

Restoring over-wide channels

Issues

Past drainage activity (*see Gravel Rehabilitation* section), and the activity of grazing animals (*see Management of Riparian and Instream vegetation* and *Protecting marginal habitat* sections) has resulted in the over-widening of many river channels. Low summer flows, often as a result of over-abstraction, can mimic the impact of over-widening.

As a result of these processes, instream habitat diversity is reduced, with the increase in cross-sectional area resulting

from over-widening reducing water velocity within the channel, and promoting the deposition of fine sediments. The erosion of friable banks following damage by stock can compound these impacts.

The resulting silt laden, often shallow channels provide ideal growing conditions for a range of emergent and submerged vegetation. By reducing water velocity locally, these plant species tend to accumulate more sediment around their base, further degrading habitat for spawning and juvenile salmonids.



AN OVER-WIDE SECTION OF CHALKSTREAM.....



.....WITH ASSOCIATED DEPOSITS OF FINE SILT.

Potential restoration options

All of the techniques described below rely on restoring the channel's cross-sectional area to an approximation of its 'natural width'. Changes in the abstraction regime, surface run-off patterns and climate variation mean that the selection of this cross-section can never be an exact science. The extent to which the channel should be narrowed can be decided by reference to hydraulic modelling based on detailed survey data (expensive), by reference to more 'natural' unaffected reaches of the river that occur locally (the most practical and preferred option) or by expert assessment from a river restoration specialist, and Environment Agency or Natural England staff.

In many cases, the width of the silt band preferentially deposited in the marginal zone of the river will provide a good indication of the desirable finished width of the channel. Whichever method is used, natural physical processes affecting the river will result in a degree of self-adjustment to the width of restored channels. The aim of restoration should be to use these natural processes to encourage the deposition of fine sediment ('silt') in marginal, low velocity areas, where it will consolidate, and help narrow the channel.

It is important that any narrowing undertaken has due regard to both the natural shape and form of chalkstream channels. Avoid uniformity, with respect to both the width and line of the narrowed river. Moderate sinuosity and a varied width along each section of river will not only make it visually more attractive but will also help in optimising its ecological value.

The selection of techniques to be adopted should be made with reference to the natural form of the river and the availability of suitable, locally occurring materials. Generally, this will mean making use of timber and brushwood derived from the coppicing, pollarding, singling or thinning of riparian and floodplain trees (see **Tree Management** section). The use of materials imported to site should be avoided where possible. If it is impossible not to use imported materials, consideration should be given to their geographic

origin, and any manufacturing processes that have been used to produce the product. There is a responsibility on all scheme designers to try and minimise the carbon footprint and ecological impact of any project undertaken.

The selection of suitable techniques should also have due regard to the energetics of the river. Chalkstreams are characterised by their remarkably stable flow regime and relatively low energy. As such, all of the techniques detailed below would be suitable for installation in a chalkstream. It is important to note that all of them rely heavily on the establishment of strongly rooted marginal vegetation to optimise their stability and resistance to erosion. Timing of the installation of narrowing is thus fundamental. Ideally, work should be done in spring/early summer in order to optimise the growth of plants prior to high winter flows. Generally installation in the autumn or winter should be avoided as it risks significant damage to the narrowing occurring before adequate development of plant growth.

Similar concerns dictate the need for minimal shading of areas of narrowing. Where shading is significant, it may be necessary to trim branches of ambient light. Narrowing channels under a shaded canopy is likely to fail.



SELECTIVE COPPICING TO REDUCE SHADE AND PROMOTE NARROWING OF THE CHANNEL.

Marginal narrowing



CREATING A NEW BANKLINE USING FAGGOTS AND UNTREATED STAKES.

Natural wood

The use of natural wood, derived from locally occurring trees, encompasses possibly the simplest and most ecologically acceptable techniques that can be used to narrow river channels. It is likely that chain saws will need to be used in the execution of some of the techniques below.

Chainsaws have the potential to be fatal if used incorrectly; it is imperative that only suitably qualified and experienced personnel should use them. In addition, the health and safety of all other individuals on the working site must be ensured.

