Notes for meeting for Town-scale Gravitational Water Vortex Power Plant at Llandysul 9/2/15 with Natural Resources Wales

1. You can see the Agenda on the screen. I'll start with a brief introduction to the project. But you all have seen the proposal so I won't go into it in too much detail.

2. Then for the main core of the meeting I'd like to go through each of NRW's concerns – Flood Risk, Impact on Protected Plant Species and Fish, Hydromorphology, and the question of Overriding Public Interest.

3. I will explain what has been described in the pre-application proposal to address each of the concerns. Then I'd be grateful if the relevant expert from NRW could reply to each point to explain where the concerns have not been met.

4. So in 2013 we started looking into hydro-electricity as a community project to help generate income for the community to keep public services running such as the parks and the swimming pool and to keep LLandyusl & Pontweli Ymlaen running after continuous funding cuts. As well as to increase the amount of local renewable energy projects to improve local energy security and the environment.

5. We have a perfect historical precedent as Llandysul & Pont Tyweli were originally powered by electricity from water turbines here at the Powerhouse, between then 1920s and 1940s. There were 3 generators generating up to 106kW of power.

6. Our initial intention was to largely re-instate the historical scheme using the existing leat and remains of the previous weir, but bringing it up to date by using a fish friendly Archimedes screw.

7. This proposal was submitted to NRW and they replied with the following concerns:

8. The possible impact on migratory fish, on a rare moss, flooding, other SSSI species and features, hydromorphology, other water users, abstraction and impoundment licence requirements, and overall the scheme was considered too small to be of overriding public interest.

9. So we researched into ways to address each of these concerns.

10. The main reasons for the concerns were related to the fact that the scheme would need a depleted reach, where we take water from a higher up section of the river and return it to a lower down section. So the water in the main river channel is reduced.

11. If we could remove the depleted reach we could address most of the concerns immediately.

12. So we found the Gravitational Water Vortex system. Designed by an Austrian company called Zotloeterer.

13. This is simply a concrete tank with a big hole in the bottom, designed to be large enough for the largest fish in the river to be able to easily navigate. Water feeds in through the side of the tank and goes out through the hole in the bottom. As it does, it naturally rotates and forms a vortex which can drive a paddle to generate electricity.

14. This has the positives of no depleted reach, no impact on fish, no impact on moss, no impact on flooding, and no abstraction.

15. It does have some negatives we need to manage. The visual impact, and the construction impact on the banks.

16. You can have tanks of various size and number. I chose 20 in response to Elizabeth's comments at the previous meeting where she mentioned that the Archimedes Screw proposal was too small. So I picked a figure that would use 100% of the flow of the river for 80% of the year. For the remaining 20% of the year, the excess spills over the top of the weir.

17. Looking at the flow duration curve of the river we can see the area marked in yellow shows the usable power of the river that can be converted to electricity. We lose only a very small part of the power of the river where the flow is too much and the remaining water spills over the top of the weir. To be able to capture that much power is pretty unique in a hydro-power system which must also allow free passage to river life.

18. In a phone call with Elizabeth a couple of weeks ago, she pointed out that there was a large volume of water that has to be passed through the vortex tanks and out through the exit here. In fact yes - the whole flow of the river must pass through this exit here. And to be fish as friendly as possible we don't want the exit speed to exceed 1m/s. So how can all the water from the river fit through this small exit and below the tanks with this small area here?

19. The schematic included in the proposal is exactly that – it is not a detailed design. For that we need a lot of work and therefore cost for Zotloeterer to make those designs. I have been in a lot of contact with Zotloeterer about this and Elizabeth's question has always been a major stumbling block for me too. However, I am confident that this is just an engineering issue and can easily be overcome.

20. The exact positioning and size of the tanks is not fixed. Indeed the ideal positioning is to put the tanks directly in the middle of the main river channel then there is no diversion of the flow, there's no digging into the banks, and you don't need a weir. But we didn't think NRW would like that idea.

21. So one possible example is here. We can double up the tanks width wise, which means we need less length of the bank length wise. In this example we go from 120m to 84m length of bank. The tanks can also be covered to minimise the visual impact.

