Don Catchment Rivers Trust

River Loxley: Fish Passage Scoping Study

Options Report

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1 Introduction

Arup has been commissioned by the Don Catchment Rivers Trust to undertake a feasibility study for 7 barriers to fish migration on the River Loxley between Hillsborough Weir and Loxley Old Wheel Weir. The sites are shown in Figure 1.

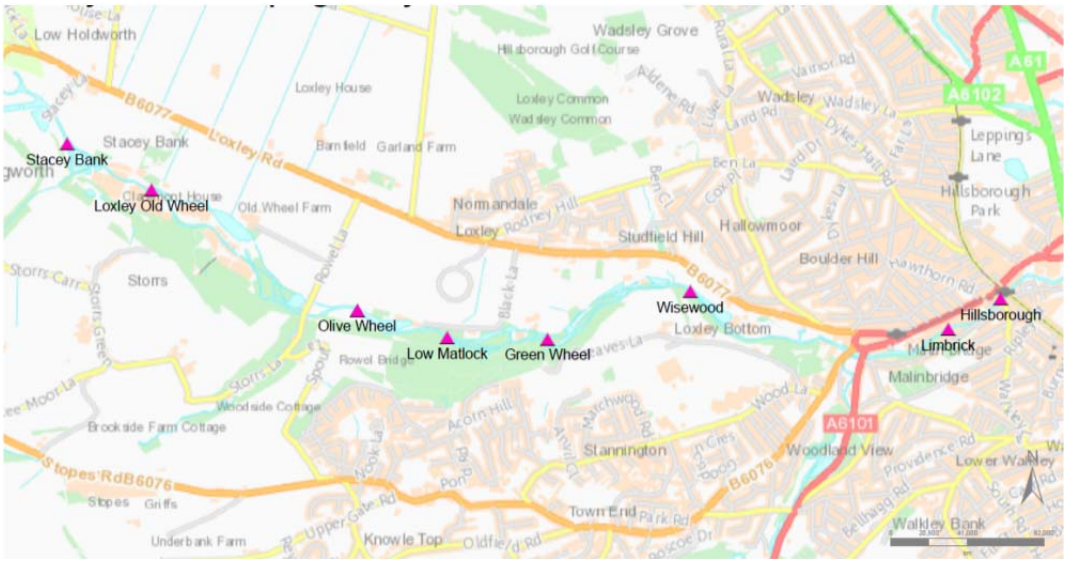


Figure 1: River Loxley Weirs

1.1 Fish Pass Background

Fish passes in recent years have become increasingly important for the restoration of free passage for fish and other aquatic species. Many fish migrate as part of their behaviour, examples being the salmon and the eel. However it is now known that other species also migrate as part of their life span, seeking habitats or spawning ground.

Historically rivers have been altered through the introduction of weirs to exploit water power and these features remain today, providing flood protection and the cultural landscape we have come to know. However, these structures also provide a barrier to the migration of fish within our river network.

Fish and benthic invertebrates migrate: migration can be longitudinally along the river corridor or between the main channel and side waters. Longitudinal connectivity of rivers has an important role to play in the re-colonisation of river reaches and the development of a diverse fishery: barriers to migration prevent this happening.

Improving opportunities for the migration of fish along the River Loxley will allow the growth, survival and reproduction of the various species within the watercourse.

1.2 Scope and Objectives

In order to improve fish migration at the 7 sites on the River Loxley, the Don Catchment Rivers Trust requires a scoping/feasibility study, the key outputs of which are:

- Provide two options for improvement of fish passage at each weir
- An assessment of the options against a number of criteria including:
  - Species applicability at various flows
  - Site suitability and constraints
  - Archaeology
  - Flood Defence/Risk
  - Health and Safety
  - Access for construction and maintenance
  - Maintenance
  - Environmental assessment and review
  - Capital Cost

1.3 Methodology

The study combined desk based investigations and research with site visits and inspections to determine the site specific characteristics and the nature of the watercourse.

An initial site visit was undertaken on 14th November 2012 to identify the weirs and any significant technical and physical constraints likely to affect the proposals. This was followed by a further site visit on 10th January 2013 focussing on geomorphology and ecology of the river and the impact of the proposals on these factors. This visit also included a more detailed engineering assessment in order to develop the proposals for the weirs.

1.4 Information

The following information has been obtained and consulted to inform this stage of the project:

Data	Description	Source
OS 10k Background Mapping	Background mapping	EA Data Share
Utility Information	Utility information for each weir	Sourced by EA through various utility companies
Land Ownership Information	Land ownership information	Sourced by DCRT from land registry
Access Information	Report detailing access information for each site	Prepared by DCRT
Fish Data	Data regarding fish	Provided by DCRT

Data	Description	Source
	population at Loxley, Rivelin and Don	
Yorkshire Water HMWB Fish Data 2011 for River Loxley	Data regarding fish population at Loxley	Provided by DCRT
River Loxley Hydraulic Model	ISIS Model of River Loxley	Provided by EA for previous project, renewed license for current project
Limbrick Weir Report	Report on the impact of the removal of Limbrick Weir	Provided by DCRT
Low Cost Baffle Solution Design Tool	Low Cost Baffle Solution Design Tool	Provided by DCRT
Low Cost Baffle Solution at Jessops Weir on the River Asker	Description of successful low cost baffle system project	Provided by DCRT
Weirs on the River Loxley, Bradfield, Sheffield, South Yorkshire: Heritage Statement	Archaeology assessment of the weirs	Prepared by Brigantia Archaeological Practice on behalf on DCRT
Physical Modelling of low cost modifications to the Crump weir to improve fish passage: Development of favourable swimming conditions and investigation of the hydrometric effect		Prepared by Susan Servais
Otter Survey	1977-2010	EA Data Share

Table 1: Information consulted

2 River Loxley

2.1 The river

The source of the River Loxley is a number of small streams on the Bradfield Moors, which converge to form Agden Dike: this watercourse then combines with Emlin Dike immediately upstream of Agden Reservoir. The river is joined by Dale Dike downstream of Agden Reservoir and then flows into Damflask Reservoir: downstream of Damflask the River is named as the Loxley. From here the river flows through Storrs Bridge, where Storrs Brook joins, before passing through Wisewood; at Malin Bridge the River Rivelin joins. The Loxley flows on through Hillsborough towards its confluence with the River Don about 1.5km further downstream.

Sheffield has long been established as an important location in the cutlery industry, with the area around the River Loxley being of importance due to opportunities for the use of water powered machinery.

Consequently, the Loxley area had a number of water powered mill or 'wheels', which in this location were commonly grinder wheels, used for finishing of knives, scissors etc. However other uses for the water powered wheels on the Loxley were also found.

The "Great Sheffield Flood" occurred in 1864 resulting from the failure of the newly constructed Dale Dyke Dam; this catastrophe devastated the Loxley area with the loss of 240 lives and caused significant damage to the industry in the valley.

Currently four reservoirs are located in this area: the upper three reservoirs are used for the impoundment of drinking water whilst Damflask Reservoir was constructed as a 'compensation' reservoir to ensure a constant flow in the River Loxley for use by the industry in this area.

A detailed history of the Loxley valley in the study area can be found in The Brigantia Archaeological practice report for the Don Catchment Rivers Trust entitled "Weirs on the River Loxley, Bradfield, Sheffield, South Yorkshire: Heritage Statement", dated 7th November 2012. This was commissioned by DCRT as part of this study and specific information for each weir will be highlighted later in this report.

2.2 Water Framework Directive

The lower River Loxley system within the study area extent falls within the following two Waterbody catchments under the Water Framework Directive (WFD):

- River Loxley from Strines Dyke to Rivelin (GB104027057370)
- Loxley from Rivelin to River Don (GB104027057350)

Both these waterbodies are classified as 'Heavily Modified Water Bodies' (HMWBs) with a current 'Moderate' Ecological Potential status. As such, in order to achieve their target objective of 'Good Ecological Potential' (GEP) a number of hydromorphological Mitigation Measures are required to be successfully in place, in order to support the biological and physic-chemical status of the waterbody.

A set of generic Mitigation Measures have been derived by the Environment Agency (EA) for fluvial HMWBs associated with impoundment assets, which are categorised under Fish Passage, Hydromorphology, and Water Quality drivers. These are summarised below:

Driver	RBMP1 HMWB Mitigation Measure	
1. Fish migration	1	Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works.
	2	Where structures or other mechanisms are in place to enable fish to access waters upstream of the impounding works, the volume and timing of flow releases is sufficient to enable and, where relevant, trigger fish migration.
	3	Management of the risk of fish entrainment in turbines or intakes to enable downstream fish passage.
	4	Enable access to relevant feeder-streams draining into the reservoir at appropriate times for spawning and migration.
2. River flow	5	Establish an appropriate baseline flow regime.
	6	Re-engineering of the river where the flow regime cannot be modified.
3. River sediment	7	Maintain sediment management regime to avoid degradation of the natural habitat characteristics of the downstream river.
	8	Provide flows to move sediment downstream (freshets and/ or spills).
4. River water quality	9	Ensure that good status of dissolved oxygen levels is being achieved downstream of the impounding works
	10	Ensure that the thermal regime in waters downstream of the impounding works is consistent with good status conditions.
5. Lake level	11	Ensure the rate and range of any artificial drawdown is appropriately managed to maintain aquatic plant and animal communities in the shore zones of impoundments with gently shelving shore zones.
	12	Ensure the seasonal pattern of water levels during each year is managed so as to enable the establishment and retention of aquatic plant and animal communities in the shore zone of the impoundment.

Table 2: WFD Drivers and Mitigation measures

Where possible, good practice recommends restoration solutions that address multiple mitigation measures under the various drivers; and thus provide multiple benefits to a range of target biological (e.g. target species of fish, macroinvertebrates, and macrophytes) and physic-chemical (e.g. DO, temperature, pH, phosphate) quality elements.

2.3 Barriers to Fish Migration

DCRT has identified 7 weirs between Damflask Reservoir and Hillsborough which are currently acting as barriers to fish migration and these are the focus of this study:

- Hillsborough Weir
- Limbrick Weir
- Wisewood Weir
- Green Wheel Weir
- Low Matlock Weir
- Olive Wheel Weir
- Loxley Old Wheel

Two additional weirs are located on the River Loxley; these are being addressed separately by the Environment Agency.

2.4 Fish Type

Don Catchment Rivers Trust has a vision of salmon breeding on the River Loxley by 2020: therefore this study focuses on salmon migration but will also consider the migration of brown trout and grayling along with eels and lamprey. Fish populations in the river are currently predominantly brown trout: there are no established populations of coarse fish.

2.5 Flows

Historical flow data is available from the 1980s and this has been downloaded from the Centre for Ecology and Hydrology: the data shown on Table 3 is from the gauging station downstream of Damflask Reservoir. Compensation flows may have been altered from the reservoir since recording ended; however this gives a rough idea of the flows likely to occur.

Mean Flow:	**0.761 m^3/s**
95% Exceedance (Q_{95}):	0.401 m^3/s
70% Exceedance (Q_{70}):	0.478 m^3/s
50% Exceedance (Q_{50}):	0.533 m^3/s
10% Exceedance (Q_{10}):	1.128 m^3/s

Table 3: River Loxley Flows

2.6 Flood Risk

Flood maps have been downloaded from the Environment Agency's website for the Loxley area. Extracts from these maps are shown in Figure 2 to Figure 4.

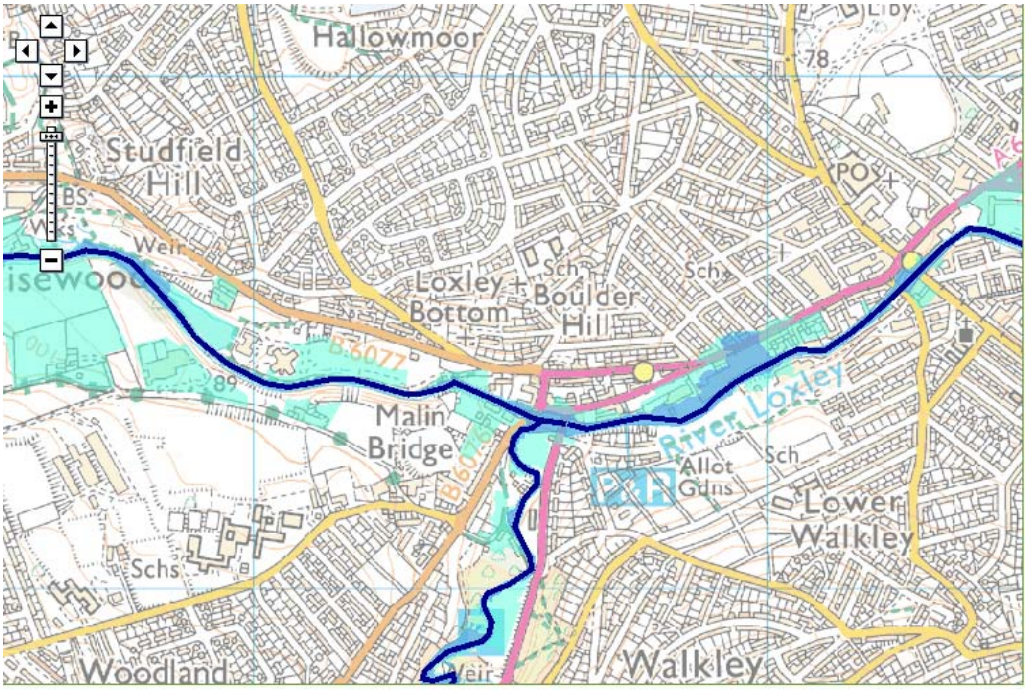


Figure 2: River Loxley Flood Map Hillsborough to Wisewood

Figure 3: River Loxley Flood Map Wisewood to Old Wheel

Figure 4: River Loxley Flood Map Old Wheel to Damflask

Dark blue shading identifies areas vulnerable to flooding from rivers or the sea during a 1 in 100 year return period storm event if there were no flood defences in place. Light blue shading shows flooding from rivers or the sea if there were no flood defences during a 1 in 1000 year return period storm event.

- Hillsborough Weir – 1 in 100 year flooding
- Limbrick Weir – 1 in 100 year flooding upstream
- Wisewood Weir – 1 in 100 year flooding upstream
- Green Wheel Weir – 1 in 100 year flooding downstream
- Low Matlock Weir – 1 in 100 year flooding
- Olive Wheel Weir - 1 in 100 year flooding
- Loxley Old Wheel - 1 in 100 year flooding

2.7 River Loxley Hydraulic Model

There is an existing ISIS hydraulic model provided by the Environment Agency used to model flooding on the River Loxley: this model has been used to determine the approximate dimensions of the weirs in the study area; topographical survey was not part of the scope of this project andno topographical survey of the weirs has yet been undertaken. Additional modelling was carried out using this model by the Environment Agency to determine the effect of removing the weir at Limbrick.

This hydraulic model of the River Loxley could be further developed at the detailed design phase to determine if any of the proposed works alter flood risk in the area.

3 Geomorphology Overview

A high-level geomorphological site assessment was undertaken of the reaches of the River Loxley immediately around the seven weir sites. A full desk-based and site walkover geomorphological assessment of the River Loxley catchment has not been undertaken at this stage of the project.

3.1 Catchment Overview

Key high-level catchment characteristics of the River Loxley are summarised below:

Characteristic	Description
Catchment Area (km^2)	$44km^2$
Total Length (m)	7.1km (Damflask Reservoir to River Don)
Elevation	Source: 180 mAOD; Min: 58mAOD.
Typical Geology (Bedrock)	**Rough Rock - Sandstone**. Sedimentary Bedrock formed approximately 316 to 318 million years ago in Carboniferous Period. Local environment previously dominated by rivers. **Millstone Grit Group – Mudstone, Siltstone, Sandstone**. Sedimentary Bedrock formed approximately 316 to 327 million years ago in the Carboniferous Period. Local environment previously dominated by swamps, estuaries and deltas. **Pennine Lower Coal Measures Formation – Mudstone, Siltstone and Sandstone**. Sedimentary Bedrock formed approximately 314 to 316 million years ago in the Carboniferous Period. Local environment previously dominated by swamps, estuaries and deltas. Sedimentary Bedrock formed approximately 314 to 316 million years ago in the Carboniferous Period. Local environment previously dominated by swamps, estuaries and deltas. These rocks were formed in marginal coastal plains with lakes and swamps periodically inundated by the sea; or estuaries and deltas, and shallow seas
Typical Geology (Superficial Deposits)	**Alluvium – Clay, Silt, Sand and Gravel.** Superficial deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by rivers. These rocks were formed from rivers depositing mainly sand and gravel detrital material in channels to form river terrace deposits, with fine silt and clay from overbank floods forming floodplain alluvium, and some bogs depositing peat; includes estuarine and coastal plain deposits mapped as alluvium. **Head – Clay, Silt, Sand and Gravel.** Superficial Deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by sub-aerial slopes. These rocks were formed from the material accumulated by down slope movements including landslide, debris flow, solifluction, soil creep and hill wash.
Soils	Free draining, slightly acid loamy soils
Land Use	River Corridor: Mixed woodland, historical industry infrastructure Floodplain: Agricultural (arable and pasture), urbanised downstream

Principle Tributaries	River Rivelin
Minor Tributaries	Stors Brook; Stykehouse Brook

Table 4: Catchment Characteristics (taken from Arup's River Don Study)

3.2 Key Pressures

The lower River Loxley system is heavily modified by the combination of the presence of the Damflask Reservoir at its upstream end, the regulated flow release regime from the reservoir, numerous large historical mill weirs along its length, sections of hard bank protection, and channelisation along its lower reaches through the urbanised area of Hillsborough. Together, these key pressures historically have had (and are continuing to have) a significant impact on the hydromorphological condition of the river system, both at the catchment and reach scale. These are described in brief below:

Critically, construction of the reservoirs at the upstream end of the watercourse have restricted natural sediment supply from the upper reaches of the river, and its delivery downstream to the mid and lower reaches of the watercourse. This has resulted in the lack of recharge of gravel sediments; which would naturally be entrained from the steeper gradient and high energy upper reach of the river via bank and bed erosion processes, and transported and deposited downstream along the watercourse. This is exacerbated further by the lack of major tributary inflows along the mid and upper reach of the watercourse, which would otherwise provide alternative natural sediment sources. In turn, regulated flow release events from the reservoir, as well as high flow / spill events, will have resulted in the entrainment of fine and gravel sediments present along the channel bed ("plucking") and their transportation downstream. With limited re-supply of gravel-sized sediments from upstream, this has gradually led to channel incision (bed scour), leaving predominately coarse cobble and boulder sized substrates along the river channel (which are less actively entrained and transported under the regulated flow regime). Resultantly, the lower River Loxley system observed downstream of Damflask Reservoir is generally gravel-starved relative to its expected 'natural' (pre-modified) state. This is likely having an adverse impact on aquatic habitat quality for certain biological indicators (including target fish, macroinvertebrate and macrophyte species). In particular, lack of gravel substrates will be restricting the quality of potential spawning habitat for migratory fish species such as Salmon and Brown Trout.

The construction of the numerous large weirs along the length of the watercourse has further disrupted natural sediment continuity processes along the river system. Paradoxically, the presence of the weirs will have artificially stabilised the longitude bed profile along the river channel and acted to slow the gravel plucking effects relating the influence of the reservoir (described above). However, the hydraulic influence of the weirs is also adversely impacting upon hydromorphological quality at the reach scale.

The weirs act to attenuated flows, increasing water depths and reducing flow velocities immediately upstream, which in turn promotes sediment deposition. This back-ponding effect of the weirs, and resultant increased water depths, siltation and lack of hydromorphological diversity, are likely promoting sub-optimum conditions for key biological indicators (including target fish, macroinvertebrate and macrophyte species). Moreover, the construction of the

weirs has led to the localised over-widening of the river channel relative to more 'naturalised' reaches in-between. At some of the weir sites, this artificial over-widening of the channel (together with the attenuation effect of the weir) has promoted sediment deposition and the creation of bar features immediately downstream of the weirs. As a result, sediment deposition along the river system is in general expected to be largely focused in localised areas immediately upstream and downstream of the weirs, where impacts on flow depths and velocities (and thus hydromorphological quality) are greatest. As such, this will be further reducing gravel availability along the more 'naturalised' reaches of the river system in between the weirs.

The above impacts are also compounded in places by the impact of artificial bank reinforcement (i.e. stone pitching and masonry retaining walls associated with the historical mill race channels) and channelised sections of the river on marginal aquatic habitat value and natural sediment regime processes (sediment entrainment, transport, and deposition).

The gravel starvation impacts observed along the lower River Loxley system, as described above, are likely to have long term implications for the biological status of the waterbody, and as such the sustainability of any fish pass improvement works undertaken on the weirs. As such, it is recommended that a catchment-wide sediment management and river restoration strategy is developed and opportunities sought for undertaking ancillary restoration and habitat enhancement works alongside the proposed fish passage improvement works, in order to maximise ecological benefits.

The key geomorphological characteristics, constraints and opportunities identified at this stage at each weir site are described in Section 7 to 1 below.

4 Ecological Overview

An ecological walkover survey was undertaken of the seven weir sites located between Stacey Bank (SK292,899) and Hillsborough (SK322,895). The section of the River Loxley located within the survey area largely flows through an areas of semi-natural broadleaved woodland located within the urban fringe to Sheffield City Centre. The lower section of the survey area flows through the urban area of Hillsborough, although the majority of the riparian corridor within this section is vegetated by broadleaved woodland trees.

