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Shannon International River Basin District Project

Freshwater Morphology POMS Study

Cost Effectiveness and Feasibility of River Enhancement Schemes

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SHANNON INTERNATIONAL RIVER BASIN DISTRICT

PROJECT

Cost Effectiveness and Feasibility of River Enhancement Schemes

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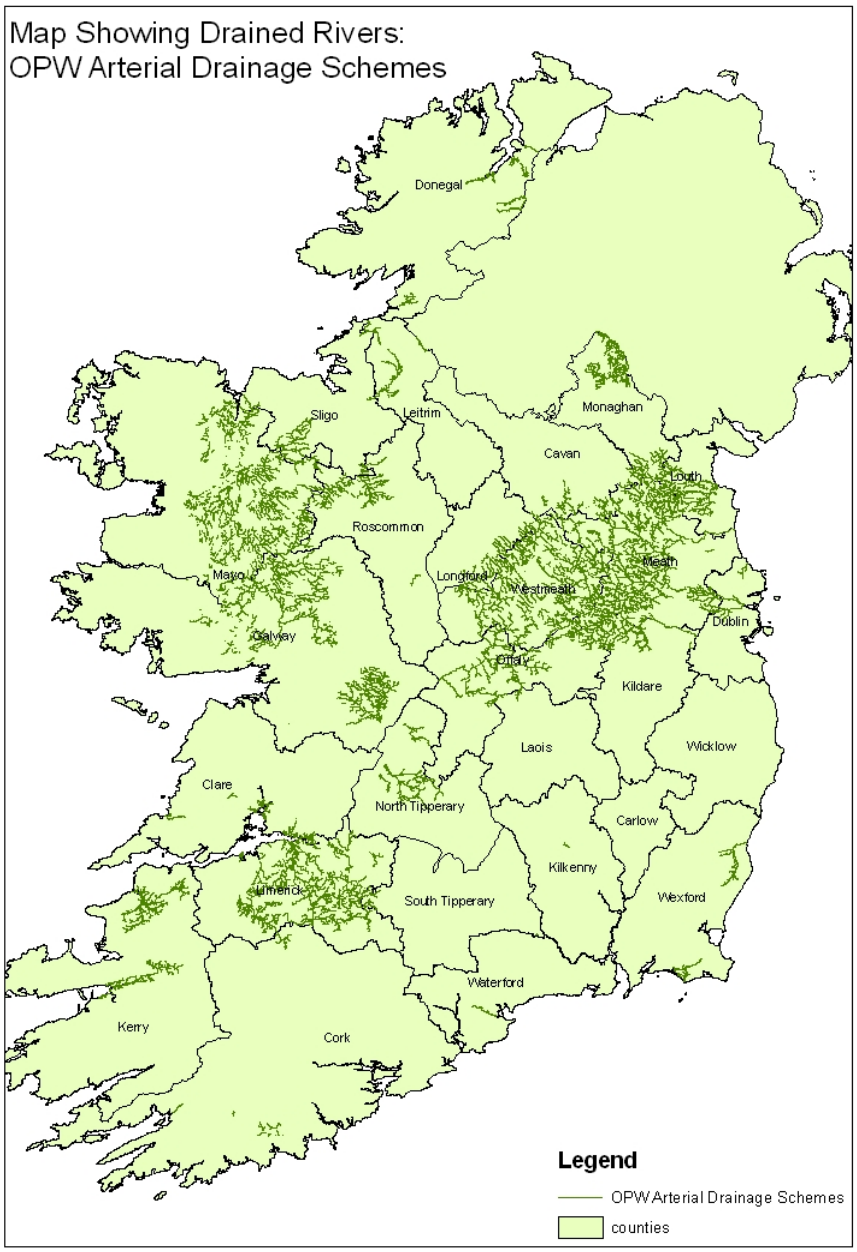
1.0 Introduction

This report has been completed under Work Package 1 of the Shannon International River Basin District, Freshwater Morphology, Programmes of Measures and Standards (POMS) Study Terms of Reference as agreed in October 2005.

Over recent years, Central Fisheries Board (CFB) have implemented enhancement schemes in drained rivers throughout Ireland, mainly to create habitat and spawning areas for salmonids. Analysis of data from these schemes has improved the understanding of how a river's physical condition can be improved following drainage, and have proven successful in many cases. This has been documented in a Channelisation Recovery Assessment report, also completed under the Shannon IRBD Freshwater Morphology POMS Study (Work Package 2).

