



# A CINDERELLA RIVER: THE RIVER GLAVEN CONSERVATION GROUP (RGCG) IN-RIVER HABITAT RESTORATION 2006

*The River Glaven is a small chalk river in north Norfolk. The headwaters are at Lower Bodham and Baconsthorpe. The river flows for some 17km, first in a south-westerly direction, then turning to the north before finally entering the sea at the tidal sluice at Cley. The gradient is steep for a lowland river. Historically there were 11 water mills on the Glaven. Today five mill structures remain and that at Letheringsett is still in operation. The RGCG undertook a river restoration project upstream of Letheringsett Ford, between TG 060383 and TG 057376. Most of the practical work took place in October 2006, but there was a spread of tasks through September to November.*

*The project had a long gestation period. The concept of what we wanted to develop followed a Wild Trout Trust advisory visit in September 2003. The finance required to make it happen was granted in May 2006 through the newly formed Cinderella Chalk Rivers Project, a national scheme run by the Wild Trout Trust in partnership with the Environment Agency and Natural England.*

*This report sets out the main steps as the concept, preparation work and the implementation. The concept section includes the characteristics of the river, the proposed improvements, and the thinking behind these. The part on implementation sets out in some detail how the work was done: logistics and materials; construction work for riffles, river narrowing, mid stream islands, large woody debris deflectors and bank spoil removal and protection; project costs and control; and the follow-through.*

*This was the first major project to be undertaken by the RGCG. The final section of the report highlights key points to consider in the planning and implementation of a river restoration project. Other conservation bodies in a similar situation might find that the Key Points section gives them some additional useful pointers.*

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## THE CONCEPT.

The River Glaven is set in most attractive countryside, and the closer the examination the more we realise how valuable it is as a wildlife habitat and the range of species dependent on it; including a number of protected or featuring in national and local Biodiversity Action Plans.

Nevertheless for a variety of reasons the river as a whole has suffered over past decades through changes in farming and land management practices, and policies for flood risk management; a principal reason for the existence of the RGCG to work with those concerned to make changes which are beneficial to the river and the wider catchment.

Even within the relatively short stretch of river concerning this project, there are considerable differences in the river landscape and wildlife habitat. There are broadly four sections along "our" stretch.

The upper section is thickly wooded on both sides, with mature alder and some fine ash, with a fair amount of ivy on many trees. The river here is on a steep gradient and fast flowing, and retains natural bank formations. There are variations in the river course, with bends and deep pools, and areas where it races over the gravel bed. These characteristics make it good for brown trout, invertebrates in the river, and for the wildlife chain as a whole. The trees add some leaves and light woody debris to the river, which add to the value by nurturing insect life. We planned to do no work here other than in a short section where we would clear a few sycamore trees which would permit sunlight on the river beside footbridge 2 (map 1 summarises our work proposals); the rest of this section would remain heavily shaded.

The upper-middle section is similar in most respects but almost all the trees are confined to the west bank. Again this is a "good" section of river for trout, a marker species for much wildlife; and with the additional light the appearance of water crowfoot in the river bed. It is also a part of the river frequented by the kingfisher.

It suffers however from the 1970s and 1980s legacy of widening of the river, and dredging with a subsequent lowering of the river bed. These operations left a high bank of spoil on the open side facing a meadow, and where there are just two trees. Thus the natural progression of the degree of wetness between the river and meadow, and the characteristic species of plants and insects which depend on this, is lost to a high and dry spoil bank.

We have been keen to select a place such as this where the spoil bank could be removed and the natural regeneration that follows could be studied by the RGCG. The Environment Agency was supportive in principle for another reason. They favour, where appropriate, the re-connection of river and natural flood plain. In severe rain events flood water may be "held-up" in areas where there are no houses which could be affected. So spoil bank removal, and the formation of a more natural profile, was introduced into our programme. Our plan for this would involve the removal of hundreds of tonnes of spoil off-site, and recovery of the gravel and flint in the spoil, and disposal of the separated soil on arable land.

The lower-middle section of the river runs diagonally across the meadow, with high spoil banks on each side and no trees. The gradient of the river remains quite steep, so that the flow is fast over a generally good gravel bed. It is however rather uniform in nature, and the plan is to introduce some flow deflector measures, to be created by "large woody debris"; a good "natural" example, a tree which had fallen across, was shown in the article "Let Sleeping Logs Lie" in our April 2006 Newsletter.

The lower section of the stretch runs from footbridge 1 (see map 1, page 17) down to the Ford. Here the river profile has flattened. The flow is slower, and a sand silt deposit over the gravel dominates. The flow is also slowed by the river being too wide in places. The emphasis here is to carry out some narrowing in places, and also to introduce some gravel riffles. The riffles are beneficial to trout and invertebrates as noted above; and we would hope that they extend the amount of habitat available to four species all recorded in the vicinity of the Ford; bullhead, stone loach, brook lamprey and white-clawed crayfish.

So while the stretch of river has a great deal to offer in terms of its wildlife, the RGCG project aims to make improvements to the river habitat as a whole, and to the micro-habitats so important to the wide range of wildlife that the river supports.

