5 Modifying River Bed Levels, Water Levels and Flows

5.10 Creating 'natural' features in a heavily engineered flood scheme

River Valency
Location - Boscastle, Cornwall SX10009123
Date of construction - 2007/8
Length – 300m
Cost – not known (part of a £6.3m flood risk management scheme)

River Valency	High energy, gravel
WFD Mitigation measure	Click Here to view details
Waterbody ID	GB108049007170
Designation	None
Project specific monitoring	Fish

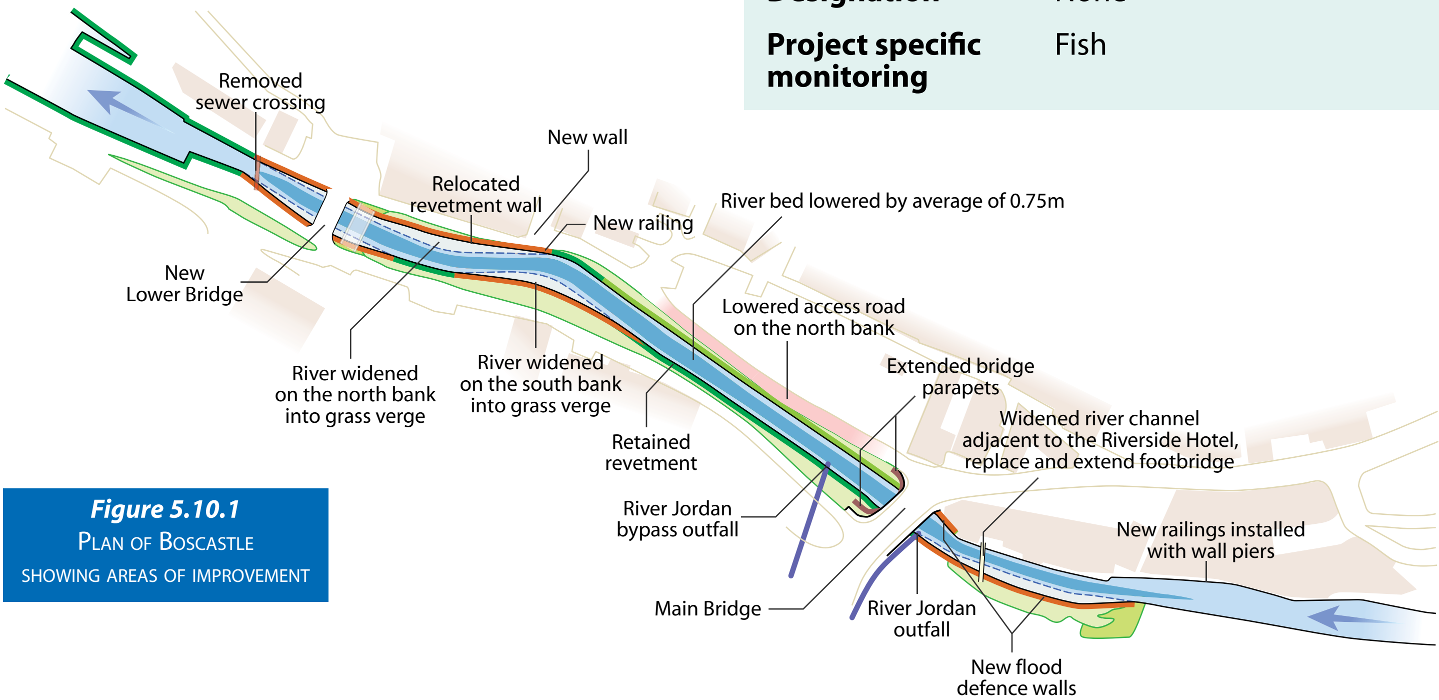

Figure 5.10.1
Plan of Boscastle
showing areas of improvement

Description

Boscastle village is located in a steep sided and narrow valley through which the River Valency flows down to the harbour. In 2004 an intense storm centred over the small wooded catchment caused massive erosion of sediment and river-side trees. This, combined with high flows, inundated the village with water and debris causing extensive damage.

The village is of great historic value and is a main attraction for visitors to North Cornwall. The river itself is the centrepiece of the village. The process of Enviromental Impact Assessment (EIA) and landscape appraisal led to the best engineering design that would deliver the multiple flood risk, landscape and environmental objectives.

