



Bridgetown Weir Fish Pass Installation

Site Specific Flood Risk Assessment



Fishtek Consulting Ltd
Unit 1a Webber's Way
Dartington
Totnes
TQ9 6JY

Phone: 01803 866680
E-mail: info@fishtek-consulting.co.uk
Web: www.fishtek-consulting.co.uk

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1. Introduction

Fishtek Consulting Ltd has been commissioned by Westcountry Rivers Trust to undertake the design and consenting phase for a fish pass on Bridgetown Weir on the River Exe, Exmoor, as a part of the wider 'Strategic Exe Weirs' program. Bridgetown Weir has been identified as an obstacle to fish migration within the River Exe (Quarme to Haddeo catchment). The results from previous assessments indicate that Bridgetown Weir impedes the migration of protected fish species, including but not limited to: Atlantic salmon (*Salmo salar*), lamprey (*Lampetra spp.*, and *Petromyzon marinus*) and European eel (*Anguilla anguilla*).

Successful upstream migration over Bridgetown Weir by adult salmon is possible, however this is constrained to small flow windows, limiting movement to spate conditions. The main limiting factors at this site include the height (1.35 m) and slope of the weir and design/function of the existing fish pass at the weir. There is a pool and traverse fish pass at the upstream end of the weir, however it does not meet best practice guidance; the pools are undersized and therefore easily overcharged.

As the River Exe upstream of Bridgetown weir presents with highly important recruitment habitat for Atlantic salmon, lamprey, and brown/sea trout, a new, best practice Larinier fish pass and smolt chute has been proposed for the site, to replace the existing fish pass.

The proposed fish pass is a single flight, 600 mm wide Larinier fish pass with 100 mm high baffles, positioned within the footprint of the existing fish pass and fixed into the existing concrete fish pass structure. A Larinier fish pass was the preferred option for the site as they provide passage for a range of species over the large head drop and range of flows and could be designed to fit within the existing concrete infrastructure.

The right bank will be adjusted to accommodate the angle of the fish pass, which will follow the angle of the existing fish pass channel, which is directed towards the bank. The entrance of the fish pass will be brought in line with the weir toe by filling the area between the fish pass and weir toe with riprap. The excavated RHB will also be reinforced with riprap. If the riverbed downstream of the fish pass entrance is too shallow to ensure a suitable approach depth, excavations will be made. This however should not be an issue as the downstream water level is maintained by a pre-barrage.

In addition to the Larinier pass, improvements to downstream smolt passage are also being proposed. A smolt screen will be fitted to the entrance of the leat. This will guide smolts towards a chute that will ensure safe passage past the weir. Repairs to the weir crest are also proposed, to re-level a section of the weir close to the true left end of the weir that has degraded over time.

A prerequisite of most works in a river is an assessment of the impact to flood risk on the surrounding area. This document intends to provide supporting technical information to assist in obtaining approvals and consents to install a Larinier type fish pass and smolt chute on Bridgetown Weir. The following Site-Specific Flood Risk Assessment (SSFRA) report assesses the flood risk of the proposed design to support Planning and Environmental Permit applications.

2. Site location

The site is located in the upper reaches of the River Exe near the village of Bridgetown at the National Grid Reference 'SS 92314 33785'. The site is a curved weir that historically fed the mill leat that leads off from the true left edge of the weir. The leat is still used periodically and flow to it is controlled by a penstock at the upstream entrance of the leat. An existing fish passage facility has previously been installed on the true right side of the weir.

Name	Grid Reference	X	Y	Latitude	Longitude	Postcode
Bridgetown	SS 92314 33785	292314	133785	51.093232	-3.5391084	TA22 9JS

