Ecclesbourne at Snake Lane Weir Design

Technical Note FINAL

Wild Trout Trust

Quality information

Document name	Prepared by	Date	Reviewed by	Approved By
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Ecclesbourne at Snake Lane Weir Design Technical Note FINAL v1.0	Seb Bentley	12-05-20	George Heritage	Neil Entwistle

1. Introduction and Methodology

1.1 Background and Objectives

The Wild Trout Trust commissioned AquaUoS to develop a design to provide fish passage at Snake Lane Weir on the River Ecclesbourne, Duffield, Derbyshire. This follows previous optioneering work undertaken by the Wild Trout Trust and Environment Agency. This is to restore fish passage at the weir structure and to enhance the ecological and geomorphological value of the river. The design should build on previous work by the Wild Trout Trust to gather enough information to enable a detailed design to be undertaken for the weir. The study area is shown in Figure 1.1 below.

Figure 1.1 Study area of the River Ecclesbourne at Snake Lane, Duffield.

1.2 Proposed Approach

We have gained a detailed understanding of the state, activity and sensitivity of the River Ecclesbourne, through the review of archival maps and aerial photography illustrating system functioning over both historical and recent time. Changes have been related to river and catchment management and diffuse sediment delivery processes to ensure that these are all treated as a single functional system.

The targeted walkover helped confirm the landscape features identified during the desk study identifying sediment sources and sinks, geomorphological units and identifying and recording geomorphological processes linked to the sediment transport and channel change regime. All data were reviewed against the hydraulic modelling outputs.

We have reviewed potential natural and artificial constraints on the proposed weir modification design (including full utilities service searches that have been used to inform the design) developing a list of opportunities that balances gains with difficulties and risks compared to the 'do nothing' scenario. The walkover and desk study findings have been used to assess the key options for the weir modification project and to identify a preferred solution to provide fish passage at the structure.

We have quantified the geomorphological and flood risk impacts of the preferred concept option (following the optioneering). We have developed a 2D hydraulic model (TUFLOW) for the river, utilising information Environment Agency LIDAR, Environment Agency model data (including hydrology) and new survey data. The 2D modelling approach has been applied across both the river and valley bottom allowing inundation areas to be mapped and channel hydraulics to be reviewed. In all scenarios it is vital that the predicted hydraulic regime is linked to the likelihood of channel change through prediction of sediment movement and bank erosion. Data from the flow modelling across the flow regime was used to confirm impacts to the flow and sediment regime and to ensure they are appropriate for a naturally functioning watercourse of this type. The model was also used to determine impacts on the flood hydrograph downstream by monitoring the flow at the downstream end of the model and comparing it to the baseline outputs.

AquaUoS produced a concept design for the preferred option, following the optioneering described below, including concept overview diagrams in Section 3. Following review of this by the Wild Trout Trust and Environment Agency, a preferred concept design was chosen, and a detailed design has been developed.

2. Data Review and Fluvial Audit

2.1 Desk Study

The River Ecclesbourne study site at Duffield is mainly underlain by mudstones, siltstones and sandstone, however, this does not outcrop at the surface (Figure 2.1). Instead the watercourse flows over river alluvium reworked from fluvioglacial mixed sands, gravels, clays and silts (Figure 2.2).