Enlargement of the river channel offered the only viable way to reduce flood risk and improve the flood capacity and sediment conveyance of the river. The scheme aimed to demonstrate 'best practice' in achieving this sympathetically, so avoiding a deep geometrically uniform channel. The channel was designed in such a way that it simulated the natural features found higher up in the undisturbed reaches of the river by engineering features into the excavated bedrock.

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Natural cascade and pool upstream of Boscastle – 2006

These techniques were developed to suit site specific criteria and may not apply to other locations

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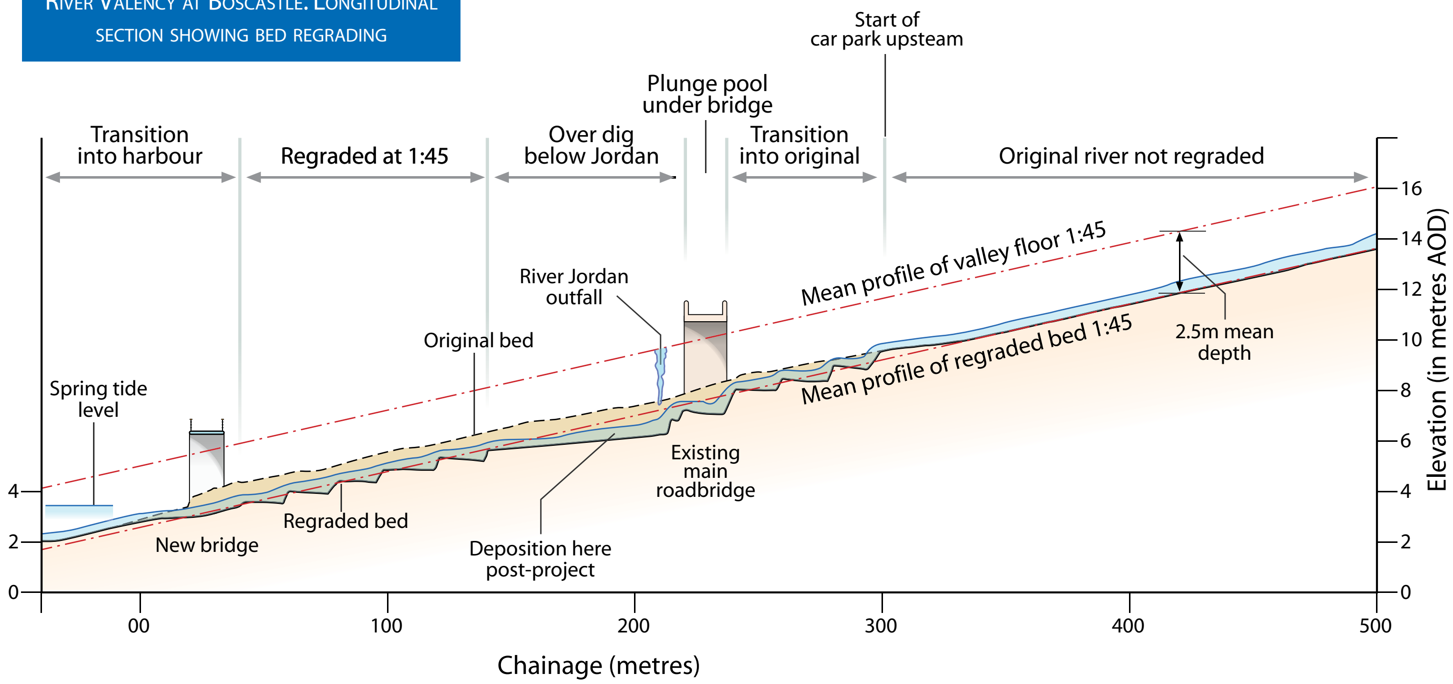
Figure 5.10.2
River Valency at Boscastle. Longitudinal section showing bed regrading



