ATTACHMENT D.1.1

EXISTING ENVIRONMENT & IMPACT OF THE ACTIVITY

ASSESSMENT OF IMPACT ON RECEIVING SURFACE WATER

D.1.1 Assessment of Impact on Receiving Surface Water

D.1.1.1 Status of Receiving Water

In 2007, Kerry Foods Shillelagh commissioned the Aquatic Services Unit (ASU) in University College Cork to carry out an assessment on the waste assimilative capacity and protection of ecological status on the Derry River under the Water Framework and EC Habitats Directives.

Data gathered for this assessment will be used to supplement this section of the licence review document.

Introduction

The Derry River is a tributary of the River Slaney. The river is approximately 25Km long, rising near Hacketstown, Co. Carlow flowing in a south easterly direction to Tinahely, Co. Wicklow, then veering south westerly through Shillelagh and on to confluence with the main body of the Slaney River at Bunclody.

There are two municipal wastewater treatment plants discharging to the Derry River upstream of the Kerry Foods outfall at Tinahely and Shillelagh, and a combined total of 79% of the catchment's land use is pastoral, mixed agricultural and commercial forestry.

Designated Protected Waters

The River Slaney is classified as salmonid waters under the first Schedule of the European Communities (Quality of Salmonid Waters) Regulations, 1988 (SI 293 of 1988), site number IE_SE_12_924.

The River Slaney is a Special Area of Conservation (SAC) (Site 00781 – Slaney River Valley; NPWS, 2005) It supports individuals and populations of a number of species listed on Annex II of the EC Habitats Directive (92/43/EC), namely - three species of lamprey (*Petromyzon lampetra*, *Lampetra fluviatiis*, *Lampetra planeri*), salmon (*Salmo salar*) and freshwater pearl mussels (*Margaritifera margaritifera*). The Derry River is one of the most important salmon spawning tributaries of the Slaney system.

Hydrological

In September 2007, ASU commissioned White Young Green Environmental Limited (WYG) to estimate the dry weather and 95th percentile flow of the Derry River beside the Kerry Foods, Shillelagh discharge.

Actual flows were measured in the Derry River at Tinahely, Shillelagh and Clonegal, the Dry weather flow (DWF) and 95th percentile flow (95 PF) were correlated using EPA flow data from Tinahely and Clonegal to obtain accurate low flow figures for Shillelagh. The full report from WYG is included in Appendix D.1.1.1.

Dry weather flow was determined as 0.148m^3 per second and 95th Percentile flow was 0.303m^3 per second.

This data will be used to calculate the assimilative capacity of the Derry River.

Biological Water Quality

EPA monitoring locations are set along the Derry River (River Code 12 D 02) at a number of locations and routine monitoring is carried out and recorded on the EPA website. Table D.1.1.A shows historical Q-value data for 2004, 2007 and 2010 recorded at EPA stations by the EPA and Wicklow County Council on the river.

Table D.1.1.A Q-Values at EPA stations on the Derry River 2004 - 2010

EPA Station	Location	2004	2007	2010
0100	Cross Bridge	3-4	4	3
0200	Tinahely Bridge	4-5		3-4
0350	Greenhall Bridge	4-5	4-5	3-4
0500	Shillelagh Bridge	3-4	4	4
0700	Balisland Bridge	4	4	3-4
0800	Ford North of Garryhasten	4		4
0900	Clonegal Bridge		4	
1000	Just u/s Slaney Confluence	4		

Water quality monitoring is also carried out annually on the Derry River on behalf of Kerry Foods, Shillelagh at locations upstream and downstream of the sites discharge point. Dixon Brosnan Environmental Consultants carry out this monitoring each year according to Condition C.6 Ambient Monitoring, Receiving Water Monitoring in the sites IPPC Licence P0804-01.

Table D.1.1.B shows data collated from Dixon Brosnan annual monitoring reports from 2008 to 2010.

Annual Aquatic Surveys of Derry and Slaney Rivers for 2008 to 2010 are included in Appendix D.1.1.2.

Table D.1.1.B Q-Values at Annual Monitoring Stations in relation to Kerry Foods outfall

Location	2008	2009	2010
Greenhall Bridge	4-5	3-4	4-5
Deegins Bridge	4-5	4	4-5
50m u/s Kerry Foods outfall	3-4	3-4	3-4
15m d/s Kerry Foods outfall in mixing zone	3-4	3-4	3-4
100m d/s Kerry Foods outfall	3-4	3-4	3-4
500m d/s Kerry Foods outfall	3-4	3-4	4
1500m d/s Kerry Foods outfall	4	4	4
2500m d/s Kerry Foods outfall	4	3-4	4
Balisland Bridge	3-4	4	4
Kilcarry Bridge	3-4	4	3-4
New Bridge	4	4	4

The EPA utilise a protocol for calculating Q values, the biological river quality (Q Value or biotic index) classification system (Toner *et al*., 2005). This biotic index used by the EPA allows river quality to be compared under standardised guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. The relationship between Q values and water quality is summarised below in Table D.1.1.C

Table D.1.1.C Biological River Quality (Q-Value or Biotic Index) Classification System

Q Value	Community Diversity	Quality	Water Condition
Q5	High	Good	Satisfactory
Q4	Reduced	Fair	Satisfactory
Q3	Much Reduced	Doubtful	Unsatisfactory
Q2	Low	Poor	Unsatisfactory
Q1	Very Low	Bad	Unsatisfactory

Intermediate indices are used to denote transitional conditions i.e. Q1-2, 2-3, 3-4 and 4-5. Biotic indices are related to four Water Quality Classes (Unpolluted, Slightly Polluted, Moderately Polluted and Seriously Polluted) and to the Water Framework Directive (WFD) water status as follows in Table D.1.1.D.

Table D.1.1.D EPA Biotic Indices relationship to Water Quality Status

Biotic Index	Quality Status	Quality Class	WFD Status
Q5, Q4-5, Q4	Unpolluted	Class A	High
Q3-4	Slightly Polluted	Class B	Moderate
Q3, Q2-3	Moderately Polluted	Class C	Poor
Q2, Q1-2, Q1	Seriously Polluted	Class D	Bad

The EPA classifies the Derry River from just above Deegins Bridge (Station number 0400) to just upstream of Slaney River confluence (Station number 1000) as moderate status, Class B and slightly polluted under the Water Framework Directive. The EPA ENVision Online Map Viewer for Irish environmental data also shows the Q-Value for the River Derry. This map is included in Appendix D.1.1.3.

EC Environmental Objectives (Surface Waters) Regulations 2009, S.I. No. 272 of 2009 Schedule 3, The Presentation of Monitoring Results and Surface Water Classification, Table 1 Ecological Status lists the status classification and colour code for each class. This can be seen below in Table D.1.1.E.

Table D.1.1.E EC Environmental Objectives (Surface Waters) Regulations 2009 Ecological Status

Ecological Status Classification	Colour Code
High	Blue
Good	Green
Moderate	Yellow
Poor	Orange
Bad	Red

The EPA ENVision Online Map Viewer for Irish environmental data shows the Derry River from just above Deegins Bridge (Station number 0400) to just upstream of Slaney River confluence (Station number 1000) as yellow in colour. Therefore the river is classed as moderate status according to the criteria set out above in S.I. No. 272 of 2009.

The EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009 Part III Environmental Objectives point 28 (2) states that "*A surface water body whose status is determined to be less than good (or good ecological potential and good surface water chemical status as the case may be) when classified by the Agency in accordance with these Regulations shall be restored to at least good status (or good ecological potential and good surface water chemical status as the case may be) by not later than 22 December 2015 unless otherwise provided for by these Regulations*"

D.1.1.2 Background Water Chemistry

The relevant EPA water chemistry sampling stations on the Derry River are Shillelagh Bridge (Station 0500), approximately 350m upstream of the Kerry Foods outfall, and Balisland Bridge (Station 0700) downstream of the Kerry Foods outfall.

Importantly, the Shillelagh Waste Water Treatment Plant (WWTP) outfall is also in the stretch between these two EPA sampling locations, so water chemistry is also (potentially) being influenced by the WWTP effluent characteristics.

Water chemistry monitoring is also carried out annually on the Derry River on behalf of Kerry Foods, Shillelagh at locations upstream and downstream of the sites discharge point. Dixon Brosnan Environmental Consultants carry out this monitoring each year.

The water temperature and pH, dissolved oxygen concentration are measured on site at each sampling station. The other chemical parameters analysed for are Biological Oxygen Demand (BOD) and Orthophosphate.

Appendix D.1.1.2 includes the Annual Aquatic Surveys of Derry and Slaney Rivers for 2008 to 2010 where the temperature, pH, dissolved oxygen levels, BOD and Orthophosphate results are outlined.

The site also monitors the final effluent discharge (SW 1) to the Derry River for the following parameters in accordance with Schedule C.2.2 Monitoring of Emissions to Water of the sites IPPC Licence; Flow, Temperature, pH, Chemical Oxygen Demand, Biological Oxygen Demand, Suspended Solids, Ammonia, Total Nitrogen, Total Phosphorus, Oils, Fats & Greases, Chlorides, Detergents and Sulphates.

Table D.1.1.F summarises the average concentrations of the quality parameters in the final effluent discharge from the facility and in the Derry River recorded at stations upstream and downstream of Kerry Foods. The Environmental Quality Standards (EQS) specified in EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009 are also quoted below.

Table D.1.1.F Final Effluent Discharge (SW 1), Derry River Average Concentration of Quality Parameters and Environmental Quality Standards (EQS) (S.I. No. 272 of 2009)

Parameter	Average Concentrations			EQS
	SW 1	Derry River U/S KF Outfall	Derry River D/S KF Outfall	
BOD (mg/l)	5.25 [1]	1.6 [2]	1.6 [3]	≤ 1.5 (mean) ≤ 2.6 (95%ile)
Total Ammonia (mg/l)	1.08 [1]	0.024 [2]	0.038 [3]	≤ 0.065 (mean) ≤ 0.140 (95%ile)
Orthophosphate (mg/l)	0.48 [1] (Total Phosphorus)	0.018 [2]	14.734 [3]	≤ 0.035 (mean) ≤ 0.075 (95%ile)

The results and standards in the table above, together with the flow data for the river (see Appendix D.1.1.1) and the final effluent discharge SW 1 flow (based on results of Emissions of Treated Effluent to Surface Water, submitted to the Agency as part of the AER for 2010), can be used to assess the impact of the discharge from the facility on the receiving water and in determining whether the discharge is in compliance with the EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009.

It must be noted that the average concentration for orthophosphate quoted above, is for total phosphorus as there is no requirement in the sites IPPC licence, P0804-01 to test the final effluent discharge SW 1 for orthophosphate.

[1] Based on Kerry Foods Shillelagh monitoring results for final effluent discharge SW 1 to Derry River in 2010
[2] Based on EPA monitoring results from 2007 - 2009 at Sampling Station 0500 on Derry River (River Code 12 D 02)
[3] Based on EPA monitoring results from 2007 - 2009 at Sampling Station 0700 on Derry River (River Code 12 D 02)

D.1.1.3 Waste Assimilative Capacity of Receiving Water & Current Loading from Final Effluent Discharges

Assimilative Capacity for BOD

Based on the last EPA monitoring results (2007 – 2009), the Biological Oxygen Demand (BOD) median concentration upstream (Station 0500 Shillelagh Bridge) of the Kerry Foods Shillelagh final effluent discharge was 1.6 mg/l. Figures from Dixon Brosnan report for 2010 at site 3 (upstream from the Shillelagh WWTP and Kerry Foods outfall) show that the background levels of BOD average <1 mg/l.

The more conservative upstream median value reported by the EPA, will be adopted for the calculation of the assimilative capacity. This median value reported for 2007 – 2009, by the Agency was derived from 25 samples taken during this period at Station 0500 Shillelagh Bridge which is upstream of the Kerry Foods Shillelagh final effluent discharge.

The assimilative capacity calculation is as follows;

Assimilative Capacity (AC) = (Cmax – Cback) x F95 x 86.4 kg/day [4]

Where:
Cmax = maximum permissible concentration (EQS 95%ile value) (mg/l)
Cback = background upstream concentration (mg/l mean value)
F95 = the 95%ile flow in the river (m^3/s)

Note: (60x60x24)/1000 = 86.4

Cmax = 2.6 mg/l [5]
Cback = 1.6 mg/l [6]
F95 = 0.303 m^3/s [7]

Applying the calculation above;

AC = (2.6 mg/l – 1.6 mg/l) x 0.303 m^3/s x 86.4 kg/day

= 1 mg/l x 0.303 m^3/s x 86.4 kg/day

= 26.18 kg / day

[4] Water Services Training Group 'Guidance to Applicant – Discharge to Surface Waters'
[5] EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009, Good Status EQS 95%ile for BOD
[6] EPA monitoring Results 2007 – 2009 BOD median concentration Station 0500 Shillelagh Bridge
[7] 95%ile flow derived from White Young Green Report 2007

Current BOD Loading to the River from Kerry Foods Shillelagh

The annual median discharge volume from the Kerry Foods Shillelagh facility is 480 m^3. This was calculated from the sites 2010 continuous flow data and is based on results of Emissions of Treated Effluent to Surface Water, submitted to the Agency as part of the AER for 2010. This represents 64% of the maximum allowable volume under the current IPPC Licence, P0804-01 held by the site.

Under existing operating conditions the median daily total BOD level in the sites final effluent discharge is 5.25 mg/l (calculated using the sites effluent monitoring figures for 2010).

Using annual median daily volume (480 m^3), the present annual median daily BOD loading from the final effluent discharge can be calculated as follows;

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000 [8]

Effluent Load = 480 m^3 x 5.25 mg/l / 1000

= 2520 mg/l / 1000

= 2.52 kg / day

From the above calculation, it can be seen that the BOD loading of 2.52 kg/day does not exceed the assimilative capacity at 95%ile flow on this part of the river. It follows that operating at full capacity under the current IPPC licence limits (10 mg/l, 750 m^3/day); the assimilative capacity of the river would not be exceeded.

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000

Effluent Load = 750 m^3 x 10 mg/l / 1000

= 7500 mg/l / 1000

= 7.5 kg / day

According to the Water Services Training Group 'Guidance to Applicants – Discharge to Surface Waters', the mass balance calculation can be used to determine the "*concentration of a parameter in the receiving water downstream of the discharge*", and that this concentration "*may then be compared directly with the water quality standard EQS to determine whether the discharge will cause an exceedance of the EQS value*".

[8] Water Services Training Group 'Guidance to Applicant – Discharge to Surface Waters'

The mass balance equation is as follows;

$$T = FC + fc / F + f$$

Where:
F = river flow upstream of the discharge (95%ile flow m^3 / s)
C = concentration of pollutant in the river upstream of the discharge (mean concentration mg/l)
f = flow of the discharge (m^3 / s)
c = maximum concentration of pollutant in the discharge (mg/l)
T = concentration of pollutant downstream of the discharge

To determine whether the Kerry Foods final effluent discharge will cause an exceedance of the BOD EQS, both the annual median daily volume (480 m^3) and the maximum allowable daily volume (750 m^3) under the current IPPC licence P0804-01 must be considered.

Annual Median Daily Volume

F = 0.303 m^3/s
C = 1.6 mg/l
f = 0.0056 m^3/s [9]
c = 10 mg/l [10]

$$T = (0.303\ m^3/s \times 1.6\ mg/l) + (0.0056\ m^3/s \times 10\ mg/l) / 0.303\ m^3/s + 0.0056\ m^3/s$$

$$T = (0.4848) + (0.056) / 0.3086$$

$$T = 0.5408 / 0.3086$$

$$T = 1.75\ mg/l$$

At annual median daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream BOD concentration will not exceed the EQS value of 2.6 mg/l at 95%ile flow.

[9] Based on Kerry Foods Shillelagh continuous flow data for final effluent discharge SW 1 to Derry River in 2010
[10] IPPC Licence P0804-01 Schedule B.2 Emissions to Water Emission Limit Values

Maximum Allowable Daily Volume

F = 0.303 m^3/s
C = 1.6 mg/l
f = 0.0087 m^3/s [10]
c = 10 mg/l

$$T = (0.303\ m^3/s \times 1.6\ mg/l) + (0.0087\ m^3/s \times 10\ mg/l) / 0.303\ m^3/s + 0.0087\ m^3/s$$

$$T = (0.4848) + (0.087) / 0.3117$$

$$T = 0.5718 / 0.3117$$

$$T = 1.83\ mg/l$$

At maximum allowable daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream BOD concentration will not exceed the EQS value of 2.6 mg/l at 95%ile flow.

Assimilative Capacity for Orthophosphate

Based on the last EPA monitoring results (2007 – 2009), orthophosphate median concentration upstream (Station 0500 Shillelagh Bridge) of the Kerry Foods Shillelagh final effluent discharge was 0.018 mg/l. Figures from Dixon Brosnan report for 2010 at site 3 (upstream from the Shillelagh WWTP and Kerry Foods outfall) show that the background levels of orthophosphate average 0.009 mg/l.

EPA and Dixon Brosnan records tend to show that orthophosphate levels in the Derry River in the vicinity of Shillelagh have improved in recent years.

The more conservative upstream median value reported by the EPA, will be adopted for the calculation of the assimilative capacity. This median value reported for 2007 – 2009, by the Agency was derived from 25 samples taken during this period at Station 0500 Shillelagh Bridge which is upstream of the Kerry Foods Shillelagh final effluent discharge.

The assimilative capacity calculation is as follows;

$$\text{Assimilative Capacity (AC)} = (Cmax - Cback) \times F95 \times 86.4\ kg/day$$

Cmax = 0.075 mg/l [11]
Cback = 0.018 mg/l [12]
F95 = 0.303 m^3/s

[11] EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009, Good Status EQS 95%ile for Molybdate Reactive Phosphorus
[12] EPA monitoring Results 2007 – 2009 orthophosphate median concentration Station 0500 Shillelagh Bridge

Applying the calculation above;

AC = (0.075 mg/l – 0.018 mg/l) x 0.303 m^3/s x 86.4 kg/day

= 0.057 mg/l x 0.303 m^3/s x 86.4 kg/day

= 1.49 kg / day

Current Phosphate Loading to the River from Kerry Foods Shillelagh

Under existing operating conditions the median daily total phosphorus (as P) levels in the sites final effluent discharge is 0.48 mg/l (calculated using the sites effluent monitoring figures for 2010).

Using annual median daily volume (480 m^3), the present annual median daily total phosphorus (as P) loading from the final effluent discharge can be calculated as follows;

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000

Effluent Load = 480 m^3 x 0.48 mg/l / 1000

= 230.4 mg/l / 1000

= 0.23 kg / day

It must be noted that these calculations are based on total phosphorus (as P) results as the sites IPPC Licence P0804-01 sets an ELV of 0.75 mg/l for total phosphorus but no ELV for orthophosphate.