The River Loxley is located within the Coal Measures Natural Area. This Natural Area is characterised by dense populated urban centres which have largely developed as a result of the underlying coal fields. The topography of the Natural Area can be described as gently undulating. The key habitat mosaics which characterise the Coal Measures Natural Area are acidic ancient and secondary woodlands, valley wetlands, neutral and acid grasslands and mixed agriculture. Canals, mill ponds and natural rivers are also important features within the Natural Area.

The key ecological constraints identified following the desk based review and walkover survey are summarised below:

- No international designations (e.g. Special Protection Areas (SPAs) or Special Areas of Conservation (SACs)) are located within the 2km search radius surrounding the survey area on the River Loxley.

- Stanington Ruffs Sites of Special Scientific Interest (SSSIs) is the only national designation located within the search radius surrounding the River Loxley approximately 250m south of Low Matlock Weir. However, given the proximity of the SSSI designation from the weir sites, it is not considered that there will be any adverse impacts to this site as result of the proposed works.
- Loxley and Wadsley Common Local Nature Reserve (LNR) is located approximately 1km north of the survey area. Given the proximity and nature of this local designation it is not envisaged that the proposed works will have any adverse impacts on this site.
- With respect to non-statutory designations, a number of woodland areas located within the River Loxley corridor have been designated as areas of ancient woodland, namely:
    - Little Matlock Wood ancient and semi-natural woodland.
    - Beacon Wood / Storrs Wood ancient and semi-natural woodland.
    - Unnamed woodland (adjacent to Stacey Bank).
    - Areas of deciduous woodland UK Biodiversity Action Plan (BAP) priority habitat are also located within the majority of the riparian corridor. This includes the survey area between Stacey Bank and Hillsborough.
    - Data records provided by the Don Catchment Rivers Trust have identified an otter record approximately 100m west of Green Wheel Weir in 2009 (SK 30981 89405). Following a high level search for protected species records held by the Environment Agency, no protected species were identified within the survey area along the affected sections of the River Loxley (Pers comms., Andrew Virtue (Biological Technical Officer), Jan 2013). A negative record for white-clawed crayfish were identified in 2008 at SK 25923 90187 approximately 2km upstream of Stacey Bank Weir (i.e. white-clawed crayfish surveys were undertaken at this location and not positively identified). Two records for North American signal crayfish (non-native species of crayfish) were identified on the River Rivelin in 2011 (SK 32414 88828 and SK 32385 88807) approximately 500m upstream of the confluence with the River Loxley.
    - Fish records provided by the Don Catchment Rivers Trust from Yorkshire Water and the EA indicate the presence of brown trout and bullhead within the River Loxley. Brook lamprey has been identified within the River Rivelin but not the River Loxley (the reason for this is not clearly understood). Grayling are present on the River Don at the confluence with the River Loxley. It is understood that the River Loxley has been identified as a key tributary to open up in relation to migratory salmonids since it is one of the first tributaries of the River Don from the sea (pers comms., Jerome Masters (EA Fisheries Technical Officer), Jan 2013).

Ecological constraints are highlighted at each weir in the summary tables in Section 7 to Section 1.

5 Consultation Overview

A consultation was held with the key stakeholders and local residents on Tuesday 15th January at St. Polycarp's Church Hall in Sheffield at 7:30pm. This was well

attended and the general feeling from the attendees was of support for the proposed works. Some of the key outcomes/questions/comments from the evening are shown below, with further comments included in the Appendix A.

- **Any potential for double wins?**
  For example improve the impounding problems caused by the weirs by partial removal or take the opportunity to document the construction of the weirs. E.g. Beeley Woods. So giving the opportunity to solve impoundment issues and improve spawning habitat and therefore other enhancements.

- **Maintenance?**
  This will be dependent on the fish pass type. Most solutions will not require significant maintenance. The maintenance responsibility will fall on the owner of the structure however the trust may be able to assist with volunteers. The River Stewardship Company may also be able to assist the owner with debris clearance. S.P.R.I.T.E are already undertaking some of this work.

- **Would use of Arup exclude low tech solutions?**
  No, the aim is to provide solutions that can be undertaken by volunteers if possible and that are sympathetic to the local heritage.

- **Is there an argument for provision of interim easements while waiting for full fish passes to be built?**
  The area is a popular residential park enjoyed by many people and is loved by many people who have grown up there, this will therefore mean there is greater resistance to full fish passes, so the more minimalist the better. However if full fish passes are required consider looking for multiple benefits e.g. Improving access. The trust recognises the heritage value of the sites and would look to providing information about this at each weir and improving the area as a whole providing benches, walks, footpaths etc. Looking for options that work with the structures not against them and that are sensitive to their surroundings. This is important for funding also as now when applying for funding the trust must prove that they are looking at the complete picture including social benefit.

- **Is weir removal an option? As Limbrick weir is particularly problematic in terms of access is it an option to remove the weir?**
  Although weir removal is good in terms of ecology, in terms of heritage it is not as good. Therefore there are very few opportunities to consider removal of weirs on this stretch of the Loxley.

- **Comment from attendee: It would be preferred that Denil fish passes are not used.**

- **Would ponds need to be emptied? In what ways would owners be expected to contribute? When? What order?**
  We would not anticipate having to drain any of the dams. There may need to be a temporary alteration to the feed of water, but we would not expect this to have any adverse impact. In terms of maintenance, this will be most likely to be limited to occasional debris clearance and the removal of silt build up. This is likely to be a couple of times a year and after a storm event and should not be too onerous. Land owners may also be able to contribute at the feasibility stage when we are considering access routes for machinery to the site: local

knowledge of possible routes, any restrictions and offers of the use of adjacent land for access and construction will be useful to help minimise the disruption to the local environment. The Trust's ambition is to set up a local group to take on the responsibility of carrying out general maintenance of the fish passes. This would require the support and consent of the owners. The extent of this responsibility will be determined by the type of passage facility chosen for the individual sites. Our programme for construction would be to begin at Hillsborough, working progressively upstream.

- **Access**
  Depending on how & on what part of the weir the build will take place - Access requirements will be dependent on the solutions proposed: if small scale low cost easements are adopted, access will likely be needed only for local volunteers using small equipment and small quantities of materials. For larger engineering options access will be required for larger plant and materials. Ideally access will available to the side of the weir where the work is proposed, however this may not be possible at all locations.

6 Fish Passage Improvements

The following proposals have been put forward by DCRT as options for consideration for improving the fish passage at the weirs on the River Loxley.

6.1 Complete Weir Removal

Weir removal is often the preferred option when considering improvements to fish passage. However there are a number of associated issues with weir removal; these include the cost of removal and disposal, the effect on flood risk, risk of detrimental ecological effects and risk of significant changes to river morphology and aesthetics.

6.2 Partial Weir Removal

In some circumstances partial removal of the weir to create notches is more sustainable than full weir removal, where materials arising from lowering of the weir crest can be used as perturbation boulders to assist fish ascent. This aims to provide benefits with fewer potential issues than those associated with full weir removal.

6.3 Technical Fish Pass in river or in bank

Technical fish passes are essentially hydraulic structures proportioned and designed to enable fish to ascend an obstruction by either reducing the overall level change to a series of smaller manageable steps or by reducing water velocity to levels suitable for fish to advance against the current. Typical technical passes include step/pool types and baffled fishways.

6.4 Bypass channel

In order to avoid affecting the weir structure itself, it is possible to bypass the weir by creating a separate migration channel if sufficient land is available. The bypass channel can include technical fish passes to increase the gradient of the bed, so reducing the length of the bypass channel required and therefore the land take.

6.5 Non-technical Fish Passage solution/ Easements

Easements can be considered as “informal” works made to improve opportunities for fish to pass an obstruction by creating more favourable conditions at the site. Easements are generally not subjected to the hydraulic analysis and design processes associated with technical fish passes (such as the pool and weir or baffled type) but rather rely on a subjective assessment and design procedure to identify the factors impeding passage and the options available to reduce those impacts.

For any site, a suitable depth of water and flow conditions are required which will enable fish to advance against the flow, passing through any high velocity zones without becoming exhausted. The objective of the easement is to reduce the risk of an obstruction completely preventing upstream migration: it is generally recognised that some weaker swimming species may be unable to pass and that the all-species design criteria normally adapted for technical fish passes is not applied.

The Environment Agency Fish Pass Design Manual recognises that although such works do not necessarily fall within the scope of the formal authorisation process, the Fish Passage Panel should be informed of the details of such passes so that their status in relation to authorisation can be confirmed. Furthermore, the Panel can give guidance on best practice and design, maintain a database of such structures and circulate information on application and design throughout the Agency for the benefit of those wishing to construct easements.

6.5.1 Easement Options

This study considers that the following general categories may be appropriate for some or all of the weirs:

- Notches and gaps
- Baulks
- Baffle Systems
- Preliminary Weirs (Pre-barrages, Check Weirs)
- Rock Ramps

It is often the case that a combination of easement types is required to achieve the objective of enabling fish passage across obstructions: for example, notches and gaps are frequently used in combination with rock ramps and baulks to create sections of deeper water where fish are able to cross a weir crest.

Table 5 below shows the advantages and disadvantages of the easement options:

Option Ref	Easement type	Description	Suitable species	Head difference	Velocity	Strengths	Weaknesses
1	Notches, gaps and slots	A short section of lowered weir crest with sufficient water depth to permit fish to pass	Notches are generally more suitable for salmonids if plunging flow occurs. If streaming flow conditions prevail notches in vertical weirs will be suitable for many species. Gaps - can be designed to accommodate most species	Notches – no greater than 1m. in broad weirs Not greater than 0.5m. in vertical weirs No more than 0.5m for gaps	Typically 1.4-3.1m/s.	Cheap, and easy to maintain. Can be simple to fit in existing weirs	Notches - limited head difference and hence limited range of operation. Gaps - may lead to loss of head above the weir. Removal of material may compromise the integrity of the weir.
2	Baulks	Transverse sloping rectangular timber or concrete members fixed to the downstream weir glacis. The purpose of the structure is to gather water over-spilling the crest of the weir and concentrate it in a diagonal run across and down the glacis.	Typically used for larger salmonids, but may be effective for some coarse species, depending on head differences, lengths and gradients.	Optimum head difference approx. 2m Maximum glacis gradient:1 in 4 Maximum length of baulk: c. 20m Angle of baulk in relation to weir crest: between 25º and 45º	N/A	Cheap and easy to construct and maintain. Relatively simple to retro-fit to existing weirs.	Limited application for fish species. Limited range of operation. Lack of sound design criteria. Suitable only for weirs with sloping downstream glacis
3	Baffle systems	A variety of baffle types and configurations, constructed from a range of materials, are available to improve fish passage, particularly over low head difference weirs. These are designed to retain water depths, reduce velocities and create heterogeneous flow conditions on the structure.	Usually need some rational design and hydraulic modelling to suit specific species		Depends on detailed design	Could be relatively inexpensive to install	Complex design process including modelling is likely to be needed
4	Preliminary	Preliminary weirs enable fish to ascend the obstruction in a series	Suitable for most species if streaming	Up to maximum 0.5m for migratory		Generally cheap and easy	Can be problematic for fish passage at

Option Ref	Easement type	Description	Suitable species	Head difference	Velocity	Strengths	Weaknesses
	Weirs	of smaller steps. A crest notch is also likely to be needed.	flow conditions occur, otherwise suitable only for salmonids and larger surface and mid-water swimming coarse fish.	salmonids, 0.30m for coarse fish, but preferably less than 0.35m and 0.20m respectively.		to construct and maintain.	low flows.
5	Rock ramps	A ramp of bedrock and mixed bed material is located on the downstream side of an existing weir, to create a semi-natural river bed of reasonable gradient (≤5%) to allow fish passage over a low head (≤1m) structure	Can potentially accommodate a wide range of aquatic fauna.	Normally ≤1m but can be used up to 2m with the use of resting pools.	Maximum heterogeneity desirable.	Suitable for a wide range of fish species and sizes. Relatively cheap and easy to install and operate and maintain. Can be adapted to a wide range of flow regimes. High aesthetic value.	May settle or disintegrate in high flows if not constructed robustly.

Table 5: Fish Passage Easement Options

6.6 Low Cost Baffle Systems

A pilot study has been carried out on the River Asker in Bridport, Dorset into the use of "Low-cost modifications of the Crump weir to improve fish passage: Science Report SC010027". In this case the weir was much larger than weirs traditionally using low cost modifications/easements. Baffles were proposed over one section of the weir face formed of recycled plastic. A meandering gap is formed through the baffles to allow for fish passage, this is shown in the figure below.

Figure 5: Baffle system from '"Low Cost" modification of a crump weir at Jessop's Avenue, Bridport to improve fish passage'

The report concludes that after installation the weir is passable to large migratory fish as well as some smaller fish.

6.7 Appraisal criteria

Using published guidelines and the output from site specific inspections and observations, the fish passage solutions will require appraisal against a number of parameters.

Table 6: Appraisal Criteria

Criterion	Assessment
Fish passage effectiveness	How effective the proposals are likely to be in enabling the present (and anticipated) fish species in the river to ascend the obstruction
Site suitability and constraints	An assessment of how physical features at the site will impact

Criterion	Assessment
	on implementation of the proposals.
Archaeology	An assessment of the short and long term effects on archaeology and heritage value and the impacts on project wide constraints (i.e. consents and mitigations)
Flood Risk	A qualitative assessment of the impact on flood risk
Health and safety	A qualitative assessment of the relative H&S implications during construction, operation, maintenance and demolition of the proposals.
Access	Consideration of any access constraints affecting implementation of the proposals
Maintenance	Likely future maintenance requirements
Environmental matters	Comparison of relative environment/ecology impacts
Capital cost	Comparative budget costs for construction
Buildability	An assessment of the complexity of the proposals and any recommendation for professional assistance
Residual Risks	An assessment of project wide risks

6.8 Options short list

The long list of options has been assessed for each site and the relevant solutions have been shortlisted for each site in Table 7: Options short list selection matrix below: the shortlist has been developed based on the appraisal requirements above. Additionally, an options workshop took place on 8th February 2013 with DCRT and the EA to discuss the shortlisted options.

In line with the geomorphology and environmental summary of the sites, and the archaeological significance of the area, as well as the views of the local residents from the consultation meeting, the most appropriate solutions for this area are generally considered to be the less intrusive option of easements where these will deliver the required benefits.

	1. Complete weir removal	2. Partial weir removal	3. Technical Fish Passage	4. By-pass channel (with/without technical fishpass)	5. Easement	6. Low Cost Baffle System	Comments and observations
Hillsborough	x	x	✓	n/a	✓	✓	Hillsborough weir is key to successful regeneration of migratory fish population in the Rivers Loxley and Rivelin. Partial or complete weir removal is not considered to be an option at Hillsborough due to the amenity benefits and proximity to the confluence with the River Don. Easements are considered as options for this location as the site presents opportunities for modifications to the weir glacis to mitigate the risk of easements failing to facilitate fish passage. However all-species passage is not certain with this arrangement due to the height and slope of the weir. A technical fish pass will provide all species with the means to ascend the weir albeit at a high cost.
Limbrick	✓	x	✓	n/a	x	x	Limbrick Weir is an obstruction to migration in the River Loxley and also the Rivelin: providing all-species passage at this site will ensure that the benefits of any improvements further upstream will be delivered. The use of easements is not considered in this location due to the steep gradient of the weir and the confined site precluding modifications to the glacis slope. Therefore the option of complete weir removal must be considered as well as a technical fish pass.
Wisewood	x	x	x	x	✓	✓	The lower gradient of the weir means easements can be considered at this location: this is preferable to the more expensive option of technical fish passage or weir removal, especially as this site is upstream of the Rivelin/Loxley confluence.
Green Wheel	x	x	x	✓	✓	x	The small head difference and lower gradient of the weir should enable easements to be used as an option. A bypass channel already appears to exist around the weir which could be improved and made suitable for fish passage.

Low Matlock	n/a	n/a	✓	x	x	✓	Due to the weir being a scheduled ancient monument the removal of the weir is not possible. The steep gradient of the weir reduces the possibility of easement options. A bypass channel is also not considered possible due to the length of the goit. Therefore a technical fish passage or baffled solution must be considered, probably in –bank to avoid affecting the listed structures. Some element of reversibility may assist when considering options for permanent solutions at the site.
Olive Wheel	n/a	n/a	x	x	✓	✓	Due to the presence of the EA gauging station, the removal of the weir is not possible. Due to the low gradient and small head difference the use of easements should be considered over a more costly technical fish passage.
Loxley Old Wheel	x	x	x	x	✓	n/a	Due to the gentle gradient and small head difference easements are considered the best option here unless the development calls for greater engineered solutions.

Table 7: Options short list selection matrix

6.9 Appraisal of short listed options

The shortlisted options have been appraised against the appraisal criteria shown in Table 6: Appraisal Criteria. The options appraisal is aimed at assessing the overall suitability of the proposed works to deliver the project objectives considering the constraints and opportunities which are present at the site.

Additionally, the appraisal is intended to inform of the project risks and possible future actions needed to manage and control residual risks.

6.10 Costs

Costs have been provided with assistance from A Torn Construction Ltd. The costs provided were for Limbrick and Hillsborough engineered fish passage options. These gave indicative costs for construction and access. However an optimism bias of 60% has been added to these costs to allow for design, risk, licenses etc. and other cost uncertainties at this feasibility stage. Costs for the other weirs have been priced based on previous experience and other guidance. These have also had an optimism bias of 60% added to allow for the same uncertainties described above.

7 Hillsborough Weir

Location Plan

Photographs

Figure 6: View from Walkley Lane.

Figure 7: View from Walkley Lane bridge.

General description

Hillsborough Weir is located at OS Grid Reference SK 332 896. The weir is 2.1m high by 43m wide with a heavy skew to the line of the channel and comprises a sloping glacis divided by longitudinal string courses in a series of panels. The weir appears to be built from dressed masonry blocks with a stepped downstream face. The slope of the downstream glacis is estimated at close to1 in 3 from the site visit.

The downstream channel is crossed by a masonry arch bridge (Malin Bridge) which carries highway and tram traffic. Walkley Lane bridge, a steel girder structure crosses the channel immediately upstream of the weir. The river in the vicinity of the weir is contained within masonry walls varying between 1.8 and 4m in height. The most upstream location in the downstream reach is at the south eastern corner of the weir (the right bank).

Benefits of improved fish passage

Providing fish passage at this location will open 310m of the River Loxley to fish passage bringing benefits as far upstream as the next weir.

Access

The weir is bordered by Langsett Road to the north east and by Holme Lane to the north west: these are both tram routes. A narrow one-way street (Walkley Lane) borders the site to the southwest and crosses a low capacity bridge over the river. Buildings extend up to the water's edge to the south east but one has recently been demolished leaving a vacant plot. The site is therefore very constrained in terms of access. The optimum fish pass location is within the area to the south, although the limited capacity bridge is a further constraint to work in this vicinity. Access for high vehicles or crane operation may also be impeded by overhead line equipment associated with tram operations.

Access to the weir would require overcoming the vertical drop form river bank to bed and may involve construction of a ramp or causeway reaching from bank to weir.

Geomorphology

Key characteristics, constraints and opportunities:

Upstream

- The existing aquatic habitat quality (particularly potential spawning habitat) immediately upstream of the weir is poor. This is due to the back-ponding of flows behind the weir for approximately 100m, resulting in an unnaturally over-deep channel in relation to the more 'naturalised' channel reaches further upstream. This increase in water depths and decrease in flow velocities in turn results in a lack of hydromorphological diversity and is likely to be prompting the accretion of fine sediments along the channel bed. Channel substrates upstream of the weir were obscured during the site visit due to water depths; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of fines. This combination of factors is likely to comprise poor local aquatic habitat conditions for migratory fish.
- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features; provide refugia/cover habitat features for fish; improve marginal habitat value; and

potentially introduce and fix gravel substrates upstream of the hydraulic influence of the weir to benefit spawning.

Downstream

- The river channel has been over-widened at the location of weir, in relation to the more 'naturalised' channel reaches downstream. This has resulted in shallow flows and reduced transport capacity immediately downstream of the weir, which in turn has promoted the deposition of coarse sediments. These coarse sediments have been deposited to form small mid-channel and side-channel cobble shoals, which are exposed during typical and low flows. These depositional features are not vegetated; suggesting that they are likely relatively dynamic and submerged frequently. Large shoal removal was carried out at this location after the 2007 floods.
- Under typical conditions, flow is focused into shallow runs between the coarse sediment deposits described above. A quasi-riffle feature comprising shallow, turbulent flow is present underneath the road bridge immediately downstream of the weir; due to the general lack of gravels present within the lower river system.
- Finer sediments have been entrained and transported downstream, leaving predominately coarse sediments and artificial materials along the channel bed and margins (with limited re-supply of gravels from upstream due to the presence of the reservoir). The degree of gravels present within the channel at this location is reduced in relation to sites observed further upstream around the mid reaches of the river system. This is likely due a combination of flow accretion from the Rivelin tributary inflow (approximately 800m upstream) and increased flow depths and velocities caused by the channelisation of the river system through its urbanised lower reaches (and the associated increased capacity for the entrainment and transport of fine and gravel sediments during high flow events).
- Due to the conditions described above, fish passage improvement works at this weir may need to consider ancillary bio-engineering works immediately downstream of the weir to narrow the channel width, in turn increasing flow depths and velocities and discourage continued sedimentation around the approach to the weir. Such works could potentially reduce the capacity for continued sedimentation immediately downstream of the weir and increase attraction flows, to improve the effectiveness of the fish passage improvement works at the weir under low and normal flow conditions.

