allocates the condition of the channel in a site to one of five modification classes, based on the total HMS score (1 = pristine to 5 = severely modified).

Table A1.1: Summary of RHS spot check and sweep up features contributing to HQA sub-scores.

Sub-score	Spot check	Sweep up
Flow types	Number of flow types	Additional flow types
Channel substrates	Number of natural substrate types	Additional substrate types
Channel features	Exposed bedrock/boulders, vegetated rock, unvegetated mid-channel bar, vegetated mid-channel bar, mature island	Additional features Numbers of riffles and pools
Bank features	Eroding earth cliff, stable earth cliff, unvegetated point bar, vegetated point bar, unvegetated side-bar, vegetated side-bar, natural berm	Additional features
Bank vegetation	Simple and complex bank face and bank top	
Channel vegetation	Number of morphotypes	
Land use	Only broadleaf woodland, Coniferous woodland, moorland/ heath, and wetland score	
Trees & associated features	Tree coverage	Overhanging boughs, exposed bankside roots, underwater tree roots, large (coarse) woody debris and fallen trees
Special features		All special features score

Table A1.2: Habitat Modification Score (HMS), description of scoring categories and HMS categories.

HMS Score	Descriptive category of channel	HMS category
0-16	Pristine	1
17-199	Predominantly unmodified	2
200-499	Obviously modified	3
500-1399	Significantly modified	4
1400+	Severely modified	5

APPENDIX 2 RHS FIELD SHEETS

RIVER HABITAT SURVEY 2003 VERSION: SITE HEALTH AND SAFETY ASSESSMENT			
Site Number[1]:	Site Ref:	River Name:	Date:
Grid References/Co-ordinates:	Spot 1[2]:	Mid-site:	End of site[2]:
Surveyor Name:		Accredited Surveyor Code:	
[1] Leave blank if new site.		[2] Optional	

Weather Conditions:
Flow Conditions:

Site details: (enter comments or circle if applicable and give details)	**Risk Level (Low/Mod/High)**
Access and Parking: (entry & exit)	
Conditions: comment on ground stability, footing, exposure/remoteness	
Obstacles/Hazards: fencing, stiles, dense vegetation, steep bank	
Occupied/Unoccupied: people, livestock, animals	
Activities/Land-use: agriculture, woodland, residential, industrial, construction, recreational	
Risk if lone-working	

IF THERE ARE ANY HIGH RISKS OR MORE THAN THREE MODERATE RISKS DO NOT CONTINUE WITH THE SURVEY.

Weil's Disease (*Leptospirosis*)

Instructions to card holders

1. As infection may enter through breaks in the skin, ensure that any cut, scratch or abrasion is thoroughly cleansed and covered with a waterproof plaster.
2. Avoid rubbing your eyes, nose and mouth during work.
3. Clean protective clothing, footwear and equipment etc. after use
4. After work, and particularly before taking food or drink, wash hands thoroughly.
5. Report all accidents and/or injuries, however slight.
6. Keep your card with you at all times.

Lyme Disease

1. Dress appropriately with skin covered up.
2. Regularly inspect for ticks when in the field.
3. Check for, and remove, any ticks as soon as possible after leaving the site.
4. Seek medical attention if bitten by a tick.

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RIVER HABITAT SURVEY 2003 VERSION: SPOT-CHECK KEY Page 1 of 2

PHYSICAL ATTRIBUTES (SECTION E)

BANKS

Predominant bank material

NV = not visible

BE = bedrock
BO = boulder
CO = cobble
GS = gravel/sand
EA = earth (crumbly)
PE = peat
CL = sticky clay

CC = concrete
SP = sheet piling
WP = wood piling
GA = gabion
BR = brick/laid stone
RR = rip-rap
TD = tipped debris
FA = fabric
BI = bio-engineering materials

Bank modifications

NK = not known
NO = none

RS = resectioned (reprofiled)
RI = reinforced
PC = poached
PC(B) = poached (bare)
BM = artificial berm
EM = embanked

Marginal and bank features

NV = not visible (e.g. far bank)
NO = none

EC = eroding cliff (EC if sandy substrate)
SC = stable cliff (SC if sandy substrate)

PB = unvegetated point bar
VP = vegetated point bar

SB = unvegetated side bar
VS = vegetated side bar

NB = natural berm

CHANNEL

Predominant substrate

NV = not visible

BE = bedrock
BO = boulder
CO = cobble
GP = gravel/pebble (G or P if predominant)
SA = sand
SI = silt
CL = clay
PE = peat
EA = earth
AR = artificial