From the above calculation, it can be seen that the phosphate loading of 0.23 kg/day does not exceed the assimilative capacity at 95%ile flow on this part of the river. It follows that operating at full capacity under the current IPPC licence limits (0.75 mg P/l, 750 m^3 / day); the assimilative capacity of the river would not be exceeded.

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000

Effluent Load = 750 m^3 x 0.75 mg/l / 1000

= 562.5 mg/l / 1000

= 0.56 kg / day

The mass balance equation is as follows;

$$T = FC + fc / F + f$$

To determine whether the Kerry Foods final effluent discharge will cause an exceedance of the Orthophosphate EQS, both the annual median daily volume (480 m^3) and the maximum allowable daily volume (750 m^3) under the current IPPC licence P0804-01 must be considered.

Annual Median Daily Volume

F = 0.303 m^3/s
C = 0.018 mg/l
f = 0.0056 m^3/s [9]
c = 0.75 mg/l [10]

$$T = (0.303\ m^3/s \times 0.018\ mg/l) + (0.0056\ m^3/s \times 0.75\ mg/l) / 0.303\ m^3/s + 0.0056\ m^3/s$$

$$T = (0.005454) + (0.0042) / 0.3086$$

$$T = 0.009654 / 0.3086$$

$$T = 0.031\ mg/l$$

At annual median daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream total phosphorus concentration and hence the orthophosphate concentration will not exceed the EQS value of 0.075 mg/l at 95%ile flow.

Maximum Allowable Daily Volume

F = 0.303 m^3/s
C = 0.018 mg/l
f = 0.0087 m^3/s
c = 0.75 mg/l

$$T = (0.303\ m^3/s \times 0.018\ mg/l) + (0.0087\ m^3/s \times 0.75\ mg/l) / 0.303\ m^3/s + 0.0087\ m^3/s$$

$$T = (0.005454) + (0.0065) / 0.3117$$

$$T = 0.011954 / 0.3117$$

$$T = 0.038\ mg/l$$

At maximum allowable daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream total phosphorus concentration and hence the orthophosphate concentration will not exceed the EQS value of 0.075 mg/l at 95%ile flow.

Assimilative Capacity for Ammonia

Based on the last EPA monitoring results (2007 – 2009), the Ammonia median concentration upstream (Station 0500 Shillelagh Bridge) of the Kerry Foods Shillelagh final effluent discharge was 0.024 mg/l.

This upstream median value reported by the EPA, will be adopted for the calculation of the assimilative capacity. This median value reported for 2007 – 2009, by the Agency was derived from 24 samples taken during this period at Station 0500 Shillelagh Bridge which is upstream of the Kerry Foods Shillelagh final effluent discharge.

The assimilative capacity calculation is as follows;

Assimilative Capacity (AC) = (Cmax – Cback) x F95 x 86.4 kg/day

Cmax = 0.14 mg/l [13]
Cback = 0.024 mg/l [14]
F95 = 0.303 m^3/s

Applying the calculation above;

AC = (0.14 mg/l – 0.024 mg/l) x 0.303 m^3/s x 86.4 kg/day

= 0.116 mg/l x 0.303 m^3/s x 86.4 kg/day

= 3.04 kg / day

[13] EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009, Good Status EQS 95%ile for Total Ammonia
[14] EPA monitoring Results 2007 – 2009 Total Ammonia median concentration Station 0500 Shillelagh Bridge

Current Ammonia Loading to the River from Kerry Foods Shillelagh

Under existing operating conditions the median daily total ammonia level in the sites final effluent discharge is 1.08 mg/l (calculated using the sites effluent monitoring figures for 2010).

Using annual median daily volume (480 m^3), the present annual median daily Ammonia loading from the final effluent discharge can be calculated as follows;

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000

Effluent Load = 480 m^3 x 1.08 mg/l / 1000

= 518.4 mg/l / 1000

= 0.52 kg / day

From the above calculation, it can be seen that the Ammonia loading of 0.52 kg/day does not exceed the assimilative capacity at 95%ile flow on this part of the river.

But operating at full capacity under the current IPPC licence limits (10 mg/l, 750m^3/day); the assimilative capacity of the river would be exceeded.

Effluent Load (kg/day) = Effluent flow x effluent concentration / 1000

Effluent Load = 750 m^3 x 10 mg/l / 1000

= 7500 mg/l / 1000

= 7.5 kg / day

To determine whether the Kerry Foods final effluent discharge will cause an exceedance of the Ammonia EQS, both the annual median daily volume (480 m^3) and the maximum allowable daily volume (750 m^3) under the current IPPC licence P0804-01 must be considered.

The mass balance equation is as follows;

$$T = FC + fc / F + f$$

Annual Median Daily Volume

F = 0.303 m^3/s
C = 0.024 mg/l
f = 0.0056 m^3/s
c = 10 mg/l [10]

$$T = (0.303\ m^3/s \times 0.024\ mg/l) + (0.0056\ m^3/s \times 10\ mg/l) / 0.303\ m^3/s + 0.0056\ m^3/s$$

$$T = (0.007272) + (0.056) / 0.3086$$

$$T = 0.06372 / 0.3086$$

$$T = 0.205\ mg/l$$

At annual median daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream Ammonia concentration will exceed the EQS value of 0.14 mg/l at 95%ile flow.

Maximum Allowable Daily Volume

F = 0.303 m^3/s
C = 0.024 mg/l
f = 0.0087 m^3/s
c = 10 mg/l

$$T = (0.303\ m^3/s \times 0.024\ mg/l) + (0.0087\ m^3/s \times 10\ mg/l) / 0.303\ m^3/s + 0.0087\ m^3/s$$

$$T = (0.007272) + (0.087) / 0.3117$$

$$T = 0.09472 / 0.3117$$

$$T = 0.302\ mg/l$$

At maximum allowable daily volume from the final effluent discharge from Kerry Foods Shillelagh, the downstream Ammonia concentration will exceed the EQS value of 0.14 mg/l at 95%ile flow.

As a result of this, the current IPPC Licence ELV for Ammonia may have to be reduced to ensure that Good Status (95%ile) limits are achieved in the Derry River by 2015.

Table D.1.1.G summarises the receiving water assimilative capacity, the final effluent discharge loading concentrations of the quality parameters and the predicted downstream concentrations in the Derry River. The Environmental Quality Standards Good Status EQS (95%ile) specified in EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009 are also quoted below.

Table D.1.1.G Summary of Assimilative Capacity, Final Effluent Discharge Loading Concentrations, Predicted Downstream Concentrations and EQS Good Status Limits

Parameter	BOD	Orthophosphate	Total Ammonia
Assimilative Capacity in receiving water (kg / day)	26.18	1.49	3.04
Kerry Foods Effluent Loading at median flows and median concentrations (kg / day)	2.52	0.23	0.52
Kerry Foods Effluent Loading at maximum (IPPC ELV) flows and concentrations (kg / day)	7.5	0.56	7.5
Predicted Downstream Concentration at median flows and IPPC Licence ELV's (mg / l)	1.75	0.031	0.205
Predicted Downstream Concentration at IPPC Licence ELV's and flow (mg / l)	1.83	0.038	0.302
Good Status (95%ile) EQS Surface Water Regulations 2009 (mg / l)	2.6	0.075	0.14

The table shows that the assimilative capacity for all three parameters would not be exceeded at median flow and concentrations and at maximum flow and concentrations (IPPC Licence ELV's) with the exception of Total Ammonia at the current IPPC Licence ELV's.

The predicted downstream concentrations would be in compliance with the EC Environmental Objectives (Surface Waters) Regulations 2009 S.I. No. 272 of 2009 Good Status EQS (95%ile), again with the exception of Total Ammonia which would exceed the standard at both the current median conditions and at full capacity.

An Environmental Impact Study (EIS) was completed in 1990 for the purposes of obtaining planning permission. This EIS is included in Appendix D.1.1.4.

D.1.1.4 Storm Water Discharges to Derry River

Storm water runoff from roofs, buildings and other paved areas discharge through a network of down pipes, gullies and manholes to the River Derry. Oil Interceptor traps are also in place on the storm water drainage line prior to discharge to the River Derry. Condenser blow down is also transferred to the River Derry through storm water drains.

Storm water discharges from the plant to the River Derry are monitored in accordance with the sites IPPC Licence at monitoring location SW-2. The range and frequency of analysis was as specified in Schedule C.2.3 of the sites IPPC Licence P0804-01.

The analyses of storm water for Quarter 1 and Quarter 2 in the period of January to December 2010 had an Ammonium level of 0.85mg/l in Quarter 1 and 1.27 mg/l in Quarter 2. The Total Nitrogen was 10mg/l in Quarter 1 and 16.3 mg/l in Quarter 2.

The European Communities SI 278 (Drinking Water) Regulations of 2007 limit value for Ammonium is 0.3mg/l. The storm water was tested in September and November 2010 and the Ammonium levels were <0.03mg/l and 0.03mg/l respectively.

The Drinking Water Regulations SI 278 of 2007 does not list any limit value for Total Nitrogen. The storm water was tested in September and November 2010 and the Total Nitrogen levels were 8.2mg/l and 7.7mg/l respectively.

The site proposes that any parameters for Storm water that are reported over the Drinking Water Standard SI 278 of 2007 and/or are seen to have elevated levels will be sent for retest and an investigation will be carried out.

Also during an Agency unannounced site inspection on the 20th of October 2010, it was noted that there was a constant flow in the storm water drain even though the previous rainfall event was approximately 18 hours prior to the inspection.

Following an investigation of the flow of water in the storm water drains, it was established that the condenser blow down was responsible. Condenser blow is also transferred to the River Derry through storm water drains. This was declared by the site in the Integrated Pollution Prevention and Control Licence Application in 2006.

Appendix D.1.1.1 White Young Green Report on Derry River Flow Estimations

White Young Green

Our Ref: CE06267

Date: 20th September 2007

Lauren Williams
Aquatic Services Unit
Environmental Research Institute
UCC, Cork

Environmental
Contaminated Land
Environmental Consultancy
Geographic Information Systems
Health & Safety
Hydrogeology
Management Systems
Waste Management

Re: Derry River Low Flow Estimations

Dear Lauren,

As requested White Young Green Environmental (Ireland) Limited (WYG), for Kerry Group plc., estimated the dry weather and 95th percentile flow of the Derry River besides their meat processing facility in Shillelagh, Co. Wicklow. The estimation is to be used as part of a discharge licence application for the facility adjacent to the river on the outskirts of the town.

As requested by the EPA, the flows at Shillelagh were interpolated using dry weather and 95th percentile flow data from the closest upstream and downstream EPA hydrometric stations with available data. These are at Tinahely upstream and Clonegal downstream. Flow measurements were taken by WYG at all three locations, Tinahely EPA station, Shillelagh discharge point and Clonegal EPA station, on 18th September 2006 to allow the interpolation to be carried out.

A hand held GPS was used to find the exact location of the EPA hydrometric stations. In Tinahely a location approximately 30m downstream of the EPA GPS location was chosen (Photo 1) because it was deemed more suitable for flow measurements. The chosen location in Shillelagh (Photo 2) was located approximately 15m upstream of the discharge point. In Clonegal the EPA GPS location was not in the Derry River and so a location (Photo 3) with the same northing was used which, according to the land owner, is visited on occasions by the EPA.

In accordance with British Standards, velocity measurements were taken using a Valeport flow meter at 10% intervals of the total river width using the 1-point method where the impellor is positioned at 60% of the depth. The velocity and depth were recorded at each interval.

The flow was initially calculated for each section by taking the area (section width × mean of bounding interval depths) and multiplying it by the mean velocity at the bounding intervals. The sum of each of the 10 sections was then taken to give the flow for the whole river.

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Athlone - Belfast - Cork - Derry - Dublin - Kilkenny - Limerick - Sligo - Waterford - Offices throughout the UK and overseas

thinking beyond construction

Linear correlations (Graph 1) were found between the dry weather (DWF) and 95th percentile flows (95PF) and the flow recorded on 18th September 2007 (WYGF). These are:

DWF = 0.1299 × WYGF - 0.0105

and 95PF = 0.2725 × WYGF - 0.0295

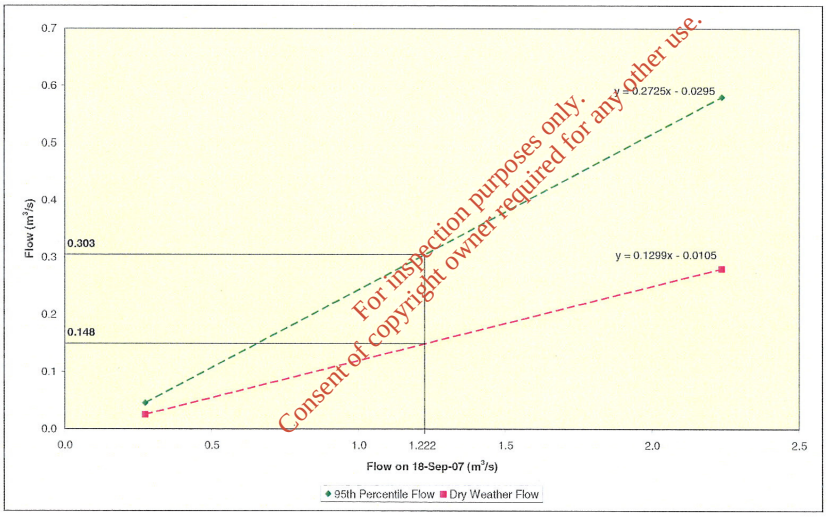
Using these equations at Shillelagh the dry weather flow is 0.148m^3/s and the 95th percentile flow is 0.303m^3/s (Table 1).

Table 1. Location and Flow Calculations and Measurements.

Location	Easting	Northing	Dry Weather Flow (m³/s)	95th Percentile (m³/s)	18-Sep-07 (m³/s)
Tinahely	303719	173242	0.025	0.045	0.273
Shillelagh	299077	167674	**0.148**	**0.303**	1.222
Clonegal	291647	160615	0.280	0.580	2.237

Bold indicates interpolated result

Graph 1. Dry Weather and 95th Percentile Flows against Flow on 18th September 2007



If you require any more information please contact me.

Yours sincerely,

White Young Green Environmental (Ireland) Ltd.

SIMON SHOLL
Hydrogeologist

Photo 1. Tinahely Flow Measurement Location

Photo 2. Shillelagh Flow Measurement Location

Photo 3. Clonegal Flow Measurement Location

Tinahely

Location (m)	Depth (m)	Velocity (m/s)	Section Area (m^2)	Mean Velocity (m/s)	Section Discharge (m^3/s)
0.00	0.20	0.000			
0.51	0.23	0.000	0.110	0.000	0.000
1.02	0.31	0.145	0.138	0.073	0.010
1.53	0.48	0.450	0.201	0.298	0.060
2.04	0.36	0.255	0.214	0.353	0.076
2.55	0.31	0.303	0.171	0.279	0.048
3.06	0.29	0.240	0.153	0.272	0.042
3.57	0.25	0.107	0.138	0.174	0.024
4.08	0.22	0.080	0.120	0.094	0.011
4.59	0.13	0.000	0.089	0.040	0.004
5.15	0.09	0.000	0.062	0.000	0.000
			TOTAL DISCHARGE		**0.273**

Shillelagh

Location (m)	Depth (m)	Velocity (m/s)	Section Area (m^2)	Mean Velocity (m/s)	Section Discharge (m^3/s)
0.00	0.00	0.000			
1.03	0.43	0.900	0.221	0.450	0.100
2.06	0.54	0.321	0.500	0.611	0.305
3.09	0.58	0.406	0.577	0.364	0.210
4.12	0.60	0.421	0.608	0.414	0.251
5.15	0.57	0.301	0.603	0.361	0.218
6.18	0.52	0.103	0.561	0.202	0.113
7.21	0.44	0.000	0.494	0.052	0.025
8.24	0.42	0.000	0.443	0.000	0.000
9.27	0.30	0.000	0.371	0.000	0.000
10.30	0.24	0.000	0.278	0.000	0.000
			TOTAL DISCHARGE		**1.222**

Clonegal

Location (m)	Depth (m)	Velocity (m/s)	Section Area (m^2)	Mean Velocity (m/s)	Section Discharge (m^3/s)
0.00	0.00	0.000			
1.01	0.18	0.664	0.091	0.332	0.030
2.02	0.26	0.771	0.222	0.718	0.159
3.03	0.32	0.707	0.293	0.739	0.216
4.04	0.40	0.767	0.364	0.737	0.268
5.05	0.50	0.764	0.455	0.766	0.348
6.06	0.53	0.810	0.520	0.787	0.409
7.07	0.56	0.653	0.550	0.732	0.403
8.08	0.34	0.535	0.455	0.594	0.270
9.09	0.15	0.347	0.247	0.441	0.109
10.10	0.06	0.103	0.106	0.225	0.024
			TOTAL DISCHARGE		**2.237**

Appendix D.1.1.2 Annual Aquatic Surveys of Derry and Slaney Rivers for 2008 to 2010

DixonBrosnan

Environmental consultants

Project			
Aquatic survey of Derry and Slaney Rivers 2008			
Client			
Celtic Watercare			
Project ref	Report no	Client ref	Pages
09011	09011.1	-	24

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Contents

1. Introduction

1.1 Dixon.Brosnan were commissioned by Celtic Watercare to carry out an aquatic survey of the Derry and Slaney Rivers on behalf of their client Kerry Foods who operate a food processing facility at Shillelagh, Co. Wicklow. This facility discharges treated wastewater to the Derry River in accordance with a discharge licence issued by Wicklow County Council under the Local Government (Water Pollution) Act, 1977.

1.2 The survey, which consisted of chemical and biological analyses at a number of sampling stations, was carried out in order to assess the current water quality of the two rivers at these stations. Data recorded were compared to results obtained during previous surveys.

2. Location

2.1 The Slaney River drains a large catchment spread over counties Carlow, Wexford and Wicklow. One of its tributaries – the Derry River – flows through Shillelagh before its confluence with the Slaney 17 km downstream.

2.2 Eleven sampling stations were agreed previously between the client and Wicklow County Council, nine of which are located on the Derry River and the remainder on the Slaney. These stations have been monitored during previous surveys on the client's behalf.

2.3 During a survey undertaken in April 2000, it was noted that a discharge from a wastewater treatment plant (WWTP) upstream of the Kerry Foods outfall may be having a negative impact on the river. In order to quantify any impact, station 3 was relocated upstream of this discharge during the current survey.