22. So to get a maximum exit water speed of 1m/s when the full flow of 26m3/s is going through the tanks we need a cross sectional area of 26m2. You can configure this as a width of 17m and a depth of 1.5m.

23. Looking at a vertical cross section you can see that all the tanks are not the same size. We start with the tallest one at the edge so that we have a continuous water flow through the bottom of the tank onto the level of the natural river bed without a drop. That allows fish always to be able to navigate the channel and up into a tank. Then the tanks get shorter as we move along so that a greater water flow can be contained beneath them.

24. So with a very small amount of water flowing through the river we have a single tank open and the water level at the exit is 0.1m.

25. As more flow goes through the river, more tanks are opened and the exit water level rises. Until we get all the tanks open and the exit depth is 1.5m.

26. So the design can easily be adapted for the local site, and if it turns out that full detailed engineering design shows that there will be too many problems with 20 tanks, that number is flexible, so we can go down to fewer tanks.

27. Before we tackle the detailed concerns of NRW it is important to consider the reasons for doing this project. And to weigh up the pros and cons at each stage.

28. From a local community point of view:

    a. There's the Historical Precedent.

    b. Energy security: UK's coal fired power stations closing. Huge demand on national grid. Local energy security is vital. The Water Vortex provides 100+ years of energy security for town of Llandysul. And it's important to emphasise the 100+ years. Other renewable sources such as wind power have a design life of 25 years because of mechanical fatigue in the materials used. Even nuclear power plants only have design life of 30 years or so after which you have to deal with the waste for 30,000 years.

    c. Energy policy: UK law to provide 15% of all energy by renewables by 2020 (currently only 5%). (40% reduction in CO2 by 2020, 95% by 2050)

    d. Considering the Alternatives: Hydro is better than wind, nuclear power and gas fracking.

    e. Community benefit: Local project, not a large foreign company. Income for local investors. All have a chance to be involved. No minimum investment. There is a total £1.2m investment potential at 8% annual return.

    f. Community fund for local projects up to £30,000 per year.

    g. We could also set up a Community Energy Supply Company: Sell electricity direct to members.

    h. It also fits in with the aims of the Teifi Valley Local Growth Zone.

    i. And it reduces CO_2 emissions so improves environment and reduces climate change.

29. But those are all quite local benefits. We also have to look at the big picture.

30. The Llandysul Water Vortex project will be an exemplar of new technology not yet used in the UK.

31. If we can prove through this exemplar project that the Water Vortex poses no significant negative impact on the river environment then it opens the way for thousands of small plants across the UK's rivers in the same way we had thousands of water wheels not so long ago.

32. How significant a contribution will this be?

33. There is enough power in Wales' rivers to provide 13TWhours of energy per year. This is largely un-tap-able using conventional hydro power systems. But using the Water Vortex we can tap large amounts of power for very low heads down to 0.7m.

34. So we have the potential for producing up to **50% of Wales' entire electricity generation** for the next 100+ years through completely clean low maintenance renewable sources. That's a huge Public Benefit.

35. This will hugely reduce the amount of CO2 generated and will make a significant global impact if other countries take it up also. This will help reduce climate change. And it is climate change that is the biggest single threat to the environment and public not just in the UK but globally.

36. You may be able to protect a few species by blocking this proposal, but those species will die out in the area anyway because of climate change if we do nothing as we are likely to have hotter drier summers meaning less water in the rivers and warmer wetter winters, meaning too much water in the rivers. And that's until the North Atlantic Conveyor moves or stops, in which case we are likely to have conditions more similar to Moscow and Canada with winter temperatures routinely down to -40.

37. So as we go through please consider any potential small risks against those huge national and global aims.

38. Also consider that this is new technology to the UK so some existing guidelines may not be applicable. You may need to go back to the objectives and aims that led to those guidelines and ensure the aims are fulfilled without blindly following previous practice.

39. Now to tackle the conclusion in Elizabeth's briefing note to Elin.

40. "While we agree that this innovative technology has prospective uses and could be investigated further, a more suitable site should be identified for the first trial in Britain of this technology. A suitable location should avoid main rivers and designated conservation sites. From our understanding of the existing operating schemes they are sited on canals and leats supplied from a main river and not in the main river channel itself."

