Please find attached a submission from the Environment Agency which includes comments on responses to our Relevant Representations.

Kind regards,

Annette Hewitson
Principal Planning Advisor

Environment Agency
✉ Waterside House, Waterside North, Lincoln, LN2 5HA
☎ 01522 785896
☎ [redacted]
[redacted]

Awarded to the Environment, Planning and Engagement Department, Anglian Region, Northern Area.

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Able Humber Ports Ltd
Marine Energy Park
Proposal to build a quay and associated development on the south bank of the River Humber

Planning Inspectorate Reference: TR030001

Comments on response (by the Applicant) to Relevant Representations made by The Environment Agency including comments on Supplementary Information submitted by the Applicant

Unique Reference Number: [redacted]

3 August 2012

Submitted on behalf of the
Environment Agency by:
Annette Hewitson, MSc, MRTPI
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1.0 Introduction

1.1 The following comments are given in response to Able Humber Ports Ltd (the applicant)'s comments on the Environment Agency (EA)'s Relevant Representations. The applicant's paragraph numbering is quoted where applicable.

2.0 Flood risk – Marine Energy Park site

2.1 ***63.2 and EX13.2 (Addendum to Flood Risk Assessment)*** The EA has reviewed the supplementary information, which includes updated modelling for the square edged quay design and this is satisfactory. We hope to secure our remaining requirements, in respect of flood risk, in a legal agreement with the applicant before the end of the examination period.

3.0 Impact on migratory salmon

3.1 ***63.3-4*** The EA has previously explained to the applicant that impacts of the order of 10-30% are not feasibly detectable in the natural variability of the population and tracking projects are prohibitively expensive. There are examples in the literature (specific documents referenced in the Statement by Dr Adrian Fewings, attached as Appendix D to the EA's Written Representations) of death and injury to fish as well as changes in the distribution of catches associated with piling operations, sometimes at considerable range. The EA therefore does not agree with the applicant's statement at 6.3.3 that 'underwater noise will not be fatal to fish in any significant way'. Acoustic deterrent devices are used to deflect fish from intakes for power stations at the noise levels equal to that expected from the applicant's proposed activities.

3.2 ***63.5*** There is evidence of migratory fish being adversely affected by noise sources. Gregory and Clabburn (2003)[1] (attached as Appendix C) observed that shad migrating on the Wye in south Wales would not pass a site with an acoustic fish counter while the counter was operating. Whilst not an observation of salmon migration it is evidence that anadromous[2] migrants may be influenced by an "acoustic barrier".

3.3 ***63.7*** The Subacoustec assessment, carried out for the applicant, also demonstrated that the zone of behavioural response extended to the far (north bank) shore.

3.4 ***63.8*** It is our opinion that lamprey do not need to hear noise to be damaged by it. Lack of hearing capability may result in greater damage to lamprey as they will be less likely to avoid the noise source. Injury may occur to these lamprey at close range.

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[1] Avoidance behaviour of Alosa fallax fallax to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river, Jim Gregory & Peter Clabburn, Aquatic Living Resources 16 (2003) 313-316

[2] Fish which spend most of their lives in the sea and migrate to fresh water to breed

3.5 ***63.9*** It is the EA's opinion that the applicant's assessment demonstrates that it is unclear how much impact there might be on salmon and lamprey and no affordable or practicable methodology has been identified to determine this. It is, therefore, appropriate that the precautionary principle is applied, particularly as lamprey are a designated feature of the Humber SAC and Ramsar site.

3.6 ***63.10*** The tributaries of the Humber were not identified in the original tranche of rivers for salmon action plans (SAP) in 1997. However, several of these tributaries are scheduled to have the current equivalent of the SAP applied to them in recognition of their recovering status. The River Ure was the subject of a salmon restoration plan in 2002, which estimated the salmon spawning target at approximately 3,300 adult salmon. In 2004 a River Trent Salmon Action Plan consultation estimated the conservation limit for the currently accessible (2004) Trent as 977 salmon. The recent estimates of salmon output from the River Ure do not appear to be the result of stocked fish introductions.

3.7 ***Table and Figure 63.1*** These tables do not take account of anglers' low reporting rate on rivers perceived by anglers to be non-salmon rivers. It is also likely that anglers would be less likely to report salmon catches if they do not have a licence for salmon. Our independent estimates of salmon production from the River Ure alone suggest in the order of 20,000 smolt going to sea and an expected 2000 salmon return.

3.8 ***63.12*** It is our opinion that just taking the reported salmon catches gives a rather biased view of the size of salmon stock for the Humber tributaries and that this information should be given little weight in the decision making process. We would also like to reiterate that the mitigation/compensation measures required are for the protection of fish species generally present in the Humber and not solely for the protection of salmon.

3.9 ***63.13*** It is not clear how much impact these "significant piling campaigns" between 1999 and 2007 might have had given that there is no independent means of counting fish into the Humber tributaries or the Humber estuary.

3.10 ***63.15*** The EA has sought to minimise the risk of impact in the face of considerable uncertainty. The most effective way to minimise the risk would be to undertake the works when salmon are not present (between October and March). If that is not possible then works to offset the potential risk should be proportionate and relevant to the risk.

3.11 ***63.16*** The policy and law set out in the note on the precautionary principle at Appendix G make it clear that the risk of harm demonstrated in Dr Fewings' evidence is a material consideration for the Examining Authority. It also makes it clear that the burden of proof

is on the applicant as the creator of the environmental hazard to prove that there is no adverse effect. The applicant has not done this and has relied on its case of imperative reasons of overriding public interest.

3.12 ***63.17*** The applicant has carried out assessments that suggest auditory injury could occur at close range and that strong behavioural effects could occur over more than half the width of the estuary. Some behavioural effects were predicted to extend to the far shore. What is not clear is how much disturbance may be required to prevent salmon from continuing their passage through the estuary. The applicant has not provided any evidence to support the claim that recent piling activity "has not obviously harmed the fish population". This statement cannot be substantiated when the Humber is not specifically monitored with methods that could detect such harm.

3.13 ***63.19*** The EA believes the salmon population is rather larger than the applicant suggests for the reasons outlined above and included in our Written Representations. We have discussed options for limiting risk with the applicant and measures to compensate for any residual risks remaining (we attach the latest correspondence on this at Appendix D for your information), and we are currently awaiting the applicant's response on the acceptability of these. We do not believe these are disproportionate to the potential risks. Similar mitigation has been secured for another port related project on the north bank of the Humber at Green Port Hull (GPH). The applicant on this project (Associated British Ports) is also providing compensatory works in the form of a multi-species fish pass on their dam at the River Freshney and improvements to areas in their ownership at Hedon Haven and Chowder Ness to maximise the benefit for fisheries. They are also making a payment of £180,000 to the Rivers Trust to be used on projects intended to improve the success of salmon migration to the Humber tributaries.

3.14 As outlined in paragraph 5.4 of Dr Adrian Fewings' Statement (see Appendix D of the EA's Written Representations) we are able to estimate the overall proportion of fish likely to be disturbed or diverted, on a daily or annual basis, taking into account factors such as hours of working and the distribution of fish presence in the estuary. We estimate that there will be an annual risk of exposure of 14.86%, which takes into account the seasonality and amount of piling hours available within the draft conditions for the Deemed Marine Licence (DML). With other schemes around the country that have had a similar potential impact on the marine environment, we have advised that any exposure greater than 10% warrants the need for compensation. We believe this threshold should apply for this proposed scheme.

3.15 The applicant has offered to design the habitat compensation site at Cherry Cobb Sands for maximum benefit for fish. However, as the detailed design is still being finalised they have not yet been able to

quantify the value of these compensatory works. In comparison with the GPH project, we would suggest that a similar compensation payment to a Rivers Trust may need to be secured. The difficulty with providing specific advice on this at the current time is due to the differences in the predicted piling schedules for the two projects, i.e. ABP at GPH expects to pile for 12 months, and the applicant expects to pile for 6 months. If the applicant is able to schedule piling to take place between 1st October and 31st March, the residual risk would be minimal and would not warrant a significant compensatory package. It may also be the case if the piling period falls between September to February. However, if the 6 month period starts at any other time then we would suggest further compensation, over and above the Cherry Cobb Sands work, will be necessary.

3.16 The EA's position is that our preferred option would be for there to be no piling during the periods when the salmon and lamprey will be at risk (April - August). However we accept that for commercial and financial reasons the applicant may wish to programme piling during these periods of time and that the Examining Authority should apply the precautionary principle proportionately. We would therefore accept compensation as described in paragraph 3.13 above to be provided in the event that piling does take place during the higher risk periods as being adequate in the circumstances. We would be prepared to remove our objection in relation to salmon and lamprey if the applicant accepts a legal obligation to provide this compensation. We would recommend that the applicant considers the information in the seasonal risk curve summary, which was previously provided to them (a copy of the summary is reproduced in Appendix F), to assist with calculating any obligation for compensation. We would respectfully submit that as the body with statutory responsibilities for salmon, lamprey and aquatic wildlife in general, our view should be accorded considerable weight.

3.17 ***63.20*** We are disappointed that the applicant has included reference to the Grimsby Riverside Ro-Ro Terminal in response to our representations as we have already (on 1st June 2012) explained the situation to them regarding this project. The Harbour Revision Order consultation was sent to the EA in 2009. At that time the impact of piling was not an issue that was fully considered. Since that time our understanding and evidence on this issue has developed and it is now one which should be given due consideration and weight in the planning process. Natural England has confirmed that the piling restrictions imposed for the Grimsby Ro-Ro related to the protection of birds. The Examining Authority will appreciate that the EA is not able to take any action in respect of extant permissions.

4.0 Hydrodynamic and sedimentary regime

4.1 ***63.21*** The EA has only been able to undertake a 'light touch' review of the supplementary information provided in respect of the hydrodynamic and sedimentary regime. As explained at the Oral Hearing on the

DCO, some members of the EA team working on this application have also been involved in incident duty on flood risk management matters, due to the heavy rainfall and extensive flooding that occurred in June/July. The EA has been experiencing unprecedented demands on staff resources due to this.

4.2 Supplementary information notes EX8.5-EX8.10 seem to represent technical annexes, which relate to the Environmental Statement (ES), but there does not appear to be any commitment to update the relevant ES chapters in light of this. It is essential that Chapter 8 of the Environmental Statement is revised to take account of the new modelling in these annexes. We would also request that the Examining Authority consider the implications this may have for compliance with the Environmental Impact Assessment (EIA) Regulations.

4.3 ***EX8.5 (Validation of 3D Flow and Sediment Models used for Assessment of Impact of AMEP on Fine Sediment Transport)*** The EA has briefly reviewed this additional report and has no comments to make on the validation submission as it is currently presented. The EA's comments relating to the location of the E.ON and Centrica intakes and outfalls are presented below under EX8.8. The exception to this is the summary presented in 3.1.2 regarding the uncertainty in the sediment modelling. The conclusion presented refers to a precautionary approach in Chapter 8 of the ES with regard to the predictions of impact on fine sediment transport and siltation rates. As mentioned above, we would expect Chapter 8 to be revised in light of this additional modelling and findings. This would include a discussion between the difference between the fine sediment transport (mud modelling) and the other sediment transport modelling presented in Annex 8.1 and updated EX8.7.

4.4 ***EX8.6 (Maintenance Dredge Variability)*** Section 1 – the EA requests confirmation from the applicant as to whether or not they intend to implement the recommendation to relocate both the E.ON and Centrica outfalls to negate the requirement to undertake maintenance dredging in the vicinity of these two outfalls.

4.5 Section 2 – The EA accepts that the sources listed are quite comprehensive. We would advise the applicant that disposal from historic and existing FEPA (Food and Environmental Protect Act) licences will not currently be recorded in this list of information. The return values for HU082 were not previously provided as they were a construction licence and it was not a requirement of OSPAR for this to take place.

4.6 The way EX8.6 is written implies that the data presented within this document includes dredge and disposal from the Humber International Terminal (HIT) and Immingham Outer Harbour (IOH). The EA would like the applicant to confirm this is a valid assumption given the

potential for the return values not to have been included in the data. Once the applicant has confirmed the licence type under which HIT and IOH were constructed, they may need to change the assumptions as defined in Section 4.0 of EX8.6.

4.7 Section 3 - The EA acknowledges the statement that the information provided in this section represents estimates with a considerable degree of uncertainty. However, despite this caveat the EA still has some outstanding questions with regards to this section.

4.8 Table 2 presents quite large lower and upper infill estimates for the Marine Energy Park (MEP) berth, per annum. The EA would like to clarify whether this dredge requirement would be to dredge down to the chalk each year. These volumes suggest this is potentially necessary, and as such we would expect the ES and Water Framework Directive (WFD) assessment to reflect this potential requirement.

4.9 The EA would query why the data for the Immingham Outer Harbour Basin has not been included in the Tables in Section 3.0? Can the applicant confirm whether this data was modelled in the same manner as the other data in the tables?

4.10 Section 4.0 - Could the applicant please clarify what type of licence HIT and IOH were constructed under. If these had a FEPA licence, which is possible as they were construction projects, it is possible that the data in Table 4 does not include these two projects. Please see our comments under Section 2 for further clarification on this matter. Once the applicant has confirmed the licence type for HIT and IOH, it may be necessary to review this document if it is found that the HIT and IOH data were not included in this analysis.

4.11 Section 5.0 – Could the applicant please clarify why they have focused on the modelled values in Table 8 being two to nine times higher than the observations for 2010 and 2011. The data for 2007 (which the EA accepts only has two data points) shows a much greater similarity to the lower modelled estimates.

4.12 As the IOH data is within model range, the EA would have expected to see some discussion as to the potential that 2007 data could be representative of the dredge requirements and the similarity to the actual dredging undertaken. Also, that it is possible 2010 and 2011 are low years and hence why they are not showing the model to be representative. It may be advisable for the applicant to see if they can obtain data for other years to see how well the model relates to the observed values. If we refer to Table 4, showing the annual disposal figures from OSPAR, site HU080 (used for erodible maintenance dredge requirements) this has not had any values returned for 2007, 2008 or 2009. In comparison from between 1999 to 2005 it received between 1 393 833 to 3 552 949 dry tonnes per annum.

4.13 Section 5.2 - The EA would like to draw the applicant's attention to paragraphs 4.10 to 4.11 above and the variability in dredging within the Humber. The assumption that is made in 5.2.1 is based on few values. This needs to be remembered at ALL times when reflecting on the conclusions of this report.

4.14 We would question why the other potential influencing factors on dredge frequency that are discussed in 5.2.3 are not discussed in detail within the potential impacts within estuary within the ES and within EX44.1 in terms of cumulative and in-combination impacts.

4.15 Section 6.0 - This section indicates that frequent dredging of the berthing pocket is likely to be required. As such, the EA expects this impact to be adequately assessed, including within the WFD assessment where it is likely it will need to be assessed as a permanent change to the marine habitat. Please refer to our comments provided to Able on 31st July 2012 (see Appendix A) for a further explanation of this point.

4.16 ***EX8.8 (Update to Longer Term Morphology Predictions in the Region of the Centrica and E.ON intakes and outfalls)*** We cannot locate where the applicant has addressed the risk of the proximity of the E.ON intake to the Marine Energy Park (MEP) dredged pocket. This report highlights the risk to this intake as a result of slope stability issues. We request evidence that underpins how this risk is to be managed, minimised or avoided is submitted. If there is a potential risk of local bed change this needs to be assessed in the WFD assessment, and should be included in the next iteration of this.

4.17 We cannot locate the evidence regarding the potential impact of deepening around the north western edge of the quay. We would also request further evidence is presented regarding the potential impact of this deepening. The EA would need to review this data. However there is the potential that as this is also a potential bed change, this risk needs to be included in the WFD assessment (the next iteration).

4.18 The EA requests that further explanation in respect of the potential effects of the non-uniform deposition inshore of the outfalls and the impact of the potential channel formation. We request that more model outputs identifying this potential channel are provided, in order to be able to understand the potential scale of the channel and area of impact. We have not had the time to undertake detailed analysis of the model outputs provided and the absence of discussion on these critical points means that we may need to make further comments on this impact in the future.

4.19 Section 2.3 – The EA needs to review whether or not the likely movement of newly deposited material into the dredge pocket as a result of gravity has been adequate assessed in EX8.6 (Maintenance Dredge Variability). Although we have not been able to undertake a

thorough review of this in the time available, we do not think this risk has been adequately assessed within the document. The EA is raising this matter with the applicant and will review their response to this point as soon as we are able.

4.20 The potential to relocate intakes/outfalls is an example of why the ES needs to be updated in light of the supplementary information. Having reviewed this technical appendix (EX8.8), we are no wiser as to the applicant's preferred option in respect of the intakes/outfalls. EX8.8 provides evidence on the potential impacts, but the applicant has not translated the supplementary information into the implications for the application that has been submitted and what changes, amendments or additions they intend to pursue as a consequence this information. Is it intended that one or both of the intakes/outfalls is to be relocated, and what is their proposal to manage the potential risks?

4.21 ***EX8.10 (Long-Term Morphological Change of Embayment South of Quay),*** the EA would emphasis that at present the Associated Petroleum Terminals (Immingham) Ltd's (APT) outfall (mentioned in Section 1.2) does still operate and function, despite the accretion that has taken place since the outfall was installed. We would expect to see an assessment of the potential impact of the MEP on the APT outfall. This does not appear to have been undertaken. As Table 1 in Section 2.2 indicates significant accretion following the construction of the MEP, the EA would like to review the potential options that the applicant intends to deploy to manage this situation.

4.22 Section 3 – the EA would like to understand how the risk to the US dolphin and its proximity to the side slopes of the MEP dredged area will be managed. The future feasibility of the US dolphin needs to be considered and potential options for sedimentation risk management need to be presented.

4.23 Section 4 – the EA welcomes the recommendation to continue to monitor the long-term morphological development post MEP construction. We would request that this is included in the Deemed Marine Licence (DML), over a minimum period of 10 years. We are currently working with the Marine Management Organisation (MMO) on the wording of a suitable condition for the DML. If the trends recorded were to change significantly from the current trends that have been identified in the ES and all the supplementary information, it will be necessary to request mitigation measures to be undertaken. The applicant proposed that the sedimentation that will take place in the embayment to the south of the MEP negates the need to undertake any remedial work to existing flood defences. If this sedimentation is not realised, the EA will require remediation to be undertaken and this will need to be included either in a requirement of the DCO or the Legal Agreement for the flood defences.

