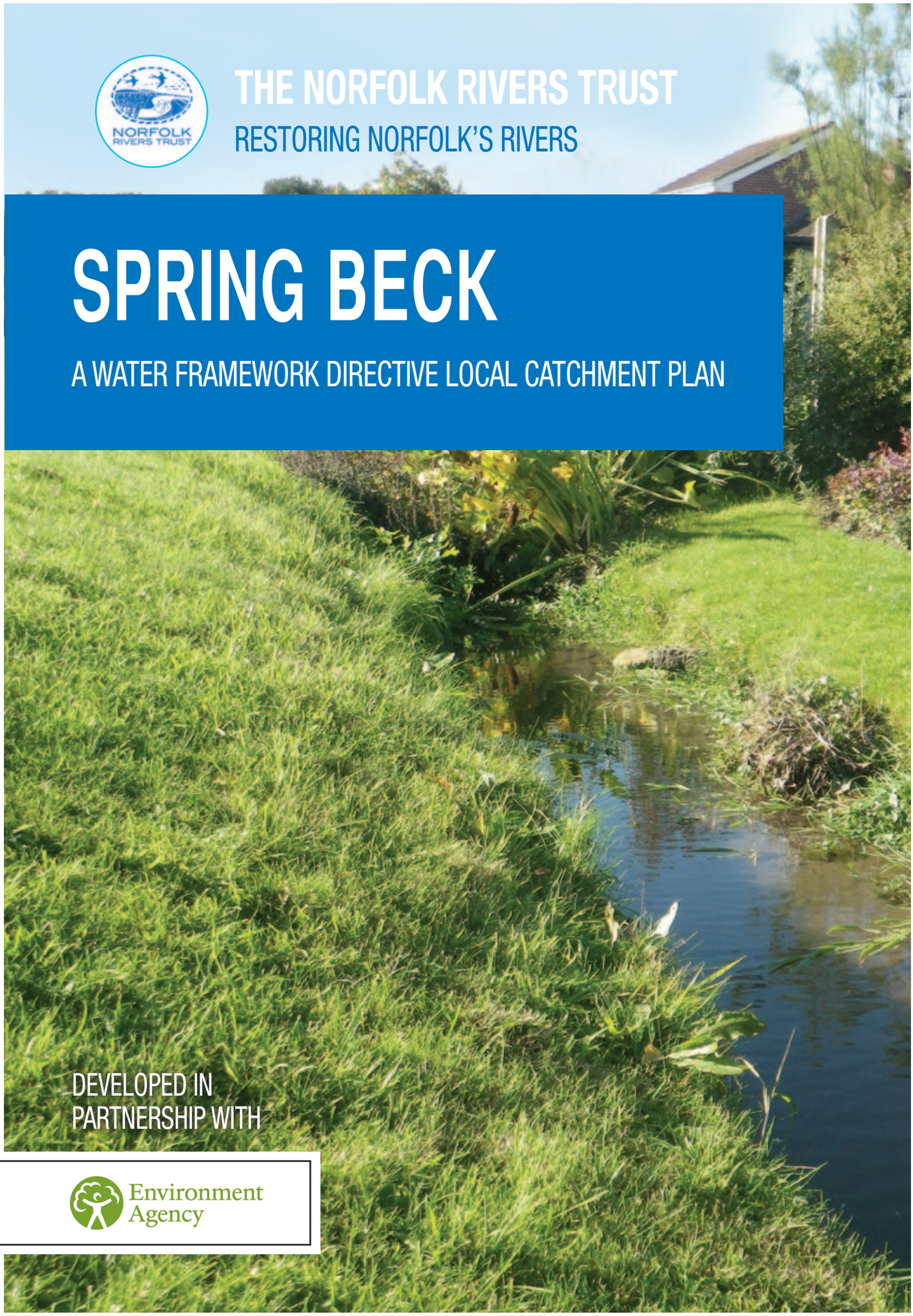

THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

SPRING BECK

A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

DEVELOPED IN
PARTNERSHIP WITH

Environment Agency

CONTENTS

THANKS

This plan has been enriched by cooperation and contributions from many different people and organisations. Norfolk Rivers Trust are grateful to the help from these individuals, and do not seek to imply that the document is necessarily endorsed by those listed here. NRT would like to thank all those involved for their help:

Jonah Tosney
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INTRODUCTION

This plan has been produced by Norfolk Rivers Trust, in consultation with a wide variety of agencies, landowners and residents in the Spring Beck catchment. The aim of the plan is to provide a framework for improvement of the ecological status of Spring Beck.

In the case of most rivers there would be a Water Framework Directive target set, and Spring Beck's progress would be judged against relatively rigorous biological, physical and chemical standards. Due to its short length and consequent low profile, Spring Beck is not given consideration under the Water Framework Directive. As such, this catchment plan has particular significance as a step in determining what objectives should be set.

The plan begins by providing an audit of the current state of the catchment, put together by a combination of river walks, reviews of existing data, consultation with local farmers and residents, and requests for specialist reviews from relevant individuals and organisations. These data are then used to identify ecological pressures in the catchment. In the final stages of the plan solutions to these pressures are identified, costed and prioritised.

SPRING BECK STATISTICS

Approximate river length:	2.25 km
Catchment area:	???
Protected areas:	Interest (SSSI)
Legal designations:	Nitrates directive

WHY RESTORE RIVERS?

Britain's rivers generally fail to reach 'good' ecological status. This is both a problem in itself and a sentinel of trouble.

A well-functioning river system is an inseparable combination of good water quality, distinctive physical processes and diverse wildlife. These factors interact to provide a number of benefits. A naturally functioning river has a floodplain with sufficient capacity to absorb inundation and to act as a store for silt carried by high flows. The river channel is also self-scouring. This reduces flood risk and the need for expensive management. Headwater forests reduce surges of water into the system by increasing drainage and removal of water. Moreover, the vegetation, microbes and invertebrates in the river corridor also absorb and process pollutants. This enhances water quality within limits. However, very polluted rivers have less wildlife and in turn a reduced capacity to provide such benefits. This leads to a downward spiral. Wildlife itself also has an intrinsic value and is enjoyed by groups such as fishermen, ramblers and bird watchers.

If any of the three pillars of the river system are damaged (water quality, physical processes, ecosystem), then the value of the entire interconnected system is reduced. Arguably, we also have a responsibility to repair our damaged natural heritage for future generations. Thus, ecological restoration aims to enhance the functioning, as well as the intrinsic value of our rivers.

A CHOICE FOR THE FUT URE OF OUR RIVERS…

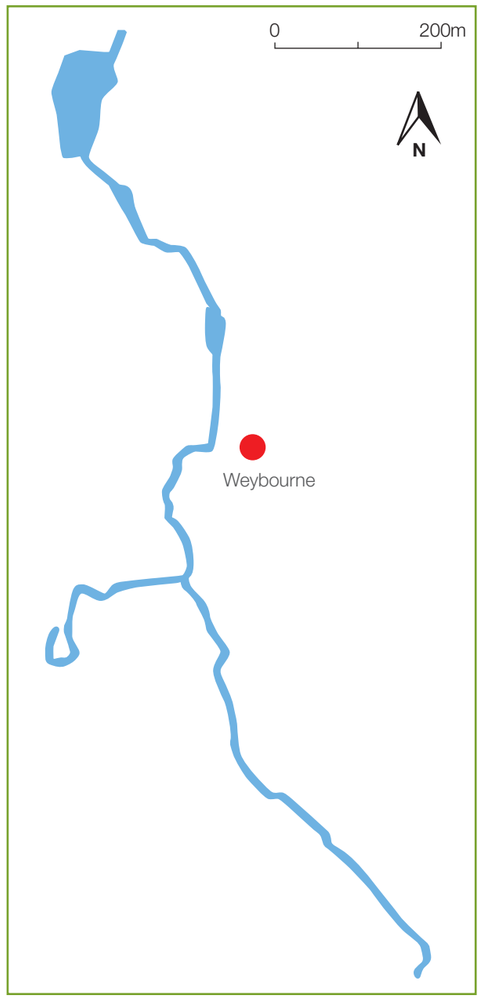
SECTION 1 THE CATCHMENT

Spring Beck, Weybourne, rises from a spring in the Hundred Acre Wood near Weybourne Railway Station. It then flows across open farmland and through the village of Weybourne before meeting the sea at Weybourne Hope. The river is only approximately 2.25 km long from source to sea, and flows through and over sand, gravel, clay and, crucially, chalk. It is this chalk bedrock that gives the river its clear waters and unique wildlife.

