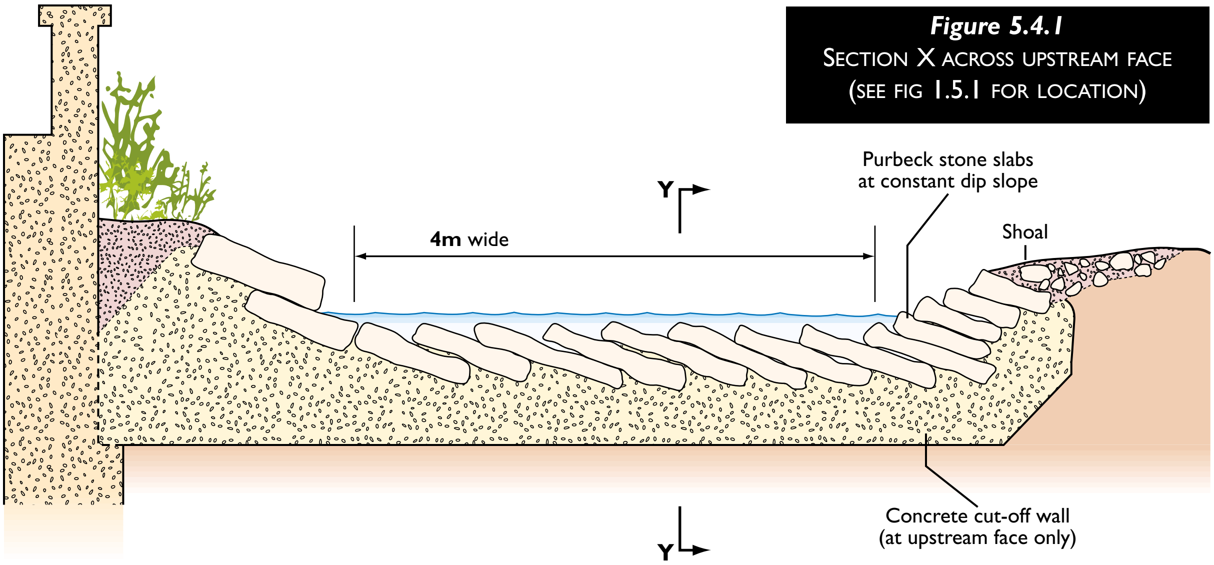
5 CONTROLLING RIVER BED LEVELS, WATER LEVELS AND FLOWS

5.4 Simulated bedrock outcrops

RIVER MARDEN

LOCATION – Town centre at Calne, Wiltshire ST 998710
DATE OF CONSTRUCTION – 1999
LENGTH – 100m
COST – not available

Figure 5.4.1
SECTION X ACROSS UPSTREAM FACE
(SEE FIG 1.5.1 FOR LOCATION)



DESCRIPTION

A straight, concrete lined, section of river channel was diverted and restored in the form of a double meander. Refer to Technique 1.5 for a plan and full description of the project.

The bed of the restored meandering channel needed to be stabilised against scour because of its steep gradient (1 in 140 mean) and the consequential high water velocities that exceed 2 metres per second during flood conditions. Two simulated rock outcrops were built into the bed to provide stability.

DESIGN

The influence of the two rock outcrops can clearly be seen in figure 1.5.2 (*see 1.5*); the longitudinal profile of the restored reach. The mean bed gradient is modified by projecting the outcrops above this profile and creating deeper pools both upstream and downstream of each. The purpose of the outcrops is to 'fix' the bed at two points thus checking any tendency of the river bed to scour deeper and to wash away the stone substrate introduced over the underlying clays. A varying hydraulic regime is created in keeping with the aims described for the project (*see 1.5*).

The design of the rock outcrops is the subject of this technique.

Simulated rock outcrop with downstream pool

Flat slabs of Purbeck limestone had been selected for a variety of purposes throughout the site and for use in the two outcrops. The slabs needed to be laid with a constant angle of dip and needed to provide a gently sloping face over which the water would tumble down to the lower level. A practical method of arranging the slabs needed to be developed; the outcome is shown in figures 5.4.1 and 5.4.2

Firstly, the upstream row of slabs was laid carefully to line and level in a bed of concrete. The concrete secures the required crest level along the tips of the

These techniques were developed to suit site specific criteria and may not apply to other locations slabs and also forms a cut-off wall that prevents water from flowing under the structure which can otherwise cause collapse. The angle of dip and the thickness of individual slabs determine the size of the jagged 'notches' created along the crest. Slab thickness of between 10cm and 15cm were found to be best suited. The slabs are extended upwards into each bank to become part of the revetments indicated on the site plan (*see 1.5*).