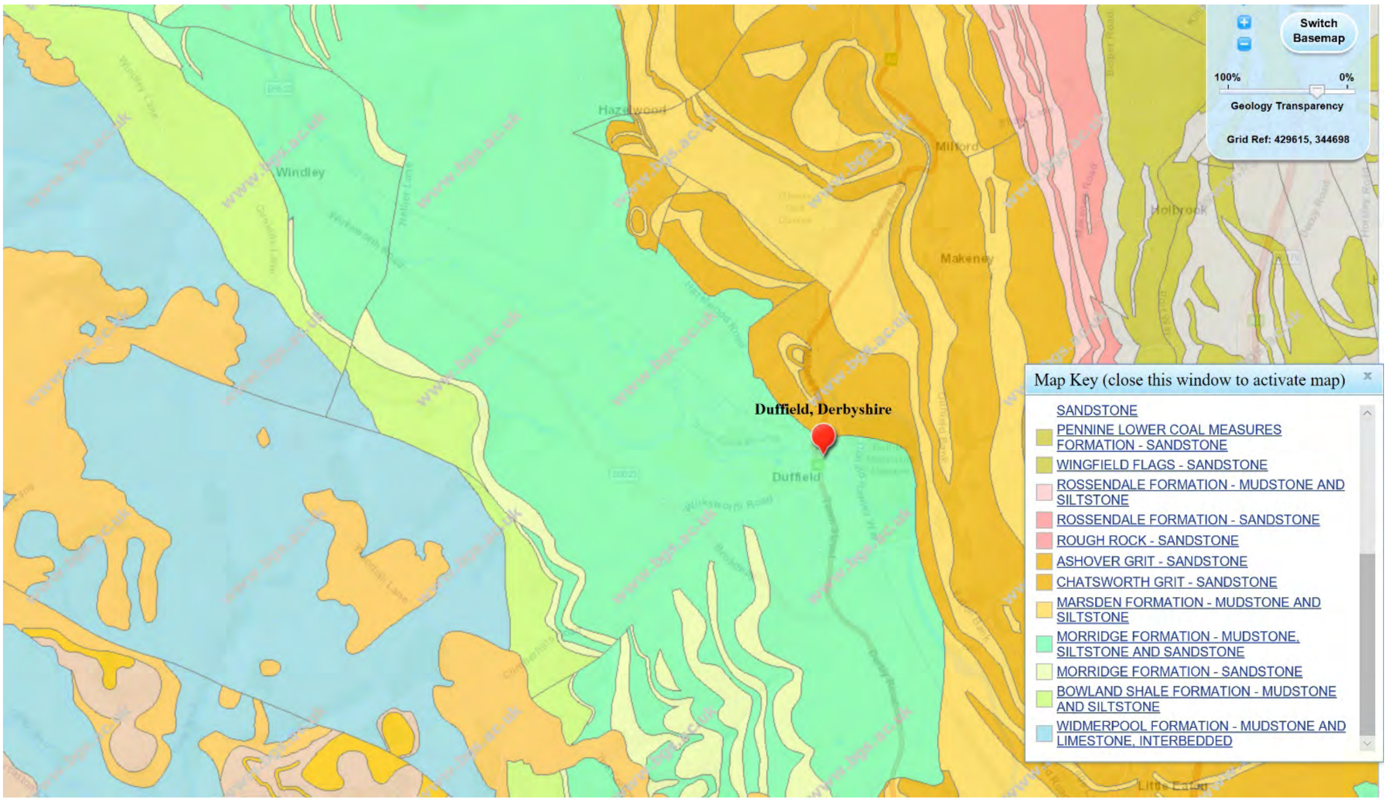

Figure 2.1 Bedrock geology of the River Ecclesbourne at Duffield

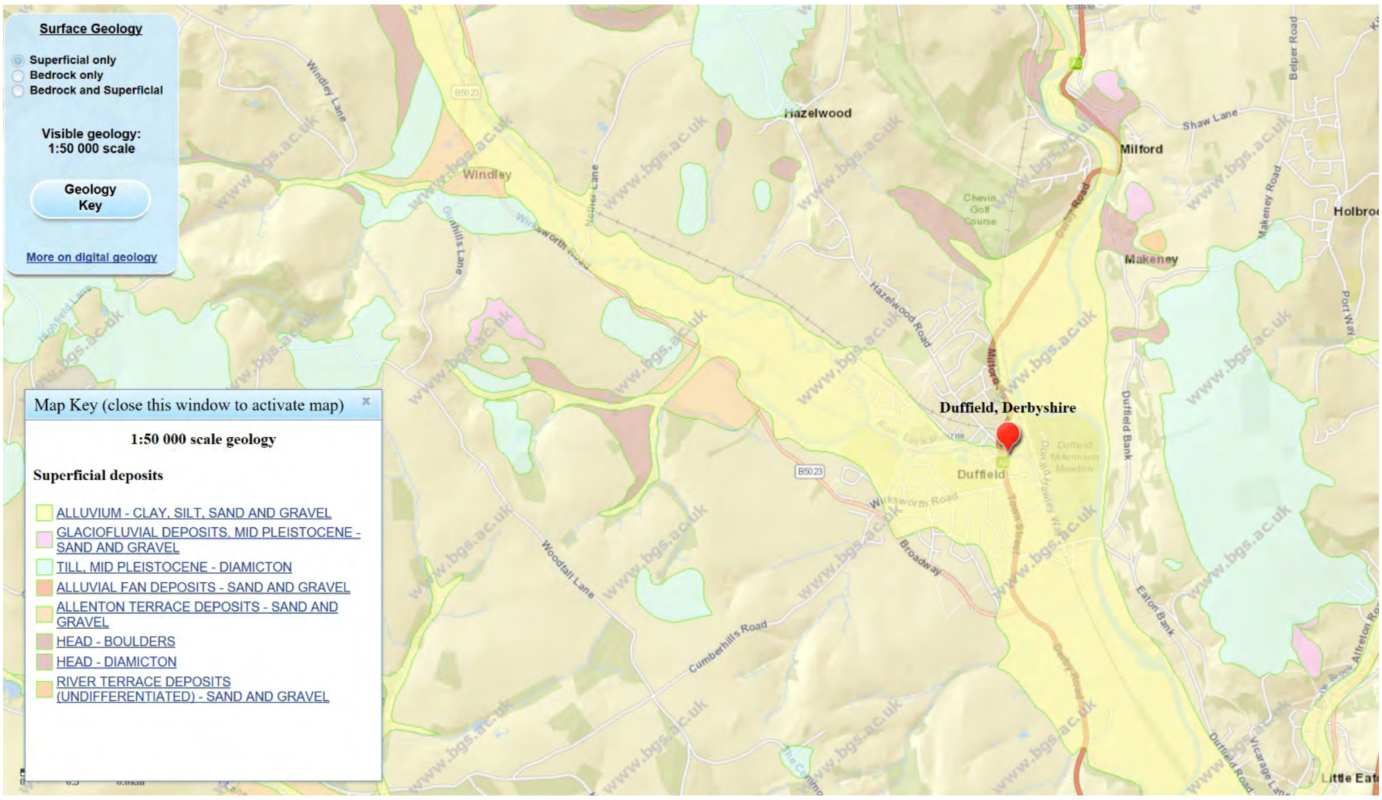

Figure 2.2 Drift geology of the River Ecclesbourne at Duffield

The watercourse flows over a moderately steep topography with a variably connected floodplain that is generally wider upstream of the study reach and narrower close to Snake Lane Weir. This is the result of significant urbanisation over both banks close to the study reach (Figure 2.3). The highly sinuous former course of the river is visible to the north of the current bifurcating reach suggesting that considerable gradient was added to the reach when it was rationalised, subsequently utilised by the mills through the construction of weirs.

Figure 2.3 General topography in the vicinity of the Ecclesbourne at Snake Lane weir

The River Ecclesbourne close to Snake Lane is likely to have been artificially straightened in the past (Figure 2.4), with straightening pre-dating the earliest available maps in 1879 (Figure 2.5 & Figure 2.3) and is likely to have been undertaken through modifications linked to the operation of the various Corn Mills (Figure 2.5) along the reach that also resulted in the creation of the split channel. There is some evidence of relict channels in the floodplain over both banks.

There has been very little change to the planform over the last ~140 years based on analysis of the current and the first epoch Ordnance Survey Map (Figures 2.4 and 2.5). This is mainly a result of the bank protection through the urbanised reach of the Ecclesbourne and subdued flow created behind the weir structures, one of which this project is looking to modify or remove. There is flow in the leat channels that needs to be retained as part of options developed for this project.

Figure 2.4 Current river course across the study site.

Figure 2.5 Historic mapping of the River Ecclesbourne at Duffield.