For the majority of its course, Spring Beck flows through freely draining, lime rich, soils, which form a shallow layer over chalk bedrock. The soil has a loamy texture and is mostly made up of calcium carbonate, which renders it very alkaline. The soil's loose structure means that it is particularly vulnerable to the leaching of nitrate and pesticides to groundwater. It is also easily eroded, which is likely to contribute to the problems of siltation reported in the middle and lower reaches of the stream

The vast majority of the land in the catchment is farmed, primarily for malting barley and sugar beet. Agricultural productivity in the area is nationally important, but the demands of irrigation, drainage and crop production can often be detrimental to the ecological well being of the river. The river has been modified over many centuries to meet our needs and little "natural" river now remains.

Figure 1. The course and location of Spring Beck



THE COMMUNITY

It is part of the Norfolk Rivers Trust mission to gain the active participation of the community to restore their river. Stakeholders help us to set objectives, keep us informed about issues on the ground such as pollution, and actively volunteer to make many more worthwhile projects possible.

Spring Beck has a rural catchment, which contains the village of Weybourne. So far we have been very pleased with the enthusiasm and participation of several locals in the process of planning future conservation work. It is clear that the beck is valuable to the community and, without exception, residents have been very positive about the potential of restoration works on their stream. Norfolk Rivers Trust would be very happy to hear from anyone who has an interest in conservation around Spring Beck.

When we chose our bungalow plot in Weybourne in 1975 we were attracted by the small stream bordering the garden. This is a tiny tributary of the beck which begins as a spring near Weybourne Steam Train station and travels just a couple of miles through the village to the sea. The sources are very pure as they percolate through Ice-Age morraines on Kelling Heath – and have never dried up.

Primroses and dog's mercury appeared on the garden's stream bank, suggesting former woodland. During the summer we allow the hairy willow herb and hemp agrimony to grow up, as it attracts a surprising range of wildlife. This includes harvest mice, which construct their nests in the tall stems, as well as a range of bumblebees (14 species), butterflies (including wall brown and migrant painted ladys), birds such as whitethroats and in the evenings, pipistrelle and natterer's bats.

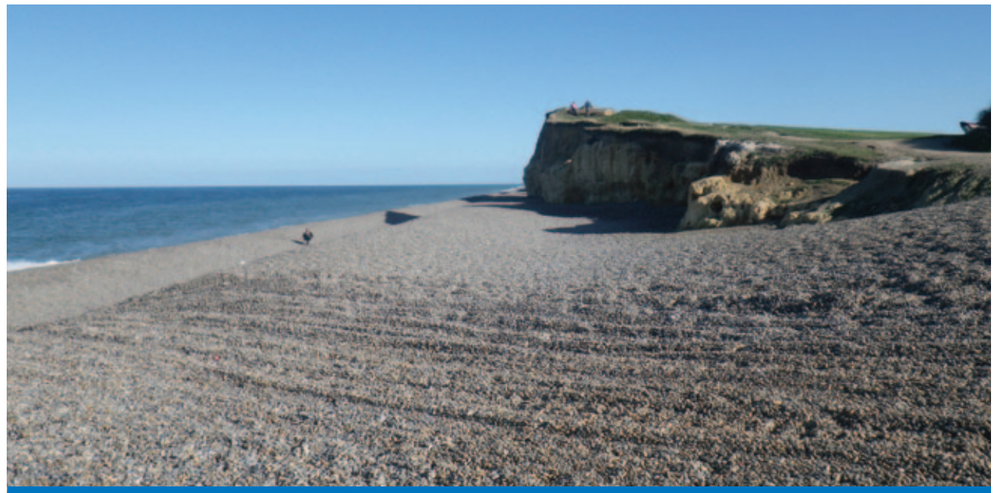
The water is inhabited by water voles, which we hear making a characteristic 'plop' as they dive. Strange squelching noises in the summer can announce the presence of a large eel pushing its way through the mud. More surprisingly, an otter has passed this way on more than one occasion. We know this by our neighbour's experience of losing all his fish from his garden pond during the night. The stream also attracts migrant waders such as green sandpipers and snipe, and there is always the possibility of something new turning up, such as the water rail which adopted our patch for a few days.

Nick and Frankie Owens
Oct. 2015

A HUMAN HISTORY

The parish of Weybourne has a long history, and was certainly well established by the time of the Norman Conquest, evidenced in the Doomsday Book of 1086 which details the residents, land ownership and productive resources of the village. Spring Beck appears to play an integral part in much of Weybourne's history, indeed it is suggested that the name 'Weybourne' is derived from the Old English 'Wearg-Burna', which translates as ' the felon stream'. This name is, rather macabrely, thought to stem from the routine drowning of criminals in Spring Beck during the medieval period.

The earliest evidence of human activity in the parish of Weybourne comes in the form of a Palaeolithic chipped flint tool, burnt flints and a flint hand axe, excavated from Weybourne cliffs in 1977. The late Saxon period left the remains of the earliest surviving structures; All Saints' Church and the ruins of Weybourne Priory. The priory was founded in the early 13th century as a place for Augustine monks to live and worship. By the 16th century the priory had become impoverished and was dissolved by Henry VIII.

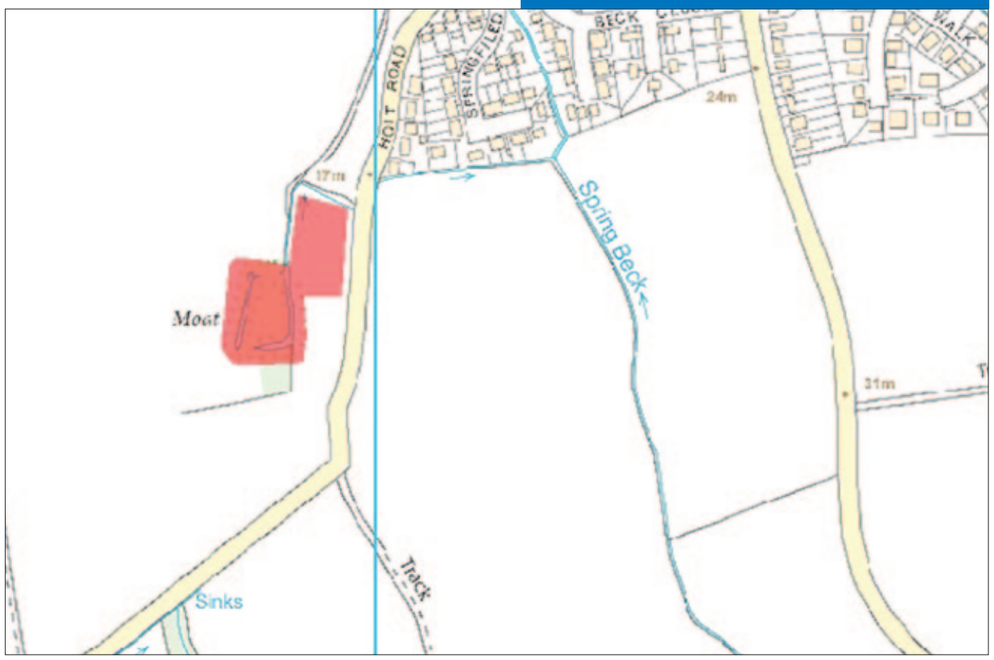


A number of paelaolithic toold were excavated from Weybourne Cliffs in 1977

A medieval moated site with associated moated enclosures is still present on a platform on the hill slope overlooking Weybourne village. The springs that arise in the moat results in a small tributary that continues to feed the main channel of Spring Beck. The larger of two moats can be seen as an earthwork, to the northeast of which lies the remains of the second, smaller moat and channels connecting the two. The field in which the features are located is known as Hall Yards, and the modern Holt Road to the east used to be known as Hall Road, evidence that there was once a medieval manor house on the land. A number of medieval objects have been recovered from this site, including coins, pottery fragments, buckles and rings.

On the Springhead Plantation is the spring-fed pool that represents the source of Spring Beck. At the south end of this pool is a wooden pumping station housing an oil-driven pump. To the north is the site of a hydraulic ram, marked on a map of 1928, of which only the stone footings remain. The pumping station and ram served the Weybourne Court Hotel, which was demolished in 1939 to prevent it being used as a landmark for enemy bombers.