41. Now to generate a significant amount energy to make a significant improvement to the environment requires a large volume of water for example $10m^3/s$. This by definition means major rivers must be used.

42. I did ask if there are any that are not protected but didn't get a reply. But looking at the Joint Nature Conservation Committee list of Special Areas of Conservation this includes all the major rivers I think in Wales – and you can see all the SACs in green on the map.

43. So I don't think Elizabeth's suggestion helps us. We need to make sure that the Water Vortex works well on major rivers and has negligible impact on Special Areas of Conservation.

44. Going on to Elizabeth's assumption that the Water Vortex currently only operate on canals and leats is not true. Listed are Zotloeterer's installations directly on major rivers – in Bali, Germany and Austria.

45. Additionally there is a Swiss-Indian enterprise to launch 1,000 Water Vortexs in India on natural rivers.

46. So to move on to the specific NRW concerns.

47. Flooding.

48. The weir is movable.

49. Once the weir is opened the river channel is exactly the same as it was before installation of the Water Vortex.

50. Therefore it cannot have any impact on flooding.

51. What if weir fails to open?

52. Is it possible to have a fail-*safe* weir?

53. Well yes – quite easily.

54. This is a counterbalance float weir.

55. The weir is a flat plate hinged at the bottom. It is fixed to a pair of weighted floats. The weight of the floats pulls the weir up against the force of river. But when the river level rises, the floats rise and allow the river to push the weir downwards to open it.

56. It is designed to maintain the 2.5m design depth of the water up river.

57. So what happens in the event of a flood. You can have a detector to detect the level of the river and when it reaches a preset limit, a winch can pull up the weights so that the weir is fully open so it presents no obstruction to the flow of the water.

58. If the motorised winch fails, it can be winched by hand.

59. If there is no one available to winch it by hand the floats will rise as the water level rises. As they do the weir opens so by the time the water level has risen by 0.5m above normal the weir will be almost open and presenting little resistance. By the time the water level has risen by 1m the weir will be fully open and presenting no resistance.

60. So that is a completely fail-safe weir.

61. I can't see a way of it failing naturally. If you are thinking the hinges may rust up at the base plate of the weir, there is 16 tons of force pushing against them when the counterbalance weights are floating freely and no amount of rust is going to keep that force back.

62. The only situation I can see for it failing is in the event of sabotage by terrorists wanting to flood Llandysul, and they weld the weir shut.

63. So let's look at what happens in that unlikely situation if the weir does remain shut in the event of flooding.

64. The maximum flow that has ever been recorded at this part of the Teifi is 230m^3/s. Taking a conservative average water speed of 3m/s at times of this flood, the water level at the Water Vortex with the weir open would be 3.6m. If the weir was closed, the water level at the Water Vortex would be 4.6m. A difference of 1m.

65. We know the rise in height of the river from the site survey we carried out, so we can see if the height of water is increased by 1m at the site of the Water Vortex, we can see it decreasing to 0.6m at this point down to no impact at all from this point upwards.

66. The house highlighted in yellow is the only property in the area. But the river has very steep banks at this point and the house is 10m above the river level. So there is absolutely no risk.

67. Now that much I covered in the pre application proposal and it seems absolutely clear cut to me. But NRW replied that "we would need to demonstrate that there is no third party detriment as a result of our proposal". I believe that has been done very clearly so I don't understand what more needs to be shown.

68. However, let's explore a little further if we need to.

69. This is the Environment Agency Flood Map showing in dark blue the areas with a 1% chance of flooding per year and in light blue the areas with 0.1% chance of flooding per year. I've lived here 12 years and have seen the 1% flooding pattern happen twice.

70. So why does it happen here? The river in the parks has very low banks so any increase in level quickly overruns the banks and the parks form a natural flood plain. But what is actually holding back the river is clear from the map – it is the pinch point at the Llandysul bridge.

71. On the Tyweli there is another pinch point here at the Tyweli bridge. Which causes backing up of the water and flooding.

72. Notice our proposed site has only the flooding of the wide shelf around the steep banks. And then you can see the contours on the map, the hillside rises very rapidly preventing further flooding. We have already shown that even if we raise the level of the river here by 1m it only has any effect up to about here. So that is well out of the way of the pinch points.