2.4 The complete list of stations is presented in Table 1. All stations are indicated in Figures 1, 2 and 3.

Table 1. Sampling station locations

Station	River	Location	County
1	Derry	Green Hall Bridge	Wicklow
2	Derry	Deegins Bridge	Wicklow
3	Derry	50m u/s STP outfall	Wicklow
3A*	Derry	40m d/s STP outfall, 250m u/s Kerry Foods outfall	Wicklow
4	Derry	15m d/s Kerry Foods outfall in mixing zone	Wicklow
5	Derry	100m d/s Kerry Foods outfall	Wicklow
6	Derry	500m d/s Kerry Foods outfall	Wicklow
7	Derry	1500m d/s Kerry Foods outfall at private bridge	Wicklow
8	Derry	2500m d/s Kerry Foods outfall	Wicklow
9	Derry	Balisland Bridge	Wicklow
10	Slaney	Kilcarry Bridge	Carlow
11	Slaney	New Bridge	Wexford

* Not surveyed in 2008

3. Survey

3.1 At each station water samples were taken and transported in a chilled container to Environmental Laboratory Services Ltd. (ELS), accredited by the Irish National Accreditation Body (INAB) for analysis. Analysis was carried out for a number of chemical parameters as described below following overnight storage at 4^0C. Temperature, pH and dissolved oxygen were measured on site at the time of sampling using a Wti Multimeter.

3.2 Biological sampling was carried out at each station using the kick-sampling technique as described by the Environmental Protection Agency (EPA) (1999). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net. Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high-powered binocular microscope.

3.3 To establish the water quality of the four samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. Macroinvertebrate abundance was rated in accordance with the classification presented in **Table 2**.

Table 2. Abundance classes

Class	Number
1-4	Present
5-20	Frequent
21-50	Common
51-100	Numerous
>100	Dominant

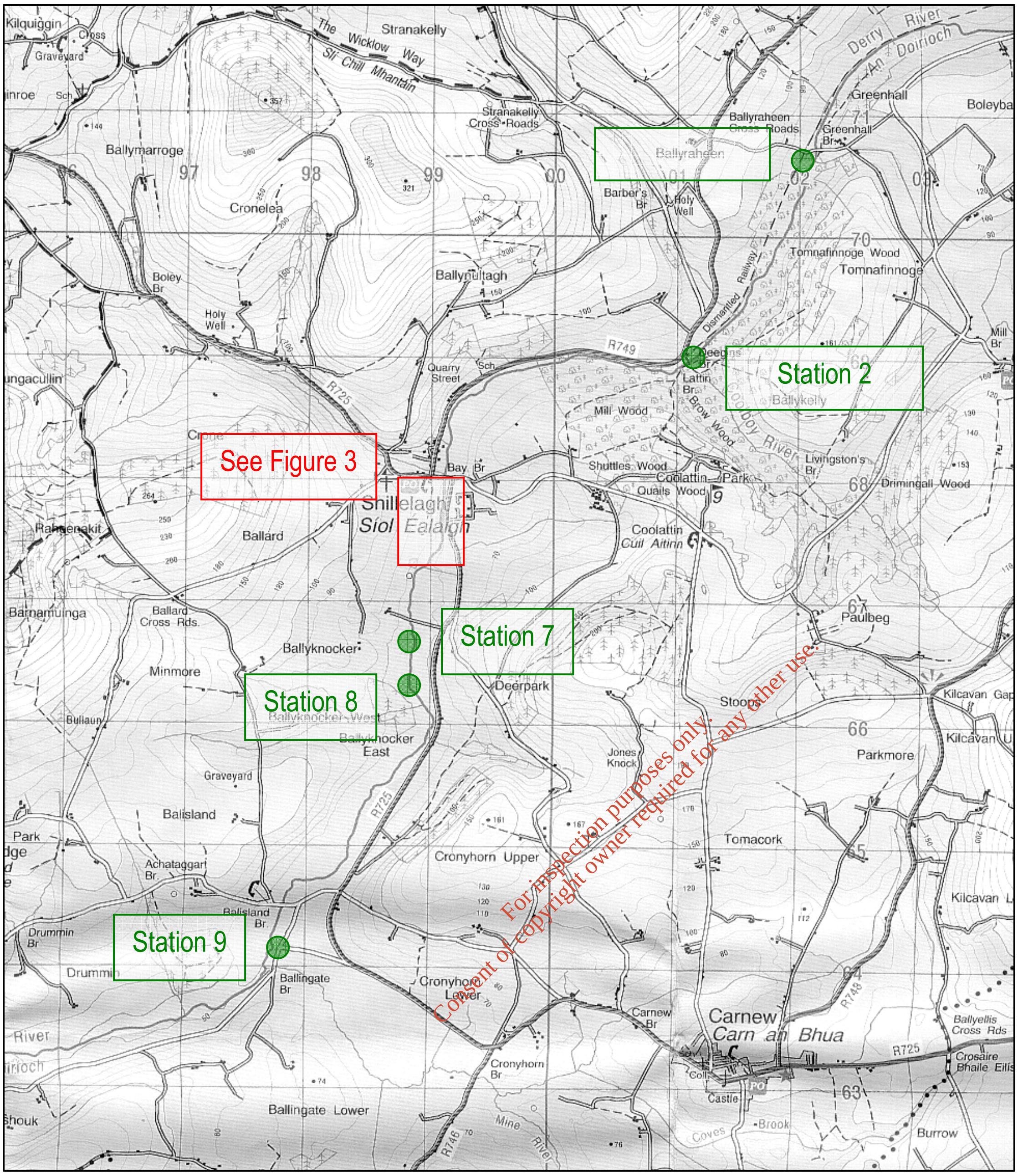

Figure 1 Derry River sampling stations

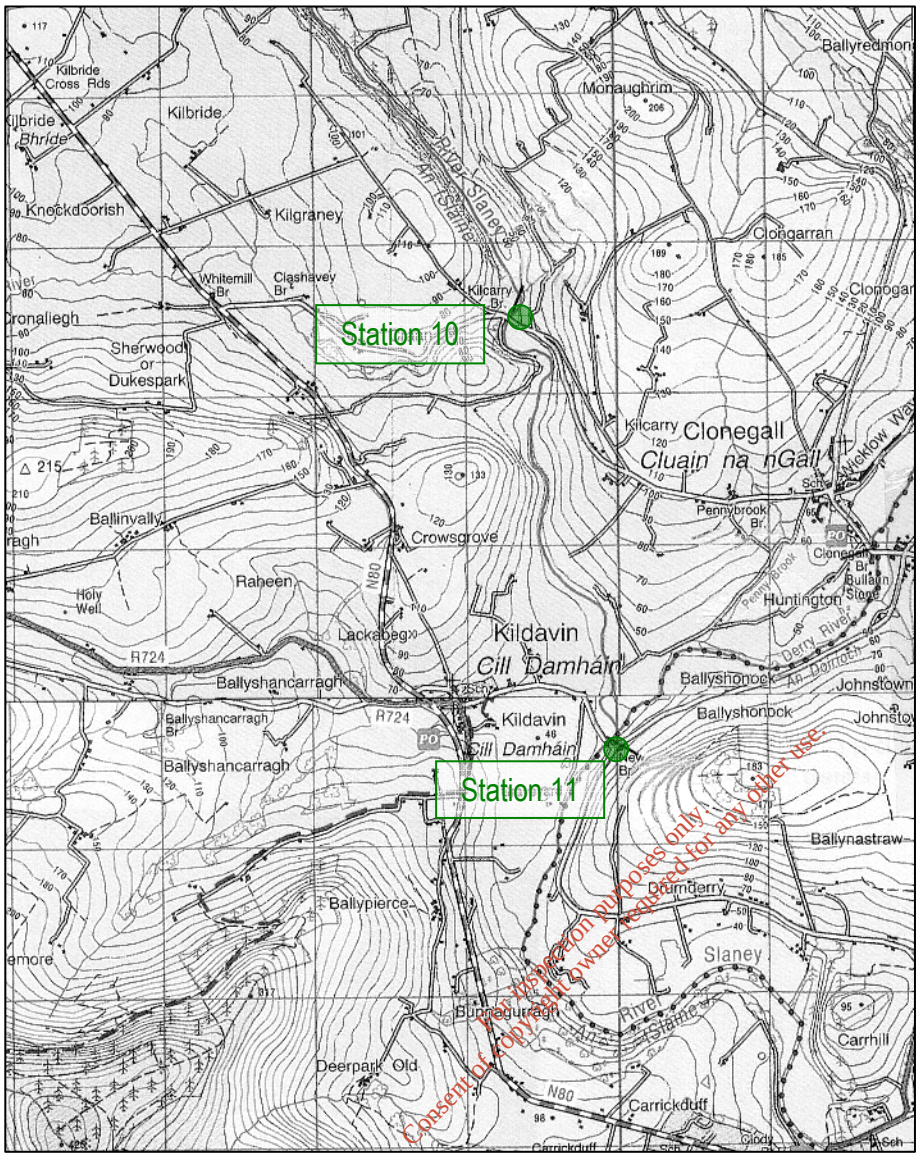

Figure 2 Slaney River sampling stations

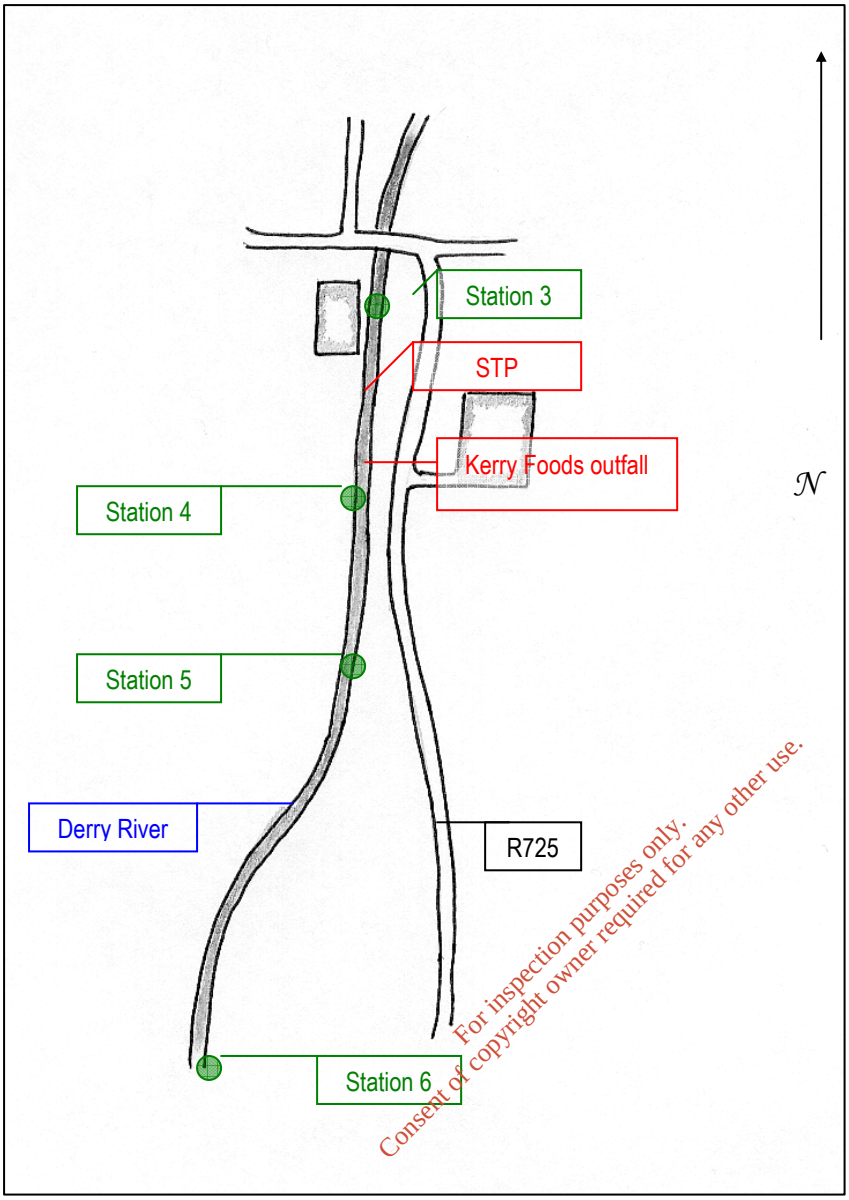

Figure 3 Shillelagh sampling stations

3.4 Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The Q-value determined using the fauna collected at each station therefore provides an indication of the quality of the water at that station. The relationship between Q values and water quality is set out in Table 3.

Table 3. Q-value and water quality.

Q-value	Water quality	Status
5	Good	Unpolluted
4	Fair	Unpolluted
3	Doubtful	Polluted
2	Poor	Polluted
1	Bad	Polluted

3.5 The intermediate ratings Q1-2, Q2-3, Q3-4 and Q4-5 are used to denote transitional conditions, while ratings within parenthesis indicate borderline values. Great importance is attached to the EPA biotic indices, and consequently it is these data that are generally used to form the basis of water quality management plans for river catchments.

3.6 In addition to determining the Q-value, the British Monitoring Working Party score (BMWP) (and the related Average Score Per Taxon - ASPT) was also calculated in order to provide a second opinion on water quality. While this scoring system was not developed for use in Ireland, and thus BMWP scores should be treated with caution, the differences in numerical values from site to site allow spatial comparisons to be made. The BMWP score is used extensively in the UK, and has superseded most other quality index schemes devised such as Simpson's and Chandler's indices. The scoring system used for the BMWP system is included in Appendix 1.

3.7 A number of texts were consulted in the identification of macroinvertebrate fauna collected. These are noted at in **Appendix 3**.

---

4. Results- Temperature and Dissolved Oxygen

4.1 The water temperature, pH and dissolved oxygen concentration were measured at each sampling station using a Wti multimeter. Recorded values are presented in **Table 4**.

4.2 The recorded values were all satisfactory and indicate that oxygen levels were not depleted at the time of sampling. Temperature and pH levels lie within the normal range.

Table 4. Temperature and dissolved oxygen levels.

Station	Temperature (^{0}C)	Dissolved oxygen (mg/l)	pH
1	6.9	10.3	7.6
2	6.5	10.4	7.3
3	6.9	10.2	7.1
4	7.2	11.2	7.6
5	7.1	10.2	7.0
6	7.1	10.2	7.2
7	7.4	11.0	7.6
8	7.6	11.1	7.6
9	7.7	10.4	7.3
10	8.0	10.7	7.8
11	7.9	11.2	7.8

5. Results- Chemical survey

5.1 Water samples taken from 11 stations were analysed for pH, BOD and orthophosphate by Environmental Laboratory Services (ELS) Cork (**Table 5**). Levels recorded during the 2006 and 2007 surveys are also presented in **Table 5** for comparison purposes. Results are discussed below in **Section 7.**

Table 5. pH, BOD and orthophosphate concentrations.

Station	BOD			Orthophosphate (mg/l)*		
	2006	2007	2008	2006	2007	2008
1	<2	<3	<3	<0.01	<0.001	<0.0092
2	<2	<3	<3	<0.01	<0.001	<0.0092
3	<2	<3	<3	<0.01	<0.001	<0.0092
4	<2	<3	<3	<0.01	<0.001	<0.0092
5	<2	<3	<3	<0.01	<0.001	<0.0092
6	<2	<3	<3	<0.01	<0.001	<0.0092
7	<2	<3	<3	<0.01	<0.001	<0.0092
8	<2	<3	<3	<0.01	<0.001	<0.0092
9	<2	<3	<3	<0.01	<0.001	<0.0092
10	<2	<3	<3	<0.01	<0.001	<0.0092
11	<2	<3	<3	<0.01	<0.001	<0.0092

Analyses as per *Standard methods for the examination of water and wastewater*, 18th Ed., 1992 (APHA, AWWA, WEF).

6. Results- Biological survey

6.1 Macroinvertebrates found at each site were identified down to the lowest taxon required for the determination of site quality, using the rating systems described in section 3 (EPA, 1999). Thus for example dipteran larvae were identified to family, while the more significant mayfly and stonefly larvae were identified to species. The complete survey results are included in **Appendix 2**.

6.2 In addition to the biological samples taken, additional information was compiled for each station in order to allow a more complete assessment of the ecological make-up at each site. This included an examination of macrophyte growth and percentage cover. Site information is summarised in **Appendix 2**.

6.3 Q-values, BMWP and ASPT scores are presented in **Table 6A**, **6B** and **6C**. Previous survey data are also presented. The significance of the results obtained is discussed below.

6.4 The EPA monitor a number of sites on the Derry and Slaney Rivers as part of the Agency's national freshwater monitoring programme. Results obtained by the EPA are presented in **Table 7** where relevant.

Table 6A. Survey results - Q-value

Station	Q-values								
	2008	2007	2006	2005	2004	2003	2001	2000	1999
1	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4 (4-5)	4-5	3-4
2	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4-5	4(4-5)	4
3*	3-4	3-4	3-4	3-4	3-4	4	4-5	4(4-5)	4
4	3-4	4	3-4	3-4	3-4	4	4	4(4-5)	4
5	3-4	3-4	3-4	3-4	3-4	4	4	4(4-5)	4
6	3-4	3-4	3-4	3-4	3-4	4 (4-5)	4(4-5)	4-5	4(3-4)
7	4	4	4	4	3-4	4	4(3-4)	4-5	3(3-4)/0
8	4	4	4	4	3-4	4	4(4-5)	4-5	3(3-4)/0
9	3-4	3-4	3-4	4	3-4	4(3-4)	4	4-5	3/0
10	3-4	3-4	3-4	4	4	4	4	4(4-5)	4(3-4)
11	4	3-4	3-4	3-4	4	4	4	4(4-5)	4

*Station 3 relocated during 2001 survey

Table 6B. Survey results- BMWP Scores

Station	BMWP Scores								
	2008	2007	2006	2005	2004	2003	2001	2000	1999
1	110	76	72	74	72	123	85	92	102
2	111	90	95	98	83	96	122	109	122
3*	63	70	74	59	61	100	102	107	106
4	69	79	65	69	70	90	75	104	103
5	64	61	50	64	61	85	90	100	134
6	92	76	73	57	63	103	98	115	109
7	84	80	78	96	46	101	57	88	69
8	89	74	70	67	57	110	85	120	91
9	68	82	87	79	63	46	105	95	55
10	54	50	62	91	59	91	112	103	102
11	49	80	76	59	54	80	85	127	94

Table 6C. Survey results-ASPT

Station						ASPT			
	2008	2007	2006	2005	2004	2003	2001	2000	1999
1	7.5	7.2	7.2	6.7	7.2	7.24	6.0	6.6	6.0
2	5.3	7.3	6.7	6.5	6.91	6.86	7.2	7.3	6.1
3*	5.3	6.1	5.8	5.4	6.1	6.25	6.2	7.1	5.3
4	5.8	5.6	5.6	5.8	4.38	6	5.7	5.8	5.7
5	7.1	6.3	6.1	5.8	5.54	5.31	6	6.3	5.8
6	7	7.3	5.5	5.2	7.0	7.36	6.1	6.4	5.7
7	6.8	7.1	5.8	6	5.75	5.94	5.7	5.9	4.9
8	6.2	7	6	5.6	7.13	7.33	7.1	6.3	5.4
9	6.2	7.5	5.7	6.1	6.30	4.6	6.2	6.3	5.5
10	6.8	7.8	6.9	6.5	7.38	6.07	6.2	5.7	6.0
11	6.2	7.6	6	5.9	5.4	5.33	5.3	6.7	5.9

Table 7. EPA Q-values.

