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Hazelford Weir Hydroelectric Project

Water Framework Directive Assessment

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Document Control

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1. Introduction

Introduction to assessment

1.1. This document accompanies a planning application plus abstraction and impoundment licence applications for a hydropower scheme and associated infrastructure at Hazelford Weir on the River Trent.

1.2. The Environment Agency's 'Guidance for run-of-river hydropower: the Water Framework Directive, nature conservation and heritage' dated December 2013 has been followed as part of this assessment.

1.3. The assessment will review the potential effects arising from the proposed scheme in relation to:

- flow patterns
- sediment availability

1.4. The Water Framework Directive (2000/60/EC) (WFD) was passed by the European Union in 2000. It became part of UK law in 2003 with the issue of The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

1.5. The WFD is implemented regionally by river basins. Each river basin has a River Basin Management Plan (RBMP) which is updated every six years. The RBMP documents the current status of the water bodies and the pressures affecting them. It outlines the improvements that can be made within the current management period and the programme of investigations to be carried out.

1.6. The fundamental objectives of the WFD that apply to surface water bodies are:

- Prevent deterioration of the status of water bodies
- Achieve at least Good ecological status and Good surface water chemical status by a set date
- Reduce pollution from priority substances and eliminate priority hazardous substances as defined by the European Commission

1.7. In additional to the objectives above there are further standards and measures to be met in areas defined as protected areas. These areas are listed in the RBMPs.

1.8. Artificial or Heavily Modified Water Bodies (AWB, HMWB) cannot achieve good ecological status as they are unable to get close enough to the required natural conditions. Instead the aim is to achieve Good ecological *potential*.

1.9. The RBMPs detail the Environment Agency (EA) objectives specific to each water body that are designed to meet the WFD objectives. The proposed measures to meet the objectives are also given.

Purpose of assessment

1.10. This assessment has been undertaken to fulfil the requirements under the Water Framework Directive.

1.11. The EU Water Framework Directive requires environmental objectives be set for all surface and ground waters to enable them to achieve Good status or potential for heavily modified water bodies by a defined date. One objective is to prevent further deterioration which can include changes to flow pattern, width and depth of channel, sediment availability/transport and ecology and biology.

1.12. This assessment looks at the current status of the water bodies that may be affected by the proposed hydropower system and discusses whether or not the proposal will deteriorate the ecological quality of the water bodies or prevent the water bodies from achieving Good ecological status.

1.13. Any EA defined objectives and measures that are specific to the water body will be considered to determine if the proposed hydropower system will prevent these objectives and measures from being realised.

1.14. The assessment includes any cumulative or in-combination effects.

Site description

1.15. The application site is located at Hazelford Weir, on the River Trent in Nottinghamshire. The river at this location flows along two separate channels; there are two weirs separated by an island and canal lock. The two channels diverge around 1 km upstream of the site and re-converge around 350 m downstream.

1.16. The weir maintains water levels for navigation between the site and Gunthorpe Weir.

Current WFD status

Water body name	Trent from Soar to The Beck
Water body ID	GB104028053110
Management Catchment	Trent and Lower Erewash
River Basin District	Humber
Hydromorphological Designation	Heavily Modified
Current Ecological Quality (2015)	Moderate
Current Chemical Quality (2015)	Good
Ecological quality objective	Moderate by 2015
Chemical quality objective	Good by 2015

Classification Item	2013	2014	2015	2016
Overall Water Body	Moderate	Moderate	Moderate	Moderate
Ecological	Moderate	Moderate	Moderate	Moderate
Supporting elements (Surface Water)	Moderate	Moderate	Moderate	Moderate
Mitigation Measures Assessment	Moderate or less	Moderate or less	Moderate or less	Moderate or less
Biological quality elements	Good	Moderate	Moderate	Moderate
Macrophytes and Phytobenthos Combined	Good	Moderate	Moderate	Moderate
Invertebrates	Good	Good	Good	High
Hydromorphological Supporting Elements	Supports Good	Supports Good	Supports Good	Supports Good
Hydrological Regime	Supports Good	Supports Good	Supports Good	Supports Good
Physico-chemical quality elements	Moderate	Moderate	Moderate	Moderate
Acid Neutralising Capacity	-	High	High	High
Ammonia (Phys-Chem)	Good	High	High	High
Biochemical Oxygen Demand (BOD)	High	High	Good	Good
Dissolved oxygen	High	High	Good	Good
pH	High	High	High	High
Phosphate	Poor	Poor	Poor	Poor
Temperature	High	High	Moderate	Good