73. Looking at those pinch points the area under Llandysul bridge is only sufficient to take a maxium flow rate of 168m3/s. Yet we know the maximum recorded flow was 230m3/s so 30% of that flow cannot go through the bridge and backs up into the park. Interestingly that also reduces the flow going down river, so 230m3/s is not reaching our site so our calculations could be adjusted downwards and the impact of our scheme reduced further.

74. The Tyweli bridge could theoretically take 60m3/s. There are no recorded flow rates for the Tyweli so we can't gain much from this information. But as the Tyweli is joining the already full Teifi at right angles it is very unlikely that it will flow at 3m/s and that speed will be much reduced. Hence the floods caused up river.

75. So to conclude:

    a. Weir automatically opens so there is no impact on flooding.

    b. Weir is fail-*safe* – so will always open.

    c. In the event of terrorist attack on the weir there is still no impact on property.

76. NRW Reply:

    Don't believe weir is fail-safe. But none of the NRW attendees had an engineering background so did not understand the mechanics.

    Must have a very expensive Flood Consequence Assessment with full hydraulic model. Or all at risk must sign to agree to the risk.

    No flood expert was present so no one was able to explain why Greg's Flood Consequence Assessment was not sufficient. Only suggestion was redraw the flood map with the 1m raised section. In our case you would not be able to see the difference as the hillside is so steep in the affected area.

    Further attempt at simple explanation:

    If I applied for planning for a weir in Cardigan would you ask me for a Flood Consequence Assessment for Llandysul?

    I hope after some thought you would say no.

    But why? Because it's pretty damn obvious that adding a weir in Cardigan will have no effect on flooding in Llandysul.

    But why? Because Cardigan is 20 miles from Llandysul.

    OK. But that's not the reason. There could be an effect from 20 miles downriver. But there isn't in this case because the Teifi in Llandysul is 55m higher than the Teifi in Cardigan and we are only raising the water level by 1m in Cardigan so it cannot have any effect.

    In the case of our GWVPP site, our weir is 1.2m below the exit point from the Tyweli to the Teifi which is where the flooding risk occurs. If we block that exit further the there is an increased risk. However, we are only raising the water by 1m in an absolute worst case scenario. So we are below the level at which any risk could occur. Admittedly it's only 20cm. But I have shown that using the same speed assumptions, that much flow cannot fit through the Llandysul bridge in the first place, so that much flow will not be in the channel so the height difference at the weir reduces to 0.4m so we have 0.8m allowance – plenty to demonstrate it can have no effect.

77. Moving onto the impact on protected species. Firstly the Cornish Moneywort. This is reported as scarce but not rare. And it shows a fairly wide distribution over the UK even up to Scotland, and it is fairly widespread over Europe. However, it is a protected species and NRW have a legal duty to protect it.

78. Jon sent me a map of the location of the protected species. We can see the red dot is the site of the Cornish Moneywort. It likes being near small streams and there is a couple of small streams joining the main river here.

79. Once we had the map we proposed to NRW that we would move the Water Vortex further up river to avoid the Cornish Moneywort site. You can see the new proposed location as the green line on the map.

80. We can see a photo from the river looking up to the stream. We can see the banks rise sharply so the Cornish Moneywort is well out of the way of the main river and any disturbance that may occur there. So we should be able to easily avoid the site by building slightly up river.

81. Moving on to the Dendrocryphaea Lamyana a rare multi-fruited river moss. This grows on rocks and trees by the side of large rivers in south-west England and south-west Wales. It occurs above the normal water level, but in a zone which is frequently flooded. The map on the right shows the overall locations, and the map on the left is not easy to read but shows the river Teifi with green squares indicating sites of Dendrocryphaea Lamyana, from Llandysul around the middle, through to Cilgeren towards the left.

82. The blue dots on NRW's distribution map show the sites of the Dendrocryphaea Lamyana around Pontweli.

83. The initially proposed Water Vortex site is 120m long which is show by the green line here. This would impact on the first of the sites. However, if we go for the design where the tanks are doubled up width wise the length of bank required reduces to 84m so we probably miss the Dendrocryphaea Lamyana here.

