Our work so far

We began talking to the community about the need to update the scheme in January 2019, presenting our ideas to the public in June of that year. We know there is local concern over the updating of the scheme and have spent the last year carrying out further work in order to bring back more information to the community for discussion. We want to work together to find the best solution for the future of the scheme.

We have continued to review and update the options that we presented to the public in June 2019. This includes calculating the potential cost and carbon impacts of the options and carrying out surveys that would normally be done at a later stage in the project. We want to respond to public concerns over water levels and wildlife by collecting and sharing this information early and these results will be a key part of our discussions with you going forward.

In addition we have been in constant conversation with residents whilst completing our maintenance work and have also invited members of the local community onto the sites to learn more about what we do.

Site visits

In February 2020 we invited a number of residents to the Spa Meadow site. The team spent the sessions talking to the residents, showing them how the gates are operated and what it takes to operate them. This enabled the residents to understand why such a scheme needs to be put in place.

Surveys

In response to local feedback, we have carried out further environmental and river depth surveys to help us better understand the Lower Mole.

A River Corridor Survey (RCS) was carried out in May 2019. The aim of this survey is to gather a more detailed inventory of the ecological features and river morphology within the project area. Fish, invertebrates and bathymetric surveys were carried out during autumn 2019. The aim of these was to provide a summary of the available baseline aquatic ecological data for the scheme.

The bathymetric (meaning underwater) survey data allowed us to create a depth map of the channel. This is primarily used in computer models to check the impact of proposed options on flood risk but also tells us how the naturalised river in options 5 and 6 is likely to look and what risks those options involve. For example, where currently submerged shallow sections of the river, may, if made of rock or concrete, form 'waterfalls' which in themselves prevent fish migration up and down river.

During the summer/autumn of 2020 a bat survey was undertaken to see whether there is the presence of bats in a number of locations around the River Mole. The Field data is gathered by using static bat detectors and infra-red cameras which record the high pitched calls and physical presence of bats. The survey suggests that there were no bats found to be using the structures as roosts.

Please see below photos of the team collecting survey data.

Flood risk modelling

Flood risk modelling can help us to understand flood risk, and allows us to plan ways of managing that risk. We have used a computer model of the Rivers Ember and Mole to test a range of options for the Lower Mole scheme. This allows us to make comparisons between the current situation, and all of the options for the future of the scheme. The model was used to help test the initial design concepts that we shared in June 2019. Since that time, we have continued to use the model to test changes to these initial design concepts following feedback from residents and the local community. For example, we have looked at ways to refine how fish passage can be incorporated into the scheme without the need to reduce water levels.

We have also updated and refined our hydraulic modelling. Hydraulic modelling looks at how the water in the channel behaves; how it flows, moves and reacts to changes (for example the operation of structures like sluice gates), and how it flows when it leaves the channel. This allowed us to test the viability of our proposed options for a second time.

Carbon

Since July 2019 we have updated our carbon modelling tool to assess the carbon footprint of each of our options. You can now view these figures on our '**what are the options**' page. We have used this tool as a part of the appraisal process to understand the whole life carbon of the options and to start to consider ways to reduce the overall future carbon footprint of the scheme such as the impact of different materials and transport options.

Cost

We have developed estimated costs by considering aspects such as the design and construction for each of the options, as well as estimations on their long term operation and maintenance.The appraisal process enables us to understand the costs and benefits of each option over the full lifetime of the schemes design, as well as the costs associated with long term maintenance.

Appraisal

We have used the government's Flood and Coastal Risk Management Appraisal Guidance, to develop options for the future of our scheme. There are six water level control structures situated along the scheme. Some initial work was undertaken to update these structures separately, but for the options we are presenting now we have considered the scheme as a whole system as because whatever we do in one location will potentially have an impact on another. We have used information gathered through surveys, as well as feedback from the community to help us carry out further appraisal work to develop the options that we are presenting now. As part of the appraisal process, we have also carried out investigations into the cost of each option, and the estimated carbon impacts they would have.

Improving the environment on the Lower Mole

We know from our conversations with you that the wildlife and environment around the scheme is highly valued by the community.