As a result, information relating to cost and associated environmental benefit, practical application and feasibility on the ground of these schemes can now be used in prioritising how and where morphological enhancement measures can be effectively applied in the River Basin Management Programmes of Measures, which outline the steps that will be taken to reach the WFD objective of Good Ecological Status for all waters by 2015.

An enhancement programme is currently being planned by the Office of Public Works (OPW) which will involve enhancement of their drained rivers over the next 5 years. OPW are working with CFB in identifying those drained rivers appropriate for enhancement and in designing the schemes. The rivers being assessed are shown on Map 1 overleaf; these are the rivers that were subject to an arterial drainage scheme under the Drainage Act, 1945 by OPW.



Map 1: OPW Arterial Drainage Schemes

The purpose of this report is to outline baseline costs and practical applicability of a range of aspects of enhancement schemes based on the experience previously gained by CFB and OPW, both through individual schemes, and through the work currently being undertaken for the OPW enhancement programme of drained rivers. A consultation meeting was held with Dr Martin O'Grady (CFB), and Nathy Gilligan (OPW) to accumulate this information so that it can be used on a national basis to inform WFD Programmes of Measures with respect to river morphology.

Feasibility of larger restoration schemes will be discussed in a separate report under the Freshwater Morphology POMS Study.

It should also be noted that channel enhancement measures address direct morphological pressures such as channelisation but measures are also required to address indirect pressures such as overgrazing.

2.0 OPW drainage requirements under Arterial Drainage Act, 1945

When implementing fisheries enhancement schemes on OPW's drained rivers, there are requirements under the Arterial Drainage Act, 1945 which must be factored into the design:

- Conveyance of 1 in 3 year return period flood must be maintained within the river.

- In many cases OPW drained rivers actually convey a 1 in 5 year or 1 in 10 year flood. This is due to the practicalities of achieving specific design widths. For example, the excavator machine used cannot physically excavate less than 3m width due to the size of the bucket, therefore the actual width of the river is often greater than the design width. Whilst this is anecdotal evidence it has been observed in the field by Fisheries staff and is regarded as providing "room to work with" in terms of in stream channel enhancement features as a 1 in 3 year return period flood conveyance is all that is required under the Drainage Act.

- Outfall for drainage is often main factor in determining depth. Datum of the river bed must be 3 feet below lowest callows.

3.0 Feasibility of Enhancement Schemes

The following rules have been derived from practical experience of past enhancement schemes and are adhered to by CFB in assessing their feasibility:

- A river steeper than 3% will not exhibit productive results in terms of fish if enhanced. It is too steep to retain gravels placed on the bed, and the energy levels are too high;
- The shallowest stream gradient suitable for enhancement is 2m/km
- Ireland is made up of 5 channel types (refer to Figure 1). According to the Rosgen typology system these are types A, B,C,D and E. – B and C types are most suitable for enhancement. E types are too low energy and sluggish; A types are too steep.
- Rivers with Biological Q value less than Q3 are unsuitable (moderately polluted or worse)

- In OPW drained rivers, a minimum flow conveyance of 1 in 3 year flood must be maintained, therefore all enhancement features must be at a low level within the river so as not to reduce channel capacity at high flows
- Enhancement programmes are not as effective in channels with catchment areas ≤ 4.5 km.² (O'Grady, 2007, WP2 Freshwater Morphology POMS Study)

