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1 INTRODUCTION

1.1 Background

Taylor Wimpey (TW) has been granted planning permission for, and is currently undertaking, construction works at a former derelict warehouse site located on Holcombe Road in Helmshore in Lancashire. Several conditions have been placed upon the planning permissions one of which is the provision of a fish pass on a weir (hereafter referred to as “the weir”) situated close to the junction between Holcombe Road and Station Road.

APEM Ltd has been commissioned by TW to undertake a fish passage options appraisal and subsequent fish pass detailed designs for the weir located on the River Ogden. This report provides details of this options appraisal for review and approval by TW and the Environment Agency (EA) prior to producing detailed design drawings for the preferred fish passage option.
2 SITE ASSESSMENT AND OPTIONS APPRAISAL

This section provides details of the site assessment and fish passage options appraisal for the weir at Helmshore.

2.1 Survey timing

This site was visited by APEM’s Senior Scientist, Dr Peter Walker, and H2OK’s Civil Engineering Associate Director John Wilson at approximately 09:30 on 14/05/2011. Representatives from the local EA Fisheries and Biodiversity team and TW were also in attendance.

2.2 Antecedent conditions

During the time of the site visit river flow conditions were estimated as being moderately low. The weather was predominantly clear skies and warm. All elements of the weir structure were clearly visible but relatively poor water clarity and greater water depths prevented surveyors from viewing the river bed within the weir pool beneath the weir.

2.3 Ownership and current function

The weir and bank retaining walls are owned by TW. The weir has no extant function but it is likely that it provides some structural support to the bank retaining walls.

2.4 Topographic survey

A topographic survey was undertaken by Survey Operations on 6th June 2012. The Computer Aided Design (CAD) outputs are provided in Appendix I and have been used to inform the site description provided below.

2.5 Site description

The weir in Helmshore is located on the River Ogden at NGR: SD 77900 21100. The River Ogden is a tributary of the River Irwell which is in turn a tributary of the River Mersey. The key features of the site are illustrated in Figures 2.1 to 2.5.

The weir comprises a broad crested, vertical face weir with a head-loss across the structure of approximately 1.7m on the day of the site visit and a non-adherent nappe over the weir face (Figure 2.1). The weir is comprised of masonry blocks and spans the entire width of the approximately 8m wide channel, and is approximately 0.5m long (i.e. along the upstream – downstream axis).

A vegetated side bar has formed on the right hand side of the channel immediately upstream of the weir (Figure 2.1) and there were several large trees along the left hand bank including one situated immediately above the weir. A culverted drain exit is situated in the extreme left hand corner of the weir face measuring approximately 50cm wide and high (Figure 2.1 and 2.2). The purpose or origins of the drain could not be determined but a small amount of flow was observed coming out of the drain suggesting that it has an extant drainage function.
Figure 2.1. Photograph of the weir on the River Ogden at NGR: SD 779 211 looking upstream.

Figure 2.2. Photograph of the culverted drain set within the weir face on the left hand bank.
A public road (Station Road) and footpath are located immediately behind the bankside wall on the right hand bank and downstream of the weir with privately owned houses being situated behind the right hand bank wall immediately upstream of the weir. A road drain is situated within the right hand bank wall and there was evidence of recent discharge from the drain during the site visit (Figure 2.3).

Figure 2.3. Photograph showing the right hand bank retaining wall and road drain.

The river channel immediately upstream of the weir (Figure 2.4) was predominantly shallow glide with a substrate comprised of silted cobble interspersed with occasional small patches of gravel and boulders. Approximately 50m and 150m upstream small riffle areas were observed but these appeared to have been created by artificial features (e.g. concreted sections of river bed). The channel was relatively uniform in shape throughout the reach immediately upstream of the weir with a canalised form characterised by steep, vertical, vegetated banks on the left hand bank and a stone wall on the right hand bank (Figure 2.4). The average depth upstream was approximately 30cm on the day of the site visit and flows were estimated as being moderately low.
Figure 2.4. Photograph looking upstream at the habitat upstream of the weir.