Ecology

- Bats: It is possible that the bridge located immediately upstream of the proposed weir site may offer suitable roosting opportunities for bats.
- Otters: It is likely that the river corridor at the location of Hillsborough Weir is utilised as a movement corridor for otters.
- Nesting birds: The areas of tall ruderal herbs and scrub located immediately adjacent to the proposed weir site were identified as offering suitable habitat for nesting birds.
- White-clawed crayfish: All reaches of the River Loxley at all weir sites were identified as offering suitable habitat for white-clawed crayfish.
- Signal crayfish: As stated above, signal crayfish have been identified within the River Rivelin which enters the River Loxley above Limbrick Weir.

- Fish: As detailed within the desk study, bullhead and brown trout have been identified within the River Loxley. Notable fish species identified downstream of the River Loxley within the River Don include grayling, eel, brook lamprey.
- Invasive plant species: It is possible that invasive plant species (for example Himalayan balsam) exist within the riparian habitat immediately adjacent to all seven weir sites. However, since the walkover survey was undertaken in January 2013 when herbaceous plant species have died back or are less obvious, no allowance can be made for the presence of seasonal invasive species at the site.

Other constraints

Ownership of the weir is not known. Overhead lines are visible for the trams in the area. A flap valve is located at the downstream of the weir on the right bank, which is believed to be owned by Yorkshire Water.

Fish Pass improvement options

Option 3 Technical Fish pass	**Larinier, Denil or pool type pass**
Fish Passage effectiveness	Proven to work effectively over a wide range of water depths and flows. Larinier type can be designed to accommodate all species, including eels and lamprey in a single structure. Denil type and pool pass will require separate facilities for eels and lamprey (bristle mat/plate on weir or external walls of fish pass.)
Site suitability and constraints	In-bank construction of any option not feasible due to site constraints. Denil passes not preferred due to increased risk of blockage in an urban environment.
Archaeology	Partial removal of the weir to build a fish pass may affect the heritage value of the structure.
Flood risk	Altering the weir crest level will affect water levels but the impact at high flows will be minimal.
Health & safety	No more hazardous to build and operate than other options.
Maintenance requirements	Minimum maintenance required – long structural design life. Debris deflector will reduce the incidence of blockages of a baffled pass. A pool pass will require periodic silt removal to maintain energy

	dissipation characteristics of the pools.
Access (Construction & maintenance)	Will require access for substantial construction equipment. Maintenance access could be by boat or a fixed walkway although more elaborate works may be needed for de-silting.
Environmental aspects	In-river working during construction will require some specific control measures to mitigate the risk of pollution.
Buildability	In-river working required with some significant temporary works. Pool pass construction will be more complex than a baffle pass arrangement, increasing construction risks and programme.
Significant residual risks	Condition and construction details of existing weir possible similar impact for all technical fish pass options. Ownership of the weir. Access for construction and maintenance.
Overall assessment	A Larinier pass is likely to be about 19m long comprising 2 flights with a central resting pool. A Denil pass would be steeper and about 13m long with 2 flights and resting pool. A step pool or slot type pass will likely comprise 8 or 9 pools and have a total length of approx. 24m. A technical fish pass can accommodate all species, not only salmonids and grayling and is a proven and reliable means of enabling fish passage. Confidence that all species can pass this weir (and Limbrick) will enable the benefits of any interventions further upstream to be maximised.
Capital cost (£k)	Typical budget costs for a technical fish pass at this site are: £230,000 for construction £70,000 for access, plus 60% contingency allowance.

Total = £480,000

Option 5 Easements	**Easements in the form of baulks fixed to the right side weir glacis**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the easements may not be suitable for weaker swimming fish species including grayling. A separate eel pass will also be needed.
Site suitability and constraints	The steeply sloping glacis is not at an ideal gradient for this option (recommended maximum slope is 1 in 4) so some further works will be required to reduce the effective gradient.
Archaeology	No significant effect provided elements are fixed to the structure and so are removable. The weir crest will require locally lowering so fish can pass into the upstream reach
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will require working in the river. Maintenance access may be difficult increasing risks when work is required on the weir. There should not be any impact on utility services but regard should be taken of overhead lines during construction activities.
Maintenance requirements	Maintenance will consist of removing debris and silt build up from the baulks a couple of times a year. Larger debris may also require removal after a storm event. Maintenance is likely to require access into the river channel.
Access (Construction & maintenance)	Access to the site is restricted but should be possible for small machinery and materials

	from Walkley Lane before the bridge, possibly using cranes to lift machines into the river. However, the bridge is weak and cannot be relied on for access. Maintenance will require access into the watercourse, although this may be limited to small equipment and labour.
Environmental aspects	Limited impact except during construction: precautions will be needed to protect against the risk of pollution.
Buildability	This option could be designed to be simple and straightforward, requiring limited construction skills and may be suitable for implementation by properly supervised and managed volunteers. Attaching baulks to the existing structure should be achievable using portable tools but will depend on the nature and quality of the substrate. Breaking out a section of weir crest to form a notch may involve more significant activities and require the use of small construction equipment.
Significant residual risks	Effectiveness in passing the required species – the design of an easement is not an exact science and effective performance cannot be guaranteed, unlike a technical pass. The nature and condition of the weir structure and its suitability to support the proposed modifications. Risk of damage from floating debris.
Overall assessment	Constructing an easement on the weir glacis is a low cost option and could be a volunteer-led exercise if properly managed to ensure health and safety during construction and a robust end product. Attaching baulks to the structure will limit the impact on heritage value of the weir and would potentially be removable if needed. Ownership of the weir represents a significant risk and adopting a solution which can be reversed if the owner (if ever identified) requires it is a positive factor.

	The risk of the easement not delivering the benefits of salmonid passage over the weir will jeopardise any investment in works further upstream.
Capital cost (£k)	£15,000- £20,000 (based on 1 weeks work for a 3 man gang and hand tools only, with lifting equipment, scaffolding and other sundries, allowing £5k for in river works)
Option 6 Low Cost Baffles	**Low cost baffle units fixed to the glacis on the right bank of the weir.**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the low cost baffles may not be suitable for weaker swimming fish species including grayling. A considerable width of baffles may be needed to provide a suitable layout for larger fish to ascend. A separate eel pass will also be needed but could be a bristle mat fixed to the weir adjacent to the baffles.
Site suitability and constraints	Steeply sloping glacis not at an ideal gradient for this option (recommended maximum of 1:4) based on trials elsewhere and design recommendation and the head is greater than the 1m recommended maximum. Further works to the weir would be required to reduce the effective gradient.
Archaeology	No significant effect provided baffles are fixed to the structure although some crest modifications will be needed to create a notch.
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will involve working in the river: installing low cost baffles may require temporary works to divert and manage flows over the weir during installation.

Maintenance requirements	Maintenance will probably be minimal and limited to removal of debris after flood events.
Access (Construction & maintenance)	Installing temporary works may require access to the river channel by construction equipment: handling large panels of pre-fabricated baffles will also demand lifting equipment. Access requirements will be less onerous than for Option 3 – technical fish pass but craneage or access ramps may be needed during construction.
Environmental aspects	Limited impact due to nature of the works. Potential pollution risk during construction
Buildability	Installing baffle panels to the weir glacis will be a simple operation within the capability of volunteer labour but the extent of the works is likely require temporary works upstream of the weir to divert water levels and allow installation to take place. The works are probably more suited to construction by a civil engineering contractor.
Significant residual risks	Low cost baffles do not provide a guaranteed means of fish passage but the risk of failure is lower than with baulk type easements. The risk of both salmonids and other weaker swimming fish being unable to pass remains.
Overall assessment	This option has a greater chance of success at passing salmonids than does Option 5, however, investment in improvements further upstream may not yield the expected benefits if passage is not available at this weir
Capital cost (£k)	Budget cost for this option: £20,000 Low cost plastic baffle panels £40,000 Temporary works £10,000 Installation & sundries +60% contingency **Total £110,000**

Recommendation

The most compact pass – the Denil type – is generally not preferred for lowland rivers where the risk of blockage from debris is high: experience with Denil passes elsewhere on the River Don system reinforces this view (the topic was also raised at the public consultation meeting).

A pool pass will need to be a much larger construction with pools of minimum length 3m to accommodate salmon and sea trout: although the construction of a pool pass is a repetitive, the process is complex with commercial and programme risks.

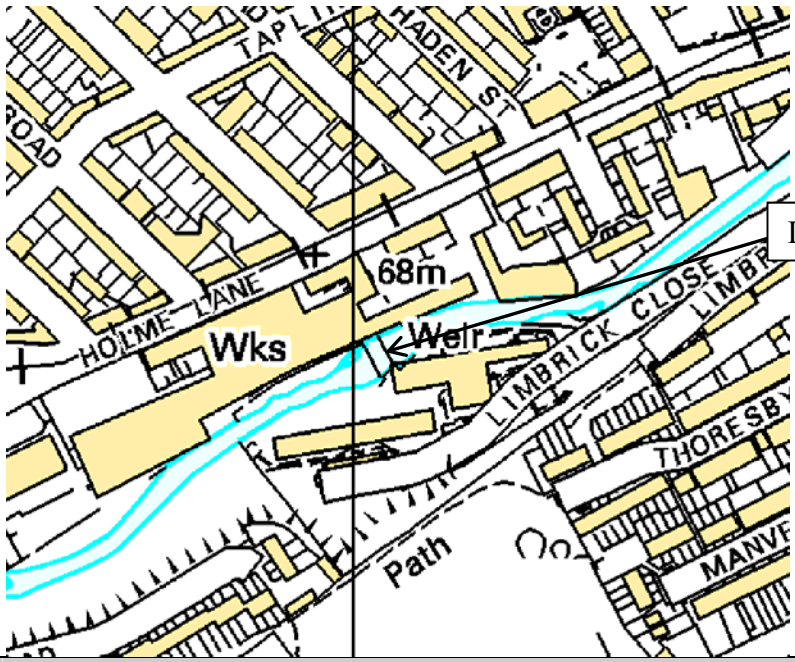
Easements formed by baulks are simple and cheap but have the significant disadvantage of being of empirical design with no certainty regarding effective operation. Low cost baffles provide a higher level of confidence that salmonids can pass but the nature and scale of construction will result in higher installation costs. The configuration of the weir at Hillsborough makes it unsuited to easement type solutions without some modifications.

As Hillsborough weir is a key location for facilitating fish passage into the Loxley and Rivelin, a reliable solution which provides a high level of confidence that salmonids can pass is recommended. A technical fish pass with predictable performance is therefore a preferred option.

A Larinier pass is recommended for this site: a Larinier pass is a proven, low maintenance means of achieving fish passage and will deliver confidence that not only salmonids will be able to ascend the pass but also that weaker swimming coarse fish species will be able to do so when conditions permit.

8 Limbrick Weir

Location Plan



Photographs

Figure 8: View from the right bank, looking upstream..

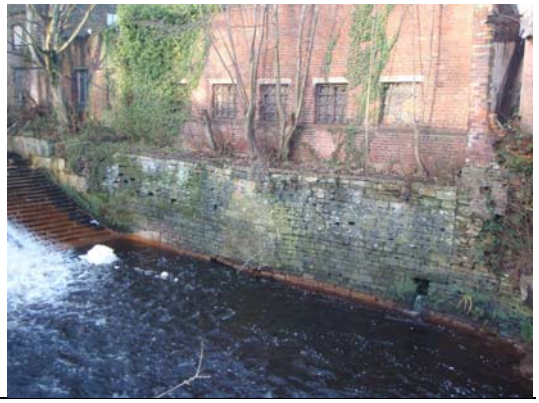


Figure 9: Left bank retaining wall

General description

Limbrick Weir is located at OS Grid Reference SK330 894. The weir is 2.5m high by 8.2m wide and is built square to the channel. The downstream sloping glacis is divided by longitudinal string courses in a series of panels. The weir appears to be built from dressed masonry blocks with a stepped downstream face. The slope of the downstream glacis is estimated to be at least 1 in 2.

The weir is situated in a heavily developed area of the river with buildings extending to the water's edge on each bank. Fish are likely to be attracted to those areas downstream of the weir with the greatest unit flow.

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weir downstream) will open 1.4km of the River Loxley to fish migration and also enable fish to access the River Rivelin.

Access

Access to the right bank is possible via a path along the side of a sheltered housing estate but this access is not suitable for use by machinery. The left bank is occupied by a number of old buildings although an access route has been identified from the upstream side of the weir through a site occupied by "Towsure": this would require tracking through the river to reach the site of the weir.

An access route may also be available through land currently occupied by a hand car wash site immediately adjacent to the weir on the left bank, however there may be height restrictions involved in this access route and enabling works will be required to make it suitable for use by construction plant.

Access to the weir from downstream is very awkward and would require overcoming the vertical drop from river bank to bed.

Geomorphology

Key characteristics, constraints and opportunities:
Upstream

- The existing aquatic habitat quality (particularly potential spawning habitat) immediately upstream of the weir is poor. This is due to the back-ponding of flows behind the weir resulting in an unnaturally over-deep channel in relation to the more 'naturalised' channel reaches further upstream. This increase in water depths and decrease in flow velocities, in turn results in a lack of hydromorphological diversity. Channel substrates upstream of the weir were obscured during the site visit due to a lack of access to the channel; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of fines (accreted due to the effect of the weir on flow velocities and sediment transport capacity immediately upstream). This combination of factors is likely to comprise poor local aquatic habitat conditions for migratory fish.
- A key driver for undertaking works at this weir may be associated with providing access for migratory fish to the River Rivelin tributary approximate 0.5km upstream. The Rivelin is also heavily modified with numerous weirs along its length; however, successful fish passage improvement works to the Limbrick Weir could potentially also open up access for migratory fish to the lower ~600m of the Rivelin before the first major weir is encountered. As such, it is recommended that a geomorphological and fish habitat walkover

assessment of the lower River Rivelin is undertaken under the subsequent stages of the project in order to help better verify the potential benefits of undertaking fish passage improvement works to the Limbrick weir.

- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features; provide refugia/cover habitat features for fish; improve marginal habitat value; and potentially introduce and fix gravel substrates upstream of the hydraulic influence of the weir to benefit spawning.

Downstream

- A scour pool is present at the base of weir, which extends for approximately 25m. Channel substrates at this location comprise predominately coarse cobble and boulder sized sediments. These coarse sediments have been displaced and deposited to form a topographic high across the channel bed at the downstream end of the scour pool; forming a quasi-riffle/cascade feature of relatively shallow, fast flowing and turbulent water.
- The river channel immediately downstream of the weir is incised; with gravels and fine sediments having largely been eroded and transported downstream, leaving predominately coarse cobble and boulder sized sediments (within limited re-supply of gravels from upstream, due to the presence of the reservoir and the attenuating effects of the weirs). This has resulted in some toe scour and undermining of the masonry retaining wall that forms the left channel bank at this location and supports the adjacent historical mill buildings .The degree of gravels present within the channel at this location is reduced from the weir sites observed further upstream; which is likely due to a combination of flow accretion from the Rivelin tributary inflow and increased flow depths and velocities caused by the channelisation of the river system through its urbanised lower reaches (and the associated increased capacity for the entrainment and transport of fine and gravel sediments during high flow events).
- Fish passage improvement works at this weir may need to consider ancillary bio-engineering works immediately downstream of the weir to protect and stabilise the channel banks and therefore reduce further scour at the toe of masonry walls and channel bed.

Ecology

- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters.
- Water voles: It is possible that the wooded riparian corridor located upstream of the proposed weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub

and tall ruderal herbs offer suitable habitat for nesting birds.

- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.
- Invasive species: As for Hillsborough Weir.

Other constraints

The left half of the weir is owned by Towsure Products Ltd. Ownership of the right bank side of the weir is unknown. There is no evidence of utilities in the area.

Fish Pass improvement options

Option 1 Weir Removal	**Partial or total weir removal**
Fish Passage effectiveness	Weir removal is the most effective form of fish passage and will permit all current and future species likely to inhabit the River Loxley to pass the site.
Site suitability and constraints	Access is difficult: removing large volumes of material from the site will be challenging and may involve dealing with contaminated material accumulated upstream of the weir. Bed re-grading to form an appropriate bed gradient will extend some distance upstream and downstream of the site and is likely to affect the stability of existing waterside structures.
Archaeology	The weir is not listed but has some heritage value.
Flood risk	Modelling has been undertaken to demonstrate that the removal of Limbrick weir does not affect flood risk.
Health & safety	Demolition is a high risk activity; there is a risk of instability of existing structures alongside the river during and after the works. Utilities will be unaffected by the works unless buried services exist within the river.

Maintenance requirements	Weir removal should have no on-going maintenance although there might be some works needed to encourage development of a naturalised bed.
Access (Construction & maintenance)	Access is very limited in this area and is likely to require making a temporary access to the weir from upstream or downstream or the use of floating plant with dredging or other improvements as needed. Any maintenance will be carried out from the channel.
Environmental aspects	Potential for the release of impounded sediments and the risk of exposure of contaminants.
Buildability	This is work which will require an experienced civil engineering contractor and large machinery.
Significant residual risks	The condition and construction details of the existing weir are not known. The risk of contaminated sediments being removed or released. Negotiations for access for construction and maintenance through third party land. River bed levels and conditions for access along the channel by water or a temporary road/causeway
Overall assessment	Weir removal is the ideal solution to overcoming this barrier to migration and will open both the river Loxley and also the Rivelin to fish assuming that the weirs downstream are made passable. The difficulties of making a suitable access to the site can possibly be overcome by negotiation with adjacent occupiers on the left bank although this might involve considerable enabling works. A comprehensive investigation of the site is required to determine the form and nature of the weir structure and to inform any precautions needed to deal with potential contaminants within the

	accumulated sediments.
Capital cost (£k)	Typical budget costs for removal of a weir of this size: £30,000 for excavation £50,000 for removal and disposal £100,000 for access and general items plus 60% contingency allowance. **Total = £288,000**
Option 3 Technical Fish pass	**Larinier, Denil, pool type or siphon pass**
Fish Passage effectiveness	Proven to work effectively over a wide range of water depths and flows. Larinier type can be designed to accommodate all species, including eels and lamprey in a single structure. Denil type and pool pass will require separate facilities for eels and lamprey (bristle mat/plate on weir or external walls of the fish pass.) Siphon passes are proven to work outside the UK and experience is being gained from a recent installation in Norfolk at Stoke Ferry.
Site suitability and constraints	In-bank construction of any option is not feasible due to site constraints. Denil passes are not preferred due to increased risk of blockage in an urban environment. A siphon pass would need to be surface mounted and of considerable size (diameter and overall length), raising concerns about impact on flood risk.
Archaeology	Partial removal of the weir to build a fish pass may affect the heritage value of the structure.
Flood risk	Altering the weir crest level will affect water levels but the impact at high flows will be minimal.
Health & safety	No more hazardous to build and operate than other options.

Maintenance requirements	Minimum maintenance required – long structural design life. Debris deflector will reduce the incidence of blockages of a baffled pass. A pool pass will require periodic silt removal to maintain energy dissipation characteristics of the pools.
Access (Construction & maintenance)	Will require access for substantial construction equipment. Maintenance access could be by boat or a fixed walkway although more elaborate works may be needed for de-silting.
Environmental aspects	In-river working during construction will require some specific control measures to mitigate the risk of pollution.
Buildability	In-river working required with significant temporary works. Pool pass construction will be more complex than a baffle pass arrangement, increasing construction risks and programme. A siphon pass will require the safe handling of large components on a restricted site.
Significant residual risks	Condition and construction details of the existing weir - similar impacts for all technical fish pass options. Access for construction and maintenance.
Overall assessment	A Larinier pass is likely to be about 25m long comprising 2 flights with a central resting pool. A step pool or slot type pass will likely comprise 11 or 12 pools and have a total length -25 - 30m. A siphon pass would be in excess of 30m in length and perhaps 2m- 2.5m diameter. A technical fish pass can accommodate all species, not only salmonids and grayling and is a proven and reliable means of enabling fish passage. Confidence that all species can pass this weir will enable the benefits of any interventions further upstream to be maximised.
Capital cost (£k)	Typical budget costs for a technical fish pass at this site are:

£265,000 for construction

£150,000 for access,

plus 60% contingency allowance.

Total = £664,000

Recommendations

Overcoming the obstruction of Limbrick weir is a key objective to enabling fish to access the River Loxley and the River Rivelin and an all-species capability is desirable for this site.