Station code	Location	1976	1980	1984	1987	1991	1995	1998	2001	2004
0350 (River Derry)	Greenhall Br	-	-	-	3-4	4-5	4	4-5	4-5	4-5
0500 (River Derry)	Shillelagh Br	-	-	-	4	3-4	4	4-5	4	3-4
0700 (River Derry)	Balisland Br	4	4	4	4	4	3-4/0	4-5	3-4	4
1000 (River Derry)	U/s Derry-Slaney confluence	-	4	4	4	4	4-5	4-5	4	4
1600 (River Slaney)	Kilcarry Br	-	-	3-4	3-4	3-4	3-4	4-5	3-4	3-4

7. Discussion- Chemical survey

7.1 The highest pH values occurred in the Slaney River as noted during previous surveys. Values recorded were satisfactory, with all measurements lying within the 6-9 pH range specified in the Council Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive) and the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988).

7.2 The BOD recorded at all stations was satisfactory, with levels indicating good water quality, which is not significantly affected by pollution.

7.3 The orthophosphate fraction of phosphorous in a river (generally estimated to be 80% of total phosphate) is that fraction which is the most readily available to plants and algae, and has been implicated as a cause of eutrophication. Surface run-off, particularly from agricultural land in receipt of fertilisers and manures, and industrial and sewage waste discharges, are the most important contributors of phosphorous to surface waters. Phosphorous and phosphates are not toxic to fish, and thus no limit is quoted in the Freshwater Fish Directive. However their influence on eutrophication is such that the Directive does include a total phosphorous limit of 0.062 mg/l-P as being that level which is desirable in order to reduce eutrophication.

7.4 The Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998 (S.I. No. 258 of 1998) were introduced to counter eutrophication observed throughout Irish watercourses and also to comply with Council Directive 76/464/EEC, on Pollution Caused by Certain Dangerous Substances, discharged into the aquatic environment. The Regulations oblige local authorities to maintain or improve the water quality at any part of a river, by 2007, by reference to the biotic index (Q-value) or to the concentration of molybdate-reactive phosphate (MRP) (largely orthophosphate). The target values specified are set out in the third schedule of the Regulations and are reproduced in **Table 8**.

Table 8. Phosphorus Regulations target values.

Existing Q-values	Either to be applied	
	Target Q-value	Target MRP (ug/l)
5	5	15
4-5	4-5	20
4	4	30
3-4	4	30
3	3-4	50
2-3	3-4	50
≤2	3	70

7.5 The target values specified in the Regulations were adopted on the basis of the empirical relationship between the biotic indices and orthophosphate concentrations in Irish waters as monitored extensively by the EPA. In practical terms Q values of 4 or more are taken to represent satisfactory water quality, where eutrophication is unlikely to be a problem. Because annual median phosphate (P) values in such waters rarely exceed 30ug P/l, this concentration was adopted as the target value to be achieved by 2007.

The empirical relationship between phosphate and eutrophication suggests that once annual MRP values exceed 30ug P/l, there is a strong statistical likelihood that the stretch of river in question will have a significant eutrophication problem.

7.6 It is also noted that although on average a Q value of 4 correlates with an orthophosphate level of 0.03mg/l, this does not hold true for all situations. In addition elevated orthophosphate levels affect watercourses by causing eutrophication, which in turn causes depletion of oxygen levels. However all rivers are dynamic and variable systems and high phosphate levels are not always correlated with low oxygen levels. For example the presence of turbulent water, waterfalls or weirs may prevent significant deoxygenation of water. In addition shade levels will also affect plant and algal growth. Orthophosphate values may show considerable fluctuation over time and the use of a limited number of samples can therefore provide a misleading picture of water quality at a given location.

7.7 The orthophosphate levels measured at all sites were consistently low at <0.092 mg/l P which is indicative of unpolluted conditions.

8. Discussion- Biological survey

8.1 Although overall numbers of macroinvertebrates were low at sites 1 and 2, the relative proportions of sensitive stonefly species was high and no signs of water quality deterioration such as excessive algae, siltation etc was noted. Sensitive species included stonefly species (*Leuctra hippopus, Isoperla gramatica* and *Chlorperla torrentium)* and small numbers of heptagenid mayflies were also recorded; therefore despite the limited density of macroinvertebrates, a classification of Q4-5 was considered appropriate.

8.2 The Q-value recorded at site 3 was Q3-4, indicating transitionary water quality. This value was also assigned in 2006. The only stonefly species recorded was *Leuctra* sp. which was recorded in small numbers. It is noted that station 3 is upstream of both the sewage discharge and the discharge from Kerry foods; however it is downstream of the confluence of the Derry River and the Shillelagh tributary. Therefore the Shillelagh tributary may be having an impact on water quality at this location.

8.3 Station 4 was situated within the mixing zone downstream of the Kerry Foods discharge in an area where the flow is relatively slow. A value of Q3-4 was assigned to site 4; the same Q value was assigned in 2007. Although some sensitive species were present, their numbers were low. Tolerant species were found in small numbers. Overall water quality at this site is in transition and a Q value of 3-4 was assigned.

8.4 The diversity and density of species recorded at stations 5 and 6 were similar to those obtained at station 4 and a Q value of 3-4 was assigned to both sites.

8.5 Stations 7, 8, 9 and 10 were assigned Q values of 4 in 2008; the same values were assigned in 2007.

8.6 The Q value at site 11 increased slightly from Q3-4 to Q4. This is the only site where the hemipteran species *Aphelocheirus* sp. was recorded.

8.7 EPA Q-values for 2007 indicate water quality declined slightly at Shillelagh bridge (0500) between 2004 and 2007 from Q4 to Q3-4 (**Table 7**). Conversely water quality improved slightly at Balisland Bridge (0700) from Q3-4 to Q4.

8.8 It has been noted in section 3.6 that the British BMWP system attempts to provide a more objective method of determining water quality. It is the most widely used system in Britain and has been banded for interpretation in different regions. For example Severn-Trent scores would be interpreted as follows: 0-12 (unsatisfactory), 13-35 (poor), 36-70 (moderate), 71-90 (good), 91-150 (very good) and >150 (excellent). As yet insufficient work has been carried out in this country to allow accurate interpretation of the scores. The lowest score (49) was recorded at station 11, indicating low levels of biodiversity at this location. The highest value (111) was recorded at site 2.

8.9 The associated Average Score Per Taxon (ASPT) helps to standardise data and minimise factors unrelated to pollution pressure such as unusually low or high habitat diversity or inconsistent sampling effort. The lowest score (5.3) was recorded at stations 2 and 3, indicating low levels of biodiversity at this location. The highest value (7.5) was recorded at site 1.

9. Conclusions

9.1 There was some variation in the pH recorded, with the highest levels occurring in the Slaney River. This is consistent with results of previous surveys. However levels were satisfactory at all stations. The BOD levels recorded at all stations were satisfactory at <3 mg/l.

9.2 Orthophosphate concentrations were consistently low at all sites at <0.0092 mg/l P.

9.3 The density of macroinvertebrates was generally low at all sites, possibly due to seasonal factors. Water remains satisfactory at sites 1, 2 and 7, 8 and 11. Water quality at the remaining sites was found to be in transition. It is noted that the difference between a Q value of 3-4 and 4 may be marginal and related to the presence/absence of small numbers of sensitive species and the presence/absence of algal species such as *Cladophora* sp. No evidence of serious pollution was noted at any of the sites surveyed.

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Appendix 1. BMWP scoring system

BMWP Score table		
Group	**Families**	**Score**
Mayflies, Stoneflies, Riverbug, Caddisflies or Sedgeflies	Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae, Taeniopterygidae, Leuctridae, Caprniidae, Perlodidae, Perlidae, Chloroperlidae, Aphelocheridae, Phryganeidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae	10
Crayfish, Dragonflies	Astacidae, Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libelluiidae	8
Mayflies, Stoneflies, Caddisflies or Sedge flies	Caenidae, Nemouridae, Rhyacophilidae, Polycentropidae, Limnephilidae	7
Snails, Caddisflies or Sedge flies, Mussels, Shrimps, Dragonflies	Neritidae, Viviparidae, Ancylidae, Hydroptilidae, Unionidae, Corophiidae, Gammaridae, Platycnemididae, Coenagriidae	6
Bugs, Beetles, Caddisflies or Sedgeflies, Craneflies/Blackflies, Flatworms	Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae, Gyrinidae, Hydrophilidae, Clambidae, Helodidae, Dryopidae, Elmidae, Chrysomelidae, Curculionidae, Hydropsychidae, Tipulidae, Simuliidae, Planariidae, Dendrocoelida	5
Mayflies, Alderflies, Leeches	Baetidae, Sialidae, Piscicolidae	4
Snails, Cockles, Leeches, Hog louse	Valvatidae, Hydrobiidae, Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudidae, Erpobdellidae, Asellidae	3
Midges	Chironomidae	2
Worms	Oligochaeta (whole class)	1

Appendix 2. Biological monitoring methodology and results

Q value-methodology

Quantitative sampling of benthic (bottom dwelling) macro-invertebrates using kick-sampling (McGarrigle *et al*., 1999; Toner *et al*, 2005). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net. Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high powered binocular microscope.

To establish the water quality of the samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. The relative abundance of invertebrates per two minute kick-sampling and stone washing in samples was described as:

- 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%

Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The relationship between Q values and water quality is set out in **Table A1.** Specimens were identified using the following keys; Quigley , M. (1977), Hynes, H. B. N. (1977), Edington, J. M. and Hildrew, A. G. (1981), Elliot, J. M., Humpesch, U. H. and Macan, T. T. (1988), Savage, A. A. (1989), Nilsson, A. (1996a), Nilsson, A. (1996b) and Wallace, I. D., Wallace, B. and Philipson, G. N. (2003).

Table A1. EPA scheme of Biotic Indices or Quality (Q) Values and its relationship to water quality.

Biotic Index	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, Q2-3	Moderately Polluted	Class C
Q2, Q1-2, Q1	Seriously Polluted	Class D

Results

Table A2. Species list

EPHEMEROPTERA - MAYFLIES	COLEOPTERA - BEETLES
Baetis rhodani	*Elmis aenea* (adult & larva)
Baetis muticus	*Esolus parallelepipedus* (adult & larva)
Caenis sp.	*Limnius volckmari* (adult & larva)
Ephemera danica	*Oulimnius tuberculatus* (adult & larva)
Heptagenia sulphurea	*Gyrinus* sp. (adult)
Ecdyonurus sp.	Dytiscidae (adult)
PLECOPTERA - STONEFLIES	CRUSTACEA - CRUSTACEANS
Leuctra hippopus	*Gammarus pulex* (freshwater shrimp)
Leuctra inermis	*Asellus* sp. (hog-lice)
Isoperla grammatica	
Amphinamura sucicolis	HYDRACARINA – WATERMITES
	Hydracarina
TRICHOPTERA - CADDISFLIES	DIPTERA - TRUE FLIES
Rhyacophila dorsalis	Simuliidae (black-flies)
Hydropsyche siltalai	Diamesinae
Hydropsyche sp. *Polycentropus flavomaculatus*	Ortrocladinae
Sericostoma personatum	Chironomidae (non-biting midges)
Lepidostoma hirtum	Tanypodinae
Limnephilis sp.	Tipulidae (daddy-long-legs)
Leptoceridae	
Glossosomatidae	HIRUDINEA - LEECHES
Odontocerum albiorne	Glossiphonidae
MOLLUSCA - MOLLUSCS	OLIGOCHAETE - WORMS
Potamopyrgus jenkensii	Tubificidae
Ancylus sp. (limpet)	HEMIPTERA
Planorbidae (ramshorn snail)	*Aphelocheirus* sp.
Lymnaea	
Pisidium (pea mussel)	

Table A2. Biological abundance

STATION	1	2	3	4	5	6	7	8	9	10	11
EPHEMEROPTERA											
Baetidae											
Caenidae											
Ephemeridae											
Ephemerellidae											
Heptageniidae	P	P	P	P	P	P	P	P	P	P	P
PLECOPTERA											
Leuctridae	C	F	P	P	P	P	F	F	P		
Perlodidae	F	P									
Chloroperlidae	F	F				P	P	P	P		
Nemouridae	P	P									
Taeniopterygidae											
TRICHOPTERA											
Rhyacophilidae	P	P	P	P	P	P	P	P	P		
Hydropsychidae	P	P	F	F	F	F	F	P	F	F	
Sericostomatidae	P	P				P	F				
Lepidostomatidae	P					P		P	P	P	
Polycentropidae		P									
Limnephilidae	P	P	P	P	P	P	F	F		P	P
Leptoceridae							P	P		P	P
Goeridae	F	P									
Beraeidae											
CRUSTACEA											
Gammarus sp.	P	P	P	P	F	F	P	P		P	F
Asellus sp.							P				
COLEOPTERA											
Elminthidae	C	C	C	C	C	C	F	F		F	F
Gyrinidae			P		P			P	P		
Helodidae			P	C	P	P	P		P		
HIRUDINEA											
Glossiphonidae			P	P	P		P	P	P		
HYDRACARINA											
Hydracarina							P	P			
HEMIPTERA											
Aphelocheirus sp.											F

Table A2 (contd). Biological abundance

STATION	1	2	3	4	5	6	7	8	9	10	11
DIPTERA											
Simuliidae		P			P						
Chironomous sp.											
Chironomidae	F	P	P	P					P		
Tipulidae			F	F					P		P
MOLLUSCA											
Ancylidae				P		P					
Planorbidae								P			F
Lymnaea											F
OLIGOCHAETE	F	F	C	C	C	F	C	P	P	P	N

*P-present, F-frequent, C-common, N-numerous, D-dominant.

Table A3. Survey site characteristics

STATION	WIDTH (m)	DEPTH (cm)	CURRENT	SUBSTRATE	COMMENT
1	4	45	Moderate - fast	Sand & gravel with sections of larger stones	%S* = 20% primarily alder and some ferns. Clarity moderate. Macrophyte/ bryophyte cover 25% with water crowfoot (*Ranunculus* sp.) dominant species. Clean gravels with no sewage fungus, slime or excessive algal development noted.
2	8	45	Fast	Gravel, large stones with sections of sand	%S = 30%. Macrophyte/ bryophyte cover 60% with *Fontinalis*, *Ranunculus*, and *O. crocata* main species. Clear. No sewage fungus, slime or excessive algal development noted.
3	6	38	Fast	Mixed	%S = 40% primarily alder, willow, sycamore and riparian herbaceous vegetation eg. bramble, nettle, hogweed etc. Macrophyte/ bryophyte cover primarily *O. crocata* and *Ranunculus* sp. No sewage fungus, slime or excessive algal development noted.
4	7.5	47	Slow	Sand/fine gravel with an isolated larger stone	%S = 15% primarily alder, willow on opposing bank. Car park has been created adjacent to the outflow point. Macrophyte/ bryophyte cover 3% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
5	7.5	49	Slow - moderate	Fine gravel/ sand with few larger stones	. %S = 15% with willow on opposing bank. Also hogweed and grasses such as Reed Sweet-Grass (*Glyceria maxima*) and *Carex* sp. Macrophyte/ bryophyte cover 30% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
6	9	41	Fast	Fine sand/gravel with some larger stones	%S = 4% with hogweed and large grasses such as Reed Sweet-Grass (*Glyceria maxima*) nettle, bramble etc. Macrophyte/ bryophyte cover 25% with *Ranunculus* sp the main species. No sewage fungus, slime or excessive algal development noted.
7	7	37	Fast	Sand overlaid with cobbles, gravel & larger stones	%S = 10% with main species willow. No sewage fungus, slime growths or excessive algal development noted
8	10	40	Moderate	Large stones with some gravel & sand	%S = 15% with main species holly, bramble, willow and ivy. Macrophyte/bryophyte consisting of *Fontinalis* sp. and water crowfoot. No sewage fungus, slime growths or excessive algal development noted.
9	8	38	Slow	Mud/silt at margins with gravel & some larger stones	%S = 40% with main species willow, reed grass, grasses and sedges. Macrophyte/ bryophyte cover 10% with *Ranunculus* sp main species. No sewage fungus, slime or excessive algal development noted.
10	10	50	Moderate	Large stones with some limited areas of gravel	%S = 40% mainly due to proximity of bridge. No sewage fungus, slime or excessive algal development noted.
11	45	55	Moderate	Cobbles & sand	%S = 20% with mature trees e.g. ash. No sewage fungus, slime or excessive algal development noted. Sample taken in turbulent water at natural weir. Difficult sampling location.

*%S = percentage shade

Appendix 3 References

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Project

Aquatic survey of Derry and Slaney Rivers 2009

Client

Celtic Watercare

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4.1.2010	1	First Draft	Carl Dixon M.Sc Ecological monitoring	

Contents

1. Introduction

1.1 Dixon.Brosnan were commissioned by Celtic Watercare to carry out an aquatic survey of the Derry and Slaney Rivers on behalf of their client Kerry Foods who operate a food processing facility at Shillelagh, Co. Wicklow. This facility discharges treated wastewater to the Derry River in accordance with a discharge licence issued by Wicklow County Council under the Local Government (Water Pollution) Act, 1977.

1.2 The survey, which consisted of chemical and biological analyses at a number of sampling stations, was carried out in order to assess the current water quality of the two rivers at these stations. Data recorded were compared to results obtained during previous surveys.

2. Location

2.1 The Slaney River drains a large catchment spread over counties Carlow, Wexford and Wicklow. One of its tributaries – the Derry River – flows through Shillelagh before its confluence with the Slaney 17 km downstream.

2.2 Eleven sampling stations were agreed previously between the client and Wicklow County Council, nine of which are located on the Derry River and the remainder on the Slaney. These stations have been monitored during previous surveys on the client's behalf.

2.3 During a survey undertaken in April 2000, it was noted that a discharge from a wastewater treatment plant (WWTP) upstream of the Kerry Foods outfall may be having a negative impact on the river. In order to quantify any impact, station 3 was relocated upstream of this discharge during the current survey.