The river channel immediately downstream is canalised with stone walls lining both banks. The weir pool comprises very slow, almost standing water with an average depth of approximately 0.6m. Several small (approximately 15-20cm) brown trout were observed in the weir pool during the site visit. A vegetated silt island was present at the downstream end of the weir pool on the left hand bank. Further downstream the water is very shallow (average depth <20cm) with faster flowing, run interspersed with occasional riffle areas. The substrate downstream of the weir was comprised predominantly of cobble interspersed with small boulders.
2.6 Fish species considerations

According to electric fishing survey data provided by the EA, there are five species of fish present in the River Ogden in the vicinity of Helmshore. These include:

- Three-spined stickleback (*Gasterosteus aculeatus*)
- Stone loach (*Barbatula barbatula*)
- Bullhead (*Cottus gobio*)
- Chub (*Leuciscus cephalus*)
- Brown trout / sea trout (*Salmo trutta*)

According to local EA fisheries staff, fish passage issues require considering for brown trout (*Salmo trutta*) only (Kevin Nash, EA, *pers comm.*). In the absence of detailed fisheries data it has been assumed that adult brown trout between 15 and 49cm will require passage and thus their respective swimming speeds are provided here to inform the detailed design of the fish pass:

- 15cm = 144cm s$^{-1}$ (90% confidence intervals = 25-263)
- 49cm = 225cm s$^{-1}$ (90% confidence intervals = 82-367)

The swimming speeds were calculated for a temperature of 5°C using SWIMIT.
2.7 Hydrometry

Gauged flow data was not available for this river, however flow as calculated using the ‘Low Flows 2000’ model was provided by the EA (Table 2.1). ‘Influenced’ (estimated flows accounting for the presence of upstream reservoirs) and ‘natural’ (estimated flows in the absence of upstream reservoirs) flows were calculated. For the purpose of completing the fish pass approval form, the ‘influenced’ flow data was used to account for the presence of upstream reservoirs. It should be noted that the confidence in the predicted flows is low, and spot gaugings are recommended to validate the calculated flows in Table 2.1

Table 2.1. Flow percentiles for Ogden Brook, calculated using ‘Low Flows 2000’ software.

<table>
<thead>
<tr>
<th>Flow percentile (Q)</th>
<th>Influenced flow m³/s</th>
<th>Natural flow m³/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.000</td>
<td>1.744</td>
<td>1.968</td>
</tr>
<tr>
<td>10.00</td>
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<td>0.0300</td>
<td>0.0620</td>
</tr>
<tr>
<td>Mean flow</td>
<td><strong>0.45</strong></td>
<td><strong>0.61</strong></td>
</tr>
</tbody>
</table>

2.8 Barrier passability assessment

Due to the very large head-loss and flow characteristics over the weir face (e.g. plunging flows and non-adherent nappe) the weir is considered to be completely impassable to upstream migrating fish in its current configuration.

2.9 Fish passage options appraisal

This section provides a brief discussion of the various fish passage options considered for the weir at Helmshore. Information contained within the EA fish pass manual (Armstrong et al., 2010) has been used to inform this options appraisal and the brief description of the preferred option. Fish passage has only been considered for non-migratory brown trout following discussions with EA Senior Fisheries Technical Specialist, Kevin Nash.

Do nothing

It is a specific condition of the planning consent that appropriate fish passage facilities are provided at the existing weir. In the event that such facilities are not provided then TW would be in breach of their planning permission conditions. Consequently, a “do nothing” approach is not possible at this site.
**Barrier removal**

The removal of barriers to migrating fish offers the benefits of restoring connectivity within the watercourse and re-establishing the natural hydromorphological features of the river channel.

This option would be preferred from an ecological/hydromorphological perspective. However, weir removal is unlikely to be acceptable due to the technical difficulties and costs associated with removing the weir and reprofiling the channel in a manner which provides adequate fish passage opportunities without negatively impacting upon the structural integrity/stability of the surrounding walls, roads and houses. Weir removal is therefore not considered to be a viable option for this site.