Use of brushwood

Brushwood arising from the cutting of trees, is a fantastic material, when used as a revetment. Its fine, 'feathery' nature reduces water velocity, promoting the deposition of fine sediment. Perhaps the best known method of using brushwood is as faggots. These are bundles of brushwood, bound together using string (ideally biodegradable sisal), to form faggots of around 2m in length and 0.3m in width. The faggots can then be installed along the agreed line for narrowing and held in place using untreated stakes (diameter 75mm-100mm) driven firmly at 0.6m centres into the riverbed. Some practitioners weave the faggots through the stakes, creating a robust and very attractive finish to the revetment. A simpler and equally robust approach is to force the faggots



over the stakes, wiring them down once in position. It is important that the faggots are packed tightly down and are overlapped in the horizontal plane, in order to reduce the risk of erosion. A similar concern dictates that the upstream and downstream ends of the faggot bundles are adequately 'keyed' into the original bankline.

The area between the line of faggots and the original bank should be filled with excess brushwood, tightly tied or wired down to a matrix of stakes driven vertically. The brushwood backfill can then be 'seeded' with emergent vegetation such as sedge *Carex spp.*, reed canary grass *Phalaris arundinacea*, reed sweet grass *Glyceria maxima* and yellow flag *Iris pseudacorus*. These and other naturally recruiting plants will grow into the faggot mass, helping to increase its stability. Whilst this is a good and cheap technique that can produce excellent establishment of marginal zones, it may not be suitable in areas where there are aesthetic considerations or concerns regarding wash out of accumulating sediment. In these situations, it may be necessary to use locally derived backfill to create a finished marginal shelf area as part of the enhancement scheme. Reprofilng of the banks (or 'cut and fill') can be used to both provide the necessary infill, and extend the width of the shallow waters edge shelf, suitable for the growth of marginal plants. The extensive use of chalk backfill can restrict access to burrowing water vole. This concern should therefore be a significant consideration in locations known to harbour this increasingly rare species.