4.24 Appendix A – Figure A2 is absent from the document.

4.25 ***63.22 to 63.30*** The EA engaged independent consultants (Deltares) to review the hydrodynamic modelling work and the findings of this review concluded that additional compensation, to compensate for indirect losses, needs to be secured. The applicant's consultant, Black and Veatch, have challenged this review, the details of which were outlined in the applicant's response to the EA's Relevant Representations.

4.26 The Deltares memo (attached as Appendix E) responds to these comments by giving a more in-depth summary of the findings of the previous Humber study and evaluating these against the conclusions of Black and Veatch. The conclusion of the evaluation is that the estimated long-term large-scale effects by Deltares, based on the setback study, are the best estimates that can be made given the scope of that study. Deltares stands by their original assessment and the estimated quantity of morphological change remains. It is further recommended to compare the hypsometry[3] characteristics of the area where the wharf is planned and the characteristics of the compensation area, in order to give a more accurate insight into the development of the compensation ratio in time.

4.27 In summary, the EA's objection to the proposal remains unless the applicant demonstrates that they will provide a further 10ha of compensation (to account for the 100 year scenario) for the indirect loss of inter-tidal habitat.

4.28 **EX11.24** ***(Medium and Long Term Losses within the Designated Site)*** The 5 ha loss of intertidal area that Able quote in paragraph 10 of EX11.24 arising from the Deltares work, is the quantum of habitat Deltares refer to excluding a precautionary principle that would be applied as a result of the uncertainty in modelling outputs.

4.29 The information that the applicant has presented in paragraph 13 does not reflect the method by which the EA calculate inter-tidal losses at present. The applicant has received a copy of the EA's Humber Flood Risk Management Strategy Habitat Regulations Assessment that was approved by Defra in 2011, following their request on 15th May 2012. In addition, the EA provided information regarding the rate of intertidal losses within the estuary in our response to the Examining Authority's Questions (Questions 68 and 86). The EA is unclear why the applicant has undertaken new work in June 2012 based on the Humber CHaMP (2005). The EA does not believe that the calculation of 1 mm sea level rise to give rise to a loss of 2 ha of intertidal habitat throughout the estuary reflects the EA's understanding of where the actual intertidal losses as a consequence of sea level rise are taking place. Due to the large volume of supplementary information provided by the applicant and the short-time scale in which to review this, the EA has not been

[3] The measurement of elevation relative to sea level.

able to undertake its own analysis in order to present our understanding of losses in this sector of the estuary.

4.30 The applicant has further developed their argument in paragraph 16, still based on the 2005 CHaMP. The EA would like the applicant to clarify the date they have used in order to calculate the intertidal area in the middle estuary and how they have arrived at the 1.2% presented in paragraph 16.

4.31 The EA does not believe that the applicant's assessment that 4.32 ha of existing intertidal at Killingholme Marshes will become sub-tidal due to sea level rise by 2050 to be accurate, as it is based on data and understanding of intertidal losses that is now out of date. Most importantly however, the applicant needs to appreciate that the argument they are presenting is based on a "hold the line" policy. Any future calculations based on the EA's data will not reflect the advance the line sector at MEP. This needs to be included when predicting longer-term changes to the baseline, and is the scenario considered within the EA's latest predictions of losses (the EA response to Questions 68 and 86 discuss this in more detail).

5.0 Choice of Site

5.1 ***63.32*** Please see the EA's comments in paragraphs 4.104 to 4.111 of our Written Representations and answers to Examining Authority's Question 68 for our views on this issue, which remain valid.

5.2 ***EX11.23 (Immediate Habitat Losses within the Designated Site)*** The EA has only undertaken a light touch review of this document. The main issue we would raise in respect of this supplementary document is the absence of assessment of the berthing pocket impacts. In the supplementary information supplied by the applicant in EX8.6, the evidence suggests that it will be necessary to undertake maintenance dredging of the berthing pocket on an annual basis. What is unclear in the application to date is whether the applicant intends to dredge to the chalk layer that is being installed in the bed of the Humber as part of the marine works. If this is the case, the EA would expect this loss to be assessed as functional loss of habitat due to the change to another marine habitat not naturally occurring in the area. The EA has provided further information on this matter in its response on the WFD assessment to the applicant (attached at Appendix A).

6.0 Flood risk – Cherry Cobb Sands compensation site

6.1 ***63.33*** Since making our Relevant Representations, the applicant has provided us with further information (Black and Veatch, Wave Analysis Design memo, 18 Jan 2011) on the design crest level for the new flood defence. This information has also been included in the applicant's submission of supplementary information (***see EX36.2 North Bank Flood Defence Crest Height***). This issue is now resolved.

6.2 ***63.34*** We would also like to stress that the applicant's proposal outlined in this paragraph is not acceptable. The requirement included in Schedule 11, Requirement 4, of the draft DCO states that "*The authorised development shall be carried out in accordance with the design drawings unless otherwise approved in writing by the relevant planning authority*". Draft Requirement 29 in Schedule 11 seeks to similarly secure approval of detailed design from tidal defences by the Local Planning Authority. Neither of these Requirements are acceptable to the EA in respect of flood defences for the reason stated in our Summary of Oral Representations submitted following the issue specific hearing on the DCO held on the 12th July 2012 and repeated here for completeness:

> "*The EA does not agree that Requirement 29 is an appropriate requirement. We do not know where it has come from – we did not suggest it or seek it. The issue of design and construction of flood defences is not one for the Local Planning Authority, but is entirely within the remit of the EA and so any requirement of this kind would need to be for the benefit of the EA. We will endeavour to resolve this point with the applicant when we discuss the protective provisions and legal agreements we have requested*".

6.3 ***63.35*** We do not yet have sufficient information regarding the suitability of site winnings to use in the construction of the new defence embankment. The additional site investigation and testing of soils has not yet demonstrated suitability. At present we do not have the confidence that this material is suitable from which to construct a flood defence embankment. We confirm that all comments contained in paragraphs 4.1-6.4 of the Statement provided by Dan Normandale, included as Appendix L to the EA's Written Representations, remain valid.

6.4 ***63.36*** In respect of siltation at Stone Creek, we would refer the Examining Authority to the EA's Written Representations (Paragraph 4.130) and paragraphs 32.3.5-6 of the Statement of Common Ground (SoCG) between the applicant and the EA. It is now agreed that a monitoring and action plan is required for Stone Creek and we are awaiting confirmation as to whether the applicant accepts the EA's suggested wording for the Requirement to be included in the DCO. It is essential that the monitoring scheme agrees how the applicant intends to define "demonstrably outside any established natural variation" and that sufficient long-term data is provided to establish "natural variability" and the necessary triggers for action. We would consider a period of 10 years insufficient to establish the baseline. The EA has observed changes within the estuary during 2012 that have not been observed since 1975-76 when the last sustained dry weather occurred. We will continue to work with the applicant and other

relevant bodies, such as the MMO, to determine an acceptable baseline period.

6.5 ***63.37*** We can confirm that we are currently working with the applicant and their legal advisor to draw up a Legal Agreement in respect of the flood defence works for Cherry Cobb Sands.

7.0 Potential land contamination – Cherry Cobb Sands compensation site

7.1 ***63.38 and EX31.5 (Re-use of In-Situ Material at CCS (including Cherry Cobb Sands Phase 2 Site Investigation))*** We have reviewed the Supplementary Information contained in EX31.5, which provides further information in respect of an intrusive geo-environmental ground investigation at Cherry Cobb Sands. The scope of the intrusive investigation appears satisfactory. Although this information will be useful in determining remedial options, it does not negate the need for a full risk assessment to be undertaken. We would refer the Examining Authority to the Requirements listed in paragraphs 4.115 and 4.116 of our Written Representations, which remain valid. These Requirements will ensure the EA is able to approve the remedial approach undertaken and secure the necessary protection for the water environment.

8.0 Foul water drainage

8.1 We note in the applicant's response to the Examining Authority's 1st questions in respect of Table 50.1, there are three entries relating to Anglian Water Services' (AWS) environmental permits. The 'status' of these consents is recorded as 'pre-consent'. We are not sure what is meant by this status entry and we are presuming it relates to the intended consent application date, i.e. they will be obtained pre-consent (where consent relates to the DCO).

8.2 We would like to advise the Examining Authority that it is very unlikely that these permits will be in place by the end of the Examination period, as they can take up to 4 months to determine once all the supporting information is submitted to us. As advised in the Written Representations provided by AWS, we are currently in pre-application discussions with them, and they anticipate it being 3-6 months before they will be in a position to submit the applications to us.

8.3 ***63.40*** Although the applicant's response to our Relevant Representations now provides a figure for increased flows, which AWS will be using in its modelling of the post-development situation, we are still not in a position to be able to provide the Examining Authority with any further certainty that the permit variation required for foul water disposal can be accommodated within environmental limits.

8.4 The impacts of the project on the North Killingholme Main Drain should also be included in the applicant's Water Framework Directive assessment. The applicant will need information from AWS in respect

of the impact of the increased sewage treatment work flows, if these will be discharged to this Drain.

8.1 Water and Sediment Quality

8.1.1 ***EX9.1 (Assessment of the effects of relocation of the E.ON and Centrica outfall on thermal recirculation)*** We have briefly reviewed this additional report and have no comments to make on it. The EA's comments with regard to the E.ON and Centrica intakes and outfalls are presented with comments on EX8.8 above.

9.0 Water Framework Directive

9.1 ***63.42 and EX8.12 (Water Framework Direct Assessment – Project wide)*** We have now reviewed this assessment, which was included in Able's submission of 29th June 2012. At the hearing on the DCO on 12th July 2012, we had not had the opportunity to review it and were therefore not in a position to discuss the new Requirement detailed below. Our detailed comments on the WFD assessment are attached at Appendix A in the form of a letter sent to Able on 31 July 2012. Since our review of the WFD assessment further issues have arisen out of our review of other supplementary information documents. You will note these throughout this response, particularly in section 4 above.

9.2 The Panel will see from this response that the WFD assessment is not yet adequate and that we would also request an additional requirement within the DCO, which we suggest should be included under Schedule 9, Part 3 and read:

Requirement

No development shall commence until a Monitoring and Management Scheme has been submitted to and approved by the Environment Agency, to ascertain the spatial and temporal extent of impact on the Humber Lower Water Body on the following Water Framework Directive parameters:

i. Those "biological elements" and "ecological potential elements" as defined in the Humber River Basin Management Plan for the Humber Middle and Humber Lower Water Bodies (GB53040269201 and GB530402609202), to include, but not limited to: macro algae, angiosperms, macrophytes, benthic/macro invertebrates, fish;

ii. Those biological and ecological elements defined as "Water-dependent habitats or species for which the Protected Area was designated" as defined in Annex D of the Humber River Basin Management Plan.

Development shall proceed fully in accordance with the approved scheme and monitoring/management contained therein.

Reason: To ensure the project is in compliance with the Water Framework Directive

9.3 We also provide further evidence (at Appendix B) in support of our position on the WFD in a report from the EA's Marine Monitoring Service, entitled "*Impacts of proposed dredging on benthic macro-invertebrate WFD classification: Humber Lower water body*" for information.

10.0 In-combination and cumulative impacts

10.1 ***63.31, 63.43 and EX44.1 (Supplementary In-Combination Assessment)*** The EA has attempted a review of this document, but it is incomplete at present due to the lack of cross-referencing to the ES and the difficulty in following the arguments that the applicant is presenting. In Section 4.2 (Hydrodynamic and Sedimentary Regime) the applicant has presented a screening table (Table 4.2) indicating what has been screened in and out. Those projects that have been screened out do not have any evidence provided to support the justification. In the case of the Managed Realignment project at Donna Nook, the only evidence presented is it "..is sufficiently outside the estuary and small enough that its contribution to in combination impacts within the estuary will be negligible". The EA would expect to see the evidence of the potential impact on the tidal prism presented, and the potential impacts of this scheme presented within the ES to have been reviewed and supporting information presented in this table. This is again replicated with the Tidal Stream Generator, where the project is screened out. This is based on the "contribution to in combination impacts will be negligible". Such statements need to be underpinned by evidence and the evidence should be presented or as a minimum referenced.

10.2 In the potential impacts section of the Hydrodynamic and Sedimentary Regime section, the applicant has not referred to the potential combined capital disposal of dredged material should any of the identified projects be constructed simultaneously. In addition, Section 4.2.2-4.2.6 provides no evidence to give any indication of the scale or detailed nature of potential impacts. This review is very qualitative with no quantification, and the cumulative impacts that the applicant has concluded arising from in-combination effects (Table 4.3) presents no evidence.

10.3 At present there is insufficient evidence (qualitative and quantitative) for the EA to be able to undertake a comprehensive review of this supplementary chapter of the ES. We need to be able to understand the process that the applicant has followed to arrive at their conclusion and the evidence they have used to underpin their assessment. At present this is not possible. We therefore consider this assessment to be inadequate. It is essential that some of these cumulative and in-combination impacts are adequately assessed in order to inform the Habitat Regulations Assessment.

10.4 ***63.44 and (EX9.7 Assessment of the effects of relocations of the E.ON and Centrica outfalls on thermal recirculation)*** The applicant has submitted supplementary information in respect of the effects of relocation on the E.ON and Centrica outfalls on thermal recirculation. We have no comments to make on this information. E.ON has advised us that if its cooling water outfall pipe needs to be relocated, as a result of the MEP quay, it will not submit an application to vary the existing environmental permit until the DCO has been secured by the applicant.

11.0 Supplementary Information

11.1 As mentioned in paragraph 4.1 above, the EA's specialists have not been able to fully review all the supplementary information submitted by the applicant. This is due in part to the recent heavy rainfall and demands on staff resources, as well as the extensive volume of information provided by the applicant and the complexity of the project. The outstanding information that we still need to review and comment on include EX8.7, EX8.9, EX10.4, EX10.6, and EX28.1. However, we appreciate that the Examining Authority may not be able to take any comments on these documents that we submit at a later date into account.

12.0 List of Appendices

Appendix A	EA letter to Able re Project Wide WFD Assessment (EX8.12), dated 31 July 2012
Appendix B	Report from the EA's Marine Monitoring Service – "Impacts of proposed dredging on benthic macro-invertebrate WFD classification: Humber Lower water body"
Appendix C	Avoidance behaviour of Alosa fallax fallax to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river, Jim Gregory & Peter Clabburn, Aquatic Living Resources 16 (2003) 313-316
Appendix D	EA letter to Able re Piling Mitigation, dated 31 July 2012
Appendix E	Memo from Deltares, 6 July 2012
Appendix F	Summary of seasonal risk curves for salmon impacts
Appendix G	The Precautionary Principle – Policy and Law

Appendix A

EA letter to Able re Project Wide WFD Assessment (EX8.12)

Mr Richard Cram
Able UK Ltd
Able House
Billingham Reach Industrial Estate
BILLINGHAM
Teeside
TS23 1PX

Your ref: TR030001/APP/14b
Our ref: AN/2012/113982

Date: 31 July 2012

Dear Richard,

Marine Energy Park, Killingholme Marshes, North Lincolnshire
Water Framework Directive Assessment – Supplementary Report EX8.12

The Environment Agency (EA) has reviewed the Supplementary Report EX8.12, and provides the following comments in response to it:

1. Firstly, we would like it to be noted that we have had difficulty in assessing this, and other documents, within a reasonable time period due to the frequency with which the dredge schedule and methods have been amended. On some occasions revisions have been received before we have responded to the original document. This has made the process less than ideal.

2. We would also refer you to our responses of 29 May 2012 and 6 June 2012 where we explicitly explained the need to identify where in the Environmental Statement (ES) the data resided if it were being relied upon to demonstrate a compliant Water Framework Directive (WFD) assessment had been undertaken.

<u>Method for calculating dredging area of impact</u>

3. The information currently provided in the ES and associated documents does not sufficiently follow the guidance contained in the EA's "Clearing the Waters: Marine dredging and the Water Framework Directive" or provide the information required to judge potential ecological impacts associated with these activities. The EA has provided a more detailed response to this in respect of the spatial extent of impacts associated with dredging activities, mitigation measures and monitoring activities. This information can be found in detail in "*Impacts of proposed dredging on the benthic macro-invertebrate WFD classification: Humber Lower water body*" (section 1.1). It appears from the WFD assessment that you have not followed the guidance with regard to the area of impact of the total project. As you have not provided the dimensions of the total area of impacts for dredging in an accessible form or been clear from where in the ES this information has been taken from, we have had to conclude that, at present, this is unsatisfactory.

Maintenance dredge

4. The supplementary information from the application on Maintenance Dredging (EX 8.6) does not seem to have been reflected in the WFD assessment. The EA is still reviewing all the supplementary information submitted by you on 29 June 2012. If this document has been used in the undertaking of this assessment, could you please be explicit within the assessment referencing the document in detail.

Berthing pocket

5. At present, it is very difficult for us to assess whether the berthing pocket has been included in the habitat loss calculations, as it is not explicit on which information this assessment is based. As the maintenance dredge requirements presented in EX8.6 suggest that dredging within the berthing pocket is to be frequent, it should be included in the habitat loss (to another marine habitat not naturally occurring in the area). If you do not intend to dredge to the chalk level that you are creating as part of the application, this needs to be explicit. If this were to be the case, we would request this be a condition of the Deemed Marine Licence (DML). Otherwise, we expect a full assessment of this impact to be undertaken.

Prevention of deterioration in WFD

6. We raised the potential impact of the project on the prevention of deterioration in WFD in our letter of 29 May2012. Although the present assessment, which we presently agree with, confirms the project does not prevent a deterioration in WFD status, it is not adequate because it has not followed our published guidance in “Clearing the Waters”. In addition, we require all the additional clarification outlined within this response. The overall deterioration issue will need to be re-visited upon completion of a revised assessment. We will review the conclusions that you come to, upon submission of a revised assessment.

Section 1: Introduction

7. This section does not address maintenance dredging. We would expect to see this issue addressed within the assessment. In particular, how you intend to manage this aspect of the project in the longer-term to ensure no impact on the Humber Lower water body. This point is addressed in further detail in paragraph 4 above.

