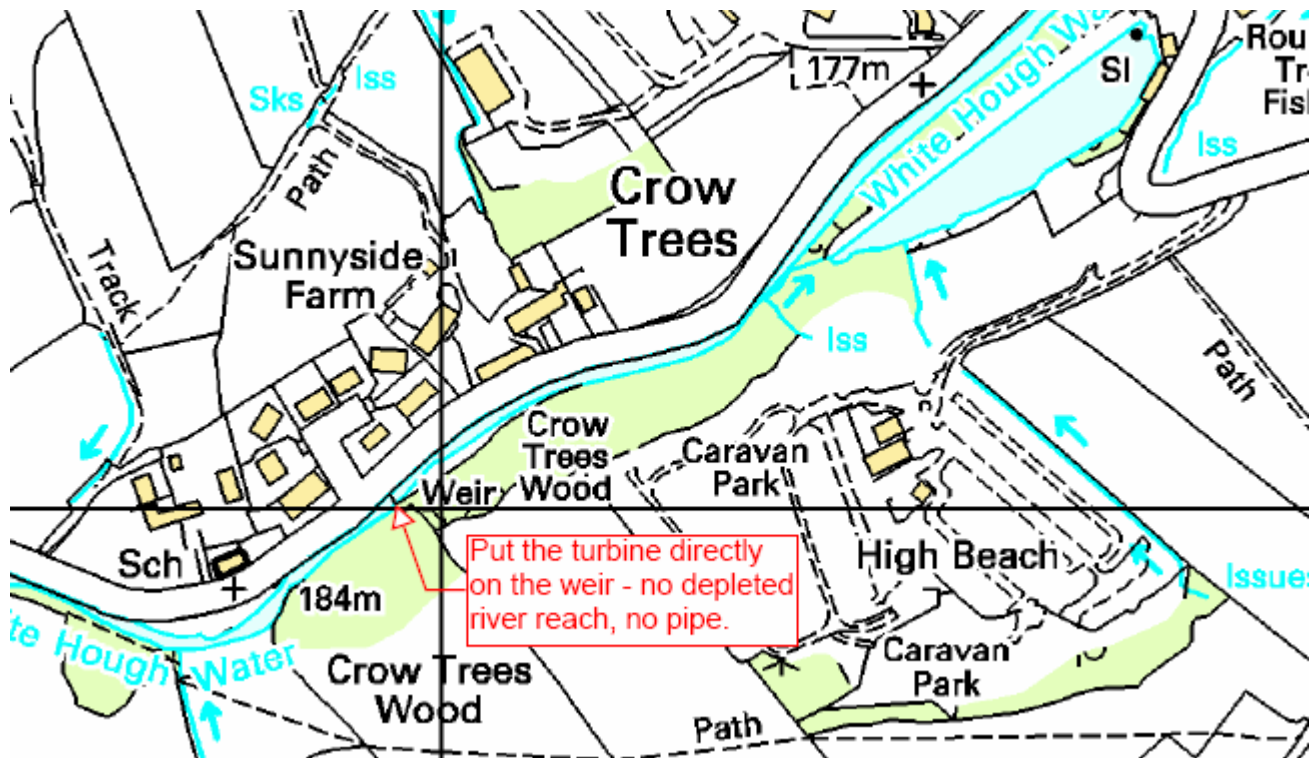


Site 2: Roughlee weir, Roughlee

Site Assessment

Figure 1 Map showing general layout



This weir is thought to have been constructed for a mill or mills in the village of Roughlee, and is likely to be at least 100 years old, though this has not been confirmed. On the day of the site visit, it was not possible to assess the state of repair of the weir due to the build up of ice over its surface. Adjacent to the weir there is a sluice gate and beginnings of a channel, with the water immediately over spilling back into the beck. It is interpreted that historically a leat ran down the side of the river, at approximately the level of the weir. The line of this old channel is now over grown with trees, and it seems that there has also been some subsidence of the bank above the leat. Apart from immediately adjacent to the weir, there are no obvious signs of a channel here.