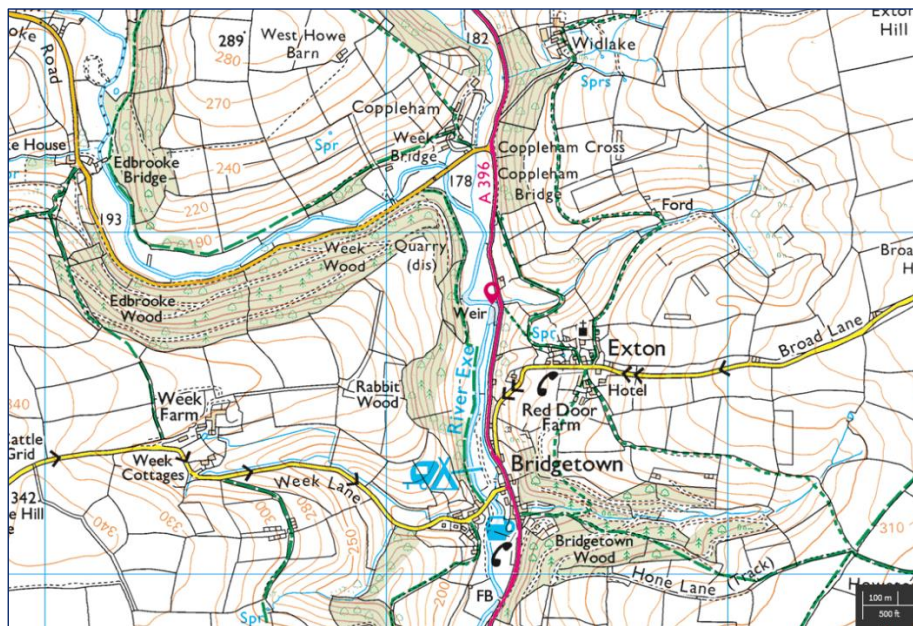


Figure 2.1: Site location. Weir location is indicated by red pin adjacent to the A397

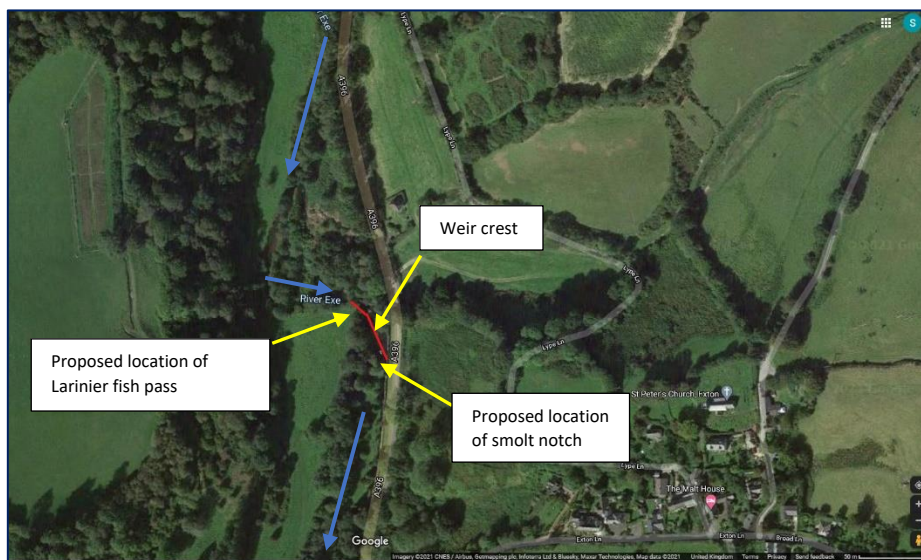


Figure 2.2: Location of Bridgetown Weir and proposed fish passes

2.1. Current hydraulic structures / flow routes

There are currently four routes by which water flows past or over Bridgetown weir. These are as follows:

- The existing fish pass, at the upstream end of the weir (see figure 2.3 and 2.4)
- The weir crest (see figure 2.5). This is in a varying state of repair along its length and has a variable level. One section in particular towards the downstream end of the weir has degraded, resulting in a section of weir crest that is lower than the remainder of the structure
- The notch at the downstream end of the weir, which typically has 'weir boards' placed in it (see figure 2.6)
- The leat, which has a large sluice at the upstream end (see figure 2.7)



Figure 2.3: image of the fish pass at the upstream end of the weir, looking from downstream



Figure 2.4: Image of the upstream end of the fish pass, where flow enters the pass. Boards are typically placed in here, to reduce flow into the pass

