Walkover Habitat Survey

Nettleham Beck, Lincolnshire

November 2016

Contents

Summary

- Approximately 8.5 km of the Nettleham Beck was inspected between the Riseholme campus to Sudbrooke Park. The Beck is a small stream fed by springs from the Lincolnshire limestone aquifer. It has clear water and aquatic plant growth characteristic of calcareous conditions.

- Throughout the course of the beck, the channel has been significantly modified from its natural state, having been straightened, widened, and its course altered. There are few meanders and a pool-riffle sequence is not evident. Instream habitat quality is generally poor, with uniform channel shape, depth and substrate composition, limiting its value for wildlife.

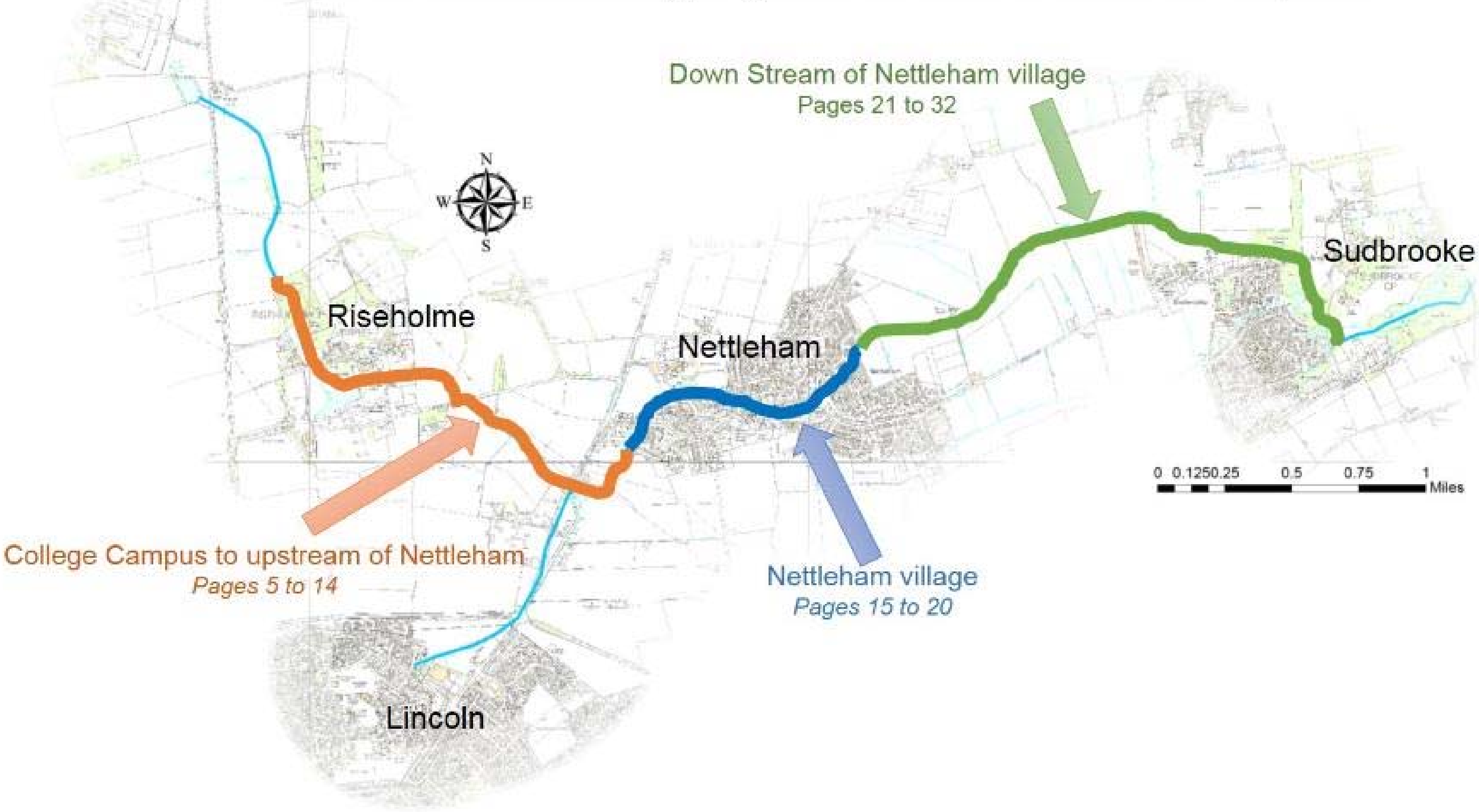
- The approximate gradient of the beck upstream of the A46 is 0.5% (1 in 200), lessening to around 0.38% (1 in 260) downstream of Nettleham. There are few significant impoundments along the course, apart from the lakes near the source at Riseholme and a flow gauging weir (TF 01828 75826) near the sewage works downstream of Nettleham.

- There are opportunities for significant river re-naturalisation projects downstream of Nettleham village and within Sudbrooke Park, providing biodiversity, amenity gains and potential flood risk reduction through use of natural process. Both areas are the subject of proposed developments and there may be opportunities for planning gain.