Predominant flow-type

NV = not visible
FF = free fall
CH = chute
BW = broken standing waves (white water)
UW = unbroken standing waves
CF = chaotic flow
RP = rippled
UP = upwelling
SM = smooth
NP = no perceptible flow
DR = no flow (dry)

Channel modifications

NK = not known
NO = none

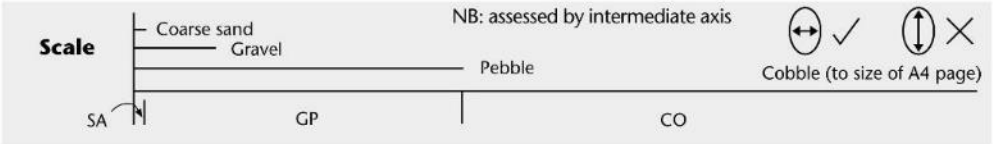
CV = culverted
RS = resectioned
RI = reinforced
DA = dam/weir/sluice
FO = ford (man-made)

Channel features

NV = not visible
NO = none

EB = exposed bedrock
RO = exposed boulders
VR = vegetated rock
MB = unvegetated mid-channel bar
VB = vegetated mid-channel bar
MI = mature island
TR = Trash (urban debris)

FLOW-TYPES	DESCRIPTION
FF: Free fall	clearly separates from back-wall of vertical feature ~ associated with waterfalls
CH: Chute	low curving fall in contact with substrate ~ often associated with cascades
BW: Broken standing waves	white-water tumbling waves must be present ~ mostly associated with rapids
UW: Unbroken standing waves	upstream facing wavelets which are not broken ~ mostly associated with riffles
CF: Chaotic flow	a chaotic mixture of three or more of the four fast flow-types with no predominant one obvious
RP: Rippled	no waves, but general flow direction is downstream with disturbed rippled surface ~ mostly associated with runs
UP: Upwelling	heaving water as upwellings break the surface ~ associated with boils.
SM: Smooth	perceptible downstream movement is smooth (no eddies) ~ mostly associated with glides
NP: No perceptible flow	no net downstream flow ~ associated with pools, ponded reaches and marginal deadwater
DR: No flow (dry)	dry river bed



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RIVER HABITAT SURVEY: SPOT-CHECK KEY

Page 2 of 2

LEFT **Banks are determined by looking downstream** **RIGHT**

CHANNEL MODIFICATION INDICATORS

One or more of the following may be indicative of resectioning:

1. Uniform bank profile
2. Straightened planform
3. Bankfull width/bankfull height ratio <4:1
4. Uniform/low energy flow-types
5. No trees/uniformly-aged trees along bank
6. Intensive/urban land-use

LAND-USE WITHIN 5m OF BANKTOP (SECTION F) & 50m (SECTION H)

BL = Broadleaf/mixed woodland (semi-natural)
BP = Broadleaf/mixed plantation
CW = Coniferous woodland (semi-natural)
CP = Coniferous plantation
SH = Scrub & shrubs
OR = Orchard
WL = Wetland (e.g. bog, marsh, fen)
MH = Moorland/heath
AW = Artificial open water
OW = Natural open water
RP = Rough unimproved grassland/pasture
IG = Improved/semi-improved grassland
TH = Tall herb/rank vegetation
RD = Rock, scree or sand dunes
SU = Suburban/urban development
TL = Tilled land
IL = Irrigated land
PG = Parkland or gardens
NV = Not visible

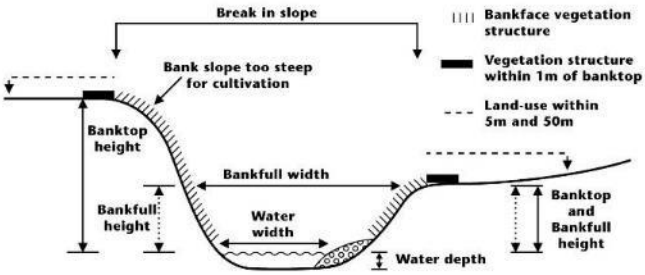
BANKTOP AND BANKFACE VEGETATION STRUCTURE To be assessed within a 10m wide transect (SECTION F)

			vegetation types
bare	B	bare earth/rock etc.	bryophytes
uniform	U	predominantly one type (no scrub or trees)	short/creeping herbs or grasses
simple	S	two or three vegetation types	tall herbs/ grasses
complex	C	four or more types	scrub or shrubs
			saplings and trees

Channel dimensions guidance (Section L)

- Select location on uniform section.
- If riffle is present, measure there. If not, measure at straightest and shallowest point.
- **Banktop** = first major break in slope above which cultivation or development is possible.
- **Bankfull** = point where river first spills on to floodplain.