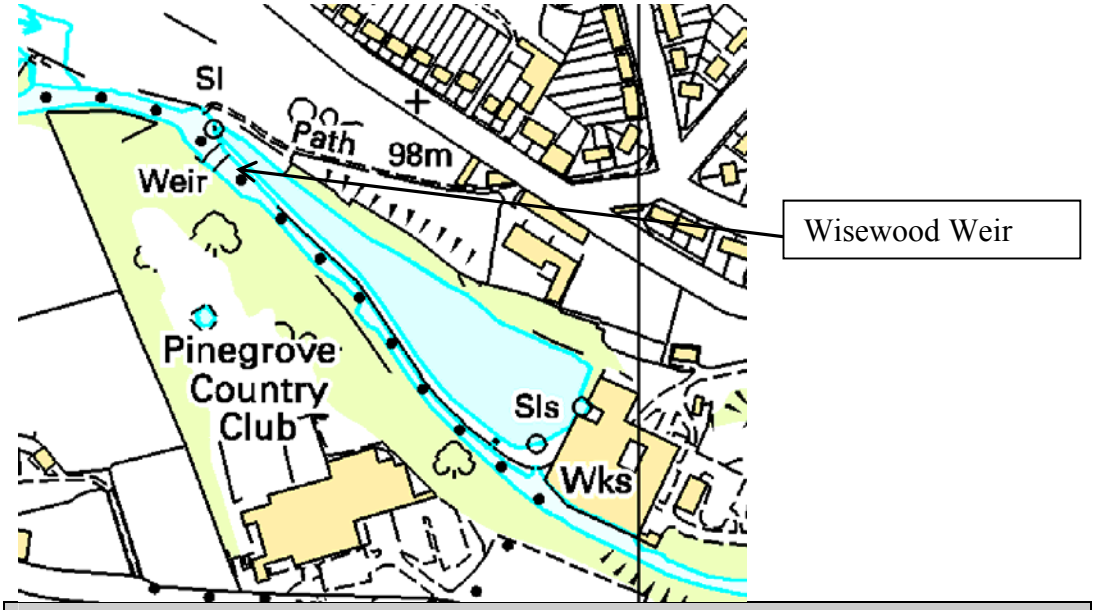
Although weir removal is generally the preferred option whenever possible, it carries with it considerable commercial and physical risks which will be difficult to manage economically – a comprehensive investigation of the weir and bed is required to inform the design of the removal works and the likely management strategy for dealing with potentially contaminated materials.

The difficulties of access to this site compound the risks.

A Larinier pass is recommended for this site: a Larinier pass is a proven, low maintenance means of achieving fish passage and will deliver confidence that not only salmonids will be able to ascend the pass but also that weaker swimming coarse fish species will be able to do so when conditions permit.

9 Wisewood Weir

Location Plan



Photographs

Figure 10: Looking at weir from left bank downstream

Figure 11: View from the left bank looking upstream.

Figure 12: View from the left bank looking downstream.

General description

Wisewood Weir is located at OS Grid Reference SK317 896. The weir is about 2m high by 11.1m wide and is built square to the channel. The downstream sloping glacis is divided by longitudinal string courses in a series of panels. The weir appears to be built from dressed masonry blocks with a stepped downstream face. The slope of the downstream glacis is estimated at close to1 in 3.

The weir is situated in a rural area of the river with woodland and scrub extending to the water's edge on each bank. Fish are likely to be attracted to those areas downstream of the weir with the greatest unit flow.

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weirs downstream) will enable fish to migrate into 810m river upstream of the site.

Access

A narrow path leads from the disused millpond (now ornamental lake) adjacent to a residential housing estate along a promontory between the river and the lake leading to the downstream side of the weir. Small construction plant could access the site from downstream via this route.

A slightly wider path exists at the weir and leads from the nearby Loxley Road;

this path ends at a steep slope (currently steps) but could be made suitable with some improvements for small construction plant to access the site. Either route must cross the goit which connects the river to the lake, either via existing bridges of unknown capacity or by some other temporary means.

Geomorphology

Key characteristics, constraints and opportunities:
Upstream

- Flow is back-ponded behind the weir for approximately 35m., which has resulted in an over-deep channel and reduced hydromorphological diversity locally. This has accentuated the natural pool feature that is expected to be located here along the outside of the meander bend. Channel substrates immediately upstream of the weir were not visible during the site visit due to water depths; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of finer sediments (accreted due to the effect of the weir on flow velocities and sediment transport capacity immediately upstream). Given the above conditions, this area is unlikely to comprise suitable spawning habitat, but may offer a refugia/resting area for migratory fish having traversed the weir.
- The left bank of the channel upstream of the weir forms the outside of a low amplitude meander, and is steep and subject to fluvial erosion and geotechnical failures. This is likely to comprise a source of direct fine sediment inputs to the river system, with potentially adverse impacts upon the substrate habitat quality within the ponded reach immediately upstream of the weir. The bank is partially reinforced with a masonry retaining wall approximately 30m upstream of the weir. Accordingly, ancillary bio-engineering works immediately upstream of the weir to re-profile and stabilise the left channel bank in order to reduce erosion and fine sediment delivery to the channel, and improve marginal aquatic habitat value, may provide additional benefits to the proposed fish passage improvement works.
- A number of quasi-riffle features are present upstream of the ponded reach described above; comprising predominately coarse cobble and boulder substrates, due to the general lack of gravels present within the river system.
- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features and/or the re-profiling of the channel bed and banks; provide refugia/cover habitat features for fish; improve marginal habitat value; and potentially introduce and fix gravel substrates to benefit spawning.

Downstream

- A scour pool is present at the base of weir, which extends for approximately 15m. Channel substrates at this location comprise predominately coarse cobble and boulder sized sediment with some interstitial coarse gravels. These coarse sediments have been displaced and deposited to form a topographic high across the channel bed at the downstream end of the scour pool; forming

a small cobble and gravel side bar on the left side of the channel that is exposed at typical and low flow conditions. Coarse cobble and boulder sized substrates have formed a quasi-riffle/cascade feature of relatively shallow, fast flowing water.

- The left channel bank downstream of the weir is formed by a masonry retaining wall supporting the access track running between the river and the adjacent historical mill race channel. The right bank is shallow grading initially, with marginal deposits of coarse cobble and boulder sized sediments and a number of mature trees lining the channel. Beyond this the bank raises steeply, with potential for a high degree of surface runoff, sediment and CWD delivery to the channel.
- The channel system both up and downstream of the weir is gravel starved in general. This is due to the past entrainment ("plucking") of gravels and their downstream transport, with a limited re-supply available from upstream (due to the presence of the reservoir and the attenuating effects of the weirs). The degree of gravels present within the channel at this location is greater than further upstream, however; which is likely due to the downstream transport of gravels entrained upstream, and an increasing natural supply of gravels directly to the channel with progression down the river system from bank erosion and minor tributary inflows.

Ecology

- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Badgers: The adjacent areas of woodland surrounding the weir site were identified as offering suitable locations for badger setts.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters. It is also possible that the wooded riparian habitat offers suitable habitat for otter holts (dens) / couches (laying up sites).
- Water voles: It is possible that the wooded riparian corridor located at the weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub and tall ruderal herbs offer suitable habitat for nesting birds.
- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.
- Invasive species: As for Hillsborough Weir.

Other constraints

The left half of the weir is owned by Medicx Health (Loxley Park) Limited: ownership of the right bank section is unknown. There is no evidence of utilities in the area; however, works may temporarily affect the public footpaths around the site.

Fish Pass improvement options

Option 5 Easements	**Easements in the form of baulks fixed to the left side weir glacis**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the easements may not be suitable for weaker swimming fish species including grayling. A separate eel pass will also be needed.
Site suitability and constraints	The steeply sloping glacis is not at an ideal gradient for this option so some additional measures are likely to be needed to reduce the effective gradient.
Archaeology	No significant effect provided elements are fixed to the structure and so are removable. The weir crest will require locally lowering so fish can pass into the upstream reach
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will require working in the river. Potential manual handling risks if machine access is not possible. There should not be any impact on utility services but regard should be taken of overhead lines during construction activities.
Maintenance requirements	Maintenance will consist of removing debris and silt build up from the baulks a couple of times a year. Larger debris may also require removal after a storm event. Maintenance is likely to require access into the river channel but may be possible from the left bank.
Access (Construction & maintenance)	Access to the site is difficult as the main access routes are via narrow paths and will require some enabling works to cross the

	goit channels. Access is likely to be by the left bank as the right bank is overgrown with no visible means of ready access. There are a number of public footpaths in the area of the works which may require temporary diversion or (unlikely) closure.
Environmental aspects	Limited impact except during construction: precautions will be needed to protect against the risk of pollution.
Buildability	This option could be designed to be simple and straightforward, requiring limited construction skills and may be suitable for implementation by properly supervised and managed volunteers. Attaching baulks to the existing structure should be achievable using portable tools but will depend on the nature and quality of the substrate. Breaking out a section of weir crest to form a notch may involve more significant activities and require the use of small construction equipment.
Significant residual risks	Effectiveness in passing the required species – the design of an easement is not an exact science and effective performance cannot be guaranteed, unlike a technical pass. The nature and condition of the weir structure and its suitability to support the proposed modifications. Risk of scour damage to downstream waterway walls Risk of damage from floating debris.
Overall assessment	Constructing an easement on the weir glacis is a low cost option and could be a volunteer-led exercise if properly managed to ensure health and safety during construction and a robust end product. Attaching baulks to the structure will limit the impact on heritage value of the weir and would potentially be removable if needed. The risk of the easement not delivering the benefits of salmonid passage over the weir will jeopardise any investment in works further upstream.

Capital cost (£k)	£8,000- £10,000 (based on 1 weeks work for a 3 man gang and hand tools only, with a mini excavator or similar to lift equipment, scaffolding and other sundries, allowing £2k for in river works)
Option 6 Low Cost Baffles	**Low cost baffle units fixed to the glacis over the full or part width of the weir**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the low cost baffles may not be suitable for weaker swimming fish species including grayling. A considerable width of baffles may be needed to provide a suitable layout for larger fish to ascend. A separate eel pass will also be needed but could be a bristle mat fixed to the weir adjacent to the baffles.
Site suitability and constraints	Steeply sloping glacis not at an ideal gradient for this option based on trials elsewhere and design recommendation (maximum 1:4 slope) and some additional measures will be needed to make the weir suited to this option.
Archaeology	No significant effect provided baffles are fixed to the structure although some crest modifications will be needed to create a notch.
Flood risk	There should be no significant impact on flood risk: attaching baffles to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will involve working in the river: installing low cost baffles may require temporary works to divert and manage flows over the weir during installation.
Maintenance requirements	Maintenance will probably be minimal and limited to removal of debris after flood events.
Access (Construction & maintenance)	Installing temporary works may require access to the river channel by construction

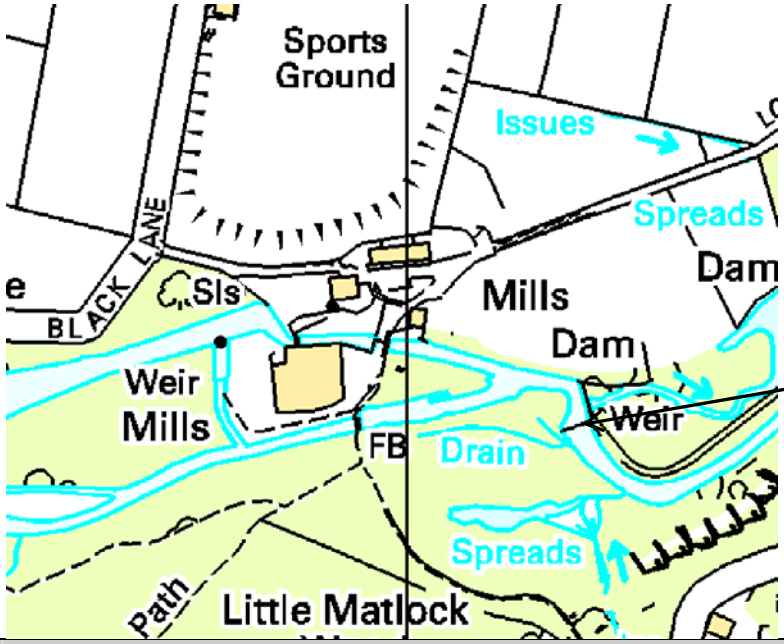
	equipment: handling large panels of pre-fabricated baffles will also demand lifting equipment. Access requirements will be more onerous than for Option 5 – easement but larger equipment will be needed to create the temporary works and handle materials needed during construction.
Environmental aspects	Limited impact due to nature of the works. Potential pollution risk during construction
Buildability	Installing baffle panels to the weir glacis will be a simple operation within the capability of volunteer labour but the extent of the works is likely to require temporary works upstream of the weir to divert water levels and allow installation to take place. The works are probably more suited to construction by a civil engineering contractor.
Significant residual risks	Low cost baffles do not provide a guaranteed means of fish passage but the risk of failure is lower than with baulk type easements. The risk of both salmonids and other weaker swimming fish being unable to pass remains.
Overall assessment	This option has a greater chance of success at passing salmonids than does Option 5, however, investment in improvements further upstream may not yield the expected benefits if passage is not available at this weir
Capital cost (£k)	Budget cost for this option: £20,000 Low cost plastic baffle panels £20,000 Temporary works & access £10,000 Installation & sundries +60% contingency **Total £80,000**
Recommendation	Access to this site is possible for small scale plant after modest improvement works so either a baulk or a baffle option is feasible. The risk of an easement solution not delivering the expected benefits must be

recognised but as coarse fish are unlikely to find the Loxley attractive, providing a means for strong swimming salmonids to pass the weir may be appropriate when considering the cost differential.

The recommended solution to this site is an easement formed using baulks or similar fixed to the weir glacis.

10 Green Wheel Weir

Location Plan



Photographs

Figure 13: View from the right bank looking upstream at the weir.

Figure 14: View right bank looking upstream..

Figure 15: Historic bypass channel to right of weir

General description

Green Wheel Weir is located at OS Grid Reference SK310 893. The weir is 1.1m high by 16.2m wide and is built square to the channel.

The downstream sloping glacis is constructed from stone slabs and is at a gradient of about 1 in 2.

The weir is situated in a rural area of the river with woodland and scrub extending to the water's edge on each bank. Fish are likely to be attracted to those areas downstream of the weir with the greatest unit flow.

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weirs downstream) will enable fish to reach 500m river upstream of the sites.

Access

Pedestrian access to the weir involves crossing two small pedestrian bridges. However a field leads from Low Matlock Lane to the water's edge and it may be possible to negotiate access to the weir by this route: this will involve crossing about 75m of field.

Geomorphology

Key characteristics, constraints and opportunities:

- This site comprises a complex existing hydromorphological condition; with regards to both low and high flow dynamics, sediment transport and deposition processes, bank erosion process, and artificial influences. Accordingly, a detailed geomorphological site assessment and a high degree of geomorphological input into the design stage of any proposed fish passage improvement works is highly recommended at this site.
- The river channel around the location has been unnaturally over-widened due to the presence of the weir, in relation to the more 'naturalised' channel reaches downstream. This has resulted in shallower flows and reduced transport capacity around the weir, which in turn has promoted the deposition of coarse sediments immediately upstream and downstream of this relatively low head weir as the river has re-narrowed its width. This has accentuated natural depositional processes that occur along the inside of the meander bend at this site (across which the weir has been constructed) immediately downstream of the weir; forming a large cobble point bar on the right bank. Combined with the back-ponding effects of the weir, this has also resulted in the deposition of a large mid-channel bar immediately upstream of the weir; which predominately comprises coarse gravels and cobble sized sediments.
- Fine sediments have largely been entrained and transported downstream (with a limited re-supply of gravels from upstream likely due to the presence of the reservoir and retaining effects of the large weirs upstream). However, the amount of gravels present at this site is noticeably greater than at locations observed upstream; which is likely due to the gradual accumulation of gravels that have been plucked from reaches upstream and transported downstream, together with the increasing natural supply of gravels to the channel with progression down the river system from bank erosion and minor tributary inflows.
- As is expected at this meander location, typical flows are focused (deeper and faster) around the outside of the meander along the left bank. This is exacerbated, however, due to the pattern of sediment deposition described above. The right bank at this location has been artificially reinforced with block-stone bank protection. A quasi-riffle feature is present immediately downstream of the weir, comprising predominately coarse cobble and boulder substrates; due to the general lack of gravels present within the river system.
- The river channel has naturally begun to cut a by-pass channel along the right side of the channel, through the inside of the meander bend. This channel is currently dry under typical and low flow conditions, but is expected to become active during high flow events. Accordingly, there is potential scope to formalise this natural by-pass channel in order to provide fish passage and improve biological and sediment continuity around the weir. This would need to be designed to ensure that: adequate flow depths to support fish passage are maintained under normal conditions; sediment deposition at the downstream end of the by-pass channel (currently a natural deposition zone) is discouraged to prevent the effectiveness of this solution being compromised (e.g. suitable attraction flows and depths are maintained); and future channel erosion and instability risk is adequately controlled.

- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to improve refugia/cover habitat features for fish, and potentially introduce and fix gravel substrates to benefit spawning. Ancillary work may also need to be considered at this site with regards to sediment management, due to the immediate site being a natural depositional zone. There may be scope to utilise gravel sediments deposited at this site as a potential supply source for gravel augmentation river restoration works to improve spawning habitat elsewhere along the watercourse in the less hydraulically impacted areas between the weirs.
- In combination with the fish pass easement works proposed at this weir, there may be potential to open up the historic mill race channel and pond located upstream, in order to provide additional biological continuity/connectivity benefits between the reaches upstream and that upstream of the Low Matlock weir further up the catchment. This would likely require some form of fish passage improvement works at the downstream (outflow) end of the mill pond and along the mill race channel. This is likely to be less effective for migratory species though due to the lack of attraction flows, however could potentially provide wider fish passage and biodiversity benefits in alignment with WFD objectives. However, the potential implications of re-opening and modifying the mill race channel and pond would need to be further investigated, in relation to channel stability, flood risk, and heritage/amenity constraints.

Ecology

- Ancient woodland: Little Matlock Ancient and Semi-Natural Woodland is located immediately south of the proposed weir site.
- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Badgers: The adjacent areas of woodland surrounding the weir site were identified as offering suitable locations for badger setts.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters. It is also possible that the wooded riparian habitat offers suitable habitat for otter holts (dens) / couches (laying up sites).
- Water voles: It is possible that the wooded riparian corridor located at the proposed weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub and tall ruderal herbs offer suitable habitat for nesting birds.
- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.

- Invasive species: As for Hillsborough Weir.

Other constraints

No land ownership information is available. There is no evidence of utilities in the area.

Fish Pass improvement options

Option 4 By-pass channel	**Rehabilitate existing channel at right bank**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids and all other species. Attraction flow should be considered to ensure that fish find the entrance; the entrance is well located close to the toe of the weir.
Site suitability and constraints	Rehabilitation of the existing channel is possible, avoiding extensive earthworks
Archaeology	No effect.
Flood risk	There should be no significant impact on flood risk: although conveyance at the weir will be increased by the by-pass channel
Health & safety	No unusual hazards but there is a risk of exposure to contaminated materials in the channel
Maintenance requirements	Maintenance will probably be minimal and limited to removal of debris after flood events and possible repairs to scour damage.
Access (Construction & maintenance)	Access is available from the nearby Low Matlock Lane across fields for about 75m to the left bank of the river. A crossing of the goit and the river would then be required but could easily be achieve using temporary pipes and a causeway.

Environmental aspects	Limited impact due to nature of the works. Potential pollution risk during construction. Additional biodiversity enhancements could accrue from a by-pass channel.
Buildability	Cleaning out a channel could be manual operation completed by volunteers. Some scour protection measures are likely to be needed and an inlet structure will be required to control flow into the channel. The assistance of a civil engineering contractor may be needed.
Significant residual risks	Generally low risk provided attraction flow is adequate and fish can reach the site.
Overall assessment	This option has potential to deliver a cost effective solution to fish passage at the weir and could form part of a community initiative using volunteers to carry out the unskilled activities required.
Capital cost (£k)	Budget cost for this option: £6,000- £8,000 (based on 3days works for a 3 man gang and hand tools only, allowing£1k for in river works). A further £5,000 should be allowed for plant access if needed.
Option 5 Easements	**Easements in the form of baulks fixed to the weir glacis**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the easements may not be suitable for weaker swimming fish species including grayling. A separate eel pass will also be needed.
Site suitability and constraints	The steeply sloping glacis is not at an ideal gradient for this option so some modifications may be required to reduce the effective gradient. Could be fitted on either side of the weir.