- Other smaller scale habitat improvement opportunities involving the local community, landowners and the Internal Drainage Board are highlighted.

- A search of Lincolnshire Environmental Records Centre data, centred on the Beck, was requested by Lincolnshire Rivers Trust in October 2016 and includes recent records of the following species associated with aquatic habitats: otter; water vole. The full search report is available from marie.taylor@lincsrivers.org.uk.

Index of Sections Highlighted in this Walkover Report



Introduction

This report is the output of a site visit undertaken by Tim Jacklin of the Wild Trout Trust to the Nettleham Beck, approximately 5km north east of Lincoln, on 28th and 29th November, 2016. Comments in this report are based on observations on the day of the site visit and discussions with Marie Taylor (Lincolnshire Rivers Trust) and David Hutchinson (Environment Agency).

Normal convention is applied throughout the report with respect to bank identification, i.e. the banks are designated left hand bank (LHB) or right hand bank (RHB) whilst looking downstream. Specific locations are identified using the Ordnance Survey National Grid Reference (NGR) system.

Catchment Overview

The walkover survey was conducted to identify opportunities for habitat improvement along the Beck which could form part of the potential Lincolnshire Limestone Becks project, a partnership project currently under development by Lincolnshire Rivers Trust (LRT), Wild Trout Trust (WTT) and the Environment Agency (EA).

The Nettleham Beck is a small stream which rises to the west of Nettleham village and flows through Nettleham and Sudbrooke to join the Barlings Eau near Langworth (TF 06486 76740). The Beck is groundwater fed, flowing off the Lincolnshire limestone, with a spring source near Riseholme (SK 97126 77355). Nettleham experienced flooding in the village centre in 2007 and subsequently the reach immediately downstream towards the sewage works was dredged. Flow data is available from the EA flow gauging station in this reach (TF 01828 75826).

Nettleham Beck is designated as a heavily modified waterbody under the Water Framework Directive. The Directive sets all water bodies the target of achieving good status or good potential by 2027 based on ecological health and water quality. The Nettleham Beck was assessed in 2009 and 2015 and the recorded results were below target levels for invertebrates and water quality (high phosphate levels). The Beck is not routinely assessed for macrophytes (plants), phytobenthos (algae) or fish (http://environment.data.gov.uk/catchment-planning/WaterBody/GB105030062210), although recent electric fishing surveys in the vicinity of the sewage works (TF 01800 75900) and Sudbrooke Park (TF 03988 76083) on 24th October 2016 recorded only stone loach and 3-spined stickleback.

River	Nettleham Beck
Waterbody Name	Nettleham Beck
Waterbody ID	GB105030062210
Management Catchment	Witham (Operational catchment: Lower Witham)
River Basin District	Anglian
Current Ecological Quality	Overall **Moderate** ecological potential in assessment cycles 2009 and 2015.
U/S Grid Ref inspected	SK9775676710
D/S Grid Ref inspected	TF0408675767
Length of river inspected	~8.5 km

Habitat Assessment

Throughout the course of the beck, the channel has been significantly modified from its natural state, having been straightened, widened and its course altered at various points, as noted below. There are few meanders and a pool-riffle sequence is not evident at any point. This means in-stream habitat quality is generally poor, with uniform channel shape, depth and substrate composition, limiting its value for wildlife.

Riseholme Campus to Upstream of Nettleham

The beck rises above the Riseholme Campus and flows through agricultural land before entering a woodland area, then two online lakes (Photos 1 – 5). The channel through the woods is artificially straight but connected to its floodplain and there may be opportunity here to create wet woodland habitat as part of the stewardship scheme which is in existence.

The upper lake appears heavily sedimented with abundant aquatic vegetation. This is an inevitable consequence of an online lake and periodic maintenance to remove sediment is required to prevent habitat succession to wetland and ultimately terrestrial habitat. The upper lake currently acts as a sediment trap for the lower lake. Diverting the beck around the lakes would greatly reduce the rate of sedimentation, but it is a project beyond the scope of the current Limestone Becks initiative.

Downstream of the large lake, the beck is impounded by a weir above the former fish farm site (Photos 6 – 9), then there is a 200-m section down to a lower impoundment (former sluice). The beck between these impoundments is over-wide, silty and choked with aquatic vegetation. This section has potential for tree thinning and channel narrowing; removal or lowering of the impoundments is also possible.

Between Riseholme Campus and Riseholme Road, the beck runs through agricultural land and is maintained for land drainage (Photo 10). Creating a two-stage channel may be possible here. Liaison with the body currently maintaining the channel is essential. Downstream of Riseholme Road, there is an 820-m section to the A46, which is also maintained for land drainage and is straight, incised and very open and has a perched culvert under a farm track (Photos 11 – 12). There is possibly opportunity here for naturalising the beck by re-meandering; this would be dependent on the availability of land and agri-environment incentives going forward.

