

## Modifying River Bed Levels, Water Levels and Flows

### 5.9 Replacing an armoured bed with boulder step-pools

#### INCHEWAN BURN

LOCATION – BIRNAM, NEAR PERTH, SCOTLAND NO017405

DATE OF CONSTRUCTION – SEPTEMBER – NOVEMBER 2007

LENGTH – 100m

COST – £100,000

#### Description

The Inchewan Burn is a tributary of the River Tay SAC and flows through the village of Birnam. The upstream section retains much of its natural character, though in a heavily forested valley. The catchment is steep and flashy which has caused flooding in Birnam in the past.

In the 1970s the village was bypassed by the A9 trunk road, which runs alongside the main Edinburgh to Inverness railway. At this location a 100m reach of the burn was realigned and channelled between the supports for the road bridge. The channel was stabilised using concrete, gabion baskets and a stepped Reno Mattress base. These wire structures had begun to break down and became a barrier to Atlantic salmon (*Salmo salar*), a feature of the Tay SAC. In low flow conditions this reach had no surface water flow, with all water flowing through, rather than over, the loose stone and wire. This heavily degraded reach was restricting access to 3km of good spawning habitat upstream, though a steep natural chute restricts upstream fish movement until high flows.

Close up of the degraded Reno Mattress base – 2007



© A. Pepper

Although the bed could be replaced, work on the banks was still heavily constrained as they provide structural foundations for the A9 (the concrete right bank) and support to the re-graded steep left bank (a three tier gabion wall).

The aim of the scheme was to recreate a boulder step-pool bed to mimic the natural upstream character of the burn, and so improve fish passage for salmon.

<b>Inchewan Burn</b>	High energy, gravel
<b>WFD Mitigation measure</b>	
<b>Waterbody ID</b>	150290
<b>Designation</b>	None
<b>Project specific monitoring</b>	Hydraulic habitat, fish



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Before restoration works showing complete failure of the wire structure and no surface flow – August 2006

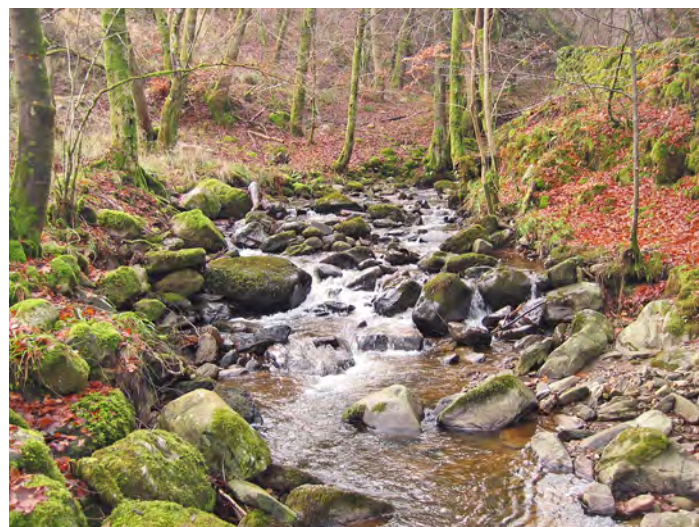
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### Design

The method statement for the works was a simple concept based on utilising the gradient of the degraded reach (1 in 14) to form a series of step-pools, replicating as closely as possible the upstream bed form (*Figure 5.9.1*).

A schematic of the reach illustrating the repeat step and pool features (all varying in boulder arrangement) helped to guide the contractor. Further guidance was provided using the upstream reference site to aid discussions with the RRC and the supervising local ghillie.