Successive rows of stone were then laid parallel to the above, working down the slope, with the final row being stepped down to a level below any likely scour depth. These rows were all bedded in gravel reject stone to introduce flexibility to the lower structure and to improve the opportunity for plants to root between the stones, e.g. *Ranunculus*.

The random nature of stone slab size and thickness meant that a certain amount of selection was needed to achieve a reasonably tight fit where each abuts another, but this was not unduly critical. The structure is sufficiently robust and flexible to ensure security without resorting to the use of concrete or mortar in joints. Each outcrop was built in a day by 3 men and a machine for lifting.

SUBSEQUENT PERFORMANCE 1999 – 2001

The structures have achieved the main purpose of stabilising the river bed against scour without any problems. The appearance is excellent and will improve once vegetation is established between the stone slabs.

The effect of the jagged notches created by laying the stones at an angle is to generate an audible tumble of water over the whole structure. The concentration of flow down these irregular notches is likely to prove helpful to the passage of fish.

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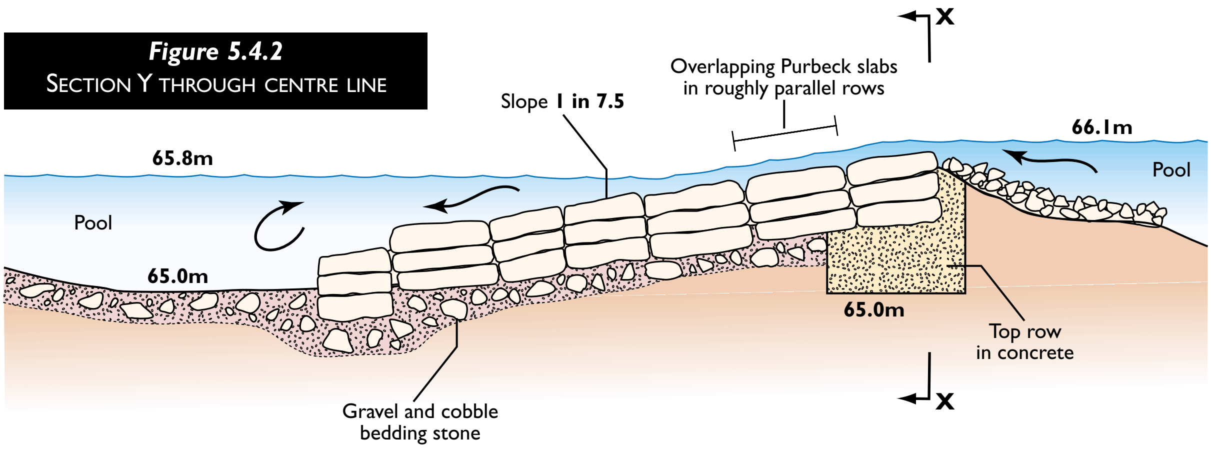
Figure 5.4.2
SECTION Y THROUGH CENTRE LINE



The outcrops provide stability to the bed and banks as well as aesthetic interest

5

Controlling River Bed Levels, Water Levels and Flows

5.5 Raising river bed levels

Upper Kennet

Location - Ramsbury, Wiltshire

Date of construction - 2nd October – 20th October 2000

Length – 210m

Cost - £12, 000 – £14, 000 for construction and reinstatement works only†

† The cost of £14,000 did not cover design, surveys, administration and consents. The work was carried out by an experienced local river keeper and not a commercial contractor.