Figure 2. Location of medieval moated site (http://gisservices.historicengland.org.uk)



I lived at the Springs, the house half way up the hill from the station, from birth in 1951 to 1969. Up until about 1960, when mains water supply was put on, all our water was pumped from the pond at the spring, to tanks in the wood above the house. Water was also pumped to a storage tank in High Kelling up to the 1970's. This pump was maintained by C.T.Baker, who came daily to top up the diesel and check it. The pump is still in situ, but the hut has collapsed onto it! The water supply was taken from a well dug beside the pump house. Before the diesel pump was installed for High Kelling, there was a hydraulic ram at the North end of the pond, and the concrete footings are still there. The pond used to be much deeper, and as a child, I used to fish for brown trout, catching several over the years. Also we used to try to stop the water escaping under the footings of the dam wall at the North end of the pond, so the level would rise and overflow through the pipe at the top of the wall. We succeed once or twice, but the water soon found its way back under the wall!

Philip Randell
Oct. 2015

Weybourne is notorious for having a steeply shelving beach, and thus the existence of deep water close to land. It was therefore recognised as a potential invasion site as far back as the Elizabethan era, when there were fortifications in the area due to the fear of a possible Spanish invasion. The 16th century saying *'He who would Old England win, must at Weybourne Hope begin'* poignantly reflected the threat of enemy invasion on this small stretch of Norfolk's coast. This threat was also recognised during both world wars, during which time Weybourne had a large military presence. The remains of a World War I pillbox can be still be observed, along with evidence of numerous defensive structures installed during World War II.

The steeply shelving beach at Weybourne Hope made it the perfect site for possible wartime invasion

Information taken from the following websites:

Norfolk Heritage Explorer
(http://www.heritage.norfolk.gov.uk/record-details?TNF1635-Parish-Summary-Weybourne-(Parish-Summary)

Historic England
(http://historicengland.org.uk/listing/the-list/list-entry/1013097)

Weybourne Parish Council
(http://weybournepc.norfolkparishes.gov.uk/2013/08/27/weybourne-2/)

WEYBOURNE WATERMILL AND THE CHANGING COURSE OF SPRING BECK

Weybourne watermill is thought to date back to 1729, and was visible in the earliest O.S. maps in 1838. It is thought that Weybourne Priory originally owned the mill and it is likely that the present day configuration of the stream, pond and mill site is due largely to the priory inmates. The watermill ceased working in approximately 1930, and is now a private property that has been converted for residential use.

When active, the mill was fed by Spring Beck which, unmodified, had barely enough flow to turn a millwheel. It was therefore necessary to divert and dam the stream in order to create a millpond, which is now located approximately 6 metres above the tailrace. It could be that the first dam was not so high and step-by-step was increased in height to counter the natural process of sedimentation.

Due to the small amount of water flowing through the beck, it was necessary for Weybourne Mill to be powered by an overshot wheel, rather than the more commonly found undershot wheels. Overshot wheels are comparatively rare in Norfolk due to the mainly gentle terrain, however they make the best use of small amounts of water because they rely on the deadweight of water contained in the buckets and virtually every drop contributes something to the power output. The only other mills to use this system in Norfolk were located at Buxton (one of the two wheels) Foulden, Hingham, Mundesley and Tharston.

By rights, Spring Beck should flow down Beach Road, which clearly was the original watercourse, and indeed for a short way an upper overflow channel does just that. But above the mill pond the beck runs round the side of the valley. This can easily be verified by noting the place where the stream crosses the main coast road. It does so near the church, at a point some ten to fifteen feet above the lowest point on the road. Streams cannot do this unaided, and it is thought to follow an artificial course from some way behind the village, through the site of the old priory and then on to the mill pond. Water no longer flows through the mill; the flume is blocked off with pre-formed concrete slabs. The spillway is similarly reinforced and it conducts the flow round the boundary of the property to join the tailrace below. The stream then passes through a culvert under the road, before it flows out into the lagoon behind the shingle bank of Weybourne Hope.

The old watermill, which has now been converted into a residential property

FARMING

Spring Beck is located at the heart of one of Britain's most productive agricultural areas. Sugar beet and barley are farmed in the catchment. The upper section of Spring Beck flows through agricultural land, with fields on one side of the channel are cropped with a rotation of sugar beat and spring and winter barley, whilst those on the other side are grazed by horses. Although the crops rely on a constant supply of water, none is currently taken directly from the stream. Along with the provision of drinking water, agricultural production is arguably the most important use of water in the catchment.

It has been recognised that some of the ecological threats to the river have agricultural origins, notably the input of fine sediment evident in the middle and lower reaches of the beck. Through initiatives such as catchment sensitive farming and countryside stewardship schemes, as well as through personal endeavour, farmers have been working to address these problems for several years. Rough field margins and riverside fencing are both evident on farmland within the catchment and are working to protect the river.

Arable fields and grazing land around Spring Beck

Farm profile

Interview with ***Paul Middleton***, Abbey Farm Nov 2015

Where and what do you farm?

Abbey farm is in Weybourne, and cropping is a rotation of winter and spring barley, and sugar beat. Fields on the eastern side of Spring Beck, bordering Springhill Plantation, are grazed by horses for six months of the year, and left ungrazed for the remaining six months.

Why is water management important to your farm?

We do not currently abstract water from the beck to irrigate our fields, however water was historically taken from the beck to spray crops as recently as the 1970s. Spring Beck was also once a valuable water source for the local community and the steam railway station.

In the past we have thought about enhancing the reservoir (the hollow where the springs rise from the hillside in Springhead Plantation), in order to abstract from the stream. We would be interested in installing a flow metre in the upper reaches of the beck to find out whether the flow is sufficient to support abstraction in the future.

Has the river changed in recent years?

The development of new housing estates has led to canalisation of the beck, which has contributed to the siltation problems that are seen in the stream's middle and lower reaches. Once the beck reaches the housing estate that borders our land, the gradient it flows down becomes almost flat. This means that silt is deposited and allowed to build up.

Do you consider Spring Beck a valuable part of your farm?

I think that any farm is a better environment with water running through it and, as such, Spring Beck is a valuable amenity. We are considerate of the stream's biodiversity when farming and leave six metre vegetated margins as buffers between our crops and the water. We have recently agreed to floristically enhance these margins under Higher Level Stewardship, which should help create a more valuable habitat for wild birds and pollinators. Our nitrogen use is also relatively low which helps limit excessive nutrient input to the stream.

ECOLOGY

AN ICONIC CHALK STREAM

Chalk streams are defined as streams, which derive most of their flow from chalk groundwater, and exhibit the 'classic' chalk stream characteristics of clear water and equable flows. These streams are found flowing from the chalk bedrock that stretches from Yorkshire to Dorset and across the English Channel into France and Belgium. There are approximately 250 chalk streams worldwide, the vast majority of which are located in England. It is the chalk itself that gives these streams and rivers their unique character and ecology. The porous chalk acts as a sponge, soaking up rainwater, filtering it and releasing it slowly. This means the water is clean and clear, and river levels remain fairly constant. The water is also mineral rich, particularly in calcium. The constant, clear flows allow rich plant growth, and the clean, mineral-rich water is ideal for invertebrates, particularly molluscs and crustacea.

Consequently, chalk streams display an abundance and diversity of life unseen in other rivers. This rich productivity allows the river to support a variety of iconic species such as eels (*Anguilla anguilla*), water voles (*Arvicola amphibious*), whirligig beetles (*Gyrinidae*) and grey heron (*Ardea cinerea*).

The geology not only influences life in the river, but also throughout the catchment, with springs and low gradients naturally producing wet woodlands and meadows, some of the UK's most threatened habitats. Although centuries of drainage for grazing and farming mean they are greatly diminished, remnants of these habitats can be seen near the source of Spring Beck, and woodland plants such as dog's mercury (Mercurialis perennis) and primrose (Primula sp.) still remain on the banks of the stream, throughout much of its midsection.

Sadly, these rare and delicate ecosystems are under threat. Of the chalk stream water bodies assessed in the UK, 77% failed to meet the statutory requirement, laid out under the Water Framework Directive, of 'Good' status in 2014. The main factors behind this failure were identified as physical modifications to streams (including barriers to fish passage, such as weirs and sluices), groundwater and surface abstraction, sewage pollution, diffuse agricultural and urban pollution, and invasive species. Now that the key threats have been identified, it is imperative that there is a national effort to remediate processes detrimental to chalk stream health in order to preserve the unique suite of flora and fauna that depend upon the habitat.

AQUATIC PLANTS

Clean, mineral rich water and lack of flow variation renders chalk streams the ideal habitats for a wealth of aquatic plants, and Spring Beck is no exception, although the plant community may be showing signs of occasional low flows.