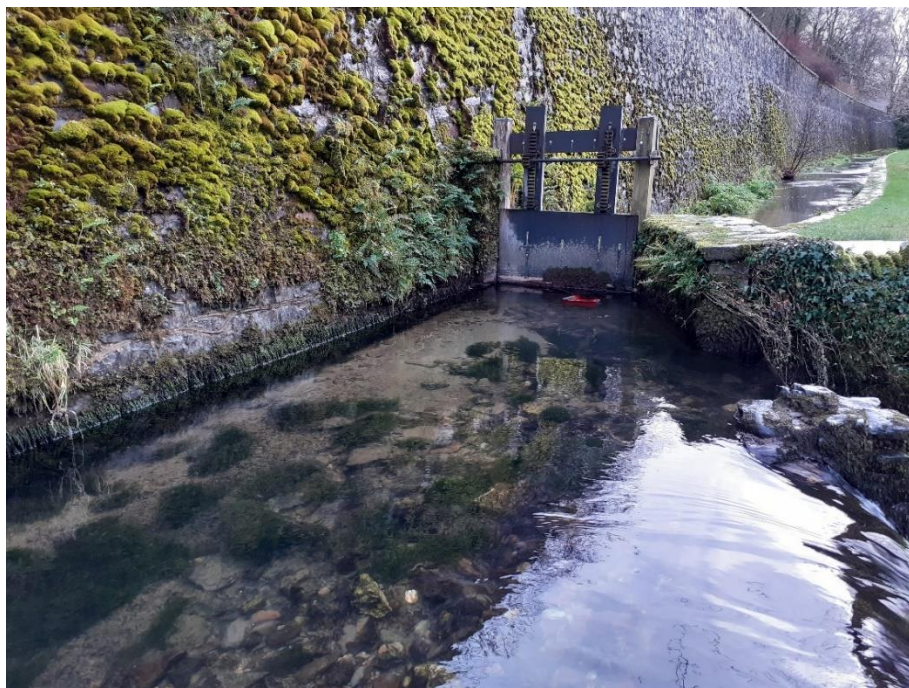


Figure 2.5: Image looking downstream towards the leat with sluice at the head of the leat



Figure 2.6: Image looking along the weir crest in an upstream direction



Figure 2.7: Image of the notch (with boards inserted) at the downstream end of the weir, close to the sluice at the head of the leat

2.2. Site flows & water levels

Flow data for the site is given in Table 1 and Flow Duration Curves in Figure 2.8. The flow estimates were obtained using Low Flows 2000 software.

Table 1: Site flows

% exceedance	Exe at Bridgetown (m ³ /s)
0.1	24.72
1	13.01
5	7.387
10	5.333
15	4.30
20	3.569
25	3.028
30	2.64
35	2.304
40	2.023
45	1.769
50	1.533
55	1.349
60	1.159
65	0.944
70	0.856
75	0.71
80	0.576
85	0.467
90	0.352
95	0.253
99	0.143

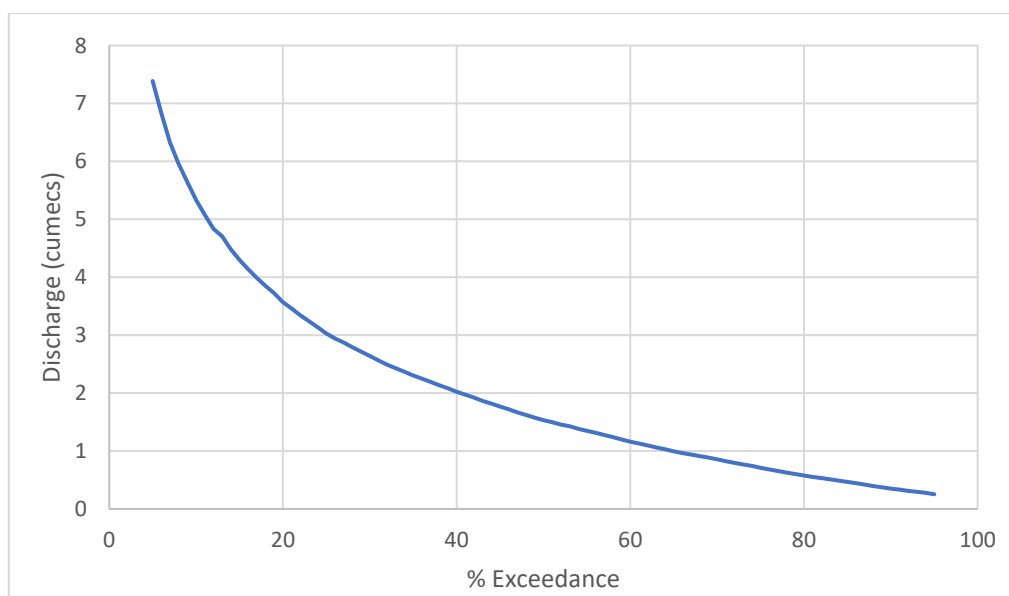


Figure 2.8. % Exceedance curve for the River Exe at Bridgetown

2.3. Proposed fish pass works

It is being proposed that fish passage improvements are made at the weir, as follows:

- Installation of a new 600 mm wide Larinier fish pass at the upstream end of the weir, in the footprint of (and replacing) the existing pool and traverse pass
- Repair of the weir crest for a distance of approximately 12 m. The intention of this work is to restore the level of the weir crest to its historical level along its whole length. A section towards the downstream end (which is to be repaired) has become damaged and degraded over time and has reduced in level. This creates effectively a shallow, wide notch which attracts fish, particularly at higher flows and which may reduce the effectiveness of the fish pass.
- Installation of a new smolt notch and chute at the downstream end of the weir, in the location of the current notch and boards (see figure 2.7)

All of the proposed works can be seen on the detailed design drawings that have been produced (see Fishtek drawings *02900-Bridgetown-Detailed Design-210525*).

3. Analytical approach

A flow analysis was performed to determine the relative water levels for a given flow at Bridgetown weir in three different scenarios:

- 1) The existing situation at the weir
- 2) A future scenario with the new Larinier fish pass installed, smolt notch installed and section of weir crest repaired
- 3) A future scenario with the new Larinier fish pass installed, smolt notch installed but no repairs carried out to the section of weir crest

Scenario 1) was then compared to scenario 2) and scenario 3) separately. Please note that in all cases, there was considered to be no flow passing down the leat. This flow route can and is shut off at times and as such, it was considered that flow passage through this route should not be modelled or included within the analysis, which represents a conservative approach with respect to flood risk in the main river channel. For reference, the level of the top of the sluice when closed is 175.80 m AOD.

In the two scenarios the various structures which flow can pass over or through are as follows:

- 1) Existing scenario
 - a. Over the existing weir (which has a varying level along its length) – see figure 2.6
 - b. Through the existing fish pass (see figure 2.3 and 2.4)
 - c. Through the existing notch at the end of the weir, which was considered as having boards in (see figure 2.7)
- 2) Future scenario with repaired weir crest
 - a. Over the existing weir (which has a varying level along its length, but which will be repaired to a more consistent level)
 - b. Through the new Larinier pass
 - c. Through the new smolt notch and chute
- 3) Future scenario with no repaired weir crest
 - a. Over the existing weir (which has a varying level along its length) – see figure 2.6
 - b. Through the new Larinier pass
 - c. Through the new smolt notch and chute

Flow through each of the various routes was modelled for a range of upstream water levels with the hydraulic approach taken for each structure as follows:

- Weir structure: considered as a broad-crested weir with a varying level. The weir was split into sections for the analysis with each section having a length and level assigned to it from the detailed topographic survey taken at the site
- Existing fish pass: calculated using flow relationship for a thin-plate weir as flow into the structure is controlled by the boards placed at the upstream end of the fish pass (see figure 2.4). Boards were at an average level of 174.40 m AOD when the topographic survey was taken.
- Existing notch at downstream end of weir: calculated using flow relationship for a thin-plate weir as flow into the structure is controlled by the boards placed in the structure, which were at an average level of 174.715 m AOD when the topographic survey was taken (see figure 2.7)

- Larinier: calculated using the flow relationship described in Environment Agency Science Report: SC020053/SR2 (Flow measurement structure design to aid fish migration without compromising flow data accuracy)
- New smolt notch and chute: calculated using flow relationship for a contracted notch. Smolt notch invert level 174.55 m AOD

The assessment was carried out from an upstream water level range of 174.65 m AOD (which is below the level of the majority of the weir crest, other than one small section where the weir crest is particularly breached) up to a flow of approximately 30 m³/s, which equates to an approximate upstream water level of 175.20 m AOD – 175.25 m AOD. Levels obtained during the topographic survey of the field on the true right bank of the river suggests that water will start to spill over this field at a level of approximately 174.20 m AOD. Note that the scenario of the new Larinier being blocked with debris was not modelled as the existing Larinier will replace and sit within the footprint of the existing fish pass. It is not considered that the new Larinier is any more likely to become blocked than the existing fish pass and as such there is a neutral impact of blockage risk and this impacting upon upstream water levels and flood risk.

4. Results

The three different scenarios were assessed to determine how the volume of water passing Bridgetown weir (and associated structures) will differ in each scenario, in terms of the resulting water level upstream of the weir.

