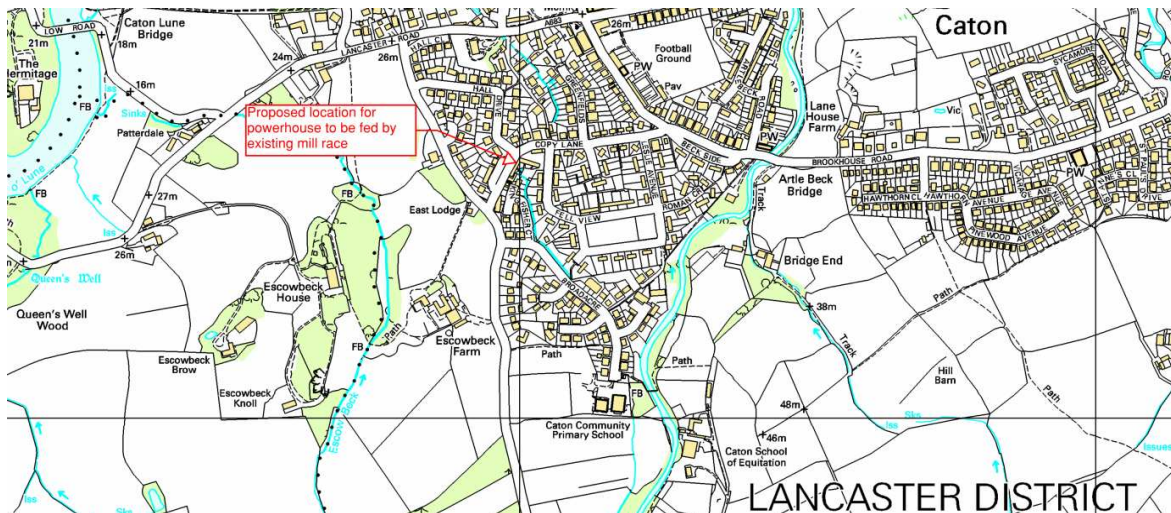


## Site 24: Willow Mill, Caton

### Site Assessment

Figure 1 Map showing general layout



The original water wheel at Willow Mill was 15 foot in diameter and 20 horse power. It was replaced in about 1900 by a 16 horse power Gilkes turbine. This is a listed Grade II building. It was built as a water-powered corn mill shortly before 1790, before being extended and converted into a cotton mill prior to 1795, and a bobbin mill from 1861-1973. This mill is now used as an office complex for multiple companies. The intake for the mill leat is at Gresgarth Hall. There is only a limited amount of head available at this site, and unless a scheme can be constructed very cheaply, it is unlikely to be economic

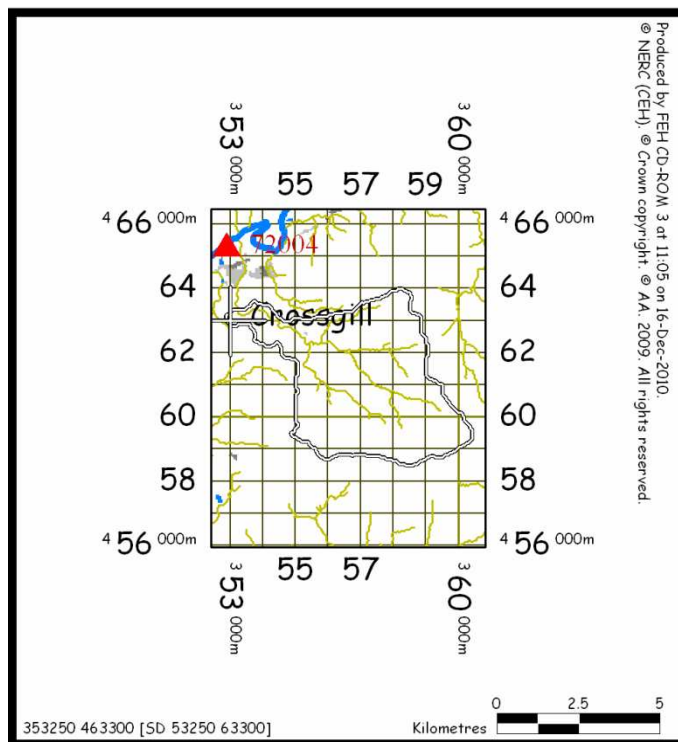
The potential scheme would involve installing a turbine directly onto the millrace approximately at the footbridge in front of Willow Mill.



Figure 2 The leat running to the mill building

## Catchment Analysis

Figure 3 Catchment boundary defined by Flood Estimation Handbook Software



The Flood Estimation Handbook software is used to determine the following catchment descriptors, for the proposed intake location, selected during the site visit.

Intake Grid Reference	353000, 464430
Powerhouse Grid Reference	353000, 464430
Catchment Area	22 km <sup>2</sup>
Annual Rainfall	1534 mm

## Annual Flow Statistics

The intake for this mill race is at the weir at Gresgarth Hall, therefore this site shares its broad hydrology with Gresgarth Mill further south and Low Mill downstream and to the north. There is likely to be some runoff entering the millrace along its length from Gresgarth, but there may also be some leaks. In order to assess the flow available accurately it is recommended that flow measurements be taken.