Aerial photography suggests that the watercourse is moderately energetic with riffle/rapids a frequent occurrence upstream of the impoundment zone of the various weirs through the study reach and evidence of recently deposited gravels downstream of the weirs. This is a known issue in Duffield and the Environment Agency have removed gravels from the Town centre in the past.

2.3 Field studies

A field audit was conducted along the study reach of the River Ecclesbourne in Summer 2019 and February 2020. The floodplain zone in the vicinity of the weir is urbanised. The bridge immediately downstream of the weir is used to access the right-hand bank residential properties on Duck Island (Figure 2.6). The weir itself provides a 2m high barrier within the river channel that is completely impassable to fish and significant disrupts the natural flow and sediment regime. The weir is connected to the Duck Island concrete bridge crossing wing walls. No details are available regarding the bridge or weir design, how they are connected and their composition and this needs to be considered in the design process.

Figure 2.6 Snake Lane weir and access bridge to Duck Island

The watercourse is over-deep (Figure 2.7), displaying width depth ratios <1 confirming the LiDAR evidence, this is likely due to the surrounding urbanisation meaning flood risk protection needs to be maintained through Duffield. Despite being over-deep the bed of the channel displays some morphologic variation beyond the influence of the various weir structures along its course. Gravels and cobbles form the majority of the visible bed material (visibility during the audits was hampered by high river levels) with riffle / rapid type features evident in places, reflecting the relatively high energy flow conditions along this reach outside of the impounding influences of the weir structures. The prevalence of gravel material suggests a strong supply from upstream, which is evidenced by the presence of gravels further downstream within the main town area. Mixed sediment has accumulated behind Snake Lane weir within the impoundment zone, but it is likely this could be redistributed as part of feature creation alongside weir modification options discussed below.

Flow in the main channel is disrupted by the weir (Figure 2.8) and ponding extends back upstream for around 60 m. Despite this, some bedload now passes over the structure as evidenced by the deposits of mobile sediment downstream within the main town of Duffield. These deposits have been historically removed by the Environment Agency to maintain flood capacity (it is unclear whether this still occurs at the time of writing). Removal of the weir will encourage the transport of sediment through the reach, but will still be interrupted by the further weir structure downstream. As such the deposition in the town will continue with or without the proposed work occurring.

Figure 2.7 High energy flood flows during audit

Flow is split around 60m upstream of the Snake Lane weir via a secondary overspill weir into the channel to the south of the main Ecclesbourne channel. Flow into this secondary channel needs to be maintained as part of designs developed for this project. The channel bed and banks are protected in numerous locations along the study reach by hard measures (principally rip rap and walling) due to the close presence of residential properties, footpaths and other infrastructure. A single line of trees also lines the banks along many reaches (Figure 2.8 & Figure 2.9).

Figure 2.8 Impoundment zone upstream of Snake Lane weir

Figure 2.9 Walling lining the river bank

A poorly connected narrow floodplain is present on the right and left banks, reduced in extent by nearby residential property. This creates increased velocities within the channel during elevated flows, as shown in Figure 2.7 above. This needs to be considered in the design of in-channel features, as described in the sections below, to ensure installed features are stable across the flood flow regime. Two outfalls are also present just upstream of the overspill weir (Figure 2.10), these are just beyond the influence of the proposed scheme.

The right bank floodplain area upstream of the weir (Duck Island), is apparently heavily contaminated as a result of past industrial use as a paint factory with the potential presence of lead following contamination assessments a few years ago (no records available). This has ruled out the potential to bypass the weir over this bank due to associated costs for disposal of this waste to landfill.

Figure 2.10 Outfall upstream of overspill weir

3. Model and Audit Driven Optioneering

3.1 Flow Model Construction

To assess potential opportunities to provide fish passage at Snake Lane weir, a 2D TUFLOW model of the reach has been developed using available Environment Agency 1 m cell size LIDAR, the existing hydraulic model of the River Ecclesbourne at Duffield and new survey data gathered for the purposes of this study. The model was developed at a 1 m cell size to enable accurate representation of the channel and floodplain, that were of significant importance for the opportunity identification for this project. In-channel information was surveyed on site and the DEM adjusted where necessary in combination with the EA model information supplied, and the hydrology for the River Ecclesbourne was utilised from the supplied Environment Agency hydraulic model and used as flow inputs to the 2D model.

The purpose of the modelling was to test potential options for modification or removal of the weir at Snake Lane, with the primary aim to identify an option that best provides fish passage and general ecological and geomorphological improvements of the river and floodplain. This enabled assessment of the impacts to in-channel processes and the hydrological regime across the floodplain. The model has also assessed the impact on flood risk both locally and downstream through use of a monitoring line at the downstream extent of the model.

To determine the flood risk impact associated to the preferred option identified from the 2D modelling described above, the supplied 1D-2D Flood Modeller Pro – TUFLOW model of the River Ecclesbourne, supplied by the Environment Agency, was utilised (Figure 3.1). The baseline model was updated with the newly gathered survey to ensure this reflected current channel conditions. This resulted in some minor adjustments to the existing model cross-sections and a minor change to the height of the Snake Lane weir. The 1D model geometry was then modified to reflect the preferred option and run for a variety of return periods to determine the flood risk impact of the scheme.

Figure 3.1 1D-2D Model extent (Google Earth base map)

Hydrology

Flow inputs to the upstream end of the 2D model domain were developed using hydrology supplied along with the Environment Agency model of the River Ecclesbourne. For the purposes of this design assessment, a flow of 52.9 m^3/s was run through the model to represent a 1 in 100yr plus allowances for climate change event. Intermediate flows were also assessed including the 5yr event which is assessed below in terms of impact to flood risk. For the low flow modelling, a Q95 flow was used of ~0.1m^3/s using information from the upstream gauge

Model Run Parameters

Simulated depths, velocities, water level, bed shear stress, flow and mass balance were output to assess flood extents across the model domain. Model outputs were sensibility checked by AquaUoS to ensure these reflected information gathered during the Fluvial Audit undertaken prior to the modelling and model results were deemed to be appropriate and sensible. Once the restoration design was agreed, bed shear stress and velocity information extracted from the model was used to inform system change. Initial outputs from the baseline hydraulic model run from the 100 year plus allowances for climate change return period event are shown below in Figure 3.2.