Archaeology	No significant effect provided elements are fixed to the structure and so are removable. The weir crest will require locally lowering so fish can pass into the upstream reach
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will require working in the river. Potential manual handling risks if machine access is not possible.
Maintenance requirements	Maintenance will consist of removing debris and silt build up from the baulks a couple of times a year. Larger debris may also require removal after a storm event. Maintenance is likely to require access into the river channel but may be possible from the left bank.
Access (Construction & maintenance)	Access can be made via low Matlock Lane if machines are required. Installing baulks will require fairly small scale equipment.
Environmental aspects	Limited impact except during construction: precautions will be needed to protect against the risk of pollution.
Buildability	This option could be designed to be simple and straightforward, requiring limited construction skills and may be suitable for implementation by properly supervised and managed volunteers. Attaching baulks to the existing structure should be achievable using portable tools but will depend on the nature and quality of the substrate. Breaking out a section of weir crest to form a notch may involve more significant activities and require the use of small construction equipment.
Significant residual risks	Effectiveness in passing the required

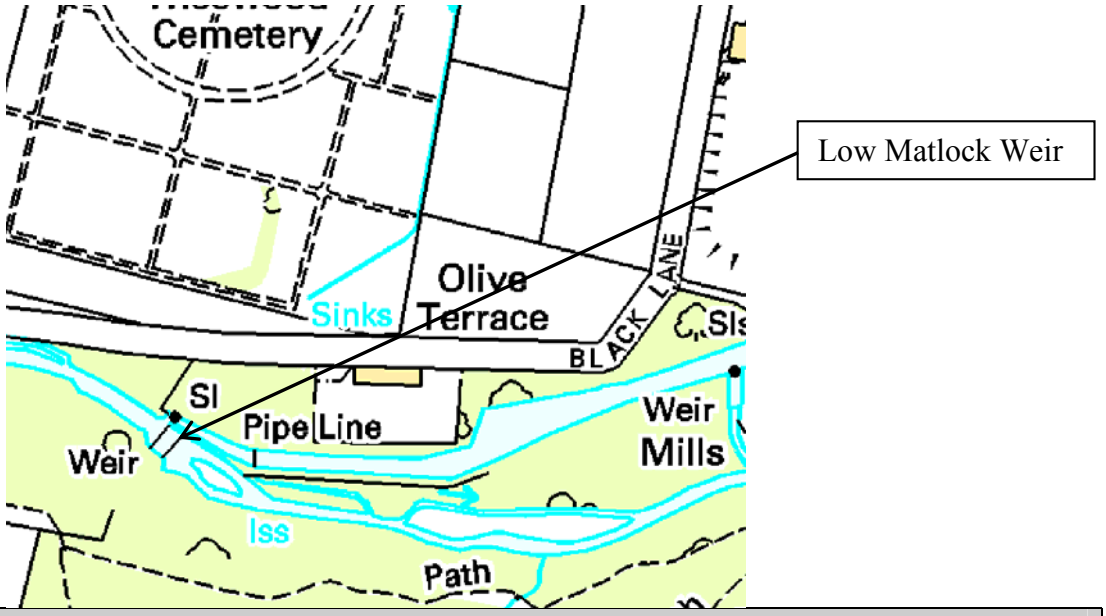
	species – the design of an easement is not an exact science and effective performance cannot be guaranteed, unlike a technical pass. The nature and condition of the weir structure and its suitability to support the proposed modifications. Risk of scour damage to downstream waterway walls Risk of damage from floating debris.
Overall assessment	Constructing an easement on the weir glacis is a low cost option and could be a volunteer-led exercise if properly managed to ensure health and safety during construction and a robust end product. Attaching baulks to the structure will limit the impact on heritage value of the weir and would potentially be removable if needed. The risk of the easement not delivering the benefits of salmonid passage over the weir will jeopardise any investment in works further upstream.
Capital cost (£k)	£4,000- £5,000 (based on 2 days works for a 3 man gang and hand tools only, allowing £1k for in river works). A further £5,000 should be added for plant access.
Recommendation	Access to this site is possible for small scale plant after modest improvement works so either a baulk or a by-pass channel option is feasible. The risk of an easement solution not delivering the expected benefits must be recognised but as coarse fish are unlikely to find the Loxley attractive, providing a means for strong swimming salmonids to pass the weir may be appropriate when considering the cost differential. A by-pass channel may be considered a more sustainable solution and should generate additional biodiversity benefits. **The recommended solution to this site is an easement** formed using baulks or similar fixed to the weir glacis *if*

minimum cost is the driver.

If *biodiversity benefits are to be maximised* at modest additional cost, the **rehabilitation of the existing by-pass channel is recommended**.

11 Low Matlock Weir

Location Plan



Photographs

Figure 16: View from the right bank looking upstream

Figure 17: View from the right bank looking upstream.

Figure 18: View of left bank at toe of weir from the right bank, looking further downstream, goit can be seen in centre of picture.

General description

Low Matlock Weir is located at OS Grid Reference SK306 894. The weir is 2.5m high by 16.5m wide and is built square to the channel.

The downstream sloping glacis is constructed from stone slabs and is at a gradient of close to 1 in 3 with a step at the toe of the apron.

The weir is situated in a rural area of the river with woodland and scrub extending to the water's edge on each bank. Fish are likely to be attracted to those areas downstream of the weir with the greatest unit flow.

The weir appears to be built from dressed masonry blocks with a stepped downstream glacis. The weir is divided into discrete panel by longitudinal string courses

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weirs downstream) will enable fish to reach 475m of river upstream of the site.

Access

Access to the weir is from a footpath on the right bank: however, the bank drops

steeply to the weir and access for machinery would not be possible from this bank without extensive and disruptive works. Houses back onto the left bank and access may be possible across their land from Black Lane. However any machinery would have to cross the goit before it could reach the left bank of the weir.

Geomorphology

Key characteristics, constraints and opportunities:
Upstream

- The existing aquatic habitat quality (particularly potential spawning habitat) immediately upstream of the weir is poor. This is due to the back-ponding of flows behind the weir resulting in a unnaturally over-deep and over-wide channel in relation to the more 'naturalised' channel reaches further upstream and downstream. This increase in water depths and decrease in flow velocities, together with limited marginal vegetation or refugia habitat features, in turn results in a lack of hydromorphological diversity. Channel substrates upstream of the weir were obscured during the site visit due to a lack of access; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of fines (accreted due to the effect of the weir on flow velocities and sediment transport capacity immediately upstream). This combination of factors is likely to comprise poor aquatic habitat conditions for migratory fish.
- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features and/or the re-profiling of the channel bed and banks; provide refugia/cover habitat features for fish; improve marginal habitat value; and potentially introduce and fix gravel substrates to benefit spawning.

Downstream

- The river channel immediately downstream of the weir is incised; with gravels and fine sediments having largely been eroded and transported downstream, leaving predominately coarse cobble and boulder sized sediments (within limited re-supply of gravels from upstream, due to the presence of the reservoir and the attenuating effects of the weirs). The river channel at this location has been unnaturally over-widened due to the presence of the weir, resulting in shallower flows and reduced transport capacity immediately downstream of the weir, in turn promoting the deposition of coarse sediments as the river has re-narrowed its width. This deposited coarse sediment has formed a large mid-channel bar immediately downstream of the weir; which has become partially vegetated with grasses, suggesting that this feature is relatively stable. However, this bar is likely to become submerged during high flow conditions. It is possible that some of these coarse sediments may have been scoured from the channel bed at the base of the weir and deposited directly downstream.
- A scour pool is present at the base of the weir. Immediately downstream of this, the mid-channel bar described above acts to focus flows predominately along the left side of the channel in a run. This has resulted in some toe scour and undermining of the masonry retaining wall that forms the left channel bank at

this location and supports the adjacent historical mill race channel. Flow along the right side of the channel is presently ponded during typical /low flow conditions due to the influence of in-channel deposition and debris accumulations. Downstream of this flow is re-focused to the middle of the channel in a small cascade feature. The right channel bank at the site is steep, with a potential for a high degree of surface runoff, sediment and CWD delivery to the channel

- Due to the conditions described above, fish passage improvement works at this weir may need to consider ancillary bio-engineering works immediately downstream of the weir to narrow the channel width, in turn increasing flow depths and velocities and discouraging further sedimentation around the approach to the weir. Such works could potentially reduce the capacity for continued deposition immediately downstream of the weir and increase attraction flows, to improve the effectiveness of the fish passage solution applied at the weir under low and typical flow conditions. In addition, such works may be designed to potentially reduce erosion risk to the masonry wall bank protection along the left channel bank downstream of the weir.
- In combination with the fish passage improvement works proposed at the weir, there may be potential to open up the historic mill race channel and pond along the left side of the channel, in order to provide additional biological continuity/connectivity benefits between the reaches upstream and downstream of the weir. This would likely require some form of fish passage improvement works at the downstream (outflow) end of the mill pond and along the mill race channel, in order to allow access from the river channel downstream. This is likely to be less effective for migratory species due to the lack of attraction flows, however could potentially provide wider fish passage and biodiversity benefits in alignment with WFD objectives. However, the potential impactions of re-opening and modifying the mill race channel and pond would need to be further investigated, in relation to channel stability, flood risk, and heritage/amenity constraints.

Ecology

- Ancient woodland: Little Matlock Ancient and Semi-Natural Woodland is located immediately south of the proposed weir site.
- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Badgers: The adjacent areas of woodland surrounding the weir site were identified as offering suitable locations for badger setts.
- Bats: The mature trees located in close proximity to the weir site may offer suitable roosting opportunities for bats.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters. It is also possible that the wooded riparian habitat offers suitable habitat for otter holts (dens) / couches (laying up sites).
- Water voles: It is possible that the wooded riparian corridor located at the proposed weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub and

tall ruderal herbs offer suitable habitat for nesting birds.

- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.
- Invasive species: As for Hillsborough Weir.

Other constraints

The left half of the weir is owned by David and Steve Shaw. The right half is owned by Tobin Threvethick. There is no evidence of utilities in the area.

Grade II* listed, the wheel is the largest of its type to survive in Sheffield. The listing is for the whole site.

Fish Pass improvement options

Option 3 Technical Fish pass	**Larinier, Denil or pool type pass**
Fish Passage effectiveness	Proven to work effectively over a wide range of water depths and flows. Larinier type can be designed to accommodate all species, including eels and lamprey in a single structure. Denil type and pool pass will require separate facilities for eels and lamprey (bristle mat/plate on weir or external walls of fish pass.)
Site suitability and constraints	In-bank construction of any option is not feasible due to site constraints, including the listed status of the area, the goit and access difficulties to both banks. Denil passes are not preferred due to increased risk of blockage in a heavily wooded environment.
Archaeology	Partial removal of the weir to build a fish pass will affect the heritage value of the structure and mitigations may be required. Listed Building Consent will be needed.
Flood risk	Altering the weir crest level will affect water levels but the impact at high flows will be minimal.
Health & safety	No more hazardous to build and operate than other options.

Maintenance requirements	Minimum maintenance required – long structural design life. Debris deflector will reduce the incidence of blockages of a baffled pass. A pool pass will require periodic silt removal to maintain energy dissipation characteristics of the pools.
Access (Construction & maintenance)	Will require access for substantial construction equipment. Maintenance access could be by boat or a fixed walkway although more elaborate works may be needed for de-silting.
Environmental aspects	In-river working during construction will require some specific control measures to mitigate the risk of pollution.
Buildability	In-river working required with substantial temporary works. Pool pass construction will be more complex than a baffle pass arrangement, increasing construction risks and programme.
Significant residual risks	Condition and construction details of existing weir - possible similar impact for all technical fish pass options. Agreement with owners of the weir. Statutory Consents and approvals Access for construction and maintenance.
Overall assessment	A Larinier pass is likely to be about 25m long comprising 2 flights with a central resting pool. A Denil pass would be steeper and about 18m long with 2 flights and resting pool. A step pool or slot type pass will likely comprise 10 or 11 pools and have a total length -25 - 30m. A technical fish pass can accommodate all species, not only salmonids and grayling, and is a proven and reliable means of enabling fish passage. Confidence that all species can pass this weir will enable the benefits of any interventions further upstream to be maximised.
Capital cost (£k)	Typical budget costs for a technical fish

	pass at this site are: £265,000 for construction £50,000 for access plus 60% allowance **Total = £504,000**
Option 6 Low Cost Baffles	**Low cost baffle units fixed to the glacis on the left side of the weir.**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the low cost baffles may not be suitable for weaker swimming fish species including grayling. A considerable width of baffles may be needed to provide a suitable layout for larger fish to ascend. A separate eel pass will also be needed but could be a bristle mat fixed to the weir adjacent to the baffles.
Site suitability and constraints	Steeply sloping glacis not at an ideal gradient for this option based on trials elsewhere and design recommendation: some modifications will be needed to make the weir suitable.
Archaeology	The baffles would be removable and alterations to the structure would be limited to a crest notch. Any modifications to the slope could be designed as reversible. This may find favour with English Heritage.
Flood risk	There should be no significant impact on flood risk: attaching baffles to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will involve working in the river: installing low cost baffles will require temporary works to divert and manage flows over the weir during installation.
Maintenance requirements	Maintenance will probably be minimal and limited to removal of debris after

	flood events.
Access (Construction & maintenance)	Installing temporary works may require access to the river channel by construction equipment: handling large panels of pre-fabricated baffles will also demand lifting equipment. Access requirements will be less onerous than for Option 3 – technical fish pass but access by construction machinery will be needed during construction.
Environmental aspects	Limited impact due to nature of the works. Potential pollution risk during construction
Buildability	Installing baffle panels to the weir glacis will be a simple operation within the capability of volunteer labour but the extent of the works is likely to require temporary works upstream of the weir to divert water levels and allow installation to take place. The works are probably more suited to construction by a civil engineering contractor.
Significant residual risks	Low cost baffles do not provide a guaranteed means of fish passage but the risk of failure is lower than with baulk type easements. The risk of both salmonids and other weaker swimming fish being unable to pass remains. The consent of the weir owner and English Heritage will be required.
Overall assessment	This option has a lower chance of success at passing salmonids than does Option 3 and coarse fish may be unable to pass at all.
Capital cost (£k)	Budget cost for this option: £20,000 Low cost plastic baffle panels £50,000 Temporary works £10,000 Installation & sundries +60% contingency **Total £130,000**

Recommendation

The most compact pass – the Denil type – is generally not preferred for lowland rivers where the risk of blockage from debris is high: experience with Denil passes elsewhere on the River Don system reinforces this view (the topic was also raised at the public consultation meeting).

A pool pass will need to be a much larger construction with pools of minimum length 3m to accommodate salmon and sea trout: although the construction of a pool pass is repetitive, the process is complex with commercial and programme risks.

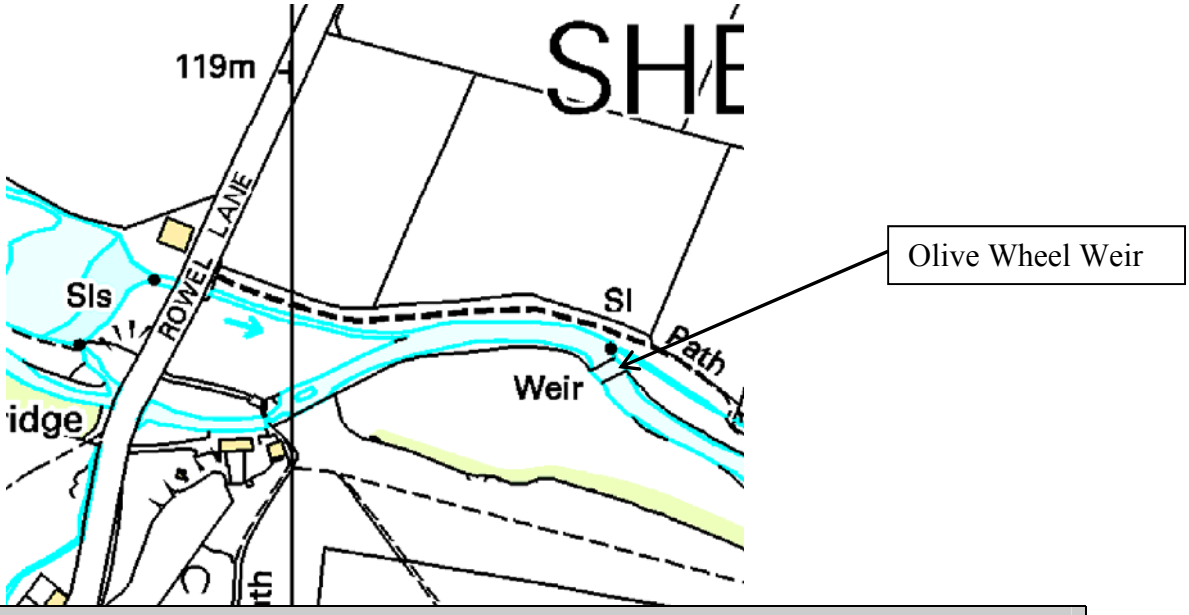
Low cost baffles provide a higher level of confidence that salmonids can pass but the nature and scale of construction will result in higher installation costs.

As this weir is so far up the catchment, it may be difficult to justify spending large sums on an all species technical pass.

A low cost baffle option is recommended for this site: salmonid passage can be assured with some confidence although coarse fish may be unable to use the pass. A residual risk remains that this option may not be fully effective as the slope of the glacis and height of the weir are outside current best practice guidelines.

13 Olive Wheel Weir

Location Plan



Photographs

Figure 19: View from the left bank looking upstream

Figure 20: Side on view from the left bank.

Figure 21: View from the left bank looking downstream.

General description

Olive Wheel Weir is located at OS Grid Reference SK 301 895.

The weir is 1.85m high by 15.5m wide and is built square to the line of the channel. It comprises a sloping glacis divided by longitudinal string courses in a series of panels with an apron extending about 4m downstream from the toe of the weir, this is slightly shorter on the left bank than the right bank. The weir appears to be built from dressed masonry blocks and is used by the EA for flow gauging. The slope of the upper downstream glacis is estimated at 1 in 2, with a lower less steeply sloping apron extending at a gradient of about 1 in 4.

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weirs downstream) would enable fish to reach 1300m of river upstream.

Access

Access to Olive Wheel is along a public footpath on the left bank from Rowel Lane. The footpath is narrow and is unlikely to be suitable for machinery without some localised improvements. A field is located on the right bank which connects

to the road about 175m away and it may be possible to negotiate with the landowner to create access for machinery from this bank.

Geomorphology

Key characteristics, constraints and opportunities:
Upstream

- The existing aquatic habitat quality (particularly potential spawning habitat) immediately upstream of the weir is poor. This is due to the back-ponding of flows behind the weir resulting in an unnaturally over-deep and over-wide channel in relation to the more 'naturalised' channel reaches further upstream and downstream. This increase in water depths and decrease in flow velocities, together with limited marginal vegetation or refugia habitat features, in turn results in a lack of hydromorphological diversity. Channel substrates upstream of the weir were partially obscured during the site visit due to water depths; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of fines (accreted due to the effect of the weir on flow velocities and sediment transport capacity immediately upstream).
- There are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features and/or the re-profiling of the channel bed and banks; provide refugia/cover habitat features for fish; improve marginal habitat value; and potentially introduce and fix gravel substrates upstream of the hydraulic influence of the weir to benefit spawning.

Downstream

- The weir is positioned on the downstream side of a meander bend, so that flow velocities during high flow conditions are likely to be concentrated along the left bank / side of the weir. However, the presence of an in-channel tree immediately downstream of the weir towards the left side of the channel, has encouraged sediment deposition to its lee and the formation of a cobble mid bar. Resultantly, typical flows immediately downstream of the weir comprise runs and small cascades, which are largely focused along the right side of the channel on the inside of the meander bend. Any works to improve fish passage that are targeted on the left side of the weir would likely require the removal of the tree and excavation of the mid bar (and potentially replacement along the right bank), in order to ensure attraction flows are suitable whilst discouraging further deposition around the approach to the fish pass solution that may impact upon its effectiveness.
- The river channel immediately downstream of the weir is incised; with gravels and fine sediments having largely been eroded and transported downstream, leaving predominately coarse cobble and boulder sized sediments. Resultantly, the right channel bank is steep and has been artificially supported /protected with stone pitching. Gravel starvation within the channel has resulted due to limited re-supply directly from the banks and from upstream due to the presence of the reservoir and the attenuating effects of the weir and those

upstream.

Ecology

- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Badgers: The adjacent areas of woodland surrounding the weir site was identified as offering suitable locations for badger setts.
- Bats: The mature trees located in close proximity to the weir site may offer suitable habitat to support roosting bats.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters. It is also possible that the wooded riparian habitat offers suitable habitat for otter holts (dens) / couches (laying up sites).
- Water voles: It is possible that the wooded riparian corridor located at the proposed weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub and tall ruderal herbs offer suitable habitat for nesting birds.
- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.
- Invasive species: As for Hillsborough Weir.

Other constraints

No ownership information is available. A gas marker post is located on the upstream side of the weir, this confirms the location of the gas main shown on the utility plans crossing the river upstream of the weir. A water level gauge is located on the upstream side of the weir which may have associated cables. Public footpath on left bank.

Fish Pass improvement options

Option 5 Easements	**Easements in the form of baulks fixed to the right side weir glacis**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the easements may not be suitable for weaker swimming fish species including grayling. A separate eel pass will also be needed.

