South Yorkshire's Historic Water Management Assets
in Relation to Water Framework Directive Requirements

Historic England

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Executive Summary

This project comprises a desk-based assessment looking at identifying the physical nature of historic water management assets, assessing their significance in terms of heritage values, and considering their sensitivity in relation to activities undertaken as part of Water Framework Directive environmental objectives.

The Water Framework Directive (European Parliament and of the Council Directive 2000/60/EC) establishes a legal framework to protect and restore clean water across Europe and to ensure its long-term, sustainable use. Under the Water Framework Directive each Member State is required to produce River Basin Management Plans for each River Basin District (a group of smaller river catchments in a relatively distinct regional area which drain into a single major river system).

The study area for the project is defined as South Yorkshire, comprising the metropolitan districts of Sheffield, Doncaster, Barnsley and Rotherham which lie largely within the Don and Rother and the Idle and Torne catchment areas of the Humber River Basin District.

A number of categories of historic water management assets are identified (water power, transport, subsidence, recreation, utilities and river structures), described and a summary of their heritage significance provided in terms of their evidential, historic, aesthetic and communal interest.

The River Basin Management Plans include an overarching aim, and corresponding environmental objectives for each body of water with a summary of the programme of measures necessary to reach those objectives. The report assesses the potential risks from undertaking the range of measures to achieve these objectives (such as the removal of barriers to fish migration, the improvement to the condition of channels, and the reduction of pollution sources), against the identified categories of historic water management assets. This illustrated through a number of select case studies and regional examples.

The report concludes that historic water management assets within South Yorkshire cover a broad range of dates and functions and are of considerable importance in illustrating the historical development of the region. The Water Framework Directive is driving change along river corridors, in areas that have seen relatively little change in the recent past, which is both a risk and an opportunity for the historic environment. Collaboration with the organisations overseeing and undertaking these changes presents not only the best chance of achieving the long term survival of important heritage assets, but also the opportunity to promote high quality projects that will lead to better results for both natural and built heritage. The route to ensuring success is through improved engagement with those organisations, but also through the enhancement of the available guidance and advice to enable both the identification and assessment of heritage constraints within developments.

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Glossary

Abutments	The walls that flank the edge of a weir, typically comprising a reinforcement of the river bank to either side of the weir. Wingwalls extend from the abutments beyond weir structure both above and below stream.
Crest (of weir)	Top part of weir. The level of the crest, its length and its cross-sectional shape determine the discharge (flow) characteristics of the weir.
Fish Pass	A structure provided to allow fish to migrate over or around an obstacle.
Glacis	The sloping downstream face of a weir
Head (of water)	The height of the water level above a datum, such as the crest of weir.
Hydraulic Jump	Abrupt rise in water level when flow changes from a supercritical to a subcritical state, with associated dissipation of energy. Hydraulic jumps are a feature of weir structures and are characterised by very turbulent flow and surface waves.
Leat	A Leat is a man-made water course usually for conveying water to or from a waterwheel.
Mill Pond	A Mill Pond is a reservoir of water retained above a mill dam for driving a mill.
Stilling Basin	Energy dissipator comprising a basin in which a hydraulic jump occurs. The turbulent water downstream of a weir should be contained within the stilling basin to avoid erosion to the river bed and banks downstream.
Weir	A Weir is a low wall or barrier built across a river to raise the water level upstream, or to control the flow.
Wingwall	A wall on a weir or other hydraulic structure that ties the structure into the river bank. Wingwalls extend from the weir abutments into the river bank. They may be aligned to divert water across the weir.
Wheel	In the Sheffield region Wheel typically refers to a cutler's works rather than a waterwheel.

Abbreviations and Conventions used in the text

ADS	Archaeological Data Service
BGS	British Geological Survey
c.	circa
EU	European Union
ha	hectares
HA	Heritage Asset reference
km	kilometres
m	metres
NHLE	National Heritage List for England
NPPF	National Planning Policy Framework
OS	Ordnance Survey
RBD	River Basin District
RBMP	River Basin Management Plan
SMR	Sites and Monuments Record
WFD	Water Framework Directive

Periods referred to in the text

Palaeolithic	500,000 to 10,000 BC
Mesolithic	10,000 to 4,000 BC
Neolithic	4,000 to 2,200 BC
Bronze Age	2,200 to 700 BC
Iron Age	800 BC to AD 43
Romano-British	AD 43 to 410
Early medieval	410 to 1066
Medieval	1066 to 1540
Post-medieval	1540 to 1901
Industrial	1750 to 1914
19th Century	1800 to 1899
First World War	1914 to 1918
Second World War	1939 to 1945
20th Century	1901 to present

1. Introduction

1.1 Project Background

1.1.1 This project comprises a desk-based assessment looking at identifying the physical nature of historic water management assets, assessing their significance in terms of heritage values, and considering their sensitivity in relation to activities undertaken as part of Water Framework Directive (WFD) environmental objectives. This project falls within Measure 4 of the National Heritage Protection Plan, specifically 4B1: Historic Water Management Assets.

1.2 Study Area

1.2.1 The study area for the project (**Plate 1**) is defined as South Yorkshire, comprising the metropolitan districts of Sheffield, Doncaster, Barnsley and Rotherham which lie largely within the Don and Rother and the Idle and Torne catchment areas of the Humber River Basin District. The study area also clips three other catchments, comprising the Aire and Calder to the north, and the Upper Mersey and Derwent Derbyshire to the west.

1.2.2 Within the study area are 72 Water Bodies and 19 Lakes. As part of the data gathering exercise a buffer of 500 m was used around the water bodies to identify recorded heritage assets that were likely to share some meaningful relationship.

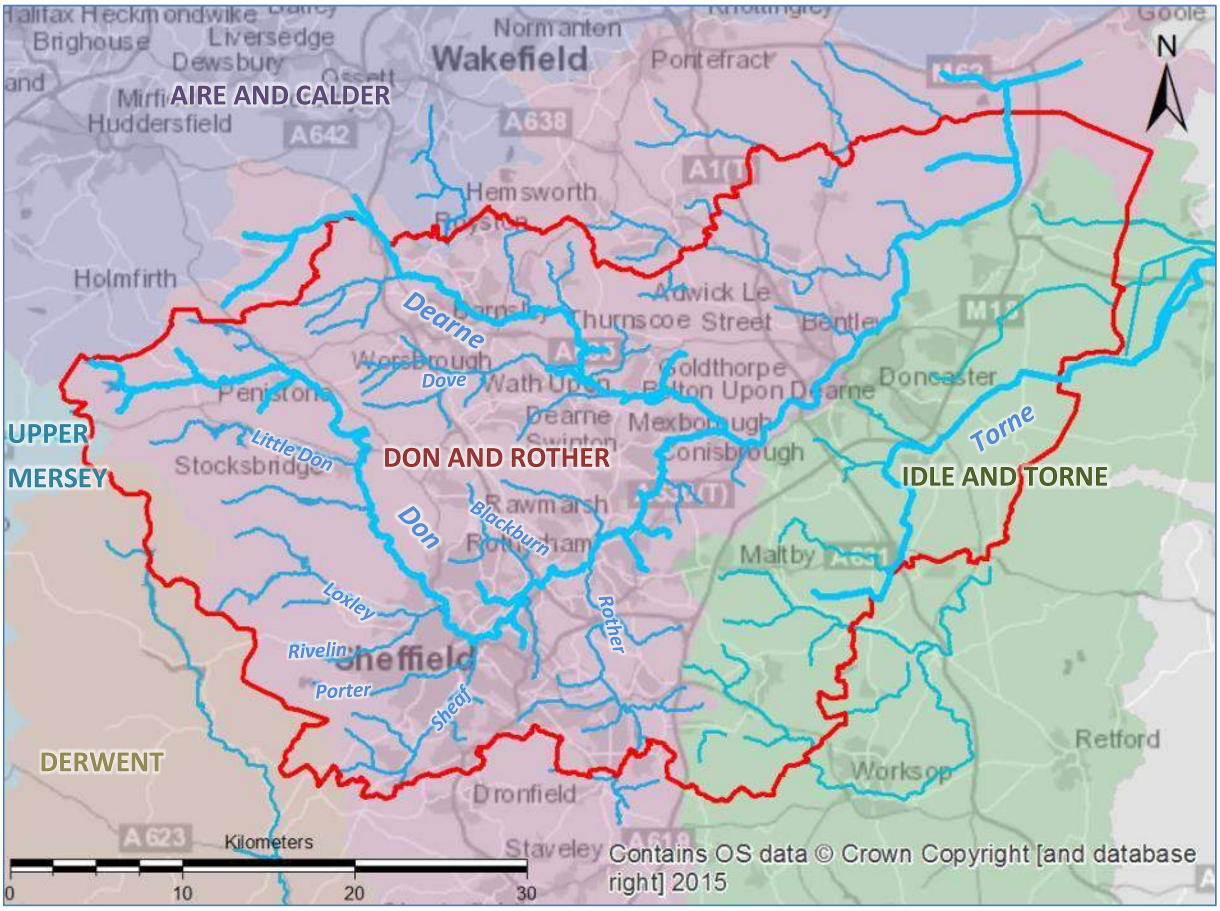

Plate 1: The Study Area showing major water courses and catchments within South Yorkshire.

1.2.3 The principal water bodies within the County are the Rivers Don and Torne, with the Rivers Dearne and Rother comprising a significant tributary of the Don. Other significant tributaries of the Don include the Little Don River, the River Loxley and its tributary the Rivelin, the Porter Brook, the River Sheaf, Blackburn Brook and the Rother.

1.2.4 As would be anticipated the topography of the region has had a significant factor in the development of historic water management, with the county stretching from the Pennines in the west to the levels at the head of the Humber Estuary in the east. As the rivers traverse this landscape their character changes from fast flowing tributaries of the Pennines to the wide canalised channels of the Humberhead Levels.

1.2.5 The Don and Rother catchment has a long history of metal manufacturing and engineering that has developed from an influential water powered industry focused on the Upper Don area, to the north and west of Sheffield. This industry experienced rapid growth during the Industrial Revolution due to the attraction of numerous fast running tributaries, the availability of local coal and ironstone and the growing expertise of the local populous.

1.2.6 The eastern area of the Don and Rother catchment and the northern area of the Idle and Torne catchment form part of a wider area of artificially drained wetlands at the head of the Humber Estuary. The dominant land use in the area is arable agriculture established and managed via a comprehensive system of land drainage.

1.3 Methodology

1.3.1 The majority of the work within the project was desk-based utilising existing datasets and published material. A limited amount of fieldwork was undertaken to assess the availability and contribution of historical archive information in understanding the historical significance of historic water management assets, and site visits to identify factors affecting condition, survival and re-use of structures. The following sources were consulted:

- South Yorkshire Sites and Monuments Record (SMR);
- Historic England's National List for England;
- South Yorkshire Historic Landscape Characterisation Project (HLC);
- Archaeology Data Service;
- Barnsley Record Office;
- Doncaster Archives;
- Rotherham Archives;
- Sheffield Archives and Local Studies Library;
- South Yorkshire Industrial History Society archives;
- Published and online sources detailed in Section 6: References.

1.3.2 Environment Agency open data was used for the location and extent of water bodies, catchments, and river basins relating to the Water Framework Directive cycle 2 (Environment Agency 2015).

1.3.3 An initial data gathering exercise was undertaken combining recorded data of the location and survival of historic water management assets from the South Yorkshire SMR, the South Yorkshire HLC, Historic England's National List for England, and published material.

1.3.4 Each water body was examined on modern 1:25,000 Ordnance Survey mapping, with the location of water management features noted where not already captured in existing data records (such as weirs, reservoirs, aqueducts, locks etc.). Areas where there appeared to be data gaps were then also examined on the first or second edition Ordnance Survey maps of *c.*1850-1900 to identify whether features had been lost and record their sites. Specifically 6 inch scale First Edition Ordnance Survey maps were examined for the upper reaches and tributaries of the Don (Little Don River, the River Loxley and the Rivelin, the Porter Brook, the River Sheaf, and Blackburn Brook),and the Rivers Dearne, Dove, Rother, Went and Torne. Where water management systems (ponds, dams, mills etc.) were annotated, but specific structures (such as leats and weirs) not illustrated, the 25 inch First Edition Ordnance Survey maps were examined to identify the presence and plot the location of such features.

1.3.5 The overarching aim (see section 3) and status objectives of each water body published within the River Basin Management Plan (EA 2009) for Humber River Basin District were examined to identify where mitigation measures were proposed. The summaries of information for each management catchment (EA 2015, published as part of the second cycle River Basin Management Plan consultation) were then also consulted to identify priority activities identified for the forthcoming plan. The results of this assessment are presented in Appendix 1.

1.3.6 The data produced as part of this study comprises an electronic spreadsheet detailing the location, form and source of identified heritage assets in Microsoft excel format and will be submitted to South Yorkshire Archaeology Service for enhancement of the South Yorkshire Sites and Monuments Record.

Consultation

1.3.7 Consultation was undertaken with a wide number of organisations, receiving responses from the South Yorkshire Archaeology Service; the Environment Agency; the Canal and River Trust; Don Catchment Rivers Trust; Aire River Trust; South Yorkshire Industrial History Society; West Yorkshire Archaeological Advisory Service; and member organisations of the Sheffield Waterways Strategy Group.

2. Historic Water Management Assets

2.1 Introduction

2.1.1 The following section discusses the range of historic water management assets within the study area. The intention of this list is to provide description and context for the assessment of significance of individual assets that may be affected by measures associated with the Water Framework Directive. Those assets discussed have been identified through consultation of sources indicated in Section 1.2, and whilst it is hoped this will represent a robust and thorough representation of the range of water management assets within the study area, it is not possible to be completely exhaustive.

2.1.2 There is a high degree of cross-over between some water management assets, such as mill ponds and reservoirs, and thus some assets may refer the reader to earlier assets for specific details.

2.1.3 It is important to note that the terms employed in describing the parts of the water management system sometimes have distinct regional variations. For the purposes of wider application this report has adopted terms from the Historic England Thesaurus. However individual records may utilise the regional variations where relevant. The differing terms, and the preferred term local to South Yorkshire, are identified within the following descriptions of asset types.

2.1.4 To avoid a potential source of confusion in the following discussion it should be noted that the use of local dialect terms for the names of mills is used. It is therefore worth noting that in the Sheffield region a *Wheel* (see **Plate 1**) was the historical term used to describe a mill where blades were ground, as opposed to referring to a waterwheel.

2.2 Water Power

2.2.1 Broad guidance on the assessment of significance of extant and buried remains of water power sites is presented in Historic England's *Designation Heritage Assets: Industrial Structure* (2011a)*, Introduction to Heritage Assets: Mills* (2011b), and *Scheduling Selection Guide: Industrial Sites* (2013). Whilst these touch on water management systems, the following section is intended to provide additional detail by which the qualities of these features can be understood and therefore their significance inferred.

2.2.2 Waterwheel installations were engineered to suit their location, with factors such as diameter and width of the wheel and the velocity and height of the water dictating its power. The quantity of water available determined how large a wheel could be powered, and for how long, leading to the creation of mill ponds to build up reserves for the working day. Whilst the majority of water power sites within the study area were associated with mills or factories, waterwheels were also often used for other purposes such as pumping or raising ore.

2.2.3 The ideal situation for water powered sites was where there was both a sufficient fall of water and adequate room for the dam and leats to be laid out. Access to the water power site was subsidiary to those requirements, however their position along rivers often coincided with existing transport networks. The most commonly adopted arrangement for water power sites was a by-pass system, in which water was impounded in a river behind a weir which deflected the water through a head race to a mill pond and then to the waterwheel before being returned to the river further down stream along a tail race (**Plate 1**).

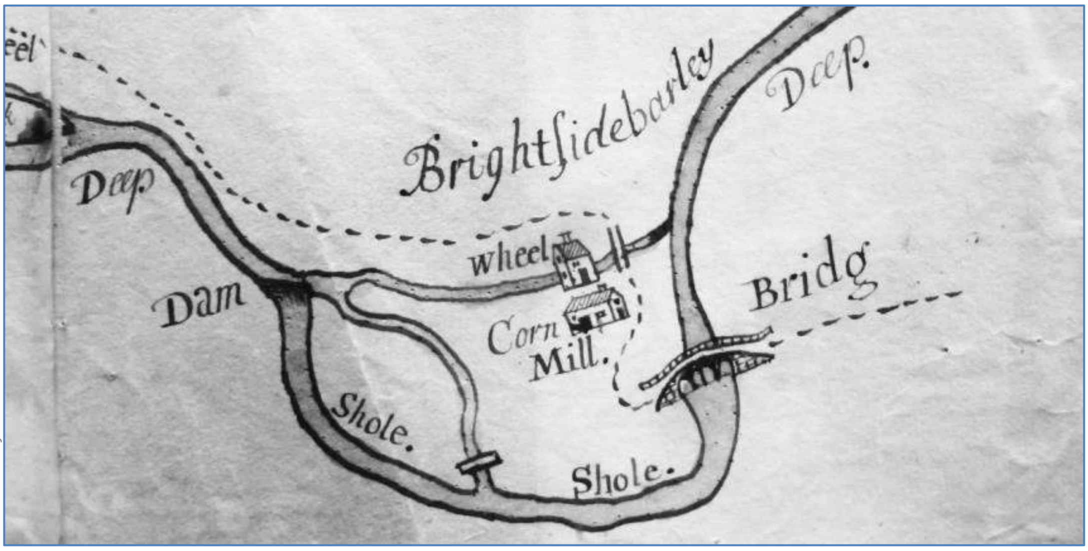

Plate 1: Example of a by-pass water management system

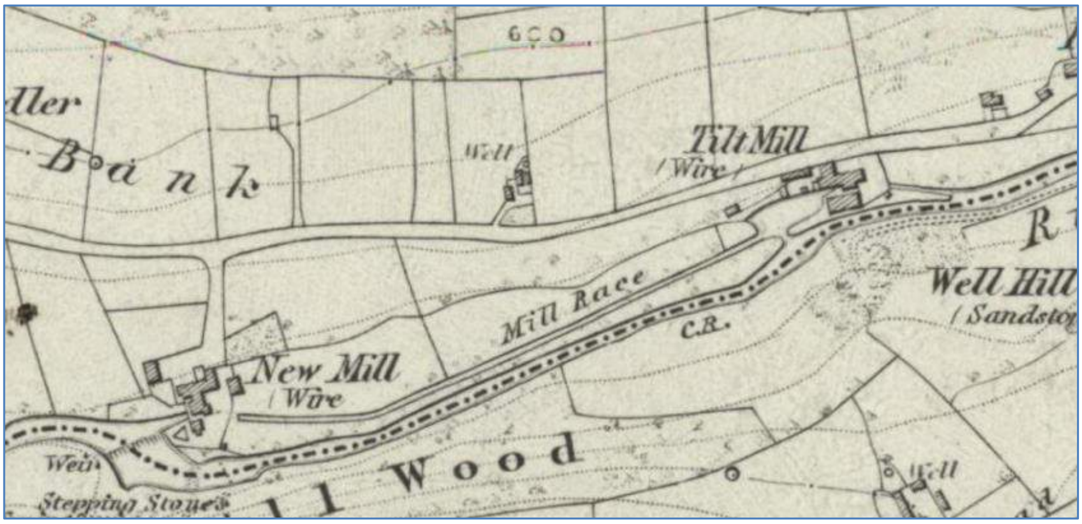

Plate 2: New Mill and Tilt Mill (River Don), near Huthwaite, 1855 six-inch OS

2.2.4 Where the local topography was such that this arrangement was impractical, other solutions were found. On occasion a bank was constructed across the width of a valley, impounding the entire flow and releasing surplus by an overflow weir (e.g. Fullwood Corn Mills and Whiteley Wood Forge on the Porter).

2.2.5 In areas such as Sheffield, which grew to possess a very high density of mills certain compromises were made to this layout as the potential for the river to provide power reached capacity. Two mills might share the same weir, the wheels operating in tandem, or a mill may be fed from the water channel leading away from another mill without an intermediate return of water to the river (**Plate 2**). Whilst chains of mills could be established in this manner, it was generally undesirable as the running of mills down the chain would be more reliant on a predictable release of water from those upstream of them.

2.2.6 The vast majority of water power sites are now redundant, with the exception of a small number still operated for demonstration/conservation purposes (e.g. Wortley Top Forge and Abbeydale Industrial Hamlet), and even fewer for commercial purposes (e.g. Worsbrough Watermill).

