Radlett Road Recreation Ground

River Improvement Plan

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Contents

Introduction

The Rediscovering the River Colne Project

Rediscovering the River Colne is a ground breaking project that aspires to bring the River Colne to the heart of Watford and its people. The project will see the Colne corridor become a positive asset within the borough, enabling it to reach its full potential for both local people and wildlife.

The project aims to provide sustainable solutions to resolve the issues affecting the river and to regenerate the public spaces it flows through, providing a healthy river corridor, with clean water, diverse wildlife and low flood risk that is accessible to all and of high amenity value to local people.

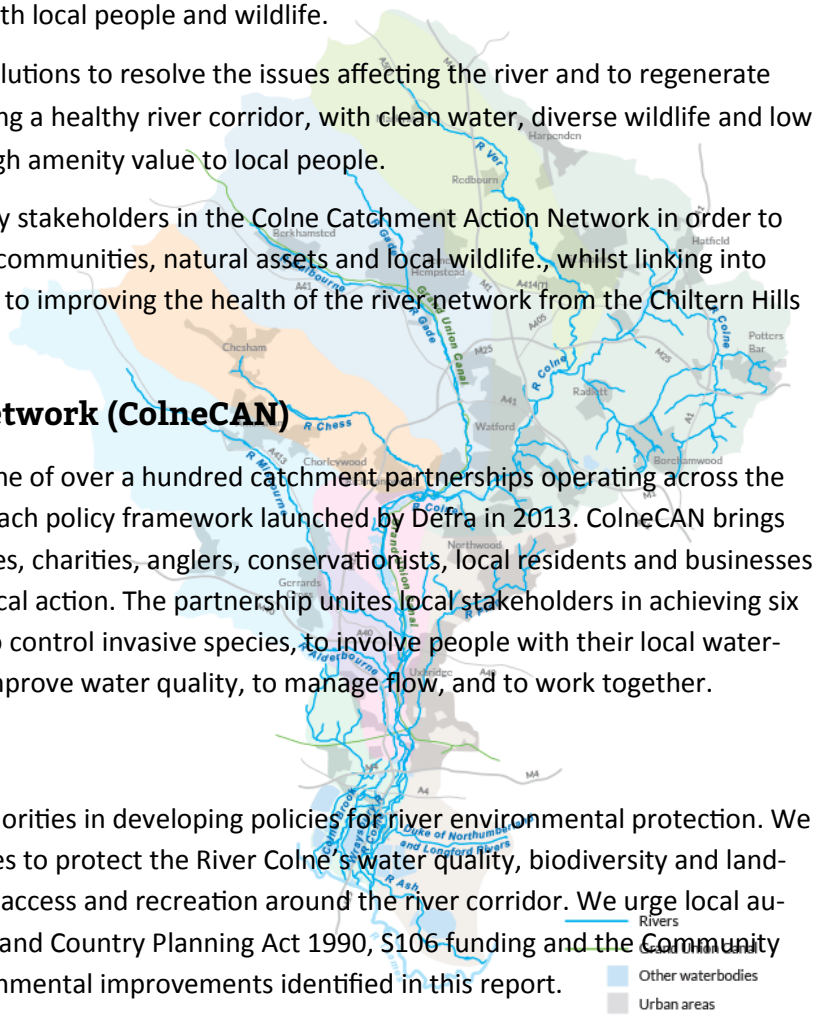
The project builds on the knowledge of key stakeholders in the Colne Catchment Action Network in order to remain in keeping with Watford's diverse communities, natural assets and local wildlife., whilst linking into catchment wide initiatives that contribute to improving the health of the river network from the Chiltern Hills to the River Thames.

The Colne Catchment Action Network (ColneCAN)

The Colne Catchment Action Network is one of over a hundred catchment partnerships operating across the UK as part of The Catchment Based Approach policy framework launched by Defra in 2013. ColneCAN brings together water companies, local authorities, charities, anglers, conservationists, local residents and businesses to ensure catchment-wide thinking and local action. The partnership unites local stakeholders in achieving six aims for improving the river catchment: to control invasive species, to involve people with their local waterbodies, to improve wildlife corridors, to improve water quality, to manage flow, and to work together.

Note to Local Planners

This plan aims to assist local planning authorities in developing policies for river environmental protection. We encourage local planners to include policies to protect the River Colne's water quality, biodiversity and landscape in addition to making provisions for access and recreation around the river corridor. We urge local authorities to consider the role of The Town and Country Planning Act 1990, S106 funding and the Community Infrastructure Levy to facilitate the environmental improvements identified in this report.



Radlett Road Recreation Ground

Radlett Road Recreation Ground is an open space owned by Watford Borough Council and Hertsmere Borough Council on the River Colne in North Watford. Watford's land provides a popular space for public recreation and sport, in addition to offering a wild river corridor with informal walking routes, allowing site users to enjoy local wildlife. Hertsmere's land is not publicly accessible but provides an important secluded refuge for wildlife, away from the surrounding urban landscape. The ecological value of the river corridor and it's surrounding habitats have declined over the past 20 years and urgent intervention is required to ensure the site reaches its full ecological potential.

The section of the river is designated as a Local Wildlife Site 84/014 for Flowing waters (rivers and streams); species.' Local Wildlife Sites are non-statutory sites designated at a county level as being of conservation importance and often recognised in Local Authority development plans. The aim of this identification is to protect such sites from land management changes, which may lessen their nature conservation interest, and to encourage sensitive management to maintain and enhance their importance.

Site Plan

Radlett Road Recreation Ground land ownership

Habitat and Geomorphology

The following text summarises the results of the botanical survey and modular river surveys undertaken by the project team. The full results of each survey can be found within the appendices of this report.

Land Use

The eastern bank of the river is bordered by publicly accessible amenity grassland, owned and managed by Watford Borough Council. The main use of this area is for sport and recreation with the site being home to Glen Rovers Football Club. The site contains a hard standing footpath that runs along the crest of a set-back embankment, adjacent to the river channel. The topography of the site has been artificially raised due to its former use for landfill and for flood defence purposes. At the foot of the embankment, a more wild area is present, providing a riparian buffer strip between the intensively managed playing fields and the river corridor. This area offers an informal footpath running adjacent to the river corridor, providing a second walking route for site users.

The land to the west of the river corridor is owned by Hertsmere Council but does not receive any form of management currently. The site is not publicly accessible and is bordered by the Stephenson's Way (A4008) and Link Road. An electricity substation is present to the north of the site, next to Link Road, and a row of high voltage pylons run adjacent to the river corridor. The area was formerly enhanced as part of a wetland restoration scheme undertaken by the National Rivers Authority (now Environment Agency) during the 1990's, however due to a lack management the wetland features that were once installed are now no longer present.

River Profile and Course

The river follows its original course through the site, buts its profile has been modified over time. In 1990 the river was redesigned to facilitate the construction of the Watford M1 Link Road. This involved bed regrading, channel deepening and channel widening. As a result the channel became trapezoidal, relatively straight and overly wide for the predicted minimum flows (NRA, 1996). In the years preceding the scheme, a river restoration project was delivered by the NRA to improve areas of habitat that had been degraded. This involved the creation of pools, riffles and rock deflectors, designed to recreate the natural geomorphology of the River Colne. The features that were installed have had varying success, with some functioning as intended and others now obsolete.

Both banks of the river are low in profile with shallow (<45°) gradients. The eastern bank of the river is bordered by a set-back embankment, between 2-3 meters high. The western bank of the river retains its low profile and extends to a low lying floodplain between the Colne and Stephenson's Way.

Both banks of the river are lined with trees, which interact with the watercourse in a number of ways, including encouraging the width of the river to narrow over time.

The wetted width of the river varies between 3-8 meters, with the bankfull width of the river being between 9–13 meters. The channel appears too large for the low flow conditions regularly observed on the Colne in Watford and intervention is required to adapt the profile of the channel to provide a watercourse where natural morphological processes occur more freely. The depth of the river also varies noticeably throughout the site, with most areas of the watercourse being relatively shallow in nature (>0.3 m) and other areas being significantly deepened (>1m). The deeper and wider areas of river channel are likely to be the product of the modifications undertaken to the river in the 1990s as part of the Link Road Scheme. Despite the NRA's best efforts to rehabilitate the river channel in subsequent years, it is for the most part, a low energy water course with uniform flow and little morphological activity.

Western Floodplain Habitat

The majority of the Western floodplain is comprised of amenity grassland and is separated from the river

Radlett Road Playing Fields habitat map

by a raised embankment of around 2-3 meters tall. As a result of this, the river is not able to laterally expand onto the majority of the floodplain during times of high flow. This has resulted in an elevated floodplain that is dry in nature, with few wetland features. The floodplain is managed for sport and recreation purposes and therefore does not present many opportunities for habitat improvement.

Wildflower Area

There is a notable exception within the amenity area, where there is a curious patch of rank wildflower grassland in the north-west corner. This area looks to have been seeded with a wildflower mix and has some botanical interest with Common Knapweed, Wild Carrot Common Mallow, Weld, Mugwort, Creeping Thistle and Bird's-foot Trefoil evident. Consequently some ruderals have also colonised the area and a diverse botanical community with a complex structure has been created. This is a nice feature but needs managing if it is not to be lost to scrub, as is happening at the moment.


Wildflower area

Embankment

The embankment bordering the river and playing field offers better habitat for wildlife and is comprised of rank grassland, stinging nettles, bramble and pockets of scrub. This shows the successionary process in action and is a consequence of withdrawing cutting from this area. At the foot of the embankment is a small area of floodplain that is of low enough topography to be inundated with water during a flood event. This low lying area is wetter in nature than the surrounding floodplain and is comprised of bramble scrub, rank grassland, stinging nettle and scrub, depending on local conditions.

Constructed Wetland

A constructed wetland feature lies to the South of the floodplain and drains towards the main river from the east of the site. The feature was constructed in the 1990s in order to attenuate surface water run off from the surrounding urban area before being discharged to the River Colne. The wetland receives water from a Thames Water attenuation tank located to the North of the Radlett Road that was originally designed to separate grit and oil from road run off. Since the creation of the feature the surface water catchment area has grown and the number of properties with sewage misconnections has increased. This has resulted in a greater quantity of water and increased levels of pollution entering the constructed wetland. Today, the feature is in need of urgent management and could be redesigned to improve both habitat for wildlife and the settlement of surface water before being discharged to the River Colne.

Eastern Floodplain habitat

The Hillfield Brook

To the North of the site, The Hillfield Brook flows in a westerly direction across the floodplain before meeting the River Colne. The brook flows from Hillfield Reservoir and through the area of Bushey before reaching the site via a culvert beneath the Stephenson's Way. The brook has a straightened profile and receives both urban and rural run off from the surrounding landscape. After times of heavy rainfall, plumes of sediment can be regularly observed at the confluence of the brook with the River Colne, illustrating that the watercourse can be a significant source of siltation of the main river. Invasive species are also present, with Japanese Knotweed and Himalayan Balsam observed at the time of survey.

The Hillfield Brook

Former Backwaters

Immediately to the south of the brook is a former backwater that was created as part of the NRA's restoration scheme in 1996. The backwater was originally designed to have a constant connection with the main river and to provide valuable refuge for juvenile coarse fish. The feature was planted with common reed which provided good habitat for a range of bird species, fish and freshwater invertebrates. Today the backwater no longer has a constant connection with the main river and has become silted and dry over time. The majority of the reed bed habitat has now been succeeded by nettle and bramble scrub. The feature remains dry throughout most of the year, but is inundated with water from the main river during peak flows, illustrating that the features main function is now to relieve fluvial flooding.