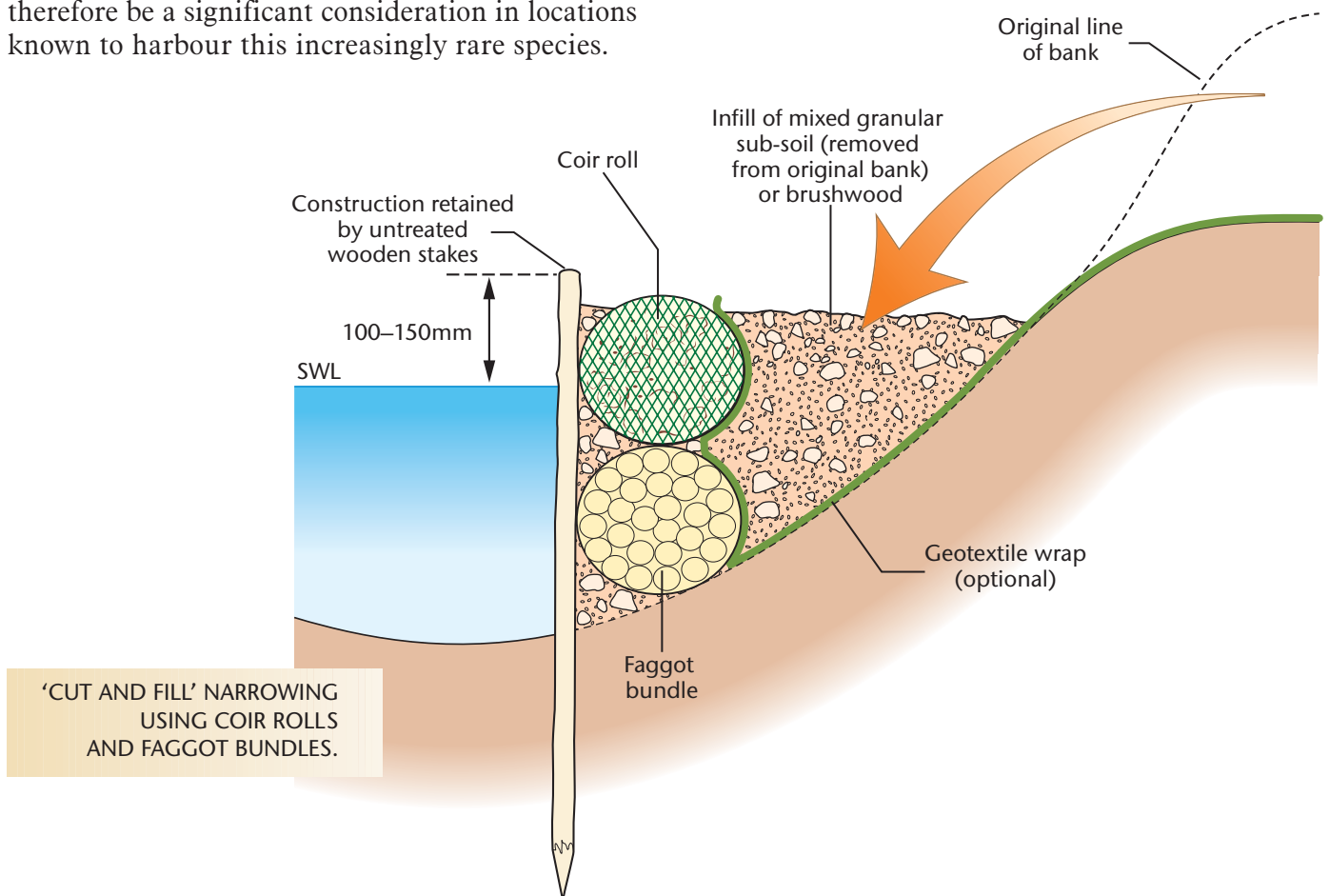
Use of heather bales and straw bales

Bales constructed from heather and straw (particularly linseed and rape straw) are of potentially great value for channel narrowing. They are relatively cheap, and are easy to transport and handle. They can be used in similar way to faggots, being held in place within a channel using wooden stakes. The loose weave of the bales provides a superb habitat for a range of macroinvertebrates that are also able to use the bales as a food source.

Use of timber

(see **Use of Large Woody Debris** section)

Larger timber can be utilised for channel narrowing in a number of ways. Perhaps the simplest and most effective utilises some of the skills involved in hedge-laying. Where trees that respond well to coppicing (species such as ash *Fraxinus excelsior*, willow *Salix Spp*, alder *Alnus glutinosa*, field maple *Acer campestre* and hazel *Corylus avellana*) grow adjacent to the river, it is





CUT AND HINGED TIMBER. NOTE CHANGE IN FLOW PATTERN DOWNSTREAM INDICATING SCOUR OF THE BED.

possible to partially cut through their trunks, and 'hinge' the partially severed trunks into the channel, where they can be laid roughly parallel to the flow. The trunks are then secured in position using wooden stakes firmly driven into the bed. By repeating this process for a number of trees, a robust revetment can be formed, with the finer branches of the trees reducing flow velocity and encouraging deposition of silt in the same way as faggot bundles. The matrix of timber will also provide excellent habitat for juvenile fish and many invertebrate species, whilst the reduction in shading resulting from felling of the trees will promote the growth of emergent vegetation in the accreting margins.

Where suitable trees are not available adjacent to the channel, trees can be cut from nearby locations, and placed into the channel. The trees should be firmly fixed in place using a combination of stakes and, where necessary, high tensile steel wire. The butt of each section of timber should be tied back to a firm anchor point on the bank to prevent wash-out in extreme flood events.

By selective hinging/felling and placement of trees, long sections of river can be narrowed relatively quickly and cheaply.

Narrowing using coir fibre

There are a range of modern manufactured 'bioengineering' materials utilising coir fibre (derived from coconut husks). Of most interest are the so-called coir rolls (or logs). These comprise a densely packed 300mm diameter roll of coir, constrained within an 'envelope' of coarse polypropylene or jute mesh. The rolls are supplied in varying lengths, most commonly between 2m–3m. They can be purchased 'bare' or pre-planted with a range of well-established marginal plants at a density of at least 6 per linear metre.



NEWLY-NARROWED CHANNEL USING PREPLANTED COIR FIBRE ROLLS .



Coir rolls can be used as direct replacements for faggots. They are structurally strong, with the vegetation contained in pre-planted rolls rapidly growing into the backfill and sub-soil, dramatically increasing the erosion strength and stability of the revetment, whilst increasing its ecological value. This allows for direct backfilling to take place in areas where aesthetic considerations dictate. Degradation of the coir takes place over a number of years. In a well-designed scheme, the area of narrowing behind the coir will have stabilised sufficiently to function in its absence.