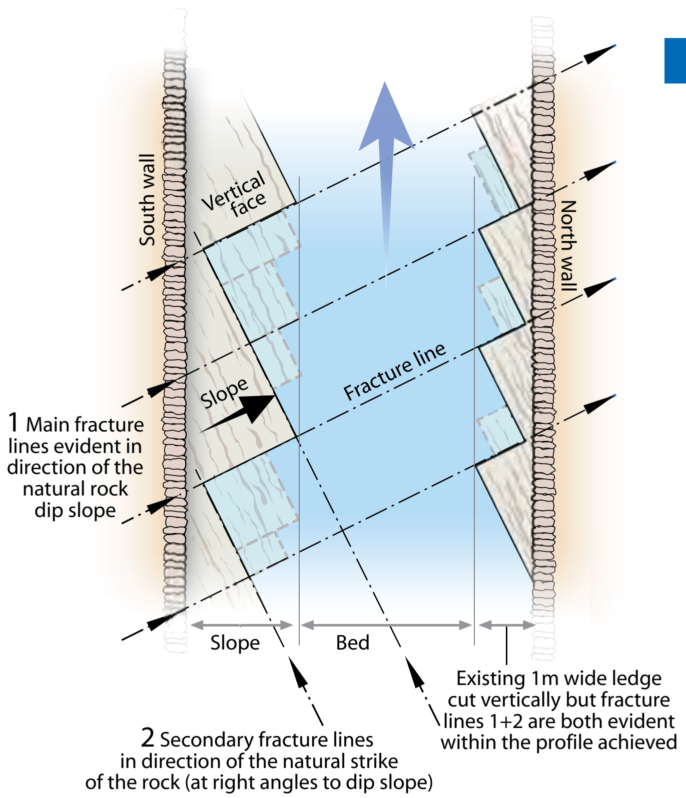


Figure 5.10.3
Simplified plan of the river channel showing the effect of natural fracture lines within the rock break

Design

A detailed topographical survey of the longitudinal profile of the river was an important design tool. This enabled a new, lower bed gradient to be superimposed onto the original one, giving the 'best fit' with the levels upstream and downstream of the reach.

The natural valley slope at Boscastle is 1 in 45 and the channel bed upstream of the village has a depth of approximately 2.5m. Extending this channel depth down through the village to the harbour, the longitudinal section showed the original bed to be typically 1 metre higher. This helped to explain the loss of capacity through the village and its propensity to flood. Bed regrading to this 2.5m depth profile was therefore considered feasible (*Figure 5.10.2*).

The design of the cross section and longitudinal profile of the lowered bed involved close study of the natural characteristics of the rock visible in the upper river and in the harbour. The rock featured strong bedding planes that typically dip from left to right bank, angled downstream at about 45°. It had vertical fracture lines as well as regular intrusions of much harder quartz. Concept drawings were provided to show how the rock was to be removed. An engineer worked closely with machine operators to obtain the desired result of the left side sloping with the dip and the right side vertical along the fractures. Both sides were zig-zagged to stay within the 'character' stone retaining walls.

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The low flow course had to be entirely excavated to best mimic millennia of erosion of a hard rock bed.

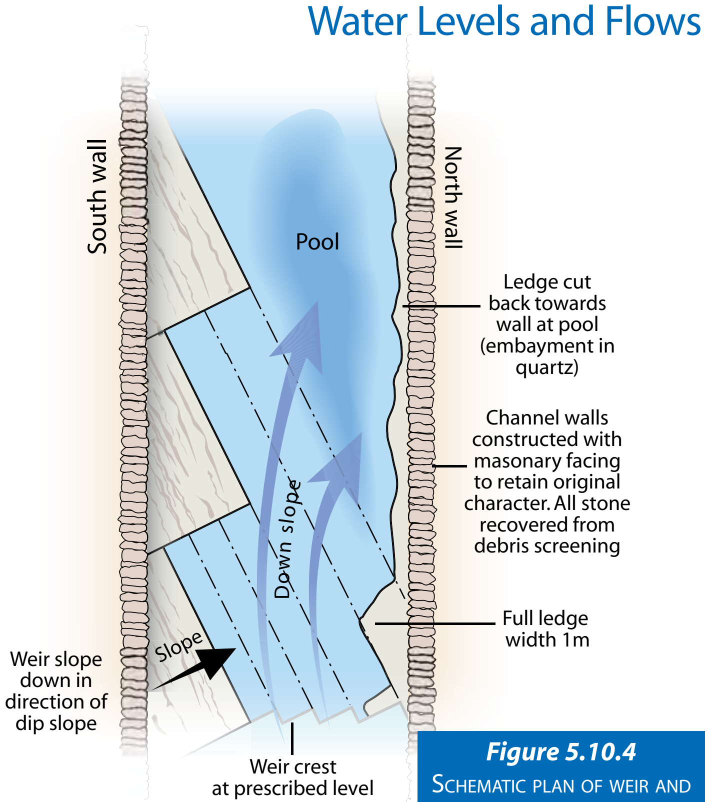

Figure 5.10.4
SCHEMATIC PLAN OF WEIR AND POOL IN QUARTZ STRATA

Understanding the geology and morphology of the river was critical to the design. This avoided the potential problems that can arise if the rock is broken out in a way that does not mimic the natural structure. For example simply cutting to a uniform profile could trigger subsequent collapse as the river erodes the rock back to a naturally stable profile.

