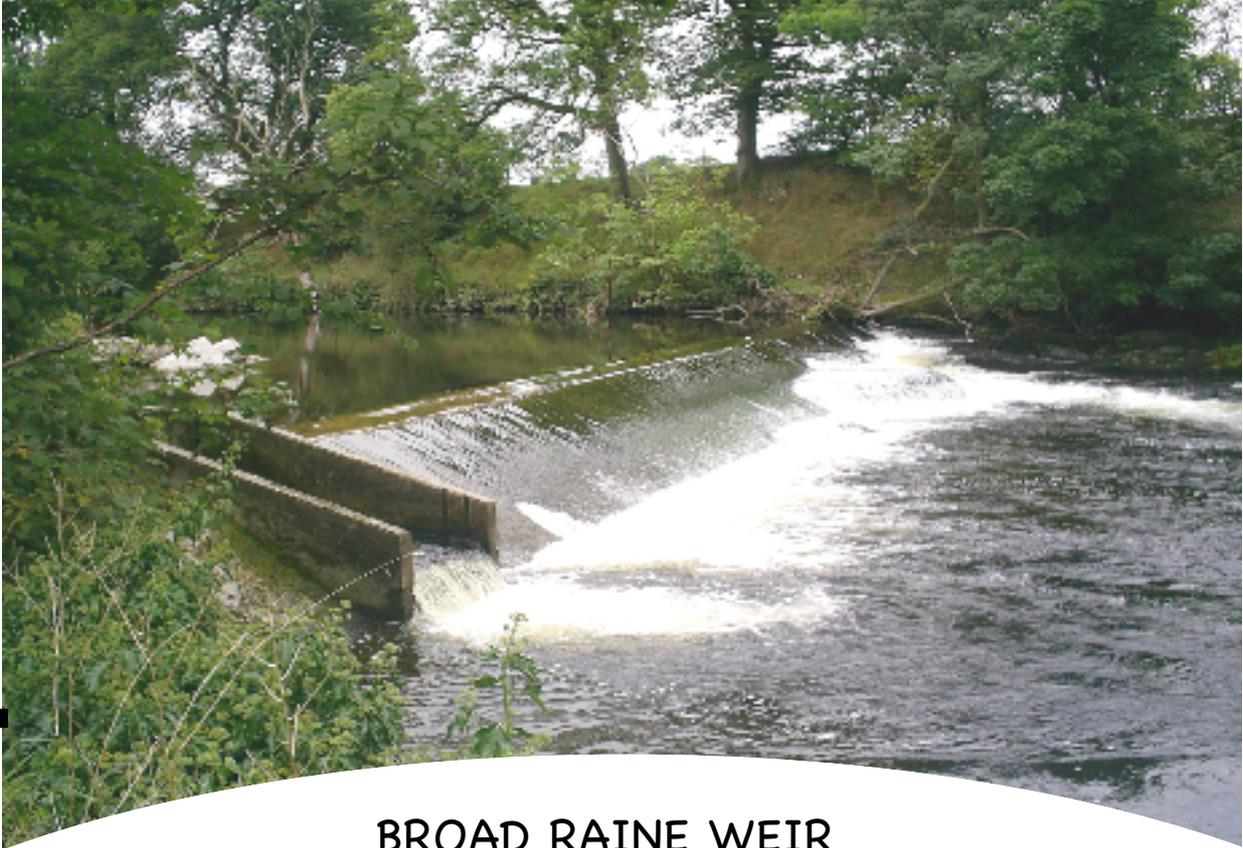


# FEASIBILITY REPORT for K-SET



## BROAD RAINE WEIR

## MICRO HYDRO PROJECT

PRODUCED FOR THE KILLINGTON SUSTAINABLE  
Energy Trust

Contributions by  
the Environment Agency  
South Lakeland District Council  
and  
Lancaster University

October 2010  
*K-SET FS*

Revised December 2010  
*0*

## CONTENTS

1. Brief	1
2. Introduction	2
3. Hydrology (i) Flow statistics (ii) Head	3
4. Environment	4
5. Planning.	5
6. Social	6
7. Engineering	7
8. Financial Summary	7
9. Conclusion	9
<i>References</i>	9

## EXECUTIVE SUMMARY

This report examines the feasibility of a micro hydro installation on the weir at Broad Raine, Killington, Sedbergh. This is a low head site with a salmon fish pass. The social, economic, financial, engineering and environmental constraints are examined. It is concluded that the scheme is likely to be viable if a hydraulic screw type turbine is used developing 50kW of power. No insuperable problems have been revealed during these initial investigations.