HYBRID GEOTEXTILE USED IN CONJUNCTION WITH WOODEN STAKES.

Non-biodegradable and 'hybrid' geotextiles

Whilst it is generally desirable to use biodegradable geo-textiles in most situations, this may not always be possible. For instance, in locations

with very high water velocities (e.g. below hatch pools), with very steep vertical banks or where burrowing Signal crayfish *Pacifasticus leniusculus* threaten the physical integrity of banks, it may be necessary to employ more robust geotextiles

with increased longevity. In recent years, considerable use has been made of so-called 'hybrid' geotextiles. These comprise a hardwearing plastic geotextile, usually installed behind a covering of biodegradable coir or jute. This mix of materials can provide excellent structural strength, coupled with a good medium for the establishment of plants.

The use of non-biodegradable and hybrid geotextiles should not be contemplated without advice from river restoration professionals.

Narrowing using causeways

The use of causeways to narrow channels is a well-established technique. It is of particular value where there are large water vole *Arvicola terrestris* colonies that could be threatened by traditional narrowing techniques, or where there is a requirement to undertake a dramatic narrowing of a channel that would require inordinate amounts of backfill material.

Two parallel lines of preplanted coir fibre rolls or faggots retained by untreated wooden stakes driven into the river bed, are used to establish the outline of the causeway. The centre of the causeway structure can then either be 'hard' filled, using locally excavated sub-soil retained behind a vertical coir/jute geotextile, or 'soft' filled, with densely packed brushwood firmly tied into place. Hard filling is more suited to areas exposed to faster water flow and hence erosion, or where the causeway is to be used to provide access to anglers fishing the water. Where hard

filling is the preferred option, material can often be excavated from adjacent flood meadow areas, creating new areas of high quality habitat.

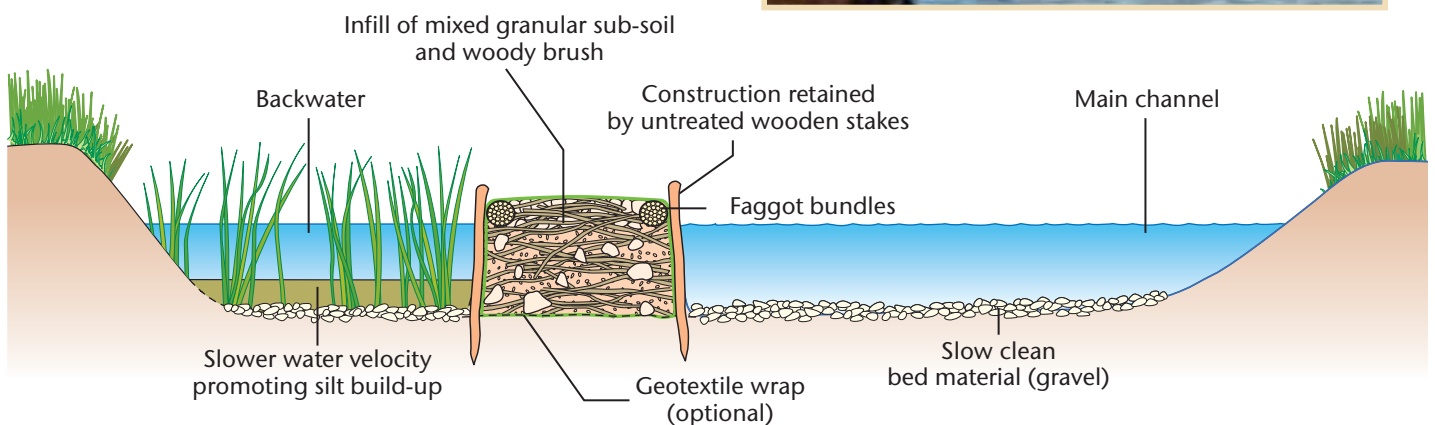
The upstream and downstream limits of the structure must be firmly keyed into the existing bankline. Water will be able to flow over the causeway and into the area behind over a range of discharges. By careful setting of the upstream and downstream bed levels during construction, limits can be set to these flows, creating potential low flow refuge areas for fish fry, amphibians and invertebrates.