Site suitability and constraints	The steeply sloping glacis is not at an ideal gradient for this option so works to the weir may be required to reduce the effective gradient. There may be some impacts on the gauging function of the weir but the effect is unlikely to be significant except at low flows.
Archaeology	No significant effect provided elements are fixed to the structure and so are removable. The weir crest will require locally lowering so fish can pass into the upstream reach
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will require working in the river. Maintenance access may be difficult increasing risks when work is required on the weir. There should not be any impact on utility services but the location of the gas main should be confirmed before the start of any construction activities.
Maintenance requirements	Maintenance will consist of removing debris and silt build up from the baulks a couple of times a year. Larger debris may also require removal after a storm event. Maintenance is likely to require access into the river channel.
Access (Construction & maintenance)	Access is directly available from Rowell Lane for small items of plant. If larger machinery is needed, access across the right bank fields may be possible.
Environmental aspects	Limited impact except during construction: precautions will be needed to protect against the risk of pollution.
Buildability	This option could be designed to be simple and straightforward, requiring limited construction skills and may be suitable for implementation by properly

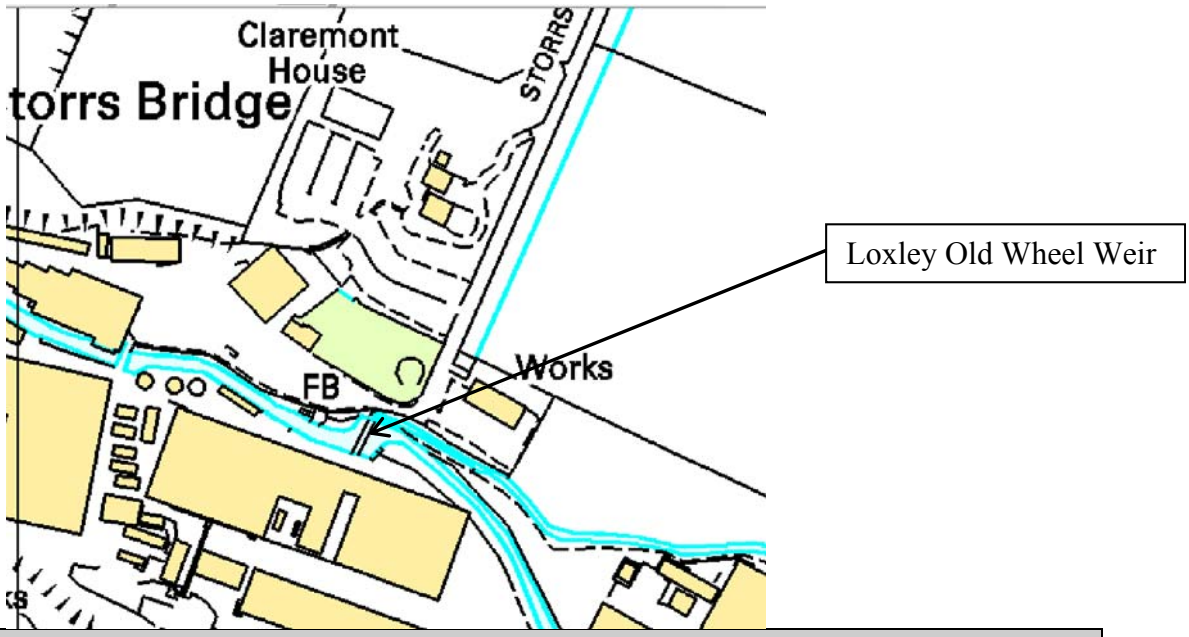
	supervised and managed volunteers. Attaching baulks to the existing structure should be achievable using portable tools but will depend on the nature and quality of the substrate. Breaking out a section of weir crest to form a notch may involve more significant activities and require the use of small construction equipment.
Significant residual risks	Effectiveness in passing the required species – the design of an easement is not an exact science and effective performance cannot be guaranteed, unlike a technical pass. The nature and condition of the weir structure and its suitability to support the proposed modifications. Risk of damage from floating debris. Impact on gauging at weir
Overall assessment	Constructing an easement on the weir glacis is a low cost option and could be a volunteer-led exercise if properly managed to ensure health and safety during construction and a robust end product. Attaching baulks to the structure will limit the impact on heritage value of the weir and would potentially be removable if needed. The risk of the easement not delivering the benefits of salmonid passage over the weir will jeopardise any investment in works further upstream but this will be relatively minor due to the limited length of river available.
Capital cost (£k)	£10,000- £15,000 (based on 1 weeks work for a 3 man gang and hand tools only, with lifting equipment, scaffolding and other sundries, allowing £2k for in river works)
Option 6 Low Cost Baffles	**Low cost baffle units fixed to the glacis on the right side of the weir.**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible

	for salmonids: however the low cost baffles may not be suitable for weaker swimming fish species including grayling. A considerable width of baffles may be needed to provide a suitable layout for larger fish to ascend. A separate eel pass will also be needed but could be a bristle mat fixed to the weir adjacent to the baffles.
Site suitability and constraints	Steeply sloping glacis not at an ideal gradient for this option based on trials elsewhere and design recommendation although this option has been developed specifically for use at gauging weirs.
Archaeology	No significant effect provided baffles are fixed to the structure although some crest modifications will be needed to create a notch.
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will involve working in the river: installing low cost baffles may require temporary works to divert and manage flows over the weir during installation.
Maintenance requirements	Maintenance will probably be minimal and limited to removal of debris after flood events.
Access (Construction & maintenance)	Installing temporary works may require access to the river channel by construction equipment: handling large panels of pre-fabricated baffles will also demand lifting equipment.
Environmental aspects	Limited impact due to nature of the works. Potential pollution risk during construction
Buildability	Installing baffle panels to the weir glacis will be a simple operation within the capability of volunteer labour but the

	extent of the works is likely require temporary works upstream of the weir to divert water levels and allow installation to take place. The works are probably more suited to construction by a civil engineering contractor.
Significant residual risks	Low cost baffles do not provide a guaranteed means of fish passage but the risk of failure is lower than with baulk type easements. The risk of both salmonids and other weaker swimming fish being unable to pass remains.
Overall assessment	This option has a reasonable chance of success at passing salmonids and should have limited effect on the hydrological function of the weir. However, investment in improvements further upstream may not yield the expected benefits if passage is not available at this weir
Capital cost (£k)	Budget cost for this option: £20,000 Low cost plastic baffle panels £5,000 Temporary works £10,000 Installation & sundries +60% contingency **Total £60,000**
Recommendation	Either a baulk easement or low cost baffle solution is appropriate to the site. A low cost baffle option is probably more reliable but has a cost disadvantage. If minimum cost and limited reliability is acceptable, then the baulk option may be suitable.

14 Loxley Old Wheel

Location Plan



Photographs

Figure 22: View of weir from left bank.

Figure 23: Upstream of the weir looking downstream

Figure 24: View from the left bank looking upstream.

General description

Loxley Old Wheel Weir is located at OS Grid Reference SK 291 901.

The weir is 1.50m high by 20.2m wide and is built square to the line of the channel. It comprises a sloping glacis divided by longitudinal string courses in a series of panels with slightly higher section at about mid channel. The weir appears to be built from dressed masonry blocks. The slope of the downstream glacis is estimated at 1 in 2.

Benefits of improved fish passage

The provision of fish passage at this weir (in conjunction with the weirs downstream) would enable fish to reach 1300m of river upstream along with Sykehouse Beck.

Access

Access to the site is directly from Storrs Bridge Lane. However there is a goit between the road and the weir which is currently crossed by a concrete platform, the strength of this must be checked before allowing any machinery or equipment to be loaded on this slab. Some localised temporary access works will be needed.

Geomorphology

Key characteristics, constraints and opportunities:
Upstream

- The existing aquatic habitat quality (particularly potential spawning habitat) immediately upstream of the weir appears to be poor. The river channel is channelised and highly constrained at this location due to the historical mill developments; which in turn has promoted channel incision (bed scour) and resulted in poor riparian and marginal habitat value. In combination with the back-ponding of flows caused by the presence of the weir, this has resulted in and over-deep channel with a lack of hydromorphological diversity; which is unlikely to provide suitable spawning and or refugia habitat for migratory fish. Channel substrates immediately upstream of the weir were not visible during the site visit due to water depths and poor access along the channel; however, these are expected to comprise predominately coarse cobble and boulder sized sediment with overlying deposits of fines (accreted due to the effect of the weir on flow velocities and sediment transport capacity along this reach).
- Due to the poor existing habitat quality immediately upstream of the weir described above, together with the relative short reach of river that would be accessible prior to reaching the reservoir spillway infrastructure, the benefits of providing fish passage improvements at this weir are potentially limited. As such, a key driver for undertaking works at this weir may be associated with providing access for migratory fish to the Stykehouse Beck tributary upstream. It is recommended, therefore, that a geomorphological and fisheries habitat walkover assessment of the Stykehouse Beck tributary is undertaken in order to help better verify the potential benefits of undertaking fish passage improvement works to the Loxley Old Wheel weir.
- In addition, there are opportunities to consider ancillary river restoration / aquatic habitat enhancement works along the reaches upstream of the weir, in order to increase the benefits of undertaking fish passage improvement works to the weir as well as providing additional wider environmental and amenity benefits. This could potentially involve various river restoration techniques to: increase hydromorphological diversity through the creation of in-channel features and/or the re-profiling of the channel bed and banks; provide refugia/cover habitat features for fish; improve marginal habitat value (including potential removal/replacement of hard bank engineering); and potentially introduce and fix gravel substrates upstream of the hydraulic influence of the weir to benefit spawning.

Downstream

- The river channel has been artificially over-widened at the location of weir, in relation to the more ‘naturalised’ channel reaches downstream. This has resulted in shallow flows and reduced transport capacity immediately downstream of the weir, which in turn has promoted the deposition of coarse sediments as the river has re-narrowed its width. This deposited coarse sediment has formed a mid-channel bar at the base of the weir and a side-channel bar along the right bank. These bar features have become vegetated with grasses, suggesting that they are relatively stable, but are likely to become partially submerged during high flow conditions. Finer sediments have been entrained and transported downstream, leaving predominately coarse sediments and artificial materials along the channel bed and margins (with limited re-supply of gravels from upstream due

to the presence of the reservoir).

- Due to the conditions described above, fish passage improvement works at this weir may need to consider ancillary bio-engineering works immediately downstream of the weir to narrow the channel width, in turn increasing flow depths and velocities and discouraging continued sedimentation around the approach to the weir. Such works could potentially reduce the capacity for continued sedimentation immediately downstream of the weir and increase attraction flows, to improve the effectiveness of the fish passage improvement works at the weir under low and normal flow conditions.

Ecology

- UK BAP Habitat: The areas of broadleaved woodland trees located immediately adjacent to the weir site qualify as deciduous woodland UK BAP habitat.
- Badgers: The wooded areas located within the downstream end of the weir site were identified as offering suitable locations for badger setts.
- Otters: It is likely that the river corridor at the location of the weir site is utilised as a movement corridor for otters. It is also possible that the wooded riparian habitat offers suitable habitat for otter holts (dens) / couches (laying up sites).
- Water voles: It is possible that the wooded riparian corridor located downstream of the proposed weir site offers suitable habitat for water vole burrows.
- Nesting birds: It is likely that the adjacent areas of broadleaved trees, scrub and tall ruderal herbs offer suitable habitat for nesting birds.
- White-clawed crayfish: As for Hillsborough Weir.
- Signal crayfish: As for Hillsborough Weir.
- Fish: As for Hillsborough Weir.
- Invasive species: As for Hillsborough Weir.

Other constraints

Owned by Bovis Homes Limited. There is understood to be development planned in the area. A public footpath runs along the left bank and may need diverting during any works. There is no record of utilities in the area of the weir.

Fish Pass improvement options

Option 5 Easements	**Easements in the form of baulks fixed to the right side or left side weir glacis**
Fish Passage effectiveness	Careful design using published guidance should ensure the fish passage is possible for salmonids: however the easements may not be suitable for weaker swimming fish species including grayling. A separate eel pass will also be needed.

Site suitability and constraints	The steeply sloping glacis is not at an ideal gradient for this option so some modifications to the weir may be required to reduce the effective gradient. The glacis is short due to the low height of the weir and an easement is probably usable by most species.
Archaeology	No significant effect provided elements are fixed to the structure and so are removable. The weir crest will require locally lowering so fish can pass into the upstream reach
Flood risk	There should be no significant impact on flood risk: attaching baulks to the weir will alter the discharge characteristics of the structure but the overall effect is unlikely to be significant.
Health & safety	Construction will require working in the river. Maintenance access may be difficult increasing risks when work is required on the weir. There should not be any impact on utility services but regard should be taken of utility markers during construction activities.
Maintenance requirements	Maintenance will consist of removing debris and silt build up from the baulks a couple of times a year. Larger debris may also require removal after a storm event. Maintenance is likely to require access into the river channel.
Access (Construction & maintenance)	Access is directly available onto the left bank for small items of plant with some modest improvements and alterations.
Environmental aspects	Limited impact except during construction: precautions will be needed to protect against the risk of pollution.
Buildability	This option could be designed to be simple and straightforward, requiring limited construction skills and may be suitable for implementation by properly

	supervised and managed volunteers. Attaching baulks to the existing structure should be achievable using portable tools but will depend on the nature and quality of the substrate. Breaking out a section of weir crest to form a notch may involve more significant activities and require the use of small construction equipment.
Significant residual risks	Effectiveness in passing the required species – the design of an easement is not an exact science and effective performance cannot be guaranteed, unlike a technical pass although the low height of this weir reduces the risk. The nature and condition of the weir structure and its suitability to support the proposed modifications. Risk of damage from floating debris.
Overall assessment	Constructing an easement on the weir glacis is a low cost option and could be a volunteer-led exercise if properly managed to ensure health and safety during construction and a robust end product. Attaching baulks to the structure will limit the impact on heritage value of the weir and could potentially be removable if needed. The risk of the easement not delivering the benefits of salmonid passage over the weir will jeopardise any investment in works further upstream but this will be relatively minor due to the limited length of river available upstream.
Capital cost (£k)	£8,000- £10,000 (based on 1 weeks work for a 3 man gang and hand tools only, with lifting equipment, scaffolding and other sundries, allowing £2k for in river works). An allowance of £10,000 should be made if access for large items of plant is needed

15 Risks

Construction risk is considered high at Hillsborough and Limbrick due to the access difficulties. Early contractor involvement has been sought to make appropriate allowances for access arrangements to be included in the initial costings.

As discussed at the options workshop, there are a number of weirs where the ownership is unknown; works could be carried out at these sites but complications are likely to arise if ownership is subsequently claimed. This could involve removal of any works from the structure or the payment of compensation for damage caused.

Planning permission will be required where works are to be undertaken on the weirs: early discussions should be held with English Heritage and the local council to ensure that the proposals are in line with their requirements.

The lower weirs, Hillsborough and Limbrick, represent key assets to provide fish passage to open up the river for fish passage: if fish passage is not effectively provided at these weirs then there is limited benefit in opening up the rest of the river(s) to fish.

Easements have been offered as solutions for fish passage at a number of the weirs upstream of Limbrick where the length of habitat made available to migrating fish is limited:, there is a risk that these will not provide fish passage for the weaker swimming fish including grayling.

16 Conclusions

The River Loxley between Hillsborough and Loxley Old Wheel can be conveniently divided into three sections:

Section 1: Hillsborough to downstream of Wisewood

Section 2: Wisewood to downstream of Low Matlock

Section 3: Upstream of Low Matlock

Section 1: the principal recommendation of this report is that efforts should be focussed on providing fish passage through this section: Hillsborough and Limbrick weirs are the most significant barriers on the Loxley/Rivelin system and the sites where the greatest potential benefits can be realised. The most effective means of providing all-species passage at these sites is considered to be means of engineered fish pass solutions. If it is not possible to provide fish passage at these weirs there is very limited benefit in providing passage at weirs further upstream. It is recommended that investment is focussed here first and that smaller, lower cost easement options are used at the weirs upstream as the benefit/cost ratio reduces.

Section 2: the weirs at Wisewood and Green Wheel represent lesser obstructions to fish passage due to the configuration, access and height of these weirs: however, Low Matlock weir, at the upstream end of this section, is a more significant obstruction where the status of the weir as a Scheduled Ancient Monument Status may preclude any permanent modifications such as those required to provide an all-species technical fish pass to overcome the height of this barrier. A pragmatic option for Low Matlock would be to install easements here which will provide a low cost opportunity for some fish to pass upstream in suitable conditions.

Section 3: upstream of Low Matlock the availability of spawning areas reduces as Damflask Dam nears and the benefits of providing fish passage at Olive Wheel and Loxley Old Wheel reduce correspondingly. Easements are more suited to this section, especially if passage at Low Matlock is not ensured.

A summary of the proposals is shown below:

Weir Name	Proposal	Benefit (m)	Cumulative Benefit (m)
Hillsborough	Engineered fish pass	310	310
Limbrick	Engineered fish pass	1400 plus River Rivelin	1710 plus River Rivelin
Wisewood	Easements	810	2520 plus River Rivelin
Green Wheel	Easements/Bypass channel	500	3020 plus River Rivelin
Low Matlock	Easements	475	3495 plus River Rivelin
Olive Wheel	Easements/Baffles	1300	4795 plus River Rivelin, plus Storrs Brook
Loxley Old Wheel	Easements	500	5295 plus River Rivelin plus Stykehouse Beck, plus Storrs Brook

Sketches of the proposals are included in **Error! Reference source not found.**

17 Next Steps

17.1 General

Confirm water levels and structure levels to ensure operation can be provided over a range of typical migratory flow conditions.

Consideration of costs and benefits of providing fish passage at all sites, leading to a programme and schedule aimed at delivering staged improvements to fish passage

In order to provide more cost certainty for the construction of the fish pass at Limbrick it is recommended that a bed survey be carried out upstream and downstream of the weir. This will assist in determining the possible methods for getting materials to the site and therefore reduce the risks associated with providing a cost for the construction of the fish pass.

Any construction details of the existing weirs will assist in cost certainty.

Discussions should be held at an early stage with English Heritage and Sheffield Council to understand their requirements for planning permission for fish passage.

Ground investigation will be required prior to the construction of any technical fish passes.

17.2 Ecology next steps

This section provides a summary of the key recommendations required in order to ensure legal compliance / adherence to best practice in relation to fish pass proposals at the seven weir sites on the River Loxley:

- Ancient Woodland: It is recommended that works are avoided where possible (e.g. proposed access / haul routes, tree felling, etc.) within the areas designated as ancient woodland located immediately south of Green Wheel Weir and Low Matlock Weir. This would entail locating proposed access routes to the weir sites from the northern bank, which is understood to be the preferred access routes to both weir sites. Where works within areas of ancient woodland are unavoidable it is recommended that consultation is undertaken with relevant Local Planning Authorities / Natural England in the first instance.
- UK BAP Habitat: The woodland areas located adjacent to all weir sites apart from the Hillsborough Weir, is designated as deciduous woodland UK BAP habitat. To avoid any potential adverse impacts on UK BAP habitat, it is recommended that all tree removal is avoided where possible. Where tree removal is unavoidable, it is recommended that all mature trees are avoided in preference for smaller, juvenile trees. Replacement planting will be required for all trees removed. It is recommended that native species of local provenance are utilised replacing all trees to be lost on a 2:1 ratio.
- Badgers: The areas of woodland located in close proximity to the following weir sites were identified as offering suitable locations for badger setts, i.e. Wisewood Weir, Green Wheel, Low Matlock Weir, Olive Wheel Weir and Loxley Old Wheel Weir. It is recommended that badger surveys are

undertaken at these weir sites to determine the presence of active badger setts located within close proximity to the proposed working areas.

- Bats: The bridge located at Hillsborough Weir and the mature trees located within the riparian corridor at the remaining weir sites may offer suitable habitat to support roosting bats. It is understood that both the bridge structure and all mature trees will be avoided where possible. Hence, it is not envisaged that there will be any impacts on roosting bats as part of the planned works. However, should the removal of mature trees or works directly impacting the bridge structure be unavoidable then it is recommended that advice is sought by an ecologist in the first instance. The purpose of this is to determine the bat roost potential of the identified tree / bridge structure to be affected.
- Otters: It is likely that otters utilised the river corridor at all seven weir sites as a movement corridor. Records of otter have also been identified on the River Loxley. It is recommended that measures are implemented via a method statement to ensure that the movement of otters along the watercourse is not obstructed at any point during construction. The habitat mosaics located at the following weir sites were identified as providing suitable habitat for otters holts (dens) and couches (laying up sites): Wisewood Weir, Green Wheel, Low Matlock Weir, Olive Wheel Weir and Loxley Old Wheel Weir. It is recommended that otter surveys are undertaken prior to works commencing at these sites to determine the presence or likely absence of any areas of habitat in use by otters in close proximity to the proposed working areas.
- Water vole: The habitat mosaics located at the following sites were identified as providing suitable habitat for water voles: Wisewood Weir, Green Wheel, Low Matlock Weir, Olive Wheel Weir and Loxley Old Wheel Weir. It is recommended that water vole surveys are undertaken to determine the presence or likely absence or active water vole burrows located within the proposed works areas.
- Nesting birds: Areas of tall ruderal herbs, scrub and broadleaved woodland trees located within the proposed works areas at all weir sites were identified to offer suitable habitat for nesting birds. If vegetation clearance during the bird nesting season (March – August) is unavoidable then areas of suitable habitat must be surveyed by a qualified ecologist immediately prior to the clearance taking place. If the survey confirms the absence of nesting birds within the works areas then work can be permitted, providing it is done within three days of the survey. If a nest site is discovered then work / vegetation clearance can only continue as long as the active bird nest is not destroyed until nesting has ceased.
- It is also possible that the habitat mosaics located within the riparian corridor also support Schedule 1 bird species, for example kingfisher (listed under the Wildlife and Countryside Act (1981) (as amended). Schedule 1 bird species receive extra protection. For these species it is an offence to recklessly disturb a species whilst it is on its nest or the dependant young.
- Crayfish: Although the habitat located at all weir sites may offer suitable habitat for white-clawed crayfish, following consultation with the Environment Agency, it is understood that white-clawed crayfish are not located within the affected reaches of the River Loxley (Pers comms., Andrew Virtue (Biodiversity Technical Officer) Jan, 2013). The presence of white-

clawed crayfish is therefore not envisaged to be a constraint to the proposed works.