A second backwater, created as part of the 1996 restoration scheme, is also present and is in a different phase of succession to the first. Common reed can still be observed in the feature, but due to lower water levels and the effects of siltation, the species has now expanded over the entire bed of the pond. This illustrates the backwater is much dryer than it used to be and will reach a similar stage of succession to its counterpart over the next five years unless intervention is made to restore the feature. The inlet channel of the backwater is now blocked with sediment and trees and does not provide a constant connection with the main river, although connection still occurs when the backwater is inundated with water during peak flows.

Backwater 2

Ditch Network

To the south of the two backwaters a number of ditches cut through the site and drain towards the main river Colne. The ditches flow from the east of the Stephenson's Way but their exact geography is difficult to ascertain as the majority of the ditch network has now been culverted. The ditches remain dry for the majority of the year and therefore are not reaching their full potential for aquatic wildlife. Nettle and bramble scrub dominate the banks of the ditch network, illustrating that they do not retain water during dry weather.

Bank Face Habitat

The banks of the river are comprised primarily of earth, with occasional silt bars lining the bottom third of the bank face. Although they have been reshaped, they are not enforced with any hard revetment. The western bank of the river ranges between 1-1.5 metres high and the eastern bank of the river ranges between 1.5-2.0 meters. The profile of the banks ranges from steep to gentle.

Steeper areas of river bank are less favourable for the colonisation of aquatic plant species. Marginal features such as berms, unvegetated side bars and vegetated sidebars are present throughout the watercourse, which demonstrates that the river is slowly recovering from the effects of modification. Although sediment is beginning to stabilise in the river's margins, large areas of loose silt are also present, showing that intervention is required to catalyse the river's recovery.

The majority of the river bank receives a high degree of shading from dense tree cover in the riparian zone, which limits the diversity of marginal plant life that is able to establish. The riparian zone is largely comprised of Crack Willow, White Willow and Ash

with less frequent examples of Hawthorn, Dogwood, Crab Apple, Domestic Apple and Elder, both planted and self-set. The banks of the river are largely dominated by stinging nettle throughout the shaded zone, with less frequent examples of fern, dock and lichen species.

Bank face habitat in shaded area

A higher diversity of plant species is present in the few areas with less tree cover. Towards the centre of the site an open, non-shaded area of river is present which illustrates the diversity of plant species that could be achieved with an appropriate ratio of light and shade. The banks of the river in this location are populated with pendulous sedge, greater pond-sedge, great willowherb, reed sweet-grass, gypsy-wort, water mint, butterbur, reed canary grass, common reed, common club-rush and yellow flag iris. It is also worth noting that the width of the river has been significantly narrowed where emergent vegetation is present, which has worked to stabilise sediment, providing bench and berm features at the toe of the river bank.

Bank face habitat in unshaded area

River Bed Habitat, Substrate and Flow

Throughout the majority of the site, the river is a low energy watercourse with a uniformly smooth flow type. There is high variation in the bathymetry of the river bed due to historic modification, with depths ranging from 0.2 meters to over 1 meter. The river's substrate is predominantly comprised of silt with occasional traces of sand and gravel pebble. The dominance of silt substrate reflects that the river has a poor ability to appropriately sort and grade sediment into morphological features and that the river is still recovering from the impact of the channel re-profiling undertaken in 1990. In some areas where the river has been artificially deepened, its substrate is primarily comprised of organic debris, which is gradually raising the level of the river bed as it accumulates. Areas such as these do not provide favourable conditions for diverse fish and invertebrate populations to thrive. Intervention is required to catalyse morphological processes and to provide a self-sustaining, dynamic water course.

Low energy, smooth flowing river

Occasional areas of good flow and substrate are intermittently dispersed throughout the length of the watercourse, with many of these areas being the product of the river restoration project undertaken by the NRA in 1996. Most areas such as these provide artificially created riffle habitat and contain rock deflectors and imported substrate (gravel flint reject stone). Some features function better than others in respect to their ability to increase flow and to provide self-cleaning gravels. Some deflectors have done very little to increase scour and flow but have worked to narrow the width of the watercourse and to increase in-stream habitat complexity.

Submerged plant species are present in most areas where light levels are sufficient, with the open area

towards the centre of the site providing the most favourable conditions. Large beds of river water crow foot can be observed throughout this zone, as flow, substrate and light conditions are appropriate. Filamentous algae was also observed to line some areas of substrate, demonstrating slightly eutrophic conditions arising from both urban and rural pollution.

Occasional, energetic, faster flowing sections

Artificial Structures

Two outfalls are present along the river channel and have been observed to regularly pollute the watercourse (CVFC Pollution Monitoring Application, 2019). The outfall receives surface water from the constructed wetland and Thames Water asset referenced previously in this report. The locations of the outfalls are illustrated on page 4..

One road bridge is present to the North of the site and one railway viaduct is present to the South of the site. The river beneath each bridge is overly wide, shaded and slow flowing.

Invasive Species

Himalayan balsam is present throughout the river channel on site, but does not dominate over native species due to diligent regular management from the Knutsford Green Gym volunteer group. If the regular management were to cease, Himalayan balsam would rapidly recolonize and spread throughout the site. Small patches of Japanese Knotweed are also present throughout the river corridor. The site should be surveyed for invasive plant species each year using the CVFC invasive species reporting application and management works carried out accordingly.

American signal crayfish burrows were found throughout the site. The species is common place in the Colne Catchment. Crayfish Burrowing mobilises sediment which has a negative impact on both water quality and habitat. If deemed a priority, the species should be monitored via the Rediscovering the River Colne Environmental Monitoring Project.

American Mink are known to be present throughout Hertfordshire and the Colne Catchment. Mink are aggressive predators that predate on the endangered water vole. One reason that mink cause such a problem for the species is that female and young mink are small and agile enough to follow a water vole into its burrow, leaving very few areas of refuge for the species. It is widely accepted that the presence of American Mink is one of the primary reasons for the decline of water vole populations across the catchment.

Himalayan Balsam

Japanese Knotweed

American signal crayfish

Historic Habitat Improvement Works

This section of the Colne was extensively modified during the construction of the Watford Link Road in 1990. These modifications included bed regrading channel deepening and widening. The modifications to the river channel reduced the habitat diversity of the river and resulted in severely degraded conditions for fish, invertebrates and other wildlife.

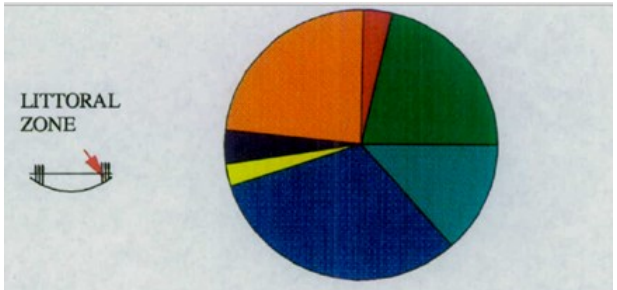
As part of the landscaping proposals for the scheme, the two ponds located to the east of the river were created. Each pond was created with a single inlet channel from the main river designed to allow water from the main river to over spill into the ponds to maintain water levels. Initially the inlet channels were set at too high a level to facilitate this, except under exceptionally high flood levels. Consequently the ponds remained dry from the time of construction.

In 1993 a habitat reinstatement scheme was implemented by the former National Rivers Authority (now Environment Agency) to improve the river channel where habitat and geomorphology had been degraded and to improve the two ponds by connecting them to the main river as backwaters. This consisted of creating a new inlet for the ponds with a two staged profile. The bed level of the channel and ponds were designed to match those of the connection point with the main river. This allowed water from the main river to fill the ponds without impact on surface water flows. This enabled a connection between the river and pond throughout the year, allowing fish and invertebrates to migrate freely between them. The average depth within the backwaters at normal flows was 1m. A 1m wide marginal shelf was also installed within the ponds to increase habitat complexity within the backwater itself.

Fisheries surveys undertaken the year after the backwater was created showed that the feature had been rapidly colonised by juvenile coarse fish, with 7 species present in good numbers. The backwater was noted to offer particularly good recruitment habitat with the majority of the fish population being comprised of juveniles who primarily occupied the littoral zone of the lake.

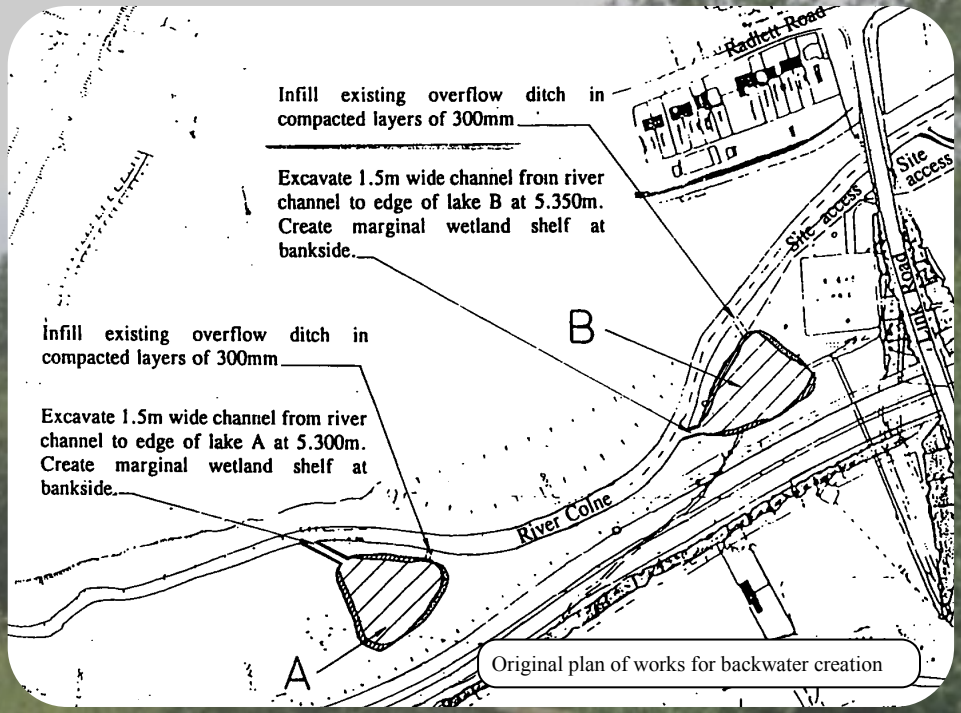
Backwater 1 in 2019 (dry)