The finished height of the causeway relative to summer water level is critical; too high and colonisation with emergent vegetation will be restricted, too low and the causeway will be permanently submerged. Ideally, the margins of the causeway should be set between 100mm-200mm above summer water level.

If access is required onto the finished causeway for angling or other purposes, particular attention should be paid to Health and Safety considerations.



X-SECTION OF A TYPICAL CAUSEWAY SHOWING CONSTRUCTION.



Narrowing using mid-channel islands

An alternative strategy for channel narrowing is the generally underused option of the construction of small, mid-stream islands. Where islands have been created in order to narrow rivers, benefits include refuge areas for animals and plants. Remote from human disturbance and grazing, they may support different plant communities compared to more accessible banks.

Islands can be created from a range of materials, including faggot bundles, coir fibre rolls and locally derived granular material. Construction techniques are similar to those already described above.

Permanent, vegetated mid-channel islands are valuable habitats for otters (*Lutra lutra*), and water voles, providing secure sites for lying-up and breeding. This habitat is also of benefit to breeding ground nesting birds, such as mallard (*Anas platyrhynchos*), tufted duck (*Aythya fuligula*) and mute swan (*Cygnus olor*), whilst also providing additional shallow water edges for feeding birds.



MID-CHANNEL ISLANDS CONSTRUCTED ON THE RIVER GLAVEN.

Narrowing using redistribution of instream gravel

This is a novel technique that has recently been used with great success on the River Darent in Kent. In essence, it involves the redistribution of uniform bed gravels in order to create a sinuous, more clearly defined and deeper channel.

By the careful use of hydraulic excavators, the gravel is manipulated locally to form elevated edge 'bunds'. Over time, these gradually recolonise with emergent vegetation, binding the new bank together.



GRAVEL REDISTRIBUTED WITHIN CHANNEL...



...AND RESULTING CHANNEL.

Narrowing using groynes

The careful placement of upstream facing groynes constructed of timber, faggot bundles, stone and coir, can encourage deposition of fine sediment in marginal zones, encouraging channel narrowing.

The use of groynes is discussed more fully in the **Use of Large Wood Debris** and **Instream Structures** sections.

Summary

Technique	Advantages	Disadvantages
Faggot narrowing	Cheap if on-site materials are used. 'Natural' approach producing high ecological benefit. Additional benefit accrued from coppicing/pollarding in order to obtain materials	Faggot manufacture can be labour intensive. Large amount of material required per linear metre of channel narrowed. Material only be seasonally available.
Large timber narrowing	Cheap if on-site materials are used. 'Natural' approach producing high ecological benefit. Additional benefit accrued from coppicing/pollarding in order to obtain materials. Long lengths of bank can be enhanced with limited material.	Likely requirement for qualified chain saw operators.
Coir fibre narrowing	Quick and easy to install by semi-skilled work force. Good structural strength. Rapid establishment and high ecological value	Relatively high cost. Large carbon footprint of material.
Narrowing using causeways	Reduces impact on bankside habitat, particularly water voles. Provides additional habitat type, particularly if shallow water are created behind causeway. Excellent, relatively cheap technique if very significant narrowing is required.	Construction can be challenging in deeper water. Potential Health and Safety implications if access is required onto causeway for angling
Narrowing using mid-channel islands	No impact on bankside habitat. Provides an additional habitat type.	Construction can be challenging if water levels are high or depths excessive. Relatively expensive per linear metre constructed.
Redistribution of bed gravels	Relatively cheap and quick technique. Requires no imported materials. Very little impact on surrounding bank areas if work can be undertaken instream.	Can cause significant short term impact on instream macrophytes and macroinvertebrates