1.17. The upstream waterbodies are: Causeway Dyke Catchment (trib of Trent), Cocker Beck Catchment (trib of Trent), Devon from Cotham to Trent, Dover Beck Catchment (trib of Trent), Erewash from Gilt Brook to Trent, Fairham Brook Catchment (trib of Trent), Greet Catchment (trib of Trent), Leen from Day Brook to Trent, Ouse Dyke Catchment (trib of Trent), Polser Brook from Cotgrave Brook to Trent, Shelford Brook Catchment (trib of Trent), Slough Dyke Catchment (trib of Trent), Soar from Long Whatton Brook to Trent, Trent Bifurcation Pingleu Dyke to Winthorpe, Trent from Derwent to Soar.

1.18. The downstream waterbody is Trent from Carlton-on-Trent to Laughton Drain.

Proposal summary

1.19. The proposal is for the installation of a hydropower scheme consisting of a single large Kaplan turbine and associated infrastructure at Hazelford Weir, within the left bank of the main channel.

1.20. The application includes the installation, at both weirs, of fish pass facilities and an adjustable weir crest. The purpose of the adjustable weir crests is to maintain water levels for navigation and increase the head to improve energy capture from the hydropower scheme.

1.21. The scheme is expected to generate a peak power output of 999 kW and an average annual energy production of 6.0 GWh. This is sufficient to power 1540 homes and provides an effective CO2e saving of around 3,120 tonnes per year.

Interaction with other hydropower schemes

1.22. Currently, there are no hydropower schemes in operation within 10 km upstream or downstream of the site. The following schemes are known to be operation, consented or within development along the River Trent:

Operational

Holme Lock, 16 km upstream

Beeston Weir, 24 km upstream

Consented

Nether Weir, 9 km downstream

Cromwell Weir 14 km downstream

Proposed

Gunthorpe Weir, 7 km upstream

Stoke Weir, 12 km upstream

2. Impact on WFD objectives

2.1. The following table reviews the RBMP and online classification data for the relevant section 'Trent from Soar to The Beck':

Receptor	Current status (2016 C2)	Objective	Reasons for status	Impact	Assessment
OVERALL	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Ecological	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Ecological – biological quality elements					
Overall	Moderate	Good by 2027	Disproportionate burdens	No adverse impact	See individual elements below
Macrophytes and phytobenthos combined	Moderate	Good by 2027	Disproportionate burdens	No adverse impact	There will be no significant hydromorphological impacts of the proposal - see below. The ecological impact of changes in water level were assessed as part of the Ecological Appraisal by Fauna Forest Ecology, concluding that 'flora species are unlikely to be negatively impacted by the future increases, given that in previous years they will have been subjected to such conditions.' Overall, as there is no adverse impact on other related elements such as water quality, there will be no significant impact on macrophytes or phytobenthos.
Invertebrates	High	Good by 2015	-	No adverse impact	There will be no significant hydromorphological impacts of the proposal - see below. As there is no adverse impact on other

					related elements such as water quality, there will be no significant impact on invertebrates.
Ecological – hydromorphological supporting elements					
Overall	Supports Good	Supports Good by 2015	-	No adverse impact	The hydromorphological impacts of the proposal were assessed by APEM, with the general conclusion that some changes in sediment size may occur near the HEP tailrace and downstream of the south weir, however any accumulation of fines would continue to be flushed intermittently. Please see the Discussion for further details, including impacts due to changes in water level. Overall, there is a minor and temporary hydromorphological impact, which is not considered to cause any deterioration in the WFD status.
Hydrological Regime	Supports Good	Supports Good by 2015	-	No adverse impact	See above. The hydropower scheme is a 'run-of-river' scheme and so will not affect the flow rate in the watercourse, except for directly at the weir.
Ecological – physico-chemical quality elements					
Overall	Moderate	Moderate by 2015	Unfavourable balance of costs and benefits Disproportionate burdens	No adverse impact	See individual elements below
Biochemical oxygen demand (BOD)	Good	-	-	No adverse impact	There will be no significant impacts on aquatic species that contribute to BOD, nor any impact due to changes in DO, see below.
Dissolved oxygen	Good	Good by 2015	-	No adverse impact	APEM concluded the following: 'Given recent DO data, in addition to the fact that re-oxygenation of water would still occur via several means at Hazelford following construction of the HEP scheme, no adverse impacts on the WFD status of the waterbody or ecological receptors are anticipated.'

