

The Challenges and Practicalities of Reinstating Hydromorphological Processes in a Heavily Modified Water Body

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Yorkshire Water, in collaboration with Arup, are investigating compliance of its reservoir assets with the Good Ecological Potential (GEP) objectives of Heavily Modified Water Bodies (HMWBs) under the European Water Framework Directive (WFD).

Arup together with specialist supply chain is supporting Yorkshire Water (YWS) on a number of pilot projects to establish technical feasibility, effectiveness and cost-benefit of a range of solutions to mitigate hydromorphological, biological and water quality impacts of impoundment assets; setting out a framework for their trial, assessment and optimisation.

These pilot projects include the investigation of the use of river restoration to mitigate impoundment impacts based on geomorphological principles. In this context, Arup has developed an innovative approach for one of these schemes downstream of Swinsty Reservoir (Northern England) by developing designs on the ground making use of existing features and resources to be incorporated into the scheme.

Project Overview

The scheme aims to address Mitigation Measure (MM) 6 of the impoundments for water storage and supply under WFD:
- Re-engineering of the river where the flow regime cannot be modified.

The purpose is to investigate a range of innovative solutions to mitigate the impacts of impoundments where increasing water discharge is not a feasible option, and to create a framework that can be used as a reference for future work.

The project will assess the success of this team with reference to addressing WFD objectives and the cost-benefit in comparison to traditional water resources solutions.

The specific objectives of the scheme are:

- To adapt the channel morphology to existing flow conditions
- To re-naturalise the river using existing materials and resources.

Baseline ecological monitoring has been undertaken at the site for two years and will continue post-construction in order to quantify the benefits of the scheme. The learning from this scheme will feed into future scheme design and inform YWS investment decisions.

Site Description

The site is located on the River Washburn, downstream of Swinsty Reservoir. The River Washburn is heavily regulated over 19 km by a series of four water storage reservoirs (Thruscross, Fewston, Swinsty and Lindley Wood), capturing over 70% of the flows coming into the catchment. The pilot scheme is located in an inter-reservoir site, with Lindley Wood Reservoir 3.5 km downstream. Currently there are no other trials or significant asset maintenance works being undertaken. This provides an appropriate controlled setting where a range of measures can be tested. Swinsty Reservoir, built over 130 years ago, has no compensation flow and has an overwide channel which is an artefact of the original flow regime before it was regulated.

WFD status

Water Body: Washburn – Spinksburn Bk (Swinsty Res) to River Wharfe

Classified as Heavily Modified

Overall Ecological Potential: Moderate

Fish Status: Moderate

Invertebrate Status: High

Mitigation Measure Assessment: Moderate

Baseline Condition

The channel is overwide, with limited habitat potential and poorly defined geomorphological features. Over more than a century of reservoir existence small-medium size gravel has been entrained downstream with no new sediment supply.