Figure 2 The weir from above with the old sluice gate on the far right and overspill

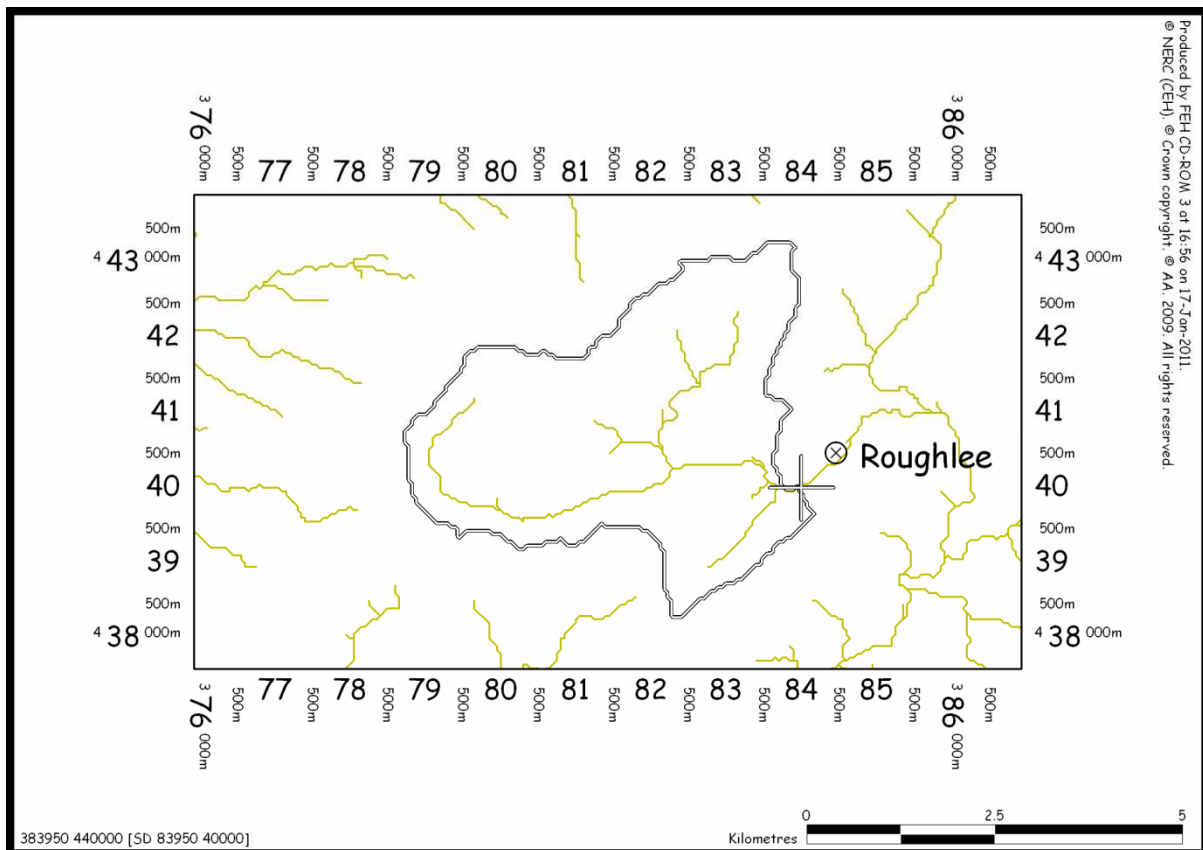


Figure 3 The weir face showing the overspill on the far left

This site would be suitable for the installation of a turbine directly onto the weir or approximately where the overspill is located. Access for construction would be on the far bank through the land associated with the caravan park.

Catchment Analysis

Figure 4 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 | 383950, 440000 |
| Powerhouse Grid Reference | 383950, 440000 |
| Catchment Area | 15.3 km ² |
| Annual Rainfall | 1437 mm |

Annual Flow Statistics

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. 'Q₉₅' refers to the flow rate which is exceeded 95% of the year.

No existing abstractions have been identified at this site, but it is recommended that should this site be further investigated, flow monitoring equipment be installed at the earliest opportunity.

Table 1 Mean flow rate and flow rate at Q₉₅

| Period | Mean Flow Rate [m ³ /s] | Flow Rate at Q ₉₅ [m ³ /s] |
|-----------|------------------------------------|--|
| Annual | 0.493 | 0.0738 |
| January | 0.876 | 0.182 |
| February | 0.637 | 0.142 |
| March | 0.656 | 0.154 |
| April | 0.406 | 0.105 |
| May | 0.255 | 0.0815 |
| June | 0.197 | 0.0655 |
| July | 0.182 | 0.0592 |
| August | 0.276 | 0.0646 |
| September | 0.313 | 0.0608 |
| October | 0.55 | 0.0863 |
| November | 0.696 | 0.106 |
| December | 0.87 | 0.149 |