Cross-section of channel showing definitions used to define where spot-check recording and channel dimensions measured



ENVIRONMENT AGENCY

EMERGENCY HOTLINE 0800 80 70 60

24 hour free emergency telephone line for reporting all environmental incidents relating to air, land and water.

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RIVER HABITAT SURVEY 2003 Version **Page 1 of 4**

A FIELD SURVEY DETAILS

Site Number: (leave blank if new site)

Site Reference:

Spot-check 1 Grid Ref:

Spot-check 6 Grid Ref:

End of site Grid Ref:

Reach Reference:

River name:

Date / /20 Time:

Surveyor name:

Accredited Surveyor code:

Is the site part of a river or an artificial channel? River ☐ Artificial ☐

Are adverse conditions affecting survey? No ☐ Yes ☐

If yes, state .....

Is bed of river visible? barely or not ☐ partially ☐ ±entirely ☐

Is health and safety assessment form attached? Yes ☐ No ☐

Number of photographs taken: ☐

Photo references:

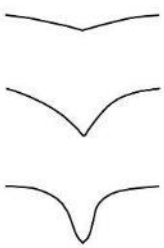
Site surveyed from: left bank ☐ right bank ☐ channel ☐

☐ **When options shown with 'shadow boxes', tick one box only**

LEFT banks determined by facing downstream RIGHT

B PREDOMINANT VALLEY FORM (within the horizon limit) (tick one box only)

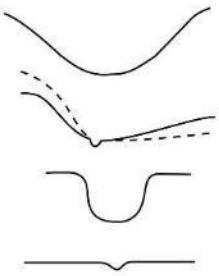
(tick one box only)



☐ shallow vee

☐ deep vee

☐ gorge



☐ concave/bowl

☐ asymmetrical valley

☐ U-shape valley

☐ no obvious valley sides

Distinct flat valley bottom? No ☐ Yes ☐

Natural terraces? No ☐ Yes ☐

C NUMBER OF RIFFLES, POOLS AND POINT BARS (enter total number in boxes)

Riffle(s)		Unvegetated point bar(s)	
Pool(s)		Vegetated point bar(s)	

D ARTIFICIAL FEATURES (indicate total number of occurrences of each category within the 500m site)

If none, tick box ☐

	Major	Intermediate	Minor		Major	Intermediate	Minor
Weirs/sluices				Outfalls/ intakes			
Culverts				Fords			
Bridges				Deflectors/ groynes/croys			
Other - state							

Is channel obviously realigned? **No** ☐ **Yes, <33% of site** ☐ **≥33% of site** ☐

Is channel obviously over-deepened? **No** ☐ **Yes, <33% of site** ☐ **≥33% of site** ☐

Is water impounded by weir/dam? **No** ☐ **Yes, <33% of site** ☐ **≥33% of site** ☐

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SITE REF.	**RIVER HABITAT SURVEY: TEN SPOT-CHECKS**	**Page 2 of 4**

Spot-check 1 is at: upstream end ❑ downstream end ❑ of site (tick one box)

E PHYSICAL ATTRIBUTES (to be assessed across channel within 1m wide transect)

When boxes 'bordered', only one entry allowed	**1 GPS**	2	3	4	5	**6 GPS**	7	8	9	10	**GPS**
LEFT BANK	Ring EC or SC if composed of sandy substrate										
Material NV, BE, BO, CO, GS, EA, PE, CL, CC, SP, WP, GA, BR, RR, TD, FA, BI											
Bank modification(s) NK, NO, RS, RI, PC(B), BM, EM											
Marginal & bank feature(s) NV, NO, EC, SC, PB, VP, SB, VS, NB											
CHANNEL	GP- ring either G or P if predominant										
Channel substrate NV, BE, BO, CO, GP, SA, SI, CL, PE, EA, AR											
Flow-type NV, FF, CH, BW, UW, CF, RP, UP, SM, NP, DR											
Channel modification(s) NK, NO, CV, RS, RI, DA, FO											
Channel feature(s) NV, NO, EB, RO, VR, MB, VB, MI, TR											
For braided rivers only: number of sub-channels											
RIGHT BANK	Ring EC or SC if composed of sandy substrate										
Material NV, BE, BO, CO, GS, EA, PE, CL, CC, SP, WP, GA, BR, RR, TD, FA, BI											
Bank modification(s) NK, NO, RS, RI, PC(B), BM, EM											
Marginal & bank feature(s) NV, NO, EC, SC, PB, VP, SB, VS, NB											

Enter channel substrate(s) not occurring as predominant in spot-checks but present in >1% of whole site.

