

Biological Assessment of the Lismagratty and Corranure Streams

Corranure Waste Facility (77-2)
Lismagratty & Corranure Townlands, Cootehill Road, Cavan

Annual Report 2008

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1. Introduction

This report details a biological assessment undertaken on watercourses in the vicinity of Corranure Landfill (EPA Waste License Registration Number 77-2), Co Cavan. This assessment was undertaken as per Condition 9.14 of the license. The scope, content and details of the contractor carrying out the assessment were previously submitted to the Agency for its approval. Samples were taken on 27th and 28th June 2008. The assessment was undertaken on behalf of BHP Laboratories by Ecofact Environmental Consultants Ltd.

2. Methods

Benthic, or bottom dwelling, macroinvertebrates were sampled qualitatively at the ten sites using kick-sampling (Abel, 1996; McGarrigle *et al*, 2002) on 27th and 28th June 2008. This procedure involved the use of a 'D' shaped hand net (mesh size 0.5 mm; 350 mm diameter) which was submerged on the river bed with its mouth directed upstream. The substrate upstream of the net was then kicked for one minute in order to dislodge invertebrates, which were subsequently caught in the net. This procedure was undertaken at three points along/across the watercourse, where depth/access allowed. Stone washings and vegetation sweeps were also undertaken to ensure a representative sample of the fauna present at each site was collected. All samples of invertebrates were combined for each site and live sorted on the river bank for 20 minutes with the assistance of a headband magnifier. Specimens were fixed in a 10% formalin solution. Identification was undertaken in the laboratory using high-power and low-power binocular microscopes.

Specimens were identified using the keys produced by the Freshwater Biological Association. These keys included Elliott & Humpesch (1988) for mayflies, Edington & Hildrew (1995) and Wallace *et al* (2003) for caddis fly larvae, Cranston (1982) for true flies, Gledhill *et al* (1993) for crustaceans, Macan (1994) for snails, Savage (1989, 1999) for bugs and Elliott & Mann (1979) for leeches. The relative abundance of invertebrates in samples was described as follows:

- 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%)

The Quality Rating (Q) System (Toner *et al.*, 2005) was used to obtain a water quality rating for each site. The use of this particular biotic index allows the comparison with data published by the EPA. This method categorizes invertebrates into one of five groups, depending on their sensitivity to pollution. The higher the biological diversity and the greater the abundance of invertebrate species sensitive to organic pollution, the higher the water quality is assumed to be, and the higher the 'Q value' assigned to that sampling station. Further details on the Q-rating system are provided in Appendix 1.

The Small Stream Risk Score (SSRS) was devised by the EPA as a biological monitoring tool for first and second order streams, as part of the Water Framework Monitoring Programme. This system does not define the status of a stream but is a risk assessment (Walsh, 2005). The SSRS was developed based on presence of indicator mayfly species, stonefly species, caddis fly larvae and the overall abundance of Gastropods, Oligochaetes and Dipteran larvae and *Asellus*. The final system is believed to be an efficient indicator of pollution risk from either point or diffuse sources in small streams. The index categorises streams into three risk groups: at risk, probably at risk and not at risk according to the score it attains where > 8 = probably not at risk, 6.5-8 = probably at risk, and < 6.5 = at risk.

Sampling is based on a standard kick sample typically two-minutes (adhering to ISO Standard for kick-sampling). Insofar as is possible the sample is taken to ensure representativeness of the biological community in each stream. The sample is required to identify the impact of pollution on the streams thus if there are riffled areas these should receive preference in sampling because the fauna of riffles generally tends to be more sensitive to pollution impacts than those characteristic of say slow-flowing pool habitats. Many small streams are slow-flowing and weedy, however, and sampling of riffles is not always possible. It is important to indicate whether the site is riffled or not on the field sheets – future modifications of the SSRS may include this as an additional step in the score calculation.

3. Site Locations

In Table 1 and Figure 1 the location of the ten sites investigated is given. Five sites were located on each of the Corranure Lismagraty streams. Site photographs are provided in Plates 1-10.

The Corranure stream is a tributary of the Cavan River (EPA Code 36C02). It is a 1st order stream and is approximately 4 km long. It rises to the southeast of the Corranure facility and runs in a northeasterly direction to join the Cavan River at Cavan town. The Cavan River ultimately flows into the Annalee River (EPA Code 36A02) – a tributary of the upper Erne. The Lismagraty stream is also a tributary of the Annalee River and rises to the northeast of the landfill site. It is joined by a four small streams between its source and Lisdunvis Glebe Bridge at which point it has achieved 3rd order status.

As part of its rollover assessment of water quality in Irish rivers, the EPA (and their predecessors) has assessed water quality in the Rivers Analee and Cavan since 1971 (McGarrigle *et al*, 1998). The results of the EPA biological water quality assessments since that time are given in Appendix 2. Both of these rivers, and in particular the Cavan River, have a long history of pollution. Agricultural pollution has been identified by the EPA as being the primary suspected pollution source in these rivers. Accidental releases of sewage in the past have also caused serious pollution in the Lismagraty stream (CFB, 2004).

4. Results

The physical characteristics of the survey sites and selected chemical water quality characteristics are given in Table 2. The results of the biological assessments are given in Table 3 where common names of invertebrate species or groups are given where they are available. Table 4 and 5 provide the derived water quality ratings, SSRS scores for the five sites investigated on the Corranure stream and Lismagraty stream respectively. Tables 4 and 5 also give the water quality results from the 2007 survey. The results from the individual sites are also discussed below.