84. So the only risk is down to raising the water level. If we raise it sufficiently that the moss is completely flooded all year round I am guessing that it may not survive, but then it may do as it likes being flooded from time to time. We can see the increase in average water levels plotted on the map. So the closest site will have the level raised by 1.5m going down to 1.1m, 0.6m and quickly down to no increase in height.

85. Looking at the site of the second blue dot on the map. I think I have identified the Dendrocryphaea Lamyana – it is fairly distinctive as it has relatively long stems for moss from 5 to 10cms. It grows on the rocks you can see below this tree and all the way up the trunk.

86. So if we raise the water level here by 1.5m the lower moss will be flooded permanently but there will still be plenty well above the river level. So this colony should survive.

87. From the third blue dot onwards the banks are much higher, as is the moss, and the amount the water level is raised reduces quickly. So there should be minimal impact.

88. So to summarise.

89. Cornish Moneywort – No impact.

90. Dendrocryphaea Lamyana - Possible impact on 1 out of 14 sites in the close vicinity which in itself is only 1 site in 17 along the Teifi (perhaps 0.4% of population).

91. So while there is some impact it will not have a significant effect on the overall population of the protected species in the area.

92. NRW have a legal duty to protect certain species. And this is governed by Statue. The main one is the Habitats Directive.

93. In Article 6(2) it says: "Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be **significant** in relation to the objectives of this Directive."

94. So what are the objectives of the Directive? That's defined as "The aim of this Directive shall be to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies."

95. "Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest."

96. So, if we do happen to remove 0.4% of a population of moss this could not be considered "**significant** in relation to the objectives of the Directive". It would have no impact on the overall population health.

97. So I can't see that we are going against the aims of the Directive here. However, if you believe we are, then there are exemptions that apply as per Article 16.

98. Provided that there is no satisfactory alternative and the derogation is not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range, Member States may derogate from the provisions of the Articles:

    (a) in the interest of protecting wild fauna and flora and conserving natural habitats;

99. So we are permitted to remove some specimens of a protected species providing it is in the interest of protecting wild fauna and flora and conserving natural habitats. That is exactly what the aim of the project. To make a serious contribution to reducing man made climate change. This will help to conserve the natural habitat of the river and the long term survival of the protected species here.

100. NRW reply:

> *There is no specific embargo on development in an SSSI. The impact on protected species must be analysed. If there was plenty of a particular species then they would not be too concerned.*
>
> *Main sites for Dendrocryphaea Lamyana are Cenarth & Llandysul – not evenly spread over the 17 sites on Teifi. So the percentage affected increases – to 4% on the Teifi.*

Will need to survey and analyse exactly how much of each Dendrocryphaea Lamyana patch is affected.

If 50% of a species was lost then that would be a major significance and not approved. If less would be affected you would still need to jump through some hoops to get approval, but it is possible.

The Habitats directive applying is for the site as a whole so need to refer to Directives 6(3) and 6(4) – but the are similar requirements. But they haven't done a derogation of 6(3) before so unsure exactly what is required.

With SSSI it is more difficult as there are no directives of what we want to achieve.

We suggested adding rocks & trees at the sites at the new water level to give the moss a chance to establish further (other species may colonise first, must these could be weeded out). But the habitable range (from high to low water will be decreased).

101. **Impact on Fish**

102. Before I cover the Water Vortex I wanted to raise a couple of poser questions.

103. Firstly What is Natural?

104. I read in A Flyfisher's Guide to the Teifi valley that the Cenarth Falls formed an impassable barrier for migratory fish until 1867, when it was blown up by the Teifi board of "Conservators".

105. So it is not natural for migratory fish to be up river of Cenarth, in the Llandysul part of the Teifi and perhaps the migratory fish have damaged the ecosystem for the native fish in the area.

106. Why class "natural" as of an arbitrary point in time at which some legislation was written – why not as of 150 years ago and remove all the migratory fish?

107. My point being, that what we consider as natural now is often heavily influenced by mankind's actions.

108. And that *change* is not necessarily a bad thing. Considering that the hugely destructive act of blowing up Cenarth falls has resulted in more migratory fish in the Teifi which many think is a good thing.