Section 1.2 Capital Dredging

8. Could you please explain whether the volume quoted includes the overdredge of the berthing pocket or not. If it does, could you also explain the exact depth of the over-dredge and where this is detailed in the ES (if it is).

Section 1.3 Disposal of Dredged Material

9. The assessment explains that HU080 is to be used for non-erodible deposits and HU082 for erodible deposits. This is contrary to the ES. Could you please confirm if this is a typo and if the correct assessment for disposal grounds has indeed been undertaken within the WFD report.

10. There is no mention of the potential to dispose of the material anywhere other than within the disposal grounds. The EA believes that Able is assessing disposing of some material to land. If this is the case, the assessment of this in the context of WFD needs to be explicit.

Section 1.5: Water Bodies

11. Figure 1, the reference to the ES is missing in the first sentence, which makes cross-referencing a substantial body of work very difficult and time-consuming.

12. Figure 1, North Killingholme Haven Pits is absent from the map.

13. We note that the only water body mentioned in this assessment on the south of the Humber is the North Killingholme Haven Pits transitional water body. The North Killingholme Main Drain (GB10402967580) is not mentioned. This is the waterbody that receives the discharge from South Killingholme Sewerage Treatment Works (STW), the waste water treatment plant, which Anglian Water Services operate and is likely to received flows from the Marine Energy Park.

14. The North Killingholme Main Drain water body will be affected both by the increased discharge from the STW and by hydromorphology changes to the system of drains (needed to accommodate surface water flows from increased impermeable areas). We would refer you to our letter of 25 July 2011 where we notified you of the additional water bodies that the WFD assessment needed to consider. All potential impacts on water bodies should be assessed, including those arising from the construction of the pumping station.

Table 3

15. Depth variation – the EA is unsure that the correct methodology has been applied from our “Clearing the Waters” guidance. Please see our comments in paragraph 3.0 above.

16. In Table 3 under the headings of "capital dredging" and "disposal of dredged material" the assessment indicates that there is no impact directly or indirectly on the intertidal habitat and that the disposal sites are sub-tidal. We would like to draw your attention to your supplementary information provided in EX8.7 which indicates that this is not necessarily the case. This supplementary information indicates that the intertidal area is affected by the disposal of material in HU082.

17. Could you please indicate where the information is presented showing no direct or indirect impact on the intertidal zone from capital dredging. At present we cannot find sufficient information to enable us to agree with the assessment, which has screened out this potential impact.

18. The EA, in its Written Representations, submitted information from Deltares on the potential impact of the project on the intertidal area within the Estuary. This work will be further supported by our submission to your comments on our Relevant Representations. We expect the WFD assessment to reflect these discussions and update and amend the assessment as necessary.

19. Wave Exposure - It is not clear if this has been updated in light of your own supplementary information recently submitted. This refers to section 3.3.1 of Annex 8.1. However, we are now currently reviewing EX8.7 which is an update to Annex 8.1. Please can you clarify this point.

Section 3.4.1: Hydromorphological conditions

Bed

20. It is not clear from this section if our guidance in “Clearing the Waters” has been accurately followed. Please see paragraph 3.0 for a more detailed explanation.

Intertidal Zone Structure

21. This section of the assessment defers to the appropriateness of the Habitats Regulations Assessment (HRA) to secure compliance with WFD. As it is not clear at present if the shadow HRA provided with your submission is compliant with the Habitat Regulations, this will need to be revised if you provide any additional supplementary information.

22. The assessment refers to the calculations undertaken and presented in 32.6.7 of the ES with regard to the impact of Cherry Cobb Sands (CCS) on the intertidal zone. We understand you are currently undertaking further design work on the compensation site. If the velocities and potential erosion, post breach, change at the site, following finalisation of the detailed design work, the WFD assessment may need to be revisited.

23. The assessment discusses the biological species in the vicinity of the reclamation site and CCS, but this is not referenced to any specific section of the ES. It is, therefore, difficult for us to check the validity of the assessment.

Conclusion

24. We would expect the conclusion to this section to be revised, if necessary, once all the points raised above have been addressed.

Section 3.4.2 Physio-chemical conditions and chemical status

Transparency

25. Could you please advise where, within the ES, the full dredging programme is outlined and that it will be complete within 6 weeks. Annex 7.6 Appendix 2 suggests a programme lasting 18 months.

Specific pollutants and priority Substances

Capital Dredging and Disposal of Dredged Material

26. "There is no significant TBT or PCB contamination" – could you please indicate where the sample results to substantiate this statement are presented.

Cherry Cobb Sands Intertidal Compensation Site

27. Could you please revise this assessment in the light of the results presented in EX31.5. It is not clear from the evidence presented in EX31.5 what remediation will be undertaken or how this will potentially affect the WFD assessment. At present the conclusions drawn in this section are inadequate in the light of the new information.

Section 3.4.3: Biological Quality Elements

Benthic Invertebrate fauna

28. Could you please explain why the draft 2012 data has been used as the basis for assessment (moderate) over the QA'd 2010 and 2011 data that holds the assessment as good status?

2009	2009	2009	2010	2010	2010	2011	2011	2011	2012	2012	2012
Status	*Conf. <Good*	*EQR*	*Status*	*Conf. <Good*	*EQR*	*Status*	*Conf. <Good*	*EQR*	***Status***	***Conf. <Good***	***EQR***
Moderate	Uncertain	0.59	Good		0.68	Good		0.67	Moderate	Uncertain	0.63

Figure 2 Benthic Invertebrate Status

29. Could you please confirm whether this is a general status map from baseline data, or if it relates to a specific sampling year.

Dredging and Reclamation

Cont/d..

30. Could you please explain how the 10 ha of sub-tidal habitat has been calculated? Table 11.6 of the ES indicates a loss of 13.5 ha of direct sub-tidal losses, and 9.83 of indirect sub-tidal losses. Please refer to paragraph 3.0 regarding calculating the area of impact in our "Clearing the Waters" guidance.

31. The assessment indicates that the proposed compensation site at CCS will negate the impact of the dredging and reclamation on benthic invertebrates. We wish to draw your attention to the fact that the WFD monitoring of benthic invertebrates is currently limited to sub-tidal sampling. Therefore, the creation of a large inter-tidal habitat, whilst supported by EA guidelines will not at present contribute to the prevention of deterioration in Ecological Status, or towards improving Ecological Status.

32. With regard to the comments made in this section on the berthing pocket, please see paragraph 5.0 for an explanation of the EA's view on this part of the assessment.

33. The EA welcomes the application of the dredging mitigation measures outlined in Table 1 of the assessment. These measures should be included in the Dredging Strategy, which needs to be approved by the Marine Management Organisation (MMO) prior to commencement of dredging. This requirement will be included as a condition on the Deemed Marine Licence (as advised in the MMO's Relevant Representations, paragraph 7.28).

Disposal of Dredged Material

34. At the time of the WFD assessment review, we have not had the time to review all of the supplementary information you have provided. The assessment refers to figures within Annex 8.1; however we are aware that this has been revised to include the capital dredging and disposal (EX8.7). We may, therefore, need to comment further on the expected current changes and potential implications under WFD.

Cherry Cobb Sands

35. Could you please indicate where in the ES the design of the compensation site is discussed. We are surprised to see that the compensation site is being designed to promote deposition and we would like to review this information but we have been unable to locate it within the ES due to the lack of referencing within this assessment.

Conclusion

36. We would expect the assessment to review the conclusions of the benthic invertebrate fauna once our point in paragraph 5.0 (berthing pocket), and our point in paragraph 28 (classification of the benthic invertebrate status) against which you have undertaken this assessment, have been addressed.

Fish Fauna

37. We would again like to draw your attention to the lack of detail held within the WFD assessment and no specific references to the ES. We presume that the basis for the conclusions being drawn in the WFD assessment is derived from the information held within the ES. Without specific reference to the relevant sections of the ES it is very difficult to confirm your conclusions with regard to fish.

38. The assessment does not appear to have taken account of the potential construction on this parameter within the assessment. At present the

Cont/d..

assessment includes the following statement "The ES also states that migration routes and foraging areas are considered unlikely to be significantly affected during operation of the AMEP site". As the construction timetable for the project is in excess of 12 months, we would expect the construction impacts of the project to be considered. Please refer to our comments of 25 July 2011 where we notified you that our monitoring frequency is yearly and we currently define a non-temporary effect as an impact lasting greater than a year. As such the impacts of construction should be assessed.

Section 3.4.5: Effect on mitigation measures 'not in place'

39. The Marine Energy Park will not impact on Environment Agency projects - please see our response in paragraphs 1-6 above. The assessment needs to be reviewed in this respect.

Section 3.4.6: Contributing to improvements in WFD status

40. The contribution of CCS to potential improvements will need to be reviewed once the final design is completed. At present the WFD assessment concludes that the CCS site has an ability to provide a 2:1 ratio of creation:loss. The certainty of this conclusion, especially with regard to mudflat, is questionable at present.

Section 4.0: Little Humber Area Water Body

4.1 Characteristics

41. The previous WFD assessment submitted included a map of the nitrate vulnerable zone. Could you please advise if there a reason that this map was excluded in the superseded assessment.

Section 4.4: Deterioration or other effects on WFD Status

4.4.2 Hydromorphological conditions

42. We agree with the assessment of the need to ensure that mitigation measures are put in place to reduce the sediment load in run-off from the construction site and to prevent accumulation of sediment on the estuary side of the sluice affecting discharge from Stone Creek.

4.4.3 Physio-chemical conditions and chemical status

Oxygenation

43. We agree with the conclusions of this section, subject to the necessary mitigation measures being implemented to minimise run-off being secured in Schedule 8 (the DML) of the DCO.

Specific pollutants and priority substances

44. This section will need to be revisited in light of the new site investigation presented in EX31.5. There appears to be no reference to this within the WFD assessment, but we note the acceptance of potential contamination and elevated levels of pollutants. We also note the assumption of more site investigations and mitigation as necessary for the construction of the realigned embankment and diverted soke dyke.

Section 5.0: Conclusions

45. It would be helpful if the document could be clear in the conclusion section whether it is just the ES and associated technical reports that have been used in this assessment, or whether any of the additional supplementary information you supplied on 29 June 2012 has been utilised. If the supplementary information has not been used, there is a need for some sections of this assessment to be updated in the light of this information.

46. Some secondary ground assessment has been undertaken at the Cherry Cobbs Sands site and this has confirmed the presence of contamination. As a consequence the second bullet point in the WFD conclusion (confirmation of a lack of contamination from the secondary ground assessment at the Cherry Cobbs Sands site) is factually incorrect. We anticipate you will want to revise this assessment in the light of this new work.

47. The EA will seek requirements within the DCO to ensure that:
    - the diverted soke dyke design meets the necessary measures to maintain or improve the water status;
    - the measures to manage sediment run-off and accumulation and ensure no exacerbation of accumulation of sediment on the estuary side of the sluice are implemented;
    - the measures to reduce saline seepage are implemented;
    - the measures to manage plant and equipment to avoid pollution during construction are implemented.

Requirements

48. As competent authority for the purposes of WFD, the EA will need a Requirement in the DCO to secure a Monitoring and Management Schedule to ensure that monitoring is undertaken to ascertain the spatial and temporal extent of the impacts on the Humber Lower Water Body on the following WFD parameters:

    i. Those "biological elements" and "ecological potential elements" as defined in the Humber River Basin Management Plan for the Humber Middle and Humber Lower Water Bodies (GB53040269201 and GB530402609202), to include, but not limited to: macro algae, angiosperms, macrophytes, benthic/macro invertebrates, fish;

    ii. Those biological and ecological elements defined as "Water-dependent habitats or species for which the Protected Area was designated" as defined in Annex D of the Humber River Basin Management Plan.

Finally, we would like to again stress that the WFD assessment will only be valid if the HRA is accepted.

Should you require any additional information, or wish to discuss these matters further, please do not hesitate to contact me on the number below.

Yours sincerely

Annette Hewitson
Principal Planning Advisor

Direct dial: [redacted]
Email: [redacted]

End

Appendix B

Report from the EA's Marine Monitoring Service – "Impacts of proposed dredging on benthic macro-invertebrate WFD classification: Humber Lower water body"

Impacts of proposed dredging on benthic macro-invertebrate WFD classification: Humber Lower water body

A report by Jayne E. Fitch and Graham Phillips
Environment Agency
Marine Monitoring Service
Kingfisher House
Peterborough

July 2012

Statement of Use

This document was prepared as by the Marine Monitoring Service in response to an Analysis and Reporting request from the Humber PSO/ Yorkshire and Northeast Environment Agency FCRM. The report is intended to provide background information to inform an assessment of the likely impact on benthic invertebrate populations (and WFD classification) of the capital and maintenance dredging and disposal and habitat compensation measure arising from the Able UK Ltd. Marine Energy Park application. It is not intended as a document to provide formal guidance on this or any associated issue.

The views expressed in this document are not necessarily those of the Environment Agency. Its officers, servants or agents accept no liability whatsoever for any loss or damage arising from the interpretation or use of the information, or reliance upon the views contained herein.

Executive Summary

Able UK Ltd. has proposed the construction of a marine energy park (MEP) near Immingham on the Southern bank of the Humber estuary, in the Humber Lower water body. The Humber is a naturally highly dynamic estuary and is classified as a heavily modified water body (HMWB) due to the many anthropogenic pressures affecting it.

The Humber estuary is designated as a special area of conservation (SAC) and a special protected area (SPA) under the Habitats and Birds Directives. Under the Water Framework Directive (WFD) the Humber Lower is classed as a transitional water body and is monitored annually to determine chemical and ecological status (ES).

The construction of the MEP will require capital and maintenance dredging of both inter-tidal and sub-tidal areas and subsequent habitat loss. The purpose of this report is to provide an assessment of the likely impact on benthic invertebrate populations (and WFD classification) of the capital and maintenance dredging and dredge spoil disposal arising from the Able MEP application.

The Environment Agency has provided guidance for the assessment of the spatial extent of impacts associated with dredging activities, mitigation measures and monitoring activities in the Clearing the Waters document.

A habitat compensation scheme will mitigate for the loss of 31.5 hectares of inter-tidal and 13.5 hectares of sub-tidal habitat, in the quay footprint, through the creation of the 115 hectare Cherry Cob Sands. The habitat compensation scheme will contribute towards the Humber Lower achieving Good Ecological Potential by 2027, as set out in the river basin management plan (RBMP), and aims to prevent the loss of mud flat habitats which are important feeding grounds for many bird species.

The applicant has not (to our knowledge) provided information as to the dredge footprint following EA guidance. Calculation of the dredge footprint is not possible using information provided by the applicant (except in the quay footprint) as the area to be dredged in the berthing channel, approach channel and turning area are not provided.

The overarching aim of the WFD (in the marine environment) is the protection and restoration of transitional and coastal waters. The WFD requires that water bodies achieve at least a Good ES by 2015 and that no deterioration of ES is observed. Classification of ES under the WFD with the biological quality element (BQE) benthic invertebrates is calculated using the infaunal quality index (IQI). The ES of the Humber Lower in 2011 was Good, but was close to the Good/Moderate boundary.

The applicant has made the assertion that the creation of Cherry Cob Sands will mitigate any deterioration in ES caused by dredging activities and will contribute to an improved ES in the Humber Lower. WFD monitoring of benthic invertebrates in the Humber is currently limited to sub-tidal sampling. Therefore the creation of a large inter-tidal habitat, whilst supported by EA guidelines will not at present, contribute to the prevention of deterioration in ES, or towards improving ES.

Previous and current dredging activities do not appear to have a disproportionate effect on benthic communities in the Humber. The dominant fauna in the Humber Lower are tolerant or opportunistic taxa, which indicates that any impact from pressures related to maintenance dredging activities will be likely to be followed by a relatively rapid recovery.

Disposal of capital dredge spoil in shallow layers in the HU080 spoil ground is one of the mitigation measures recommended in Clearing the Waters (Environment Agency, 2010). Disposal of maintenance and capital dredge material to HU082 should follow the same process as this will help to prevent de-faunation within the spoil area and will facilitate rapid recovery.

The historical industrialisation of the Humber and the fact that it is currently heavily influenced by anthropogenic activity, alongside the naturally dynamic estuarine environment, has resulted in a benthic assemblage which is resistant to disturbance and has a high level of resilience following disturbance. These factors and consideration of the pressures associated with these dredging activities lead us to conclude that any predicted effects of dredging and disposal activities in the Humber Lower will impact the benthic invertebrate fauna, but that recovery will occur within a reporting cycle (6 yrs).

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1.0 Background

Able UK Ltd. has proposed the construction of a marine energy park (MEP) near Immingham on the Southern bank of the Humber estuary. Areas of inter-tidal and sub-tidal sedimentary habitats will be lost or may be impacted due to construction and dredging activities required to accommodate the quay and the construction of an approach channel and berthing and turning areas.

The Humber is a coastal plain estuary, whose catchment is the largest in the British Isles (Penthick, 1994). It has many uses and users and is one of the most important estuaries for commerce in the UK (Aubrey and Elliott, 2006). The proposed site of the dredged channel will incorporate sub-tidal mud and sand habitats which have a history of anthropogenic pressures from a variety of chemical and physical sources.

The construction of the quay footprint and anchor trench will result in an estimated habitat loss from inter-tidal mudflats of 31.50 hectares (ha) and 13.50 ha from sub-tidal muds and sands (Able UK, 2012). Dredging activities across the remaining area of the proposed MEP have not been provided in any of the application literature (or are not easily accessible) and as such total estimated areas which will be impacted by capital and maintenance dredge activities cannot be calculated. The areas for which information is required are the berthing channel, the approach channel and the turning channel[1] (Able UK, 2011).

Dredged material will be re-used in the creation of inter-tidal compensatory habitats or disposed of in existing spoil grounds within the Humber Lower water body. Estimated quantities of capital dredge material which will require disposal are 725,000 wet tonnes (wt T) from the quay footprint, 1,675,000 wt T from the berthing pocket, 1,650,000 wt T from the approach channel and 250,000 wt T from the turning area.

1.1 Clearing the Waters

The current guidance provided by the Environment Agency in relation to dredging activities can be found in ‘Clearing the Waters: Marine dredging and the Water Framework Directive’ (2010). The guidance in this document relates to the spatial extent of impacts associated with dredging activities, mitigation measures and monitoring activities.