2.4 The complete list of stations is presented in **Table 1**. All stations are indicated in **Figures 1**, **2** and **3**.

Table 1 Sampling station locations

Station	River	Location	County
1	Derry	Green Hall Bridge	Wicklow
2	Derry	Deegins Bridge	Wicklow
3	Derry	50m u/s STP outfall	Wicklow
4	Derry	15m d/s Kerry Foods outfall in mixing zone	Wicklow
5	Derry	100m d/s Kerry Foods outfall	Wicklow
6	Derry	500m d/s Kerry Foods outfall	Wicklow
7	Derry	1500m d/s Kerry Foods outfall at private bridge	Wicklow
8	Derry	2500m d/s Kerry Foods outfall	Wicklow
9	Derry	Balisland Bridge	Wicklow
10	Slaney	Kilcarry Bridge	Carlow
11	Slaney	New Bridge	Wexford

3. Survey

3.1 The survey was carried out on the 29th of September, 2009. At each station water samples were taken and transported in a chilled container to Environmental Laboratory Services Ltd. (ELS), accredited by the Irish National Accreditation Body (INAB) for analysis. Analysis was carried out for a number of chemical parameters as described below following overnight storage at 4^0C. Temperature, pH and dissolved oxygen were measured on site at the time of sampling using a Wti Multimeter.

3.2 Biological sampling was carried out at each station using the kick-sampling technique as described by the Environmental Protection Agency (EPA) (1999). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net.

Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high powered binocular microscope.

3.3 To establish the water quality of the four samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. Macroinvertebrate abundance was rated in accordance with the classification presented in **Table 2**.

Table 2 Abundance classes

Class	Number
1-4	Present
5-20	Frequent
21-50	Common
51-100	Numerous
>100	Dominant

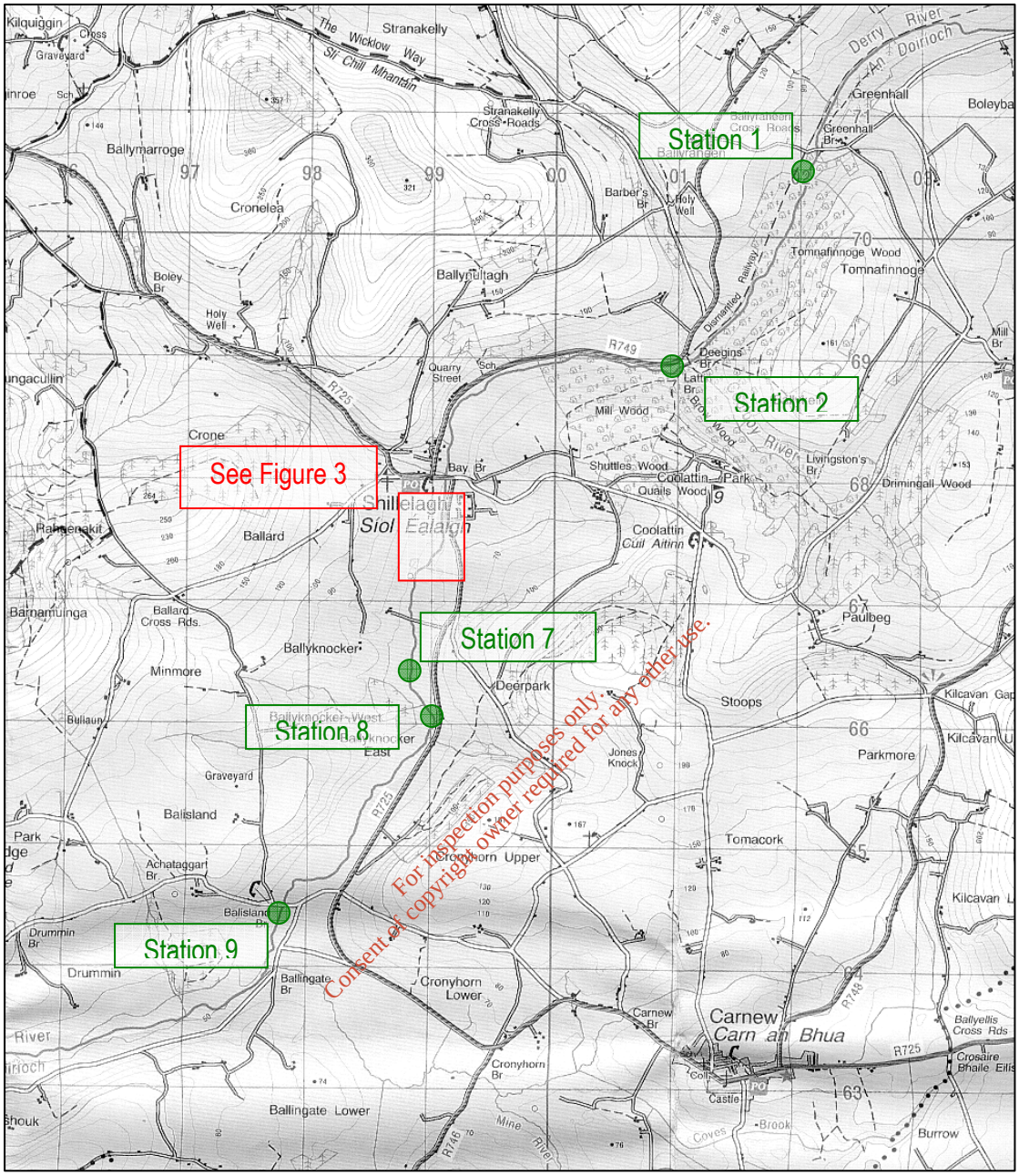

Figure 1 Derry River sampling stations

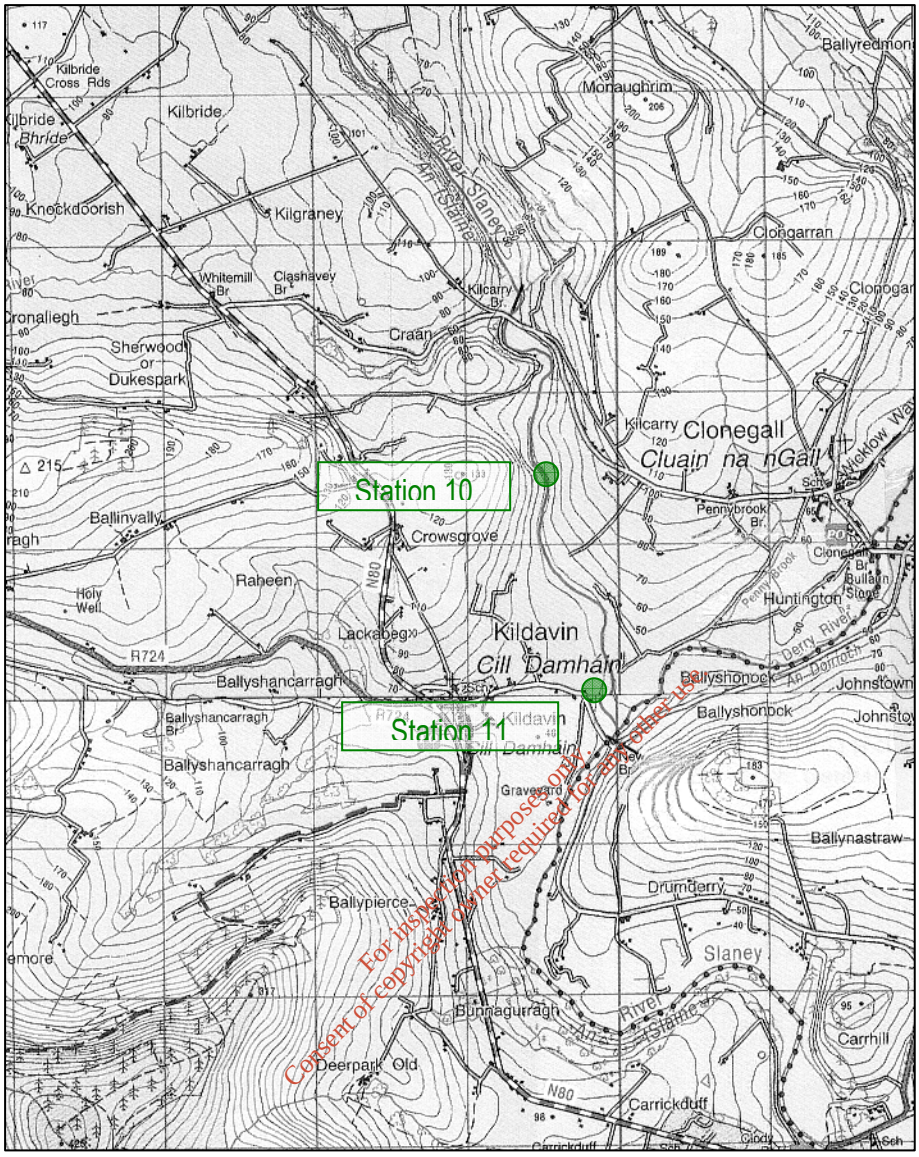

Figure 2 Slaney River sampling stations

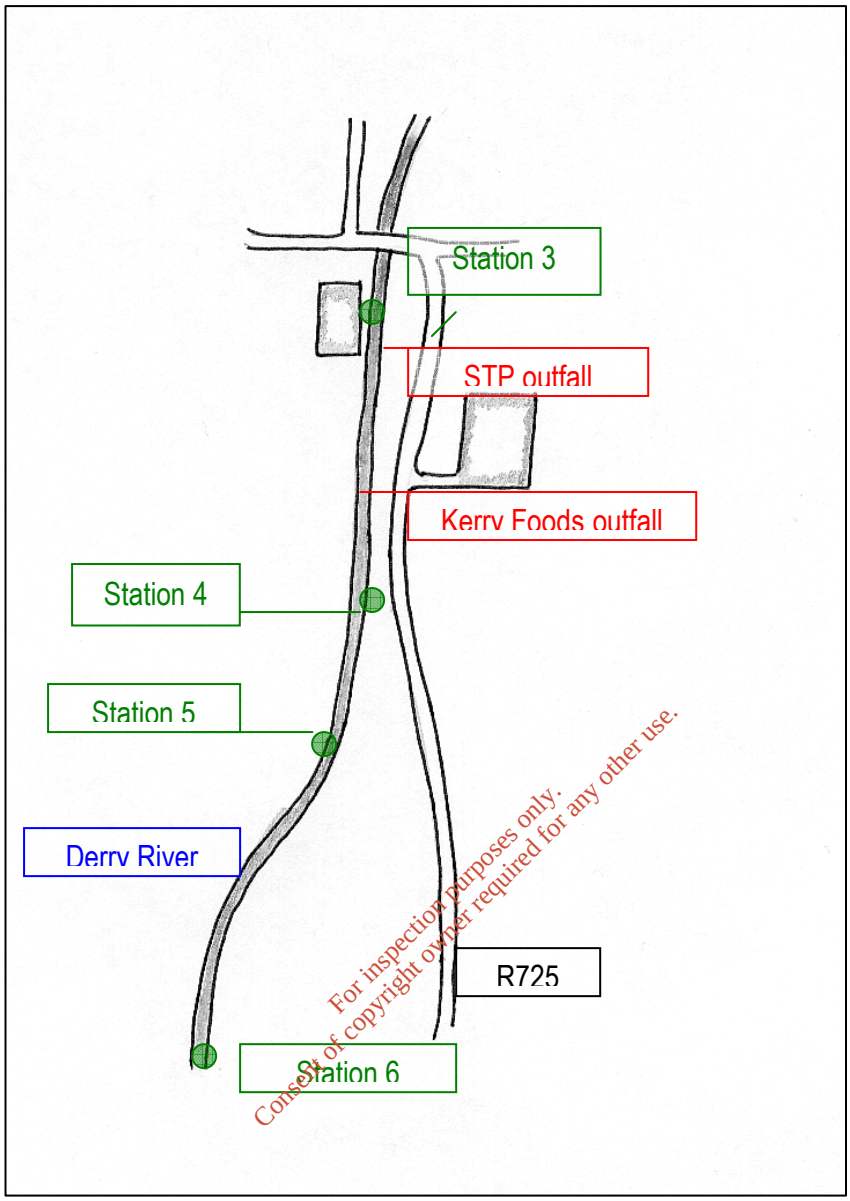

Figure 3 Shillelagh sampling stations

3.4 Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The Q-value determined using the fauna collected at each station therefore provides an indication of the quality of the water at that station. The relationship between Q values and water quality is set out in **Table 3.**

Table 3. Q-value and water quality.

Q-value	Water quality	Status
5	Good	Unpolluted
4	Fair	Unpolluted
3	Doubtful	Polluted
2	Poor	Polluted
1	Bad	Polluted

3.5 The intermediate ratings Q1-2, Q2-3, Q3-4 and Q4-5 are used to denote transitional conditions, while ratings within parenthesis indicate borderline values. Great importance is attached to the EPA biotic indices, and consequently it is these data that are generally used to form the basis of water quality management plans for river catchments.

3.6 In addition to determining the Q-value, the British Monitoring Working Party score (BMWP) (and the related Average Score Per Taxon - ASPT) was also calculated in order to provide a second opinion on water quality. While this scoring system was not developed for use in Ireland, and thus BMWP scores should be treated with caution, the differences in numerical values from site to site allow spatial comparisons to be made. The BMWP score is used extensively in the UK, and has superseded most other quality index schemes devised such as Simpson's and Chandler's indices. The scoring system used for the BMWP system is included in **Appendix 1**.

3.7 A number of texts were consulted in the identification of macroinvertebrate fauna collected. These are noted at in **Appendix 3**.

4. Results- Temperature and Dissolved Oxygen

4.1 The water temperature, pH and dissolved oxygen concentration were measured at each sampling station using a Wti multimeter. Recorded values are presented in **Table 4**.

4.2 The recorded values were all satisfactory and indicate that oxygen levels were not depleted at the time of sampling. Temperature and pH levels lie within the normal range.

Table 4. Temperature and dissolved oxygen levels.

Station	Temperature (^{0}C)	Dissolved oxygen (mg/l)	pH
1	7.1	10.1	7.3
2	7.2	9.9	7.4
3	7.0	10.2	7.4
4	6.9	10.2	7.3
5	7.1	10.2	7.0
6	7.1	10.2	7.1
7	7.2	10.2	7.6
8	7.2	10.3	7.6
9	7.2	9.90	7.2
10	7.5	10.1	7.7
11	7.4	11.1	7.7

5. Results- Chemical survey

5.1 Water samples taken from 11 stations were analysed for pH, BOD and orthophosphate by Environmental Laboratory Services (ELS) Cork (**Table 5**). Levels recorded during previous surveys are also presented in **Table 5** for comparison purposes. Results are discussed below in **Section 7.**

Table 5 pH, BOD and orthophosphate concentrations

Station	BOD			Orthophosphate (mg/l)*		
	2007	2008	2009	2007	2007	2009
1	<3	<3	<1	<0.001	<0.0092	0.017
2	<3	<3	<1	<0.001	<0.0092	0.020
3	<3	<3	<1	<0.001	<0.0092	0.013
4	<3	<3	<1	<0.001	<0.0092	0.014
5	<3	<3	<1	<0.001	<0.0092	0.040
6	<3	<3	<1	<0.001	<0.0092	0.016
7	<3	<3	<1	<0.001	<0.0092	0.015
8	<3	<3	<1	<0.001	<0.0092	0.014
9	<3	<3	<1	<0.001	<0.0092	<0.009
10	<3	<3	1	<0.001	<0.0092	<0.009
11	<3	<3	1.4	<0.001	<0.0092	<0.009

Analyses as per *Standard methods for the examination of water and wastewater*, 18th Ed., 1992 (APHA, AWWA, WEF).

6. Results- Biological survey

6.1 Macroinvertebrates found at each site were identified down to the lowest taxon required for the determination of site quality, using the rating systems described in section 3 (EPA, 1999). The complete survey results are included in **Appendix 2**.

6.2 In addition to the biological samples taken, additional information was compiled for each station in order to allow a more complete assessment of the ecological make-up at each site. This included an examination of macrophyte growth and percentage cover. Site information is summarised in **Appendix 2**.

6.3 Q-values, BMWP and ASPT scores are presented in **Table 6A**, **6B** and **6C**. Previous survey data are also presented. The significance of the results obtained is discussed below.

6.4 The EPA monitor a number of sites on the Derry and Slaney Rivers as part of the Agency's national freshwater monitoring programme. Results obtained by the EPA are presented in **Table 7** where relevant.

Table 6A Survey results - Q-value

Station	Q-values							
	2009	2008	2007	2006	2005	2004	2003	2001
1	3-4	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4 (4-5)
2	4	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4-5
3*	3-4	3-4	3-4	3-4	3-4	3-4	4	4-5
4	3-4	3-4	4	3-4	3-4	3-4	4	4
5	3-4	3-4	3-4	3-4	3-4	3-4	4	4
6	3-4	3-4	3-4	3-4	3-4	3-4	4 (4-5)	4(4-5)
7	3-4	4	4	4	4	3-4	4	4(3-4)
8	3-4	4	4	4	4	3-4	4	4(4-5)
9	4	3-4	3-4	3-4	4	3-4	4(3-4)	4
10	4	3-4	3-4	3-4	4	4	4	4
11	4	4	3-4	3-4	3-4	4	4	4

*Station 3 relocated during 2001 survey

Table 6B Survey results- BMWP Scores

Station	BMWP Scores							
	2009	2007	2006	2005	2004	2003	2001	2000
1	36	76	72	74	72	123	85	92
2	75	90	95	98	83	96	122	109
3*	47	70	74	59	61	100	102	107
4	80	79	65	69	70	90	75	104
5	60	61	50	64	61	85	90	100
6	54	76	73	57	63	103	98	115
7	35	80	78	96	46	101	57	88
8	52	74	70	67	57	110	85	120
9	64	82	87	79	63	46	105	95
10	78	50	62	91	59	91	112	103
11	80	80	76	59	54	80	85	127

Table 6C. Survey results-ASPT

Station	ASPT							
	2009	2008	2007	2006	2005	2004	2003	2001
1	5.14	7.5	7.2	7.2	6.7	7.2	7.24	6.0
2	5.77	5.3	7.3	6.7	6.5	6.91	6.86	7.2
3*	5.88	5.3	6.1	5.8	5.4	6.1	6.25	6.2
4	5.71	5.8	5.6	5.6	5.8	4.38	6	5.7
5	6	7.1	6.3	6.1	5.8	5.54	5.31	6
6	5.4	7	7.3	5.5	5.2	7.0	7.36	6.1
7	5.83	6.8	7.1	5.8	6	5.75	5.94	5.7
8	5.78	6.2	7	6	5.6	7.13	7.33	7.1
9	5.82	6.2	7.5	5.7	6.1	6.30	4.6	6.2
10	6.5	6.8	7.8	6.9	6.5	7.38	6.07	6.2
11	6.67	6.2	7.6	6	5.9	5.4	5.33	5.3

Table 7 EPA Q-values

Station code	Location	1976	1980	1984	1987	1991	1995	1998	2001	2004	2007
0100	Cross Br	-	4	4	4	4	4	4-5	4	3-4	4
0350 (River Derry)	Greenhall Br	-	-	-	3-4	4-5	4	4-5	4-5	4-5	4
0500 (River Derry)	Shilelagh Br	-	-	-	4	3-4	4	4-5	4	3-4	4
0700 (River Derry)	Balisland Br	4	4	4	4	4	3-4/0	4-5	3-4	4	4
0900 (River Derry)	Clonegal Bridge	4	4	4	4						4
1000 (River Derry)	U/s Derry-Slaney confluence	-	4	4	4	4	4-5	4-5	4	4	-
1600 (River Slaney)	Kilcarry Br	-	-	3-4	3-4	3-4	3-4	4-5	3-4	3-4	4

7. Discussion- Chemical survey

7.1 The highest pH values occurred in the Slaney River as noted during previous surveys. Values recorded were satisfactory, with all measurements lying within the 6-9 pH range specified in the Council Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive) and the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988).