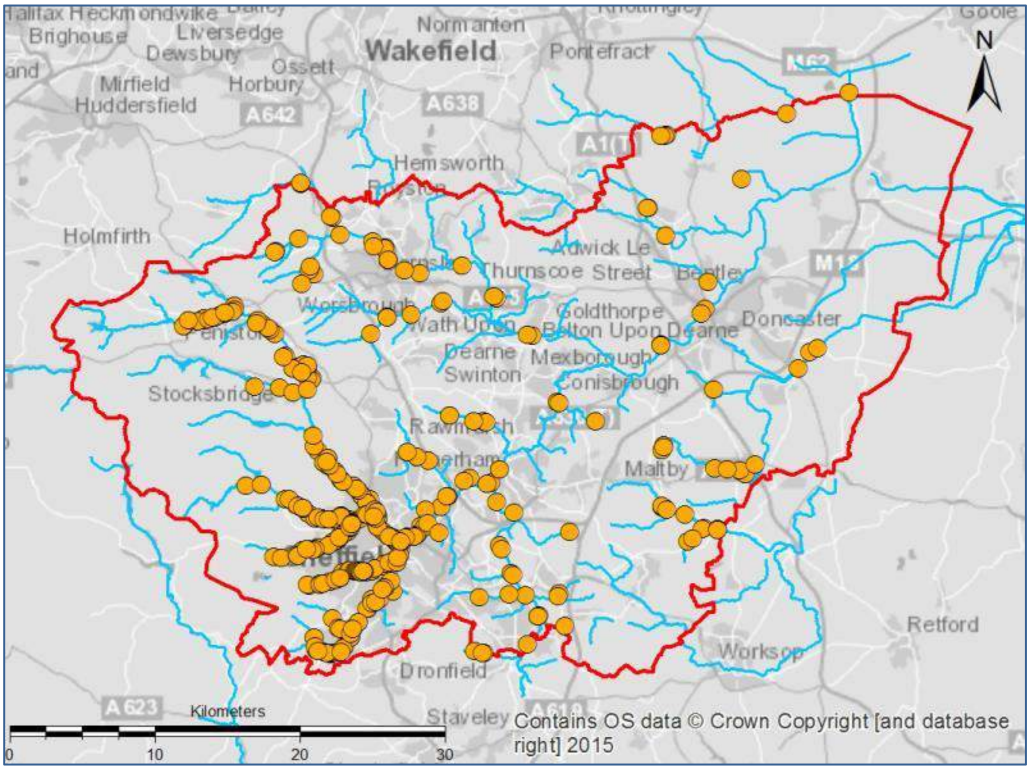

Plate 3: Distribution of known waterpower sites from data gathering exercise.

Weirs

2.2.7 A **Weir** is a low wall or barrier built across a river to raise the water level upstream or to control the flow (Jones 2006, 428) (**Plate 4**).

2.2.8 The data gathering exercise identified the sites of 132 weirs associated with water power sites in South Yorkshire. Of these eight records were for weirs that are known to have been removed. It is also anticipated that there are likely to be a number more unrecorded weirs within the study area as the stated figure is based on existing published data and no comprehensive recording programme has been undertaken. In total 12 weirs in South Yorkshire have been nationally designated (four within Scheduled Monuments, 1 Grade I Listed, 1 Grade II* and 6 Grade II).

2.2.9 Low pressure for change within river environments historically has resulted in the survival of many weirs long after the mill sites and associated water management system had been lost. As weirs fell into disuse so their active management also declined leading to the gradual ruination of many as stones became loosened and dislodged by flood waters and vegetation. The management of historical weirs is an ongoing concern and the potential impact caused by unmanaged collapse is a consideration in deciding whether the structure should be removed.

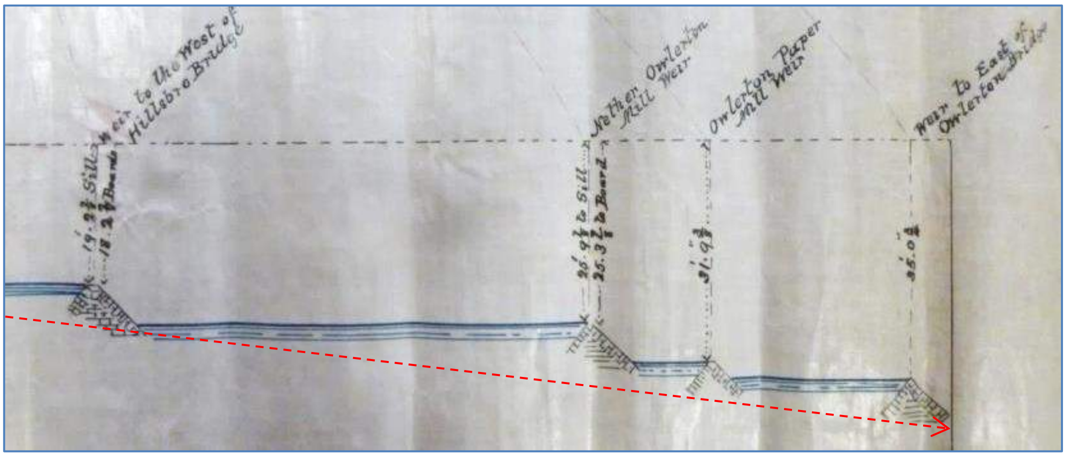

Plate 4: Extract from a plan showing the arrangement of weirs between Hillsborough Bridge and Owlerton Bridge illustrating how weirs could be used to artificially control the level of water within the river.

Function and Form

2.2.10 The function of the weir's design is to impound water, raising its level, in order that it can be drawn off and put to a waterwheel. To this end the height of the top kerb of the weir is crucial to the operation of the system. It was possible in some cases to raise the height of the top kerb temporarily through the addition of wash- or slot- boards using iron brackets (Ball *et al.* 2006, xix; see for example Storrs Bridge Wheel Weir). The height of the weir was important not only for the mill pond it served, but also for the mills upstream and downstream neighbours who could be affected either by rising water levels backing up into their wheel pit or through the reduction in water flow. The profile of weirs can take a variety of forms, the most common types including:

A weir with downstream, and often upstream, glacis – reduces water turbulence from undermining the foundation through reducing scouring action and buttresses the weir increasing stability. The slope may be parabolic to reduce hydraulic jump.

A weir with stepped downstream fall - reduces water turbulence from undermining the foundation through reducing the impact of the fall, buttresses the weir increasing stability, reduces flow velocity of water over the weir, and creates an aesthetically pleasing cascade.

A weir comprising of a vertical structure - utilised where foundations were sufficient to resist undermining. Reduced the amount of material required in construction.

2.2.11 Similarly the plan of weirs take a variety of forms, including:

Weir formed at right angles across the channel. Suitable for small water bodies.

Weir spans the channel at an angle. Reduce the rise of water level at the leat entrance during river spate due to increased length of crest. Can be combined with Curved.

Weir forms a V-shape, the base of the V pointing up stream. Resisted water pressure similar to Curved.

Weir takes horizontal arched form across channel. Increases length of crest and resists water pressure behind the weir by transferring the force to the river banks.

2.2.12 Further details on the form and function of weir structures can be found in Rickard *et al.* (2003) *River Weirs – Good Practice Guide.*

2.2.13 Weirs were constructed between abutment walls with wing walls which served to direct the flow of water over the weir and consolidated the banks to either side reducing the chance of erosion causing the weir to be by-passed (Richard *et al* 2003).

Plate 5: New Mill weir west of Huthwaite

2.2.14 In order to prevent deterioration of the weir, vegetation would have had to be managed along the riverbed above the weir and along the weir apron which could otherwise lead to the loosening of stones which could be carried away in storm water. Paving of the riverbed was sometimes employed to reduce the potential for erosion (Ball *et al.* 2006, xix), sometimes incorporating a kerb across the river to form a stilling basin below the weir to dissipate the energy of the hydraulic jump caused by the turbulent flow and surface waves of water flowing over the weir, such as at Storrs Bridge Rolling Mill on the River Loxley.

2.2.15 In addition to these common forms there are occasional deviations. The weir at Roscoe Wheel on the Rivelin incorporates a baffle above the weir which would have reduced the flow velocity of water approaching the weir, thereby likely aiding in reducing impacts to the weir in times of spate. Weirs may incorporate a number of additional features, including a notch for water flow measurements, fish passes, and fish or eel traps (an example of a historic fish pass is the eighteenth century salmon ladder at Linton Lock Weir on the Ouse, List No. 1293712).

2.2.16 Weirs occasionally also incorporated a by-wash or low level drain controlled by a shuttle which could be opened to dewater the weir to facilitate maintenance or to increase flows to disperse silt. Such a mechanism was situated parallel to the Whiteley Wood Forge weir on the Porter Brook, and Sanderson's Weir on the River Don, whilst at New Mill to the west of Huthwaite incorporated a drain in the centre of the weir (**Plate 5,** see also **Plate 2**).

2.2.17 Whilst not identified within the study area, on some navigable rivers from the medieval period, flash locks and staunches were incorporated to allow passage through weirs. The locks effectively allowed a temporary gap in the weir to be opened. These were not ideal for either the weir owner who wanted to impound as much water as possible, or the boatmen who had to navigate the shallows and high flow of water created by such installations. They were replaced by pound locks in many places during the post-medieval period, which by-passed the weir and reduced water loss. As an aside, paddle and rymer weirs continued utilising the same basic technology of the flashlocks well into the twentieth century (Truman 2004).

Construction and Materials

2.2.18 The methods employed in construction vary according to period and situation, although the following method appears to have been commonly followed.

2.2.19 Timber piling was a common solution for the creation of foundations in areas of weak soils. This practice has been dated as early as the twelfth century at a weir excavated in Leicestershire, which comprised of a crib of timber piles filled in between with stone (Clay *et al.* 1990). The remains of sixteenth century weirs were also encountered at Greenham Mill on the River Kennet and Northenden Weir on the River Mersey exposing timber piles at the base of the structures (Richard *et al* 2003, 91 and 137). The technique continued well into the nineteenth century, with a description of a weir at Bromley Mill detailing a similar piled foundation of three rows of eight piles covered over with a surface of timber planks (Weale 1842, 29). Archaeological observations at Ward End weir in Sheffield also recorded timber piles at the base of the weir, linked transversely by timber beams (ArcHeritage 2015). Other techniques were also employed with a mid-nineteenth century weir recorded in the Upper Lode at Tewkesbury comprising a row of piles left projecting to the height of the weir and linked laterally by joists, around which a clay and sandstone core was erected and then dressed in ashlar (Bateman 1995).

2.2.20 Above foundations, weir construction by the eighteenth century commonly comprised the creation of kerbs at the top and bottom with a sloping apron, or glacis, of stones set into a bed of clay (Ball *et al.* 2006, xix). A glacis could be formed to both up and down stream sides. A partially permeable apron utilising gravel was also used in some places, possibly to allow the timber piles to remain wet (Richard *et al.* 2003, 137). The top kerb was often heavily engineered to resist breaching from debris or flood events, typically comprising rectangular blocks that could be linked with iron staples set within mortises and secured with lead. The lower kerb was less subject to damage, and could often be formed of timber (Ball *et al.* 2006, xix).

2.2.21 Local variations in materials persisted from the medieval period into the nineteenth century. One notable example is the use of furnace slag from the cementation process on a number of weirs in Sheffield which would have been a hard wearing and readily available material (e.g. the Grade II Listed Sanderson's Weir on the River Don).

2.2.22 Weirs were subject to maintenance during their operational lifetime, and the vast majority are considered to have been rebuilt in their entirety through piecemeal repairs or total reconstruction. Through this process the historic form of many weirs was lost as the new engineering solutions were employed (see **Case Study 1**), although remains of the original weir potentially survived at foundation level or encapsulated within the later structure.

Leats

2.2.23 A **Leat** is a man-made water course usually for conveying water to or from a waterwheel (Jones 2006, 221). Other terms include **Lade**, **Goit**, **Flume**, **Sluice**, **Feeder** and **Race.** The leat leading to the water wheel was typically known as a **Head Race**, and the leat leading water from the water wheel was a **Tail Race**. Within South Yorkshire the most frequently adopted term is *goit* (sometimes written *goyt*), with *head goit*, and *tail goit* used to describe the channels leading towards and from the waterwheel (Ball *et al.* 2006, xviii).

2.2.24 The study identified 25 records for leats within South Yorkshire. All but three of these were recorded as elements of their parent mill sites. It is anticipated that there are a large number of unrecorded leats within the study area as no comprehensive recording programme has been undertaken.

2.2.25 Following the decline of water power, many leats have become silted up and, where their associated mill ponds have fallen into disuse, survive only as earthworks rather than active water channels.

Function and Form

2.2.26 The form of an individual leat can vary significantly; their lengths, width, plan, and whether they were open or culverted dictated by the local topographical situation and the individual requirements of the industry which the waterwheel powered.

2.2.27 On rivers with high flows, in order to minimise the loss to the potential energy stored in the head of water set by the weir, the head race would often follow a shallow gradient, cut or embanked as dictated by the local topography. On smaller streams where there were lower flows it was often necessary to retain the velocity of the water (and therefore its kinetic power) and leats could therefore be short and fast flowing (Jones 2006, 422-423).

2.2.28 Some mills exist where this is not the case, with the arrangement of head race and mill pond not making full use of the available head of water (Stoyel 2015, 12).

2.2.29 The length of the head race corresponded to the desired head of water. Where the leat could be formed at a shallower gradient than the river from which the water was drawn, the head of water put to the wheel could be increased over distance. The width of the head race corresponded with its gradient such that a wide shallow leat might supply the same amount of water as a narrow steeper leat.

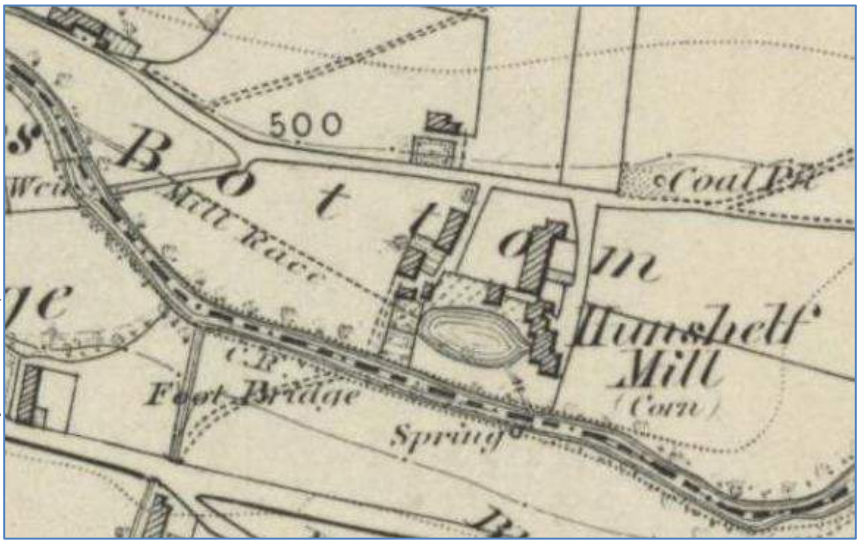

Plate 6: Hunshelf Corn Mill (Little Don), near Stocksbridge, 1854 six-inch OS

2.2.30 The length of the tail race corresponded with the need to keep the waterwheel free from pooling water that would otherwise impede its motion. In order to establish a free draining wheelpit the tail race would follow the lowest course available, often leading to it being culverted, and travelling over sufficient distance to a point where the level of water coincided with the river (Ball *et al* 2006, xxi). At Sharrow Wheel, on the Porter Brook, the desired fall of the tail race and the character of the surrounding topography resulted in the tail race being culverted beneath the river in order to join it further down stream.

2.2.31 Whilst the vast majority of leats were commonly open channels originally, some may have been culverted in parts to pass roads, buildings, or cut spurs off an adjacent hillside and thus avoid an overly circuitous route (e.g. the former Hunshelf Corn Mill on the Little Don; **Plate 6**). Where urban development grew up around the leat it was not uncommon for it to be increasingly culverted. Whilst its route may in some cases be preserved within the line of streets and paths, their alignment can be entirely lost beneath development.

2.2.32 The top of the head goit, adjacent to the top of the weir (**Plate 7**), would often incorporate a rising shuttle that could control the admission of water. In addition some head goits included additional water level management features including sluices and overflows for directing water back into the river.

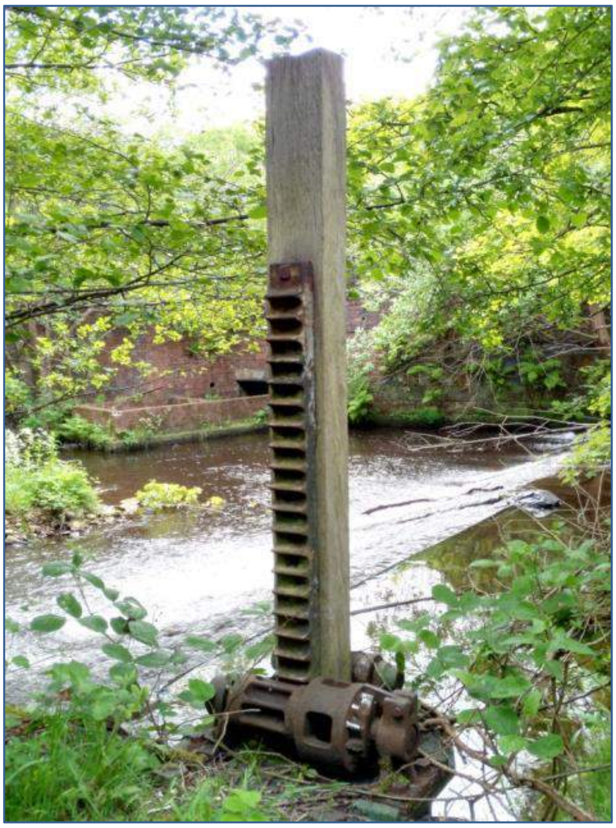

Plate 7: Ratchet and pinion shuttle mechanism in place at the entrance to the leat above the weir at Storrs Bridge on the Loxley.

Construction and Materials

2.2.33 Commonly, a leat will be formed through making a cut into the valley side of the river and using the spoil to build up its banks. In areas where there was potential for collapse or erosion masonry would be used to canalise the bank. This masonry could be rubble or ashlar, dependent on requirements. The entrances to head races were commonly built of durable ashlar masonry, owing to the requirement for a shuttle at these locations to control the inflow of water from the weir towards the mill pond. In other instances, such as at Holme Head Wheel on the Rivelin, the goit could be separated from the river by edge-set slabs (Ball *et al.* 2006, 101).

Mill Pond

2.2.34 The **Mill Pond** is a reservoir of water retained above a mill dam for driving a mill, also referred to simply as a **Pond**, or a **Bay**, **Dam** or **Reservoir**. The word *pond* had limited local usage is South Yorkshire, the word *dam* having been preferred for the reservoir as a whole rather than just the embankment that formed it.

2.2.35 The data gathering exercise identified the sites of 51 mill ponds in South Yorkshire, of which 5 have been nationally designated (2 Scheduled and 3 Listed). It is anticipated that there are likely to be a number more unrecorded ponds within the study area as the stated figure is based on existing published data and no comprehensive recording programme has been undertaken.

2.2.36 The gradual silting up of mill ponds during the years following their active management has often led to the upstream end of the dam becoming increasingly marshy as vegetation takes hold and reducing the area of the water body from its original extent.

Function and Form

2.2.37 The principal function of the mill pond was to impound and store water ready for use by a waterwheel. In many instances the reserve of water was gradually depleted during the working day, and topped back up during the night; however this is not always the case. A study compiled of the mill ponds in Sheffield (Ball *et al.* 2006, xx) indicated that contemporary estimates for the amount of water needed by the mills during a day were not typically met by the capacity of their respective mill ponds. On the basis of these observations it was judged that the mill ponds acted principally as a buffer against short term alterations in flow rather than providing a reservoir for a whole working day (*ibid.*).

2.2.38 On sites where there was a regular low flow of high velocity the mill pond could be entirely dispatched with in favour of retaining the kinetic power of the water and putting it from the leat directly to an overshot waterwheel.

2.2.39 The scale of capacity between some mills varied significantly, with some possessing chains of mill ponds (such as Wortley Top Forge on the River Don, **Plate 8**, but more common in other areas such as along the Calder Valley in West Yorkshire), and others little more than a widened head race (**Plate 9**).

2.2.40 The form of dams is generally dictated by the local topography, either formed by the enclosure of low lying land or along the edge of a hillside beside the river, whilst its profile is often deepest at the downstream end trailing off towards the upstream end.

2.2.41 The mill pond would also posses an overflow, either as a spillway or shuttle, enabling the level of the water within the mill pond to be kept constant. The leat leading from this overflow would either return to the river on its own course or discharge into the tail race. A low level drain was often incorporated into the overflow structure to enable draining and scouring of the mill pond for maintenance.