1997 Fish Survey Results

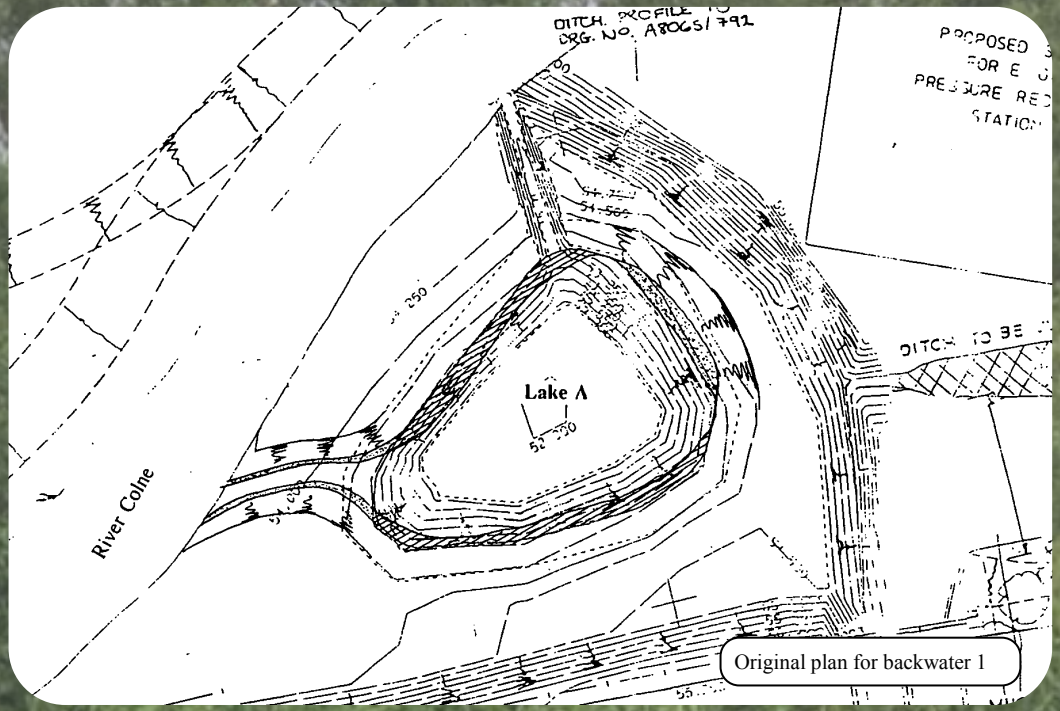


FISH SPECIES	No. captured	% of total catch
Chub	32	21
Dace	5	3
Gudgeon	35	23.5
Minnow	6	4
Perch	4	3
Roach	47	31.5
Stickleback	21	14
TOTAL	150	100

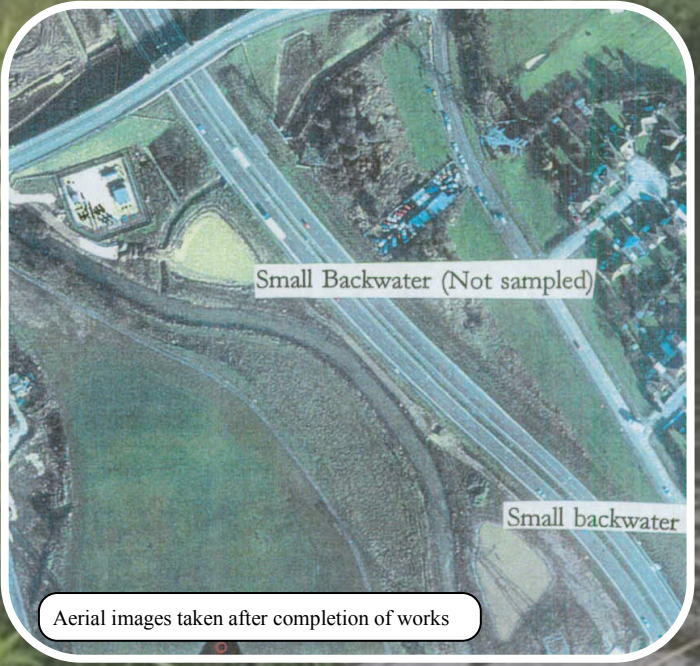
NRA (1996)



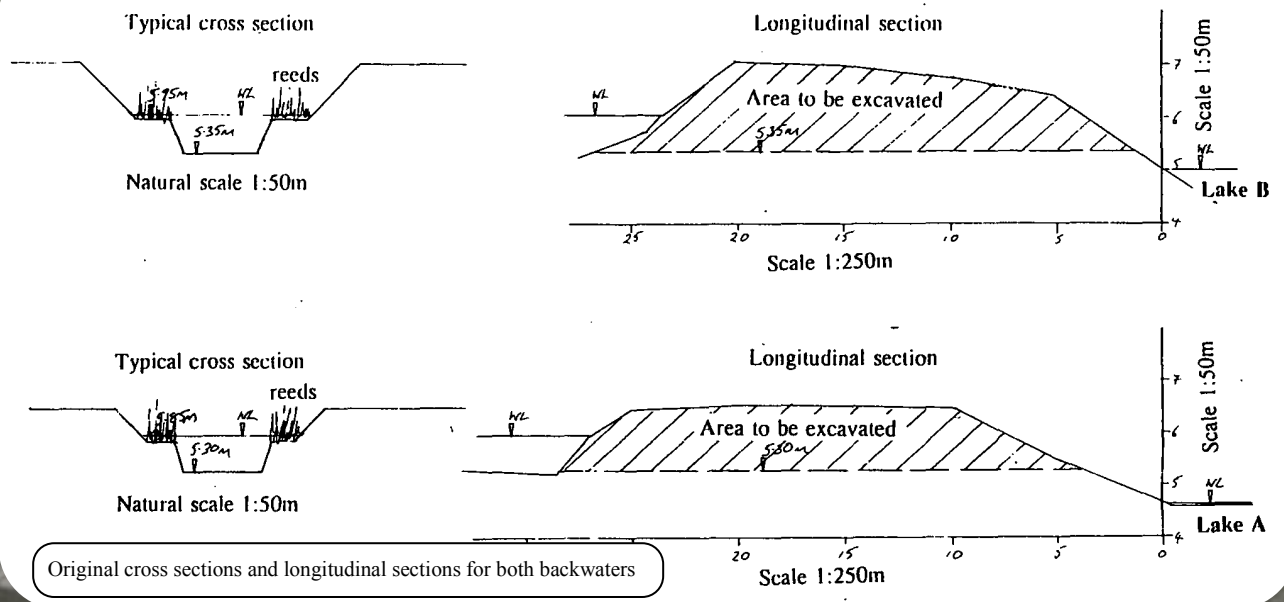
Original plan of works for backwater creation



Original plan for backwater 1



Aerial images taken after completion of works



Original cross sections and longitudinal sections for both backwaters

Site Ecology

Site Criteria

The section of the river is designated as a Local Wildlife Site for Flowing waters (rivers and streams); species.' Local Wildlife Sites are non-statutory sites designated at a county level as being of conservation importance and often recognised in Local Authority development plans. The aim of this identification is to protect such sites from land management changes, which may lessen their nature conservation interest, and to encourage sensitive management to maintain and enhance their importance.

The site is designated for the following features: A long stretch of the River Colne with well vegetated margins supporting a good diversity of emergent and submerged flora. Species recorded include Reed Sweet-grass, Purple Loosestrife, Lesser Pond-sedge, Branched Bur-reed, Fool's Water-cress and of particular interest are Common Club-rush and Flowering-rush, both uncommon in the county. Lining the river banks there are occasional trees and shrubs, mainly Hawthorn willow, Alder, Hybrid Black Poplar and Sycamore Water Voles have been recorded along the river.

Bats

The bat survey conducted by the project team (HMWT, 2019) identified three species of bat at the site: common pipistrelle, soprano pipistrelle and daubentons. The presence of common pipistrelle and soprano pipistrelle are to be expected and are common throughout the Colne Valley. Noctules are large, far ranging bats and can occur over suitable feeding areas or more likely in this case, passing over the site. The bat population is likely to be limited at the site due to its urban nature, associated light pollution and poor water quality.

Water Voles

No signs of water voles were recorded during the most recent survey undertaken by the project team (HMWT, 2019). The nearest known population of water voles is about 3km downstream, at Croxley Hall Fishery. Overall, there is probably enough reasonable habitat to allow water voles to move through Watford, but relatively few places that would allow a population to establish and thrive.

Otters

The otter survey conducted by the project team (HMWT, 2019) did not identify any evidence of otters at the site. Otter spraint was recorded at two sites downstream however. It is presumed that the spraint was deposited by Otters prospecting up the River Colne from what is believed to be an established population in the mid-Colne Valley. Otter populations are likely to increase in Watford should the Colne's fish populations become more resilient.

Coarse Fish

The 2017 EA fisheries surveys conducted at the site found that chub, dace, gudgeon, perch, roach and pike were present. The results showed that the average density of fish at the site had declined to just a quarter of the density recorded in 2015. This is believed to be the result of a major pollution event in 2015 which resulted in a fish a kill. Intervention is required to resolve reoccurring water pollution issues at the site in addition to improving spawning and recruitment habitat for coarse fish.

Bird Life

At the time of survey, the project team identified the following bird species at the site: Blackbird, Wren, Chifchaff, Blue Tit, Great Tit, Blackcap, Robin and Chaffinch (HMWT, 2019).

Butterflies

At the time of survey, the project team identified two species of butterfly: Meadow Brown and Marbled White (HMWT, 2019).

Site Water Quality

River flies

A range of aquatic invertebrates are present and emerge in their flying form in spring and summer to provide an essential food source for fish, birds and bats. The river fly population is currently limited due to poor water and habitat quality.

River fly Monitoring

Water quality is monitored on a monthly basis at the site via the Anglers Riverfly Monitoring Initiative (ARMI). ARMI is a citizen science initiative that facilitates regular monitoring of river water quality by trained volunteer monitors, to complement the more detailed work carried out by the EA.

The method involves taking a three minute kick sample using transects that are reflective of the habitat available at the monitoring site. Eight target groups of aquatic invertebrate 'indicator species' are monitored and a score is generated based on their abundance and the number of individuals recorded. The score can be used to detect any severe perturbations in river water quality providing an evidence base to address sources of pollution.

Radlett Road Results

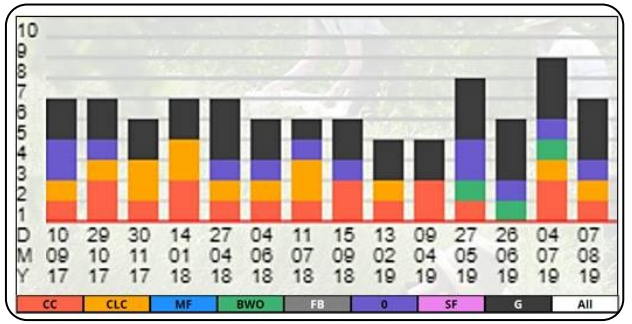
Radlett Road Recreation Ground returns an average ARMI score of 3.64. This is a slightly lower score than the nearest site upstream (Link Road, 4.50) and significantly higher than the nearest site downstream (Lower High Street Bridge 2.05). This illustrates an overall trend of declining water quality throughout Watford. The average score returned at the most upstream monitoring site in Watford (Bushy Mill Lane) is 5.57 and the next five sites downstream of this location return significantly lower scores.

There are two outfalls present at the southern end of the site immediately upstream of the ARMI monitoring point (see plan for location), both of these outfalls have been observed to pollute the river on a regular basis and will contribute to the progressive decline in ARMI scores as the river flows through Watford (CVFC, 2019).

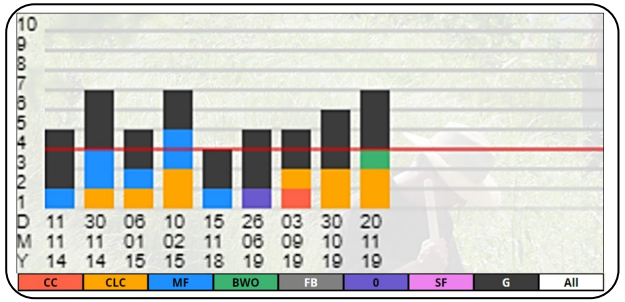
Additional Monitoring Activities

The *Rediscovering The River Colne Project* intends to extend the river fly monitoring network to reflect all sites in Watford and to facilitate additional monitoring activities to improve understanding of pollution in Watford. The project facilitates a regular meeting, known as Watford Water Quality Forum, between Watford Borough Council, Thames Water, The Environment Agency, Groundwork, The CVFC and Community Connections Projects CIC. The forum works to identify and deliver improvements to surface water and waste water infrastructure in Watford. Please see the *Rediscovering The Colne Environmental Monitoring Project Feasibility Study* for more information.