4.2 Corranure stream

4.2.1 Site A1

This site was the uppermost site on the Corranure Stream, see Plate 1. It was located to the south of the Corranure facility (across the R188 Cavan-Cootehill regional road). This part of the stream has a high gradient and has been modified presumably for agricultural purposes. Despite heavy rainfall in days prior to the survey, this stretch of stream was dry so could not be surveyed. This stream was most recently surveyed in 2006. At this time, the stream appeared to be clean but was deemed to offer only marginal habitat for macroinvertebrates owing to its small size and modified status (O' Connor, 2006). In the 2006 survey, this site was given a Q-value of Q2 and was therefore rated as 'Seriously Polluted – Class D'. However, a stream of this size is not suited the EPA biological monitoring scheme.

4.2.2 Site A2

This site can be seen in Plate 2 and was the furthest upstream site that could be examined on the Corranure Stream. This site is less than 0.5km to the south of the Corranure facility. Bank slippage from both the left and right hand banks was noted along the stretch of stream around the site and the water in the stream was seen to be mildly tainted white. Conductivity was elevated at 1032 mS/cm while the dissolved oxygen (D.O.) was low at 70.1%. This stretch of the stream was silted where flow was reduced. There was much decomposing organic matter (leaves and twigs, etc.) in the stream that may have been partly responsible for the reduced D.O. concentration. Much of the biological sampling at this site was by stone washing and examining the debris within the stream – bedrock and fairly low water levels made kick sampling difficult.

A total of 7 macroinvertebrate families were recorded at this site, mostly pollution tolerant organisms. The most frequently encountered organism was the hog louse *Asellus aquaticus* which was numerous. Chironomidae were well represented with larvae of both the green chironomid and midge *Chironomus* sp. occurring in small numbers. Small numbers of an indeterminate cased caddisfly larva (undergoing pupation) were also recorded and caseless trumpet-net caddisfly larvae of *Plectrocnemia conspersa* were scarce. Freshwater shrimp *Gammarus deubeni* and the leech *Erpobdella octoculata* were also scarce. A diving beetle in sub-family Colymbetinae was present at this site.

Applying the WRFB Small Streams Risk Score (SRSS) (Walsh, 2005), this stretch of site had a score of 2.4 and is therefore considered to be 'at risk'. Pollution tolerant organisms were dominant at this site with group 'A' pollution indicators absent. Using the EPA Q-rating system (Toner *et al.*, 2005), this stream is rated as 'Moderately Polluted - Class C (Q3)' and therefore in an unsatisfactory condition.

In the previous surveys undertaken by Ecofact (O'Connor, 2006 & 2007), this site was considered to be Seriously Polluted - Class D. A similar macroinvertebrate community was present as in the previous survey of this site and indeed the same SSRS score of 2.4 was recorded in the current and previous surveys. A group 'B' cased caddisfly, not recorded last year was found this year but the broad-shouldered water strider (Veliidae) and the lesser water boatman (Corixidae), generally surface dwellers were absent this year. The dissolved oxygen (D.O.) concentration in the previous survey was critically low at only 19.5% but showed an improvement in the current survey when it was 70.1%.

4.2.3 Site A3

This site was located just over 1km downstream of the Corranure landfill site. It was difficult to survey given the density of the riparian vegetation and the low water levels (Plate 3). A coat of silt was seen to cover the substrate at this site. Conductivity and dissolved oxygen (D.O.) were 762 mS and 70%, respectively. As in the previous surveys, the physical characteristics of this part of the stream were suboptimal for macroinvertebrate production.

A total of 8 macroinvertebrate families were recorded at this site. One species of Ephemeropteran/mayfly larvae was recorded (scarce); that of the large dark olive *Baetis rhodani*. Fair numbers of larvae of the northern cased caddisfly *Limnephilus lunatus* were recorded while *Micropterna sequax* larvae were present. Small numbers of trumpet-net caddisfly and green chironomid larvae were found. Another chironomid larva, the bloodworm *Chironomus* sp. was present at this site. Fair numbers of aquatic earthworms in family Lumbriculidae were recorded. Small numbers of the native freshwater shrimp *Gammarus deubeni* and few hog louse were found (both crustaceans). Broad-shouldered water striders (Veliidae) were also present at this site.

An SSRS score of 4.0 was calculated for this site, implying that this stretch of the stream is 'at risk'. This compares to the previous SSRS rating. This corresponds with the dissolved oxygen (D.O.) levels in the two surveys. In addition, the macroinvertebrate diversity increased from 6 families in 2007 to 8 families currently, a return to the diversity recorded in the 2006 survey.

This stretch is considered to be 'Moderately Polluted – Class C' under the EPA biological monitoring scheme; no change from the survey carried out in 2007.

4.2.4 Site A4

This site was located at Curragho West at the northern side of Cavan town (Plate 4). Though there is a good range of substrate classes in this part of the stream, excessive shading, bank slippage and considerable siltation means that potential for macroinvertebrate production is only suboptimal.

A total of 6 different families were recorded in the biological sampling of this site. The pollution tolerant freshwater shrimp *Gammarus deubeni* (native species) was dominant while another freshwater shrimp, *Gammarus pulex* (introduced species) was present. Large dark olive mayfly larvae were present while larvae of the northern caddisfly *Micropterna sequax* were common. Another caseless trichopteran larva, the trumpet-net caddisfly, was scarce at this site. Midge larvae and green chironomid larvae were scarce and present in that order. Lumbricid aquatic earthworms were present at this site.

Based on the taxa present at this site and an SSRS score of 4.8, this stretch of stream is deemed to be 'at risk'. Though this score indicates that this part of the stream is 'at risk' it is greater than the score in the previous survey undertaken in 2007. Using the Q-rating system, the biological water quality of this site has returned to the 2006 status of 'Moderately Polluted (Q3)' having been Q2 in 2007. This is due to the reappearance of cased caddisfly larvae. Also of note is that group 'D' pollution tolerant leeches were not recorded in the current assessment. Furthermore, chemical water quality appears to have improved somewhat with dissolved oxygen concentrations increasing from 65.7% in 2007 to 92.6% in the current survey. However, while working through the macroinvertebrate sample an oil film was evident on top of the water from the stream. This could have resulted from runoff from nearby roads.