An abundance of **watercress** (*Nasturtium officinale*) was observed in the hollow, near the source of Spring Beck. **Fool's watercress** (*Apium nodiflorum*), **water parsnip** (*Berula erecta*) and **willow herb** (*Epilobium hirsutum*) were common along the middle reaches of the stream, with the chalk stream classic, **water crowfoot** (*Ranunculus spp.*) also recorded. **Meadow sweet** (*Filipendula ulmaria*), **horsetail** (*Equisetum*) and **hemp agrimony** (*Eupatorium cannabinum*) were observed along the banks for the majority of the stream's course.

Common reed (*Phragmites australis*), **reed mace** (*Typha latifolia*) and **sedge** (*Carex pendula*) were recorded in association with ponds along the stream. P. australis is known to thrive in alkaline waters and tolerate brackish conditions. The species forms a dense reed bed where Spring Beck opens up into the lagoon, at the end of Beach Road.

Duckweed (*Lemna minor*) has been recorded in the old millpond and in the pond behind the remains of Weybourne Priory. This species can be a sign of high nutrient input into the riverine ecosystem. It is structurally adapted to undergo rapid growth and outcompetes other species by rapidly absorbing nutrients, forming a thick carpet over still water bodies and effectively smothering other plant species.

Stream water crowfoot (Ranunculus penicillatus)

Photograph: © Mark Rylands

Watercress in hollow near source of stream

The benefits of aquatic plants for lowland river systems are threefold; they reduce pollution, improve river structure and are a vital habitat for other wildlife.

Scientific studies have shown that plants remove excess nutrients caused by sewage effluent or agriculture. Their sinuous fronds create a large surface area for colonisation by algae, bacteria and invertebrates, which process nutrients and organic matter within the river. Their roots directly remove nutrients, as well as stabilising sediment; thus preventing the movement of toxins which are bound to sediment particles.

Aquatic plants also physically modify the river by adding complexity to the shape of the river channel. This creates a more dynamic flow regime, with fast channels appearing between clumps of growth scouring clean gravels, and silt being deposited in the areas where the growth slows the water. Together with trees, aquatic plants are nature's architects of channel structure, allowing rivers that have been artificially straightened to recover a more meandering form.

INVERTEBRATES

The invertebrate community in Spring Beck is generally typical of an English chalk stream, dominated by **freshwater shrimp** (*Gammarus pulex*), **blackfly larvae** (*Simuliid spp.*) and the **New Zealand mud snail** (*Potamopyrgus antipodarum*). Six different species of **mayfly** (*Baetidae spp.*) were recorded, along with fifteen different species of **caddis fly** (*Trichopteran spp.*).

Invertebrate assemblages are known to vary significantly under different environmental conditions and, as such, can be used to build a picture of habitat quality. An invertebrate survey was carried out on behalf of the Norfolk Rivers Trust at two plots in Weybourne village, and at one plot near the entrance to the lagoon. A number of biological indices were applied to the invertebrate communities recorded at these three sites, in order to infer environmental conditions in corresponding sections of the stream. Based on these indices, both sample plots in the village were shown to be relatively unpolluted but suffering from the impact of moderate sedimentation. Conversely, the invertebrate assemblage recorded at the entrance to the lagoon implied a degree of organic pollution and heavy sedimentation.

The high abundances of blackfly larvae recorded at the two village plots suggests that dissolved oxygen levels were high, and water was reasonably fast flowing. Blackfly larvae are filter feeders in fast-flowing water, where they cling to a firm surface using their abdominal hooks and catch particles in their fan-like, modified antennae.

FISH

As well as recording the presence of **three-spined sticklebacks** (*Gasterosteus aculeatus*), recent surveys undertaken by the Norfolk Rivers Trust have confirmed the existence of the critically endangered **European eel** (*Anguilla anguilla*) in Spring Beck. This species is subject to UK legislation, which can be used to compel work to aid migration of the species, where the Environment Agency deem free passage is hindered.

Although no **brown trout** (*Salmo trutta*) were observed during an electrofishing survey carried out by the Norfolk Rivers Trust, a number of local residents have reported sightings of the species in the stream. These sightings have however declined over recent years and trout have only been observed recently in the old millpond. This suggests that the small population of trout in Spring Beck are declining, and have likely been unsuccessful in migrating into the beck from the ocean, due to a number of anthropogenic obstructions.

Brown trout

Photograph: © Roger Tidman

MAMMALS AND BIRDS

An array of bird and mammal species have been reported by the local residents of Weybourne. Birds using Spring Beck or the habitat associated with it include **grey heron** (*Ardea cinerea*), **kingfisher** (*Alcedo atthis*), **mallard** (*Anas platyrhynchos*), **moorhen** (*Gallinula chloropus*), **water rail** (*Rallus aquaticus*), **snipe** (*Scolopacidae*), **green sandpiper** (*Tringa ochropus*), **sedge warbler** (*Acrocephalus schoenobaenus*), **whitethroat** (*Sylvia communis*), **pied wagtail** (*Motacilla alba*), **grey wagtail** (*Motacilla cinerea*) and **yellowhammer** (*Emberiza citronella*). **Sparrow hawk** (*Accipiter nisus*) and **barn owl** (*Tyto alba*) have been observed hunting along the banks of the stream, whilst **marsh harriers** (*Circus aeruginosus*) have been reported hunting over the reed bed, near the mouth of the beck.

Signs of **water voles** (*Arvicola amphibious*) were not encountered during a recent survey performed on behalf of the Norfolk River's Trust, however past records do exist of sightings along the beck. **Brown rat** (*Rattus norvegicus*), **common shrew** (*Sorex araneus*) and **pygmy shrew** (*Sorex minutus*) have also been observed, in association with the stream's vegetated margins. **Harvest mice** (*Micromys minutus*) have also been reported to live in the vegetation alongside the beck. They are classified as a priority species under the UK Biodiversity Action Plan, and are known to build spherical nests of tightly woven grass in the long vegetation associated with rivers. Several reports of **otters** (*Lutra lutra*) have been received from local residents and wildlife enthusiasts, although, due to the small size of the river, it is unlikely that the individuals observed would be permanently resident on Spring Beck itself.

Kingfisher

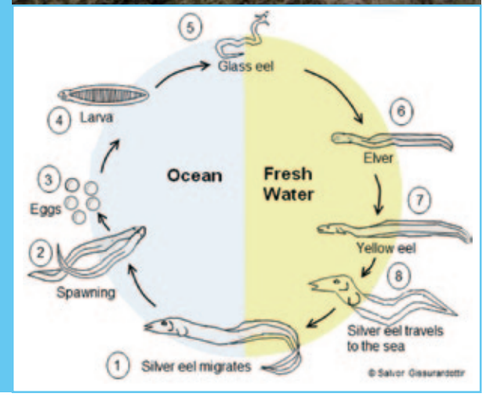
Photograph: © Jonathan Lewis.

Species profile: The European eel

The European eel (*Anguilla anguilla*) posed a great mystery to the biologists and fishermen of the past. It is catadromous, meaning that it spends most of its life in freshwater, but migrates out to sea to spawn. To this day, very little is known about the marine phase of the eel's life cycle. Although there is no exact data about spawning sites, it is commonly accepted that spawning takes place exclusively in the Sargasso Sea, in the West Central Atlantic. The larvae drift toward Europe; a journey that is thought to last up to two years. When approaching the European coast, the larvae metamorphose into glass eels, which are elongate with a transparent body. Upon entering freshwater the glass eels become elvers (a miniature version of an adult eel), and then continue to grow to become yellow eels. Finally, after anything between four and twenty years, the eels become sexually mature and transform into silver eels. At this stage they will migrate out to sea and the life cycle with begin again.

The European eel is listed as a critically endangered species on the IUCN Red List. Since the 1970s the number of eels reaching European rivers is thought to have declined by at least 90%. The reason for this decline is though to be due to a number of factors, including overfishing, parasites, climate change and, key to this catchment plan, barriers to upstream and downstream migration.

Photograph: © Jack Perks



Species profile: Riffle Beetle

Riffle beetles such as *Elmis aenea* are excellent indicators of water quality and are only found in river systems with high proportions of dissolved oxygen, and regular flow rates. Consequently, their presence in Spring Beck is encouraging as it infers a relatively unpolluted and oxygen-rich habitat.

Riffle beetles have aquatic larvae with gills, which pupate out of water before metamorphosing into their adult form; a small brown crawling beetle. Adults live amongst macrophytes, and are able to respire under water due to a dense coating of hydrofuge (microscopic hairs that cover their ventral surface), which trap air. As this oxygen source is depleted, it is replaced by the diffusion of dissolved oxygen from the surrounding water.

Riffle beetle and larvae (Elmis aenea)

Photograph: © APEM©

County Wildlife Sites (CWS) in Spring Beck's Catchment

Weybourne Beck rises from a spring in Hundred Acre wood County Wildlife Site (CWS) 1150. This is a large site comprising semi-natural broad-leaved woodland and dry heath with associated scrub. The primary use of the site is as a caravan park.

