# River Mease SSSI/SAC Restoration Plan






NATURAL ENGLAND

Environment Agency

## Document control sheet BPP 04 F8

Client: Natural England

Project: River Mease SSSI/SAC Restoration Job No: B1753400

Document Title: River Mease SSSI/SAC Restoration Plan

| | Originated by | Checked by | Reviewed by | Approved by |
|---|---|---|---|---|
| **ORIGINAL** | NAME **Duncan Wishart** | NAME **Joanne Barlow** | NAME **Joanne Barlow** | NAME **Suzanne Maas** |
| DATE **7th December 2011** | INITIALS | INITIALS | INITIALS | INITIALS |
| | **Document Status** | DRAFT FOR CLIENT COMMENT | | |

| | Originated by | Checked by | Reviewed by | Approved by |
|---|---|---|---|---|
| | NAME **Duncan Wishart** | NAME **Suzanne Maas** | NAME **Suzanne Maas** | NAME **Suzanne Maas** |
| DATE **22nd December 2011** | INITIALS | INITIALS | INITIALS | INITIALS |
| | **Document Status** | FINAL DRAFT REVISED DRAFT FOR CLIENT APPROVAL | | |

| | Originated by | Checked by | Reviewed by | Approved by |
|---|---|---|---|---|
| | NAME **Duncan Wishart** | NAME **Suzanne Maas** | NAME **Suzanne Maas** | NAME **Suzanne Maas** |
| DATE3 **3rd January 2012** | INITIALS | INITIALS | INITIALS | INITIALS |
| | **Document Status** | APPROVED DRAFT FOR CONSULTATION | | |

| | Originated by | Checked by | Reviewed by | Approved by |
|---|---|---|---|---|
| | NAME **Duncan Wishart** | NAME **Suzanne Maas** | NAME **Suzanne Maas** | NAME **Suzanne Maas** |
| DATE **1st March 2012** | INITIALS | INITIALS | INITIALS | INITIALS |
| | **Document Status** | REVISION FOR CLIENT APPROVAL, FOLLOWING PUBLIC CONSULTATION | | |

| | Originated by | Checked by | Reviewed by | Approved by |
|---|---|---|---|---|
| | NAME **Duncan Wishart** | NAME **Suzanne Maas** | NAME **Suzanne Maas** | NAME **Shirley Henderson** |
| DATE **15th March 2012** | INITIALS | INITIALS | INITIALS | INITIALS |
| | **Document Status** | FINAL | | |

Any advice, opinions, or recommendations within this document (a) should be read and relied upon only in the context of the document as a whole; (b) do not, in any way, purport to include any manner of legal advice or opinion; (c) are based upon the information made available to Jacobs at the date of this document and on current UK standards, codes, technology and construction practices as at the date of this document. It should be noted and it is expressly stated that no independent verification of any of the documents or information supplied to Jacobs has been made. No liability is accepted by Jacobs for any use of this document, other than for the purposes for which it was originally prepared and provided. Following final delivery of this document to the Client, Jacobs will have no further obligations or duty to advise the Client on any matters, including development affecting the information or advice provided in this document.

This document has been prepared for the exclusive use of the Client and unless otherwise agreed in writing by Jacobs, no other party may use, make use of or rely on the contents of this document. Should the Client wish to release this document to a third party, Jacobs may, at its discretion, agree to such release provided that (a) Jacobs' written agreement is obtained prior to such release; and (b) by release of the document to the third party, that third party does not acquire any rights, contractual or otherwise, whatsoever against Jacobs and Jacobs, accordingly, assume no duties, liabilities or obligations to that third party; and (c) Jacobs accepts no responsibility for any loss or damage incurred by the Client or for any conflict of Jacobs' interests arising out of the Client's release of this document to the third party.

# Contents

**Individual plans showing potential restoration options for specific river reaches can be found as summarised below:**

# Section 1 **Introduction**

## Why do we need to restore the River Mease SSSI/SAC?

The River Mease and the lower part of Gilwiskaw Brook are special lowland rivers that are designated as a Special Area of Conservation (SAC) under the EU Habitats Directive, and a Site of Special Scientific Interest (SSSI) under the Wildlife and Countryside Act. They were designated because the River Mease represents one of the best examples of an unspoilt meandering lowland river, which supports characteristic habitats ad species. The SSSI/SAC supports populations of spined loach (*Cobitis taenia*) and bullhead (*Cottus gobio*), two notable species of native freshwater fish that have a restricted distribution in England. The rivers also support populations of white-clawed crayfish (*Austropotamobius pallipes*), otter (*Lutra lutra*) and a range of river plants such as water crow-foot (*Ranunculus sp.*).

### Spined loach, bullhead, white clawed crayfish, otter and water crow-foot

There are opportunities to make the river even better to ensure these species continue to thrive and support more wildlife, and are more resilient to climate change. There have also been several pollution incidents on the River Mease over the past decade which have reduced fish populations. Fish populations, together with white-clawed crayfish and otter numbers, have not increased and have declined in some stretches of the river since 2007. This coincides with the time the Environment Agency ceased stocking the river. The management of the fishery is now geared towards natural recovery and recruitment of fish, which is more sustainable but this means it takes longer for fish populations to recover. Changing from an artificially managed fishery to a naturally maintained fishery will take time and in the short-term, variations in population levels can be expected.

**What is river restoration?**

River restoration refers to river improvement activities that are designed to return the structure (morphology) and ecology of a river back towards a pre-disturbance (natural) condition. This can include river management activities such as complete restoration (involving in-channel works) of an existing section of channel, enhancement of an existing section of channel (such as by improved management) and/or the creation of a new section of river channel with features designed to replicate natural conditions.

This study considers past modifications to the river channel and floodplain. Modifications such as weir construction, over-deepening of the channel, land use change and agricultural intensification have, in combination, led to a reduction in the diversity of natural habitats. If a more naturally functioning channel and floodplain connectivity can be restored where the impacts of past modifications are evident, then the length of suitable habitat for wildlife will increase, as will the numbers of animals and plants that depend on the river. Restoration would also help increase resilience of the river system to the more extreme high and low flows expected in future because of climate change.

Water quality is also a key issue, so organisations are already working closely together to address the negative impact it's having particularly high levels of phosphorous) from sewage treatment works, road runoff and agricultural land. Himalayan Balsam, a non-native invasive plant which colonises the river banks, is also being eradicated, this will help more native riverside plant species to thrive and these plants will reduce the amount of fine sediment entering the channel through surface runoff.

## European Directives

This and future work on the Gilwiskaw Brook and the River Mease will help achieve the objectives of the Habitats Directive and the Water Framework Directive, which are pieces of European legislation that aim for SAC rivers to achieve favourable condition and all rivers to good ecological status respectively. Funding relating to achieving the aims of these Directives will help deliver the future conservation, enhancement and ecological restoration of rivers where feasible.

**Favourable condition**
Refers to the condition of the features (e.g. species) for which a SSSI or SAC has been designated and means that all of the targets for the mandatory attributes (e.g flow, water quality, population size, habitat) used to assess a feature have been met.

**Good ecological status**
The general objective of the Water Framework Directive (WFD) is to achieve 'good status' for all surface waters by 2015. 'Good status' means the achievement of both 'good ecological status' and 'good chemical status'. Good ecological status refers to situations where the ecological characteristics show only a slight deviation from 'reference conditions'. In such a situation the biological, chemical and physio-chemical and hydromorphological conditions are associated with limited or no human pressures.

## Aim and objectives of the restoration plan

The aim of this restoration plan is to identify river restoration or enhancement actions that can address physical modifications to the River Mease SSSI/SAC which contribute to unfavourable condition. This includes the following specific objectives:

1. Determine the impact of physical modification.
2. Provide an outline restoration plan for the river on a reach-by-reach basis.
3. Identify potential delivery mechanisms.

The plan is intended to provide a framework for the improvement of the River Mease SSSI/SAC for the next 20 to 30 years.

## Stakeholder involvement

This outline restoration plan aims to identify possible options that could be implemented along the River Mease SSSI/SAC to improve the natural function of the river, and increase the length and number of habitat features for aquatic and terrestrial wildlife. To achieve the aims of this river restoration plan, the Environment Agency and Natural England recognise the need for effective and positive engagement with landowners and land managers.

The plan outlines the options that have been identified as desirable to meet the conservation objectives for the river. This version of the restoration plan has been updated to incorporate feedback on general constraints to the restoration options obtained during a consultation held on the 10th January 2012 at Chilcote Village Hall. General suggestions and concerns have been considered and incorporated (where compatible with favourable condition) into this version of the plan. More detailed comments on specific river reaches are being held on file and will be used to inform future 1-1 discussions with landowners as reach specific restoration projects are taken forward.

In addition to landowners and tenants, the stakeholders engaged in the development of the restoration plan include the National Farmers Union (NFU), Country Land and Business Association (CLA), Angling Associations, Wildlife Trusts, Trent Rivers Trust, OnTrent, Forestry Commission, National Forest and Local Councils. A copy of the plan can be obtained from the OnTrent website, the National Farmers Union (NFU), Natural England or the Environment Agency.

This plan is accompanied by a technical report to support the potential restoration options for the River Mease SSSI/SAC. Going forward, Natural England and the Environment Agency will work with stakeholders to agree how best to deliver the restoration plan. Whilst some options will be able to be implemented over the next few years, other measures will take longer to organise with the landowners and interested parties. This plan should be considered as a long term restoration strategy.

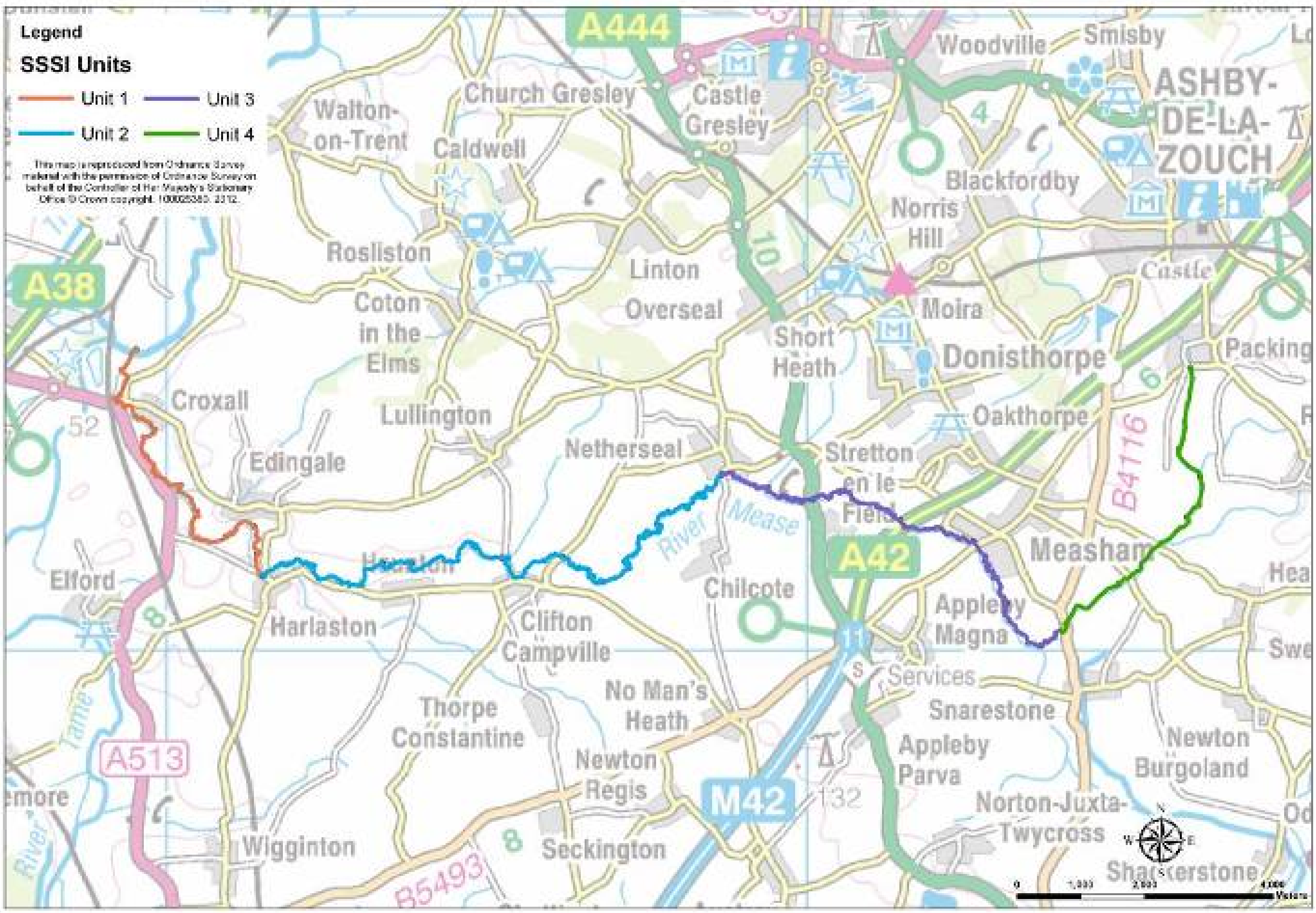
# Section 2 **The River Mease SSSI/SAC**

## Overview

The SSSI/SAC is approximately 25km in length and comprises the lower reaches of the Gilwiskaw Brook downstream of Packington, and the River Mease downstream of its confluence with the Gilwiskaw Brook. The SSSI/SAC comprises 4 management units across 3 counties; Leicestershire, Derbyshire and Staffordshire (Map 1).

Unit 1: River Trent – Harlaston Bridge
Unit 2: Harlaston Bridge – Netherseal
Unit 3: Netherseal – Snarestone
Unit 4: Snarestone – Packington (Gilwiskaw Brook)

### Map 1: River Mease SSSI/SAC extent and management units




## Geology and topography

The river flows predominantly westwards across a largely rural and agricultural landscape to its confluence with the River Trent at Croxall. The geology of the catchment comprises sandstone and mudstone, which give rise to a reddish clay soil with occasional areas of sandier soils. The catchment has a relatively low topography (130m above sea level). The clay rich soil and low relief mean the river is a lowland, passively meandering river. The Gilwiskaw Brook is steeper than the River Mease, which results in a slightly different character, in-channel features and vegetation, which adds to the diversity of the SSSI/SAC (see Section 3).

## Channel changes and past practices

The channel course has not changed significantly over recent time, as the river is a relatively low energy river, generally with cohesive banks, so reducing any excessive erosion. Historic changes include mills, with their associated weirs and leats (Clifton, Harlaston and Croxall Mills) and the localised impacts of straightening and realignment due to mineral extraction, land drainage and infrastructure developments. Records and accounts of Severn Trent Water describing their river maintenance programme (held in the British Library) indicate that Gilwiskaw Brook underwent a comprehensive 'channel improvement scheme' during the 1980s. These also indicate that a 'comprehensive arterial drainage scheme', possibly involving over-deepening to allow for land drains to be installed and operational, was undertaken on the River Mease between Measham and the confluence with the River Trent in the mid 1980s. Since then, little or no channel maintenance has been carried out, so the river has started to recover, re-establishing more natural river processes and morphological features and habitats. Since the SSSI/SAC designation in 2000, only works considered to improve the habitats have been undertaken on the River Mease (e.g. weir removal at Harlaston; Himalayan Balsam eradication).

## Hydrology

The hydrology of the River Mease is characterised by pronounced variations between low and high flows. The flow is primarily determined by rainfall, which is a function of the local and regional climate regime, which changes over time. Climate change is likely to lead to increases in extreme rainfall and therefore flow events. A range of factors influence the rate at which rainfall induced runoff reaches the river, including topography, geology (interception by aquifers), soils (infiltration rates), urban and road runoff. The hydrology is also influenced by discharges from industry, small sewage treatment works and rising mine water (Natural England and Environment Agency, 2010).

## Ecology

The River Mease has reaches of both poor and good fish populations. The patchy distribution of fish reflects their mobile nature, seasonality, habitat preferences and sensitivity to poor water quality. The Environment Agency has been surveying fish populations since 2002 in several locations along the River Mease. Chub and roach are the two most common fish, with dace, pike, perch and gudgeon also evident. Since 2007 there appears to have been an overall decline in fish numbers, but this coincides with the time the Environment Agency ceased stocking the river. There have also been several pollution incidents on the River Mease over the past decade. In February 2010, Natural England commissioned a fish survey which concluded that both spined loach and bullhead populations failed to achieve favourable condition in at least two of the SSSI/SAC units in terms of population size, and in all units in terms of population structure (where the distribution in the ages of fish shows a healthy population).

Native white clawed crayfish currently appear to be absent from the SSSI/SAC, other than at the confluence, where very low numbers were recorded. A spot survey undertaken by the Environment Agency and Staffordshire Wildlife Trust in June 2011 recorded a dominant population of American Signal Crayfish here (likely to have come from the adjacent fishing pool on the Catton Estate). As a result the native white clawed crayfish population is deemed to be failing the targets associated with favourable condition.

In terms of habitat requirements (river bed conditions), spined loach require fine substrate comprising at least 20% sand and no more than 40% silt, and bullhead require a clean coarse (gravel) bed with no excessive siltation (maximum of 20% in the upper 10cm of mid-channel gravels) (Natural England and Environment Agency, 2010). Adult crayfish utilise tree roots and rocks in the banks to provide shelter, whilst juveniles shelter in vegetation and grass growing out of the riverbanks.

Along the River Mease, stands of marginal vegetation are typically dominated by common club-rush (*Schoenoplectus lacustris*), reed sweet-grass (*Glyceria maxima*), reed canary-grass (*Phalaris arundinacea*), branched bur-reed (*Sparganium erectum*), greater pond-sedge (*Carex riparia*) and bulrush (*Typha latifolia*). Submerged aquatic vegetation is more varied along the lower reaches of the river and includes river water-crowfoot (*Ranunculus fluitans*), common water-crowfoot (*Ranunculus aquatilis*), blunt-leaved pondweed (*Potamogeton obtusifolius*), fennel pondweed (*Potamogeton pectinatus*), arrowhead (*Sagittaria sagittifolia*) and yellow water-lily (*Nuphar lutea*) (Scott Wilson, 2010).

Bankside tree cover varies, but they are a vital feature of a fully functioning river corridor and channel, as submerged root systems provide important in-channel cover for fish, crayfish and aquatic insects. Fallen trees are an important source of in-channel woody debris which plays an important role in helping previously modified parts of the river recover lost variation in physical habitat. Shading by trees also influences water temperatures which is important for fish.

The Gilwiskaw Brook is steeper than the River Mease and the flow velocities in the brook are higher. As a result the bed sediments are coarse, aquatic vegetation is sparse and marginal vegetation is restricted to stands of floating sweet-grass (*Glyceria fluitans*). This marginal vegetation and coarse substrate provide valuable habitat for bullhead.

## Pressures and impacts

### *Condition assessment*

A condition assessment of the SSSI/SAC, conducted during 2009, has shown that there are stretches of river that are in unfavourable condition and particular attributes that are not achieving the conservation objectives (Table 1) (Scott Wilson, 2010). Many of these reasons for unfavourable condition are also reflected in risks to achieving WFD objectives. Gilwiskaw Brook is currently considered to have poor ecological status, and the River Mease within the SSSI/SAC extent is achieving moderate ecological status. Any elements that are necessary to achieve the SSSI/SAC conservation objectives should be improved to enable these objectives to be achieved by December 2015 and all elements should be improved to enable GES to be achieved by December 2027.

**Table 1: Results of recent condition assessment undertaken along the River Mease SSSI/SAC**

| Unit | Condition (HD and WFD) | Reasons for adverse condition | Assessment comment |
|---|---|---|---|
| 1 | Unfavourable; poor ecological status | Drainage; inappropriate weirs, dams and other structures; invasive freshwater species; siltation; water abstraction, water pollution - agriculture/run off; water pollution - discharge | The River Mease fails on the following targets: biological GQA phosphorus - due to point source and diffuse pollution; physical modifications - over dredging, weirs, other impoundments; non native species; lack of river bank vegetation; lack of macrophyte species abundance and composition; over abstraction - lack of freshwater entering the river; density of the designated fish species |
| 2 | Unfavourable; moderate ecological status | | |
| 3 | Unfavourable; moderate ecological status | | |
| 4 | Unfavourable; moderate ecological status | | |

*Field survey*

The condition assessment (summarised in Table 1) was undertaken at four representative locations along the river. To gain a more complete picture of the condition of the physical structure (geomorphology) of the channel, a walkover survey of the full length of the SSSI/SAC in a downstream direction was undertaken during November 2011. This followed an ecological survey (APEM, 2010b) and a walkover survey conducted between October 2007 and June 2008 by Environment Agency Biodiversity staff Kathryn Edwards and Chris Farmer (Fradley Area Office, Lichfield). To assess the need for channel restoration, the condition of the river channel as recorded during the field survey was compared to the characteristics of the river channel that might be expected with limited human impact (Table 2). The river is regarded as being a relatively unmodified example of a lowland river (JNCC Type II) but nevertheless is affected by physical habitat modifications.

**Table 2: The characteristics of natural lowland rivers (based on Mainstone, 2007)**

| Feature | Description | Ecological significance |
|---|---|---|
| Bed | Sands and silts with gravel accumulating at riffles (with the amount of gravel depending on the supply of gravel and the energy of the river). | River bed gravels provide an essential, but relatively scarce, habitat for a wide variety of species including caddis-flies, riffle-beetles and mayflies, and fish such as dace, bullheads, stone-loach, brook lamprey, minnow and stickleback.<br>Gravels and faster flows also provide rooting opportunities for species such as water-crowfoot. |
| Flow types | Dominated by glides and occasional pools with coarse sections creating localised riffles. Occasional log jams (coarse woody debris) creating ponded sections. | Creates habitat variability.<br>Woody debris attracts decomposer species.<br>In ponded sections and backwaters with finer bed sediments, a flora and fauna more associated with stillwaters develops, including unionid mussels and pea-mussels, libellulid dragonflies, agrionid damselflies, burrowing mayflies, water-snails, alder-flies, and various families of caddis-fly.<br>Where flows are stronger fish species may include perch, roach and eel, with chub and gudgeon. |
| Planform and banks | Extensive meandering which, depending on natural sediment supply and hydraulic energy, generates sequences of alternating steep and shallow bank profiles together with point bars on the inside of bends. | On shallow banksides (particularly the insides of meander bends), a significant zone of hydrological transition can be expected, with beds of emergent species such as branched bur-reed and reed canary-grass, and wetland species such as brook-lime, water forget-me-not, water-mint, and water-cress.<br>Vertical cliffs provide nesting opportunities for kingfisher and sand martins, as well as for burrowing bees and wasps and a range of other insects specialising in bare soils. Water voles thrive in banksides of intermediate slopes with tall herb vegetation and an active marginal zone of emergent plants.<br>The insect fauna is heavily dependent on an active marginal and wetland fringe of vegetation for hatching, resting, feeding and mating, and as a flow refuge under spate conditions. |
| Riparian zone | Near continuous lining of the channel by riparian trees. | Submerged exposed root systems that provide in-channel habitat for fish and invertebrates such as white-clawed crayfish, potential holt and resting sites for otters.<br>Trees are a source of woody debris and leaf litter for the |

| | | |
|---|---|---|
| | | river.<br>Tree lining creates variations in within-channel light and temperature regimes that add further habitat diversity.<br>Riparian scrub provides additional important habitat for otter and bird species such as warblers. |

### *Key findings*

The field results revealed that the channel of the River Mease SSSI/SAC varies along its length and displays many of the features which would be expected under natural conditions. However the entire SSSI/SAC has been impacted to varying degrees by human activities. Despite this, some reaches of the river channel have adjusted and recovered following disturbance and now exhibit good morphology (physical function and form) and associated habitat diversity. The overall picture is varied; some reaches exhibit good morphology close to that which might be expected under natural circumstances, whilst other reaches are severely degraded and relative devoid of the typical features expected. The majority of the river channel shows some degree of human impact (pressures) which need to be addressed to restore more natural geomorphological and ecological conditions as described in Table 2.

Pressures on the river caused by human activities affect in a number of ways:

Riparian zone:

- Degraded riparian vegetation
- Lack of trees

Banks:

- Degraded bank vegetation
- Accelerated bank erosion (e.g. poaching of the banks by livestock)
- Lack of morphological diversity due to channel re-sectioning, dredging and removal of fallen trees (non-willow)

Bed:

- Lack of morphological diversity due to channel re-sectioning

Planform:

- Lack of morphological diversity due to straightening and re-sectioning (large scale)

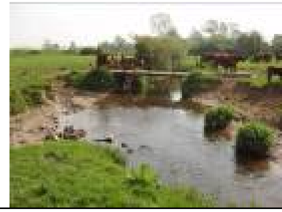
Flow (pattern and velocity):

- Over-deepened (lack of floodplain connectivity)
- In-formal embankments (lack of floodplain connectivity)
- Impounded flows (weirs)
- Limited variety in flow velocity/depth (lack of woody debris in the channel)

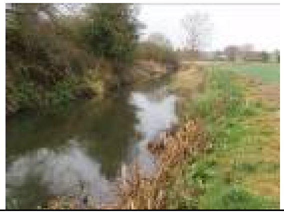
Further details are provided in Table 3.

The distribution of these impacts are summarised in Table 4. The significance of these impacts varies within the reaches; in some cases they were relatively localised (e.g. embankments), whereas in other cases they were very extensive (degraded riparian vegetation). Significantly, in a number of cases, the river was found to be adjusting and recovering from past channel engineering (re-sectioning and deepening) towards a more natural morphology as indicated in Table 4.