We looked to close some circles in how we would implement the works. The felled sycamore trees would supply the trunk sections required for the large woody debris. But also we estimated a need for some 120 faggots for river narrowing works, and some 200 wood stakes; a portion of this would come from these trees, and much of the remainder from hazel and alder growing close by.

The plan for the spoil from the river bank was to sieve off-site on an arable field nearby, using a grading machine to give two “cuts” of stone material. These were to be a spawn gravel in the size range 10-50 mm, and larger stone, to be used in the construction of the riffles. The recovered soil will be spread over arable land.

Finally we would have the potential for flood risk reduction in the removal of the spoil bank as well as the conservation (and landscape) benefits where we make a re-connection between river and flood plain.

## THE FUNDING AND PREPARATION WORK.

The RGCG received in March 2006 a grant of £1,500 from the Wild Trout Trust's Cinderella Chalk Rivers Project (this project is a national initiative, and aims to promote improvements to the less well known chalk rivers in England). We planned to use this grant to obtain the services of a consultant to "work up" our concept proposals in the detail of what would be done, and how it should be done, to comply with the licence consent required from the Environment Agency.

In May we heard that the Biodiversity team of the Anglian Region of the Agency was prepared to fund the proposed works to the tune of £7,000, plus a further £1,500 to carry out a Demonstration Day on behalf of the Cinderella Project. The money was for this financial year only. We were on a very tight time schedule from the start, as will be seen below, but the RGCG very much welcomed the opportunity to take the project forward.

Within the RGCG we had discussed and refined the concepts for what we wanted to do over many months previously, but we were very much aware the implementation is as important as the ideas in making a successful project.

First was the need to obtain a licence of consent to carry out the works from the Environment Agency engineering development control. In our case this was for a complex and interacting series of measures. The Agency considerations are, as they must be, thorough and detailed and involve a number of staff in various disciplines. The time it would take to prepare the necessary documentation and hopefully receive approval was going to be absolutely crucial to the timing of the programme.

We were fortunate in having Vaughan Lewis, a nationally respected consultant, to see us through this process. He visited the site for an initial familiarisation. Also for the pre-application site visit, when RGCG members discussed our proposals with the Agency, who fielded the Norfolk Development Control Engineer, and colleagues in flood protection and conservation.

This visit took place on the 13<sup>th</sup> July 2006, and was invaluable in helping an interactive discussion on the general principles and approaches to be taken. Following this the extensive documentation was prepared and submitted to the Agency by the end of July. The Agency worked to see approval by mid-September. This involved, under the rather special circumstances, giving a high priority to the application. No work affecting the river could take place before the approval of the licence.

In progressing the actual work we faced a variety of constraints and some logistical considerations; plus working within the money available. The natural constraints include conservation issues. We had to ensure that in doing what we planned we would not have an inadvertent adverse impact on wildlife. In particular this included a very detailed survey of water vole sites, and looking for the presence of the otter. This was carried out by committee member Steve Henson of the Norfolk Wildlife Trust (NWT) in June, and the report formed part of the licence application. In addition another member carried out a survey of vascular plants on the spoil bank to be removed, to make sure that there were no significant plants that might have to be moved.

One important reason to complete the bulk of the work quickly was that water voles tend to hold to their burrows from November for the winter, and trout start to spawn. But the nature of the terrain was another pressing reason to start the work by mid-September and finish by end October, certainly all the "heavy" work. The meadows are peaty, wet and soft. Heavy plant can cause "cut-up" even without vehicles getting stuck and literally becoming "bogged down".

With the long time farmer we discussed how best this could be avoided, and also how to cross the side stream to get off the meadows in removing spoil from the bank of the river at the upper middle section. The chosen route was for the heavy plant to travel close to the raised spoil banks on the east side of the river. This in turn pointed to the felling and removal of the sycamore trees as the first piece of work; to be followed next by the removal of the selected section of spoil river bank, working from the upstream part to the downstream end. We wanted the timber for large woody debris and other work, and a key aim was to reclaim gravel and stone from the spoil.

The offer by the flood protection wing of the Agency to take out the designated spoil bank section would clearly be a huge help to the project on time-scale and project costs. It would involve a caterpillar tracked digger, with two 2.5 tonne tracked dumpers working alongside, to take the spoil away and place in heaps along the arable field adjacent to the meadows. It was estimated that there were 700-1,000 tonnes of spoil to be removed and 5 working days or more would be required.

The bank removal was scheduled to take a week in the second half of September. As soon as this was done, the off-site riddling operation was to be completed for the w/c 2<sup>nd</sup> October. Vaughan Lewis was scheduled to return then to supervise and work with RGCG volunteers to carry out the implementation of much of the in-river work in a three day work spell, with another two days pencilled in a week later. The same volunteers would carry out some preparation work in the second half of September, namely the making of the faggot bundles and stakes. There were other important tasks to be done before then, in particular a survey and the “flagging up” of the water vole sites that we need to work around, as mentioned above. The felling and trimming of six sycamore trees, not a part of the licence application, took place in August. In early September we posted notices around the site to inform the public that the work was about to take place, which enabled local people to ask for more information. Our September Newsletter set out the work aims and plan for members and others.