Downstream of the A46, the beck is joined by the Roaring Meg tributary and a permanent spring flow, both from the right bank. This section of beck down to the outskirts of Nettleham has some excellent opportunities for habitat improvement (Photos 13 – 16). The land on the left bank appears to be outside agricultural use, so there may be opportunity there for channel re-alignment and/or bank re-profiling to introduce meanders. In-stream work is also possible, narrowing the low-flow channel to create a two-stage channel.

Photo 1 View upstream towards spring source of the Beck, on land owned by University of Lincoln and tenanted for agriculture.

Photo 2 Woodland area upstream of Riseholme lakes. Straight channel but good connectivity to floodplain.

Photo 3 As above, impoundment.

Photo 4 Upper lake, Riseholme campus

Photo 5 Lower lake, Riseholme campus

Photo 6 Impounded section upstream of former fish farm weir, Riseholme campus

Photo 7 Former fish farm weir, Riseholme campus

Photo 8 Alongside former fish farm, Riseholme campus

Photo 9 Sluice structure (boards removed) at downstream end of former fish farm site.

Photo 10 Between former fish farm and Riseholme Road

Photo 11 Downstream of Riseholme Road towards A46. A straightened channel maintained for land drainage.

Photo 12 A perched culvert on the reach downstream of Riseholme Road towards A46, which presents a barrier to free fish movement. Ideally this should be replaced with a much larger pipe/box culvert set well below river bed level to ensure continuity of the natural river bed.

Photo 13 Downstream end of culvert under A46 and confluence of the Roaring Meg tributary

Photo 14 Downstream of A46, upstream view. A permanent spring joins the Beck here on the true RHB, left of picture. The Beck has been less intensively maintained here and is recovering some sinuosity, through formation of low berms.

Photo 15 As above, downstream view. Land on the left bank here does not appear to be used for agriculture, so there may be potential for creating meanders there.

Photo 16 Some reasonable instream habitat is present in the reach downstream of the A46, with bed scour, depth variety and sorting of substrate. This is a product of the lighter maintenance of this reach.

Nettleham Village

A short section of the beck leading down into the Police HQ grounds was not inspected. From the pond within the Police grounds downstream to the old water mill, the beck channel is relatively narrow and steep, possibly running through the site of the former mill pond supplying the water mill (Photo 17). There is a wooded area on the left bank here and gardens on the right. A rare area of deep water habitat was found where a mature tree and a garden wall on the opposite bank had pinched the channel, scouring down the river bed (Photo 18)

Progressing downstream into the village, the beck channel has been widened and the banks formed from stone or concrete walls (Photos 19 – 25). The artificially wide and uniformly shallow channel is very poor in-stream habitat. In unshaded areas, aquatic vegetation is likely to encroach across the channel in these conditions, requiring regular maintenance to preserve the channel capacity. Some check weirs are present in front of the church to maintain water levels during periods of low flow. There is scope to improve in-stream habitat within the village by installing vegetated margins and establishing a low-flow channel within the larger flood conveyance channel, along with possible removal or modification of the weirs. Nettleham village centre was flooded in 2007 so any works would have to carefully consider flood risk.

Limited capacity bridge culverts can be more significant bottlenecks on conveyance than channel capacity (Photos 22 and 25). The Faber Maunsell report into the June 2007 flood in the village noted, ‘It is also considered that the lack of capacity of various culverts along the Nettleham Beck may also have been a contributing factor.’

Photo 17 Upstream of the former water mill, the channel is narrower, deeper and steeper gradient.

Photo 18 A rare deeper area formed by bed scour between the bole of the tree and the hard bank revetment. This gives an indication of the degree of channel narrowing necessary to create deeper water features.

Photo 19 Downstream of water mill and ford in Nettleham. The channel is maintained artificially wide to increase conveyance of higher flows. The natural tendency of the river is to narrow itself; note the vegetated berms which have formed on the far bank.

Photo 20 Wide channel within Nettleham.

Photo 21 One of a series of low weirs in Nettleham, designed to retain water levels in the over-wide channel at times of low flow.

Photo 22 Narrow bridge culverts can act as a pinch point and back up water at times of higher flow, potentially increasing flood risk.

Photo 23 At this point, the beck is a vehicular access route to a residential property.

Photo 24 Wide and shallow reach downstream from the Church towards the Co-op.

Photo 25 Another small capacity culvert.

Downstream of Nettleham

Below Nettleham village down to the sewage treatment works (TF 01865 75846), the beck is straightened and maintained for drainage and has very poor in-stream habitat (Photo 26). It is evident from aerial photography and observations on the ground that the original beck channel ran through the land on the right bank (Photos 27 – 28) in a meandering course. The land on the right bank is clearly lower lying than the existing beck channel and was waterlogged at the time of the visit.

