Project Proposal

Thornton le Dale Village Hub

July 2019

1.0 Introduction & Rationale

Members of the Thornton le Dale Village Hub requested input from the Wild Trout Trust to assess potential for habitat improvements on the village pond (a site owned by North Yorkshire Moors National Park) and a carrier (artificial channel) of Thornton Beck. This report was compiled by Prof Jon Grey from observations and discussions held during a site visit in July, 2019.

It was thought that the pond vegetation and sediment required better management to maintain aesthetic and ecological value. In particular, the build-up of nuisance algae (*Cladophora* spp.) has been a focus for volunteers, manually removing it via raking. The pond is artificial, supplied by an offtake of water from a carrier of Thornton Beck which skirts approximately 50% of the pond perimeter. The outflow is returned to the beck via pipework. Anecdotal evidence from residents and from the Environment Agency (*pers. comm*.) indicates that the pond was last dredged ~15y ago and that a fish 'rescue' was undertaken at that time. Brown trout, eel and several goldfish were released to the beck (or removed in the case of the non-native goldfish). Stickleback were observed during the visit.

While the focus of the visit was the condition of the pond, it would be remiss not to consider the carrier of Thornton Beck as well. The beck percolates through limestone, and thus has similar characteristics in terms of productivity to chalkstreams. Since a large part of the Village Hub activities involve education and engagement, it would seem an ideal opportunity to promote the health of the stream as well.

Throughout the report, normal convention is applied with respect to the beck bank identification, i.e. left bank (LB) or right bank (RB) whilst looking downstream. Upstream and downstream references are often abbreviated to u/s and d/s, respectively, for convenience.

2.0 Habitat Assessment

The following images are used to exemplify available habitat, and highlight issues and opportunities around the pond and beck.

Fig 1. The pond from the formalised banking at the inflow (lower panel). The current of the inflow supplied via a pipe of ~20cm diameter was noticeable only for a distance of ~3m. There was no discernible impact of sediment delivered via the pipe into the pond despite a considerable accumulation of fine silt in the beck at the offtake. Excess biofilm (a matrix of algae, bacteria and other microscopic life) was evident on the stones as a brown filamentous covering. The lighter green silk weed (*Cladophora* spp.), indicative of nutrient enrichment was evident on the surface and smothering submerged plants.

This area is a focal point for people viewing the pond and feeding the ducks. As such, it will remain relatively devoid of vegetation and a point source for nutrients via whatever is fed to the ducks (directly as waste or indirectly as faeces).

The edges were bare stone and concrete and vertical around the formal inflow, the walling effectively severing any ecological tie between the land-water interface. However, the banks were more naturalised within several metres to either side. Low overhanging branches provide shade and cover, as well as access points for insects emerging or entering the water.

Opportunities: This is clearly a 'sacrificial' point on the bank, always subject to heavy footfall and disturbance from people. For education & engagement, there could be signage highlighting where the water supply is coming from and hence signposting people to visit the beck too, and encouragement for people to feed the birds with healthy food in moderation rather than waste bread.