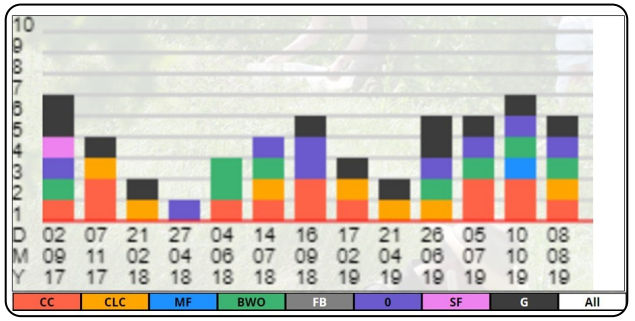
ARMI Results:



Bushey Mill Lane ARMI results (1.2km upstream)



Timberlake Allotments ARMI results (0.9km upstream)



Radlett Road ARMI results

Water Framework Directive (WFD)

What is the WFD?

During the 1990s the European Commission recognised that we needed an integrated and comprehensive way of managing the water environment and so the Water Framework Directive (WFD) came into existence. It has been part of UK law since 2003.

The original aim of the WFD was for all rivers, lakes, reservoirs, streams, canals, estuaries, coastal and groundwater (known as water bodies) to be in good ecological health by 2015. However, the EU has recognised that it will be an almost impossible task to reach this goal by 2015, so in most cases this deadline has been extended to 2021 or 2027.

What is a healthy water body?

A healthy water body has thriving populations of fish, invertebrates, plants and diatoms (microscopic algae). They depend upon a healthy flow of water and a variety of natural habitats. All of these are affected by the levels of pollution and nutrients in the water, and the shape and structure of the water body. The Environment Agency uses many different measures to assess the ecological health of a water body. They include:

- the variety and numbers of different types of animals and plants living in the water body
- the state of the water itself, such as the temperature.
- the amount of oxygen, how acidic or alkaline it is (the pH), and the concentration of nutrients like ammonia and phosphate
- the concentration of polluting chemicals from human activity, such as arsenic, cyanide and the breakdown products of pesticides
- and for Heavily Modified and Artificial Water Bodies, whether it could be made more natural without interfering with the way it is used.

These are combined to come up with an overall classification for each water body. The classifications are:

High	Good	Moderate	Poor	Bad

When the status of a water body is Moderate, Poor or Bad, the Environment Agency investigate the reasons why it is not in good ecological health.

Current WFD Status

- The overall WFD classification for *The Colne (Ver to Gade)* waterbody is **moderate.**
- It's chemical classification is **good.**
- Its ecological classification is **moderate.**

Reasons for Not Achieving Good Status

The Colne (Ver to Gade) waterbody is currently not achieving *good status* due to the following factors:

1. Changes to the river's natural flow and water levels due to abstraction from the water industry.
2. Continuous pollution from waste water related to the water industry.
3. Physical modifications to the watercourse arising from urban transport and infrastructure.

Activities Listed in this plan which address these issues

1. Wooded debris installation (P15)
   Backwater restoration (P17-18)
   Leaky dams / ditch restoration (P18)
2. Constructed wetland enhancement (15)
   Additional Monitoring Activities (P12)
   Watford Water Quality Forum (P12)
3. Wooded debris installation (P18-19)
   Backwater restoration (P17-18)
   Constructed wetland enhancement (P15)
   Improved riparian habitat management (P17)
   Tree works (P18-19)

Habitat Improvement Recommendations

Western Floodplain

Playing Fields

The playing fields do not provide many opportunities for improvement for wildlife due to their use for sport and recreation. The main opportunity for improvement is the restoration of the constructed wetland near the south western perimeter of the site. Intervention is required in order to improve the wetland's ability to retain and settle surface water arising from the Thames Water attenuation tank to the west of the Radlett Road. The backwater could also be modified to provide an extensive reed bed which would provide valuable habitat for a range of aquatic wildlife.

1. The wetland should be dredged to remove silt and debris that has accumulated over the past few decades and to increase water storage capacity.
2. A series of bunds, descending in height and profile, could be installed along the length of the channel to divide the wetland into three distinct settlement ponds. If feasible, each bund could be constructed with sediment removed from the bed or the banks of the channel.
3. Flow conveyance between each pond could be facilitated by water overtopping each bund as water levels rise, or by installing a series of pipes in each bund, set at an appropriate level to allow water through as levels rise. The bunds/pipes would also have to be set at an appropriate level to ensure that the hydraulic head of the upper pond was not raised to the extent where water backed up into the attenuation tank that feeds the wetland.
4. Gravel flit reject stone could be introduced to the bed of channel in order to provide aerated substrate and a suitable medium for beneficial bacteria to colonise.
5. Common reed could be introduced to the channel to trap sediment and to provide filtration to surface water discharged from the attenuation tank to the west of the Radlett Road.
6. Tree cover could be thinned on the banks of the channel in order to provide sufficient light levels for the reed bed to flourish.
7. The banks of the wetland could be scalloped to provide an appropriate gradient for marginal plant species to establish.
8. The fence line surrounding the channel could be removed and replaced with a hedge row.
9. Suitable viewpoints around the wetland feature could be created to allow site users to observe the wetland.
9. Suitable access points should be created to allow for the maintenance of the wetland.

The only other area where enhancement is recommended within the playing fields is the wildflower area to the north-west of the site. This area should be managed annually with the following actions undertaken:

1. The area should be cut and cleared in mid-July and October to maximise botanical diversity.
2. In order to reduce the impact of the hay cut on invertebrates, retain strips of uncut material through the area amounting to approximately 15% of the total in every cutting episode.
3. Rotate these strips around the area so that different sections are left uncut each time, to prevent net nutrient enrichment and declines in botanical diversity.

Riverside Area

The low lying area at the foot of the set back embankment adjacent to the river channel is currently very nutrient rich and dominated by aggressive nutrient demanding species. This means that attempting to create biodiverse complexities such as wildflower meadow communities would be

Legend:

- 1 — Coppice trees to provide 60:40 light/shade ratio
- 2 — Install marginal berms and flow deflectors
- 3 — Restore and reconnect historic backwater
- 4 — Enhance ditch network
- 5 — Enhance constructed wetland as SuDS
- 6 — Improved riparian habitat management
- 7 — Improved wildflower meadow management
- Install bat box

Radlett Road habitat improvement map

unlikely to succeed. The aim should therefore be to retain and create diverse structure through the management regime.

1. Continue to mow paths within the area.
2. Create mown bays by the river to enable viewing of the river channel. Select areas currently dominated by nettle.
3. Link path network to open bays to the river which are also managed by regular cutting. Leave emergent vegetation fringe of the river to develop.
4. Control woody growth in these bays by annual removal.
5. Periodically cut and clear patches of bramble on rotation in the winter so that different heights and stages of succession are created.
6. Create three rotational clearance areas which are cut and cleared in succession, one year in three.
7. Coppice on rotation small pockets of woody vegetation (Hawthorn, Willow sp. and other shrubs) within this area and along the riverside. This will let more light into the river, halt the successionary process and stimulate the ground flora adding more diversity to woodland floor. Coppice these designated areas on rotation one year in 5.
8. Cut and clear 50% of the rank grassland blocks every year to conserve as species poor tussocky rank grassland but prevent their loss to scrub. Clear alternate strips amounting to 50% rather than two large blocks, to maximise interface between habitats. Cut and clear in October. This is not intended to deplete the nutrients of the areas and increase botanical diversity but merely to halt succession and create structural diversity primarily for invertebrates.
9. Create a path network to the south of the river to enable access and create more structural diversity.
10. Cut and lay occasional small thorn trees to provide ground nesting habitat.

Eastern Floodplain

The main opportunities for improvement on the eastern floodplain is the restoration of a series of wetland features. These include the Hillfield Brook, two former backwaters to the river Colne, and the ditch network to the south of the site.

Hillfield Brook and Backwater 1:

The issues preventing these features from reaching their full potential for wildlife are as follows.

1. The Hillfield Brook follows a straightened course and is a major source of siltation to the River Colne during times of high flow.
2. The backwater has dried out since its creation in 1993 and is no longer connected to the main river channel.

In order to rectify these issues the following improvement works are recommended:

1. The backwater should be desilted and reconnected to the main river so its bed level matches that of the connection point with the main river. This will provide a constant connection between the two water bodies, allowing wildlife to ingress/egress as required.
2. A low lying marginal shelf should be created to provide a complex littoral zone around the feature. The marginal shelf should be planted with common reed and other native species translocated from the wetland immediately upstream at Timberlake Allotments or other local sites.
3. The Hillfield Brook should be diverted to feed into the backwater before entering the river Colne. This will provide a degree of settlement for sediment and urban run off before flows reach the main river. It will also ensure the backwater receives a constant feed of water, ensuring that the feature remains wet during times of low flow on the main river. It may also reduce flood risk to a minor degree.
4. A silt trap could be created upstream of the brook's connection point with the backwater

to provide a point where sediment can be easily managed in subsequent years.

Backwater 2

Like the backwater upstream, the second backwater has dried out since its creation and is no longer connected to the main river channel. The feature could be restored by undertaking the following actions:

1. The backwater should be desilted and reconnected to the main river so its bed level matches that of the connection point with the main river. This will provide a constant connection between the two water bodies, allowing wildlife to ingress/egress as required.

2. A low lying marginal shelf should be created to provide a complex littoral zone around the feature. The marginal shelf should be planted with common reed and other native species translocated from the wetland immediately upstream at Timberlake Allotments or other local sites.

Ditch Network

The ditch network remains dry for the majority of the year and offers little wetland habitat for aquatic wildlife. The ditch network could provide additional habitat for water voles should the species return to the area and for a range of aquatic invertebrates, such as dragonflies. The following actions are recommended to enhance the habitat value of the ditch network.

1. The banks of the ditches should be regarded to provide a gentle profile. This will allow wildlife to ingress/egress to the ditches and will provide more favourable conditions for aquatic plant life to establish.

2. Leaky dams could be installed in appropriate locations throughout the ditch network to retain water following times of rainfall. This would ensure that the ditches remain wet for a longer period of time in addition to delaying run off rates to the river Colne following rainfall.

Riparian management recommendations:

1. Coppice on rotation small pockets of woody vegetation (Hawthorn, Willow sp. and other shrubs) within this area and along the riverside. This will let more light into the river, halt the successionary process and stimulate the ground flora adding more diversity to woodland floor. Coppice these designated areas on rotation one year in 5.

2. Use cut material to create shaded habitat piles. Habitat piles could be designed to incorporate covered pockets within them, with access to the river which may be used for shelter by otters either temporarily or more permanently if food resources allow. Habitat piles will also be used by many other organisms for shelter, e.g. amphibians, reptiles, birds.

River Channel

The following issues affecting the river channel have been identified in this location:

1. Where the river channel is shaded, marginal vegetation is not present to stabilise sediment. This has resulted in some areas of the river becoming wide and slow flowing with visible areas of loose silt covering the gravel bed.

2. There is little variation in the depth and little sinuosity due to the channel's straightened profile.

3. There is little variation in flow type, with the flow of the river being predominantly smooth and slow flowing.

4. The river channel lacks suitable habitat for bat roosting.

In order to improve the river in this location the following interventions are required:

1. Tree removal work should be carried out in areas where the river is over shaded and prone to siltation.

2. The encroachment of the remaining woodland should be prevented by periodic coppicing of self-set material i.e. maintain the current vegetative margin balance and prevent increase in shading to the channel.

3. Wooded debris, in the form of brush berms, hinged trees and flow deflectors should be introduced to the river channel in appropriate locations to increase sinuosity, diversify flow, stabilise sediment, increase physical habitat complexity and to increase scour of the ivererbed.