No formal compensation flow means sub-optimal flows are an issue

Overwide channel, abundance of large cobbles, boulders and fine sediments



Trees - overshadowing

Series of isolated pools, especially in summer

No formal low flow channel

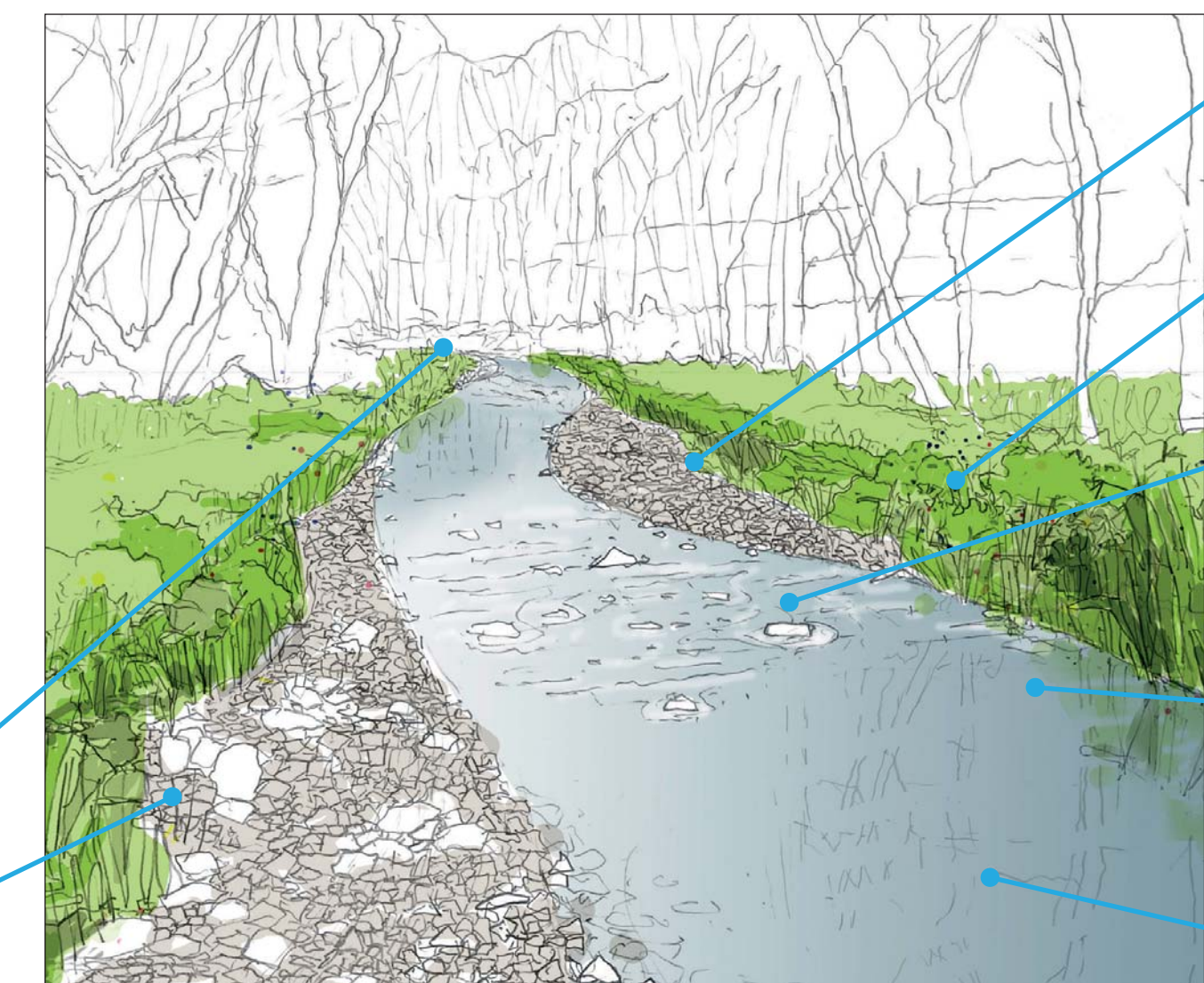
Fine and medium sized gravel stripped from the bed during scour tests and spills (winter only)

Concept Design

By reducing channel dimensions and narrowing the low flow channel, a more defined channel can be created, resulting in deeper, faster flowing sections of river that function appropriately for the modified flow regime and will create the desired habitats.

This image has been used to convey ideas and general principles to a range of stakeholders and landowners.