## Table 3: Pressures caused by human activity and their impact on the River Mease SSSI/SAC

| Feature | Description of impact | Consequences | Example |
|---|---|---|---|
| **Riparian zone** | **Degraded riparian vegetation**<br>Change in the type of terrestrial vegetation along the river corridor away from that characteristic of the river type, due to land use. This may include complete removal due to ploughing or reduction in variety and density of vegetation due to grazing by livestock. | Increases the amount of surface runoff reaching the channel which may supply high loads of fine sediment or dissolved nutrients.<br>Increases the vulnerability of the river corridor to suffer erosion (soil loss) during floods where the ground is bare.<br>Makes the banks more vulnerable to erosion (e.g. lack of roots binding the banks). |  |
| | **Lack of trees**<br>Some sections of river, which may (or may not) have generally good riparian vegetation cover due to low land use pressures lack trees due to earlier removal. | May make the banks more vulnerable to erosion (e.g. lack of roots binding the banks).<br>Lack of a supply of woody debris which would, if present, vary flow and sediment deposition patterns and associated habitat benefits.<br>Lack of channel shading increases summer water temperatures.<br>Lack of cover for fish and otter. |  |
| **Banks** | **Degraded bank face vegetation**<br>Change in the type of bank face vegetation along the river corridor away from that characteristic of the river type, due to land use or channel modification. This may include damage by livestock or modifications such as steepening the banks. | Reduces the habitat variability along the banks.<br>Lack of cover for fish and otter.<br>Makes the banks more vulnerable to erosion and good vegetation cover protects and binds (e.g. roots) bank sediments reducing their vulnerability to entrainment by river flow (see below). |  |
| | **Accelerated bank erosion**<br>Increase in bank erosion due to land use or channel modification. This may include damage by livestock or modifications such as steepening the banks. | Higher rates of bank erosion occur than would be characteristic of the river type increases the supply of sediment to the channel. Can lead to increased siltation downstream. |  |
| | **Lack of morphological diversity due to re-sectioning or engineered structure**<br>Reduction in the degree in variation of the bank slope, often leading to very uniform bank face profiles, close to vertical. | Reduces the habitat variability along the banks.<br>Lack of cover for fish.<br>Lack of transitional habitats suitable for macrophytes. |  |

| Feature | Description of impact | Consequences | Example |
|---|---|---|---|
| **Bed** | **Lack of morphological diversity due to channel re-sectioning**<br>Channel deepening (dredging) and re-shaping associated with re-sectioning to improve water conveyance and land drainage can lead to a uniform bed topography with little variation in composition (sediment type). | Reduces the range of habitats which would be expected to be characteristic of the river type such as those associated with different water depths and flow velocities (see Table 2). For example, shallow areas typical of gravel riffles are often damaged or removed by dredging.<br>Often creates long slow glides where the channel becomes choked by emergent vegetation.<br>Higher flows in trapezoidal channels are particularly hostile to fish (especially fry) and invertebrates, causing loss or fragmentation of localised populations, especially where refuges are missing (fallen trees and backwater features). |  |
| **Planform** | **Lack of morphological diversity due to straightening and re-sectioning (large scale)**<br>The realignment of the river channel into a straighter course is often associated with land use or attempts to improve flow conveyance. | Reduces the variation in flow patterns associated with sinuous channels such as fast and slow areas and secondary circulations. This reduces the range of habitats associated with different flow velocities (see Table 2).<br>Straight channels also tend to have uniform bank profiles as flow is generally parallel to the bank and this limits the occurrence of variations associated with local areas of scour/erosion.<br>Higher flows in trapezoidal channels are particularly hostile to fish (especially fry) and invertebrates, causing loss or fragmentation of localised populations, especially where refuges are missing (fallen trees and backwater features). |  |
| **Flow** | **Uniformity of flow type**<br>Channel modification re-sectioning. Channel deepening (dredging), re-shaping and the removal of woody debris to improve water conveyance and land drainage can lead to a uniform flow. | Lack of habitat variability, sedimentation increasing sedimentation which increases channel vegetation causing choking during summer low flows and poor oxygenation. |  |
| | **Over-deepened channel (lack of floodplain connectivity)**<br>Channel deepening (dredging) to improve land can increase the amount of water that can be contained in the channel before the floodplain is inundated. | The increase in the capacity of the channel to contain water can (but not always) lead to higher flow velocities than would be characteristic of the river type and can increase the risk of excessive erosion.<br>Reduction in the occurrence of floodplain inundation means that fine sediment, which would otherwise be deposited in the floodplain, is deposited within the channel, this can increase siltation.<br>Higher flows in trapezoidal channels are particularly hostile to fish (especially fry) and invertebrates, causing loss or fragmentation of localised populations, especially where refuges |  |

| Feature | Description of impact | Consequences | Example |
| --- | --- | --- | --- |
| | | are missing (fallen trees and backwater features). | |
| | **In-formal (often low) embankments (lack of floodplain connectivity)**<br>Creating embankments along the river bank tops can increase the amount of water that can be contained in the channel before the floodplain is inundated. | Reduction in the occurrence of floodplain inundation means that fine sediment, which would otherwise be deposited in the floodplain, is deposited within the channel, this can increase siltation.<br>Embankments may be subject to sudden breaches, which can cause erosion of the land surface on the floodplain beyond.<br>If embankments are over-topped flow can become trapped behind the embankments and increase the duration of floodplain inundation.<br>This leads to reductions in the effectiveness of sediment transfer thus increasing sedimentation, increased channel vegetation causing choking during summer low flows and poor oxygenation. |  |
| | **Impounded flows**<br>Weirs impound the river and increase water levels upstream (to the level of the weir crest) which may cause ponding for some distance upstream where the channel gradient is low. | Reduces the variation in flow depth and velocity leading to long slow deep glides. This reduces the range of habitats associated with different flow velocities and water depths (see Table 2). |  |

## Table 4: Key pressures recorded during the field survey along the River Mease SSSI/SAC

| SSSI unit | Reach | Key issues | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Riparian | | Banks | | | Bed | Planform | Flow | | |
| | | Degraded riparian vegetation | Lack of trees | Degraded bank face vegetation | Accelerated bank erosion (e.g. poaching) | Lack of morphological diversity due to re-sectioning or structures | Lack of morphological diversity due to re-sectioning | Lack of morphological diversity due to straightening (large scale) | Over-deepened (lack of floodplain connectivity) | Embanked (lack of floodplain connectivity) | Impounded flows |
| 4 | GIL001 | ✓[A] | - | - | - | - | ✓[EA] | ✓[E] | ✓[E,A] | - | ✓[L] |
| | GIL002 | ✓ | ✓ | ✓ | ✓ | ✓[A] | ✓[A] | ✓[A] | - | - | - |
| | GIL003 | ✓[E] | ✓[E] | ✓ | ✓[L] | ✓ | ✓[A] | ✓[A] | ✓[E] | - | - |
| | GIL004 | ✓[E] | ✓[E] | - | ✓[L] | ✓ | ✓[A] | ✓[E] | ✓[E] | - | - |
| | GIL005 | ✓ | - | - | ✓[L] | ✓[A] | ✓[A] | ✓[E] | ✓[E] | - | ✓[L] |
| | GIL006 | ✓ | ✓ | ✓ | ✓[L] | ✓ | ✓[A] | ✓[E] | ✓[E] | ✓ | - |
| | GIL007 | ✓ | ✓ | - | ✓[L] | - | - | - | - | - | - |
| 3 | MEA001 | ✓[E] | - | - | - | ✓[A] | ✓[A] | - | - | - | - |
| | MEA002 | ✓[E] | ✓[E] | ✓ | ✓ | ✓[A] | ✓[A] | - | - | - | - |
| | MEA003 | ✓[E] | ✓ | - | - | ✓ | ✓ | ✓[E] | - | - | - |
| | MEA004 | ✓[E] | ✓ | - | ✓ | ✓ | ✓[A] | - | ✓ | - | - |
| | MEA005 | ✓[E] | ✓[E] | ✓ | ✓[L] | ✓[E] | ✓[E] | ✓[E] | ✓[E] | - | - |
| | MEA006 | ✓[A] | ✓[A] | ✓[A] | - | ✓[A] | ✓ | ✓[E] | ✓[E] | - | - |
| | MEA007 | ✓[E] | ✓[E] | ✓ | ✓ | ✓ | ✓[A] | - | ✓[E] | - | ✓[L] |
| 2 | MEA008 | ✓[E] | ✓ | - | ✓ | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA009 | ✓ | ✓ | - | ✓[L] | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA010 | ✓[E] | ✓[E] | - | - | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA011 | ✓[E] | ✓[E] | - | - | ✓[E] | ✓[E] | ✓[E] | - | - | - |
| | MEA012 | ✓ | - | - | - | ✓[A] | ✓[A] | - | - | - | - |
| | MEA013 | ✓[E] | ✓[E] | - | - | ✓ | ✓ | - | ✓[A] | - | ✓ |
| | MEA014 | ✓[A] | - | - | ✓[L] | ✓[A] | ✓[A] | - | ✓[A] | - | ✓[L A] |
| | MEA015 | ✓[A] | - | - | ✓[L] | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA016 | ✓[E] | ✓[E] | - | - | ✓[A] | ✓ | - | ✓[A] | - | - |
| | MEA017 | ✓ | ✓ | - | - | ✓[A] | ✓[A] | - | - | - | - |

| SSSI unit | Reach | Key issues | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Riparian** | | **Banks** | | | **Bed** | **Planform** | **Flow** | | |
| | | Degraded riparian vegetation | Lack of trees | Degraded bank face vegetation | Accelerated bank erosion (e.g. poaching) | Lack of morphological diversity due to re-sectioning or structures | Lack of morphological diversity due to re-sectioning | Lack of morphological diversity due to straightening (large scale) | Over-deepened (lack of floodplain connectivity) | Embanked (lack of floodplain connectivity) | Impounded flows |
| 1 | MEA018 | ✓ | - | - | - | - | - | - | - | - | - |
| | MEA019 | ✓[E] | ✓[E] | - | - | ✓[A] | ✓[A] | ✓[L] | ✓[L] | - | - |
| | MEA020 | ✓ | - | - | - | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA021 | ✓[E] | ✓[E] | ✓[L] | ✓[L] | ✓[A] | ✓ | - | ✓[A] | - | - |
| | MEA022 | ✓[A] | ✓[L] | - | - | - | - | - | - | - | - |
| | MEA023 | ✓ | ✓ | - | - | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA024 | ✓[E] | ✓ | - | - | ✓[A] | ✓[A] | - | ✓[A] | - | - |
| | MEA025 | ✓[A] | - | ✓[L] | - | ✓[A] | ✓[A] | ✓[A] | ✓[A] | - | - |

Key to symbols:

- \- Not a morphological pressure*
- ✓ Present
- ✓[L] Localised (<10%)
- ✓[E] Extensive (>60%)
- ✓[A] Adjusting toward a more natural morphology

*The pressures summarised in the table above refer to those which have an adverse impact on the geomorphology and therefore provision of associated habitat for typical habitats and species of the River Mease SSSI/SAC. In some instances a pressure may be present (e.g. degraded riparian vegetation) but not impacting adversely on the geomorphology of the channel, in these situations the pressure is not recorded in the table.

# Section 3 **Potential solutions**

## Selecting restoration solutions

The pressures identified along the Gilwiskaw Brook and River Mease (Tables 3 and 4) which are contributing to the unfavourable status of the SSSI/SAC reflect the impact of land use on the river. The River Mease SSSI/SAC is situated in a section of the catchment which is dominated by a mixture of arable and grazed land. The floodplain is used for both growing crops and grazing livestock. In order to maximise the productivity of this land, the floodplain has been subject to land improvement over time including:

- Woodland clearance.
- Land drainage.
- Deepening and straightening of tributary streams.
- Deepening, and localised straightening, of the River Mease and Gilwiskaw Brook so they act like arterial drains.

The floodplain is now highly managed and intensively farmed along much of its length. River channels and their surrounding floodplains are linked systems and changes to the floodplain have had a range of impacts on the river channel. However, the number and types of impacts varies spatially. The most extensive pressures are those which affect the quality of the vegetation in the riparian zone and also the bank face (Table 3 and 4).

The second most prevalent pressure is channel engineering to improve land drainage (re-sectioning, deepening and straightening) which affects the banks, bed, planform and flow (Table 3) and as a result the abundance of aquatic fauna and flora. Significantly however, it is more than two decades since widespread channel modification for this purpose was undertaken (arterial drainage works were conducted during the 1980s). Over the last 20 years, the channel has begun to adjust, recovering to a more natural condition in response to the lack of continued maintenance. This adjustment has involved:

- Natural narrowing of the channel through the deposition of sediment along the channel margins, often enhanced by vegetation colonisation.
- Accumulation of sediment on the bed of the channel, reducing the degree of over-deepening.
- Formation of new riffles through localised accumulation of coarse sediment.
- Increased flow and habitat variability associated with the accumulation of woody debris (which would previously have been removed).

This adjustment towards a channel morphology typical of this river type (see Figure 1 for examples) is significant and demonstrates that the river is capable of recovering without intervention in some places, and secondly it provides an indication as to the type of restoration actions which are likely be successful.

**Figure 1: Adjustment by (a) natural narrowing, (b) deposition on the bed and (c) riffle development**

a b c

In order to deliver **optimal** river channel processes and form, it would be necessary to both improve the morphology of the river channel and also address the impact of land use pressures on the floodplain. Ideally this would involve ending the drainage of the floodplain on the outer boundary and establishing a mosaic of wet grassland and wet woodland habitats on the entire floodplain. This would not preclude the use of the floodplain for agriculture, as grazing of this new habitat would be desirable to help maintain different habitats, however it would be a significant shift from the current farming systems. The floodplain would still be managed, but managed in a way that would deliver optimal conditions for the SSSI/SAC. There are some locations along the SSSI/SAC which provide examples of the range of habitat we would ideally like to encourage (Figure 2).

**Figure 2: Examples of optimal floodplain habitats (a) wet woodland along Gilwiskaw Brook (GIL005), (b) wet grassland with open channel margin (MEA011) and (c) wet grassland with tree lined channel (MEA014).**

a b c

Full restoration of the floodplain is a long-term aspiration. However, the floodplain is regarded as an important part of the existing farmed landscape, containing productive agricultural land. As such, widespread land use change is unlikely to be feasible in the short or even medium-term. In recognition of this, when selecting river restoration solutions, emphasis has been placed on the identification of measures that would bring improvements to the river channel through channel restoration and/or improvements to the river corridor. Such measures, which could be implemented more easily would address the pressures affecting the riparian and bank vegetation (Table 3) and those affecting the morphology of the channel (banks and bed), which have consequences for flow (Table 4).

In the absence of wider reductions in land use pressures, restoration of the river corridor (the riparian zone), would be a key aspect of the restoration plan. Although a compromise, restoring the riparian zone would bring multiple benefits by providing:

- A buffer separating agricultural land from the river channel which can filter diffuse pollution from runoff and remove dissolved nutrients from water moving through subsurface.
- A source of woody debris to the channel.
- Cover, shelter and shade for both mammals, fish and crayfish.

The ideal, best practice, width of the riparian zone would be between 12 and 24 metres. However, this is a guide and we recognise there will be a need for **flexibility** as to the extent of the riparian zone that can be restored. The degree to which the riparian zone can be restored will therefore vary along the river. Similarly the actual type of restoration will also vary, this is considered further later in this section.

## Creating a restoration vision

Combining knowledge about the general characteristics of lowland rivers (Table 3) with observations made regarding the geomorphological and ecological characteristics that are emerging through adjustment towards a more natural morphology, allows a vision for restoration of the Mease SSSI/SAC to be produced. This gives a blueprint on which to base site specific restoration activities.

## Our vision for the River Mease and Gilwiskaw Brook SSSI/SAC

**Our objective** is to improve the physical function and form of the River Mease and Gilwiskaw Brook by identifying and implementing measures that will address past modifications to the river environment. To do this we have surveyed the SSSI to identify everything that is good and bad about the rivers physical function and form, and associated habitats. This, together with expert judgment based on a scientific understanding of has enabled us to create **visions** which illustrate how we hope the River Mease and Gilwiskaw Brook will look and behave, and the typical ecology they will support after the restoration work has been implemented. These visions are the basis for developing restoration proposals for the sections of river that are currently degraded.

### *River Mease*

**Overview**

The River Mease is a passively meandering lowland river, which means the channel does not change its position over time (migrate). Passively meandering rivers have a varied bed morphology with alternating shallow (riffles and runs) and deep sections (pools and glides). These features do not change appreciably over time, and their position does not necessarily match the planform of the river (as is the case with an actively meandering river). The river is like this naturally because of its low gradient (low energy) and because it has relatively high, fine grained cohesive banks which are relatively resistant to erosion by flow.

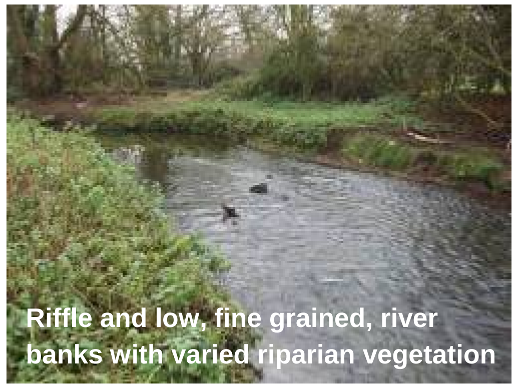
**Key characteristics**

**Variable flows** – the flow of the River Mease, like all rivers, fluctuates over time. This means there are contrasts between periods of low or base flow and times when the river is in flood and inundates the surrounding floodplain. Floodplain inundation is a natural and important part of the functioning of the river.


Meandering section viewed from the air

**Planform** – the river has a meandering planform except where it has been modified by straightening.

**Diverse bed and flow types** – alternating between shallow fast flowing sections (riffles and runs) with turbulent flow where the bed is composed of gravel, pebbles and cobbles, and deep slow flowing sections (pools and glides) where the bed is covered by a layer of soft, fine grained sediments (sand and some silt). In lowland rivers, deeper sections are more extensive than shallow areas, due to the low channel gradient.


Riffle and low, fine grained, river banks with varied riparian vegetation

**Varied bank profiles** with areas of steep banks where the channel is straight or around the outside of bends, to gentle banks on the inside of bends. Bank heights are variable but should be relatively low (¼ or less of the channel width), however naturally high banks can also occur.

**Bank materials** are generally composed of relatively fine grained. cohesive sediment (clay, silt and fine sand). These banks have built-up over time as successive floods have deposited sediment onto the floodplain.

**Bank and riparian vegetation** comprising a mosaic of different habitats and vegetation from grass to mature trees. Trees are important as their root systems exposed in the river banks provide cover for fish and otter, and fallen branches provide a source of coarse woody debris which creates variation in flow, particularly areas of slack water, and bed composition.

**In-channel vegetation** including reeds and rushes along the margins, where the channel is relatively deep and the flow slow and water-crowfoot where flow is shallow and fast.


Good riparian vegetation cover and marginal in-channel vegetation

### *Gilwiskaw Brook*

**Overview**

The Gilwiskaw Brook is a lowland river which has been extensively modified (at some point prior to the late nineteenth century), by mineral extraction and land drainage activities, to such an extent that it has a predominantly straight planform. Under more natural conditions the Gilwiskaw Brook would have a sinuous or meandering planform and be similar in form to (although smaller than) the River Mease. The Gilwiskaw Brook is steeper than the River Mease, partly due to straightening, and this means that it has a higher flow energy. The Gilwiskaw Brook is therefore more geomorphologically active than the River Mease, which enables the channel to recover (where it is not constrained by stone bank reinforcing) towards a more typical diverse morphology.

**Key characteristics**

**Variable flows** – the Gilwiskaw Brook also has a varied flow regime ranging from low flows to periods of flooding. During floods flow velocities can be high.


Meander with varied bank forms

**Planform** – despite the extensive nature of past channel straightening there is a short section towards the lower end of the watercourse where the channel is meandering. Elsewhere channel recovery (adjustment) is leading to the development of a sinuous channel.

**Diverse bed and flow types** – the relatively high gradient of the Gilwiskaw Brook creates enough flow energy to allow the development of a varied bed alternating between shallow fast flowing sections (riffles) with turbulent flow where the bed is composed of gravel, pebbles and cobbles and deep flow flowing sections (pools and glides) where the bed is covered by a layer of soft, fine grained sediments (sand and some silt). Exposed gravel and cobble deposits occur at bends in the channel.


Sinuous channel with riffles and gravel bars

**Varied bank profiles** would be expected under natural circumstances but these are currently restricted to those areas where a sinuous planform has developed. Typically the banks of the channel are high; however sections where adjustment has occurred where the banks are lower.

**Bank materials** are generally composed of relatively fine grained sediment (clay, silt and fine sand). In some areas a layer of gravel and pebbles occurs at the base of the bank. This represents incision (bed lowering) of the channel through old river bed sediments.

**Bank and riparian vegetation** comprising a mosaic of different habitats and vegetation from grass to mature trees. Trees are important as their root systems exposed in the river banks provide cover for fish and otter, and fallen trees and branches provide a source of woody debris which creates variation in flow, particularly areas of slack water.

**In-channel vegetation** is relatively scarce; this reflects the relatively fast flowing nature of Gilwiskaw Brook.


Diverse riparian vegetation and coarse woody debris

## Types of restoration

To restore the river channel to the condition described in the restoration visions, a series of restoration measures are suggested. These fall into two categories: rehabilitation and restoration. Rehabilitation measures broadly involve riparian and floodplain management, while the restoration measures mostly comprise in-channel works such as bank re-profiling and bed level raising. Some reaches already exhibit the typical characteristics expected for this type of river, therefore conservation is the main objective. Individual plans have not been prepared for these reaches, but they should still be considered as part of the wider vision, especially for linking riparian woodland areas together. No enhancement or restoration actions will be undertaken without consultation and agreement with the appropriate landowners and other relevant stakeholders. Maps 2a and 2b show the reaches categorised by restoration measure.

**Conserve and enhance** those reaches where the river character is already consistent with good morphology and ecology.

**Rehabilitate** degraded riparian zones to minimise runoff and fine sediment supply to the river and provide an improved wildlife corridor.

**Restore** the channel, for example by removing weirs, altering the cross section, raising the bed level and enhancing the riparian zone to improve its morphology and habitat diversity.

*Conserve and enhance*

Ten sections (reaches) of the River Mease exhibit good channel morphology (Table 5, Map 2a and 2b). These reaches broadly fall into two categories:

1. Reaches where either no pressures adversely affect the channel form (bed or banks) or the flow of water within the channel, and
2. Reaches previously impacted by pressures such as channel engineering that have since undergone adjustment, recovering towards a more natural form.

Typically these reaches show less degradation of the riparian zone than other sections of the SSSI. Despite this it would be beneficial to seek opportunities to enhance the condition of the riparian zone in these sections. Specific actions are described in Section 4.

*Rehabilitate*

Five reaches within the SSSI/SAC show evidence of active adjustment of the channel morphology towards a more natural form, following past modification such as channel deepening (Table 5; Map 2a and 2b). However, in many cases pressures affecting the riparian zone are preventing the channel from fully recovering. Typically natural riparian vegetation is sparse or absent in these areas. Improving the condition of the riparian zone will allow further channel adjustment to occur with additional benefits such as reduced rates of bank erosion and increased supply of coarse woody debris to the channel.

*Restore*

Seventeen reaches that have been degraded by pressures affecting both the riparian zone and the channel are not adjusting towards a more typical form (Table 5, Map 2a and 2b). These sections require both enhancements to the riparian zone and channel restoration measures if the morphology of the channel is to be improved.

*Descriptions of the restoration measures*

The following pages describe the range of measures that could be implemented to enhance or restore the morphology of the SSSI/SAC so that the channel morphology is consistent with favourable condition.

## Riparian zone management

**Category: Rehabilitate**

**Sub-options:**

E1 – Fill gaps in existing riparian zone

E2 – Improve riparian vegetation parallel to river

E3 – Create riparian corridor along river

**Description of actions:**

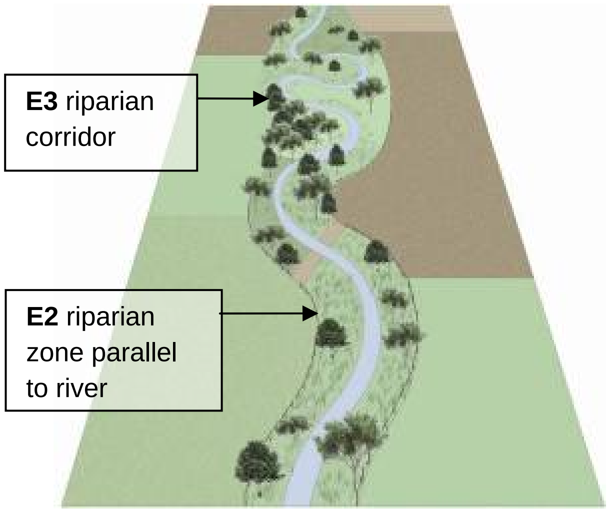
Riparian zone management can involve a range of actions that allow a **mosaic of different habitats** to develop along the river.

The intention is **not** to create an entirely wooded corridor but to create a more varied corridor where land use pressure is reduced.

Actions **could** include **combinations** of the following:

- Providing a strip of species rich grassland parallel to the channel which is cut periodically;
- Creating areas of species rich grassland in between meanders to create a riparian corridor;
- Planting of suitable species along banks parallel to the channel where the river is straighter;
- Planting clumps of vegetation between meanders to create a wider corridor of vegetation;
- Fencing areas of river bank (ideally 12m behind the bank top, this is a guideline) to reduce livestock access and allow existing vegetation to fully establish (appropriate management of vegetation within fence line would be required);
- Allowing periodic summer grazing by livestock to reduce undesirable species and prevent over-shading. Light grazing with appropriate stocking levels at the right time of the year, possibly controlled by temporary electric fencing, can improve vegetation structure and niche habitat structure. Any planted trees would need protection until mature;
- If grazing is not possible, alternative forms of vegetation management could be undertaken such as rotational mowing, occasional thinning out, pollarding or coppicing of trees.

**Illustration:**




**Riparian corridor of native mixed trees and shorter vegetation - parallel to straighter channel (foreground) or creating a corridor along meandering sections (in distance)**

**Potential benefits:**

- Helps concentrate any siltation along the channel margins and in areas of slow flow such as pools and backwaters;
- Improves water quality by acting as a filtration system for run-off (e.g. phosphorus) and restricting access of livestock to the bank and river channel;
- Creation of a source of woody debris to provide morphological diversity through small-scale erosion and sediment deposition in the channel, creating a variety of habitat niches for various aquatic species;
- Bank-side vegetation creates diversity in shading and cover- important for juvenile fish;
- Bank side trees regulate water temperature, this may offer a significant benefit in future by off-setting the impact of climate change;
- Reduced rates of bank erosion due to the increase in vegetation cover;

Bank-side trees and dense vegetation can provide habitat for otters and bats.

**Examples:**

Example of a good existing riparian zone with mixed vegetation creating areas of cover and shade along the River Mease near Edingale:

Example of a good corridor of riparian vegetation (viewed from the air) upstream form Netherseal. Note that the corridor contains a range of different vegetation types and densities and also varies in width.

Note how this contrasts with an area of more intensive land use right up to the river bank:

**Potential constraints**

Creating a riparian corridor will require a change in land management, it will therefore be necessary to provide appropriate incentives and funding (see Section 5);

There would need to be flexibility in the width of the riparian zone created to allow for site specific conditions and constraints.

Riparian improvements to be undertaken after any in-channel restoration work such as bank re-profiling.

## Woody debris

**Category: Restore**

**Sub-options:**

R1 – Introduction of woody debris

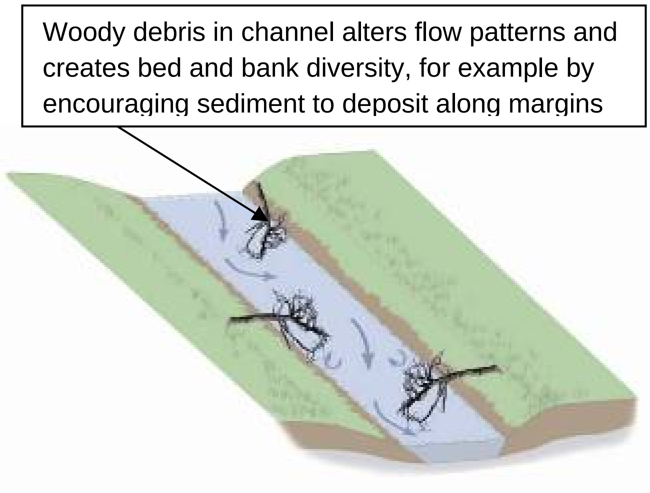
**Description:**

- Woody debris is a natural feature of rivers where adjacent trees or branches fall into the channel, and provides a variety of important ecological and small-scale geomorphological functions;
- Woody debris can include whole trees, branches or limbs, twigs and leaf litter;
- Woody debris could be introduced to areas of straightened, widened or deepened channels to create physical habitat variation;
- Fallen trees should be left in place where possible (anchored if in a flood risk zone or near infrastructure);
- Woody debris can be either installed in the bank to remain in place, or introduced less formally to 'find its own place'.

**Potential benefits:**

- Creation of in-channel sinuosity and habitat niches but unlikely to cause significant erosion in a low energy system;
- Provides small-scale variations in flow velocity providing slower areas of flow and small pools that accumulate finer sediments and act as fish refuges and nursery sites, spawning habitat for bullhead;
- Creates areas of cover and shading that can reduce predation of fish, but also provide foraging sites for terrestrial species such as otter;
- Valuable invertebrate and algae habitats, creating food sources for fish, helping to sustain aquatic/terrestrial food chain;
- Helps regulate sediment transfer and water quality by temporary trapping of mobile silts, reducing siltation of shallower gravels/riffles and turbidity;
- Introduced river gravels with woody debris improves bed structure, flow variation and habitat diversity.

**Illustration:**




**Concept of introduced woody debris to create sinuosity/variability of flow in a straight section of channel**

**Example of fallen tree creating some variation and habitat cover in an over-wide/over-deep section of the River Mease**

**Potential constraints and other considerations**

- Woody debris can become snagged on bridges and other structures and in exceptional events create blockages. When planning work involving the installation of woody debris, consideration should be given to the need to anchor the debris to prevent it being washed downstream and collecting on structures;
- Where the river channel is relatively narrow, woody debris may accumulate in significant quantities, for example where it collects on a fallen tree, which may create an obstruction which the natural flow of the river is incapable of moving. This may increase flood risk to the surrounding land or increase the risk of bank erosion. Where such obstructions occur it may be necessary to intervene to reduce the amount of woody debris in the channel, consent for reduction or removal of woody debris;
- Fallen willows, which can re-grow in the channel and lead to undesirable consequences such as excessive erosion, will require careful management.

These management activities need consent from Natural England.

## Bank structure removal

**Category: Restore**

**Sub-options:**

R2 – Remove bank protection

R3 – Remove embankments

**Description:**

- Reinforced banks create a hard bank face which reduces marginal habitats;
- Removing or allowing non-essential bank reinforcements to degrade can allow the river to develop more natural bank profiles and planform morphology, more able to adjust to changes in flow and sediment supply;
- May need to be undertaken in conjunction with re-profiling of the bank face to lower slopes (see action R4) to ensure banks are stable and to maximise habitat gains;
- Embankments located along the bank tops can be removed to allow the natural inter-relationship between the river channel and floodplain to be reinstated, this could be undertaken in conjunction with wetland creation (see action R8).

**Potential benefits:**

- Provides connectivity between the river channel and surrounding floodplain, reducing flood impacts downstream;
- Reduces 'wash out' impact of flood flows on in-channel habitats and ecology by allowing water flow energy to dissipate beyond the channel (embankments also less likely to fail in high flow events);
- Allows the deposition of fine sediment on to the floodplain, reducing smothering of the bed and deposition within the river channel;
- Can improve drainage of the floodplain by allowing flood waters to drain more freely back into the river;
- Allows natural bank materials to be exposed, allowing natural supply of sediments to channel and creating potential burrow locations for white-clawed crayfish;
- Natural banks support a more diverse range of habitats, including undercut banks and naturally vegetated banks (fish cover and juvenile habitat).

**Illustrations:**

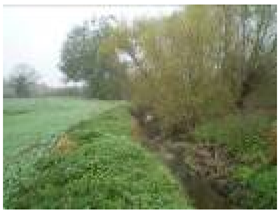
<u>**R2** Removal of bank protection:</u>

Present

Remove bank protection and re-profile bank on insider of bend and fence of to allow riparian and bank vegetation to recover

Following recovery (after 10 years)

<u>**R3** Embankment removal:</u>



Present

Remove embankment and fence of to allow riparian and bank vegetation to recover

Following recovery of riparian zone (10 years)

**Potential constraints and other considerations**

- Removing structures, especially bank protection, may lead to short term increases in bank erosion, although recovery of the bank face and riparian vegetation will reduce the impact of this;
- Removal of bank protection structures should also involve re-profiling the river bank (see next page);
- Restricting agricultural use of the riparian zone will require a change in land management along the river channel (see riparian zone management).