F BANKTOP LAND-USE AND VEGETATION STRUCTURE (to be assessed over a 10m wide transect)

Land-use: choose one from BL, BP, CW, CP, SH, OR, WL, MH, AW, OW, RP, IG, TH, RD, SU, TL, IL, PG, NV

LAND-USE WITHIN 5m OF LEFT BANKTOP											
LEFT BANKTOP (structure within 1m) B/U/S/C/NV											
LEFT BANK-FACE (structure) B/U/S/C/NV											
RIGHT BANK-FACE (structure) B/U/S/C/NV											
RIGHT BANKTOP (structure within 1m) B/U/S/C/NV											
LAND-USE WITHIN 5m OF RIGHT BANKTOP											

G CHANNEL VEGETATION TYPES (to be assessed over a 10m wide transect: use E (≥ 33% area), ✓ (present) or NV (not visible)

None (✓) or Not Visible (NV)											
Liverworts/mosses/lichens											
Emergent broad-leaved herbs											
Emergent reeds/sedges/rushes/grasses/horsetails											
Floating-leaved (rooted)											
Free-floating											
Amphibious											
Submerged broad-leaved											
Submerged linear-leaved											
Submerged fine-leaved											
Filamentous algae											

Use end column for overall assessment over 500m, including types not occurring in spot-checks (use ✓, E or NV)

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SITE REF.	**RIVER HABITAT SURVEY : 500m SWEEP-UP**	**Page 3 of 4**

H LAND-USE WITHIN 50m OF BANKTOP Use ✓ (present) or E (≥ 33% banklength)

	L	R		L	R
Broadleaf/mixed woodland (semi-natural) (BL)			Natural open water (OW)		
Broadleaf/mixed plantation (BP)			Rough/unimproved grassland/pasture (RP)		
Coniferous woodland (semi-natural) (CW)			Improved/semi-improved grassland (IG)		
Coniferous plantation (CP)			Tall herb/rank vegetation (TH)		
Scrub & shrubs (SH)			Rock, scree or sand dunes (RD)		
Orchard (OR)			Suburban/urban development (SU)		
Wetland (e.g. bog, marsh, fen) (WL)			Tilled land (TL)		
Moorland/heath (MH)			Irrigated land (IL)		
Artificial open water (AW)			Parkland or gardens (PG)		
			Not visible (NV)		

I BANK PROFILES Use ✓ (present) or E (≥ 33% banklength)

Natural/unmodified	L	R	**Artificial/modified**	L	R
Vertical/undercut			Resectioned (reprofiled)		
Vertical with toe			Reinforced - whole		
Steep (>45°)			Reinforced - top only		
Gentle			Reinforced - toe only		
Composite			Artificial two-stage		
Natural berm			Poached bank		
			Embanked		
			Set-back embankment		

J EXTENT OF TREES AND ASSOCIATED FEATURES *record even if <1%

TREES (tick one box per bank)	Left	Right
None	☐	☐
Isolated/scattered	☐	☐
Regularly spaced, single	☐	☐
Occasional clumps	☐	☐
Semi-continuous	☐	☐
Continuous	☐	☐

ASSOCIATED FEATURES (tick one box per feature)	None	Present	E (≥33%)
Shading of channel	☐	☐	☐
*Overhanging boughs	☐	☐	☐
*Exposed bankside roots	☐	☐	☐
*Underwater tree roots	☐	☐	☐
Fallen trees	☐	☐	☐
Large woody debris	☐	☐	☐

K EXTENT OF CHANNEL AND BANK FEATURES (tick one box for each feature) *record even if <1%

	None	Present	E(≥33%)		None	Present	E (≥33%)
*Free fall flow	☐	☐	☐	Exposed bedrock	☐	☐	☐
Chute flow	☐	☐	☐	Exposed boulders	☐	☐	☐
Broken standing waves	☐	☐	☐	Vegetated bedrock/boulders	☐	☐	☐
Unbroken standing waves	☐	☐	☐	Unvegetated mid-channel bar(s)	☐	☐	☐
Rippled flow	☐	☐	☐	Vegetated mid-channel bar(s)	☐	☐	☐
*Upwelling	☐	☐	☐	Mature island(s)	☐	☐	☐
Smooth flow	☐	☐	☐	Unvegetated side bar(s)	☐	☐	☐
No perceptible flow	☐	☐	☐	Vegetated side bar(s)	☐	☐	☐
No flow (dry)	☐	☐	☐	Unvegetated point bar(s)	☐	☐	☐
Marginal deadwater	☐	☐	☐	Vegetated point bar(s)	☐	☐	☐
Eroding cliff(s)	☐	☐	☐	*Unvegetated silt deposit(s)	☐	☐	☐
Stable cliff(s)	☐	☐	☐	*Discrete unvegetated sand deposit(s)	☐	☐	
				*Discrete unvegetated gravel deposit(s)	☐	☐	

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SITE REF.