Initially, scenario 1 was compared to scenario 2 (new Larinier pass, new smolt notch and chute and repaired weir crest). Figure 4.1 presents the results of this analysis and shows that there is a slight difference in the upstream water level for the two different scenarios. The water level in the proposed future scenario is slightly higher than the current situation at the weir, for a given flow. This difference is, however, relatively minor and equates to ~40 mm across most of the modelled flows.

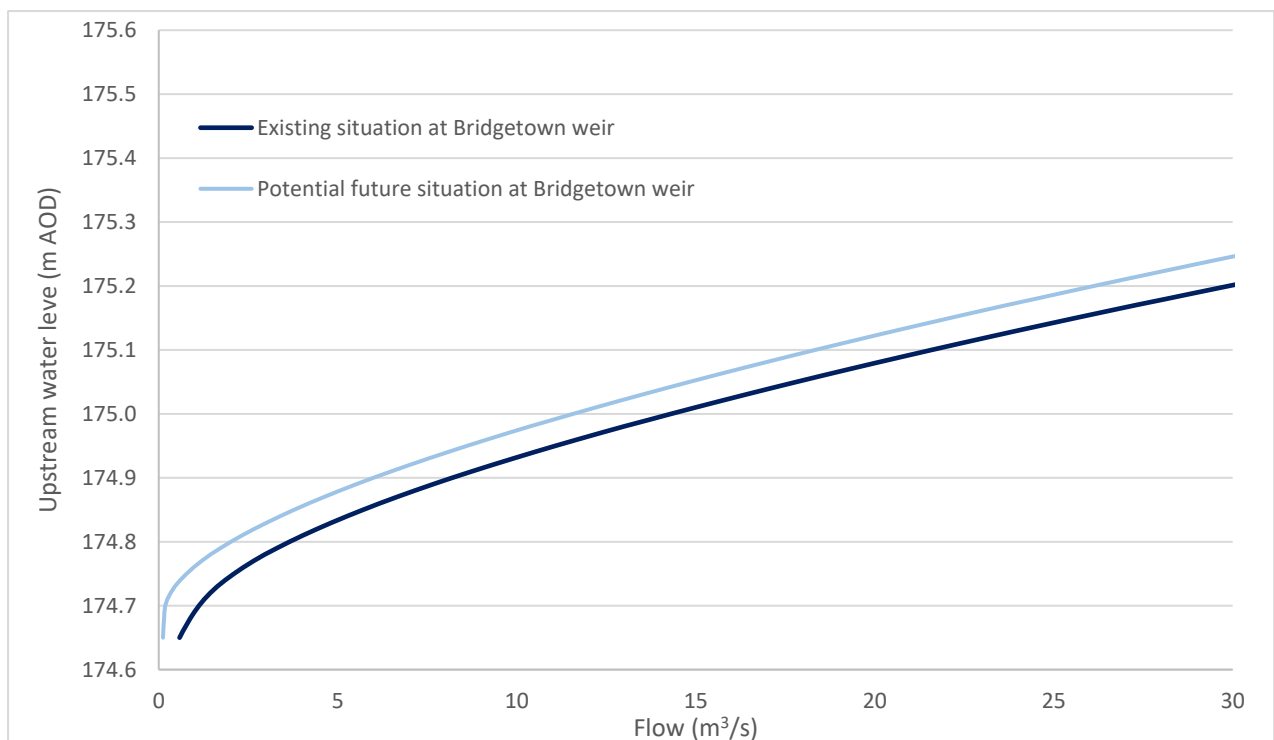


Figure 4.1: upstream water levels at Bridgetown weir across a total flow range of 0.1 – 30 m³/s for the two initial scenarios (Scenario 1 and Scenario 2)

An examination of the data and proportional flow passing through the different flow routes showed that the main hydraulic flow route is the weir crest at higher flows, but at low to medium flows, flow at the site will split between the different routes more evenly. At Q10, approximately 50% of the flow at the site will be passing over the weir crest and this increases to 75% by Q1. Given this, a secondary comparison was made, comparing the existing scenario at the weir with a future scenario where the weir crest is not repaired. The results are given in figure 4.2.