Trees thinned out, opening channel to light in places
Improved marginal habitats



Bars emphasised to narrow channel

Stabilised banks

Restored riffles to provide spawning habitats

Narrower channel with faster, deeper and more diverse flow

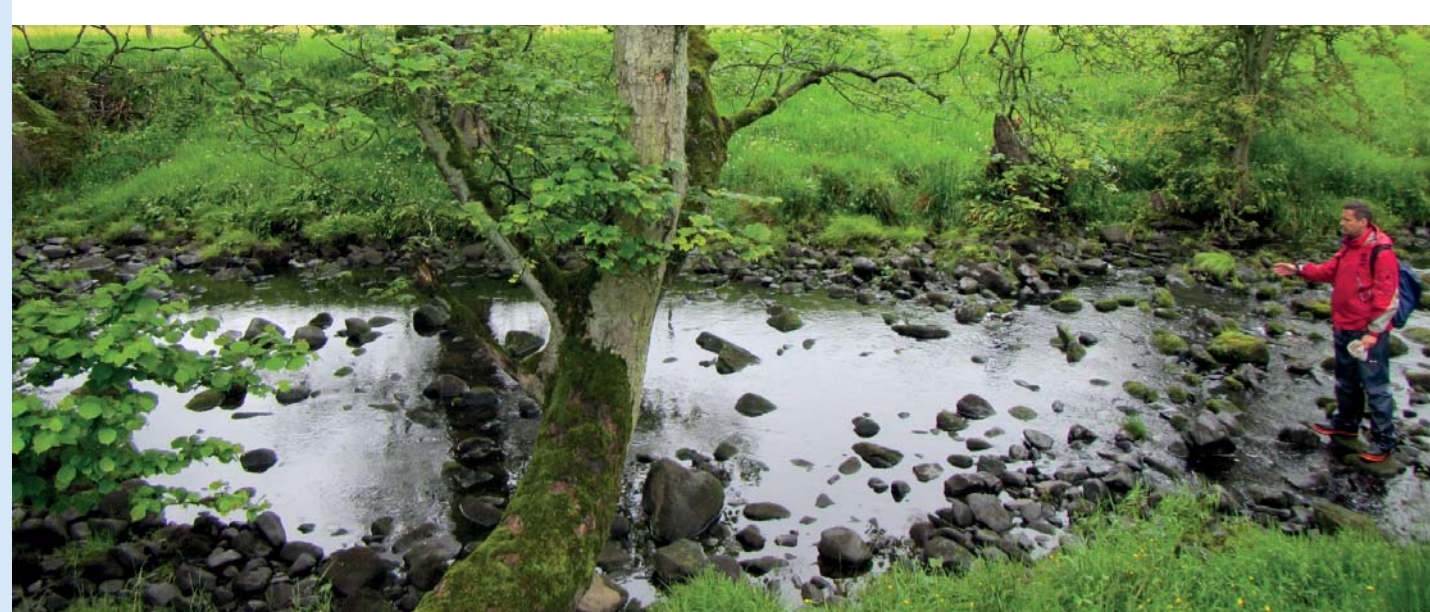
Deep pools with diverse habitats

Detailed Surveys



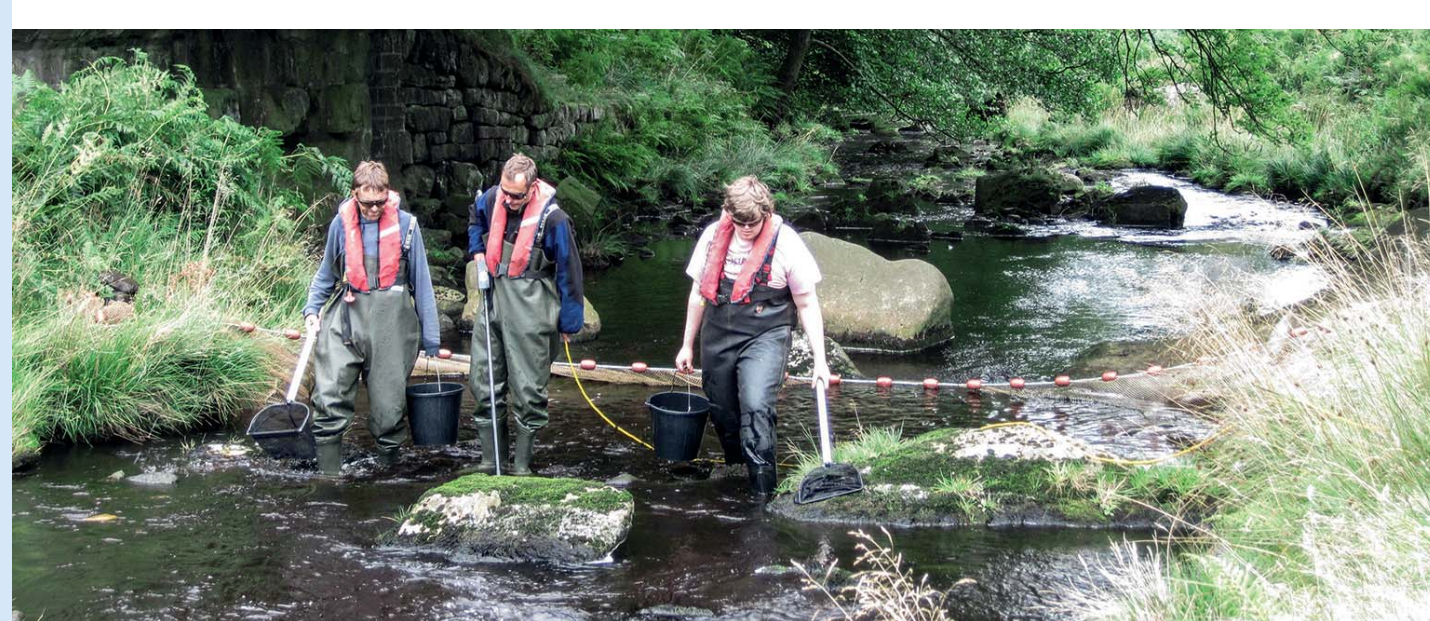
