**Settle Hydro limited Comments in regard to the 'report on impact of Archimedean screw on fish migration'.**

James Todd e-mail 03.11.13
The following statements are misleading:

Section 5.1, 1st paragraph, 1st sentence states that "....the turbine is not having a major impact,..."

Section 6, 1st paragraph states "... little firm evidence that operation of the Settle Archimedes screw turbine has a negative impact ..."

The first of these statements implies that there is evidence that the turbine is having a 'minor' impact; the second that there is some firm evidence (not defined) of a negative impact. There is no evidence whatsoever to show that there is any negative impact and the wording of the report should be modified to accurately reflect this.

While Section 1.3 defines the aims of the study as being to assess "the impact of the Settle Archimedes Screw" the conclusions of the report are imbalanced in that they focus on a negative impact of the turbine, ignoring the findings that actually support the hypothesis that the turbine has a positive effect. What the report does bring out is that there are so many other factors at play that a definite conclusion either way cannot be drawn by this limited study, however it does provide some indications that the turbine's effect on fish migration past Settle Weir is likely to be more positive than negative.

**Detailed observations**
Section 3.3 states that model outputs demonstrated a significant interaction between turbine operation states. A visual inspection of the data highlights the likelihood that turbine operation is not reducing fish passage throughout the year and that the interaction is being influenced by the greater range of flows utilised by fish when the turbine is being operated. This interpretation is further supported by the lack of a singular relationship between migrants and river height.

In other words, turbine operation at higher flows increases the range of conditions during which fish can pass. Section 4.1 and Fig 4.2 support this statement.

**More general observations regarding the background to the study**
The second paragraph of Section 1.1 Project background refers to "Anthropogenic structures (weirs, sluices etc.) or activities (e.g. abstraction, noise, pollution etc.)"that can have deleterious impacts in fish populations which undertake upstream and/or downstream migration, in both the long and short term.

The discussion, Section 5.1 refers in the second paragraph to lack of study into "the effect of hydromorphologically-mediated impacts of the impoundment and turbine operation on adult refuges and juvenile salmonid habitat above and below the weir".

The original weir, offtake and power generation at the site is just such an anthropogenic structure with power generating facilities and has been in operation

for far longer than the Archimedes Screw turbine which merely replaces the original water wheel. While a study into the effect of the new installation in isolation can hardly give a more definitive result than the studies already undertaken, the modern equivalent, operated under a more stringent regime than the water wheel it replaces, dictated by the Environment Agency, can hardly be other than an improvement on the earlier installation.

Another “more subtle, potential  impact” not mentioned is the influence of changes to the river flow regime as a whole. Due to rapid runoff in the catchment, increasing urbanization, drainage of upland areas for farming and more violent storms due to climate change, the frequency and severity of spate conditions is increasing and must contribute to a loss of hydromorphological conditions on such a scale as to make any effect of the Archimedes Screw insignificant.

James Todd e-mail 20.12.13

Yes, we did find the meeting you convened useful and informative and we came away with a feeling of having consulted openly and honestly in a spirit of teamwork and co-operation. That only adds to our dismay to learn that you have “chosen” not to make any of the amendments we discussed and that you have decided to consign our comments to your “records”.

The study was carried out in response to complaints from a pressure group who have in the past shown unremitting hostility to the Settle Hydro project and have no scientific or factual basis for their claims. It is our view that a non-technical review of the APEM report is now required focussing on whether the conclusions given in para 6, which will probably be the only part read by interested non-technical parties, adequately represents the findings in the body of the report, having regard to its aims as expressed in para 1.3.

This would be in the interest of the EA as well as ourselves as the most likely outcome of publication of the present report is that it will elicit a demand for a more rigorous study of migration past Settle weir in order to pin any responsibility for a perceived shortage of salmon in the Ribble onto Settle Hydro. As we learned from discussion at the meeting this would involve the Environment Agency in considerable extra expenditure and waste of valuable resources. It will not give a definitive result as the geometry of the outfall at Settle weir, together with the effects of turbulence and air entrainment, will make the measurement of fish passage highly unreliable.

We are therefore arranging to have a third independent non-technical review carried out on our behalf to look into those elements we perceive to be missing from the reviews carried out so far.

Hopefully your management will realise that it is in the interest of both our organisations to respond robustly to these unjustified claims.

## S Amphlett e-mail 05.11.13

The agreement of Settle Hydro to voluntarily support the study into the impact of the hydro on salmonid migration was given conditional on the final report being peer reviewed. This was discussed and agreed with Jason Pusey and Brian Shields at the Settle Hydro AGM held on 25th October 2012.

An extract from the approved minutes of the AGM reads:

Ann asked the assembled shareholders if we should confirm to continue to volunteer to be involved with the trial. One shareholder (Prof Glynn Turton) said that he had grave misgivings about the politics and was deeply distrustful of the provenance due to the political lobbying. He asked for the report to be peer reviewed outwith the department. The shareholders confirmed to continue with the work subject to it being peer reviewed.
Brian said that he would take that forward and that the report would be written as objectively as possible.

It will be clear from the comments submitted by both Settle Hydro and Dave Mann that we are unhappy with the apparent biased nature by which conclusions have been drawn and recommendations made.

Could you please confirm that, as promised by the EA, the report has been peer reviewed 'outwith the department'. If a peer review has been conducted, could you please let us have the name of the reviewer and sight of their comments.