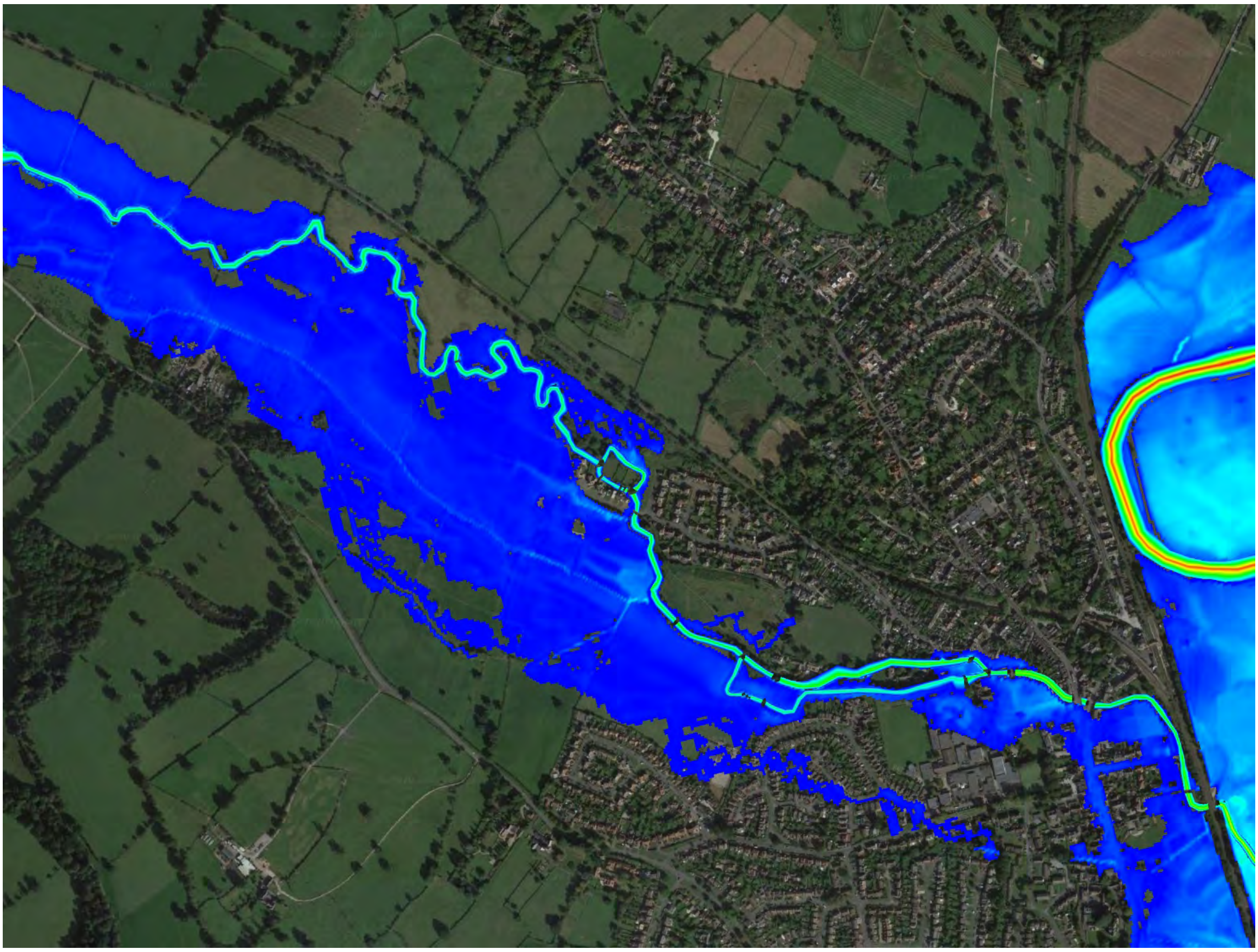

Figure 3.2 Baseline model flood levels, (blue-shallow, green-deep) at the study site

3.3 Optioneering

The summary tables below review the potential options at the site to provide fish passage at the Snake Lane weir on the River Ecclesbourne at Duffield.

Option 1.	Positive aspects	Negative aspects
Do Nothing	Main weir is presently robust. Current established habitats maintained but these are poor within the impoundment zone of the weir with at least a veneer of fine sediment on the channel bed. Some hydromorphic processes operating with coarse sediment passing over the weir, evidenced by mobile sediment and riffle features downstream.	Fish passage not achieved. Hydromorphic processes remain disrupted. Poor quality in-channel morphology upstream of the weir. Weir risk failure in the long term

	Improving in-channel morphology downstream.	
		Fails to achieve fish passage **REJECT**

Option 2.	**Positive aspects**	**Negative aspects**
Maintain the weir	Main weir is presently quite robust and does not require maintenance. Current established habitats maintained but these are poor within the impoundment zone of the weir with at least a veneer of fine sediment on the channel bed. Some hydromorphic processes operating with coarse sediment passing over the weir, evidenced by riffle features downstream. Improving in-channel morphology downstream.	Fish passage not achieved. Hydromorphic processes remain disrupted. Poor quality in-channel morphology upstream of the weir. Costly repairs in the long term.
		Fails to achieve fish passage **REJECT**

Option 3.	**Positive aspects**	**Negative aspects**
Install fish pass (e.g. pool-traverse, larinier etc)	Main weir is presently quite robust and will be maintained as part of this option to ensure future functioning of fish pass. Current established habitats maintained but these are poor within the impoundment zone of the weir with at least a veneer of fine sediment on the channel bed. Some hydromorphic processes operating with coarse sediment passing over the weir, evidenced by riffle features downstream. Improving in-channel morphology downstream. Fish passage improved.	Very costly option due to size of weir when compared to costs for removal of the weir. Space for location of the fish pass also an issue due to land use over both banks. Only partial improvement to fish passage as will only provide passage for a limited range of species and sizes according to the design. Hydromorphic processes remain disrupted. Poor quality in-channel morphology upstream. Fish pass will require continual maintenance.
		Only provides fish passage for a limited range of species and sizes according to the design **No improvement to the hydromorphology of the river or floodplain** **High cost** **REJECT**