## **1. BRIEF**

To examine the feasibility of a micro hydro scheme on the River Lune at Broad Raine weir, Killington. In preparation for a design study, the Trust requires to know the hydrological, environmental, planning, social, engineering and financial parameters that favour or restrict the development of hydro power on this site.

## **2. INTRODUCTION**

### **2.1 Legal status of Trust**

The Trust is a not for profit company, limited by guarantee, so any profits generated by the scheme would be used to further the environmental objects of the trust for the benefit of Sedbergh and the Western Dales and the Upper Lune valley as far south as Kirkby Lonsdale.

### **2.2 Funding**

The funding of the project will be from money raised by the Trust from grants, loans and local fund raising.

### **2.3 The Site**

The location of the weir at Broad Raine (OS grid reference 34 (SD) 621 901) is on the River Lune in the parish of Killington, south west of Sedbergh. The proposed site is on a weir with an adjacent fish pass and a fish tank for the extraction of salmon eggs that are sent to a hatchery at Middleton. There is a small control hut for counting the fish passing up the fish ladder and for accessing the fish tank.

Some 20 yards downstream is the original mill building, now converted to a house. Other mill buildings are now converted to a residential property and approximately 150 metres from the site is the millers cottage and another converted barn.

### **2.4 The weir**

The weir, which was rebuilt some 10 years ago, is approximately 25m wide and the fish pass on the right bank is 1.5m wide. The pass is of an old design with a steep initial step and would benefit from refurbishment.

### **2.5 The Gauging Station**

Approximately 600m upstream from the weir at Killington New Bridge, there is an Environment Agency gauging station (No 72005), OS map reference 622 907. This is used to gather figures to warn of likely flooding downstream and has provided hydrological statistics from 1969 onwards.

### 3. HYDROLOGY

#### 3.1. Flow Statistics

The quantity of water flowing over the fish pass is minimal, compared to the flow over the weir, which cannot be diverted, so this will be discounted in the calculations.

According to the Environment Agency data, the site has a mean flow of 10.06 cu.m/sec over the course of the year, but it varies between an average of under 1 cu.m/sec towards the end of September to over 100 cu.m/sec in December. The average maximum and minimum daily mean flows over 34 years is shown in figure 1. The flow duration curve is shown in Figure 2.