## Pete Kibbel (Fishtek) 05.11.13

Essentially the report concluded that upstream fish migration was higher when the turbine was on. However, the suggestion in the report is that this may not be the case and in fact the turbine could be having a detrimental impact, hence more studies required to change the operational regime.

In my original assessment I concluded that the turbine would potentially improve upstream migration for 2 reasons. Improved attraction flow and reduced energy densities in the fish pass across the migration window.

The analysis seems to support this, so why does it leave the reader with the impression that Archimedes are bad for fish?

Toby is assessing the statistical approach and will email a response in the next half an hour.

## Dave Mann email 04.11.13

Generally (in particular the discussion) the report is not neutral, as a scientific report should be. It inherently feels 'anti-hydro'. The authors find the apparent result that there is more upstream passage with the turbine on (i.e. the turbine has a positive impact on upstream migration through the fish pass)! However, they do not really say this, instead saying that the data "present little firm evidence that operation of the Settle Archimedes screw turbine has a negative impact on the efficacy of the fish

pass to accommodate upstream passage of adult salmonids."

I have no doubt if the findings were the reverse, they would have said that the turbine had a definite negative impact on fish passage. This is poor science and disappointing.

There are fundamental issues with the analysis and these **must be recognised and amended** before the report is issued more widely. A few points are as follows:

- Using day as the dependent variable is essentially pseodoreplication as the extent of the variable has been chosen. This artificially inflates the data set size. The most accurate dependent variable is actually the number of salmon moving upstream, not the number of days. There are more elegant ways of analysing this data using this approach.

- Was a poisson error structure actually used for the analysis? Was overdispersion tested as this can be an issue with large data-sets with a poisson error structure?

- Using a migration index (e.g. that used by Solomon) would have been a better way to examine the data and could have been framed within a statistical analysis framework, e.g. creating a migration index for the turbine on and turbine off situations and comparing them

- The flow range bins (section 3.5) used are uneven and no apparent control is made for the amount of time that the flows were within each of these flow ranges. E.g. if 50% of the days were within a certain flow range, you would expect a lot of fish to move at this flow due to probability. A migration index accounts for this.

- A fundamental flaw is that no account has been made of the number of days the turbine was on or off in the analyses. *This is hugely important* as it means that your 'treatment' (turbine on or off) is not even. The turbine was on for only 28 days and off for 63 days (this is mentioned in section 4.1), however it is not accounted for in the statistical analyses and essentially invalidates them and in the least, makes the result stronger (i.e. more migration when turbine on). With the turbine off for more days, statistical probability would dictate that more fish will move when the turbine is off.

- What were the different flows when the turbine was on versus off and has this been accounted for? It is mentioned in the discussion, but no apparent control has been made for this in the analyses.

- The repeated analyses of the data, using sub-sets of the same data-set is poor statistical practice and is an example of 'fishing for results' - Analysing the same data set or sub-sets of the data-set increases the chance of finding a statistical result by sheer chance alone, as does pseudoreplication.

- Table 3.4 is an example of pseudo-replication. The df is much greater than the number of fish, increasing the chance of finding a significant result hugely.

- Section 4.2 - there is no control of the number of days per Q category. This must be

controlled for. If there are more days at a certain flow, you would expect more fish to move upstream, independent of the flow itself

- The df in the various tables don't add up. If the data-set is the same (i.e number of days) it should be the same for the different analyses (e.g. total raw data and binned data) but it differs (e.g. table 3.1 to table 4.3)

These are relatively brief comments. I would like to see these addressed and if I have more time, properly read through an amended version of the report.

Dave Mann email 03.11.13

- Please find my comments on this report below:-

- Section 2.5 and Table 2.2 title. The comment about the On/Off operation in practice not following the proposed regime is presumably simply because there was insufficient flow in the river on some days. The way it reads implies that there was some other problem that prevented it.

- Section 3.2. All numbers stating maximum output should be in kW, not kWh. It is not relevant to comment that the maximum output recorded was lower than numbers found in earlier reports without making some reference to why. This just feeds into the general heresay provided by the AT indicating that the scheme is under-performing. The reason for the lower number is because the EA insisted on building a new wall just below the scheme at the last minute that has reduced the operating head of the scheme.

- Table 3.1 This table is difficult to understand, but the comments below are very important – essentially the only factor that had a positive impact on the numbers of upstream migrants was if the turbine was on.

- Section 4.1 This reads as if it was really expected that the turbine could be running for every proposed 7 day section, when in reality it was always going to depend on river flows. To properly assess this then all periods when the turbine was off due to low water should really be excluded. Doing this would mean that the caveats outlined on page 19 of the discussion would no longer apply, and the questions cited in the conclusions on control are not relevant. I would like to see a clear graph showing the upstream migration numbers plotted against river flow for when the turbine is both on and off.

Conclusion:

- It states that there is little firm evidence – I cannot find any firm evidence in the rest of the report to support this statement. Indeed there is in fact some evidence to support the fact that the turbine has a beneficial effect.
- The study was not asked to look at what effect the weir had so I don't see the relevance of recommending further investigations to assess this.
- If there is no evidence that there is a problem with the existing operation then what is the point of suggesting designing an operational programme to limit the impact.

- In general the conclusion does not seem to really draw out the rest of the information presented in the report in a concise way, but instead brings up further questions which are not necessarily relevant to the specific aims of the study. It is crucial that this is corrected as many people will only read this and will likely not therefore properly understand the actual results of the study.