The main programme of works was planned for completion by the end of October, but we realised that will not be the end of the story. We would need to follow through by monitoring to see how the measures bed down, and observe the broad changes in the river and wildlife over time. The whole project would be a steep learning curve experience for the RGCG, which we felt would undoubtedly benefit future projects that we expect to undertake.

## **IMPLEMENTATION OF THE WORK.**

### **1. SUMMARY OF MAIN WORKS.**

The main works carried out in the river were the introduction of:

- six riffle areas, two of which were combined with a cattle crossing/drinking of total length about 64 metres
- two lengths of river narrowing, lengths 10m and 13m
- the creation of three mid-stream islands
- nine lengths of tree trunk as large woody debris (LWD) at a spread of points.

Work proceeded from downstream to upstream to take account of any water level changes and interactions between the various measures.

The placing of the stone and gravel in the river to form the riffles, and the setting of the LWD, were the most intensive parts of the works. These required the use of a tracked digger and a 3.5t dumper truck, with our consultant Vaughan Lewis directing the operations and driving the dumper. This work was carried out on the 5<sup>th</sup> October, and on the 11<sup>th</sup> and 12<sup>th</sup> October; but with subsequent much hand labour to form the upper cattle crossing/riffle, and re-instate the cattle crossing across the side channel.

Vaughan was also with us on the 3<sup>rd</sup> and 4<sup>th</sup> October. The work carried out then was the bank narrowing and island creation work, working with hazel materials. This used no heavy machinery but was labour intensive.

Running parallel to the in-river work, the spoil was removed along the bank length of some 120m of the upper middle section meadow. This was a separate exercise carried out by Environment Agency staff and machinery working with their tracked digger feeding two 2.5t tracked dumper trucks. Some 700-1,000t of spoil were taken off-site to an adjacent arable field. This took seven working days to move in the period from the 6<sup>th</sup> to the 16<sup>th</sup> October.

### **2. LOGISTICS AND MATERIALS.**

The meadow terrain can withstand heavy plant operating on the strip between the east side of the river and side channel and the hedge running between the meadow and the farm track (see map 2, page 18) in reasonably dry weather conditions. When operating to the west side of the side channel, heavy plant has to move material close to the river bank, which through the deposition of dredged material over the years is higher and drier than the meadows as a whole.

We were fortunate that there was little rain in the first three weeks of October and ground conditions were drier than they could have been. However after one mid-afternoon shower on the 10<sup>th</sup> October the approaches to the side channel started to churn up very quickly with the continuous passage of the two spoil removal tracked dumpers. Work was stopped to put in a temporary bridge of sleepers the next morning. Up until then the dumpers had crossed through the side channel, whose bed had been protected by putting down some 8t of large flint, destined for later use further upstream as part of that needed for the cattle crossing 3/riffle work.

A gap in the hedge, an old entry point, gave a direct access to a corner of the arable field with hard standing, next to the farm track. This route was used by the tracked dumpers to get the spoil to the arable field with minimum distance on the meadow. This made for both quicker dumper turnaround time and less wear on the meadows. The hard standing was used to stockpile the 20t loads of stone and gravel coming from a local quarry.

Sampling at two of the highest areas of spoil had indicated that there was sufficient stone and gravel present to make it worthwhile to carry out a machine riddling (grading) operation off-site at the arable field work station. However once the top six inches of nettle cover and soil was removed across much of the area it was clear that the yield would be small and this approach was abandoned.

However some 10t of larger stone was recovered by hand from the spoil, either at the river bank area, or where it was heaped and then later spread over the field. A local Cemex (RMC) quarry, less than 2km away, supplied 60t of reject flint; and 40t of 20-40mm gravel, all that was used. This was obtained at a favourable price through the NWT. Another 40t of reject flint came from a small disused pit on the Bayfield estate, also a journey of 4-6km, and no charge was made for this material; and another 5t came from a stock adjacent to the site.

So in all we used some 115t of reject flint and 40t of gravel over six areas on the main river, 4 riffles and two cattle crossings serving a dual purpose also a riffle. The total length of these was some 62m. The plan had been to make more and longer riffle areas and use some 300t of reject flint and 100t of gravel but when costed out it was clear that we would exceed budget if we bought in more reject flint and gravel.

The other material requiring heavy plant to move about, a tracked digger with lifting chains, was sections of tree trunk of 4.5 - 5.5m in length and between 300 and 600mm in diameter. These were used as flow deflectors and one end set in the bank with an up-stream angle of about 30 degrees. Nine sections were required, and all were drawn from the six sycamores that had been felled in the preparation stage.

The main wood material used was hazel, and in the plan was to be designated for bank narrowing, with a smaller amount for the island work. As part of the preparations leading up to the work in the second half of September 120 hazel faggots were made from material cut from trees on the Bayfield estate. The bundles were some 2m long and 300mm in diameter.

It was estimated that we would need some 200 stout stakes for river narrowing. Chestnut was not available so we bought 200 hazel, which in fact were a mix (in decreasing thickness) of stakes, and baton and peg material. We also purchased 30 long round posts with pointed ends, mainly to secure the tree trunk sections. In terms of our budget these materials were costly to buy as opposed to having access to hazel at no charge and cutting and producing with voluntary labour.