## Bank re-profiling

**Category: Restore**

**Sub-options:**

R4 – Re-profile bank to reduce bank slope

**Description:**

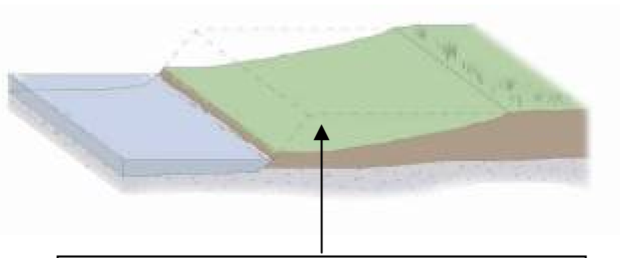
- Where banks have been steepened, through either channel deepening or straightening, the variety of marginal habitats will be reduced and flow within the channel is made faster and more uniform;
- Banks can be re-profiled (to make them less steep) to allow areas of marginal vegetation to develop.
- Removal of material from the bank to form a more gently sloping bank face;
- Shallow bank slopes typically occur on the inside of meanders. The extensive re-sectioning/deepening that has occurred along the River Mease in the past, means that often the banks on the inside of bends are steep. There areas should be prioritised for re-profiling.
- The actual slope of the bank will depend upon its location and will need to be confirmed during the production of a detailed design. Providing a range of bank slopes will provide diverse channel morphology to be created.

**Potential benefits:**

- Increased space to allow a variety of marginal habitats to develop. This will help the macrophyte community within the river channel to move towards favourable condition;
- More marginal vegetation will provide shelter and nursery areas for fish;
- The reshaped channel will allow high flows to dissipate onto the re-profiled margins reducing flow velocities within central channel, creating slower flows at the margins for fish refuge;
- Re-shaping the channel will help to encourage natural re-adjustment of the bed through sediment deposition;
- Increasing the top width of the channel will reduce the likelihood of debris jams forming from woody debris in the channel;
- Improved foraging habitat and bank-side passage for otters.

**Illustration:**

<u>**R4** Re-profile bank to reduce slope</u>



Bank profile prior to restoration (dashed)

Lower inside of bend

**Example of natural channel narrowing on the River Mease in the foreground. The bank profile is less steep and vegetation encroaches into channel. This contrasts with the bend in the distance where the bank remains high and could be improved by re-profiling.**

**Potential constraints and other considerations**

- Bank re-profiling may lead to short term increases in bank erosion until vegetation colonises the disturbed ground. It is therefore important that vegetation colonisation of disturbed ground is encouraged. This could involve seeding the ground and possibly also planting shrubs and trees to encourage rapid vegetation colonisation;
- Re-profiling the banks will require a change in land management along the river channel (see riparian zone management);
- This activity should be undertaken in conjunction with improvements to the riparian zone, but should be completed prior to rehabilitation of the riparian and bank vegetation;
- Bank re-profiling can be undertaken in conjunction with installing woody debris and creating shallow riffles using gravels to maximise morphological improvements.

## Bed raising / riffle creation

**Category: Restore**

**Sub-options:**

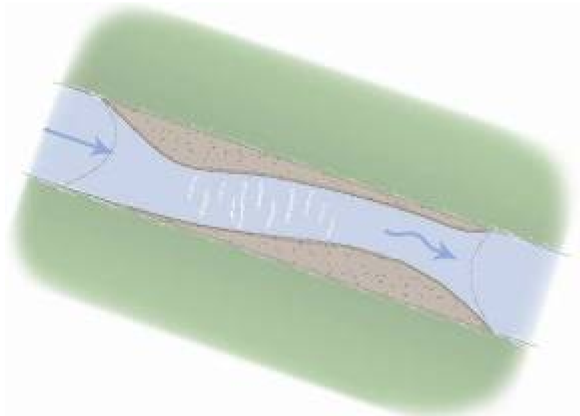
R5 – Reinstate coarse (gravel) bed material to create riffle

**Description:**

- Gravel can be used to raise the river bed slightly at suitable locations within over-deepened channels, to create areas of flow variation in terms of speed, depth and direction;
- Choosing a suitable gravel size is ecologically important, and also to ensure it is reasonably stable in higher flows;
- Riffles can also be shaped to create a slightly narrower sinuous low flow channel. This means that during low flows the flow does not become too diffuse. This also creates areas of variation at low flow.
- In some situations riffles can form naturally in response to bank erosion and increasing channel sinuosity or channel widening. However this requires an adequate supply of coarse sediment (gravel) and flow velocities sufficient to transport this material (e.g. Gilwiskaw Brook and upper River Mease). Riffles are less likely to develop without help where the channel gradient is low and the supply of coarse sediment is limited in the middle and lower reaches of the River Mease (downstream of Stretton Bridge).
- Should be undertaken in conjunction with bank re-profiling (R4).

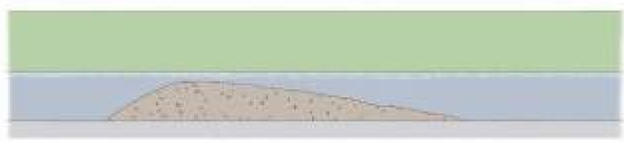
**Illustrations:**

Riffle in planform shown at low flow (at normal and high flow the riffle will be completely submerged):



Effect of narrowing the channel at low flow:

Long-section (creating areas of shallower flow across riffle and deeper flow up and downstream):



**Example riffle on River Mease with shallow flow creating disturbance to water surface and some *ranunculus* beds present**

**Potential benefits:**

- Creates a more varied channel morphology improving flow and physical habitat diversity for a range of species, including macro invertebrates and fish;
- Gravels and shallow, fast flow types are important spawning and juvenile habitats for bullhead;
- Slacker areas behind riffles may accumulate sandier substrates of benefit to spined loach;
- Increased water oxygenation to improve conditions for growth of *ranunculus* and other macrophytes.

**Potential constraints and other considerations**

- Installing riffles will lead to localised increases in the elevation of the bed, this may not be desirable in some locations, and therefore further feasibility work is recommended (see Section 5);
- Riffle creation can be undertaken in conjunction with installing woody debris and bank re-profiling to maximise morphological improvements.

| **Remove Weir** | **Category: Restore** |
|---|---|
| | **Sub-options:**<br>R6 – Remove weir |

**Description:**

- Weirs create barriers to downstream passage of flow and sediments and to free-migration of fish and other fauna up and down the river channel;
- Removal of weirs may involve removing the structure (wing-walls and bed stones) and bank lowering or widening (re-profiling) to help the channel re-establish a more natural form;
- Existing scour pools located below a removed weir may silt up from the margins over time, this may become colonised with vegetation creating additional variation in habitat.

**Potential benefits:**

- Allows more natural water level variations upstream (reduces deep water from impoundment);
- Enables natural downstream sediment transport and reduces upstream silt smothering of river bed caused by impoundment;
- Allows the development of more varied flow types upstream of the former structure, increasing habitat variety including potential areas suitable for *ranunculus* and other macrophytes;
- Allows the river channel morphology to respond and adjust to changes in flow and sediment supply, creating diverse channel morphology;
- Removes barriers or obstacles to bullhead, spined loach and other fish movement through the river system between suitable local habitats.

**Illustration:**

Present

Present

Remove wing walls and weir and reprofiled banks

Following recovery (10 years)

**Weir on the River Mease at Clifton Campville, impounding flow upstream and significant scour pool downstream**

**Potential constraints and other considerations**

- Weir removal can lead to significant lowering of water levels upstream, this may lead to some slumping of banks and adjustment of channel shape over time. Further feasibility work is recommended (see Section 5);
- Weir removal can be undertaken in conjunction with bank re-profiling, installing woody debris and riffle creation to maximise morphological improvements.

| **Create wetland and wet woodland** | **Category: Restore** |
|---|---|
| | **Sub-options:**<br>R7 – Create an area of wetland |

**Description:**

- Creation of areas of wetland can help to provide links between aquatic and terrestrial habitats as part of a functioning lowland river-floodplain ecosystem, and also help with water quality and sediment management issues;
- This can be achieved by creating floodplain scrapes to create wet areas in the floodplain, targeted at areas that show signs of poor drainage;
- Alternatively by lowering banks to widen field ditches or small tributaries at their confluence with the main river, creating marginal reed beds or areas of wet woodland to trap sediment at high flow. This is likely to be required where ditches are relatively deep.
- Some planting of suitable wetland species may be required if natural recolonisation is unlikely.

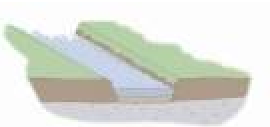
**Illustration:**

Wet areas on floodplain

**Area of poorly draining rush pasture, which could be enhanced in areas close to the channel to create a more varied and functional wetland**

**Illustration:** Widen tributaries to create marginal reed beds or wet woodland

Initial condition:

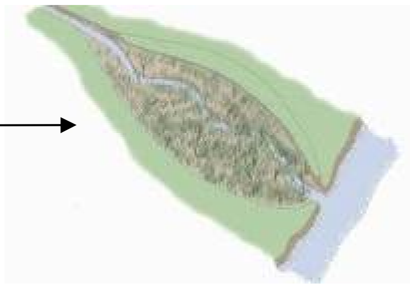


Wet woodland

Widen and slightly deepen channel and create low lying area of wetland and wet woodland.

Marginal reed beds

Widen and slightly deepen channel and create low, waterlogged ledges along the margins of a narrow low flow channel



**Potential benefits:**

- Reduction in potentially phosphorous-rich fine sediment from field drainage reaching the main river channel, improving water quality, as this could be captured and ‘buffered’ by wetland vegetation;
- Creation of areas of marginal habitat and fish refuges where water velocity is reduced at high flow.
- Reduction in rapid run off, helping to make the river more resilient to extremely low or high flow events

**Potential constraints and other considerations**

- Marginal reed beds or wet woodland may not be effective in every situation and further feasibility work to determine the exact details of sediment interception techniques on a site specific basis;
- Occasional silt removal may be required to ensure the wetland function as effective silt traps;
- Widening the lower sections of ditches may lead to a temporary release of sediment, however working methods can minimise this risk;
- Widening the lower sections of tributaries will require a change in land management along the river channel (see riparian zone management);
- Widening the lower sections of tributaries will require adequate space into which to widen the channel, this may be a constraint in some locations.

# Section 4 **Reach-scale restoration options**

## Organisation of the options

The assessment of the need for channel restoration, described in Section 2, involved dividing the SSSI/SAC into reaches based on the geomorphological and ecological conditions recorded during the field survey. In the majority of cases the extent of the reaches was defined on the basis of the need for differing degrees of intervention required, based on the need to either conserve, enhance or restore (Table 5 and Map 2a and 2b). In cases where reaches require restoration, rehabilitation measures have also been recommended.

**Table 5: The degree of intervention required along the SSSI/SAC on a reach by reach basis**

| SSSI Unit | Section | Reach | Solution |
|---|---|---|---|
| 4 | Packington to Snarestone | GIL001 | Restore |
| | | GIL002 | Rehabilitate |
| | | GIL003 | Restore |
| | | GIL004 | Restore |
| | | GIL005 | Restore |
| | | GIL006 | Restore |
| | | GIL007 | Conserve and enhance |
| 3 | Snarestone to Netherseal | MEA001 | Restore |
| | | MEA002 | Restore |
| | | MEA003 | Restore |
| | | MEA004 | Rehabilitate |
| | | MEA005 | Restore |
| | | MEA006 | Conserve and enhance |
| | | MEA007 | Restore |
| 2 | Netherseal to Harlaston | MEA008 | Restore |
| | | MEA009 | Conserve and enhance |
| | | MEA010 | Restore |
| | | MEA011 | Restore |
| | | MEA012 | Conserve and enhance |
| | | MEA013 | Restore |
| | | MEA014 | Conserve and enhance |
| | | MEA015 | Conserve and enhance |
| | | MEA016 | Restore |
| | | MEA017 | Restore |
| 1 | Harlaston to River Trent | MEA018 | Conserve and enhance |
| | | MEA019 | Rehabilitate |
| | | MEA020 | Rehabilitate |
| | | MEA021 | Restore |
| | | MEA022 | Conserve and enhance |
| | | MEA023 | Conserve and enhance |
| | | MEA024 | Rehabilitate |
| | | MEA025 | Conserve and enhance |

## Reach-scale options

### *Reaches for conservation and enhancement*

The reaches that have been identified as being consistent with good morphology and ecology are listed in Table 6 (pages 28 to 30). The table provides a summary of the characteristics of the reach and a summary of the specific conservation and enhancement actions which should be undertaken.

The future management of reaches designated for conservation and enhancement should adopt the following guiding principles:

- Conserve the existing riparian and river bank vegetation;
- Look for opportunities to improve the width, density, composition of the riparian zone;
- Retain woody debris within the channel (unless it poses a significant flood risk to buildings or infrastructure);
- Do not modify the river channel (e.g. by dredging or bank reinforcement);
- Ensure that, if new land drainage ditches are excavated, or old ones restored, these are not routed to directly discharge into the river but are routed into an area of wetland or wet woodland to ensure that this water is filtered before entering the channel.

These principles should be applied to the whole river (in addition to the specific proposals).

### *Reaches for rehabilitation and physical restoration*

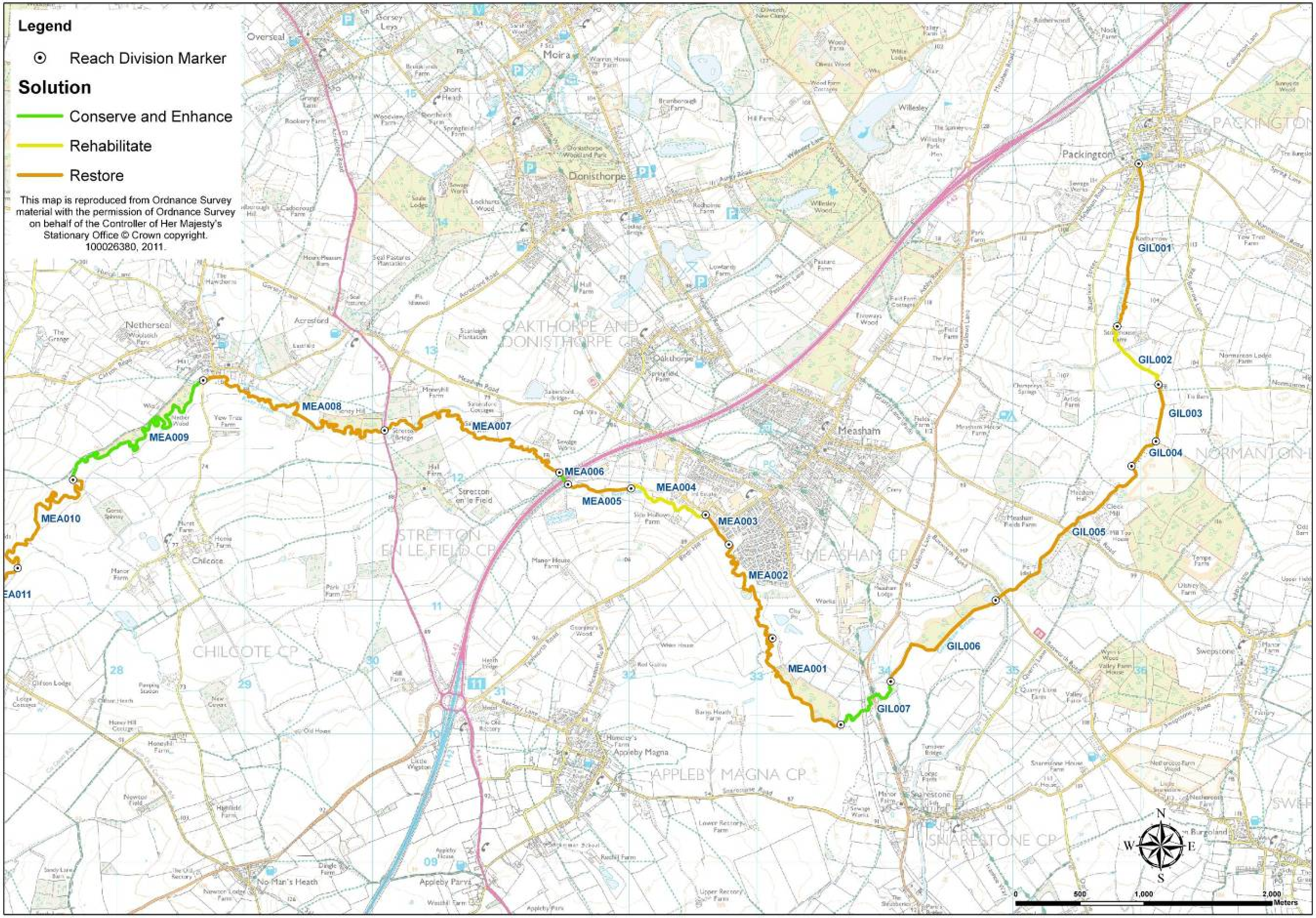
For those reaches where rehabilitation and physical restoration is required (categories enhance and restore) individual plans have been produced which set out the suggested approach for each location (pages 28 to 52). The plans comprise the following components:

- Site name;
- Category of intervention required;
- SSSI/SAC unit number (refer also to Map 1);
- Reach reference number (refer also to Map 2a and 2b);
- Start and end grid references;
- Location map;
- Annotated maps, aerial and ground based photographs detailing the suggested actions;
- General extent of 1:100 flood (shown in light blue on the annotated maps);
- Summary of potential benefits and constraints.

The dimensions of restoration actions shown on the plans are indicative and do not necessarily represent the actual footprint of the activity, which would be determined by future more detailed planning of actions (see Section 5).

The plan outlines the options that have been identified as desirable to meet the conservation objectives for the river. This version of the restoration plan has been updated to include general feedback received during a consultation event held on the 10th January 2012 at Chilcote Village Hall. More detailed comments on specific river reaches are being held on file and will be used to inform future 1-1 discussions with landowners as reach specific restoration projects are taken forward

**Map 2a: Map showing type of intervention required on a reach-by-reach in the upper half of the SSSI/SAC**



**Map 2b: Map showing type of intervention required on a reach-by-reach in the lower half of the SSSI/SAC**

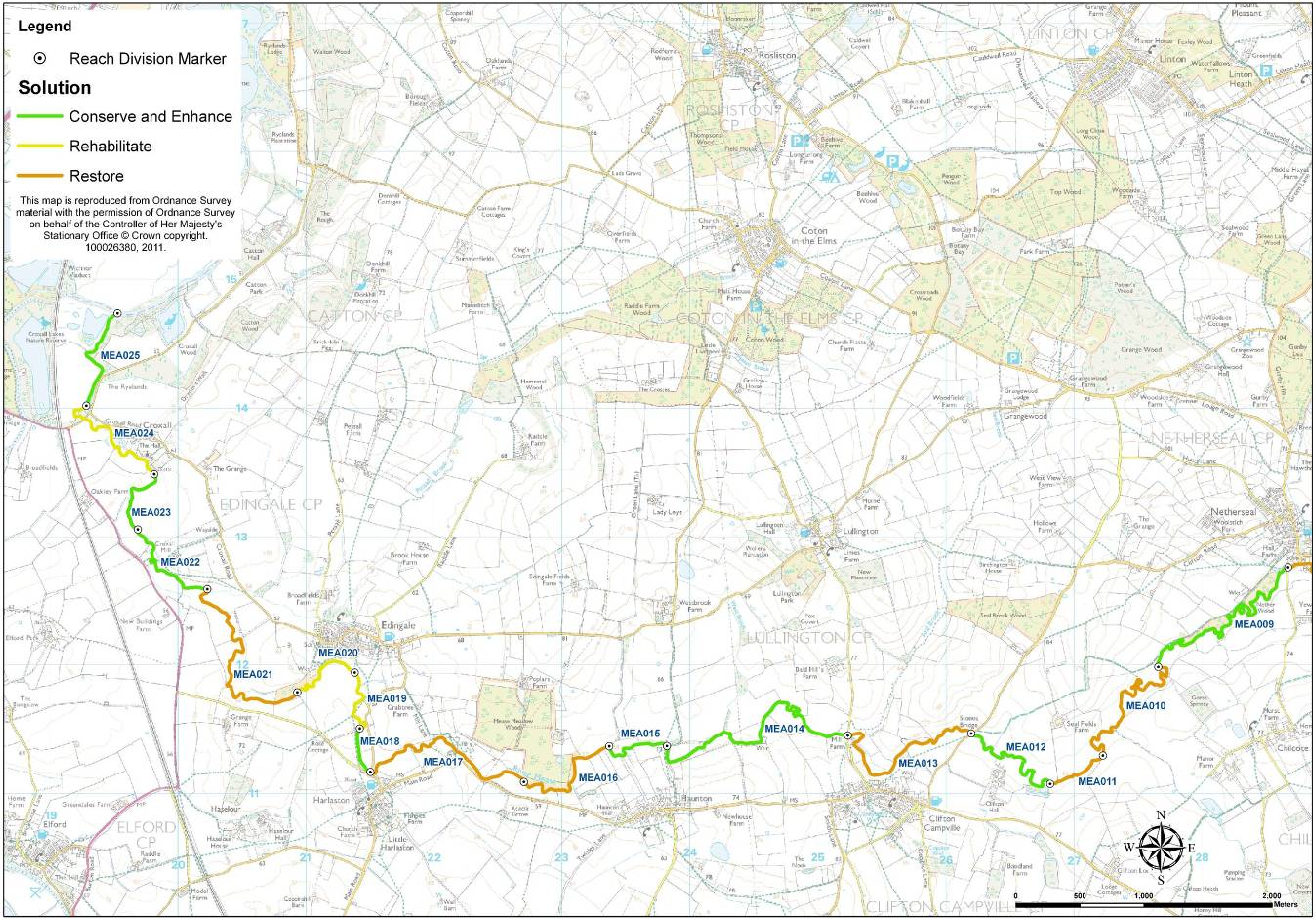


**Table 6: Summary of the river characteristics and actions required along the reaches recommended for conservation and enhancement**

| Description | Photographs |
|---|---|
| **Reach** GIL007 **Start NGR** 434047 310411 **End NGR** 433656 310072<br>**Key features:**<br>• Meandering section showing evidence of adjustment and recovery towards a more typical morphology, through localised bank erosion and deposition (gravel point bars), which is leading to the development of a highly varied channel morphology (pools and riffles).<br>• Supply of coarse woody debris, which when located in the channel adds to flow diversity and the creation of microhabitat patches.<br>**Conservation actions:**<br>• Improve the riparian zone, particularly along the right bank. This should involve creating a strip of natural riparian vegetation parallel to the bank top. |   |
| **Reach** MEA006 **Start NGR** 431527 311949 **End NGR** 431459 312042<br><br>**Key features:**<br>• Highly modified section of channel passing beneath the A42 trunk road.<br>• The channel has been straightened and substantially over-widened.<br>• However, it has now adjusted towards a more natural channel form through narrowing following the deposition of sediment along the banks and subsequent colonisation by vegetation including some trees.<br>**Conservation actions:**<br>• Due to the constraints in this location (trunk road and access routes) it is unlikely that the channel can be further improved. Attention should focus on preventing actions which may degrade the channel (e.g. vegetation clearance or dredging). |   |
| **Reach** MEA009 **Start NGR** 428674 312761 **End NGR** 427658 311984<br><br>**Key features:**<br>• Evidence of adjustment and recovery, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation, which is leading to the development of varied channel morphology (range of flow velocities).<br>• Channel banks and margins have good vegetation cover indicating little erosion or disturbance of the banks.<br>**Conservation actions:**<br>• Increase the width of the riparian zone along both banks. This should involve creating a corridor of natural riparian vegetation. The riparian zone should encompass the floodplain on the inside of meanders. |   |

| Description | Photographs |
|---|---|
| **Reach** MEA012 **Start NGR** 2426814 311073 **End NGR** 426197 311465<br><br>**Key features:**<br>• Meandering section of river with a natural planform undergoing adjustment, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.<br>• Localised sediment deposition on the bed creates occasional riffles.<br>• Channel banks and margin have good vegetation cover.<br>**Conservation actions:**<br>• Restore a corridor of natural riparian vegetation along both banks. The riparian corridor should encompass the floodplain on the inside of meanders. |   |
| **Reach** MEA014 **Start NGR** 425232 311450 **End NGR** 423819 311368<br><br>**Key features:**<br>• Meandering section of channel which is located along the valley side in a number of sections.<br>• Evidence of natural adjustment, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.<br>• Localised sediment deposition on the bed has created a number of shallow riffles which have been colonised by *Ranunculus*.<br>• Channel banks and margin have good vegetation cover.<br>**Conservation actions:**<br>• Create a corridor of natural riparian vegetation along both banks. |   |
| **Reach** MEA015 **Start NGR** 423819 311368 **End NGR** 423368 311366<br><br>**Key features:**<br>• Evidence of adjustment, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.<br>• Localised sediment deposition on the bed has created a number of shallow riffles which have been colonised by *Ranunculus*.<br>• Channel banks and margin has good vegetation.<br>**Conservation actions:**<br>• Create a corridor of natural riparian vegetation along both banks.<br>• Manage livestock access to the channel (there is currently a small drinking point on the right bank) either through fencing or by providing livestock operated drinkers. |   |
| **Reach** MEA018 **Start NGR** 412503 311167 **End NGR** 421419 311505<br><br>**Key features:**<br>• Section of channel which is located along the left side of the valley.<br>• Evidence of adjustment, through narrowing and localised sediment deposition on the bed which has created a number of shallow riffles.<br>• Good supply of coarse woody debris that creates to flow diversity and microhabitat patches.<br>**Conservation actions:**<br>• Encourage development of natural riparian vegetation along the right bank. |   |

**Description** | **Photographs**

**Reach** MEA022 **Start NGR** 420229 312590 **End NGR** 419685 313057

**Key features:**

- Located along the valley side in the upper part of the reach.
- Has adjusted towards a more natural form through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.
- Localised sediment deposition on the bed has created a number of shallow riffles which have been colonised by *Ranunculus*.
- Channel banks and margins have good vegetation cover.
- Good supply of coarse woody debris.

**Conservation actions:**

- While the riparian vegetation generally natural and diverse there are some gaps which could be filled.


**Reach** MEA023 **Start NGR** 419685 313057 **End NGR** 419814 313486

**Key features:**

- Meandering section of river with a natural planform undergoing adjustment, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.
- The varied channel width has created varied flow velocities.
- Channel banks and margins have good vegetation cover.

**Conservation actions:**

- The land along both banks is arable and the uncultivated margin is relatively narrow in places. The width of the uncultivated margin could be increased by restoring a strip of natural riparian vegetation at least 12m wide along both banks.


**Reach** MEA025 **Start NGR** 419283 314020 **End NGR** 419528 314739

**Key features:**

- Previously realigned section of river, which has a relatively straight planform with occasional bends. However, despite this modification the channel has a highly varied morphology.
- Evidence of adjustment, through narrowing as a result of marginal sediment deposition and colonisation of deposits by vegetation.
- Localised sediment deposition on the bed has created a number of shallow riffles which have been colonised by *Ranunculus*.
- Channel banks and margins have good vegetation cover.

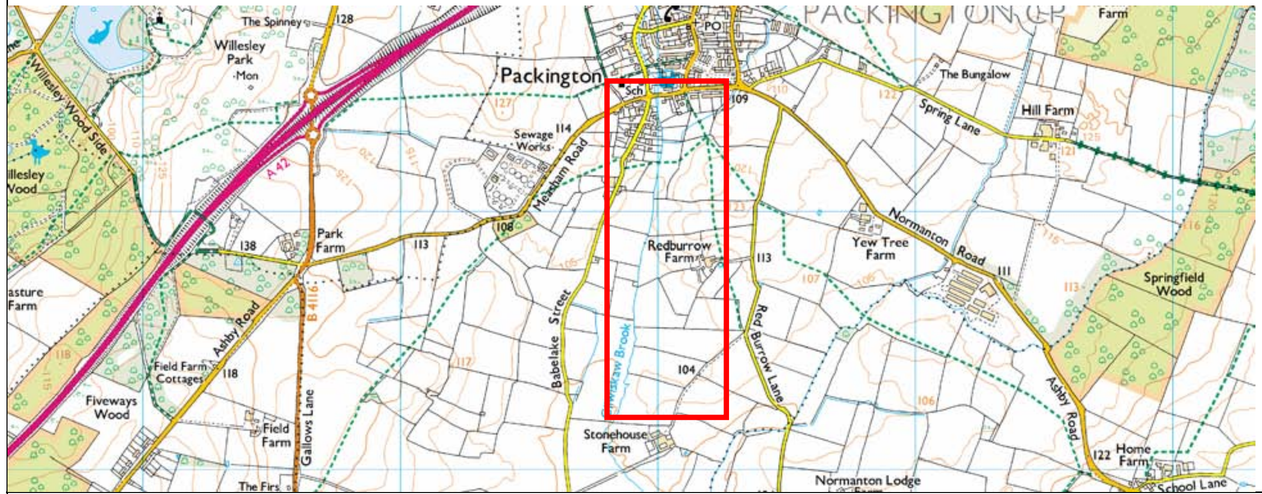
**Conservation actions:**

- The extent of natural riparian vegetation could be increased along the left bank.