109. My next question.

110. Have the number of obstructions and weirs in the Teifi *decreased* over the last 50 years? I assume the answer is yes as it is NRWs policy to keep the rivers clear.

111. Have the number of fish in the river decreased over the last 50 years? I assume the answer is yes from what I have seen in the news and heard from anglers.

112. Therefore you cannot argue that obstructions and weirs *as such* are bad for fish, because if they are bad, removing the obstructions should cause fish numbers to increase, but it hasn't.

113. In fact the statistics show that increasing the number of obstructions increases the number of fish.

114. This could make sense – obstructions cause areas of slow moving water where insects can breed more easily so producing more food for fish. And providing quieter areas for spawning away from the main current.

115. So why not go back to the 1945 situation with the weir in Llandysul parks, and the Powerhouse with its hugely fish un-friendly turbine? The fish survived the weir and the turbine – in fact they prospered as there were many more fish in the river then. The weir did not have a significant negative impact on the fish.

116. Clearly there are other factors at play that are reducing the number of fish – most likely diffuse agricultural chemicals.

117. But my point being, that it is not the weirs that are causing the decline of the fish. They survived perfectly well with plenty more weirs. So we need to look at the whole picture, rather than a fixed policy that is effectively a blanket ban on weirs.

118. So moving onto the impact of the Water Vortex on fish.

119. One big advantage of the Water Vortex is that there is no depleted reach so no part of the river has less flow than natural flows. So there are no non-natural restrictions to swimming.

120. Conventional Hydro Electric Plants need a fish ladder to help fish swim up river past the obstruction. The Water Vortex is completely open to fish and forms no barrier.

121. The problem with a traditional hydro scheme is that you have three flows of water – one through the turbine, one over the weir and one through the fish pass. This confuses fish as they do not know which one to take and can get exhausted repeatedly trying the wrong route. With the Water Vortex the full flow goes through the vortex so there is only one route and no confusion or delay for the fish.

122. Water Vortex is also a bio-reactor generating microbes which are food for fish, which lure them into the tank so they can pass freely. They also act as an additional food source, and clean the water.

123. The maximum speed of water through the Vortex is lower than 1m/s. While a traditional fish ladder can be up to 1.8m/s.

124. The power density is 120W/m3 as opposed to 150W/m3 for fish ladder.

125. The entry speed to the Water Vortex is less than 0.5m/s so there is no danger to fish at all.

126. Fish can pass both up and down stream. Fish ladders only works up stream.

127. Fish only have to traverse a *single* Water Vortex tank (we have 20 tanks in our design, but the fish can chose any one of them and pass through freely directly to the main river). With fish ladder there could be 20 or more basins and doorways that have to be traversed.

128. The Water Vortex needs no additional fish ladder so there is no additional building required.

129. The Water Vortex aerates the water so improving the quality.

130. A study has been carried out of fish migration through the Water Vortex and we have previously circulated that too everyone.

131. The conclusion of the study is that fish can move freely through the vortex.

132. Let's look at the impact of the weir itself.

133. Now I read in my favourite book on Flyfishing that the best areas for fishing on the Teifi are where there are deep pools .

134. Presumably that's because there is always plenty of water even in low flow conditions of the river. And the pools are protected from the main current so make ideal spawning grounds.

135. The weir will create a 120m stretch of river that is always at least 1.5m deep no matter how low the flow. Some areas of this will be sheltered from the main flow, making ideal insect breeding grounds, providing food for fish.

136. So this could create the ideal fish nursery.

137. To conclude:

138. The Water Vortex and Weir combination poses no negative effect on fish movement up or down river.

139. The increased stable depth of the 120m stretch of river may improve spawning conditions and make it more likely more fish will survive.

140. Possibly increased fish food generated in the Water Vortex and by the weir.

141. So the Overall impact to fish is a Benefit

142. NRW Reply:

    Very interested in potential of this new technology and would be keen to see how fish really do respond.

    The fish study was not using fish in the Teifi.

    Must have a fish study on Teifi migratory fish, but unable to do that on the main Teifi. But would allow at a site of smaller catchment with a smaller scale trial.