There is good potential in this area for a river re-naturalisation project, creating a new channel approximately along its historic course using the principles of natural river geomorphology; this concept is illustrated in Figure 1. A number of similar projects have been carried out elsewhere and further examples are provided in Appendix 1. The advantages of such a project in this location include:

- Substantial gains for biodiversity with the creation of a naturally functioning river and floodplain.
- Potential flood risk benefits from the increased capacity provided by a) the natural floodplain alongside the new channel (storing and slowing medium to high flows) and b) the retention of the existing channel as a flood relief pathway for extreme events.
- Amenity value through improved landscape and biodiversity.

The land in this vicinity is currently the subject of proposed development (http://thelincolnite.co.uk/2015/05/proposed-hybrid-nettleham-development-would-include-200-homes/) and there may be synergies between this and the above project idea.

Consideration would need to be given to the EA flow gauging station at the downstream end of this reach (Photo 29) and the existing sewage works discharge point (Photo 30).

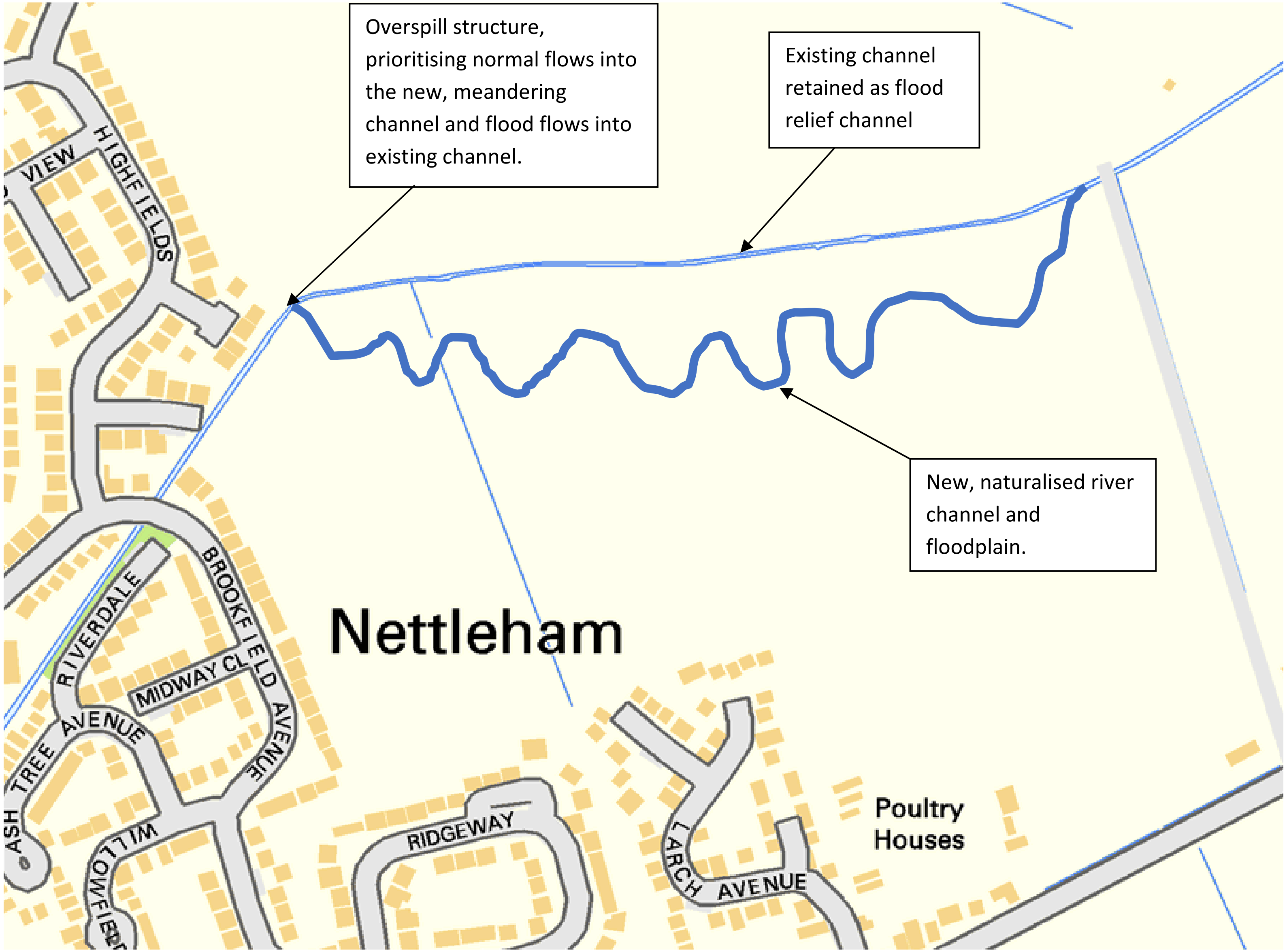


Figure 1 Concept for naturalised beck channel downstream of Nettleham, providing gains for biodiversity, flood risk reduction and public amenity. For illustrative purposes only, not to scale.

Photo 26 Straightened channel downstream of Nettleham with poor habitat value.

Photo 27 Low-lying field on the right bank upstream of the sewage works which contained the historic beck channel.