Low Flows software is used to produce a Flow Duration Curve (FDC), which demonstrates how the river flow varies throughout the year. It presents the percentage time of the year each flow rate is exceeded. A particular notation is used to refer to FDC flow rates; e.g. 'Q<sub>95</sub>' refers to the flow rate which is exceeded 95% of the year.

Table 1 Mean flow rate and flow rate at Q<sub>95</sub>

Period	Mean Flow Rate [m <sup>3</sup> /s]	Flow Rate at Q <sub>95</sub> [m <sup>3</sup> /s]
Annual	0.103	0.791
January	0.231	1.234
February	0.170	0.931
March	0.187	0.913
April	0.134	0.692
May	0.108	0.472
June	0.0764	0.338
July	0.0828	0.390
August	0.0771	0.543
September	0.0848	0.653
October	0.114	0.892
November	0.180	1.128
December	0.225	1.311

Table 2 Annual flow duration data

Exceedance Probability	Flow Rate [m <sup>3</sup> /s]
5	2.687
10	1.823
20	1.094
30	0.754
40	0.549
50	0.414
60	0.321
70	0.247
80	0.185
90	0.131
95	0.103
99	0.0750

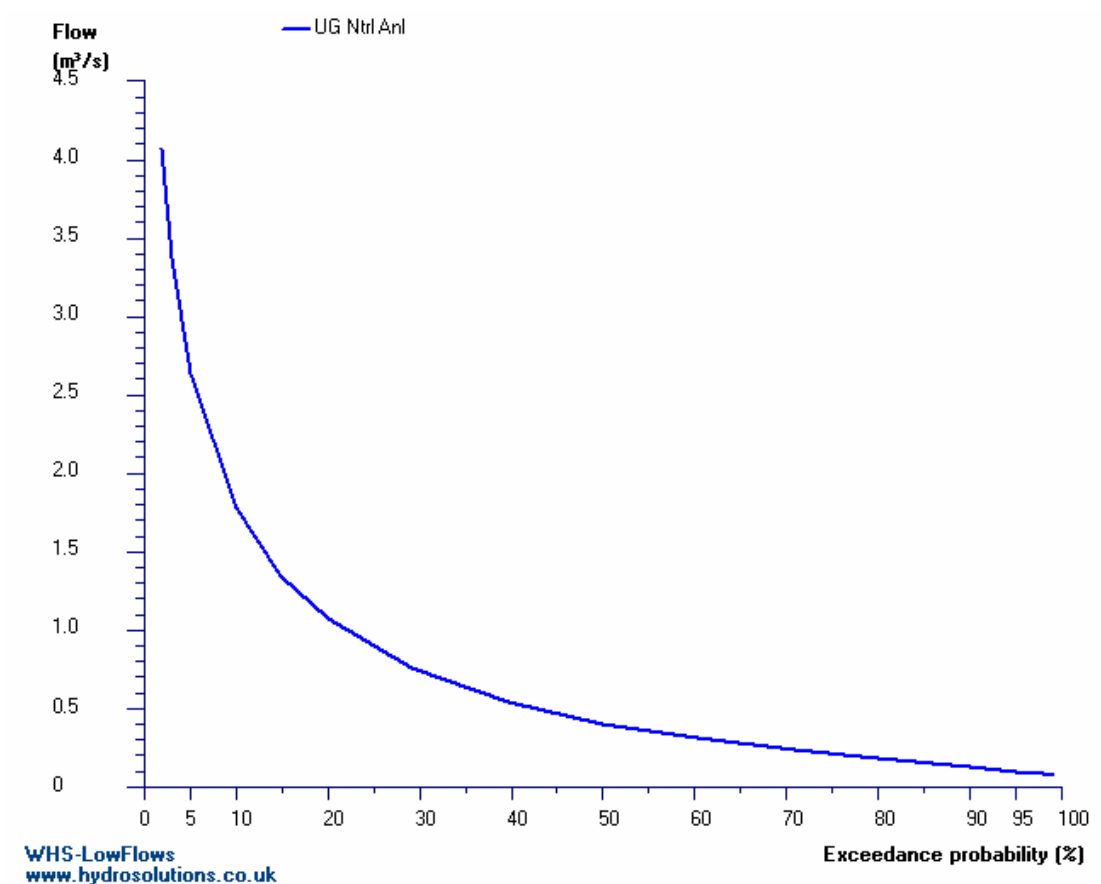


Figure 4 Annual flow duration curve produced using low flows software

## Hydropower Analysis

Site: Willow Mill Run Date / Time: 16 December 2010 at 11:33					
	<b>Mean Flow:</b> 0.85 m <sup>3</sup> /s <b>Provisional Rated Flow:</b> 0.20 m <sup>3</sup> /s <b>Residual Flow:</b> 0.096 m <sup>3</sup> /s		<b>Rated Flow:</b> 0.10 m <sup>3</sup> /s <b>Gross Hydraulic Head:</b> 1.96 m <b>Nett Hydraulic Head:</b> 1.86 m		
Applicable Turbines	Gross Annual Average Output	Nett Annual Average Output	Maximum Power Output	Rated Capacity	Minimum Operational Flow
Crossflow	10.8	10.6	1.5	1.4	0.11
	<b>MWh</b>	<b>MWh</b>	<b>kW</b>	<b>kW</b>	<b>m<sup>3</sup>/s</b>