Temperature	Good	Good by 2015	-	No adverse impact	Any impacts on water temperature due to changes in flow distribution will be very minor and highly localised.

2.2. All conditions assessed above are shown to have either no impact or a slight positive impact on each individual WFD element.

3. Discussion

Overview

3.1. Hazelford Weir is located within the 'Trent from Soar to The Beck' section of Nottingham Urban Operational Catchment Area. The Management catchment area is Trent and Lower Erewash within the Humber River Basin District.

3.2. The catchment of the Lower Trent and Erewash is a very large sub-catchment covering an area of approximately 2045 km^2, extending from the River Dove confluence with the River Trent south west of the city of Derby and finishing at Alkborough Flats where the Trent flows into the Humber Estuary. Within this area the River Trent is 174 km long with its main tributaries including the rivers Derwent, Soar, Erewash, Leen, Greet, Devon, Idle, Torne and Eau and the Dover Beck.

3.3. The Vision for the Lower Trent & Erewash Catchment Partnership is "A Lower Trent & Erewash catchment that has a healthy, functioning water environment including rivers, lakes and groundwater". A long-term objective is that "water quality from point and diffuse sources is improved" and that "fish can move freely throughout the catchment with ample spawning and nursery areas".

3.4. The Humber RBMP cites not setting the 2015 ecological quality target at Good due to it 'unfavourable balance of costs and benefits' and 'disproportionate burdens'.

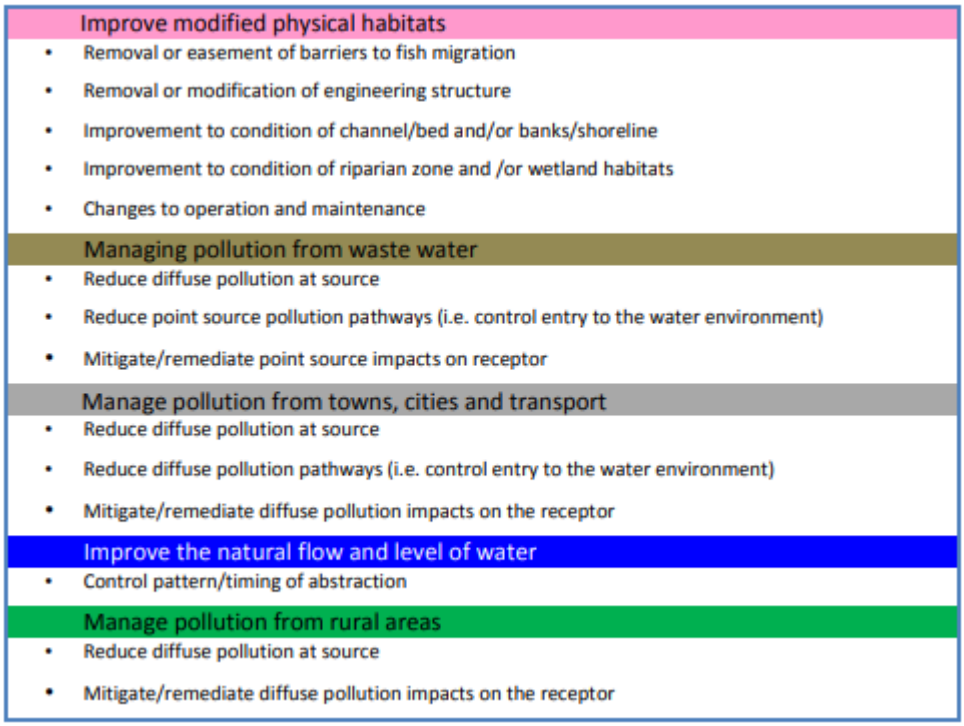
3.5. The Trent Lower and Erewash Catchment Management Plan shows that the main reason for not achieving Good status is due to the catchment is failing on ecological status.