4.2.5 Site A5

As in previous surveys, this site on the outskirts of Cavan town was visibly polluted. The water was turbid during the current survey and the substrate was heavily silted. Some dead filamentous algae was recorded at the sides of the stream and the pool shown in Plate 5 had rubbish within. The sluggish parts of the stream had a soft and loose substrate. This substrate dispersed easily when disturbed to discolour the water (black), create a significant oil slick on top and release a rank smell signifying anoxic conditions.

A family diversity of 7 at this site signaled a reduction in diversity since the 2007 survey when 10 families were recorded. Pollution tolerant organisms dominated the macroinvertebrate community at this site with bloodworms being common and the leech *Erpobdella octoculata* found in fair numbers. Fair numbers of the freshwater shrimp *Gammarus deubeni* (group 'C' pollution indicator) and small numbers of hog louse (group D pollution indicator) were also recorded. Larvae of the northern caddisfly *Micropterna sequax* and the large dark olive mayfly were recorded in small numbers and scarce, correspondingly.

Using the SRSS scheme, this stretch of stream is 'at risk', scoring low at 2.4. This corresponds to the SSRS result in the previous year. A dissolved oxygen (D.O.) concentration of 96.5% at this site indicated good water quality but all other parameters and observations suggest that water quality at this site is unsatisfactory. Indeed, the bloodworm/midge larvae *Chironomus sp.* was common and some of the cased caddisfly larvae collected were dead in their cases. Therefore, according to EPA biological monitoring criteria, this site is deemed to be 'Seriously Polluted, Class D (Q2)', i.e. poor water quality.

4.2 **Lismagratty Stream**

4.3.1 Site B1

This site was located to the north of the Corranure facility. The headwaters on this part of the stream had completely dried up (Plate 6) and therefore could not be examined. In the 2006

survey, this site was considered to provide only marginal habitat for macroinvertebrates due to its size and modified status. At the time, it was given a Q-value of Q3 and rated as 'Moderately Polluted, Class C'.

4.3.2 Site B2

This site was located on the Lismagratty Stream to the north-east of the Corranure landfill site. A pool shown in Plate 6 is the widest part of this stretch of stream and but the stream is generally only 0.8m wide with a mean depth of 10cm. Dissolved oxygen (D.O.) was low at this site at 45%. This site appeared to be visibly polluted with considerable siltation and turbid water. Like the previous survey undertaken in 2007, water levels were very low and as a result, sampling in riffled sections was difficult.

Despite the existing conditions, 8 different families of macroinvertebrates were recorded. This represents an increase of over a factor of two in macroinvertebrate richness when compared to the 2007 survey. Cased caddisfly were the most diverse group with at least two species occurring. Little black caddisfly larvae, *Agapetus fuscipes* were scarce while northern caddisfly larvae and another species undergoing pupation were both present. True fly larvae (Diptera) of two species in family Chironomidae were found, the green chironomid in small numbers and the midge *Chironomus sp.* being present. Also present were the leech *Glossiphonia complanata* and the water scavenger beetle *Helophorus brevipalpis*. At this site, the introduced freshwater shrimp *Gammarus pulex* was excessive and had completely displaced the native freshwater shrimp which had been present/scarce in the previous survey. Other organisms recorded at this site were broad-shouldered water striders (small numbers), river limpets *Ancylus fluviatilis* (scarce) and water scavenger beetles (present). Three-spined stickleback *Gasterosteus aculeatus* were also recorded at this site.

This site scored 4.8 on the SSRS scale so is deemed to be 'at risk'. This value has increased from the previous year when a score of 3.2 was recorded at this site. Organisms from pollution sensitivity group B were generally scarce at this site and the group 'C' freshwater shrimp was excessive. Using the EPA biological monitoring system, this part of the stream is therefore considered to be 'Moderately Polluted Class C (Q3)'.

4.3.3 Site B3

This site was located at Unshinagh approximately 1.5 km north of the Corranure facility (Plate 8). Some bank slippage was recorded at this site and the substrate was considerably silted. Rocks that were exposed to the air had a coat of silt that had hardened. Roughly 25% of this stretch of the Lismagratty Stream was riffled and the dissolved oxygen (D.O.) concentration was a favourable 90.8%.

A fair diversity of organisms was recorded at this site with 10 different families occurring. This corresponds to the result in the 2007 survey, suggesting that the aquatic macroinvertebrate community has not changed significantly over the course of the last year. Larvae of the cased caddisflies *Silo pallipes* (Goeridae) and *Micropterna sequax* (Limnephilidae) were both scarce. True fly larvae found were those of the crane fly *Dicronanta sp.* (scarce) and blackfly (present). Fair numbers of Jenkin's spire shell *Potamopyrgus jenkinsi* were recorded while another mollusc, the river limpet was scarce. The freshwater shrimp *Gammarus pulex* was excessive at this site, comprising over 75% of the sample. Beetles were well represented at this site, with small numbers of water scavenger beetles and few diving beetles in sub-family Colymbetinae. Riffle beetle at larval stage were scarce while adults were present in small numbers. Large dark olive mayfly larvae, common whirligig beetles and native freshwater shrimp which were present at this site in the previous survey were not recorded in the current survey.

A SSRS score of 4.8 ('at risk') was attained for this site. This is an improvement since the previous survey when this site scored only 2.4, half the current value. The biological water quality rating is deemed to be 'Moderately Polluted Class C (Q3)' due to the absence of group 'A' pollution indicators and the abundance of the group 'C' freshwater shrimp. The water

quality status of this site has been consistent over the course of the most recent three surveys of this site.

4.3.4 Site B4

This site was located downstream of the bridge at Lisdunvis Glebe over 2 km from the Corranure landfill site. All aspects of this site were similar to previous surveys. Siltation of the mainly rocky substrate was in evidence at this site, especially at the edges of the stream where flow was reduced. The dissolved oxygen (D.O.) concentration was 85.6% and the stretch was consisted of riffle (10%), glide (40%) and pool (50%).

