Audit of 20 Rehabilitation Projects
Environment Agency
Thames Region

By *the* **RIVER RESTORATION CENTRE**

THE RIVER RESTORATION CENTRE

Working to restore & enhance our rivers

1998

Audit of 20 Rehabilitation Projects
Environment Agency
Thames Region

Projects Audited

Bear Brook - Aylesbury
River Blackwater – Nr. Frimley
River Chess – Nr. Chesham
River Cole – Sevenhampton
River Colne – Watford
River Crane – Twickenham
River Dun – Froxfield
Gatwick Stream – Crawley
Kyd Brook – Nr Bromley
River Mole – Westhumble
River Pool - Catford
River Ravensbourne – Bromley
River Roding - Redbridge
River Thame – Winchendon
River Thames – Clifton Hampden
Doctor's and Skinner's islands
London Yard, Isle of Dogs
Shiplake lock
Sonning Bridge
River Windrush - Worsham

Janes, M. D. and Holmes, N. T. H.
River Restoration Centre
1998

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Thames Rehabilitation Projects

The Environment Agency (Thames Region) has for many years promoted nature conservation through its Flood Defence Committee, redressing some of the adverse legacies of past schemes. In doing so it collaborates with other Agency functions and external organisations.

This year a series of 'audits' were undertaken, by RRC, of projects carried out primarily since 1989 mostly through the Thames Region's Flood Defence Enhancement Programme, as well as those promoted through fisheries, conservation and landscape architects sections. Twenty projects from small enhancements to more complex restoration schemes were chosen which demonstrate examples of best-practice, innovation and design improvements within river management. The audits give an independent review of some of the region's extensive array of rehabilitation schemes.

Accompanied site visits were made for all projects following consultation and information gathering with the key staff involved. These visits enabled the scope of works, and subsequent development since completion, to be seen and assessed against objectives. This information formed the basis of RRC's audits which were presented as a series of short reports containing the following:

General/catchment information;
Background;
Objectives;
Works carried out;
Success/lessons;
Overall conclusion;
Recommendations for the site;
Recommendations/considerations for future application;
Costs;
Available information;
Key personnel.
Accompanying photographs

Lessons Learnt

Some lessons learnt from these 'audits' are summarised below. These may help other practitioners plan restoration projects and ensure that data are collected before, during and after implementation of future schemes in such a way as to extend the pool of knowledge and experience of river restoration techniques.

Channel Design

- Design of groynes/deflectors is critical to avoid creating new bank erosion problems and ensure that, in low-flow conditions, flow is concentrated sufficiently to create and sustain habitat diversity.
- Successful placement of self-cleaning gravel riffles is highly dependent on sediment sizing and riffle design (e.g., size, shape, gradient, etc).
- It is impossible to be totally accurate in setting the height of berms – common sense and calculations of water levels need to be used together.
- River narrowing can be achieved, whilst retaining flood capacity, by in-filling part of the low-flow width with material from the bank slopes.
- On-site expertise is invaluable – part art and part science – and must be able to adapt to on-site conditions – costs incurred through additional supervision are usually justified by the end result.
- Berms should accrete silt and therefore may eventually dry out. These may act as effective low-flow channel narrowers. This needs to be considered at design stage.
- Getting the size, shape, angle, water-, etc. of deflectors, groynes, etc. is critical.
- Keying in securely to existing stable banks is vital for all works, especially on wave-effected reaches.

Integrated Design Planning

- Fishery, ecology and landscape interests must be integrated in all schemes at the start of the planning process, not as 'late entry add-ons.'
- Ecological benefits should not be over-shadowed by lack of consideration and effort in landscape design, e.g., by unnecessary, unsightly, engineering structures.
- Assessing the potential benefits that could accrue from capital investment in restoration projects needs to take account of how these will be dependent on future management of the site.
- Attention to visual amenity must be an integral part of the planning process if the full benefits of the works are to be achieved - e.g. channel narrowing and bank re-profiling are visually less effective if old spoil levees remain on the bank tops.

Material Selection

- Non-degradable geo-textiles may be over-kill where only *initial* edge stability is needed in advance of vegetation growth and earth stabilisation – far better to use bio-degradable materials.
- Geotextile (Nicospan) can be an effective alternative to sheet piling, and is suitable for holding soft silt in place where back-fill is very fine.
- Planted coir rolls provide a very effective 'soft face' habitat in association with low-level piling/bag work required for additional strength.
- Berms retained by hurdles, faggots and spiling are unsightly if well above water level, especially if back-fill settles. The *temporary* use and removal of such materials, when the back-fill has consolidated may be appropriate.
- Bare Enkamat is visually disastrous.
- Using river silts to form ledges, without holding in place with a membrane, risks early flood washout.

Vegetation Establishment

- Vegetation growth is an essential ingredient in successful channel narrowing, both for sustainable natural habitat creation/recovery and visual amenity. The design should plan to allow plant growth to determine the width of the low-flow channel, commensurate with flow character.
- Where wide impounded reaches are rehabilitated by removing downstream control structures, channel narrowing often occurs naturally over time, without the need of expensive and interventionist engineering.
- In over-deepened, over-wide channels with little marginal habitat, vegetation growth can begin the processes of wet ledge development and narrowing through simple re-profiling of the banks.
- Visual impact of bank reinforcements, e.g., faggots or hurdles, can be reduced by back-filling with reeds, turf or seeded topsoil.
- If plant plugs are to be successfully established on banks, timing and after-care maintenance is essential.
- Tree planting as part of, or after, a scheme must take into account shading and future management implications.
- Rank vegetation growth on re-profiled banks can be avoided by not re-topsoiling and so help establishment of low-maintenance grass mixes.
- Allow/plan for vegetation growth on margins/berms/ledges to help determine the low-flow width. Very important part of recovery of 'naturalness'.
- Steep stone banks will be poor for marginal vegetation recovery, which is important in shaping the flow, creating habitats and visual aesthetics, etc.

Monitoring

- Scheme objectives must be clearly documented prior to construction to facilitate useful auditing.

- Pre-scheme surveys and photographs are invaluable for future reference.
- Long-term monitoring is needed at many sites to determine if the objectives of restoration are achieved and to establish the time-scale of change.
- Simple monitoring by regular photography can show the rate of vegetation establishment and changes to longevity of measures introduced for rehabilitation.
- Good photographic and technical specifications of all projects are essential if they are to give confidence to others and be replicated in future schemes.
- After-care monitoring, and the provision of resources to undertake minor modifications and enhancements, can provide better value for money than new works.
- Advances in setting up and assessing the results of monitoring programmes for biota (especially fish) are needed if the benefits of restoration are to be identified in a more quantifiable way.
- Narrowing using hurdles, geo-textiles, etc. need to be inspected periodically after completion to ensure they are not exposed or non-functional due to erosion/degradation, etc. In common with many restoration works, this should be part of after-care monitoring and resources made available for minor necessary adjustments (or things missed before) - these resources may provide better value for money than new works.

The Future

1. The audits were retrospective, not planned as part of the project planning process. All future projects should planned with clear auditable objectives to make their appraisal more objective.
2. The audits were of a general nature, primarily observations and very qualitative. Long-term monitoring may enable future quantitative to be presented.
3. The projects were assessed for gross changes and commented on flora, fauna and habitat. Future audits should also comprise geomorphological audit and comparisons of Habitat Quality Assessment before and after, using RHS.
4. ~~There is a need to develop an improved standard auditing methodology.~~
5. Basic data from ALL rehabilitation projects should as a matter of course be logged with RRC for entry onto the Projects Inventory. This will ensure a good range of schemes can be selected for audit, and also help develop future audit strategies based on instantly available data.

The Environment Agency is planning to support the River Restoration Centre and will very shortly produce a report on rehabilitation initiatives. The report recommends:

- On ALL occasions where significant river/riparian/floodplain habitat rehabilitation is initiated by the Environment Agency (e.g. during Maintenance, Capital, Conservation or Fishery schemes) a **Project form** should be filled in. *This should take no more than 10 minutes* if undertaken as a routine action as part of project promotion, implementation and reporting.
- Where significant river/riparian/floodplain habitat rehabilitation is achieved by external bodies on works requiring consent from the Environment Agency, a **Summary form** should be used to detail the project on ALL occasions.
- A **National Centre** for receiving the above information is desirable.
- Within two years a simple computerised database system for inputting and accessing such data should be in place.

The RRC database 'Project' and 'Summary' Proformas are attached which can be copied for use or further copies requested from RRC

	R. Blackwater	Bear Brook	River Chess	River Cole	River Colne	River Crane	River Dun	Gatwick Stream	Kyd Brook	River Mole	River Pool	Ravensbourne	River Roding	River Thame	Clifton Hampden	Doctors & Skinners	London Yard	Shiplake Island	Thames at Sonning	R. Windrush	Primary	Secondary	Minor
Type 1 Rehabilitation of Watercourse Reaches																							
1.1 Reach remeandered (>500m)		P																			1		
1.2 Reach remeandered (<500m)	P						S		S												1	2	
1.3 Culverted Reach re-opened (>100m)									P												1		
1.4 X-sectional habitat enhancement (>500m) -two-stage channel profiles etc.	P		P			P	M		M	S		P								M	4	1	3
1.5 Long section habitat enhancement (>500m) - pool/riffle, etc. restored	P			P	P				M			P		P							5		1
1.6 River narrowing due to depleted flows or previous over-widening		S	P				P			M	S									P	3	2	1
1.7 Backwaters and pools established/reconnected with water-course	M		M					M								P					1		3
1.8 Bank reprofiling to restore lost habitat type/structure/armouring removed		S		S			M				P	S			P		P				3	3	1
1.9 Boulders etc. imported for habitat enhancement										M	S									S		2	1
1.10 Gravel and other sediments imported/managed for habitat enhancement	S		S	M	S	S		S		S				M	M		S			S		8	3
1.11 Fish cover established by other means											P										1		
1.12 Current deflectors/concentrators to create habitat and flow diversity			S	S	S		S				P										1	4	
1.13 Sand, gravel and other sediment traps to benefit wildlife			M									M											2
1.14 Tree/shrub planting along bankside (only if covers >500m bank/>0.5ha)		M																					1
1.15 Artificial bed/bank removed and replaced by softer material (>100m)																			P		1		
1.16 Establishment of vegetation for structure/revetment (e.g. use of willows)	M								M			M			P			S	S		1	2	3
1.17 Eradication of alien species											M												1
1.18 Provision of habitat especially for individual species - otter, kingfisher etc.	M													M	M	S						1	3
1.19 Removal of floodbanks.																							
1.20 Fencing along river banks; fencing floodplain habitats for management		M		M		M								M		M							5
1.21 Marginal/aquatic planting	M	M	S		S	S					M	M			M			S	M			4	6
																					23	29	34
Type 2 Restoration of Free Passage - benefit >1km upstream																							
2.1 Obstructing structure replaced by riffle																							
2.2 Obstructing structure replaced by meander																							
2.3 Obstructing structure modified/removed to enable fish migration			P				P						P	P							4		
2.4 Obstructing structure retained, but riffle/meander established alongside																							
2.5 Culverted reach re-opened									P												1		
2.6 Obstructions within culvert (e.g. lack of depth, vertical falls) redressed																							
2.7 Dried river reach has flow restored								P													1		
2.8 Other measures undertaken to restore free animal passage																S						1	
																					6	1	0
Type 3. River Floodplain Restoration																							
Water-table levels raised or increased flooding achieved by (*):																							
3.1 *Unspecified means/rationalised control																							
3.2 *Water-course re-meandering																							
3.3 *Raising river bed level		S																				1	
3.4 *Weirs established specifically to increase floodplain flooding/waterlevel										S												1	
3.5 *Termination of field drains to watercourse																							
3.6 *Feeding floodplain with water (sluice feeds, watermeadow restoration)																							
3.7 *Narrowing water-course specifically to increase floodplain wetting		P																			1		
3.8 Lakes, ponds, wetlands established (may be flood storage areas)		P		P	S																2	1	
3.9 Lakes, ponds, wetlands, old river channels restored/revitalised										P						P					2		
3.10 Vegetation management in floodplain										M													1
3.11 Riparian zone removed from cultivation				M																			1
3.13 Substantial floodplain tree/shrub planting																							
																					5	3	2
P = Primary objective. S = Secondary objective. M = Minor achievements.																							

Table 1. Enhancement schemes showing objectives. P = Primary objective. S = Secondary objective. M = Minor achievements.

BEAR BROOK REALIGNMENT AND FLOOD ALLEVIATION SCHEME AT ALYESBURY.

DATES: 1993/4

LOCATION: Eastern edge of Aylesbury, BUCKS.

GRID REF: SP 842140

CONTACT: Environment Agency, Thames Region, Conservation, Alastair Driver. Tel. 01189 535563.

LAND OWNERSHIP: Private/Environment Agency.

CATCHMENT INFORMATION

Bear Brook is a small clay stream draining intensive agricultural land on the suburban edge of Aylesbury. Natural riverbed gravels are often completely covered by silt. Gradient is c1:650. The brook's hydrology is dominated by its clay and urban surroundings, giving rise to a very flashy rainfall response.

BACKGROUND

Bear Brook was straightened, deepened and re-aligned in 1966 as part of a major capital flood relief scheme. Subsequent 'improvement' works were carried out in the early 1970's. Despite the increased capacity, the risk of flooding was still high due to increased urbanisation and lack of upstream floodplain storage. The NRA proposed a c.90,000m^3 flood storage area as a flood alleviation scheme for Aylesbury, designed to attenuate flows upstream, whilst retaining the integrity of Bear Brook.

The length of brook chosen was straight, deep and very silty, and on the edge of a housing estate. However, there was also an adjacent area of wet grassland of county importance, and many opportunities for habitat and landscape restoration.

OBJECTIVES

- Alleviate flooding problems in Aylesbury by creating flood storage areas with increased wet land wildlife habitats;
- re-aligning the straightened brook on a more sinuous course;
- restoring in-stream and bank diversity;
- improving landscape value and access for the local community.

WORKS CARRIED OUT

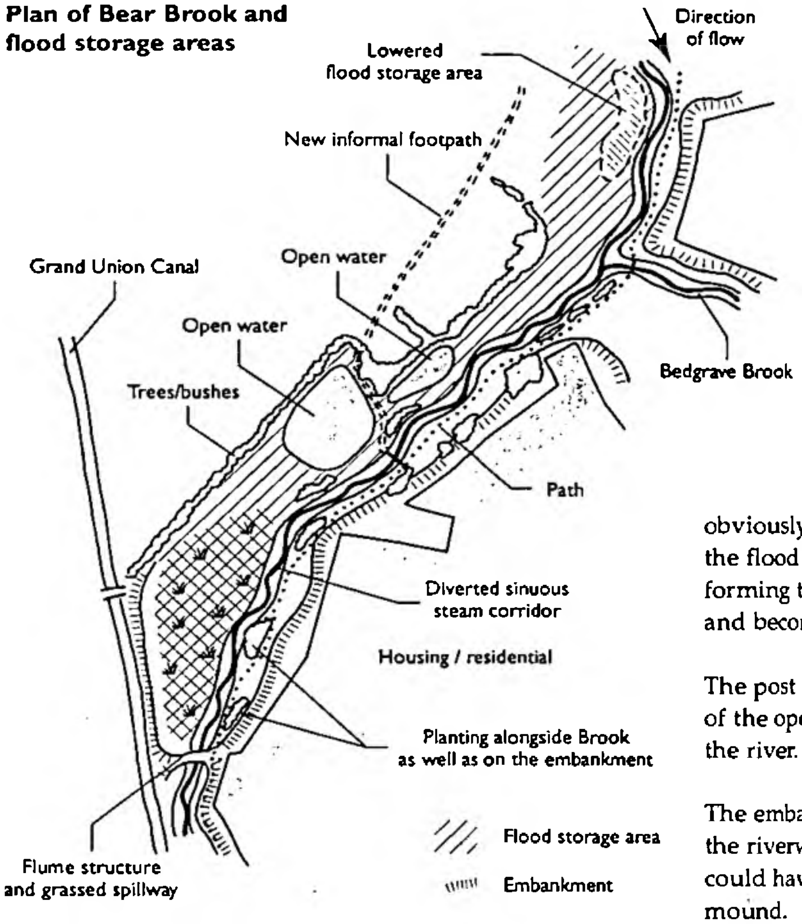
The brook was re-meandered roughly following its original line, over 1km (Plate 1). Low berms were constructed and the banks reprofiled, sloping gently down to the water's edge. At various places a total of 20m of the right bank was lowered to act as a spillway into the flood storage area (Plate 2). The bed depth was reduced by cutting the new channel at a higher level.

Where Bedgrove Brook (a tributary of Bear Brook) enters the site it has also been re-aligned, though the bed is still protected by concrete at the new footbridge before entering Bear Brook. To ensure sufficient overspill into the storage area during floods, flow is controlled by an engineered brick flume, just downstream of the confluence (Plate 3).

At the downstream limit of the works Bear Brook enters a large grated flume built into a large grassed concrete spillway (Plates 4&5). This spillway is designed to hold back floodwaters, and only over-top in a >1:100 year event. To protect the housing on the left bank, a large bund was constructed along the length of the river. This was incorporated into the re-landscaping by planting trees and shrubs both on the floodbank and riverbank, but being careful not to obscure the views of local residents.

To allow increased access to the site a formal surfaced low-level path was built following the brook (Plate 6). New footbridges were constructed over Bear Brook and Bedgrove Brook, and informal rights of way agreed with the right bank landowner.

Plan of Bear Brook and flood storage areas



To restrict animal access from the right bank and prevent excessive poaching by livestock a post and rail fence was erected tight along the bank.

SUCCESS/LESSONS

The remeandered channel, though smaller than the previous straight course was still overwide for the flow regime of the Bear Brook with silt being deposited within the channel. However, given its new sinuous form and the abundant supply of agricultural sediment, the brook is quickly narrowing itself (from 2m to 0.7m in places) and these berms are vegetating and promoting a central 'clean' gravel-bed channel (Plate 7).

The hard engineering has not been so successful. Some of the concrete lattice protecting the Bedgrove Brook bed and banks has moved (probably due to vandalism) and is being undercut in places (Plate 8). The brickwork flume is totally out of character with the rest of the channel works and the concrete apron designed to prevent erosion is being undercut at its downstream end. The visual intrusion of the gated flume through the spillway detracts from the riverworks also, though this is obviously necessary for the successful operation of the flood alleviation scheme. The concrete lattice forming the spillway is gradually grassing over and becoming visually 'softer'.

The post and rail fence is also very stark because of the open nature of the site and its proximity to the river.

The embankment planting scheme complements the riverworks and reduces the impact of what could have been a very visually intrusive earth mound.

The storage areas to the right are working as expected and have established small stands of marginal vegetation (mostly *Typha* (bulrush)) (Plate 9). Further downstream the additional wet grassland area, increased by the flood storage scrapes, is colonising rapidly with *Juncus* (rush). Snipe, Teal, Moorhen and Heron are known to visit the site (Plate 10).

OVERALL CONCLUSION

The project meets all of its environmental/habitat objectives for the brook; increased wetland wildlife habitat, re-meandering to a more sinuous course, restoring channel diversity. It also addresses the issue of access and visual amenity, though some of the engineering structures detract from its aesthetic appeal.

RECOMMENDATIONS FOR THE SITE

The oversizing of the channel has led to interesting variations within the brook, through silt deposition and vegetation narrowing. It is important to leave the site to develop further, to allow the berms to narrow and gravel beds to develop. Annual maintenance work must be sensitive to

this whilst ensuring that the scheme performs to the design flood alleviation standard.
Monitoring of the site is needed to assess if 'over-sizing' a channel is a good method of restoration, allowing more natural development of channel size, habitat and character where there is sufficient input of sediment. This also has implications for reducing costs by reducing the detail that has to be built into the works.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Where important engineering structures need to be built into the overall scheme, their visual impact on the rest of the works needs to be looked at in detail to avoid detracting from an otherwise attractive scheme. Specialist advice from landscape architects should be incorporated at an early stage in the design.

COSTS

£800,000 capital Flood Alleviation Scheme, funded wholly by the Environment Agency. The Bear Brook rehabilitation measures and landscaping accounted for c£100,000.

AVAILABLE INFORMATION

General plans and drawings,
Pre and post works photo records

KEY PERSONNEL

Conservation – Alastair Driver (EA)
Landscape – Richard Copas (EA)
Consultants – In-house.
Contractor – PTC Ltd and Fergal Contracting.

Bear Brook (1 of 2)

PLATE 1 Bear Brook along its new sinuous course.

PLATE 2 Temporarily inundated flood storage area. – March 1998

PLATE 3 Brook flowing into the brick flume. This throttle ensures upstream overspill. – March 1998

PLATE 4 Large grated flume structure set into the flood embankment. – March 1998

PLATE 5 Top of the embankment spillway. Grassed concrete lattice. – March 1998

PLATE 6 A formal low-level path follows the brook. Opposite livestock access is restricted by a post and rail fence. – March 1998

PLATE 7 A lowered spillway section showing significant narrowing by vegetation encroachment and siltation. – March 1998

PLATE 8 Bedgrove Brook was also re-aligned but its bed protected with concrete. This is beginning to be undercut and displaced by vandals. – March 1998

Bear Brook (2 of 2)

PLATE 9 Storage areas in flood. – December 1996

PLATE 10 The area of wet grassland has increased significantly. – March 1998

BLACKWATER VALLEY ROAD – RIVER DIVERSION SCHEME

DATES: 1991/2 and 1996

LOCATION: 1991/2 – Northern section - Coleford Bridge Road to the disused railway bridge, HANTS. 1995/6 – Central section - Aldershot Road to A3011 Lynchford Road, SURREY.

GRID REF: Northern - SU 879559 to SU 880563
Central - SU 887514 to SU 885519

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Dave Webb. Tel. 01483 577655.

LAND OWNERSHIP: County Councils.

CATCHMENT INFORMATION

The River Blackwater flows through an area of alluvial gravels and drift deposits, overlain by silts and fine clays. The gradient is fairly flat, approximately 1:1000. The hydrology of the river is flashy as a result of the clay soils and the high percentage of urban runoff entering the system. Baseflows are high, due in part to the supply via sewage treatment works. Urban runoff and effluent discharges also impact river water quality.

BACKGROUND

The river had been degraded by various gravel extraction works and channel diversions. The upstream section had a problem with excessive growth of *Potamogeton natans* (broad-leaf pondweed) (Plate 1). In the late 1980's construction of a new road began, joining the A31 to the M3 to bypass Aldershot and Farnborough. Due the heavily urbanised nature of this area the road followed the Blackwater valley along the course of the River Blackwater. The road necessitated the diversion of the river at several locations.

The road and river works were completed in two stages; the northern section and central section. Work was undertaken by both Hampshire and Surrey County Councils, with the obligation to incorporate habitat enhancement in the design of the diverted reaches.

Northern Section.

Previous works to the river had left much of this section straight and deepened with little flow or bed diversity. Some of the original sinuous planform remained, though this had been deepened and divorced from the floodplain (Plate 2).

Central Section.

This section of the Blackwater retained a fairly diverse river corridor, which gave greater impetus to the council to enhance the ecological value of the site.

OBJECTIVES

- To minimise and mitigate the impact of the road scheme;
- to introduce/increase geomorphological diversity within the channel;
- to increase biological diversity.

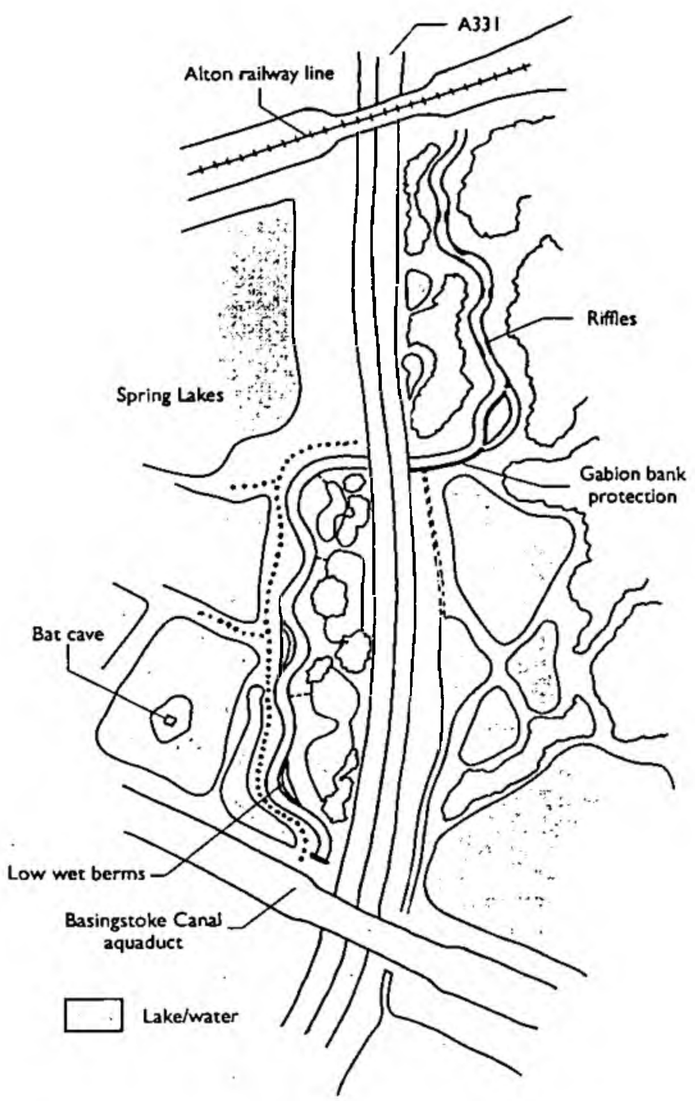
WORKS CARRIED OUT

Northern Section – 1991/2 - HCC.

The diversion channel is a two-stage design incorporating a sinuous meandering planform (Plate 3). Willow spiling was used to revet the bank of the low flow channel where they were formed from the silty fill arising from the old channel. The new low flow channel is approx. 500mm deep, and the original gravel bed has been re-created. Riffles were also introduced at various locations.

Further downstream within this section the new road cut off a large meander loop belonging to the original sinuous course. This meander was reinstated on the opposite side of the channel, using the same dimensions, whilst lowering the inside profile of the bend (Plate 4).