Table 2 Annual flow duration data

| Exceedance Probability | Flow Rate [m ³ /s] |
|------------------------|-------------------------------|
| 5 | 1.668 |
| 10 | 1.131 |
| 20 | 0.697 |
| 30 | 0.481 |
| 40 | 0.349 |
| 50 | 0.263 |
| 60 | 0.202 |
| 70 | 0.155 |
| 80 | 0.117 |
| 90 | 0.087 |
| 95 | 0.074 |
| 99 | 0.06 |

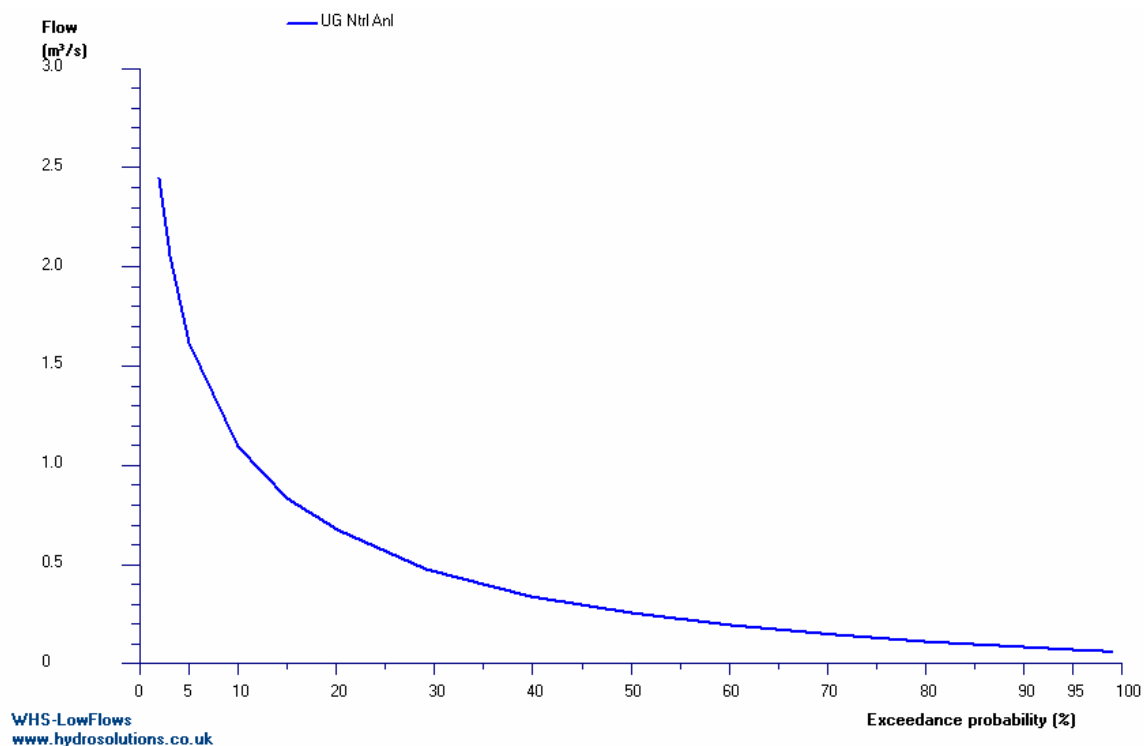


Figure 5 Annual flow duration curve produced using low flows software

Hydropower Analysis

| Site: Roughlee Run Date / Time: 12 January 2011 at 13:47 Mean Flow: 0.42 m ³ /s Provisional Rated Flow: 0.46 m ³ /s Residual Flow: 0.045 m ³ /s Rated Flow: 0.42 m ³ /s Gross Hydraulic Head: 5.00 m Nett Hydraulic Head: 4.75 m | | | | | |
|---|-----------------------------|----------------------------|----------------------|----------------|--------------------------|
| Applicable Turbines | Gross Annual Average Output | Nett Annual Average Output | Maximum Power Output | Rated Capacity | Minimum Operational Flow |
| Propellor | 49.0 | 48.5 | 16.9 | 16.2 | 0.31 |
| Crossflow | 62.5 | 61.9 | 15.5 | 14.5 | 0.11 |
| | MWh | MWh | kW | kW | m ³ /s |

(Residual flow = Q95)

Table 3 Hydropower Analysis

| | |
|--------------------------------------|-----------------------|
| Gross Head [m] | 5 |
| Net Head [m] | 4.75 |
| Design Flow [m ³ /s] | 0.46m ³ /s |
| Rated Capacity [kW] | 15 kW |
| Average Annual Energy Output [MWh] | 60MWh |
| Average annual Carbon Dioxide offset | 138 tonnes |

Impact Assessment

This is an existing barrier to fish migration. As a consequence, a fish pass may not be required for this scheme. Alternatively, depending on stakeholder's wishes, the corresponding installation of a fish pass may benefit the ecology of this watercourse. Upstream of Roughlee however, there are further significant barriers in the form of United Utilities reservoirs.