# Gilwiskaw Brook downstream of Packington

| | |
|---|---|
| **Category: Restore** | |
| **SSSI/SAC Unit:** 4 | **Reach:** GIL001 |
| **Start NGR:** 435986 314448 | **End NGR:** 435816 313183 |

**Location:**



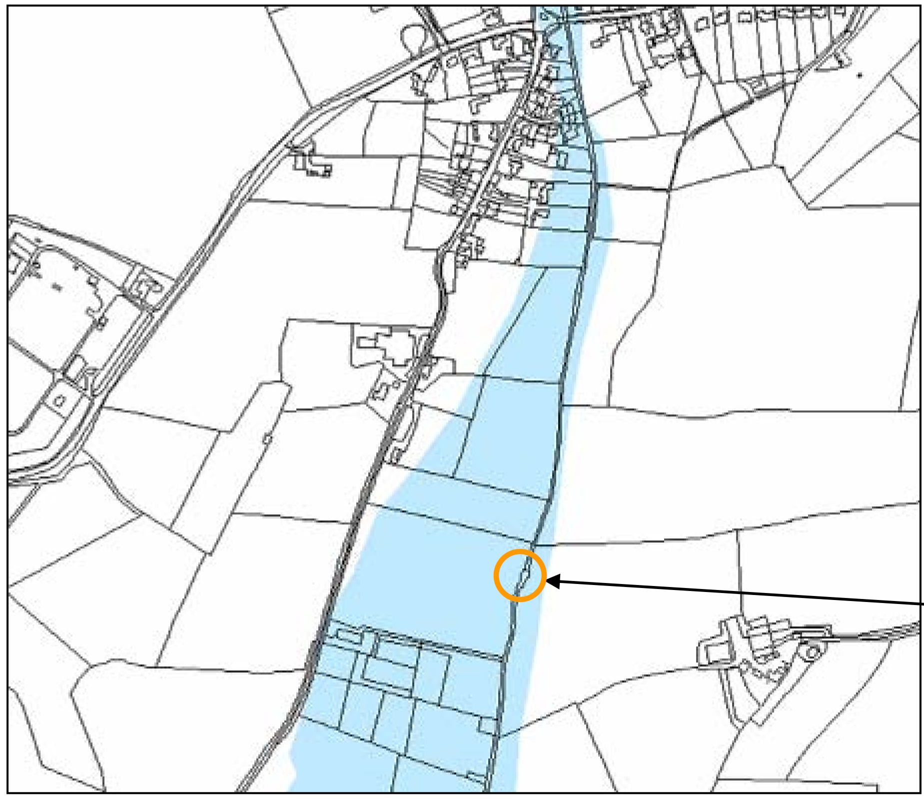

**Context:**

- This section of the Gilwiskaw Brook has been impacted by past channel straightening, likely to date to the eighteenth or early nineteenth century.
- The bed of the channel has subsequently lowered through incision in response to the increase in channel gradient caused by straightening.
- Despite modification, subsequent channel adjustment (including reworking of the bed during incision) and the development of continuous tree lining has enabled the channel to recover and develop a relatively varied morphology.

**Key issues:**

- A weir approximately 450mm high crosses the full width of the channel.
- The weir is a barrier to fish migration.
- The weir is in a state of disrepair and there is evidence that the crest is failing.

**Restoration actions:**



**Action R6**
Remove weir and associated walls along the banks.

**Action R4**
Re-profile the banks in the immediate vicinity of the weir to prevent collapse following weir removal.

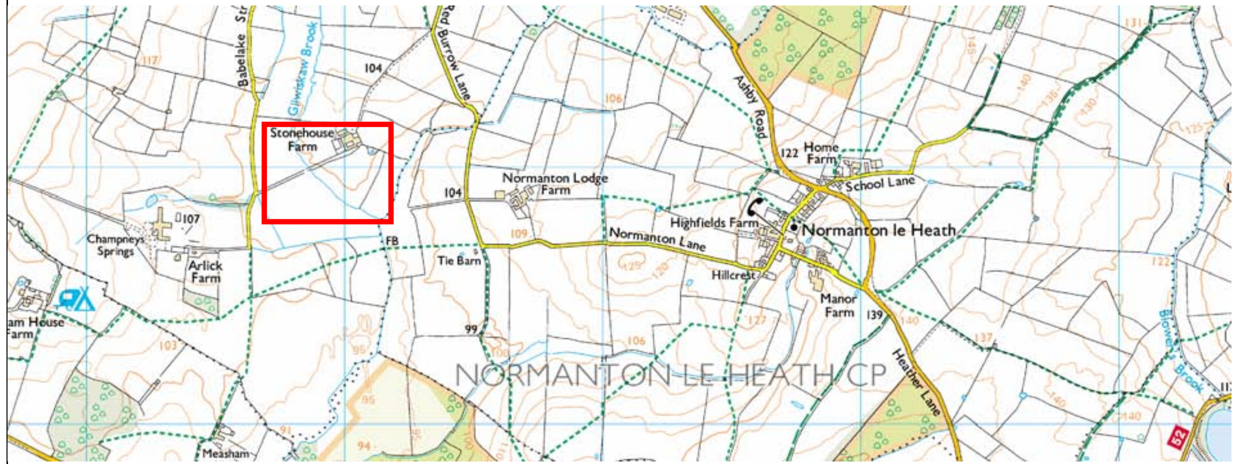
**Action E1**
Tree lining is present, consider if there is a need to replace trees if they are removed in any great number during weir removal and associated access work.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Remove Weir and associated walls | Weir crosses the full with of the channel and ties into brick walls along the banks. These should be completely removed. | Would restore natural bed (cobble/gravel) and bank (earth) conditions.<br>Would allow the unrestricted movement of fish through the reach. | Removal may destabilise the bed of the channel upstream involving channel incision.<br>The banks of the channel in the location of the former walls may become unstable. |
| Re-profile banks | The banks are currently vertical. Removal of the walls would be likely to trigger bank instability. | Re-profiling the banks would reduce the likelihood of bank instability developing. | Ground vegetation and some shrubs and trees may need to be removed to allow bank re-profiling. |
| Fill gaps in riparian vegetation by planting as appropriate | Bank re-profiling would create a gap in the riparian vegetation. | Reinstating riparian vegetation would help to stabilise the banks of the channel. | None Identified. |

# Gilwiskaw Brook at Stonehouse Farm

| | | |
|---|---|---|
| **Category: Rehabilitate** | | |
| **SSSI/SAC Unit:** 4 | **Reach:** GIL002 | |
| **Start NGR:** 435816 313182 | **End NGR:** 436138 312729 | |

**Location:**



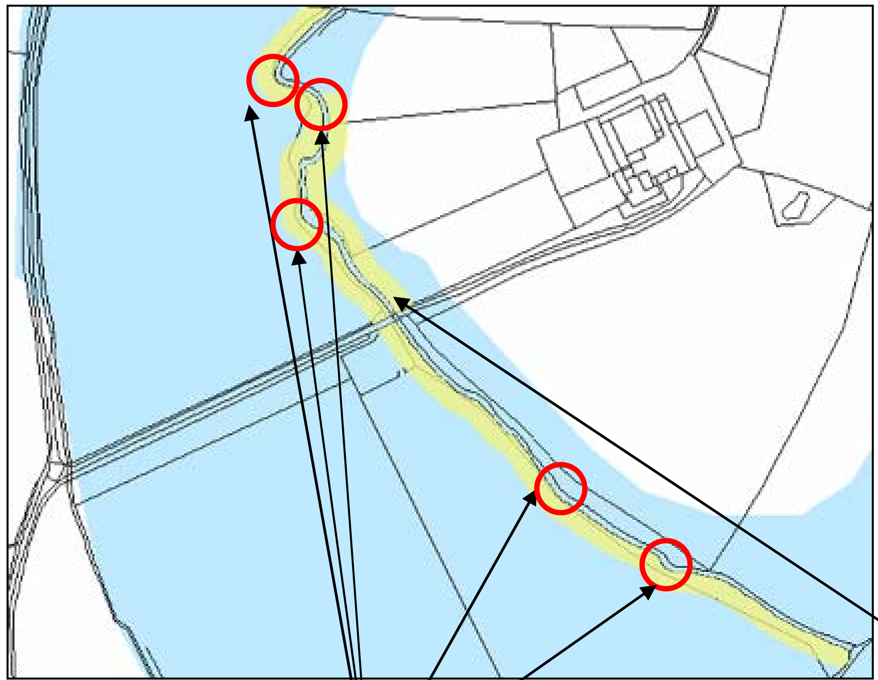

**Context:**

- The channel has been realigned into a straight course through this reach.
- The channel is now actively recovering through natural readjustment and is developing a wider and more diverse morphology with a complex channel structure and a highly varied bed with good riffles.
- There are a number of sections where the banks are actively eroding thus creating the natural complex channel

**Key issues:**

- While active channel readjustment is a beneficial processes as it is creating a highly varied channel morphology, the rate of change, particularly bank erosion is relatively high due to land use pressures along the channel, primarily grazing close to he bank top and the absence of a natural and diverse riparian zone along the banks, especially the right bank.
- Tree lining is generally absent along the right bank.

**Restoration actions:**



Locations of particularly high rates of bank erosion

**Action E2**
Create a corridor of natural riparian vegetation along (parallel to) both banks along the full length of the reach. This should ideally be at least 12m wide along both sides of the channel. Tree planting will be required and a way to control stock access until the riparian vegetation has established will be required.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Create riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Will require fencing set at least 12m back from the bank tops and therefore some change in land management. |

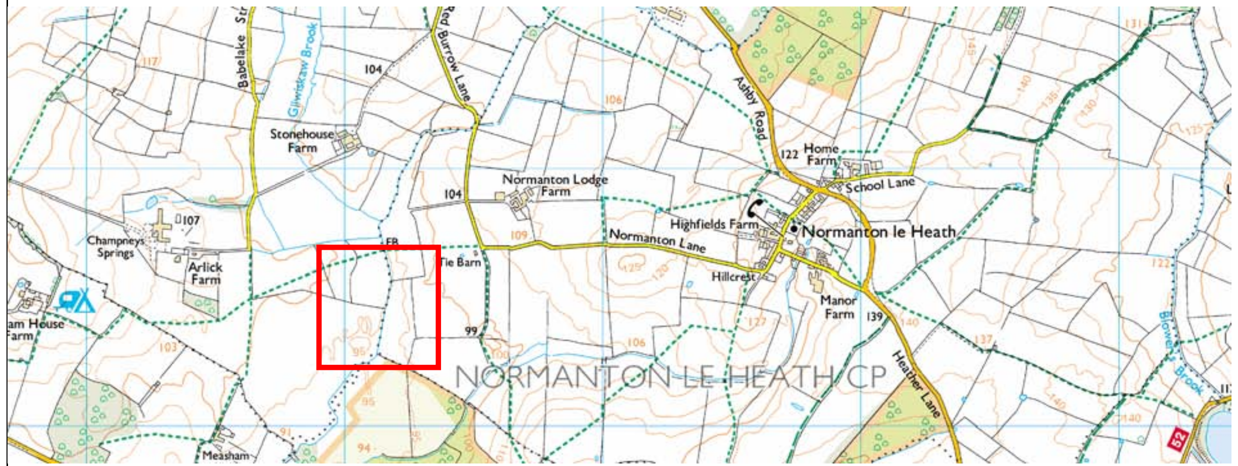
# Gilwiskaw Brook downstream of Stonehouse Farm upper

**Category: Restore**

**SSSI/SAC Unit:** 4 | **Reach:** GIL003

**Start NGR:** 436138 312729 | **End NGR:** 436119 312285

**Location:**



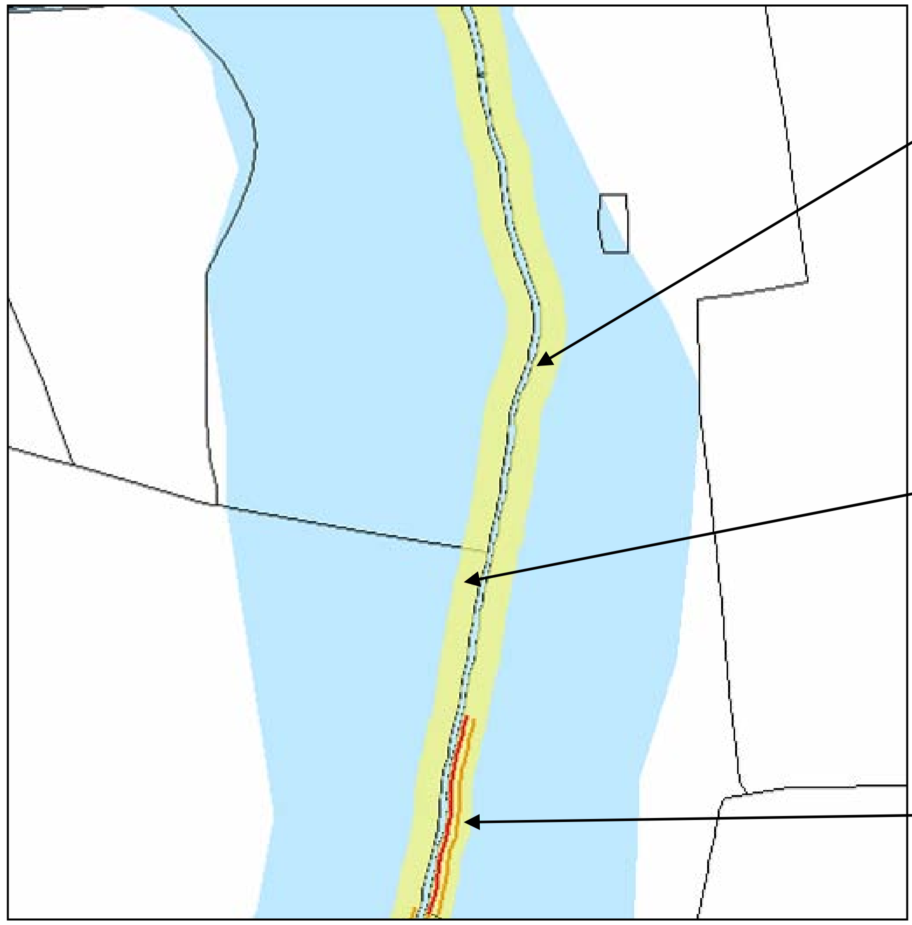

**Context:**

- The channel has been realigned into a straight course through this reach.
- The channel is now recovering through natural readjustment and is developing a more diverse morphology resulting in a complex channel structure.

**Key issues:**

- Despite the general pattern of adjustment towards a more natural morphology along this reach there are local sections which could be improved.
- In the middle of the reach these is an area of active bank erosion which reflects unrestricted livestock access to the channel.
- Tree lining is discontinuous and absent for much of the reach. The riparian zone is also relatively narrow.
- There is a sections of bank reinforcement (small boulders), at the lower end of the reach, which are collapsing into the channel, while this creates some flow variation, these stones are coarser than would be expect for a channel in this setting.

**Restoration actions:**



**Action E2**
Improve the riparian vegetation along (parallel to) both banks along the full length of the reach.

Below: An example of a section which has started to recover through natural adjustment:

**Action R2 and R4**
Remove stone bank reinforcement and re-profile the banks to reduce the bank slope.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Remove bank reinforcement and re-profile the banks | Remove the stone bank reinforcement along both banks in the middle section of the reach and re-profile the banks to reduce the bank slope. | Would restore natural bed (cobble/gravel) and bank (earth) conditions. | None Identified. |
| Improve the riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Will require grazing to be restricted in the short to medium term, probably fencing set at least 12m back from the bank tops and therefore change in land management. |

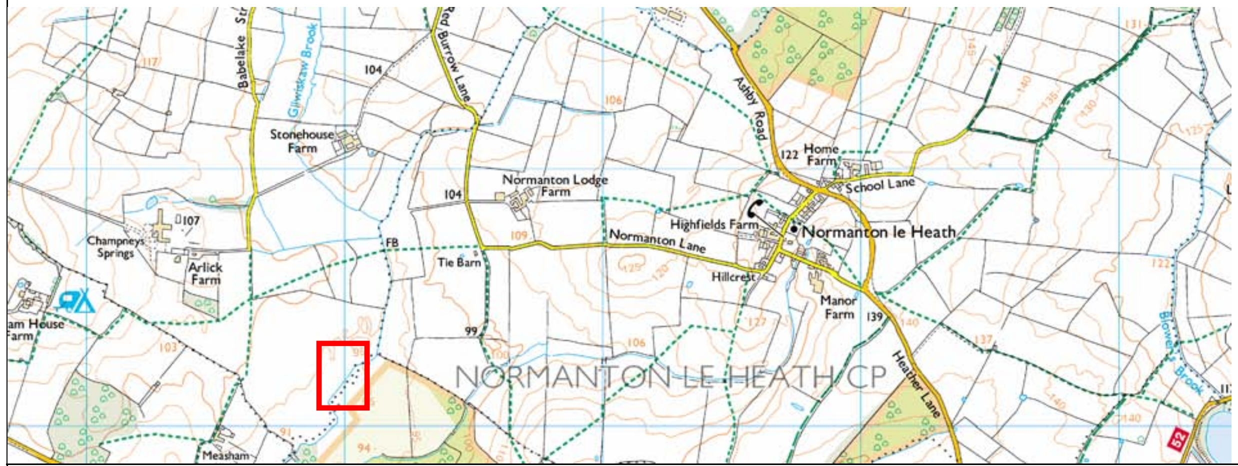
# Gilwiskaw Brook downstream of Stonehouse Farm lower

**Category: Restore**

**SSSI/SAC Unit:** 4

**Reach:** GIL004

**Location:**




**Start NGR:** 436119 312285

**End NGR:** 435929 312091

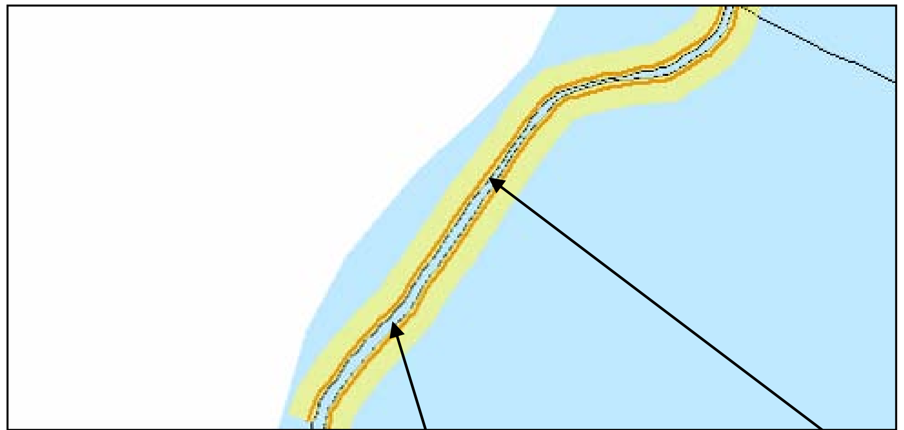
**Context:**

- The channel has been realigned into a straight course through this reach. While the section upstream appears to be adjusting and adjusting towards a more diverse morphology, this section is highly uniform.

**Key issues:**

- The channel is very straight with a relatively uniform bed and high and steep banks which show little variation.
- Tree lining is absent, with only the occasional tree present along the bank top.
- There is a strip of uncultivated land along each bank top however this is simply a grass strip which may not be effective at trapping sediment and nutrient runoff.

**Restoration actions:**



**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

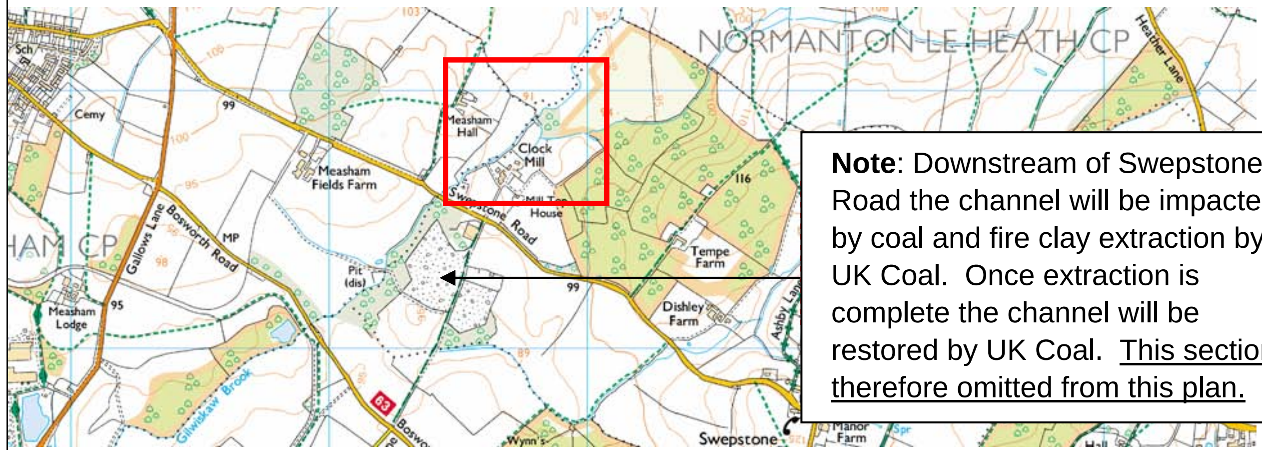
**Action E2**
Improve the riparian zone vegetation along (parallel to) both banks along the full length of the reach. This should ideally be at least 12m wide along both sides of the channel.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles and a sinuous low flow channel including introduced woody debris | Allows a sinuous channel course to develop with a more varied bed, similar to that recorded upstream. | Would require change in land management along the channel margins. |
| Improve the riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a future source of woody debris. | Will require some change in land management. |

# Gilwiskaw Brook at Clock Mill

| | |
|---|---|
| **Category: Restore** | |
| **SSSI/SAC Unit:** 4 | **Reach:** GIL005 |
| **Start NGR:** 435929 312091 | **End NGR:** 434867 311045 |

**Location:**




**Note**: Downstream of Swepstone Road the channel will be impacted by coal and fire clay extraction by UK Coal. Once extraction is complete the channel will be restored by UK Coal. This section is therefore omitted from this plan.

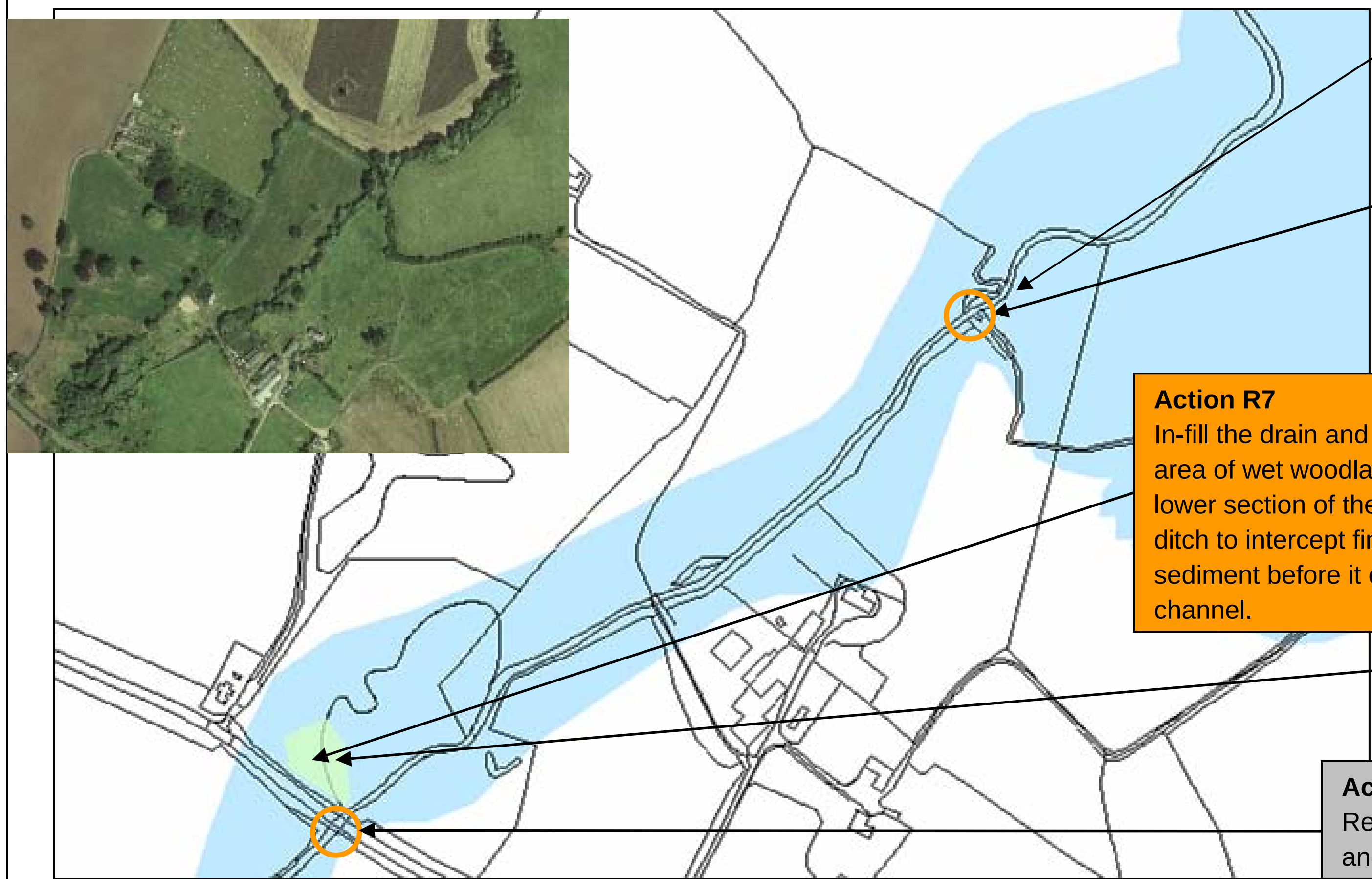
**Context:**

- The channel is relatively straight in this section and shows evidence of past incision which has created a narrow and deep channel along much of the reach upstream of Swepstone Road.
- Generally the channel has a varied bed (pools and riffles) with a good supply of coarse woody debris.
- Downstream of Swepstone Road the channel is deep and this reflects confinement by the valley sides which been disturbed by mineral extraction; this appears have increased the degree of channel confinement.

**Key issues:**

- The left bank tributary has been impacted by culverting at the confluence with Gilwiskaw Brook, this causes local scour of the channel bed and banks.
- A drainage ditch has been excavated to the right of the channel immediately upstream of Swepstone Road; this is supplying fine sediment to the channel.
- The channel appears to have been dredged at Swepstone Road bridge with dredged material tipped onto the bank where it damages the riparian vegetation and is vulnerable to being washed into the river during floods.

**Restoration actions (upstream of Swepstone Road):**



**Action R2**
Remove culvert and reinstate a natural section of tributary channel.

**Action R7**
In-fill the drain and plant an area of wet woodland at the lower section of the drainage ditch to intercept fine sediment before it enters the channel.

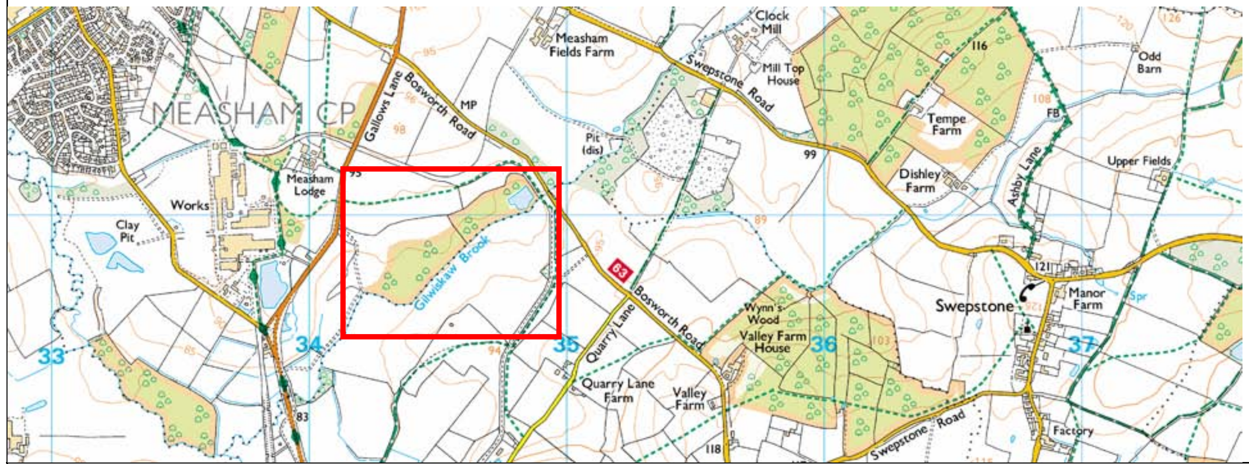
**Action: Other**
Review the need for sediment management with highway authority and develop an appropriate management strategy.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Remove culvert | Remove culvert and reinstate a natural open channel section of tributary channel. | Prevents local scour. | Access to the culvert to undertake removal may be limited. |
| Create wet woodland | In-fill the lower section of the ditch and plant an area of wet woodland to intercept fine sediment. | Reduced fine sediment and diffuse pollution supply to the channel. | Would require change in land management along the channel margins. |
| Review sediment management | Review the need for sediment management with highway authority and develop an appropriate management strategy. | Ensures that maintenance actives are undertaken in a sympathetic manner. | The road bridge is very low and as a result blockage by sediment and woody debris is likely during floods. |

# Gilwiskaw Brook downstream of Bosworth Road

| | |
|---|---|
| **Category: Restore** | |
| **SSSI/SAC Unit:** 4 | **Reach:** GIL006 |
| **Start NGR:** 434867 311045 | **End NGR:** 434047 310411 |

**Location:**




**Context:**

- The channel has been realigned to flow around the boundaries of surrounding fields and enclosures. The channel is deep in the upper section and embanked in the lower section. The terrain along ether side of the channel is relatively flat and represents a broad floodplain.
- The land to the left of the channel is used for arable framing, while to the right the land use is pasture.

**Key issues:**

- The channel has a relatively uniform morphology, particular in the upper part of the reach.
- The left bank in the upper of the reach has collapsed, due to steepening associated with channel deepening, this creates a source of fine sediment and has also led to the formation of a ledge along the toe of the left bank.
- The lower half of the reach is shallow and more natural but has been embanked to limit floodplain inundation.
- There is a very narrow uncultivated margin along the left bank, but this is unlikely to be effective in preventing surface runoff supplying nutrients and fine sediment to the channel.