4. Berms may also be constructed from materials excavated from the back water areas proposed to the east of the river channel. The materials could be secured behind brushwood faggots and coir liners before being planted with an appropriate array of native plant species.

5. Small pools could be created downstream of each flow deflector installed. The gravel from each pool could be redistributed to form sediment bars or riffle features. This will increase variation in depth and diversify flow.

6. Locally sourced gravel substrate could be introduced in areas where the river has been artificially deepened to restore the rivers natural gradient or to create riffle features.

7. Materials arising from the excavation of backwaters on the eastern floodplain could be used to construct bench features in artificially widened areas of river channel. The benches could be planted with an appropriate array of native aquatic plant species.

8. Bat boxes should be erected on suitable trees by the water course. Bat boxes should be Schwegler 2F-DP and located in deep shade and dappled sunlit glades, with good flight access, to attract target species e.g. Dauben ton's, soprano pipistrelle and Nathusius' pipi strelle.

Further Management Recommendations:

1. Eradicate the Himalayan Balsam by constant pulling during summer months.

2. Continue to treat stands of Japanese Knotweed on an annual basis.

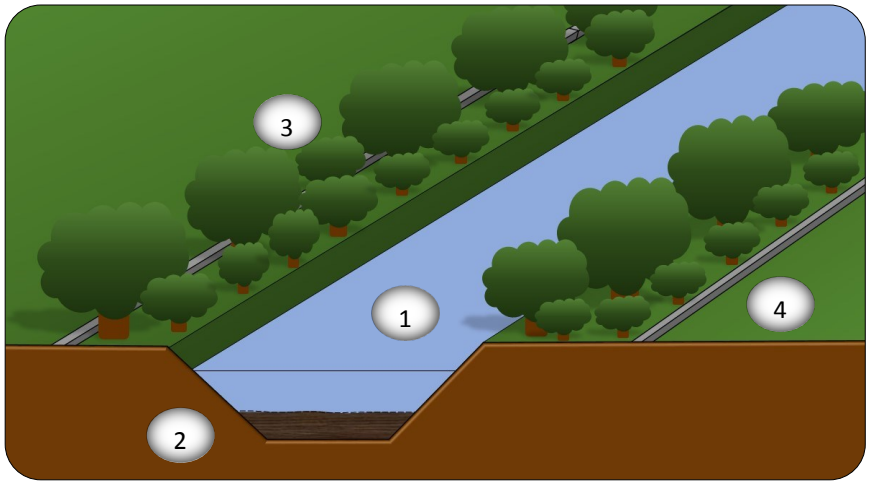
3. Introduce mink monitoring rafts within the river. These should be sited away from public areas to avoid disturbance.

4. Regularly remove litter from the watercourse with local volunteers.

Design Considerations

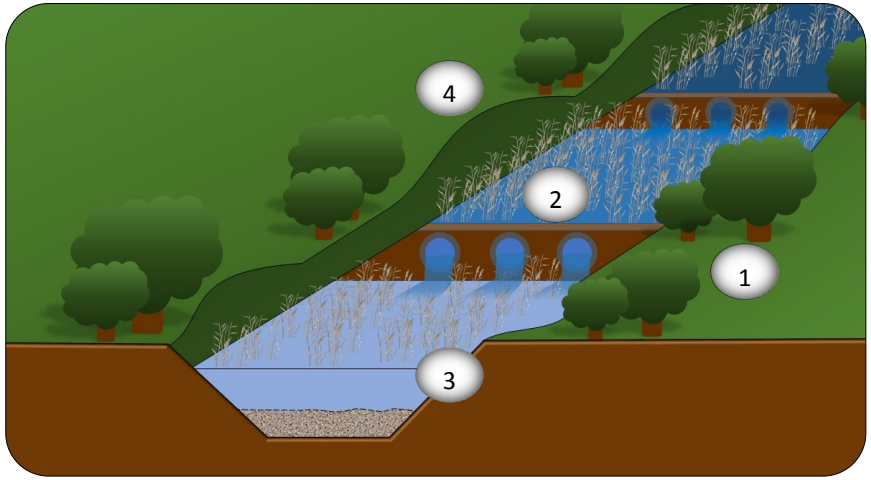
Constructed Wetland

Before Enhancement



1. Surface water flows from an attenuation tank into the wetland and then on to the River Colne via an outfall. Due to the straightened nature of the channel, water quickly reaches the river, leaving little time for natural water filtration to occur.
2. Silt, organic detritus and sewage rag has accumulated in the wetland over time, reducing its water storage capacity and value to wildlife.
3. A thick tree line shades the wetland, preventing diverse plant communities from establishing. The steep gradient of the banks also contribute to this.
4. A fence line blocks access to the wetland meaning that it cannot be accessed or maintained easily.

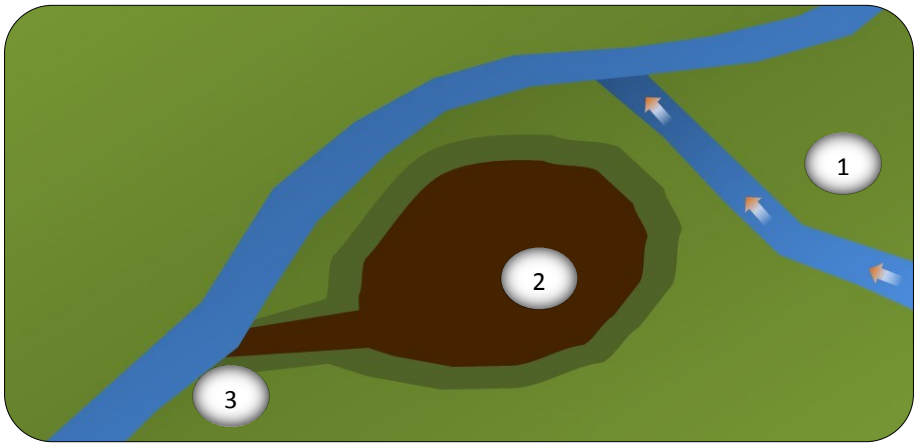
After Enhancement



1. The tree line is thinned and fence line removed to increase light levels and to allow access for maintenance/construction.
2. The wetland is desilted to increase its water storage capacity. Excavated materials are used to create a series of bunds of descending height to separate the wetland into three ponds that cascade into each other as water levels rise, thus slowing conveyance and allowing water to be stored for longer. The water level of each pond can be set either by the height of each bund or by installing outlet pipes at descending levels.
3. The bed of the wetland should be dressed with gravel where appropriate and common reed introduced to each pond to aid natural water filtration.
4. The banks of the wetland should be scalloped/regraded to encourage diverse plant communities to establish.

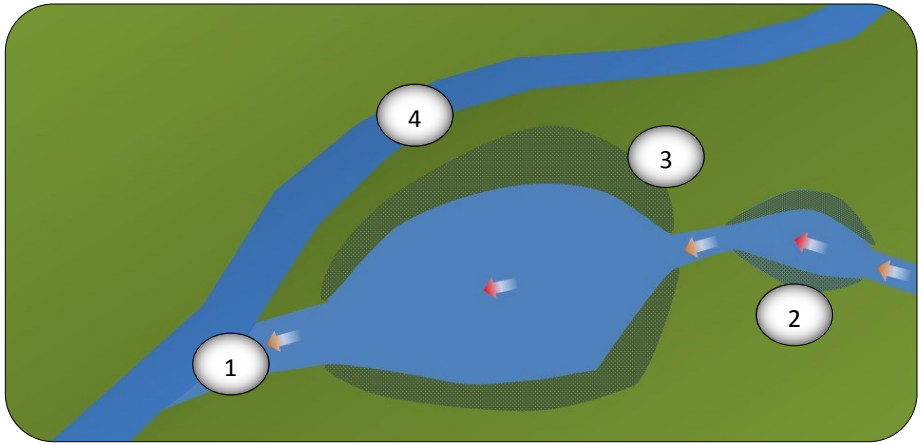
Backwater 1 and Hillfield Brook Restoration

Before Restoration



1. The Hillfield Brook currently flows past the former backwater and into the River Colne. The brook brings surface water run off to the river from both urban and rural areas, which can contain high loadings of fine sediment and contaminants associated with urban pollution.
2. The former backwater is currently disconnected from the main river due to the accumulation of organic debris and silt. The backwater only fills with water during periods of high flow and does not provide refuge habitat for aquatic wildlife.
3. The outlet channel is currently blocked with silt and willow trees.

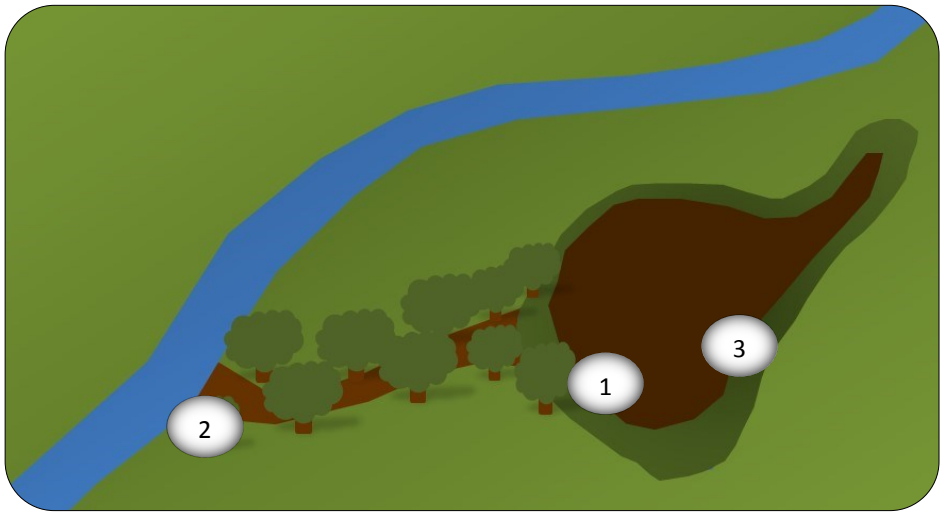
After Restoration



1. The bed level of the pond and outlet channel is lowered to match the bed level of the adjacent river channel. This will provide a constant connection between the main river and backwater area and will allow aquatic wildlife to ingress/egress at all times. Any trees blocking the outlet channel are removed.
2. The Hillfield Brook is rerouted to flow into a silt trap (a small pond of decent depth) before flowing into the backwater area. The silt trap will be easy to maintain and sediment should be removed every few years by hand, machine or other methods such as using siltex. The constant supply of water to the feature will ensure that it does not dry out again.
3. Common reed is introduced to the backwater to trap any remaining sediment, to aid natural water filtration and to provide habitat for wildlife.
4. Excavated materials may be used to create marginal berms along the river channel.

