

Guidance for run-of-river hydropower

December 2013

Fish passage

This document is part of our set of advice notes to help you design your hydropower scheme. You should read our [Guidance for run-of-river hydropower development](#) first, which contains an overview of our guidance and a glossary of technical terms.

Introduction

The natural movement of fish within river systems is critical to the health and maintenance of populations. Artificial obstructions are the principal reason for the loss of biological connectivity. Species that make long-distance migrations are more obviously affected by this loss and include Atlantic salmon, sea trout, eels, river lamprey and shad. Other species of fish need to move within and between river reaches for breeding, feeding and shelter. These movements may be in the;

- upper reaches – for example brook lamprey and bullhead
- middle reaches – for example dace, chub and barbel
- lower reaches – for example roach and bream
- between the sea and lower river reaches – for example sea lamprey, twaite shad and mullet.

Hydropower schemes are typically associated with impounding structures that impede the movement of fish. In most situations a new hydropower scheme will need to address the issue of fish passage. Where a fish pass is required, the presumption is that it will allow the effective passage of multiple species and sizes of fish unless local circumstances dictate otherwise.

When a fish pass is needed

A new hydropower scheme should not make it more difficult for fish to move up or downstream. We will require developers to install a fish pass and appropriate flow management on rivers where upstream or downstream fish passage is made worse. In some cases this may require provision of an additional pass while maintaining passage in an existing pass facility.

In deciding whether fish passage would be made worse by the introduction of the scheme, we will take account of the scheme design, the environmental legislation relevant at the site and the species of interest. (See Annex 1 for further details of legislative requirements).

A fish pass will also be required where fish passage is not made worse by the introduction of a hydropower scheme but improved fish passage is needed to fulfil the requirements of legislation such as the Salmon and Freshwater Fisheries Act and the Eel Regulations.

In determining water resource licences (abstraction or impoundment) we also have a duty to secure the requirements of the Water Framework Directive (WFD), which includes resolving

failures due to obstructions to fish passage. We may require a developer to fund fish passage improvements as part of a scheme where improved fish passage is needed to meet the objectives of the WFD, even though the introduction of the hydropower scheme may not make fish passage worse and no species specific legislation applies. For example, we may require a fish pass where there is currently total obstruction to fish passage and even though a hydropower scheme cannot make the situation worse a scheme can provide the opportunity to make it better. We will apply, where appropriate, the tests of costs and benefits in making any decisions on schemes.

Flows and fish passage

As well as increasing physical barriers to fish migration, hydropower schemes may also affect fish movements by causing changes to the distribution of water flows in the watercourse. Scheme proposals need to manage flows to ensure that they support the fish passage requirements at the site. For example, site-specific flows should not attract migrating fish away from the entrance to a fish pass or from a principal migration route.

Where a depleted reach is created in the design of a hydropower scheme, the flows in the depleted reach need to be sufficient to support fish populations and allow migration where required.

A fish pass must have sufficient flow passing through it to allow for efficient fish passage. To work effectively and efficiently a fish pass must also have sufficient hydrodynamic attraction properties for fish to find it and be encouraged to enter it. Attraction can be a combination of a number of stimuli, but the principles ones are location, flow and velocity (momentum). The 'residual flow' calculation in your application will need to include the flow required to service an appropriate 'upstream fish pass and/or downstream fish bywash'

Upstream fish passage

Where there is existing provision for fish passage, approved or otherwise, any hydropower development must maintain the effectiveness and efficiency of the pass or passage through the site. When existing fish passes are to be used, but are known to be inefficient, we shall expect developers to address opportunities for improving fish passage.

In some cases, the introduction of a hydropower scheme may compromise the efficiency of an existing pass. An example is where hydropower is developed on the opposite bank from an existing fish pass. If the efficiency of an existing pass cannot be maintained, more than one fish pass may be required.

We will expect a fish pass to be provided as part of any scheme developed on a river that is frequented by migratory salmonids, even if no fish pass is currently provided. This includes rivers that are recovering or rehabilitated.

We will require improved passage for eels where we have identified the need to improve upstream passage for eels, in support of our eel management plans.

On other rivers, a fish pass will be required where we consider that any reduction in fish passage would occur or where failure to improve fish passage would prevent delivery of WFD objectives.