- The presence of signal crayfish, the non-native American species of crayfish, is known within the River Rivelin which joins the River Loxley above Limbrick weir. It is therefore recommended that measures in relation to biosecurity are implemented during all in-channel works to ensure that American signal crayfish are not caused to spread during the proposed works.
- The weir sites located upstream of the Rivelin tributary may be providing a barrier to signal crayfish from moving further upstream within the catchment. Consideration during the detailed design should therefore be implemented to ensure that any fish pass scheme prohibit the movement of signal crayfish further up the catchment.
- Fish: Brown trout and bullhead fish species have been identified within the River Loxley. A number of notable species have also been identified downstream of the weir sites within the River Don. It is recommended that consultation is undertaken with EA fisheries team once the preferred option has been chosen in relation to the design of the proposed fish pass. In addition, all measures prescribed by the EA fisheries team to limit any potential impacts on spawning fish located downstream of the proposed works (e.g. installing silt traps, programming works to avoid key spawning seasons, etc.) are implemented during all in-channel works.
- Invasive plant species: It is possible that invasive plant species listed under Schedule 9, Part II of the Wildlife and Countryside Act 1981 (as amended) exist within the riparian corridor immediately adjacent to all seven weir sites. However, due to the timing of the walkover survey (January 2013), the presence of invasive plant species could not be identified. It is therefore recommended that a pre-start check for invasive plant species is undertaken prior to works commencing to determine the presence of any invasive species located within the proposed works area and access routes. If invasive plant species are identified within the proposed work areas then it is recommended that a method statement is prepared to ensure Himalayan balsam, or any other invasive species, are not caused to spread off the site during any proposed work.

Appendix A

Consultation Summary

File Note

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d +44 20 775Click here to enter extn

[HELP1]

Project title	River Loxley Fish Passage	Job number	228382
cc	Karen Eynon	File reference	
Prepared by	Sarah Rab	Date	16 January 2013
Subject	Consultation Meeting Notes		

- **Will the construction work affect the environment and/or the community?**
  Access – will try to avoid tree felling and large access roads. The aim is to be sensitive to the environment and the community as well as taking any opportunities to enhance the environment.

- **Any potential for double wins?**
  For example improve the impounding problems caused by the weirs by partial removal or take the opportunity to document the construction of the weirs. E.g. Beeley Woods. So giving the opportunity to solve impoundment issues and improve spawning habitat and therefore other enhancements.

- **Consents from riparian owners?**
  The owners have been identified where possible and have already been approached by DCRT. Any works will require planning permission and owners permissions. Although there is legislation the EA can use to force owners to allow the works DCRT would like to avoid using this.

- **Maintenance?**
  This will be dependent on the fish pass type. Most solutions will not require significant maintenance. The maintenance responsibility will fall on the owner of the structure however the trust may be able to assist with volunteers. The River Stewardship Company may also be able to assist the owner with debris clearance. S.P.R.I.T.E are already undertaking some of this work.

- **Would use of Arup exclude low tech solutions?**
  No, the aim is to provide solutions that can be undertaken by volunteers if possible and that are sympathetic to the local heritage.

- **Scheduled Ancient Monument**
  Need to start considering consents required ASAP.

- **Potential Development at Storrs Bridge and how this will link in to the works?**
  This is dependent on whether the development is going ahead and if permission is given to build. Discussions will be had.

- **Currently there is some foul water entering the river around Wisewood.**

This is the water company's responsibility but could be reported to the EA to ensure it is addressed.

- **Are the trust planning on seeding salmon?**
  The aim at present is to try and create the population naturally relying on 'lost fish' to restore the population by them finding these new patches. Active seeding is thought to not be effective in situations like these. Relying on the vagrant population will be slow but better in the long run.

- **How will the plans affect existing fish/other species?**
  The environment is suited for Salmon, Trout and Grayling, other species like Pike are not really suited to this type of environment. The fish passes are not intended to be all species fish passes. There is a hope there will be an upstream movement of grayling from the River Don.

- **Eels?**
  Eel passes will be considered during the feasibility, the environment will not be perfect for eels but would be a good fall back option for encouraging species to the river.

- **What support can groups do to help?**
  Some easements may be possible to be built by volunteers.

- **Is there an argument for provision of interim easements while waiting for full fish passes to be built?**

- **The area is a popular residential park enjoyed by many people and is loved by many people who have grown up there, this will therefore mean there is greater resistance to full fish passes, so the more minimalist the better. However if full fish passes are required consider looking for multiple benefits e,g. Improving access.**
  The trust recognises the heritage value of the sites and would look to providing information about this at each weir and improving the area as a whole providing benches, walks, footpaths etc. Looking for options that work with the structures not against them and that are sensitive to their surroundings. This is important for funding also as now when applying for funding the trust must prove that they are looking at the complete picture including social benefit.

- **Is weir removal an option? As Limbrick weir is particularly problematic in terms of access is it an option to remove the weir?**
  Although weir removal is good in terms of ecology, in terms of heritage it is not as good. Therefore there are very few opportunities to consider removal of weirs on this stretch of the Loxley.

- **Consider the use of artificial spates?**
  There is ongoing research by YW as to whether this is effective, and this will be discussed with them.

<u>Other notes:</u>

- **Comment from attendee: It would be preferred that Denil fish passes are not used.**
- **The overall objective of the scheme is for Salmon to be breeding in the Loxley by 2020.**

Prepared by	Sarah Rab		

Appendix B

Drawings

A3

N

Holme Lane

Langsett Road

Low cost baffles over a third of the weir

Flap Valve

Empty site - potential for compound.Lifting equipment would be required to lift materials into river bed.

Walkley Lane

Do not scale

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Issue	Date	By	Chkd	Appd
P1	14/03/13	JI	SR	JP
First Issue				

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Client

Don Catchment Rivers Trust

Job Title

River Loxley Fish Passage Feasibility Study

Drawing Title

Hillsborough
Low Cost Baffles

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
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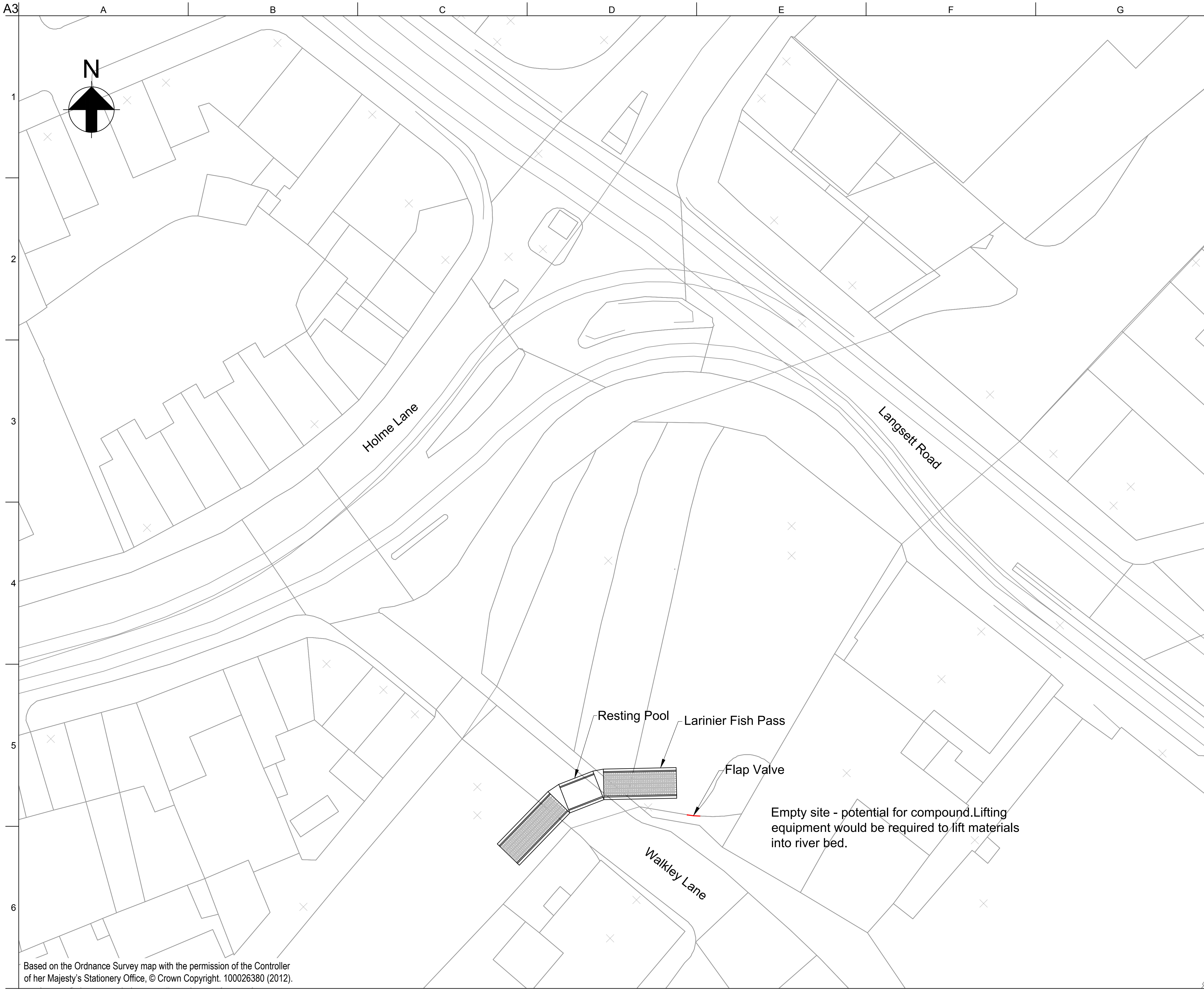

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Client
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Job Title
River Loxley Fish Passage
Feasibility Study

Drawing Title
Hillsborough
Technical Fish Pass

Scale at A3
1:500

Discipline
Water

Drawing Status
Preliminary

Job No	Drawing No	Issue
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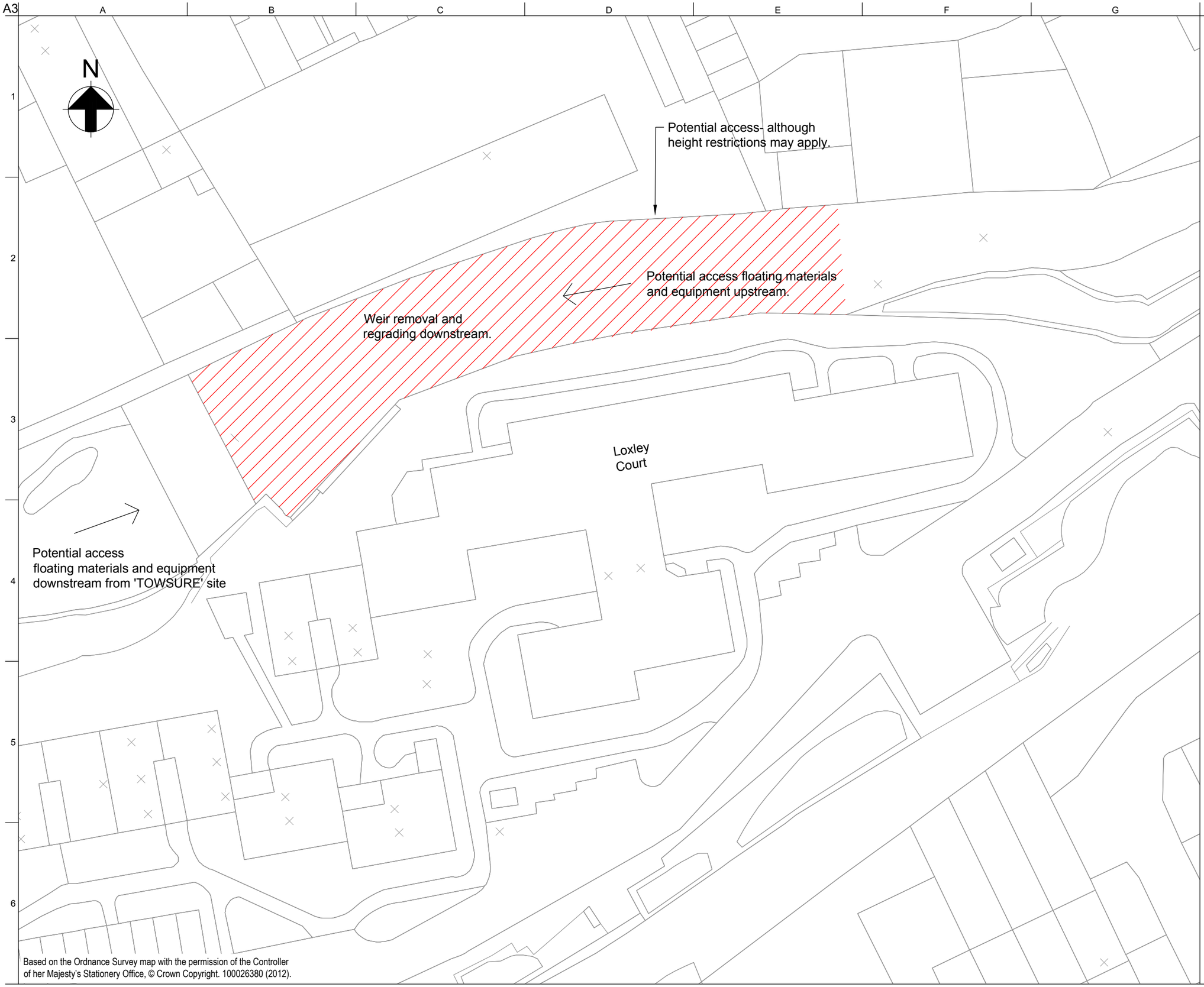

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Job Title

River Loxley Fish Passage
Feasibility Study

Drawing Title

Limbrick
Weir Removal

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
228382-00	**002A**	**P1**

A3

A B C D E F G

1 2 3 4 5 6

N

Potential access- although height restrictions may apply.

Potential access floating materials and equipment upstream.

Potential access floating materials and equipment downstream from 'TOWSURE' site

Larinier fish pass approx 25m long

Resting Pool

Loxley Court

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P1	14/03/13	JI	SR	JP
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Client

Don Catchment Rivers Trust

Job Title

River Loxley Fish Passage
Feasibility Study

Drawing Title

Limbrick
Technical Fish Pass

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

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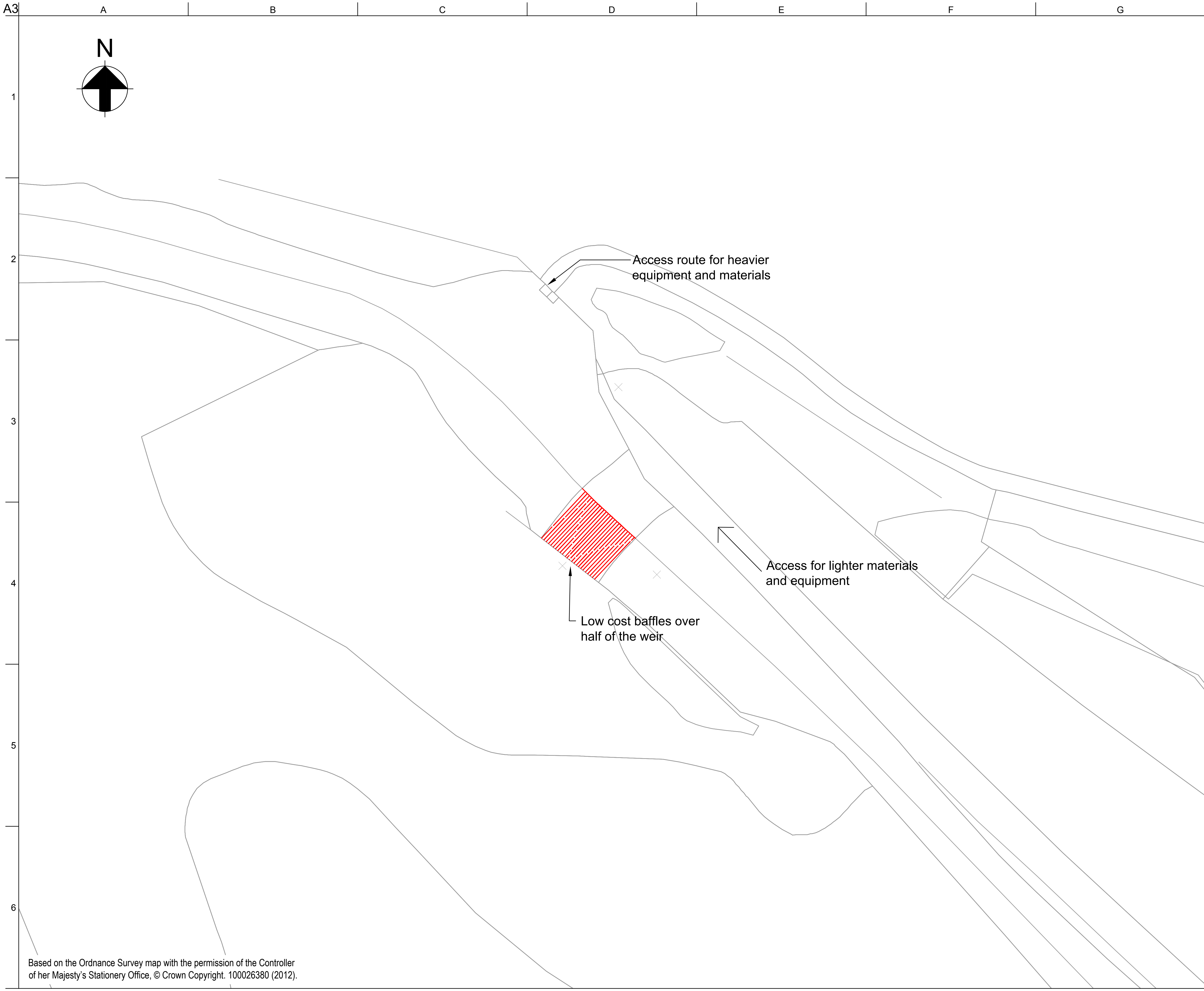

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Client
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Job Title
River Loxley Fish Passage Feasibility Study

Drawing Title
Wisewood
Low Cost Baffles

Scale at A3 1:500

Discipline Water

Drawing Status
Preliminary

Job No	Drawing No	Issue
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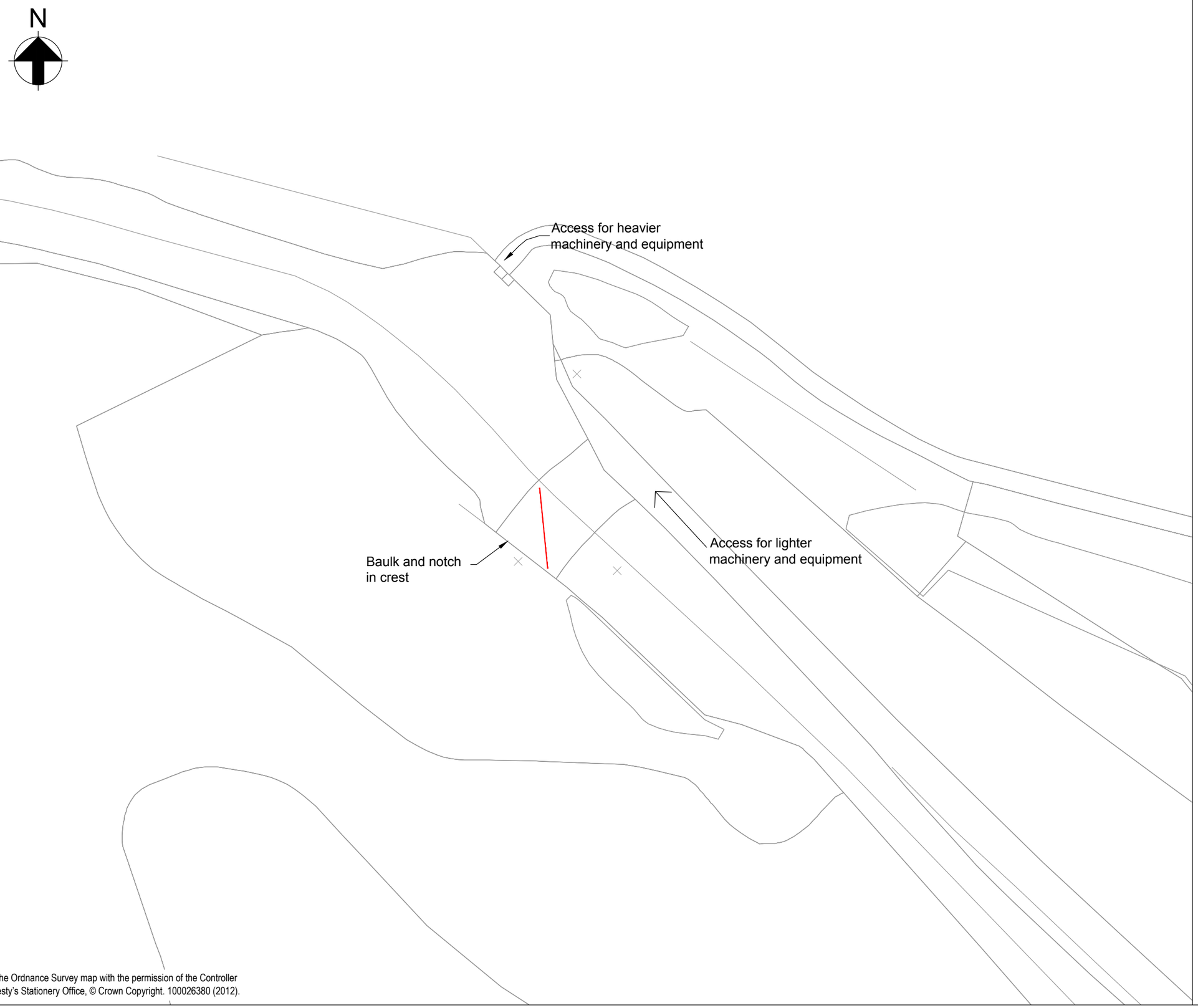