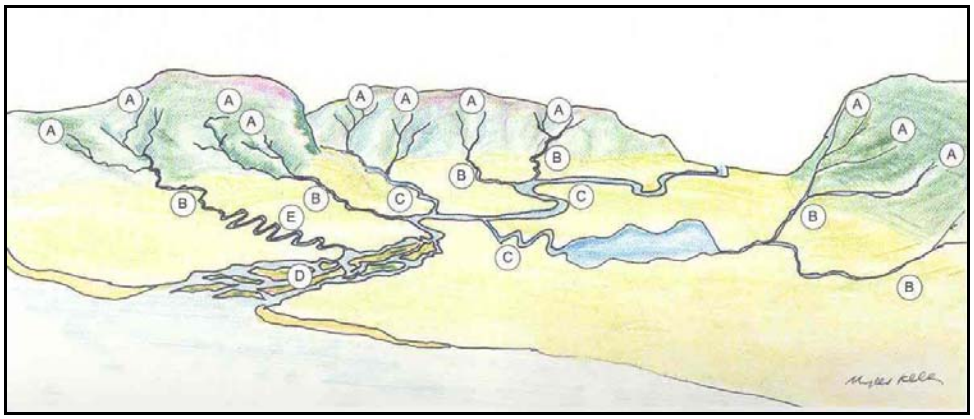


Figure 1: Typical Types of River Channels in Ireland based on the Rosgen Typology System (Channels and Challenges, O'Grady 2007)

4.0 Prioritising Rivers for Enhancement

At present, OPW are preparing an enhancement programme on their drained rivers in conjunction with CFB. Of 11,500 km of drained OPW channels (refer to Map 1), it is envisaged that only a small percentage will be suitable for enhancement. This is based on the fact that most drained rivers are lowland, low energy channels (type E according to Figure 1) and as such enhancement measures will yield little results in terms of fisheries, and other biological indicators. CFB are working with OPW in an initial screening process to determine this percentage so that their enhancement programme can be prepared. The steps taken in that screening process are as follows:

- Delineation of zones based on EPA Biological Q value and overlaying this with channel gradient to identify rivers with a Q value greater than 3 (moderately polluted) and gradients within the suitable range;

- Identification of "bottle-necks" in terms of fish populations in the catchment i.e. where the problems areas are. This may be upstream in the catchment where streams that should naturally be used for spawning are not, or further downstream in wider rivers that should

naturally be used as nursery for 1+ or older fry and are not. Similarly, rivers are identified that are not suitable fish habitat naturally and should not be enhanced artificially to achieve this. These are mainly very low gradient, low energy wider rivers at the downstream end of catchments and form the majority of OPW's drained rivers given their lack of flood conveyance pre-drainage.

Whilst this screening process is being undertaken by CFB on OPW's drained rivers, there is a need to apply this process nationally for the purpose of identifying all waterbodies for which:

a) Restoration to Good Morphological Status is necessary
b) Enhancement schemes to achieve Good Morphological Status will actually be effective

The question of what authority is responsible for implementing these measures when the screening process is applied nationally must be addressed.

5.0 Cost Effectiveness of Enhancement Schemes

CFB have advised that a 1no. 15t excavator machine plus driver, plus one man on the ground can cover an average of 100m of river length per day undertaking a combination of the following items:

- Revetments (at specified spacing along river)
- Weirs for pools (at specified spacing along river)
- Creation of sinuous channels by building deflectors (at specified spacing)
- Fencing off (continuous)

Enhancing wider rivers is more cost effective than enhancing narrower rivers. Natural pool riffle features in rivers generally occur at a linear spacing of 5 to 7 times the river width. In designing enhancement schemes, this naturally occurring ratio is replicated when specifying how far apart features such as stone weirs and rubble mats should be located.

On the basis of enhancing:

20m wide river: enhancement feature spacing = 5 x 20m = 1 enhancement feature per 100m

5m wide river: enhancement feature spacing = 5 x 5m = 1 enhancement feature per 25m

Therefore enhancement of narrower channels is more labour intensive and requires more material.

However, the overriding factor in determining suitability of rivers for enhancement is not cost effectiveness but the aforementioned prioritisation methods such as pollution and in particular, identified “bottle-necks” in terms of fisheries:

- Narrower rivers – if narrow rivers should be used for spawning and are not, an enhancement scheme to create spawning areas will be prioritised despite it being less cost-effective in terms of labour intensity and the higher material requirement for placement of stone riffles, rubble mats etc.

- Wider rivers – if they should be used for 1+ fry or older and are not, enhancement schemes will be prioritised here. It is more cost-effective to implement enhancement schemes in wider rivers.

5.1 Costs of typical enhancement schemes

A typical enhancement scheme includes revetments, weirs for pools, creating sinuous channels by placing deflectors, and fencing off to prevent livestock access.