**Restoration actions:**

**Action R4**
Re-profile left bank to reduce the slope of the left bank.

**Action E2**
Improve the natural riparian vegetation along (parallel to) both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel.

**Action R3**
Remove embankment to allow flood flows to dissipate uniformly over the bank.

**Action E3**
Create riparian corridor along the channel. As this is a low lying area which is at risk of flooding opportunities should be sought to maximise the extent of this area to prevent soil erosion during floods.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile left bank | Reduce the slope of the left bank to create a wider channel with a gentle bank slope. | Improve the stability of the left bank and the capacity of the channel to contain flood water. | Would require a change in land management along the left bank. |
| Remove embankment | Remove embankment along the top of the left bank. | Restore natural floodplain connectivity. | Would increase the likelihood and frequency of flooding of the field, but reduce any ponding behind current embankment. |
| Create riparian corridor | Reinstate natural riparian vegetation along the top of the left bank in a strip at ideally least 12m in width. This could involve either natural adjustment or tree planting. | Would reduce the risk of erosion of the banks and the floodplain along the channel margin during floods. | Would require a change in land management along the left bank. |

# River Mease near Barns Heath Farm

| Category: Restore | |
|---|---|
| **SSSI/SAC Unit:** 3 | **Reach:** MEA001 |
| **Start NGR:** 433656 310072 | **End NGR:** 433123 310747 |

**Location:**

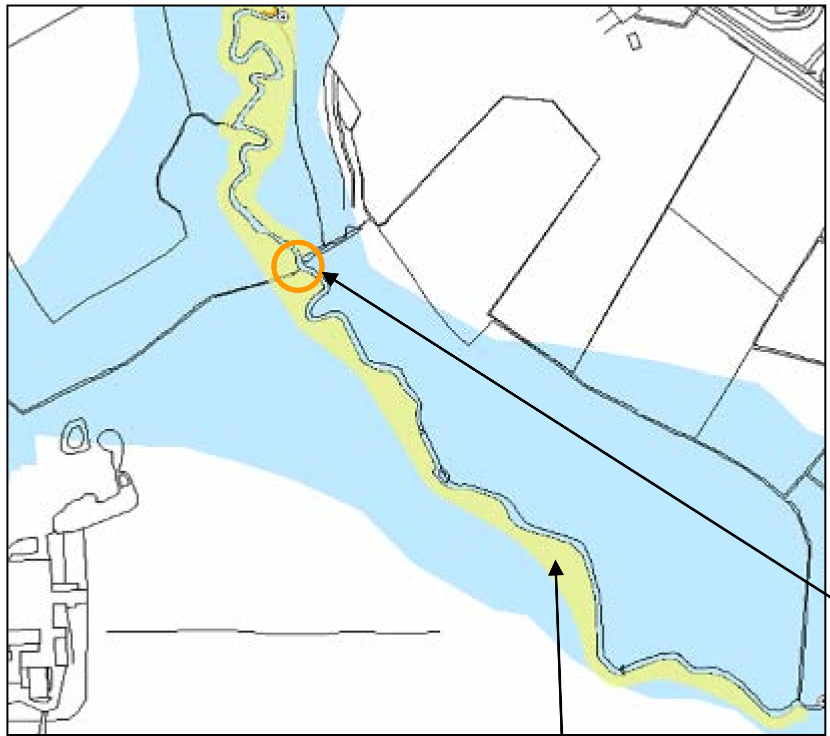
**Context:**

- The channel is in this area is relatively natural with a sinuous planform, varied cross-sectional form and diverse bed morphology with a pools and riffles.
- The land to the right of the river is now covered by a broadleaf woodland plantation which provides good cover for the channel and source of woody debris. Land use to the left of the channel is dominated by arable farming.
- Woody debris is common in this reach and this contributes to the diverse channel morphology.

**Key issues:**

- The left bank has been impacted by the agricultural land use. The uncultivated margin is narrow and tree lining is generally absent. The narrow uncultivated margin means that silt laden surface runoff is likely to enter the channel during heavy rainfall.
- Two drains enter the channel in the middle section of this reach. These both appear to supply significant amounts of fine sediment to the river channel.

**Restoration actions:**



**Action E3**
Create a riparian corridor along the river a minimum of 12m in width.

**Action R7**
Create areas of wet woodland near the confluence of the open drains (ditches) to the left and right of the channel and divert discharge from drains through this woodland.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Create wet woodland | Create areas of wet woodland near the confluence of the open drains (ditches) to the left and right of the channel and divert discharge from drains through this woodland. | Will reduce fine sediment and diffuse pollution input to the river. | Would require localised change in land management along the channel left bank. |
| Create riparian corridor | Reinstate natural riparian vegetation along the top of the left bank in a strip at ideally least 12m in width. This could involve either natural colonisation or tree planting. | Would reduce the risk of erosion of the banks and the floodplain along the channel margin during floods. | Would require a change in land management the channel left bank. |

# River Mease at Measham (South)

**Category: Restore**

**SSSI/SAC Unit:** 3 | **Reach:** MEA002

**Start NGR:** 433123 310748 | **End NGR:** 432781 311479

**Location:**

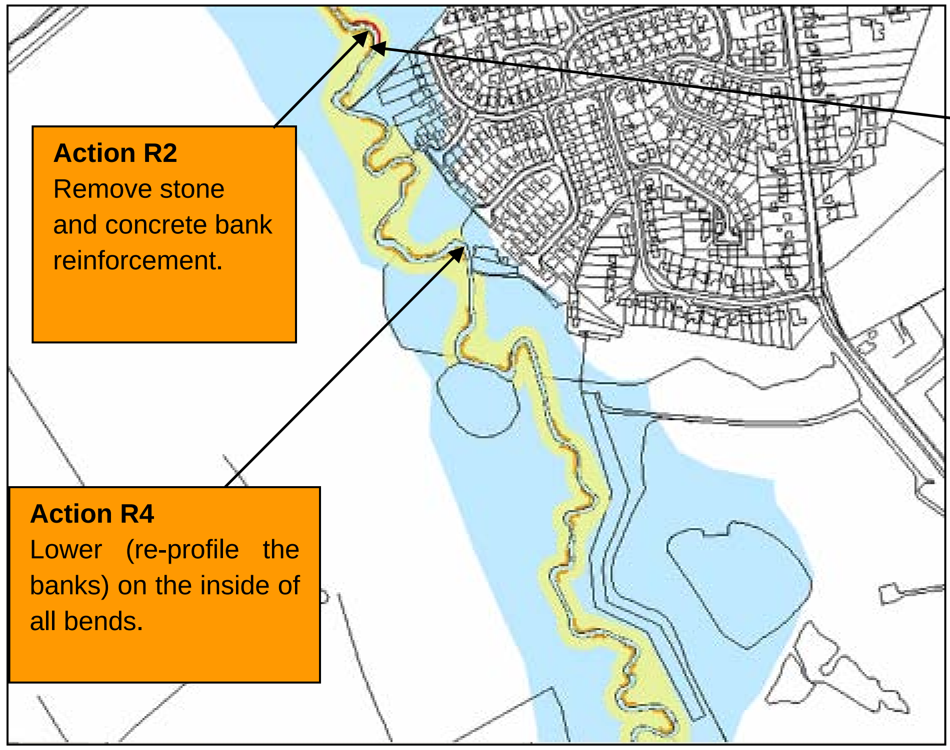

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the left bank is dominated by arable while the land to the right is used for grazed pasture.
- The channel has a meandering planform and a relatively varied morphology, which reflects adjustment following past deepening. The banks are of variable slope, the channel width varies and flow velocities are variable.

**Key issues:**

- Despite adjustment following past deepening, the riparian zone along both banks has been degraded. Trees are restricted to occasional clumps.
- The land along the right of the river is grazed right up to the bank top. In some areas this results in accelerated bank erosion which supplies fine sediment to the channel.
- The left bank is generally covered by vegetation; however the land is tilled into the corner of the meanders making it vulnerable to soil erosion during floods.

**Restoration actions:**




**Action E3**
Create a riparian corridor along the channel. As this is a low lying area which is at risk of flooding, opportunities should be sought to maximise the extent of this in the core of meanders to reduce the risk of soil erosion during floods.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Lower banks on the inside of all bends. | Lower banks on the inside of all bends to restore a varied cross-section, typical of meandering rivers. | Improved morphological diversity. | Would require some change in land management along both banks. |
| Remove bank reinforcement | Remove the stone bank reinforcement along both banks in the middle section of the reach. | Would restore natural bed (cobble/gravel) and bank (earth) conditions. | There is adequate space between the river and the nearby housing to allow removal of bank reinforcement without risk to property, assuming the riparian zone is also enhanced. |
| Create riparian corridor | Reinstate natural riparian vegetation along both banks in a strip ideally at least 12m in width. This could involve either natural colonisation or tree planting. Some adjustment has already taken place along the left bank; however increased tree cover should be encouraged throughout the reach. | Would ensure rates of bank erosion typical of more natural conditions. | Would require some change in land management along both banks. |

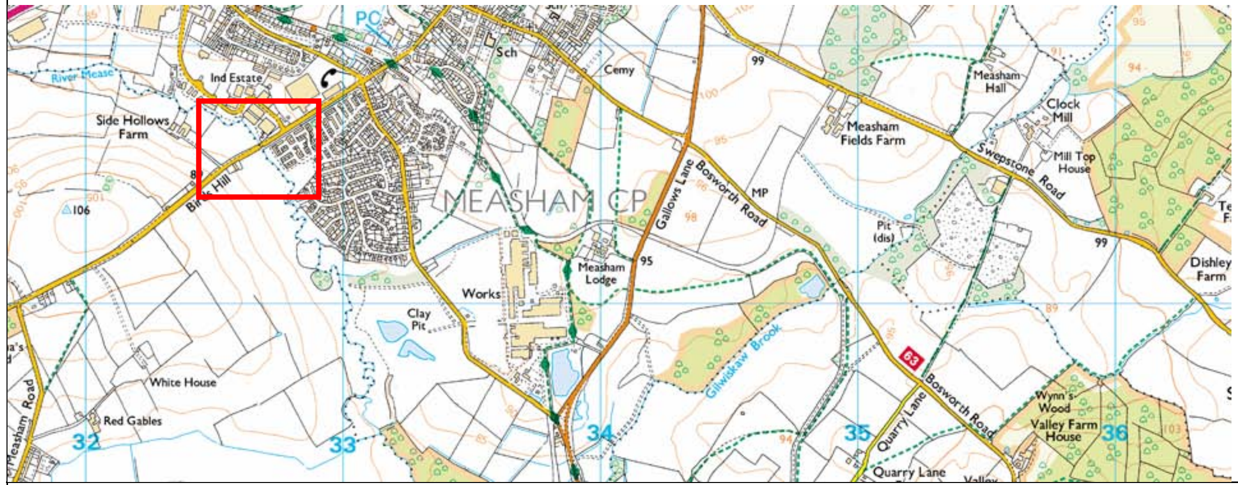
# River Mease at Measham (Birds Hill)

**Category: Restore**

**SSSI/SAC Unit:** 3 | **Reach:** MEA003

**Start NGR:** 432781 311479 | **End NGR:** 432600 311711

**Location:**



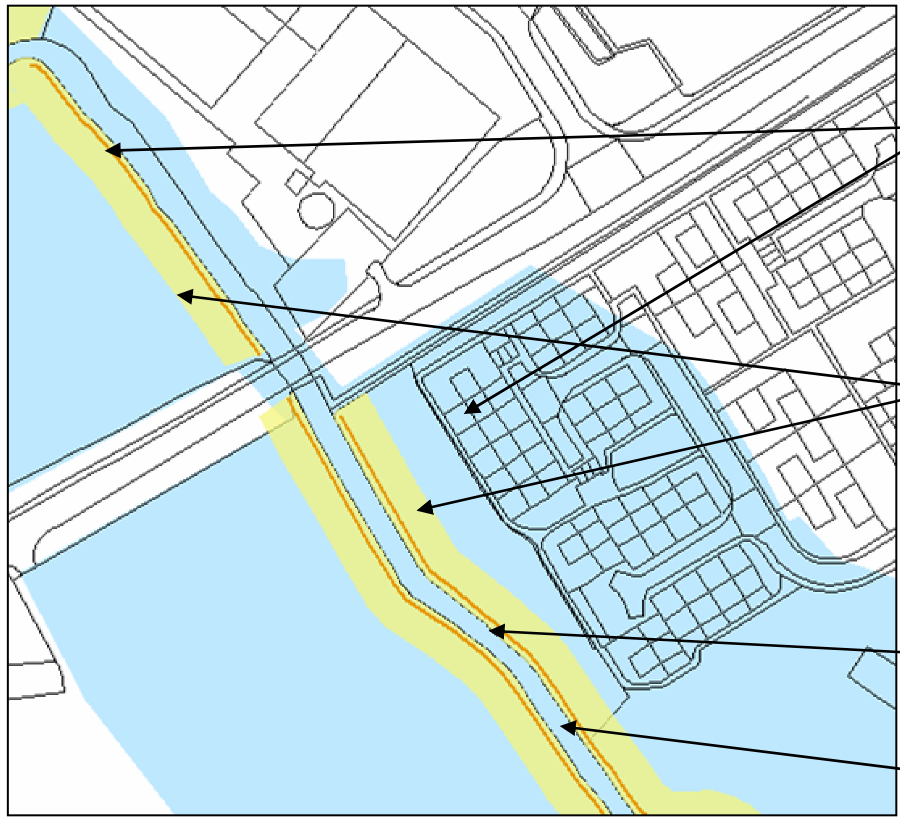

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the left bank is dominated by arable while the land to the right is used recreational grass land.
- The channel has been realigned into a straight course through this reach.

**Key issues:**

- The channel is very straight with a relatively uniform bed and high and steep banks which show little variation.
- The tree lining is relatively sparse, with only occasional clumps of trees present along the bank top.
- There is a section of bank reinforcement (mainly concrete) around the outside of the bend at the upper end of the reach, this prevents erosion and stops the channel developing a natural morphology.
- There is a strip of uncultivated land along the left bank top upstream of Birds Hill, however this is narrow and is unlikely to be effective at trapping sediment and nutrient runoff.

**Restoration actions:**



**Action R4**
Re-profile banks to create to create a variety of bank profiles along the full length of the reach.

**Action E2**
Improve the riparian zone vegetation along (parallel to) both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel.

**Action R5**
Reinstate coarse (gravel) bed material to create riffles in selected locations.

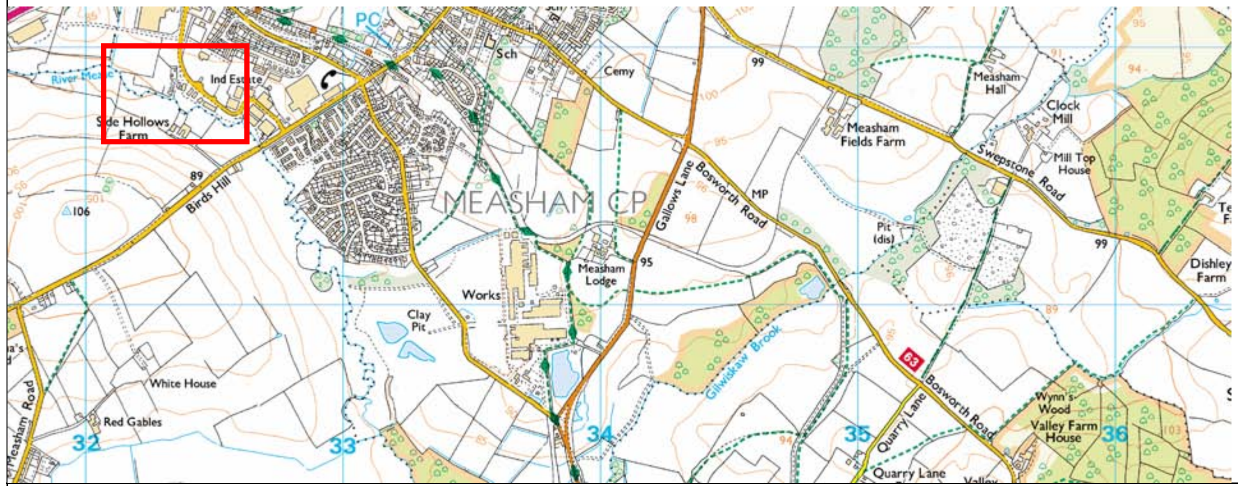
**Action R1**
Introduce woody debris along reach.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks and also introduce woody debris and gravel (riffle creation). | Re-profile both banks along the full length of the reach to create a variety of bank profiles and also introduce woody debris and gravels | Would allow a varied channel morphology to be created and provide variations in flow velocities. | Would require some change in land management along the channel margins. Increased woody debris may increase flood risk to properties. Further feasibility work would be required. |
| Improve the riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the channel margins, and change in land use on left bank. |

# River Mease at Side Hollows Farm

| Category: Rehabilitate | |
|---|---|
| **SSSI/SAC Unit:** 3 | **Reach:** MEA004 |
| **Start NGR:** 432600 311710 | **End NGR:** 432018 311917 |

**Location:**



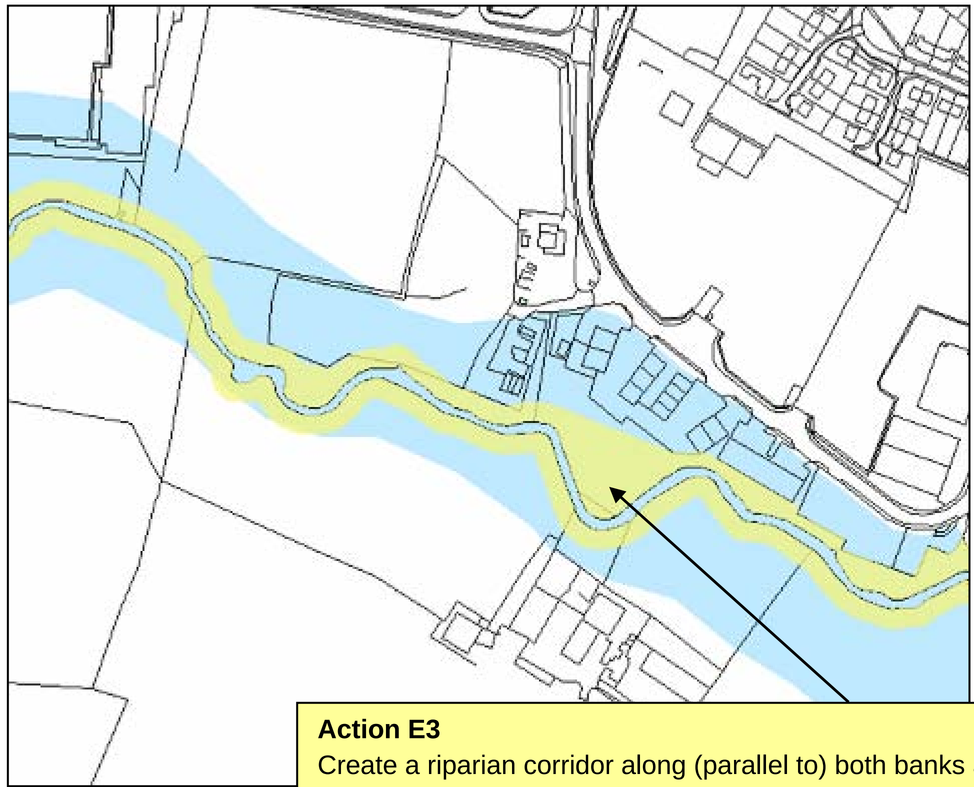

**Context:**

- The River Mease is set within a relatively narrow section of valley in this area with a narrow floodplain located along both banks.
- Land use along the left bank is dominated by grazed pasture while the land to the right is dominated by an industrial estate with a narrow strip of scrub between this and the channel.
- The channel has a sinuous channel course.

**Key issues:**

- The channel is grazed close to the bank top along the left side of the river.

**Restoration actions:**



**Action E3**
Create a riparian corridor along (parallel to) both banks along the full length of the reach. This should be at least 12m wide.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Create riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river and appropriate grazing or management of the river corridor.<br>The industrial estate along the right bank may limit the width of the riparian zone. |

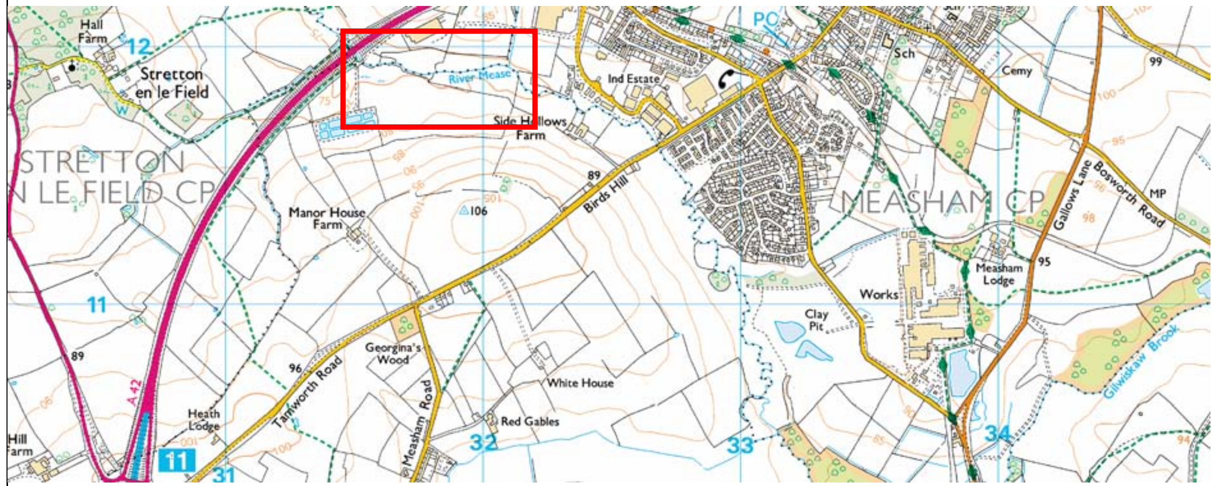
# River Mease upstream of the A42

**Category: Restore**

**SSSI/SAC Unit:** 3 | **Reach:** MEA005

**Start NGR:** 432018 311917 | **End NGR:** 431527 311949

**Location:**



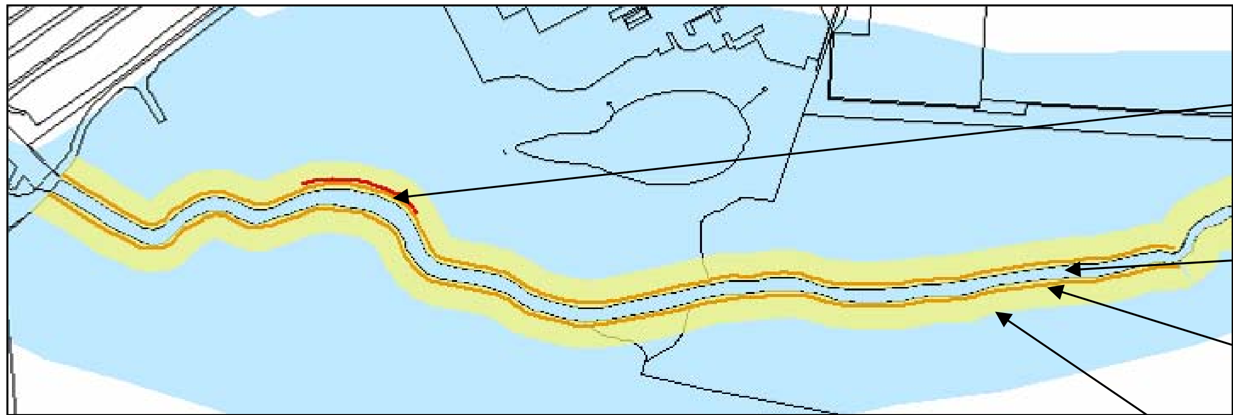

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the left bank is dominated by grazed pasture while the land to the right is fallow.
- The channel has been realigned into a straight course through this reach.

**Key issues:**

- The channel is very deep and has been straightened and deepened (re-sectioned).
- The riparian zone has been degraded by grazing and land disturbance.
- The floodplain to the left of the channel is heavily grazed up to the bank top.
- The floodplain to the right is generally fallow and covered by scrub with dense stands of nettle.
- The left bank is subject to localised erosion.
- Flow is very uniform and deep.

**Restoration actions:**



**Action R2**
Remove rock armour bank protection.

**Action R1 and R5**
Introduce woody debris and gravels into channel in selected locations.

**Action R4**
Re-profile banks to create to create a variety of bank profiles along the full length of the reach.

**Action E2**
Improve the natural riparian zone vegetation along (parallel to) both banks along the full length of the reach. This should ideally be at least 12m wide along both sides of the channel.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles. | Would allow a varied channel morphology to be created and provide variations in flow velocities. | Would require some change in land management along the river. |
| Remove bank reinforcement | Remove the stone bank reinforcement along the right bank. | Restores bank (earth) conditions. | It is unlikely that any subsequent bank erosion would be at scale that could impact on infrastructure, especially if the riparian vegetation is improved. |
| Add woody debris and gravels (riffle creation) to channel. | Flow is very uniform along this reach.<br>Adding gravels would allow riffles to be reinstated. | Increased diversity of flow patterns, water depths and velocities encourages a varied bed to develop by erosion and deposition. | None Identified. |
| Improve the riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some land management change (and appropriate grazing regime or other management along the river. |

# River Mease downstream of the A42

**Category: Restore**

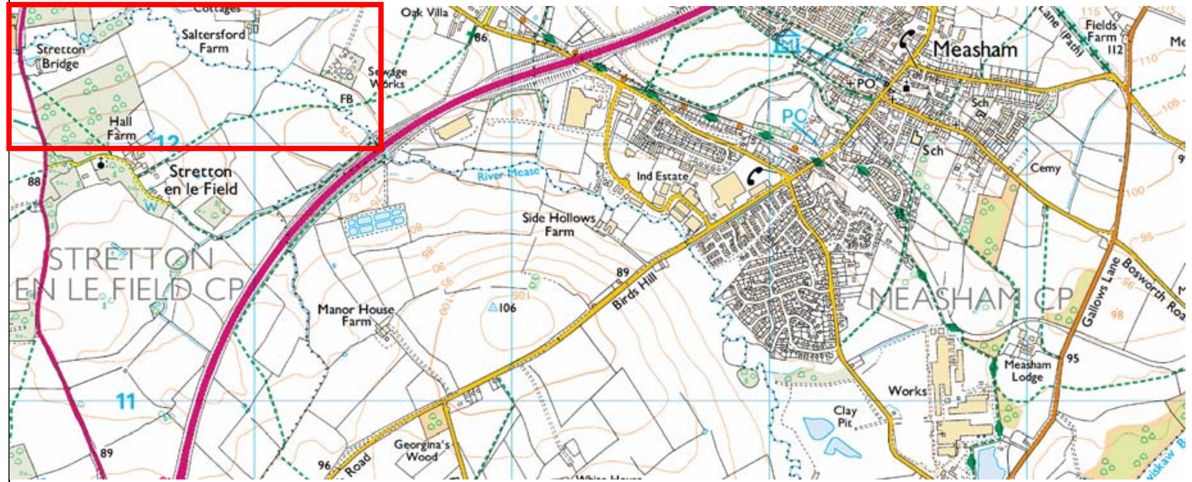
**SSSI/SAC Unit:** 3

**Reach:** MEA007

**Start NGR:** 431459 312042

**End NGR:** 430093 312371

**Location:**



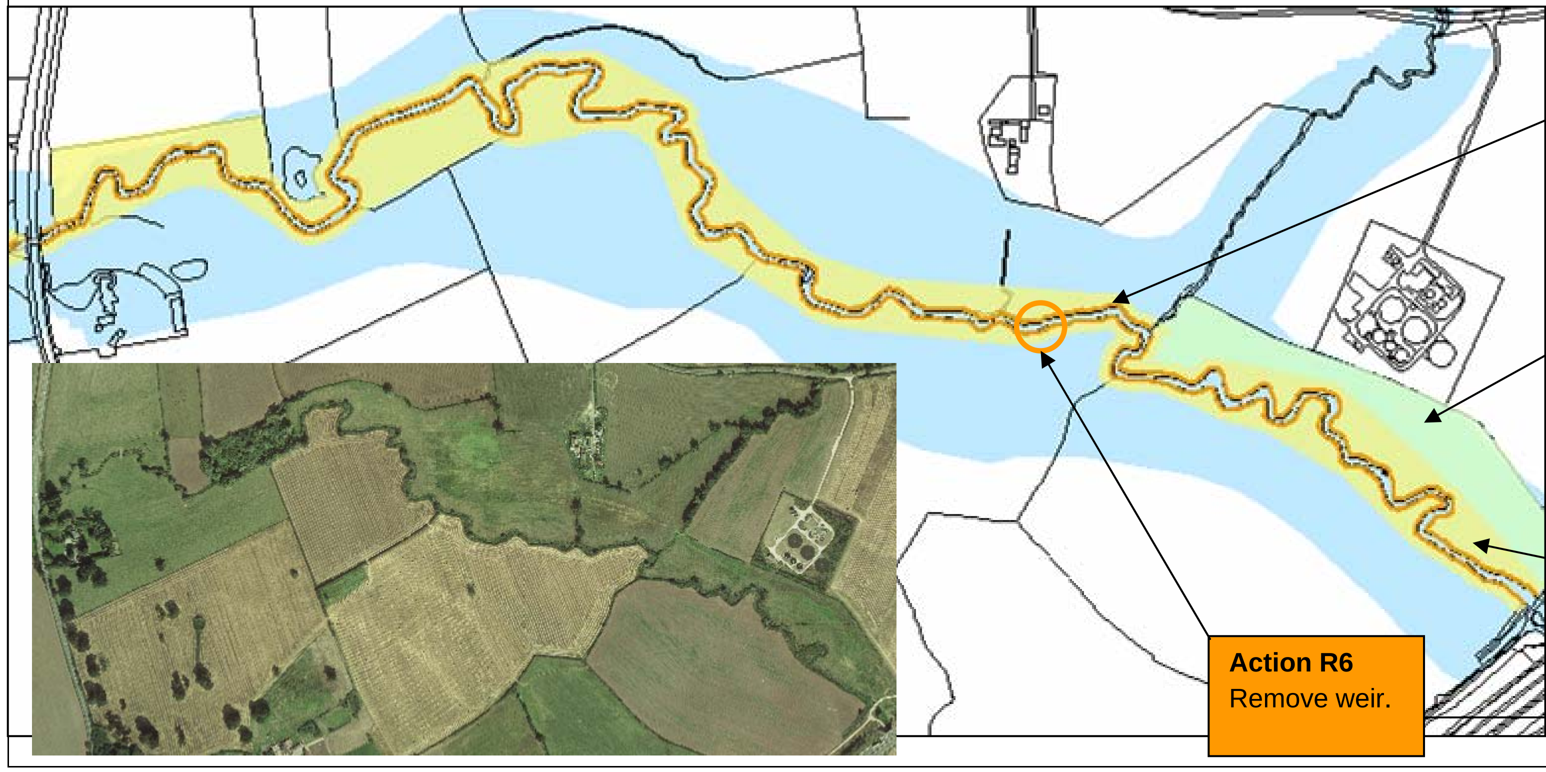

**Context:**

- The River Mease is set within a relatively narrow valley with floodplain located along both banks.
- Land use along the left bank is dominated by arable land while to the right improve grassland predominates.
- The channel has a meandering course through this reach.