RIVER HABITAT SURVEY : DIMENSIONS AND INFLUENCES

Page 4 of 4

L CHANNEL DIMENSIONS (to be measured at one location on a straight uniform section, preferably across a riffle)

LEFT BANK		CHANNEL		RIGHT BANK	
Banktop height (m)		Bankfull width (m)		Banktop height (m)	
Is banktop height also bankfull height? (Y or N)		Water width (m)		Is banktop height also bankfull height? (Y or N)	
Embanked height (m)		Water depth (m)		Embanked height (m)	

If trashline lower than banktop, indicate: height above water (m) = width from bank to bank (m) =

Bed material at site is: consolidated ❑ unconsolidated (loose) ❑ unknown ❑

Location of measurements is: riffle ❑ other ❑ (state)

M FEATURES OF SPECIAL INTEREST Use ✓ or E (≥ 33% length) *record even if <1%

None	☐	Very large boulders (>1m)	☐	Backwater(s)	☐	Marsh(es)	☐
Braided channels	☐	*Debris dam(s)	☐	Floodplain boulder deposits	☐	Flush(es)	☐
Side channel(s)	☐	*Leafy debris	☐	Water meadow(s)	☐	Natural open water	☐
*Natural waterfall(s) > 5m high	☐	Fringing reed-bank(s)	☐	Fen(s)	☐	Others (state)	☐
*Natural waterfall(s) < 5m high	☐	Quaking bank(s)	☐	Bog(s)	☐		
Natural cascade(s)	☐	*Sink hole(s)	☐	Wet woodland(s)	☐		

N CHOKED CHANNEL (tick one box)

Is 33% or more of the channel choked with vegetation? No ❑ Yes ❑

O NOTABLE NUISANCE PLANT SPECIES Use ✓ or E (≥ 33% length) *record even if <1%

		bankface	banktop to 50m		bankface	banktop to 50m
None ☐	*Giant hogweed	☐	☐	*Himalayan balsam	☐	☐
	*Japanese knotweed	☐	☐	*Other (state).....	☐	☐

P OVERALL CHARACTERISTICS (Circle appropriate words, add others as necessary)

Major impacts: landfill - tipping - litter - sewage - pollution - drought - abstraction - mill - dam - road - rail - industry - housing mining - quarrying - overdeepening - afforestation - fisheries management - silting - waterlogging - hydroelectric power

Evidence of recent management: dredging - bank mowing - weed cutting - enhancement - river rehabilitation - gravel extraction - other (please specify)

Animals: otter - mink - water vole - kingfisher - dipper - grey wagtail - sand martin - heron - dragonflies/damselflies

Other significant observations: if necessary use separate sheet to describe overall characteristics and relevant observations

Q ALDERS (tick one box in each of the two categories) *record even if <1%

*Alders? None ❑ Present ❑ Extensive ❑ | *Diseased Alders? None ❑ Present ❑ Extensive ❑

R FIELD SURVEY QUALITY CONTROL (✓ boxes to confirm checks)

- Have you taken at least two photos that illustrate the general character of the site and additional photos of any weirs/ sluices and major/intermediate structures across the channel? ☐
- Have you completed all ten spot-checks and made entries in all boxes in E & F on page 2? ☐
- Have you completed column 11 of section G (and E if appropriate) on page 2? ☐
- Have you recorded in section C the number of riffles, pools and point bars (even if 0) on page 1? ☐
- Have you given an accurate (alphanumeric) grid reference for spot-checks 1, 6 and end of site (page 1)? ☐
- Have you stated whether spot-check 1 is at the upstream or downstream end of the site (top of page 2)? ☐
- Have you cross-checked your spot-check and sweep-up responses with the channel modification indicators given on page 2 of the spot-check key? ☐

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APPENDIX 3 RHS HMS & HQA RESULTS

Table A3.1: Habitat Modification Score (HMS).

Site	3	5	7
Culverts	0	0	0
Bank & bed reinforcement	0	0	0
Bank & bed resectioning	200	0	40
Berms & embankments	0	0	0
Weirs, dams & sluices	0	0	0
Bridges	0	200	0
Poaching	10	0	10
Fords	0	0	0
Outfalls & deflectors	0	50	0
HMS score	210	250	50
HM Classification	3	3	2

Key – HM Classification Description: 1 Pristine/Semi-natural; 2 Predominantly unmodified; 3 Obviously modified; 4 Significantly modified; 5 Severely modified; 0 Not classified

Table A3.2: Habitat Quality Assessment (HQA) results.