Option 4.	Positive aspects	Negative aspects
Lower the weir	Fish passage achieved if morphology downstream is adjusted to raise the river bed. Main weir is presently robust but has undergone repairs over time which may reduce the integrity of the structure if lowered. Current established habitats will alter slightly, this is likely to be positive with more higher energy areas within the former impoundment zone. Hydromorphic processes will be improved but will remain sub-optimal. Flood risk likely to remain near neutral.	Hydromorphic processes likely to remain partly disrupted. Unknown internal structure of the weir poses significant design risk and must be engineered to remain robust. This includes consideration of its interaction with the bridge. Remnant structure remains as a liability to the client/landowner. Installed morphology downstream may impact bridge conveyance.
Multiple marginal benefits achieved **Fish passage achieved** **Potential structure integrity issues for remaining structure** **REJECT**		

Option 5.	Positive aspects	Negative aspects
Breach the main weir	Fish passage achieved if morphology downstream is adjusted to raise the river bed. Main weir is presently robust but has undergone repairs over time which may reduce the integrity of the structure if lowered. Current established habitats will alter slightly, this is likely to be positive with more higher energy areas within the former impoundment zone. Hydromorphic processes will be improved but will remain sub-optimal. Flood risk likely to remain near neutral.	Hydromorphic processes likely to remain partly disrupted. May result in release of sediment downstream. Unknown internal structure of the weir poses significant design risk and must be engineered to remain robust. This includes consideration of its interaction with the bridge. Remnant structure remains as a liability to the client/landowner. Installed morphology downstream may impact bridge conveyance.
Multiple benefits achieved but structure potentially severely compromised **Residual structure remains a liability** **Potential for uncontrolled sediment release** **REJECT**		

Option 6.	Positive aspects	Negative aspects

Construct downstream 'rock ramp'	Cost effective. Main structure remains in place. Fish passage achieved.	Hydromorphic processes remain disrupted. Poor quality in-channel morphology upstream. Weir and rock ramp increases flood risk locally, particularly as will severely compromise bridge conveyance capacity.
		Flood risk issues. High cost. **REJECT**

Option 7.	Positive aspects	Negative aspects
Bypass the main weir over the right hand bank	Full fish passage achieved. Flood risk benefits locally if both channels are allowed to operate. Current established habitats will be largely maintained and new habitats created. Hydromorphic processes will be improved.	Remnant structure remains as a liability to the client/landowner – but it remains robust with little risk to the river if it does. Import of materials required to create new morphology. Long bypass necessary to create a dynamically stable channel – but creates significantly improved morphology and habitat compared to existing. Land through which it would pass is heavily contaminated and would result in very high costs to dispose of.
		Full fish passage achieved **Dynamically stable river created with improved geomorphology and habitats** **Very high cost for disposal of contaminated sediment excavated to build the bypass channel** **REJECT**

Option 8.	Positive aspects	Negative aspects
Notch the main weir and maintain a buffer at each edge where connects to bridge wing walls, creation / adjustment of existing morphology.	Full fish passage achieved. River bed morphology will be adjusted to allow controlled adjustment of upstream sediments. No issues with residual structure integrity. Current established habitats will improve significantly. Hydromorphic processes will be re-established. Flood risk likely to be locally slightly improved. Flow split into leat channel retained through incorporation of proposed morphology upstream.	Import of materials likely to create new features to maintain dynamic stability and to provide flow into leat channel. Current straight channel planform maintained and channel likely to remain over deep. Unknown impacts to adjoining bridge structure, this is to be managed during construction through an engineering watching brief and contingency allow for repairs if required.

Full fish passage achieved **Dynamically stable river created with improved geomorphology and habitats** **Unknown archaeological value to the weir** **Contingency required for any repairs to bridge structure during weir works** **TAKE FORWARD**		

Suggested weir notching approach

Given the contamination issues over the right-hand bank where a bypass channel could be located, the optioneering undertaken above suggests that notching of the weir and installation of an appropriate morphology to control the increased hydraulic gradient and flow into the leat channel is the most cost-effective and environmentally preferable solution. The weir base below the new river bed level and margins close to the bridge wing walls are to be retained to negate any impact to the bridge and abutments. An engineering watching brief on site is suggested during the weir works, with a contingency for any repairs to the wing walls and bridge, rather than a costly intrusive investigation of the structure that is unlikely to provide any answers with regards to the connection of the weir to the bridge wing walls and any associated impact. This option will provide fish passage, and will significantly improve the morphology and habitats within this reach of the Ecclesbourne.

See the outline design drawing overview below in Figure 3.3.