**Key issues:**

- The riparian zone is narrow and tree cover is sparse. There is an area of heavy grazing in the lower section.
- Drainage from the A42 trunk road enters the channel immediately upstream of this reach. It is thought that this drainage increases the frequency of flooding along the river downstream.
- A sewage works on the right bank also discharges into river.
- There is an old weir on the river downstream of Saltersford Brook which causes ponding upstream.
- The channel has a uniform, narrow and deep cross-section which reflects past channel engineering.

**Restoration actions:**



**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

**Action R7**
Create an area of wetland to the right of the river. This could be used to intercept water draining from the A42 and water discharged from the sewage works.

**Action E3**
Create a riparian corridor along both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel. The riparian corridor should include the inside of the meanders in the channel to reduce the risk of soil erosion.

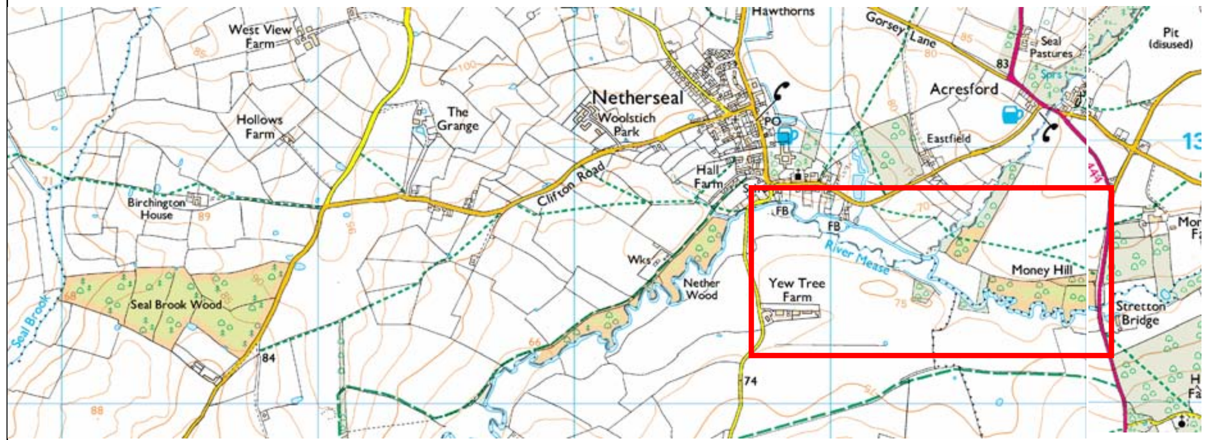
**Action R6**
Remove weir.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks; add woody debris and gravels (riffle creation). | Re-profile both banks along the full length of the reach to create a variety of bank profiles especially on inside banks of meanders. Add woody debris and gravels to increase the diversity of the channel. | Would allow a varied channel morphology to be created and provide variations in flow velocities. | Would require some change in land management along the channel. |
| Create an area of wetland | Create an area of wetland in the floodplain and also widening the lower section of Saltersford Brook. | Would help to attenuate flood flows and help trap fine sediment supplied by drainage from the A42, the sewage works and Saltersford Brook | Would require some change in land management to the right of the river. Look at land agreements to facilitate this. |
| Remove weir | Remove weir and associated embankments on either side of structure. | Would allow unrestricted movement of fish. Would lower water levels upstream and increase variation in flow velocities. | Reduced water levels may lead to localised bank instability. Improvements to the riparian zone would help stabilise the channel |
| Create a corridor of riparian vegetation. | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would involve preventing livestock access to the channel so would reduce the impact of poaching. | Would require some change in land management along the channel, including appropriate grazing regime |

# River Mease downstream of Stretton Bridge

| | | |
|---|---|---|
| **Category: Restore** | | |
| **SSSI/SAC Unit:** 2 | **Reach:** MEA008 | |
| **Start NGR:** 430093 312371 | **End NGR:** 428674 312761 | |

**Location:**



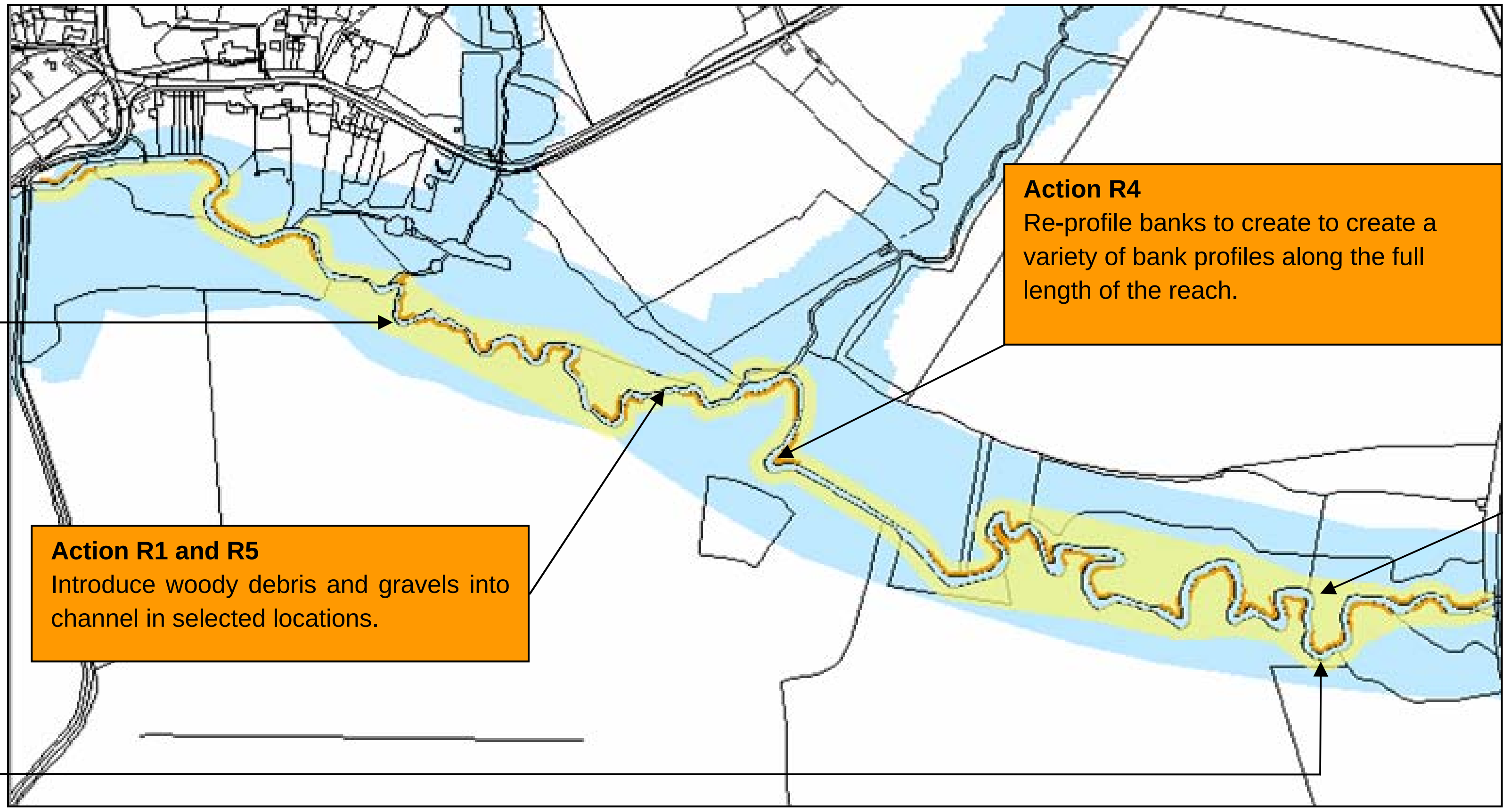

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the left bank is arable while the land to the right is improved grass land (pasture).
- The channel has a sinuous planform and has a relatively diverse in-channel morphology which reflects readjustment following past modification (the channel width and depth varies and a range of flow types are present.

**Key issues:**

- The land to the left of the river channel is tilled up to the bank top including areas of floodplain on the insides of tight meanders (although the degree to which this occurs varies between years) (see aerial photographs below). Cultivating the land on the inside of meanders in this manner increases the risk of soil erosion during floods as flood water often cuts across the inside of the bends.
- The left bank is subject to localised erosion which appears to be exacerbated by the proximity of ploughing and the absence of natural riparian vegetation.

**Restoration actions:**



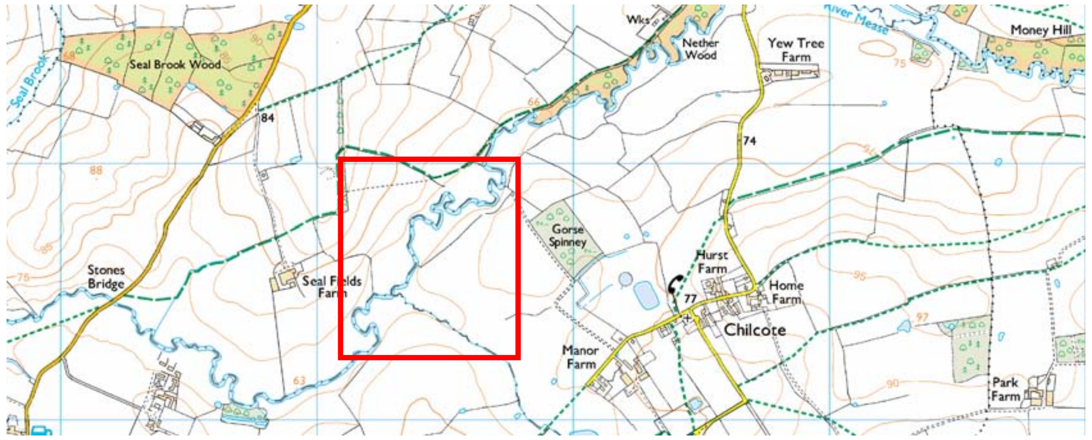

**Action E3**
Create riparian corridor along both banks along the full length of the reach. This should be at least 12m wide along both sides of the channel. The riparian corridor should include the inside of the meanders in the channel to reduce the risk of soil erosion. The current situation and the proposed approach are shown in the aerial photograph above.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks; add woody debris and gravels (riffle creation). | Re-profile banks on inside of meanders. Add woody debris and gravels to increase the diversity of the channel. | Would allow a varied channel morphology to be created and provide variations in flow velocities. | Would require some change in land management along the channel. |
| Create a corridor of riparian vegetation | Create a riparian corridor along both banks of the channel. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor, including appropriate grazing regime. |

# River Mease east of Seal Fields Farm

| Category: Restore | |
|---|---|
| **SSSI/SAC Unit:** 2 | **Reach:** MEA010 |
| **Start NGR:** 427658 311985 | **End NGR:** 427225 311294 |

**Location:**



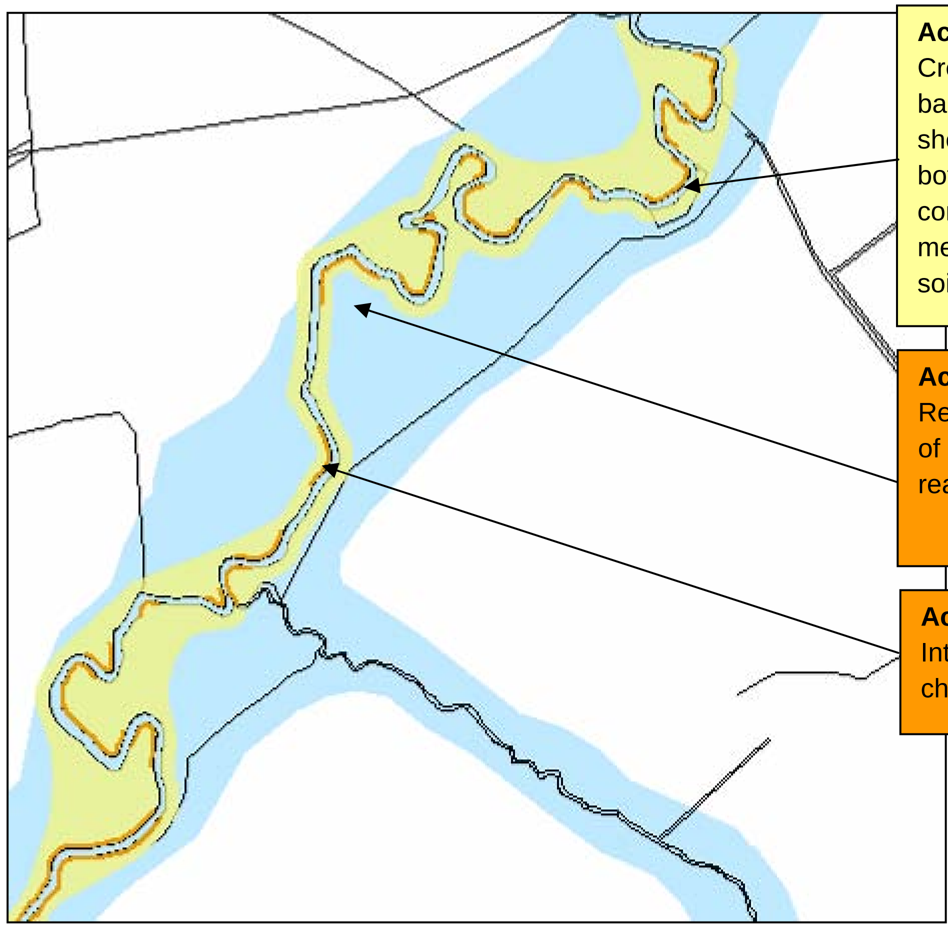

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the right bank is dominated by arable fields while the land to the left includes some areas of improved grass land (pasture).
- The channel has a sinuous planform and has a relatively diverse in-channel morphology which reflects readjustment following past modification (the channel width and depth varies and a range of flow types are present).

**Key issues:**

- The land to the right of the river channel is tilled close to the bank top and also on the inside of tight meanders. Cultivating the land on the inside of meanders in this manner increases the risk of soil erosion during floods as flood water often cuts across the inside of the bends.
- Tree lining in this reach is discontinuous.

**Restoration actions:**



**Action E3**
Create a riparian corridor of along both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel. The riparian corridor should include the inside of the meanders in the channel to reduce the risk of soil erosion.

**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

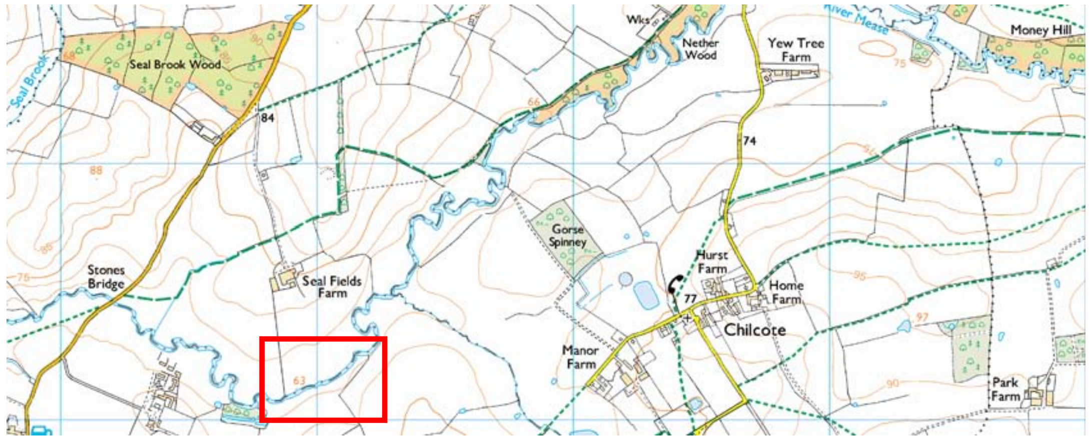
**Action R1 and R5**
Introduce woody debris and gravels into channel in selected locations.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks; add woody debris and gravels (riffle creation). | Re-profile banks on inside of meanders. Add woody debris and gravels to increase the diversity of the channel. | Would allow a varied channel morphology to be created and provide variations in flow velocities. | Would require some change in land management along the channel. |
| Create a riparian corridor | Create a riparian corridor along both banks of the channel. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor. |

# River Mease south of Seal Fields Farm

| Category: Restore | |
|---|---|
| **SSSI/SAC Unit:** 2 | **Reach:** MEA011 |
| **Start NGR:** 427225 311294 | **End NGR:** 426814 311073 |

**Location:**



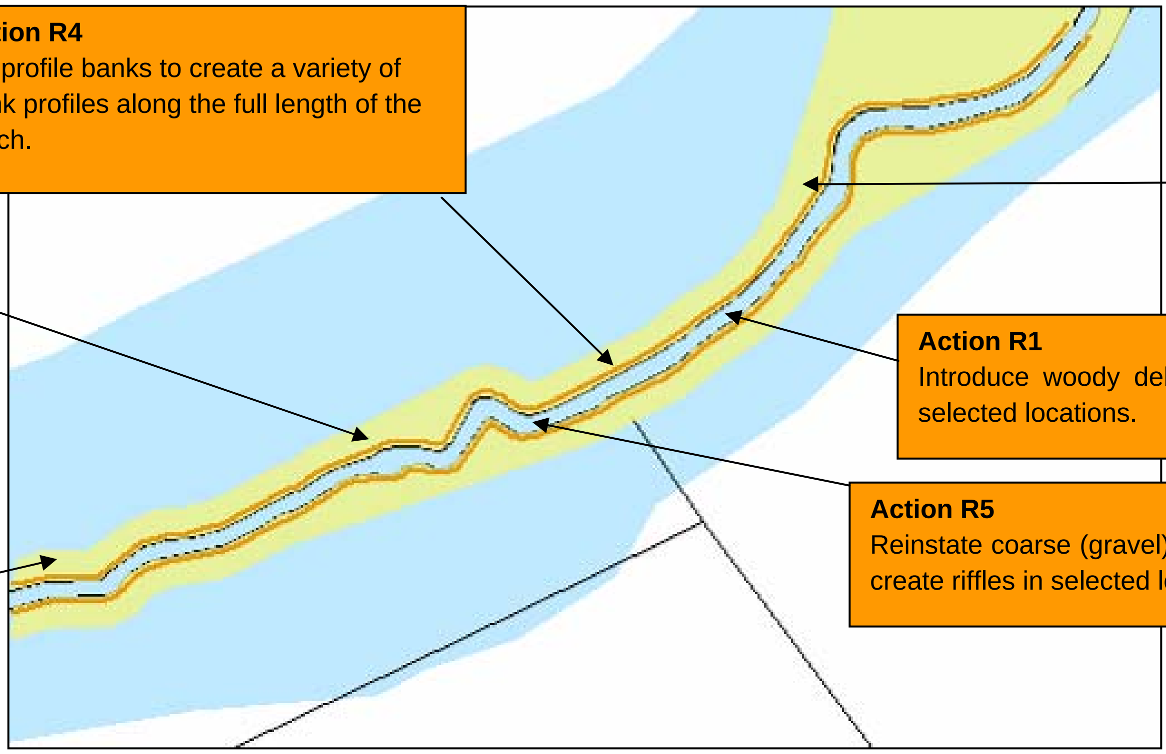

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along both banks bank is dominated by arable fields, although the land to the left of the river has been left uncultivated in places and appears to be becoming increasingly water logged (rushes are present).
- The channel has a straight planform.

**Key issues:**

- The land along both banks of the river channel is tilled close to the bank top and the uncultivated margin is very uniform.
- The channel has a very straight planform which is atypical of the river in this part of the catchment.
- The flow is very uniform and deep (glide) throughout.
- Tree lining of the channel is absent in this reach.

**Restoration actions:**



**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

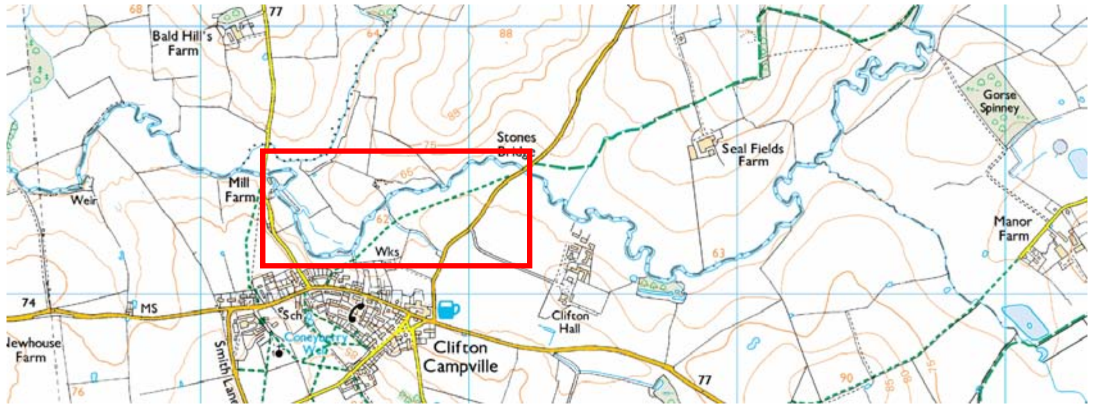
**Action R1**
Introduce woody debris into channel in selected locations.

**Action R5**
Reinstate coarse (gravel) bed material to create riffles in selected locations.

**Action E2**
Improve the riparian vegetation along (parallel to) both banks along the full length of the reach. This should be at least 12m wide along both sides of the channel.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles and a sinuous low flow channel. | Would allow a sinuous channel course to be created and also opportunities to increase flow velocity by narrowing the channel. | Would require some change in land management along the river banks. |
| Add woody debris to channel | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities, Encourages a varied bed to develop by erosion and deposition. | None identified. |
| Reinstate coarse bed (riffle creation) | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities | May raise water levels upstream.<br>May reduce effectiveness of field drains. |
| Improve the riparian vegetation | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor. |

| **River Mease at Clifton Campville** | **Category: Restore** | |
|---|---|---|
| | **SSSI/SAC Unit:** 2 | **Reach:** MEA013 |
| **Location:** | **Start NGR:** 426198 311466 | **End NGR:** 425233 311450 |



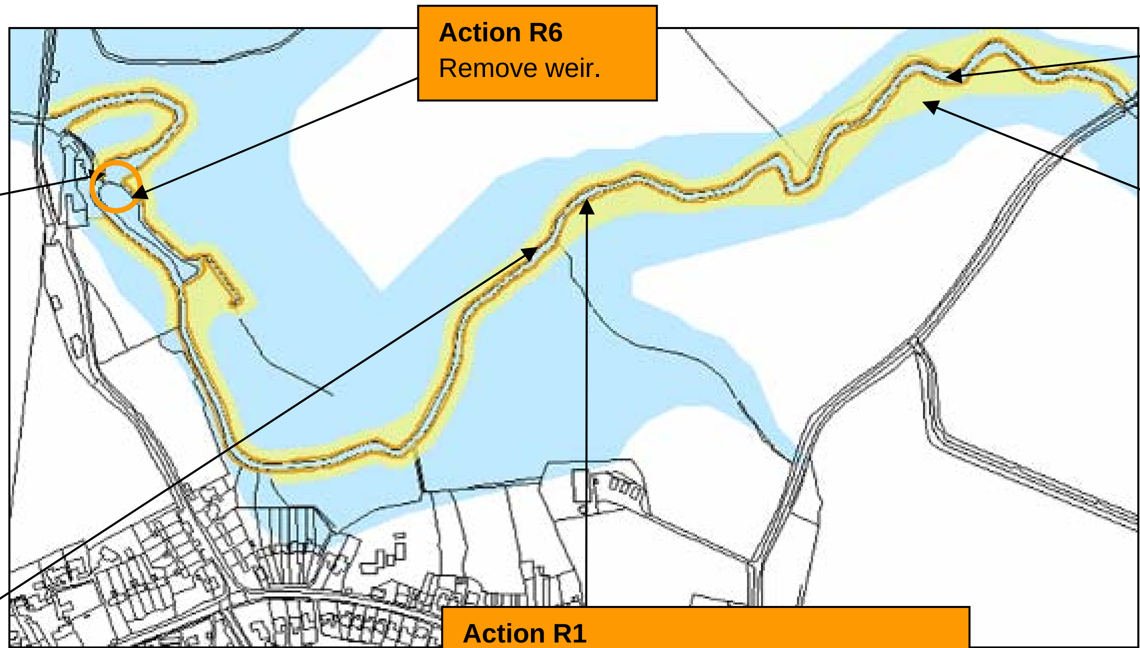

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along both banks bank is dominated by arable fields, although the land to the left of the river in the lower reaches is dominated by improved grassland.
- The channel has a gently sinuous planform with occasional meanders.

**Key issues:**

- The land along both banks of the river channel is tilled close to the bank top and the uncultivated margin is very uniform. Tree lining of the channel is limited with trees being restricted to occasional clumps.
- The flow is very uniform and deep (glide) throughout.
- There is a weir at the lower end of the reach with acts as a barrier to fish and also increases water depth upstream creating deep water with uniform flow (glide).

**Restoration actions:**



**Action R6**
Remove weir.

**Action R5**
Reinstate coarse (gravel) bed material to create riffles in selected locations.

**Action E3**
Create a riparian corridor along both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel.

**Action R1**
Introduce woody debris into channel in selected locations along the reach.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Remove weir | Remove weir and associated embankments on either side of structure. | Would allow unrestricted movement of fish.<br>Would lower water levels upstream and increase variation in flow velocities creating a more dynamic natural bed | Reduced water levels may lead to localised bank instability. However, improvements to the riparian zone would help stabilise the channel reduce. A separate feasibility report is being produced. |
| Add woody debris to channel and mixed river gravels | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities encourages a varied bed to develop by erosion and deposition. | None identified. |
| Reinstate coarse bed (riffle creation) | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities | Would only be effective if weir removal is undertaken. |
| Create a riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor, including appropriate grazing regime. |

# River Mease south of Poplars Farm

**Category: Restore**

**SSSI/SAC Unit:** 2 | **Reach:** MEA016

**Start NGR:** 423369 311366 | **End NGR:** 422704 311088

**Location:**

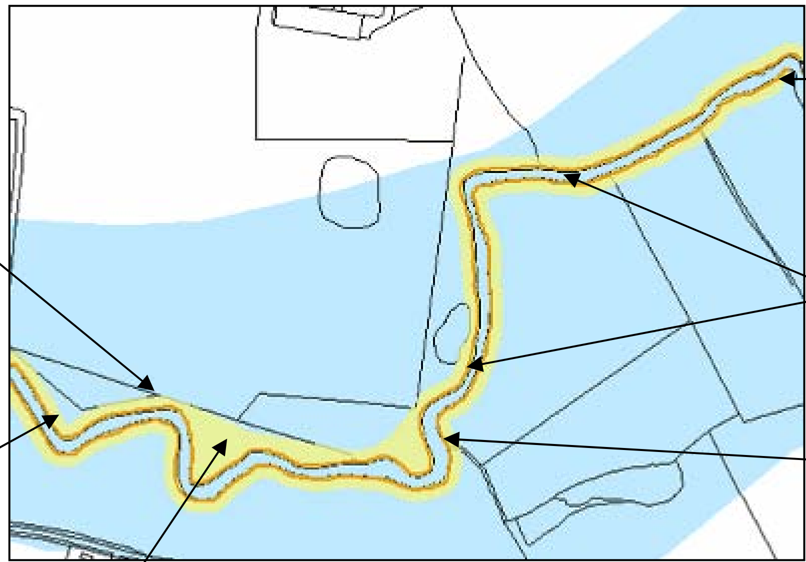

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along both banks is dominated by arable fields while the land use to the left includes some areas of improved grassland used for pasture.
- The planform is straight with occasional bends where the channel changes direction. There are two minor meanders.