[1] Figures are provided for quantities to be dredged from the berthing area, approach channel and turning area, but surface area estimates are not provided.

The information currently provided in the environmental statement and associated documents does not sufficiently follow these guidelines or provide the information required to judge potential ecological impacts associated with these activities.

The dimensions for the entire area where dredging activity is proposed is not accessible. The area of the proposed quay footprint is provided and is broken down into inter-tidal and sub-tidal habitats giving a total area to be dredged of 45 ha or 0.45 km². The actual footprint of this dredging must be calculated in relation to the Clearing the Water guidance, e.g. zone of effect = 1.5 x dredge footprint. So the footprint for dredging activities in the quay footprint would be 67.5 ha or 0.675 km². The zone effect calculations must be repeated with the correct dimensions for the berthing area, turning area and approach channel. It is the responsibility of the applicant to provide accurate information as to the dredging footprint following Clearing the Water guidelines. The total area to be effected by dredging activities should be <5% of the total area of the Humber Lower (247 km²) or scoping is required. It should be note that that loss of inter-tidal habitat would trigger scoping under Clearing the Waters, but this does not negate the need to assess sub-tidal effects.

Dimensions of the disposal site are required for scoping purposes to asses the proportion of the water body impacted by disposal activities. The footprint of the disposal sites is taken as a direct measure. The footprint of dredging activities should be <5% area of the total area for the water body. Again the loss of inter-tidal habitat would have triggered scoping and assessment, but the applicant is required to provide these dimensions and to do these calculations.

The requirement for assessment in relation to dredging activates are clearly laid out in the Clearing the Waters document (Chapter 3). Minimum requirements include the dimension of the dredge footprint and disposal which are not available in the current application documents and must be provided.

As the Able UK MEP has been screened to require assessment (on the basis of inter-tidal habitat loss initially and potentially due to dredge footprint also) the ecology of the area must be monitored. Existing data must be provided in the vicinity of the dredge and disposal areas and new data should be collected from marine ecological surveys. Currently no data is provided in the disposal areas. The likelihood of there being deterioration in the ES as measured by the IQI cannot be estimated until further information is provided. However as the IQI is close to the Good/Moderate boundary it is probable that deterioration will occur at small spatial scales in the vicinity of the activity, and it is possible that these deteriorations will be measured at the water body level.

The requirement for on-going monitoring to detect potential impacts of dredging activities is indicated for the Able UK MEP. Current guidance states that monitoring should follow the Environment Agency WFD monitoring programme with the aim of ‘reducing uncertainty’. Recommendations are made later in this document as to what constitutes acceptable monitoring to detect potential impacts of dredging activity.

Recommendations for mitigation activities following dredging activities are provided in Chapter 4 of Clearing the Waters. The managed realignment and use of dredged material in its creation, proposed by the applicant, is supported in the guidance for both mitigation and improvement. In the case of the Humber Lower, inter-tidal re-claimed land cannot, at present, contribute to the improvement of ES calculated by the IQI under the WFD. The disposal of dredge spoil in shallow layers, as per the planned disposal in HU080, is supported by the guidance provided in Clearing the Waters.

2.0 The Humber

The Humber Estuary is a heavily modified water body (HMWB) and is classified as such due to the presence of flood defences, land drainage and navigation activities. The Humber is located on the east coast of England and has the largest catchment of any UK river, at 20% of the total land area (Townend and Whitehead, 2003; ICES 2004; Aubrey and Elliott, 2006). The estuary is 62 km long and increases in width from 1 km in the upper estuary to 8km at its mouth (Bolam, 2003). The Humber is a well mixed estuary with a small vertical salinity gradient (Bolam, 2003). The estuary is dominated by tidal conditions, with a tidal amplitude of over 7 m and current speeds of between 2 and 3 m s^{-1} (Bolam, 2003; Townend and Whitehead, 2003). Suspended sediment loads and turbidity in the estuary are high (Townend and Whitehead, 2003) varying from hundreds to thousands mg l^{-1}. Turbidity max has been recorded at 20,000 mg l^{-1} far upstream during summer months and as low as 500 mg l^{-1} in the mid-estuary during winter months (Uncles et al 1998, Cave et al 2003).

The Humber is a highly industrialised estuary and has many uses and users. It is one of the most important estuaries for commerce in the UK with an expanding port complex and extensive industries. Sectors which make use of the estuary include power generation, oil refineries, industrial processing, shipping, aquaculture and fisheries, all of which require infrastructure and involve activities which can exert a variety of pressures on natural ecosystems (Cave et al 2003, Aubrey and Elliott, 2006). These activities and pressures include:

- Dredging and fishing which can cause
  - Physical disturbance
  - Habitat loss
  - Loss of biomass
  - Release of inorganic and organic contaminants stored in sediments
  - Sedimentation and burial
- Waste disposal which can cause
  - Introduction of inorganic and organic contaminants
  - Organic and nutrient enrichment
  - Thermal stress
  - Sedimentation
- Construction and flood defence which can cause
  - Habitat loss
  - Hydrodynamic alterations

3.0 Water Framework Directive Classifications

3.1 Benthic Ecological Status

Under the Water Framework Directive (WFD) there is a requirement to monitor the ecological status (ES) of transitional and coastal water bodies. As a HMWB the Humber is subject to different environmental objectives, that of achieving Good Ecological Potential which is the condition of the water body when all uses for which they are designated are fully mitigated. Ecological Status of quality elements are measured in the determination of Ecological Potential.

For the purposed of this application the biological quality element (BQE) being used to asses ES is the benthic macrofauna. The tool currently in use to assign an ecological status as a result of sampling the benthos is the Infaunal Quality Index (IQI). The IQI is a multi-metric index which combines measures of diversity and the proportion of sensitive and opportunistic taxa to calculate an ecological quality ratio (EQR). Reference conditions, against which the EQR is calculated, are specified according to natural environmental conditions in the coastal or transitional water body being monitored e.g. salinity and sediment type.

Monitoring of the Humber Lower for the determination of the ES from benthic macrofaunal communities is currently only carried out in sub-tidal habitats. Whilst the Humber Lower contains extensive inter-tidal mud and sand flats, which are of conservation interest, they have not been included in the calculation of EQR and subsequent ES for current classification using the benthic invertebrate BQE. The scale of habitats is not factored into the classification and as such the creation of inter-tidal mud flat habitats at Cherry Cob Sands will not, at present, contribute towards an improved ES.

The overall classification for the Humber Lower for benthic invertebrates in the 2011 WFD classifications was Good ES, based on an average EQR of 0.648, using data from the 2008 and 2010 Environment Agency WFD surveillance monitoring programme. Under the draft 2012 classifications with additional data from the 2010 Natural England Habitats Directive monitoring programme, and updated reference conditions, the water body has been classified as Moderate ecological status, with an average EQR of 0.639. However, the 2012 classifications are currently in draft form and have yet to be officially signed off following the WFD QA process. As the Moderate/Good boundary is set at 0.64, the close proximity of both the 2011 and 2012 water body level classifications to this value means that both classifications should be treated with a low degree of confidence (approximately 66% of being at Good status in 2011 and 52% of being at Moderate status in 2012),

The 2011 and 2012 classifications were based on sub-tidal data. Whilst generally relatively variable, the classification EQR’s show a slight correlation in a North-Easterly direction, with elevated EQR’s located away from the main channel

approximately 1km offshore from Trinity sands on the landward side of Spurn Head. Although of interest as features under the EC Habitats Directive (H1140: mudflats and sandflats not covered by water at low tide), EC Birds Directive and multiple SSSI designations in the Humber flats and marshes, inter-tidal areas have not been used in the classification due to an absence of appropriate data for WFD classification. However, the inclusion of appropriate inter-tidal data would improve the degree to which the benthic classification would represent the entire Humber Lower water body, and should be used in future if available.

3.2 Chemical status

Chemical status of the Humber Lower is generally high for metals, PAH's and PCB's. The exceptions to this were zinc (at two stations) and Cadmium (at one station) being assigned a moderate status in 2009.

The organotin compound TBT is a persistent contaminant. Chemical status for TBT has consistently been Moderate in the 2009, 2010 and 2011 monitoring programmes from the upstream extent of the Humber Lower to Immingham.

3.3 Biological communities

The most recent sub-tidal benthic WFD survey[2] of the Humber Lower water body showed benthic macrofaunal communities were dominated by tolerant and opportunistic polychaetes, amphipods and oligochaetes. The top ten taxa ranked by abundance are listed in the table below (Table 3.1)

[2] Data provided by Environment Agency is from 2011 Lower Humber WFD classifications.

Table 3.1. Percentage dominance of top ranked taxa identified in the 2011 WFD monitoring period.

Taxon	% dominance
Aphelochaeta marioni	61.10
Aphelochaeta	20.15
Tubificoides swirencoides	4.50
Tharyx (agg)	2.79
Corophium volutator	1.40
Streblospio shrubsolii	1.38
Tharyx	0.80
Scoloplos armiger	0.78
Tubificoides pseudogaster	0.64
Spiophanes bombyx	0.52

The benthic ecology of the Humber estuary has been previously characterised and does not appear to have altered over the last 10 years. The main communities identified were by Covey (1998) are described below (Figure 3.1):

The central channel of the Humber Lower is dominated by impoverished marine sand, which was characterised by *Nephtys sp*., Mysidae, *Spio filicornis* and *Spiophanes bombyx*.

The upper section of the Humber Lower and a channel to the south side of the Humber Middle was dominated by transitional muddy sand, with *C. capitata*, *Polydora* sp., Mysidae, Gammaridae, and *Nephty*s sp.

The Middle Humber was dominated by impoverished estuarine muddy sand. Fauna were sparse and the sediment could be distinguished from transitional muddy sand by the absence of polychaetes.

Marine sand was present near to the mouth of the Humber to the south of the estuary. The faunal community was rich (compared to the impoverished marine sand in the main channel). Characteristic species included *S. bombyx* and *S. filicornis*.

Patches of nearshore mud were present in the eastern Lower Humber to the south and north of the channel near to Grimsby, with a rich mud fauna including *Polydora* sp. and *Pygospio elegans*.

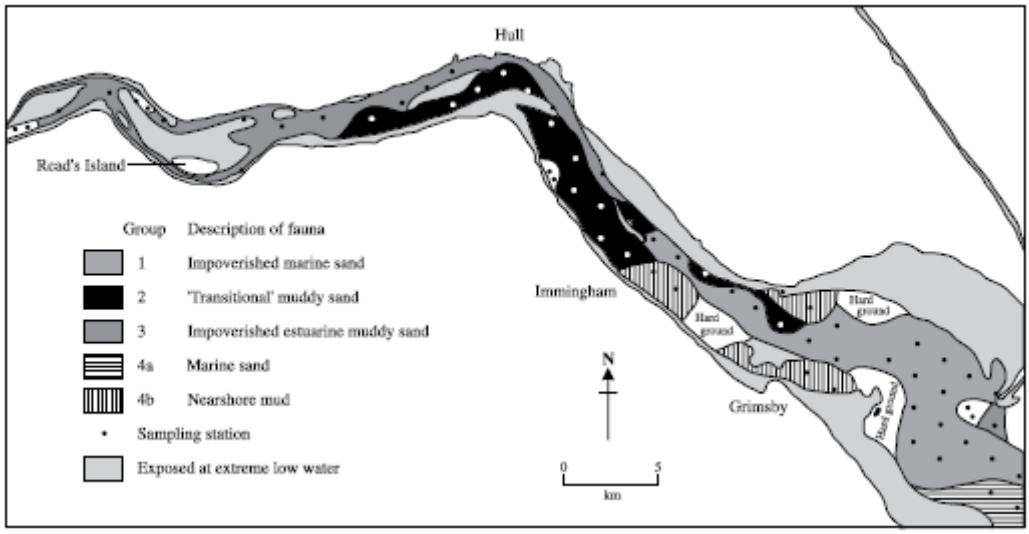

Figure 6.3. Faunal associations of the Humber estuary (re-drawn from Rees, Barnett & Urquhart 1982). Reproduced by permission of the Humber Estuary Committee.

Figure 3.1. Description of fauna and sediment associations in the Humber estuary, (reproduced from Covey, (1998)).

4.0 Potential impacts of dredging and dredge spoil[3]

4.1 Capital and maintenance dredging

Dredging of the sea floor to enable the construction of harbours or flood defences and the passage of ships, and other vessels, is vital to facilitate many industrial activates which depend on the marine environment. Pressures associated with dredging include (but are not limited to) habitat change, physical disturbance, sedimentation, contamination by non-synthetic and synthetic compounds and removal of non-target species (Crowe et al, 2011). The impacts of these pressures on benthic macrofaunal communities are dependant on a variety of factors including[4]:

- existing faunal and sediment compositions
- width and depth of dredge channel
- amount of material removed
- frequency of dredging activities
- chemical contaminants stored in and released from the sediment

The impacts of dredging on benthic macrofauna include decreased diversity and numbers of sensitive taxa, particularly suspension feeders as their feeding apparatus can become 'clogged up' by re-suspended particles.

Whilst a direct study of the effects of dredging on the IQI has not been undertaken, each metric within the IQI (and presumably the IQI itself) are expected to reflect several levels of disturbance (e.g. AMBI (Muxika et al, 2005), species richness and diversity (Rosenberg, 1977) and M-AMBI (Borja et al, 2009)). The removal of

[3] Information provided in Section 4.0 is intended to give a general overview of the impact associated with dredge and dredge spoil activities. It is not intended to provide predictions as the potential impacts associated with the Able UK MEP.

[4] If dredging is carried out so the construction of a permanent structure can take place then total defaunation will occur and no recovery of benthic infaunal invertebrates can occur.

sediments at the dredge sites would result in the areas being de-faunated, which would correspond to a localised Bad ES. This de-faunation would be expected to be relatively short lived and re-colonisation, and thus improved ES, should occur within 1 year of cessation of the activity.

4.2 Dredge spoil

The effects of dredge spoil on benthic ecosystems will vary depending on many factors including:

-
- the similarity of dredged sediments to those at the dumpsite
- dredge material contamination
- disposal method (e.g. high numbers of shallow layers will allow motile fauna to migrate upwards whilst single large deposits will not)
- local hydrodynamic of the dumpsite and adaptability of resident fauna (see Smith and Rule, 2001 for further discussion).

Commonly observed trends in benthic macrofauna at dredge spoil sites are a decrease in diversity and an increase in the abundance of opportunistic taxa (Harvey et al, 1998, Roberts et al 1998, Smith and Rule, 2001). The depth of overburden and the period of burial will be influential in the level of impact observed in the benthic macrofauna. The disposal of dredge spoil can also lead to increased turbidity and rates of sedimentation, lowered light levels and the release of buried organic matter and organic and inorganic contaminants.

No supporting information is available to predict the effects of dredge spoil on the IQI. Depending on the nature of the dredge spoil material and the means by which it is deposited, it is expected that the physical disturbance and smothering effects would result in a localised ES of between bad and moderate at the disposal site for the duration of the activity.

The WFD surveillance programme is designed to monitor background ecological status outside the zones of effect of consented activities. The dredging channels and disposal grounds would not be monitored directly, so localised adverse effects within the licensed areas would not contribute to the overall status of the Humber Lower water body. The potential implications of the activity would be from changes to water quality due to the re-suspension of sediment and release of contaminants as described above. However, due to the dynamic nature of the Humber Lower water body, and the existing disposal of spoil material at the proposed disposal grounds, it is anticipated that the influence on the ES at a water body level would be low.

4.3 Recovery following dredging activities

Estuarine communities are often characterised by large populations of taxa well adapted to living in mobile fine sand and mud which are subjected to frequent disturbance (Newell et al, 1998). Initial recovery of the opportunistic taxa in the benthos following maintenance dredging or spoil activities will facilitate the recovery of the whole community. Recovery of communities to one which is characteristic of undisturbed conditions often occurs within one year in estuarine ecosystems. Recovery of disturbed muds and channel muds in dredged areas have been reported to take between 4 weeks and 6 months, while recovery of muds and sand has been report to take up to 18 months (UK Marine Protected Areas Centre, 2007).

The predicted rapid recovery of benthic ecosystems in transitional and coastal waters can, to some extent, be explained by the naturally disturbed conditions of these areas. Dredging activities do not necessarily cause greater increases in suspended sediments than commercial shipping, trawling or storm events (Parr et al, 1998). Re-suspended sediments are only likely to cause a problem if they are carried outside of the immediate dredge or spoil location by tidal and hydrodynamic processes, which due to its highly dynamic nature is probable in the Humber Lower. However the impact on benthic macrofauna is not likely to be high and recovery should be rapid due to a lack of sensitive species and dominance of tolerant and opportunistic r-strategists.

4.3.1 WFD classifications:

Recovery from dredging activities often follows well established successional patterns in benthic ecosystems (e.g. Pearson and Rosenberg, 1978; Smith and Rule, 2001). The trajectory to recovery will depend to some extent on pre-impact conditions at the site, for instance: where frequent dredging activities occur a recovery to baseline will be quicker as frequent disturbances of estuarine mud prevent the establishment of long-lived species in the first place (Newell et al, 1998).

Existing studies into the recovery of benthic communities, as measured by the IQI, range between 6 months and 3 years. The dynamic nature of the Humber Lower, and

the pre-existing communities, indicate that any deterioration in ES will return to a pre-impact ES following cessation of the activity within the 6 year WFD RBD reporting cycle[5].

Recovery of coastal marine macrofauna in high energy locations following the cessation of dredging is summarised in Figure 4.1 (taken from Newell et al, (2004)).