3.6. Key pressures include:

- Diffuse pollution from roads and urban areas
- Heavily modified river channels
- Rural point source and diffuse pollution
- Separation of the river from its floodplain
- Loss of riparian wetland habitats
- Raised levels of phosphates
- Risk of properties and roads flooding
- Impeded fish passage

Mitigation measures

3.7. When a failure is identified, a range of measures are assessed that would be needed to improve the status of water bodies. Mitigation measures proposed for this catchment are:



3.8. The Reasons for Not Achieving Good Status (RNAGS) within the water body are:

- Mitigation measures assessment
  - Confirmed physical modifications due to:
    - Navigation
    - Flood protection
    - Urbanisation
- Macrophytes and Phytobenthos Combined
  - Probable phosphate pollution from:
    - Waste water discharges
    - Urban transport drainage

Biodiversity and fish passage

3.9. The immediate area is not subject to any statutory environmental designations. Part of the development area is within areas designated as Local Wildlife Sites. For further details on Local Wildlife Sites as well as terrestrial and riparian habitats, please see the separate ecological reports.

3.10. An eel pass on the main weir is currently the only existing fish pass facility at Hazelford. The weirs are currently deemed to pose a complete barrier to the upstream passage of coarse fish and lamprey due to excessive head drops and high velocities over the weir face. The weirs are deemed to be a high impact barrier to the upstream passage of salmon and sea trout.

3.11. This application proposes the installation of new multi-species fish passes to provide fish passage for salmonids, coarse fish, eel and lamprey.

3.12. The installation of the fish passes will fulfil requirements under the Salmon and Freshwater Fisheries Act 1975 and the Eels (England and Wales) Regulations 2009.

3.13. The proposal includes lamprey passage provisions and as such will contribute to the migration of lamprey throughout the River Trent from the Humber Estuary SAC and the upper Catchment, which includes the Attenborough Gravel Pits SSSI. This is in line with the conservation objections of the Humber Estuary SAC.

3.14. Taking into account the very high base flow, for the separate channel to the south a hands-off flow of 10% of the mean flow in this channel will be provided. This will maintain some flow through the habitats along the south channel, whilst minimising flow that may attract migratory fish away from the northern channel and fish pass location.

3.15. The proposed weir crest operation will stabilise upstream water levels within key fish migration windows. This makes it significantly easier to install a fish pass that operates effectively across a wide range of flow conditions.

3.16. Overall the hydropower scheme does not create any additional barrier to fish passage and with the installation of a fish pass, upstream fish, eel and lamprey migration at Hazelford will improve.

3.17. Although not currently assessed by the EA, the element 'Ecological >> Biological quality elements – Fish' is of particular relevance to the current proposal. A specialist study was commissioned from APEM to assess the impact of the proposals on aquatic habitats and fish passage, based on a detailed geomorphology assessment. A summary of their findings is presented below:

- *The fish habitat assessment focused on potential impacts to adult, juvenile, and spawning life stages of rheophilic coarse fish and eurytopic fish (roach) as well as spawning salmon and lamprey and juvenile lamprey (ammocoete) habitat. The proposed HEP scheme showed differing effects on and between species in the northern and southern channels.*
- *There is a predicted increase in the availability of adult rheophilic habitat in the northern weir pool after commencement of the HEP scheme. In contrast, there is a predicted decrease in juvenile rheophilic habitat. Spawning salmon and lamprey, juvenile lamprey and adult rheophilic habitat suitability remain largely unchanged under the HEP scheme in the northern weir pool.*
- *Habitat availability is predicted to increase for spawning and juvenile rheophilic coarse fish as well as adult roach in the southern reach after commencement of the HEP scheme. Spawning salmon and lamprey and adult rheophilic habitat suitability is predicted to decrease slightly due to reductions in flow and mean velocities through the channel.*

- *The modelled regions in this study are largely unsuitable for spawning and juvenile roach as well as juvenile lamprey. This is primarily due to unsuitably coarse substrate present throughout the modelled reaches.*
- *The two weirs at Hazelford are currently deemed to pose a complete barrier to the upstream passage of cyprinid coarse fish species and lamprey due to excessive head drops and high velocities over the weir face; the south weir is also deemed to pose a complete barrier to the upstream passage of eel. The weirs are deemed to be high impact barriers to the upstream passage of salmon and sea trout.*
- *Despite a reduction in the passability of the main weir structures due to the addition of inflatable weir crests associated with the HEP scheme, the overall upstream passability at the site would increase significantly following construction of the HEP scheme due to the addition of a multi-species fish pass and separate lamprey passes on both the north and south channels and an eel pass on the southern channel.*
- *EA monitoring of DO at Gunthorpe, upstream of Hazelford, indicates that levels have been consistent with High WFD status during 2017 and 2018. Given recent DO data, in addition to the fact that re-oxygenation of water would still occur via several means at Hazelford following construction of the HEP scheme, no adverse impacts on the WFD status of the waterbody or ecological receptors are anticipated.*
- *Based on the distance of Hazelford upstream of the tidal limit (< 30 km), screening with a 2 mm mesh size would be required for compliance with the EA guidance to protect elver and small yellow eel life stages. However, given the low intake approach velocities and that the proposed eel pass which would provide the primary route of upstream passage is located on the opposite bank to the intake, the overall risk to juvenile eels is considered to be low. Intake screening with a 9 mm mesh size would therefore be sufficient to prevent entrainment of larger resident yellow eels and downstream migrating silver eels, whilst also complying with the Salmon and Freshwater Fisheries Act for protection of salmon smolts.*