The northern section of wood is steeply sloping with oak *Quercus robur* and sycamore *Acer pseudoplatanus* co-dominant and frequent birch *Betula pendula* and rowan *Sorbus aucuparia*. The slopes support a field layer of mostly bracken *Pteridium aquilinium* with more open areas covered in bryophytes and frequent male fern *Dryopteris filix-max*. Characteristic woodland species such as herb robert *Geranium robertianum*, wood avens *Geum urbanum* and bluebell *Endymion non-scriptus* are present at the foot of the slopes. The southern section of woodland has an extensive canopy of sycamore, oak and silver birch, with less frequent beech *Fagus sylvatica* and sweet chestnut *Castanea sativa*. Derelict coppiced hazel *Corylus avellana* and goat willow *Salix caprea* are present. A sparse field layer has locally dense bracken interspersed with bare leaf litter, with bramble *Rubus fruticosus* agg. and honeysuckle *Lonicera periclymenum*. Occasionally heather *Calluna vulgaris* persists in the field layer, an indication as to the previous nature of the site.

The heathland in the centre of the caravan site comprises mature heather with occasional gorse *Ulex europaeus* and broom *Cytisus scoparius*. Heath vegetation is also found bordering the many sandy tracks, species such as heath bedstraw *Galium saxatile*, bell heather *Erica cinerea*, pill sedge *Carex pilulifera*, and heath wood-rush *Luzula multiflora* flourish here.

Before joining the sea the beck feeds into the east of CWS 1150 Beach Lane, which is an area of reed bed occupying a shallow pool. The reed bed consists of uniform aged reed *Phragmites australis* and has remained unmanaged for many years.

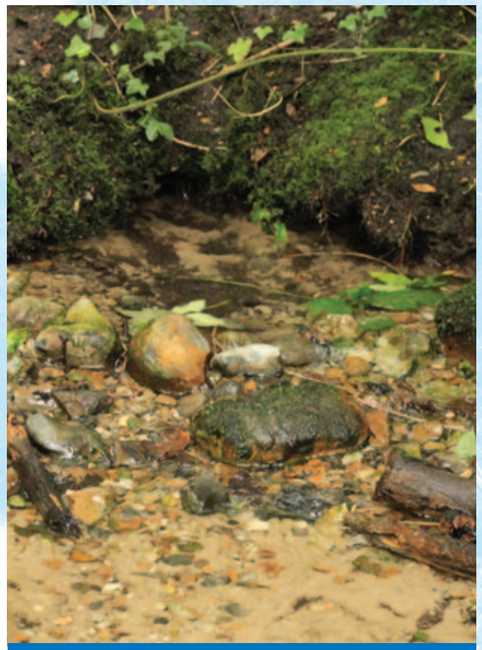
A small area of brackish open water just inside the sea defences supports frequent *Enteromorpha* species. Drier land lies south of the stream and is dominated by a tall ruderal herb community characterised by alexanders *Smyrnium olustratum* and fennel *Foeniculum vulgare* with rosebay willowherb *Chamerion angustifolium*. The sward is generally tall, including frequent coarse grasses such as false oat grass *Arrhenatherum elatius* and cock's foot *Dactylis glomerata*, with locally abundant wall barley *Hordeum murinum*. Other herbaceous species present include common mallow *Malva sylvestris*, mugwort *Artemesia vulgaris*, perennial sow thistle *Sonchus arvensis*, broad-leaved dock *Rumex obtusifolius*, and spear-leaved orache *Atriplex prostrata*, with amphibious bistort *Persicaria amphibia*, and sea club-rush *Scirpus maritimus* in damper areas. Scattered willow Salix sp. occurs throughout the site and more densely in the slightly drier area on the eastern boundary where great willowherb *Epilobium hirsutum* is abundant. The stream is very overgrown, but supports a small amount of water cress *Nasturtium officinale* and brooklime *Veronica beccabunga*.

Sam Brown
Norfolk Wildlife Trust

SPRING BECK: FROM SOURCE TO MOUTH

Spring Beck rises from a spring on the edge of Hundred Acre Wood, near Weybourne Railway Station. The spring flows into a substantial hollow, which appears green due to an abundance of watercress. The stream then flows under the railway track and into Spring Head Plantation.

Stream leaving the hollow near the source of the beck. The watercress causes the water to appear green



Spring emerging from the hillside at the source of the beck

The stream flows through a culvert under the railway bridge.

After just a few metres woodland gives way to open farmland and the river flows through a short tunnel, under a bank of land, and into an artificially straightened channel that cuts through gently sloping arable and grazing land. The banks on this section of the river are relatively deep and are buffered from the surrounding agricultural land by dense willowherb, hemp agrimony and patches of reed and blackthorn, which all but obscure the channel from view. There is evidence of land drainage from the neighbouring farmland, with numerous pipes emptying into the river channel.

At the foot of Lemon Hill, where the farmland meets the village, the main channel of Spring Beck is joined by a smaller tributary that originates from springs that flow into a medieval moat to the west of Holt road. The moat and its emergent channel is overgrown with horsetail and fools watercress and shaded by a small copse of trees that have grown where a manor house would once have stood. Water exits the moat through a small stream that flows under Holt Road and through the foot of a line of village gardens until it joins the main channel. The low gradient and straight course of this small tributary has allowed a notable layer of silt to build up in the bottom of the channel. Local residents have reported that the level of silt has increased over recent years.

The upper reaches of spring beck flow out of spring head plantation and across the neighbouring farmland.

The river channel is obscured from view by dense vegetation as it flows through arable and grazing land.

A small tributary to Spring Beck's main channel follows a straight course through the gardens of village residents.

The streams flows through a number of village gardens.

After the tributary joins the main channel, Spring Beck flows through village gardens and under roads via culverts. Drain water from the roads is piped into the stream in a number of locations.

The pond behind the remains of Weybourne Priory suffers from notably high silt levels. A dense algal mat can also be seen in this photo.

The flow of the stream appears to speed up as it heads from Station Road toward the remains of Weybourne Priory. Behind the old priory the beck opens up into a highly silted pond; a large proportion of which is cover by filamentous algae and overgrown with reeds. The presence of a blanket of algae may indicate an unnaturally high nutrient load and may be detrimental to other aquatic life.

Water exits the pond through a sluice gate and flows through agricultural land, before the channel widens into a millpond as the watercourse approaches Beach Lane. The stream exits the pond through another sluice and flows around the boundary of the old water mill, dropping by approximately 6 metres, via a series of concrete weirs. It is likely that this structure will present a serious obstacle to the passage of both eels and trout upstream into the higher reaches of Spring Beck. The water then passes through a culvert under Beach Road and flows out into a large lagoon.

A dense bed of watercress at the entrance to the millpond

The millpond

The water falls by approximately 6 metres via a weir as it exits the millpond

The lagoon is highly vegetated with reed and filled with silt. It is also reported to be prone to seasonal flooding. As such it may benefit from partial clearance to create a pond feature, which could arguably improve the environment, both for wildlife and the local community.

The lagoon near the river's mouth

Water flows out of the lagoon through the shingle bank of Weybourne Hope and passes into the sea via a piped outfall. The exit to this pipe is above sea level during at least half of the tidal cycle and, as such, is though to impede the recruitment of migratory fish species such as brown trout and eels into Spring Beck.

The outfall pipe runs through the shingle bank and runs out to sea at Weybourne Hope.

SECTION 2 THE PROBLEMS AND SOLUTIONS

MORPHOLOGY – THE IMPORTANCE OF RIVER FORM AND FUNCTION

The diversity of life associated with chalk streams is reliant on the health and diversity of the habitats in and around the streams themselves. Lowland chalk streams such as Spring Beck typically meander across their floodplains. Although its valley is relatively steep by Norfolk standards, Spring Beck's small size should mean that is not powerful enough to cut deep channels through the bedrock, but instead would respond to subtle changes in gradient and substrate resistance by flowing round, rather than through. Bends in the river create a gradient of water velocities and depths, exposing clean gravels where the water flows faster, and depositing silt in the slower areas. This diversity in flow and substrate creates numerous microhabitats, which support a variety of life.