Once much of the spoil was removed from the bank of the upper middle section meadow it was clear that the re-profiled bank would have to be protected against higher river flows and any major flood event. The bank would be vulnerable to breaking off until such time the whole area has time to develop vegetation and bind the bank soil. This could have been foreseen, but not to the extent of the overall requirement vulnerability. This was because the river at this point was revealed as far more sinuous, and with some sharp bends, than could be appreciated with the spoil bank in place.

This 122 metre length of meadow frontage, increased to some 130m by the winding course of the river, was protected by the same revetment technique as used for river narrowing, but the outer line of stakes were set much closer to the bank. It required 97 stakes, and the same number each for bank side pegs and the batons to be set at a diagonal to stakes and peg. The river "facing" to the revetment required about 70 hazel faggots; about 20 remained from the Bayfield 120, leaving another 50 to be made up.

These 50 faggots, the stakes, batons and pegs, and the soft filling brash, were obtained by coppicing 10 hazel trees on the lower part of meadows. The temporary bridge across the side channel proved its worth again as it enabled the movement of the bulky material to be done with a Land Rover and trailer. There was zero wastage of material in this exercise.

Seven of the hazel trees were 13 years old, grown from saplings, and this was the first coppicing. The other three were mature trees. The river is shallower here than downstream, and the stakes were around some 1.2 - 1.5m in length and 50 - 75mm in diameter, the batons and pegs about 50mm in thickness.

## CONSTRUCTION WORK.

### RIFFLES.

Reject flint from Cemex stacked at the hard surface area was loaded by a digger into a 3t dumper which ferried it to the various areas of river bank where it was to be used, and similarly for the gravel. The stone was placed by digger in the river bed to a depth to around 75% of the final level of stone and gravel required. The lengths of the riffles were a compromise between the ideal (15m or more) and what could be contained within the project costs, and the material spread by the digger bucket. The stone was followed by the upper layer of 20-40mm gravel, a compromise between what was best for spawning brown trout and the habitat for the white-clawed crayfish. The weight ratio of stone to gravel was around 3 to 1, but varied with water depth.

The first and last (sixth) riffles were formed to serve as both a riffle and a cattle crossing. The other four riffles were set so as leave a narrow and deep run along the side of the far bank for the benefit of larger trout. Best estimates of the amounts of stone in gravel in each are shown below.

	<u>Length</u>	<u>Reject Flint</u>	<u>Gravel</u>	<u>Total</u>
CC1/Riffle 1.	8m	17t	5t	22t
Riffle 2.	13m	24t	7t	31t
Riffle 3.	15m	27t	8t	35t
Riffle 4.	10m	18t	9t	27t
Riffle 5.	12m	21t	10t	31t
CC3/Riffle 6.	4m	8t	1t	9t
Total.	62m	115t	40t	155t

The deeper the river section, the more reject flint required. The positions of the riffles are shown on map 2, page 18, which shows the location for all the finished works.

The licence plan submitted to the Environment Agency was for up to 10 small riffles (including the two with dual function as cattle crossings/drinks) from the screened gravel, with a length of riffle at 15m or more in length. The riffle would increase the retained head by 15-30 cm. The depth of gravel in each riffle should exceed 50cm for the benefit of macro invertebrate. For the optimisation for brown trout to spawn the water depth should be between 25cm and 60cm; and water velocity between 25cm/sec and 75cm/sec.

There is an option over time to extend the length of the riffles by hand labour should more stone and gravel material become available and experience indicated this would be beneficial. In fact, cattle crossing 3 was done by hand, after the other riffles were done by heavy plant work. Some local sourced reject flint was barrowed in, and all the gravel gleaned by rake and shovel from the digger spill on the bank side of the other riffles.

The need to build a bridge over the side channel at cattle crossing 2 required that the stone that had been placed there was supplemented by spoil to give a firm base on which to place the sleepers. The stream here was about a metre wide with a bed of small stone and gravel bed in shallow water. After the bridge was removed, the digger then cleared the stream, and levelled the stone and spoil over the approaches. This was followed by four days of digging by hand to recover the large stone that had been placed there and the material that had formed the channel bed. With some additional replenishment the bed of the stream was enhanced and extended on completion of this work, with a length of small stone and gravel extended from 2.75m to 9m.

## RIVER NARROWING.

The licence agreement was for the extension of the present bank into the channel to be no more than 1.5m at any point, and the total length of river narrowing over the whole stretch of the river would not exceed 50m. Faggot bundles would be woven between the stakes, driven to a depth of 600mm into the river bed. The area created between the new and original bank lines will be “soft-filled” with woody brash in order to promote the accumulation of fine sediment. The structure would be keyed into the bank to reduce the risk of erosion.

Two sections of river narrowing revetment were built. One was 10m long, in line with two willow trees facing on the opposite bank. The revetment required 15 stakes set in an arc from either bank end to a maximum width of 1m at the central point. The stakes were “faced” with hazel faggots pushed down over the stakes, and back filled with faggots and brash, the latter mainly hazel but containing some willow coppiced from one of the trees opposite. The filling was held in place by battens fixed (wire nails) to the stakes and pegs set in the bank.

