Case study 19

River Medlock restoration study - Manchester, Lancashire

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1. Catchment summary

Study location

The River Medlock at Clayton Vale and Philips Park on the outskirts of Manchester in north-west England.

Catchment summary

Urban development has imposed a number of constraints on restoration options for the Medlock. Although it has a good supply of gravel material from upstream, it is unable to create geomorphological features within the brick-lined channel due to the unnaturally smooth surface giving rise to high energy flows.

Contaminated land is also a problem on the floodplain in Clayton Vale and Philips Park. Any restoration works therefore had to consider carefully how to reconnect the river to its floodplain without increasing pollution levels. Downstream of the site, the river flows into central Manchester, so it was imperative that any works did not increase flood risk locally or downstream.

Study summary

The aim of this investigation was to assess river restoration options for the brick-lined River Medlock within a section of Clayton Vale and through Philips Park (Figure 1). The Irwell Rivers Trust commissioned a restoration options report (Irwell Rivers Trust 2012) and the scheme attracted media attention, with a video report being released on the BBC website (www.bbc.co.uk/news/science-environment-24562282) in October 2013. Figure 2 shows the location of the areas for restoration.

Community involvement

The Environment Agency and Groundworks carried out engagement work with the local community. This included surveys of park users, the general public and various stakeholders, including fisheries, during the project planning phase.

Figure 1: Uniform brick-lined channel of the Medlock

Source: JBA Consulting

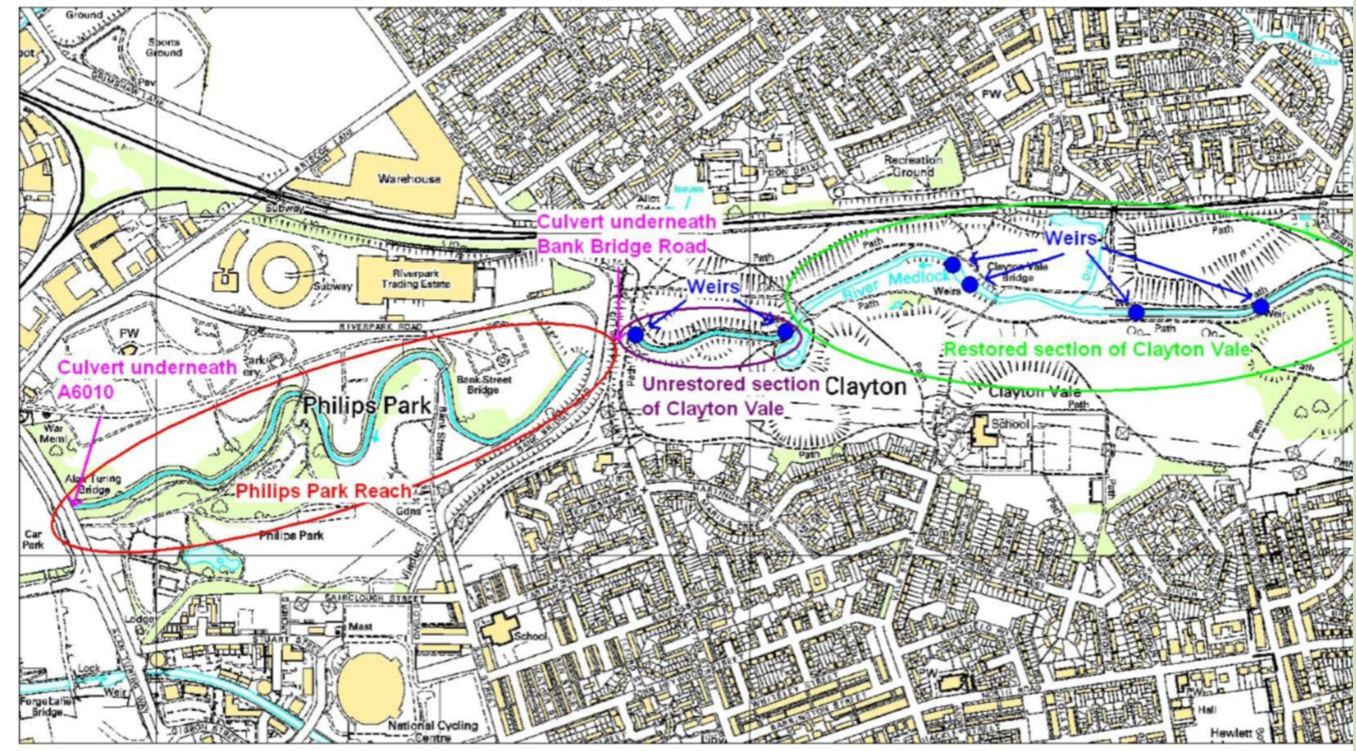

Figure 2: Site map showing location of areas for restoration

Notes: Contains Ordnance Survey material under license to the Environment Agency, license Z12961, 2012

Source: Environment Agency

2. Data summary

Datasets and analysis techniques used

The findings from a new channel survey and light detection and ranging (LiDAR) data were used to improve an existing ISIS model.

A hydraulic assessment was made based on velocity and shear stress distributions from one-dimensional (1D) ISIS modelling. The shear stresses were used in conjunction with the Hjulström curve and shear stress classification curves to estimate the grain size of sediments the river could transport before and after restoration. This allowed an assessment of the likely impacts to the sediment regime following restoration.

Data restrictions

The Environment Agency was the lead in this investigation and so all data was covered by its licence.