A total of 14 different families were recorded at this site, an increase of 5 since the survey in the previous year. The most diverse group were the trichopterans/caddisflies of which five cased species at larval stage were recorded. These were the northern caddisflies *Limnephilus lunatus* (small numbers), *Micropterna sequax* (small numbers) and *Potamophylax latipennis* (present) along with the little black caddisfly (common) and *Silo pallipes* (small numbers). Blackfly larvae and crane fly larvae of *Dicranota sp.* were both scarce while biting midge larvae (Ceratopogonidae) were present; all of these are dipterans. The leech *Glossiphonia complanata*, Jenkin's spire shell, large dark olive mayfly larvae and aquatic earthworms in families Lumbricidae and Lumbriculidae were all present. Fair numbers of both river limpet and the riffle *Helmis maugei* were recorded at this site. The most abundant organism was the freshwater shrimp *Gammarus pulex* which was numerous. Species recorded in the previous survey but not recorded in the current survey include the freshwater shrimp *Gammarus deubeni*, 3-spined sticklebacks and the fish leech *Piscicola geometra*.

A score of 4.8 was allocated to this site for the SRSS (small streams risk score) and is therefore considered to be 'at risk'. This score corresponds exactly with that obtained in the previous survey. This site has consistently been rated as 'Moderately Polluted Class C (Q3)'. Based on the current macroinvertebrate assemblage, this unsatisfactory water quality status remains the same. However, the increase in diversity of the macroinvertebrate community at this site would imply that there is an improvement in water quality since the previous survey. This improvement is not reflected in the Q determination scheme due to the presence of pollution tolerant taxa.

4.3.5 Site B5

This site was located upstream of Lisnacark Bridge and can be seen in Plate 10. In correspondence with previous surveys however, the aquatic faunal community was dominated by pollution tolerant species. The dissolved oxygen (D.O.) was 103.7% saturation for a temperature of 14.4°C. Siltation was light at this site.

Thirteen different families of macroinvertebrate were recorded at this site compared to 12 in the previous survey. Small numbers of both large dark olive mayfly larvae and midge larvae of *Chironomus sp.* were recorded. Cased caddisfly larvae were diverse with *Potamophylax latipennis*, *Halesus digitatus* (both limnephilids) and *Silo pallipes* being present, while the little black caddisfly was scarce. Blackfly larvae, crane fly larvae of *Dicranota sp.*, lumbricid aquatic earthworms and the ectoparasitic fish leech *Piscicola geometra* were all present. The freshwater shrimp *Gammarus pulex* was dominant at this site. Fair numbers of riffle beetle *Helmis maugei* was recorded while larva of same was scarce. Marsh beetle larvae (Helodidae) and Broad-shouldered water strider bugs were both present. Three-spined stickleback were also recorded at this site. The following macroinvertebrates were previously recorded from this site but were not found in the current survey: river limpet, *Gammarus deubeni*, the leech *Glossiphonia complanata* and a species of riffle beetle (Helmidae).

The SRSS for this site was worked out to be 4.8 meaning that this stretch of stream is 'at risk'. As in the preceding surveys, this site was given a Q-value of Q3 and rated as being 'Moderately Polluted, Class C'. This is due to the absence of group 'A' pollution indicators and the dominance of group 'C' organisms.

5. Conclusions

Pollution tolerant organisms were found to be dominant at all sites on both the Corranure and Lismagratty Streams, with the exception of sites where sampling was not possible due to low flow conditions. The best sites on these streams were considered to provide only sub-optimal physical habitats for macroinvertebrates. The faunal community present in the Corranure Stream was dominated by the pollution tolerant freshwater shrimp *Gammarus deubeni*. The situation was slightly better on the Lismagratty Stream with the absence of the hog louse, but the introduced freshwater shrimp *G. pulex* had displaced the native *G. deubeni*. Also, in the Lismagratty Stream, the 'little black caddisfly' *Agapetus fuscipes* was generally found in fair numbers. The only mayfly recorded during the entire survey was the pollution tolerant large dark olive *Baetis rhodani* and it was by and large only scarce. High siltation levels recorded during the survey may have been due to the prolonged dry spell (May to mid-June) followed by recent heavy rainfall. The stream banks at a number of sites were found to be eroding into the streams.

Biological surveys are usually undertaken in the summer-autumn period (June-September) when flows are relatively low and water temperatures highest (McGarrigle *et al.*, 2002). The timing of this survey therefore coincided with the worst conditions to be expected in those reaches affected by waste inputs (i.e. this assessment was carried out at the optimal time for such an appraisal). However, no discernible decline in water quality was apparent in either the Corranure or Lismagratty Streams, when compared with previous survey results. As noted in previous surveys, harsh environmental conditions for macroinvertebrates occur at the upper sites on both streams due to drying out. Temporary water bodies will have reduced macroinvertebrate diversity. Compared to the 2006 survey, all sites had reduced water levels and the uppermost sites on both the Corranure and Lismagratty Streams were completely dry. Increased competition, space considerations and reduced oxygen levels would be expected in low water conditions. Indeed, the dissolved oxygen (D.O.) concentration at the upper site on the Corranure Stream was only 45%.

Accordingly, all sites scored low on the SRSS scale, principally due to the absence of stoneflies and mayflies (other than family Baetidae mayflies), and in the case of the Corranure Stream the presence of the pollution tolerant hog louse at most sites. The presence of the latter lowers the SSRS value. All sites still have either 'Poor' or 'Doubtful' water quality and are in an 'Unsatisfactory Condition'.