Central section: River diversion works



In addition, a small backwater was created from a redundant loop of the old modified channel. This is linked both to the new channel and the road, to try to improve the road runoff quality.

No planting was undertaken due to the use of silt to form the berms. It was assumed that the seed bank within this material would be sufficient to ensure good colonisation.

Central Section - 1995/6 - SCC.
This section was dissected by the new road. The upstream reach was diverted adjacent to an area of lakes (Spring Lakes), whilst the downstream reach had to be diverted under the new road and through a wooded area.

At Spring Lakes the new course of the river was constructed within the shallow lakes (Plate 5). An access strip retained the water so that the new channel could be cut in the dry. The new banks and bed were formed, together with overflow wetlands and pools. Some low berms/ledges were constructed using low level 'dead' spiling to retain the gravel fill. The new course follows a sinuous line alongside the road.

A 'bat cave' was constructed on an artificial island in the lakes to replace the previous roost, an old culvert in the nearby canal embankment.

Downstream, the Blackwater passes under the new road into another diverted reach. Here the design refrained from using the usual steel piling techniques in favour of willow spiling and stone gabion baskets. The two-stage channel option was again used to ensure sufficient depth at low-flows whilst being able to cope with storm events (Plate 6).

The design consists of a meandering channel with low berms on the inside of the bends, and outsides supported by live willow. Similar to the upstream lakeside reach, the channel was cut in the dry (Plate 7). Shallow 'riffles' (10-20cm) have been constructed using gravel to form a dished profile to narrow and focus the flow, in conjunction with 1m deep pools (Plate 8).

Where the channel emerges from the road culvert gabions have been used to stabilise the bend.

A secondary channel/backwater and island was also constructed, using a line of gabions to define the channel side of the island (Plate 9).

Road runoff is fed into a retention/treatment pond that has been planted with *Phragmites* (common reed).

SUCCESS/LESSONS

Northern Section
The channel now exhibits greater cross-sectional variation, both in terms of the low flow channel and second stage. The low gradient is insufficient to promote much bed variation or sustain the imported gravel riffles.

The berms created by the second stage channel have been colonised by terrestrial vegetation to such a degree that follow-up hydraulic modelling suggests a potential problem in terms of impedance of flood flows over the berms. Self-seeded willows and alders are abundant. It may be necessary to implement a cutting regime to create a flood route over the berms. Also, where willow spiling was used to revet the silty banks the growth now needs maintenance every 2-3 years.

In-channel the establishment and growth of vegetation has also been very successful. Species in abundance include *Typha* (bulrush), *Phalaris* (reed canary-grass), *Sparganium* (bur-reed), *Callitriche* (water-starwort), *Juncus effusus* (soft rush) and *Elodea canadensis* (Canadian pondweed). In places the *Typha* has had the effect of narrowing the low-flow channel, simulating a run. This vegetation growth should also promote shoal development and further narrowing in places (Plate 10).

The previous maintenance regime was to control the excessive growth of *Potomogeten natans* (broad-leaved pondweed). This has now been replaced by bi/tri-annual willow cutting and berm mowing.

Central Section

Lessons leant from the earlier work on the northern section, led to the setting up of a multi-functional team during the construction phase.

To link the lakes with the new course, pipes were used. The headwalls of these pipe outfalls were constructed from concrete and are very visual, detracting from the enhancement work. Attention to this kind of detail should be implicit in such schemes, but is often overlooked.

Some of the 'riffles' have undergone down-cutting and in doing so have provided material for the raising of the gravel berms further downstream.

OVERALL CONCLUSION

Over both sections the county councils have very successfully mitigated the impacts of diverting the river by incorporating in to the work aspects to enhance the new channel. The later central section has been more successful in this respect, mostly due to the involvement of the Environment Agency and a geomorphologist at the design stage, and a multi-functional team during construction. This process of involvement is reflected in the achievement of the objectives relating to geomorphological and ecological habitat diversity.

The northern section has a more sinuous planform, incorporating low berms and improved habitat potential, though is lacking in bed and bank variation. The central section exhibits greater structural diversity and integration of natural flow characteristics, which should in time develop a diverse vegetation structure.

RECOMMENDATIONS FOR THE SITE

Monitoring the two sites will provide valuable information.

Within the northern section this should address the development of channel narrowing, bed features and flow diversity, and problems associated with terestrialisation of low berms and rapid self-set tree growth.

The central section, being younger, has had less opportunity to become vegetated, but terestrialisation is beginning to occur on the raised gravel berms. In addition, further down-cutting of the gravel 'riffles' may result in narrow shutes, increasing velocity locally but not as a riffle.

The gabion banks still look very artificial. A possible solution is to incorporate live willow/alder to screen the wire baskets and provide additional support/stability through the root system (Plate 11).

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. The importance of early involvement of geomorphologists, landscape architects and ecologists with engineers in the design process is evident in the two approaches followed above. This needs to be related to councils and consultants when looking to undertake work of a similar nature.

2. Similarly the appointed clerk of works should have an awareness of the scheme design and issues involved. This is crucial to the success of such projects.

3. Where a great deal of thought and effort has been spent in designing a riverine landscape, it is important that this is not negated by a lack of attention to detail being applied to seemingly minor issues such as pipe outfalls.

4. When using live materials to support new banks/erosion points the maintenance implications must be adequately considered.

5. Low berms that have a critical conveyance role may need regular management or modified design.

COSTS

The county councils funded both sections with additional time input from the Environment Agency (NRA). Individual costings for the river improvement works are not available.

AVAILABLE INFORMATION

Pre and post photo records
Invertebrate survey - pre and post scheme
Fisheries survey – June 1997
River Corridor Surveys – Pre-works (1991), post-works (1996)
Conservation monitoring report – 1996
Environmental statement – June 1993

KEY PERSONNEL

Conservation – Dave Webb (EA)
Geomorphologist – Andrew Brookes (EA)
Contractor – Northern section – Hampshire County Council
– Central section – Alfred McAlpine
Consultants – Northern section – Hampshire County Council
Central section – ECD (Surrey County Council)

Blackwater Valley (1 of 2)

PLATE 1 Northern section – Before. Channel choked with Potamogeton natans.

PLATE 2 Northern section – Remnants of sinuous course remain, but separated from the floodplain. – March 1998

PLATE 3 Northern section – Two-stage channel with heavily vegetated berms. – March 1998

PLATE 4 Northern section – Meander loop reinstated with a gently sloping inside berm profile. – March 1998

PLATE 5 Central section – Spring Lakes. New sinuous course with low wet berms. Bat cave to the left of picture. – March 1998

PLATE 6 Central section – Two-stage channel. – March 1998

PLATE 7 Central section – The channel was cut in the dry and the bed lined with gravel.

Blackwater Valley (2 of 2)

PLATE 8 Central section – Gravel 'riffles' were introduced to create flow and depth diversity to the very low energy reach.

PLATE 9 Central section – Secondary channel/backwater. – March 1998

PLATE 10 Northern section – Narrowing by vegetation is introducing flow variation and substrate movement. – March 1998

PLATE 11 Central section – Gabion bank reinforcement. Introduction of willow/alder would soften the engineered appearance. – March 1998

RIVER CHESS ENHANCEMENT AT BLACKWELL HALL

DATES: Minor works 1993,
Fish pass and enhancements 1994/5.

LOCATION: Blackwell Hall, Latimer, BUCKS.

GRID REF: SU 980997

CONTACT: Environment Agency, Thames Region, NE Area, Conservation, Chris Catling. Tel 01707 632370

LAND OWNERSHIP: Private.

CATCHMENT INFORMATION

The Chess is a chalk stream. Water quality is generally good due to the stream's spring fed nature. However, urban runoff from Chesham town (the source of the Chess) and Chesham STW cause some eutrophication and enhanced organic silt deposition. The latter has undergone extensive refurbishment in recent years to improve effluent quality. The Chess at Blackwell Hall flows over flint and gravel deposits with patches of silt.

BACKGROUND

The River Chess, naturally a shallow fast flowing chalk stream with a good gravel bed, had been impounded at various places along its length from Chesham to Rickmansworth where it enters the Colne. It is also one of the few rivers in the NE area of Thames Region to have a self-sustaining brown trout population. In 1993, at Blackwell Hall the old mill weir head was removed to reduce flood risk and the opportunity taken to restore fish passage to the impoverished channel upstream where deep silt had accumulated.

Due to the size of the old mill weir a pool and traverse fish pass was considered rather than the usual Larrinier design. Just prior to the scheme Thames Water decided to re-site its effluent outfall downstream of the treatment works. This enabled the inclusion of works downstream to the new outfall structure.

OBJECTIVES

The scheme aimed to:

- modify the impoundment, remove the accumulated anoxic sludge (a function of previous poor quality effluent);
- recreate a more semi-natural vegetation structure based on *Ranunculus* (water-crowfoot) and *Callitriche* (water-star wort);
- improve habitat for adjacent native crayfish;
- improved visual/landscape quality.

The work would also contribute to a long-term strategic objective for the River Chess, namely to improve conditions for the native brown trout population and restore free passage through the system.

WORKS CARRIED OUT

Minor works were carried out in 1993, prior to the main fish pass/enhancement contract.

Downstream Meadow.

300m downstream of Blackwell Hall Lane, the Chess had been impounded by a low (300mm) concrete weir.

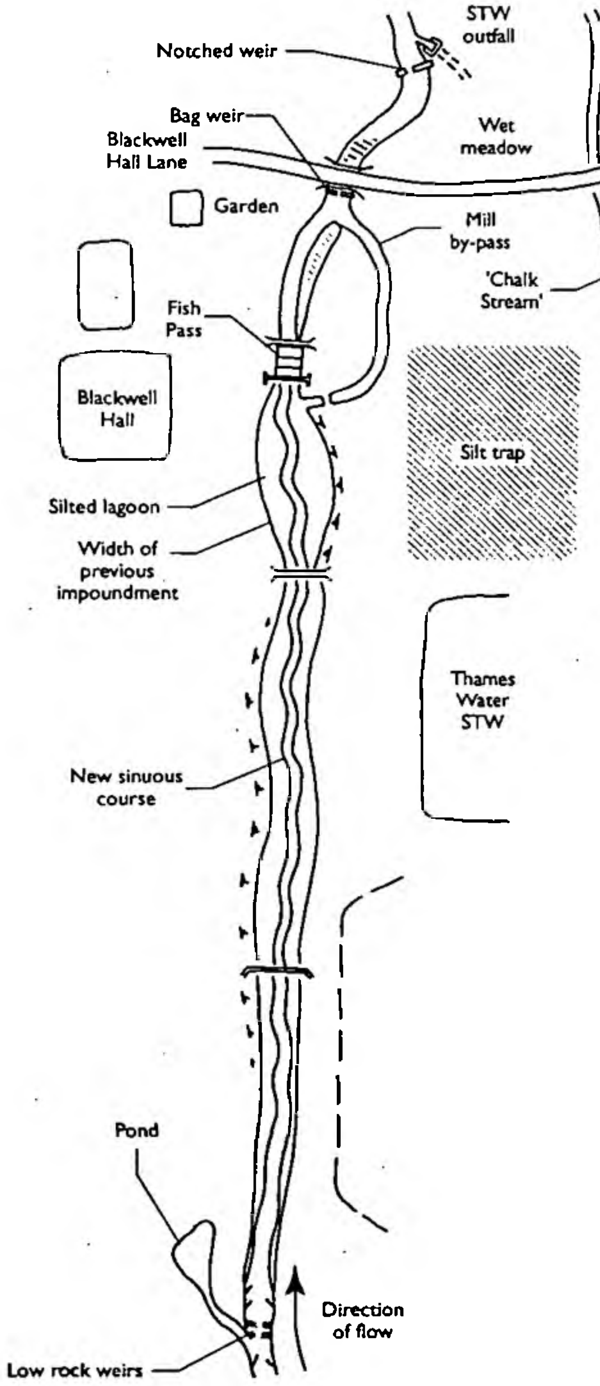
On the right bank was a wet meadow used for grazing specimen cattle (very low stocking density). However, the majority of inundation of the meadow came from the parallel 'Chalk Stream'. This impounded section of the Chess had not previously been dredged and the original gravel substrate was evident beneath the silty bed at the riffle below Blackwell Hall Lane bridge where the backwater effect from the weir ended.

To restore this section a 3m wide notch was cut in the weir, down to bed level, using an angle grinder (Plate1). The effect was to immediately increase velocity in a low-flow channel which has uncovered the gravel bed. Vegetation growth is further narrowing the flow to a central channel.

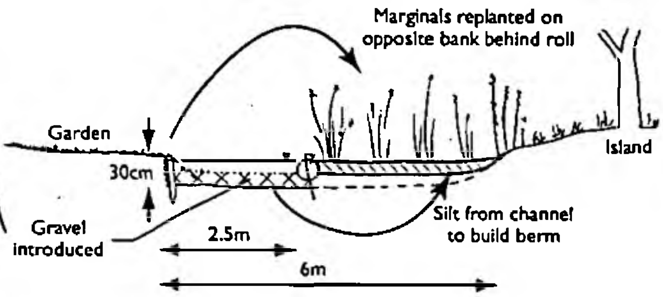
The meadow has not suffered from drying as a result of the work.

Garden - downstream of fish pass.
As a result enhancement works were carried out on the main channel, narrowing it from 6 to 2.5m; the narrow mill bypass channel was not modified. Bessmann fibre rolls were used to retain a berm (set at moderate flow level) created from silt from the stream.

River Chess at Blackwell Hall



Immediately upstream of Blackwell Hall Lane bridge a second low weir had been previously constructed from bagwork, with the probable aim of ponding/retaining water in the adjacent garden. The result had been a sluggish silt trap. As the structure was obviously 'home made' and without a fixed crest, it was easy to kick down. This similarly acted to increase velocity, however the section previously impounded had also been severely overwidened and gravels removed.



Channel narrowing d/s of fish pass

As a result, existing marginal vegetation (*Iris* (flag iris), *Glyceria* (reed sweet-grass) and *Carex* (sedge)) was removed from the left bank and replanted behind the rolls. The grassed left (garden) bank was retained by faggots, free of marginal vegetation at the request of the landowner, to open up the view of the stream (Plate 2). Some coarse gravel was introduced, this being too large to be reworked by the stream.

Fish pass.
A major component of the 1994/5 enhancement works involved the replacement of the mill weir with the pool and traverse fish pass (Plate 3).

A pool and traverse pass design consisting of three tiers, each with a 2m pool to absorb sufficient energy to allow the fish to rest between ascents, and achieve the required swim velocities to navigate the pass, was used to replace the old structure (Plate 4). Each tier is notched to accept the 95 percentile flow. The notch for all three weirs was 250mm in depth by 600mm width. The height between each notch was limited to 350mm to allow fish passage. The design was a modification of MAFF guidelines relating to such passes, produced by the in-house NRA team.

As a result the crest of the upper weir is 1.5m below the old weir level, resulting in an increase in gradient from 1:10,000 to 1:700.

Silted lagoon.
The channel above the old mill weir had, over many years, accumulated a vast quantity of sludge, mainly from the STW discharge directly upstream. In association with the fish pass works, dredging and reprofiling of the wide silted lagoon reach upstream was carried out.

To recreate a semi natural chalk stream the previous channel size needed to be drastically reduced, both in width (15m to 2m) and in depth. In places it was up to 2m deep (95% silt). The sustainable desirable depth would be c. 0.3m with an undulating gravel bed.

After de-watering via the bypass sluice, material was dredged from the channel and used to form a series of bunds in an adjacent field. This novel silt trap was then used to route silt-laden water round a tortuous path depositing its load before ultimately rejoining the bypass channel. In this way 1300m^3 of material was removed from the stream (Plate 5).

The narrowed new course of the Chess was formed using chestnut, birch and hazel faggots behind stakes. Berms were then created and held in place behind these using some of the excavated material. This formed a 300m length of sinuous, narrow, fast flowing channel, meandering within its originally oversized banks (on average 1m above the new water level) (Plate 6). Due to the quantity of silt which was encountered on site (far in excess of the 1000m^3 estimated) the berms are higher than is desirable, with the faggots and stakes protruding (up to 300 mm in places). The berms were planted with *Caltha palustris* (marsh marigold), *Myosotis scopioides* (water forget-me-not), *Rorippa* (yellow-cress), and *Veronica* (water-speedwell) where the most substantial narrowing had taken place. The landowner has since made adjustments in places by removing the marginal vegetation and grassing over the left bank.

Due to previous channel works the natural periglacial gravels were extremely rare. Imported gravels were introduced into the stream by means of a skip, a large pump and 200m of pipe. This method of placement overcomes the problems associated with access and disturbance of bankside vegetation. Some redistribution of gravel has occurred locally, forming deeper hollows and bars.

Upstream pond.
Towards the upstream limit of the works the impounding effect of the mill weir had been underestimated. Its replacement had resulted in a 250mm drop over a small weir which diverted water from the main stream into a small pond. To retain this feeder flow, two low rock weirs were erected together with hurdle deflectors to minimise the amount of fall at any one point. This work was carried out by hand due to the access problems for machinery (Plate 7). Further upstream a series of heather hurdles were used as deflectors to create flow diversity within the stream and to encourage narrowing by vegetation encroachment.

SUCCESS/LESSONS

The narrowing of the stream has proved very effective in creating good instream habitat, but the height of the adjacent berms is such they remain high and dry. This also exposes the unsightly faggoting and blue plastic ties (Plate 8).

The fibre roll berm, although having been constructed at water level, is being invaded by *Epilobium* (willow-herb), however this is probably a result of recent low flows not inundating frequently enough to control this species.

Some young horse chestnut standards have been added by the landowner, which may cause problems in terms of shading once they begin to spread.

OVERALL CONCLUSION

The project has successfully achieved its objectives, but with significant differences in terms of the landscape impact of various elements.

The effect of the downstream notch-cut has been very successful both physically and aesthetically (Plate 9).

The berms created within the Hall's gardens have achieved the objectives set, but look too well manicured - not what was expected. This is also due to the perceptions of the landowners who have made changes of their own, towards a more 'gardened' appearance.

Results from an early study of the effectiveness of the fish pass (1995) showed that three weeks after stocking with a population of 150 fish below the pass, c.40% were recorded having ascended the fish pass. As the size range was 95-300mm the weir did not solely favour adults, indicating considerable early success in promoting free passage.

RECOMMENDATIONS FOR THE SITE

Give the site time to settle and adjust to its new course.

Monitor vegetation growth on the berms to see if their height has a significant adverse effect. On the low berms at the island by the bypass channel, observe whether the *Epilobium* will die back as is hoped (however, this is not expected to occur naturally).

Fish movement through the pass needs to be monitored regularly to assess the continued effectiveness of the design, long term, and success in terms of the original objective. In addition, monitoring of other biotic recovery indicators is also important.

Tree growth will need to be managed and maintained as necessary to prevent increased shading.

It is important that the natural breakdown of the faggoting be monitored to assess its use on further schemes, and the possible need for its later removal.

Consideration should be given to the experimental removal of a section of faggoting once growth on the berms has established sufficiently and they have become firm and dry.

To reduce the visual impact of the faggots, reeds, etc. could be planted directly behind them. This would have the added benefit of increasing future stability and sustaining the narrowed channel, whilst improving marginal habitat.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Ensure the removal/lowering of weirs does not lead to drying of adjacent terrestrial wetlands.

2. Be sensitive to landowner aspirations where creating wet ledges in gardens.

3. Ensure that if they are being provided with a natural habitat of ecological value, that they do not think it is merely an unsightly mess which they will alter given the first opportunity.

4. Consider temporary use of, or other treatments instead of, vertical faggoting which is visually intrusive if left protruding above water level.

5. Use pre-planted 'Bessmann' type coir rolls as alternatives to faggots, grading the bank up gradually from the water's edge.

COSTS

The entire scheme was funded by Thames Region's Flood Defence Enhancement Budget.

Initial low weir removal/modification work carried out in 1993 cost c. £5,000.
The 1994/5 externally contracted works, including the fish pass and channel works, totalled £107,000. The pool and traverse pass accounted for £46,000.

Co-operation was received from the four landowners.

AVAILABLE INFORMATION

Contract documents
Drawings - plans, long and cross sections,
Site record photographs (pre and post)
RCS - post project
RHS - post project
Fisheries surveys
Macrophyte surveys
Invertebrate surveys

KEY CONTACTS

Conservation Officer - Chris Catling
Fisheries Officer - Richard Tyner
Flood Defence Engineer - Steve Lavens
Contractor - J. Murphy & Sons Ltd.
Consultant - EA In-house.

Chess (1 of 2)

PLATE 1 Notched weir. – February 1998

PLATE 2 Looking upstream through the garden. The right bank is free from vegetation, providing the requested open view of the stream.

PLATE 3 Old mill weir, a barrier to fish passage.

PLATE 4 New fish pass, lowered the crest by 1.5m. – February 1998

PLATE 5 Before – On removal of the old mill head 1300m^3 of material (up to 2m deep) was dredged from the channel.

PLATE 6 After – faggoting was used to form the new narrow sinuous channel. – February 1998

Chess (2 of 2)

PLATE 7 Two small rock weirs were erected to retain a feed to the upstream pond. – February 1998

PLATE 8 Raised berm and faggots. – February 1998

PLATE 9 Notching the downstream weir has removed the previous backwater effect that covered the bed with silt. – February 1998

RIVER COLE ENHANCEMENT WORKS

DATES: 1992

LOCATION: Roves Farm, Sevenhampton, nr. Swindon, WILTS.

GRID REF: SU 218874 to 217888

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Graham Scholey. Tel. 01491 832801.

LAND OWNERSHIP: Private

CATCHMENT INFORMATION

The River Cole is a flashy river within a mainly clay catchment. This effect is exacerbated by rapid run-off from Swindon. The channel gradient is sufficient to sustain pool and riffle sequences, however these have mostly been removed through land drainage operations, leaving an over-wide and deep channel. Like much of the Cole this section has been realigned, the nearby tortuous county boundary line would almost certainly have been the course of the river at one time. Water quality is moderate to good and was not a constraint to the proposed works.

BACKGROUND

The project reach exhibited eroding/slumping banks where no tree/shrub cover was available to stabilise them. This instability also prevented the establishment of marginal flora. The sluggish over-wide channel led to minimal low-flow summer water depths and lack of oxygenation. The landowner was also regularly loosing sheep/lambs which sheltered in undercut banks, but were unable to escape from the river during flash flood events.

The landowner wished to increase the conservation value of part of the farm, particularly an area of riverside meadow that flooded regularly and was being considered for entry into the Countryside Stewardship Scheme.

The fisheries team surveyed two sites within the proposed reach. Both failed to meet NRA Thames Region target biomass figures for EC designated coarse fisheries. The main factor was given as a lack of in-stream habitat.

OBJECTIVES

- Increase turbulence using riffles to provide silt-free spawning areas, invertebrate habitat and stimulate re-oxygenation;
- create pools for fish shelter;
- improve in-channel and bankside diversity - width, depth, substrate and flow velocities;
- create a wetland feature fed by out of bank flood events, between the river and a tributary ditch.

WORKS CARRIED OUT

Enhancement works were implemented over a total river length of 1.3km.

Bank re-profiling

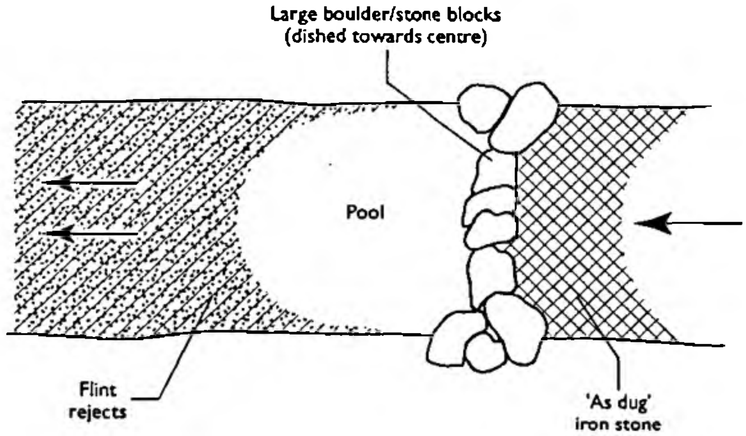
Four sections were identified, between existing tree/shrub-lined banks, where re-profiling could be undertaken.

At each a length of the left bank has been pulled back from the water's edge, forming a 1m ledge rising to a gentle slope. A toe of blockstone funnels the downstream 'return' to the old channel shape. No planting was undertaken.

1. *Downstream.* - A 100m section, ledge at or below water level, rising to a 6m wide gentle uniform slope. The bank is fenced off from grazing stock as it is adjacent to the wetland (Plate 1).

2. *Lower-mid.* - A 40m length, ledge at water level, rising to a 4-5m wide gentle slope. The river edge is not fenced from stock.

3. *Upper-mid.* - A 30m reach, ledge at or above water level, rising to a convex 4-5m wide slope.



River Cole pool/riffle structures

The river edge does not appear to be accessed by stock.

4.*Upstream.* - A 60m section, (similar to 3 above).

Pool/riffle structures
Seven pool/riffle structures were constructed at intervals over the reach (Plate 2). Positioning was decided on-site, to maximise their effect.

Flow deflectors
A number of blockstone groynes were constructed to provide in-channel flow diversity and promote silt accretion and narrowing of the low-flow channel. These extend to one third of the channel width and are backfilled with bank material.

Wetland scrape
A wetland feature was excavated in an adjacent meadow, surrounded by ditches, which regularly floods. Approximately two acres, the linear scrape has two deeper (up to 1m) pools separated by a central 'spit' (Plate3). The bed was found to be clay, with one seam of gravel that is now known not to connect to the river. The wetland is perched above the river level but retains water well after flooding, which occurs frequently (Plate 4).

Approximately 10,000m^3 of spoil was excavated, mostly from the wetland, and disposed of by constructing raised earth banks along the hedge line set back from the riverside meadows. This constructive use of the material saved on costly removal off site.

No topsoil was returned to the scrape and little wetland planting was carried out (some by the Great Western Community Forest; transplants from Coatewater).

SUCCESS/LESSONS

Each re-profiled bank section (1 to 4 above), though similar in design, has developed and colonised differently.