    Would not suggest an alternative site.

    "Precautionary principle" is place – need to prove no impact beyond scientific doubt.

    The Core management plan is the benchmark for what is impact.

    The legislation is there to allow development if there is no significant negative impact.

143. Hydromorphology

144. Hydromorphology: “the physical characteristics of the shape, boundaries and content of a water body”.

145. This is affected by the erosion caused by sediment, gravels and cobbles which pass through the river. And NRW’s guidance is not to interfere with the natural erosion process.

146. The channel at this site is hard bedrock so the scheme does not raise a concern of erosion or mobilisation of sediment within the river either in construction or operation.

147. Unlike most hydro-electric plants, sediment, gravel and small cobbles will pass directly through the Water Vortex without problem as the Water Vortex is simply an open channel, so there will be no effect on the morphology of the river further downstream.

148. Larger stones and debris carried down river at times of flood may well be stopped at the weir. But the weir is movable and can be periodically lowered to allow free transit of the larger material down river.

149. The exit from the Water Vortex is at a straight part of the river, with a wide plateau of hard bedrock and banks. Additionally the exit speed of the Water Vortex is designed to be a low 1m/s so there is no reason to expect a significant change in the pattern of erosion and movement of the river in the area compared to the Water Vortex not being in place.

150. In Elizabeth briefing note to Elin she says: “Natural Resources Wales produced revised hydropower guidance in January 2014. Within this, ‘Hydropower Guidance Note 14’ states that hydropower schemes should avoid disrupting longitudinal connectivity, that is the movement of sediment, animals or organic matter through the channel network, and to avoid sites that require the installation of new weirs. It goes on to say that we are unlikely to be able to grant licences in connection with applications for *such* schemes in designated sites and their supporting habitats.”

151. The Guidance Note exact wording is: “In most circumstances, hydropower developers should seek to avoid building new weirs *that interfere* with the natural movement of sediment, animals or organic matter through the channel network.”

152. This is a valid argument against weirs for use with traditional hydro-electric schemes because sediment is not passed through the turbine. However, for the Water Vortex we have demonstrated that it will *not interfere* with the movement of fish and will *not interfere* with the movement of sediment, so there is no reason to object to installation of the movable weir in this particular case.

153. To conclude there is no impact on Hydromorphology.

154. NRW reply:

Will need to prove that the sediment can travel through.

Some sediment will drop down at the weir but this could be managed by having a leaky weir with exit for sediment through the bottom, or by periodically opening it (but opening will cause irregular passing of large amounts of sediment).

155. Moving on the question of Overriding Public Interest. We saw earlier one exemption clause in the Habitats Directive. There is another one that applies point(c). You are permitted to derogate from the directive "in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment;"

156. In our case, it's a no-brainer that we fulfil those requirements.

157. In the case of Social or economic interest: We are helping to preserve local community and local services at every single site that is developed across the country.

158. And as for **Primary importance for the environment**

159. We have the potential to deliver up to 50% of Wales' entire electricity generation cleanly through Water Vortex Power Plants.

160. This will be a huge reduction in CO_2 emissions for Wales.

161. It will set an exemplar to rest of the world to help reduce global CO_2 emissions.

162. It will reduce further climate change.

163. This will minimise changes to the environment of protected species in Wales and along the Teifi. So helping to ensure their long term survival.

164. NRW reply:

Explained process of tests that have to go through.

Has been used e.g. for St. David's lifeboat station.

Need to have compensation for Atlantic Salmon – very difficult to suggest what that would be. (E.g. if developer destroyed salt marsh in one area they would have to create one in another area). But not saying that it wouldn't get through.

Did not accept that the reduction in climate change to help the Altantic Salmon keep returning to the Teifi for the long term would be sufficient compensation.

Derogation tests have to be carefully applied otherwise NRW may be taken to European Court.

165. NRW Corporate Plan.

166. So it looks like you will fulfil your corporate plan by supporting the GWV. You will be using the water you manage to mitigate and reduce the effects of climate change. And you will be an exemplar to others by doing this.

167. That’s all in your plan.

168. Or is this Corporate Plan just empty words?