As observed in past surveys, the Corranure stream is currently under considerable ecological stress. The sites surveyed are still dominated by a low diversity of pollution tolerant organisms. With the exception of the lower site (A5), this stream is rated as being Moderately Polluted (Class C). The lower site is still deemed to be 'Seriously Polluted' despite a slight increase in diversity since the previous survey. This is probably due to the suburban nature of the catchment, with the stream being influenced by runoff from artificial surfaces such as roads, paths and houses. Suspended solids were clearly elevated at this lower site. The lower reaches of this stream appears to be deficient in class 'B' organisms given its size – only one species at A4 and A5. These sites showed a reduction in family diversity but water quality at Site A4 has slightly improved with the disappearance of the hog louse and a corresponding rise in the SSRS and Q-rating. The two upper sites surveyed had an increased diversity and the SSRS at Site A3 increased considerably from 0.8 in 2007 to 4.0 in the current survey. The Corranure Stream is highly modified throughout most its course, being crossed by at least 7 bridges in a 3km stretch upstream of Drumalee and it runs along the R188 for a good deal of its length.

The Lismagratty stream is also 'Moderately Polluted (Class C)' along the corridor investigated. The Q-rating at all sites remain the same as in the previous survey. The stream continues to be dominated by pollution tolerant organisms. The ecological competition between the native *Gammarus duebeni* and the introduced *G. pulex* has resulted in *G. pulex* gradually displacing *G. duebeni*. *Gammarus pulex* was dominant at the lower sites in 2006 but was found to have outcompeted *G. duebeni* at all sites in 2007 and again in 2008. All sites investigated on the Lismagratty Stream either had the same macroinvertebrate family diversity (B3) or increased diversity (B2, B4 and B5). Despite all sites still being 'at risk', a higher score was recorded at the two upper sites investigated.

The exact sources of pollution at the sites investigated could not be established during the current study. Previous published reports by the EPA for the Annalee catchment in general have implicated agricultural sources. However there have been episodes of sewage pollution here also in the past. The most recent available EPA assessment of the Cavan River (Code 36/C/02) states that 'once again quality deteriorated considerably below Cavan town where the river was very heavily silted and was characterised by excessive algal growth and a faunal composition indicative of considerable organic pollution'. This statement ensued from observations and surveying at station 0300 just over 2km downstream of Cavan and station 0400 at the bridge u/s of the Annalee confluence).

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Table 1 Location of the ten aquatic survey sites and selected water quality results.

Site	Watercourse	Grid reference (12 point)	Location	Temp (°C)	Conductivity (mS/cm)	Dissolved oxygen (%)	Dissolved oxygen (mg/l)
A1*	Corranure Stream	H244550 307810	Near main entrance of Corranure facility	N/A	N/A	N/A	N/A
A2	Corranure Stream	H244180 307490	Immediately downstream of where stream leaves facility	12.8	1032	70.1	7.41
A3	Corranure Stream	H243450 307300	Curragho north	12.8	762	70	7.41
A4	Corranure Stream	H242870 306720	Curragho west	12.5	614	92.6	9.87
A5	Corranure Stream	H242410 306020	Drumalee Bridge	13	434	96.5	10.13
B1*	Lismagraty Stream	H244120 308450	North fork of feeder stream	N/A	N/A	N/A	N/A
B2	Lismagraty Stream	H244530 308860	Northeast of Corranure facility	12.4	717	45	4.79
B3	Lismagraty Stream	H245130 309190	Unshinagh	14.2	561	90.8	9.31
B4	Lismagraty Stream	H246100 309600	Downstream of the bridge at Lisdunvis Glebe	13.8	511	85.6	8.82
B5	Lismagraty Stream	H246600 309700	Lisnacark Bridge	14.4	511	103.7	10.6

*these sites were dry at the time of the current survey.

Table 2 Physical characteristics of the ten aquatic survey sites.

Physical characteristic	Site									
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5
Bank height (m)	1.0	1.5	2	3	1.0	0.3	0.4	0.4	0.3	0.3
Maximum depth (cm)	N/A	15	15	30	40	N/A	30	25	25	30
Mean depth (cm)	N/A	5	5	15	25	N/A	10	10	10	10
Riffle (%)	N/A	5	5	30	50	N/A	20	25	10	30
Glide (%)	N/A	2	15	20	30	N/A	20	20	40	20
Pool (%)	N/A	90	80	50	20	N/A	60	55	50	50
Wetted width (m)	N/A	40	40	70	1.0	N/A	0.9	1.5	2.6	2.0
Rock (%)	0	10	5	5	5	0	25	15	5	15
Cobble (%)	40	40	40	40	75	10	45	70	35	45
Gravel (%)	50	35	40	50	10	10	15	10	45	30
Fine (%)	10	15	15	5	10	80	15	5	15	10
Shade (%)	75	95	65	60	5	55	65	25	35	55
Bank slope (°)	80	80	50	40	45	60	30	70	40	80
Bank cover (%)	90	95	95	100	85	100	90	95	95	95
Instream vegetation cover (%)	0	0	0	0	5	0	5	0	0	0

Table 3 Results of the June 2008 biological assessment of the Lismagraty and Corranure streams.