Over the years Spring Beck's chaneel has been straightened, which has allowed it to cut unnaturally deep channels through the bedrock

Over the centuries, Spring Beck's channel has been straightened and re-directed, therefore much of its variability has been lost. Straightening creates a uniformity of flow, and the faster flowing areas from which silt would naturally be scoured disappear, allowing silt deposition along the whole riverbed. Creatures adapted to uniform flows and silty substrates thrive in such conditions, but those requiring pools and riffles, clean gravels, or fast or slow water do not. Slowly the structure of the ecological community changes, and diversity is lost. Spring Beck has been straightened and marginalised throughout its entire course, with very little of the river retaining a "natural" form.

Due to the small length and breadth of Spring Beck, physically restoring meanders in the stream is not considered a worthwhile option, however it may be possible to add complexity to the channel by the addition of stable woody material. This would act to narrow the river in places and thus increase variability in flow speeds and regulate silt deposition. The variety of different microhabitats, and the shelter provided by the woody material itself would also help to increase the biological richness of the stream.

CONNECTIVITY BETWEEN THE RIVER AND ITS FLOODPLAIN

In a natural, highly productive stream there is a seasonal connectivity between the river and its floodplain. In unmodified, spring-fed streams there is typically little difference between the water level at normal height and the top of the bank. This means that on occasion the river naturally spills over its banks, depositing sediment along its margins, which gradually become colonised by riparian plants. A stream the size of Spring Beck would only be expected to have a modest floodplain size, nonetheless this would have been of value to native wildlife.

The artificially straight form of Spring Beck's channel has resulted in a structurally simplified river, which cuts deeper into the bedrock than a naturally meandering stream. This inhibits the natural flooding process, disconnecting the stream from much of its floodplain, even during periods of high flow. This greatly reduces the river's marginal habitat, and prevents the rich ecological interchange between the stream and its river, which would naturally occur during inundation.

Much of Spring Beck flows through agricultural or residential land and so full floodplain restoration is unlikely to be an option. It may however be possible, and beneficial, to bring back the banks and create wet shelves within the existing channel, creating marginal habitat for a variety of wildlife.

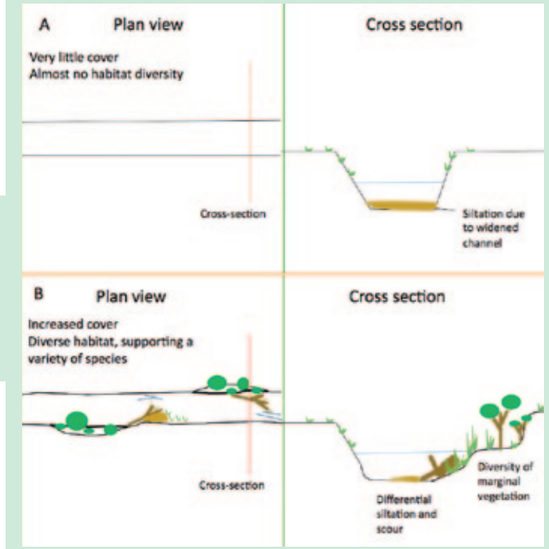


Figure 3. Schematic showing (**A**) the siltation and poor habitat caused by the current form of the river channel (**B**) potential improvements to the straightened river channel which would improve biodiversity and reduce siltation problems further downstream.

FISH PASSAGE

There are multiple obstructions along Spring Beck that isolate different fish populations in the stream. These barriers also cause water to pool upstream of them, thus preventing the establishment of natural flow velocities and river form. Sedimentation and emergent plant growth is encouraged by these obstructions, resulting in an inefficient situation where the channel would have reduced capacity and could require periodic cleaning. A natural channel would not require maintenance of this type. The poor fish community within Spring Beck is likely largely attributable to these anthropogenic obstructions, which cause fish populations to become fragmented, impeding and in some cases prohibiting natural migration along the river.

Five barriers to fish passage have been identified along Spring Beck, the highest priority of which being the outfall pipe at Weybourne Hope, which in all but the highest tidal conditions stands above sea level. Whilst not entirely impassable to a fit adult eel or elver when submerged, the fact that the entrance to the pipe is generally open to the air will put severe temporal restrictions on their movement into the beck.

In addition to the outflow pipe, a weir and three sluice gates are installed on the lower reaches of the river. These barriers will hinder the passage of a proportion of fish, probably expose all fish to an increased risk of predation and require unnecessary energy expenditure. Eels are a critically endangered migratory species and passage of eels is the subject of UK legislation, which can be used to compel the construction of eel passes where the Environment Agency deem free passage is hindered. The installation of an eel pass on the weir that runs through the grounds of the old mill house on Beach Road would be a relatively inexpensive measure to aid the passage of eels into the higher reaches of the beck.

As well as restricting Spring Beck's eel population, it is also likely that the aforementioned obstacles may hinder

The weir at the old millhouse would benefit from the installation of an eel pass, which would aid the migration of the species within the stream

the passage of species that are rarely recorded in the stream. Fish such as brown trout are found in coastal waters and may migrate into Spring Beck, if permitted to do so.

Norfolk Rivers Trust has initiated communications with the Environment Agency and local councils to establish whether the outflow pipe at Weybourne Hope is necessary as a flooding defence. If not, there may be the potential to remove the pipe, allowing the stream to flow freely out to sea and allowing fish to pass more freely into Spring Beck.

PHOSPHATES, NITRATES AND NUTRIENT BALANCE

The wildlife of Spring Beck, and other chalk streams, has evolved to exploit the levels of nutrients and minerals naturally found in the chalk-filtered water and the run-off coming through wet meadows and woodlands. An increase in the levels of nutrients (typically phosphates and nitrates) allows the growth of an alternative biota in the river, leading to an increase in algal growth and a shift in the plant community to more nutrient-hungry species. This increased plant and algal growth can deplete the oxygen levels in the water, threatening the natural chalk stream flora and fauna. Persistent and high nutrient input can lead to a complete domination of the stream by a very limited number of species, and an exclusion of the iconic higher plants, insects and fish.

Spring Beck is not located in a Catchment Sensitive Farming Priority Area, however farmers in the catchment are still considerate of the environment when using fertilisers and pesticides. Even so, it is likely that the vast majority of the nutrient input in Spring Back originates from agriculture. Although crop fertilisers are now generally used much more sparingly and intelligently than in past decades, and the beck is protected by a nitrate sensitive zone, some leaching into the river still occurs, and high nitrate levels persist in the groundwater, a legacy of generations of use.

The vast majority of phosphates now found in UK rivers originate from human sewage, however Weybourne's sewage treatment works was shut down in 2001 and the village's effluent is now transported away via sewers, with no known inputs directly into Spring Beck.

SILTATION

Anecdotal evidence from members of Weybourne's community suggests an increase in siltation in the beck over the past 20 years. Historic straightening and disconnection from the floodplain means that once silt enters the river system it is evenly distributed across the entire riverbed and cannot be exported onto the floodplain.

The land use in the catchment also poses a particular threat, as sugar beet farming in particular can leave large areas of ground bare during periods when heavy rainfall is likely. The increasing use of un-cropped field boundaries and more latterly the use of cover crops to minimise the areas of earth left bare over winter have reduced the direct input from fields, however, large quantities of silt still enter the river. Much of the silt now entering the river comes from roads, fords and farm access tracks, and the increasing volume and size of traffic in the catchment's narrow lanes is exacerbating the problem. Recent research shows that although the majority of silt entering British rivers is still agricultural in origin, an increasing proportion is coming from road verges, and it is this material which poses the greater threat due to its high organic content, and its traces of hydrocarbons, heavy metals and other chemicals.

Recent work by Norfolk Rivers Trust on the Nar is showing how these problem points can be addressed relatively easily and cheaply, either by diverting rain-flow away from the river, or by trapping silt in the river close to its point of entry. Bringing back the banks and creating habitat complexity by adding woody material in the stretch of Spring Beck above Weybourne village, may help tackle siltation problems further downstream. The historic millpond, the pond next to Weybourne Priory and the lagoon at the bottom of Beach Road all have notably high silt content and may benefit from excavation.

Residents have reported that silt levels in this low energy tributary stream have increased over recent years.

INVASIVE SPECIES

Spring Beck is relatively isolated from main roads and large towns. It is also too small to attract a major fishing interest and has limited public access. As such, the stream has not yet been victim to invasive species to the same extent that other, larger British rivers have. There are as yet no records of signal crayfish, or Himalayan balsam in association with the beck, however the Norfolk Biodiversity Information Service (NBIS) shows that Japanese knotweed has been recorded near the source of Spring Beck in the past. Muntjac deer have also been observed by Norfolk Rivers Trust during a walkover survey of the stream. Local residents have also reported regular sightings of muntjac in the farmland above Weybourne village.