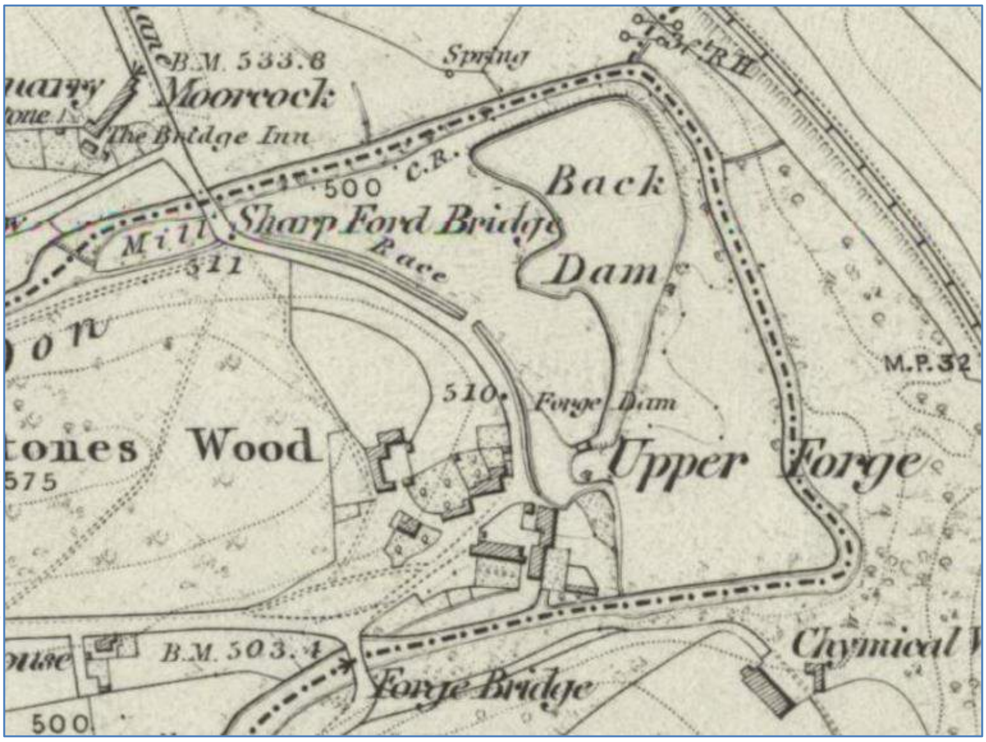

Plate 8: Top Forge (River Don), near Wortley, 1855 six-inch OS

Plate 9: 1766 map of Attercliffe Nether Hammer

Construction and Materials

2.2.42 The mill pond was typically formed on a hillside by erecting a dam along the length of the pond. The storage area could be widened by quarrying into the hillside with spoil being used to heighten the dam. The dams in the study area are commonly gravity dams, relying on its dead weight for stability, and typically comprised ramped earthen banks with puddling clay core. The interior and/or exterior of the dam could be built of masonry to prevent erosion, whilst on tall ramped dams the exterior may be stepped with level berms to reduce the risk of erosion.

2.2.43 It was important that the mill pond was water-tight, and thus where it was situated on permeable ground, puddling clay could be used to line the bottom. The integrity of this lining required attentive maintenance to remove vegetation that could grow in deposited silts and thus compromise the linings integrity. The gradual build-up of silt from sediment within the water would also gradually reduce the capacity of the mill pond over time and so low level drains were often incorporated at the deepest point in the dam in order to scour the pond.

Waterwheels

2.2.44 It is not the aim of this report to fully detail the forms or construction of the mills associated with water management systems. This has been tackled in more detail in a recently commissioned pilot study undertaken for Historic England in Herefordshire (Stoyel 2015). For completeness, a brief discussion is provided here.

2.2.45 The data gathering exercise identified 252 mills within South Yorkshire including 22 Listed Buildings and five Scheduled Monuments. The majority of these comprise the sites of now demolished mills identified by the SMR, however 19 records relate to extant buildings. It is anticipated the total of both lost and extant mills is likely to be higher as although there have been some focused studies (on the mills of Sheffield and the River Dearne in particular, see Ball *et al.* 2006 and Umpleby 2000) other water bodies within the county have not been systematically studied.

Function and Form

2.2.46 The mill was typically situated at the edge of the mill pond to allow the smallest fall in the head of water between the dam and the wheel. Although not identified in this study, instances where the mill is situated a slight distance away from the mill pond are possible where required by the local topography.

2.2.47 Typically the water fed into a pentrough, being a tank of wood or metal construction, which had a sluice raised by levers that allowed the amount of water reaching the wheel to be altered. Buckets arranged around the circumference of the wheel were aligned so as to use the weight of the water falling into them to turn the wheel. The motive force could then be taken off from the axle or from a ring gear and pinion system around the inner circumference of the wheel. Where it was possible to have a tail race of sufficient length to provide good fall it was not uncommon for the axel of the wheel to be sited below ground level in order to accommodate a larger wheel. More rarely it was also possible where there was an especially high fall for multiple wheels to be positioned vertically above one another (such as at Lumbetts Mill on the Upper Calder Valley in West Yorkshire where the 90ft fall allowed three 30ft diameter wheels to be positioned one above the other).

Construction and Materials

2.2.48 Whilst the wheel could be located on the outside of a building or housed internally, it was very common for wheels to be situated within substantial ashlar built wheel pits within which, especially for wheels of pitch back or breast shot design, curved masonry was created to reduce turbulence from water as it exited the wheel.

2.2.49 Wood was the traditional material used in waterwheel construction, however cast-iron was introduced in the late eighteenth century followed later by a lighter weight suspension or tension wheel design by the end of the century (Jones 2006, 423).

Summary of Significance

2.2.50 Identification and interpretation of waterpower sites is heavily dependent on their connection with water, and their significance can be significantly affected by dewatering or separation from the river. A significant consideration in the assessment of significance of water power sites is also derived from their connection with the industrial development or urban expansion of their surrounding area, with water power in South Yorkshire in particular possessing particular significance in respect to its involvement in internationally important metal trade.

Evidential Value

2.2.51 The principal evidential value of any component of a water power site's water management system is in the means and ends to which the system as a whole operated. Both excellent survivals of common water management systems and examples of unusual solutions will be of interest. Each component's evidential value also stems from the potential evidence documenting its origins and alterations, as well as the engineering processes involved in their construction.

2.2.52 Significant examples of water power management systems are considered to embody the following evidential values:

- Excellent survival of major component parts such as weir, leats, mill pond and mill (water power systems required regular renewal and therefore appropriate allowance for intactness of individual parts must be made);
- Survival of minor parts such as shuttles or other associated mechanical components;
- Tackles unusual technical challenges;
- Intact early examples of water management systems;
- Known archaeological remains documenting development of early or influential technologies or transitional periods;
- Makes use of unusual or locally distinct materials or techniques.

Historical Value

2.2.53 Historical value of a water power system principally derives from the importance of its associated mill and the extent to which other remains of the mill are visible. It is considered that the historical value of any component will be at its highest where it survives as part of an extant water management system associated with a site of national or higher importance. However, the historical value of a component could also be considered to be high where it provides an appreciable associative historical connection to an important past character of an area, including where development has led to the loss of its associated infrastructure.

2.2.54 Significant examples of water power management systems are considered to embody the following historical values:

- Illustrative of an early adoption or influential industry, technology or individual;
- Associated with nationally important individuals;
- Good documentary evidence for their development and operation;
- Strong connections to their wider landscape context or form part of a larger system of sites that share a common connection.

Aesthetic Value

2.2.55 Water management systems associated with water power sites can be considered to have aesthetic value deriving from the pleasant visual and audible effects caused by the movement of water, reflections of light from its surface, and the natural heritage found both within it and within its vicinity.

2.2.56 The architecture of the structures associated with water management systems for water power sites were principally functional in design, although their design in responding to the natural environment typically forms sinuous and curving lines, combining the horizontal line of the water with vertical mechanisms to present a visually interesting composition.

2.2.57 Significant examples of water power management systems are considered to embody the following aesthetic values:

- Possesses structures of a high architectural quality for its style and period;
- Excellent legibility of its original design, in terms of distinguishing functional components and form.

2.2.58 When assessing the potential affect on this quality from change, it should be noted that such water management systems often reflect a narrow period of history, and that consideration could also be given to the comparative aesthetic value that a naturalised river would have, as well as their relative contributions to the wider historic environment.

Communal Value

2.2.59 The communal value of many water power sites derives from the local sense of place felt by communities gained their connection with the past. Whilst in recent history these systems would typically have been at the polluted centre of industrial areas, the cleaning up of riverine environments has led to many water powered management systems acquiring a wider recreational attraction. As ecological conservation activities have cleaned up the rivers, local development has also gradually reoriented towards them, providing improved public access from where both natural and built heritage can also be better appreciated.

2.2.60 Significant examples of water power management systems are considered to embody the following communal values:

- Good interpretability of function;
- Combines heritage with mixed amenities;
- Good access.

Case Study 1: Weir Forms

Introduction

There was potential for great variation in the design of weirs, the basic requirement being that they be able to raise the level of the water at a greater height than natural. Whilst the majority of modern weirs tend to follow the same broad forms detailed in section 2.2, historically there would have been much more variation.

Plate 10: Brightside Weir 1741

Discussion

Evidence for the form of early weirs is potentially present in some degree in historical mapping. For instance whilst Brightside weir, as depicted in 1741 (**Plate 10**), comprised a more standard orthogonal structure of two sills and sloping apron; Sanderson's weir in 1768 was shown to be a irregular mitred shape (**Plate 11**).

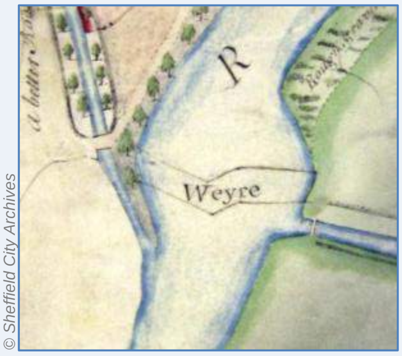

Plate 11: Sanderson Weir 1768

Many earlier weirs were replaced during the nineteenth century by stronger designs (**Plate 13**; Ball et al. 2006, xix). A common design evident on the Don and Loxley is where the apron of the weir is divided into bays by ashlar ribs. Unusual weirs did continue to some degree with that at Roscoe wheel featuring an unique double curved baffle above the weir (**Plate 12**).

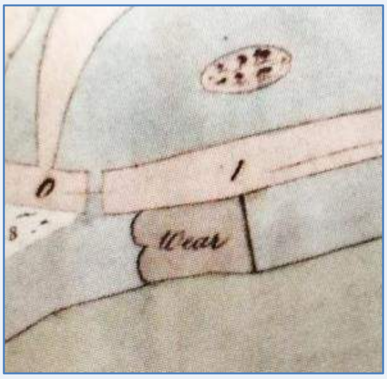

Plate 12: Roscoe Wheel Weir 1830

Outside of urban areas, where there was less pressure for development, it is anticipated that surviving weirs are likely more illustrative of the variety of forms utilised during the growth of water power industry in the post-medieval and industrial periods.

For instance, the straight drop weir at Wortley Tin Mill on the Upper Don with rough stone steps below (**Plate 14**) is formed from rough stone, whilst further upstream the weir at Bullhouse Mill was exaggerated by a natural fall over bedrock.

Plate 13: Aldwarke Weir

Plate 14: Wortley Tin Mill Weir

2.3 Transport

2.3.1 Historic England has published guidance on Listing Selection for Transport Buildings (Historic England 2011c), including canals and bridge structures, which offers a baseline for the assessment of their significance. It is considered that this resource offers sufficient guidance on these heritage assets, and the following information presents a summary for completeness in the context of the aims and study area or this document.

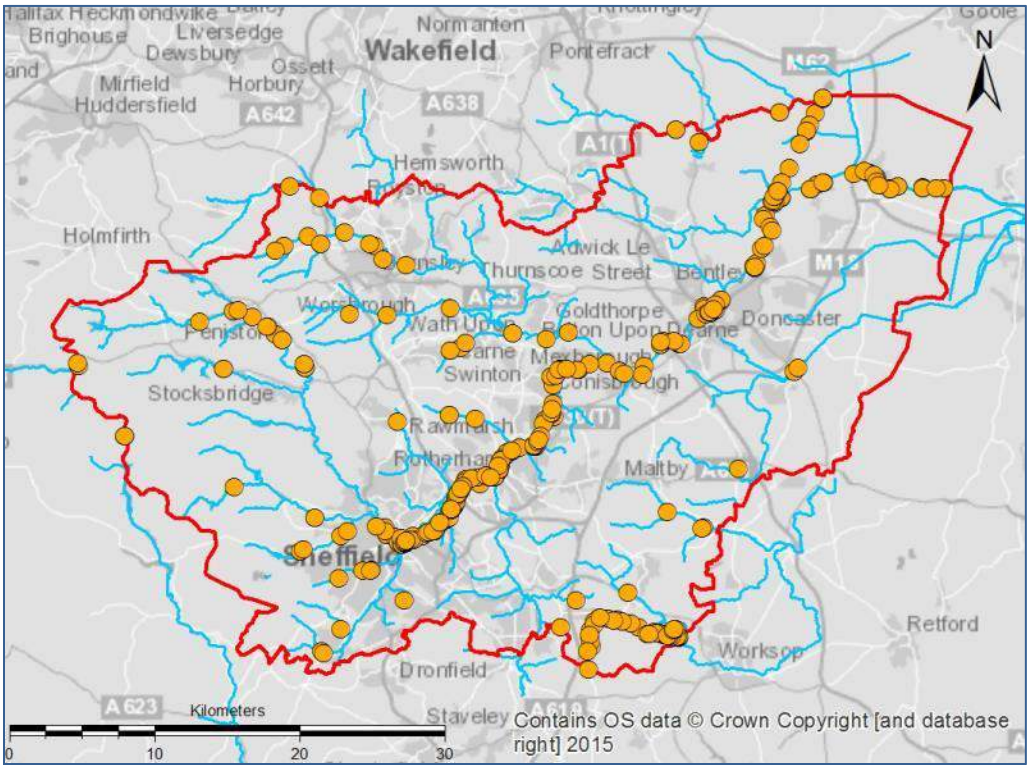

Plate 15: Distribution of known transport water management heritage assets from data gathering exercise.

Canals

2.3.2 Within South Yorkshire the principal canals were the Chesterfield Canal, the Barnsley Canal, the Dearne and Dove Canal, the Sheffield and Tinsley Canal and the Dun Navigation. Other smaller canals and branches include the Worsborough and Elsecar branches of the Dearne and Dove Canal, the New Junction Canal which links the Don to the Aire and Calder Navigation and the Stainforth and Keadby Canal which links the Don to the Trent. Of these the Sheffield and Tinsley Canal, Don Navigation, New Junction Canal, Stainforth and Keadby Canal, and part of the Chesterfield Canal remain in operation.

2.3.3 In general these waterways are not identified as water bodies in terms of WFD objectives, except where they represent the canalisation of the main river (the Dun Navigation for instance). Where the canal follows a historic water body, however, there is likely to be a significant interrelationship between the environmental status of the water body and the canal (such as the Stainforth and Keadby Canal which follows the North Soak Drain). For the purposes of this study, the principal components with potential to be affected by WFD measures are therefore considered to be those connected to or within a WFD water body.

2.3.4 The data gathering exercise identified 54 canal related water management structures within 500 m of a WFD water body, comprising two reservoirs, seven aqueducts (two of which are Listed), 41 Locks (two Listed), one tunnel, and three weirs (**Plate 15**). Virtually all of these structures are associated with the operational canals, and it is considered the remains of further currently unknown structures are likely to survive along the course of the disused canals.

Plate 16: Sprotbrough Lock on the River Don

Function and Form

2.3.5 The majority of the canals within the study area were formed by making new cuttings, utilising water diverted from existing water bodies (such as the Sheffield and Totley Canal). In some cases the water bodies (such as the North Soak Drain) were diverted from their historic course to run adjacent to the canal. Reservoirs were often formed to provide water to top up the canal, whilst overflows between the canal and nearby water body facilitated drainage.

2.3.6 Where unavoidable, or where it was more economical to do so, locks or tunnels were created to move across gradients. On the River Don a combination of river navigation and new cuttings was utilised to provide the desired course and depth. To manage water levels on the river weirs were constructed with locks built alongside, often in separate cuts, to allow boats to circumnavigate them (such at Jordan, Aldwarke, and Kilnhurst). In other areas existing weirs built for waterpower were utilised and similarly bypassed (such as in Rotherham and at Sprotbrough: **Plate 16**). Meanders were often cut and other reaches straightened leaving redundant sections of the earlier watercourse.

2.3.7 Static bridges and aqueducts were constructed, depending on the level of the canal, to allow passage of large roads and water bodies, whilst minor roads were often served by movable bridges and small streams culverted beneath.

Construction and Materials

2.3.8 Earth from the cutting of the canal was used to embank the canal where necessary and the whole cutting would be puddle clay lined to retain water (Paget-Tomlinson 2006, 35). Similarly spoil from dredging and widening of rivers could be used to raise banks if the river was liable to flooding or spread across adjacent fields. When constructed, the banks of most canals were predominantly simply ramped and planted with reed beds, although they were increasingly improved with masonry walls or sheet piling as erosion caused by the wake of motor powered boats became an issue.

2.3.9 In the location of structures such as locks, bridges, aqueducts and culverts the canal side is more heavily engineered. Weirs for navigation purposes were built to similar standards as those formed for industrial purposes (see the Water Power category).

Bridges

2.3.10 Whilst not strictly water management assets, bridges do constrain the flow of water which can have significant implications for both flooding and natural habitats.

2.3.11 The data gathering exercise identified 279 bridges within the Study Area of which 87 are designated (84 Listed and three Scheduled). The remaining non-designated bridges largely derive from the SMR, whilst further bridges of heritage interest not yet recorded are likely to exist within the study area.

Function and Form

2.3.12 Some of the earliest surviving bridges in South Yorkshire comprise medieval stone structures across the Don in Sheffield and Doncaster, whilst the remains of much earlier remains, such as the possible site of a Romano-British bridge at Rossington, are also known. On a smaller scale there are also numerous post-medieval packhorse bridges throughout the county relating to the development and expansion of trade in the region.

2.3.13 With the rapid increase of transport projects for turnpikes, canals and railways from the eighteenth century rose greater standardisation in the design of bridges.

Construction and Materials

2.3.14 The high point of the theory and practice of masonry bridge construction is considered to have been the eighteenth century, with increasing demand during the expansion of transport infrastructure in the subsequent century increasing demand for quicker solutions (Historic England 2011a). Timber was historically a common material for bridge construction, although unavoidable deterioration has left very few examples. Arched iron bridges appeared towards the end of the eighteenth century, superseded by stronger truss and suspension type bridges in the early nineteenth century. Concrete as a bridge material was first used in 1877, and the first major use of steel was in 1890 (*ibid.*).

Summary of Significance

2.3.15 Identification and interpretation of water management assets associated with transport sites are heavily dependent on their connection with water, and their significance can be significantly affected by dewatering. This is perhaps less true of bridges for which their architectural quality could still be appreciated. Transport networks also possess strong connections to their surrounding landscape, in terms of providing physical links between them, as well as providing vantage points from which the wider environment can be appreciated.

Evidential Value

2.3.16 The principal evidential value of transport infrastructure is in understanding their origins, their evolution, and the engineering solutions employed in their creation. Significant examples of transport structures are considered to embody the following evidential values:

- Of pre-1840 date, where substantially intact (operational structures such as weirs and locks required regular renewal and allowances for a lower degree of intactness should be made);

- Altered structures of intrinsic interest whose modifications reflect important developments of a particular route;
- Retains important archaeological interest (such as the remains of historic bridge piers or abutments in river banks and beds);
- Displays technological innovation in design and materials.

Historical Value

2.3.17 Significant examples of transport structures are considered to embody the following historical values:

- Highly important historical associations in terms of its pioneering date, engineering sophistication or influential nature.

Aesthetic Value

2.3.18 Significant examples of transport structures are considered to embody the following aesthetic values:

- Early date for their form or type;
- Structures of high architectural quality;
- Structures of unique design;

Communal Value

2.3.19 The communal value of many transport sites derives from the local sense of place and wider connects felt by communities. Significant examples of transport structures are considered to embody the following communal values:

- Forms an important vantage point of restricted landscapes or townscapes;
- Good access;
- Good interpretability of function.

2.4 Subsistence and Domestic

Fishponds

2.4.1 During the medieval period, religious observance meant that a great deal of fish was eaten, with most monasteries and manor houses possessing their own fishponds (Historic England 2012, 11). This is evident within the study area where the data gathering exercise identified 16 records of medieval to post-medieval fishponds (**Plate 17**). Of these three sites are contained within Scheduled Monuments of wider manorial landscapes.

2.4.2 The provision of ponds for waterfowl, including flight ponds and duck decoys, is also common. Although no records were identified for these features through the data gathering exercise it is anticipated that such ponds are present with many ponds serving dual purposes.