Organism	Pollution sensitivity group	Functional group	Site Code							
			A2	A3	A4	A5	B2	B3	B4	B5
SEGMENTED WORMS (Annelida, Oligochaeta)										
Aquatic earthworm (Lumbricidae)	D	Collector			*				*	*
Aquatic earthworm (Lumbriculidae)	D	Collector		****					*	
LEECHES (Hirudinea)										
Family Glossiphoniidae										
<i>Glossiphonia complanata</i>	D	Predator					*		*	
<i>Helobdella stagnalis</i>	D	Predator								
Piscicolidae										
<i>Piscicola geometra</i>	C	Predator								*
Erpobdellidae										
<i>Erpobdella octoculata</i>	D	Predator	**			****				
SNAILS (Mollusca, Gastropoda)										
Lymnaeidae										
Wandering snail <i>Lymnaea peregra</i>	D	Shredder								
Hydrobiidae										
Jenkin's spire shell <i>Potamopyrgus jenkinsi</i>	D	Grazer						****	*	
Ancylidae										
River limpet <i>Ancylus fluviatilis</i>	D	Shredder				**	**	**	****	
CRUSTACEANS (Crustacea, Malostraca)										
Amphipods (Amphipoda, Gammaridae)										
Freshwater shrimp <i>Gammarus deubeni</i>	C	Shredder	**	***	*****	****				
Freshwater shrimp <i>Gammarus pulex</i>	C	Shredder			*		*****	*****	*****	*****
Isopods (Order Isopoda, Asellidae)										
Hog louse <i>Asellus aquaticus</i>	D	Shredder	*****	**		***				

Present *, Scarce/Few **, Small Numbers ***, Fair Numbers ****, Common *****, Numerous *****, Dominant *****, Excessive *****

Table 3 (continued) Results of the June 2008 biological assessment of the Lismagraty and Corranure streams.

Organism	Pollution sensitivity group	Functional group	Site Code							
			A2	A3	A4	A5	B2	B3	B4	B5
BEETLES (Coleoptera)										
Riffle Beetles (Elminthidae)										
<i>Helmis mauegi</i> (larvae)	C	Predator						**		**
<i>Helmis mauegi</i>	C	Predator						***	****	****
Water Scavenger Beetles (Hydrophilidae)										
Subfamily Helophorinae										
<i>Helophorus brevipalpis</i>	C	Predator & collecting gatherer					*	***		
Diving beetle (Dysticidae)										
Subfamily Colymbetinae	C	Predator	*					**		
Marsh beetle larvae (Helodidae/Scirtidae)	C	Predator								*
BUGS (Hemiptera)										
Broad-shouldered water striders (Veliidae)	C	Predator		*				***		*
FLATWORMS (Platyhelminthes)	D	Collector								
Number of families			7	8	6	7	8	10	14	13

Present *, Scarce/Few **, Small Numbers ***, Fair Numbers ****, Common *****, Numerous *****, Dominant *****, Excessive *****

Table 4 Water quality rating and SSRS (Small Stream Risk Score) of the five sites investigated during the June 2008 and September 2007 biological assessments of the Corranure stream.

Note: Results for Site A1 are from the 2006 survey as this site was dry during 2008 and 2007.

	Site A1 (2006)*	Site A2		Site A3		Site A4		Site A5	
		2007	2008	2007	2008	2007	2008	2007	2008
Diversity (Families)	6	6	7	6	8	8	6	10	7
Q-value	Q2	Q2	Q3	Q3	Q3	Q2	Q3	Q2	Q2
Rating	Class D	Class D	Class C	Class C	Class C	Class D	Class C	Class D	Class D
Quality Status	Seriously Polluted	Seriously Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Seriously Polluted	Moderately Polluted	Seriously Polluted	Seriously Polluted
SSR Score	N/A	2.4	2.4	0.8	4	3.2	4.8	2.4	2.4
SSRS Assessment	N/A	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk

Table 5 Water quality rating and SSRS (Small Stream Risk Score) of the five sites investigated during the June 2008 and September 2007 biological assessments of the Lismagraty Stream.

Note: Results for Site B1 are from the 2006 survey as this site was dry during 2008 and 2007.

	Site B1 (2006)	Site B2		Site B3		Site B4		Site B5	
		2007	2008	2007	2008	2007	2008	2007	2008
Diversity (Families)	10	3	8	10	10	9	14	12	13
Q-value	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3	Q3
Rating	Class C	Class C	Class C	Class C	Class C	Class C	Class C	Class C	Class C
Quality	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted	Moderately Polluted
SSR Score	N/A	3.2	4.8	2.4	4.8	4.8	4.8	4.8	4.8
SSRS Assessment	N/A	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	At Risk