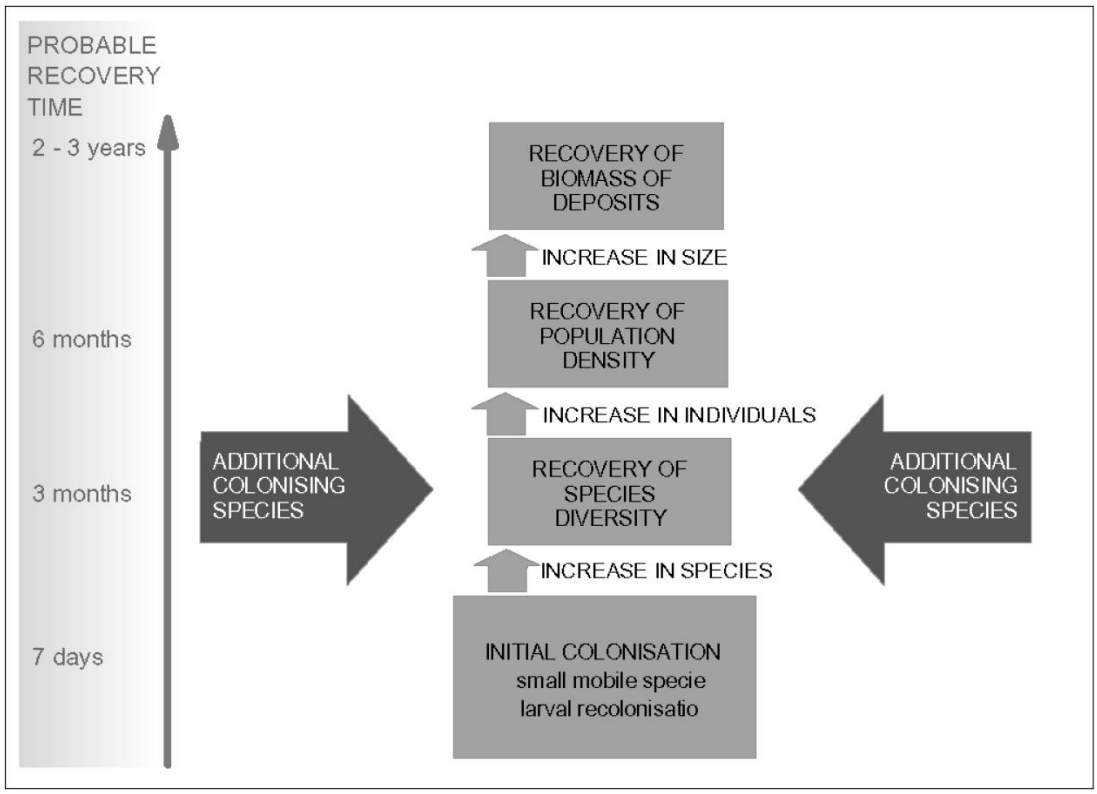

Figure 4.1. Generalised flow diagram showing the sequence of recovery of the macrofauna in coastal marine deposits in a high energy disturbed area (Newell et al, (2004)).

In the absence of specific dredge impact-recovery analysis case studies using the IQI, the implications in terms of the Humber Lower recovering to the original pre-dredge classification are based on the likely return of the IQI component metrics to pre-dredge levels. The expected state of the benthic macrofaunal assemblages at 12

[5] This does not mean that effects will be non-temporary (<1yr) in nature.

months (the limit of non-temporary effects), 3 years (WFD surveillance monitoring cycle) and 6 years (WFD RBD reporting cycle) are as follows:

12 months post-dredge

Following the complete removal of benthic macrofauna from intensive dredging, AMBI values returned to pre-dredge values within ~180 days in the Bilbao Harbour coastal system (Muxika et al 2005). From these findings it may be anticipated that recovery within transitional waters following the removal of fauna and sediment via dredging would be <180 days. This is due to the increased ability of communities within naturally dynamic systems to recover in contrast to those within more stable environments (e.g. coastal systems (Muxika et al, 2005)).

The potential increase in resources and available niches for colonisation may result in a temporary increase in species richness and abundance of opportunist taxa prior to the benthic assemblages reaching a stable state (Rosenberg, 1977)

3 years post-dredge

Borja et al, (2009) studied the response of the Multivariate AZTI Marine Biotic Index (M-AMBI) to a range of anthropogenic pressures, including dredging and dredge spoil disposal. The recovery of the local ecological status as derived by M-AMBI indicated periods of between 2-3 years for dredging and 2 years for dredge disposal to pre-activity levels in transitional waters (Borja et al 2009). The strong association between the M-AMBI and IQI (primarily due to the overlap of the component metrics) leads to the M-AMBI being a suitable surrogate for the IQI. It expected that these timeframes would be similar for the IQI.

6 years post-dredge

There is no evidence (to our knowledge) to indicate that recovery periods in terms of WFD ecological status would extend beyond 6 years of the activity ceasing.

5.0 Impacts predicted in the Able UK Environmental Statement

Able UK Ltd has provided an environmental statement outlining potential impacts associated with the construction of the MEP and where applicable mitigation measure which will be implemented. Further information is required to allow a full assessment of the potential impacts of the dredging activities: i.e. dimensions of the area to be dredged in the berthing channel, approach channel and turning area, with calculations as per guidance in Clearing the Waters. The assertion that the sub-tidal footprint of the dredging will be 18.4ha (H.R. Wallingford WFD technical note) is not supported by information from other sources. If the sub-tidal footprint was from within the quay area alone the foot print would still be 20.25ha (e.g. 13.50ha x 1.5 as per guidance in Clearing the Waters).

A sampling programme was carried out in the proximity of the proposed capital and maintenance dredging operations (Burdon et al, 2010). Sediments in the areas were dominated by mud and muddy sand close to the banks of the estuary, transitioning to sand with compacted clay and muddy sand with coal fragments towards the centre of the estuary. Dominant fauna in this area of the estuary included the barnacles *Balanus improvisus* and *Elminius modestus*, the polychaete worms *Arenicola marina*, *Capitella capitata* and *Polydora cornuta*, the edible mussel *Mytilus edulis* and the oilgochaete *Tubificoides benedii*.

The majority of fauna identified in Chapter 10.1 (Burdon et al, 2010) of the environmental statement were also sampled in the WFD monitoring programme. *B. improvisus* and *E. modestus* were not, however, sampled during WFD sampling. This may be due the use of a Hamon grab (a Day grab is used in WFD monitoring) and the position of sampling stations in the environmental statement survey being such that they provide a baseline in the area of the proposed MEP construction. It may be worthy of note that filter and suspension feeders such as barnacles could be impacted by increased sediment loads in the water column as feeding apparatus can become clogged up with fine particles. However this does not present a significant impact of planned activates and is not considered relevant to the permitting process.

The supplementary report EX 34.2 (An Assessment of Temporal Variation of Benthic Invertebrate Communities in the Humber Estuary) has not been considered in this report as it is an incomplete document.

5.1 Habitat Loss

The loss of 45 ha of inter- and sub-tidal mudflat habitat in the area where the quay will be constructed will be mitigated for by the creation of 115ha of inter-tidal area, Cherry Cob Sands. The inclusion of this mitigation measure in the form of managed re-alignment is positive as it follows guidance on mitigation measures set out in Clearing the Waters. The Humber is a HMWB and one of the pressures contributing

to this classification is land drainage. The creation of Cherry Cob Sands will therefore assist in the water body achieving Good Ecological Potential[6] by 2027 (as set out in the river basement management plan (Environment Agency, 2009)). Currently no inter-tidal monitoring is carried out for WFD benthic classifications using the IQI tool in the Humber Lower water body. As such the creation of Cherry Cob Sands cannot reduce the risk of a temporary reduction in ES or contribute towards an improvement of ES under the WFD. However if and when appropriate data become available inter-tidal areas may be monitored and contribute towards the water body classification of the IQI.

There appears to be some ambiguity as to the climax habitat and communities expected in Cherry Cob Sands. It is not debatable that 'the excavation of salt marsh will result in permanent loss of habitat and its associated benthic communities' or that there are 'no species or particular conservation importance' in the benthic macrofaunal communities (H.R. Wallingford, 2012). It should be noted that salt marsh habitats support communities distinct from those observed in mud and sand flat habitats so the ability of the compensation site to perform its role as a replacement habitat for lost inter-tidal mudflats on the south bank of the Humber may depend on the succession of taxa and habitats within it. Furthermore, the potential for the area to contribute to improved ES measured through the IQI will not be possible if salt marsh is created (in this case the WFD salt marsh tool will be utilised).

5.2 Dredging Activities

5.2.1 Capital dredging

Capital dredging activities will involve the removal of sediments from the quay foot print and anchor pocket, the berthing channel and the approach and turning areas. The total volume of sediment to be removed is estimated at 1,891,000 m^3 (Able, 2011). The break down of quantities by sediment type is provided in Table 5.1.

[6] Good ecological status is defined as a slight variation from undisturbed natural conditions, but waters designated as artificial or heavily modified are not able to achieve natural conditions. Instead the target for these waters is good ecological potential. This is the condition of the water body when all uses for which they are designated are fully mitigated. Good ecological potential is measured on the scale high, good, moderate, poor and bad. The chemical status of these water bodies is measured in the same way as for natural water bodies (Environment Agency Operational Instruction 293_09, Issued 12/06/2009).

Table 5.1. Total quantities of each sediment type licensed to be removed from the Able Marne Energy Park during capital dredging (according to the draft development consent order).

Sediment type	Quantity (wet Tonnes)
Gravel	385,000
Sand	857,500
Silt	630,000
Clay	1,940,0000

Glacial Till deposits will be removed through backhoe dredging. The expected increase in suspended sediment resulting from this activity is between 10 and 50 mg l^{-1} in the vicinity of the activity and will continue for 10 or more weeks (H.R. Wallingford, 2011). A plume of suspended sediments in the water column will be created up to 8km away from dredging activity, both up and down stream. The maximum increase in suspended sediments is expected to be 10 mg l^{-1} at this distance. Increased suspended sediment loads and sedimentation resulting from backhoe dredging are unlikely to have an impact of a non-temporary nature on benthic macrofauna but the duration of the activity should be taken into account when the assessment is made.

A trail suction hopper dredger (TSHD) will be used to remove sand and gravel and alluvium and clay deposits. The capital dredging activity using TSHD is expected to take 1-1.5 weeks in the area of the MEP and a further 3 weeks at the E.ON and Centrica outfalls. Increased suspended sediment loads in the water column are expected to be 100 mg l^{-1} near to the activity and up to 20 mg l^{-1} at a distance of 12 km (Able, 2011).

Suspended sediment loads in the estuary range between hundreds and thousands mg l^{-1}. The expected increases in sediment loads due to capital dredging activates are reported to be relatively short in nature (1-10 weeks) and do not represent level which will take suspended sediment loads outside of those naturally occurring in the estuary.

The total time for all dredging activities in the reclamation area is expected to take up to 48 days. The time to dredge the berthing area, turning area and approach channel may be up to 265 days, using a variety of methods depending on the substrate type (Able, 2011). The impact on benthic macrofauna will be high during dredging operations, and as they will occur over long time periods may be considered non-temporary. However recovery following cessation will occur, although the time scale to reach climax communities is not clear.

Capital dredging activities result in substantial physical disturbance to the sea floor and subsequently to benthic macrofauna. The physical disturbance caused by capital dredging activities is expected to have a greater effect than any predicted rise in suspended sediments or resultant sedimentation. Resistance to physical disturbance is not high and losses of a significant proportion of the benthic community can be

expected. In general communities inhabiting muds and muddy sands in disturbed environments are resistant to impacts results from sedimentation and when impacted recover quickly (Crowe et al, 2011).

5.2.2 Maintenance dredging

Maintenance dredging of the berthing pocket and dock area is expected to be required on a relatively frequent basis[7]. The predicted maximum volume of sediment expected to be removed during maintenance dredging operations is 1.5 million wt T per year.

Minimal maintenance dredging activity is expected to be required in the approach and turning channel areas which is reflected in the licensing for the disposal of 50,000 wt T per year from each.

Maintenance dredging operations may impact benthic macrofauna inside the quay on a non-temporary basis, that is, recovery may take longer than 1 year. The frequency of the maintenance dredging activities will influence the nature of any impact i.e. whether it is temporary or non-temporary. Physical disturbance can cause significant loss of fauna and recovery following this can take up to 2 years. The enclosed nature of the quay will minimise the spatial extent of impacts associated with maintenance dredging.

No recovery of benthic macrofauna is expected in the berthing channel. The berthing channel will be taken down to the chalk layer thus removing habitat availability for re-colonisation.

5.2.3 Disposal

Sand, gravel and silt deposits will be disposed of in the HU080 disposal site. The HU080 site currently receives and average of 4,740,002 wt T of spoil per year.

The quantity of sand, gravel and silt to be disposed of in HU080 following capital dredging will be 2,372,500 wt T. A total of 1,940,000 wt T of clay is planned to be disposed of in HU082 following capital dredging.

Effects in the Humber of dredging and spoil are not known despite, or because of, a long history of dredge activities (Cave et al, 2003). Faunal communities inside and

[7] An indication of what frequency of maintenance dredging ‘relatively frequently’ constitutes will be invaluable in predicting impacts on benthic communities.

near to disposal sites have not been reported to be distinct from those across the remainder of the Humber estuary or the Humber Lower water body. The characteristic fauna in the area represent tolerant and opportunistic species which recover rapidly following smothering, either by migrating upwards through disposed material or by re-colonisation from surrounding areas. The proposed strategy of disposing of spoil in shallow layer in the HU080 disposal site will facilitate rapid recovery and will help to prevent non-temporary impacts occurring.

Maintenance dredging activities are common in the Humber Lower. Predicted maintenance dredging from the Able MEP will require the annual (maximum) removal of 1.5 million wt T from the quay and berthing areas and subsequent disposal in HU082. A strategy of disposal of shallow layer in HU082 (as described for HU080) will assist in ensuring impacts on benthic macrofauna are kept to a minimum.

Whilst not currently assessed for WFD, recommendations on the surface water assessment schemes by the UK Technical Advisory Group (UKTAG) include the assessment of the spatial extent of failures of condition limits (i.e. the area of a water body not reaching good ecological status). For transitional waters, UKTAG advise that thresholds of 5% and 15% of the water body surface area are used as the Good/High and Moderate/Good boundaries respectively. The surface area of the Humber Lower is approximately 247 km^2. The surface area of the existing dredging and disposal activities across the water body, within which failure of achieving condition limits are expected, are estimated at approximately 3.18 km^2 (dredging) and 8.85 km^2 (open spoil disposal grounds). These total approximately 12.04 km^2 or 4.9% of the surface area of the Humber Lower water body. Under the UKTAG recommendations, the current spatial extent assessment would be at high status. However, the close proximity to the proposed Good/High boundary has further reaching implications. Firstly, that the assessment is likely to hold a high degree of uncertainty, but secondly, based on the proposed developments total surface area of 2.45 km^2 and dredging footprint of at least 0.675 km^2 (the actual figure is expected to be larger once areas for the berthing channel and approach and turning area are provided), it is probable that the Able MEP development and associated dredging would result in deterioration from high status to good status under these spatial extent criteria. Under the existing classifications of the Humber Lower water body; this would not result in an overall deterioration in ecological status at the water body level. This does not, however, preclude future classifications from recording a deterioration in ES.

6.0 Monitoring plan to detect potential impacts of maintenance dredge and /or spoil

To design a monitoring programme to detect the effects of the dredging in relation to a control site (in this case, the background ecological status of the Humber Lower water body), the variability must be established in the context of the aspect of the benthic assemblages of interest; in this case benthic macrofauna used to calculate the IQI. As described above, depending on the survey objectives the spatial effect of both the dredging and the spoil disposal would be suitably detected using sites along a series of transects with sufficient sample frequency.

Within station variability can be estimated using existing CSEMP data from the Humber Lower water body. The average within-station standard deviation from 32 CSEMP surveys undertaken within the Humber Lower water body at between 1992 and 2009 is ~0.04.

Based on this estimated within-station standard deviation, the required number of samples at each station for varying degrees of confidence in detecting differing extents of deterioration (in terms of the IQI) between the dredge/spoil disposal sites and sites at increasing distance from the disturbance are recommended below (Table 6.1). Sample numbers are estimated from 0.1 m^2 Day Grab data processed using a 500 µm sieve, sampling effort may vary if different methods are applied.

Table 6.1: Required sampling effort at each sampling station to detect a given difference in IQI values to a given degree of confidence for the Humber Lower water body[8]

Detectable difference	Required confidence	50%	75%	80%	90%	95%	99%
0.2		1*	1*	1*	1*	2*	2*
0.1		2*	3*	3*	4*	5	7
0.05		6	10	11	15	18	25
0.01		132	235	265	353	436	614

(* *power analysis process generally suitable to estimating values down to n=5 - recommended that a minimum of 5 samples are used at each station)*

Sampling should be undertaken to quantify the effect of the dredging and spoil disposal both at stations within the impact site, within zones potentially effected by deposition, and at control stations outside the area of the potential impact. To achieve this, sampling stations should be located i) directly within the licensed dredging area and disposal ground, ii) outside the licensed area but within close proximity (e.g. 25-50 m) positioned on the upstream and downstream edges and on edged perpendicular to these. Samples should be taken at regular spatial intervals (e.g. 25-50 m) until benthic communities are not significantly different from those sampled in control station. iii) two control sites positioned at a suitable distance up/downstream of the affected areas.

The frequency with which the sampling programme should be carried out is dependant on the scale of temporal effects which are being measured. The ability of monitoring to detect recovery of benthic ecosystems and to determine non-temporary effects, will require frequent monitoring, e.g. every 3 months for the first year and every 6 months after this until no impacts are detectable. To align with current WFD timeframes, monitoring at a frequency of one in three or one in six years would correspond to the TraC surveillance monitoring or RBD reporting cycle respectively.

[8] Power analysis details given here show variability in the context of measuring the IQI in the Lower Humber only. In power analysis variability is contextual and is dependant on factors such as habitat sampled and metric being calculated.

7.0 Recommendation related to Able UK MEP dredge activities in the Humber Lower.

The overarching aim of the WFD (in the marine environment) is the protection and restoration of transitional and coastal waters. The WFD requires that water bodies achieve at least a Good ES by 2015 and that no deterioration of ES is observed (e.g. High to Good, or Moderate to Bad).

The historical industrialisation of the Humber and the fact that is currently heavily influenced by anthropogenic activity (which have led to its classification as a HMWB), alongside the naturally dynamic estuarine environment, have resulted in a benthic assemblage which is resistant to disturbance and has a high level of resilience following disturbance.

Previous and current dredging activities do not appear to have a disproportionate effect on benthic communities, as evidenced through the High ES assigned to stations close to the currently dredged channel. The dominant fauna in the Humber Lower are tolerant or opportunistic taxa which indicates that any impact from pressures related to maintenance dredging activities will be followed by a relatively rapid recovery (1-1.5 yr)[9].