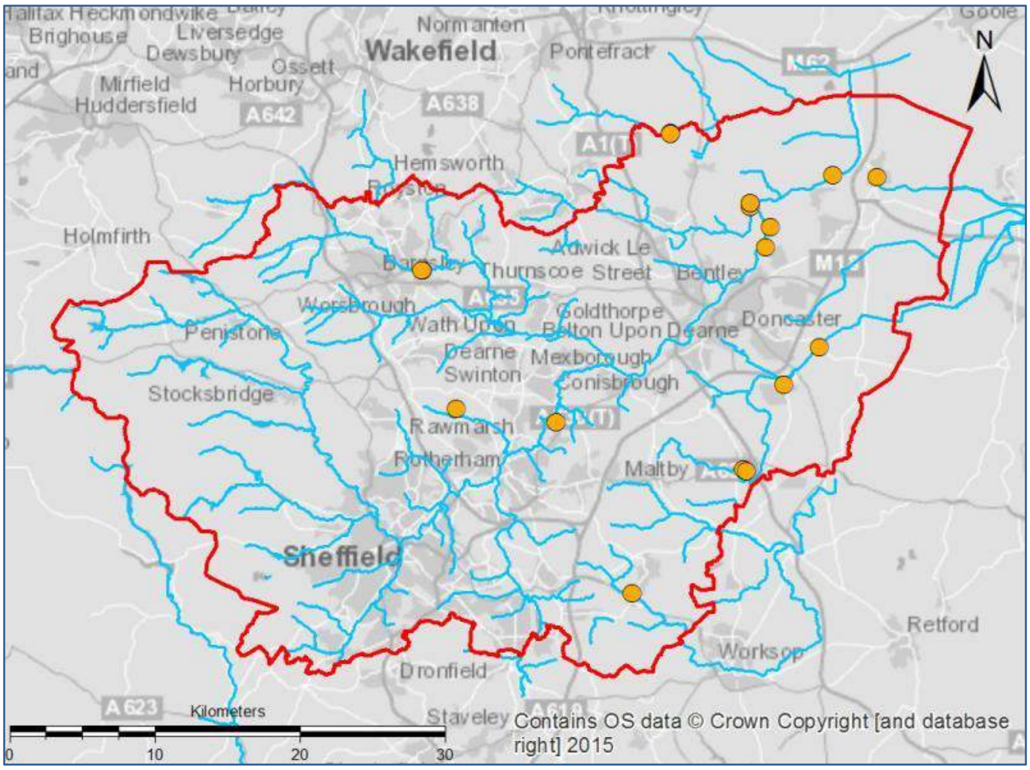

Plate 17: Distribution of known fishponds from data gathering exercise.

Function and Form

2.4.3 Fishponds were easily formed on valley-bottom streams or could be enclosed by dams in a clough or on the valleyside. In other instances rectangular ponds could be formed in chains allowing improved management (**Plate 18**). An example of the latter is at Norton Priory where there is a series of three sub-rectangular fishponds formed alongside the tail race of the priory's corn mill.

2.4.4 Ponds for waterfowl often lie in similar locations, although more commonly away from working areas of the estate to avoid disturbance. In form they often provide a longer area to allow water landing and taking off, and islands to encourage nesting. On decoy ponds, sinuous arms may be present from the main body of the pond to facilitate luring and trapping.

2.4.5 Management of water levels and quality, in terms of oxygenation and prevention of silting, would be important consideration in fishpond design. This required sluices and drains to control levels and flow, as well as silt traps on stream inlets.

Plate 18: Example of a fishpond at Farnborough Hall in Oxfordshire

Moated Sites

2.4.6 The moats dug around isolated farmsteads in the thirteenth and early fourteenth centuries are one of the more immediately recognisable elements of medieval dispersed settlement (Historic England 2013b, 10). Other features, such as fishponds, are occasionally described as moats, usually due to misinterpretation (Taylor 1978, 5).

2.4.7 Within South Yorkshire, the data gathering exercise identified 21 known moated sites, including 10 Scheduled Monuments (**Plate 19**).

Function and Form

2.4.8 The presence of a surrounding or partially surrounding ditch is a vital part of the definition of a moated site. Within the moat is an enclosure, accessed by bridge, where the farmstead buildings were situated.

2.4.9 Water management features associated with moated sites were basically designed to fill and keep filled the surrounding ditch with water. Water could be obtained by seepage, or through diverting water from an existing water body (Taylor 1978, 10). Once filled, water level was controlled with an overflow.

Construction and Materials

2.4.10 Moated sites are formed from earth cut ditches, sometimes incorporating a dam on one side where the site is sloped, and occasionally with stone built revetments. Whilst rare moated sites are occasionally found on pervious soils requiring puddling of the base of the ditch to retain water (*ibid.* 8).

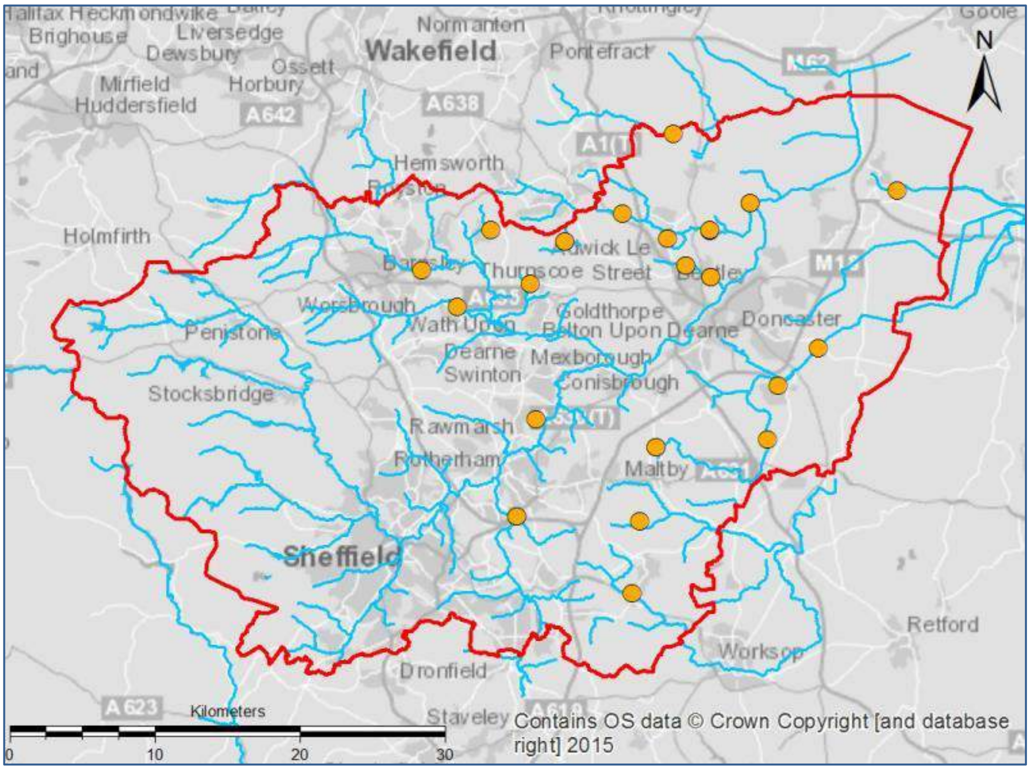

Plate 19: Distribution of known moated sites from data gathering exercise.

Summary of Significance

2.4.11 Whilst the vast majority of historic fishponds and moated sites have become dewatered through lack of maintenance following abandonment, it is considered that the interpretability of fishponds in particular derives from its association with water. In terms of their contribution to the wider historic environment they are particularly valued where they survive within the setting of associated settlement remains.

Construction and Materials

2.4.12 Significant examples of subsistence or domestic management systems are considered to embody the following evidential values:

- Survival of major component parts such as leats, sluices, pond/moat and associated contemporary landscape;
- No known modern dredging events below the original base of the pond/moat features;
- Survival of minor parts such as shuttles or other associated mechanical components;
- Intact early examples of water management systems for their type;
- Known archaeological remains documenting development of early or influential technologies or transitional periods.

Historical Value

2.4.13 Significant examples of subsistence or domestic management systems are considered to embody the following historical values:

- Illustrative of an early or influential adoption of the technology;
- Associated with nationally important individuals;
- Good documentary evidence for their development and use.

Aesthetic Value

2.4.14 Significant examples of subsistence or domestic management systems are considered to embody the following aesthetic values:

- Possesses structures of a high architectural quality for its style and period;
- Excellent legibility of its original design, in terms of distinguishing functional components and form.

Communal Value

2.4.15 Significant examples of subsistence or domestic management systems are considered to embody the following communal values:

- Good interpretability of function;
- Combines heritage with other community valued amenities;
- Good access.

2.5 Recreation

Parks

2.5.1 South Yorkshire contains 25 Registered Parks and Gardens, of which seven are situated on one of the WFD water bodies, comprising Sandbeck Park and Roche Abbey, Wentworth Woodhouse and Sheffield General Cemetery (at Grade II*) and Hickleton Hall, Cannon Hall, Porter Valley Parks, and Bretton Hall (at Grade II). The data gathering exercise identified a number of distinct parkland water management assets including 5 cascades (**Plate 20**).

2.5.2 The parks located on water bodies comprise one urban landscape, one landscape of remembrance and six rural designed landscapes. Historic England has released guides to all of these three forms of designed landscape (Historic England 2013c-e) which offer a baseline for the assessment of the significance of water management assets in park. Beyond the significance they draw from their intentional aesthetic qualities, the mechanics of water management assets within parks are very similar to those created for water power and reference should be made to the Water Power category for additional detail.

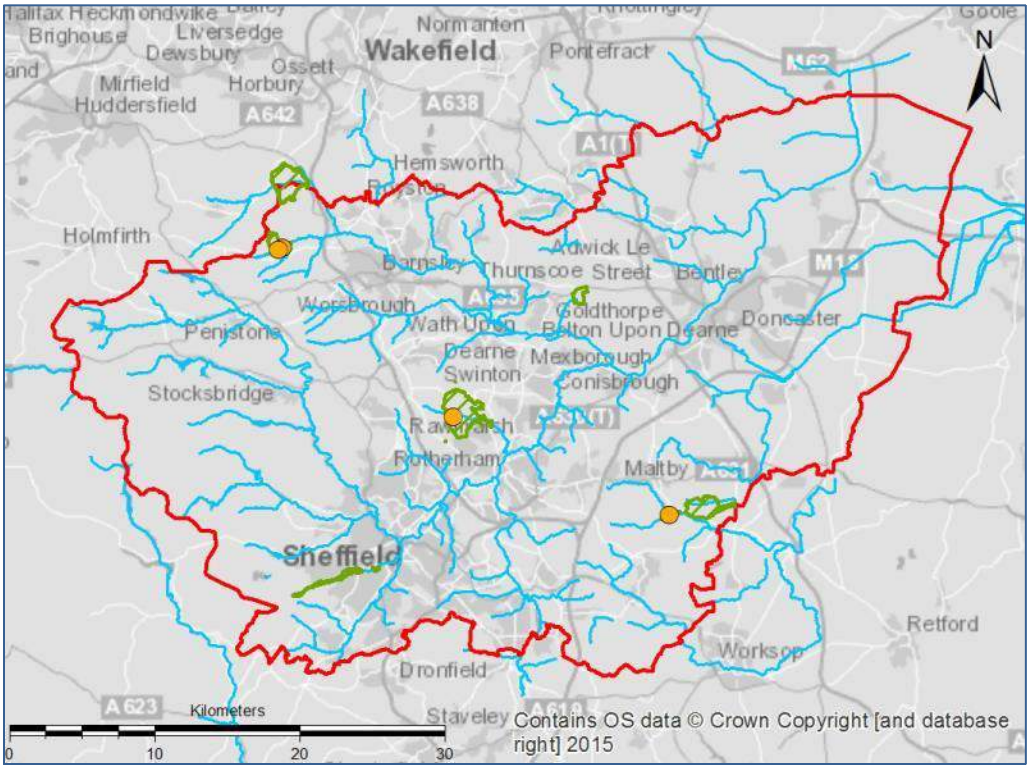

Plate 20: Distribution of Registered Parks and Gardens situated on water bodies, with location of known associated water management features from data gathering exercise

Function and Form

2.5.3 Whilst in general there is often little variation within the basic form of water management assets within parks and gardens, the significant difference was in the intentional design element in their creation. The flow of rivers through parkland was frequently altered to provide what was considered by the designer to be a more picturesque form, often including river widening, diverting and the creation of ponds and lakes.

Plate 21: The Grade II Listed Cascade at Cannon Hall Country Park.

2.5.4 The basic mechanics of controlling flows involved the silt traps, weirs and sluices common of other water management systems, though the creation of weirs and outfalls could be designed to form visual centrepieces with the formation of cascades (**Plate 21**). Foot and estate bridges would also be formed to provide focal points and platforms for appreciating an intentional view.

2.5.5 Functions too could be very similar to other categories discussed here, in that they could be formed for the purposes of breeding fish and waterfowl, but the emphasis was principally on recreation often being used for bathing, boating or shooting.

2.5.6 It was often also possible for the gardens to incorporate elements of earlier water management systems. Porter Valley Parks (List entry no. 1001502) is unique within the study area in this respect, as it comprises the landscaping of a former industrial landscape, the park containing the remains of eight mills and their associated water management assets (**Plate 22**).

Construction and Materials

2.5.7 The construction of the basic components of parkland water management assets are similar to those recorded in the Water Power and Subsistence and Domestic sections above. The principal difference is in the quality of the design and materials.

Summary of Significance

2.5.8 Where rivers are present within a designed landscape they can often form a central focal point within the design, and as such their retention in use significantly contributes to their significance and the setting of other heritage assets in the surrounding landscape.

Evidential Value

2.5.9 Significant examples of subsistence or domestic management systems are considered to embody the following evidential values:

- Excellent survival of major component parts such as weir, leats, pond and associated designed landscape elements;

- Survival of minor parts such as shuttles or other associated mechanical components;
- Rare or unusual example of technological/engineering solution;
- Known archaeological remains documenting development of early or influential activities, technologies or transitional periods.

Historical Value

2.5.10 Significant examples of subsistence or domestic management systems are considered to embody the following historical values:

- Illustrative of an early or influential in the development of taste;
- Early or representative examples of a style or type of system, or the work of an individual of national importance;
- Associated with nationally important individuals;
- Good documentary evidence for their development and use.

Aesthetic Value

2.5.11 Significant examples of subsistence or domestic management systems are considered to embody the following aesthetic values:

- Possesses high architectural/design quality for its style and period;
- Excellent legibility of its original design, in terms of distinguishing functional components and form.

Communal Value

2.5.12 Significant examples of subsistence or domestic management systems are considered to embody the following communal values:

- Good interpretability of function;
- Combines heritage with other community valued amenities;
- Good access.

Plate 22: Porter Valley Parks (Endcliffe Park)

2.6 Utilities

2.6.1 Historic England has published guidance on Listing Selection for Utilities and Communications structures (Historic England 2011d), including water supply and sewage disposal, which offers a baseline for the assessment of their significance.

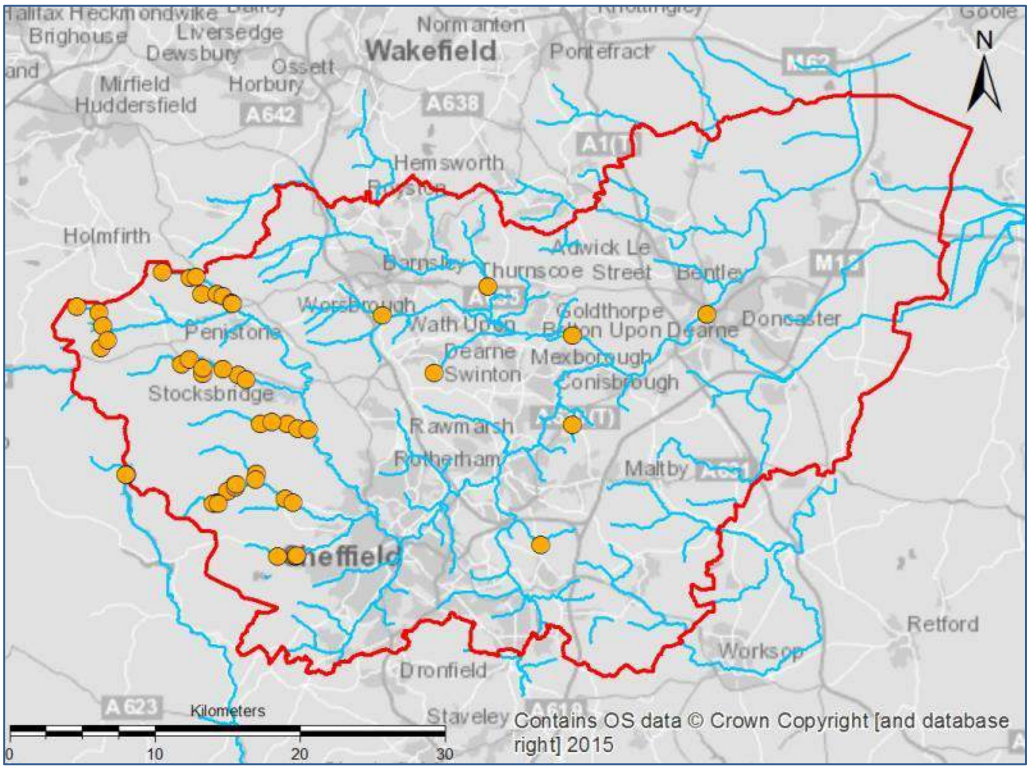

Plate 23: Distribution of known utility water management heritage assets identified from the data gathering exercise.

Water Treatment

2.6.2 Water utilities within the study area are managed by Yorkshire Water, involving a number of large reservoirs which feed into a network of treatment works and storage sites before reaching the user. The data gathering exercise identified 26 such reservoirs within the Study Area (**Plate 23**) with associated infrastructure including dams and weirs. These predominantly date to the industrial period and remain as operational structures therefore having experienced regular maintenance and alterations during their use. Howden Dam, on the boundary of South Yorkshire and Derbyshire is Grade II Listed. In addition associated features including water towers and gauging weirs were also identified.

2.6.3 The location of treatment works (both water and sewage) were not identified as part of the data gathering exercise, however there is potential for effects to these buildings as a result of the responsibility of Yorkshire Water to improve water quality under WFD. In cases such as the Blackburn Meadows sewage treatment works, the complex and associated infrastructure is of interest as an example of an early large scale sewage works. However due to the scale of improvement to water treatment systems since the nineteenth century it is highly unlikely that any original water management assets survive intact.

Function and Form

2.6.4 The proliferation of water utilities was a mid to late nineteenth century phenomenon, deriving principally from the establishment of link between cholera and foul water and the founding of a regulatory framework from the 1840s to provide universal access to clean water.

2.6.5 The quantities of water required in urban settings resulted in the construction of chains of reservoirs impounding water across the foothills of the Pennines, and pumping stations across the lower lying land to the east. The reservoirs were commonly formed on the outskirts of development in order to collect un-fouled water and in order not to compete with water power industries.

2.6.6 Reservoirs were formed by constructing dams across the water body, the scale ranging from low earth and clay cored bunds to the monumental stone clad and turreted structure of Howden Dam. Weirs carried overflows across or around the structures into long spillways dispersing their energy before returning them to the impounded river. The water from the reservoirs is piped to water treatment works for filtering before entering storage reservoirs and the distribution network.

2.6.7 Reservoirs often necessitated the provision of ancillary structures such as pump, valve, gauge, and meter houses often made in the image of gate-lodges or modest castles to complement the carefully designed landscape (Historic England 2011d, 4).

Construction and Materials

2.6.8 The dams for reservoirs within the study area are all of the gravity type, comprising earthen banks with clay cores relying on their dead weight to resist water pressure. Many of the larger dams are clad in stone. In practice the construction and materials of reservoir dams are largely similar to those associated with mill ponds (see the Water Power category), although much larger in scale and therefore requiring significantly more complex engineering.

Summary of Significance

Evidential Value

2.6.9 Significant examples of utility water management assets are considered to embody the following evidential values:

- Excellent survival of major component parts such as weir, leats, pond and associated designed landscape elements;
- Survival of minor parts such as shuttles or other associated mechanical components;
- Rare or unusual example of technological/engineering solution;
- Known archaeological remains documenting development of early or influential activities, technologies or transitional periods.

Historical Value

2.6.10 Significant examples of utility water management assets considered to embody the following historical values:

- Illustrative of an early adoption or influential industry, technology or individual;
- Associated with nationally important individuals;
- Good documentary evidence for their development and operation;
- Strong connections to their wider landscape context or form part of a larger system of sites that share a common connection.

Aesthetic Value

2.6.11 Significant examples of utility water management assets considered to embody the following aesthetic values:

- Possesses structures of a high architectural quality for its style and period;
- Excellent legibility of its original design, in terms of distinguishing functional components and form.

Communal Value

2.6.12 Significant examples of utility water management assets considered to embody the following aesthetic values:

- Good interpretability of function;
- Combines heritage with mixed amenities;
- Good access.

2.7 River Structures

Land Improvement

2.7.1 Rivers have been affected by increasingly intensive land management from the medieval and post-medieval periods, especially within the valley floor pastures of the Rivers Don and Went.

2.7.2 The data gathering exercise identified only three records relating to flood control within the Study Area (**Plate 24**). This comprised one record of medieval embankment at Kirk Sandall and two records of flood-control structures on the River Don. There are a large number of unrecorded flood banks and drains within the study area, created to improve the drainage of wetlands or impound water in previously dry fields. The extent of wetland enclosure is indicated in the South Yorkshire Historic Landscape Characterisation project (Lines *et al.* 2008; Wetland Enclosure Zone).