**Key issues:**

- The channel has a relatively straight planform with fewer meanders than other sections of the river in this part of the catchment.
- Flow is very uniform and deep (glide) throughout.
- The channel is relatively wide and is filled by dense beds of emergent aquatic vegetation along much of the reach.
- Tree lining of the channel is generally absent in this reach although occasional clumps are present.

**Restoration actions:**



**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

**Action R1**
Introduce woody debris into channel in selected locations.

**Action R5**
Reinstate coarse (gravel) bed material to create riffles in selected locations.

**Action E3**
Create a riparian corridor along both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles and a sinuous low flow channel. | Would allow a sinuous channel course to be created and also opportunities to increase flow velocity by narrowing the channel. | Would require some change in land management along the river corridor. |
| Add woody debris to channel | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities encourages a varied bed to develop by erosion and deposition. | None identified. |
| Reinstate coarse bed (riffle creation) | Flow is very uniform, slow and deep along this reach and this appears to have encouraged the growth of dense beds of in-channel vegetation. | Increased diversity of flow patterns and velocities | May raise water levels upstream in certain flow conditions.<br>May reduce effectiveness of field drains. |
| Create a riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor, including appropriate grazing regime. |

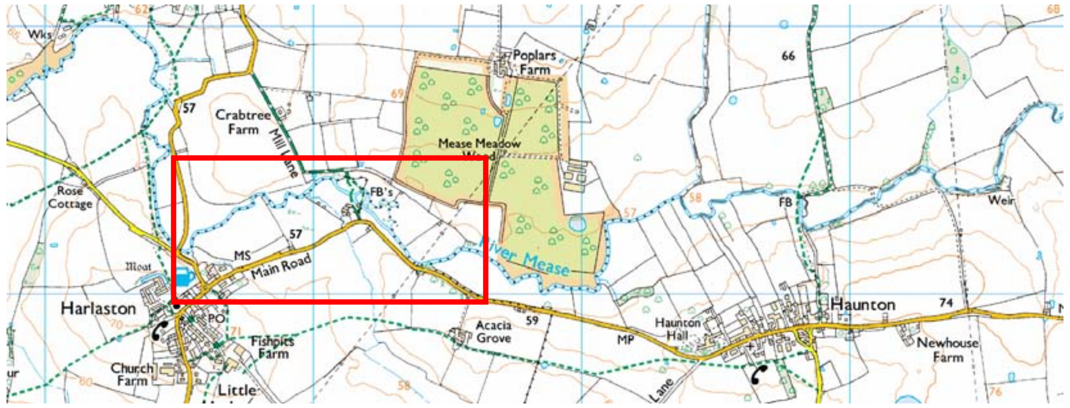
# River Mease upstream of Harlaston

**Category: Restore**

**SSSI/SAC Unit:** 2 | **Reach:** MEA017

**Start NGR:** 422704 311088 | **End NGR:** 421504 311167

**Location:**



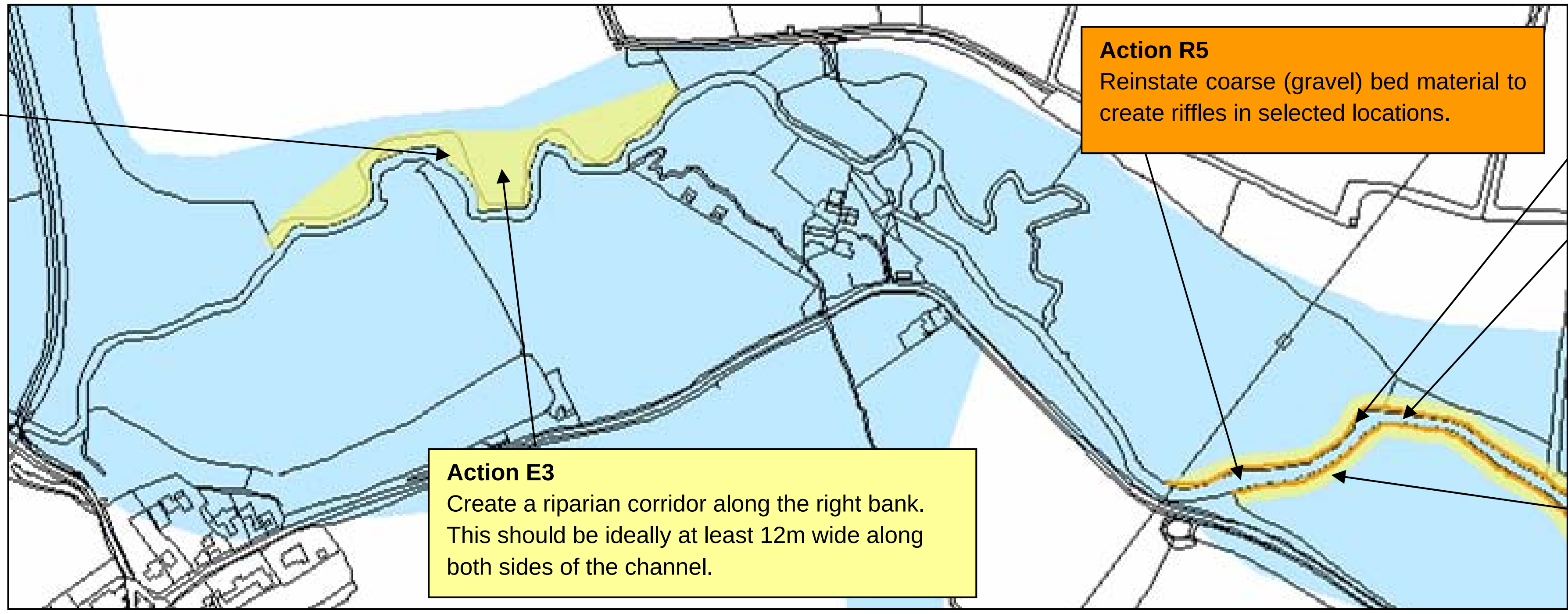

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along both banks is dominated by arable fields with occasional areas of pasture and woodland plantations. The land use to the left is generally dominated by improved grassland used for pasture.
- The planform is sinuous and meandering in places.

**Key issues:**

- In the upper part of the reach the channel has a relatively straight planform with fewer meanders than other sections of the river in this part of the catchment.
- The channel has narrowed along the reach, however, flow is very uniform and deep (glide) throughout.
- The land to the right of the river channel in the lower section of the reach is tilled close to the bank top and also in the inside of tight meanders. Cultivating the land on the inside of meanders in this manner increases the risk of soil erosion during floods as flood water often cuts across the inside of the bends.

**Restoration actions:**




**Action R4**
Re-profile banks to create a variety of bank profiles.

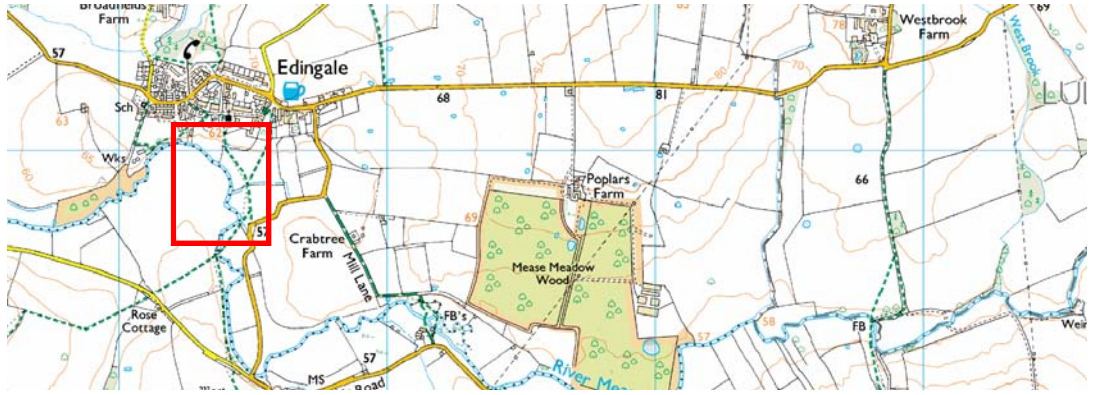
**Action R1**
Introduce woody debris into channel in selected locations.

| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles and a sinuous low flow channel. | Would allow a sinuous channel course to be created and also opportunities to increase flow velocity by narrowing the channel. | Would require some change in land management along the river corridor. |
| Add woody debris to channel | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities encourages a varied bed to develop by erosion and deposition. | None identified. |
| Reinstate coarse bed (riffle creation) | Flow is uniform, slow and deep along this reach and this appears to have encouraged the growth of dense beds of in-channel vegetation. | Increased diversity of flow patterns and velocities | May raise water levels upstream in certain flow conditions.<br>May reduce effectiveness of field drains. |
| Create a riparian corridor | Create a riparian corridor along the banks of the channel, including the re-profiled banks. | Would help to prevent sediment release from field runoff and also provide cover for fish and a source of woody debris. | Would require some change in land management along the river corridor, including appropriate grazing regime. |

# River Mease upstream of Edingale

| **Category: Rehabilitate** | |
|---|---|
| **SSSI/SAC Unit:** 1 | **Reach:** MEA019 |
| **Start NGR:** 421420 311506 | **End NGR:** 421381 311941 |

**Location:**



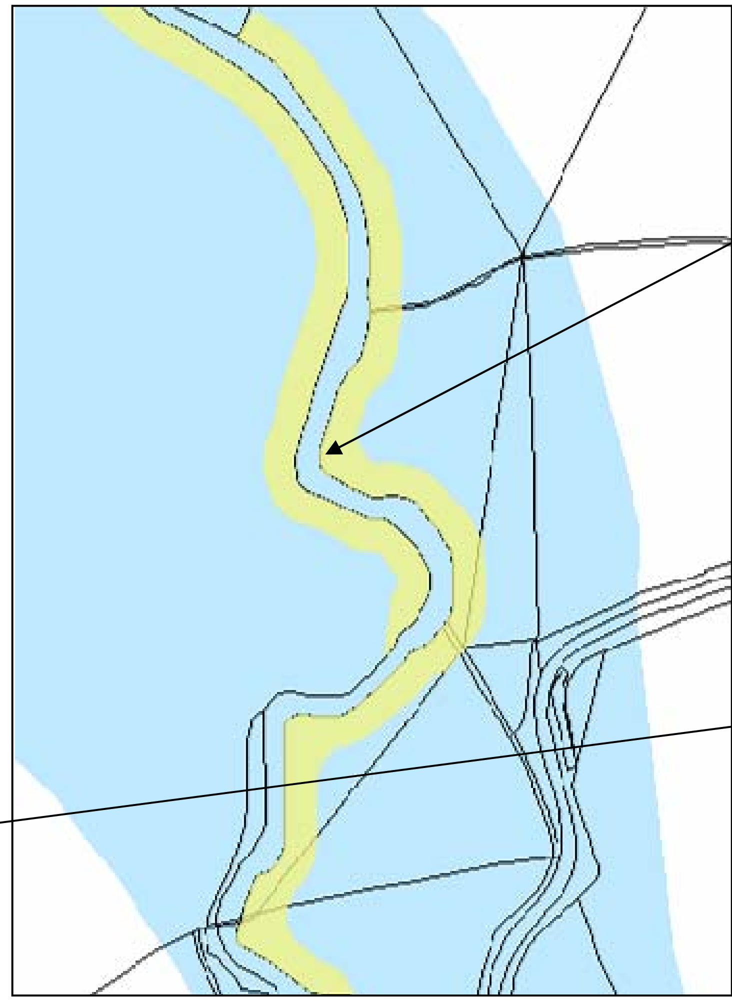

**Context:**

- The River Mease is set within a relatively narrow section of valley. The position of the channel alternates from the left side of the valley to the right. The floodplain is high and slopes towards the channel along the right bank.
- Land use along the left side of the channel is dominated by a single large arable field. Land use to the right is generally dominated by improved grassland used for pasture.
- The planform has a relatively low sinuosity.

**Key issues:**

- The channel shows evidence of adjustment towards a more natural form following past modification, primarily through narrowing. However, flow is very uniform and deep (glide) throughout.
- The land to the left of the river channel in the lower section of the reach is tilled close to the bank top
- In the lower half of the reach livestock are free to graze the river bank right up to the waterline.
- Tree lining of the channel is discontinuous and trends to be restricted to the upper section of the reach.

**Restoration actions:**



**Action E2**
Improve the riparian vegetation along (parallel to) both banks along the full length of the reach. This should be ideally at least 12m wide along both sides of the channel.

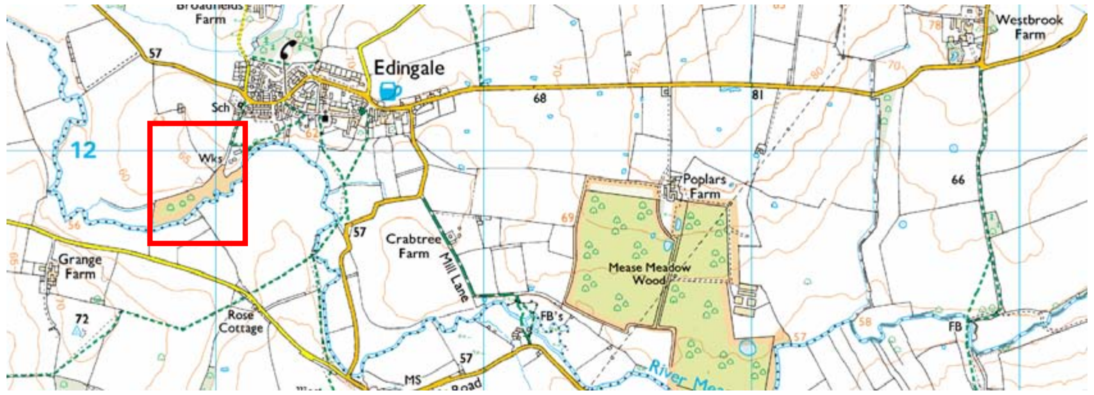
The photograph below illustrates a section of the reach which shows good tree cover.

| Action | Sites specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Improve the riparian vegetation | Create a riparian corridor along both banks of the channel. | Would help to prevent sediment release from field runoff and also provide cover for fish and a source of woody debris enabling further adjustment of the channel morphology over time. | Would require some change in land management along the river corridor, including appropriate grazing regime. |

# River Mease downstream of Edingale

| | |
|---|---|
| **Category: Rehabilitate** | |
| **SSSI/SAC Unit:** 1 | **Reach:** MEA020 |
| **Start NGR:** 421381 311941 | **End NGR:** 420932 311788 |

**Location:**



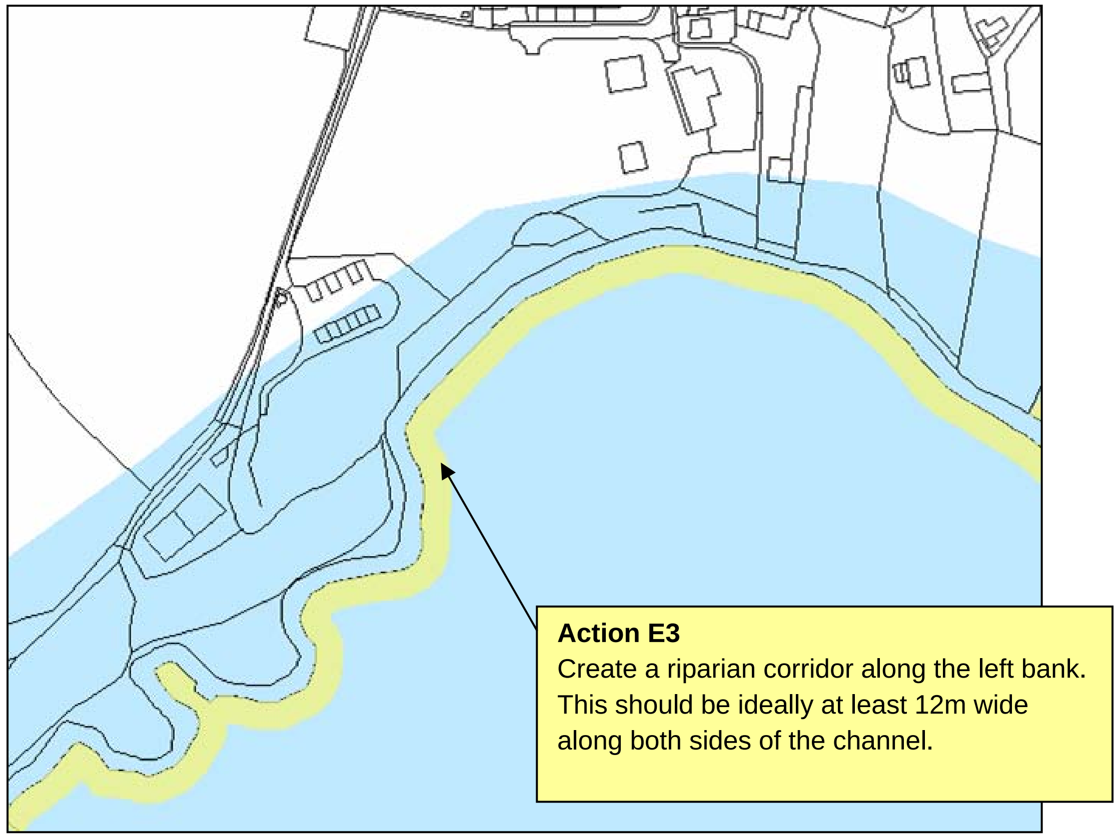

**Context:**

- The River Mease is set within a relatively narrow section of valley. The channel is located along the base of the right side of the valley in this reach.
- Land use along the left side of the channel is dominated by a single large arable field
- The land use to the right is dominated by an area of woodland.
- The river has a meandering planform and the channel morphology appears to be adjusting (increasing in diversity) through the deposition of sediment promoting the development of marginal features (berms).

**Key issues:**

- The land to the left of the river is ploughed close to the bank top and the existing uncultivated margin is relatively narrow.
- The left side of the channel lacks tree cover.

**Restoration actions:**



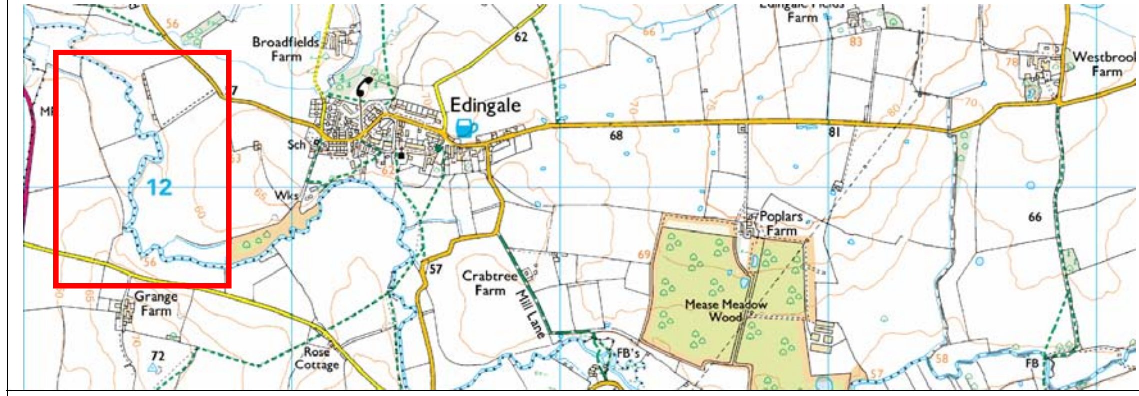

| Action | Sites specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Create a riparian corridor | Create a riparian corridor along the left bank of the channel. | Would help to prevent sediment release from field runoff and also provide cover for fish and a source of woody debris enabling further adjustment of the channel morphology over time. | Would require some change in land management along the left bank. |

# River Mease north of Grange Farm

**Category: Restore**

| **SSSI/SAC Unit:** 1 | **Reach:** MEA021 |
|---|---|
| **Start NGR:** 420932 311788 | **End NGR:** 420229 312590 |

**Location:**



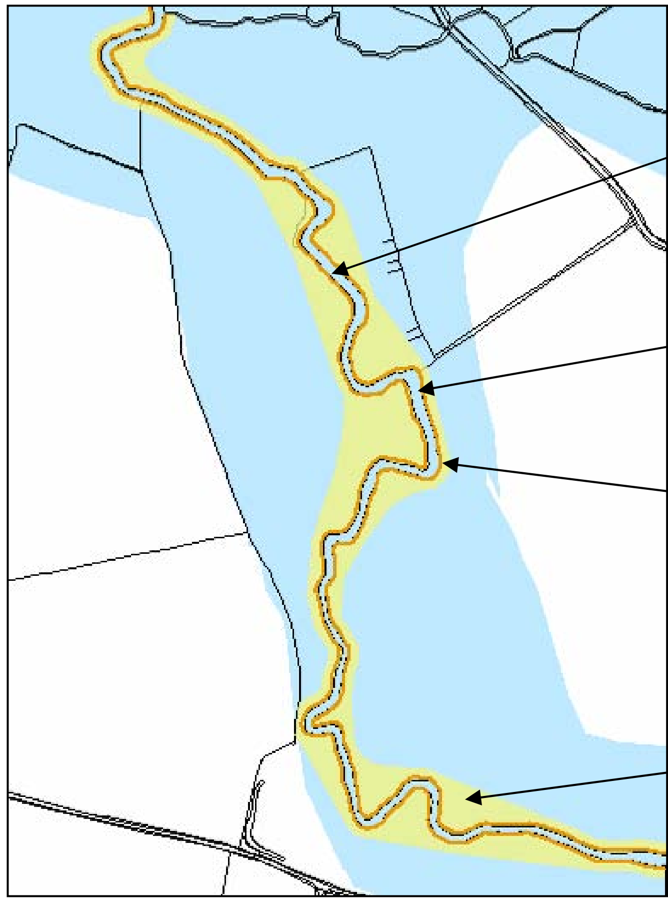

**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the river channel is either arable or improved grassland used for pasture.
- The planform is sinuous with occasional meanders.
- The channel is deep and flow is relatively uniform (deep glide). The bank slopes are variable ranging from steep to gentle. This appears to reflect adjustment following past modification.

**Key issues:**

- In the upper section of the reach the left bank has been damaged by trampling by livestock (poaching).
- The riparian zone lacks trees and is very narrow in places, especially in the upper half of the reach.
- Flow is very uniform and deep (glide) throughout.

**Restoration actions:**



**Action R4**
Re-profile banks to create a variety of bank profiles along the full length of the reach.

**Action R1**
Introduce woody debris into channel in selected locations.

**Action R5**
Reinstate coarse (gravel) bed material to create riffles in selected locations.

**Action E3**
Create a riparian corridor along both banks in the lower half of the reach. This should be ideally at least 12m wide along both sides of the channel.

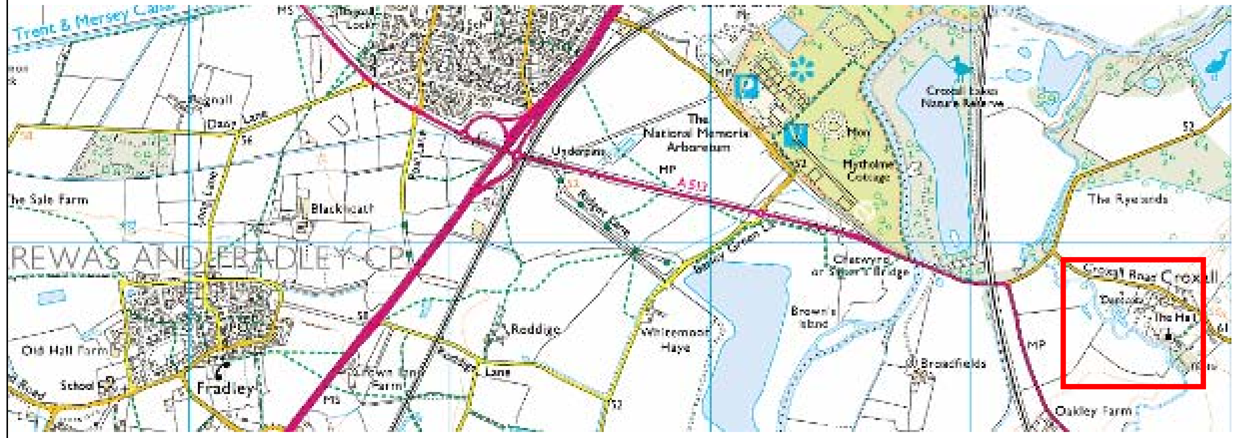
| Action | Site specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Re-profile banks | Re-profile both banks along the full length of the reach to create a variety of bank profiles and a sinuous low flow channel. | Would allow a sinuous channel course to be created and also opportunities to increase flow velocity by narrowing the channel. | Would require some change in land management along the river corridor. |
| Add woody debris to channel | Flow is very uniform along this reach. | Increased diversity of flow patterns and velocities Creates a varied bed through by erosion and deposition. | None identified. |
| Reinstate coarse bed (riffle creation) | Flow is very uniform, slow and deep along this reach and this appears to have encouraged the growth of dense beds of in-channel vegetation. | Increased diversity of flow patterns and velocities. | May reduce effectiveness of field drains. |
| Create a riparian corridor | Create a riparian corridor along both banks of the channel, including the re-profiled banks. | Would help to stabilise the banks of the channel, provide cover for fish and a source of woody debris, | Would require some change in land management along the river corridor, including appropriate grazing regime. |

# River Mease at Croxall

**Category: Rehabilitate**

| **SSSI/SAC Unit:** 1 | **Reach:** MEA024 |
|---|---|
| **Start NGR:** 419814 313487 | **End NGR:** 419284 314020 |

**Location**



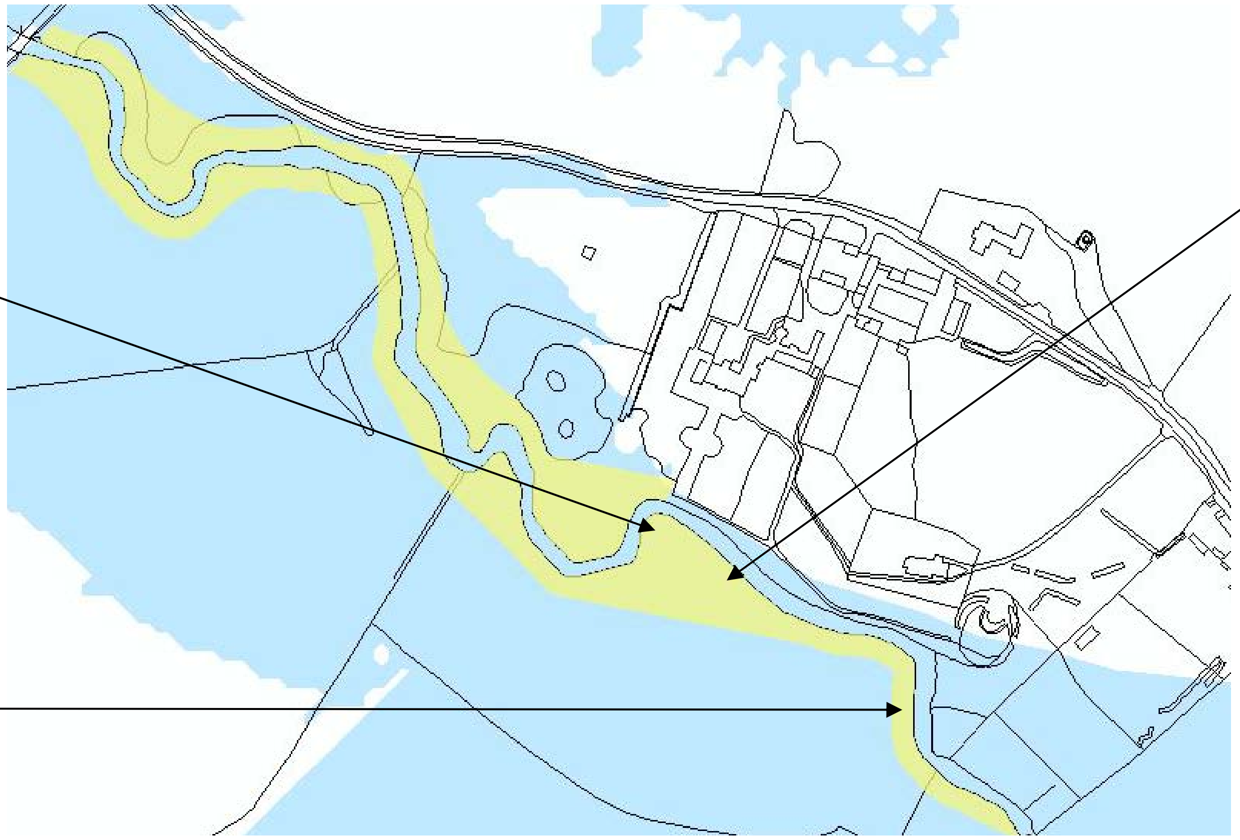
**Context:**

- The River Mease is set within a relatively broad valley with floodplain located along both banks.
- Land use along the river channel is dominated by arable fields along the left bank and improved grassland (grounds of property) along the right bank.
- The planform is sinuous with occasional meanders.
- The channel is deep and flow is relatively uniform (deep glide), however the bank slopes are variable ranging from steep to gentle and the channel width is highly varied. This appears to reflect adjustment following past modification.

**Key issues:**

- The riparian zone to the left of the river lacks trees and is very narrow in places as ploughing occurs close to the bank top (narrow uncultivated margin).
- While there are tree present along the right bank, these are actively managed and relatively scattered and the ground vegetation is managed by mowing along the bank tops. This reduces the amount of wood debris supply and the degree of channel cover provided by trees.