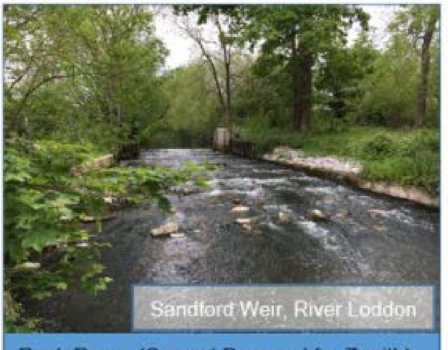
When the scheme was first built the primary aim of its design was to protect properties from flooding and as a result it did not take into account the impact on wildlife. To accommodate high flows the scheme created a deeper, wider artificial channel. The current water level control structures impound water within this channel – backing up the river and resulting in a static, deep, lake-like appearance for stretches up to 14.7 km long.

It is important to note that a meaningful increase in biodiversity for this project is only possible where we reduce or remove **impoundments** (the amount of water backed up behind a structure).

Opportunities to enhance the environment

The options that retain the water level control structures (Options 1 to 4), mean habitats will remain as they are, with limited ability to improve. There will however be fish passes added to these structures, which provides the ability for fish to migrate upstream. This is because the scheme is currently a barrier to **fish passage**. Natural river processes however will still be prevented and the passes may not be 100% effective for all fish, particularly smaller species.

Please see below two examples of different fish passes being considered as part of options 1 to 4.



Rock Ramp (Current Proposal for Zenith)

Technical Fish Pass (current proposal for Viaduct)

Options 5 and 6 reduce the impoundment which will allow the river to flow more naturally and allow us to restore habitats in the river therefore increasing biodiversity. The channel will begin to meander within its existing footprint.

Please see below an example of where an impounded river has been restored at Avington Sluice on the River Kennet. Three large penstocks were raised out of the water and locked into place, river banks were regraded and the channel was narrowed. Under normal flow conditions, water levels dropped by almost a meter and the upstream stretch, 500 to 600 metres in length, was restored. The local fisheries team have seen increases in the wild fish population, a more established aquatic macrophyte community and a more diverse array of invertebrates. Further case studies on river restoration can be found in the links at the top right hand side of this page.

November 2009 before

March 2010

April 2011

May/June 2012

Reducing or removing the impoundments will allow naturalised flows to strip away years of fine sediment from the centre of the river and reveal more gravels. The fine sediment will be re-deposited to form new vegetated berms along the margins. There will be a mixture of shallow, wide gravelly areas (riffles) where the babbling water is oxygenated, and deeper, slower-flowing pools.

Large reedy margins can establish along the river, with plants species such as branched bur reed and yellow flag iris. These will provide nesting sites for birds, such as reed warblers, ducks, coots and swans. They are also places for herons to hunt, and mammals such as otters to lie up during the day.

Aquatic plants in the river will provide food and shelter for a wide variety of birds, fish and insects, such as dragonflies and damselflies, and plenty of opportunity for kingfishers to feed.

The variety of depths and reconnected river, will allow fish to migrate up and down stream to utilise habitats for spawning, feeding and shelter, including deeper water for mature fish, and the shallows for fry.

Biodiversity Net Gain

Biodiversity Net Gain (BNG) is an approach that aims to leave the natural environment significantly improved as a result of any development. The Department for Environment, Food and Rural Affairs carried out a consultation in 2018/19 which led to BNG becoming a mandatory element of the planning system within the UK. BNG is an approach to development that results in measurable net gains in biodiversity, having taken positive and negative impacts into account. Net gains for biodiversity are typically either an increase in overall biodiversity, or an improvement to the biodiversity which is already present.

The Environment Agency has made a commitment in its Sustainability Plan "e:mission 2030" to achieve 20% BNG on its projects, to deliver improvements across all areas of work, giving priority to natural solutions. We will be carrying out a BNG assessment during 2021 through a combination of desk studies and field work to help us understand what this means for the Lower Mole Flood Alleviation Scheme.

Assessing and understanding the environmental impacts

We have conducted a number of surveys to ensure we have a good baseline of the existing habitats and wildlife found along the River Mole.

- River corridor surveys
- River condition assessments
- Protected species surveys
- Invertebrate and fish survey

For more information please go to '**Our work so far**' page.

In order to highlight both the positive and negative impacts of a scheme we carry out an Environmental Impact Assessment which is a statutory process. It also identifies the measures we'll take to avoid or reduce any negative impacts.