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First Issue				

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Client
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Job Title
River Loxley Fish Passage Feasibility Study

Drawing Title
Wisewood Easements

Scale at A3 1:500

Discipline Water

Drawing Status
Preliminary

Job No	Drawing No	Issue
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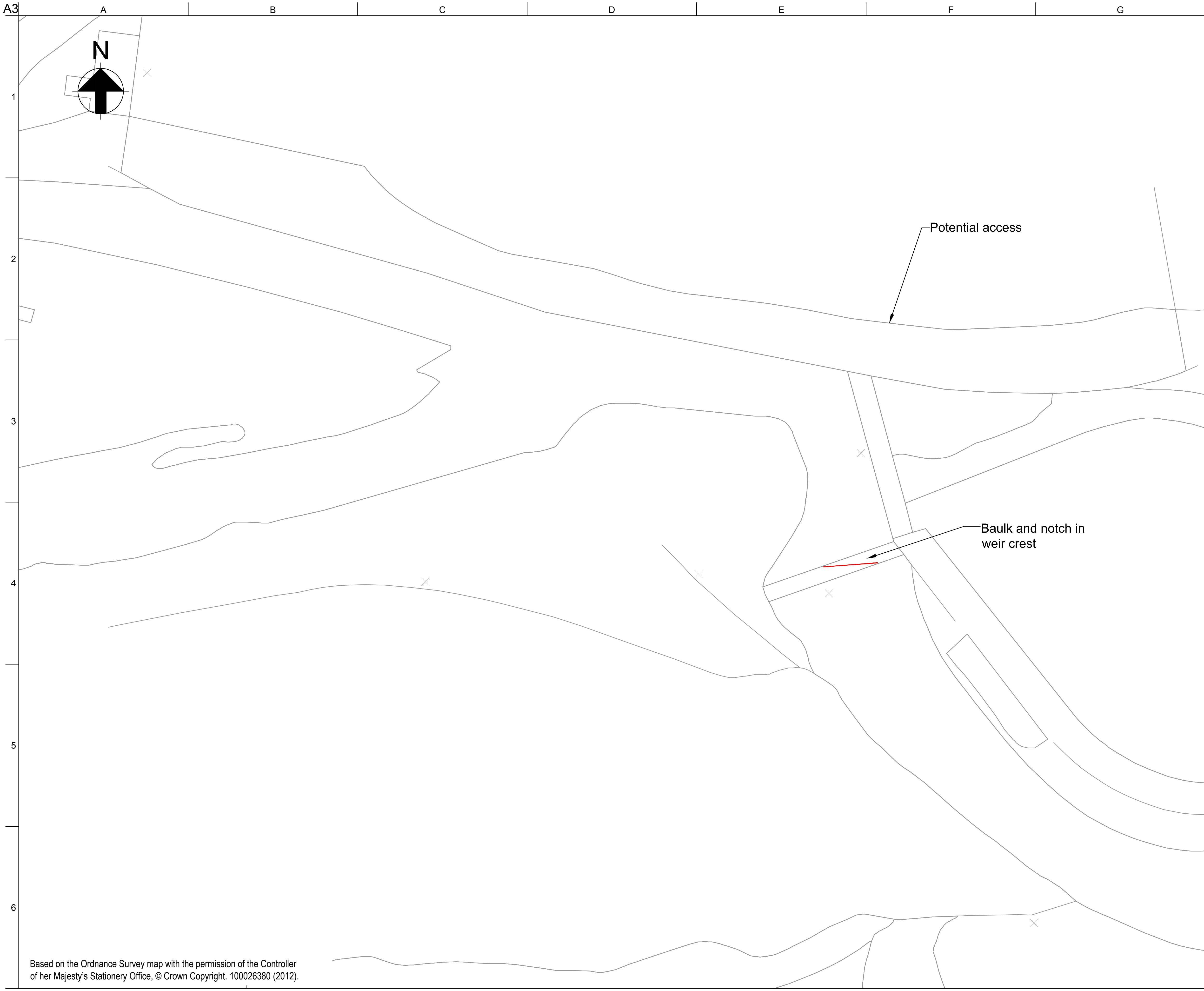

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Client
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Job Title
River Loxley Fish Passage Feasibility Study

Drawing Title
Green Wheel Easement

Scale at A3: 1:500

Discipline: Water

Drawing Status
Preliminary

Job No	Drawing No	Issue
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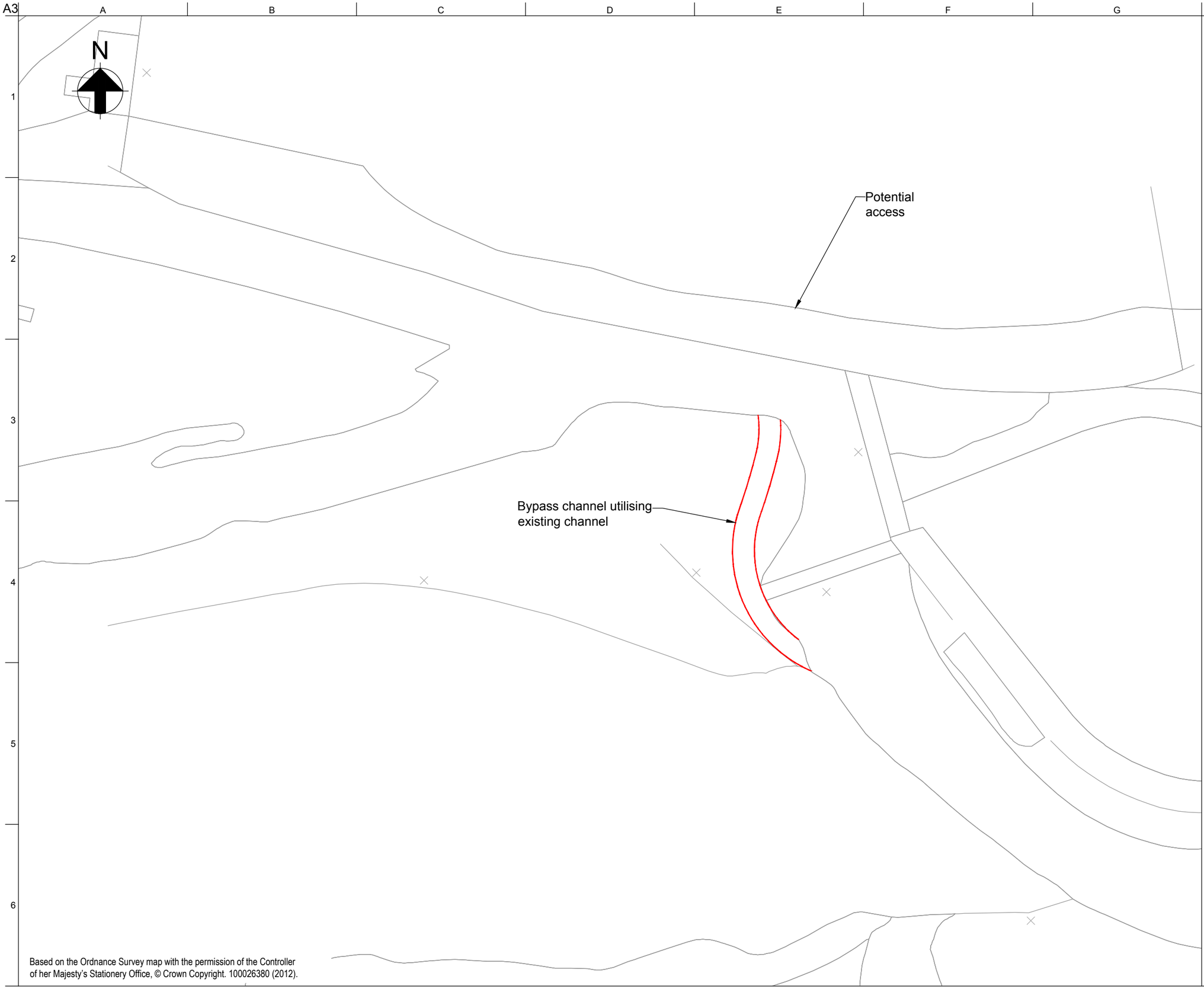

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Job Title

River Loxley Fish Passage Feasibility Study

Drawing Title

Green Wheel Bypass Channel

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
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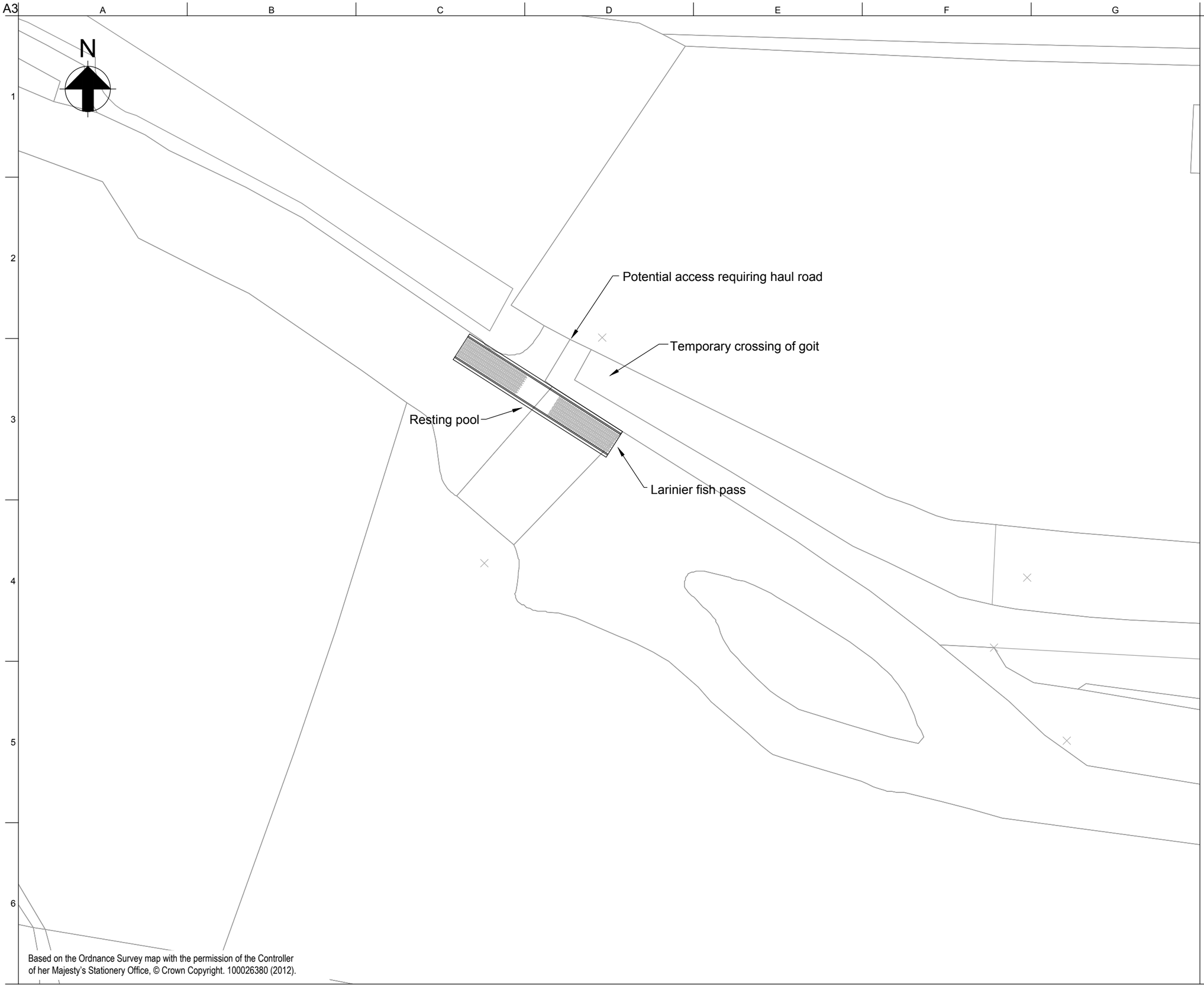

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Client

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Job Title

River Loxley Fish Passage
Feasibility Study

Drawing Title

Low Matlock
Technical Fishpass

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
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Do not scale

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Client

Don Catchment Rivers Trust

Job Title

River Loxley Fish Passage
Feasibility Study

Drawing Title

Low Matlock
Low Cost Baffles

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
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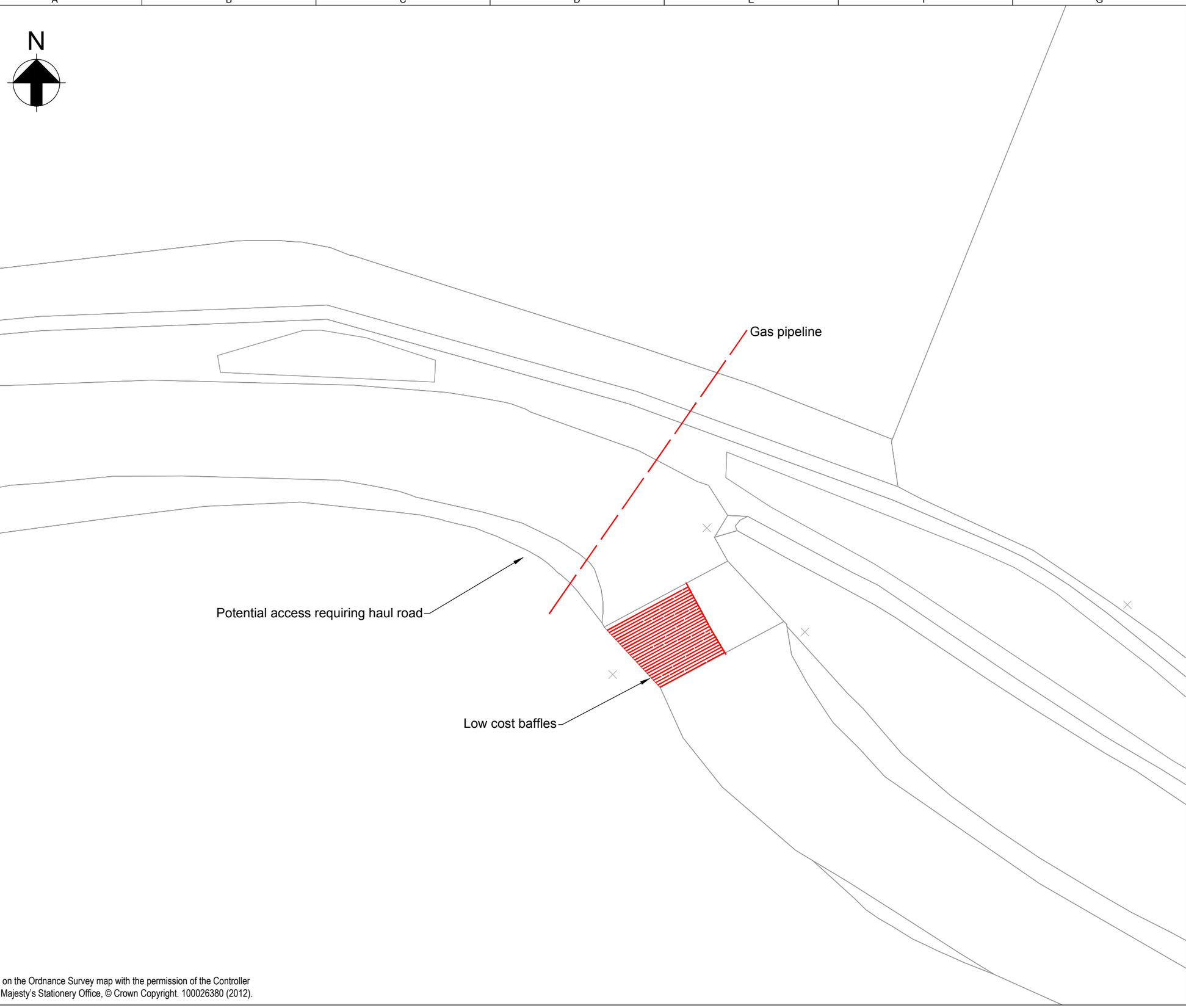

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Client

Don Catchment Rivers Trust

Job Title

River Loxley Fish Passage
Feasibility Study

Drawing Title

Olive Wheel
Low Cost Baffles

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
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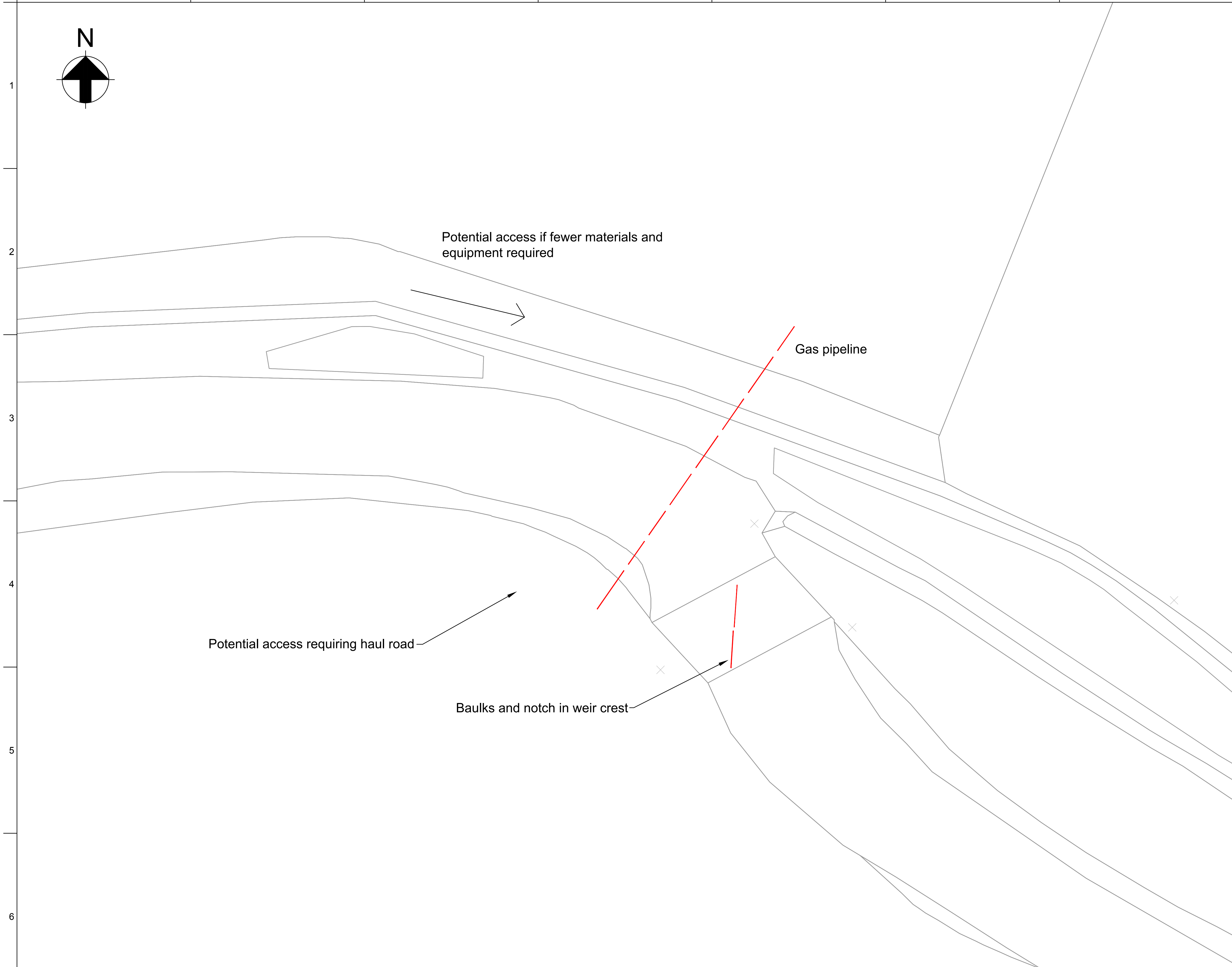

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Client
Don Catchment Rivers Trust

Job Title
River Loxley Fish Passage Feasibility Study

Drawing Title
Olive Wheel Easements

Scale at A3: 1:500

Discipline: Water

Drawing Status
Preliminary

Job No	Drawing No	Issue
228382-00	006B	P2

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A3

N

Storrs Bridge Lane

Access route- requiring temporary crossing of goit and wall removal

Baulks and notch in weir crest

0 5 10 20 Metres

Scale 1:500

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P1	14/03/13	JI	SR	JP
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Client

Don Catchment Rivers Trust

Job Title

River Loxley Fish Passage Feasibility Study

Drawing Title

Loxley Old Wheel Easements

Scale at A3 1:500

Discipline Water

Drawing Status

Preliminary

Job No	Drawing No	Issue
228382-00	**007**	**P1**