The second length of river narrowing took place over 13m of bank and took 18 stakes. Again the maximum (mid-point) of extending into the river was 1m. At the mid-way point on the opposite bank was a mature alder. In both cases the river was about 3m wide, representing a narrowing of about one third when the revetment consolidates as a mature bank. Within two or three weeks of building (5<sup>th</sup> October) it was clear that silt and leafy debris was being accumulated.

Map 2 shows the position of the two constructions. The plan for a third length of river narrowing just upstream from the ford was abandoned as the river bed proved to be just too hard to drive in the stakes, even though a two-handled heavy metal post “thumper” (drivall) was being used for this task.

In general the river bed was found to be very hard, making it difficult to drive stakes in to 0.5 metres or more. An old heavy metal fencing post, rectangular in cross section and with a pointed dagger end, was found to be very useful in penetrating the bed and loosening up to make way for a stake.

## MID-STREAM ISLANDS.

Three mid-stream islands were constructed near footbridge 1 (see map 2). The method of construction was similar to the river narrowing work, and in time the structures would develop as islands with vegetation. The top level of the islands were planned to be 150-200mm above water level.

Following the construction of the two upstream islands they were surrounded with flint reject topped with gravel as part of riffle 3. The braided flow over the riffle provides a juvenile trout habitat within the spawning area created. The backwater effect also improves access for spawning fish to the side channel which enters the river immediately upstream from the islands.

Each of the islands formed a point at the upstream end, but set at a slight angle to the river flow. They were 2-3m long and some half metre wide. Each was built around a frame of seven stakes driven into the river bed. The third island was in a metre of water, and as noted above the other two had been set where riffle 3 was to be placed. The islands quickly collected silt, leaves and much water cress.

## LARGE WOODY DEBRIS DEFLECTORS.

Sections of tree trunk were placed in nine different parts of the river, all in or close to the lower middle section (see map 2). The purpose of these is to promote the scouring of the river bed in relatively homogeneous areas, and create high physical diversity within the channel. Past practice of removing all naturally occurring woody debris has an adverse impact on juvenile and adult trout. LWD create simple flow deflectors and provide deeper pools used by adult fish, and smaller pools and shelter areas also. The tree section is orientated to reduce bank erosion and secured by staking and wiring. All sections point upstream.

All nine sections of tree trunk were secured by setting the “downstream” end into the bank to a depth of 600 mm to 900 mm. The exposed in-river lengths for six of the nine ranged between 1.5 and 2.5m, at an upstream angle of about 55 degrees to the bank. Six were set on the river bed and submerged by the flow. Three were set across riffles

4 and 5 and broke the surface of the water. One of the trunk sections (LWD 7, 3m) was set in a diagonal from bank to bank, all the rest fell short of this. Two other 3m sections were set in place upstream of this, LWD 8 at an acute angle to the bank, and LWD 9 at a diagonal and stopping just short of reaching bank to bank.

In addition to anchoring into the bank all sections of LWD were secured by at least two stakes in stream, and the stakes and trunk wired together with fencing wire held by heavy duty staples.

#### BANK SPOIL REMOVAL: UPPER MIDDLE SECTION MEADOW.

Some 700-1,000t of spoil were removed along a meadow width about 122m. with a tracked digger and two 2.5t tracked dumper trucks, as described in the Logistics section above. The work revealed the sinuous character of this section of river, the frontage of the river bank itself extending to some 130m. The re-profiled bank was taken to about 48cm above the water line, and 2m further back it was stepped up another 9" or so to bring the profile to the level of the meadow as a whole.

The spoil had been piled to the highest level close to the river and it fell away gradually to meadow level. When all was cleared it showed that in the main the buried area stretched back some 9 -11m from the river. However where the river swung away in two bends the area of coverage with spoil had extended to 14m immediately downstream of tree 2, and similarly to 19m at tree 1, the old alder.

The restoration of the site not only re-connects the river with the floodplain meadow, but completely transforms the visual impact. One can now see the whole section of the river on this meadow, instead of peering down a high bank to see just a few metres to left and right.

The spoil was principally a good rather peaty soil, probably coming from river widening in the past with some bank removal over a much wider area of river frontage. Within this were some areas of sandy soil containing stone and gravel. Presumably this came from dredging of the river bed. It was these spots, where we had cut two of the three sampling sections with a digger, that had lead us to believe that it would be worth riddling the spoil to recover stone and gravel.

The spoil was covered with dense nettle growth, with some other vascular plants present. The vegetation was stripped off to make a separate heap on the arable field, where it would be allowed to rot down. The major part of the spoil removed was heaped on the field and later spread over about 2,500 square metres to a depth of 150 mm or so. Some 10t of larger stone was recovered by hand from both ends of the operation, the river bank and heaping and then spreading on the arable field. The stone recovered at the river end was used to create two areas of larger stone on the river bed there.