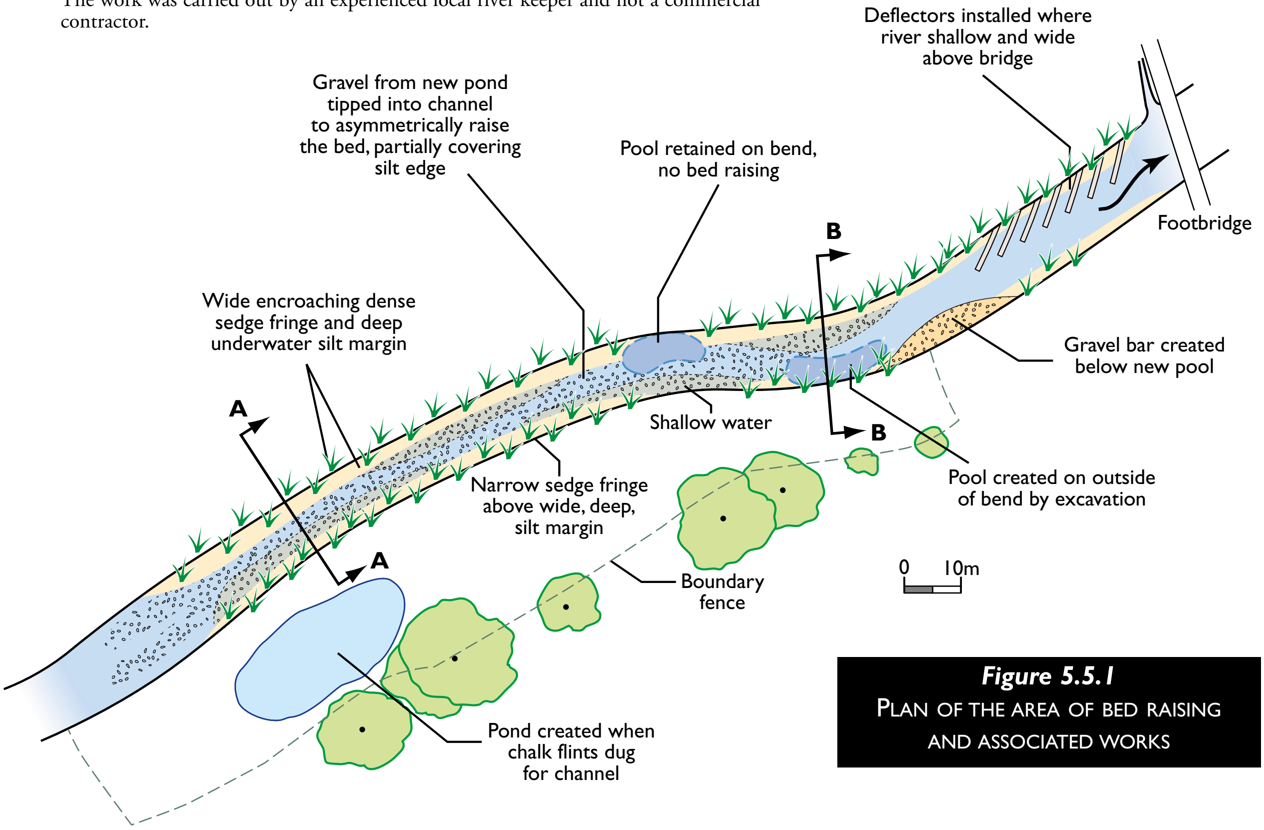


Figure 5.5.1
Plan of the area of bed raising and associated works

Description

The Upper River Kennet is a chalk river (Habitat Action Plan interest) under European Regulations and notified under UK legislation as a Site of Special Scientific Interest. Despite its designation, the river exhibits interesting contrasts in habitat quality. Some stretches support pristine chalk river characteristics (beds of abundant *Ranunculus* (Water-crowfoot) and clean gravels suitable for sustaining wild brown trout populations). However, past management works, ranging from mill impoundments to more recent dredging activities, have resulted in over-widened, over-deepened, sluggish, stretches that are prone to silt deposition and lack gravel or crowfoot.

The site is a secondary channel of the Kennet, the probable natural course of the river prior to splitting into a leet to feed a mill. The channel had been widened and deepened many decades ago, but did not recover its natural characteristics. However, it did exhibit some signs of self-narrowing where marginal sedge had spread into the channel and accreted

Before: sluggish deep water with encroaching sedge significant silt shoulders. Despite this development, the channel remained too wide to sustain fast water currents and even in mid-channel the bed was subject to deep silt accretion.