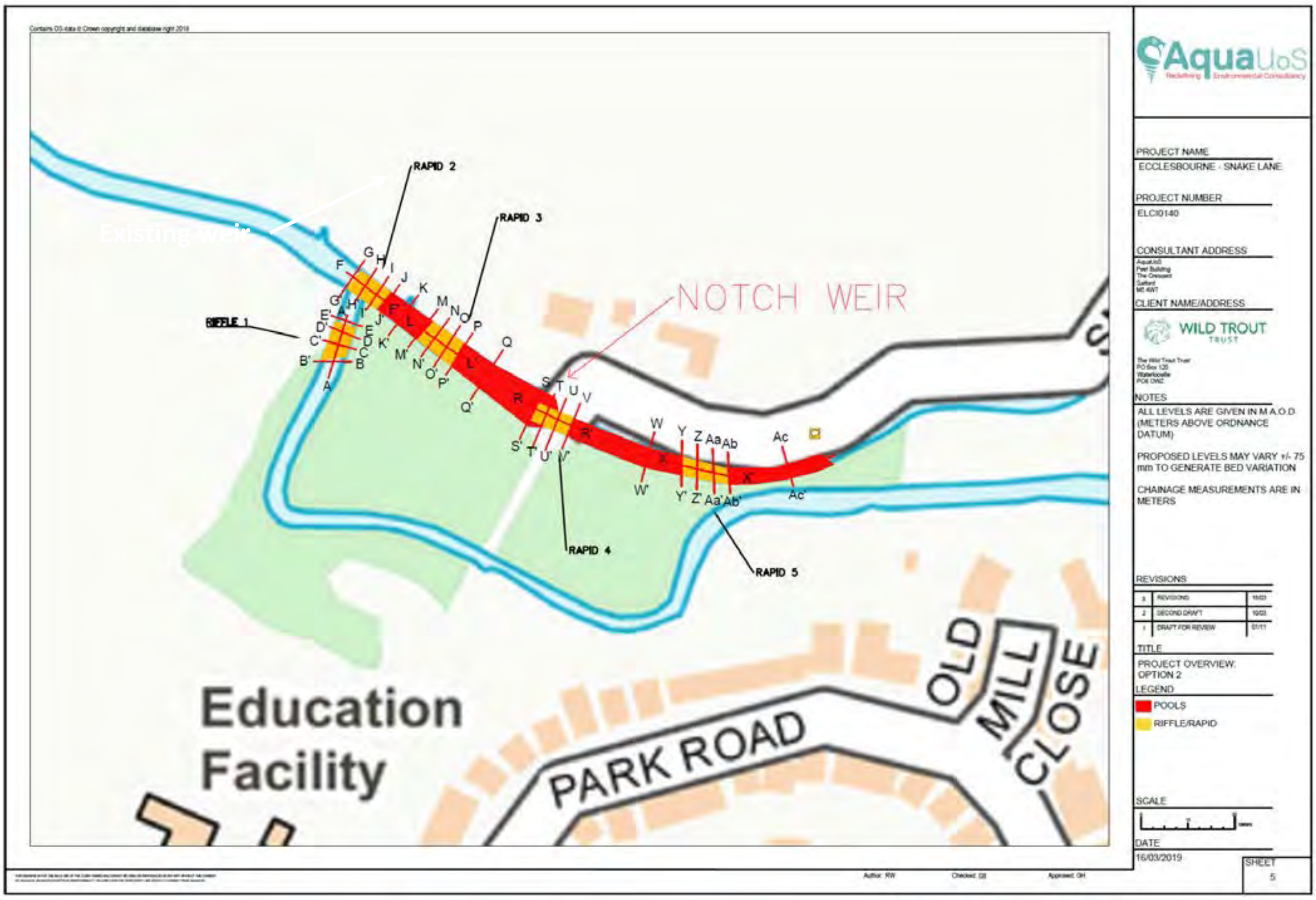

Figure 3.3 Suggested weir removal / modification approach.

4. Restoration Design and Flood Risk

Services

A services search has been conducted for the site (see design drawings supplied). This revealed that no utilities will be directly impacted as a result of the works. However, some services may be crossed under or over for access purposes and this should be considered by the contractor when delivering the works.

Design

The preferred design option is shown as a concept drawing in Figure 3.3 above. Detailed design drawings have been produced alongside a Method Statement that outline how a contractor might safely deliver the works, a Designers Risk Register that highlights all risks related to the project and a Bill of Quantities details works required. The below sections outline the hydraulic habitat gains linked to the preferred scheme, review of shear stress and associated sediment impacts and the flood risk impacts as a result of the preferred scheme design.

The design recommends notching of the weir and maintaining a ‘buffer’ section of the structure alongside the bridge wing walls to negate the risk of compromising the structure of the bridge and the wing walls following removal. This will need to be carefully cut by the contractor on site with a watching brief from an engineer during these works to advise on bridge stability and on any remedial repair works following removal. It is suggested that this is the best approach for managing the risk associated to the bridge stability as a result of the works since, in the absence of detailed designs associated to the existing bridge, wing walls and weir, detailed intrusive investigations of all structures is unlikely to provide conclusions to the connectivity of the bridge and wingwalls with the weir and the impact of modification to the weir as proposed for this option. This is based on past experiences of similar investigations for other similar design situations. Therefore, it is recommended a contingency is allowed for during fund planning to allow for repairs to the bridge, wingwalls and remaining weir sections. This would be advised by an engineer supervising the works that again must be allowed for in the scheme construction funding.

Hydraulic Habitat

Figure 4.1 shows the hydraulic habitat change, compared to baseline, under good summer flow (Q95) conditions as a result of the proposed weir modification scheme described above to provide fish passage across the Snake Lane weir.

The hydraulic habitat area under the same flow conditions is similar as the overall wetted channel length does not change as a result of the weir option and feature introduction. However, there are expected increases in hydraulic habitat diversity as a result of removing the impounding influence of the weir and introduction of the rapid features within the former impoundment zone. This has resulted in 4% increase in riffle habitat and 9% increase in rapid type habitat, with associated reductions in glide and pool habitat. This is supported by the higher proportion of shallower depth flow associated to these higher energy hydraulic habitat types.