Cascades with pools below were formed along the bed with nominally 0.2m drops at 9m intervals to approximate the 1 in 45 gradient. Excavation was only undertaken under the supervision of an experienced river engineer, enabling every aspect of the final topography to reflect the specific nature of the rock in situ as it was worked. The alternative of trying to detail the bed profile for the contractor would have been impractical.

Deepened channel using natural fracture lines within the bedrock. Retaining walls becoming vegetated

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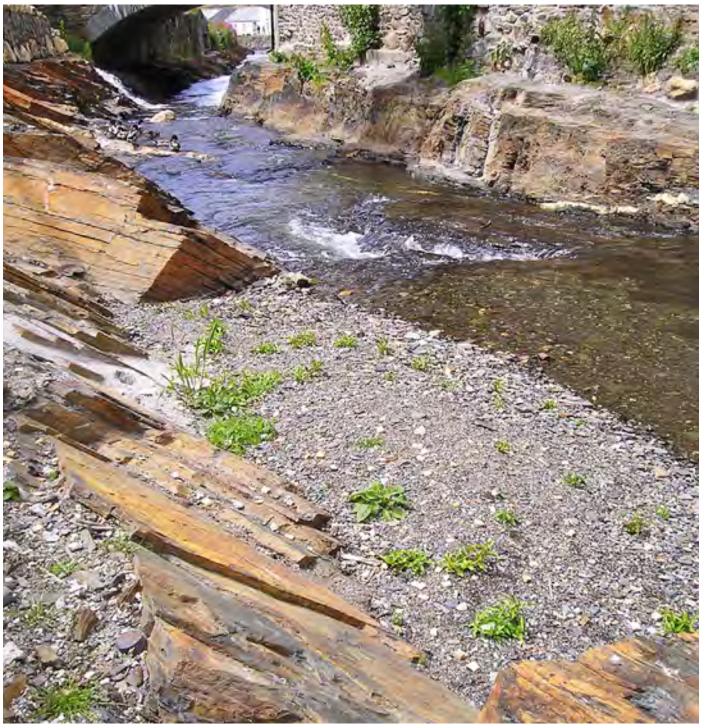
These techniques were developed to suit site specific criteria and may not apply to other locations

Subsequent performance

The re-profiled river has performed well during the years since completion. The excavated profile has remained stable, as have the individually sculpted cascades, pools and embayments. Within the latter a good diversity of flow characteristics provides niche habitats, with some gravel in sheltered eddies as well as small beaches. It is also visually attractive, enhanced by the sound of the cascading water. This contrasts markedly with the flat, featureless river bed that existed before.



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Gravel beaches have formed within the bedrock channel

A single negative aspect has been the excessive deposition of stony sediment at one location. This is where the bed was significantly cut down below the optimum mean bed gradient of 1 in 45, to provide greater flow capacity where an overspill culvert of a tributary stream, the River Jordan, enters (*See Figure 5.10.2*). Bed material has simply filled this over-deepened pool to bring the bed back up to the 1 in 45 mean. Consequently there are no rock features in the bed here. This outcome was foreseen and this 'pool' had been designed such that the excess fine deposits would remobilise during flood flows, thus

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River Jordan outfall. The over-deepened pool has clearly filled with large stone sediment – October 2008

restoring channel capacity when required. As an additional part of the scheme, large sediment is now intercepted upstream of the village, but an intermediate reach has scoured clean and it is this larger material that has filled the pool. This is planned to be removed to see whether or not subsequent, finer sediment will remobilise as intended.

The project demonstrated that visual references for the contractor were essential, in the form of site visits and first hand explanations. This helped the design consultants and contractor to understand the complexity of the project's requirements.

Observations suggest that the key objectives of lowering the bed to provide greater flood capacity whilst creating a functioning and visually attractive landscape have been achieved. Electrofishing surveys carried out two years after completion found Atlantic salmon (*Salmo salar*) and other migratory fish such as eel (*Anguilla anguilla*) had navigated to the upper catchment.

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Reference material – Click here