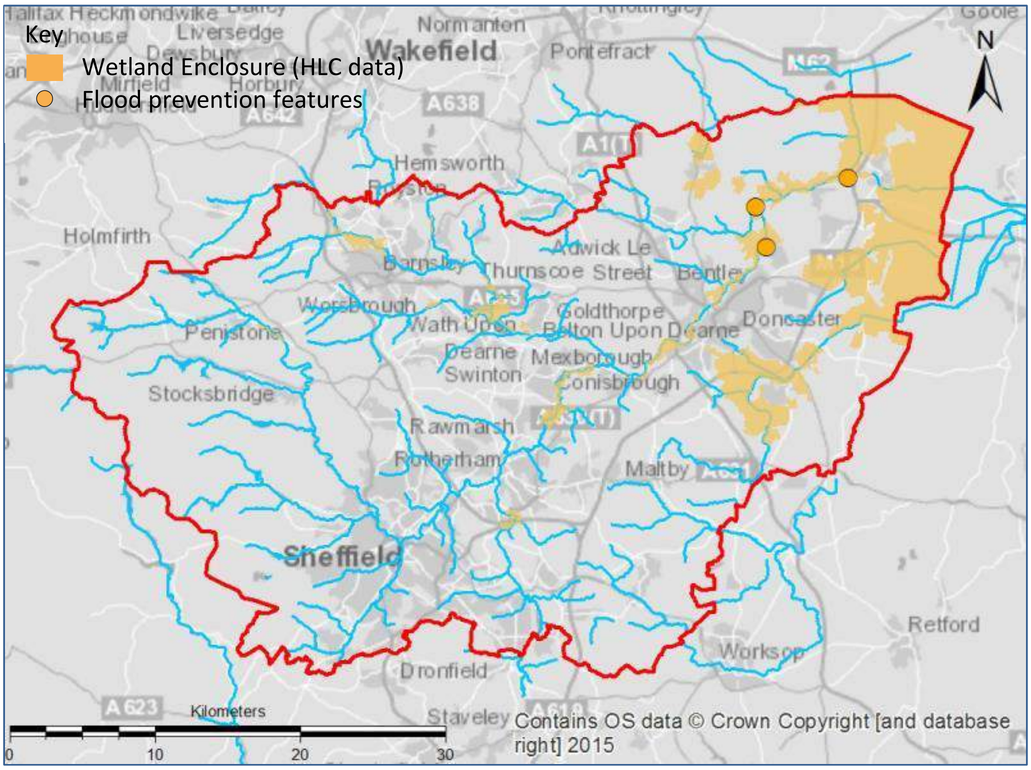

Plate 24: Location of flood prevention features for data gathering exercise and Wetland Enclosure areas from the South Yorkshire Historic Landscape Characterisation project.

Function and Form

2.7.3 During the medieval period considerable effort was put into water management in bringing low lying lands in fenland and coastal areas into agricultural use (Historic England 2012, 10). Within South Yorkshire the earliest large-scale drainage scheme was created during the seventeenth century by the Dutch engineer Cornelius Vermuyden and whilst largely successful it proved highly unpopular - altering land ownership and increasing flooding in surrounding lands (Dinnin 1997, 26; Hey 1979, 129). Much of this secondary flooding was eventually alleviated during the period of Parliamentary Enclosure c1750- c1850. Enclosure too would have created new channels and inlets into the rivers and the construction of numerous sluices.

2.7.4 Vermuyden's measures involved straightening substantial portions of the River Don north of Doncaster, between Newbridge and Goole, and much of the River Went (Paget-Tomlinson 2006, 114). Extensive warping drains were constructed within the wetlands around Hatfield and Thorne incorporating sluices at their confluence with the Don to control flows. Banks were built up around the river and drains in these locations to reduce the risk of floods.

2.7.5 During the post-medieval and industrial period, flood banks were ultimately constructed along many of the major rivers to allow more intensive utilisation of former flood plains. Many of these barriers are still utilised, although improvement works have reconnected flood plains to improve habitats, for instance along the Rivers Dearne and Idle (see **Case Study 3**). "Re-meandering" straightened river sections is also an key aim on many of the rivers in the area, such as along the River Dearne where the channel had been straightened at a relatively late date due to subsidence from mining in the area.

Construction and Materials

2.7.6 Most early flood banks consisted simply of dumps of earth, although occasionally with masonry components where the area was liable to flash flooding or in conjunction with outfall work (Historic England 2011e, 3). Very few flood defences have been properly examined by excavation, and constructional details are consequently sparse (*ibid.*). Post-medieval and Industrial period flood banks are more ubiquitous, forming long, almost unbroken, linear banks along the majority of rivers in the study area.

Culverts

Form and Function

2.7.7 The presence and significance of culverts is difficult to quantify within the study area. Within a recent survey of the River Don between Lady's Bridge and Meadowhall 215 outfalls were identified, of which perhaps a sixth appeared to be of post-medieval construction at their aperture (Ecus 2015). Many of these relate to drainage, whilst a few form the openings of derelict leats, and some the culverted course of streams and rivers. For instance where the Sheaf and Porter Brooks converge beneath Sheffield Station there are monumental nineteenth century brick and stone built vaulted culverts, with similar structures also known in Manchester and Leeds.

2.7.8 The potential presence for remains of culverts of earlier date beyond the modern riverbank is considered to be high within urban areas, and the survival of medieval drains would not be without precedent with research of the Kennet and Avon catchment highlighting several medieval culverts as well as the potential for later riverside structures to encapsulate earlier structures (Firth 2014, 15). Potential culverts of historic interest are also possible in rural locations, with the example of a de-culverting project at the head of the Porter Brook revealing the structure had likely dated from the initial enclosure of the area for agriculture during the post-medieval period (Scurfield 2013).

Construction and Materials

2.7.9 Construction and materials vary significantly in relation to period and function. Very early culverts may be of timber construction, with increasingly complex structures in stone and brick emerging during the industrial period. Most modern culverts are of pre-cast concrete.

2.7.10 Outfalls can be situated both above or below normal water level, and in instances where there is a risk of problems arising from flow reversal during flooding they are often fitted with flapgates.

River Walls

Function and Form

2.7.11 In a similar vein to culverts, the canalising of rivers and tributaries may comprise structures of archaeological or historic interest and there is also the potential for remains of earlier riverside structures to survive behind existing walls or encapsulated within them. In many instances, the requirements of retaining river walls coupled with difficulty of access have led to the retention of earlier buildings within the river walls of later developments. The growing requirements of flood defences have resulted in the consolidation or encapsulation of these walls.

Construction and Materials

2.7.12 Construction and materials vary significantly in relation to period and local vernacular. Within urban areas, where the majority of canalisation has taken place, river walls are often a patchwork of industrial and modern period brick and stonework.

Summary of Significance

Evidential Value

2.7.13 Significant examples of subsistence or river structures associated with water management are considered to embody the following evidential values:

- Excellent survival of major component parts such as weir, leats, pond and associated designed landscape elements;
- Rare or unusual example of technological/engineering solution;
- Known archaeological remains documenting development of early or influential activities, technologies or transitional periods.

Historical Value

2.7.14 Significant examples of subsistence or river structures associated with water management are considered to embody the following historical values:

- Illustrative of an early or influential technology;
- Early or representative examples of a style or type of system, or the work of an individual/organisation of national importance.

Aesthetic Value

2.7.15 Significant examples of subsistence or river structures associated with water management are considered to embody the following aesthetic values:

- Possesses high architectural/design quality for its style and period;
- Excellent legibility of its original design, in terms of distinguishing functional components and form.

Communal Value

2.7.16 Significant examples of subsistence or river structures associated with water management are considered to embody the following communal values:

- Good interpretability of function;
- Combines heritage with other community valued amenities;
- Good access.

3. Water Framework Directive

3.1 An Introduction to the Water Framework Directive

3.1.1 The Water Framework Directive (WFD; European Parliament and of the Council Directive 2000/60/EC) establishes a legal framework to protect and restore clean water across Europe and to ensure its long-term, sustainable use. The purpose of the Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

a. prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
b. promotes sustainable water use based on a long-term protection of available water resources;
c. aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
d. ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and
e. contributes to mitigating the effects of floods and droughts

3.1.2 The Directive establishes an approach for water management based on River Basins Districts (RBD), the natural geographical and hydrological units, and sets specific deadlines for European Member States to protect aquatic ecosystems. The Directive addresses inland surface waters, transitional waters, coastal waters and groundwater.

3.1.3 The units of management follow a defined hierarchical structure, comprising:

- River Basin District (i.e. Humber River Basin District)
    - Management Catchment (i.e. Don and Rother Management Catchment)
        - Operational Catchment (i.e. Don Middle Operational Catchment)
            - Water Body (i.e. Don from River Rother to River Dearne)

3.2 River Basin Management Plans

3.2.1 Under the WFD each Member State is required to produce River Basin Management Plans (RBMP) for each RBD. A River Basin District, as implemented in the UK, comprises a group of smaller river catchments, which neighbour each other in a relatively distinct regional area, each generally comprising a number of connected water bodies which drain into a single major river system. There are eight River Basin Districts in total within England.

3.2.2 The first-cycle River Basin Management Plans for the eight River Basin Districts in England were published in December 2009, with second-cycle reports published on the updated RBMPs in December 2015.

3.2.3 RBMPs in England are a high level strategic planning document, which provides stakeholders concerned with the River Basin District a measure of certainty about the future objectives for water management in that district. The plans include an overarching aim, and corresponding environmental objectives for each body of water with a summary of the programme of measures necessary to reach those objectives.

3.2.4 For instance, the overarching aim of the Humber RBMP is:

Historically all rivers within the district contained salmon and sea trout. Following decades of pollution, water quality has improved greatly and all river systems within the Humber River basin district now contain stocks of migratory salmonids to a greater or lesser extent. Man-made physical barriers to fish movement prevent these fish, along with freshwater fish, eels and lampreys, from reaching their true natural potential in rivers such as the Ouse and Trent and their tributaries.

- *We will seek to remove all artificial barriers to fish migration for all species, starting with the highest priority obstructions.*
- *We will work with communities and partners to provide opportunities and funding for the removal of prioritised barriers.*

All rivers within the Region will hold naturally self-sustaining spawning populations of migratory fish by 2021.

3.2.5 In 2015, an online tool was released by the Environment Agency, the Catchment Data Explorer (http://environment.data.gov.uk/catchment-planning/), which allows users to navigate catchments and water bodies, view catchment summaries and download data. The purpose of Catchment Data Explorer is to support consultation by providing up to date information to the River Basin Management Plans.

Classification of Ecological Status

3.2.6 Each RBMP classifies the waters of the River Basin District to assess whether environmental conditions are good enough to support biology. The status of each water body within a RBD is assessed in terms of ecological, chemical and physical elements.

3.2.7 The WFD requires surface water bodies to be classified into one of five ecological status classes (high, good, moderate, poor or bad) and one of two chemical status classes (good or failing to achieve good). In addition, there are two stages to groundwater classification, considering water quantity and chemical status as one of two status classes (good or poor).

3.2.8 For each water body; objectives are defined using the classification system considering social, environmental and economic factors (such as "Good by 2027"). The WFD also allows alternative objectives to be set in circumstances where it may not be possible to achieve good status or where it would be disproportionately expensive to do so. These latter objectives are justified on the basis of a full socio-economic and feasibility assessment. This primarily focuses on whether measures are technically infeasible and/or disproportionally costly (for further details refer to section 5 of Environment Agency 2016).

Protected Areas

3.2.9 The WFD specifies that areas requiring special protection under other EU Directives and waters used for the abstraction of drinking water are identified as Protected Areas. These areas have their own objectives and standards, and comprise:

- areas designated for the abstraction of water for human consumption (Drinking Water Protected Areas);
- areas designated for the protection of economically significant aquatic species (Freshwater Fish and Shellfish Directive; European Parliament and of the Council Directive 2006/44/EC, repealed by the Water Framework Directive 2000/60/EC on 22/12/2013);
- bodies of water designated as recreational waters, including areas designated as Bathing Waters;
- nutrient-sensitive areas, including areas identified as Nitrate Vulnerable Zones under the Nitrates Directive or areas designated as sensitive under Urban Waste

Water Treatment Directive (Directive 1991/271/EEC of the European Parliament and of the Council of 21st May 1991 concerning urban waste-water treatment) and
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection including relevant Natura 2000 sites.

3.2.10 A number of statutory instruments are in place within the UK to ensure water resources comply with European legislation, as outlined above. These include in the UK: the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 to implement the WFD; the Urban Waste Water Treatment Regulations (England and Wales) (Amendment) Regulations 2003 implement the Urban Waste Water Treatment Directive. The National Planning Policy Framework (NPPF) (Department for Communities and Local Government 2012) sets out the Government's planning policies for England and how these are expected to be applied. It aims to protect and enhance the environment by looking at economic and social drivers, paying particular attention to water quality and water resources, including the implementation of the WFD.

Artificial and Heavily Modified Water Bodies

3.2.11 Some water bodies contain features that provide valuable social and economic benefits or uses, for instance flood risk management schemes or reservoirs that supply drinking water. Where modification to achieve good ecological status would compromise a water body's benefit to society, it can be designated as artificial or heavily modified and their objectives determined accordingly.

3.2.12 Once designated, artificial and heavily modified water bodies are required to reach the objective of good ecological potential rather than good ecological status. This is the highest ecological quality that can be achieved given the physical modifications or alterations necessary for its designated use and without having negative impacts on the wider environment.

3.2.13 Artificial and heavily modified water bodies are still required to aim to achieve good chemical status and, if also designated as a protected area, the protected area objectives.

3.2.14 For artificial and heavily modified water bodies an assessment of the potential mitigation measures required to achieve good ecological status in undertaken. Where the mitigation measure cannot be implemented in any way, without causing a significant adverse impact to its social or economic value, it is excluded from the classification process and would not prevent a water body from achieving good ecological potential.

Proposed Measures

3.2.15 For each water body the RBMP is required to include an overall status objective with reference to WFD status classification and identify a range of measures to:

- address areas failing to make good status;
- protect or improve "Protected Areas"; and
- prevent water bodies from deteriorating from their current status.

3.2.16 RBMPs are not required to set out detailed actions at specific locations, with detailed measures date held at a local scale, however, specific examples are given in RBMPs in some circumstances.

3.2.17 For WFD, "measures" are identified as "actions that are undertaken to deal with a particular issue and to protect and improve the water environment" (Environment Agency 2014a). The specific implementation of measures are tailored to the individual constraints of each water body; however they are divisible into more general objectives which can be broadly categorised (**Table 1**).

Table 1: Measure Types

Measure	Description
Improve modified physical habitats	Removal or easement of barriers to fish migration, Removal or modification of engineering structure, Improvement to condition of channel/bed and/or banks/shoreline, Improvement to condition of riparian zone and /or wetland habitats Vegetation management Changes to operation and maintenance Dredging and silt management Sustainable aggregate extraction Sustainable marine development
Improve and manage the natural flow and level of water	Control pattern/timing of abstraction Improvement to condition of channel/bed and/or banks/shoreline Water demand management Use alternative source/relocate abstraction or discharge Sustainable access and recreation management – reduce the impact of water based and terrestrial activities
Manage pollution from waste water / towns cities and transport / rural areas	Reduce point/diffuse source pollution at source (all areas) Reduce point/diffuse source pollution pathways (i.e. control entry to the water environment) (all areas) Mitigate/remediate point/diffuse source impacts on receptor (all areas) Sustainable woodland and forestry management (rural areas)
Manage pollution from mines	Mitigate/remediate point source impacts on receptor
Manage non-native species	Mitigation, control and eradication (to reduce extent) Building awareness and understanding (to slow the spread) Early detection, monitoring and rapid response (to reduce the risk of establishment)

3.2.18 More details on some of the common measures have also been set out by the EA for Flood Risk Management projects which could be applied to mitigate changes occurring either from historic or proposed modifications (http://evidence.environment-agency.gov.uk/FCERM/en/SC060065.aspx).

3.3 Assessment

3.3.1 For each RBD a Strategic Environmental Assessment report (SEA) has been completed (to fulfil the requirements of the Environmental Assessment of Plans and Programmes Regulations 2004) that considers the significant environmental effects of the draft update to the River Basin Management Plans and to ensure the plan takes those effects into account.

3.3.2 The SEA is based on an "Ecosystem Services Approach". The focus of this approach is to develop a practical methodology / decision making framework that can be implemented at the catchment scale to meet requirements of the WFD and other water-related policies, while maximising the delivery of multiple benefits. The core of the assessment is an economic appraisal of the costs and benefits of delivering measures to a range of ecosystem services.

3.3.3 Cultural heritage (referred to as 'heritage' throughout this report) is identified as an "ecosystem service" which is likely to receive change as a result of the draft updates to the RBMPs and is therefore included in the scope of the assessment. The scope of the SEA was not to include all measures being proposed for catchments but to consider the significance of their effects at a river basin district scale.

3.3.4 The assessment of heritage features at SEA level focuses principally on protected (i.e. designated) heritage assets, with unrecorded heritage assets considered in terms of identifying the types of measures which could have a potential adverse effect on them and thus where mitigation may be required (Environment Agency 2014b, 15). However the assessments do appreciate that there is an under-representation of historic water management assets in existing records, stating that "these sites are also often omitted from Listing and Scheduling, despite many of them meeting the criterion for designation" (*ibid,* 36).

3.3.5 The measures which lead to negative effects on heritage are primarily identified as arising from modifications or removal of structures for the benefit of river morphology and fish movement, river restoration, and those which involve excavation of unmade ground (see Chapter 4). This reflects the significant potential for currently unrecorded archaeological sites to survive within rivers, and in a number of assessments it is stated that "the presence of a river corridor indicates an area where significant unrecorded monuments are likely to survive" (*ibid.* 36).

3.3.6 Within the SEA for Humber River Basin District there is identified to be local negative effects to heritage (*ibid,* 38) where measures modify or remove historic features, especially those associated with the management of water for supply, transport and power (**Table 2**). The economic appraisal of each of the catchments within the Study Area identified 'little or no impact' in the Idle Operational Catchment, a 'positive impact' to the Rother and Doe Lea, Middle Don, and Dearne Operational Catchments, and a 'very positive impact' to the Upper Don Operational Catchment.

3.3.7 Mitigation for this negative effect is considered to comprise sympathetic design to avoid or minimise the effects on heritage and where it is not possible to completely avoid negative effects, careful recording and local preservation of features and artefacts of heritage interest (*ibid,* 6). A heritage assessment to manage the effects is also recommended.

3.3.8 The potential positive effects derive from the enhancement of interest, understanding, preservation and enjoyment developed through promoting their significance and encouraging engagement with landowners and local communities. This is envisaged to form part of an integrated approach to catchment management and sustainable land management, as well as through improving public access and interpretation.

Table 2: Summary of potential negative local effects arising from proposed actions to Operational Catchments within the Study Area derived from comparison of stated proposed actions in Environment Agency management catchment summaries (2014c-d) and the assessment of potential effects undertaken as part of this study detailed in *Appendix 1: Table 4*.

Description	Potential Impacts affecting Historic Water Management Assets	Heritage Assets with Potential to Receive Effects	Affected Operational Catchments
Improve modified physical habitats			
Removal or easement of barriers to fish migration	Impact to structures that impede flows through removal or insertion of fish passes. Impact to buried remains associated with effected structures. Effects to setting of associated structures.	Weirs, dams, archaeological remains within rivers.	Upper Don Middle Don Lower Don Dearne Rother and Doe Lea Idle
Removal or modification of engineering structure	Impact to structures that modify the natural flow and sediment regime. Impact to buried remains. Effects to setting of associated structures.	Canal structures, culverts, riverside walls, bridges archaeological remains behind riverside walls	Upper Don Middle Don Lower Don Dearne Rother and Doe Lea
Improvement to condition of channel/bed and/or banks/shoreline	Direct physical impact to riverside walls and culverts, flood bunds and other riverside water management structures. Impact to buried remains through reengineering banks to improve flows and through creation of flood planes.	Riverside walls, archaeological remains behind riverside walls	Upper Don Middle Don Lower Don Dearne Rother and Doe Lea Idle
Manage pollution from waste water / towns cities and transport / rural areas			
Reduce point/diffuse source pollution at source (all areas) Reduce point/diffuse source pollution pathways (i.e. control entry to the water environment) (all areas) Mitigate/remediate point/diffuse source impacts on receptor (all areas)	Impact to structures that are a source of pollution. Impact to buried remains within areas requiring subsurface investigation (such as investigations to uncover and rectify wrong connections) Impact to buried remains within river walls.	Utilities, archaeological remains behind riverside walls	Upper Don Middle Don Lower Don Dearne Rother and Doe Lea Idle
Manage pollution from mines			

Description	Potential Impacts affecting Historic Water Management Assets	Heritage Assets with Potential to Receive Effects	Affected Operational Catchments
Mitigate/remediate point source impacts on receptor	Impact to historical mines in terms of both fabric and deposits.	Mines.	Upper Don Middle Don Dearne Rother and Doe Lea

3.4 Implementation

3.4.1 In England, regulatory competencies are shared between Defra and the Environment Agency (EA). The Department for Environment, Food and Rural Affairs (Defra) acts as the 'appropriate authority', ensuring that the Directive is given effect, while the EA acts as the competent authority, and is responsible for practical implementation of the WFD. This includes reporting, monitoring, authorisation and regulation of measures, and reporting public information and consultation. The approving authority for England is the Secretary of State.