1. The shallow bank and ledge supports a good diversity of wetland plants.

2. Fairly bare due to sheep grazing. This may promote good diversity over time, though periodic fencing/restricted access may be necessary.

3. The ledge and bank slope has been colonised mainly by Dock and patches of Nettle. Few wetland species are evident. It is believed that this bank was open to sheep grazing for a number of years (Plate 4).

4. Supporting Dock and Nettle. Again the ledge is higher/dryer than section 1 and 2, and may have been grazed initially.

The groynes benefit flow diversity during low-flows, though the desired accretion and vegetation establishment behind the groyne, to promote channel narrowing, is not evident.

The pool/riffle structures have settled/moved more than expected. The original design incorporated a low central section to concentrate flow into the pool to maintain its depth and clean the downstream gravels. Some bank erosion is evident where the crest has become level or forces flow into the bank. The gravel has not remained free of silt at most locations and is therefore not suitable for spawning.

The wetland site has developed well with wetland plant species, and is periodically grazed to control excessive growth. Waders including Curlew and

Lapwing breed on the site and it supports various waterfowl. A measure of its early success was the erection of shooting hides on the request of a local club, since discouraged by the NRA/Environment Agency on grounds of it conflicting with the original conservation purpose of the wetland.

OVERALL CONCLUSION

The in-channel enhancement works have improved flow diversity, especially at low-flow which was the main concern. The replacement of spawning gravels has not worked as well as expected, they remain largely silty or have been displaced. The re-profiling has increased bankside diversity, and has addressed the farmer's concern over sheep loss, but not increased wetland plant diversity significantly other than at one of the ledges.

The wetland scrape has proved the most successful. It is also the most valuable since good wetland habitat in this part of the Cole catchment is very rare.

RECOMMENDATIONS FOR THE SITE

Continued informal monitoring of the wetland and in-stream features.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. A combination of fencing re-profiled banks from stock, and a shallow slope with a wet ledge, appears to produce the best results in terms of increased bankside diversity. Problems arise when allowing stock access and creating a more terrestrial environment.
2. The design of the riffle weirs is critical. The whole structure should have a fall from bank to river to discourage bank edge scour. The placement of gravel and the ability of the river to keep it clean also depend on the weir design, flow regime and gradient. Greater flow concentration at low to medium flows helps this.

COSTS

The total cost was borne by the Environment Agency - £13,500, from the Flood Defence Enhancement Budget. The Landowner was partly compensated for his loss of grazing by Stewardship grants. In addition, the landowner, in conjunction with the Great Western Community Forest, carried out some minor planting work after completion.

AVAILABLE INFORMATION

General plans and drawings,
Audit survey - 10/2/93,
Pre and post photo records

KEY PERSONNEL

Conservation Officer – Graham Scholey (EA)
Fisheries Officer – Eddie Hopkins (EA)
Operations – Simon Beaven (EA)
Contractor – In-house workforce

Cole

PLATE 1 No. 1 – Downstream, bank re-profiling and ledge vegetation establishment. – May 1998

PLATE 2 Constructed 'riffle'. – May 1998

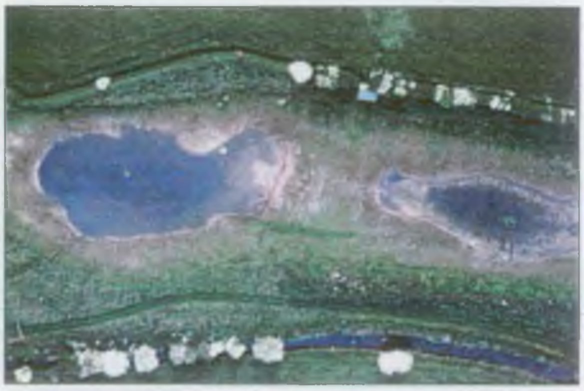


PLATE 3 The River Cole and wetland, dry weather showing central 'spit'.

PLATE 4 Wetland scrape. Good diversity of self seeded plants supporting waders and wildfowl. – May 1998

PLATE 5 No. 3 – Doc and nettle have colonised the re-profiled bank. – May 1998

RIVER COLNE ENHANCEMENT AT WATFORD

DATES: Main NRA enhancements 1993, Additional backwater work 1996.

LOCATION: Off link road (Stephensons Way) to M1, J5, Watford, HERTS.

GRID REF: TQ 118970 (upstream start of reach).

CONTACT: Environment Agency, Thames Region, NE Area, Conservation, Chris Catling. Tel. 01707 632370.

LAND OWNERSHIP: Public.

CATCHMENT INFORMATION

Geology is chalk overlain by boulder clay. Gravel deposits are present around the Watford area which accounts for the gravel bed. The water quality is usually good and not thought to be a limiting factor to the proposed enhancements, although it is affected by variable standards achieved by a large STW upstream of the reach. Flood risk is high due to the size of the catchment and speed of run-off from the urban/clay catchment.

BACKGROUND

In 1989/1990, to facilitate construction of the Watford M1 Link Road, the River Colne was 'redesigned' and realigned. As a result the channel became trapezoidal, relatively straight and over wide (by up to 2m) for the predicted minimum flows. The bed (deepened by nearly 1m) was uniform and silty and marginal vegetation was very sparse. This resulted most notably in a drastic reduction in fish numbers (270 recorded in October 1988, 3 recorded in October 1992) following the general loss of habitat diversity. Three balancing ponds were constructed as part of the road scheme, to store excess river water during high flows.

After assessment of the reach by the NRA, Watford District Council and the NRA jointly funded a number of instream measures in 1993, designed to enhance the reach. Realignment of the river was not possible.

Further works were carried out in 1996 after to improve the habitat value of the adjacent lakes and prevent them from drying out in hot summers.

OBJECTIVES

The 1993 enhancement scheme was aimed at reversing the effects of the previous works and achieving broad habitat objectives:

- good fisheries data indicated very poor conditions, so a target was set at previous biomass figures;
- increase marginal and aquatic vegetation;
- develop varying flow characteristics, absent due to overwidening and deepening.

The 1996 work reprofiled and reconnected the ponds, which were not serving any useful ecological or water quality purpose. This was seen as an opportunity to increase shelter for fish by creating good backwater habitat.

WORKS CARRIED OUT

The reach can be separated into two fairly distinct sections. Upstream covers the reach from Link Road to the railway bridge. Downstream extends from the railway bridge to Water Lane.

Upstream

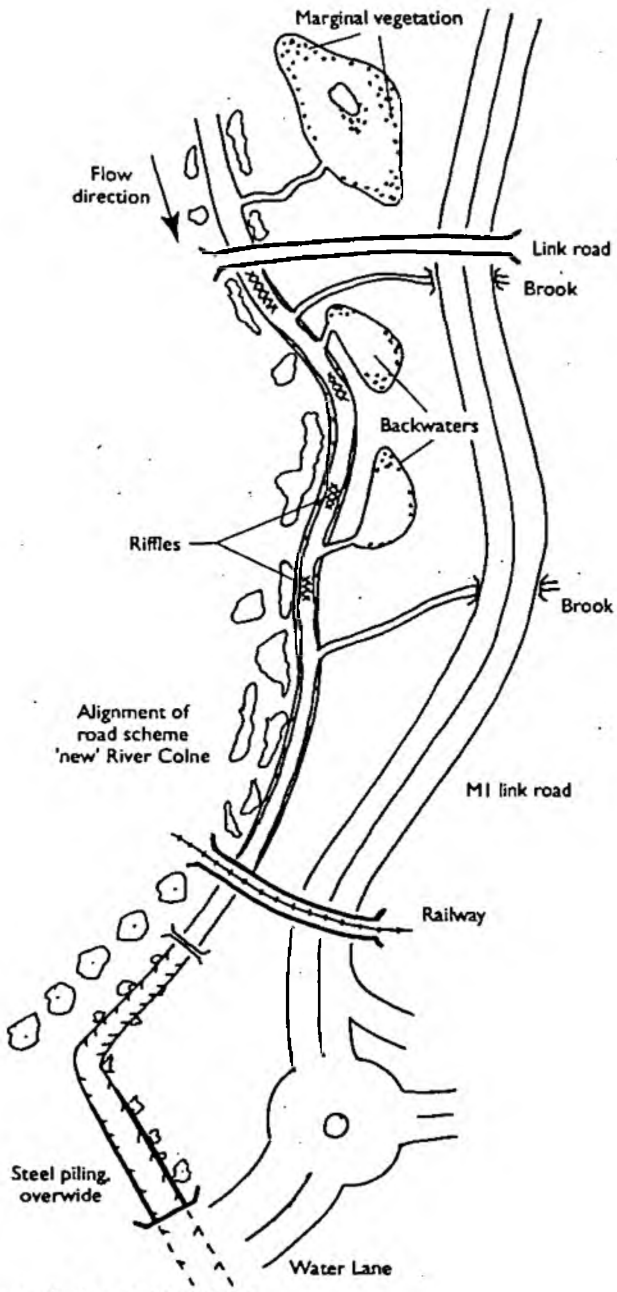
This section already had some sinuosity and a gradient sufficient to enable the introduction of in-channel features without causing long backwater effects. Normal water depth was approximately 150 mm. Some marginal vegetation (primarily *Glyceria* (reed sweet-grass)) was present prior to the enhancement work being undertaken.

Flow deflectors pointing downstream, in the form of blockstone groynes, were placed in the channel at varying intervals. Layout was specified on site using general geomorphological principles provided by in-house expertise.

Groynes were placed singly or in pairs depending on the desired effect. The stone was large, between 1 –2 tonne angular limestone blocks.

The number of groynes over this length is approximately 12.

Two artificial riffles were also introduced. This involved a downstream opposite pair of groynes, with a lower lip of holding rock and an upstream pair of groynes to shoot water over the riffles.



River Colne at Watford

Gravel was imported to a design specification, fairly large coarse angular material, designed, in conjunction with the groynes, to stay in place (Plate 1). Gravel movement within the river was not desirable due to the proximity to central Watford and the perceived risk of flooding to properties.

The three ponds were originally a part of the road scheme, not the river realignment. They were designed to store the run-off from the road, which was discharged directly to the river. Connection was by a narrow, upstream facing, 1m wide cut at the upstream end of the ponds. A weir at the inlet prevented low flows in the river entering the ponds. As a result they dried up in hot summers and after floods fish became stranded. In addition the banks were very steep and bare, the largest pond sporting a conical mound as an 'island'.

The banks of all 3 ponds were reprofiled to form wetland shelves at the low-level, Th eoriginal inlets were filled in and replaced with downstream angled inlets to prevent polluted water entering the ponds. The inlets were located at the downstream end of the ponds where feasible. (Plate 2).

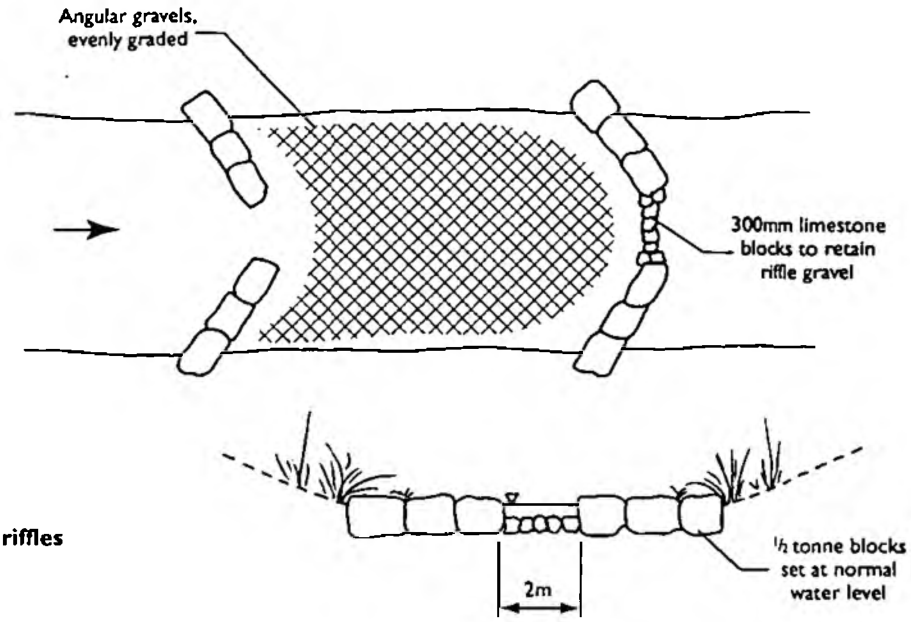
All three backwaters were planted to varying degrees with a mixture of *Phragmites* (common reed) and other marginal species.

The larger backwater had its island reprofiled to 50% just above, and 50% just below, normal water level. Its new downstream connection channel was necessarily four times longer than before, resulting, together with the deepening of the backwater, in an excess of spoil. For this reason the connection was left looking very trapezoidal. The spoil was used to form wetland shelves at the edge of the ponds (Plate 3).

Downstream

The bank along this section consists of gabions and/or sheet piling near to the bridges, with a trapezoidal concrete and gabion mattress channel in between.

Groynes have been placed every 10-15m, sometimes in pairs, to attempt to create flow diversity and promote accretion and subsequent colonisation (Plate 4). The groynes were placed at low flow level to provide capacity for flood flows.



Constructed riffles

The end of the enhancement reach widens out and begins to lose its gradient just prior to the start of the sheet piling. In this engineered section the groynes are only a quarter of the channel width and poorly constructed a result of the method of installation imposed by the weight of the granite blocks. They had to be deposited upstream then rolled into place by a JCB.

SUCCESS/LESSONS

Upstream

The groynes have successfully increased flow diversity and promoted accretion, which has become well vegetated, having the desired effect of narrowing the overall channel width. The groynes have also increased scour and silt removal within the central channel and formed runs.

All of the constructed riffles have remained in place during the subsequent 5 year period. Some localised movement has occurred elongating the downstream slope and scouring the bed directly downstream. Each riffle has also had the effect of creating a slack reach just upstream, due to a short backwater effect, and localised deeper runs downstream.

An upstream riffle has self-seeded itself with gravel, possibly due to transportation of material from the top end of the site where excess gravel was spread into the river opposite the site compound forming a long 20m gravel bed.

All of the riffles have become colonised by appropriate species such as *Ranunculus* (water-crowfoot), with encroachment of marginal species, mostly *Glyceria*, narrowing and further increasing flow velocity.

The speed of vegetation establishment and narrowing at the margins provides very important lessons. It is felt that this is a function of getting everything right in terms of groyne height, length and position, riffle size and placement, and the slope and the materials of the banks. When banks are steep and composed of gabion baskets, little establishment of marginals can take place due to a lack of growing medium. In contrast, shallower earth banks are ideal and the vegetation becomes an important component/factor in shaping the channel width and flow characteristics. The blockstone, sized to withstand flood flows, was felt to have been very successful in achieving the desired narrowing upstream. Most are now barely visible even when the vegetation has died back.

In the backwaters planting has matured and spread over the past two years and 'no fishing' signs have been erected by the large backwater to minimise disturbance. Unfortunately, Hertfordshire County Council have laid a gravel path and bridged the connecting channel, forming a circular walk around the large backwater.

Downstream
The reach between the railway bridge and Water Lane has had less opportunity to recover naturally, even with the aid of the enhancement works. Some colonisation has occurred, mainly terrestrial vegetation on the banks, with some instances of marginal plants clinging on in the lee of a few groynes where silt has accreted. Gradient here is sufficient for the deflectors to achieve a sinuous central low-flow path, however, accretion and colonisation is limited due to the steepness of the gabion bank slopes, the 'porosity' of the stonework and lack of existing marginal vegetation, which plays an important role in trapping fines.

At the end of the downstream reach the river is now too wide for the groynes to have any real effect. They lie much lower in the water than those further upstream, and are more likely to be drowned out even at moderate flows. Their angular shape and depth in the water allows flow through and over the stones, even at normal flow, preventing silt accumulation. Where silt does build up colonisation is poor and will be washed away in higher flows

In addition, shading by the main road bridge further restricts growth. Some fish have been recorded in this section sheltering just downstream of the tip of the deflectors, the only habitat available. Following the success of the enhancement scheme Watford Borough Council has entered into two further schemes (one planned) totalling up to £200,000.

OVERALL CONCLUSION

Upstream
This section has been very successful, exceeding the aspirations of the original objectives. This achievement is a function of a good design and ideal site conditions in terms of gradient, shallow earth banks and an abundance of emergent vegetation. The more recent backwater work also appears to be developing well.

Fish numbers, biomass and species have all improved beyond that recorded prior to the original road scheme.

Downstream
The straight reach from the railway bridge is showing reasonable flow diversity and should form good habitat for fish and invertebrates. It will, however, be limited by a lack of marginal vegetation due to the steepness of the gabion banks.

The section dominated by sheet piling has not achieved the set objectives as the channel is too wide and the groynes are not sufficiently solid to deflect flows under low to medium conditions.

RECOMMENDATIONS FOR THE SITE

None for the upstream section other than observing the *Glyceria* growth to make sure it does not become too invasive.

Downstream, the gabion banks would require too much modification to establish a marginal fringe. It would be difficult to justify the costs involved to remove the stone and expose/re-profile the earth bank.

Within the sheet pile lined channel it may be possible to try to create a sinuous low-flow channel using imported stone and excavation of in-channel material. The stone would need to interlock effectively to work as a deflector. A potential concern may be the risk of snagging urban rubbish, which the present drowned groynes do not do.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Concentrate effort in areas where the structural benefits of the groynes and riffles will be accentuated by the natural spread of bankside and marginal vegetation.

2. Steep, gabion lined banks will take much longer, if ever, to establish a good marginal vegetation fringe. Therefore, the structural benefits of the groynes are reduced because of the poor cover provided for fish and invertebrates.

3. Stone groynes, when used in wide, vegetation poor sections, must be interlocked to form an impenetrable barrier to flow if they are to be capable of creating the desired flow conditions.

4. The spacing of deflectors and whether they are placed opposite, alternately or otherwise needs to be determined by the prevailing site conditions and the scheme objectives.

5. Supervision was provided in-house and took approximately 2 days per week. This is thought to be a major contributing factor to the success upstream, together with having a suitably flexible specification to allow a degree of modification on site to ensure correct levels. Art and experience, not rigid science, are important components. This does of course incur both time and cost penalties. The conservation officer involved made various amendments on site as a response to work in progress (riffle /groyne placement and level adjustment).

6. The method of working, ie downstream to upstream, is of particular importance when removing or introducing structures which will affect levels upstream.

COSTS

The 1993 scheme was jointly funded by:
NRA - £13,000;
Hertfordshire County Council - £25,000.
The 1996 works was funded wholly by the Environment Agency Flood Defence Enhancement Budget, total cost £18,800.

AVAILABLE INFORMATION

General plans.
Engineering Drawings.
Pre and post site photo records (including aerials).
RHS 1995.
RCS 1986.
Fisheries surveys 1988, 1992, 1994, Apr 1995, Oct 1995.
Macrophyte survey 1997.

KEY PERSONNEL

Conservation Officer - Chris Catling (EA)
Fisheries Officer - Richard Tyner (EA)
Geomorphology - Karen Hills (WS Atkins)
Engineers - Martin Japes, Steve Lavens (EA)
Contractor - NRA In-house.
Consultant - NRA In-house

Colne

PLATE 1 **Constructed gravel riffle, *Ranunculus* starting to colonise.** – February 1998

PLATE 2 **Small backwater and connection to the river.** – February 1998

PLATE 4 **Groynes introducing flow diversity (downstream of the railway bridge).** – February 1998

PLATE 3 **Large reed fringed backwater, connected by a steep sided ditch.** – February 1998

TIDAL RIVER CRANE ENHANCEMENT

DATES: 1993/5 and 1995/7

LOCATION: Confluence with the Thames upstream of Richmond Lock, Richmond Road Bridge, Twickenham, LONDON.

GRID REF: TQ 166754

CONTACT: Environment Agency, Thames Region, Landscape Architecture Group, Richard Copas. Tel. 01189 535565

LAND OWNERSHIP: Private/Local Authority

CATCHMENT INFORMATION

The River Crane is a tributary of the R. Thames. The catchment covers approx. 100 km^2 consisting of 40 km of channel rising in West Harrow. The bed gradient is approx. 1:1400 for most of its length, but steeper (1:500) at both its upstream and downstream limits. The geology is London clay, extending over practically the whole area; this combined with the large percentage of urban development results in a very flashy rainfall response.

BACKGROUND

A feasibility study was undertaken by Thames Water - Rivers Division in 1985; to evaluate the need for flood defence works on the lower tidal Crane. Serious flooding had not occurred recently but the area was known to be at risk.

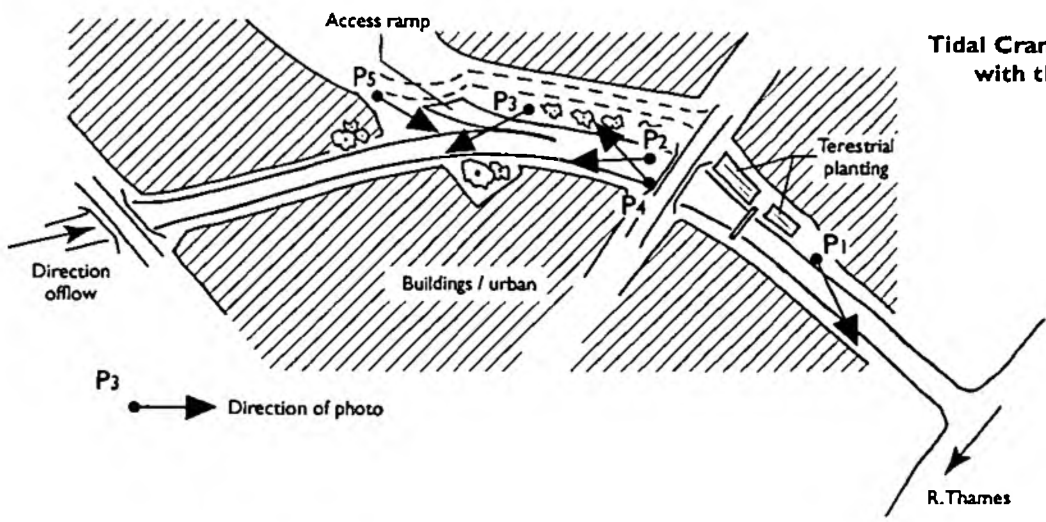
Contract 1 of the works was the 250m of river from its confluence with the Thames. This involved renewing the tidal flood defences that had badly deteriorated and could cause flooding upstream if a collapse occurred. The first stage was the capital flood defence works, followed by a separate landscape contract to produce the desired end effect.

The original design option consisted of long high vertical sheet piling covered with a brick facing. This utilitarian option met with strong local opposition and the scheme was re-designed to incorporate stepped walling, to conserve riverside trees and to include marginal planting in terraced areas in the channel.

OBJECTIVES

The landscape design objectives were to:

- introduce variety to the vertical profile;
- utilise a range of different materials to minimise the linearity of the defences;
- integrate vegetation into the works and retain existing mature trees.



Tidal Crane confluence with the R.Thames

WORKS CARRIED OUT

Pile screens

The capital works scheme required the use of steel piling to provide maximum protection (Plate 1). The majority of the piles were then clad with other materials to soften the appearance (Plate 2). This included:

- stonework, with the grout recessed to allow silts and seed to deposit and colonise (Plate 2);
- brickwork with a horizontal pattern above the high tide mark;
- timber cladding;
- some exposed piling with planted boxes at various levels.

Landform work

In addition to the above face-work, every opportunity was taken to reduce the uniformity of the 3m vertical profile. This was achieved by:

- creating low level raised ledges, planted with *Angelica sylvestris* (wild angelica), *Scirpus lacus tris* (club rush), *Lythrum salicaria* (purple-looses trife), *Carex* (sedge) and *Iris* (flag iris) (Plate 3);
- constructing private mooring platforms where the landowner was co-operative, and steps up to the bank top;
- creating high level planted ledges containing trees and shrubs;
- emphasising the theme of navigation by providing wooden mooring pillars at intervals along the reach.

Landscape work

The overall landscape was conserved and enhanced by:

- retaining existing impressive mature bankside trees by altering methods of working to prevent damage, etc;
- planting low trailing species which hang over the bank side (Plate 4);
- planting up any ledges created with appropriate species able to survive and thrive in the tidal environment;
- careful choice of materials, for example the type of railings, to integrate into the overall visual appearance.

In-channel, the concrete bed was covered with a layer of gravel.

SUCCESS/LESSONS

All of the above works served to greatly enhance the habitat and aesthetic value of the river from that which was originally proposed.

OVERALL CONCLUSION

The overall objective, to renew the tidal flood defences incorporating a range of benefits associated with the soft engineering and landscape works, was achieved (Plate 5).

RECOMMENDATIONS FOR THE SITE

Informal monitoring of the site in terms of photographic records to demonstrate the establishment of vegetation and longevity of other measures. Make use of experience gained to ensure the importance of the visual and aesthetic benefits here can be adopted confidently elsewhere.

The site should be promoted widely and used to demonstrate the approach taken and the practical alternatives available to the 'standard' solutions to flood defence renewal works.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Ensure landscape design objectives are built into new projects from the onset to avoid the need to redesign new structures so as to fit in with existing site features and character.

COSTS

Approximately £40,000 to £50,000. Difficult to differentiate costs from the overall £2 million NRA capital scheme.

AVAILABLE INFORMATION

Contract drawings.
Information leaflet.
Post project photos.

KEY PERSONNEL

Project Manager – Dak Gor/Phil Elmer (EA)
Landscape Architect – Richard Copas (EA)
Contractor – Calabasas Ltd
Consultant LA – Bell Fischer/Jung & Partner
Consulting Engineers – Haiste Group Ltd

Crane

PLATE 1 Steel piling, the most common utilitarian solution. – April 1998

PLATE 2 A variety of finishes to break up the vertical bank. Mooring posts portray the theme of 'navigation'. – April 1998

PLATE 3 Hardy marginal plants were planted in the tidal ledges. – April 1998

PLATE 4 Existing trees were retained unharmed and trailing plants used to soften the brickwork face. – April 1998

PLATE 5 View showing many of the enhancement techniques used. In particular note the retention of the impressive horse chestnut trees within an amenity area, and stepped access route leading to moorings and planted ledges. – April 1998

RIVER DUN HABITAT ENHANCEMENT AT FROXFIELD

DATES: 1995

LOCATION: North Standen Estate, Froxfield, Nr. Hungerford, BERKS.