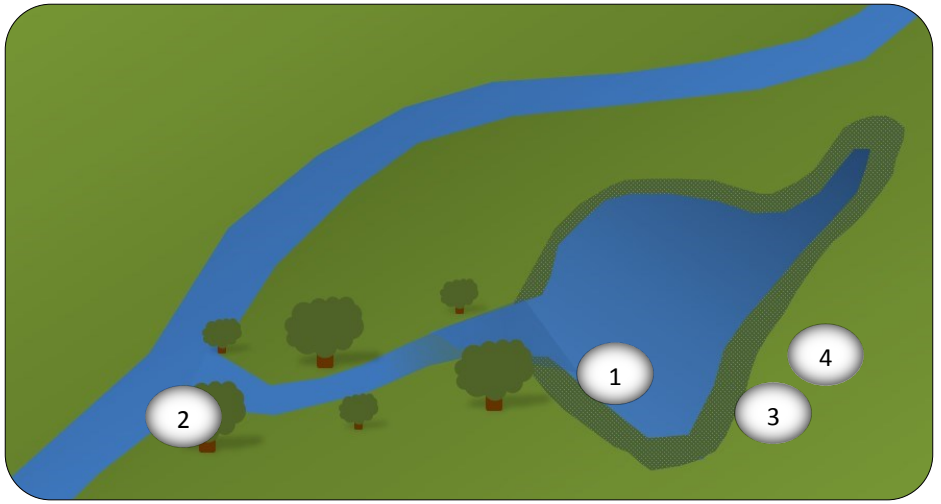
Backwater 2 Restoration

Before Restoration



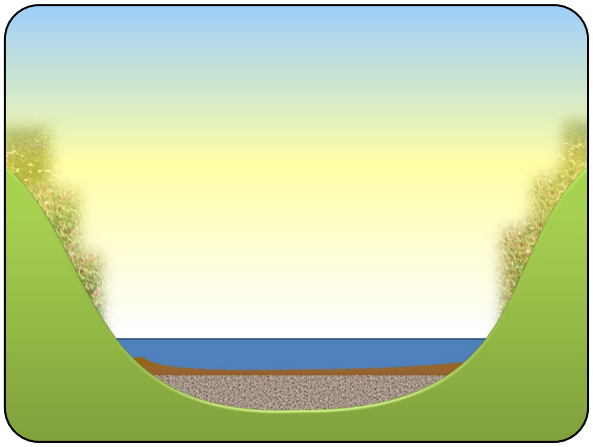
1. The backwater is currently disconnected from the main river due to the accumulation of organic debris and silt in the pond area and outlet channel.
2. The outlet channel is impeded further by the presence of willow trees that block its connection with the pond area.
3. A reed bed has encroached over the area where the old pond was present but is slowly drying out as the feature is dry for most of the year.

After Restoration



1. The bed level of the pond and outlet channel is lowered to match the bed level of the adjacent river channel.
2. Water is able to back up the channel from the main river, providing a constant connection between the two features.
3. A marginal shelf is created at the edge of the pond which is planted with common reed retained during construction and other native aquatic plant species.
4. The reedbed is be cut on rotation, annually, to maintain the balance between vegetated areas and open water.
5. If a connection with the river cannot be facilitated, the pond should be enhanced in isolation from the main river.

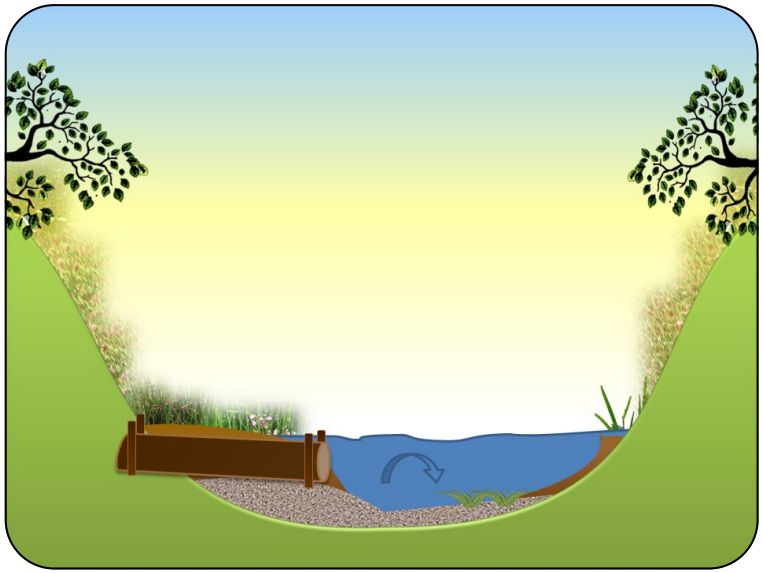
Brush Berms and Flow Deflectors



The river channel has a modified profile and uniform depth. Siltation occurs in over shaded areas where emergent plant species are not present to stabilise loose silt in the margins of the river.

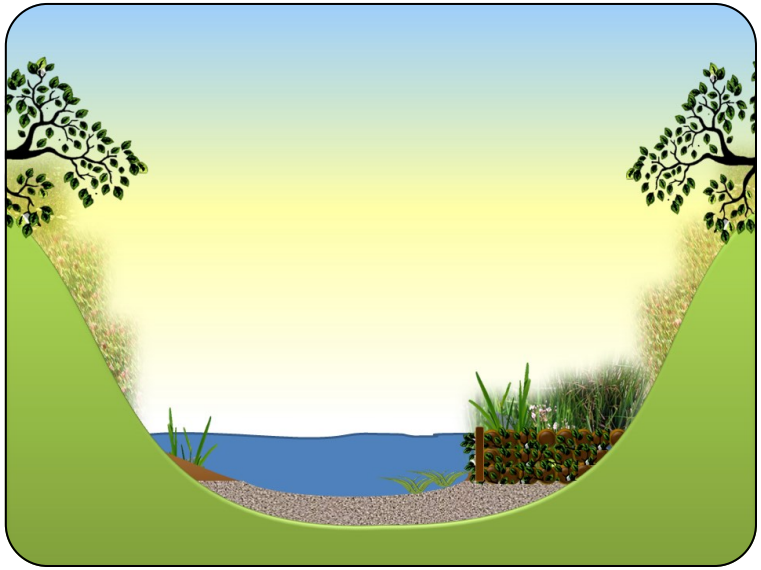
Over shading trees can be coppiced and repurposed to create brush berms and flow deflectors within the channel to mimic natural sinuosity, stabilise sediment and to create a variety of depths and flow types.

These features can be easily installed by local volunteer teams. An environmental permit must be obtained from the Environment Agency in order to undertake this activity.



Flow deflectors are used to pinch the width of the river which reduces siltation, creates scour and facilitates a variety of different flow types.

They are created by securing tree trunks to the bed of the river with chestnut posts and galvanised steel wire. A pool feature can also be created downstream of each deflector's location to provide a variety of depths. Materials won from excavating pools can be repurposed to create riffles or side bars, which further increase physical habitat complexity.

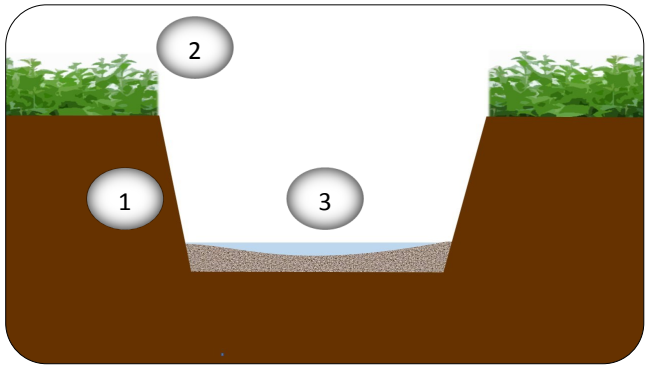


Brush berms can also be installed to pinch the width of the river and can be used to mimic natural sinuosity. They provide useful low lying areas for aquatic plants to colonise in addition to providing physical structures for aquatic wildlife to shelter.

They are created by using tree branches to reshape the river, which are secured in place with chestnut posts and galvanised steel wire.

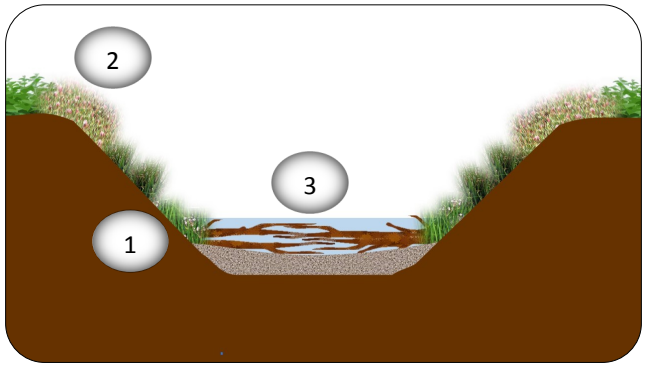
Ditch Enhancement

Before Enhancement



1. The banks of the ditch network are often too steep to allow marginal plant life to establish.
2. The bank top is often dominated by stinging nettles and invasive species.
3. The ditch network does not retain water during dry times of year, meaning that it cannot be utilised by aquatic wildlife.

After Enhancement



1. Steep blanks are regraded to enable a wider diversity of plant species to establish and allowing wildlife safe ingress/egress to the ditch network.
2. Invasive species are managed annually to prevent them taking over the ditch network and migrating towards the main river. An array of native plant species may be introduced if required.
3. Wooded debris, in the form of leaky dams, are placed in key locations throughout the ditch network in order to allow it to retain water for longer periods of time.

Bat Boxes

Schwegler 2F Bat Boxes

Species such as the Lesser Noctule and the Common Noctule, as well as Daubenton's, Nathusius's Pipistrelle and Bechstein's Bat, are typical representatives of Bats that live in woods and forests. They prefer Bat Boxes as closed systems, as in nature they prefer, for example, woodpecker cavities and hollow tree branches. However, as old, diseased or dead trees tend not to be available or rather are removed from managed forests, natural roosts for Bats have become scarce.

Bat Boxes can provide a remedy and are readily accepted by the animals. So-called "House Bats" are mainly those that like to roost in buildings, for example, in roller shutter boxes, behind window shutters, niches and gaps. These are, above all, Serotine, Mouse-Eared and Pipistrelle Bats. These Bats prefer, for example, flat boxes or round boxes with several hanging panel partitions.

The box has a special double front panel, made of long-term resistant, grooved wooden boards, which creates a particularly popular and readily acceptable roosts and can be easily converted into a 2F Bat Box without double front panel or a 2M Nest Box for Birds at any time. The front panel can be removed for inspection and cleaning.

Site Action Plan

Backwater restorations and riparian tree works

Activity	Action		Comments	Delivered by:
All	1.	Procure contractor to undertake project design and permitting.	Three contractors to tender for the initial phase of the project. The tender should cover the following activities: 1. Tree works (Backwater area and river corridor) 2. Backwater restoration works (including the Hillfield Brook)	Groundwork
Backwater restoration	2.	Undertake topographical survey to assess the feasibility of reconnecting the back water to the main river.	• The survey should highlight whether a constant connection between ponds , river and Hillfield Brook can be maintained. • If a constant connection cannot be maintained, the option to connect the river and pond should not be abandoned in favour of restoring the features as offline wetlands.	Contractor
Backwater restoration	3.	Undertake sediment analysis to establish whether materials in backwater area are contaminated.	• The results of the analysis should establish whether materials can be reused on site or disposed of in landfill.	Contractor
Backwater restoration Tree works	4.	Produce designs for back water or pond enhancement.	The following construction drawings should be produced should be produced 1. Site plan *Illustration showing the location of each improvement proposed on site (backwater and riparian tree works)* 2. Topographical Survey *Survey of site topography around key construction areas.* 3. Cross sections and longitudinal sections for backwater area and connection point with river corridor. *A cross sectional diagram produced for key areas.*	Contractor

Backwater Restoration Tree Works	5.	Apply and obtain bespoke environmental permit to cover works.	The following documentation is required for an Environmental Permit application. 1. The construction drawings listed previously. 2. Site management plan *Document containing all aspects of site management.* 3. Construction Methodology *Method of construction for each activity proposed.* 4. Sediment analysis results *With interpretation illustrating what materials can be used for.* 5. Water Framework Directive Compliance Assessment *WFD compliance evaluated for each activity proposed.* 6. Environmental Risk Assessment *Environmental risk and mitigation identified for each activity.* 7. Site Risk Assessment *Risk to workers/site users and appropriate mitigation identified.*	Contractor
Backwater restoration	6.	Procure contractor to deliver construction phase.	Three contactors to tender for construction phase of project. The tender should cover the following activities: 1. Backwater restoration or pond enhancement works. 2. Riparian tree works	Groundwork
Backwater restoration Tree works	7.	Deliver capital improvement works as per design specifications	**Likely construction methodology for each activity:** **Tree Works:** 1. Trees are cut and cleared as per design. *Willow to be used to create hibernacula for reptiles, amphibians and invertebrates on Affinity Water Site. Excess materials to be chipped and spread on informal pathways or removed from site.* 2. Other species to be retained for the creation of wooded debris features in the river channel.	Contractor