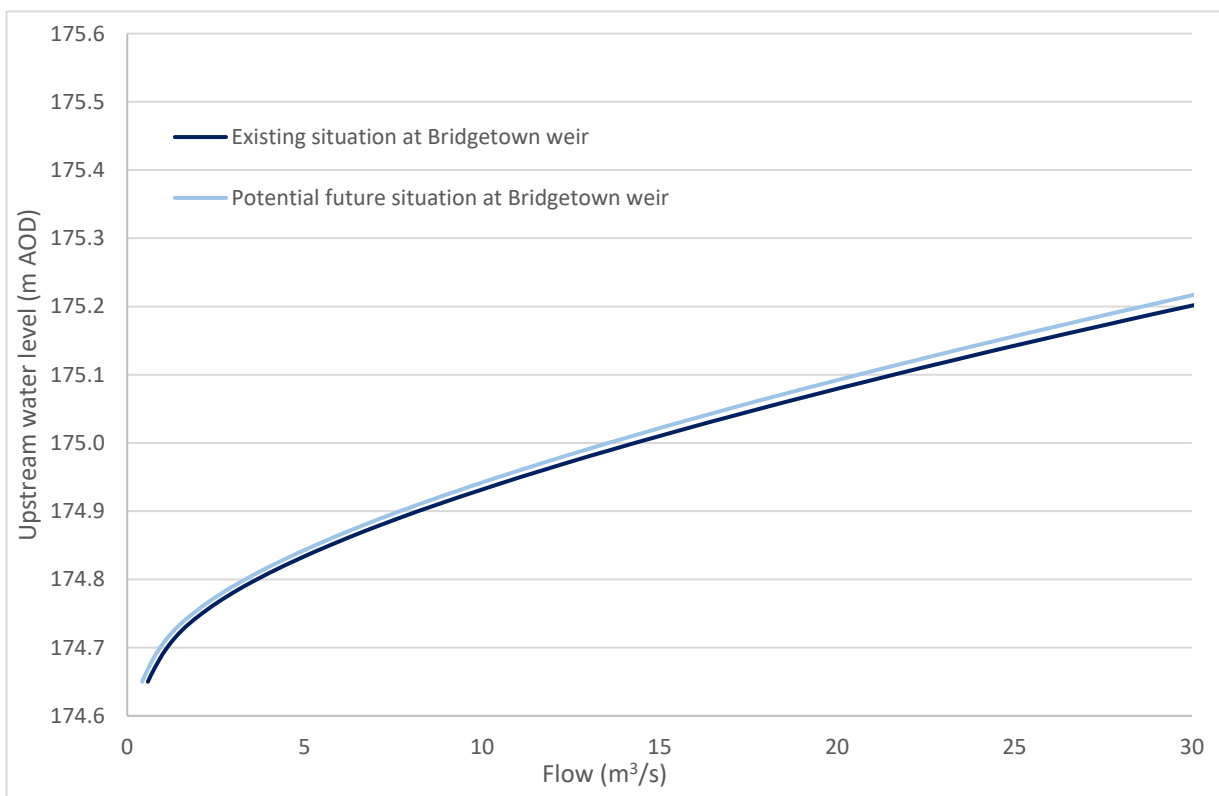


Figure 4.2: upstream water levels at Bridgetown weir across a total flow range of 0.1 – 30 m³/s for the two initial scenarios (Scenario 1 and Scenario 3)

The water level in the proposed future scenario with no repairs to the weir crest is only a small amount higher than it is for the current situation at the weir, for a given flow. This difference equates to ~10 mm across most of the modelled flows.

4.1. Impact of proposed works on flood risk

The proposed works at the site will result in an increase in water level upstream of Bridgetown weir. It is not considered, however, that this will increase the risk of flooding to any structure or property. There are no anthropogenic structures upstream of the weir that will be detrimentally impacted by the modelled increases in water level at the site.

The leat at the site conveys water down to a mill building, however this is controlled by a sluice at the upstream end of the leat. Operation (or non-operation) of this sluice by the landowner has a far larger impact on the risk of flooding at the mill building than the small change in upstream water levels that will result from the proposed improvements to fish passage at the site.

5. Conclusion

The installation of a proposed fish pass, with associated improvement works will greatly improve the situation for fish passage (both upstream and downstream) at Bridgetown weir. The alteration in the existing hydraulic structures at the weir will result in a small (non-significant) increase in upstream water level at the weir. The greater increase in water levels in Scenario 2 is largely due to the repair/re-leveling of the weir crest, and this repair work will restore the weir crest along its length to the historical level and will not result in a raising of the weir crest above this.

There will not be a significant alteration in the distribution of flow at the weir, with flow splitting between the fish pass, weir crest and smolt notch at low-flows and the weir crest taking the majority of the flow at high flows. This future scenario is the same as the situation at the weir currently.

Despite the predicted change in upstream water levels, it is not considered that there will be an increase in flood risk at the site as a result of the proposed work.