Costs based on covering an average of 100m river length a day using:

- 1 15t hydraulic excavator - €1000 / week
- 1 driver - €200 per day
- 1 man on ground - €200 per day
- Fencing (treated timber posts, sheep wire and 2 rows of barbed wire - €8 per day
- Stone for rubble mats - €15 per tonne

Enhancement Scheme – Example 1

e.g. Enhancement of a 20m wide river at a working rate of 100m per day (500m per week)

- 60 tonnes of stone are needed per rubble mat.
- 5 rubble mats needed per week (1 per 100m)

Item	Quantity	Unit	Rate	Unit	Cost
Hydraulic Excavator	1	item	€1,000.00	week	€1,000.00
Driver	1	labour	€200.00	day	€1,000.00
Man on Ground	1	labour	€200.00	day	€1,000.00
Stone for rubble mats	300	tonne	€15.00	tonne	€4,500.00
Fencing off	500	metre	€8.00	metre	€4,000.00

	Total	€11,500.00
	Cost per km	**€23,000.00**
Addition to reflect life cycle costs	**+ 25%**	**€28,750.00**

Enhancement Scheme -Example 2

e.g. Enhancement of a 5m wide river at a working rate of 50m per day (500m per 2 weeks)

- 20 tonnes of stone needed for a rubble mat
- 20 rubble mats needed per 500m (4 per 100m)

Item	Quantity	Unit	Rate	Unit	Cost
Hydraulic Excavator	1	item	€1,000.00	week	€2,000.00
Driver	1	labour	€200.00	day	€2,000.00
Man on Ground	1	labour	€200.00	day	€2,000.00
Stone for rubble mats	400	tonne	€15.00	tonne	€6,000.00
Fencing off	500	metre	€8.00	metre	€4,000.00

	Total	€16,000.00
	Cost per km	**€32,000.00**
Addition to reflect life cycle costs	**+ 25%**	**€40,000.00**

These costs are not life cycle costs. They do not include design fees, clients administration, supervision or monitoring. OPW have advised that an extra percentage should be added to the overall cost to take account of these overheads. For this purpose 25% has been added to indicatively reflect life cycle costs. Therefore an average cost per kilometre can be taken as €34,375.00.

6.0 Conclusions

River enhancement has been identified as one of the measures that can be used to restore the morphological status of a river from 'less than good' to 'good'. The decision to undertake an enhancement scheme on a waterbody will me made using a prioritisation process based on overall waterbody status, morphological status and identification of the pressures acting on it. The next step in the decision making process will be determining if an enhancement scheme is practically feasible and cost effective. CFB and OPW have practical experience in implementing these schemes in Ireland. This knowledge base has been drawn upon to highlight key points in practical feasibility and cost effectiveness of river enhancement.

- A river steeper than 3% will not exhibit productive results in terms of fish if enhanced. It is too steep to retain gravels placed on the bed, and the energy levels are too high;
- The optimum range of stream gradient for enhancement is 0.1-0.2%;
- Ireland is made up of 5 channel types (refer to Figure 1). According to the Rosgen typology system these are types A, B,C,D and E. – B and C types are most suitable for enhancement. E types are too low energy and sluggish; A types are too steep.
- Rivers with Biological Q value less than Q3 are unsuitable (moderately polluted or worse)
- In OPW drained rivers, a minimum flow conveyance of 1 in 3 year flood must be maintained, therefore all enhancement features must be at a low level within the river so as not to reduce channel capacity at high flows
- Enhancement programmes are not as effective in channels with catchment areas ≤ 4.5 km.² (O'Grady, 2007, WP2 Freshwater Morphology POMS Study)

A national screening process is necessary to identify all waterbodies for which:

c) Restoration to Good Morphological Status is necessary
d) Enhancement schemes to achieve Good Morphological Status will actually be effective

The question of what authority is responsible for implementing these measures when the screening process is applied nationally must be addressed.

Enhancement of wider rivers may be more cost-effective; however the ecological benefit in terms of fisheries and other biological indicators, as well as other pressures acting on the river such as pollution, must play a significant role in the prioritisation process.

The average cost per kilometre of a typical enhancement scheme, based on practical experience of OPW and CFB is of the order of €34,375.00. This includes a 25% addition for life cycle costing.

It should also be noted that channel enhancement measures address direct morphological pressures such as channelisation but measures are also required to address indirect pressures such as overgrazing.