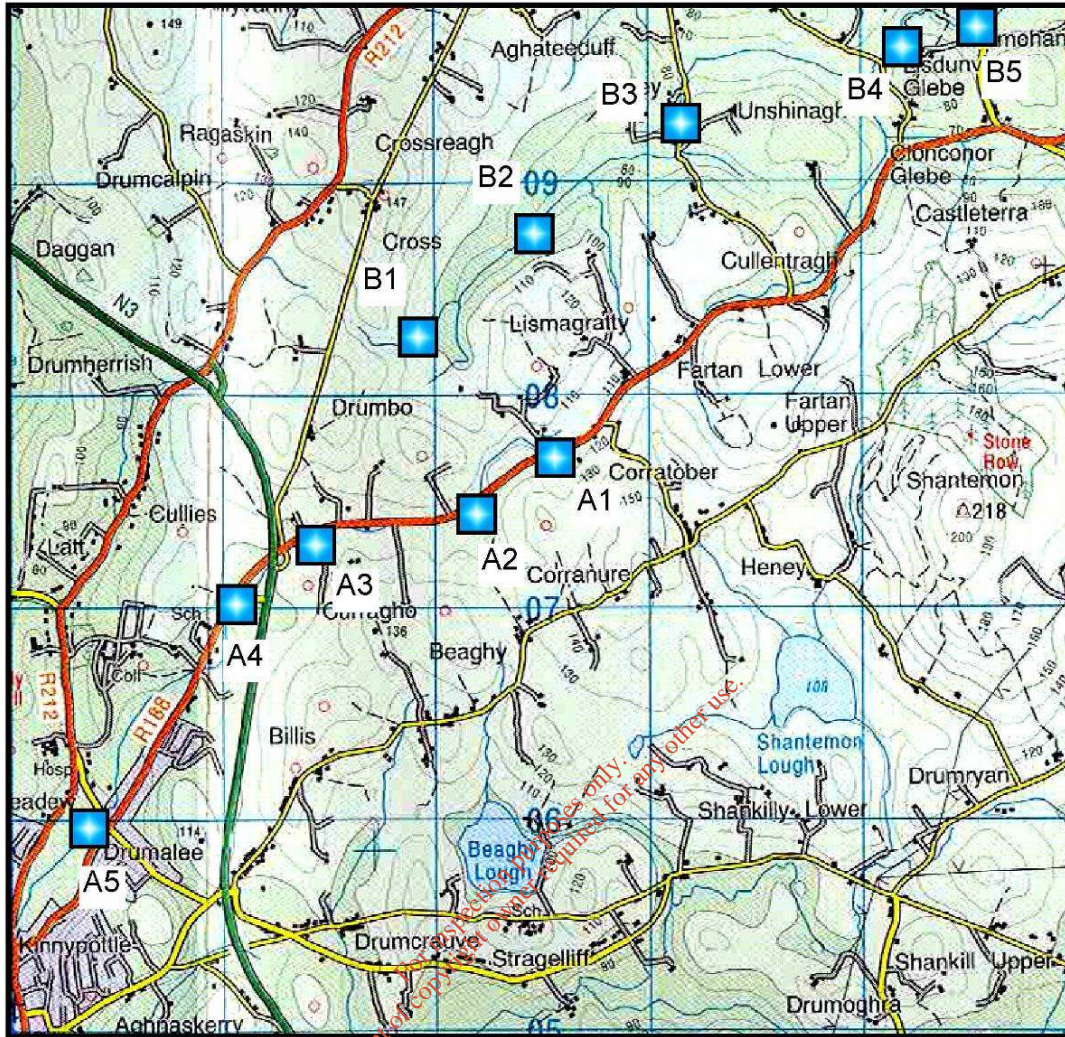


Figure 1 General location of the 10 biological assessment sites (O.S License Agreement Number to be supplied by client).

Plates - Corranure Stream



Plate 1 In the current survey, Site A1 to the south of the Corranure facility had completely dried up.



Plate 2 Site A2 adjacent to the R188 was difficult to sample, had lots of organic debris and eroding banks.



Plate 3 Site A3, approximately 1km southwest of the Corranure facility.



Plate 4 Site A4 was very shaded – suboptimal macroinvertebrate habitat.



Plate 5 Site A5, just downstream of Drumalee Br. on the northern outskirts of Cavan was visibly polluted.

Plates - Lismagratty Stream



Plate 6 Site B1 near the headwaters of the Lismagratty Stream.



Plate 7 At Site B2, the water was turbid and heavily silted.



Plate 8 Site B3 at Unshinagh, next to a third class road serving the area.



Plate 9 Site B4 was heavily silted downstream of the bridge at Lisdunvis Glebe.



Plate 10 Site B5 upstream of Lisnacark Bridge.

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Appendix 1 EPA River Quality Classification Scheme

The Q values are a measure of the EPA's Biological River Quality classification system. The EPA conducts a rolling programme of biological surveys of selected rivers. The higher the biological diversity and the greater the abundance of invertebrate species sensitive to organic pollution, the higher the water quality is assumed to be, and the higher the 'Q value' assigned to that sampling station. The EPA's water quality classification systems are summarised below:

Class 'A' waters are those in which problems relating to existing or potential uses are unlikely to arise. They are therefore regarded as being in a 'satisfactory' condition. Classes 'B', 'C' and 'D' are to a lesser or greater extent 'unsatisfactory' in this regard. For example, the main characteristics of Class 'B' and 'C' waters is eutrophication, which may interfere with the amenity, abstraction or fisheries uses of such waters. The general characteristics of waters of the various Biological Quality Classes are provided in Table A1.1.

Table A1.1 The general characteristics of waters of the various Biological Quality Classes.

Quality Classes	Class A		Class B	Class C	Class D	
	Q5	Q4	Q3-4	Q3	Q2	Q1
Pollution Status	Pristine, Unpolluted	Unpolluted	Slight Pollution	Moderate Pollution	Heavy Pollution	Gross Pollution
Organic Waste Load	None	None	Light	Considerable	Heavy	Excessive
Maximum B.O.D.	Low (< 3mg/l)	Low (< 3mg/l)	Occasionally elevated	High at times	Usually High	Usually very high
Dissolved Oxygen	Close to 100% at all times	80%-120%	Fluctuates from <80% to >120%	Very unstable, Potential fish-kills	Low, sometimes zero	Very low, often zero
Annual median PO₄	0.015 mg/l	0.03 mg/l	0.045 mg/l	0.07 mg/l	> 0.1 mg/l	> 0.1 mg/l
Siltation	None	May be light	May be light	May be considerable	Usually heavy	Usually very heavy and anaerobic
'Sewage Fungus'	Never	Never	Never	May be some	Usually abundant	May be abundant
Filamentous Algae	Limited Development	Considerable growth, diverse communities	Luxuriant growths, typically Cladophora	Excessive growths, typically Cladophora	Usually abundant	None
Macrophytes	Diverse communities, limited growths	Diverse Communities, Considerable Growths	Reduced diversity, luxuriant growths	Limited diversity, excessive growths	Tolerant species only, may be abundant	Most tolerant forms, minimal diversity
Water Quality	Highest quality	Fair Quality	Variable quality	Doubtful quality	Poor quality	Bad quality
Abstraction Potential	Suitable for all	Suitable for all	Potential problems	Advanced treatment	Low grade abstractions	Extremely limited
Fishery Potential	Game fisheries	Good game fisheries	Game fish at risk	Coarse fisheries	Fish usually absent	Fish absent
Amenity Value	Very high	High	Considerable	Reduced	Low	Zero

Table 1.2 EPA Biological River Quality Classifications and River Water Quality Class System.