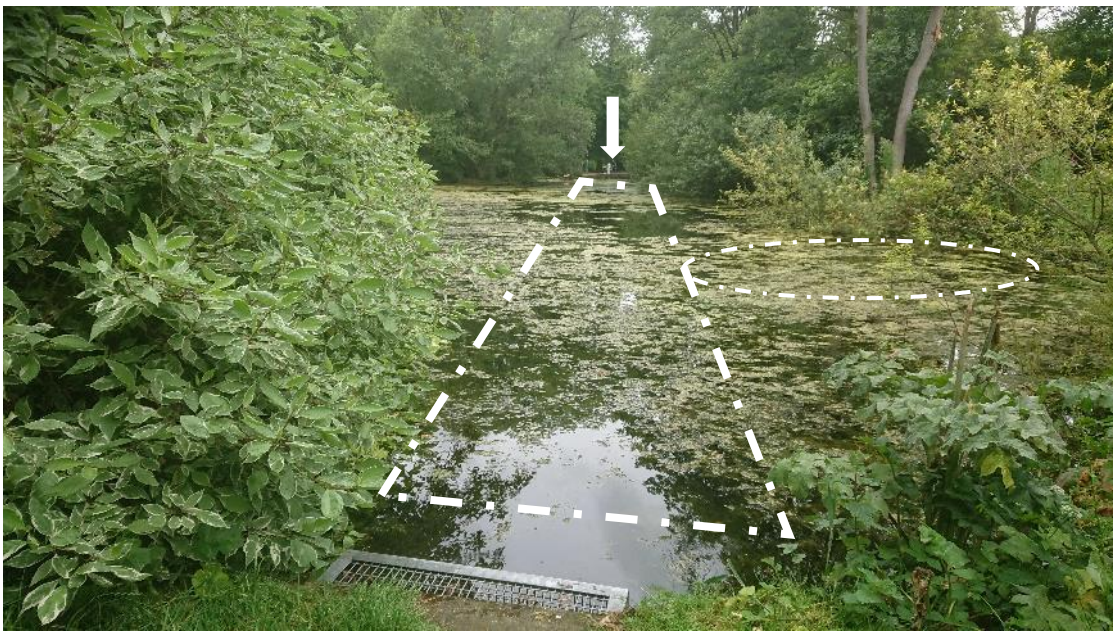

Fig 2. Looking back to the inflow (white arrow) from the screened outflow in the foreground along the longest axis of the pond. The extent of the submerged weed and the problematic silk weed was clear.

Undisturbed, self-set tree cover along the bank can be seen in the top right of the image, and should be maintained thus as a refuge in such a busy site. The low-lying willow branches reaching out over the water provide excellent cover and shade and should not be tidied back. However, a non-native shrub growing next to the outflow (left of image) should be removed.

Opportunities:-

- **The white dashed polygon depicts a channel maintained through the submerged weed along this axis and also encircling the island. Cutting out the weed creates a greater amount of 'edge' habitat and therefore structural habitat diversity. Removal of the weed biomass will remove nutrient from the system. It may also increase water circulation.**
- **The white dashed ellipse indicates another area for clearing (detail in Fig 3) which would link into the main channel.**
- **A couple of further clearings in the submerged weed could be created near to the bank but against the undisturbed tree cover, i.e. replicating the shallower edge habitat but without the prospect of disturbance at a viewpoint.**

Fig 3. One of the more natural viewpoints allowing for a window on the pond, bordered by native vegetation. Trailing stems from the bankside herbaceous plants keep the margins protected and provide ideal habitat for a variety of invertebrates, despite the underlying formal banking still being vertical.

Opportunities:-

- **Maintain a 'window' into the water. Keep the pond immediately in front of the viewing platform free from submerged plants, and link into the channel as described in Fig 2.**
- **Construct a berm to one side of the viewing point for true emergent and marginal plants to diversify the plant community and soften the formalised banking, making better access / egress points for invertebrates and vertebrates.**

Fig 4. Highly formalised bank around the pond-dipping site. This is a fantastic engagement and education feature but the pond habitat immediately adjacent will degrade over time with disturbance from repeated sweep netting.

The large almost horizontal trunk of a crack willow still growing from the island should be maintained as vital habitat. The boarded banks of the island created an unnatural vertical edge, and there appeared to be little in the way of understory either through shading from the dense tree canopy or from the activities of the numerous waterfowl which use it as a refuge.

Opportunities:-

- **Construction of a berm on either side of the pond-dipping area for the creation of emergent and marginal plant habitat.**
- **Careful thinning of some overhanging vegetation on the island to diversify the understory and increase opportunities for marginal plants. To be effective, such an activity will require exclusion of waterfowl from the proposed area of the island, and the construction of further berms along the boarded edges. These will also require protection from waterfowl until well established.**

Fig 5. A 'forgotten corner' – the inaccessible bank of the pond between the pond-dipping area and the inflow was lovely and wild and should be retained thus. The only modification proposed would be the opening up of a channel through the weed to circumnavigate the island, extending that proposed in Fig 2.

Fig 6. The substantial weir which impounds the flow of a Thornton Beck carrier to provide the offtake for the pond which is piped through the wall immediately u/s on the LB. The carrier is a highly artificial channel historically diverted from Thornton Beck, originally for industry but in latter years adapted for the creation of the pond. As such, it has been engineered to completely unnatural proportions within walled banks; straightened and over-capacity (too wide) meaning that it has lost the capacity to be 'self-cleansing'.

The weir structure obviously causes a severe obstruction to fish passage as well as impounding and hence drowning out habitat u/s. Over time, the u/s reach has filled in and the typical limestone gravel bed has been smothered with fine sediment to the extent that there are exposed banks of mud (white ellipse). The resultant channel is too shallow and uniform, devoid of habitat features.