	Site 3	Site 5	Site 7
Flow	3	8	4
Channel substrate	2	2	3
Channel features	2	4	6
Bank features	4	5	8
Bank vegetation structure	3	4	3
In-stream channel vegetation	2	1	3
Land-use	1	2	0
Trees & associated features	7	8	5
Special features	0	4	0
HQA Score	24	33	32

APPENDIX 4 MACROINVERTEBRATE SPECIES LIST

Table A4.1: Macroinvertebrates recorded during biological sampling at selected aquatic survey locations on the River Slaney.

	Pollution sensitivity group	Functional group	Site 3	4	5	7	10
MAYFLIES (Uniramia, Ephemeroptera)							
Family Heptagenidae							
Yellow may dun *Heptagenia sulphurea*	A	Scraper & gathering collector			**		*
Rhithrogena semicolorata	A	Scraper & gathering collector					*****
Spiny crawler mayflies (Seratellidae)							
Blue-winged olive *Seratella ignita*	C	Gathering collector			*		
Baetidae							
Large dark olive *Baetis rhodani*	C	Scraper & gathering collector		*****	****	*****	******
White midges (Caenidae)							
Caenis sp.	C	Gathering collector					**
STONEFLIES (Order Plecoptera)							
Perlodid stoneflies (Perlodidae)							
Common yellow sally *Isoperla grammatica*	A	Shredder					*
Needleflies (Leuctridae)							
Leuctra sp.	B	Shredder	*	**	*	***	***
CASED CADDIS FLIES (Tricoptera)							
Long horned caddisflies (Leptoceridae)							
Oecetis sp.	B	Scraper	*	*	**	***	
Glossosomatidae							
Little black caddisfly *Agapetus fuscipes*	B	Scraper		**			
Primitive caddisflies (Sericostomatidae)							
Black caperer Sericostoma personatum	B	Shredder		*		*	
Family Goeridae							
Goera pilosa	B	Scraper				**	
Little brown-green sedges (Lepidostomatidae)							
Lepidostoma sp.	B	Shredder					*
CASELESS CADDIS FLIES (Trichoptera)							
Grey flags (Hydropsychidae)							
Hydropsyche pellucidula	C	Filtering collector	***	***	******	***	****
Green sedges (Rhyacophilidae)							
The sandfly *Rhyacophila dorsalis*	C	Predator					**
Trumpet-net caddisflies (Polycentopodidae)							
Polycentropus kingi	C	Filtering collector	*	**			
DAMSELFLIES (Odonata, Zygoptera)							
Jewelwings/Demoiselles (Agriidae)							
Agrion sp.	B	Predator					*
ALDERFLIES (Megaloptera)							
Alderfly larvae (Sialidae)							
Sialis sp.	D	Predator		*			
TRUE FLIES (Diptera)							
Blackfly (Simulidae)							
Similium sp.	C	Filtering collector		***	**	***	****
Craneflies (Tipulidae)	C	Shredder					
Dicranota sp.	C	Shredder	*	**	*	**	
Tipula sp.	C	Shredder	*****			*	
Family Chironomidae							

	Pollution sensitivity group	Functional group	Site 3	4	5	7	10
Green chironomid	C	Filtering collector	*****	****	*	**	**
Bloodworm Chironomous sp.	E	Filtering collector		**			
Biting Midge (Ceratopogonidae)	C	Filtering collector		*			
BEETLES (Coleoptera)							
Whirligig beetle larvae (Gyrinidae)	C	Predator					
Common whirligig beetle *Gyrinus substriatus*	C	Predator			**		
Crawling water beetles (Haliplidae)							
Haliplus sp.	C	Predator					
Riffle Beetle (Elmidae)							
Limnius sp.	C	Scraper		*	*	**	**
Minute moss beetles (Hydraenidae)							
Hydraena sp.	C	Predator					*
SNAILS (Mollusca, Gastropoda)							
Family Lymnaeidae							
Wandering snail *Lymnaea peregra*	D	Shredder	***		**	****	
Family Planorbiidae							
Keeled Ramshorn Snail *Planorbis carinatus*	C	Scraper			*	****	
Family Hydrobiidae							
Common Bithynia *Bithynia tentaculata*	C	Shredder					*
Jenkin's spire shell *Potamopyrgus antipodarium*	C	Scraper	****	****	***	*****	
Family Ancylidae							
River limpet *Ancylus fluviatilis*	C	Scraper	**		***		
MUSSELS (Mollucsa, Lamellibranchiata)							
Orb/Pea Mussels (Sphaeridae)							
Pisidium sp.	D	Filtering collector		**			
CRUSTACEANS (Crustacea)							
Amphipods (Amphipoda, Gammaridae)							
Freshwater shrimp *Gammarus duebeni*	C	Shredder	***	*****	****	*****	**
Isopods, Asellidae							
Asellus aquaticus	D	Shredder	*	*	*		
Corophidae							
Corophium sp.	C	Predator & scraper	*				
LEECHES (Hirudinae)							
Erpobdellidae							
Erpobdella testacea	D	Predator	*	*			
Glossiphonidae							
Glossiphonia complanata	D	Predator		*			
BUGS (Hemiptera)							
Lesser water boatman (Corixidae)	C	Predator	*		*		
Family Aphelocheiridae	C	Predator					
Aphelocheirus aestivalis	B	Predator		****	*	*	****
SEGMENTED WORMS (Annelida, Clitellata)							
Aquatic earthworm (Lumbriculidae)	D	Gathering collector	*				*