The weir is immediately opposite private dwellings and a primary school, on the main road through Roughlee. It will therefore be important to minimise noise from any installation. Roughlee is an attractive village, and the weir is an important historic feature of the village as a visitor attraction and beauty spot. It is also close to private residential properties. The visual and noise impact of a scheme here will need to be minimised.

According to the Forest of Bowland Landscape Character Assessment, this land is identified as Moorland Fringe, and is within the Forest of Bowland Area of Outstanding Natural Beauty.

Statutory Requirements

The Environment Agency will need to be consulted for works in a river and to gain an abstraction license. As the existing weir presents a fish migration barrier, the Environment Agency may be interested in installing a fish pass in parallel with any work to construct a hydro scheme. This scheme would not result in any depleted reach, and a pipe line is not required.

It will be necessary to gain advice from an Ecologist to ascertain the degree of environmental assessment required at this site.

Budget Development Cost

The total budget cost for the whole scheme is approximately **£280,000**. 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

Roughlee

| | ITEM | UNIT | QUANTITY | MIN | MAX |
|--------------------------|---------------------------------|----------------|----------|-------------|-------------|
| Turbine | | | | | |
| | Turbine Quotation | No | 1 | £70,000.00 | £87,500.00 |
| Grid Connection | | | | | |
| | Grid Connection | No | 1 | £5,000.00 | £6,250.00 |
| Civils | | | | | |
| | Weir | m ³ | 40 | £20,000.00 | £25,000.00 |
| | Fish Pass | m ³ | 0 | £0.00 | £0.00 |
| | Metalwork | m | 8 | £16,000.00 | £20,000.00 |
| | Fish Pass Length | m | 0 | £0.00 | £0.00 |
| | Pipe Installation | m | | | |
| | Rock | m | 10 | £1,100.00 | £1,375.00 |
| | Gravels | m | 10 | £400.00 | £500.00 |
| | Soft | m | 0 | £0.00 | £0.00 |
| | Pipe Materials | No | 1 | £0.00 | £0.00 |
| | Temporary Access | m | | | |
| | Rock | m | 50 | £22,000.00 | £27,500.00 |
| | Gravels | m | 200 | £16,000.00 | £20,000.00 |
| | Soft | m | 0 | £0.00 | £0.00 |
| | Temporary Access on Good Ground | m | 0 | £0.00 | £0.00 |
| Powerhouse | | | | | |
| | Powerhouse | kW | 15 | £15,000.00 | £18,750.00 |
| Prelims | | | | | |
| | Duration | Months | 4 | £12,000.00 | £15,000.00 |
| Sub Total | | | | | |
| | Sub Total | | | £177,500.00 | £221,875.00 |
| Professional Fees | | | | | |
| | Professional Fees | | | £26,625.00 | £44,375.00 |
| Sub Total | | | | | |
| | Sub Total | | | £204,125.00 | £266,250.00 |
| Contingency | | | | | |
| | Contingency | | | £40,825.00 | £53,250.00 |
| GRAND TOTAL | | | | £244,950.00 | £319,500.00 |

Revenue and Simple Payback period

Energy produced by a hydro scheme at this weir could be used by the community of Roughlee, or sold to the national grid. Due to the relatively remote location of Roughlee village, a grid connection may be problematic, but this has yet to be confirmed.

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. If this electricity would be used on site/in the village (e.g. by the local primary school), then this would significantly offset import costs. This increases the value of the generated electricity by the import tariff, which is specific to their chosen provider. We have assumed an import value of 5p.

In conclusion, the total value of the generated electricity might be 24.9p/kWh, giving an average annual value of approximately **£12,480**. This gives a simple payback time of approximately 23 years.

Conclusion

This scheme would seem fairly straightforward to build. There is an existing weir with access for construction. The visual impact and any noise impact would need to be minimised due to the proximity of the scheme to private dwellings. However, the long pay back period of this scheme is likely to render it unattractive economically.

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>