We are working to identify existing barriers where fish passage must be improved to achieve the delivery of WFD objectives. Where there are multiple barriers to fish passage within a catchment, we will refer to this work to ensure that improvements to fish passage are consistent with the wider aims for the catchment.

Where a fish pass is required, or an existing pass requires modification, the design and associated flow requirements must be approved by the Environment Agency. Where a fish pass is provided, the licence holder will be required to maintain the pass.

Design considerations for fish passes in hydropower schemes

The following sections provide examples of the different types of arrangement of hydropower schemes and fish passes.

Low head scheme, on-weir

Where a fish pass is already present, or where a fish pass is provided by the scheme, the downstream fish pass entrance should be co-located with the discharge from the turbine(s). The turbine flow will help attract more fish to the vicinity of an adjacent fish pass entrance. Any competing flow, away from the fish pass, will reduce the effectiveness and efficiency of the pass and will not be acceptable.

Where the entrance and discharge are co-located, a suitable pass attraction flow is between 5 and 10 per cent of the maximum turbine flow, dependent on the effectiveness and efficiency of its design. This is subject to the minimum flow required for the pass to attract and convey the numbers and sizes of fish expected.

A fish pass can be made more effective by providing augmentation and/or auxiliary flows. An augmentation flow is one where flow is added directly to the fish pass, so that higher levels of flow leave the fish pass entrance and draw fish into the fish pass. An auxiliary flow is a separate flow which runs beside the pass. This increased flow will help to attract fish towards the entrance to the fish pass.

However, an auxiliary flow is a flow competing with the fish pass discharge and is less effective than an augmentation flow.

The flow through a fish pass is considered to be part of the residual flow.

Further details are available in the [Environment Agency Fish Pass Manual \(2010\)](#).

Low-head leat system

Where the hydropower scheme is to be located within a leat system a fish pass may need to be located next to the turbine within the leat system and/or on the weir within the main channel of the river, or both.

The preferred solution is to retain the fish in the main river channel and the appropriate location for the fish pass should therefore be in the main river channel. This can be achieved with effective flow and screening management. The final design will depend on the requirements of the species that should be present, the management of flow at the site and the relevant environmental legislation.

During periods of fish migration, the majority of the flow through the scheme should be in the route of the fish pass to attract the fish. Flow through the site must be managed to ensure effective and efficient fish passage.

High-head scheme

Where a fish pass is needed for a high-head scheme, it should be sited at the impounding structure. Sufficient flow should pass through the fish pass and the depleted reach for the effective and efficient passage of the relevant fish species.

No fish pass requirement – other future considerations

If a fish pass is not a requirement of a scheme, we may still require you to make allowance for the installation of a fish pass in the future. When this is necessary, you will need to make sure that suitable space for a fish pass is safeguarded and sufficient flow is reserved for its future operation.

Downstream fish passage

Salmon and sea trout migrate downstream after spawning to return to the marine environment. Some species of coarse fish, particularly rheophilic species, will also move back downstream after spawning. If such fish have to pass over weirs (or other impounding structures) at your proposed scheme, you will need to consider the minimum depth of water passing over the weir and the size of fish that are likely to be passing downstream.

Where the minimum depth of water passing over the weir is less than the depth at which fish can pass freely, your development must make provision for these fish to pass without delay or injury.

It is acceptable to create a notch, or notches, within the weir crest that will allow fish to pass safely and without delay. Notches will need to be located in appropriate locations and be of an acceptable size.

Where this is not possible, and all fish cannot be guided to pass via a bypass channel, you must increase the minimum height of the water passing over the weir to an acceptable level. Consider the timing of any downstream migrations and whether the flow then passing over the weir could be too low.

What do you need to do?

The requirement for a fish pass will depend upon the fish species that are present or that migrate through the site of the hydropower scheme. Where rivers have impacted or recovering fish populations you may also need to consider the species of fish that should be

present. This is particularly relevant when considering the objectives of the Water Framework Directive. You will need to know which fish species are relevant to that location – and their migratory needs. You may need to consult with local Environment Agency fisheries staff to establish what is needed. You should do this through your account manager.