3.4.2 RBMP compliance is enforced through the regulatory powers of the EA, with legislation placing a general duty on the EA and Secretary of State to secure approvals and standards are met within the requirements of the Directive. For each RBD, the EA is responsible for ensuring the achievement of its environmental objectives, and in particular that the programme of measures is coordinated for the whole of the RBD. Once approved by ministers, the environmental objectives of the RBMPs are legally binding, and all public bodies must have regard to the document when exercising any functions affecting the water environment.

3.4.3 The Catchment Based Approach (Department for Environment, Food and Rural Affairs 2013) has been adopted by the EA, in order to promote the development of more appropriate RBMPs in partnership with other local and national stakeholders. Within South Yorkshire the catchment partnerships are hosted by the Don Catchment Rivers Trust and The Environment Agency (Don and Rother), and the Yorkshire Wildlife Trust (Thorne). The core partners within each partnership include wildlife and environmental organisations, water companies, Local Authorities, Government Agencies, landowners, angling clubs, farming groups, academia and local businesses. Amongst the partners, built heritage interests are poorly represented.

3.4.4 The RBMP propose numerous works principally delivered through collaborations with other organisations (e.g. South Yorkshire Forest Partnership, Aire River Trust, Don Catchment Rivers Trust, Local Authorities etc.). Measures are implemented through individual targeted actions, and on an opportunistic basis often as mitigation to new modifications (see **Case Studies 2 and 3**), including:

- Flood Alleviation schemes; and
- Optimising planning gain during development; and
- Hydropower proposals.

3.4.5 For example, in relation to the 2009 Humber River Basin District RBMP, the Environment Agency has identified priority artificial obstructions on the Rivers Wharfe, Aire, Trent, Calder, Don, Derwent, Ure, Esk, Idle, Torne, Dove and Soar. It is stated that the "Environment Agency will seek funding and opportunity to improve passage either through provision of fish passes or removal of obstructions" and that they "will take an opportunistic approach to removing other artificial obstructions to fish migration as funds and opportunities permit". One such opportunity utilised by the EA is in the recommendation of planning conditions to Local Planning Authorities to put the onus of fish passage onto developers.

3.4.6 Other organisations are also stated as being able to take action on obstructions (Environment Agency 2009c, 24). Water companies, for instance, are provided public funding from Ofwat to provide improvements to water quality and water resources, in partnership with the EA, as part of their National Environmental Programme which can also lead to broader environmental improvements.

3.4.7 Where a development is likely to have a significant effect on the environment, developers are required to carry out an Environmental Assessment (EC Directive 85/337/EEC (as amended)). The relevant Planning authority will require such an Assessment under the powers of the Town and Country Planning Act 1990.

3.5 Legislative Mechanisms

3.5.1 There are several legislative mechanisms that govern Environment Agency activities. Key pieces of legislation are summaries below, with particular regard to those dealing with structures in and around rivers. The full wording of this legislation is included in **Appendix 2**.

Salmon & Freshwater Fisheries Act (SAFFA).

3.5.2 The Environment Agency has a duty to implement SAFFA. This law was created to protect salmon and trout from commercial poaching, to protect migration routes, to prevent wilful vandalism and neglect of fisheries, ensure correct licensing and water authority approval. This helps to sustain the rural inland freshwater fisheries industry, which employs around 37,000 people in the UK.

3.5.3 Section 9 of the Salmon and Freshwater Fisheries Act allows the Agency to serve notice on the owner or occupier of a dam or obstruction, to install a fish pass where necessary. Where notice is served the owner or occupier of the dam or obstruction has a duty to make a fish pass within a reasonable time as specified in the notice and subject to such form and dimensions as the Agency may approve and thereafter to maintain the pass in an efficient state. The fish pass details are now approved by the Agency, rather than the Minister or Secretary of State as previously - S9(1). This section applies to dams which are either new or have been altered to create an increased obstacle to the passage of migratory salmonids. It is also applicable where dams in a state of disrepair have been rebuilt over at least one half of their length.

3.5.4 Section 10 of the Act gives water authorities power to construct and alter fish passes so long as no injury is done to the milling power, water supply of or to inland navigation.

Water Resources Act

3.5.5 In any waters where fish passage is an issue, downstream or upstream, the Water Resources legislation (Sections 24 and 25 Water Resources Act 1991) may be used to make sure that provision is made for passage of fish (upstream or downstream) as the Agency can impose what conditions it sees fit on abstraction or impoundment licences. This means that where impoundment or abstraction licences are required, and fish migration (upstream or downstream) would be impeded, conditions can be placed on the licence to install suitable forms of fish passage (passes, bywashes, etc) or even screens, etc.

3.5.6 The Agency has broad powers to impose conditions in abstraction or impoundment licences under Section 38(2)(a) Water Resources Act 1991 i.e. "may grant a licence containing such provisions as the Agency considers appropriate". In exercising this power the Agency considers its statutory duty under Section 6(6) of the Environment Act, 1995 as amended by the Marine and Coastal Access Act, 2009 to 'maintain, improve and develop fisheries for salmon, trout, eels, lamprey, smelt and freshwater fish'. It also considers its duty to further the conservation of flora, fauna and geological or physiographical features of special interest under Section 7(1)(a) and take account of effects generally on flora or fauna under Section 7(1)(c)(ii) Environment Act 1995 and its principal aim in relation to attaining objective of achieving sustainable development under Section 4 Environment Act 1995. In addition the WFD Regulations 2003 require the Agency to exercise all our functions (powers & duties) including those in WRA 1991 and SAFFA 1975 so as to secure compliance with WFD requirements.

3.5.7 S105(3) of the Water Resources Act also places a duty on the Agency in exercising its flood defence powers to have due regard to the interests of fisheries and conservation. S109 of the Act can also be in the installation of bywashes, etc.

3.5.8 The WRA was introduced in December 1991 along with four other pieces of legislation (Water Industry Act 1991, Land Drainage Act 1991, Statutory Water Act 1991 and the Water (Consequential Provisions) Act 1991) whose combined purpose was to consolidate existing water legislation, which was previously spread out over 20 separate pieces of legislation. The Act governs the quality and quantity of water by outlining the functions of the Environment Agency. The WRA sets out offences relating to water, discharge consents, and possible defences to the offences. The Environment Agency has the power to bring criminal charges against people or companies responsible for crimes concerning water.

Environment Act

3.5.9 Section 7 of the Environment Act gives details the general and recreational duties of the Environment Agency, It places a duty on them that in formulating and considering proposals that they use their powers to further conservation and enhancement of natural beauty and conservation of flora, fauna and geological or physiographical features of special interest.

3.5.10 The section also places specific duties on the Agency:

- to have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological, architectural, engineering or historic interest;
- to take into account any effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects; and
- to have regard to any effect which the proposals would have on the economic and social well-being of local communities in rural areas.

Eel Regulations

3.5.11 The Eel Regulations are UK legislation to bring about compliance with the European Council Regulation (No 1100/2007) that established measures for the recovery of the stock of European eel. Regulation 14 allows the Agency to serve notice on the responsible person to install a fish pass, make alterations to an existing eel pass structure, operate an eel pass in accordance with conditions, remove an obstruction, or take any other necessary action to improve or maintain eel passage.

3.1 Funding Streams

3.1.1 Funding for implementing measures derive from a number of sources:

- Planning. The Environment Agency, as statutory consultees, may recommend to Local Authorities in response to development proposals that measures are conditioned as part of the planning permission process.
- Beneficiary pays. The person who will benefit from the improvement (or reduced risk) to the environment pays. This is sometimes called payment for ecosystem services.
- Government pays. The UK government directly or indirectly (via EU, central and local government) pays.

3.1.2 In addition to the above, there are voluntary or grant giving funding routes. Taking advantage of these funding options are Non-Government Organisations such as the river trusts, often possessing charitable status, working for the public benefit. Other examples include the partnership organisations formed to run the Nature Improvement Areas established by Defra in 2012 (for example see **Case Study 2**). These organisations are often able to draw on other funding streams not available to the Environment Agency or other developers such as Heritage Lottery Funding or European Union structural funds.

3.2 Guidance

3.2.1 There are several Environment Agency commissioned documents guiding consideration of heritage during works, comprising:

Richard, C. Day, R. & Purseglove, J. (2003). River Weirs – Good Practice Guide. Environment Agency: Bristol.

3.2.2 Whilst produced around the time the WFD came into force, this document does not refer to the Directive and was completed prior to the completion of the first-cycle River Basin Management Plans. This document does however provide advice and guidance for the design, construction and improvement of weirs and identified heritage and archaeology as constraints when planning rehabilitation or removal works. The document also provides several useful case studies discussing different weir alteration projects within different scenarios including several where heritage was a factor. The document stresses early consultation with Historic England, local authority development control archaeologists and the public to avoid delays and ensure a successful project.

Environment Agency (2008).Consideration of the historic environment in strategic environmental assessment.

3.2.3 This document provides guidance for the consideration of the historic environment in strategic environmental assessments (SEA), more specifically for catchment flood management plans, flood risk management strategies and other such flood or coastal risk management strategies. Whilst not specifically relevant to planning and designing WFD measures it does provide a broad framework for internal and external consultation and is illustrative of the type of formulaic guidance that would be useful in the context of WFD measures. Since the production of this document, Historic England has produced complementary advice in the form of: Historic England (2013f) *Strategic Environmental Assessment, Sustainability Appraisal and the Historic Environment.*

Environment Agency (2010). Environment Agency Fish Pass Manual.

3.2.4 This document details the legislation guiding the design and installation of fish passes, as well as selection guidance, details of the approval process and details of the project process. Within the document archaeology is identified as a principal consideration at the feasibility stage of the project.

Case Study 2: Upper River Don Weirs

Introduction

The rivers through the main cities of South Yorkshire were heavily industrialised during the post-medieval period, resulting in significant modifications to enhance their potential to provide power. These changes have left a significant legacy, reflecting a significant period in the formation of local identify, but also dramatically altering the natural environment. The following case study is illustrative of recent attempts to balance these considerations in Sheffield.

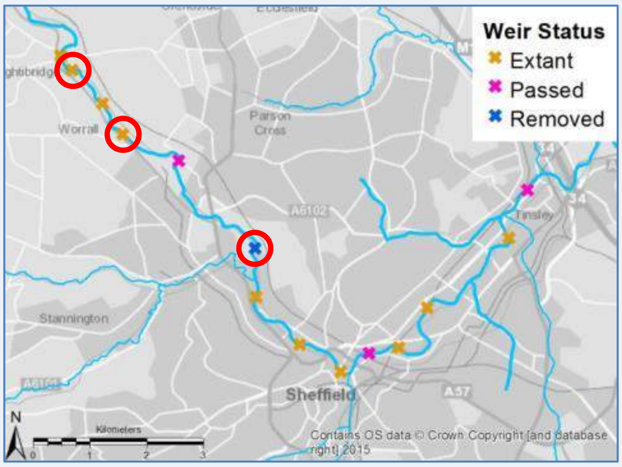

Plate 25: Weirs on the Don through Sheffield

Background

There was considerable focus in 2014/15 on reconnecting the River Don through Sheffield. The river is historically a salmon river and, following recent fish passage installation in Spotborough, salmon have reappeared in the Dearne and at Aldwarke Weir to the east of Rotherham. Whilst improvements in water quality mean that the river once more provides suitable salmon habitat, weirs across the river are still preventing salmon from accessing spawning habitats. The weirs also create a pooling effect that results in water being too deep and builds sediment deposits which smother spawning gravels.

Three weirs (circled in **Plate 25**) were identified in 2015 at Owlerton (Ward End Weir), Middlewood (Beeley Woods Lower Weir) and Oughtibridge (Middlewood Ironworks Weir) where partial removal was proposed as the optimal solution to improve salmon spawning grounds and other environmental effects included habitat restoration and geomorphological reconnection. In addition there was a foreseen heritage benefit of enabling maintenance of the remaining structures which would be preserved.

As part of the feasibility work to inform the measures, the EA commissioned a heritage assessment (Nexus Heritage 2015), and conducted engagement work with interested parties. The assessment considered the assets in terms of the heritage interest of both their physical presence and their setting, concluding that the importance of the weirs in the landscape to be 'moderately-high', but assessing their individual importance to 'low'. The low assessment of interest of the individual assets derived from the poor condition of their structure, the loss of their associated mills and poor integrity of their wider water management system.

Consultation on the scheme was undertaken with MPs, local representatives, South Yorkshire Archaeology Service, Natural England, Highways Authority, local landowners, Sheffield Geology Society, Sheffield Waterways Strategy Group, South Yorkshire Local Nature Partnership, River Stewardship Company, Don Catchment Rivers Trust, Wildlife Trust, canoe groups and the Don Network.

The EA received wide ranging support for the plan to restore the connectivity of the River Don and for the individual project work at Ward End weir and at Beeley Wood weir. Out of the many individuals and groups consulted the Agency received two notifications of concern about the proposed work at Beeley Wood weir which were subsequently addressed during a site visit.

Case Study 2: Upper River Don Weirs (continued)

Ward End Weir Removal

Ward End Weir (**Plate 26**) was assessed to comprise a late eighteenth century rebuild of an earlier weir serving two forges, neither of which survives (Nexus Heritage 2015). The weir was associated with a heavily modified sluice at the point of the historic head race to Club Mill, although no other remaining associated water management features were identified. The weir, and its surrounding setting, was assessed to be of local importance, compromised by poor survival.

Plate 26: Ward End Weir before works

There was no active management in place on the structure and, as with many historic weirs, the current ownership was unknown. Substantial damage had occurred to one of its bays which put the survival of the remaining structure at risk of collapse.

It was assessed by the EA that the best solution, in consideration of cost, environmental benefits, and the significance of the affected historic weir, that partial removal would be the best option with consolidation of the remaining structure as a ruin. The works would also have additional benefits to reduction in flood risk, achievement of WFD objections, and increase in amenity for anglers and canoeists.

To mitigate the effect to the historic environment from its partial loss, a programme of archaeological recording was proposed to record the structure during works. The subsequent EA funded archaeological watching brief (ArcHeritage 2015) recorded details of the form and construction of the weir indicating it comprised a large supporting timber frame resting upon a sloped gravel base, built upon with sandstone blocks secured with metal straps.

Discussion

The proposed works along the Don, and those undertaken at Ward End Weir, reflect the process of assessment and consultation undertaken by the Environment Agency in approaching works affecting historic weirs.

The partial retention of Ward End Weir is seen to have allowed the preservation of part of its fabric which would otherwise have been left to deteriorate, and ultimately collapse. The loss of two-thirds of the structure and the absence of water flow over the remaining section has, however, affected the interpretability of its function (see **Plate 30**). The low number of heritage interest groups forming part of the consultation in this project also raises the question of whether the proposals would have been different if local heritage/history groups had responded (such as the South Yorkshire Industrial History Society).

This project illustrates the sensitive balance required in weighing the effect of impact on significance of historic structures and highlights the need for a retrospective assessment of the perceived success of the works to inform future works where similar measures are proposed.

Case Study 3: Environmental Programme

Introduction

A wide range of activities have been supported by the Environment Agency through its Environment Programme (Environment Agency 2014, 16). The proposed activities often offered opportunities that benefited water environment, WFD objectives and flood risk management. The following examples are illustrative of these works.

Plate 27: Weir on the River Dearne, north of Darfield Bridge prior to creation of rock ramp.

Background

Fish easement within the Dearne Valley was undertaken involving the modification of a twentieth century weir north of Darfield and its replacement with a rock ramp (**Plates 27-28**). This work was undertaken in partnership between the EA the Darfield Community Association, Barnsley MBC, Barnsley Development Agency, Villages 4 Community Partnership and Houghton Main Angling Club. The works were informed by a heritage assessment produced by the EA which identified the weir was of late origin and low interest, and consultation with SYAS identified potential for archaeological remains to be encountered during the construction of an adjacent path.

Plate 28: Site of the weir on the River Dearne, following creation of rock ramp in 2010.

Habitat recreation and restoration works include the enhancement of 1 ha of Environment Agency owned wet grassland in the River Idle Washlands SSSI, including scrape creation and reseeding. In this a high potential for archaeological remains was identified during consultation, which had not been fully appreciated during scoping. The project was re-designed, limiting the final scale of works but allowing for an archaeological watching brief that led to the identification and recording of a Roman coin hoard and ritual site.

Discussion

These projects highlight how environmental works can affect both in channel built heritage and archaeological remains within adjacent land. They also illustrate how early assessment and consultation with local planning archaeologists can allow potential heritage constraints to be planned in, and how greater understanding of the linkages of built heritage and natural heritage within river settings would lead to the identification of measures that benefit both, adding quality through existing funding streams.

4. Heritage Impacts

4.1 Introduction

4.1.1 There are considered to be a number of potential impacts to the historic environment from works proposed within the River Basin Management Plans (RBMPs). This chapter aims to first broadly identify the location and range of impacts associated with management proposals and measures, and then goes on to discuss the potential effects from these impacts in relation to historic water management assets identified in Chapter 2.

4.2 River Basin Management Plan Measures

4.2.1 The second-cycle draft reports for each management catchment area within the study area provide some general and specific details in regards to proposed measures to be undertaken within the Humber River Basin over the following 5 year cycle. These measures have been summarised by water body in **Appendix 1** (**Table 3**) alongside any specific actions (Environment Agency 2009a) recorded (including the mitigation targets detailed for each artificial or heavily modified water body (A/HMWB) (Environment Agency 2009b) in the first-cycle RBMP and a summary of known WFD driven mitigation that has so far been undertaken.

4.2.2 In comparing the target mitigation measures identified in the first-cycle RBMP with those measures known to have been actually undertaken it is evident that the target measures and actual measures do not match. This is a reflection both of the fact that some measures have yet to be undertaken, and of opportunistic measures that have been undertaken but were not targeted during the first-cycle of the RBMP. Furthermore, for each River Basin there are a number of more generalised actions, such as 'remove obsolete structures', under which these actions can be seen to conform to the overall strategy for improvement. This is anticipated to be similarly true of the final measures that are proposed as part of the finished second-cycle RBMP.

4.2.3 It is, however, worthwhile identifying the broad measures identified in the draft RBMP to provide a context for the discussion of potential impacts that may arise to historic water management assets over the following cycle.

4.2.4 The range of measures proposed as part of the second-cycle RBMP is detailed in **Appendix 1** (**Table 4**), along with a summary of potential impacts these measures could have and the broad range of historic water management assets that each measure could potentially affect.

4.3 Impacts

4.3.1 Comparison of the likely impacts arising from the proposed and completed measures undertaken as part of the WFD objectives provides a baseline for the assessment of more specific effects from these activities to particular historic water management assets.

River Restoration and Fish Passage

4.3.2 It is considered that one of the principal effects of measures proposed in the RBMPs will be impacts to in-river water management assets, specifically weirs. Weirs represent a considerable focus for WFD measures due to their impact on ecology and geomorphology. The same also applies to navigation weirs associated with the canal network. The northern British rivers, of which the River Don is one, have been identified by the EA as important to the future of Atlantic Salmon and other fish populations. Declining feeding grounds in southern UK waters, and the more widespread effects of climate change, make the northern river important habitat for this species.

4.3.3 Works to weirs are considered to be very sensitive in terms of heritage owing to their prominence, their significance to the water power process, and the likely concentration of other associated historic features around them including sluices, leats and mill buildings.

4.3.4 Improvement of fish passage is generally seen as a viable measure within the majority of artificial and heavily modified water bodies within the study area, and therefore is proposed as mitigation in achieving good ecological potential. In total 42 of the 72 water bodies within the study area were identified as requiring removal or easement of barriers to fish migration in the first-cycle RBMPs. This resulted in 9 fish pass installations in the study area, and this measure is being carried forward into the second-cycle of RBMPs with fish passage identified as a priority along much of the Rivers Don, Ewden Beck, Little Don, Loxley, Rother, Strines Dyke and Reservoir, Went and parts of the Dearne.

4.3.5 Fish passage is achieved through a number of routes, namely:

- Removal of obstacle;
- Reduction in width or height of obstacle;
- Installation of fish pass in obstacle;
- Creating a channel to by-pass the obstacle

Removal

4.3.6 Removal has been undertaken in the Study Area on Ewden Beck where the weir was of a late date and of no heritage interest. Removal of weirs is the optimum solution in terms of achieving unobstructed passage for fish migration and restoring natural geomorphological processes. It also has other location dependant benefits, including reconnecting habitats and returning the channel to a more natural state which, in up river locations, improves the quality of the riverbed for spawning. Removal of a weir is not always practicable for a number of reasons, including:

- Value to stakeholders (including its heritage significance);
- Active function (including flow gauging, navigation and flood risk management);
- Engineering reasons (including the effect of changes to flow rate and depth from weir removal to the stability of structures alongside the river); and
- Economic reasons.

4.3.7 The condition of the weir and the degree of active management are considerations, and in instances where there is substantial existing damage (**Plates 29-31**) then removal, or replacement, may form the most cost effective strategy in achieving WFD objectives. In the majority of circumstances full removal is not undertaken, due principally to their active function and value to stakeholders.