GRID REF: SU 314680 to SU 316679

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Graham Scholey. Tel. 01491 832801.

LAND OWNERSHIP: Private.

CATCHMENT INFORMATION

The Dun is a chalk stream, part of the Upper Kennet valley. Similar to many other chalk streams the Dun has a fairly stable flow regime. The stream has a good gradient, and can maintain a clean, though over-widened, gravel bed. Water quality is also generally good.

BACKGROUND

The reach at Froxfield was identified as being in need of enhancement works from an initial fisheries survey carried out in May 1989. Three 'home made' corrugated iron and post weirs had been constructed to form a ponded section (Plate 1). This area was being used intensively as a duck feeding pond, feed going directly into the stream. At the upstream end of the site an off-line duck pond fed poor quality water into the reach.

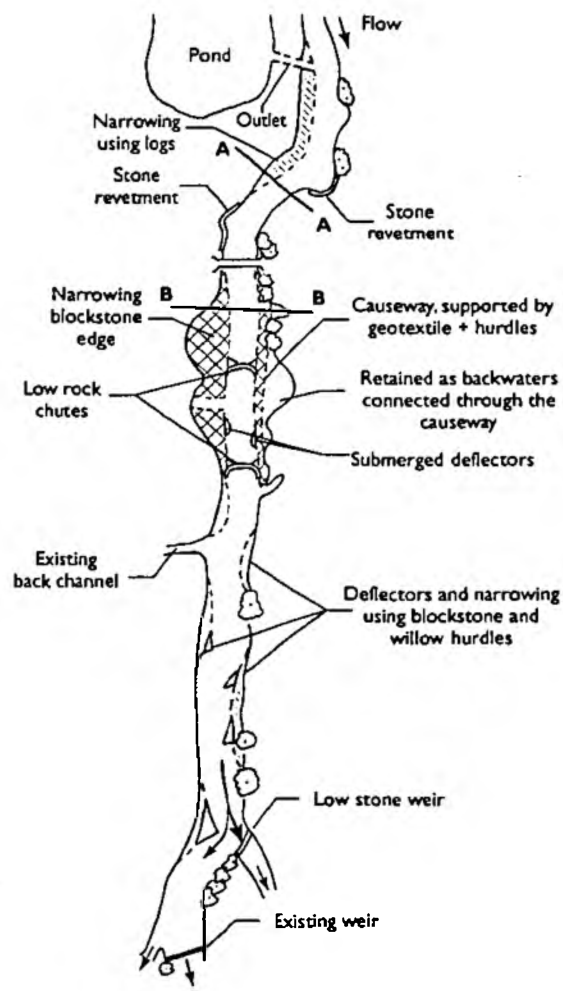
Due to the number of ducks the banks were bare and badly eroding (up to 3 times the original width), further accentuating the stream's ponded nature. The streambed, once clean gravel, was heavily silted; up to 1m of anoxic material at the weirs (3/4 of the channel depth). In addition, the number of rats was a major concern for the landowner.

The new landowner, North Standen Estate, was also keen to improve the fishery and increase habitat value, including removing the ducks and relieving the rat problem.

OBJECTIVES

- Remove impoundments;
- reinstate the original gravel bed, pools and riffles to improve the fishery;
- define an appropriately sized channel;
- enhance in-channel and bankside diversity, through re-profiling, ledge creation, etc.

Habitat enhancement and narrowing on the River Dun at Froxfield



WORKS CARRIED OUT (3 sections)

Section A - pond outlet to existing footbridge - 80m

As the upstream section was far enough from the impoundments to retain a good gradient, a central strip of exposed gravel was evident through the wide silted channel. The works were modelled on the supervisor's visual interpretation of the pattern of silt deposition and natural channel adjustments.

Just above the pond outlet small stone groynes were used to promote pool scour and narrow the left bank. Some eroded 'bays' were left to silt up naturally and to provide slow, shallow water.

Most of the narrowing occurred on the right bank (no vehicular access available on the left). The bank was steep and eroded by ducks. Narrowing was achieved by the use of 300mm dia. larch and willow logs (easily available due to tree work on the site). These staked logs defined the stream edge and were backfilled with bank material to form a damp/wet ledge, between 2 and 5 m wide (up to 50% of the eroded channel – Plate 2). Concern was expressed over potential washout of the ledges so they were sown with a standard rye grass seed mix to bind the bare earth. At the top and bottom end the ledge was keyed into the bank and protected with blockstone.

Where the pond outlet fed into the Dun it was extended using a pipe, built into the new ledge.

Small parts of the section were revetted with stone to prevent perceived erosion problems due to the narrowing and flow concentration, mainly at the footbridge.

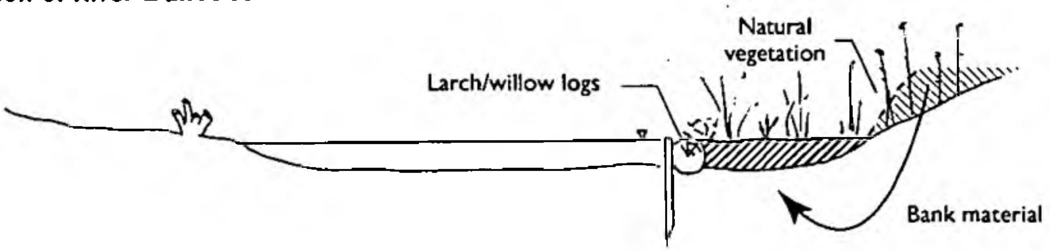
Section B - Existing footbridge to central impoundment - 70m

Downstream of the footbridge the channel had suffered massive widening by duck erosion (Plate 3). The channel was up to 30m wide at several points. A new sinuous channel was defined with a hard edge, using hazel hurdles on the left and stone on the right. The width was returned to approximately 5m (Plate 4).

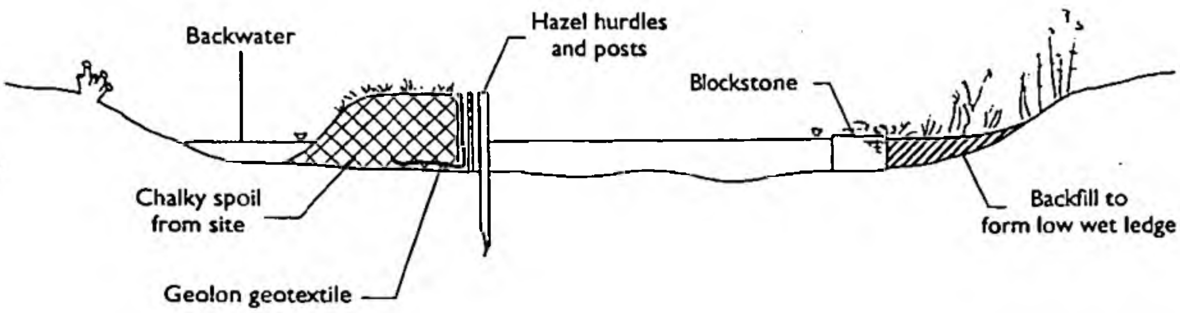
The left bank hazel hurdles were backed with Geolon (a fine weave geotextile) and backfilled for two metres using chalky spoil, previously excavated from the off-line pond. The remaining silty eroded edge and open water was retained and left to re-colonise with wetland species.

The right bank, formed using limestone blocks, was set at a much lower level to create a wet, boggy ledge (Plate 5).

Cross section of River Dun A–A



Cross section of River Dun B–B



The impoundment was removed and replaced with two low rock chutes aimed to concentrate flow and sustain small pools. Several submerged deflectors were added, 1.5m wide, to ensure continued flow concentration even at very low flows.

The work immediately exposed the gravel substrate so *Ranunculus* (water-crowfoot) was fixed to plastic mesh and weighted down in the pools and riffles to encourage re-colonisation.

Section C - central impoundment to downstream overspill weir - 130m
Various narrowing works were carried out over this section on both banks, using willow hurdles and blockstone. The height of the hurdle revetment increases downstream to 1m (Plate 6). Deflectors were also used to create flow diversity, whilst retaining small back channels fed by springs. The old overspill weir was replaced by a much lower blockstone crest, lowering water levels by 0.6m (Plate 7).

SUCCESS/LESSONS

Section A.
The combination of narrowing and groynes has concentrated flows sufficiently to retain a clean gravel bed. Some minor siltation is occurring where the eroded 'bays' were left. The seeded ledge has colonised well with wetland species and some young willow. Initially, concern was raised over the use of fairly recently cut willow logs, however none have taken so no maintenance problem has arisen.

The added blockstone protection was probably not necessary given the fairly stable flow regime of the stream.

Section B.
The right bank's low blockstone edge has worked well to retain the backfill. The limestone is the softer oolitic variety and is beginning to crumble and 'weather', blending in to the landscape. Low growing marginals are also starting to 'soften' the stone edge.

The left bank was constructed at a higher elevation, with approximately 300mm of hurdle exposed above water level. Due to the height of the bank terrestrial vegetation has colonised. The hazel shows signs of degrading, but the Geolon will prevent the natural softening and colonisation of the edge, and will become exposed once the hurdles have gone. The chalky, flinty material used to backfill the channel edge may have been sufficiently stable without any form of protection.

The wetland area behind the hurdles has not colonised, probably due to the retention of the anoxic silt.

The new channel is mostly silt free and the chutes/pools and deflectors are working as desired. The *Ranunculus* is still present but has not colonised from the mats.

Section C.
The use of narrowing and low deflectors has cleaned, and kept clear, the gravel bed right through to the new stone-crested weir. Mature grayling and trout are both visible in good numbers in the deeper shaded areas.

The height of the hurdles increases downstream, up to 1m. This is as a result of the final water level being much lower than the original (Plate 8). This combined with the use of the Geolon prevents a good variety of edge habitat establishing, and looks unattractive.

OVERALL CONCLUSION

The removal of impoundments, and the new channel works, has narrowed the stream to re-expose the original gravel bed and keep it clean. Some marginal aquatic vegetation has established on the wet ledges to improve diversity. The more 'regimented' hurdles have not been so successful.

RECOMMENDATIONS FOR THE SITE

General monitoring of fish populations, siltation and vegetation should be undertaken.

The hurdles should be inspected when the majority begin to degrade. It may be necessary to carry out some remedial works in terms of removing the Geolon and perhaps the posts. The fill material should be sufficiently well settled, after 3 years, to withstand high flows. Some scour and localised slumping may occur, but this will merely produce the desired bank diversity. In some areas macrophyte growth may be poor due to the amount of bank shading.

Another area where remedial work may be an option is the blockstone edged ledge. To give a more gentle profile to the edge it would be relatively easy to remove some short sections of the blockstone.

A more costly consideration would be to carry out some re-profiling to the high banks of the lower section when removing the Geolon.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. The use of a geotextile in a situation such as the one described above is unnecessary. If some initial stabilisation is desired, this should be limited to a biodegradable hessian type material, which will rot with the hurdles.

2. Narrowing may occur naturally, sometimes at a fast rate, once any impoundments are removed, however it is more difficult to predict the end result. Where downstream impact is not a concern, and the speed of recovery is not imperative, this option could reduce costs significantly, and produce a more 'natural' and varied edge habitat.

COSTS

The total cost of the works was £24,000, funded by the EA Flood Defence Enhancement Budget.

AVAILABLE INFORMATION

General plans and drawings,
Audit survey - 10/2/93,
Pre and post works photo records

KEY PERSONNEL

Conservation Officer - Graham Scholey (EA)
Fisheries Officer - Eddie Hopkins (EA)
Operations - Dave Ludford (EA)
Contractor - In-house workforce

Dun

PLATE 1 **Downstream limit. Levels impounded by makeshift weir.**

PLATE 2 **Narrowing and ledge creation using willow and larch logs has been successful.** – May 1998

PLATE 3 **Duck and rat activity had eroded the banks, up to 30m wide.**

PLATE 4 **The person is standing in the main channel, to the right remains a backwater (part of the old channel width).**

PLATE 5 **Hurdles and blockstone were used to redefine a hard bank.**

PLATE 6 **Some willow hurdles stand proud of the river due to the substantial drop in levels.** – May 1998

PLATE 7 **Weirs removed and levels lowered. A low stone drop weir is the replacement.**

PLATE 8 **Levels lowered considerably after the silt was washed away; more than originally expected.**

GATWICK STREAM - WEIR BYPASS VIA GRATTONS PARK DITCH

DATES: Spring/autumn 1996

LOCATION: Grattons Park, NE Crawley, WEST SUSSEX.

GRID REF: TQ 288379 to TQ 289382

CONTACT: Environment Agency, Thames Region, South East Area, Conservation, David Webb. Tel:01483 577655.

LAND OWNERSHIP: Crawley District Council

CATCHMENT INFORMATION

Geology is mixed (sand and clay with gravels). Due to the clay soils and extensive upstream urbanisation the hydrology is characterised as 'flashy', with very low base flows. Water quality in the stream was very poor but has improved since the late 80's following upgrading of the upstream sewage treatment works. This quality improvement has had a large effect in terms of increased fish catches.

BACKGROUND

In the 1950's, as a part of the development of Crawley New Town, the Gatwick Stream at Grattons Park was modified to ensure high flows were stored in Hazelwich flood balancing pond. The adjacent stream was concrete lined, both bed and bank in places, to control the rate and volume of overspill (Plate 1). Several concrete bed drops/weirs were added to retain levels and control erosion. Due to a history of poor water quality and lack of free passage the fishery value of the reach was very poor. After improvements in water quality the local angling club started to record increased catch sizes in the stream. Downstream of the obstructions there was a full range of species and upstream an isolated trout population (Plate 2).

The scale of modifications needed for Gatwick Stream were so great that it was impractical and too costly to attempt to restore the original channel characteristics.

A narrow channel, thought to drain the nearby railway embankment, bounded the opposite side of the flood storage area. The channel, possibly an old mill bypass, cut-off by the railway, was previously ditch-like; deep, steep sided, shaded and stagnant, with iron oxide pollution (Plate 3).

The biological quality of the site (including the ditch), before the works began, was monitored and found to be poor.

Fisheries and conservation staff identified the opportunity of diverting a proportion of the Gatwick stream flow into the parallel Grattons Park ditch and thereby restore free passage for fish.

OBJECTIVES

The prime objective was to restore fish passage between the lower section (downstream of the concrete weirs) and the headwaters. In addition, general objectives proposed were:

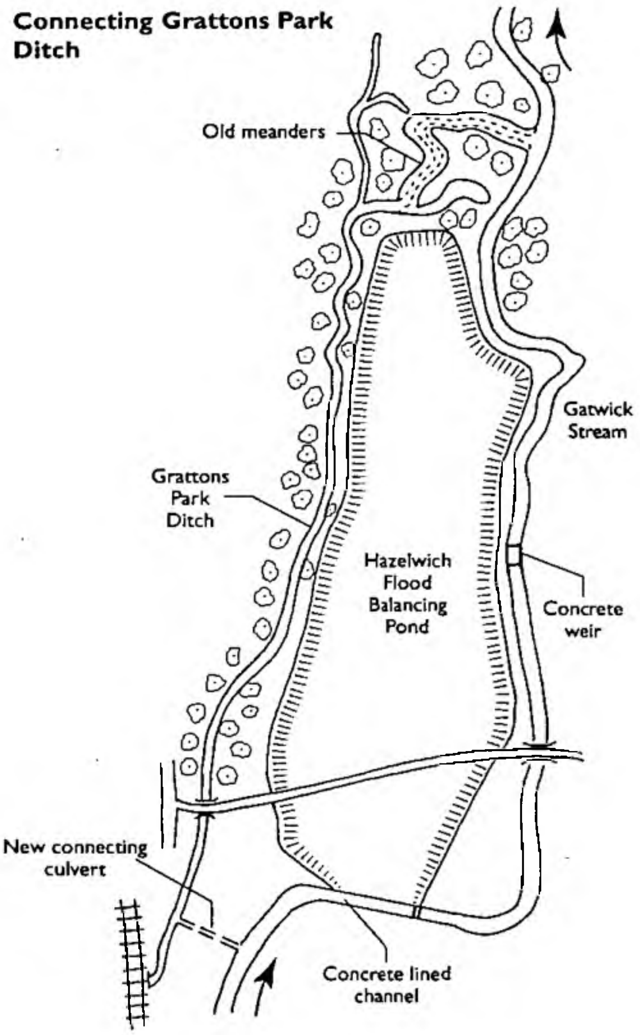
- marginal and in-stream habitat creation;
- reduce bank disturbance and retain terrestrial habitat.

WORKS CARRIED OUT

A connection was made at the upstream end of the site between the stream and 'ditch' via a 0.4m dia. pipe, designed to throttle the flow in high flow conditions (allowing 300-400l/s through the pipe out of a total maximum flow of about 11 cumecs). Conversely it was also designed to retain a depth of 0.3-0.4m in the pipe in low flow conditions, similar to the 0.3m design depth in the ditch.

Downstream of the connection the ditch was dredged by up to 1m, uncovering a gravel bed, and in places the banks pulled back (Plate 4). The overall length, approx. 500m, was re-graded to a slope of 1:350 to tie in upstream and downstream

Connecting Grattons Park Ditch



water levels. Some tree work was carried out, though more had been suggested. During the works the contractor had to be careful not to damage the surrounding woodland and areas of bulbs.

At the downstream end of the ditch (below the main concrete weir), reconnection to Gatwick Stream was made through a section of previously cut-off meanders. The meanders were much wider than the ditch, but at a higher level, with the old connection to the stream lost to sedimentation. A low flow cut was made in the bottom of the meanders at the bed level of the ditch (approx. 0.5m deep and 1m wide – Plate 5).

This cut was continued through to the confluence with the stream, again as a narrow ditch like channel to reduce spoil and disturbance to the surrounding habitat. All excess spoil was initially stockpiled on site and then removed. A small backwater was also retained/reconnected to the new system (previously the upstream entrance to the cut-off meanders). This feature was left at its high level to provide a pond habitat for amphibians (mainly frogs).

The gradient was varied in the ditch locally to produce pools and enable gravel riffles to be introduced.

SUCCESS/LESSONS

The exposed gravel banks of the re-graded 'ditch' have begun to be undercut in places, providing habitat/shelter and acting as a source for bed material required for in-stream habitat diversity to develop. The improvements in the bed and bank features are important due to the absence of any in-channel plant growth (shaded out by the surrounding woodland).

The connection between the two waterways has retained its structure and it is assumed is fulfilling its function.

The park/flood storage area is popular with dog walkers and the general public; a shallow slope/beach was incorporated into the design for use by schools. The new work appears to be appreciated by the users and the informal path alongside the ditch is widely used. This recreation element of the scheme was not previously identified as part of the objectives and is therefore a 'bonus' in terms of success.

OVERALL CONCLUSION

The works have achieved the objectives in terms of additional habitat creation, and retention/minimal disturbance of the surrounding terrestrial habitat. The fisheries officer is confident that the main objective of aiding free passage past the Gatwick Stream structures has also been achieved, however a fisheries survey of the ditch and reach above the site has not yet been undertaken (but is planned for late 1998). Informal surveys suggest populations of bullhead, brook lamprey and native brown trout use/inhabit the new ditch.

RECOMMENDATIONS FOR THE SITE

The planned fisheries survey is needed to confirm the assumption that the scheme is performing as desired.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Where fish passage is the only, or overriding, objective and funding is limited, an alternative solution could be to create a 'ramp' at the problem weir. If space and gradient allows, the most natural solution is to create a stone/gravel 'riffle'. This may also be the only cost effective alternative if a secondary ditch/channel is not available.

2. Redundant channels with little flow are often important for amphibia and other animals. The RCS did not draw attention to breeding amphibia, but when work began their presence was noted. The flood storage area would have been ideal for small compensatory pools, but this was not considered. Tadpoles are now at greater risk in the enhanced 'ditch' of being washed downstream.

COSTS

Total cost of the works was £28,000. This was funded on a 50/50 basis between Crawley District Council and the Environment Agency (flood defence enhancement budget).

AVAILABLE INFORMATION

General plan
Pre and post works photo records.
Fisheries survey data
RCS - May '96 – (pre scheme)
Biological baseline survey - Nov '97 (pre scheme)
Audit surveys - April '97

KEY PERSONNEL

Conservation Officer - David Webb
Flood Defence - Trevor Odell
Fisheries - Nick Foulkes
Contractor - Crawley District Council work force
Consultant - Roffe, Kennard and Lapworth

Gatwick Stream

PLATE 1 Main channel - Gatwick Stream. Concrete bed and banks. – March 1998

PLATE 2 Further downstream the channel reverts to steep but natural earth banks. – March 1998

PLATE 3 Gratton's Park ditch, deeply incised. – March 1998

PLATE 4 Some bank re-profiling was possible. – March 1998

PLATE 5 The old meanders were reconnected with the river. Main channel down-cutting meant a low flow channel needed to be excavated. – March 1998

KYD BROOK DECULVERTING AT SUNDRIDGE PARK GOLF COURSE

DATES: 1995/6

LOCATION: Sundridge Park Golf Course, 2km NE of Bromley, LONDON

GRID REF: TQ 418707

CONTACT: Environment Agency, Thames Region, Landscape Architecture Group. Richard Copas. Tel. 01189 535565.

LAND OWNERSHIP: Private.

CATCHMENT INFORMATION

The Kyd Brook (changing to the River Quaggy in the middle of Sundridge Park Golf Course) is a tributary of the River Ravensbourne. The Brook is flashy due to its urban nature, however it is still only relatively small when it reaches the golf course. The geology of the site is tertiary gravels and sand. The average gradient through the site is approx. 1:300.

BACKGROUND

The park landscape and the Mansion House are of significant historical value, having been laid out in accordance with advice from Humphrey Repton. The Mansion is a Grade I listed building and the landscape is included in the Register of Parks and Gardens of Special Historic Interest in England. The presence of communities including acid grassland, heathland and areas of deciduous woodland mean that Sundridge Park has been listed as a Site of Nature Conservation Interest by Kent Trust for Nature Conservation.

The landscape and conservation interest has been modified by the golf course, though the culverting in question has been so since 1869, 30 years before the existence of the golf course. The Brook enters the golf course in a culvert, continues as culvert and open channel and then leaves the course, once again in a culvert.

Flooding was occurring at the golf course, attributable to two main factors:

- increased rate and volume of runoff from urban development;
- due to the age of the culverted section in question, collapses were common causing blockages (Plate 1).

In addition there was a health and safety issue associated with the subsidence.

OBJECTIVES

Several objectives were identified:

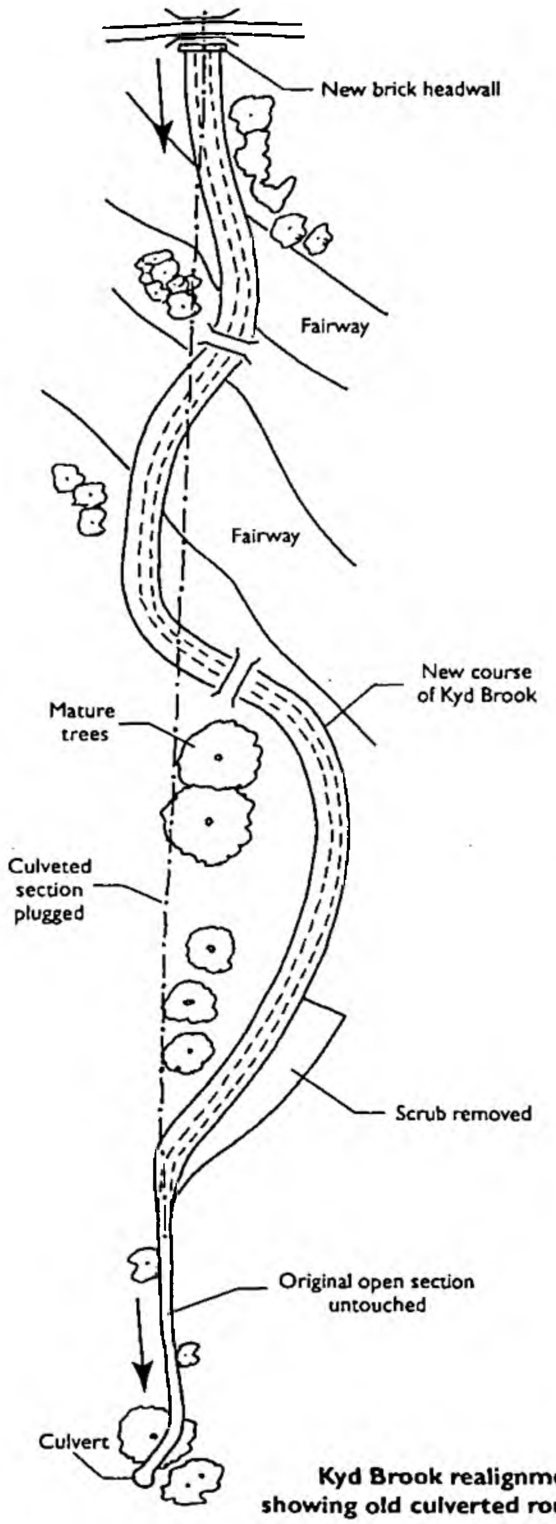
- alleviate flooding of the golf course;
- reduce a health and safety hazard;
- enhancing the landscape and habitat value of the brook.

WORKS CARRIED OUT

A 370m section of the Kyd Brook was re-routed away from the Victorian culvert into an open channel. This included replacing a 6m section of culvert between the existing weed screen and the start of the channel. The redundant culvert was filled with a pulverised fuel ash/cement grout to prevent further collapse. The new culvert exit was dressed with brickwork (Plate 2).

The new channel follows an open sinuous course, incorporating pools and riffles, and has developed a good gravel bed from the surrounding natural gravel deposits. Low stone drop structures/runs were used to dissipate energy within the brook (Plate 3).

The new course was designed to avoid mature trees and root systems, and designed to suit the golf courses' requirements in terms of fairway layout (Plate 4). Where the brook crossed the fairways the banks were supported using dead hazel spiling to just above water level (Plate 5). The outsides of bends were revetted with tanalised larch posts and spiled willow withies to prevent erosion occurring.