Topographical and LiDAR surveys

To capture a baseline of the current morphology.



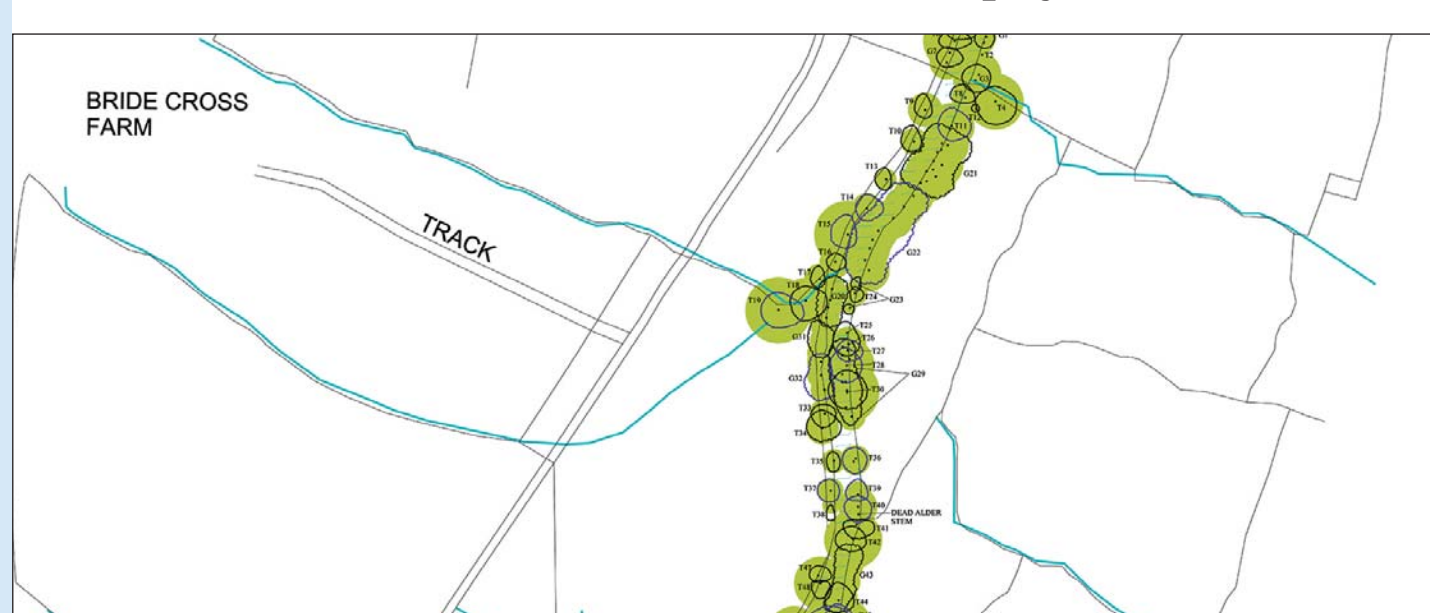
Geomorphological survey

To identify partial features that needed restoring to fully functioning features.



Ecological surveys

To monitor fish invertebrates and macrophytes.



Tree survey

To map trees along river and identify bat roost potential.