A common approach to achieving self-sustaining habitats in enlarged degraded rivers is to narrow the river bed width and thereby concentrate flows within a defined low-flow channel. However, where the river also has a history of deepening, this may simply lead to the formation of a very constricted, deep course. To restore a more appropriate width to depth ratio, bed raising may also need to be considered (*see 1.2 for further discussion on selecting the appropriate cross section*).

A 210m stretch upstream of Ramsbury was re-configured, primarily through raising the bed. The channel bed was raised asymmetrically to ensure that there was a narrow low-flow course and shallow edges to encourage marginal vegetation encroachment.

As the Kennet is a chalk stream the predominant flow is derived from groundwater, so major fluctuations in water level and velocity are much less than in rivers fed primarily by surface water. Consequently, a more flexible approach can be adopted for the location of gravel materials to raise the bed, as there is less risk of subsequent mass re-distribution.

Detailed flow modelling was a key element to determine the effects of the works under low-flow and flood conditions, for land drainage consent and to allay potential landowner concerns.

DESIGN

Throughout, bed levels were raised to leave a maximum water depth of 500mm at low water level (based on the Q90 discharge level - the level at which flows are exceeded 90% of the time). At this discharge, the margins of the channel would have a depth of <100mm. The Q90 flow was indicative; the desire was to ensure that under very low flows the bed-width would be constricted to sustain at least some clean gravel at all times. The maximum depth of 500mm at Q90 was based on a target reference width and depth.

Work was scheduled to commence in early October when river flows are usually at an annual low, approximating to Q90. Prior to undertaking work, stakes were placed in the river to mark this level as a guide to the contractor during the gravel placement process. This was especially important since water levels would change if silt entrapment measures had needed to be installed downstream (on standby but not needed).

Gravel placement may influence or be influenced by fluctuating water levels

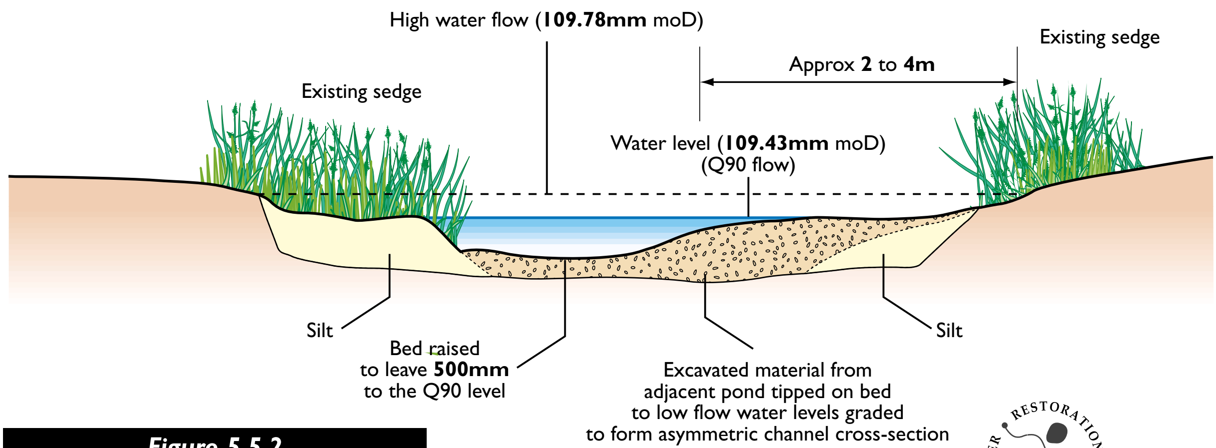
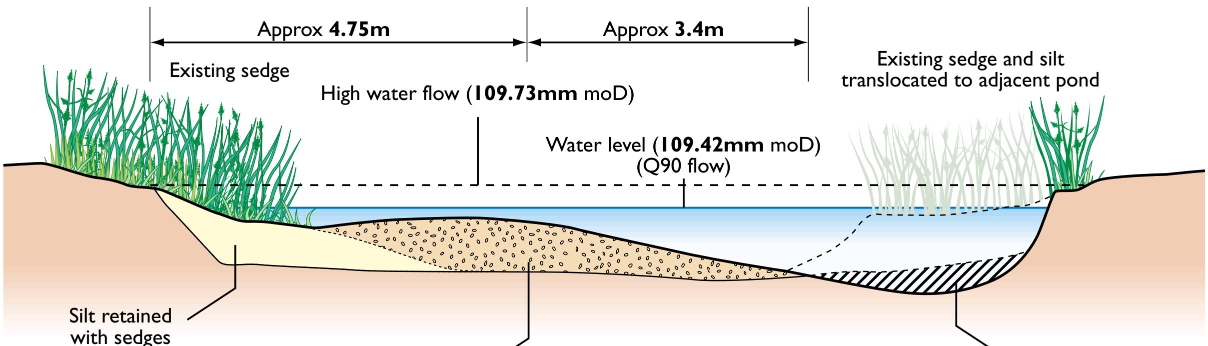