Fish Passage Factsheet

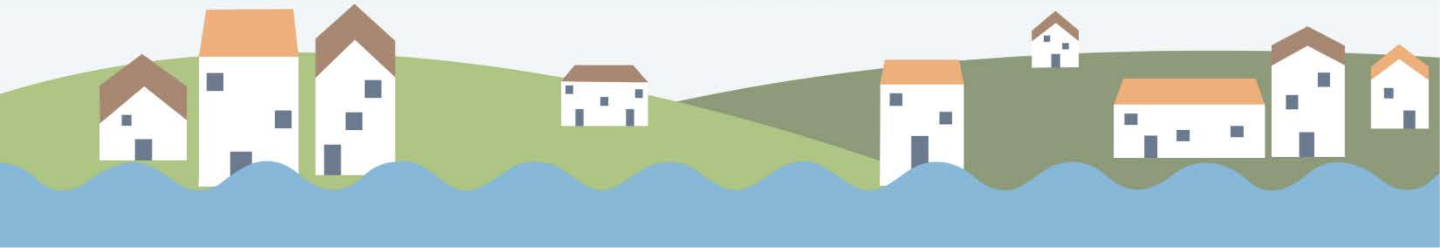
Fish passage refers to the movement of fish into, out of and within waterbodies, typically river systems. Man-made structures used to control and manipulate water levels, such as weirs and sluices, more often than not prevent the free movement of fish along the length of river systems.

The structures which make up the current Lower Mole Scheme form a complete barrier to fish passage, except for eels where specially built passes have been erected. This means whilst fish may be washed downstream under flood events, they are otherwise confined to a short stretch of river and can only use the limited habitat that is available to them. It also means any fish displaced downstream during high flow events are unable to make their way back upstream.

Why is fish passage important?

Removing barriers to fish passage is important for a number of reasons:

- Different fish species require a multitude of habitats across their life cycle (i.e. fry, juveniles, adults). Each habitat provides a different function such as spawning, feeding and refuge from predators or during flood events. Removing these barriers allows these habitats to be connected so fish can freely move between them. Some species can travel several kilometres over periods of days to make use of specific habitats.
- Migratory fish species such as eels and sea trout, have an intrinsic need to migrate upstream, often to the upper reaches of a river catchment, in search of suitable habitats required to complete their life cycle.
- Populations that are well connected and are able to move freely are more resilient to disturbance as they are able to move away from and subsequently recolonise affected areas. Disturbances may include pollution and poor water quality events. This improved resilience (i.e. ability to adapt to adverse events) is crucial against a back drop of climate change where extreme weather events, which can have adverse impacts of water quality, are predicted to increase.
- The importance of achieving fish passage is recognised under different pieces of national legislation including The Eels Regulations (England and Wales) 2009 and the Salmon and Freshwater Fisheries Act 1975 (as amended).



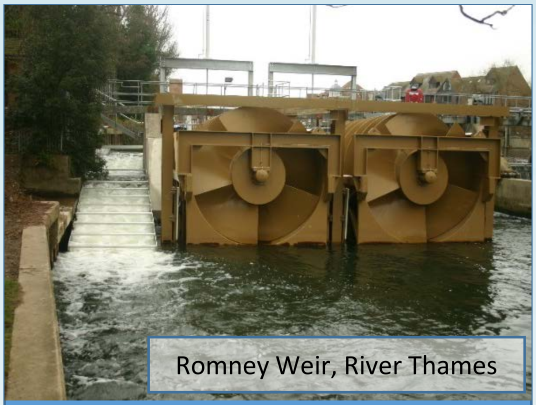
Achieving fish passage

Fish passage can be achieved in a number of ways.

The most obvious and first choice is the removal of a structure, which often results in significant improvements to upstream habitats associated with the removal of an impoundment (see Environment page and Impoundments Factsheet/Page for further information). Better habitat quality, combined with the removal of a barrier, has been shown to lead to an increase in both the density and number of fish species, all of which results in overall improvement to the status of the river.