An extensive mature tree canopy and a high density of evergreen yew trees has resulted in a depauperate understory.

Opportunities:-

- **Education – this section could be included in the trail around the pond, to highlight how the stream has had to be engineered to accommodate the pond and how the structures impact upon ecology, e.g. fish passage. Plus engagement re restoration.**
- **Restoration of the beck to a functional limestone stream.**
    - **Crown-lifting of the mature trees on the RB (as in the background of the image) to allow light to the understory and to allow a better view from over the wall.**
    - **Introduction of low berms and woody debris to return the channel to natural proportions and create a sinuous path within the confines of walls.**
    - **Planting of marginal / emergent plants and water crowfoot to stabilise berms and focus flows thereby keeping gravel free from silt.**
    - **Fish passage solution at the weir(s) to cater for salmonids and eels.**

Fig 7. Typical views along much of the beck, highlighting the dense canopy and paucity of understory, degradation/erosion of the bank by footfall at focal points, the overly wide and uniform proportions of the channel, and the subsequent smothering of silt across the bed.

Opportunities:-

- **Judicious thinning of the canopy to allow more regeneration and understory.**
- **Arisings from the canopy work could be used for berm creation.**
- **Introduction of large woody debris from the plentiful supply on the banks to diversify the channel form.**
- **Restoration of the bank and either formalisation to prevent further degradation or restriction to the currently walled / concreted sections (Figs 6&9).**
- **Education boards re stream ecology and the restoration works.**

Fig 8. A low-head weir which appeared to split the flow between a small carrier to the forge and on parallel to Maltongate, and the remainder continuing over the weir and around the pond. The considerable width of the structure means that the flow is reduced to a thin skim of water across the channel, and hence there is insufficient depth of water for fish to reside in, let alone approach and attempt to leap the weir.

Opportunities:-

- **Ample opportunity to use bankside vegetation to pinch the channel to a more natural width and hence create a greater depth of faster flowing water (both u/s & d/s of the weir).**
- **A focal flow arising from the works described above would help to keep silt clear from the gravel.**
- **Improve fish passage (possibility of a small notch in the weir crest plus eel / lamprey bristles or tiles).**

Fig 9. The weir immediately u/s of the pond outflow pipes. It was not immediately clear what historic purpose this weir served. If it was deemed defunct (i.e. no services within the structure, or current abstraction licences associated with it), then it should be removed to reinstate connectivity.

Opportunities:-

- **Part removal of the structure – a nod to its historic presence as part of the education / engagement aspect, but reinstatement of riverine processes through a full bed-depth notch of width to accommodate most flows but pinch sufficiently to create some scour. The walling and infrastructure necessarily remaining around the outflow pipes could be better formalised as steps into the beck here.**
- **Restoration of a sinuous channel.**

3.0 Recommendations

The pond and beck at this location are artificial systems, essentially constrained within engineered walls. Natural ponds undergo slow but inevitable succession as they infill with leaf litter and woodfall and eventually morph into wetlands and then terrestrial ecosystems as land plants encroach. A beck should be dynamic and meandering, well connected to its floodplain. Within the constraints of Thornton le Dale, the desired state for both pond and beck are somewhat more fixed along the 'evolutionary' spectrum, and both will require ongoing maintenance to hold them in that state. It must also be appreciated that there is inherent conflict in making the site more attractive and accessible to people, because the resultant disturbance is damaging to the environment.

Thus, while not being entirely natural, both the pond and beck can be useful analogues of natural systems while contributing significant education and engagement to the visitor experience. The ideas below will enhance not only the natural environment but also contribute to the excellent educational trail already developed to date.

The following proposals can be viewed as modular. In isolation, each will provide some benefit but used complementarily, the benefits to both aquatic and terrestrial ecology will be greater.

3.1 Management of weed within the pond

It would be appropriate to maintain the current course of action, raking out submerged weed and associated silk weed to form a clear channel circumnavigating the island, extending from inflow to outflow, and potentially creating joining channels from each viewing access point. This would break up the 'monoculture' of dense weed habitat and diversify the physical structure by creating edges where the majority of ecology actually happens. Removal of the biomass effectively strips out nutrients from the system making it more challenging for silk weed in future. It is important to leave the weed to 'drain' on the bank for 48h or so, thereby allowing invertebrates / vertebrates an opportunity to return to the water. Also, focus some energy on keeping shaded margins clear of submerged weed (where it is already challenged for light).