**Easements and barrier modification**

Various types of easements have been used to facilitate the passage of fish at different types of obstacles. Easements are modifications carried out at barriers to fish migration which, although designed to facilitate fish passage, are not considered to be technical fish passes. Easements typically fall into one of the following categories:

- Creating streaming flow and heterogeneous conditions
- Adherent (non-aerated) nappes
- Notches and gaps
- Baulks
- Installing baffle systems
- Preliminary weirs (pre-barrages, check weirs)
- Modifications to the natural bed

For this site it is considered that the range of easements available would not be sufficient, due to the large head loss (at least partly), to enable fish passage under the majority of flows without extensive modification of the river channel and bed. Easement options are thus not considered further.

**Bypass channels**

Nature like bypass channels are becoming increasingly popular as fish passage solutions where they are practically feasible. In addition to increasing connectivity between sections of a watercourse, bypass channels can offer the extra benefit of creating additional habitat for use by a variety of wildlife. In the case of this site however there is a lack of available space in the surrounding land within which a fish bypass channel could be created, and thus this option is not considered viable at this location.

**Rock ramp**

Rock ramps entail the creation of a ramp to spread the head loss over a greater distance and the selective placement of boulders/rocks to dissipate energy and create low velocity areas which upstream migrating fish can exploit. Rock ramps, when
constructed properly, provide fish passage for a wide array of species and have the additional benefit of a naturalised appearance, thus minimising the impact on aesthetic qualities of a site. Rock ramps can also provide additional benefits for other species in terms of habitat and by increasing connectivity (e.g. for invertebrate species). However, rock ramps are technically complex and frequently require adjustments post installation to achieve the desired flows and thus incur high costs to design and install. Furthermore, it is considered that there is insufficient space in order to provide a suitable gradient and associated velocities for facilitating the upstream passage of brown trout. Due to the highly technical nature of this potential solution, the associated costs and the limited available space for installation, this option is not recommended as the preferred method of barrier mitigation for this site.

**Technical fish pass**

Various types of technical fish pass could theoretically be employed to provide adequate fish passage facilities at this site. Technical fish passes considered as potentially suitable for providing adequate fish passage facilities at this location include:

1) Pool and traverse
2) Larinier super-active baffle pass
3) Denil plane baffle pass
4) Alaskan ‘A’ baffle pass

Pool and traverse type passes have been extensively tried and tested and shown to be applicable for most species providing they are designed with the appropriate dimensions. Furthermore they are typically considered to have low maintenance requirements compared with other types of fish pass. However, due to the low gradient typically required (10-12.5%) the construction costs are relatively high, and thus this fish pass type is not recommended as the preferred option for this site.

**Estimated cost for Pool & Traverse = £150,000 - £200,000**

Bottom baffle fish passes such as Larinier Super-active Baffle pass entail the installation of a low gradient channel with a series of baffles mounted on the bed of the channel to dissipate energy and reduce water velocities within the fish pass. Bottom baffle passes are becoming increasingly popular primarily due to the fact that they require very little routine maintenance (because they are not prone to blocking with debris) and that they are suitable for passing a large range of species and life stages. However, they typically require a gradient not more than 10-15% to be effective and thus require considerable space and construction materials which can make them significantly more costly than side-baffle passes (e.g. Denil and Alaskan A passes). This fish pass type is therefore not recommended as the preferred option for this site.

**Estimated cost for twin flight Larinier pass with resting pool = £90,000 - £120,000**

Plane baffle Denil fish passes are comprised of a channel lined with baffles in a single flat plane typically set at 45° to the fish pass channel slope. The gradient within a Denil typically ranges between 10 and 20% with the latter suitable only for larger salmonid species. Denil passes are considered to be relatively simple to design and construct and are well understood and proven to be effective when installed at
appropriate locations. They are however limited in terms of their species suitability, and maintenance costs can be high where debris loads within the river are large due to their being prone to blocking. The risk of blocking can be reduced with the installation of an appropriate trash deflector however. A plane baffle Denil fish pass is considered to be a potential option for installation at this site.