7.2 The BOD recorded at all stations was satisfactory, with levels indicating good water quality which is not significantly affected by pollution. A slight elevation in the BOD figure (1.4 mg/l) was recorded at site 11.

7.3 The orthophosphate fraction of phosphorous in a river (generally estimated to be 80% of total phosphate) is that fraction which is the most readily available to plants and algae, and has been implicated as a cause of eutrophication. Surface run-off, particularly from agricultural land in receipt of fertilisers and manures, and industrial and sewage waste discharges, are the most important contributors of phosphorous to surface waters. Phosphorous and phosphates are not toxic to fish, and thus no limit is quoted in the Freshwater Fish Directive. However their influence on eutrophication is such that the Directive does include a total phosphorous limit of 0.062 mg/l-P as being that level which is desirable in order to reduce eutrophication.

7.4 The Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998 (S.I. No. 258 of 1998) were introduced to counter eutrophication observed throughout Irish watercourses and also to comply with Council Directive 76/464/EEC, on Pollution Caused by Certain Dangerous Substances, discharged into the aquatic environment. The Regulations oblige local authorities to maintain or improve the water quality at any part of a river, by 2007, by reference to the biotic index (Q-value) or to the concentration of molybdate-reactive phosphate (MRP) (largely orthophosphate). The target values specified are set out in the third schedule of the Regulations and are reproduced in **Table 8**.

Table 8 Phosphorus Regulations target values.

Existing Q-values	Either to be applied	
	Target Q-value	Target MRP (ug/l)
5	5	15
4-5	4-5	20
4	4	30
3-4	4	30
3	3-4	50
2-3	3-4	50
≤2	3	70

7.5 The target values specified in the Regulations were adopted on the basis of the empirical relationship between the biotic indices and orthophosphate concentrations in Irish waters as monitored extensively by the EPA. In practical terms Q values of 4 or more are taken to represent satisfactory water quality, where eutrophication is unlikely to be a problem. Because annual median phosphate (P) values in such waters rarely exceed 30ug P/l, this concentration has been adopted as the target value to be achieved by 2007. The empirical relationship between phosphate and eutrophication suggests that once annual MRP values exceed 30ug P/l, there is a strong statistical likelihood that the stretch of river in question will have a significant eutrophication problem.

7.6 It is also noted that although on average a Q value of 4 correlates with an orthophosphate level of 0.03mg/l, this does not hold true for all situations. In addition elevated orthophosphate levels affect watercourses by causing eutrophication, which in turn causes depletion of oxygen levels. However all rivers are dynamic and variable systems and high phosphate levels are not always correlated with low oxygen levels. For example the presence of turbulent water, waterfalls or weirs may prevent significant deoxygenation of water. In addition shade levels will also affect plant and algal growth. Orthophosphate values may show considerable fluctuation over time and the use of a limited number of samples can therefore provide a misleading picture of water quality at a given location.

7.7 The orthophosphate levels measured at all sites were generally low and not indicative of elevated levels. However an elevated value of 0.04 mg/l P was recorded at S5.

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8. Discussion- Biological survey

8.1 Although numbers of macroinvertebrates were low at site 1 and with the exception of small numbers of stonefly (*Leuctra hippopus*), sensitive species were absent. No obvious signs of organic enrichment were noted and the substrate is dominated by clean gravels.

There was an slight increase in biodiversity at site 2 and both stoneflies (*Leutra hippopus*) and heptageniid mayflies (*Rhritrogena semicolator*) were recorded. Freshwater shrimp (*Gammerus sp*.) and Elmintidae beetle larvae were the dominant species.

The Q-value recorded at site 3 was Q3-4, indicating transitionary water quality. This value was also assigned in 2007. The only sensitive group A species recorded was *Heptagenia sp*. which occurred in small numbers. *Gammerus sp.* was the dominant species. It is noted that station 3 is upstream of both the sewage discharge and the discharge from Kerry foods; however it is downstream of the confluence of the Derry River and the Shillelagh tributary. Therefore the Shillelagh tributary may be having an impact on water quality at this location.

Station 4 is situated within the mixing zone downstream of the Kerry Foods discharge in an area where the flow is relatively slow. It is also noted that this site is downstream of the discharge from the wastewater plant. A value of Q3-4 was assigned to site 4; and only small numbers of sensitive stonefly species were recorded. Numbers of Oligochaeta, *Baetis rhodani* and Elminthidae beetle larvae were relatively high. Overall water quality at this site is in transition and a Q value of 3-4 was assigned.

The diversity and density of species recorded at stations 5 and 6 were similar to those obtained at station 4 and a Q value of 3-4 was assigned to both sites.

A Q value of 4 was assigned to site 7. The higher value was due to the higher numbers of sensitive mayfly and stonefly recorded at the site. However biodiversity is very high at this site.

There was a slight deterioration detected at site 8 which was assigned a Q value of 3-4. The most numerous species were *Gammerus* sp., *Baetis* sp,. Simuldae fly larvae, oligocheates and elminthidae beetle larvae.

8.6 A Q value of 4 was assigned to sites 9,10 and 11 with hemipteran species *Aphelocheirus* sp. recorded at site 10.

8.7 EPA Q-values for 2007 indicate water quality declined slightly at Shilelagh bridge (0500) between 2004 and 2007 from Q4 to Q3-4 (**Table 7**). Conversely water quality improved slightly at Balisland Bridge (0700) from Q3-4 to Q4.

8.8 It has been noted in section 3.6 that the British BMWP system attempts to provide a more objective method of determining water quality. It is the most widely used system in Britain and has been banded for interpretation in different regions. For example Severn-Trent scores would be interpreted as follows: 0-12 (unsatisfactory), 13-35 (poor), 36-70 (moderate), 71-90 (good), 91-150 (very good) and >150 (excellent). As yet insufficient work has been carried out in this country to allow accurate interpretation of the scores. The lowest score (36) was recorded at station 1, indicating low levels of biodiversity at this location. The highest value (80) was recorded at sites 4 and 11.

8.9 The associated Average Score Per Taxon (ASPT) helps to standardise data and minimise factors unrelated to pollution pressure such as unusually low or high habitat diversity or inconsistent sampling effort. The lowest score (5.14) was recorded at stations 1, indicating low levels of biodiversity at this location. The highest value (6.67) was recorded at site 11.

9. Conclusions

9.1 There was some variation in the pH recorded with the highest levels occurring in the Slaney River. This is consistent with results of previous surveys. However levels were satisfactory at all stations. The BOD levels recorded at all stations were satisfactory.

9.2 Orthophosphate concentrations were consistently low at all sites at <0.0092 mg/l P. A slightly elevated figure of 0.04 mg/l P was recorded at site 5.

9.3 The density of macroinvertebrates was generally low at all sites, possibly due to seasonal factors. However it is noted that in general the numbers of invertebrates recorded within the river system are lower than expected. Water remains satisfactory at sites 2 and 7, 9, 10 and 11. Water quality at the remaining sites was found to be in transition. It is noted that the difference between a Q value of 3-4 and 4 may be marginal and related to the presence/absence of small numbers of sensitive species and the presence/absence of algal species such as *Cladophora* sp. No evidence of serious pollution was noted at any of the sites surveyed.

Appendix 1 BMWP scoring system

BMWP Score table		
Group	**Families**	**Score**
Mayflies, Stoneflies, Riverbug, Caddisflies or Sedgeflies	Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae, Taeniopterygidae, Leuctridae, Caprniidae, Perlodidae, Perlidae, Chloroperlidae, Aphelocheridae, Phryganeidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae	10
Crayfish, Dragonflies	Astacidae, Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libelluiidae	8
Mayflies, Stoneflies, Caddisflies or Sedge flies	Caenidae, Nemouridae, Rhyacophiilidae, Polycentropidae, Limnephilidae	7
Snails, Caddisflies or Sedge flies, Mussels, Shrimps, Dragonflies	Neritidae, Viviparidae, Ancylidae, Hydroptilidae, Unionidae, Corophiidae, Gammaridae, Platycnemididae, Coenagriidae	6
Bugs, Beetles, Caddisflies or Sedgeflies, Craneflies/Blackflies, Flatworms	Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae, Gyrinidae, Hydrophilidae, Clambidae, Helodidae, Dryopidae, Elmidae, Chrysomelidae, Curculionidae, Hydropsychidae, Tipulidae, Simuliidae, Planariidae, Dendrocoelida	5
Mayflies, Alderflies, Leeches	Baetidae, Sialidae, Piscicolidae	4
Snails, Cockles, Leeches, Hog louse	Valvatidae, Hydrobiidae, Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudidae, Erpobdellidae, Asellidae	3
Midges	Chironomidae	2
Worms	Oligochaeta (whole class)	1

Appendix 2 Biological monitoring methodology and results

Q value-methodology

Quantitative sampling of benthic (bottom dwelling) macro-invertebrates using kick-sampling (McGarrigle *et al*., 1999; Toner *et al*, 2005). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net. Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high powered binocular microscope.

To establish the water quality of the samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. The relative abundance of invertebrates per two minute kick-sampling and stone washing in samples was described as:

- 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%

Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The relationship between Q values and water quality is set out in **Table A1.** Specimens were identified using the following keys; Quigley , M. (1977), Hynes, H. B. N. (1977), Edington, J. M. and Hildrew, A. G. (1981), Elliot, J. M., Humpesch, U. H. and Macan, T. T. (1988), Savage, A. A. (1989), Nilsson, A. (1996a), Nilsson, A. (1996b) and Wallace, I. D., Wallace, B. and Philipson, G. N. (2003).

Table A1 EPA scheme of Biotic Indices or Quality (Q) Values and its relationship to water quality

Biotic Index	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, Q2-3	Moderately Polluted	Class C
Q2, Q1-2, Q1	Seriously Polluted	Class D

Results

Table A2. Species list

EPHEMEROPTERA - MAYFLIES	COLEOPTERA - BEETLES
Baetis rhodani	*Elmis aenea* (adult & larva)
Baetis muticus	*Esolus parallelepipedus* (adult & larva)
Caenis sp.	*Limnius volckmari* (adult & larva)
Ephemera danica	*Oulimnius tuberculatus* (adult & larva)
Heptagenia sulphurea	*Gyrinus* sp. (adult)
Ecdyonurus sp.	Dytiscidae (adult)
PLECOPTERA - STONEFLIES	CRUSTACEA - CRUSTACEANS
Leuctra hippopus	*Gammarus pulex* (freshwater shrimp)
Leuctra inermis	*Asellus* sp. (hog-lice)
Isoperla grammatica	
Amphinamura sucicolis	HYDRACARINA – WATERMITES
	Hydracarina
TRICHOPTERA - CADDISFLIES	DIPTERA - TRUE FLIES
Rhyacophila dorsalis	Simuliidae (black-flies)
Hydropsyche siltalai	Diamesinae
Hydropsyche sp.	Ortrocladinae
Polycentropus flavomaculatus	
Sericostoma personatum	Chironomidae (non-biting midges)
Lepidostoma hirtum	Tanypodinae
Limnephilis sp.	Tipulidae (daddy-long-legs)
Leptoceridae	
Glossosomatidae	HIRUDINEA - LEECHES
Odontocerum albiorne	Glossiphonidae
MOLLUSCA - MOLLUSCS	OLIGOCHAETE - WORMS
Potamopyrgus jenkensii	Tubificidae
Ancylus sp. (limpet)	HEMIPTERA
Planorbidae (ramshorn snail)	*Aphelocheirus* sp.
Lymnaea	
Pisidium (pea mussel)	

Table A2 Biological abundance 2009

STATION	1	2	3	4	5	6	7	8	9	10	11
EPHEMEROPTERA											
Baetidae	P	C	F	F	F	C	C	N	C	C	C
Caenidae											
Ephemeridae											
Ephemerellidae											P
Heptageniidae		F	P		P	P	P	P		P	F
PLECOPTERA											
Leuctridae	P	P		P	P		F		F	P	P
Perlodidae											
Chloroperlidae											
Nemouridae											
Taeniopterygidae											
TRICHOPTERA											
Rhyacophilidae	P	F	P	P	P	P	P	C	F	F	F
Hydropsychidae	F	P	P	P		P					C
Sericostomatidae		P	F	P	F	P			F	F	P
Lepidostomatidae				P							
Polycentropidae									P		
Limnephilidae											
Leptoceridae											
Goeridae											
Beraeidae											
CRUSTACEA											
Gammarus sp.		N	C	N	C	P	F	C	F	P	F
Asellus sp.								P	P		
COLEOPTERA											
Elminthidae	C	F		F	F	C			C		C
Gyrinidae		P		P							
Dytiscidae				P	P			P		F	F
Helodidae											
HIRUDINEA											
Glossiphonidae		P		P	P						P
HYDRACARINA	P										
Hydracarina											
HEMIPTERA											
Aphelocheirus sp.								F		F	

Table A2 (contd) Biological abundance

STATION	1	2	3	4	5	6	7	8	9	10	11
DIPTERA											
Simuliidae	F	F	F	P		P	N	C	C	N	
Chironomous sp.											
Chironomidae						P			P		
Tipulidae		P		P				P			
MOLLUSCA											
Ancylidae											
Planorbidae											
Lymnaea										F	
Odonata									P	P	F
OLIGOCHAETE	C	C	C	C	C	C		C	F	C	C

*P-present, F-frequent, C-common, N-numerous, D-dominant.

Table A3. Survey site characteristics

STATION	WIDTH (m)	DEPTH (cm)	CURRENT	SUBSTRATE	COMMENT
1	4	45	Moderate - fast	Sand & gravel with sections of larger stones	%S* = 20% primarily alder and some ferns. Clarity moderate. Macrophyte/ bryophyte cover 25% with water crowfoot (*Ranunculus* sp.) dominant species. Clean gravels with no sewage fungus, slime or excessive algal development noted.
2	8	45	Fast	Gravel, large stones with sections of sand	%S = 30% . Macrophyte/ bryophyte cover 60% with *Fontinalis*, *Ranunculus*, and *O. crocata* main species. Clear. No sewage fungus, slime or excessive algal development noted.
3	6	38	Fast	Mixed	%S = 40% primarily alder, willow, sycamore and riparian herbaceous vegetation eg. bramble, nettle, hogweed etc. Macrophyte/ bryophyte cover primarily *O. crocata* and *Ranunculus* sp. No sewage fungus, slime or excessive algal development noted.
4	7.5	47	Slow	Sand/fine gravel with an isolated larger stone	%S = 15% primarily alder, willow on opposing bank. Car park has been created adjacent to the outflow point. Macrophyte/ bryophyte cover 3% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
5	7.5	49	Slow - moderate	Fine gravel/ sand with few larger stones	. %S = 15% with willow on opposing bank. Also hogweed and grasses such as Reed Sweet-Grass (*Glyceria maxima*) and *Carex* sp. Macrophyte/ bryophyte cover 30% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
6	9	41	Fast	Fine sand/gravel with some larger stones	%S = 4% with hogweed and large grasses such as Reed Sweet-Grass (*Glyceria maxima*) nettle, bramble etc. Macrophyte/ bryophyte cover 25% with *Ranunculus* sp the main species. No sewage fungus, slime or excessive algal development noted.
7	7	37	Fast	Sand overlain with cobbles, gravel & larger stones	%S = 10% with main species willow. No sewage fungus, slime growths or excessive algal development noted
8	10	40	Moderate	Large stones with some gravel & sand	%S = 15% with main species holly, bramble, willow and ivy. Macrophyte/bryophyte consisting of *Fontinalis* sp. and water crowfoot. No sewage fungus, slime growths or excessive algal development noted.
9	8	38	Slow	Mud/silt at margins with gravel & some larger stones	%S = 40% with main species willow, reed grass, grasses and sedges. Macrophyte/ bryophyte cover 10% with *Ranunculus* sp main species. No sewage fungus, slime or excessive algal development noted.
10	10	50	Moderate	Large stones with some limited areas of gravel	%S = 40% mainly due to proximity of bridge. No sewage fungus, slime or excessive algal development noted.
11	45	55	Moderate	Cobbles & sand	%S = 25% with mature trees e.g. ash. No sewage fungus, slime or excessive algal development noted. Sample taken in turbulent water at natural weir. Difficult sampling location.

*%S = percentage shade

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4/11/10	1	First Draft	Carl Dixon	
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Contents

1. Introduction

1.1 Dixon.Brosnan were commissioned by Celtic Watercare to carry out an aquatic survey of the Derry and Slaney Rivers on behalf of their client Kerry Foods who operate a food processing facility at Shillelagh, Co. Wicklow. This facility discharges treated wastewater to the Derry River in accordance with an IPPC Licence P0804-01 issued by the Environmental Protection Agency.

1.2 The survey, which consisted of chemical and biological analyses at a number of sampling stations, was carried out in order to assess the current water quality of the two rivers at these stations. Data recorded were compared to results obtained during previous surveys.

2. Location

2.1 The Slaney River drains a large catchment spread over counties Carlow, Wexford and Wicklow. One of its tributaries – the Derry River – flows through Shillelagh before its confluence with the Slaney 17 km downstream.

2.2 Eleven sampling stations were agreed previously between the client and Wicklow County Council, nine of which are located on the Derry River and the remainder on the Slaney. These stations have been monitored during previous surveys on the client's behalf.