4.3.8 The removal of historic weirs results in the substantial loss of any heritage value it possessed, and can have wider setting effects to any associated water power site as well as the historic character of the area. These impacts are typically mitigated through a process of archaeological recording of built fabric and potential buried remains and through interpretation. This can preserve some of the structures evidential and illustrative historical values, but cannot fully mitigate the loss.

Partial Removal

4.3.9 Partial removal has been completed at Ward End Weir (**Plate 29-31**, see also **Case Study 2**) where approximately two-thirds of the length of the weir was removed whilst the remainder was consolidated for preservation. This was undertaken under archaeological supervision, allowing important evidence on the construction of the weir to be recorded (ArcHeritage 2015). This method was considered to have a lower degree of impact than full removal, as the remaining portion would preserve part of the fabric and location of the structure where there would otherwise not be available funds to do so.

4.3.10 The partial removal of weirs essentially dewaters any remaining element as the water levels fall, leading to a visual detachment of any remaining structure from the river it was associated with. The potential impacts from partial removal are substantial in terms of the loss of heritage values to the weir itself and any associated water power components that may have drawn significance from its presence within their setting. Where partial removal is able to maintain the interpretability of the function of the weir, possibly through maintaining it in water, then the preservation of its contribution to the wider area will be much higher than in total removal, and is therefore preferable.

4.3.11 Lowering weirs, or managed ruination, could potentially be a better method of preservation of character in instances where there is sufficient justification for significant impact; however this is likely to not be as satisfactory ecologically, as well as being technically more difficult and have higher cost implications. No instances of weir lowering were identified within the study area.

© Environment Agency

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Plates 29-30: Illustration of the damage at Ward End Weir

© ArcHeritage 2015

Plates 31: Ward End Weir following partial removal

Plate 32: Niagara Weir fish

Fish Passes

4.3.12 Installation of fish passes is by far the most common form of easement past obstructions. There are several forms of fish pass commonly considered, comprising:

- Pool and Weir: consists of a number of pools arranged in steps (example at Heeley Bridge, Sheffield);
- Rock Ramp: whole or part of weir is replaced with an uneven rock surface (example at Darfield and Orgreave)
- Baffled: rectangular channel formed through weir with shaped baffles within to reduce water velocity (four main types: Larinier, Plane Baffle, Alaskan and Chevron).
- Fish Lock: works on the same principle as a navigation lock
- Pre-barrage: for use at small obstructions, comprising the provision of smaller weirs downstream that allow the total height to be split into smaller leaps.

4.3.13 The form of fish pass is determined by the height of the obstacle and the range of species that will use the pass. Location of the passes is based on where fish naturally gather before the obstacle and on where would create the best attractant flow.

4.3.14 In terms of materials, fish passes can be constructed from whichever material is deemed sympathetic to the existing structure. Typically concrete is chosen for durability (**Plate 32**), which can be textured and coloured as at Hadfield Weir (**Plate 33**). This material allows the structure to be distinguished as a later insertion, therefore facilitating interpretation and in Castleford the material was preferred by the local planning authority as it provided a degree of visual separation. In other instances such as at Burley Mill Weir on the River Aire in Kirstall (**Plate 34**) the structures were stone clad to reference the surrounding historic materials so to complement the surrounding treatment of the historic built form.

4.3.15 The potential impact from a fish pass varies considerably based on size and type, with the common baffled-type pass possessing one of the lowest impacts in terms of footprints, whilst the impact from rock ramp and pool and weir passes is generally higher. Removable fish passes do exist, however they are typically short term solutions as they are more likely to become damaged through impact from debris during flooding. Fish pass insertion has an impact to the evidential value of the weir and any associated buried remains, although any impact is generally localised and can be mitigated through archaeological monitoring. The greater impact is considered to be to its illustrative historical and aesthetic values through the potential creation of a modern, conspicuous, structure which detracts from the interpretability of the weir in terms of its function and connection with associated wider historic environment. This impact would be at its highest where the pass impacts any associated weir-side structures such as sluices or leat entrances. This impact is often mitigated through design, in terms of materials, improved public access and interpretation.

© Don Catchment River Trust

© Aire River Trust

Plates 33-34: Fish passes installed Hadfield Weir (left) and at Burley Mill Weir (right)

Fish By-Pass Channels

4.3.16 Another option for fish passage is by-passing the obstruction. Selection of this option is often constrained by the availability of suitable adjacent land which can be an issue in built-up areas. Two main options generally appear to be considered for by-passing obstructions, including the creation of fish pass similar to those identified above but to the side of the weir; and the creation of a longer, sometimes meandering, channels that also provides habitat.

4.3.17 An example of the former is at Sprotbrough (**Plate 35**; **Case Study 4**), a navigation weir on the River Don to the west of Doncaster. The weir here had originally been constructed to serve two mills to either side of the river, and had been retained with the navigation of the Don, bypassed to via a lock through a separate cutting to the north. Bypass channels have the potential to affect archaeological remains adjacent to the river; however such potential effects may on occasion be preferable to directly impacting the weir itself.

Plate 35: Sprotbrough Weir fish and eel pass

Plate 37: One of the weirs bypassed by the Millhouses Park fish bypass channel

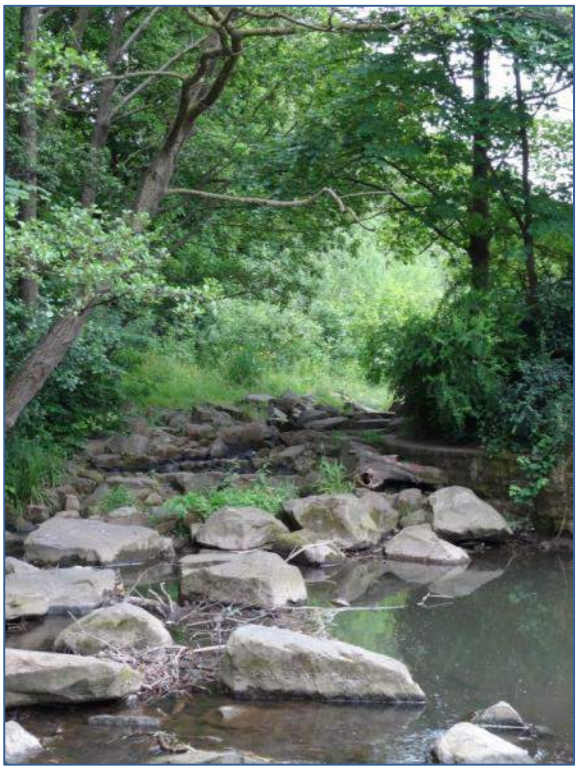

Plate 36: Millhouses Park fish bypass channel

4.3.18 The other main method of by-passing weirs is the creation of a more circuitous channel that avoids the structure entirely (see **Case Study 5**). Within South Yorkshire such a channel was created in Millhouses Park, where it reused an earlier 1950s lido which had gone out of use. The by-pass channel forms a series of relatively low stepped pools formed between rocks taking water from above of one weir and returning to the River Sheaf to the side of a second (**Plates 36-37**). A further channel was constructed around Crimpsall Sluice, near to Doncaster, which utilised a former meander of the Don and formed a long rock ramp creating pools and channels.

4.3.19 By-pass channels are often preferred over in-channel works due to the degree of risk associated deriving from the difficulty of establishing the ground conditions, and the conditions of historic structures, prior to the commencement of works.

4.3.20 The potential impacts arising from these forms of fish easement principally comprise the impact to buried remains to the side of the weir. This, as at Sprotbrough, could include structures of archaeological importance including mill buildings and associated water management assets. The method does, however, avoid direct impact to the weir itself, and would be a good option where such an impact would be less desirable. The potential impact to archaeological remains could be assessed at design stage to determine its potential magnitude in comparison to the impact to weir itself, and appropriate mitigation undertaken to secure preservation through record.

River Channel Improvements

4.3.21 Beyond fish passage, the other principal potential impacts to historic water management assets from the measures proposed as part of the RBMPs are those associated with improvement to condition of channel/bed and/or banks and improvements to conditions of riparian zone/ wetland habitats.

4.3.22 In total 31 of the 72 water bodies within the study area were identified as requiring improvements to the river channel in the first-cycle RBMPs. This resulted in four known actions within the study area over the last 5 years comprising improved wetlands at Houghton Washlands and Idle Washlands SSSI near Bawtry (both involving groundworks), and two sections of deculverting on the Porter Brook (**Plate 38**). Within the second-cycle of RBMPs several priority water bodies have been identified for deculverting/daylighting, comprising areas of the Went, and at points on the Sheaf and Porter.

Plate 38: Section of the Porter showing extent of canalisation

Deculverting and Decanalising

4.3.23 Beyond the works identified in the second-cycle draft RBMPs, a significant focus for river channel improvement is the urban areas of Sheffield, Doncaster, Barnsley and Rotherham. Rivers as they pass through these settlements have typically been heavily canalised with flood walls and occasionally engineered river beds which leads to poor ecological status. Within these regions the opening up of rivers in order to establish more natural channels and develop them as a focus of local communities is a feature of specific local plans which draw on WFD to provide impetus and promote good ecological practice. Specific plans in the area comprise Sheffield's *City of Rivers* (2014) and Rotherham's *New Life for Rotherham's Rivers and Waterways* (2009).

4.3.24 The preliminary driver for these measures is often the enhancement of ecological condition, but they also have much further ranging benefits, including the enhancement of the historic environment. Whilst undertaken for flood alleviation work, the Nursery Street pocket park in Sheffield is a good example of this. The project improved the riverbank and provided flood water storage but also improved the setting of a Conservation Area, and several Listed Buildings. The scheme also required archaeological work (ARCUS 2008 and Wessex Archaeology 2010 and 2012) which ultimately led to the preservation of the remains of a cementation furnace within the eastern half of the site (**Plate 39**).

4.3.25 The culverting of rivers through the cities was often a product of gradual urban encroachment as pressure for space intensified. In many places the structure forming the culvert is likely to be of archaeological interest in understanding this process, whilst in rarer occasions the culvert structure itself may also be of significant architectural, such as the tunnels where the Sheaf passes under Sheffield Station, often referred to as the Megatron (**Plate 40**). The planned deculverting of the confluence of the Sheaf and the Don may have an impact on part of this structure.

4.3.26 The potential impact arising from these measures derives from the impact they have on extant heritage assets represented by the river walls, bridges and culverts that contain the river and the potential for buried remains to survive behind them or encapsulated within them.

Plate 39: Nursery St pocket park, the River Don in Sheffield

Plate 40: The River Sheaf as it passes beneath Sheffield Station

Flood Plain Connectivity and Wetland Creation

4.3.27 Work to river channels outside of urban areas has involved actions to improve flood plain connectivity, and the quality of wetland habitat. The potential impacts arising from these works typically go beyond the impact to historic water management assets to include potential buried remains of all periods.

4.3.28 Reconnecting flood plains at Houghton Washlands and Idle Washlands was principally driven by the Nature Improvement Area partnerships, restoring natural features and inundating grassland create improved wetland habitats. Similar impacts may also arise from other environmental projects aiming to reintroduce meanders into artificially straight sections of the Dearne at Rabbit Ings and Knoll Beck. In general these improvements do not impact historic water management assets, however there is potential for them to impact other archaeological remains either directly or through changing the environmental conditions through flooding.

4.3.29 Specific measures within the RBMPs include works along the Rivers Sheaf, Went and Skell which aim to undertake alterations to existing flood banks to remove hard revetments and set back the embankments allowing for a more natural riparian environment. Whilst these works have potential to impact buried archaeological remains in a similar way to the above improvements, there is the added potential that they may have an impact upon historical flood defence structures.

Case Study 4: Sprotbrough Weir Fish Pass

Plate 41: 1854 Ordnance Survey 6 inch map

Introduction

In 2014 a fish pass was constructed at Sprotbrough, bypassing the weir on the south bank. The project involved a programme of archaeological assessment and mitigation and was a collaboration of the Environment Agency, Canal and River Trust and other partners.

One of the overarching aims of the Humber RBMP was the return of sustainable populations of migratory fish to the region. And fish passage is now a key action on the wider Middle Don Operational Catchment in the draft second-cycle RBMP (see **Case Study 2**).

Background

The old mill at Sprotbrough is known to have existed by the sixteenth century and may have medieval origins. Both the mill and the weir were depicted in around 1705, indicating the existence of a weir on this site from at least this period. The extant weir follows an oblique, gently curving line across the river comprising, in profile, an initial straight drop onto a steeply pitched apron. Interestingly the weir is sited to provide no advantage in directing flows to either of the known associated mill sites suggesting its location predates significant channel modifications (possibly associated with the Sheffield and South Yorkshire Navigation).

An archaeological desk-based assessment was undertaken in 2009 identifying the potential for the fish pass to impact the buried remains of a former mill. Archaeological mitigation was secured through a condition for archaeological investigation placed on the application for the access track. A programme of recording was then undertaken prior to the fish pass works and an interpretative board has since been erected.

Discussion

Whilst heritage mitigation was undertaken during development, there is considered to have been a failure during the course of the project process in not weighing the potential impact to the archaeological remains of the mill against the alternative of placing the pass through the historic weir structure. This arose from problems in identifying issues during communication between developer, their archaeological supplier and planners. A clearer understanding of the questions developers need to ask of their archaeological suppliers and guidance on weighing impacts between related water management assets in both extant and buried form would assist in avoiding these issues in future.

Plates 42-43: Sprotbrough Weir (left) and the fish pass (right)

Case Study 5: Weir By-Pass Channels

Introduction

The creation of fish by-pass channels around weirs enables the preservation of the weir as well as enabling opportunities for significant habitat improvements beyond what is possible through any on-weir fish pass design.

Background

There are several significant factors in the viability of a by-pass scheme, principal among them the availability of suitable land to the side of the weir. The constraints of many sites in urban locations would likely make such schemes unviable. The second-most factor is hydraulic factors. Establishing a strong enough flow from the channel to attract fish to the entrance, whilst keeping water in the channel of a depth and speed to enable fish to traverse it.

The construction of a bypass channel at Rodley Weir on the River Aire near Leeds was selected by Yorkshire Water as one of their first sites to trial tackling the barriers faced by returning the rivers in the county to good ecological potential. The project was constrained by not being able to work directly on the weir owing to ownership, and by the presence of a high voltage transmission line.

The resulting design incorporated backwater habitats and the provision of access for maintenance as well as dipping pond and hides for Rodley Nature Reserve (**Plates 44-45**).

A technically very similar scheme was also undertaken in Millhouses Park in Sheffield, within the footprint of a former 1950s lido (**Plate 46**), whilst a further example is that at Crimpsall Sluice in Doncaster.

Plate 44: Rodley Weir bypass channel

Plate 45: ARUPs Plan for Rodley Weir bypass channel

Plate 46: Millhouses Park fish bypass channel

Discussion

Whilst the benefits to both natural and built heritage of such schemes are high, their viability is dependant on the physical constraints of sites. In addition, as illustrated in Case Study 4, there is also potential for archaeological remains to be present within the site of the bypass which will need weighing against the other risks and benefits of the scheme.

5. Discussion

5.1 Summary of Key Points

5.1.1 During the process of this assessment several key themes have been identified in respect to how historic water management assets are currently addressed within the context of WFD activities, comprising:

- Identification of Historic Water Management Assets
- Guidance for Developers and Heritage Consultants
- Designation of Historic Water Management Assets
- Collaboration

Identification

5.1.2 The identification of heritage assets is critical to facilitate the early consideration of important water management assets when scoping and designing potential WFD measures. This study recognises two principal stages of assessment for WFD measures where improved identification of historic water management assets would be beneficial.

5.1.3 The first comprises the initial feasibility assessment by the EA in the preparation of the River Basin Management Plans as to the potential impact to heritage from required measures to achieve target ecological status, and whether the impact could be mitigated. The Environment Agency's archaeologists (as part of the National Environmental Assessment Service or NEAS) are involved in this screening process. This initial assessment is achieved through the following:

- Identifying the presence or absence of designated heritage assets within the proposal area;
- Consultation with internal Archaeological Officers; and
- Identifying whether the proposed activity is likely to have an impact on buried archaeological remains and therefore whether any further heritage assessment is required.

5.1.4 The general low number of water management assets that have been designated has hindered appreciation of the actual constraints at these early stages where they would be best identified so to fully accommodate them within the projects.

5.1.5 The second stage of assessment is during the detailed design of the individual activity by the commissioning party. This can be initiated through the Environment Agency directly, through other stakeholders such as water suppliers or by other developers in response to planning conditions. This secondary assessment is achieved through the following:

- Consultation with the Local Planning Authority;
- Consultation with Historic England;
- Potentially consultation with environmental consultants; and
- Within the EA, consultation can also be undertaken on detail designs with the NEAS archaeologists.

5.1.6 The outcome from the second stage of assessment is the identification of specific constraints relating to both designated and non-designated heritage assets, some of which may be a material constraint on the design of the scheme.

5.1.7 The extent to which important heritage constraints have been identified at the appropriate stage of planning WFD measures has been of mixed success. In relation to measures undertaken within South Yorkshire, the implications of this were evident in the River Idle Washlands (**Case Study 3**), and Sprotbrough Weir (**Case Study 4**). In these instances the extent to which heritage would be a constraint on the project was greater than anticipated at the project design stage, leading to significant changes to the final design. There is not considered to be a single reason for these problems, but rather the result of a combination of one or more of the following:

- Consultation not having occurred at the appropriate time;
- The right questions not having been asked of those providing heritage advice by developers and planners; and
- The lack of guidance for those providing heritage advice in assessing impacts.

5.1.8 Two measures that would improve identification of heritage constraints would be the development of heritage asset guidance for water management assets, and increased capture of the most significant water management assets through national and local designation, and record in the appropriate Historic Environment Record.

Guidance

5.1.9 There is a clear requirement to expand guidance for the design of WFD measures and other river based environmental improvement projects with regard to implications for the sustainable management of the historic environment. The failings described above are likely to be illustrative of a learning curve in the identification and assessment of heritage assets alongside ecological constraints since the production of the first-cycle River Basin Management Plans in 2009. As such it would be anticipated that these plans will improve with experience with dealing with heritage assets; it also highlights the need to build on lessons learnt through the production and improvement of guidance.

5.1.10 Primarily, the significance of water management assets has previously received little attention within Historic England guidance documents. Where water management systems are mentioned as components of related structures (such as mills, settlements, industrial sites and utilities) they are not discussed sufficiently to understand what makes them significant and what their contribution is to the principal feature that they serve. It is recommended that future revisions of this guidance should take the opportunity to expand on entries for related structures, and that new guidance specifically for water management assets could be considered. These documents principally aid the heritage professional by providing a baseline for the identification of heritage assets and assessments of their values in providing advice to developers.

5.1.11 Understanding what makes the asset important is also crucial in developing appropriate designs and mitigation strategies for WFD measures. Works affecting assets of particular heritage significance can then be designed with an eye to lower impact solutions which consider both what makes the asset important (in terms of its intrinsic values) and the significance of associated features around it.

5.1.12 Secondly, closer collaboration between Historic England, the Environment Agency and Local Authorities is needed to form guidance on how to take account of heritage in planning and designing river improvement activities. It would be essential in producing any guidance that its existence is made clear to those who would most benefit from using it.

5.1.13 This could take the form of workshops to train Environment Agency staff in assessing the values and impacts of proposals to heritage to ensure their consideration at appropriate points, to provide guidance on what questions they should be asking of planners and archaeological suppliers, and when to seek advice from Historic England or local authority archaeologists. It is anticipated that the greatest value for any such work would be gained through working with the Environment Agency, who through their legislative powers are considered to set the standard for the industry.

Designation

5.1.14 The impetus for river enhancement activity on the back of the RBMPs is revealing a need for a more strategic approach to protection for historic water management assets. Water management assets not only form an interdependent string of features within their own water management system within a specific reach of a river, but are also more widely linked with other reaches and water management systems along their water body. Due to this interconnectedness, it is important that historic water management assets are considered in terms of linear group value in order to appreciate the significance of its part within the overall function of the system, but also to understand how change could affect the heritage values of its local and wider system.

5.1.15 It is recognised that designations at present do not sufficiently capture all of the most important historic water management assets in the region. Whilst a comprehensive study would be required to rectify this, the first stage should be consideration for enhancement of existing Listed or Scheduled waterpower sites.

5.1.16 Little Matlock Wheel Scheduled Monument and Wortley Top Forge are considered to be examples of good designation (NHLE 1019857 and 1018262) with the scheduling boundaries extending to include the mills and full water management systems which are also fully described in the designation text. At Abbeydale Works on the other hand, which is Scheduled (NHLE: 1004822) and includes a Grade I Listed Building (NHLE: 1246418) neither the head race or weir are included within the scheduled area or individually recognised through Listing, nor described in the designation text.

5.1.17 At other sites where the mill/works are considered of sufficient significance to merit designation then it is considered that there is likely a strong case for including associated extant water management structures under group value. This would preserve the evidential and historical value of the heritage assets intrinsic link to the river. Similarly, it is considered that there is also a strong argument for the designation of navigation weirs for group value where their associated lock is already listed. At the very least the designations of the parent site should include a description of the survival and contribution of their associated water management systems due to the significant associative and illustrative value in understanding how these sites operated.