Photo 28 Aerial view of the field in Photo 27. The existing beck course follows the hedge line across the top of the frame. A historic meandering course of the beck can be seen in the field, marked by darker vegetation.

Photo 29 EA Flow gauging weir.

Photo 30 Sewage works discharge point.

Photo 31 Channel downstream of the sewage works.

Photo 32 Channel downstream of the sewage works, IDB maintained section. Specialised low weir structures spaced at the correct intervals could provide much needed deeper pool habitat along straight sections like this. The aim would be to promote bed scour downstream of the structure, not impoundment upstream.

Photo 33 Uniform and shallow – very poor habitat.

Photo 34 More sinuous reach upstream of Sudbrooke Road with a nice shallow gradient on the bank on the inside of the bend. Bank reprofiling to achieve similar on other bends (e.g. red dashed line) would promote good instream habitat.

Photo 35 Section downstream of Sudbrooke Road, alongside Poachers Lane.

Photo 36 Straightened section within Ten Acre Covert, with very uniform, poor in-stream habitat.

Photo 37 More meandering section downstream of culvert under track leading off West Drive. Some good in-stream habitat here with meanders, lateral scour pools and riffles.

Photo 38 Straightened, poor habitat section within woodland, approximately TF040758.

Downstream of the sewage works, the beck channel continues in its straightened form with generally poor in-stream habitat for approximately 1500m to Sudbrooke Road. The poor in-stream habitat caused by the engineered nature of the channel is offset to a degree by good riparian habitat in the upstream part, with trees, shrubs, coarse vegetation and marginal aquatic plants present (Photo 31). There is a notable change in riparian habitat where the Beck is maintained for land drainage by the Internal Drainage Board (Photos 32 - 33). Just upstream of Sudbrooke Road there is a more sinuous section of channel (Photo 34).

There are opportunities here to create constructed pools on the straightened channel sections to increase the variety of water depths and bank re-profiling on the inside of bends on the sinuous section. It may also be possible to make changes to the channel management regime, utilising selected techniques from The Drainage Channel Biodiversity Manual (Buisson et al., 2008). Close liaison with the IDB and landowner is required to ensure the drainage function and ecological improvements would be sustained in the long term.

Downstream of Sudbrooke Road and alongside Poachers Lane (Photo 35), the beck flows in a straightened, engineered channel into woodland within Ten Acre Covert and Sudbrooke Park (Photos 36 – 38). There is a short section of meandering channel downstream of the culvert under the access track from West Drive into Sudbrooke Park which has some good instream habitat (meanders, lateral scour pools, riffles). Apart from this, the in-stream habitat is generally poor, having a uniform channel shape and shallow depth.

The area within Ten Acre Covert and Sudbrooke Park has good potential for a river re-naturalisation project, restoring meanders and floodplain connectivity using the principles of natural river geomorphology; the concept is illustrated in Figure 2. A number of similar projects have been carried out elsewhere and examples are provided in Appendix 1. The advantages of such a project in this location include:

- Substantial gains for biodiversity with the creation of a naturally functioning river and floodplain.

- Potential flood risk and sustainable drainage benefits from the increased capacity provided by the natural floodplain alongside the new, longer channel (storing and slowing higher flows).

- Amenity value through improved landscape and biodiversity.

This area is the subject of a proposed housing development (http://parklands-sudbrooke.co.uk/) and there may be synergies between this development and the above project idea.

Figure 2 Plan of proposed development in Sudbrooke Park from http://parklands-sudbrooke.co.uk/. The superimposed yellow lines indicate the concept of re-meandering the beck through this reach, enhancing biodiversity, potentially reducing flood risk and providing sustainable drainage benefits (for example, integrating the proposed attenuation pond into the floodplain of the beck). For illustrative purposes only, not to scale.

Opportunities for Habitat Improvements

The following sections give examples of river habitat improvement techniques that have been used elsewhere, along with where they might be used for projects on the Nettleham Beck.

1.1 River re-naturalisation projects

These are large capital projects which involve significant alterations to previously engineered channels, re-creating meanders and re-connecting the river with its floodplain. Figure 3 and Photos 39 – 41 illustrate such a project carried out on the River Glaven, Hunworth, Norfolk in 2010.