Table 3 Hydropower Analysis

Gross Head [m]	1.9
Net Head [m]	1.7
Design Flow [m <sup>3</sup> /s]	0.1m <sup>3</sup> /s
Rated Capacity [kW]	1.4 kW
Average Annual Energy Output [MWh]	10MWh
Average annual Carbon Dioxide offset	6 tonnes

## Impact Assessment

This mill is not within the Forest of Bowland AONB. It is classified as Undulating lowland farmland with wooded brooks. It is not thought that the historic landscape would suffer negatively from such a small-scale development. The quality of the natural environment provided by this mill race is not known.

## Statutory Requirements

The Environment Agency would need to be consulted for advice on whether an abstraction licence would be required. The council would need to advise on whether planning permission would need to be sought for such a small development.

The mill building is a Grade II Listed Building and so consent would be required for any alterations. However it is not thought that any alterations would be necessary.

An ecologist would be able to advise on whether any environmental assessment would be required for this development to take place.

## Budget Development Cost

The total budget cost for the whole scheme is **£109,000**. It should be noted that the civil works costs can vary considerably as material costs fluctuate. Likewise, mechanical and electrical (M&E) equipment costs vary in accordance with demand. Professional fees should be considered subject to change, as the scope of licensing and planning requirements are not yet defined. Consequently the budget estimate at this stage should be considered accurate to plus or minus 20%.

Table 4 Development Budget Cost

**Budget Scheme Cost Estimate**

**Willow Mill, Caton**

	ITEM	UNIT	QUANTITY	MIN	MAX
<b>Turbine</b>					
	Turbine Quotation	No	1	£40,000.00	£50,000.00
<b>Grid Connection</b>					
	Grid Connection	No	1	£0.00	£0.00
<b>Civils</b>					
	Concrete Works	m <sup>3</sup>	5	£2,500.00	£3,125.00
	Fish Pass	m <sup>3</sup>	0	£0.00	£0.00
	Metalwork	m	1	£2,000.00	£2,500.00
	Fish Pass Length	m	0	£0.00	£0.00
	Pipe Installation	m			
	Rock	m	0	£0.00	£0.00
	Gravels	m	0	£0.00	£0.00
	Soft	m	0	£0.00	£0.00
	Pipe Materials	No	1	£0.00	£0.00
	Temporary Access	m			
	Rock	m	0	£0.00	£0.00
	Gravels	m	0	£0.00	£0.00
	Soft	m	0	£0.00	£0.00
	Temporary Access on Good Ground	m	0	£0.00	£0.00
<b>Powerhouse</b>					
	Powerhouse	kW	4	£15,000.00	£18,750.00
<b>Prelims</b>					
	Duration	Months	3	£9,000.00	£11,250.00
<b>Sub Total</b>					
	Sub Total			£68,500.00	£85,625.00
<b>Professional Fees</b>					
	Professional Fees			£10,275.00	£17,125.00
<b>Sub Total</b>					
	Sub Total			£78,775.00	£102,750.00
<b>Contingency</b>					
	Contingency			£15,755.00	£20,550.00
<b>GRAND TOTAL</b>				£94,530.00	£123,300.00

## Revenue and Simple Payback period

Due to the very small scale of this development a grid connection would not be necessary. Any energy produced would be consumed on site within the offices of Willow Mill.

Under the current government feed-in tariff regulations, hydropower schemes receive a generation tariff according to their rated capacity. Schemes less than 15kW receive 19.9p/kWh. This generation tariff is received regardless of how the electricity is used. The owner has indicated that the electricity would be used on site, thereby offsetting import costs. This increases the value of the generated electricity by the import tariff, which we have assumed is 5p/kWh.

In conclusion, the total value of the generated electricity would be 24.9p/kWh, giving an average annual value of approximately **£2520**. The simple payback period for this scheme is 43 years.

## Conclusion

This is a very small scheme. If it can be constructed very cheaply then it may be worth developing. The development has been priced based on getting building contractors to complete the work, and includes professional fees. There would be some historical benefit to developing a hydro at this mill. There is a suitable user for the power and the access for construction is very good. Permissions and preliminaries should be minimal due to its small scale.

## Further Information

This site report is produced by Inter Hydro Technology on behalf of Forest of Bowland AONB, and funded by a partnership including Lancashire County Council, Lancaster & District Local Strategic Partnership, Pendle Borough Council and Ribble Valley Local Strategic Partnership.

This site report should be read in conjunction with the rest of the Forest of Bowland AONB Hydro Feasibility Study which can be downloaded at

<http://www.forestofbowland.com/climatechange#hydro>