2.3 During a survey undertaken in April 2000, it was noted that a discharge from a wastewater treatment plant (WWTP) upstream of the Kerry Foods outfall may be having a negative impact on the river. In order to quantify any impact, station 3 was relocated upstream of this discharge during the survey.

2.4 The complete list of stations is presented in **Table 1**. All stations are indicated in **Figures 1**, **2** and **3**.

Table 1 Sampling station locations

Station	River	Location	County
1	Derry	Green Hall Bridge	Wicklow
2	Derry	Deegins Bridge	Wicklow
3	Derry	50m u/s STP outfall	Wicklow
4	Derry	15m d/s Kerry Foods outfall in mixing zone	Wicklow
5	Derry	100m d/s Kerry Foods outfall	Wicklow
6	Derry	500m d/s Kerry Foods outfall	Wicklow
7	Derry	1500m d/s Kerry Foods outfall at private bridge	Wicklow
8	Derry	2500m d/s Kerry Foods outfall	Wicklow
9	Derry	Balisland Bridge	Wicklow
10	Slaney	Kilcarry Bridge	Carlow
11	Slaney	New Bridge	Wexford

3. Survey

3.1 This survey was conducted on the 15th of September 2010. At each station water samples were taken and transported in a chilled container to Environmental Laboratory Services Ltd. (ELS), accredited by the Irish National Accreditation Body (INAB) for analysis. Analysis was carried out for a number of chemical parameters as described below following overnight storage at 4^0C. Temperature and pH, dissolved oxygen were measured on site at the time of sampling using a Wti Multimeter pH meter with an inbuilt thermometer.

3.2 Biological sampling was carried out at each station using the kick-sampling technique as described by the Environmental Protection Agency (EPA) (1999). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net. Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high powered binocular microscope.

3.3 To establish the water quality of the eleven samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. Macroinvertebrate abundance was rated in accordance with the classification presented in **Table 2**.

Table 2 Abundance classes

Class	Number
1-4	Present
5-20	Frequent
21-50	Common
51-100	Numerous
>100	Dominant

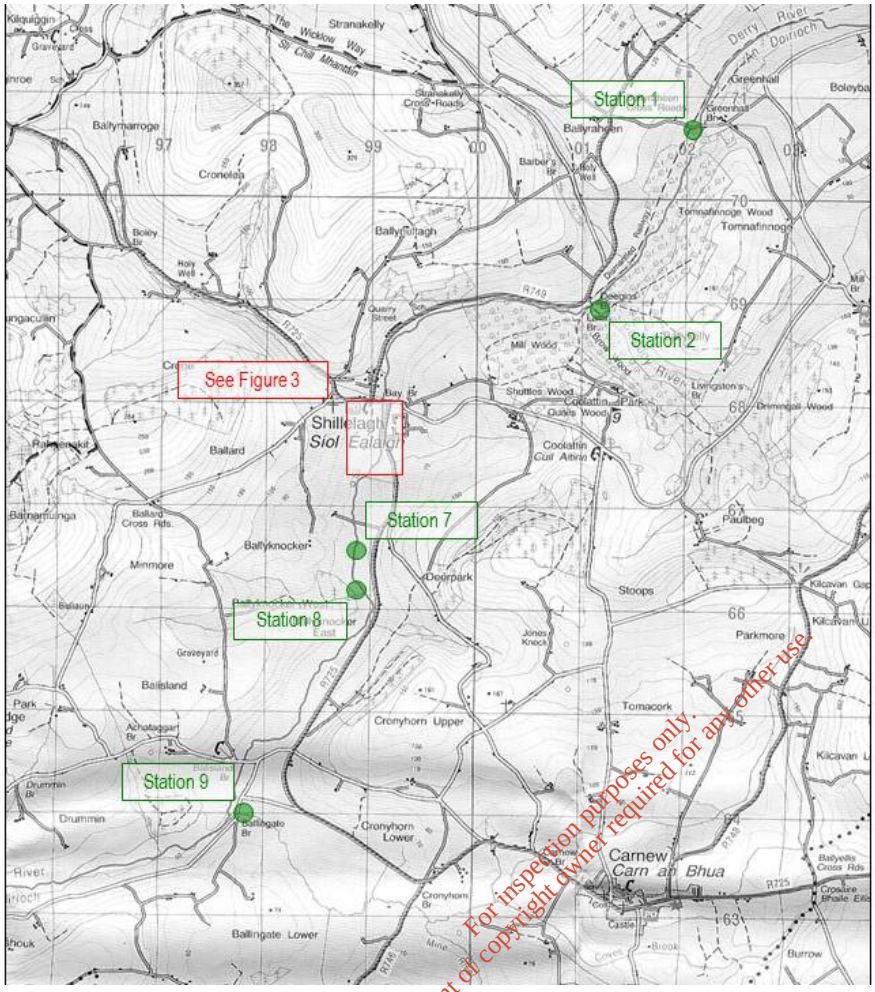

Figure 1 Derry River sampling stations

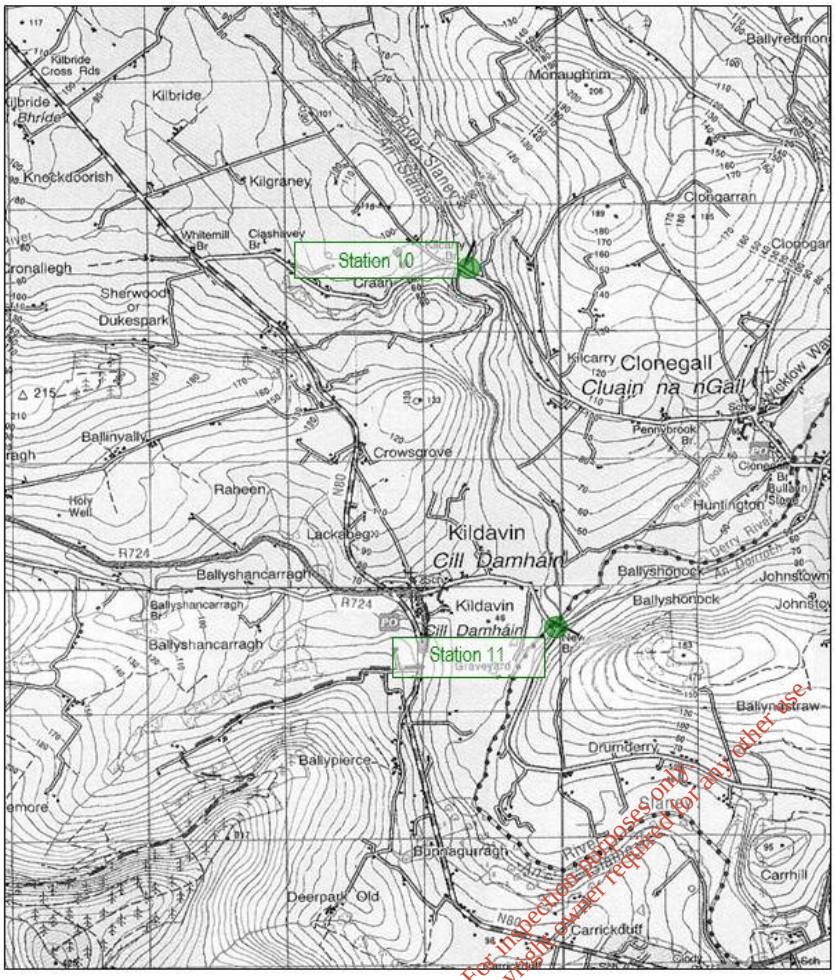

Figure 2 Slaney River sampling stations

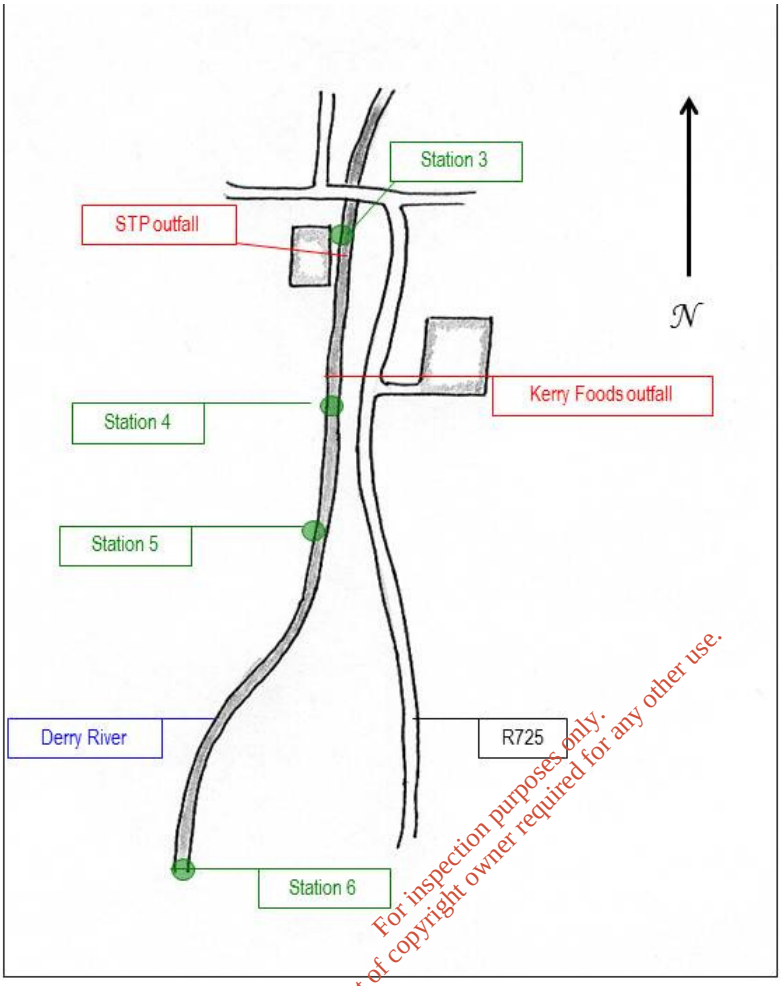

Figure 3 Shillelagh sampling stations

3.4 Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The Q-value determined using the fauna collected at each station therefore provides an indication of the quality of the water at that station. The relationship between Q values and water quality is set out in **Table 3.**

Table 3 Q-value and water quality

Q-value	Water quality	Status
5	Good	Unpolluted
4	Fair	Unpolluted
3	Doubtful	Polluted
2	Poor	Polluted
1	Bad	Polluted

3.5 The intermediate ratings Q1-2, Q2-3, Q3-4 and Q4-5 are used to denote transitional conditions, while ratings within parenthesis indicate borderline values. Great importance is attached to the EPA biotic indices, and consequently it is these data that are generally used to form the basis of water quality management plans for river catchments.

3.6 In addition to determining the Q-value, the British Monitoring Working Party score (BMWP) (and the related Average Score Per Taxon - ASPT) was also calculated in order to provide a second opinion on water quality. While this scoring system was not developed for use in Ireland, and thus BMWP scores should be treated with caution, the differences in numerical values from site to site allow spatial comparisons to be made. The BMWP score is used extensively in the UK, and has superseded most other quality index schemes devised such as Simpson's and Chandler's indices. The scoring system used for the BMWP system is included in **Appendix 1**.

3.7 A number of texts were consulted in the identification of macro-invertebrate fauna collected. These are included in **Appendix 3**.

4. Results- Temperature and Dissolved Oxygen and pH

4.1 The water temperature and pH, dissolved oxygen concentration were measured at each sampling station using a Wti multimeter pH meter with an inbuilt thermometer. Recorded values are presented in **Table 4**.

4.2 The recorded values were all satisfactory and indicate that oxygen levels were not depleted at the time of sampling. Temperature and pH levels lie within the normal range.

Table 4 Temperature and dissolved oxygen levels

Station	Temperature (^{0}C)	Dissolved oxygen (mg/l)	pH
1	13.7	9.3	7.39
2	13.8	10.4	7.38
3	12.9	10.3	7.44
4	13.0	10.2	7.42
5	13.0	10.2	7.40
6	13.0	10.1	7.43
7	13.2	10.0	7.44
8	13.0	10.5	7.30
9	13.4	10.4	7.24
10	14.1	10.5	8.04
11	13.9	11.1	8.02

5. Results- Chemical survey

5.1 Water samples taken from 11 stations were analysed for BOD and orthophosphate by Environmental Laboratory Services (ELS) Cork (**Table 5**). Levels recorded during the 2008 and 2009 surveys are also presented in **Table 5** for comparison purposes. Results are discussed below in **Section 7.**

Table 5 BOD and orthophosphate concentrations

Station	BOD			Orthophosphate (mg/l)*		
	2008	2009	2010	2008	2009	2010
1	<3	<1	<1	<0.0092	0.017	<0.009
2	<3	<1	<1	<0.0092	0.020	<0.009
3	<3	<1	<1	<0.0092	0.013	<0.009
4	<3	<1	<1	<0.0092	0.014	<0.009
5	<3	<1	<1	<0.0092	0.040	<0.009
6	<3	<1	<1	<0.0092	0.016	<0.009
7	<3	<1	<1	<0.0092	0.015	<0.009
8	<3	<1	<1	<0.0092	0.014	<0.010
9	<3	<1	<1	<0.0092	<0.009	0.011
10	<3	1	<1	<0.0092	<0.009	0.021
11	<3	1.4	<1	<0.0092	<0.009	0.02

Analyses as per *Standard methods for the examination of water and wastewater*, 18th Ed., 1992 (APHA, AWWA, WEF

6. Results- Biological survey

6.1 Macroinvertebrates found at each site were identified down to the lowest taxon required for the determination of site quality, using the rating systems described in section 3 (EPA, 1999). Thus for example dipteran larvae were identified to family, while the more significant mayfly and stonefly larvae were identified to species. The complete survey results are included in **Appendix 2**.

6.2 In addition to the biological samples taken, additional information was compiled for each station in order to allow a more complete assessment of the ecological make-up at each site. This included an examination of macrophyte growth and percentage cover. Site information is summarised in **Appendix 2**.

6.3 Q-values, BMWP and ASPT scores are presented in **Table 6A**, **6B** and **6C**. Previous survey data are also presented. The significance of the results obtained is discussed below.

6.4 The EPA monitors a number of sites on the Derry and Slaney Rivers as part of the Agency's national freshwater monitoring programme. Results obtained by the EPA are presented in **Table 7** where relevant.

6.5. Though not a species of concern in the context this aquatic survey which uses invertebrates as indicators of water quality, it is worth noting that river lamprey *Lampetra fluviatilis* was recorded during the kick sampling survey. Two individuals were recorded at site 4, 15 meters downstream of the Kerry plant outfall, in the mixing zone. The deep, loose gravels in this section of the river are suitable for adults and juveniles to burrow into. The river lamprey is protected under the Wildlife Act 1976, as amended in 2000, and Annex II and V of the Habitats Directive, which was transposed into Irish law in the European Communities (Natural Habitats) Regulations (S.I. 94 of 1997), as amended.

Table 6A Survey results - Q-value

Station			Q-values							
	2010	2009	2008	2007	2006	2005	2004	2003	2001	2000
1	4-5	3-4	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4 (4-5)	4-5
2	4-5	4	4-5	4-5	4-5	4-5	(3-4) 4	4-5	4-5	4(4-5)
3	3-4	3-4	3-4	3-4	3-4	3-4	3-4	4	4-5	4(4-5)
4	3-4	3-4	3-4	3-4	4	3-4	3-4	4	4	4(4-5)
5	3-4	3-4	3-4	3-4	3-4	3-4	3-4	4	4	4(4-5)
6	4	3-4	3-4	3-4	3-4	3-4	3-4	4 (4-5)	4(4-5)	4-5
7	4	4	4	4	4	4	3-4	4	4(3-4)	4-5
8	4	3-4	4	4	4	4	3-4	4	4(4-5)	4-5
9	4	4	3-4	3-4	3-4	4	3-4	4(3-4)	4	4-5
10	3-4	4	3-4	3-4	3-4	4	4	4	4	4(4-5)
11	4	4	4	4	3-4	3-4	4	4	4	4(4-5)

Table 6B Survey results- BMWP Scores

Station	2010	2009
1	89	36
2	97	75
3	77	47
4	71	80
5	70	60
6	93	54
7	85	35
8	82	52
9	85	64
10	55	78
11	60	80

Table 6C Survey results-ASPT

Station	2010	2009
1	7.41	5.14
2	6.93	5.77
3	5.92	5.88
4	5.92	5.71
5	5.83	6
6	7.17	5.4
7	7.08	5.83
8	6.3	5.78
9	6.54	5.82
10	6.87	6.5
11	6.0	6.67

Table 7 EPA Q-values

Station code	Location	1976	1980	1984	1987	1991	1995	1998	2001	2004
0350 (River Derry)	Greenhall Br	-	-	-	3-4	4-5	4	4-5	4-5	4-5
0500 (River Derry)	Shillelagh Br	-	-	-	4	3-4	4	4-5	4	3-4
0700 (River Derry)	Balisland Br	4	4	4	4	4	3-4/0	4-5	3-4	4
1000 (River Derry)	U/s Derry-Slaney confluence	-	4	4	4	4	4-5	4-5	4	4
1600 (River Slaney)	Kilcarry Br	-	-	3-4	3-4	3-4	3-4	4-5	3-4	3-4

7. Discussion- Chemical survey

7.1 The highest pH values occurred in the Slaney River as noted during previous surveys. Values recorded were satisfactory, with all measurements lying within the 6-9 pH range specified in the Council Directive 78/659/EEC on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive) and the European Communities (Quality of Salmonid Waters) Regulations, 1988 (S.I. No. 293 of 1988).

7.2 The BOD recorded at all stations was satisfactory, with levels indicating good water quality with no indications that water quality is significantly affected by pollution.

7.3 The orthophosphate fraction of phosphorous in a river (generally estimated to be 80% of total phosphate) is that fraction which is the most readily available to plants and algae, and has been implicated as a cause of eutrophication. Surface run-off, particularly from agricultural land in receipt of fertilisers and manures, and industrial and sewage waste discharges, are the most important contributors of phosphorous to surface waters. Phosphorous and phosphates are not toxic to fish, and thus no limit is quoted in the Freshwater Fish Directive. However their influence on eutrophication is such that the Directive does include a total phosphorous limit of 0.062 mg/l-P as being that level which is desirable in order to reduce eutrophication.

7.4 The orthophosphate levels measured at all sites except for 8, 9, 10 and 11 were consistently low at <0.009 mg/l P which is indicative of satisfactory water quality.

8. Discussion- Biological survey

8.1 Typically numbers of macro-invertebrates are low at sites 1 and 2, however the relative proportions of sensitive stonefly species was high and no signs of water quality deterioration such as excessive algae, siltation etc was noted. Sensitive species included stonefly species (*Leuctra hippopus, Isoperla gramatica* and *Chlorperla torrentium)* and small numbers of heptagenid mayflies were also recorded; therefore despite the limited density of macro-invertebrates, a classification of Q4-5 was considered appropriate. This is an improvement from the values of 4 and 3-4 recorded respectively in 2009.