Kyd Brook realignment showing old culverted route

Berms located on the inside of bends were designed at a low level to encourage marginal vegetation colonisation.

Excess spoil was retained on-site to be used by the golf course for future groundworks. Topsoil was stored and reinstated.

SUCCESS/LESSONS

The culverted section now flows within an open channel, with the associated benefits to in-channel wildlife.

The scheme was engineering led within a strictly maintained golf course environment, as a result the channel is almost totally devoid of marginal vegetation and the low grass banks are mown right up to the water's edge.

The low berms appear to have been raised by the golf course to prevent tall vegetation establishment. The only evident growth is the willow, established as spiling, which have been pruned into standards and looks out of place (Plate 6).

OVERALL CONCLUSION

The work has been a success in terms of the objectives; opening the channel, alleviating a safety problem and reducing flood risk. The final result could have been more sensitive to environmental considerations, given more support by the landowner in both the design stage and the subsequent management of the site.

RECOMMENDATIONS FOR THE SITE

Upstream of the de-culverted section the brook currently occupies a vertical banked 'ditch', with a concrete bed in places (Plate 7). Re-profiling of this section is urgently needed.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Better integration of landscape and ecology needed within the civil engineering design of flood defence schemes.

2. Partial spiling of both banks in a fairly low energy watercourse is likely to prevent the establishment of good marginal bank vegetation. In the above case the golf club were unwilling to

accept a design that facilitated marginal vegetation growth.

COSTS

Environment Agency capital works expenditure of £200,000.

AVAILABLE INFORMATION

Sundridge Park Study - Land Use Consultants - Oct. 1988.

Written justification for not preparing an environmental statement – Sept 1995.

KEY PERSONNEL

Landscape Architect – Richard Copas
Conservation Officer – Lesley Sproat
Geomorphology – Andrew Brookes
Catchment planner – Mark Hodgins
Operations – Graham Hawes
Contractor – Worth Landscape Contractor's Ltd
Consultant – Sir William Halcrow & Partners.

Sundridge Park (Kyd Brook)

PLATE 1 **Culvert collapse was occurring frequently.** – April 1998

PLATE 2 **The channel design was engineering driven.** – April 1998

PLATE 3 **Stone 'riffles' were built, but perhaps over-armoured.** – April 1998

PLATE 4 **The new channel was excavated around the mature trees. The formal design was required to meet golf club objectives.**– April 1998

PLATE 5 **Where used, hazel spiling revetment has prevented marginal vegetation from establishing.** – April 1998

PLATE 6 **Live spiling was used on the outside of the bends, but has since been pruned into standards by the golf course managers.**– April 1998

PLATE 7 **Upstream the Brook flows through an open but steep and engineered channel.** – April 1998

RIVER MOLE CUT OFF MEANDER REINSTATEMENT

DATES: 1996/97

LOCATION: Norbury Park, West Humble, NW of Dorking, SURREY.

GRID REF: TQ 166523

CONTACT: Environment Agency, Thames Region, Conservation, David Webb.

LAND OWNERSHIP: Surrey County Council

CATCHMENT INFORMATION

The River Mole drains a catchment of mixed geology (mainly clay with sand and chalk). Urbanisation of the catchment has produced a very flashy response to peak discharges. Flows fluctuate markedly both in summer and winter (overbank flow occurs, 3m+ in height). At the study site peak flows can reach 30 cumecs, with a mean summer flow of 1.4 cumecs. Water quality is generally good and was not a limiting factor to the success of the works.

BACKGROUND

The 250m cut-off meander was disconnected from the main channel during past works to straighten the river. It is probably linked to the building of the Victorian railway bridge immediately upstream, as a precautionary measure to avoid backing up around the structure.

The channel has also down-cut, possibly due to dredging. The bed of the cut-off was therefore greater than 1m above the bed of the river and was dry for most of the year.

The land is farmed as grazing pasture for sheep and of no floristic ecological value.

The site retains RIGGS (Regionally Important Geological and Geomorphological Site) status.

OBJECTIVES

The scheme objectives were identified by the EA SE Area Enhancement Committee as part of their business plan for environmental enhancements. The following were key aspects agreed following detailed consultation.

- restore flow to cut-off loop of the original River Mole channel by reconnecting the main river;
- create holding/spawning areas for fish;
- re-instate shallow water and shallow edge habitats lost by down-cutting;
- promote a significant improvement for biology, fisheries, landscape and conservation.

These were to be achieved without increasing flood risk, and retaining public and farmers access to the site

This type of reinstatement had not previously been tried in SE Area, and aimed at restoring backwater habitat that is extremely limited within the catchment.

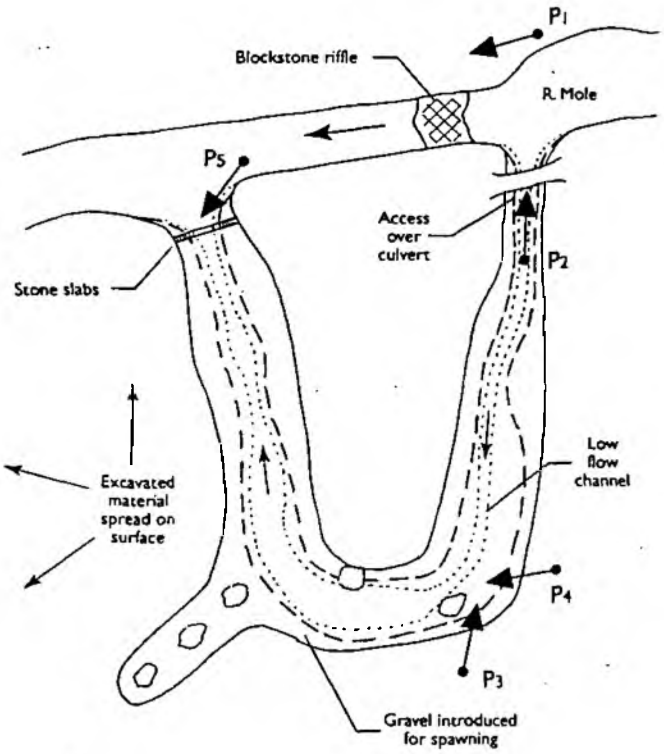
WORKS CARRIED OUT

Main Channel

A long blockstone and gravel weir was created downstream of the meander entrance (Plate 1). The purpose was to create a higher head to force a proportion of the flow through the excavated cut-off, and to construct it so it would also become established as a riffle. Stones between 0.5 and 1 tonne were used due to the velocities encountered during peak discharge. The weir was set at approximately 0.5 m above the proposed meander bed to raise the water level and create a flow gradient through the meander. The structure was notched (1.6 by 0.5m) to retain flows in the main channel at low flow conditions.

The meander entrance and exit were excavated, the upstream inlet passing through a short section of Armco culvert, whilst the exit was left open.

Cut-off meander reinstatement



The culvert was required to allow continued access for farm equipment and stock, and to avoid the problem of stock being stranded on an island liable to inundation in very high flows. This was an amendment to the original design which originally proposed a ford as an access point (which could not address the stock isolation problem). Some landscaping of the structure was undertaken using stonework, however this appears to be affected by vandalism (Plate 2).

Cut-off Meander
A variable width low-flow channel was cut into the bed throughout the length of the meander (gaining in depth towards the exit, 0.3 to 0.5m) to account for the gradual deepening of the main river. This produced the effect of having wet marginal ledges, which submerged at higher flows. The varying width produced faster narrow runs (Plate 3) and slower wide slack water areas (Plate 4), even under moderate summer flows. This type of flow diversity and habitat is scarce on the rest of the river. To meet the set objectives it was important to encourage a good macrophyte growth to create suitable spawning habitat for fish that spawn in dense vegetation.

Excavated material, of which there was little, was thinly spread on the adjacent field (maximum depth 300mm). Mounding, given the surrounding landscape, was not an option. Flood storage was not an issue.

Some gravels were introduced (though some existed within the meander bed) to encourage spawning, however these were located in the wider sections rather than the more suitable runs and have become silted.

Trees were retained, even the smaller ones which had obviously colonised since the meander was cut-off. Two large Ash and Oak trees are protected at the foot by a palisade of vertical posts. No marginal vegetation was planted as this was already present and a good seedbank also assumed. Due to the type of landuse, planting would also have needed fencing from stock.

To encourage public access a crossing point was constructed over the meander exit. This consisted of worked stone slabs set upon support stones, with timber sleepers forming steps up both sides (Plate 5).

SUCCESS/LESSONS

The river almost immediately reworked the blockstone weir; forming a more natural long stone and gravel riffle, dished in the centre. This has been very effective in creating a new dace spawning area and has retained a good flow through the meander. This habitat creation on the main river was unexpected but is a valuable bonus, especially due to its proximity to a good backwater habitat.

Post project surveys and inspections indicate that the project has been very successful. The meander is now often "black " with fry, whilst in flood conditions the slack flow offers protection from the increased velocities of the main river (Fish were seen in the meander during the first flood event, within weeks of completion). A full fisheries survey has not yet been carried out.

Colonisation by a variety of wetland plants has occurred and is likely to develop further. Thirteen new species of riparian/wetland plants were recorded as part of a recent PPA, though three previously present were not found.

Schools often visit the site as part of curriculum projects.

It was felt that the palisade protection for the mature trees may not have been necessary judging by the lack of visible scour in the meander.

OVERALL CONCLUSION

The works have successfully achieved the objectives of restoring the original meander channel and continuing to allow unrestricted public and landowner access. All observations appear to indicate similar success with fish spawning and refuge, and general habitat improvement.

RECOMMENDATIONS FOR THE SITE

No specific needs were identified since the pre-scheme stated objectives are being achieved. Some maintenance of the meander entrance may eventually be required in terms of silt and gravel deposition, and colonisation by macrophytes. This will be determined by monitoring, which should include a fish survey in the near future

To prevent more of the stone cladding from the entrance culvert being removed it may be prudent to cement these in place. By setting the grouting 5cm back from the stone face silt and seeds will collect and 'soften' the visual appearance of the structure.

Visually, the use of flat-topped irregular blockstone may have been a better choice instead of the stone slabs, however the slabs do offer a good platform for dipping.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

Possible alternative scenarios:

1. *Open one end only.*
   This would prove cheaper, but would lead to a more isolated backwater habitat, being less accessible to fish.

2. *No access track.*
   A 'true island habitat' of half a hectare could have been allowed to develop. This would again have been cheaper in construction terms, but entail a loss to the farmer (requiring compensation payments perhaps). Removing the throttle effect of the culvert would allow larger flows and possible increased velocities, reducing the value of the backwater for protection. Practicalities also include fishing access and safety.

3. *No riffle.*
   In some areas the associated rise in upstream water levels may not be acceptable. This would require much more excavation to a deeper level, more material to dispose of and potential loss of wet margins to dry ledges (less like a reconnection of the cut-off, and more like construction of a side channel).

4. *Ford access.*
   More of a natural feature than the culvert option but brings with it the associated risk of animal/human isolation during floods.

5. *No low-flow channel excavation in the meander.*
   Instead, raise the level of the riffle even higher to send flow into the meander at 'original' bed level. This would substantially increase costs associated with the riffle and cause greater backing up of the main channel, which may not be acceptable. There would also be a drop-off, prone to erosion, at the exit to the meander and the gradient would steepen, perhaps enough to reduce its effectiveness as a backwater/refuge.

6. *Relocation of riffle.*
   Siting the riffle slightly further downstream (5m) would reduce the problem of a shoal developing at the meander entrance. If this was more than 10-15m downstream costs might increase due to the increase in height necessary. If a ponded backwater was required, the riffle could be sited just downstream of the meander exit, the meander would then become an entirely still backwater removing any flow gradient.

From the above alternatives it is concluded that the design for the River Mole cut-off meander was the best for the conditions prevailing at the site.

COSTS

EA Flood Defence Enhancement Budget funded the total cost of the project, £68,000.

The landowner, Surrey County Council, fully backed the project but were unable to support the work financially. British rail was consulted about the scope of the works due to the proximity of the railway bridge.
A large part of the justification of the project was the public and landscape value of reconnecting the meander in an area open to the public.

AVAILABLE INFORMATION

General plans and specification.
Engineering drawings
Pre and post works photo records, including aerials.
RCS 21/7/95
Post project audit 31/10/97

KEY PERSONNEL

Project Manager – Trevor Odell (EA)
Fisheries – Nick Foulkes (EA)
Conservation – Dave Webb (EA)
Contractor – In-house work force.
Consultant - Rofe, Kennard and Lapworth.

Mole

PLATE 1 Cut-off inlet to the left, blockstone weir ahead. – March 1998

PLATE 2 Access culvert with blockstone facade. – March 1998

PLATE 3 Narrow low flow channel. – March 1998

PLATE 4 Wide, slow, shaded backwater. – March 1998

PLATE 5 Stone slab footpath. – March 1998

RIVER POOL ENHANCEMENT SCHEME

DATES: Summer 1994

LOCATION: Downstream of Winsford Road, between Catford and Sydenham, South of Lewisham, LONDON.

GRID REF: TQ 371724 to 373728

CONTACT: Environment Agency, Thames Region, Landscape Architecture Group, Richard Copas.
Tel. 01189 535565.

LAND OWNERSHIP: London Borough of Lewisham.

CATCHMENT INFORMATION

The River Pool is part of the Ravensbourne catchment. The river's hydrological regime is dominated by its urban surroundings, producing a flashy response to rainfall, though baseflow is fairly consistent. The bed is mainly gravel. Water quality is very poor and a limiting factor in terms of restoration.

BACKGROUND

The R. Pool at Winsford Road had previously been heavily engineered and straightened, mostly by the GLC, in the 1960's. This had severely degraded the in-channel habitat, resulting in an over-widened, toe-board lined, uniform, straight channel with little in-stream or marginal vegetation. A large concrete crump weir half way along the site had been identified in a previous landscape survey as being in need of replacement due to its visual impact and barrier to fish movement.

A fisheries survey revealed very limited eel and perch populations, with the main constraint being lack of suitable cover. The perch were thought to be associated with the few areas where some shelter was available behind failed toe-boarding. Recommendations included upstream stocking and reach habitat enhancement.

The NRA/Agency reviewed the need for maintaining the channel in its existing form (particularly the toe boarding) in view of the presence of upstream flood storage areas (Plate 1). Fisheries staff approached the landscape team to produce an enhancement scheme for the river.

OBJECTIVES

- Fisheries improvement in terms of flow diversity, edge habitat and shelter;
- general habitat enhancement;
- increase the visual and amenity value of the site.

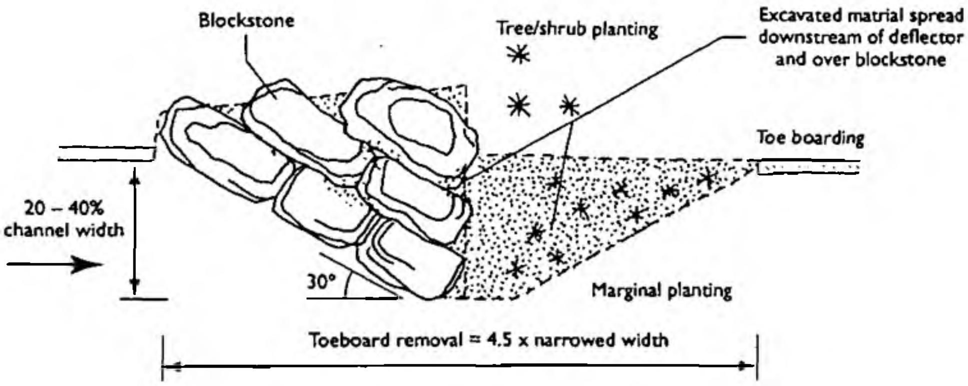
WORKS CARRIED OUT

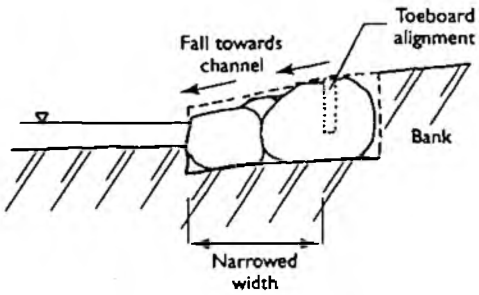
Rotten wooden toe boarding was removed over 20% of the 650m reach to encourage marginal vegetation to spread into the channel. Some planting was done where the boarding was removed, consisting of *Iris* (flag iris), *Carex pendula* (pendulous sedge) and *Potamogeten crispus* (curled pondweed). This was mainly in conjunction with deflectors, up and downstream.

Blockstone deflectors were installed, either in pairs or singly, to diversify flow and to create localised scour (Plate 2). These were designed to minimise the possibility of bank erosion by keying them into the bank and ensuring a sloped top, falling towards the river. Also important was the need for interlocking, (preventing 'leakage' through the structure), and anchoring into the bed. Deflector sizes varied, most were only 20% of the channel width, with the largest 40%.

In addition large 'stepping stones' were placed in the river to create turbulence and act as fish lies. These blocks have since been moved to the channel side to form deflectors after problems with litter and failure to create the desired lies (Plate 3).

Three under-bank fish shelters were constructed at a cost of £3,000 each, and designed to be incon-





Deflectors varied from 20 – 40% of the channel width

spicuous to avoid vandalism. They consisted of an under-bank deep recess fronted by an opening to the river, constructed of blockstone, steel girders and flat stone slabs, all covered by vegetation to resemble the bank (Plate 4).

Where the toe boarding had disintegrated completely, some erosion had occurred. Where this needed to be checked, and also to narrow the river, hazel spiling was used, bowing out into the channel. *Carex pendula* and *Iris* were planted to consolidate the fill material derived from the bank. Areas where natural channel narrowing was occurring were enhanced and extended by simple cut and fill from the bank, and planted with marginal species once it had settled/dried (3 months later – reducing the risk of the plugs being washed out).

To improve the visual appeal, and to try to diversify the bankside vegetation, areas of invasive *Impatiens glandulifera* (himalayan balsam) and *Fallopia japonica* (Japanese knotweed) were removed to a depth of 2m (though in some cases the root system had wound round tree roots). Further treatment by glyphosate was carried out for a season.

Two damp bankside 'bays' were cut into the slope and planted with *Carex pendula* and *Salix caprea* (goat willow), to add diversity to the bank profile.

Mature overhanging willows were either pollarded where necessary or left.

The works were complimented by a fisheries restocking programme upstream of the site.

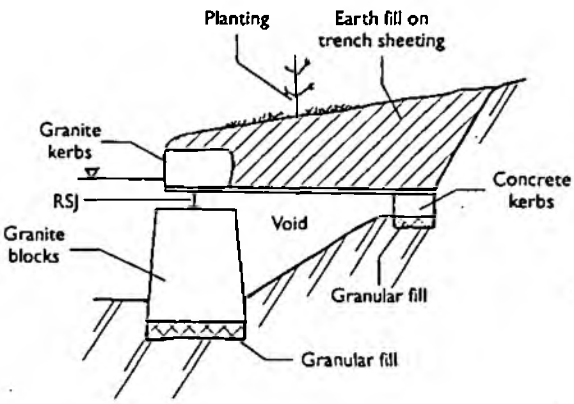
SUCCESS/LESSONS

Channel adjustment through toe board removal and associated planting is developing well, but slower than expected in terms of promoting silt accretion and further narrowing. The hurdle narrowing and planting has not been successful, with erosion occurring faster than vegetation growth, leaving shallow puddles behind the proud posts. However, these new areas are being used extensively by fry (Plate 5). The additional narrowing by planting into fill has worked well.

The deflectors have had a varied effect on the channel, depending on their size. The largest has accreted a 5m shoal, which is colonising with the planted species and others (Plate 6). The presence of a willow on the tip of the deflector is obviously creating additional turbulence at higher flows, combined with the increased height designed into the larger deflector. The smaller deflectors are having proportionally less effect.

The scattered blocks received a mixed review. They allowed more access to and across the river, especially for children to play on. However, they were also seen as litter collectors and a possible flood defence problem, instigating their removal. Where the individual blocks have been recently moved to form additional deflectors the work has not been carried out to the same standard. The deflectors are not well placed within the channel, the blocks have not been keyed into the bed or bank and allow water to pass through them. Some deflectors slope towards the bank which will promote bank erosion and isolation of the deflector (Plate 7).

Fish shelters



The fish shelters have remained free from sediment accretion, and have not been damaged. At the interface between shelter and original toe board there are signs of erosion and collapse of the old bank which may impact on the shelters. Due to the difficulties involved in surveying their use no data exists to show fishery benefits.

Fisheries staff have indicated that the scheme and stocking were progressing well, until a large pollution incident wiped out the fish population.

The knotweed and balsam remain a problem, though the areas stripped have not totally re-colonised yet. The establishment of *Potamogeton crispus* has not succeeded.

OVERALL CONCLUSION

The scheme has met its target objectives to some degree, but more was hoped for.

RECOMMENDATIONS FOR THE SITE

Remedial works are needed to address the recently constructed deflectors. Without additional work these will probably either cause bank erosion or simply have no beneficial effect at all.

At the same time as the above works, removal of the hurdle posts and wire, now that the hurdles have degraded, would improve the unsightly nature of these narrowed areas where vegetation has not established.

Continue to monitor the site in terms of :

- fisheries - to try to appraise the use/usefulness of the shelters and the overall habitat enhancements;
- vegetation establishment - monitor spread and colonisation by non-planted species;
- narrowing - to evaluate the continued success/failure of the deflectors and any associated siltation.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. More toe boarding might have been removed without impacting flood defence. Even if it is not possible to plant or re-profiled the banks, landscape, fishery and wildlife interest should benefit;

2. Size, shape and design of deflectors is critical, but site specific;

3. The value of expensive fish shelters at £3,000 each should be reviewed when water quality issues are a serious risk to fish populations;

4. Degradable coir rolls, instead of hurdles, to retain sediment and promote vegetation growth, may be more suitable alternatives. This is especially important if backfill is likely to consist of wet silts and gravels which need to dry or be vegetated to stay in place.

COSTS

£42,600 capital landscape scheme funded wholly by the Environment Agency.

AVAILABLE INFORMATION

Detailed contract plans and drawings (including fish shelter and deflector designs).
Pre and post works photo records and aerials.
Fisheries surveys - 1991, 1994, 1996.
Invertebrate survey - post scheme.

KEY PERSONNEL

Project Manager/Landscape Architect – Kevin Patrick (formerly EA)
Fisheries Officers – Steve Coates/Steve Colclough (EA)
Contractor – Woodlands Ltd T/A English Landscapes

Pool

PLATE 1 Toe boarding was removed over 20% of the reach. – March 1998

PLATE 2 Blockstone flow deflectors. – March 1998

PLATE 3 Randomly placed 'stepping stones' created turbulence and acted as fish lies, but also collected rubbish.

PLATE 4 The stone covered fish shelters were designed to be hidden, to blend in visually and to avoid vandalism. – March 1998

PLATE 5 Though some fines were washed out marginal vegetation is developing. – March 1998

PLATE 6 Looking upstream at a deposited shoal being colonised. This was the largest deflector. – March 1998

PLATE 7 The 'new' deflectors are at risk of eroding the bank because the fall is from the river towards the bank. – March 1998

RAVENSBOURNE (EAST BRANCH) REHABILITATION SCHEME

DATES: 1993

LOCATION: Bromley Common Golf Course, Southborough, Bromley, LONDON.

GRID REF: TQ 424669

CONTACT: Environment Agency, Thames Region, Landscape Architecture Group, Richard Copas. Tel. 01189 535565

LAND OWNERSHIP: London Borough of Bromley.

CATCHMENT INFORMATION

The upper catchment of the Ravensbourne has a gradient of approximately 1:400. The surrounding area to the site is predominantly urban, giving rise to a flashy response to rainfall, though normal flow is generally small. Water quality is poor, a function of the urban surroundings and periodic foul water inputs. This limits colonisation of the rehabilitated river by invertebrates and plants.

BACKGROUND

The Ravensbourne Landscape Assessment identified seventy potential enhancement projects on the river. The East branch of the Ravensbourne at Bromley Common Golf Course was selected on the basis of starting in the upper catchment.

The river enters and leaves the golf course via culverts (Plate 1). A 200m reach in between had been totally straightened and severely maintained as a steep sided drain (Plate 2). Dredgings had been piled either side to further remove the river from its floodplain. Bed width was up to 2m with near vertical banks up to 1.5m high. The bed and banks consisted of well concreted rounded gravel (Plate 3).

No historical information was found to indicate the previous course of the brook, though the site inspection revealed a remnant of old channel within the elm grove.

OBJECTIVES

- Recreate a sinuous channel with a narrow low-flow width, low berms and shallow slopes;
- improve flow diversity with riffles and pools;
- improve the visual appearance of the brook;
- increase habitat for invertebrates and fish;
- avoid taking material off-site by constructing landforms outside the floodplain to improve other areas of the golf course.

WORKS CARRIED OUT

Work was programmed to avoid unnecessary inconvenience to golfers.

Phase 1 - Upstream culvert to elm grove
The culvert face was dressed with blockstone to reduce the amount of concrete face exposed (Plate 4). The banks and bed were re-profiled to form a pool. Gravel was placed in the channel to create a riffle/pool sequence.