ES calculated in the days and weeks immediately following dredging and disposal activities may be lower than those calculated prior to these activities taking place. However ES is predicted to return to pre-dredging levels within an assessment cycle of 6 years, it should be noted this does not necessarily represent a non-temporary effect.

The Humber is a dynamic system and sediment loads in the water columns are naturally high. Additional sediment loads as a result of capital and maintenance dredging activities are estimated to increase this load by 10's to 100's mg l^{-1} for up to 265 days at a time, the level of increased suspended solids will depend on the type of dredging activity being undertaken and the substrate being removed.

The impacts of dredging and disposal activities and their duration cannot be estimated with any certainty and as such neither can the prediction of their effect on the ES of the Humber Lower. Proposed mitigation measures following habitat loss

[9] This is an estimate and the time for recovery to pre-impacted communities will vary depending on factors such as frequency of disturbance, sediment type and pre-impact community present.

will provide a substantial inter-tidal habitat. This area will not however, at present, contribute to either an improved ES or to prevention of deterioration of ES under the WFD for benthic invertebrates. Disposal of dredge spoil in shallow layers is one of the mitigation measures recommended in Clearing the Waters (Environment Agency, 2010) and will reduce de-faunation within the spoil area and facilitate rapid recovery of benthic macrofaunal communities. The impacts of dredging activity and disposal of dredge material will vary depending on factors such as existing communities and substrata on the sea floor.

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Appendix C

Avoidance behaviour of Alosa fallax fallax to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river, Jim Gregory & Peter Clabburn, Aquatic Living Resources 16 (2003) 313-316

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Avoidance behaviour of *Alosa fallax fallax* to pulsed ultrasound and its potential as a technique for monitoring clupeid spawning migration in a shallow river

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Accepted 3 March 2003

Abstract

A hydroacoustic monitoring technique to quantify and assess the ecological requirements for migration of the anadromous clupeid, *Alosa fallax fallax* (twaite shad) was developed, and its effectiveness studied, on the River Wye in Wales. The acoustic monitoring technique was a side aspect application, with two transducers fixed permanently to the riverbank and the acoustic beam from each aimed horizontally across the river towards the opposite bank, perpendicular to flow. Two split-beam echo sounders and transducers were deployed, each operating at different frequencies (200 and 420 kHz). Using a combination of these two frequencies it was possible to demonstrate that shad show strong avoidance behaviour to sound transmitted at 200 kHz and would not pass the monitoring site when sound was transmitted at this frequency. They remained unaffected by sound transmitted at 420 kHz and were observed migrating upstream in large, loosely aggregated shoals. From visual observations above and below the water, shoals were estimated to comprise of many hundreds of individuals, covering a size range of between 30 and 45 cm. Only a few individuals could be resolved by the acoustic system operating at 420 kHz, and it was therefore, not possible to obtain a count of fish by "target tracking" single shad. However, by transmitting 200 kHz sound pulses on a 50% duty cycle the seasonal and daily patterns of shad migration were derived from the analysis of data gathered by the acoustic system operating at 420 kHz.
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Keywords: Fish behaviour; Split-beam; Shad

1. Introduction

It is clear from research into the sensitivity of fish to sound that some species of clupeiforms are unique amongst fish in being able to detect high frequencies.

Published sensitivities for other teleost fish range from 10 Hz to 1 kHz (Popper, 2000) with the odd exception like the Atlantic cod (*Gadus morhua*) demonstrating sensitivity up to 38 kHz (Astrup and Møhl, 1993). However, most fish detect a much lower range of frequencies, as typified by the anadromous Atlantic Salmon (*Salmo salar*) which has been found to detect frequencies within the 10–380 Hz range (Hawkins and Johnstone, 1978).

Studies conducted on the Alewife, *Alosa pseudoharengus* (Dunning et al., 1992; Ross et al., 1996), Blueback herring, *Alosa aesivalis* (Nestler et al., 2002) and American shad, *Alosa sapidissima* (Popper and Carlson, 1998) showed avoidance responses to sound at frequencies over 120 kHz. The highest frequency to solicit a response was 180 kHz for American shad.

More recent research has indicated that this ability to detect ultrasound may be limited to the alosids. Mann et al. (2001) used auditory brainstem response to show that the alosid gulf menhaden (*Brevoortia patronus*), detected frequencies over 100 kHz but the bay anchovy(*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*) and Spanish sardine (*Sardinella aurita*) did not respond to frequencies over 4 kHz.

This study describes observations on the behaviour of a species of clupeid, the twaite shad (*Alosa fallax fallax*), when subjected to two frequencies of pulsed ultrasound, 200 and 420 kHz, as they migrate up the River Wye along the border between England and Wales. It discusses a potential technique that utilises this behaviour to discriminate and enumerate shoals of shad and assess the ecological requirements for the migration of twaite shad as they pass an acoustic fish

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counter deployed primarily to count salmon passage. The twaite shad is an anadromous species that enters freshwater to spawn between April and June.

This study is different from previous studies in that it describes empirical observations of fish behaviour to sound in a natural river environment rather than at an impoundment or a measured brainstem response. It is a study on a European species of anadromous fish and demonstrates an avoidance reaction to a higher frequency of sound (200 kHz) than previously published for any fish species.

It also illustrates a method of utilising this behaviour to discriminate alosid species from others and assess fish migration using a fixed location acoustic counter.

2. Methods

An acoustic echo sounder (HTI model 243) has been deployed on the lower reaches of the River Wye to monitor salmon migration since 1995. The split-beam transducer is aimed horizontally to the river bed and perpendicular to the river flow across the 30-m width. A second acoustic system and transducer operating at a frequency of 420 kHz was deployed next to the 200 kHz transducer, aimed in the same way.

The 420 kHz system was operated continuously from April to July to cover the migration period for twaite shad into the River Wye. Data from the acoustic systems were collected and analysed during this period. The 200 kHz system was operated for 30 min every hour and deactivated for 30 min. Data were collected and analysed for the 30 min of operation each hour.

Observations on fish behaviour as they approached the acoustic beams were recorded on video cameras deployed from the bank in air and from underwater cameras deployed at various ranges across 26 m of the 30 m river width. Maximum water depth was around 2.5 m. The water clarity in the Wye enabled shoals of shad to be clearly identified from bank side observations as they swam upstream.

Observations on fish behaviour were made:

- During continuous operation of the 200 kHz system.
- Immediately following the disabling of the 200 kHz system.
- During the continuous operation of the 420 kHz system, with the 200 kHz system deactivated for 30 min of every hour.

Acoustic data were collected and analysed for all three periods.

2.1. Technical specifications of the two acoustic systems

The acoustic parameters of the sound pulse generated by the 200 and 420 kHz systems were standardised as much as possible. The major parameter settings used are shown in Table 1.

Table 1
Pulse transmission details for the two frequencies used

Parameter	Setting	
	420 kHz	200 kHz
Frequency (kHz)	420	200
Maximum processing range (m)	26	20
Source level (reference pressure 1 μPa at 1 m)	202 dB	2218 dB
Ping rate (s^{-1})	20	20
FM slide or CW pulse	CW	CW
Transmit pulse width (ms)	0.2	0.2
Transmit power (dB W)	18	24
Nominal transducer beam width (in degrees off axis of the –3 dB points of the beam)	2.8° vertical × 10° horizontal	2.8° vertical × 10° horizontal

3. Results

3.1. Shad behaviour under constant operation of the 200 kHz system

Shoals of shad migrating upstream were seen to abruptly reverse direction when they came within 5 m of the acoustic beam axis as it pointed towards the opposite river bank. Every shoal that approached the beam demonstrated this behaviour and returned downstream. It was not possible to tell how many different shoals approached the acoustic beam or how many approaches each shoal made. However, after several days under this operating regime, a very large "super" shoal of shad containing what looked like many thousands of individuals had formed downstream of the acoustic beam. This shoal circulated about 30 m downstream and made repeated approaches to the acoustic beam without passing through it. The underwater cameras recorded just two fish breaking away from the main shoal and passing through the acoustic beam.

During this operating regime, two changes to the transmit parameters of the acoustic system were made and the results observed. The parameters changed were transmit power and ping rate. Changing the transmitted pulse rate from 20 s^{-1} down to 1 s^{-1} made no observable difference to shoal behaviour. After lowering the transmit power to give a source level of 185 dB, the shad would swim much further upstream, and closer to the acoustic beam, before turning away and swimming downstream as before.

3.2. Shad behaviour on deactivation

On the deactivation of the 200 kHz system, approaching shad shoals passed upstream through the previously ensonified area without any apparent hesitation. If the 200 kHz system was activated when a shoal was within the beam of its transducer, the individual fish demonstrated an immediate "C" body shape startle response and scattered in different directions.

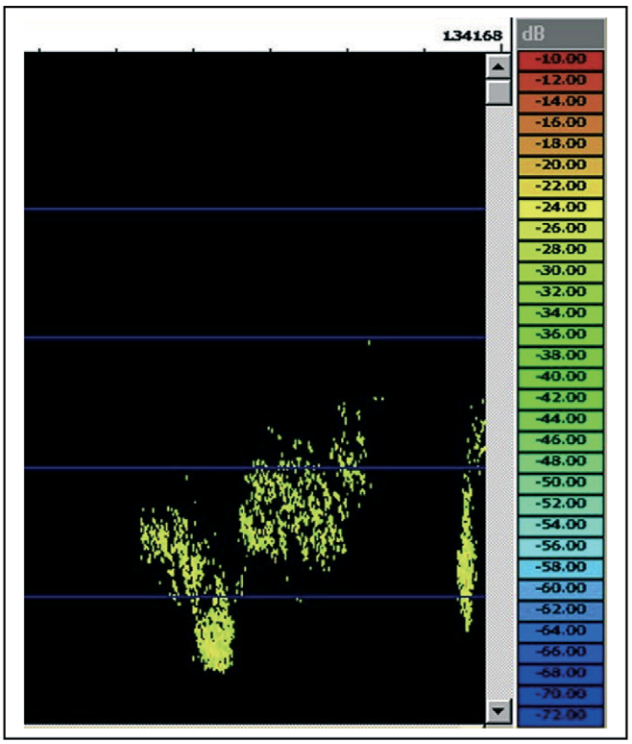

Fig. 1. Echogram display of shad shoals passing through the acoustic beam of the 420 kHz system. The horizontal lines are 5 m range intervals, representing a range of 0–25 from top to bottom. The echogram represents 4 min of data collection.

3.3. Shad behaviour during 60 min duty cycle of the 200 kHz system

During the 30 min each hour the 200 kHz system was deactivated, all shad shoal approaches observed resulted in unhindered passage. Estimations of the number of individual fish in the shoals ranged from 10 to many hundreds. The lengths of individual fish were estimated to range from 30 to 45 cm. All shad shoal approaches made during the 30 min of 200 kHz activation resulted in a failure to pass upstream.

4. Acoustic data results

The large aggregations of echoes on the echogram shown in Fig. 1 came from shoals of shad moving upstream. It was assumed that these are shad shoals because a corresponding echo pattern was not detected during activation of the 200 kHz system. These shoals were also confirmed by the underwater video camera array.

The fish were travelling too close to each other to resolve individual targets and it was not possible to obtain a count of fish by "target tracking" single shad. The fish migrated in large shoals from which only a very few individuals could be resolved by the acoustic system. However, shoals of shad could clearly be identified from the echogram and criteria developed to distinguish individual shoals so that the spatial and temporal migration patterns could be derived for shoal migration. A direction of travel for each shoal could be assigned by examining the average position of echoes in the horizontal plane. The change in average position over time as the shoal passed through the beam was used to determine positive (upstream) movement or negative (downstream) movement.

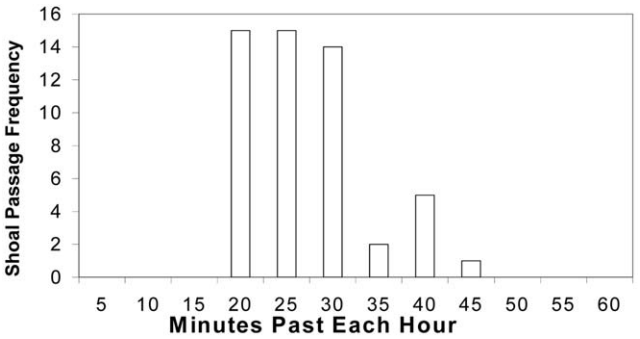

Fig. 2. Distribution of shoal passage within each hour for a 2-week period in May 2000. The 200 kHz system is active from 45 to 15 min.

The avoidance response of shad shoals to 200 kHz is clearly demonstrated in Fig. 2. The data displayed are from a 2-week sub-sample during the early part of the shad migration period. The 200 kHz system was active for half an hour from 45 min past each hour. All shoals passed the site when the 200 kHz system was deactivated, with one exception. This one exception passed upstream when the 200 kHz system was briefly shut down for maintenance.

The upstream spawning migration of twaite shad during 2000 is shown in Fig. 3, together with the subsequent downstream migration of post-spawning shoals. The river flow in cubic metres per second is also displayed.

Fig. 4 shows the diel distribution of upstream and downstream migrating shad shoals for 2000. Movement past the counter was much reduced from 21:00 to 03:00, with a peak in activity around dawn. This is a similar distribution to that found for allis shad (*Alosa alosa*) on the Dordogne in South West France by Travade et al. (1998).

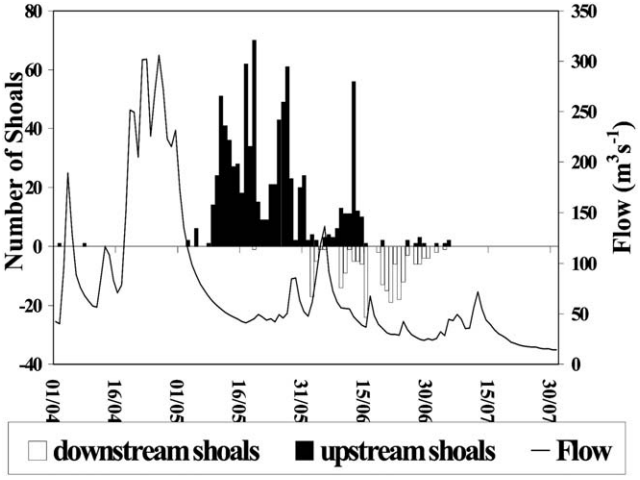

Fig. 3. The number of upstream and downstream migrating shad shoals detected by the 420 kHz acoustic system during 2000, in relation to river flow.

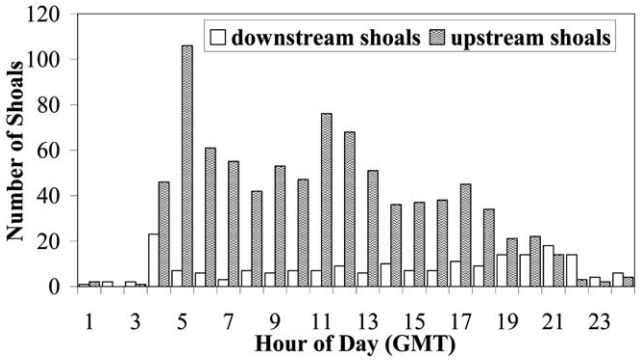

Fig. 4. Diel distribution of shoal migration.

5. Discussion

Twaite shad demonstrate a very strong avoidance reaction to a sound pulse transmitted at 200 kHz and would not pass upstream of a transducer aimed across a 30-m width of river. This behaviour remained unchanged on the variation of the ping rate. A lowering of the transmit power appeared to reduce the fishes sensitivity to the transmitted pulse. Only two fish were observed on the underwater video array to leave a shoal and pass upstream through the beam. It was not possible to tell from the video images whether these "break-away" fish were Twaite shad that may have become acclimatised to the sound or were the less abundant Allis shad, *A. alosa*, which are thought to be present in the Wye. Guillard and Colon (2000) monitored twaite shad with a 70 kHz acoustic system on the River Rhône in France with no reported avoidance reaction.

Twaite shad behaviour on the River Wye appeared unaffected by a sound pulse with similar characteristics transmitted at 420 kHz. Shoals of shad were observed passing through the acoustic beam without hesitation. This allowed them to be detected and enumerated by the acoustic system.

Although it was not possible to obtain a count of fish by "target tracking" single shad, shoals could be counted and spatial and temporal distribution patterns derived. On the Wye there were no other fish species shoaling at this time of year so species apportionment of these shoals was not an issue. However, it would be possible to apportion acoustic shoal or individual counts as either clupeid or not clupeid based on the difference in the number of events counted when the 200 kHz system was activated compared to periods of deactivation. In this way, the dual frequency technique could be used to distinguish and enumerate clupeids sensitive to ultrasound in situations where other shoaling fish species are present.

Although two shoals of shad were first recorded migrating upstream in early April, the main run did not begin until the 10th May when flows had dropped to 50 $m^3\ s^{-1}$. When river flows increased to over 100 $m^3\ s^{-1}$, there was a marked decrease in upstream migration. Although water temperatures were not recorded, they would have been rising during May as the river flow dropped. Boisneau et al. (1985) and Guillard and Colon (2000) have reported positive correlation of shad migration with water temperature for *A. alosa*. Downstream migration was first recorded on 1st June, with the last shoal being detected on 4th July. Upstream migrating shoals continued to be detected into early July.

Very little upstream migration occurred during the hours of darkness (22:00–03:00), although the peak in downstream movement corresponded to decreasing light levels in the evening. Similar patterns of movement have been reported for the American shad, *A. sapidissima*, from observations made by underwater video cameras (Haro and Kynard, 1997).

Echo integration, as used in the marine environment to estimate shoal densities, was not considered applicable to data collected from a shallow river using a horizontally aimed transducer as many of the key assumptions required for the echo integration technique do not appear to hold true under these circumstances. However, enumeration of shoals and assessment of their run timing characteristics is possible.

Acknowledgements

The authors would like to thank the Environment Agency Wales and the Country side Council for Wales for their support of this work.