**Estimated cost for Denil plane baffle pass** = £40,000 - £60,000

An Alaskan ‘A’ fish pass is similar to a plane baffle Denil. Alaskan ‘A’ passes have three-dimensional baffles and are considered to be more effective hydraulically than a plane baffle Denil pass with similar dimensions. These passes are also available as pre-fabricated modular units which can result in lower construction costs compared with other types of fish pass. Alaskan ‘A’ fish passes can be effective for some fish species at gradients of up to 25% although lower gradients are advised where smaller or less athletic fishes require passage. As with plane baffle Denil fish passes, Alaskan ‘A’ s are prone to blockage and thus further consideration of likely debris loads within the Ogden and the potential requirement of a trash deflector is advised during the detail design phase. An Alaskan ‘A’ type fish pass is the recommended fish passage option for this site.

**Estimated cost for Alaskan A pass** = £40,000 – 60,000
2.10 Proposed fish passage option

Based on the options appraisal undertaken in Section 2.9 it is recommended that an Alaskan ‘A’ style technical fish pass is installed on the right hand bank as the preferred fish passage option for this site. Figure 2.6 illustrates the proposed location for the fish pass.

Figure 2.6. Schematic illustrating the key features of the preferred fish passage option at Weir. The blue arrow indicates the flow direction.

According to guidance in the EA Fish Pass Manual (Armstrong et al., 2010), in order to pass brown trout, the pass should not exceed 12m in total length or have a gradient of more than 20%. The total channel width should be 0.56m with a free passage width (i.e. the gap between left hand and right hand baffles) of 0.35m (Armstrong et al., 2010).

The silt island currently located on the right hand side of the channel immediately upstream of the weir should be removed. The presence of this island currently indicates that there is potential for silt and other debris to accumulate here which may impact upon the effectiveness of the pass and this should be borne in mind during the detailed design phase. Notwithstanding this, increased flow down this side of the channel due to installation of the fish pass will remove the propensity of fine sediment to accumulate here.
3 DETAILED DESIGNS OF THE PROPOSED FISH PASSAGE OPTION

This section provides detailed design schematics and further information concerning the proposed fish passage option of a single flight Alaskan ‘A’ Denil pass, as identified in Section 2.10.

The detailed design (CAD) drawings for the proposed Alaskan ‘A’ pass are provided in Appendix II, which are supplied in PDF and CAD format accompanying this report. The pass should be located on the right hand bank, adjacent to the stone wall. Downstream of the weir, the river curves to the left and a vegetated silt island has formed on the left hand bank. Therefore in the absence of fish tracking data to accurately determine where fish accumulate downstream of the weir, it is assumed that the right hand bank is the most likely location where fish will currently travel and would attempt to pass upstream. To accommodate passage of brown trout, the Alaskan ‘A’ pass will be constructed with a 16.4% gradient, a total head loss from the upstream inlet to the downstream toe of the pass of 1.92m, and a flight length of 12m. These dimensions are within the guidelines provided in the EA Fish Pass Manual (Armstrong et al., 2010) for passing non-migratory salmonid species of fish, whereby a maximum of a 20% gradient and 12m length should not be exceeded for a single flight. Information concerning the baffle height, and width of the pass are provided in Appendix II, along with the proposed location and various relevant elevation (AOD) details required for completing the EA application for fish pass approval form.

3.1 Monitoring programme

To determine that the Alaskan ‘A’ pass functions as expected, it is recommended that a monitoring programme is undertaken following installation (indeed this is often a requirement of fish pass approval by the EA). Monitoring will help to determine if any minor modifications to the fish pass are required to improve efficiency. APEM has considerable experience of monitoring fish populations within rivers at a number of locations throughout the UK and abroad, using a range of techniques including video monitoring, Didson camera, radio tagging and fish traps.

4 REFERENCES

5 APPENDIX I

**CAD and PDF files of the topographic surveys are provided as additional files accompanying this report.**

6 APPENDIX II

**CAD and PDF files of the detailed plan drawings are provided on a separate cd.**