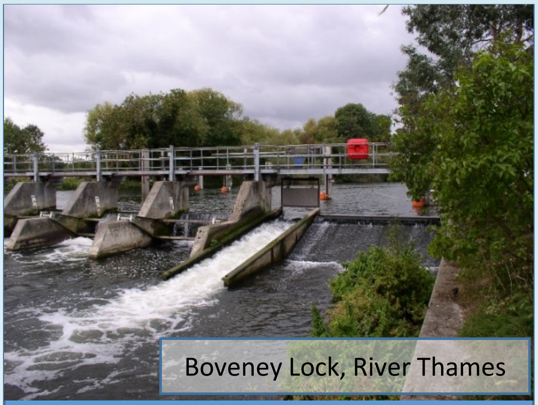
Where a structure cannot be removed, fish passage is often achieved using a rock ramp or technical fish pass, both of which come in many shapes and sizes. A fish pass has to be designed specifically for the individual site or structure, taking into account the unique characteristics and needs of the site, such as the fish species which will need to use it. It is important to understand, whilst typically designed to pass as many fish species as possible, technical fish passes are not a substitute for structure removal.

Below are examples of what a technical fish pass and rock ramp can look like.



Romney Weir, River Thames

Technical Fish pass known as a 'larinier'



Boveney Lock, River Thames

Technical Fish pass known as a 'larinier'

Knightwick, River Teme

Before - Replacing redundant gauging Weir

Knightwick, River Teme

After - Construction of a Rock Ramp

Carbon Factsheet

Environment Agency

What is Carbon?

Carbon is in all living things. When we talk about carbon (carbon footprint, carbon emissions), we are referring to a range of greenhouse gases that trap heat close to the earth. It is this act of trapping the heat which explains why such gases (including carbon dioxide (CO2) and methane) are labelled a 'greenhouse gas'. Fossil fuels contain carbon which were previously stored in living things, and when burned it releases CO2 into the atmosphere.

Why is it important for this project?

To update the scheme we will be using fuels; whether through vehicles driving materials to and from the site, in powering the operation of gates in the structures to divert water so we can work safely or in the fuel used to manufacture the parts we need for construction.

Understanding the carbon footprint of a scheme is an important consideration, as the world works to meet targets to reduce its carbon emissions to combat the negative effects of climate change.

Is this linked to global warming and climate change?

Yes. Greenhouse gases such as CO2 trap heat from the sun. Even the smallest increase of greenhouse gases in the atmosphere can cause the Earth to get warmer.

Across the world climate change is already having an impact with changes in rainfall patterns, sea level rise and increased risk of flooding and droughts.

Did you know? One family of four taking a round-trip flight from London to Cape Town, South Africa, would have an estimated carbon footprint of 5.8 tonnes of CO_2

Assessing carbon on the Lower Mole scheme

When appraising potential scheme options, carbon is a key consideration within the government guidance. We must carefully balance the needs of communities alongside tackling the global climate emergency.

We've used our carbon modelling tool to carry out some initial calculations on the carbon footprint of our options.

There are two components of our carbon calculations. The first is called Capital Carbon, this is the carbon associated with construction activities to update the scheme in the near future.

The second is Future Carbon which considers carbon potentially produced during the future operation of the scheme. It includes aspects like the ongoing maintenance of structures.

The two numbers combined gives us the total Whole Life Carbon. This is the number you will see within the options page and summaries.

Impoundments Factsheet

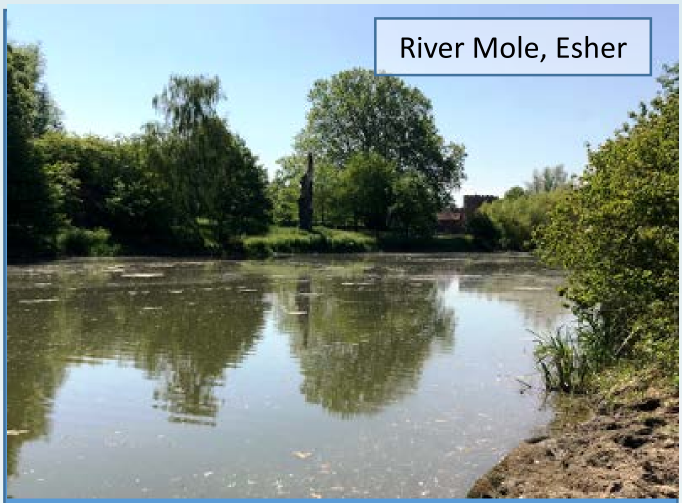
Environment Agency

An impoundment occurs as a result of water being backed up by structures, such as sluices, on a river. This results in the river having a static, deep, lake like appearance.