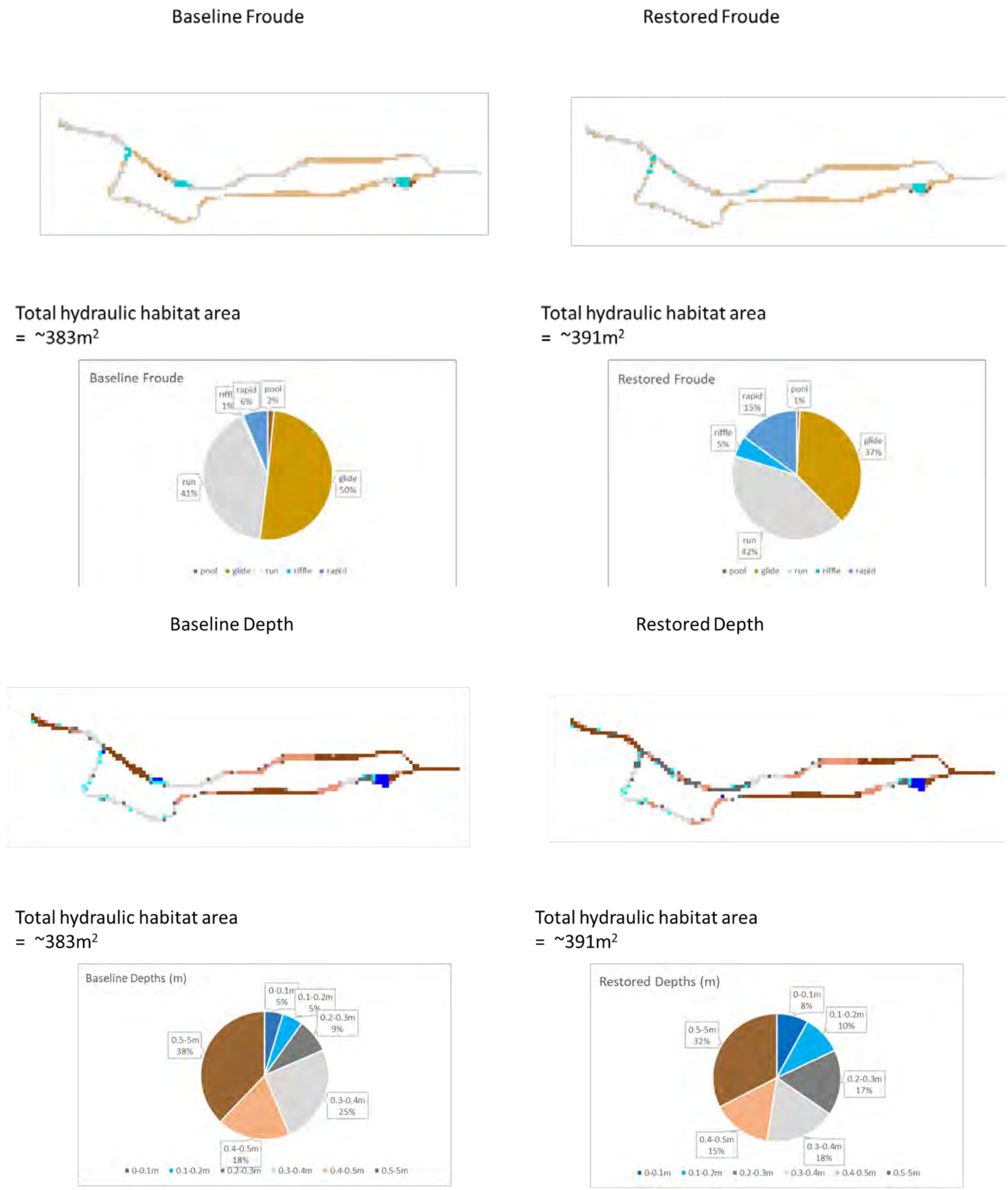

Figure 4.1 Good summer flow (Q95) hydraulic habitat / biotope and depth change compared to baseline for impacted reach of the Ecclesbourne (pie chart size scaled to show area change).

Bed Shear Stress

Bed shear stress has been calculated using the 1D-2D and 2D model outputs across the impacted reach of the Ecclesbourne during an extreme flood (1 in 100yr plus allowances for climate change). There are increases of the order of 100 N/m^2 compared to baseline as a result of notching the weir structure, which is expected as a result of the increased in hydraulic gradient through the formally impounded reach. Without the designed rapid features, this increase would be significantly higher.

Under weir notched conditions with the associated rapids constructed, bed shear stresses reach a maximum of 500 N/m^2 for the 1 in 100yrCC event, corresponding velocities reach around 2.5 m/s. This is unsurprising given the relatively high bed shear stresses during flood flows under baseline conditions (see Figure 2.7). The morphology of the rapids is in-keeping with these flow conditions, and will need to include boulder sized material of a minimum 600 mm diameter across the b axis as part of the rapid design composition (see design drawings and Bill of Quantities for suggested rapid composition mix). This is to ensure stability across the flow regime.

Flood Risk

Model Flood Outputs

Flood modelling for the current and restored site scenario has been undertaken to determine the fluvial flood risk impacts as a result of the proposed scheme. This has been undertaken for the 100yr plus allowances for climate change and 5yr event. Low flows and associated restoration impacts are discussed in the section above with regards to habitat changes.

Figures 4.2 to 4.3 demonstrate the flood extent changes for each of the flood return periods listed above, with baseline shown in blue and the restored scenario shown in red. The ‘a’ figures show flood extent increases as a result of the restored option for each return period modelled (visible red areas) and the ‘b’ figures show flood extent decreases as a result of the restored option (visible blue areas). For the 1 in 100yrCC event, there are minor flood extent reductions as a result of notching the weir over the immediate right and left bank close to the weir structure, this is a result of a lowering of the impounding influence of the significant weir structure. There is no flood extent increase associated to this option within model tolerances. For the 1 in 5yr event, there is very little out of bank flow and therefore limited difference between baseline and restored conditions.

Figure 4.2a 1 in 100yrCC flood extent change, blue = baseline, red = restored (where red is visible indicates flood extent increase).

Figure 4.2b 1 in 100yrCC flood extent change, blue = baseline, red = restored (where blue is visible indicates flood extent decrease).

Figure 4.3a 1 in 5yr flood extent change, blue = baseline, red = restored (where red is visible indicates flood extent increase).