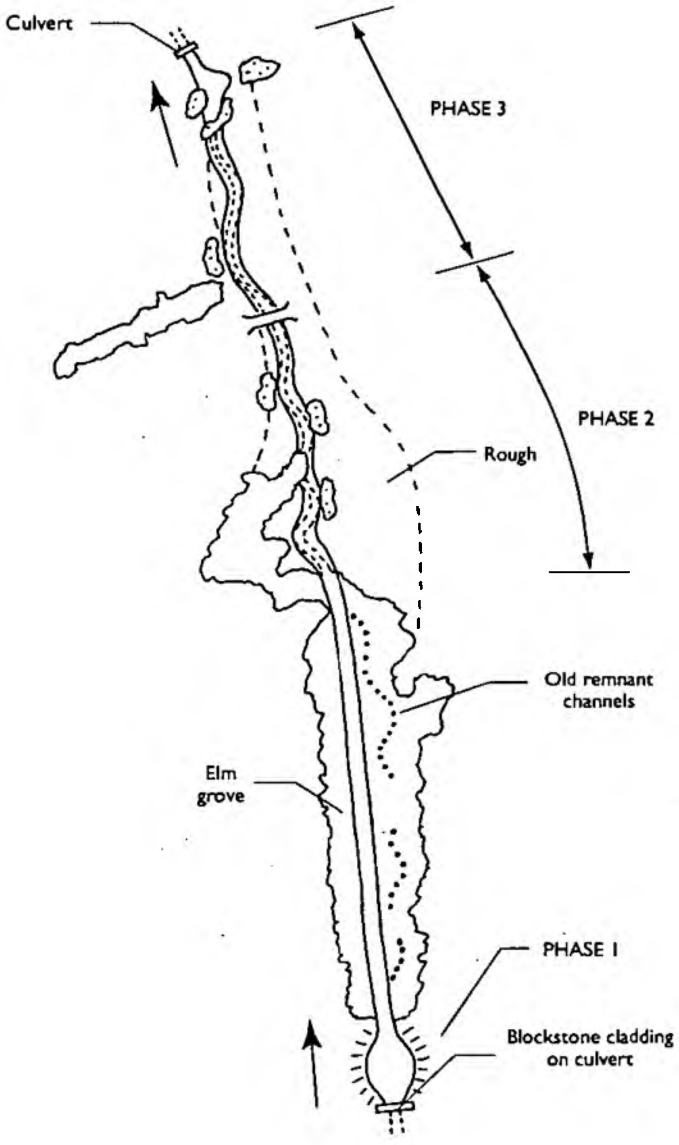
Phases 2&3 - Elm grove to downstream culvert
Banks were pulled back to form a two-stage channel profile (Plate 5). The new sinuous course winds through the lowered section, its edges protected by 150mm high hazel spiling (below normal water level).

The low flow channel was excavated with deeper 'pools' on the bends and riffle areas on the straights, covered with imported angular gravel to the desired level.

Just upstream of the culvert a pool has been excavated to reduce flow velocities and collect transported gravel, stopping it entering the culvert.

Planting was carried out and directed on site by the project manager. Plugs of *Iris pseudacorus* (flag iris) and *Carex pendula* (pendulous sedge) were planted direct into bare earth behind the spiling, whilst *Potomogeten crispus* (curled pondweed) was

Phases of work on the Ravensbourne at Bromley Common Golf Course



planted directly into the channel. No topsoil was replaced on the banks, but they were seeded with a low maintenance grass and wildflower seed mix, and plug planted with selected flowers.

All cut material was removed and used in other areas of the golf course, out of the floodplain.

SUCCESS/LESSONS

The low flow channels are developing well. Early colonisers, such as *Apium nodiflorum* (fool's water-cress), caused a flooding problem by covering the channel, then being swept downstream to block the culvert grills. This excessive early growth has been checked by other species such as *Juncus sp.* (rush) and *Glyceria* (reed sweet-grass), together with the spread of the planted *Iris* and *Carex* (Plate 6). It is not expected to be a problem in the future. The vegetation growth has also acted to continue to narrow the channel towards the dimensions of the old course evident in the elm grove (0.5 to 0.75m wide), and so increase flow diversity.

The berms have accreted silt and are developing more of a terrestrial community, this has concentrated flows and enhanced the low flow channel.

The downstream pool designed to trap sediment has also developed a good wetland habitat.

The banks have vegetated well with low maintenance grass and flowers and have not been smothered by rank vegetation due to the removal of topsoil. The plug planted flowers have not taken.

OVERALL CONCLUSION

The visual appearance of the site has improved greatly, an important consideration for the golf course and Borough Council. The channel form is now much more varied, bringing diversity to the previously uniform flow pattern. As a result of the scheme the brook is continuing to work to attain its desired width, helped by the growth of planted and colonising marginal vegetation.

RECOMMENDATIONS FOR THE SITE

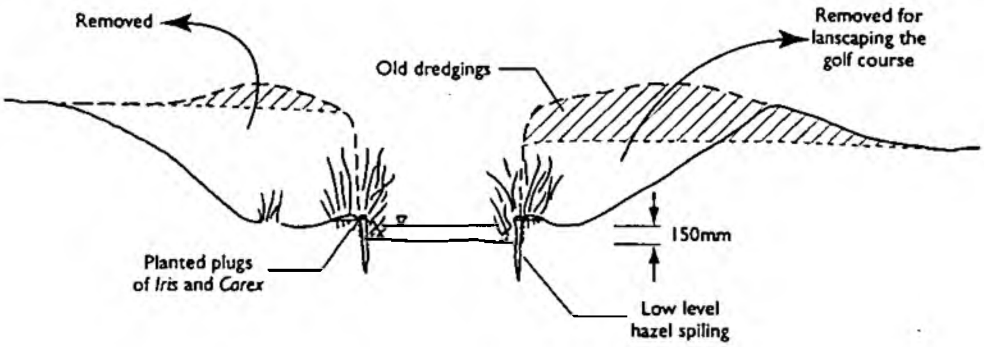
Continue informal monitoring of the site as the vegetation matures and the channel settles to its desired width. No other work is needed as the objectives have been met.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. A thorough site investigation is critical to be able to identify old remnant channels to provide information on the design width and depth of the new channel.

2. In the creation of two-stage channels, a small amount of material can be used to narrow the low flow channel and still providing greater capacity than the original course if upper slopes are re-profiled.

3. Bank re-profiling can be improved by removing old dredgings. In the above case some banks now exhibit a shallow profile, but the raised lip above the general floodplain level is unsightly.



Cross section showing two stage channel and hazel spiling

4. A mixture of common sense and accurate calculations of water level can enable successful use of hazel spiling to retain low berms, visually this is best if just below water level.

5. Simply re-profiling banks to leave a shallow toe at the base can lead to narrowing by vegetation too. This is a cheap alternative to physical narrowing if the likely consequences of erosion are nil.

COSTS

The Environment Agency's capital landscape budget provided £27,600 out of a total of £36,600. London Borough of Bromley's contribution towards the cost of the project was £9,000.

AVAILABLE INFORMATION

Detailed contract plans and drawings
Tender documents
Pre and post works photo records
Invertebrate survey - pre and post scheme.

KEY PERSONNEL

Project Manager/Landscape Architect – Kevin Patrick (formerly EA)
Geomorphologist – Andrew Brookes (EA)
Contractor – Capital Landscapes Construction, T/A Worth Contractors

Bromley Common (Ravensbourne)

PLATE 1 The stream entering the golf course via a concrete culvert.

PLATE 2 Before, steep banks, little habitat.

PLATE 4 Re-profiled edges and blockstone facing. – March 1998

PLATE 3 Elm grove. Steep and wide but disturbance of the copse would be detrimental. – March 1998

PLATE 5 After, Planted and re-profiled. – March 1998

PLATE 6 Marginal vegetation narrowing the channel. – March 1998

RIVER RODING NOTCH CUT WEIR

DATES: August 1995

LOCATION: Adjacent to M11, Woodford, Redbridge.

GRID REF: TQ 415889

CONTACT: Environment Agency, Thames Region, NE Area, Conservation, Chris Catling. Tel. 01707 632370.

LAND OWNERSHIP: Redbridge Borough Council

CATCHMENT INFORMATION

The Roding catchment consists of chalk to the north, running into London clay and sand/gravel deposits. Hydrology is impacted by run-off from the surrounding urban developments and directly by the M11 at the site. As a result of the nature of the runoff water quality is moderate.

BACKGROUND

The River Roding at Redbridge had been extensively straightened during the 1970's to accomodate the M11 motorway and North Circular Road improvements. The result was an embanked oversized two-stage channel. Due to the straightening works weirs were introduced to compensate for the increased gradient, which overwise would have increased velocities and scour. The weir at Woodford is approx. 15m wide by 1.2m high (downstream height), with accumulation of material upstream. In-channel vegetation was absent and little flow variation was apparent due to the impoundment.

Further up and downstream of the weir the channel retained some semi-natural habitat features such as gravel riffles and pools with good flow and varied macrophyte assemblages.

The reach directly above the weir was identified as a poor fisheries habitat, compounded by the discrete nature of the upstream and downstream fish populations. A technique of cutting a notch in a weir had been tried previously on a chalk stream. It was felt that this could also benefit the Roding.

OBJECTIVES

The overall objective was fisheries improvement, however, this also encompassed other broad benefits:

- removing the impoundment, so aiding fish passage;
- increasing fish habitat;
- encouraging self-cleansing velocities at low flow in the previously impounded reach to reveal the gravel substrate;
- creating flow diversity;
- improving habitat for aquatic macrophytes and macroinvertebrates.

WORKS CARRIED OUT

A notch measuring 2.5m across by 0.75m deep, designed to accept mean flow, was cut in the weir (Plate 1). This had the immediate effect of dropping water levels. Vertical channel banks still show evidence of previous levels.

SUCCESS/LESSONS

The upstream reach is now accessible to fish from downstream via the notch cut. The backwater effect created by the weir has been significantly reduced (though one does still exist). Water levels are down from an impounded depth of 1m to 0.5m at mean flow.

This has introduced flow variation and exposed previously submerged riffles above the impoundment (Plate 2).

The increased diversity of the reach has allowed colonisation by some desirable and undesirable macrophyte species, in particular the alien *Hydrocotyle ranunculoides* (floating penny-wort), which periodically forms an extensive blanket (up to 60% of the channel).

Encouraged by this very small but successful project, Redbridge Borough Council are to part fund a further 3.5km scheme on this section of the river. Financial support from an SRB bid will be matched by the Environment Agency, providing a total budget of £450,000. The project will include new footpaths, footbridges and a range of channel enhancements.

OVERALL CONCLUSION

This simple and cheap option to aid fish passage has succeeded in meeting the objectives set for the project. Further monitoring is needed to assess the long-term benefits of the work.

RECOMMENDATIONS FOR SITE

Continue to monitor the following:

- geomorphology in terms of scour up and downstream of the weir;
- macrophyte growth, both in-channel and marginal. Especially the *Hydrocotyle;*
- fisheries improvement.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. This work shows that it is possible to achieve wide benefits at low cost in heavily engineered rivers. However, the right site conditions must be present and sufficient thought given to the design, even though the actual works are minimal.
2. A longitudinal survey is a useful tool for assessing the likely impact of such a scheme, however on this reach it was not felt necessary because of the obvious impoundment effect.
3. Some concerns were voiced by the in-house geomorphologist with regard to the potential for scour of the upstream face of the weir. This has not occurred at this site, but should be considered at others.

COSTS

Internal Environment Agency funding from the Flood Defence Enhancement Budget of £2,500.

AVAILABLE INFORMATION

Engineering Drawings.
Pre and post site photo records.
Fisheries surveys: May '93, Apr '95, Nov '95, Oct '96 .
Invert survey: 1997

KEY PERSONNEL

Conservation Officer – Chris Catling (EA)
Fisheries Officer – Steve Coates (EA)
Geomorphology – Andrew Brookes (EA)
Engineer – Martin Japes
Contractor – EA In-house

Roding

PLATE 1 **Notch cut in weir.** – February 1998

PLATE 2 **Levels lowered and marginals establishing.** – February 1998

HABITAT ENHANCEMENTS ON THE RIVER THAME

DATES: 1993 and 1997

LOCATION: Nether and Lower Winchendon, nr. Cuddington, Aylesbury, BUCKS.

GRID REF: SP 744121 (Nether) and 731117 (Lower)

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Graham Scholey. Tel. 01491 832801.

LAND OWNERSHIP: Private.

CATCHMENT INFORMATION

The catchment is predominantly clay, giving a rapid response to rainfall. Baseflow is generally low as is the gradient. Water quality is average, but recent pollution incidents have affected fish populations. The Thame suffers from a lack of good in-channel flow velocities, and habitat diversity and in some areas has dense macrophyte growth occluding the whole channel.

BACKGROUND

Nether Winchendon

In 1990 a fisheries survey at Nether Winchendon revealed a fish biomass below the EC recommended standard of $20gm^2$. The reasons for the low score were assumed to be poor water quality and impoverished habitat. The channel was very uniform with little habitat diversity. The banks were steep and eroding, and the bed consisted almost entirely of silt. Improving the habitat rather than restocking with fish was the only sustainable approach.

Lower Winchendon

Based on the success of habitat enhancement upstream, additional work was planned for this reach which also suffered from deepening, widening and gravel removal (Plate L1). The presence of a mill downstream exacerbated the lack of flow diversity leading to very poor opportunities for fish spawning.

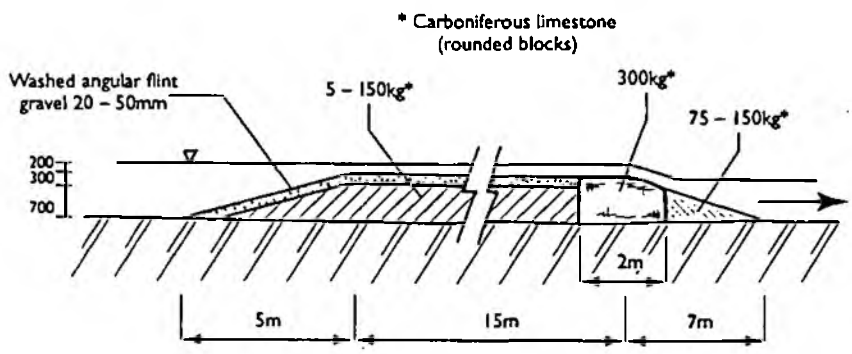
OBJECTIVES

- Habitat enhancement via the introduction of a pool/riffle sequence;
- increase fish spawning and recruitment;
- facilitate fish passage past the mill weir via a side overspill (Lower Winchendon).

WORKS CARRIED OUT

Nether Winchendon

Three riffles were constructed along the 700m reach, together with some bank re-profiling and fencing in association with construction of cattle drinks.



Constructed riffle

The riffles were formed using limestone blocks to raise the bed and increase velocity over the structure. The blockstone was placed to form a central 'dished' profile to concentrate flow away from and prevent erosion of, the banks. Blocks were covered with gravel and more stone placed upstream to form a riffle/run habitat.

At all three of the sites some re-profiling was undertaken on the left bank. This involved grading back the bank, which was eroding due to animal poaching and grazing (Plate N1). A stoned cattle drink was provided and fencing erected to allow regeneration.

Lower Winchendon
Three riffles were constructed (four had been planned). The design was similar to that of the upstream works with minor modifications. The riffles were built from carboniferous limestone of varying sizes (all specified). A downstream 'wall' made from 300kg blocks was used to retain the main riffle stone (5 to 150kg blocks). The riffle was sloped at both ends and dished, then topped with 300mm of angular Kennet Valley flint gravel. The riffles were designed to raise the bed to the existing water level (approximately 1.5m) thereby creating a 200mm depth of fast flowing water over the top of them.

All three riffles were fenced off from stock to prevent them crossing the river. A cattle drink was built at one riffle to prevent excessive poaching (Plate L2). The material used was crushed limestone; when wetted it forms a concrete hard surface and is much more stable than stone.

The old mill bypass weir (concrete wall with apron and a 1m drop into a deep pool – Plate L3) was replaced by a blockstone ramp, 10-15m long descending to the pool. The ramp was dished with a small low-flow central channel (Plate L4).

Some additional tree planting was carried out at the side spill to replace disturbed planting.

SUCCESS/LESSONS

Nether Winchendon
In-stream physical habitat structure has been enhanced and sustained. The design of both the 'riffle' and cattle drinks being successful. A positive effect on fish population has been recorded, though water quality incidents have since had a negative impact.

The re-profiling of the bank, has worked stabilising and protecting it against cattle erosion. It also provided ideal conditions for the natural development of a wet ledge habitat.

A blockstone toe at the base of the banks is considered to be overkill; however it has now been covered and is hidden by vegetation (Plate N2).

The bank re-profiling had dual value. In addition to habitat improvement it created extra flood capacity to appease the landowner who was concerned that the bed raising would cause flooding to his land. In reality the rise in water level was limited to approximately 100mm, easily drowned out as levels rise.

Lower Winchendon
The riffles exhibit a good fast shallow flow, evenly distributed across the surface. Visually they appear as a natural riffle, with only the presence of the fencing revealing their man made nature (Plate L5). No post project fisheries surveys have been undertaken yet (one is planned for 1999, 2 years after construction). Visual inspection suggests they should provide good habitat for spawning.

The marginal fringe is beginning to re-colonise the banks of the riffle and will in time narrow these areas down to pre works dimensions. Some colonising aquatic vegetation (*Callitriche* (water-starwort)) is evident on the riffles.

The side spill has not worked as well as planned due to a number of factors. Flow constraints recommended by Water Resources (EA), dictated that flow over the side spill could not be increased. A greater flow would have allowed a gentler slope with more depth. The depth of the pool was too great to extend the ramp long enough to increase the overall length, within budget. These factors have resulted in a structure that has too little water passing over it to allow free passage of fish except under high flows. The covering of gravel has been washed away.

OVERALL CONCLUSION

Both sites have achieved most of their habitat enhancement objectives, but planned biotic responses still require audit. At low flows the side spill at Lower Winchendon is unlikely to be passable. Fish spawning and recruitment surveys are planned for Lower Winchendon.

RECOMMENDATIONS FOR THE SITE

Continue the monitoring work on macrophytes, invertebrates and fish to determine benefits.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Where cost is a constraint, such as the amount of material needed to extend the side spill into the pool, it could be cheaper to use inert waste material/rubble (the old concrete weir structure) to be topped by blockstone, etc. However the cost of transporting material may preclude this option.

2. The company supplying the blockstone, once it realised that it was the only viable supplier, raised its prices substantially, forcing a large increase in the total cost of the project. This should obviously be avoided.

COSTS

Lower Winchendon - £50,000 from the EA Flood Defence Enhancement Budget.
Nether Winchendon - £27,130.

AVAILABLE INFORMATION

Nether Winchendon
Pre and post works photo records.
Invertebrate survey - pre and post scheme.
Macrophyte survey - pre and post scheme.
Lower Winchendon
Pre and post works photo records.
Contract drawings and spec.
Pre scheme RHS (post will follow).
Pre scheme RCS (post will follow).

KEY PERSONNEL

Project Manager/Flood Defence – Dave Ludford (EA)
Conservation – Graham Scholey (EA)
Fisheries – Bob Preston (EA) – L. Winchendon
– Vaughan Lewis (formerly EA) – N. Winchendon
Contractor – NRA/EA In-house workforce

Lower Winchendon

PLATE L1 Riffle No. 2 – before. Very deep and lack of surface movement.

PLATE L2 Riffle No.2 – after. Fast shallow flow over well graded gravels. The cattle drink prevents poaching of the margins and allow the *Glyceria* to recover.
– March 1998

PLATE L3 The overspill weir – before.

PLATE L4 The new stone sidespill may be too steep to provide passage at low flows. – March 1998

PLATE L5 All the appearance of a natural riffle.
– March 1998

Nether Winchendon

PLATE N1 Re-profiling the left bank and fencing has added stability and reduced erosion. – March 1998

PLATE 2 The toe of the bank at the riffle was protected by blockstone. This was probably unnecessary and unsightly though it is now hidden by vegetation.
– March 1998

RIVER THAMES BANK PROTECTION AT CLIFTON HAMPDEN

DATES: 1988

LOCATION: Downstream of Clifton Hampden Lock, Clifton Hampden, OXON.

GRID REF: SU 546947

CONTACT: Environment Agency, Thames Region, Conservation, Alastair Driver. Tel. 01189 535563.

LAND OWNERSHIP: Environment Agency.

GENERAL INFORMATION

For centuries the River Thames has been heavily managed for the purposes of flood defence and navigation. Deep lock cuts are particularly prone to instability, erosion and bank damage by boats. Often these areas are protected with some form of revetment, however this may give rise to more rapid erosion where the protection ends and the natural bank begins.

BACKGROUND

Immediately downstream of Clifton Hampden Lock, the lock cut channel is steep and deeply incised. The banks were being undercut and slippage was occurring. In places the adjacent toe path was being affected where the banks had migrated by up to 3m, pushing the line of the path into the adjoining field, which was unacceptable to the farmer.

Steel sheet piling, possibly with the addition of concrete bagwork, was previously the most common method used to alleviate such problems. This gave a stable bankline, but usually entailed removal of any existing trees and would not benefit wildlife in terms of habitat value. This type of revetment was evident immediately upstream of the eroding section.

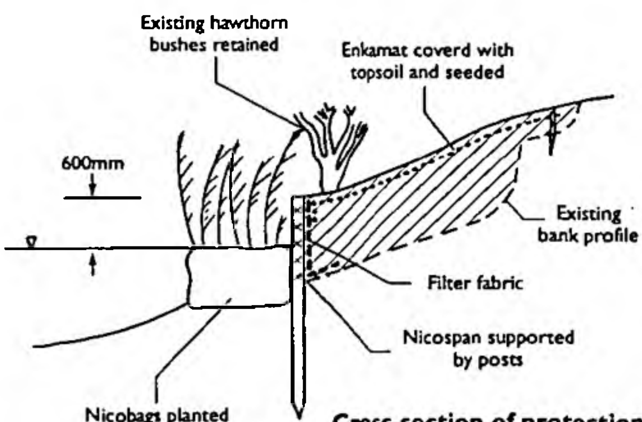
OBJECTIVES

- Bank protection from boatwash and general instability;
- extension of the reedy margin developing immediately downstream of the work.;
- retention of the existing bankside trees.

WORKS CARRIED OUT

Bank protection was achieved over a length of 50m using a combination of geotextile and emergent planting. This was carefully keyed into the existing bank (tight against the upstream bagwork) to prevent scour.

The original bank line was redefined using Nicospan geotextile supported by wooden posts. Directly behind the Nicospan a filter fabric was used to prevent fines washing out of the imported subsoil backfill. Enkamat was then used to cover the fill, and was in turn covered with topsoil and grass seeded. To protect and give added support to the Nicospan 'wall', large Nicobags (2m by 1m by 0.5m deep) were placed against the toe of the new bank, at water level. These geotextile bags were filled with a mixture of ballast material and river silt dredged from the adjacent bed and positioned once full. The bags were slit with three 25mm incisions and hand planted with rhizomes of *Phragmites* (common reed), *Carex riparia* (greater



Cross-section of protection works at Clifton Hampden

pond-sedge) and *Typha* (bulrush) (Plate 1). Construction caused limited bankside disturbance, allowing retention of bankside trees and bushes.

SUCCESS/LESSONS

The bank has now remained stable for 10 years and has re-vegetated. Some limited erosion by fishermen gaining access to the river has occurred.

The Nicobags are intact and the planted stand of vegetation has increased from a patchy 15m by 0.5m to a dense 30m by 1.5m stand, spreading out into the channel (Plate 2). Most of the growth has developed from the natural spread of rhizomes around the margins of the bags. The planted *Typha* has now been almost totally out-competed by *Phragmites*. The stand now looks very similar to the downstream natural reed edge (Plate 3).

Some of the bags are exposed above the surface of the water where additional colonisation by *Mentha aquatica* (water-mint), *Epilobium* (willowherb) and *Lythrum salicaria* (purple-loosestrife) has occurred. Initial development of the ledge was also delayed by trampling from fishermen (Plate 4).

Reed and Sedge Warblers are both breeding in the reed bed despite boat noise and disturbance, as are Mallard and Moorhen.

In summer the vegetation almost completely covers the 500mm vertical Nicospan face, however once this begins to die back the geotextile becomes visible. In addition where fishermen have gained access and where trees overhang and shade the bank, the bare vertical face can be seen (Plate 5). The Nicospan has begun to sag on the front face, though unsightly this should not affect its stability.

OVERALL CONCLUSION

The work has met all of its set objectives and is viewed by those involved as a great success, given that it was a very early trial use of alternative bank protection and habitat enhancement. From the general public's point of view (and the lock keeper's) the work looks 'natural' and appropriate.

RECOMMENDATIONS FOR THE SITE

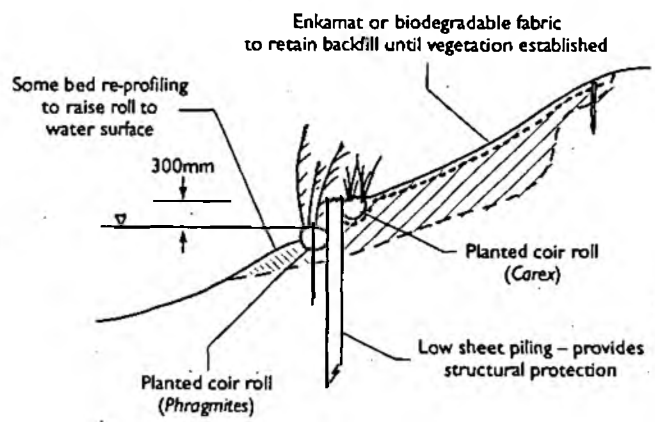
Informal monitoring of the continued development of the ledge as a wildlife habitat, and the possibility that some maintenance may be necessary if the *Phragmites* begins to significantly reduce the navigable channel. Annual checks (by the lock-keeper) on the integrity of the Nicospan may be prudent.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. When backfilling the Nicospan, the use of seeded topsoil placed immediately behind the filter fabric may provide some vegetative covering of the vertical face.

2. The current preferred option, as an alternative to non-biodegradable fabrics, is the use of short steel piles (max. 300mm above water level) to provide long-term bank stability, backfilled and planted with *Carex riparia*, in conjunction with planted coir fibre rolls at water level.

Alternative design to Nicospan and Nicobags – Same original bank profile



3. Whichever technique is used in such circumstances the aim should always be to provide adequate long-term protection with maximum ecological and aesthetic value. The use of emergent vegetation is important as it provides a buffer from wave action and boatwash.

COSTS

Environment Agency (NRA) Navigation maintenance budget.

AVAILABLE INFORMATION

General plans and drawings,
Pre and post works photo records.

KEY PERSONNEL

Conservation – Alastair Driver (EA)
Contractor – In-house workforce

Clifton Hampden

PLATE 1 New bankline backfilled behind Nicospan. Nicobags planted with rhizomes.

PLATE 2 Downstream of the lock cut *Phragmites* has formed a dense stand providing habitat for birds and wildfowl. – October 1991

PLATE 3 The 'new' bank and its vegetation merge well with the downstream reed fringe. – March 1998

PLATE 4 *Phragmites* dominates the ledge, spreading out into the channel. Posts are visible where fishermen gain access to the bank. – March 1998

PLATE 5
Where reed growth has been inhibited by access and/or shading the black Nicospan 'wall' is still visible, especially in winter – March 1998.