3.18. Overall, the development is expected to result in some changes to fish habitat suitability for specific species, life stages, and flow conditions, however any reductions in suitability are typically offset by improvements elsewhere.

3.19. In addition, the proposal will transform the site from being a complete or significant barrier to fish passage to enabling passage for fish, eel and lamprey within both channels. This will have wide-reaching positive impacts given its cumulative impact with other fish passage improvements along the Trent.

Hydromorphology

3.20. Prior to commissioning the geomorphology assessment, a detailed hydraulic model of the site was created to simulate upstream and downstream water levels and the flow split between weir, fish pass and hydropower scheme, for existing and proposed scenarios across the full range of flow conditions.

3.21. A specialist study commissioned from APEM assessed the geomorphological impact of the proposals, based on bathymetric survey data, sediment grab sampling and 2D hydraulic modelling. APEM make the following concluding statements:

- *The proposed HEP scheme is predicted to result in some scour and coarsening of bed material at the turbine tailrace due to the small D50 under current conditions, combined with a notable increase in boundary shear stress ($\tau 0$) under post-HEP conditions. This results in a predicted increase in the maximum mobilised particle size from very coarse sand to coarse gravel. Slight coarsening of bed material in the order of a maximum single change in size class of the Dcr (e.g. very fine gravel to fine gravel) is also possible in places on the right hand bank downstream of the north weir due to the small D50 at these locations. Additionally, there may be some localised fine sediment deposition on the left bank upstream of the tailrace and potentially also slightly further downstream due to changes in the orientation of the faster flow.*
- *The analysis indicates that there may be some fine sediment deposition downstream of the southern weir immediately upstream of the gravel bar due to reductions in shear stress. Calculated critical particle sizes suggest that shear stress will be insufficient to entrain particles <0.062 mm (silt) at a number of sampling points under the proposed HEP scheme, where entrainment would be expected under the baseline scenario.*
- *Reductions in shear stress at Q5 also indicate that the frequency of competent flushing flows would be reduced through the southern channel under the proposed HEP scenario. The frequency and magnitude of flows exceeding the baseline Q5 (high flows being most important for controlling coarse sediment transport dynamics) is expected to reduce downstream of the south weir with the HEP scheme in place.*
- *Reductions in grain size, frequently in the order of two particle size classes (e.g. coarse sand to fine sand), are therefore possible, assuming fine material is supplied to the reach, which it may not be. However, any such accumulation or ingress of fines would be flushed intermittently, as flushing flows competent to entrain these larger particle sizes would still occur, albeit less frequently.*
- *The HEP scheme includes provision of additional inflatable weir crests to raise the upstream water level by 0.30 – 0.37 m during low to moderate flows. The increase is not expected to significantly alter the character of the upstream river channel given the occurrence of low velocity glide/pool flow under the current baseline conditions.*
- *The proposed increase in weir crest height is unlikely to have a substantial impact on coarse sediment transport processes which are of most importance in influencing channel morphology. This is because the existing structures at Hazelford are likely to inhibit the majority of downstream sediment transport, and because the weir crests will not be raised during high flows which are responsible for the majority of coarse sediment transport.*

3.22. In summary, some hydromorphological changes may occur due to the proposed development, however the effects are expected to be minor and temporary.

4. Conclusions

4.1. The proposed development will not impact negatively on the current status of the water body and will not have an adverse impact on meeting future WFD objectives.

4.2. The introduction of a multi-species fish pass with eel and lamprey facilities has been independently assessed to provide a significant positive improvement to fish passage at this site, providing opportunities for improvements more widely along the Trent.

4.3. Overall, the proposed development will have no impact or a positive impact on each individual element of the relevant WFD classifications.