Design Development

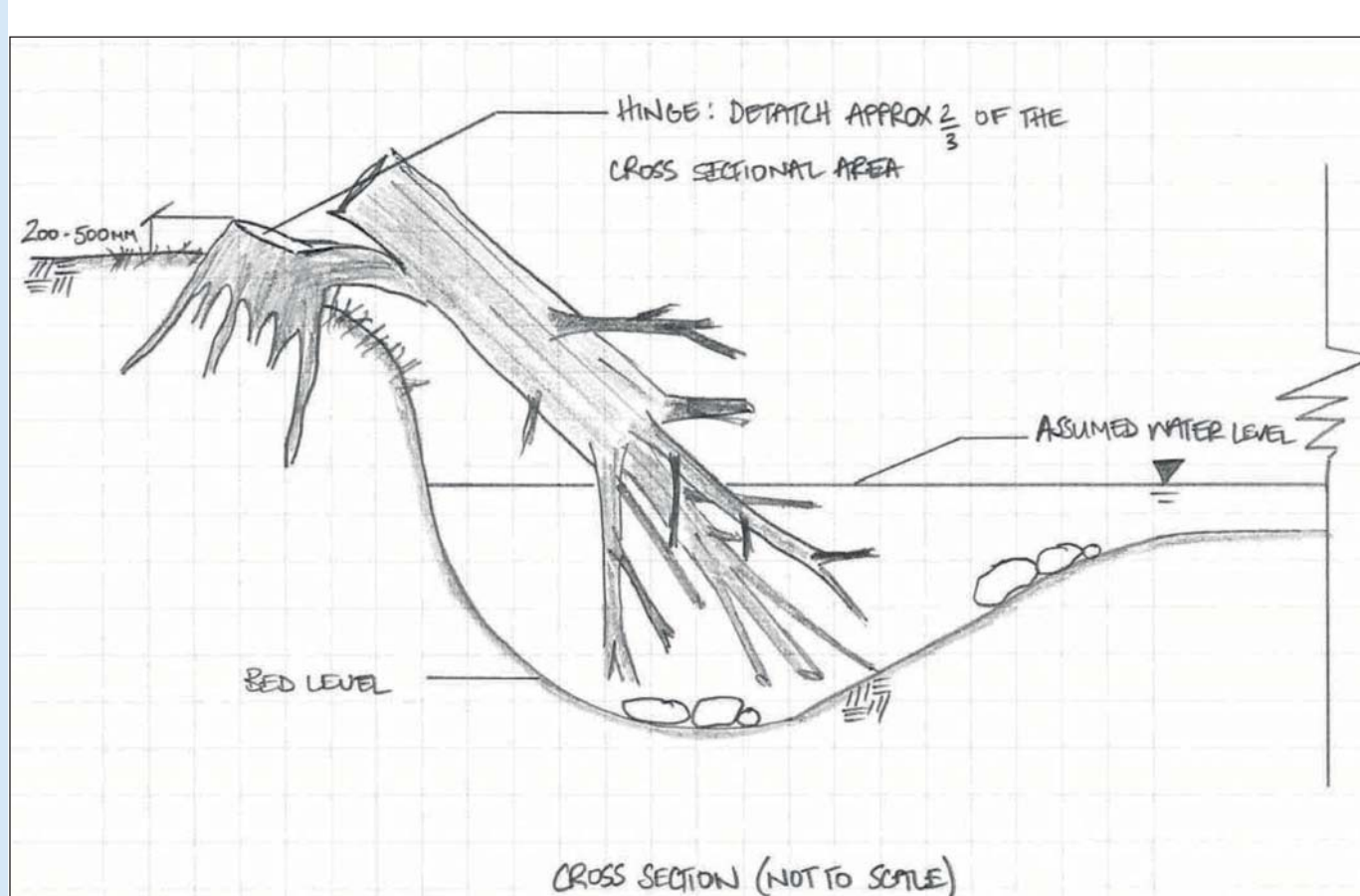
The current condition of the river means that features need to be retrofitted utilising available materials, such as gravels and wood. The aim is to work with the existing features and make them appropriately sized for the regulated flow regime.

Using available trees that show no bat roost potential will contribute to the improvement of in-channel features, by hinging them into pools or treched along edge of bars to define the low flow channel.

Trees will be used to:

- Define channel edges and bars
- Encourage maintenance of pools through scour
- Encourage development of berms and fine sediment deposition (brush boxes)
- In addition, removal of some trees contributes to reduce overshadowing.

Introduction of new sediment will also be required due to the lack of supply and the reduced gravel size fraction within the current size distribution.



Detailed Design

This is one of the detailed design drawings that has been produced which the contractors will use to construct the scheme with on-site support from an Arup geomorphologist.

The design layout and sized features will be used to generate dimensions and quantities of materials.