Manual removal from specified areas can be undertaken with unskilled volunteers with weighted rakes / grapnels pulled by rope

from the shore. The more remote sections might require deployment of rakes from a boat. The biomass should be sufficiently removed from the bank (after draining) so that any decomposition (solids or liquor) and associated nutrient does not flow back to the pond. Without direct experience of the weed growth rate (which will vary from year to year anyway), it is suggested that weed is raked three times a year: a light sculpting of the intended clear areas in spring to knock back first growth, a mid-summer clearance, and again in later autumn as the weed starts to die back (to ensure those extra nutrients are removed).

3.2 Tree management around the pond

In general, overhanging branches are good because they provide low cover and shade the water, thereby helping to keep it cool, but also preventing light being used by nuisance algae. Consider removal of a small number of overhanging branches in specific locations (nick-points) for the benefit specifically of emergent vegetation (see following point). Fully submerged branches, from fallen trees or limbs provide further ecological benefits and should be retained: as a substrate for epiphytes and their grazers, or for eggs for aquatic invertebrates as well as amphibians (and refugia for the resulting larvae).

Leaf litter is an important seasonal subsidy of food for a different variety of aquatic invertebrates. Given the rich variety and density of trees around the pond, litter accumulation will require ongoing management. However, in conjunction with the weed removal programme proposed above, the need to dredge the pond should be reduced.

3.3 Emergent vegetation for the pond

Along the very formal edges of the pond, there is little in the way of emergent vegetation (e.g. flag iris, water mint, bistort etc). These plants will take up nutrients from the water column, as well as providing important habitat structure at the water-land interface. Currently the depth at the edges is too great for most emergent species so to soften the 'step', low-level berms could be created using chestnut stakes and brash arising from tree management, tied or woven into position using biodegradable jute string. Tightly packed brash, perhaps also using some of the submerged weed cleared from

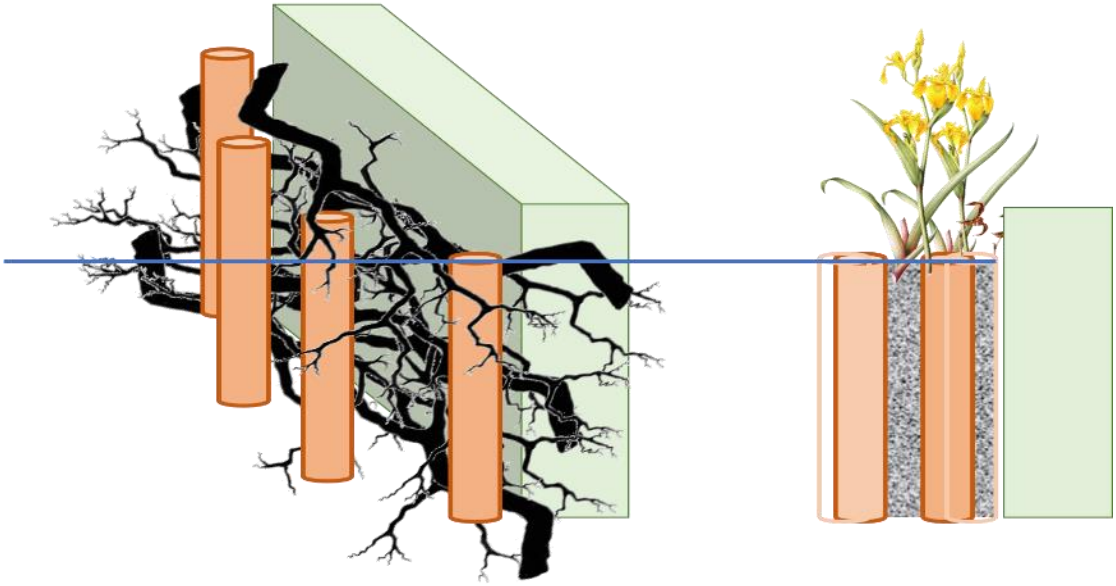

Fig 10. Schematic of brash berm or ledge creation against pond walls: stakes driven flush with water surface, packed tightly with brash and planted with emergent plants like flag iris.

channels, will provide an ideal planting matrix for emergent plant plugs or locally sourced seed. Netting will be required initially to prevent repeated trampling / resting by waterfowl. Sufficient light is also needed for successful establishment and hence there might be some requirement to manage tree cover above any planned berms. Many of our native emergent species are extremely colourful so will enhance the aesthetic appeal of the pond edge as well as increasing plant diversity and improving forage for pollinators.