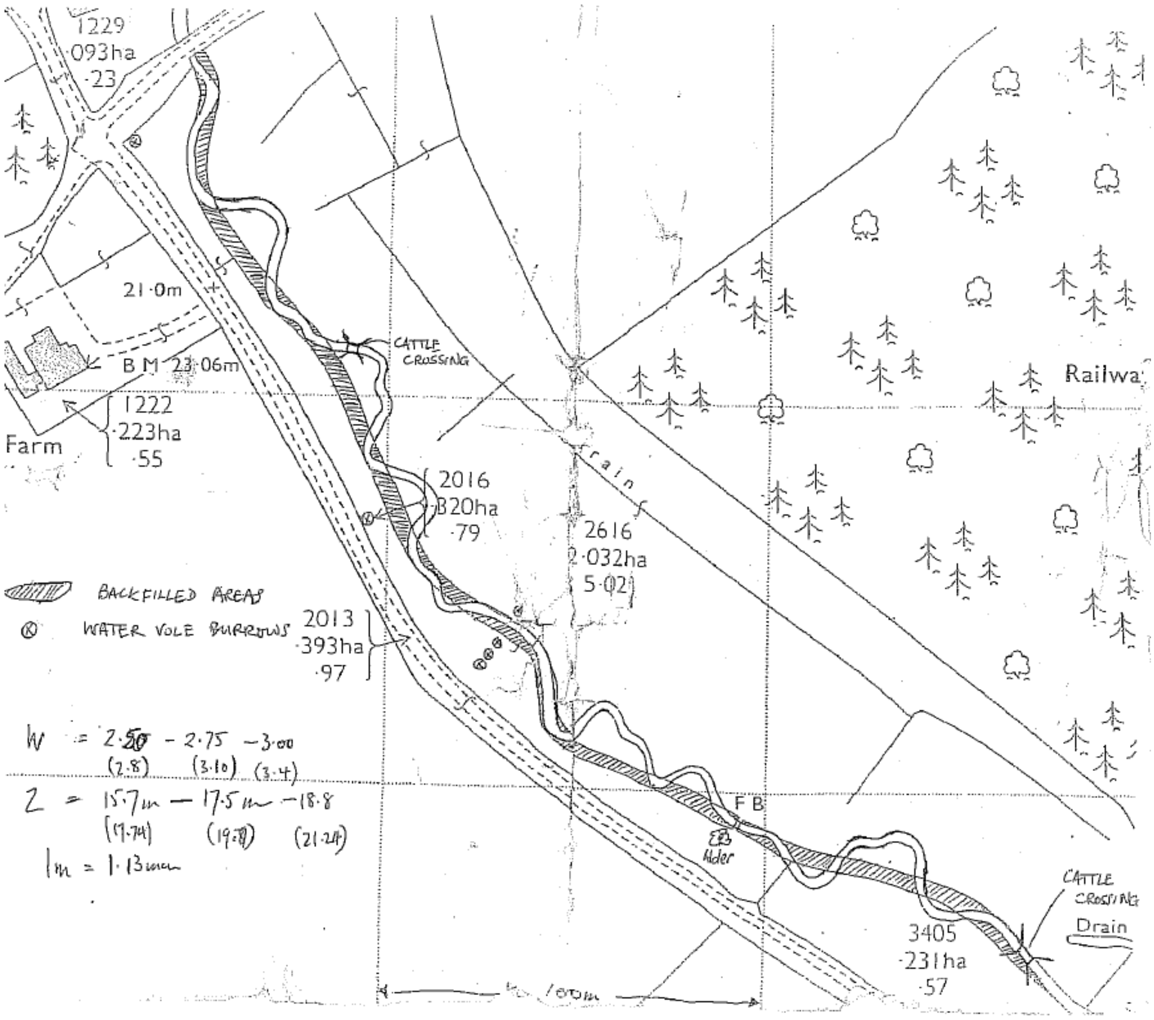


Figure 3 Plan of river re-naturalisation project carried out on River Glaven, Hunworth, Norfolk. Shaded line is the original engineered channel, open line is the new, restored course. The engineered channel was back-filled with spoil excavated from the new channel. (River flowing SE to NW).

Photo 39 Typical condition of River Glaven pre-restoration – straightened, incised channel disconnected from the floodplain and lacking a pool-riffle sequence.

Photo 40 River Glaven at Hunworth immediately post-restoration. Original channel course indicated by dashed line. (Picture: Ross Haddow)

Photo 41 River Glaven at Hunworth four years post-restoration, in flood conditions, illustrating flood storage function of the reconnected floodplain (Picture Ross Haddow).

Projects of this kind have the potential to reduce flood risk to downstream reaches by providing greatly increased storage capacity for floodwater (on the floodplain) and slowing the flow (in a longer, meandering, lower gradient channel). There are also significant benefits for wildlife and fish, and increased visual and recreational amenity value.

Links to other projects similar to Hunworth are provided in Appendix 1. Depending upon scale, the costs of such projects are in the region of £150K – £200K. A project similar to the above could be feasible on the Nettleham Beck between the village and the sewage works and within the woodland at Ten Acre Covert / Sudbrooke Park.

Channel narrowing

Creation of a low-flow channel, by establishing marginal shelves (berms) within the over-widened, engineered channel. This creates a two-stage channel, providing improved habitat at low flows, but retaining the larger channel capacity for flood flows. The materials used are generally natural (brushwood bundles, coir fibre rolls) but stone may be used in some circumstances (for example where staking natural materials to the river bed is impossible). The berms are back-filled with material excavated from the river bed or from re-profiled banks, or with brushwood which naturally accumulates silt. The berms can be planted or left to colonise with plants naturally.