Additional information and guidance on fish passage

The Environment Agency's Fish Pass Manual

The Environment Agency has produced [a Fish Pass Manual](http://publications.environment-agency.gov.uk/pdf/GEHO0910BTBP-E-E.pdf) as a guide for its own staff and developers. A copy can be obtained from your Account Manager or from this location (Link: <http://publications.environment-agency.gov.uk/pdf/GEHO0910BTBP-E-E.pdf>)

The manual contains background information on fish passes and the requirements of different species of fish, and gives examples of designs which may be suitable in different circumstances. There are also details of the approval process which we will use to formalise the approval for a specific site.

Best practice guide for eel and elver passage

A guide, [The Eel Manual: an overview](http://publications.environment-agency.gov.uk/PDF/GEHO0411BTQC-E-E.pdf), is also available which identifies solutions for improving passage of eels and elvers. (<http://publications.environment-agency.gov.uk/PDF/GEHO0411BTQC-E-E.pdf>)

We advise developers to consult us early in the development process about the need for a fish pass. If there is a need, we advise developers to submit and discuss their ideas at the concept stage. This avoids the risk of wasting time on detailed proposals which may prove unsatisfactory.

Annex 1 - Statutory requirements

A range of legislation is associated with the issue of fish passage. The legislation serves two purposes, both identifying those cases where improved fish passage is needed and providing the legislation to require its inclusion. The following section highlights the relevant legislation and explains how and when they would apply.

Salmon and Freshwater Fisheries Act 1975

The Salmon and Freshwater Fisheries Act 1975 states that, in waters frequented by salmon and sea trout, a pass can/will be required if:

- a new impoundment is constructed, or
- an impoundment is rebuilt or reinstated over more than half its length, or
- an existing impoundment is raised or otherwise altered, or any other obstruction to the passage of salmon or migratory trout is created, increased or caused.

Where an existing impounding structure is partially passable, removing flow from it to a hydropower scheme will in most circumstances reduce passage for fish. It may prevent passage altogether or, which is more likely, reduce the window of opportunity for fish to pass.

Eel (England and Wales) Regulations 2009

Under the Eel (England and Wales) Regulations 2009, the Environment Agency has powers to make provision for the passage of eels through dams and other obstructions. This is to enable the delivery of the Eel Management Plans required under the EU Eel Regulation.

Water Framework Directive 2000/60/EC (WFD)

Our permitting process for hydropower developments must ensure that no WFD objectives will be compromised and that the current status for each element of a water body (including environmental standards) are maintained. The Environment Agency has a legal duty under the Water Environment (Water Framework Directive) Regulations 2003 to exercise its functions, such as the licensing of hydropower schemes, so as to secure compliance with the requirements of the Water Framework Directive i.e. to ensure WFD objectives are met.

A fish pass will be required where failure to include one would result in:

1. a deterioration in the status of the water body in which the hydropower scheme is situated or associated upstream and downstream water bodies, or
2. preventing the achievement of Water Framework Directive objectives (e.g. Good Ecological Status or Good Ecological Potential)

A fish pass may also be required where a hydropower scheme is built on an existing barrier to fish migration that has been identified as a reason for a water body failing to achieve its WFD objectives. This includes situations where the introduction of the hydropower scheme does not make fish passage worse, but improved fish passage is still needed.

Water Resources Act 1991

A hydropower scheme may cause problems for fish passage so that it is harder for the species of fish present to complete their life cycles. Fish passage can be made worse either by an increase in the physical barrier or changes to the site that results in a delay or reduced cues to migration. This includes the potential effect of depleted reaches on fish migration such as where leat systems are used or in high-head applications. In these cases a fish pass may be required as a condition of an abstraction licence, impoundment licence, or a flood defence/land drainage consent granted under the Water Resources Act 1991.

Section 6(6) of the Environment Act 1995

The Environment Agency has a duty to maintain, improve and develop fisheries. Where the introduction of a hydropower scheme would impact on a fishery through changes to fish passage, a fish pass may be needed to ensure that duty is met.

Protected Areas

There may be other legal obligations where the sites or species affected have nature conservation designations, for example Special Areas of Conservation or Special Protection Areas under the Habitats Directive, Ramsar sites or Sites of Special Scientific Interest

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