3.4 Fish stocking in the pond

There are numerous problems with managing an online artificial pond for fish. The native fish found in a flowing limestone stream like Thornton Beck (e.g. brown trout, grayling, stone loach, bullhead, European eel and brook lamprey) are not as well suited to a stillwater (pond) environment. Those species that are, tend to have adverse effects on water quality (especially clarity), at least at the densities desired to be visible to the public. Furthermore, permission to stock fish other than those found naturally in the nearby beck would not be granted because there is nothing to prevent their escape into the beck via the outflow. A further unwanted consequence of promoting fish in the pond is the intentional release of unwanted pet fish, which has already happened according to EA data: goldfish were recorded during the last dredging event.

There is significant benefit to managing the pond as a 'fish-free' environment (or free from larger bodied species – it may be

impossible to rid the pond of sticklebacks!) for the promotion of larger invertebrate predators like dragonflies and diving beetles, and frogs, toads and newts. Amphibian populations across the UK are struggling for various reasons, one being lack of suitable habitat, so a conservation story for the pond might be as a haven for amphibians. Far better to invest some time and effort in fish habitat in the beck and help those wild populations in a (currently) severely degraded section of river.

3.5 Beck restoration

Currently, the trapezoidal channel is overly straight and uniform. In some areas, deposition of fine sediment has occurred because of insufficient flow energy to carry that silt onward (e.g. Fig 6). Extensive forestry in the fine/sandy surface geology of the catchment has created ongoing problems for Thornton beck and bringing pressure to bear on forestry practices upstream would markedly reduce many of the degrading impacts noted. With ample light, those bars of mud would have been colonised by plants, thereby narrowing the channel to more natural proportions. However, under typical flow conditions, the channel is over-capacity: too wide and hence the water depth generally too shallow; see Figs 7-9 as compared to the schematic in Fig 11.

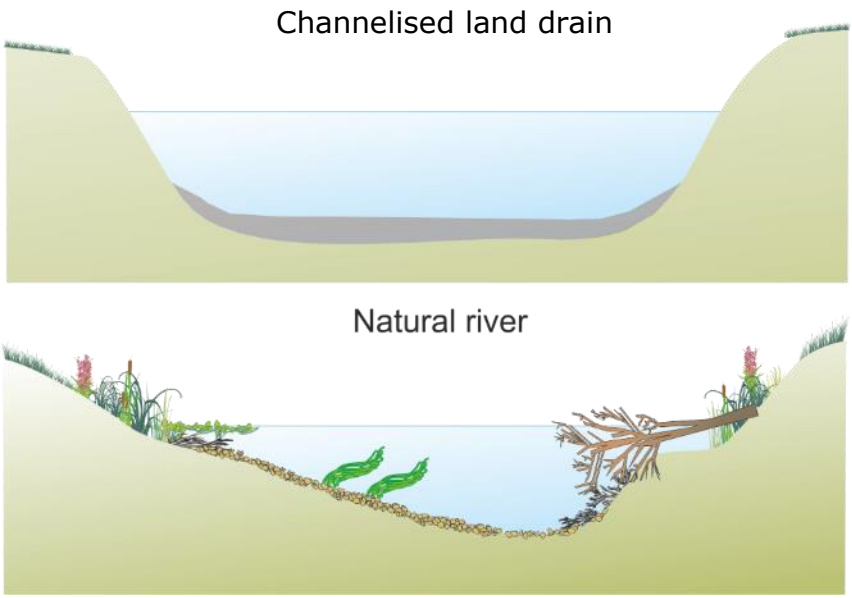

Fig 11. Simplified, uniform dimensions of a trapezoidal channel designed for conveyance of water, as compared to the diversity found in a natural channel.

Creation of a two-stage channel, i.e. a meandering low flow channel within the confines of the engineered walls significantly improves opportunities for biodiversity while not increasing flood risk (in cross-section profile - Fig 12, and in creation – Fig 13).