The examples below show the technique in an urban environment, using stone to define the outer edges of the berms. Photo 42 shows coir (natural fibre) products that can be used to establish softer margins, subject to the ability to stake the rolls in place (depending upon river bed and margin substrate). Photos 43 – 44 show the before and after of a scheme using natural materials in a more rural location on the upper Witham, Easton.

Areas on the Nettleham Beck where this technique could be used include the old fish farm reach (Riseholme Campus), upstream of Riseholme Road, downstream of the A46 and within the village.

	River restoration carried out in Midsomer Norton illustrating the principles of narrowing the channel with low, vegetated shelves. Top left (before), top right (during) and left (after 1 year). http://restorerivers.eu/wiki/index.php?title=Case_study%3ARiver_Somer_channel_enhancement,_Midsomer_Norton

Photo 42 Coir logs can be used to soften the margins of engineered channels. Picture: Salix Products.

Photo 43 River Witham, Easton (before works).

Photo 44 River Witham, Easton (after channel narrowing works). Note that the embankment has been graded to create an inset flood plain retaining high flow capacity.

Pool creation

Pools are important features of natural channels, providing deep-water habitat for fish and other wildlife. Pools are generally lost when channels are straightened, greatly reducing habitat quality. On straightened sections of channel with sufficient gradient, pools can be created by building low weir-like structures within the channel. There are various designs, but the purpose of all is to focus the stream energy on scouring the river bed downstream of the structure, <u>not</u> impounding water upstream. Photo 45 and Figure 4 show examples. Areas of the Nettleham Beck where this technique may be useful are the very straight sections upstream and downstream of Sudbrooke Road and the reach within Ten Acre covert (if a re-naturalisation project is not possible, see above). The gradient of the channel and spacing of the structures is critical and specialist advice should be taken before installation.

Photo 45 Low, stone crescent weir in a previously drained, lowland limestone stream in Ireland. Note the focus of stream energy to scour the bed downstream.

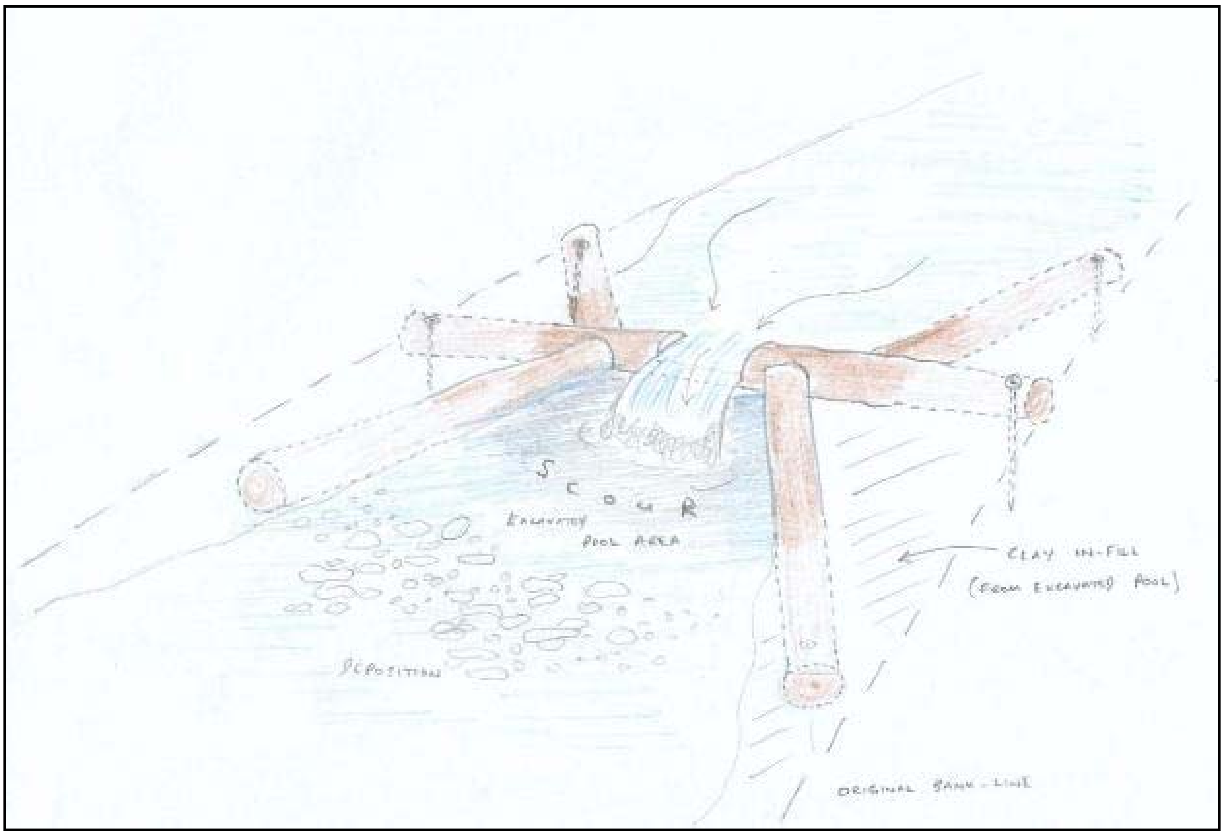


Figure 4 Schematic of a K-dam, a log built structure to create pool habitat in straightened reaches.