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Appendix D

EA letter to Able re Piling Mitigation, dated 31 July 2012

Mr Richard Cram
Able UK Ltd
Able House
Billingham Reach Industrial Estate
BILLINGHAM
Teeside
TS23 1PX

Your ref: RC.LH.A.L12-0330
Our ref: AN/2012/113982

Date: 31 July 2012

Dear Richard,

Marine Energy Park, Killingholme Marshes, North Lincolnshire
Piling Mitigation & Compensation Proposals

Thank you for your letter dated 6 July 2012 in respect of the above,

I have considered the points you have raised and will address some of them specifically below. However, I would also direct you to our detailed Written Representations, including the Statement by Dr Adrian Fewings, for our case and opinions on this issue. As the requirements are not solely for the protection of migratory fish, I would also refer you to the representations made by Natural England (NE) and the Marine Management Organisation (MMO) on lamprey, over-wintering birds and marine mammals.

We do not accept that our requirements are over-precautionary, we believe that they are proportionate and in line with the precautionary principle. However, we too remain committed to trying to achieve a solution that provides the protection for the species of concern that we require and allows you to deliver your project.

Soft Start

Natural England has reviewed the soft start report sent through by Able and agree that you have followed the same methodology that Associated British Ports (ABP) employed for Green Port Hull (GPH) and presented a case for reducing its soft start duration. This report comes to the same conclusion as ABP in that it is concluded that 120 seconds of soft start is sufficient to avoid damage to grey seal hearing. Natural England believes that this is an absolute minimum and would normally advise that the Joint Nature Conservation Committee (JNCC) soft start guidance should be adhered to. However, following consideration of the proposal put forward by ABP, we did agree to a 180 second soft start for GPH, which was calculated by adding a 50% precautionary increase to the 120 seconds proposed. We therefore advise that Able should also undertake a 180 second soft start, together with a 100m mitigation zone.

Piling Method Statement
We are pleased to your agreement to this requirement, which will be included in the Deemed Marine Licence.

Active Monitoring Scheme
Please see below, under dissolved oxygen and water temperature for our comments on this issue.

Piling Restrictions
We understand your view with respect to the 'work blocks' and can appreciate how you may have mis-interpreted what was meant by it. The reason it was re-defined in respect of your proposal was to try and provide further clarity. The meaning is the same for the GPH project. However, we are aware that the method of piling intended for that project differs from your own – GPH intends that 4-5 piles will be set up in a jig and then percussive piling of them will be done immediately, one after another, without any lengthy gaps for resetting of rigs/hammers.

We note your views in respect of the restrictions between July and September. We understand that in the information you attached on your piling programme, where you quote 'impact piling' this may (particularly for day 1) represent vibro-piling and does not necessarily represent percussive piling. It is our opinion, therefore, that the restrictions should not hinder the project to the point of disproportionate financial risk, which you claim. During the most restricted period, July to Sept, the restrictions give you a daily average of 4.1hours with 1 rig and 7hours with 2 rigs (average 3.5hrs per rig). Based on your piling schedule the 2nd day of percussive piling would require approx 5.3hrs – averaging out at 2.65hrs per day. Even with potential unforeseen difficulties this leaves a contingency of 1.45hrs on a single rig and 0.85hrs per rig where 2 are used. If you think this interpretation of your proposed piling methodology is incorrect, we will be pleased to discuss it with you further.

You will note that the restrictions as currently drafted do also enable you more piling hours than the GPH project – the reason for this is that Hull City Council required restrictions not only for the aquatic environment, but also to protect surrounding amenity.

We note your comments in respect of the GPH draft decision notice. It is for the decision maker to ensure they are satisfied that the conditions are worded in a way they believe appropriate and enforceable. The piling restrictions for the GPH project will also be included in a Marine Licence. In the interests of consistency we attach a revised schedule of the piling related conditions (see Appendix), which include wording that is now as consistent as possible to those the MMO intends to include on the GPH Marine Licence and we would ask that you consider the acceptability of these for your project.

Compensation Proposal
It is disappointing that you cannot yet place a monitory value on the Cherry Cobb Sands works. However, we look forward to receiving this when the detailed design is progressed.

Dissolved Oxygen and Water Temperature
The issue with dissolved oxygen and water temperature levels is fully explained in Paragraph 7.3 of Appendix D (Statement by Dr Adrian Fewings) of our Written Representations. In summary, the reason for this restriction is because if these

conditions (low dissolved oxygen and/or high water temperature) are experienced the fish will become stressed and this will be compounded by any behavioural response resulting from exposure to the piling noise.

It is disappointing that you are now challenging this issue given the numerous references, within your Environmental Statement, to the effects of reduced dissolved oxygen and temperature level on ecological receptors such as macrophytes, fish, and benthic Invertebrates. You also previously confirmed to us, in your letter of 11th May 2012, that you would cessate impact piling in the event that water temperature in the estuary exceeds 21.5 degrees Celsius.

Cold Weather Restriction

Natural England has always advised that the seasonal restriction that is required for SPA/ Ramsar waterbirds should be *based on* the wildfowling cold weather restriction. Wildfowling is an example of an activity that is regulated during periods of cold weather but it would not be appropriate to directly compare the situation as regards wildfowling and a programme of industrial construction works. In addition, the regulatory mechanisms are not intended to do a comparable job. The wildfowling ban is a nationwide ban that is implemented when certain ground conditions are met at 13 official weather stations around the coast of Britain. The purpose of the ban is to ensure that wildfowling disturbance does not affect waterfowl survival during periods of severe weather.

Construction disturbance will be more intensive and more prolonged. Any potential constraints on disturbing construction activity should focus specifically on the given set of activities at that precise location and the SPA/ Ramsar species involved. As you will be aware, the aim is to avoid an adverse effect on site integrity and ensure that the conservation objectives are not compromised. Natural England's advice is that the restrictions as set out in our letter of 19 June 2012 are required to achieve this. A slightly amended cold weather condition (this is the one that will be included in the GPH Marine Licence) is included in the attached Appendix.

No Sunday Working

We were of the impression that you did not intend to pile on Sundays. The purpose of this restriction is to ensure that this is the case, and secures the benefit of a quiet period for fish and lamprey. The intention here is identical to the similar restriction you have accepted for no night-time working.

Restriction on Pile Diameter

The purpose for this restriction is exactly as explained within the reason. The risk/impact assessments have been undertaken using this diameter pile and therefore we would not wish larger piles to be used. However, we can agree to your request to insert "unless otherwise agreed in writing with" and this will be now be incorporated into the piling methodology statement condition, please see Condition 1 on the amended schedule contained in the Appendix to this letter.

Residual Effects

Using the seasonal risk curves, we are able to estimate the percentage risk if peak periods are avoided. This should be used, together with the Cherry Cobb Sands works and information on the monetary value of the fisheries affected, to quantify any residual effect.

We hope that the above explanations, together with the schedule of amended conditions, will be sufficient for you to reconsider your position with a view to

Cont/d..

accepting the requirements in order to avoid any further representations having to be made on these issue.

Hull City Council Written Representations

We have also now considered the Written Representations made by Hull City Council, which state the need for the Planning Inspectorate "to restrict construction operations relating to Marine Piles occurring concurrently from different marine developments". Hull City Council include Condition 19 in the GPH schedule to secure adherence to a noise reduction scheme (to be submitted and agreed) if percussive piling is to be carried out at the same time as Able's Marine Energy Park. This condition relates to the protection of redshank, a Humber Estuary SPA species. As you will be aware, Able is providing compensation at Cherry Cobb Sands for the indirect loss of adjacent intertidal habitat due to disturbance during construction and operation of the new port. Mitigation, in the form of seasonal restrictions, is required to mitigate the impact on the remaining intertidal habitat. Redshank have been included in your in-combination assessment – see Natural England's letter of 22 December 2011 - and therefore your proposed mitigation already covers this issue.

Should you require any additional information, or wish to discuss these matters further, please do not hesitate to contact me on the number below.

Yours sincerely

Annette Hewitson
Principal Planning Advisor

Direct dial [redacted]
Direct fax [redacted]
Direct e-mail [redacted]

Appendix – Schedule of proposed conditions for inclusion in DCO Schedule 8, Deemed Marine Licence

Prior to works commencing

Condition 1
The Licence Holder must ensure that a detailed piling methodology statement is submitted and approved by the MMO prior to the commencement of works (for consultation with Natural England and Environment Agency). The method statement shall include the following measures:

Pile pads shall be utilised at all times;

Soft start piling shall be utilised at the commencement of any piling. The statement must detail the exact soft start protocol to be followed;

The maximum pile diameter shall be 2.1 meters unless otherwise agreed in writing by the MMO (following consultation with Natural England and the Environment Agency);

Piling shall not take place during periods when the data from the Active Monitoring Buoy shows temperatures above 21.5 degrees Celsius and/or dissolved oxygen to be below 5 mg/l;

Details of the piling methodology to be adopted which sets out the likely spread of piling activity throughout a day.

Percussive piling shall thereafter proceed only in strict accordance with the agreed Piling Method Statement.

Reason: To minimise the noise impact of piling on fisheries. To maximise the time fish have to vacate the affected area before sound pressures increase. To reduce the risk to migratory fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, and Eel.

Condition 2
The Licence Holder must ensure that an Active Monitoring Scheme has been submitted to and agreed in writing by the MMO (following consultation with Natural England and Environment Agency). The Scheme shall include the following details:

Location of Active Monitoring Buoy(s) and depth and design of sensors;

Full details of the frequency of measurement of temperature and dissolved oxygen in order to ascertain compliance with condition 1;

24 hours a day, 7 days a week monitoring of noise in order to ascertain compliance with conditions 4 and 5;

Full details of when monitoring will commence and cease, which will include a 2 week period of pre and post construction monitoring in order to establish baseline conditions and the return to baseline conditions once construction activity has finished;

Cont/d..

A log of the number and approximate location of piling rigs which are in operation on any given day;

Full details of how the monitored information will be accessed by or communicated to the site contractor, the MMO, Natural England and the Environment Agency, where necessary.

The monitoring scheme shall thereafter be implemented in accordance with the timetable approved as part of the scheme.

Reason: To ensure appropriate information is available to allow noise mitigation measures to be implemented and monitored. To avoid periods when water conditions will make fish more vulnerable to disturbance - in accordance with condition 1. To reduce the risk to migratory fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, and Eel.

Condition 3
The Licence Holder must ensure a cold weather construction restriction strategy is submitted to and agreed with the MMO (in consultation with Natural England) before any percussive piling takes place. The strategy shall include the following elements/procedures:

No percussive piling (other than to finish driving any pile that is in the process of being driven at the point the cold weather restriction comes into force) shall take place following 7 consecutive days of zero or sub zero temperatures (where the temperature does not exceed 0ºc for more than 6 hours in any day or any other pre-agreed formula to define short periods of thaw);

3 temperature monitoring points shall be agreed within the Humber Estuary such as Immingham, Grimsby and Killingholme;

The restrictions will be reviewed as follows:

After 24 hours of above-freezing temperatures, the restrictions will be lifted on a "probationary basis", provided that the weather forecast (met office forecast location to be agreed) indicates that freezing conditions will not return within 5 days.

After a further 5 clear days of above-freezing temperatures, the restrictions will be lifted entirely and the "clock reset to zero".

The Strategy shall thereafter be implemented in strict accordance with the details agreed.

Reason: To ensure there is no adverse effect on the interest features of the Humber Estuary SPA/Ramsar site.

During works

Condition 4
The Licence Holder must ensure that no percussive piling of marine piles (the marine element being defined as a pile that will, during construction, be in a free water condition and the term “percussive piling” referring to the driving of piles, but excluding the handling, placing and vibro-driving of piles) shall take place between 7th April and 1st June inclusive in any one calendar year.

Cont/d..

Reason: To reduce the risk to migratory fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, and Eel.

Condition 5
The Licence Holder must ensure percussive piling of marine piles (the marine element being defined as a pile that will, during construction, be in a free water condition and the term “percussive piling” referring to the driving of piles, but excluding the handling, placing and vibro-driving of piles) shall be restricted in the following way:

Timeframe 1: From 2nd June to 22nd July inclusive in any one calendar year, the maximum amount of percussive piling permitted within each four-week work-block shall be limited to:

101 hours where a single rig is in operation; or
A combined total of 168 hours where two or more rigs are in operation.

Timeframe 2: From 23rd July to 10th September inclusive in any one calendar year, the maximum amount of percussive piling permitted each week-long work-block shall be limited to:

25 hours where a single rig is in operation; or
A combined total of 42 hours where two or more rigs are in operation;

Timeframe 3: From 11th September to 31st October inclusive in any one calendar year, the maximum amount of percussive piling permitted within each four-week work-block shall be limited to:

134 hours where a single rig is in operation; or
A combined total of 224 hours where two or more rigs are in operation.

Timeframe 4: From 1st November to 6th April inclusive in consecutive calendar years, the maximum amount of percussive piling permitted within each eight-week work-block shall be limited to:

336 hours where a single rig is in operation; or
A combined total of 560 hours where two or more rigs are in operation.

The measurement of time during each work-block shall begin at the start of each timeframe, roll throughout it, then cease at the end. Measurement will begin again at the start of the next timeframe. This process will be repeated until the end of piling works.

Reason: To reduce the risk to migratory fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, and Eel.

Condition 6
The Licence Holder must ensure percussive piling of marine piles (for the purposes of this condition percussive piling means the driving of piles by percussive means but does not include the handling, placing and vibro-driving of piles and a marine pile means a pile which will, during construction, be in a free-water state) in connection with the development shall be restricted in the following way:

there shall be at least a 180 second "soft start" period for percussive piling of marine piles . The exact form of “soft start” shall be agreed prior to the commencement of piling with the MMO in consultation with Natural England.

a 100m marine mammals observation zone, the centre-point being the location of the marine pile being driven percussively piled, shall be followed with the purpose of

Cont/d..

identifying any marine mammals within that zone and no piling shall take place whist marine mammals are within the zone.

Reason: To ensure there is no adverse effect on the interest features of the Humber Estuary SAC/Ramsar site.

Condition 7
No piling shall take place between 22.00hours on a Saturday and 06.00hours on the following Monday.

Reason: To ensure periods of quiet when no percussive piling is taking place for the benefit of fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, Eel, Herring, Sole and Plaice.

Condition 8
No piling shall take place between 22.00hours and 06.00hours.

Reason: To ensure periods of quiet when no percussive piling is taking place for the benefit of fish species including Atlantic Salmon, Sea Trout, River and Sea Lamprey, Eel, Herring, Sole and Plaice.

End

Appendix E

Memo from Deltares, 6 July 2012

Memo

To
Philip Winn , The Environment Agency, Albion Mills, Great Gutter Lane, Willerby, Hull, HU10 6DN, UK

Date	Reference	Number of pages
6 July 2012	1206573-000-ZKS-0001	6
From	**Direct line**	**E-mail**
dr. Claire Jeuken and Prof. Z.B. Wang	[redacted]	[redacted]

Classification
confidential until further notice

Subject
Response to memo Black and Veatch

Background

In April 2012 Deltares carried out a short desk study to advice the Environment Agency on the two port developments on the north and south banks of the Humber Estuary that are currently going through the planning process (Wang and Jeuken, 2012). Associated British Ports (ABP) are progressing a major north bank scheme (Green Port Hull, abbreviated as GPH). Able UK is promoting a south bank scheme (Able Marine Energy Park abbreviated as AMEP). In their desk study, Wang and Jeuken (2012) amongst other concluded that long-term and large-scale in estuary effects have not been accounted for in the EIA studies. Wang and Jeuken estimated these effects using results of a previous Humber set-back study, the elaborated effects of the Thorngumbald-Sunk Island setback in particular.

Able UK asked Black and Veatch for a second opinion. Black and Veatch question the findings of the desk study by Wang and Jeuken (2012). More specifically, they state:

- The 22 ha gain in section 3 at the centre of the setback area is assumed to be additional flooding in the setback area and not an estuary effect.
- This gives **no** net change in estuary area as a result of the Sunk Island setback after 50 years'

The Environment Agency asked Deltares to respond to the comments raised by Black and Veatch. This memo responds to these comments by giving a more in depth summary of the findings of the previous Humber study (Wang and Jeuken, 2004, Jeuken et al, 2007) and evaluating these against the conclusions of Black and Veatch.

Summary of findings previous Humber set back study

General effects of set backs
Setting back of defences, also referred to as realignment, creates room for water. It is considered as a promising measure in the development of new flood defence strategies in the Humber estuary and elsewhere in United Kingdom. In addition it supports the sustainable creation of new intertidal habitat.

The impacts of set backs on the morphology and hydrodynamics can be assessed with morphological models like ESTMORF by comparing model simulations with and without a setback scenario, even if the effects are small (see Wang and Jeuken, 2004).

Setbacks induce long-term morphological and hydrodynamic changes landward and seaward of the setback that differ from the initial response (see Figure 1, see also Jeuken et al., 2007):

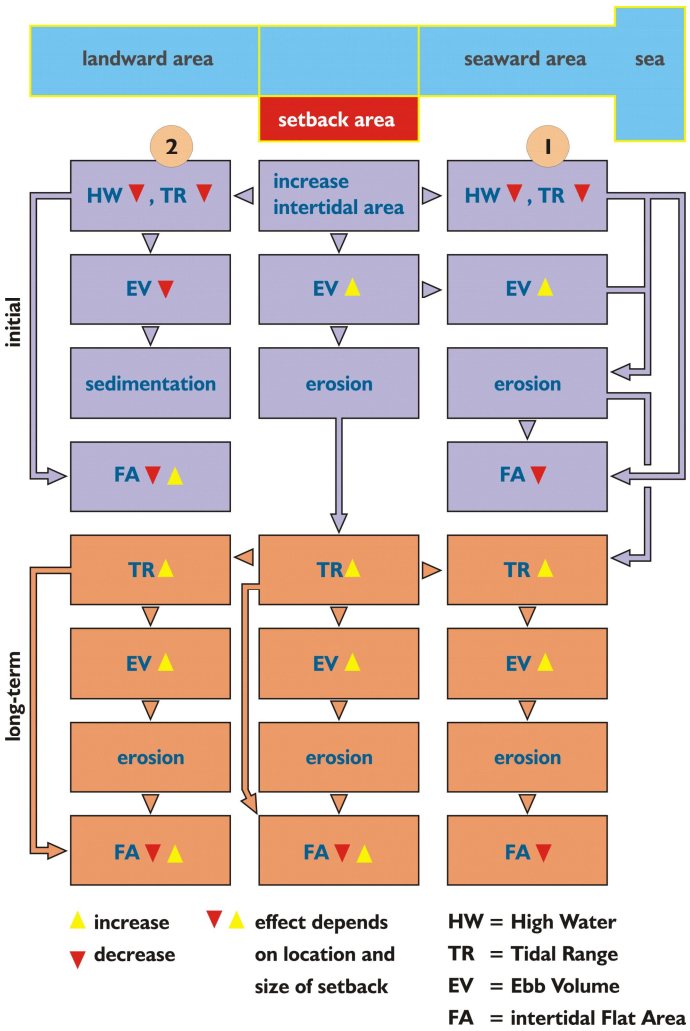


Fig. 1 Schematic representation of initial and long term effects of set backs (from Jeuken et al.2007)

1. Initially, high water levels and tidal ranges decrease throughout the estuary. Seaward of the setback the ebb volumes however increase as a result of the enlarged intertidal basin storage in the setback area. This causes erosion and a loss of intertidal area, initially and on longer time scales.
2. Landward of the set back the initial decrease in tidal range and the associated reduction of the ebb volumes induce sedimentation. The deposited sediments however erode again on longer time scales because of the erosion in the seaward area which enhances the tidal intrusion. The net effect of this sedimentation and erosion depends on the location and size of the set backs and the considered timescale. At the scale of the entire estuary set backs always cause a loss of sediments.