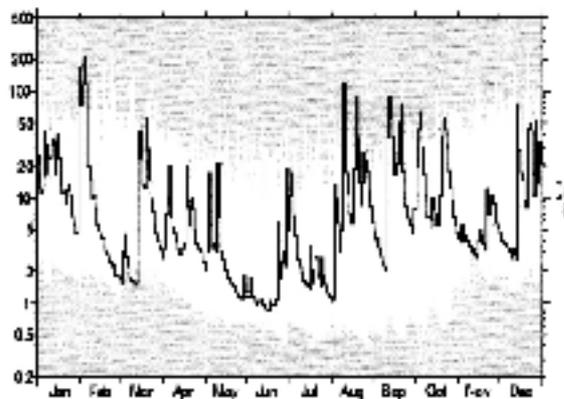


figure 1 Max and min daily mean flows from 1969 to 2003<sup>1</sup>

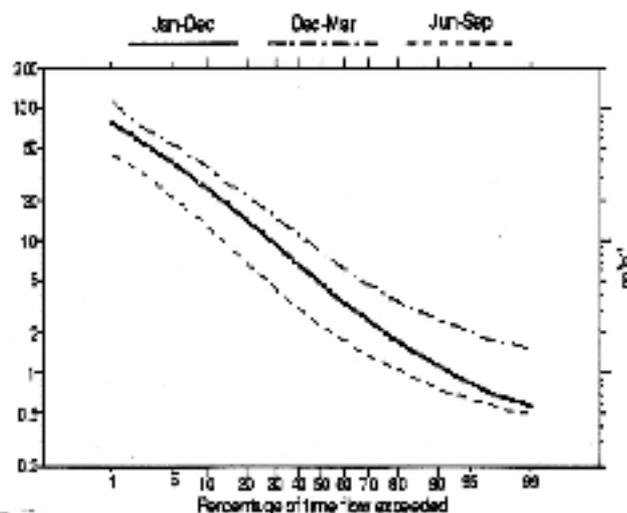


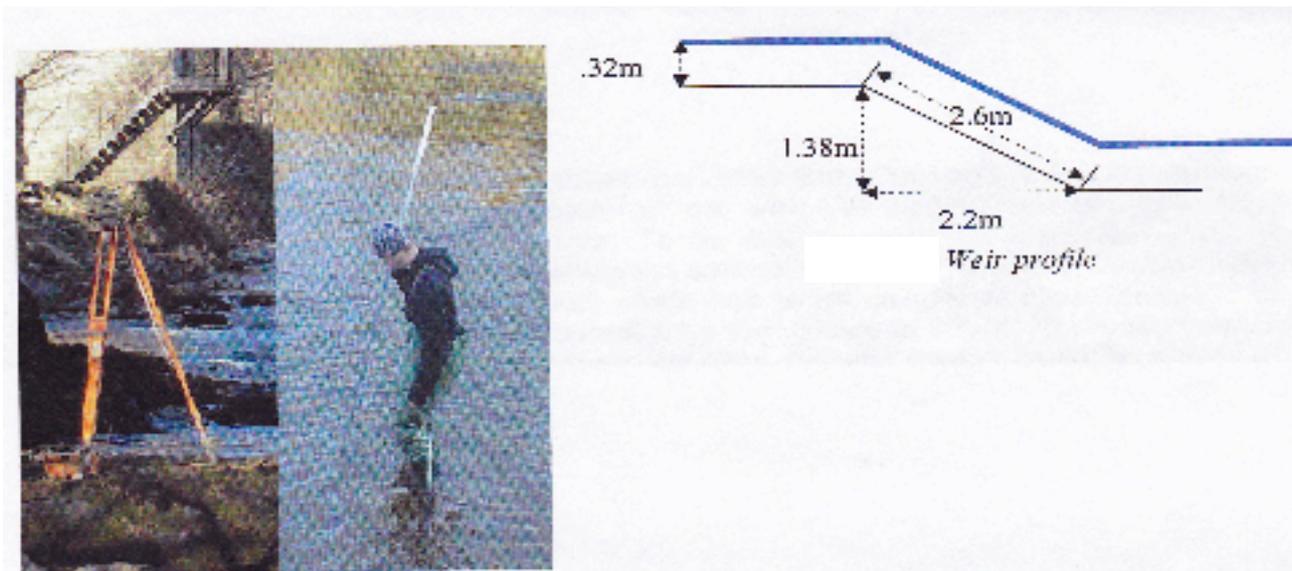
figure 2 Flow duration curve for gauged daily curves at station 72005<sup>1</sup>

The Lancaster University team calculated that the 95% exceedence figure (Q95) was 0.841.cu.m/sec.

1 [http://www.nwl.ac.uk/ih/nrfa/station\\_summaries/072/004.html](http://www.nwl.ac.uk/ih/nrfa/station_summaries/072/004.html)

### 3.2 Head measured at the the weir

Although the river continues to drop downstream of the weir, the biggest and probably the most usable head is the drop over the weir itself. The Lancaster University team took measurements to establish the profile and the head, including the weir height, on which to base their calculations. The calculated head was 1.38m but they suggested that for simplicity and to overcome measuring measured using a leveller. Figure 3.



*Surveying in Progress  
figure 3*

(Courtesy of Lancaster University)

This head is at the lower limit of what is feasible, but the latest generation of hydro dynamic screw generators can deal with a head as low as 1m. (MannPower Consulting Ltd, Kirkham Abbey, York).