**Restoration actions:**



**Action E3**
Create a riparian corridor along both banks. This should be ideally at least 12m wide along both sides of the channel.

| Action | Sites specific details (refer also to Section 3) | Site specific benefits (refer also to Section 3) | Site specific constraints |
|---|---|---|---|
| Create a riparian corridor | Create a riparian corridor along both banks of the channel. | Would help to prevent sediment release from field runoff and also provide cover for fish and a source of woody debris enabling further adjustment of the channel morphology over time. | Would require some change in land management along the river corridor, including fencing where land is grazed.<br>Croxall Hall is Grade 2 Listed building. Riparian improvement proposals must be sensitive to the landscape and historic context of the site. The grounds are currently maintained for the benefit of wildlife and as such major improvements in this area may not be necessary. |

# Section 5 **Implementing the plan**

## Working with landowners and land managers

To achieve the aims of this river restoration plan, the Environment Agency and Natural England recognise the need for effective and positive engagement with landowners and land managers. General comments on restoration options has helped identify immovable constraints (such as major infrastructure) and additional opportunities, whilst comments on individual river reaches in this report will inform future 1-1 discussions with landowners as reach specific restoration projects are taken forward. The main comments and concerns raised are summarised below:

During the consultation event a range of valid concerns were raised by riparian land owners and their representatives. One of the key issues was the proposal for a 12m riparian buffer strip along the river banks. The 12m width is an ideal, best practice width but it is recognised there are local constraints and as such, there will be flexibility about the width of buffer strips on a site-by site basis when refining the details of the plan. Concerns were also raised that the riparian zone would consist of dense trees and shrubs throughout the length of the river. The intention is to provide a range of different habitats in the riparian corridor, rather than a uniform length of a single habitat such as trees and shrubs. In some locations this may include trees; elsewhere however, it could be primarily grass. The overall aim is to establish or enhance an uncultivated riparian corridor, with a variety of habitats within it. Appropriate management such as grazing or mowing, rotational cutting or coppicing will be required in order to achieve this.

A further major source of concern regarded the potential for increased flood risk due to the formation of blockages in the channel. Permanent blockage of the river is not a desired outcome of the restoration plan, and as such Natural England are willing to consider authorising cutting fallen trees into smaller pieces to prevent this. The need for adaptive management of this issue has now been made more explicit within the plan.

The impact of the proposals on land drainage was raised, particularly in connection with the introduction of gravel into the channel. Gravel would not be introduced over wide areas (whole reaches), rather it would be targeted in key locations to create features such as riffles. These will make the water depth/flow shallower in some locations (by raising the bed) but this will not be undertaken in a manner that could increase water levels upstream. Flow at riffles is faster than in slow deep sections and this compensates for a loss of capacity.

Reductions in the effectiveness of land drains due to sediment deposition on the bed was also highlighted. It is recognised that in some specific locations this may cause problems. However, the sensitivity of the river ecology precludes dredging or de-silting. Such activities are not sustainable. Where drainage issues occur this plan provides a means by which farmers can seek support to alter land management in order to adapt to these changes in the river. One of the objectives of this plan is to reduce the amount of fine sediment washed into the river.

Several attendees suggested that decline in fish stocks in the river could be attributed to the way in which the river has been managed since designation as a SSSI/SAC (i.e. reduced maintenance). There is no scientific evidence to support this. On the contrary, restoring the natural habitat of fish species is known to bring improvements, assuming other pressures are addressed. The decline in fish stocks in the River Mease SSSI/SAC is far more likely to reflect a number of severe pollution incidents over the past decade, and the fact that since 2007 the Environment Agency has ceased restocking the river. The EA fishery management approach is now geared towards natural recovery and recruitment of fish, which is more sustainable but this means it take longer for fish populations to recover. Changing from an artificially managed fishery to a naturally maintained fishery will take time and in the short-term, variations in population levels can be expected.

For any of the proposals in the plan to be implemented, it will be necessary to work closely with landowners and, where appropriate, other stakeholders. Landowners and managers will play an important role in developing the proposals, and in some cases may take ownership of the implementation of the actions with appropriate technical and financial assistance.

Whilst some options will be able to be implemented over the next few years, other measures will take longer to organise with the landowners and interested parties. Some reaches will have little active intervention, but may still need agreements on adjacent land use or to allow the river to naturally recover in its own time, which may take many years.

## Prioritisation and cost

The restoration options have been prioritised according to the degree of improvement to the SSSI/SAC they will bring. Restoration options which will bring the most significant improvements, by restoring the degraded reaches showing no evidence of natural recovery, have been prioritised for implementation in the short-term (by 2015) (Table 7). Those reaches which show evidence of natural recovery have been sub-divided according to the degree of recovery. Reaches showing some recovery will be implemented in the medium term (by 2027) (Table 8). Those reaches which already exhibit evidence of significant recovery or a low degree of modification will be addressed in the longer-term (by 2050) (Table 9). It may be that ongoing natural recovery in these reaches, while attention is focused elsewhere, further reduces the need for the implementation of restoration measures.

Costs to carry out this restoration work have been estimated based on similar measures on other projects and on past experience. Minimum and maximum costs have been provided for each type of restoration measure suggested in this Plan which gives a price range for restoring each reach. Costs will be site specific and will vary according to a number of factors including, for example, the need for further investigations, external contractors, access, reuse or disposal of materials, local gravel import. There are also a number of assumptions attached to the costs which relate to the percentage of reach length that needs to be restored, for example, 10% of channel length requiring bank reprofiling and 50% for riparian improvement (see Technical Report for more details). The likely annual HLS costs have also been calculated per hectare and are based on the 12m buffer width for riparian improvement (but this could be more or less).

A delivery lead has been indicated, however there are a number of actions that are suitable for implementation by angling clubs, the river and wildlife trusts. The Environment Agency and Natural England will seek to work in partnership with a range of external parties to deliver the actions.

**Table 7: Short-term restoration actions (by 2015) with broad indicative costs- note these are subject to change**

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost |
|---|---|---|---|---|---|---|
| 4 | GIL001 | Remove minor weir | EA | £5000 | £19000 | |
| | GIL001 | Re-profile banks | EA | £1348 | £18601 | |
| | GIL003 | Remove bank reinforcement | EA | £750 | £1380 | |
| | GIL005 | Remove culvert | EA | £850 | £1380 | |

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost |
|---|---|---|---|---|---|---|
| | | Wet woodland | NE | £571 | £571 | £39 |
| | | Review sediment management | EA | £5000 | £5000 | |
| | GIL006 | Remove embankment | EA | £400 | £27600 | |
| 3 | MEA002 | Remove bank reinforcement | EA | £750 | £1380 | |
| | MEA003 | Re-profile banks | EA | £300 | £4136 | |
| | | Install gravel | EA | £749 | £1948 | |
| | | Introduce woody debris | EA | £60 | £108 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £2098 (£2769) | £2098 (£4940 ) | £212 |
| | MEA005 | Remove bank reinforcement | EA | £750 | £1380 | |
| | | Re-profile banks | EA | £520 | £7177 | |
| | | Install woody debris | EA | £104 | £187 | |
| | | Install gravel | EA | £1300 | £3380 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £3640 (£4588) | £3640 (£7914) | £500 |
| | MEA007 | Remove minor weir | EA | £5000 | £19000 | |
| 2 | MEA011 | Re-profile banks | EA | £504 | £6954 | |
| | | Install woody debris | EA | £101 | £181 | |
| | | Install gravel | EA | £1260 | £3276 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £3528 (£4456) | £3528 (£7698) | £617 |
| | MEA013 | Remove major weir | EA | £36000 | £60000 | |
| **Short-term total** (including fencing and field gates) | | | | **£73130** | **£203191** | **£1368** |

**Table 8: Medium-term restoration actions (by 2027) with broad indicative costs- note these are subject to change**

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost |
|---|---|---|---|---|---|---|
| 4 | GIL003 | Improve riparian zone (including fencing and field gates) | NE | £3197 (£4066) | £3197 (£7060) | £440 |
| | GIL004 | Improve riparian zone (including fencing and field gates) | NE | £1976 (£2627) | £1976 (£4705) | £271 |
| | GIL006 | Re-profile banks | EA | £1175 | £16218 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £8227 (£9994) | £8227 (£16760) | £1045 |
| 3 | MEA001 | Improve riparian zone (including fencing and field gates) | NE | £8780 (£10646) | £8780 (£17827) | £1126 |
| | | Create wetland | NE | £439 | £439 | £3 |
| | MEA002 | Re-profile banks | EA | £1281 | £17671 | |

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost |
|---|---|---|---|---|---|---|
| | | Improve riparian zone (including fencing and field gates) | NE | £8964 (£10863) | £8964 (£18181) | £1290 |
| | MEA004 | Improve riparian zone (including fencing and field gates) | NE | £5267 (£5940) | £5267 (£8109) | £790 |
| | MEA007 | Re-profile banks | EA | £2114 | £29180 | |
| | | Install woody debris | EA | £423 | £761 | |
| | | Install gravel | EA | £5286 | £13744 | |
| | | Create wetland | NE | £1057 | £1057 | £541 |
| | | Improve riparian zone (including fencing and field gates) | NE | £14801 (£17742) | £14801 (£29439) | £3219 |
| 2 | MEA012 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £572 |
| | MEA013 | Install woody debris | EA | £310 | £558 | |
| | | Install gravel | EA | £3874 | £10073 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £10848 (£13083) | £10848 (£21815) | £1671 |
| | MEA016 | Re-profile banks | EA | £1024 | £14127 | |
| | | Install woody debris | EA | £205 | £369 | |
| | | Install gravel | EA | £2559 | £6654 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £7166 (£8744) | £7166 (£14714) | £1096 |
| | MEA017 | Re-profile banks | EA | £1614 | £22273 | |
| | | Install woody debris | EA | £323 | £581 | |
| | | Install gravel | EA | £4035 | £10491 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £11298 (£13614) | £11298 (£22683) | £698 |
| 1 | MEA019 | Improve riparian zone (including fencing and field gates) | NE | £4249 (£5306) | £4249 (£9089) | £356 |
| | MEA021 | Re-profile banks | EA | £1834 | £25315 | |
| | | Install woody debris | EA | £917 | £1651 | |
| | | Install gravel | EA | £4586 | £11924 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £12841 (£15432) | £12841 (£25659) | £2379 |
| **Medium-term costs** (including fencing and field gates) | | | | **£151113** | **£379127** | **£15497** |

**Table 8: Long-term restoration actions (by 2050) with broad indicative costs- note these are subject to change**

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost* |
|---|---|---|---|---|---|---|
| 4 | GIL002 | Improve riparian zone (including fencing and field gates) | NE | £4630 (£5755) | £4630 (£9823) | £367 |
| 4 | GIL007 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £363 |
| 3 | MEA006 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £55 |
| 2 | MEA008 | Re-profile banks | EA | £2340 | £32295 | |
| | | Install woody debris | EA | £468 | £842 | |
| | | Install gravel | EA | £5851 | £15211 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £16381 (£19604) | £16381 (£32486) | £2779 |
| | MEA009 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £1056 |
| | MEA010 | Re-profile banks | EA | £1766 | £24365 | |
| | | Install woody debris | EA | £353 | £636 | |
| | | Install gravel | EA | £4414 | £11476 | |
| | | Improve riparian zone (including fencing and field gates) | NE | £12359 (£15007) | £12359 (£24729) | £2279 |
| | MEA014 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £1056 |
| | MEA015 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £282 |
| 1 | MEA018 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £179 |
| | MEA020 | Improve riparian zone (including fencing and field gates) | NE | £4828 (£5988) | £4828 (£10205) | £315 |
| | MEA022 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £444 |
| | MEA023 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £298 |
| | MEA024 | Improve riparian zone (including fencing and field gates) | NE | £7882 (£9588) | £7882 (£16095) | £939 |
| | MEA025 | Improve riparian zone | NE | This would be delivered under HLS | This would be delivered under HLS | £445 |

| Unit | Reach | Action | Delivery Lead | Minimum Cost | Maximum Cost | HLS Cost* |
|---|---|---|---|---|---|---|
| **Long-term costs** (including fencing and field gates) | | | | **£71134** | **£178163** | **£10857** |

## Shaping the actions

The level of detail in which the restoration options are described in this report reflects its strategic focus. To accurately cost and implement the restoration actions further work will be required to undertake feasibility studies and develop detailed designs for each of the restoration options included in the plans. The degree of feasibility assessment and design work required will depend upon the details of each action and the outcomes of consultation. An indication to the potential scale of this work is provided in Table 10. Both stages of this further work would be undertaken in co-operation with the land owners who will play an important role in shaping the detail of the restoration work.

**Co-operation and engagement** will not end with the implementation of restoration measures. Natural England and the Environment Agency, and any funding bodies (see next section) will continue to work proactively with land owners to ensure the long terms success and sustainability of the measures. This would includes monitoring the restored areas and where necessary, undertaking adaptive management. Management of the river and its surroundings is an ongoing and long term process, with an emphasis on maximising the habitat value of the river environment.

Examples of the types of management that are likely to be necessary include:

- Managing woody debris within the channel in line with best practice.
- Managing fallen willows, which can re-grow in the channel and lead to undesirable consequences such as excessive erosion.
- Managing living trees through coppicing or pollarding to maintain healthy trees and manage the supply of woody debris or the degree of shading.
- Rarely but occasionally rremoving blockages, caused by a localised build-up of debris (including wood or rubbish), from the river channel.

All of these activities will require the agreement of Natural England, who will be happy to provide advice on techniques and, where appropriate, potential sources of funding.

## An opportunity

Floodplain land owners and managers are currently faced with a range of challenges including:

- Crop damage and/or soil loss associated due to flood events (which are natural, butdue to climatic change likely to increase in frequency and magnitude in the future).
- Managing nutrient runoff in accordance with the catchment diffuse water pollution plan.
- Maintaining land drainage in areas where the river is re-adjusting following the cessation of land drainage work.
- Limits on water availability for abstraction, especially during the summer (which is likely to increase in frequency and severity due to climatic change).

Natural England and the Environment Agency recognise these pressures and want to work with farmers to help them deal with these issues while protecting the internationally important wildlife within the river.

This river restoration plan offers a means by which farmers can be supported to meet the challenges of farming the floodplain.  The plan, which is designed to be a strategic, high level guide may assist in the uptake of agri-environmental schemes and provide an opportunity for farmers to seek financial assistance to adapt their practices, if they so wish.  For example, financial support (through Environmental Stewardship) may be given to farmers to change land management practices where land is subject to repeated flood impacts (crop damage or soil loss) and/or land drainage issues.  Similarly the restoration plan can be used as means to supporting farmers who wish to apply for grants or other funding streams, to fund adapt floodplain land management e.g woodland planting can be funded through grants schemes.

### Table 10: Summary of potential further work required to develop designs to accurately cost and implement each option

| | Action | Feasibility assessment | Design requirements |
|---|---|---|---|
| Conserve | Improve riparian zone | Determine the actual extent (e.g. width) of improvements required.<br>Determine whether it will be necessary to undertake planting or just allow natural colonisation and succession to occur through appropriate management.<br>Evaluate the need for alternative land management arrangement (e.g. fencing, crossing points and livestock watering arrangements). | Produce a plan of the proposed improvements from which the actual extent of the works can be derived, enabling a detailed cost to be derived. |
| Rehabilitation | **E1** Fill gaps in riparian zone | As above | As above |
| | **E2** Restore riparian zone parallel to river | As above | As above |
| | **E3** Create riparian corridor along the river channel | As above | As above |
| Restore | **R1** Introduce woody debris and retain fallen debris) | Undertake a site specific assessment for the potential for adverse impacts such as blockages on structures downstream to assess whether the debris should be anchored (although this is unlikely to be necessary). | Produce a specification for the type, source and placement of woody debris. |
| | **R2** Remove bank protection or allow to degrade | Consider factors such as such as: ecological constraints, ground conditions, access to the site and potential means of disposing of spoil. The importance of these factors is likely to vary. | Produce a specification for the removal of the bank protection, including drawings illustrating how the work should be undertaken and how the site should look on completion. |
| | **R3** Remove informal embankments | Consider factors such as changes to flood risk, land management implications, ecological constraints, ground conditions, access to the site and potential means of disposing of spoil. The importance of these factors is likely to vary. | Produce a specification for the removal of the embankment, including drawings illustrating how the work should be undertaken and how the site should look on completion. |
| | **R4** Re-profile bank to reduce bank slope | Consider factors such as ecological constraints, ground conditions, access to the site and potential means of disposing of spoil. The importance of these factors is likely to vary. | Develop a site specific design including specifying the slope angle required and how this will vary along the reach, and therefore the amount of excavation required. |
| | **R5** Reinstate degraded river bed with mixed river gravel to create riffle | Evaluate the implications of factors such as: ecological constraints, access to the site and potential means of disposing of spoil. | Develop a site specific design including the height, slope, footprint and sediment grading. |
| | **R6** Remove weir | Evaluate the implications of factors such as: ecological constraints, access to the site and potential means of disposing of spoil. | Produce a specification for the removal, or modification of the weir, including drawings illustrating how the work should be undertaken and how the site should look on completion. |
| | **R7** Create wetland and wet woodland | Consider factors such as ecological constraints, ground conditions, access to the site and potential means of disposing of spoil. The importance of these factors is likely to vary. | |

## Delivery mechanisms and sources of funding

Whole river restoration plans are based on multi-partner working, time horizons suited to the nature and scale of each site's problems and solutions (typically 20-50 year time horizons), a negotiated settlement to any disagreements, and a best endeavours approach to implementation. Funds need to be secured to maintain best endeavours over time, including rolling bids to obvious budgets such as EA Flood and Coastal Risk Management (FCRM) capital works, Catchment Restoration Funds, and Environmental Stewardship, but also opportunistic bids to a range of other funding sources including European programmes. Work in-kind from organisation, including 'third sector' partners such as the Rivers Trusts have a vital part to play.

Delivering the restoration vision will involve working in partnership with a range of individuals and organisations including:

- Trent Rivers Trust;
- Angling Associations;
- Severn Trent Water (STW);
- National Farmers Union;
- Country Land and Business Association (CLA);
- On Trent;
- National Forest;
- Highways Agency;
- Forestry Commission;
- The Wildlife Trusts.

All stakeholder contributions that can help to deliver this plan will be welcome.

### *Trent Rivers Trust*

The restoration plans involve a range of different techniques which vary in the amount of work required. This variation means that implementation approaches and funding requirements will vary between the different types of restoration classes. The Trent Rivers Trust (TRT) is one such delivery mechanism. The TRT is an independent environmental charity established to promote the preservation, protection and improvement of the rivers and streams in the Trent catchment and the habitats they support, increasing awareness and understanding of the management of water bodies and the wider environment (see: http://www.trentriverstrust.co.uk). Rivers Trusts generally rely on public funding, but many have successfully applied for European Union structural funds such as Interreg and Objectives One, Two and 5b or Lottery funds. They deliver major programs of physical works and practical river improvements in partnership with the Environment Agency and Natural England. Rivers Trusts are a cost-effective means of delivering environmental, social and economic outputs with strong community stakeholder involvement. At present the Trent Rivers Trust is undertaking work on the River Trent near the confluence of the River Mease and they are currently running a programme to eradicate Himalayan Balsam from the area.

### *Water Framework Directive Improvement Fund*

In 2011 the government announced a £110m fund to improve the health of over 880 lakes, streams and other water bodies, whilst also helping to boost local involvement in caring for blue spaces. £92 million will be provided over the next four years to remove non-native invasive weeds and animals, clear up pollution, and remove redundant dams, weirs, and other man-made structures so that wildlife can thrive in water catchments across England.

An additional £18 million was allocated during 2011 to provide help to farmers to install measures such as buffer strips and fences to protect watercourses and other actions to prevent agricultural pollution, under the Catchment Sensitive Farming programme.

### *Nutrient Management Plan*

In 2011 the Environment Agency, Natural England, Severn Trent Water and Local Authorities agreed a list of actions under the Nutrient Management Plan. The intention of these actions within the plan is to ensure water quality targets are met. One action in this plan is the Developers Contribution Scheme. This scheme has been added to the plan to allow development within the catchment to continue, and any new development provides an agreed amount of funding for the Developers Contribution Scheme. Funding from the Developers Contribution scheme will be given to projects across the catchment.

### *Diffuse Water Pollution Plan*

A range of measures are being implemented to reduce diffuse water pollution in the catchment, these include:

- Reducing sediment supply to the river by enhancing riparian habitats along the river corridor;
- Reduced sediment runoff from fields;
- Reduced sediment runoff from livestock poaching, and
- Reduction of unconsented pollution incidents.

The measures, which are described in more detail in the River Mease Diffuse Water Pollution Plan (www[1]) will complement the River Mease Restoration Plan. Indeed some of the actions included in the restoration plan associated with reducing land use pressures and improving the riparian zone will help to deliver the objectives of the DWPP. A Water Quality (Phosphorous) Management Plan has also been produced, this builds on the DWPP and is specific to addressing the high levels of phosphorous in the river. Measures have been assigned to Natural England, Environment Agency, Local Authorities, the Highways Agency and Severn-Trent Water. Mechanisms to deliver these improvements include the Environmental Stewardship schemes (ELS, HLS), Catchment Sensitive Farming (CSF), Catchment Restoration Fund (CRF) and Severn-Trent Water's environmental improvement programme associated with Asset Management Period 5 (2010-2015).

### *European funding*

The Innovation and Environment Regions of Europe Sharing Solutions (Interreg) are co-financed by the European Regional Development Fund (ERDF). It includes monies for water management, including:

- Improving quality of water supply and treatment, including co-operation in the field of water management;
- Supporting integrated, sustainable and participatory approaches to management of inland and marine waters, including waterway infrastructure;
- Adapting to climate change effects related to water management.

The LIFE programme is the EU's funding mechanism for the environmental improvement initiatives. LIFE projects support a wide range of water-related issues, such as urban water management, industrial wastewater treatment, river basin monitoring and improving groundwater quality. LIFE has co-financed over 3000 projects across the EU, equating to approximately €2.2bn to the protection of the environment.

### *Environmental Stewardship Schemes*

The Environmental Stewardship scheme is likely to be an appropriate source of funding for this type of work, and is particularly appropriate to measures aimed at improving the riparian zone and giving the river more space by defining such land as buffer strips. Improvements to the riparian zone can also provide improved soil conservation, especially in arable areas.

There are a number of levels of Stewardship:

- Entry Level Stewardship;
- Organic Entry Level Stewardship;
- Upland Entry Level Stewardship; and
- Higher Level Stewardship.

The Higher Level Stewardship (HLS) provides funding for land management / land use changes relating to proposals such as livestock management and improved wetland riparian land use (Natural England encourage enhancements of at least 12m width buffer strips for watercourses on cultivated land).

Environmental Stewardship is a key part of the EU funded Rural Development Programme for England. The overall budget provides for over £700 million for new HLS agreements for the period 2007 - 2013, compared to £420 million for new Countryside Stewardship / ESA agreements under the old programme. Countryside Stewardship Scheme (CSS) is an initiative driven by Natural England which encourages farmers and land owners to adopt particular conservation measures to sustain, improve and extend the beauty and diversity of existing wildlife habitats, whilst also creating new wildlife habitats and landscape features.

### *Catchment Sensitive Farming*

Catchment Sensitive Farming is a partnership between the Environment Agency and Natural England, funded by Defra and the EU Rural Development Programme. The initiative delivers practical solutions to reduce diffuse pollution from agricultural land to protect water bodies and habitats. Funding is prioritised and targeted within each catchment through a Funding Priority Statement. In 2012 there will be the opportunity to apply for capital grant funding under the Catchment Sensitive Farming Scheme. A priority funding target statement will be available in the New Year which will provide information on the priority target area and funding opportunities. The River Mease Catchment Sensitive Farming Officer (CSFO), Robert Gornall will be at the consultation event on $10^{th}$ January and will be happy to discuss what he can do for you and provide details of the 2012 funding scheme. Alternatively, Robert can be contacted on 0300 060 4646.

### *Forestry Commission England Woodland Grant Scheme*

The planting of riparian woodland may be supported by the English Woodland Grant Scheme (EWGS) administered by the Forestry Commission. This stream of funding has been designed to develop the co-ordinated delivery of public benefits from England's woodlands. Grants are available to improve the stewardship of existing woodland and to promote and enable the creation of new woodland.

### *National Forest*

The planting of riparian woodland may be supported by National Forest tender schemes. A number of these have already been carried out along the River Mease.

*Catchment Restoration Fund*

The Department for Environment, Food and Rural Affairs (Defra) has created the Catchment Restoration Fund to support this aim. A £28m fund, providing up to £10m each year, has been allocated for projects to be delivered in 2012/13, 2013/14 and 2014/15.

The fund will support work that aims to:

- restore more natural features in and around waters;
- reduce the impact of man-made structures on wildlife in waters, or
- reduce the impact of small, spread-out (diffuse) sources of pollution that arise from rural and urban land use.

The Environment Agency will administer the fund. Formal applications and expressions of interest for projects starting in 2012/13 are invited by **18 May 2012**.

The fund will run for three years, so there will be several opportunities to apply for funding. The lead applicant for funding **must** be a charity or an organisation with charitable, benevolent or philanthropic purposes under the Charities Act 2006.

# References


APEM, 2010a. River Mease SSSI and SAC Fish Survey. Report to Natural England, 71pp.

APEM, 2010b. Development of an ecologically based vision for the River Mease SAC and River Eye SSSI. Report to Natural England, 46pp.

Natural England and Environment Agency, 2010. River Mease Diffuse Water Pollution Plan, 26pp.

Mainstone, C. 2007. Rationale for the physical restoration of the SSSI river series in England. Natural England Report.

Scott Wilson, 2010. Condition Monitoring of Canal, River and Open Water SSSIs in the East Midlands Area Common Standards Monitoring Condition Assessment of River Mease SSSI. Report to Natural England, 97pp.

www[1]:
http://www.nwleics.gov.uk/files/documents/river_mease_appendix_1_diffuse_water_pollution_plan/Appendix%201%20River%20Mease%20DWPP%20(2).pdf

# Glossary

| Terminology | Definition |
|---|---|
| Catchment | Area drained by a river and its tributaries. |
| Deposition | Laying down of part, or all, of the sediment load of a stream on the bed, banks or floodplain. Mostly occurs as high flows recede. The process forms various sediment features such as bars, berms and floodplain deposits. |
| Ecological status | Surface waters are classified as being of good ecological status when each of the quality elements that represent indicators of ecological quality of the waterbody are classified as being good or high. The quality elements fall into three categories, i) biological quality elements, ii) chemical and physicochemical quality elements and iii) hydromorphological quality elements. |
| Favourable Condition | If a SSSI site is in Favourable Condition, it means that the site is being adequately conserved and is meeting its 'conservation objectives'. |
| Erosion | Removal of sediment or bedrock from the bed or banks of the channel by flowing water. Mostly occurs during high flows and flood events. Forms various river features such as scour holes and steep outer banks. |
| Favourable condition | Description of the condition of the features for which a SSSI or SAC has been designated. Favourable condition means that all of the targets for the mandatory attributes (population and habitat) used to assess a feature have been met. |
| Floodplain | A floodplain is flat or nearly flat land adjacent to a stream or river, stretching from the banks of its channel to the base of the enclosing valley walls and (under natural conditions) experiences flooding periods of high discharge. |
| Geomorphology | The study of landforms and the processes which create them. |
| Good status | The general objective of the WFD is to achieve 'good status' for all surface waters by 2015. 'Good status' means the achievement of both 'good ecological status' and 'good chemical status'. |
| Good ecological status | WFD term denoting a slight deviation from 'reference conditions' in a waterbody, or the biological, chemical and physio-chemical and hydromorphological conditions associated with little or no human pressure. |
| Glide | Deeper water flowing smoothly over river bed. Occasional larger boulders on the bed may create some surface disturbance. |
| Planform | River channel pattern when viewed from above. This often either straight, sinuous, meandering or braided. |
| Pool | Deeper, steadier water. Pools are usually located at bends in water courses, depth decreases towards the outside of the bend. |
| Pressure | The direct effect of the driver (for example, an effect that causes a change). Pressures include morphological alterations, abstraction diffuse source pollution, point source pollution and flow regulation. In the context of the WFD a significant pressure is one that, on its own, or in combination with other pressures, would be liable to cause a failure to achieve the environmental objectives set out under Article 4. |
| Reach | A length of channel which, for example, may have a homogeneous geomorphology (river type) or restoration solution. |
| Reference conditions | For any surface waterbody type, reference condition is a state in the present or in the past where there are no, or only very minor, changes to the values of the hydromorphological, physico-chemical, and biological quality elements which would be found in the absence of anthropogenic disturbance. |
| Re-profiling | The reshaping of a river bank. May be a reflection of channel modification (impact) or restoration. |
| Riffle | A stream bed accumulation of coarse alluvium linked with the scour of an upstream pool. |

| Terminology | Definition |
|---|---|
| Riparian Zone | Strip of land along the top of a river bank. Plant communities along the river banks are often referred to as riparian vegetation. |
| Run | Quicker water, deeper than riffles and usually with a stony or rocky bed which creates a ruffled surface. |
| Tributary | A stream or river which flows into a main river. A tributary does not flow directly into the sea. |
| Unfavourable condition | Description of the condition of the features for which a SSSI or SAC has been designated. Unfavourable condition means that all of the targets for the mandatory attributes (population and habitat) used to assess a feature have not been met. |
| Woody debris | Woody debris are logs, sticks, branches, and other wood that falls into streams and rivers. This debris can influence the flow and the shape of the stream channel. |

**Acronyms**

EA Environment Agency
GQA General Quality Assessment
NE Natural England
SAC Special Area of Conservation
SSSI Site of Special Scientific Interest
WFD Water Framework Directive