RIVER THAMES ISLANDS – BACKWATER RESTORATION

DATES: Skinner's Island - 1994/5, Doctor's Island - 1995/6

LOCATION: River Thames, Immediately up and downstream of Pinkhill Lock, Northmoor, Opposite Farmoor Reservoir, OXON.

GRID REF: Skinner's Island: SP 438065.
Doctor's Island: SP 442073.

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Graham Scholey. Tel. 01491 832901

LAND OWNERSHIP: Environment Agency

GENERAL INFORMATION

For centuries the River Thames has been heavily managed and constrained in engineered channels for the purposes of flood defence and navigation. The river, in its lower reaches, is restricted and controlled by weirs and locks, though overbank flooding is not uncommon in lower lying rural areas. Water quality is not a limiting factor when planning rehabilitation works on this section of the river. Siltation requires periodic maintenance to ensure passage for river craft. Boatwash is a major concern where natural and semi-natural (unprotected) banks exist.

BACKGROUND

To enable navigation of the River Thames many small and tortuous meander bends have been cut off from the main channel (this is evident from the size of some of the remaining cut-off meanders). Where backwater habitats remain they are prone to siltation at their connections to the main channel, creating a dry-land barrier at normal flows separating the Thames from the still backwater habitat.

Two islands, Doctor's and Skinner's, were identified in this scheme. The upstream connection of the backwaters had silted up and terrestrialised over many years and now formed high and dry land bridges to the previous islands.

Both inlets remained connected at their downstream end though silt and reeds filled the open water channels, isolating the backwaters from the Thames. In the case of Doctor's Island the link was quite tenuous (Plate 1).

The restoration of Skinner's Island was originally highlighted by the Edward Grey Institute for Field Ornithology, as it was seen to be important for mute swans as a nesting site. Bittern are also known to winter on the site as dense *Phragmites* (common reed) is present.

OBJECTIVES

To restore the functional connectivity of the backwaters to the Thames, in particular:

- restore the open water access link to breeding habitat for waterfowl and fish;
- provide refugia (for river fish in times of flood), spawning habitats, and enhanced recruitment through provision of fry habitat.

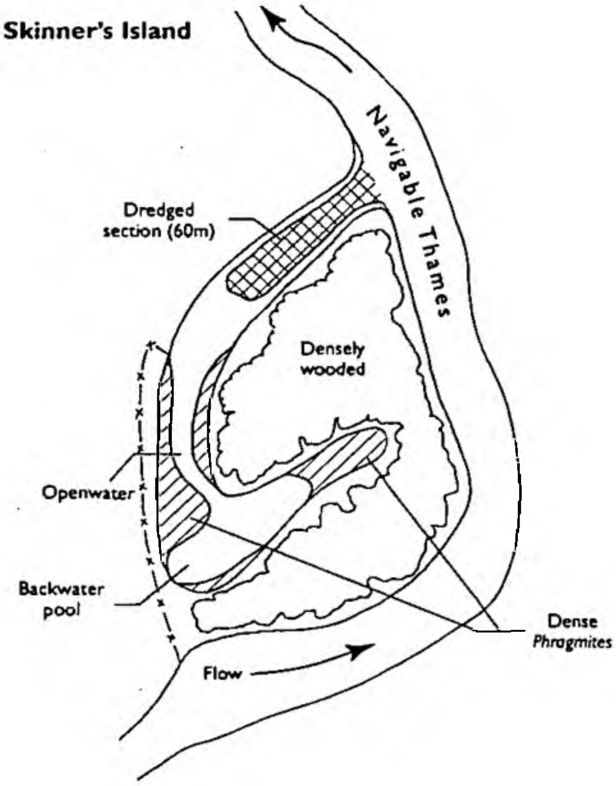
WORKS CARRIED OUT

Skinner's Island (partially occluded).

The channel was dredged from the mouth back up to connect with the large, still open reed fringed pool (Plate 2). This involved removing approximately 60m by 10m of silt and emergent reeds (mostly *Glyceria* (reed sweet-grass)), to a depth of 2m (deep enough for the draught of the dredger). This restored low flow access for fish, invertebrates and birds between the backwater pool and the Thames (Plate 3).

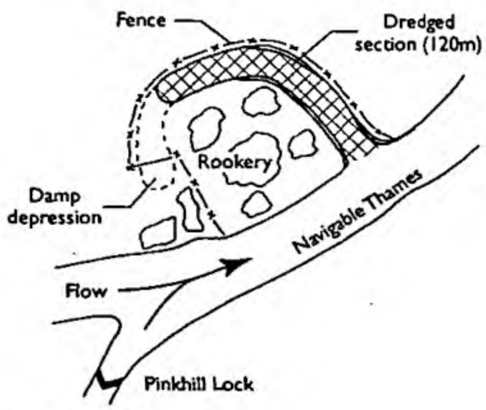
Further back from this point the backwater was still open with a reasonable depth, becoming significantly deeper at the large pool. In addition, substantial marginal stands of *Phragmites* had become established, but still allowed free passage for fish and waterfowl to a large area of the backwater (Plate 4).

Skinner's Island



A ledge of silt/marginal plants was left on either side of the dredged channel to retain a mature fringe.

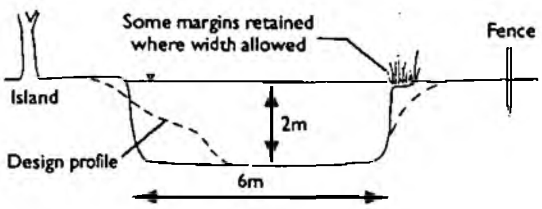
Doctor's Island (Occluded).
The cut-off at Doctor's Island was much smaller and much more heavily silted than the open water backwater at Skinner's Island. Terrestrial vegetation had colonised much of the upstream end, *Glyceria* had occluded the rest, and the backwater held no permanent water (Plate 5).



Doctor's Island

The excavation length was 120m by the width of the channel (approximately 8m) and as deep as was necessary to enable access for the dredger (c.2m). An area of wet reedbed and fallen trees was retained to ensure existing wildlife would not lose its previous habitat (Plate 6).

This channel was less than half the width of Skinner's, and due to the method of excavation - a grab dredger - it was not possible to profile the bank and create shallow sloping ledges. Therefore, where the channel narrowed towards the end of the backwater, the banks are relatively bare and steep. This does however increase overall edge diversity as there are many low, shallow, exit points still accessible to wildfowl (Plate 7).



Doctor's Island cross-section

Some pollarding and coppicing work was also carried out as standard procedure; fallen willows and thorn trees. The arisings were used to construct a simple log pile otter holt (at present used only by rabbits).

Tree work was carried out with care as the site is used as a rookery.

A post and wire fence was erected to deter public access from the Island.

SUCCESS/LESSONS

Both backwaters have been successfully restored. Skinner's Island continues to be used as a nesting site for Great-crested Grebe, Mute Swans and Coot, whilst Doctor's may need more time to mature.

A fisheries report on a number of backwaters in the Thames catchment showed Doctor's Island to support a very healthy fish population, despite the present lack of marginal cover in places (or perhaps because of poor predatory pike habitat).

Skinner's Island backwater continues to be fished, and is now in no danger of isolating the pool fishery from the main river. This provides a very substantial area of backwater to service the Thames, where such habitat/refugia are not common.

OVERALL CONCLUSION

The works have achieved the habitat objective of restoring the two cut-off backwaters to the Thames. Fisheries surveys indicate immediate success at Doctor's island, but further monitoring will be required to confirm full achievement of all objectives at both sites.

RECOMMENDATIONS FOR THE SITES

Continued monitoring of the fisheries should be a priority, both as a spawning/recruitment area and as a refuge, to evaluate the priority of other similar sites. High cost may be justified by high benefit.

Monitoring of siltation rates at the openings would provide an indication of potential lifetime of the works.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. The method of silt extraction is one area where cost may be significantly reduced if access from the bank is available and trees can be worked round. Disposal of spoil adjacent to the site would also be more cost effective where possible.
   Information collected on rates of siltation could lead to a pre-emptive partial desilt. This may be cheaper over the long term, say every 15-25 years.
2. When looking at similar situations it may be worthy of consideration to explore the benefits (and disbenefits) of opening both ends of the cut-off. This would obviously restore the 'island' status and provide flushing of the channel, however, a backwater may be a more valuable habitat with a higher priority locally/regionally.

COSTS

Both Island projects were funded by the EA from the Flood Defence Enhancement Budget.
Skinner's Island £25,000
Doctor's Island £36,000

Both schemes were expensive due to the use of the Thames Dredger and the need to remove all material to tip via barges.

AVAILABLE INFORMATION

General plans and project specification (Doctor's Island).
Pre and post site photo records, including aerials.
Fisheries survey (Doctor's Island)
Student report - Thames ORSU's

KEY PERSONNEL

EA West Area Enhancement Team:
Conservation Officer - Graham Scholey
Flood Defence - Dave Ludford
Fisheries – Bob Preston/Vaughan Lewis
Contractor - In house work force (IBU)
Consultant - In house.

Thames: Doctor's and Skinner's Islands

PLATE 1 Doctor's Island. The link with the R. Thames was heavily vegetated.

PLATE 2 Skinner's Island. Aerial view after completion.

PLATE 3 Skinner's Island. Dredged to restore access for fish, invertebrates and waterfowl, but retaining a vegetated ledge. – March 1998

PLATE 4 Skinner's Island. Backwater pool with large stands of *Phragmites*. – March 1998

PLATE 5 Doctor's Island. Terrestrial vegetation had occluded part of the backwater. The rest was choked with *Glyceria*.

PLATE 6 Doctor's Island. Some of the reedy habitat was retained. – March 1998

PLATE 7 Doctor's Island. Due to the method of dredging steep, bare edges were unavoidable in places. – March 1998

RIVER THAMES BEACH CREATION AT LONDON YARD

DATES: 1983

LOCATION: Amsterdam Road, Isle of Dogs, LONDON.

GRID REF: TQ 386792

CONTACT: Environment Agency, Thames Region, Landscape Architecture Group, Richard Copas. Tel. 01189 535565.

LAND OWNERSHIP: Private.

GENERAL INFORMATION

The Tidal River Thames has been heavily managed for centuries. Banks consist primarily of timber or steel sheet piling providing the required standard of flood defence protection and allowing maximum development, right up to the river. Water quality was not a limiting factor for this project.

BACKGROUND

The banks upstream and downstream of the site are formed from heavy steel piling, enabling development right up to the riverbank (Plate 1). Some sections of the opposite bank do retain what appears to be a natural tidal mud bank, however this could also be underlain by historical pitched stone protection.

As part of the planning process for a new riverside apartment development, the developer was asked to consider alternative designs to the standard use of steel piling.

OBJECTIVE

The key objective was to use a more aesthetically sensitive bank protection type, to improve landscape value whilst ensuring the integrity of the tidal defences was maintained.

WORKS CARRIED OUT

The bank defences are set back from the rivers edge by approx. 15m over a distance of 150m (Plate 2). At this point concrete 'steps' rise at an angle of 30 degrees until they reach the height of the surrounding piling.

As part of the riverside development a series of Dutch style apartments surround a central communal 'garden'. The steps are separated from the garden by a walkway.

The area between the steps and the river has been formed to resemble a shingle beach (Plate 3). The shingle was imported. At each end of the beach the steps end abruptly, reverting to new steel piling to tie back in to the old riverbank piling.

SUCCESS/LESSONS

The shingle has remained and the beach is generally clear of unsightly debris (though some weed, driftwood, etc. is evident at the high tide mark. Some localised redistribution of the shingle has occurred over the years, however this would be expected on a 'natural' beach.

This is an excellent example of what can be achieved instead of developing right up to the river's edge.

OVERALL CONCLUSION

The project achieves its objectives by combining an appropriate standard of flood defence with an aesthetically pleasing design. There is also a recreational benefit in terms of the usual attraction of beaches in the summer months.

RECOMMENDATIONS FOR THE SITE

An informal check on the migration of the shingle should be made annually. Eventually, assuming little replenishment from the river, it may be necessary to either redistribute or add more shingle to prevent the bare surface below from being exposed.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Major redevelopment sites along the tidal Thames should consider this and other options to reduce the length of continuous steel piling, both in terms of landscape and recreational value, and as habitat for birds and invertebrates where none at present exists.

2. A consideration that has not been adequately addressed at London Yard is the method for tying back into the upstream/downstream sheet piling. The use of new piling at either end should have been avoided, even if this meant the loss of a few metres of beach, to continue the step effect at a steeper angle.

3. Photographic material and technical specifications will be essential to encourage deviation away from the use of vertical banks, primarily sheet piling, which although proven as a technique is environmentally unsympathetic.

COSTS

Cost information is not available due to the age of the project and its fundamental incorporation into the overall development.

AVAILABLE INFORMATION

Original drawings and project file.

KEY PERSONNEL

Conservation Officer – Rachael Hill
Flood Defence – Lucky Wehalle
Developer – Greater London Council
Consultants – Brian Colgnhoun
Contractor – Christian Nielsen

Thames: London Yard

PLATE 1 Concrete banks for flood defence allow development right up to the water's edge. – April 1998

PLATE 2 The defenses are set back from the adjacent bank lines. – April 1998

PLATE 3 A shingle beach provides access to the riverside. – April 1998

ISLAND CONSERVATION AT SHIPLAKE LOCK

DATES: Works from December 1995 to planting in early 1996.

LOCATION: River Thames, immediately downstream of Shiplake Lock, Shiplake, NE of Reading, BERKS.

GRID REF: SU 777787

CONTACT: Environment Agency, Thames Region, Conservation, Alastair Driver. Tel. 01189 535563

LAND OWNERSHIP: Private landowner with sole ownership.

GENERAL INFORMATION

For centuries the River Thames has been heavily managed and constrained in armoured channels for the purposes of flood defence and navigation. This has led to regular maintenance of bed and banks, with shoal development not being tolerated. Islands, many of which would have developed historically from shingle deposits, are no longer being formed. In addition, many existing islands are eroding or disappearing altogether.

Some mature wooded islands still exist on the Thames, most being privately owned. They have great landscape, historic and ecological value, often being very important locally for wildlife. Conservation of such islands is a strategic goal of the Environment Agency in Thames Region, identified as a priority in its Local Environmental Agency Plan for areas covering the Thames.

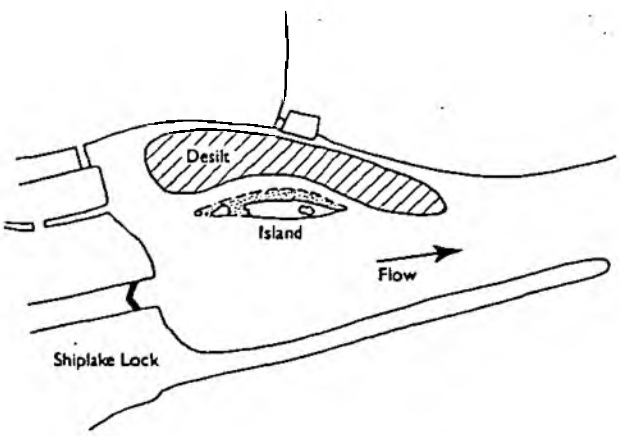
BACKGROUND

Typical of several remaining islands, the one at Shiplake lock was getting smaller and smaller as it eroded due to wave action from boatwash. The 35m length was being divided into a smaller main island with minor upstream extensions, mainly as a result of willow and alder trees providing some resistance. Some attempts at restoration had been tried in the past (still evident as wooden piles); however, this was mainly to the rear of the island on the opposite side to the river traffic. Where more extensive work has been undertaken on other islands, such as encasing the island in exposed steel sheet piling, the result is often ecologically poor. There is no possibility of edge habitat development or easy access for waterfowl.

The channel at the rear of the island had historically been a bypass/weir channel but was now blocked off. This meant that the backwater was heavily silted, with no flushing flows. Similarly to the island, the presence of deep quiet backwaters on the Thames are now scarce, and much in demand as fish refugia.

'Environmentally friendly' island restoration had not previously been attempted on the Thames.

Location of the works



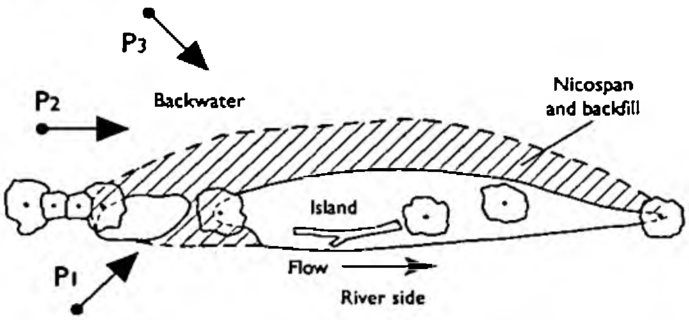
OBJECTIVES

- Conservation and restoration of the island and backwater, with associated benefits for wildlife and landscape;
- demonstrate that such work could be achieved in a heavily maintained river using materials other than steel piling.

WORKS CARRIED OUT

- protection of the island on the traffic side prone to boatwash,
- extension of the backwater side using silt from the dredging operation.

Plan of the Island



The river side, where a significant gap was appearing, needed protecting (Plate 1) as did the area to be extended on the opposite side (Plate 2). Rather than opting for the usual sheet piling a technique involving Nicospan was specified, to project only slightly above existing water levels.

The backwater was very shallow in terms of water depth. This was increased to the original bed in the centre of the old channel, retaining silt ledges at the edge of bank and island. Desilt material was then used to backfill the shelf and grade back to the island level. Excess material was removed by barge, an expensive method which increased the overall cost considerably.

Some pollarding was carried out to reduce the risk of mature trees falling and concentrating scour around the island. Live cuttings were then planted in the 'gap' to help consolidate the silt.

Native wetland plants and woody shrubs were planted. Dog Rose and other thorny shrubs were specifically planted on the river side to dissuade boaters from mooring/picnicking on the island and to screen properties. Wetland plants were also planted on the new shelf to quickly colonise and prevent wash out of the fine silts but retain a semi-open view of the island for the owner (Plate 3).

SUCCESS/LESSONS

After two years the rear of the island is now well vegetated, visibly consisting mainly of tall *Epilobium* (willow-herb) and *Scrophularia auriculatar* (figwort). No obvious washout of the backfill has occurred though the shelf was underwater when visited. The river side appears stable with no apparent gap reforming.

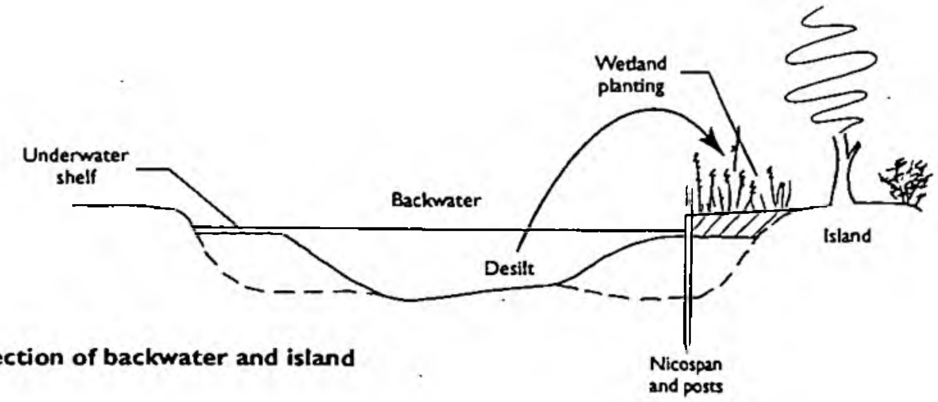
Swans, Moorhen, Great-crested Grebe and Coot have all bred on the island since the works were completed.

There are no obvious signs of boats using the island for mooring and disturbing the wildlife.

The success of this project can be used to promote further work on Thames islands. The landowner is keen to work with the Agency to achieve a similar project on the island immediately upstream of Shiplake lock, Phillimore's Island, which has undergone substantial reduction in area (measured on maps to be over a third) over the past 75 years.

OVERALL CONCLUSION

Successful protection and enhancement of a small Thames island. Considering the small size, this was an expensive project, however, such features will not be retained on the Thames



Cross section of backwater and island

unless such measures are taken. Backwaters will become completely silted and islands eroded.

RECOMMENDATIONS FOR THE SITE

None, except retain contact with owner and informally monitor stabilisation and vegetation growth. Manage the latter as necessary if both are successful.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. With very soft silt some measure of holding the material in its desired location is needed. Nicospan appears to be effective, remaining intact for many years. As coir and other degradable products become more commonly used in less stringent locations, their value at sites similar to the above can be re-appraised for future work. However, where a significant depth of silt (>1m) has to be retained, Nicospan appears to be the most cost effective and environmentally sound long term solution.

COSTS

Conservation led, internally funded project with financial input from Flood Defence towards the desilting work. Landowner co-operation and £300 contribution to planting.

Flood Defence budget £18,000.
Conservation budget £6,000.
Total cost of the works £24,000.

Budget increased above that which was initially anticipated due to cost of removing from site unforeseen excess silt.

AVAILABLE INFORMATION

General plans and specification.
Pre and post works photo records.

KEY PERSONNEL

Conservation Manager - Alastair Driver (EA)
Flood Defence - Amanda Palm (EA)
Contractor - EA In-house
Consultant - EA In-house

Thames: Shiplake

PLATE 1 Nicospan used to retain material and form a hard edge.

PLATE 2 Island extended into the newly dredged backwater.

PLATE 3 View of the vegetated island from the owner's property. – March 1998

SONNING LOCK ACCESS ROAD PROTECTION

DATES: Sections A&B, 1990/1991 and section C, 1994/5

LOCATION: River Thames, immediately upstream of Sonning Bridge, Sonning, NE of Reading, BERKS.

GRID REF: SU 755757

CONTACT: Environment Agency, Thames Region, Conservation, Alastair Driver. Tel. 01189 535563.

LAND OWNERSHIP: Environment Agency.

GENERAL INFORMATION

For centuries the River Thames has been heavily managed for the purposes of flood defence and navigation. Various techniques of bank revetment are used throughout the UK, however on the navigable Thames the most prevalent is steel sheet piling, often combined with concrete bagwork. The main areas of weakness are at the toe caused by erosion from boatwash and fluvial processes.

BACKGROUND

Access to Sonning Lock is via a narrow access road from Sonning Bridge, in places little more than 1m from the riverbank. Bank protection consisted of concrete bagwork on a toe of ballast but in some places there had been complete failure of old protection measures, and gradual erosion elsewhere. Both compromised the stability of the road and in places subsidence had occurred.

An initial solution of sheet piling and concrete bagwork was proposed. Due to the height of the bank this would protrude up to 2m above water level. Alternative options were developed by NRA conservation staff, using a combination of hard and soft engineering, which would satisfy the requirements of flood defence and navigation but enhance habitat and landscape features.

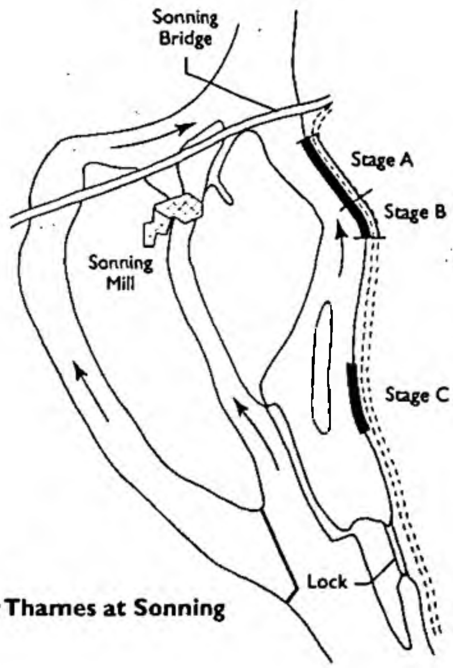
The access road also doubles as a footpath.

OBJECTIVES

- To provide bank protection against boat wash whilst increasing wildlife habitat on an otherwise virtually bare section of riverbank;
- Being a high profile site with heavy public access, a more aesthetically acceptable option than piling and bagwork was sought.

WORKS CARRIED OUT

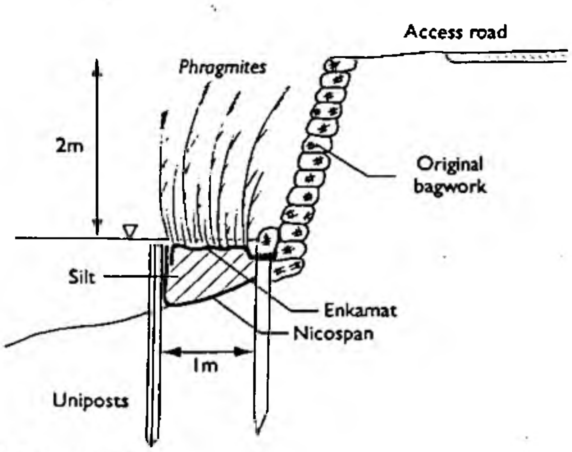
The works can be divided into sections A and B, carried out in 1990/91, and section C in 1994/95.



River Thames at Sonning

Section A
– Access road nearest to Sonning bridge – 65m length.

This section showed some evidence that the original bagwork may be prone to failure in the future, however at the time it was still intact. Bagwork rose directly from the river, there being no marginal fringe at all. Due to the location of this length, on the inside curve of the bend, a small underwater ledge was judged to be suitable to protect the bagwork from erosion and create an edge habitat.



Nicospan shelf

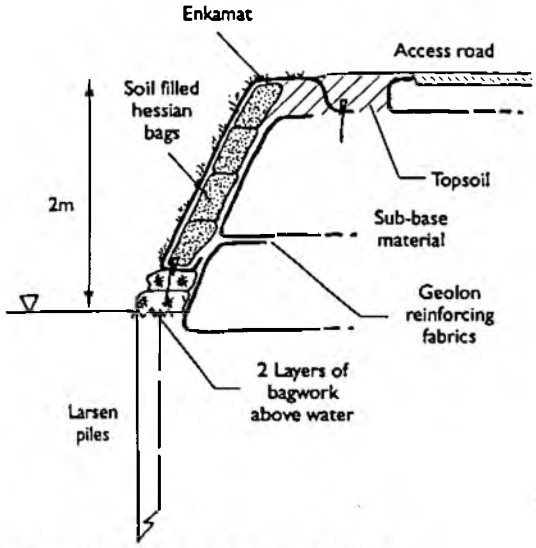
Nicospan was used to form a retaining 'wall' approximately 1m out from the bank, supported by timber posts. The area behind the Nicospan was then backfilled with silt from the channel, retained by a cover of Enkamat, and anchored by a line of concrete bags placed hard against the original bagwork wall.