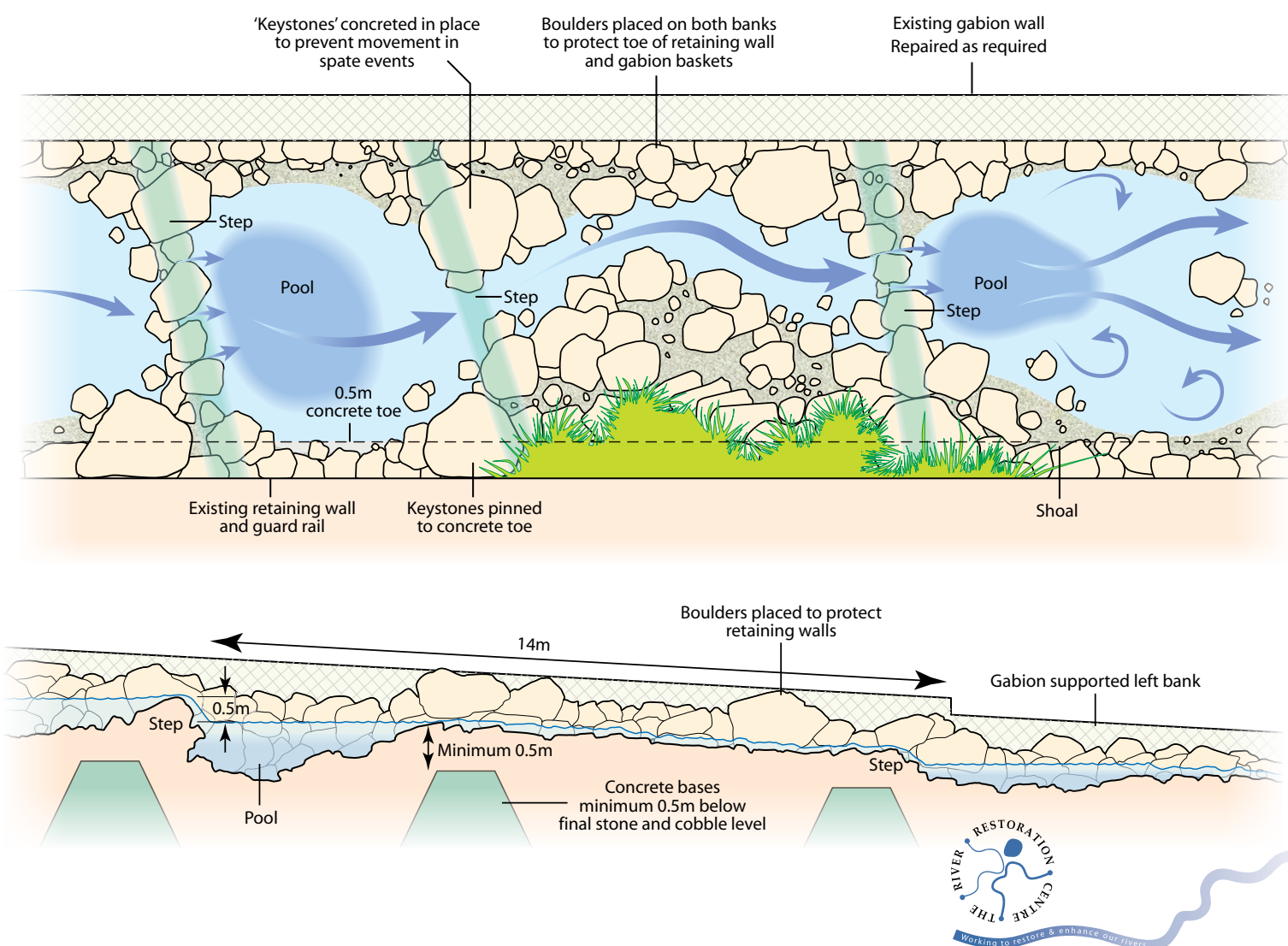


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The natural channel, a few hundred metres upstream, showing the variable step-pool configuration formed by large boulders – November 2005