As described above in Logistics and Materials, the 130m of bank required protection with a hazel buffer structure to protect the bank from higher and stronger flow levels. Areas of sharp turn would be the most vulnerable. The same technique was used as described under bank narrowing. In addition coir matting was used to give additional protection. The matting came in rolls 2m wide and some 30m long. This was spread over the top of the revetment and the first level of bank, and additional pegs were fixed to hold the bank edge of the matting in place.

For the final 28m the matting was put down first before the hazel revetment work was done. This is not expected to make any difference to the final result as regards how well the bank is stabilised and the regeneration of vegetation, but this will be monitored. The plant species that grow from the bare soil, and the succession stages, will be an important part of the follow through studies on the whole bank of the upper middle section meadow.

The removal off-site of the spoil to the field was carried out under a waste disposal exemption licence. This necessitated the analysis of soil samples taken from the spoil bank and the arable field for which it was destined. A wide range trace metals and other elements were measured. In all cases there was a lesser amount of trace constituents in the spoil bank material than there was in the arable field. This could reflect a generally "cleaner" environment dating from the 1960s or 1970s; or more likely the fact that the rivers and meadows have not borne an application of agrichemicals that can compare with arable land over the past decades. It would have taken a third analysis, that of the meadow itself as well as the spoil on it, to be sure on this point.

## PROJECT COSTS.

The project Cinderella funding was set with £7,000 for the practical implementation of the planned programme. As the RGCG have no significant funds it was imperative to stay within budget. The breakdown of costs incurred are set out below.

<u>Chargeable Item.</u>	<u>Units/Activity.</u>	<u>Cost.</u>
Specialist expertise. Consultant.	5 days on site, 3 +2, in October. And frequent e-mail contact.	£2,650
Heavy plant, with operator.	Tracked digger, equivalent to 8 days. Includes tree felling 1 day, 0.75 consult.	£2,055
Reject stone, gravel. Cemex (RMC).	Reject flint 60t, gravel 40t; £9.50t + VAT. 50% discount via NWT.	£1,135
Coir matting.	4 rolls of 2m x 33m.	£315
Dumper 3t hire.	£103 for 5 <sup>th</sup> Oct., £145 for 11 <sup>th</sup> /12 <sup>th</sup> .	£250
Reject flint and other transport costs.	5 times 8t deliveries of stone, woody and other materials.	£470
Hazel stakes purchase.	200, mixed material, incl. £50 transport.	£200
Long stake posts for LWD.	Purchase of 30.	£70
Misc. supplies.	Fencing wire, wire nails, staples, etc.	£70
<b>TOTAL.</b>		<b><u>£7,200</u></b>

### Non-Charged Item.

Spoil bank removal.	1 tracked digger, 2x2.5t dumpers; 7 days. Environment Agency. [our estimate]	£4,500
Spoil disposal.	Waste disposal exemption licence, internal EA	£800
Water vole survey.	Field survey/report; and otter survey. NWT.	£400
Reject flint, 55t.	40t ex Bayfield, 15t local to site; market cost.	£1,230
10 hazel trees site, plus trees from Bayfield.	Pollarding for stakes, faggots and brash. Material value estimate.	£400
Practical work.	50 man days; plus 10 project co-ordinate. [Volunteers 48 x £64; NWT 12 x £105 day]	£4,330
<b>TOTAL</b>		<b><u>£11,700</u></b>

In addition to the above budget and costs for the implementation there was a cost of £1,760 for work by the consultant in detailing the measures planned to be done, and for the processing of this into a document for the Environment Agency for the licence approval. In addition to the £1,500 grant for this stage there was another £1,500 for mounting a Cinderella Demonstration Day on the 23<sup>rd</sup> October; under-spend on the latter meant the total costs were contained within the overall budget of £10,000.

## THE FOLLOW-THROUGH.

The post-works visit of the Environment Agency has taken place. A number of monitoring and management issues as regards the completed works were discussed. One will be the placing of water level gauges at locations to be decided, and the measuring regime for these. Some depth measurements were indicated by "flagged" stakes before work started, but it would have been useful to have had a longer and more systematic study beforehand.

Physical changes will be noted, as will be changes in wildlife. We have as a "baseline" the distribution of water vole burrows and latrines along the whole length of river and the side stream, which was documented in a detailed report before the work started. Similarly the type and distribution of aquatic plants such as water-crowfoot has been examined and recorded.

The biomass of fish has been recorded at intervals in the past by the Environment Agency just upstream of Letheringsett Ford, so this provides another baseline for this section of river. The presence of brown trout above this area will be more qualitative but any change year on year noted.

A specialist survey for the white-clawed crayfish was carried out on the upper and upper middle sections before any in-river work was started there, and this will also be periodically continued in the future for the section worked on and we hope the river as a whole.

A very important exercise will be the monitoring of the upper middle reach meadow where the spoil has been removed from the bank. In particular how the exposed soil regenerates with vegetation, and the succession pattern of the re-colonisation by plants and insects. There may also be some changes or additions to bird life, such as the presence and possible breeding of grey wagtails.

Finally of course, we study the physical integrity of the work carried out and take any remedial measures should these be necessary. We shall follow the rate of maturation of the protected bank, the development of extended (river narrowing) bank and the islands to permanent vegetation and solidity.