Continued from previous page		**Backwater restoration works:** 1. A long reach excavator should be used to lower the bed level of the pond to the levels specified in the construction design. 2. The outlet channel of the pond should be desilted and regraded to provide a constant connection with the main river. 3. A marginal shelf should be created within the perimeter of the pond and planted with common reed and other native aquatic plant species. **Hillfield Brook** 1. The Hillfield Brook should be diverted to flow into a small silt trap before reaching the backwater area. 2. The banks of the watercourse should be regraded to encourage marginal plant life to establish.	Contractor

Constructed Wetland Enhancement

Activity	Action		Comments	Delivered by:
All	1.	Procure contractor to undertake project design and permitting.	Three contractors to tender for the initial phase of the project. The tender should cover the following activities: 1. Tree works (Backwater area and river corridor) 2. Wetland enhancement works	Groundwork
Wetland enhancement	2.	Undertake topographical survey to assess the feasibility of separating constructed wetland into three ponds.	• The survey should highlight whether the provision of three ponds with descending water levels is viable. • If three ponds cannot be provided other options should be considered.	Contractor

Wetland Enhancement	3.	Undertake sediment analysis to establish whether materials in backwater area are contaminated.	• The results of the analysis should establish whether materials can be reused on site or disposed of in landfill.	Contractor
Wetland Enhancement Tree works	4.	Produce designs for constructed wetland enhancement.	The following construction drawings should be produced. 1. Site plan *Illustration showing the location of the improvements identified.* 2. Topographical Survey *Survey of site topography around key construction areas.* 3. Cross sections and longitudinal sections for the wetland area and connection point with river corridor. *A cross sectional diagram produced for key areas.*	Contractor
Wetland Enhancement Tree Works	5.	Apply and obtain bespoke environmental permit to cover works.	The following documentation is required for an Environmental Permit application. 1. The construction drawings listed previously. 2. Site management plan *Document containing all aspects of site management.* 3. Construction Methodology *Method of construction for each activity proposed.* 4. Sediment analysis results *With interpretation illustrating what materials can be used for.* 5. Water Framework Directive Compliance Assessment *WFD compliance evaluated for each activity proposed.* 6. Environmental Risk Assessment *Environmental risk and mitigation identified for each activity.* 7. Site Risk Assessment *Risk to workers/site users and appropriate mitigation identified.*	Contractor

Backwater restoration	6.	Procure contractor to deliver construction phase.	Three contactors to tender for construction phase of project. The tender should cover the following activities: 1. Constructed wetland enhancement 2. Riparian tree works	Groundwork
Backwater restoration Tree works	7.	Deliver capital improvement works as per design specifications	**Likely construction methodology for each activity:** **Tree Works:** 1. Trees are cut and cleared as per design. *Willow to be used to create hibernacula for reptiles, amphibians and invertebrates. Excess materials to be chipped and spread on informal pathways or removed from site.* 2. Other species to be retained for the creation of wooded debris features in the river channel. **Backwater restoration works:** 1. A long reach excavator should be used to lower the bed level of the wetland to the levels specified in the construction design. 2. The banks of the wetland should be scalloped to provide a variation in gradients. 3. Excavated materials may be used to create the two bunds designed to separate the wetland into three ponds. The crest height of each bund should match the specifications of the construction drawings. 4. Alternatively pipes may be set in each bund at descending levels, as per the specifications of the construction drawings. 5. If appropriate, the wetland should be lined with gravel to aid filtration and the establishment of common reeds. 6. Pre planted coir pallets of common reeds should be introduced to each of the three ponds.	Contractor

			1. Excess materials may be used for landscaping adjacent to the wet-land area or removed from site. 2. The banks of the wetland and any newly landscaped area should be planted with an appropriate array of UK native plant species.	Contractor

Wooded debris installation, Minor Tree Works and Bat Box Installation

Activity	Action		Comments	Delivered by:
Wooded Debris Installation Minor Tree Works	1.	Produce design illustrating chosen locations of brash berms, flow deflectors, hinged trees, pools and riffles, minor tree works.	The following construction drawings should be produced should be produced: 1. Site plan *Illustration showing the location of each improvement proposed on site.* 2. Cross sections and longitudinal sections for each improvement	Groundwork
Wooded Debris Installation Minor Tree Works	2.	Apply and obtain bespoke environmental permit to cover works.	The following documentation is required for an Environmental Permit application. 1. The construction drawings listed above *2.* Site management plan *Document containing all aspects of site management.* 3. Construction Methodology *Method of construction for each activity proposed.* 4. Water Framework Directive Compliance Assessment *WFD compliance evaluated for each activity proposed.* 5. Environmental Risk Assessment *Environmental risk and mitigation identified for each activity.* *6.* Site Risk Assessment *Risk to workers/site users and appropriate mitigation identified.*	Groundwork
Wooded Debris Installation Minor Tree Works	3.	Undertake improvement works with local volunteers.	**Likely Construction Methodology** Trees in shaded locations should be coppiced to provide materials for the creation of brash berms and flow deflectors. Willow should not be used as it will regrow and require persistent management.	Knutsford Green Gym & Community Connections Projects CIC

Brush Berms

Design Considerations:

In order to ensure that brash berms do not cause blockages or excessively limit the water storage capacity of the channel they should be installed following these specifications:

1. Brash berms should extend no further than one third of the width of the river channel in any location.
2. Brash Berms should be no higher than 25% of the river's banks in any location they are placed.
3. Brash berms should be spaced at least 10meters apart to avoid creating pinch points in the river.
4. All berms should be installed via the method specified below

Installation method

1. The area of the berm is marked out by two rows of chestnut or hazel posts.
2. This area is backfilled with wooded debris (hawthorn). The heavy trunk ends of branches are placed facing upstream. The light 'leaf' ends are faced downstream so that the berm is hydrodynamic. As the berm is filled, new pieces of wood are locked and woven in behind existing pieces so that the berm will hold together as one structure when river levels rise.
3. When the berm is positioned correctly, it is secured by looping galvanized steel wire over each pair of posts surrounding the berm (bank side to river side). Additional steel staples are also used to secure the wire to the posts.
4. The loops of wire are then strained so that they are held tightly over the berm.

5. Each row of chestnut posts is hammered down with a fencing maul, permanently securing all material positioned in the berm under the loops of strained wire they are attached to.
6. Finally the berm is checked for material that may come loose and cause blockages elsewhere in the river channel. Excess wood sticking out from the berm is also trimmed to improve hydrodynamics.

Flow Deflectors

Design considerations

1. In order to ensure that flow deflectors do not cause blockages or excessively limit the water storage capacity of the channel they should be installed follow these specifications:
2. Deflectors should extend no further than one third of the width of the river channel in any location.
3. Deflectors should be no higher than 25% of the river's banks river in any location they are placed.
4. All deflectors should be installed via the method specified below.

Installation Method

1. A cross section of tree trunk/branch is obtained and positioned facing upstream from the margins of the river.
2. Every meter, two pairs of posts are hammered into the river bed on either side of the deflector so that it is secured firmly along its length.
3. Galvanized steel wire is looped around both sets of posts and secured with heavy duty metal staples. The wire is then strained so that it is strung tightly between each pair of posts, with no slack.
4. Each pair of posts is then hammered further into the river bed so that the strained galvanized steel wire pins the deflector permanently to the bed of the river.

Bat Boxes	4.	Install bat boxes with local volunteers	**Design Considerations** 1. Bat boxes should be Schwegler 2F-DP 2. Should be located in deep shade and dappled sunlit glades, with good flight access, to attract target species. 3. Should be located on the eastern bank of the river to avoid disturbance. 4. Bat boxes should ideally be placed between 3m-6m in height on a tree. 5. Bat boxes should be located approximately 20m apart across the site. **Installation Method** 1. Batboxes should be installed by a minimum of two people (one to attach box to tree, one to hold ladder / supervise. 2. Bat boxes are attached to trees simply by mounting on a screw or nail.	Herts and Middlesex Wildlife Trust

Ongoing management actions

Activity	Action		Comments	Delivered by:
Reedbed Management	1.	Cut reedbed on annual rotation.	Once enhancement is complete, the reed beds present in the two backwaters and constructed wetland should be cut on rotation each winter (25% per year). New vegetation colonising areas of open water should also be removed each year.	Knutsford Green Gym / Community Connections Projects CIC
Wildflower Meadow Management	2.	Cut and clear wildflower area on annual rotation.	1. The area should be cut and cleared in mid-July and October to maximise botanical diversity. 2. In order to reduce the impact of the hay cut on invertebrates, retain strips of uncut material through the area amounting to approximately 15% of the total in every cutting episode.	Knutsford Green Gym / Community Connections Projects CIC

			3.	Rotate these strips around the area so that different sections are left uncut each time, to prevent net nutrient enrichment and declines in botanical diversity.	
Riparian Habitat Management	3.	Undertake ongoing riparian habitat management.	1.	Continue to mow paths within the area.	Knutsford Green Gym / Community Connections Projects CIC / Site maintenance contractor
			2.	Create mown bays by the river to enable viewing of the river channel. Select areas currently dominated by nettle.	
			3.	Link path network to open bays to the river which are also managed by regular cutting. Leave emergent vegetation fringe of the river to develop.	
			4.	Control woody growth in these bays by annual removal.	
			5.	Periodically cut and clear patches of bramble on rotation in the winter so that different heights and stages of succession are created.	
			6.	Create three rotational clearance areas which are cut and cleared in succession, one year in three.	
			7.	Coppice on rotation small pockets of woody vegetation on rotation every 5 years (Hawthorn, Willow sp. and other shrubs)	
			8.	Cut and clear 50% of the rank grassland blocks every year in October to conserve as species poor tussocky rank grassland but prevent their loss to scrub.	
			9.	Create a path network to the south of the river to enable access and create more structural diversity.	
			10.	Cut and lay occasional small thorn trees to provide ground nesting habitat.	