## 4. ENVIRONMENT

### 4.1 Fish Studies

If an hydraulic screw type turbine were to be used adjacent to the weir it has been shown that this can be beneficial to the fish. A comprehensive study on this was done for the River Ribble hydro scheme at Settle by Fishtek Consulting and their report shows that minimal harm will be done to the fish. It appears that the

turbulence of a screw adjacent to a fish pass is advantageous because it seems to direct the salmon and trout moving upstream towards the pass. The Fishtek study, supported by others done in Germany and Holland, shows that no observable damage was done to most species, including smolts and eels . Even if the screw is unprotected by a screen the fish were able to pass unharmed downstream through the screw.

## **4.2 The Environment Agency**

Representatives of the Environment Agency, Jana Kahl (Technical Officer) and Kyle Young, (EA Fisheries Technical Specialist), based in Preston attended a site meeting on 17 September.

These were Kyle's recommendations:-

- (i) Efficiency of existing fish pass must be safeguarded
- (ii) provision to be made for fish passing up and down stream including for elvers
- (iii) habitat and species surveys may be required
- (iv) habitat risk assessment to be done during flood - EA will give guidance on this
- (v) the turbine should be sited as close as possible to the fish pass

Although the Agency owns the site and the fish pass, it is not clear whether or not it owns the weir. If no-one owns the weir, the Trust could, if it wished, acquire it for one pound.

Jana Kahl confirmed it was not within a protected site (16/02/10).

## **4.3. Abstraction Licence**

4.3.1 Application forms have been acquired by the Trust for a Preliminary Abstraction Licence, for which there is no charge, and a Full Abstraction Licence for which there is a charge. The Full Licence will be awarded within four months of a valid application being received.

4.3.2 An Environmental Impact Assessment or Appraisal may be required.

4.3.3 A detailed study of the Agency's 'Good Practice Guidelines' (The Environmental Assessment of Proposed Low Head Power Developments) is recommended.

## **4.4 Consultation**

The Environment Agency recommended that the Trust keep in touch with them on a regular basis.

## **5. PLANNING**

### **5.1 South Lakeland District Council**

The weir is on the boundary between the Yorkshire Dales National Park and the planning jurisdiction of the South Lakeland District Council. If the turbine is sited on the right bank of the river, only SLDC will be involved in the planning application, but the YDNPA will have also to be consulted.

### **5.2. Site meeting**

A site meeting was held on 17 September with Linda Hopkins from the Planning Department of SLDC. She said that there appeared to be no major obstacles to obtaining planning permission for the scheme but noted the following:-

- i) The size, location and construction materials for any buildings and any screening will be the most important considerations.
- ii) The disturbance to wildlife during construction must also be considered.

### **5.3 Yorkshire Dales National Park**

Andrew McCulloch, Deputy Chief Planning Officer from the YDNP also attended the meeting. As the Park boundary follows the left bank of the river, the YDNPA would not be required to consider any planning application. They would however like to be informed of the details of the scheme as it progressed.

## **6. SOCIAL**

The major concerns would be the disruption of the engineering operations, the effect on walkers using the public footpath adjacent to the site and from noise. The noise level will be considerably less than that of the existing noise from water in the river.

### **6.1 Adjacent properties**

Each of the owners of the four nearby residential properties has been informed of the outline proposal as well as the owners of the field on the right bank. We have had no objections to date.

### **6.2 Engineering Operations**

Most affected would be the owners of the field on the right bank, across which the construction machinery would move, and they must be kept fully informed before and during operations.

### **6.3 Public Footpath**

A public footpath passes through the site. The Environment Agency have fully fenced the area of the fish ladder and the fish trap and they have put up warning notices for visitors. It is suggested that a notice board is erected on the footpath to explain the hydro operation to passing walkers.

## **7. ENGINEERING**

### **7.1 Access for Engineering Operations**

The site is approximately 200m from the lane, across a field, which already has a hardcore drive laid down by the Environment Agency for the heavy vehicles needed for repairs to the weir. The Environment Agency has a right of way from the lane to the weir. The owners of the field will have to be asked to allow vehicles across this drive for the construction vehicles which will be needed for the project.

### **7.2 Construction Work**

All of the operations will take place on land owned by the Environment Agency who have offered no initial objection.

The Planning Authority will make certain demands in connection with the type of construction and the disturbance to wildlife during construction. Apart from the turbine, which, if it is a hydrodynamic screw, will be located on the weir next to the fish pass, a small kiosk will be required to house the generator and the control system.