'Q' value	Community Diversity	Water Quality	Condition*	Status	Quality
Q5	High	Good	Satisfactory	Unpolluted	Class A
Q4	Reduced	Fair	Satisfactory	Unpolluted	Class A
Q3	Much Reduced	Doubtful	Unsatisfactory	Slightly Polluted	Class B
Q2	Low	Poor	Unsatisfactory	Moderately Polluted	Class C
Q1	Very Low	Bad	Unsatisfactory	Seriously Polluted	Class D

* 'Condition' refers to the likelihood of interference with beneficial or potential beneficial use.

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Appendix 2 EPA Water Quality Data

Water Quality Data for the Rivers Annalee and Cavan (from Toner *et al*, 2005, 2004 results and assessments downloaded from the EPA website www.epa.ie on 1/7/08).

River and Code : **ANNALEE** **36/A/02**
Tributary of : Lough Oughter OS Catchment No: 123
OS Grid Ref : H 393 101

Sampling Stations No.	Biological Quality Ratings (Q Values)												
	1971	1977	1979	1980	1982	1983	1986	1989	1993	1997	1998	2001	2004
0080	-	-	-	-	-	-	-	3-4	3-4	3-4	4-5	3-4*	4
0100	4	3-4	4	3	4	-	4	-	-	-	-	-	-
0150	-	-	-	-	-	-	-	-	3-4	3	3	3	3
0200	4-5	4	4	3	3-4	-	3-4	-	-	-	-	-	-
0250	-	-	-	-	-	-	-	3-4	3-4	4	3-4	3-4*	3-4
0300	-	-	4	4-5	4-5	-	3	-	-	-	-	-	-
0350	-	-	-	-	-	-	-	3	4	4	3-4	4	4
0500	5	3	3/0	4	5	-	5	2-3	4-5	4-5	3	4	4
0550	-	-	-	-	-	-	-	-	-	-	-	-	-
0600	-	-	4	3-4	4	-	4	2-3	4	4-5	3-4	3-4	4
0700	4-5	4	5	3-4	4-5	-	4	3	-	-	-	-	-
0800	5	4	5	5	5	-	4-5	3-4	4-5	4-5	4	4-5	4
0900	-	-	4	4-5	4-5	-	4-5	4	4	4	4	3-4	4
0950	-	-	-	-	-	-	-	4	-	-	-	-	-
1000	3	3-4	-	-	-	-	4-5	4	4	4	4	3-4	3-4
1100	3-4	-	4	4	4-5	-	4	3-4	4	-	-	-	-
1150	-	4	-	4	4-5	-	5	3-4	4-5	4-5	4	3-4	4-5
1200	-	-	-	-	-	3-4	-	3	-	-	-	-	-
1300	-	-	4	4	4	-	4-5	3-4	-	-	-	-	-
1350	-	-	-	-	-	-	4-5	4-5	4	3-4	4	3-4	3-4
1400	-	-	-	3-4	3-4	-	3-4	3-4	4	3-4	3-4	3	3-4

No.	Location	No.	Location
0080	2nd Br u/s L Sillan	0800	Br NW of Rakenny Ho
0100	Br just u/s L Sillan	0900	Ballynallon Br
0150	2nd Br d/s L Sillan	0950	Br S of Kilmacananoran
0200	Br u/s L Tacker	1000	Ballyhaise Br
0250	1st Br d/s L Tacker	1100	1km d/s Ballyhaise Br
0300	Br nr Lisclogher	1150	Br nr Curraghanoë
0350	Br nr Ann's Fort	1200	0.2km u/s Butlersbridge
0500	New Grove Br	1300	Butlersbridge (d/s side)
0550	Br W of Fair Mount	1350	0.2km u/s Cavan R confl
0600	Br SE of Fort William	1400	0.2km d/s Cavan R confl
0700	Corick Br		

EPA Assessment: A widespread slight improvement was recorded in the quality of the Annalee in 2004. This was apparent at five of the twelve locations surveyed, including Station 1400 downstream of the Cavan River. A more marked improvement was apparent in the Curraghanoë area (1150) where quality has been restored to a highly satisfactory status (Q4-5). Despite this favourable state of affairs the upper river continued to be adversely affected by eutrophic outflows from Loughs Sillan and Tacker and also by heavy substratum siltation at several locations (0080, and 0250 to 0500).

Biological Assessment of the Lismagratty and Corranure Streams
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River and Code : **CAVAN**
Tributary of : Annalee
OS Grid Ref : H 475 112

36/C/02
OS Catchment No: 123

Sampling Stations No.	Biological Quality Ratings (Q Values)											
	1978	1980	1984	1986	1987	1989	1990	1993	1997	1998	2001	2004
0040	-	-	-	-	-	-	-	3-4	3	4	3	3
0085	-	-	-	-	-	-	-	-	4-5	4	4	4
0090	-	-	-	-	-	3	-	-	-	-	-	-
0100	-	4-5	3-4	3-4	-	3	-	-	-	-	-	-
0200	1	1	1	2	2-3	2	2-3	3	-	-	-	-
0300	-	-	-	2	2	2-3	2-3	3	2-3	2-3	2-3	2-3
0400	2	2	2	2-3	2-3	2-3	-	3	2-3	2-3	2-3	2-3

No.	Location	No.	Location
	<i>Shantemon Lake Branch</i>	0100	In Royal School Grounds
0040	Br nr Breffni Park	0200	Br d/s Cavan (Lisdarn)
	<i>Main Channel</i>	0300	Br d/s St 0200
0085	Br N of Killycannan	0400	Br u/s Annalee R confluence
0090	Br near Lisduff		

EPA Assessment: The Shantemon Lake Branch was again significantly polluted at Breffni park (0040) in June 2004. The Main Channel continued to be in a satisfactory condition upstream of Cavan (0085) but this situation is threatened by heavy cattle usage at this location: fencing is required to restrict cattle access. Once again quality deteriorated considerably below Cavan town (0300, 0400) where the river was very heavily silted and was characterised by excessive algal growth and a faunal composition indicative of considerable organic pollution.

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