## ACKNOWLEDGEMENTS.

This was a joint project undertaken primarily with the Wild Trout Trust and the Environment Agency. The Wild Trout Trust helped initiate the project and provided technical support, with generous funding of £9000 through the Cinderella Chalk Rivers Project, which aims to initiate partnerships to improve the conservation status of lesser known chalk rivers.

Thanks to the local officers of the Environment Agency for their pre-application site visit and processing our licence application with all speed; and the time and skilled machine work required for the spoil bank removal. We also thank Cemex for the supply of reject flint and gravel at a favourable price; and others who were part of the project team who supplied additional stone and the hazel requirements. The Norfolk Wildlife Trust for the considerable time and expertise through a committee member. Our consultant provided very necessary technical expertise to the project, combined with his hard work and good humour on site.

Finally, warm thanks for the support of the local land ownership interests and to those RGCG members who made a vital contribution in time and effort to the evolution and implementation of the project.

River Glaven Conservation Group,  
February 2007



## **KEY POINTS IN PLANNING A RIVER RESTORATION PROJECT.**

**This is a companion report to that on the river restoration project carried out on a stretch of the River Glaven upstream of Letheringsett Ford. This was the first practical river restoration project to be carried out by the River Glaven Conservation Group (RGCG), a voluntary body with a local membership. The project involved several different types of remedial measures, not all of which are as yet commonly done. Based on this experience, we set out a number of factors that were important to take into account when planning and implementing the programme of works. We hope that others embarking on a similar chalkstream project might find this report useful.**

### **TIME OF YEAR.**

Ideally the in-river work should take place in August and September for a number of reasons; given luck with the weather it can slip to early October. There are a number of reasons for this. The meadows are likely to be at their driest and best withstand the working with heavy plant; this is the window of opportunity best suited for wildlife interests in general, and species such as the water vole and brown trout in particular; the river is likely to be at its shallowest and easiest to work in; transport of heavy materials is likely to be easiest in reaching the site general "holding area". If part of an arable field is used as a base for this it can be after a cereal cropping. In our case also for soil disposal, by spreading and ploughing in before the next crop (sugar beet).

### **TERRAIN AND LOGISTICS.**

One advantage of the site we selected was the use of local knowledge to ascertain how materials might be brought in and deployed to where they will be needed on site, in particular where heavy plant is to be used. Also in our case how heavy material (spoil) may be taken off site and where it can be disposed. For delivery of materials and other contacts it is a useful bonus if a team member lives close to the site.

### **THE LICENCE OF CONSENT.**

No work can start on the river itself until the application for consent is approved by the Environment Agency. Given the complexity of our programme and other special reasons our six week clearance time was unusually fast. It may be necessary to think in months rather than weeks. The preparation of the document itself for the Environment Agency requires some specialist skills and time. Prior to this a pre-application site visit is likely to be very helpful and reduce rather than increase timescales to obtaining the consent.

### **OVERALL TIME SCALES.**

Build in the necessary time for obtaining the licence of consent and other necessary steps required before practical work can start, and then work backwards from August-September to give the overall timescale for the project in planning terms. It would be advisable to build in some allowance for slippage for the main steps so that the start of practical work is not delayed. In our case we were on a tight timescale from the start due to funding availability; the use of e-mail then becomes an absolute necessity.

### **PREPARATION WORK.**

Note that application processing time can be well spent on careful planning of the work, and taking this through to some preparation as regards the provision of materials to be used. The latter applies in particular to tree and woody materials as a source of large woody debris deflectors and coppiced hazel for the faggots, stakes, batons, pegs and brash that will be required. It is important to carry out studies on any protected species that might otherwise suffer inadvertently from the proposed works, such as water vole, otter and white-clawed crayfish. Water levels at selected points should be measured at least before work is started on a specific measure, and preferably over some period of time. When the measures are to be implemented, the works will proceed from downstream to upstream on the length of river selected.

## **SPECIALIST HELP**

The RGCG had the benefit of a specialist advisory visit in thinking through the concept in principle of “what might be done where” on the stretch of river selected. Given our (lack of) experience, and the unavoidably tight timescale, it was essential to enlist the aide of a specialist consultant in translating the concept into the practical work proposals and preparing the documentation for the Environment Agency. Also in our case, we needed the direction for the execution of the main practical work to be carried out.

## **INTERESTED PARTIES.**

It is imperative to ensure that all interested parties have been consulted and are supportive of the work planned: landowners or their representative, farmers, tenant farmers and land agents. This is best done between the advisory visit and the working out of the detailed plan of work to be presented to the Environment Agency. Notices should be displayed at site entrances to inform the public of the work before it starts.

## **NATURE OF THE WORK.**

River restoration work tends to fall into two broad categories; whether heavy plant and a consultant are required as well as the volunteers, or work that can largely be carried out by volunteers, working “in their own time”. Riffle and large woody debris (LWD) work are the most dependent on the “expensive” deployment of heavy plant and a consultant, and as the saying goes, “time means money”. The timing to bring together these, and making ready the materials required and perhaps also the hire of other equipment, has to be carefully co-ordinated to make best use of the resource. The risk of “downtime” due to wet conditions increases towards October.