Norfolk County Council are currently preparing a North Norfolk Biosecurity Plan that will provide guidance on the control and eradication of these species. Biosecurity is now a critical issue, and anyone visiting or working on the beck should be aware of the requirements to cleanse and dry all clothing and equipment, which may have been used at other sites.

Japanese knotweed is native to Eastern Asia and was introduced to Britain as an ornamental garden plant in the mid-19th century. The plant has creamy white flowers that appear at the tips of the stems between August and September. It has rhizomes (underground stems) that can spread up to seven metres from the parent plant, and to a depth of up to three metres. This makes the plant extremely difficult to eradicate. A new plant can grow from only 0.7 g of rhizome.

Japanese knotweed is known to outcompete native vegetation. It also contributes to riverbank erosion, increases the risk of flooding and also causes significant damage to infrastructure (the rhizomes of the plant are able to push through many hard substrates, including asphalt, building foundations and drains).

The most cost effective way to eradicate Japanese knotweed is by using a glyphosphate based herbicide such as Roundup. This can either be applied by a foliar spray or by injecting the herbicide directly into the stem of the plant. Experience in Norfolk has shown that the stem injection method is capable of eradicating the plant in a much shorter period of time. After 1 year of stem injection we typically see only 10-20% re-growth the following year. A second year of stem injection delivers almost total eradication. Herbicide application has the biggest impact in September when the plant is investing more resources in growing its rhizome network than its above-ground vegetation.

SECTION 3 AN ACTION PLAN

OVERVIEW OF RESTORATION OPTIONS

Spring Beck is a river with good water quality and is a valued ecological resource within its catchment. In the future it could be a haven for wildlife; supporting migratory fish, and acting as a corridor for birds, insects and mammals. In order for this to happen, targeted ecological restoration works will need to be implemented along the beck, with the help and support of the local community.

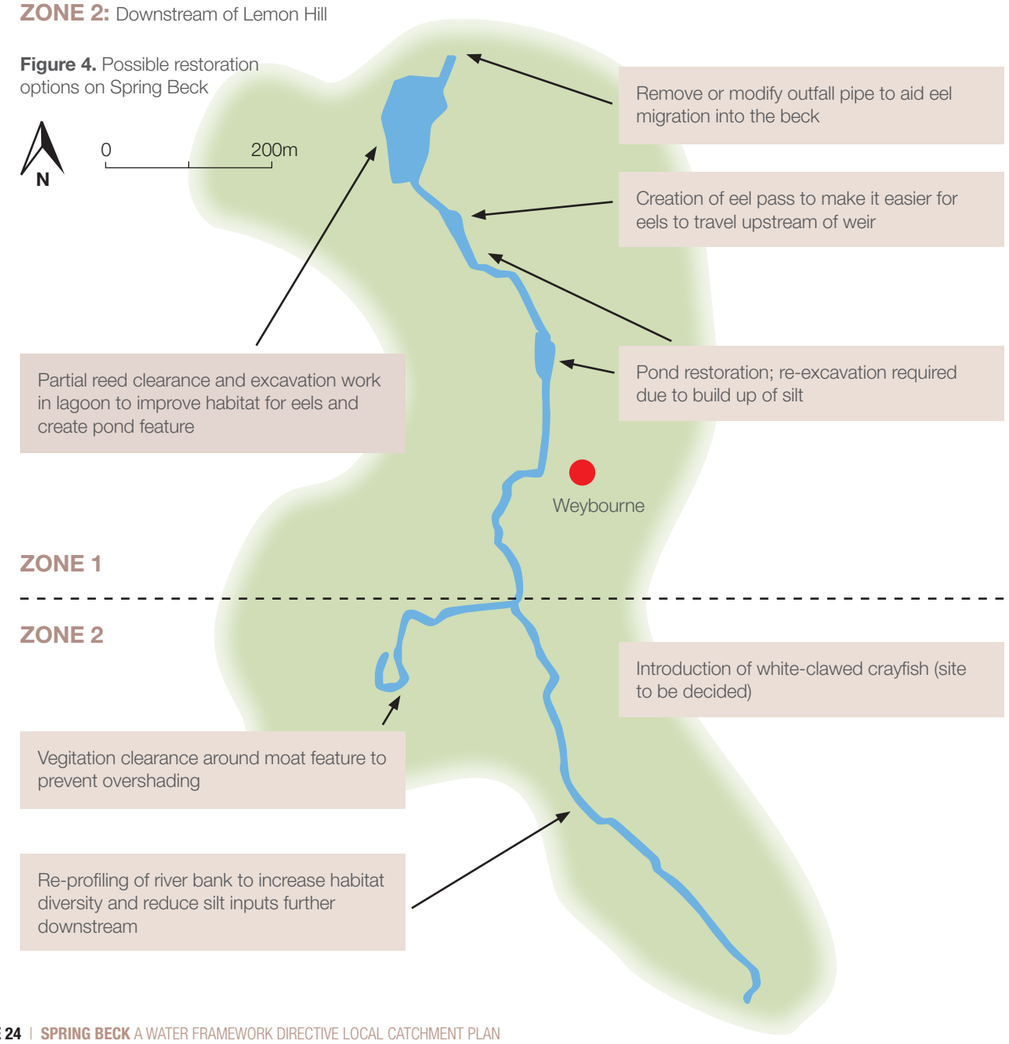
Norfolk Rivers Trust propose to run a series of meetings and workshops to discuss the possibilities of river restoration with farmers, landowners, various agencies and the general public. We would especially like to engage farmers and landowners in the catchment to ascertain where work on the river may be undertaken. This plan provides a basic overview of the ecological requirements of the river and floodplain, but restoration is constrained by valuable agriculture, and owners' consent. The actions described are based on problems identified previously in this plan.

The figure below summarises possible restoration options on Spring Beck. These proposals are likely to greatly enhance the environmental quality and biodiversity of the stream. It is stressed that these plans are subject to landowner consent and are only outline ideas at this stage. Two river 'zones' are discussed in the subsequent text, which can be approximately located as follows:

ZONE 1: From the source in Hundred Acre Wood to the foot of Lemon Hill (where agricultural land meets the village).

ZONE 2: Downstream of Lemon Hill

Figure 4. Possible restoration options on Spring Beck



ZONE 1: FROM THE SOURCE IN HUNDRED ACRE WOOD TO THE FOOT OF LEMON HILL

The main river channel could be improved between Springhead Plantation and the foot of Lemon Hill, by re-grading the riverbank and putting in place lower level berms. It may also be possible to add woody debris to the channel to increase variability in flow speeds and regulate silt deposition. These measures would help to reconnect the river to its floodplain, and help reduce siltation further downstream, as well as creating habitat diversity within the channel. There is also at least one culvert in this section of channel that appears to be redundant, as the land above it is overgrown and is no longer likely to be used for access. If restoration work on this section of Spring Beck were agreed it would be recommended that unnecessary culverts should be removed, so as to improve habitat connectivity.

The moat area to the west of Holt Road is currently over-shaded and the site would benefit from some tree clearance and silt removal. This would allow a more diverse flora and, consequently, fauna to development.

This section of the river runs through valuable agricultural and grazing land and, as such, any proposed works would have to be discussed and agreed with the landowner before they could take place. The moat at Hall Yards is also listed under the Ancient Monuments and Archaeological Areas Act 1979, so this may also affect the extent of future restoration works.

The old moat to the west of Holt Roaf is currently overgrown and full of siltyears.

ZONE 2: DOWNSTREAM OF LEMON HILL

A number of obstructions to fish passage exist in the lower section of Spring Beck, the most significant of which having been identified as a weir on the site of the old watermill, and the outfall pipe at the mouth of the stream. Although eels are already known to be present, the installation of an eel pass on the weir would greatly improve the chances of European Eel migrating into the beck, and thus hopefully increase the population of the species in Spring Beck.

The tidal outfall pipe has been identified as a major obstruction to fish migration into the steam. From an ecological point of view, the ideal would be to remove the pipe and allow the beck to flow naturally over the shingle beach and out to sea. There is however considerable risk of flooding in the Beach Road area, due to both tidal ingress and heavy rainfall. As such, removal of the pipe may not be a practical option. It is recommended that a scoping survey be carried out to look into possible options for improving fish passage through the outfall, so as to find a practical solution that balances the requirements of biodiversity and the local community.

Siltation has been recognised as a problem in both the pond behind the remains of Weybourne Priory and the former millpond. Both sites would benefit from silt excavation, which would improve the environment both for wildlife and, aesthetically, for the community and local landowners. It may also be beneficial to establish small reed beds around the ponds to act as filters to reduce the deposition of further solids into the water body.