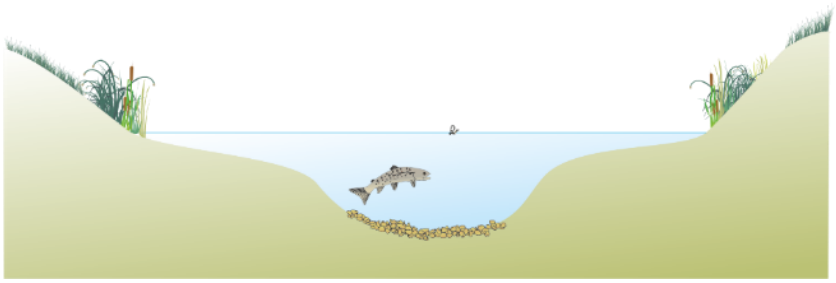

Fig 12. Cross section of a watercourse with a two-stage channel wherein water is confined to the deepest point during low flows but can accommodate a much greater volume under spate conditions.

Fig 13. A constructed two-stage channel on the River Somer, creating a sinuous low flow-path. The low berms on either side are quickly overtopped during spate flow and hence do not significantly reduce the carrying capacity of the channel.

Low berms on low energy systems like Thornton Beck can be created and using stakes and tightly woven or packed brash as was proposed for the emergent plant ledges in the pond. On the beck however, the tight matrix of branches will slow flow passing through it so silt will readily accumulate and trap there, rapidly stabilising the structure and providing the perfect growing medium for plants. In such an engineered system, there will be a requirement for removal of any tree saplings that take hold in the vegetated berms. Native species such as flag iris, marsh marigold, hemp agrimony, purple loosestrife

and pendulous sedge, which are attractive to insects and human visitors alike, have evolved to cope with inundation and die back to a low level over winter. They will quickly cover the edge of the stakes and brash with trailing stems, thereby providing vital low cover for fish fry and insects.

As demonstrated for the River Somer (Fig 13), there is space within the carrier of Thornton Beck to consider alternating placement of berms from one bank to the other, thereby creating meanders, and to place them directly opposite each other to 'pinch' the channel and create a deeper run in between. As the beck widens out again downstream of a pinch, it should cause a ramp of deposited gravel which is the ideal habitat for spawning trout.

The use of structure to impede flow and hence diversify flow patterns around that structure has knock-on effects to the surrounding substrate via scour and deposition. Physical habitat diversity begets biological diversity, be it microbial, plant, insect or fish. Different life-stages also require different habitat characteristics. It is most often achieved using woody material (debris) pinned into the channel using chestnut stakes to mimic natural wood fall (trunks / limbs) but which cannot move and thereby does not impose a flood risk downstream. It is important to stress that these are modest features, ~30cm high and not occupying more than 25% of the channel width, so that they do not increase local stage-height. They are also aligned (30° to the flow) in an upstream direction to reduce the risk of erosion to the bank immediately downstream.

3.6 Connectivity

The various weirs were noted to be degrading habitat and creating issues of fragmentation, preventing the free movement of sediment and fish. Removal is the gold standard as it reinstates full connectivity and removes any requirement for ongoing maintenance. However, it is appreciated that because of historic and contemporary infrastructure, removing the impounding effects of at least two of the weirs is unlikely to occur. The lowest weir (Fig 9) appears to be redundant and should be removed.

To maximise the potential of any restoration work on the beck, better connectivity for fish populations should be considered and various low-cost solutions could be explored on a bespoke basis requiring further examination of each individual structure. Given the footfall within the park, this presents an ideal opportunity to engage and

educate the public about such barriers, and potentially leverage funding to improve fish passage.

4.0 Examples of similar works

Creation of a two-stage channel in an engineered urban channel and a flood relief channel:-

https://www.wildtrout.org/content/river-avill-project

https://www.therrc.co.uk/sites/default/files/projects/p1710.pdf

5.0 Making it Happen

Works within river require assessment and permission from the Environment Agency as Thornton Beck is classified as main river, and from NYMNP for the pond. Early engagement with those authorities can often help with the smooth progression of a potential project and open funding opportunities.

As the site lies within a heavily engineered channel and an urban setting, considerable effort should be made to check for services that might be buried beneath the channel and which might be affected by some of the proposed techniques, particularly pinning of materials.

WTT can help draw up more detailed funding plans, as well as oversee the installation of features perhaps via a series of practical demonstration days.

6.0 Disclaimer

This report is produced for guidance only; no liability or responsibility for any loss or damage can be accepted by the Wild Trout Trust as a result of any other person, company or organisation acting, or refraining from acting, upon guidance made in this report.