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

PLATES

Plate 1: Sea Lamprey spawning survey (snorkelling), June 2016 – no activity recorded across entire survey.

Plate 2: Kick sampling survey June 2016, at Clohamon.

Plate 3: Juvenile lamprey survey July 2016, at Enniscorthy.

Plate 4: Juvenile lamprey survey July 2016, at Scarawalsh.

Plate 5: Juvenile lamprey survey July 2016, at Scarawalsh.

Plate 6: Stretch of the River Slaney downstream of Enniscorthy (Site 3).

Plate 7: The mayfly larvae *Ephemera danica* – a Group A pollution sensitive organism occurs in the study area and is associated with juvenile lamprey habitats.

Plate 8: larvae of the mayfly *Heptagenia sulphurea* was recorded at Clohamon (Site 10).

Plate 9: No lamprey spawning activity was recorded below this point at Enniscorthy Bridge (Site 4)

Plate 10: The Ballingale Stream approximately 300m upstream of the Slaney confluence. Despite ideal spawning habitat in this watercourse, no activity was recorded during an investigation of the lower 600m reach of this watercourse on the 15th April.

Plate 11: River Bann downstream of Bann Bridge approximately 250m upstream of the Slaney River. Flow and substrate conditions at the end of this pool provide an ideal spawning habitat for lampreys and salmonids.

Plate 12: Lamprey redd found in the River Slaney downstream of Scarawalsh Bridge on the 22nd April 2016.

Plate 13: The river at Ballycarney Bridge was surveyed using polarised glasses. No Lamprey were recorded.

Plate 14: Stretch of the Slaney downstream of Clohamon Weir. This stretch of the river is depleted due to the operation of a small hydroelectric scheme at the left side of the channel.

Plate 15: Clohamon Weir is considered an obstacle for migrating lampreys. A Grey Heron was seen under the bridge on 14th April and was deemed to have been preying on River Lampreys.

Plate 16: Clohamon weir.

Plate 17: Surveying Clohamon hydro tailrace screen, June 2016. Lampreys and salmonids are entering here and getting trapped below hydro scheme in significant numbers.

Plate 18: The spacing between the bars on the Clohamon hydro-scheme tailrace fish screen are in the order of 35mm. It is considered that River Lampreys could easily swim through this screen.

Plate 19: A seal at Clohamon in March 2016 (from Slaney Rivers Trust).

Plate 20: River Lamprey (dropped by heron), Clohamon weir, 14th April 2016.

Plate 21: There is a lack of a protective riparian area along much of the River Slaney. The impact of flooding in a field downstream of Clohamon is obvious here, where soil has been lost to the river and will continue to be eroded.

Plate 22: Bank slippage is an undesirable feature along the left bank of the River Slaney in the stretch upstream of Enniscorthy town.

Plate 23: Stretch of the River Slaney upstream of Enniscorthy at the upper end of the study area. Gravels in this part of the river are regarded as suitable for spawning lampreys and salmonids. No lamprey spawning activity was observed or evidence of same recorded during the surveys carried out on the 14th and 15th. A single River Lamprey was recorded in this area on 22nd April 2016.

Plate 24: Underwater view of the substrate in the above photo. Numerous parr of Salmon *Salmo salar* were recorded in this fast-flowing area but no YOY were recorded.

Plate 25: Stretch of the River Slaney at Enniscorthy. Depositing habitat in the river alongside the left bank of the river is considered important with respect to the larval lampreys, which depend on soft substrates into which they can burrow.