The lagoon at the end of beach road is designated as a County Wildlife Site (CWS), however both the Norfolk Rivers Trust and the Norfolk Wildlife Trust have identified it as being in need of restoration work. In its current state

the lagoon at Weybourne will revert to marsh as the reeds continue to colonise over the next few years. The lagoon is also currently of little value to the community. It is, however, possible to enhance the stream as it flows into the lagoon by clearing the reed and narrowing the banks to promote a swifter flow. This will prevent the re-colonisation of reed and produce an attractive, clean gravel bed, which will be of benefit to the stream's fish and insects. It would be beneficial to leave reeds around the margins of the lagoon for the bird and dragonfly species, which use them, but to deepen the centre of the pond sufficiently (approx. 1.5m) to prevent rapid re-colonisation). This will create an attractive feature close to the village centre, which will be rich in wildlife.


Photograph: © Jack Perks

Spring Beck has been identified as a possible reintroduction site for the white-clawed crayfish (Austropotamobius pallipes). The white-clawed crayfish is Britain's only native crayfish and requires clean, well-oxygenated and mineral-rich water. It was once common throughout southern and eastern England, but is now listed as 'Endangered' on the IUCN Red List and is on the verge of extinction in the UK, following the introduction of the American signal crayfish (Pacifastacus leniusculus). A population of white-clawed crayfish was recently transferred to the River Stiffkey from the neighbouring River Glaven, in an attempt to establish a population in a river that is not yet threatened by the introduction of American signal crayfish.


Photograph: © Jack Perks

Invertebrate and water quality assessments suggest that the conditions in Spring Beck are suitable to support a population of white-clawed crayfish. It is therefore proposed that a small population is transferred to the stream from the River Glaven.

White-clawed crayfish (Austropotamobius pallipes)

COSTS AND TIMELINE

As mentioned in the opening paragraph of this plan, Spring Beck is not given consideration under the Water Framework Directive. As such, this catchment plan has particular significance as a step in determining what objectives should be set.

As a result of centuries of modification, Spring Beck would benefit from measures to increase habitat quality and fish passage as outlined in the Action Plan above. Overall, the order of priorities for the river is as follows:

1. To ease fish passage along the lower sections of the steam, by installing eel passes and considering options to improve the tidal outfall..
2. To restore the lagoon at the end of Beach Road, by clearing reed and removing silt.
3. To remove silt and restore habitat in the pond behind the remains of Weybourne Priory, the old millpond and the moat in Hall Yards.
4. To introduce a population of native white-clawed crayfish into the stream.
5. To enhance stream habitat on the section of Spring Beck that runs down Lemon Hill by re-grading the riverbanks and adding diversity to the channel.

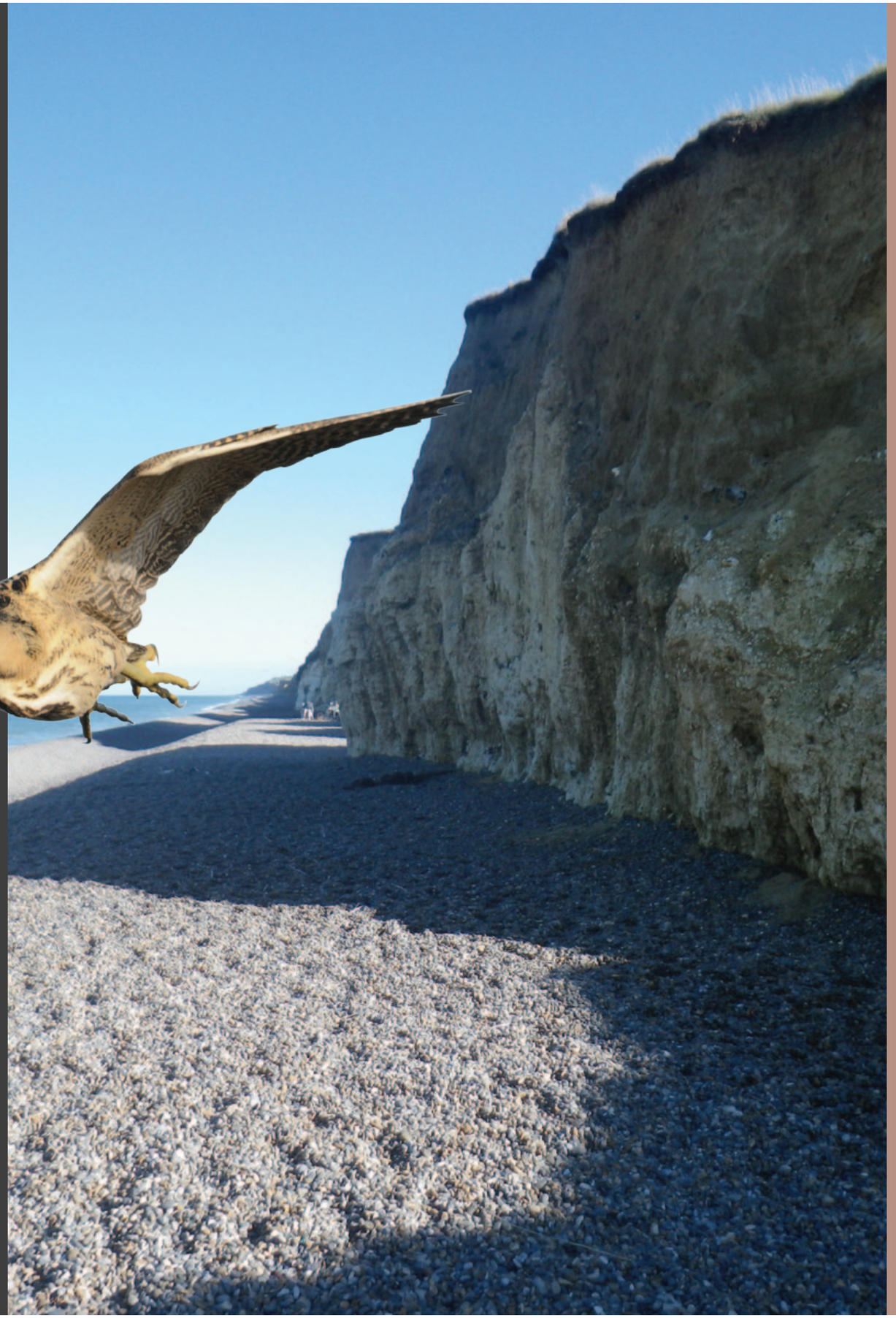
These measures need to be discussed and decided upon by the community and other partners with an interest in the area so that a comprehensive package can be agreed. Thereafter, works measures should be undertaken when funding becomes available.

Action	Number of sites/Length	Predicted cost	Achievable timeline	Responsibility / capability
Zone 1: Tree clearance and silt removal around/in moat	1	£1,500	2020	Norfolk Rivers Trust (NRT)
Zone 1: Re-profiling of river channel by re-grading river bank	0.8 km	??	2020	Norfolk Rivers Trust (NRT)
Zone 2: Silt removal in ponds	2	£2,500 each	2018	Norfolk Rivers Trust (NRT)
Zone 2: Excavation, reed clearance and silt removal in lagoon	1	£8750 (plus an additional £3, 600 if digging and labour required)	2018	Norfolk Rivers Trust (NRT), Environment Agency, Norfolk Wildlife Trust (NWT)
Zone 2: Installation of eel pass on weir in ground of old watermill	1	£750	2016	Norfolk Rivers Trust (NRT)
Zone 2: Scoping study for options on tidal outfall	1	£5000	2018	Norfolk Rivers Trust (NRT), Environment Agency, Nortn Norfolk District Council
Introduction of white-clawed crayfish	Site to be decided	Negligible	2018	Norfolk Rivers Trust (NRT)

* Note: costs include another 10% for monitoring where appropriate and always include VAT.

FURTHER INFORMATION

Environment Agency - Keeping Rivers Cool report
Rivers by Design - rethinking development and river restoration
World Wildlife Fund - Why are chalk streams special?
Norfolk Wildlife Trust
River Restoration Centre manual of river restoration techniques
River Rehabilitation for Eastern England Rivers
Environment Agency homepage
Introduction to the Water Framework Directive
The North Norfolk Catchment Abstraction Management Strategy
The State of England's Chalk Rivers Report



Weybourne

By Cameron Self

Above the cliff-top
Meadow today, the skylark
Rises up into

The sun's face - higher
And higher and higher; its
Brown speck vanishing

Beyond neck-crick and
The eye's sudden blindness - and
From this height it pours

Down its river of
Sound - bubbling and sparkling and
Glitteringly clear.

THE NORFOLK RIVERS TRUST
RESTORING NORFOLK'S RIVERS

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