**Figure 5.9.1**

SCHEMATIC OF STEP-POOL SEQUENCES  
AND LONG PROFILE





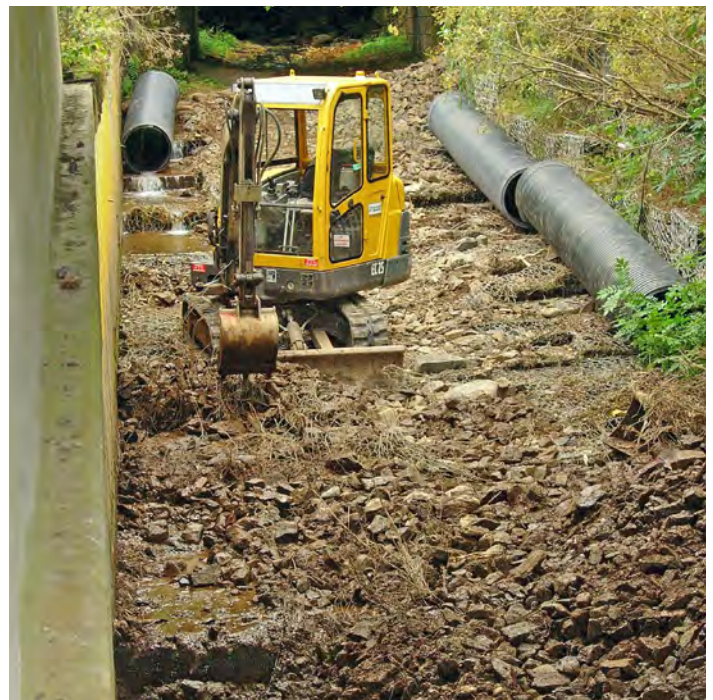
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This meant that the contractor only had minimal fixed dimensions (the number of steps, step drop and distance between steps) to guide the placement of boulders, and the instruction to make it resemble the upstream template reach as far as possible.

First, the wire from the disintegrating mattresses was removed. The cobbles that had been transported downstream were retained for reuse. The work was carried out during a dry period, with all of the low flow in the burn routed through a 0.5m diameter pipe.

The large boulders required for the bed were sourced from local field stone piles. These were lowered in to the burn and placed using a system of levers and pulleys. The largest (0.5 tonne) were used as 'keystones', mimicking the upstream channel where the largest boulders were integral to the step features, retaining the smaller interlocked boulders (the 'step') behind them.

The high gradient meant that there was a need to ensure that the keystones did not move. For this reason, a buried concrete base and steel pins were used to fix the most critical bed elements. Where concrete was to be used to bed-in the steps, it was specified to be buried at least 0.5m below the stone and cobble base to ensure that it remained unseen (*Figure 5.9.1*).



© SEPA

Wire from mattresses in bed removed. The stone was retained to use in the new step-pool system – 2007



© SEPA

Excavating for the concrete base to bed the larger boulders – October 2007



© SEPA

Steel pins in the concrete retaining wall toe awaiting boulder placement – 2007

The vertical concrete right bank (i.e. the road bridge footing) was constructed with a 0.5m wide toe which had previously been hidden beneath the wire mesh bed. This stepped ledge needed to be hidden by the new works (for aesthetic reasons and to prevent undercutting) and therefore provided a secure foundation for locating a number of the keystones. The boulders and concrete ledge were both drilled and the boulders then fixed in place with resin and steel pins.



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Immediately after  
completion  
– December 2007

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Boulders were also placed along the gabion basket left bank retaining wall, partly to hide the gabions but also to protect them from the abrasive throughput of bed material which had destroyed the Reno Mattress base.

The restoration works were coordinated and supervised by the local ghillie, and funded by Transport Scotland, with input from RRC, SNH, SEPA, Scottish Native Woods and Perth & Kinross Council.

### Subsequent performance

In December 2007, the local ghillie observed salmon, sea trout and brown trout (*Salmo trutta*) swimming through the reconstructed section of the burn and upstream once more. The work has made a dramatic improvement to the aesthetics of the reach, which is appreciated by regular users of a footpath close to the river bank.

Monitoring by the University of Stirling in 2009 compared the hydraulic habitat and fish density in the unmodified upstream reach with that of the restored reach. This showed that hydraulic habitat had been successfully restored and that juvenile salmon and brown trout were colonising this reach. However, passage upstream was being impaired by the shallow masonry culvert bed beneath the railway.

The success of the scheme was in part a result of basing its design on the upstream reference reach. This provided a visual template for restoration which could be easily understood as a 'shared vision' by the design engineers, stakeholders and contractor.



Beneath the A9,  
five years after  
– May 2012

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The restored reach mimicking the step pool configuration  
of the upstream reach– May 2011

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Reference material – Click [here](#)