The RGCG in making the riffles required the consultant who also played a very active part in the construction work, a tracked digger with operator, the hire of a dumper truck driven by the consultant, and the in-time delivery of the stone and gravel to the holding delivery area.

LWD also falls into the “heavy” plant and consultant category, but is simpler than the riffle work in that the trees can be cut and trimmed and kept out of the way but on site well before the time they are required. No dumper truck will be required, but a set of lifting chains are required. It is very useful, as in our case, if the digger driver also has a chain saw licence and can do felling, cutting and trimming of the trees, as well as moving them.

River narrowing, island creation and bank protection can all be done by hand labour. Preferably this is aided by some chain saw work for the coppicing of hazel (best), and the sectioning into stakes, batons and pegs, and for making up into faggots, while using the remaining brash as soft filling. The work can be carried out by one or more people, with some spread of timescale. It can be picked up and stopped again without undue detriment to the program of works, and can be fitted around more time and cost critical activities.

It is very useful to have a 4WD and trailer to take bulky and quite heavy woody materials to the positions where they are needed.

## **PLAN COMPLEXITY.**

Delays can be experienced, such as by a spell of wet weather, and in specific activities. The more complex the programme, and the level of interaction between activities, then the greater is the vulnerability to these and the chances of delays and the potential for something going wrong.

In our case we had planned two separate and parallel operations involving heavy plant work. The first was the RGCG work on riffles and LWD placements; the second the spoil bank removal being carried out by the Environment Agency team using a tracked digger and two dumper trucks. These could have operated quite separately, and any delay in one would not have affected the other.

However in this case we had embarked on a plan to recover stone and gravel from the spoil, and use this in the riffle work. This of course then linked the two operations through the production and supply of the stone and gravel.

Further the recovery of the stone and gravel introduced a third component into the equation; a riddler/grader machine, a digger to feed the spoil to this, and an operator to work both machines. To weigh against the value of the re-covered material was the cost at £500 a day to do this, and the uncertainty whether it would take 1 - 2 days depending on the weather and the dryness or otherwise of spoil in the separation process, and what the level and yield of stone and gravel in the spoil might be.

There was in fact a 2-3 week slippage on starting the spoil bank removal in mid September, with the approval of the licence expected (and obtained) then. This happened through two factors; the time to obtain the waste disposal exemption licence, and additional discussion with interested parties on the spoil bank removal. So the decision was taken that the project would have to start with "imported" stone and gravel to the site, and cleared with the Environment Agency in this respect, rather than any import coming in the later stages in the programme to balance up the requirements.

In the final event, at the end of the first day of the Environment Agency starting work by stripping off much of the bank vegetation and spoil surface, it was clear that the yield of stone and gravel would be low in relation to the need, and the riddling approach was abandoned; and the two main exercises unhooked. Following this some 80-90% of the larger stone was pulled out by hand from the spoil, as described in the "Construction" section above.

The idea of recovery by riddling was good in principle, but even if the yield had lived up to expectation, in a tight timescale there was little room for any delay. The moral of this story is to look hard at dependent interactions in a plan. Here they carried with them both a degree of uncertainty (on yield of stone and gravel and the cost effectiveness), and a timing interaction (provision of material for other planned work). And perhaps there are much simpler ways in getting some of the benefits sought, in this case the picking up of larger flints material by hand from the spoil and barrowing it to where required.

## **PLAN B.**

It is useful when planning the days work with "expensive" resource, such as with a consultant and heavy plant, to have a collective plan B on what else might be usefully done in the light of a delay in the expected delivery of material or equipment, or bad weather. We were fortunate that we did not experience any of these.

## **POSITION OF MEASURES TO BE CARRIED OUT.**

The more detail on the position of all works to be carried out makes it easier in making use of "before and after" photographs, and also the measurement of any changes in water levels in this respect. It has in addition other advantages, see below.

## **MATERIALS REQUIREMENTS AND COST CONTROL.**

In the case of riffle creation, the measurement of the river depth, width and the length of bank at the chosen location can give an indication of the tonnage of reject flint required for the specified item of work. The gravel requirement is largely independent of the depth. In our case, riffles 1-3 were set in water about 1m deep. Riffle 4 and 5 were placed in the river where it was about half a metre deep.

This knowledge is useful as regards pre-ordering, but perhaps more importantly as regards aiding project cost control. Stone and gravel are a large component in total costs, along with those for heavy plant and consultant charges. The length of the riffles installed can provide some flexibility and a degree of contingency in delivering the main project aims within budgetary constraints, as it did in this case. Further it still leaves the possibility of extending a riffle at some stage in the future, either through further finance, or free flint and gravel and a wheel barrow and voluntary labour.

In our case we were fortunate (see the Costs table in the project report) in being able to purchase 60t of reject flint and 40t of gravel at half price from Cemex, and obtain a total of a further 55t of reject flint at no cost for the material itself. Gleaning with rake, shovel and wheelbarrow for gravel spill where heavy plant has worked on a riffle is a worthwhile recovery exercise as well as being part of the clearing up tasks. RGCG, December 2006.

# Map 1