Estimated Costs

Backwater Restoration / Enhancement and Riparian Tree Works

Activity	Items	Cost	Total
Design and Permitting for backwater restoration/enhancement and tree works	Survey Work	£1,000	£9,000
	Design Work	£5,000	
	Sediment Analysis	£2,000	
	Permitting	£1,000	
Tree Works	Tree clearance, coppicing, treatment of stumps	£15,000	£15,000
Backwater Restoration / Enhancement	Labour	£15,000	£45,000—£205,000
	Materials	£15,000	
	Plant hire, fuel and insurance	£2,000	
	Site security and welfare	£3,000	
	Scenario 1: Disposal of materials to landfill (if contaminated) Approximate disposal cost = £85 per m^3 Approximate volume = 1,800m^3	£170,000	
	Scenario 2: Movement of materials (if not contaminated)	£10,000	
TOTAL			**£69,000—£229,000**

Wooded Debris Installation, Minor Tree Works , Bat Box Installation

Design and Permitting for Wooded debris work	Design Work	£2,000	£3,000
	Permitting	£1,000	
Construction of wooded debris features and minor tree works	Staff time (20 days)	£5,000	£5,000
	Materials	£1,000	£2,000
Installation of bat boxes	Staff time (4 days)	£1,000	£1,300
	Materials	£300	
TOTAL			**£11,300**

Ditch Network Enhancement

Activity	Items	Cost	Total
Design and Permitting for backwater restoration/enhancement and tree works	Design Work	£4,000	£5,000
	Sediment Analysis	£1,000	
Ditch enhancement	Labour	£1,000	£4,000
	Materials	£2,000	
	Plant hire, fuel and insurance	£1,000	
TOTAL			**£9,000**

Constructed Wetland Enhancement

Activity	Items	Cost	Total
Design and Permitting for constructed wetland enhancement and tree works	Survey Work	£1,000	£9,000
	Design Work	£10,000	
	Sediment Analysis	£2,000	
	Permitting	£1,000	
Tree Works	Tree clearance, coppicing, treatment of stumps	£15,000	£15,000
wetland Restoration / Enhancement	Labour	£15,000	£55,000—£247,000
	Materials	£15,000	
	Plant hire, fuel and insurance	£2,000	
	Site security and welfare	£3,000	
	Scenario 1: Disposal of materials to landfill (if contaminated) Approximate disposal cost = £85 per m^3 Approximate volume = 2,500m^3	£212,500	
	Scenario 2: Movement of materials (if not contaminated)	£10,000	
TOTAL			**£79,000—£229,000**

*All estimated costs are based on recent quotes from local contactors for similar activities but should be regarded as approximate figures

Total Project Costs

Activity	Lower estimate	Upper estimate
Backwaters and Hillfield Brook restoration and riparian tree works	£69,000	£229,000
Wooded debris installation, Bat Box Installation, Minor Tree Works	£11,300	£11,300
Ditch Network Enhancement	£9,000	£9,000
Constructed Wetland Enhancement	£79,000	£229,00
TOTAL	**£168,300**	**£478,300**

Ongoing Annual Maintenance Costs

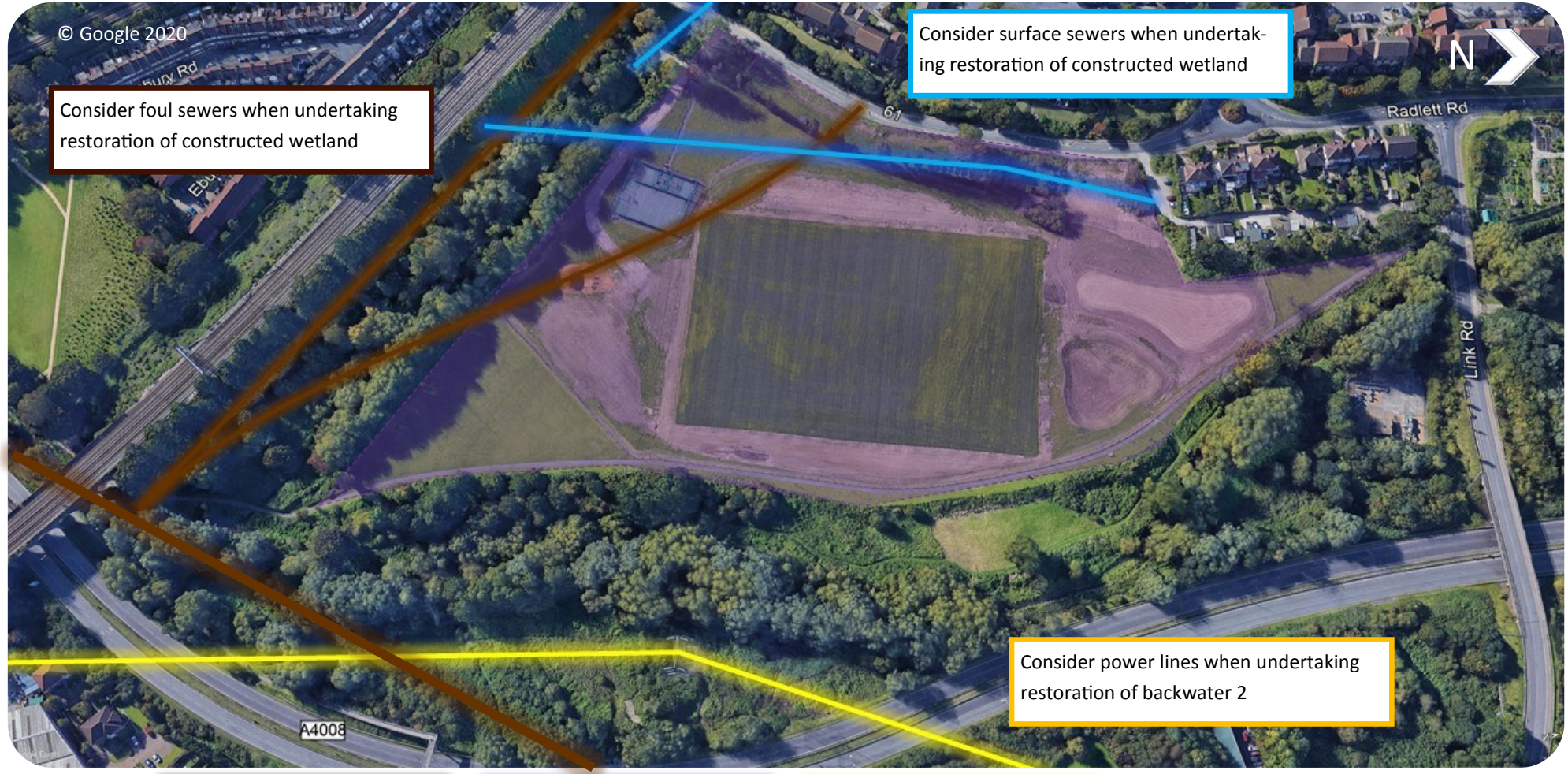
Contractor maintenance	Tree works	£5,000	£6,000
	Invasive species removal	£1,000	
Volunteer maintenance	Staff time for volunteer day facilitation (24 days per year)	£6,000	£7,000
	Tools and equipment	£1,000	
TOTAL			**£13,000**

*All estimated costs are based on recent quotes from local contactors for similar activities but should be regarded as approximate figures

Site Access Plan

There are four entry points to the Western floodplain and one entry point to the Eastern floodplain for plant access. There are also numerous areas of river where temporary crossings could be created to access both floodplains (shallow areas with low lying banks).

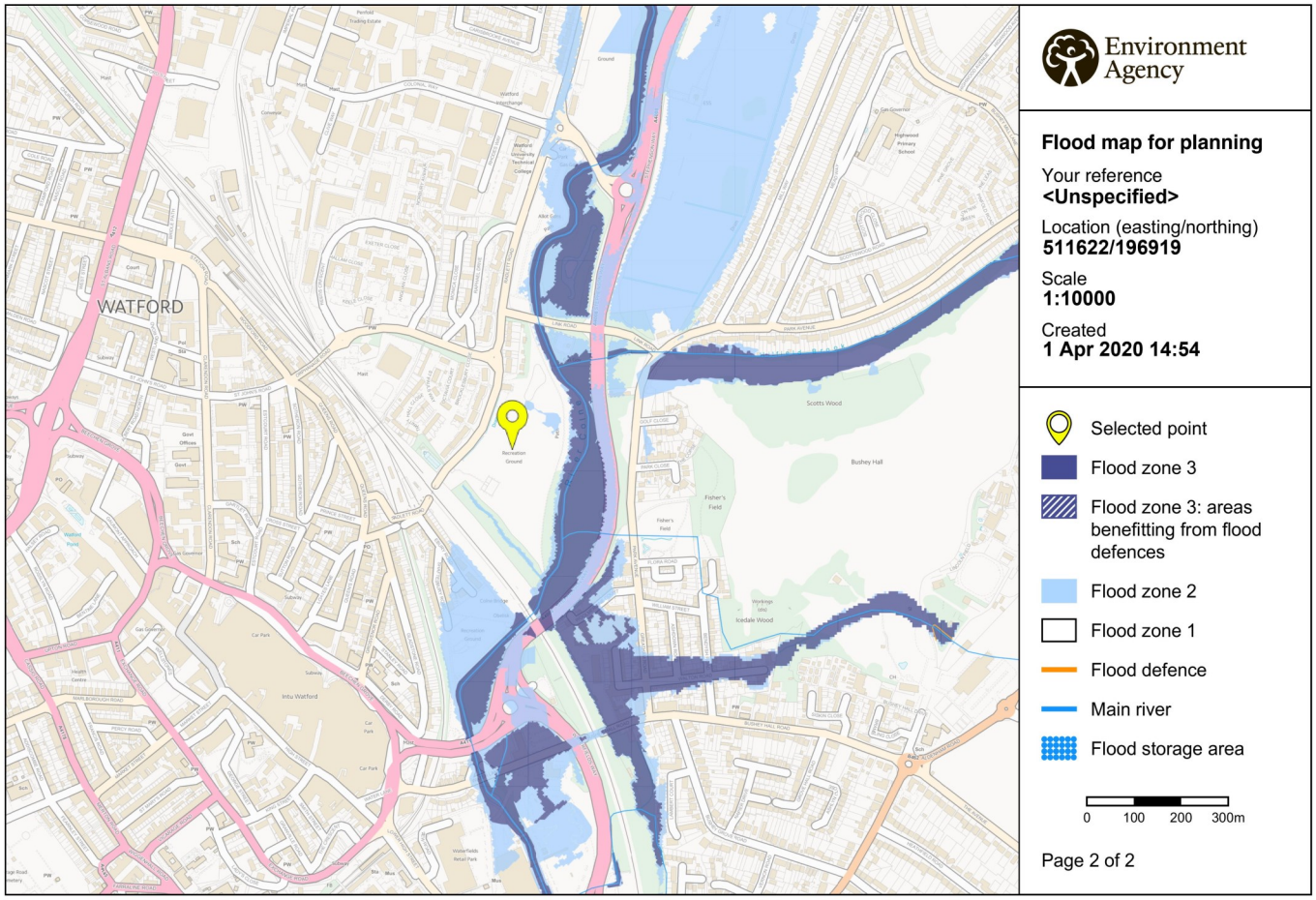
Utilities Search



Sewers - Foul | Sewers - Surface | National grid overhead lines | Historic Landfill

The locations of utilities should be interpreted as an initial guide in order to inform further design work. It is recommended that a new utilities search is conducted by the appointed contractor before construction works commence

Flood Map



The majority of the Western floodplain is in flood zone 1 due to its high topography. Parts of this area, including the land around the constructed wetland, could be used to relocate materials arising from construction works elsewhere on site. Any proposals of this nature will have to be agreed with Watford Borough Council.

The majority of the Eastern floodplain is in flood zone 3. The backwater and Hillflield Brook restoration works proposed in this area should help to increase floodwater storage capacity. Materials arising from construction must be redistributed elsewhere or sent to landfill.

Any works proposed within the main river channel should not encourage out of channel flow and should not cause any significant obstruction or impoundment.

References

1. Herts and Middlesex Wildlife Trust (2019) Water Vole survey of the River Colne through Watford.
2. Herts and Middlesex Wildlife Trust (2019) Botanical survey and management for River Colne in Watford
3. Groundwork South (2019) Knutsford Playing Fields modular river survey 2019.
4. Community Connections Projects CIC (2019) Riverfly Monitoring Report.

Acknowledgements

This plan has been prepared by Groundwork South, host of the Colne Catchment Action Network, as part of the Rediscovering The River Colne Project, with funding from Watford Borough Council. We would like to thank the following organisations for making the production of this plan a truly collaborative process: Watford Borough Council, the Mayor of Watford Peter Taylor, The Environment Agency, Community Connections Projects CIC, The Colne Valley Fisheries Consultative, Herts and Middlesex Wildlife Trust, Thames Water, Affinity Water, and Knutsford Green Gym.