5.1.18 Additionally, any further designation should aim to improve the representative sample of rural sites. For instance, of the 12 designated water power weirs in South Yorkshire, the vast majority are either situated with Sheffield or within a Registered Park and Garden. Lower pressure from development in rural areas has resulted in greater survival of water management systems, as well as the potential for rare and unusual weir forms.

5.1.19 In areas where there are groups of strongly connected heritage assets which are considered to cumulatively have a particularly high value, then designation as a Conservation Area should be considered similar to those often formed for canals. A Conservation Area is an area of special architectural or historic interest, the character or appearance of which is desirable to preserve or enhance (Section 69 of the 1990 Planning (Listed Buildings and Conservation Area) Act). The main attributes that define the special character of an area are its physical appearance and history, i.e. the form and features of buildings and the spaces between them, their former uses and historical development.

5.1.20 There is considered to be a particularly strong case for this in Sheffield, where designation as a Conservation Area where the survival of a high density of weirs and associated infrastructure are illustrative of the internationally important metal trade that developed there. Such designation would also be of assistance in ensuring a consistent approach to design of fish passes and river channel improvements.

5.1.21 On a wider scale, the improved identification of water management assets at a more local scale of importance would benefit from enhancement of the local Historic Environment Record or Sites and Monuments Record. Historic Landscape Characterisation projects are another potential area of enhancement as they have traditionally not identified rivers as character areas in their own right, leading to the under representation of the rivers themselves and their associated history of use within the record.

Collaboration

5.1.22 The importance of working with groups involved in planning and implementing river improvement measures cannot be overstated – it is judged to be absolutely essential to the preservation and enhancement of heritage within and alongside rivers.

5.1.23 The catchment based approach launched by Defra (Defra 2013) has resulted in the formation of Catchment Partnerships, in each management catchment, which are working with local stakeholders to form a vision and plan for the future of rivers. Based on a review of the published list of stakeholders for the Don Catchment, the group is commonly formed by stakeholders from background of natural heritage and recreational use of rivers, and there appears to have relatively little involvement from heritage interest groups. As a consequence historic water management assets such as weirs are generally seen as obstacles to returning the river to a more naturalised form rather than as opportunities for adding value. It is considered that greater engagement needs to be encouraged amongst relevant heritage groups, such as (in the South Yorkshire region) the South Yorkshire Industrial History Society and local history groups.

5.2 Conclusion

5.2.1 Historic water management assets within South Yorkshire cover a broad range of dates and activities and are of considerable importance in illustrating the historical development of the region. The Water Framework Directive is driving change along river corridors, in areas that have seen relatively little change in the recent past, which is both a risk and an opportunity for the historic environment. Collaboration with the organisations overseeing and undertaking these changes presents not only the best chance of achieving the long term survival of important assets, but also the opportunity to promote high quality projects that will lead to the best results for both natural and built heritage. This will be best achieved through developing links with the organisations involved, such as the Environment Agency and Catchment Partnerships.

5.2.2 The route to ensuring success is through improved engagement with those organisations, but also through the enhancement of the available guidance and advice to enable both the identification and assessment of heritage constraints within developments. This requires a three-fold approach:

- Primarily ensure that there is an appropriate level of guidance and advice to enable decision-makers to identify historic water management assets as heritage assets and to give their significance appropriate weight in management decisions and measures.
- Secondly heritage designations need to be reviewed to capture water management assets of high significance, and to enhance designation descriptions

of existing assets that draw significance from their association with water to make appropriate mention of that relationship.

- Thirdly there is a need to improve and promote appreciation of rivers as historic landscapes which posses significant groups of heritage assets whose influence extends beyond the river banks. This last point will enable historic water management assets to be better understood in terms of their relationship within a system, and will better reveal the links between communities and the heritage of their rivers, improving engagement and appreciation which will contribute to key regeneration targets in both urban and rural areas.

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Appendix 1: WFD Mitigation

Table 3: Table detailing the known completed and proposed WFD measures

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
Aire and Calder									
Owler Beck from Source to River Calder			Y	Y		Y		Y	
Derwent Derbyshire									
Derwent from R Westend to R Wye					Y		Y		
Derwent from Source to R Westend									
Derwent Upper Reservoir									
Howden Reservoir									
Westend from Source to R Derwent									
Don and Rother									
Agden Reservoir			Y						
Bentley Mill Stream	water company actions to address continuous and intermittent discharges		Y	Y	Y	Y			
Blackburn Brook from Source to River Don	removal of obsolete structure		Y	Y		Y		Y	
Blowell Drain from Source to the Went									
Bramwith Drain from Source to River Don									
Broadstone Reservoir			Y						
Broomhead Reservoir		Fish passage	Y						
Car Brook from Source to River Don			Y	Y		Y	Y	Y	
Cawthorne Dyke from Source to River Dearne									
Cudworth Dyke from Source to River Dearne	water company actions to address continuous and intermittent discharges	Installed drainage and traps to reduce sediment and industrial							

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
		pollutants							
Dale Dike Reservoir			Y						
Dearne Darfield STW to River Don	water company actions to address continuous and intermittent discharges	Fish pass at Adwick Guaging Weir. Eel pass on Bolton upon Dearne weir.	Y						
Dearne from Bentley Brook to Cawthorne Dyke	water company actions to address continuous and intermittent discharges		Y		Y	Y	Y		
Dearne from Cawthorne Dyke to Lundwood STW	water company actions to address continuous and intermittent discharges								
Dearne from Lundwood to River Dove	water company actions to address continuous and intermittent discharges; fish passage (removal of weir near Houghton)	Lowering of 1970s flood bank to allow flooding of Houghton Washlands Removal of Darfield Weir							
Dearne from Source to Bentley Brook	water company actions to address continuous and intermittent discharges		Y	Y		Y		Y	
Dodworth Dyke from Source to River Dove									
Don from Little Don to River Loxley confluence	fish passage	Partial removal of Ward End Weir							
Don from Mill Dyke to River Ouse	fish passage								
Don from River Dearne to Mill Dyke	fish passage	Fish pass at Sprotbrough Weir							
Don from River Don Works to River Rother	fish passage	Fish pass at Hadfield Weir							
Don from River Loxley confl to River Don Works	fish passage								
Don from River Rother to River Dearne	fish passage								
Don from Scout Dyke to the Little	fish passage		Y	Y	Y	Y	Y	Y	

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
Don									
Don from Source to Scout Dyke	fish passage		Y	Y	Y	Y	Y	Y	
Dove from Source to River Dearne						Y		Y	
Ea Beck from Frickley Beck to the Skell	water company actions to address continuous and intermittent discharges; agricultural diffuse pollution awareness and interventions		Y	Y		Y			
Ea Beck from Source to Frickley Beck	water company actions to address continuous and intermittent discharges; agricultural diffuse pollution awareness and interventions								
Ea Beck from the Skell to River Don	water company actions to address continuous and intermittent discharges; agricultural diffuse pollution awareness and interventions								
Ewden Beck from Source to River Don	fish passage		Y		Y	Y	Y		
Frickley Beck from Source to Ea Beck									
Greasbrough Dike from Source to River Don					Y	Y			
Grimethorpe Dike from Source to River Dearne									
Harden Reservoir			Y						
Hooton Brook from Source to River Don									
Ingbirchworth Reservoir			Y						
Ings/Carr/Thurnscoe Dikes from Source to Dearne									
Kearsley Bk									
Knoll Beck from Source to River				Y		Y		Y	

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
Dearne									
Langsett Reservoir			Y						
Little Don from Source to River Don	fish passage		Y	Y	Y	Y		Y	
Loxley from Source to Strines Dyke	fish passage		Y		Y	Y	Y		
Loxley from Strines Dyke to River Don			Y		Y	Y	Y		
Midhope Reservoir									
New Fleet Drain from source to R Went						Y			
Pigeon Bridge Brook from Source to River Rother									
Porter from Source to River Sheaf	Deculverting and daylighting	Two stretches deculverted				Y			
Redmires Reservoirs			Y						
Rivelin Dams			Y						
Rivelin from Source to River Loxley			Y		Y	Y			
Rockley Dike from Source to River Dove			Y	Y	Y	Y	Y	Y	
Rother, Doe Lea to Don	fish passage; improvements to continuous water company discharges			Y		Y			
Royd Moor Reservoir			Y						
Scout Dyke from Source to River Don			Y	Y	Y	Y	Y		
Sheaf from Source to River Don	Deculverting and daylighting	Removal of weir and insertion of fish pass at Heeley in 2011 Bypass channel at Millhouses Park in 2010.	Y	Y	Y	Y			
Shire Brook									
Silkstone Beck from Source to Cawthorne Dyke									
Snailsden Reservoir			Y						
Sprotbrough Flash									

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
Strines Dyke from Source to River Loxley	fish passage		Y		Y	Y	Y		
Strines Reservoir	fish passage		Y						
The Moss from Source to River Rother									
The Skell from Source to Ea Beck	Fish passage; obsolete structure removal; deculverting		Y		Y	Y			
Ulley Brook from Source to River Rother									
Went from Blowell Drain to the River Don	Fish passage; obsolete structure removal; deculverting; water company actions to address continuous and intermittent discharges; agricultural diffuse pollution awareness and interventions		Y	Y	Y	Y		Y	
Went from Hoyle Mill Stream to Blowell Drain	Fish passage; obsolete structure removal; deculverting; water company actions to address continuous and intermittent discharges; agricultural diffuse pollution awareness and interventions		Y	Y		Y			
Windleden Reservoir - Lower			Y						
Windleden Reservoir - Upper			Y						
Winscar Reservoir			Y						
Idle and Torne									
Anston Brook from Source to River Ryton									
Broad Bridge Dyke (to Canal)									
Hatfield Waste Dr (trib of Torne/Three Rivs)					Y	Y			
Mother Drain from Source to R Torne									

WFD Water Body	Draft Second-Cycle RBMP Measures Proposed	Known Measures Undertaken To Date	First-Cycle RBMP Mitigation Targets and Other Specific Actions						
			Removal or easement of barriers to fish migration	Removal or modification of engineering structure	Improvement to condition of channel/bed and/or banks	Improvement to condition of riparian zone /wetland habitats	Dredging and silt management	improve flood plain connectivity	Reduce point/diffuse source pollution at source /pathways
North Soak Drain (trib of R Torne / Three Rivers)			Y			Y			
Oldcotes Dyke									
Owlands Wood Dyke from Source to Hodscok Brook									
Ruddle (Paper Mill Dyke) from Source to R Torne									
Ryton (to Aniston Brook)									
Ryton from Anston Brook to Idle									
St Catherine's Well Stream from Source to R Torne						Y			
Torne / Three Rivers from Mother Dr to R Trent			Y	Y		Y			
Torne from Ruddle to St Catherine's Well St									
Torne from Source to Ruddle (Paper Mill Dyke)									Y
Torne from St Catherine's Well Strm to Mother Dr									

Table 4: Table detailing the potential impacts arising from Water Framework Directive measures to historic water management assets

Description	Potential Impacts affecting Historic Water Management Assets	Heritage Assets with Potential to Receive Effects
Improve modified physical habitats		
Removal or easement of barriers to fish migration	Impact to structures that impede flows through removal or insertion of fish passes. Impact to buried remains associated with effected structures. Effects to setting of associated structures.	Weirs, dams, archaeological remains within rivers.
Removal or modification of engineering structure	Impact to structures that modify the natural flow and sediment regime. Impact to buried remains. Effects to setting of associated structures.	Canal structures, culverts, riverside walls, bridges archaeological remains behind riverside walls
Improvement to condition of channel/bed and/or banks/shoreline	Direct physical impact to riverside walls and culverts, flood bunds and other riverside water management structures. Impact to buried remains through reengineering banks to improve flows and through creation of flood planes.	Riverside walls, archaeological remains behind riverside walls
Improvement to condition of riparian zone and /or wetland habitats	Measure unlikely to create impacts.	n/a
Vegetation management	Measure unlikely to create impacts.	n/a
Changes to operation and maintenance	Measure unlikely to create impacts.	n/a
Dredging and silt management	Impact to buried remains within river bed/bank from dredging or re-profiling to improve flows	Archaeological structures and deposits
Sustainable aggregate extraction	Measure unlikely to create additional impacts than already presented by aggregate extraction.	n/a
Sustainable marine development	Measure unlikely to create impacts.	n/a
Improve and manage the natural flow and level of water		
Control pattern/timing of abstraction	Measure unlikely to create impacts.	n/a

Description	Potential Impacts affecting Historic Water Management Assets	Heritage Assets with Potential to Receive Effects
Improvement to condition of channel/bed and/or banks/shoreline	Direct physical impact to riverside walls and culverts, flood bunds and other riverside water management structures. Impact to buried remains through reengineering banks to improve flows and through creation of flood planes.	Riverside walls, archaeological remains behind riverside walls
Water demand management	Measure unlikely to create impacts.	n/a
Use alternative source/relocate abstraction or discharge	Measure unlikely to create impacts.	n/a
Sustainable access and recreation management – reduce the impact of water based and terrestrial activities	Measure unlikely to create impacts.	n/a
Manage pollution from waste water / towns cities and transport / rural areas		
Reduce point/diffuse source pollution at source (all areas)	Impact to structures that are a source of pollution. Impact to buried remains within areas requiring subsurface investigation (such as investigations to uncover and rectify wrong connections) Impact to buried remains within river walls.	Utilities, archaeological remains behind riverside walls
Reduce point/diffuse source pollution pathways (i.e. control entry to the water environment) (all areas)		
Mitigate/remediate point/diffuse source impacts on receptor (all areas)		
Sustainable woodland and forestry management (rural areas)	Measure unlikely to create impacts.	n/a
Manage pollution from mines		
Mitigate/remediate point source impacts on receptor	Impact to historical mines in terms of both fabric and deposits.	Mines.
Manage non-native species		
All measures	Measure unlikely to create impacts.	n/a

Appendix 2: Legislation

Salmon and Freshwater Fisheries Act 1975

9. Duty to make and maintain fish passes.

(1) Where in any waters frequented by salmon or migratory trout—

(a) a new dam is constructed or an existing dam is raised or otherwise altered so as to create increased obstruction to the passage of salmon or migratory trout, or any other obstruction to the passage of salmon or migratory trout is created, increased or caused; or

(b) a dam which from any cause has been destroyed or taken down to the extent of one-half of its length is rebuilt or reinstated,

the owner or occupier for the time being of the dam or obstruction shall, if so required by notice given by the water authority F1. . . and within such reasonable time as may be specified in the notice, make a fish pass for salmon or migratory trout of such form and dimensions as [F2the Agency] may approve as part of the structure of, or in connection with, the dam or obstruction, and shall thereafter maintain it in an efficient state.

(2) If any such owner or occupier fails to make such a fish pass, or to maintain such a fish pass in an efficient state, he shall be guilty of an offence.

(3) The water authority may cause to be done any work required by this section to be done, and for that purpose may enter on the dam or obstruction or any land adjoining it, and may recover the expenses of doing the work in a summary manner from any person in default.

(4) Nothing in this section—

(a) shall authorise the doing of anything that may injuriously affect any public waterworks or navigable river, canal, or inland navigation, or any dock, the supply of water to which is obtained from any navigable river, canal or inland navigation, under any Act of Parliament; or

(b) shall prevent any person from removing a fish pass for the purpose of repairing or altering a dam or other obstruction, provided that the fish pass is restored to its former state of efficiency within a reasonable time; or

(c) shall apply to any alteration of a dam or other obstruction, unless—

(i) the alteration consists of a rebuilding or reinstatement of a dam or other obstruction destroyed or taken down to the extent of one-half of its length, or

(ii) the dam or obstruction as altered causes more obstruction to the passage of salmon or migratory trout than was caused by it as lawfully constructed or maintained at any previous date.

10. Power of water authority to construct and alter fish passes.

(1) Any water authority may, construct and maintain in any dam or in connection with any dam a fish pass of such form and dimensions [as it may determine], so long as no injury is done by such a fish pass to the milling power, or to the supply of water of or to any navigable river, canal or other inland navigation.

(2) Any water authority may, abolish or alter, or restore to its former state of efficiency, any existing fish pass or free gap, or substitute another fish pass or free gap, provided that no injury is done to the milling power, or to the supply of water of or to any navigable river, canal or other inland navigation.

(3) If any person injures any such new or existing fish pass, he shall pay the expenses incurred by the water authority in repairing the injury, and any such expenses may be recovered by the water authority in a summary manner.

Environment Act 1995

7. General environmental and recreational duties

(1) It shall be the duty of each of the Ministers and of the Agency, in formulating or considering—

(a) any proposals relating to any functions of the Agency other than its pollution control functions, so far as may be consistent—

(i) with the purposes of any enactment relating to the functions of the Agency,

(ii) in the case of each of the Ministers, with the objective of achieving sustainable development,

(iii) in the case of the Agency, with any guidance under section 4 above,

(iv) in the case of the Secretary of State, with his duties under section 2 of the M1Water Industry Act 1991,

so to exercise any power conferred on him or it with respect to the proposals as to further the conservation and enhancement of natural beauty and the conservation of flora, fauna and geological or physiographical features of special interest;

(b) any proposals relating to pollution control functions of the Agency, to have regard to the desirability of conserving and enhancing natural beauty and of conserving flora, fauna and geological or physiographical features of special interest;

(c) any proposal relating to any functions of the Agency—

(i) to have regard to the desirability of protecting and conserving buildings, sites and objects of archaeological, architectural, engineering or historic interest;

(ii) to take into account any effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects; and

(iii) to have regard to any effect which the proposals would have on the economic and social well-being of local communities in rural areas.

(2) Subject to subsection (1) above, it shall be the duty of each of the Ministers and of the Agency, in formulating or considering any proposals relating to any functions of the Agency—

(a) to have regard to the desirability of preserving for the public any freedom of access to areas of woodland, mountains, moor, heath, down, cliff or foreshore and other places of natural beauty;

(b) to have regard to the desirability of maintaining the availability to the public of any facility for visiting or inspecting any building, site or object of archaeological, architectural, engineering or historic interest; and

(c) to take into account any effect which the proposals would have on any such freedom of access or on the availability of any such facility.

(3) Subsections (1) and (2) above shall apply so as to impose duties on the Agency in relation to—

(a) any proposals relating to the functions of a water undertaker or sewerage undertaker,

(b) any proposals relating to the management, by the company holding an appointment as such an undertaker, of any land for the time being held by that company for any purpose whatever (whether or not connected with the carrying out of the functions of a water undertaker or sewerage undertaker), and

(c) any proposal which by virtue of section 156(7) of the **M2**Water Industry Act 1991 (disposals of protected land) falls to be treated for the purposes of section 3 of that Act as a proposal relating to the functions of a water undertaker or sewerage undertaker,

as they apply in relation to proposals relating to the Agency's own functions, other than its pollution control functions.

(4) Subject to obtaining the consent of any navigation authority, harbour authority or conservancy authority before doing anything which causes obstruction of, or other interference with, navigation which is subject to the control of that authority, it shall be the duty of the Agency to take such steps as are—

(a)reasonably practicable, and

(b)consistent with the purposes of the enactments relating to the functions of the Agency,

for securing, so long as the Agency has rights to the use of water or land associated with water, that those rights are exercised so as to ensure that the water or land is made available for recreational purposes and is so made available in the best manner.

(5) It shall be the duty of the Agency, in determining what steps to take in performance of any duty imposed by virtue of subsection (4) above, to take into account the needs of persons who are chronically sick or disabled.

(6) Nothing in this section, the following provisions of this Act or the 1991 Act shall require recreational facilities made available by the Agency to be made available free of charge.

(7) In this section—

"building" includes structure;

"pollution control functions", in relation to the Agency, has the same meaning as in section 5 above.

Eel Regulations 2009

14. Eel passes

(1) This regulation applies where the Agency determines that the passage of eels is impeded or likely to be impeded by—

(a) a dam or obstruction in or near waters to which these Regulations apply;

(b) any works notified to the Agency under regulation 12; or

(c) any obstruction notified to the Agency under regulation 13.

(2) The Agency may, by service of a notice, require a responsible person, at their own cost, to—

(a) construct an eel pass;

(b) make alterations to an existing eel or fish pass;

(c) operate an existing eel pass in accordance with any conditions stated in the notice;

(d) remove an obstruction; or

(e) take any other action specified in the notice.

(3) The notice—

(a) may not require anything that interferes with any statutory right of navigation;

(b) may require the responsible person to submit plans for an eel pass or for alterations to an existing eel pass or fish pass to the Agency for approval;

(c) must give the date by which such plans must be submitted;

(d) may require the construction of an eel pass, or alterations to an existing eel or fish pass, to be carried out in accordance with plans approved by the Agency.

(4) The Agency may, by service of a further notice, require the responsible person—

(a) to operate any eel pass constructed or altered, or any fish pass altered, under this

regulation in accordance with any conditions stated in the notice;

(b) to make any alterations to an eel pass constructed or altered or to any fish pass altered under this regulation.

(5) Failure to comply with a notice served under paragraph (2) or (4) is an offence.