Weir removal

Weirs interrupt natural sediment transport processes, prevent free fish passage and degrade habitat in the upstream impounded reach. Removal of redundant weir structures provides the best outcomes for the ecology of the river. The weirs associated with the old fish farm site (Riseholme Campus) could be removed in conjunction with channel narrowing works. Similar could be considered within Nettleham village on the impoundments near the Church as part of wider improvements (see channel narrowing, coir rolls above), subject to the view of local people.

Photo 46 River Wandle, south London, upstream of weir, before weir removal (Picture: South East Rivers Trust)

Photo 47 River Wandle, upstream of weir, some months after weir removal (Picture: South East Rivers Trust).

Acknowledgement

The WTT would like to thank the Environment Agency for supporting the advisory and practical visit programme in England.

Disclaimer

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Reference

Buisson, R. S. K., Wade, P. M., Cathcart, R. L., Hemmings, S. M., Manning, C. J. & Mayer, L. (2008). *The Drainage Channel Biodiversity Manual: Integrating Wildlife and Flood Risk Management.* Association of Drainage Authorities and Natural England, Peterborough.

Appendix 1 – Examples of river restoration projects involving channel realignment and the principles of natural river geomorphology.

- River Glaven, Bayfield Hall, Glandford, North Norfolk.

Creation of a 1.2-km long nature-like channel bypassing an estate lake. Completed in September 2014. www.wildtrout.org/content/bayfield-project-river-glaven.

- River Glaven, Hunworth, North Norfolk

Restoration of a straightened 400-m long section of river, including meander creation and restoration of a pool-riffle sequence. Land owned by Stody Estate, subsequently included in Higher Level Stewardship. www.wildtrout.org/content/river-glaven

- River Bain, Donington on Bain, Lincolnshire

Project led by Lincolnshire Chalk Streams Project which involved realigning the river to bypass a former mill. www.wildtrout.org/content/river-bain-project

- River Witham, Stoke Rochford, Lincolnshire

A partnership project between Environment Agency, Wild Trout Trust and landowner Neil McCorquodale which created a new 600-m channel around a weir on the upper River Witham www.wildtrout.org/news/new-old-section-channel-river-witham.

Glossary

Bank-full	The point when , during high flows, the river channel is at full capacity and any further increase in flow results in water spilling onto the **floodplain**. At bank-full flows, the river has its greatest power (for example, for erosion).
Bank re-profiling	Changing the slope of a river bank to a different angle. Usually used on channels previously engineered for drainage/flood reduction, to create a shallower bank angle on the inside of a bend. This helps restore more natural flow patterns and habitats.
Berm	A shelf in the margins of a river. Berms form in channels that have been engineered to be wider than their natural width. They can also be created as part of habitat improvement measures (see **two-stage channel**).
Conduit flow	The flow of groundwater through cracks and fissures in the geology (for example, limestone); this flow is quicker than the more gradual seepage in porous rocks (for example, chalk).
Conveyance	The capacity of a channel to transport water. Straight, smooth channel have a greater conveyance than meandering, rough channels.
Dig and dump	A habitat improvement technique used on previously engineered, lowland rivers involving the re-shaping of the river bed with an excavator. Deeper pools are dug and the resulting material used to pinch the width of the channel upstream, fluming the flow into the pool to maintain its depth.
Easement	A term describing a range of low-tech, low cost techniques to improve the ability of fish to cross barriers (e.g. weirs, culverts) in a watercourse.

Floodplain	The flat land adjacent to a watercourse that is inundated during higher flows. Watercourses engineered for drainage overtop into the floodplain less frequently than unaltered watercourses (the former are often described as disconnected from their floodplain). Floodplains can store floodwater and hence protect downstream areas.
Habitat	The natural environment in which a species or group of species lives and complete their life cycle.
LiDAR	An acronym for Light Detection and Ranging, a surveying method which measures distance with a laser light. Often carried out from an aircraft, it allows terrain maps to be compiled showing differences in height to a high resolution (30 cm or better).
Pool-riffle sequence	In low to moderate gradient rivers, the natural sequence of deeper pools separated by shallow riffles of broken water. **Scour pools** form on the outside of meanders and riffles form on the straighter sections of channel in between. The pool-riffle sequence is the basis of good in-stream habitat in lowland rivers, but is often disrupted or destroyed by engineering for drainage (e.g. river straightening).
Scour pool	A pool formed by flow directed either laterally or obliquely against a partial channel obstruction or bank. Often found on the outside of a meander bend in a river.
Two-stage channel	A channel engineered to have a smaller capacity channel within a larger one. The smaller channel mimics the dimensions (and better habitat) of the natural watercourse, containing low to medium flows. Higher flows overtop the small channel but are retained within the larger channel. The channel therefore works at two different stages of flow.