Plate 26: Many of the slower flowing areas of the River Slaney within the study area are considered suitable for the juvenile life stages of lampreys including sluggish water around pillars of bridges within the town of Enniscorthy (Site 5).

Plate 27: River Lampreys nest building in the River Slaney at Scarawalsh Bridge on 5th May 2016.

Plate 28: River Lampreys spawning in the River Slaney at Scarawalsh Bridge on 5th May 2016.

Plate 29: Mature River Lamprey *Lampetra fluviatilis* recorded in the River Slaney at the end of the pool downstream of Scarawalsh Bridge on the 22nd April 2016.

Plate 30: Freshwater Pearl Mussel at Scarawalsh, April 2016.

Plate 31: Freshwater Pearl Mussel shells at Enniscorthy, April 2016.

Plate 32: Adult Brook Lamprey (dropped by a heron), Scarawalsh, 22nd April 2016.

Plate 33: Little egret and Heron preying on spawning lampreys at Scarawalsh, April 2016.

Plate 34: Adult River Lamprey, April 2016.

Plate 35: River Lamprey, River Slaney, downstream of Bann confluence, 14th May 2016.

Plate 36: River Lampreys, River Slaney downstream of Bann confluence, 15th May 2016.

Plate 37: River Lampreys, Scarawalsh, 14th May 2016.

Plate 38: River Lampreys, Scarawalsh, 14th May 2016.

Plate 39: River Lampreys, River Slaney at Clohamon, 15th May 2016.

Plate 40: River Lamprey, River Slaney at Clohamon, 15th May 2016.

Plate 41: River Lamprey, River Bann (tributary), 14th May 2016.

Plate 42: River Lamprey, River Slaney at Clohamon, 15th May 2016.

Plate 43: River Lamprey recorded in the River Slaney approximately 20m upstream of the Railway Bridge in Enniscorthy on the 22nd April 2016.

Plate 44: Adult River Lamprey, Enniscorthy, 22nd April 2016.

Plate 45: Adult River Lampreys, Enniscorthy, 5th May 2016.

Plate 46: Adult River Lampreys (and a minnow), Scarawalsh, 5th May 2016.

Plate 47: Clohamon weir on the 26th May 2016. This is a major fish migration barrier.

Plate 48: Residual channel of the River Slaney at Clohamon, 26th May 2016. Too much water was being taken into the hydroelectric scheme on this day.

Plate 49: Tailrace screen of Clohamon hydroelectric scheme on the 26th May 2016. Adult lampreys are likely to enter the tailrace here in significant numbers.

Plate 50: River Slaney at Enniscorthy on 7th June 2016.

Plate 51: River Slaney immediately upstream of Enniscorthy within scheme area on 7th June 2016. Suitable spawning habitat for Sea Lampreys but none were found.

Plate 52: Dead Sea Lamprey found at Clohamon weir, 7th June 2016. This was the only evidence of this species found during the current survey.

Plate 53: Brook/River Lamprey catch from one quadrate.

Plate 54: Juvenile lamprey ammocoetes from Enniscorthy – only River/Brook (*Lampetra* sp. recorded).

Plate 55: Young-of-the-year Juvenile lamprey ammocoetes from Enniscorthy (*Lampetra* sp.).

Plate 56: Young-of-the-year Juvenile lamprey ammocoetes from Enniscorthy (*Lampetra* sp.).

Plate 57: Brook/River Lamprey ammocoete and the sample quadrate.

Plate 58: Close-up of River/Brook Lamprey ammocoete's head showing absence of ventral oral hood pigmentation – an identification diagnostic.

Plate 59: Minnows and Three-spined sticklebacks from the freshwater tidal stretch of the river downstream of Enniscorthy.

Plate 60: Juvenile salmon Salmo salar (left), Minnow *Phoxinus phoxinus* and Flounder *Platichthys flesus* from the July electrical fishing survey at Enniscorthy.

Plate 61: Juvenile Atlantic Salmon *Salmo salar* (1+) from Lower River Slaney at Enniscorthy.

Plate 62: Brown Trout *Salmo trutta* from the Lower River Slaney.

Plate 63: European Eel *Anguilla anguilla* were frequent during the electrical fishing survey.

Plate 64: Most common fish species in study area – Three-spined Stickleback *Gasterosteus aculeatus* (left) and Minnow *Phoxinus phoxinus*.

Plate 65: Stone Loach *Barbatula barbatula* are common in the study area.

Plate 66: Gudgeon *Gobio gobio* also common in the Lower Slaney.