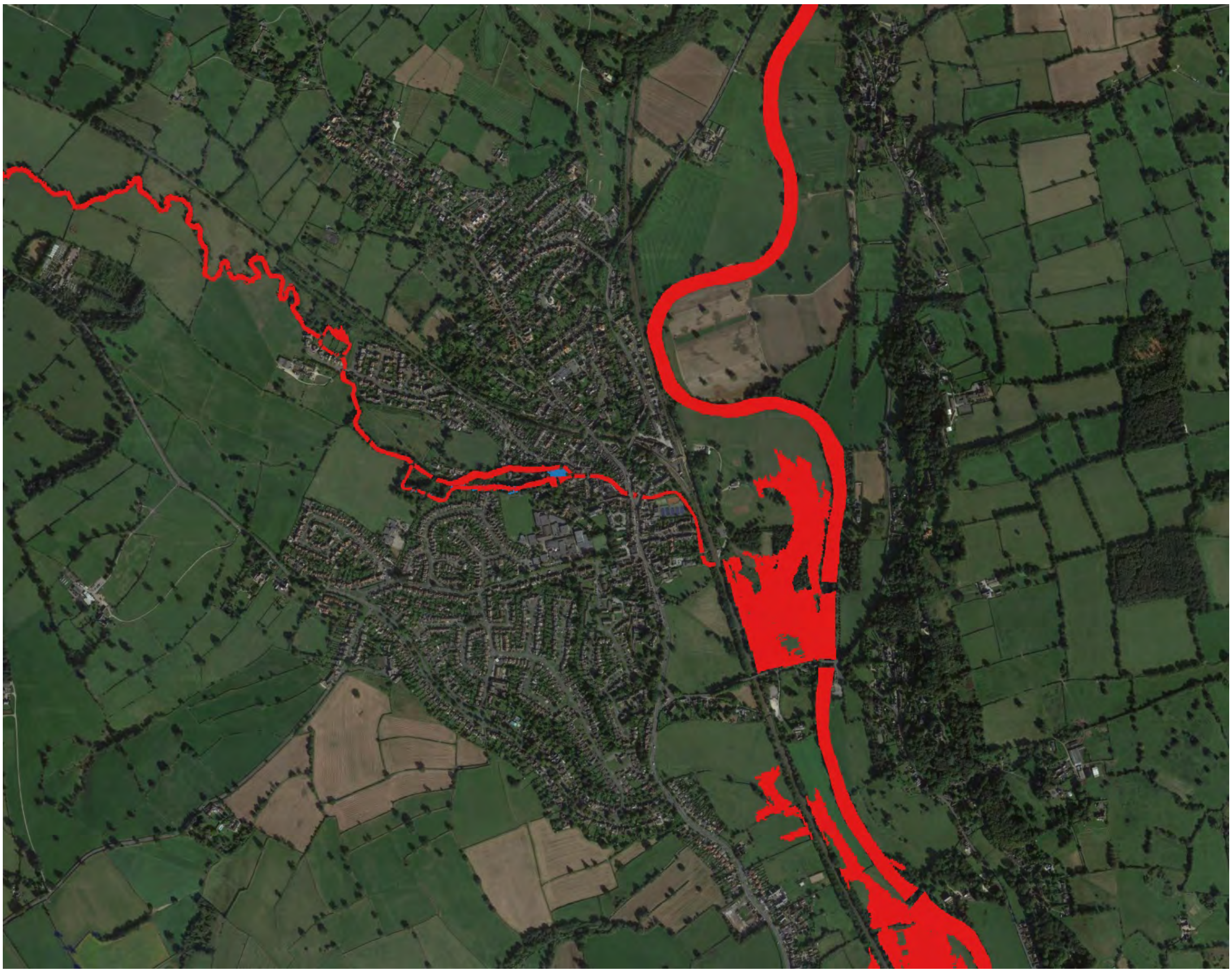

Figure 4.3b 1 in 5yr flood extent change, blue = baseline, red = restored (where blue is visible indicates flood extent decrease).

The model extends downstream to the Derwent and there are no increases in flood risk down to the confluence with the Derwent for either the 1 in 100yrCC or the 1 in 5yr return period events, as shown in Figure 4.2 and 4.3 above.

5. Conclusions and Recommendations

- The Snake Lane weir on the River Ecclesbourne at Duffield provides a complete barrier to fish passage and significantly influences river processes along the reach (both flow and sediment), due to its impounding influences;
- The channel is over-deep and disconnected from its urbanised floodplain, creating high energy flow conditions during floods that are able to transport coarse sediment downstream;
- The weir has resulted in the deposition of mixed sediment within the impoundment zone, but some material is transported over the weir and downstream during flood events;
- Optioneering has been undertaken that considers a variety of options for providing fish passage at the structure including full removal, bypassing, technical fish passes etc, this builds on optioneering undertaken by Atkins in 2011 and the Wild Trout Trust in 2019. The Wild Trout Trust identified removal of the weir as the preferred option due to the issues with bypassing the weir through the contaminated land over the right-hand bank. The optioneering undertaken for this study agrees with this option, but through notching the weir, with associated morphological feature creation upstream to manage the increase in hydraulic gradient and to maintain the flow split into the secondary Duck Island channel across the overspill weir;
- The design recommends notching of the weir and maintaining a 'buffer' section of weir alongside each bridge wing wall to minimise the risk of compromising the structure of the bridge and the wing walls following removal. This will need to be carefully cut by the contractor on site with a watching brief from an engineer during these works to advise on bridge stability and on any remedial repair works following removal. It is suggested that this is the best approach for managing the risk associated to the bridge stability as a result of the works since, in the absence of detailed designs associated to the existing bridge, wing walls and weir, detailed intrusive investigations of all structures is unlikely to provide conclusions to the connectivity of the bridge and wingwalls with the weir and the impact of modification to the weir as proposed for this option. This is based on past experiences of similar investigations for other similar design situations. Therefore, it is recommended a contingency is allowed for during fund planning to allow for repairs to the bridge, wingwalls and remaining weir sections. This would be advised by an engineer supervising the works that again must be allowed for in the scheme construction funding.
- Hydraulic modelling has demonstrated the improved hydromorphological functioning of the new channel compared to baseline in terms of hydraulic habitat and ability to provide fish passage. The outputs have also been used to size the new morphological features to be created;
- Modelling has also shown that there are no negative flood risk impacts associated to the scheme that would impact people or property;
- It is imperative that an engineer and geomorphologist supervises the site works during construction, as detailed in the accompanying Method Statement and described above.