Sluices and weirs have been constructed throughout history on rivers, for example to power mills, divert or abstract water for agriculture, or improve navigation for large commercial boats. Until the 1990s there was little interest in understanding the ecological impact of doing this.

Along the River Ember channel there are three structures fitted with sluice gates that impound water. These gates are operated when flows start to increase. Prior to the construction of the Lower Mole Scheme, the river had small weirs in place, backing up the water.

The structures built along the River Ember as part of the Lower Mole Scheme during the 1980s did not take into account the impact on wildlife. A deeper, wider artificial channel was created as part of the flood alleviation scheme to accommodate high flows. The sluice gates were installed to maintain a water level within the artificial channel for amenity purposes.



River Mole, Esher

Impounded River

River Mole, Downstream of Cobham

Un-impounded free flowing River

The impact of impoundments

Impoundments have a number of impacts on lowland rivers in England including the Mole:

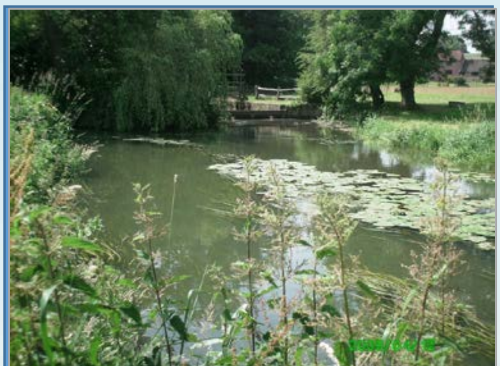
- Habitat is simplified to a series of long, lake-like bodies of slow moving water. The river is audibly muted apart from at the sluices.
- The lack of diverse flow and habitat types limits the variety of animal and plant species present.
- Silt settles on the bed of the channel under normal flow conditions. This silt can be remobilised as gates are operated during flood events, potentially releasing nutrients and contaminants into the water.
- Over the summer period, low flows and higher temperatures can have negative impacts on water quality as slow moving water contains less oxygen and can warm up more rapidly.
- In slow moving water, warmer, nutrient-rich conditions can lead to algal blooms, reducing water quality further and leading to fish kills if dissolved oxygen reaches dangerously low levels. Impounded sections of river are therefore considered less resilient to climate change.
- Due to the deep water, and lack of light reaching the bottom aquatic plants struggle to colonise and provide diverse in-channel habitats.
- The artificially deep and wide channel lacks shallow margins preventing reeds and other marginal plants growing that should border the river.
- The structures divide the river into sections, often preventing the natural movement of gravel downstream and fish migration upstream. This limits how fish can use the river for spawning, shelter and feeding.

Case Study: Fletching Mill, River Ouse

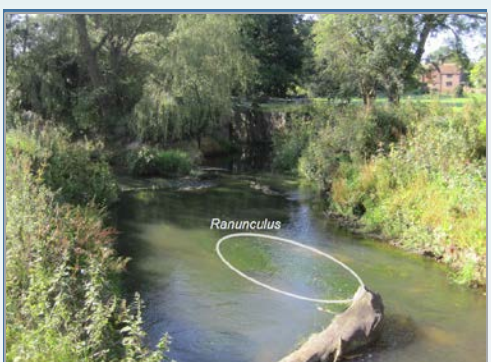
At Fletching in East Sussex, there used to be two structures; a historic mill weir and temporary sluice that impounded the River Ouse. This created a overly wide, deep channel with little flow, a river bed covered with silt and prevalence of pond plants such as lilies. It also restricted fish passage.

Before a restoration plan was implemented in 2010, the weir failed and was then removed. This lead to a drop in water level, increase in velocities and diversity of flow types (pools and riffles).

Increased velocities led to in-channel vegetation, such as *Ranunculus,* and clean gravel free of silt, used by fish for spawning.
Free movement of fish led to large numbers utilising habitats in the restored stretch upstream and more diverse fish population, with new species (brown trout, gudgeon, bull head) not previously recorded.