### **7.3 Connection to the Grid**

The best way to market the electricity from a small scheme such as this is via an energy aggregator, which represents a small number of energy generators.

A power line connection can be made to the grid at a pole on the lane approximately 200m from the weir. We have been given to understand this line will take 3 phase electricity.

## **8. FINANCIAL SUMMARY**

### **8.1 Capital Costs and Revenue**

It is important to emphasize that at this stage only approximate estimates can be made of the capital cost and the rate of return. The following figures are based on estimates made by Spaans Babcock Ltd.

## Summary Table

Turbine Power Rating (kW)	Average Annual Energy Output MWh	CO <sub>2</sub> Offset*	Feed in Tariff p/kWh	Annual Average Revenue	Estimated Capital Cost	Pay back <sub>z</sub> (Years) (approx)
50	233.82 <sup>^</sup>	126.959	17.8 + 3	£48,630	£375,000	15 years

<sup>^</sup> Total output including downtime of 3%

\* Calculated using the current carbon emission factor of 0.54303 tonnes of CO<sub>2</sub>/MWh

<sub>z</sub> Payback: calculated from Feed in Tariff (i.e. generation tariff based on turbine power) of 17.8p plus 3p export tariff, which is the selling price to the grid at 3p/kWh minimum and assuming a loan of £200,000 repaid at £15,000 p/a.

## 8.2 Sources of Capital Funding

Three sources of finance have been investigated:-

### 8.2.1 Loans

**Bank Loans** Because there is a secure income, banks are now willing to lend for hydro projects that benefit from the FIT. There are a number of banks, such as the Charity Bank, that lend to community organisations on very reasonable terms

**Personal Loans** Local people who support what the Trust is trying to achieve will be offered an opportunity of helping the scheme by lending at a low rate of interest.

### 8.2.2 Grants

There are a number of grant giving organisations that have funds specifically for environmental or green energy projects. These include the E-on Small Hydro Grant (max £20,000), Scottish Power Green Energy Trust (up to £25,000), the Foundation Fund (up to £50,000) and the NatureSave Trust.

Other funders, from which larger grants may be available, but which are not specifically for the environment but for communities, include the Hadfield Trust and the Big Lottery Fund.

### 8.2.3 Fund Raising by the Trust

This cannot be expected to contribute a significant portion of the funds, but fund raising events likely to raise several hundred pounds on each occasion could be held.

## 9. CONCLUSION

### 9.1 Uncertainties

- (i) An Environmental Appraisal or Impact Assessment will need to be undertaken at an early date.
- (ii) A Design Study is needed to check out any problems not yet identified that might affect the viability of the scheme.
- (iii) The final capital cost will be affected by the choice of contractor, any additional studies that may be required, negotiations with the electricity supply companies and any additional work that will be needed that will be revealed only while work is in progress.

### 9.2 Recommendations

- (i) The investigations so far have shown that there are no major obstacles at this present time to progressing with the scheme. It is recommended that a Design Study is undertaken as soon as funds are available and that quotations for this are acquired from at least two or three reliable consultants.
- (ii) The indications are that 50 kW of power is available from this site if an hydraulic screw is used. The Kaplan turbine is a possible alternative but it is not so efficient at the wide range of flows recorded for this site. An Archimedes screw type turbine will operate with a head as low as 1m with a flow range of 0.05 to 10cumecs and they can have a 'water to wire' efficiency of 77%.
- (iii) It is recommended that the screw should be sited on the right bank of the river, on the weir and next to the fish pass.
- (iv) Include the rebuilding of the fish pass in the project budget.

#### *References and Consultants*

Yorkshire Dales National Park: Survey of Potential Hydro Power Sites  
Lancaster University Report: Alex Bale, Tom Cox, Tim Doole, Naomi Turner  
MannPower Hydro Consultancy: Dave Mann  
Settle Hydro Scheme: Ann Harding  
J.N. Bentley Ltd: Hydro Engineers, Skipton: Austin Flather  
Derwent Hydro Developments, Duffield:  
Environment Agency: Jana Kahl (Technical Officer) and Kyle Young (Fisheries Technical Specialist) Lune River Catchment.  
Western Renewable Energy, Ponsworthy, Devon: Chris Elliott  
Spaans Babcock Ltd