In addition to size and considered time scale, the effects of a setback also depend on its location along the estuary. For seaward located setbacks:
- The nett erosion at the scale of the entire estuary is smaller than for landward located set backs.
- The initial reduction of high waters and the gain in intertidal area is preserved longer than for landward situated setbacks.
- The initial gain in intertidal area tends to increase, whereas it is likely to reduce for more landward located setbacks.

These general principles can be applied in the site selection and design of sustainable set backs in estuaries. In addition, they can be used to assess the (reverse) impacts of estuaries to embankments.

Effects Thorngumbald-Sunk island setback

Table 1 summarizes the principal effects of the Thorngumbald-Sunk Island setback (Fig.2) on the development of the intertidal area in the estuary based on the previous study by Wang and Jeuken (2004, Jeuken et al. 2007).

The reference scenario refers to the autonomous evolution in the estuary with an averaged sea level rise of 1,8mm/yr. After 50 years the following evolutions can be observed (row 3, Table 1):
- The intertidal area decreases throughout the estuary with 146 ha in total.
- In lower part of estuary (parts 1-7) the HWS and LWS follow sea level rise (SLR), i.e. no change in tidal range (see Wang and Jeuken, 2004).
- Landward of section 7 (Hull, Kingston) the HWS level increases more than the sea level. The LWS spring level increases less than sea level, implying an increase in tidal range. Despite the increase in tidal range, the intertidal area decreases, most likely as result of coastal squeeze.
- Accelerated sea level rise scenario's result in qualitatively similar but larger effects.

The *initial effects* of considered setback (numbers in row 1, Table 1) are:
- An increase of the intertidal area in the setback region of 814 ha due to the setback.
- A reduction of the intertidal area in the upper estuary of about 3 ha and additional 1 ha loss in the rivers due to a decrease of the high water level and hence a reduction in tidal range. The sedimentation associated with the reduction in tidal range manifest itself in the sub tidal channel area.

Table 1 Summary of the predicted changes in intertidal area related to the setback scenario for Thorngumbuld-Sunk Island elaborated as part of the Humber studies 2003/2004 by Deltares (formerly Delft Hydraulics). For location of parts see Figure 2.

	Changes per estuary section	1	partially setback 2	setback 3	setback 4	setback 5	6	7	8	9	Alkborough 10	Estuary 1-10	Rivers
	Surface area and initial gains (in ha) at t=0 yrs												
	reference (no setback)	3328	1876	782	529	435	270	342	169	1374	497	9603	165
	setback	3328	2123	1139	684	490	270	342	169	1372	496	10412	164
1	Relative *initial* change (setback-reference)	0	247	357	155	55	0	0	0	-2	-1	**809**	-1
						814							
	Surface area and gains and losses (in ha) at t=50 yrs												
	Reference (no setback)	3295	1859	771	523	428	263	327	165	1333	492	9456	169
	Setback	3281	2104	1150	681	487	267	330	168	1332	490	10289	166
2	Effect of setback (setback - reference at 50 yrs)	-14	245	379	158	59	4	3	3	-1	-2	**833**	-2
						841							
	Aboslute gains (>0) and losses (<) in ha over 50 yrs												
3	Reference (t50-t0)	-33	-17	-11	-6	-7	-7	-15	-4	-41	-5	-146	4
4	Setback (t50-t0)	-47	-19	11	-3	-3	-3	-12	-1	-40	-6	-123	2
5	Effect of setback (setback-reference)	-14	-2	22	3	4	4	3	3	1	-1	**23**	-2
						27							
	Relative gains & losses (%) over 50 yrs												
6	reference	-1,0	-0,9	-1,4	-1,1	-1,6	-2,6	-4,4	-2,4	-3,0	-1,0	-1,5	2,4
7	Set back (Fig 5.14)	-1,4	-0,9	1,0	-0,4	-0,6	-1,1	-3,5	-0,6	-2,9	-1,2	-1,2	1,2
8	Effect set back (setback - reference)	-0,4	0,0	2,4	0,7	1,0	1,5	0,9	1,8	0,1	-0,2	0,3	-1,2

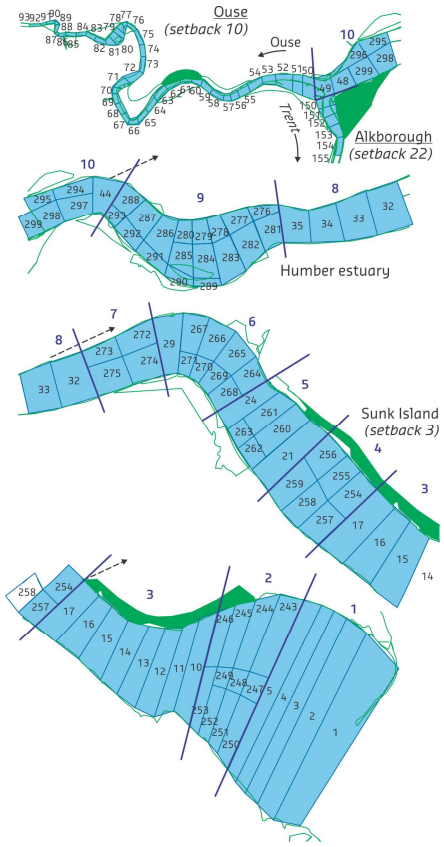


Figure 2. ESTMORPH schematisation and aggregation into 10 sections.

The setback has the following *long-term* (after 50 yrs) effects:

- Also in the setback scenario the intertidal area reduces throughout the estuary, except for part 3 (see also below).
- The overall reduction of in intertidal area in the estuary of 123 ha (row 4, Table 1) is however 23 ha (row 5, Table 1) smaller than the 146 ha loss in reference situation (row 3 Table1). This relative overall gain of 23 ha caused by the set-back displays some notable spatial variations, pointing at *'in estuary'* effects of the set-back (row 5 Table 1):
  - Seaward of the setback the reduction in intertidal area is *larger* than in the reference run (relative loss), presumably as a result of coastal squeeze and erosion associated with the increase in tidal range.
  - In the setback area and landward of the setback the reduction of intertidal area tends to be *smaller*, than in the reference scenario i.e. a relative gain. This is due to a reduction in tidal range (reduction of HWS and increase of LWS) and hence a sedimentation and reduced coastal squeeze at the considered timescale of 50 yrs.
  - In contrast the intertidal area of part 3 increases with 11 ha (row 4 Table 1). When compared to the reference situation the *relative* gain in intertidal area amounts to 22ha in this area, coincidentally almost equalling the total (net) relative gain in the estuary of 23 ha. The local increase is probably inherent to the hypsometry of the set back: initially (t=0) not the whole area is flooded at HWS, i.e. locally there is no coastal squeeze issue. Consequently the intertidal area can increase with increasing sea level and HWS and LWS levels. It is not completely clear, but such a situation might also exist at the location where the AMEP wharf is planned.

Conclusions and recommendation

- Especially the long-term and large-scale effects, as outlined above have not been taken into account in previous studies for AMEP. The estimated effects provided by Wang and Jeuken (2012), based on the setback study are the best estimates that can be made given the scope of that study.
- A development of a wharf in an intertidal region implies long term changes in tidal elevations, sedimentation/erosion and intertidal area that are qualitatively opposite to the above described effects of a set back: the envisioned wharf will most likely enhance an autonomous reduction of the intertidal area. This additional reduction will manifest itself in the wharf region and landward of the wharf and will be due to an increase in tidal range and associated enhanced coastal squeeze and erosion.
- Thus, whether it is a setback or a wharf, or any other development where intertidal area is replaced by supra tidal area and vice-versa, long-term *in estuary* effects will occur that differ from the initial effects. The magnitudes of the effects depend on the size of the development, its location as well as the considered timescale. Effects may be small when compared to autonomous developments, but they will occur and can be assessed with validated morphological models.

Finally it is recommended to compare the hypsometry characteristics of the area where the wharf is planned and the characteristics of the compensation area. This gives insight into whether or not coastal squeeze is or will be an issue with (accelerated) sea level rise. Additionally, this will give a more accurate insight into the compensation ratio and the, to be anticipated, effects of the wharf.

References

Wang Z.B. and M.C.J.L. Jeuken, 2004, Long-term morphologic modelling of the Humber Estuary with ESTMORPH, The future morphologic evolution and the impact of set backs, Report Z3451/Z3521, WL | Delft Hydraulics.

M.C.J.L. Jeuken, Z.B. Wang and D. Keiller, 2007, Impact of setbacks on the estuarine morphology, In Dohmen-Jansen, C.M. and S.J.M.H. Hulscher (eds.), River, Coastal and Estuarine Morphodynamics, RCEM2007, Taylor & Francis, 2008, London, pp1125-1134.

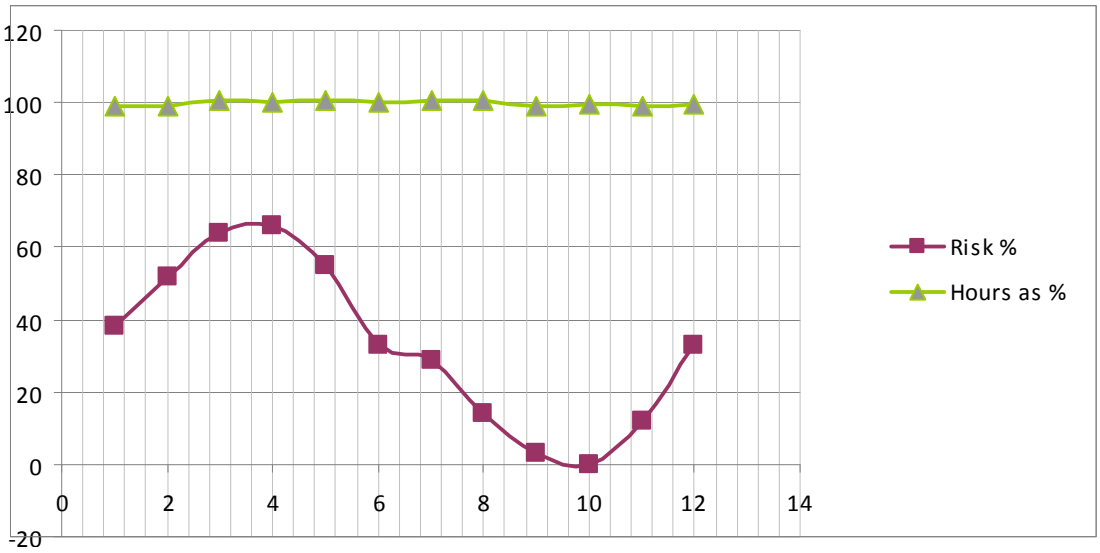
Z.B. Wang and M.C.J.L. Jeuken, 2012, Review EIA documents GPH & AMEP. Deltares memo

Appendix F

Summary of seasonal risk curves for salmon impacts

Summary of seasonal risk curves for salmon impacts

Period	Piling Hours Available	% of piling hours reqd.	Threshold Risk	Total Risk	Modulus Risk
Jan-Jun	2896	99.18	1	38%	38
Feb-Jul	2896	99.18	1	52%	52
Mar-Aug	2944	100.82	1	64%	64
Apr-Sep	2928	100.27	1	66%	66
May-Oct	2944	100.82	1	55%	55
Jun-Nov	2928	100.27	1	33%	33
Jul-Dec	2944	100.82	1	29%	29
Aug-Jan	2944	100.82	1	14%	14
Sep-Feb	2896	99.18	1	3%	3
Oct-Mar	2912	99.73	1	0%	0
Nov-Apr	2896	99.18	1	12%	12
Dec-May	2912	99.73	1	33%	33



Appendix G

The Precautionary Principle – Policy and Law

NOTE ON THE PRECAUTIONARY PRINCIPLE – Policy and Law

1. The usual starting point for consideration of the precautionary principle is Principle 15 of the Rio Declaration on Environment and Development adopted by the United Nations Conference on Environment and Development in1992. That Principle states:

> *"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*

2. At the European Union level, Article 191 of the Treaty on the Functioning of the European Union provides (paragraph (2)) as follows:

> *"Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."*

3. The UK Sustainable Development Strategy (2005) states

> ***Environmental limits***
>
> *While resources such as biodiversity and soils are thought of as 'renewable', they can be exploited to the extent that long-term irreversible damage will be caused; hence the development of the concept of 'environmental limits'. Environmental limits are the level at which the environment is unable to accommodate a particular activity or rate of activities without sustaining unacceptable or irreversible change.*
>
> *There is evidence that this is already occurring in many places, the commercial extinction of the Newfoundland cod fisheries being a notable example....*
>
> *The UK holds some of the best information about natural resources available anywhere in the world. There are, however, still instances where decisions on managing natural resources will have to be taken on the basis of partial information. In these instances and where, firstly, there is a risk of significant adverse environmental effects occurring and secondly, any possible mitigation measures seem unlikely to safeguard against these effects, the precautionary principle will be adopted. Where evidence exists of likely harm to ecosystems or biodiversity, we will adopt practices that avoid irreversible damage'*

4. The EA accepts that the ILGRA report cited by the applicant is relevant. However we would set out the following extract from the report.

> • *The purpose of the precautionary principle is to create an impetus to take a decision notwithstanding scientific uncertainty about the nature and extent of the risk.*

- *Although there is no universally accepted definition, the Government is committed to using the precautionary principle, which is included in the 1992 Rio Declaration on Environment and Development.*

- *The precautionary principle should be invoked when:*

    - *there is good reason to believe that harmful effects may occur to human, animal or plant health or to the environment; and*

    - *the level of scientific uncertainty about the consequences or likelihood of the risk is such that the best available scientific advice cannot assess the risk with sufficient confidence to inform decision-making....*

- *Applying the precautionary principle is essentially a matter of making assumptions about consequences and likelihoods to establish credible scenarios, and then using standard procedures of risk assessment and management to inform decisions on how to address the hazard or threat.*

- *Decision-making should bring together all relevant social, political, economic and ethical factors in selecting an appropriate risk management option.*

- *Invoking the precautionary principle shifts the burden of proof in demonstrating presence of risk or degree of safety towards the hazard creator. The presumption should be that the hazard creator should provide, as a minimum, the information needed for decision-making. ..."*

5. The EA would also refer to the 1997 case of *Mid Kent Water plc ('MKW') v Secretary of State for the Environment* (McCullough J, March 1997) which involves a licence refused by the EA's predecessor, the National Rivers Authority.

6. The Court held as follows:

    i. *The licensing decision called for a decision about what the public interest required, with the balancing of a variety of competing factors: the risk that harm would result from granting the licence was one such factor. The greater the risk and the greater the degree of harm which might be caused the more weight would attach to the risk (at p10). Even a relatively slight risk of significant harm would be a material consideration (p13). Also relevant, and tending the other way, would be the extent and likelihood of any benefit the grant of a licence would yield (p10).*

    ii. *In order to grant the licence variation, the Inspector needed to be satisfied that 'no unacceptable risk of harm would result' (p12).*

iii. *The Inspector's approach – that the greater the potential harm, the stronger should be the evidence that it would not occur (and the evidence of need) was exactly the right approach (p13) in the light of the precautionary principle (p12).*

iv. *Thus, although the language of burden and standard of proof was not apposite (because this was a question of balancing all relevant factors in order to determine what was in the public interest), the Inspector had not erred in his approach (p13).*

v. *While adherence to the precautionary principle might also have been met by the grant of a time-limited licence (because of the uncertainty about the effects of the abstraction sort), that did not undermine the lawfulness of the decision in fact reached (of refusing the licence variation) (p13). (Thus, there was here a range of options potentially satisfying the precautionary principle.)*

7. The application of the precautionary principle is considered in European law. The leading ECJ case is Case C-127/02 *Waddenzee* (ECJ, 7 September 2004), which has been followed in numerous other cases. In that case, the ECJ considered the test to be applied under Article 6(3) of the [Habitats] Directive when establishing the absence of adverse effects. It held

   a. *That it was clear that the authorisation criterion laid down in Article 6(3) integrated the precautionary principle [58].*

   b. *That an activity could be authorised under Article 6(3) only where it was 'certain' that it would not adversely effect the integrity of the site, and that would be the case only where 'no reasonable scientific doubt remain[ed] as to the absence of such effects' [59].*

8. In relation to the lamprey, they are a feature of interest in the SAC.

9. In a recent case in the ECJ (Case C-77/09, *Gowan* (22 December 2010)), the Second Chamber held as follows [75-78]:

> *"A correct application of the precautionary principle presupposes, first, identification of the potentially negative consequences for health of the proposed use of the substance at issue, and, secondly, a comprehensive assessment of the risk to health based on the most reliable scientific data available ..*

Where it proves to be impossible to determine with certainty the existence or extent of the alleged risk because of the insufficiency, inconclusiveness or imprecision of the results of studies conducted, but the likelihood of real harm to public health persists should the risk materialise, the precautionary principle justifies the adoption of restrictive measures, provided they are non-discriminatory and objective.

3 August 2012