8.2 The Q-value recorded at site 3 was Q3-4, indicating transitionary water quality. This value was also assigned in 2009. The only stonefly species recorded was *Leuctra* sp. which was recorded in small numbers. Small numbers of heptageniid mayflies were also recorded. It is noted that station 3 is upstream of both the sewage discharge and the discharge from Kerry foods; however it is downstream of the confluence of the Derry River and the Shillelagh tributary. Therefore the Shillelagh tributary may be having an impact on water quality at this location. It is noted that site 3 is located upstream of the discharge from Kerry Foods.

8.3 Station 4 is situated within the mixing zone downstream of the Kerry Foods discharge in an area where the flow is relatively slow. A value of Q3-4 was assigned to site 4; the same Q value was assigned in 2009. Although some sensitive species were present, their numbers were low. Tolerant species were found in small numbers.

8.4 The diversity and density of species recorded at stations 5 was similar to those recorded at station 4 and a Q value of 3-4 was assigned to this site.

8.5 Stations 6, 7, 8, and 9 were assigned Q values of 4 in 2010; the same values were assigned in 2009 to sites 7 and 9. However sites 6 and 8 were assigned Q values of 3-4 in 2009 and thus the values obtained in 2010 are an improvement.

8.6 A Q value of 3-4 was assigned to site 10; a decrease from Q 3-4 which was assigned in 2009. Values at this site have historically fluctuated between Q4 and Q3-4. The Q value at site 11 increased slightly from Q3-4 to Q4. This is the only site where the hemipteran species *Aphelocheirus* sp. was recorded.

8.7 EPA Q-values for 2007 indicate water quality declined slightly at Shillelagh Bridge (0500) between 2004 and 2007 from Q4 to Q3-4 (**Table 7**). Conversely water quality improved slightly at Balisland Bridge (0700) from Q3-4 to Q4.

8.8 It has been noted in section 3.6 that the British BMWP system attempts to provide a more objective method of determining water quality. It is the most widely used system in Britain and has been banded for interpretation in different regions. For example Severn-Trent scores would be interpreted as follows: 0-12 (unsatisfactory), 13-35 (poor), 36-70 (moderate), 71-90 (good), 91-150 (very good) and >150 (excellent). As yet insufficient work has been carried out in this country to allow accurate interpretation of the scores. The lowest score (55) was recorded at station 10, indicating low levels of biodiversity at this location. The highest value (97) was recorded at site 2.

8.9 The associated Average Score Per Taxon (ASPT) helps to standardise data and minimise factors unrelated to pollution pressure such as unusually low or high habitat diversity or inconsistent sampling effort. The lowest score (5.83) was recorded at stations 5, indicating low levels of biodiversity at this location. The highest value (7.41) was recorded at site 1.

9. Conclusions

9.1 There was some variation in the pH recorded, with the highest levels occurring in the Slaney River. This is consistent with results of previous surveys. However levels were satisfactory at all stations. The BOD levels recorded at all stations were satisfactory at <1 mg/l.

9.2 Orthophosphate concentrations were consistently low at all sites except for 8,9,10 and 11, at <0.009 mg/l P.

9.3 The density of macroinvertebrates was generally low at all sites, possibly due to seasonal factors. Water remains satisfactory at sites 1, 2 and 6, 7, 8, 9 and 11. Water quality at the remaining sites was found to be in transition. It is noted that the difference between a Q value of 3-4 and 4 may be marginal and related to the presence/absence of small numbers of sensitive species and the presence/absence of algal species such as *Cladophora* sp. No evidence of serious pollution was noted at any of the sites surveyed.

References

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Appendix 1 BMWP scoring system

BMWP Score table		
Group	**Families**	**Score**
Mayflies, Stoneflies, Riverbug, Caddisflies or Sedgeflies	Siphlonuridae, Heptageniidae, Leptophlebiidae, Ephemerellidae, Potamanthidae, Ephemeridae, Taeniopterygidae, Leuctridae, Caprniidae, Perlodidae, Perlidae, Chloroperlidae, Aphelocheridae, Phryganeidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae, Goeridae, Lepidostomatidae, Brachycentridae, Sericostomatidae	10
Crayfish, Dragonflies	Astacidae, Lestidae, Agriidae, Gomphidae, Cordulegasteridae, Aeshnidae, Corduliidae, Libelluiidae	8
Mayflies, Stoneflies, Caddisflies or Sedge flies	Caenidae, Nemouridae, Rhyacophilidae, Polycentropidae, Limnephilidae	7
Snails, Caddisflies or Sedge flies, Mussels, Shrimps, Dragonflies	Neritidae, Viviparidae, Ancylidae, Hydroptilidae, Unionidae, Corophiidae, Gammaridae, Platycnemididae, Coenagriidae	6
Bugs, Beetles, Caddisflies or Sedgeflies, Craneflies/Blackflies, Flatworms	Mesoveliidae, Hydrometridae, Gerridae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae, Haliplidae, Hygrobiidae, Dytiscidae, Gyrinidae, Hydrophilidae, Clambidae, Helodidae, Dryopidae, Elmidae, Chrysomelidae, Curculionidae, Hydropsychidae, Tipulidae, Simuliidae, Planariidae, Dendrocoelida	5
Mayflies, Alderflies, Leeches	Baetidae, Sialidae, Piscicolidae	4
Snails, Cockles, Leeches, Hog louse	Valvatidae, Hydrobiidae, Lymnaeidae, Physidae, Planorbidae, Sphaeriidae, Glossiphoniidae, Hirudidae, Erpobdellidae, Asellidae	3
Midges	Chironomidae	2
Worms	Oligochaeta (whole class)	1

Appendix 2 Biological monitoring methodology and results

Q value-methodology

Quantitative sampling of benthic (bottom dwelling) macro-invertebrates using kick-sampling (McGarrigle *et al*., 1999; Toner *et al*, 2005). The kick-sampling technique involved using a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged in a fast flowing area of the river bed with its mouth directed upstream. The substrate immediately upstream of the net was kicked for two minutes in order to dislodge invertebrates and substrate, which were subsequently caught in the net. Stone washings were also undertaken to ensure a representative sample of the fauna present at each site was collected. Samples were transferred to plastic containers and preserved using 70% alcohol. Identification was undertaken in the laboratory using a high powered binocular microscope.

To establish the water quality of the samples the EPA protocol for calculating Q values was utilised (Toner *et al*, 2005). This biotic index is used by the EPA and allows river quality to be compared under standardized guidelines. This method divides macroinvertebrates into five groups, depending on their sensitivity to pollution. The relative abundance of invertebrates per two minute kick-sampling and stone washing in samples was described as:

- 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%

Having determined the relative proportions of the various organisms in a sample, water quality can be inferred by a comparison of this data with that which might be expected from unpolluted habitats of the type under investigation. The relationship between Q values and water quality is set out in **Table A1.** Specimens were identified using the following keys; Quigley , M. (1977), Hynes, H. B. N. (1977), Edington, J. M. and Hildrew, A. G. (1981), Elliot, J. M., Humpesch, U. H. and Macan, T. T. (1988), Savage, A. A. (1989), Nilsson, A. (1996a), Nilsson, A. (1996b) and Wallace, I. D., Wallace, B. and Philipson, G. N. (2003).

Table A1. EPA scheme of Biotic Indices or Quality (Q) Values and its relationship to water quality

Biotic Index	Quality Status	Quality Class
Q5, Q4-5, Q4	Unpolluted	Class A
Q3-4	Slightly Polluted	Class B
Q3, Q2-3	Moderately Polluted	Class C
Q2, Q1-2, Q1	Seriously Polluted	Class D

Results

Table A2. Species list

EPHEMEROPTERA - MAYFLIES	COLEOPTERA - BEETLES
Baetis rhodani	*Elmis aenea* (adult & larva)
Baetis muticus	*Esolus parallelepipedus* (adult & larva)
Caenis sp.	*Limnius volckmari* (adult & larva)
Ephemera danica	*Oulimnius tuberculatus* (adult & larva)
Heptagenia sulphurea	*Gyrinus* sp. (adult)
Ecdyonurus sp.	Dytiscidae (adult)
PLECOPTERA - STONEFLIES	CRUSTACEA - CRUSTACEANS
Leuctra hippopus	*Gammarus pulex* (freshwater shrimp)
Leuctra inermis	*Asellus* sp. (hog-lice)
Isoperla grammatica	
Amphinamura sucicolis	HYDRACARINA - WATERMITES
	Hydracarina
TRICHOPTERA - CADDISFLIES	DIPTERA - TRUE FLIES
Rhyacophila dorsalis	Simuliidae (black-flies)
Hydropsyche siltalai	Diamesinae
Hydropsyche sp.	Ortrocladinae
Polycentropus flavomaculatus	
Sericostoma personatum	Chironomidae (non-biting midges)
Lepidostoma hirtum	Tanypodinae
Limnephilis sp.	Tipulidae (daddy-long-legs)
Leptoceridae	
Glossosomatidae	HIRUDINEA - LEECHES
Odontocerum albiorne	Glossiphonidae
MOLLUSCA - MOLLUSCS	OLIGOCHAETE - WORMS
Potamopyrgus jenkensii	Tubificidae
Ancylus sp. (limpet)	HEMIPTERA
Planorbidae (ramshorn snail)	*Aphelocheirus* sp.
Lymnaea	
Pisidium (pea mussel)	

Table A2. Biological abundance

STATION	1	2	3	4	5	6	7	8	9	10	11	BMWP score
EPHEMEROPTERA												
Baetidae												
Caenidae												
Ephemeridae												
Ephemerellidae												
Heptageniidae	P	F	P	P	P	P	P	P	P	P	P	10
PLECOPTERA												
Leuctridae	P	P	P	P	P	P	P	F	P			10
Perlodidae	P	P										10
Chloroperlidae	F	F				P	P		P			10
Nemouridae		P										7
Taeniopterygidae												
TRICHOPTERA												
Rhyacophilidae	P	P	P	P	P	P	P	P	P			7
Hydropsychidae	P		P	F	F	F	P	P	P	F		6
Sericostomatidae	P					P	P					10
Lepidostomatidae						P		P	P	P		10
Polycentropidae		P										7
Limnephilidae	P	P	F	P	P	P	P	C	F	P	P	7
Leptoceridae			P				F	P		P	P	10
Goeridae	F	P										10
Beraeidae												10
CRUSTACEA												
Gammarus sp.	P	P		P	F	F				P	P	6
Asellus sp.												3
COLEOPTERA												
Elminthidae		P	P	P	F	C		F		F	F	5
Gyrinidae					P				P			5
Helodidae			P	P	P	P	P		P			5
HIRUDINEA												
Glossiphonidae			P		P		P	P	P			3
HYDRACARINA												
Hydracarina												
HEMIPTERA												
Aphelocheirus sp.											F	10

Table A2 (contd) Biological abundance

STATION	1	2	3	4	5	6	7	8	9	10	11	BMWP score
DIPTERA												
Simuliidae		P			P							5
Chironomous sp.												
Chironomidae	F	P	P	P				P	P			2
Tipulidae			F	F							P	5
MOLLUSCA												
Ancylidae			P	P		P	P	P	P			6
Planorbidae								P			F	3
Lymnaea											F	3
OLIGOCHAETE	P	P	P	F	C	F	F	P	P	P	C	1
Total BMWP score (per site)	89	97	77	71	70	93	85	82	85	55	60	
ASTP score.	7.41	6.93	5.92	5.92	5.83	7.15	7.08	6.3	6.54	6.87	6.0	

*P-present, F-frequent, C-common, N-numerous, D-dominant.

Table A3. Survey site characteristics

STATION	WIDTH (m)	DEPTH (cm)	CURRENT	SUBSTRATE	COMMENT
1	4	45	Moderate - fast	Sand & gravel with sections of larger stones	%S* = 20% primarily alder and some ferns. Clarity moderate. Macrophyte/ bryophyte cover 25% with water crowfoot (*Ranunculus* sp.) dominant species. Clean gravels with no sewage fungus, slime or excessive algal development noted.
2	8	45	Fast	Gravel, large stones with sections of sand	%S = 30%. Macrophyte/ bryophyte cover 60% with *Fontinalis*, *Ranunculus*, and *O. crocata* main species. Clear. No sewage fungus, slime or excessive algal development noted.
3	6	38	Fast	Mixed	%S = 40% primarily alder, willow, sycamore and riparian herbaceous vegetation e.g. bramble, nettle, hogweed etc. Macrophyte/ bryophyte cover primarily *O. crocata* and *Ranunculus* sp. No sewage fungus, slime or excessive algal development noted.
4	7.5	47	Slow	Sand/fine gravel with an isolated larger stone	%S = 15% primarily alder, willow on opposing bank. Car park has been created adjacent to the outflow point. Macrophyte/ bryophyte cover 3% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
5	7.5	49	Slow - moderate	Fine gravel/ sand with few larger stones	. %S = 15% with willow on opposing bank. Also hogweed and grasses such as Reed Sweet-Grass (*Glyceria maxima*) and *Carex* sp. Macrophyte/ bryophyte cover 30% with *Ranunculus* sp. dominant. No sewage fungus, slime or excessive algal development noted.
6	9	41	Fast	Fine sand/gravel with some larger stones	%S = 4% with hogweed and large grasses such as Reed Sweet-Grass (*Glyceria maxima*) nettle, bramble etc. Macrophyte/ bryophyte cover 25% with *Ranunculus* sp the main species. No sewage fungus, slime or excessive algal development noted.
7	7	37	Fast	Sand overlaid with cobbles, gravel & larger stones	%S = 10% with main species willow. No sewage fungus, slime growths or excessive algal development noted
8	10	40	Moderate	Large stones with some gravel & sand	%S = 15% with main species holly, bramble, willow and ivy. Macrophyte/bryophyte consisting of *Fontinalis* sp. and water crowfoot. No sewage fungus, slime growths or excessive algal development noted.
9	8	38	Slow	Mud/silt at margins with gravel & some larger stones	%S = 40% with main species willow, reed grass, grasses and sedges. Macrophyte/ bryophyte cover 10% with *Ranunculus* sp main species. No sewage fungus, slime or excessive algal development noted.
10	10	50	Moderate	Large stones with some limited areas of gravel	%S = 40% mainly due to proximity of bridge. No sewage fungus, slime or excessive algal development noted.
11	45	55	Moderate	Cobbles & sand	%S = 20% with mature trees e.g. ash. No sewage fungus, slime or excessive algal development noted. Sample taken in turbulent water at natural weir. Difficult sampling location.

*%S = percentage shade

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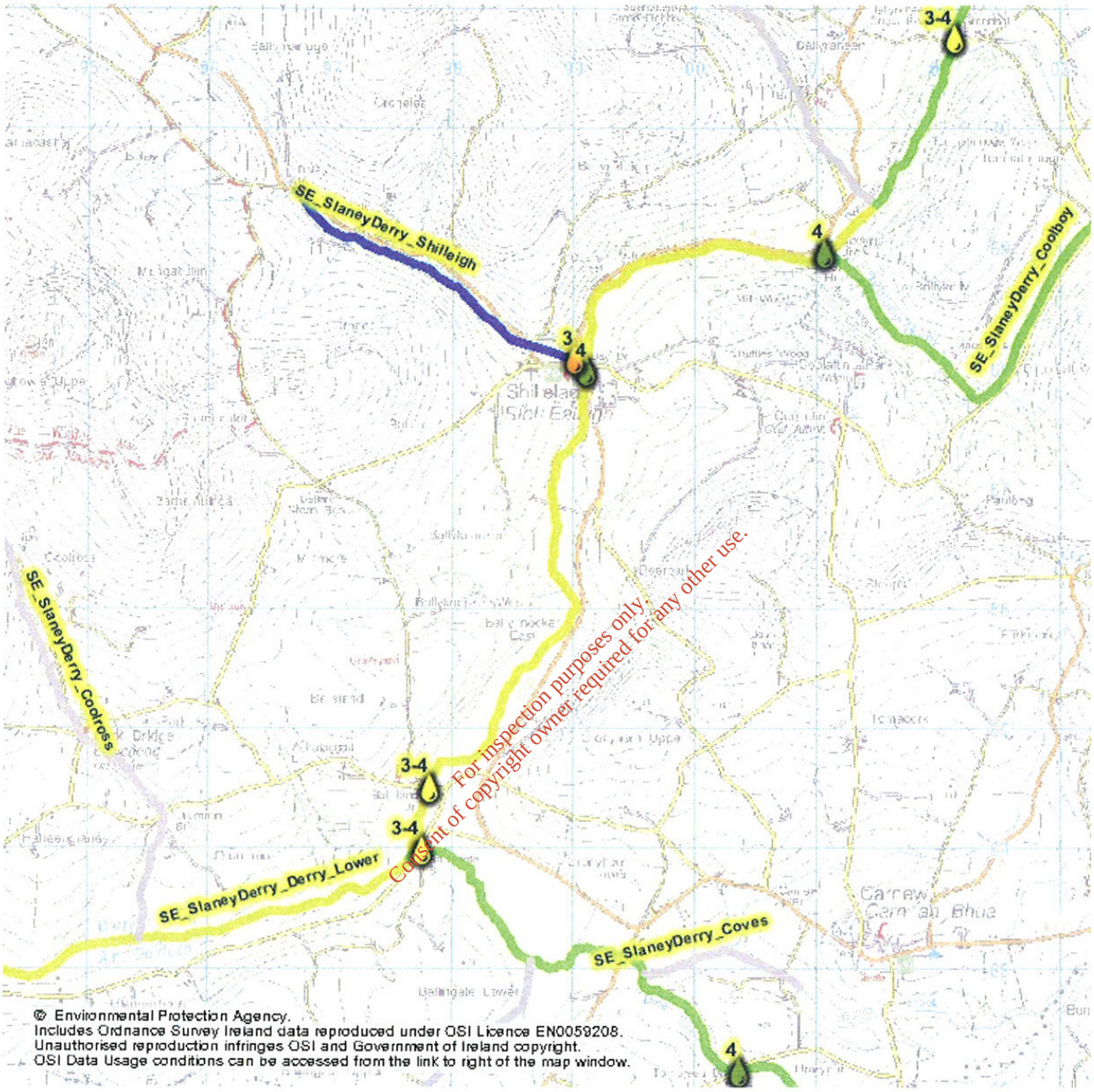
Appendix D.1.1.3 EPA ENVision Online Map Viewer of Derry River



Appendix D.1.1.4 Environmental Impact Study

See EIS separate document.