Before Restoration



After Restoration

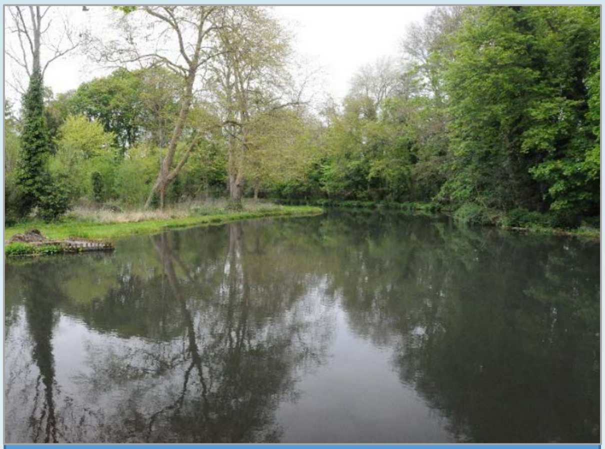
This table highlights key changes in the classification of the overall water body and invertebrates and number of fish species found upstream of the weir, before and after weir removal. Note the improvement in both classifications and increase in species numbers, demonstrating how the restoration has led to an overall improvement to the river and its biodiversity.

Parameter	Pre restoration (2009)	Post restoration (2011)
Fish - Upstream (No. of species)	6	14
Invertebrates - Upstream (Classification)	Moderate	High
Overall Waterbody Classification	Poor	Good

Case Study: Bossington Estate, River Test

The River Test is one of the best examples of Chalk Rivers in England and is designated as a Site of Special Scientific Interest. However, damage from industry, historic dredging, barriers and siltation prevent it from reaching its full potential and is considered to be in 'unfavorable condition'.

To help address these issues, a joint river restoration project is working with landowners to restore the river by channel narrowing, bed level raising, building islands and removing structures

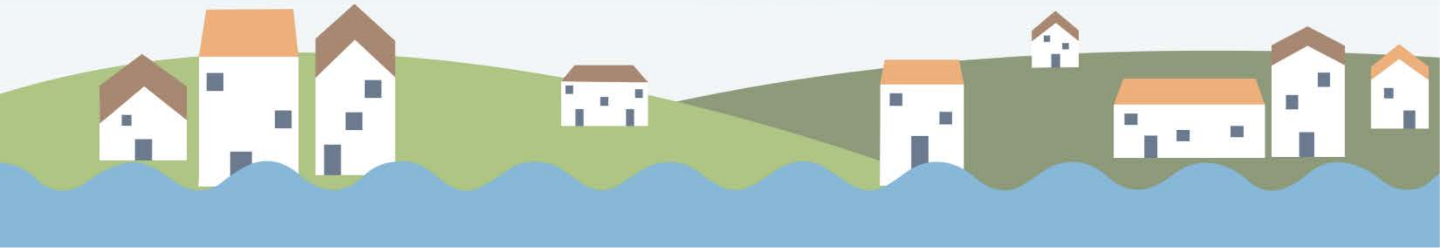


Before Restoration

Two years after Restoration

In 2017, one of the largest historic weirs was removed resulting in:

- An 800 metre stretch of river restored upstream and downstream.
- Narrowed channel by re-profiling the banks and using woody material.
- Upstream water levels dropped by almost 1 metre & velocities increased.
- Increased velocities encouraged submerged vegetation to grow, providing habitat for juvenile fish and invertebrates.
- Salmon spawned upstream of the old structure just 3 weeks after.
- In 2018 the highest number of juvenile salmon ever recorded on the Test.



Case Study: River Thur, Switzerland

Before 1890 the Swiss Thur was a very biodiverse river with frequent gravels bars, islands and forest mixed in. In 1890, it was formed into a single uniform channel with stone fronted sides and earth flood embankments. This was to gain new agricultural land but also to reduce flood risk to town and villages.

Before Construction

After Construction

A restoration scheme was conducted by the Deltares institute in 2002 along 1.5 km of the channel, widening it on one side and removing embankments where no housing or urban areas were present. Natural structures were added into the channel to help gravels to gather and the channel to braid once again. Biodiversity returned with no increase in flood risk.

This table shows the change in number of species belonging to different functional groups before and after restoration. Note the increase across all functional groups, demonstrating how the restoration has led to an overall improvement in biodiversity.

Species	Pre restoration	Post restoration
Bed dwelling invertebrates	39	47
Fish	7	10
Ground beetles	3	13
In channel vegetation	3	9
Bankside vegetation	20	29