It had been possible to coppice and retain some small tree growth due the incorporation of the ledge. Spoil from a downstream wetland creation project was placed, to a depth of 300mm, on top of the shelf (Plate 1).

Section B
– Upstream of section A – 25m length, very close to road.

Similar to section A, but at this point the bagwork was failing and subsidence evident. Cause most likely to be a combination of boatwash and slightly increased velocities associated with the outside of the bend. The incorporation of a ledge was not felt to be appropriate at this location.

To ensure rigid protection of the bank toe larsen piles were driven into the bed to water level with two layers of bagwork above.

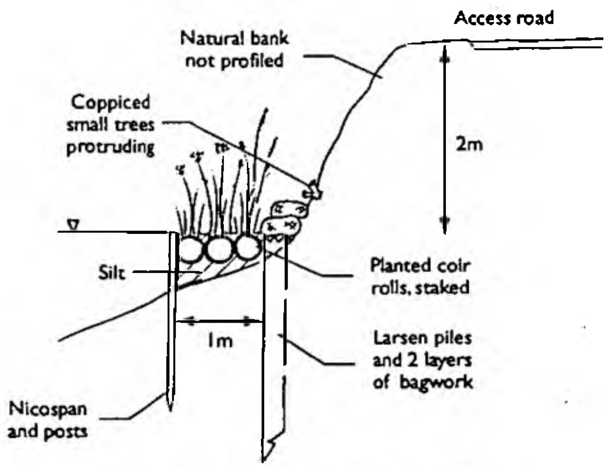


Soil filled pre-seeded hessian bags

Enkamat was then pinned into the bagwork with pre-seeded soil filled hessian bags placed on top, laying back to the regraded bank. Once the desired top height had been achieved the Enkamat was pulled up over the surface of the hessian and secured. Minor backfill between the hessian bags and the road used topsoil (Plate 2).

Section C
– Access road upstream of section B, opposite island – 50m length.

Erosion of the upstream section of the access road bank required additional works to be carried out in 1995.



Nicospan and planted coir fibre rolls

Here bagwork was absent and boatwash was having an obvious effect, in addition anglers were causing localised erosion when climbing down the 2m drop to the waters edge.

As a result of the success of the section A&B work a similar approach was taken here to avoid the use of visually intrusive hard engineering above the water line.

Modifications to the original design were developed by the consulting engineer and the conservation officer. Coconut (coir) matting with pre-planted vegetation above silt backfill was used in conjunction with low level piles.

Sheet piles and two layers of bagwork were again used at the base of the bank to provide secure toe protection (necessary due to the height of the bank and the weight of access traffic). A Nicospan line was then set 1m out from the piling, backfilled with silt from the river. Pre-planted coir rolls were set three abreast and firmly staked into the back-fill. Enkamat was not used to cover the upper bank because of its unsightly nature in winter and it was thought that natural reseeding would be adequate.

The rolls were planted with *Iris* (yellow-flag), *Carex riparia* (pond sedge), *Sparganium erectum* (branched bur-reed) and *Phalaris* (reed canary-grass). Small bankside Ash, Willow, Sycamore and Alder were coppiced to
protrude 200-300mm out of the regraded bank (Plates 3&4).

SUCCESS/LESSONS

Section A.

Initially, the silt ledge was washed out from beneath the Enkamat by high flood flows in 1991. This failure was largely due to bad luck in terms of having a large flood event so soon after completion. Subsequently, silt rich in *Phragmites* was placed on top of the ledge. This has now grown into a tall stand of marginal vegetation, providing good edge habitat.

Section B.

Visually this technique has not performed as well as was expected. Some settlement/slumping of the hessian bags has occurred resulting in a 100-150mm difference between road height and bank edge. The grass growth is not sufficient to totally obscure the Enkamat, however this would not normally be noticed except from the opposite bank (private landowner) and boaters. In addition, the Enkamat is showing signs of animal damage.

In terms of habitat the uniform grass cover is relatively poor, though is still far better than uniform concrete bagwork.

Section C

The aquatic marginal ledge now appears to be vegetating well, and boatwash erosion is being limited by the Nicospan and the vegetated habitat between it and the bank. The planted rolls worked well and the ledge was entirely vegetated in its first season, though some silt washout did occur around the rolls. Other species of marginals are also colonising, and water vole droppings indicate a return of this declining animal in an area where habitat was unsuitable prior to the work.

Erosion due to access by fishermen to the waters edge still appears to be a problem in places, though this was known to be a problem previously.

OVERALL CONCLUSION

The two aquatic ledges have achieved all the required objectives, improving the toe protection of the bank and enhancing the ecology and aesthetics of the site. Planted vegetation has established well and helped to stabilise the ledge, so the native species of the river can naturally re-colonise. The Enkamat still looks extremely stark and vulnerable to wave action.

The success of the ledges and planted coir roll on such a high profile river bank has demonstrated its potential for further use elsewhere. When used in conjunction with the low level piling and layers of concrete bags it has proven to be effective in meeting erosion control needs, enhancing edge habitat, and improving landscape value.

RECOMMENDATIONS FOR THE SITE

An area of concern is the beginnings of some localised erosion at the junction of old (bagwork) and new bank. Some attention in the future may be required.

Section B could benefit, in terms of diversity, visual appearance and bank stability, from planting whips of shrubby willow species directly into the Enkamat/hessian bank. These would need a degree of future maintenance, however so will the coppiced trees in section A.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Erosion pockets can easily develop around the end of the old bank protection through lack of keying in of the new. Detailed attention to this aspect should be included within the design stage and be subject to special attention during construction.

2. Some concern still exists about the durability of coir rolls and the ability of the plant system to bind and hold the silt in place afterwards. Feedback from monitoring of the site should help to address this potential issue at future sites. This is important bearing in mind the continued growth in the use of these products.

3. Simply using river silts without a membrane to hold the fines in place is potentially risky, due to vulnerability to flood scour. An assessment therefore needs to be made in terms of using a geotextile or risking the potential erosion.

COSTS

The work was funded from the NRA Navigation budget.
Stages A and B (1990/1), information unavailable.
Stage C (1994) works £28,000.

AVAILABLE INFORMATION

General plans and specifications.
Engineering drawings.
Pre and post works photo records.

KEY PERSONNEL

Conservation Manager - Alastair Driver (EA)
Navigation - John Waters (EA)
Contractor - Stages A and B: NRA In-house,
Stage C: EA In-house.
Consultant - Stages A and B: NRA In-house,
Stage C: Halcrow Thames.

Thames: Sonning

PLATE 1 Section A. *Phragmites* growing on the ledge. – March 1998

PLATE 2 Section B. Grass cover, but the soil filled bags are starting to slump. – March 1998

PLATE 3 Section C. Planted coir rolls being installed, looking downstream.

PLATE 4 Section C. Planted coir rolls well established, looking upstream.

RIVER WINDRUSH ENHANCEMENT WORKS

DATES: 1992/3

LOCATION: Downstream of Worsham, nr. Minster Lovell, OXON.

GRID REF: SP 300105

CONTACT: Environment Agency, Thames Region, West Area, Conservation, Graham Scholey. Tel. 01491 832901.

LAND OWNERSHIP: Private.

CATCHMENT INFORMATION

The River Windrush flows through Cotswold limestone in the north west of the Thames catchment. Soils are mixed clay/alluvium. This combination of soils and geology gives a high, but variable, baseflow, together with a fairly flashy response to heavy rainfall. Water quality is very good (GQA grade A) and the gradient is sufficient to keep many gravel beds clean.

BACKGROUND

The Windrush has been subject to various land drainage schemes, including dredging and removal of natural gravel substrate. Land-use is mainly sheep grazing, which was causing a minor problem in terms of concentrated bank poaching and erosion. The channel at the enhancement site was over-wide (by up to 100% in places).

Just upstream of the site the Thames Water Utilities surface water abstraction works at Worsham takes 11.4 Ml/d (some 30-40% of extremely dry weather flow). This heightened the low summer flow problems experienced in this reach and significantly reduced flow velocities.

Low flows and low velocities had caused accelerated siltation and a resultant encroachment of emergent vegetation, predominantly *Scirpus* (club-rush). Dredging was necessary every 2-3 years. In 1990 and 1991 following complaints from two leasing angling clubs, the NRA inspected the site and found the channel totally choked, preventing angling, reducing the ecological diversity of the site and posing a potential flood defence problem (Plate 1).

OBJECTIVES

The following objectives were to be met by narrowing the channel and introducing gravels and a specially designed 'spawning weir':

- increase summer flow velocities to prevent excessive siltation and macrophyte growth;
- re-create the natural gravel bed;
- increase spawning sites;
- increase in-channel and edge habitat diversity.

WORKS CARRIED OUT

Channel Narrowing

Previous narrowing works on the Windrush had used scaffold poles and 'Nicospan' to form a retaining edge. This was deemed to be unsatisfactory in this location. A bio-degradable option was preferred to achieve the same effect, as was a second technique, using oolitic limestone blocks (approx. size 1m by 1m by 0.6m).

A 500m length of the Windrush was narrowed by up to 60 % along the right bank, with a varied edge line (average new width 4.5m).

Coir fibre (Dekowe) and Larch posts

This was designed to last for 5 to 8 years before degrading, allowing the fill material and plant root systems to bind together and form a stable new bank and edge. Posts were placed at 2m intervals, driven into the bed, and the coir fibre fixed to the posts and returned along the bed. Once backfilled the posts were cut off to water level.

Blockstone

Two layers of blockstone were used to create a retaining wall. Backfill was, where possible, graded with the larger/more cohesive material directly behind the stones to prevent silt washout. Single blocks were also placed directly into the channel to vary the flow pattern.

The central channel was dredged of silt and emergents which was placed behind the retained edge. More material was needed than was originally anticipated for backfill. To reduce expense and benefit the landowner, an access track was cut into the valley side along the upstream section of the works, and the material used to complete the back-filling (Plate 2).

In both cases the new ledge was designed to create dry to damp conditions, to allow access for fishermen and to benefit wading birds.

Gravel Introduction
500 tonnes of angular flint rejects were broadcast into the narrowed reach to recreate a gravel bed. No shaping or great care in gravel placement was thought necessary. A further 100 tonnes of graded 4-2cm gravel was used to 'dress' the rejects.

Spawning Weir
The Windrush lacks good spawning sites for both coarse fish and brown trout. A special 'spawning weir' was designed to provide the required conditions. A wide section of the river just downstream of the narrowed reach supported a natural island feature. Two weirs were installed, one each side of the island (Plate 3). The design uses a weir with buried perforated pipes to flush and aerate the downstream gravel bed. The pipes need periodic rodding to keep them clean, via the downstream capped end.

SUCCESS/LESSONS

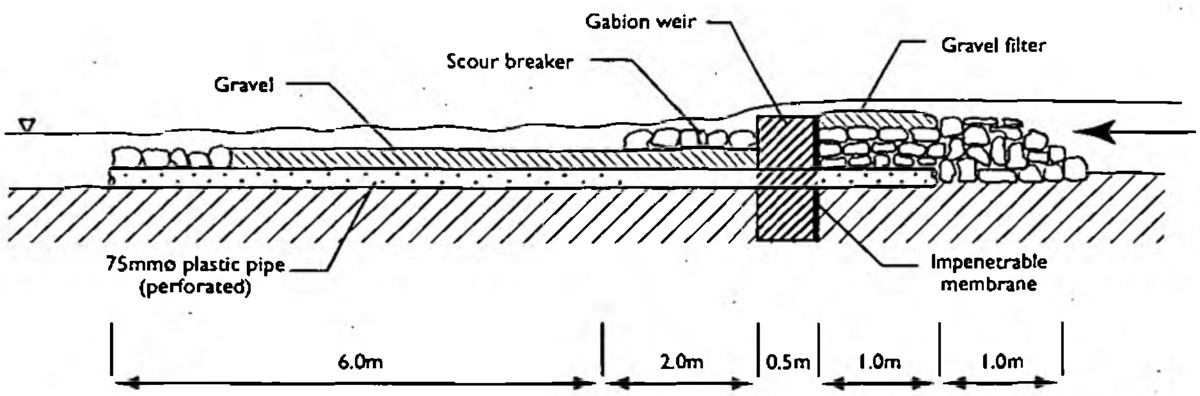
Subsurface bedrock hampered the installation of the larch posts. Compressed air guns were needed to loosen the bed and the poles driven in using pneumatic pile driving equipment, increasing the cost of this particular technique.

Within three months the coir fibre had rotted away and the unsupported edge was being rapidly eroded (Plate 4). A decision was taken to replace the entire length of coir fibre/larch posts with limestone blocks (Plate 5).

The height of the ledge was difficult to judge at the time of construction (Winter 1991/2), and currently is lower than was anticipated (with respect to current summer water levels). The drier 'design' level was in keeping with angling access requests, but did not address ecological objectives However, this damp/submerged ledge teems with fish fry and exhibits good plant diversity. Summer water levels are also variable depending primariliy on baseflow, and also abstraction, therefore the ledge habitat will vary from season to season and year to year (Plate 6).

Varied settlement of the limestone blocks has produced a non-uniform edge, and joints/gaps between blocks provide eddies/shelter for fry, ameliorating the effect of an essentially vertical bank profile.

The Island between the spawning weirs has remained (originally strengthened on the upstream end) and even elongated to the length of the gravel beds. The weirs are used for spawning, however the flow velocities are too fierce in winter at the



Spawning weir

weir, so spawning occurs on the gravels 30-40 m downstream.

The landowner is happy with the scheme in terms of the enhancement of the river and improved fishery, and also the improved safety for his sheep (sheep loss in high flows was a problem previously) and better summer grazing as a result of restored summer water levels. A section of riverside meadow has become isolated from the river (aided by machine compaction/tracking/etc., during the works period). This is developing into a shallow perched wetland, fed by rain and floodwater (Plate 7). The landowner is happy for this to remain as it is.

An indication of the improvement in the fisheries quality of the Windrush at the site can be derived from the catches recorded by the angling clubs. Five years on from completion catches of wild brown trout are up (small fish first recorded 3 years after the works).

OVERALL CONCLUSION

The narrowing works have prevented the deposition/accretion of silts and the associated re-colonisation by emergents, by increasing low-flow velocities. This has also kept clean the gravel bed that has, in conjunction with the variable width, sorted into a pool/riffle profile. Aquatic macrophytes such as *Potamogeton pectinatus* (fennel pondweed) and *Ranunculus* (water-crowfoot) now dominate the channel.

The two weirs have created spawning areas which are being used by both coarse fish and trout (wild and stocked), though not exactly at the designed location. It is thought that the capital value of the fishery has increased 2-3 fold due to the works.

The quick replacement of the coir/post technique with blockstone has not affected the end result. Both blockstone sections are similar in appearance and development in terms of plant colonisation and settlement of the blocks.

The new ledges serve as a refuge for fish fry, food source for waders (sightings of redshank, ringed plover, sandpiper, lapwing, snipe) and are developing a good mix of dry to wetland plant species.

A significant factor influencing the overall success of the project was the daily supervision by the Fisheries Officer, and thus the ability to adapt the design to site specific considerations.

RECOMMENDATIONS FOR THE SITE

Monitoring of the fish populations to give some quantitative measure of success. This could include analysis of fish catch records over the post and perhaps pre-scheme period.

Some survey and analysis of the bed structure/formations and the effect of the single limestone blocks would be of interest for use at other sites.

RECOMMENDATIONS/CONSIDERATIONS FOR FUTURE APPLICATION

1. Test driving installation of posts (if a similar post/natural fibre mat is to be used) is recommended to ascertain their suitability. Costs will increase if specialist equipment is needed.

2. The use of coir and other natural fibres (eg. jute) is becoming more common, though they still need to prove their manufacturers claims of life expectancy and use under tension. Currently available products certainly remain viable for years rather than the few months experienced at this site.

3. Budget provision for on-site supervision at regular (if not daily intervals) can be crucial for a successful scheme which addresses all the site specific constraints/issues, and meets objectives. This may add significantly to the works cost.

COSTS

The work was funded from Flood Defence at a total cost of £42,000.

AVAILABLE INFORMATION

General plans and drawings,
Audit survey - 10/2/93,
Pre and post works photo records
Student report - 1995

KEY PERSONNEL

Conservation Officer - Graham Scholey (EA)
Fisheries Officer - Vaughan Lewis (formerly EA)
Operations - Dave Ludford (EA)
Contractor - In-house workforce

Windrush

PLATE 1 Pre-scheme the channel was choked with macrophytes, due to sluggish low flow velocities.

PLATE 2 A new access track was excavated into the slope to benefit the landowner and gain additional backfill material. – May 1998

PLATE 3 Downstream a pair of 'spawning riffles' were installed, one either side of the island, incorporating aeration pipes. – May 1998

PLATE 4 Coir fibre stapled to posts and backfilled. Washout was almost immediate as the coir degraded within a few months.

PLATE 5 The replacement blockstone has prevented the same thing occuring again. – May 1998

PLATE 6 Water levels are variable between years so the ledge is both wet and dry. – May 1998

PLATE 7 Water ponds on the adjacent field surface resulting in improved grazing. – May 1998

the River Restoration Centre

Project Database - compiling information

Please return forms to:
RRC, Silsoe Campus, Silsoe, Beds.
MK45 4DT Tel/Fax 01525 863341

To enable the Centre to collate a detailed database relating to river and floodplain restoration requires standard summary details to be provided by those undertaking projects. The main elements of this form should take less than half an hour to complete if the project file is at hand. It is preferable to have all the details, but do not worry if some elements are missing. Having a project record at the Centre is important, without some information we cannot make people aware of your work.

The information provided will be entered on to RRC's database and be available to a wide variety of users of the Centre. This summary information will also be used, in conjunction with recommendations from those providing it, for selecting individual projects for more detailed assessment, where post project appraisals will be carried out, case studies prepared, or information on the techniques used will be gathered in more detial.

You are invited to provide information on projects that have been undertaken in the 1990s which have made a significant contribution to rehabilitating river and floodplain habitats and features. In addition to recording what has been done, RRC wish to record how is was made possible (funding arrangements, staff involved etc.) so that others can benefit from the leasons learnt.

Page 1: Project Features

Through a simple tick-list this page provides us with details regarding elements comprising the restoration project. Restoration activities have been divided into five GENERIC types, the first three being consistent with previous work for the Environment Agency and the European Centre for River Restoration.

Identify which of the five generic types was the PRIMARY (P) focus by ticking just one of the five grey boxes; if the other four types were of SECONDARY (S) or MINOR (M) considerations tick appropriately. For generic types 1-3 tick which ELEMENTS were P, S or M components of the project, but do not have more than three ticks in the P column. For catchment activities please list activities, and expand on a seperate sheet if necessary.

Page 2: Contact, site details

These details help RRC identify who is the key contact for a project, its geographical location, the primary objectives, and characteristics of the site and its catchment. Linking objectives, drivers and site/catchment details helps in the assessment of success and failure of different techniques and features identified on page 1 and 3.

Page 3: Technical Aspects

Information provided here on project funding and partnerships with other organisations, may be very helpful to others when they are assessing likely costs and the potential for collaboration support. Please be as accurate as possible, but ranges of expenditure are equally usable. We would also like to record the team involved; their addresses will be entered on RRC's main database and the people contacted wth information about RRC as part of a commitment to broadening the network. Finally, the end section of the form allows you to comment on the success / failure of the project and any additional material on the project.

Page 1: Project Features

RRC Project Code ....

Project Name ....

Main Contact ....

	P	S	M
Type 1 Rehabilitation of Watercourse Reaches			
1.1 Reach remeandered (>500m)			
1.2 Reach remeandered (<500m)			
1.3 Culverted reach re-opened (state length)			
1.4 X-sectional habitat enhancement (>500) - two-stage channel profiles etc.			
1.5 Long section habitat enhancement (>500m) - pool/riffle sequences etc. restored			
1.6 River narrowing due to depleted flows or previous over-widening			
1.7 Backwaters and pools established/reconnected with watercourse			
1.8 Bank reprofiling to restore lost habitat type and structure/armouring removed			
1.9 Boulder etc. imported for habitat enhancement			
1.10 Gravel and other sediments imported/managed for habitat enhancement			
1.11 Fish cover established by other means			
1.12 Current deflectors/concentrators to create habitat and flow diversity			
1.13 Sand, gravel and other sediment traps to benefit wildlife			
1.14 Tree/shrub planting along bankside (only if covers >500m of bank or >0.5ha)			
1.15 Artificial bed/bank removal and replaced by softer material (>100m)			
1.16 Establishment of vegetation for structure/revetment (e.g., use of willows)			
1.17 Eradication of alien species			
1.18 Provision of habitat especially for individual species - otter, kingfisher etc.			
1.19 Fencing along river banks; fencing floodplain habitats for management			
1.20 Aquatic/marginal planting			
1.21 Removal of floodbanks			
1.22 Other (specify)			
Type 2 Restoration of Free Passage Between Reaches			
2.1 Obstructing structure replaced by riffle			
2.2 Obstructing structure replaced by meander			
2.3 Obstructing structure modified/removed to enable fish migration			
2.4 Obstructing structure retained, but riffle/meander structure established alongside			
2.5 Culverted reach re-opened			
2.6 Obstruction within culvert (e.g., lack of depth, vertical fall) redressed			
2.7 Dried river reach has flow restored			
2.8 Other measures taken to restore free animal passage			
2.9 Other (specify)			
Type 3 River Floodplain Restoration *Water-table levels raised or increased flooding achieved by* *			
3.1 * Unspecified means/rationalized control			
3.2 * Water-course re-meandering			
3.3 * Raised river bed level			
3.4 * Weirs established specifically to increase floodplain flooding/water-table			
3.5 * Termination of field drains to water-course			
3.6 * Feeding floodplain with water (sluice feeds, water meadow restoration)			
3.7 * Narrowing water-course specifically to increase floodplain wetting			
3.8 Lakes, ponds, wetlands established (maybe flood storage areas)			
3.9 Lakes, ponds, wetlands, old river channels restored/revitalised)			
3.10 Vegetation management in floodplain			
3.11 Riparian zone removed from cultivation			
3.12 Substantial floodplain tree/shrub planting			
3.13 Other (specify)			
Type 4 Catchment Activities continue on seperate sheet .. State key activities implemented			
Type 5 River Management ☐ Maintenance changed ☐ Equipment changed ☐ Maintenance withdrawn (natural regeneration)			

Page 3: Technical Aspects

RRC Project Code

Project Funds and Source

Total Cost (£.K) ....

Percentage Breakdown of Total Cost

% Promotion / Design / Planning / Consultation .... %

% Works Contact / Supervision .... %

% Monitoring / Post Assessment .... %

	Budget Source of Funds (if applicable)	Funds £.K
Primary Funding Organisation		
Other Funding Organisation (s)		

Other Partners ....

Project Team

Names, Address and Tel. No.

Hydrologist ....

Geomorph-ologist ....

Ecologist ....

Landscape Architect ....

Design engineer ....

Works Contractor ....

EA - Flood Defence ....

EA - Conservation / Fisheries ....

Water Quality ....

Community Liason ....

Project Comments and Documentation

Success or Failure Comment ....

Documentation (available)

- ☐ Stated Objectives
- ☐ Job Specification
- ☐ Technical Specifications
- ☐ Contract Documents
- ☐ Audits
- ☐ RHS RCS
- ☐ Fisheries Survey
- ☐ Monitoring Reports
- ☐ Photographs Pre works
- ☐ Photographs Post works

Other Documents ....

Journal Citation ? ....

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Page 2: Contact, Location and Background Information

RRC Project Code ....

Main Contact (full details)

Forename .... Surname ....

Organisation ....

line 1 ....

line 2 ....

line 3 ....

line 4 ....

County .... Tel ....

Country .... Fax ....

Email ....

Project Name & Objectives

....

Main River	Watercourse Name	Site County	Site Country
....	....	....	....

Location Description ....

....

OS Sheet Letters .... OS 6 Digit Reference ....

Project Start Date .... Project Status
- ☐ Proposed
- ☐ Detail Design Stage
- ☐ in-contruction
- ☐ Completed (No Monitoring)
- ☐ Monitoring

Project Finish Date ....

Project Objectives ....

....

Main Focus - Driver

☐ Bank Erosion ☐ Development Gain ☐ Flood Defence ☐ Landscape ☐ Pollution Mitigation

☐ Community Demand ☐ Fisheries ☐ Habitat ☐ Navigation ☐ Other...

Site Information (Pre-project)

Section Length (km) ....

Site Background ....

....

....

....

....

River Substrate ....

River Bed Gradient ....

Floodplain Soils ....

Was Water Quality a Constraint ? ____________________

Habitat Quality (general) ____________________

____

Catchment Information (Outline)

Catchment Type
- ☐ Upstream of Urban Area
- ☐ Within Urban Area
- ☐ Downstream of Urban Area
- ☐ Rural - Dominantly Agricultural
- ☐ Rural - Dominantly Forestry

Cumecs

Dryflow Cumecs __________

Bankfull Cumecs __________

1:5 Cumecs __________

1:50 Cumecs __________

1:100 Cumecs __________

Catchment Geology (Dominant Solid or Drift) ____________________

____

the River Restoration Centre - Summary of Projects

Project Name ....

Main River .... Site County ....

Watercourse Name .... Site Country ....

Site Background .... Project Objectives ....

Main Focus - Driver

☐ Bank Erosion ☐ Development Gain ☐ Flood Defence ☐ Landscape ☐ Pollution Mitigation
☐ Community Demand ☐ Fisheries ☐ Habitat ☐ Navigation ☐ Other...

Main Contact .... tel ....

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the River Restoration Centre - Summary of Projects

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Main Contact .... tel ....

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Main Contact .... tel ....

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