Working Examples

River Avon at Woodford

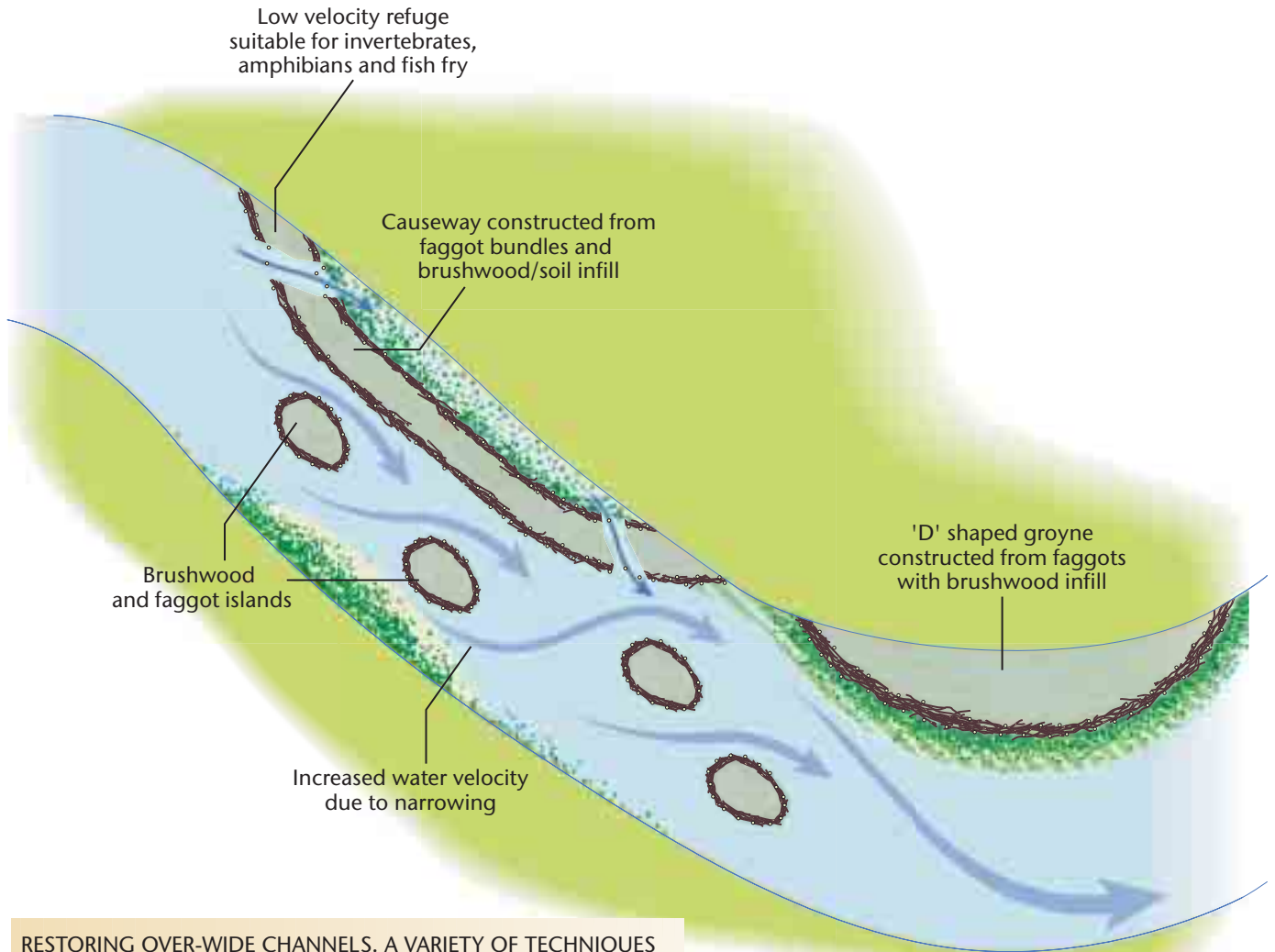
This was one of the demonstration sites for the EU funded STREAM (Strategic Restoration And Management) project. A range of techniques was used to narrow the channel. These included the installation of a 100m long faggot causeway, infilled with chalk and brushwood to allow angler access. The causeway had lowered inverts at its upstream and downstream limits in order to create a low velocity backwater, whilst permitting flow to pass during high discharge events.

Existing mid-channel islands were reinstated, with a range of new islands constructed. Finally, marginal narrowing was created using a series of large 'D' shaped structures.

More detail of these works can be found at <http://www.streamlife.org.uk/>



VARIOUS METHODS OF CHANNEL NARROWING USED ON THE RIVER AVON AT WOODFORD.



RESTORING OVER-WIDE CHANNELS. A VARIETY OF TECHNIQUES INCLUDING CAUSEWAY CONSTRUCTION, FAGGOT ISLANDS AND 'D' SHAPED GROYNES HAVE BEEN USED TO NARROW THE CHANNEL AND INCREASE WATER VELOCITY.