3. Model summary

Catchment processes investigated

The study started with an appraisal of the whole catchment to understand:

- the supply and movement of sediment
- the nature of the river upstream of the heavily modified reaches

1D hydraulic modelling was carried out using an ISIS model with updated cross-section survey data.

However, river bed restoration is 2-dimensional (2D) in nature, with changing morphology in a cross-stream direction as well as a downstream direction. To understand the effects of this in a 1D model, it is possible to output the flows and velocities in panel segments for each cross-section. This provides information on the shear stresses and therefore the sediment grain sizes that the river can transport.

Having established restoration features with appropriate sediment transport rates that were also acceptable in terms of fish habitat, the flood risk impacts of the new morphology on flood risk were assessed. This was done by running several flood design events to ensure that the restoration work did not make flood risk worse downstream.

This project focussed on the following catchment processes:

- Sediment sources, pathways and receptors
- Effects of in-channel barriers
- Effects of longitudinal barriers
- Catchment change

Model assumptions

The 1D ISIS model allows for depth averaged quantities such as velocities. The cross-sections were also broken down into panels to understand transverse variations in shear stresses. However, this approximates the complex 3-dimensonal circulations present in natural flows and simplifies the shear stress distributions. It was assumed that the approach could be used to make a broad scale assessment for average sediment mobilisation rates. The approach did not consider the effects of vegetation and adjustments to the bed material which can subsequently change bed roughness.

Data and model outputs

A fluvial audit was carried out and data from a new topographic survey were collected to supplement the model cross-sections used in the existing 1D river model. Google Earth imagery (see Figure 3) was used to understand the historical course of the channel. It was also used as a tool to demonstrate evidence of preserved channel features in the floodplain and gravel bar features within the channel. This provided valuable information on how the channel could be restored. The upstream geomorphological change was assessed as slow, but sufficiently active that it is generates gravel and finer sediments that are transported along the main channel. Consequently, there is a continuing supply of gravel sediment into the Philips Park reach, which had to be taken into consideration with the restoration features.

Figure 3: Aerial view of the Medlock upstream of study reach

Notes: Copyright Google Earth 2011, Infoterra and Bluesky 2011

Most of the banks are lined with trees, which helps to prevent significant lateral migration upstream and downstream of Philips Park. There are significant fine sediment inputs from surrounding urban areas, which are an important consideration for the morphological design, requiring sufficient velocities to prevent fine sediment choking within the channel. A 1D hydraulic model based in ISIS was improved using updated cross-section data from a new survey. These data were used to assess the flood risk and impacts on hydraulics linked to the sediment regime and design of restored bed morphology.

The model was used to look at depths, velocities, levels and bed shear stresses averaged across a cross-section. Like all 1D models, ISIS divides the cross-sections into panels and then computes the portion of flow in each panel. This was taken advantage of so as to estimate the flows in different segments of the channel, allowing the generation of pseudo-2D information from the 1D model. This was useful because the velocities in the deeper, more active part of the channel can be computed independently of the outer, shallower parts. This aided the design and testing of a more natural channel, making sure that velocities were sufficiently high in places to transport the fine sediments delivered from urban wash-off.

Model performance

The reinstated riffles–rapids–pools created a backwater effect (compared with the brick-lined channel), which creates temporary storage of flood water by elevating flood levels in the parkland, and reduces flood risk downstream. The failure of such features during a very large flood event was not investigated.

4. Lesson learnt

Choice of tools

This study used a combination of a fluvial audit with 1D hydrodynamic modelling. The initial fluvial audit provided an estimate of sediment supply and the innovative use of cross-section panels enabled an assessment of sediment mobility for different restoration options. The 1D hydrodynamic modelling also enabled an assessment of different restoration scenarios to hold backwater in areas of lower risk and reduce flooding downstream, while reinstating hydromorphological diversity.

Catchment scale and typology

This was carried out at a reach scale (1–2km), but the 1D approach can be upscaled quite easily. However, every reach is unique and has different features, populations at risk and opportunities for water storage. Restoration techniques therefore need to be adjusted depending on these features, sediment supply, erodibility and transportation rates depending on, for example, local slope. Understanding local typology is therefore crucial to this approach and as important as understanding the wider catchment. Areas with more extensive floodplains, or floodplains that can be re-connected to enhance restoration, would require 2D flow modelling in place of the 1D model used for this study.

Wider benefits

The Study's objectives, which are driven by the Water Framework Directive, are to identify opportunities to improve the hydromorphological and ecological status of this reach. The River Medlock at Philips Park is designated as a heavily modified water body. Its overall river status is defined under the Water Framework Directive as 'Poor Potential' but with a target of reaching 'Good Ecological Potential' by 2027. An opportunity existed to improve this morphological and ecological status/potential by restoring the reach of the Medlock at Philips Park.

Future research needs

The hydromorphic audit and geomorphological modelling have shown that removing the brick lining through the downstream section of Clayton Vale and through Philips Park of the River Medlock, alongside restoration of the channel, will improve the hydromorphology and fish passage through the study reach. The removal of the brick-lined channel on the Medlock is unique, although the modelling approaches used in this study are often used for restoration. The Environment Agency is continuing to monitor the channel bed and sediment depths as the reach re-adjusts following restoration.

5. Bibliography

IRWELL RIVERS TRUST, 2012. River Medlock at Philips Park hydromorphic audit and options assessment. Final report. Bury: Irwell Rivers Trust.

Project background

This case study relates to information from project SC120015 'How to model and map catchment processes when flood risk management planning'.

It was commissioned by the Environment Agency's Evidence Directorate, as part of the joint Flood and Coastal Erosion Risk Management Research and Development Programme.

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