Figure 5.5.2
SECTION A THROUGH RAISED BED AND MARGINAL SHOAL

Figure 5.5.3
SECTION B THROUGH RAISED BED AND NEW POOL



The material used to shallow the channel depth was chalky and gravel flints. Where possible it is advisable to use material from the immediate area to reflect the type of bed that would have been present under natural conditions. Here the gravel fill was excavated from the floodplain by the creation of an adjacent pond on the right bank. The suitability of the material was checked beforehand by the inspection of machine-excavated trial pits. Infill material was predominantly a mixture of gravels and flints varying in size from 20 to 10mm, with <5% coarse sand and minimal silt. A few larger flints were also present.

Flinty gravel used to narrow and raise the river bed

Topsoil and overburden were first stripped and stored before the gravel was dug out and transported by dumpers to the river bank. Representative cross sections were produced as references for the placement of material so that a degree of sinuosity was created under low flow.

The contractor followed the drawings and had the advantages of both knowing the river stretch well and having been involved in the final design. Regular on-site supervision was provided by an experienced team member.

The works length can be divided into three sections.

A. *Straight with marginal sedge on both sides*
Cross section A (*fig. 5.5.2*) is a typical section across this reach. Silt colonised by sedge represents up to half of the total channel width.

New pond with early growth, showing the gravelly nature of the floodplain material

Gravel has been used to shallow and narrow the remaining open water channel by up to a half, with the shallower margins finishing just below the Q90 level. The remaining low-flow channel is raised to within 500mm of the Q90 surface.

B. *'S' bend with some marginal sedge*
The outsides of each bend are enhanced with a pool, the first by retaining existing very deep

A few months after completion, the raised bed evident

water, the second by dredging the silty sedge margin (material then used to provide marginal substrate in the new pond). Cross section B (*fig. 5.5.3*) shows the asymmetric section with fill material for this latter scenario. To ensure the pools are sustained by scour, the inside of bends had gravel deposited on them to simulate natural point bars.

C. *Straight, wide and shallow section*
After exiting the bends the channel widens. Significant narrowing is expected to naturally develop as sedge encroaches from the bank and entraps newly accreted silt. This narrowing process has been enhanced by the addition of deflectors (up to 5m in length and facing upstream), installed to help to deflect flow into mid-channel and accelerate silt deposition between the deflectors (*see 3.1 for further discussion of deflectors*). Here deflectors were chosen due to the shallower and wider nature of the channel, and the limited access requiring hand installation.

The associated pond, from which material was won, was re-profiled to give shallow margins and bank slopes, and planted with emergents excavated from the channel, and additional native wetland species.

SUBSEQUENT PERFORMANCE 2000 – 2001

Work was only completed in October 2000, prior to very high flows. Evidence after 1 year indicates that the reduction in channel size has not resulted in any bank erosion, and that the gravel has stayed predominantly in place. Minor local changes in gravel composition have occurred, with less fines in the low-flow channel.

The re-configured channel has restored typical chalk stream habitat, establishing a self-cleansing gravel bed suitable for *Ranunculus* to establish and for wild brown trout spawning.

During subsequent high flows the full (c10m) channel width will be occupied by water, yet under Q90 flows the channel width will narrow in most places to less than half of this, maintaining a cleaning velocity to keep the new gravels free of silt.

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